Trio Motion Technology
Motion Coordinator

Technical Reference Manual

Sixth Edition • 2008

Revision 6.7

All goods supplied by Trio are subject to Trio's standard terms and conditions of sale.

This manual applies to systems based on the *Motion Coordinator* MC302X with system software 1.94 or higher, MC206X, Euro 205x, Euro209 and MC224 with system software version 1.94, or higher. For information about MC202, MC216 and system software versions before 1.94, please refer to revision 6.6 of this manual.

The material in this manual is subject to change without notice. Despite every effort, in a manual of this scope errors and omissions may occur. Therefore Trio cannot be held responsible for any malfunctions or loss of data as a result.

Revision 6.7 July 2008

Copyright (C) 2000-2008 Trio Motion Technology Ltd.

All Rights Reserved

UK

Trio Motion Technology Ltd.
Shannon Way
Tewkesbury
GL20 8ND
United Kingdom

Phone: +44 (0)1684 292333
Fax: +44 (0)1684 297929

USA

Trio Motion Technology LLC.
1000 Gamma Drive, Suite 206
Pittsburgh
PA 15238,
USA

Phone: +1 412 968 9744
Fax: +1 412 968 9746

CHINA

Trio Shanghai
Tomson Centre
188 Zhang Yang Road, B1602,
Pudong New Area, Shanghai,
200122, CHINA

Tel/Fax: +86-21-58797659

SAFETY WARNING

During the installation or use of a control system, users of Trio products must ensure there is no possibility of injury to any person, or damage to machinery.

Control systems, especially during installation, can malfunction or behave unexpectedly. Bearing this in mind, users must ensure that even in the event of a malfunction or unexpected behaviour the safety of an operator or programmer is never compromised.

CONTENTS

INTRODUCTION 1-1
Setup and Programming 1-4
Products 1-5
System Building 1-12
System Examples 1-13
Features and Typical Applications 1-16
The Trio Motion Technology Website 1-17
HARDWARE OVERVIEW 2-1
Motion Coordinator MC302X 2-2
Connections to the MC302X 2-2
MC302X - Feature Summary 2-9
Motion Coordinator Euro205x 2-10
Axis Configuration 2-11
Connections to the Euro 205x 2-12
Euro 205x Backplane Connector 2-13
Euro205x - Feature Summary 2-19
Motion Coordinator Euro209 2-20
Axis Configuration 2-21
Connections to the Euro 209 2-22
Euro 209 Backplane Connector 2-23
Euro209 - Feature Summary 2-29
Motion Coordinator MC206X 2-30
Connections to the MC206X 2-32
Amplifier Enable (Watchdog) Relay Output 2-35
Reference Encoder Input 2-36
Universal Serial Bus 2-36
MC206X - Stepper Outputs / Encoder Inputs 2-37
MC206X - Feature Summary 2-38
Motion Coordinator MC224 2-40
Connections to the MC224 2-43
MC224 - Feature Summary 2-48
INSTALLATION 3-1
Motion Coordinator MC302X 3-3
Motion Coordinator Euro 205x 3-5
Motion Coordinator Euro 209 3-6
Motion Coordinator MC206X 3-7
Motion Coordinator MC224 3-8

EMC Considerations 3-10
Installation Requirements to Ensure Conformance 3-12
Motion Coordinator MC302X 3-12
Motion Coordinator Euro205x 3-12
Motion Coordinator Euro209 3-13
Motion Coordinator MC206X 3-14
Motion Coordinator MC224 3-14
DAUGHTER BOARDS 4-1
Fitting and Handling Daughter Boards 4-4
MC224 + Axis Expander Slot Sequence 4-6
Fitting Daughter Boards to the Euro205x and Euro209 4-7
Fitting Daughter Boards to the MC206X 4-9
Enhanced Servo Encoder Daughter Board 4-11
Servo Encoder Daughter Board 4-14
Servo Resolver Daughter Board 4-15
Reference Encoder Daughter Board 4-17
Analogue Input Daughter Board 4-19
Stepper Daughter Board 4-20
Stepper Encoder Daughter 4-22
Hardware PSWITCH Daughter Board 4-24
Analogue Output Daughter Board 4-25
SSI Servo Encoder Daughter Board 4-26
Differential Stepper Daughter Board 4-29
CAN Daughter Board 4-31
Enhanced CAN Daughter Board 4-32
SERCOS Daughter Board 4-33
SLM Daughter Board 4-34
USB Daughter Board 4-36
Ethernet Daughter Board 4-37
Profibus Daughter Board 4-38
Ethernet IP Daughter Board 4-39
EXPANSION MODULES 5-1
Input/Output Modules 5-3
CAN 16-I/O Module (P316) 5-3
CAN Analog Inputs Module (P325) 5-12
Operator Interfaces 5-16
Membrane Keypad (P503) 5-17
Mini-Membrane Keypad (P502) 5-20
Programming the Membrane Keypad 5-21
Keypad KEY ON - KEY OFF Mode 5-25

FO-VFKB Fibre Optic Keypad/Display Interface (p504) 5-26
Serial to Fibre-Optic Adapter (P435) 5-28
SD Card Adaptor (P396) 5-29

SYSTEM SETUP AND DIAGNOSTICS 6-1
Preliminary Concepts 6-3
System Setup 6-3
Preliminary checks 6-4
Checking Communications and System Configuration 6-4
Input/Output Connections 6-6
Setting Servo Gains 6-8
Proportional Gain 6-10
Integral gain 6-10
Derivative gain 6-10
Output Velocity Gain 6-11
Velocity Feed Forward Gain 6-11
Diagnostic Checklists 6-13

PROGRAMMING 7-1
What is a program? 7-3
Sequence 7-4
Selection 7-5
Iteration 7-5
Controller Functions 7-7
Identifiers 7-7
Expressions 7-8
Parameters 7-10
Command Line Interface 7-14

TRIO BASIC COMMANDS 8-1
Motion and Axis Commands 8-13
Input / Output Commands 8-91
Program Loops and Structures 8-111
System Parameters and Commands 8-121
Mathematical Operations and Commands 8-192
Constants 8-209
Axis Parameters 8-211

PROGRAMMING EXAMPLES 9-1
Example Programs 9-3

SUPPORT SOFTWARE 10-1
Motion Perfect 2 10-3
System Requirements: 10-4

Connecting *Motion* Perfect to a controller 10-5
Motion Perfect 2 Projects 10-6
Project Check Window 10-6
Project Check Options 10-7
The *Motion* Perfect Desktop 10-10
Main Menu 10-11
Controller Menu 10-12
Controller Configuration 10-14
CAN I/O Status 10-15
Ethernet Configuration 10-16
Feature Enable 10-17
Flashstick support 10-19
Memory Card Support 10-20
Loading New System Software 10-21
Lock / Unlock 10-23
Motion Perfect Tools 10-24
Terminal 10-25
Axis Parameters 10-26
Oscilloscope 10-29
Keypad Emulation 10-38
Table / VR Editor 10-40
Jog Axes 10-41
Digital IO Status 10-44
Analogue Input Viewer 10-46
Linking to External Tools 10-47
Control Panel 10-49
Creating and Running a program 10-54
The *Motion* Perfect Editor 10-55
Editor Menus 10-58
Program Debugger 10-61
Running Programs 10-64
Making programs run automatically 10-66
Set Powerup Mode 10-66
Storing Programs in the Flash EPROM 10-67
Configuring The *Motion* Perfect 2 Desktop 10-68
Communications 10-68
Editor Options 10-71
General Options 10-71
CAN Drive Options 10-72
Diagnostics 10-72
Terminal Font 10-72

Program Compare 10-73
CX-Drive Configuration 10-73
FINS Configuration 10-73
Saving the Desktop Layout 10-73
Running *Motion* Perfect 2 Without a Controller 10-75
MC Simulation 10-75
Project Encryptor 10-79
Introduction 10-79
Encryption Process 10-79
Encrypting a Project 10-79
CAD2Motion 10-83
DocMaker 10-84
AUTO LOADER AND MC LOADER ACTIVEX 11-1
Project Autoloader 11-3
Files 11-4
Running the program 11-5
Script Commands 11-6
Script File 11-15
MC Loader 11-16
Installation of the MC Loader Component 11-16
Properties 11-17
Methods 11-22
USING THE PC MOTION ACTIVEX CONTROL 12-1
Introduction 12-3
Requirements 12-3
Installation of the ActiveX Component 12-3
Using the Component 12-3
Connection Commands 12-4
Properties 12-7
Motion Commands 12-9
Process Control Commands 12-18
Variable Commands 12-19
Input / Output Commands 12-22
General commands 12-28
Events 12-30
TrioPC status 12-31
COMMUNICATIONS PROTOCOLS 13-1
MODBUS RTU 13-3
Introduction 13-3

Initialisation and Set-up 13-3
Modbus Technical Reference 13-4
Glossary 13-7
Profibus 13-8
Installation and Set-up 13-8
DeviceNet 13-13
Installation and Set-up 13-13
DeviceNet Information 13-13
Connection Types Implemented 13-14
DeviceNet Objects Implemented 13-14
MC Object 13-20
DeviceNet Status LEDs 13-25
Ethernet 13-26
Default IP Address 13-26
The Subnet Mask 13-27
Connecting to the Trio Ethernet Daughter Board 13-28

FIBRE-OPTIC NETWORK 14-1
General Description 14-3
Connection of Network 14-4
Network Programming 14-6
Examples of network programming 14-8
Network Specification 14-12

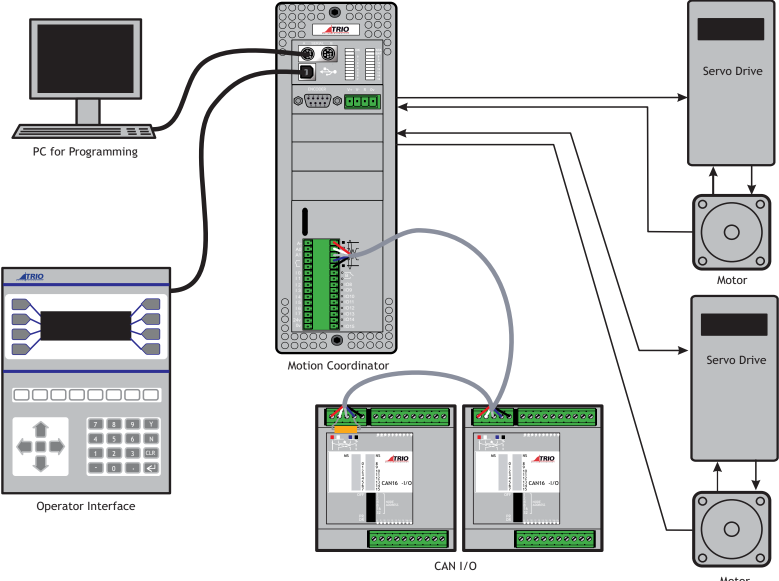
REFERENCE 1-1
ATYPE 1-3
COMMSTYPE 1-5
AXISSTATUS / ERRORMASK 1-6
CONTROL 1-7
Communications Ports 1-7
Communications Errors 1-8
MTYPE 1-9
NETSTAT 1-10
Data Formats and Floating-Point Operations 1-11
Single-Precision Floating Point Format 1-11
Product Codes 1-12

CHAPTER

1

INTRODUCTION

Trio Motion Technology's range of *Motion* Coordinator products are designed to enable the control of industrial machines with a minimum of external components. The products may be combined to build a control system capable of driving a multi-axis machine and its auxiliary equipment. The *Motion* Coordinator system described in this manual allows you to control up to 24 servo or stepper motors, Digital I/O and additional equipment such as keypads and displays from a single master. Up to fifteen masters can be networked together using the Trio fibre optic network allowing up to 360 axes of control. The controller is programmed using the *Trio* BASIC programming language. This may be used to build stand-alone programs or commands can be sent from an external computer.

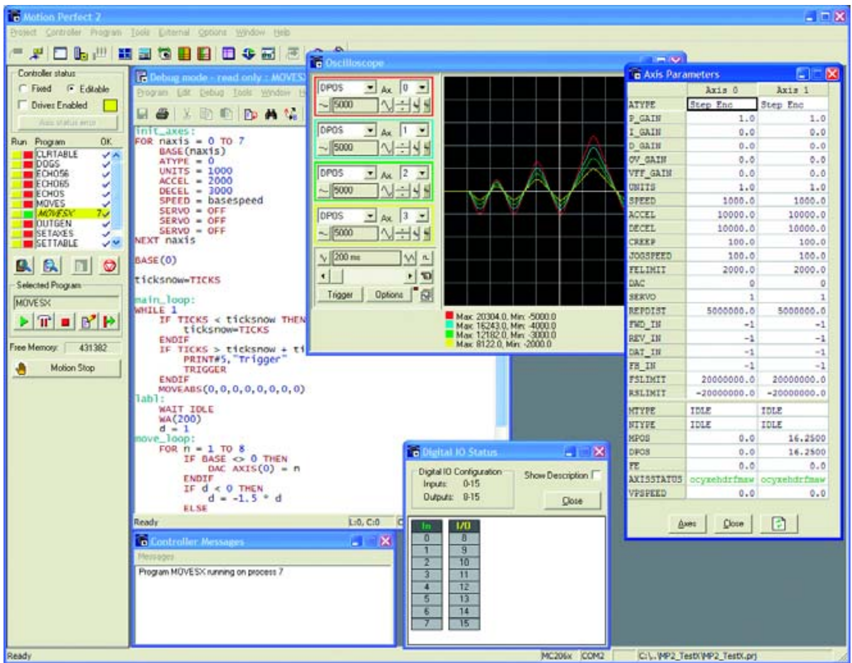


Typical System Configuration

The *Motion* Coordinator system is modular, allowing the user to tailor the controller to their specific needs, but also allowing the flexibility to incorporate new modules if needs should change.

Setup and Programming

To program the *Motion* Coordinator a PC is connected via an RS-232, USB serial or Ethernet link. The dedicated *Motion* Perfect program is normally used to provide a wide range of programming facilities, on a PC running Microsoft Windows 2000, XP or Vista 32bit versions.



Motion Perfect 2

Once connected to the *Motion* Coordinator, the user has direct access to *Trio* BASIC, which provides an easy, rapid way to develop control programs. All the standard program constructs are provided; variables, loops, input/output, maths and conditions. Extensions to this basic instruction set exist to permit a wide variety of motion control facilities, such as single axis moves, synchronized multi axis moves and unsynchronised multi axis moves as well as the control of the digital I/O.

The *Motion* Coordinator range described in this manual currently consists of the MC302X, MC206X, Euro 205x, Euro209 and MC224. The MC464 is not covered here, but will be described separately. These controllers feature multi-tasking BASIC. Multiple *Trio* BASIC programs can be constructed and run simultaneously to make programming complex applications much easier.

Products

The range of Trio *Motion* Coordinator products covered by this manual:

Motion Coordinator Master Controllers

Product Code	Name	Description
P192	MC302X	Compact, low cost DIN-rail mounting module features 1 1/2 servo or 2 stepper axes. 4 Opto-isolated Inputs and 4 Opto-isolated I/O channels are built in user serial support RS232/RS485. Multi-tasking *Trio* BASIC. I/O CANbus expansion.
P136	MC206X	Low cost, high performance DIN-rail mounting controller for 1-8 axes with additional daughter board. 8 Opto-isolated Inputs and 8 Opto-isolated Input/Output channels,1 Opto-isolated analogue input, USB and memory stick socket are built in. Multi-tasking *Trio* BASIC. I/O CANbus expansion.
P151	Euro 205x	For OEM applications, Trio offer a 3U Eurocard format controller featuring 4 onboard axes plus the option for a further axis via a standard Trio daughter board. 16 Opto-isolated Inputs and 8 Opto-isolated Output channels are built in. Multi-tasking *Trio* BASIC. I/O CANbus expansion.
P159	Euro 209	For OEM applications, Trio offer a 3U Eurocard format controller featuring 8 onboard axes plus the option for a further axis via a standard Trio daughter board. 16 Opto-isolated Inputs and 8 Opto-isolated Output channels are built in. Multi-tasking *Trio* BASIC. I/O CANbus expansion. *Motion* Perfect programming via Ethernet ports.
P170	MC224	Flexible high performance master controller for 1-24 axes. 8 Opto-isolated Inputs and 8 Opto-isolated Input/Output channels, 2 Opto-isolated analogue inputs, USB and memory stick socket are built in. Multi-tasking *Trio* BASIC. I/O CANbus expansion.

Daughter Boards

The Daughter Board concept is a one of the key features which give the *Motion* Coordinator system enormous flexibility in its configuration.

The Daughter Boards provide the interface to many types of Servo or Stepper Axes, plus a number of advanced communications options as well.

There are 19 types of daughter boards currently available:

Product Code:	Name	Description
P200 / P201	Servo Encoder	**+/- 10v Output, Differential Encoder Input plus Hardware Registration Input** The Servo Encoder daughter board provides the interface to a DC or Brushless servo motor fitted with an encoder or encoder emulation.
P210	Servo Resolver	**+/- 10v Output, Resolver Input plus Hardware Registration Input** The Servo Resolver daughter board provides the interface to a DC or Brushless servo motor fitted with a resolver. The resolver port provides absolute position feedback within one motor turn.
P220	Reference Encoder	**Differential Encoder Input plus Hardware Registration Input** The Encoder daughter board provides an encoder input without any servo feedback facility for measurement, registration and synchronization functions on conveyors, drums, flying shears, etc.
P225	Analog Inputs	**8 x 0 to 10 Volt Analogue Inputs** The Analog Inputs daughter board has 8 x 16 bit inputs for use as general analog input channels or as feedback for up to 8 axes. When used for feedback, the A to D is synchronised to the SERVO_PERIOD.

Product Code:	Name	Description
P230	Stepper	**Open-collector Step, Direction, Boost and Enable outputs** The Stepper daughter board generates pulses to drive an external stepper motor amplifier. Single step, half step and micro-stepping drives can be used with the board.
P240	Stepper Encoder	**Open-collector Step, Direction, Boost and Enable outputs plus Differential Encoder Input.** The Stepper Encoder daughter board with position verification has all the features of the simpler stepper daughter board. Position verification is added to a stepper axis by providing encoder feedback to check the position of the motor.
P242	Hardware Pswitch	**Differential Encoder Input** **plus Hardware Position Switch Outputs** The Hardware PSWITCH daughter board allows 4 open-collector outputs to be switched ON and OFF at programmed positions. This function is similar to the PWITCH command which is implemented in the system software and allows outputs to be switched ON and OFF over defined position sectors. The Hardware PSWITCH daughter board performs the position comparison in electronic hardware on the daughter board. This allows the pulses generated to be very accurately timed.
P260	Analogue Output	**+/- 10v Output with direct DAC control** The Analogue Output daughter board provides a 12 bit +/-10v voltage output for driving inverters and other devices. The board is a simplified servo daughter board and the connections are similar.
P270	SSI Absolute Servo	**+/- 10v Output, Differential Encoder Input** **plus Hardware Registration Input** The SSI daughter board provides the interface to a DC or Brushless servo motor fitted axis with an absolute encoder using the Synchronous Serial Interface (SSI).

Product Code:	Name	Description
P280	Differential Stepper	**Differential Line Driver outputs for Step, Direction, Boost and Enable, plus Hardware Registration Input** The Differential Stepper daughter board is a stepper daughter board with the output signals provided as differential 5 volt signals on a 15 way 'D' connector. The daughter board does not feature an encoder port for position verification, but does have a registration input to allow for capture of the number of step pulses when a registration signals arrives.
P290 / P293	CAN	**Digital Link to CANBus drives** The CAN daughter board provides synchronous control of up to four axes using the CanOpen protocol. Alternatively, it can be set up as a DeviceNet slave node, or may use the can directly from Trio Basic.
P291	SERCOS	**Digital Link to SERCOS drives** The SERCOS daughter board provids digital control to appropriate servo drives via a Fibre Optic loop. Up to 8 axes can be connected to each P291, which allows the MC224 to control up to 24 axes.
P292	SLM	**Digital Link to SLM drives** The SLM daughter board is aimed at providing digital control channels for servo drives utilising the SLM protocol.
P295	USB Interface	**Universal Serial bus interface for high-speed PC communications** The USB daughter board provides a high speed interface between the Euro205x and Euro 209 and a host PC fitted with a USB port. Support for this high speed interface is included in Trio's *Motion*Perfect 2 application and software libraries allow developers to support the interface within their own programs.

Product Code:	Name	Description
P296	Ethernet	**10 base-T Ethernet interface for TCP/IP networks** The Ethernet daughter board provides a very high speed interface between the *Motion* Coordinator and a host PC fitted with an Ethernet port. Support for Ethernet is included in Trio's MotionPerfect 2 application and software libraries allow developers to support the interface within their own programs. In addition to this, support for Modbus TCP is included on the board..
P297	Profibus	**Profibus Fieldbus Interface** With the Profibus Daughter Board and appropriate software on the *Motion* Coordinator, it is possible to connect to external devices using the Profibus protocol.
P298	Ethernet IP	**Ethernet IP interface** Adds 1 channel of Ethernet IP server for connection to PLC's and other devices supporting Ethernet Common Industries Protocol (CIP).

Custom Daughter Boards

Trio can produce custom daughter boards for specific customer applications where required.

I/O Expansion options

Prod. Code	Name	Description
P316	**CAN 16 IO**	DIN Rail mounted 24v I/O expander module provides 16 opto-isolated channels each of which may be used as an Input or an Output.
P325	**CAN Analog Inputs**	DIN Rail mounted +/- 10v Analog Input module provides 8 opto-isolated channels.
P301	**Axis Expander**	Expansion module provides housing for up to 4 additional axis daughter boards. Up to 3 connect to the MC224 and MC224.

P316 - CAN-16 I/O

P325 - CAN-8 Analog Inputs

MC224 and the P301 Axis Expander

Operator Interfaces

Name	Name	Description
P502	Mini-Membrane Keypad	Compact operator keypad/display
P503	Membrane Keypad	High performance general purpose operator key-pad/display

System Building

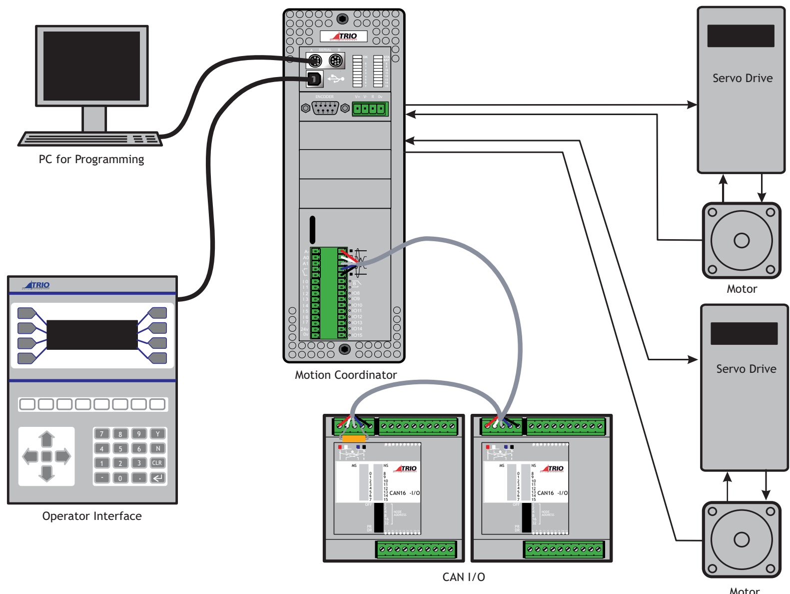
The modules and boards may be mixed within the system rules:

1) Every system must start with one *Motion* Coordinator master unit as this contains the processor and logic power supply for the system.

2) The MC224 master unit can house up to 4 daughter boards. The Euro 205x, Euro 209 and MC206X will accept a single daughter board. These can be of any type.

3) The MC224 can have up to 3 axis expander modules added to house up to 16 daughter boards. 4 being housed in the Master and 4 in each of the axis expanders.

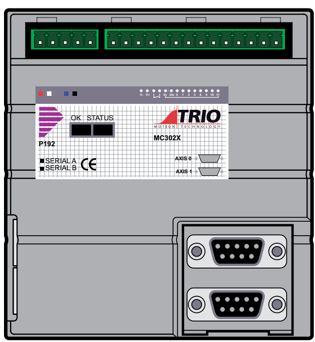
4) Up to 16 CAN-16 I/O and 4 CAN Analog Input modules can be connected to any *Motion* Coordinator.



Typical System Configuration

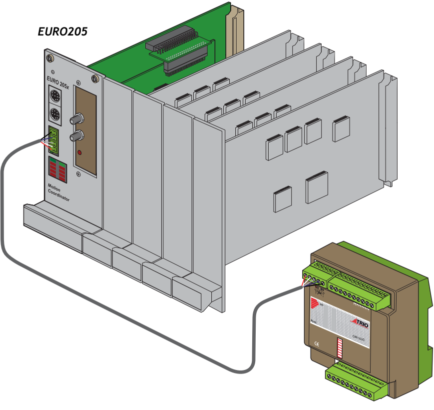
System Examples

Example 1 Simplest Possible System - Single MC302X



- 1½ Axis Servo (Servo + reference encoder) or 2 Axis Stepper
- 8 Channels of 24v I/O on board
  - 4 Inputs
  - 4 I/O

Example 2 Euro205x, 5 Axis Rack mounted System



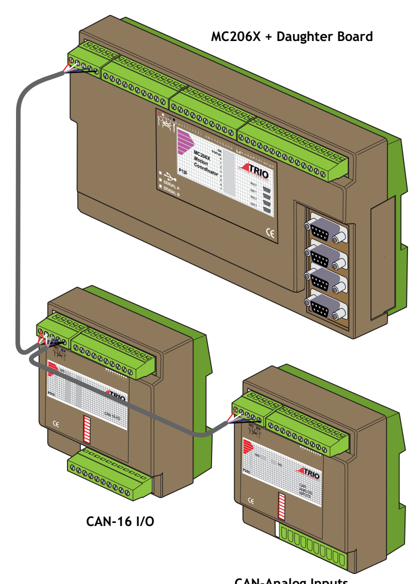
The Euro 205x controller provides a compact rack-mounted controller ideal for volume OEM applications.

The four internal axes are configured as stepper axes and connected via the backplane to third party stepper drives.

An optional P200 Servo Daughter Board provides a fifth axis connected to a servo drive.

- 5 servo axes
- 40 Channels of 24v I/O
  - 16 in + 8 out on Euro205x, plus
  - 16 I/O on CAN-16 I/O expander

Example 3 MC206X - 5½ Axis Servo System

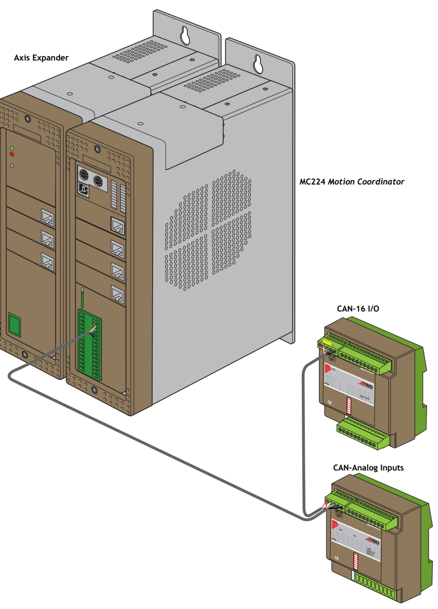


Utilising the four internal axis as servo axes, an optional servo daughter board and the reference encoder input to provide a total of 5 servo axes plus the reference (master) encoder.

The MC206X has 16 channels of 24v I/O as standard, this is expanded up to 32 channels with the addition of a CAN-16 I/O module. 8 Analog Inputs (+/- 10v) are provided by the CAN Analog Inputs module.

- 5 servo / stepper axes
- 32 Channels of 24v I/O
  - 8 in + 8 I/O on MC206, plus
  - 16 I/O on CAN-16 I/O expander
- 8 Analogue Input Channels

Example 4 MC224 - 7 Axis System



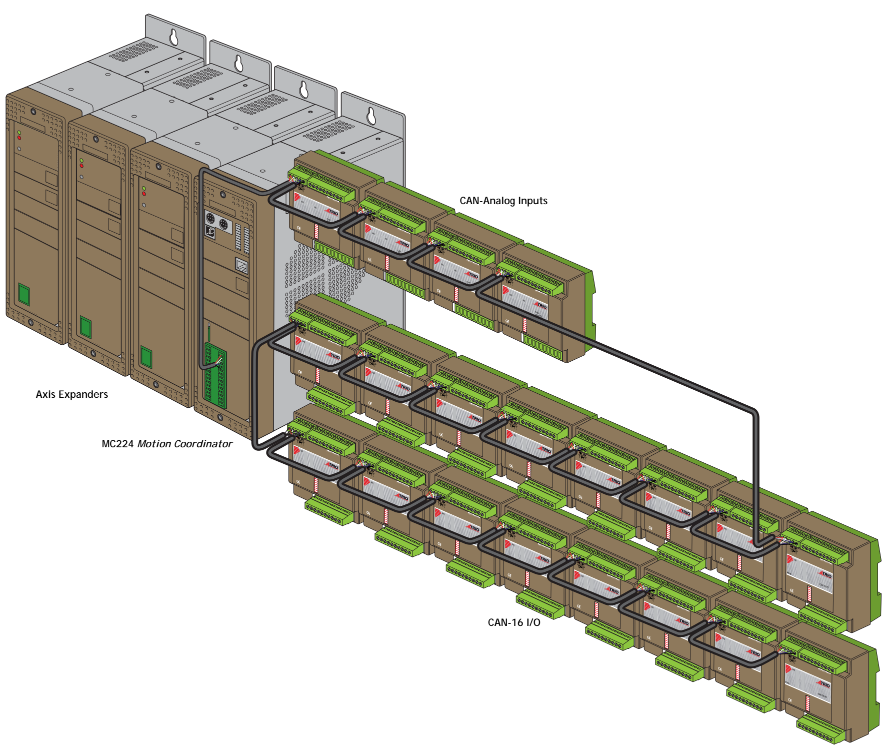
The system comprises an MC224 Master with and additional three axes in the optional Axis Expander module. The axes can be any combination of servo and stepper drives determined by the daughter boards used.

The MC216 has 16 channels of 24v Digital I/O as standard, this is expanded up to 32 with the addition of a CAN-16 I/O module. 8 Analog Inputs (+/- 10v) are provided by the CAN Analog Inputs module.

- 7 axes
  - 4 on MC2224 Master, plus
  - 3 on Axis Expander
- 32 Channels of 24v I/O
  - 8 in + 8 I/O on MC204, plus - 16 I/ O on CAN-16 I/O expander
- 8 Analogue Input Channels

Example 5 MC224 - 16 axis system with maximum I/O expansion

The example system illustrated below shows an MC224 controller with the maximum possible I/O expansion. Applications for a system of this complexity might include collating or packaging machinery where there are multiple operations performed on a product and many I/O are used for sensors etc.



- 16 Axes (Any type)
- 272 Channels of 24v I/O
  - 8 in + 8 I/O on MC224, plus
  - 256 I/O (16 * 16) on the 16 CAN-16 I/O modules
- 32 Analogue Input Channels (8 per module)

Features and Typical Applications

Trio BASIC contains accurate motion control functions for the generation of complex movements of various types, including:

- Linear interpolation of up to 24 axes
- Circular and helical interpolation
- Variable speed and acceleration profiles
- Electronic gearboxes
- Electronic cam profiles

The operator interface may be achieved by any combination of the following:

- Dedicated host computer (connected via USB, Ethernet or RS-232 serial port)
- Membrane Keypad with Vacuum Fluorescent Display
- Dedicated Operator Panel using the'Modbus' serial protocol.
- Switches / Thumbwheels
- Status lamps

The system is able to control a wide range of mechanisms and equipment including:

- Brushless servo motors
- Stepper motors
- Brushed DC servo motors
- Hydraulic servo valves
- Hydraulic proportional valves
- Pneumatic/hydraulic solenoids
- Relays/contactors

Typical applications:

- Cut to length
- Flying shears
- Glue laying
- Web control
- Tension control
- Pick & Place
- Coil winding
- Laser guidance
- Electronic assembly
- Printing
- Collating
- Packaging
- Automotive welding
- Spark erosion
- Drilling
- Milling
- YOUR application

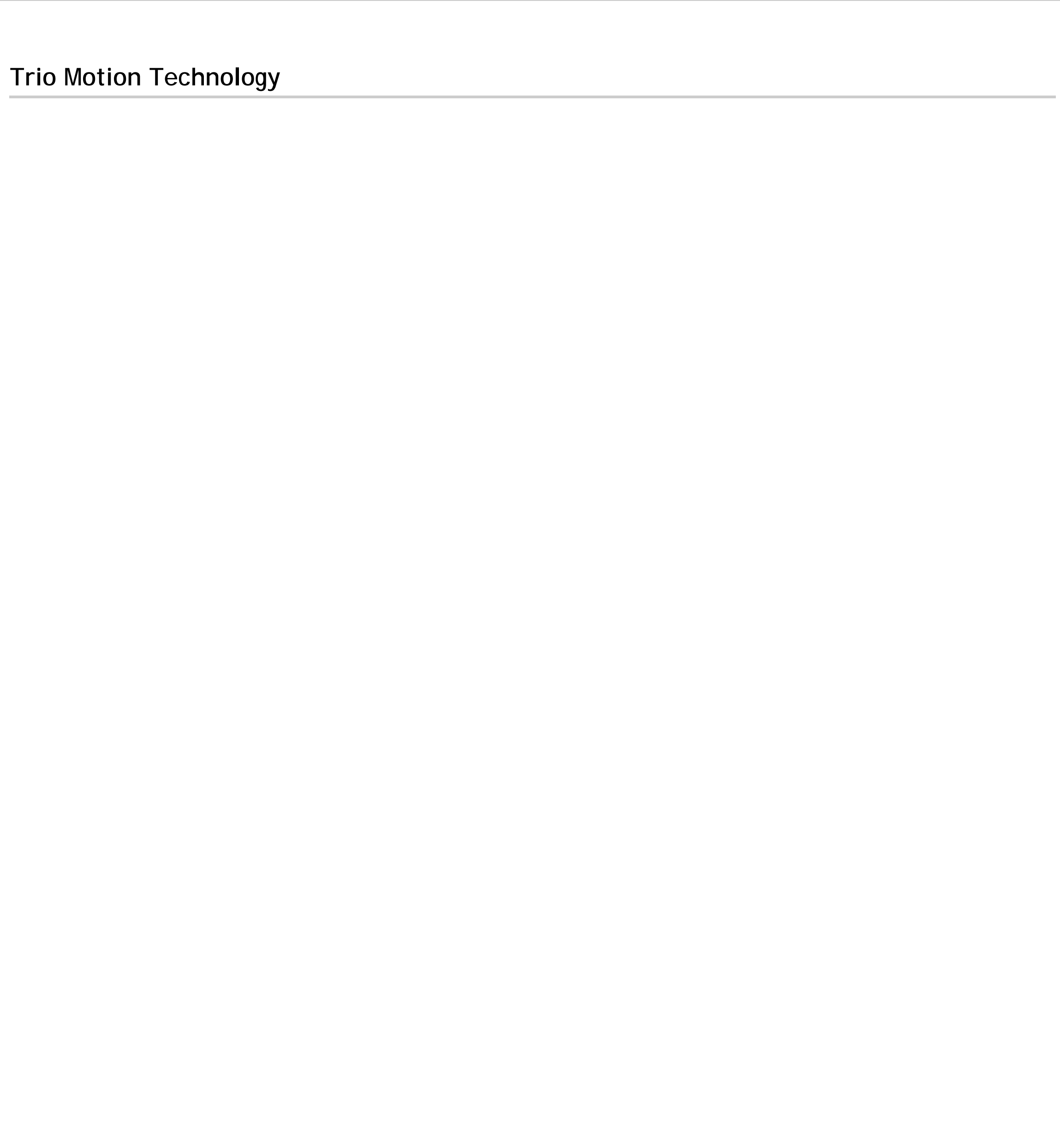
The Trio Motion Technology Website

The Trio website contains up to the minute news, information and support for the *Motion* Coordinator product range.

Website Features

- Latest News
- Product Information
- Manuals
- Support Software
- System Software Updates
- Technical Support
- User's Forum
- Application Examples
- Employment Opportunities

WWW.TRIOMOTION.COM



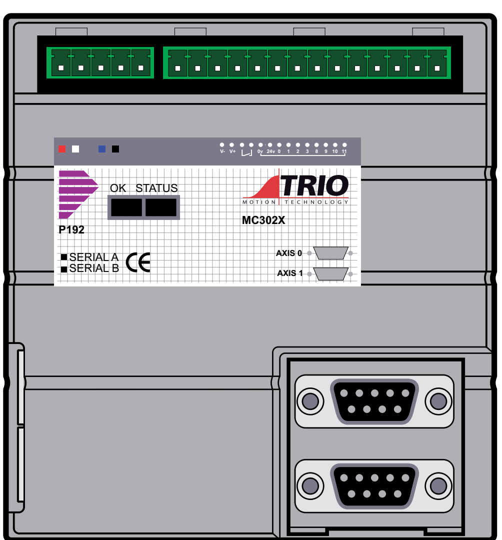
CHAPTER

2

HARDWARE OVERVIEW

Motion Coordinator MC302X

Overview



The MC302X is a miniature stepper/servo positioner with the built-in ability to control one servo/stepper axis with additional synchronisation encoder, or two stepper axes.

The MC302X is designed to provide a compact, low cost, easy to use unit for OEM machine builders.

It is designed to be configured and programmed for the application with a PC running the *Motion* Perfect application, and then may be set to run “standalone” if an external computer is not required for the final system.

Programming

The Multi-tasking ability of the MC302X allows parts of a complex application to be developed, tested and run independently, although the tasks can share data and motion control hardware. On the MC302X up to 3 Trio BASIC programs can be run simultaneously.

I/O Capability

The MC302X has 4 built in 24v inputs and 4 built-in bi-directional input/output channels. These may be used for system interaction or may be defined to be used by the controller for end of travel limits, datuming and feedhold functions if required.   The MC302X can have up 256 external Input/Output channels and up to 32 analogue input channels connected using DIN rail mounted I/O modules. These units connect to the built-in CAN channel of the MC302X

Communications

The MC302X has a built-in RS-232 programming port. A further serial channel is available at both RS-232 and RS485 levels. RS-232 port #1, or RS-485 port #1 may be configured to run the MODBUS protocol for PLC or HMI interfacing.

If the built-in CAN connection is not being use to for I/O modules it may be used for CAN communications.

Connections to the MC302X

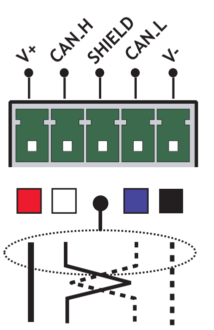
Wiring

All wires and cables should be of suitable size and type for the signals carried and the operating environment.

Suitable wires would include multi-core screened cable for encoder feedback and the serial links. The analogue output from the MC302X (if used) should be connected to the servo drive via a screened twisted pair. Drive enable outputs and 24v inputs do not have a large current requirement so the choice of wire is not critical.

Connectors

Top 5-Way Connector



This is a 5 way 3.81mm pitch connector. The connector is used both to provide the 24 Volt power to the MC302X and provide connections for I/O expansion via Trio's P316 and P325 CAN I/O expanders. 24 Volts must be provided as this powers the unit.

This 24 Volt input is internally isolated from the I/O 24 volts and the +/-10V voltage output. The MC302X has internal power supply filters for the 24v power supply. This supply should be isolated and independent from the I/O 24V.

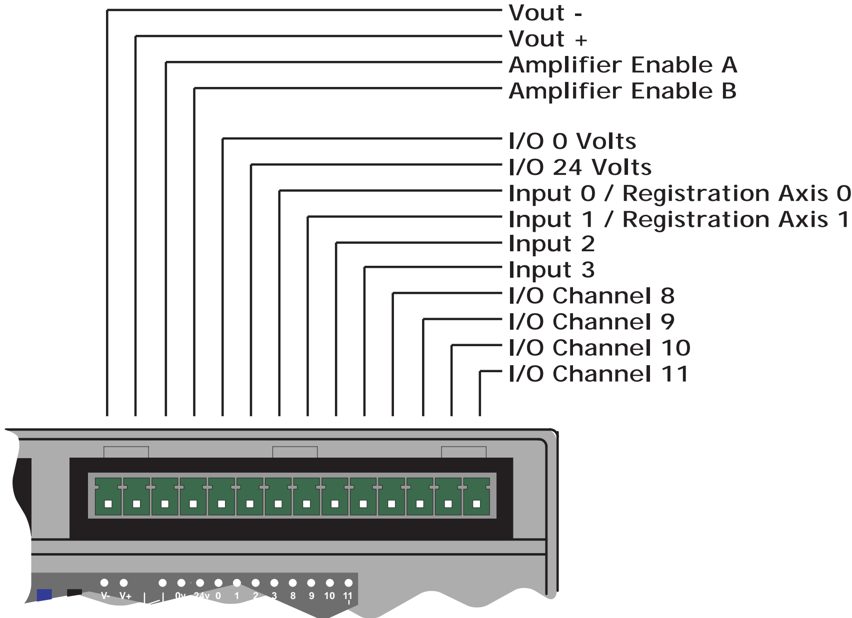
Note: *The CAN connections are optional, although the CAN Shield pin must be connected to Earth in all cases.*

The V+(24V) and V- MUST be connected as this powers the MC302X.

Power supply: 24V dc, Class 2 transformer or power source.

Top 14 Way Connector:

This is a 14 way 3.81 pitch connector. The connector provides for the +/-10Vvolt analogue output, the enable relay contacts, and the I/O connections.



Analogue Output

This feature when required is used to drive a servo drive or inverter connected to axis 0. The +/-10 Volt analogue output is isolated from the power input and the I/O modules of the MC302X and is powered via an internal DC-DC converter. The pair of connections should be connected by a screened cable to the drive input.

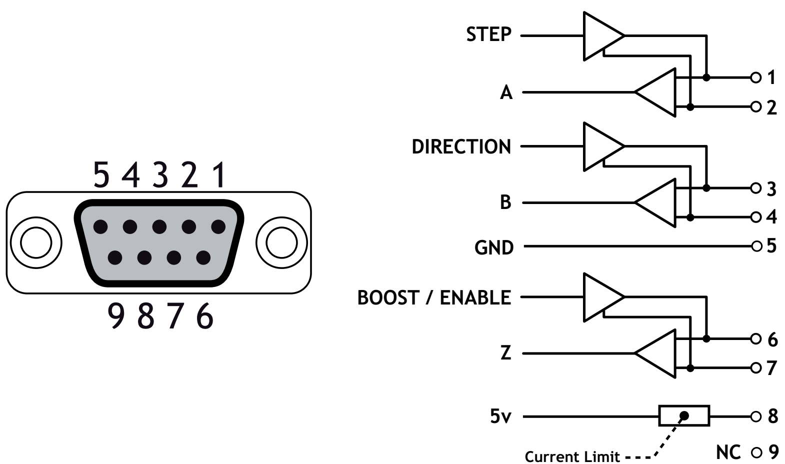
The drive enable pins are used to interlock the MC302X with a servo OR stepper drive and should be used in all cases. The connections are internally connected to a volt-free normally open solid-state relay which closes to enable the drive(s).

I/O Power Inputs

The I/O 0 Volts and I/O 24 Volts are used to power the 24 Volt inputs and outputs. The I/O connections are isolated from the module power inputs on the 5-way CAN connector. The I/O 0 Volts connection must be made if any inputs or outputs are used. The I/O 24 Volts is only required to power outputs and may be omitted if none are used. The I/O channels 8 to 11 are bi-directional and can be used either as an input or an output. They are numbered from 8 to 11 for greater compatibility with other Trio *Motion Coordinator*s. The inputs channels 0 to 3 are not bi-directional. Inputs 0 and input 1 can be used as registration inputs for axes 0 and 1 for use with the **REGIST** command.

Stepper Outputs/Encoder Inputs:

There are 2 x 9 pin D-type connectors which provide for 2 axes of 5V differential encoder inputs, 2 axes of step and direction outputs and a 5 Volt output for powering external encoder only.



Pin	Servo Axis	Stepper Axis
1	Enc. A	Step +
2	Enc. /A	Step -
3	Enc. B	Direction +
4	Enc. /B	Direction -
5	GND	GND
6	Enc. Z	Boost +
7	Enc. /Z	Boost -
8	5V	5V
9	Not Connected	Not Connected
shell	Screen	Screen

The function of the 9-pin 'D' connectors will be dependant on the specific axis configuration which has been defined. If the axis is setup as a servo, the connector will provide the encoder input. If the axis is configured as a stepper, the connector provides differential outputs for step/direction and boost/enable signals.

Special Stepper and Encoder Modes:

Either axis 0 or axis 1 can be put into a special mode to enable both stepper output and encoder input on the same axis. This allows the MC302X programmer to emulate most of the earlier MC202 axis configurations.

Atype Axis (0)=46 (Stepper encoder with external encoder input)
Atype Axis(1)=1 (stepper)

Pin	Axis 0 D-type	Pin	Axis 1 D-type
1	Step_0+	1	Step_1+
2	Step_0-	2	Step_1-
3	Direction_0+	3	Direction_1+
4	Direction_0-	4	Direction_1-
5	GND	5	GND
6	Enc. A0	6	Enc. B0
7	Enc. /A0	7	Enc. /B0
8	5V	8	5V

Atype Axis (1)=46 (Stepper encoder with external encoder input)
Atype Axis(0)=3 (encoder)

Pin	Axis 0 D-type	Pin	Axis 1 D-type
1	Enc A0	1	Enc A1
2	Enc /A0-	2	Enc /A1-
3	Enc B0	3	Enc B1
4	Enc /B0	4	Enc /B1
5	GND	5	GND
6	Step_1+	6	Direction_1+
7	Step_1-	7	Direction_1-
8	5V	8	5V

Note: *In the special mode there is no Z pulse or boost signal.*

Encoder Inputs:

When the axis type is set to **SERVO** or **ENCODER**, the D-type connector provides dedicated encoder inputs. The inputs are 5 Volt differential encoder inputs. The inputs must be connected to the encoder via a screened cable and the screen connected to the panel ground, and 0V wire connected to pin 5.

Encoder Power Supply:

Pins 8 and 5 provide a low power output at 5V (150mA maximum). This supply is provided for driving one or two encoders (if current consumption permits). The power supplies should be included within the encoder screened cable. Do not use the 0V as a screen ground point.

Stepper Outputs :

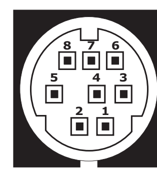
When the axis type is set to **STEPPER** or **STEPPER + ENCODER**, the connectors are used to provide stepper outputs. The outputs are 5 Volt differential line driver outputs and they must be connected to the stepper drive using screened cable with the screen connected to the panel ground, and the 0V wire to pin 5.

MC302X Serial Connections

The MC302X features a standard RS-232 serial port for programming (port 0), and an additional serial ports for external communications. The external communications Ports are available in both RS-232 (port 1) and RS-485 (port 2) standards.

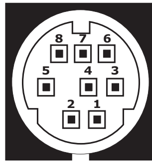
Note: *The MC302X uses high speed default setting in Motion Perfect.*

Serial Connector A:



Pin	Function	Note
1	Internal 5V	
2	Internal 0V	
3	RS232 Transmit	Serial Port #0
4	RS232 GND	
5	RS232 Receive	
6	Internal 5V	Serial Port #3 / #4
7	No Connection	
8	No Connection	
Note: Port 0 is the default programming port for connection to the PC running *Motion Perfect*.		

Serial Connector B:

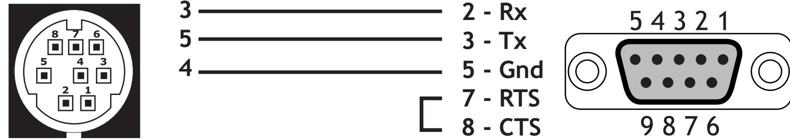


Pin	Function	Note
1	RS485 Data In A Rx+	Serial Port #1
2	RS485 Data In B Rx-	
3	RS232 Transmit	Serial Port #1
4	RS232 GND	
5	RS232 Receive	

Pin	Function	Note
6	Internal 5V	Serial Port #1
7	RS485 Data Out Z Tx-	
8	RS485 Data Out Y Tx+	

Serial Cables

Trio recommend the use of their pre-made serial cables (product code P350). If cables need to be made to connect to a PC serial port the following connections are required:



Motion Coordinator to 'AT' style PC with 9pin serial connector

MC302X - Feature Summary

Size	94 mm x 101 mm x 48mm Overall
Weight	200 g
Operating Temperature	0 - 45 degrees C
Control Inputs	Forward Limit, Reverse Limit, Datum Input, Feedhold Input.
Communication Ports	(1) RS232 Channel: 38400 baud. (1) RS-232/RS-485 serial Channel 38400 baud, (1) CAN channel.
Position Resolution	32 bit position count
Speed Resolution	32 bit. Speed may be changed at any time. Moves may be merged.
Interpolation modes	Linear 1-3 axes, circular, helical, CAM profiles, speed control, electronic gearboxes.
Programming	Multi-tasking Trio BASIC system, maximum 3 user tasks.
Servo Cycle	Programmable: 1ms, 500µs or 250µs.
Memory	512k user memory. Entire contents may be flashed to EPROM.
Power Input	24V dc, Class 2 transformer or power source. 18 … 29V dc at 90mA.
Amplifier Enable Output	Normally open solid state relay contact Maximum voltage 24Vdc @ 100mA.
Analogue Output	1 Isolated 16 bit +/- 10V
Registration Inputs	2. One per axis shared with inputs 0 to 1.
Encoder Power Output	5v at 150mA total for 2 encoders.
Encoder Inputs	2 axes, Differential 5V inputs, 6Mhz maximum edge rate.
Stepper Outputs	2 Differential Step / Direction outputs 2MHz Max Rate
Digital Inputs	4 Opto-isolated 24V inputs, 2 may be used for high speed registration
Digital I/O	4 Opto-isolated 24V outputs. Current sourcing (PNP) 250mA. (max. 1A per bank of 8)

Motion Coordinator Euro205x

Overview The *Motion Coordinator* Euro205x is a Eurocard stepper/servo positioners with the built-in ability to control up to 4 servo or stepper motors in any combination. In addition a single Trio Daughter Board may be fitted to allow the control of a fifth axis or communications channel. The Euro205x is designed to provide a powerful yet cost-effective control solution for OEM machine builders who are prepared to mount the unit and provide the power supplies required. It is designed to be configured and programmed for the application with Multi-tasking Trio BASIC using a PC, and then may be set to run "standalone" if an external computer is not required for the final system. The Multi-tasking version of Trio BASIC for the Euro205x allows up to 7 Trio BASIC programs to be run simultaneously on the controller using pre-emptive multi-tasking.

Programming The Multi-tasking ability of the Euro205x allows parts of a complex application to be developed, tested and run independently, although the tasks can share data and motion control hardware.

I/O Capability The Euro205x has 16 built in 24v inputs and 8 built-in output channels. These may be used for system interaction or may be defined to be used by the controller for end of travel limits, datuming and feedhold functions if required. 8 status LEDs are available which can be set to display the status of banks of inputs or outputs;

(See **DISPLAY**, Chapter 8). The Euro205x can have up to 256 external Input/Output channels and up to 32 analogue input channels connected using DIN rail mounted I/O modules. These units connect to the built-in CAN channel of the Euro205x.

Communications The Euro205x has two RS-232 ports and one RS-485 built in, and one further serial channel available at TTL levels. An external adapter is available to allow the TTL port to be used with Trio Fibre Optic Network devices, e.g. P504 Membrane Keypad.

One of the RS-232 ports or the RS485 port may be configured to run the MODBUS protocol for PLC or HMI interfacing.

If the built-in CAN channel is not used for connecting I/O modules, it may optionally be used for CAN communications or DeviceNet.

Ethernet, USB and Profibus daughter boards may be fitted to provide additional communications options.

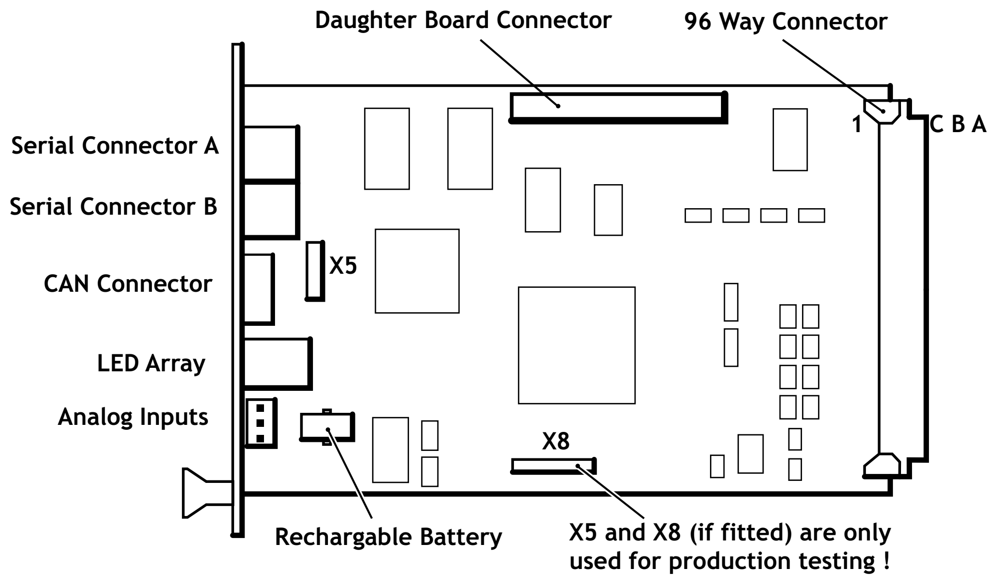
Axis Configuration

The default Euro205x configuration is as a single axis stepper base card (P151). Additional servo or stepper axes may be specified up to the 4 internal axis limit. In addition axes may be added in the field by the entry of “feature enable codes” into the controller. The codes can be purchased already installed into a new controller or may be ordered for controllers purchased earlier and added using Motion Perfect.

The gate array at the heart of the Euro205x design has facilities for 4 servo and 4 stepper axes built into every chip. The “feature enable codes” allow users to purchase only those facilities required for their configuration. Once entered onto the controller, the feature enable codes are stored in permanent flash memory. The feature enable codes are unique for each Euro205x.

The Euro205x features a total of 8 axes in software. Any axes not having a hardware interface can be used as a “virtual” axis.

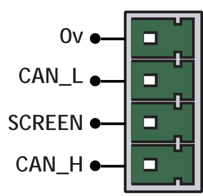
Connections to the Euro 205x



5 Volt Power Supply

The minimum connections to the Euro205x are just the 0V and 5V pins. The Euro205x is protected against reverse polarity on these pins. Application of more than 5.25 Volts will permanently damage the *Motion Coordinator* beyond economic repair. All the 0V are internally connected together and all the 5V pins are internally connected together. The 0V pins are, in addition, internally connected to the AGND pins. The Euro205x has a current consumption of approximately 500mA on the 5V supply. The supply should be filtered and regulated within 5%.

Built-in CAN Connector



The Euro205x features a built-in CAN channel. This is primarily intended for Input/Output expansion via Trio's P316 and P325 modules. It may be used for other purposes when I/O expansion is not required.

Euro 205x Backplane Connector

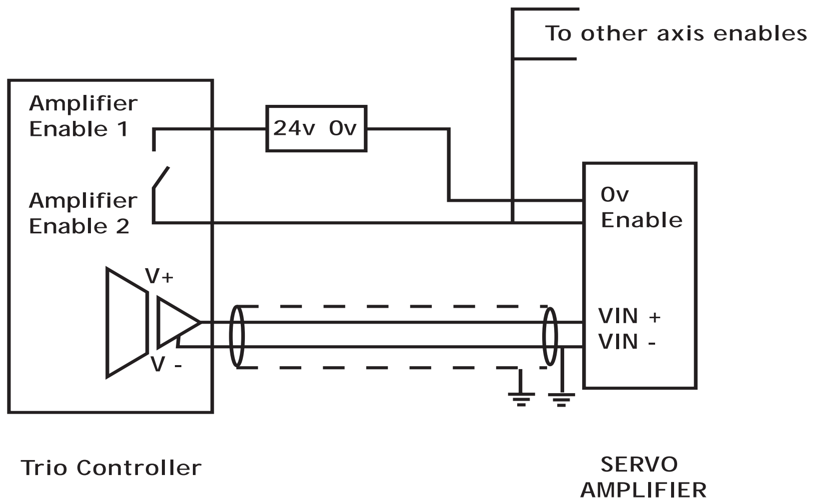
Most connections to the Euro205x are made via the 96 Way DIN41612 backplane Connector.

	C	B	A
1	5V	5V	5V
2	5V	5V	5V
3	0V	0V	0V
4	IO GND	OP13	OP10
5	OP9	OP12	OP15
6	OP8	OP11	OP14
7	IO 24V	IN0 / R0	IN1 / R1
8	IN2 / R2	IN3 / R3	IN4
9	IN5	IN6	IN7
10	IN8	IN9	IN10
11	IN11	IN12	IN13
12	IN14	0V	IN15
13	0V	DIR2	0V
14	STEP1	STEP2	DIR3
15	DIR0	DIR1	STEP3
16	STEP0	FAULT	RESET
17	ENABLE 1	ENABLE (OC)	AIN(0)
18	BOOST1	BOOST0	ENABLE 2
19	BOOST3	BOOST2	Z3- / BOOST3-
20	A3- / STEP3-	B3- / DIR3-	Z3+ / BOOST3+
21	A3+ / STEP3+	B3+ / DIR3+	Z2- / BOOST2-
22	A2- / STEP2-	B2- / DIR2-	Z2+ / BOOST2+
23	A2+ / STEP2+	B2+ / DIR2+	Z1- / BOOST1-
24	A1- / STEP1-	B1- / DIR1-	Z1+ / BOOST1+
25	A1+ / STEP1+	B1+ / DIR1+	Z0- / BOOST0-
26	A0- / STEP0-	B0- / DIR-	Z0+ / BOOST0+
27	A0+ / STEP0+	B0+ / DIR+	VOUT0
28	VOUT3	VOUT2	VOUT1
29	+12V	+12V	+12V
30	AGND	AGND	AGND
31	-12V	-12V	-12V
32	Earth	Earth	Earth

Amplifier Enable (Watchdog) Relay Output

An internal relay contact is used to enable external amplifiers when the controller has powered up correctly and the system and application software is ready. The amplifier enable is a solid-state relay on the Euro205x with normally open "contacts". The enable relay will be open circuit if there is no power on the controller OR a motion error exists on a servo axis OR the user program sets it open with the WDOG=OFF command.

The amplifier enable relay may, for example, be incorporated within a hold-up circuit or chain that must be intact before a 3-phase power input is made live.



Amplifier Enable Output

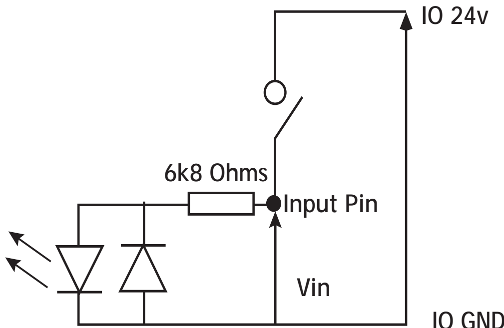
Note: *ALL STEPPER AND SERVO AMPLIFIERS MUST BE INHIBITED WHEN THE AMPLIFIER ENABLE OUTPUT IS OPEN CIRCUIT*

Amplifier Enable Open Collector Output

In addition to the relay, an open collector output is provided which goes on (pulls low) when the WDOG=ON command is executed. This output has the same specification as the step and direction OC signals and must be connected to a suitable pull-up or series resistor depending on the external circuit requirements.

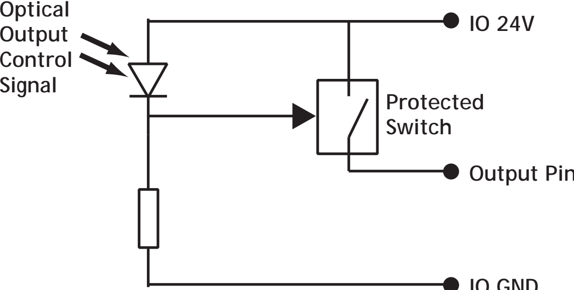
24V Input Channels

The *Motion Coordinator* has 16 24V Input channels built into the master unit. These may be expanded to 256 Inputs by the addition of CAN-16 I/O modules.



24V Output Channels

8 output channels are provided. These channels are labelled 8..15 for compatibility with other *Motion Coordinator*s, but are NOT bi-directional as on some *Motion Coordinator*s. Each channel has a protected 24V sourcing output. The output circuit has electronic over-current protection and thermal protection which shuts the output down when the current exceeds 250mA. Care should still be taken to ensure that the 250mA limit for the output circuit is not exceeded, and that the total load for the group of 8 outputs does not exceed 1 amp. Up to 256 further Outputs may be added by the addition of CAN-16I/O modules (P316).

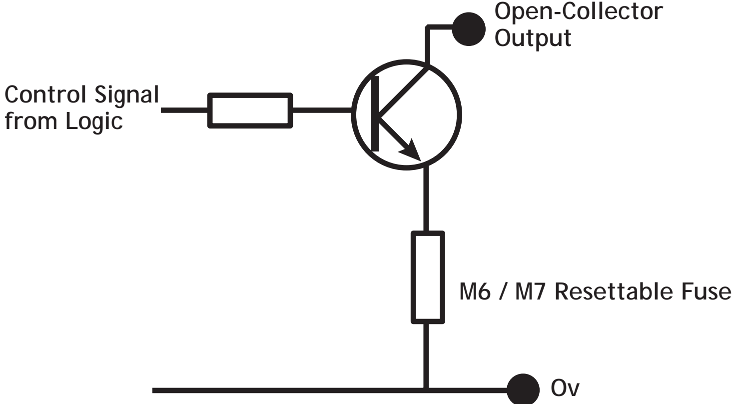


Open Collector Stepper Driver Outputs

The STEP, DIR, BOOST and ENABLE signals use open-collector outputs. These outputs are NOT opto-isolated from the processor logic. The open-collector outputs may be pulled up to any voltage in the range 5V...24V as required but a current limiting resistor MUST be provided externally to the Euro205x to limit the current in the output channel. Normally this current limiting resistor is built-in to the stepper amplifier circuit.

The BOOST output is provided for use in stepper motor systems, where the drive requires the controller to switch control of the motor current between a low holding torque current and the full step motion current. It is under the direct control of the BOOST command in Trio BASIC.

The open-collector outputs are protected by 2 resettable fuses. These fuse links will go high impedance if a total of more than 200mA is passed through a group of open-collector outputs. M6 protects STEP0, STEP1, STEP2, STEP3, DIR0, DIR1 and DIR2. M7 protects DIR3, BOOST0, BOOST1, BOOST2, BOOST3 and ENABLE. If any outputs are overloaded it is necessary to remove the power from the circuit in order to reset the fuses.



Fault and Reset Inputs

Fault is a non-isolated 5 Volt input for connection to stepper amplifier fault outputs. Signals connected to this input should NOT exceed 5 Volts.

The Reset input can be momentarily connected to 0V to reset the Euro205x. Signals connected to this pin must not exceed 5 Volts.

Registration Inputs

The registration inputs are 24 Volt isolated inputs that are shared with digital inputs 0 to 3. The Euro205x can be programmed to capture the position of an encoder axis in hardware when a transition occurs on the registration input.

Differential Encoder Inputs

The encoder inputs on the Euro205x are designed to be directly connected to 5 Volt differential output encoders. Incremental encoders can be connected to the ports.

The encoder ports are also bi-directional so that when axes are set to stepper, the encoder port for that axis becomes a Differential Stepper output.

Voltage Outputs

The Euro205x can generate up to 4 +/-10 Volt analogue outputs which are primarily designed for controlling servo-amplifiers. Note that for servo operation the necessary feature enable codes must have been entered into the Euro205x. However, the voltage outputs can be used seperately via the DAC command in Trio BASIC even when the axis is not enabled. To use the voltage outputs the +/-12 Volt supplies must be present.

Analogue Inputs

Two built-in 12 bit analogue inputs are provided which are set up with a scale of 0 to 10 Volts. In order to make external connection to these inputs, there is a 2 part molex connector behind the front panel. Pin 1 is nearest the CAN connector.

Pin 1	AIN(32)
Pin 2	AIN(33)
Pin 3	0V

Mating MOLEX connector part number

Connector housing: 22-01-2035

Crimp receptacles : 08-50-0032 (3 required)

In addition AIN(32) can be connected via pin A17 of the rear DIN41612 connector.

Using End of Travel Limit Sensors

Each axis of the *Motion Coordinator* system may have a 24V Input channel allocated to it for the functions:

FORWARD Limit	Forward end of travel limit
REVERSE Limit	Reverse end of travel limit
DATUM Input	Used in datuming sequence
FEEDHOLD Input	Used to suspend velocity profiled movements until the input is released

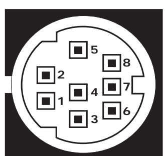
Switches used for the FORWARD/REVERSE/DATUM/FEEDHOLD inputs may be normally closed or normally open but the NORMALLY CLOSED type is recommended.

Each of the functions is optional and may be left unused if not required. Each of the 4 functions are available for each axis and can be assigned to any input channel in the range 0..31. An input can be assigned to more than one function if desired.

The axis parameters: **FWD_IN**,**REV_IN**, **DATUM_IN** and **FH_IN** are used to assign input channels to the functions. The axis parameters are set to -1 if the function is not required.

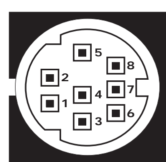
Euro 205x Serial Port Connections

Serial Connector A:



Pin	Function	Note
1	Internal 5V	
2	Internal 0V	
3	RS232 Transmit	Serial Port #0
4	RS232 GND	
5	RS232 Receive	
6	+5V output	Serial Port #3 / #4
7	Externally buffered output (TTL)	
8	Externally buffered input (TTL)	
On the MC224 pins 1,2,7 and 8 can be used to interface a fibre optic adapter. Note: Port 0 is the default programming port for connection to the PC running *Motion Perfect*.		

Serial Connector B:



Pin	Function	Note
1	RS485 Data In A Rx+	Serial Port #2
2	$\overline{\text{RS485 Data In}}$ B Rx-	
3	RS232 Transmit	Serial Port #1
4	RS232 GND	
5	RS232 Receive	
6	Internal 5V	Serial Port #2
7	$\overline{\text{RS485 Data Out}}$ Z Tx-	
8	RS485 Data Out Y Tx+	

Network Interconnection

The Euro 205x supports Trio's fibre-optic network with the optional P435 serial to fibre-optic adaptor connected to the appropriate serial connector.

The software for the network supports interconnection of up to 15 nodes in a token-ring network format. The nodes may consist of any combination of compatible master controllers and Trio Membrane Keypads.

Euro205x - Feature Summary

Size	170 mm x 129 mm Overall (160mm x 100 mm PCB) 25mm deep
Weight	170 g
Operating Temp.	0 - 45 degrees C
Control Inputs	Forward Limit, Reverse Limit, Datum Input, Feedhold Input.
Communication Ports	(2) RS232 channels: up to 38400 baud. (1) RS485 channel built in, (1) Serial adapter port. CANbus port (*DeviceNet* compatible).
Position Resolution	32 bit position count
Speed Resolution	32 bits. Speed may be changed at any time. Moves may be merged.
Interpolation modes	linear 1-5 axes, circular, helical, CAM Profiles, speed control, electronic gearboxes.
Programming	Multi-tasking Trio BASIC system, maximum 7 user tasks.
Servo Cycle	Programmable: 1ms, 500μs or 250μs.
Memory	512k battery-backed user memory. Entire contents may be flashed to EPROM.
Power Input	500mA at 5V d.c. (+/-12V at 50mA required for DAC output)
Amplifier Enable Output	Normally open solid-state relay. Maximim load 100mA, maximum voltage 29V.
Analogue Outputs	4 Isolated 16 bit +/- 10V
Analogue Inputs	2 x 12 bit 0 to 10V
Digital Inputs	16 Opto-isolated 24V inputs
Registration Inputs	4. One per axis shared with inputs 0 to 3.
Encoder Inputs	4 differential 5V inputs, 6MHz maximum edge rate
Stepper Outputs	4 differential (5V) or open collector (5 to 24V) step & direction outputs. Maximum frequency 500kHz (OC), 2MHz (Differential).
Digital I/O	8 Opto-isolated 24V current sourcing (PNP) 250 mA outputs

Motion Coordinator Euro209

Overview The *Motion Coordinator* Euro209 is a Eurocard stepper/servo positioners with the built-in ability to control up to 8 servo or stepper motors in any combination. In addition a single Trio Daughter Board may be fitted to allow the control of a ninth axis or communications channel. The Euro209 is designed to provide a powerful yet cost-effective control solution for OEM machine builders who are prepared to mount the unit and provide the power supplies required. It is designed to be configured and programmed for the application with Multi-tasking Trio BASIC using a PC, and then may be set to run “standalone” if an external computer is not required for the final system. The Multi-tasking version of Trio BASIC for the Euro209 allows up to 7 Trio BASIC programs to be run simultaneously on the controller using pre-emptive multi-tasking.

Programming The Multi-tasking ability of the Euro209 allows parts of a complex application to be developed, tested and run independently, although the tasks can share data and motion control hardware.

I/O Capability The Euro209 has 16 built in 24V inputs and 8 built-in output channels. These may be used for system interaction or may be defined to be used by the controller for end of travel limits, datuming and feedhold functions if required. 8 status LEDs are available which can be set to display the status of banks of inputs or outputs; (See **DISPLAY**, Chapter 8). The Euro209 can have up to 256 external Input/Output channels and up to 32 analogue input channels connected using DIN rail mounted I/O modules. These units connect to the built-in CAN channel of the Euro209.

Communications The Euro209 has one Ethernet port for primary communications, one RS-232 port and one RS-485 built in.

The Ethernet port, RS-232 port or the RS485 port may be configured to run the MODBUS protocol for PLC or HMI interfacing.

If the built-in CAN channel is not used for connecting I/O modules, it may optionally be used for CAN communications or DeviceNet.

A profibus daughter board may be fitted to provide additional communications options.

Removable Storage A micro SD card can be used with the Euro209 allows a simple means of transferring programs without a PC connection. Offering the OEM easy machine replication and servicing. The Euro209 supports SD cards up to 2Gbytes. Each Micro SD Card must be pre-formatted using a PC to FAT32 before it can be used in the SD Card Adaptor.

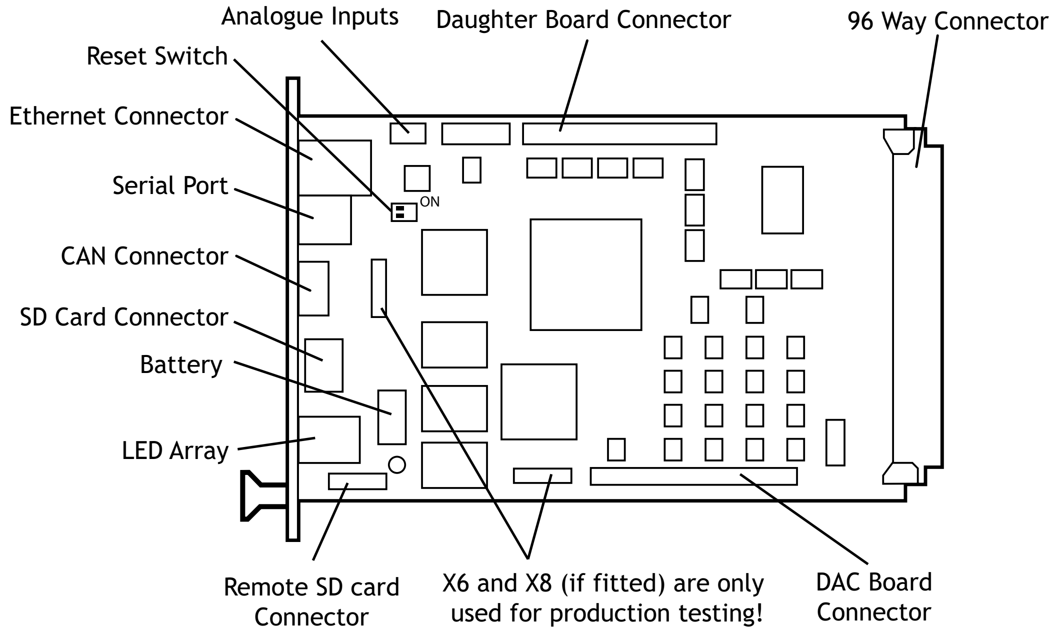
Axis Configuration

The default Euro209 configuration is as a two axis stepper base card. Additional servo or stepper axes may be specified up to the 8 internal axis limit. Four or eight axis DAC boards may be purchaced to enable servo outputs. In addition axes may be added in the field by the entry of “feature enable codes” into the controller. The codes can be purchased already installed into a new controller or may be ordered for controllers purchased earlier and added using Motion Perfect.

The gate array at the heart of the Euro209 design has facilities for 8 servo and 8 stepper axes built into every chip. The “feature enable codes” allow users to purchase only those facilities required for their configuration. Once entered onto the controller, the feature enable codes are stored in permanent flash memory. The feature enable codes are unique for each Euro209.

The Euro209 features a total of 16 axes in software. Any axes not having a hardware interface can be used as a “virtual” axis.

Connections to the Euro 209

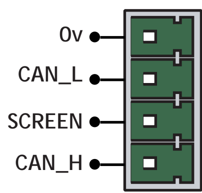


5 Volt Power Supply

The minimum connections to the Euro209 are just the 0V and 5V pins. The Euro209 is protected against reverse polarity on these pins. Application of more than 5.25 Volts will permanently damage the *Motion Coordinator* beyond economic repair. All the 0V are internally connected together and all the 5v pins are internally connected together. The 0V pins are, in addition, internally connected to the AGND pins. The Euro209 has a current consumption of approximately 500mA on the 5V supply. The supply should be filtered and regulated within 5%.

Built-in CAN Connector

The Euro209 features a built-in CAN channel. This is primarily intended for Input/Output expansion via Trio's P316 and P325 modules. It may be used for other purposes when I/O expansion is not required.



Euro 209 Backplane Connector

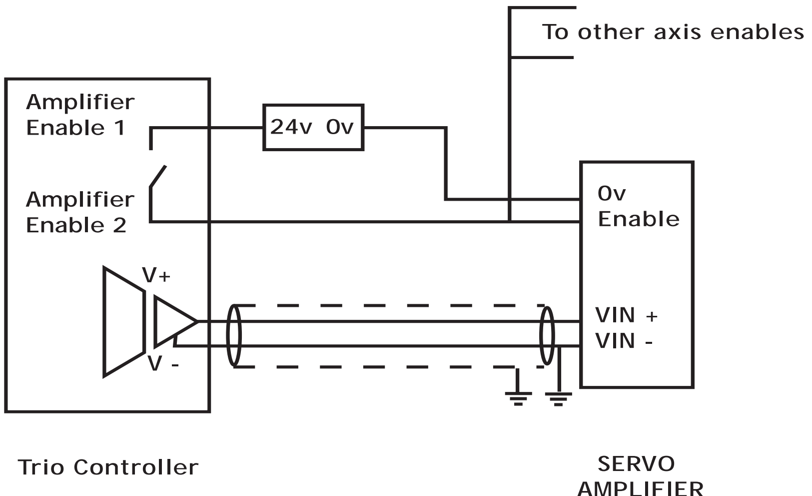
Most connections to the Euro209 are made via the 96 Way DIN41612 backplane Connector.

	C	B	A
1	5V	5V	5V
2	5V	5V	5V
3	0V	0V	0V
4	IO GND	OP13	OP10
5	OP9	OP12	OP15
6	OP8	OP11	OP14
7	IO 24V	IN0 / R0	IN1 / R1
8	IN2 / R2	IN3 / R3	IN4 / R4
9	IN5 / R5	IN6 / R6	IN7 / R7
10	IN8	IN9	IN10
11	IN11	IN12	IN13
12	IN14	0V	IN15
13	A7- / STEP7-	B7- / DIR7-	Z7- / BOOST7-
14	A7+ / STEP7+	B7+ / DIR7+	Z7+ / BOOST7+
15	A6- / STEP6-	B6- / DIR6-	Z6- / BOOST6-
16	A6+ / STEP6+	B6+ / DIR6+	Z6+ / BOOST6+
17	A5- / STEP5-	B5- / DIR5-	Z5- / BOOST5-
18	A5+ / STEP5+	B5+ / DIR5+	Z5+ / BOOST5+
19	A4- / STEP4-	B4- / DIR4-	Z4- / BOOST4-
20	A4+ / STEP4+	B4+ / DIR4+	Z4+ / BOOST4+
21	A3- / STEP3-	B3- / DIR3-	Z3- / BOOST3-
22	A3+ / STEP3+	B3+ / DIR3+	Z3+ / BOOST3+
23	A2- / STEP2-	B2- / DIR2-	Z2- / BOOST2-
24	A2+ / STEP2+	B2+ / DIR2+	Z2+ / BOOST2+
25	A1- / STEP1-	B1- / DIR1-	Z1- / BOOST1-
26	A1+ / STEP1+	B1+ / DIR1+	Z1+ / BOOST1+
27	A0- / STEP0-	B0- / DIR-	Z0- / BOOST0-
28	A0+ / STEP0+	B0+ / DIR+	Z0+ / BOOST0+
29	VOUT7	VOUT6	VOUT5
30	AGND	VOUT4	VOUT3
31	VOUT2	VOUT1	VOUT0
32	ENABLE1	ENABLE2	Earth

Amplifier Enable (Watchdog) Relay Output

An internal relay contact is used to enable external amplifiers when the controller has powered up correctly and the system and application software is ready. The amplifier enable is a solid-state relay on the Euro209 with normally open “contacts”. The enable relay will be open circuit if there is no power on the controller OR a following error exists on a servo axis OR the user program sets it open with the WDOG=OFF command.

The amplifier enable relay may, for example, be incorporated within a hold-up circuit or chain that must be intact before a 3-phase power input is made live.

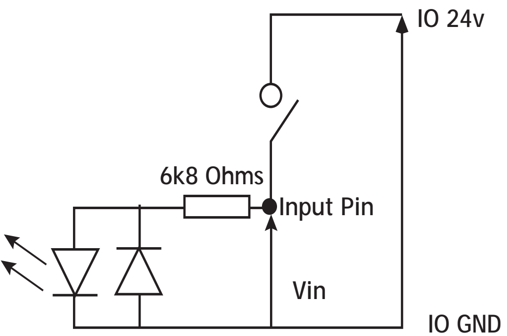


Amplifier Enable Output

Note: *ALL STEPPER AND SERVO AMPLIFIERS MUST BE INHIBITED WHEN THE AMPLIFIER ENABLE OUTPUT IS OPEN CIRCUIT*

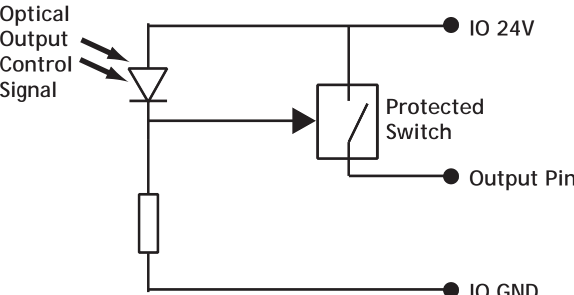
24V Input Channels

The *Motion Coordinator* has 16 24V Input channels built into the master unit. These may be expanded to 256 Inputs by the addition of CAN-16 I/O modules.



24V Output Channels

8 output channels are provided. These channels are labelled 8..15 for compatibility with other *Motion Coordinator*s, but are NOT bi-directional as on some *Motion Coordinator*s. Each channel has a protected 24v sourcing output. The output circuit has electronic over-current protection and thermal protection which shuts the output down when the current exceeds 250mA. Care should still be taken to ensure that the 250mA limit for the output circuit is not exceeded, and that the total load for the group of 8 outputs does not exceed 1 amp. Up to 256 further Outputs may be added by the addition of CAN-16I/O modules (P316).



Registration Inputs

The registration inputs are 24 Volt isolated inputs that are shared with digital inputs 0 to 7. The Euro209 can be programmed to capture the position of an encoder axis in hardware when a transition occurs on the registration input.

Differential Encoder Inputs

The encoder inputs on the Euro209 are designed to be directly connected to 5 Volt differential output encoders. Incremental encoders can be connected to the ports.

The encoder ports are also bi-directional so that when axes are set to stepper, the encoder port for that axis becomes a Differential Stepper output.

Voltage Outputs

The Euro209 can generate up to 8+/-10 Volt analogue outputs when fitted with the P184 or the P185 which are primarily designed for controlling servo-amplifiers. Note that for servo operation the necessary feature enable codes must have been entered into the Euro209. However, the voltage outputs can be used seperately via the DAC command in Trio BASIC even when the axis is not enabled. To use the voltage outputs the +/-12 Volt supplies must be present.

Analogue Inputs

Two built-in 12 bit analogue inputs are provided which are set up with a scale of 0 to 10 Volts. In order to make connection to these inputs, there is a 2 part molex connector behind the front panel. Pin 1 is nearest the CAN connector.

Pin 1	AIN(32)
Pin 2	AIN(33)
Pin 3	0V

Mating MOLEX connector part number

Connector housing: 22-01-2035

Crimp receptacles : 08-50-0032 (3 required)

Using End of Travel Limit Sensors

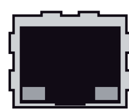
Each axis of the *Motion Coordinator* system may have a 24v Input channel allocated to it for the functions:

FORWARD Limit	Forward end of travel limit
REVERSE Limit	Reverse end of travel limit
DATUM Input	Used in datuming sequence
FEEDHOLD Input	Used to suspend velocity profiled movements until the input is released

Switches used for the FORWARD/REVERSE/DATUM/FEEDHOLD inputs may be normally closed or normally open but the NORMALLY CLOSED type is recommended.

Each of the functions is optional and may be left unused if not required. Each of the 4 functions are available for each axis and can be assigned to any input channel in the range 0..31. An input can be assigned to more than one function if desired.

The axis parameters: **`FWD_IN`**,**`REV_IN`**, **`DATUM_IN`** and **`FH_IN`** are used to assign input channels to the functions. The axis parameters are set to -1 if the function is not required.

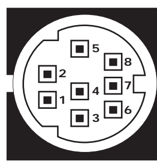


Ethernet Port Connection

Pysical layer: 10/100 baseT
Connector: RJ-45
Connection and activity LED indicators
Fixed IP address set up using the ETHERNET command (Chapter 8)
User settable subnet mask and default gateway
DHCP client: Not available (fixed IP only)

A switch is provided on the board to reset the IP address to a known value. To reset to the default value of 192.168.000.250, slide switch 1 to the right (ON) and power up the Euro209. Make connetion with the Euro209 using *Motion* Perfect on the default address and use the ETHERNET command to set the required IP address. e.g. for 192.168.000.123 set ETHERNET(1,-1,0,192,168,000,123). Once the IP address has been set, slide switch 1 to OFF and power down the Eurocard. Next time the Euro209 is powered up, the new IP address can be used.

Serial Connector B:



Pin	Function	Note
1	RS485 Data In A Rx+	Serial Port #2
2	RS485 Data In B Rx-	
3	RS232 Transmit	
4	RS232 GND	Serial Port #1
5	RS232 Receive	
6	Internal 5V	
7	RS485 Data Out Z Tx-	Serial Port #2
8	RS485 Data Out Y Tx+	

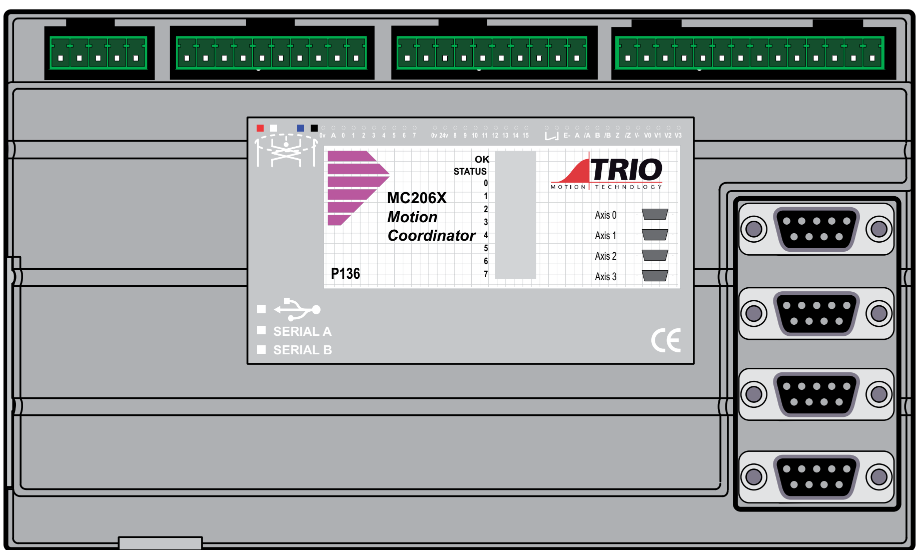
Euro 209 Serial Port Connections

Euro209 - Feature Summary

Size	170 mm x 129 mm Overall (160mm x 100 mm PCB) 25mm deep
Weight	160 g
Operating Temp.	0 - 45 degrees C
Control Inputs	Forward Limit, Reverse Limit, Datum Input, Feedhold Input.
Communication Ports	(1) RS232 channels: up to 38400 baud, (1) RS485 channel built in, CANbus port (***DeviceNet*** compatible), (1) Ethernet 10/100baseT.
Position Resolution	32 bit position count
Speed Resolution	32 bits. Speed may be changed at any time. Moves may be merged.
Interpolation modes	Linear 1-16 axes, circular, helical, CAM Profiles, speed control, electronic gearboxes.
Programming	Multi-tasking Trio BASIC system, maximum 7 user tasks.
Servo Cycle	Programmable: 1ms, 500µs or 250µs.
Memory	1Mbyte battery-backed user memory. Entire contents may be flashed to EPROM.
Memory Stick	Socket for Micro SD Card. Used for storing programs and/or data.
Power Input	900mA at 5V d.c.
Amplifier Enable Output	Normally open solid-state relay. Maximim load 100mA, maximum voltage 29V.
Analogue Outputs	8 Isolated 16 bit +/-10V can be provided by P184 / P185
Analogue Inputs	2 x 12 bit 0 to 10V
Digital Inputs	16 Opto-isolated 24V inputs
Registration Inputs	8. One per axis shared with inputs 0 to 7.
Encoder Inputs	8 differential 5V inputs, 6MHz maximum edge rate
Stepper Outputs	8 Differential Step / Direction outputs 2MHz Max Rate
Digital Outputs	8 Opto-isolated 24V outputs. Current sourcing (PNP) 250 mA. (max. 1A per bank of 8)

Motion Coordinator MC206X

Overview The MC206X is based on Trio's high-performance 32-bit DSP technology and provides up to 4 axes of servo or stepper control, plus a master encoder axis. Trio uses advanced FPGA techniques to reduce the size and fit 4 axes of stepper and servo circuitry in a compact DIN-rail mounted package. The housing allows for a single daughter board to be mounted internally (with the optional P399 adaptor). This daughter board may provide additional axis control or communications functions.



User programs are written in Trio's established multi-tasking Trio BASIC language using the powerful *Motion* Perfect development software for the PC. Complex motion such as cams, gears, linked axes, and interpolation is made easy with the comprehensive Trio BASIC command set.

I/O Capability The MC206X has 16 opto-isolated digital I/O (8 in, 8 bi-directional). A high-speed hardware registration input is available on each axis for highly accurate control of print and packaging lines. A single 0..10V opto-isolated analogue input is built-in.

The I/O count can be expanded using Trio CANbus digital and analogue modules to provide a further 256 digital 24v I/O channels and 32 +/-10V analogue inputs.

Communications The MC206X offers wide communications capability with two RS-232 serial ports, an RS-485 port, a TTL serial port, a USB port and a CAN channel as standard. Adapters are available to convert the TTL port to Trio's fibre-optic network.

RS-232 port #1, or RS-485 port #2 may be configured to run the MODBUS protocol for PLC or HMI interfacing.

If the built-in CAN channel is not used for connecting I/O modules, it may optionally be used for CAN communications.

USB and Profibus daughter boards may be fitted to provide additional communications options.

Removable Storage

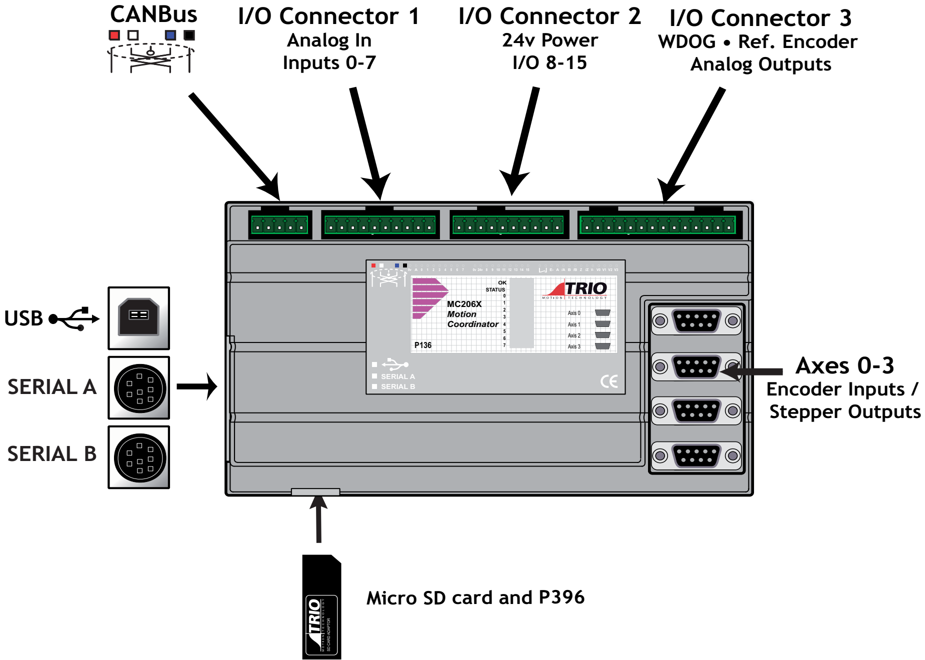
A memory adaptor used with the MC206X allows a simple means of transferring programs without a PC connection. Offering the OEM easy machine replication and servicing. The memory adaptor is compatable with a wide range of Micro SD cards up to 2Gbytes. Each Micro SD Card must be pre-formatted using a PC to FAT32 before it can be used in the SD Card Adaptor.
Order the SD Card Adaptor from a Trio supplier (order code: P396).
The adaptor does not include the Micro SD Card which must ne bought separately.

Axis Configuration

The MC206X initialises 8 axes in its software: up to four real axes of servo or stepper are built in, one daughter board axis may optionally be used, an encoder follower input axis is also built in to every MC206X. Any axis of the 8 not used in hardware can be used as a virtual axis for camming, on-the-fly registration adjustments, and linking motion.

The MC206X can be a servo or stepper controller by using a “feature enable code”. All necessary DAC and stepper circuitry is installed and ready for use. The controller can be supplied with any combination of servo or stepper axes pre-enabled, and has been designed to allow the user to upgrade at a later date by entering additional feature enable codes. Up to 4 axes can be enabled on the MC206X.

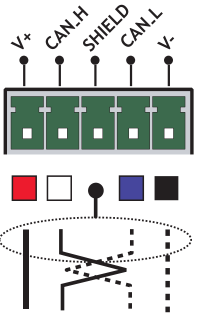
Connections to the MC206X



5-Way Connector

This is a 5 way 3.81mm pitch connector. The connector is used both to provide the 24 Volt power to the MC206X and provide connections for I/O expansion via Trio's P316 and P325 CAN I/O expanders. 24 Volts must be provided as this powers the unit.

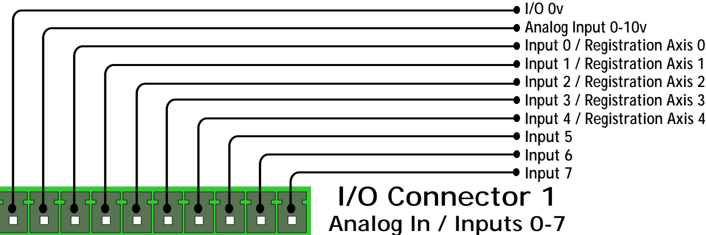
This 24 volt input is internally isolated from the I/O 24 Volts and the +/-10V voltage outputs.



Note: *The 24v (V+) and 0v (V-) MUST be connected as they power the MC206X. The Shield MUST also be connected as it provides the EMC screen for the Motion Coordinator. The CAN connections are optional.*

Power supply: 24V dc, Class 2 transformer or power source.

I/O Connector 1



Analogue Input

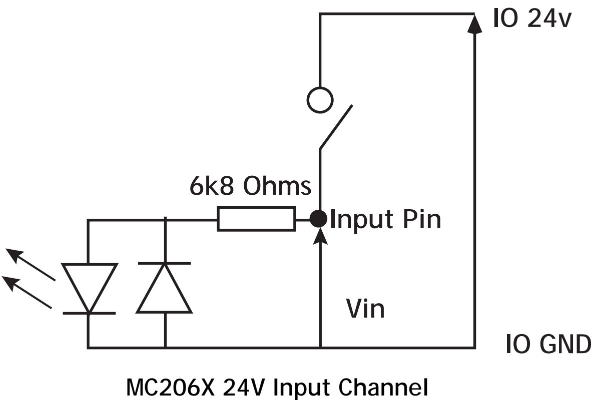
The MC206X provides a single 0-10v, 10-Bit analogue input as standard. The analogue input resolution is fixed and will return values 0..1023 to the system parameter **AIN0**. The input works "single ended" and is referenced to the IOGND pin alongside the AIN. Power must be applied to the 24V I/O power input in order for the analogue input to function.

It is possible to add further analogue inputs via the P325 CAN Analog modules. Each P325 module provides a further 8 single ended +/- 10V inputs with a 12 Bit resolution.

24V Input Channels

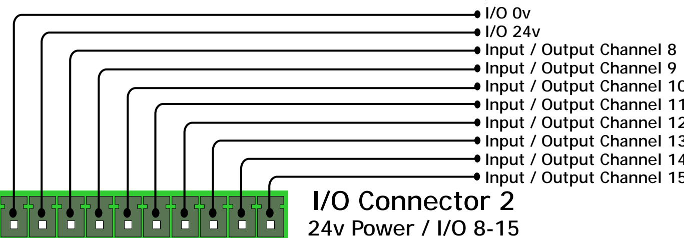
The MC206X has 8 dedicated 24V Input channels and 8 bi-directional 24V I/O channels built into the master unit. A further 256 inputs can be provided by the addition of CAN-16 I/O modules. The dedicated input channels are labelled channels 0..7.

Inputs 0 to 4 can be used as registration inputs for axes 0 to 4 for use with the **REGIST** command..



MC206X 24V Input Channel

I/O Connector 2



I/O Power Inputs

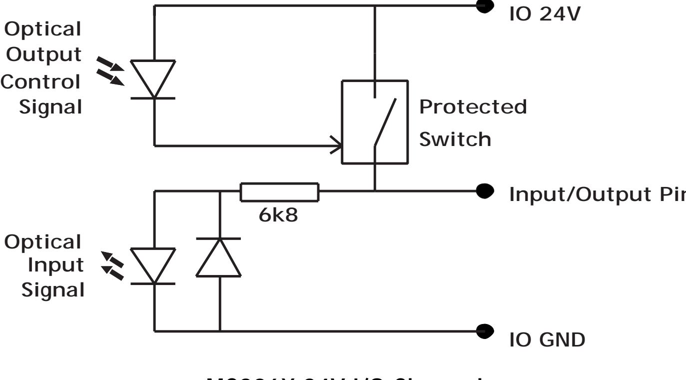
The I/O 0 Volts and I/O 24 Volts are used to power the 24 volt inputs and outputs.

The I/O connections are isolated from the module power inputs. The I/O channels are bi-directional and can be used either as an input or an output.

24V I/O Channels

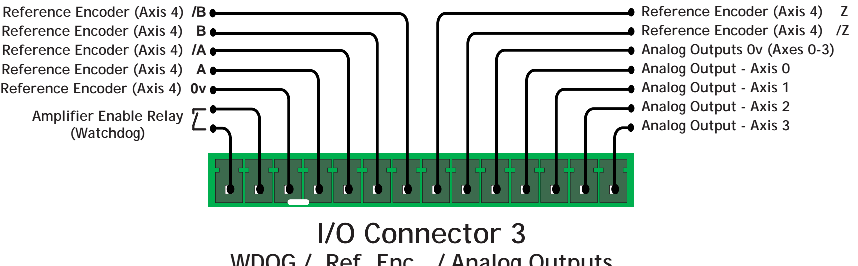
Input/output channels 8..15 are bi-directional. The inputs have a protected 24V sourcing output connected to the same pin. If the output is unused it may be used as an input in the program. The input circuitry is the same as on the dedicated inputs. The output circuit has electronic over-current protection and thermal protection which shuts the output down when the current exceeds 250mA.

Care should be taken to ensure that the 250mA limit for the output circuit is not exceeded, and that the total load for the group of 8 outputs does not exceed 1 amp.



MC206X 24V I/O Channel

I/O Connector 3

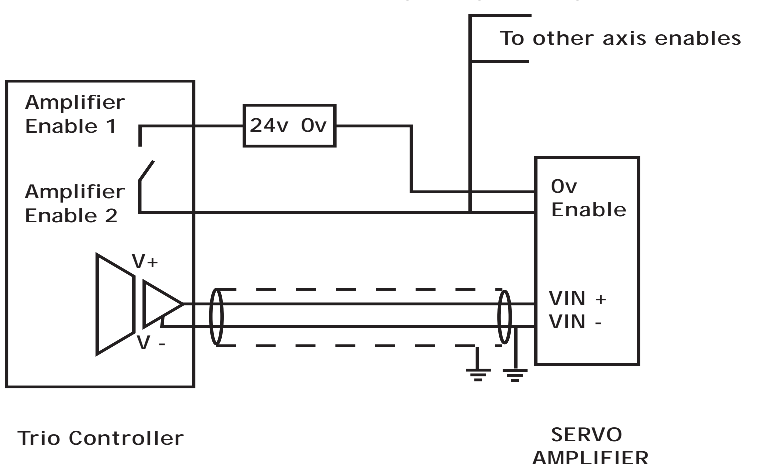


I/O Connector 3
WDOG / Ref. Enc. / Analog Outputs

Amplifier Enable (Watchdog) Relay Output

An internal relay contact is used to enable external amplifiers when the controller has powered up correctly and the system and application software is ready. The amplifier enable is a single pole relay with a set of normally open contacts. The enable relay contact will be open circuit if there is no power on the controller OR a following error exists on a servo axis OR the user program sets it open with the WDOG=OFF command.

The amplifier enable relay may, for example, be incorporated within a hold-up circuit or chain that must be intact before a 3-phase power input is made live.



Amplifier Enable Output

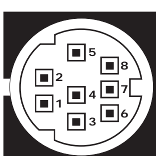
Note: *ALL STEPPER AND SERVO AMPLIFIERS MUST BE INHIBITED WHEN THE AMPLIFIER ENABLE OUTPUT IS OPEN CIRCUIT*

Reference Encoder Input

A reference encoder - axis 4, provides an encoder input facility for measurement, registration and synchronization functions on conveyors, drums, flying shears, etc. The encoder port features high speed differential receiver inputs.

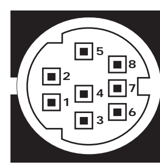
MC206X Serial Connections

Serial Connector A:



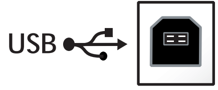
Pin	Function	Note
1	Internal 5V	
2	Internal 0V	
3	RS232 Transmit	Serial Port #0
4	RS232 GND	
5	RS232 Receive	
6	+5V output	
7	Externally buffered output (TTL)	Serial Port #3 / #4
8	Externally buffered input (TTL)	
On the MC206X pins 1,2,7 and 8 can be used to interface a fibre optic adapter. Note: Port 0 is the default programming port for connection to the PC running *Motion Perfect*.		

Serial Connector B:



Pin	Function	Note
1	RS485 Data In A Rx+	Serial Port #2
2	$\overline{\text{RS485 Data In}}$ B Rx-	
3	RS232 Transmit	Serial Port #1
4	RS232 GND	
5	RS232 Receive	
6	Internal 5V	Serial Port #2
7	$\overline{\text{RS485 Data Out}}$ Z Tx-	
8	RS485 Data Out Y Tx+	

Universal Serial Bus



The USB port provides a high-speed Universal Serial Bus link to a PC or other device supporting USB.

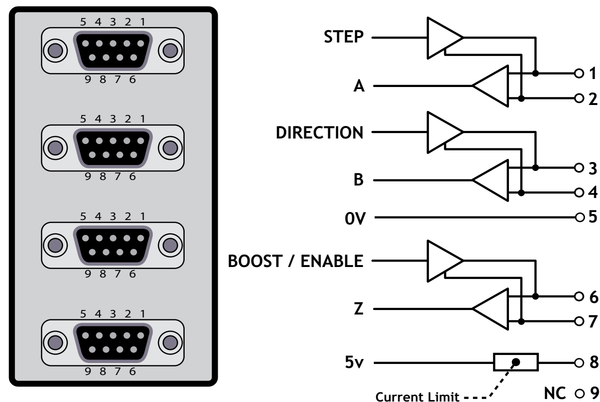
This port can be used for a high speed connection to *Motion* Perfect, or to a user program on the PC via Trio's ActiveX component.

MC206X - Stepper Outputs / Encoder Inputs

The MC206X controller is designed to support any combination of servo and stepper motors on the standard controller hardware. Each of the first four axes (0-3) can be enabled as either servo or stepper according to the users requirements.

The function of the 9-pin 'D' connectors will be dependant on the specific axis configuration which has been defined. If the axis is setup as a servo, the connector will provide the encoder input. If the axis is configured as a stepper, the connector provides differential outputs for step/direction and boost/enable signals.

The encoder port also provides a current-limited 5V output capable of powering most encoders. This simplifies wiring and eliminates external power supplies.



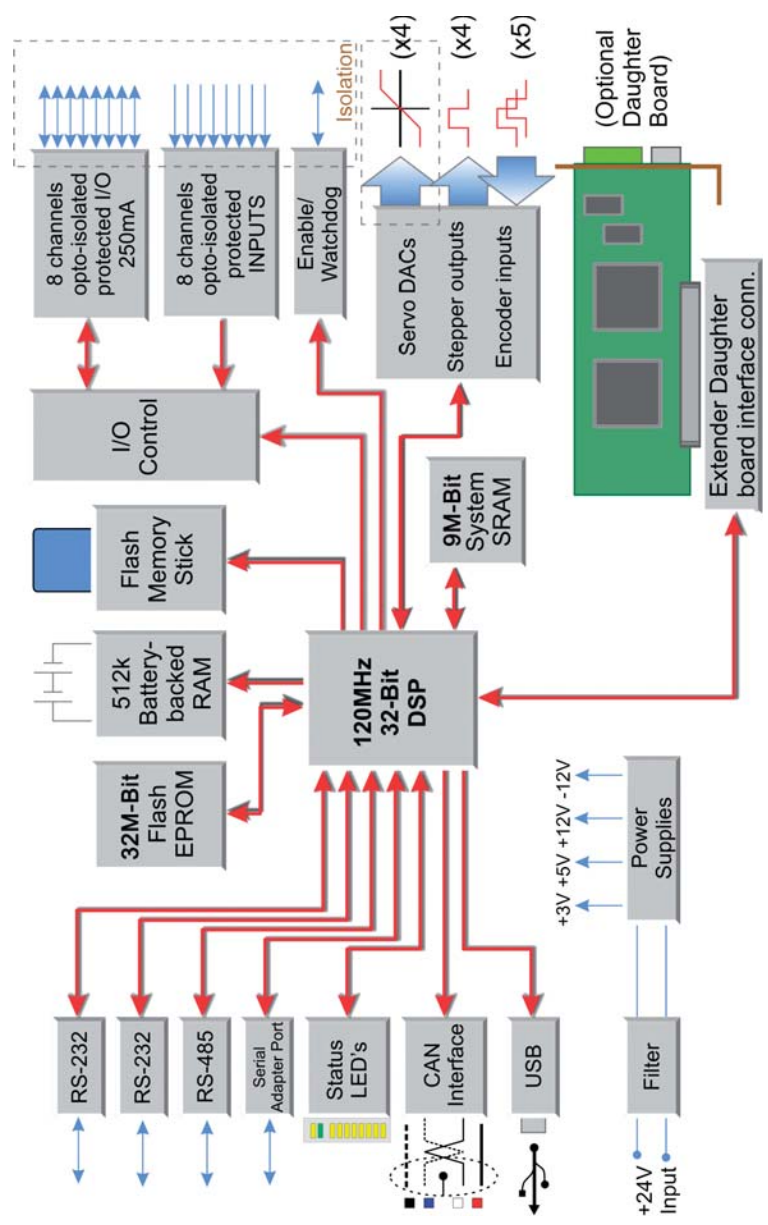
Once the axes have been enabled, using the **FEATURE_ENABLE** function, the controller will enable the appropriate hardware for each axis and the connector will function as below.

Pin	Servo Axis	Stepper Axis
1	Enc. A	Step +
2	Enc. /A	Step -
3	Enc. B	Direction +
4	Enc. /B	Direction -
5	GND	GND
6	Enc. Z	Boost +
7	Enc. /Z	Boost -
8	5V	5V
9	Not Connected	Not Connected
shell	Screen	Screen

MC206X - Feature Summary

Size	107mm(H) x 182mm(W) x 53mm(D)
Weight	325 g
Operating Temp.	0 - 45 degrees C
Control Inputs	Forward Limit, Reverse Limit, Datum Input, Feedhold Input.
Communication Ports	(2) RS232 channels: up to 38400 baud. (1) RS485 channel built in, (1) Serial adapter port. CANbus port (*DeviceNet* compatible), (1) USB 12Mb
Position Resolution	32 bit position count
Interpolation modes	linear 1-5 axes, circular, helical, CAM Profiles, speed control, electronic gearboxes.
Programming	Multi-tasking Trio BASIC system, maximum 8 user tasks.
Speed Resolution	32 bits. May be changed at any time. Moves may be merged for continuous motion.
Servo Cycle	250 μs minimum for all axes, 1 mS default
Memory	512k battery-backed user memory. Entire contents may be flashed to EPROM.
Memory Stick	Socket for plug-in “Nexflash Mediastick” or P396 Micro SD card adaptor. Used for storing programs and/or data.
Power Input	24V dc, Class 2 transformer or power source. 18 … 29V dc at 300mA.
Amplifier Enable Output	Normally open solid state relay contact. Maximum voltage 24Vdc at 100mA.
Analogue Outputs	4 Isolated 16 bit +/- 10V
Analogue Input	Isolated 10 bit 0-10Vdc
Registration Inputs	4. One per axis shared with inputs 0 to 3.
Encoder Inputs	5 differential 5V inputs, 6MHz maximum edge rate
Digital Inputs	18 Opto-isolated 24V inputs.
Stepper Outputs	4 Differential Step / Direction outputs 2MHz Max Rate
Digital I/O	8 Opto-isolated 24V outputs. Current sourcing (PNP) 250 mA. (max. 1A per bank of 8)
Encoder Power Output	5v at 150mA total for 4 encoders plus daughter board

MC206X - Schematic



Motion Coordinator MC224

Overview

The *Motion Coordinator* MC224 is Trio's most powerful modular servo control positioner with the ability to control servo or stepper motors in any combination by the insertion of “Axis Daughter Boards” to suit the application. Up to 24 axes can be controlled by means of Digital Bus links (e.g. SERCOS) or 16 axes via traditional analogue command / encoder feedback. It is housed in a rugged metal chassis and incorporates all the isolation circuitry necessary for direct connection to external equipment in an industrial environment. Filtered power supplies are included so that it can be powered from the 24V d.c. logic supply present in most industrial cabinets.

It is designed to be configured and programmed for the application using a PC running the *Motion* Perfect application software, and then may be set to run “standalone” if an external computer is not required for the final system.

The Multi-tasking version of Trio BASIC for the MC224 allows up to 14 Trio BASIC programs to be run simultaneously on the controller using pre-emptive multi-tasking.

Programming The Multi-tasking ability of the MC224 allows parts of a complex application to be developed, tested and run independently, although the tasks can share data and motion control hardware.

I/O Capability The MC224 has 8 built in 24v inputs and 8 bi-directional I/O channels. These may be used for system interaction or may be defined to be used by the controller for end of travel limits, datuming and feedhold functions if required. Each of the Input/Output channels has a status LED to make it easy to check them at a glance. The MC224 can have up 256 external Input/Output channels connected using DIN rail mounted CAN 16-I/O modules. These units connect to the built-in CAN channel.

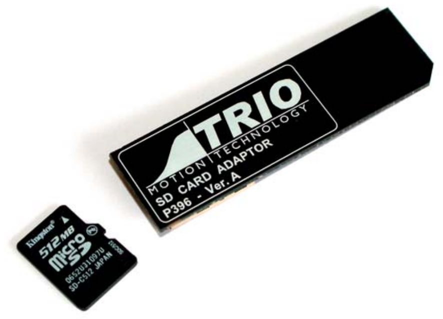
Communications The MC224 has two built in RS-232 ports and one built in duplex RS-485 channel for simple factory communication systems. The TRIO fibre optic network system can be added with an optional adapter cable.

One of the RS-232 ports or the RS485 port may be configured to run the MODBUS protocol for PLC or HMI interfacing.

If the built-in CAN channel is not used for connecting I/O modules, it may optionally be used for CAN communications. e.g. DeviceNet, CANopen etc.

Ethernet, CANbus and Profibus daughter boards may be fitted to provide additional communications options.

Removable Storage A memory adaptor used with the MC224 allows a simple means of transferring programs without a PC connection. Offering the OEM easy machine replication and servicing. The memory adaptor is compatable with a wide range of Micro SD cards up to 2Gbytes and is ordered separately from the MC224 if required (order code: P396).

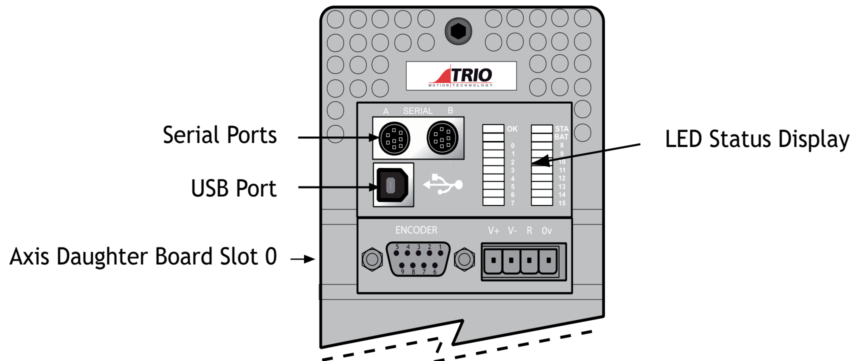


Axis Positioning Functions The motion control generation software receives instructions to move an axis or axes from the Trio BASIC language which is running concurrently on the same processor. The motion generation software provides control during operation to ensure smooth, coordinated movements with the velocity profiled as specified by the controlling program. Linear interpolation may be performed in as many axes as the controller provides, and circular or helical interpolation in any two orthogonal axes. Each axis may run independently or they may be linked in any combination using interpolation, CAM profile or the electronic gearbox facilities.

Consecutive movements may be merged to produce continuous path motion and the user may program the motion using programmable units of measurement (e.g. mm, inches, revs etc.). The module may also be programmed to control only the axis speed. The positioner checks the status of end of travel limit switches which can be used to cancel moves in progress and alter program execution.

Note: The MC224 incorporates a user replaceable battery for the battery back-up RAM. For replacement, use battery model CR2450 or equivalent.

Connections to the MC224



MC224 upper front panel

MC224 Serial Connections

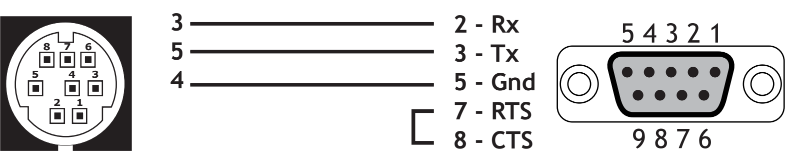
The MC224 features two serial connectors. Both connectors have a standard RS-232 serial interface. In addition, the left-hand connector (skt A) has connections for the Fibre-Optic Adapter and skt B contains the RS-485 multi-drop terminals (addressed as port 2).

Below the serial port connectors is the built in USB port.

Port 0 is the default connection between the *Motion Coordinator* and the host PC running *Motion* Perfect for programming. As an option, *Motion* Perfect may be connected via USB.

