INTELLIGENT MOTION SYSTEMS, INC.
Excellence in Motion

MFORCE™ MICRO DRIVE *Plus*
MOTION CONTROL

HARDWARE REFERENCE

RoHS CE

www.imshome.com

Motion Control MForce MicroDrive Hardware Reference Change Log		
Date	Revision	Changes
11/27/2006	R112706	Initial release.

IMS PN MAN-MFIMicro

Revision R112706

Table of Contents

Appendices

List of Figures

Part 2: Connections and Interface

Appendices

List of Tables

Part 1: Hardware Specification

Part 2: Connections and Interface

Appendices

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Getting Started

> WARNING! Please ensure that you read the sections of the product manual pertaining to the MForce MicroDrive model you purchased in their entirety prior to placing the unit into full operation.

Before You Begin

A printed Quick Reference guide designed to help get you connected and communicating with the MForce is shipped with your product. The following examples will help you get the motor turning for the first time and introduce you to Immediate and Program modes of operation.

Immediate Mode: In Immediate Mode, commands are issued and executed directly to the MForce MicroDrive by user input into the terminal window of the IMS Terminal Program, shown later in this section.

Program Mode: Program mode is used to input user programs into the Motion Control MForce MicroDrive .

Tools and Equipment Required

- Motion Control MForce MicroDrive.
- NEMA Size 14, 17 or 23 frame stepping motor.
- Communications Converter Cable IMS P/N MD-CC400-000 or equivalent (USB to RS-422).
- Product CD or internet access to www.imshome.com.
- A +12 to +48 VDC unregulated power supply.
- Basic tools: wire cutters / strippers / screwdriver.
- 20 AWG wire for power supply.
- 20 AWG wire for motor or optional prototype development cable IMS P/N PD04-MF17-FL3.
- A PC with Windows XP Service Pack 2.
- A free serial communications or USB port.

Connecting the Power Supply

Using 20 AWG wire, connect the DC output of the power supply to the +V input of the MForce MicroDrive.

Connect the power supply ground to the Power Ground pin appropriate for your MForce MicroDrive. See Figure GS.1.

Connecting Communications

Connect the Host PC to the Motion Control MForce MicroDrive using the IMS Communications Converter Cable MD-CC400-000 or equivalent. See Figure GS-1.

Connecting the Motor

In accordance with the motor manufacturer documentation, connect the Motor Phases to the MForce MicroDrive Connector P4 (Prototype Development Cable IMS P/N PD04-MF17-FL3 recommended). See Figure GS.1.

Minumum Required Connections

The following Table and Diagram illustrate the minimum required connections to operate the MForce MicroDrive.

Minumum Required Connections			
Connector P1	Flying Leads	7-Pin Termnal	16-Pin Wire Crimp
+12 to +48 VDC	Red	Pin 7	Pin 15
Power Ground	Black	Pin 6	Pin 16
Connector P2	10 Pin IDC		10 Pin Wire Crimp
TX+	Pin 1		Pin 9
TX –	Pin 2		Pin 10
RX +	Pin 3		Pin 7
RX -	Pin 4		Pin 8
COMM GND	Pin 10		Pin 2
Connector P4	4-Pin Locking Wire Crimp		
Motor Phase $\overline{A}$	Pin 1		
Motor Phase A	Pin 2		
Motor Phase $\overline{B}$	Pin 3		
Motor Phase B	Pin 4		

Table GS.1: Minimum Required Connections

WARNING: Do not connect or disconnect DC input to the MForce MicroDrive with power applied! Disconnect the AC power side to power down the DC Supply.

For battery operated systems, conditioning measures should be taken to prevent device damage caused by in-rush current draws, transient arcs and high voltage spikes.

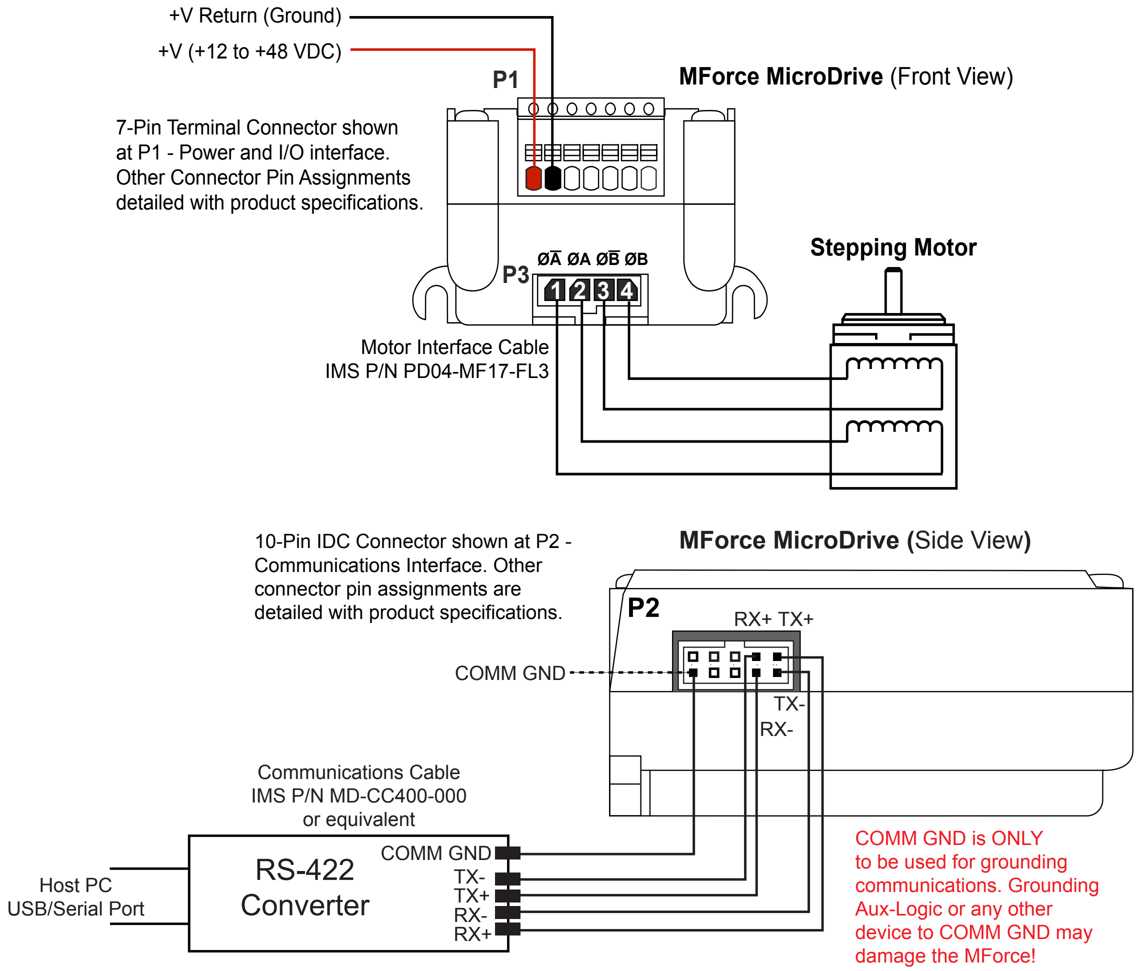

Figure GS.1: MForce MicroDrive Minimum Required Connections

Install IMS Terminal Software

Note: Interactive Tutorials covering the installation and use of the IMS Terminal are located on the IMS Web Site at http://www.imshome.com/tutorials.html.

IMS Terminal is an integrated ASCII text editor and terminal emulator designed to easily communicate with and program IMS Motion Control products. Using this freely provided program will eliminate the added complication of configuring and using a separate text editor and terminal software.

1. Insert the CD included with the product into the CD Drive of your PC.
   If not available, go to http://www.imshome.com/software_interfaces.html.
2. The CD will autostart.
3. Click the Software Button in the top-right navigation Area.
4. Click the IMS Terminal link appropriate to your operating system.
5. Click SETUP in the Setup dialog box and follow the on-screen instructions.
6. Once IMS Terminal is installed, the Communications Settings can be checked and/or set.

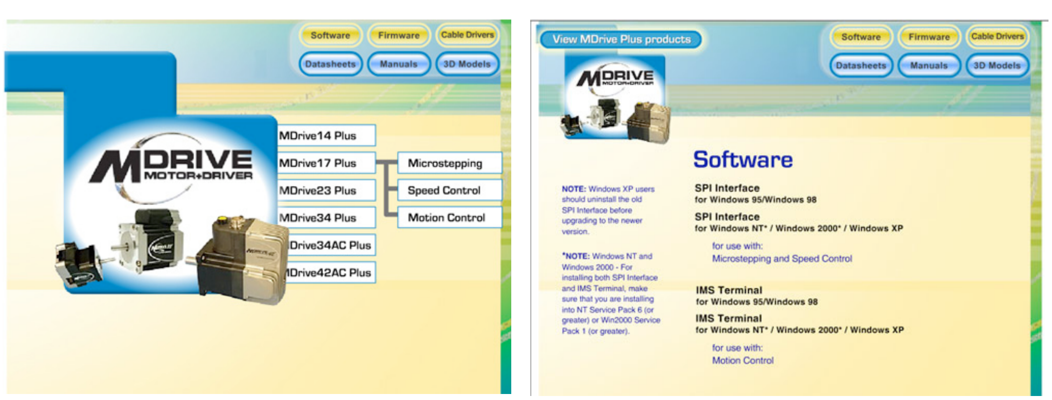

Figure GS.2: Product CD Entry and Installation Screens

Establishing Communications

1. Open IMS Terminal by clicking Start>Programs>IMS Terminal>IMS Term. The Program Edit Window (left) and Terminal Window (right) will be displayed.

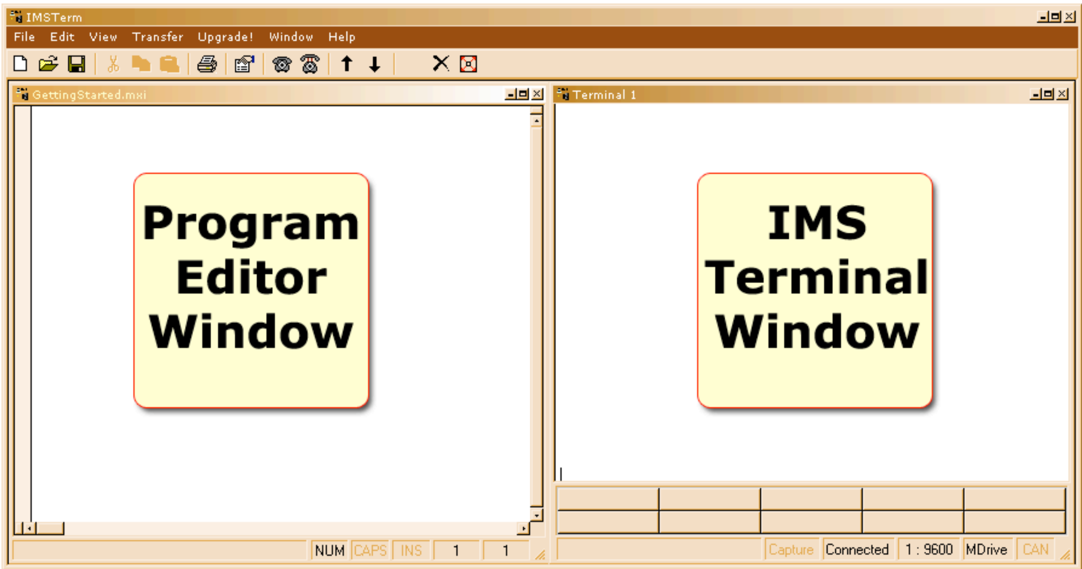

Figure GS.3: IMS Terminal Main Screen

2. On the Menu Bar click Edit / Preferences to open the Preferences dialog box.
3. Click on the Comm Settings tab to open the Comm Settings page.
   a. Set Scroll Back to desired range of text lines to be displayed.
   b. Under Device, confirm MDrive has been selected and also verify the Comm Port being used. Do not change any other settings. Click "OK".

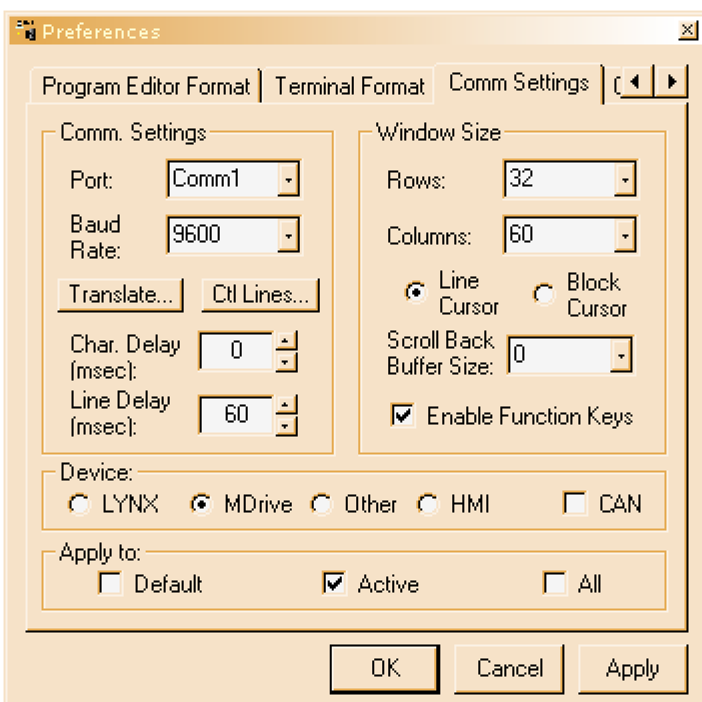

Figure GS.4: IMS Terminal Preferences Dialog

Note: Entering MForce MicroDrive commands directly into the Terminal Window is called "Immediate Mode".

The Motion Control MForce MicroDrive command set is not case sensitive except for command DN = < >

Warning: If you have installed the MForce MicroDrive to a load, be sure the load can safely be moved before testing.

Tip: A small piece of tape on the motor shaft is a visual aid to help see the shaft turning.

Apply Power to the Motion Control MForce MicroDrive

1. Verify that all connections have been made, then apply power to the Motion Control MForce MicroDrive. Click on the Phone icon or the Disconnect status box to establish communications between IMS Terminal and the MForce MicroDrive. The following sign-on message should appear in the Terminal Window:

"Copyright 2001-2006 by Intelligent Motion Systems, Inc."

2. If you can see the sign-on message, then the MForce MicroDrive is properly powered-up and communicating.
   a. If the sign-on message does not appear, try using a software reset. Hold down the "Ctrl" key and press "C". If the sign-on message still does not appear, check all connections, as well as all hardware and software configurations, then start IMS Terminal again.
3. You are now connected and communicating to the Motion Control MForce MicroDrive.
   Note: There are indicators at the bottom of the Terminal Window that show whether you are connected or disconnected, the current Baud Rate, and the type of device (MDrive displayed when using MForce) for which the IMS Terminal is configured. These three items may be changed directly from this screen by double clicking on each of them.

Testing the Motion Control MForce MicroDrive

1. Click in the Terminal Window, and type (followed by ENTER):
   PR VM
2. The Motion Control MForce MicroDrive will return a value of 768000
3. Type the following in the Terminal Window (followed by ENTER):
   VM=360000
   PR VM
4. The Motion Control MForce MicroDrive will return a value of 360000
5. Type FD and press ENTER. (FD = Factory Defaults)

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should appear in the Terminal Window within a few seconds.

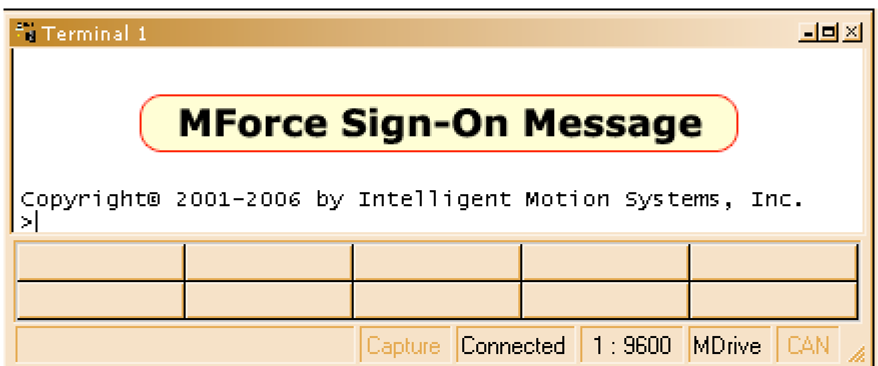

Figure GS.5 Motion Control MForce MicroDrive Sign-On Message

Make the Motion Control MForce MicroDrive Move

1. Type MR 51200 into the Terminal Window and press ENTER. (MR = Move Relative)
   a. With the default settings, the MForce Motion Control should move one revolution in approximately 0.066 seconds, or at a velocity of 15 revolutions per second.
2. Type SL 102400 and press ENTER. (SL = Slew)
   a. With the default settings, the Motion Control MForce MicroDrive should run constantly at a speed of approximately 2 revolutions per second or 120 revolutions per minute.
3. Type SL 0 and press ENTER. The Motion Control MForce MicroDrive should decelerate to a full stop.

Motion Control Example Using Program Mode

NOTE: Entering MForce MicroDrive commands into the Program Edit Window, to be edited and saved, is called "Program Mode".

NOTE: The program can be stopped by pressing the Escape Button or by pressing Ctrl+C.

1. Click on drop-down menu View > New Edit Window to open the Program Edit Window.
2. Type "XYZ Test" into the "Open a New file for editing" dialog box, and click "OK".
3. Click anywhere within the Program Edit Window, and type (followed by ENTER):

```
VA LP=0        'user variable name LP = start count 0
A=100000       'set acceleration to 100000 steps/sec^2
D=100000       'set deceleration to 100000 steps/sec^2
PG 1           'enter program mode, start program at address 1
LB AA          'label program AA
MR 250000      'move motor 250000 steps in the positive direction
H              'hold program execution until motion completes
H 1000         'hold 1000 milliseconds
MR -250000     'move motor 250000 steps in the negative direction
H              'hold program execution until motion completes
H 1000         'hold 1000 milliseconds
IC LP          'increment user variable LP
PR " LP=",LP;  'print axis position, 4 characters used, the
               'terminal will display LP=1 LP=2 LP=3
BR AA, LP<3    'branch to process label AA, if user variable LP< 3
E              'end program execution
PG             'exit program, return to immediate mode
```

4. Type FD in the Terminal Window and press ENTER to clear the MDrive buffer to factory defaults before downloading any program.
5. Click on drop-down menu Transfer > Download to transfer the program from the Program Edit Window to the Terminal Window. (Under "Source Type" choose "Edit Window".)
6. Type EX 1 in the Terminal Window and press ENTER to execute the program. (EX = Execute at address 1.)
7. The Motion Control MForce MicroDrive will turn the motor 250,000 microsteps in a clockwise direction, accelerating at 100,000 microsteps per sec^2, then decelerating at 100,000 microsteps per sec^2, pausing for 1000 milliseconds, then reversing the sequence in a counterclockwise direction, repeating the motion cycle 3 times until the program ends.

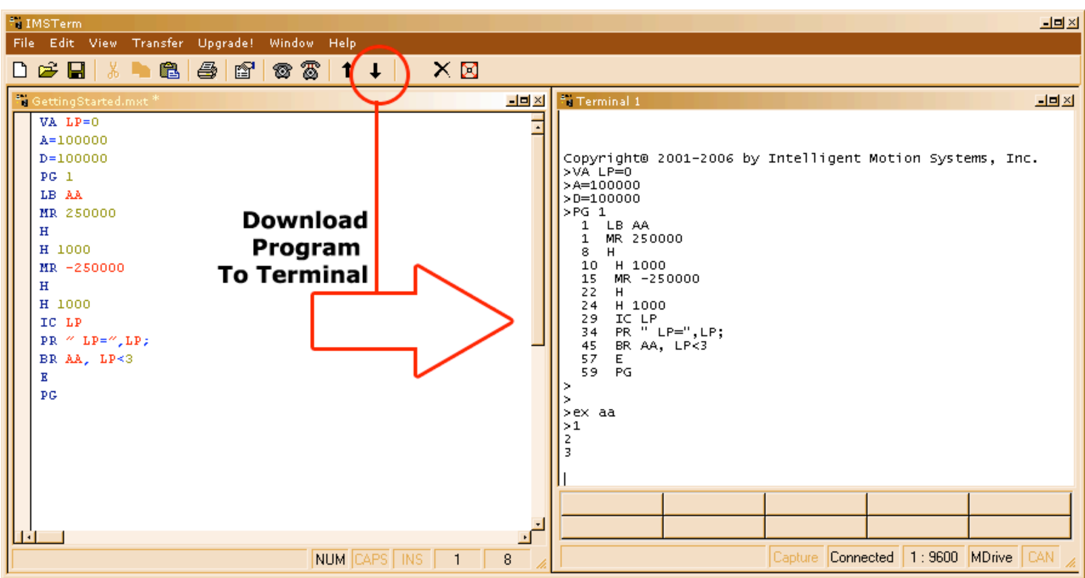

Figure GS.6: Download the Program

Programming Notes

The example above demonstrates basic commands that verify that your Motion Control MForce MicroDrive is communicating with your PC. More complex commands and movement may require that your I/O and/or Analog Input be interfaced and configured. Refer to the Programming and Software Reference for details.

For more information on Programming and Command Control Sets, refer to the Programming and Software Reference Manual available on the your product CD or via the IMS web site at http://www.imshome.com/manuals.html.

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INTELLIGENT MOTION SYSTEMS, INC.

Excellence in Motion™

MFORCE™ MICRO DRIVE *Plus* MOTION CONTROL

PART 1: HARDWARE SPECIFICATIONS

CE RoHS

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Product Introduction

Note: The Motion Control MForce MicroDrive is available with CAN communications. For more information see IMS Web Site at www.imshome.com.

Introduction

The Motion Control MForce MicroDrive offers system designers a low cost, intelligent motion controller integrated with a +12 to +48 volt/2A RMS Output Current microstepping drive and Motion Controller.

Figure 1.1.1: MForce MicroDrive With 1-Pin Terminal Strip

The unsurpassed smoothness and performance delivered by the Motion Control MForce MicroDrive are achieved through IMS's advanced 2nd generation current control. By applying innovative techniques to control current flow through the motor, resonance is significantly dampened over the entire speed range and audible noise is reduced.

The MForce MicroDrive accepts a broad input voltage range from +12 to +48 VDC, delivering enhanced performance and speed. Oversized input capacitors are used to minimize power line surges, reducing problems that can occur with long runs and multiple drive systems. An extended operating range of –40° to +85°C provides long life, trouble free service in demanding environments.

Standard features available in the MForce MicroDrive include four +5 to +24 volt general purpose I/O lines, one 10 bit analog input, 0 to 5MHz step clock rate, 20 microstep resolutions up to 51,200 steps per revolution, and full featured easy-to-program instruction set.

Expanded features in the MForce MicroDrive Plus^2 version include eight +5 to +24 volt general purpose I/O lines and the capability of electronic gearing by following a rotary or linear axis at an electronically controlled ratio, or an output clock can be generated fixed to the internal step clock.

Figure 1.1.2: MForce MicroDrive Plus^2 Wire Crimp

MForce MicroDrive Plus^2 models are available with optional closed loop control. This increases functionality by adding stall detection, position maintenance and find index mark. The closed loop configuration offers an expanded choice of line counts and resolutions by interfacing to a remotely mounted user-supplied external encoder.

The Motion Control MForce MicroDrive communicate over RS-422/485 which allows for point-to-point or multiple unit configurations utilizing one communication port. Addressing and hardware support up to 62 uniquely addressed units communicating over a single line. Baud rate is selectable from 4.8 to 115.2kbps.

Power and signal interface connections are accomplished using 12.0” (30.5cm) flying leads or a 7 position terminal strip. Plus^2 versions interface using a pluggable locking wire crimp connector. Motor phases are connected via a pluggable 4-pin locking wire crimp connector.

The MForce MicroDrive is a compact, powerful and inexpensive solution that will reduce system cost, design and assembly time for a large range of applications.

Feature Summary – Standard and Plus^2 Expanded

Standard Features

- Highly Integrated Microstepping Driver and Motion Controller
- Advanced 2nd Generation Current Control for Exceptional Performance and Smoothness
- Single Supply: +12 to +48 VDC
- Compact Size: 1.7 x 2.3 x 1.3 inches (42 x 59 x 1.3 mm)
- 2A RMS/2.8 A Peak (per phase) Output Current
- Low Cost
- Extremely Compact
- Auxiliary Logic Power Supply Input
- 20 Microstep Resolutions up to 51,200 Steps Per Rev Including: Degrees, Metric, Arc Minutes

- Open or Closed Loop Control
- Programmable Motor Run and Hold Currents
- Four +5 to +24 VDC I/O Lines Accept Sourcing or Sinking Outputs
- One 10 Bit Analog Input Selectable: 0 to +10 VDC, 0 to +5 VDC, 0-20 mA, 4-20 mA
- 0 to 5MHz Step Clock Rate Selectable in 0.59Hz Increments
- RS-422/485 Communications (Optional CANopen dtails available at www.imshome.com)
- 62 Software Addresses for Multi-Drop Communications
- Simple 1 to 2 Character Instructions
- Interface Options:
  - 12.0” (30.5cm) Flying Leads
  - 7-Pin Pluggable Terminal

Expanded Features – Available only in the Plus^2 Version

- +5 to +24 VDC Tolerant Sourcing or Sinking, Inputs and Outputs:
- 8 I/O Points with Electronic Gearing (or)
- 4 I/O Points with External/Remote Encoder for Closed Loop Control
- High Speed Position Capture Input or Trip Output
- Pluggable Locking Wire Crimp Interface

Motion Control MForce MicroDrive Specifications

Standard Electrical Specifications

Electrical Specifications	
Input Voltage (+V) Range*	+12 to +48 VDC
Max Power Supply Current (Per MForce MicroDrive)*	2 Amps
Aux-Logic Input Voltage**	+12 to +24 VDC

** Actual Power Supply Current will depend on Voltage and Load.*
*** Maintains power to control and feedback circuits [only] when input voltage is removed*

Output Current	
Output Current RMS	2 Amps
Output Current Peak (Per Phase)	2.8 Amps

Environmental Specifications	
Heat Sink Temperature	-40°C to +85°C

I/O Specifications	
General Purpose I/O - Number and Type	
Plus (I/O Points 1-4)	4 Sourcing or Sinking Inputs or 4 Sinking Outputs
General Purpose I/O - Electrical	
Inputs	TTL up to +24 VDC
Sinking Outputs (All)	Up to +24 VDC
Output Sink Current (Plus)	up to 600 mA (One Channel)
Logic Threshold (Logic 0)	< 0.8 VDC
Logic Threshold (Logic 1)	> 2.2 VDC
Protection (Sinking)	Over Temp, Short Circuit
Protection (Sourcing)	Transient Over Voltage, Inductive Clamp
Analog Input	
Resolution	10 Bit
Range (Voltage Mode)	0 to +5 VDC, 0 to +10 VDC
Range (Current Mode)	4 to 20 mA, 0 to 20mA
Clock I/O	
Types	Step/Direction, Up/Down, Quadrature
Logic Threshold	TTL Input, TTL Output (with 2 kΩ Load to Ground)
Trip Output/Capture Input	
Logic Threshold	TTL Input, TTL Output (with 2 kΩ Load to Ground)

Communications Specifications	
Protocol	RS-422/RS-485
BAUD Rate	4.8k, 9.6k, 19.2k, 38.4k, 115.2 kbps

WARNING! The maximum +48 VDC Input Voltage of the MForce MicroDrive series includes motor Back EMF, Power Supply Ripple and High Line.

