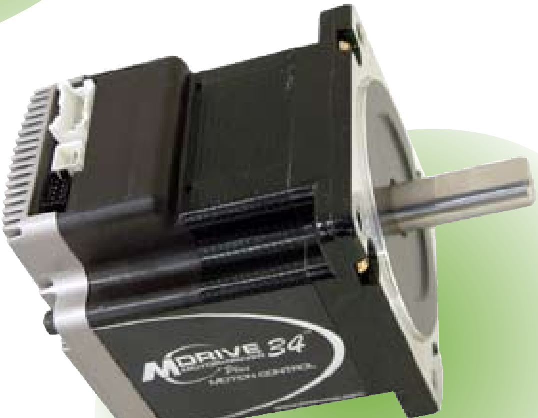
INTELLIGENT MOTION SYSTEMS, INC.
Excellence in Motion

MDRIVE 34™ MOTOR+DRIVER Plus

MOTION CONTROL

HARDWARE REFERENCE

Flying Leads Interface



Pluggable Interface

www.imshome.com

MDrive34Plus Motion Control Hardware Reference Change Log		
Date	Revision	Changes
06/29/2006	R062906	Initial Release
08/01/2006	R080106	Added connector orientation drawings to Part 1: Hardware Specifications, added Cable info to Appendix F.

MDrive34Plus Motion Control Hardware Reference Revision R080106

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GETTING STARTED

Getting Started - MDrivePlus Motion Control

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

Before You Begin

The Quick Start guide is designed to help get you connected and communicating with the MDrivePlus Motion Control. The following examples will help you get the motor turning for the fist time and introduce you to Immediate and Program modes of operation.

Immediate Mode: In Immediate Mode, commands are issued and executed directly to the MDrive34Plus Motion Control by user input into the terminal window.

Program Mode: Program mode is used to input user programs into the MDrive34Plus Motion Control.

Tools and Equipment Required

- MDrivePlus Motion Control Unit.
- Communications Converter Cable or equivalent (USB to RS-422).
- MDrivePlus Product CD or Internet access to www.imshome.com.
- An +12 to +75 VDC Unregulated Power Supply .
- Basic Tools: Wire Cutters / Strippers / Screwdriver.
- 18 AWG Wire for Power Supply.
- A PC with Windows XP Service Pack 2.
- A free serial communications or USB port.

Connecting the Power Supply

Using the recommended wire (see the specifications for your MDrivePlus Motion Control), connect the DC output of the power supply to the +V input of the connector appropriate for your MDrivePlus model.

Connect the power supply ground to the Power Ground pin appropriate for your MDrivePlus.

Connecting Communications

Connect the Host PC to the MDrivePlus Motion Control using the IMS Communications Converter Cable or equivalent.

Install IMS Terminal Software

1. Insert the MDrive CD 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.

N **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.

WARNING: Do not connect or disconnect DC input to the MDrivePlus 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.

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.

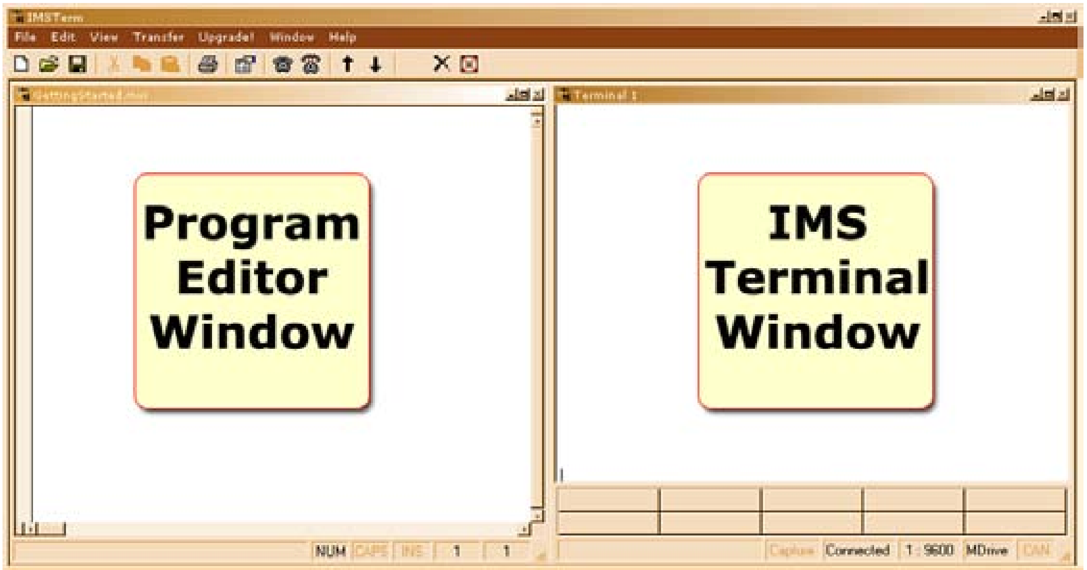

Figure GS.1: IMS Terminal Main Screen

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, verify that MDrive has been selected, and also verify the Comm Port being used. Do not change any other settings. Click "OK".

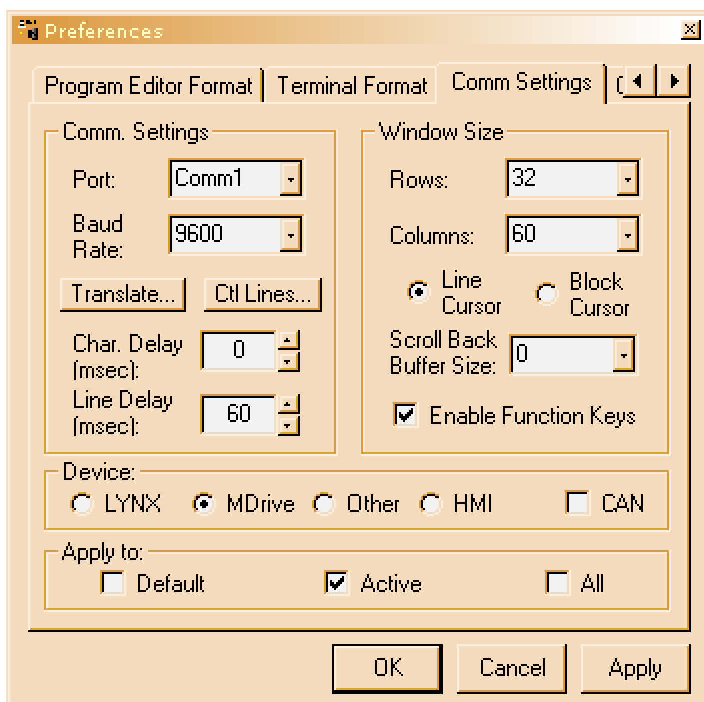

Figure GS.2: IMS Terminal Prefrences Dialog

Apply Power to the MDrivePlus Motion Control

1. Verify that all connections have been made, then apply power to the MDrivePlus Motion Control. Click on the Phone icon or the Disconnect status box to establish communications between IMS Terminal and the MDrivePlus. 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 MDrivePlus 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 MDrivePlus Motion Control.
   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) 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 MDrivePlus Motion Control

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

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

should appear in the Terminal Window within a few seconds.

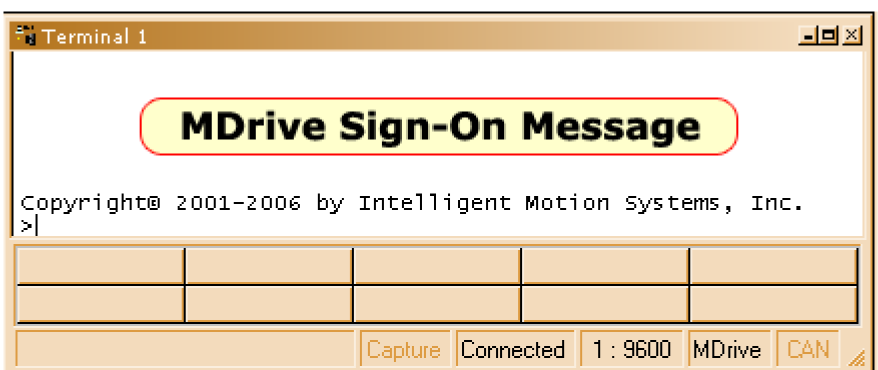

Figure GS.3: MDrivePlus Motion Control Sign-On Message

Make the MDrivePlus Motion Control Move

1. Type MR 51200 into the Terminal Window and press ENTER. (MR = Move Relative)
   a. With the default settings, the MDrive 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 MDrivePlus Motion Control 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 MDrivePlus Motion Control should decelerate to a full stop.

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

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

Warning: If you have installed the MDrivePlus 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.

NOTE: Entering MDrivePlus 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.

Motion Control Example Using Program Mode

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 MDrivePlus Motion Control will turn 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.

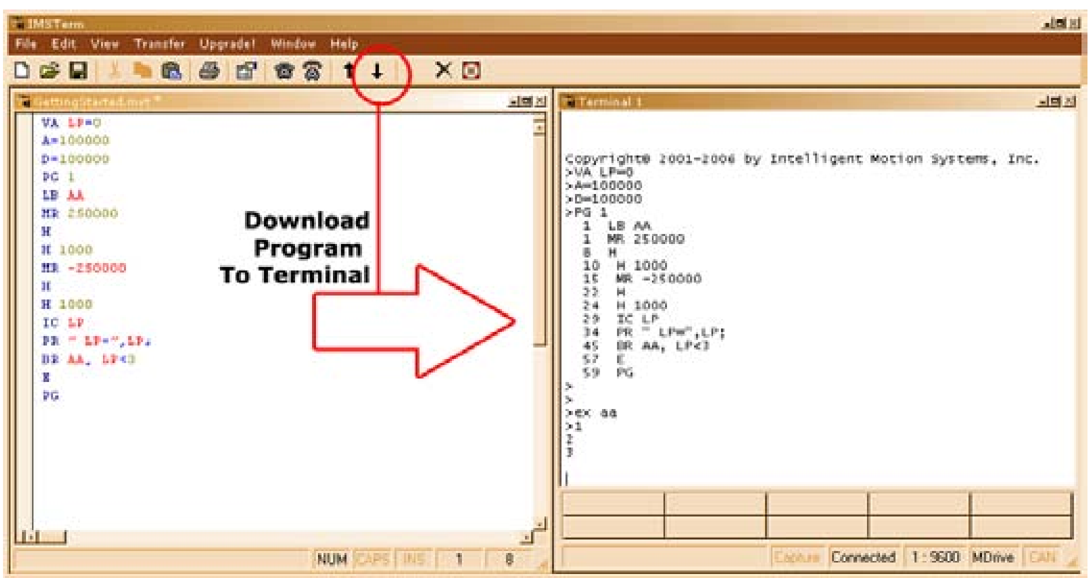

Figure GS.4: Download the Program

Programming Notes

The example above demonstrates basic commands that verify that your MDrivePlus Motion Control 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 MDrivePlus Motions Control Software Reference for details.

For more information on MDrivePlus Motion Control Programming and Command Control Sets, refer to the Software Section of this manual.

MDRIVE MOTOR+DRIVER 34™ Plus
MOTION CONTROL

PART 1: HARDWARE SPECIFICATIONS

Section 1.1: MDrive34Plus Motion Control Product Introduction

Section 1.2: MDrive34Plus Motion Control Detailed Specifications

Section 1.3: MDrive34Plus^2 Motion Control Detailed Specifications

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MDrive34Plus Motion Control Product Introduction

N Note: The MDrivePlus Motion Control is available in a CAN communications configuration. For more information see IMS Web Site.

Introduction to the MDrive34Plus Motion Control System

The MDrive34Plus Motion Control offers system designers a low cost, intelligent motion controller integrated with a NEMA 34 high torque brushless motor and a +12 to +75 volt microstepping driver.

The unsurpassed smoothness and performance delivered by the MDrive34Plus Motion Control 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.

Figure 1.1.1: MDrive34Plus With Flying Leads

The MDrive34Plus accepts a broad input voltage range from +12 to +75 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 MDrive34Plus Motion Control 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 MDrive34Plus2 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.

All MDrive34Plus Motion Control are available with optional closed loop control. This increases functionality by adding stall detection, position maintenance and find index mark.