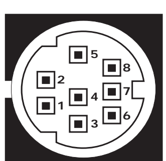
Serial Cables

Trio recommend the use of their pre-made serial cables (product code P350). If cables need to be made to connect to a PC serial port the following connections are required:



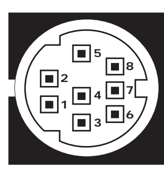
Motion Coordinator to 'AT' style PC with 9pin serial connector

Serial Connector A:



Serial Connector 0:		
Pin	Function	Notes
1	Internal 5V	
2	Internal 0V	
3	RS232 Transmit	Serial Port #0
4	RS232 Ground	
5	RS232 Receive	
6	+5V Output	Serial Port #3 / #4
7	Externally buffered output (TTL)	
8	Externally buffered input (TTL)	
On the MC224 pins 1,2,7 and 8 can be used to interface a fibre optic adapter. Note: Port 0 is the default programming port for connection to the PC running *Motion Perfect*.		

Serial Connector B:



Serial Connector 1		
Pin	Function	Note
1	RS485 Data in A Rx+	Serial Port #2
2	RS485 Data in B Rx-	
3	RS232 Transmit	Serial Port #1
4	RS232 Ground	
5	RS232 Receive	
6	+5V Output	Serial Port #2
7	RS485 Data out Z Tx-	
8	RS485 Data out Y Tx+	

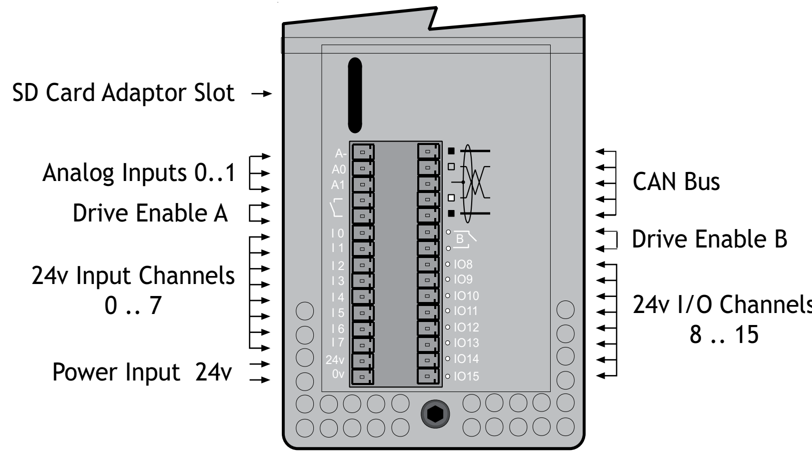
There is no hardware handshake on the serial ports. An XON/XOFF protocol is used.

Network Interconnection

The optional Fibre-Optic Network connection is designed for communication between the master modules and membrane keypads on large machines, or small workgroups of machines.

The software for the network supports interconnection of up to 15 nodes in a token-ring network format. The nodes may consist of any combination of compatible master controllers and Trio Membrane Keypads.

Note: Any membrane keypads connected must have software version 2.01 or higher.



MC224 lower front panel

24V Power Supply Input

The MC224 is powered entirely via the 24v d.c.supply connections. The unit uses internal DC-DC converters to generate independent 5V logic supply, the encoder 5V supply and other internal power supplies.

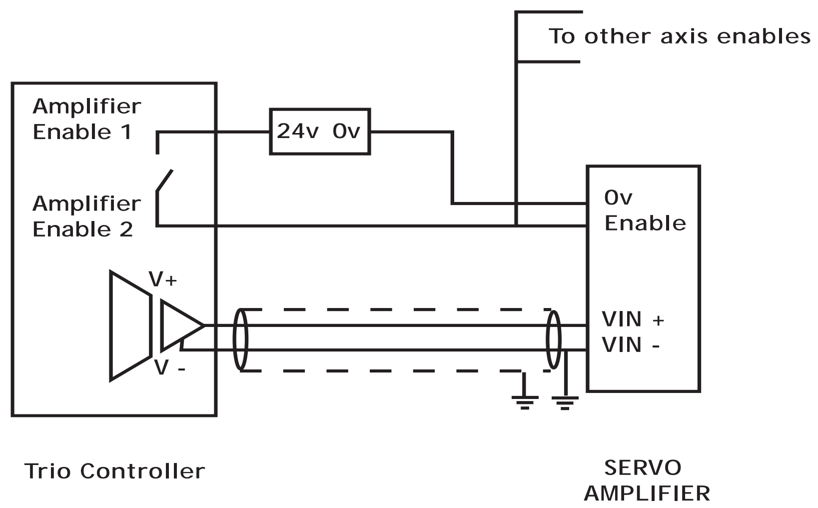
Note: *24V dc, Class 2 transformer or power source.*

Amplifier Enable (Watchdog) Relay Outputs

Two internal relay contacts are available to enable external amplifiers when the controller has powered up correctly and the system and application software is ready. The amplifier enables A and B are solid-state relays with an ON resistance of 25 ohms at 100mA. The enable relay will be open circuit if there is no power on the controller OR a following error exists on a servo axis OR the user program sets it open with the WDOG=OFF command.

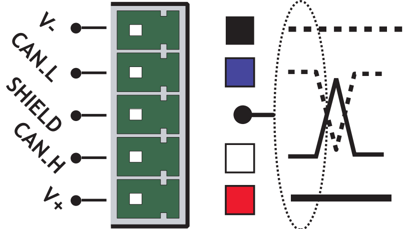
The amplifier enable relay may, for example, be incorporated within a hold-up circuit or chain that must be intact before a 3-phase power input is made live.

Note: *ALL STEPPER AND SERVO AMPLIFIERS MUST BE INHIBITED WHEN THE AMPLIFIER ENABLE OUTPUTS ARE OPEN CIRCUIT*



Amplifier Enable Output

CAN Bus:



The MC224 features a built-in CAN channel. This is primarily intended for Input/Output expansion via Trio's P316 and P325 modules. It may be used for other purposes when I/O expansion is not required.

The CANbus port is electrically equivalent to a *DeviceNet* node.

Analogue Inputs

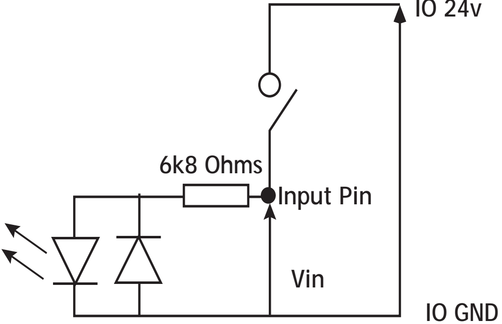
Two built-in 12 bit analogue inputs are provided which are set up with a scale of 0 to 10 Volts. External connection to these inputs is via the 2-part screw terminal strip on the lower front panel. The connections are labelled A-, A0 and A1.

24V dc must be applied to the CANbus port to provide power for the analogue input circuit.

24V Input Channels

The *Motion Coordinator* has 16 24V Input channels built into the master unit. These may be expanded to 256 Inputs by the addition of CAN-16 I/O modules.

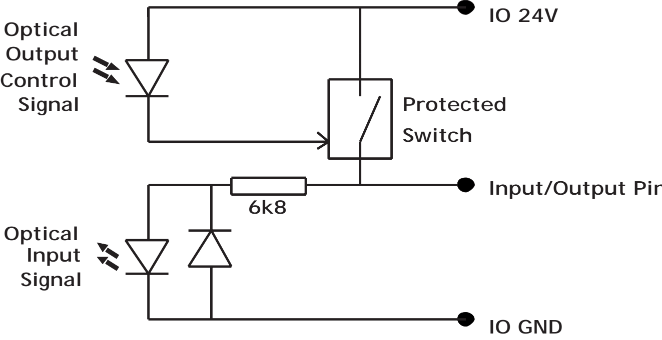
All of the 24V input channels have the same circuit although 8 on the master unit have 24V Output channels connected to the same pin. These bi-directional channels may be used for Input or Output to suit the application. If the channel is to be used as an Input the output should not be switched on in the program.



24V I/O Channels

Input/output channels 8..15 are bi-directional. The inputs have a protected 24V sourcing output connected to the same pin. If the output is unused it may be used as an input in the program. The input circuitry is the same as on the dedicated inputs. The output circuit has electronic over-current protection and thermal protection which shuts the output down when the current exceeds 250mA.

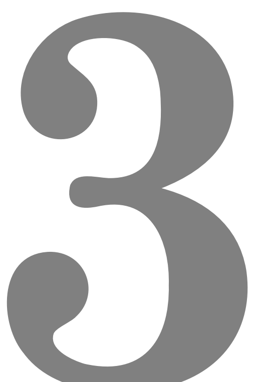
Care should be taken to ensure that the 250mA limit for the output circuit is not exceeded, and that the total load for the group of 8 outputs does not exceed 1 amp.



MC224 - Feature Summary

Size	262 mm x 68 mm x 198 mm (HxWxD)
Weight	750 g
Operating Temp.	0 - 45 degrees C
Control Inputs	Forward Limit, Reverse Limit, Datum Input, Feedhold Input.
Communication Ports	(2) RS232 channels: up to 38400 baud. (1) RS485 channel built in, (1) Serial adapter port. CANbus port (***DeviceNet*** compatible), (1) USB 12Mb
Position Resolution	32 bit position count
Speed Resolution	32 bits. Speed may be changed at any time. Moves may be merged.
Servo Cycle	250 µs minimum for all axes, 1 mS default
Programming	Multi-tasking TRIO BASIC system, maximum 14 user tasks.
Interpolation modes	Linear 1-24 axes, circular, helical, CAM Profiles, speed control, electronic gearboxes.
Memory	1 Mbyte battery-backed user menory. 1 Mbyte TABLE memory. Flash EPROM program storage.
Memory Stick	Socket for plug-in “Nexflash Mediastick” or P396 Micro SD card adaptor. Used for storing programs and/or data.
Power Input	24V dc, Class 2 transformer or power source. 18..29V dc at 450mA typical. Maximum: 800 mA + digital output current.
Amplifier Enable Output	2 Normally open solid-state relays rated 24V ac/dc nominal. Maximum load 100mA. Maximum voltage 29V.
Analogue Inputs	2 isolated x 12 bit 0 to 10V.
Encoder Power Output	5v at 600mA total for 4 encoders via daughter boards. Maximum 150mA per daughter board.
Digital Inputs	8 Opto-isolated 24V inputs.
Digital I/O	8 Opto-isolated 24V outputs. Current sourcing (PNP) 250 mA. (max. 1A per bank of 8)

CHAPTER

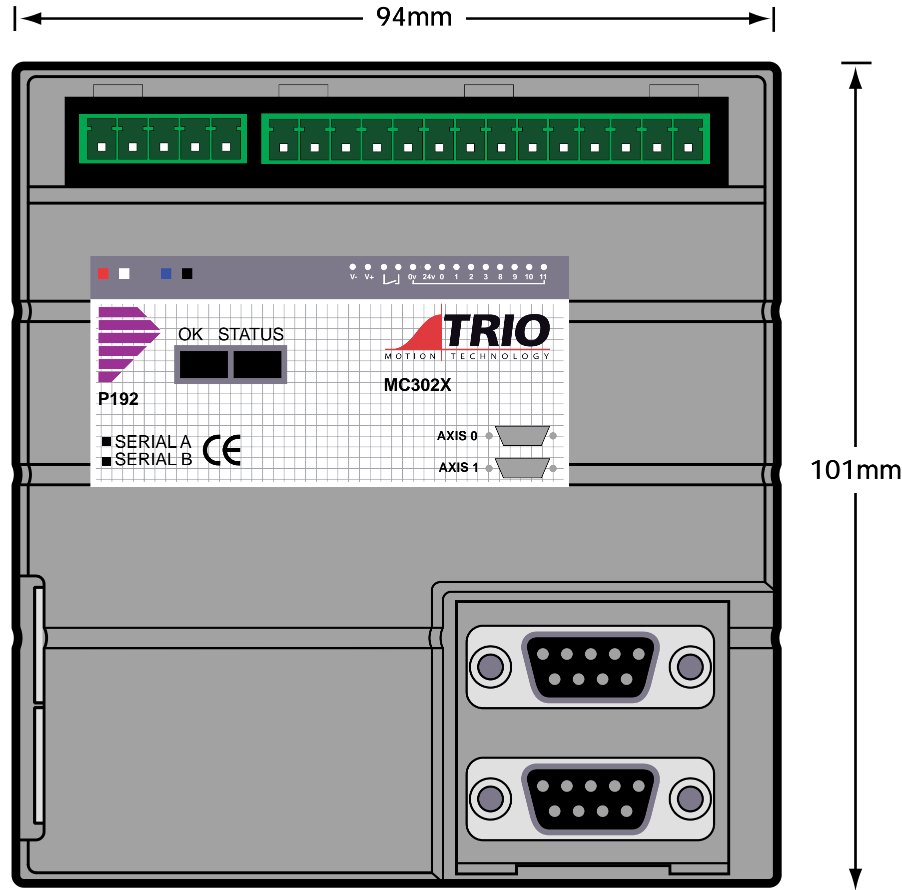


INSTALLATION

Motion Coordinator MC302X

Packaging

The *Motion Coordinator* MC302X is a DIN rail mounting product. The module is held by a spring clip on its bottom edge on to the DIN rail. The unit should be mounted vertically and should not be subjected to mechanical loading. Care should be taken to ensure that there is a free flow of air vertically around the unit. The dimensions are as shown below.



Including the disconnect terminal, the unit is 48mm deep.
When the serial connector is fitted, around 60mm more width is required.

Connection To Other Trio Products

The MC302X may be connected to other *Motion Coordinator* modules on the CAN bus or using encoder emulation output.

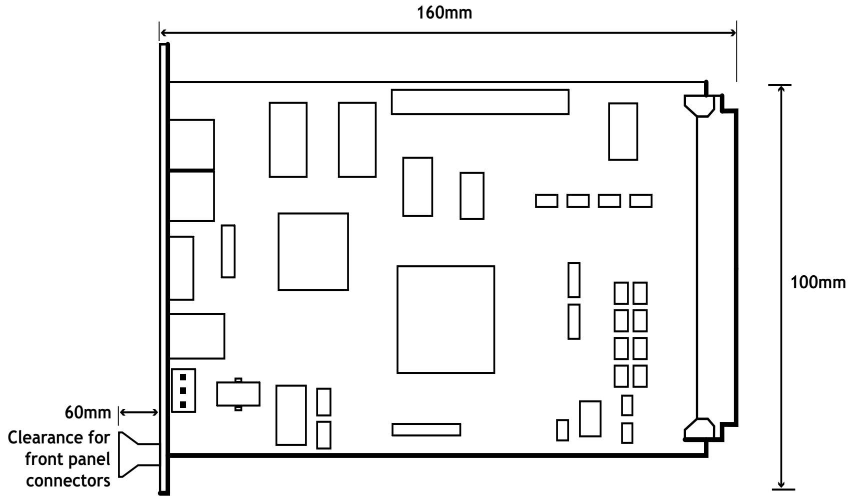
Environmental Considerations

Ensure that the area around the ventilation holes and top of the module are kept clear. Avoid violent shocks to, or vibration of, the system modules whilst in use or storage.

Motion Coordinator Euro 205x

Packaging

The *Motion Coordinator* Euro205x is a 3U Euro rack mounting product. The PCB dimensions are 160mm long x 100mm height. The connectors and front panel overhang these dimensions.



Rack Mounting

The Euro205x should be mounted in a shielded metal rack. The unit should be mounted vertically and should not be subjected to mechanical loading. Care should be taken to ensure that there is a free flow of air around the unit.

Connection To Other TRIO Products

The Euro205x may be connected to other *Motion Coordinator*s on the CAN bus, fibre-optic network or using encoder emulation output.

Environmental Considerations

Avoid violent shocks to, or vibration of, the Euro205x whilst in use or storage.

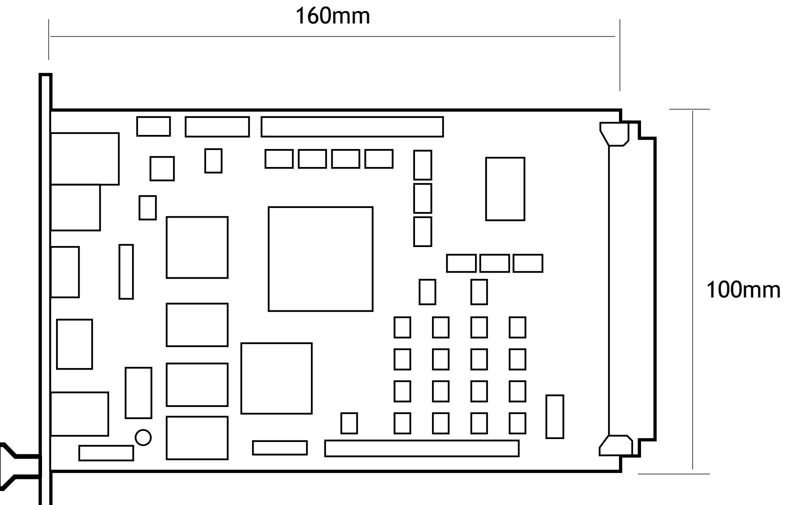
EMC Considerations

The Euro205x requires external power supplies, a card housing and suitable back-plane connections to be supplied and fitted by the machine builder before it can be used. For this reason the Euro205x is not considered by Trio to be a product for which we can offer qualification to known EMC standards. It is therefore only suitable to be taken into service on machines where the whole system fulfils the necessary EMC requirements.

Motion Coordinator Euro 209

Packaging

The *Motion Coordinator* Euro209 is a 3U Euro rack mounting product. The PCB dimensions are 160mm long x 100mm height. The connectors and front panel overhang these dimensions.



Rack Mounting

The Euro209 should be mounted in a shielded metal rack. The unit should be mounted vertically and should not be subjected to mechanical loading. Care should be taken to ensure that there is a free flow of air around the unit.

Connection To Other TRIO Products

The Euro209 may be connected to other *Motion Coordinator*s on the CAN bus, fibre-optic network or using encoder emulation output.

Environmental Considerations

Avoid violent shocks to, or vibration of, the Euro209 whilst in use or storage.

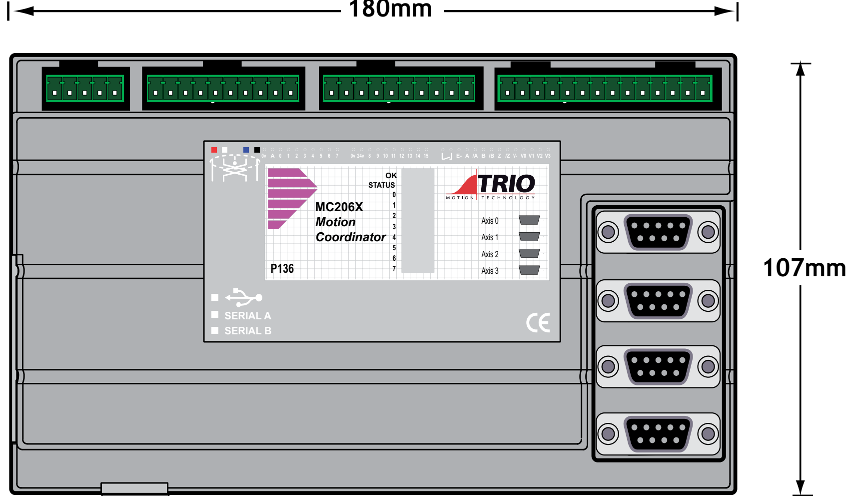
EMC Considerations

The Euro209 requires external power supplies, a card housing and suitable back-plane connections to be supplied and fitted by the machine builder before it can be used. For this reason the Euro209 is not considered by Trio to be a product for which we can offer qualification to known EMC standards. It is therefore only suitable to be taken into service on machines where the whole system fulfils the necessary EMC requirements.

Motion Coordinator MC206X

Packaging

The *Motion Coordinator* MC206X is a DIN rail mounting product. The module is held by spring clips on its bottom edge on to the DIN rail. The unit should be mounted vertically and should not be subjected to mechanical loading. Care should be taken to ensure that there is a free flow of air vertically around the unit. The dimensions are as shown below.



Including the disconnect terminal, the unit is 48mm deep.
When the serial connector is fitted, around 60mm more width is required.

Connection To Other TRIO Products

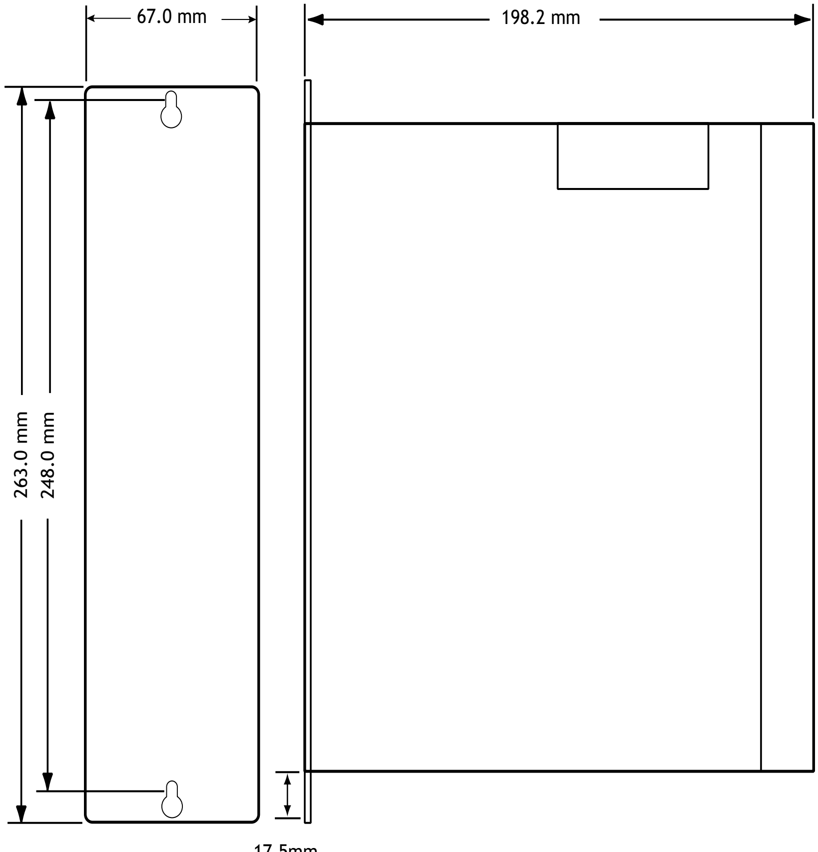
The MC206X may be connected to other *Motion Coordinator*s on the CANbus, fibre-optic network or using encoder emulation output.

Environmental Considerations

Ensure that the area around the ventilation holes and top of the module are kept clear. Avoid violent shocks to, or vibration of, the system modules whilst in use or storage.

Motion Coordinator MC224

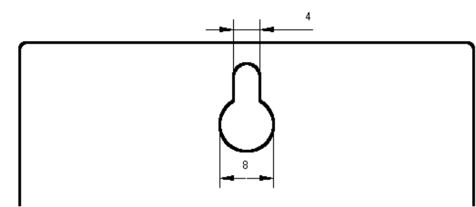
The *Motion Coordinator* MC224 modules are supplied with exterior packaging which has been specifically designed for ease of use and flexibility of mounting. The MC224 dimensions are given below.



Allow 70mm clearance for connectors at the front of the module.

Bulkhead Mounting

The module may be bulkhead mounted by securing in two locations through the rear panel of the unit with M4 screws. The unit should be mounted vertically and should not be subjected to mechanical loading. Care should be taken to ensure that there is a free flow of air vertically through the unit.



Module Interconnection

Modules to be connected should be mounted on 70mm centres at the same height. The MC224 should be at the right hand end. After mounting on the bulkhead the interconnection bus cover may be removed by unscrewing the 2 securing screws. The appropriate length of ribbon cable will be supplied ready assembled and tested by TRIO. With the power off, the ribbon cable can be inserted and the cable locked with the ears on each connector. The power may then be re-applied and all the interconnection bus covers replaced

Note: *Modules must never be connected or disconnected whilst the power supply is on.*

Environmental Considerations

Ensure that the area around the ventilation holes and top of the module are kept clear. Avoid violent shocks to, or vibration of, the system modules whilst in use or storage.

EMC Considerations

Most pieces of electrical equipment will emit noise either by radiated emissions or conducted emissions along the connecting wires. This noise can cause interference with other equipment near by which could lead to that equipment malfunctioning. These sort of problems can usually be avoided by careful wiring and following a few basic rules.

1) Mount noise generators such as contactors, solenoid coils and relays as far away as possible from the modules.
2) Where possible use solid-state contactors and relays.
3) Fit suppressors across coils and contacts.
4) Route heavy current power and motor cables away from signal and data cables.
5) Ensure all the modules have a secure earth connection.
6) Where screened cables are used terminate the screen with a 360 degree termination, if possible, rather than a "pig-tail" and connect both ends of the screen to ground.

The screening should be continuous, even where the cable passes through a cabinet wall or connector.

These are just very general guidelines and for more specific advice on specific controllers, see the installation requirements later in this chapter. The consideration of EMC implications is now more important than ever since the introduction of the EC EMC directive which makes it a legal requirement for the supplier of a product to the end customer to ensure that it does not cause interference with other equipment and that it is not itself susceptible to interference from other equipment.

Background to EMC Directive

Since 1st January 1996 all suppliers of electrical equipment to end users must ensure that their product complies with the 89/336/EEC Electromagnetic Compatibility directive. The essential protection requirements of this directive are:

1) Equipment must be constructed to ensure that any electromagnetic disturbance it generates allows radio and telecommunications equipment and other apparatus to function as intended.
2) Equipment must be constructed with an inherent level of immunity to externally generated electromagnetic disturbances.

Suppliers of equipment that falls within the scope of this directive must show “due diligence” in ensuring compliance. Trio has achieved this by having products that it considers to be within the scope of the directive tested at an independent test house.

As products comply with the general protection requirements of the directive they can be marked with the CE mark to show compliance with this and any other relevant directives. At the time of writing this manual the only applicable directive is the EMC directive. The low voltage directive (LVD) which took effect from 1st January 1997 does not apply to current Trio products as they are all powered from 24V which is below the voltage range that the LVD applies to.

Just because a system is made up of CE marked products does not necessarily mean that the completed system is compliant. The components in the system must be connected together as specified by the manufacturer and even then it is possible for some interaction between different components to cause problems but obviously it is a step in the right direction if all components are CE marked.

Testing Standards

For the purposes of testing a typical system configuration had to be chosen because of the modular nature of the *Motion Coordinator* products. Full details of this and copies of test certificates can be supplied by Trio if required. For each typical system configuration testing was carried out to the following standards:

Emissions - BS EN61000-6-4 : 2001.

(depending on the particular product.)

Note that both standards specify the same limits for radiated emissions which is the only applicable part of the standards to Trio products. Most products conform to the Class A limits but some products, such as the range of membrane keypads, are within Class B limits.

Immunity - BS EN61000-6-2 : 2001.

This standard sets limits for immunity in an industrial environment and is a far more rigorous test than part 1 of the standard.

Installation Requirements to Ensure Conformance

Motion Coordinator MC302X

When the Trio products are tested they are wired in a typical system configuration. The wiring practices used in this test system must be followed to ensure the Trio products are compliant within the completed system.

A summary of the guidelines follows:

1) The MC302X modules must be earthed via its shield connection of the CAN connector.
2) If any IO lines are not to be used they should be left unconnected rather than being taken to a terminal block, for example, as lengths of unterminated cable hanging from an IO port can act as an antenna for noise.
3) Screened cables should be used for encoder, stepper and registration input feedback signals and for the demand voltage from the controller to the servo amplifier if relevant. The demand voltage wiring must be less than 1m long and preferably as short as possible. The screen should be connected to earth at both ends. Termination of the screen should be made in a 360 degree connection to a metallised connector shell. If the connection is to a screw terminal e.g. demand voltage or registration input the screen can be terminated with a short pig-tail to earth.
4) Connection to the serial ports should be made with a Trio supplied cable. When a *Motion Coordinator* is not connected to a PC the serial cable must be removed as it will act as an antenna for electrical noise if it is left unterminated.
5) The MC302X should not be handled whilst the 24 volt power is connected.

As well as following these guidelines, any installation instructions for other products in the system must be observed.

Motion Coordinator Euro205x

The Euro205x should be mounted in a screened metal card cage. The power supplies should be generated by regulated filtered supplies.

The following requirements should also be adhered to:

1) The Euro205x's front panel should be earthed.
2) If any I/O lines are not to be used they should be left unconnected rather than being taken to a terminal block, for example, as lengths of unterminated cable hanging from an I/O port can act as an antenna for noise.

3) Screened cables should be used for encoder, stepper and registration input feedback signals and for the demand voltage from the controller to the servo amplifier if relevant. The demand voltage wiring must be less than 1m long and preferably as short as possible. The screen should be connected to earth at both ends. Termination of the screen should be made in a 360 degree connection to a metallised connector shell. If the connection is to a screw terminal e.g. demand voltage or registration input the screen can be terminated with a short pig-tail to earth.

4) Connection to the serial ports should be made with a Trio supplied cable. When a *Motion Coordinator* is not connected to a PC the serial cable must be removed as it will act as an antenna for electrical noise if it is left unterminated.

The Euro205 should not be handled whilst the power is connected.

As well as following these guidelines, any installation instructions for other products in the system must be observed.

Motion Coordinator Euro209

The Euro209 should be mounted in a screened metal card cage. The power supplies should be generated by regulated filtered supplies.

The following requirements should also be adhered to:

1) The Euro209's front panel should be earthed.

2) If any I/O lines are not to be used they should be left unconnected rather than being taken to a terminal block, for example, as lengths of unterminated cable hanging from an I/O port can act as an antenna for noise.

3) Screened cables should be used for encoder, stepper and registration input feedback signals and for the demand voltage from the controller to the servo amplifier if relevant. The demand voltage wiring must be less than 1m long and preferably as short as possible. The screen should be connected to earth at both ends. Termination of the screen should be made in a 360 degree connection to a metallised connector shell. If the connection is to a screw terminal e.g. demand voltage or registration input the screen can be terminated with a short pig-tail to earth.

4) Connection to the serial ports should be made with a Trio supplied cable. When a *Motion Coordinator* is not connected to a PC the serial cable must be removed as it will act as an antenna for electrical noise if it is left unterminated.

The Euro209 should not be handled whilst the power is connected.

As well as following these guidelines, any installation instructions for other products in the system must be observeed.

Motion Coordinator MC206X

When the Trio products are tested they are wired in a typical system configuration. The wiring practices used in this test system must be followed to ensure the Trio products are compliant within the completed system.

A summary of the guidelines follows:

1) The MC206X modules must be earthed via its SHIELD connection of the CAN connector.

2) If any I/O lines are not to be used they should be left unconnected rather than being taken to a terminal block, for example, as lengths of unterminated cable hanging from an I/O port can act as an antenna for noise.

3) Screened cables should be used for encoder, stepper and registration input feedback signals and for the demand voltage from the controller to the servo amplifier if relevant. The demand voltage wiring must be less than 1m long and preferably as short as possible. The screen should be connected to earth at both ends. Termination of the screen should be made in a 360 degree connection to a metallised connector shell. If the connection is to a screw terminal e.g. demand voltage or registration input the screen can be terminated with a short pig-tail to earth.

4) Connection to the serial ports should be made with a Trio supplied cable. When a *Motion Coordinator* is not connected to a PC the serial cable must be removed as it will act as an antenna for electrical noise if it is left unterminated.

5) The MC206X should not be handled whilst the 24 volt power is connected.

As well as following these guidelines, any installation instructions for other products in the system must be observed.

Motion Coordinator MC224

1) When the Trio products are tested they are wired in a typical system configuration. The wiring practices used in this test system must be followed to ensure the Trio products are compliant within the completed system. A summary of the guidelines follows:

   The case of the modules must be earthed via their back panel. If the mount-

ing panel is painted an area of paint should be removed to ensure a good electrical connection between the module and the cabinet.

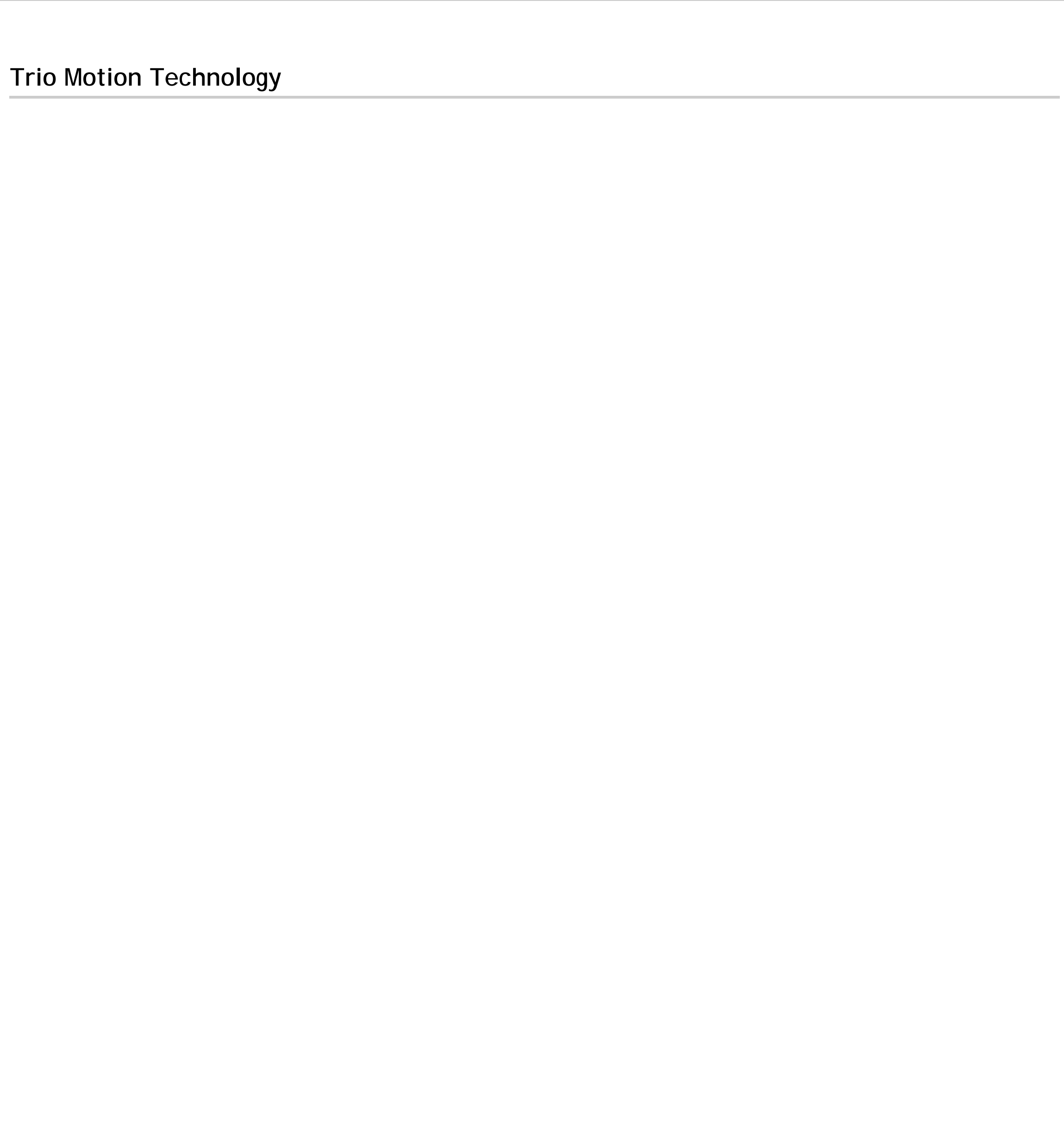
2) If any I/O lines are not to be used they should be left unconnected rather than being taken to a terminal block, for example, as lengths of unterminated cable hanging from an I/O port can act as an antenna for noise.

3) Screened cables should be used for encoder, resolver and registration input feedback signals and for the demand voltage from the controller to the servo amplifier if relevant. The demand voltage wiring must be less than 1m long and preferably as short as possible. The screen should be connected to earth at both ends. Termination of the screen should be made in a 360 degree connection to a metallised connector shell. If the connection is to a screw terminal e.g. demand voltage or registration input the screen can be terminated with a short pig-tail to one of the screw locks of the D-type shell of the encoder connector.

4) Connection to the serial ports should be made with a Trio supplied cable. When a *Motion Coordinator* is not connected to a PC the serial cable must be removed as it will act as an antenna for electrical noise if it is left unterminated.

5) Where the P230 Stepper Daughter Board is fitted in a P301 Axis Expander, the stepper connections must be made with screened cable. The screen must be terminated at both ends to earth (The case of the p301. A ferrite should be fitted near to the daughter board with at least 1.5 turns of the cable through the ferrite. E.g. TDK ZCAT 3036-1330.

As well as following these guidelines, any installation instructions for other products in the system must be observed.



CHAPTER

4

DAUGHTER BOARDS

Description The axis daughter boards give the *Motion Coordinator* system enormous flexibility in its configuration.

The number of daughter boards which may be fitted is dependant on the controller type.

The MC224 master units can hold up to 4 daughter boards in any combination. Up to 12 further daughter boards can be connected using optional Axis Expander units (4 daughter boards per unit). Communication Daughter Boards P291, P292, P293, P295, P296, P297 and P298 can only be fitted in the master unit.

The Euro 205x and the Euro209 have a single daughter board slot which can be used to provide a fifth axis in addition to the four axes (maximum) on board.

The MC206X can use a single daughter board to provide a sixth axis in addition to the five axes (maximum) which are available on the standard controller.

The *Motion Coordinator* recognises the type of axis daughter board or communications daughter board fitted in each slot. For example, a slot with a stepper daughter board fitted will return its **ATYPE** axis parameter as 1:

```
>>PRINT ATYPE
1.0000
```

Also slot 0 fitted with a USB daughter board, will return its **COMMSTYPE** parameter as 21:

```
>>PRINT COMMSTYPE SLOT(0)
21.0000
```

There are 19 types of daughter board currently available:

Product Code:	Description	ATYPE	COMMS TYPE
P200	Servo Encoder	2	
P201	Enhanced Servo Encoder	12	
P210	Servo Resolver	5	
P220	Reference Encoder	3	
P225	Analogue Input (8 x 16 bit)		28
P230	Stepper	1	
P240	Stepper Encoder	4	
P242	Hardware Pswitch	10	
P260	Analogue Output	6	
P270	SSI Absolute Servo	7	
P280	Differential Stepper	4	
P290	CAN		20
P291	SERCOS		24
P292	3 Axis SLM		22
P293	Enhanced CAN		29
P295	USB Interface		21
P296	Ethernet		25
P297	Profibus		23
P298	Ethernet IP		30

Note: For volume / OEM applications, Trio can produce custom daughter boards for specific customer applications where required.

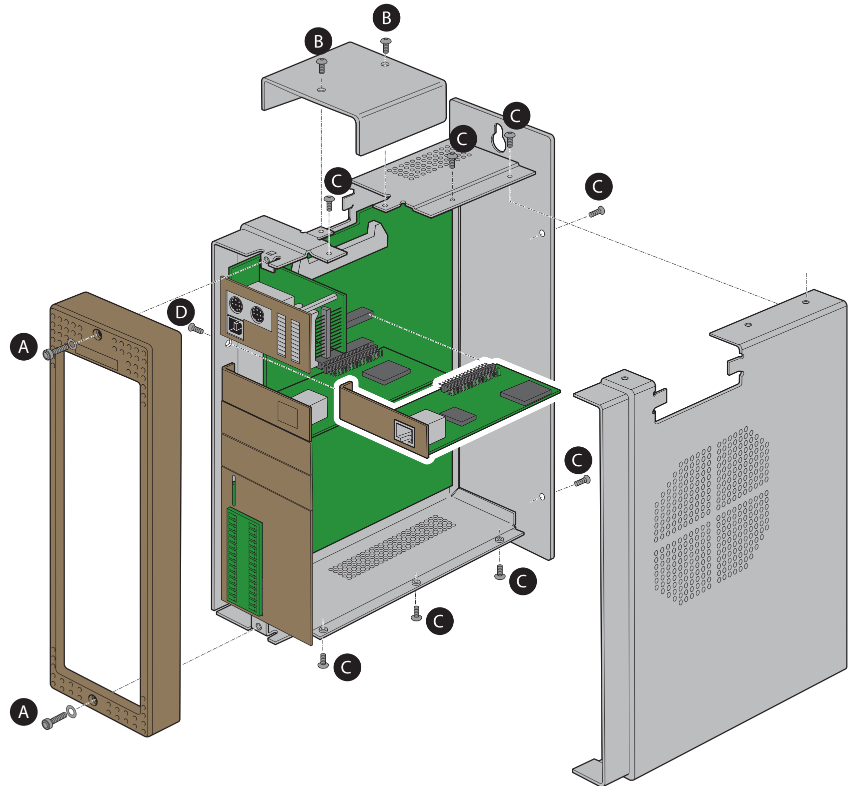
Fitting and Handling Daughter Boards

The axis daughter boards are normally supplied fitted into a *Motion Coordinator* system. If daughter boards need to be moved or replaced the following sequence must be followed.

The axis daughter boards are supplied in an anti-static bag or box. This should be used to hold the axis daughter board at all times when not installed in the *Motion Coordinator*.

Fitting Daughter Boards to the MC224 / Axis Expander

- Check there is no power on the module
- Unscrew the 2 Allen screws (A) which secure the front moulding cover and remove the cover
- Unscrew the top ribbon cable bus cover (B). If the ribbon cable is connected, remove this by pushing the retaining levers outwards.
- Unscrew the 8 screws (C) which secure the right hand side cover of the module
- Unscrew the single screw (D) which secures the axis daughter board to the left hand side of the module. This is located by the left hand end of the axis daughter front panel
- The sequence is reversed after inserting any new modules.



MC224 + Axis Expander Slot Sequence

The slot number of any daughter board is fixed by its position in the MC224 module. For standard axis daughter boards, this also fixes the axis number as shown.

Location	Axis
Slot 0 (Top)	Axis 0
Slot 1	Axis 1
Slot 2	Axis 2
Slot 3 (Bottom)	Axis 3

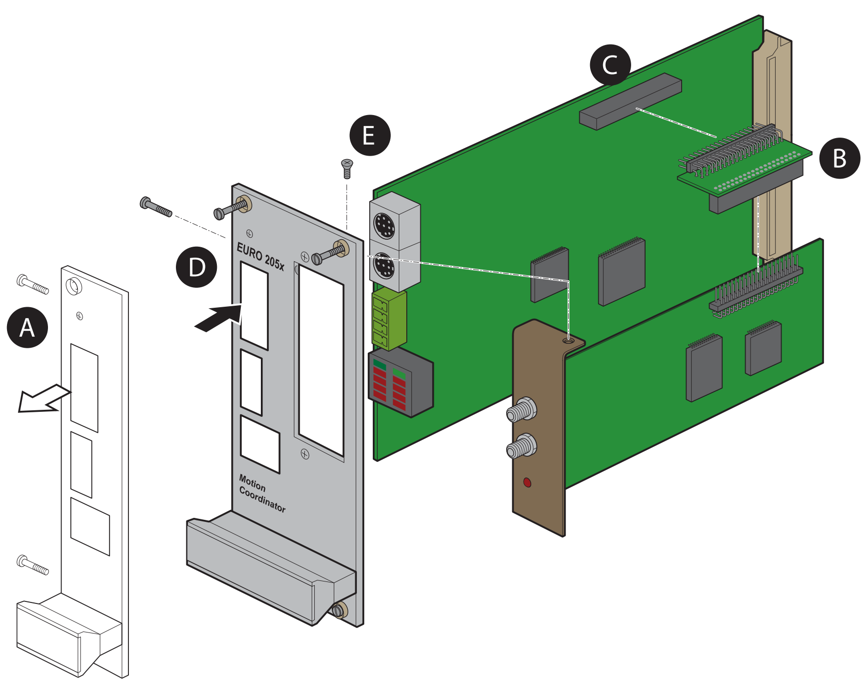
The axis number of any axis daughter board in the Axis Expander module is fixed by its position and the setting of the front panel selector switch on the Axis Expander.

Location	4-7*	8-11*	12-15**
Slot 0 (Top)	Axis 4	Axis 8	Axis 12
Slot 1	Axis 5	Axis 9	Axis 13
Slot 2	Axis 6	Axis 10	Axis 14
Slot 3 (Bottom)	Axis 7	Axis 11	Axis 15

Where digital drive communications daughter boards are used, the axis number is set by software and may not necessarily be the same as the slot number. In any case, with CANopen, SLM and SERCOS, multiple axes can be controlled via a single daughter board.

Fitting Daughter Boards to the Euro205x and Euro209

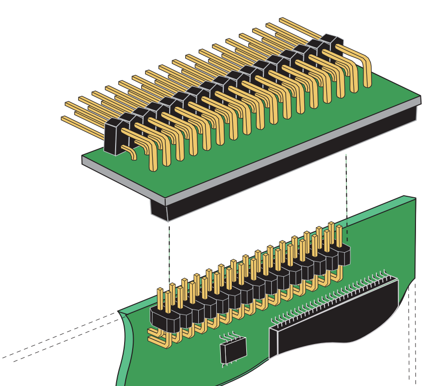
The *Motion Coordinator* Euro205x can use a single daughter board with an optional P445 Euro 205 Daughter Board Mounting Kit. The Euro 209 can use the P447 for the same purpose. Both consist of a replacement (double width) front panel and 90º header connector.



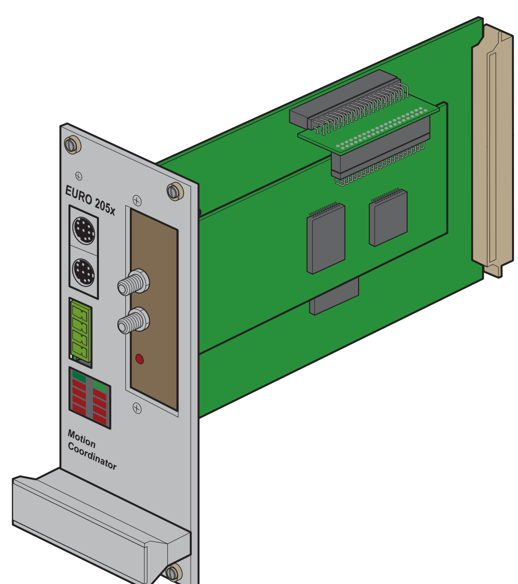
Installation Procedure

- Ensure that anti-static precautions are taken when handling the Euro205x and Euro209 boards.
- Check there is no power on the module
- Remove the standard front panel (A) by undoing the retaining screws from the rear of the PCB.
- Insert the new daughter board into the bottom of the adaptor (B), ensuring that the pins are inserted into the holes nearest the front of the Eurocard as shown in the following diagram.

Note: Some daughter boards, such as the CAN-Bus and Profibus communications boards, feature a longer connector and so the adaptor features a full-length socket to accommodate these. On an axis Daughter Board with the standard (shorter) connector the board should be inserted into the holes nearest the edge of the adaptor, as shown:

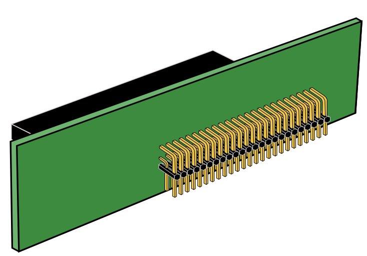


- Place the Euro205x/Euro209 PCB down on a firm flat surface and insert the adaptor pins into the daughter board socket (C).
- Fit the new front panel, being careful to line up the mounting bracket with the front panel of the daughter board (D).
- Insert the retaining screw into the front panel bracket to hold the daughter board in place (E).



Euro205x shown with Daughter Board in place

Fitting Daughter Boards to the MC206X

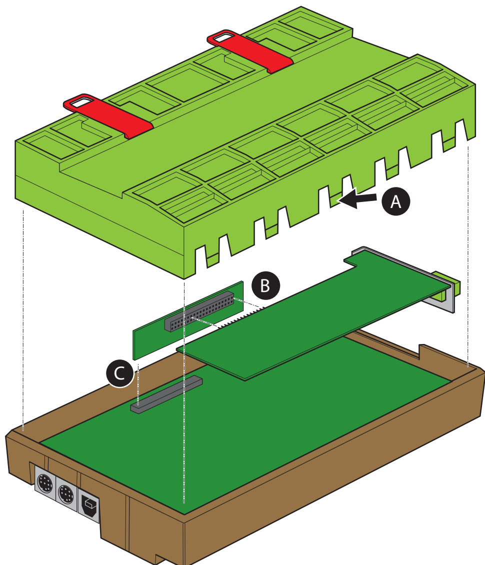


The *Motion Coordinator* MC206X can use a single daughter board. This is fitted internally, and connected via the optional P399 MC206X Daughter Board Adaptor (shown right).

The axis daughter boards are supplied in an anti-static bag or box. This should be used to hold the daughter board at all times when not installed in the *Motion Coordinator*.

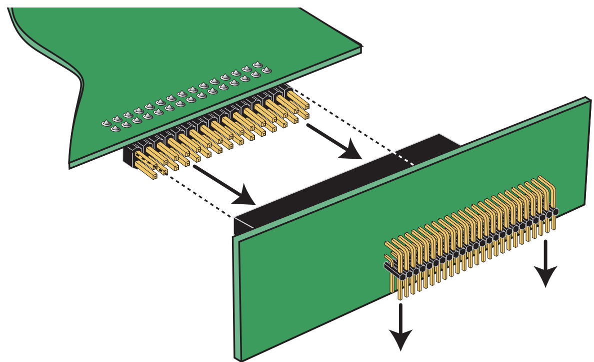
Installation Procedure

- Check there is no power on the module
- Turn the module face-down and carefully remove the back moulding.
  To remove the back moulding, a thin bladed small screwdriver needs to be inserted between the back and front mouldings to release in sequence each of the five latches (A) which locate the top edge of the back on to the front.
- Ensure that anti-static precautions are taken when handling the MC206X board.
- Connect the daughter board to the P399 adaptor (B), and insert the adaptor into the connector on the MC206X circuit board (C), as shown below

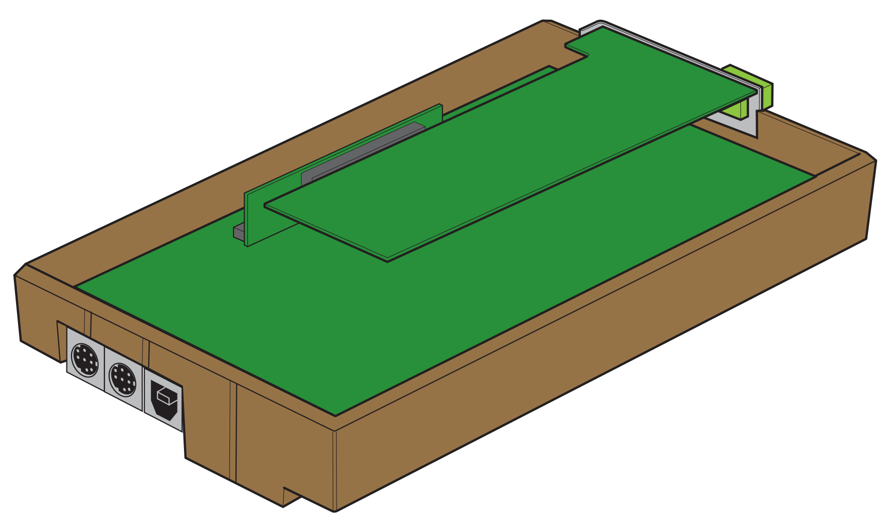


Rear of MC206X showing P399 daughter board adaptor

Note: Some daughter boards, such as the CANBus and Profibus communications boards, feature a longer connector and so the adaptor features a full-length socket to accommodate these. On an axis Daughter Board with the standard (shorter) connector the board should be inserted into the holes nearest the edge of the adaptor, as shown:



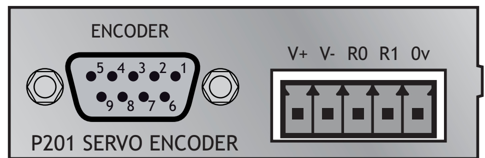
Alignment of MC206X daughter board adaptor



Rear of MC206X with Daughter Board In place

Enhanced Servo Encoder Daughter Board

Trio Product Code P201



Description: **ATYPE** parameter for Enhanced Servo Encoder Daughter Board = 12

The enhanced servo daughter board provides the interface to a DC or Brushless servo motor fitted with an encoder or encoder emulation.

Analogue Output

The Servo Encoder Daughter board provides a 16 bit +/-10V voltage output to drive most servo-amplifiers. The voltage output is opto-isolated as standard to maximise the noise immunity of the system.

Encoder Inputs

The encoder port provides differential line receiver inputs capable of counting up to 6MHz edge rate. These inputs are opto-isolated to maximise the noise immunity of the system. The encoder port also provides a convenient 5V output for powering the encoder, simplifying wiring and eliminating external supplies.

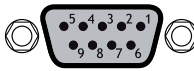
Registration Function

The Servo Encoder Daughter provides two hardware position capture functions for both the Z input and a dedicated 24 Volt registration input. Transitions of either polarity on both these inputs can be used to record the position of the axis at the time of the event within less than 1 micro second. This practically eliminates time delays and avoids interrupting the processor frequently in multi-axis systems.

Connections: **Encoder Connections:**

The encoder is connected via a 9 pin 'D' type socket mounted on the front panel. The plug supplied should be cable mounted and wired as shown below.

<u>The encoder port is designed for use with differential output 5 Volt encoders.</u>



Pin.	function
1	channel A true
2	channel A complement
3	channel B true
4	channel B complement
5	0V
6	marker (Z) true
7	marker (Z) complement
8	+5V (see Motion Coordinator for current rating)
9	Registration Input 5V Input pin
shell	Screen

The encoder may be powered from the +5V supply output on the daughter board, provided it requires a current that is less than the rating of the Motion Coordinator encoder supply. If the encoder is situated so far from the module that the supply is inadequate an external supply should be used and regulated locally to the encoder. In this case the +5V connection from pin 8 should not be used and the external supply 0V should be connected to pin 5 (0V).

If the encoder does not have complementary outputs, pins 2, 4 and 7 should be connected to a +2.5V bias voltage. This may be simply derived from a pair of 220 Ohm resistors in series with one end of the pair connected to 0v and the other end to +5V. The centre point of the pair will form approximately 2.5V.

If the encoder does not have a marker pulse, pins 6 and 7 may be left unconnected.

Voltage Output

The +/-10V output voltage to drive external servo amplifiers is generated between the V+ and V- pins. The voltage output is isolated and floating but if multiple servo daughter boards are fitted it should be noted that the boards share a common power supply for generation of the +/-10V. This means that the V- pins should not be referenced to different external voltages. Screened cable should be used for the voltage output connection and the screen connected to the metal case or backplate. Do not connect screens to the registration 0V terminal.

Registration Inputs

The two registration inputs are 24V dc input connected through high-speed opto-isolation into the encoder counter circuit. An alternative 5V input pin is available for R0 on the encoder port. The internal circuitry can be used to capture the position at which the registration input makes a transition from low to high or vice-versa. This function is accessed in software from the REGIST command. The input is measured relative to the 0V input on the servo daughter board which must be connected if the registration input is used. Note that this is the same 0V as the encoder port.

Registration Function

The board has two hardware position capture functions. One is available for both the Z input or a dedicated 24 Volt registration input, the second registration function is via a 24 Volt input only. Software access to the second registration input is by commands REGIST. See chapter 8 for further details.

Software Considerations: The servo function can be switched on or off with the SERVO axis parameter:

>>SERVO =ON

When the servo function is OFF the value in the axis parameter DAC is written to the 16 bit digital to analogue converter:

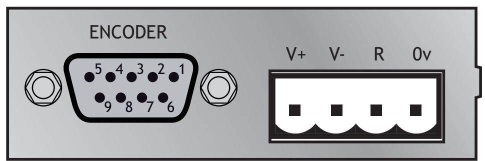
>>DAC=32767	This will set +10 Volts on voltage output when servo is OFF
>>DAC=0	This will set 0 Volts on voltage output when servo is OFF
>>DAC=-32768	This will set -10 Volts on voltage output when servo is OFF

Note: To maintain compatibility with earlier products, the axis parameter DAC_SCALE is provided.

DAC_SCALE=16	Simulates the operation of a 12 bit DAC
DAC_SCALE=1	Uses the full resolution of the 16 bit DAC

Servo Encoder Daughter Board

Trio Product Code P200



Description: **ATYPE** parameter for Servo Encoder Daughter Board = 2

The servo daughter board provides the same functionality as the P201 but with differences in specification. These include a 12 bit DAC, lower frequency encoder port and 1 registration input. The information here shows the differences between the P201 and P200 and the P201 section should be referred to for the D connector pinout etc.

Analogue Output

The daughter board provides a 12 bit +/-10V voltage output to drive most servo-amplifiers. The voltage output is inverted for backward compatibility with older products.

>>DAC=2047	This will set -10 Volts on voltage output when servo is OFF
>>DAC=0	This will set 0 Volts on voltage output when servo is OFF
>>DAC=-2048	This will set 10 Volts on voltage output when servo is OFF

Encoder Inputs

The encoder port provides differential line receiver inputs capable of counting up to 2MHz edge rate. These inputs are opto-isolated to maximise the noise immunity of the system. The encoder port also provides a convenient 5V output for powering the encoder, simplifying wiring and eliminating external supplies.

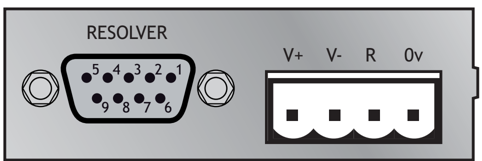
Registration Function

The board has one hardware position capture functions. This is available for either the Z input or a dedicated 24 Volt registration input.

Note: *The daughter board hardware inverts the voltage relative to the DAC parameter.*

Servo Resolver Daughter Board

Trio Product Code P210



Description: **ATYPE** parameter for Servo Resolver Daughter Board = 5

The resolver daughter board provides the interface to a DC or Brushless servo motor fitted with a resolver. The resolver port provides absolute position feedback within one motor turn. The resolver inputs are opto-isolated to maximise the noise immunity of the system. The resolver port also provides an oscillator output capable of driving many resolvers.

The resolver daughter board provides a hardware position capture function for both the zero marker input and a dedicated 24 Volt registration input. Transitions of either polarity on both these inputs can be used to record the position of the axis at the time of the event within less than 1 micro seconds. This practically eliminates time delays and avoids interrupting the processor frequently in multi-axis systems.

The resolver daughter board provides a 12 bit +/-10V voltage output to drive most servo-amplifiers. The voltage output is opto-isolated as standard to maximise the noise immunity of the system.

Connections: Voltage Output

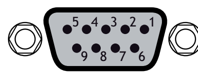
The +/-10V output voltage to drive external servo amplifiers is generated between the V+ and V- pins. The voltage output is isolated and floating but if multiple servo daughter boards are fitted it should be noted that the boards share a common power supply for generation of the +/-10V. This means that the V- pins should not be referenced to different external voltages.

Note: *The daughter board hardware inverts the voltage relative to the DAC parameter.*

Registration Input

The registration input is a 24V dc input connected through high-speed opto-isolation into the resolver circuit. An alternative 5V input pin is available on the encoder port. The internal circuitry can be used to capture the position at which the registration input makes a transition from low to high or vice-versa. This function is accessed in software from the REGIST command. The input is measured relative to the 0V input on the servo daughter board which must be connected if the registration input is used. Note that this is the same 0V as the resolver port.

Resolver Port Pinout



Pin	Function
1	SIN +
2	SIN -
3	COS +
4	COS -
5	0V
6	REF +
7	REF -
8	Analogue Velocity Output
9	Registration 5V Input

The reference oscillator runs at 2kHz and produces a +/- 2 Volt output.

The servo function can be switched on or off with the **SERVO** axis parameter:

>>SERVO =ON
When the servo function is OFF the value in the axis parameter **DAC** is written to the 12 bit digital to analogue converter.

Therefore:

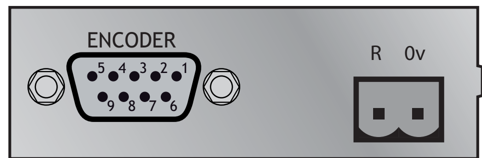
>>DAC=2047	This will set -10 Volts on voltage output when servo is OFF
>>DAC=0	This will set 0 Volts on voltage output when servo is OFF
>>DAC=-2048	This will set +10 Volts on voltage output when servo is OFF

The measured position of the axis **MPOS** is not reset to zero on power up but reset to a value in the range 0-4095. All other software functions are similar to the servo daughter board. The resolver converter circuit uses a fixed 12 bit conversion. The motor resolution will therefore be 4096 "edges"/turn.

Note: *The daughter board hardware inverts the voltage relative to the DAC parameter.*

Reference Encoder Daughter Board

Trio Product Code P220



Description: **ATYPE** parameter for Encoder Daughter Board = 3

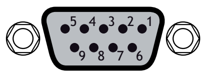
The encoder daughter board provides an encoder input without a servo feedback facility for measurement, registration and synchronization functions on conveyors, drums, flying shears, etc. The encoder port provides high speed differential receiver inputs. These inputs are opto-isolated to maximise the noise immunity of the system. The encoder port also provides an isolated 5Vv output capable of powering most encoders. This simplifies wiring and eliminates external power supplies.

The encoder daughter board provides a hardware position capture function for both the encoder Z input and the dedicated 24 Volt registration input. Transitions of either polarity on both these inputs can be used to record the position of the axis at the time of the event within less than 1 micro second. This practically eliminates time delays and avoids interrupting the processor frequently in multi-axis systems.

Connections: **Encoder Connections:**

The encoder is connected via a 9 pin 'D' type socket mounted on the front panel. The plug supplied should be cable mounted and wired as shown below.

<u>The encoder port is designed for use with differential output 5 Volt encoders.</u>



Pin.	function
1	channel A true
2	channel A complement
3	channel B true
4	channel B complement
5	0V
6	marker (Z) true
7	marker (Z) complement

Pin.	function
8	+5V (see Motion Coordinator for current rating)
9	Registration Input 5V Input pin
shell	protective ground

The encoder may be powered from the +5V supply output on the daughter board, provided it requires a current that is less than the rating of the Motion Coordinator encoder supply. If the encoder is situated so far from the module that the supply is inadequate an external supply should be used and regulated locally to the encoder. In this case the +5V connection from pin 8 should not be used and the external supply 0v should be connected to pin 5 (0V).

If the encoder does not have complementary outputs, pins 2, 4 and 7 should be connected to a +2.5V bias voltage. This may be simply derived from a pair of 220 Ohm resistors in series with one end of the pair connected to 0V and the other end to +5V. The centre point of the pair will form approximately 2.5V.

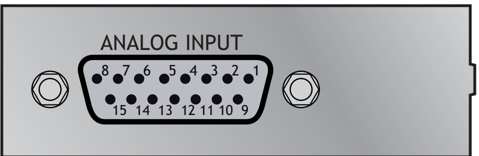
If the encoder does not have a marker pulse, pins 6 and 7 may be left unconnected.

Registration Input

The registration input is a 24V dc input connected through high-speed opto-isolation into the encoder counter circuit. An alternative 5V input pin is available on the encoder port. The internal circuitry can be used to capture the position at which the registration input makes a transition from low to high or vice-versa. This function is accessed in software from the **`REGIST`** command. The input is measured relative to the 0V input on the servo daughter board which must be connected if the registration input is used. Note that this is the same 0V as the encoder port.

Analogue Input Daughter Board

Trio Product Code P225

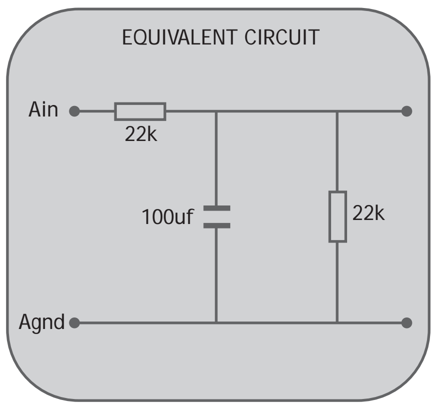


Description: **COMMSTYPE** parameter for Analogue Input Daughter Board = 28

The P225 analogue input daughter board provides 8 channels of 16 bit analogue inputs. By putting the analogue inputs on a daughter board they are especially useful for use as position feedback. The reading of the analogue inputs is synchronised with the servo loop of the *Motion Coordinator* at 1msec, 500usec or 250usec servo period.

Connections: The analogue inputs are connected via a 15 way "D" connector. The P225 has an isolation barrier between the analogue to digital converters and rest of the *Motion Coordinator*. However on *Motion Coordinator*s without an isolated external power supply, such as the Euro205x, the Euro209 and the MC206X the isolators will only isolate the data signals, not provide full isolation.

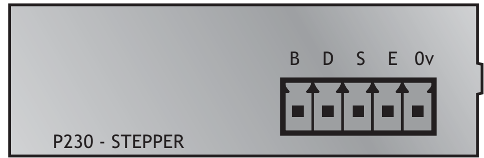
Pin.	function
1	Analogue Input 0
2	Analogue Input 1
3	Analogue Input 2
4	Analogue Input 3
5	Analogue Input 4
6	Analogue Input 5
7	Analogue Input 6
8	Analogue Input 7
9 .. 15	Analogue Ground (0V)
shell	protective ground



Programming: See the AIN() and AXIS_ADDRESS commands in chapter 8 for programming details.

Stepper Daughter Board

Trio Product Code P230



Description **ATYPE** parameter for Stepper Daughter Board = 1

The stepper daughter board generates pulses to drive an external stepper motor amplifier. Single step, half step and micro-stepping drives can be used with the board. All four output signals are opto-isolated on the stepper daughter board and each features overcurrent protection.

Specifications **Maximum Output Frequency**

In Single/Half step mode the stepper daughter board can generate pulses at up to 62 Khz.

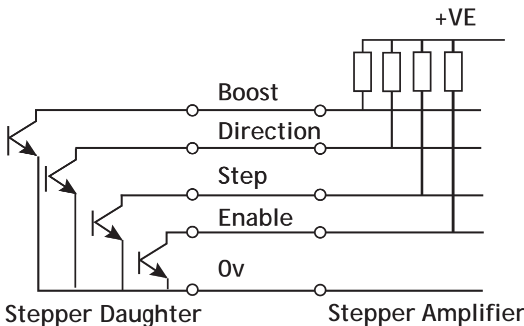
In microstep mode the stepper daughter can generate pulses at up to 250 KHz. See MICROSTEP command.

Connections

Pin	Function
B	Boost
D	Direction
S	Step
E	Enable
0v	0V reference for all connections

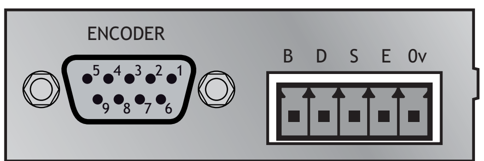
Each of the connections B, D, S, and E is an open-collector output. The outputs can be pulled up to 24V externally and can drive up to 100mA. Overcurrent protection is provided on the outputs.

Circuit



Stepper Encoder Daughter

Trio Product Code P240



Description: **ATYPE** parameter for Stepper Encoder Daughter Board = 4

The stepper daughter board with position verification has all the features of the standard stepper daughter board. Position verification is added to a stepper axis by providing encoder feedback to check the position of the motor.

An encoder port on the daughter board allows the position of the motor to be checked on every servo cycle. If the difference between the demanded number of steps and the measured position exceeds the programmed limit, the *Motion Coordinator* can take undertake a programmed error sequence.

Connections: **Stepper Output**

Each of the connections B, D, S, and E is an open-collector output. The outputs can be pulled up to 24V externally and can drive up to 100mA. Overcurrent protection is provided on the outputs.

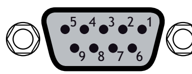
Pin	Function
B	Boost
D	Direction
S	Step
E	Enable
0V	0V reference for all connections

The circuit is identical to that of the P230 Stepper Daughter Board

Reference Encoder Input

The encoder is connected via a 9 pin 'D' type socket mounted on the front panel. The plug supplied should be cable mounted and wired as shown below.

The encoder port is designed for use with differential output 5 Volt encoders.



Pin.	function
1	channel A true
2	channel A complement
3	channel B true
4	channel B complement
5	0V
6	marker (Z) true
7	marker (Z) complement
8	+5V (see Motion Coordinator for current rating)
9	Registration Input 5V Input pin
shell	protective ground

The encoder may be powered from the +5V supply output on the daughter board, provided it requires a current that is less than the rating of the *Motion Coordinator* encoder supply. If the encoder is situated so far from the module that the supply is inadequate an external supply should be used and regulated locally to the encoder. In this case the +5V connection from pin 8 should not be used and the external supply 0V should be connected to pin 5 (0V).

If the encoder does not have a marker pulse, pins 6 and 7 may be left unconnected.

Choosing an encoder for position verification:

Stepper encoder daughter boards generate fewer pulses than the number of steps the controller considers the axis to be moving. The daughter board divides the number of steps the controller according to the axis parameter **MICROSTEP**:

MICROSTEP=OFF a factor of 16 (default mode)

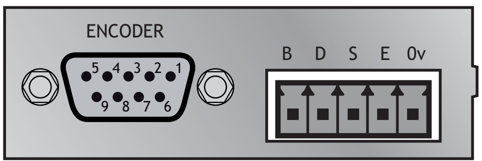
MICROSTEP=ON a factor of 2

The encoder for position verification should have a number of edges equal to the number of steps the controller moves by, or an integer factor higher. If a factor higher is used the **PP_STEP** axis parameter should be set.

Example: A stepper motor has 200 pulses/rev and is driven with **MICROSTEP=OFF**. The controller therefore moves a distance of 200*16=3200 counts to rotate the motor 1 turn. If an encoder is to be used for position verification the encoder would therefore need 3200, 6400, 9600 or 12800 etc.. edges/turn. As the encoder port will count 4 edges per encoder pulse, the ideal encoder would therefore have 800 pulses/rev or multiples thereof.

Hardware PSWITCH Daughter Board

Trio Product Code P242



Description: **ATYPE** parameter for Hardware PSWITCH Daughter Board = 10

The hardware PSWITCH daughter board allows 4 open-collector outputs to be switched ON and OFF at programmed positions. This function is similar to the software PSWITCH command which is implemented in the system software and allows outputs to be switched ON and OFF over position sectors. The Hardware PSWITCH daughter board performs the position comparison in electronics hardware on the daughter board. This allows the pulses generated to be very accurately timed.

Encoder Connections:

The encoder connections for a hardware PSWITCH daughter board are identical to those on the encoder port of a servo daughter board. The daughter board encoder input does NOT have registration facilities. The encoder edge rate for hardware PSWITCH functioning is limited to 500kHz.

Note: PP_STEP = -1 cannot be used to reverse the count direction on this card.

Output Connections:

The hardware PSWITCH daughter board is built as a Stepper Encoder daughter board with an alternative gate array fitted. The 5 way miniature disconnect connector is used to bring out the open-collector outputs:

Pin	Function
B	Output Channel 0
D	Output Channel 1
S	Output Channel 2
E	Output Channel 3
0V	Common 0V for outputs

Programming: See the PSWITCH command in chapter 8 for programming details.

Analogue Output Daughter Board

Trio Product Code P260

Description: **ATYPE** parameter for Voltage Output Daughter Board = 6.

The Analogue Output Daughter board provides a 12 bit +/-10v voltage output for driving inverters and other devices. The board is a simplified servo daughter board and the connections are similar. The encoder port does not function even if the connector is fitted.

Voltage Output

The +/-10V output voltage to drive external servo amplifiers is generated between the V+ and V- pins. The voltage output is isolated and floating but if multiple daughter boards are fitted it should be noted that the boards share a common power supply for generation of the +/-10V. This means that the V- pins should not be referenced to different external voltages.

The board functions like a servo daughter board with the SERVO= OFF the value in the axis parameter DAC is written to the 12 bit digital to analogue converter.

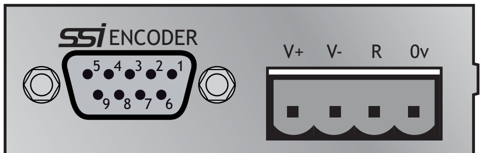
Therefore:

>>DAC=2047	This will set -10 Volts on voltage output
>>DAC=0	This will set 0 Volts on voltage output
>>DAC=-2048	This will set +10 Volts on voltage output

Note: *The daughter board hardware inverts the voltage relative to the DAC parameter.*

SSI Servo Encoder Daughter Board

Trio Product Code P270



Description: **ATYPE** parameter for Absolute Servo (SSI) Daughter Board = 7

The SSI daughter board provides the interface to a DC or Brushless servo motor fitted with an absolute SSI Gray Code encoder or encoder emulation. The encoder port provides high speed differential synchronous serial interface (SSI). This port is opto-isolated to maximise the noise immunity of the system.

The SSI port is programmable so that any number of bits from 1 to 24 can be clocked into the position registers.

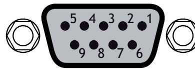
If the registration function is to be used then a minimum of 12 bits is required for correct operation.

The SSI daughter board provides a hardware position capture function for both a 5V differential input and a dedicated 24volt registration input. Transitions of either polarity on both these inputs can be used to record the position of the axis at the time of the event within less than 1 micro seconds. This practically eliminates time delays and avoids interrupting the processor frequently in multi-axis systems. It should be noted however that the SSI system overall does not support this level of accuracy due to delays in clocking data from the encoders.

The servo daughter board provides a 12 bit +/-10V Voltage output to drive most servo-amplifiers. The voltage output is opto-isolated as standard to maximise the noise immunity of the system.

Connections: SSI Connections:

The SSI encoder is connected via a 9 pin 'D' type socket mounted on the front panel. The socket supplied should be cable mounted and wired as shown below. The SSI encoder port is designed for use with differential output 5 Volt encoders.



Pin.	function
1	data true
2	data complement
3	clock true
4	clock complement
5	0V- must be connected even if an external PSU is used to power the encoder.
6	marker (Z) true - can be used as a second general purpose regist input.
7	marker (Z) complement - can be used as a second general purpose regist input.
8	+5V (see Motion Coordinator for current rating)
9	Registration Input 5v Input pin
shell	protective ground

The SSI encoder may be powered from the +5V supply output on the daughter board, provided it requires a current that is less than the rating of the *Motion Coordinator* encoder supply. If the SSI encoder requires a 24V supply then this must be provided externally. In this case the +5V connection from pin 8 should NOT be used and the external supply 0v should be connected to pin 5 (0V).

Voltage Output

The +/-10V output voltage to drive external servo amplifiers is generated between the V+ and V- pins. The voltage output is isolated and floating but if multiple servo daughter boards are fitted it should be noted that the boards share a common power supply for generation of the +/-10V. This means that the V- pins should not be referenced to different external voltages.

Registration Input

The registration input is a 24V dc input connected through high-speed opto-isolation into the encoder counter circuit. An alternative 5V input pin is available on the encoder port. The internal circuitry can be used to capture the position at which the registration input makes a transition from low to high or vice-versa. This function is accessed in software from the **REGIST** command. The input is measured relative to the 0V input on the servo daughter board which must be connected if the registration input is used. Note that this is the same 0v as the encoder port. Note: the Z pulse input normally used with incremental encoders is still available for use as a general purpose differential 5V regist input.

Software: The number of bits to be shifted in from the encoder attached to the SSI port is set using the **ENCODER_BITS** axis parameter. This parameter defaults to 0 on power up and this disables the reading of the encoder position into the MPOS parameter. As soon as **ENCODER_BITS** is set to a value in the range 1 - 24 the MPOS parameter will be set with the current position of the encoder and will then follow the position of the encoder until the controller is powered down or **ENCODER_BITS** is set to 0. For example if a 12 bit multi-turn encoder with 12 bits per turn is being used the command:

```
ENCODER_BITS=24
```

should be put at the start of the program or typed on the command line.

Binary operation.

Daughter boards fitted with FPGA version 1.2 are able to operate in either Bbinary or gray code data format. The **VERIFY** perameter is used for mode selection.

```
VERIFY ON = 'gray code
VERIFY OFF = 'Binary code
```

The SSI daughter board returns axis parameter ATYPE of 7. The servo function can be switched on or off with the **SERVO** axis parameter:

```
>>SERVO=ON
```

When the servo function is OFF the value in the axis parameter DAC is written to the 12 bit digital to analogue converter.

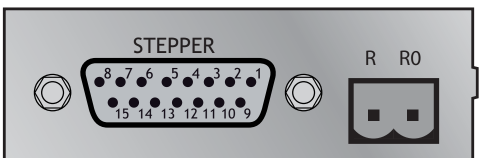
Therefore:

>>DAC=2047	This will set -10 Volts on voltage output when servo is OFF
>>DAC=0	This will set 0 volts on voltage output when servo is OFF
>>DAC=-2048	This will set +10 Volts on voltage output when servo is OFF

Note: *The daughter board hardware inverts the voltage relative to the DAC parameter.*

Differential Stepper Daughter Board

Trio Product Code P280



Description: **ATYPE** parameter for Differential Stepper Daughter Board = 4

The differential stepper daughter board is a stepper daughter board with the output signals provided as differential 5 Volt signals on a 15 way 'D' connector. The daughter board does not feature an encoder port for position verification, but does have a registration input to allow for capture of the number of step pulses when a registration signals arrives.

Connections: The differential stepper daughter board is fitted with a 15 way female 'D' connector:

Pin	Use
1	Step+
2	Direction+
3	Boost+
4	no connection
5	Fault input
6	no connection
7	no connection
8	Screen
9	Step-
10	Direction-
11	Enable+
12	Enable-
13	0V
14	0V
15	Boost-

All outputs are RS422 differential lines without terminating resistors. A 26LS31 line driver is employed. The fault input and registration inputs are single ended opto-isolated inputs that sink approximately 8mA.

WARNING: The Fault input and Registration input are designed for 5 Volt operation. Applying 24 Volts will damage the input circuit.

For 24 volt operation a 4k7 0.5Watt resistor must be added in series with the input.

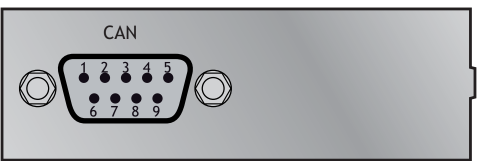
A 2 pin terminal connector is provided for the registration input.

Software Considerations

The differential daughter board uses the same axis gate array as a stepper encoder daughter board as is therefore recognised by the *Motion Coordinator* as this type (ATYPE=4). It does not however have an encoder inputs fitted so may only be used in the VERIFY=OFF mode where the stepper pulses are fed back into the encoder counter circuit.

CAN Daughter Board

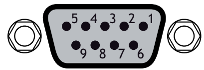
Trio Product Code P290



Description: **COMMSTYPE** parameter for CAN Daughter Board = 20

The CAN daughter board is particularly aimed at providing dedicated CAN channels for controlling servo amplifiers. It features opto-isolation and the ability to support communications at 1M Baud.

CAN Connections The CAN connection of the CAN daughter board is via a 9 way Male 'D' type connector. Pinout is compatible with that suggested by the CAN in AUTOMATION organisation:



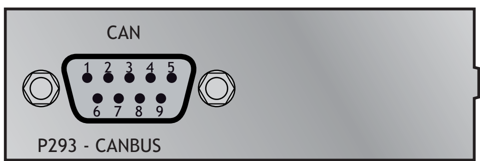
Pin	Use
1	no connection
2	CAN_L
3	CAN_GND
4	no connection
5	Shield
6	no connection
7	CAN_H
8	no connection
9	no connection

No terminating resistor is fitted internally to the CAN daughter board. A 120 ohm resistor must be fitted between pins 2 and 7 if at the end of the CAN network.

The daughter board CAN channel can be controlled using the Trio BASIC CAN command. The system software has dedicated communication software built-in to support particular communication protocols, such as that for INFRANOR SMT-BD CANbus drives and some CANopen drives.

Enhanced CAN Daughter Board

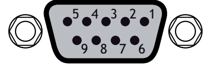
Trio Product Code P293



Description: **COMMSTYPE** parameter for Enhanced CAN Daughter Board = 29

The Enhanced CAN daughter board is particularly aimed at providing dedicated CAN channels for controlling servo amplifiers. It features the new OKI CAN controller, opto-isolation and the ability to support communications at 1M Baud.

CAN Connections The CAN connection of the CAN daughter board is via a 9 way Male 'D' type connector. Pinout is compatible with that suggested by the CAN in AUTOMATION organisation:



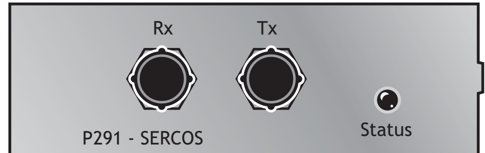
Pin	Use
1	no connection
2	CAN_L
3	CAN_GND
4	no connection
5	Shield
6	no connection
7	CAN_H
8	120 Ohm terminating resistor
9	no connection

The terminating resistor, fitted internally to the CAN daughter board, is selected by joining pins 7 and 8 of the d-type connector.

The daughter board CAN channel can be controlled using the Trio BASIC CAN command. There is also dedicated communication software built into the *Motion Coordinator* system software for the support of CANbus drives using the CIA CanOpen protocol. Please contact Trio for a list of supported drive manufacturers.

SERCOS Daughter Board

Trio Product Code P291



Description: **COMMSTYPE** parameter for SERCOS Daughter Board = 24

The SERCOS daughter board is designed to control up to 8 servo amplifiers using the standard SERCOS fibre-optic ring. It has the benefit of full isolation from the drives and greatly reduces the wiring required.

SERCOS Connections: SERCOS is connected by 1mm polymer or glass fibre optic cable terminated with 9mm FSMA connectors. The SERCOS ring is completed by connecting Tx to Rx in a series loop.

LED Indicator: The red LED lights to indicate that the ring is open or there is excessive distortion in the signal.

SERCOS Interface: **SE**rial **R**ealtime **CO**mmunications **S**ystem

IEC61491 / EN61491

SERCON 816 ASIC

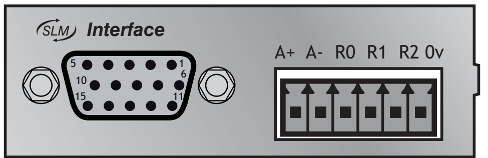
2, 4, 8 and 16 Mbit/sec selectable by software

Software settable intensity

Up to 8 axes per ring at 250usec servo update

SLM Daughter Board

Trio Product Code P292



Description: **COMMSTYPE** parameter for SLM Daughter Board = 22

The SLM daughter board is aimed at providing digital control channels for servo drives utilising the SLM protocol of Control Techniques. This daughter board has the necessary circuits for controlling between 1 and 3 axes which can be individual drives or a single drive using the CT Multiax concept.

SLM Connections The SLM connector is a 15 way high-density D-type socket.

Pin	Use
1	Com axis 0
2	/Com axis 0
3	Hardware enable
4	0V external
5	24V output to supply SLM
6	Com axis 1
7	/Com axis 1
8	no connection
9	no connection
10	no connection
11	24V output to supply SLM
12	0V external
13	Com axis 2
14	/Com axis 2
15	Earth / Shield

Connect the cable screen to the plug shell (screen/cable clamp) as well as pin 15.

A 6-way terminal is provided for power and registration inputs.

Pin	Function
A+	24V supply for SLM
A-	0V supply for SLM
R0	Axis 0 24V registration capture input
R1	Axis 1 24V registration capture input
R2	Axis 2 24V registration capture input
0V	0V return for registration capture inputs

A 24 volt power source must be applied to A+ and A- to supply the SLM modules. This may be the same supply as is used for the *Motion Coordinator*.

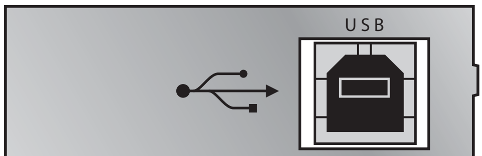
The power requirements are:

Supply voltage, 24V d.c. +/-10%.

Current consumption, 400mA in-rush, 100mA typical under normal running conditions.

USB Daughter Board

Trio Product Code P295



Description: **COMMSTYPE** parameter for USB Daughter Board = 21

The USB daughter board provides a very high speed Universal Serial Bus link between the *Motion Coordinator* and a host PC fitted with a USB port.

Support for this high speed interface is included in Trio's *Motion* Perfect 2 application and an ActiveX (OCX) software library is available which allows developers to include direct access to the *Motion Coordinator* within their own programs. Active X controls are supported by the majority of PC development platforms, including Visual Basic, Delphi, Visual C++, C++ Builder etc.

Note: MC206X and MC224 *Motion Coordinators* have USB port built-in as standard and so do not require this daughter board for USB operation.

Ethernet Daughter Board

Trio Product Code P296

Description: `COMMSTYPE` parameter for Ethernet Daughter Board = 25

The Ethernet daughter board provides a high speed link between the *Motion Coordinator* and a host PC via a factory or office local area network (LAN).

An industry standard Telnet terminal can be used to access the *Motion Coordinator's* command line over Ethernet.

The daughter board can run the Modbus TCP protocol as a slave, Thus allowing a Modbus master to read and write integer or floating point values to the global VRs and to access the I/O.

Software Support: Support for Ethernet is included in Trio's *Motion* Perfect 2 application and an ActiveX (OCX) software library is available which allows developers to include direct access to the *Motion Coordinator* within their own programs. Active X controls are supported by the majority of PC development platforms, including Visual Basic, Delphi, Visual C++, C++ Builder etc.

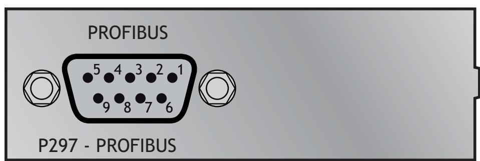
Ethernet Interface: Physical Layer: 10 Base-T

Connector: RJ-45

Protocols: Industry standard RFC compliant TCP/IP stack and protocol support for HTTP server, TCP, UDP, ARP, ICMP and IP.

Profibus Daughter Board

Trio Product Code P297



Description: **COMMSTYPE** parameter for Profibus Daughter Board = 23

PROFIBUS is a fieldbus system, which is in widespread use all over the world. With the P297 Profibus Daughter Board and appropriate software on the *Motion Coordinator*, it is possible to connect to a variety of third party Master devices using the Profibus DP protocol.

Connections:

Pin	Use
1	Not Connected
2	Not Connected
3	Data Line B
4	Request To Send
5	0V
6	+5V Output
7	Not Connected
8	Data Line A
9	Not Connected

Example: A example Trio BASIC Profibus driver for cyclic data transfer is available from the Trio Web Site **www.triomotion.com** (in the **DOWNLOADS** section, under **Application Notes**).

This program sets up the SPC3 chip for transfer of 16 integers from the master and 16 integers to the master on a cyclic basis as determined by master unit.

Ethernet IP Daughter Board

Trio Product Code P298

Description: **COMMSTYPE** parameter for Ethernet Daughter Board = 30

The Ethernet IP daughter board provides an industry standard CIP interface to the *Motion Coordinator* via a factory or office local area network (LAN).

Based on the HMS Anybus® IC chip, the Ethernet IP daughter board has complete Ethernet/IP adaptor class with I/O server, message client and CIP message routing. Additional support is provided for Modbus-TCP V1.0 server.

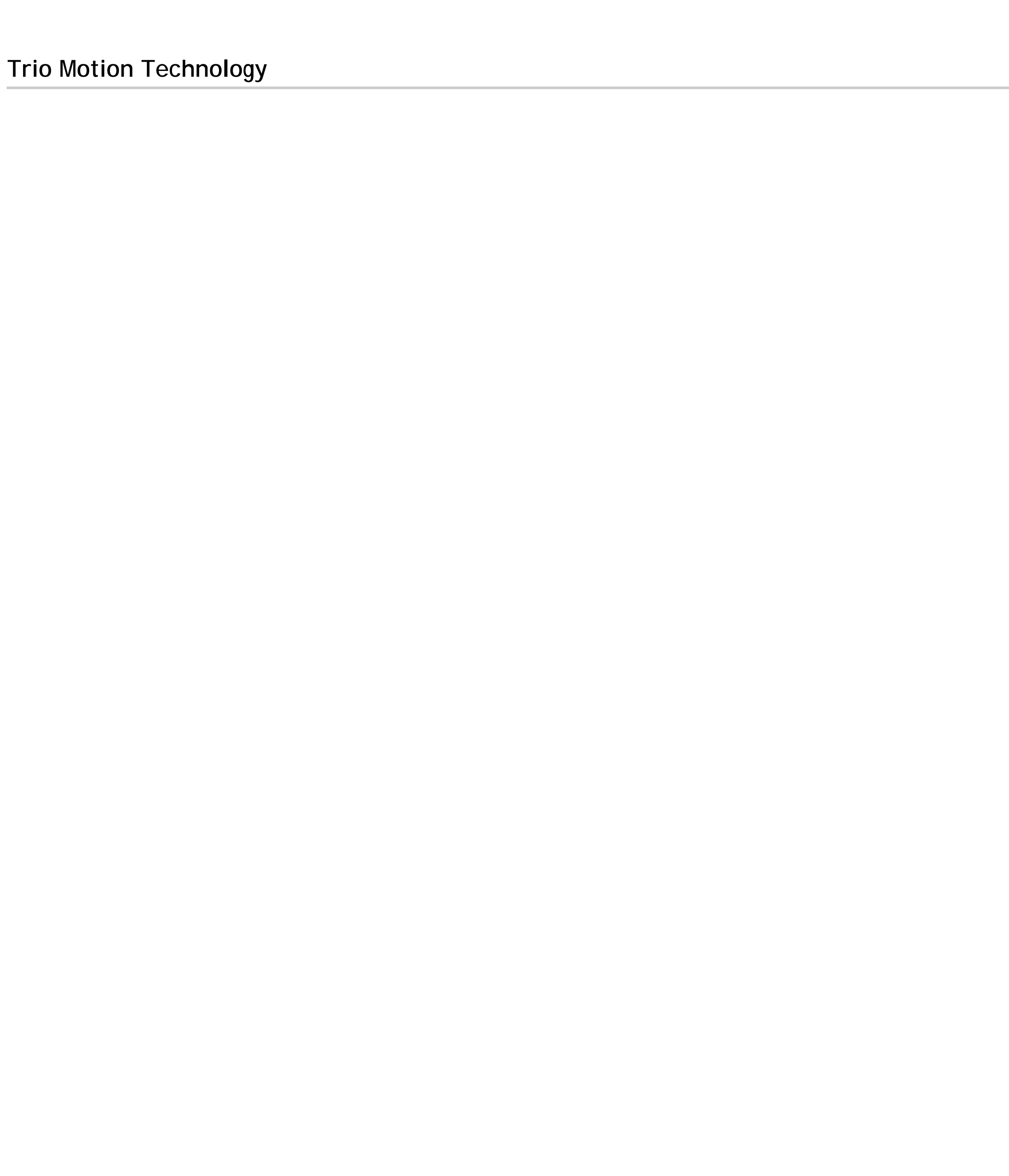
The daughter board has an integrated FTP server and dynamic web server with SSI script capability. In addition there is an email client with SSI script support

Software Support Third party software must be used to access the functions in the Ethernet IP daughter board. For example, a CIP compliant interface, web browser or Modbus TCP client.

Ethernet Interface Physical Layer: 10 Base-T, 10/100 base-T

Connector: RJ-45

Protocols: Ethernet IP, Modbus TCP, HTML web browser, TCP/IP Socket interface and IT functions.



CHAPTER

5

EXPANSION MODULES

Input/Output Modules

General Description

Trio can supply a range of Input/Output Modules and Operator Interface Units. The *Motion Coordinator* controllers allow for I/O expansion by having a CAN interface. This allows the I/O modules to form a network up to 100m in length. The operator interface units all communicate with controllers using the Trio fibre-optic network system. Alternatively third party operator interface units may be connected via a serial port. A third option is for machine manufacturers to build a dedicated operator interface for their application. Dedicated operator interfaces can be easily connected to the Trio fibre-optic network by building in a flexible interface board: FO-VFKB.

Product:	Product Code:
CAN 16-I/O Module	P316
CAN Analog Input Module	P325
Membrane Keypad	P503
Mini-Membrane Keypad	P502
Application Specific Keypad using FO-VFKB	P504

CAN 16-I/O Module (P316)

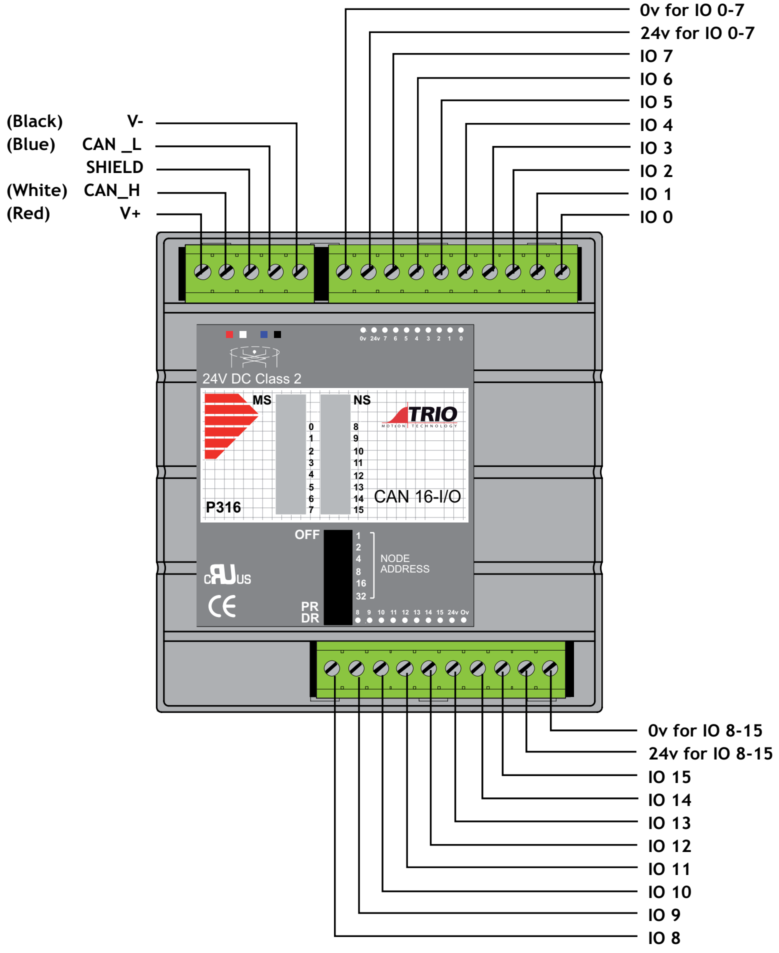
The CAN 16-I/O Module allows the 24 volt digital inputs and outputs of the *Motion Coordinator* to be expanded in blocks of 16 bi-directional channels.

Up to 16 CAN 16-I/O Modules may be connected allowing up to 256 I/O channels in addition to the internal channels built-in to the *Motion Coordinator*. Each of the 16 channels in each module is bi-directional and can be used either as an input OR as an output.

Convenient disconnect terminals are used for all I/O connections.

The CAN 16-I/O Module may also be used as an I/O expander for Lenze drives with an appropriate CAN interface.

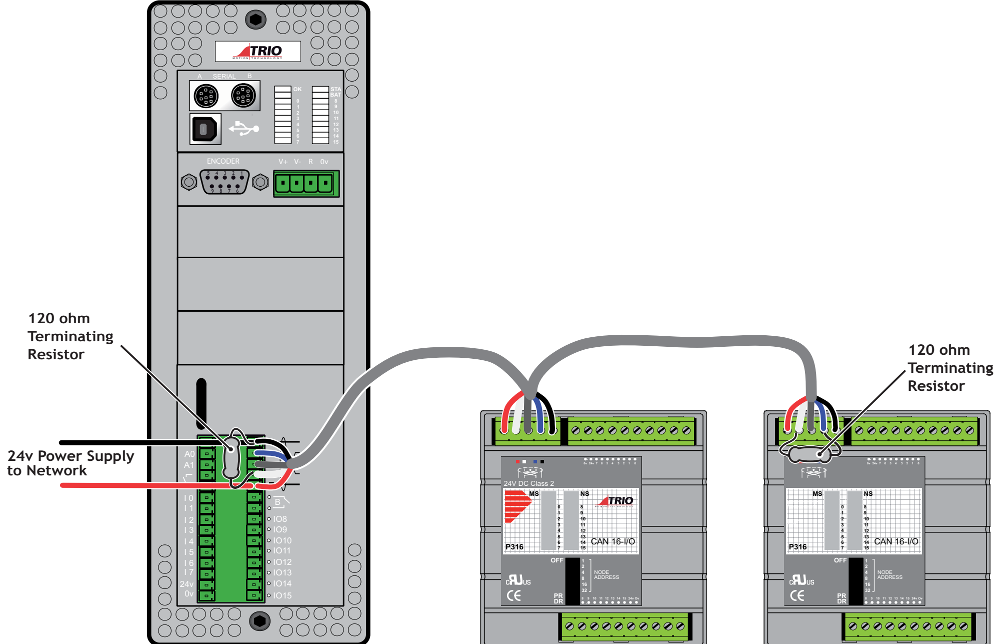
The earlier CAN Module (P315) is entirely compatible with the P316. P315 and P316 can be mixed within the same system.



I/O Connections: The CAN 16-I/O Module has 3 disconnect terminal connectors:

- DeviceNet physical format 5 way CAN connector
- Input/Output Bank 0 - 7 and power supply for bank 0 - 7 on 10 way connector
- Input/Output Bank 8 - 15 and power supply for bank 8 - 15 on 10 way connector.

Bus Wiring The CAN 16-I/O Modules and the *Motion Coordinator* are connected together on a network which matches the physical specification of DeviceNet running at 500kHz. The network is of a linear bus topology. That is the devices are daisy-chained together with spurs from the chain. The total length is allowed to be up to 100m, with drop lines or spurs of up to 6m in length. At both ends of the network, 120 Ohm terminating resistors are required between the CAN_H and CAN_L connections. The resistor should be 1/4 watt, 1% metal film.



The cable required consists of:

Blue/White 24AWG data twisted pair
+ Red/Black 22AWG DC power twisted pair
+ Screen

A suitable type is Belden 3084A.

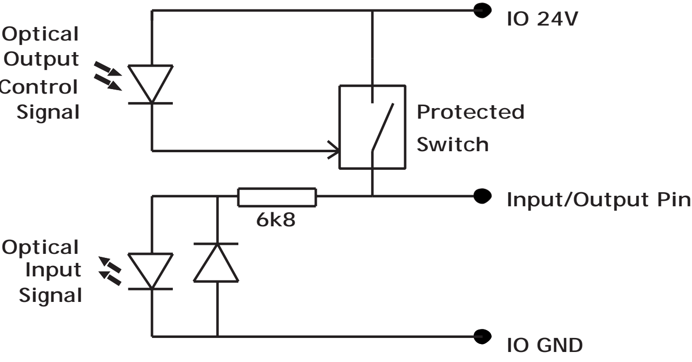
The CAN 16-I/O modules are powered from the network. The 24 Volts supply for the network must be externally connected. The *Motion Coordinator* **does NOT provide the network power.** In many installations the power supply for the *Motion Coordinator* will also provide the network power.

Note: *It is recommended that you use a separate power supply from that used to power the I/O to power the network as switching noise from the I/O devices may be carried into the network.*

24V I/O Channels

All input/output channels are bi-directional. The inputs have a protected 24V sourcing output connected to the same pin. If the output is unused it may be used as an input in the program. The output circuit has electronic over-current protection and thermal protection which shuts the output down when the current exceeds 250mA.

Care should be taken to ensure that the 250mA limit for the output circuit is not exceeded, and that the total load for the group of 8 outputs does not exceed 1 amp.



CAN16-I/O 24V I/O Channel

DIP Switch Settings

Address:	Start:	End:
0	16	31
1	32	47
2	48	63
3	64	79
4	80	95
5	96	111
6	112	127
7	128	143
8	144	159
9	160	175

Address:	Start:	End:
10	176	191
11	192	207
12	208	223
13	224	239
14	240	255
15	256	271

Alternative connection protocols

The DIP switches can be set up to allow for different protocols to be used, enabling the Trio I/O module to be used with other manufacturers devices. At present the only other protocol supported is that utilised by LENZE drives.

The DIP switch marked “PR” selects the protocol to be used. Switched right it selects the TRIO protocol, switched left it selects the module to act as a LENZE drive expansion I/O.

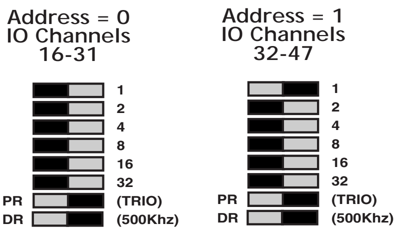
TRIO Protocol:

The switch marked PR is set ON to select the standard TRIO protocol.

The top 6 DIP switches on the CAN 16-I/O set the module address. Only addresses 0 - 15 are valid for CAN 16-I/O modules.

The switch marked DR sets the CAN Bus communications rate to 125kHz or 500kHz. Only 500Khz is valid with the TRIO protocol.

The addresses for I/O modules MUST be set in sequence, 0,1,2 etc. Therefore the first two CAN 16-I/O Modules would have switch settings as shown below:



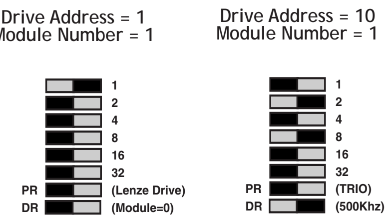
Note: *The I/O Channels referred to above start at 16. This is because the numbering sequence starts with channels 0 - 15, which are on the Motion Coordinator master unit itself.*

LENZE Drive Protocol:

The switch marked PR is set OFF to select the LENZE protocol.

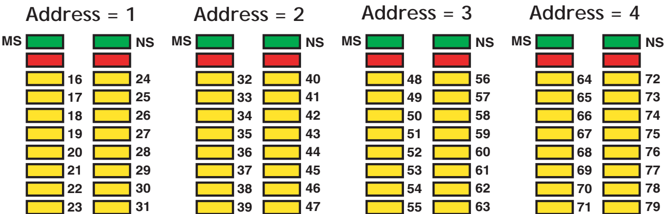
The top 6 DIP switches are used to set the drive number. This should be set to a to 1..63. If the drive number is set to 0, the module will transmit to drive 1.

The switch marked DR selects which of 2 potential I/O modules can transmit to each drive. The drive should be set to use 500Khz baudrate.



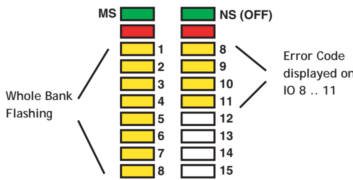
LED Indicators

When NS is ON LEDs marked 0 - 15 represent the input channels 0 - 15 of the module. The actual input as seen by the *Motion Coordinator* software will depends on the I/O modules address:



Error Codes:

When an error occurs on a CAN I/O module, the fault code is represented by a binary number displayed on the leds.



Code	Error Description
1	Invalid Protocol
2	Invalid Module Address
3	Invalid Data Rate
4	Uninitialised
5	Duplicate Address
6	Start Pending
7	System Shutdown
8	Unknown Poll
9	Poll Not Implemented
10	CAN Error
11	Receive Data Timeout

Software Interfacing

The *Motion Coordinator* will automatically detect and allow the use of correctly connected CAN I/O channels. The CAN I/O are accessed with the same **IN** and **OP** commands used to access the built-in I/O on the *Motion Coordinator*. The *Motion Coordinator* sets the system parameter **NIO** which reflects the number of I/O's connected to the system. 3 system parameters are available to facilitate the use of the CAN 16-I/O:

CANIO_STATUS, CANIO_ADDRESS and CANIO_ENABLE

When choosing which I/O devices should be connected to which channels the following points need to be considered:

- Inputs 0 - 31 ONLY are available for use with system parameters which specify an input, such as **FWD_IN**, **REV_IN**, **DATUM_IN** etc.
- Outputs 8 - 31 ONLY are available for use with the **PSWITCH** command.
- The built-in I/O channels have the fastest operation <1mS
- CAN I/O channels 16 - 64 have the next fastest operation <2mS
- CAN I/O channels 64 - 191 have the next fastest operation <8mS

It is not possible to mix the CAN 16-I/O module which is running the TRIO I/O protocol with DeviceNet equipment on the same network.

Troubleshooting

If the network configuration is incorrect 2 indications will be seen: The CAN 16-I/O module will indicate that it is uninitialised and the *Motion Coordinator* will report the wrong number when questioned:

```
>>? NIO
```

If this is not as expected check:

- Terminating 120 Ohm Network Resistors fitted?
- 24Volt Power to each IO bank required?
- 24Volt Power to Network?
- DIP switches in sequence starting 0,1,2...?
- System Software Version 1.40 (or higher)?
- *Motion Coordinator* CANIO_ADDRESS=32?

Specification

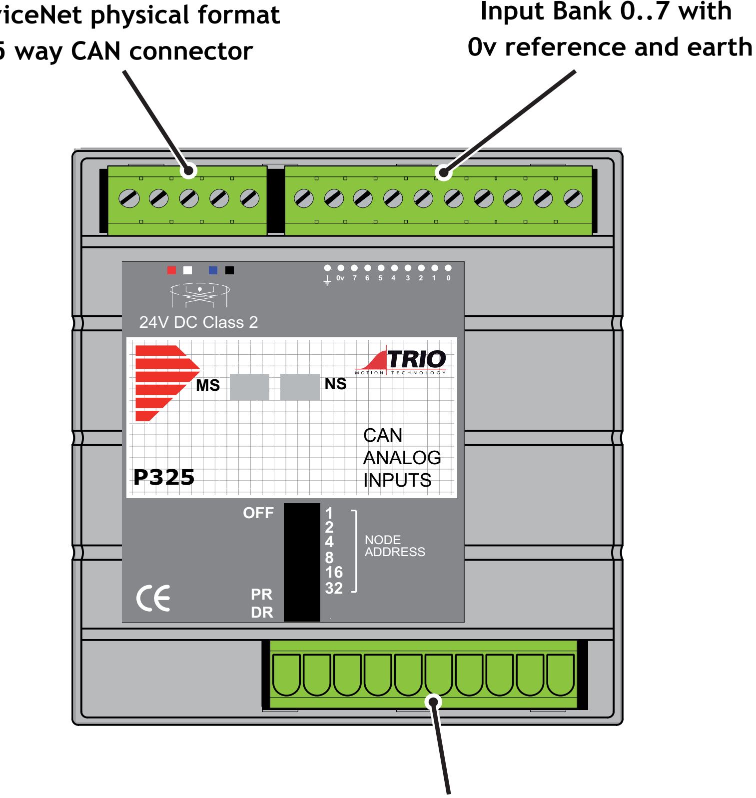
Inputs:	16 24Volt inputs channels with 2500V isolation
Outputs:	16 24Volt output channels with 2500V isolation
Configuration:	16 bi-directional channels
Output Capacity:	Outputs are rated at 250mA/channel. (1 Amp total/ bank of 8 I/O's)
Protection:	Outputs are overcurrent and over temperature protected
Indicators:	Individual status LED's
Address Setting:	Via DIP switches
Power Supply:	24V dc, Class 2 transformer or power source. 18 ... 29V dc / 1.5W
Mounting:	DIN rail mount
Size:	95mm wide x 45mm deep x 105mm high
Weight:	200g
CAN:	500kHz, Up to 256 expansion I/O channels
EMC:	BSEN50082-2 (1995) Industrial Noise Immunity / BS EN55022 (2001) Industrial Noise Emissions

CAN Analog Inputs Module (P325)

The CAN Analog Input Module allows the *Motion Coordinator* to be expanded with banks of 8 analogue input channels. Up to 4 x P325 Modules may be connected allowing up to 32 x 12 bit analogue channels. Convenient disconnect terminals are used for the I/O connections. The input channels are designed for +/-10Volt operation. Each bank of 8 channels is opto-isolated from the CAN bus.

I/O Connections

The CAN Analog Input Module has 3 disconnect terminal connectors:

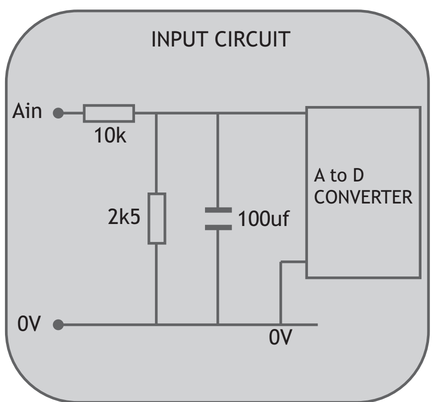


Bus Wiring

See Can 16-I/O for details

Input Terminals

The 8 analogue inputs are single-ended and are interfaced to a common 0V. An earth connection is provided as a termination point for shielded cables. Analogue input nominal impedance = 12k

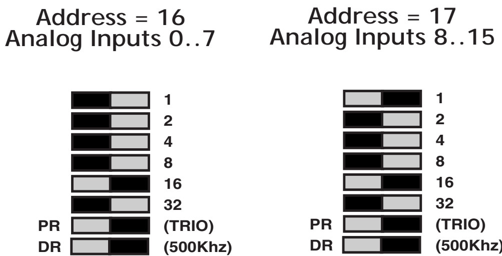


DIP Switch Settings

The switch marked “PR” selects the protocol, but is currently unused as only the TRIO protocol is available.

The switch marked DR sets 125kHz or 500kHz. Only 500Khz is valid with the TRIO protocol.

The addresses for P325 modules MUST be set 16,17,18... in sequence. Therefore the first P325 Module should have the switch setting:



The AIN command addresses the analogue inputs as per the following table.

Address:	Start:	End:
16	0	7
17	8	15
18	16	23
19	24	31

Note: P325 modules and P316 (16-I/O) modules may be mixed on the network. The P316 addresses will be 0 to 15 in sequence and the P325 modules will be 16 to 19 in sequence.

LED Indicators

MS	"Module Status"	ON when module powered on OK
NS	"Network Status"	ON when module powered on OK and initialised.

Software Interfacing

The *Motion Coordinator* will automatically detect and allow the use of correctly connected P325 modules. The number of connected analogue input channels is reported in the startup message and is also available to the programmer via an additional system parameter "NAIO".

The analogue input resolution is fixed at +10Volts to -10Volts and will return values
-2047 to 2048 to the function AIN(). The first 4 channels are also available as system parameters AIN0, AIN1, AIN2, and AIN3. This allows these values to be seen using the SCOPE function.

The P325 works "single ended" and does not return differential values.

It is not possible to mix the P325 module which is running the TRIO I/O protocol with DeviceNet equipment on the same network.

Troubleshooting

If the network configuration is incorrect 2 indications will be seen: The P325 module will indicate that it is uninitialised and the *Motion Coordinator* will report the wrong number when questioned:

```
>>? NAIO
```

If this is not as expected check:

- Terminating 120 Ohm Network Resistors fitted?
- 24Volt Power to Network?

- DIP switches in sequence starting 16,17,18...?
- System Software Version 1.42 (or higher)?
- *Motion Coordinator* CANIO_ADDRESS=32?

Specification

Analogue Inputs:	8+/-10Volt inputs with 500v isolation from CAN bus
Resolution:	12 bit
Protection:	Inputs are protected against 24v over voltage.
Address Setting:	Via DIP switches
Power Supply:	24V dc, Class 2 transformer or power source. 18 ... 29V dc / 1.5W
Mounting:	DIN rail mount
Size:	95mm wide x 45mm deep x 105mm high
Weight:	200g
CAN:	500kHz, Up to 32 analogue input channels
EMC:	BSEN50082-2 (1995) Industrial Noise Immunity / BS EN55022 (2001) Industrial Noise Emissions

Operator Interfaces

There are two main options when considering Operator Interface products. You can utilise products connected to either the Trio Fibre-Optic Network, or third party products connected to one of the *Motion Coordinator*'s communication ports.

Using the Trio Fibre-Optic Network

Trio supply a range of operator interfaces which are designed to connect via the *Motion Coordinator*'s fibre-optic network connection. these are:

- P502 - Membrane Keypad
- P503 - Mini-membrane keypad
- P504 - Fibre-optic interface module (Allows users to design their own keypad on Trio fibre-optic network)

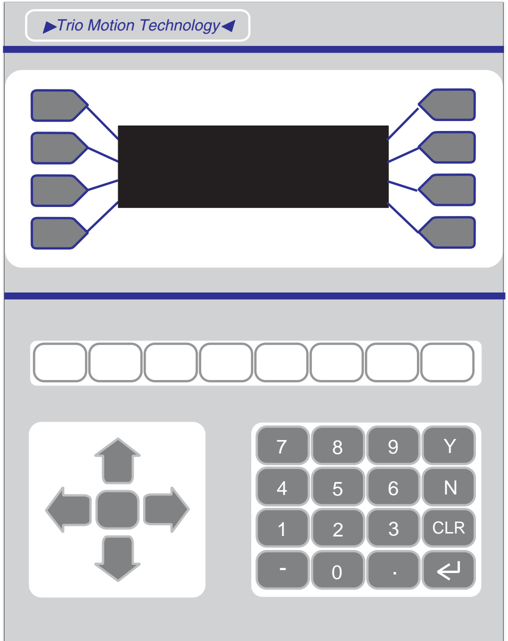
Third Party Modules

It is possible to connect to a wide variety of third-party operator interface panels via one of the *Motion Coordinator*'s serial ports (RS232 or RS485).

