IMS™

# INTELLIGENT MOTION SYSTEMS, INC.

*Excellence in Motion™*

MDRIVE 23™
MOTOR+DRIVER
MOTION CONTROL

# O P E R A T I N G  I N S T R U C T I O N S

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# Table of Contents

# List of Figures



# List of Tables

# SECTION 1

## *Introduction to the MDrive23 Motion Control*

### Introduction to the MDrive23 Motion Control

The MDrive23 Motion Control offers the system designer a low-cost, intelligent motion controller integrated with a NEMA 23 high torque stepping motor and a +12 to +48 VDC microstepping drive.

The MDrive23 Motion Control adds a versatile array of functions by combining a complete programmable motion controller with our already compact and cost effective standard MDrive23, adding little cost and no increase in size. Standard offerings include four 5 to 24 volt programmable I/O points, one 10 bit, 0 to 5 volt analog input, 0 to 5 MHz step clock rate, microstep resolution up to 51,200 steps per revolution and a full featured easy-to-program instruction set.

The MDrive23 Motion Control communicates using the RS-485 communications protocol, this allows for point-to-point or multi-drop communications using one communications port. Addressing and hardware support up to 62 MDrive nodes in a system. The communications BAUD rate is software selectable and ranges from 4.8 kbps to 115 kbps.

The MDrive23 is also available with an optional closed loop control. The closed loop configuration adds a 512 line (2048 count) internal magnetic rotary encoder with index mark without increasing the length of the unit. Closed loop configuration adds position maintenance, stall detection and find index mark.

Available motor configurations include: single shaft, double shaft with control knob, and long life ACME screw linear actuator. Rotary versions are available in three stack lengths: 18, 22 & 31. Interface connections are accomplished using either a 7 position terminal block or optional 12” flying leads.

### Feature Summary

- Integrated Microstepping Drive/Motion Controller with Optional Encoder/NEMA 23 High Torque Stepping Motor
- +12 to +48VDC Input Voltage
- Low Cost
- Extremely Compact
- Available Configurations: Single Shaft*, Linear Actuator, Integral Encoder*, Double Shaft with Knob for Manual Positioning*
- Three Motor Stack Lengths Available*
- Single Power Supply
- Microstep Resolution up to 51,200 Steps Per Revolution
- Open Loop or Optional Closed Loop Control
- Programmable Motor Run and Hold Current Settings
- Four 5 to 24 VDC Programmable I/O Points
- One Analog 10 Bit, 0 to 5 Volt Analog Input
- 0 to 5 MHz Step Clock Rate, Selectable in 0.59 Hz Increments
- RS-485 Communications Protocol
- Communications BAUD Rate Selectable from 4.8 kbps to 115 kbps
- 62 Software Addresses for Multidrop Communications
- Simple 1 and 2 Character Programming Instructions
- Pluggable Terminal Strip or 12” Flying Lead Interface
- Optional Integrated RS-232 to RS-485 Converter/Communications Cable

*Rotary Motor Only

# SECTION 2

## MDrive23 Motion Control Specifications

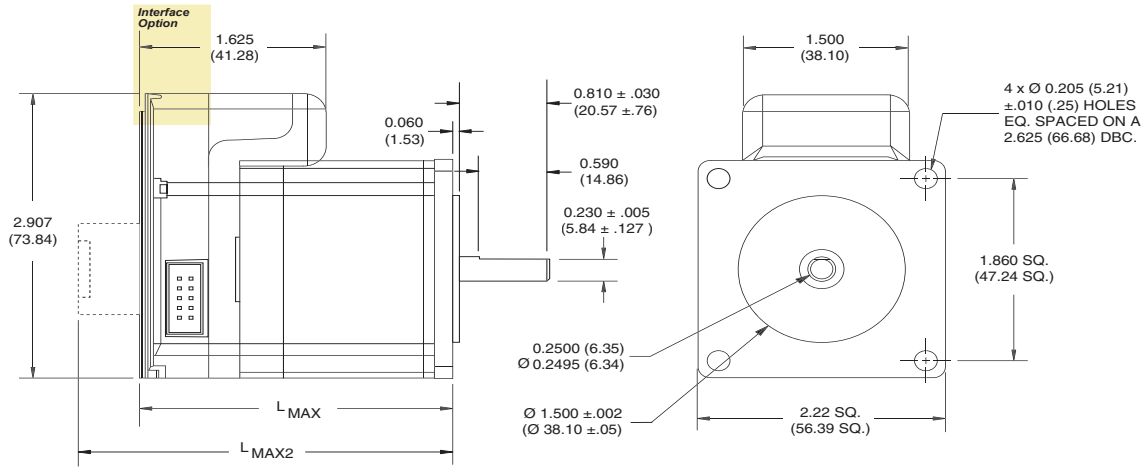
### Section Overview

This section contains mechanical, motor and electrical specifications specific to each version of the MDrive23 Motion Control. Shown are:

- Rotary Motor Specifications
- Linear Motor Specifications
- General Specifications
- Power Supply Requirements
- Thermal Specifications

### Rotary Motor Specifications

#### Mechanical Specifications - Dimensions in Inches (mm)




| Standard Rotary Motor ($L_{MAX}$) | |
|---|---|
| Stack | In (mm) |
| 2218 | 2.632 (66.85) |
| 2222 | 3.000 (76.20) |
| 2231 | 3.960 (100.58) |

| Control Knob ($L_{MAX2}$) | |
|---|---|
| Stack | In (mm) |
| 2218 | 3.088 (78.44) |
| 2222 | 3.537 (89.84) |
| 2231 | 4.416 (112.17) |

*Figure 1: Rotary MDrive23 Motion Control Mechanical Specifications*

#### MDrive Motion Control 2218 Motor Specs and Speed/Torque Curves

| MD2218 | |
|---|---|
| Holding Torque oz-in (N-cm) | 90 (64) |
| Detent Torque oz-in (N-cm) | 3.5 (2.5) |
| Rotor Inertia oz-in-sec$^2$ (kg-cm$^2$) | 0.0025 (0.18) |
| Weight (Motor+Driver) oz (gm) | 20.1 (569.8) |

*Table 1: MDI2218 Motor Specifications*

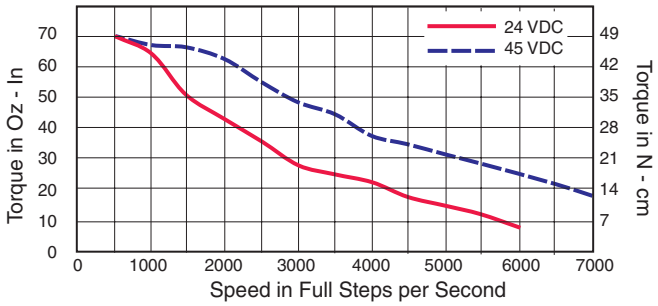



*Figure 2: Rotary MDrive Motion Control 2218 Speed/Torque Data*

## MDrive Motion Control 2222 Motor Specs and Speed/Torque Curves

| MD2222 | |
|---|---|
| Holding Torque oz-in (N-cm) | 144 (102) |
| Detent Torque oz-in (N-cm) | 5.6 (3.92) |
| Rotor Inertia oz-in-sec$^2$ (kg-cm$^2$) | 0.0037 (0.26) |
| Weight (Motor+Driver) oz (gm) | 24.4 (691.7) |

*Table 2: Rotary MDI2222 Motor Specifications*

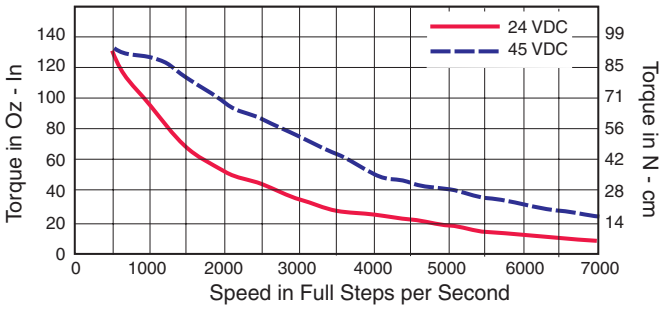



*Figure 3: Rotary MDrive Motion Control 2222 Speed/Torque Data*

## MDrive Motion Control 2231 Motor Specs and Speed/Torque Curves

| MD2231 | |
|---|---|
| Holding Torque oz-in (N-cm) | 239 (169) |
| Detent Torque oz-in (N-cm) | 9.7 (6.86) |
| Rotor Inertia oz-in-sec$^2$ (kg-cm$^2$) | 0.0065 (0.46) |
| Weight (Motor+Driver) oz (gm) | 38.5 (1091.5) |

*Table 3: Rotary MDI2231 Motor Specifications*

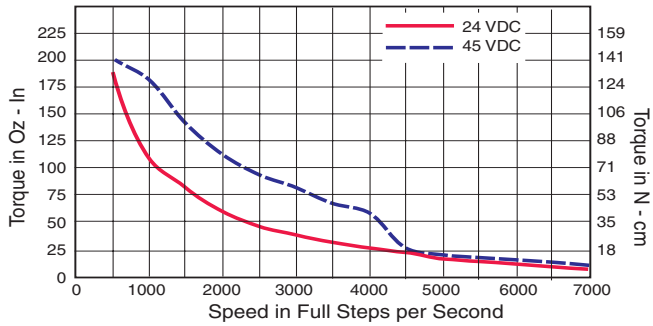



*Figure 4: Rotary MDrive Motion Control 2231 Speed/Torque Data*

# Linear Motor Specifications

## Mechanical Specifications - Dimensions in Inches (mm)

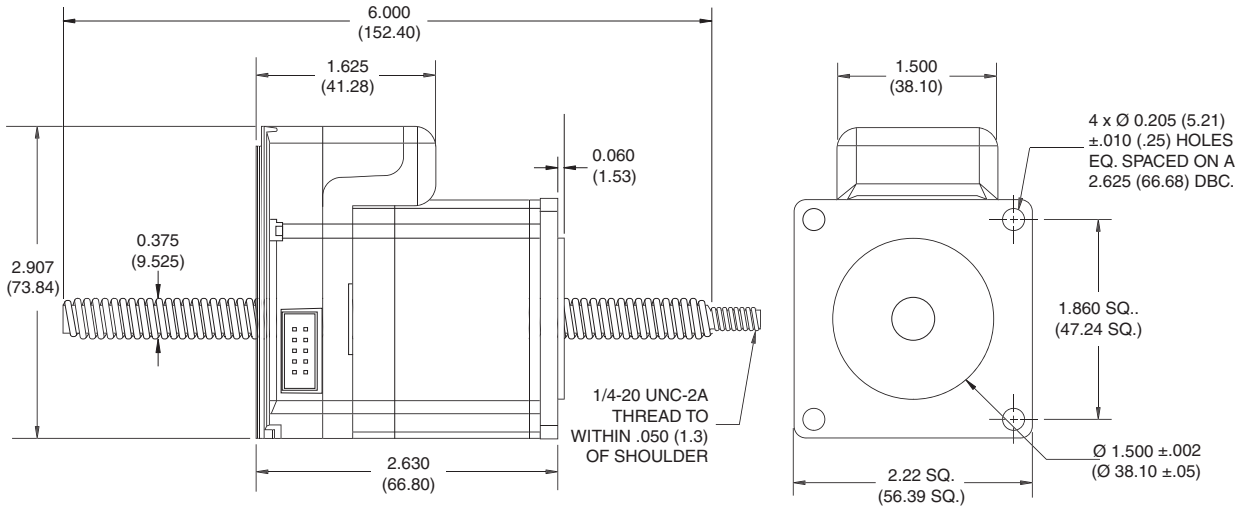



*Figure 5: Linear Actuator MDrive23 Motion Control Mechanical Specifications*

| MDI23 Linear Actuator | |
|---|---|
| Maximum Thrust lbs (kg) | 200 (90.7) |
| Maximum Screw Deflection | ±1° |
| Backlash inches (mm) | 0.005 (0.127) |
| Weight (Motor+Driver) oz (gm) | 20.4 (578.3) |

*Table 4: Linear Actuator MDrive23 Motion Control Motor Specifications*

## Speed-Force Curve: 24 VDC

Refer to Table 5 for screw pitch information

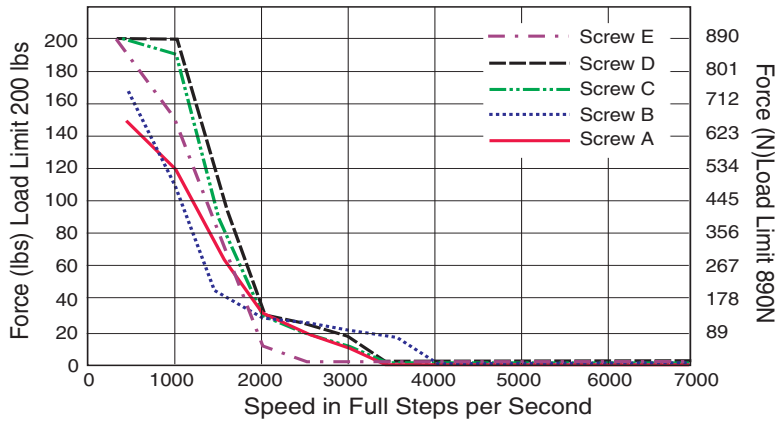



*Figure 6: Speed-Force Curve - 24VDC (100% Current)*

## Speed-Force Curve: 45 VDC

Refer to Table 5 for screw pitch information

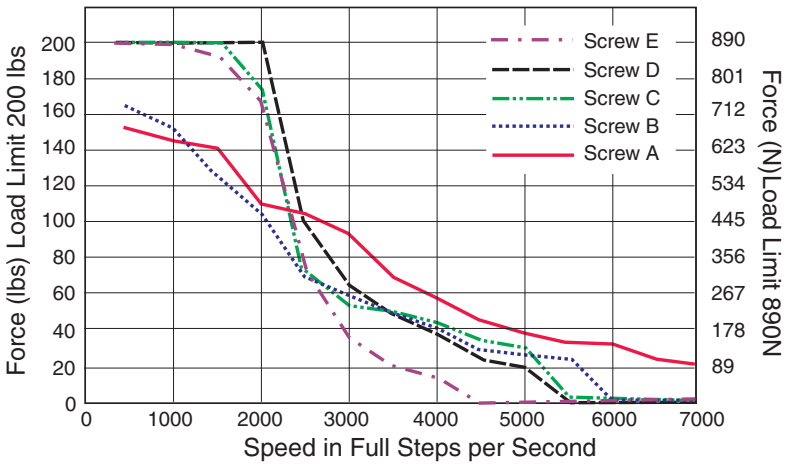



*Figure 7: Speed-Force Curve - 45VDC (100% Current)*

**WARNING:** The maximum axial load limit for the MDrive23 Linear motor is 200 lbs (90.7 kg). Do not exceed this rating!

**WARNING:** The ACME Screw **MUST NOT** deflect more than ± 1 degree perpendicular to the motor face. Additional support for radial loads may be required!