The closed loop configuration is added via a 512 line (2048 edge) magnetic encoder with index mark, internal to the unit so there is no increase in length. Or, for an expanded choice of line counts and resolutions with MDrive34Plus2 versions only, closed loop control is available with an interface to a remotely mounted user-supplied external encoder.

Figure 1.1.2: MDrive34Plus2 Locking Wire Crimp

The MDrive communicates 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.

Available motor configurations include a single shaft rotary motor and a linear actuator with long life Acme screw*. Rotary versions are available in three motor lengths. Interface connections are accomplished using 12.0” (30.5cm) flying leads, or with pluggable locking wire crimp connectors for Plus2 versions only.

The MDrive34Plus is a compact, powerful and inexpensive solution that will reduce system cost, design and assembly time for a large range of brushless motor applications.

Standard Feature Summary

- Highly Integrated Microstepping Driver, Motion Controller and NEMA 34 High Torque Brushless Motor
- Advanced 2nd Generation Current Control for Exceptional Performance and Smoothness
- Single Supply: +12 to +75 VDC
- Low Cost
- Extremely Compact

- Available Options:
  - Internal Optical Encoder for Closed Loop Control
  - Integrated Planetary Gearbox
  - Control Knob for Manual Positioning
- Three Rotary Motor Lengths Available
- Auxiliary Logic Power Supply Input
- 20 Microstep Resolutions up to 51,200 Steps Per Rev Including: Degrees, Metric, Arc Minutes
- Open or Optional 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 or Optional CANopen* Communications
- 62 Software Addresses for Multi-Drop Communications
- Simple 1 to 2 Character Instructions
- Interface Options:
  - 12.0” (30.5cm) Flying Leads

Expanded Plus^2 Features

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

The MDrive34Plus Motion Control Key Differences and Enhanced Features

There are two different variants of the MDrive34Plus Motion Control, these are:

1. MDrive34Plus Motion Control

The MDrive34Plus Motion Control is the standard version of the MDrive34Plus and is drop-in compatible with the legacy MDrive34 Motion Control product. The key additions in the new Plus units are:

- Improved current control.
- 20 Microstep resolutions to 51,200 steps per rev including degrees, metric and arc minutes.
- Four+5 to +24 VDC I/O lines which accept sinking or sourcing inputs.
- One 0 to +10 VDC Analog input.

See Section 1.2 of this document for detailed specifications on the MDrive34Plus Motion Control.

2. MDrive34Plus^2 Motion Control

The MDrive34Plus^2 Motion Control adds expanded functionality to the MDrive34Plus in the form of:

- Enhanced and expanded I/O set (8 lines) which can be configured as sinking or sourcing inputs or outputs.
- Remote Encoder option.
- High speed position capture input or trip output.
- Pluggable wire crimp interface.
- Electronic gearing.

MDrive34Plus Detailed Specifications

WARNING! The maximum +75 VDC Input Voltage of the MDrive34Plus series includes motor Back EMF, Power Supply Ripple and High Line.

WARNING! Because the MDrivePlus 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.

Standard Electrical Specifications

Input Voltage (+V)

Range .... +12 to +75 VDC

Aux. Logic Input Voltage

Range .... +12 to +24 VDC
(Maintains power to control and feedback circuits [only] when input voltage is removed)

Analog Input (IN5)

Resolution .... 10 Bit
Voltage Range .... 0 to +5 VDC, 0 to +10 VDC, 4 - 20mA, 0 - 20mA

General Purpose I/O

Number/Type

Plus (1-4) .... 4 Sinking Outputs / 4 Sourcing or Sinking Inputs

Voltage Range

Input .... TTL level compatible, up to +24 VDC
Output .... (Sinking) up to +24 VDC

Logic Threshold

Logic 0 .... <0.8VDC
Logic 1 .... >2.2VDC
Output Sink Current (per channel)* .... Up to 600 mA
Protection .... Over Temp, Short Circuit, Transient Over Voltage, Inductive Clamp

Communication

Protocol (Standard) .... RS-422/RS-485, Full/Half Duplex Selectable
Baud Rate 4.8k, 9.6k, 19.2k, 38.4k, 115.2kbps

* See I/O Ratings on In Section 2.3: Interfacing the MDrivePlus Motion Control I/O

Thermal Specifications

Operating Temperature .... -40 to 85°C

Standard Motion Specifications

Microstep Resolution – Open Loop Configuration

Number of Microstep Resolution Settings 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

Encoder (Optional)

Type .... Internal, Optical
Resolution .... 512 Lines/2048 counts per Revolution

> **WARNING!** When using the MDrivePlus Motion Control with optional internal magnetic encoder, no axial force may be applied to the motor shaft without use of a load bearing isolation coupling.

Counters

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

Velocity

Range .... ±5,000,000 Steps per Second
Resolution .... 0.5961 Steps per Second

Acceleration/Deceleration

Range .... 1.5 x 10^9 Steps per Second^2
Resolution .... 90.9 Steps per Second^2

† Adjusting the microstep resolution can increase the range.

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 & Call (conditonal or unconditional)
Predefined I/O Functions .... Inputs Home, Limit Plus, Limit Minus, Go, Stop, Pause, Jog Plus, Jog Minus, Analog In
Outputs .... Moving, Fault, Stall, Velocity Change
Trip Functions .... Trip on Input, Trip on Position, Trip on Time, Trip Capture
Party Mode Addresses 62
Encoder Functions .... Stall Detection, Position Maintenance, Find Index

Motor Specifications

Single Length

Holding Torque .... 381 oz-in/269 N-cm
Detent Torque .... 10.9 oz-in/7.7 N-cm
Rotor Inertia .... 0.01416 oz-in-sec^2/1.0 kg-cm^2
Weight (Motor + Driver) .... 4.1 lb/1.9 kg

Double Length

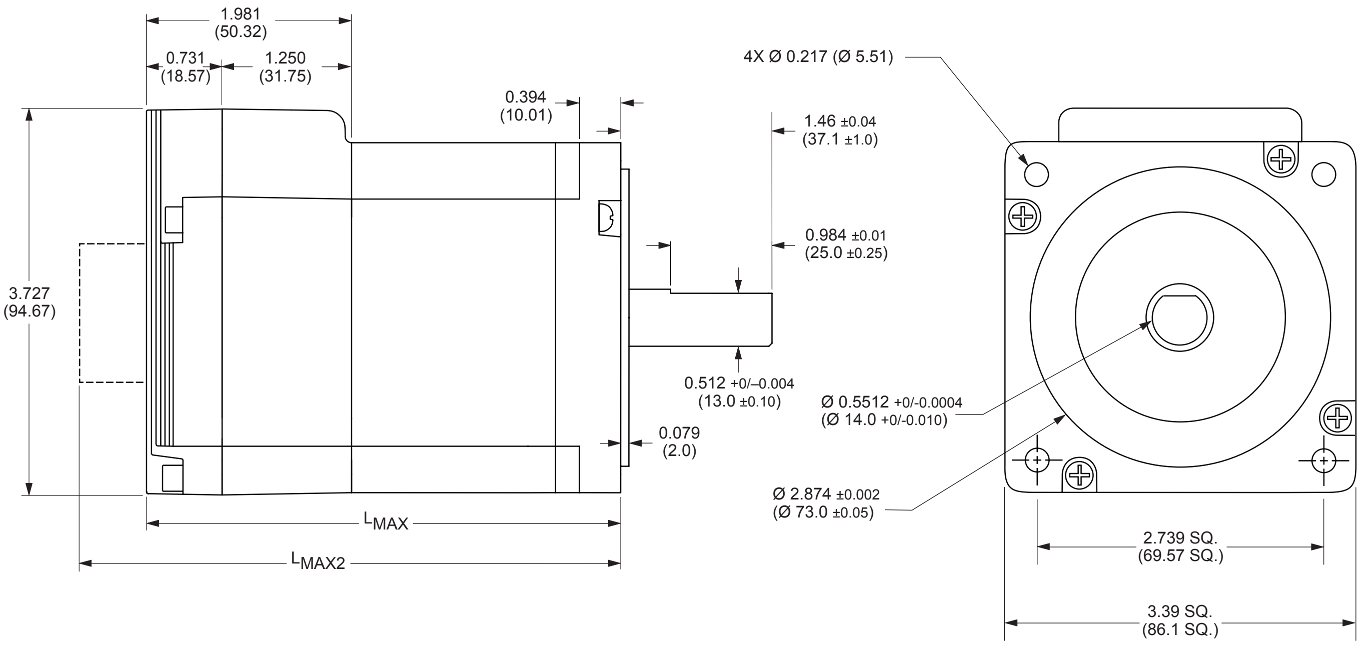
Holding Torque .... 575 oz-in/406 N-cm
Detent Torque .... 14.16 oz-in/10.0 N-cm
Rotor Inertia .... 0.02266 oz-in-sec^2/1.6 kg-cm^2
Weight (Motor + Driver) .... 5.5 lb/2.5 kg

Triple Length

Holding Torque .... 1061 oz-in/749 N-cm
Detent Torque .... 19.83 oz-in/14.0 N-cm
Rotor Inertia .... 0.04815 oz-in-sec^2/3.4 kg-cm^2
Weight (Motor + Driver) .... 8.8 lb/4.0 kg

Mechanical Specifications

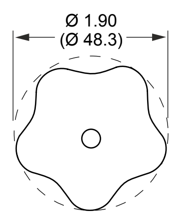
Dimensions in Inches (mm)



MDrive Lengths Inches (mm)

Motor Length	LMAX SINGLE SHAFT, INTERNAL ENCODER	LMAX2 CONTROL KNOB VERSION
Single	3.71 (94.23)	4.42 (112.27)
Double	4.50 (114.30)	5.21 (132.33)
Triple	6.07 (154.18)	6.78 (172.21)

LMAX2 Option



Control Knob

Connector Options

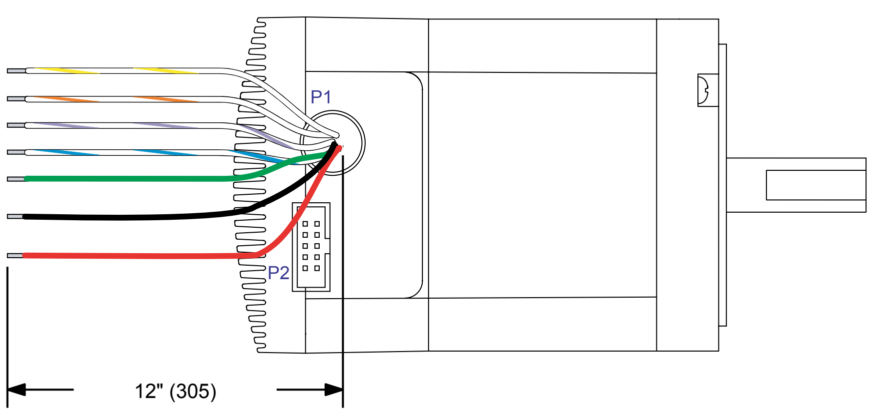
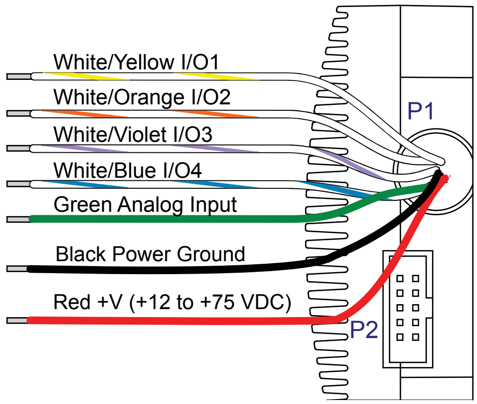


Figure 1.2.1: Mechanical Specifications

Pin/Wire Assignments

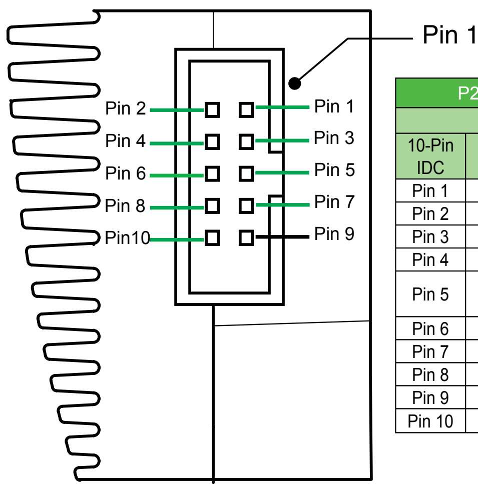
P1 Connector - I/O and Power Connections



Flying Leads - I/O and Power Connection	
Wire Color	Function
White/Yellow	I/O 1
White/Orange	I/O 2
White/Violet	I/O 3
White/Blue	I/O 4
Green	Analog Input
Black	Power/Aux-Ground
Red	+V (+12 to +75 VDC)

Figure 1.2.2: P1 - 12 in/304.8 cm Flying Leads

P2 Connector - RS-422/485 Communications



P2: COMM CONNECTOR		
RS-422/485		
10-Pin IDC	Wire Crimp	Function
Pin 1	Pin 9	TX +
Pin 2	Pin 10	TX –
Pin 3	Pin 7	RX +
Pin 4	Pin 8	RX –
Pin 5	Pin 5	Aux-Logic (+12 to +24 VDC)
Pin 6	Pin 6	RX +
Pin 7	Pin 3	RX –
Pin 8	Pin 4	TX –
Pin 9	Pin 1	TX +
Pin 10	Pin 2	COMM Ground

Figure 1.2.3: P2 - 10-Pin IDC, RS-422/485 Communications

Options and Accessories

Internal Encoder

All MDrive34Plus Motion Control versions are available with an optional internal 512-line (2048 count) optical encoder with index mark.