A growing number of programmable keypads and HMIs provide the user with a choice of serial interface protocols to enable communication with various PLCs and Industrial Computers. One such protocol is Modbus RTU. The *Motion Coordinator* system software provides built-in support for the Modbus protocol.

The Modbus protocol provides single point to point communication between the *Motion Coordinator* and a programmable keypad/display. Implementation of the protocol is provided on serial port 1 for RS232 and port 2 for RS485. Port 0 is the main programming port and does not have the Modbus option.

Membrane Keypad (P503)

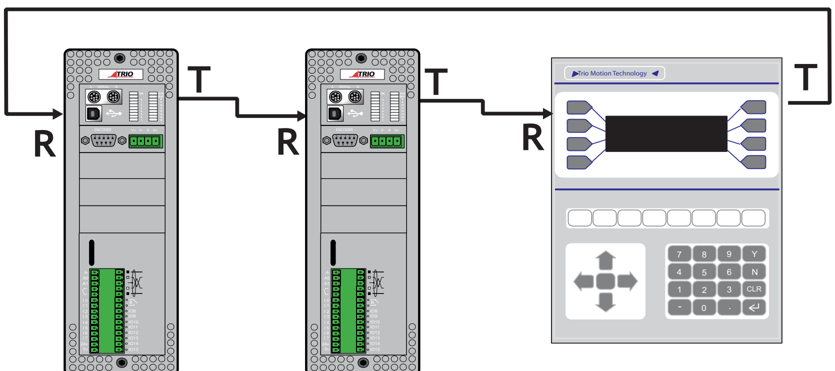


The Membrane Keypad brings together all the elements required for an effective man-machine interface in one package thus minimising the time taken to mount and connect to the rest of the system. The keypad has 37 tactile keys, eight of which can be defined by the user by inserting key legends from the rear of the keypad. Incorporated into the keypad is a four line by twenty character vacuum fluorescent display. Connection to the control system is via a fibre optic cable to the *Motion Coordinator* master module or network of master modules and membrane keypads. The interfacing to the master is provided by a built in fibre-optic interface module. The only other connection necessary is a 24 Volts DC power supply input.

The TRIO fibre optic network has been designed to link up to fifteen *Motion Coordinator* modules and membrane keypads. Any number of either type of module can be on the network up to the maximum of fifteen but at least one must be a *Motion Coordinator*.

The physical connection of the network takes the form of a ring. The interconnections between nodes being made with fibre optic cable

.



Example of Network Connection

Connection of the Membrane Keypad

The fibre optic link to a master module or network of masters is the Hewlett-Packard "Versatile Link" format connected using the P435 Serial to Fibre-Optic Adaptor.

The fibre optic connectors are colour coded:

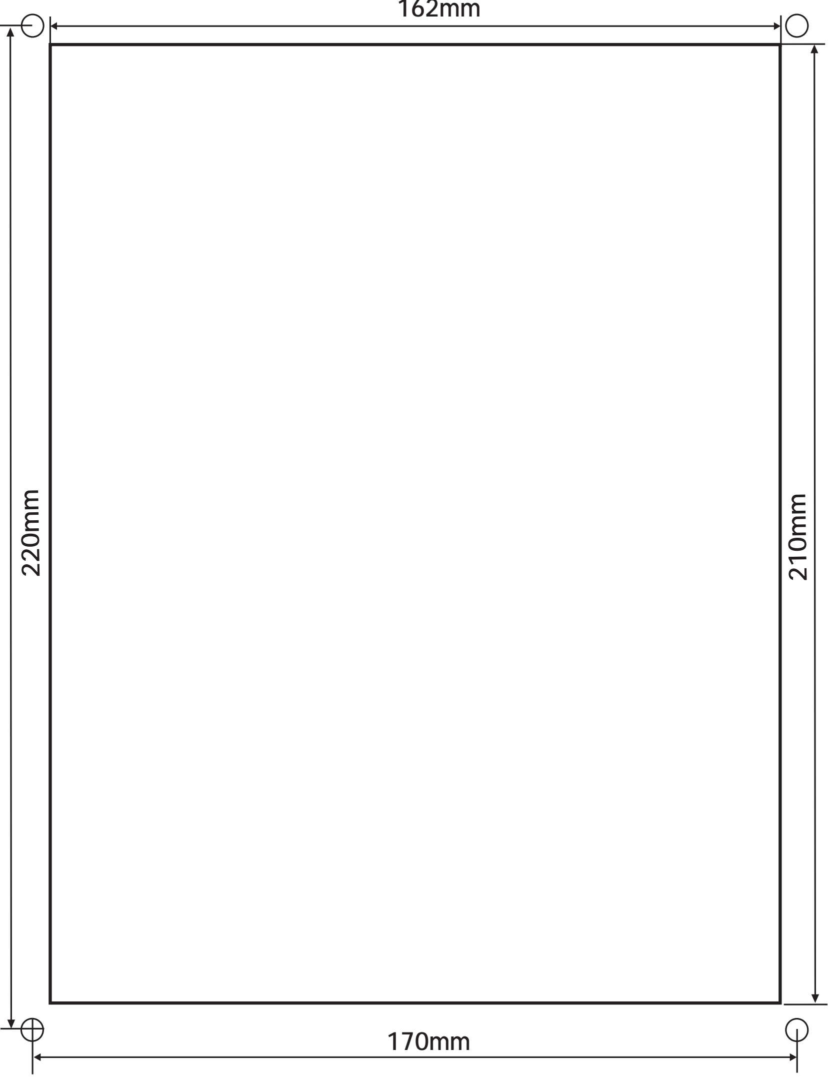
- Grey or Black- Transmitter
- Blue - Receiver

The receiver on the membrane keypad must be connected a transmitter and vice-versa. The fibre optic link is running at 38400 baud and will operate over a distance of up to 30m. Care must be taken when installing the fibre cable, making sure it is not bent in a tighter radius than 100mm. Failure to observe this restriction could lead to a break in the cable or at very least attenuation of a signal giving a reduced distance over which the link will operate. An excessive number of bends in the cable will attenuate the signal and hence reduce the operating distance.

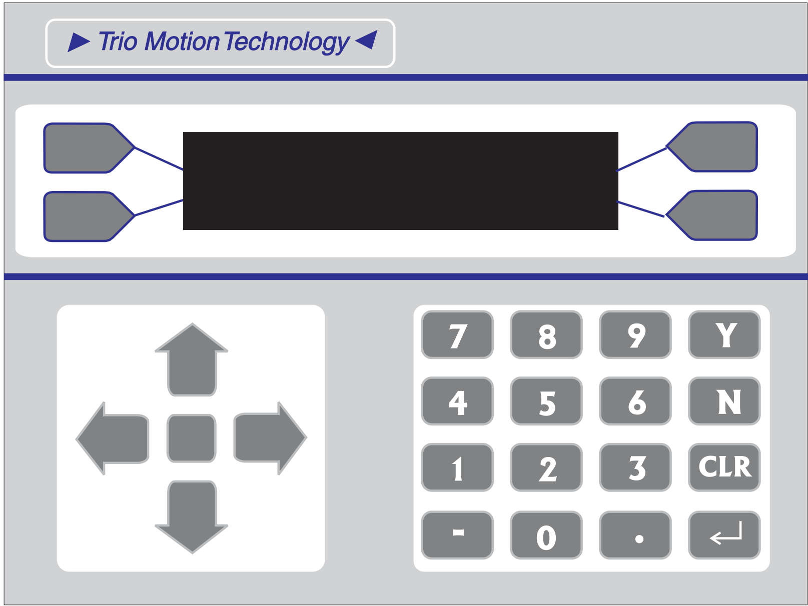
Power is applied to the two pin disconnect terminals on the side of the Keypad.

Mounting the Membrane Keypad

To mount the Membrane Keypad a rectangular cutout and four holes are required, as shown below. The Keypad is offered up to the front of the panel and fixed with the four studs in the corners of the Keypad. A depth of 50mm behind the front panel is needed to mount the Keypad, with an extra 50mm clearance for the fibre optic connector on the back.



Mini-Membrane Keypad (P502)

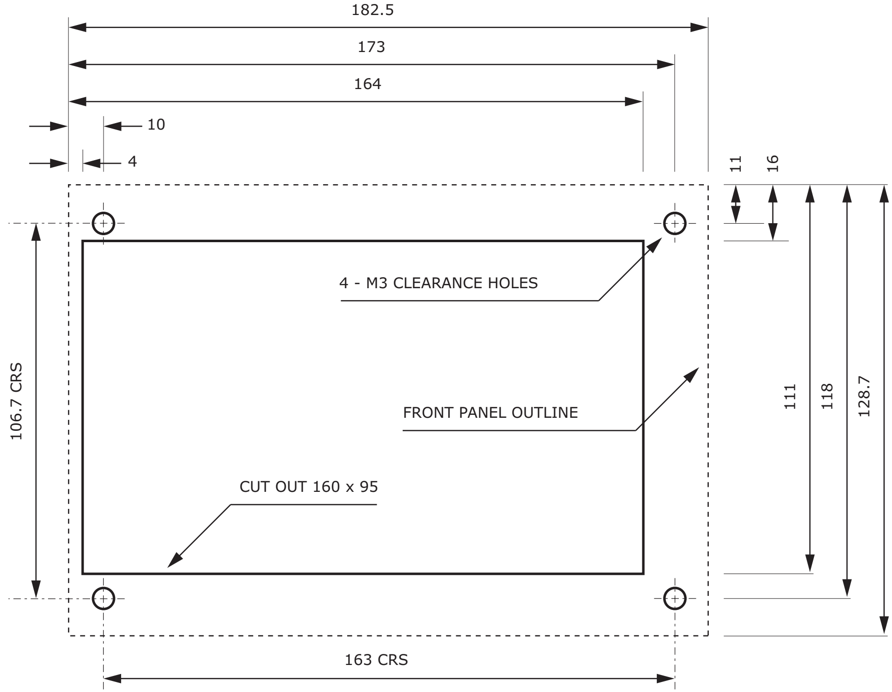


The Mini-Membrane Keypad is a lower cost alternative to the full membrane keypad. The keypad has 25 tactile keys. Incorporated into the keypad is a two line by twenty character vacuum fluorescent display. Connection to the control system is via a fibre optic cable to the *Motion Coordinator* master module or network of master modules. The interfacing to the master is provided by a built in fibre-optic interface module. The only other connection necessary is a 24 Volts DC power supply input.

Mounting the Mini-Membrane Keypad

The Mini-Membrane Keypad can be either mounted into a rectangular cutout or may the mounted into a 3U rack. If rack mounted the 4 blind holes in the panel need to be extended to allow 4 2.5mm diameter screws (Not supplied) to be fitted to secure the unit into a rack. To mount the Mini-Membrane Keypad into a rec-

tangular cutout the figure 5.7 should be followed. The Keypad is offered up to the front of the panel and fixed with the four studs in the corners of the Keypad. A depth of 50mm behind the front panel is needed to mount the Keypad, with an extra 50mm clearance for the fibre optic connector on the back.



Connection of Mini-Membrane Keypad

The connections are identical to the membrane keypad.

Programming the Membrane Keypad

The Keypads make use of standard Trio BASIC commands to write to the display and read from the keypad. The output /input device should be specified as 4 or 3 in any PRINT, GET, or KEY statement E.G.

```
>>PRINT#4,"Hello"
```

Alternatively the membrane keypad can be used as part of a network, in which case see chapter 11 for further details.

Writing to the Membrane and Mini-Membrane Display

The Trio BASIC command **PRINT** is used to write to the display. By using the **CHR** command with the **PRINT** it is possible to send control codes to the display to perform certain functions as described below:

CHR(..)	Function	Description
8	Back Space	The cursor moves one character to the left.
9	Horizontal Tab	The cursor moves one character to the right.
10	Line Feed	The cursor moves to the same column on the next line down.
12	Form Feed	The cursor moves to the top left hand corner.
13	Carriage Return	The cursor moves to the end on the same line.
14	Clear	All displayed characters are cleared. The cursor doesn't move.
17	Overwrite Mode	When the cursor reaches the bottom right hand corner it moves to the top left hand corner.
18	Scroll Up Mode	display scrolls up one line and the cursor moves to the left hand end of the next line.
20	Cursor _	Cursor is displayed as an _ character (Mini-Membrane only)
21	Cursor Visible	Cursor is displayed as a blinking all dot character.
22	Cursor Invisible	Cursor is turned off.
23	Cursor Flashing _	Cursor is displayed as a blinking _ character (Mini Only)
27+72+ 0..79	Position Cursor	The cursor is moved to the position specified by the last number (in the range 0..79 on Membrane keypad, 0..39 on Mini-Membrane) where each position on the screen is numbered,starting with zero in the top left hand corner to 79 or 39 in the bottom right hand corner.

Note: The **CURSOR** command provides a easy method of controlling the cursor.

Example:

```
PRINT CURSOR(10);
```

This will send the cursor to the 10th position on the first row. Note the use of the semicolon to suppress the carriage return which the **PRINT** command would normally send as well.

Reading from the Membrane Keypad/Mini-Membrane Keypad

Use the KEY command to test if a key has been pressed and the GET command to read which key has been pressed. **For simplicity and consistency it is recommended to use KEY and GET with the #4 channel number.** It is also possible to use the #3 channel number, in which case the numbers returned can be modified using DEFKEY.

Key	Key #	Get #4 Value	Get #3 Value
Up Arrow	1	33	20
Left Arrow	2	34	22
Centre Button	3	35	24
Right Arrow	4	36	23
Down Arrow	5	37	21
*Undefined 1 (Left most)	12	44	30
*Undefined 2	13	45	31
*Undefined 3	14	46	32
*Undefined 4	15	47	33
*Undefined 5	16	48	34
*Undefined 6	17	49	35
*Undefined 7	18	50	36
*Undefined 8 (Right most)	19	51	37
7	23	55	55
8	24	56	56
9	25	57	57
Y	26	58	89
4	27	59	52
5	28	60	53
6	29	61	54
N	30	62	78
1	34	66	49
2	35	67	50
3	36	68	51
CLR	37	69	27
-	38	70	45
0	39	71	48
.	40	72	46
<enter>	41	73	13

Key	Key #	Get #4 Value	Get #3 Value
*Menu Select 4 (Bottom Left)	45	77	50
*Menu Select 3	46	78	51
Menu Select 2	47	79	52
Menu Select 1 (Top Left)	48	80	53
Menu Select 5 (Top Right)	49	81	54
Menu Select 6	50	82	55
*Menu Select 7	51	83	56
*Menu Select 8 (Bottom Right)	52	84	57

Keys marked * are not present on Mini-Membrane

Keypad KEY ON - KEY OFF Mode

Keypads with software version 3.00 (see back panel for version number) and higher support a mode of operation where the keypad returns the key pressed and then a further character (31) is returned when the key is released. The keypad has to be set into this mode. On power up the keypad is in the normal mode where it returns just the key number.

Example: To set KEY ON-KEY OFF mode:

```
PRINT#4,CHR(140);CHR(127);CHR(136);
```

To return to default mode:

```
PRINT#4,CHR(140);CHR(0);CHR(136);
```

Note: In this mode the key presses should be fetched with a GET#4 rather than GET#3. This is because the KEY RELEASED character (31) is not included in the DEFKEY table used with GET#3.

This character sequence is formatted as a Trio network message (type 4). It is designed to work only when there is one keypad and one *Motion Coordinator* OR where the keypad is the next node in the network. See chapter 11 for details of how to construct network messages for keypads at other nodes.

Summary of Features		
	P503 Membrane Keypad	P502 Mini-Membrane
Size	230mm x 180mm x 50mm	192mm z 183mm x 50mm
Weight	1.450Kg	0.600Kg
Operating Temperature	0-45 degrees C	0-45 degrees C
Power supply	24V dc, Class 2 transformer or power source. 18 ... 29V dc 500mA.	24V dc, Class 2 transformer or power source. 18 ... 29V dc 500mA.
Number of Keys	37	25
Type of Keys	Metal dome tactile, debounced.	Metal dome tactile, debounced.
Display	4x20 Vacuum Fluorescent, with anti-glare filter.	2x20 Vacuum Fluorescent, with anti-glare filter.
Environmental	Sealed to IP65, provided mating face to panel is sealed.	Sealed to IP65, provided mating face to panel is sealed.

Summary of Features		
	P503 Membrane Keypad	P502 Mini-Membrane
Material	Polyester top layer resistant to most solvents	Polyester top layer resistant to most solvents
Data Output	8 bit serial, no parity	8 bit serial, no parity

FO-VFKB Fibre Optic Keypad/Display Interface (p504)

This is not packaged as a module like the rest of the TRIO range. Instead it is a single PCB designed to fix directly on to the back of a Vacuum Fluorescent display to allow customers to easily build their own design of membrane keypad on the Trio fibre-optic network.

The connectors and mounting holes on the board are specifically intended for mounting on the following displays:

ITRON 2 x 20

4 x 20

Other displays can be supported but connection may have to be made via a short cable from the display to the FO-VFKB. To give reliable, noise free transmission of data to and from the FO-VFKB, the link to the master module is made with a fibre optic cable.

FO-VFKB Display Interface

Display Interface DIL connector:

FUNCTION	PIN NO.		FUNCTION
D7	1	2	D6
D5	3	4	D4
D3	5	6	D2
D1	7	8	D0
WR	9	10	GND
N/C	11	12	BUSY
GND	13	14	GND
+5V	15	16	+5V

FO-VFKB Keypad Interface

The keypad interface permits connection of proprietary or custom keypads with matrix outputs of up to 5 rows by 11 columns. Up to five common output keypads may be connected provided that each one has no more than 11 keys. The keypad is easily accessed via Trio BASIC commands which enables a program to accept run-time data from an operator or scroll through a menu for example. Connection to the keypad is made via a short ribbon cable between the 16 way IDC plug on the back of the FO-VFKB module and the similar connector on the back of the keypad.

~Function	IDC plug pin no.		Function
Row 4	1	2	Column 0
Row 1	34		Column 7
Column 4	5	6	Row 2
Column 1	7	8	Column 8
Column 5	9	10	Row 3
Column 2	11	12	Column 9
Column 6	13	14	Column 3
Row 0	15	16	Column 10

Power Requirements

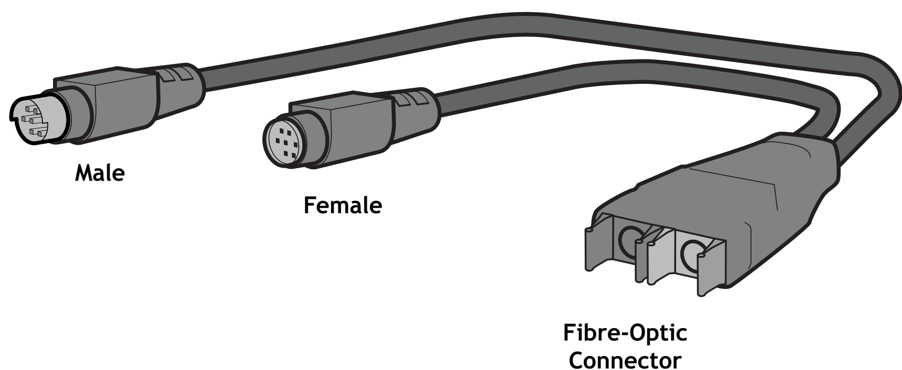
A 24V DC power supply is required to drive the FO-VFKB. This is also the supply for the display so must be capable of delivering at least 750mA. Power is applied on the two way disconnect terminal. The board is diode protected against reverse voltages being applied to the power connector. With power applied to the board the green LED on the top of the board should be lit.

Data Connection

The data connection is identical to that of a membrane keypad.

Summary of Features P504 FO-VFKB	
Size	150mm x 64mm
Weight	0.065 Kg
Operating Temperature	0-45 degrees C
Keypad	5x11 debounced keypad decoder with key on/key off option
V/F Display	Direct connection on DIL header
Data Connection	Fibre optic data link
Power supply	24V DC external power supply required

Serial to Fibre-Optic Adapter (P435)



The P435 Fibre Optic Adapter may be connected to the MC224, Euro205x or MC206X controllers to enable the connection of the Trio Mini-membrane, Membrane Keypad and the FO-VFKB.

The adapter provides a pass-through connector for the RS-232 serial port.

Controller Type	Serial Connector Used
Euro205x	A
Euro209	A
MC206X	A
MC224	A

SD Card Adaptor (P396)

Removable Storage

A memory adaptor used with the MC206X and MC224 allows a simple means of transferring programs without a PC connection. Offering the OEM easy machine replication and servicing.

The memory adaptor is compatable with a wide range of Micro SD cards up to 2Gbytes. Each Micro SD Card must be pre-formatted using a PC to FAT32 before it can be used in the SD Card Adaptor.

Order the SD Card Adaptor from a Trio supplier (order code: P396). The adaptor does not include the Micro SD Card which must ne bought separately.

Checking Programs on Micro SD card:

DIR D	Lists a directory of the Micro SD card in a DOS-like format.
FILE "cd" "directory_name"	Change the current directory

Reading Programs from Micro SD card:

FILE "load_program" "prog_name"	load one program from the Micro SD card to the controller.
FILE "load_project" "proj_name"	Load complete project from the Micro SD card to the controller.
FILE "type" "filename.bas"	Print a file to the *Motion* Perfect terminal 0.

Saving Programs to Micro SD card:

FILE "save_program" "program"	Save a program to the current SD card directory.
FILE "save_project" "proj_name"	Save all the programs to the named project on the SD card.

Read and Write data from/to Micro SD card:

STICK_WRITE(flash_file#, table_start[, length[, format]])	Write controller TABLE data to a file on the SDCARD in either comma separated values (CSV) or binary (BIN).
STICK_READ(flash_file#, table_start[, format])	Read TABLE data stored in a file from the SDCARD to the controller. Binary or CSV data can be read depending on the setting of the format parameter.

Note: See Chapter 8 for full description of SD Card commands.

Automatic Program Loading:

Programs will be copied on power up or **EX** from the Micro SD card into the Motion Coordinator if an adaptor is inserted and the SD card has a TRIOINIT.BAS file in the root directory.

The programs on the Micro SD card have auto/manual run settings in the same way as programs loaded from a *Motion* Perfect project do.

Typical TRIOINIT.BAS:

Load and run from RAM	load and copy into EPROM
FILE "LOAD_PROJECT" "proj_name" AUTORUN	**FILE 2LOAD_PROJECT" "proj_name"** **EPROM** **POWER_UP=1** **AUTORUN**

Notes: The programs on the Micro SD card must be arranged as a project in the same way that *Motion* Perfect saves projects.

While multiple projects can be saved on the Micro SD card, only one is loaded using the example TRIOINIT.BAS shown. This provides compatibility with the Next-Flash Mediastick stick cards. Requires system software 1.6629 or later.

Methods of Use: A machinery builder could use a P396 + Micro SD card with programs loaded and the TRIOINIT.BAS set to install programs on to a series of machines.

If an application update is sent out on a Micro SD card to a machinery customer the EPROM function could be left off. In this way if the update does not do what is required the old program will be copied from internal EPROM when the P396 is removed.

CHAPTER

6

System Setup and Diagnostics

Preliminary Concepts

Host Computer	A Windows PC running *Motion* Perfect 2.
Motor	A tuned servo drive / motor configuration for a servo axis or a stepper motor and drive combination
Prompt	When the controller is ready to receive a new command, the prompt >> will appear on the left hand side of the current line in the "terminal" under the "tools" menu
Axis Parameters	Can be written to or read from. For example the proportional gain of a servo axis has the name **`P_GAIN`**. It can be written to: **`P_GAIN=0.5`** or read from: **`PRINT P_GAIN.`** For further information see chapter 8.

System Setup

A control system should be treated with respect as careless or negligent operation may result in damage to machinery or injury to the operator. For this reason the setting up of the system should not be rushed. This section describes a methodical approach to system configuration and is designed to gradually test each aspect of the system in turn, finally resulting in the connection of the motor. If followed cautiously no unexpected situations should arise.

In cases where the setup procedure for servo and stepper systems differ a sepa-rate description is provided for each. In multiple axis systems it is advantageous to set up one axis at a time. The following procedure applies both to all *Motion Coordinator* modules.

Note:

It is recommended that this section is read in full before attempting to operate the system for the first time.

Preliminary checks

All wiring should be checked for possible misconnection and integrity before any power is applied.

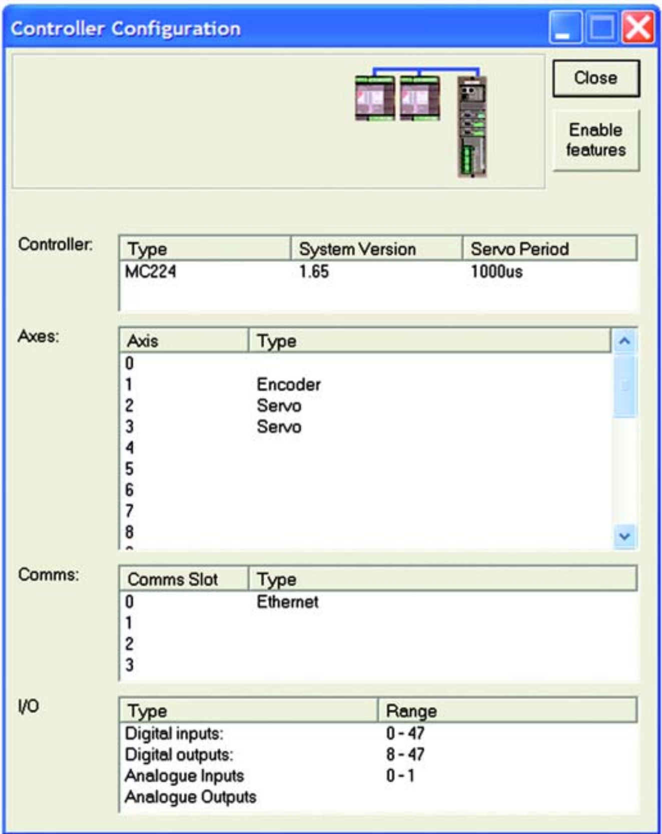
- Disconnect all external connectors from the system, apart from the CANBus and ribbon cable bus (only required if using an Axis Expander module)
- Check bank selector switches on any Axis Expander modules, and the module address DIP switches on the CAN I/O
- Apply power to system and check the 24V power input on master module.
- Connect a serial (connector A), USB or Ethernet lead between the controller and an unused port on your PC.

Checking Communications and System Configuration

- Ensure that the serial lead is connected between the *Motion Coordinator* master (serial connector A) and a free serial port on the computer.
- Apply 24V to the *Motion Coordinator*.
- Run *Motion* Perfect on the computer. When *Motion* Perfect detects a controller press the OK button. If this is the first time you have connected you will need to select the “New Project” option when *Motion* Perfect tries to ensure that your “Project” on the controller matches its copy on disk.
- When the “Project Consistent” message is received in the “Check Project” window you know:

  1. *Motion* Perfect has made a serial connection between your PC and the controller.
  2. *Motion* Perfect has an exact copy of the programs on the controller.
- The controller hardware configuration can now be checked using the “Controller configuration” option under the “Controller” menu. *Motion* Perfect draws a graphical representation of your system, as shown following.

Example:



This message would be produced by a *Motion Coordinator* MC224 with the following configuration:

- System Software version 1.65
- An Ethernet Comms daughter board in slot 0
- A encoder daughter board in axis slot 1.
- Two servo daughter boards in axis slots 2 and 3.
- 2 CAN16 I/O modules, which adds a further 32 I/O channels, making a total of 47 channels (All 47 can be used as inputs, channels 8-47 are bidirectional and may be used as input or output as required)
- A CAN Analog Inputs module providing input channels 0-7.

Check that the system description corresponds with the modules that are actually present. If this is not so, check the CANBus and ribbon cable connections and the settings of the address switches on any CAN or axis expander modules.

Input/Output Connections

- Check each of the 24V input connections with a meter then connect them to the controller.
- Test each of the input channels being used for correct operation in turn. These may be easily viewed in the I/O window. Use “IO Status” under the “Tools” menu.
- Switch each output being used in turn for correct operation. These may be easily set with the IO status window.

Connecting a Servo Motor to a Servo Daughter Board

Note: *This description assumes the motor / drive combination has been already tested and is functioning optimally.*

Each servo axis should be connected in turn.

- With the servo drive off or inhibited connect the motor encoder only (or the encoder emulation output from the servo drive).
- Check the encoder counts both up and down by looking at the measured axis position **MPOS** in the Axis parameter window of *Motion* Perfect (“Axis parameters” under the “Tools” menu) whilst turning the axis by hand.
- Ensure the **SERVO** axis parameter is set OFF (0) in the Axis parameter and that the **DAC** axis parameter is set to 0. It may be necessary to use the scroll buttons to view these parameters. This will force 0 volts out of the +/-10v output for the axis. Now connect the servo drive to the V+/V- connections.
- Enable the servo drive by clicking the “Drives disabled” button on the control panel. If the axis runs away the motor/drive combination must be re-checked. (Note: clicking “Drives disabled/ Drives enabled” is equivalent to issuing a **WDOG=ON** or **WDOG=OFF** command).
  The servo motor should now be powered and is likely to be creeping in one direction as the position servo has been switched OFF.
- Set a small positive output voltage by setting **DAC=25**. The motor should then move slowly forward - Check the encoder is counting up by looking at the **MPOS** axis parameter. If this is correct check that the motor reverses and the encoder counts down when **DAC=-25**.
- If the encoder counts down when a positive **DAC** voltage is applied. The motor or position feedback needs to be reversed.

  This can be achieved by:

  - Swap A and /A connections on the encoder input, or
  - Swap BOTH motor terminals and tacho terminals (DC motors only!) On many digital brushless motors the direction can be reversed by a drive setting, or

- If the drive has differential inputs, reverse the voltage as it enters the drive. (This can cause problems with some servo-drives. The V- pins of the daughter board are internally connected inside the *Motion Coordinator* so the axis voltage outputs cannot float relative to each other), or
- set a negative **`PP_STEP`** axis parameter. (This is not possible using SSI encoders)
- Set a negative **`DAC_SCALE`** axis parameter.

We are now ready to apply the position servo as described following.

Setting Servo Gains

The servo system controls the motor by constantly adjusting the voltage output which gives a speed demand to the servo drive. The speed demand is worked out by looking at the measured position of the axis from the encoder comparing it with the demand position generated by the *Motion Coordinator*.

The demand position is constantly being changed by the *Motion Coordinator* during a move. The difference between the demand position (Where you want the motor to be) and the measured position (Where it actually is) is called the following error.

The controller checks the following error typically 1000 times per second and updates the voltage output according to the "servo function". The *Motion Coordinator* has 5 gain values which control how the servo function generates the voltage output from the following error.

Default Settings:

Gain	Parameter Name	Value
Proportional Gain	**P_GAIN**	1.0
Integral Gain	**I_GAIN**	0.0
Derivative Gain	**D_GAIN**	0.0
Output Velocity Gain	**OV_GAIN**	0.0
Velocity Feedforward Gain	**VFF_GAIN**	0.0

A simple test program can be used to generate movement to and fro for examination of the motion profile generated on an oscilloscope. The oscilloscope should be connected to the tacho or velocity output from the servo drive.

Example:

```
PRINT "Enter Axis Number ":INPUT VR(0)
BASE(VR(0))
SPEED=20000
ACCEL=200000
DECEL=200000
WHILE TRUE:
  MOVE(1000)
  WAIT IDLE
  WA(100)
  MOVE(-1000)
  WAIT IDLE
  WA(100)
WEND
```

The editor built into *Motion* Perfect may be used to enter the test program. Click on Program, New from the pull down menus and enter a program name, replacing the name **UNTITLEDx**. Now click on the EDIT button and an edit window will be opened where the program shown above may be typed in. See the *Motion* Perfect section for more details on how to use the editor. Once the program is entered, it can be run by clicking on the red button next to its name or the RUN button in the Controller Status panel.

The servo gain parameters may be set to achieve the desired response from the servo system. The desired response can vary depending on the type of machine.

Different gain settings can be used to obtain:

Smoothest motor running

This can be achieved by using low proportional gain values, adding output velocity gain adds smoothing damping at the expense of higher following errors.

Low following errors during complete motion cycle

This can be achieved by using velocity feed forward to compensate for following errors together with higher proportional gains.

Exact achievement of end points of moves

This can be achieved by using integral gain in the system together with proportional gain. However overshoot will occur at the end of rapid deceleration.

Typically a combination of the above is required.

Note: *The system should be set with proportional gain alone firstly starting with the default value of 1.0 The other gains should then be introduced if necessary according to the descriptions which follow.*

Proportional Gain

Description The proportional gain creates an output voltage, Op that is proportional to the following error E.

$$O_p = K_p \times E$$

Axis parameter is called **P_GAIN**

Syntax: **P_GAIN=0.8**

Note: ***All practical systems use proportional gain, many use this gain parameter alone.***

Integral gain

Description The Integral gain creates an output Oi that is proportional to the sum of the errors that have occurred during the system operation.

$$O_i = K_i \times \int E$$

Integral gain can cause overshoot and so is usually used only on systems working at constant speed or with a slow acceleration.

Axis parameter is called **I_GAIN**

Syntax: **I_GAIN=0.0125**

Derivative gain

Description This produces an output Od that is proportional to the rate of change in the following error and speeds up the response to changes in error whilst maintaining the same relative stability.

$$O_d = K_d \times \delta_e$$

This gain may create a smoother response. High values may lead to oscillation.

Axis parameter is called **D_GAIN**

Syntax: **D_GAIN=5**

Output Velocity Gain

Description This increases the system damping, creating an output that is proportional to the change in measured position.

$$O_{ov} = K_{0v} \times \delta P_m$$

This parameter can be useful for smoothing motions but will generate high following errors. Note that a NEGATIVE OV_GAIN is required for damping.

Axis parameter is called **OV_GAIN**

Syntax: **OV_GAIN=-5**

Velocity Feed Forward Gain

Description As movement is created by following errors at high speed the following error can be quite appreciable. To overcome this the Velocity Feed Forward creates an output proportional to the change in demand position so creating movement without the need for a following error.

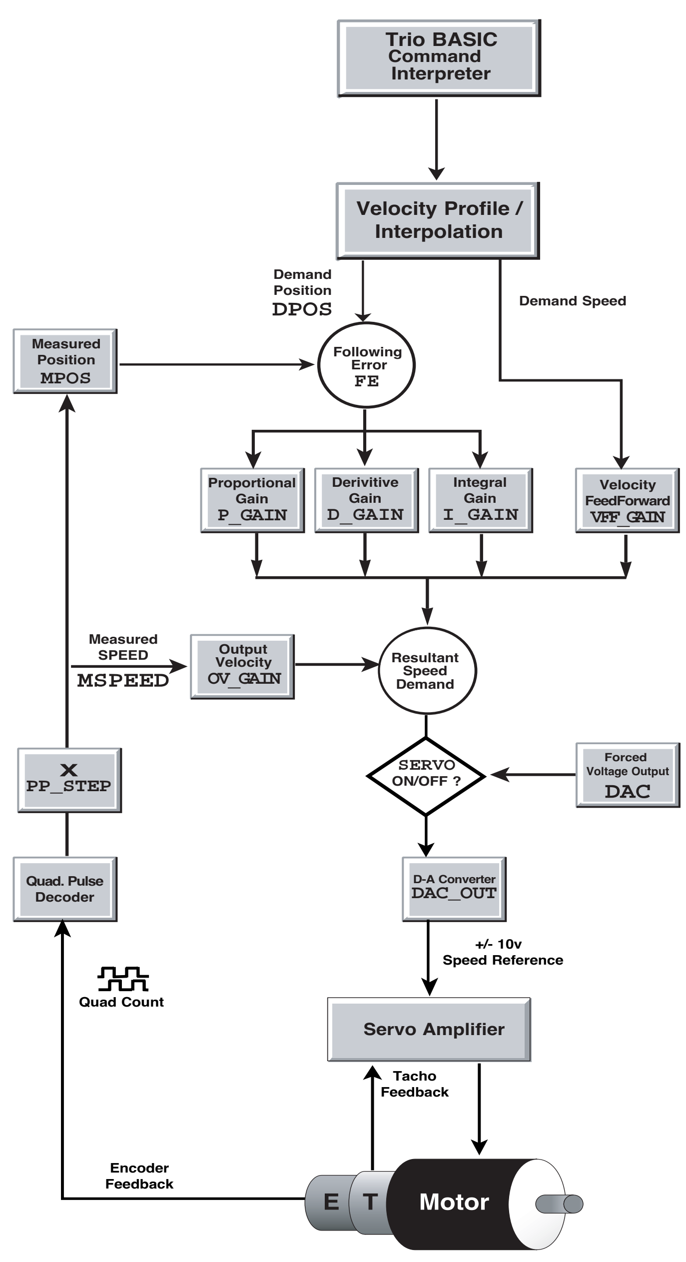
$$O_v = K_{vff} \times \delta P_d$$

Axis parameter is called **VFF_GAIN**

Syntax: **VFF_GAIN=10**

The VFF_GAIN parameter can be set by minimising the following error at a constant machine speed AFTER the other gains have been set.

Servo Loop Diagram



Diagnostic Checklists

Problem	Potential reasons
No Status LEDs on any module	• Power Supply
LEDs lit on Master but not on other modules	• Ribbon cable / Bank select switch
OK LED ON & Status LED flashing	• Following error on at least one axis. The axis demand position and measured position exceed the programmed limit
Motor runs away without issuing a move command	• tacho/drive polarity • encoder/controller polarity • gains (drive and/or controller)
Motor runs away upon issuing a move command	• tacho feedback • encoder feedback • gains (drive and/or controller)
Motor does not move upon issuing a move command	• wiring (enables/inhibits/limits on drive and controller) • check status on all axes • drive power • feedhold applied • speed, acceleration and/or deceleration set to zero • servo set off/watchdog set off • gains (drive and/or controller) • axis is already running a move which has not completed - Check MTYPE and NTYPE
Axis goes out on following error after a time	• speed being requested requires more than 10v - check drive tacho gain and motor/ drive speed characteristics. • drive shutting down on current limit after a time

Problem	Potential reasons
Axis losing position	• encoder coupling • encoder signal (wire length, differential/single ended encoder) • mechanics
Motion Perfect cannot "connect" with the controller	• Controller running a program which transmits on serial port 0. If this prevents *Motion* Perfect connecting to the controller, open Terminal screen in *Motion* Perfect unconnected mode and type a "halt" command at the command prompt. • Faulty or unconnected serial cable • *Motion* Perfect baudrate, data bits, parity or stop bits have been changed. - Adjust to default of 9600 baud, 7 data bits, 2 stop bits, even parity under the "Options" menu. • Check *Motion* Perfect version. The latest version can be downloaded from **www.triomotion.com**

CHAPTER

7

PROGRAMMING

What is a program?

The traditional description of a program is a task that you want the computer (the *Motion Coordinator*) to perform. The task is described using statements written in the Trio BASIC language which the *Motion Coordinator* can understand.

A program is simply a list of instructions to the *Motion Coordinator*, some of these instructions have a dedicated function to be performed by the controller, others control the program flow, the sequence in which instructions are actually executed.

Statements in your program must be written using a set of rules known as 'Syntax'. You must follow these rules if you are to write Trio BASIC programs. Trio BASIC instructions are divided into the following types:

- Instructions
  - Program Flow
  - Controller Specific
- Identifiers
  - Labels
  - Data Storage

Controlling the Sequence of Events

In order to write a program we must break the function of our system down into logical operations which the controller must perform. As we are not able to solve every problem in a purely linear manner, we need more control of the ‘flow’ of the program instructions, for example to make a decision and decide whether or not certain instructions need to be executed, or to perform a certain task several times. In programming terms we refer to these concepts as **SEQUENCE**, **SELECTION** and **ITERATION**.

Sequence

The ability to process a series of instructions, in a logical order, and to control the flow by branching to another part of the program.

Normally, a program executes statements in sequence starting at the top. In order to branch between different sections of the program we need to be able to identify specific sections of the code. Labels are used as place markers to indicate the start of a routine, or the target for the 'branch' instructions, **GOTO** and **GOSUB**.

It is useful to split your program up into a series of routines, each of which handles a particular funtion of the machine. The **GOSUB** command will jump to a label and continue from its new location. When the program encounters a **RETURN** command, the program will jump back to the **GOSUB** from where it originally came. Take the following example:

```
PRINT "Hello"
GOSUB a_subroutine
STOP

a_subroutine:
  PRINT "World"
RETURN
```

The program will print the "Hello" text to the terminal window, then jump to the line of the program labelled **'a_subroutine'** and continue execution. The next command it finds will print "World". The **RETURN** command then returns the program to the point it left, where it then proceeds onto the next command after the **GOSUB** command which in this case is the **STOP** command, which halts the execution of the program.

The **GOTO** command does not remember where it jumped from and will continue running from its new location permanently. This might be used for example, if we have a certain process which needs to be performed when shutting down a machine, we might jump directly to that routine:

i.e. **GOTO shut_down**

Trio BASIC instructions:

Labels, GOTO, GOSUB, RETURN, STOP

Selection

Commands that enable us to selectively execute instructions depending on certain criteria being met.

Example: **IF** we have made a complete batch **THEN** stop the machine

Trio BASIC Instructions:

```
IF … THEN … ELSEIF … ENDIF
ON ... GOTO
ON ... GOSUB
```

Iteration

To repeatedly execute one or more commands automatically, either for a specified number of times, or until a certain condition is met or event occurs.

Example

```
REPEAT
  GOSUB index_conveyor
UNTIL IN(product_sensor)=ON
```

Trio BASIC instructions:

```
FOR … TO … STEP … NEXT
REPEAT … UNTIL
WHILE … WEND
```

FOR..NEXT Statements

The **FOR .. NEXT** commands are used to create a finite loop in which a variable is incremented or decremented from a value to a value.

Example:

```
FOR t=1 TO 5
  PRINT t;" ";
NEXT t
PRINT "Done"
```

The output to the screen would read:

```
1.0000 2.0000 3.0000 4.0000 5.0000
```

The program would set the variable **t** to a value of 1 and then go to the next line to **PRINT**. After the print, the **NEXT** command would return the program to the **FOR** command and increment the value of T to make it 2. When the **PRINT** command is used again, the value of T has changed and a new value is printed. This continues until T has gone from 1 through to 5, then the loop ends and the program is permitted to continue. The next command after the **NEXT** statement prints "Done" to the screen slowing the program has left the loop.

You can also use for-next loops to create a loop within a loop, as the following example shows:

```
FOR a=1 TO 5
  PRINT "MAIN A=";a
  FOR b=1 TO 10
    PRINT "LITTLE B=";b
  NEXT b
NEXT a
```

The **FOR..NEXT** statement loops the main A variable from 1 to 5, but for every loop of A the **FOR..NEXT** statement inside the first loop must also loop its variable B from 1 to 10. This is known as a nested loop as the loop in the middle is nested inside an outer loop..

Such loops are especially useful for working on array data by using the variables that increment as position indexes for the arrays. As an example, we could perform a sequence of absolute moves like this:

```
FOR y=12 TO 1 STEP-1
  FOR x=10 to 120 STEP10
    MOVEABS(x,y)
  NEXT x
NEXT y
```

As can be seen,the for-next loop can count down as well as step in value, insted of simply incrementing the loop counter.

Controller Functions

The specific commands, which instruct the processor to perform a predefined function or operation. Each instruction will be assigned its own *reserved word* in the language.

For example the **PRINT** instruction in Trio BASIC is used to display a message or numeric value on the computer screen or another output device, such as a printer.

Instructions vary in complexity and will take a variety of formats. Some will be a single keyword with a clearly defined function, such as **CANCEL** or **STOP**, whereas others may take one or more *parameters* which affect the operation of the command.

examples:

WA(1000)	wait for a specified time (in milliseconds)
PRINT "Hello"	Display the word "hello" on the terminal screen
GOTO show	redirect the program to the part labelled *show*

Identifiers

Identifiers are the names which the programmer uses to identify (!) things in the program. There are essentially two main types of user-defined identifier, Labels and Variables.

Labels

Labels are used to provide a place-marker in a program. Not only does this make the code more readable, it also enables us to direct the flow of our program to a specific place.

In Trio BASIC, labels are defined by placing a name at the start of the line, followed by a colon (:).

e.g.

```
start:
enter_password:
error_handler:
```

Variables

Variables are storage locations for numeric values. they are called variables as they can be changed at any time. Just like labels, variables can often be given a user-defined name. Anywhere a number is required a variable can be used. Only the first charactors of each variable name are used to identify the unique variable. For example; *Micromanipulator1* is the same as *Micromanipulator2*

Example: **batch_size=10**

would assign a value of 10 to a variable called "batch_size". Then anywhere in the program that needs to know the value stored can read this value by name.

Trio BASIC *has three different variable types:*

named variables These are LOCAL variables - i.e. they are only valid within the task they are defined.

Each process can define up to 1024 named variables .

Example:

```
a=123
SPEED=user_speed
PRINT #3,"Length = ";prod_length[2]
```

VR() variables The controller has a global array of 1024 **VR()** variables which are shared between tasks (1024 on MC206).

Example:

```
VR(2)=123.4567
```

TABLE memory The **TABLE** memory is a large array of up to 256k entries depending on the controller type. Normally used to store profiles for the **CAM**/**CAMBOX** commands.

If the controller features a battery backed memory, **VR()** variables and **TABLE** memory will be retained when the power is off. For controllers without a battery, e.g., the MC302X, the **FLASHVR()** command is provided to store the values in flash eprom memory.

Expressions

An expression is defined as any calculation or logical function which has to be evaluated. An expression may be used anywhere a number is required, or a logical (TRUE/FALSE) decision. In the case of logical expressions, TRUE is deemed to be any non-zero result.

In programming, the component parts of an expression are known as operands and operators. The *operands* are the values, either specific numbers, or variables. The *operators* are those functions or actions which act on the operands.

Example 1: You can assign the result of an expression to a variable,

`num_widgets = total_length / widget_length`
has three operands, **`num_widgets, total_length`** and **`widget_length`**
and two operators, = (assignment) & / (divide).

Reading the above as simple English would equate to:

Divide the variable **`total_ length`** by **`widget_length`** and assign the result to the variable **`num_widgets`**

Example 2: you could use an expression directly:

`MOVE(widget_length+10) '`(MOVE is a Trio BASIC instruction)

Example 3: Sometimes an expression is used to make a decision..

```
IF batch_count = batch_size THEN GOTO batch_done
```

Parameters

Parameters are special purpose variables, used by the system for configuration and feedback.

Axis Parameters

Each of the axes has its own set of axis parameters which are used to achieve many of the *Motion Coordinator* features. The axis parameters may be floating point or 32 bit integer. The parameters are all set to default values on every power up. Parameters are read from and written to like variables. The Trio BASIC assumes the current BASE axis is the required axis unless the AXIS modifier is used:

```
>>P_GAIN=2
>>P_GAIN AXIS(8)=0.25
>>? VP_SPEED AXIS(2)
```

A list of all the axis parameters is given in chapter 8

System Parameters

Trio BASIC holds a list of parameters which are common for the whole controller. These parameters can be read from and written to like variables. The system parameters are described in chapter 8. Note that as there is only one system there is no modifier for system parameters.

Process Parameters

Trio BASIC also holds a small number of parameters which are held separately for each PROCESS.

These are:

1) **TICKS**
2) **PROCNUMBER**
3) **PMOVE**
4) **ERROR_LINE**
5) **INDEVICE / OUTDEVICE**
6) **BASE**

The process assumed is the current process the command is using, however it is possible to force the controller to read parameters from a specific process with the PROC() modifier.

Example:
```
WAIT UNTIL PMOVE PROC(14)=0
```

Forcing priority of program execution

When a user program is running, it is known as a 'task', or a 'process'. The number of simultaneous processes available is dependant on the controller type. When a program is started, the *Motion Coordinator* will allocate it to a process automatically to make the system easier to use. This will normally be sufficient for most applications, especially when there are less than 4 programs in use.

Allocation of Time

For more complex applications it can be useful to allocate execution priorities to programs. In order to do this we need to understand how the *Motion Coordinator* normally allocates the available processing time:

The default servo period is 1mS. This period is internally divided into 3 time slots of 1/3mS each, which are used internally for processing the servo functions, communications and general 'housekeeping' tasks respectively. The remaining time in each of these slots is used for running the user's application programs.

1ms			1ms			1ms		

Table 1:

Process Numbers

The processes available for programs are identified by numbers, from 1 to the maximum available on the controller. For example, an MC224 can run 14 simultaneous programs. Process 0 is also allocated automatically to the *Motion Coordinator*'s command line interface / *Motion* Perfect connection.

Note: The maximum number of processes available is dependant on the controller type, as shown in the table below.

Controller	Max # Processes	High Priority Processes
MC302X	3	3
Euro205x	7	7,6
MC206x	7	7,6
MC224	14	14,13

The two highest numbered processes (14 and 13 in our example MC224) are allocated a fixed time slot. These are referred to as the "fast" tasks. They should be used for processes which require:

- Guaranteed processing every servo cycle
- A large number of calculations or processing
- Program execution which does not vary in speed as tasks are started or stopped.

Any other processes (including the command line) share the third time slot. Execution speed will therefore reduce as the number of programs running increases. In practice however, a useful execution speed is still obtained. Processes 1..12 are referred to as “standard” tasks.

Programs can be forced to run on a specific process using the commands **RUN** or **RUNTYPE**:

>>RUN "progname",7	Run the named program immediately on specified task
>>RUNTYPE “progname”,ON,7	Assigns start-up mode for specified program

If equal time is required to be given to all programs, the high priority processes (14 and 13) should NOT be used. The time available will then be divided evenly between the remaining processes. The command line and processes 1, 2 & 3 share the remaining third. These programs and the command line use the available time slot with equal priority

Examples: No fast tasks, two standard tasks

1ms			1ms			1ms		
1	2	C/L	1	2	C/L	1	2	C/L

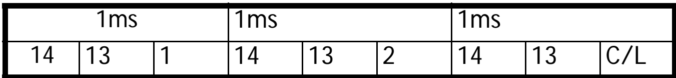
Table 2:

No fast tasks, three standard tasks

1ms			1ms			1ms		
1	2	3	C/L	1	2	3	C/L	1

Table 3:

Two fast tasks, two standard tasks



1ms			1ms			1ms		
14	13	1	14	13	2	14	13	C/L

Table 4:

One fast task, two standard tasks

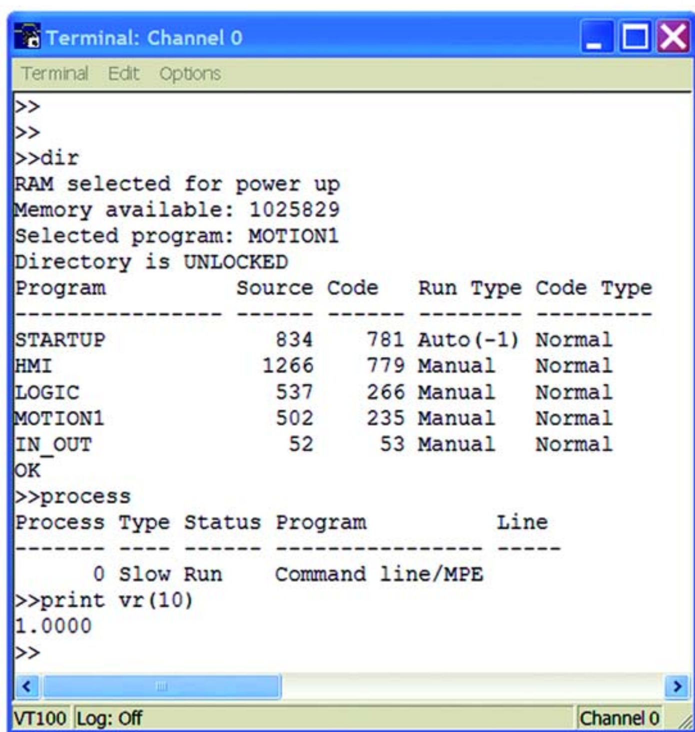
This example shows the case where there is one fast task only. This is the exception to the rule as it is allocated BOTH 'fast' time slots.

1ms		1ms		1ms	
14	1	14	2	14	C/L

Table 5:

Command Line Interface

A “Command Line” interface to the controller can be set up by opening a “Terminal” window in *Motion* Perfect. *The command line interface always uses channel 0.*



Typing Commands for Immediate Execution

When the controller is waiting for a Trio BASIC command to be typed in it prints the prompt >>

Example: **>>PRINT “HELLO”**

Note: *A line must always be terminated by pressing the ENTER key (<CR>)*

Limitations of the command line

The command line interface is intended to execute single commands. It is not possible to process multiple-statement lines or those commands which control the sequence or 'flow' of a program.

For example, the following type of commands are not available on the command line:

- Loop Instructions:
  FOR..NEXT, WHILE..WEND, REPEAT..UNTIL
- Wait Instructions:
  WA(time), WAIT UNTIL, WAIT IDLE
- Named variables:
  These are local to a program

Attempting to use any of these commands on the command line may produce unpredictable results!

Tip! *The command line features a buffer of the last 10 commands used. This can save a lot of typing on the PC. Pressing the up arrow or down arrow cycles through the buffer.*
If you find a command you do not recognise it was probably put there by Motion Perfect!

Setting Programs to run on power up

Programs can be set to run automatically on power-up using the "Set power up mode..." facility under the "Program" menu. This sets the **RUNTYPE** automatically

Example Typically only ONE program is set to run on power up. This program can then start the others under program control:

```
...body of program
RUN "Prog2"
RUN "Prog3"
...body of program
```

After setting one or more programs to run on power up the project should be set to "Fixed". The programs will then be stored in flash Eprom.

Example Programs

Example 1

```
start:
  TICKS=0
  PRINT "Press a key"
  WAIT UNTIL KEY
  GET k
  PRINT "You took ";-TICKS/1000;" seconds"
GOTO start
```

Example 2

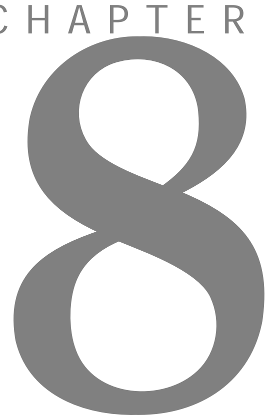
```
'Set speed then move forward then back:
  PRINT "EXAMPLE PROGRAM 2"
  SPEED=100
  ACCEL=1000
  DECEL=1000
  MOVE(250)
  MOVEABS(0)
  STOP
```

Note that the last line stops the program, not the motion. The first line is a comment. It has no effect on the program execution.

Example 3

```
'Display 16 INPUTS as a row of 1's and 0's
REPEAT
  FOR i=0 TO 15
    IF IN(i)=ON THEN
      PRINT "1";
    ELSE
      PRINT "0";
    ENDIF
  NEXT i
  PRINT CHR (13);
  'Character 13 will do <CR> without linefeed
UNTIL 0
```

CHAPTER



TRIO BASIC COMMANDS

MOTION AND AXIS COMMANDS 13
ACC 13
ADD_DAC 14
ADDAX 16
AXIS 19
BACKLASH 20
BASE 21
CAM 22
CAMBOX 27
CANCEL 36
CONNECT 38
DATUM 40
DEC 45
DEFPOS 46
DISABLE_GROUP 48
ENCODER_RATIO 51
FORWARD 52
MHELICAL 55
MHELICALSP 57
MOVE 58
MOVEABS 60
MOVEABSSP 63
MOVECIRC 64
MOVECIRCSP 66
MOVELINK 67
MOVEMODIFY 71
MOVETANG 75
MOVESP 78
MSPHERICAL 78
RAPIDSTOP 80
REGIST 83
REVERSE 87
STEP_RATIO 89

INPUT / OUTPUT COMMANDS 91
AIN 91
AIN0..3 / AINBI0..3 92
AOUT0...3 92
CHR 92
CURSOR 93

DEFKEY 93
ENABLE_OP 94
FLAG 94
FLAGS 95
GET 95
GET# 96
HEX 97
IN()/IN 97
INPUT 98
INPUTS0 / INPUTS1 99
INVERT_IN 99
KEY 99
LINPUT 100
OP 101
PRINT 102
PRINT# 103
PSWITCH 104
READ_OP() 106
READPACKET 107
RECORD 107
SEND 108
SETCOM 109

PROGRAM LOOPS AND STRUCTURES 111
BASICERROR 111
ELSE 111
ELSEIF 111
ENDIF 112
FOR..TO.. STEP..NEXT 113
GOSUB 114
GOTO 115
NEXT 115
ON.. GOSUB 115
ON.. GOTO 116
REPEAT.. UNTIL 116
RETURN 117
THEN 117
TO. 117
UNTIL 118
WA 118

WAIT IDLE 118
WAIT LOADED 119
WAIT UNTIL 119
WEND. 120
WHILE 120
SYSTEM PARAMETERS AND COMMANDS 121
ADDRESS 121
APPENDPROG 121
AUTORUN 121
AXISVALUES 122
BATTERY_LOW 122
BREAK_ADD 123
BREAK_DELETE 123
BREAK_LIST 123
BREAK_RESET 124
CAN 124
CANIO_ADDRESS 126
CANIO_ENABLE 127
CANIO_STATUS 127
CANOPEN_OP_RATE 127
CHECKSUM 128
CLEAR 128
CLEAR_PARAMS 128
COMMSERROR 129
COMMSTYPE 129
COMPILE 130
CONTROL 130
COPY 131
DATE 131
DATE$ 132
DAY 132
DAY$ 132
DEL 132
DEVICENET 133
DIR 134
DISPLAY 134
DLINK 135
EDIT 139
EDPROG 139

EPROM 140
ERROR_AXIS 141
ETHERNET 141
ETHERNET_IP 143
EX 143
EXECUTE 143
FB_SET 144
FB_STATUS 144
FEATURE_ENABLE 145
FLASHVR 145
FRAME 147
FREE 147
HALT 148
HLM_COMMAND 148
HLM_READ 150
HLM_STATUS 151
HLM_TIMEOUT 152
HLM_WRITE 152
HLS_MODEL 153
HLS_NODE 154
INCLUDE 154
INITIALISE 154
LAST_AXIS 155
LIST 155
LIST_GLOBAL 155
LOAD_PROJECT 156
LOADSYSTEM 156
LOCK 157
MOTION_ERROR 158
MPE 158
NAIO 159
NETSTAT 160
NEW 160
NIO 160
PEEK 161
POKE 161
PORT 161
POWER_UP 161
PROCESS 162
PROFIBUS 162

PROTOCOL 163
REMOTE 163
RENAME 163
RS232_SPEED_MODE 163
RUN 164
RUNTYPE 165
SCOPE 165
SCOPE_POS 166
SELECT 166
SERCOS 167
SERCOS_PHASE 172
SERIAL_NUMBER 172
SERVO_PERIOD 172
SLOT 173
STEP 173
STEPLINE 173
STOP 174
STICK_READ 174
STICK_WRITE 175
STORE 176
TABLE 176
TABLEVALUES 178
TIME 178
TIME$ 179
TRIGGER 179
TROFF 179
TRON 179
TSIZE 180
UNLOCK 180
USB 181
USB_HEARTBEAT 181
USB_STALL 182
VERSION 182
VIEW 182
VR 183
VRSTRING 184
WDOG 184
: 185
' 185
. . . . 186

$ 186
ERROR_LINE 187
INDEVICE 187
LOOKUP 188
OUTDEVICE 188
PMOVE 188
PROC 189
PROC_LINE 189
PROC_MODE 189
PROC_STATUS 189
PROCNUMBER 190
RESET 190
RUN_ERROR 190
TICKS 190

MATHEMATICAL OPERATIONS AND COMMANDS 192

+ Add 192
- Subtract 192
* Multiply 193
/ Divide 193
^ Power 194
= Equals 194
<> Not Equal 194
> Greater Than 195
>= Greater Than or Equal 195
< Less Than 196
<= Less Than or Equal 196
ABS 197
ACOS 197
AND 197
ASIN 198
ATAN 199
ATAN2 199
B_SPLINE 199
CLEAR_BIT 200
CONSTANT 200
COS 201
EXP 201
FRAC 201
GLOBAL 202

IEEE_IN . . . 202
IEEE_OUT . . . 203
INT . . . 203
LN . . . 203
MOD . . . 204
NOT . . . 204
OR . . . 204
READ_BIT . . . 205
SET_BIT . . . 205
SGN . . . 206
SIN . . . 206
SQR . . . 207
TAN . . . 207
XOR . . . 207

CONSTANTS . . . 209
OFF . . . 209
ON . . . 209
FALSE . . . 209
PI . . . 209
TRUE . . . 210

AXIS PARAMETERS . . . 211
ACCEL . . . 211
ADDAX_AXIS . . . 211
AFF_GAIN . . . 211
ATYPE . . . 212
AXIS_ADDRESS . . . 214
AXIS_ENABLE . . . 214
AXISSTATUS . . . 215
BACKLASH_DIST . . . 216
BOOST . . . 216
CAN_ENABLE . . . 217
CLOSE_WIN . . . 217
CLUTCH_RATE . . . 217
CREEP . . . 217
D_GAIN . . . 218
D_ZONE_MIN . . . 218
D_ZONE_MAX . . . 219
DAC . . . 219
DAC_OUT . . . 220

DAC_SCALE 220
DATUM_IN 221
DECEL 221
DEMAND_EDGES 222
DEMAND_SPEED 222
DPOS 222
DRIVE_CLEAR 222
DRIVE_CONTROL 223
DRIVE_ENABLE 223
DRIVE_EPROM 224
DRIVE_HOME 224
DRIVE_INPUTS 224
DRIVE_INTERFACE 224
DRIVE_MODE 225
DRIVE_MONITOR 225
DRIVE_READ 225
DRIVE_RESET 226
DRIVE_STATUS 226
DRIVE_WRITE 227
ENCODER 227
ENCODER_BITS 227
ENCODER_CONTROL 228
ENCODER_ID 229
ENCODER_READ 229
ENCODER_STATUS 229
ENCODER_TURNS 229
ENCODER_WRITE 230
ENDMOVE 230
ENDMOVE_BUFFER 230
ENDMOVE_SPEED 231
ERRORMASK 231
FAST_JOG 232
FASTDEC 232
FE 232
FE_LATCH 232
FE_LIMIT 233
FE_LIMIT_MODE 233
FE_RANGE 233
FEGRAD 234
FEMIN 234

FHOLD_IN 234
FHSPEED 235
FORCE_SPEED 235
FS_LIMIT 235
FULL_SP_RADIUS 236
FWD_IN 236
FWD_JOG 237
I_GAIN 237
INVERT_STEP 237
JOGSPEED 238
LIMIT_BUFFERED 238
LINKAX 238
MARK 238
MARKB 239
MERGE 239
MICROSTEP 240
MOVES_BUFFERED 240
MPOS 241
MSPEED 241
MTYPE 241
NEG_OFFSET 242
NTYPE 243
OFFPOS 243
OPEN_WIN 244
OUTLIMIT 244
OV_GAIN 245
P_GAIN 245
PLM_OFFSET 246
POS_OFFSET 246
PP_STEP 246
PWM_CONTROL 247
PWM_CYCLE 248
PWM_ENCODER 248
PWM_MARK 248
REG_POS 249
REG_POSB 250
REGIST_CONTROL 250
REMAIN 250
REMOTE_ERROR 250
REPDIST 251

REP_OPTION 251
REV_IN 251
REV_JOG 252
RS_LIMIT 252
SERVO 252
SP 253
SPEED 253
SPHERE_CENTRE 253
SRAMP 254
TANG_DIRECTION 254
TRANS_DPOS 255
UNITS 255
VECTOR_BUFFERED 256
VERIFY 256
VFF_GAIN 257
VP_SPEED 257

Motion and Axis Commands

ACC

Type: Axis Command

Syntax: **ACC(rate)**

Description: Sets both the acceleration and deceleration rate simultaneously.

This command is provided to aid compatibility with older Trio controllers. Use the **ACCEL** and **DECEL** axis parameters in new programs.

Parameters:

rate:	The acceleration rate in UNITS/SEC/SEC.

Example 1: Move an axis at a given speed and using the same rates for both acceleration and deceleration.

```
ACC(120)     ' set accel and decel to 120 units/sec/sec
SPEED=14.5   ' set programmed speed to 14.5 units/sec
MOVE(200)    ' start a relative move with distance of 200
```

Example 2: Changing the ACC whilst motion is in progress.

```
SPEED=100000              'set required target speed (units/sec)
ACC(1000)                 'set initial acc rate
FORWARD
WAIT UNTIL VP_SPEED>5000  'wait for acutal speed to exceed 5000
ACC(100000)               'change to high acc rate
WAIT UNTIL SPEED=VP_SPEED 'wait until final speed is reached
WAIT UNTIL IN(2)=OFF
CANCEL
```

ADD_DAC

Type: Axis Command

Syntax: **ADD_DAC(axis)**

Description: Adds the output from the 5-term servo control block of a secondary axis to the output of the base axis. The resulting **DAC_OUT** is then the sum of the two control loop outputs.

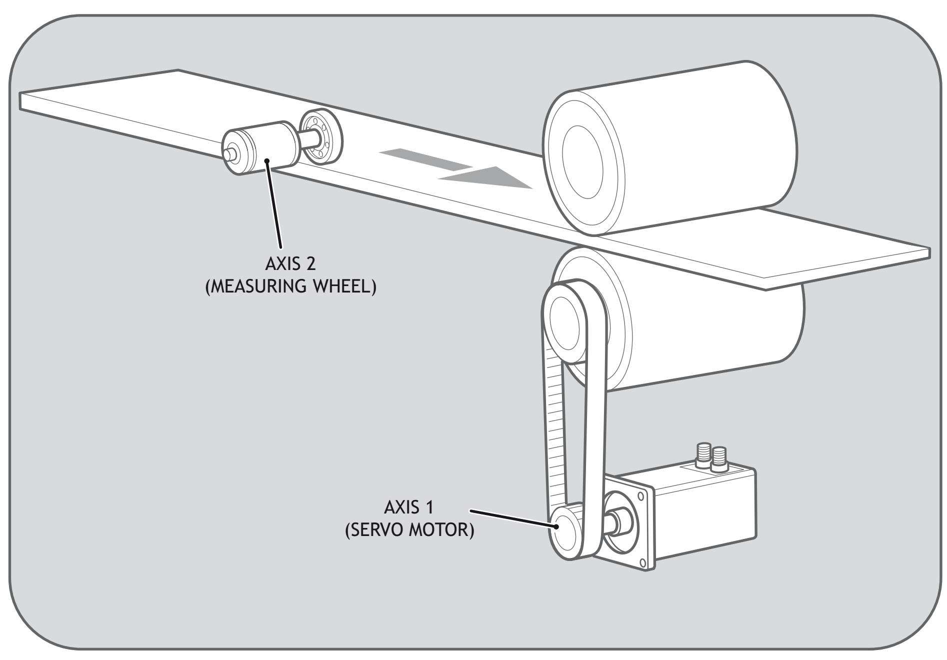
The **ADD_DAC** command is provided to allow a secondary encoder to be used on a servo axis to implement dual feedback control. This would typically be used in applications such as a roll-feed where you need a secondary encoder to compensate for slippage.

Parameters:

axis:	Number of the second axis, who's output will be added to the current axis. -1 will terminate the ADD_DAC link.

Example 1: Use **ADD_DAC** to add the output of a measuring wheel to the servo motor axis controlling a roll-feed. Set up the servo motor axis as usual with encoder feedback from the motor drive. The measuring wheel axis must also be set up as a servo by setting the **AYTPE** to 2. This is so that the software will perform the servo control calcualtions on that axis.

It is necessary for the two axes to be controlled by a common demand position. Typically this would be achieved by running the moves on a virtual axis and using **ADDAX** to produce a matching **DPOS** on BOTH axes. The servo gains are then set up on BOTH axes, and the output summed on to one physical output using **ADD_DAC**. If the required demand positions on both axes are not identical due to a difference in resolution between the 2 feedback devices, **ENCODER_RATIO** can be used on one axis to produce matching **UNITS**.




```
BASE(1)
‘ match the encoder counts per linear distance of the 2 axes
ENCODER_RATIO(counts_per_mm2, counts_per_mm1)
UNITS AXIS(1) = counts_per_mm1
UNITS AXIS(2) = counts_per_mm1 ‘ units MUST be the same
ADD_DAC(2) ' Combine axis(2) DAC_OUT with axis(1)
ADDAX(1) AXIS(2)    ' Superimpose axis 1 demand on axis 2
                    ‘ the axes are now set up and ready to move
MOVE(1200)
WAIT IDLE
```

ADDAX

Type: Axis Command

Syntax: **ADDAX(axis)**

Description: The **ADDAX** command is used to superimpose 2 or more movements to build up a more complex movement profile:

The **ADDAX** command takes the demand position changes from the specified axis and adds them to any movements running on the axis to which the command is issued. The specified axis can be any axis and does not have to physically exist in the system. After the **ADDAX** command has been issued the link between the two axes remains until broken and any further moves on the specified axis will be added to the base axis.

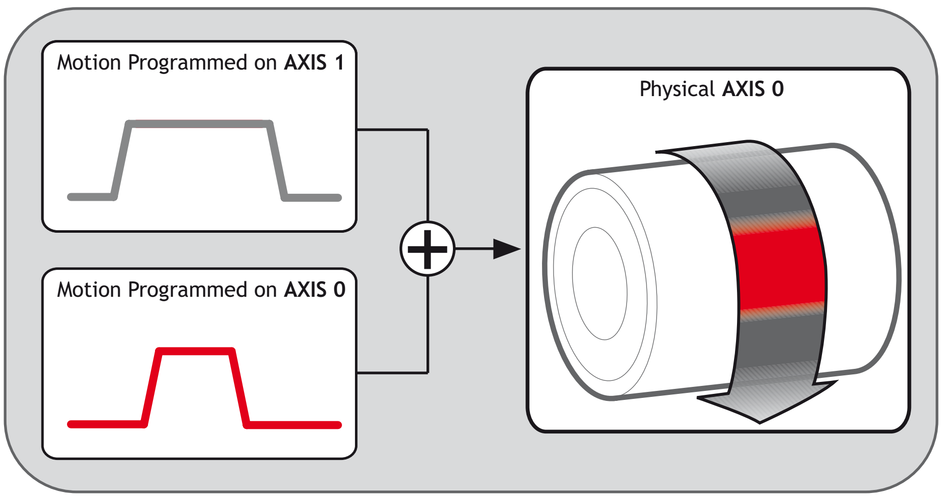
The **ADDAX** command therefore allows an axis to perform the moves specified on TWO axes added together. When the axis parameter **SERVO** is set to **OFF** on an axis with an encoder interface the measured position **MPOS** is copied into the demand position **DPOS**. This allows **ADDAX** to be used to sum encoder inputs.

Parameter: **axis:** Axis to superimpose.
-1 breaks the link with the other axis.

Note: The **ADDAX** command sums the movements in encoder edge units.

Example 1:

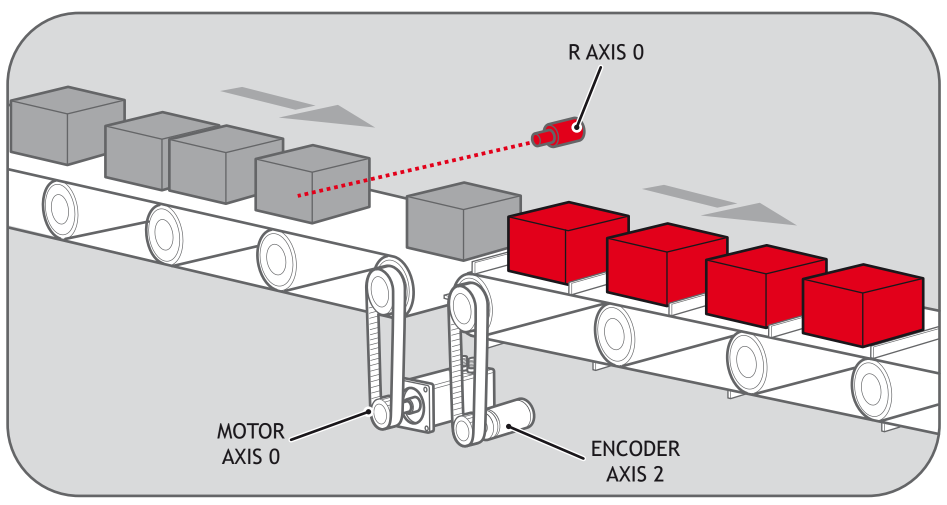
```
UNITS AXIS(0)=1000
UNITS AXIS(1)=20
' Superimpose axis 1 on axis 0
ADDAX(1) AXIS(0)
MOVE(1) AXIS(0)
MOVE(2) AXIS(1)
'Axis 0 will move 1*1000+2*20=1040 edges
```



Example 2: Pieces are placed randomly onto a continuously moving belt and further along the line are transferred to a second flighted belt. A detection system gives an indication as to whether a piece is in front of or behind its nominal position, and how far.

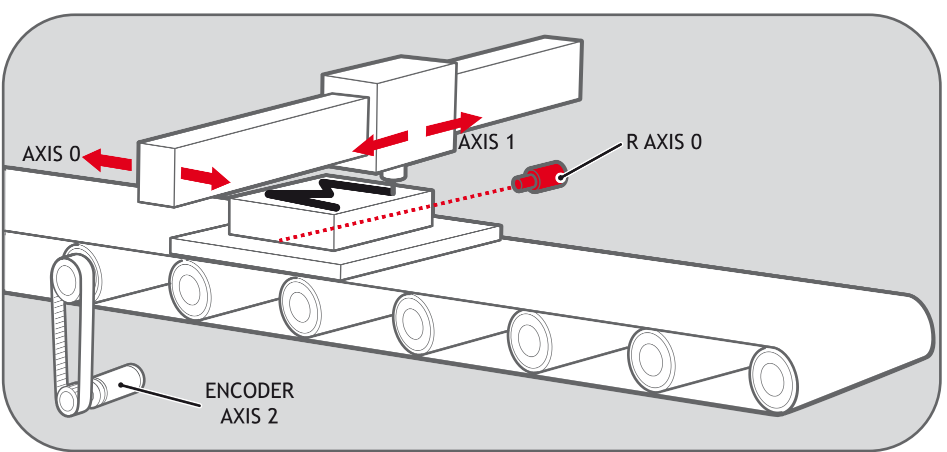
```
expected=2000 'sets expected position
BASE(0)
ADDAX(1)
CONNECT(1,2)  'continuous geared connection to flighted belt
REPEAT
  GOSUB getoffset      'get offset to apply
  MOVE(offset) AXIS(1) 'make correcting move on virtual axis
UNTIL IN(2)=OFF        'repeat until stop signal on input 2
RAPIDSTOP
ADDAX(-1) 'clear ADDAX connection
STOP

getoffset: ' sub routine to register the position of the
           ' piece and calculate the offset
BASE(0)
REGIST(3)
WAIT UNTIL MARK
seenat=REG_POS
offset=expected-seenat
RETURN
```

Axis 0 in this example is connected to the second conveyor's encoder and a superimposed **MOVE** on axis 1 is used to apply offsets



Example 3: An XY marking machine must mark boxes as they move along a conveyor. Using **CONNECT** enables the X marking axis to follow the conveyor. A virtual axis is used to program the marking absolute positions; this is then superimposed onto the X axis using **ADDAX**.

```
  ATYPE AXIS(3)=0 'set axis 3 as virtual axis
  SERVO AXIS(3)=ON
  DEFPOS(0) AXIS(3)
  ADDAX (3)AXIS(0) 'connect axis 3 requirement to axis 0
  WHILE IN(2)=ON
    REGIST(3)  'registration input detects a box on the conveyor
    WAIT UNTIL MARK OR IN(2)=OFF
    IF MARK THEN
      CONNECT(1,2) AXIS(0)'connect axis 0 to the moving belt
      BASE(3,1) 'set the drawing motion to axis 3 and 1
      'Draw the M
      MOVEABS(1200,0)'move A > B
      MOVEABS(600,1500)'move B > C
      MOVEABS(1200,3000)' move C > D
      MOVEABS(0,0)'move D > E
      WAIT IDLE
      BASE(0)
      CANCEL 'stop axis 0 from folowing the belt
      WAIT IDLE
      MOVEABS(0) 'move axis 0 to home position
    ENDIF
  WEND
CANCEL
```



AXIS

Type: Modifier

Syntax: **AXIS(expression)**

Description: Assigns ONE command or axis parameter operation to a particular axis.

If it is required to change the axis used in every subsequent command, the **BASE** command should be used instead.

Parameters: **Expression:** Any valid Trio BASIC expression. The result of the expression should be a valid integer axis number.

Example 1: The command line has a default base axis of 0. To print the measured position of axis 3 to the terminal in *Motion* Perfect, you must add the axis number after the parameter name.

```
>>PRINT MPOS AXIS(3)
```

Example 2: The base axis is 0, but it is required to start moves on other axes as well as the base axis.

```
MOVE(450) '        Start a move on the base axis (axis 0)
MOVE(300) AXIS(2) 'Start a move on axis 2
MOVEABS(120) AXIS(5) 'Start an absolute move on axis 5
```

Example 3: Set up the repeat distance and repeat option on axis 3, then return to using the base axis for all later commands.

```
REP_DIST AXIS(3)=100
REP_OPTION AXIS(3)=
SPEED=2.30 ‘ set speed accel and decel on the BASE axis
ACCEL=5.35
DECEL=8.55
```

See Also: **BASE()**

BACKLASH

Type: Motion Command

Syntax: **BACKLASH(on/off, distance, speed, accel)**

Description: This axis function allows the parameters for the backlash compensation to be loaded. The backlash compensation is achieved by applying an offset move when the motor demand is in one direction, then reversing the offset move when the motor demand is in the opposite direction. These moves are superimposed on the commanded axis movements.

Parameters:

on/off:	Control flag: ON to enable backlash.
distance:	The distance to be offset in user units.
speed:	The speed at which is the compensation move is applied in user units.
accel:	The accel/decel rate at which is compensation move is applied in user units.

The backlash compensation is applied after a change in the direction of change of the **DPOS** parameter.
The backlash compensation can be seen in the TRANS_DPOS axis parameter. This is effectively **DPOS** + backlash compensation.

Example 1:

```
’Apply backlash compensation on axes 0 and 1:

BACKLASH(ON,0.5,10,50) AXIS(0)
BACKLASH(ON,0.4,8,50) AXIS(1)
```

BASE

Type: Motion Command

Syntax: **BASE(axis no<,second axis><,third axis>...)**

Alternate Format: **BA(...)**

Description: The **BASE** command is used to direct all subsequent motion commands and axis parameter read/writes to a particular axis, or group of axes. The default setting is a sequence: zero, one, two…

Each process has its own BASE group of axes and each program can set BASE values independently.

The Trio BASIC program is separate from the MOTION GENERATOR program which controls motion in the axes. The motion generator has separate functions for each axis, so each axis is capable of being programmed with its own speed, acceleration, etc. and moving independently and simultaneously OR they can be linked together by interpolation or linked moves.

Parameters:

axis numbers: The number of the axis or axes to become the new base axis array, i.e. the axis/axes to send the motion commands to or the first axis in a multi axis command.

Example 1: Set up calibration units, speed and acceleration factors for axes 1 and 2.

```
BASE(1)
UNITS=2000' unit conversion factor
SPEED=100'Set speed axis 1 (units/sec)
ACCEL=5000'acceleration rate (units/sec/sec)
BASE(2)
UNITS=2000'unit conversion factor
SPEED=125'Set speed axis 2
ACCEL=10000'acceleration rate
```

Example 2: Set up an interpolated move to run on axes; 0 (x), 6 (y) and 4 (z). Axis 0 will move 100 units, axis 0 will move -23.1 and axis 4 will move 1250 units. The axes will move along the resultant path at the speed and acceleration set for axis 0.

```
BASE(0,6,4)
SPEED=120
ACCEL=2000
DECEL=2500
```

```
MOVE(100,-23.1,1250)
```

Note 1: The **BASE** command sets an internal array of axes held for each process. The default array for each process is 0,1,2...up to the number of controller axes. If the **BASE** command does not specify all the axes, the **BASE** command will "fill in" the remaining values automatically. Firstly it will fill in any remaining axes above the last declared value, then it will fill in any remaining axes in sequence:

```
' Set BASE array on a 16 axis MC224 controller
BASE(2,6,10)
```

This will set the internal array of 16 axes to:

2,6,10,11,12,13,14,15,0,1,3,4,5,7,8,9

Note 2: Command line process ONLY; the **BASE** array may be seen by typing **BASE** with no parameters. For example on an MC206X with 8 axes:

```
>>BASE
(0,2,3,1,4,5,6,7)
>>
```

See Also: **AXIS()**
The **AXIS()** command also redirects commands to different axes but applies to just a single command, and to a single axis.

CAM

Type: Axis Command

Syntax: **CAM(start point, end point, table multiplier, distance)**

Description: The **CAM** command is used to generate movement of an axis according to a table of POSITIONS which define a movement profile. The table of values is specified with the **TABLE** command. The movement may be defined with any number of points from 3 up to the maximum table size available. The controller interpolates between the values in the table to allow small numbers of points to define a smooth profile.

Parameters:

start point: The cam table may be used to hold several profiles and/or other information. To allow freedom of use each command specifies where to start in the table.

end point: Specifies end of values in table. Note that 2 or more **CAM()** commands executing simultaneously can use the same values in the table.

table multiplier: The table values are absolute positions from the start of the motion and are normally specified in encoder edges. The table multiplier may be set to any value to scale the values in the table.

distance: The distance parameter relates the speed of the axis to the time taken to complete the cam profile. The time taken can be calculated using the current axis speed and this distance parameter (which are in user units).

For example the system is being programmed in mm and the speed is set to 10mm/sec. If it is required to take 10 seconds to complete the profile a distance of 100mm should be specified. The speed may be changed at any time to any value as with other motion commands. The **SPEED** is ramped up to using the current **ACCEL** value. To obtain a **CAM** shape where **ACCEL** has no effect the value should be set to at least 1000 times the **SPEED** value (assuming the default **SERVO_PERIOD** of 1ms).

Note : When the **CAM** command is executing, the **ENDMOVE** parameter is set to the end of the PREVIOUS move

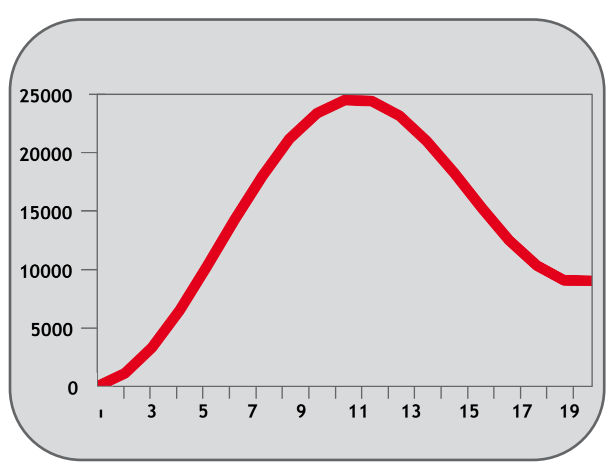
Example1: Motion is required to follow the POSITION equation:

t(x) = x*25 + 10000(1-cos(x))
Where x is in degrees. This example table provides a simple oscillation superimposed with a constant speed. To load the table and cycle it continuously the program would be:

```
FOR deg=0 TO 360 STEP 20 'loop to fill in the table
  rad = deg * 2 * PI/360 'convert degrees to radians
  x = deg * 25 + 10000 * (1-COS(rad))
  TABLE(deg/20,x) 'place value of x in table
NEXT deg

WHILE IN(2)=ON 'repeat cam motion while input 2 is on
  CAM(0,18,1,200)
  WAIT IDLE
WEND
```

Note: The subroutine camtable loads the data into the cam TABLE, as shown in the graph below.

Table Position	Degrees	Value
1	0	0
2	20	1103
3	40	3340
4	60	6500
5	80	10263
6	100	14236
7	120	18000
8	140	21160
9	160	23396
10	180	24500
11	200	24396
12	220	23160
13	240	21000
14	260	18236
15	280	15263
16	300	12500
17	320	10340
18	340	9103
19	360	9000



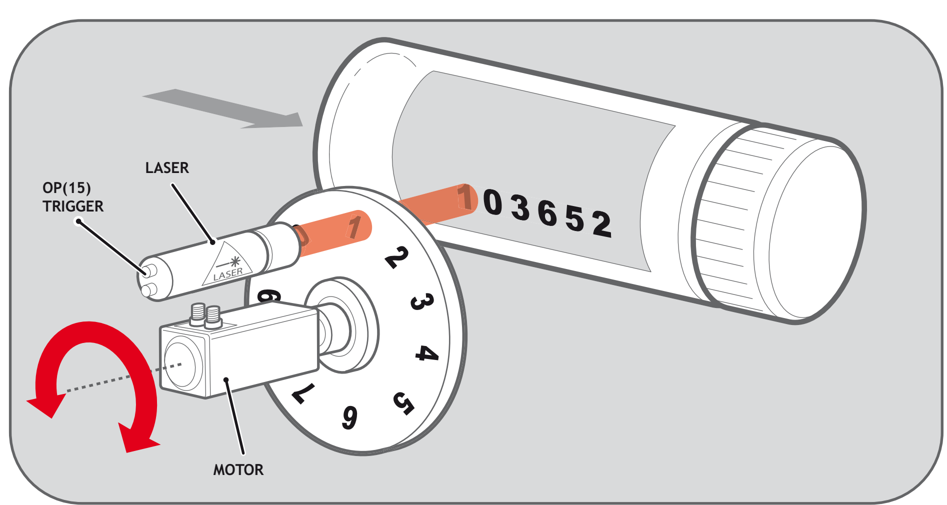
Example 2: A masked wheel is used to create a stencil for a laser to shine through for use in a printing system for the ten numerical digits. The required digits are transmitted through port 1 serial port to the controller as ASCII text.

The encoder used has 4000 edges per revolution and so must move 400 between each position. The cam table goes from 0 to 1, which means that the CAM multiplier needs to be a multiple of 400 to move between the positions.

The wheel is required to move to the pre-set positions every 0.25 seconds. The speed is set to 10000 edges/second, and we want the profile to be complete in 0.25 seconds. So multiplying the axis speed by the required completion time (10000 x 0.25) gives the distance parameter equals 2500.

```
GOSUB profile_gen
 WHILE IN(2)=ON
   WAIT UNTIL KEY#1              'Waits for character on port 1
   GET#1,k
   IF k>47 AND k<58 THEN         'check for valid ASCII character
```

```
        position=(k-48)*400         'convert to absolute position
        multiplier=position-offset  'calculate relative movement
        'check if it is shorter to move in reverse direction
        IF multiplier>2000 THEN
          multiplier=multiplier-4000
        ELSEIF multiplier<-2000 THEN
          multiplier=multiplier+4000
        ENDIF
        CAM(0,200,multiplier,2500)   'set the CAM movment
        WAIT IDLE
        OP(15,ON)                    'trigger the laser flash
        WA(20)
        OP(15,OFF)
        offset=(k-48)*400      'calculates current absolute position
      ENDIF
    WEND

  profile_gen:
    num_p=201
    scale=1.0
    FOR p=0 TO num_p-1
      TABLE(p,((-SIN(PI*2*p/num_p)/(PI*2))+p/num_p)*scale)
    NEXT p
    RETURN
```



Example 3: A suction pick and place system must vary its speed depending on the load carried. The mechanism has a load cell which inputs to the controller on the analogue channel **(AIN)**.

The move profile is fixed, but the time taken to complete this move must be varied depending on the AIN. The **AIN** value varies from 100 to 800, which has to result in a move time of 1 to 8 seconds. If the speed is set to 10000 units per second and the required time is 1 to 8 seconds, then the distance parameter must range from 10000 to 80000. (distance = speed x time)

The return trip can be completed in 0.5 seconds and so the distance value of 5000 is fixed for the return movement. The Multiplier is set to -1 to reverse the motion.

```
GOSUB profile_gen         'loads the cam profile into the table
SPEED=10000:ACCEL=SPEED*1000:DECEL=SPEED*1000
WHILE IN(2)=ON
    OP(15,ON)             'turn on suction
    load=AIN(0)           'capture load value
    distance = 100*load   'calculate the distance parameter
    CAM(0,200,50,distance) 'move 50mm forward in time calculated
    WAIT IDLE
    OP(15,OFF)            'turn off suction
    WA(100)
    CAM(0,200,-50,5000)    'move back to pick up position
WEND

profile_gen:
  num_p=201
  scale=400               'set scale so that multiplier is in mm
  FOR p=0 TO num_p-1
    TABLE(p,((-SIN(PI*2*p/num_p)/(PI*2))+p/num_p)*scale)
  NEXT p
  RETURN
```

CAMBOX

Type: Axis Command

Syntax: **CAMBOX(start point, end point, table multiplier, link distance , link axis[, link options][, link pos])**

Description: The **CAMBOX** command is used to generate movement of an axis according to a table of POSITIONS which define the movement profile. The motion is linked to the measured motion of another axis to form a continuously variable software gearbox. The table of values is specified with the **TABLE** command. The movement may be defined with any number of points from 3 up to the maximum table size available. The controller interpolates between the values in the table to allow small numbers of points to define a smooth profile.

Parameters:

start point: The cam table may be used to hold several profiles and/or other information. To allow freedom of use each command specifies where to start in the table.

end point: Specifies end of values in table. Note that 2 or more **CAMBOX** commands executing simultaneously can use the same values in the table.

table multiplier: The table values are positions relative to the start of the motion and are specified in encoder edges or steps. The table multiplier may be set to any value to scale the values in the table.

link distance: The link distance specifies the distance the link axis must move to complete the specified output movement. The link distance is in the user units of the link axis and should always be specified as a positive distance.

link axis: This parameter specifies the axis to link to.

link options: Bit Values:

1 - link commences exactly when registration event occurs on link axis

2 - link commences at an absolute position on link axis (see **link pos**)

4 - CAMBOX repeats automatically and bi-directionally when this bit is set. (This mode can be cleared by setting bit 1 of the REP_OPTION axis parameter)

8 - PATTERN mode. Advanced use of cambox: allows multiple scale values to be used. Normally combined with the automatic repeat mode. See example 4.

Note:

The start options (1 and 2) may be combined with the repeat-options (4 and 8).

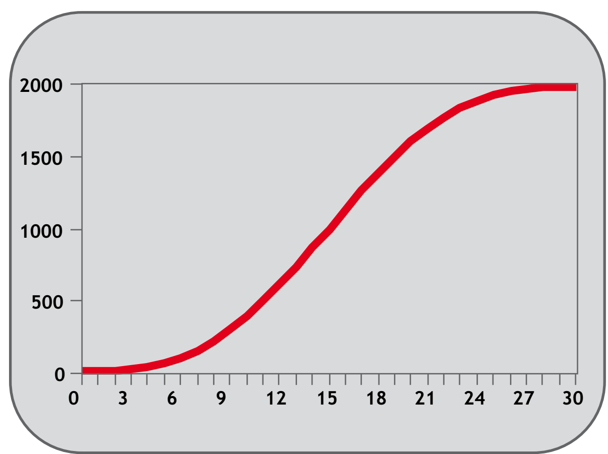
link pos: This parameter is the absolute position where the **CAMBOX** link is to be started when parameter 6 is set to 2.
Link pos cannot be at or within one servo_period's worth of movement of the **REP_DIST** position.

Note: When the **CAMBOX** command is executing the **ENDMOVE** parameter is set to the end of the PREVIOUS move. The **REMAIN** axis parameter holds the remainder of the distance on the link axis.

Parameters 6 and 7; link options and link pos, are optional.

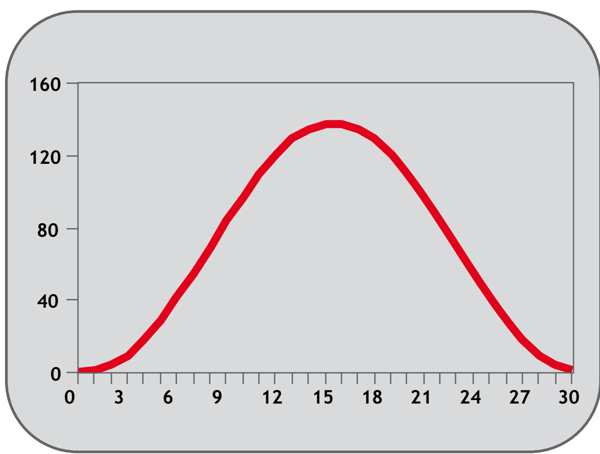
Example 1:

```
  ' Subroutine to generate a SIN shape speed profile
  ' Uses: p is loop counter
  ' num_p is number of points stored in tables pos 0..num_p
  ' scale is distance travelled scale factor
profile_gen:
  num_p=30
  scale=2000
  FOR p=0 TO num_p
    TABLE(p,((-SIN(PI*2*p/num_p)/(PI*2))+p/num_p)*scale)
  NEXT p
  RETURN
```



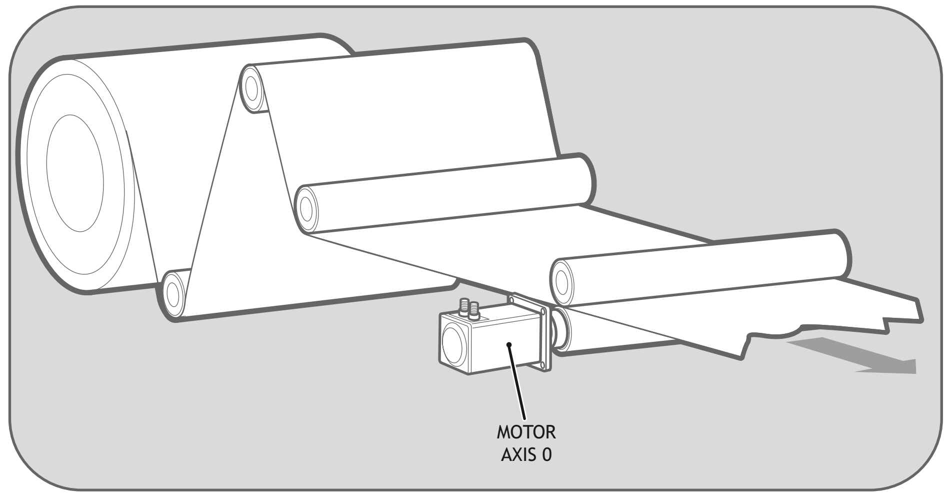
This graph plots **TABLE** contents against table array position. This corresponds to motor POSITION against link POSITION when called using **CAMBOX**. The **SPEED** of the motor will correspond to the derivative of the position curve above:

Speed Curve



Example 2: A pair of rollers feeds plastic film into a machine. The feed is syncronised to a master encoder and is activated when the master reaches a position held in the variable "start". This example uses the table points 0...30 generated in Example 1:

```
start=1000
FORWARD AXIS(1)
WHILE IN(2)=OFF
  CAMBOX(0,30,800,80,15,2,start)
  WA(10)
  WAIT UNTIL MTYPE=0 OR IN(2)=ON
WEND
CANCEL
CANCEL AXIS(1)
WAIT IDLE
```



Note:

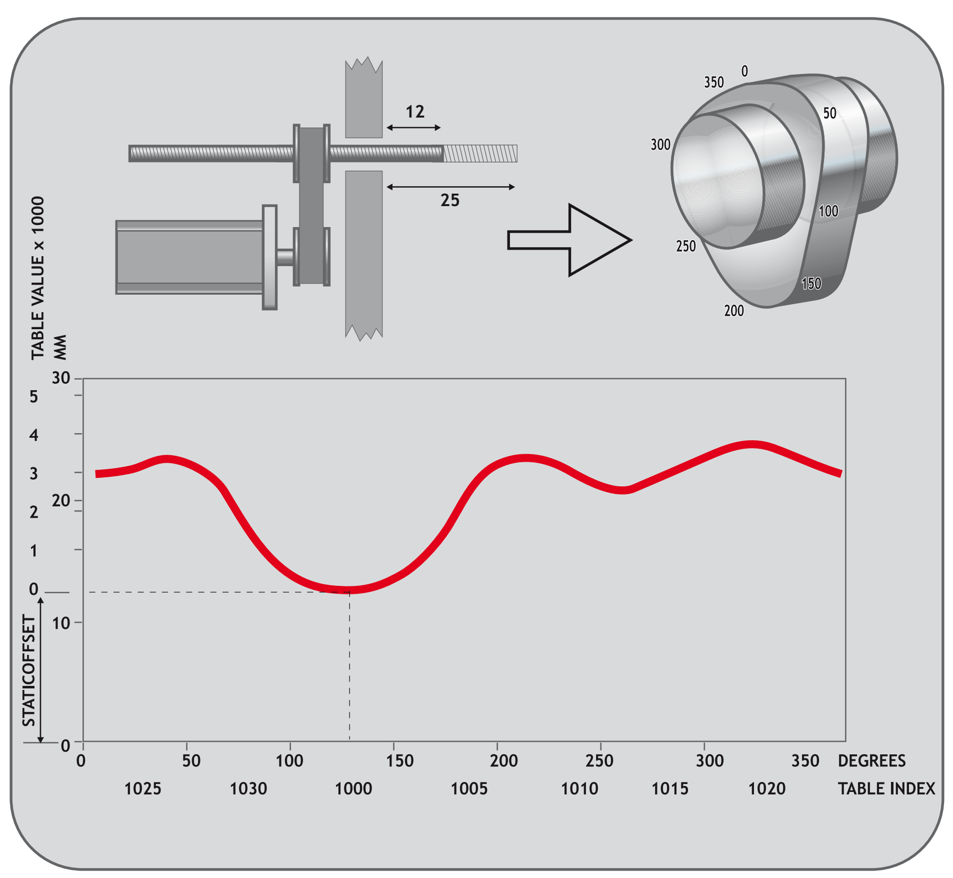
0	The start of the profile shape in the **TABLE**
30	The end of the profile shape in the **TABLE**
800	This scales the **TABLE** values. Each **CAMBOX** motion would therefore total 800*2000 encoder edges steps.
80	The distance on the product conveyor to link the motion to. The units for this parameter are the programmed distance units on the link axis.
15	This specifies the axis to link to.
2	This is the link option setting - Start at absolute position on the link axis.
“start”	variable “start”. The motion will execute when the position “start” is reaches on axis 15.

Example 3: A motor on Axis 0 is required to emulate a rotating mechanical **CAM**. The position is linked to motion on axis 3. The "shape" of the motion profile is held in **TABLE** values 1000..1035.

The table values represent the mechanical cam but are scaled to range from 0-4000

```
TABLE(1000,0,0,167,500,999,1665,2664,3330,3497,3497)
TABLE(1010,3164,2914,2830,2831,2997,3164,3596,3830,3996,3996)
TABLE(1020,3830,3497,3330,3164,3164,3164,3330,3467,3467,3164)
TABLE(1030,2831,1998,1166,666,333,0)

BASE(3)
MOVEABS(130)
WAIT IDLE
'start the continuously repeating cambox
CAMBOX(1000,1035,1,360,3,4) AXIS(0)
FORWARD             'start camshaft axis
WAIT UNTIL IN(2)=OFF
REP_OPTION = 2      'cancel repeating mode by setting bit 1
WAIT IDLE AXIS(0)   'waits for cam cycle to finish
CANCEL              'stop camshaft axis
WAIT IDLE
```

Note: The system software resets bit 1 of **REP_OPTION** after the repeating mode has been cancelled.



CAMBOX Pattern Mode:

Description: Setting bit 3 (value 8) of the link options parameter enables the **CAMBOX** pattern mode. This mode enables a sequence of scale values to be cycled automatically. This is normally combined with the automatic repeat mode, so the options parameter should be set to 12. This diagram shows a typical repeating pattern which can be automated with the **CAMBOX** pattern mode:

The parameters for this mode are treated differently to the standard **CAMBOX** function

```
CAMBOX(start, end, control block pointer, link dist, link axis,
options)
```

The start and end parameters specify the basic shape profile ONLY. The pattern sequence is specified in a separate section of the **TABLE** memory. There is a new **TABLE** block defined: The "Control Block". This block of seven **TABLE** values defines the pattern position, repeat controls etc. The block is fixed at 7 values long.

Therefore in this mode only there are 3 independently positioned **TABLE** blocks used to define the required motion:

SHAPE BLOCK	This is directly pointed to by the **CAMBOX** command as in any **CAMBOX**.
CONTROL BLOCK	This is pointed to by the third **CAMBOX** parameter in this options mode only. It is of fixed length (7 table values). It is important to note that the control block is modified during the **CAMBOX** operation. It must therefore be re-initialised prior to each use.
PATTERN BLOCK	The start and end of this are pointed to by 2 of the CONTROL BLOCK values. The pattern sequence is a sequence of scale factors for the SHAPE.

Control Block Parameters

		R/W	Description
0	CURRENT POSITION	R	The current position within the TABLE of the pattern sequence. This value should be initialised to the START PATTERN number.
1	FORCE POSITION	R/W	Normally this value is -1. If at the end of a SHAPE the user program has written a value into this TABLE position the pattern will continue at this position. The system software will then write -1 into this position. The value written should be inside the pattern such that the value: CB(2)<=CB(1)<=CB(3)
2	START PATTERN	R	The position in the **TABLE** of the first pattern value.
3	END PATTERN	R	The position in the **TABLE** of the final pattern value
4	REPEAT POSITION	R/W	The current pattern repeat number. Initialise this number to 0. The number will increment when the pattern repeats if the link axis motion is in a positive direction. The number will decrement when the pattern repeats if the link axis motion is in a negative direction. Note that the counter runs starting at zero: 0,1,2,3...
5	REPEAT COUNT	R/W	Required number of pattern repeats. If -1 the pattern repeats endlessly. The number should be positive. When the ABSOLUTE value of CB(4) reaches CB(5) the **CAMBOX** finishes if CB(6)=-1. The value can be set to 0 to terminate the **CAMBOX** at the end of the current pattern. See note below, next page, on REPEAT COUNT in the case of negative motion on the link axis.
6	NEXT CONTROL BLOCK	R/W	If set to -1 the pattern will finish when the required number of repeats are done. Alternatively a new control block pointer can be used to point to a further control block.

Note: READ/WRITE values can be written to by the user program during the pattern **CAMBOX** execution.

Example 4: A quilt stitching machine runs a feed cycle which stiches a plain pattern before starting a patterned stitch. The plain pattern should run for 1000 cycles prior to running a pattern continuously until requested to stop at the end of the pattern. The cam profile controls the motion of the needle bar between moves and the pattern table controls the distance of the move to make the pattern.

The same shape is used for the initialisation cycles and the pattern. This shape is held in **TABLE** values 100..150

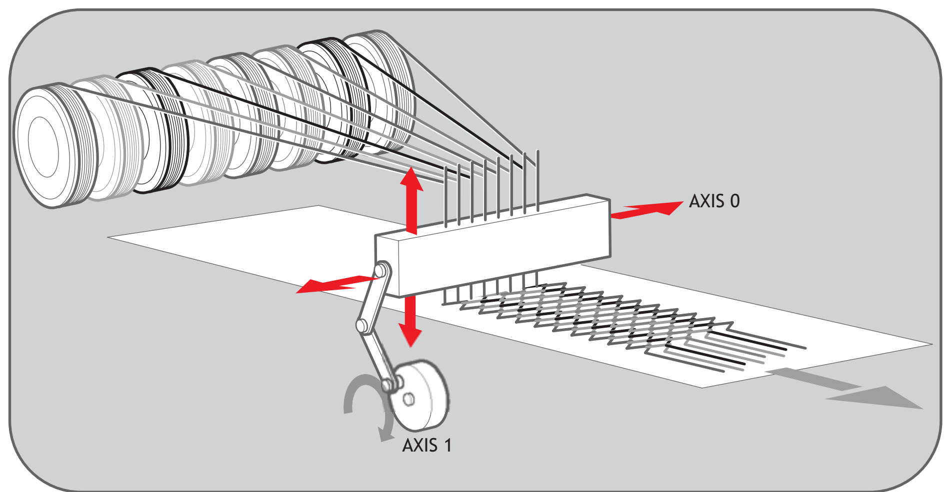
The running pattern sequence is held in **TABLE** values 1000..4999

The initialisation pattern is a single value held in **TABLE(160)**

The initialisation control block is held in **TABLE(200)..TABLE(206)**

The running control block is held in **TABLE(300)..TABLE(306)**

```
' Set up Initialisation control block:
TABLE(200,160,-1,160,160,0,1000,300)

' Set up running control block:
TABLE(300,1000,-1,1000,4999,0,-1,-1)

' Run whole lot with single CAMBOX:
' Third parameter is pointer to first control block

CAMBOX(100,150,200,5000,1,20)
WAIT UNTIL IN(7)=OFF

TABLE(305,0) ' Set zero repeats: This will stop at end of pattern
```



Note: Negative motion on link axis:
The axis the **CAMBOX** is linked to may be running in a positive or negative direction. In the case of a negative direction link the pattern will execute in reverse. In the case where a certain number of pattern repeats is specified with a negative direction link, the first control block will produce one repeat less than expected. This is because the **CAMBOX** loads a zero link position which immediately goes negative on the next servo cycle triggering a REPEAT COUNT. This effect only occurs when the **CAMBOX** is loaded, not on transitions from CONTROL BLOCK to CONTROL BLOCK. This effect can easily be compensated for either by increasing the required number of repeats, or setting the initial value of REPEAT POSITION to 1.

CANCEL

Type: Motion Command

Syntax: **`CANCEL / CANCEL(1)`**

Alternate Format: **`CA`**

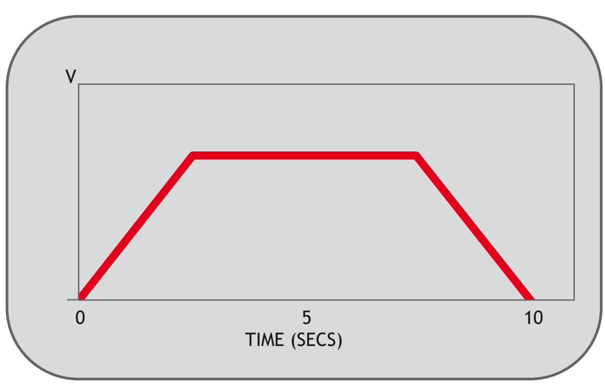
Description: Cancels a move on an axis or an interpolating axis group. Velocity profiled moves, for example; **`FORWARD, REVERSE, MOVE, MOVEABS, MOVECIRC, MHELICAL, MOVEMODIFY`**, will be ramped down at the programmed deceleration rate then terminated. Other move types will be terminated immediately.

`CANCEL(1)` clears a buffered move, leaving the current executing movement intact.

Note: Cancel will only cancel the presently executing move. If further moves are buffered they will then be loaded and the axis will not stop.

Example 1: Move the base axis forward at the progammed SPEED, wait for 10 seconds, then slow down and stop the axis at the programmed DECEL rate.

```
FORWARD
WA(10000)
CANCEL' stop movement after 10 seconds
```

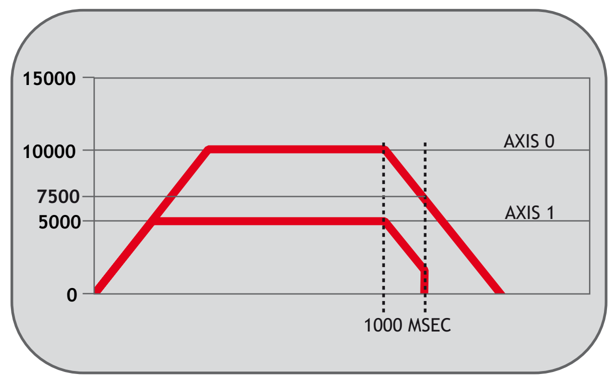


Example 2: A flying sheer uses a sequence of **`MOVELINKs`** to make the base axis follow a reference encoder on axis 4. When the shear returns to the top position an input is triggered, this removes the buffered **`MOVELINK`** and replace with a decelrating **`MOVELINK`** to ramp down the slave (base) axis.

```
ref_axis = 4
REPEAT
  MOVELINK(100,100,0,0,ref_axis)
  WAIT LOADED   ' make sure the NTYPE buffer is empty each time
UNTIL IN(5)=ON
CANCEL(1)       ' cancel the movelink in the NTYPE buffer
MOVELINK(100,200,0,200,ref_axis) ' deceleration ramp
CANCEL           ' cancel the main movelink, this starts the decel
```

Example 3: Two axes are connected with a ratio of 1:2. Axis 0 is cancelled after 1 second, then axis 1 is cancelled when the speed drops to a specified level. Following the first cancel axis 1 will decelerate at the **DECEL** rate. When axis 1's **CONNECT** is cancelled it will stop instantly.

```
BASE(0)
SPEED=10000
FORWARD
CONNECT(0.5,0) AXIS(1)
WA(1000)
CANCEL
WAIT UNTIL VP_SPEED<=7500
CANCEL AXIS(1)
```



See also: RAPIDSTOP.

CONNECT

Type: **Axis Command**

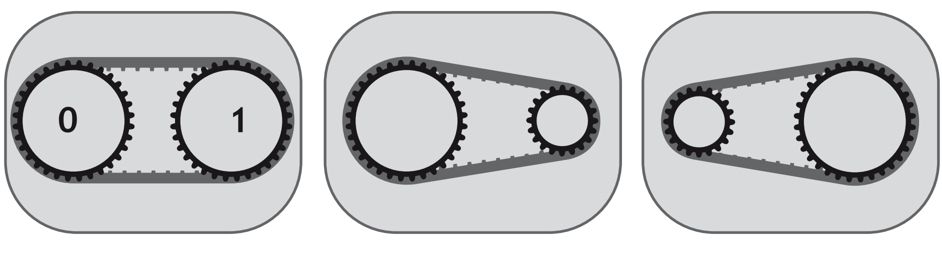
Syntax: **CONNECT(ratio , driving axis)**

Alternate Format: **CO(...)**

Description: **CONNECT** the demand position of the base axis to the measured movements of the driving axes to produce an electronic gearbox.
The ratio can be changed at any time by issuing another **CONNECT** command which will automatically update the ratio without the previous **CONNECT** being cancelled.
The command can be cancelled with a **CANCEL** or **RAPIDSTOP** command

Parameters:

ratio:	This parameter holds the number of edges the base axis is required to move per increment of the driving axis. The ratio value can be either positive or negative and has sixteen bit fractional resolution. The ratio is always specified as an encoder edge ratio.
driving axis:	This parameter specifies the axis to link to.



CONNECT(1,1) **CONNECT(0.5,1)** **CONNECT(2,1)**

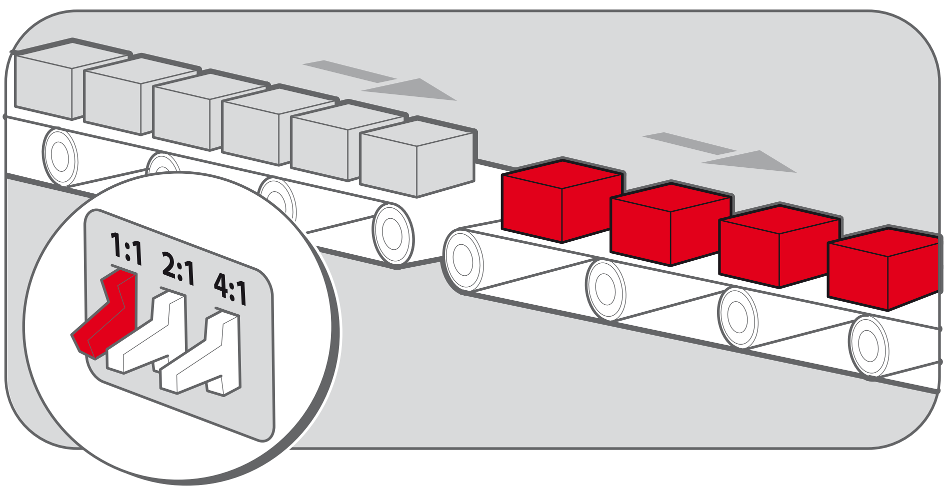
Note: To achieve an exact connection of fractional ratio's of values such as 1024/3072. The **MOVELINK** command can be used with the continuous repeat link option set to ON.