| MDI23 ACME Screws | |
|---|---|
| Screw | Travel/Full Step - Inches (mm) |
| F | 0.002 (0.0508) |
| A | 0.001 (0.0254) |
| B | 0.000833 (0.0211582) |
| C | 0.0005 (0.0127) |
| D | 0.0004167 (0.00793750) |
| E | 0.0003125 (0.0079375) |

*Table 5: ACME Screws for the MDrive23 Linear Actuator*

## General Specifications

### Input Voltage (+V)

Range ..... +12 to +48 VDC

### Analog Input

Resolution ..... 10 Bit
Voltage Range ..... 0 to +5 Volts

### Programmable I/O

Number ..... 4
Interface Type ..... Open Collector
Voltage Range ..... 0 to +24 VDC
Output Sink Current ..... 700 mA
Protection ..... Over Temp., Short Circuit, Inductive Clamp

### Communication

Protocol ..... RS-485, Full/Half Duplex Selectable
BAUD Rate ..... 4800, 9600, 19.2k, 38.0k, 115.2k

### Motion

**Microstep Resolution (Open Loop Configuration)**
Number of Settings ..... 14
Steps per Revolution ..... 400, 800, 1000, 1600, 2000, 3200, 5000
6400, 10000, 12800, 25000, 25600, 50000
51200

**Microstep Resolution (Closed Loop Configuration)**
Steps per Revolution (Fixed) ..... 51200

**Encoder (Optional)**
Type ..... Internal, Magnetic
Resolution ..... 512 Lines/2048 counts per Revolution

**Counters**
Type ..... Position(C1), Encoder (C2)
Resolution ..... 32 Bit
Edge Rate (Max) ..... 5 MHz

**Velocity**
Range ..... ±5,000,000 Steps per Second
Resolution ..... 1 Step per Second

**Acceleration/Deceleration**
Range ..... $1.5 \times 10^9$ Steps per Second$^2$
Resolution ..... 90.9 Steps per Second$^2$

## General Specifications

*Software*

| | |
|---|---|
| Program and Data Storage | Non-Volatile |
| User Program Space | 767 Bytes |
| User Registers | 4 - 32 Bit |
| Math Functions | +, -, x, ÷, <>, =, <, <=, >, >=, AND, OR, XOR, NOT |
| Branch Functions | Branch & Call (Conditional) |

**Predefined I/O Functions**

| | |
|---|---|
| Inputs | Home, Limit +, Limit -, Go, Stop, Pause, Jog +, Jog -, Analog Input |
| Outputs | Moving, Fault |
| Trip Functions | Input, Position |
| Party Mode Node Addresses | 62 |
| Encoder Functions | Stall Detect, Position Maintenance, Find Index |

*Protection*

| | |
|---|---|
| Types | Thermal |

## Power Supply Requirements

Each MDrive will require a maximum power supply current of 2A. Actual power supply current will depend upon the load and duty cycle.

### *Recommended IMS Power Supplies*

Listed below are the power supplies recommended for use with both voltage ranges of the MDrive23 Motion Control.

*Unregulated Linear Supply*

IP404(MDI23)

**Input Specifications**

| | |
|---|---|
| AC Input Voltage Range | 102-132VAC/Optional 240VAC |
| Frequency | 50-60Hz |

**Output Specifications**

| | |
|---|---|
| Voltage (Nominal - No Load) | 40 VDC |
| Current (Peak) | 4 Amps |
| Current (Continuous) | 2 Amps |

*Unregulated Switching Supply*

ISP200-4(MDI23)

**Input Specifications**

| | |
|---|---|
| AC Input Voltage Range | 102-132VAC/Optional 240VAC |
| Frequency | 50-60Hz |

**Output Specifications**

| | |
|---|---|
| Voltage (Nominal - No Load) | 45 VDC |
| Current (Peak) | 3 Amps |
| Current (Continuous) | 1.5 Amps |

## Thermal Specifications

Because the MDrive consists of two core components, a drive and a motor, close attention must be paid to the thermal environment where the device is used. The following maximum temperatures apply to the MDrive23:

**Heatsink Temperature**

| | |
|---|---|
| Max | 85°C |

**Motor Temperature**

| | |
|---|---|
| Max | 100°C |

# SECTION 3

## *Interfacing the MDrive Motion Control*

## Section Overview

This section will acquaint the user with connecting and using the MDrive Motion Control.

- Layout and Interface Guidelines
- Pin Configuration and Descriptions
- Interfacing Power
- Interfacing RS-485 Communications
- Interfacing Digital I/O
- Interfacing Analog Input

## Layout and Interface Guidelines

Logic level cables must not run parallel to power cables. Power cables will introduce noise into the logic level cables and make your system unreliable.

Logic level cables must be shielded to reduce the chance of EMI induced noise. The shield needs to be grounded at the signal source to earth. The other end of the shield must not be tied to anything, but allowed to float. This allows the shield to act as a drain.

Power supply leads to the driver need to be twisted. If more than one driver is to be connected to the same power supply, run separate power and ground leads from the supply to each driver.

### *Recommended Wiring*

The following wiring/cabling is recommended for use with the MDrive Motion Control:

*Power*

Belden Part# 9740 or equivalent 18 Gauge

*Logic Wiring (I/O, Communications)*

Wire Size ..... 20-22 AWG

*General Practices*

The following wire strip length is recommended:

Wire Strip Length ..... 0.250” (6.0 mm)

## Pin Configuration and Descriptions

| Connector P1 | | | |
|---|---|---|---|
| Pin # | Flying Lead | Function | Description |
| 1 | TBD | I/O1 | Open Collector I/O Point #1, +5 to +24VDC |
| 2 | TBD | I/O2 | Open Collector I/O Point #2, +5 to +24VDC |
| 3 | TBD | I/O3 | Open Collector I/O Point #3, +5 to +24VDC |
| 4 | TBD | I/O4 | Open Collector I/O Point #4, +5 to +24VDC |
| 5 | TBD | Analog Input | 10 Bit, 0 to 5V Analog Input |
| 6 | Black | GND | Ground |
| 7 | Red | +V | +12 to +48 VDC Power Supply Input |

*Table 6: P1 Pin Configuration and Description*

| Connector P2 - 10 Pin Header | | |
|---|---|---|
| Pin # | Function | Description |
| 1- 5 | N/C | MUST BE LEFT OPEN! |
| 6 | RX+ | RS-485 Receive + |
| 7 | RX- | RS-485 Receive - |
| 8 | TX- | RS-485 Transmit - |
| 9 | TX+ | RS-485 Transmit + |
| 10 | GND | Communications Ground |

*Table 7: P2 Pin Configuration and Description*

## Interfacing Power

An advantage of the MDrive Motion Control is that only a single, +12 to +48VDC unregulated linear or unregulated switching power supply is required to power the control circuitry and motor power.

A maximum of 2A output is required from the supply for each MDrive. Note that the actual power required will be based upon the load and duty cycle.

Wiring should be accomplished using shielded twited pair Belden Part# 9740 or equivalent 18 Gauge. The shield should be attached to earth at the power supply end and left floating at the MDrive end.

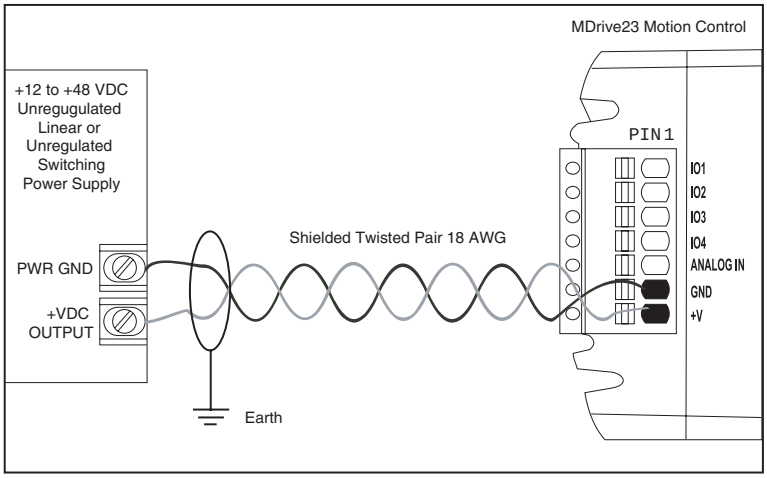



*Figure 8: Power Supply Interface*

## Interfacing RS-485 Communications

The MDrive Motion Control communicates to the host using the RS-485 protocol. Communications may be configured as either half or full duplex using the EM (Echo Mode) Instruction. RS-485 may be used in two ways: either to communicate to a single MDrive Motion Control, or to address up to 62 individually named MDrive nodes in a multidrop system.

### *Single MDrive*

Optionally available for the MDrive Motion Control is a communications cable, IMS P/N MD-CC200-000 which has built-in RS-232 to RS-485 conversion circuitry. This will allow you to connect directly to the serial port of your PC to the MDrive Motion Control.

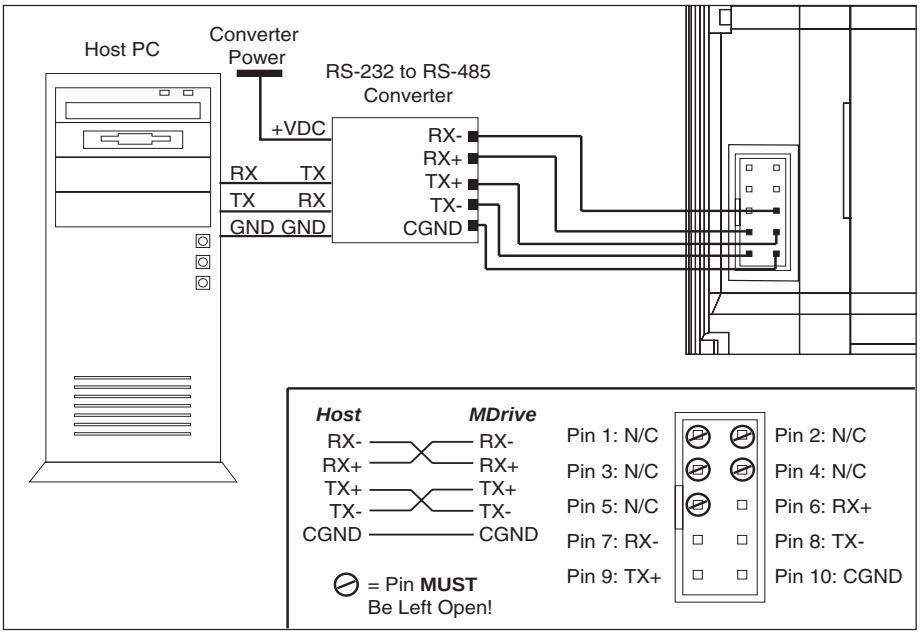



*Figure 9: RS-485 Interface, Single MDrive Motion Control*

## *Multiple MDrive Motion Control System (Party Mode)*

In systems with multiple controllers it is necessary to communicate with the control modules using party mode (PY=1) of operation. The MDrive Motion Control nodes in the system are configured in software for this mode of operation by setting the Party Flag (PY) to True (1). It is necessary for all of the nodes in a system to have this configuration selected. When operating in party mode each MDrive Motion Control in the system will need a unique address, or name, to identify it in the system. This is accomplished by using the software command DN, or Device Name. For example, to set the name of an MDrive to "A" you would use the following command: DN=65 or DN="A" (65 is the ASCII decimal equivalent of uppercase A). The factory default name is "!". The asterisk character "*" is used to issue global commanes to every device in the system. See Appendix A for ASCII table.

In setting up your system for party operation the most practical approach would be to observe the following steps:

1. Connect the first MDrive Motion Control to the Host PC configured for Single Mode Operation.
2. Establish communications. Using the command DN name the MDrive Motion Control. This can be any upper or lower case ASCII character or number 0-9.
3. Set the party flag PY=1. Remove power.
4. Connect the next MDrive Motion Control in the system, set the party flag to true.
5. Establish communications with this module using the factory default name "!". This name cannot be reused. Rename and save the new name. Remove power.
6. Repeat the last two steps for each additional MDrive in the system.

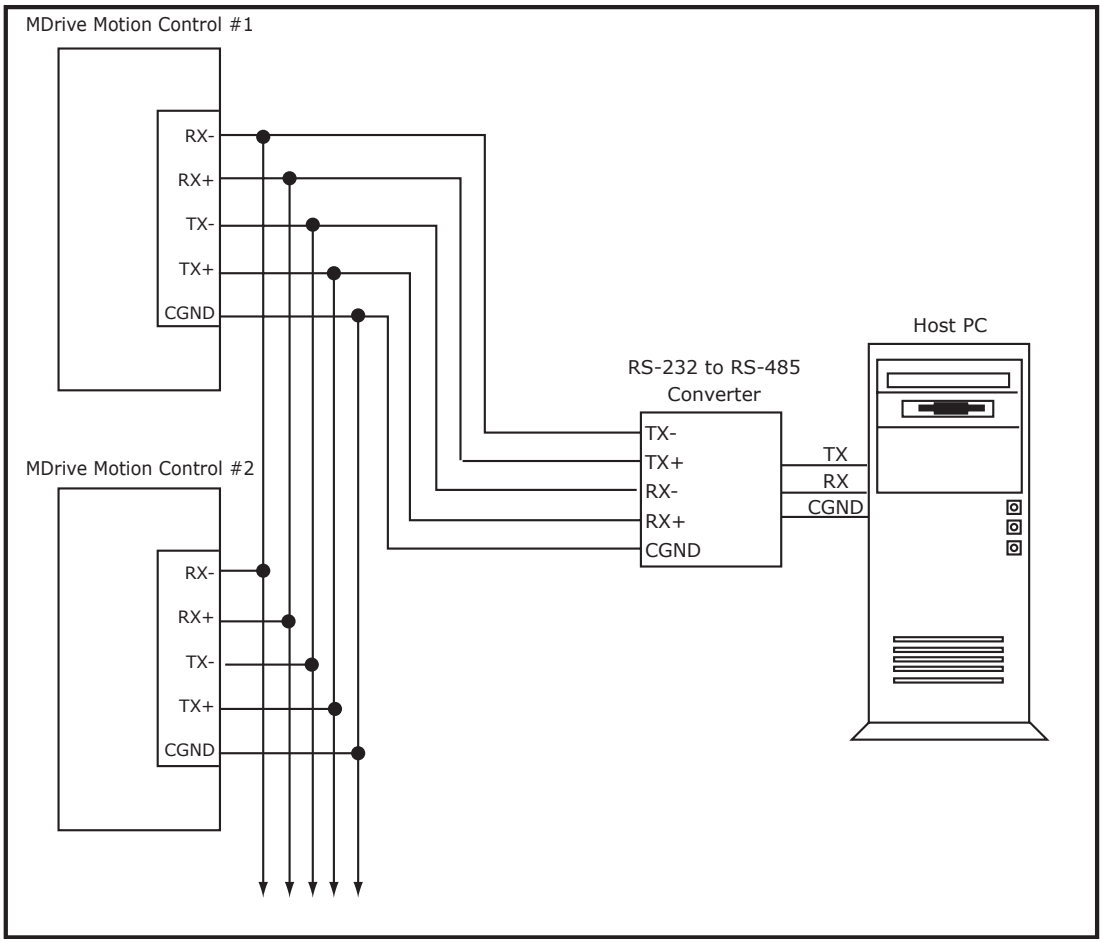



*Figure 10: RS-485 Interface, Multiple MDrive Motion Control System*

## Interfacing the Digital I/O

The MDrive Motion Control comes standard with a set of four (4) open collector +5 to +24VDC I/O point which may be programmed individually as either general purpose or dedicated inputs or outputs, or collectively as a group.