WARNING! Because the MForce MicroDrive consists of two core components, a drive and a motor, close attention must be paid to the thermal environment where the device is used. See Thermal Specifications.

Motion Specifications

Microstep Resolution - Open Loop	
Number of Resolutions	20

Available Microsteps Per Revolution									
200	400	800	1000	1600	2000	3200	5000	6400	10000
12800	20000	25000	25600	40000	50000	51200	36000[1]	21600[2]	25400[3]

1=0.01 deg/µstep 2=1 arc minute/µstep 3=0.001 mm/µstep

Counters	
Counter 1 (C1) Type	Position
Counter 2 (C2) Type	Encoder
Resolution	32 Bits
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

* Microstep Resolution must be set to 2x the Encoder Counts/Rev minimum.

Software Specifications

Program Storage Type/Size	Flash/6384 Bytes
User Registers	(4) 32 Bit
User Program Labels and Variables	192
Math, Logic and Conditional Functions	+, -, x, ÷, <, >, =, ≤, ≥, AND, OR, XOR, NOT
Branch Functions	Branch and Call (Conditional)
Party Mode Addresses	62
Encoder Functions	Stall Detect, Position Maintenance, Find Index
Predefined I/O Functions	
Input Functions	Home, Limit+, Limit -, Go, Stop, Pause, Jog+, Jog-, Analog Input
Output Functions	Moving, Fault, Stall, Velocity Changing
Trip Functions	Trip on Input, Trip on Position, Trip on Time, Trip Capture

Mechanical Specifications

Dimensions in Inches (mm)

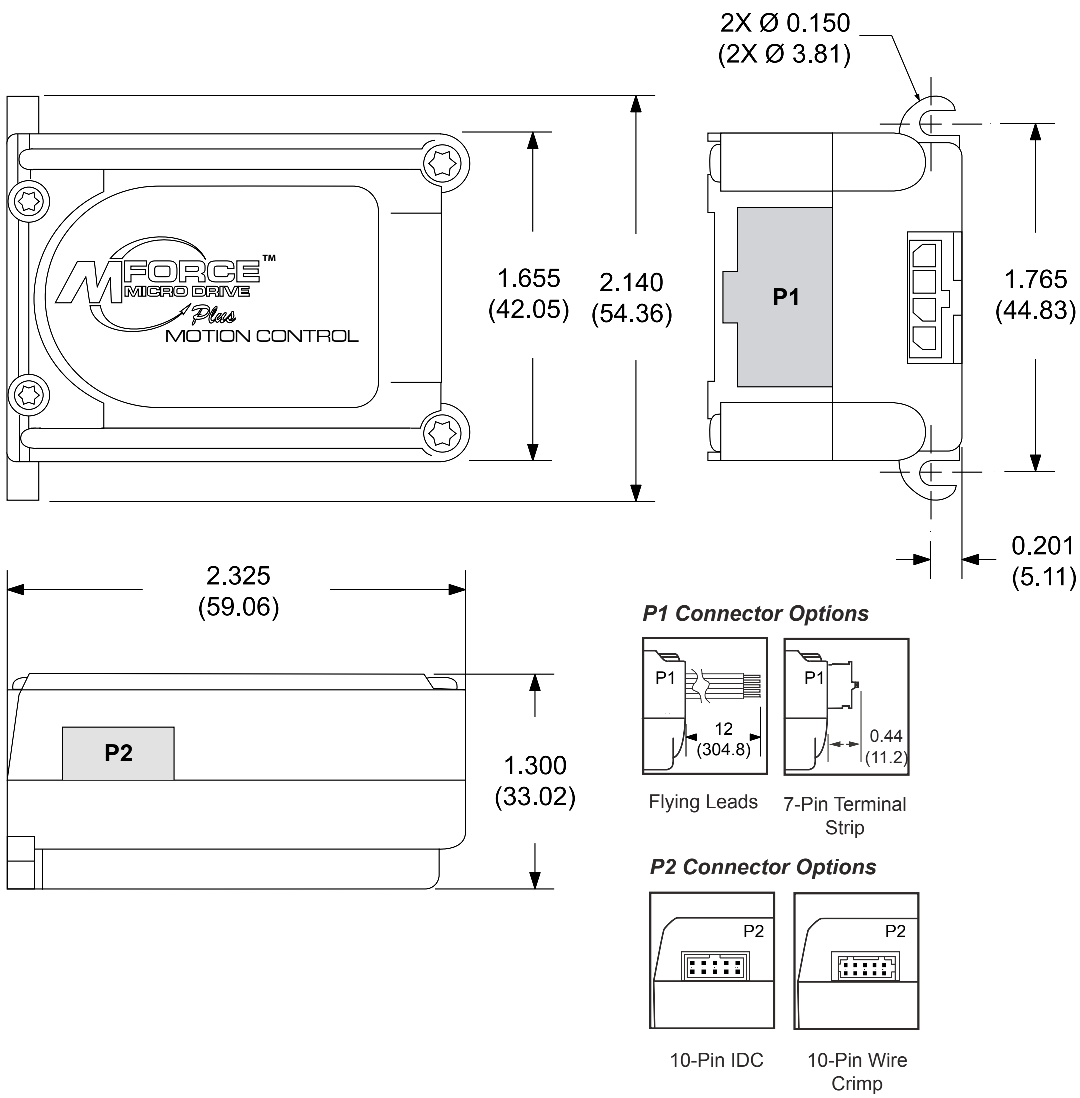


Figure 1.2.1: Mechanical Specifications

Pin/Wire Assignments and Description

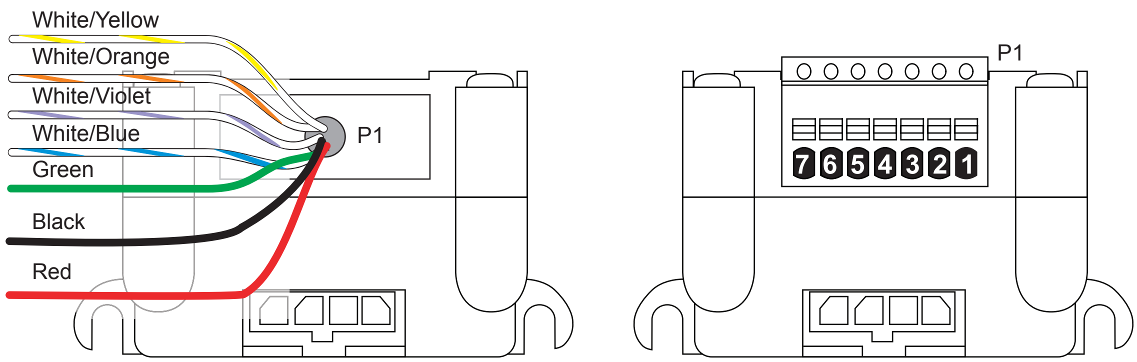
P1 Connector - I/O and Power Connections

Flying Lead Wire Color	7-Pin Pluggable Terminal Strip	Function	Description
White/Yellow	Pin 1	I/O 1	0 to +24 VDC Programmable I/O Point 1
White/Orange	Pin 2	I/O 2	0 to +24 VDC Programmable I/O Point 2
White/Violet	Pin 3	I/O 3	0 to +24 VDC Programmable I/O Point 3
White/Blue	Pin 4	I/O 4	0 to +24 VDC Programmable I/O Point 4
Green	Pin 5	AIN	0 to +5 VDC/0 to +10 VDC / 4 to 20 mA / 0 to 20 mA Analog Input
Black	Pin 6	GND	Power and Auxiliary Ground
Red	Pin 7	+V	+12 to +48 VDC Motor Power Supply Input

Table 1.2.1: P1 — Pin Assignment, Power and I/O

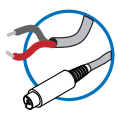
WARNING! Because the MForce MicroDrive DOES NOT have a Pin Configuration label on the body of the device please ensure that all wiring connections are cross-checked against these tables and figures.

P1 Connector Options



12” Flying Leads **7-Pin Pluggable Terminal**

Figure 1.2.2: P1 Wire Color and Pin Assignment



NEED A CABLE? The following cables and converters are available to interface communications with P2:

USB to RS-422/485: MD-CC400-000

10-Pin IDC to 10-Pin Wire Crimp Adapter: MD-ADP-H

Multi-Drop for 10-Pin Wire Crimp Party-Mode PD10-1434-FL3

P2 Connector - RS-422/485 Communications

Pin Assignment - P2 RS-422/485 Communications

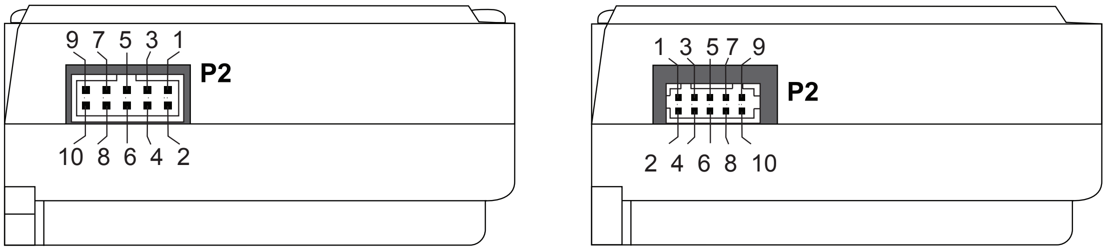
10-Pin IDC	*10-Pin Wire Crimp*	*Function*	*Description*
Pin 1	Pin 9	TX +	Transmit +: Connects to Receive + of the Communications Host.
Pin 2	Pin 10	TX –	Transmit –: Connects to Receive – of the Communications Host.
Pin 3	Pin 7	RX +	Receive +: Connects to Transmit + of the Communications Host.
Pin 4	Pin 8	RX –	Receive –: Connects to Transmit – of the Communications Host.
Pin 5	Pin 5	Aux-Logic	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
Pin 6	Pin 6	RX +	Receive +: This point will typically be used to connect to RX+ (Pin 3/7*) of a second MDrivePlus for Multidrop Communications.
Pin 7	Pin 3	RX –	Receive –: This point will typically be used to connect to RX – (Pin 4/8*) of a second MDrivePlus for Multidrop Communications.
Pin 8	Pin 4	TX –	Transmit –: This point will typically be used to connect to TX – (Pin 1/9*) of a second MDrivePlus for Multidrop Communications.
Pin 9	Pin 1	TX +	Transmit –: This point will typically be used to connect to TX + (Pin 2/10*) of a second MDrivePlus for Multidrop Communications.
Pin 10	Pin 2	COMM GND	Communications Ground. This Ground is ONLY to be used to ground communications. Auxiliary Logic Supply must be grounded at the motor supply ground.
Recommended Converter/Cable	***Recommended Converter/Cable***	** For multi-drop communications systems IMS offers the PD10-1434-FL3 Prototype Development Cable. See Cables and Cordsets in the Appendices for more details.*	
MD-CC400-000	MD-CC400-000 and MD-ADP-H		

Table 1.2.2: P2 — Pin Assignment, RS-422/485 Communications

P2 Connector Options

10-Pin IDC

10-Pin Friction Lock Wire Crimp



Recommended Cable:
P/N MD-CC400-000

Recommended Cables:
P/N MD-CC400-000
P/N MD-ADP-H

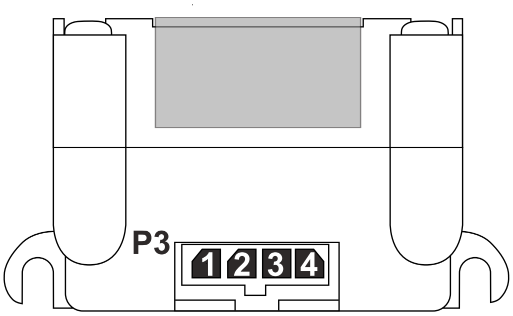
Figure 1.2.3: P2 Pin Assignment

P3 Connector - Motor Phase Connector

4-Pin Wire Crimp	Function	Description
Pin 1	$\overline{\text{ØA}}$	$\overline{\text{Phase A}}$ of the Motor
Pin 2	ØA	Phase A of the Motor
Pin 3	$\overline{\text{ØB}}$	$\overline{\text{Phase B}}$ of the Motor
Pin 4	ØB	Phase B of the Motor

Table 1.2.3: P3 — Pin Assignment, Motor Phase Connections

P3 Connector



4-Pin Locking Wire Crimp

Recommended Cable: P/N PD04-MF17-FL3

Recommended Connector Shell and Pins

Shell: AMP 1445022-4
Pins: AMP 1-794610-2
Wire: 20 AWG Shielded Twisted Pair

WARNING! Ensure proper connection of the motor phases prior to power application!

Figure 1.2.4: P3 — 4-Pin Locking Wire Crimp Motor Connector

Options and Accessories

Motors and Encoders

IMS offers a wide range of motors, encoders and accessories recommended for interface with the Motion Control MForce MicroDrive. For complete specifications on these products, please visit the IMS web site at www.imshome.com. See Appendix C for Encoder information and Appendix E for Motor details.

Power Supplies

IMS recommends the following power supplies for operating the MForce MicroDrive: ISP402, ISP404, ISP200-4. For complete power supply specifications, visit the IMS web site at www.imshome.com. See Appendix A for recommended IMS power supplies.

Communications Converter Cables

These convenient accessory cables connect a PC's USB Port to the P2 Connector of the MForce MicroDrive. Total cable length is 12.0' (3.6m). An in-line RS-422 converter enables parameter setting to a single Motion Control MForce. Purchase recommended with first orders. See Appendix D for details.

USB to 10-Pin IDC MD-CC400-000
10-Pin IDC to Wire Crimp Adapter .... MD-ADP-H

Prototype Development Cables

To speed prototyping, these 10' (3m) cables are available:

Comm: 10-pin Wire Crimp Cable PD10-1434-FL3
Motor Interface: 4-pin Wire Crimp Cable.. PD04-MF17-FL3

See Appendix D for details.

MForce MicroDrive Plus^2 Expanded Specifications

Plus^2 Electrical Specifications

Electrical Specifications	
Input Voltage (+V) Range*	+12 to +48 VDC
Max Power Supply Current (Per MDrive17Plus)*	2 Amps
Aux-Logic Input Voltage**	+12 to +24 VDC

** Actual Power Supply Current will depend on Voltage and Load.*
*** Maintains power to control and feedback circuits [only] when input voltage is removed*

Output Current	
Output Current RMS	2 Amps
Output Current Peak (Per Phase)	2.8 Amps

Environmental Specifications	
Heat Sink Temperature	-40°C to +85°C

I/O Specifications	
General Purpose I/O - Number and Type	
Plus (I/O Points 1-4)	4 Sourcing or Sinking Inputs or 4 Sinking Outputs
Plus^2 (I/O Points 1-4, 9-12)	8 Sourcing or Sinking Inputs or 8 Sourcing or Sinking Outputs (2 Banks of 4 Each)
General Purpose I/O - Electrical	
Inputs	TTL up to +24 VDC
Sinking Outputs (All)	Up to +24 VDC
Sourcing Outputs (Plus^2)	+12 to +24 VDC
Output Sink Current (Plus)	up to 600 mA (One Channel)
Output Sink Current (Plus^2)	up to 600 mA (One Channel in each I/O Bank)
Logic Threshold (Logic 0)	< 0.8 VDC
Logic Threshold (Logic 1)	> 2.2 VDC
Protection (Sinking)	Over Temp, Short Circuit
Protection (Sourcing)	Transient Over Voltage, Inductive Clamp
Analog Input	
Resolution	10 Bit
Range (Voltage Mode)	0 to +5 VDC, 0 to +10 VDC
Range (Current Mode)	4 to 20 mA, 0 to 20mA
Clock I/O	
Types	Step/Direction, Up/Down, Quadrature
Logic Threshold	TTL Input, TTL Output (with 2 kΩ Load to Ground)
Trip Output/Capture Input	
Logic Threshold	TTL Input, TTL Output (with 2 kΩ Load to Ground)

Communications Specifications	
Protocol	RS-422/RS-485
BAUD Rate	4.8k, 9.6k, 19.2k, 38.4k, 115.2 kbps

Motion Specifications

Microstep Resolution - Open Loop	
Number of Resolutions	20

Available Microsteps Per Revolution									
200	400	800	1000	1600	2000	3200	5000	6400	10000
12800	20000	25000	25600	40000	50000	51200	36000[1]	21600[2]	25400[3]

1=0.01 deg/μstep 2=1 arc minute/μstep 3=0.001 mm/μstep

Optional Remote Encoder (Plus² Only)‡	
Type	User Defined Differential
Steps Per Revolution	See Microstep Resolution - Open Loop
Resolution	User Defined*
Counters	
Counter 1 (C1) Type	Position
Counter 2 (C2) Type	Encoder
Resolution	32 Bits
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}
Electronic Gearing (Plus² Only)	
Range (Ratio)	0.001 to 2.000
Resolution	32 Bits
Voltage	+5 VDC Logic Level
Input Filter Range	50 nS to 12.9 μS
Secondary Output Clock Range	1 to 1
High Speed I/O (Plus² Only)	
Position Capture Input - Resolution	32 Bits
Position Capture Input - Filtering	50 nS to 12.9 μS
Trip Output - Speed	150 nS
Trip Output - Resolution	32 Bits
Trip Output Voltage	+5 VDC Logic Level

* Microstep Resolution must be set to 2x the Encoder Counts/Rev minimum.

‡With Optional Remote Encoder the Encoder Inputs replace I/O Points 9-12 and the Step/Direction Clock I/O Points.

Software Specifications	
Program Storage Type/Size	Flash/6384 Bytes
User Registers	(4) 32 Bit
User Program Labels and Variables	192
Math, Logic and Conditional Functions	+, -, x, ÷, <, >, =, ≤, ≥, AND, OR, XOR, NOT
Branch Functions	Branch and Call (Conditional)
Party Mode Addresses	62
Encoder Functions	Stall Detect, Position Maintenance, Find Index
Predefined I/O Functions	
Input Functions	Home, Limit+, Limit -, Go, Stop, Pause, Jog+, Jog-, Analog Input
Output Functions	Moving, Fault, Stall, Velocity Changing
Trip Functions	Trip on Input, Trip on Position, Trip on Time, Trip Capture

Mechanical Specifications

Dimensions in Inches (mm)

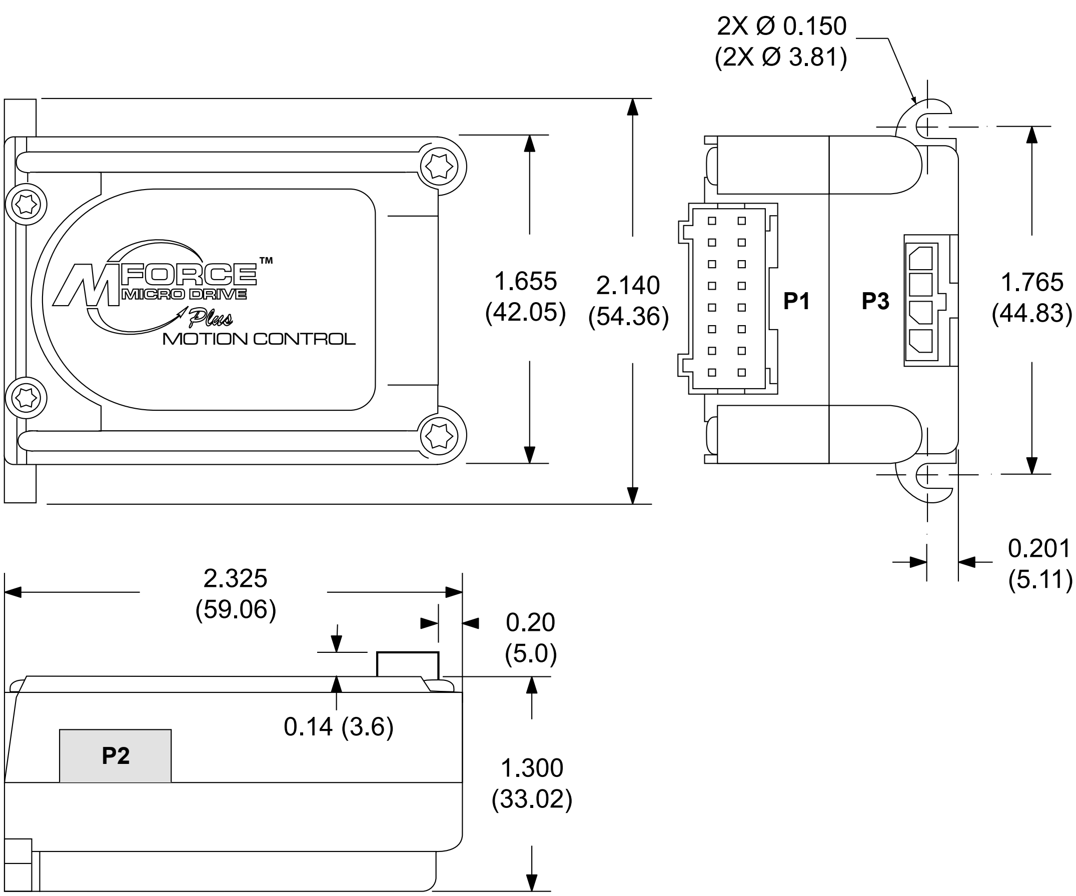


Figure 1.3.1: Mechanical Specifications

Pin Assignments and Description

P1 Connector - Power and Expanded I/O Configuration

P1 - Expanded I/O Configuration		
16-Pin Wire Crimp	**Function**	**Description**
Pin 1	I/O PWR	I/O Power, used with sourcing inputs or outputs. See Section 2.3 for more details.
Pin 2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
Pin 3	I/O 1	0 to +24 VDC Programmable I/O Point 1
Pin 4	I/O 2	0 to +24 VDC Programmable I/O Point 2
Pin 5	I/O 3	0 to +24 VDC Programmable I/O Point 3
Pin 6	I/O 4	0 to +24 VDC Programmable I/O Point 4
Pin 7	I/O 9	0 to +24 VDC Programmable I/O Point 9
Pin 8	I/O 10	0 to +24 VDC Programmable I/O Point 10
Pin 9	I/O 11	0 to +24 VDC Programmable I/O Point 11
Pin 10	I/O 12	0 to +24 VDC Programmable I/O Point 12
Pin 11	Capture/Trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
Pin 12	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
Pin 13	SCLK	Step Clock I/O. Can also be configured as Quadrature or Clock Up/Down.
Pin 14	DIR	Direction I/O. Can also be configured as Quadrature or Clock Up/Down.
Pin 15	+V	+12 to +48 VDC Motor Power Supply Input.
Pin 16	GND	Power and Auxiliary Ground
Recommended Cable		
PD16-1417-FL3		

Table 1.3.1: P1 — Pin Assignment, Expanded I/O Configuration

P1 Connector - Power and I/O with Remote Encoder Configuration

P1 - Expanded I/O Configuration		
16-Pin Wire Crimp	**Function**	**Description**
Pin 1	I/O PWR	I/O Power, used with sourcing inputs or outputs. See Section 2.3 for more details.
Pin 2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
Pin 3	I/O 1	0 to +24 VDC Programmable I/O Point 1
Pin 4	I/O 2	0 to +24 VDC Programmable I/O Point 2
Pin 5	I/O 3	0 to +24 VDC Programmable I/O Point 3
Pin 6	I/O 4	0 to +24 VDC Programmable I/O Point 4
Pin 7	Channel A +	Encoder Channel Channel A + Input.
Pin 8	Channel A –	Encoder Channel Channel A – Input.
Pin 9	Channel B +	Encoder Channel Channel B + Input.
Pin 10	Channel B –	Encoder Channel Channel B – Input.
Pin 11	Capture/Trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
Pin 12	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
Pin 13	Index +	Encoder Index + Input.
Pin 14	Index –	Encoder Index – Input.
Pin 15	+V	+12 to +48 VDC Motor Power Supply Input.
Pin 16	GND	Power and Auxiliary Ground
Recommended Cable		
PD16-1417-FL3		

Table 1.3.2: P1 — Pin Assignment, Remote Encoder Configuration

P1 Connector

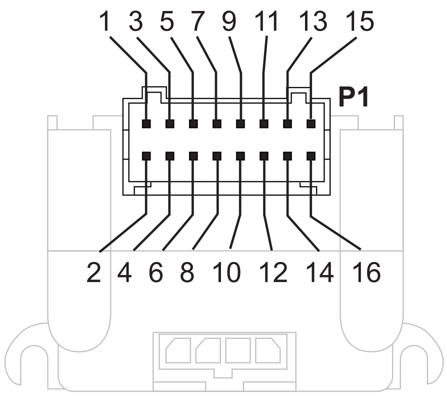


Figure 1.3.2: 16-Pin Wire Crimp Connector P1 Pin Numbers

P2 Connector - RS-422/485 Communications

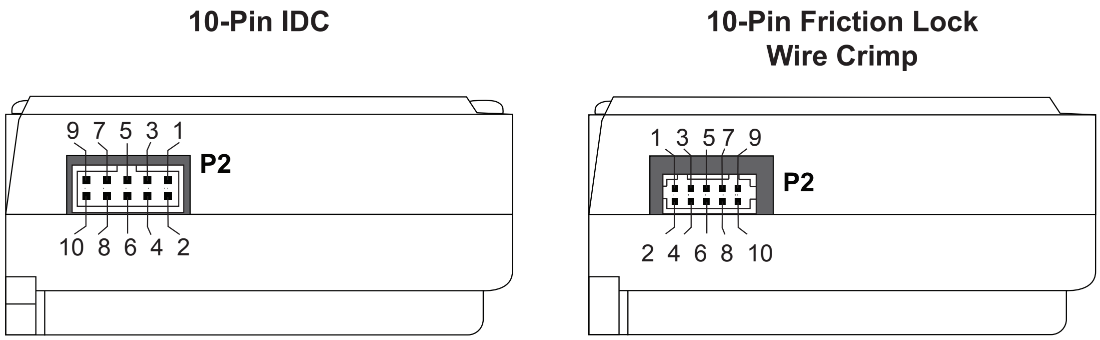
Pin Assignment - P2 RS-422/485 Communications			
10-Pin IDC	***10-Pin Wire Crimp***	***Function***	***Description***
Pin 1	Pin 9	TX +	Transmit +: Connects to Receive + of the Communications Host.
Pin 2	Pin 10	TX –	Transmit –: Connects to Receive – of the Communications Host.
Pin 3	Pin 7	RX +	Receive +: Connects to Transmit + of the Communications Host.
Pin 4	Pin 8	RX –	Receive –: Connects to Transmit – of the Communications Host.
Pin 5	Pin 5	Aux-Logic	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
Pin 6	Pin 6	RX +	Receive +: This point will typically be used to connect to RX+ (Pin 3/7*) of a second MDrivePlus for Multidrop Communications.
Pin 7	Pin 3	RX –	Receive –: This point will typically be used to connect to RX – (Pin 4/8*) of a second MDrivePlus for Multidrop Communications.
Pin 8	Pin 4	TX –	Transmit –: This point will typically be used to connect to TX – (Pin 1/9*) of a second MDrivePlus for Multidrop Communications.
Pin 9	Pin 1	TX +	Transmit –: This point will typically be used to connect to TX + (Pin 2/10*) of a second MDrivePlus for Multidrop Communications.
Pin 10	Pin 2	COMM GND	Communications Ground. This Ground is ONLY to be used to ground communications. Auxiliary Logic Supply must be grounded at the motor supply ground.