Control Knob

The MDrive34Plus is available with a factory-mounted rear control knob for manual shaft positioning.

Planetary Gearbox

Efficient, low maintenance planetary gearboxes are offered assembled with the MDrive34Plus. Refer to details in Appendix C.

Communications Converter Cables

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

USB to 10-Pin IDC..MD-CC400-000

SECTION 1.3

MDrive34Plus² Detailed Specifications

WARNING! The maximum +75 VDC Input Voltage of the MDrive34Plus series includes motor Back EMF, Power Supply Ripple and High Line.

WARNING! Because the MDrivePlus 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.

Standard Electrical Specifications

Input Voltage (+V)

Range .... +12 to +75 VDC
Power supply current requirements (max. per MDrive34Plus) 4A
(Actual power supply current will depend on voltage and load)

Aux. Logic Input Voltage

Range .... +12 to +24 VDC
(Maintains power to control and feedback circuits [only] when input voltage is removed)

Analog Input (IN5)

Resolution .... 10 Bit
Voltage Range .... 0 to +5 VDC, 0 to +10 VDC, 4 - 20mA, 0 - 20mA

Communication

Protocol (Standard) .... RS-422/RS-485, Full/Half Duplex Selectable
Baud Rate 4.8k, 9.6k, 19.2k, 38.4k, 115.2kbps

* See I/O Ratings on In Section 2.3: Interfacing the MDrivePlus Motion Control I/O

Enhanced Electrical Specifications

General Purpose I/O

Number/Type
Default Configuration (No external encoder) .... 8 Sinking/Sourcing Inputs/Outputs

Voltage Range
Input .... TTL level compatible, up to +24 VDC
Output .... (Sourcing) +12 to +24 VDC
Output .... (Sinking) up to +24 VDC
Output Sink/Source Current (per channel)* .... Up to 600 mA

Logic Threshold
Logic 0 .... <0.8VDC
Logic 1 .... >2.2VDC
Output Sink Current (per channel)* .... Up to 600 mA
Protection .... Over Temp, Short Circuit, Transient Over Voltage, Inductive Clamp

Thermal Specifications

Operating Temperature .... -40 to 85°C

Standard Motion Specifications

Microstep Resolution – Open Loop Configuration

Number of Microstep Resolution Settings 20

Available Microsteps Per Revolution									
200	400	800	1000	1600	2000	3200	5000	6400	10000
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Resolution .... 512 Lines/2048 counts per Revolution

Counters

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

Velocity

Range .... ±5,000,000 Steps per Second
Resolution .... 0.5961 Step per Second

Acceleration/Deceleration

Range .... 1.5×10^9 Steps per Second^2
Resolution .... 90.9 Steps per Second^2

Enhanced Motion Specifications

Electronic Gearing

Range .... 0.001 to 2.000†
Resolution .... 32 Bit
Threshold (External clock in) .... TTL
Input Filter Range .... 50 nS to 12.9 µS
Range (Secondary clock out) .... 1 to 1†

High Speed I/O

Position Capture .... 32 Bit Resolution, 50 nS to 12.9 µS Input Filter Range
Trip Output Speed 150nS
Trip Output Resolution .... 32 Bit
Trip Output Threshold .... TTL

Remote Encoder (Optional)

Type .... User-Supplied Differential Encoder
Steps per Revolution .... See Microstep Resolutions - Open Loop, Above
Resolutions .... User-Defined

† Adjusting the microstep resolution can increase the range.

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 & Call (conditonal or unconditional)
Predefined I/O Functions .... Inputs Home, Limit Plus, Limit Minus, Go, Stop, Pause, Jog Plus, Jog Minus, Analog In
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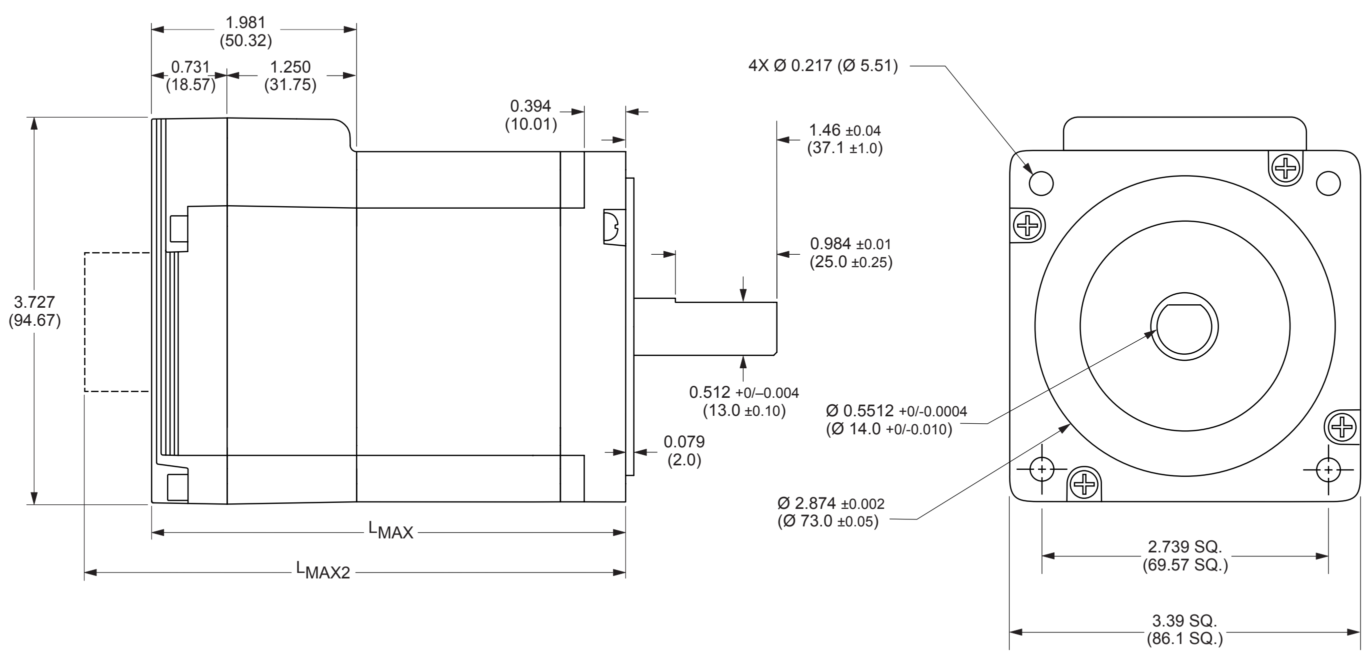
Mechanical Specifications

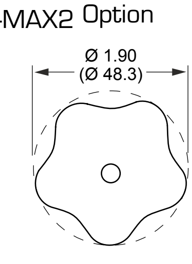
Dimensions in Inches (mm)



MDrive Lengths Inches (mm)

Motor Length	L_{MAX} SINGLE SHAFT, INTERNAL ENCODER	L_{MAX2} CONTROL KNOB VERSION
Single	3.71 (94.23)	4.42 (112.27)
Double	4.50 (114.30)	5.21 (132.33)
Triple	6.07 (154.18)	6.78 (172.21)

L_{MAX2} Option



Control Knob

Figure 1.3.1: Mechanical Specifications

Connector Options

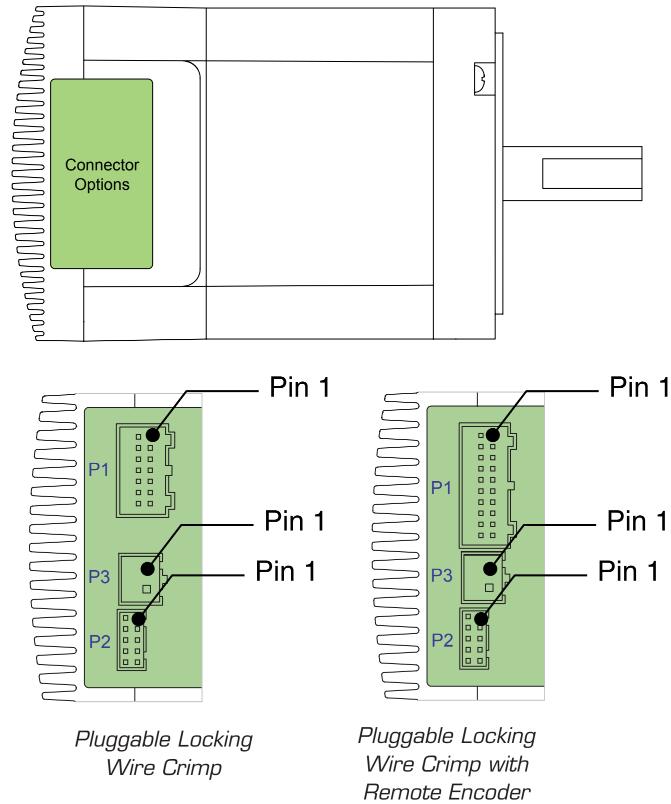
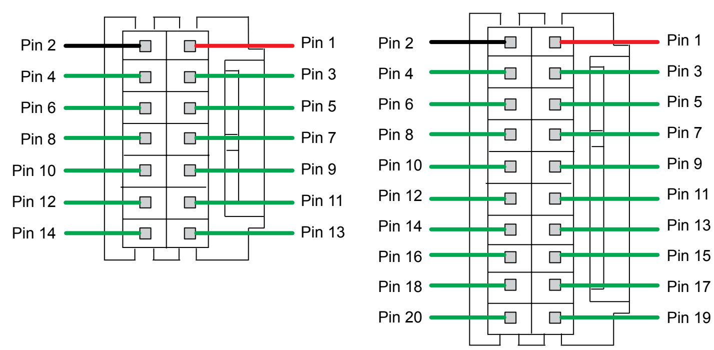


Figure 1.3.2: Connector Orientation

Pin/Wire Assignments

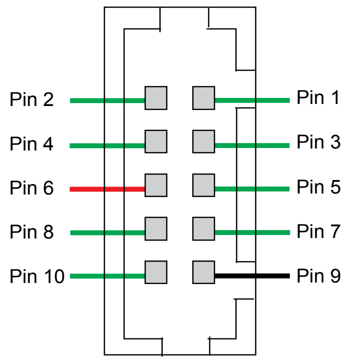
P1 Connector - I/O and Power Connections



P1: I/O CONNECTOR		
Wire Crimp	Function	
	Expanded I/O	Remote Encoder Closed Loop Control
Pin 1	I/O Power	I/O Power
Pin 2	I/O Ground	I/O Ground
Pin 3	I/O 1	I/O 1
Pin 4	I/O 2	I/O 2
Pin 5	I/O 3	I/O 3
Pin 6	I/O 4	I/O 4
Pin 7	I/O 9	I/O 9
Pin 8	I/O 10	I/O 10
Pin 9	I/O 11	I/O 11
Pin 10	I/O 12	I/O 12
Pin 11	Capture/Trip I/O	Capture/Trip I/O
Pin 12	Analog In	Analog In
Pin 13	Step/Clock I/O	Step/Clock I/O
Pin 14	Direction/Clock I/O	Direction/Clock I/O
Pin 15	n/a	Channel A +
Pin 16		Channel A -
Pin17		Channel B +
Pin 18		Channel B -
Pin 19		Index +
Pin 20		Index -

Figure 1.3.3 P1 14 Pin and 20-Pin Wire Crimp Connector Pin Configuration

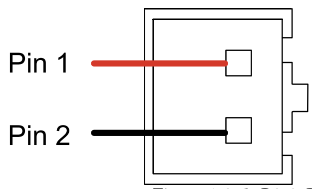
P2 Connector - RS-422/485 Communications



P2: COMM CONNECTOR	
Wire Crimp	Function
Pin 1	TX +
Pin 2	Comm Ground
Pin 3	RX –
Pin 4	TX –
Pin 5	Aux-Logic (+12 to +24 VDC)
Pin 6	RX +
Pin 7	RX +
Pin 8	RX –
Pin 9	TX +
Pin 10	TX –

Figure 1.3.4: P2 10-Pin Wire Crimp Communications Connector

P3 Connector - Power



P3: POWER CONNECTOR	
Wire Crimp	Function
Pin 1	+V (+12 to +75 VDC)
Pin 2	Power/Aux Ground

Figure 1.3.5: P3 2-Pin Locking Wire Crimp Power Connector

Options and Accessories

Internal Encoder

All MDrive34Plus Motion Control versions are available with an optional internal 512-line (2048 count) optical encoder with index mark.