The digital I/O may be defined as either active HIGH or active LOW. When the I/O is configured as active HIGH, the level is +5 to +24 VDC and the state will be read/set as a "1". If the level is 0 VDC then the state will be read/set as "0". Inversely, if configured as active LOW, then the state of the I/O will be read/set as a "1" when the level is LOW, and a "0" when the level is HIGH. The active HIGH/LOW state is configured by the third parameter of the I/O Setup (S1-4) variable, which is explained further on. The goal of this I/O configuration scheme is to maximize compatibility between the MDrive Motion Control and standard sensors and switches.

The MDrive Motion Control's I/O scheme is a powerful tool for machine and process control.

### Uses of the Digital I/O

The I/O may be utilized to receive input from external devices such as sensors, switches or PLC outputs. When configured as outputs, devices such as relays, solenoids, LED's and PLC inputs may be controlled from the MDrive Motion Control.

Each I/O point may be individually programmed to any one of 9 dedicated input functions, 3 dedicated output functions, or as general purpose inputs or outputs. The I/O may be addressed individually, or as a group. The active state of the line or group may also be set. All of these possible functions are accomplished with of the I/O Setup Variable (S1-4).

### Interfacing Inputs

The MDrive Motion Conrol inputs may be interfaced to a variety of sinking devices. A single input may be programmed to be a general purpose user input, or to one of nine dedicated input functions. These then may be programmed to have an active state of either HIGH or LOW.

Additionally the inputs may read as a group using the "IN" keyword. This will display as a decimal between 0 and 15 representing the 4 bit binary number. Used thus Input 1 is the Least Significant Bit (LSB) and Input 4 will be the Most Significant Bit (MSB).

*Interfacing a Single Input Examples*

| Input Functions | | |
|---|---|---|
| S<point>= | Function | Active |
| 0 | General Purpose | 0/1 |
| 1 | Home | 0/1 |
| 2 | Limit + | 0/1 |
| 3 | Limit - | 0/1 |
| 4 | G0 | 0/1 |
| 5 | Soft Stop | 0/1 |
| 6 | Pause | 0/1 |
| 7 | Jog + | 0/1 |
| 8 | Jog - | 0/1 |
| 10 | Index (encoder only) | 0/1 |

*Table 8: Input Functions*

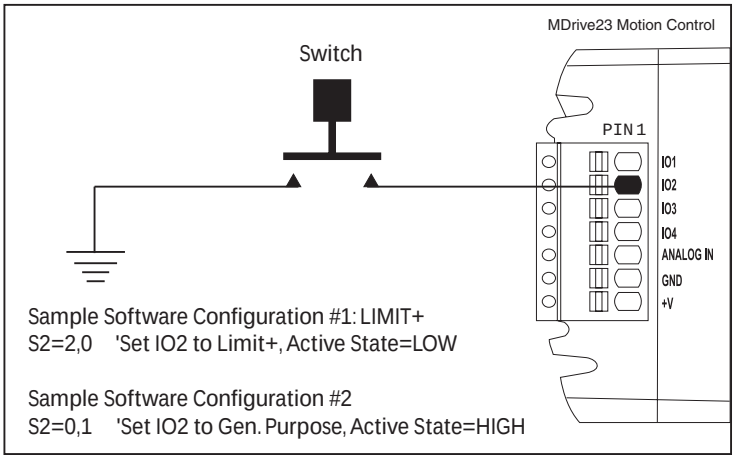



*Figure 11: Input Interfaced to a Switch*

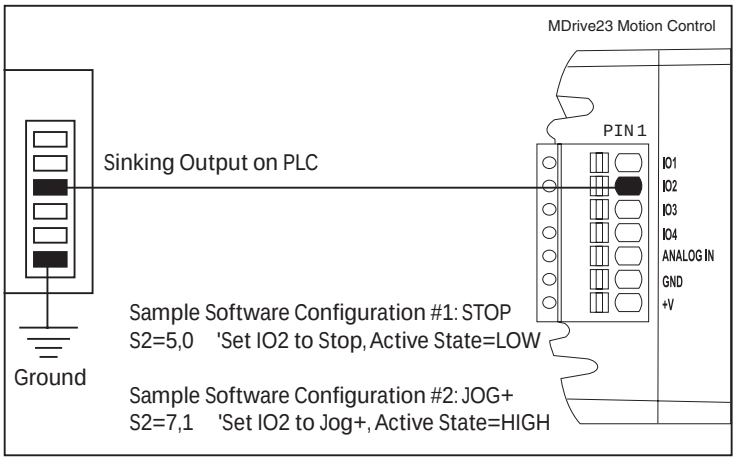



*Figure 12: Input Interfaced to a PLC*

***Interfacing Inputs as a Group Example***

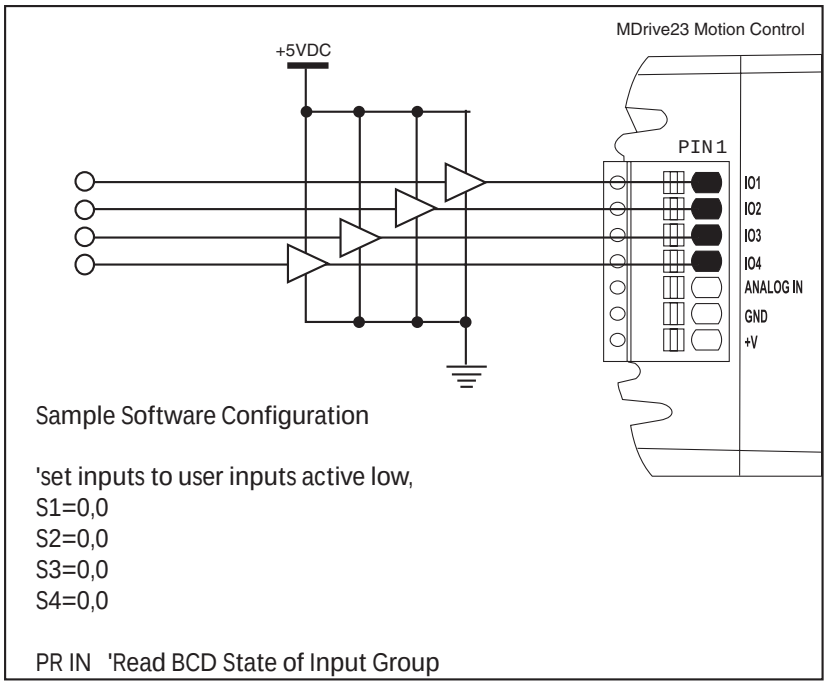



*Figure 13: TTL Interface to Input Group*

| Truth Table - I/O Used as a Group | | | | |
|---|---|---|---|---|
| DEC | IO4 | IO3 | IO2 | IO1 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 1 | 1 |
| 4 | 0 | 1 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 |
| 6 | 0 | 1 | 1 | 0 |
| 7 | 0 | 1 | 1 | 1 |
| 8 | 1 | 0 | 0 | 0 |
| 9 | 1 | 0 | 0 | 1 |
| 10 | 1 | 0 | 1 | 0 |
| 11 | 1 | 0 | 1 | 1 |
| 12 | 1 | 1 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 |
| 14 | 1 | 1 | 1 | 0 |
| 15 | 1 | 1 | 1 | 1 |

*Table 9: I/O Group Truth Table*

## Interfacing Outputs

The MDrive Motion Control Outputs may be configured as either general purpose or set to one of two dedicated functions, Fault or Moving. These outputs will sink up to 700 mA max and may be connected to +5 to +24VDC. Note that a current limiting resistor may be required to limt the current to 700 mA.

As with the inputs the MDrive Motion Control Outputs may be used singularly or collectively as a group.

### Interfacing a Single Output Examples

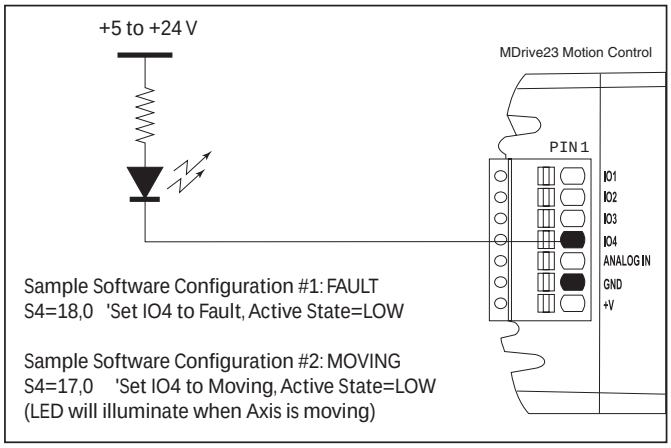



*Figure 14: Output Interfaced to an LED*

| Input Functions | | |
|---|---|---|
| S<point>= | Function | Active |
| 16 | General Purpose | 0/1 |
| 17 | Fault | 0/1 |
| 18 | Moving | 0/1 |

*Table 10: Output Functions*

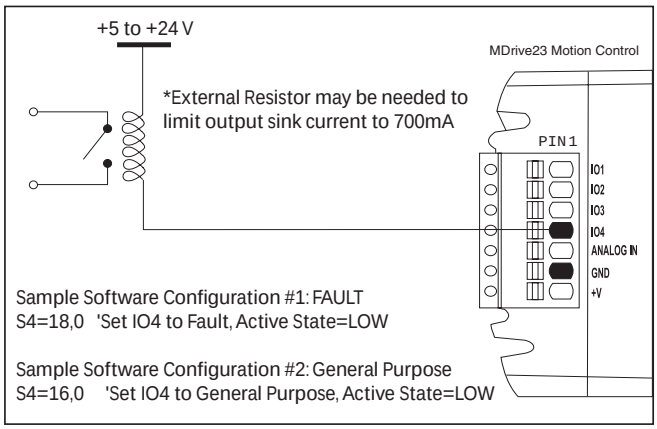



*Figure 15: Output Interfaced to a Relay*

### Interfacing Outputs as a Group Example

To write to the outputs as a group the OT instruction is used. This will give you a binary output of 0000 to 1111 from a decimal entry of 0-15. Output 1 will be the Least Significant Bit (LSB), Output 4 will be the Most Significant Bit (MSB).

See Table 9 for Truth Table.

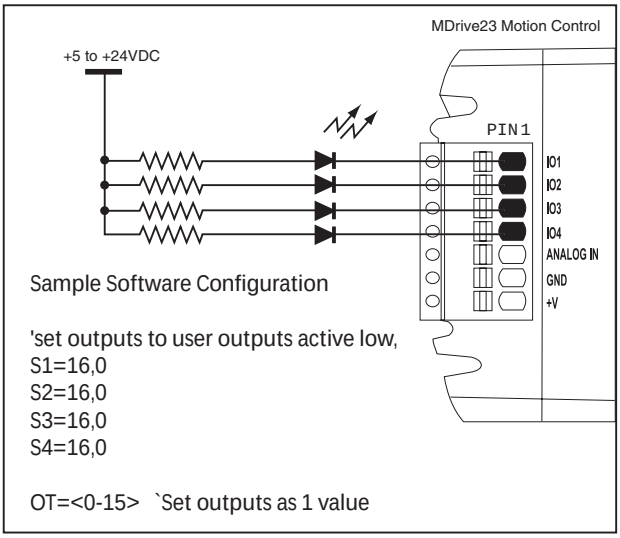



*Figure 16: Outputs Interfaced to LED's as a Group*

## Interfacing the Analog Input

The analog input of the MDrive Motion Control is a 0 to 5V, 10 bit resolution input. This offers the user the ability to receive input from temperature, pressure or other forms of sensors then control events based upon the input.

The value of this input will be read using the I5 instruction, which has a range of 0 to 1024, where 0 = 0 volts and 5 = 5.0 volts. You may then use the program branch (BR) or subroutine call (CL) instructions to control events within the system.

### *Sample Usage*

```
'*********Main Program***********

PG 100              'start prog. at address 100
LB A1               'label program A1
CL A2, I5<500       'Call Sub A2, If I5 is less than 500
CL A3, I5>524       'Call Sub A3, If I5 is greater than 524
BR A1               'loop to A1
E                   'End
PG                  'Exit program

'*********Subroutines************
LB A2               'label subroutine A2
MA 2000             'Move Absolute 2000 steps
H                   'Hold program execution until motion ceases
RT                  'return from subroutine

LB A3               'label subroutine A3
MA -2000            'Move Absolute -2000 steps
H                   'Hold program execution until motion ceases
RT                  'return from subroutine
```

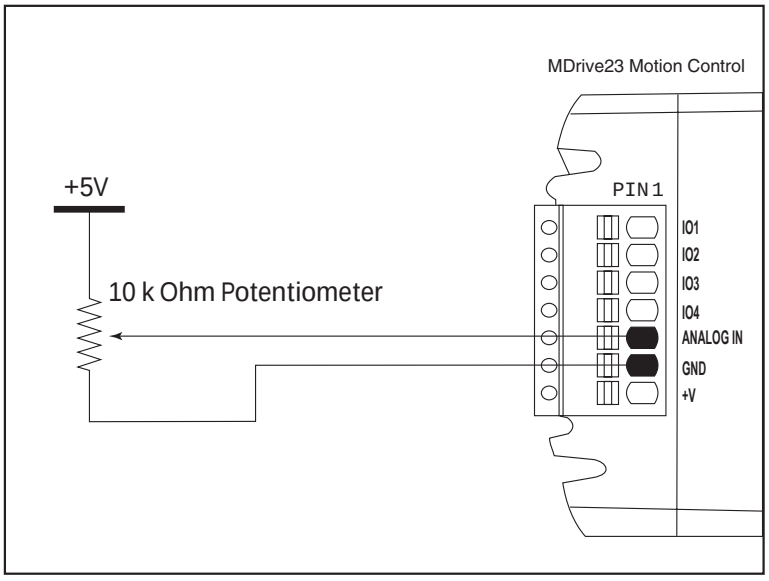



*Figure 17: Analog Input Interface*

# SECTION 4

## MDrive Motion Control Software Introduction

### Section Overview

This section will acquaint the user with basics of MDrive Motion Control Programming

- Installing IMS Terminal Software
- Upgrading the MDrive Firmware
- The MDrive Program

### Installing and Using IMS Terminal

#### System Requirements

- IBM Compatible PC.
- Windows 95/98 or Windows NT4.0 SP6, Windows 2000 SP2, Windows XP
- 10 MB hard drive space.
- A free serial communications port.