Recommended Converter/Cable	***Recommended Converter/Cable***
MD-CC400-000	MD-CC400-000 and MD-ADP-H

** For multi-drop communications systems IMS offers the PD10-1434-FL3 Prototype Development Cable. See Cables and Cordsets in the Appendices for more details.*

Table 1.3.3: P2 — Pin Assignment, RS-422/485 Communications

P2 Connector Options



Recommended Cable:
P/N MD-CC400-000

Recommended Cables:
P/N MD-CC400-000
P/N MD-ADP-H

Figure 1.3.3: P2 Pin Assignment

WARNING! Ensure proper connection of the motor phases prior to power application!

P3 Connector - Motor Phase Connector

Pin Assignment - P3 Motor		
4-Pin Wire Crimp	***Function***	***Description***
Pin 1	$\overline{\text{ØA}}$	$\overline{\text{Phase A}}$ of the Motor
Pin 2	ØA	Phase A of the Motor
Pin 3	$\overline{\text{ØB}}$	$\overline{\text{Phase B}}$ of the Motor
Pin 4	ØB	Phase B of the Motor

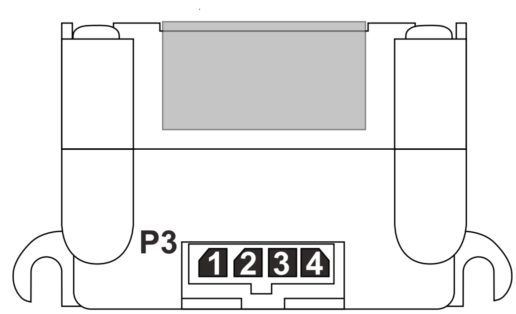
Table 1.3.4: P3 — Pin Assignment, Motor Phase Connections

Recommended Cable: P/N PD04-MF17-FL3

Recommended Connector Shell and Pins

Shell: AMP 1445022-4
Pins: AMP 1-794610-2
Wire: 20 AWG Shielded Twisted Pair

P3 Connector



4-Pin Locking Wire Crimp

Figure 1.3.4: P3: 4-Pin Locking Wire Crimp Motor Connector

Options and Accessories

Motors and Encoders

IMS offers a wide range of motors, encoders and accessories recommended for interface with the Motion Control MForce MicroDrive. For complete specifications on these products, please visit the IMS web site at www.imshome.com. See Appendix C for Encoder information and Appendix E for Motor details.

Power Supplies

IMS recommends the following power supplies for operating the MForce MicroDrive: ISP402, ISP404, ISP200-4. For complete power supply specifications, visit the IMS web site at www.imshome.com. See Appendix A for recommended IMS power supplies.

Communications Converter Cables

These convenient accessory cables connect a PC's USB Port to the P2 Connector of the MForce MicroDrive. Total cable length is 12.0' (3.6m). An in-line RS-422 converter enables parameter setting to a single Motion Control MForce. Purchase recommended with first orders. See Appendix D for details.

USB to 10-Pin IDC MD-CC400-000
10-Pin IDC to Wire Crimp Adapter .... MD-ADP-H

Prototype Development Cables

To speed prototyping, these 10' (3m) cables are available:

I/O: 16-pin Wire Crimp Cable PD16-1417-FL3
Comm: 10-pin Wire Crimp Cable PD10-1434-FL3
Motor Interface: 4-pin Wire Crimp Cable PD04-MF17-FL3

See Appendix D for details.

INTELLIGENT MOTION SYSTEMS, INC.

Excellence in Motion™

MFORCE™ MICRO DRIVE Plus

MOTION CONTROL

PART 2: CONNECTING AND INTERFACING

Section 2.1: Mounting and Connection Recommendations

Section 2.2: Motor Sizing and Selection

Section 2.3: Interfacing Communications

Section 2.4: Interfacing and Using the MForce I/O

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Mounting and Connection Recommendations

Mounting Recommendations

Flange mounting holes are drilled through with a diameter of 0.1.50" (3.81mm) to take standard 6X32 (M3 Metric) screws. The length of the screw used will be determined by the mounting flange width. See Mechanical Specifications for mounting hole pattern.

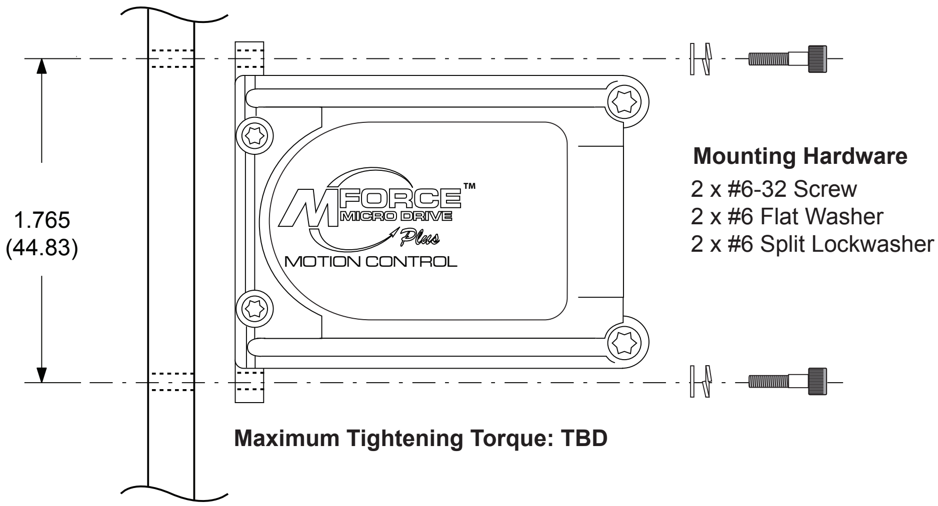


Figure 2.1.1: MForce MicroDrive Mounting Recommendations

DC Power Recommendations

The power requirements for the MForce MicroDrive are:

Output Voltage ....+12 to +48 VDC
Current (max. per unit).. 2 Amps
(Actual power supply current requirement will depend upon voltage and load)

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 MForce MicroDrive 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.

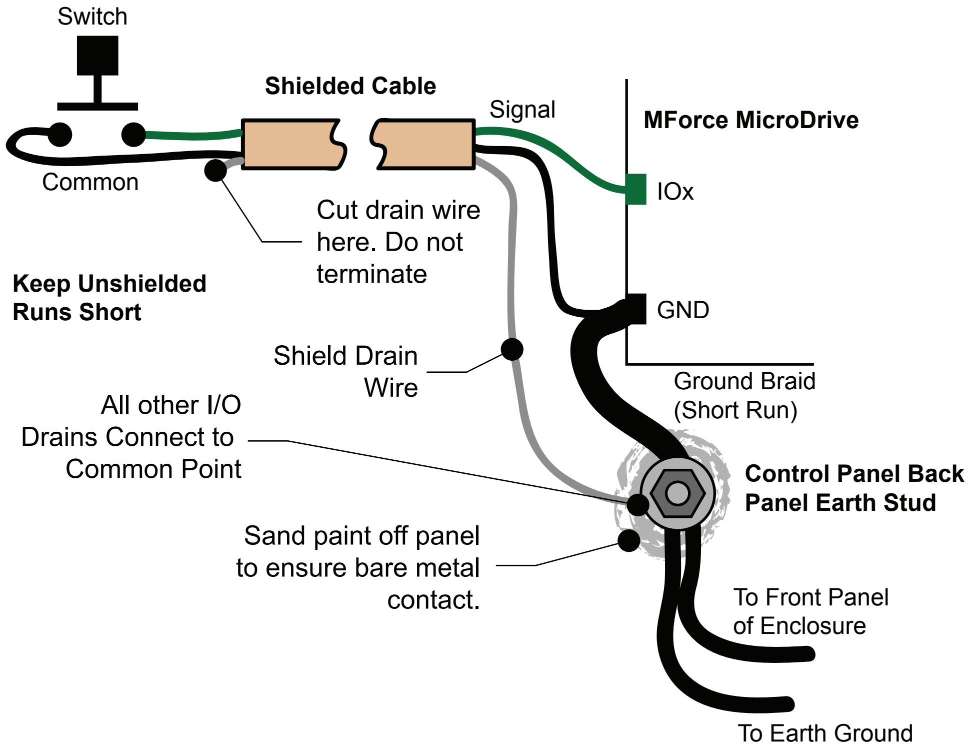


Figure 2.1.2: Grounding and Shielding for Logic Connections

Recommended Wiring

The following wiring/cabling is recommended for use with the MForce MicroDrive:

Logic Wiring..22 AWG
Wire Strip Length ....0.25" (6.0 mm)
Power and Ground .... See Appendix B: Recommended Power and Cable Configurations

Recommended Mating Connectors and Pins

Communications

10-Pin IDC...Samtec TCSD-05-01-N
10-pin Friction Lock ....Hirose DF11-10DS-2C
Crimp Contact for 10-pin Friction Lock (22 AWG)..........................DF11-22SC
Crimp Contact for 10-pin Friction Lock (24 - 28 AWG) DF11-2428SC
Crimp Contact for 10-pin Friction Lock (30 AWG)..........................DF11-30SC

Logic and Power

The following mating connectors are recommended for the MForce MicroDrive Plus² Units ONLY! Please contact a JST distributor for ordering and pricing information.

Enhanced I/O - P2

16-pin Locking Wire Crimp Connector Shell ....JST PN PADP-16V-1-S
Crimp Pins...JST PN SPH-001T-P0.5L

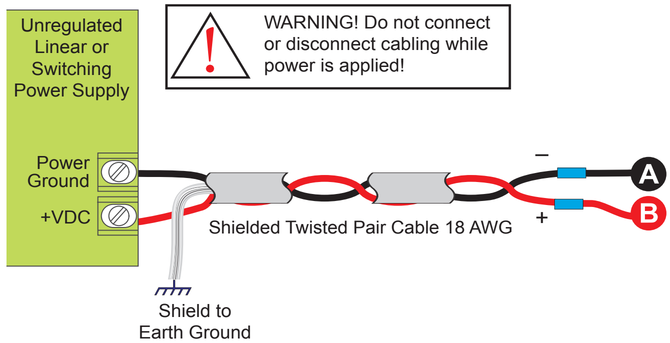
Motor

4-Pin Locking Wire Crimp Connector Shell ....AMP (Tycho) 1445022-4
Crimp Pins.. AMP (Tycho) 1-794610-2
Recommended Wire...20 AWG Shielded Twisted Pair

Securing Power Leads and Logic Leads

Some applications may require that the MForce move with the axis motion. If this is a requirement of your application, the motor leads must be properly anchored. This will prevent flexing and tugging which can cause damage at critical connection points within the MForce.

Power Supply Connection



+V Voltage: +12 to +48* VDC
+V Current: 2A Max Per MForceMicroDrive

Recommended IMS Power Supplies:
ISP200-4
IP402
IP404

*Includes Back EMF!

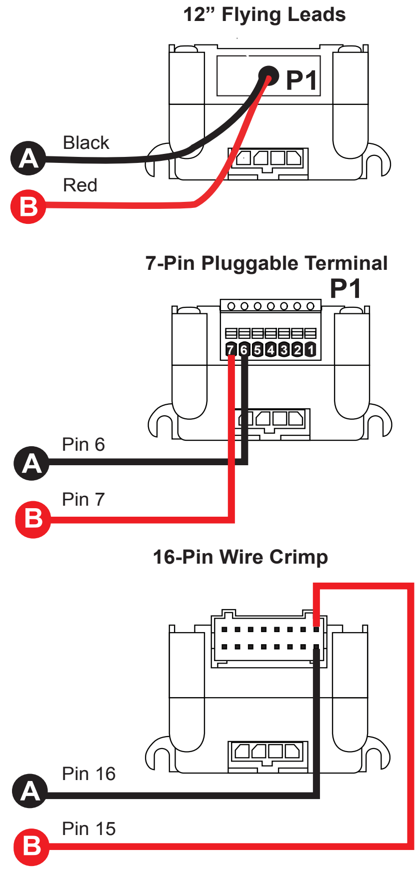


Figure 2.1.3: MForce MicroDrive Power Connections

Aux-Logic Supply Connection

The Auxiliary Logic input will maintain power to the Logic circuitry in the absence of motor power. The user will still be able to communicate with the device, however motion commands will be ignored and the internal counter will update by the number of pulses commanded. If stall detection is enabled a stall will register.

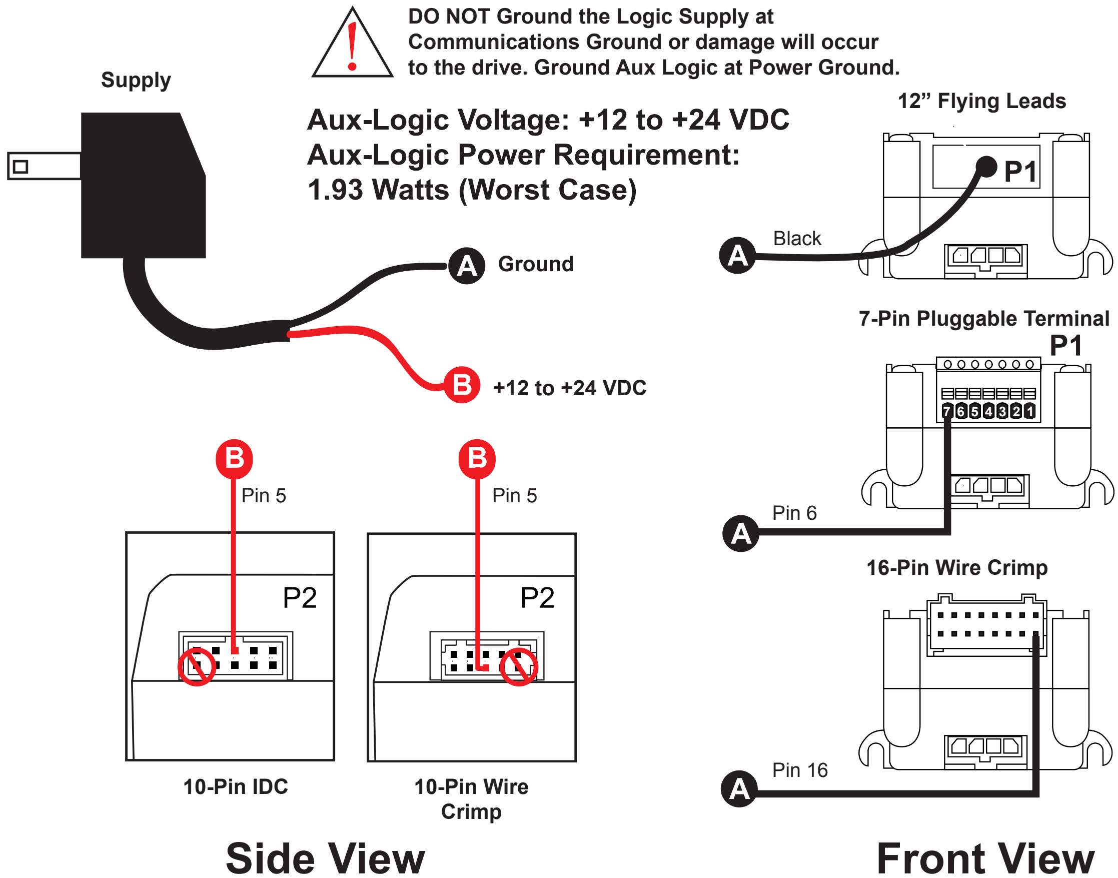


Figure 2.1.3: Aux-Logic Connection

Motor Sizing and Selection

Selecting a Motor

When selecting a stepper motor for your application, there are several factors that need to be taken into consideration:

- How will the motor be coupled to the load?
- How much torque is required to move the load?
- How fast does the load need to move or accelerate?
- What degree of accuracy is required when positioning the load?

While determining the answers to these and other questions is beyond the scope of this document, they are details that you must know in order to select a motor that is appropriate for your application. These details will affect everything from the power supply voltage to the type and wiring configuration of your stepper motor. The current and microstepping settings of your MForce MicroDrive will also be affected.

Types and Construction of Stepping Motors

The stepping motor, while classed as a DC motor, is actually an AC motor that is operated by trains of pulses. Although it is called a “stepping motor”, it is in reality a polyphase synchronous motor. This means it has multiple phases wound in the stator and the rotor is dragged along in synchronism with the rotating magnetic field. The MForce MicroDrive is designed to work with the following types of stepping motors:

1) Permanent Magnet (PM)

2) Hybrid Stepping Motors

Hybrid stepping motors combine the features of the PM stepping motors with the features of another type of stepping motor called a variable reluctance motor (VR). VR motors are low torque and load capacity motors which are typically used in instrumentation. The MForce MicroDrive cannot be used with VR motors as they have no permanent magnet.

On hybrid motors, the phases are wound on toothed segments of the stator assembly. The rotor consists of a permanent magnet with a toothed outer surface which allows precision motion accurate to within ± 3 percent. Hybrid stepping motors are available with step angles varying from 0.45° to 15° with 1.8° being the most commonly used. Torque capacity in hybrid steppers ranges from 5 - 8000 ounce-inches. Because of their smaller step angles, hybrid motors have a higher degree of suitability in applications where precise load positioning and smooth motion is required.

Sizing a Motor for Your System

The MForce MicroDrive is a bipolar driver which works equally well with both bipolar and unipolar motors (i.e. 8 and 4 lead motors, and 6 lead center tapped motors).

To maintain a given set motor current, the MForce MicroDrive chops the voltage using a variable chopping frequency and a varying duty cycle. Duty cycles that exceed 50% can cause unstable chopping. This characteristic is directly related to the motor’s winding inductance. In order to avoid this situation, it is necessary to choose a motor with a low winding inductance. The lower the winding inductance, the higher the step rate possible.

Winding Inductance

Since the MForce MicroDrive is a constant current source, it is not necessary to use a motor that is rated at the same voltage as the supply voltage. What is important is that the MForce MicroDrive is set to the motor’s rated current.

The higher the voltage used the faster the current can flow through the motor windings. This in turn means a higher step rate, or motor speed. Care should be taken not to exceed the maximum voltage of the driver. Therefore, in choosing a motor for a system design, the best performance for a specified torque is a motor with the lowest possible winding inductance used in conjunction with highest possible driver voltage.

The winding inductance will determine the motor type and wiring configuration best suited for your system. While the equation used to size a motor for your system is quite simple, several factors fall into play at this point.

The winding inductance of a motor is rated in milliHenrys (mH) per Phase. The amount of inductance will depend on the wiring configuration of the motor.

The per phase winding inductance specified may be different than the per phase inductance seen by your MForce MicroDrive driver depending on the wiring configuration used. Your calculations must allow for the actual inductance that the driver will see based upon the wiring configuration.

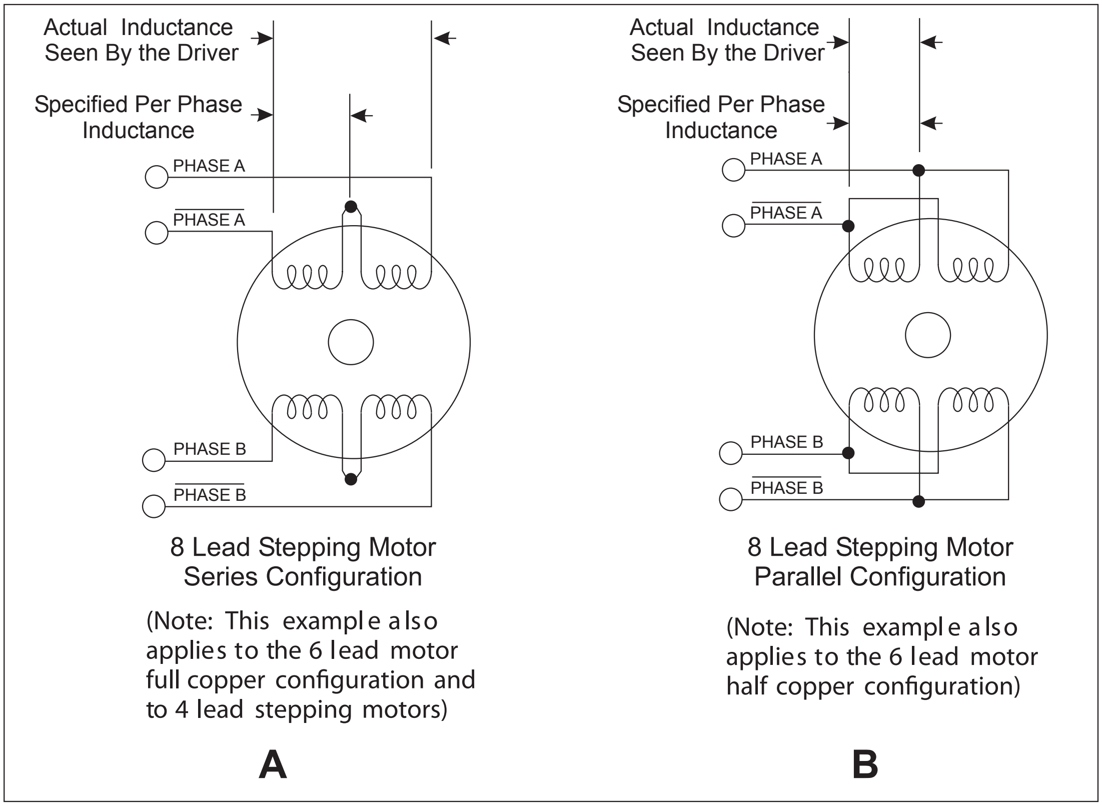


Figure 2.2.1 A & B: Per Phase Winding Inductance

N NOTE: In calculating the maximum phase inductance, the minimum supply output voltage should be used when using an unregulated supply.

Figure 2.2.1A shows a stepper motor in a series configuration. In this configuration, the per phase inductance will be 4 times that specified. For example: a stepping motor has a specified per phase inductance of 1.47mH. In this configuration the driver will see 5.88 mH per phase.

Figure 2.2.1B shows an 8 lead motor wired in parallel. Using this configuration the per phase inductance seen by the driver will be as specified.

> Maximum Motor Inductance (mH per Phase) =
> .2 X Minimum Supply Voltage

Using the following equation we will show an example of sizing a motor for an MForce MicroDrive used with an unregulated power supply with a minimum voltage (+V) of 18 VDC:

.2 X 18 = 3.6 mH

The recommended per phase winding inductance we can use is 3.6 mH.

Recommended IMS Motors

IMS also carries a series of 14, 17 and 23 frame enhanced stepping motors that are recommended for use with the MForce MicroDrive. These motors use a unique relationship between the rotor and stator to generate more torque per frame size while ensuring more precise positioning and increased accuracy.

The special design allows the motors to provide higher torque than standard stepping motors while maintaining a steadier torque and reducing torque drop-off.

These CE rated motors are ideal for applications where higher torque is required.

For more detailed information on these motors, please see the IMS Full Line catalog or the IMS web site at http://www.imshome.com._

14 Frame Enhanced (0.75A)

Single Shaft	Double Shaft
M-1410-0.75S	M-1410-0.75D

17 Frame Enhanced (1.5A)

Single Shaft	Double Shaft
M-1713-1.5S	M-1713-1.5D
M-1715-1.5S	M-1715-1.5D
M-1719-1.5S	M-1719-1.5D

23 Frame Enhanced (2.4A) — Not Available with Double Shaft

Single Shaft	Double Shaft
M-2218-2.4S	N/A
M-2222-2.4S	N/A
M-2231-2.4S	N/A

IMS Inside Out Stepper Motors

The new inside out stepper (IOS) motor was designed by IMS to bring versatility to stepper motors using a unique multi-functional, hollow core design.

This versatile new motor can be converted to a ball screw linear actuator by mounting a miniature ball screw to the front shaft face. Ball screw linear actuators offer long life, high efficiency, and can be field retrofitted. There is no need to throw the motor away due to wear of the nut or screw.

The IOS motors offer the following features:

- The shaft face diameter offers a wide choice of threaded hole patterns for coupling.
- The IOS motor can be direct coupled in applications within the torque range of the motor, eliminating couplings and increasing system efficiency.
- The IOS motor can replace gearboxes in applications where gearboxes are used for inertia damping between the motor and the load. The induced backlash from the gearbox is eliminated providing improved bidirectional position accuracy.
- Electrical or pneumatic lines can be directed through the center of the motor enabling the motors to be stacked end-to-end or applied in robotic end effector applications. The through hole is stationary, preventing cables from being chaffed by a moving hollow shaft.
- Light beams can be directed through the motor for refraction by a mirror or filter wheel mounted on the shaft mounting face.
- The IOS motor is adaptable to valves enabling the valve stem to protrude above the motor frame. The stem can be retrofitted with a dial indicator showing valve position.
- The motor is compatible with IMS bipolar drivers, keeping the system cost low.
- The IOS motor can operate up to 3000 rpm's.

The IOS motor is available in the following frames:

Frame Size	IMS PN
17 Frame	M3-1713-IOS
23 Frame	M3-2220-IOS

WARNING! Ensure proper connection of the motor phases prior to power application!

Motor Wiring

As with the power supply wiring, motor wiring should be run separately from logic wiring to minimize noise coupled onto the logic signals. Motor cabling exceeding 1' in length should be shielded twisted pairs to reduce the transmission of EMI (Electromagnetic Interference) which can lead to rough motor operation and poor system performance. Below are listed the recommended motor cables:

Dual Twisted Pair Shielded (Separate Shields)

≤ 5 feet..Belden Part# 9402 or equivalent 20 Gauge
≥ 5 feet..Belden Part# 9368 or equivalent 18 Gauge

When using a bipolar motor, the motor must be within 100 feet of the drive.

Connecting the Motor

The motor leads are connected to the following connector pins:

Phase	**Connector: Pin**
$\overline{\text{Phase A}}$	P4: 1
Phase A	P4: 2
$\overline{\text{Phase B}}$	P4: 3
Phase B	P4: 4

8 Lead Motors

8 lead motors offer a high degree of flexibility to the system designer in that they may be connected in series or parallel, thus satisfying a wide range of applications.