Example 1: In a press feed a roller is required to rotate at a speed one quarter of the measured rate from an encoder mounted on the incoming conveyor. The roller is wired to the master axis 0. The reference encoder is connected to axis 1.

```
BASE(0)
SERVO=ON
CONNECT(0.25,1)
```

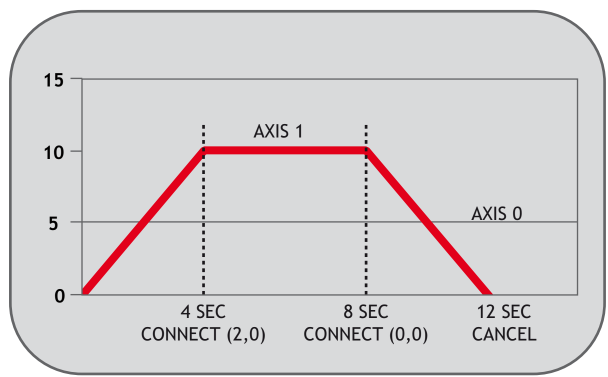
Example 2: A machine has an automatic feed on axis 1 which must move at a set ratio to axis 0. This ratio is selected using inputs 0-2 to select a particular "gear", this ratio can be updated every 100msec. Combinations of inputs will select intermediate gear ratios. For example 1 ON and 2 ON gives a ratio of 6:1.

```
BASE(1)
FORWARD AXIS(0)
WHILE IN(3)=ON
  WA(100)
  gear = IN(0,2)
  CONNECT(gear,0)
WEND
RAPIDSTOP       ' cancel the FORWARD and the CONNECT
```



Example 3: Axis 0 is required to run a continuous forward, axis 1 must connect to this but without the step change in speed that would be caused by simply calling the **CONNECT**. **CLUTCH_RATE** is used along with an initial and final connect ratio of zero to get the required motion.

```
FORWARD AXIS(0)
BASE(1)
CONNECT(0,0)      'set intitial ratio to zero
CLUTCH_RATE=0.5   'set clutch rate
CONNECT(2,0)      'apply the required connect ratio
WA(8000)
CONNECT(0,0)      'apply zero ratio to disconnect
WA(4000)          'wait for deceleration to complete
CANCEL            'cancel connect
```



DATUM

Type: Command

Syntax: **DATUM(sequence no)**

Description: Performs one of 6 datuming sequences to locate an axis to an absolute position. The creep speed used in the sequences is set using **CREEP**. The programmed speed is set with the **SPEED** command.

DATUM(0) is a special case used for resetting the system after an axis critical error. It leaves the positions unchanged.

Parameter:

Seq.	Description
0	**DATUM(0)** clears the following error exceeded **FE_LIMIT** condition for ALL axes by setting these bits in **AXISSTATUS** to zero: BIT 1 Following Error Warning BIT 2 Remote Drive Comms Error BIT 3 Remote Drive Error BIT 8 Following Error Limit Exceeded BIT 11 Cancelling Move For stepper axes with position verification, the current measured position of ALL axes are set as demand position. FE is therefore set to zero. **DATUM(0)** must only be used after the **WDOG** is set to OFF, otherwise there will be unpredictable effects on the motion.
1	The axis moves at creep speed forward till the Z marker is encountered. The Demand position is then reset to zero and the Measured position corrected so as to maintain the following error.

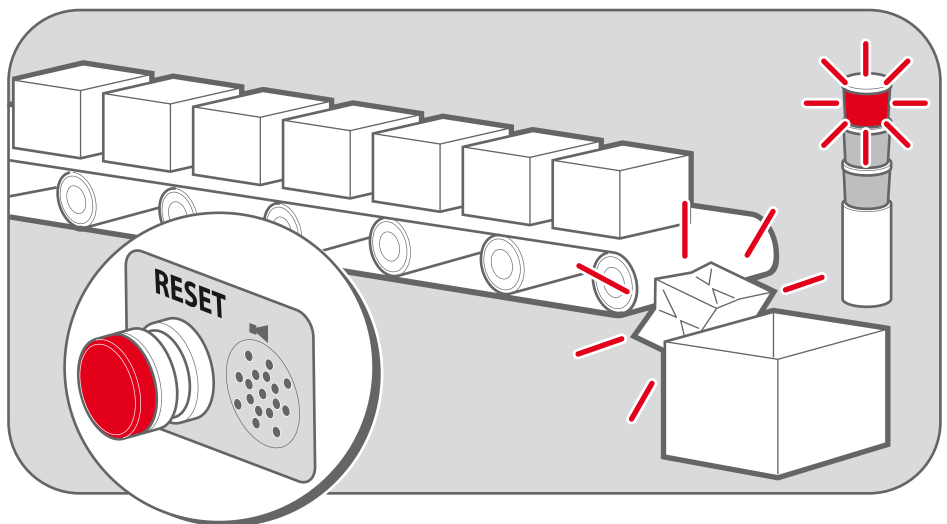
Seq.	Description
2	The axis moves at creep speed in reverse till the Z marker is encountered. The Demand position is then reset to zero and the Measured position corrected so as to maintain the following error.
3	The axis moves at the programmed speed forward until the datum switch is reached. The axis then moves backwards at creep speed until the datum switch is reset. The Demand position is then reset to zero and the Measured position corrected so as to maintain the following error.
4	The axis moves at the programmed speed reverse until the datum switch is reached. The axis then moves at creep speed forward until the datum switch is reset. The Demand position is then reset to zero and the Measured position corrected so as to maintain the following error.
5	The axis moves at programmed speed forward until the datum switch is reached. The axis then reverses at creep speed until the datum switch is reset. It then continues in reverse at creep speed looking for the Z marker on the motor. The demand position where the Z input was seen is then set to zero and the measured position corrected so as to maintain the following error.
6	The axis moves at programmed speed reverse until the datum switch is reached. The axis then moves forward at creep speed until the datum switch is reset. It then continues forward at creep speed looking for the Z marker on the motor. The demand position where the Z input was seen is then set to zero and the measured position corrected so as to maintain the following error.
7	Clear **AXISSTATUS** error bits for the **BASE** axis only. Otherwise the action is the same as **DATUM(0)**.

Note: The datuming input set with the **DATUM_IN** is active low so is set when the input is OFF. This is similar to the **FWD**, **REV** and **FHOLD** inputs which are designed to be “fail-safe”.

Example 1: A production line is forced to stop if something jams the product belt, this causes a motion error. The obstacle has to be removed, then a reset switch is pressed to restart the line.

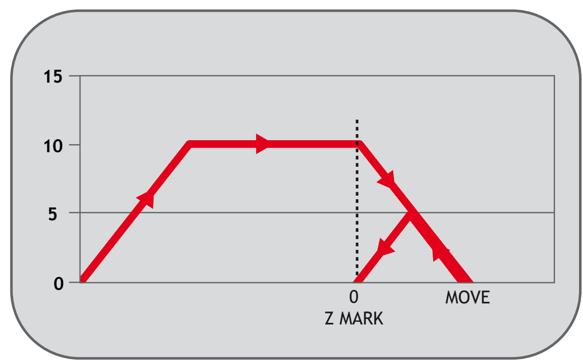
```
  FORWARD               'start production line
  WHILE IN(2)=ON
    IF MOTION_ERROR=0 THEN
       OP(8,ON)         'green light on; line is in motion
          ELSE
       OP(8, OFF)
      GOSUB error_correct
    ENDIF
  WEND
  CANCEL
  STOP

error_correct:
   REPEAT
```

```
    OP(10,ON)
    WA(250)
    OP(10,OFF)          'flash red light to show crash
    WA(250)
   UNTIL IN(1)=OFF
  DATUM(0)              'reset axis status errors
  SERVO=ON              'turn the servo back on
  WDOG=ON               'turn on the watchdog
  OP(9,ON)              'sound siren that line will restart
  WA(1000)
  OP(9,OFF)
  FORWARD               'restart motion
RETURN
```



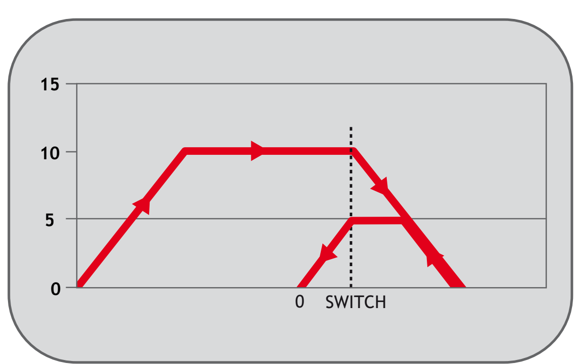
Example 2: An axis requires its position to be defined by the Z marker. This position should be set to zero and then the axis should move to this position. Using the datum 1 the zero point is set on the Z mark, but the axis starts to decelerate at this point so stops after the mark. A move is then used to bring it back to the Z position.

```
  SERVO=ON
  WDOG=ON
  CREEP=1000     'set the search speed
  SPEED=5000     'set the return speed
  DATUM(1)       'register on Z mark and sets this to datum
  WAIT IDLE
MOVEABS (0)       'moves to datum position
```



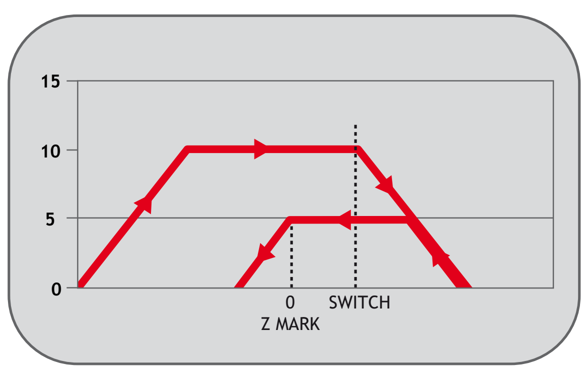
Example 3: A machine must home to its limit switch which is found at the rear of the travel before operation. This can be achieved through using **DATUM(4)** which moves in reverse to find the switch.

```
SERVO=ON
WDOG=ON
REV_IN=-1     'temporarily turn off the limit switch function
DATUM_IN=5    'sets input 5 for registration
SPEED=5000    'set speed, for quick location of limit switch
CREEP=500     'set creep speed for slow move to find edge of switch
DATUM(4)      'find "edge" at creep speed and stop
WAIT IDLE
DATUM_IN=-1
REV_IN=5      'restore input 5 as a limit switch again
```



Example 4: A similar machine to Example 3 must locate a home switch, which is at the forward end of travel, and then move backwards to the next Z marker and set this as the datum. This is done using **DATUM(5)** which moves forwards at speed to locate the switch, then reverses at creep to the Z marker. A final move is then needed, if required, as in Example 2 to move to the datum Z marker.

```
SERVO=ON
WDOG=ON
DATUM_IN=7   'sets input 7 as home switch
SPEED=5000   'set speed, for quick location of switch
CREEP=500    'set creep speed for slow move to find edge of switch
DATUM(5)     'start the homing sequence
WAIT IDLE
```



DEC

Type: Axis Command

Syntax: **DEC(rate)**

Description: Sets the deceleration rate for an axis. Different rates may be set for each axis. The **DEC** command is included to maintain compatibility with older controllers. Axis Parameter **DECEL** provides the same functionality and is the preferred method for setting the decleration rate.

Parameters: **rate:** The deceleration rate in UNITS/SEC/SEC.

Note: **ACC** sets both the acceleration and the deceleration rates to the same value. As **DEC** sets only the deceleration rate, you must use **DEC** after the **ACC** command in the program in order to make acceleration and deceleration rates different.

See Also: **ACCEL** and **DECEL** axis parameters.

Example 1: Initialising an axis to use different rates for acceleration and deceleration, then processing a move.

```
ACC(120)     'set accel and decel to 120 units/sec/sec
DEC(90)      'set deccel to 90 units/sec/sec
SPEED=14.5   'set programmed speed to 14.5 units/sec
MOVE(500)  'start a relative move with distance of 500
```

DEFPOS

Type: Function

Syntax: **DEFPOS(pos1 [,pos2[, pos3[, pos4.....]]])**

Alternate Format: **DP(pos1 [,pos2[, pos3[, pos4]]])**

Description: Defines the current position(s) as a new absolute value. The value pos# is placed in **DPOS**, while **MPOS** is adjusted to maintain the FE value. This function is completed after the next servo-cycle. **OFFPOS** is set non-zero when the **DEFPOS** begins execution and **OFFPOS** returns to 0 when the **DPOS** and **MPOS** have been updated. **DEFPOS** may be used at any time, even whilst a move is in progress, but its normal function is to set the position values of a group of axes which are stationary.

Parameters:

pos1: Absolute position to set on current base axis in user units.

pos2: Abs. position to set on the next axis in **BASE** array in user units.

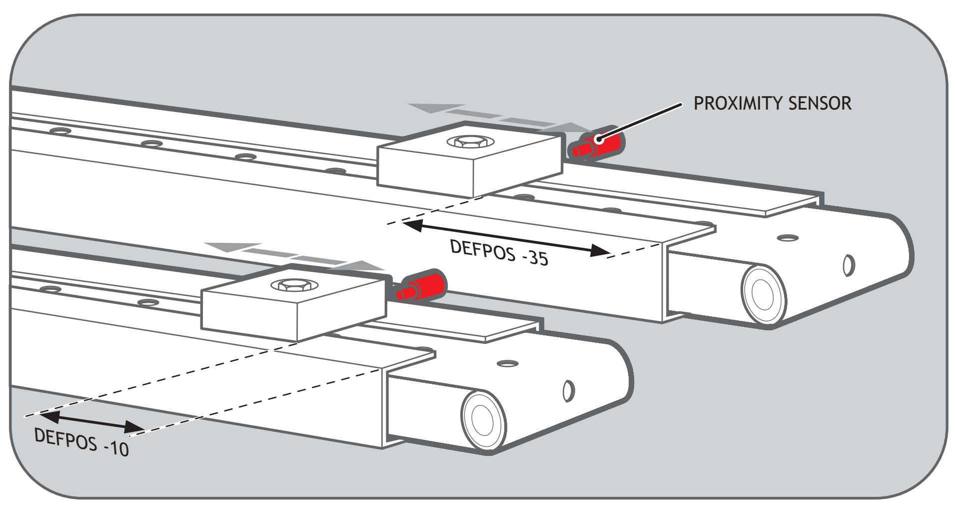
pos3: Abs. position to set on the next axis in **BASE** array in user units.

As many parameters as axes on the system may be specified.

See Also: **OFFPOS** which performs a relative adjustment of position.

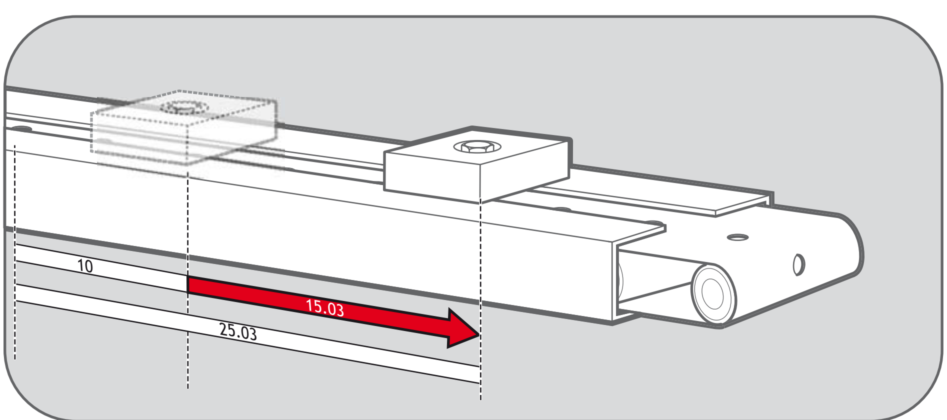
Example 1: After homing 2 axes, it is required to change the **DPOS** values so that the “home” positions are not zero, but some defined positions instead.

```
DATUM(5) AXIS(1) ‘ home both axes.  At the end of the DATUM
DATUM(4) AXIS(3) ‘ procedure, the positions will be 0,0.
WAIT IDLE AXIS(1)
WAIT IDLE AXIS(3)
BASE(1,3)        ‘ set up the BASE array
DEFPOS(-10,-35)  ‘ define positions of the axes to be -10 and -35
```



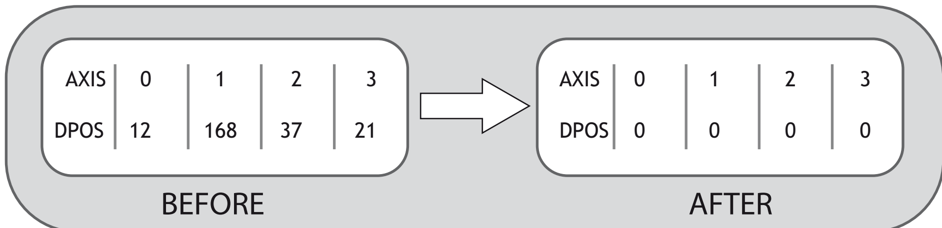
Example 2: Define the axis position to be 10, then start an absolute move, but make sure the axis has updated the position before loading the **MOVEABS**.

```
DEFPOS(10.0)
WAIT UNTIL OFFPOS=0' Ensures DEFPOS is complete before next line
MOVEABS(25.03)
```



Example 3: From the Motion Perfect terminal, quickly set the **DPOS** values of the first four axes to 0.

```
>>BASE(0)
>>DP(0,0,0,0)
>>
```



DISABLE_GROUP

Type: Function

Syntax: **DISABLE_GROUP(axis1 [,axis2[, axis3[, axis4.....]]])**

Description: Used to create a group of axes which will be disabled if there is a motion error in one or more of the group. After the group is created, when an error occurs all the axes in the group will have their **AXIS_ENABLE** set to OFF and SERVO set to OFF. Multiple groups can be made, although one axis cannot belong to more than one group.

All groupings will be cleared with the command **DISABLE_GROUP(-1)**.

Parameters:

axis1: Axis number of first axis in group.

axis2: Axis number of second axis in group.

axisN: Axis number of Nth axis in group.

Note: As many parameters as axes on the system may be specified.

Example 1: A machine has 2 functionally separate parts, which have their own emergency stop and operator protection guarding. If there is an error on one part of the machine, the other part can remain running while the cause of the error is removed and the axis group re-started. We need to set up 2 separate axis groupings.

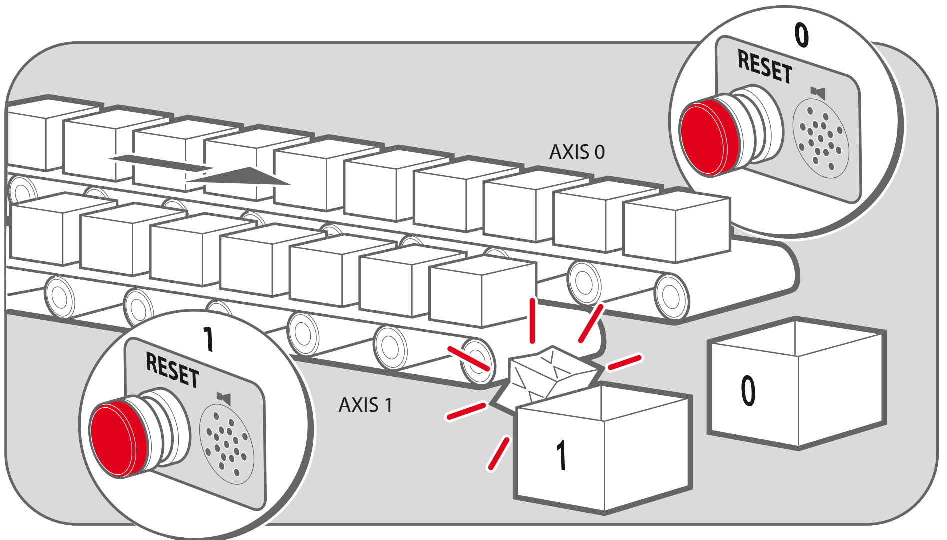
```
DISABLE_GROUP(-1) ' remove any previous axis groupings
DISABLE_GROUP(0,1,2,6) ' group axes 0 to 2 and 6
DISABLE_GROUP(3,4,5,7) ' group axes 3 to 5 and 7
```

```
WDOG=ON ‘ turn on the enable relay and the remote drive enable

FOR ax=0 TO 7
  AXIS_ENABLE AXIS(ax)=ON ‘ enable the 8 axes
  SERVO AXIS(ax)=ON ‘ start position loop servo for each axis
NEXT ax
```

Example 2: Two conveyors operated by the same *Motion Coordinator* are required to run independently so that if one has a “jam” it will not stop the second conveyor.

```
DISABLE_GROUP(0) 'put axis 0 in its own group
DISABLE_GROUP(1) 'put axis 1 in another group

GOSUB group_enable0
GOSUB group_enable1
WDOG=ON

FORWARD AXIS(0)
FORWARD AXIS(1)

WHILE TRUE
  IF AXIS_ENABLE AXIS(0)=0 THEN
    PRINT "motion error axis 0"
    reset_0_flag=1
  ENDIF
  IF AXIS_ENABLE AXIS(1)=0 THEN
    PRINT "motion error axis 1"
    reset_1_flag=1
  ENDIF
  IF reset_0_flag=1 AND IN(0)=ON THEN
    GOSUB group_enable0
    FORWARD AXIS(0)
    reset_0_flag=0
  ENDIF
  IF reset_1_flag=1 AND IN(1)=ON THEN
    GOSUB group_enable1
    FORWARD AXIS(1)
    reset_1_flag=0
  ENDIF
WEND

group_enable0:
  BASE(0)
  DATUM(7) ' clear motion error on axis 0
  WA(10)
```

```
  AXIS_ENABLE=ON
  SERVO=ON
RETURN
group_enable1:
  BASE(1)
  DATUM(7) ' clear motion error on axis 0
  WA(10)
  AXIS_ENABLE=ON
  SERVO=ON
RETURN
```



Example 3: One group of axes in a machine require resetting, without affecting the remaining axes, if a motion error occurs. This should be done manually by clearing the cause of the error, pressing a button to clear the controllers' error flags and re-enabling the motion.

```
DISABLE_GROUP(-1)         'remove any previous axis groupings
DISABLE_GROUP(0,1,2)      'group axes 0 to 2
GOSUB group_enable        'enable the axes and clear errors
WDOG=ON

SPEED=1000
FORWARD
```

```
WHILE IN(2)=ON
    'check axis 0, but all axes in the group will disable together
    IF AXIS_ENABLE =0 THEN
      PRINT "Motion error in group 0"
      PRINT "Press input 0 to reset"
      IF IN(0)=0 THEN       'checks if reset button is pressed
        GOSUB group_enable  'clear errors and enable axis
        FORWARD             'restarts the motion
      ENDIF
    ENDIF
  WEND
  STOP                      'stop program running into sub routine

group_enable:               'Clear group errors and enable axes
  DATUM(0)                  'clear any motion errors
  WA(10)
  FOR axis_no=0 TO 2
    AXIS_ENABLE AXIS(axis_no)=ON  'enable axes
    SERVO AXIS(axis_no)=ON        'start position loop servo
  NEXT axis_no
  RETURN
```

See Also: **AXIS_ENABLE** for enabling remote axes.

Note: For use with SERCOS and MECHATROLINK only.

ENCODER_RATIO

Type: Function

Syntax: **ENCODER_RATIO(mpos_count, input_count)**

Description: This command allows the incoming encoder count to be scaled by a non integer ratio, using the following ratio;

MPOS = (mpos_count / input_count) x encoder_edges_input

ENCODER_RATIO affects the number of edges within the servo loop at a low level and it will be necessary to change the position loop gains to maintain perfomance and stablilty. Unlike the **UNITS** parameter, which only affects the scaling seen by the user programs, **ENCODER_RATIO** affects all motion commands including **MOVECIRC** and **CAMBOX**.

Parameters:

mpos_count :	A number between 0 and 16777215 which defines the denominator of the above function.
input_count:	A number between 0 and 16777215 which defines the numerator of the above function.

Note 1: Large ratios should be avoided as they will lead to either loss of resolution or much reduced smoothness in the motion. The actual physical encoder count is the basic resolution of the axis and use of this command may reduce the ability of the Motion Coordinator to accurately achieve all positions.

Note 2: **ENCODER_RATIO** does not replace **UNITS**. Only use **ENCODER_RATIO** where absolutely necessary. **PP_STEP** and **ENCODER_RATIO** cannot be used at the same time on the same axis.

Example 1: A rotary table has a servo motor connected directly to its centre of rotation. An encoder is mounted to the rear of the servo motor and returns a value of 8192 counts per rev. The application requires the table to be calibrated in degrees so that each degree is an integer number of counts.

```
' 7200 is closest to the encoder resolution, but can be divided
' by an integer to give degrees.  (7200 / 20 = 360)
ENCODER_RATIO(8192,7200)
UNITS = 20 ' axis calibrated in degrees, resolution = 0.05 deg.
```

Example 2: An X-Y system has 2 different gearboxes on its vertical and horizontal axes. The software needs to use interpolated moves, including **MOVECIRC** and MUST therefore have **UNITS** on the 2 axes set the same. Axis 3 (X) is 409 counts per mm and axis 4 (Y) has 560 counts per mm. So as to use the maximum resolution available, set both axes to be 560 counts per mm with the **ENCODER_RATIO** command.

```
ENCODER_RATIO(409,560) AXIS(3) ' axis 3 is now 560 counts/mm
UNITS AXIS(3) = 56 ' X axis calibrated in mm x 10
UNTIS AXIS(4) = 56 ' Y axis calibrated in mm x 10
MOVECIRC(200,100,100,0,1) ' move axes in a semicircle
```

FORWARD

Type: Axis Command

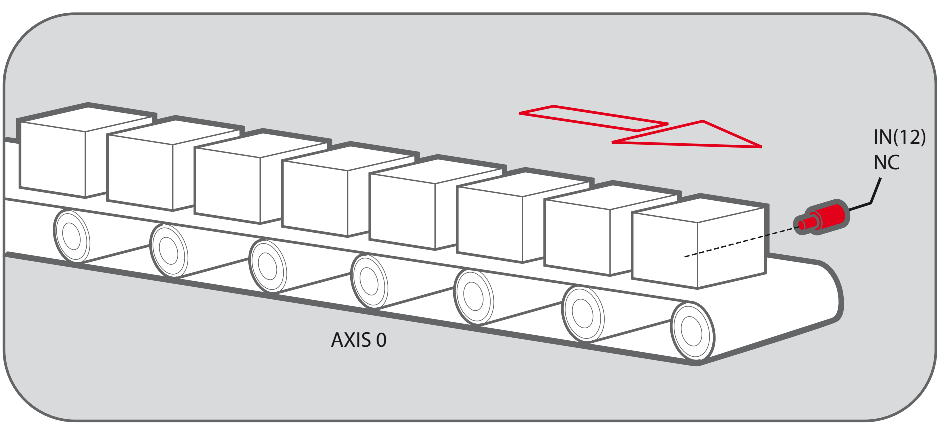
Syntax: **FORWARD**

Alternate Format: **FO**

Description: Sets continuous forward movement. The axis accelerates at the programmed **ACCEL** rate and continues moving at the **SPEED** value until either a **CANEL** or **RAPIDSTOP** command are encountered. It then declerates to a stop at the programmed **DECEL** rate.
If the axis reaches either the forward limit switch or forward soft limit, the **FORWARD** will be cancelled and the axis will decelerate to a stop.

Example 1: Run an axis forwards. When an input signal is detected on input 12, bring the axis to a stop.

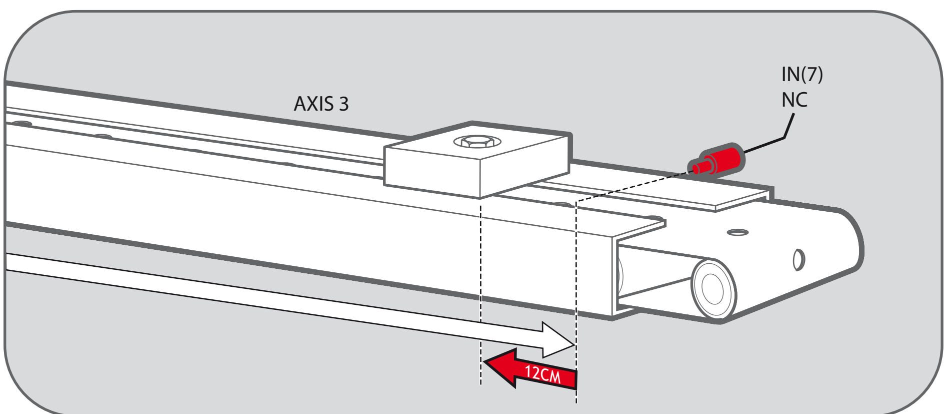
```
FORWARD
' wait for stop signal
WAIT UNTIL IN(12)=ON
CANCEL
WAIT IDLE
```



Example 2: Move an axis forwards until it hits the end limit switch, then move it in the reverse direction for 25 cm.

```
BASE(3)
FWD_IN=7 ‘ limit switch connected to input 7
FORWARD
```

```
WAIT IDLE ' wait for motion to stop on the switch
MOVE(-25.0)
WAIT IDLE
```



Example 3: A machine that applies lids to cartons uses a simulated line shaft. This example sets up a virtual axis running forward, this is to simulate the line shaft. Axis 0 is then CONNECTed to this to run the conveyor. Axis 1 controls a vacuum roller that feeds the lids on to the cartons using the **MOVELINK** control.

```
BASE(4)
ATYPE=0      'Set axis 4 to virtual axis
REP_OPTION=1
SERVO=ON
FORWARD      'starts line shaft
BASE(0)
CONNECT(-1,4) 'Connects base 0 to virtual axis in reverse
WHILE IN(2)=ON
  BASE(1)
  'Links axis 1 to the shaft in reverse direction
  MOVELINK(-4000,2000,0,0,4,2,1000)
  WAIT IDLE
WEND
RAPIDSTOP
```

MHELICAL

Type: Motion Command.

Syntax: **MHELICAL(end1,end2,centre1,centre2,direction,distance3,[mode])**

Alternate Format: **MH()**

Description: Performs a helical move.
Moves 2 orthogonal axes in such a way as to produce a circular arc at the tool point with a simultaneous linear move on a third axis. The first 5 parameters are similar to those of an **MOVECIRC()** command. The sixth parameter defines the simultaneous linear move. End1 and centre1 are on the current **BASE** axis. End2 and centre2 are on the second axis. The first 4 distance parameters are scaled according to the current unit conversion factor for the **BASE** axis. The sixth parameter uses its own axis units.

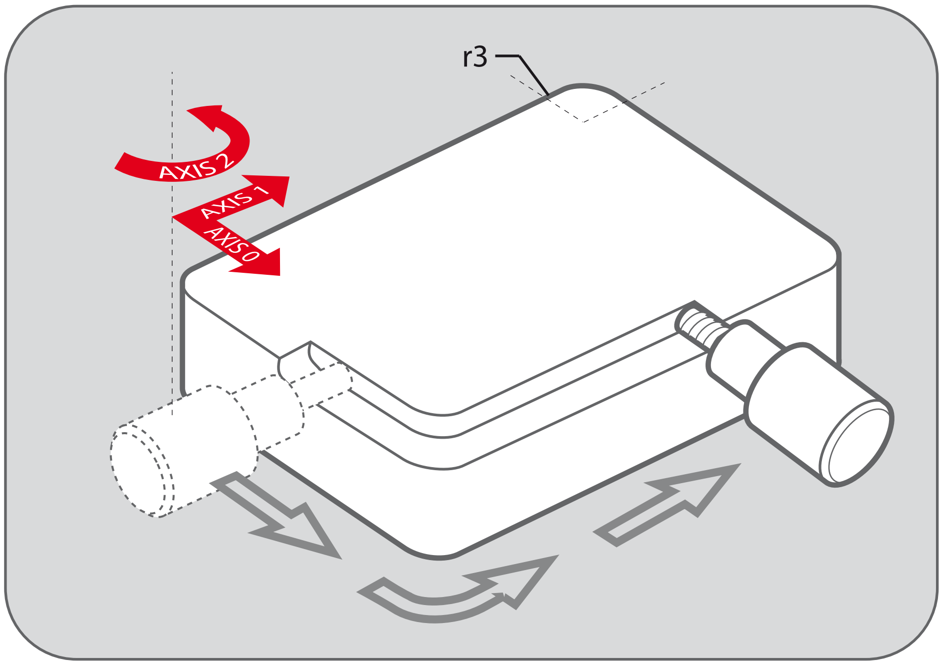
Parameters:

end1:	position on **BASE** axis to finish at.
end2:	position on next axis in **BASE** array to finish at.
centre1:	position on **BASE** axis about which to move.
centre2:	position on next axis in **BASE** array about which to move.
direction:	The "direction" is a software switch which determines whether the arc is interpolated in a clockwise or anti- clockwise direction. The parameter is set to 1 or 0. See **MOVECIRC**.
distance3:	The distance to move on the third axis in the **BASE** array axis in user units
mode:	0 = Interpolate the 3rd axis with the main 2 axes when calcualting path speed. (True helical path) 1 = Interpolate only the first 2 axes for path speed, but move the 3rd axis in coordination with the other 2 axes. (Circular path with following 3rd axis)

Example1: The command sequence follows a rounded rectangle path with axis 1 and 2. Axis 3 is the tool rotation so that the tool is always perpendicular to the product. The UNITS for axis 3 are set such that the axis is calibrated in degrees.

```
REP_DIST AXIS(3)=360
REP_OPTION AXIS(3)=ON
' all 3 axes must be homed before starting
MERGE=ON
MOVEABS(360) AXIS(3) 'point axis 3 in correct starting direction
WAIT IDLE AXIS(3)
MOVE(0,12)
```

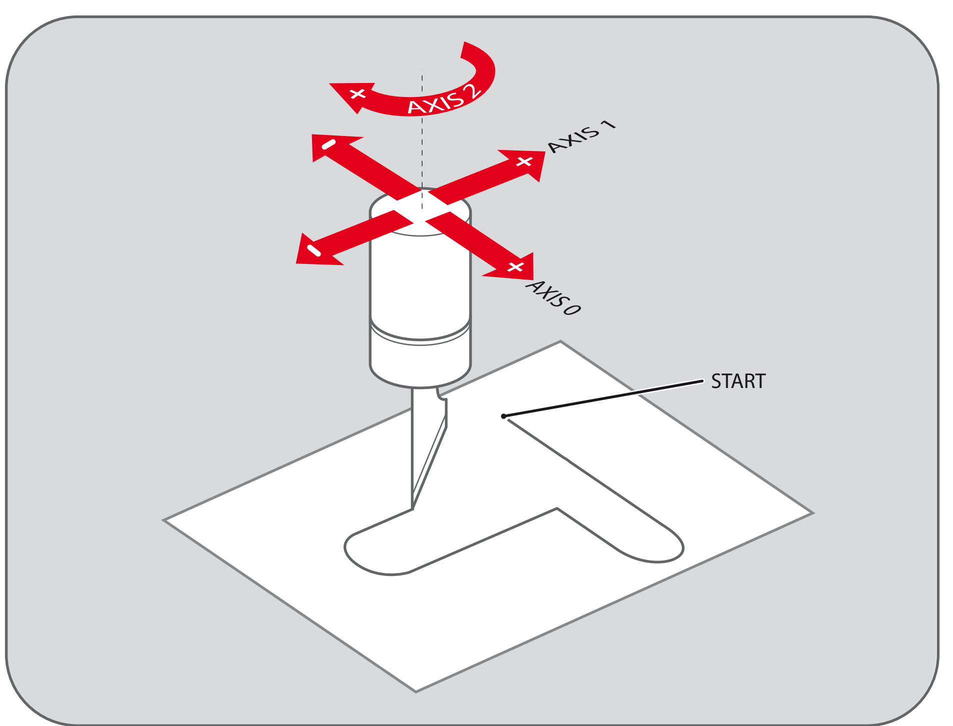
```
MHELICAL(3,3,3,0,1,90)
MOVE(16,0)
MHELICAL(3,-3,0,-3,1,90)
MOVE(0,-6)
MHELICAL(-3,-3,-3,0,1,90)
MOVE(-2,0)
MHELICAL(-3,3,0,3,1,90)
```



Exapmle 2: A PVC cutter uses 2 axis similar to a xy plotter, a third axis is used to control the cutting angle of the knife. To keep the resultant cutting speed for the x and y axis the same when cutting curves, mode 1 is applied to the helical command.

```
BASE(0,1,2) : MERGE=ON 'merge moves into one continuous movement
MOVE(50,0)
MHELICAL(0,-6,0,-3,1,180,1)
MOVE(-22,0)
WAIT IDLE
MOVE(-90) AXIS(2)    'rotate the knife after stopping at corner
WAIT IDLE AXIS(2)
```

```
MOVE(0,-50)
MHELICAL(-6,0,-3,0,1,180,1)
MOVE(0,50)
WAIT IDLE             'pause again to rotate the knife
MOVE(-90) AXIS(2)
WAIT IDLE AXIS(2)
MOVE(-22,0)
MHELICAL(0,6,0,3,1,180,1)
WAIT IDLE
```



MHELICALSP

Type: Motion Command.

Only available in system software versions where “LookAhead” is enabled.

Syntax: **MHELICALSP(end1,end2,centre1,centre2,direction,distance3,[mode])**

Description: Performs a helical move the same as **MHELICAL** and additionally allows vector speed to be changed when using multiple moves in the look-ahead buffer. Uses additional axis parameters **FORCE_SPEED** and **ENDMOVE_SPEED**.

Example: In a series of buffered moves using the look ahead buffer with **MERGE=ON** a helical move is required where the incoming vector speed is 40 units/second and the finishing vector speed is 20 units/second.

```
FORCE_SPEED=40
ENDMOVE_SPEED=20
MHELICALSP(100,100,0,100,1,100)
```

For more information see **MHELICAL** and Chapter 14; Look-ahead move buffer.

MOVE

Type: Motion Command

Syntax: **MOVE(distance1 [,distance2 [,distance3 [,distance4...]]])**

Alternate Format: **MO()**

Description: Incremental move. One axis or multiple axes move at the programmed speed and acceleration for a distance specified as an increment from the end of the last specified move. The first parameter in the list is sent to the **BASE** axis, the second to the next axis in the **BASE** array, and so on.

In the multi-axis form, the speed and acceleration employed for the movement are taken from the first axis in the **BASE** group. The speeds of each axis are controlled so as to make the resulting vector of the movement run at the **SPEED** setting.

Uninterpolated, unsynchronised multi-axis motion can be achieved by simply placing **MOVE** commands on each axis independently. If needed, the target axis for an individual **MOVE** can be specified using the **AXIS()** command. This overrides the **BASE** axis setting for one **MOVE** only.

The distance values specified are scaled using the unit conversion factor axis parameter; **UNITS**. Therefore if, for example, an axis has 400 encoder edges/mm and **UNITS** for that axis are 400, the command **MOVE(12.5)** would move 12.5 mm. When **MERGE** is set to **ON**, individual moves in the same axis group are merged together to make a continuous path movement.

Parameters:

distance1: distance to move on base axis from current position.

distance2: distance to move on next axis in BASE array from current position.]

[distance3: distance to move on next axis in BASE array from current position.]

[distance4: distance to move on next axis in BASE array from current position.]

The maximum number of parameters is the number of axes on the controller

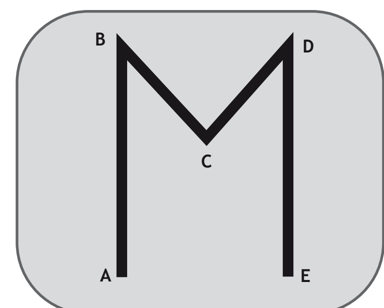
Example 1: A system is working with a unit conversion factor of 1 and has a 1000 line encoder. Note that a 1000 line encoder gives 4000 edges/turn.

```
MOVE(40000) ‘ move 10 turns on the motor.
```

Example 2: Axes 3, 4 and 5 are to move independently (without interpolation). Each axis will move at its own programmed **SPEED, ACCEL and DECEL** etc.

```
'setup axis speed and enable
BASE(3)
SPEED=5000
ACCEL=100000
DECEL=150000
SERVO=ON
BASE(4)
SPEED=5000
ACCEL=150000
DECEL=560000
SERVO=ON
BASE(5)
SPEED=2000
ACCEL=320000
DECEL=352000
SERVO=ON
WDOG=ON
MOVE(10) AXIS(5)     'start moves
MOVE(10) AXIS(4)
MOVE(10) AXIS(3)
WAIT IDLE AXIS(5)    'wait for moves to finish
WAIT IDLE AXIS(4)
WAIT IDLE AXIS(3)
```

Example 3: An X-Y plotter can write text at any position within its working envelope. Individual characters are defined as a sequence of moves relative to a start point so that the same commands may be used regardless of the plot origin. The command subroutine for the letter ‘M’ might be:




```
write_m:
  MOVE(0,12) 'move A >  B
  MOVE(3,-6) 'move B >  C
  MOVE(3,6)  'move C >  D
  MOVE(0,-12)'move D > E
  RETURN
```

MOVEABS

Type: Motion Command.

Syntax: **MOVEABS(position1[, position2[, position3[, position4...]]])**

Alternate Format: **MA()**

Description: Absolute position move. Move one axis or multiple axes to position(s) referenced with respect to the zero (home) position. The first parameter in the list is sent to the axis specified with the **AXIS** command or to the current **BASE** axis, the second to the next axis, and so on.

In the multi-axis form, the speed, acceleration and deceleration employed for the movement are taken from the first axis in the **BASE** group. The speeds of each axis are controlled so as to make the resulting vector of the movement run at the **SPEED** setting.

Uninterpolated, unsynchronised multi-axis motion can be achieved by simply placing **MOVEABS** commands on each axis independently. If needed, the target axis for an individual **MOVEABS** can be specified using the **AXIS()** command. This overrides the **BASE** axis setting for one **MOVEABS** only.

The values specified are scaled using the unit conversion factor axis parameter; **UNITS**. Therefore if, for example, an axis has 400 encoder edges/mm the **UNITS** for that axis is 400. The command **MOVEABS(6)**would then move to a position 6 mm from the zero position. When **MERGE** is set to ON, absolute and relative moves are merged together to make a continuous path movement.

Parameters:

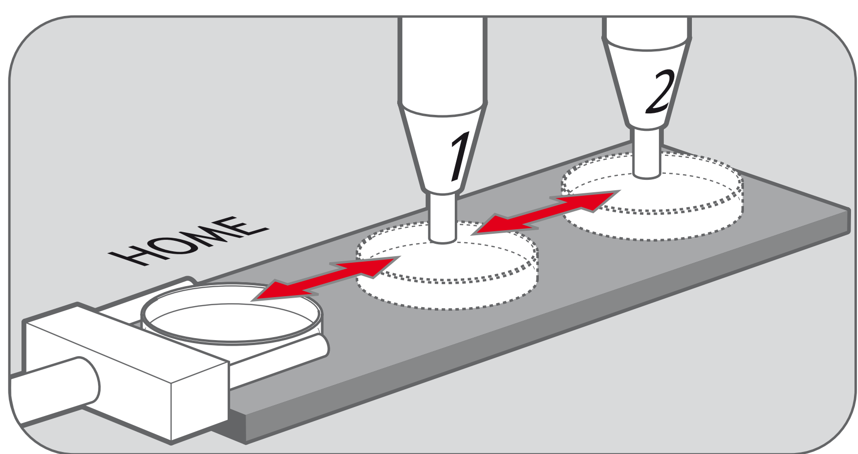
position1:	position to move to on base axis.
position2:	position to move to on next axis in BASE array.
position3:	position to move to on next axis in BASE array.
position4:	position to move to on next axis in BASE array

Note1: The **MOVEABS** command can interpolate up to the full number of axes available on the controller.

Note2: The position of the axes' zero(home) positions can be changed by the commands: **OFFPOS, DEFPOS, REP_DIST, REP_OPTION**, and **DATUM**.

Example 1: A machine must move to one of 3 positions depending on the selection made by 2 switches. The options are home, position 1 and position 2 where both switches are off, first switch on and second switch on respectively. Position 2 has priority over position 1.

```
'define absolute positions
home=1000
position_1=2000
position_2=3000

WHILE IN(run_switch)=ON
  IF IN(6)=ON THEN 'switch 6 selects position 2
    MOVEABS(position_2)
    WAIT IDLE
  ELSEIF IN(7)=ON THEN 'switch 7 selects position 1
    MOVEABS(position_1)
    WAIT IDLE
  ELSE
    MOVEABS(home)
    WAIT IDLE
  ENDIF
WEND
```

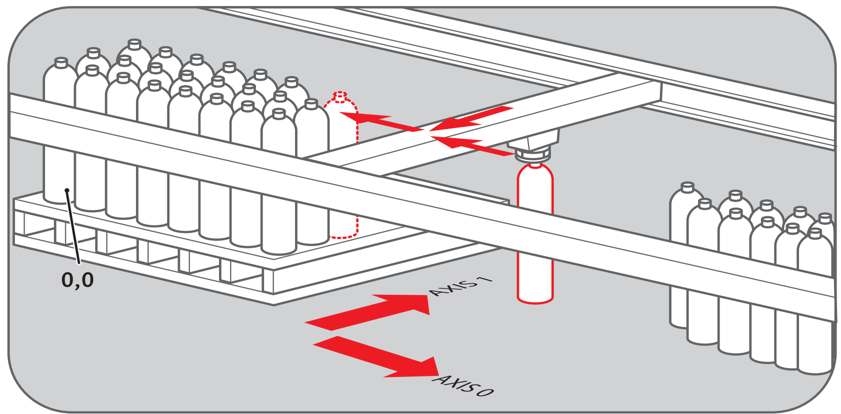


Example 2: An X-Y plotter has a pen carousel whose position is fixed relative to the plotter absolute zero position. To change pen an absolute move to the carousel position will find the target irrespective of the plot position when commanded.

```
MOVEABS(28.5,350) ‘ move to just outside the pen holder area
WAIT IDLE
SPEED = pen_pickup_speed
MOVEABS(20.5,350) ‘ move in to pick up the pen
```

Example 3: A pallet consists of a 6 by 8 grid in which gas canisters are inserted 185mm apart by a packaging machine. The canisters are picked up from a fixed point. The first position in the pallet is defined as position 0,0 using the **DEFPOS()** command. The part of the program to position the canisters in the pallet is:

```
FOR x=0 TO 5
  FOR y=0 TO 7
    MOVEABS(-340,-516.5)          'move to pick-up point
    WAIT IDLE
    GOSUB pick                    'call pick up subroutine
    PRINT "Move to Position: ";x*6+y+1
    MOVEABS(x*185,y*185)          'move to position in grid
    WAIT IDLE
    GOSUB place                   'call place down subroutine
    NEXT y
NEXT x
```



MOVEABSSP

Type: Motion Command.

Only available in system software versions where "LookAhead" is enabled.

Syntax: **MOVEABSSP(position1[, position2[, position3[, position4]]])**

Description: Works as **MOVEABS** and additionally allows vector speed to be changed when using multiple moves in the look ahead buffer when **MERGE=ON**, using additional parameters **FORCE_SPEED** and **ENDMOVE_SPEED**.

Parameters:

position1:	position to move to on base axis.
position2:	position to move to on next axis in BASE array.
position3:	position to move to on next axis in BASE array.
position4:	position to move to on next axis in BASE array

Note: *Absolute moves are converted to incremental moves as they enter the buffer. This is essential as the vector length is required to calculate the start of deceleration. It should be noted that if any move in the buffer is cancelled by the programmer, the absolute position will not be achieved.*

Example 1: In a series of buffered moves using the look ahead buffer with **MERGE=ON**, an absolute move is required where the incoming vector speed is 40units/second and the finishing vector speed is 20 units/second.

```
FORCE_SPEED=40
ENDMOVE_SPEED=20
MOVEABSSP(100,100)
```

Only Available in Look-Ahead mode.
For more information see **MOVEABS** and Chapter 14

MOVECIRC

Type: Motion Command.

Syntax: **MOVECIRC(end1, end2, centre1, centre2, direction)**

Alternate Format: **MC()**

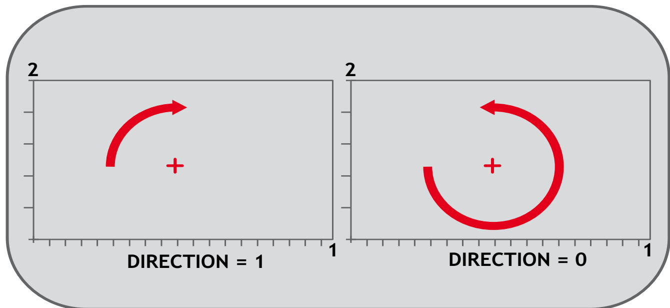
Description: Moves 2 orthogonal axes in such a way as to produce a circular arc at the tool point. The length and radius of the arc are defined by the five parameters in the command line. The move parameters are always relative to the end of the last specified move. This is the start position on the circle circumference. Axis 1 is the current **BASE** axis. Axis 2 is the next axis in the **BASE** array. The first 4 distance parameters are scaled according to the current unit conversion factor for the **BASE** axis.

Parameters:

end1:	position on BASE axis to finish at.
end2:	position on next axis in BASE array to finish at.
centre1:	position on BASE about which to move.

centre2: position on next axis in **BASE** array about which to move.

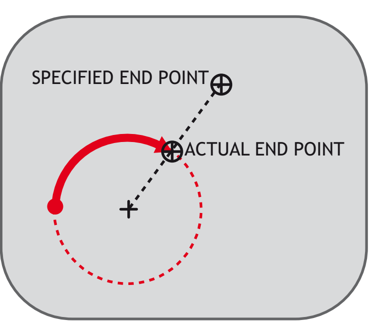
direction: The "direction" is a software switch which determines whether the arc is interpolated in a clockwise or anti- clockwise direction.



Note 1: *In order for the* **MOVECIRC()** *command to be correctly executed, the two axes generating the circular arc must have the same number of encoder pulses/ linear axis distance. If this is not the case it is possible to adjust the encoder scales in many cases by using* **ENCODER_RATIO** *or* **STEP_RATIO.**

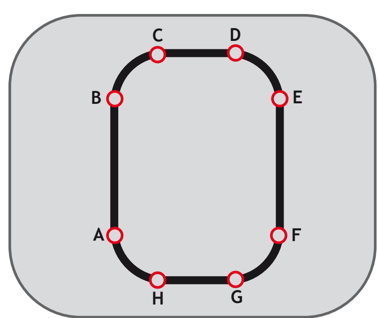
Note 2: *If the end point specified is not on the circular arc. The arc will end at the angle specified by a line between the centre and the end point.*

Note 3: *Neither axis may cross the set absolute repeat distance (***REP_DIST***) during a* **MOVECIRC***. Doing so may cause one or both axes to jump or for their* **FE** *value to exceed* **FE_LIMIT***.*



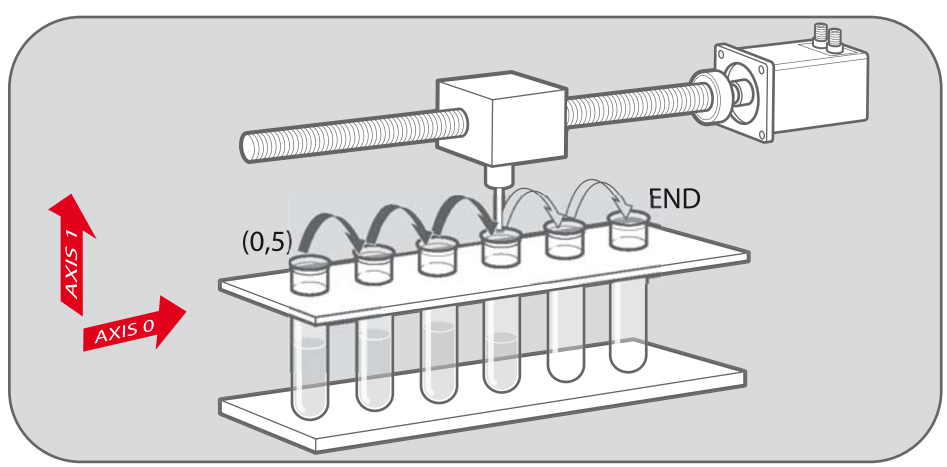
Example 1: The command sequence to plot the letter '0' might be:

```
MOVE(0,6)              'move A -> B
MOVECIRC(3,3,3,0,1)    ' move B -> C
MOVE(2,0)              'move C -> D
MOVECIRC(3,-3,0,-3,1) ' move D -> E
MOVE(0,-6)             'move E -> F
MOVECIRC(-3,-3,-3,0,1)' move F -> G
MOVE(-2,0)             'move G -> H
MOVECIRC(-3,3,0,3,1)  ' move H -> A
```



Example 2: A machine is required to drop chemicals into test tubes. The nozzle can move up and down as well as along its rail. The most efficient motion is for the nozzle to move in an arc between the test tubes.

```
BASE(0,1)
MOVEABS(0,5)              'move to position above first tube
MOVEABS(0,0)              'lower for first drop
WAIT IDLE
OP(15,ON)                 'apply dropper
WA(20)
OP(15,OFF)
FOR x=0 TO 5
  MOVECIRC(5,0,2.5,0,1)  'arc between the test tubes
  WAIT IDLE
  OP(15,ON)               'Apply dropper
  WA(20)
  OP(15,OFF)
NEXT x
MOVECIRC(5,5,5,0,1)         'move to rest position)
```



MOVECIRCSP

Type: Motion Command.

Only available in system software versions where "LookAhead" is enabled.

Syntax: **MOVECIRCSP(end1, end2, centre1, centre2, direction)**

Description: Works as **MOVECIRC** and additionally allows vector speed to be changed when using multiple moves in the look ahead buffer when **MERGE=ON**, using additional parameters **FORCE_SPEED** and **ENDMOVE_SPEED**.

Example 1: In a series of buffered moves using the look ahead buffer with **MERGE=ON**, a circular move is required where the incoming vector speed is 40units/second and the finishing vector speed is 20 units/second.

```
FORCE_SPEED=40
ENDMOVE_SPEED=20
MOVECIRCSP(100,100,0,100,1)
```

Note: Only available in Look-Ahead version.
For more information see **MOVECIRC**.

MOVELINK

Type: Motion Command.

Syntax: **MOVELINK (distance, link dist, link acc, link dec, link axis[, link options][, link pos]).**

Alternate Format: **ML()**

Description: The linked move command is designed for controlling movements such as:

- Synchronization to conveyors
- Flying shears
- Thread chasing, tapping etc.
- Coil winding

The motion consists of a linear movement with separately variable acceleration and deceleration phases linked via a software gearbox to the MEASURED position (**MPOS**) of another axis.

Parameters:

distance: incremental distance in user units to be moved on the current base axis, as a result of the measured movement on the "input" axis which drives the move.

link dist: positive incremental distance in user units which is required to be measured on the "link" axis to result in the motion on the base axis.

link acc: positive incremental distance in user units on the input axis over which the base axis accelerates.

link dec: positive incremental distance in user units on the input axis over which the base axis decelerates.

N.B. If the sum of parameter 3 and parameter 4 is greater than parameter 2, they are both reduced in proportion until they equal parameter 2.

link axis: Specifies the axis to "link" to. It should be set to a value between 0 and the number of available axes.

link options:

1 link commences exactly when registration event occurs on link axis.

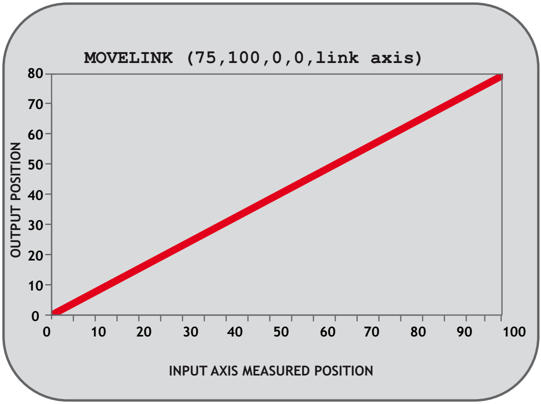
2 link commences at an absolute position on link axis (see **link start** parameter)

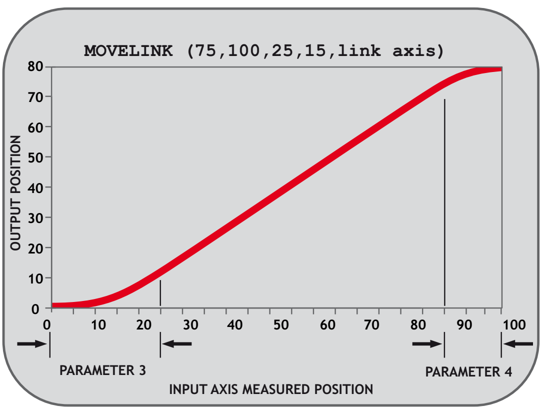
4 **MOVELINK** repeats automatically and bi-directional when this bit is set. (This mode can be cleared by setting bit 1 of the **REP_OPTION** axis parameter)

link pos: This parameter is the absolute position where the **MOVELINK** link is to be started when parameter 6 is set to 2.

Note 1: The command uses the **BASE()** and **AXIS()**, and unit conversion factors in a similar way to other move commands.

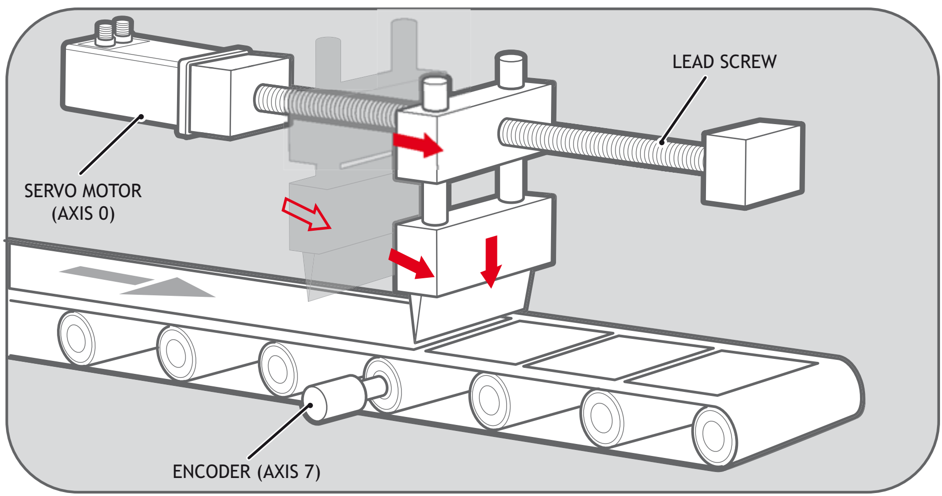
Note 2: The "link" axis may move in either direction to drive the output motion. The link distances specified are always positive.





Example 1: A flying shear cuts a long sheet of paper into cards every 160 m whilst moving at the speed of the material. The shear is able to travel up to 1.2 metres of which 1m is used in this example. The paper distance is measured by an encoder, the unit conversion factor being set to give units of metres on both axes: (Note that axis 7 is the link axis)

```
WHILE IN(2)=ON
  MOVELINK(0,150,0,0,7) ' dwell (no movement) for 150m
  MOVELINK(0.3,0.6,0.6,0,7) ' accelerate to paper speed
  MOVELINK(0.7,1.0,0,0.6,7) ' track the paper then decelerate
  WAIT LOADED ' wait until acceleration movelink is finished
  OP(8,ON)    ' activate cutter
  MOVELINK(-1.0,8.4,0.5,0.5,7) ‘ retract cutter back to start
  WAIT LOADED
  OP(8,OFF)      ' deactivate cutter at end of outward stroke
WEND
```



In this program the controller firstly waits for the roll to feed out 150m in the first line. After this distance the shear accelerates up to match the speed of the paper, moves at the same speed then decelerates to a stop within the 1m stroke. This movement is specified using two separate **MOVELINK** commands. This allows the program to wait for the next move buffer to be clear, **NTYPE=0**, which indicates that the acceleration phase is complete. Note that the distances on the measurement axis (link distance in each **MOVELINK** command): 150, 0.8, 1.0 and 8.2 add up to 160m.

To ensure that speed and positions of the cutter and paper match during the cut process the parameters of the **MOVELINK** command must be correct: It is normally easiest to consider the acceleration, constant speed and deceleration phases separately then combine them as required:

Rule 1: In an acceleration phase to a matching speed the link distance should be twice the movement distance. The acceleration phase could therefore be specified alone as:

```
MOVELINK(0.3,0.6,0.6,0,1)' move is all accel
```

Rule 2: In a constant speed phase with matching speed the two axes travel the same distance so distance to move should equal the link distance. The constant speed phase could therefore be specified as:

```
MOVELINK(0.4,0.4,0,0,1)' all constant speed
```

The deceleration phase is set in this case to match the acceleration:

```
MOVELINK(0.3,0.6,0,0.6,1)' all decel
```

The movements of each phase could now be added to give the total movement.

```
MOVELINK(1,1.6,0.6,0.6,1)' Same as 3 moves above
```

But in the example above, the acceleration phase is kept separate:

```
MOVELINK(0.3,0.6,0.6,0,1)
MOVELINK(0.7,1.0,0,0.6,1)
```

This allows the output to be switched on at the end of the acceleration phase.

Example 2: Exact Ratio Gearbox

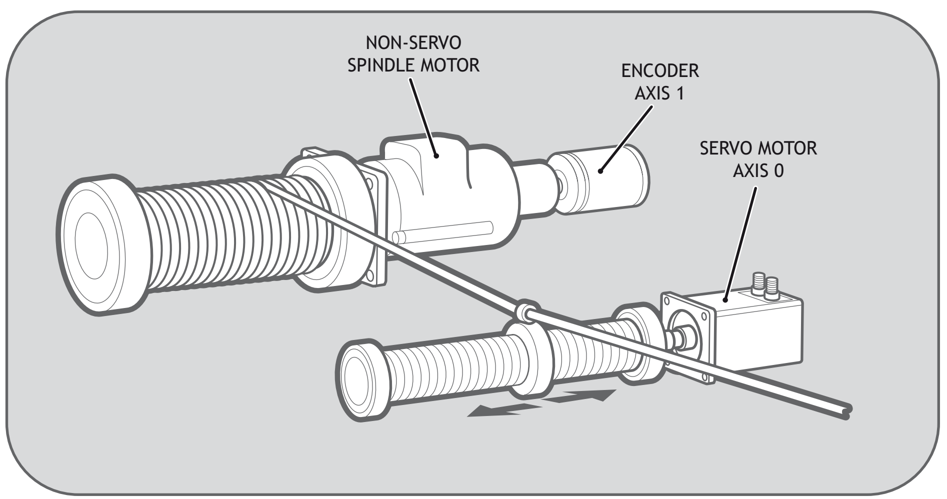
MOVELINK can be used to create an exact ratio gearbox between two axes. Suppose it is required to create gearbox link of 4000/3072. This ratio is inexact (1.30208333) and if entered into a **CONNECT** command the axes will slowly creep out of synchronisation. Setting the “link option” to 4 allows a continuously repeating **MOVELINK** to eliminate this problem:

```
MOVELINK(4000,3072,0,0,linkaxis,4)
```

Example 3: Coil Winding

In this example the unit conversion factors **UNITS** are set so that the payout movements are in mm and the spindle position is measured in revolutions. The payout eye therefore moves 50mm over 25 revolutions of the spindle with the command **MOVELINK(50,25,0,0,linkax)**. If it were desired to accelerate up over the first spindle revolution and decelerate over the final 3 the command would be **MOVELINK(50,25,1,3,linkax)**.

```
(motor,ON)   '- Switch spindle motor on
FOR layer=1 TO 10
  MOVELINK(50,25,0,0,1)
  MOVELINK(-50,25,0,0,1)
NEXT layer
WAIT IDLE
OP(motor,OFF)
```



MOVEMODIFY

Type: Axis Command.

Syntax: **MOVEMODIFY(absolute position)**

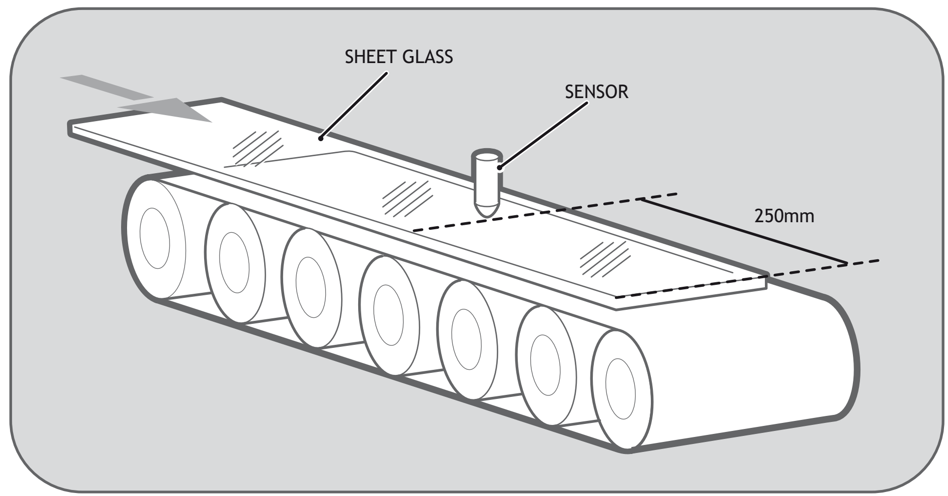
Alternate Format: **MM()**

Description: This move type changes the absolute end position of the current single axis linear move (**MOVE, MOVEABS**). If there is no current move or the current move is not a linear move then **MOVEMODIFY** is loaded as a **MOVEABS**.

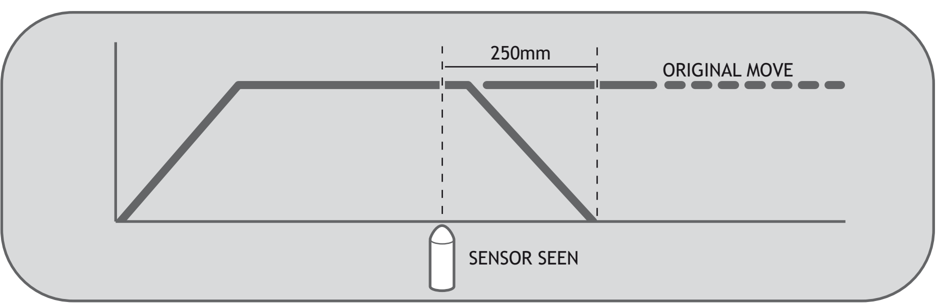
See also: **ENDMOVE**

Parameters: **absolute position:** The absolute position to be set as the new end of move.

Example 1: A sheet of glass is fed on a conveyor and is required to be stopped 250mm after the leading edge is sensed by a proximity switch. The proximity switch is connected to the registration input:

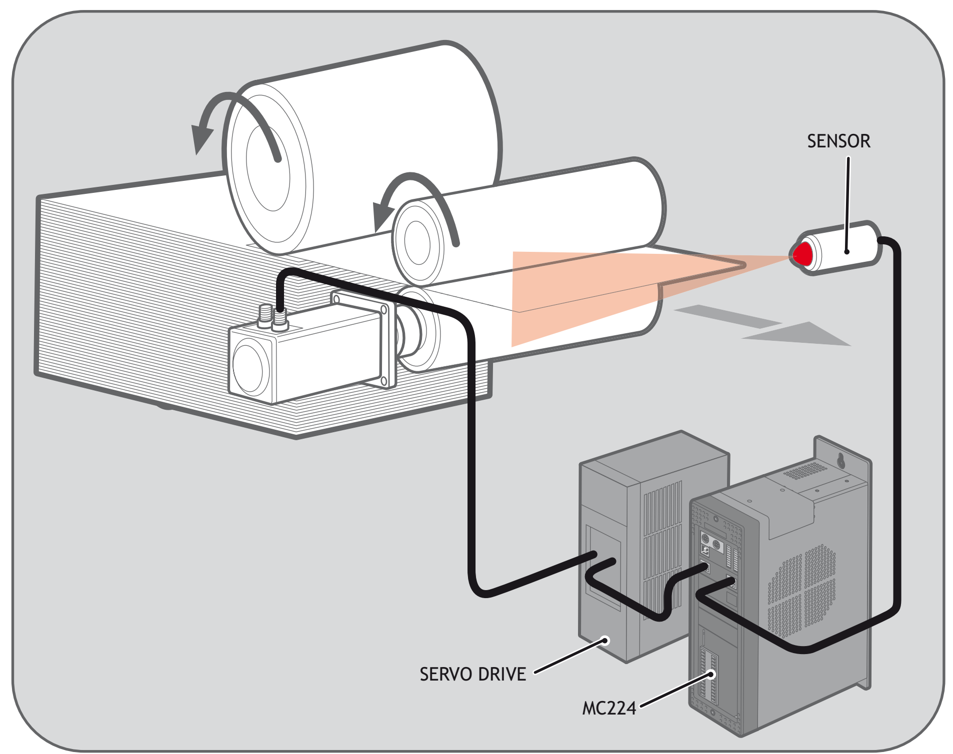



```
MOVE(10000)        'Start a long move on conveyor
REGIST(3)          'set up registration
WAIT UNTIL MARK    'MARK goes TRUE when sensor detects glass edge
OFFPOS = -REG_POS  'set position where mark was seen to 0
WAIT UNTIL OFFPOS=0     'wait for OFFPOS to take effect
MOVEMODIFY(250)    'change move to stop at 250mm
```



Eample 2: A paper feed system slips. To counteract this, a proximity sensor is positioned one third of the way into the movement. This detects at which position the paper passes and so how much slip has occurred. The move is then modified to account for this variation.

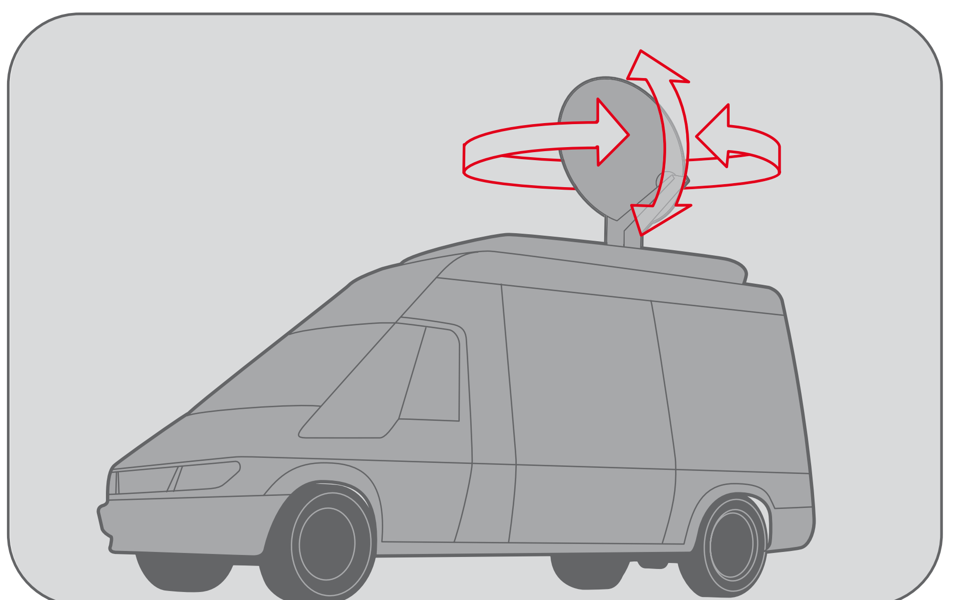
```
paper_length=4000
DEFPOS(0)
REGIST(3)
MOVE(paper_length)
WAIT UNTIL MARK
slip=REG_POS-(paper_length/3)
offset=slip*3
MOVEMODIFY(paper_length+offset)
```



Eample 3: A satellite receiver sits on top of a van; it has to align correctly to the satellite from data processed in a computer. This information is sent to the controller through the serial link and sets VR's 0 and 1. This information is used to control the two axes. **MOVEMODIFY** is used so that the position can be continuously changed even if the previous set position has not been achieved.

```
bearing=0                          'set lables for VRs
elevation=1
UNITS AXIS(0)=360/counts_per_rev0
UNITS AXIS(1)=360/counts_per_rev1
WHILE IN(2)=ON
  MOVEMODIFY(VR(bearing))AXIS(0)   'adjust bearing to match VR0
  MOVEMODIFY(VR(elevation))AXIS(1)'adjust elevation to match VR1
  WA(250)
WEND
RAPIDSTOP 'stop movement
WAIT IDLE AXIS(0)
MOVEABS(0) AXIS(0)                 'return to transport position
```

```
WAIT IDLE AXIS(1)
MOVEABS(0) AXIS (1)
```



MOVESP

Type: Motion Command

Only available in system software versions where “LookAhead” is enabled.

Syntax: **MOVESP(distance1[,distance2[,distance3[,distance4]]])**

Description: Works as **MOVE** and additionally allows vector speed to be changed when using multiple moves in the look ahead buffer when **MERGE=ON**, using additional parameters **FORCE_SPEED** and **ENDMOVE_SPEED**.

Parameters:

distance1: distance to move on base axis from current position.

distance2: distance to move on next axis in BASE array from current position.

distance3: distance to move on next axis in BASE array from current position.

distance4: distance to move on next axis in BASE array from current position.

The maximum number of parameters, and therefore axes interpolated, is 4.

Example: In a series of buffered moves using the look ahead buffer with **MERGE=ON**, an incremental move is required where the incoming vector speed is 40units/second and the finishing vector speed is 20 units/second.

```
FORCE_SPEED=40
ENDMOVE_SPEED=20
MOVESP(100,100)
```

Note: *For more information see* **MOVE**.

MSPHERICAL

Type: Motion Command

Syntax: **MSPHERICAL(endx, endy, endz, midx, midy, midz, mode)**

Description: Moves the three axis group defined in BASE along a spherical path with a vector speed determined by the SPEED set in the X axis. There are 2 modes of operation with the option of finishing the move at an endpoint different to the start, or returning to the start point to complete a circle. The path of the movement in 3D space can be defined either by specifying a point somewhere along the path, or by specifying the centre of the sphere.

Parameters:

endx, endy, endz: Mode=0 or 1: Coordinates of the end point.
Mode=2: Coordinates of a second point on the curve.

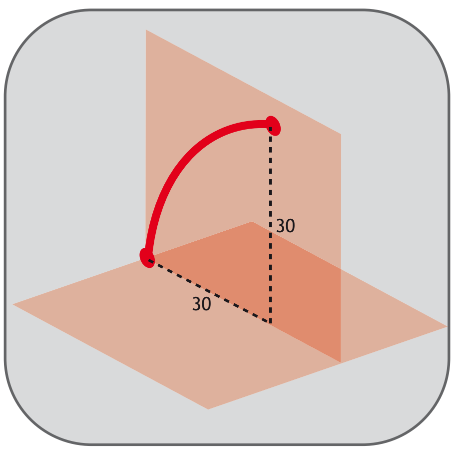
midx, midy, midz: Mode=0 or 2: Coordinates of a point along the path of the curve.
Mode=1 or 3: Coordinates of the sphere centre.

mode: Specifies the way the end and mid parameters are used in calculating the curve in 3D space.
0 = specify end point and mid point on curve.
1 = specify end point and centre of sphere.
2 = mid point 2 and mid point 1 are specified and the curve completes a full circle.
3 = mid point on curve and centre of sphere are specified and the curve completes a full circle.

Note: *The coordinates of the mid point and end point must not be co-linear. Semi-circles cannot be defined by using mode 1 because the sphere centre would be co-linear with the endpoint.*

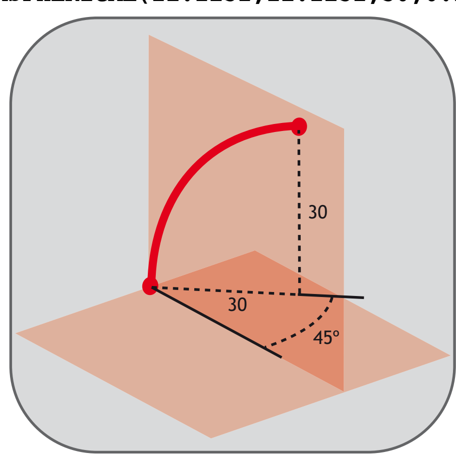
Example 1: A move is needed that follows a spherical path which ends 30mm up in the Z direction:

```
BASE(3,4,5)
MSPHERICAL(30,0,30,8.7868,0,21.2132,0)
```



Example 2: A similar move that follows a spherical path but at 45 degrees to the Y axis which ends 30mm above the XY plane:

```
BASE(0,1,2)
MSPHERICAL(21.2132,21.2132,30,6.2132,6.2132,21.2132,0)
```



MOVETANG

Type: Motion Command

Only available in system software versions where "LookAhead" is enabled.

Syntax: **MOVETANG(absolute_position, [link_axis])**

Description: Moves the axis to the required position using the programmed **SPEED**, **ACCEL** and **DECEL** for the axis. The direction of movement is determined by a calculation of the shortest path to the position assuming that the axis is rotating and that **REP_DIST** has been set to PI radians (180 degrees) and that **REP_OPTION=0**.

Important: The **REP_DIST** value will depend on the **UNITS** value and the number of steps representing PI radians. For example if the rotary axis has 4000 pulses/turn and **UNITS=1** the **REP_DIST** value would be 2000.

If a **MOVETANG** command is running and another **MOVETANG** is executed for the same axis, the original command will not stop, but the endpoint will become the new absolute position.

Parameters:

absolute_position: The absolute position to be set as the endpoint of the move. Value must be within the range -PI to +PI in the units of the rotary axis. For example if the rotary axis has 4000 pulses/turn, the UNITS value=1 and the angle required is PI/2 (90 deg) the position value would be 1000.

link_axis An optional link axis may be specified. When a link_axis is specified the system software calculates the absolute position required each servo cycle based on the link axis **TANG_DIRECTION**. The **TANG_DIRECTION** is multiplied by the REP_DIST/PI to calculate the required position. Note that when using a link_axis the absolute_position parameter becomes unused. The position is copied every servo cycle until the **MOVETANG** is **CANCEL**led.

Example 1: An X-Y positioning system has a stylus which must be turned so that it is facing in the same direction as it is travelling at all times. A tangential control routine is run in a separate process.

```
BASE(0,1)
WHILE TRUE
  angle=TANG_DIRECTION
  MOVETANG(angle) AXIS(2)
WEND
```

Example 2: An X-Y positioning system has a stylus which must be turned so that it is facing in the same direction as it is travelling at all times.

The XY axis pair are axes 4 and 5. The tangential stylus axis is 2:

```
MOVETANG(0,4) AXIS(2)
```

Example 3: An X-Y cutting table has a “pizza wheel” cutter which must be steered so that it is always aligned with the direction of travel. The main X and Y axes are controlled by Motion Coordinator axes 0 and 1, and the pizza wheel is turned by axis 2.

Control of the Pizza Wheel is done in a separate program from the main X-Y motion program. In this example the steering program also does the axis initialisation.

Program TC_SETUP.BAS:

```
' Set up 3 axes for Tangential Control

WDOG=OFF

BASE(0)
P_GAIN=0.9
VFF_GAIN=12.85
UNITS=50 ' set units for mm
SERVO=ON

BASE(1)
P_GAIN=0.9
VFF_GAIN=12.30
UNITS=50 ‘ units must be the same for both axes
SERVO=ON

BASE(2)
UNITS=1 ' make units 1 for the setting of rep_dist
REP_DIST=2000 ‘ encoder has 4000 edges per rev.
REP_OPTION=0
UNITS=4000/(2*PI) ‘ set units for Radians
SERVO=ON

WDOG=ON
' Home the 3rd axis to its Z mark
DATUM(1) AXIS(2)
WAIT IDLE
WA(10)

‘ start the tangential control routine
BASE(0,1) ‘ define the pair of axes which are for X and Y
REPEAT
```

```
    MOVETANG(TANG_DIRECTION) AXIS(2)
UNTIL FALSE
```

Program MOTION.BAS:

```
' program to cut a square shape with rounded corners
MERGE=ON
SPEED=300

nobuf=FALSE ' when true, the moves are not buffered
size=120 ' size of each side of the square
c=30 ' size (radius) of quarter circles on each corner

DEFPOS(0,0)
WAIT UNTIL OFFPOS=0
WA(10)

MOVEABS(10,10+c)
REPEAT
  MOVE(0,size)
  MOVECIRC(c,c,c,0,1)
  IF nobuf THEN WAIT IDLE:WA(2)
  MOVE(size,0)
  MOVECIRC(c,-c,0,-c,1)
  IF nobuf THEN WAIT IDLE:WA(2)
  MOVE(0,-size)
  MOVECIRC(-c,-c,-c,0,1)
  IF nobuf THEN WAIT IDLE:WA(2)
  MOVE(-size,0)
  MOVECIRC(-c,c,0,c,1)
  IF nobuf THEN WAIT IDLE:WA(2)
UNTIL FALSE
```

RAPIDSTOP

Type: Motion Command

Syntax: **RAPIDSTOP**

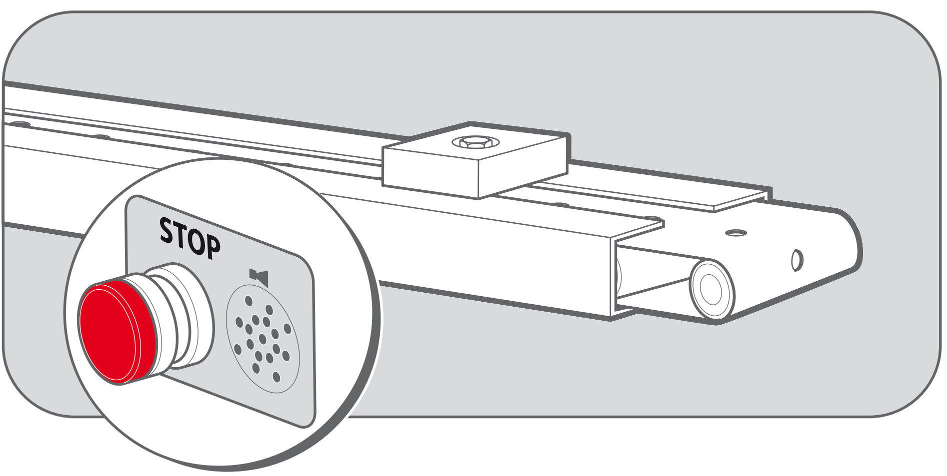
Alternate Format: **RS**

Description: Rapid Stop. The **RAPIDSTOP** command cancels the currently executing move on ALL axes. Velocity profiled move types such as **MOVE, MOVEABS, MHELICAL** etc. will be ramped down at the axes' programmed **DECEL** rate. Others will be immediately cancelled.

The next-move buffers and the process buffers are NOT cleared.

Example 1: Implementing a stop override button that cuts out all motion.

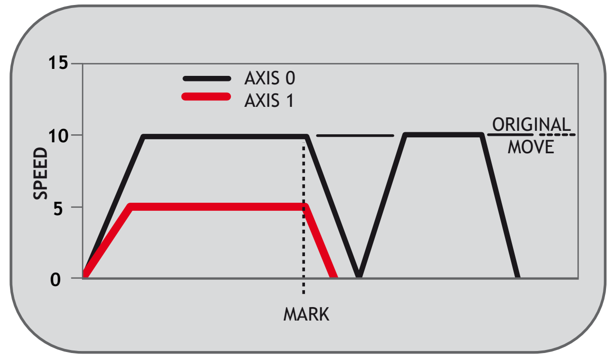
```
CONNECT (1,0) AXIS(1) 'axis 1 follows axis 0
BASE(0)
REPAEAT
  MOVE(1000) AXIS (0)
  MOVE(-100000) AXIS (0)
  MOVE(100000) AXIS (0)
UNTIL IN (2)=OFF 'stop button pressed?
RAPIDSTOP
WA(10)     'wait to allow running move to cancel
RAPIDSTOP  'cancel the second buffered move
WA(10)
RAPIDSTOP  'cancel the third buffered move
```



Example 2: Using **RAPIDSTOP** to cancel a **MOVE** on the main axis and a **FORWARD** on the second axis. After the axes have stopped, a **MOVEABS** is applied to re-position the main axis.

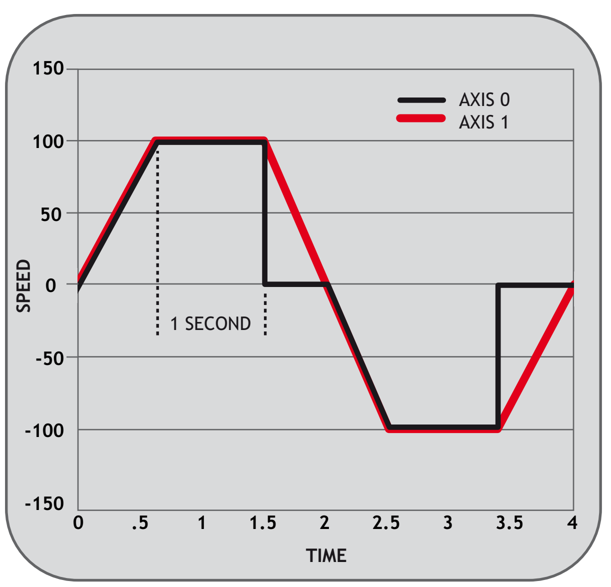
```
BASE(0)
REGIST(3)
FORWARD AXIS(1)
```

```
  MOVE (100000) 'apply a long move
  WAIT UNTIL MARK
  RAPIDSTOP
  WAIT IDLE     'for MOVEABS to be accurate, the axis must stop
MOVEABS(3000)
```



Example 3: Using **RAPIDSTOP** to break a connect, and stop motion. The connected axis stops immediately on the **RAPIDSTOP** command, the forward axis decelerates at the decel value.

```
BASE(0)
CONNECT(1,1)
FORWARD AXIS(1)
WAIT UNTIL VPSPEED=SPEED 'let the axis get to full speed
WA(1000)
RAPIDSTOP
WAIT IDLE AXIS(1)       'wait for axis 1 to decel
CONNECT(1,1)            're-connect axis 0
REVERSE AXIS(1)
WAIT UNTIL VPSPEED=SPEED
WA(1000)
RAPIDSTOP
WAIT IDLE AXIS(1)
```



REGIST

Type: Axis Command

Syntax: **REGIST(mode,{distance})**

Description: The regist command captures an axis position when it sees the registration input or the Z mark on the encoder. The capture is carried out by hardware so software delays do not affect the accuracy of the position capture. The capture is initiated by executing the **REGIST()** command. If the input or Z mark is seen as specified by the mode within the specified window the **MARK** parameter is set **TRUE** and the position is stored in **REG_POS**.

On the MC206X built-in axes; 2 registration registers are provided for each axis. This allows 2 registration sources to be captured simultaneously and their difference in position determined. To use this dual registration mode the **REGIST** commands "mode" parameter is set in the range 6..9. Two additional axis parameters **REG_POSB** and **MARKB** hold the results of the Z mark registration in this mode.

The Enhanced Servo Daughter Board has similar functionality to the MC206X, with the dual registration capability extended to 2 separate 24V inputs in addition to the Z mark. Mode numbers 10 to 13 cover the use of inputs R0 and R1.

Parameters: **mode:** Determines the position to capture.

All registration capable products:

1 - Absolute position when Z Mark rising edge

2 - Absolute position when Z Mark falling edge

3 - Absolute position when R Input rising edge

4 - Absolute position when R Input falling edge

5 - Unused

MC206X, PCI208 and P201 only:

6 - R Input rising into REG_POS & Z Mark rising into REG_POSB.

7 - R Input rising into REG_POS & Z Mark falling into REG_POSB.

8 - R Input falling into REG_POS & Z Mark rising into REG_POSB.

9 - R Input falling into REG_POS & Z Mark falling into REG_POSB

P201 Enhanced Servo Daughter Board only:

10 - R0 Input rising into REG_POS & R1 Input rising into REG_POSB.

11 - R0 Input rising into REG_POS & R1 Input falling into REG_POSB.

12 - R0 Input falling into REG_POS & R1 Input rising into REG_POSB.

13 - R0 Input falling into REG_POS & R1 Input falling into REG_POSB

distance: The distance parameter is used for the pattern recognition mode ONLY, and specifies the distance over which to record transitions

Note: Windowing Functions

Add **256** to the above mode values to apply inclusive windowing function:

When the windowing function is applied signals will be ignored if the axis measured position is not in the range:

Greater than **OPEN_WIN** and Less than **CLOSE_WIN**

Add **768** to the above values to apply exclusive windowing function:

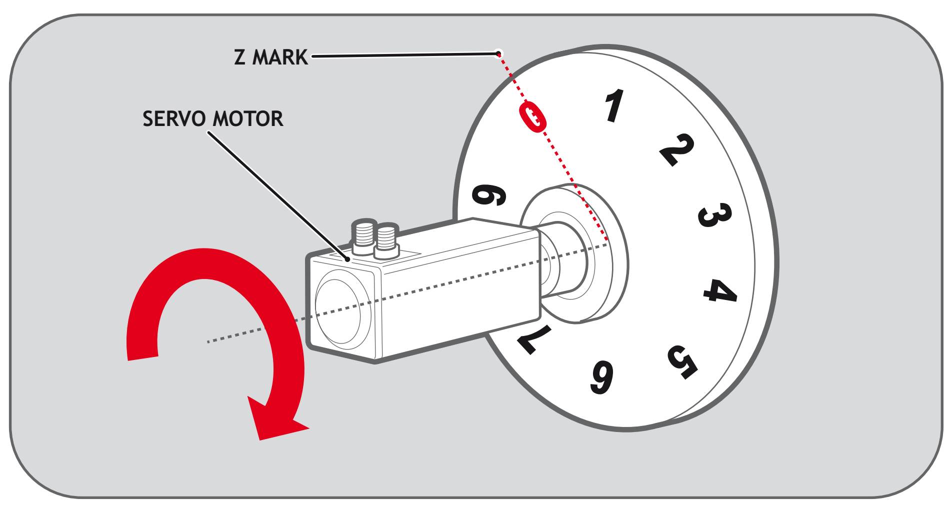
When the windowing function is applied signals will be ignored if the axis measured position is not in the range:

Less than **OPEN_WIN** or Greater than **CLOSE_WIN**

Note: The **REGIST** command must be re-issued for each position capture.

Example1 : A disc used in a laser printing process requires registration to the Z marker before printing can start. This routine locates to the Z marker, then sets that as the zero position.

```
REGIST(1)            'set registration point on Z mark
FORWARD              'start movement
WAIT UNTIL MARK
CANCEL               'stops movement after Z mark
WAIT IDLE
MOVEABS (REG_POS)    'relocate to Z mark
WAIT IDLE
DEFPOS(0)            'set zero position
```

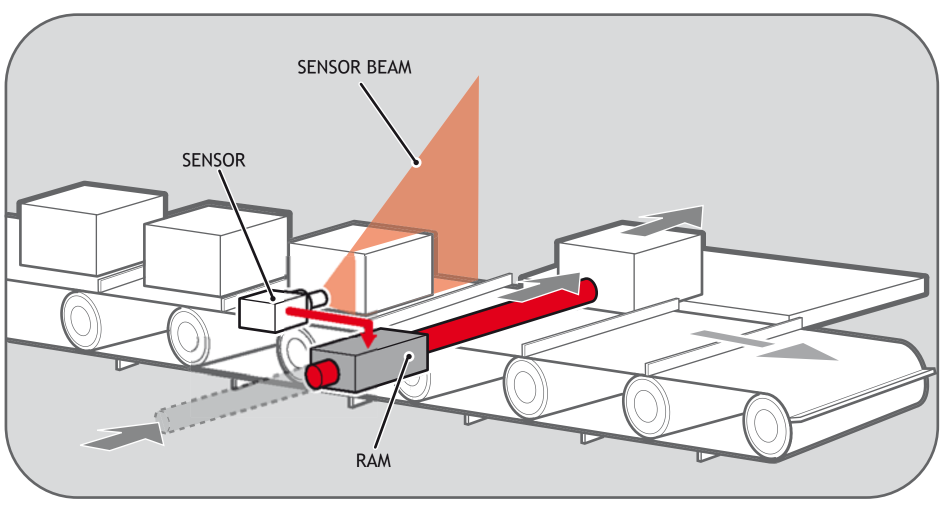


Example 2: Registration with windowing

It is required to detect if a component is placed on a flighted belt so windowing is used to avoid sensing the flights. The flights are at a pitch of 120 mm and the component will be found between 30 and 90mm. If a component is found then an actuator is fired to push it off the belt.

```
REP_DIST=120      'sets repeat distance to pitch of belt flights
REP_OPTION=ON
OPEN_WIN=30             'sets window open position
CLOSE_WIN=90            'sets window close position
REGIST(4+256)           'R input registration with windowing
FORWARD                'start the belt
box_seen=0
REPEAT
```

```
    WAIT UNTIL MPOS<60   'wait for centre point between flights
    WAIT UNTIL MPOS>60   'so that actuator is fired between flights
    IF box_seen=1 THEN   'was a box seen on the previous cycle?
      OP(8,ON)           'fire actuator
      WA(100)
      OP(8,OFF)          'retract actuator
      box_seen=0
    ENDIF
    IF MARK THEN box_seen=1 'set "box seen" flag
    REGIST(4+256)
  UNTIL IN(2)=OFF
  CANCEL ' stop the belt
  WAIT IDLE
```

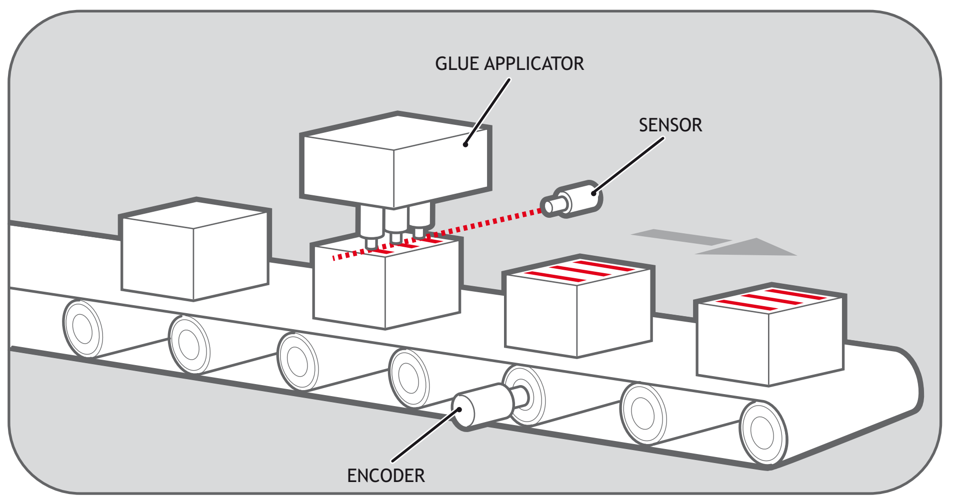


Example 3: Dual Input Registration

A machine adds glue to the top of a box by switching output 8. It must detect the rising edge (appearance) of and the falling edge (end) of a box. Additionally it is required that the mpos be reset to zero on the detection of the z position.

```
reg=6 'select registration mode 6 (rising edge R, rising edge Z)
REGIST(reg)
FORWARD
WHILE IN(2)=OFF
  IF MARKB THEN 'on a Z mark mpos is reset to zero
    OFFPOS=-REG_POSB
    REGIST(reg)
  ELSEIF MARK THEN 'on R input output 8 is toggled
```

```
      IF reg=6 THEN
      'select registration mode 8 (falling edge R, rising edge Z)
      reg=8
      OP(8,ON)
    ELSE
      reg=6
      OP(8,OFF)
    ENDIF
    REGIST(reg)
  ENDIF
  WEND
CANCEL
```



REVERSE

Type: Axis Command

Syntax: **REVERSE**

Alternate Format: **RE**

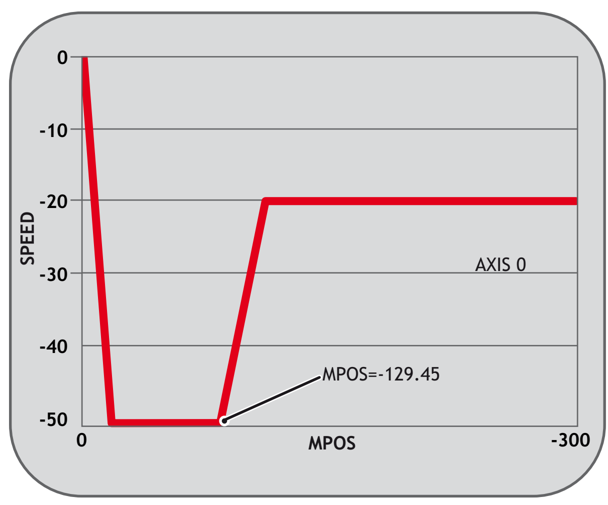
Description: Sets continuous reverse movement on the specified or base axis. The axis accelerates at the programmed **ACCEL** rate and continues moving at the **SPEED** value until either a **CANCEL** or **RAPIDSTOP** command are encountered. It then decelerates to a stop at the programmed **DECEL** rate.
If the axis reaches either the reverse limit switch or reverse soft limit, the **REVERSE** will be cancelled and the axis will decelerate to a stop.

Example 1: Run an axis in reverse. When an input signal is detected on input 5, stop the axis.

```
back:
  REVERSE
  'Wait for stop signal:
  WAIT UNTIL IN(5)=ON
  CANCEL
  WAIT IDLE
```

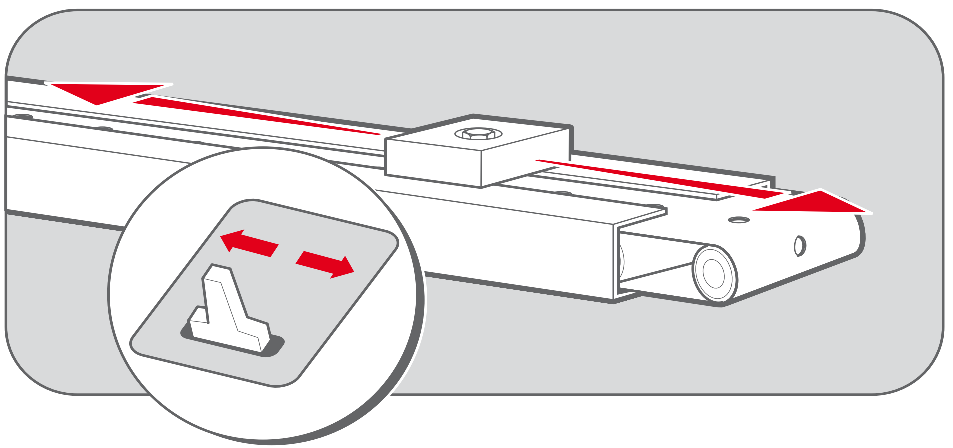
Example 2: Run an axis in reverse. When it reaches a certain position, slow down.

```
  DEFPOS(0)      'set starting position to zero
  REVERSE
  WAIT UNTIL MPOS<-129.45
  SPEED=slow_speed
  WAIT UNTIL VP_SPEED=slow_speed ' wait until the axis slows
  OP(11,ON)      'turn on an output to show that speed is now slow
```



Example 3: A joystick is used to control the speed of a platform. A deadband is required to prevent oscillations from the joystick midpoint. This is achieved through setting reverse, which sets the correct direction relative to the operator, the joystick then adjusts the speed through analogue input 0.

```
REVERSE
WHILE IN(2)=ON
  IF AIN(0)<50 AND AIN(0)>-50 THEN 'sets a deadband in the input
    SPEED=0
  ELSE
    SPEED=AIN(0)*100               'sets speed to a scale of AIN
  ENDIF
WEND
CANCEL
```



STEP_RATIO

Type: Axis Command

Syntax: **`STEP_RATIO(output_count, dpos_count)`**

Description: This command sets up an Integer ratio for the axis' stepper output. Every servo-period the number of steps is passed through the step_ratio function before it goes to the step pulse output.

The **`STEP_RATIO`** function operates before the divide by 16 factor in the stepper axis. This maintains the good timing resolution of the stepper output circuit.

Parameters:

`output_count:`	Number of counts to output for the given dpos_count value. Range: 0 to 16777215.
`dpos_count:`	Change in DPOS value for corresponding output count. Range: 0 to 16777215.

Note 1: *Large ratios should be avoided as they will lead to either loss of resolution or much reduced smoothness in the motion. The actual physical step size x 16 is the basic resolution of the axis and use of this command may reduce the ability of the Motion Coordinator to accurately achieve all positions.*

Note 2: *`STEP_RATIO` does not replace `UNITS`. Do not use `STEP_RATIO` to remove the x16 factor on the stepper axis as this will lead to poor step frequency control.*

Example 1: Two axes are set up as X and Y but the axes' steps per mm are not the same. Interpolated moves require identical **UNITS** values on both axes in order to keep the path speed constant and for **MOVECIRC** to work correctly. The axis with the lower resolution is changed to match the higher step resolution axis so as to maintain the best accuracy for both axes.

```
' Axis 0: 500 counts per mm (31.25 steps per mm)
' Axis 1: 800 counts per mm (50.00 steps per mm)

  BASE(0)
  STEP_RATIO(500,800)
  UNITS = 800
  BASE(1)
  UNITS = 800
```

Example 2: A stepper motor has 400 steps per revolution and the installation requires that it is controlled in degrees. As there are 360 dgrees in one revolution, it would be better from the programmer's point of view if there are 360 counts per revolution.

```
BASE(2)
STEP_RATIO(400, 360)
' Note: this has reduced resolution of the stepper axis
MOVE(360*16) ' move 1 revolution
```

Example 3: Remove the step ratio from an axis.

```
BASE(0)
STEP_RATIO(1, 1)
```

Input / Output Commands

AIN

Type: Function

Syntax: **AIN(analogue chan)**

Description: Reads a value from an analogue input. A variety of analogue input modules may be connected to the *Motion Coordinator* and some *Motion Coordinator*s have one or two analogue inputs built-in. The value returned is the decimal equivalent of the binary number read from the A to D converter.

Parameters: **analogue chan:** analogue input channel number 0...71

0 to 31:	P325 CAN Analog input channels.
32 to 39:	Analogue inputs built-in to the *Motion Coordinator*.
40 to 71	P225 Analog Input Daugther Board.

	Resolution	Biploar / Unipolar / Scale
MC206X:	10 bit	Unipolar, 0 - 12V, 0 - 1023
Euro295x:	12 bit	Unipolar, 0-10V
MC224:	12 bit	Unipolar, 0 - 10V
P325:	12 bit	Bipolar, -10V - +10V, -2048 - +2047
P225:	16 bit	Unipolar, 0 - 10V, 0 - 65535
MC302X	Analogue input of Servodrive	

Example: The speed of a production line is to be governed by the rate at which material is fed onto it. The material feed is via a lazy loop arrangement which is fitted with an ultra-sonic height sensing device. The output of the ultra-sonic sensor is in the range 0V to 4V where the output is at 4V when the loop is at its longest.

```
MOVE(-5000)
REPEAT
  a=AIN(1)
  IF a<0 THEN a=0
  SPEED=a*0.25
UNTIL MTYPE=0
```

The analogue input value is checked to ensure it is above zero even though it always should be positive. This is to allow for any noise on the incoming signal which could make the value negative and cause an error because a negative speed is not valid for any move type except **FORWARD** or **REVERSE**.

Note: Speed of analogue response depends on which module it comes from. P325 updates at 10msec, P225 at the selected **SERVO_PERIOD** and built-in analogue ports at 1 msec.

If no P325 CAN Analog modules are fitted, **AIN(0)** and **AIN(1)** will read the built-in channels so as to maintain compatibility with previous versions.

AIN0..3 / AINBI0..3

Type: System Parameter

Description: These system parameters duplicate the **AIN()** command.

They provide the value of the analogue input channels in system parameter format to allow the **SCOPE** function (Which can only store parameters) to read the analogue inputs.

AOUT0...3

Type: Reserved Keyword

CHR

Type: Command

Description: The **CHR(x)** command is used to send individual ASCII characters which are referred to by number. **PRINT CHR(x);** is equivalent to PUT(x) in some other versions of BASIC.

Example:

```
>>PRINT CHR(65);
A
PRINT #1,CHR($32);CHR(71);CHR(75);
```

CURSOR

Type: Command

Description: The **CURSOR** command is used in a print statement to position the cursor on the Trio membrane keypad and mini-membrane keypad. **CURSOR(0), CURSOR(20), CURSOR(40), CURSOR(60)** are the start of the 4 lines of the 4 line display. **CURSOR(0) and CURSOR(20)** are the start of the 2 line display.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	45	47	48	49	50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79

4 Line Display as featured on the Membrane Keypad

Example:
```
PRINT#4,CURSOR(60);">Bottom line";
```

DEFKEY

Type: Command

Syntax: **DEFKEY(key no, keyvalue1, [keyvalue2, [keyvalue3 ..]])**

Description: Under most circumstances this command is not required and it is recommended that the values of keys are input using a **GET#4** sequence. A **GET#4** sequence does not use the **DEFKEY** table. In this example a number representing which key has been pressed is put in the variable k:

```
GET#4,k
```

The **DEFKEY** command can be used to re-define what numbers are to be put in the variable when a key is pressed on a MEMBRANE keypad or Mini-Membrane keypad interfaced using an FO-VFKB module. To use the **DEFKEY** table the values are read using **GET#3**:

```
GET#3,k
```

The key numbers of the membrane keypad are shown in chapter 5 of this manual. To each of these key numbers is assigned a value by the **DEFKEY** command that is returned by a **GET#3** command.

Parameters:

key no:	start key number
keyvalue1:	value returned by start key through a **GET#3** command.
keyvalue2.. keyvalue11:	values returned by successive keys through a **GET#3** command.

Example: The command **DEFKEY (33,13**) would therefore be used to generate 13 when the first key on row 3 of a pad was pressed. Note **DEFKEY** can only be used to redefine input on channel#3.

ENABLE_OP

Type: Reserved Keyword

FLAG

Type: Command/Function

Syntax: **FLAG(flag no [,value])**

Description: The **FLAG** command is used to set and read a bank of 24 flag bits. The **FLAG** command can be used with one or two parameters. With one parameter specified the status of the given flag bit is returned. With two parameters specified the given flag is set to the value of the second parameter. The **FLAG** command is provided to aid compatibility with earlier controllers and is not recommended for new programs.

Parameters:

flag no:	The flag number is a value from 0..23.
value:	If specified this is the state to set the given flag to i.e. ON or OFF. This can also be written as 1 or 0.

Example 1:

```
FLAG(21,ON)' Set flag bit 21 ON
```

FLAGS

Type: Command/Function

Syntax: **FLAGS([value])**

Description: Read/Set the FLAGS as a block. The **FLAGS** command is provided to aid compatibility with earlier controllers and is not recommended for new programs. The 24 flag bits can be read with **FLAGS** and set with **FLAGS(value)**.

Parameters: **value:** The decimal equivalent of the bit pattern to set the flags to

Example: Set Flags 1,4 and 7 ON, all others OFF

Bit #	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1

```
FLAGS(146)’ 2 + 16 + 128
```

Example 2: Test if FLAG 3 is set.

```
IF (FLAGS and 8) <>0 then GOSUB somewhere
```

GET

Type: Command.

Description: Waits for the arrival of a single character on the default serial port 0. The ASCII value of the character is assigned to the variable specified. The user program will wait until a character is available.

Example:
```
GET  k
```

GET#

Type: Command

Description: Functions as **GET** but the input device is specified as part of the command. The device specified is valid only for the duration of the command.

Parameters

n:
- 0 Serial port 0
- 1 Serial port 1
- 2 Serial port 2
- 3 Fibre optic port (value returned defined by **DEFKEY**)
- 4 Fibre optic port (returns raw keycode of key pressed)
- 5 *Motion* Perfect user channel
- 6 *Motion* Perfect user channel
- 7 *Motion* Perfect user channel
- 8 Used for *Motion* Perfect internal operations
- 9 Used for *Motion* Perfect internal operations
- 10+ Fibre optic network data

x: Variable

Example:

```
GET#3,k 'Just for this command input taken from fibre optic
```

Note: Channels 5 to 9 are logical channels which are superimposed on to Serial Port A by *Motion* Perfect.

Example 2: Get a key in a user menu routine

```
REPEAT
    PRINT #kpd,CHR(12);CHR(14);CHR(20);
    PRINT #kpd,CURSOR(00);"<=|General Setup1|=>";
    PRINT #kpd,CURSOR(20);"Cut Length : ";VR(clength)
    GET #kpd,option
    IF option=lastmenu OR option=f1 THEN RETURN
    IF option=menu_l2 THEN GOSUB set_cut_length
UNTIL TRUE
```

HEX

Type: Command

Description: The **HEX** command is used in a print statement to output a number in hexadecimal format.

Example:
```
PRINT#5,HEX(IN(8,16))
```

IN()/IN

Type: Function.

Syntax: **IN(input no<,final input>)/IN**

Description: Returns the value of digital inputs. If called with no parameters, IN returns the binary sum of the first 24 inputs (if connected). If called with one parameter whose value is less than the highest input channel, it returns the value (1 or 0) of that particular input channel. If called with 2 parameters **IN()** returns in binary sum of the group of inputs. In the 2 parameter case the inputs should be less than 24 apart.

Parameters:

input no:	input to return the value of/start of input group
<final input>:	last input of group

Example 1: In this example a single input is tested:

```
test:
  WAIT UNTIL IN(4)=ON
  GOSUB place
```

Example 2: Move to the distance set on a thumb wheel multiplied by a factor. The thumb wheel is connected to inputs 4,5,6,7 and gives output in BCD.

```
WHILE TRUE
  MOVEABS(IN(4,7)*1.5467)
  WAIT IDLE
WEND
```

Note how the move command is constructed:

Step 1: IN(4,7) will get a number 0..15
Step 2: multiply by 1.5467 to get required distance
Step 3: absolute MOVE by this distance

Note: **IN** is equivalent to **IN(0,23)**

Example: Test if either input 2 or 3 is ON.

```
If (IN and 12) <> 0 THEN GOTO start
' (Bit 2 = 4 + Bit 3 = 8) so mask = 12
```

INPUT

Type: Command.

Description: Waits for a string to be received on the current input device, terminated with a carriage return <CR>. If the string is valid its numeric value is assigned to the specified variable. If an invalid string is entered it is ignored, an error message displayed and input repeated. Multiple inputs may be requested on one line, separated by commas, or on multiple lines, separated by <CR>.

Example1:

```
INPUT num
PRINT "BATCH COUNT=";num[0]
```

On terminal:

```
123 <CR>
BATCH COUNT=123
```

Example2:

```
getlen:
  PRINT ENTER LENGTH AND WIDTH ?";
  INPUT VR(11),VR(12)
```

This will display on terminal:

```
ENTER LENGTH AND WIDTH ? 1200,1500 <CR>
```

Note: This command will not work with the serial input device set to 3 or 4, i.e. the fibre optic port, as the received codes are not ASCII 0..9. It is also not possible for a program to use the serial port 0 as the command line process will remove the characters. Programs needing a “terminal” style interface should use one of the channel 6 to channel 7 ports if using *Motion* Perfect.

INPUTS0 / INPUTS1

Type: System Parameter

Description: The **INPUTS0** parameter holds 24 Volt Input channels 0..15 as a system parameter. **INPUTS1** parameter holds 24 Volt Input channels 16..31 as a system parameter. Reading the inputs using these system parameters is not normally required. The **IN**(x,y) command should be used instead. They are made available in this format to make the input channels accessible to the **SCOPE** command which can only store parameters.

INVERT_IN

Type: Command.

Syntax: **INVERT_IN(input,on/off)**

Description: The **INVERT_IN** command allows the input channels 0..31 to be individually inverted in software. This is important as these input channels can be assigned to activate functions such as feedhold. The **INVERT_IN** function sets the inversion for one channel ON or OFF. It can only be applied to inputs 0..31.

Example1:

```
>>? IN(3)
0.0000
>>INVERT_IN(3,ON)
>>? IN(3)
1.0000
>>
```

KEY

Type: Function.

Description: Returns **TRUE** or **FALSE** depending on whether a character has been received on an input device or not. This command does not read the character but allows the program to test if any character has arrived. A true result will be reset when the character is read with **GET.**

The **KEY** command checks the channel specified by **INDEVICE** or by a # channel number.

Input device:

Chan	Input device:-
0	Serial port 0
1	Serial port 1
2	Serial Port 2
3	Fibre optic port (value returned defined by DEFKEY)
4	Fibre optic port (returns raw keycode of key pressed)
5	*Motion* Perfect user channel
6	*Motion* Perfect user channel
7	*Motion* Perfect user channel
8	Used for *Motion* Perfect internal operations
9	Used for *Motion* Perfect internal operations
10	Fibre optic network data

Example 1:

```
main:
  IF KEY#1 THEN GOSUB read
...
read:
  GET#1  k
RETURN
```

Example 2: To test for a character received from the fibre optic network:

```
  IF KEY#4 THEN GET#4,ch
```

LINPUT

Type: Command

Syntax: **LINPUT variable**

Description: Waits for an input string and stores the ASCII values of the string in an array of variables starting at a specified numbered variable. The string must be terminated with a carriage return <CR> which is also stored. The string is not echoed by the controller.

Parameters: None.

Example: **LINPUT VR(0)**

Now entering: **START<CR>** will give:

VR(1)	84	ASCII 'T'
VR(2)	65	ASCII 'A'
VR(3)	82	ASCII 'R'
VR(4)	84	ASCII 'T'
VR(5)	13	ASCII carriage return

OP

Type: Command/Function.

Syntax: **OP[([output no,] value)]**

Description: Sets output(s) and allows the state of the first 24 outputs to be read back. The command has three different forms depending on the number of parameters. A single output channel may be set with the 2 parameter command. The first parameter is the channel number 8-95 and the second is the value to be set 0 or 1.

If the command is used with 1 parameter the parameter is used to simultaneously set the first 24 outputs with the binary pattern of the number. If the command is used with no parameters the first 24 outputs are read back. This allows multiple outputs to be set without corrupting others which are not to be changed. (See example 3).

Note: The first 8 outputs (0 to 7) do not physically exist on the *Motion Coordinator* so if they are written to nothing will happen and if they are read back they will always return 0.