Remote Encoder (Plus2 versions only)

MDrive34Plus2 Motion Control versions are available with differential encoder inputs for use with a remote encoder (not supplied).

Control Knob

The MDrive34Plus^2 is available with a factory-mounted rear control knob for manual shaft positioning.

Planetary Gearbox

Efficient, low maintenance planetary gearboxes are offered assembled with the MDrive34Plus. Refer to details in Appendix C..

Communications Converter Cables

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

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

Prototype Development Cables

For testing and development of MDrives with pluggable locking wire crimp connectors, the following 10.0' (3m) interface cables are recommended with first orders:

I/O: 14-Pin Wire Crimp Cable PD14-2334-FL3
I/O: 20-Pin Wire Crimp Cable PD20-3400-FL3
Power: 2-Pin Wire Crimp Cable..PD02-3400-FL3
Communications: 10-Pin Wire Crimp Cable PD10-1434-FL3

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INTELLIGENT MOTION SYSTEMS, INC.

Excellence in Motion™

MDRIVE MOTOR+DRIVER 34™ Plus

MOTION CONTROL

PART 2: CONNECTING AND INTERFACING

Section 2.1: Mounting and Connection Recommendations

Section 2.2: Interfacing Communications

Section 2.3: Interfacing and Using the MDrivePlus Motion Control I/O

Mounting and Connection Recommendations

Mounting Recommendations

There are no special mounting considerations for this device. Flange mounting holes are drilled through with a diameter of 0.217" (5.51mm) to take standard M5 screws. The length of the screw used will be determined by the mounting flange width. See Mechanical Specifications for mounting hole pattern.

DC Power Recommendations

MDrive34Plus Motion Control

The power requirements for the MDrive34Plus Motion Control are:

Output Voltage ....+12 to +75 VDC
Current (max. per unit)..4A
(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 MDrivePlus need to be twisted. If more than one driver is to be connected to the same power supply, run separate power and ground leads from the supply to each driver.

Recommended Wiring

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

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

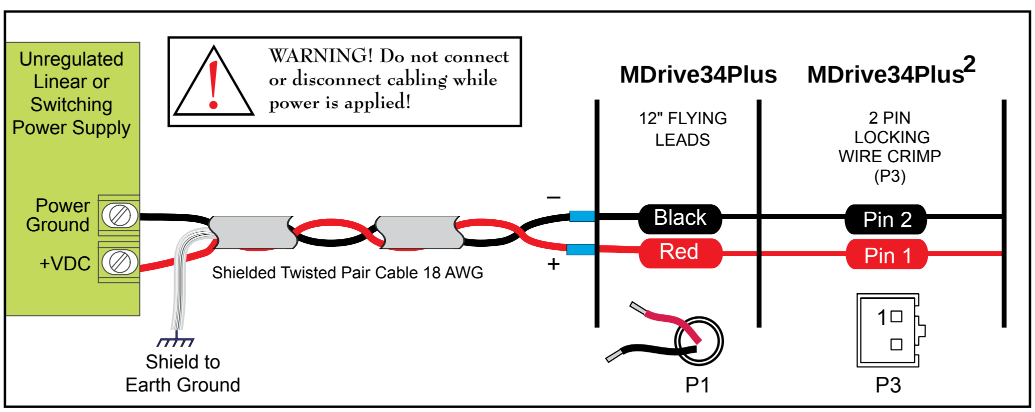


Figure 2.1.1: MDrive Motion Control Power Connections

Recommended Mating Connectors and Pins

Communications

10-Pin IDC (MDI34Plus).. Samtec TCSD-05-01-N
10-pin Friction Lock (MDI34Plus[2]).. 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 MDrive34Plus[2] Units ONLY! Please contact a JST distributor for ordering and pricing information.

Enhanced I/O - P2
14-pin Locking Wire Crimp Connector Shell ....JST PN PADP-14V-1-S
Crimp Pins..JST PN SPH-001T-P0.5L

Enhance I/O with Remote Encoder - P2
20-pin Locking Wire Crimp Connector Shell ....JST PN PADP-20V-1-S
Crimp Pins..JST PN SPH-001T-P0.5L

Power - P3
2-pin Locking Wire Crimp Connector Shell .... Molex 51067-0200
Crimp Pins.. Molex 50217-9101 Brass

Securing Power Leads and Logic Leads

Some applications may require that the MDrive 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 MDrive.

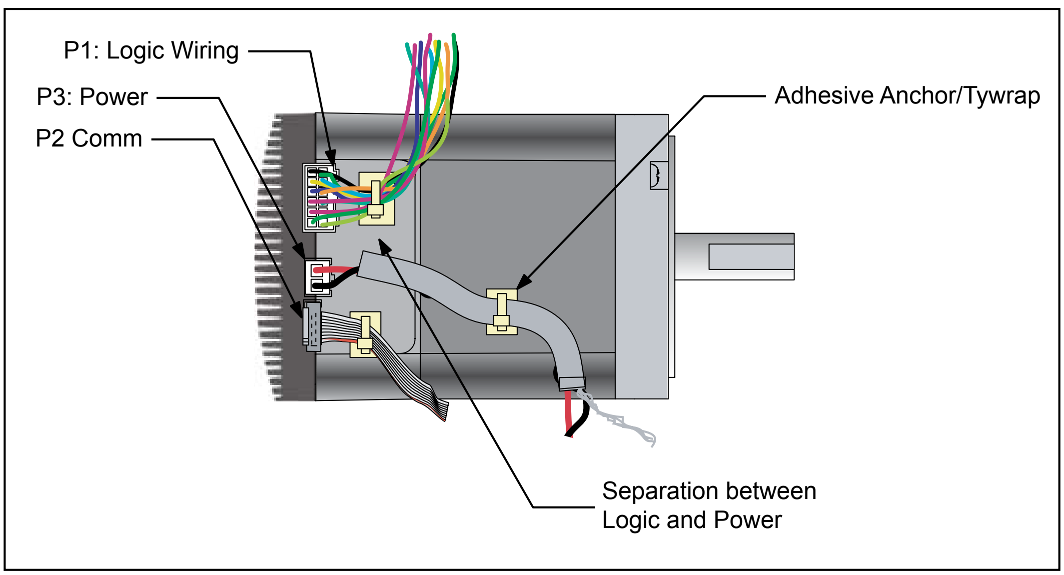


Figure 2.1.2: Typical MDrive Shown with Leads Secured

Interfacing Communications

Available Communications Cables/Converters

To simplify the wiring and connection process IMS offers USB to RS-422 communications cables for each of the MDrivePlus Motion Control models. These convenient 12.0' (3.6m) accessory cables connect a PC's USB Port to the MDrivePlus P2 Connector. An in-line RS-422 converter enables parameter setting to a single MDrivePlus Motion Control. Cable purchase recommended with first orders. Versions include:

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 F: Optional Cables and Cordsets.

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

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

Interfacing Single Mode Communications

The MDrivePlus Motion Control 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 MDrivePlus Motion Control, or to address up to 62 individually named MDrivePlus nodes in a multidrop system.

Single Mode Communications Full Duplex (RS-422)

To interface the MDrivePlus Motion Control 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 appropriate to your MDrivePlus Motion Control model.

Use the following diagram to connect RS-422 communications to the MDrivePlus Motion Control.

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

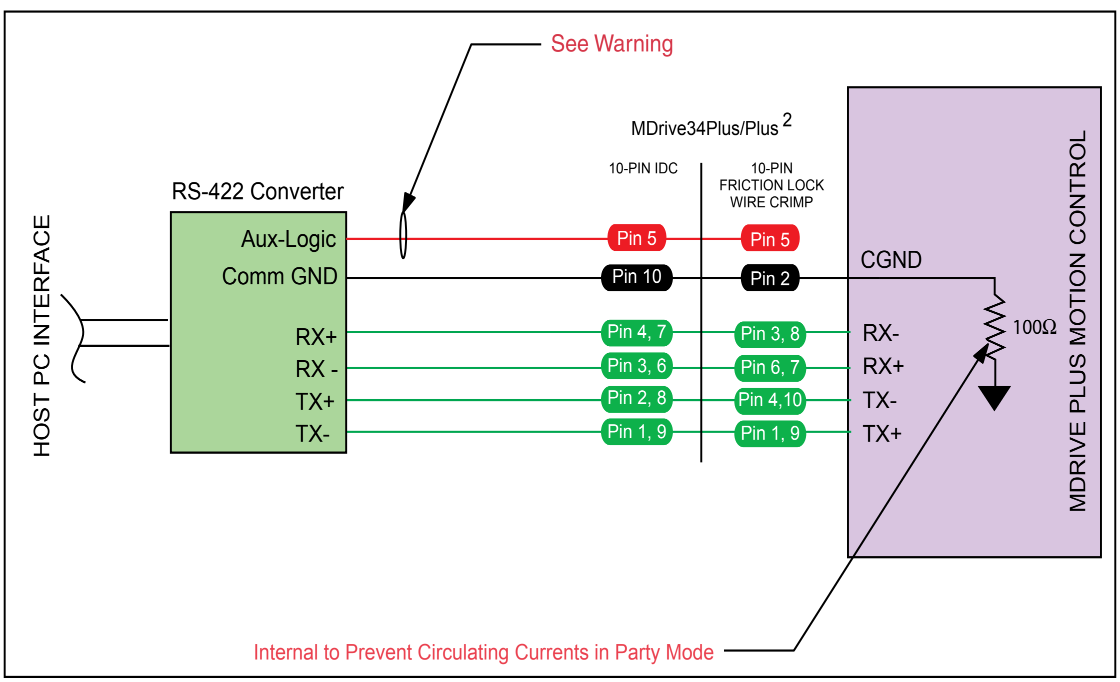


Figure 2.2.1: Full Duplex Communications (RS-422)

Single Mode Communications Half Duplex (RS-485)

The MDrivePlus Motion Control 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 MDrivePlus 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 MDrivePlus communication into "half duplex" mode. Connect the driver in the 2 wire RS-485 configuration. The following diagram illustrates how to connect the MDrivePlus 4 wire RS-485 to operate as a 2 wire system.