Series Connection

A series motor configuration would typically be used in applications where a higher torque at lower speeds is required. Because this configuration has the most inductance, the performance will start to degrade at higher speeds. Use the per phase (or unipolar) current rating as the peak output current, or multiply the bipolar current rating by 1.4 to determine the peak output current.

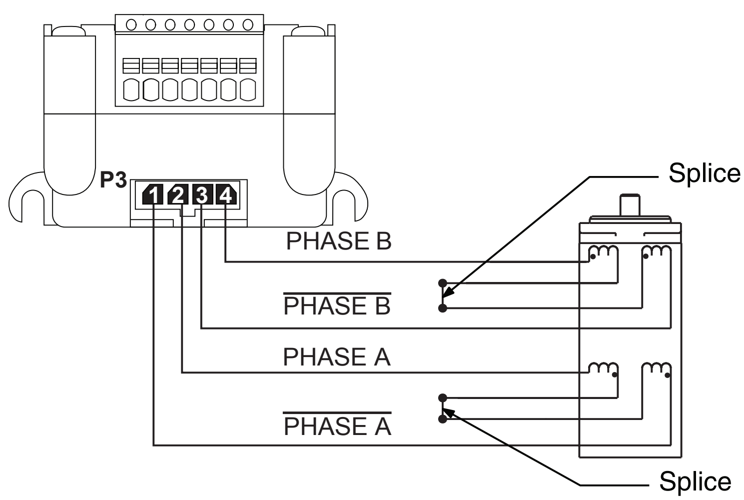


Figure 2.2.2: 8 Lead Motor Series Connections

Parallel Connection

An 8 lead motor in a parallel configuration offers a more stable, but lower torque at lower speeds. But because of the lower inductance, there will be higher torque at higher speeds. Multiply the per phase (or unipolar) current rating by 1.96, or the bipolar current rating by 1.4, to determine the peak output current.

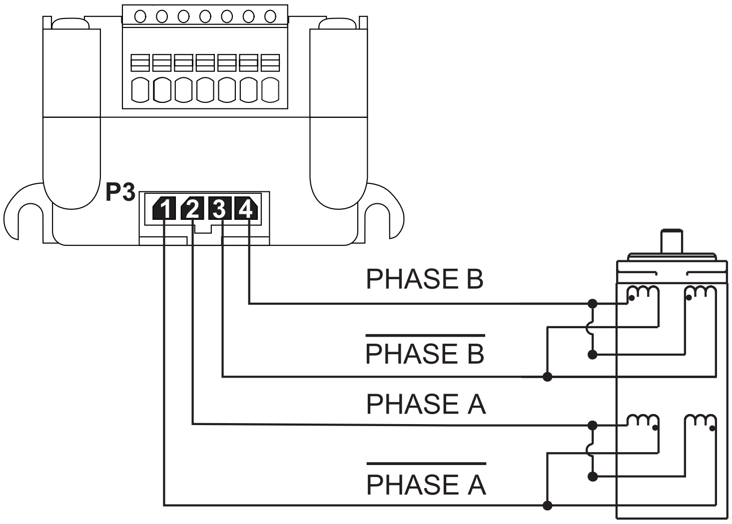


Figure 2.2.3: 8 Lead Motor Parallel Connections

WARNING! Ensure proper connection of the motor phases prior to power application!

6 Lead Motors

Like 8 lead stepping motors, 6 lead motors have two configurations available for high speed or high torque operation. The higher speed configuration, or half coil, is so described because it uses one half of the motor's inductor windings. The higher torque configuration, or full coil, uses the full windings of the phases.

Half Coil Configuration

As previously stated, the half coil configuration uses 50% of the motor phase windings. This gives lower inductance, hence, lower torque output. Like the parallel connection of 8 lead motor, the torque output will be more stable at higher speeds. This configuration is also referred to as half copper. In setting the driver output current multiply the specified per phase (or unipolar) current rating by 1.4 to determine the peak output current.

Full Coil Configuration

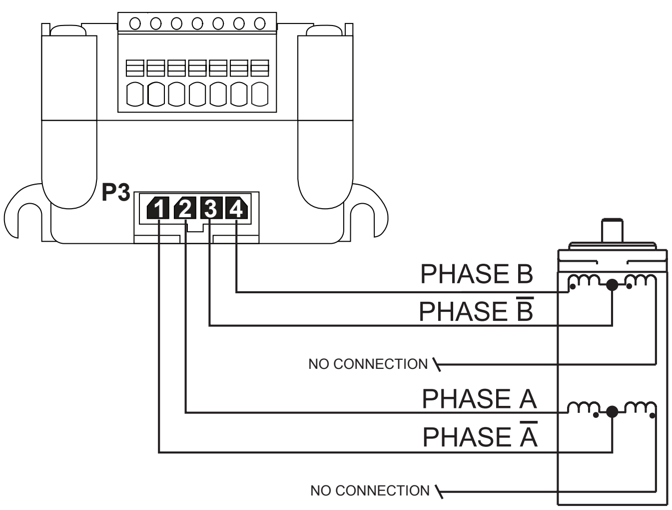


Figure 2.2.4: 6 Lead Half Coil (Higher Speed) Motor Connections

The full coil configuration on a six lead motor should be used in applications where higher torque at lower speeds is desired. This configuration is also referred to as full copper. Use the per phase (or unipolar) current rating as the peak output current.

WARNING! Ensure proper connection of the motor phases prior to power application!

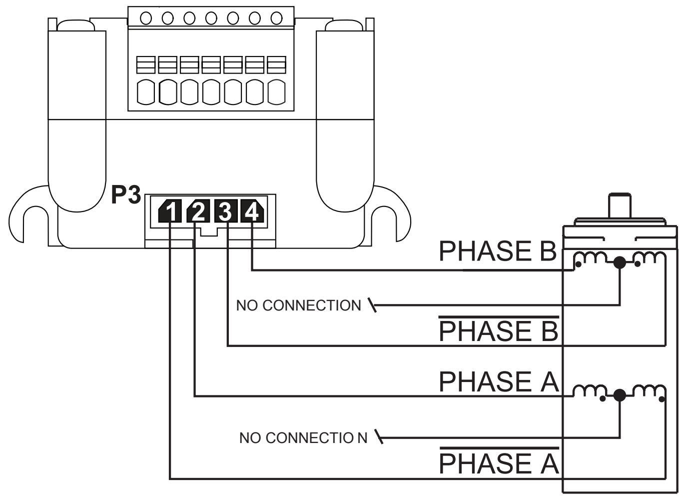


Figure 2.2.5: 6 Lead Full Coil (Higher Torque) Motor Connections

4 Lead Motors

4 lead motors are the least flexible but easiest to wire. Speed and torque will depend on winding inductance. In setting the driver output current, multiply the specified phase current by 1.4 to determine the peak output current.

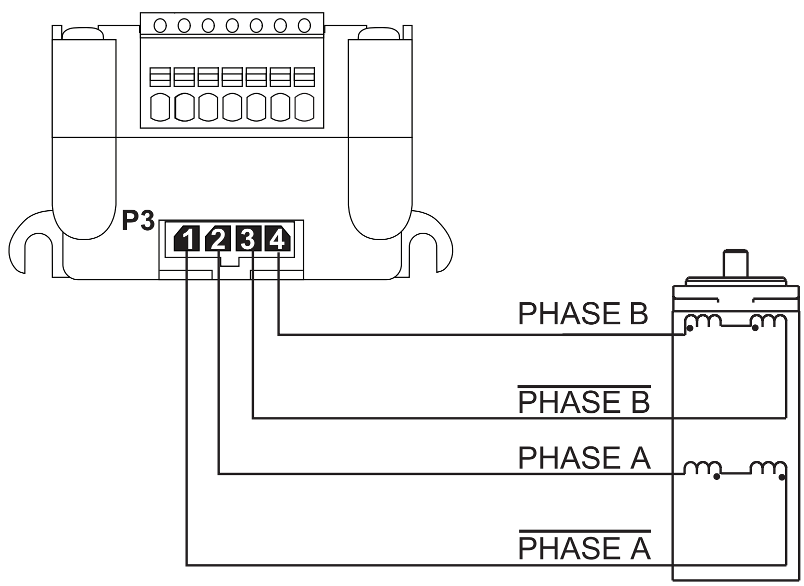


Figure 2.2.6: 4 Lead Motor Connections

Interfacing Communications

Note: See the Specifications Section of this document specific to the MForce MicroDrive model you purchased for detailed connector and pin information.

Available Communications Cables/Converters

To simplify the wiring and connection process IMS offers a USB to RS-422 communications cable for the MForce MicroDrive. This convenient 12.0' (3.6m) accessory cable connects a PC's USB Port to the MForce MicroDrive P2 Connector. An in-line RS-422 converter enables parameter setting to a single MForce MicroDrive. Cable purchase recommended with first orders.

USB to 10-Pin IDC ....Part No. MD-CC400-000
10-Pin IDC to Wire Crimp Adapter ....Part No. MD-ADP-H

For more information on these cables please reference Appendix D: Optional Cables and Cordsets.

WARNING! Do not connect or disconnect the Communications Converter Cable while power is applied!

Interfacing Single Mode Communications

The MForce MicroDrive communicates to the host using the RS-422/485 protocol. Communications may be configured as either half duplex (RS-485) or full duplex (RS-422) using the EM (Echo Mode) Instruction. RS-422/485 may be used in two ways: either to communicate to a single MForce MicroDrive, or to address up to 62 individually named MForce MicroDrive nodes in a multidrop system.

Single Mode Communications Full Duplex (RS-422)

To interface the MForce MicroDrive using RS-422 protocol you will need one of the following:

- A PC equipped with RS-422 Interface.
- A PC RS-232 to RS-422/485 Converter.
- The USB to RS-422 accessory cable.

WARNING! If using AUX-Logic, the Power return MUST be connected to the Motor Power Ground. DO NOT connect the return to Communications Ground!

Use the following diagram to connect RS-422 communications to the MForce MicroDrive.

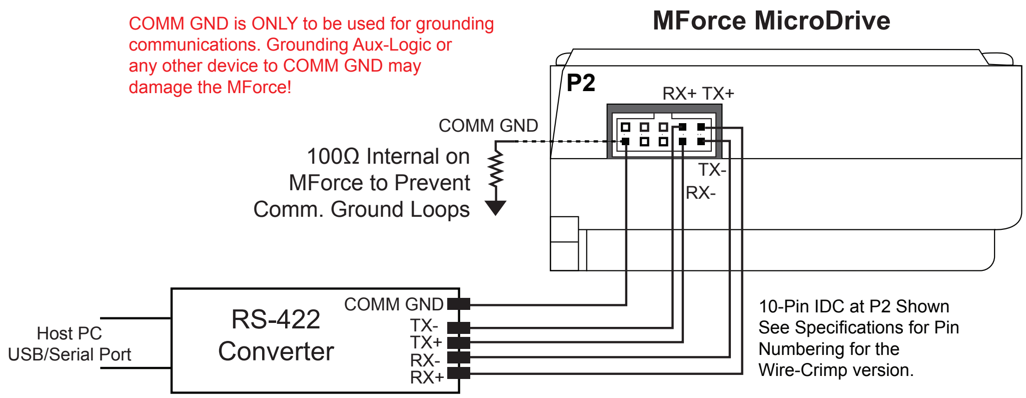


Figure 2.3.1: Full Duplex Communications (RS-422)

Single Mode Communications Half Duplex (RS-485)

The MForce MicroDrive can be operated in a 2 wire RS-485 communication bus. Before connecting the 2 wire RS-485, download your program and setup instructions using the standard 4 wire RS-422 Communications Cable. If a program is not being used, download and save any setup parameters. To ensure the MForce MicroDrive responds only to commands specifically meant for it, set the unit in Party Mode (Please see Party Mode below). The Echo Mode command (EM) must be set to the value of 1 (EM=1). This will set the MForce MicroDrive communication into "half duplex" mode. Connect the driver in the 2 wire RS-485 configuration. The following diagram illustrates how to connect the MForce MicroDrive 4 wire RS-485 to operate as a 2 wire system.

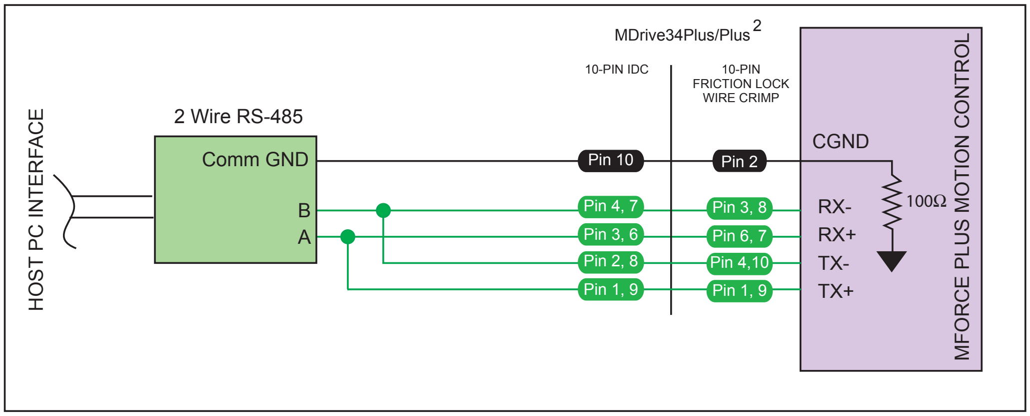


Figure 2.3.2: Half Duplex 2 Wire Communications (RS-485)

Interfacing Party Mode Communications

In systems with multiple controllers it is necessary to communicate with the control modules using party mode (PY=1). The MForce MicroDrive 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 MForce 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 MForce 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 commands to every device in the system. NOTE: When using the asterisk "*" in Party Mode, typed entries and commands will not be echoed. See Appendix A of the Software Reference for ASCII table.

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

1. Connect the first MForce MicroDrive to the Host PC configured for Single Mode Operation.
2. Establish communications and download program if required.
3. Using the command DN, name the MForce MicroDrive. This can be any upper or lower case ASCII character or number 0-9. (DN="A"{enter}) (Note: The quotation marks before and after the device name are required.)
4. Set the party flag PY=1{enter}.
5. Press CTRL+J to activate the Party Mode.
6. Type the letters AS and press CTRL+J (Save device name and Party Mode).
7. Remove power.
8. Repeat steps 1 through 7 for each additional MForce in the system.
9. After all MForce MicroDrives are assigned a Device Name, the Multiple MForce Interface can be configured as shown in the following figure.

Data Cable Termination Resistors

Data Cable lengths greater than 15 feet (4.5 meters) are susceptible to signal reflection and/or noise. IMS recommends 120 Ω termination resistors in series with 0.1µf capacitors at both ends of the Data Cables. An example of resistor placement is shown in Figure 2.3.3. For systems with Data Cables 15 feet (4.5 meters) or less, the termination resistors are generally not required.

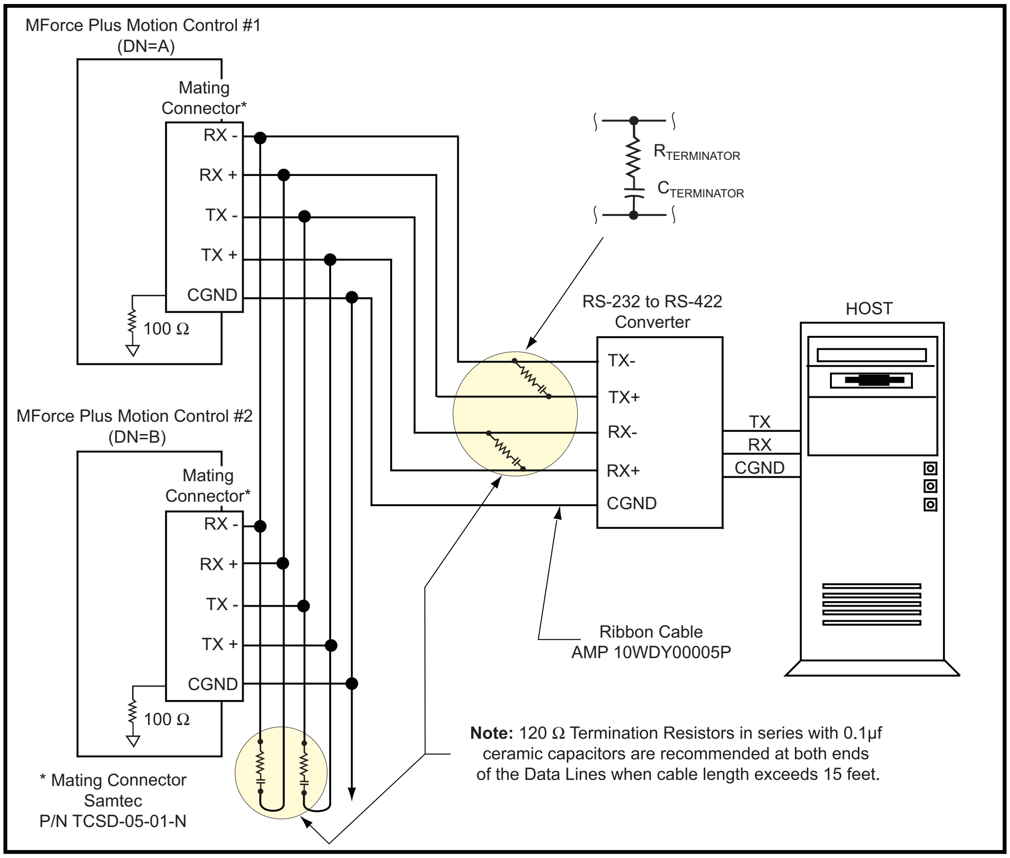


Figure 2.3.3: RS-485 Interface, Multiple MForce MicroDrive System

MForce MicroDrive Communication Format

The following communication formats are used by the MForce MicroDrive.

```
{}          The contents between the {} symbols are transmitted.
{0D}        Hex equivalent for a CR (Carriage Return).
{0A}        Hex equivalent for a LF (Line Feed).
{DN}        Represents the Device Name being sent.
{CS}        Check Sum; {ACK} 06 Hex; {NAK} 15 Hex
         EM = Echo Mode;   PY = PartY Mode;   CK= ChecK sum
```

The word {command} represents the immediate command sent to the MForce MicroDrive.

Command Execution Time (CET) is the time the MForce MicroDrive takes to execute a command. This varies from command to command and usually is in the 1-5 millisecond range.

MForce MicroDrive Response to Echo Mode

Dependent on how the Echo Mode (EM) is set in conjunction with Party Mode (PY) and Check Sum (CK), the MForce MicroDrive will respond differently. The following tables illustrate the various responses based on how the EM, PY and CK parameters are set.

Parameter Setting	Transmission to MForce MicroDrive	MForce MicroDrive Initial Response	MForce MicroDrive Final Response	Notes
EM=0 & PY=0 CK=0	(command) (D)	(command) Echoed back one character at a time as the character is entered.	CET (0D) (0A)>	The last character sent is the prompt >
EM=1 & PY=0 CK=0	(command) (0D)	–	CET (0D) (0A)	The last character sent is LF
EM=2 & PY=0 CK=0	(command) (0D)	–	–	No response except to PR and L commands
EM=3 & PY=0 CK=0	(command) (0D)	–	CET command (0D) (0A)	Queued response. The last character sent is the LF

Table 2.3.1: MForce MicroDrive Response to Echo Mode - Party and Check Sum are Zero (0)

Parameter Setting	Transmission to MForce MicroDrive	MForce MicroDrive Initial Response	MForce MicroDrive Final	Notes
EM=0 & PY=1 CK=0	(DN) (command) (0A)	(command) Echoed back one character at a time as the character is entered.	CET (0D) (0A)>	The last character sent is the prompt >
EM=1 & PY=1 CK=0	(DN) (command) (0A)	–	CET (0D) (0A)	The last character sent is LF
EM=2 & PY=1 CK=0	(DN) (command) (0A)	–	–	No response except to PR and L commands
EM=3 & PY=1 CK=0	(DN) (command) (0A)	–	CET command (0D) (0A)	Queued response. The last character sent is the LF

Table 2.3.2: MForce MicroDrive Response to Echo Mode - Party is One (1) and Check Sum is Zero (0)

Parameter Setting	Transmission to MForce MicroDrive	MForce MicroDrive Initial Response	MForce MicroDrive Final Response	Notes
EM=0 & PY=0 CK=1	(DN) (command) (0A)	(command) Echoed back one character at a time as the character is entered.	CET (0D) (0A)>	The last character sent is the prompt >
EM=1 & PY=0 CK=1	(DN) (command) (0A)	–	CET (0D) (0A)	The last character sent is LF
EM=2 & PY=0 CK=1	(DN) (command) (0A)	–	–	No response except to PR and L commands
EM=3 & PY=0 CK=1	(DN) (command) (0A)	–	CET command (0D) (0A)	Queued response. The last character sent is the LF

Table 2.3.3: MForce MicroDrive Response to Echo Mode - Party is Zero (0) and Check Sum is One (1)

Parameter Setting	Transmission to MForce MicroDrive	MForce MicroDrive Initial Response	MForce MicroDrive Final Response	Notes
EM=0 & PY=1 CK=1	(DN) (command) (CS) (0A)	(command) Echoed back one character at a time as the character is entered.	CET (ACK) or (NAK)>	The last character sent is the prompt >
EM=1 & PY=1 CK=1	(DN) (command) (CS) (0A)	–	CET (ACK) or (NAK)>	The last character sent is ACK or NAK
EM=2 & PY=1 CK=1	(DN) (command) (CS) (0A)	–	–	No response except to PR and L commands
EM=3 & PY=1 CK=1	(DN) (command) (CS) (0A)	–	CET command (CS) (ACK) (NAK)	Queued response. The last character sent is ACK or NAK

Table 2.3.4: MForce MicroDrive Response to Echo Mode - Party and Check Sum are One (1)

Using Check Sum

For communication using Check Sum, the following 2 commands demonstrate sending and receiving.

Sending Command

1. Check Sum set to ZERO before first character is sent.
2. All characters (ASCII values) are added to Check Sum, including the Device Name DN (if PY=1), to the end of the command, but not including terminator.
3. Check Sum is 2's complement, then "OR" ed with Hex 80 (prevents Check Sum from being seen as Command Terminator).
4. Terminator Sent.

Example command:

MR (space) 1	**Note:** Any combination of upper/lower case may be used. In this example, if a lower case <mr> were to be used, the decimal values will change to 109 and 114. Subsequently the Result Check Sum value will change. (Possible entries: MR, mr, Mr, mR.) (M = 77, R =82, m = 109, r = 114) (See ASCII table appendix in MForce MicroDrive Software Manual.)
77 82 32 49	Decimal value of M, R, <space> and 1
4D 52 20 31	Hex
77+82+32+49 = 240	Add decimal values together
1111 0000 = 240	Change 240 decimal to binary
0000 1111	1's complement (invert binary)
0001 0000	Add 1 [2's complement]
1000 0000	OR result with 128 (Hex 80)
1001 0000 144	Result Check Sum value

Once the result is reached, add the check Sum value (144 in this example) to your string by typing: MR 1(Alt Key + 0144) (Use the symbol of 0144 in your string by holding down the alt key and typing 0144). You must type the numbers from the Numlock key pad to the right of the keyboard. The numbers at the top of the keyboard will not work.

Receiving Command

1. Check Sum set to ZERO.
2. All characters are added to Check Sum.
3. When receiving a Command Terminator, the lower 7 bits of the Check Sum should be equal to ZERO.
    a) If not ZERO, the command is ignored and NAK echoed.
    b) If ZERO, ACK is sent instead of CR/LF pair.
4. Responses to PR commands will be Check Summed as above, but the receiving device should NOT respond with ACK or NAK.

MForce MicroDrive Party Mode Sample Codes

1. Download this segment of code into the first MForce MicroDrive. After downloading the program to the unit, follow the Set Up instructions described earlier. Be sure to set your first unit with the unique Device Name of A (DN=”A”). The device name is case sensitive.

```
RC=25               'Run current
HC=5                'Hold current
MS=256              'Microstep selection
A=250000            'Acceleration
D=250000            'Deceleration
PG 1                'Enter program mode
S1=0,0              'Setup I/O 1 as an input low true
LB SU               'Start program upon power up
LB AA               'Label program AA
MR 104400           'Move relative 104400 counts
H                   'Hold program execution to complete the move
LB DD               'Label program DD
BR DD,I1=0          'Branch to DD if I1=0
4PR "Bex 1"         'Print device name B to execute program
                    'at address 1
H 2000              'Hold program execution 2000 milliseconds
PR "Cex 1"          'Print device name C to execute program at
                    'address 1
H 2000              'Hold program execution 2000 milliseconds
BR AA               'Branch to label AA
E
PG                  'Exit program, return to immediate mode
```

2. Download this segment of code into your second MForce MicroDrive. After downloading the program to the unit, follow the previous party mode instructions. Be sure to set your second unit with the unique address of B (device name is case sensitive).

```
RC=25               'Run current
HC=5                'Hold current
MS=256              'Microstep selection
A=250000            'Acceleration
D=250000            'Deceleration
PG 1                'Enter program mode
LB BB               'Label program BB
MR 208000           'Move relative 208000 counts
H                   'Hold program execution to complete the move
E
PG                  'Exit program, return to immediate mode
```

3. Download this segment of code into your third MForce MicroDrive. After downloading the program to the unit, follow the previous party mode instructions. Be sure to set your third unit with the unique address of C (device name is case sensitive).

```
RC=25               'Run current
HC=5                'Hold current
MS=256              'Microstep selection
A=250000            'Acceleration
D=250000            'Deceleration
PG 1                'Enter program mode
LB CC               'Label program CC
MR 300000           'Move relative 300000 counts
H                   'Hold program execution to complete the move
E
PG                  'Exit program, return to immediate mode
```

MForce MicroDrive Immediate Party Mode Sample Codes

Once Party Mode has been defined and set up as previously described under the heading “Multiple MForce MicroDrive System (Party Mode)”, you may enter commands in the Immediate Mode in the IMS Terminal Window. Some examples follow.

Move MForce A, B or C 10000 Steps

Assuming there are three MForce MicroDrives set up in Party Mode as shown in the Sample Codes above.

- To move MForce Unit “A”, Press Ctrl+J and then type: AMR^10000 and press Ctrl+J. MForce Unit “A” will move 10000 steps.
- To print the position type: APR P and press Ctrl+J. The position of MForce Unit “A” will be printed.
- To move MForce Unit “B” type: BMR 10000 and press Ctrl+J. MForce Unit “B” will move 10000 steps.
- To move all three MForce MicroDrives at the same time type: *MR 10000 and press Ctrl+J. All MForce MicroDrives will move 10000 steps.
- To change a Variable in the “C” unit type: C<variable name><number> and press Ctrl+J. The variable will be changed. To verify the change type: CPR <variable name> and press Ctrl+J. The new value will be displayed.

  All Commands and Variables may be programmed in this manner.
- To take an MForce out of Party Mode type: <device name>PY=0 and press Ctrl+J. That unit will be taken out of Party Mode. To take all units out of Party Mode type: *PY=0 and press Ctrl+J. All units will be taken out of Party Mode.