Parameters:

output no: Output number to set.

value: Output value to be set. 0/1 for 2 parameter command, decimal equivalent of binary number to set on outputs for one parameter command

Example 1: **OP(44,1)**
This is equivalent to **OP(44,ON)**

Example 2: **OP (18*256)**
This sets the bit pattern 10010 on the first 5 physical outputs, outputs 13-31 would be cleared. Note how the bit pattern is shifted 8 bits by multiplying by 256 to set the first available outputs as 0 to 7 do not exist.

Example 3:
```
read_output:
   VR(0)=OP
   'SET OUTPUTS 8..15 ON SIMULTANEOUSLY
   VR(0)=VR(0) AND $FF00
   OP(VR(0))
```
Note how this example can also be written:

```
   'SET OUTPUTS 8..15 ON SIMULTANEOUSLY
   OP(OP AND $FF00)
```

See also READ_OP()

PRINT

Type: Command.

Description: The **PRINT** command allows the Trio BASIC program to output a series of characters to either the serial ports or to the fibre optic port (if fitted). The **PRINT** command can output parameters, fixed ascii strings, and single ascii characters. Multiple items to be printed can be put on the same **PRINT** line provided they are separated by a comma or semi-colon. The comma and semi-colon are used to control the format of strings to be output.

Example 1:
```
PRINT "CAPITALS and lower case CAN BE PRINTED"
```

Example 2:
```
>>PRINT 123.45,VR(1)
123.4500 1.5000
>>
```
Note how the comma separator forces the next item to be printed into the next tab column. The width of the field in which a number is printed can be set with the use of [w,x] after the number to be printed. Where w=width of column and x=number of decimal places.

Example 3: Suppose VR(1)=6 and variab=1.5:
```
PRINT VR(1)[4,1],variab[6,2]
```
print output will be:
```
6.0  1.50
```
Note that the numbers are right justified in the field with any unused leading characters being filled with spaces. If the number is too big then the field will be filled with asterisks to signify that there was not sufficient space to display the number. The maximum field width allowable is 127.

Example 4:
```
length:
PRINT "DISTANCE=";mpos
DISTANCE=123.0000
```
Note how in this example the semi-colon separator is used. This does not tab into the next column, allowing the programmer more freedom in where the print items are put. The **PRINT** command prints variables with 4 digits after the decimal point. The number of decimal places printed can be set by use of [x] after the item to be printed. Where x is the number of decimal places from 1..4

```
params:PRINT "DISTANCE=";mpos[0];" SPEED=";v[2];
DISTANCE=123 SPEED=12.34
```

Example 5:
```
15 PRINT "ITEM ";total" OF ";limit;CHR(13);
```
The **CHR(x)** command is used to send individual ASCII characters which are referred to by number. The semi-colon on the end of the print line suppresses the carriage return normally sent at the end of a print line. ASCII (13) generates CR without a line feed so the line above would be printed on top of itself if it were the only print statement in a program.

PRINT CHR(x); is equivalent to PUT(x) in some other versions of BASIC.

Note: The **PRINT** statements are normally transmitted to serial port 0. They can be redirected to other output ports by using **PRINT#**.

PRINT#

Type: Command

Description: This performs the same function as **PRINT** but the serial output device is specified as part of the command. The device is selected for the duration of the **PRINT#** command only. When execution is complete the output device reverts back to that specified by the common parameter **OUTDEVICE**.

Parameters:

n:	Output device:-
0	Serial port 0
1	Serial port 1
2	Serial port 2
3	Fibre optic port
4	Fibre optic port duplicate
5	RS-232 port A - channel 5
6	RS-232 port A - channel 6
7	RS-232 port A - channel 7
8	RS-232 port A - channel 8 - reserved for use by *Motion* Perfect

n:	Output device:-
9	RS-232 port A - channel 9 - reserved for use by *Motion* Perfect
10..24	send text string to fibre optic network node 1..15

Example: **PRINT#10,"SPEED=";SPEED[6,1];**

PSWITCH

Type: Command

Syntax: **PSWITCH(sw,en,[,axis,opno,opst,setpos,rspos])**

Description: The **PSWITCH** command allows an output to be fired when a predefined position is reached, and to go OFF when a second position is reached. There are 16 position switches each of which can be assigned to any axis, and can be assigned ON/OFF positions and OUTPUT numbers.

Multiple PSWITCH's can be assigned to a single output. The result on the output will be the OR of the position switches and the standard BASIC OP setting.

The command must be used with all 7 parameters to enable a switch, just the first 2 parameters are required to disable a switch.

Parameters:

sw: The switch number in the range 0..15

en: Switch enable -

1 or ON to enable software **PSWITCH**
0 or OFF to disable **PSWITCH**
3 to enable hardware **PSWITCH**
(hardware PSWITCH can only be used with a P242 daughter board
5 enable **PSWITCH** on DPOS

axis: Axis number which is to provide the position input in the range 0..number of axes on the controller. For a hardware **PSWITCH** it should be set to the daughter board axis number.

opno: Selects the physical output to set, should be in range 8..31. For a hardware **PSWITCH** it should be set to 0..3.

opst: Selects the state to set the output to, if 1 then output set **ON** else set it **OFF**

setpos: The position at which output is set, in user units

rspos: The position at which output is reset, in user units

Example: A rotating shaft has a cam operated switch which has to be changed for different size work pieces. There is also a proximity switch on the shaft to indicate TDC of the machine. With a mechanical cam the change from job to job is time consuming but this can be eased by using the **PSWITCH** as a software 'cam switch'. The proximity switch is wired to input 7 and the output is fired by output 11. The shaft is controlled by axis 0 of a 3 axis system. The motor has a 900ppr encoder. The output must be on from 80° after TDC for a period of 120°. It can be assumed that the machine starts from TDC.

The **PSWITCH** command uses the unit conversion factor to allow the positions to be set in convenient units. So first the unit conversion factor must be calculated and set. Each pulse on an encoder gives four edges which the controller counts, therefore there are 3600 edges/rev or 10 edges/°. If we set the unit conversion factor to 10 we can then work in degrees.

Next we have to determine a value for all the **PSWITCH** parameters.

sw The switch number can be any one we chose that is not in use so for the purpose of this example we will use number 0.

en The switch must be enabled to work, therefore this must be set to 1.

axis We are told that the shaft is controlled by axis 0, thus axis is set to 0.

opno We are told that output 11 is the one to fire, so set opno to 11.

opst When the output is set it should be on so set to 1.

setpos The output is to fire at 80° after TDC hence the set position is 80 as we are working in degrees.

rspos The output is to be on for a period of 120° after 80° therefore it goes off at 200°. So the reset position is 200.

This can all be put together to form the two lines of Trio BASIC code that set up the position switch:

```
switch:
  UNITS AXIS(0)=10'   Set unit conversion factor (°)
  REPDIST=360
  REP_OPTION=ON
  PSWITCH(0,ON,0,11,ON,80,200)
```

This program uses the repeat distance set to 360 degrees and the repeat option ON so that the axis position will be maintained in the range 0..360 degrees.

Note: After switching the **PSWITCH** off, the output may remain ON if the state was ON when the **PSWITCH** was switched off. The **OP()** command can be used to force an output OFF:

```
PSWITCH(2,OFF)'Switch OFF pswitch controlling OP 14
OP(14,OFF)
```

READ_OP()

Type: Function.

Syntax: **READ_OP(output no[,final output])**

Description: Returns the value of digital outputs. If called with one parameter whose value is less than the highest output channel, it returns the value (1 or 0) of that particular output channel. If called with 2 parameters **READ_OP()** returns, in binary, the sum of the group of outputs. In the 2 parameter case the outputs should be less than 24 apart.

Parameters:

output no:	output to return the value of/start of output group
[final output]:	last output of group

Example 1: In this example a single output is tested:

```
test:
  WAIT UNTIL READ_OP(12)=ON
  GOSUB place
```

Example 2: Check the group of 8 outputs and call a routine if any of them are ON.

```
  op_bits = READ_OP(16,23)
  IF op_bits<>0 THEN
    GOSUB check_outputs
  ENDIF
```

Note: **READ_OP checks the state of the output logic. No actual output needs to be present for the returned value to be ON.**

In the Euro205x, READ_OP(8 … 15) is different to IN(8 … 15) because there are separate inputs and outputs at these addesses.

READPACKET

Type: Command

Syntax: **READPACKET(port#,vr#,vr count, format)**

Description: **READPACKET** is used to transmit numbers from an external computer into the global variables of the *Motion Coordinator* over a serial communications port. The data is transmitted from the PC in binary format with a CRC checksum. A detailed description of the **READPACKET** format can be downloaded from WWW.TRIOMOTION.COM

Parameters:

Port Number	This value should be 0 or 1
VR Number	This value tells the *Motion Coordinator* where to start setting the variables in the **VR()** global memory array.
VR count.	The number of variables to download
Format	The number format for the numbers being downloaded

RECORD

Type: Command

Syntax: **RECORD(count, table address)**

Description: The **RECORD** command is part of the pattern recognition system built into the *Motion Coordinator*. Following the recording of a sequence of transitions the **RECORD** command is used to:

1 - Reduce the number of transitions to a number defined by the programmer
2 - Store the transition pattern for subsequent comparison with **MATCH**

Parameters:

count	Number of transitions to record. The actual transitions seen may be greater than this number but the shortest ones are removed so that only the programmed transition count is stored.
table address	This value tells the *Motion Coordinator* where to store the pattern information in the global **TABLE** memory. Table used is address to address+24.

Note: See the **MATCH** command for an example of a complete recognition sequence.

SEND

Type: Command

Syntax: **SEND(n,type,data1[,data2])**

Description: Outputs a fibre-optic network message of a specified type to a given node.

Parameters:

n: Number from 10 to 24 defining the destination node.

type: Message type:

1 - Direct variable transfer
2 - Keypad offset

data1: Message type 1: data1 is the VR variable number on the destination *Motion Coordinator*.
Message type 2; data1 is the number of nodes from the keypad that the key characters are to be sent, in the range 10..24. 10 is the next node and 24 is the fifteenth node away from the keypad.

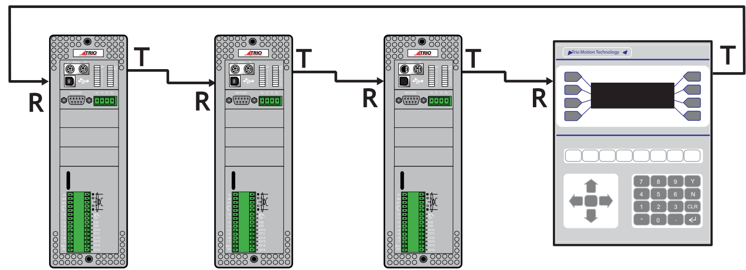
data2: Only used if message is type 1. In this case it contains the value for the specified variable.

Example 1: Two *Motion Coordinator*s are fibre-optic networked together. One is acting under instruction from the other. Instructions are given by setting VR(100) to different values on the receiving *Motion Coordinator*. The program on the master *Motion Coordinator* would have the following send routine:

```
SEND(10,1,100,value)' Set vr(100) on dest. to value
```

Example 2: Any network containing membrane keypad(s) must initialise the keypads to tell them where to send their output and to set them into network mode. To do this a keypad offset message is sent to the membrane keypad. Consider a network with four nodes; 3 *Motion Coordinator*s and 1 membrane keypad connected as follows:

MCa ---> MCb---> MCc ---> Keypad ---> (back to MCa)



	MCa	MCb	MCc	Keypad
Offset from MCa	0	10	11	12
Offset from Keypad	10	11	12	0

If MCa is to initialise the keypad (offset of 2 from MCa) but MCc is to receive the keypad output (Offset of 0,1,2 from Keypad to MCc).

```
SEND(10+2,2,10+2)
```

SETCOM

Type: Command

Syntax: `SETCOM(baudrate,databits,stopbits,parity,port[,mode][,variable])`

Description: Permits the serial communications parameters to be set by the user.

By default the controller sets the RS232-C port to 9600 baud, 7 data bits, 2 stop bits and even parity.

Parameters:

baudrate:	1200, 2400, 4800, 9600, 19200 or 38400
databits:	7 or 8
stopbits:	1 or 2
parity:	0 = none, 1 = odd, 2 = even

port number: 0, 1 or 2

mode: This switch is available on serial ports #1 and #2 ONLY.
0 : XON/XOFF inactive
1 : XON/XOFF active
4 : MODBUS protocol (16 bit Integer)
5 : Hostlink Slave
6 : Hostlink Master
7 : MODBUS protocol (32 bit IEEE floating point)
8 : REMOTE end of TrioPC ActiveX synchronous link
9 : MODBUS protocol (32bit long word integers)

variable: Determines the target variable array for MODBUS transfers.
0 : VR()
1 : TABLE()

Timeout Value in mSec for RS485 TX to release.

Example 1:

```
' Set port 1 to 19200 baud, 7 data bits, 2 stop bits
' even parity and XON/XOFF enabled

SETCOM(19200,7,2,2,1,1)
```

Example 2:

```
' Set port 2 (RS485) to 9600 baud, 8 data bits, 1 stop bit
' no parity and no XON/XOFF handshake

SETCOM(9600,8,1,0,2,0)
```

Example 3: The Modbus protocol is initialised by setting the mode parameter of the **SETCOM** instruction to 4. The **ADDRESS** parameter must also be set *before* the Modbus protocol is activated.

```
' set up RS485 port at 19200 baud, 8 data, 1 stop, even parity
' and enable the MODBUS comms protocol

ADDRESS=1
SETCOM(19200,8,1,2,2,4)
```

Example 4: Set port 1 to receive commands from a PC running the TrioPC ActiveX component.

```
' set up RS232 port at 38400 baud, 8 data, 1 stop, even parity
' then start the REMOTE process which will handle the commands
' received from TrioPC.

SETCOM(38400,8,1,2,1,8)
REMOTE(0)
```

Program Loops and Structures

BASICERROR

Type: Program Structure

Description: This command may only be used as part of an **ON... GOSUB** or **ON... GOTO** command. When used in this context it defines a routine to be run when an error occurs in a Trio BASIC command.

Example:
```
ON BASICERROR GOTO error_routine
....(rest of program)

error_routine:
  PRINT "The error ";RUN_ERROR[0];
  PRINT " occurred in line ";ERROR_LINE[0]
STOP
```

ELSE

Type: Program Structure

Description: This command is used as part of a multi-line **IF** statement.

See Also **IF, THEN, ENDIF**

ELSEIF

Type: Program Structure

Syntax:
```
IF  <condition1> THEN
  commands
ELSEIF <condition2> THEN
  commands
ELSE
  commands
ENDIF
```

Description: The command is used within an **IF .. THEN .. ENDIF**. It evaluates a second (or subsequent) condition and if TRUE it executes the commands specified, otherwise the commands are skipped. MC206X and MC224 only.

Parameters:

condition(s): Any logical expression.

commands: Any valid Trio BASIC commands including further **IF..THEN ..{ELSEIF}..{ELSE} ENDIF** sequences

Example 1:

```
IF IN(stop)=ON THEN
  OP(8,ON)
  VR(cycle_flag)=0
ELSEIF IN(start_cycle)=ON THEN
  VR(cycle_flag)=1
ELSEIF IN(step1)=ON THEN
  VR(cycle_flag)=99
ENDIF
```

Example 2:

```
IF key_char=$31 THEN
  GOSUB char_1
ELSEIF key_char=$32 THEN
  GOSUB char_2
ELSEIF key_char=$33 THEN
  GOSUB char_3
ELSE
  PRINT "Character unknown"
ENDIF
```

Note: The **ELSE** sequence is optional. If it is not required, the **ENDIF** is used to mark the end of the conditional block.

See Also **IF, THEN, ELSE, ENDIF**

ENDIF

Type: Program Structure

Description: The **ENDIF** command marks the end of a multi-line **IF** statement.

Example:

```
IF count >= batchsize THEN
  PRINT #3,CURSOR(20);"   BATCH COMPLETE   ";
  GOSUB index ' Index conveyor to clear batch
  count=0
ENDIF
```

See Also **IF, THEN, ELSE**

FOR..TO.. STEP..NEXT

Type: Program Structure

Syntax:
```
FOR variable=start TO end [STEP increment]
   ...
   block of commands
   ...
NEXT variable
```

Description: On entering this loop the variable is initialized to the value of start and the block of commands is then executed.

Upon reaching the **NEXT** command the variable defined is incremented by the specified **STEP**. The **STEP** parameter is optional. If not defined then it is assumed to be 1. The **STEP** value may be positive or negative.

If the value of the variable is less than or equal to the end parameter then the block of commands is repeatedly executed until this is so.

Once the variable is greater than the end value the program drops out of the **FOR..NEXT LOOP**.

Parameters:

variable:	A valid Trio BASIC variable. Either a global VR variable, or a local variable may be used.
start:	A valid Trio BASIC expression.
end:	A valid Trio BASIC expression.
increment:	A valid Trio BASIC expression. (Optional)

Example 1:
```
FOR opnum=10 TO 18
    OP(opnum,ON)
NEXT opnum
```
This loop sets outputs 10 to 18 ON.

Example 2:
```
loop:
  FOR dist=5 TO -5 STEP -0.25
    MOVEABS(dist)
    GOSUB pick_up
  NEXT dist
```

Example 3: **FOR.. NEXT** statements may be nested (up to 8 deep) provided the inner **FOR** and **NEXT** commands are both within the outer **FOR..NEXT** loop:

```
FOR x=1 TO 8
  FOR y=1 TO 6
    MOVEABS(x*100,y*100)
    WAIT IDLE
    GOSUB operation
  NEXT l2
NEXT l1
```

Note: **FOR..NEXT** loops can be nested up to 8 deep in each program.

GOSUB

Type: Program Structure

Syntax: **GOSUB label**

Description: Stores the position of the line after the **GOSUB** command and then branches to the line specified. Upon reaching the **RETURN** statement, control is returned to the stored line.

Parameters: **label:** A valid label that occurs in the program. If the label does not exist an error message will be displayed during structure checking at the beginning of program run time and the program execution halted.

Example:

```
main:
  GOSUB routine1
  GOSUB routine2
GOTO main

routine1:
  PRINT "Measured Position=";MPOS;CHR(13);
RETURN

routine2:
  PRINT "Demand Position=";DPOS;CHR(13);
RETURN
```

Note: Subroutines on each process can be nested up to 8 deep.

GOTO

Type: Program Structure

Syntax: **GOTO label**

Description: Identifies the next line of the program to be executed.

Parameters: **label:** A valid label that occurs in the program. If the label does not exist an error message will be displayed during structure checking at the beginning of program run time and the program execution halted.

Example:
```
loop:
  PRINT "Measured Position=";MPOS;CHR(13);
  WA(1000)
  GOTO loop
```

Note: Labels may be character strings of any length. Only the first 15 characters are significant. Alternatively line numbers may be used as labels.

NEXT

Type: Program Structure

Description: Used to mark the end of a **FOR..NEXT** loop. See **FOR**.

ON.. GOSUB

Type: Program Structure

Syntax: **ON expression GOSUB label[,label[,...]]**

Description: The expression is evaluated and then the integer part is used to select a label from the list. If the expression has the value 1 then the first label is used, 2 then the second label is used, and so on. If the value of the expression is less than 1 or greater than the number of labels then an error occurs. Once the label is selected a **GOSUB** is performed.

Example:
```
REPEAT
  GET #3,char
UNTIL 1<=char AND char<=3
ON char GOSUB mover,stopper,change
```

ON.. GOTO

Type: Program Structure

Syntax: **ON expression GOTO label[,label[,...]]**

Description: The expression is evaluated and then the integer part is used to select a label from the list. If the expression has the value 1 then the first label is used, 2 then the second label is used, and so on. If the value of the expression is less than 1 or greater than the number of labels then an error occurs. Once the label is selected a **GOTO** is performed.

Example:
```
REPEAT
  GET #3,char
UNTIL 1<=char and char<=3
ON char GOTO mover,stopper,change
```

REPEAT.. UNTIL

Type: Program Structure

Syntax: **REPEAT commands UNTIL condition**

Description: The **REPEAT..UNTIL** construct allows a block of commands to be continuously repeated until a condition becomes **TRUE**. **REPEAT..UNTIL** loops can be nested without limit.

Example: A conveyor is to index 100mm at a speed of 1000mm/s wait for 0.5s and then repeat the cycle until an external counter signals to stop by setting input 4 on.

```
cycle:
  SPEED=1000
  REPEAT
    MOVE(100)
    WAIT IDLE
    WA(500)
UNTIL IN(4)=ON
```

RETURN

Type: Program Structure

Description: Instructs the program to return from a subroutine. Execution continues at the line following the **GOSUB** instruction.

Note: Subroutines on each process can be nested up to 8 deep.

Example:
```
' calculate in subroutine:
  GOSUB calc
  PRINT "Returned from subroutine"
  STOP

calc:
  x=y+z/2
RETURN
```

THEN

Type: Program Structure

Description: Forms part of an **IF** expression. See IF for further information.

Example:
```
IF MARK THEN
    offset=REG_POS
ELSE
    offset=0
ENDIF
```

Note: Comments should not be placed after a **THEN** statement

TO

Type: Program Structure

Description: Precedes the end value of a **FOR..NEXT** loop.

Example:
```
FOR x=10 TO 0 STEP -1
```

UNTIL

Type: Program Structure

Description: Defines the end of a **REPEAT..UNTIL** multi-line loop, or part of a **WAIT UNTIL** structure. After the **UNTIL** statement is a condition which decides if program flow continues on the next line or at the REPEAT statement. **REPEAT..UNTIL** loops can be nested without limit.

Example:
```
' This loop loads a CAMBOX move each time Input 0 comes on.
' It continues until Input 6 is switched OFF.


REPEAT
  WAIT UNTIL IN(0)=OFF
  WAIT UNTIL IN(0)=ON
  CAMBOX(0,150,1,10000,1)
UNTIL IN(6)=OFF
```

WA

Type: Command

Syntax: **WA(delay time)**

Description: Holds up program execution for the number of milliseconds specified in the parameter.

Parameters: **time:** The number of milliseconds to wait for.

Example:
```
OP(11,OFF)
WA(2000)
OP(17,ON)
'This turns output 17 off 2 seconds after switching output 11 off.
```

WAIT IDLE

Type: Command

Description: Suspends program execution until the base axis has finished executing its current move and any further buffered move.

Note: This does not necessarily imply that the axis is stationary in a servo motor system.

Example:
```
MOVE(100)
WAIT IDLE
PRINT "Move Done"
```

WAIT LOADED

Type: Command

Description: Suspends program execution until the base axis has no moves buffered ahead other than the currently executing move

Note: This is useful for activating events at the beginning of a move, or at the end of a move when multiple moves are buffered together.

Example: Switch output 45 ON at start of **MOVE(350)** and **OFF** at the end

```
MOVE(100)
MOVE(350)
WAIT LOADED
OP(45,ON)
MOVE(200)
WAIT LOADED
OP(45,OFF)
```

WAIT UNTIL

Type: Command

Syntax: **WAIT UNTIL** condition

Description: Repeatedly evaluates the condition until it is true then program execution continues.

Parameters: **condition:** A valid Trio BASIC logic expression.

Example 1:
```
WAIT UNTIL MPOS AXIS(0)>150
MOVE(100) AXIS(7)
```

In this example the program waits until the measured position on axis 0 exceeds 150 then starts a movement on axis 7.

Example 2: The expressions evaluated can be as complex as you like provided they follow the Trio BASIC syntax, for example:

WAIT UNTIL DPOS AXIS(2)<=0 OR IN(1)=ON
This waits until demand position of axis 2 is less than or equal to 0 or input 1 is on.

WEND

Type: Program Structure

Description: Marks the end of a **WHILE..WEND** loop.

See also: **WHILE**

Note: **WHILE..WEND** loop can be nested without limit other than program size.

WHILE

Type: Program Structure

Syntax: **WHILE condition**

Description: The commands contained in the **WHILE..WEND** loop are continuously executed until the condition becomes **FALSE**.

Execution then continues after the **WEND**.

Parameters: **condition:** Any valid logical Trio BASIC expression

Example:

```
WHILE IN(12)=OFF
  MOVE(200)
  WAIT IDLE
  OP(10,OFF)
  MOVE(-200)
  WAIT IDLE
  OP(10,ON)
WEND
```

System Parameters and Commands

ADDRESS

Type: System Parameter

Syntax: **ADDRESS=value**

Description: Sets the RS485 or Modbus multi-drop address for the board. This parameter should be in the range of 1..32

Example:
```
ADDRESS=5
SETCOM(19200,8,1,2,1,4)
```

APPENDPROG

Type: System Command (This function is used by the *Motion* Perfect editor)

Syntax: **APPENDPROG <string>**

Alternate Format: **@ <string>**

Description: This command appends a line to the currently selected program.

Parameters: **string:** The text, enclosed in quotation marks, that is to be appended to the program

AUTORUN

Type: System Command

Description: Starts running all the programs that have been set to run at power up.

See Also: **RUNTYPE.**

Note: This command should only be used on the Command Line Terminal.

AXISVALUES

Type: System Command

Syntax: **AXISVALUES(axis,bank)**

Description: Used by *Motion* Perfect to read axis parameters. Reads banks of axis parameters. There are 2 banks of parameters for each axis, bank 0 displays the data that is only changed by the Trio BASIC, bank 1 displays the data that is changed by the motion generator.

Parameters **The data is given in the format:**

<Parameter><type>=<value>

<Parameter> is the name of the parameter

<type> is the type of the value.

- **i** integer
- **f** float
- **c** float that when changed means that the bank 0 data must be updated
- **s** string
- **c** string of upper and lower case letters, where upper case letters mean an error

<value> an integer, a float or a string depending on the type

BATTERY_LOW

Type: System Parameter (Read only)

Syntax: **var = BATTERY_LOW**

Description: For controllers fitted with non rechargeable batteries, this parameter returns the current state of the battery condition. If **BATTERY_LOW** returns 1 then the battery needs to be changed. If **BATTERY_LOW** returns 0 then battery condition is ok.

BREAK_ADD

Type: System Command

Syntax: **BREAK_ADD "program name" line_number**

Description: Used by Motion Perfect to insert a break point into the specified program at the specified line number.

Example: **BREAK_ADD "simpletest" 8**
Will add a break point at line 8 of program "simpletest"

Note 1: If there is no code at the given line number **BREAK_ADD** will add the breakpoint at the next available line of code. i.e. If line 8 is empty but line 9 has "NEXT x" and a **BREAK_ADD** is issued for line 8, the break point will be added to line 9.

Note 2: If a non existent line number is selected (i.e. line 50 when the program only has 40 lines), the controller will return an error.

BREAK_DELETE

Type: System Command

Syntax: **BREAK_DELETE "program name" line_number**

Description: Used by *Motion* Perfect to remove a break point from the specified program at the specified line number.

Example: **BREAK_DELETE "simpletest" 8**
Will remove the break point at line 8 of program "simpletest"

Note: If a non existent line number is selected (i.e. line 50 when the program only has 40 lines), the controller will return an error.

BREAK_LIST

Type: System Command

Syntax: **BREAK_LIST "program name"**

Description: Returns a list of all the break points in the given program name. Displays the line number of the breakpoint and the code associated with that line.

Example: For a program called "simpletest" with break points inserted on lines 8 and 11;

```
>>BREAK_LIST "simpletest"

Program: SIMPLETEST
Line 8: SERVO=ON
Line 11: BASE(0)
```

BREAK_RESET

Type: System Command

Syntax: **BREAK_RESET "program name"**

Description: Used by *Motion* Perfect to remove all break points from the specified program.

Example: **BREAK_RESET "simpletest"**
Will remove all break points from program "simpletest"

CAN

Type: System Function

Syntax: **CAN(channel,function#,{parameters},[rw])**

Description: This function allows the CAN communication channels to be controlled from the Trio BASIC programming system. All *Motion Coordinator*'s have a single built-in CAN channel which is normally used for digital and analogue I/O using Trio's I/O modules. With up to 4 CAN daughter boards plus the built-in CAN channel the units can control a maximum of 5 CAN channels:

Channel:	Channel Number:	Maximum Baudrate:
Built-in CAN	-1	500 KHz
Daughter Slot 0	0	1 Mhz
Daughter Slot 1	1	1 Mhz
Daughter Slot 2	2	1 Mhz
Daughter Slot 3	3	1 Mhz

In addition to using the **CAN** command to control CAN channels, Trio is introducing

specific protocol functions into the system software. These functions are dedicated software modules which interface to particular devices. The built-in CAN channel will automatically scan for Trio I/O modules if the system parameter **CANIO_ADDRESS** is set to its default value of 32.

The *Motion Coordinator* CAN hardware uses the Siemens 81C91 CAN interface chip or the OKI ML9620 interface chip. This chip can be programmed at a register level using the **CAN** command if necessary. To program in this way it is necessary to obtain a copy of the chip data sheet.

The **CAN** command provides access to 10 separate functions:

CAN(channel#,function#,...,[rw])

Channel#
The channel number is in the range -1 to 3 and specifies the hardware channel

Function #:
There are 10 CAN functions 0..9:

0	Read Register:	**val=CAN(channel#,0,register#)**
1	Write Register:	**CAN(channel#,1,register#,value#)**
2	Initialise Baudrate:	**CAN(channel#,2,baudrate)**
3	Check if msg received	**val=CAN(channel#,3,message#)**
4	Set transmit request	**CAN(channel#,4,message#)**
5	Initialise message	**CAN(channel#,5,message#,identifier, length,[rw])**
6	Read message	**CAN(channel#,6,message#,variable#)**
7	Write message	**CAN(channel#,7,message#,byte0,byte1..)**
8	Read CanOpen Object	**CAN(channel#,8,transbuf,recbuf,object, subindex,variable#)**
9	Write CanOpen Object	**CAN(channel#,9,transbuf,recbuf,format, object,subindex,value,{valuems})**

Notes: **register#** is the register number.

Baudrate: 0=1Mhz, 1=500kHz, 2=250kHz etc.

The 81C91 has 16 message buffers(0..15). The **message#** is which message buffer is required to be used.

"**Identifier**" is the CAN identifier.

variable# is the number of the global variable to start loading the data into. The function will load a sequence of n+1 variables. The first variable holds the identifier. The subsequent values hold the data bytes from the can packet.

Functions 8 and 9 are only available in system software V1.62 and later.

Products based on the OKI ML9620 chip require the optional rw parameter in the **CAN(5 ..)** command. rw is 0 to set up a read buffer, and 1 for a write buffer.

CANIO_ADDRESS

Type: System Parameter (Stored in FLASH Eprom)

Description: The **CANIO_ADDRESS** holds the address used to identify the *Motion Coordinator* when using the Trio CAN I/O networking. The value is held in flash eprom in the controller and for most systems does not need to be set from the default value of 32. The value may be changed to a different value in the range 33..47 but in this case the *Motion Coordinator* will not connect to Trio CAN-I/O modules following reset. The value of **CANIO_ADDRESS** should be changed from 32 if it is required to use the built-in CAN channel for functions other than controlling Trio CAN I/O modules.

Value	**Function**
32	**Trio CAN I/O Master 64in/64out**
40	**CanOpen I/O Master 64in/64out**
41	**CanOpen I/O Master 128in/128out**

An additional function of **CANIO_ADDRESS** is to set the initial bit rate for the CANbus port on power up. This enables the CANbus port to come online at the correct rate when installed in factory networks like DeviceNet. Bits 8 and 9 have the following meaning:

Bit 9 , 8 value	Decimal value	Initialisation Baudrate:
0 , 0	0	500 KHz
0 , 1	256	256 KHZ
1 , 0	512	125 KHz
1 , 1	768	1 MHz

CANIO_ENABLE

Type: System Parameter

Description: The **CANIO_ENABLE** should be set OFF to completely disable use of the built-in CAN interface by the system software. This allows users to program their own protocols in Trio BASIC using the **CAN** command. The system software will set **CANIO_ENABLE** to **ON** on power up if the **CANIO_ADDRESS** is set to 32 and any Trio CAN I/O or CAN analog modules have been detected, otherwise it will be set to **OFF**.

CANIO_STATUS

Type: System Parameter

Description: A bitwise system parameter:

Bit 0 set indicates an error from the I/O module 0,3,6 or 9

Bit 1 set indicates an error from the I/O module 1,4,7 or 10

Bit 2 set indicates an error from the I/O module 2,5,8 or 11

Bit 3 set indicates an error from the I/O module 12,13,14 or 15

Bit 4 should be set to re-initialise the CANIO network

Bit 5 is set when initialisation is complete

CANOPEN_OP_RATE

Type: System Parameter

Description: Used to adjust the transmission rate of CanOpen I/O PDO telegrams. Default is 5msec. Adjustable in 1msec steps.

CHECKSUM

Type: System Parameter (Read Only)

Description: The **checksum** parameter holds the checksum for the programs in battery backed RAM. On power up the checksum is recalculated and compared with the previously held value. If the checksum is incorrect the programs will not run.

CLEAR

Type: System Command

Description Sets all global (numbered) variables to 0 and sets local variables on the process on which command is run to 0.

Note: Trio BASIC does not clear the global variables automatically following a **RUN** command. This allows the global variables, which are all battery-backed to be used to hold information between program runs. Named local variables are always cleared prior to program running. If used in a program **CLEAR** sets local variables in this program only to zero as well as setting the global variables to zero.

CLEAR does not alter the program in memory.

Example:
```
VR(0)=44:VR(10)=12.3456:VR(100)=2
PRINT VR(0),VR(10),VR(100)
CLEAR
PRINT VR(0),VR(10),VR(100)
```

On execution this would give an output such as:

```
44.0000 12.345 62.0000
0.0000 0.0000 0.0000
```

CLEAR_PARAMS

Type: System Command

Description Clears all variables and parameters stored in flash eprom to their default values. On the MC302X **CLEAR_PARAMS** will erase all the VR's stored using **FLASHVR**. **CLEAR_PARAMS** cannot be performed if the controller is locked.

COMMSERROR

Type: System Parameter

Description: This parameter returns all the communications errors that have occurred since the last time that it was initialised. It is a bitwise value defined as follows:

Bit	Value
0	RX Buffer overrun on Network channel
1	Re-transmit buffer overrun on Network channel
2	RX structure error on Network channel
3	TX structure error on Network channel
4	Port 0 Rx data ready
5	Port 0 Rx Overrun
6	Port 0 Parity Error
7	Port 0 Rx Frame Error
8	Port 1 Rx data ready
9	Port 1 Rx Overrun
10	Port 1 Parity Error
11	Port 1 Rx Frame Error
12	Port 2 Rx data ready
13	Port 2 Rx Overrun
14	Port 2 Parity Error
15	Port 2 Rx Frame Error
16	Error FO Network port
17	Error FO Network port
18	Error FO Network port
19	Error FO Network port

COMMSTYPE

Type: Slot Parameter

Syntax: **`COMMSTYPE SLOT(slot#)`**

Description: This parameter returns the type of communications daughter board in a controller slot. On the MC206X, a communications daughter board will respond with its type if the **`COMMSTYPE`** is requested from slot(0).

#	Description
20	CAN Communications card
21	USB Communications card
22	SLM Communications card
23	Profibus Communications card
24	SERCOS Communications card
25	Ethernet Communications card
26	P184 4 Analog Out card for PCI208
27	P185 8 Analog Out card for PCI208
28	Analog Input card
29	Enhanced CAN Communications card
30	ETHERNET IP

COMPILE

Type: System Command

Description: Forces compilation (to intermediate code) of the currently selected program. Program compilation is performed automatically by the system software prior to program **RUN** or when another program is **SELECT**ed. This command is not therefore normally required.

CONTROL

Type: System Parameter (Read Only)

Description: The Control parameter returns the type of *Motion Coordinator* in the system:

Controller	CONTROL
MC302X	293
Euro205x	255

Controller	CONTROL
Euro209	259
MC206X	207
PCI208	208
MC224	224

Note: When the Motion Coordinator is LOCKED, 1000 is added to the above numbers. eg a locked MC206X will return 1207.

COPY

Type: System Command

Description: Makes a copy of an existing program in memory under a new name

Example: **>>COPY "prog" "newprog"**

Note: *Motion* Perfect users should use the “Copy program...” function under the “Program” menu.

DATE

Type: System Parameter (MC224 Only)

Description: Returns/Sets the current date held by the MC224's real time clock. The number may be entered in DD:MM:YY or DD:MM:YYYY format.

Example 1: **>>DATE=20:10:98**
or
>>DATE=20:10:2001

Example2: **>>PRINT DATE**
36956

This prints the number representing the current day. This number is the number of days since 1st January 1900, with 1 Jan. 1900 as 1. Trio has issued a year 2000 compliance statement which describes the year 2000 issue in relation to all Trio products.

DATE$

Type: Command (MC224 Only)

Description: Prints the current date DD/MM/YY as a string to the port. A 2 digit year description is given.

Example: **PRINT #3,DATE$**

This will print the date in format for example: 20/10/01

DAY

Type: System Parameter (MC224 only)

Description: Returns the current day as a number 0..6, Sunday is 0. The **DAY** can be set by assignment.

Example:
```
>>DAY=3
>>? DAY
3.0000
>>
```

DAY$

Type: System Command (MC224 only)

Description: Prints the current day as a string.

Example:
```
>>? DAY$
Wednesday
>>
```

DEL

Type: System Command

Alternate Format: **RM**

Syntax: **DEL progname**

Description: Allows the user to delete a program from memory. The command may be used without a program name to delete a currently selected program.

Motion Perfect users should use "Delete program..." on Program menu.

Example: **>>DEL "oldprog"**

DEVICENET

Type: System Command

Syntax: **DEVICENET(slot,func,baud,mac id,poll base,poll inlen,poll outlen)**

Description: The command **DEVICENET** is used to start and stop the DeviceNet slave function which is built into the *Motion Coordinator*.

Parameters:

slot:	Specifies the communications slot where the CAN daughter board is placed. Set -1 for built-in CAN port and 0 for a CAN daughter board in the MC206X.
func:	0 = Start the DeviceNet slave protocol on the given slot. 1 = Stop the DeviceNet protocol. 2 = Put startup baudrate into Flash EPROM
baud:	Set to 125, 250 or 500 to specify the baudrate in kHz.
mac id:	The ID which the *Motion Coordinator* will use to identify itself on the DeviceNet network. Range 0..63.
poll base:	The first TABLE location to be transfered as poll data
poll in len:	Number of words to be received during poll. Range 0..4
poll out len:	Number of words to be sent during poll. Range 0..4

Polled IO data is transferred periodically:
From PLC to [TABLE(poll_base) -> TABLE(poll_base + poll_in_len)]
To PLC from [TABLE(poll_base + poll_in_len + 1) -> TABLE(poll_base + poll_in_len + poll_out_len)]

Example 1:

```
' Start the DeviceNet protocol on the built-in CAN port;
DEVICENET(-1,0,500,30,0,4,2)
```

Example 2:

```
' Stop the DeviceNet protocol on the CAN board in slot 2;
DEVICENET(2,1)
```

Example 3:

```
' Set the CAN board in slot 0 to have a baudrate of 125k bps on
power-up;
DEVICENET(0,2,125)
```

DIR

Type: System Command

Alternate Format: **LS**

Description: Prints a list of all programs in memory, their size and their **RUNTYPE**. Alternative formats:
DIR F may be used to list the programs stored in the FlashStick if present.
DIR D lists the programs stored in SD card if present.

Note: This command should only be used on the *Motion Coordinator* Command Line

DISPLAY

Type: System Parameter

Description: Determines the I/O channels to be displayed on the front panel LEDS.

Certain controllers, such as the Euro205x and MC206X do not have LEDs for every I/O channel. The **DISPLAY** parameter may be used to select which bank of I/O should be displayed.

The parameter default value is 0.

Parameters:

0	Inputs 0-7
1	Inputs 8-15
2	Inputs 16-23
3	Inputs 24-31
4	Outputs 0-7 (unused on existing controllers)
5	Outputs 8-15
6	Outputs 16-23
7	Outputs 24-31
8	DeviceNet Status

Example:

```
DISPLAY=5
' Show outputs 8-15
```

DLINK

Type: System Command

Syntax: **DLINK(function,…)**

Description: This is a specialised command, to allow access to the SLM™ digital drive interface. During the power sequence, when a SLM™ interface card is found, all the ASICs are initialised, starting the communications protocol.

The axis parameters have to be initialised by the **DLINK** function 2 command before the interface can be used for controlling an external drive.

Parameters:

Function: Specifies the required function.
0 = Read a register on the SLM™ ASIC
1 = Write a register on the SLM™ ASIC
2 = Check for presence SLM module
3 = Check for presence of SLM servo drive
4 = Assign a *Motion Coordinator* axis to a SLM channel
5 = Read an SLM parameter
6 = Write an SLM parameter
7 = Write an SLM command
8 = Read a drive parameter
9 = Returns slot and asic number associated with an axis
10 = Read an EEPROM parameter

Read a register on the SLM™ ASIC.

Parameters:

Function 0

Slot The communications slot in which the interface daughter board is inserted.

ASIC The number of the ASIC to be used. Each SLM™ daughter board has 3 ASICs. The master ASIC is 0, the first slave is 1 and the second slave is 2.

Register The number of the register to be read.

Example:

```
>>PRINT DLINK(0,0,0,3)
117.0000
>>
```

Write a register on the SLM™ ASIC.

Parameters:

Function 1

Slot The communications slot in which the interface daughter board is inserted.

	ASIC	The number of the ASIC to be used.
	Register	The number of the register to be written to.
	Value	The value to be written.

Example:
```
>>DLINK(1,0,0,1,244)
>>
```

Check for presence SLM module on rear of motor. Returns 1 if the SLM is answering, otherwise it returns 0.

Parameters:	**Function**	2
	Slot	The communications slot in which the interface daughter board is inserted.
	ASIC	The number of the ASIC to be used.

```
>>? DLINK(2,0,0)
1.0000
>>
```

Check for presence of SLM servo drive, such as MultiAx. Returns 1 if the drive is answering, otherwise it returns 0. **The current SLM software dictates that the drive MUST be powered up after power is applied to the *Motion Coordinator* / SLM.**

Parameters:	**Function**	3
	Slot	The communications slot in which the interface daughter board is inserted.
	ASIC	The number of the ASIC to be used.

Example:
```
>>? DLINK(3,0,0)
0.0000
>>
```

Assign a *Motion Coordinator* axis to a SLM channel.

Parameters:	**Function**	4
	Slot	The communications slot in which the interface daughter board is inserted.
	ASIC	The number of the ASIC to be used.
	Axis	The axis to be associated with this drive. If this axis is already assigned then it will fail. The **ATYPE** of this axis will be set to 11.

Example: **>>DLINK(4,0,0,0)**

Read an SLM parameter

Parameters:

Function	5
Axis	The axis to be associated with this drive. If this axis is out of range, or is not of the correct type (see function 2) then the function will fail.
Parameter	The number of the SLM parameter to be read. This is normally in the range 0...127. See the drive documentation for further information.

Example:
```
>>PRINT DLINK(5,0,1)
463.0000
>>
```

Write an SLM parameter

Parameters:

Function	6
Axis	The axis to be associated with this drive.
Parameter	The number of the SLM parameter to be read. See Function 4
Value	The value to be set.

Example:
```
>>DLINK(6,0,0,0)
>>
```

Write an SLM command. If command is successful this function returns a TRUE, otherwise it returns FALSE

Parameters:

Function	7
Axis	The axis to be associated with this drive.
Command	The command number. (see drive documentation)

Example:
```
>>PRINT DLINK(7,0,250)
1.0000
>>
```
Read a drive parameter

Parameters:		
	Function	8
	Axis	The axis to be associated with this drive.
	Parameter	The number of the drive parameter to be read. This must be in the range 0…127. See the servo drive documentation for further information.

Example:

```
>>PRINT DLINK(8,0,53248)
20504.0000
>>
```

Return slot and asic number associated with an axis

Parameters:		
	Function	9
	Axis	Axis number.
	Returns	10 x slot number + ASIC number.

Example:

```
>>PRINT DLINK(9,2)
>>11.0000
```

This example is for slot 1, asic 1

Read an EEPROM parameter

Parameters:		
	Function	10
	Axis	The axis to be associated with this drive/SLM.
	Parameter	EEPROM parameter number. (see drive documentation)

Example:

```
>>PRINT DLINK(10,0,29)
>>62128.0000
```

Returns EEPROM parameter 29, the Flux Angle

EDIT

Type: System Command

Syntax: **`EDIT [optional line sequence number]`**

Description: The edit command starts the built in screen editor allowing a program in the controller memory to be modified using a VT100 terminal. The **`SELECT`**ed program is edited.

The line sequence number may be used to specify where to start editing.

`Quit Editor`	-Control K then D
`Delete line`	-Control Y
`Cursor Control`	-Cursor Keys

EDPROG

Type: System Command

Alternate Format: **`&`**

Description: This is a special command that may be used to manipulate the programs on the controller. It is not normally used except by *Motion* Perfect.

It has several forms:

&C	Print the name of the currently selected program
&<line>D	Delete line <line> from the currently selected program
&<line>I,<string>	Insert the text <string> in the currently selected program at the line <line>. Note - you should NOT enclose the string in quotes unless they need to be inserted into the program.
&K	Print the checksum of the system software
&<start>,<end>L	Print the lines of the currently selected program between <start> and <end>
&N	Print the number of lines in the currently selected program

&<line>R,<string>	Replace the line <line> in the currently selected program with the text <string>.
	Note - you should NOT enclose the string in quotes unless they need to be inserted into the program.
&Z,<progname>	Print the CRC checksum of the specified program.
	This uses the standard CCITT 16 bit generator polynomial

EPROM

Type: System Command

Description: Stores the Trio BASIC programs in the controller in the FLASH EPROM. This information is be retrieved on power up if the **POWER_UP** parameter has been set to 1. The **EPROM(n)** functions are only usable on *Motion Coordinator*s with a FlashStick socket...

EPROM or **EPROM(0)**	Stores application programs in ram into on board flash.
EPROM(1)	Stores application programs in ram into FlashStick.
EPROM(2)	Stores application programs in ram into the FlashStick and marks the EPROM request flag so that the programs are copied from the FlashStick into on board flash when the stick is inserted into a controller which is unlocked.
EPROM(3)	Deletes all programs in the FlashStick, leaves data sectors intact.

Note: This command should only be used on the command line. *Motion* Perfect performs the **EPROM** command automatically when the *Motion Coordinator* is set to “Fixed”

See Also: **STICK_WRITE, STICK_READ, DIR**

When using the Memory Stick, users should refer to the information in the MC206X Hardware Overview for a complete description of the Memory Stick functionality.

ERROR_AXIS

Type: System Parameter (Read Only)

Description: Returns the number of the axis which caused the enable **WDOG** relay to open when a following error exceeded its limit.

Example: **>>? ERROR_AXIS**

ETHERNET

Type: System Command

Syntax: **ETHERNET(read/write, slot number, function [,data])**

Description: The command **ETHERNET** is used to read and set certain functions of the Ethernet daughter board. The **ETHERNET** command should be entered on the command line with *Motion* Perfect in “disconnnected” mode via the serial port 0.

Parameters:

read / write: Specifies the required action.
0 = Read
1 = Write to Flash EPROM
2 = Write to RAM

slot number: The daughter board slot where the Ethernet port has been installed. On the MC206X this is always slot 0.

function: Function number must be one of the following values.

0 = IP Address
1 = Static(1) or dynamic(0) addressing. (Only static addressing is supported.)
2 = Subnet Mask
3 = MAC address
4 = Default Port Number (initialised to 23)
5 = Token Port Number (initialised to 3240)
6 = Ethernet daughter board firmware version (read only)
7 = Modbus TCP mode. Integer (0) or Floating point (1). (R)
8 = Default Gateway
9 = Data configuration. VR() variables (0) or TABLE (1). (R)
10 = Modbus TCP port number. (initialised to 502)

data: The optional data is used when changing a parameter value.

When writing to the EPROM on the Ethernet daughter board, the new value will only be used after power has been cycled to the controller. Any data written to RAM (R) is used straight away.

Example 1: Set the IP address, subnet mask and default gateway for the Ethernet daughter board in slot 0.

```
ETHERNET(1,0,0,192,200,185,2)
ETHERNET(1,0,2,255,255,255,0)
ETHERNET(1,0,8,192,200,185,210)
```

Example 2: Read the firmware version number in the Ethernet daughter board in slot 2.

```
ETHERNET(0,2,6)
```

Example 3: Set the Modbus TCP port number in the Ethernet daughter board in slot 1.

```
ETHERNET(1,1,10,1024)
```

Example 4: Initialise the Modbus TCP port for floating point TABLE data. Must be entered before the Modbus master opens the port connection.

```
ETHERNET(2,1,7,1)
ETHERNET(2,1,9,1)
```

Note: Examples 1 to 3 must be entered from the terminal. Example 4 is placed in a startup program as the values are stored in ram.

ETHERNET_IP

Type: Reserved keyword

EX

Type: System Command

Description: Software reset. Resets the controller as if it were being powered up again.

On **EX** the following actions occur:

- The global numbered (**VR**) variables remain in memory.
- The base axis array is reset to 0,1,2... on all processes
- Axis following errors are cleared
- Watchdog is set OFF
- Programs may be run depending on **POWER_UP** and **RUNTYPE** settings
- ALL axis parameters are reset.

EX may be included in a program. This can be useful following a run time error. Care must be taken to ensure it is safe to restart the program.

Note: When running *Motion* Perfect executing an **EX** command is not allowed. The same effect as an **EX** can be obtained by using “Reset the controller...” under the “Controller” menu in *Motion* Perfect. To simply re-start the programs, use the **AUTORUN** command.

EXECUTE

Type: System Command

Description: Used to implement the remote command execution via the Trio PC activex. For more details see the section on using the OCX control.

FB_SET

Type: System Parameter

Description: This special parameter is available on certain *Motion Coordinators* only. Fieldbus Set controls the source for the second value returned by a DeviceNet I/O poll response. The values can be set as follows:

0 I/O Poll returns VR(0) as 16 bit Integer

1 I/O Poll returns inputs 0-15

2 I/O Poll returns inputs 16-31

FB_STATUS

Type: System Parameter

Description: This Read-only parameter returns the current status of the fieldbus connection. At present, only the DeviceNet connection status is supported.

FB_STATUS returns the following values:

0 I/O Polling is OFF

1 I/O Polling is ON

Example:

```
' Test the Polled I/O status to see if PLC is still online
IF FB_STATUS=0 THEN
  ' PLC link has failed; set global flag and stop motion
  RAPIDSTOP
  VR(50) = 0
ENDIF
```

FEATURE_ENABLE

Type: System Function

Syntax: **FEATURE_ENABLE(feature number)**

Description: Many *Motion Coordinator*s, have the ability to unlock additional axes by entering a "Feature Enable Code". This function is used to enable protected features, such as additional servo axes or remote CAN/SERCOS/Analogue feedback axes, of a controller. It is recommended to use *Motion* Perfect 2 to enter and store the feature enable codes.

Controllers with features which can be enabled in this way are fitted with a unique security code number when manufactured. This security code number can be found by typing **FEATURE_ENABLE** with no parameters:

Example 1:

```
>>feature_enable
Security code=17980000000028
Enabled features: 0 1
```

If you require additional features for a controller. These can be enabled by the entry of a password which is unique for each feature and controller security code. To obtain a feature enable code, the feature must be ordered via the Trio website or from a Trio distributor.

Example 2: In example one axes 0 and 1 are enabled for stepper operation. If axis 2 was required to operate as a stepper axis it would be necessary to obtain the password. For this card and this feature only the password is 5P0APT.

```
>>feature_enable(2)
Feature 2 Password=5P0APT
>>
>>feature_enable
Security code=17980000000028
Enabled features: 0 1 2
```

Note: When entering the passwords always enter the characters in upper case. Take care to check that 0 (zero) is not confused with O and 1 (one) is not confused with I.

FLASHVR

Type: System Function

Syntax: **FLASHVR(function, [flashpage, tablepage])**

Description: Copies user data in RAM to the permanent flash memory.

Parameters:

function: Specifies the required action.
0 to 1023: Store single VR in Flash EPROM
-1: Store one page of TABLE to the Flash EPROM and use it to replace the RAM table data on power-up.
-2: Stop using the EPROM copy of table during power-up.
-3: Write a page of TABLE data into flash EPROM.
-4: Read a page of flash memory into TABLE data.

flashpage: The index number (0 … 15) of a 16k page of Flach EPROM where the table data is to be stored to or retrieved from.

tablepage: The index number (0 … INT(TSIZE/16384)) of the page in table memory where the data is to be copied from or restored to.

Note: Where this feature is provided on controllers which do not have battery backed ram **VR()** storage, each **FLASHVR** command generates a write to flash eprom. After 8000 writes the flash sector will be erased and the firmware writes the data into a second sector. Each sector can be erased over 1,000,000 times. It is therefore possible to use the **FLASHVR([0 ... 1023])** command many hundreds of millions of times. It does however have a finite life and cannot easily be replaced. Programmers MUST allow for this fact.

The **FLASHVR(-1)** and **FLASHVR(-2)** functions can be used with all *Motion Coordinator*'s that have system software 1.52 or later. These functions write a whole block of data to flash memory and the programmer must ensure that they are only used occasionally.

FLASHVR(-3) and **FLASHVR(-4)** is only available with system software 1.6411 or later. Each "page" of table data transferred with this command is 16,384 floating point numbers.

Example 1:

```
VR(25)=k
FLASHVR(25) ' store one VR variable in the MC302X
```

Example 2:

```
FOR v=1 to 10
  FLASHVR(v) ' store a sequence of VR variables
NEXT v
```

Example 3:

```
FLASHVR(-1)' Store TABLE memory to flash EPROM
```

Example 4:

```
FLASHVR(-3,2,5)' Store TABLE page 2 to flash EPROM page 5
```

FRAME

Type: System Parameter

Description: Used to specify which "frame" to operate within when employing frame transformations. Frame transformations are used to allow movements to be specified in a multi-axis coordinate frame of reference which do not correspond one-to-one with the axes. An example is a SCARA robot arm with jointed axes. For the end tip of the robot arm to perform straight line movements in X-Y the motors need to move in a pattern determined by the robot's geometry.

A number of pre-defined **FRAME**s are available. Please contact your Trio distributor for details.

A machine system can be specified with several different "frames". The currently active **FRAME** is specified with the **FRAME** system parameter.

The default **FRAME** is 0 which corresponds to a one-to-one transformation.

Example:
```
FRAME=1
```

FREE

Type: System Parameter (Read Only)

Description: Returns the amount of program memory available for user programs.

Note: Each line takes a minimum of 4 characters (bytes) in memory. This is for the length of this line, the length of the previous line, number of spaces at the beginning of the line and a single command token. Additional commands need one byte per token, most other data is held as ASCII.

The *Motion Coordinator* compiles programs before they are run, this means that a little under twice the memory is required to be able to run a program.

Example 1:
```
>>PRINT FREE
47104.0000
>>
```

See Also: **DIR, TABLE**

HALT

Type: System Command.

Description: Halts execution of all running programs. The **STOP** command will stop a specific program.

Example:
```
HALT '  Stop ALL programs
```
or
```
STOP "main"
' Stop only the program called 'MAIN'
```

Note: **HALT** does not stop any motion. Currently executing, or buffered moves will continue unless they are terminated with a **CANCEL** or **RAPIDSTOP** command.

HLM_COMMAND

Type: Hostlink Command

Syntax: **HLM_COMMAND(command, port[, node[, mc_area/mode[, mc_offset]]])**

Description: The **HLM_COMMAND** command performs a specific Host Link command operation to one or to all Host Link Slaves on the selected port. Program execution will be paused until the response string has been received or the timeout time has elapsed. The timeout time is specified by using the **HLM_TIMEOUT** parameter. The status of the transfer can be monitored with the **HLM_STATUS** parameter.

Parameters: command

The selection of the Host Link operation to perform:

HLM_MREAD (or value 0)	This performs the Host Link PC MODEL READ (MM) command to read the CPU Unit model code. The result is written to the MC Unit variable specified by mc_area and mc_offset.
HLM_TEST (or value 1)	This performs the Host Link TEST (TS) command to check correct communication by sending string "MCxxx TEST STRING" and checking the echoed string. Check the **HLM_STATUS** parameter for the result.
HLM_ABORT (or value 2)	This performs the Host Link **ABORT (XZ)** command to abort the Host Link command that is currently being processed. The **ABORT** command does not receive a response.

HLM_INIT (or value 3)	This performs the Host Link **INITIALIZE** (**) command to initialize the transmission control procedure of all Slave Units.
HLM_STWR (or value 4)	This performs the Host Link **STATUS WRITE (SC)** command to change the operating mode of the CPU Unit.

port The specified serial port. (See specific controller specification for numbers)

node (for **HLM_MREAD, HLM_TEST, HLM_ABORT and HLM_STWR**):

The Slave node number to send the Host Link command to.
Range: [0, 31].

mode (for **HLM_STWR**)

The specified CPU Unit operating mode.

0 PROGRAM mode
2 MONITOR mode
3 RUN mode

mc_area (for **HLM_MREAD**)

The MC Unit's memory selection to write the received data to.

mc_offset (for **HLM_MREAD**)

The address of the specified MC Unit memory area to read from.

mc_area	Data area
MC_TABLE (or value 8)	Table variable array
MC_VR (or value 9)	Global (VR) variable array

Note 1: When using **HLM_COMMAND**, be sure to set-up the Host Link Master protocol by using the **SETCOM** command.

Note 2: The Host Link Master commands are required to be executed from one program task only to avoid any multi-task timing problems.

Example 1: The following command will read the CPU Unit model code of the Host Link Slave with node address 12 connected to the RS-232C port. The result is written to VR(233).

```
HLM_COMMAND(HLM_MREAD,1,12,MC_VR,233)
```

If the connected Slave is a C200HX PC, then VR(233) will contain value 12 (hex) after successfull execution.

Example 2: The following command will check the Host Link communication with the Host Link Slave (node 23) connected to the RS-422A port.

```
HLM_COMMAND(HLM_TEST,2,23)
PRINT HLM_STATUS PORT(2)
```

If the **HLM_STATUS** parameter contains value zero, the communication is functional.

Example 3: The following two commands will perform the Host Link **INITIALIZE** and **ABORT** operations on the RS-422A port 2. The Slave has node number 4.

```
HLM_COMMAND(HLM_INIT,2)
HLM_COMMAND(HLM_ABORT,2,4)
```

Example 4: When data has to be written to a PC using Host Link, the CPU Unit can not be in **RUN** mode. The **HLM_COMMAND** command can be used to set it to **MONITOR** mode. The Slave has node address 0 and is connected to the RS-232C port.

```
HLM_COMMAND(HLM_STWR,2,0,2)
```

HLM_READ

Type: Hostlink Command

Syntax: **HLM_READ(port,node,pc_area,pc_offset,length,mc_area,mc_offset)**

Description: The **HLM_READ** command reads data from a Host Link Slave by sending a Host Link command string containing the specified node of the Slave to the serial port. The received response data will be written to either VR or Table variables. Each word of data will be transferred to one variable. The maximum data length is 30 words (single frame transfer). Program execution will be paused until the response string has been received or the timeout time has elapsed. The timeout time is specified by using the **HLM_TIMEOUT** parameter. The status of the transfer can be monitored with the **HLM_STATUS** parameter.

Parameters:

port	The specified serial port. (See specific controller specification for numbers)
node	The Slave node number to send the Host Link command to. Range: [0, 31].
pc_area	The PC memory selection for the Host Link command.

pc_area	Data area	Hostlink command
PLC_DM (or value 0)	DM	RD
PLC_IR (or value 1)	CIO/IR	RR
PLC_LR (or value 2)	LR	RL
PLC_HR (or value 3)	HR	RH
PLC_AR (or value 4)	AR	RJ
PLC_EM (or value 6)	EM	RE

pc_offset The address of the specified PC memory area to read from. Range: [0, 9999].

length The number of words of data to be transfered. Range: [1, 30].

mc_area The MC Unit's memory selection to write the received data to.

mc_offset The address of the specified MC Unit memory area to write to.

mc_area	Data area
MC_TABLE (or value 8)	**Table variable array**
MC_VR (or value 9)	**Global (VR) variable array**

Note 1: When using the **HLM_READ**, be sure to set-up the Host Link Master protocol by using the **SETCOM** command.

Note 2: The Host Link Master commands are required to be executed from one program task only to avoid any multi-task timing problems.

HLM_STATUS

Type: System Command.

Description: Returns the status of the Host Link serial communications.

HLM_TIMEOUT

Type: Host Link Command.

Description: Sets the timeout value for Hostlink communications.

Example: **HLM-TIMEOUT = 600**

Note: Default value is 500msec.

HLM_WRITE

Type: Hostlink Command

Syntax: **HLM_WRITE(port,node,pc_area,pc_offset,length,mc_area,mc_offset)**

Description: The **HLM_WRITE** command writes data from the MC Unit to a Host Link Slave by sending a Host Link command string containing the specified node of the Slave to the serial port. The received response data will be written from either VR or Table variables. Each variable will define on word of data which will be transferred. The maximum data length is 29 words (single frame transfer). Program execution will be paused until the response string has been received or the timeout time has elapsed. The timeout time is specified by using the **HLM_TIMEOUT** parameter. The status of the transfer can be monitored with the **HLM_STATUS** parameter.

Parameters:

port The specified serial port. (See specific controller specification for numbers)

node The Slave node number to send the Host Link command to. Range: [0, 31].

pc_area The PC memory selection for the Host Link command.

pc_area	Data area	Hostlink command
PLC_DM (or value 0)	**DM**	**RD**
PLC_IR (or value 1)	**CIO/IR**	**RR**
PLC_LR (or value 2)	**LR**	**RL**
PLC_HR (or value 3)	**HR**	**RH**

pc_area	Data area	Hostlink command
PLC_AR (or value 4)	**AR**	**RJ**
PLC_EM (or value 6)	**EM**	**RE**

pc_offset The address of the specified PC memory area to write to. Range: [0, 9999].

length The number of words of data to be transfered. Range: [1, 30].

mc_area The MC Unit's memory selection to read the data from.

mc_offset The address of the specified MC Unit memory area to read from.

mc_area	Data area
MC_TABLE (or value 8)	**Table variable array**
MC_VR (or value 9)	**Global (VR) variable array**

Note 1: When using the **HLM_WRITE**, be sure to set-up the Host Link Master protocol by using the **SETCOM** command.

Note 2: The Host Link Master commands are required to be executed from one program task only to avoid any multi-task timing problems.

Example: The following example shows how to write 25 words from MC Unit's VR addresses 200-224 to the PC EM area addresses 50-74. The PC has Slave node address 28 and is connected to the RS-232C port.

```
HLM_WRITE(1, 28, PLC_EM, 50, 25, MC_VR, 200)
```

HLS_MODEL

Type: Reserved Keyword.

HLS_NODE

Type: Reserved Keyword.

INCLUDE

Type: System Command.

Syntax: **INCLUDE "filename"**
(filename - The program to be included).

Description: The **INCLUDE** command resolvies all local variable definitions in the included file at compile time and allows all the local variables to be declared "globally". Whenever an included program is modified, all program that depend on it are re-compiled as well, avoiding inconsistencies.

Example: PROGRAM "T1":

```
      'include global definitions
INCLUDE "GLOBAL_DEFS"
     ' Motion commands using defined vars
FORWARD AXIS(drive_axis)
CONNECT(1, drive_axis) AXIS(link_axis)
```

PROGRAM "GLOBAL_DEFS":

```
drive_axis=4
link_axis=1
```

Note: (1) Nested INCLUDEs are not allowed.
(2) The **INCLUDE** command must be the first BASIC statement in the program.
(3) Only variable definitions are allowed in the include file. It cannot be used as a general subroutine with any other BASIC commands in it.
(4) Not available on the MC302 range.

INITIALISE

Type: System Command.

Description: Sets all axis, system and process parameters to their default values. The parameters are also reset each time the controller is powered up, or when an **EX** (software reset) command is performed. When using *Motion* Perfect a "Reset the controller.." under the "Controller" menu performs the equivalent of an **EX** command

LAST_AXIS

Type: System Parameter (Read Only)

Description: In order to maximise the processor time available to BASIC, the *Motion Coordinator* keeps a record of the highest axis number that is in use. This axis number is held in the system parameter **LAST_AXIS.** Axes higher than **LAST_AXIS** are not processed.

LAST_AXIS is set automatically by the system software when an axis command is used.

LIST

Type: System Command

Alternate Format: **TYPE**

Description: Prints the current **SELECT**ed program or a specified program to channel 0.

Note: **LIST** is used as an immediate (command line) command only and should not be used in programs. Use of **LIST** in *Motion* Perfect is not recommended.

LIST_GLOBAL

Type: System Command (Terminal only)

Syntax: **LIST_GLOBAL**

Description: When executed from the command line, (terminal channel 0) all the currently set **GLOBAL** and **CONSTANT** parameters will be printed to the terminal.

Example: In an application where the following **GLOBAL** and **CONSTANT** have been set;

```
CONSTANT "cutter", 23
GLOBAL "conveyor",5
>>LIST_GLOBAL
Global           VR
---------------- ----
conveyor 5
Constant         Value
---------------- -------
cutter 23.0000
>>
```

LOAD_PROJECT

Type: System Command

Description: Used by *Motion* Perfect to load projects to the controller.

LOADSYSTEM

Type: System Command

Description: Loads new version of system software:

On the *Motion Coordinator* family of controllers the system software is stored in FLASH EPROM. It is copied into RAM when the system is powered up so it can execute faster. The system software can be re-loaded through the serial port 0 into RAM using *Motion* Perfect. The command **STORE** is then used to transfer the updated copy of the system software into the FLASH EPROM for use on the next power up.

To re-load the system software you will need the system software on disk supplied by TRIO in COFF format. (Files have a.OUT suffix, for example I167.OUT)

The download sequence:

Run *Motion* Perfect in the usual way. Under the “Controller” menu select “Load system software...”. Select the version of system software to be loaded and follow the on screen instructions. The system file takes around 12 minutes to download. When the download is complete the system performs a checksum prior to asking the user to confirm that the file should be loaded into flash eprom. The storing process takes around 10 seconds and must NEVER be interrupted by the power being removed. If this final stage is interrupted the controller may have to be returned to Trio for re-initialisation.

Note 1: All *Motion Coordinator* models have different system software files. The file name indicates the controller type.

Controller Type	Filename
MC302X	**MC302Xvnnnnn.s37**
Euro205X	**Knnn.OUT**
Euro209	**Qnnn.OUT**
MC206X	**Mnnn.OUT**
PCI208	**Jnnn.OUT**
MC224	**Innn.OUT**

Updates can be obtained from Trio's website at **WWW.TRIOMOTION.COM**

Note 2: Application programs should be stored on disk prior to a system software load and MUST be reloaded following a system software load.

LOCK

Type: System Command

Syntax: **LOCK(code)**

Description: **LOCK** is designed to prevent programs from being viewed or modified by personnel unaware of the security code. The lock code number is stored in the flash eprom.

When a *Motion Coordinator* is locked, it is not possible to view, edit or save any programs and command line instructions are limited to those required to execute the program.

To unlock the *Motion Coordinator*, the **UNLOCK** command should be entered using the same lock code number which was used originally to **LOCK** it.

The lock code number may be any integer and is held in encoded form. Once **LOCK**ed, the only way to gain full access to the *Motion Coordinator* is to **UNLOCK** it with the correct code. For best security the lock number should be 7 digits.

Parameters: **code** Any integer number

Example: **>>LOCK(5619234)**
The program cannot now be modified or viewed.

>>UNLOCK(5619234)
The system is now unlocked.

Note 1: **LOCK** and **UNLOCK** are available from the *Motion Coordinator* menu in *Motion* Perfect.

Note 2 *If you forget the security code number, the Motion Coordinator may have to be returned to your supplier to be unlocked!*

Note 3 *It is possible to compromise the security of the lock system. Users must consider if the level of security is sufficient to protect their programs.*

MC_TABLE

Type: Reserved Keyword

MC_VR

Type: Reserved Keyword

MOTION_ERROR

Type: System Parameter

Description: This system parameter returns a non-zero value when a motion error has occured on at least one axis, (normally a following error, but see **ERRORMASK**), and the value 0 when none of the axes has had a motion error. When there is a motion error then the **ERROR_AXIS** contains the number of the first axis to have an error. When any axis has a motion error then the watchdog relay is opened. A motion error can be cleared by resetting the controller with an **EX** command ("Reset the controller.." under the "Controller" menu in *Motion* Perfect), or by using the **DATUM(0)** command.

MPE

Type: System Command

Description: Sets the type of channel handshaking to be performed on the serial port 0. This is normally only used by the *Motion* Perfect program, but can be used for user applica-tions. There are 4 valid settings

Parameters **channel type:** Any valid Trio BASIC expression

0 No channel handshaking, **XON/XOFF** controlled by the port. When the current output channel is changed then nothing is sent to the serial port. When there is not enough space to store any more characters in the current input channel then XOFF is sent even though there may be enough space in a different channel buffer to receive more characters

1 Channel handshaking on, **XON/XOFF** controlled by the port. When the current output channel is changed, the channel change sequence is sent (<ESC><channel number>). When there is not enough space to store any more characters in the current input channel then **XOFF** is sent even though there may be enough space in a different channel buffer to receive more characters

2 Channel handshaking on, **XON/XOFF** controller by the channel. When the current output channel is changed, the channel change sequence is sent (<ESC><channel number>). When there is not enough space to store any more characters in the current input buffer, then **XOFF** is sent for this channel (**<XOFF><channel number>**) and characters can still be received into a different channel.

Whatever the **MPE** state, if a channel change sequence is received on serial port A then the current input channel will be changed.

3 Channel handshaking on, **XON/XOFF** controller by the channel. In **MPE(3)** mode the system transmits and receives using a protected packet protocol using a 16 bit CRC.

Example1:

```
>> PRINT #5,"Hello"
Hello
```

Example2:

```
MPE(1)
>> PRINT #5,"Hello"
<ESC>5Hello
<ESC>0
>>
```

NAIO

Type: System Parameter (Read Only)

Description: This parameter returns the number of CAN analogue input channels connected on the IO expansion CAN bus. For example an MC224 will return 8 if there is 1 x P325 CAN Module connected as it has 8 analogue input channels.

If no external I/O is fitted, **NAIO** returns the number of Analogue inputs within the *Motion Coordinator*.

NETSTAT

Type: System Parameter

Description: This parameter stores the network error status since the parameter was last cleared by writing to it. The error types reported are:

Bit Set	Error Type	Value
0	TX Timeout	1
1	TX Buffer Error	2
2	RX CRC Error	4
3	RX Frame Error	8

NEW

Type: System Command

Description Deletes all the program lines in the controller memory. It also may be used to delete the current **TABLE** entries.

Note:

NEW	Deletes the currently selected program
NEW progname	Deletes a particular program
NEW ALL	Deletes all programs in memory
NEW "TABLE"	Delete TABLE (In this case ONLY the program name “TABLE” must be in quotes)

NIO

Type: System Parameter

Description: This parameter returns the number of inputs/outputs fitted to the system, or connected on the IO expansion CAN bus.

Note: Depending on the particular controller type, there may be a number of channels which are input only. For example, on the MC224 the first 8 channels are inputs, the next 8 bi-directional. If an MC224 has 2 P316 CAN-16 I/O modules connected the **NIO** parameter will return 48.

All channels on the CAN-16 I/O modules are bi-directional.

Though normally used as a read-only parameter, **NIO** can be set to any value for simulation purposes. Any I/O read or written that is not physically there, will have no function.

PEEK

Type: System Command

Syntax: **PEEK(address<,mask>)**

Description: The **PEEK** command returns value of a memory location of the controller **AND**ed with an optional mask value.

POKE

Type: System Command

Syntax: **POKE(address,value)**

Description: The **POKE** command allows a value to be entered into a memory location of the controller. The **POKE** command can prevent normal operation of the controller and should only be used if instructed by Trio Motion Technology.

PORT

Type: Modifier

Description: Reserved keyword.

POWER_UP

Type: Flash EPROM stored System Parameter

Description: This parameter is used to determine whether or not programs should be read from Flash Eprom on power up or software reset (**EX**).

Two values are possible:

0 Use the programs in battery backed RAM

1 Copy programs from the controllers Flash Eprom or Memory Stick (if present) into RAM.

Programs are individually selected to be run at power up with the **RUNTYPE** command

Note: **POWER_UP** is always an immediate command and therefore cannot be included in programs.

This value is normally set by *Motion* Perfect. It can also be set by the Flashstick or by the **trioinit.bas** file on the SD Card.

Note: When using the Memory Stick users should refer to the overview in the MC206X Hardware Overview for a complete description of the Memory Stick functionality.

PROCESS

Type: System Command

Description: Displays the running status and process number for each current process.

PROFIBUS

Type: System Command

Syntax: **PROFIBUS(slot,function<,register><,value>)**

Description: The command **PROFIBUS** provides access to the registers of the SPC3 ASIC used on the Profibus daughter board. Trio can supply sample programs using this command to setup and control a Profibus daughter board.

Parameters:

slot:	Specifies the slot on the controller to be used. Set 0 for the daughter board slot of an MC206X/Euro205x or the slot number of an MC224.
function:	Specifies the function to be performed. 0: read register 1: write register
register:	The SPC3 register number to read or write
value:	The value to write into an SPC3 register

PROTOCOL

Type: System Command

Description: Reserved keyword.

REMOTE

Type: System Command

Syntax: **REMOTE(slot)**

Description: Transfers control of a process to the remote computer via a USB interface and the Trio OCX control. The **REMOTE** command is normally inserted automatically on to a process by the system software. When a process is performing the **REMOTE** function execution of BASIC statements is suspended.

RENAME

Type: System Command

Syntax: **RENAME oldname newname**

Description: Renames a program in the *Motion Coordinator* directory.

Example: **>>RENAME car voiture**

Note: *Motion* Perfect users should use "Rename Program..." under the "Program" menu to perform a **RENAME** command.

RS232_SPEED_MODE

Type: System

Syntax: **RS232_SPEED_MODE=modevalue**

Description: Sets the default programming port speed on power-up.

Parameters: 0 = low speed defaults (9600 baud)

1 = high speed defaults (38400 baud)

Cycle the power to the *Motion Coordinator* after setting. High speed mode is shown on power-up by the ok and status LEDs flashing alternately.

Note: This command dhould only be used on the command line terminal.

RUN

Type: System Command

Syntax: **RUN "progname" [, process#[, interrupt#]]**

Description: **Runs a program on the controller.**

Parameters:

program:	Name of program to be run. Must be contained within quotation marks.
process#:	Optional process number. If this is left off, the next available number will be used, starting with the highest.
interrupt#:	Optional value between 0 and 2 to select the exact interrupt slot in the servo cycle that the process will run on. **PROC_MODE** must be set to 1 to use this parameter.

Note:
Execution continues until:

- There are no more lines to execute
- or **HALT** is typed at the command line. This stops all programs
- or **STOP** "name" is typed at the command line. This stops single program

RUN may be included in a program to run another program: e.g. **RUN "CYCLE"**

Example: **RUN** - this will run currently selected program, normally used in the terminal.

Example 2: **RUN "SAUSSAGE"** - this will run the named program, normally used in the terminal

Example 3: **RUN "SAUSSAGE",3** - run the named program on a particular process, normally used in the terminal

Example 4:

```
RUN "MAIN",1,2   'run 2 programs in the same interrupt slot.
RUN "HMI",2,2
RUN "MOTION",1,1 'run motion in it's own interrupt slot.
```

RUNTYPE

Type: System Command

Syntax: **>>RUNTYPE progname,autorun[,process#]**

Description: Sets whether program is run automatically at power up, and which process it is to run on. The current status of each program's **RUNTYPE** is displayed when a **DIR** command is performed. For any program to run automatically on power-up ALL the programs on the controller must compile without errors.

Parameters:

program name	Can be in inverted commas or without autorun
autorun	1 to run automatically, 0 for manual running
<process number>	optional to force process number

Example: **>>RUNTYPE progname,1,10**
- Sets program "progname" to run automatically on power up on process 10

>>RUNTYPE "progname",0
- Sets program "progname" to manual running

Note 1: To set the **RUNTYPE** using *Motion* Perfect select the "Set Power-up mode" option in the "Program" menu.

Note 2: The **RUNTYPE** information is stored into the flash EPROM only when an **EPROM** command is performed.

See Also: **POWER_UP**

SCOPE

Type: System Command

Syntax: **SCOPE(control,period,table start,table stop,p0[,p1[,p2[,p3]]])**

Description: The **SCOPE** command is used to program the system to automatically store up to 4 parameters every sample period. The sample period can be any multiple of the servo period. The data stored is put in the **TABLE** data structure. It may then be read back to a PC and displayed on the *Motion* Perfect Oscilloscope or stored to a file for further analysis using the "Save TABLE file" option under the "File" menu.

Motion Perfect uses the **SCOPE** command when running the Oscilloscope function.

Parameters:		
	ON/OFF control	Set ON or OFF to control the **SCOPE** function. OFF implies that the scope data is not ready. ON implies that the scope data is loaded correctly and is ready to run when the TRIGGER command is executed.
	Period	The number of servo periods between data samples
	Table start	Position to start to store the data in the table array
	Table stop	End of table range to use
	P0	first parameter to store
	P1	optional second parameter to store
	P2	optional third parameter to store
	P3	optional fourth parameter to store

Example 1:
```
SCOPE(ON,10,0,1000,MPOS AXIS(5), DPOS AXIS(5))
```
This example programs the **SCOPE** facility to store away the **MPOS** axis 5 and **DPOS** axis 5 every 10 milliseconds. The **MPOS** will be stored in table values 0..499, the **DPOS** in table values 500 to 999. The sampling does not start until the **TRIGGER** command is executed.

Example 2:
```
SCOPE(OFF)
```

Note 1: The **SCOPE** facility is a “one-shot” and needs to be re-started by the **TRIGGER** command each time an update of the samples is required.

Note2: Data saved to the TABLE memory by the **SCOPE** command is not placed in battery backed memory so will be lost when power is removed.

SCOPE_POS

Type: System Parameter (Read Only)

Description: Returns the current index position at which the **SCOPE** function is currently storing its parameters.

SELECT

Type: System Command

Description: Selects the current active program for editing, running, listing etc. **SELECT** makes a new program if the name entered is not a current program.

When a program is **SELECT**ed the commands **EDIT, RUN, LIST, NEW** etc. assume that the **SELECT**ed program is the one to operate with unless a program is specified as in for example: **RUN progname**

When a program is selected any previously selected program is compiled.

Note: The **SELECT**ed program cannot be changed when programs are running.

Note 2: *Motion* Perfect automatically **SELECT**s programs when you click on their entry in the list in the control panel.

SERCOS

Type: System Function

Syntax: **SERCOS(function#,slot,{parameters})**

Description: This function allows the SERCOS ring to be controlled from the Trio BASIC programming system. A SERCOS ring consists of a single master and 1 or more slaves daisy-chained together using fibre-optic cable. During initialisation the ring passes through several 'communication phases' before entering the final cyclic deterministic phase in which motion control is possible. In the final phase, the master transmits control information and the slaves transmit status feedback information every cycle time.

Once the SERCOS ring is running in CP4, the standard Trio BASIC motion commands can be used.

The *Motion Coordinator* SERCOS hardware uses the Sercon 816 SERCOS interface chip which allows connection speeds up to 16Mhz. This chip can be programmed at a register level using the **SERCOS** command if necessary. To program in this way it is necessary to obtain a copy of the chip data sheet.

The **SERCOS** command provides access to 11 separate functions:

Slot: The slot number is in the range 0 to 3 and specifies the hardware channel

Function:

0 Read SERCOS Asic:

1 Write SERCOS Asic:

2 Initialise command:

3 Link SERCOS drive to Axis

4 Read parameter

5	Write parameter
6	Run SERCOS procedure command
7	Check for drive present
8	Print network parameter
9	Reserved
10	SERCOS ring status

Parameters:

Function 0	SERCOS(0, slot, ram/reg, address)
Slot	The communication slot in which the SERCOS is fitted.
ram/reg	0 = read value from RAM 1 = read value from register.
address	The index address in RAM or register.

Example: **>>?SERCOS(0, 0, 1, $0c)**

Parameters:

Function 1	SERCOS(1, slot, ram/reg, address, value)
Slot	The communication slot in which the SERCOS is fitted.
ram/reg	0 = write value to RAM 1 = write value to register.
address	The index address in RAM or register.
value	Date to be written

Example: Do not use this function without referencing the Sercon 816 data sheet.

Parameters:

Function 2	SERCOS(2, slot [,intensity [,baudrate [, period]]])
Slot	The communication slot in which the SERCOS is fitted.
intensity	Light transmission intensity (1 to 6). Default value is 3.
baudrate	Communication data rate. Set to 2, 4, 6, 8 or 16.
period	Sercos cycle time in microseconds. Accepted values are 2000, 1000, 500 and 250usec.

Example: `>>SERCOS(2, 3, 4, 16, 500)`

Parameters:

Function 3	SERCOS(3, slot, slave addr, axis [slave drive type])
Slot	The communication slot in which the SERCOS is fitted.
slave addr	Slave address of drive to be linked to an axis.
axis	Axis number which will be used to control this drive.
slave drive type	Optional parameter to set the slave drive type. All standard SERCOS drives require the GENERIC setting. The other options below are only required when the drive is using non-standard SERCOS functions. 0 Generic Drive 1 Sanyo-Denki 3 Yaskawa + Trio P730 4 PacSci 5 Kollmorgen

Example: `>>SERCOS(3, 1, 3, 5, 0)  'links drive at address 3 to axis 5`

Parameters:

Function 4	SERCOS(4, slot, slave address, parameter ID [, parameter size[, element type [, list length offset, [VR start index]]]])
Slot	The communication slot in which the SERCOS is fitted.
slave addr	SERCOS address of drive to be read.
parameter ID	SERCOS parameter IDN
parameter size	Size of parameter data expected: 2 = 2 byte parameter (default). 4 = 4 byte parameter 6 = list of parameter IDs 7 = ASCII string
element type	SERCOS element type in the data block: 1 ID number 2 Name 3 Attribute 4 Units 5 Minimum Input value 6 Maximum Input value 7 Operational data (default)

	List length offset	Optional parameter to offset the list length. For drives that return 2 extra bytes, use -2.
	VR start index	Beginning of VR array where list will be stored.

Note: This function returns the value of 2 and 4 byte parameters but prints lists to the terminal in *Motion* Perfect unless VR start index is defined.

Example:
```
>>SERCOS(4, 0, 5, 140, 7) 'request "controller type"
>>SERCOS(4, 0, 5, 129) 'request manufacturer class 1 diagnostic
```

Parameters:		
	Function 5	SERCOS(5, slot , slave address, parameter ID, parameter size, parameter value [, parameter value ...])
	Slot	The communication slot in which the SERCOS is fitted.
	slave addr	SERCOS address of drive to be written.
	parameter ID	SERCOS parameter IDN
	parameter size	Size of parameter data to be written. 2, 4, or 6.
	parameter value	Enter one parameter for size 2 and size 4. Enter 2 to 7 parameters for size 6 (list).

Example:
```
>>SERCOS(5, 1, 7, 2, 2, 1000)  'set SERCOS cycle time
>>SERCOS(5, 0, 2, 16, 6, 51, 130)  'set IDN 16 position feedback
```

Parameters:		
	Function 6	SERCOS(6, slot , slave address, parameter ID [, time-out,[command type]])
	Slot	The communication slot in which the SERCOS is fitted.
	slave addr	SERCOS address of drive.
	parameter ID	SERCOS procedure command IDN.
	time out	Optional time out setting (msec).
	command type	Optional parameter to define the operation: -1 Run & cancel operation (default value) 0 Cancel command 1 Run command

Example:
```
>>SERCOS(6, 0, 2, 99)  'clear drive errors
```

Parameters:

Function 7	SERCOS(7 , slot , slave address)
Slot	The communication slot in which the SERCOS is fitted.
slave addr	SERCOS address of drive. Returns 1 if drive detected, -1 if not detected.

Example:

```
IF SERCOS(7, 2, 3) <0 THEN
    PRINT#5, "Drive 3 on slot 2 not detected"
END IF
```

Parameters:

Function 8	SERCOS(8 , slot , required parameter)
Slot	The communication slot in which the SERCOS is fitted.
required parameter	This function will print the required network parameter, where the possible 'required parameter' values are: 0: to print a semi-colon delimited list of 'slave Id, axis number' pairs for the registered network configuration (as defined using function 3). Used in Phase 1: Returns 1 if drive is detected, 0 if no drive detected. 1: to print the baud rate (either 2, 4, 6, or 8), and 2: to print the intensity (a number between 0 and 6).

Example:

```
>>?SERCOS(8,0, 1 )
```

Parameters:

Function 10	SERCOS(10,<slot>)
Slot	The communication slot in which the SERCOS is fitted.

This function checks whether the fibre optic loop is closed in phase 0. Return value is 1 if network is closed, -1 if it is open, and -2 if there is excessive distortion on the network.

Example:

```
>>?SERCOS(10, 1)
IF SERCOS (10, 0) <> 1 THEN
  PRINT "SERCOS ring is open or distorted"
END IF
```

Notes: MotionPerfect2 contains support for commissioning SERCOS rings. This tool simplifies the creation of a Trio BASIC startup program which consists of SERCOS statements to initialise the ring following power-on, and configure the ring in the deterministic cyclic phase.

SERCOS_PHASE

Type: System Parameter

Syntax: **SERCOS_PHASE SLOT(n) = value**

Description: Sets the phase for the sercos ring attached to the daughter board in slot n.

Example 1: Set the sercos ring attached to daughter board in slot 0 to phase 3

```
SERCOS_PHASE SLOT(0) = 3
```

Example 2: Check the phase of sercos ring attached to daughter board in slot 2

```
IF SERCOS_PHASE SLOT(2)<>4 THEN OP(8,ON)
```

SERIAL_NUMBER

Type: System Parameter (Read only)

Syntax: **SERIAL_NUMBER**

Description: Returns the unique Serial Number of the controller.

Example: For a controller with serial number 00325:

```
>>PRINT SERIAL_NUMBER
325.0000
>>
```

SERVO_PERIOD

Type: System Parameter

Description: This parameter allows the controller servo period to be specified.

SERVO_PERIOD is specified in microseconds. Only the values 2000, 1000, 500 or 250 usec may be used and the *Motion Coordinator* must be reset before the new servo period will be applied.

SLOT

Type: Slot Modifier

Description: Modifier specifies the slot number for a slot parameter such as **COMMSTYPE**.

Example:
```
PRINT COMMSTYPE SLOT(1)
```

STEP

Type: Program Structure

Description: This optional parameter specifies a step size in a **FOR..NEXT** sequence. See **FOR**.

Example:
```
FOR x=10 TO 100 STEP 10
MOVEABS(x) AXIS(9)
NEXT x
```

STEPLINE

Type: System Command

Syntax: **STEPLINE {Program name}{,Process number}**

Description: Steps one line in a program. This command is used by *Motion* Perfect to control program stepping. It can also be entered directly from the command line or as a line in a program with the following parameters.

Parameters:

Program name: This specifies the program to be stepped. All copies of this named program will step unless the process number is also specified. If the program is not running it will step to the first executable line on either the specified process or the next available process if the next parameter is omitted. If the program name is not supplied, either the **SELECT**ed program will step (if command line entry) or the program with the **STEPLINE** in it will stop running and begin stepping.

Process number: This optional parameter determines which process number the program will use for stepping, or, if multiple copies of the same program exist, it is used to select the required copy for stepping.

Example 1: `>>STEPLINE "conveyor"`

Example 2: `>>STEPLINE "maths",2`

STOP

Type: Command

Description: Stops one program at the current line. A particular program may be specified or the selected program will be assumed.

Example 1: `>>STOP progname, [process_number]`

Example 2:

```
'DO NOT EXECUTE SUBROUTINE AT label
STOP
label: PRINT var
RETURN
```

STICK_READ

Type: System Function

(A) Flashstick fitted

Syntax: `STICK_READ(sector, table start)`

Description: Copy one block of 128 values from a sector on the NexFlash FlashStick to TABLE memory.

Parameters:

sector:	A number between 0 and 2047 that is used as a pointer to the sector to be read from the FlashStick.
table start:	The start point in the TABLE where the 128 values will be transferred to.

Example: `IF STICK_READ(25, 1000) THEN PRINT "Stick read OK"`

(B) SD Card fitted

Syntax: `STICK_READ(<flash_file#>,<table_start>[,<format>])`

Description: If an SDCARD is detected then the file SD<flash_file#>.BIN or SD<Flash_file#.CSV> is opened. All the binary data in the file is read into TABLE memory. By default, if the format parameter is left off, the data is read in IEEE floating point binary format, little-endian, i.e. the least significant byte first.

Perameters:

flash_file#: A number which when appended to the characters "SD" will form the data filename.

table start: The start point in the TABLE where the data values will be transferred to.

format: 0 = Binary floating point format
1 = ASCII comma seperated values

Example:

```
STICK_READ (1984, 16500, 1)
'reads the ASCII file SD1984.csv from the SD card and copies the
'data to the table starting at TABLE(16500)
```

The function returns TRUE (-1) if the **STICK_READ** was successful and FALSE (0) if the command failed, if for example the FlashStick or SD Card is not present.

STICK_WRITE

Type: System Function

(A) Flashstick fitted

Syntax: **STICK_WRITE(sector, table start)**

Description: Copy one block of 128 values from TABLE memory to a sector on the NexFlash Flash-Stick.

Parameters:

sector: A number between 0 and 2047 that is used as a pointer to the sector to be written to the FlashStick.

table start: The start point in the TABLE where the 128 values will be transferred from.

Example:

```
STICK_WRITE (25, 1000)
IF check = TRUE THEN PRINT "stick write ok"
```

(B) SD Card fitted

Syntax: **STICK_WRITE(<flash_file#>,<table_start>[,<length>[,<format>]])**

Description: If an SDCARD is detected then the file SD<flash_file#>.BIN or SD<Flash_file#.CSV> is created. If this file already exists, it is overwritten.

If no format is specified, or <format>=0 then the data is stored in IEEE floating point binary format little-endian, i.e. the least significant byte first, and has the extension "BIN".

If **<format>** is specified and non 0 then the data is stored in ASCII format and has the extension "CSV", one value per line.

Parameters:

flash_file#:	A number which when appended to the characters “SD” will form the data filename.
table start:	The start point in the TABLE where the values will be transferred from.
length:	The number of the table values to be transferred.
format:	0 = Binary floating point format 1 = ASCII comma seperated values

Example:

```
STICK_WRITE (1501, 1000, 2000,0)
'transfers 2000 values starting at TABLE(1000) to the SD Card file
'called SD1501.BIN
```

The function returns TRUE (-1) if the **STICK_WRITE** was successful and FALSE (0) if the command failed, if for example the FlashStickor SD Card is not present.

STORE

Type: System Command

Description: Stores an update to the system software into FLASH EPROM. This should only be necessary following loading an update to the system software supplied by TRIO. See also **LOADSYSTEM.**

Warning: *Removing the controller power during a STORE sequence can lead to the controller having to be returned to Trio for re-initialization.*

Note: Use of **STORE** and **LOADSYSTEM** is automated for *Motion* Perfect users by the “Load system software...” option in the “Controller” menu.

TABLE

Type: System Command

Syntax: **TABLE(address [, data1..data20])**

Description: The **TABLE** command is used to load and read back the internal cam table. This table has a fixed maximum table length of 32000 points on all *Motion Coordinator*s EXCEPT the MC302X which has a 16000 point table length and the MC224 which has 256k. Issuing the **TABLE** command or running it as a program line must be done before table points are used by a **CAM** or **CAMBOX** command. The table values are floating point and can therefore be fractional.

The command has two forms:

(i) With 2 or more parameters the **TABLE** command defines a sequence of values, the first value is the first table position.

(ii) If a single parameter is specified the table value at that entry is returned. As the table can be written to and read from, it may be used to hold information as an alternative to variables.

The values in the table may only be read if a value of THAT NUMBER OR GREATER has been specified. For example, if the value of table position 1000 has been specified e.g. **TABLE(1000,1234)** then **TABLE(1001)** will produce an error message. The highest **TABLE** which has been loaded can be read using the **TSIZE** parameter.

Except in the MC302X the table entries are automatically battery backed. If FLASH Eprom storage is required it is recommended to set the values inside a program or use the **FLASHVR(-1)** function. It is not normally required to delete the table but if this necessary the **DEL** command can be used:

>>DEL "TABLE"

Parameters:

address: location in the table at which to store a value or to read a value from if only this parameter is specified.

data1..data20: the value to store in the given location and at subsequent locations if more than one data parameter is used.

Example 1: **TABLE(100,0,120,250,370,470,530)**

This loads the internal table:

Table Entry:	Value:
100	0
101	120
102	250
103	370
104	470
105	530

Example 2:
```
>>PRINT TABLE(1000)
0.0000
>>
```

Note: The Oscilloscope function of *Motion* Perfect uses the table as a data area. The range used can be set in the scope "Options..." screen. Care should be taken not to use a data area in use be the Oscilloscope function.

TABLEVALUES

Type: System Command

Syntax: **TABLEVALUES(first table number, last required table number, format)**

Description: Returns a list of table points starting at the number specified. There is only one format supported at the moment, and that is comma delimited text.

Parameters

address:	Number of the first point to be returned
number of points:	Total number of points to be returned
format:	Format for the list

Note: **TABLEVALUES** is provided mainly for *Motion* Perfect to allow for fast access to banks of **TABLE** values.

TIME

Type: System Parameter (MC224 only)

Description: Returns the time from the real time clock. The time returned is the number of seconds since midnight 24:00 hours.

Example 1:
```
Sets the real time clock in 24 hour format; hh:mm:ss
  'Set the real time clock
>>TIME = 13:20:00
```

Example 2:
```
  'calculate elapsed time in seconds
time1 = TIME
  'wait for event
time2 = TIME
timeelapsed = time1-time2
```

TIME$

Type: System Command (MC224 only)

Description: Prints the current time as defined by the real time clock as a string in 24hr format.

Example:
```
>>? TIME$
  14/39/02
>>
```

TRIGGER

Type: System Command

Description: Starts a previously set up **SCOPE** command

Note: *Motion* Perfect uses **TRIGGER** automatically for its oscilloscope function.

TROFF

Type: System Command

Description: Suspends the trace facility started by a previous **TRON** command, at the current line and resumes normal program execution. A program name can be specified or the selected program will be assumed.

Example:
```
>>TROFF "lines"
```

TRON

Type: System Command

Description: The trace on command suspends a programs execution at the current line. The program can then be single stepped, executing one line at a time, using the **STEPLINE** command.

Note: Program execution may be restarted without single stepping using **TROFF**.
The trace mode may be halted by issuing a **STOP** or **HALT** command.
Motion Perfect highlights lines containing **TRON** in its editor and debugger.

Example:
```
TRON
MOVE(0,10)
MOVE(10,0)
TROFF
MOVE(0,-10)
MOVE(-10,0)
```

TSIZE

Type: System Parameter

Description: Returns one more than the highest currently defined table value.

Example:
```
>>TABLE(1000,3400)
>>PRINT TSIZE
1001.0000
```

Note: **TSIZE** can be reset using **>>DEL "TABLE"**

UNLOCK

Type: System Command

Syntax: **UNLOCK(code)**

Description: Enables full access to a *Motion Coordinator* which has a security lock code applied via the **LOCK()** command.

When a *Motion Coordinator* is locked, it is not possible to view, edit or save any programs and command line instructions may be limited to those required to execute the program only.

To unlock the *Motion Coordinator*, the **UNLOCK** command should be entered using the same security code number which was used originally to **LOCK** it.

The security code number may be any integer and is held in encoded form. Once **LOCK**ed, the only way to gain full access to the *Motion Coordinator* is to **UNLOCK** it with the correct code.

Parameters:

code	Any integer number

Example: **>>LOCK(561234)**
The program cannot now be modified or seen.

>>UNLOCK(561234)
The system is now unlocked.

Note 1: It is not normally necessary to use the **LOCK/UNLOCK** commands from the command line as the they are available directly from the Controller menu in *Motion* Perfect 2.

USB

Type: System Command

Syntax: **USB(slot,function<,register><,value>)**

Description: The command **USB** provides access to the registers of the USBN9602 USB controller. It is not required to use this command as the functions are included in the *Motion Coordinator* system software.

Parameters:

slot:	Specifies the slot on the controller to be used. Set 1 for the built-in USB of the MC206X/MC224 or the slot number of a Euro205x.
function:	Specifies the function to be performed. 0: Read register 1: Write register 2: Open / initialise USB chip 3: Close USB port
register:	The register number to read or write
value:	The value to write into a register

Example:

```
USB(1, 3) ‘ manually reset the USB port
WA(200)
USB(1, 2)
```

USB_HEARTBEAT

Type: System Parameter

Description: Indicates that the USB Heartbeat function is operating. When the value is 1, the heartbeat is running and if no data is received via the USB link then after 60 seconds, the USB port in the controller will be reset automatically.

The value defaults to 0 on power-up and is automatically set to 1 when a PC opens the USB connection. The user can disable the heartbeat function by manually setting the value to 0 again.

Example 1:
```
' test to see if USB port is open and heartbeat is running
IF USB_HEARTBEAT=1 THEN
  PRINT "USB port is in use"
ENDIF
```

Example 2:
```
' turn off the usb heartbeat function from the terminal
>>USB_HEARTBEAT = 0
```

USB_STALL

Type: System Parameter

Description: This parameter returns TRUE if the USB controller chip has its “stalled” (unable to communicate) bit set.

VERSION

Type: System Parameter

Description: Returns the version number of the system software installed on the *Motion Coordinator*.

Example:
```
>>? VERSION
   1.5000
```

VIEW

Type: System Command

Description: Lists the currently selected program in tokenised and internal compiled format.

Example: For the following program:

```
VR(10)=IN AND 255
```

the view command will give the output:

```
Source code: from xxx to xxx
10725: 00 15 00 29 92 95 31 30 00 93 88 64 A2 95 32 35 35 00 9B
10746: 15 00 00 00
```

```
Object code: from yyy to yyy
10750: 01 00 29 92 95 00 20 03 91 93 9A 64 95 00 00 7F 07 8E 91 9B
10771:
```

VR

Type: Variable

Syntax: **VR(expression)**

Description: Recall or assign to a global numbered variable. The variables hold real numbers and can be easily used as an array or as a number of arrays. There are 1024 variable locations which are accessed as variables 0 to 250.

The numbered variables are used for several purposes in Trio BASIC. If these requirements are not necessary it is better to use a named variable:

The numbered variables are BATTERY BACKED (except on MC302X) and are not cleared between power ups.- The numbered variables are globally shared between programs and can be used for communication between programs. To avoid problems where two processes write unexpectedly to a global variable, the programs should be written so that only one program writes to the global variables.

The numbered variables can be changed by remote controllers on the TRIO Fibre Optic Network, or from a master via a MODBUS or other supported network.

The numbered variables can be used for the **LINPUT, READPACKET** and **CAN** commands.

Example 1: ' put value 1.2555 into VR() variable 15. Note local variable 'val' used to give name to global variable:

```
val=15
VR(val)=1.2555
```

Example 2: A transfer gantry has 10 put down positions in a row. Each position may at any time be FULL or EMPTY. **VR(101)** to **VR(110)** are used to hold an array of ten1's or 0's to signal that the positions are full (1) or EMPTY (0). The gantry puts the load down in the first free position. Part of the program to achieve this would be:

```
movep:
  MOVEABS(115) ' MOVE TO FIRST PUT DOWN POSITION:
  FOR VR(0)=101 TO 110
    IF VR(VR(0))=0 THEN GOSUB load
    MOVE(200)' 200 IS SPACING BETWEEN POSITIONS
  NEXT VR(0)
```

```
  PRINT "All Positions Are Full"
  WAIT UNTIL IN(3)=ON
GOTO movep

load:
  'PUT LOAD IN POSITION AND MARK ARRAY
  OP(15,OFF)
  VR(VR(0))=1
RETURN
```

Note: The variables are battery-backed so the program here could be designed to store the state of the machine when the power is off. It would of course be necessary to provide a means of resetting completely following manual intervention.

Example 3:

```
'Assign VR(65) to VR(0) multiplied by Axis 1 measured position
VR(65)=VR(0)*MPOS AXIS(1)
PRINT VR(65)
```

VRSTRING

Type: Command

Syntax: **VRSTRING(vr start)**

Description: Combines the contents of an array of VR() variables so that they can be printed as a text string. All printable characters will be output and the string will terminate at the first null character found. (i.e. VR(n) contains 0)

Parameters:

vr start: number of first VR() in the character array.

Example:

```
PRINT #5,VRSTRING(100)
```

WDOG

Type: System Parameter

Description: Controls the **WDOG** relay contact used for enabling external drives. The **WDOG=ON** command MUST be issued in a program prior to executing moves. It may then be switched ON and OFF under program control. If however a following error condition exists on any axis the system software will override the **WDOG** setting and turn watchdog contact OFF. In addition the analogue outputs and step/direction outputs are also disabled when **WDOG=OFF**.

Example: **WDOG=ON**

Note 1: **WDOG=ON / WDOG=OFF** is issued automatically by *Motion* Perfect when the "Drives Enable" button is clicked on the control panel

Note 2: When the **DISABLE_GROUP** function is in use, the watchdog relay and WDOG remain on if there is an axis error. In this case, the digital enable signal is removed from the drives in that group only.

:

Type: Special Character

Description: The colon character is used to terminate labels used as destinations for **GOTO** and **GOSUB** commands.

Labels may be character strings of any length. (The first 15 characters are significant) Alternatively line numbers can be used. Labels must be the first item on a line and should have no leading spaces.

Example: **start:**

The colon is also used to separate Trio BASIC statements on a multi-statement line. The only limit to the number of statements on a line is the maximum of 100 characters per line (79 in system software V1.66 and lower).

Example: **PRINT "THIS LINE":GET low:PRINT "DOES THREE THINGS!"**

Note: The colon separator must not be used after a **THEN** command in a multi-line **IF..THEN** construct. If a multi-statement line contains a **GOTO** the remaining statements will not be executed:

PRINT "Hello":GOTO Routine:PRINT "Goodbye"
Goodbye will not be printed.

Similarly with **GOSUB** because subroutine calls return to the following line.

'

Type: Special Character

Description: A single ' is used to mark a line as being a comment only with no execution significance.

Note: The REM command of other BASICs is replaced by '.
Like REM statements ' must be at the beginning of the line or statement or after the executable statement. Comments use memory space and so should be concise in very long programs. Comments have no effect on execution speed since they are not present in the compiled code.

Example:
```
'PROGRAM TO ROTATE WHEEL
turns=10
'turns contains the number of turns required
MOVE(turns)' the movement occurs here
```

#

Type: Special Character

Description: The # symbol is used to specify a communications channel to be used for serial input/output commands.

Note: Communications Channels greater than 3 will only be used when the controller is running in *Motion* Perfect mode (See **MPE** command).

Example 1:
```
PRINT #3,"Membrane Keypad"
PRINT #2,"Port 2"
```

Example 2:
```
' Check membrane keypad on fibre-optic channel
IF KEY #3 THEN GET #3,k
```

$

Type: Special Character

Description: The $ symbol is used to specify that the number that follows is in hexadecimal format.

Example 1:
```
VR(10)=$8F3B
OP($CC00)
Process Parameters and Commands
```

ERROR_LINE

Type: Process Parameter (Read Only)

Description: Stores the number of the line which caused the last Trio BASIC error. This value is only valid when the **BASICERROR** is **TRUE**. This parameter is held independently for each process.

Example:
```
>>PRINT ERROR_LINE PROC(14)
```

INDEVICE

Type: Process Parameter

Description: This parameter specifies the active input device. Specifying an **INDEVICE** for a process allows the channel number for a program to set for all subsequent **GET** and **KEY**, **INPUT** and **LINPUT** statements. (This command is not usually required - Use **GET #** and **KEY #** etc. instead)

Chan	Input device:-
0	Serial port A
1	Serial port B
2	RS485 Port
3	Fibre optic port (value returned defined by DEFKEY)
4	Fibre optic port (returns raw keycode of key pressed)
5	*Motion* Perfect user channel
6	*Motion* Perfect user channel
7	*Motion* Perfect user channel
8	Used for *Motion* Perfect internal operations
9	Used for *Motion* Perfect internal operations
10	Fibre optic network data

Example:
```
INDEVICE=5
  ' Get character on channel 5:
GET k
```

LOOKUP

Type: Process Command

Syntax: **LOOKUP(format,entry) <PROC(process#)>**

Description: The **LOOKUP** command allows *Motion* Perfect to access the local variables on an executing process. It is not normally required for BASIC programs.

Parameters:

format:
0: Prints (in binary) floating point value from an expression
1: Prints (in binary) integer value from an expression
2: Prints (in binary) local variable from a process
3: Returns to BASIC local variable from a process
4: Write

entry:
Either an expression string (format=0 or 1) or the offset number of the local variable into the processes local variable list.

OUTDEVICE

Type: Process Parameter

Description: The value in this parameter determines the serial output device for the **PRINT** command for the process. The channel numbers are the same as described in **INDEVICE**.

PMOVE

Type: Process Parameter

Modifier: **PROC**

Description: Returns 1 if the process move buffer is occupied, and 0 it is empty. When one of the *Motion Coordinator* processes encounters a movement command the process loads the movement requirements into its "process move buffer". This can hold one movement instruction for any group of axes. When the load into the process move buffer is complete the **PMOVE** parameter is set to 1. When the next servo interrupt occurs the motion generation program will load the movement into the "next move buffer" of the required axes if these are available. When this second transfer is complete the **PMOVE** parameter is cleared to 0. Each process has its own **PMOVE** parameter.

PROC

Type: Process Modifier

Description: Allows a process parameter from a particular process to be read or set.

Example: **WAIT UNTIL PMOVE PROC(14)=0**

PROC_LINE

Type: Process Parameter (Read Only)

Description: Allows the current line number of another program to be obtained with the **PROC(x)** modifier.

Example: **PRINT PROC_LINE PROC(2)**

PROC_MODE

Type: Process Parameter

Description: Enables user control of processes and interupt slot numbers with the extended RUN command.

Example:

```
PROC_MODE = (0)  'set "standard" multi-tasking control
                 '(compatible with older system software versions)
PROC_MODE = 1    'set up advanced multi-tasking control
RUN "prog1", 5,5 'prog 1 runs as process 4 sharing the same
                  'interrupt slot.
```

PROC_STATUS

Type: Process Parameter (Read Only)

Description: Returns the status of another process, referenced with the **PROC(x)** modifier.

Example: **WAIT UNTIL PROC_STATUS PROC(12)=0**

Returns

0	Process Stopped
1	Process Running

2 Process Stepping

3 Process Paused

PROCNUMBER

Type: Process Parameter

Description: Returns the process on which a Trio BASIC program is running. This is normally required when multiple copies of a program are running on different processes.

Example: **MOVE(length) AXIS(PROCNUMBER)**

RESET

Type: Process Command

Description: Sets the value of all the local named variables of a Trio BASIC process to 0.

RUN_ERROR

Type: Process Parameter

Modifier: **PROC**

Description: Contains the number of the last program error that occurred on the specified process.

Example:

```
>>? RUN_ERROR PROC(5)
  9.0000
>>
```

TICKS

Type: Process Parameter

Description: The current count of the process clock ticks is stored in this parameter. The process parameter is a 32 bit counter which is DECREMENTED on each servo cycle. It can therefore be used to measure cycle times, add time delays, etc. The ticks parameter can be written to and read.

Example:

```
delay:
  TICKS=3000
  OP(9,ON)
test:
  IF TICKS<=0 THEN OP(9,OFF) ELSE GOTO test
```

Note: **TICKS** is held independently for each process.

Mathematical Operations and Commands

+ Add

Type: Arithmetic operation

Syntax `<expression1> + <expression2>`

Description: Adds two expressions

Parameters:

Expression1: Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example:

```
result=10+(2.1*9)
```

Trio BASIC evaluates the parentheses first giving the value 18.9 and then adds the two expressions. Therefore result holds the value 28.9

- Subtract

Type: Arithmetic operation

Syntax `<expression1> - <expression2>`

Description: Subtracts expression2 from expression1

Parameters:

Expression1: Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example:

```
VR(0)=10-(2.1*9)
```

Trio BASIC evaluates the parentheses first giving the value 18.9 and then subtracts this from 10. Therefore VR(0) holds the value -8.9

* Multiply

Type: Arithmetic operation

Syntax **<expression1> * <expression2>**

Description: Multiplies expression1 by expression2

Parameters:

Expression1: Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example:

```
factor=10*(2.1+9)
```

Trio BASIC evaluates the brackets first giving the value 11.1 and then multiplies this by 10. Therefore factor holds the value 111

/ Divide

Type: Arithmetic operation

Syntax **<expression1> / <expression2>**

Description: Divides expression1 by expression2

Parameters:

Expression1: Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example:

```
a=10/(2.1+9)
```

Trio BASIC evaluates the parentheses first giving the value 11.1 and then divides 10 by this number

Therefore a holds the value 0.9009

^ Power

Type: Arithmetic operation

Syntax **<expression1> ^ <expression2>**

Description: Raises expression1 to the power of expression2

Parameters:

Expression1: Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example:

```
x=2^6
PRINT x
```

Trio BASIC raises the first number (2) to the power of the second number (6)

Therefore x has the value of 64

= Equals

Type: Arithmetic Comparison Operation

Syntax **<expression1> = <expression2>**

Description: Returns **TRUE** if expression1 is equal to expression2, otherwise returns false.

Note: **TRUE** is defined as -1, and **FALSE** as 0

Parameters:

Expression1: Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example:

```
IF IN(7)=ON THEN GOTO label
```

If input 7 is ON then program execution will continue at line starting “**label:**”

<> Not Equal

Type: Arithmetic Comparison Operation

Syntax **<expression1> <> <expression2>**

Description: Returns **TRUE** if expression1 is not equal to expression2, otherwise returns false.

Note: **TRUE** is defined as -1, and **FALSE** as 0

Parameters:

Expression1: Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example:

```
IF MTYPE<>0 THEN GOTO scoop
If axis is not idle (MTYPE=0 indicates axis idle) then goto label
"scoop"
```

> Greater Than

Type: Arithmetic Comparison Operation

Syntax **<expression1> > <expression2>**

Description: Returns **TRUE** if expression1 is greater than expression2, otherwise returns false.

Note: **TRUE** is defined as -1, and **FALSE** as 0

Parameters:

Expression1: Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example 1:

```
WAIT UNTIL MPOS>200
```

The program will wait until the measured position is greater than 200

Example 2:

```
VR(0)=1>0
```

1 is greater than 0 and therefore VR(0) holds the value -1

>= Greater Than or Equal

Type: Arithmetic Comparison Operation

Syntax **<expression1> >= <expression2>**

Description: Returns **TRUE** if expression1 is greater than or equal to expression2, otherwise returns false.

Note: **TRUE** is defined as -1, and **FALSE** as 0

Parameters: **Expression1:** Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example: **IF target>=120 THEN MOVEABS(0)**
If variable target holds a value greater than or equal to 120 then move to the absolute position of 0.

< Less Than

Type: Arithmetic Comparison Operation

Syntax **<expression1> < <expression2>**

Description: Returns **TRUE** if expression1 is less than expression2, otherwise returns false.

Note: **TRUE** is defined as -1, and **FALSE** as 0

Parameters: **Expression1:** Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example: **IF AIN(1)<10 THEN GOSUB rollup**
If the value returned from analogue input 1 is less than 10 then execute subroutine "**rollup**"

<= Less Than or Equal

Type: Arithmetic Comparison Operation

Syntax **<expression1> <= <expression2>**

Description: Returns **TRUE** if expression1 is less than or equal to expression2, otherwise returns false.

Note: **TRUE** is defined as -1, and **FALSE** as 0

Parameters: **Expression1:** Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example: **maybe=1<=0**
1 is not less than or equal to 0 and therefore variable **maybe** holds the value 0

ABS

Type: Function

Syntax: **ABS(expression)**

Description: The **ABS** function converts a negative number into its positive equal. Positive numbers are unaltered.

Parameters: **Expression:** Any valid Trio BASIC expression

Example:
```
IF ABS(AIN(0))>100 THEN
  PRINT "Analogue Input Outside +/-100"
ENDIF
```

ACOS

Type: Function

Syntax: **ACOS(expression)**

Description: The **ACOS** function returns the arc-cosine of a number which should be in the range 1 to -1. The result in radians is in the range 0..PI

Parameters: **Expression:** Any valid Trio BASIC expression.

Example:
```
>>PRINT ACOS(-1)
3.1416
```

AND

Type: Logical and bitwise operator

Syntax **<expression1> AND <expression2>**

Description: This performs an **AND** function between corresponding bits of the integer part of two valid Trio BASIC expressions.

The **AND** function between two bits is defined as follows:

Parameters: **Expression1:** Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example 1: **IF (IN(6)=ON) AND (DPOS>100) THEN tap=ON**

Example 2: **VR(0)=10 AND (2.1*9)**

Trio BASIC evaluates the parentheses first giving the value 18.9, but as was specified earlier, only the integer part of the number is used for the operation, therefore this expression is equivalent to:

VR(0)=10 AND 18

AND is a bitwise operator and so the binary action taking place is:

	0	1
0	0	0
1	0	1

```
     01010
AND  10010
     -----
     00010
```

Therefore **VR(0)** holds the value 2

Example 3: **IF MPOS AXIS(0)>0 AND MPOS AXIS(1)>0 THEN GOTO cyc1**

ASIN

Type: Mathematical Function

Syntax: **ASIN(expression)**

Alternate Format: **ASN(expression)**

Description: The **ASIN** function returns the arc-sine of a number which should be in the range +/-1. The result in radians is in the range -PI/2.. +PI/2 (Numbers outside the +/-1 input range will return zero)

Parameters: **Expression:** Any valid Trio BASIC expression.