#### Installation

The IMS Terminal software is a programming/communications interface. This program was created by IMS to simplify programming and upgrading the MDrive Motion Control. The IMS Terminal is also necessary to upgrade the software in your MDrive Motion Control. These updates will be posted to the IMS website at www.imshome.com as they are made available.

To install the IMS Terminal to your hard drive, insert the IMS CD into your CD-ROM Drive. The installation front-end will automatically open.

Follow the on-screen instructions to complete the installation.

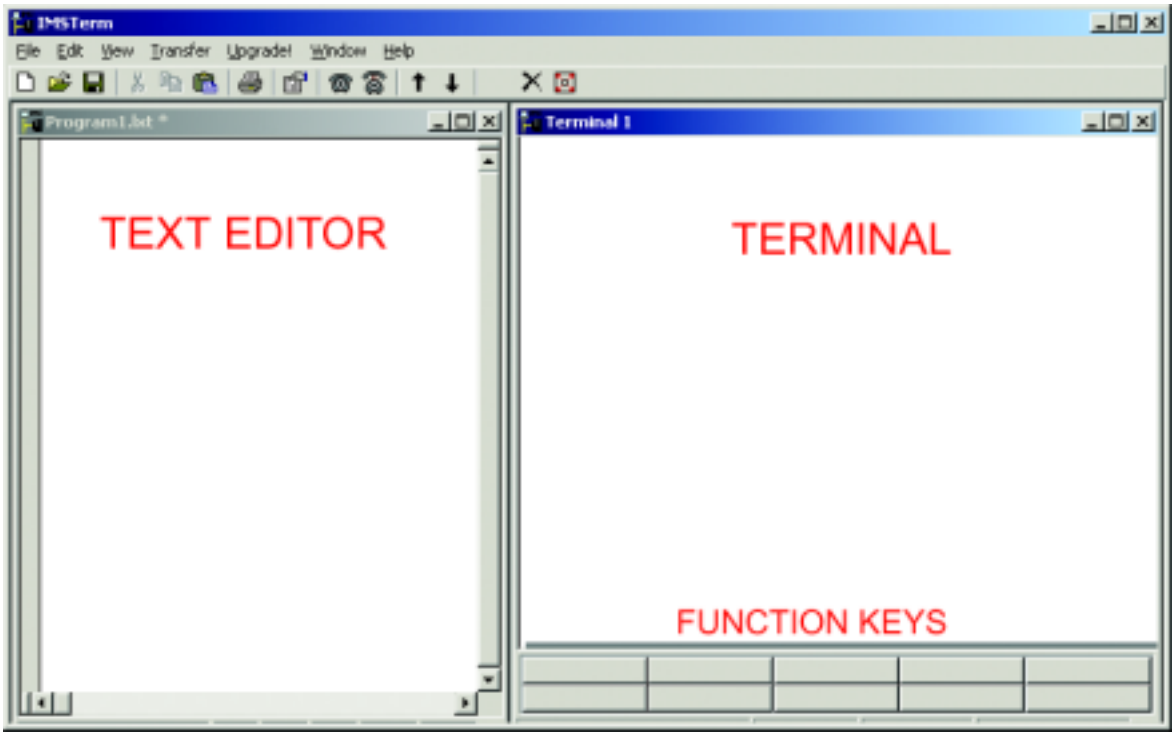



*Figure 18: IMS Terminal Window*

1) To open the IMS Terminal select Start > Programs > IMS Terminal > IMS Terminal.
2) Click the File Menu Item “Edit>Preferences”.
3) Click the “Comm Settings” tab.
4) Select the Communications Port that you will be using with your MDrive Motion Control.
5) The BAUD rate is already set to the MDrive Motion Control default. Do not change this setting until you have established communications with the MDrive Motion Control.
6) The “Window Size” settings are strictly optional. You may set these to whatever size is comfortable to you.
7) Click “OK”. The settings will be automatically saved upon a normal shutdown.
8) Apply power to the MDrive Motion Control. A sign-on message should appear in the terminal window.

If you can see this sign-on message then you are up and running! If the sign-on banner does not appear, try using a software reset: hold down the “Ctrl” key and press “C” (^C). If the sign-on banner still does not appear then there may be a problem with either the hardware or software configuration of the MDrive Motion Control or Host PC.

## Using the IMS Terminal Software

The IMS Terminal software is an easy to setup and use interface for MDrive Motion Control programming. It is also required to upgrade the firmware in the MDrive Motion Control.

### Configuring Communications Settings

The communications settings are configured by means of the “Preferences Dialog”. This dialog is accessed through the “Edit > Preferences” menu item or by clicking the “Preferences” icon on the toolbar. The preferences dialog gives the user the ability to set the format for text size, font and color, as well as general communications settings. It is set by default to the optimum communications settings for the MDrive Motion Control. If you change the BAUD rate setting for the MDrive Motion Control, power will have to be cycled for the change to take effect. Ensure that the IMS Terminal preferences are adjusted for the new BAUD settings.

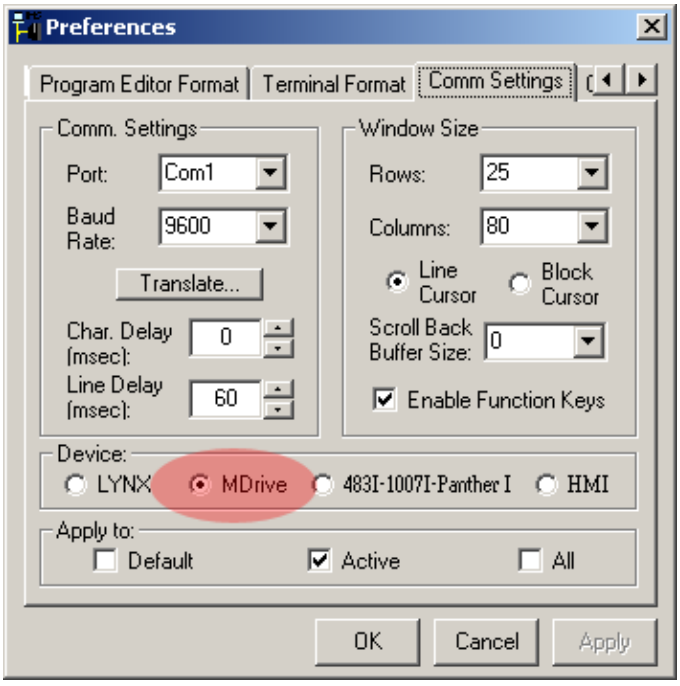



*Figure 19: IMS Terminal Preferences*

### Downloading a Program to the MDrive Motion Control

There are two ways to download programs to the MDrive Motion Control:

1] Directly from the text editor window of the IMS Terminal.
2] From a text file located on a hard drive or removeable disk.

To download a program from the text editor window click the menu item “Transfer > Download”. The download dialog will open. Select the “Source Type > Edit Window” option, click download. The program will transfer to the MDrive Motion Control.

Programs can be downloaded to the MDrive Motion Control from a text file by selecting “Source Type > File” on the dialog and typing in a drive location:\file name in the “File Name” box on the dialog, or browsing to the file location.

### Uploading a Program From the MDrive Motion Control

Programs may also be uploaded from the MDrive Motion Control in two ways:

1] Directly to the text editor window of the IMS Terminal.
2] To a text file located on a hard drive or removable disk.

To upload a program to the text editor window click the menu item “Transfer > Upload”. The upload dialog will open. Select the “Destination Type > Edit Window” option, click “Upload”. The program will transfer from the MDrive Motion Control.

Programs may be uploaded from the MDrive Motion Control to a text file by selecting “Destination Type > File” on the dialog and typing in a drive location:\file name in the “File Name” box on the dialog.

### *Setting the Programmable Function Keys*

The IMS Terminal features the capability of programming up to 10 function keys, a feature typically found in more advanced terminal programs. These can be set to provide quick access to commonly used MDrive Immediate mode commands, execute programs, or even hold entire MDrive programs as there is no character limit for each function.

A fly-out dialog can be brought up by clicking the arrow on the right of the function key "Contents" field. This enables the programmer to embed common ASCII control codes in the function key text string.

To access the function key setup dialog, right-click the function key area on the terminal window.

To setup the function keys:

1] Enter a caption in the "Caption" text field, this will be displayed on the function button.

2] Enter the text string consisting of MDrive Motion Control commands and ASCII control codes. Remember to terminate each command with a line feed (^M) and and appropriate pause time (typically 50 msec, ^p).

3] Click "Done" to set the function.

## Upgrading the MDrive Motion Control Firmware

1] Connect power to the MDrive Motion Control.

2] Open the IMS Terminal Software.

3] Select the Terminal screen.

4] Click the "Upgrade" menu item on the Menu bar.

5] Enter 2956102 in the Type Number field.

6] Click Next, follow the instructions.

7] Cycle power on the MDrive Motion Control.

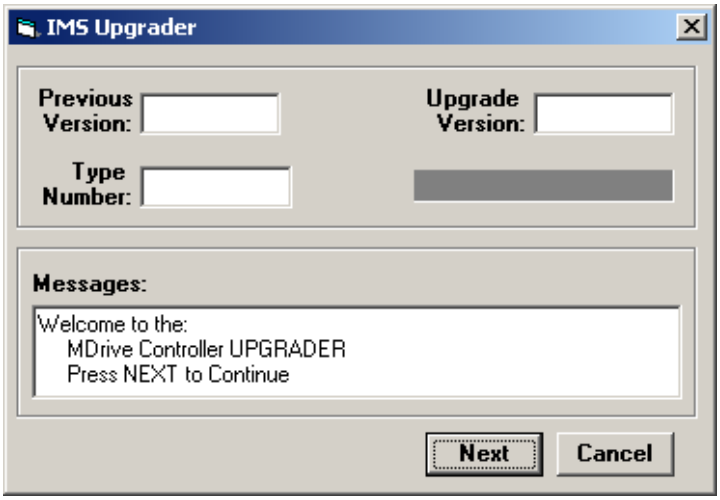



*Figure 20: IMS Terminal Upgrader Window*

# MDrive Motion Control Programming

The MDrive programming language consists of simple 1-2 character mnemonics.

## Operational Modes

There are two operational modes for the MDrive. Immediate and Program:

1] Immediate: Commands are issued and executed directly to the MDrive Motion Control by user entry into the terminal window.

2] Program: Commands and processes are run from within an MDrive program. This mode is also used for program entry.

# Basic Components of MDrive Motion Control Software

## Instructions

An instruction results in an action, there are three types:

### Motion

Motion instructions are those that result in the movement of a motor. The syntax of these commands are as such: first type the command followed by a space, and then the velocity or position data. For example, *MA 2000* will move the motor to position 2000.

### I/O

An I/O instruction results in the change of parameters or the state of an Input or Output. The syntax of these commands are as such: first type the command followed by a space, then the I/O #, then an equal sign, then the data. Example: *PR I1* will read the state of input 1, *O2=0* will set output 2 to 0.

### Program

A program instruction allows program manipulation. The syntax of these vary due to the nature of the command. Some examples would be as such: *PG 100*, this command toggles the system into program mode starting at address 100. *BR LP, IO 21=1*, this command will Branch to a program labeled LP if I/O 21 is true.

### System

A system instruction is an instruction that can only be used in immediate mode to perform a system operation such as program execution (EX) or listing the contents of program memory (L). For example: EX 100 will execute a program located at line 100 of program memory space, or EX K1 will execute a program labeled K1.

## Variables

Variables are labeled data that allow the user to define or manipulate data. These can also be used with the built-in math functions to manipulate data. There are two classes of variables: factory defined and user defined. The syntax for each variable may differ. See Section 6 for usage instructions and examples.

### Factory Defined Variables

These variables are predefined at the factory. They cannot be deleted. When an FD (Factory Default) instruction is given, these variables will be reset to their factory default values. There are two types of factory defined variables. They are:

- Read/Writable: These factory defined variables can have their value altered by the user to effect events inside or outside of a program. For example, A (Acceleration Variable) can be used to set the Acceleration, or P (Position Variable) can be used to set a position reference point.
- Read Only: These factory defined variables cannot be manipulated by the user, but contain data that can be viewed or used to effect events inside a program. For example, V (Velocity Variable) registers the current velocity of the motor in steps per second.

### User Defined Variables

The VA instruction allows the user to assign a 32 bit, 2 character name to a user defined variable.

The restrictions for this command are:

1] A variable cannot be named after an MDrive Motion Control Instruction, Variable or Flag.

2] The first character must be alpha, the second character may be alpha-numeric.

3] A variable is limited to two characters.

With these the user can define a variable to store and retreive data and perform math functions. When the FD (Factory Defaults) instruction is given, these variables will be deleted! There are two types of user defined variables:

- Global Variables: Global variables are variables that are defined outside of a program. The benefit to using a global variable is that no user memory is required. For example, the user can define a variable called SP for speed by entering VA SP into the terminal. The user can then set that variable to equal the value of the read only variable V (velocity) by entering SP = V into the terminal.
- Local Variables: This type of user defined variable is defined within a program and can only effect events within that program. It is stored in RAM. Examples of this type of variable will be given later in the section. It is worthy of note that a local variable is not static, but is erased and declared again each time a program is executed.

### Flags

Flags show the status of an event or condition. A flag will only have one of two possible states: either 1 or 0. Unlike variables, there are only factory defined flags

#### Factory Defined Flags

Factory defined flags are predefined at the factory and cannot be deleted. When a FD (Factory Defaults) instruction is given, these flags will be returned to their factory default state. There are two types of factory defined flags:

- Read/Writable: This type of flag is user alterable. They are typically used to set a condition or mode of operation for the MDrive Motion Control. For example: EE = 1 would enable encoder operation, or EE = 0 would disable the encoder functions.
- Read Only: Read Only flags cannot be modified by the user. They only give an indication of an event or condition. Typically this type of flag would be used in a program in conjunction with the BR (Branch Instruction) to generate an if/then event based upon a condition. For Example: the following line of code in a program BR SP, MV = 0 would cause a program to branch to a subroutine named “SP” when the MV, the read only moving flag, is false.

### Keywords

Keywords are used in conjunction with the PR and IP instructions to indicate or control variables and flags. For instance, PR UV would print the state of all the user-defined variables to the screen. IP would restore all the factory variables from the EEPROM.

## Most Commonly Used Variables and Commands

### Variables

#### P

P indicates the position in either steps or encoder counts depending upon the enable/disable state of encoder functions.

- P takes its reading from C1 (Counter 1) when encoder functions are disabled. The reading is taken from C2 (Counter 2) when encoder functions are enabled
- *To read the position, type* PR P *or* PR C1/C2 *then hit enter*
- *To zero the position, type* P=0 *then hit enter*

#### VI

Initial velocity in steps per second.

- *To read the initial velocity, type* PR VI *then hit enter*
- *To write to the Initial velocity, type* VI=500 *then hit enter*

#### VM

Maximum or final velocity in steps per second.