N NOTE: When instructed to type Ctrl+J, that is the key + the key. It will not display in the Terminal Window so be certain you press the correct keys. CtrlJ activates the Party Mode.

N NOTE: Once you have activated Party Mode with the first Ctrl+J you do not have to type it before each successive command. However, every command must be followed with a Ctrl+J.

N NOTE: The asterisk (*) is a global command which addresses all units. Since three units can not answer together, the asterisk (*) as well as other global commands will not be displayed in the Terminal Window.

NOTE: On the Standard MForce MicroDrive, when configured as outputs, the I/O set is sinking ONLY! The Plus^2 Models add the functionality of I/O Power, which enables the user to use all the outputs, both Standard and Enhanced, as Sinking or Sourcing.

NOTE: If the unit purchased has the remote encoder option, the additional points become dedicated to encoder functions!

Interfacing and Using the MForce MicroDrive I/O

The MForce MicroDrive Digital I/O

The MForce MicroDrive product line is available with two digital I/O configurations, Standard and Enhanced.

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 "0" when the level is HIGH. The active HIGH/LOW state is configured by the third parameter of the I/O Setup (S1-4, S9-12) variable. The goal of this I/O configuration scheme is to maximize compatibility between the MForce MicroDrive and standard sensors and switches.

Standard .... ***All MForce MicroDrive***
Available Points .... IO1, IO2, IO3, IO4 (Sinking or Sourcing Inputs, Sinking Outputs ONLY)

Enhanced (16-Pin) .... ***Plus^2 Only***
Available Points .... IO1, IO2, IO3, IO4 (Sinking Sourcing, Outputs/Inputs)
Additional Points .... IO9, IO10, IO11, IO12 (Sinking Sourcing, Outputs/Inputs)
Dedicated I/O .... Step/Clock Input, Step/Direction I/O, Capture Input/Trip Output

Remote Encoder Configuration (16-Pin) .... ***Plus^2 Only***
Available Points .... IO1, IO2, IO3, IO4 (Sinking Sourcing, Outputs/Inputs)
Dedicated I/O .... Capture Input/Trip Output
Remote Encoder I/O .... Channel A±, Channel B±, Index±

Standard I/O Set

The MForce MicroDrive comes standard with a set of four I/O — (4) sinking or sourcing 0 to +24 VDC inputs or (4) sinking 0 to +24 VDC outputs, which may be programmed individually as either general purpose or dedicated inputs or outputs, or collectively as a group.

Enhanced I/O Set - MForce MicroDrive Plus^2 Version

The MForce MicroDrive Plus^2 Version is equipped with a set of eight I/O — (8) sinking or sourcing 0 to +24 VDC inputs or (8) sinking or sourcing +12 to +24 VDC outputs, which may be programmed individually as either general purpose or dedicated inputs or outputs, or collectively as a group. The eight I/O consist of two separate banks of four points: Bank 1: IO1 - IO4, Bank 2: IO9 - IO12.

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, LEDs and PLC inputs may be controlled from the MForce MicroDrive.

Each I/O point may be individually programmed to any one of 9 dedicated input functions, 4 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 the I/O Setup Variable (S1-4, S9-12)

When the level is HIGH. The active HIGH/LOW state is

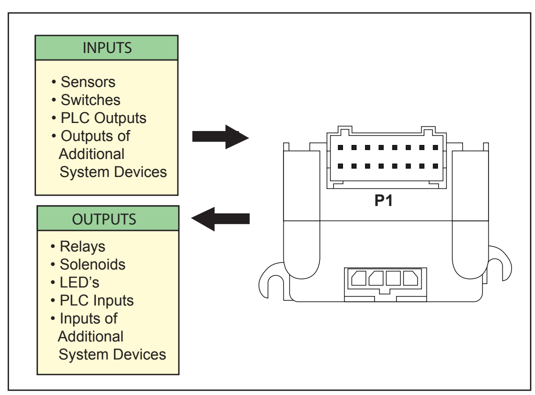


Figure 2.4.1: Uses for the Digital I/O

configured by the second parameter of the I/O Setup (S1-4, S9-12) variable. The goal of this I/O configuration scheme is to maximize compatibility between the MForce MicroDrive and standard sensors and switches.

MForce MicroDrive Digital Input Functions

The MForce MicroDrive inputs may be interfaced to a variety of sinking or sourcing devices. An input may be programmed to be a general purpose user input, or to one of nine dedicated input functions. These may then be programmed to have an active state of either HIGH or LOW.

The inputs are configured using the "S" Variable (See MCode Software Reference Manual for precise details on this command). The command is entered into the IMS terminal or program file as S<IO point>=<IO Type>,<Active State><Sink/Source>.

Example:

```
S9=3,1,0      'set IO point 9 to be a Limit- input, Active HIGH, Sourcing
S3=0,0,1      'set IO Point 3 to be a General Purpose input, Active LOW,
              'Sinking
```

Input Functions (I/O Points 1-4, 9-12)

The following table lists the programmable input functions of the MForce.

Function	Description	Parameter (S1-S4, S9-S12)	Active	Sink/ Source
General Purpose	General Purpose Input function used to control program branches, subroutine calls or BCD functions when input bank is used as a group	0	0/1	0/1
Home	Homing input. Will function as specified by the Home (HM) command.	1	0/1	0/1
Limit +	Positive Limit Input. Will function as specified by the Limit (LM) Command.	2	0/1	0/1
Limit –	Negative Limit Input. Will function as specified by the Limit (LM) Command.	3	0/1	0/1
G0	G0 Input. Will run program located at address 1 on activation.	4	0/1	0/1
Soft Stop	Soft Stop input. Stops motion with deceleration and stops program execution.	5	0/1	0/1
Pause	Pause/Resume program with motion.	6	0/1	0/1
Jog +	Will Jog motor in the positive direction at Max. Velocity (VM). The Jog Enable (JE) Flag must be set for this to function.	7	0/1	0/1
Jog –	Will Jog motor in the negative direction at Max. Velocity (VM). The Jog Enable (JE) Flag must be set for this to function.	8	0/1	0/1
Reset	When set as RESET input, then the action is equivalent to a ^C entered into a terminal.	11	0/1	0/1

Table 2.4.1: Programmable Input Functions

NOTE: On the Standard MForce MicroDrive, when configured as outputs, the I/O set is sinking ONLY! The Plus[2] Models add the functionality of I/O Power, which enables the user to use all the outputs, both Standard and Enhanced, as Sinking or Sourcing.

Input Functions (Points 7 & 8 — Clock Inputs and Point 13 — Capture)

Function	Description	Parameter (S7, S8)	Active
Step/Direction	Sets I/O 7 and 8 to receive step and direction inputs from an external source. The motion will occur based on the input frequency seen at I/O 7 in the Direction relative to the logic state of I/O 8. The step rate will be based upon the ratio set by Clock Ratio (CR)	33	0/1
Quadrature	Sets I/O 7 and 8 to receive Channel A and Channel B Quadrature inputs from an external source such as an encoder. The motion will follow the Quadrature Input.	34	0/1
Up/Down	Sets I/O 7 and 8 to receive Clock Up/Clock Down inputs from an external source. The motion will occur based upon the input clock frequency in the direction relative to the input being clocked. The step rate will be based upon the ratio set by Clock Ratio (CR)	35	0/1
Function	**Description**	**Parameter (S13)**	**Active**
High Speed Capture	The Capture input is a momentary high speed input that operates with the Trip Capture (TC) variable to run a subroutine upon the trip. It feature variable input filtering ranging from 50 nS to 12.9 µS	60	0/1

Table 2.4.2: Dedicated Input Functions

Active States Defined

The Active State determines at what voltage level the input will be active.

Active HIGH .... The input will be active when +5 to +24 VDC is applied to the input.
Active LOW .... The input will be active when it is grounded (0 VDC).

Active LOW example:

IO 1 is to be configured as a Jog– input which will activate when a switch is toggled to ground (Sinking Input):

```
S1=8,0,0      'set IO point 1 to Jog-, Active LOW, Sinking
```

Active HIGH example:

IO 4 is to be configured as a Home input which will activate when instructed by a PLC (+24VDC Sourcing Input):

```
S4=1,1,1      'set IO point 1 to Home, Active HIGH, Sourcing
```

MForce MicroDrive Digital Output Functions

The MForce MicroDrive Outputs may be configured as general purpose or set to one of two dedicated functions, Fault or Moving. These outputs will sink up to 600 mA (one channel of two banks) and may be connected to an external VDC source. See Output Functions Table and I/O Ratings Table.

The outputs are set using the "S" command (See MCode Software Reference Manual for precise details on this command). The command is entered into the IMS terminal or program file as S<IO point>=<IO Type>,<Active State><Sink/Source>.

Example:

```
S9=17,1,0     'set IO point 9 to be a Moving Output, Active HIGH, Sinking
S3=18,0,0     'set IO Point 3 to be a Fault Output, Active LOW, Sinking
```

Programmable Output Functions

The MForce MicroDrive Output functions may be programmed to be a general purpose user output or to one of five output functions.

Function	Description	Parameter (S1-S4, S9-S12)	Active	Sink/ Source
General Purpose User	A general purpose output can be set in a program or in immediate mode to trigger external events. When used as a group they can be a BCD output.	16	0/1	0/1
Moving	Will be in the Active State when the motor is moving.	17	0/1	0/1
Fault	Will be in the Active State when a error occurs. See Software Manual for error code listing.	18	0/1	0/1
Stall	Will be in the Active State when a stall is detected. Encoder Required, Stall Detect Mode (SM) must be enabled.	19	0/1	0/1
Velocity Changing	Will be in the Active State when the velocity is changing. Example: during acceleration and deceleration.	20	0/1	0/1

Table 2.4.3: Programmable Output Functions

Output Functions (Points 7 & 8 — Clock Outputs and Point 13 — Trip)

Function	Description	Parameter (S7, S8)	Active
Step/Direction	Step clock pulses will be output from Point 7, Direction from Point 8. The step clock output rate will be based upon the Pulse Width set by Clock Width (CW). The logic state of the Direction output will be with respect to the direction of the motor.	49	0/1
Quadrature	Will output Quadrature signals.	50	0/1
Up/Down	Will output Clock Up/Clock Down signals. The step clock output rate will be based upon the Pulse Width set by Clock Width (CW). The Active output will be based on the motor direction.	51	0/1
Function	**Description**	**Parameter (S13)**	**Active**
High Speed Trip	The trip output will activate on Position Trips (TP) only. The output will pulse out at the trip point. The pulse width will be determined by Clock Width (CW)	61	0/1

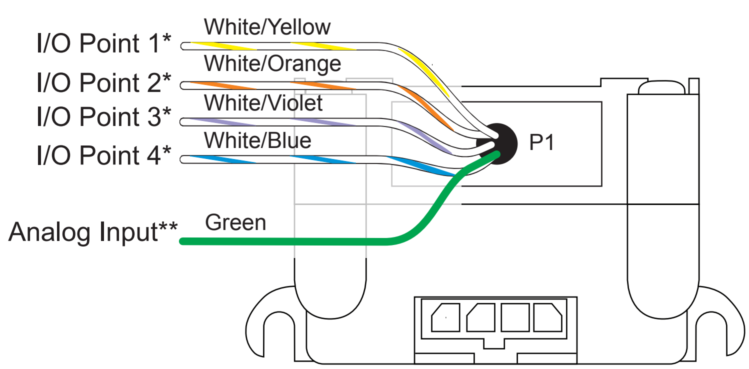
Table 2.4.4: Dedicated Output Functions

MForce MicroDrive I/O Ratings

MForce MicroDrive I/O Ratings			
Standard Output Voltage (IOPWR) Rating	0 to +24 VDC		
Expanded Plus² Output Voltage (IOPWR) Rating	+12 to +24 VDC (Sourcing) | 0 to +24 VDC (Sinking)		
Load Rating* (equal current per I/O Point)	I/O State	I Continuous	I Peak (D=0.84)
* Heatsink Temp = 85□C	1 on, 3 off	550 mA	600 mA
	2 on, 2 off	390 mA	425 mA
	3 on, 1 off	320 mA	350 mA
	4 on, 0 off	275 mA	300 mA
To compute FET dissipation for unequal loads, calculate the FET power for each I/O not to exceed 425 mW.			
Continuous Current	FET Power = I_{cont}^2 x 1.4		
Peak Current	FET Power = I_{peak}^2 x D x 1.4		
Duty Cycle	(D =T on /T period) = ≤ 1.0 seconds at 85˚C heatsink temperature.		
Protection Ratings			
Independent Over-temperature			
Current Limit	0.6A to 1.2 A		
Clamp	+45V, -20V		

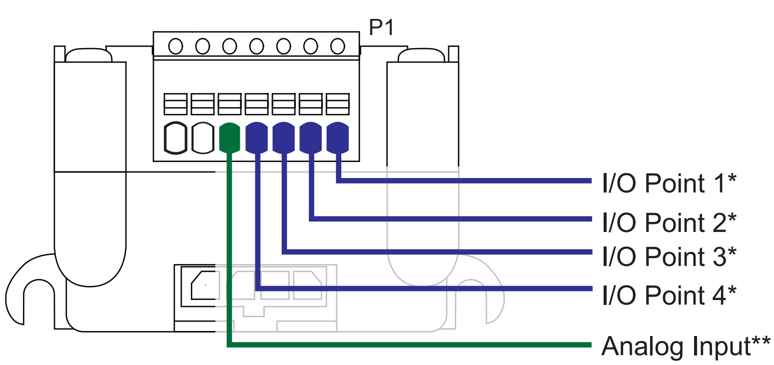
Table 2.3.5: MForce MicroDrive I/O and Protection Ratings

MForce Standard I/O Connections



*Sinking or Sourcing Inputs/Sinking Output
** 0 to 5 VDC, 0 to 10 VDC, 0 to 20 mA, 4 to 20 mA, PWM

Figure 2.4.2: Flying Lead I/O Connections



7-Pin Pluggable Terminal

*Sinking or Sourcing Inputs/Sinking Output
** 0 to 5 VDC, 0 to 10 VDC, 0 to 20 mA, 4 to 20 mA

Figure 2.4.3: 7-Pin Pluggable Terminal I/O Connections

MForce Expanded Plus² I/O Connections

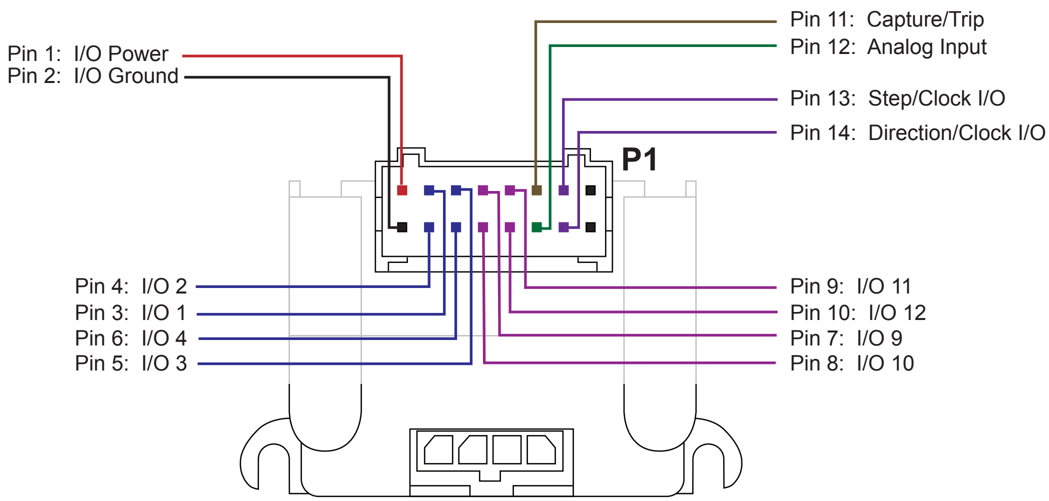


Figure 2.4.4: Plus 2 I/O Connections - Expanded I/O Configuration

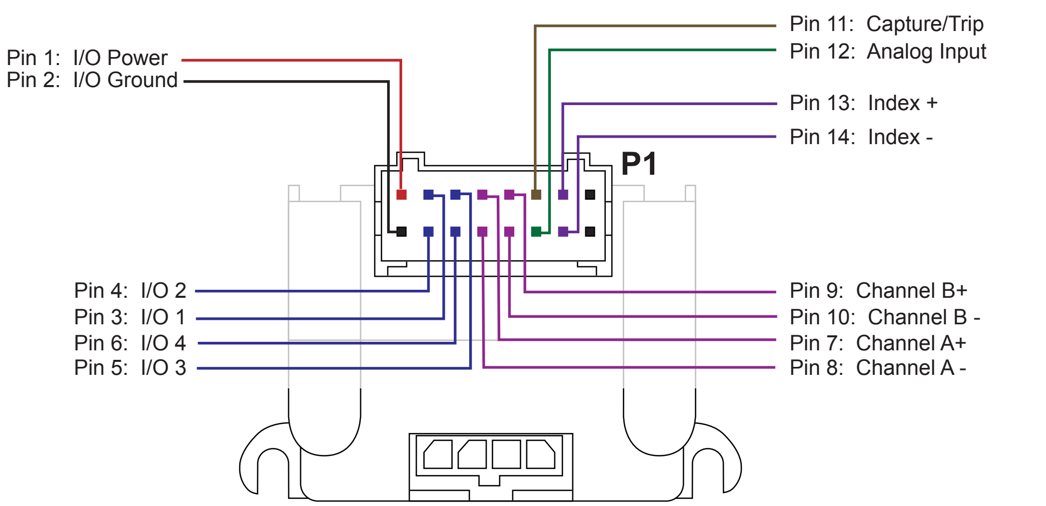


Figure 2.4.5: Plus 2 I/O Connections - Closed Loop Configuration

NOTE: On the Standard MForce MicroDrive, power ground is used to ground the I/O interface.

NOTE: Advanced I/O interface circuit diagrams and application examples are available in the I/O Applications Guide Appendix.

I/O Usage Examples — MForce MicroDrive Standard I/O Set

The circuit examples below illustrate possible interface examples for using the MForce MicroDrive Digital I/O. Additional diagrams and code snippets are available in Appendix D: I/O Application Guide.

The code samples included with these examples will also serve to introduce the user to MForce MicroDrive programming. Please reference the MForce software manual for more information on the Instructions, Variables and Flags that make up the MForce MicroDrive command set as well as material on setting up and using the IMS Terminal.

Input Interface Example - Switch Input Example (Sinking Input)

The following circuit example shows a switch connected between an I/O point and power ground.

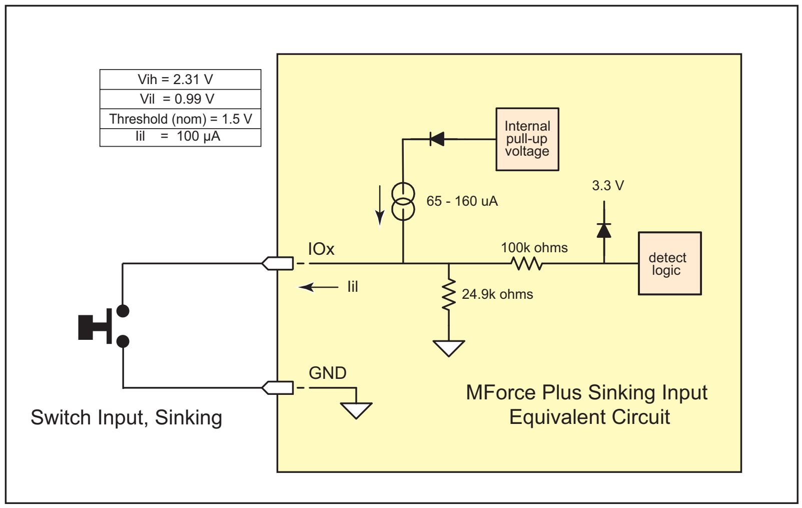


Figure 2.4.6: Sinking Input Example using a Push Button Switch

Code Sample

For the code sample, this switch will be set up as a G0 sinking input, active when low. When pressed, the switch will launch the program beginning at address1 in MForce memory:

```
***Setup Variables***
Sx=4,0,0      'set IO point x to be a G0 input, active when LOW, sinking

****Program***
PG1
MR 20000      'Move +20000 steps relative to current position
H             'Hold program execution until motion completes
MR -20000     'Move -20000 steps
H             'Hold program execution until motion completes
E
PG            'End program, exit program mode
```

Input Interface Example - Switch Input Example (Sourcing Input)

The following circuit example shows a switch connected between an I/O point and a voltage supply which will source the input to perform a function.

Code Sample

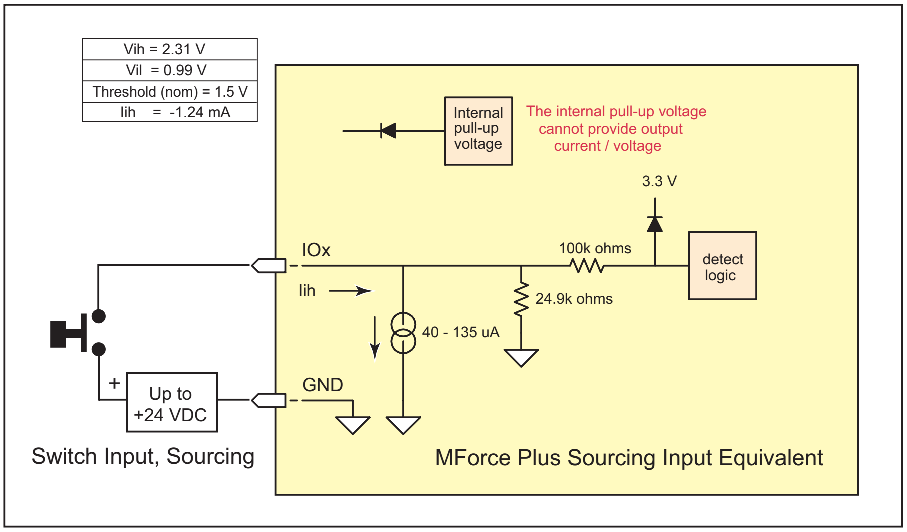


Figure 2.4.7: Sourcing Input Example using a Push Button Switch

For the code sample, the switch will be set up as a Soft Stop sourcing input, active when HIGH. When pressed, the switches will stop the motor.

```
S1=5,1,1      'set IO point 1 to be a Soft Stop input, active when HIGH,
              'sourcing
SL 200000     'enter this to slew the motor at 200000 µsteps/sec
```

When the switch is depressed the motor will decelerate to a stop.

NOTE: On the Standard MForce MicroDrive, when configured as outputs, the I/O set is sinking ONLY! The Plus[2] Models add the functionality of I/O Power, which enables the user to use all the outputs, both Standard and Enhanced, as Sinking or Sourcing.

Output Interface Example (Sinking Output)

The following circuit example shows a load connected to an I/O point that will be configured as a sinking output.

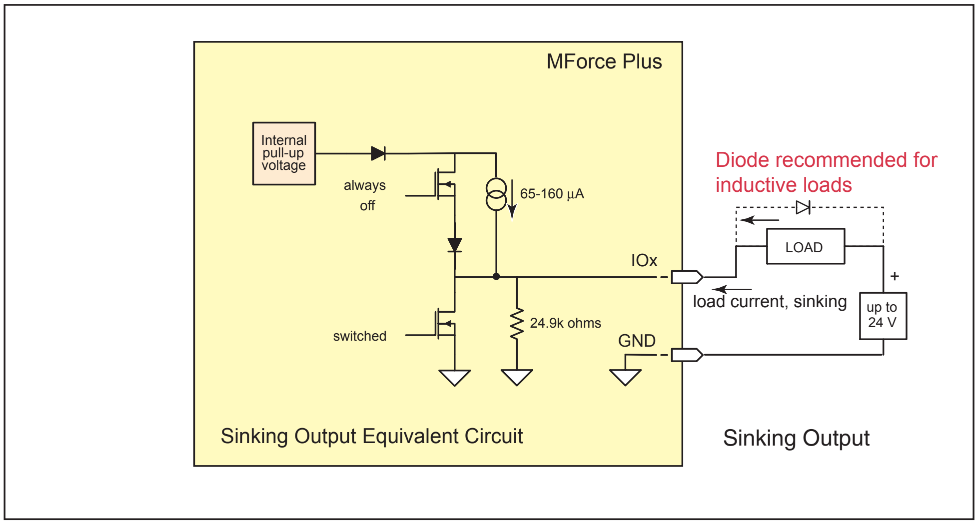


Figure 2.4.8: Sinking Output Example

Code Sample

For the code sample, the load will be an LED. The I/O point will be configured such that the LED will be unlit while the velocity is changing. Use the switch set-up from the previous input, modified to be sinking, example to soft stop the motor.

```
S1=5,0,0      'set IO point 1 to be a Soft Stop input, active when LOW,
              'sinking.
S1=20,0,0     'set IO point 2 to be a Velocity Changing output, active when
              'LOW
SL 2000000    'enter this to slew the motor at 200000 µsteps/sec
```

While the motor is accelerating the LED will be dark, but will light up when the motor reaches a constant velocity. When the Soft Stop switch is depressed the motor will begin to decelerate, the LED will go dark again while velocity is changing.

S1=16,1,0 Output, Active HIGH, Sinking	O1=1 (Sink OFF, Hi-Z)
	O1=0 (Sink ON)
S1=16,1,1 Output, Active LOW, Sourcing	O1=1 (Sink ON)
	O1=0 (Sink OFF, Hi-Z)

General Purpose I/O Usage Examples — Enhanced I/O Set

The Expanded MForce Plus2 models add the functionality of either an additional 4 I/O points or an optional interface for a user-defined remote encoder. Additionally, the I/O points, when configured as outputs have the added functionality of being configured as sinking or sourcing outputs.

The circuit examples below illustrate possible interface examples for using the Expanded Digital I/O. Additional diagrams and code samples are available in the I/O Applications Guide appendix.

The code samples included with these examples will also serve to introduce the user to the MCode programming language that is used to operate and program the MForce. Please reference the MCode Programming and Software Reference manual for more information on the Instructions, Variables and Flags that make up the MCode command set as well as material on setting up and using the IMS Terminal.

NOTE: Advanced I/O interface circuit diagrams and application examples are available in Appendix B: I/O Application Guide.

Input Interface Example - Switch Input Example (Sinking Input)

The following circuit example shows a switch connected between an I/O point and I/O Ground.