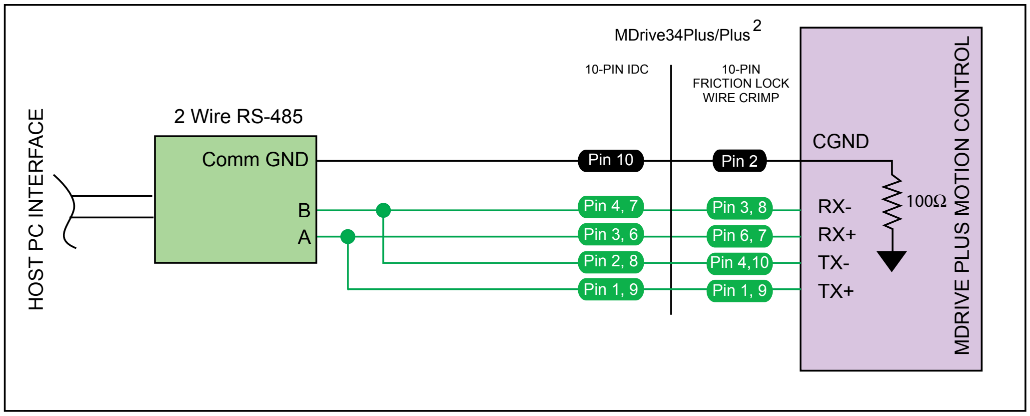


Figure 2.2.2: Half Duplex 2 Wire Communications (RS-485)

Interfacing Party Mode Communications

In systems with multiple controllers it is necessary to communicate with the control modules using party mode (PY=1). The MDrivePlus Motion Control nodes in the system are configured in software for this mode of operation by setting the Party Flag (PY) to True (1). It is necessary for all of the nodes in a system to have this configuration selected. When operating in party mode, each MDrive Motion Control in the system will need a unique address, or name, to identify it in the system. This is accomplished by using the software command DN, or Device Name. For example, to set the name of an MDrive to "A" you would use the following command: DN=65 or DN="A" (65 is the ASCII decimal equivalent of uppercase A). The factory default name is "!". The asterisk character "*" is used to issue global 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 MDrivePlus Motion Control to the Host PC configured for Single Mode Operation.
2. Establish communications and download program if required.
3. Using the command DN, name the MDrivePlus Motion Control. 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 MDrive in the system.
9. After all MDrives are assigned a Device Name the Multiple MDrive Interface can be configured as shown in the following figure.

Data Cable Termination Resistors

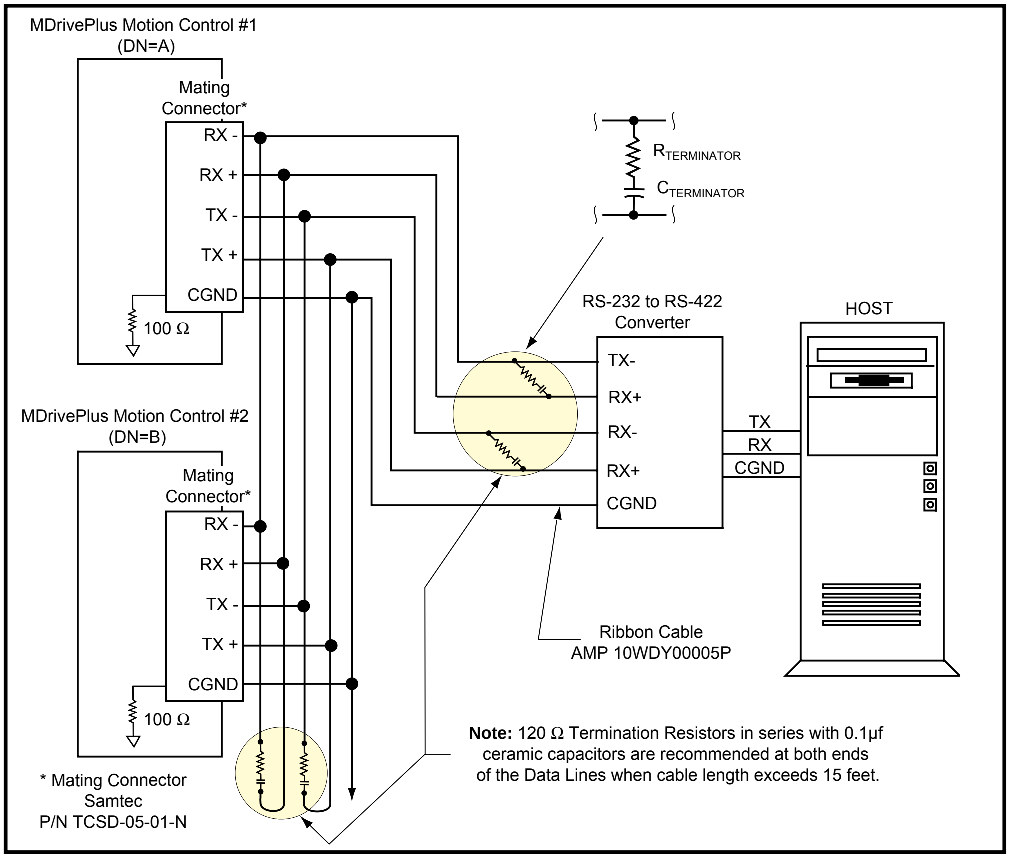


Figure 2.2.3: RS-485 Interface, Multiple MDrivePlus Motion Control System

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 2.2.3 above. For systems with Data Cables 15 feet (4.5 meters) or less, the termination resistors are generally not required.

MDrivePlus Motion Control Communication Format

The following communication formats are used by the MDrive34Plus Motion Control.

```
{}          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 MDI.

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

MDrivePlus Motion Control (MDI) Response to Echo Mode

Dependent on how the Echo Mode (EM) is set in conjunction with Party Mode (PY) and Check Sum (CK), the MDI 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 MDI	MDI Initial Response	MDI 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 2.2.1: MDI Response to Echo Mode - Party and Check Sum are Zero (0)

Parameter Setting	Transmission to MDI	MDI Initial Response	MDI Final Response	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 2.2.2: MDI Response to Echo Mode - Party is One (1) and Check Sum is Zero (0)

Parameter Setting	Transmission to MDI	MDI Initial Response	MDI 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 2.2.3: MDI Response to Echo Mode - Party is Zero (0) and Check Sum is One (1)

Parameter Setting	Transmission to MDI	MDI Initial Response	MDI 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 2.2.4: MDI 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 MDI 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.

MDrivePlus Motion Control Party Mode Sample Codes

1. Download this segment of code into the first MDrivePlus Motion Control. 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 MDrivePlus Motion Control. 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 MDrivePlus Motion Control. 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
```

MDrivePlus Motion Control Immediate Party Mode Sample Codes

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

Move MDrive A, B or C 10000 Steps

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

- To move MDrive Unit "A", Press Ctrl+J and then type: AMR∧10000 and press Ctrl+J. MDrive Unit "A" will move 10000 steps.
- To print the position type: APR P and press Ctrl+J. The position of MDrive Unit "A" will be printed.
- To move MDrive Unit "B" type: BMR 10000 and press Ctrl+J. MDrive Unit "B" will move 10000 steps.
- To move all three MDrives at the same time type: *MR 10000 and press Ctrl+J. All MDrives 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 MDrive 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 Ctrl + the J 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 MDrivePlus, 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!

SECTION 2.3

Interfacing and Using the MDrivePlus Motion Control I/O

The MDrivePlus Motion Control Digital I/O

The MDrivePlus Motion Control 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 MDrivePlus Motion Control and standard sensors and switches.

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

Enhanced (14-Pin) .... ***Plus^2***
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

Enhanced (20-Pin) .... ***Plus^2***
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 I/O .... Channel A±, Channel B±, Index±

Standard I/O Set

The MDrivePlus Motion Control 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 - MDrive34Plus^2

The MDrivePlus^2 Motion Control 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.

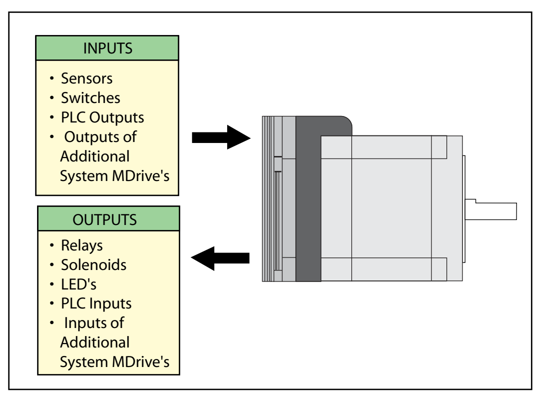


Figure 2.3.1: Uses for the Digital I/O

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 MDrivePlus

Motion Control.

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 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 MDrivePlus Motion Control and standard sensors and switches.

MDrivePlus Motion Control Digital Input Functions

The MDrivePlus Motion Control 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 MDrive Motion Control Sofware 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
```

Programmable Input Functions

The following table lists the programmable input functions of the MDrive Motion Control.

MDrivePlus Motion Control Input Functions			
Parameter (S1-S4, S9-S12)	Function	Active	Sink/Source
0	General Purpose	0/1	0/1
1	Home	0/1	0/1
2	Limit +	0/1	0/1
3	Limit –	0/1	0/1
4	GO	0/1	0/1
5	Soft Stop	0/1	0/1
6	Pause	0/1	0/1
7	Jog +	0/1	0/1
8	Jog –	0/1	0/1
11	Reset	0/1	0/1

Table 2.3.1: Programmable Input Functions

Dedicated Input Functions

MDrivePlus Motion Control Dedicated Input Functions		
Parameter (S7, S8)	Function	Active
33	Step/Direction	0/1
34	Quadrature	0/1
35	Up/Down	0/1
Parameter (S13)	Function	Active
60	High Speed Capture	0/1

Table 2.3.2: 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 top +24 VDC is applied to the input.

Active LOW .... The input will be active when it is gorunded (0 VDC).

NOTE: On the Standard MDrivePlus, 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.

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
```

MDrivePlus Motion Control Digital Output Functions

The MDrivePlus Motion Control 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" comand (See MDrive Motion Control Sofware 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 MDrivePlus Motion Control Output functions may be programmed to be a general purpose user output or to one of five output functions.

MDrivePlus Motion Control Output Functions			
Parameter (S1-S4, S9-S12)	**Function**	**Active**	**Sink/Source**
16	General Purpose User	0/1	0/1
17	Moving	0/1	0/1
18	Fault	0/1	0/1
19	Stall	0/1	0/1
20	Velocity Changing	0/1	0/1

Table 2.3.3: Programmable Output Functions

Dedicated Output Functions

MDrivePlus Motion Control Dedicated Output Functions		
Parameter (S7, S8)	**Function**	**Active**
49	Step/Direction	0/1
50	Quadrature	0/1
51	Up/Down	0/1
Parameter (S13)	**Function**	**Active**
61	High Speed Trip	0/1

Table 2.3.4: Dedicated Output Functions

MDrivePlus Motion Control I/O Ratings

MDrivePlus I/O Ratings			
MDrivePlus Output Voltage (IOPWR) Rating	0 to +24 VDC		
MDrivePlus2 Output Voltage (IOPWR) Rating	+12 to +24 VDC (Sourcing) | 0 to +24 VDC (Sinking)		
Load Rating* (equal current per I/O Point) * Heatsink Temp = 85□C	I/O State	I Continuous	I Peak (D=0.84)
	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: MDrivePlus Motion Control I/O and Protection Ratings

MDrivePlus Motion Control I/O Connections

MDrive34Plus Motion Control

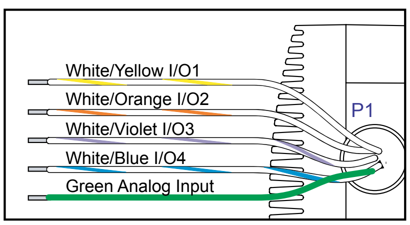


Figure 2.3.2: P1 - 12 in/304.8 cm Flying Leads

Flying Leads - I/O and Power Connection	
Wire Color	Function
White/Yellow	I/O 1
White/Orange	I/O 2
White/Violet	I/O 3
White/Blue	I/O 4
Green	Analog Input

Table 2.3.6: MDrive34Plus P1 I/O

MDrive34Plus² Motion Control

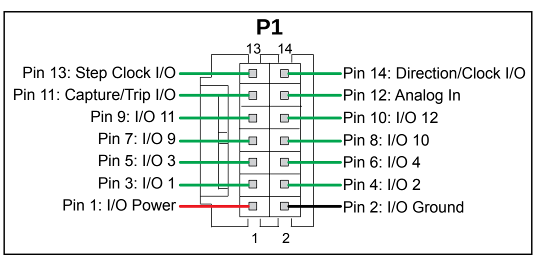


Figure 2.3.3: P1 14-Pin Wire Crimp: Enhanced I/O

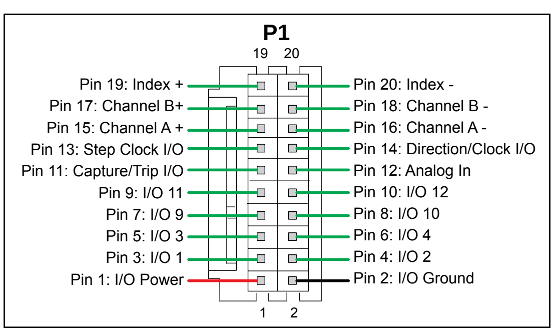


Figure 2.3.4: P1 20-Pin Wire Crimp: Enhanced I/O and External Remote Encoder

P1: I/O CONNECTOR		
Wire Crimp	Function	
	Expanded I/O	Remote Encoder Closed Loop Control
Pin 1	I/O Power	I/O Power
Pin 2	I/O Ground	I/O Ground
Pin 3	I/O 1	I/O 1
Pin 4	I/O 2	I/O 2
Pin 5	I/O 3	I/O 3
Pin 6	I/O 4	I/O 4
Pin 7	I/O 9	I/O 9
Pin 8	I/O 10	I/O 10
Pin 9	I/O 11	I/O 11
Pin 10	I/O 12	I/O 12
Pin 11	Capture/Trip I/O	Capture/Trip I/O
Pin 12	Analog In	Analog In
Pin 13	Step/Clock I/O	Step/Clock I/O
Pin 14	Direction/Clock I/O	Direction/Clock I/O
Pin 15	n/a	Channel A +
Pin 16		Channel A -
Pin17		Channel B +
Pin 18		Channel B -
Pin 19		Index +
Pin 20		Index -

Table 2.3.7: P1 Pin Descriptions

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

NOTE: Advanced I/O interface circuit diagrams and application examples are available in Appendix D: I/O ApplicationsGuide.