- *To read the final velocity, key-in* PR VM *then hit enter*
- *To write to the final velocity, key-in* VM=5000 *then hit enter*

#### A

Acceleration in steps per second$^2$.

- *To read the acceleration, key-in* PR A *then hit enter*
- *To write to the acceleration, key-in* A=7500 *then hit enter*

#### D

Deceleration in steps per second$^2$.

- *To read the deceleration, key-in* PR D *then hit enter*
- *To write to the deceleration, key-in* D=A *then hit enter*

## Math Functions

Another powerful feature of the MDrive Motion Control is its ability to perform common math functions and to use these to manipulate data.

Addition ..... K2†=P+R2
Subtraction ..... K3†=R1-P
Multiplication ..... A=A*2
Division ..... A=A/2
†User-defined variable used as an example.

## Motion Commands

*MA*

Move to an absolute position relative to a defined zero position.

For example, type the following commands followed by hitting enter:

```
P=0
MA 20000
H
PR P
```

The terminal screen will read 20000

```
MA 3000
H
PR P
```

The screen will echo back 3000.

*MR*

Move number of steps indicated relative to current position.

For example, type the following commands followed by hitting enter:

```
P=0
MR 20000
H
PR P
```

The terminal screen will read 20000

```
MR 3000
H
PR P
```

Notice the position echoed is 23000 and not 3000.

*SL*

Move at a constant velocity.

```
SLEW 200000
```

The motor will move at a constant velocity 200000 steps per second.

*H*

An H (hold) should typically follow any MA or MR commands in a program so that program execution is suspended until motion is complete.

(Note: There are circumstances where you may not want to hold up program execution.)

Below is a usage example.

```
PG 100       'enter program mode at address 100
LB M1        'label program M1
MR 20000     'set motion mode to relative, move relative 20000 steps
H            'hold until motion completes
-20000       'move relative -20000 steps
H            'hold until motion completes
E            'end program
PG           'exit program mode
```

### I/O Commands

*S<1-4>*

This command configures the Type and Active state of I/O points 1-4.

Using the PR command to read IO parameters

*Read IO1 Setup* – "PR S1"

*Read IO2 Setup* – "PR S2"

Setting the I/O parameters

*Set IO 3 parameters* – "S3=0,1" Sets IO3 as a General Purpose Input, Active High

For example: To set IO4 as a Jog+ Input/Active Low

S4 =7,0

*I<1-4>*

Used to read the state of an individual input.

*PR I1 will read the state of input 1 and display it to the terminal window.*

*BR K5, I2=0 will branch to the program address labled K5 when Input 2 is LOW*

*IN*

Used to read the decimal equivalent of the 4 bit binary number represented by all 4 inputs collectively. Note the Input 4 is the Most Significant Bit.

*PR IN will print the decimal value of the inputs.*

*O<1-4>*

Used to set the state of an output.

*O2=1 will set Output 2 TRUE*

*OT*

Used to set the 4 bit binary equivalent of the decimal number represented by all 4 outputs collectively. Note the Output 4 is the Most Significant Bit.

*OT=13 will set the outputs to 1101*

## System Instructions

The following System Instructions will be used frequently.

*CP*

The CP Instruction is used to clear Program memory space.

*FD*

The FD Instruction is used to return the MDrive Motion Control to its factory default state.

## Program Instructions

*PG*

This instruction toggles the MDrive Motion Control into or out of program mode.

| | |
|---|---|
| Switch to program mode at address 200 | PG 200 |
| | xxxxx |
| Program starting at address 200 | xxxxx |
| | xxxxx |
| Switch out of program mode | PG |

*LB*

The MDrive Motion Control also offers the user the convenience of naming programs, subroutines and processes to ease in branching from one part of a program to another, or calling a subroutine.

These labels, once set will act as pointers to locations in program memory space.

The LB, or Label Instruction allows the user to assign a 2 character name to a program or branch process within a program or subroutine.

The restrictions for this command are:

1] A label cannot be named after a MDrive Motion Control Instruction, Variable or Flag.

2] The first character must be alpha, the second character may be alpha-numeric.

3] A label is limited to to characters.

4] A program labeled SU will run on power-up

**Please Note: Any program labeled "SU" will execute on power-up.**

| | |
|---|---|
| Switch to program mode at address 200 | PG 200 |
| Label command will name the program | LB K1 |
| | xxxxx |
| Program named by LB command | xxxxx |
| | xxxxx |
| Switch out of program mode | PG |

*BR*

Used to branch conditionally or unconditionally to a routine.

| | |
|---|---|
| Switch to program mode at address 200 | PG 200 |
| Label command will name the program | LB K1 |
| | xxxxx |
| Program named by LB command | xxxxx |
| | xxxxx |
| Unconditional branch to Program1 | BR K1 |
| Switch out of program mode | PG |

*E*

Designates the end of a program.

| | |
|---|---|
| Switches to program mode at address 200 | PG 200 |
| Label command will name the program | LB K1 |
| | xxxxx |
| Program named by LB command | xxxxx |
| | xxxxx |
| Unconditional branch to K1 | BR K1 |
| Designates the end of the program | E |
| Switches out of program mode | P |

*H*

Delays program execution in milliseconds.

| | |
|---|---|
| Switches to program mode at address 200 | PG 200 |
| Label command will name the program | LB K1 |
| | xxxxx |
| Program named by LB command | xxxxx |
| | xxxxx |
| Delay 2 seconds between re-execution of program | H 2000 |
| Unconditional branch to K1 | BR K1 |
| Designates the end of the program | E |
| Switches out of program mode | P |

*PRINT*

Outputs specified text and parameter values to a terminal or terminal software on a Host PC.

| | |
|---|---|
| Switches to program mode at address 200 | PG 200 |
| Label command will name the program | LB K1 |
| | xxxxx |
| Program named by LB command | xxxxx |
| | xxxxx |
| Prints text in quotes and then POS | PR “Position = ” P |
| Delay 2 seconds between re-execution of program | H 2000 |
| Unconditional branch to K1 | BR K1 |
| Designates the end of the program | E |
| Switches out of program mode | PG |

*VAR*

Command used to define a variable with 8 alphanumeric characters.

| | |
|---|---|
| Switches to program mode at address 200 | PGM 200 |
| Define a variable named CT for Count | VAR CT |
| Label command will name the program | LBL K1 |
| | xxxxx |
| Program named by LB command | xxxxx |
| | xxxxx |
| Prints text in quotes and then POS | PRINT “Position = ” P |
| Delay 2 seconds between re-execution of program | H 2000 |
| Unconditional branch to K1 BR K1 | |
| Designates the end of the program | E |
| Switches out of program mode | PGM |

# SECTION 5

## *MDrive Motion Control Command Set Summary*

### Setup Instructions, Variables and Flags

| Mnemonic | Function | Unit | Range | Syntax Example |
|---|---|---|---|---|
| BD | Communications BAUD Rate | BAUD | 48, 96, 19, 38, 11 | BD=<baud> |
| DE | Enable/Disable Drive | - | 1/0 | DE=<1/0> |
| DN | Device Name | Character | a-z, A-Z, 0-9 | DN=<char> |
| EM | Echo Mode 0 (def)=Full Duplex, 1=Half Duplex | Mode | 0/1 | EM=<mode> |
| IP | Intial Parameters from EEPROM | - | - | IP |
| PY | Enable/Disable Party Mode | Mode | 1/0 | PY=<mode> |
| UG | Upgrade Firmware | Code | 2956102 | IMS Term. Upgrader |

### Miscellaneous Instructions, Variables and Flags

| Mnemonic | Function | Unit | Range | Syntax Example |
|---|---|---|---|---|
| AL | All Parameters, Used with PR (Print) | - | - | PR AL |
| BY | BSY Flag 1=Prog. Running | - | 0/1 | PR BY |
| PR | Print Selected Data and/or Text | - | - | PR <data/text string> |
| R1 | User Register 1 | Number | Signed 32 bit | R1=<number> |
| R2 | User Register 2 | Number | Signed 32 bit | R2=<number> |
| R3 | User Register 3 | Number | Signed 32 bit | R3=<number> |
| R4 | User Register 4 | Number | Signed 32 bit | R4=<number> |
| VR | Firmware Version | Number | - | PR VR |
| UV | Read User Variables | - | = | PR UV |

### Motion Instructions, Variables and Flags

| Mnemonic | Function | Unit | Range | Syntax Example |
|---|---|---|---|---|
| (-) | Do Previously Set Mode to/at This Value | per mode | | -<number> |
| A | Set Accerleration | Steps/Sec$^2$ | 1000000000 | A=<accel> |
| D | Set Deceleration | Steps/Sec$^2$ | 1000000000 | D=<decel> |
| HC | Set Hold Current | % (Percent) | 0 to 100 | HC=<percent> |
| HT | Set Hold Current Delay Time | milliseconds | 0-65000 | HT=<msec> |
| MA | Set Mode and Move to Abs. Position | ±Position | Signed 32 bit | MA <±pos> |
| MD | Motion Mode Setting | - | - | - |
| MR | Set Mode and Move to Relative Position | ±Distance | Signed 32 bit | MR <±dist> |
| MS | Set Microstep Resolution | Microsteps/step | MSEL Table | MS=<param> |
| MT | Motor Settling Delay Time | milliseconds | 0-65000 | MT=<msec> |
| MV | Moving Flag | - | - | PR MV |
| RC | Set Run Current | % (Percent) | 1 to 100 | RC=<percent> |
| SL | Set Mode and Slew Axis | Steps/sec | ±5000000 | SL=<velocity> |
| V | Read Current Velocity | Steps/sec | ±5000000 | PR V |
| VI | Set Initial Velocity | Steps/sec | 1-5000000 | VI=<velocity> |
| VM | Set Maximum Velocity | Steps/sec | 1-5000000 | VM=<velocity> |

## I/O Instructions, Variables and Flags

| Mnemonic | Function | Unit | Range | Syntax Example |
|---|---|---|---|---|
| I1 | Read Input 1 | - | 0/1 | PR I1, BR I1,<cond> |
| I2 | Read Input 2 | - | 0/1 | PR I2, BR I2,<cond> |
| I3 | Read Input 3 | - | 0/1 | PR I3, BR I3,<cond> |
| I4 | Read Input 4 | - | 0/1 | PR I4, BR I4,<cond> |
| I5 | Read Input 5 (Analog) | - | 0-1024 | PR I5, BR I5,<cond> |
| I6 | Read Encoder Index Mark Low true | | | |
| IN | Read Inputs 1-4 as One Value | data | 0-15 | PR IN |
| O1 | Set Output 1 to Logic State | - | 0/1 | O1=<1/0> |
| O2 | Set Output 2 to Logic State | - | 0/1 | O2=<1/0> |
| O3 | Set Output 3 to Logic State | - | 0/1 | O3=<1/0> |
| O4 | Set Output 4 to Logic State | - | 0/1 | O4=<1/0> |
| OT | Write Data to Outputs 1-4 as One Value | data | 0-15 | OT=<data> |
| S1 | Setup IO Point 1 | Type, Active | Type Table, 0/1 | S1=<type>,<active> |
| S2 | Setup IO Point 2 | Type, Active | Type Table, 0/1 | S2=<type>,<active> |
| S3 | Setup IO Point 3 | Type, Active | Type Table, 0/1 | S3=<type>,<active> |
| S4 | Setup IO Point 4 | Type, Active | Type Table, 0/1 | S4=<type>,<active> |
| TI | Trip on Input | - | - | TI <input>,<addr> |
| TE | Trip Enable | See Table | <1-4> | TE=<num> |

## Program Instructions, Variables and Flags

| Mnemonic | Function | Unit | Range | Syntax Example |
|---|---|---|---|---|
| BR | Branch (Conditional/Unconditional) | - | - | BR <addr>, <cond> |
| CL | Call Subroutine (Conditional/Unconditional) | - | - | CL <addr>, <cond> |
| CP | Clear Program | Address | 1-767 | CP <addr> |
| DC | Decrement Variable | - | - | DC <var/ureg> |
| E | End Program Execution | - | - | E |
| EX | Execute Program at Address Using Selected Trace Mode | | 1-767 | EX <addr>, <mode> |
| H | Hold Prog. Execution Blank/0=Motion stops | milliseconds | Blank(0)/1-65000 | H=<msec> |
| IC | Increment Variable | - | - | IC <var> |
| L | List Program | Address | 1-767 | L <addr> |
| LB | Create a Program Address Label Name | | | |
| OE | On Error Handler 0=Disabled | Address | 0/1-767 | OE <addr> |
| PG | Start Program Entry at Specified Address | - | Blank/1-767 | PG <addr> |
| RT | Return from Subroutine | - | - | RT |
| S | Save to EEPROM | - | - | S |
| VA | Create A User Variable Name | | | |
| UV | Read User Variables | - | - | PR UV |

## Position Related Instructions, Variables and Flags

| Mnemonic | Function | Unit | Range | Syntax Example |
|---|---|---|---|---|
| C1 | Set Counter 1 | Motor Counts | Signed 32 bit | C1=<counts> |
| HM | Home to Home Switch | Type | 1-4 | HM <type> |
| P | Set/Read Position | Motor/Encoder Counts | Signed 32 bit | P=<counts> |
| PC | Read Captured Position at Trip | | | |
| TP | Trip on Position | Position | - | TP <pos>, <addr> |
| TE | Trip Enable | See Table | <1-4> | TE=<num> |

## Encoder Related Instructions, Variables and Flags

| Mnemonic | Function | Unit | Range | Syntax Example |
|---|---|---|---|---|
| C2 | Set Counter 2 | Encoder Counts | Signed 32 bit | C2=<counts> |
| DB | Set Encoder Deadband | Encoder Counts | 0-65000 | DB=<counts> |
| EE | Enable/Disable Encoder Functions | - | 1/0 | EE=<1/0> |
| HI | Home to Encoder Index | Type | 1-4 | HI=<type> |
| I6 | Read Encoder Index Mark | - | - | I6 |
| SF | Set Stall Factor | Encoder Counts | 0-65000 | SF=<counts> |
| SM | Set Stall Mode | 0=Stop Motor/1=Don't Stop | 1/0 | SM=<mode> |
| ST | Stall Flag | - | 0/1 | PR ST |

## Mathematical Functions

| Symbol | Function |
|---|---|
| + | Add Two Variables and/or Flags |
| - | Subtract Two Variables and/or Flags |
| * | Multiply Two Variables and/or Flags |
| / | Divide Two Variables and/or Flags |
| <> | Not Equal |
| = | Equal |
| < | Less Than |
| <= | Less Than and/or Equal |
| > | Greater Than |
| >= | Greater Than and/or Equal |
| & | AND (Bitwise) |
| \| | OR (Bitwise) |
| ^ | XOR (Bitwise) |
| ! | NOT (Bitwise) |

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **A** | **Acceleration** | **Motion Variable** |

DESCRIPTION

The A Variable sets the peak acceleration that will be reached by the MDrive in steps per second$^2$.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| A=<accl> | Steps/sec$^2$ | 0 to 1525878997 | 1000000 |

EXAMPLE:

| | |
|---|---|
| A=20000 | ‘set acceleration to 20000 steps/sec$^2$ |
| A=D | ‘set acceleration equal to deceleration |

RELATED COMMANDS: D

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **AL** | **Retrieve All Parameters** | **Keyword** |

DESCRIPTION

The AL parameter is used with the PR (PRINT) instruction to print the value/state of all variables and flags to the terminal program.