Code Sample

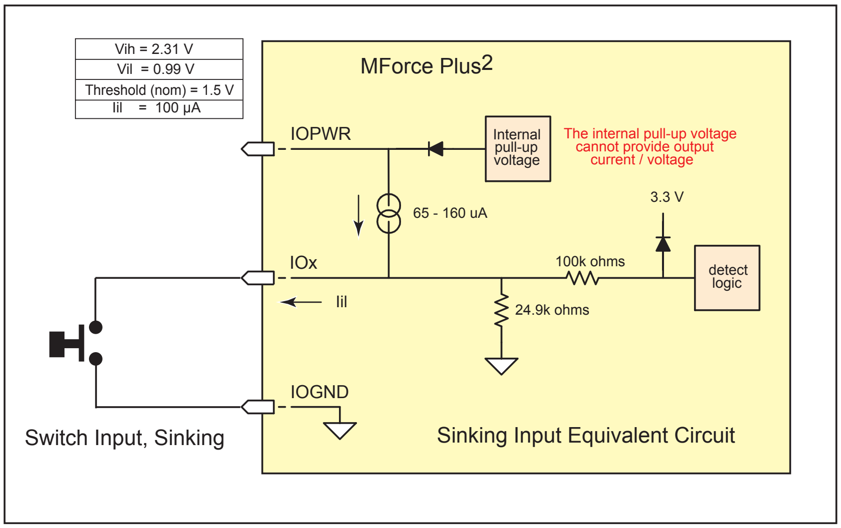


Figure 2.4.9: Switch Interface to Input, Sinking

For the code sample, this switch will be set up as a G0 sinking input, active when low. When pressed, the switch will launch the program beginning at address1 in MForce memory:

```
***Setup Variables***
Sx=4,0,0       'set IO point x to be a G0 input, active when LOW, sinking

****Program***
PG1
MR 20000       'Move +20000 steps relative to current position
H              'Hold program execution until motion completes
MR -20000      'Move -20000 steps
H              'Hold program execution until motion completes
E
PG             'End program, exit program mode
```

Input Interface Example - Switch Input Example (Sourcing Input)

The following circuit example shows a switch connected between an I/O point and a voltage supply which will source the input to perform a function.

Code Sample

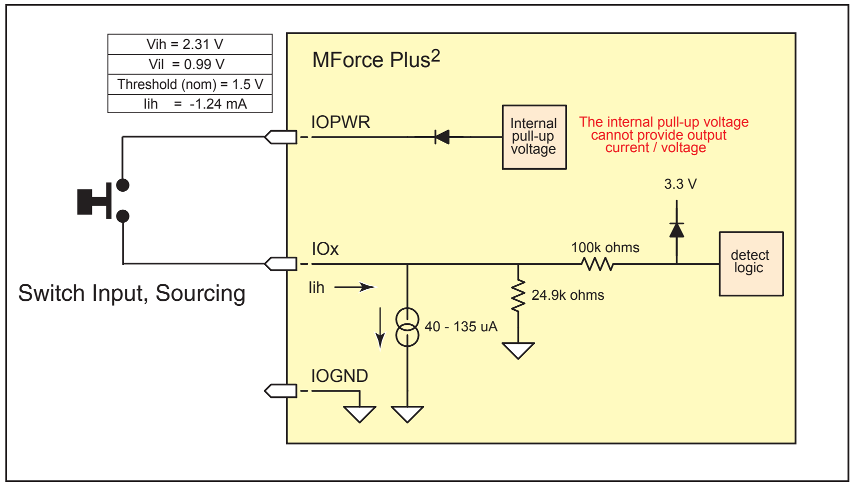


Figure 2.4.10 Sourcing Input Example using a Push Button Switch

For the code sample, the switch will be set up as a Soft Stop sourcing input, active when HIGH. When pressed, the switches will stop the motor.

```
S1=5,1,1      'set IO point 1 to be a Soft Stop input, active when HIGH,
              'sourcing
SL 200000     'enter this to slew the motor at 200000 µsteps/sec
```

When the switch is depressed the motor will decelerate to a stop.

Output Interface Example (Sinking Output)

The following circuit example shows a load connected to an I/O point that will be configured as a sinking output.

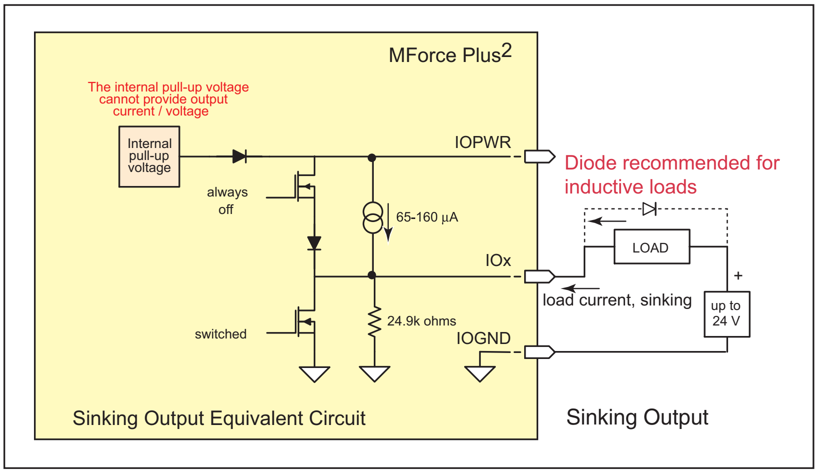


Figure 2.4.11: Sinking Output Example

Code Sample

For the code sample, the load will be an LED. The I/O point will be configured such that the LED will be unlit while the velocity is changing. Use the switch set-up from the previous input, modified to be sinking, example to soft stop the motor.

```
S1=5,0,0       'set IO point 1 to be a Soft Stop input, active when LOW,
               'sinking.
S1=20,0,0      'set IO point 2 to be a Velocity Changing output, active
               'when LOW
SL 2000000     'enter this to slew the motor at 200000 µsteps/sec
```

While the motor is accelerating the LED will be dark, but will light up when the motor reaches a constant velocity. When the Soft Stop switch is depressed the motor will begin to decelerate, the LED will go dark again while velocity is changing.

S1=16,1,0 Output, Active HIGH, Sinking	O1=1 (Sink OFF, Hi-Z)
	O1=0 (Sink ON)
S1=16,1,1 Output, Active LOW, Sourcing	O1=1 (Sink ON)
	O1=0 (Sink OFF, Hi-Z)

Output Interface Example (Sourcing Output)

The following circuit example shows a load connected to an I/O point that will be configured as a sourcing output.

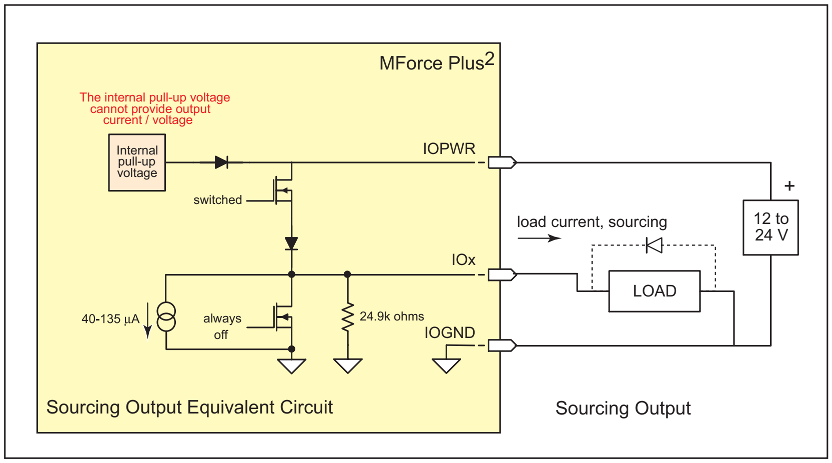


Figure 2.4.12: Sourcing Output Example

Code Sample

For the code sample, the load will be a relay. The output will be configured to be a General Purpose user output that will be set active when a range of motion completes.

```
******Setup Variables******
S1=16,1,1      'set IO point 1 to be a user output, active when HIGH,
               'sourcing.

******Program******
PG 100         'Enter program at address 100
MR 2000000     'Move some distance in the positive direction
H              'Hold execution until motion completes
MR -1000000    'Move some distance in the negative direction
H              'Hold execution until motion completes
O1=1           'Set output 1 HIGH
```

Enter EX 100 to execute the program, the motion will occur and the output will set high.

S1=16,1,1 Output, Active HIGH, Sourcing	O1=1 (Source ON)
	O1=0 (Source OFF, Hi-Z)
S1=16,0,1 Output, Active LOW, Sourcing	O1=1 (Source OFF, Hi-Z)
	O1=0 (Source ON)

Dedicated Digital I/O - Enhanced I/O Set

Step/Direction/Clock I/O

These dedicated I/O lines are used to receive clock inputs from an external device or provide clock outputs to an external device such as a counter or a second MForce MicroDrive in a system.
The Clock I/O can be configured as one of three clock types using the S7 and S8 variable:

1. Step/Direction
2. Quadrature
3. Up/Down

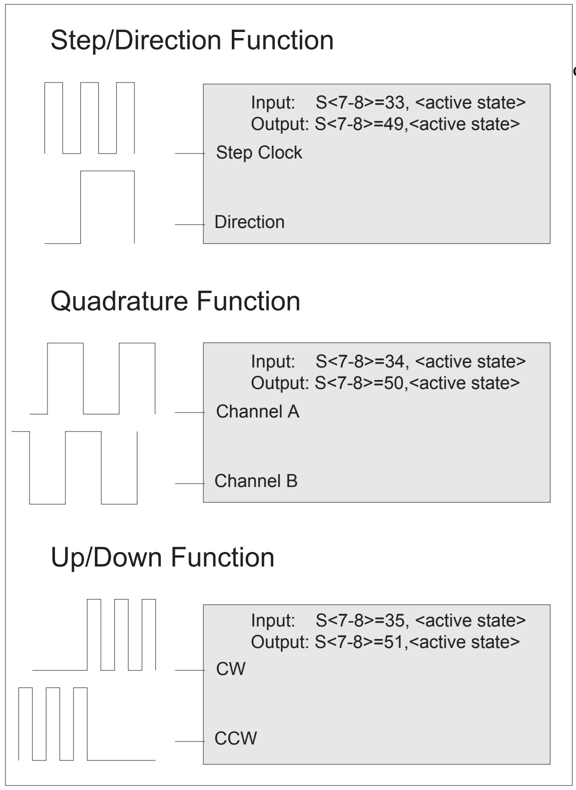


Figure 2.4.13: MForce MicroDrive Clock Functions

Step/Direction

The Step/Direction function would typically be used to receive step and direction instructions from a second system MForce or secondary controller. When configured as outputs the MForce can provide step and direction control to another system drive for electronic gearing applications.

Quadrature

The Quadrature clock function would typically be used for following applications where the MForce would either be a master or slave in an application that would require two MForce MicroDrives to move the same distance and speed.

Up/Down

The Up/Down clock would typically be used in a dual-clock direction control application, or to increment/decrement an external counter.

V_{in} Max = +5 V
V_{in} Hi = 1.86 V
V_{in} Low = 0.9 V
I_{in} Hi = 1 mA
I_{in} Low = -0.8 mA
V_O Min = 2 V
V_O Max = 5 V
Iosc Min = 35 mA
Iosc Max = 250 mA

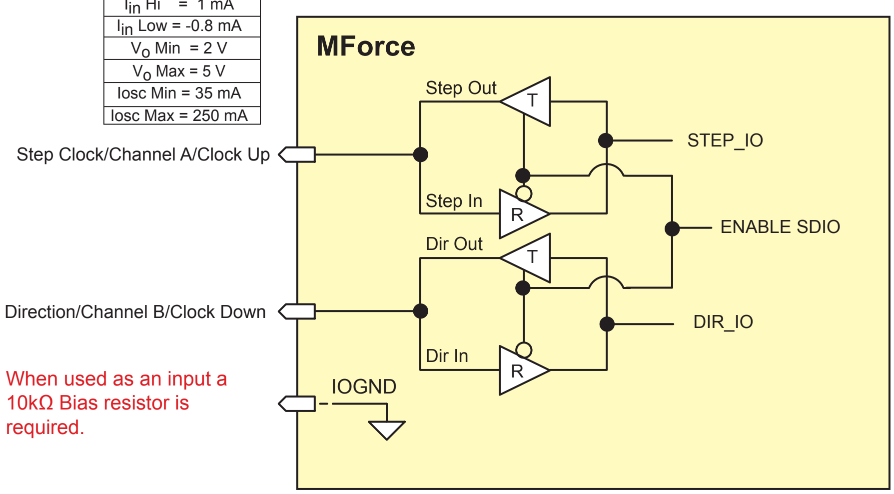


Figure 2.4.14: Step Direction I/O Equivalent Circuit

NOTE: Advanced I/O interface circuit diagrams and application examples are available in the I/O Application Guide Appendix.

NOTE: When using the MForce MicroDrive2 with the external encoder option, the step an direction I/O are not available! These I/O points become Index + and Index -. See the Closed Loop Control Appendix for encoder connection and configuration information.

WARNING: The Clock I/O and Capture/Trip I/O are TTL Level compatible. DO NOT Exceed +5VDC!

Capture/Trip

The Capture Input/Trip Output point is a high speed I/O point which can be used for time critical events in motion applications.

Capture Input

When configured as a capture input I/O point 13 has programmable filtering with a range of 50nS to 12.9 µS and has a resolution of 32 bits. The capture input needs to be pulled up to TTL using a 10k ohm resistor.

To configure the Capture input

```
S13=60,<0/1> 'configure IO13 as a capture input, <active HIGH/LOW>
FC <0-9>      'set input filtering to <range>
```

Trip Output

When configured as a trip output I/O 13 trip speed is 150 nS with 32 bit resolution.

To configure the Trip output

```
S13=61,<0/1> 'configure IO13 as a trip output, <active HIGH/LOW>
CW=10         'set the trip output pulse width to 500 nS
```

V_{in} Max = +5 V
V_{in} Hi = 1.86 V
V_{in} Low = 0.9 V
I_{in} Hi = 1 mA
I_{in} Low = -0.8 mA
V_O Min = 2 V
V_O Max = 5 V
Iosc Min = 35 mA
Iosc Max = 250 mA

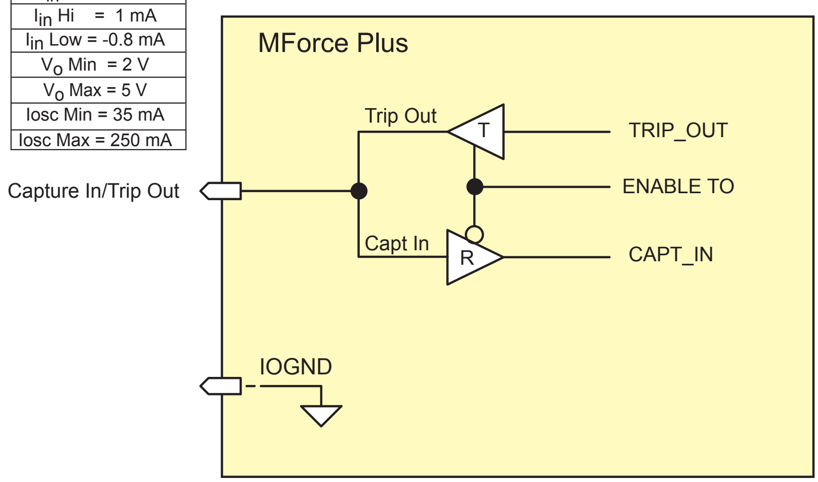


Figure 2.4.15: Capture/Trip I/O Equivalent Circuit

Interfacing the Analog Input

The analog input of the MForce MicroDrive is configured from the factory as a 0 to 5V, 10 bit resolution input (S5=9). This offers the user the ability to receive input from temperature, pressure, or other forms of sensors, and 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 1023, where 0 = 0 volts and 1024 = 5.0 volts. The MForce MicroDrive may also be configured for a 4 to 20 mA or 0 to 20 mA Analog Input (S5 = 10).

Sample Usage

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

S5=9,0          'set analog input to read variable voltage (0 to +5VDC)
PG 100          'start prog. 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

'***********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
E               'End
PG              'Exit program
```

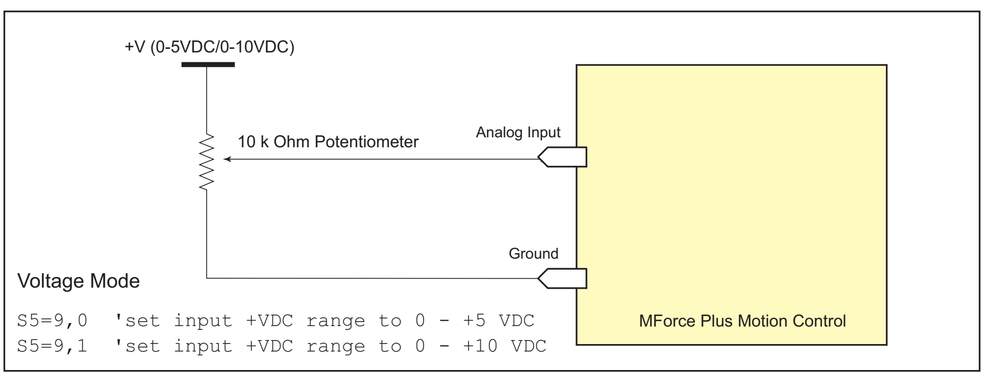


Figure 2.4.16: Analog Input - Voltage Mode

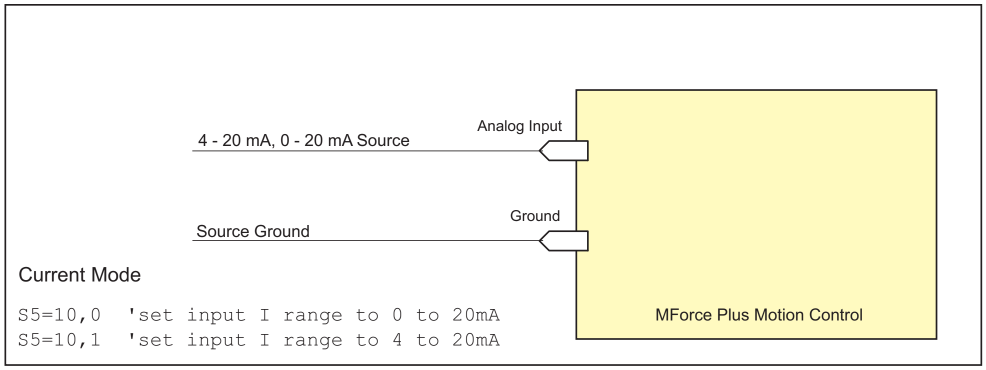


Figure 2.4.17: Analog Input - Current Mode

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MFORCE™ MICRO DRIVE *Plus* MOTION CONTROL

APPENDICES

RoHS CE

APPENDIX A

Recommended Power and Cable Configurations

Cable length, wire gauge and power conditioning devices play a major role in the performance of your MForce.

Example A demonstrates the recommended cable configuration for DC power supply cabling under 50 feet long. If cabling of 50 feet or longer is required, the additional length may be gained by adding an AC power supply cable (see Examples B & C).

Correct AWG wire size is determined by the current requirement plus cable length. Please see the MForce Supply Cable AWG Table at the end of this Appendix.

> **N** NOTE: These recommendations will provide optimal protection against EMI and RFI. The actual cable type, wire gauge, shield type and filtering devices used are dependent on the customer's application and system.

> **N** NOTE: The length of the DC power supply cable to an MForce should not exceed 50 feet.

> **N** NOTE: These recommendations will provide optimal protection against EMI and RFI. The actual cable type, wire gauge, shield type and filtering devices used are dependent on the customer's application and system.

> **N** NOTE: Always use Shielded/Twisted Pairs for the MForce DC Supply Cable and the AC Supply Cable.

Example A – Cabling Under 50 Feet, DC Power

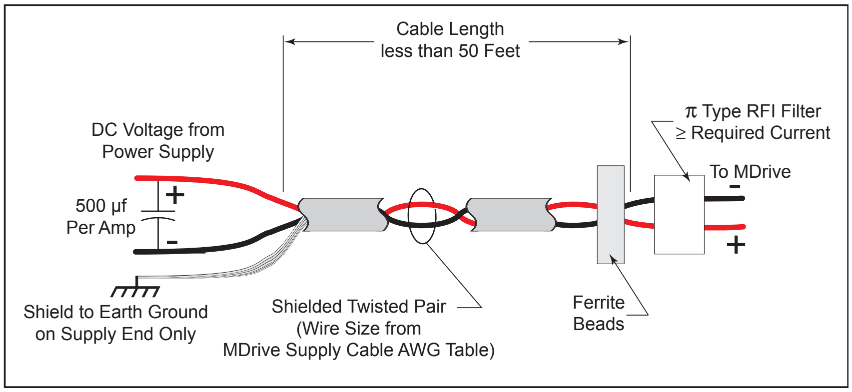


Figure A.1: DC Cabling - Under 50 Feet

Example B – Cabling 50 Feet or Greater, AC Power to Full Wave Bridge

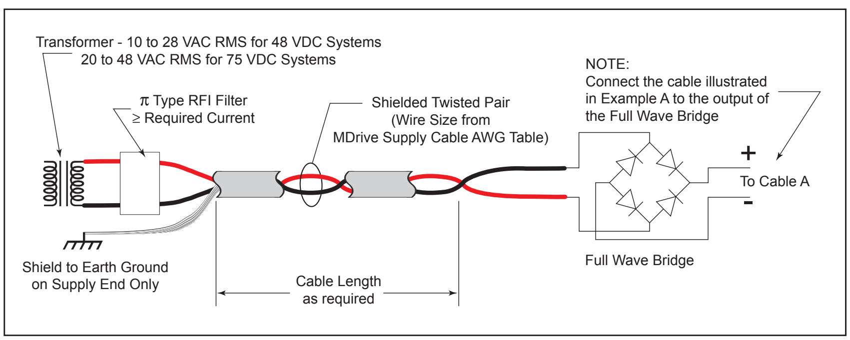


Figure A.2: DC Cabling - 50 Feet or Greater - AC To Full Wave Bridge Rectifier

Example C – Cabling 50 Feet or Greater, AC Power to Power Supply

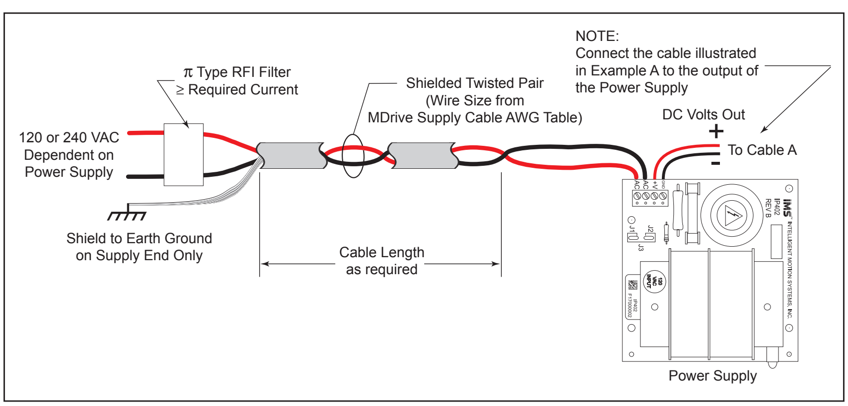


Figure A.3: AC Cabling - 50 Feet or Greater - AC To Power Supply

Recommended IMS Power Supplies

IMS unregulated linear and unregulated switching power supplies are the best fit for IMS drive products.

IP402 Unregulated Linear Supply

Input Range

120 VAC Versions ....102-132 VAC
240 VAC Versions ....204-264 VAC

Output (All Measurements were taken at 25°C, 120 VAC, 60 Hz)

No Load Output Voltage..39 VDC @ 0 Amps
Half Load Output...30 VDC @ 2 Amps
Full Load output...25 VDC @ 4 Amps

IP404 Unregulated Linear Supply

Input Range

120 VAC Versions ....102-132 VAC
240 VAC Versions ....204-264 VAC

Output (All Measurements were taken at 25°C, 120 VAC, 60 Hz)

No Load Output Voltage..43 VDC @ 0 Amps
Half Load Output...32 VDC @ 3 Amps
Full Load Output..26 VDC @ 6 Amps

ISP200-4 Unregulated Switching Supply

Input Range

120 VAC Versions ....102-132 VAC
240 VAC Versions ....204-264 VAC

Output (All Measurements were taken at 25°C, 120 VAC, 60 Hz)

No Load Output Voltage..41 VDC @ 0 Amps
Continuous Output Rating..38 VDC @ 2 Amps
Peak Output Rating..35 VDC @ 4 Amps

Recommended Power Supply Cabling

MForce Plus Supply Cable AWG Table					
1 Ampere (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimun AWG	20	20	18	18	16
2 Amperes (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimun AWG	20	18	16	14	14
*Use the alternative methods illustrated in examples B and C when cable length is ≥ 50 feet. Also, use the same current rating when the alternate AC power is used.					

Table A.1: Recommended Supply Cables

I/O Application Guide

Standard I/O Set Interfacing and Application

NPN Sinking Input

Application Example

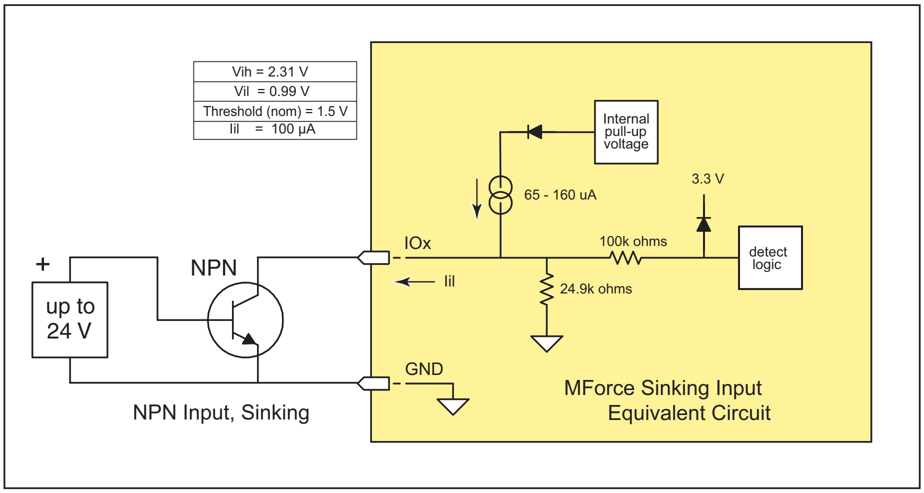


Figure B.1: NPN Interface to an MForce Sinking Input

Proximity sensor will operate as a +Limit. When active LOW will index the motor to a specified position.