I/O Usage Examples — MDrivePlus Standard I/O Set

The circuit examples below illustrate possible interface examples for using the MDrivePlus Motion Control 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 MDrivePlus Motion Control programming. Please reference the MDrive software manual for more information on the Instructions, Variables and Flags that make up the MDI 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.

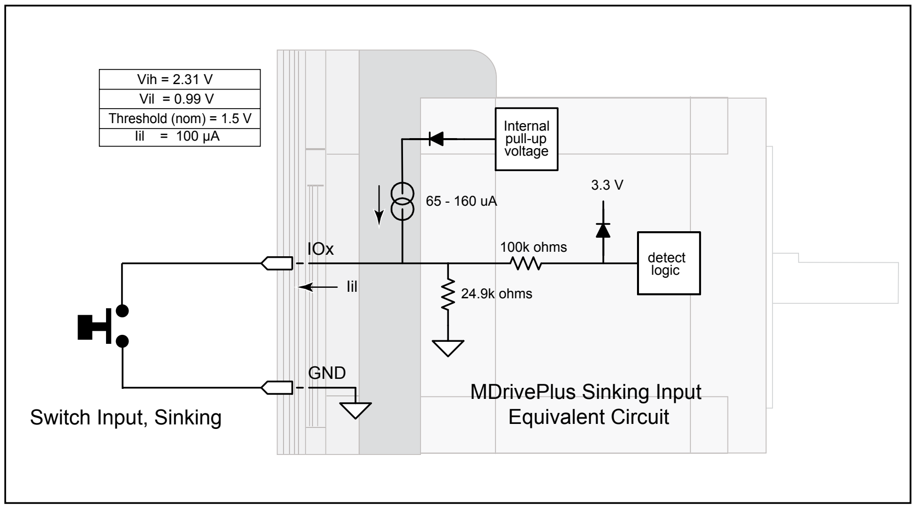


Figure 2.3.5: Sinking Input Example using a Push Button Switch

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 MDrive 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.

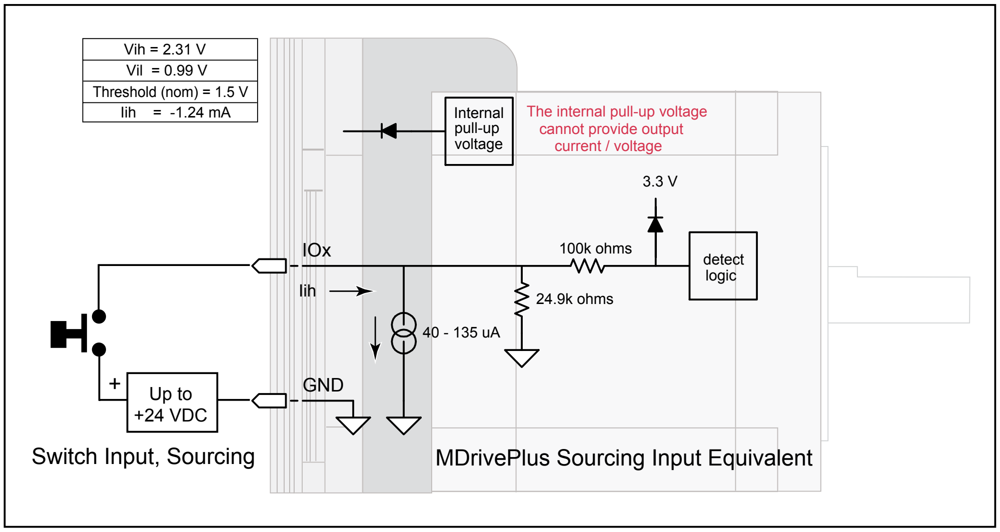


Figure 2.3.6: Sourcing Input Example using a Push Button Switch

Code Sample

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 MDrivePlus, 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.

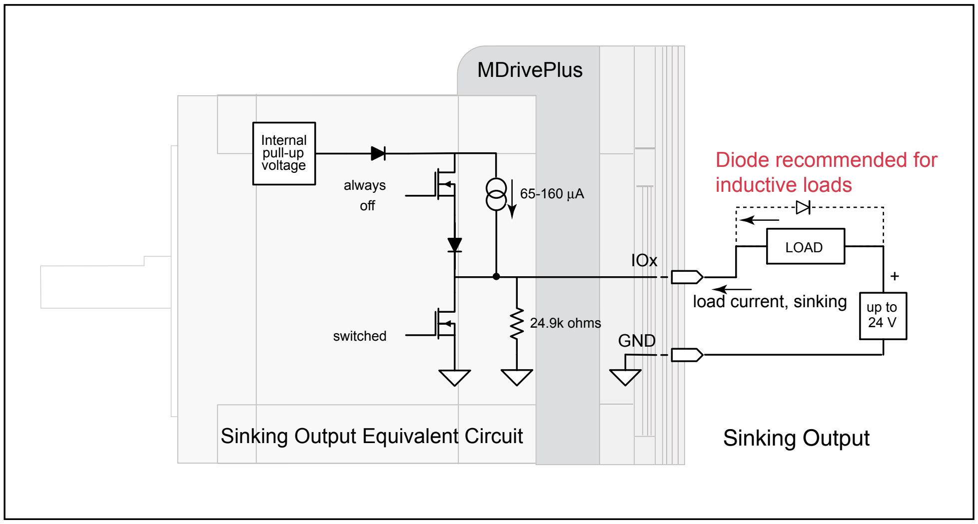


Figure 2.3.7: Sinking Output Example

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 MDrivePlus2 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 MDrivePlus2 Motion Control Digital I/O. Additional diagrams and code samples are available in Appendix D: I/O Applications Guide.

The code samples included with these examples will also serve to introduce the user to MDrivePlus Motion Control programming . Please reference the MDrive software manual for more information on the Instructions, Variables and Flags that make up the MDI 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 D: 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.

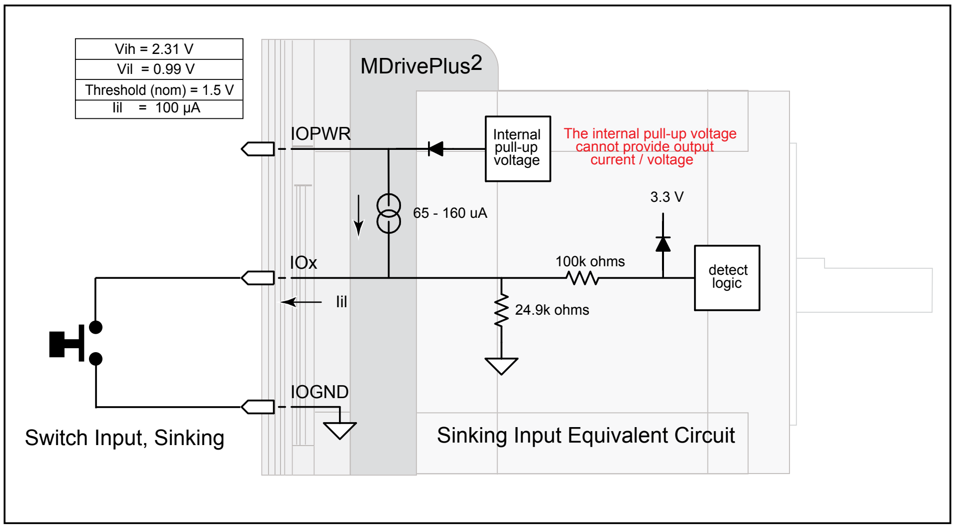


Figure 2.3.8: Switch Interface to Input, Sinking

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 MDrive 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.

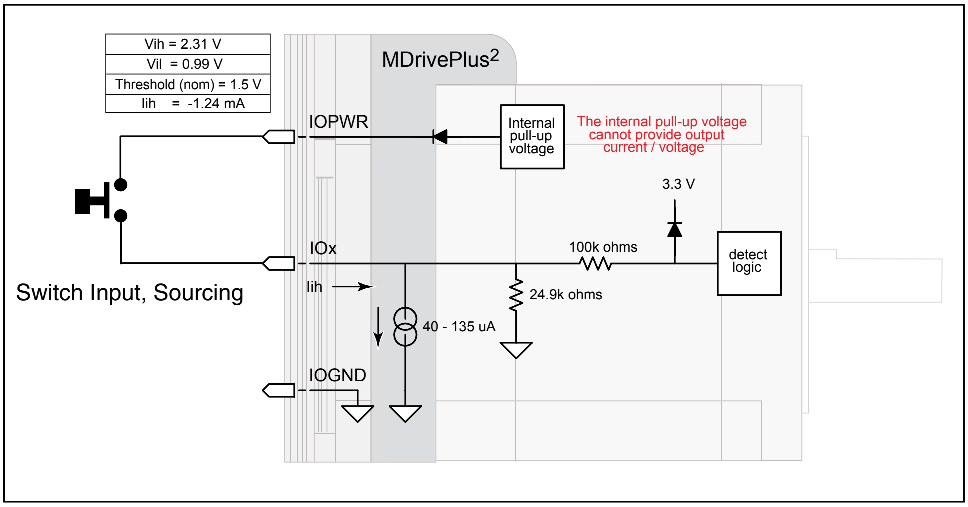


Figure 2.3.9 Sourcing Input Example using a Push Button Switch

Code Sample

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.

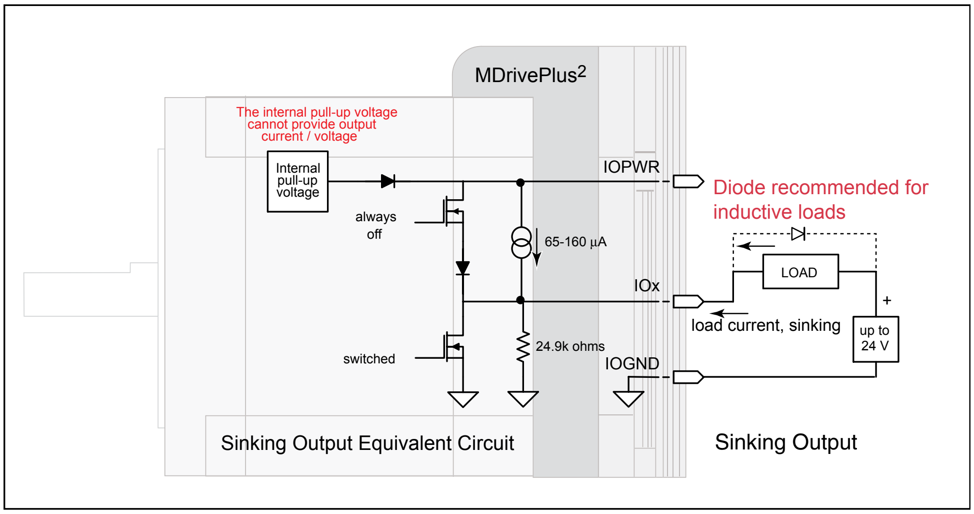


Figure 2.3.10: Sinking Output Example

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.