USAGE

PR AL

RELATED COMMANDS: PR

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **BD** | **BAUD Rate** | **Setup Variable** |

DESCRIPTION

This variable sets the baud rate for serial communications with the MDrive. It sets the rate for the RS-485 interface. The baud rate is set by indicating the first two digits of the desired rate as shown in the range section below.

In order for the new BAUD rate to take effect, the user must issue the S (SAVE) instruction and then reset the MDrive. When the MDrive is reset, it will communicate at the new BAUD rate.

48 = 4800 bps, 96 = 9600 bps, 19 = 19200 bps, 38 = 38000 bps, 11 = 115200 bps

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| BD=<baud> | bits per second | 48, 96, 19, 38, 11 | 9600 bps |

EXAMPLE:

| | |
|---|---|
| BD=96 | ‘set communications BAUD rate to 9600 bps |

RELATED COMMANDS: —

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **BR** | **Branch** | **Program Instruction** |

DESCRIPTION

The branch instruction can be used to perform a conditional or unconditional branch to a routine in an MDrive program. It can also be used to perform loops and IF THEN logic within a program.

There are two parameters to a branch instruction. These are used to perform two types of branches:

**Conditional Branch**

This type of branch first specifies an address or process label where program execution should continue if the second parameter, the condition, is true. The condition parameter may include flags as well as logical functions that are to be evaluated.

**Unconditional Branch**

In this type of branch the second parameter is not specified, then the execution will continue at the address specified by the first parameter.

USAGE

BR <addr/label, cond>

EXAMPLE:

```
BR 256, I2      'Branch to program line 256 if  Input 2 is TRUE
BR 120          'Unconditional Branch to program line 120

BR JC, I1=1     'Branch to process labeled JC if input 1 is True
```

RELATED COMMANDS: —

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **BY** | **Busy Flag (Read Only)** | **Motion Flag** |

DESCRIPTION

This read only status flag will indicate whether or not the axis is moving.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| PR BY | — | 0/1 | 0 |

EXAMPLE:

```
PR BY           'read the state of the busy flag
```

RELATED COMMANDS: PR

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **C1** | **Set Counter 1 (Motor Counts)** | **Motion Variable** |

DESCRIPTION

This variable contains the raw count representation of the clock pulses sent to the motor drive.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| C1=<counts> | Motor Counts | -2147483648 to 2147483647 | 0 |

EXAMPLE:

```
C1=20000        'Set Counter 1 to 20000 motor counts
PR C1           'Print the value of C1 to the terminal screen
```

RELATED COMMANDS: C2, P

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **C2** | **Set Counter 2 (Encoder Counts)** | **Motion Variable** |

DESCRIPTION

This variable contains the raw count representation of the integral 512 line encoder.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| C2=<counts> | Encoder Counts | -2147483648 to 2147483647 | 0 |

EXAMPLE:

```
C2=512          'Set Counter 2 to 512 encoder counts
PR C2           'Print the value of C2 to the terminal screen
```

RELATED COMMANDS: C1, EE, P

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **CL** | **Call Subroutine** | **Program Instruction** |

DESCRIPTION

This function can be used to invoke a subroutine within a program. This allows the user to segment code and call a subroutine from a number of places rather than repeating code within a program.

There are two parameters to the CL instruction. The first specifies the program address or label of the subroutine to be invoked if the second parameter, the condition, is true. If the second parameter is not specified, the subroutine specified by the first parameter is always invoked. The condition parameter can include flags as well as logical functions that are to be evaluated.

The subroutine should end with a RT (RET) instruction. The RT instruction will cause program execution to return to the line following the CL instruction.

USAGE

CL <addr/label, cond>

EXAMPLE:

```
CL 256, I1=1    'Call subroutine at program line 256 if Input 1 is TRUE
CL JK           'Call subroutine labeled JK
```

RELATED COMMANDS: RT

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **CP** | **Clear Program** | **Program Instruction** |

DESCRIPTION

This instruction will clear the program space in the EEPROM as specified by the instruction parameter. Programs are stored directly to the EEPROM and executed from there.

USAGE

CP <addr/label>

EXAMPLE:

```
CP 256    'Clear program space beginning at line 256 to the end of program space
CP        'Clear all of program space
```

RELATED COMMANDS:

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **D** | **Deceleration** | **Motion Variable** |

DESCRIPTION

The D variable sets the peak deceleration of the MDrive in steps per second$^2$.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| D=<decl> | Steps/sec$^2$ | 0 to 1525878997 | 1000000 |

EXAMPLE:

| | |
|---|---|
| D=20000 | ‘set acceleration to 20000 step/sec$^2$ |
| D=A | ‘set deceleration equal to acceleration |

RELATED COMMANDS: A,

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **DB** | **Set Encoder Deadband** | **Setup Variable** |

DESCRIPTION

This variable defines the + and - length of the encoder deadband in encoder counts.

When the encoder is enabled, a move is not completed until motion stops within DB.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| DB=<counts> | Encoder Counts | 0 to 65000 | 1 |

EXAMPLE:

| | |
|---|---|
| DB=5 | ‘Set Encoder Deadband to ± 5 encoder counts |

RELATED COMMANDS: EE

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **DC** | **Decrement Variable** | **Program Instruction** |

DESCRIPTION

The DC instruction will decrement the specified variable by one.

USAGE

DC <var>

EXAMPLE:

| | |
|---|---|
| DC R1 | ‘Decrement User Register 1 |

RELATED COMMANDS: IC

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **DE** | **Drive Enable Flag** | **Setup Flag** |

DESCRIPTION

The DE flag enables or disables the drive portion of the MDrive Motion Control.

| USAGE | DEFAULT |
|---|---|
| DE= <0/1> | 1 (Enabled) |

EXAMPLE:

```
DE=0        'Disable drive
DE=1        'Enable drive
```

RELATED COMMANDS: —

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **DN** | **Device Name** | **Setup Variable** |

DESCRIPTION

The DN Variable stores the device name to be used when the MDrive is to be addressed in party mode operation. The name is only used when party mode communications is being used (PY = 1).

All MDrive system nodes will respond if the name in a command is given as "*".

When the name is changed it must be saved into the nonvolatile memory if it is to be used in later sessions without being changed again.

See Appendix A: ASCII table for decimal codes.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| DN=<char> | ASCII Characters | a-z, A-Z, 0-9 | ! |

EXAMPLE:

```
DN=A        'Set the device name to the character  A
```

RELATED COMMANDS: PY

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **E** | **End Program Execution** | **Program Instruction** |

DESCRIPTION

Stops the execution of  a program.

USAGE

E

EXAMPLE:

```
PG 100          'Start program at line 100
LB J2           'Label Program J2
MR  20000       'move relative 20000 motor counts
H               'hold until motion stops
MR  -20000      'move relative -20000 motor counts
H               'hold until motion stops
E               'End program execution
PG              'exit program mode
```

RELATED COMMANDS: PG, EX

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **EE** | **Encoder Enable Flag** | **Setup Flag** |

DESCRIPTION

The EE flag enables or disables the optional encoder mode of the MDrive Motion Control.

| USAGE | DEFAULT |
|---|---|
| EE= <0/1> | 0 (Disabled) |

EXAMPLE:

```
EE=0        'Disable encoder mode
EE=1        'Enable encoder mode
```

RELATED COMMANDS: DB, C2, SF, SM, ST

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **EM** | **Echo Mode Flag** | **Setup Flag** |

DESCRIPTION

The Echo Mode Flag will set the full/half duplex configuration of the RS-485 channel. 0=Full Duplex (default), 1=Half Duplex.

| USAGE | DEFAULT |
|---|---|
| EM= <0/1> | 0 (Full Duplex) |

EXAMPLE:

```
EM=0        'full duplex mode
EM=1        'half duplex mode
```

RELATED COMMANDS: BD

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **EF** | **Read-Only Error Flag** | **Status Flag** |

DESCRIPTION

The Error flag will indicate whether or not an error condition exists. It is automatically cleared when a new program is executed. The only way to manually clear the EF flag is to read the value of the ER variable or set ER=0

There is an instruction, OE, which allows the user to specify the execution of a subroutine in the program memory when an error occurs. The subroutine might contain instructions to read the ER variable which would clear the EF flag.

| USAGE | RESPONSE |
|---|---|
| PR EF | 0 = No Error Exists<br>1 = Error Condition Exists |

EXAMPLE:

```
PR EF       'read the state of the error flag
```

RELATED COMMANDS: ER, OE

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **ER** | **Error Number Variable** | **Status Variable** |

DESCRIPTION

The ER variable indicates the program error code for the most recent error that has occurred in the MDrive Motion Control. The ER variable must be read in order to clear the EF flag.

See Appendix A of this document for a complete listing of MDrive Motion Control Error Codes.

| USAGE | RESPONSE |
|---|---|
| PR ER | <numerical error code> |

EXAMPLE:

```
PR ER          'read the error number
```

RELATED COMMANDS: EF, OE

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **EX** | **Execute Program** | **Program Instruction** |

DESCRIPTION

Execute program at a specified address or label using a selected trace mode. Used in immediate mode.

There are three modes of program execution.

**Mode 0** Normal execution, is specified by a mode of 0 (or simply leaving the mode blank).

**Mode 1** Trace mode is specified by a mode of 1. This means that the program executes continuously until the program END is encountered, but the instructions are "traced" to the communications port so the user can see what instructions have been executed.

**Mode 2** Single step mode is specified by a mode of 2. In this mode, the user can step through the program using the space bar to execute the next line of the program. The program can be resumed at normal speed in this mode by pressing the enter key.

| USAGE | MODES |
|---|---|
| EX <addr/label>,<mode> | <mode> = 0: run program normally |
| | <mode> = 1: run program in trace mode |
| | <mode> = 2: run program in single-step mode |

EXAMPLE:

```
EX 127         'execute program at line 127 normally
EX 127,1       'execute program at line 127 in trace mode
```

RELATED COMMANDS: PG, E

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **H** | **Hold Program Execution** | **Program Instruction** |

DESCRIPTION

The hold instruction is used in a program to suspend program execution. If no parameter is specified the execution of the program will be suspended while motion is in progress. This will typically be used following a MA or MR instruction.

A time in milliseconds may be placed as a parameter to the hold instruction, This will suspend program execution for the specified number of milliseconds

USAGE

H <time> ‘Blank or 0 - hold while moving, 1 - 65000 usec.

EXAMPLES:

```
‘example 1
MA 20000        ‘move absolute 20000 motor units
H               ‘hold program execution until motion completes
MA -20000       ‘move absolute -20000 motor units
H               ‘hold program execution until motion completes

‘example 2
O2=1            ‘set output 2 HIGH
H 1000          ‘hold 1 second
O2=0            ‘set output 2 LOW
```

RELATED COMMANDS: PG, E

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **HI** | **Home to Index Mark Variable** | **Setup Variable** |

DESCRIPTION

This instruction will find the the encoder index mark. There are four types for this command:

1) Speed (S): Specifies the direction and speed that the axis will move until the index mark is found (VM).

2) Creep (C): Specifies the direction and speed that the axis will move off the index mark until it becomes inactive again (VI).

When HI is executed, the axis moves in the direction specified by the sign of speed at VM. It then creeps off of the switch in the direction specified by the sign of creep at VI. Motion is stopped as soon as the switch becomes deactivated.

| USAGE | TYPES |
|---|---|
| HI=<type> | 1: S- C+, 2: S- C-, 3: S+ C-, 4: S+ C+ |

EXAMPLE:

```
HM=2            ‘Find index mark at VM in the minus direction, Creep off at VI in the minus direction
```

RELATED COMMANDS: VM, VI, EE, I6

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **HC** | **Hold Current** | **Setup Variable** |

DESCRIPTION

This variable defines the motor holding current in percent.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| HC=<percent> | Percent | 0 to 100 | 5 |

EXAMPLE:

```
HC=5            ‘Set motor holding current to 5%
```

RELATED COMMANDS: HT, RC, HI

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **HM** | **Home to Home Switch Variable** | **Setup Variable** |

DESCRIPTION

This instruction will find the selected I/O switch. There are four types for this command:

1) Speed (S): Specifies the direction and speed that the axis will move until the switch is activated (VM).

2) Creep (C): Specifies the direction and speed that the axis will move off the switch until it becomes inactive again (VI).

When HM is executed, the axis moves in the direction specified by the sign of speed at VM. It then creeps off of the switch in the direction specified by the sign of creep at VI. Motion is stopped as soon as the switch becomes deactivated.

| USAGE | TYPES |
|---|---|
| HM=<type> | 1: S- C+, 2: S- C-, 3: S+ C-, 4: S+ C+ |

EXAMPLE:

```
HM=3        'Find home switch at VM in the plus direction, Creep off at VI in the minus direction
```

RELATED COMMANDS: VM, VI, S1-S4

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **HT** | **Hold Current Delay Time** | **Setup Variable** |

DESCRIPTION

The HT variable sets the delay time in milliseconds between the cessation of motion and when the MDrive Motion Control shifts to the holding current level specified by the HC (Motor Holding Current) variable. The delay time is also effected by the MT (Motor Settling Delay Time) variable in that the total time from motion ceasing to current change is represented by the sum of MT + HT

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| HT=<time> | milliseconds | 0 to 65000 | 500 |

EXAMPLE:

```
HT=1500     'Set hold current delay time to 1.5 seconds
```

RELATED COMMANDS: HC, MT, RC

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **I1 - I4** | **Read Input** | **Keyword** |

DESCRIPTION

This keyword will read the state of the specified input 1 - 4 Can be used with PR (Print), BR (Branch) and Cl (Call Subroutine) instructions. Can also be used with

USAGE

```
PR I<1-4>
BR <addr>, I<1-4>=<1/0>
CL <addr>, I<1-4>=<1/0>
```

EXAMPLES:

```
PR I2       'Print the state of Input 2 to the Terminal Screen
BR 128, I3=1    'Conditional branch to program line 128 if Input 3 = 1
CL 432, I4=0    'Call subroutine at line 432 if Input 4 = 0
```

RELATED COMMANDS: IN, O1-O4, PR, S1-S4

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **I5** | **Read Analog Input** | **Keyword** |

DESCRIPTION

This keyword will read the value of the voltage seen on the Analog Input. Can be used with PR (Print), BR (Branch) and Cl (Call Subroutine) instructions. The value read will between 0 and 1028.