```
'[VARIABLES]
S1=2,0,0              'set IO1 to Limit+, Active LOW, sinking
'[PROGRAMS]
PG   100              'enter program mode at address 100
LB AA                 'label program AA
  MR 200000000        'move relative x distance
  H                   'hold program execution until move completes
  CL AB , I1 =  0     'call subroutine AB if I1 = 0 (limit reached)
  BR AA , I1 =  1     'branch to AA if I1=1
LB AB                 'Label Sub AB
  PR "Error 83, Positive Limit Reached"
  ER=0
  MA - 10000          'Absolute move to Pos. -10000
  H                   'hold program execution until move completes
E                     'end program
PG                    'exit program.
'[END]
```

PNP Sourcing Input

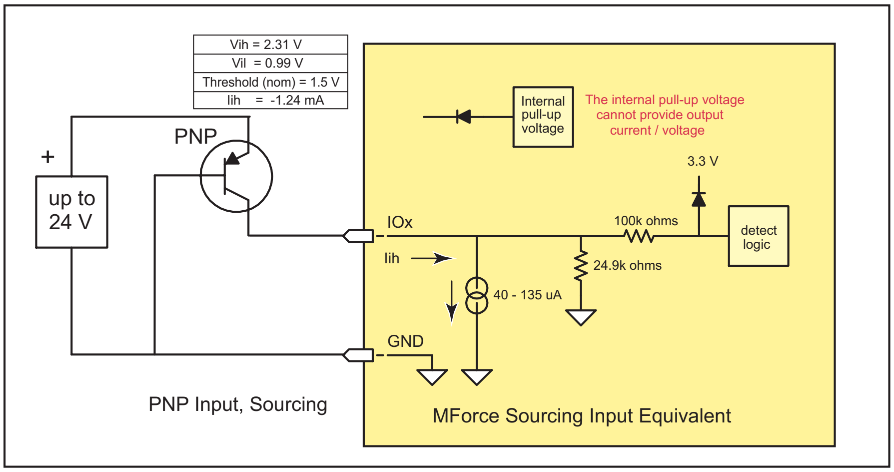


Figure B.2: PNP Interface to a Sourcing Input

Application Example

Will use this input as a general purpose input which will run a motion subroutine when HIGH.

```
'[VARIABLES]
S1=0,1,1            'set IO1 Gen Purpose User, active HIGH, src
S2=0,1,1            'set IO1 Gen Purpose User, active HIGH, src
'[PROGRAMS]
'*****Main Program*****
PG 100
LB AA
     CL SA,I1=1     'call sub SA if IO1=1
     CL SB,I2=1     'call sub SB if IO2=1
     BR AA
'******Subroutines*******
LB SA               'Subroutine will perform some motion
     MR 200000
     H
     MR -200000
     H
     BR SA,I1=1     'conditional branch to beginning of sub
     BR AA,I1=0     'Branch to main program if IO1=0
     RT
LB SB               'Subroutine will perform some motion
     MR 10000
     H
     MR -10000
     H
     BR SB,I2=1     'conditional branch to beginning of sub
     BR AA,I2=0     'Branch to main program if IO1=0
     RT
E
PG
'[END]
```

Sinking Output

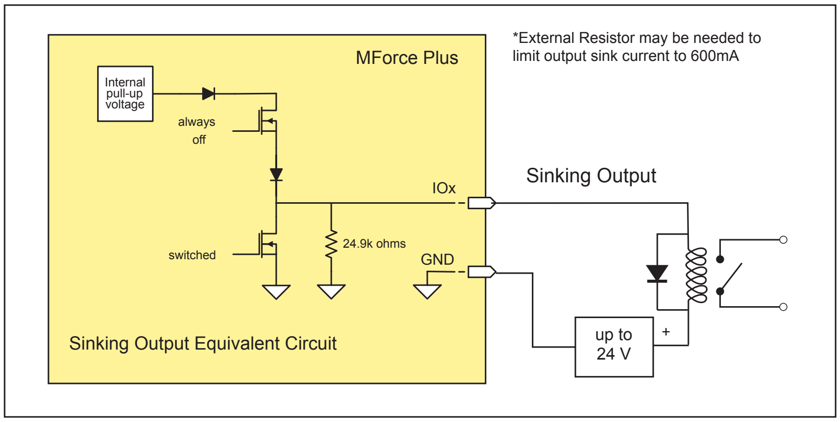


Figure B.3: Sinking Output to Relay

NOTE: On the Standard MForce Plus, when configured as outputs, the I/O set is sinking ONLY! The Plus^2 Models add the functionality of I/O Power, which enables the user to use all the outputs, both Standard and Enhanced, as Sinking or Sourcing.

Application Example

Active LOW Output will be opem a relay, useful for Fault.

```
'[VARIABLES]
S1=19,0,0             'Configure IO 1 as a Fault output.
```

Mixed Input/Output Example

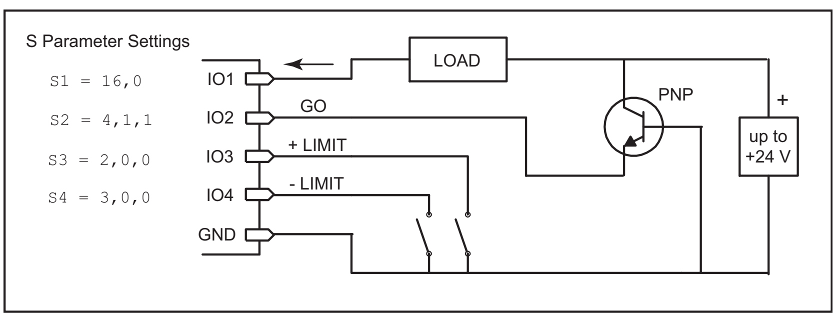


Figure B.4: Mixed Output Example- Standard I/O Set

Enhanced I/O Set Interfacing and Application

NPN Sinking Input

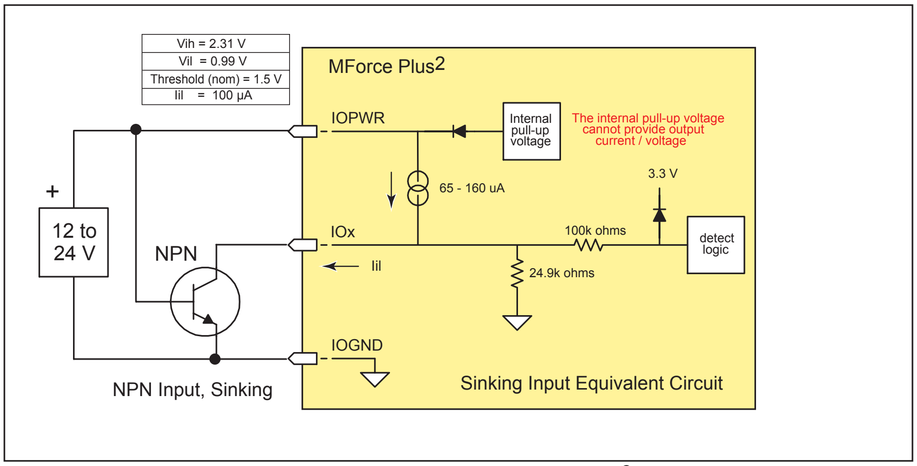


Figure B.5: NPN Sinking Input on an MForce Plus2 Motion Control

Application Example

Sensor using the HOME function.

```
'[VARIABLES]
S2=1,1,0              'Configure IO2 as a Home Input, active HIGH, sinking.

Enter to IMS Terminal in Immediate mode or in a Program

HM 1                   'Slew at VM - until IO2 = 1, Creep off + at VI
```

PNP Sourcing Input

Application Example

Sensor using the Jog+ function.

```
JE=1                   'Enable Jog function
```

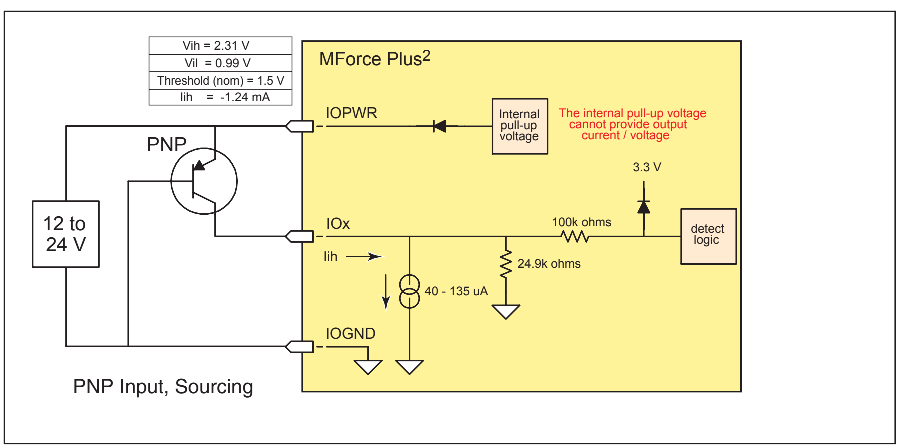


Figure B.6: PNP Sourcing Input on an MForce Plus2 Motion Control

```
S11=7,1,1              'Configure IO11 as a Jog+ Input, active HIGH, sourcing
```

Sourcing Output

Application Example

This application example will illustrate two MForce Plus2 units in a system. In the program example MForce Plus2 #1 will be configured as a Fault Output, which when HIGH will trip an input on MForce Plus2 #2 which will be configured as a Pause Input.

```
MForce #1
```

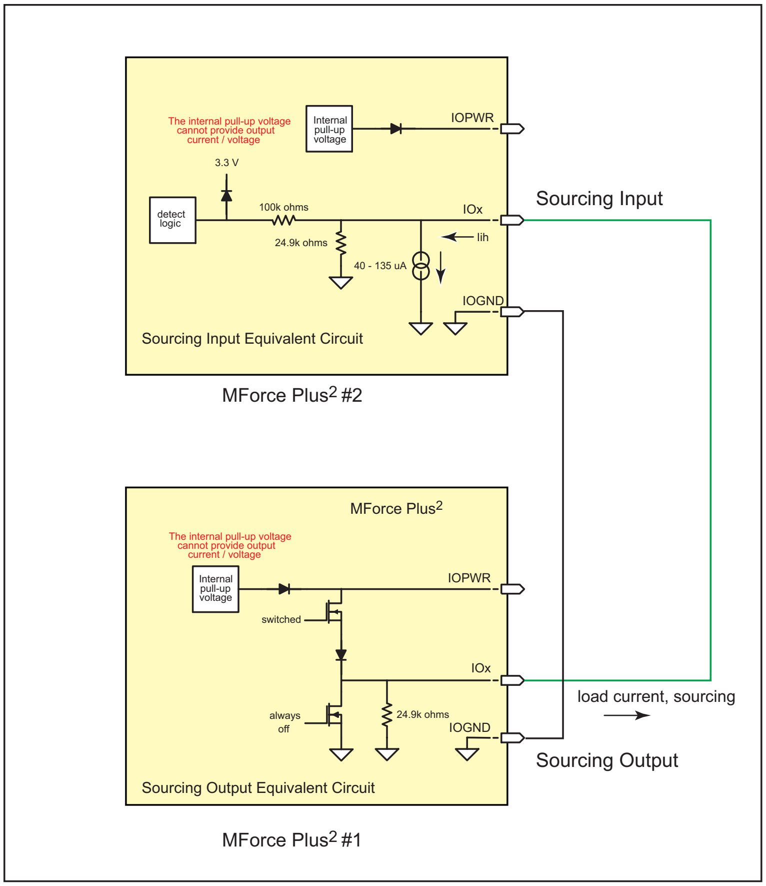


Figure B.7: Sourcing Output to Sourcing Input

```
S9=18,1,1          'Configure IO9 as a Fault output, active HIGH, sourcing

MForce #2
S9=6,1,1           'Configure IO9 as a Pause Input, active HIGH, sourcing.
```

Mixed Input/Output Example

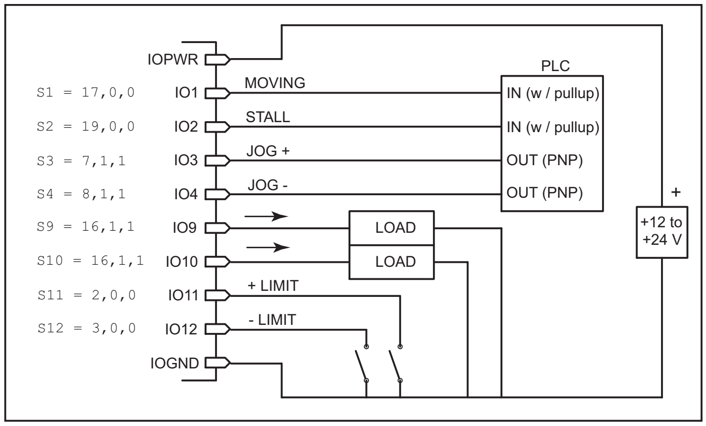


Figure B.8: Mixed Input/Output Example - Enhanced I/O

Interfacing Inputs as a Group Example

The MForce inputs may read as a group using the IL. IH and IN keywords. This will display as a decimal between 0 to 15 representing the 4 bit binary number (IL, IH) or as a decimal between 0 and 255 representing the 8 bit binary number on the MForce Plus^2 models. The IN keyword will function on the standard MForce but will only read inputs 1 - 4. Inputs will be configured as user inputs (S<point>=0).

Standard MForce Plus Motion Control

```
PR IN         'Reads Inputs 4(MSB) through 1(LSB)
PR IN         'Reads Inputs 4(MSB) through 1(LSB)
```

Enhanced MForce Plus2

```
PR IL         'Reads Inputs 4(MSB) through 1(LSB)
PR IH:        'Reads Inputs 12(MSB) through 9(LSB)
PR IN:        'Reads Inputs 12(MSB) -  9 amd 4 - 1(LSB)
```

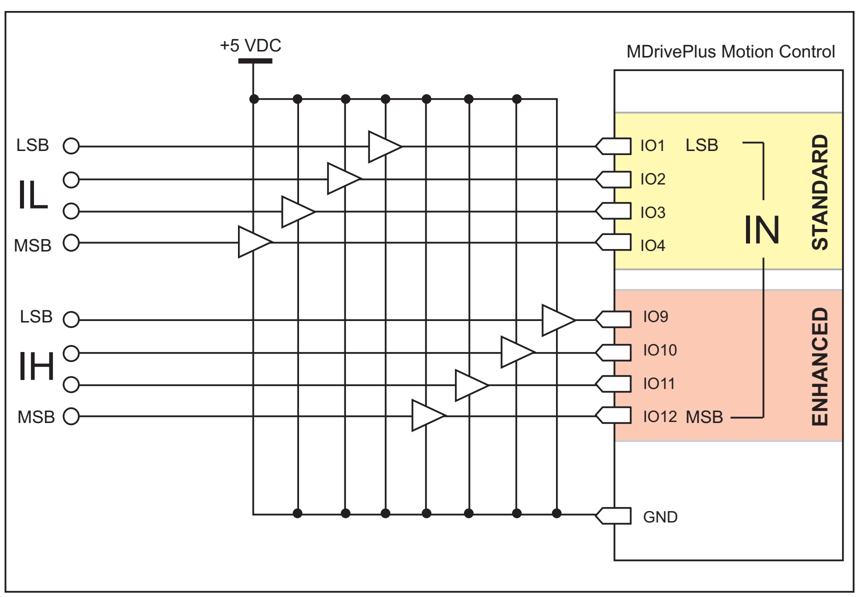


Figure B.9: TTL Interface to an Input Group

Interfacing Outputs as a Group Example

The MForce inputs may be written to as a group using the OL, OH and OT keywords. This will set the outputs as a binary number representing the decimal between 0 to 15 representing the 4 bit binary number (OL, OH) or as an 8 bit binary number representing the decimal 0 to 255 on the Expanded MForce Plus^2 models. The OT keyword will function on the standard MForce but will only set inputs 1 - 4. Outputs will be configured as user outputs (S<point>=16).

Standard MForce Plus Motion Control

```
OL=3          'set the binary state of the standard I/O to 0011
OT=13         'set the binary state of the standard I/O to 1101
```

Enhanced MForce Plus2