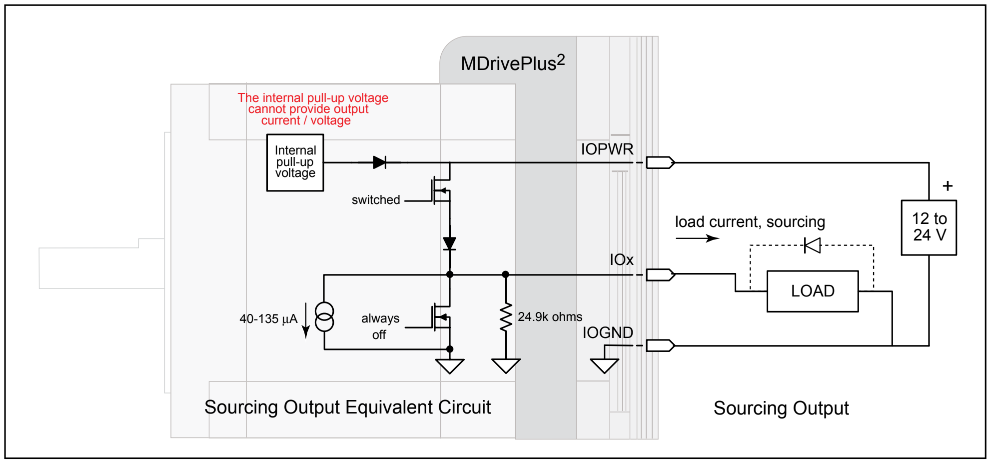


Figure 2.3.11: Sourcing Output Example

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 MDrivePlus 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

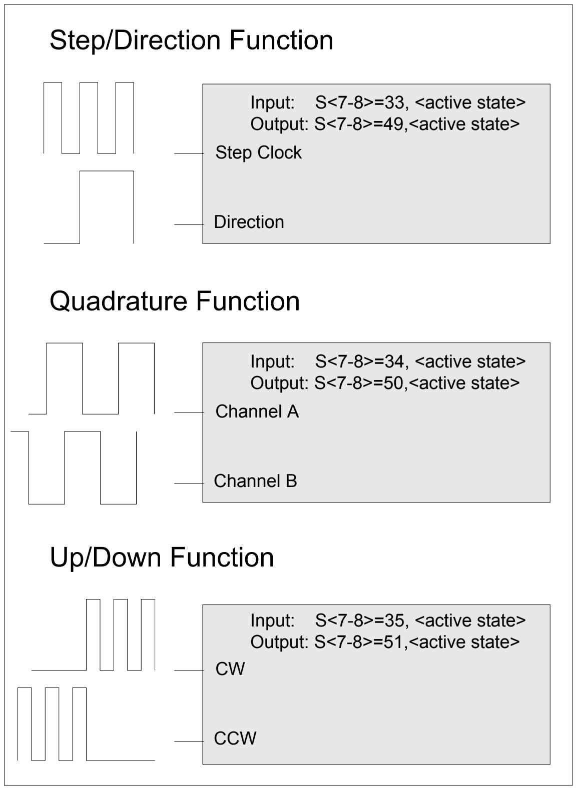


Figure 2.3.12: MDrivePlus Motion Control Clock Functions

Step/Direction

The Step/Direction function would typically be used to receive step and direction instructions from a second system MDrivePlus or secondary controller. When configured as outputs the MDrivePlus Motion Control 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 MDrivePlus would either be a master or slave in an application that would require two MDrives 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.

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.

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>
```

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

N NOTE: When using the MDrivePlus2 with the external encoder option, the step an direction I/O are not available! These I/O points become Index + and Index -. See Appendix E: MDrivePlus Motion Control Closed Loop Control for encoder connection and configuration information.

Interfacing the Analog Input

The analog input of the MDrivePlus Motion Control 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 MDrivePlus Motion Control 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
```

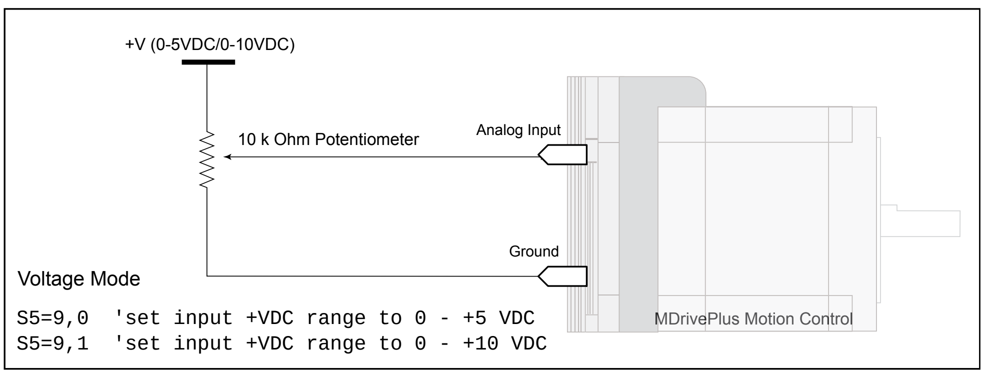
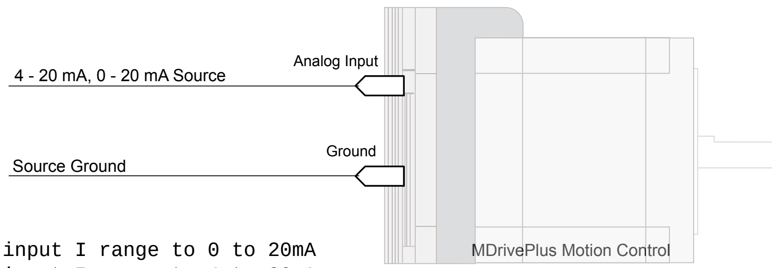


Figure 2.3.13: Analog Input - Voltage Mode



Current Mode

```
S5=10,0  'set input I range to 0 to 20mA
S5=10,1  'set input I range to 4 to 20mA
```

Figure 2.3.14: Analog Input - Current Mode

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INTELLIGENT MOTION SYSTEMS, INC.

Excellence in Motion™

MDRIVE 34™ MOTOR+DRIVER Plus

MOTION CONTROL

APPENDICES

Appendix A: MDrivePlus Motion Control Motor Performance

Appendix B: Recommended Power and Cable Configurations

Appendix C: Planetary Gearboxes

Appendix D: I/O Application Guide

Appendix E: MDrivePlus Motion Control Closed Loop Control

Appendix F: Optional Cables and Cordsets

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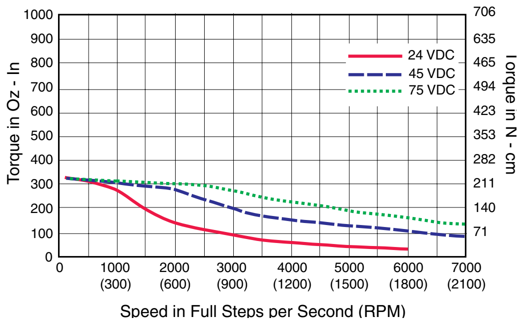
MDrivePlus Motion Control Motor Performance

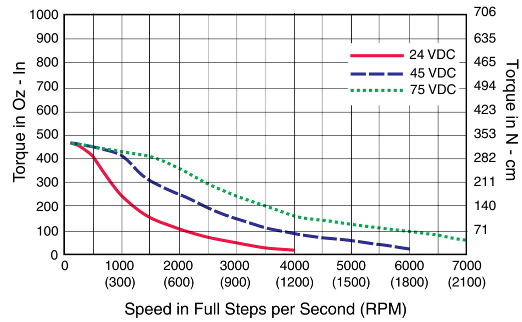
Speed-Torque Curves/Motor Specifications

Single Length



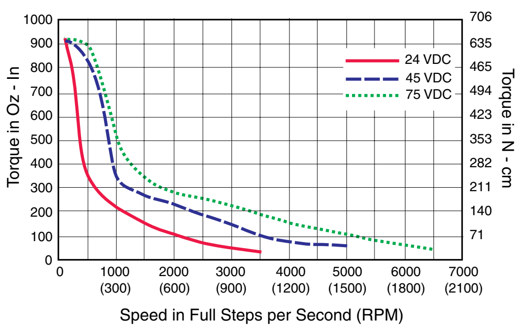
Holding Torque............................ 381 oz-in/269 N-cm
Detent Torque.............................. 10.9 oz-in/7.7 N-cm
Rotor Inertia ....0.01416 oz-in-sec^2/1.0 kg-cm^2
Weight (Motor + Driver)...........................4.1 lb/1.9 kg

Double Length



Holding Torque............................ 575 oz-in/406 N-cm
Detent Torque.......................... 14.16 oz-in/10.0 N-cm
Rotor Inertia ....0.02266 oz-in-sec^2/1.6 kg-cm^2
Weight (Motor + Driver)...........................5.5 lb/2.5 kg

Triple Length



Holding Torque.......................... 1061 oz-in/749 N-cm
Detent Torque.......................... 19.83 oz-in/14.0 N-cm
Rotor Inertia ....0.04815 oz-in-sec^2/3.4 kg-cm^2
Weight (Motor + Driver)...........................8.8 lb/4.0 kg

Figure A.1: MDrive34Plus Motion Control Speed-Torque Curves

Recommended Power and Cable Configurations

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.

NOTE: The length of the DC power supply cable to an MDrive should not exceed 50 feet.

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.

NOTE: Always use Shielded/Twisted Pairs for the MDrive DC Supply Cable and the AC Supply Cable.

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

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 MDrive Supply Cable AWG Table at the end of this Appendix.

Example A – Cabling Under 50 Feet, DC Power

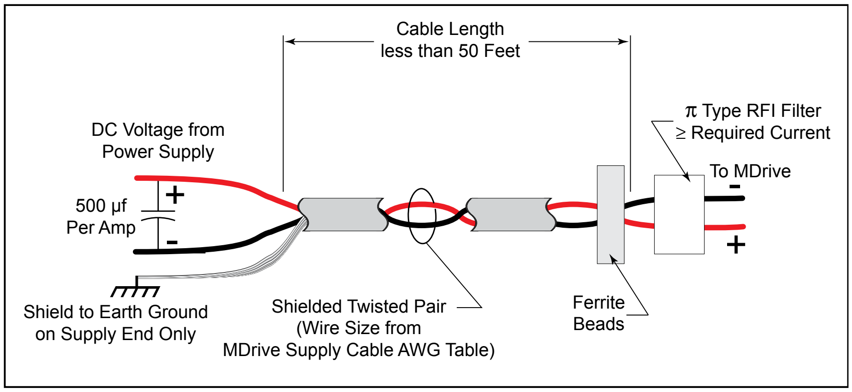


Figure B.1: DC Cabling - Under 50 Feet

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

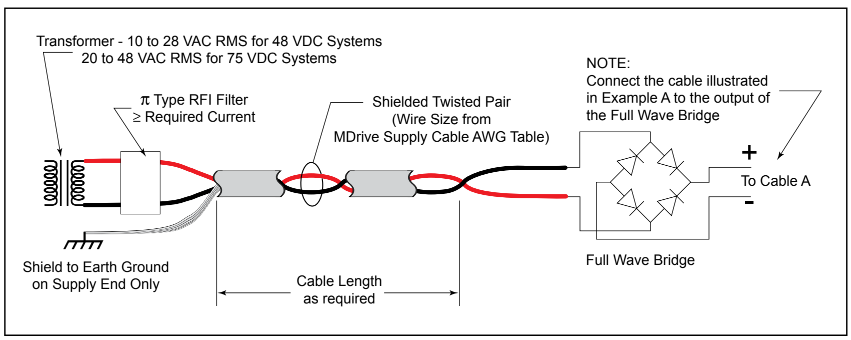


Figure B.2: DC Cabling - 50 Feet or Greater - AC To Full Wave Bridge Rectifier

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

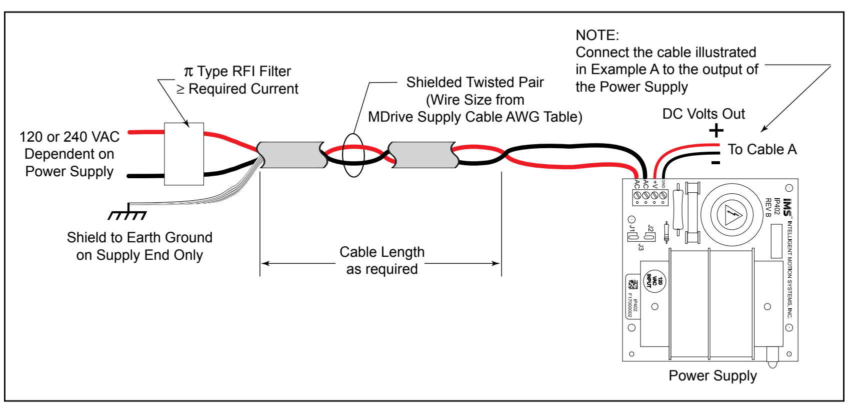


Figure B.3: AC Cabling - 50 Feet or Greater - AC To Power Supply

Recommended IMS Power Supplies

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

IP804 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..76 VDC @ 0 Amps
Half Load Output..65 VDC @ 2 Amps
Full Load output..58 VDC @ 4 Amps

IP806 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..76 VDC @ 0 Amps
Half Load Output..68 VDC @ 3 Amps
Full Load Output...64 VDC @ 6 Amps

ISP300-7 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..68 VDC @ 0 Amps
Continuous Output Rating..63 VDC @ 2 Amps
Peak Output Rating ....59 VDC @ 4 Amps

Recommended Power Supply Cabling

MDrivePlus Supply Cable AWG Table					
3 Amperes (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimun AWG	18	16	14	12	12
4 Amperes (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimun AWG	18	16	14	12	12
*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 B.1: Recommended Supply Cables

Planetary Gearboxes

Section Overview

This section contains guidelines and specifications for MDrives equipped with an optional Planetary Gearbox, and may include product sizes not relevant to this manual.