USAGE

PR I5

BR <addr/label>, I5=<0 - 1028>

CL <addr/label>, I5=<0 - 1028>

EXAMPLES:

| | |
|---|---|
| PR I5 | 'Print the value of the Analog Input to the Terminal Screen |
| BR K1, I5=512 | 'Branch to Program labled K1 if Analog Input = 512 |
| CL 432, I5=0 | 'Call subroutine at line 432 if Analog Input = 0 |

RELATED COMMANDS: BR, CL, PR

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **I6** | **Read Encoder Index Mark** | **Keyword** |

DESCRIPTION

This keyword will read the on/off state of the Encoder Index Mark. Can be used with PR (Print), BR (Branch) and Cl (Call Subroutine) instructions. The value read will be 0 (off mark) or 1 (on mark).

USAGE

PR I6

BR <addr/label>, I6=<0/1>

CL <addr/label>, I6=<0/1>

EXAMPLES:

| | |
|---|---|
| PR I6 | 'Print the on/off state of the encoder index mark |
| BR K1, I6 | 'Branch to Program labled K1 if encoder index mark is TRUE |
| CL 432, I6=0 | 'Call subroutine at line 432 if I6=0 |

RELATED COMMANDS: BR, CL, PR

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **IC** | **Increment Variable** | **Program Instruction** |

DESCRIPTION

The IC instruction will increment the specified variable by one.

USAGE

IC <var>

EXAMPLE:

| | |
|---|---|
| IC R4 | 'Increment User Register 4 |

RELATED COMMANDS: IC

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **IN** | **Read Inputs 1-4 As 1 Value** | **Keyword** |

DESCRIPTION

This keyword will read the binary state of inputs 1-4 and print them as a decimal value. When used thus Input 1 is the Least Significant Bit (LSB), Input 4 is the Most Significant Bit (MSB). It may be used in conjunction with the R1-R4 (User Registers), PR (Print), BR (Branch) and Cl (Call Subroutine) instructions.

USAGE

PR IN

BR IN=<0-15>

CL IN=<0-15>

EXAMPLES:

| | |
|---|---|
| PR IN | 'Print the state of Inputs 1-4 to the Terminal Screen |
| BR 128, IN=8 | 'Conditional branch to program line 128 if the binary state of Inputs 1-4 = 8 (1000) |
| CL 432, IN=13 | 'Call subroutine at line 432 if the binary state of Inputs 1-4 = 13 (1101) |

RELATED COMMANDS: I1-5, O1-O5, PR, S1-S4

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **IP** | **Initialize Parameters** | **Instruction** |

DESCRIPTION

The IP instruction will return all of the MDrive Motion Control parameters to their stored values.

USAGE

IP

EXAMPLE:

IP

RELATED COMMANDS: CP, S

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **JE** | **Joystick Enable Flag** | **Setup Flag** |

DESCRIPTION

The will enable joystick mode for the Analog Input. States are 0=Disabled, 1=Enabled.

| USAGE | DEFAULT |
|---|---|
| JE= <0/1> | 0 (Disabled) |

EXAMPLE:

| | |
|---|---|
| JE=0 | 'Disable Joystick |
| JE=1 | 'Ensable Joystick |

RELATED COMMANDS: I5

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **L** | **List Program Space** | **Instruction** |

DESCRIPTION

The L instruction will print the contents of program space beginning at the specified address to the end. If no address is specified it will list beginning at line 1.

USAGE

L

L <addr/label>

EXAMPLE:

| | |
|---|---|
| L 128 | ‘display contents of program space beginning at line 128 |

RELATED COMMANDS: —

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **LB** | **Label Program/Subroutine** | **Instruction** |

DESCRIPTION

The LB, or Label Instruction, allows the user to assign a 2 character name to a program, branch process within a program or subroutine.

The restrictions for this command are:

1] A label cannot be named after a MDrive Motion Control Instruction, Variable or Flag.

2] The first character must be alpha, the second character may be alpha-numeric.

3] A label is limited to two characters.

4] A program labeled SU will run on power-up

USAGE

LB <char><char>

EXAMPLE:

| | |
|---|---|
| PG 100 | ‘start program at adress 100 |
| LB J0 | ‘Label program J0 |

RELATED COMMANDS: BR, CL, EX, TI, TP, L, CP

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **MA** | **Move To Absolute Position** | **Motion Instruction** |

DESCRIPTION

Set mode for absolute move and move to an absolute position. MD (Current Mode) will be set to MA.

| USAGE | UNITS |
|---|---|
| MA <±pos> | motor counts |

EXAMPLE:

| | |
|---|---|
| MA 51200 | ‘move motor to absolute position 51200 in positive direction |
| MA -51200 | ‘move motor to absolute position 51200 in negative direction |

RELATED COMMANDS: MD, MR, MS, P

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **MD** | **Motion Mode** | **Motion Instruction** |

DESCRIPTION

Indicates what the last motion command was, so that when just a number is entered, then it will read MD to define the new motion

USAGE

MD

EXAMPLE:

```
MA 200000       'move absolute 200000 steps, set current mode to MA
-200000         'move absolute -200000 steps

MR 1000000      'move relative 1000000 steps, set current mode to MR
-1000000        'move relative -1000000 steps

SL 20000        'slew 20000 steps/sec. set current mode to SL
-10000          'slew 10000 steps/sec in minus direction

PR MD           return current mode setting
```

RELATED COMMANDS: MD, MR, MS, P, PR, SL

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **MR** | **Move To Relative Position** | **Motion Instruction** |

DESCRIPTION

Set mode for relative move and move a relative distance. MD (Current Mode) will be set to MR.

| USAGE | UNITS |
|---|---|
| MR <±distances> | motor counts |

EXAMPLE:

```
MR 200000       'move motor to 200000 motor counts postive direction
MR -50000       'move motor to 50000 motor counts in a negative direction
```

RELATED COMMANDS: MD, MA, MS, P

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **MS** | **Microstep Resolution** | **Motion Variable** |

DESCRIPTION

The MS variable controls the microstep resolution of the MDrive Motion Control. There are 14 parameters that can be used with this variable, 8 binary and 6 decimal. The table below illustrates the parameter settings and their associated resolutions for the 1.8° stepping motor used with the MDrive Motion Control.

The MS parameters given in the table below are the only valid parameters that will be accepted by the MDrive.

| USAGE | DEFAULT |
|---|---|
| MS=<parameter> | 256 |

EXAMPLE:

MS=4 ‘Set Microstep Resolution to 4 Microsteps/Step (400 Steps/Rev)

MS=50 ‘Set Microstep Resolution to 50 Microsteps/Step (10000 Steps/Rev)

PR MS ‘Print the MS setting to the terminal

| Microstep Resolution Settings (MS) | |
|---|---|
| **MS= (Microsteps/Step)** | **Steps/Rev** |
| **Binary Microstep Resolution Settings** | |
| 2 | 400 |
| 4 | 800 |
| 8 | 1,600 |
| 16 | 3,200 |
| 32 | 6,400 |
| 64 | 12,800 |
| 128 | 25,600 |
| 256 | 51,200 |

| Decimal Microstep Resolution Settings | |
|---|---|
| 5 | 1,000 |
| 10 | 2,000 |
| 25 | 5,000 |
| 50 | 10,000 |
| 125 | 25,000 |
| 250 | 50,000 |

*Table 11: Microstep Resolution Settings*

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **MT** | **Motor Settling Delay Time** | **Motion Variable** |

DESCRIPTION

Specifies the motor settling delay time in milliseconds. MT allows the motor to settle following a move. This is the time between moves if consecutive motions are executed.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| MT=<time> | milliseconds | 0 to 65000 | 0 |

EXAMPLE:

```
MT=50          'Set motor setling delay time to 50 milliseconds
```

RELATED COMMANDS: HC, HT, RC

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **O1 - O4** | **Set/Print Output Logic State** | **I/O Instruction** |

DESCRIPTION

This instruction will set the logic state of the specified output to 1 or 0. When used with the PR (Print) instruction it will print the state of the specified output to the terminal screen.

The value of the bit state will be dependant on the active (low/high) state of the input.

USAGE

O<1-4>=<0/1>

PR O<1-4>

EXAMPLES:

```
O4=1           'Set Output 4 to 1
PR O2          'Print the state of  Output 2 to the Terminal Screen
```

RELATED COMMANDS: OT, I1-I4, PR, S1-S4

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **OE** | **On Error Handler** | **Instruction** |

DESCRIPTION

When an error occurs in a program or due to an immediate command, the specified subroutine is called. If a program was running when the fault occurs, once the error routine completes, program execution continues with the instruction after the one that caused the error. A program need not be running for the subroutine specified by OE to run.

The ON ERROR function is disabled by setting the address parameter to 0 or resetting the MDrive Motion Control.

USAGE

OE <address>

EXAMPLE:

```
'the following subroutine will set an output high upon an error
PG 100         'Start sub at address 100
OE E1          'On Error go to E1
LB E1          'label subroutine E1
O3=1           'Set Output 3 to Logic 1
RT             'Return from subroutine
E              'End program
PG             'Return to immediate mode
```

RELATED COMMANDS: EF, ER

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **OT** | **Set Ouputs 1-4 As 1 Value** | **I/O Instruction** |

DESCRIPTION

The OT instruction allows the user to set Outputs 1-4 as one 4 bit binary value. The value is entered in decimal, with a range of 0-15 and will display in binary where Output 1 will be the LSB and Output 4 will be the MSB.

Example: OT=12

Output 4 = 1

Output 3 = 1

Output 2 = 0

Output 1 = 0

USAGE

OT=<0-15>

PR OT

EXAMPLES:

```
OT=7    'Set outputs 1-4 to O1=1, O2=1, O3=1, O4=0
```

RELATED COMMANDS: I1-I4, S1-S4

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **P** | **Set/Print Position Counter** | **Instruction** |

DESCRIPTION

This instruction is used to set or print the value of the MDrive Motion Control position counter. The position will read in Motor Counts from C1 (Counter 1) by default, if encoder functions are enabled, the position counter will read in Encoder Counts from C2 (Counter 2).

The main difference in the relationship of the two counters is that where C1 is variable, the value of each count in terms of distance moved is based upon the MS, or microstep resolution setting, C2 will always be 2048 counts per motor revolution, regardless of the microstep resolution setting.

Modifying P in essence changes the frame of reference for the axis. P will probably be set once during system set up to reference or "home" the system.

| USAGE | UNITS | RANGE |
|---|---|---|
| P <±position> | Steps | -2147483648 to 2147483647 |
| PR P | | |

EXAMPLES:

```
P=0     'Clear position counter, set to 0
PR P    'Print the state of the position counter
```

RELATED COMMANDS: C1, C2

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **PG** | **Enter/Exit Program Mode** | **Program Instruction** |

DESCRIPTION

When starting program mode, you must specify at what address to enter the program instructions in the program space. Simply type “PG” again when you have finished entering your program commands to go back to immediate mode.

While in program mode, leading tabs, spaces and blank lines are ignored. This allows the user to format a text file for readability, and then download the program to the MDrive by transferring the text file in a program such as LYNXTerminal or Hyperterminal. The example given below could be stored in a text file and downloaded. The lines preceded by an apostrophe (‘) are comments and will be ignored by the MDrive Motion Control.

USAGE

PG <address>

EXAMPLES:

```
PG 100          ‘Enter program mode, start program at address 100
*********PROGRAM*********
E               ‘End prgram
PG              ‘Exit program, return to immediate mode
```

RELATED COMMANDS: E,

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **PR** | **Print Selected Data/Text** | **Instruction** |

DESCRIPTION

This instruction is used to output text and parameter value(s) to the host PC. Text should be enclosed in quotation marks while parameters (variables and flags) should not. Text strings and parameters which are to be output by the same PR instruction should be separated by commas. The information being output is followed by a carriage return and line feed unless a semicolon (;) is included at the end of the PR instruction to indicate that the cursor should remain on the same line.

It is important to note that the receive buffer for the MDrive Motion Control is 64 characters, this includes the PR instruction itself, any spaces, text characters, etc. If the buffer length is exceeded ASCII code “OxFF” will echo to the terminal screen.

USAGE

PR <data/text>

EXAMPLES:

```
PR  “Position =”, P          ‘print axis position, 18 characters used
‘the terminal will display: Position = 1234567
```

RELATED COMMANDS: —

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **PY** | **Party Mode Enable Flag** | **Setup Flag** |

DESCRIPTION

The party flag will be set to 1 if the MDrive Motion Control is being used in a multidrop system.

When party mode is enabled each MDrive in the system must be addressed using the device name, specified by the DN instruction. This name will precede any command given to a specified unit in the sytem. By default the DN assigned at the factory is the exclamation character (!) .

The global name is the asterisk character (*). Commands preceded by this character will be recognized by every MDrive in the system.

| USAGE | DEFAULT |
|---|---|
| PY= <0/1> | 0 (Disabled) |

EXAMPLE:

```
PY=0        'Party Mode Disabled (Default)
PY=1        'Party Mode Enabled
```

RELATED COMMANDS: DN

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **R1 - R4** | **User Registers** | **User Variable** |

DESCRIPTION

The MDrive Motion Control has four, 32 bit user registers to contain numerical data. These registers may contain up to 11 digits including the sign and may be used to store and retrieve data to set variables, perform math functions, store and retrieve moves and set conditions for branches and subroutine calls.

| USAGE | RANGE | DEFAULT |
|---|---|---|
| R<x>=<data> | -2147483647 to 2147483647 | 0 |

EXAMPLE:

```
R1=50000        'Set Register 1 to 50000
'Subroutine using a register value to perform a math function that will display axis position in revolutions rather than motor steps
'****variable setup*****
MS=256          'set resolution to 256 microsteps/step
P=0             'set position counter to 0
R1=51200/1      '51200 steps = 1 rev
*****Program Content*******
MR R1           'move relative 102400 steps
H               'Hold execution until motion stops
CL 348          'call subroutine at address 348
'******Sub at address 348******
R2=P            'set Register 2 equal to the position counter
R3=R2/R1        'set Register 3 equal to R2/R1
PR "Position = ", R3, "Revolutions";
H 60000         'hold for 1 minute
RT              'return to prog
```

RELATED COMMANDS:

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **RC** | **Run Current** | **Setup Variable** |

DESCRIPTION

This variable defines the motor run current in percent.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| RC=<percent> | Percent | 1to 100 | 25 |

EXAMPLE:

```
RC=75          'Set motor run current to 75%
```

RELATED COMMANDS: HC

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **RT** | **Return From Subroutine** | **Instruction** |

DESCRIPTION

This instruction defines the end of a subroutine. This instruction is required and will be the final instruction in the subroutine executed by the CL instruction. When used, it will return to the program address immediately following the CL instruction which executed the subroutine.

USAGE

RT

EXAMPLES:

```
'****Program*****
        PG100       'enter program mode at address 100
100     MR 51200    'move relative 51200
105     H           'suspend prog. execution until motion completes
109     CL 238      'Call subroutine at address 238

238     O1=1        'set output 1 to 1
241     RT          'return from subroutine
```

RELATED COMMANDS: CL

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **S** | **Save to EEProm** | **Instruction** |

DESCRIPTION

Saves all variables and flags currently in working memory (RAM) to nonvolatile memory (NVM). The previous values in NVM are completely overwritten with the new values.