Example:

```
>>PRINT ASIN(-1)
-1.5708
```

ATAN

Type: Mathematical Function

Syntax: **ATAN(expression)**

Alternate Format: **ATN(expression)**

Description: The **ATAN** function returns the arc-tangent of a number. The result in radians is in the range -PI/2.. +PI/2

Parameters: **Expression:** Any valid Trio BASIC expression.

Example:
```
>>PRINT ATAN(1)
0.7854
```

ATAN2

Type: Mathematical Function

Syntax: **ATAN2(expression1,expression 2)**

Description: The **ATAN2** function returns the arc-tangent of the ratio expression1/expression 2. The result in radians is in the range -PI.. +PI

Parameters: **Expressions:** Any valid Trio BASIC expression.

Example:
```
>>PRINT ATAN2(0,1)
0.0000
```

B_SPLINE

Type: Command

Syntax: **B_SPLINE(type, data_in, #in, data_out, #expand)**

Description: Expands an existing profile stored in the TABLE area using the B Spline mathematical function. The expansion factor is configurable and the **B_SPLINE** stores the expanded profile to another area in the TABLE.

This is ideally used where the source CAM profile is too coarse and needs to be extrapolated into a greater number of points.

Parameters:

type	Reserved for future expansion ALWAYS SET TO 1.
data_in	Location in the TABLE where the source profile is stored.
#in	Number of points in the source profile.
data_out	Location in the TABLE where the expanded profile will be stored.
#expand	The expansion ratio of the **B_SPLINE** function. (i.e. if the source profile is 100 points and #expand is set to 10 the resulting profile will be 1000 point (100 * 10).

Example: **B_SPLINE(1,0,10,200,10)**
Expands a 10 point profile in TABLE locations 0 to 9 to a larger 100 point profile starting at TABLE address 200.

CLEAR_BIT

Type: Command

Syntax: **CLEAR_BIT(bit#,vr#)**

Description: **CLEAR_BIT** can be used to clear the value of a single bit within a **VR()** variable.

Example: **CLEAR_BIT(6,23)**
Bit 6 of VR(23) will be cleared (set to 0).

Parameters:

bit #	Bit number within the VR. Valid range is 0 to 23
vr#	VR() number to use

See also **READ_BIT, SET_BIT**

CONSTANT

Type: System Command

Syntax: **CONSTANT "name", value**

Description: Declares the *name* as a constant for use both within the program containing the **CONSTANT** definition and all other programs in the *Motion Coordinator* project.

Parameters:

name:	Any user-defined name containing lower case alpha, numerical or underscore (_) characters.
value	The value assigned to *name*.

Example: **CONSTANT "nak",$15**

```
CONSTANT "start_button",5

IF IN(start_button)=ON THEN OP(led1,ON)
IF key_char=nak THEN GOSUB no_ack_received
```

Note: The program containing the **CONSTANT** definition must be run before the name is used in other programs. For fast startup the program should also be the ONLY process running at power-up.

A maximum of 128 **CONSTANTs** can be declared (64 constants in MC302-K).

COS

Type: Mathematical Function

Syntax: **COS(expression)**

Description: Returns the **COSINE** of an expression. Will work for any value. Input values are in radians.

Parameters: **Expression:** Any valid Trio BASIC expression.

Example:
```
>>PRINT COS(0)[3]
1.000
>>
```

EXP

Type: Mathematical Function

Syntax: **EXP(expression)**

Description: Returns the exponential value of the expression.

FRAC

Type: Mathematical Function

Syntax: **FRAC(expression)**

Description: Returns the fractional part of the expression.

Example:
```
>>PRINT FRAC(1.234)
0.2340
```

GLOBAL

Type: System Command

Syntax: **GLOBAL "name", vr_number**

Description: Declares the *name* as a reference to one of the global VR variables. The name can then be used both within the program containing the **GLOBAL** definition and all other programs in the *Motion Coordinator* project.

Parameters:

name:	Any user-defined name containing lower case alpha, numerical or underscore (_) characters.
vr_number	The number of the VR to be associated with *name*.

Example:

```
GLOBAL "srew_pitch",12
GLOBAL "ratio1",534

ratio1 = 3.56
screw_pitch = 23.0
PRINT screw_pitch, ratio1
```

Note: The program containing the **GLOBAL** definition must be run before the name is used in other programs. For fast startup the program should also be the ONLY process running at power-up.

In programs that use the defined **GLOBAL**, **name** has the same meaning as **VR(vr_number)**. Do not use the syntax: VR(name).

A maximum of 128 **GLOBALs** can be declared (64 constants in MC302-K).

IEEE_IN

Type: Mathematical Function

Syntax: **IEEE_IN(byte0,byte1,byte2,byte3)**

Description: The **IEEE_IN** function returns the floating point number represented by 4 bytes which typically have been received over a communications link such as Modbus.

Parameters:

byte0 - 3:	Any combination of 8 bit values that represents a valid IEEE floating point number.

Example:

```
VR(20) = IEEE_IN(b0,b1,b2,b3)
```

Note: Byte 0 is the high byte of the 32 bit floating point format.

IEEE_OUT

Type: Mathematical Function

Syntax: **byte_n = IEEE_OUT(value, n)**

Description: The **IEEE_OUT** function returns a single byte in IEEE format extracted from the floating point value for transmission over a bus sytem. The function will typically be called 4 times to extract each byte in turn.

Parameters:

value:	Any Trio BASIC floating point variable or parameter.
n:	The byte number (0 - 3) to be extracted.

Example:

```
a = MPOS AXIS(2)
byte0 = IEEE_OUT(a, 0)
byte1 = IEEE_OUT(a, 1)
byte2 = IEEE_OUT(a, 2)
byte3 = IEEE_OUT(a, 3)
```

Note: Byte 0 is the high byte of the 32 bit IEEE floating point format.

INT

Type: Mathematical Function

Syntax: **INT(expression)**

Description: The **INT** function returns the integer part of a number.

Parameters:

expression:	Any valid Trio BASIC expression.

Example:

```
>>PRINT INT(1.79)
1.0000
>>
```

Note: To round a positive number to the nearest integer value take the **INT** function of the (number + 0.5)

LN

Type: Mathematical Function

Syntax: **LN(expression)**

Description: Returns the natural logarithm of the expression.

Parameter: Any valid Trio BASIC expression.

MOD

Type: Mathematical Function

Syntax: **MOD(expression)**

Description: Returns the integer modulus of an expression.

Example:
```
>>PRINT 122 MOD(13)
5.0000
>>
```

NOT

Type: Mathematical Function

Description: The **NOT** function truncates the number and inverts all the bits of the integer remaining.

Parameter: **expression:** Any valid Trio BASIC expression.

Example:
```
PRINT 7 AND NOT(1.5)
  6.0000
>>
```

OR

Type: Logical and bitwise operator

Description: This performs an **OR** function between corresponding bits of the integer part of two valid Trio BASIC expressions. The **OR** function between two bits is defined as follows:

OR	0	1
0	0	1
1	1	1

Parameters:
Expression1:	Any valid Trio BASIC expression
Expression2:	Any valid Trio BASIC expression

Example 1: **IF KEY OR IN(0)=ON THEN GOTO label**

Example 2: **result=10 OR (2.1*9)**

Trio BASIC evaluates the parentheses first giving the value 18.9, but as was specified earlier, only the integer part of the number is used for the operation, therefore this expression is equivalent to:

result=10 OR 18

The OR is a bitwise operator and so the binary action taking place is:

```
     01010
OR   10010
----------
     11010
```

Therefore result holds the value 26

READ_BIT

Type: Command

Syntax: **READ_BIT(bit#,vr#)**

Description: **READ_BIT** can be used to test the value of a single bit within a **VR()** variable.

Example: **res=READ_BIT(4,13)**

Parameters:
bit #	Bit number within the VR. Valid range is 0 to 23
vr#	VR() number to use

See also **SET_BIT, CLEAR_BIT**

SET_BIT

Type: Command

Syntax: **SET_BIT(bit#,vr#)**

Description: **SET_BIT** can be used to set the value of a single bit within a **VR()** variable. All other bits are unchanged.

Parameters:

bit #	Bit number within the VR. Valid range is 0 to 23
vr#	**VR()** number to use

Example:

```
SET_BIT(3,7)
Will set bit 3 of VR(7) to 1.
```

See also **READ_BIT, CLEAR_BIT**

SGN

Type: Mathematical Function

Syntax: **SGN(expression)**

Description: The **SGN** function returns the SIGN of a number.

1	Positive non-zero
0	Zero
-1	Negative

Parameters: **expression:** Any valid Trio BASIC expression.

Example:

```
>>PRINT SGN(-1.2)
-1.0000
>>
```

SIN

Type: Mathematical Function

Syntax: **SIN(expression)**

Description: Returns the SINE of an expression. This is valid for any value in expressed in radians.

Parameters: **expression:** Any valid Trio BASIC expression.

Example:

```
>>PRINT SIN(0)
   0.0000
```

SQR

Type: Mathematical Function

Syntax: **SQR(number)**

Description: Returns the square root of a number.

Parameters: **number:** Any valid Trio BASIC number or variable.

Example:
```
>>PRINT SQR(4)
2.0000
>>
```

TAN

Type: Mathematical Function

Syntax: **TAN(expression)**

Description: Returns the **TANGENT** of an expression. This is valid for any value expressed in radians.

Parameters: **Expression:** Any valid Trio BASIC expression.

Example:
```
>>PRINT TAN(0.5)
   0.5463
```

XOR

Type: Logical and bitwise operator

Description: This performs and exclusive or function between corresponding bits of the integer part of two valid Trio BASIC expressions. It may therefore be used as either a bitwise or logical condition.

The **XOR** function between two bits is defined as follows:

Parameters: **Expression1:** Any valid Trio BASIC expression

Expression2: Any valid Trio BASIC expression

Example: **a = 10 XOR (2.1*9)**

Trio BASIC evaluates the parentheses first giving the value 18.9, but as was specified earlier, only the integer part of the number is used for the operation, therefore this expression is equivalent to: **a=10 XOR 18**. The **XOR** is a bitwise operator and so the binary action taking place is:

```
     01010
XOR  10010
----------
     11000
```

The result is therefore 24.

Constants

OFF

Type: Constant

Description: **OFF** returns the value 0

Example:
```
IF IN(56)=OFF THEN GOSUB label
'run subroutine label if input 56 is off.
```

ON

Type: Constant

Description: **ON** returns the value 1.

Example:
```
OP(lever,ON)'  This sets the output named lever to ON.
```

FALSE

Type: Constant

Description: The constant **FALSE** takes the numerical value of 0.

Example:
```
test:
res=IN(0) OR IN(2)
  IF res=FALSE THEN PRINT "Inputs are off"
ENDIF
```

PI

Type: Constant

Description: **PI** is the circumference/diameter constant of approximately 3.14159

Example:
```
circum=100
PRINT "Radius=";circum/(2*PI)
```

TRUE

Type: Constant

Description: The constant **TRUE** takes the numerical value of -1.

Example:

```
t=IN(0)=ON AND IN(2)=ON
IF t=TRUE THEN
  PRINT "Inputs are on"
ENDIF
```

Axis Parameters

ACCEL

Type: Axis Parameter

Syntax: **ACCEL=value**

Description: The **ACCEL** axis parameter may be used to set or read back the acceleration rate of each axis fitted. The acceleration rate is in units/sec/sec.

Example:
```
ACCEL=130:' Set acceleration rate
PRINT " Accel rate:";ACCEL;" mm/sec/sec"
```

ADDAX_AXIS

Type: Axis Parameter (Read Only)

Syntax: **ADDAX_AXIS**

Description: Returns the axis currently linked to with the **ADDAX** command, if none the parameter returns -1.

AFF_GAIN

Type: Axis Parameter

Syntax: **AFF_GAIN = value**

Description: Sets the acceleration Feed Forward for the axis. This is a multiplying factor which is applied to the rate of change of demand speed. The result is summed to the control loop output to give the **DAC_OUT** value.

Note: **AFF_GAIN** is only effective in systems with very high counts per revolution in the feedback. I.e. 65536 counts per rev or greater.

ATYPE

Type: Axis Parameter

Description: The **ATYPE** axis parameter indicates the type of axis fitted. On daughter board based axes, the **ATYPE** axis parameter is set by the system software at power up.

Controllers that use Feature Enable Codes to activate axes, such as the Euro205x and MC206X, have the **ATYPE** of each axis set by the system software depending on the Enabled Features on that *Motion Coordinator*. The **ATYPE** of Remote Axes must be set during initialisation in a suitable Trio BASIC program. e.g. STARTUP.BAS.

On the MC302X the **ATYPE** parameter must be set to select the axis function.

#	Description
0	No axis daughter board fitted
1	Stepper daughter board
2	Servo daughter board
3	Encoder daughter board
4	Stepper daughter with position verification / Differential Stepper
5	Resolver daughter board
6	Voltage output daughter board
7	Absolute SSI servo daughter board
8	CAN daughter board
9	Remote CAN axis
10	PSWITCH daughter board
11	Remote SLM axis
12	Enhanced servo daughter board
13	Embedded axis
14	Encoder output
15	Trio CAN
16	Remote SERCOS speed axis
17	Remote SERCOS position axis
18	Remote CANOpen position axis

#	Description
19	Remote CANOpen speed axis
20	Remote PLM axis
21	Remote user specific CAN axis
22	Remote SERCOS speed + registration axis
23	Remote SERCOS position + registration axis
24	SERCOS torque
25	SERCOS speed open
26	CAN 402 position mode
27	CAN 402 velocity mode
30	Remote Analog Feedback axis
31	Tamagawa absolute encoder + stepper
32	Tamagawa absolute encoder + servo
33	EnDat absolute encoder + stepper
34	EnDat absolute encoder + servo
35	PWM stepper
36	PWM servo
37	Step z
38	MTX dual port RAM
39	Empty
40	Trajexia Mechatrolink
41	Mechatrolink speed
42	Mechatrolink torque
43	Stepper 32
44	Servo 32
45	Step out 32
46	Tamagawa 32
47	Endat 32

#	Description
48	SSI 32
49	Mechatrolink servo inverter

Note: Some ATYPEs are not available on all products.

Example:
```
>>PRINT ATYPE AXIS(2)
1.0000
```
This would show that an stepper daughter board is fitted in this axis slot.

```
ATYPE AXIS(20)=16
```
Sets axis 20 to be a remote SERCOS speed axis. (This feature must be enabled with the correct Feature Enable Code first)

```
ATYPE AXIS(0)=4
```
Sets axis 0 to be a stepper with encoder verification axis on the MC302X.

AXIS_ADDRESS

Type: Axis Parameter

Description: The **AXIS_ADDRESS** axis parameter is used when control is being made of remote servo drives with SERCOS or CANOpen communications, or if an analogue input is used for feedback. The **AXIS_ADDRESS** holds the address of the remote servo drive or the AIN number of the analogue input to be used for feedback.

Note: Remote axes will require a Feature Enable Code to be entered before the remote axis can be used. When a SERCOS or CAN daughter board is fitted, 2 remote axes are enabled automatically.

AXIS_ENABLE

Type: Axis Parameter

Syntax: **AXIS_ENABLE = (ON/OFF)**

Description: Used when independent axis enabling is required with either SERCOS or MECHATRO-LINK. This parameter can be set ON or OFF for each axis individually. The default value is ON to maintain compatibility with earlier versions. The axis 'x' will be enabled if **AXIS_ENABLE AXIS(x) = ON and WDOG = ON.**

Note 1: **MOTION_ERROR** now returns a bit pattern showing the axes which have a motion error. i.e. if axes 2 and 5 have an error, the **MOTION_ERROR** value would be 40. (32+8)

Note 2: Both **WDOG** (non axis specific) & **AXIS_ENABLE** (axis specific) must be set ON for the axis to be enabled. If an axis has not been included in a **DISABLE_GROUP** and an error occurs on that axis, **WDOG** will be set OFF.

AXISSTATUS

Type: Axis Parameter (Read Only)

Description: The **AXISSTATUS** axis parameter may be used to check various status bits held for each axis fitted:

Bit	Description	Value	char
0	Unused	1	
1	Following error warning range	2	**w**
2	Communications error to remote drive	4	**a**
3	Remote drive error	8	**m**
4	In forward limit	16	**f**
5	In reverse limit	32	**r**
6	Datuming	64	**d**
7	Feedhold	128	**h**
8	Following error exceeds limit	256	**e**
9	In forward software limit	512	**x**
10	In reverse software limit	1024	**y**
11	Cancelling move	2048	**c**
12	Encoder power supply overload (MC206X)	4096	**o**
13	Set on SSI axis after initialisation	8192	
14	Status of FAULT input	16384	

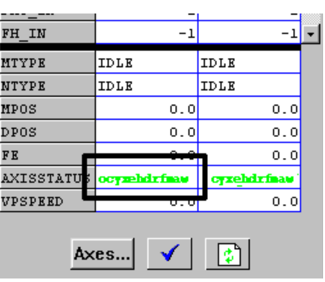
The **AXISSTATUS** axis parameter is set by the system software is read-only..

Example:

```
IF (AXISSTATUS AND 16)>0 THEN
  PRINT "In forward limit"
ENDIF
```

Note: In the *Motion* Perfect parameter screen the **AXISSTATUS** parameter is displayed as a series of characters, **ocyxehdrfmaw**, as listed in the table above.

These characters are displayed in green lowercase letters normally, or red uppercase when set.



See Also: **ERRORMASK, DATUM(0)**

BACKLASH_DIST

Type: Axis Parameter

Syntax: **value = BACKLASH_DIST**

Description: Amount of backlash compensation that is being applied to the axis when **BACKLASH** is on.

Example:

```
IF BACKLASH_DIST>100 THEN
  OP (10, ON)  'show that backlash compensation has reached
               'this value
ELSE
  OP (10, OFF)
END IF
```

BOOST

Type: Axis Parameter

Syntax: **BOOST=ON / BOOST=OFF**

Description: Sets the boost output on a stepper daughter board. The boost output is a dedicated open collector output on the stepper and stepper encoder daughter boards. The open collector can be switched on or off for each axis using this command.

Example: **BOOST AXIS(11)=ON**

CAN_ENABLE

Type: Axis Parameter

Description: The **CAN_ENABLE** axis parameter is used when control is being made of the remote servo drives with CAN communications. The **CAN_ENABLE** is used to control the enable on the remote servo drive.

CLOSE_WIN

Type: Axis Parameter

Alternate Format: **CW**

Description: By writing to this parameter the end of the window in which a registration mark is expected can be defined. The value is in user units.

Example: **CLOSE_WIN=10.**

CLUTCH_RATE

Type: Axis Parameter

Description: This affects operation of **CONNECT** by changing the connection ratio at the specified rate/second.

Default **CLUTCH_RATE** is set very high to ensure compatibility with earlier versions.

Example: **CLUTCH_RATE=5**

CREEP

Type: Axis Parameter

Description: Sets the creep speed on the current base axis. The creep speed is used for the slow part of a **DATUM** sequence. The creep speed must always be a positive value. When given a **DATUM** move the axis will move at the programmed **SPEED** until the datum input **DATUM_IN** goes low. The axis will then ramp the speed down and start a move in the reversed direction at the **CREEP** speed until the datum input goes high.

The creep speed is entered in units/sec programmed using the unit conversion factor. For example, if the unit conversion factor is set to the number of encoder edges/inch the speed is programmed in INCHES/SEC.

Example:
```
BASE(2)
CREEP=10
SPEED=500
DATUM(4)
CREEP AXIS(1)=10
SPEED AXIS(1)=500
DATUM(4) AXIS(1)
```

D_GAIN

Type: Axis Parameter

Syntax: **D_GAIN=value**

Description: The derivative gain is a constant which is multiplied by the change in following error.

Adding derivative gain to a system is likely to produce a smoother response and allow the use of a higher proportional gain than could otherwise be used.

High values may lead to oscillation. For a derivative term K_d and a change in following error d_e the contribution to the output signal is:

$$O_d = K_d \times \delta_e$$

Example: **D_GAIN=0.25**

D_ZONE_MIN

Type: Axis Parameter

Description: For Piezo Motor Control. This sets works in conjunction with **D_ZONE_MAX** to clamp the DAC output to zero when the demand movement is complete and the magnitude of the following error is less than the **D_ZONE_MIN** value. The servo loop will be reactivated when either the following error rises above the **D_ZONE_MAX** value, or a fresh movement is started.

Example:
```
D_ZONE_MIN = 3
D_ZONE_MAX = 10
```

With these 2 parameters set as above, the DAC output will be clamped at zero when the movement is complete and the following error falls below 3. When a movement is restarted or if the following error rises above a value of 10, the servo loop will be reactivated.

D_ZONE_MAX

Type: Axis Parameter

Description: This sets works in conjunction with **D_ZONE_MIN** to clamp the DAC output to zero when the demand movement is complete and the magnitude of the following error is less than the **D_ZONE_MIN** value. The servo loop will be reactivated when either the following error rises above the **D_ZONE_MAX** value, or a fresh movement is started.

Example:
```
D_ZONE_MIN = 3
D_ZONE_MAX = 10
```

With these 2 parameters set as above, the DAC output will be clamped at zero when the movement is complete and the following error falls below 3. When a movement is restarted or if the following error rises above a value of 10, the servo loop will be reactivated.

DAC

Type: Axis Parameter

Description: Writing to this axis parameter when **SERVO=OFF** allows the user to force a specified voltage on a servo axis. The range of values that a 12 bit DAC can take is:

DAC=-2048 corresponds to a voltage of 10V
to
DAC=2047 corresponds to a voltage of -10v

The range of values that a 16 bit DAC can take is:

DAC=32767 corresponds to a voltage of 10V
to
DAC=-32768 corresponds to a voltage of -10v

Note: See **DAC_SCALE** for a list of DAC types.

Example: To force a square wave of amplitude +/-5V and period of approximately 500ms on axis 0.

```
WDOG=ON
SERVO AXIS(0)=OFF
square:
  DAC AXIS(0)=1024
  WA(250)
  DAC AXIS(0)=-1024
  WA(250)
GOTO square
```

DAC_OUT

Type: Axis Parameter (Read Only)

Description: The axis DAC is the electronics hardware used to output +/-10volts to the servo drive when using a servo daughter board. The **DAC_OUT** parameter allows the value being used to be read back. The value put on the DAC comes from 2 potential sources:

If the axis parameter **SERVO** is set **OFF** then the axis parameter DAC is written to the axis hardware. If the **SERVO** parameter is **ON** then a value calculated using the servo algorithm is placed on the DAC. Either case can be read back using **DAC_OUT**. Values returned will be in the range -2048 to 2047.

Example:

```
>>PRINT DAC_OUT AXIS(8)
288.0000
>>
```

DAC_SCALE

Type: Axis Parameter

Description: The **DAC_SCALE** axis parameter is an integer multiplier which is applied between the control loop output and the Digital to Analog converter. **DAC_SCALE** can be set to value 16 on axes with a 16 bit DAC. This scales the values applied to the higher resolution DAC so that the gains required on the axis are similar to those required on axes with a 12 bit DAC.

DAC_SCALE may be set negative to reverse the polarity of the DAC output signal. When the servo is off the magnitude of **DAC_SCALE** is not important as the voltage applied is controlled by the DAC parameter. The polarity is still reversed however by **DAC_SCALE**.

Example: **DAC_SCALE AXIS(3)=-16**

Product	DAC Size	Default DAC_SCALE
P200 Servo DB	12 bit	1
P270 SSI Servo DB	12 bit	1
P201 Enhanced Servo DB	16 bit	1
P136 MC206X	16 bit	16
P156 Euro205x	12 bit	1
P184 / P185 PCI208	16 bit	16

Note: To obtain true 16 bit output with a 16 bit D to A converter, the **DAC_SCALE** must be set to 1 or -1 and the loop gains increased by a factor of 16 compared to those used on an equivalent 12 bit axis.

DATUM_IN

Type: Axis Parameter

Alternate Format: **DAT_IN**

Description: This parameter holds a digital input channel to be used as a datum input. The input can be in the range 0..31. If **DATUM_IN** is set to -1 (default) then no input is used as a datum.

Example: **DATUM_IN AXIS(0)=28**

Note: Feedhold, forward, reverse, datum and jog inputs are ACTIVE LOW.

DECEL

Type: Axis Parameter

Syntax: **DECEL=value**

Description: The **DECEL** axis parameter may be used to set or read back the deceleration rate of each axis fitted. The deceleration rate will be returned in units/sec/sec.

Example:

```
DECEL=100' Set deceleration rate
PRINT " Decel is ";DECEL;" mm/sec/sec"
```

DEMAND_EDGES

Type: Axis Parameter (Read Only)

Description: Allows the user to read back the current **DPOS** in encoder edges.

Example: **>>PRINT DEMAND_EDGES AXIS(4)**

DEMAND_SPEED

Type: Axis Parameter (Read Only)

Description: Returns the speed output of the UPU in edges or counts per millisecond. Normally used for low level debug of the motion system.

Example:
```
>>?DEMAND_SPEED
5.0000
```

DPOS

Type: Axis Parameter (Read Only)

Description: The demand position **DPOS** is the demanded axis position generated by the move commands. Its value may also be adjusted without doing a move by using the **DEF-POS()** or **OFFPOS** commands. It is reset to 0 on power up or software reset. The demand position must never be written to directly although a value can be forced to create a step change in position by writing to the **ENDMOVE** parameter if no moves are currently in progress on the axis.

Example: **>>? DPOS AXIS(10)**
This will return the demand position in user units.

DRIVE_CLEAR

Type: Axis Function

Syntax: **DRIVE_CLEAR**

Description: Reset and clear the local drive and clear the drive fault flags. Trio “Drive-In” module only. **DRIVE_CLEAR** will run the drive’s own error reset procedure so that if the external conditions allow, the drive will then be ready to run.

Example:

```
WHILE TRUE'Error Handler Program
      IF AXISSTATUS=256 OR AXISSTATUS=258 THEN  'Check for FE fault
      GOSUB reset_routine
      PRINT #5,"All Clear…"
      ENDIF
      WEND 'End program loop
Reset_routine:
     DATUM(0)'Clear FE fault in MC302-K
     DRIVE_CLEAR'Reset drive faults
     WA(100)'Wait in ms
     WDOG=OFF'Cycle enable (WDOG) to the drive…
     WA(50)
     SERVO=ON'Close position loop in MC302-K
     WDOG=ON'Enable drive
     WA(50)
     RETURN
```

DRIVE_CONTROL

Type: Axis Parameter

Description: Sets the value of a control word that is sent to a drive via a digital communications bus, e.g. SERCOS, CAN etc, or to the the local drive when used with a Trio “Drive-In” module.

DRIVE_ENABLE

Type: Axis Parameter

Description: Controls the cyclic communication to a remote drive. When set to 1 cyclic transmission is started. Cyclic comms include a sync telegram and set point telegram sent via the communications bus in use.

Example:

```
DRIVE_ENABLE AXIS(0)=1
DRIVE_ENABLE AXIS(1)=1
```

DRIVE_EPROM

Type: Drive Function

Syntax: **DRIVE_EPROM**

Description: Forces the local drive to perform a save function and save the drive perameters to the drive's flash eprom. Trio "Drive-In" module only.

DRIVE_HOME

Type: Drive Function

Syntax: **DRIVE_HOME**

Description: When the **DRIVE_HOME** is encountered in a Trio BASIC program, the drive will begin its internal homing sequence.

The mode of homing will be based on the settings of the drive's **DREF, NREF, VREF, IN1MODE**, and **REFMODE** parameters. See the homing example in the "Drive-In" Technical Reference Manual. The Trio BASIC program will pause on the **DRIVE_HOME** line until the drive completes the homing sequence (when the Motion Task Active is cleared).

DRIVE_INPUTS

Type: Axis Parameter

Syntax: **DRIVE_INPUTS**

Description: Read input word from a remote or "Drive-In" drive with digital communications capability.

Example: **PRINT DRIVE_INPUTS AXIS(2)**

DRIVE_INTERFACE

Type: Axis Parameter

Syntax: **DRIVE_INTERFACE (function, parameter value)**

Description: Low-level communications link between a "Drive-In" module and the local drive.

The **DRIVE_INTERFACE** provides direct access to the Dual Port RAM in the drive regardless of communication status between the "Drive-In" and the Drive. Even catastrophic drive errors such as "System Error" can be read back using function mode 5, letting a Trio BASIC program determine the drive's status.

Example: **DRIVE_INTERFACE(5,ERRCODE_Byte) 'get error code byte from S3000 drive**

Note: The above example returns either the Most Significant Word (MSW) when **ERRCODE_byte=0**; and the Least Significant Word (LSW) when ERRCODE_byte=1. This is the 32-bit value ERRCODE that is provided by the drive, with 1 bit per fault raised by the drive. A 0 indicates that the fault is not present and a 1 indicates that it is. Bit 0 indicates the status of F01 and bit 31 indicates the status of F32. For example, if faults F29 and F04 are present then **DRIVE_INTERFACE (5,0)** would return 4096 (or hex 1000) and **DRIVE_INTERFACE (5,1)** would return 8.

DRIVE_MODE

Type: Axis Parameter

Syntax: **DRIVE_MODE**

Description: Read or set the mode of a remote or "Drive-In" drive with digital communications capability.

Example: **DRIVE_MODE AXIS(5)=mode1**

DRIVE_MONITOR

Type: Axis Parameter

Syntax: **DRIVE_MONITOR**

Description: Read a monitor word from a remote or "Drive-In" drive with digital communications capability.

Example: **PRINT DRIVE_MONITOR AXIS(0)**

DRIVE_READ

Type: Drive Function

Syntax: **DRIVE_READ (register[, time])**

Description: Reads a drive parameter from the local drive. Trio "Drive-In" modules only.

Parameters: **Register:** Drive parameter 1

Time: Optional time out value in msec (default=100)

Example: **PRINT DRIVE_READ ($0A, 256)**

DRIVE_RESET

Type: Axis Parameter

Syntax: **DRIVE_RESET [phase]**

Description: Reset the communications link between A "Drive-In" module and the local drive. The **DRIVE_RESET** is typically not required for normal operation. The optional communication phase parameter between the "Drive-In" module and the drive.

Example: **DRIVE_RESET**

Command used to re-establish communications after a "Network Timeout Error" or "Network Protocol Error" error. These errors are due to a command timeout between the MC302-K and the drive. The **DRIVE_RESET** command will reset the communications link between the MC302-K and the local drive.

DRIVE_STATUS

Type: Axis Parameter

Syntax: **DRIVE_STATUS**

Description: Returns the status register of a drive with digital communications capability connected to the *Motion Coordinator*.

In the case of an SLM axis it returns the SLM and drive status:
Bits 0..7 return bits 0..7 of register 0x8000 on the drive. Bits 8..23 return register 0xD000 on the SLM.

Example:

```
>>PRINT DRIVE_STATUS AXIS(8)
0.0000
>>
```

DRIVE_WRITE

Type: Drive Function

Syntax: **DRIVE_WRITE (register, value[, time])**

Description: Writes a value to a drive parameter in the local drive. Trio "Drive-In" modules only.

Parameters:

Register:	Drive parameter 1
Value:	Value to be written
Time	Optional time out value in msec (default=100)

ENCODER

Type: Axis Parameter (Read Only)

Description: The **ENCODER** axis parameter holds a raw copy of the encoder hardware register or the raw data received from a fieldbus controlled drive. On Servo daughter boards, for example, this can be a 12 bit (Modulo 4096) or 14 bit (Modulo 16384) number. On absolute axes the **ENCODER** register holds a value using the number of bits programmed with **ENCODER_BITS**.

The **MPOS** axis measured position is calculated from the **ENCODER** value automatically allowing for overflows and offsets. On MC302X and the built-in axes of a Euro205x or MC206X the **ENCODER** register is 14 bit.

ENCODER_BITS

Type: Axis Parameter

Description: This parameter is only used with an absolute encoder axis. It is used to set the number of data bits to be clocked out of the encoder by the axis hardware. There are 2 types of absolute encoder supported by this parameter; SSI and EnDat. For SSI, the maximum permitted value is 24. The default value is 0 which will cause no data to be clocked from the SSI encoder, users MUST therefore set a value to suit the encoder. With the EnDat encoder, bits 0..7 of the parameter are the <u>total</u> number of encoder bits and bits 8..14 are the number of multi-turn bits to be used.

If the number of **ENCODER_BITS** is to be changed, the parameter must first be set to zero before entering the new value.

Example 1:
```
‘ set up 2 axes of SSI absolute encoder
ENCODER_BITS AXIS(3) = 12
ENCODER_BITS AXIS(7) = 21
```

Example 2:
```
‘re-initialise MPOS using absolute value from encoder
SERVO=OFF
ENCODER_BITS = 0
ENCODER_BITS = databits
```

Example 3:
```
‘ A 25 bit EnDat encoder has 12 multi-turn and 13 bits/turn
‘ resolution. (total number of bits is 25)
ENCODER_BITS = 25 + (256 * 12)
```

Note: If the number of **ENCODER_BITS** is to be changed, the parameter must first be set to zero before entering the new value.

ENCODER_CONTROL

Type: Axis Parameter

Description: Endat encoders can be set to either cyclically return their position, or they can be set to a parameter read/write mode. The mode is controlled with the parameter **ENCODER_CONTROL**.

ENCODER_CONTROL = 1 ' sets parameter read/write mode

ENCODER_CONTROL = 0 ' sets cyclic position return mode

ENCODER_CONTROL is set to 0 on power up or reset. Using the **ENCODER_READ** or **ENCODER_WRITE** functions will set the parameter to 1 automatically.

On the PCI 208 the **ENCODER_CONTROL** should be set for the axis pairs 0/1, 2/3, 4/5 or 6/7 at the same time due to the configuration of the interface transceivers.

Example 1:
```
' Set axes to parameter mode in a pair (PCI 208)
ENCODER_CONTROL AXIS(0)=1
ENCODER_CONTROL AXIS(1)=1
```

ENCODER_ID

Type: Axis Parameter

Description: This parameter returns the ENID parameter from the encoder (fixed at 17 decimal).

(Tamagawa abolute encoder only)

ENCODER_READ

Type: Axis Command

Syntax: **ENCODER_READ (register address)**

Description: Read an internal register from an Absolute Encoder. EnDat absolute encoder only.

Example: **PRINT ENCODER_READ (endat_address)**

ENCODER_STATUS

Type: Axis Parameter

Syntax: **ENCODER_STATUS**

Description: This axis parameter returns both the status field SF and the ALMC encoder error field. The ALMC field is in bits 8..15. The SF field is in bits 0..7.

(Tamagawa abolute encoder only)

ENCODER_TURNS

Type: Axis Parameter

Description: **1. Tamagawa absolute encoder:** This axis parameter returns the number of multi-turn counts from fields ABM0/ABM1/AMB2 of the encoder. The multi-turn data is not automatically applied to the axis **MPOS** after initialisation. The application programmer must apply this from BASIC using **OFFPOS** or **DEFPOS** as required.

2. EnDat absolute encoder: This axis parameter returns the number of multi-turn counts from the encoder.

ENCODER_WRITE

Type: Axis Command

Syntax: **ENCODER_WRITE (register addres, value)**

Description: Write an internal register to an Absolute Encoder. EnDat absolute encoder only.

Example: **ENCODER_WRITE (endat_address, setvalue)**

ENDMOVE

Type: Axis Parameter

Description: This parameter holds the position of the end of the current move in user units. It is normally only read back although may be written to if required provided that **SERVO=ON** and no move is in progress. This will produce a step change in **DPOS**. Making step changes in **DPOS** can easily lead to "Following error exceeds limit" errors unless the steps are small or the **FE_LIMIT** is high.

ENDMOVE_BUFFER

Type: Axis Parameter (Read only)

Only available in system software versions where "LookAhead" is enabled.

Description: This holds the absolute position at the end of the buffered sequence. It is adjusted by **OFFPOS/DEFPOS**. The individual moves in the buffer are incremental and do not need to be adjusted by **OFFPOS** (Look-ahead versions only).

Example: **>>? ENDMOVE_BUFFER AXIS(0)**

This will return the absolute position at the end of the current buffered sequence on axis 0.

ENDMOVE_SPEED

Type: Axis Parameter

Only available in system software versions where “LookAhead” is enabled.

Description: This is used in conjunction with **MOVESP, MOVEASBSSP, MOVECIRCSP** and **MHELICALSP**. It is loaded into the buffer at the same time as the move. The controller will (using the specified value of **ACCEL** or **DECEL**) change the speed of the vector moves so by the end of the **MOVE** starts in **MTYPE** the axis **VPSPEED = FORCE SPEED** (Look-ahead versions only).

Example:

```
SPEED=15
```

(other moves are loaded into the buffer)

```
ENDMOVE_SPEED=10
MOVESP(20)
```

In this example the controller will start ramping down the speed (at the specified rate of **DECEL**) so at the end of the **MOVESP(20)** the **VPSPEED=10**. After which, if another SP move type isn't issued the speed will ramp back to a speed of 15. **ENDMOVE_SPEED** takes priority over **FORCE_SPEED**).

ERRORMASK

Type: Axis Parameter

Description: The value held in this parameter is bitwise **AND**ed with the **AXISSTATUS** parameter by every axis on every servo cycle to determine if a runtime error should switch off the enable (**WDOG**) relay. If the result of the **AND** operation is not zero the enable relay is switched OFF.

On the MC302X the default setting is 256. This will trip the enable relay only if a following error condition occurs.

For the MC206X and Euro205x, the default value is 268 which is set to also trap critical errors with digital drive communications.

After a critical error has tripped the enable relay, the *Motion Coordinator* must either be reset, or a **DATUM(0)** command must be executed to reset the error flags. **DATUM(0)** is a global command (affects all axes) and needs to run once only.

See Also: **AXISSTATUS, DATUM(0)**

FAST_JOG

Type: Axis Parameter

Description: This parameter holds the input number to be used as the fast jog input. The input can be in the range 0..31. If **FAST_JOG** is set to -1 (default) then no input is used for the fast jog. If the **FAST_JOG** is asserted then the jog inputs use the axis **SPEED** for the jog functions, otherwise the **JOGSPEED** will be used.

Note: Feedhold, forward, reverse, datum and jog inputs are ACTIVE LOW.

FASTDEC

Type: Axis Parameter

Description: The **FASTDEC** axis parameter may be used to set or read back the fast deceleration rate of each axis fitted. Fast deceleration is used when a **CANCEL** is issued, for example; from the user, a program, or from a software or hardware limit. If the motion finishes normally or **FASTDEC = 0** then the **DECEL** value is used.

Example:

```
DECEL=100 'set normal deceleration rate
FASTDEC=1000 'set fast deceleration rate
MOVEABS(10000) 'start a move
WAIT UNTIL MPOS= 5000 'wait until the move is half finished
CANCEL 'stop move at fast deceleration rate
```

FE

Type: Axis Parameter (Read Only)

Description: This parameter is the position error, which is equal to the demand position(**DPOS**)- measured position (**MPOS**). The parameter is returned in user units.

FE_LATCH

Type: Axis Parameter (Read Only)

Description: Contains the intial FE value which caused the axis to put the controller into "MOTION_ERROR". This value is only set when the FE exceeds the **FE_LIMIT** and the **SERVO** parameter has been set to 0. **FE_LATCH** is reset to 0 when the axis' **SERVO** parameter is set back to 1.

FE_LIMIT

Type: Axis Parameter

Alternate Format: **FELIMIT**

Syntax: **FE_LIMIT = value**

Description: This is the maximum allowable following error. When exceeded the controller will generate a run time error and always resets the enable (**WDOG**) relay thus disabling further motor operation. This limit may be used to guard against fault conditions such as mechanical lock-up, loss of encoder feedback, etc. It is returned in USER UNITS.

The default value is 2000 encoder edges.

FE_LIMIT_MODE

Type: Axis Parameter

Syntax: **FE_LIMIT_MODE = value**

Description: When this parameter is set to 0, the axis will cause a **MOTION_ERROR** immediately if the FE exceeds the **FE_LIMIT** value.

If **FE_LIMIT_MODE** is set to 1, the axis will only generate a **MOTION_ERROR** when the FE exceeds **FE_LIMIT** during 2 consecutive servo periods. This means that if **FE_LIMIT** is exceeded for one servo period only, it will be ignored.

The default value for **FE_LIMIT_MODE** is 0.

FE_RANGE

Type: Axis Parameter

Syntax: **FE_RANGE = value**

Description: Following error report range. When the following error exceeds this value on a servo axis, the axis has bit 1 in the **AXISSTATUS** axis parameter set.

FEGRAD

Type: Axis Parameter

Syntax: **FEGRAD=value**

Description: Following error limit gradient. Specifies the allowable increase in following error per unit increase in velocity profile speed. The parameter is not currently used in the motion generator program.

FEMIN

Type: Axis Parameter

Syntax: **FEMIN=value**

Description: Following error limit at zero speed. The parameter is not currently used in the motion generator program.

FHOLD_IN

Type: Axis Parameter

Alternate Format: **FH_IN**

Syntax: **FHOLD_IN=value**

Description: This parameter holds the input number to be used as a feedhold input. The input can be in the range 0..31. If **FHOLD_IN** is set to -1 (default) then no input is used as a feedhold. When the feedhold input is set motion on the specified axis has its speed overridden to the Feedhold speed (**FHSPEED**) WITHOUT CANCELLING THE MOVE IN PROGRESS. This speed is usually zero. When the input is reset any move in progress when the input was set will go back to the programmed speed. Moves which are not speed controlled E.G. **CONNECT**, **CAMBOX**, **MOVELINK** are not affected.

Note: Feedhold, forward, reverse, datum and jog inputs are ACTIVE LOW.

FHSPEED

Type: Axis Parameter

Syntax: **FHSPEED=value**

Description: When the feedhold input is set motion is usually ramped down to zero speed as the feedhold speed is set to its default zero value. In some cases it may be desirable for the axis to ramp to a known constant speed when the feedhold input is set. To do this the **FHSPEED** parameter is set to a non zero value. The value is in user units/sec.

FORCE_SPEED

Type: Axis Parameter

Only available in system software versions where "LookAhead" is enabled.

Description: This is used in conjunction with **MOVESP, MOVEASBSSP, MOVECIRCSP** and **MHELICALSP**. It is loaded into the buffer at the same time as the move. The controller will (using the specified value of **ACCEL** or **DECEL**) change the speed of the vector moves so at the point the move starts in **MTYPE** the axis **VPSPEED = FORCE SPEED** (LookAhead versions only).

Example:

```
SPEED = 15
```

(other moves are loaded into the buffer)

```
FORCE_SPEED = 10
MOVESP(20)
```

In this example the controller will ramp the speed down to a speed of 10 for the duration of the **MOVESP(20)**, after which it will ramp back to a speed of 15. (If **ENDMOVE_SPEED** is set then this takes priority over force speed).

FS_LIMIT

Type: Axis Parameter

Alternate Format: **FSLIMIT**

Description: An end of travel limit may be set up in software thus allowing the program control of the working envelope of the machine. This parameter holds the absolute position of the forward travel limit in user units. When the limit is hit the controller will ramp down the speed to zero then cancel the move. Bit 9 of the **AXISSTATUS** register is set when the axis position is greater than the **FS_LIMIT**.
FS_LIMIT is disabled when it has a value greater than **REP_DIST**.

FULL_SP_RADIUS

Type: Controller Parameter

Only available in system software versions where "LookAhead" is enabled.

Description: This sets the full speed radius in user UNITS. Once set the controller will use the full programmed **SPEED** value for radii above the value of **FULL_SP_RADIUS**. Where the radius is below the value of **FULL_SP_RADIUS** the controller will proportionally reduce the speed.

Example: In the following program, when the first **MOVECIRC** is reached the speed remains at 10 because the radius (8) is greater than that set in **FULL_SP_RADIUS**. For the second **MOVECIRC** the speed is reduced by 50% to a value of 5, because the radius is 50% of that stored in **FULL_SP_RADIUS**.

```
MERGE=ON
SPEED=10
FULL_SP_RADIUS=6
DEFPOS(0,0)

MOVE(10,10)
MOVE(10,5)
MOVE(5,5)
MOVECIRC(8,8,0,8,1)
MOVECIRC(3,3,0,3,1)
MOVE(5,5)
MOVE(10,5)
```

FWD_IN

Type: Axis Parameter

Description: This parameter holds the input number to be used as a forward limit input. The input can be in the range 0..31. If **FWD_IN** is set to -1 (default) then no input is used as a forward limit. When the forward limit input is asserted any forward motion on that axis is stopped.

Example: **FWD_IN=19**

Note: Feedhold, jog forward, reverse and datum inputs are ACTIVE LOW.

FWD_JOG

Type: Axis Parameter

Description: This parameter holds the input number to be used as a jog forward input. The input can be in the range 0..31. If **FWD_JOG** is set to -1 (default) then no input is used as a forward jog.

Example: **FWD_JOG=7**

Note: Feedhold, forward, reverse, datum and jog inputs are ACTIVE LOW.

I_GAIN

Type: Axis Parameter

Description: The integral gain is a constant which is multiplied by the sum of following errors of all the previous samples. This term may often be set to 0 (Default). Adding integral gain to a servo system reduces position error when at rest or moving steadily but it will produce or increase overshoot and may lead to oscillation.

For an integral gain K_i and a sum of position errors $\int e$, the contribution to the output signal is:

$$O_i = K_i \times \int e$$

Note: Servo gains have no effect on stepper motor axes.

INVERT_STEP

Type: Axis Parameter

Description: **INVERT_STEP** is used to switch a hardware inverter into the stepper pulse output circuit. This can be necessary in for connecting to some stepper drives. The electronic logic inside the *Motion Coordinator* stepper pulse generation assumes that the FALLING edge of the step output is the active edge which results in motor movement. This is suitable for the majority of stepper drives. Setting **INVERT_STEP=ON** effectively makes the RISING edge of the step signal the active edge. **INVERT_STEP** should be set if required prior to enabling the controller with **WDOG=ON**. Default=OFF.

Note: If the setting is incorrect. A stepper motor may lose position by one step when changing direction.

JOGSPEED

Type: Axis Parameter

Description: Sets the slow jog speed in user units for an axis to run at when performing a slow jog. A slow jog will be performed when a jog input for an axis has been declared and that input is low. The jog will be at the **JOGSPEED** provided the **FAST_JOG** input has not be declared and is set low. Two separate jog inputs are available for each axis **FWD_JOG** and **REV_JOG**.

LIMIT_BUFFERED

Type: Controller Parameter

Only available in system software versions where “LookAhead” is enabled.

Description: This sets the maximum number of move buffers available in the controller. The maximum value (and also the default) is 16 (look-Ahead versions only).

Example:
```
LIMIT_BUFFERED=10
```

This will set the total number of available buffered moves in the controller to 10.

LINKAX

Type: Axis Parameter (Read Only)18

Description: Returns the axis number that the axis is linked to during any linked moves. Linked moves are where the demand position is a function of another axis. E.G. **CONNECT, CAMBOX, MOVELINK**

MARK

Type: Axis Parameter (Read Only)

Description: Returns **TRUE** when a registration event has occurred. This is set to **FALSE** by the **REGIST** command and set to true when the registration event occurs. When **TRUE** the **REG_POS** is valid.

Example:
```
loop:
  WAIT UNTIL IN(punch_clr)=ON
  MOVE(index_length)
  REGIST(3)' rising edge of R
  WAIT UNTIL MARK  MOVEMODIFY(REG_POS + offset)
  WAIT IDLE
GOTO loop
```

MARKB

Type: Axis Parameter (Read Only)

Description: MARKB returns **TRUE** when the second registration position has been latched. This is set to **FALSE** by the **REGIST** command and set to **TRUE** when the registration event occurs. When **MARKB** is **TRUE** the **REG_POSB** is valid.

The second registration input is R1 on the P201 and the Z input on the MC206X.

See also **REGIST()** and **REG_POSB**.

MERGE

Type: Axis Parameter

Syntax: **MERGE=ON / MERGE=OFF**

Description: This is a software switch which can be used to enable or disable the merging of consecutive moves. With merging enabled, if the next move is already in the buffer the axis will not ramp down to zero speed but load up the following move allowing them to be seamlessly merged. Note that it is up to the programmer to ensure that the merging is sensible. For example merging a forward move with a reverse move will cause an attempted instantaneous change of direction.

MERGE will only function if:

1) The next move is loaded

2) Axis group does not change on multi-axis moves

3) Velocity profiled moves (**MOVE, MOVEABS, MOVECIRC, MHELICAL, REVERSE, FORWARD**) cannot be merged with linked moves (**CONNECT,MOVELINK,CAMBOX**)

Note: When merging multi-axis moves only the base axis **MERGE** flag needs to be set.

If the moves are short a high deceleration rate must be set to avoid the controller ramping the speed down in anticipation of the end of the buffered move

Example:
```
MERGE=OFF'   Decelerate at the end of each move
MERGE=ON'    Moves will be merged if possible
```

MICROSTEP

Type: Axis Parameter

Description: Sets microstepping mode when using a stepper daughter board, P230, P240 and P280. On these controllers the stepper pulse circuit contains a circuit which places the step pulses more evenly in time by dividing the pulse rate by 2 or 16:

MICROSTEP=OFF (DEFAULT)	62.5 kHz Maximum
MICROSTEP=ON	500 kHz Maximum

(On the MC206X a different pulse generation circuit is used which always divides the pulse rate by 16 and is NOT affected by the **MICROSTEP** parameter. This circuit can generate pulses up to 2Mhz) The stepper daughter board can generate pulses at up to 62500 Hz with **MICROSTEP=OFF** (This is the default setting and should be used when the pulse rate does not exceed 62500 Hz even if the motor is microstepping) With **MICROSTEP=ON** the stepper board can generate pulses at up to 500,000 Hz although the pulses are not so evenly spaced in time.

With **MICROSTEP=OFF** the **UNITS** parameter should be set to 16 times the number of pulses in a distance parameter. With **MICROSTEP=ON** the **UNITS** should be set to 2 times the number.

Example:
```
UNITS AXIS(2)=180*2' 180 pulses/rev * 2
MICROSTEP AXIS(2)=ON
```

MOVES_BUFFERED

Type: Axis Parameter (Read only)

Only available in system software versions where "LookAhead" is enabled.

Description: This returns the number of moves being buffered by the axis when using the look-ahead functionality (look-ahead versions only).

Example:
```
>>? VECTOR_BUFFERED AXIS(0)
```

This will return the total number of current buffered moves.

MPOS

Type: Axis Parameter (Read Only)

Description: This parameter is the position of the axis as measured by the encoder or resolver. It is reset to 0 (unless a resolver is fitted) on power up or software reset. The value is adjusted using the **DEFPOS()** command or **OFFPOS** axis parameter to shift the datum position or when the **REP_DIST** is in operation. The position is reported in user units.

Example:
```
WAIT UNTIL MPOS>=1250
SPEED=2.5
```

MSPEED

Type: Axis Parameter (Read Only)

Description: The **MSPEED** represents the change in measured position in user units (per second) in the last servo period. The **SERVO_PERIOD** defaults to 1msec. It therefore can be used to represent the speed measured. This value represents a snapshot of the speed and significant fluctuations can occur, particularly at low speeds. It can be worthwhile to average several readings if a stable value is required at low speeds.

MTYPE

Type: Axis Parameter (Read Only)

Description: This parameter holds the type of move currently being executed.

MTYPE	Move Type
0	Idle (No move)
1	MOVE
2	MOVEABS
3	MHELICAL
4	MOVECIRC
5	MOVEMODIFY
10	FORWARD
11	REVERSE
12	DATUMING
13	CAM
14	Forward Jog
15	Reverse Jog
20	CAMBOX
21	CONNECT
22	MOVELINK

This parameter may be interrogated to determine whether a move has finished or if a transition from one move type to another has taken place.

A non-idle move type does not necessarily mean that the axis is actually moving. It may be at zero speed part way along a move or interpolating with another axis without moving itself.

NEG_OFFSET

Type: Axis Parameter

Description: For Piezo Operation. This allows a negative offset to be applied to the output DAC signal from the servo loop. The offset is applied after the **DAC_SCALE** function. An offset of 327 will represent an offset of 0.1 volts when using an MC206X with a 16bit DAC. An offset of 20 will represent 0.1 volts when using a servo daughterboard with a 12bit DAC. It is suggested that an offset of 65% to 70% of the value required to make the stage move in an open loop situation is used

If **MTYPE** is tested directly after a **MOVE** is started, it is neccessary to allow a short delay while the move is loaded into the Velocity Profile Generator.

Example 1:
```
MOVE(100)
WA(2)
WAIT UNTIL(MTYPE=0) OR (IN(56)=ON)
```

Example 2:
```
MOVELINK(200, 250, 50, 50, 4)
MOVELINK(120, 180, 60, 60, 4)
WAIT LOADED
WHILE MTYPE<70
    'do something while waiting
WEND
```

NTYPE

Type: Axis Parameter (Read Only)

Description: This parameter holds the type of the next buffered move. The values held are as for **MTYPE**. If no move is buffered zero will be returned. The **NTYPE** parameter is read only but the **NTYPE** can be cleared using **CANCEL(1)**

OFFPOS

Type: Axis Parameter

Description: The **OFFPOS** parameter allows the axis position value to be offset by any amount without affecting the motion which is in progress. **OFFPOS** can therefore be used to effectively datum a system at full speed. Values loaded into the **OFFPOS** axis parameter are reset to 0 by the system software after the axis position is changed.

Example 1: Change the current position by 125, using the command line terminal:

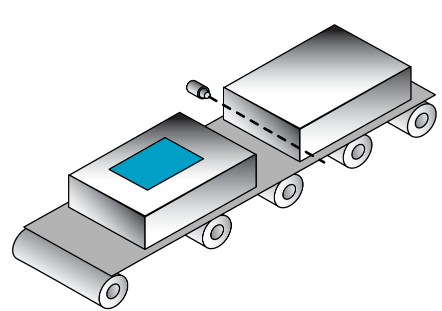
```
>>?DPOS
300.0000
>>OFFPOS=125
>>?DPOS
425.0000
```

Example 2: Define the current demand position as zero:

```
OFFPOS=-DPOS
WAIT UNTIL OFFPOS=0'   wait until applied
```

This is equivalent to **DEFPOS(0)**

Example 3: A conveyor is used to transport boxes onto which labels must be applied.



Using the **REGIST()** function, we can capture the position at which the leading edge of the box is seen, then by using **OFFPOS** we can adjust the measured position of the axis to be zero at that point. Therefore, after the registration event has occurred, the measured position (seen in **MPOS**) will actually reflect the absolute distance from the start of the box, the mechanism which applies the label can take advantage of the absolute position start mode of the **MOVELINK** or **CAMBOX** commands to apply the label.

```
BASE(conv)
REGIST(3)
WAIT UNTIL MARK
OFFPOS = -REG_POS ' Leading edge of box is now zero
```

Note: The **OFFPOS** adjustment is executed on the next servo period. Several Trio BASIC instructions may occur prior to the next servo period. Care must be taken to ensure these instructions do not assume the position shift has occurred.

OPEN_WIN

Type: Axis Parameter

Alternate Format: **OW**

Description: This parameter defines the first position of the window which will be used for registration marks if windowing is specified by the **REGIST()** command.

Example:
```
'only look for registration marks between 170 1nd 230mm
OPEN_WIN=170.00
CLOSE_WIN=230.0
REGIST(256+3)
WAIT UNTIL MARK
```

OUTLIMIT

Type: Axis Parameter

Description: The output limit restricts the voltage output from a servo axis to a lower value than the maximum. The value required varies depending on whether the axis has a 12 bit or 16 bit DAC. If the voltage output is generated by a 12 bit DAC values an **OUTLIMIT** of 2047 will produce the full +/-10v range. If the voltage output is generated by a 16 bit DAC values an **OUTLIMIT** of 32767 will produce the full +/-10v range. See DAC types for each controller.

Example:
```
OUTLIMIT AXIS(0)=1023
```

The above will limit the voltage output to a ±5V output range on a servo daughter board axis. This will apply to the **DAC** command if **SERVO=OFF** or to the voltage output by the servo if **SERVO=ON**.

OV_GAIN

Type: Axis Parameter

Description: The output velocity gain is a gain constant which is multiplied by the change in measured position. The result is summed with all the other gain terms and applied to the servo DAC. Default value is 0. Adding NEGATIVE output velocity gain to a system is mechanically equivalent to adding damping. It is likely to produce a smoother response and allow the use of a higher proportional gain than could otherwise be used, but at the expense of higher following errors. High values may lead to oscillation and produce high following errors. For an output velocity term Kov and change in position ΔPm, the contribution to the output signal is:

$$O_{ov} = K_{0v} \times \delta P_m$$

Note: Negative values are normally required. Servo gains have no effect on stepper motor axes.

P_GAIN

Type: Axis Parameter

Description: The proportional gain sets the 'stiffness' of the servo response. Values that are too high will produce oscillation. Values that are too low will produce large following errors.
For a proportional gain K_p and position error E, its contribution to the output signal is:

$$O_p = K_p \times E$$

Note: **P_GAIN** may be fractional values. The default value is 1.0. Servo gains have no effect on stepper motor axes.

Example: **P_GAIN AXIS(11)=0.25**

PLM_OFFSET

Type: Axis Parameter

Description: Sets an internal position offset within the *Motion Coordinator* to allow for a difference between **DPOS** and the position feedback of the PLM axis.

POS_OFFSET

Type: Axis Parameter

Description: For Piezo Operation. This keyword allows a positive offset to be applied to the output DAC signal from the servo loop. The offset is applied after the **DAC_SCALE** function. An offset of 327 will represent an offset of 0.1 volts when using an MC206X with a 16bit DAC. An offset of 20 will represent 0.1 volts when using a servo daughterboard with a 12bit DAC. It is suggested that as offset of 65% to 70% of the value required to make the stage move in an open loop situation is used.

PP_STEP

Type: Axis parameter

Description: This parameter allows the incoming raw encoder counts to be multiplied by an integer value in the range -1024 to 1023. This can be used to match encoders to high resolution microstepping motors for position verification or for moving along circular arcs on machines where the number of encoder edges/distance do not match on the axes. Using a negative number will reverse the encoder count.

Example 1: A microstepping motor has 20000 steps/rev. The *Motion Coordinator* is working in **MICROSTEP=ON** mode so will internally process 40000 counts/rev. A 2500 pulse encoder is to be connected. This will generate 10000 edge counts/rev. A multiplication factor of 4 is therefore is required to convert the 10000 counts/rev to match the 40000 counts/rev of the motor.

```
PP_STEP AXIS(3)=4
```

Example 2: An X-Y machine has encoders which give 50 edges/mm in the X axis (Axis 0) and 75 edges/mm in the Y axis (Axis 1). Circular arc interpolation is required between the axes. This requires that the interpolating axes have the same number of encoder counts/distance. It is not possible to multiply the X axis counts by 1.5 as the **PP_STEP** parameter must be an integer. Both X and Y axes must therefore be set to give 150 edges/mm:

```
PP_STEP AXIS(0)=3
PP_STEP AXIS(1)=2
UNITS AXIS(0)=150
UNITS AXIS(1)=150
```

Note: If used in a Servo axis, increasing **PP_STEP** will require a proportionate decrease of all loop gain parameters.

PWM_CONTROL

Type: Axis Command

Syntax: **PWM_CONTROL (function [, ...])**

Description: **PWM_CONTROL** has seven options which have the following functions:

PWM_CONTROL(0)
The PWM output is switched OFF using this axis function.

PWM_CONTROL(1)
PWM output is switched on. The **PWM_MARK** value comes from the **PWM_MARK** axis parameter.

PWM_CONTROL(2, multiplier,offset,limit value,link axis)
PWM output is calculated via **VP_SPEED** (path velocity of an axis) of an axis and multiplier and will be adjusted on each servo cycle. The value loaded into the **PWM_MARK** is given by **VP_SPEED***multiplier/100000 + offset. If the calculated value exceeds the "limit value" the limit value is applied. The **VP_SPEED** value is the velocity profile speed for the link axis.

PWM_CONTROL(3, GT/LT, ON/OFF, table start, table end)
This axis function loads a sequence of positions into the gating FIFO. The GT/LT value should be set to 1 for a GT comparison, 0 for a LT comparison. The ON/OFF bit is toggled as the positions are loaded automatically by the function. The FIFO is up to 256 positions deep, and can be loaded with one or more **PWM_CONTROL(3,…** functions. Longer sequences of positions can be loaded as the position buffer becomes available.

PWM_CONTROL(4)
The FIFO can be emptied using the **PWM_CONTROL(4)** function.

PWM_CONTROL(5)

The FIFO gating is switched on using the P**WM_CONTROL(5)** function.

PWM_CONTROL(6)
The PWM_ENCODER register can be cleared to zero using the **PWM_CONTROL(6)** function.

Note: The **PWM_CONTROL** function is an axis function and can be directed to an axis using the **AXIS()** modifier or the **BASE()** function.

PWM_CYCLE

Type: Axis Parameter

Description: For use with **PWM_CONTROL**. Defines the total **PWM_CYCLE** time in increments of 50 nano seconds.

Example: For an application where the required **PWM_CYCLE** time is 20KHz;

(1/20000 = 0.05 milliseconds = 50 nano seconds * 1000)

```
PWM_CYCLE = 1000
```

PWM_ENCODER

Type: Axis Parameter

Description: For use with **PWM CONTROL**. This parameter returns the value of the dedicated 29 bit encoder hardware register that records the position of the **PWM_AXIS**. When the axis moves the **PWM_ENCODER** register will change with the **MPOS** register. However, the **PWM_ENCODER** register is independent of the **MPOS** register and it can be reset separately. It is not affected by the **DEFPOS** and **OFFPOS** commands.

PWM_MARK

Type: Axis Parameter

Description: For use with **PWM_CONTROL**. Defines the ON time of the **PWM_CYCLE** in increments of 50 nano seconds.

Example: For an application where the required **PWM_CYCLE** time is 20KHz and the required ON time for each pulse is 0.025 milliseconds (50 nano seconds * 500)

```
PWM_CYCLE = 1000
PWM_MARK = 500
```

REG_POS

Type: Axis Parameter (Read Only)

Alternate Format: **RPOS**

Description: Stores the position at which a registration mark was seen on each axis in user units. See **REGIST()** for more details.

Example: A paper cutting machine uses a **CAM** profile shape to quickly draw paper through servo driven rollers then stop it whilst it is cut. The paper is printed with a registration mark. This mark is detected and the length of the next sheet is adjusted by scaling the CAM profile with the third parameter of the **CAM** command:

```
'  Example Registration Program using CAM stretching:
' Set window open and close:
  length=200
  OPEN_WIN=10
  CLOSE_WIN=length-10
  GOSUB Initial
Loop:
  TICKS=0' Set millisecond counter to 0
  IF MARK THEN
    offset=REG_POS
  '  This next line makes offset -ve if at end of sheet:
    IF ABS(offset-length)<offset THEN offset=offset-length
      PRINT "Mark seen at:"offset[5.1]
  ELSE
      offset=0
    PRINT "Mark not seen"
    ENDIF

  ' Reset registration prior to each move:
  DEFPOS(0)
    REGIST(3+768)' Allow mark at first 10mm/last 10mm of sheet
    CAM(0,50,(length+offset*0.5)*cf,1000)
  WAIT UNTIL TICKS<-500
  GOTO Loop
```

(variable “cf” is a constant which would be calculated depending on the machine draw length per encoder edge)

REG_POSB

Type: Axis Parameter (Read Only)

Description: Useable only on MC206X built-in axes. **REG_POSB** returns the position at which a registration Z mark was seen on an axis. See **REGIST()** for more details.

REGIST_CONTROL

Type: Axis Parameter

Description: Read or set the low-level bit pattern in the registration control register.

Note: In normal operation, the **REGIST(n)** command should be used.

REMAIN

Type: Axis Parameter (Read Only)

Description: This is the distance remaining to the end of the current move. It may be tested to see what amount of the move has been completed. The units are user distance units.

Example: To change the speed to a slower value 5mm from the end of a move.

```
start:
  SPEED=10
  MOVE(45)
  WAIT UNTIL REMAIN<5
  SPEED=1
  WAIT IDLE
```

REMOTE_ERROR

Type: Axis Parameter

Description: Returns the number of errors on a drive's digital communication link.

Example:

```
>>PRINT REMOTE_ERROR
1.0000
>>
```

REPDIST

Type: Axis Parameter

Description: The repeat distance contains the allowable range of movement for an axis before the position count overflows or underflows. For example, when an axis executes a **FORWARD** move the demand and measured position will continually increase. When the measured position reaches the **REPDIST** twice that distance is subtracted to ensure that the axis always stays in the range **-REPEAT DISTANCE** to **+REPEAT DISTANCE** (Assuming **REP_OPTION=OFF**). The *Motion Coordinator* will adjust its absolute position without affecting the move in progress or the servo algorithm.

REP_OPTION

Type: Axis Parameter

Description: Bit 0 of the **REP_OPTION** parameter controls the way the **REP_DIST** is applied. In the default setting (**REP_OPTION bit 0=0**) **REP_DIST** operation is selected in the range **-REPEAT DISTANCE** to **+REPEAT DISTANCE**. In some circumstances it more convenient for the axis positions to be specified from 0 to **+REPEAT DISTANCE**. (**REP_OPTION bit 0=1**)

REP_OPTION bit 1: when set **ON, the** automatic repeat option of the **CAMBOX** or **MOVELINK** function will be turned OFF. When the system software has set the option OFF it automatically clears bit 1 of **REP_OPTION**.

REP_OPTION bit 2: when this is set **ON**, the functions **REP_DIST, DEFPOS and OFFPOS** will affect **MPOS** only. Bit 2 is an option for Stepper + Encoder axes, it is not appropriate for servo axes.

REV_IN

Type: Axis Parameter

Description: This parameter holds the input number to be used as a reverse limit input. The input should be in the range 0..31. If **REV_IN** is set to -1 (default) then no input is used as a reverse limit. When the reverse limit input is asserted moves going in the reverse direction will be cancelled. The axis status bit 5 will also be set.

Note: Feedhold, forward, reverse and datum inputs are ACTIVE LOW.

REV_JOG

Type: Axis Parameter

Description: This parameter holds the input number to be used as a reverse jog input. The input should be in the range 0..31. If **REV_JOG** is set to -1 (default) then no input is used as a reverse jog. When the input is asserted then the axis is moved forward at the **JOG-SPEED** or axis **SPEED** depending on the status of the **FAST_JOG** input.

Note: Feedhold, forward, reverse and datum inputs are ACTIVE LOW.

RS_LIMIT

Type: Axis Parameter

Alternate Format: **RSLIMIT**

Description: An end of travel software limit may be set up in software thus allowing the program control of the working envelope of the machine. This parameter holds the absolute position of the reverse travel limit in user units. When the limit is hit the controller will ramp down the speed to zero then cancel the move. Bit 10 in the axis status parameter is set when the axis is in the **RS_LIMIT.**

RS_LIMIT is disabled when its value is outside the range of **REP_DIST**.

SERVO

Type: Axis Parameter

Description: On a servo axis this parameter determines whether the axis runs under servo control or open loop. When **SERVO=OFF** the axis hardware will output a voltage dependent on the DAC parameter. When **SERVO=ON** the axis hardware will output a voltage dependent on the gain settings and the following error.

SERVO is also used on stepper axes with position verification. If **SERVO=ON** the system software will compare the difference between the **DPOS** and **MPOS (FE)** on the axis with the **FE_LIMIT**. If the difference exceeds the limit the following error bit is set in the **AXISSTATUS** register, the enable relay is forced OFF and the servo is set OFF. If the **SERVO=OFF** on a stepper verification axis the **FE** is not compared with the **FE_LIMIT**.

Example:

```
SERVO AXIS(0)=ON'   Axis 0 is under servo control
SERVO AXIS(1)=OFF'  Axis 1 is run open loop
```

Note: Stepper axes with position verification need consideration also of **VERIFY** and **PP_STEP.**

SP

Type: Axis Command - Use the **SPEED** axis parameter for new applications.

Description: This format is only provided to simplify compatibility with earlier controllers. Sets demand speed of the current or base axis.

Example:
```
SP(1000)
```

SPEED

Type: Axis Parameter

Description: The **SPEED** axis parameter can be used to set/read back the demand speed axis parameter. The speed is returned in units/s. The demand speed is the speed ramped up to during the movement commands **MOVE, MOVEABS, MOVECIRC, FORWARD, REVERSE, MHELICAL and MOVEMODIFY**.

Example:
```
SPEED=1000
PRINT "Speed Set=";SPEED
```

SPHERE_CENTRE

Type: Axis Command

Syntax: **SPHERE_CENTRE(tablex, tabley, tablez)**

Description: Returns the co-ordinates of the centre point (x, y, z) of the most recent **MOVE_SPHERICAL**. x, y and z are returned in the **TABLE** memory area and can be printed to the terminal as required.

Example:
```
SPHERE_CENTRE(10, 11, 30)
PRINT TABLE(10);", ";TABLE(11);", ";TABLE(12)
```

SRAMP

Type: Axis Parameter

Description: This parameter stores the s-ramp factor. This controls the amount of rounding applied to trapezoidal profiles. 0 sets no rounding. 10 maximum rounding. Using S ramps increases the time required for the movement to complete. **SRAMP** can be used with **MOVE, MOVEABS, MOVECIRC, MHELICAL, FORWARD, REVERSE** and **MOVE-MODIFY** move types.

Note: The **SRAMP** factor should not be changed while a move is in progress.

TANG_DIRECTION

Type: Axis Parameter

Only available in system software versions where “LookAhead” is enabled.

Description: When used with a 2 axis X-Y system, this parameter returns the angle in radians that represents the vector direction of the interpolated axes. The value returned is between -PI and +PI and is determined by the directions of the interpolated axes as follows:

X	Y	value
0	1	0
1	0	PI/2
0	-1	PI/2 (+PI or -PI)
-1	0	-PI/2

Example1: Note scale_factor_x MUST be the same as scale_factor_y

```
UNITS AXIS(4)=scale_factor_x
UNITS AXIS(5)=scale_factor_y

BASE(4,5)
MOVE(100,50)
angle = TANG_DIRECTION
```

Example2:

```
BASE(0,1)
angle_deg = 180 * TANG_DIRECTION / PI
```

TRANS_DPOS

Type: Axis Parameter (Read Only)

Description: Axis demand position at output of frame transformation. **TRANS_DPOS** is normally equal to **DPOS** on each axis. The frame transformation is therefore equivalent to 1:1 for each axis. For some machinery configurations it can be useful to install a frame transformation which is not 1:1, these are typically machines such as robotic arms or machines with parasitic motions on the axes. Frame transformations have to be specially written in the "C" language and downloaded into the controller. It is essential to contact Trio if you want to install frame transformations.

Note: See also **FRAME**

UNITS

Type: Axis Parameter

Description: The unit conversion factor sets the number of encoder edges/stepper pulses in a user unit. The motion commands to set speeds, acceleration and moves use the **UNITS** parameter to allow values to be entered in more convenient units e.g.: mm for a move or mm/sec for a speed.

Note: Units may be any positive value but it is recommended to design systems with an integer number of encoder pulses/user unit.

Example: A leadscrew arrangement has a 5mm pitch and a 1000 pulse/rev encoder. The units should be set to allow moves to be specified in mm. The 1000 pulses/rev will generate 1000 x 4=4000 edges/rev. One rev is equal to 5mm therefore there are 4000/5=800 edges/mm so:

```
>>UNITS=1000*4/5
```

Example 2: A stepper motor has 180 pulses/rev and is being used with **MICROSTEP=OFF**

To program in revolutions the unit conversion factor will be:

```
>>UNITS=180*16
```

Note: Users with stepper axes should also refer to the **MICROSTEP** command when choosing **UNITS**.

VECTOR_BUFFERED

Type: Axis Parameter (Read only)

Only available in system software versions where “LookAhead” is enabled.

Description: This holds the total vector length of the buffered moves. It is effectively the amount the VPU can assume is available for deceleration. It should be executed with respect to the first axis in the group (look-ahead versions only).

Example:
```
>>BASE(0,1,2)
>>? VECTOR_BUFFERED AXIS(0)
```

This will return the total vector length for the current buffered moves whose axis group begins with axis(0).

VERIFY

Type: Axis Parameter

Description: The verify axis parameter is used to select different modes of operation on a stepper encoder, encoder or servo axis. Its use depends upon the hardware.

(A) P240, P280, MC302X, PCI208

VERIFY=OFF
Encoder count circuit is connected to the **STEP** and **DIRECTION** hardware signals so that these are counted as if they were encoder signals. This is particularly useful for registration as the registration circuit can therefore function on a stepper axis.

VERIFY=ON
Encoder circuit is connected to external A,B, Z signal

(B) Euro205x

VERIFY=OFF

The encoder counting circuit is configured to accept **STEP** and **DIRECTION** signals hard wired to the encoder A and B inputs.

VERIFY=ON

The encoder circuit is configured for the usual quadrature input.

Take care that the encoder inputs do not exceed 5 volts.

(B) P270 SSI Daughter Boardx

VERIFY=ON

SSI Binary encoder operation.

VERIFY=OFF

SSI code encoder operation.

Gray code / Binary option available on P270 with V1.2 FPGA onwards.

Example: **VERIFY AXIS(3)=ON**

VFF_GAIN

Type: Axis Parameter

Description: The velocity feed forward gain is a constant which is multiplied by the change in demand position. Adding velocity feed forward gain to a system decreases the following error during a move by increasing the output proportionally with the speed. For a velocity feed forward term K_{vff} and change in position δP_d, the contribution to the output signal is:

$$O_v ff = K_{vff} \times \delta P_d$$

Note: Servo gains have no effect on stepper motor axes.

VP_SPEED

Type: Axis Parameter (Read Only)

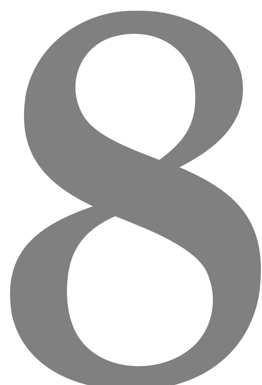
Alternate Format: **VPSPEED**

Description: The velocity profile speed is an internal speed which is ramped up and down as the movement is velocity profiled. It is reported in user units/sec.

Example: Wait until command speed is achieved:

```
MOVE(100)
WAIT UNTIL SPEED=VP_SPEED
```

CHAPTER



PROGRAMMING EXAMPLES

Example Programs

Example 1: Fetching an Integer Value from the Membrane Keypad

The subroutine "getnum" fetches an integer value from the membrane keypad in variable "num". The routine prints the number on the display bottom line at cursor position 70, although this can be set to other values. Only the number keys, the "CLR" key and the ENTER key are used. Other keys are ignored.

```
' Demonstrate integer number entry via Membrane Keypad:
getnum:pos=70
  num=0
  PRINT#4,CHR(20);
  REPEAT
    PRINT#4,CURSOR(pos);num[6,0];
    GET#4,k
    IF k=69 THEN GOTO getnum
    IF k>=59 AND k<=61 THEN k=k-7
    IF k>=66 AND k<=68 THEN k=k-17
    IF k=71 THEN k=48
    IF k>47 AND k<58 THEN
      k=k-48
      num=num*10+k
    ENDIF
  UNTIL k=73
RETURN
```

Example 2: Fetching a Real Value from the Membrane Keypad

This similar routine also fetches a number from the membrane keypad, but this number can have up to 2 decimal places. Note how this example uses the emulated keypad from *Motion* Perfect.

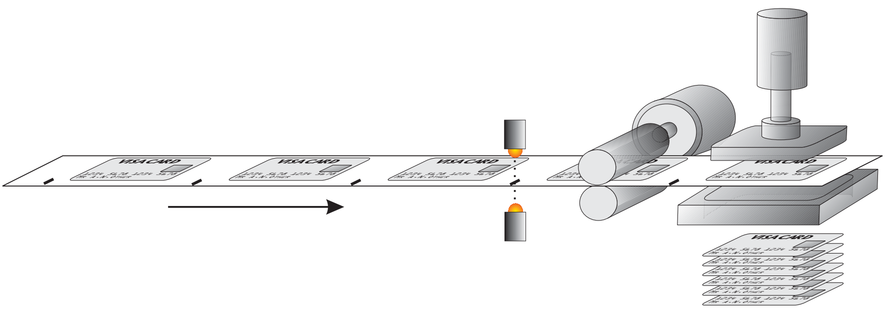
```
getnum:
  pos=40
  dpoint=0
  num=0
  negative=1
  PRINT#5,CHR(20);
  REPEAT
```

```
        PRINT#5,CURSOR(pos);num*negative[8,2];
        GET#5,k
        IF k=72 AND dpoint=0 THEN dpoint=1
        IF k=70 THEN negative=-negative
        IF k=69 THEN GOTO getnum
        IF k>=59 AND k<=61 THEN k=k-7
        IF k>=66 AND k<=68 THEN k=k-17
        IF k=71 THEN k=48
        IF k>47 AND k<58 THEN
          k=k-48
          IF dpoint>0 THEN
            dpoint=dpoint/10
            IF dpoint>=0.01 THEN num=num+k*dpoint
          ELSE
            num=num*10+k
          ENDIF
        ENDIF
      UNTIL k=73
      num=num*negative
    RETURN
```

Example 3 - ATM Card Production

Key Features Used: **REGIST, MOVEMODIFY**

An automated die-cutting machine, is designed to punch out pre-printed plastic cards for use in ATM machines etc.



There is one servo axis which is connected to the draw rollers which feed the card into the machine. A printed registration mark appears once per card and is sensed by an optical sensor connected to the Registration input of the MC2xx's Servo Daughter Board.

The operation of the machine is quite simple, the cards are printed at a known fixed-pitch. Each cycle, the draw rolls must feed the card into position, an output is then fired to operate the punch. An input signals that the punch is clear of the cards and the cycle can repeat.

In an ideal situation we would simply datum the first card and then move a fixed pitch every cycle,

```
loop:
  MOVE(card_pitch)
  WAIT IDLE
  OP(punch,ON)
  WAIT UNTIL IN(punch_clear)=OFF
  WAIT UNTIL IN(punch_clear)=ON
  OP(punch,OFF)
GOTO loop
```

In the real world we must allow for mechanical slippage and any inconsistencies which may occur in the printing. Therefore we will use the registration mark to synchronise the position of the draw each cycle

```
loop:
  DEFPOS(0)
  REGIST(3)
  MOVE(card_pitch)
  WAIT UNTIL MARK
  MOVEMODIFY(REG_POS+20)
  WAIT IDLE
  OP(punch,ON)
  WAIT UNTIL IN(punch_clear)=OFF
  WAIT UNTIL IN(punch_clear)=ON
  OP(punch,OFF)
GOTO loop
```

The above example shows only the simplest form of the main loop. It allows for a fixed offset value of 20, but there is no provision for error handling etc. An example where the code might be expanded to check for registration errors would be:

```
loop:
```

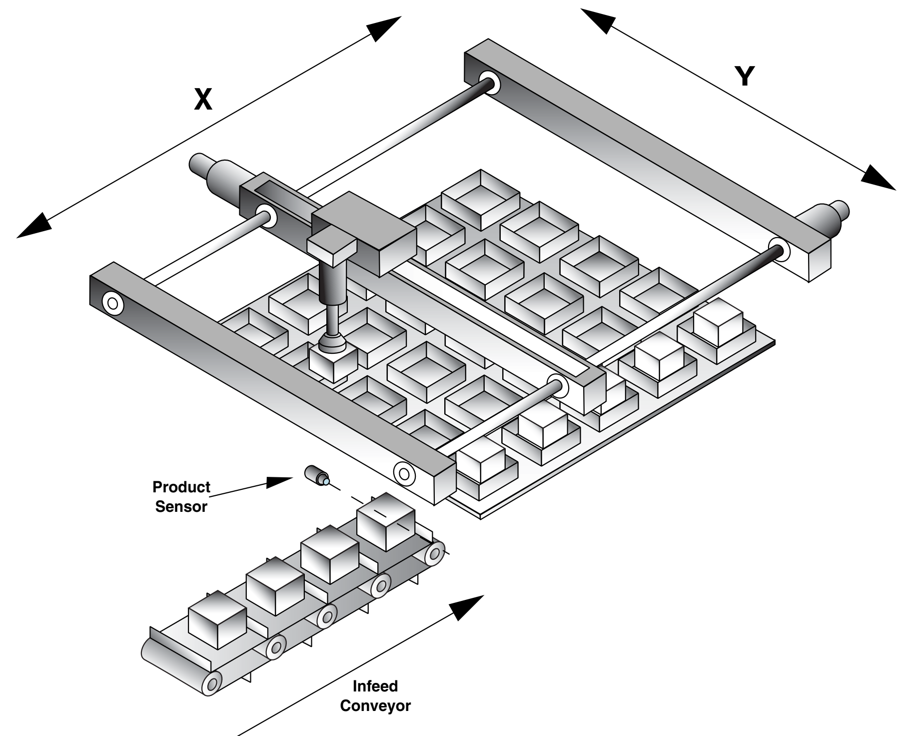
```
  DEFPOS(0)
  REGIST(3)
  MOVE(card_pitch)
  WAIT UNTIL MARK OR MTYPE=0
  IF MTYPE=0 THEN
    ' Indicate error to user
    PRINT #3,"Registration Error!"
    errors=errors+1
    if errors>max_errors then GOTO reg_failed
    OP(error_lamp,ON)
  ELSE
    OP(error_lamp,OFF)
    MOVEMODIFY(reg_pos+20)
    WAIT IDLE
  ENDIF
  ' Rest of loop as before
GOTO loop

reg_failed:
  PRINT #3,CURSOR(00);"Too many reg errors!"
  PRINT #3,CURSOR(20);"Press any key...    "
  GET #3,k
GOTO start
```

Example 4: Axis Pick & Place System

Overview A square palette has sides 1200mm long.

It must be divided into a grid, each of these positions on the palette contains a box into which a widget must be placed:

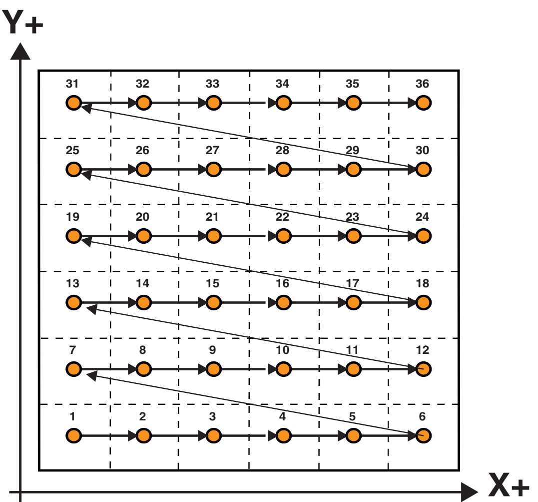
A vacuum operated pick-up mechanism collects objects from a conveyor and fills each of the boxes in turn.



Additional Information:

Whist the palette size is fixed at the maximum size of 1.2m square, the program should be flexible enough to allow for a user-defined number of boxes on the palette. The grid could contain up to 10 divisions in each direction and they may be combined in any ratio, i.e. 2x4, 6x3, 1x10, 9x4 etc.

The illustration below shows a sample palette with a 6x6 grid of boxes. The numbers/arrows show the order in which the boxes are filled. Note that we step through the rows (Y axis) in turn, filling each box (move along X axis) before moving onto the next row.



Structuring the program

This example can be solved with a very simple structure using two nested **FOR..NEXT** loops.

Firstly we create a loop to step through each row (Y) in turn:

```
FOR y=0 to ydiv-1

NEXT y
```

'ydiv' is the number of rows, and the -1 is because we start counting at 0 rather than 1.

Now, within this loop we create another for the 'X' direction:

```
FOR y=0 to ydiv-1
  FOR x=0 to xdiv-1
    '
  NEXT x
NEXT y
```

Calculating the box positions

So now we have a sequence which steps sequentially through each row, and then through each position on that row in turn. We can use the absolute move (**MOVEABS**) command to position the axes at an absolute position in our X/Y coordinate system in the form

```
MOVEABS(x,y)
```

The x and y variables with the **FOR**..**NEXT** loop are simply logical box coordinates and therefore need to be scaled to the correct positions.

If we know the palette size (1200) and the number of divisions in each direction (xdiv/ydiv) then we can simply calculate an appropriate scaling, thus for the x axis:

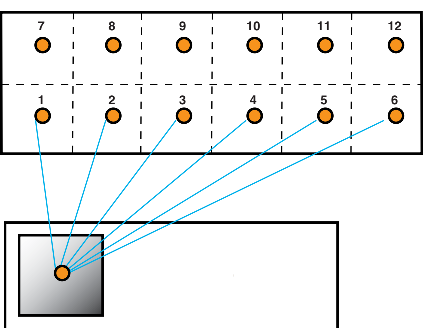
```
xscale = 1200/xdiv
```

The actual position (of the box's corner) would therefore be (x*xscale), we could adjust this for the centre of the box by adding half the box size (xscale/2). So the position would be:

```
(x*xscale)+(xscale/2)
```

Our final consideration is that for each box we first have to move to the preset pick-up position, fetch the product and then move to the appropriate empty box to place the product in.

The pick up point is at a known absolute position and so we can simply use a pair of constants (pick_x and pick_y) to reference this point.

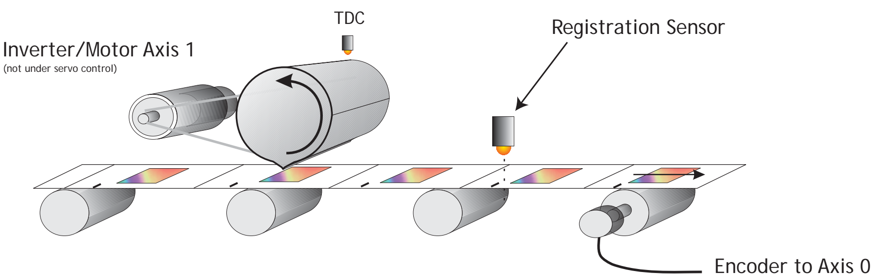



```
MOVEABS(pick_x, pick_y)
constants:
  nozzle=8 '    output - nozzle raise/lower
  vacuum=9 '    output - vacuum on / off
```

```
  xdiv=6
  ydiv=6

start:
  xscale=1200/xdiv
  xmid=xscale/2
  yscale=1200/ydiv
  ymid=yscale/2

  FOR y=0 TO xdiv-1
    FOR y=0 TO ydiv-1
    GOSUB pick
      MOVEABS((x*xscale)+xmid,(y*yscale)+ymid)
      WAIT IDLE
      GOSUB place
    NEXT x
  NEXT y
GOTO start

pick:
  MOVEABS(pick_x, pick_y)
  WAIT IDLE

  OP(nozzle,ON)
  OP(vacuum,ON)
  wa(500)
  OP(nozzle,OFF)
  wa(500)
RETURN

place:
  OP(nozzle,ON)
  OP(vacuum,OFF)
  wa(250)
  OP(nozzle,OFF)
  wa(500)
RETURN
```

Example 5: Rotating Print Head with Registration

Description: A rotating print head prints a number on a conveyor mounted product. During printing the print head must be synchronized with the conveyor. The print position must be registered to be relative to a registration mark.



The program achieves the motion profile by:

1) Making a synchronization gearbox connection between the conveyor and the print head with **CONNECT**. This will let the printer make a print on the conveyor. The distance between the prints will be the peripheral distance of the print head rotation.

2) Datuming and setting the repeat distance **REPDIST** for the print head rotation so that it has an absolute position of zero every time it touches the conveyor.

3) Superimposing a movement onto the print head. This movement has two functions: To adjust the printer position to keep the system in register and to adjust by the difference between the peripheral distance of the printer and the registration marks on the conveyor.

4) The superimposed movement is run on axis 3 of the controller (an “imaginary” axis) and the movement summed with the **ADDAX** command. The move is performed when the printer is going “over the top” of its stroke.

Program Listing:

```
'  Rotating Head with Registration:
start: GOSUB initial

loop:
  WAIT UNTIL MPOS>100' Wait 100mm past print

  IF MARK THEN
    ’ mark seen during last cycle:
    ’ Limit adjust to 10mm
```

```
    r_adj=REG_POS*0.5' Apply 50% of error
    IF ABS(r_adj)>10 THEN r_adj=SGN(r_adj)*10
    OP(8,OFF)
  ELSE
    ’ mark not seen last cycle: Set Zero adjust
    r_adj=0
    OP(8,ON)' light "no register" warning lamp
  ENDIF

  BASE(3)' Correction on axis 3
  MOVELINK(75-r_adj,150,25,25,1)
  ‘ 75 is the diff. between the mark spacing and
  ‘ the print head circumference
  ' Move linked to conveyor
  WAIT IDLE
  BASE(0)
  REGIST(3)
GOTO loop

initial:
  BASE(0)'   Setup axis 0
  UNITS=20'  Edges/mm
  P_GAIN=0.5
  REP_DIST=200' 200mm=180 degrees
  SERVO=ON

  BASE(1)'  Setup axis 1
  SERVO=OFF
  UNITS=15'Edges/mm on conveyor
  BASE(3)' Setup axis 3
  UNITS=20' Match axis 0 units

  ' Datum axis 0 keeping sync with paper:
  WDOG=ON
  BASE(0)
  CONNECT(20/15,1)
  WAIT UNTIL IN(6)=ON' Wait for prox
  DEFPOS(-150)
  ADDAX(3)'  Add moves on axis 3
RETURN
```

Example 6: *Motion Coordinator* programs sharing data

Description: These two programs run multi-tasking on a *Motion Coordinator*. The Motion Cycle program performs a movement. The Operator Interface program communicates with a membrane keypad to control the Motion Cycle program. In this simple example of multi-tasking the two tasks communicate via two global variables.

VR(start)	This holds the start/stop signal
VR(length)	This holds the movement length

Operator Interface Program

```
' Motion Coordinator Demonstration Program

start: GOSUB initial

loop:
  PRINT #3,CHR(20);CHR(14);
  PRINT #3,CURSOR(0);">LENGTH:";in_length[0];
  IF VR(start)=ON THEN
    PRINT #3,CURSOR(15);"STOP<";
  ELSE
    PRINT #3,CURSOR(15);" RUN<";
  ENDIF

  GET #3,kp
  PRINT kp
  IF kp=53 THEN GOSUB input_length
  IF kp=54 THEN VR(start)=1-VR(start)
GOTO loop

input_length:
  PRINT #3,CURSOR(60);"New Length:";
  GOSUB getnum
  IF num>=smallest_len THEN
    in_length=num
  ELSE
    PRINT #3,CURSOR(60);"Min. Length=200mm";
    WA(1000)
  ENDIF
RETURN
```

```
getnum:
  pos=40
  num=0
  PRINT#4,CHR(20);
  REPEAT
    PRINT#4,CURSOR(pos);num[6,0];
    GET#4,k
    IF k=69 THEN GOTO getnum
      IF k>=59 AND k<=61 THEN k=k-7
      IF k>=66 AND k<=68 THEN k=k-17
      IF k=71 THEN k=48
      IF k>47 AND k<58 THEN
        k=k-48
        num=num*10+k
      ENDIF
  UNTIL k=73
RETURN

initial:
  PRINT #3,CHR(20);CHR(14);
  PRINT #3,CURSOR(0);
  PRINT #3," Demonstration of  "
  PRINT #3,"Motion Coordinator "
  WA(3000)

' Set Global Variable Pointers:
  start=0
  length=1

' Set any none zero local variables:
  in_length=VR(length)
  VR(start)=0
  RUN "cycle"
RETURN
```

Motion Cycle Program

```
'
' Motion Cycle demonstration program:
'
  GOSUB setvar
```

```
  GOSUB initial

loop:
  WAIT UNTIL VR(start)=ON
  MOVE(VR(length))
  MOVEABS(0)
GOTO loop

initial:
  WDOG=ON
  WA(100)

  BASE(0)
  P_GAIN=0.8
  FE_LIMIT=1000
  SERVO=ON
  ACCEL=1000000
  DECEL=100000
  SPEED=10000
RETURN

setvar:
  ' Define Global Variable Pointers:
  start=0
  length=1
RETURN
```

Example 7: Handling Axis Errors

The *Motion Coordinator* controllers are designed to trap error conditions in hardware, and if required to automatically open the drive enable relay (watchdog) and to disable the output to the drives.

As this mechanism happens automatically, it may not be immediately apparent that an error has occurred and therefore we need a mechanism in the software to recognise it, and to set up the type of errors which will cause the controller to disable the drive / output.

The relevant parameters are:

- **AXISSTATUS**
- **ERRORMASK**

- MOTION_ERROR
- ERROR_AXIS

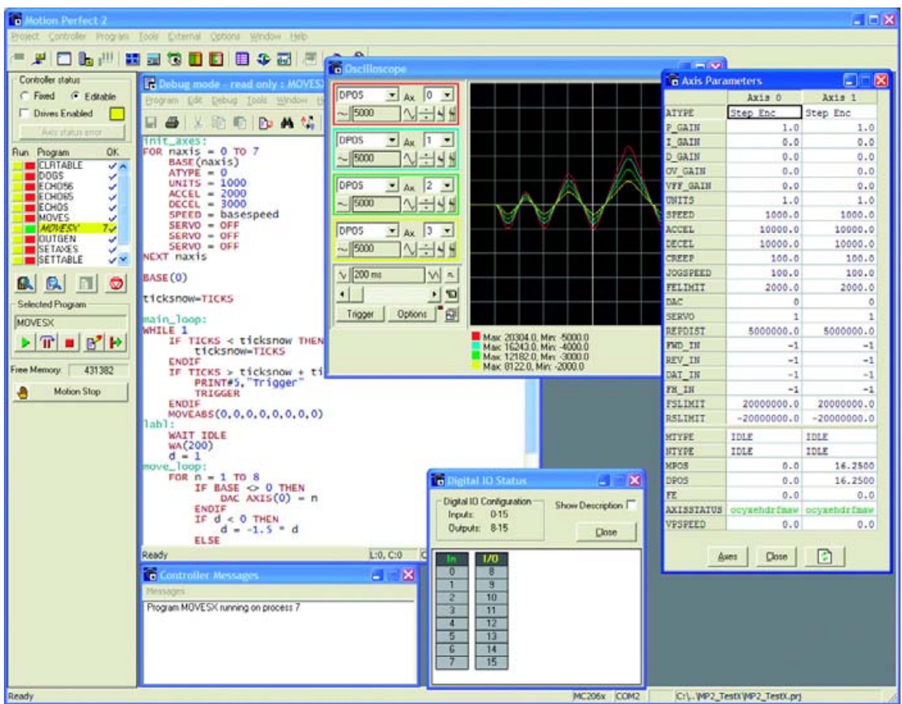
```
start:
   ‘ Monitor constantly until axis error occurs
   ‘ Set ERRORMASK so that Following Errors and Fwd/Rev limit
   ‘ switches will automatically trip the watchdog relay
   ERRORMASK = 256+16+32

REPEAT
  IF MOTION_ERROR<>0 THEN
    ax = ERROR_AXIS
    BASE(ax)
    PRINT #3,CURSOR(0);”Error on Axis “;ax[0]
    IF (AXISSTATUS AND 256)>0 THEN PRINT #3,”Fol. Error”;
    IF (AXISSTATUS AND (16+32))>0 THEN PRINT #3,”H/W Limit”;
    IF (AXISSTATUS AND 512+1024)>0 THEN PRINT #3,”S/W Limit”;
  ENDIF

  WAIT UNTIL KEY#3
  GET #3,k
GOTO start
```

CHAPTER

CHAPTER 0 SUPPORT SOFTWARE

Motion Perfect 2

Motion Perfect 2 is an application for the PC, designed to be used in conjunction with the *Motion Coordinator* range of multi-tasking motion controllers.



Motion Perfect provides the user with an easy to use Windows based interface for controller configuration, rapid application development, and run-time diagnostics of processes running on the *Motion Coordinator*.

System Requirements:

The following equipment is required to use *Motion* Perfect 2.

PC

	Minimum Specification	Recommended
CPU	Pentium class processor, operating at 300MHz	Pentium class processor, operating at 1GHz
RAM	64 Mb	256Mb
Hard disk space	20 Mb	20 Mb
	Windows 98, Windows ME, Windows 2000 or Windows XP	Windows 2000 or Windows XP.
Display	800 x 600 256 colours	1024 x 768 24-bit colour
Communications	Single RS232 Serial Port	RS232 serial port, USB port

Motion Coordinator

Motion Coordinator controller or compatible controllers.

Compatible controllers include:

MC2, MC202, MC204, Euro205, Euro205x, MC206, MC206X, PCI208, MC216, MC224, MC302X etc.

In order to use the serial link Packet Communications mode, system software version 1.49 or higher is required.

Note: *You should always try to use the most recent version of* ***Motion Perfect****.*
Updates are available from your local distributor or you can download the latest version from the Trio Web site: **WWW.TRIOMOTION.COM**

Connecting *Motion* Perfect to a controller

Motion Perfect can be connected to the *Motion Coordinator* using a serial connection, USB, Ethernet or PCI depending on the interface(s) fitted to the controller. A suitable serial cable can be supplied by Trio Motion Technology. *Motion* Perfect may use any the standard serial ports on a PC, COM1 to COM31.

If you wish to edit a project but do not have a controller connected to your PC, it is possible to edit off-line by connecting to a 'virtual' controller running on your PC. See the information on the MCSimulation at the end of this chapter.

Running *Motion* Perfect 2 for the First time

Turn your PC on and enter Windows. Make sure the *Motion Coordinator* is turned on and then launch *Motion* Perfect. During initialisation you will see a splash screen such as the one below.

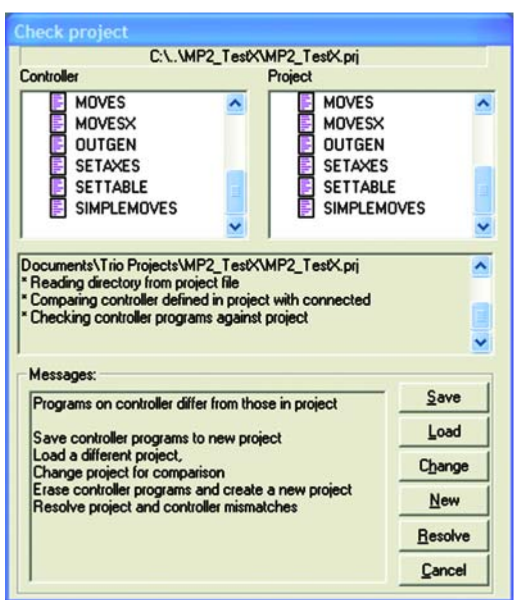
The splash screen features a small messages window (bottom left) which is used to display the status of the connection process. In this example *Motion* Perfect is connected to an MC206X controller via serial port COM1.

Motion Perfect 2 Projects

One of the keys to using *Motion* Perfect is to understand its concept of a "Project". The project facilitates the application design and development process, by providing a disk based copy of the multiple controller programs, parameters and data which may be used for a single motion application. Once the user has defined a project, *Motion* Perfect works behind the scenes automatically maintaining consistency between the programs on the controller and the files on the PC. When creating or editing programs on the controller they are automatically duplicated on the PC which means you do not have to worry about loading or saving programs and you can be confident that next time you connect to the controller you will have the correct information on your PC .

Project Check Window

Whenever you connect to the controller, *Motion* Perfect will perform a **project check** to compare the programs on the controller with those defined in the current project on the pc. During the project check a window similar to the one below will be displayed. If the projects match then you will see a "project checked ok" message and an OK button to continue. If however there is any inconsistency between the controller and the PC, the display will feature a number of addition options, shown below.



You can force *Motion* Perfect to perform a project check at any time with the "Check Project" option from the project menu. (Ctrl+Alt+P)

Project Check Options

Save Save the controller contents to disk.

If you have never connected with this controller before, and therefore do not have the project on your PC, or if there in an inconsistency in the project check and you are sure that the project on the controller is the correct version, then select SAVE to copy the programs on the controller to disk.

Note: This will of course overwrite any programs already in the PC copy of the project. If you are unsure which is the correct versiom, you should save the project with a new name to avoid overwriting any existing project programs on the PC.

Load Load the PC files onto the controller

If you are uploading a complete project from the PC to the controller, or the project check fails and you are sure the version on your PC is correct, then you should use this option to upload the entire project from the PC to the controller.

Note: The entire contents of the programs on the controller will be erased. If you are unsure, SAVE the controller contents first!

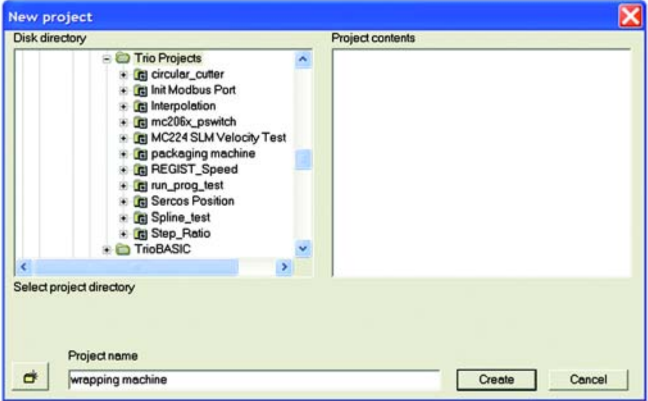
Change Change the project on the PC to compare with..

If you have been working on more than one project, the project on the controller may not match the 'last project' remembered by *Motion* Perfect. If this is the case you can use this option to select another project on the PC. Once you select an alternative, *Motion* Perfect will perform a fresh project check and the above process will be repeated.

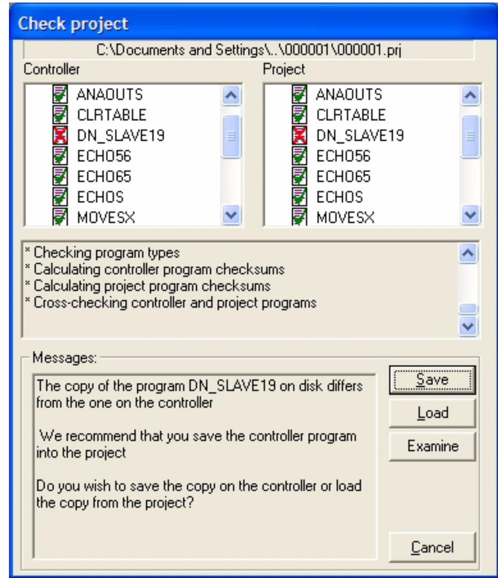
New Create a new project

The controller contents will be erased and a new project created on the PC. You will be prompted to select a directory and project name.

When you create a new project, *Motion* Perfect will make a new directory with the project name, and within that directory a project file with the same name (the .PRJ extension is added to the filename).



Resolve This option should be used when you have the correct project selected, but one or more of the files differ between the controller and PC version, or do not exist in one of the copies.

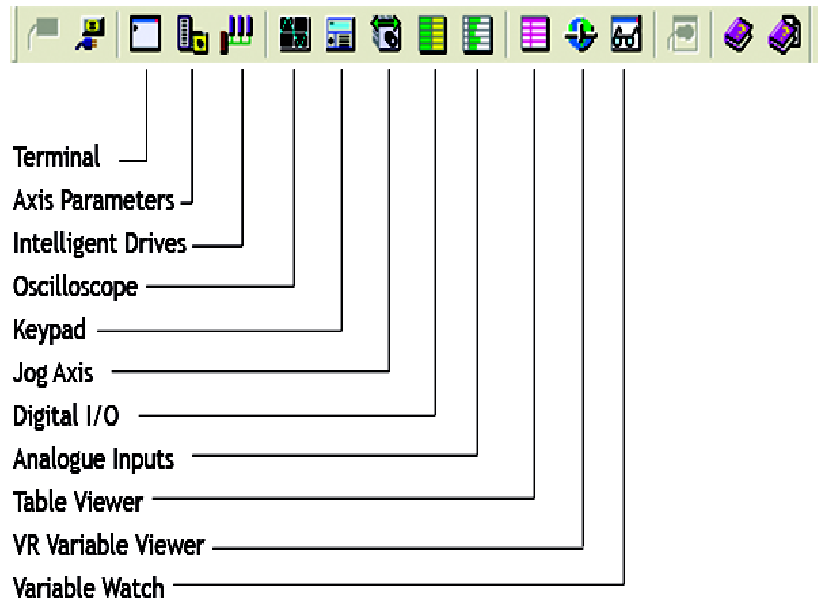


You will need to use your judgment to decide whether the disk or controller version is correct. Typically, if you are recovering the project after a comms failure or PC crash then the version on the controller should be saved. If you have modified the disk based copy of the program then you will need to load this version onto the controller. The examine button starts an external compare program to allow you to visually compare the version on the controller to the one on the PC.

Cancel Cancels the connection process and starts *Motion* Perfect in disconnected mode.

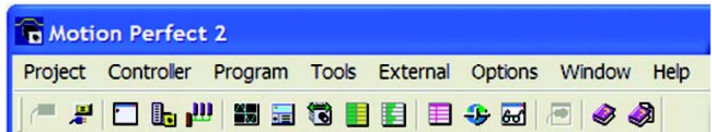
Once the project has been checked and is consistent then a backup copy of the PC project will be created.

The *Motion* Perfect Desktop



Main Menu	Standard Windows menu to access all features of the *Motion* Perfect application.
Toolbar	Shortcut buttons to access the *Motion* Perfect tools
Control Panel	Displays the current controller contents and provides controls for interrogating the controller status, running / editing programs
Desktop Workspace	This area is used to display the user windows and tools
Controller Messages	Status and error messages reported by the controller
Status Bar	Information about the current project and controller connection.

Main Menu



Project Options for Creating, Loading & Saving *Motion* Perfect Projects, Loading/Saving program files and Table data

Controller Options relating to the controller hardware, including connecting/disconnecting and checking configuration information.

Program Program specific options, including creating, editing and running controller tasks.

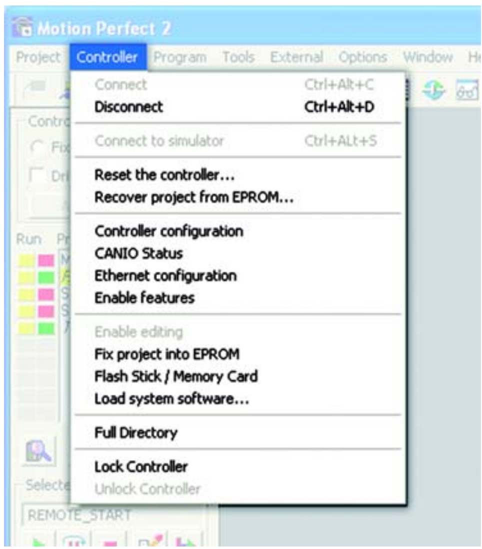
Tools Access to the main *Motion* Perfect tools. These options are also available from the Toolbar

Options Configure the *Motion* Perfect Environment. Includes options to setup the communications ports and to customise the editor display.

Window Control the appearance of the *Motion* Perfect desktop.

Help Access the help files and version information.

Controller Menu



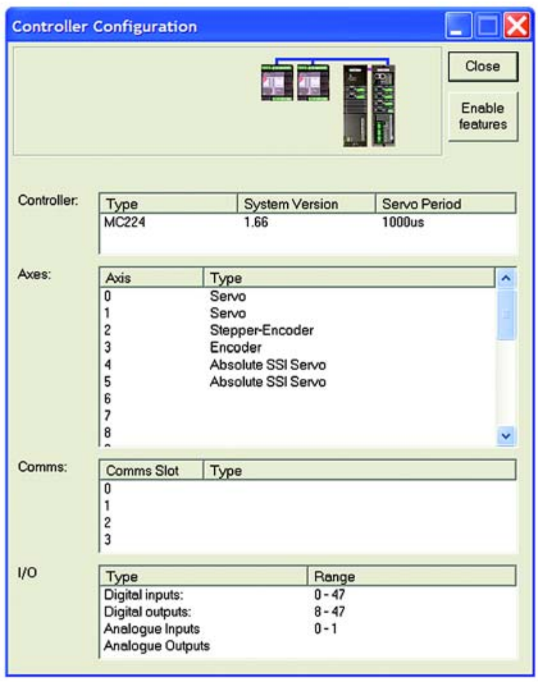
The controller menu contains the following items:

Connect	Connect to the controller and start the project manager. This is only available if *Motion* Perfect is currently disconnected from the controller.
Disconnect	Disconnect from the controller, and stop using the project tools. Only available if *Motion* Perfect 2 is currently connected to the controller.
Connect to Simulator	Connect to the controller simulator and start the project manager. The controller simulator is started if it is not already running. This is only available if *Motion* Perfect is currently disconnected from the controller.
Reset Controller	Perform a software-reset (EX) on the controller. This will cause *Motion* Perfect 2 to disconnect from the controller
Recover Project from EPROM	Reset the controller and restore the programs which were previously stored in the EPROM
Controller Configuration	Display hardware and system software configuration data for the controller.

CANIO Status	Display the ststus of any CAN I/O modules connected to the controller.
Ethernet Configuration	Configure the parameters of any ethernet interfaces on the controller.
Enable Features	Enable or disable any features which can be enabled using feature codes.
Enable Editing	Restore the power-up state of a controller currently starting from EPROM to run from RAM and allow editing.
Fix Project into EPROM	Store the programs in RAM into the controllers flash-EPROM memory. The startup state for each program will not be changed.
Flash Stick/ Memory Card	Store the current project on a flash stick or load a project from a flash stick/memory card (for controllers with a flash stick interface).
Load System Software	Update the controller system software.
Full Directory	Display a complete listing of all files on the controller, details of memory used and the run status of each program.
Lock Controller	Lock the controller to prevent modification of the programs.
Unlock Controller	Unlock a previously locked controller to allow programs to be edited.

Controller Configuration

This screen interrogates the hardware and displays the configuration information reported back by the controller.

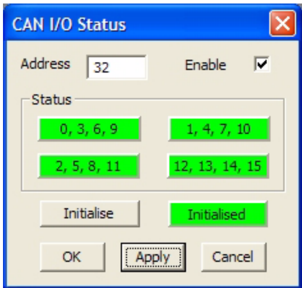


Looking at the example screen shown here from top to bottom:

Controller:	We are connected to a *Motion Coordinator* MC224
Software Version:	The controller is running version 1.64 (development version 69) of the system software.
Servo Period:	The controller is running with a control servo period of 1000µs.
Axis Types	A list of the types of all available axes.
Comms Boards	If the controller is fitted with any of the extended / communications daughter boards, that capability will be indicated here.
I/O	The channel range available for each type of I/O both digital and analogue. Remember that on many *Motion Coordinator*s the digital channels are shared, i.e. if Output 15 is available, then it implies that Input 15 is also available and shares the same connector.

CAN I/O Status

This shows the status of the built-in CAN port on a *Motion Coordinator* and any CAN I/O modules connected to it.



Address This is the CAN address of the built-in CAN port. The address can be set in the range 32 to 47. If the address is 32 the controller can automatically poll CAN I/O modules connected to it.

Enable If this is checked (and the CAN address is set to 32) automatic polling of I/O modules is active.

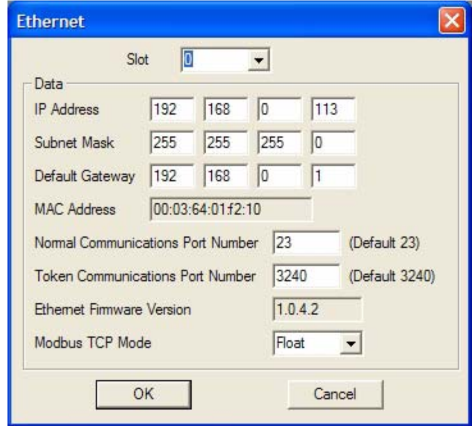
Status This shows the status of groups of I/O modules by CAN address, green for OK, red for error.

Initialise Clicking on this initilises the built-in CAN port on the controller.

Initialised This shows the state of the built-in CAN port, green for OK, red for error.

Ethernet Configuration

This shows the configuration for an ethernet interface on the controller. It allows the user to set up ethernet addressing parameters for built-in or daughterboard ethernet interfaces.



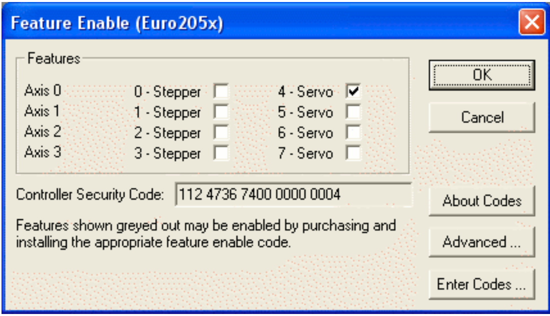
Slot	This is the daughterboard slot (-1 for built-in) of the ethernet interface being viewed.
IP Address	This is the ethernet IP address of this ethernet interface.
Subnet Mask	This is the ethernet subnet mast for the network to which this ethernet interface is connected.
Default Gateway	This is the default gateway for this ethernet interface. It is only needed if the controller is required to communicate with a device on a different ethernet subnet to its own.
MAC Address	This is the hardware MAC address for the current interface.
Normal Communications Port Number	This is the IP port number on which normal communications will take place. This is the port used by *Motion* Perfect for communications. The default value is 23, which is the reserved port for telnet communications.
Normal Communications Port Number	This is the IP port used for token based communications. This port is used by the Trio PC Motion ActiveX control. The default value is 3240, which is the reserved port for Trio Motion Control.