```
OL=5          'set the binary state of the standard I/O to 0101
OH=9          'set the binary state of the expanded I/O to 1001
OT=223        'set the binary state of the combined I/O to 1101 1111
```

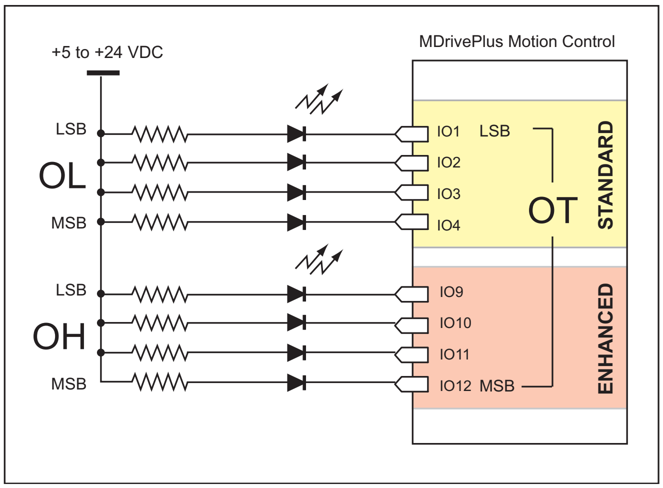


Figure B.10: Outputs Interfaced to LED's as a Group

Output Bit Weight Examples								
I/O Set	Enhanced (Plus2)				Standard			
	IO12 (MSB)	IO11	IO10	IO9	IO4	IO3	IO2	IO1 (LSB)
OL=13 OT=13	NOT AVAILABLE				1	1	0	1
OH=9	1	0	0	1	NOT ADDRESSED BY OH			
OT=223	1	1	0	1	1	1	1	1

Table B.1: Output Bit Weight Examples - Outputs set as a group

MForce Motion Control Closed Loop Options

Remote Differential Encoder - MForce MicroDrive Plus²

The MForce Plus² models are available with the option of using a remote encoder through the enhanced I/O. The advantage of using a remote encoder is that the encoder can be stationed directly on the load for increased accuracy. If ordering with a motor these encoders may be mounted for you at the factory. Only differential encoders may be used with the MForce Plus².

Set Up and Configuration

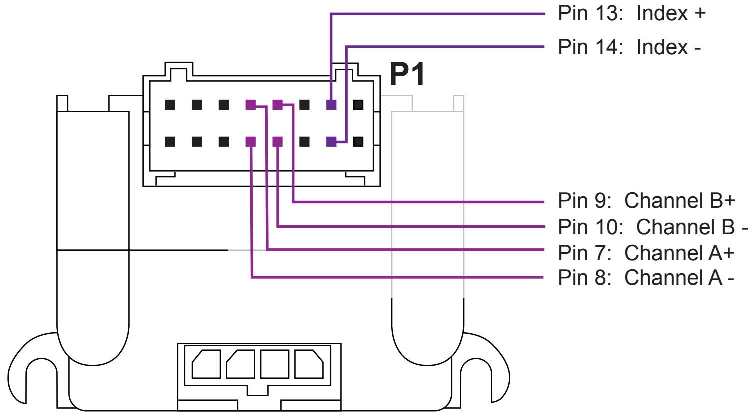
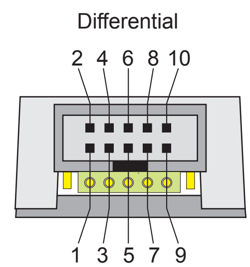


Figure C.1: Connecting a Remote Encoder

Encoders Available from IMS

	DIFFERENTIAL ENCODER
Line Count	Part Number
100	EA
200	EB
250	EC
256	EW
400	ED
500	EH
512	EX
1000	EJ
1024	EY



Pin 1: No Connect	Pin 6: Channel A +
Pin 2: +5VDC Input	Pin 7: Channel B –
Pin 3: Ground	Pin 8: Channel B +
Pin 4: No Connect	Pin 9: Index –
Pin 5: Channel A –	Pin 10: Index +

Table C.1: Available Encoder Line Counts, Part Numbers and Pin Configurations

General Specifications

	Min	Typ	Max	Units
Supply Voltage (VDC)	-0.5		7	Volts
Supply Current	30	57	85	mA
Output Voltage	-0.5		Vcc	Volts
Output Current (Per Channel)	-1.0		5	mA
Maximum Frequency				100kHz
Inertia				0.565 g-cm² (8.0 x 10^{-6} oz-in-sec²)

Temperature

Operating .... -40 to +100° C

Storage .... -40 to +100° C

Humidity .... 90% (non-condensing)

Encoder Signals

Differential Encoder

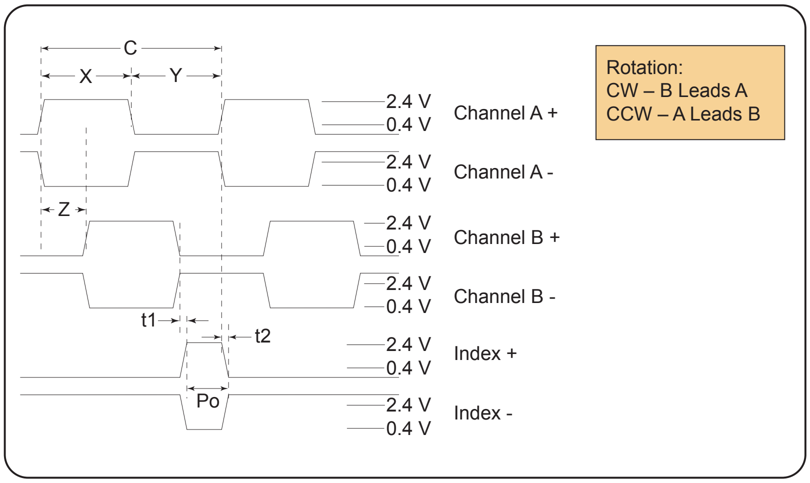


Figure C.2: Differential Encoder Signals

Note: Rotation is as viewed from the cover side.

(C)	One Cycle: 360 electrical degrees (°e)
(X/Y)	Symmetry: A measure of the relationship between X and Y, nominally 180°e.
(Z)	Quadrature: The phase lag or lead between channels A and B, nominally 90°e.
(Po)	Index Pulse Width: Nominally 90°e.

Characteristics

Parameter	Symbol	Min	Typ	Max	Units
Cycle Error			3	5.5	°e
Symmetry		130	180	230	°e
Quadrature		40	90	140	°e
Index Pulse Width	Po	60	90	120	°e
Index Rise After CH B or CH A fall	t1	-300	100	250	ns
Index Fall After CH A or CH B rise	t2	70	150	1000	ns

Over recommended operating range. Values are for worst error over a full rotation.

Encoder Cables

IMS Differential Encoder Cable (36" leads) ED-CABLE-2

Recommended Encoder Mating Connectors

IMS recommends the following mating connectors (or equivalent) if you make your own cables.

Differential Encoder

Tyco Electronics Connector with 10 Preloaded IDC Pins*... 102694-3
Shell with Polarizing Key.. 102537-3
Back Cover.. 102536-3

Tyco Electronics 10 Pin IDC Ribbon Cable Connector.. 499997-1
3M 28 AWG x 0.5 x 10 Conductor Ribbon Cable.. 3365/10

*For AWG 22 to 28 wires.

Optional Cables and Cordsets

WARNING! DO NOT connect or disconnect the MD-CC400-000 Communications Converter Cable from MForce while power is applied!

Communications Converter Cables

USB to 10-Pin IDC (MD-CC400-000)

The MD-CC400-000 is an in-line USB to RS-422 converter with integrated 10-pin IDC cable. This product is used to communicate to a single Motion Control MForce. The included components will allow you to connect the USB port of a PC* directly to the 10-Pin IDC Connector located at P2.

Supplied Components: MD-CC400-000 Communications Converter Cable, USB Cable, USB Drivers, IMS Terminal Interface Software.

Figure D.1: MD-CC400-000

10-Pin Locking Wire Crimp Adapter

An optional pin adapter is available to convert the 10-pin IDC connector on the Communications Converter Cable to a 10-pin friction lock wire crimp interface used on the Plus² units.

Adapter Part # .... MD-ADP-H

** If your PC is already equipped with RS-422, the MD-CC400-000 cable is not required.*

Electrical Specifications

MD-CC400-000 Specifications	
BAUD Rate	Up to 115 kbps
Connectors:	
USB	
RS-422 Side	10 Pin 2mm IDC
Ribbon Cable Length	6 feet (1.8 meters)
Power Requirement	Power from USB

Table D.1: MD-CC400-000 Electrical Specifications

Mechanical Specifications

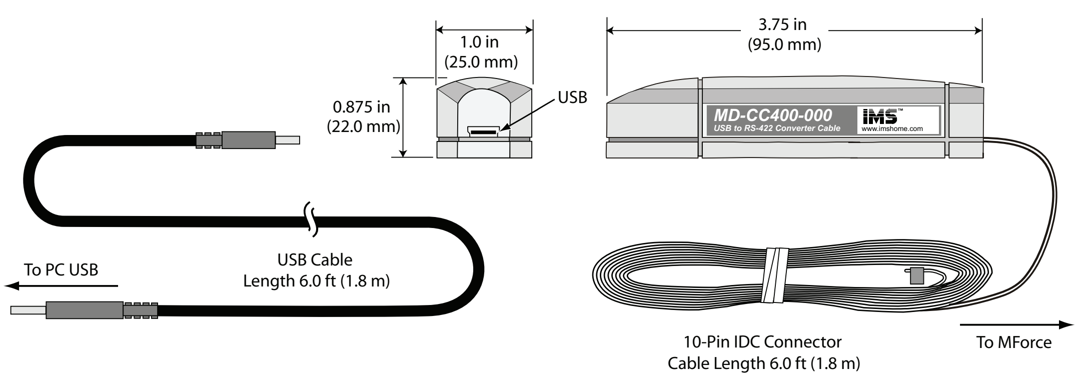


Figure D.2: MD-CC400-000 Mechanical Specifications

Note: An Interactive Tutorial covering the installation of the Cable/VCP drivers are located on the IMS Web Site at http://www.imshome.com/tutorials.html.

Installation Procedure for the MX-CC400-000

These Installation procedures are written for Microsoft Windows XP Service Pack 2. Users with earlier versions of Windows please see the alternate installation instructions at the IMS web site (http://www.imshome.com).

The installation of the MD-CC400-000 requires the installation of two sets of drivers:

- Drivers for the IMS USB to RS-422 Converter Hardware.
- Drivers for the Virtual Communications Port (VCP) used to communicate to your IMS Product.

Therefore the Hardware Update wizard will run twice during the installation process.

The full installation procedure will be a two-part process: Installing the Cable/VCP drivers and Determining the Virtual COM Port used.

Installing the Cable/VCP Drivers

1) Plug the USB Converter Cable into the USB port of the MD-CC400-000.
2) Plug the other end of the USB cable into an open USB port on your PC.
3) Your PC will recognize the new hardware and open the Hardware Update dialog.
4) Select "No, not this time" on the radio buttons in answer to the query "Can Windows Connect to Windows Update to search for software?" Click "Next" (Figure F.4).
5) Select "Install from a list or specific location (Advanced)" on the radio buttons in answer to the query "What do you want the wizard to do?" Click "Next" (Figure F.5).

Figure D.3: Hardware Update Wizard

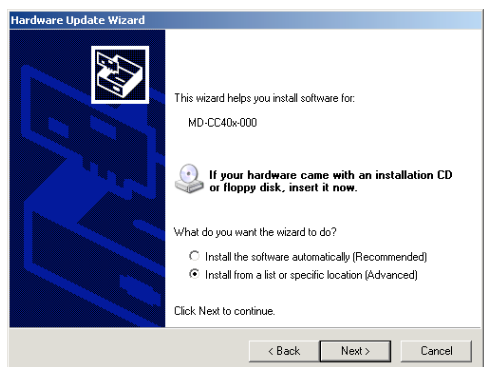


Figure D.4: Hardware Update Wizard Screen 2

6) Select "Search for the best driver in these locations."
   (a) Check "Include this location in the search."
   (b) Browse to the Product CD [Drive Letter]:\ Cable_Drivers\MD CC40x000_DRIVERS.
   (c) Click Next (Figure F.6).

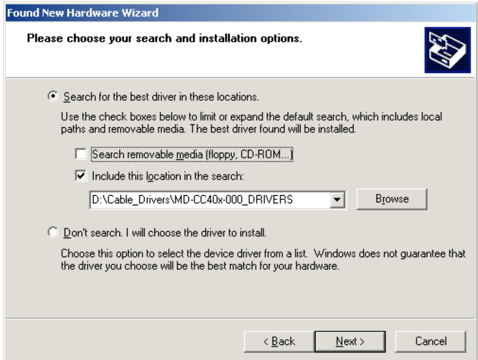


Figure D.5: Hardware Update Wizard Screen 3

7) The drivers will begin to copy.
8) On the Dialog for Windows Logo Compatibility Testing, click “Continue Anyway” (Figure F.7).
9) The Driver Installation will proceed. When the Completing the Found New Hardware Wizard dialog appears, Click “Finish” (Figure F.8).
10) Upon finish, the Welcome to the Hardware Update Wizard will reappear to guide you through the second part of the install process. Repeat steps 1 through 9 above to complete the cable installation.
11) Your IMS MD-CC400-000 is now ready to use.

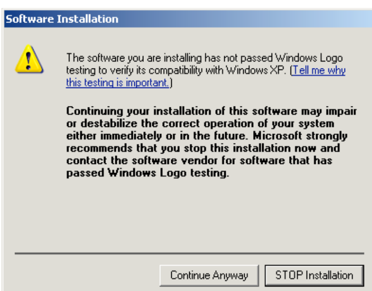


Figure D.6: Windows Logo Compatibility Testing

Figure D.7: Hardware Update Wizard Finish Installation

Determining the Virtual COM Port (VCP)

The MD-CC400-000 uses a Virtual COM Port to communicate through the USB port to the MForce. A VCP is a software driven serial port which emulates a hardware port in Windows.

The drivers for the MD-CC400-000 will automatically assign a VCP to the device during installation. The VCP port number will be needed when IMS Terminal is set up in order that IMS Terminal will know where to find and communicate with your IMS Product.

To locate the Virtual COM Port.

1) Right-Click the "My Computer" Icon and select "Properties".
2) Browse to the Hardware Tab (Figure D.8), Click the Button labeled "Device Manager".
3) Look in the heading "Ports (COM & LPT)" IMS USB to RS422 Converter Cable (COMx) will be listed (Figure D.9). The COM # will be the Virtual COM Port connected. You will enter this number into your IMS Terminal Configuration.

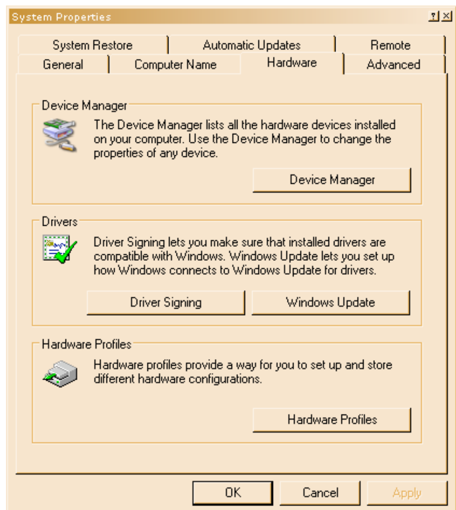


Figure D.8: Hardware Properties

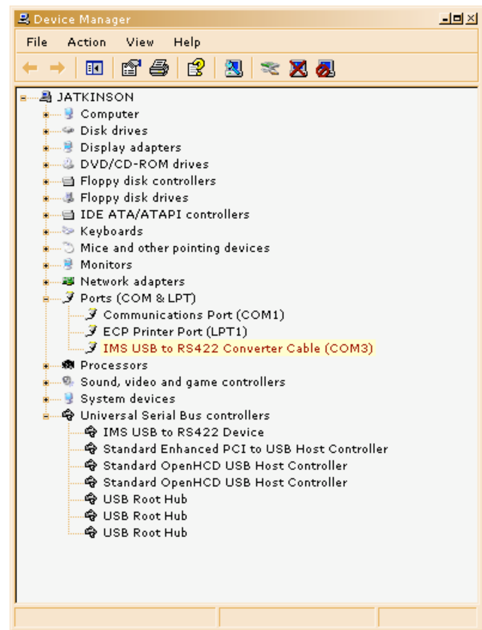


Figure D.9: Windows Device Manager

Prototype Development Cables

16-Pin Locking Wire Crimp PD16-1417-FL3

Single or Multi-Drop Communications PD10-1434-FL3

4-Pin Locking Wire Crimp (Motor Connection) PD04-MF17-FL3

PD16-1417-FL3 — Power and I/O

The PD16-1417-FL3 is a 10' (3.0 M) Prototype Development Cable used to connect to the 16-Pin Locking Wire Crimp Connector. The Connector end plugs into the P1 Connector of the MForce Plus². The Flying Lead end connects to a Control Interface such as a PLC and the users motor power supply.

Wire Color Code				
Pair Number	Color Combination	Signal Name (Expanded I/O)	Signal Name (Remote Encoder)	P1 Pin Number
1	Black	Power Ground	Power Ground	16
	Red	+V (+12 to +48 VDC)	+V (+12 to +48 VDC)	15
2	Black	Direction	Index –	14
	White	Step Clock	Index +	13
3	Black	Analog In	Analog In	12
	Green	Capture In/Trip Out	Capture In/Trip Out	11
4	Black	I/O 12	Channel B –	10
	Blue	I/O 11	Channel B +	9
5	Black	I/O 10	Channel A –	8
	Yellow	I/O 9	Channel A +	7
6	Black	I/O 4	I/O 4	6
	Brown	I/O 3	I/O 3	5
7	Black	I/O 2	I/O 2	4
	Orange	I/O 1	I/O 1	3
8	White	I/O GND	I/O GND	2
	Red	I/O Power	I/O Power	1

Table D.2: PD16-1417-FL3 Wire Color Codes

General Specifications

Length: 10 Feet (3.0 Meters)
Conductor: 22 AWG
Twisted Pairs
Shield: Tinned Copper Braid
Jacket: Gray PVC

Ensure Black-Color pair match is correct prior to connecting.

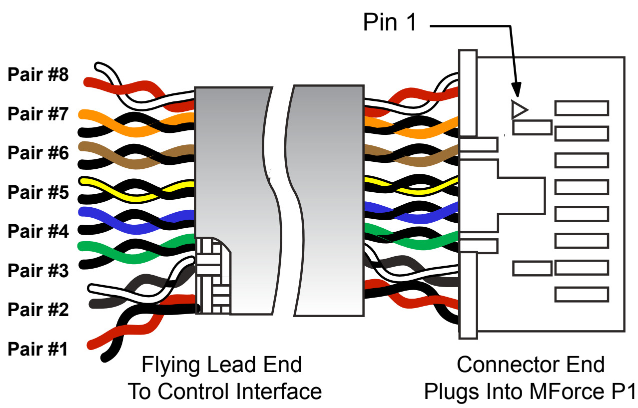


Figure D.10: PD16-1417-FL3 Prototype Development Cable

Note: If using the PD10-1434-FL3 for a single MForce System, follow only the setup instructions for Cable #1. Additional cables are not required

Prototype Development Cable PD10-1434-FL3 (All MForce Motion Control)

The PD10-1434-FL3 is used to connect to the 10-pin wire crimp option for interfacing RS-422/485 Communications. It also features an additional cable attached for multi-drop communications systems.

Setup Instructions — Cable #1

1. Cut crimp pins from Communications Wires and strip insulation back approximately 1/4".
2. Connect receive (RX) and transmit (TX) lines as shown in the diagram and table above to your RS-422/485 Host interface.
3. Connect Communications Ground line to the Comm Ground of your RS-422/485 Host.
4. Connect Aux-Power (if used) to the +VDC Output of a +12 to +24 VDC Supply.
5. Connect the return (GND) of the Aux-Supply to Power Ground of the MForce.
   Plug the wire crimp connector of Cable #1 into P2 of the MForce #1.

Setup Instructions — Cable #2 and Subsequent MForce MicroDrives

1. Insert the crimped transmit and receive lines into the 10-Pin wire crimp connector of Cable #1 as shown in the diagram and table.
2. Connect communications ground (May be daisy-chained).
3. Connect Aux-Supply at the +VDC output of the +12 to +24 VDC Supply (May NOT be daisy-chained).
4. Plug the wire crimp connector of Cable #2 into P2 of MForce #2
5. Repeat Steps 1-4 for each additional MForce MicroDrive in the system.

PD10-1434-FL3 Connections		
Color Combination	Flying Lead End Connections Cable 1	MForce #1 Wire Crimp Connection
White/Blue	RX+ (Comm Host)	TX+ (Pin 1)
Blue/White	RX+ (Comm Host)	TX- (Pin 4)
White/Orange	TX+ (Comm Host)	RX+ (Pin 6)
Orange/White	TX- (Comm Host)	RX- (Pin 3)
Green/White	COMM GND (Comm Host)	COMM GND (Pin 2)
White/Red	AUX-Power (At Supply)	AUX-Power (Pin 5)
MForce #2 Wire Crimp Connection		
Color Combination	Flying Lead End Connections Cable 2	MForce #2 Wire Crimp Connection
White/Blue	TX+ (Pin 9 - Cable 1)	TX+ (Pin 1)
Blue/White	TX- (Pin 10 - Cable 1)	TX- (Pin 4)
White/Orange	RX+ (Pin 7 - Cable 1)	RX+ (Pin 6)
Orange/White	RX- (Pin 8 - Cable 1)	RX- (Pin 3)
Green/White	COMM GND (Comm Host)	COMM GND (Pin 2)
White/Red	AUX-Power (At Supply)	AUX-Power (Pin 5)

Table D.3: PD10-1434-FL3 Wire Color Codes

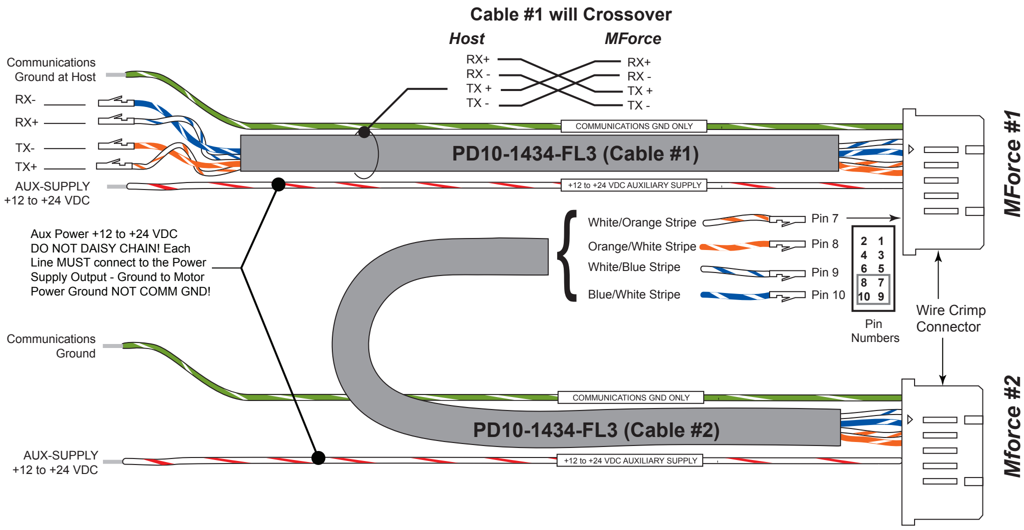


Figure D.11: PD10-1434-FL3

IMS Enhanced Torque Stepping Motors

Size 14 Enhanced Torque Stepping Motor

General Specifications

Part Number	Holding Torque	Phase Current	Number of Leads	Phase Resistance	Phase Inductance	Detent Torque	Rotor Inertia	LMax Length	Weight
	oz-in (N-cm)	Amps		ohms	mH	oz-in (N-cm)	oz-in-sec^2 (kg-cm^2)	inches (mm)	oz (g)
M-1410-0.75[X]*	10 (7)	0.75	4	4.3	4	1.4 (1.0)	0.00017 (0.012)	1.02 (26)	4.2 (120)

Table E.1: Size 14 General Specifications

Wiring And Connection

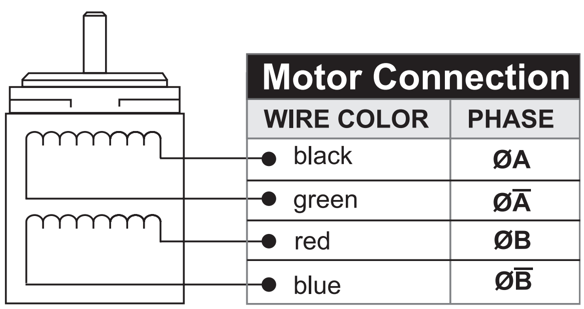


Figure E.1: Size 14 Wiring and Connection

Mechanical Specifications

Dimensions in Inches (mm)

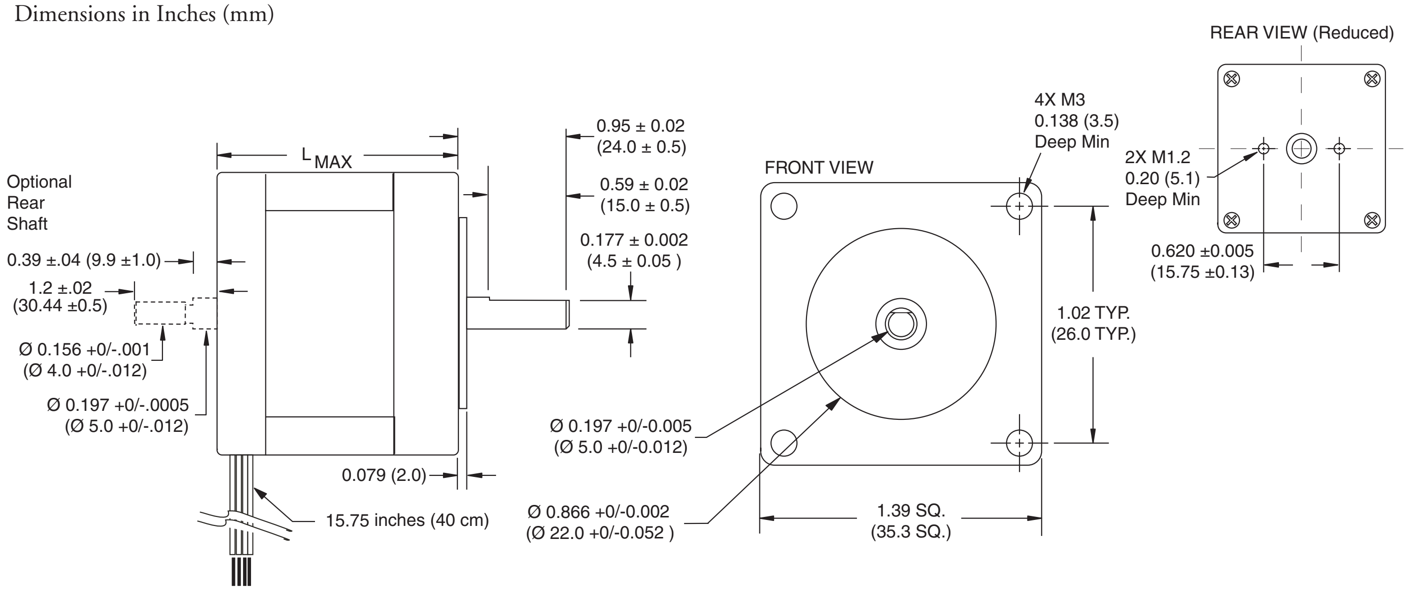


Figure E.2: Size 14 Mechanical Specifications

Size 17 Enhanced Torque Stepping Motor

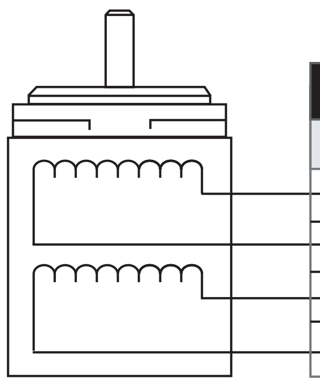
General Specifications

Part Number	Holding Torque oz-in (N-cm)	Phase Current Amps	Number of Leads	Phase Resistance ohms	Phase Inductance mH	Detent Torque oz-in (N-cm)	Rotor Inertia oz-in-sec^2 (kg-cm^2)	LMax Length inches (mm)	Weight oz (g)
M-1713-1.5[X]*	32 (23)	1.5	4	1.3	2.1	1.7 (1.2)	0.000538 (0.038)	1.34 (34)	7.4 (210)
M-1715-1.5[X]*	60 (42)	1.5	4	2.1	5.0	2.1 (1.5)	0.0008037 (0.057)	1.57 (40)	8.1 (230)
M-1719-1.5[X]*	75 (53)	1.5	4	2.0	3.85	3.5 (2.5)	0.0011562 (0.082)	1.89 (48)	12.7 (360)

*Specify S for Single Shaft; D for Double Shaft

Table E.2: Size 17 General Specifications

Wiring And Connection



Motor Connection

WIRE COLOR	PHASE
red	ØA
blue	Ø$\overline{A}$
green	ØB
black	Ø$\overline{B}$

Figure E.4: Size 17 Wiring and Connection

Mechanical Specifications

Dimensions in Inches (mm)

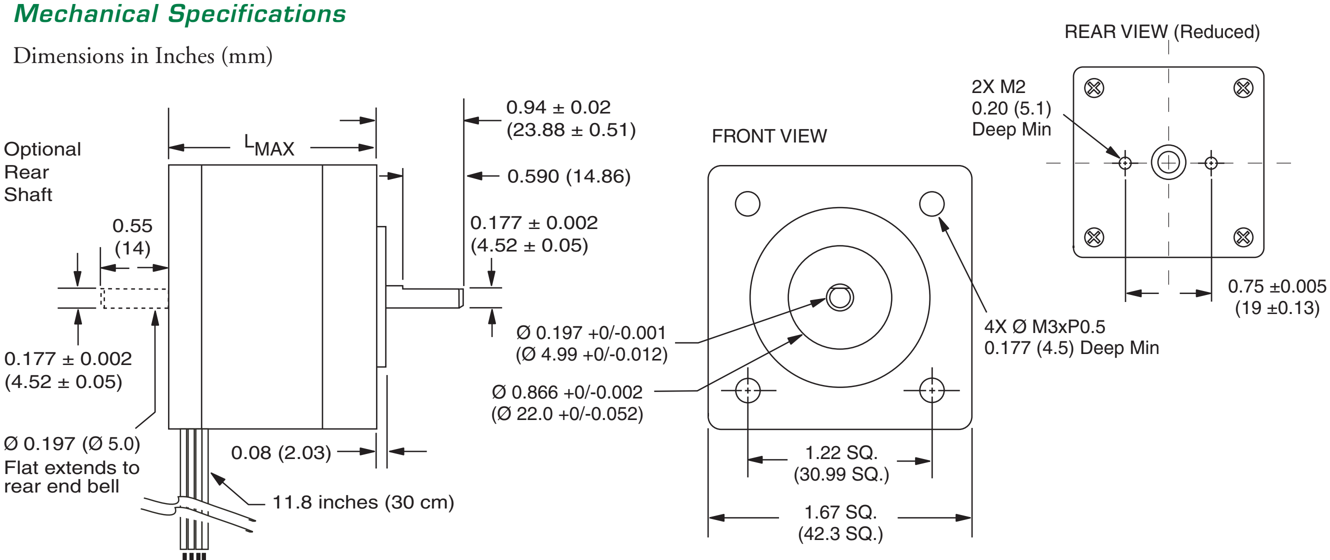


Figure E.5: Size 17 Mechanical Specifications

Size 23 Enhanced Torque Stepping Motor

General Specifications

Part Number	Holding Torque oz-in (N-cm)	Phase Current Amps	Number of Leads	Phase Resistance ohms	Phase Inductance mH	Detent Torque oz-in (N-cm)	Rotor Inertia oz-in-sec² (kg-cm²)	LMax Length inches (mm)	Weight oz (g)
2.4 Amp: M-2218-2.4S	90 (64)	2.4	4	0.95	2.4	3.9 (2.7)	0.00255 (0.18)	1.77 (45)	16.9 (480)
2.4 Amp: M-2222-2.4S	144 (102)	2.4	4	1.2	4.0	5.6 (3.9)	0.00368 (0.26)	2.13 (54)	21.2 (600)
2.4 Amp: M-2231-2.4S	239 (169)	2.4	4	1.5	5.4	9.7 (6.9)	0.0065 (0.46)	2.99 (76)	35.3 (1000)

*Specify S for Single Shaft; D for Double Shaft

Table E.3: Size 23 General Specifications

Wiring And Connection

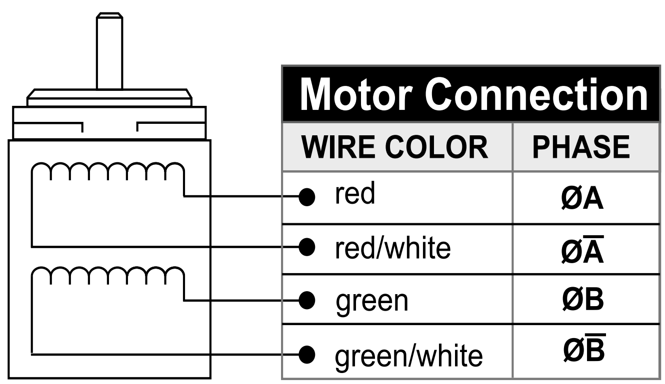


Figure E.6: Size 23 Wiring and Connection

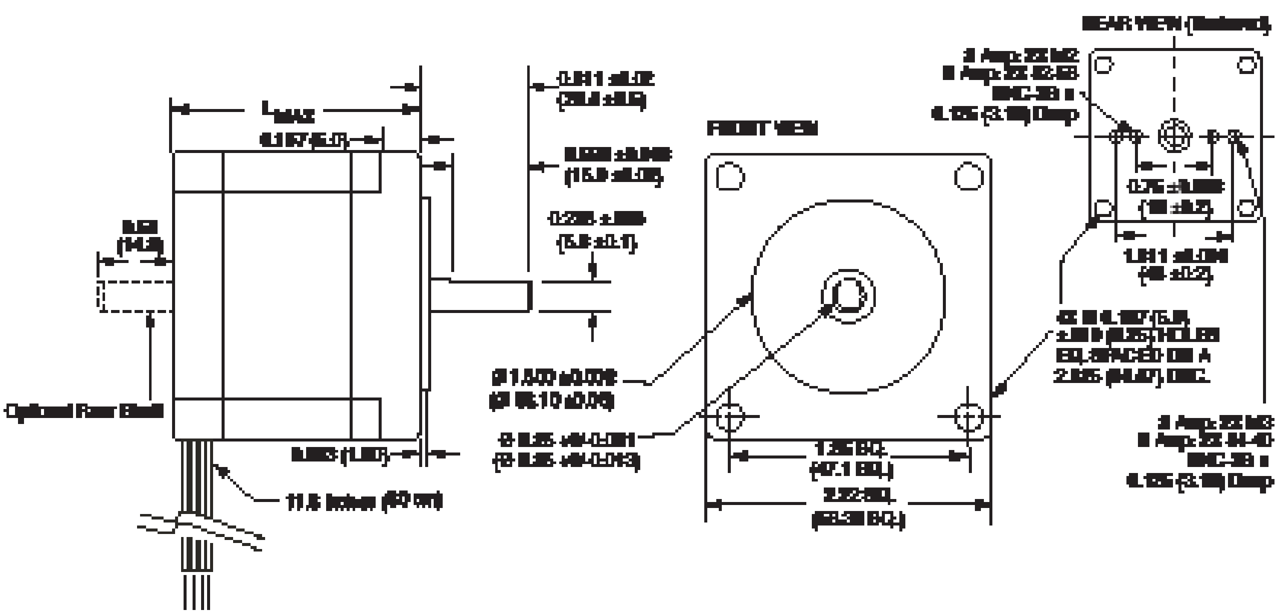


Figure E.7: Size 23 Mechanical Specifications

WARRANTY

TWENTY-FOUR (24) MONTH LIMITED WARRANTY

Intelligent Motion Systems, Inc. ("IMS"), warrants only to the purchaser of the Product from IMS (the "Customer") that the product purchased from IMS (the "Product") will be free from defects in materials and workmanship under the normal use and service for which the Product was designed for a period of 24 months from the date of purchase of the Product by the Customer. Customer's exclusive remedy under this Limited Warranty shall be the repair or replacement, at Company's sole option, of the Product, or any part of the Product, determined by IMS to be defective. In order to exercise its warranty rights, Customer must notify Company in accordance with the instructions described under the heading "Obtaining Warranty Service."

This Limited Warranty does not extend to any Product damaged by reason of alteration, accident, abuse, neglect or misuse or improper or inadequate handling; improper or inadequate wiring utilized or installed in connection with the Product; installation, operation or use of the Product not made in strict accordance with the specifications and written instructions provided by IMS; use of the Product for any purpose other than those for which it was designed; ordinary wear and tear; disasters or Acts of God; unauthorized attachments, alterations or modifications to the Product; the misuse or failure of any item or equipment connected to the Product not supplied by IMS; improper maintenance or repair of the Product; or any other reason or event not caused by IMS.

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This Limited Warranty shall be void if the Customer fails to comply with all of the terms set forth in this Limited Warranty. This Limited Warranty is the sole warranty offered by IMS with respect to the Product. IMS does not assume any other liability in connection with the sale of the Product. No representative of IMS is authorized to extend this Limited Warranty or to change it in any manner whatsoever. No warranty applies to any party other than the original Customer.

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OBTAINING WARRANTY SERVICE

Warranty service may obtained by a distributor, if the Product was purchased from IMS by a distributor, or by the Customer directly from IMS, if the Product was purchased directly from IMS. Prior to returning the Product for service, a Returned Material Authorization (RMA) number must be obtained. Complete the form at http://www.imshome.com/rma.html after which an RMA Authorization Form with RMA number will then be faxed to you. Any questions, contact IMS Customer Service (860) 295-6102.

Include a copy of the RMA Authorization Form, contact name and address, and any additional notes regarding the Product failure with shipment. Return Product in its original packaging, or packaged so it is protected against electrostatic discharge or physical damage in transit. The RMA number MUST appear on the box or packing slip. Send Product to: Intelligent Motion Systems, Inc., 370 N. Main Street, Marlborough, CT 06447.

Customer shall prepay shipping changes for Products returned to IMS for warranty service and IMS shall pay for return of Products to Customer by ground transportation. However, Customer shall pay all shipping charges, duties and taxes for Products returned to IMS from outside the United States.

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