When the user modifies variables and flags, they are changed in working memory (RAM) only. If the SAVE instruction is not executed before power is removed from the control module, all modifications to variables & flags since the last SAVE will be lost.

USAGE

S

RELATED COMMANDS: —

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **S1 - S4** | **Set/Print I/O Point Type/Active State** | **I/O Instruction** |

DESCRIPTION

This instruction is used to setup the I/O type and active states for I/O points 1 - 4. Each of MDrive Motion Control I/O points 1-4 may be programmed as either general purpose inputs and outputs, or to one of nine dedicated input functions or one of two dedicated output functions.

When programmed as inputs, these points will be sinking and may be programmed such that they are active when pulled to ground, or active when left floating. By default each point is configured as a general purpose input, active when LOW.

There are two parameters attached to this instruction: the type, specifies the function of the I/O point. The second parameter sets the active state, which defines the point as LOW or HIGH TRUE.

| I/O FUNCTION | TYPE | ACTIVE STATE | PARAMETER |
|---|---|---|---|
| **INPUTS** | | | |
| General Purpose Input | 0 | LOW = TRUE | 0 |
| Home Input | 1 | HIGH = TRUE | 1 |
| Limit + Input | 2 | | |
| Limit - Input | 3 | | |
| G0 Input | 4 | | |
| Soft Stop Input | 5 | | |
| Pause Input | 6 | | |
| Jog + Input | 7 | | |
| Jog - Input | 8 | | |
| **OUTPUTS** | | | |
| General Purpose Output | 16 | | |
| Moving Output | 17 | | |
| Fault Output | 18 | | |
| Stall | 19 | | |

| USAGE | DEFAULT |
|---|---|
| S<1-4>=<type>,<active> | <type>=0, <active>=0 |

EXAMPLES:

S1=2,0 ‘set i/o point 1 to a limit + function, active when LOW

S4=17,1 ‘set i/o point 4 as moving output, active when HIGH

RELATED COMMANDS: I1-4, IN, O1-4, OT

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **S5** | **Set/Print I/O Point 5** | **I/O Instruction** |

DESCRIPTION

This I/O point differs from I/O points 1-4 in that it is factory configured as a 0 - 5 V Analog Input with 10 bit A/D resolution.

| I/O FUNCTION | TYPE |
|---|---|
| 0-5V Analog Input | 9 |
| 4-20 mA Analog Input | 10 |

RELATED COMMANDS: I5, JE

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **SF** | **Stall Factor Variable** | **Encoder Variable** |

DESCRIPTION

If the encoder is enabled (EE = 1) and the encoder differs from the motor by more than the specified factor, a STALL is indicated. If SM is set to 0, then the motor will be stopped when a STALL is detected.

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| SF=<counts> | Encoder counts | 0 to 65000 | 10 |

EXAMPLE:

```
SF=20     'Set the stall factor to twenty counts. If the motor falls behind by more than 20 encoder counts a stall is detected.
```

RELATED COMMANDS: EE, SM, ST

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **SL** | **Slew Axis Instruction** | **Motion Instruction** |

DESCRIPTION

The SL instruction will slew the axis at the specified velocity in counts per second. The axis will accelerate at the rate specified by the A (Acceleration) variable.

Note that the maximum slew velocity is independant of the maximum velocity specified by the VM variable. If a slew is commanded at a velocity greater than the setting of VM, the axis will accelerate to that velocity regardless of the setting of VM.

| USAGE | UNITS | RANGE |
|---|---|---|
| SL <±velocity> | ± Counts per sec | ±5000000 |

EXAMPLE:

```
SL=20000          'slew the axis at 20000 counts/sec
```

RELATED COMMANDS: A, D, MS, MR

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **SM** | **Stall Detection Mode Variable** | **Encoder Variable** |

DESCRIPTION

The SM variable specifies the action which will be taken by the MDrive Motion Control when a stall is detected. When set to 0 (default) the motion will be stopped upon a stall detection. When SM=1, the motor will continue to move. In either case ST (Stall Flag) will be set.

| USAGE | DEFAULT |
|---|---|
| SM = <0/1> | 0 (Stop Motor) |

EXAMPLE:

```
SM=0              'stop motor when a stall is detected
SM=1              'do not stop motor upon a stall
```

RELATED COMMANDS: EE, SF, ST

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **ST** | **Read Only Stall Flag** | **Encoder Flag** |

DESCRIPTION

The ST flag wil be set to 1 when a stall is detected. It will be cleared upon execution of another motion command.

USAGE

PR ST

BR <addr>, ST=1

CL <addr>, ST=1

EXAMPLE RESPONSE:

| | |
|---|---|
| ST=0 | ‘motor not stalled |
| ST=1 | ‘motor stalled |

RELATED COMMANDS: EE, SF, ST

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **TE** | **Trip Enable Flag** | **Setup Flag** |

DESCRIPTION

This flag will enable or disable specified trip functions.

| | | |
|---|---|---|
| TE=0 | TI Disabled | TP Disabled |
| TE=1 | TI Enabled | TP Disabled |
| TE=2 | TI Disabled | TP Enabled |
| TE=3 | TI Enabled | TP Enabled |

| USAGE | DEFAULT |
|---|---|
| TE= <1-4> | 0 (Trips Disabled) |

EXAMPLE:

TE=1 ‘Enable trip on input functions

RELATED COMMANDS: I1-I4, P, S1-S4, TI, TP

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **TI** | **Trip on Input** | **Variable** |

DESCRIPTION

Sets up an input event (trip) for the specified input. There are two parameters for the TI variable. The first specifies the address of the subroutine that should be executed when the input goes to true. The second specifies which input line to monitor.

USAGE

TI=<input>,<addr/label>

EXAMPLE

TI=2,K1 ‘execute subroutine labeled K1 when input 2 is active.

RELATED COMMANDS: I1-4, S1-4, TP

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **TP** | **Trip on Position** | **Variable** |

DESCRIPTION

Sets up a position event (trip) for the specified position. There are two parameters for the TP variable. The first specifies the address of the subroutine that should be executed when the position is detected The second specifies the position which will cause the event.

USAGE

TP=<position>,<addr/label>

EXAMPLE

TP=200000,300 ‘execute subroutine at address 300 when at postion 200000

RELATED COMMANDS: P, TI, PC

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **UG** | **Upgrade Firmware** | **Instruction** |

DESCRIPTION

Upgrade Firmware Instruction. Upgrade code is 2956102. THis will put the MDrive in Upgrade Mode, once set the firmware MUST be upgraded.

USAGE

UG 2956102

RELATED COMMANDS: —

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **UV** | **Read User Variables** | **Keyword** |

DESCRIPTION

Read User Variables Keyword is used with the PR (Print) Instruction to read the value of all user variables

USAGE

PR UV

RELATED COMMANDS: , PR, VA

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **V** | **Read Only Velocity Variable** | **Motion Variable** |

DESCRIPTION

The velocity variable is used in conjunction with the PR (print) instruction to read the current velocity of the axis in counts per second. This variable can also be used with the BR and CL instructions to set a condition based upon a velocity. This variable can also be used in conjunction with the user registers to compute another velocity.

| USAGE | UNITS |
|---|---|
| PR V | Counts per Second |
| BR <addr>, V=<counts/sec> | |
| CL <addr>, V=<counts/sec> | |

RELATED COMMANDS: VI, VM

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **VA** | **Create User Variable Name** | **Instruction** |

DESCRIPTION

The VA instruction allows the user to assign a 2 character name to a user defined variable.

The restrictions for this command are:

1] A variable cannot be named after a MDrive Motion Control Instruction, Variable or Flag.

2] The first character must be alpha, the second character may be alpha-numeric.

3] A variable is limited to two characters.

USAGE

VA <char><char>=<value>

EXAMPLE:

```
VA P2          'create user var P2
P2=20000       'set P2 to 20000
```

RELATED COMMANDS: UV

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **VI** | **Initial Velocity Variable** | **Motion Variable** |

DESCRIPTION

Initial velocity for all motion commands. The factory default value is 1000 clock pulses per second.

The initial velocity for a stepper should be set to avoid the low speed resonance frequency and must be set lower than the pull in torque of the motor. It must also be set to a vaulue lower than VM (Max. Velocity).

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| VI=<velocity> | Counts per sec | 1 to 5000000 | 1000 |

EXAMPLE:

```
VI=2000        'set initial velocity to 2000 counts per second
```

RELATED COMMANDS: VM

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **VM** | **Maximum Velocity Variable** | **Motion Variable** |

DESCRIPTION

The VM variable specifies the maximum velocity in counts per second that the axis will reach during a move command

| USAGE | UNITS | RANGE | DEFAULT |
|---|---|---|---|
| VM=<velocity> | Counts per sec | 1 to 5000000 | 768000 |

EXAMPLE:

```
VM=51200        'set max velocity to 51200 counts per second
```

RELATED COMMANDS: VM

| MNEMONIC | FUNCTION | TYPE |
|---|---|---|
| **VR** | **Read Only Firmware Version** | **Factory Variable** |

DESCRIPTION

This variable is used in conjuction with the PR instruction to read the version of the firmware installed at the factory. If the Version number is followed by an E, the Mdrive is an Encoder Version. An I will indicate and Index version. Blank will indicate no options.

USAGE

```
PR VR
```

RELATED COMMANDS: —

# APPENDIX A

## ASCII TABLE

| Char ..... | Decimal Value |
|---|---|
| Null | 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 |
| . | 46 |

| Char ..... | Decimal Value |
|---|---|
| / | 47 |
| 0 | 48 |
| 1 | 49 |
| 2 | 50 |
| 3 | 51 |
| 4 | 52 |
| 5 | 53 |
| 6 | 54 |
| 7 | 55 |
| 8 | 56 |
| 9 | 57 |
| : | 58 |
| ' | 59 |
| < | 60 |
| = | 61 |
| > | 62 |
| ? | 63 |
| @ | 64 |
| A | 65 |
| B | 66 |
| C | 67 |
| D | 68 |
| E | 69 |
| F | 70 |
| G | 71 |
| H | 72 |
| I | 73 |
| J | 74 |
| K | 75 |
| L | 76 |
| M | 77 |
| N | 78 |
| O | 79 |
| P | 80 |
| Q | 81 |
| R | 82 |
| S | 83 |
| T | 84 |
| U | 85 |
| V | 86 |
| W | 87 |
| X | 88 |
| Y | 89 |
| Z | 90 |
| [ | 91 |
| \ | 92 |
| ] | 93 |

| Char ..... | Decimal Value |
|---|---|
| ^ | 94 |
| _ | 95 |
| ' | 96 |
| a | 97 |
| b | 98 |
| c | 99 |
| d | 100 |
| e | 101 |
| f | 102 |
| g | 103 |
| h | 104 |
| i | 105 |
| j | 106 |
| k | 107 |
| l | 108 |
| m | 109 |
| n | 110 |
| o | 111 |
| p | 112 |
| q | 113 |
| r | 114 |
| s | 115 |
| t | 116 |
| u | 117 |
| v | 118 |
| w | 119 |
| x | 120 |
| y | 121 |
| z | 122 |
| { | 123 |
| \| | 124 |
| } | 125 |
| ~ | 126 |
| | 127 |
| Ç | 128 |
| ü | 129 |
| é | 130 |
| â | 131 |
| ä | 132 |
| à | 133 |
| å | 134 |
| ç | 135 |
| ê | 136 |
| ë | 137 |
| è | 138 |
| ï | 139 |
| î | 140 |

# APPENDIX B

## Error Codes

| Error Code | Fault |
|---|---|
| 0 | No Error |
| **I/O Errors** | |
| 1 | I/O1 Fault |
| 2 | I/O2 Fault |
| 3 | I/O3 Fault |
| 4 | I/O4 Fault |
| 5 | I/O5 Fault |
| 6 | An I/O is already set to this type. |
| 7 | Tried to set an Input or defined I/O. |
| 8 | Tried to set an I/O to an incorrect I/O type. |
| 9 | Tried to write to I/O set as input or is “TYPED”. |
| 10 | Illegal I/O number. |
| **Data Errors** | |
| 20 | Tried to set unknown variable or flag. |
| 21 | Tried to set an incorrect value. |
| 22 | VI set greater than or equal to VM. |
| 23 | VM is set less than or equal to VI. |
| 24 | Illegal data entered. |
| 25 | Variable or flag is read only. |
| 26 | Variable or flag is not allowed to be incremented or decremented. |
| 27 | Trip not defined. |
| 28 | Trying to redefine a program label or variable. |
| 29 | Trying to redefine an embedded command or variable. |
| 30 | Unknown label or user variable. |
| 31 | Program label or user variable table is full. |
| **Program Errors** | |
| 40 | Program not running. |
| 41 | Program running. |
| 42 | Illegal program address. |
| 43 | Tried to overflow program stack. |
| **Communications Errors** | |
| 60 | Tried to enter unknown command. |
| 61 | Trying to set illegal BAUD rate. |
| **Motion Errors** | |
| 80 | HOME switch not defined. |
| 81 | HOME type not defined. |
| 82 | Went to both LIMITS and did not find home |
| 83 | Reached positive LIMIT switch. |
| 84 | Reached minus LIMIT switch. |
| 85 | MA or MR not allowed while in motion. |
| 86 | Stall detected. |

## TWENTY-FOUR MONTH LIMITED WARRANTY

Intelligent Motion Systems, Inc., warrants its products against defects in materials and workmanship for a period of 24 months from receipt by the end-user. During the warranty period, IMS will either, at its option, repair or replace Products which prove to be defective.

### *EXCLUSIONS*

The above warranty shall not apply to defects resulting from: improper or inadequate handling by customer; improper or inadequate customer wiring; unauthorized modification or misuse; or operation outside of the electrical and/or environmental specifications for the Product.

### *OBTAINING WARRANTY SERVICE*

To obtain warranty service, a returned material authorization number (RMA) must be obtained from customer service at (860) 295-6102 before returning product for service. Customer shall prepay shipping charges for Products returned to IMS for warranty service and IMS shall pay for return of Products to customer. However, customer shall pay all shipping charges, duties and taxes for Products returned to IMS from another country.

### *WARRANTY LIMITATIONS*

IMS makes no other warranty, either expressed or implied, with respect to the Product. IMS specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Some jurisdictions do not allow limitations on how long an implied warranty lasts, so the above limitation or exclusion may not apply to you. However, any implied warranty of merchantability or fitness is limited to the 24-month duration of this written warranty.

### *EXCLUSIVE REMEDIES*

If your Product should fail during the warranty period, call customer service at (860) 295-6102 to obtain a returned material authorization number (RMA) before returning product for service. Please include a written description of the problem along with contact name and address. Send failed product to: Intelligent Motion Systems, Inc., 370 N. Main St. Marlborough, Connecticut 06447. Also enclose information regarding the circumstances prior to Product failure.

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