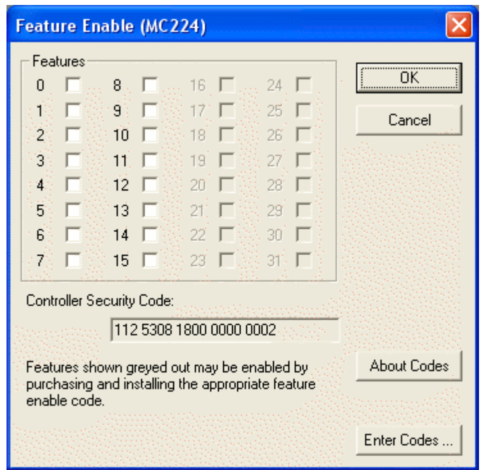
Ethernet firmware version	This shows the version number of the ethernet firmware for the current interface.
MODBUS tcp mode	This sets the type of numerical representation used by MODBUS tcp over this interface. The value can be **float** or **integer**.

Feature Enable

Certain *Motion Coordinator*s, such as the EURO205x and MC206X, have the ability to unlock additional axes by entering a "Feature Enable Code".

When you access the Feature Enable dialog, you will be presented with a display similar to one of the following:





This display shows the features which are currently available. If the codes for additional features have been purchased, the relevant boxes will be available for checking, otherwise the check boxes will be greyed out.

Enabling Additional Features

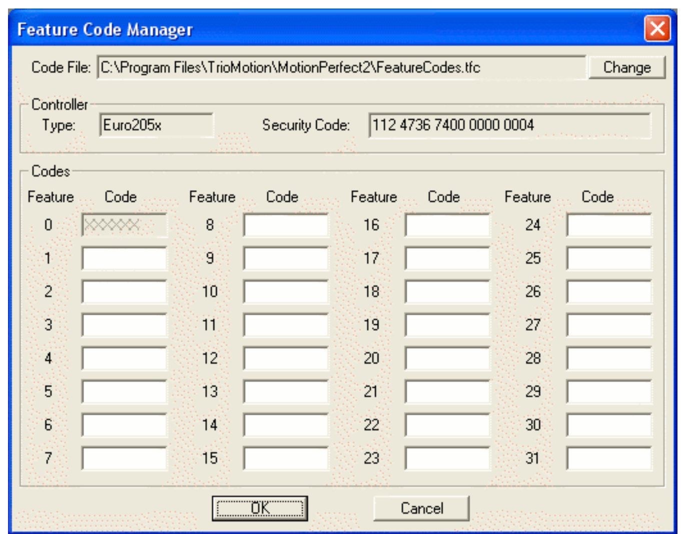
To enable a feature you must enter a Feature Enable Code, which is unique to each controller and feature. To obtain a Feature Enable Code, you will need to specify the feature required and the security code for the specific controller to be updated. The order for the required codes should be FAXed to Trio or an authorised Trio distributor.

Security Code

Controllers with features which can be enabled each have a unique security code number which is implanted when the unit is manufactured. This security code number is displayed on the above screen (as highlighted right).

Once you have the required codes, select the Enter Codes ... button.

A dialog similar to the following example will appear.



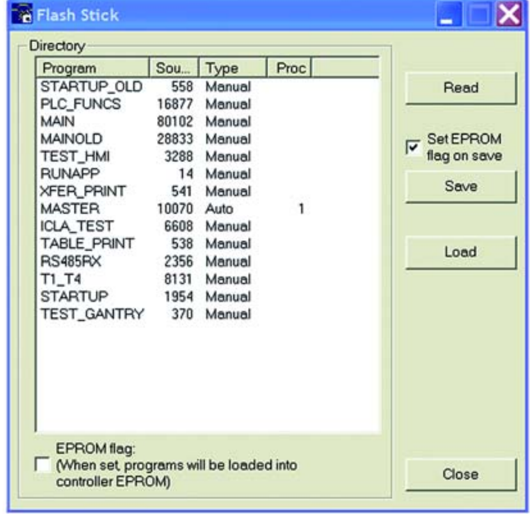
Each feature requested has a feature number. Enter the relevant code for each feature number, being careful to enter the characters in upper case. Take care to check that 0 (zero) is not confused with O and 1 (one) is not confused with the letter I.

Feature Code File

Motion Perfect stores all of the Feature Enable Codes of which it is aware in a file called "**`FeatureCodes.TFC`**". By default this file is located in the same directory as the *Motion* Perfect 2 executable file.

Flashstick support

This only applies to controllers which are fitted with a flash-stick socket (eg MC206X).



When a controller with flash-stick support is powered on with a flashstick inserted, then the controller will automatically load the programs from the flashstick into the controller RAM.

The **Read** button will read the directory of the flashstick and display it. As the directory is automatically read when the tool window is created, this button only needs to be used when the flashstick is changed.

The **Save** button will save the programs on the controller to the flashstick eassing any programs already stored on the flashstick. If the **set EPROM flag on save** box is checked then a flag is set on the flashstick which makes the controller store the programs on the flashstick in controller EPROM as well as in controller RAM at power-up.

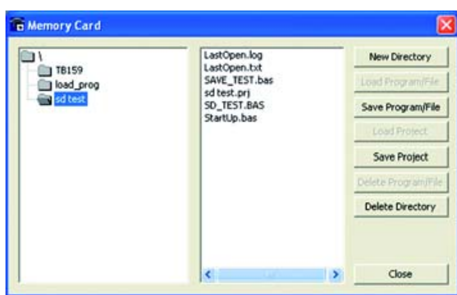
The **Load** button will load the programs from the flashstick onto the controller. This is done by resetting the controller.

Memory Card Support

This applies to controllers which are fitted with a socked for an SD, or Micro-SD memory card. It also applies to older controllers which have flashstick socket which, if the system firmware is recent enough, can use a Micro-SD memory card in a special adaptor.

Memory card support is accessed using “Controller / Memory Card” from the Motion Perfect main menu. The Memory Card dialog has a directory tree, a file list and some action buttons. When the dialog is first displayed it shows the root directory of the memory card. Double clicking on a directory will expand show (if hidden) or hide (if visible) any subdirectories. The file list always shows the contents (files only) of the directory selected in the directory tree .

The action buttons allow operations to be performed on the selected directory or file. Applicable buttons are highlighted when a directory or file is selected.



The operations performed by the buttons is as follows:

New Directory: Creates a new subdirectory on the card in the directory selected.

Load Program File: Loads the selected program from the card onto the controller.

Save Program File: Saves a program file from the controller into the directory currently selected on the card.

Load Project: Loads the project selected on the card onto the controller.

Save Project: Saves the project on the controller into the directory currently selected on the card.

Delete Program File: Delete the program file currently selected on the card.

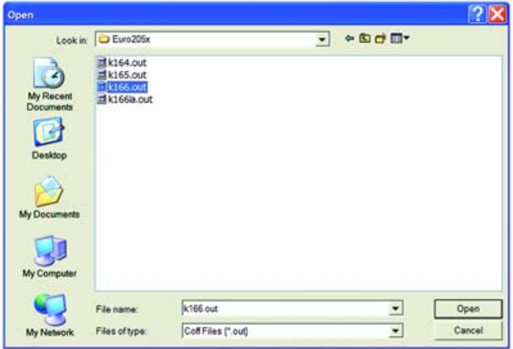
Delete Directory: Deletes the selected directory from the card.

Loading New System Software

*Motion Coordinator*s feature a flash EPROM for storage of both user programs and the system software. From *Motion* Perfect 2 it is possible to upgrade the software to a newer version using a system file supplied by Trio.

NOTE: ***We do not advise that you load a new version of the system software unless you are specifically advised to do so by your distributor or by Trio.***

When you select the 'Load System Software' option from the controller menu, you will first be presented with a warning dialog to ensure you have saved your project and are sure you wish to continue. When you press OK you will be presented with the standard Windows file selector to choose the file you wish to load.



Each *Motion Coordinator* controller has its own system file, identified by the first letter (or letters) of the file name.

System Software File Prefix Codes:

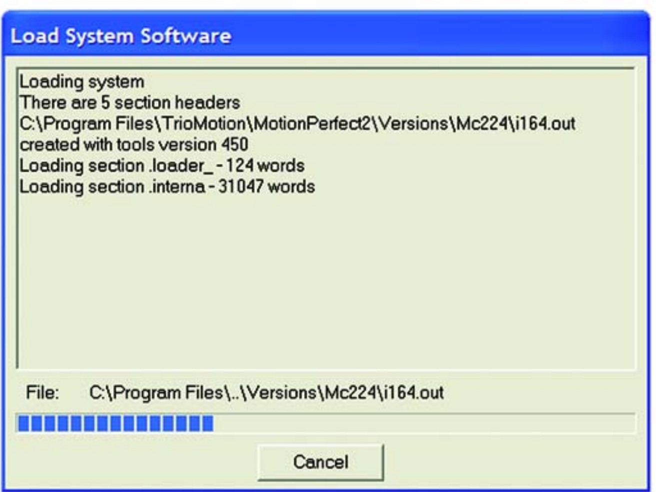
Filename	Controller Type
A*.OUT	MC2
B*.OUT	MC204
C*.OUT	MC216
E*.OUT	Euro205
F*.OUT	MC202
H*.OUT	MC206
I*.OUT	MC224
J*.OUT	PCI208
K*.OUT	Euro205x
M*.OUT	MC206X

Filename	Controller Type
Q*.OUT	Euro209
MC302K*.S37	MC302-K
MC302L*.S37	MC302-L
MC302X*.S37	MC302-X

You must ensure that you load only software designed for your specific controller, other versions will not work and will probably make the controller unusable.

When you have chosen the appropriate file you will be prompted once again to check that you wish to continue. Press OK to start the download process.

Downloading may take several minutes, depending on the speed of your PC and the controller. During the download, you should see the progress of each section updated as follows:-



When the download is complete, a checksum is performed to ensure that the download process was successful. If it saw you will be presented with a confirmation screen and asked if you wish to store the software into EPROM.

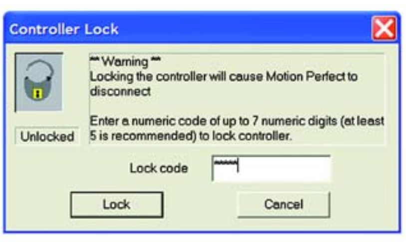
When you press Yes, the controller will take a few moments to fix the project into the EPROM and you can then continue as normal.

At this point you can check the controller configuration to confirm the new software version.

Lock / Unlock

Lock Controller

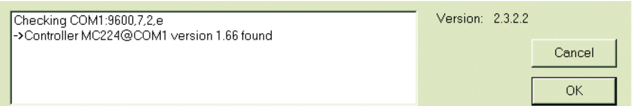
Locking the controller will prevent any unauthorised user from viewing or modifying the programs in memory.



You simply need to enter a numeric code (up to 7 digits). This value will be encoded by the system and used to lock the directory structure. The lock code is held in encrypted form in the flash memory of the *Motion Coordinator*.

This can also be achieved by issuing the LOCK(lock_code) command from the controller's command line.

Once the *Motion Coordinator* is locked it is not possible to list, edit or save any of the controller programs. You cannot connect to the controller with *Motion* Perfect 2, although the terminal screen and unlock dialog will still be available.



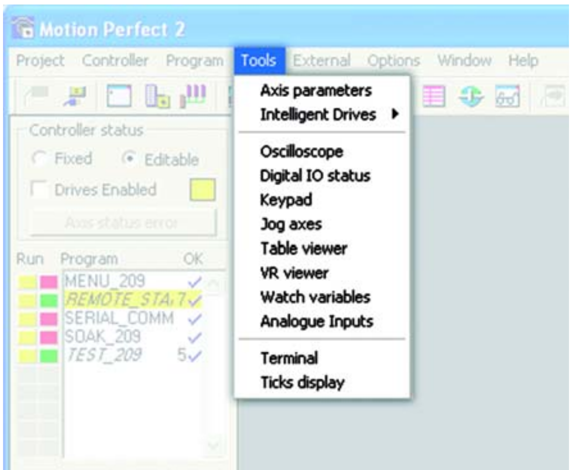
WARNING: *If you forget the lock code there is no way to unlock the controller. You will need to return it to Trio or a distributor to have the lock removed.*

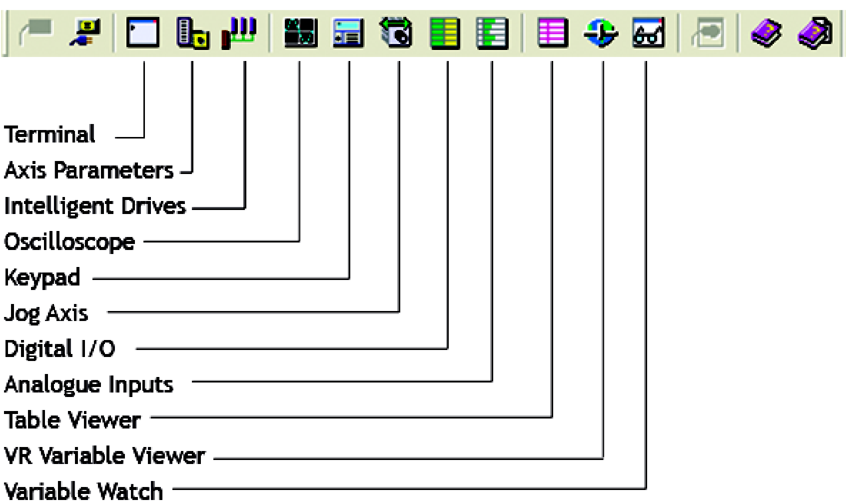
Unlock Controller

In order to unlock the controller you need to enter the same numeric code which was used to lock it. Once the unlock code is entered it will be possible to gain full access to the programs in memory.

Motion Perfect Tools

The *Motion* Perfect tools can be accessed from either the Tools Menu or the Toolbar buttons



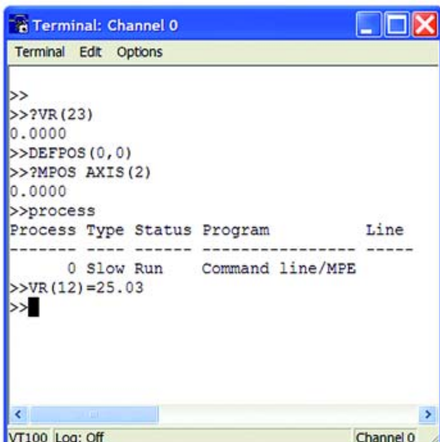


Terminal

The terminal window provides a direct connection to the *Motion Coordinator*. Most of the functions that must be performed during the installation, programming and commissioning of a system with a *Motion Coordinator* have been automated by the options available in the *Motion* Perfect menu options. However, if direct intervention is required the terminal window may be used.

When *Motion* Perfect is in connected mode then, on starting the terminal tool you will be presented with a dialog to select the communications channel. Channel 0 is used for the controller command line and channels 5, 6 and 7 are used for communication with programs running on the controller. Selecting the required channel then pressing “OK” will start a terminal tool on the selected channel. Only one terminal tool (or keypad tool) can be connected to a channel at one time.

When *Motion* Perfect is in disconnected mode then, on starting the terminal tool you will be presented with a dialog to select the communications port for connection. The available ports will be those previously configured in the communications options tool. Selecting an interface (probably COM1) and pressing “OK” will start a terminal tool. Only one terminal tool can be used at any on time when operating in disconnected mode.



Axis Parameters

The Axis Parameters window enables you to monitor and change the motion parameters for any axis on the controller.

The window is made up of a number of cells, separated into two banks, bank 1 at the top and bank 2 at the bottom:

Bank 1. contains the values of parameters that may be changed by the user.

Bank 2. contains the values of parameters that cannot be changed by the user, as these values are set by the system software of the *Motion Coordinator* as it processes the Trio BASIC motion commands and monitors the status of the external inputs.

The black dividing bar that separates the two banks may be repositioned using the mouse to redistribute the space occupied by the different banks, for example to allow the user to shrink the window and view other windows whilst still watching the bank 2 information.

When there are more parameters in a bank that can be shown in the window a scroll bar will appear beside that bank so that the user can scroll up and down the parameter list to see the required values.

Axis Parameters

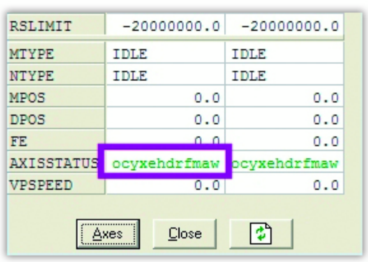
	Axis 0	Axis 2
ATYPE	Servo	Servo
P_GAIN	1.0	1.0
I_GAIN	0.0	0.0
D_GAIN	0.0	0.0
OV_GAIN	0.0	0.0
VFF_GAIN	0.0	0.0
UNITS	1.0	1.0
SPEED	1000.0	1000.0
ACCEL	10000.0	10000.0
DECEL	10000.0	10000.0
CREEP	100.0	100.0
JOGSPEED	100.0	100.0
FELIMIT	2000.0	2000.0
DAC	0	0
SERVO	0	0
REPDIST	5000000.0	5000000.0
FWD_IN	-1	-1
REV_IN	-1	-1
DAT_IN	-1	-1
FH_IN	-1	-1
FSLIMIT	20000000.0	20000000.0
RSLIMIT	-20000000.0	-20000000.0
MTYPE	IDLE	IDLE
NTYPE	IDLE	IDLE
MPOS	0.0	0.0
DPOS	0.0	0.0
FE	0.0	0.0
AXISSTATUS	ocyxehdrfmaw	ocyxehdrfmaw
VPSPEED	0.0	0.0

Axes Close

The user can select different parameters using the cursor keys or using the mouse. Multiple items may be selected by pressing the shift key and then using the cursor keys or the clicking the mouse to select a different cell, or by pressing the left mouse button in the start cell and the moving the mouse to select the last cell in the selection. Functions may be implemented in the future that work on a selection of multiples cells.

When the user changes the **UNITS** parameter for any axis, all the data for this axis is re-read as many of the parameters, such as the **SPEED**, **ACCEL**, **MPOS**, etc., are adjusted by this factor to be shown in user units.

In the *Motion* Perfect axis parameter screen the **AXISSTATUS** parameter is displayed as a series of characters, **ocyxehdrfmaw**.



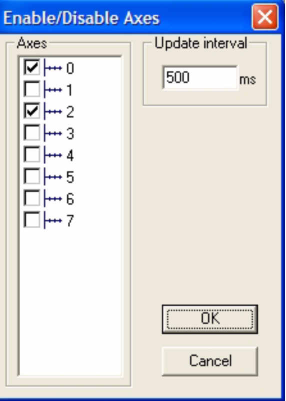
These characters represent **AXISSTATUS** bits in order, as follows:-

char	status bit
w	Warning FE Range
a	Drive Comms Error
m	Remote Drive Error
f	Forward Limit
r	Reverse Limit
d	Datum Input
h	Feed Hold Input
e	Following Error
x	Forward Soft Limit
y	Reverse Soft Limit
c	Cancelling Move
o	Encoder Overcurrent

Parameter Screen Options

Select Axes

This shows a dialog that allows the user to select the axes for which the data will be displayed.



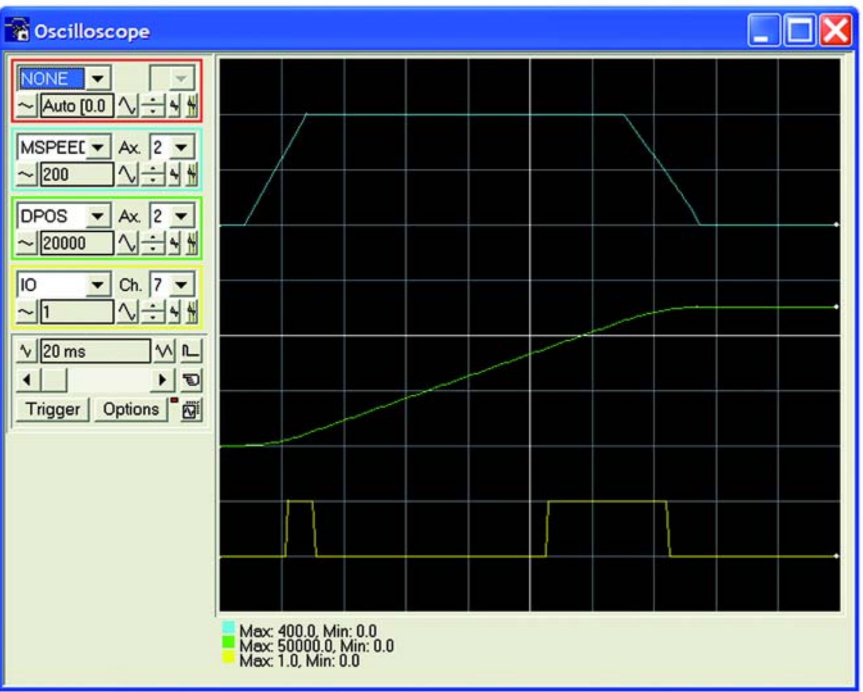
The axes set by the last Create Startup, Jog Axes window or Axes Parameters window will be displayed by default.

Refresh Display

In order to minimise the load placed upon the controller communications, the parameters in the bank 1 section are only read when the screen is first displayed or the parameter is edited by the user. It is possible that if a parameter is changed in a user program then value displayed may be incorrect. The refresh button will force *Motion* Perfect to read the whole selection again.

Note *If there is any possibility that a program has changed any of the parameters then you should ensure that your refresh the display before making changes.*

Oscilloscope



The software oscilloscope can be used to trace axis and motion parameters, aiding program development and machine commissioning.

There are four channels, each capable of recording at up to 1000 samples/sec, with manual cycling or program linked triggering.

The controller records the data at the selected frequency, and then uploads the information to the oscilloscope to be displayed. If a larger time base value is used, the data is retrieved in sections, and the trace is seen to be plotted in sections across the display. Exactly when the controller starts to record the required data depends upon whether it is in manual or program trigger mode. In program mode, it starts to record data when it encounters a **TRIGGER** instruction in a program running on the controller. However, in manual mode it starts recording data immediately.

Controls

The oscilloscope controls are organised into four channel specific control blocks, followed by the oscilloscope general controls.

Oscilloscope Channel Controls

Each oscilloscope channel has the following channel specific controls organised in each of four 'channel control blocks' surrounded by a coloured border which indicates the colour of this channels trace on the display.

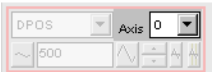
There are parameter list box / axis list box / vertical scale up-down buttons/ vertical offset scrollbar/ vertical offset reset button and cursor bars on-off button controls per scope channel.

Parameter

The parameters which the oscilloscope can record and display are selected using the pull-down list box in the upper left hand corner of each channel control block. Depending upon the parameter chosen, the next label switches between 'axis' or 'ch' (channel). This leads to the second pull-down list box which enables the user to select the required axis for a motion parameter, or channel for a digital input/output or analogue input parameter. It is also possible to plot the points held in the controller table directly, by selecting the 'TABLE' parameter, followed by the number of a channel whose first/last points have been configured using the advanced options dialog. If the channel is not required then 'NONE' should be selected in the parameter list box.

Axis / Channel Number

A pull-down list box which enables the user to select the required axis for a motion parameter, or channel for a digital input/output or analogue input parameter. The list box label switches between being blank if the oscilloscope channel is not in use, 'axis' if an axis parameter has been selected, or 'ch' if a channel parameter has been selected.



Vertical Scaling

The vertical scale (units per grid division on the display) are selected per channel, and these can be configured in either automatic or manual mode.

In automatic mode the oscilloscope calculates the most appropriate scale when it has finished recording, prior to displaying the trace. Hence if the oscilloscope is running with continuous triggering, it will initially be unable to select a suitable vertical scale. It must be halted and re-started, or used in the manual scaling mode.

In manual mode the user selects the scale per grid division.

The vertical scale is changed by pressing the up/down scale buttons either side of the current scale text box (left hand side button decreases the scale, and the right hand side button increases the scale value.) To return to the automatic scaling mode, continue pressing the left hand side button (decreasing the scale value) until the word 'AUTO' appears in the current scale text box.

Channel Trace Vertical Offset

The vertical offset buttons are used to move a trace vertically on the display. This control is of particular use when two or more traces are identical, in which case they overlay each other and only the uppermost trace will be seen on the display.

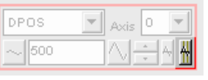
The offset value remains for a channel until the vertical offset reset button is pressed, or the scrollbar is used to return the trace to its original position.

Vertical Offset Reset

The vertical offset value applied using the vertical offset scroll bars can be cleared by pressing this vertical offset reset button.

The button latches on/off. When the button is latched ON then the vertical offset will automatically rescale each time the oscilloscope display is redrawn.

Cursor Bars



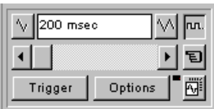
After the oscilloscope has finished running, and has displayed a trace, cursor bars can be enabled. These are displayed as two vertical bars, of the same colour as the channel trace, and initially located at the maximum and minimum trace location points. The values these represent are shown below the oscilloscope display, and again the text is of the same colour as the channel values represented.

The cursor bars are enabled/disabled by pressing the cursor button which toggles alternately displaying and removing the cursor bars. The bars can then be moved by positioning the mouse cursor over the required bar, holding down the left mouse button, and dragging the bar to the required position. The respective maximum or minimum value shown below the display is updated as the bar is dragged along with the value of the trace at the current bar position.

When the cursor bars are disabled, the maximum and minimum points are indicated by a single white pixel on the trace.

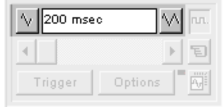
Oscilloscope General Controls

The oscilloscope general controls appear at the bottom left of the oscilloscope window. From here you can control such aspect as the time base, triggering modes and memory used for the captured data.



Time Base

The required time base is selected using the up/down scale buttons either side of the current time base scale text box (left side button decreases the scale, and the right side button increases the scale value.) The value selected is the time per grid division on the display.



If the time base is greater than a predefined value, then the data is retrieved from the controller in sections (as opposed to retrieving a compete trace of data at one time.) These sections of data are plotted on the display as they are received, and the last point plotted is seen as a white spot.

After the oscilloscope has finished running and a trace has been displayed, the time base scale may be changed to view the trace with respect to different horizontal time scales. If the time base scale is reduced, a section of the trace can be viewed in greater detail, with access provided to the complete trace by moving the horizontal scrollbar.

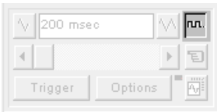
Horizontal scrollbar

Once the oscilloscope has finished running and displayed the trace of the recorded data, if the time base is changed to a faster value, only part of the trace is displayed. The remainder can be viewed by moving the thumb box on the horizontal scrollbar.

Additionally, if the oscilloscope is configured to record both motion parameters and plot table data, then the number of points plotted across the display can be determined by the motion parameter. If there are additional table points not visible, these can be brought into view by scrolling the table trace using the horizontal scrollbar. The motion parameter trace does not move.

One Shot / Continuous Trigger Mode

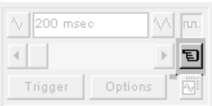
Button Raised = One Shot Trigger Mode
In one-shot mode, the oscilloscope runs until it has been triggered and one set of data recorded by the controller, retrieved and displayed.



Button Pressed = Continuous Trigger Mode:
In continuous mode the oscilloscope continues running and retrieving data from the controller each time it is re-triggered and new data is recorded. The oscilloscope continues to run until the trigger button is pressed for a second time.

Manual/Program Trigger Mode

The manual/program trigger mode button toggles between these two modes. When pressed, the oscilloscope is set to trigger in the program mode, and two program listings can be seen on the button. When raised, the oscilloscope is set to the manual trigger mode, and a pointing hand can be seen on the button.



Button Raised = Manual Trigger Mode:
In manual mode, the controller is triggered, and starts to record data immediately the oscilloscope trigger button is pressed.

Button Depressed = Program Trigger Mode:
In program mode the oscilloscope starts running when the trigger button is pressed, but the controller does not start to record data until a TRIGGER instruction is executed by a program running on the controller. After the trigger instruction is executed by the program, and the controller has recorded the required data. The required data is retrieved by the oscilloscope and displayed.

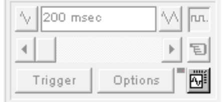
The oscilloscope stops running if in one-shot mode, or it waits for the next trigger on the controller if in continuous mode

Trigger Button

When the trigger button is pressed the oscilloscope is enabled. If it is manual mode the controller immediately commences recording data. If it is in program mode then it waits until it encounters a trigger command in a running program.

After the trigger button has been pressed, the text on the button changes to 'Halt' whilst the oscilloscope is running. If the oscilloscope is in the one-shot mode, then after the data has been recorded and plotted on the display, the trigger button text returns to 'Trigger', indicating that the operation has been completed.The oscilloscope can be halted at any time when it is running, and the trigger button is displaying the 'Halt' text, by pressing this button.

Reset Oscilloscope Configuration



The current scope configuration (the state of all the controls) is saved when the scope window is closed, and retrieved when the scope window is next opened. This removes the need to re-set each individual control every time the scope window is opened.

The configuration reset button (located at the bottom right hand side of the scope control panel) can be pressed to reset the scope configuration, clearing all controls to their default values.

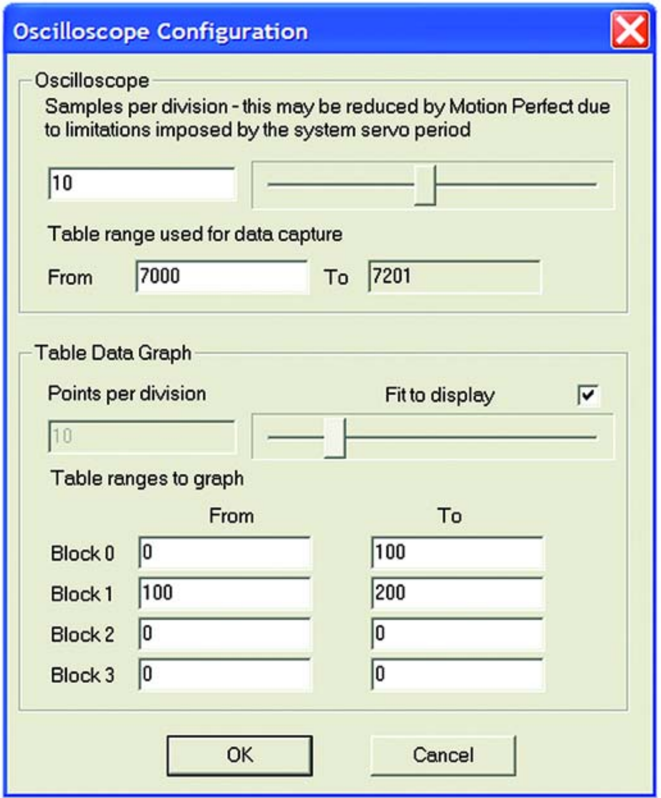
Status Indicator

The status indicator is located in between the options and configuration reset buttons. This lamp changes colour according to the current status of the scope, as follows:

Red oscilloscope stopped.
Black polling controller waiting for it to complete recording the required data.
Yellow retrieving data from the controller.

Advanced Oscilloscope Configuration Options

When the options button is pressed the advanced oscilloscope configuration settings dialog is displayed, as shown below. Click the mouse button over the various controls to reveal further information.



Samples per division

The oscilloscope defaults to recording five points per horizontal (time base) grid division. This value can be adjusted using the adjacent scrollbar.

To achieve the fastest possible sample rate it is necessary to reduce the number of samples per grid division to 1, and increase the time base scale to its fastest value (1 servo period per grid division).

It should be noted that the trace might not be plotted completely to the right hand side of the display, depending upon the time base scale and number of samples per grid division.

Oscilloscope Table Values

The controller records the required parameter data values in the controller as table data prior to uploading these values to the scope. By default, the lowest oscilloscope table value used is zero. However, if this conflicts with programs running on the controller which might also require this section of the table, then the lower table value can be reset.

The lower table value is adjusted by setting focus to this text box and typing in the new value. The upper oscilloscope table value is subsequently automatically updated (this value cannot be changed by the user), based on the number of channels in use and the number of samples per grid division. If an attempt is made to enter a lower table value which causes the upper table value to exceed the maximum permitted value on the controller, then the original value is used by the oscilloscope.

Table Data Graph

It is possible to plot controller table values directly, in which case the table limit text boxes enable the user to enter up to four sets of first/last table indices.

Parameter Checks

If analogue inputs are being recorded, then the fastest oscilloscope resolution (sample rate) is the number of analogue channels in msec (ie 2 analogue inputs infers the fastest sample rate is 2msec). The resolution is calculated by dividing the time base scale value by the number of samples per grid division.

It is not possible to enter table channel values in excess of the controllers maximum TABLE size, nor to enter a lower oscilloscope table value. Increasing the samples per grid division to a value which causes the upper oscilloscope table value to exceed the controller maximum table value is also not permitted.

If the number of samples per grid division is increased, and subsequently the time base scale is set to a faster value which causes an unobtainable resolution, the oscilloscope automatically resets the number of samples per grid division.

General Oscilloscope Information

Displaying Controller Table Points -

If the oscilloscope is configured for both table and motion parameters, then the number of points plotted across the display is determined by the time base (and samples per division). If the number of points to be plotted for the table parameter is greater than the number of points for the motion parameter, the additional table points are not displayed, but can be viewed by scrolling the table trace using the horizontal scrollbar. The motion parameter trace does not move.

Data Upload from the controller to the oscilloscope -

If the overall time base is greater than a predefined value, then the data is retrieved from the controller in blocks, hence the display can be seen to be updated in sections. The last point plotted in the current section is seen as a white spot.

If the oscilloscope is configured to record both motion parameters, and also to plot table data, then the table data is read back in one complete block, and then the motion parameters are read either continuously or in blocks (depending upon the time base).

Even if the oscilloscope is in continuous mode, the table data is not re-read, only the motion parameters are continuously read back from the controller.

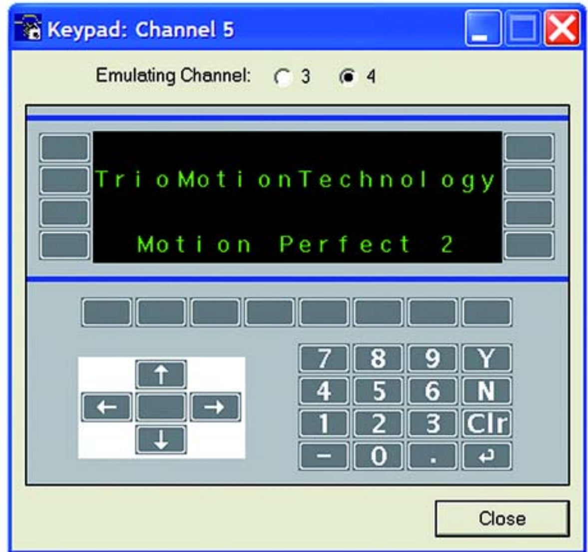
Enabling/Disabling of oscilloscope controls -

Whilst the oscilloscope is running all the oscilloscope controls except the trigger button are disabled. Hence, if it is necessary to change the time base or vertical scale, the oscilloscope must be halted and re-started.

Display accuracy -

The controller records the parameter values at the required sample rate in the table, and then passes the information to the oscilloscope. Hence the trace displayed is accurate with respect to the selected time base. However, there is a delay between when the data is recorded by the controller and when it is displayed on the oscilloscope due to the time taken to upload the data via the serial link.

Keypad Emulation



The keypad requires one of the user communications channels, and so you will be prompted for the channel to use.

If the specified channel is already in use, either by another keypad or a terminal window, the window will not open. Once a channel has been reserved then the keypad will be shown.

In the Trio BASIC program the channel definition for the commands that are associated with the Keypad must be changed from 3 (or 4) to the channel that corresponds with the channel selected for the emulation. We recommend that the channel assignment be made through a variable, so when time comes to run the program on the real machine, only one program change will be required.

example:

```
kpd=5
PRINT #kpd, "Press any key.."
```

Emulating Channel

The normal operation of the keypad emulation returns the characters as if they were read from channel #3 with the **DEFKEY** translation. Alternatively, the *Motion Coordinator* can read the characters returned directly from the Keypad using channel 4. If the emulate #4 codes is selected then the keypad emulation will return the raw characters.

Note: It is only possible to emulate the default **DEFKEY** table.

Key Functions

menu keys	This is a keypad menu key. Normally it is associated with a message on the display. This button can only be pressed by clicking the mouse over it.
function keys 1-8	This is the keypad function key 1. Normally it has an associated user label. This button can be pressed by clicking the mouse over it or using the '1' - '8' keys in the QWERTY area of the PC keyboard.
number keys	This is a keypad number key. It can be pressed by clinking the mouse over it or using the corresponding number in the numerical keypad of your PC keyboard.
Y/N keys	This is the keypad 'Y' and 'N' keys. This is usually used to respond YES or NO to some question on the display. It can be pressed by clicking the mouse over it or using the 'Y'/'N' keys in the QWERTY area of the PC keyboard.
CLR key	This is the keypad 'CLR' key. This is usually used to perform some form of CANCEL operation. It can be pressed by clicking the mouse over it or using the 'ESC' in the QWERTY area of the PC keyboard.
Return key	This is the keypad Return key. This is usually used to perform some form of ACCEPT operation. It can be pressed by clicking the mouse over it or using the 'Enter' in the QWERTY area or numerical keypad of the PC keyboard.
- key	This is the keypad '-' key. This is usually used for entering negative numbers. It can be pressed by clicking the mouse over it or using the '-' in the QWERTY area or numerical keypad of the PC keyboard.
. key	This is the keypad '.' key. This is usually used for entering fractional numbers. It can be pressed by clicking the mouse over it or using the '.' in the QWERTY area or numerical keypad of the PC keyboard.

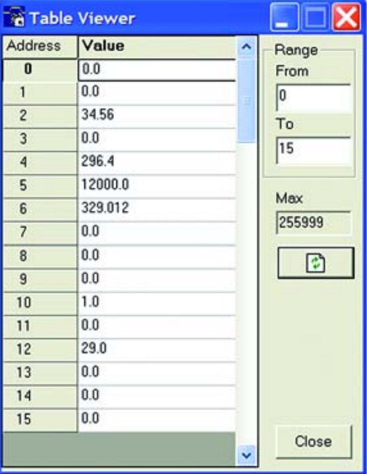
arrow keys This is the keypad up arrow key. This is usually used to select between options on the display. It can be pressed by clicking the mouse over it or using the appropriate arrow key of the PC keyboard.

centre button This is the keypad centre key.
It can only be pressed by clicking the mouse over it.

Table / VR Editor

The Table and VR Editor tools are very similar. You are presented with a spreadsheet style interface to view and modify a range of values in memory.

To modify a value, click on the existing value with the mouse and type in the new value and press return. The change will be immediate and can be made whilst programs are running.



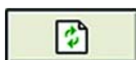
Options

Range

In both tools you have the option to set the start and end of the range to view. In the Table view tool the max value displays the highest value you can read (this is the system parameter TSIZE).

If the range of values is larger than the dialog box can display, then the list will have a scrollbar to enable all the values to be seen.

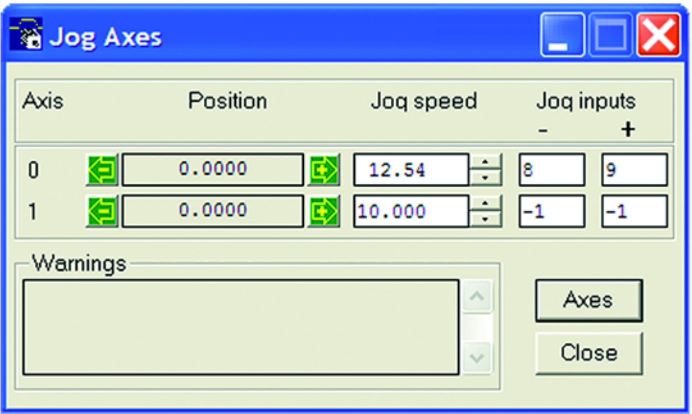
Refresh Button



This screen does not update automatically, so if a Table or VR is changed by the program you will not see the new value until you refresh the display.

Jog Axes

This window allows the user to move the axes on the *Motion Coordinator*.



This window takes advantage of the bi-directional I/O channels on the *Motion Coordinator* to set the jog inputs. The forward, reverse and fast jog inputs are identified by writing to the corresponding axis parameters and are expected to be connected to NC switches. This means that when the input is on (+24V applied) then the corresponding jog function is DISABLED and when the input is off (0V) then the jog function is ENABLED.

The jog functions implemented here disable the fast jog function, which means that the speed at which the jog will be performed is set by the **JOGSPEED** axis parameter. What is more this window limits the jog speed to the range 0..demand speed, where the demand speed is given by the **SPEED** axis parameter.

Before allowing a jog to be initiated, the jog window checks that all the data set in the jog window and on the *Motion Coordinator* is valid for a jog to be performed.

Jog Reverse

This button will initiate a reverse jog. In order to do this, the following check sequence is performed:

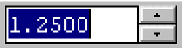
- If this is a SERVO or RESOLVER axis and the servo is off then set the warning message
- If this axis has a daughter board and the WatchDog is off then set the warning message
- If the jog speed is 0 the set the warning message
- If the acceleration rate on this axis is 0 then set the warning message
- If the deceleration rate on this axis is 0 then set the warning message
- If the reverse jog input is out of range then set the warning message
- If there is already a move being performed on this axis that is not a jog move then set the warning message

If there were no warnings set, then the message "Reverse jog set on axis?" is set in the warnings window, the **FAST_JOG** input is invalidated for this axis, the **CREEP** is set to the value given in the jog speed control and finally the **JOG_REV** output is turned off, thus enabling the reverse jog function.

Jog Forward

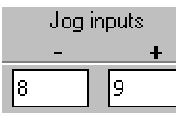
This button will initiate a forward jog. In order to do this, a check sequence identical to that used for **Jog Reverse** is performed.

Jog Speed



This is the speed at which the jog will be performed. This window limits this value to the range from zero to the demand speed for this axis, where the demand speed is given by the **SPEED** axis parameter. This value can be changed by writing directly to this control or using the jog speed control. The scroll bar changes the jog speed up or down in increments of 1 unit per second

Jog Inputs



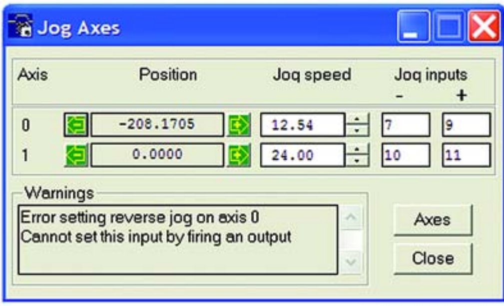
These are the inputs which will be associated with the forward / reverse jog functions.

They must be in the range 8 to the total number of inputs in the system as the input channels 0 to 7 are not bi-directional and so the state of the input cannot be set by the corresponding output.

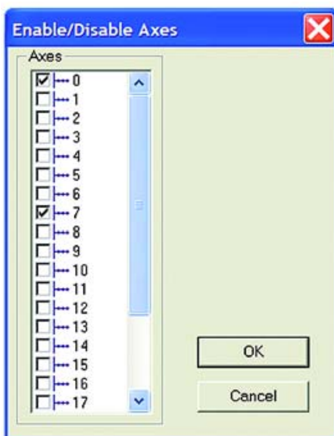
The input is expected to be ON for the jog function to be disabled and OFF for the reverse jog to be enabled. In order to respect this, when this is set to a valid input number, the corresponding output is set ON and then the corresponding **REV_JOG** axis parameter is set.

Warnings

This shows the status of the last jog request. For example, the screen below shows axis 0 with IO channel 7 selected. This is an Input-only channel and therefore cannot be used in the jog screen.



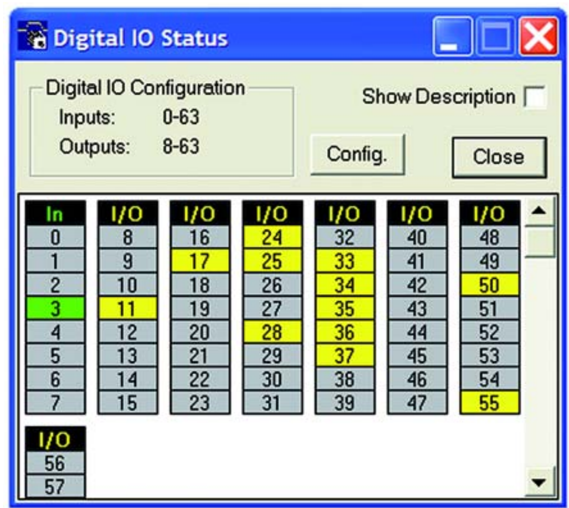
Axes



This displays an axis selector box which enables the user to select the axis to include in the jog axes display. By default, the physical axes fitted to the controller will be displayed.

Digital IO Status

This window allows the user to view the status of all the IO channels and toggle the status of the output channels. It also optionally allows the user to enter a description for each I/O line.



Digital Inputs

This shows the total number of input channels on the *Motion Coordinator*.

Digital Outputs

This shows the total number of output channels on the *Motion Coordinator*.

IO Mimic

Input Bank 0-7

This first bank of 8 LEDs shows the status of the dedicated input channels. If an LED is green then the corresponding input is ON. If an LED is white then the corresponding input is OFF.

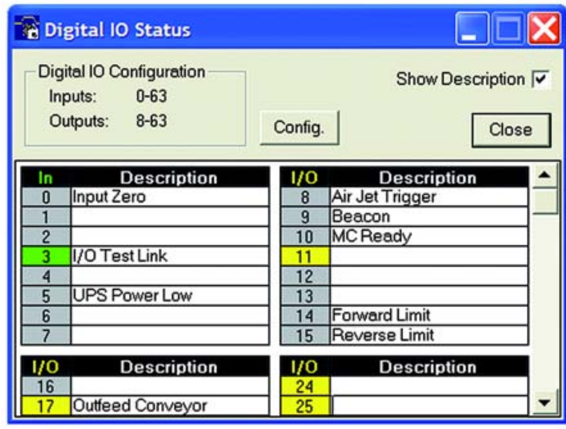
Input/Output Banks

These banks of LEDs show the status the bi-directional IO channels. If an LED is yellow then the corresponding input is ON. If an LED is white then the corresponding input is OFF. Under normal conditions the input status mimics the output status, except:

- If this input is connected to an external 24V then it may be on without the corresponding output being on.
- If the output chip detects an overcurrent situation, then the output chip will shut down and so the outputs will not be driven, even though they may be turned on.

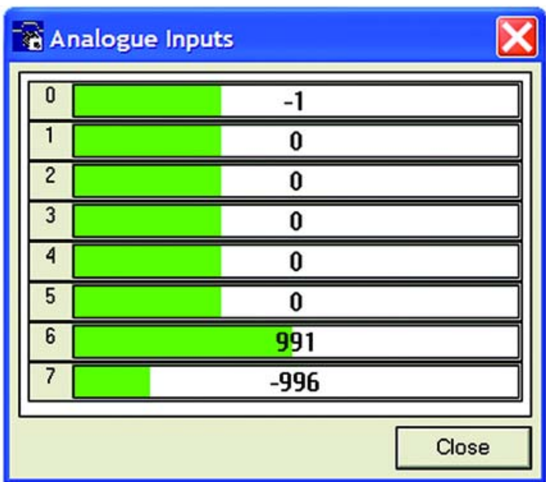
If the LED is clicked with the mouse the status corresponding output channel is toggled, i.e. if the LED is white then the output will be turned on, if the LED is yellow then the output channel will be turned off.

Checking the **Show Description** check box will toggle between dsecriptions on, and descriptions off. Descriptions are stored in the project file

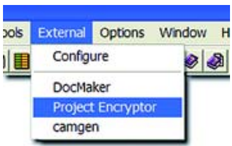


Analogue Input Viewer

The analogue input viewer is only available if the system has analogue inputs. It displays the input values of all analogue inputs in the system using a bar-graph with numeric display.



Linking to External Tools

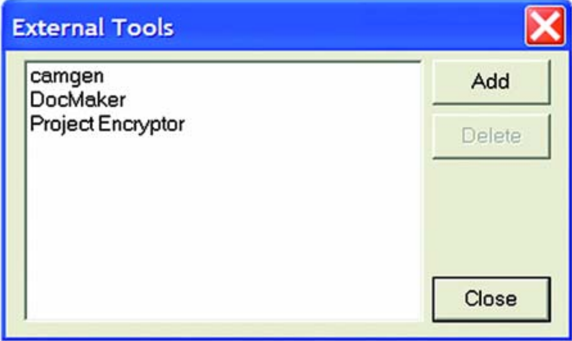


The EXTERNAL menu in *Motion* Perfect allows you to run other programs directly from the main *Motion* Perfect menu. In our example shown here, the menu has been configured to launch two other Trio applications, CAD2Motion and DocMaker. Further information on these applications is given at the end of this chapter.

Note: Cad2Motion and DocMaker are available to download from the Trio Website at www.triomotion.com.

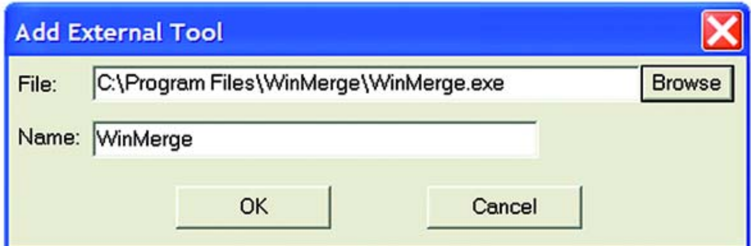
Configuring Items on the External menu

Clicking on the Configure item will bring up a list of all installed applications and from here we can add or delete items from this list.



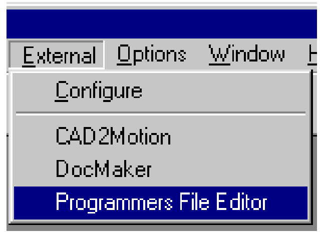
Adding a new programs to the menu

Clicking on the Add button will open the following dialog:



You can either directly enter the path and program file name in the "File" box, or use the "Browse" option to open up a standard windows file selector box which you can use to locate the file on your computer.

Once you have selected the file, it will automatically appear in the External menu every time you run *Motion* Perfect 2.

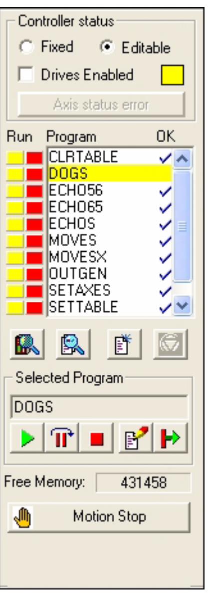


Removing program items from the menu

To delete a program from the External menu, you simply need to click on the program name in the list and press the Delete button.

Note: *This simply removes the program from the menu. it does NOT affect the original program on disk!*

Control Panel



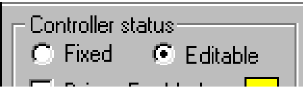
The control panel appears on the left hand side of the main *Motion* Perfect window.

It provides direct links to many of the frequently used operations within *Motion* Perfect, in particular the file and directory functions.

Please Note: *Certain Control Panel Features behave differently on controller without a battery backup. The differences are described later in this section.*

Control Panel Features

Fixed/Editable radio buttons



When the project is “fixed”, the programs are copied to the Flash EPROM on the *Motion Coordinator*, the *Motion Coordinator* is set to run from EPROM and the programs cannot be modified by *Motion* Perfect. Usually this is done when the machine programs are completed. The Flash EPROM provides a reliable permanent storage for the programs.

Drives radio button

Drives Enabled

Drives Disabled

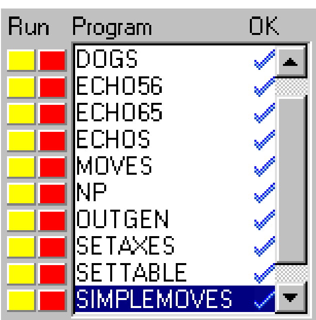
This radio button toggles the state of the enable (watchdog) relay on the controller, going between drives disabled (watchdog off) and drives enabled (watchdog on).

The LED mimic next to this control shows the status of the error LED on the *Motion Coordinator*. If it is yellow then the drives are disabled, if it is grey the drives are enabled and if it is flashing then there has been a motion error on at least one axis of the controller.

Axis Status Error

This will normally be greyed out unless a motion error occurs on the controller.
When an error does occur you can use this button to clear the error condition.

Program directory



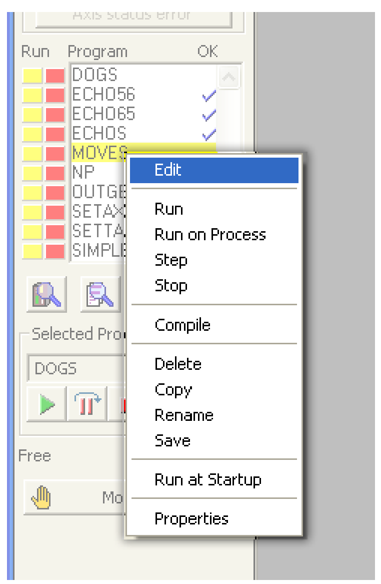
This is a scrollable list of the programs on the controller. The list shows the program name followed by two optional indicators. The first is a number which specifies which process that program is running on. If it is not running then this space is blank. The second indicator shows the status of the program. If it has a tick then the program has been compiled successfully and is ready to be run. If it has a cross then there was an error during the compilation of the program and it cannot be run.

If it is blank then it has not been compiled.

If a program name is clicked then it will become the selected program if there are no programs running. If there are programs running the select will be ignored.

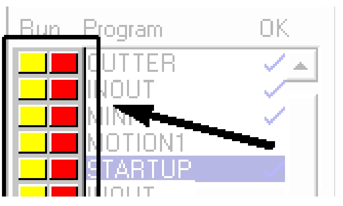
If a program name is double clicked then it will be opened for editing assuming that there are no programs running. If there are programs running then the editor will open in read-only mode.

The names of programs which are currently running are displayed in italics.



Right clicking on an entry in the program list causes a pop-up menu to appear allowing easy access to operations commonly performed on programs. The right click operation highlights the entry in the program list under the cursor whilst the pop-up menu is visible. It reverts to the program which is currently selected on the controller when the menu is closed.

Run buttons

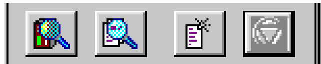


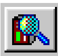
The run buttons provide short cut keys for running, stopping and single stepping programs. They can be in one of three states, red, green or yellow.

RED	Click on the red button to start the corresponding program running. The button will turn Green. *
GREEN	Click on the green button to stop the corresponding program. The button will turn red. *
YELLOW	Click on the yellow button to single step through the program.

* If the program goes into trace mode, through the use of a trace button, the selected program step button, the debug option of the program menu, the debug button on the tool bar or a TRON/STEPLINE command in a program or the terminal window, then the red/green run button will turn yellow. If the button is clicked when it is yellow then the program will be stepped one line.

General Options



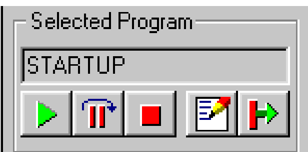
 Show Controller Configuration

Show a full directory of all programs in memory

Create a New Program. Same as the Program menu item.

HALT - Stop all programs which are running

Selected Program



The text box displays the currently selected program and the buttons below, the operations which can be performed on that program.

From left to right they are:
Run, Step, Stop, Edit and Power Up Mode

Free Memory

Free Memory: 104553

Shows the total free memory available on the controller

Motion Stop

Stops all running programs, cancels moves on all axes and disables the watchdog relay.

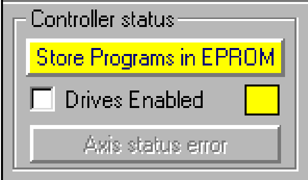
Note *MOTION STOP is a software function. It is not a substitute for a hardware E_Stop circuit and should not be used as an emergency stop.*

Control Panel Variations for Motion Coordinators without battery backup

On those controllers without a battery backup such as the MC202, the fixed / editable radio buttons are replace by a single button labeled "Store Programs into EPROM".

As the controller does not feature a battery, it is essential that you store your programs into the EPROM to avoid loss of data.

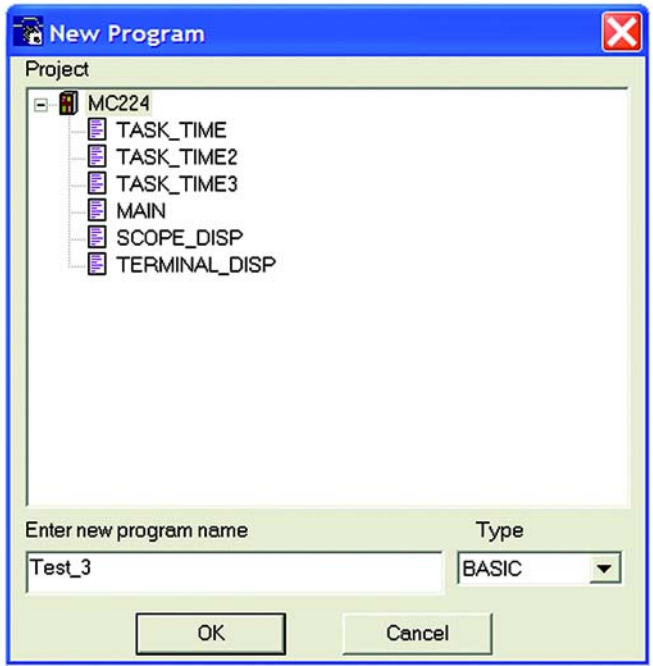
If the programs in memory have been edited, the button will be highlighted to remind you to fix into EPROM before exiting from the program



Creating and Running a program

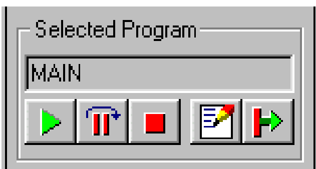
In order to create a new program on the controller, you must first have an active project. If you have already connected to the controller then you can use the default project which was created at this time.

You will be presented with a program selector dialog and prompted to enter a name for your program file. It is a good idea to make this name representative of the task performed by the program, for example “mmi”, “motion”, “logic” or something similar. In the following example, we will add a program called “test” to the current project.



Once you have created a new program it will be added to both the controller and the *Motion* Perfect project file. You can now edit the file in *Motion* Perfect Editor which will have been started up automatically when the new program was created.

The *Motion* Perfect Editor

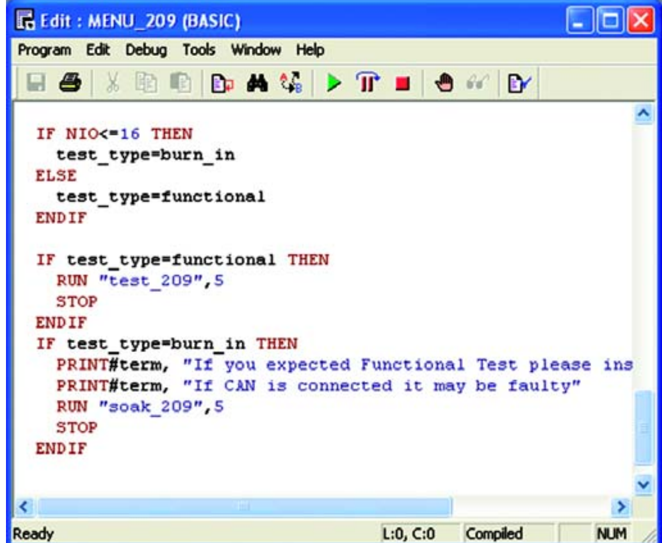


Program Section of the Control Panel

You can start the Editor from the main Program Menu, the Edit button in the program section of the control panel or by right clicking in an entry in the control panel program list and selecting **Edit** from the pop-up menu.

If you launch the editor from the control panel it will start immediately. From the program menu you will first be prompted with a program selector dialog to confirm the file you wish to edit.

The *Motion* Perfect Editor is designed to operate in a similar manner to any simple text editor found on a PC. Standard operations such a block editing functions, text search and replace and printing are all supported and conform to the standard Windows shortcut keys. In addition it provides TrioBASIC syntax highlighting, program formatting and program debugging facilities.

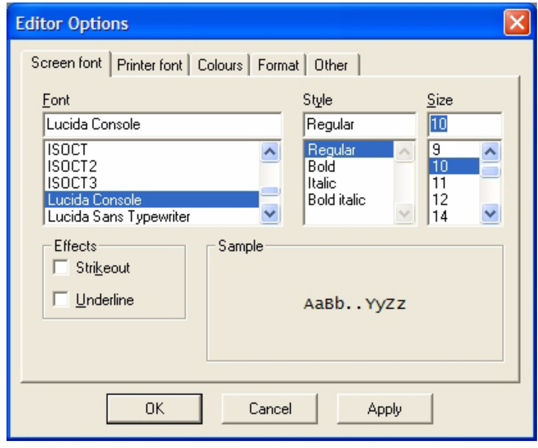


Editor Options

Options for the editor are controlled by the **Editor Options** dialog. This can be opened by selecting **Options/Editor** from *Motion* Perfect's main menu. The dialog allows to user to change the fonts used for screen display and printing, the colours used for syntax and line highlighting and the spacings used when automatically formatting a program.

Screen Font

This is the font used by *Motion* Perfect to display text in the editor window on the screen. The font is restricted to fixed pitch fonts only.

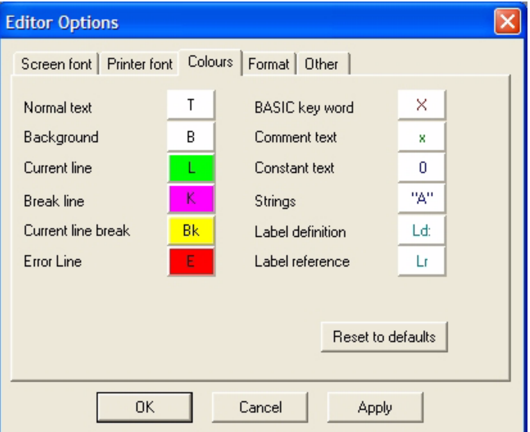


Printer Font

This is the font used by *Motion* Perfect to print program listings. The font is restricted to fixed pitch fonts only.

Colours

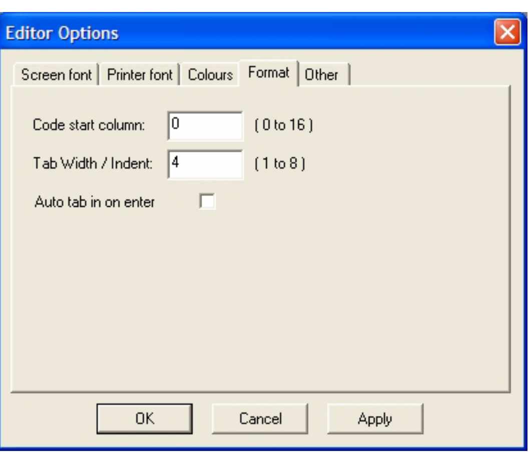
Colours can be specified for the following:



- Normal Text - Text which is not highlighted using systax highlighting.
- Screen Background.
- Current Line (background) - the current line during debugging.
- Break Line (background) - a line containing a break (TRON) command.
- Current Line Break (background) - a line containing a break command which is also the current line.
- Error Line (background) - The first line containing a compilation error.
- BASIC key word - A key word in the TrioBASIC language, usually a command or some type of system variable.
- Comment Text
- Constant Text - text making up a constant value (number).
- Strings
- Label Defenition - where a program label is defined.

- Label Reference - where a jump or branch (GOTO, GOSUB etc.) in program execution is required. The jump or branch changes the execution point to the place where the label is defined.

Format

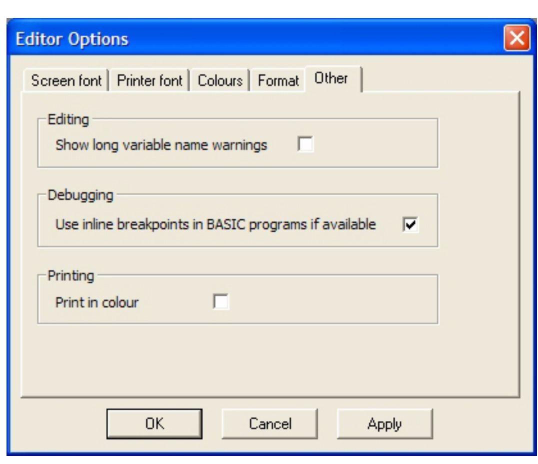


The format options affect text entry and the automatic reformatting preformed by *Motion* Perfect.

For automatic reformatting the code start column and the tab width are specifiable. As label definitions always start in column 0, the code start column can be used to indent all lines containing code thus making label definitions clearer.

The when **Auto tab on enter** check box is checked pressing the "enter" key will automatically indent the next (new) line to the same position as the current one.

Other.



The other options cover things which do not easily fit into any of the above categories.

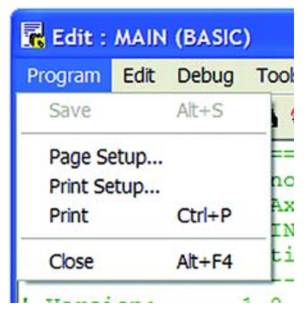
When the **Show long variable name warnings** box is checked, the editor will give a warning if a variable name exceeds the maximum number of characters which the controller checks for uniqueness of variable names (currently 16).

When the **Use inline breakpoints in BASIC programs if available** box is checked, the debugger uses inline breakpoints which the controller inserts without modifying the program. If the box is not checked then the debugger inserts a TRON statement into the program. The advantage of inline breakpoints is that, because they do not actually modify the program, they can be inserted whilst the program is running (or paused).

When the **Print in colour** box is checked any printing from the editor will be done in colour if the printer supports it. Otherwise printing is done in monochrome.

Editor Menus

Program



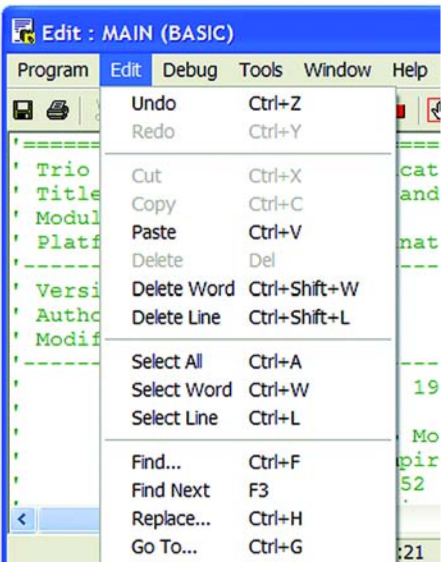
Save

Normally the program is only saved to disk when the editor is closed or a program is run, however if you have modified the program the Save Button will be available and will force *Motion* Perfect to save the file immediately.

Printing

Use **Page Setup** to set the page mrrgins, **Print Setup** to configure you printer settings and the **Print** option to send the program to the printer.

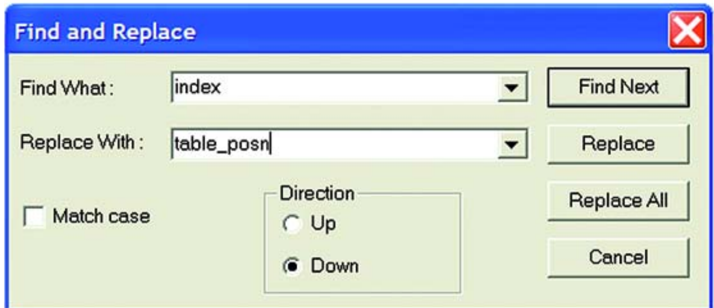
Edit



The edit menu functions are similar to many other text editors and provide the standard block cut/copy/paste operations as well as a simple text find/replace, and various select and delete functions.

Find/Replace

The options for the find & replace dialogs are very similar and feature many of the same options

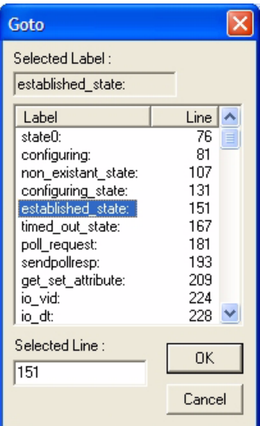


You should enter the text to search for in the “Find What” box, and if using find and replace, the text to replace it with in the “Replace With” box.

Normally the “Case Sensitive” search option is not selected, You should only use this option if you have an exact pattern to match, generally the default option is best.

GOTO

The Goto option will bring up the following dialog:

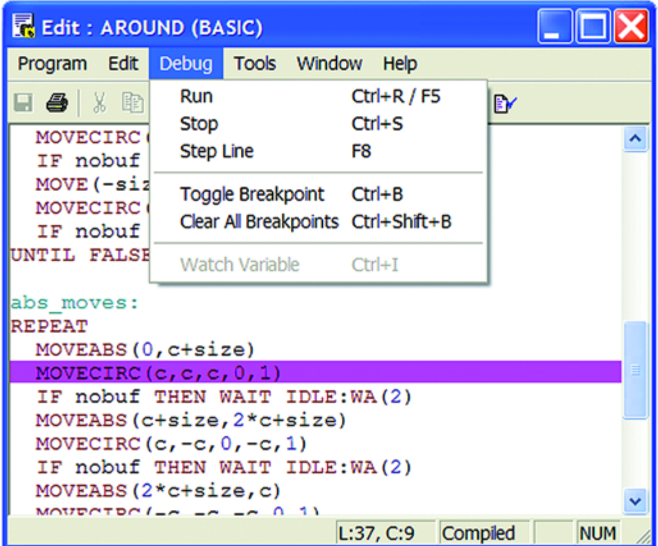


A list of labels defined in the program is displayed. You can either select a label from here, or enter a line number directly in the “Selected Line” field. Pressing the the button at the head of one of the columns in the list will cause the list to be sorted by the values in that column.

Pressing OK after a selection has been made will cause the cursor in the editor to jump directly to the beginning of the selected line.

Program Debugger

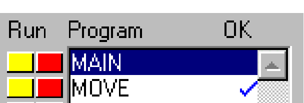
The *Motion* Perfect debugger allows you to run a program directly from the editor window in a special 'trace mode, executing one line at a time (known as stepping) whilst viewing the line in the window. It is also possible to set breakpoints in the program, and run it at normal speed until it reaches the breakpoint where it will stop, and this line of code will be highlighted in the debug window.



When programs are running on the controller, any open editor windows will automatically switch to Debug Mode and will become read-only. Hence, breakpoints are set in the edit window, and the code viewed in the same window in debug mode when the program is running.

Stepping Through a program

To commence stepping a program:



Use the mouse to press the yellow button alongside the required program name in the list box on the control panel

if the required program is currently selected, press the 'Step' button on the control panel( ) or use the menu item 'Debug-Step line'

The currently executing line of code is indicated in the debug window by high-lighting it with a green background, and a breakpoint is highlighted with a red background.

To continue stepping the program, repeatedly press the yellow button alongside the program name in the list box on the control panel, or press the 'Step' button or the 'F8' function key if the program required is currently selected on the *Motion Coordinator*.

Breakpoints

Breakpoints are special place markers in the code which allow a particular section (or sections) of the program to be identified when debugging the code. If a break-point is inserted, the program will pause at that point and return control to *Motion* Perfect where the controller may be interrogated or the program run in step mode as described above.

To insert a breakpoint, first position the text cursor on the line at which you want the break to occur, then use either Ctrl-B or the menu item to insert the break-point.

If the editor option **Use inline breakpoints in BASIC programs if available** has been selected and the controller supports inline breakpoints (this is true of most current controllers) then an inline breakpoint will be inserted. Otherwise the Trio BASIC instruction TRON is used to mark a breakpoint and TROFF to terminate a 'traced' block.

Note: *Inline breakpoints can be added or removed whilst programs are running (or paused). It is not possible to add or remove TRON breakpoints whilst any programs are running or are paused.*

Running to a breakpoint

A program can be run to the next break point by:

- using the mouse to press the red button alongside the program name in the list box on the control panel.
- if it is the currently selected program on the *Motion Coordinator*, you can pressing the 'Run' button ( ) on the control panel/editor tool bar, or by using the keyboard <F5> function key.
- by selecting the 'Debug->Run' menu option

Stopping a Program

If it is necessary to stop the program running before it reaches the breakpoint then:

- press the green button alongside the program name (running on the required process) in the list box on the control panel.
- press the stop button ( )on the control panel if the program is currently selected (this will stop all running copies of the program)
- use the 'Debug-Stop' menu option.

Alternatively all programs can be stopped by pressing the 'Halt' button on the control panel, or selecting the 'Program' 'Halt all programs' menu option, or using the <Ctrl><F> key combination.

Switching a running program into trace mode

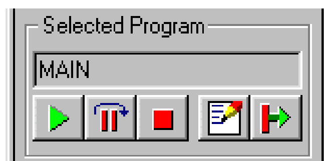
A running program can enter trace (stepping) mode by pressing the yellow button alongside the required program name in the list box on the control panel, or the 'Step' button if the required program is currently selected on the *Motion Coordinator*.

Running Programs

You can start/stop programs running in one of four ways:

From the control panel

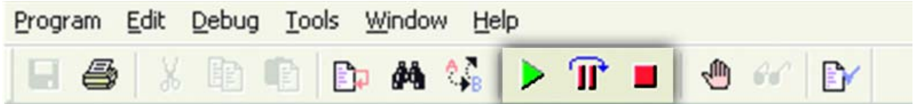
If the program is currently selected (highlighted in the control panel), you can press the green start arrow in the "selected program" box.



From the program list

Pressing the red button to the left of the program name in the list will start it running, the button will change to green and it will then function as a stop button for the same task.

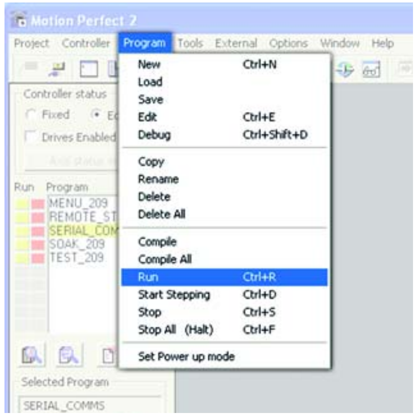
From the editor toolbar



If you have an editor or debug window open for the program you can use either the Debug menu or toolbar buttons to start the program running

From the Program Menu

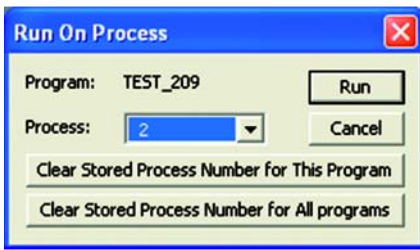
The program menu provides us with a slightly different option when running the program as we are presented with a pro-gram selector box which includes an option to choose which task we want to run the program on



Run on Process

Run on process runs a program on a specified process. The selected process number is remembered for when the program is run again from within Motion Perfect.

The dialog also has buttons for clearing the stored process number for the current program and for all programs in the project.

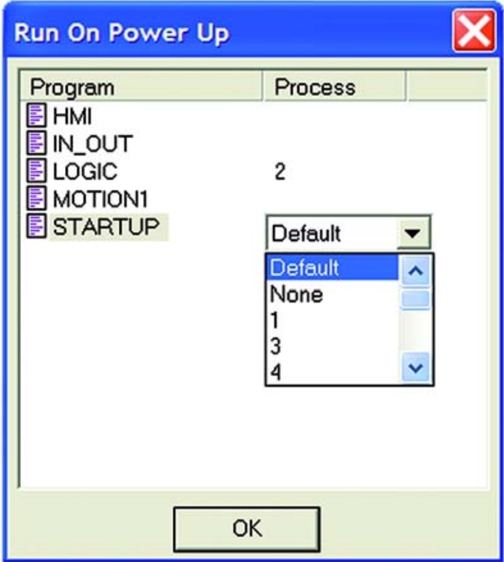


Making programs run automatically

Set Powerup Mode

It is possible to make the programs on the controller run automatically when the system first starts up. From the **Program** Menu, select “**Set Powerup Mode**” to open the following dialog.

Click on the program you want to auto run and a small drop-down list will appear to the right of the window. If you are happy to let the controller allocate which task to run on then you should choose “default” as the process number, otherwise you can specify the task explicitly in the box.



Storing Programs in the Flash EPROM

This is accomplished by selecting the “Fixed” option in the controller status section of the control panel, or the “Fix Program Into EPROM” option from the controller menu.

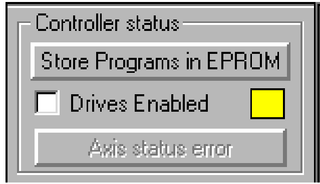
When the controller is fixed into EPROM, the programs actually still run from RAM. The information stored is copied into RAM when the controller is first started, therefore if the controller has been switched off for an extended period, or there is any corruption of the RAM, it will be refreshed with a correct copy of the programs.

When the controller is set to fixed you will not be able to edit any programs. In order to make changes you must select “Editable” from the control panel or “Enable Editing” from the controller menu.

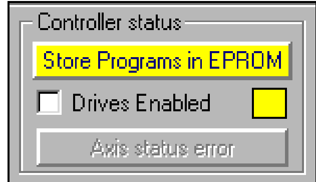
Variations for controllers without battery backup

On those controllers without battery backup, such as the MC202, it is essential that you store your programs into the EPROM to avoid loss of data.

The control panel the fixed / editable radio buttons are replaced by a single button labelled "Store Programs into EPROM".

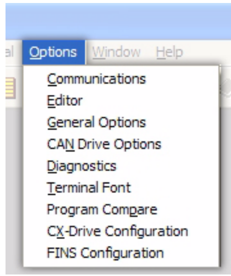


If the programs in memory have been edited, the button will be highlighted to remind you to fix into EPROM before exiting the program.



Configuring The *Motion* Perfect 2 Desktop

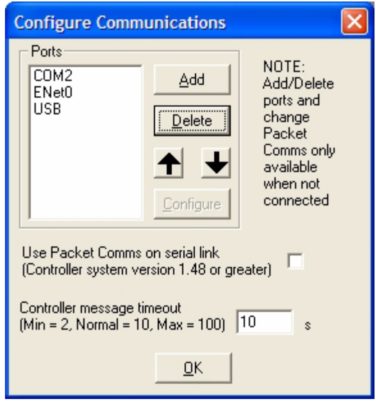
There are a number of ways in which you can configure *Motion* Perfect 2 to suit your requirements. The Options menu provides a number of choices:-



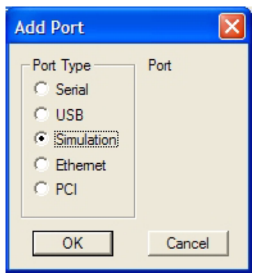
Communications

Set up the default communications device for *Motion* Perfect 2 to use.

Motion Perfect 2 needs a connection to the controller in order to operate. This can be an RS-232 serial connection, a USB connection if your controller and PC have USB ports, an ethernet connection if your controller and PC have ethernet ports, or PCI if your controller is PCI based. It will normally recognise the ports installed in your PC and will display these in the Configure Communications window.



If the port you wish to use is not shown, you need to select the Add Port option which will select the following dialog.



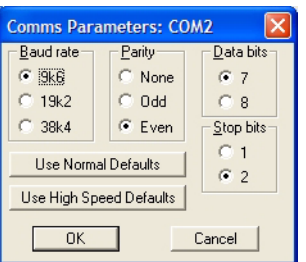
Most *Motion* Perfect 2 users will connect via a standard RS-232 serial (COM) port. Other options include a connection via a high speed Universal Serial Bus (USB) port, ethernet connection or a controller simulation for offline editing. A PCI based controller will use the PCI interface

Choose the port options you require and click on the "OK" button to install the new port.

Changing Communications Parameters

Serial

The default settings for serial communications on MC2 series controllers is:- 9600 baud, 7 data bits, 2 stop bits, even parity. For MC3 series controllers it is 34k8 baud, 8 data bits, 1 stop bit, even parity. If you wish to change these values you can do so with the configure button in the Configure Communications dialog.



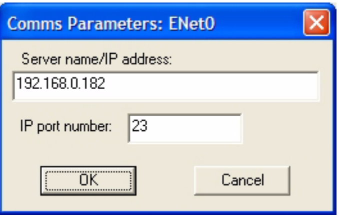
Note: *If you change the port setting to anything other than the default, you may encounter problems when the controller is reset because it will revert to the default values.*
In order to avoid this your controller will need to set the comms parameters within an auto-running program. See the ***SETCOM*** *instruction in the Trio BASIC reference for further information.*

USB

There are no configuration options for USB communications.

Ethernet

You can set the ethernet IP address used by *Motion* Perfect to communicate with the controller and also the IP port used. IP port 23 (telnet port) is the default.

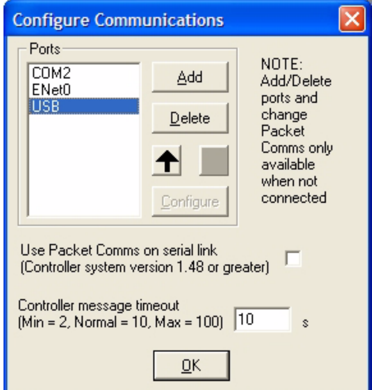


PCI

There are no configuration options for PCI communications.

Setting the Default Port

You can change the order in which the ports are scanned by the program by selecting the port in the list and using the up/down arrows to move the items as required.



Packet Based Communications

Motion Perfect 2 features an enhanced communications protocol which uses a packet based structure with error checking to significantly improve the reliability of the serial port communications. Packet communications can only be used over a serial communications link as other forms of communication have their own build in packetization or error checking.

In order to use the packet based communications mode you must have system software 1.49 or higher.

Controller message timeout

Certain controller operations may cause the controller to stop communicating for a few seconds. If you find that your PC seems to disconnect often, you can change *Motion* Perfect 2's default timeout value to allow the program to wait for a longer time before disconnecting.

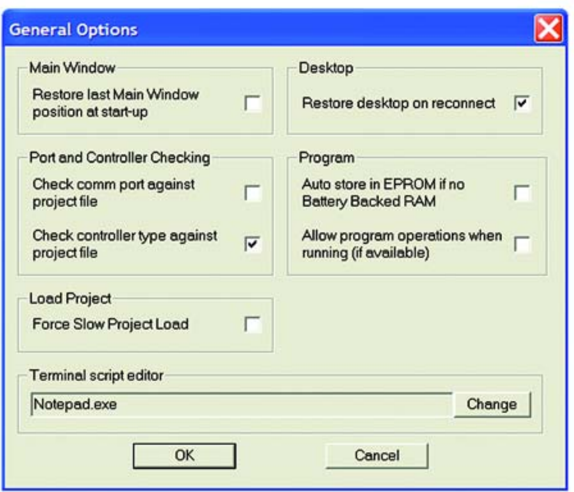
Editor Options

The Editor Options dialog allows you to modify the appearance of the *Motion* Perfect 2 editor to suit your own personal taste. You can change both the default font used and the colours used by the syntax highlighting feature. See the **Editor** section for more details

General Options

This dialog allows the user to change a number of options relating to how *Motion* Perfect 2 starts up and handles projects.

When you select General Options you will be presented with the following screen.



The check-boxes enable the following features:

Check comm port against project file

Checks the comm port being used against the one in the project file when a Check Project operation is performed.

Check controller type against project file

Checks the type of the connected controllerg used against the one in the project file when a Check Project operation is performed.

Restore desktop on reconnect

If this option is selected, the program will attempt to automatically save the desktop layout when disconnecting from the controller.

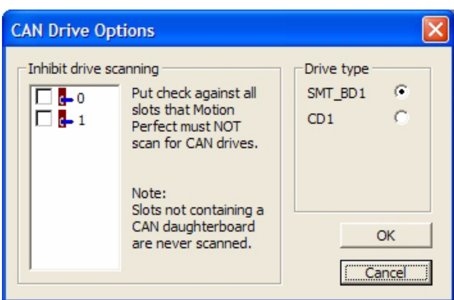
When you reconnect, *Motion* Perfect 2 will automatically restore the last desktop layout saved.

Auto EPROM if no Battery Backed RAM

If the controller does not feature battery-backed RAM memory and this option is selected, the program will attempt to automatically save the controller memory to EPROM before disconnecting from the controller.

CAN Drive Options

The CAN Drive Options dialog controlls how *Motion* Perfect interacts with CAN based drives. You can inhibit scanning for drives on any of the CAN interfaces on the controller (useful if you have other devices connected to a CAN interface) and select which drives to look for (currently only Infranor SMT_DB1 and Infranor CD1 drives are supported).



Diagnostics

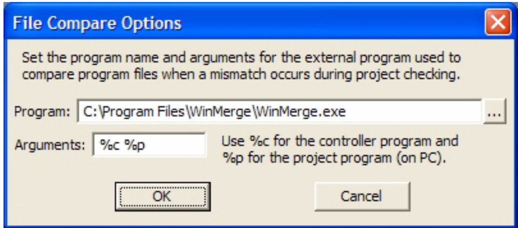
This is used to log communications and some of the internal workings of Motion Perfect as an aid to fault diagnosis. This should not be used except under direction from Omron as the data logging function has a significant effect on the speed of operation of Motion Perfect.

Terminal Font

This is used to set the font used in all terminal tool windows.

Program Compare

This is used to specify the external application used to display the differences



between controller and PC versions of a program during the check project / resolve operation. The standard Motion Perfect installer installs a version of the GLP licensed program WinMerge to do this but you can choose another program if you prefer.

CX-Drive Configuration

Not required for operation with Trio controllers.

FINS Configuration

Not required for operation with Trio controllers.

Saving the Desktop Layout

When you have a number of windows open, you can save the layout so that it can be quickly restored later. Alternatively the desktop can be set to restore automatically on each re-connection by ticking the checkbox under the menu: Options/General options.

From the Window menu...

Restore Last Desktop

Restores the last desktop which was automatically saved by *Motion* Perfect 2 when it disconnected from the controller

Restore Saved Desktop

Restore the last desktop saved using the Save Desktop option.

Save Desktop

Saves the current desktop layout to a file on disk

Clear Desktop

Closes all open tool windows.

Note: *Intelligent drive configuration windows are not restored*

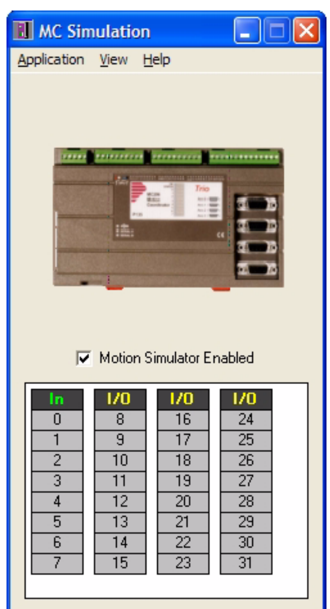
Running *Motion* Perfect 2 Without a Controller

Normally you will run *Motion* Perfect 2 on-line, that is connected to a controller. In fact *Motion* Perfect 2 is designed to operate in this manner and has little functionality without the connection.

In order that you can view or edit your project programs without a controller connected there is a special application to simulate the controller operation and to allow *Motion* Perfect 2 to operate in many ways as if a real controller were connected.

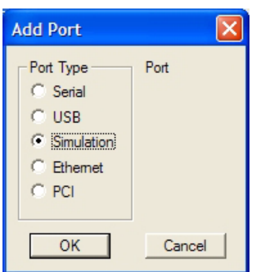
MC Simulation

MC Simulation (MCSim) is a very simple program designed to run alongside *Motion* Perfect 2 in the background. There are no options or configurations to worry about, you just have to run the program and connect as usual.

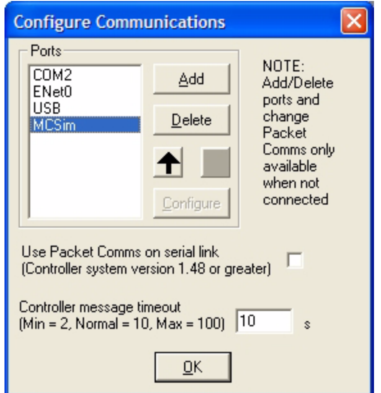


Starting MC Simulatiion from *Motion* Perfect 2

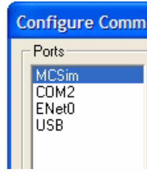
MC Simulatoion is automatically started (if it is not already running) when *Motion* Perfect tries to connect to it. To connect to MCSimuolation either use the **Connect to Simulator** tool button or set up an **MCSim** port in the connection list.

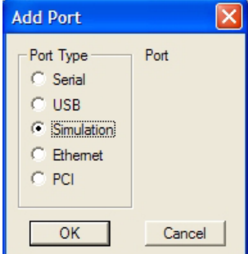


Use the Add Port option to select a new port and choose "Simulation" as the Port Type.

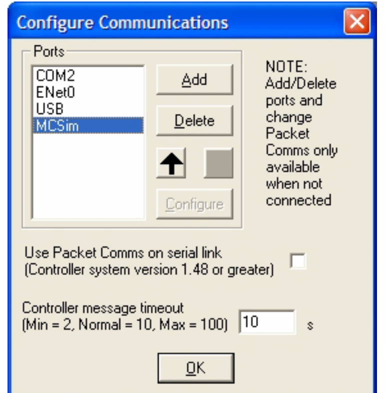


The new device will normally appear at the end of the list. Use the "move up" button to make it the default option.

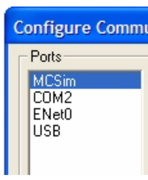




Use the Add Port option to select a new port and choose "Simulation" as the Port Type.



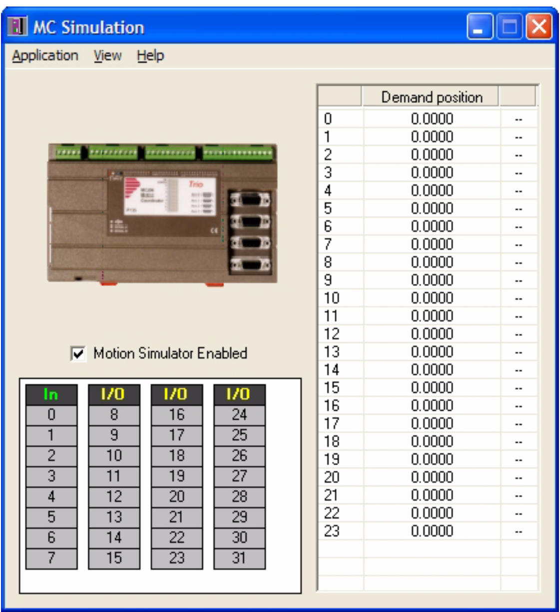
The new device will normally appear at the end of the list. Use the "move up" button to make it the default option.



Limitations of MC Simulation

The MCSimulation program does not yet cover all the functionality present in a real controller. It does allow connection to *Motion* Perfect for program editing and the running of programs in the simulated environment. There are some unsupported TrioBASIC commands (mainly those related to communications busses such as CAN).

The motion engine built into the simulation is still under development although it will handle all move types except linked moves. There is an axis demand position display which can be used to monitor the axes when moves are taking place. This can be toggled on and off by selecting **View/Axes** from the MCSimulation main menu. The motion engine can be enabled/disabled by checking/unchecking the the **Motion Simulator Enabled** check box.



Project Encryptor

Introduction

The *Motion* Perfect Project Encryptor is a stand alone program running under Microsoft^{TM} Windows which encrypts one or more programs in a *Motion* Perfect project so that the TrioBASIC source for that program cannot be read. This gives solution providers a way of protecting their work form possible reverse engineering attempts by third parties.

Encryption Process

The encryption process uses a "Project Password" to encrypt one or more programs in a project. The encryption process creates a new project leaving the original unencrypted version intact. When the encrypted version is loaded onto a motion coordinator a decryption key is required. This key, which is also generated by the encryption program, is used by the controller to decrypt the program for compilation purposes. The decryption key is generated from the "Project Password" and the serial number of the target motion coordinator and is unique to that motion coordinator.

Encrypting a Project

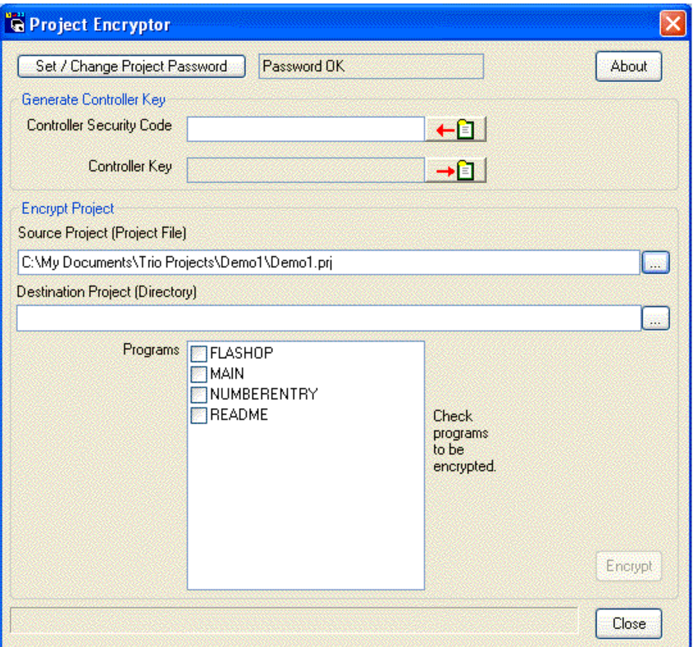
Entering the Project Password

When the project encryptor is first started, or when the "Set / Change Project Password" button is pressed, the Password "Set Project Password" dialog is displayed.

The password needs to be entered twice to reduce the chance of an entry error occurring. For security reasons the password is not displayed in the application's main window.

Selecting Source and Destination Projects

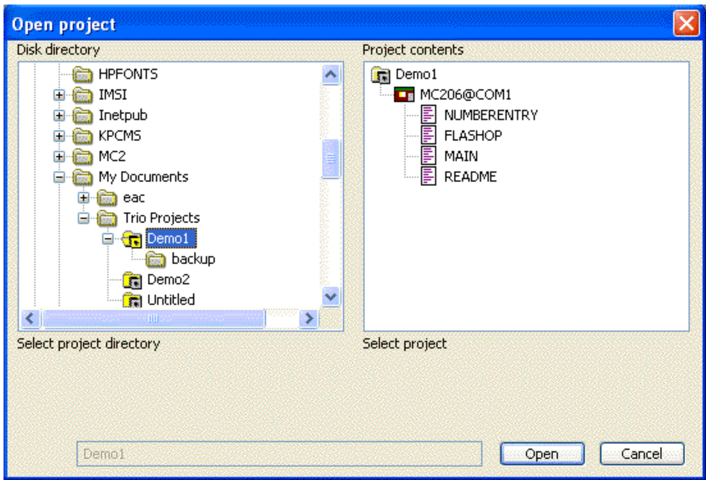
In order to be able to encrypt a project the user must select the project to be encrypted (source project) and the name and location of the encrypted project (destination project).



Source Project

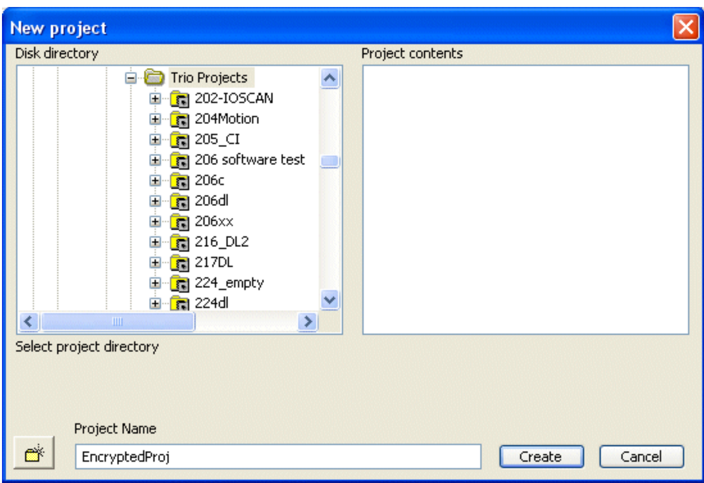
The source project is selected, either by entering the full path of the project file (which has a .prj extension) into the source project text entry box or by using the browse button (...) to the right of the source project text entry box to open up a file selection dialog.

Select the source project by clicking on an entry in the disk directory tree.



Destination Project

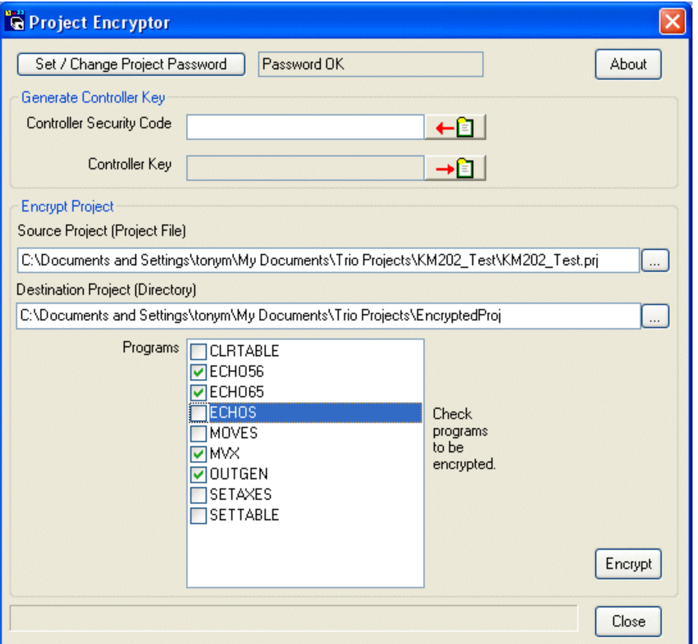
The destination project (which must be fifferent from the source project) is selected, either by enterning the full path of the new project directory into the destination project text entry box or by using the browse button (...) to the right of the destination project text entry box to open up a directory selection dialog.



Select the parent directory for the project using the disk directory tree and enter the project name into the project name text entry box.

Selecting the programs to be encrypted

To select which programs to encrypt tick the check boxes next to the program names.

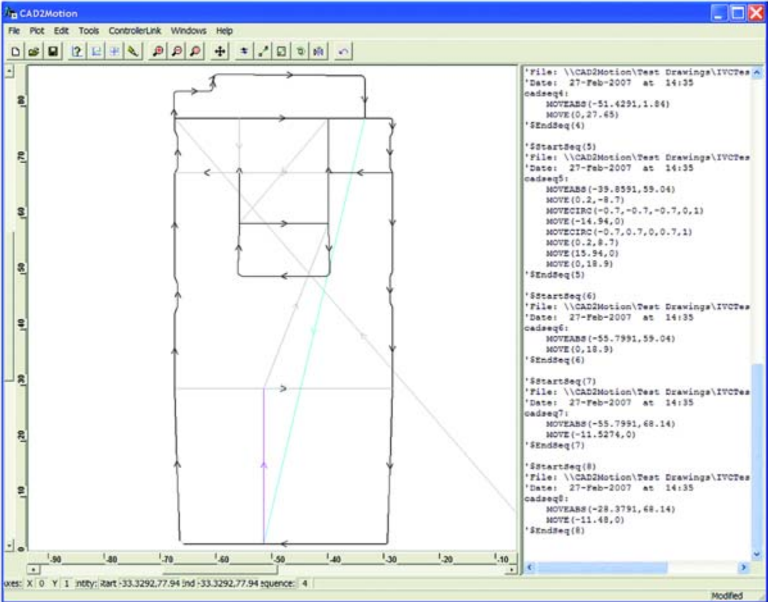


Encrypting

Click on the Encrypt button to encrypt the project. If it is not enabled then some of the data required to perform the encryption has not been entered.

CAD2Motion

CAD2Motion is a program designed to allow users to translate CAD generated two dimensional motion paths into Trio BASIC programs.



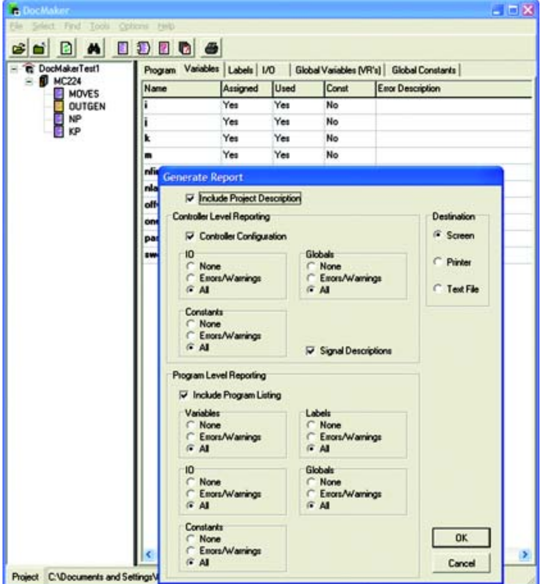
The program allows the user to create motion paths in a CAD package such as AutoCAD and convert them into code executable by a *Motion Coordinator*. Typically the path information will be drawn on a single layer in the CAD package and exported as a DXF file. The DXF file (layer with motion path only) is read into CAD2Motion to create a program to follow the motion path.

The motion path can be manipulated and edited before being saved as a Trio BASIC program file which can be loaded on to a *Motion Coordinator*.

- Can read Industry standard DXF files and TrioBASIC files.
- Outputs files as TrioBASIC programs.
- Graphical display of motion path with full pan and zoom facilities.
- Built in program text editor.
- Program list and graphical display linked together to show correlation between program code and moves within the motion path.
- Built in tools to mirror, scale, shift, reverse and rotate motion paths.
- Full undo on all tool and editor operations.
- Will handle multiple motion paths (sequences) in the same program.

DocMaker

DocMaker is a Windows application designed to assist in documenting a Trio BASIC project created with *Motion* Perfect.



DocMaker analyses the content of the program files in the project. It can be used to print program listings and to report on the programs (variables, labels, I/O and VR's) and on overall I/O and VR usage. There is also a checking routine which does a quick check on the whole project and flags up possible errors

DocMaker Benefits

- Automatic Analysis of MotionPerfect Project Files
- Highlight potential errors due to labels or variables
- Generates fully cross-referenced reports
- Reformat programs with auto-indenting

Docmaker Hardware Requirements

- IBM PC or Compatible running Microsoft Windows 98 or higher
- Works with all current Motion Coordinators

CHAPTER

10

AUTO LOADER AND MC LOADER ACTIVEX

Project Autoloader

Trio Project Autoloader is a stand alone *Motion Coordinator* program to load projects created using *Motion* Perfect 2 onto a Trio *Motion Coordinator*

The program is intended for easy loading of projects onto controllers without the need to run *Motion* Perfect and so allows OEM manufacturers to update customers equipment easily.

Operation of the program is controlled using a script file which gives a series of commands to be processed, in order, by the program.

Using the Autoloader

General

The autoloader is primerally intended to be used to update controllers already installed in equipment to allow OEM manufacturers to update customers equipment easily. It can be used from a hard disk or CD-ROM.

Script File

The autoloader program uses a script file AutoLoader.tas as a source of commands. These commands are executed in order until all commands have been processed or an error has occurred.

If any command fails the exececution terminates without completing the scripted command sequence.

Project

The project to be loaded using LOADPROJECT is in the form of a normal *Motion* Perfect 2 project. This consists of a directory containing a project definition file and Trio BASIC program files. The directory must have the same name as the project definition file less the extension.

i.e. project definition file TestProj.prj, directory TestProj

The project directory must be in the LoaderFiles directory.

Timeout

If there are large programs in the project the command timeout may need to be increased from its default value of 10 seconds otherwise the project load may fail due to the long time it takes to select a new program on the controller. The TIMEOUT command should appear in the script file before any LOADPROJECT command.

Tables

Any tables to be loaded must be in the form of *.lst files produced by Motion Perfect 2.

Normally these table files will be in the LoaderFiles directory.

Extra Programs

Programs which need to be loaded using LOADPROGRAM because they are not in the project being loaded (or if no project is being loaded)

Normally these program files will be in the LoaderFiles directory.

Files

The autoloader is designed to work with the following file structure (fixed names are shown in bold type).

Base Directory	**AutoLoader.exe**		
	LoaderFiles	**AutoLoader.tas**	
		Project	Project.**prj**
			Prog1.**bas**
			Prog2.**bas**
		Table1.**lst**	
		ExtProg1.**bas**	

Where:

Base Directory is normally the root directory, but can be any directory.

Project is the Motion Perfect 2 project directory for the project to be loaded using the LOADPROJECT command, Project.**prj** being the project file and Proj?.**bas** are the program files in the project.

Table?.**lst** are the table files to be loaded using the LOADTABLE command.

ExtProg?.**bas** are the extra programs to be loaded using the LOADPROGRAM command.

Any or all of the objects in the LoaderFiles directory can be located elsewhere as long as the file (or directory) name is specified using a full path. The script file can be specified as a single argument to the AutoLoader program.

Running the program

The program can be started in the same way as any other Windows program, in which case the LoaderFiles directory must be in the same directory as the AutoLoader executable file.

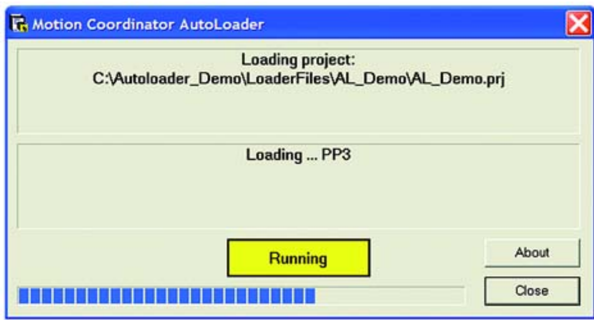
It can also be started from the command line with an optional argument which specifies the script file to process. e.g.

```
AutoLoader E:\MXUpdate\20051203\UpDate1.tas
```

Start Dialog

The start dialog displays a message specified in the script and has **continue** and **cancel** buttons so that the user can exit from the program without running the script.

Main Window



The program main window consists of two message windows; one to display the current command and the other to display the name of the program or file currently being loaded. There is a button to show the current status (Starting, running, pass or fail) and a progress bar to show the progress during file and table loading.

The **close** button closes the dialog. If it is pressed while a script is being processed then script processing will be terminated at the end of the current operation.

Script Commands

The following commands are available for use in script files

AUTORUN
CHECKPROJECT
CHECKTYPE
CHECKUNLOCKED
CHECKVERSION
COMMLINK (alternative COMMPORT)
COMPILEALL
COMPILEPROGRAM
DELETEALL (alternative NEWALL)
EPROM
FASTLOADPROJECT
HALTPROGRAMS
LOADPROGRAM
LOADPROJECT
LOADTABLE
SETPROJECT
SETRUNFROMEPROM
STARTUPMESSAGE
TIMEOUT
DELTABLE

All commands return a result of **OK** or **Fail**. An **OK** result allows script execution to continue, a **Fail** result will make script execution terminate at that point.

AUTORUN

Purpose: To run the programs on the controller which are set to run automatically at power-on.

Syntax: **AUTORUN**

CHECKPROJECT

Purpose: To check the programs on a controller against a project on disk.

Syntax: **CHECKPROJECT [<ProjectName>]**
Where <ProjectName> is the optional path of the project directory. If the project directory is in the same directory as the ALoader.exe executable then it is just the name of the of the project directory. If no <ProjectName> is specified then the current project, set by a previous SETPROJECT or LOADPROJECT command, is used. This operation is automatically performed by a LOADPROJECT operation.

Examples:
```
CHECKPROJECT
CHECKPROJECT TestProj
```

CHECKTYPE

Purpose: To check the controller type.

Syntax: **CHECKTYPE <Controller List>**

Where <Controller List> is a comma separated list of one or more valid controller ID numbers.

i.e. 206,216

Examples:
```
CHECKTYPE 206
CHECKTYPE 202,216,206
```

Controller ID Numbers

Each type of controller returns a different ID number in response to the TrioBASIC command ?CONTROL[0] . The table below gives the ID number for current controllers.

Controller	CONTROL
MC302X	293
Euro205x	255
Euro209	259
MC206X	207
PCI208	208
MC224	224

CHECKUNLOCKED

Purpose: To check that the controller is not locked.

Syntax: `CHECKUNLOCKED`

CHECKVERSION

Purpose: To check the version of the controller system code.

Syntax:

```
CHECKVERSION <Operator><Version>
CHECKVERSION <LowVersion>-<HighVersion>
```

Examples:

```
CHECVERSION >1.49
CHECKVERSION >= 1.51
CHECKVERSION 1.42-1.50
```

Comment

Purpose: To allow the user to put descriptive comments into a script.

Syntax: `' <Text>`

Where <Text> is any text.

Examples:
```
' This is a comment line
```

COMMLINK (alternative COMMPORT)

Purpose: To set the communications port and parameters.

Syntax: Serial

For a serial port this string is similar to COM1:9600,7,e,2 to specify the port, speed, number of data bits, parity and number of stop bits. 9600,7,e,2 are the default parameters for a controller.

USB

For a USB connection the string is USB:0 as only a single USB connection (0) is supported.

Ethernet

For an ethernet connection the string is similar to Ethernet:192.168.0.123:23 which specifies an ethernet connection to IP address 192.168.0.123 on port 23. The final ':' and the port number can be omitted, in which the port number defaults to 23.

PCI

For a PCI connection the string is similar to PCI:0 which specifies a connection to PCI card 0.

Examples:
```
COMMLINK COM2:9600,7,e,2
COMMLINK USB:0
COMMLINK Ethernet:192.168.0.111
COMMLINK PCI:1
```

COMPILEALL

Purpose: To compile all the programs on the controller.

Syntax: **COMPILEALL**

COMPILEPROGRAM

Purpose: To compile a program on the controller.

Syntax: **COMPILEPROGRAM <Program>**
Where <Program> is the program name.

Examples: **COMPILEPROGRAM Prog**

Note: The LOADPROGRAM command automatically compiles programs after thay are loaded so under normal circumstances there is no need to use this command.

DELETEALL (alternative NEWALL)

Purpose: To delete all programs on the controller.

Syntax: **DELETEALL**

EPROM

Purpose: To store the project currently in controller RAM into EPROM

Syntax: **EPROM**

FASTLOADPROJECT

Purpose: To load a project from disk onto the controller.

Description: FASTLOADPROJECT is a faster alternative to LOADPROJECT. It is only compatible with system software version 1.63 or later for '2' series Motion Coordinators, and version 1.9013 or later for '3' series Motion Coordinators.

FASTLOADPROJECT must be used if a project contains encrypted programs.

Syntax: **FASTLOADPROJECT [<ProjectName>]**
Where <ProjectName> is the optional path of the project directory. If the project directory is in the same directory as the ALoader.exe executable then it is just the name of the of the project directory. If no <ProjectName> is specified then the current project, set by a previous SETPROJECT command, is used.

Examples:

```
FASTLOADPROJECT
FASTLOADPROJECT TestProj
```

Note: *If FASTLOADPROJECT fails and the project only contains TrioBASIC source files then using LOADPROJECT may work.*

HALTPROGRAMS

Purpose: To halt all programs on the controller.

Syntax: **HALTPROGRAMS**
This operation is automatically performed as part of LOADPROJECT, LOADPROGRAM and DELTABLE commands.

LOADPROJECT

Purpose: To load a project from disk onto the controller.

Syntax: **LOADPROJECT <ProjectName>**
Where <ProjectName> is the optional path of the project directory. If the project directory is in the same directory as the ALoader.exe executable then it is just the name of the of the project directory. If no <ProjectName> is specified then the current project, set by a previous SETPROJECT command, is used.

Examples: **LOADPROJECT**
LOADPROJECT TestProj

Note: *LOADPROGRAM will only load TrioBASIC soruce files.*

LOADPROGRAM

Purpose: To load a program not in a project onto the controller.

Syntax: **LOADPROGRAM <ProgramFile>**

Where <ProgramFile> is the path of the program file. If the program file is in the same directory as the ALoader.exe executable then this is just the file name of the program file.

Examples: **LOADPROGRAM TestProg.bas**

Note: *LOADPROGRAM will only load TrioBASIC soruce files.*

LOADTABLE

Purpose: To load a table onto the controller.

Syntax: **LOADTABLE <TableFile>**
Where <TableFile> is the path of the table file. If the table file is in the Loader-Files directory then this is just the file name of the table file.

This command should always be used after the LOADPROJECT command.

Examples: **LOADTABLE Tbl.lst**

SETPROJECT

Purpose: To set the current project for following commands.

Syntax: **SETPROJECT <ProjectName>**

Where <ProjectName> is the path of the project directory. If the project directory is in the same directory as the ALoader.exe executable then it is just the name of the of the project directory.

Examples:
```
SETPROJECT TestProj
```

SETRUNFROMEPROM

Purpose: To set the controller to use the programs stored in its EPROM. (It actually copies the programs from EPROM into RAM at startup).

Syntax:
```
SETRUNFROMEPROM <State>
```

Where <State> is **1** for copy from EPROM and **0** is use programs currently in RAM.

A single @ character can be used to specify state in the project file.

Examples:
```
SETRUNFROMEPROM 1
SETRUNFROMEPROM @
```

Note: *This command only applies to controllers which have battery backed RAM (controllers with no battery backed RAM will always copy programs from EPROM).*

Startup Message

Purpose: To allow the user to display a custom message in the startup dialog.

Multiple lines can be used to specify the message, they are displayed in the order that they appear in the script file. The message can be specified anywhere in the script file and the lines need not be together in the file.

Syntax:
```
# <Text>
```

Where <Text> is any text.

Examples:
```
# ***
# This autoloader was set up by ABCD Inc. to change Valve
Machine to left-hand thread
# ***
```

TIMEOUT

Purpose: To set the command timeout.

Syntax: **TIMEOUT time**

Where time is the timeout value in seconds (default is 10).

Examples: **TIMEOUT 30**

Note: *It will normally only be necessary to increase the timeout above 10 if there are large programs in the target controller or you are loading large programs onto it.*

Script File

The autoloader program uses a script file AutoLoader.tas as a source of commands. These commands are executed in order until all commands have been processed or an error has occurred.

If any command fails the exececution terminates without completing the scripted command sequence.

Sample Script

```
  ' Test Script
  ' **************
  ' Startup Message
  # ***
  # This autoloader was set up by TRIO to load a test project
onto a controller of fixed type.
  # ***
  COMMLINK COM1:9600,7,e,2
  CHECKTYPE 206
  CHECKVERSION > 1.45
  CHECKUNLOCKED
  LOADPROJECT LoaderTest
  LOADTABLE tbl_1.lst
  CHECKPROJECT LoaderTest
  LOADPROGRAM flashop.bas
  LOADPROGRAM clrtable.bas
  LOADPROGRAM settable.bas
  EPROM
  SETRUNFROMEPROM @
```

For this script to work correctly the LoaderFiles directory must contain a project directory LoaderTest, a table file tbl_1.lst and three program files: flashop.bas, clrtable.bas and settable.bas.

MC Loader

Trio MC Loader is a Windows ActiveX control which can load projects (produced with Motion Perfect) and programs onto a Trio *Motion Coordinator*. Communication with the *Motion Coordinator* can be via Serial link, USB, Ethernet or PCI depending on the *Motion Coordinator*.

Requirements

- PC with one or more of USB interface, Ethernet network interface, or PCI based *Motion Coordinator.*
- Windows 98, ME, 2000 or XP (Windows 2000 or XP only for PCI connection)
- TrioUSB driver - for USB connection
- Trio PCI driver - for PCI connection (Windows 2000 and XP systems only)
- Knowledge of the Trio *Motion Coordinator* to which the TrioPC ActiveX controls will connect.
- Knowledge of the Trio BASIC programming language.

Installation of the MC Loader Component

Launch the program "Install_TrioMCLoader" and follow the on-screen instructions. The TrioUSB driver and TrioPC ocx will be installed and registered to your Windows environment. The Trio MC Loader driver will also be installed on systems running Windows 2000 or Windows XP. A Windows Help file is included as an alternative to the printed pages in this manual.

Using the Component

The MC Loader component must be added to the project within your programming environment. Here is an example using Visual Basic, however the exact sequence will depend on the software package used.

From the Menu select Project then Components... (or use shortcut ctrl+T).

When the Components dialogue box has opened, scroll down until you find "Trio MC Loader Control Module" then click in the block next to Trio MC Loader. (A tick will appear)

Now click OK and the component should appear in the control panel on the left side of the screen. It is identified as TrioMCLoader Control.

Once you have added the Trio MC Loader component to your form, you are ready to build the project and include the Trio MC Loader methods in your programs.

Properties

The control has the following properties:

CommLink
ControllerType
ControllerSystemVersion
DecryptionKey
Locked
ProjectFile
RunFromEPROM
Timeout

Events

The control does not generate any events.

CommLink

Type: BSTR (string)

Access: Read / write

Description: This property is used to get or set the configuration of the communications link. The format of the string depends on the type of communications link being used.

Serial

For a serial port this string is similar to COM1:9600,7,e,2 to specify the port, speed, number of data bits, parity and number of stop bits. 9600,7,e,2 are the default parameters for most controllers.

USB

For a USB connection the string is USB:0 as only a single USB connection (0) is supported.

Ethernet

For an ethernet connection the string is similar to Ethernet:192.168.0.123:23 which specifies an ethernet connection to IP address 192.168.0.123 on port 23. The final ':' and the port number can be omitted, in which the port number defaults to 23.

PCI

For a PCI connection the string is similar to PCI:0 which specifies a connection to PCI card 0.

Examples: Visual BASIC:

```
axLoader.CommLink = "Ethernet:192.168.22.11"
```

Visual C#:

```
axLoader.CommLink = "Ethernet:192.168.22.11";
```

ControllerType

Type: unsigned long

Access: Read

Description: This is a read-only property which returns the Controller Type code.

Examples: Visual BASIC:

```
Dim ConType As Long
ConType = axLoader.ControllerType
```

Visual C#:

```
ulong ulConType;
ulConType = axLoader.ControllerType;
```

ControllerSystemVersion

Type: double

Access: Read

Description: This is a read-only property which returns the controller system software version number.

Examples: Visual BASIC:

```
Dim Version As Double
Version = axLoader.ControllerSystemVersion
```

Visual C#:

```
double dVersion;
dVersion = axLoader.ControllerSystemVersion;
```

DecryptionKey

Type: BSTR (string)

Access: Read / write

Description: The DecryptionKey property sets/gets the decryption key for a subsequent fast mode LoadProject operations. The decryption key is only used when a project containing one or more encrypted programs is loaded onto a controller using fast LoadProject.

Examples: Visual BASIC:

```
axLoader.DecryptionKey = "hjiHU87OOo"
```

Visual C#:

```
axLoader.DecryptionKey = "hjiHU87OOo";
```

Note: *Decryption keys are a derived from the key string used to encrypt the program(s) and the security code of the target controller. Decryption keys can be generated using the Project Encryptor tool distributed with Motion Perfect.*

Locked

Type: VARIANT_BOOL

Access: Read

Description: This is a read-only property which returns the locked state of the controller (true for locked, false for unlocked).

Examples: Visual BASIC:

```
Dim IsLocked As Boolean
IsLocked = axLoader.Locked
```

Visual C#:

```
bool bLocked;
bLocked = axLoader.Locked;
```

ProjectFile

Type: BSTR (string)

Access: Read / write

Description: This property is used to get or set the current project file. The full path to the project file should be used when setting this property.

Examples: Visual BASIC:

```
If axLoader.ProjectFile.Length = 0 then
    axLoader.ProjectFile = "C:\Projects\PPX\PPX.prj"
End If
```

Visual C#:

```
if (axLoader.ProjectFile.Length == 0)
    axLoader.ProjectFile = "C:\\Projects\\PPX\\PPX.prj";
```

RunFromEPROM

Type: VARIANT_BOOL

Access: Read / write

Description: This property is used to control how the controller starts up. When set to false it uses programs stored in its RAM memory. When set to true the controller uses programs stored in its EPROM memory (overwriting the programs in RAM).

Examples: Visual BASIC:

```
If not axLoader.RunFromEPROM then
    axLoader.RunFromEPROM = True
End If
```

Visual C#:

```
if (!axLoader.RunFromEPROM)
    axLoader.RunFromEPROM = true;
```

Timeout

Type: unsigned long

Access: Read / write

Description: This property is used to set the command timeout for communications with the controller. The default value is 10 (seconds) but may need to be increased if you are using large programs or have a large project.

Examples: Visual BASIC:

```
If axLoader.Timeout < 20 Then
    axLoader.Timeout = 25
End If
```

Visual C#:

```
if (axLoader.Timeout < 20)
    axLoader.Timeout = 25;
```

Methods

The control has the following methods:

AutoRun
CheckProject
CompileAll
CompileProgram
DeleteAll
DeleteTable
GetLastError
GetLastErrorString
HaltPrograms
LoadProgram
LoadProject
LoadTable
Lock
Unlock

AutoRun

Parameters: none

Return Type: VARIANT_BOOL

Description: This method is used to run any programs on the controller which are set to auto-run on startup.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.AutoRun Then
 DisplayError(axLoader.GetLastError,
axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.AutoRun())
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

CheckProject

Parameters: none

Return Type: VARIANT_BOOL

Description: This method is used to check the programs on the controller against the project previously set using the ProjectFile.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.CheckProject Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.CheckProject())
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

CompileAll

Parameters: none

Return Type: VARIANT_BOOL

Description: This method is used to compile all programs on the controller.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.CompileAll Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.CompileAll())
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

CompileProgram

Parameters: BSTR (string): ProgramName

Return Type: VARIANT_BOOL

Description: This method is used to compile a single program on the controller.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.CompileProgram("PROG") Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.CompileProgram("PROG"))
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

DeleteAll

Parameters: none

Return Type: VARIANT_BOOL

Description: This method is used to delete the all the programs on the controller.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.DeleteAll Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.DeleteAll())
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

DeleteTable

Parameters: none

Return Type: VARIANT_BOOL

Description: This method is used to delete the table on the controller. It only works on controllers which do not have dedicated table memory.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.DeleteTable Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.DeleteTable())
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

GetLastError

Parameters: none

Return Type: unsigned long

Description: This method is used to retrieve the error code after a method call has failed (returned false). The returned error code is only valid for the previous method call.

The following error codes can be returned:

Code	Error Description
0	No error
1	File does not exist
2	Error opening file
3	Invalid IP address
4	Invalid IP port
5	Invalid integer
6	Invalid communications port
7	Invalid communications parameters
8	Communications error
9	Invalid controller system version
10	Invalid controller type
11	Controller type not found
12	Invalid range
13	Failed version check
14	Controller locked
15	Failed to set project
16	Invalid command
17	Directory does not exist
18	No file specified
19	Program not in project
20	Program not on controller
21	CRC mismatch
22	Invalid directory
23	Failed to create directory
24	Invalid program file name
25	Error writing to file
26	Error reading CRC
27	Error calculating CRC
28	File not in project
29	Invalid program name
30	Failed to halt programs
31	Error reading directory
32	Program faild to compile
33	Failed to set communications parameters
34	Failed to get communications parameters

Code	Error Description
35	Transmit failure
36	Invalid connection type
37	Internal pointer error
38	Error sending string
39	Error sending command
40	Failed to select program

Further error information can be obtained by calling the GetLastErrorString method.

Examples: Visual BASIC:

```
If Not axLoader.CompileAll Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.CompileAll())
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

GetLastErrorString

Parameters: none

Return Type: BSTR (string)

Description: This method is used to retrieve additional information from the controller. The string contains extra information which can be used in conjunction with the error code returned by the GetLastError method.

Examples: Visual BASIC:

```
If Not axLoader.CompileAll Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.CompileAll())
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

HaltPrograms

Parameters: none

Return Type: VARIANT_BOOL

Description: This method is used to halt all programs currently running on the controller.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.HaltPrograms Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.HaltPrograms())
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

LoadProgram

Parameters: BSTR (string): ProgramFileName
VARIANT_BOOL: Compile

Return Type: VARIANT_BOOL

Description: This method is used to load a single program onto the controller. It is generally good practice to compile after loading the program.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.LoadProgram("C:\Programs\Prog.bas", True) Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.LoadProgram("C:\\Programs\\Prog.bas", true))
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

LoadProject

Parameters: VARIANT_BOOL: FastLoad

Return Type: VARIANT_BOOL

Description: This method is used to load the project previously set using the ProjectFile property onto the controller. If FastLoad is true, the loader will use the fast loading algorithm. Fast loading is not available some controllers and is only available in more recent versions of system software. All controllers will perform a normal (slow) load. Fast load must be used if the project contains one or more encrypted programs.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.LoadProject(False) Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.LoadProject(false))
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

LoadTable

Parameters: BSTR (string): TableFileName

Return Type: VARIANT_BOOL

Description: This method is used to load data into the table on the controller from a table list file (usually saved by Motion Perfect).

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.LoadTable("C:\Tables\ThisTable.lst") Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.LoadTable("C:\\Tables\\ThisTable.lst"))
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

Lock

Parameters: unsigned long: Lock Code

Return Type: VARIANT_BOOL

Description: This method is used to lock the controller so that programs cannot be edited. The lock code used here must also be used if the controller is unlocked using the Unlock method.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.Lock(1234) Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.Lock(1234))
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

Unock

Parameters: unsigned long: LockCode

Return Type: VARIANT_BOOL

Description: This method is used to unlock a locked controller so that programs can be edited. The lock code used here must be the same as the code used to lock the controller.

The return value is true if the method call succeded and false if it failed. Further error information can be obtained by calling the GetLastError and GetLastErrorString methods.

Examples: Visual BASIC:

```
If Not axLoader.Unlock(1234) Then
 DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString)
End If
```

Visual C#:

```
if (!axLoader.Unlock(1234))
DisplayError(axLoader.GetLastError,axLoader.GetLastErrorString);
```

CHAPTER

11

USING THE PC MOTION ACTIVEX CONTROL

Introduction

The TrioPC ActiveX component provides a direct connection to the Trio MC controllers via a PCI bus, USB, serial or Ethernet link. It can be used in any windows programming language supporting ActiveX (OCX) components, such as Visual Basic, Delphi, Visual C, C++ Builder etc.

Requirements

- PC with one or more of USB interface, Ethernet network interface, serial port or PCI based *Motion Coordinator.*
- Windows 2000, XP or Vista
- TrioUSB driver - for USB connection
- Trio PCI driver - for PCI connection
- TrioPC OCX
- Knowledge of the Trio *Motion Coordinator* to which the TrioPC ActiveX controls will connect.
- Knowledge of the Trio BASIC programming language.

Installation of the ActiveX Component

Launch the program "Install_TrioPCMotion" and follow the on-screen instructions. The TrioUSB driver and TrioPC ocx will be installed and registered to your Windows environment. The Trio PCI driver will also be installed on systems running Windows 2000 or Windows XP. A Windows Help file is included as an alternative to the printed pages in this manual.

Using the Component

The TrioPC component must be added to the project within your programming environment. Here is an example using Visual Basic, however the exact sequence will depend on the software package used.

From the Menu select Tools then Choose Tolbox Items.

When the Choose Tolbox Items dialogue has opened, select the COM components tab then scroll down until you find "TrioPC Control" then click in the block next to TrioPC. (A tick will appear)

Now click OK and the component should appear in the toolbox on the left side of the screen. It is identified as TrioPC Control.

Now add the TrioPC component to your form. You are ready to build the project and include the TrioPC methods in your programs.

Connection Commands

Open

Description Initialises the connection between the TrioPC ActiveX control and the *Motion Coordinator*.

The connection can be opened over a PCI, Serial, USB or Ethernet link, and can operate in either a synchronous or asynchronous mode. In the synchronous mode all the Trio BASIC methods are available. In the asynchronous mode these methods are not available, instead the user must call SendData() to write to the *Motion Coordinator*, and respond to the OnReceiveChannelx event by calling GetData() to read data received from the *Motion Coordinator*. In this way the user application can respond to asynchronous events which occur on the *Motion Coordinator* without having to poll them.

If the user application requires the Trio BASIC methods then the synchronous mode should be selected. However, if the prime role of the user application is to respond to events triggered on the *Motion Coordinator,* then the asynchronous method should be used.

Syntax: **`Open(PortType, PortMode)`**

Parameters

`short PortType:`	0: USB, 1:Serial Port, 2:Ethernet, 3:PCI
`short PortMode:`	0: Synchronous Mode, 1:Asynchronous Mode

Return Value: **`TRUE`** if the connection is successfully established. For a USB connection, this means the TrioUSB driver is active (an MC with a USB card is on, and the USB connections are correct). If a synchronous connection has been opened the ActiveX control must have also successfully recovered the token list from the *Motion Coordinator*. If the connection is not successfully established this method will return **`FALSE`**.

Example

```
Rem Open a USB connection and refresh the TrioPC indicator
TrioPC_Status = TrioPC1.Open(0, 0)
frmMain.Refresh
```

Note: When **`PortType`** is set to 1, serial port, then only the syncronous mode is available. I.e. **`PortMode`** must be set to 0.

Close

Description Closes the connection between the TrioPC ActiveX control and the *Motion Coordinator*

Syntax: `Close(PortMode)`

Parameters **short PortMode:** -1: all ports, 0: synchronous port, >1: asynchronous port

Return Value: **None**.

Example

```
Rem Close the connection when form unloads
Private Sub Form_Unload(Cancel As Integer)
    TrioPC1.Close(0)
    frmMain.Refresh
End Sub
```

IsOpen

Description Returns the state of the connection between the TrioPC ActiveX control and the *Motion Coordinator*

Syntax: `IsOpen(PortMode)`

Parameters **short PortMode:** -1: all ports, 0: synchronous port, >1: asynchronous port

Return Value: **TRUE** if port is open, **FALSE** if it is closed.

Example

```
Rem Close the connection when form unloads
Private Sub Form_Unload(Cancel As Integer)
    If TrioPC1.IsOpen(0) Then
        TrioPC1.Close(0)
    End If
    frmMain.Refresh
End Sub
```

SetHost

Description Sets the ethernet host IP address, and must be called prior to opening an ethernet connection. The **HostAddress** property can also be used for this function.

Syntax: `SetHost(host)`

Parameters `VARIANT host:` host IP address (eg 192.168.0.250).

Return Value: `None`

Example

```
Rem Set up the Ethernet IP Address of the target Motion
Coordinator
TrioPC1.SetHost("192.168.000.001")
Rem Open a Synchronous connection
TrioPC_Status = TrioPC1.Open(2, 0)
frmMain.Refresh
```

GetConnectionType

Description Gets the connection type of the current connection.

Syntax: `GetConnectionType()`

Parameters `None`

Return Value: -1: No Connection, 0: USB, 1:N/A, 2: Ethernet, 3: PCI

Example

```
Rem Open a Synchronous connection
ConnectError = False
TrioPC_Status = TrioPC1.Open(0, 0)
ConnectionType = TrioPC1.GetConnectionType()
If ConnectionType <> 0 Then
    ConnectError = True
frmMain.Refresh
```

Properties

Board

Description Specifies the board number for a PCI connection. It must be specified before the **OPEN** command is used.

Type Long

Access Read / Write

Default Value 0

Example

```
Rem Open a PCI connection and refresh the TrioPC indicator
If TrioPC.Board <> 0 Then
    TrioPC.Board = 0
End If
TrioPC_Status = TrioPC1.Open(3, 0)
frmMain.Refresh
```

HostAddress

Description Used for reading or changing the ethernet host IP address, and must be set prior to opening an ethernet connection. The **SetHost** command can also be used for setting the host adddress.

Type String

Access Read / Write

Default Value "192.168.0.250"

Example

```
Rem Open a Ethernet connection and refresh the TrioPC indicator
if TrioPC.HostAddress <> "192.168.0.111" Then
    TrioPC.HostAddress = "192.168.0.111"
End If
TrioPC_Status = TrioPC1.Open(2, 0)
frmMain.Refresh
```

CmdProtocol

Description Used to specify the version of the ethernet communications protocol to use to be compatible with the firmware in the ethernet daughterboard. The following values should be used:

0: for ethernet daughterboard firmware version 1.0.4.0 or earlier.
1: for ethernet daughterboard firmware version 1.0.4.1 or later.

Type Long

Access Read / Write

Default Value `1`

Example

```
Rem Set ethernet protocol for firmware 1.0.4.0
TrioPC.CmdProtocol = 0
```

Note: Users of older daughterboards will need to update their programs to set the value of this proporty to 0.

Motion Commands

MoveRel

Description Performs the corresponding **MOVE(…)** command on the *Motion Coordinator*

Syntax: **MoveRel(Axes, Distance, [Axis])**

Parameters:

short Axes:	Number of axes involved in the move command
VARIANT Distance:	Distance to be moved, can be a single numeric value or an array of numeric values that contain at least Axes values
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS.**

Base

Description: Performs the corresponding **BASE(…)** command on the *Motion Coordinator*

Syntax: **Base(Axes, [Order])**

Parameters:

short Axes:	Number of axes involved in the move command
VARIANT Order:	A single numeric value or an array of numeric values that contain at least Axes values that specify the axis ordering for the subsequent motion commands.

Return Value: **TrioPC STATUS**.

MoveAbs

Description: Performs the corresponding **MOVEABS(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **MoveAbs(Axes, Distance, [Axis])**

Parameters:

short Axes:	Number of axes involved in the moveabs command
VARIANT Distance:	Absolute positions that specify where the move must terminate, can be a single numeric value or an array of numeric values that contain at least Axes values
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

MoveCirc

Description: Performs the corresponding **MOVECIRC(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **MoveCirc(EndBase, EndNext, CentreBase, CentreNext, Dir, [Axis])**

Parameters:

double EndBase:	Distance to the end position on the base axis
double EndNext:	Distance to the end position on the axis that follows the base axis
double CentreBase:	Distance to the centre position on the base axis
double CentreNext:	Distance to the centre position on the axis that follows the base axis
short Dir:	A numeric value that sets the direction of rotation. A value of 1 implies a clockwise rotation on a positive axis set, 0 implies an anti-clockwise rotation on a positive axis set.
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

AddAxis

Description: Performs the corresponding **ADDAX(…)** command on the *Motion Coordinator*

Syntax: **AddAxis(LinkAxis, [Axis])**

Parameters: **short LinkAxis:** A numeric value that specifies the axis to be "added" to the base axis.

VARIANT Axis: Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

CamBox

Description: Performs the corresponding **CAMBOX(…)** command on the *Motion Coordinator*

Syntax: **CamBox(TableStart, TableStop, Multiplier, LinkDist, LinkAxis, LinkOpt, LinkPos, [Axis])**

Parameters:

short TableStart: The position in the table data on the *Motion Coordinator* where the cam pattern starts

short TableStop: The position in the table data on the *Motion Coordinator* where the cam pattern stops

double Multiplier: The scaling factor to be applied to the cam pattern

double LinkDist: The distance the input axis must move for the cam to complete

short LinkAxis: Definition of the Input Axis

short LinkOpt:

1 link commences exactly when registration event occurs on link axis

2 link commences at an absolute position on link axis (see param 7)

4 CAMBOX repeats automatically and bi-directionally when this bit is set.

double LinkPos: The absolute position on the link axis where the cam will start.

VARIANT Axis: Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

Cam

Description Performs the corresponding **CAM(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **Cam(TableStart, TableStop, Multiplier, LinkDistance, [Axis])**

Parameters:

short TableStart:	The position in the table data on the *Motion Coordinator* where the cam pattern starts
short TableStop:	The position in the table data on the *Motion Coordinator* where the cam pattern stops
double Multiplier:	The scaling factor to be applied to the cam pattern
double LinkDistance:	Used to calculate the duration in time of the cam. The LinkDistance/Speed on the base axis specifies the duration. The Speed can be modified during the move, and will affect directly the speed with which the cam is performed
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

Cancel

Description: Performs the corresponding **CANCEL(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **Cancel(Mode, [Axis])**

Parameters:

short Mode:	Cancel mode. 0 cancels the current move on the base axis, 1 cancels the buffered move on the base axis
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

Connect

Description: Performs the corresponding **CONNECT(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **Connect(Ratio, LinkAxis, [Axis])**

Parameters:

double Ratio:	The gear ratio to be applied
short LinkAxis:	The driving axis
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

Datum

Description: Performs the corresponding **DATUM(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **Datum(Sequence, [Axis])**

Parameters: **short Sequence**: The type of datum procedure to be performed:

0. The current measured position is set as demand position (this is especially useful on stepper axes with position verification). **DATUM(0)** will also reset a following error condition in the **AXISSTATUS** register for all axes.
1. The axis moves at creep speed forward till the Z marker is encountered. The Demand position is then reset to zero and the Measured position corrected so as to maintain the following error.
2. The axis moves at creep speed in reverse till the Z marker is encountered. The Demand position is then reset to zero and the Measured position corrected so as to maintain the following error.
3. The axis moves at the programmed speed forward until the datum switch is reached. The axis then moves backwards at creep speed until the datum switch is reset. The Demand position is then reset to zero and the Measured position corrected so as to maintain the following error.

4. The axis moves at the programmed speed reverse until the datum switch is reached. The axis then moves at creep speed forward until the datum switch is reset. The Demand position is then reset to zero and the Measured position corrected so as to maintain the following error.
5. The axis moves at programmed speed forward until the datum switch is reached. The axis then moves at creep speed until the datum switch is reset. The axis is then reset as in mode 2.
6. The axis moves at programmed speed reverse until the datum switch is reached. The axis then moves at creep speed forward until the datum switch is reset. The axis is then reset as in mode 1.

VARIANT Axis: Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

Forward

Description Performs the corresponding **FORWARD(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **Forward([Axis])**

Parameters **VARIANT Axis:** Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

Reverse

Description: Performs the corresponding **REVERSE(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **Reverse([Axis])**

Parameters: **VARIANT Axis:** Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

MoveHelical

Description: Performs the corresponding **MOVEHELICAL(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **MoveHelical(FinishBase, FinishNext, CentreBase, CentreNext, Direction, LinearDistance, [Axis])**

Parameters

double FinishBase:	Distance to the finish position on the base axis
double FinishNext:	Distance to the finish position on the axis that follows the base axis
double CentreBase:	Distance to the centre position on the base axis
double CentreNext:	Distance to the centre position on the axis that follows the base axis
short Direction:	A numeric value that sets the direction of rotation. A value of 1 implies a clockwise rotation on a positive axis set, 0 implies an anti-clockwise rotation on a positive axis set.
double LinearDistance:	The linear distance to be moved on the base axis + 2 whilst the other two axes are performing the circular move
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

MoveLink

Description: Performs the corresponding **MOVELINK(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **MoveLink(Distance, LinkDistance, LinkAcc, LinkDec, LinkAxis, LinkOptions, LinkPosn, [Axis])**

Parameters:

double Distance:	Total distance to move on the base axis
double LinkDistance:	Distance to be moved on the driving axis

double LinkAcceleration	Distance to be moved on the driving axis during the acceleration phase of the move
double LinkDeceleration	Distance to be moved on the driving axis during the deceleration phase of the move
short LinkAxis:	The driving axis for this move.
short LinkOptions:	Specifies special processing for this move: **0** no special processing **1** link commences exactly when registration event occurs on link axis **2** link commences at an absolute position on link axis (see param 7) **4** MOVELINK repeats automatically and bi-directionally when this bit is set. (This mode can be cleared by setting bit 1 of the REP_OPTION axis parameter)
double LinkPosition:	The absolute position on the link axis where the move will start.
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

MoveModify

Description: Performs the corresponding **MOVEMODIFY(…) AXIS(…)** command on the *Motion Coordinator*

Syntax: **MoveModify(Position, [Axis]**

Parameters:

double Position:	Absolute position of the end of move for the base axis.
VARIANT Axis:	Optional parameters that must be a single numeric value that specifies the base axis for this move

Return Value: **TrioPC STATUS**.

RapidStop

Description: Performs the corresponding **RAPIDSTOP(…)** command on the *Motion Coordinator*

Parameters: None

Return Value: **TrioPC STATUS**.

Process Control Commands

Run

Description: Performs the corresponding **RUN(…)** command on the *Motion Coordinator*

Syntax: **Run(Program, Process)**

Parameters:

BSTR Program:	String that specifies the name of the program to be run.
VARIANT Process:	Optional parameter that must be a single numeric value that specifies the process on which to run this program.

Return Value: **TrioPC STATUS**.

Stop

Description: Performs the corresponding **STOP(…)** command on the *Motion Coordinator*

Syntax: **Stop(Program, Process)**

Parameters:

BSTR Program:	String that specifies the name of the program to be stopped.
VARIANT Process:	Optional parameter that must be a single numeric value that specifies the process on which the program is running.

Return Value: **TrioPC STATUS**.

Variable Commands

GetTable

Description: Retrieves and writes the specified table values into the given array.

Syntax: **`GetTable(StartPosition, NumberOfValues, Values)`**

Parameters

`Long StartPosition:`	Table location for first value in array
`Long NumberOfValues:`	Size of array to be transferred from Table Memory.
`VARIANT Values:`	A single numeric value or an array of numeric values, of at least size NumberOfValues, into which the values retrieved from the Table Memory will be stored.

Return Value: **`TrioPC STATUS`**.

GetVariable

Description: Returns the current value of the specified system variable. To specify different base axes, the **`BASE`** command must be used.

Syntax: **`GetVariable(Variable, Value)`**

Parameters

`BSTR Variable:`	Name of the system variable to read
`double *Value:`	Variable in which to store the value read

Return Value: **`TrioPC STATUS`**.

GetVr

Description: Returns the current value of the specified Global variable.

Syntax: **GetVr(Variable, Value)**

Parameters:

short Variable:	Number of the VR variable to read.
double *Value:	Variable in which to store the value read.

Return Value: **TrioPC STATUS**.

SetTable

Description: Sets the specified table variables to the values given in an array.

Syntax: **SetTable(StartPosition, NumberOfValues, Values)**

Parameters

Long StartPosition:	Table location for first value in array
Long NumberOfValues:	Size of array to be transferred to Table Memory.
VARIANT Values:	A single numeric value or an array of numeric values that contain at least NumberOfValues values to be placed in the Table Memory.

Return Value: **TrioPC STATUS**.

SetVariable

Description: Sets the current value of the specified system variable. To specify different base axes, the **BASE** command must be used.

Syntax: **SetVariable(Variable, Value**

Parameters

BSTR Variable:	Name of the system variable to write
double Value:	Variable in which the value to write is stored.

Return Value: **TrioPC STATUS**.

SetVr

Description: Sets the value of the specified Global variable.

Syntax: **`SetVr(Variable, Value)`**

Parameters:

`BSTR Variable:`	Number of the VR variable to write
`double Value:`	Variable in which the value to write is stored.

Return Value: **`TrioPC STATUS`**.

Input / Output Commands

Ain

Description: Performs the corresponding **AIN(…)** command on the *Motion Coordinator*.

Syntax: **Ain(Channel, Value)**

Parameters
short Channel: AIN channel to be read.
double *Value: Variable in which to store the value read.

Return Value: **TrioPC STATUS**.

Get

Description: Performs the corresponding **GET #**… command on the *Motion Coordinator*.

Syntax: **Get(Channel, Value)**

Parameters
short Channel: Comms channel to be read
double *Value: Variable in which to store the value read.

Return Value: **TrioPC STATUS**.

In

Description: Performs the corresponding **IN(…)** command on the *Motion Coordinator*

Syntax: **In(StartChannel, StopChannel, Value)**

Parameters:
short StartChannel: First digital I/O channel to be checked.
short StopChannel: Last digital I/O channel to be checked.
long *Value: Variable to store the value read.

Return Value: **TrioPC STATUS**.

Input

Description: Performs the corresponding **INPUT #**... command on the *Motion Coordinator*.

Syntax: **Input(Channel, Value)**

Parameters:

short Channel: Comms channel to be read

double *Value: Variable in which to store the value read.

Return Value: **TrioPC STATUS**.

Key

Description Performs the corresponding **KEY #...** command on the *Motion Coordinator*.

Syntax: **Key(Channel, Value)**

Parameters

short Channel: Comms channel to be read

double *Value: Variable in which to store the value read.

Return Value: **TrioPC STATUS**.

Linput

Description: Performs the corresponding **LINPUT #** command on the *Motion Coordinator*.

Syntax: **Linput(Channel, Startvr)**

Parameters:

short Channel: Comms channel to be read

short StartVr: Number of the VR variable into which to store the first key press read.

Return Value: **TrioPC STATUS**.

Op

Description: Performs the corresponding **OP(...)** command on the *Motion Coordinator*

Syntax: **Op(Output, State)**

Parameters:	**VARIANT Output:**	Numeric value. If this is the only value specified then it is the bit map of the outputs to be specified, otherwise it is the number of the output to be written.
	VARIANT State:	Optional numeric value that specifies the desired status of the output, 0 implies off, not-0 implies on.

Return Value: **TrioPC STATUS**.

Pswitch

Description	Performs the corresponding **PSWITCH(…)** command on the *Motion Coordinator*	
Syntax:	**Pswitch(Switch, Enable, Axis, OutputNumber, OutputStatus, SetPosition, ResetPosition)**	
Parameters:	**short Switch:**	Switch to be set
	short Enable:	1 to enable, 0 to disable
	VARIANT Axis:	Optional numeric value that specifies the base axis for this command
	VARIANT OutputNumber:	Optional numeric value that specifies the number of the output to set
	VARIANT OutputStatus:	Optional numeric value that specifies the signalled status of the output, 0 implies off, not-0 implies on.
	VARIANT SetPosition:	Optional numeric value that specifies the position at which to signal the output
	VARIANT ResetPosition:	Optional numeric value that specifies the position at which to reset the output.
Return Value:	**TrioPC STATUS**.	

ReadPacket

Description:	Performs the corresponding **READPACKET(…)** command on the *Motion Coordinator*	
Syntax:	**ReadPacket(PortNumber, StartVr, NumberVr, Format)**	
Parameters:	**short PortNumber:**	Number of the comms port to read (0 or 1).
	short StartVr:	Number of the first variable to receive values read from the comms port.
	short NumberVr:	Number of variables to receive.
	short Format:	Numeric format in which the numbers will arrive
Return Value:	**TrioPC STATUS**.	

Record

Description: Performs the corresponding **RECORD(…)** command on the *Motion Coordinator*

Syntax: **Record(Transitions, TablePosition)**

Parameters:

short Transitions:	Number of transitions to record.
long TablePosition:	Start position in the table to store the transitions.

Return Value: **TrioPC STATUS**.

Regist

Description Performs the corresponding **REGIST(…)** command on the *Motion Coordinator*

Syntax: **Regist(Mode, Dist)**

Parameters: **short Mode:** Registration mode

1. Axis absolute position when Z Mark Rising
2. Axis absolute position when Z Mark Falling
3. Axis absolute position when Registration Input Rising
4. Axis absolute position when Registration Input Falling
5. Sets pattern recognition mode

double Dist: Only used in pattern recognition mode and specifies the distance over which to record the transitions.

Return Value: **TrioPC STATUS**.

Send

Description: Performs the corresponding **SEND(…)** command on the *Motion Coordinator*

Syntax: **Send(Destination, Type, Data1, Data2)**

Parameters:

short Destination:	Address to which the data will be sent
short Type:	Type of message to be sent: 1. Direct variable transfer 2. Keypad offset
short Data1:	Data to be sent. If this is a keypad offset message then it is the offset, otherwise it is the number of the variable on the remote node to be set.
short Data2:	Optional numeric value that specifies the value to be set for the variable on the remote node.

Return Value: **TrioPC STATUS**.

Setcom

Description: Performs the corresponding **SETCOM(…)** command on the *Motion Coordinator*

Syntax **Setcom(Baudrate, DataBits, StopBits, Parity, [Port], [Control])**

Parameters:

long BaudRate:	Baud rate to be set
short DataBits:	Number of bits per character transferred
short StopBits:	Number of stop bits at the end of each character
short Parity:	Parity mode of the port (0=>none, 1=>odd, 2=> even)
VARIANT Port:	Optional numeric value that specifies the port to set (0..3)
VARIANT Control:	Optional numeric value that specifies whether to enable or disable handshaking on this port

Return Value: **TrioPC STATUS**.

General commands

Execute

Description: Performs the corresponding **EXECUTE** … command on the *Motion Coordinator*.

Syntax: **Execute(Command)**

Parameters

BSTR Command:	String that contains a valid Trio BASIC command

Return Value: **TrioPC STATUS: TRUE** if the command was sent successfully to the *Motion Coordinator* and the **EXECUTE** command on the *Motion Coordinator* was completed successfully and the command specified by the **EXECUTE** command was tokenised, parsed and completed successfully.

GetData

Description This method is used when an asynchronous connection has been opened, to read data received from the *Motion Coordinator* over a particular channel. The call will empty the appropriate channel receive data buffer held by the ActiveX control.

Syntax: **GetData(channel, data)**

Parameters

short channel:	Channel over which the required data was received (5,6,7, or 9).
VARIANT data:	data received by the control from the *Motion Coordinator*

Return Value: **TrioPC STATUS:** TRUE - if the given channel is valid, the connection open and the data read correctly from the buffer.

SendData

Description: This method is used when the connection has been opened in the asynchronous mode, to write data to the *Motion Coordinator* over a particular channel.

Syntax: **`SendData(channel, data)`**

Parameters:

`short channel:`	channel over which to send the data (5,6,7, or 9).
`VARIANT data:`	data to be written to the *Motion Coordinator*

Return Value: **`TrioPC STATUS:`** TRUE - if the given channel is valid, the connection open, and the data written out correctly.

Events

OnBufferOverrunChannel5/6/7/9

Description: One of these events will fire if a particular channel data buffer overflows. The ActiveX control stores all data received from the *Motion Coordinator* in the appropriate channel buffer when the connection has been opened in asynchronous mode. As data is received it is the responsibility of the user application to call the GetData() method whenever the OnReceiveChannelx event fires(or otherwise to call the method periodically) to prevent a buffer overrun. Which event is fired will depend upon which channel buffer overran.

Syntax: **`OnBufferOverrunChannelx()`**

Parameters: **`None`**.

Return Value: **`None`**.

OnReceiveChannel5/6/7/9

Description: One of these events will fire when data is received from the *Motion Coordinator* over a connection which has been opened in the asynchronous mode. Which event is fired will depend upon over which channel the *Motion Coordinator* sent the data. It is the responsibility of the user application to call the GetData() method to retrieve the data received.

Syntax: **`OnReceiveChannelx()`**

Parameters: **`None`**.

Return Value: **`None`**.

TrioPC status

Many of the methods implemented by the TrioPC interface return a boolean status value. The value will be **TRUE** if the command was sent successfully to the *Motion Coordinator* and the command on the *Motion Coordinator* was completed successfully. It will be **FALSE** if it was not processed correctly, or there was a communications error.

CHAPTER

12

COMMUNICATIONS PROTOCOLS

MODBUS RTU

Introduction

A growing number of programmable keypads and HMIs provide the user with a choice of serial interface protocols to enable communication with various PLCs and Industrial Computers. One such protocol is Modbus RTU. The *Motion Coordinator* system software provides built-in support for the Modbus protocol.

Scope of Operation

This document applies to *Motion Coordinator*s with system software version 1.48 and above.

The Modbus RTU protocol provides single point to point communication between the *Motion Coordinator* and a programmable keypad/display. Implementation of the protocol is provided on serial port 1 for RS232 and port 2 for RS485. Port 0 is the main programming port and does not have the Modbus option. Baud rate and slave address can be set in the Trio BASIC program during serial port initialisation.

Initialisation and Set-up

The Modbus protocol is initialised by setting the mode parameter of the SETCOM instruction to 4. The **ADDRESS** parameter must also be set *before* the Modbus protocol is activated.

example:

```
ADDRESS=1
SETCOM(9600,8,1,2,1,4) 'Port 1 as MODBUS port at 9600 baud
ADDRESS=1
SETCOM(19200,8,1,2,2,4) 'set up the RS485 port at 19200 baud
```

The protocol can be de-selected by setting the option to 0 in the SETCOM command.

```
SETCOM(19200,8,1,2,2,0) 'set the RS485 port to normal mode
```

Example The following shows a typical set-up for a HMI panel running a Modbus Link. All references below are to the programming software supplied by the HMI manufacturer and are not specific to any individual programming environment. See your HMI programming instructions for the actual set-up sequence.

In the Controller Driver section choose “Modicon Modbus”, choose any Modicon PLC type from the PLC setup section.

Program the panel to display a variable and open up a dialog box to **Define**

Choose	Example
Input bits, Output bits, Holding Register.	Holding Register
Data size/type	WORD (Binary)
Address Offset.	
Display format and field width to be displayed.	Numeric 4 digits

The *Motion Coordinator* is the slave so it will always wait for the HMI to request the data required. With the set-up shown above, the display should poll the *Motion Coordinator* for the value of VR(12) and display the data as a 4 digit number.

Modbus Technical Reference

This section lists the *Motion Coordinator*'s response to each supported Modbus Function.

Modbus Code Table

The following Modbus Function Codes are implemented:

Code	Function Name	Action
1	Read Coil Status	Returns input/output bit pattern
2	Read Input Status	Returns input/output bit pattern
3	Read Holding Registers	Returns data from VR() variables
5	Force Single Coil	Sets single output ON/OFF
6	Preset Single Register	Sets the value of a single VR() variable
16	Preset Multiple Registers	Sets the values of a group of VR() variables

(1 and 2) Read Coil Status / Read Input Status

Modbus Function Code	1 & 2
Mapped Trio Function	Read input word: IN(nn,mm)
Starting Address Range	0 to NIO-1 (NIO = Number of Input/Output Bits on Controller)
Number of Points Range	1 to (NIO-1) - Starting Address
Returned Data	Bytes containing "Number of Points" bits of data

(3) Read Holding Registers

Modbus Function Code	3
Mapped Trio Function	Read VR() Global Variable
Starting Address Range	0 to 1023 (0 to 250 on MC202 & MC216)
Number of Points Range	1 to 127 (Number of VR() variables to be read)
Returned Data	2 to 254 bytes containing up to 127 16-bit Signed Integers.

(5) Force Single Coil

Modbus Function Code	5
Mapped Trio Function	Set Single Output: OP(n,ON/OFF)
Starting Address Range	8 to NIO-1
Data	00 = Output OFF, ffH = Output ON
Returned Data	None

(6) Preset Single Register

Modbus Function Code	6
Mapped Trio Function	Set VR() Global Variable: VR(addr)=data
Register Address Range	0 to 1023 (0 to 250 on MC202 & MC216)
Data	-32768 to 32767 (16 bit signed)
Returned Data	None

(16) Preset Multiple Registers

Modbus Function Code	6
Mapped Trio Function	Set VR() Global Variables: VR(addr)=$data_1$ ...... VR(addr+n)=$data_n$
Starting Address Range	0 to 1023 (0 to 250 on MC202 & MC216)
Number of Points Range	1 to 127
$Data_1$ to $Data_n$	-32768 to 32767 (16 bit signed)
Returned Data	None

Notes The following baud rate limitations should be observed when attaching a HMI panel to the *Motion Coordinator* using Modbus.

Motion Coordinator	Maximum Baud Rate
MC202	9600
Euro205x	38400
MC206	38400
MC216	38400
MC224	38400

Some HMI's use the standard MODICON addressing for registers and I/O. If this is the case, use the following mappings:

- Holding Registers 40001 + are mapped to VR(0) +
- Inputs 10001 to 10272 are mapped to IN(0) to IN(271) when the appropriate I/O expansion is fitted.
- Output Coils 9 to 272 are mapped to OP(8,s) to OP(271,s) where s is the state (ON or OFF)

Glossary

HMI	Human – Machine Interface
MODBUS	A communications protocol developed by Modicon, part of Groupe Schneider.
RTU	One of two serial transmission modes used by Modbus, the other being ASCII.
Holding Register	A read/write variable as defined for Modicon PLC.
Coil	A programmable output as defined for Modicon PLC.

Profibus

This section applies to the BASIC program developed for *Motion Coordinator* types that can take the P297 Profibus DP Daughter Board. The program is provided for evaluation and example purposes and no guarantee is made as to its suitability for a particular Profibus application.

In order to include the *Motion Coordinator* in a Profibus network the following components are required:

1. Trio BASIC program P297DRxxx.bas (where xxx is the version number of the program)

2. Profibus GSD file; TRIO0595.GSD. (Electronic Data Sheet for COM PROFIBUS)

3. Motion Perfect and serial programming cable.

The program example and Profibus GSD file are available to download from the Trio Website `www.triomotion.com.`

Installation and Set-up

1. Trio BASIC program.

The program must be loaded into the *Motion Coordinator* and set to run from power-up. Set the "node" variable in the program to the required Profibus Address for the *Motion Coordinator.* Make sure the "db" variable is set to the slot number of the Profibus Daughter Doard.

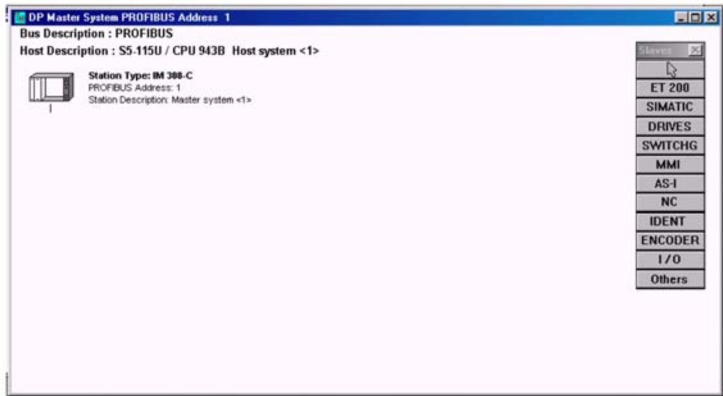
Once the SPC3 chip on the daughter board is initialised, the software is very efficient at transferring data in and out. In the MC302X, Euro205x and MC224 however, a fast process is recommended for optimum running. When using the MC206X or MC224, a low process number may be used with less impact on processing speed.

2. Profibus GSD File.

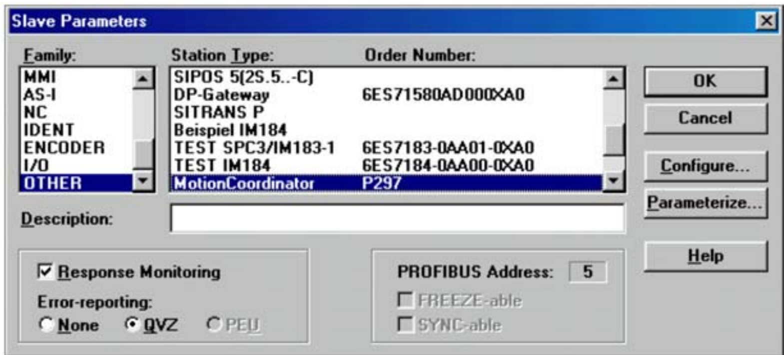
The GSD file supplied (TRIO0595.GSD) must be copied to the GSD folder used by COM PROFIBUS or the equivalent Profibus configuration tool supplied by the PLC vendor. The *Motion Coordinator* can then be added to the Profibus network by selecting OTHER and P297 *Motion Coordinator* from the list.

The following sequence shows how to include the *Motion Coordinator* in a fieldbus network using COM PROFIBUS.

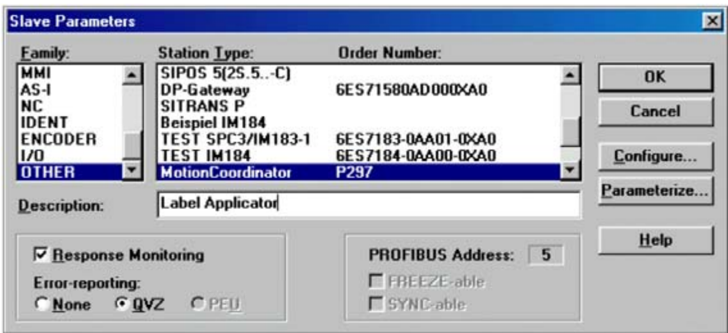
1. Launch the window shown below and click on “Others”.



2. Add the Box Icon to the network on the left and the Slave Parameters dialogue will open. Choose *Motion Coordinator* P297 from the list as shown here:



3. Add your own description in the text box like this:



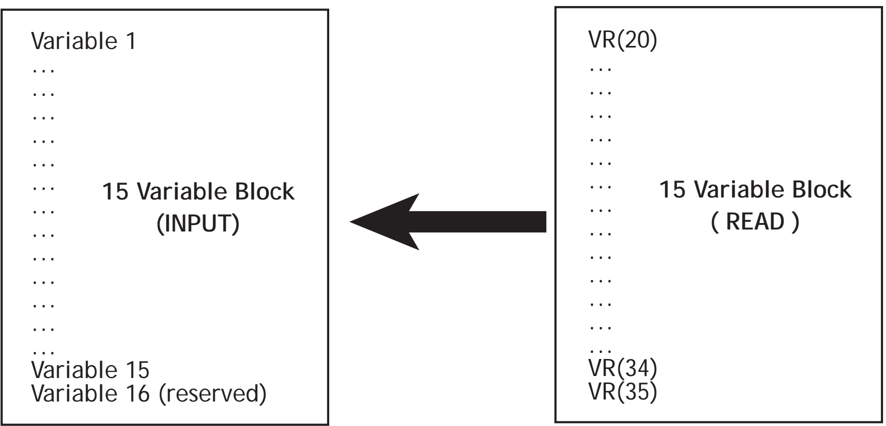
4. Click OK and the *Motion Coordinator* will appear on the diagram like this:

Now add any other nodes to the network that are required and close the window. Finally export the file in the required format, usually Binary, for use by the PLC or other Profibus Master. The master will now search for the *Motion Coordinator* on the Profibus network and when found will connect to it and start transferring the variable blocks.

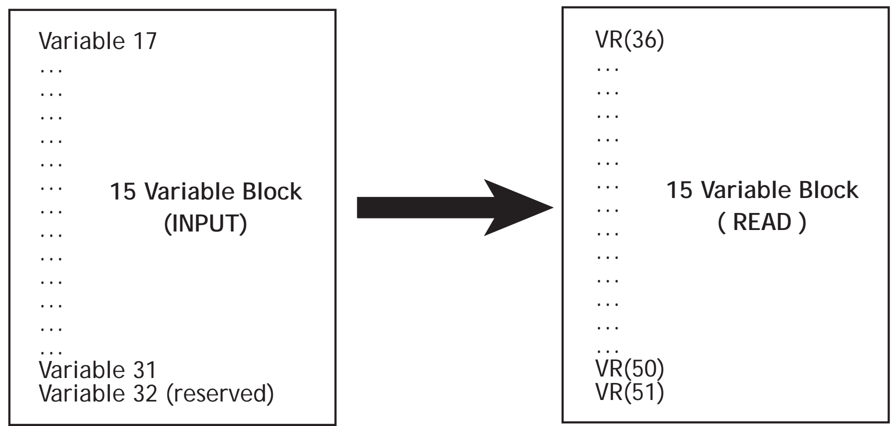
Example: Trio BASIC Profibus Driver

The latest driver can be obtained from www.triomotion.com. At the time of going to press, the most recent revision was 1.05. See below for header and revision information / dates.

```
'==========================================================================
' Title:        Profibus DP SPC3 Driver for P297 Daughter Board
' Module:       P297DR104.BAS
' Platform:     MC Series 2xx + P297 Daughter Board
'--------------------------------------------------------------------------
' Revision:     1.05
' Rev Date:     25 May 2003
'--------------------------------------------------------------------------
'             Copyright (c) 2002-2003 Trio Motion Technology Ltd
'
==========================================================================
' DESCRIPTION:
'  Profibus driver for Cyclic Data Transfer
'  This program sets up the SPC3 chip for transfer of 16 integers from
'  master and 16 intergers to master on a cylcic basis as determined by
'  master unit.
'  Variables:
'   VR(vbase) to VR(vbase+15)    : Data TO master (16bit int)
'   VR(vbase+16) to VR(vbase+31) : Data FROM master (16bit int)
'   VR(vbase+32) = PLC status. 0=running, 2=PLC in configure mode
'
' V1.00: 08/01/2001 Beta Release includes full 16+16 VR transfer
' V1.01: 15/03/2001 Reversed byte order for Word transfer
' V1.02: 24/04/2002 Added support for "Leave Data Ex". (S7 config sequence)
'                   Added local timout if no connection after BR detect.
' V1.03: 08/08/2002 Allows VR segment used to be changed by setting a variable
' V1.04: 23/10/2002 Made local timeout value settable.  See "localtimeout"
' V1.05: 25/03/2003 Fixed bug in sending negative numbers.

restart:
RESET
node = 5 '    Profibus node address
debug = TRUE 'Set TRUE to get debug messages printed to terminal
db=0 '        Daughter Board slot number
vbase = 20 '  VRs for data transfer
localtimeout = 5000 'time in msec
```



Profibus Cyclic Data Transfer
16-bit signed integer



DeviceNet

The *Motion Coordinators* MC206X and MC224 have a ***DeviceNet*** option that allows the *Motion Coordinator* to be attached as a slave node to a ***DeviceNet*** factory network. Either to built-in CANbus port or a P290 daughter board may be used as the physical connection to the ***DeviceNet*** network.

If the built-in CANbus port is used, it will not be available for CAN I/O expansion, so the digital I/O will be limited to the 8 in and 8 bi-directional on the *Motion Coordinator* itself.

Note that the CAN daughter board P290 is not tailored for use on ***DeviceNet*** and a ***DeviceNet*** buffer/isolator may be required.

Installation and Set-up

The **DEVICENET** TrioBASIC command must be in a program that runs at power-up. See the command reference in chapter 8 for infromation about the use of the **DEVICENET** command. In order to prevent the *Motion Coordinator* from acting as a CANIO master and generating non-DeviceNet CANbus messages on power-up, set the CANIO_ADDRESS to 33. This parameter is written directly into Flash EPROM adn so it is only necessary to set **CANIO_ADDRESS** once.

e.g. in an intialisation program:

```
  IF CANIO_ADDRESS<>33 THEN CANIO_ADDRESS = 33
  DEVICENET(slot, 0, baudrate, macid, pollbase, pollin,
pollout)
```

DeviceNet Information

This Section contains DeviceNet information for the multi-axis Trio *Motion Coordinator* model MC206X and MC224.

The *Motion Coordinator* operates as a slave device on the ***DeviceNet*** network and supports Explicit Messages of the predefined master/slave connection set and Polled I/O. It does not support the Explicit Unconnected Message Manager (UCMM).

Polled I/O allows the master to send up to 4 integer variables to the Motion Coordinator and to read up to 4 integer variables from the *Motion Coordinator*. These values are mapped to the TABLE memory in the *Motion Coordinator*. The values are transferred periodically at a rate determined by the DeviceNet Master. The Global variables (VRs) and TABLE memory are also accessible over DeviceNet individually by way of the Explicit Messaging service.

Connection Types Implemented

There are 3 independent connection channels in this *DeviceNet* implementation:

1. Group 2 predefined master/slave connection

   This connection will only handle Master/Slave Allocate/Release messages. The maximum message length for this connection is 8 bytes.

2. Explicit message connection

   This connection will handle explicit messaging for the *DeviceNet* objects defined below. The maximum message length for this connection is 242 bytes.

3. I/O message connection

   This connection will handle the I/O poll messaging. The maximum message length for this connection is 32 bytes.

DeviceNet Objects Implemented

The *Motion Coordinator* supports the following *DeviceNet* object classes.

Class	Object	Description
0x01	Identity	Identification and general information about the device
0x02	Router	Provides a messaging connection point through which a Client may address a service to any object class or instance residing in the physical device
0x03	DeviceNet	Provides the configuration and status of a *DeviceNet* port
0x04	Assembly	Permits access to the I/O poll connection from the explicit message channel
0x05	Connection	Manages the characteristics of the communications connections
0x8a	MC	Permits access to the VR variables and TABLE data on the *Motion Coordinator*

Identity Object

Class Code: 0x01

Instance Services

Id	Service	Description
0x05	Reset	Reinitialises the *DeviceNet* protocol
0x0E	Get Attribute Single	Used to read the instance attributes

Instance Attributes

Attribute ID	Access Rule	Name	DeviceNet Data Type	Data Value
1	Get	Vendor	UINT	0x0115 (277)
2	Get	Product Type	UINT	Generic Device (0x0000)
3	Get	Product Code	UINT	The MC type as returned by the CONTROL system variable.
4	Get	Revision Major Revision Minor Revision	Structure of: USINT USINT	 3 2
5	Get	Status	WORD	Ony bit 0 (owned) is implemented
6	Get	Serial Number	UDINT	The MC Serial Number
7	Get	Product Name String Length ASCII String1	Structure of: USINT STRING(30)	11 "Trio MC_<product code>", where <product code> is the same as defined for attribute 3.

DeviceNet Object

Class Code: 0x03

Class Services

Id	Service	Description
0x0E	Get Attribute Single	Used to read the class attributes

Class Attributes

Attribute ID	Access Rule	Name	DeviceNet Data Type	Data Value
1	Get	Revision	UINT	2

Number of Instances: 1

Instance Services

Id	Service	Description
0x0E	Get Attribute Single	Used to read the instance attributes
0x10	Set Attribute Single	Used to write the instance attributes
0x4B	Allocate Master/ Slave Connection Set	Requests the use of the Predefined Master/ Slave Connection set
0x4C	Release Group 2 Identifier Set	Indicates that the specified Connections within the Predefined Master/Slave Connection Set are no longer desired. These Connections are to be released (Deleted).

Instance Attributes

Attribute ID	Access Rule	Name	DeviceNet Data Type	Data Value
1	Get	MAC ID	USINT	DeviceNet node address. Software defines
5	Get	Allocation Information	Structure of: BYTE USINT	0-63 = master address The current allocation choice

Allocation_byte

bit 0	explicit message	Supported, 1 to allocate
bit 1	Polled	Supported, 1 to allocate
bit 2	Bit_strobed	Not supported, always 0
bit 3	reserved	always 0

Assembly Object

Class Code: 0x04

Number of Instances: 2

There are 2 instances implemented. Instance 100 is a static input object, associated with the I/O poll producer. Instance 101 is a static output object, associated with the I/O poll consumer.

Instance Services

Id	Service	Description
0x0E	Get Attribute Single	Used to read the instance attributes
0x10	Set Attribute Single	Used to write the instance attributes

Instance Attributes

Attribute ID	Access Rule	Attibute	Description
3	Get / Set	Data	Get Instance 100 : The I/O poll producer is executed and the output buffer returned Set Instance 100: Error Get Instance 101: The last received I/O poll buffer is returned Set Instance 101: The buffer received is passed to the I/O poll consumer

Connection Object

Class Code: 0x05

Instance Services

Id	Service	Description
0x0E	Get Attribute Single	Used to read the instance attributes
0x10	Set Attribute Single	Used to write the instance attributes

Number of Instances: 2

The values for these attributes are defined in the "Predefined master/slave connection set" of the "ODVA DeviceNet specification".

Instance Attributes (Instance 1)

Instance Type : Explicit Message

Attribute ID	Access Rule	Name	DeviceNet Data Type	Data Value
1	Get	State	USINT	0 = nonexistent 1 = configuring 3 = established 4 = timed out
2	Get	Instance Type	USINT	0 = explicit message
3	Get	Transport Class Trigger	USINT	83 hex
4	Get	Produced Connection ID	UINT	10xxxxxx011 binary xxxxxx = node address
5	Get	Consumed Connection ID	UINT	10xxxxxx100 binary xxxxxx = node address
6	Get	Initial Comm Characteristics	USINT	21 hex
7	Get	Produced Connection Size	UINT	7
8	Get	Consumed Connection Size	UINT	7
9	Get / Set	Expected Packet Rate	UINT	2500 default (msec) with timer resolution of 1mS
12	Get	Watchdog Timeout Action	USINT	1 = autodelete
13	Get	Produced Connection Path Length	USINT	0
14	Get	Produced Connection Path		Null (no data)
15	Get	Consumed Connection Path Length	USINT	0
16	Get	Consumed Connection Path		Null (no data)

Instance Attributes (Instance 2)

Instance Type : Polled I/O

Attribute ID	Access Rule	Name	DeviceNet Data Type	Data Value
1	Get	State	USINT	0 = nonexistent 1 = configuring 3 = established 4 = timed out
2	Get	Instance Type	USINT	1 = Polled I/O
3	Get	Transport Class Trigger	USINT	0x83
4	Get	Produced Connection ID	UINT	01111xxxxxx binary xxxxxx = node address
5	Get	Consumed Connection ID	UINT	10xxxxxx101 binary xxxxxx = node address
6	Get	Initial Comm Characteristics	USINT	0x01
7	Get	Produced Connection Size	UINT	0x08
8	Get	Consumed Connection Size	UINT	0x08
9	Get / Set	Expected Packet Rate	UINT	2500 default (msec) with timer resolution of 1 msec
12	Get	Watchdog Timeout Action	USINT	0
13	Get	Produced Connection Path Length	USINT	0
14	Get	Produced Connection Path		Null (no data)
15	Get	Consumed Connection Path Length	USINT	0
16	Get	Consumed Connection Path		Null (no data)
17	Get	Production Inhibit Time	USINT	0

MC Object

Class Code: 0x8A

Instance Services

Id	Service	Description
0x05	Reset	Performs EX on the Motion Coordinator. This will reset the DeviceNet as well.
0x33	Read Word - TABLE	Reads the specified number of TABLE entries and sends their values in 16 bit 2s complement format
0x34	Read Word - VR	Reads the specified number of TABLE entries and sends their values in 16 bit 2s complement format
0x35	Read IEEE - TABLE	Reads the specified number of TABLE entries and sends their values in 32 bit IEEE floating point format
0x36	Read IEEE - VR	Reads the specified number of VR entries and sends their values in 32 bit IEEE floating point format
0x37	Write Word - TABLE	Receives the specified number of values in 16 bit 2s complement format and writes them into the specified TABLE entries
0x38	Write Word - VR	Receives the specified number of values in 16 bit 2s complement format and writes them into the specified VR entries
0x39	Write IEEE - TABLE	Receives the specified number of values in 32 bit IEEE floating point format and writes them into the specified TABLE entries
0x3A	Write IEEE - VR	Receives the specified number of values in 32 bit IEEE floating point format and writes them into the specified VR entries

The following sections describe the message body area of the Explicit Message used to specify the different services. This ignores all of the fragmentation protocol.

Read word format

Request

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
byte 0	0	Service code = 0x33, or 0x34						
byte 1	Class ID = 0x8A							
byte 2	Instance ID = 0x01 (this is the only instance supported)							
byte 3	bits 15-8 of Source Address							
byte 4	bits 7-0 of Source Address							
byte 5	ignored							
byte 6	Number of word values to be read							

Response

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
byte 0	1	Service code = 0x33, or 0x34						
byte 1	bits 15-8 of Value 0							
byte 2	bits 7-0 of Value 0							
	...							
byte n	bits 15-8 of Value m							
byte n + 1	bits 7-0 of Value m							

Write word format

Request

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
byte 0	0	Service code = 0x37, or 0x38						
byte 1	Class ID = 0x8A							
byte 2	Instance ID = 0x01 (this is the only instance supported)							
byte 3	bits 15-8 of Source Address							
byte 4	bits 7-0 of Source Address							
byte 5	ignored							
byte 6	Number of word values to be written							
byte 7	bits 15-8 of Value 0							
byte 8	bits 7-0 of Value 0							
	...							
byte n	bits 15-8 of Value m							
byte n + 1	bits 7-0 of Value m							

Response

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
byte 0	1	Service code = 0x37, or 0x38						

Read IEEE format

Request

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
byte 0	0	Service code = 0x35, or 0x36						
byte 1	Class ID = 0x8A							
byte 2	Instance ID = 0x01 (this is the only instance supported)							
byte 3	bits 15-8 of Source Address							
byte 4	bits 7-0 of Source Address							
byte 5	ignored							
byte 6	Number of IEEE values to be read							

Response

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
byte 0	1	Service code = 0x35, or 0x36						
byte 1	bits 7-0 of Value 0							
byte 2	bits 15-8 of Value 0							
byte 3	bits 23-16 of Value 0							
byte 4	bits 31-24 of Value 0							
	...							
byte n	bits 7-0 of Value m							
byte n + 1	bits 15-8 of Value m							
byte n + 2	bits 23-16 of Value m							
byte n + 3	bits 31-24 of Value m							

Write IEEE format

Request

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
byte 0	0	Service code = 0x39, or 0x3A						
byte 1	Class ID = 0x8A							
byte 2	Instance ID = 0x01 (this is the only instance supported)							
byte 3	bits 15-8 of Source Address							
byte 4	bits 7-0 of Source Address							
byte 5	ignored							
byte 6	Number of IEEE values to be written							
byte 7	bits 7-0 of Value 0							
byte 8	bits 15-8 of Value 0							
byte 9	bits 23-16 of Value 0							
byte 10	bits 31-24 of Value 0							
	...							
byte n	bits 7-0 of Value m							
byte n + 1	bits 15-8 of Value m							
byte n + 2	bits 23-16 of Value m							
byte n + 3	bits 31-24 of Value m							

Response

	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
byte 0	1	Service code = 0x39, or 0x3A						

DeviceNet Status LEDs

To see the DeviceNet status on the *Motion Coordinator's* LEDs, you must set the DISPLAY system parameter to 8. (See the DISPLAY system variable in chapter 8)

The *Motion Coordinator's* I/O status LEDs are now read from 0 to 7 as follows:

LED	Function
0 - Amber	Module Status - DeviceNet GREEN LED
1 - Amber	Module Status - DeviceNet RED LED
2 - Amber	Network Status - DeviceNet GREEN LED
3 - Amber	Network Status - DeviceNet RED LED
4 - Amber	Bus Off Count - bit 0
5 - Amber	Bus Off Count - bit 1
6 - Amber	Bus Off Count - bit 2
7 - Amber	Bus Off Count - bit 3

LEDs 0 to 3 have the standard meanings as stated in the ODVA ***DeviceNet*** manual.

Module Status:

Off - No Power
Flashing Green/Red - Module self test
Flashing Green - Standby
Steady Green - Operational
Flashing Red - Minor Fault (software recoverable)
Steady Red - Major Fault

Network Status:

Off - Not On-line
Flashing Green - On-line, not connected
Steady Green - On-line, connected
Flashing Red - Connection timeout
Steady Red - Critical link failure

Ethernet

The Ethernet daughter board P296 can be fitted to both the MC206X and MC224 *Motion Coordinators*. This section describes how to set up a simple Ethernet connection to the P296.

Default IP Address

The IP address (Internet Protocol address) is a 32-bit address that has two parts: one part identifies the network, with the network number, and the other part identifies the specific machine or host within the network, with the host number. An organization can use some of the bits in the machine or host part of the address to identify a specific subnet. Effectively, the IP address then contains three parts: the network number, the subnet number, and the machine number.

The 32-bit IP Address is often depicted as a dot address (also called dotted quad notation) - that is, four groups of decimal digits separated by points.

For example, the Trio Ethernet daughter board has a default IP of:

```
192.168.000.250
```

Each of the decimal numbers represents a string of eight binary digits. Thus, the above IP address really is this string of 0s and 1s:

```
11000000.10101000.00000000.11111010
```

As you can see, points are inserted between each eight-digit sequence just as they are in the decimal version of the IP address. Obviously, the decimal version of the IP address is easier to read and that's the form most commonly used (192.168.000.250).

Part of the IP address represents the network number or address and another part represents the local machine address (also known as the host number or address). IP addresses can be one of several classes, each determining how many bits represent the network number and how many represent the host number. IP addresses are grouped by classes A,B,C, D and E. The Trio ethernet board is set up for a Class C address.

Using the above example, here's how the IP address is divided:

```
<-Network address->.<-Host address->
     192.168    .   000.250
```

The beginning Network Address portion of 192 begins with the first three bits as 110... and classifies it as a Class C address. This means you can have up to 256 host addresses on this particular network.

If you wanted to add sub-netting to this address, then some portion (in this example, eight bits) of the host address could be used for a subnet address. Thus:

```
<-Network address->.<-Subnet address->.<-Host address->
      192.168    .         000      .      250
```

To simplify this explanation, the subnet has been divided into a neat eight bits but an organization could choose some other scheme using only part of the third quad or even part of the fourth quad.

A subnet (short for "sub-network") is an identifiably separate part of an organization's network. Typically, a subnet may represent all the machines at one geographic location, in one building, or on the same local area network (LAN). Having an organization's network divided into subnets allows it to be connected to the Internet with a single shared network address. Without subnets, an organization could get multiple connections to the Internet, one for each of its physically separate sub-networks, but this would require an unnecessary use of the limited number of network numbers the Internet has to assign. It would also require that Internet routing tables on gateways outside the organization would need to know about and have to manage routing that could and should be handled within an organization.

The Subnet Mask

Once a packet has arrived at an organization's gateway or connection point with its unique network number, it can be routed within the organization's internal gateways using the subnet number as well. The router knows which bits to look at (and which not to look at) by looking at a subnet mask. A mask is simply a screen of numbers that tells you which numbers to look at underneath. In a binary mask, a "1" over a number says "Look at the number underneath"; a "0" says "Don't look." Using a mask saves the router having to handle the entire 32-bit address; it can simply look at the bits selected by the mask.

Using the Trio default IP address, the combined network number and subnet number occupy 24 bits or three of the quads. The default subnet mask carried along with the packet is:

```
255.255.255.000
```

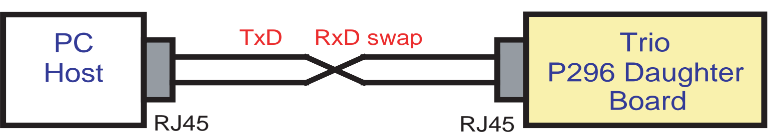
Or a string of all 1's for the first three quads (telling the router to look at these) and 0's for the host number (which the router doesn't need to look at). Subnet masking allows routers to move the packets on more quickly.

Connecting to the Trio Ethernet Daughter Board

The following steps can be followed to establish an ethernet connection from a PC to the MC controller.

1. One-to-One Connection

For a PC to the MC controller direct connection, use a "null modem" data cable.



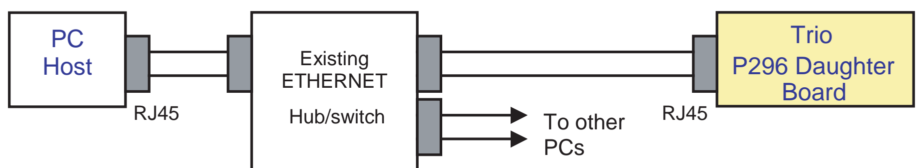
The IP address of the Host PC can be set to the match the default value of the Trio ethernet card.

```
Host PC IP: 192.168.000.251
Subnet:     255.255.255.000

Trio IP:    192.168.000.250
Subnet:     255.255.255.000
```

If leaving the Trio's IP address as default, proceed to step 6 to test communications.

2. Connecting the Trio to Network through an ethernet hub/switch

When connecting the Trio MC controller to an existing ethernet network on a hub, no swap in the data cable is required since the hub or router will handle the data inversion.



The IP address of the Trio ethernet board can be set to the match the network address. The Trio's default subnet (255.255.255.000) is generic and allows any host PC to communicate with the controller regardless of a specific sub-network mask. Below is a typical example.

```
Host PC IP: 192.200.185.001
```

```
Subnet:     255.255.255.224

Trio IP:    192.200.185.a
Subnet:     255.255.255.000
```

Where:

a = Valid IP address for the Trio ethernet board on the given network

3. Select a valid IP address for the Trio

For this network example, the 224 in the subnet indicate the network can have up to (6) sub-networks (224 = 11100000). The (5) remaining bits within the 224 mask will allow up to 30 valid host addresses ranging from 1 to 30.

Valid IP Addresses (a) for above example:

```
       002 = 11100010 to 030 = 11111110

New Trio IP: 192.200.185.002
Trio Subnet: 255.255.255.000
```

4. Checking and Setting The Trio's IP Address

The IP address of the ethernet daughter board can be verified using the RS232 command line interface ">>" of the *Motion Coordinator*. The command line can be accessed via the terminal 0 in *Motion* Perfect 2.

At the command line, use the ETHERNET command and type:

```
>>ETHERNET(0,0,0)
```

When connected correctly the controller will respond with the line:

```
>>192.168.000.250
```

The sequence (192.168.000.250) is the IP address of the *Motion Coordinator*.

5. To change the IP address to a different

Set a new IP address to match the network:

At the command line, use the ETHERNET command and type:

```
>>ETHERNET(1,0,0,192,200,185,2)
```

Verify the new IP address:

```
>>ETHERNET(0,0,0)
```

The new IP address value prints out:

```
>>192.200.185.002
```

NOTE: Cycle power to the *Motion Coordinator* for the new IP address to take effect

6. Test the Communications

The easiest way to test the ethernet link is to "ping" the Trio MC controller. This can be done using the ping command at a DOS prompt.

From the START button in Windows, select Accessories and then Command Prompt utility.

At the DOS prompt type the Trio's appropriate IP address:

```
C:\>ping 192.168.0.250
```

Successful reply from controller

```
Pinging 192.168.0.250 with 32 bytes of data:

Reply from 192.168.0.250: bytes=32 time<10ms TTL=64
Reply from 192.168.0.250: bytes=32 time<10ms TTL=64
Reply from 192.168.0.250: bytes=32 time<10ms TTL=64
Reply from 192.168.0.250: bytes=32 time<10ms TTL=64

Ping statistics for 192.168.0.250:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum =  0ms, Average =  0ms
```

If the ping command is unsuccessful you will see

```
C:\>ping 192.168.0.250

  Pinging 192.168.0.250 with 32 bytes of data:

  Request timed out.
  Request timed out.
  Request timed out.
```

```
Request timed out.

Ping statistics for 192.168.0.250:
Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum =  0ms, Average =  0ms
```

7. Telnet/Command-line Prompt

If the controller was successfully 'pinged', then the telnet application can be used to open a remote command-line prompt connection to the controller. This tests the TCP socket connection.

Type:

telnet 192.168.0.250

using the DOS prompt on the PC. This should open a telnet session, and by typing <return> the characteristic Trio command-line prompt ('>>') should be seen.

It should be noted that it is possible to use other port numbers with the controller, hence if port number 1025 has been configured then a telnet session can still be started by typing:

telnet 192.168.0.250 1025

If the serial lead is also connected to the controller then the Ethernet connection will grab and release the port 0 communications as the socket connection (telnet session) is opened and closed.

8. Modbus TCP

The Modbus/TCP communication protocol is supported by the P296 Ethernet Daughter Board and allows the *Motion Coordinator* acts as a Modbus/TCP Slave device. Its functionality is similar to the existing Trio Modbus RTU Slave (over RS-232 or RS-485), except an Ethernet connection is used and there are 3 extensions to the basic serial Modbus functionality.

1. Floating point transfers are allowed as an alternative to 16 bit integer.

2. Table memory can be read and written to instead of the VR() variables.

3. Function number 23 (17 Hex) “Read / Write 4x Registers” is supported.

Modbus TCP connects via Ethernet Port 502.

The following ETHERNET command is used to set which data type, integer or floating point, is used for communications.

ETHERNET(2, slot number, 7, data type)

slot number = comms slot where Ethernet Daughter Board is installed

data type = 0, for 16-bit signed integer data communication (default)
data type = 1, for 32-bit signed floating point data communication

This parameter only needs to be initialized if passing floating point data, and must be set before Modbus/TCP communications are attempted. It is not maintained through power cycles, so it must be initialized once after each power-up.

It should be noted that floating point mode isn't covered by the Modbus specification, so each manufacturer's chosen implementation may differ.

To use the TABLE memory instead of VR() variables set ETHERNET function 9 to 1.

`ETHERNET(2, slot number, 9, data target)`

slot number = comms slot where Ethernet Daughter Board is installed

data target = 0, for read/write VR() variables (default)
data target = 1, for read/write TABLE memory (TABLE(0) to TABLE(16384) max)

This parameter only needs to be initialized if TABLE mamory is required, and must be set before Modbus/TCP communications are attempted. It is not maintained through power cycles, so it must be initialized once after each power-up.

CHAPTER

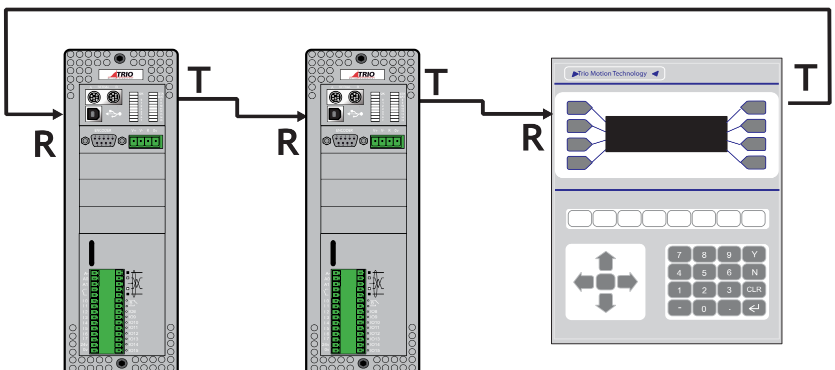
13

FIBRE-OPTIC NETWORK

General Description

The TRIO fibre optic network has been designed to link up to fifteen *Motion Coordinator* modules and membrane keypads. Any number of either type of module can be on the network up to the maximum of fifteen but at least one must be a *Motion Coordinator*.

The physical connection of the network takes the form of a ring. The interconnections between nodes being made with fibre optic cable.



Example of Network Connection

There are three fixed types of message that can be transmitted round the network. These are:

(i) Character transfer

- a string of characters is transmitted to a specified node e.g. a message to a display. This is performed with a PRINT# command. Reception of characters to a *Motion Coordinator* is carried out with the GET# command.

(ii) Direct variable transfer

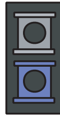
- a specified variable on a given *Motion Coordinator* node can be modified by another *Motion Coordinator* node independent of the program running on the receiving node. This is achieved with the SEND command.

(iii) Keypad offset

- a special message sent to a membrane keypad node to set it into network mode and to tell it where on the network to direct its key presses to. This message type is also transmitted by the SEND command.

Connection of Network

All the nodes have to be connected to form a ring. Single core fibre optic cable is used terminated with Hewlett Packard “Versatile Link” connectors. The fibre optic modules on the *Motion Coordinator* and membrane keypad are colour coded as follows:



Grey or Black	Transmitter
Blue	Receiver.

To form the ring the transmit of a node is connected to the receive of the next node, i.e. grey/black to blue. The transmit of the final node is connected to the receive of the first thus completing the ring.

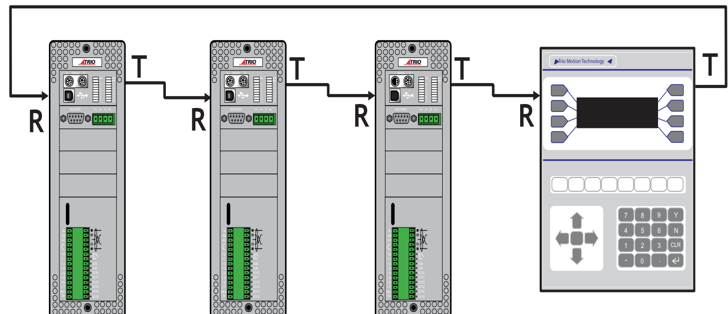
The order in which nodes are connected is not critical but the performance of the network can be affected by rearranging the order of the nodes. This is especially true if there are a large number of nodes in the network and a large amount of data being passed between two nodes. If these two nodes are not adjacent in the ring any nodes between them will be tied up re-transmitting messages and will not be able to transmit as priority is given to re-transmission of messages. This can be a particular problem if one of the nodes re-transmitting is a membrane keypad as this can cause poor response to key presses.

Fibre-optic cables

Trio can supply a fibre-optic connection kit (P570 Simplex Cable Kit) comprising a length of fibre-optic cable, connectors and assembly components.

Network Node Addressing

Nodes on the network are not given absolute addresses. Instead, when a message is sent it is labelled with the address of a destination node which defines the number of nodes along the ring from the sender that the message must travel. The addresses are in the range 10, denoting a message for the next node along the ring, to 24, denoting a message for the fifteenth node along the ring from the sender.



Node Addressing Example

The example above shows the destination node addresses for a network with respect to the transmitting *Motion Coordinator*. If a message was sent with the address 13 then the message would come back to the sender. Likewise if address 14 was used the message would completely traverse the ring once and finish up at node #10. If address 18 was used then the message would go twice round the ring and finish up at node #10.

Network Programming

Trio BASIC Commands

The transmission and reception of messages on the network is performed by four Trio BASIC commands.

GET #n

Type: Command.

Syntax: **GET#n,VR(x)**

Description: Waits for the arrival of a single character on the specified input device. The ASCII value of the received character is stored in the chosen variable. The characters received are held in a 256 character buffer.

Parameters:

n	Number to specify how the returned value generated.
3	value returned is defined by DEFKEY
4	value returned is character received
x	Variable number in the range 0 to 250.

KEY#n

Type: Function.

Syntax: **IF KEY#n THEN GET #n,VR(x)**

Description: Returns **TRUE** or **FALSE** depending on whether a character has been received on the specified input device or not. The character is not read nor the receive state reset.

Parameters:

n	Number to specify serial input device.
3	network input from fibre optic port via DEFKEY table
4	network input from fibre optic port

PRINT#n,

Type: Command.

Syntax: **PRINT #11, CURSOR(20);"Printed on Keypad 2"**

Description: The **PRINT#** command allows the program to output a series of characters to the specified output device. The **PRINT#** command can output parameters, variables, fixed ASCII strings and single ASCII characters. Multiple items to be printed can be put on the same **PRINT** line provided they are separated by a comma or semi-colon. The comma and semi-colon are used to control the format of strings to be output.

Parameters:

n: Number from 10 to 24 to specify number of nodes from transmitting node the message must be sent.

SEND

Type: Command.

Syntax: **SEND(n,type,data1[,data2])**

Description: Outputs a network message of a specified type to a given node.

Parameters:

n: Number from 10 to 24 to specify number of nodes from transmitting node the message must be sent.

type: Message type:

1 - Direct variable transfer
2 - Keypad offset

data1 if type=1: data1 is the variable number on the destination node to modify.

If type=2: data1 is in the range 10..24 to specify the number of nodes from the keypad that the key characters are sent.

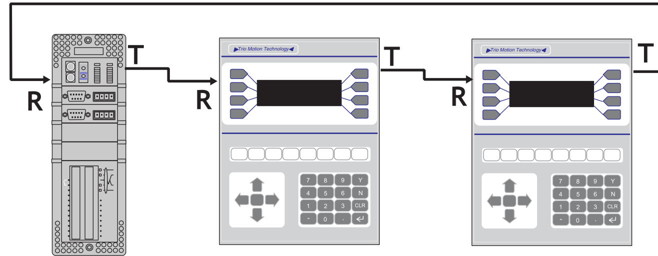
data2: If type=1: data2 is the value to change the specified variable to.

If type=2: data2 is not used.

Examples of network programming

Example 1 Consider a four axis machine which is 30m long. The operator has need to make machine adjustments at either end of the machine, thus requiring two stations for operator input. This can be achieved using a *Motion Coordinator*, four Servo Daughter Boards and two membrane keypads. The two keypads and the *Motion Coordinator* will be networked together so input from both keypads is given to the *Motion Coordinator* and any resulting change in machine parameters is displayed at either end of the machine.

The network should be connected as shown below.



Network Example 1

The program could look something like this:

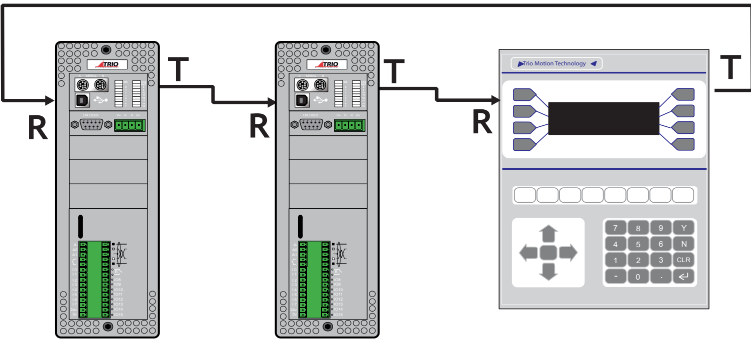
```
length=2
' Set offset on first keypad to 2, i.e. send key press to MC
SEND(10,2,11)
' Set offset on second keypad to 1, i.e. send key press to MC
SEND(11,2,10)

' Clear first display & make cursor invisible
PRINT #10,CHR(12);CHR(14);CHR(20)
' Clear second display & make cursor invisible
PRINT #11,CHR(12);CHR(14);CHR(20)
' setup display
PRINT #10,"SPEED:":PRINT #10,"LENGTH:"
PRINT #11,"SPEED:":PRINT #11,"LENGTH:"

REPEAT
  IF KEY#3 THEN GOSUB read_key ELSE GOSUB do_motion
UNTIL FALSE
read_key:
```

```
  GET #3,k
  IF k>9 THEN GOTO not_num
  a=a*10+k
  IF a>9999 THEN a=0
  PRINT #10,CHR(27);CHR(72);CHR(7);a[6,0]
  PRINT #11,CHR(27);CHR(72);CHR(7);a[6,0]
not_num:
  IF (k=10)&(VR(length)<10000) THEN VR(length)=VR(length)+0.1
  IF (k=11)&(VR(length)>0.1) THEN VR(length)=VR(length)-0.1
  PRINT #10,CURSOR(28);VR(length)[8,1]
  PRINT #11,CURSOR(28);VR(length)[8,1]
RETURN

do_motion:
' Main motion routine
```

Example 2 Consider a five axis machine with one membrane keypad. The axes can be divided into two distinct blocks. Two axes are concerned with the feeding of the material and the other three with the cutting and packing of the material.

This could also be achieved with an MC206X or an MC224 + Axis expander, but in this example because each block can be built as a stand-alone unit, each requires it's own *Motion Coordinator*. In this example our system uses two MC224 controllers.

Our network will consist of the two *Motion Coordinator*s and the membrane keypad. It should be connected as shown in below.



Network Example 2

As there are now two *Motion Coordinator*s in the network it is necessary to have a program on each.

For the purposes of this example the three axis node will act as the master and issue instructions to the two axis node. The three axis node will also receive all input from the keypad.

The program for the three axis node could be as follows:

```
init:  SEND(11,2,10)'     Set offset on keypad
     PRINT #11,CHR(12);CHR(14);"INITIALISING......."
     PRINT #10,"I";'     Send command to two axis node to
initialise
     GOSUB initax'     Initialisation routine
     WAIT UNTIL VR(200)=99'Two axis node signals ready by
setting variable 200
     PRINT #11,CHR(12);CHR(14);"MACHINE READY"

     'Get required parameters
setlen:
  PRINT #11,"FEED LENGTH:";VR(0)[6.1];
  GET #3,VR(100)
  IF VR(100)=13 THEN GOTO setsp
  IF (VR(100)=10)AND(VR(0)<1000000) THEN VR(0)=VR(0)+0.1
  IF (VR(100)=11)AND(VR(0)>0.1) THEN VR(0)=VR(0)-0.1
  PRINT#11,CHR(27);CHR(72);CHR(32);VR(0)[6.1];
GOTO setlen
setsp:
  PRINT #11,"SPEED:";VR(1)[2];
  GET #3,VR(100)
  IF VR(100)=13 THEN GOTO initnet
  IF (VR(100)=10)AND(VR(1)<100) THEN VR(1)=VR(1)+0.01
  IF (VR(100)=11)AND(VR(1)>0.01) THEN VR(1)=VR(1)-0.01
  PRINT #11,CHR(27);CHR(72);CHR(46);VR(1)[2];
GOTO setsp

initnet:
  'Update variable values on two axis node
  SEND(10,1,0,VR(0))
  SEND(10,1,1,VR(1))

start:
  PRINT #11,CHR(12);CHR(14);"PRESS START TO RUN"
```

```
readkey:
  WAIT UNTIL KEY#3
  GET #3,VR(100)
  IF VR(100)<>20 THEN GOTO readkey
  PRINT #10,"G";
  WAIT UNTIL VR(200)=999

moves:  'Main motion routine
initax: 'Initialisation routine
```

The program on the two axis node could be as follows:

```
readinit:
  IF NOT(KEY#4) THEN GOTO readinit
  GET #4, VR(100)
  IF VR(100)<>73 THEN GOTO readinit
  GOSUB initax
  SEND(11,1,200,99)
readsp:
  IF NOT(KEY#4) THEN GOTO readsp
  SPEED=VR(1)
  GET#4,VR(100)
  IF VR(100)<>71 THEN GOTO readsp
  SEND(11,1,200,999)
moves:    'Main motion routine
initax:   'Initialisation routine
```

The previous example highlights a couple of useful points:

1) The *Motion Coordinator* that is not controlling the membrane keypad must not transmit anything to or via the keypad until the keypad has been set into network mode by issuing the **SEND** command to give its keypad offset. This example uses a simple form of handshaking by setting variables and sending characters to prevent this situation but another alternative is for the controlling *Motion Coordinator* to issue the **SEND** command on the first line of its program and for all other *Motion Coordinator*s in the network to have a delay at the start of their program to allow time for the membrane keypads to be initialised.

2) When using the **GET**# command it is a good idea to test for the buffer being empty with the **KEY**# command, especially if reading input from a keypad, because it is possible for the buffer to overflow with unpredictable results if it is not emptied by reading from it with the **GET**# command.

Network Specification

Message Format

Each message is constructed of a header character, the message, a cwt. check (on direct variable transfers only) and an end of message character.

Bit	7	6	5	4	3	2	1	0
Header	1	<Address of Receiver>				<Message Type>		
Message (n bytes)	0	<----------- Character Information ---------->						
CRC (byte 0)	0	<--------------- Bits 6..0 of CRC -------------->						
CRC (byte 1)	0	<--------------- Bits 14..8 of CRC ------------>						
End of Message	1	<-Address of Receiver>				0	0	0

Note:
- Address of receiver is in the range 1 (for next node) to 15 (15th node on network). This is different to the node addressing used by Trio BASIC and is for internal use only.
- The number of message bytes (n) is determined by the message type as described below
- CRC bytes are used for direct variable transfers (message type 2)

Network Protocol

The sender places the message on the ring and assumes it arrives at its destination. Any packet checking must be done by the user because the nodes have no knowledge of the size of the net. Each successive node decrements the address by 1 and if the result is greater than zero it re-transmits the message with the decremented address in the header and end of message. If the result is zero then the message is for that node and is processed as necessary. The re-transmission is invisible to the user.

Message Types

The message types described here are for internal use only and are different to those used by the SEND command

0 End of message character.

1 Character transfer. Message can be 1 byte long, e.g. a key press from a keypad, or several bytes long, e.g. PRINT statement.

2 Direct variable transfer. The value of the variable specified is modified directly, without needing to be processed by the user program. Message length is 2 bytes (14 bits) for the variable number and 10 bytes (32 bit integer + 32 bit fraction) for the variable value. Ignored by membrane keypads.

3 Keypad offset. Message is 1 byte long and tells the keypad the number of nodes along the ring to send key presses.

4 Keypad Mode
Message is 1 byte long and controls the response of the keypad to key presses.

0 = Character sent on Key ON only
127 = Key ON/Key OFF each send seperate characters

Network Buffers

The transmit and receive on all nodes is buffered. As far as the user is concerned the buffers in the membrane keypad do not exist as all the necessary housekeeping is performed by the keypad itself. The only concern to the user is the receive buffer on the *Motion Coordinator*. This is 256 bytes long and is used to store the message characters only. The header and end of message bytes are stripped off as they are received so it is not necessary to do this through the Trio BASIC program.

Network Status

The NETSTAT common parameter shows any errors that have occurred on the network since the last time this parameter was cleared. The errors are displayed as follows:

Bit	Value	Error Type	Description
0	1	TX Timeout	Shows that a problem has occurred while trying to put information into the transmit buffer.
1	2	TX Buffer Error	indicates an error on transmission from the buffer. This part of the operation is invisible to the user and if this error ever occurs please contact TRIO for further advice.
2	4	RX CRC Error	the received variable has become corrupt. The error flag is set but the variable isn't.
3	8	RX Frame Error	an incomplete or corrupt message has been received.

APPENDIX

1

REFERENCE

ATYPE

#	Description
0	No axis daughter board fitted
1	Stepper daughter board
2	Servo daughter board
3	Encoder daughter board
4	Stepper daughter with position verification / Differential Stepper
5	Resolver daughter board
6	Voltage output daughter board
7	Absolute SSI servo daughter board
8	CAN daughter board
9	Remote CAN axis
10	PSWITCH daughter board
11	Remote SLM axis
12	Enhanced servo daughter board
13	Embedded axis
14	Encoder output
15	Reserved
16	Remote SERCOS speed axis
17	Remote SERCOS position axis
18	Remote CANOpen position axis
19	Remote CANOpen speed axis
20	Remote PLM axis
21	Remote user specific CAN axis
22	Remote SERCOS speed + registration axis
23	Remote SERCOS position + registration axis
30	Remote Analog Feedback axis

#	Description
31	Tamagawa absolute encoder + stepper
32	Tamagawa absolute encoder + servo
33	EnDat absolute encoder + stepper
34	EnDat absolute encoder + serv
35	PWM stepper
36	PWM servo
37	Step z
38	MTX dual port RAM
39	Empty
40	Trajexia Mecotrolink
41	Mechatrolink speed
42	Mechatrolink torque
43	Stepper 32
44	Servo 32
45	Step out 32
46	Tamagawa 32
47	Endat 32
48	SSI 32
49	Mechatrolink servo inverter

Note: Some ATYPEs are not available on all products.

COMMSTYPE

#	Description
20	CAN Communications card
21	USB Communications card
22	SLM Communications card
23	Profibus Communications card
24	SERCOS Communications card
25	Ethernet Communications card
26	4 Analog Out card (PCI208)
27	8 Analog Out card (PCI208)
28	Analog Input card
29	Enhanced CAN Communications card
30	ETHERNET IP

AXISSTATUS / ERRORMASK

Bit	Description:	Value:
0	Unused	1
1	Following error warning range	2
2	Communications error to remote drive	4
3	Remote drive error	8
4	In forward limit	16
5	In reverse limit	32
6	Datuming	64
7	Feedhold	128
8	Following error exceeds limit	256
9	In forward software limit	512
10	In reverse software limit	1024
11	Cancelling move	2048
12	Encoder power supply overload	4096
13	Set on SSI axis after initialisation	8192

CONTROL

Controller	CONTROL
Motion Coordinator MC202	202
Motion Coordinator MC302X	293
Motion Coordinator Euro205x	255
Motion Coordinator MC206	206
Motion Coordinator MC206X	207
Motion Coordinator PCI208	208
Motion Coordinator MC224	224
Motion Coordinator Euro209	259

Communications Ports

Chan	Device:-
0	Serial Port 0 - RS232 - Motion Perfect / Command Line
1	Serial Port 1
2	Serial Port 2
3	Fibre optic port (value returned defined by DEFKEY)
4	Fibre optic port (returns raw keycode of key pressed)
5	*Motion* Perfect user channel
6	*Motion* Perfect user channel
7	*Motion* Perfect user channel
8	Used for *Motion* Perfect internal operations
9	Used for *Motion* Perfect internal operations
10	Fibre optic network data

Communications Errors

Bit	Value
0	RX Buffer overrun on Network channel
1	Re-transmit buffer overrun on Network channel
2	RX structure error on Network channel
3	TX structure error on Network channel
4	Port 0 Rx data ready
5	Port 0 Rx overrun
6	Port 0 parity error
7	Port 0 Rx frame error
8	Port 1 Rx data ready
9	Port 1 Rx overrun
10	Port 1 parity error
11	Port 1 Rx frame error
12	Port 2 Rx data ready
13	Port 2 Rx overrun
14	Port 2 parity error
15	Port 2 Rx frame error
16	Error FO Network port
17	Error FO Network port
18	Error FO Network port
19	Error FO Network port

MTYPE

MTYPE	Move Type
0	Idle (No move)
1	MOVE
2	MOVEABS
3	MHELICAL
4	MOVECIRC
5	MOVEMODIFY
6	MOVESP
7	MOVEABSSP
8	MOVECIRCSP
9	MHELICALSP
10	FORWARD
11	REVERSE
12	DATUMING
13	CAM
14	FORWARD_JOG
15	REVERSE_JOG
20	CAMBOX
21	CONNECT
22	MOVELINK
23	MOVETANG
24	MSPHERICAL

NETSTAT

Bit Set	Error Type	Value
0	TX Timeout	1
1	TX Buffer Error	2
2	RX CRC Error	4
3	RX Frame Error	8

Data Formats and Floating-Point Operations

The TMS320C3x processor used by the *Motion Coordinator* features several different data types. In the *Motion Coordinator* we use two main formats. The following descriptions are taken directly from the TI documentation.

Single-Precision Floating Point Format

In the single precision format, the floating-point number is represented by an 8-bit exponent field (e) and a twos complement 24-bit mantissa field (man) with and implied significant non-sign bit.

31 24	23	22 0
e	s	f

Operations are performed with an implied binary point between bits 23 and 22. When the implied most significant non-sign bit is made explicit, it is located to the immediate left of the binary point.

The floating point number *'x'* is given by:

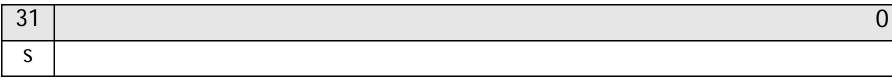
$$x = \begin{cases} 01.f \times 2^{e} & \text{if } s=0 \\ 10.f \times 2^{e} & \text{if } s=1 \\ 0 & \text{if } e=-128 \end{cases}$$

The following examples illustrate the range and precision if the single-precision floating-point format:

Most Positive:	$x = (2 - 2^{-23}) \times 2^{127}$	$= 3.4028234 \times 10^{38}$
Least Positive:	$x = 1 \times 2^{-127}$	$= 5.8774717 \times 10^{-39}$
Least Negative:	$x = (-1 - 2^{-23}) \times 2^{-127}$	$= -5.8774724 \times 10^{-39}$
Most Negative:	$x = -2 \times 2^{127}$	$= -3.4028236 \times 10^{38}$

Single-Precision Integer Format

In the single precision integer format, the integer is represented in twos complement notation.



31	0
s	

The range of an integer *x*, represented in the single-precision integer format, is:

$$-2^{31} <= x <= 2^{31} - 1$$

Product Codes

Processors	
P135	MC206X
P151	Euro205x Stepper base card
P159	Euro209 Stepper base card
P170	MC224
P180	PCI208
P190	MC302-K
P192	MC302X

Options - MC224 Only	
P301	Axis Expander, for 1 to 4 daughter baords
Options - Euro205x Only	
P445	Daughter Board Mounting Kit
Options - Euro209 Only	
P447	Daughter Board Mounting Kit
Options - MC206X Only	
P399	Daughter Board Adapter

Daughter Boards - Euro205x-Euro209-MC206X-MC224	
P200	Servo Encoder Daughter
P201	Enhanced Servo Daughter
P210	Servo Resolver Daughter
P220	Reference Encoder Daughter
P225	8 Analog Input Daughter
P230	Stepper Daughter
P240	Stepper Encoder Daughter
P242	Hardware PSWITCH Daughter

P260	Analog Output Daughter
P270	SSI Servo Encoder Daughter
P280	Differential Stepper Daughter
P290	CAN Daughter
P291	SERCOS Daughter
P292	SLM Daughter
P293	Enhanced CAN Daughter
P295	USB Daughter
P296	Ethernet Daughter
P297	Profibus Daughter
P298	Ethernet IP

Options - I/O	
P316	CAN 16-I/O
P325	CAN 8 analog Inputs

Keypads & Cables	
P350	RS232 Serial Cable
P354	Mini-DIN to Flying lead 3m
P361	USB Cable 1.5m
P435	TTL Serial to Fibre Optic Adapter (not MC302X / MC302-K)
P502	Mini-Membrane Keypad
P503	Membrane Keypad
P582	2 metre SLM Cable
P583	SLM Splitter

A range of Fibre-Optic cables can be supplied for both the Trio FO Network and to the SERCOS specification. Contact your Trio Distributor for details.

Symbols

- 8-192
8-186
$ 8-186
* 8-193
+ 8-192
/ 8-193
: 8-185
< 8-196
<= 8-196
<> 8-194
= 8-194
> 8-195
>= 8-195
^ 8-194
' 8-185

A

ABS 8-197
ACC 8-13
ACCEL 8-211
ACOS 8-197
ADD_DAC 8-14
ADDAX 8-16
ADDAX_AXIS 8-211
ADDRESS 8-121
AFF_GAIN 8-211
AIN 8-91
AIN0-3 8-92
AINBI0-7 8-92
Amplifier Enable 2-45
AND 8-197
AOUT0...3 8-92
APPENDPROG 8-121
Applications 1-16
ASIN 8-198
ATAN 8-199
ATAN2 8-199
ATYPE 8-212
AUTORUN 8-121
AXIS 8-19
Axis Parameters 7-10
AXIS_ADDRESS 8-214
AXIS_ENABLE 8-214
AXISSTATUS 8-215
AXISVALUES 8-122

B

B_SPLINE 8-199
BACKLASH 8-20
BACKLASH_DIST 8-216
BASE 8-21
BASICERROR 8-111
BATTERY_LOW 8-122
Board 12-7
BOOST 8-216
BREAK_ADD 8-123
BREAK_DELETE 8-123
BREAK_LIST 8-123
BREAK_RESET 8-124

C

CAD2Motion 10-83
CAM 8-22
CAMBOX 8-26
CAN 8-124
CAN 16-I/O Module 5-3
CAN Analog Inputs 5-12
CAN Connector 2-3, 2-32
CAN Daughter Board 4-31
CAN_ENABLE 8-217
CANCEL 8-36
CANIO_ADDRESS 8-126
CANIO_ENABLE 8-127
CANIO_STATUS 8-127
CANOPEN_OP_RATE 8-127
CHECKSUM 8-128
CHR 8-92
CLEAR 8-128
CLEAR_BIT 8-200
CLEAR_PARAMS 8-128
CLOSE_WIN 8-217
CLUTCH_RATE 8-217
CmdProtocol 12-8
Command Line Interface 7-14
COMMSERROR 8-129
COMMSTYPE 8-129

Communications Protocols 13-1
COMPILE 8-129, 8-130
CONNECT 8-38
Connections to the Euro 205x 2-12
CONSTANT 8-200
CONTROL 8-130
COPY 8-131
COS 8-201
CREEP 8-217
CURSOR 8-93

D

D_GAIN 6-10, 8-218
D_ZONE_MAX 8-219
D_ZONE_MIN 8-218
DAC 8-219
DAC_OUT 8-220
DAC_SCALE 8-220
DATE 8-131
DATE$ 8-132
DATUM 8-40
DATUM_IN 8-221
Daughter board fitting 4-4
Daughter Boards 1-11, 4-3
    Daughter Boards 1-6
DAY 8-132
DAY$ 8-132
DEC 8-44
DECEL 8-221
DEFKEY 8-93
DEFPOS 8-45
DEL 8-132, 8-133
DEMAND_EDGES 8-222
DEMAND_SPEED 8-222
DEVICENET 8-133
Diagnostic Checklists 6-13
DIP Switch Settings 5-6, 5-13
DIR 8-134
DISABLE_GROUP 8-47
DISPLAY 8-134
DLINK 8-135
DocMaker 10-84
DPOS 8-222
DRIVE_CLEAR 8-222
DRIVE_CONTROL 8-223
DRIVE_ENABLE 8-223
DRIVE_EPROM 8-224
DRIVE_HOME 8-224
DRIVE_INERFACE 8-224
DRIVE_INPUTS 8-224
DRIVE_MODE 8-225
DRIVE_MONITOR 8-225
DRIVE_READ 8-225
DRIVE_RESET 8-226
DRIVE_STATUS 8-226
DRIVE_WRITE 8-227

E

EDIT 8-139
EDPROG 8-139
ELSE 8-111
ELSEIF 8-111
EMC 3-10
ENABLE_OP 8-94
ENCODER 8-227
Encoder Connections 4-11
ENCODER_BITS 8-227
ENCODER_CONTROL 8-228
ENCODER_ID 8-229
ENCODER_RATIO 8-50
ENCODER_READ 8-229
ENCODER_STATUS 8-229
ENCODER_TURNS 8-229
ENCODER_WRITE 8-230
ENDIF 8-112
ENDMOVE 8-230
ENDMOVE_BUFFER 8-230
ENDMOVE_SPEED 8-231
Environmental Considerations 3-9
EPROM 8-140
Error Codes 5-8
ERROR_AXIS 8-141
ERROR_LINE 8-187
ERRORMASK 8-231
ETHERNET 8-141
Ethernet Daughter Baord 4-37, 4-39
ETHERNET_IP 8-143
Euro205x 2-10

Euro209 2-20
Euro209 - Feature Summary 2-29
EX 8-143
EXECUTE 8-143
EXP 8-201

F

FALSE 8-209
FAST_JOG 8-232
FASTDEC 8-232
FB_SET 8-144
FB_STATUS 8-144
FE 8-232
FE_LATCH 8-232
FE_LIMIT 8-233
FE_LIMIT_MODE 8-233
FE_RANGE 8-233
FEATURE_ENABLE 8-145
FEGRAD 8-234
FEMIN 8-234
FHOLD_IN 8-234
FHSPEED 8-235
Fibre-optic cables 14-4
Fibre-Optic Network 14-1
FLAG 8-94
FLAGS 8-95
FLASHVR 8-145
FLASHVR() 8-145
FOR 8-113
FORCE_SPEED 8-235
FORWARD 8-52
FRAC 8-201
FRAME 8-147
FREE 8-147
FS_LIMIT 8-235
FULL_SP_RADIUS 8-236
FWD_IN 8-236
FWD_JOG 8-237

G

Gains 6-8
GET 8-95
GET# 8-96
GetConnectionType 12-6
GetData 12-28
GLOBAL 8-202
GOSUB 8-114
GOTO 8-115

H

HALT 8-148
HEX 8-97
HLM_COMMAND 8-148
HLM_READ 8-150
HLM_STSTUS 8-151
HLM_TIMEOUT 8-152
HLM_WRITE 8-152
HLS_MODAL 8-153
HLS_NODE 8-154
HostAddress 12-7

I

I_GAIN 6-10, 8-237
IDLE 8-118
IEEE_IN 8-200, 8-202
IEEE_OUT 8-203
IN 8-97
INCLUDE 8-154
INDEVICE 8-187
INITIALISE 8-154
INPUT 8-98
INPUTS0/INPUTS1 8-99
Installation 3-1, 12-3
INT 8-203
INVERT_IN 8-99
INVERT_STEP 8-237
IsOpen 12-5

J

JOGSPEED 8-238

K

KEY 8-99

L

LAST_AXIS 8-155
LENZE 5-8

LIMIT_BUFFERED 8-238
LINKAX 8-238
LINPUT 8-100
LIST 8-155
LIST_GLOBAL 8-155
LN 8-203
LOAD_PROJECT 8-156
LOADED 8-119
LOADSYSTEM 8-156
LOCK 8-157
LOOKUP 8-188

M

MARK 8-239
MARKB 8-239
MC Simuation 10-75
MC_TABLE 8-158
MC_VR 8-158
MC206X 2-30
MC224 2-40
MC302X 2-2
Membrane Keypad 5-17
MERGE 8-239
MHELICAL 8-54
MHELICALSP 8-56
MICROSTEP 8-240
Mini-Membrane Keypad 5-20
MOD 8-204
MODBUS RTU 13-3
Module Interconnection 3-9
MOTION 8-158
Motion Perfect 10-3
    Analogue Input Viewer 10-46
    Axis Parameters 10-26
    Breakpoints 10-62
    CAN I/O Status 10-15
    Card Support 10-20
    Connecting to a Controller 10-5
    Control Panel 10-49
    Controller Configuration 10-14
    Controller Menu 10-12
    Creating and Running a program 10-54
    Debugger 10-61
    Desktop 10-10
    Digital IO Status 10-44
    Editor 10-55
    Ethernet Configuration 10-16
    External Tools 10-47
    Feature Enable 10-17
    Flash Eprom 10-67
    Flashstick Support 10-19
    Jog Axes 10-41
    Keypad
        Emulation 10-38
    Loading System Software 10-21
    Lock/Unlock Controller 10-23
    Main Menu 10-11
    Making programs run automatically 10-66
    Options
        CAN Drive 10-72
        Communications 10-68
        CX-Drive Configuration 10-73
        Diagnostics 10-72
        Editor 10-71
        FINS Configuration 10-73
        General 10-71
        Menu 10-68
        Program Compare 10-73
        Terminal Font 10-72
    Oscilloscope 10-29
    Project Check Options 10-7
    Project Check Window 10-6
    Projects 10-6
    Running for the first time 10-5
    Running Programs 10-64
    Running Without a Controller 10-75
    Saving the Desktop Layout 10-73
    Setting Powerup Mode 10-66
    System Requirements 10-4
    Table/VR Editor 10-40
    Terminal 10-25
    Tools 10-24
MOTION_ERROR 8-158
MOVE 8-57
MOVEABS 8-59
MOVEABSSP 8-61
MOVECIRC 8-62
MOVECIRCSP 8-65
MOVELINK 8-66

MOVEMODIFY 8-70
MOVES_BUFFERED 8-241
MOVESP 8-74
MOVETANG 8-77
MPE 8-158
MPOS 8-241
MSPEED 8-241
MSPHERICAL 8-75
MTYPE 8-242

N

NAIO 8-159
NEG_OFFSET 8-242
NETSTAT 8-160
Network 14-1
  Programming 14-6
  Specification 14-12
NEW 8-160
NEXT 8-113, 8-115
NIO 8-160
NOT 8-204
NTYPE 8-243

O

OFF 8-209
OFFPOS 8-243
ON 8-209
ON .. GOSUB 8-115
ON .. GOTO 8-116
OnBufferOverrunChannel5/6/7/9 12-30
OnReceiveChannel5/6/7/ 12-30
OP 8-101
OPEN_WIN 8-244
Operator Interfaces 1-11, 5-16
OR 8-204
OUTDEVICE 8-188
OUTLIMIT 8-244
Output Velocity Gain 6-11
OV_GAIN 6-11, 8-245

P

P_GAIN 6-10, 8-245
Packaging
  Mounting 3-8
PEEK 8-161
PI 8-209
PLM_OFFSET 8-246
PMOVE 8-188
POKE 8-161
PORT 8-161
POS_OFFSET 8-246
POWER_UP 8-161
PP_STEP 8-246
PRINT 8-102
PRINT# 8-103
PROC 8-189
PROC_LINE 8-189
PROC_MODE 8-189
PROC_STATUS 8-189
PROCESS 8-162
Process Numbers 7-11
Process Parameters 7-10
PROCNUMBER 8-189, 8-190
Products 1-5
  I/O Expansion options 1-10
  Master Controllers 1-5
PROFIBUS 8-162
Profibus Daughter Baord 4-38
Programming 7-1
Programming Examples 9-1
Project Autoloader 10-79
Project Encryptor 10-79
PROTOCOL 8-163
PSWITCH 8-104
PWM_CONTROL 8-247
PWM_CYCLE 8-248
PWM_ENCODER 8-248
PWM_MARK 8-248

R

RAPIDSTOP 8-79
READ_BIT 8-205
READ_OP 8-106
READPACKET 8-107
RECORD 8-107
REG_POS 8-249
REG_POSB 8-250

REGIST 8-82
REGIST_CONTROL 8-250
REMAIN 8-250
REMOTE 8-163
REMOTE_ERROR 8-250
RENAME 8-163
REP_OPTION 8-251
REPDIST 8-251
REPEAT 8-116
RESET 8-190
RETURN 8-117
REV 8-252
REV_IN 8-251
REV_JOG 8-252
REVERSE 8-87
RS_LIMIT 8-252
RS232_SPEED_MODE 8-163
RUN 8-164
RUN_ERROR 8-190
RUNTYPE 8-165

S

SCOPE 8-165
SCOPE_POS 8-166
SELECT 8-166
SEND 8-108
SendData 12-29
SERCOS 8-167
SERCOS Daughter Board 4-33
SERCOS_PHASE 8-172
Serial Cables 2-43
Serial Port 2-18, 2-36, 2-44
SERIAL_NUMBER 8-172
SERVO 8-252
Servo Gains 6-8
Servo Loop 6-12
SERVO_PERIOD 8-172
SET_BIT 8-205
SETCOM 8-109
SGN 8-206
SIN 8-206
SLM 8-135
SLM Daughter Board 4-34
SLOT 8-173
SP 8-253
SPEED 8-253
SPHERE_CENTRE 8-253
SQR 8-207
SRAMP 8-254
STEP 8-113, 8-173
STEP_RATIO 8-89
STEPLINE 8-173
STICK_READ 8-174
STICK_WRITE 8-175
STOP 8-174
STORE 8-176
System Building 1-12
System Parameters 7-10

T

TABLE 8-176
TABLEVALUES 8-178
TAN 8-207
TANG_DIRECTION 8-254
Testing Standards 3-11
THEN 8-117, 8-174
TICKS 8-191
TIME 8-178
TIME$ 8-179
TO 8-113, 8-117
TRANS_DPOS 8-255
TRIGGER 8-179
TROFF 8-179
TRON 8-179
TRUE 8-210
TSIZE 8-180
Typical applications 1-16

U

UNITS 8-255
UNLOCK 8-180
UNTIL 8-116, 8-118, 8-119
USB 8-181
USB_HEARTBEAT 8-181
USB_STALL 8-182
Using the MC loader ActiveX Contro 11-1

VECTOR_BUFFERED 8-256
VERIFY 8-256
VERSION 8-182
VFF_GAIN 6-11, 8-257
VIEW 8-182
VP_SPEED 8-257
VR 8-183
VRSTRING 8-184

WA 8-118
WAIT 8-118
WAIT IDLE 8-118
WAIT LOADED 8-119
WAIT UNTIL 8-119
WDOG 8-184
WEND 8-120
WHILE 8-120

XOR 8-207