Shown are:

- Product Overview
- Selecting a Planetary Gearbox
- Mechanical Specifications

Product Overview

All gearboxes are factory installed.

Mode of Function

Optional Planetary Gearbox operate as their name implies: the motor-driven sun wheel is in the center, transmitting its movement to three circumferential planet gears which form one stage. They are arranged on the bearing pins of a planet carrier. The last planet carrier in each sequence is rigidly linked to the output shaft and so ensures the power transmission to the output shaft. The planet gears run in an internally toothed outer ring gear.

Service Life

Depending on ambient and environmental conditions and the operational specification of the driving system, the useful service life of a Planetary Gerabox is up to 10,000 hours. The wide variety of potential applications prohibits generalizing values for the useful service life.

Lubrication

All Planetary Gearbox are grease-packed and therefore maintenance-free throughout their life. The best possible lubricant is used for our MDrive/Planetary Gearbox combinations.

Mounting Position

The grease lubrication and the different sealing modes allow the Planetary Gearbox to be installed in any position.

Operating Temperature

The temperature range for the Planetary Gearbox is between –30 and +140° C. However, the temperature range recommended for the Heat Sink of the MDrive is 0 to +85° C.

Overload Torque

The permitted overload torque (shock load) is defined as a short-term increase in output torque, e.g. during the start-up of a motor. In these all-metal Planetary Gearbox, the overload torque can be as much as 1.5 times the permitted output torque.

Available Planetary Gearbox

The following lists available Planetary Gearbox, diameter and corresponding MDrive.

Gearbox Diameter	MDrive
81 mm	MDrive34

Selecting a Planetary Gearbox

There are many variables and parameters that must be considered when choosing an appropriate reduction ratio for an MDrive with Planetary Greabox. This Addendum includes information to assist in determining a suitable combination for your application.

Calculating the Shock Load Output Torque (T_{AB})

Note: The following examples are based on picking "temporary variables" which may be adjusted.

The shock load output torque (T_{AB}) is not the actual torque generated by the MDrive and Planetary Gearbox combination, but is a calculated value that includes an operating factor (C_B) to compensate for any shock loads applied to the Planetary Gearbox due to starting and stopping with no acceleration ramps, payloads and directional changes. The main reason the shock load output torque (T_{AB}) is calculated is to ensure that it does not exceed the maximum specified torque for a Planetary Gearbox.

Note: There are many variables that affect the calculation of the shock load output torque. Motor speed, motor voltage, motor torque and reduction ratio play an important role in determining shock load output torque. Some variables must be approximated to perform the calculations for the first time. If the result does not meet your requirements, change the variables and re-calculate the shock load output torque.

Use the equation compendium below to calculate the shock load output torque.

N **Note:** ***The MDrive23*** and the numbers and values used in these examples have been chosen randomly for demonstration purposes. Be certain you obtain the correct data for the MDrive you have purchased.

Factors

i	=	Reduction Ratio - The ratio of the Planetary Gearbox.
n_M	=	Motor Speed - In Revolutions Per Minute (Full Steps/Second).
n_{AB}	=	Output Speed - The speed at the output shaft of the Planetary Gearbox.
T_N	=	Nominal Output Torque - The output torque at the output shaft of the Planetary Gearbox.
T_M	=	Motor Torque - The base MDrive torque. Refer to MDrive Speed Torque Tables.
η	=	Gear Efficiency - A value factored into the calculation to allow for any friction in the gears.
T_{AB}	=	Shock Load Output Torque - A torque value calculated to allow for short term loads greater than the nominal output torque.
C_B	=	Operating Factor - A value that is used to factor the shock load output torque.
s_f	=	Safety Factor - A 0.5 to 0.7 factor used to create a margin for the MDrive torque requirement.

Reduction Ratio

Reduction ratio (i) is used to reduce a relatively high motor speed (n_M) to a lower output speed (n_{AB}).

With: $i = n_M \div n_{AB}$ or: motor speed ÷ output speed = reduction ratio

Example:

The required speed at the output shaft of the Planetary Gearbox is 90 RPM.

You would divide motor speed (n_M) by output speed (n_{AB}) to calculate the proper gearbox ratio.

The MDrive speed you would like to run is approximately 2000 full steps/second or 600 RPM.

NOTE: In reference to the MDrive speed values, they are given in full steps/second on the Speed/Torque Tables. Most speed specifications for the Planetary Gearbox will be given in RPM (revolutions per minute). To convert full steps/second to RPM, divide by 200 and multiply by 60.

Where: 200 is the full steps per revolution of a 1.8° stepping motor.

2000 full steps/second ÷ 200 = 10 RPS (revolutions per second) × 60 Seconds = 600 RPM

For the Reduction Ratio (i), divide the MDrive speed by the required Planetary Gearbox output speed.

600 RPM ÷ 90 = 6.67:1 Reduction Ratio

Referring to the Available Ratio Table at the end of this section, the reduction ratio (i) of the Planetary Gearbox will be 7:1. The numbers in the left column are the rounded ratios while the numbers in the right column are the actual ratios. The closest actual ratio is 6.75:1 which is the rounded ratio of 7:1. The slight difference can be made up in MDrive speed.

Nominal Output Torque

Calculate the nominal output torque using the torque values from the MDrive's Speed/Torque Tables.

Nominal output torque (T_N) is the actual torque generated at the Planetary Gearbox output shaft which includes reduction ratio (i), gear efficiency (η) and the safety factor (s_f) for the MDrive. Once the reduction ratio (i) is determined, the nominal output torque (T_N) can be calculated as follows:

$T_N = T_M \times i \times \eta \div s_f$ or:

Motor torque × reduction ratio × gear efficiency ÷ safety factor = nominal output torque.

For gear efficiency (η) refer to the Mechanical Specifications for the 7:1 Planetary Gearbox designed for your MDrive.

For motor torque (T_M) see the appropriate MDrive Speed/Torque Table. Dependent on which MDrive you have, the torque range will vary. The torque will fall between the high voltage line and the low voltage line at the indicated speed for the MDrive. (See the example Speed/Torque Table below.)

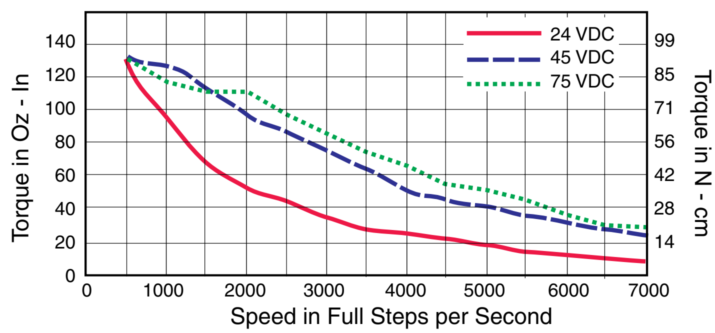


Figure C.1: MDrive23 Torque-Speed Curve

The Speed/Torque Table above is for an MDrive23 Double Size This MDrive will produce a torque range of 51 to 95 oz-in in the full voltage range at the speed of 2000 Full Steps/Second (600 RPM).

Please note that this is not the usable torque range. The torque output to the Planetary Gearbox must include a safety factor (s_f) to allow for any voltage and current deviations supplied to the MDrive.

The motor torque must include a safety factor (s_f) ranging from 0.5 to 0.7. This must be factored into the nominal output torque calculation. A 0.5 safety factor is aggressive while a 0.7 safety factor is more conservative.

Example:

The available motor torque (T_M) is 51 to 95 oz-in.

NOTE: You may specify a torque less than but not greater than the motor torque range.

For this example the motor torque (T_M) will be 35 oz-in.

A 6.75:1 reduction ratio (i) has been determined.

Gear efficiency (η) = 80% from the appropriate table for the Planetary Gearbox which is used with an MDrive23.

Nominal output torque would be:

Motor torque ($T_M = 35$) × reduction ratio (i = 6.75) × gear efficiency (η = 0.8) ÷ safety factor (s_f = 0.5 or 0.7)

35 × 6.75 = 236.25 × 0.8 = 189 ÷ 0.5 = 378 oz-in nominal output torque (T_N)

or

35 × 6.75 = 236.25 × 0.8 = 189 ÷ 0.7 = 270 oz-in nominal output torque (T_N)

With the safety factor (s_f) and gear efficiency (η) included in the calculation, the nominal output torque (T_N) may be greater than the user requirement.

Shock Load Output Torque

The nominal output torque (T_N) is the actual working torque the Planetary Gearbox will generate. The shock load output torque (T_{AB}) is the additional torque that can be generated by starting and stopping with no acceleration ramps, payloads, inertia and directional changes. Although the nominal output torque (T_N) of the Planetary Gearbox is accurately calculated, shock loads can greatly increase the dynamic torque on the Planetary Gearbox.

Each Planetary Gearbox has a maximum specified output torque. In this example a 7:1 single stage MD23 Planetary Gearbox is being used. The maximum specified output torque is 566 oz-in. By calculating the shock load output torque (T_{AB}) you can verify that value is not exceeding the maximum specified output torque.

When calculating the shock load output torque (T_{AB}), the calculated nominal output torque (T_N) and the operating factor (C_B) are taken into account. C_B is merely a factor which addresses the different working conditions of a Planetary Gearbox and is the result of your subjective appraisal. It is therefore only meant as a guide value. The following factors are included in the approximate estimation of the operating factor (C_B):

- Direction of rotation (constant or alternating)
- Load (shocks)
- Daily operating time

Note: The higher the operating factor (C_B), the closer the shock load output torque (T_{AB}) will be to the maximum specified output torque for the Planetary Gearbox. Refer to the table below to calculate the approximate operating factor (C_B).

With the most extreme conditions which would be a C_B of 1.9, the shock load output torque (T_{AB}) is over the maximum specified torque of the Planetary Gearbox with a 0.5 safety factor but under with a 0.7 safety factor.

The nominal output torque (T_N) × the operating factor (C_B) = shock load or maximum output torque (T_{AB}).

With a 0.5 safety factor, the shock load output torque is greater than the maximum output torque specification of the MDrive23 Planetary Gearbox.

(378 × 1.9 = 718.2 oz-in.)

With a 0.7 safety factor the shock load output torque is within maximum output torque specification of the MDrive23 Planetary Gearbox.

(270 × 1.9 = 513 oz-in.)

The 0.5 safety factor could only be used with a lower operating factor (C_B) such as 1.5 or less, or a lower motor torque.

Note: All published torque specifications are based on C_B = 1.0. Therefore, the shock load output torque (T_{AB}) = nominal output torque (T_N).

WARNING! Excessive torque may damage your Planetary Gearbox. If the MDrive/Planetary Gearbox should hit an obstruction, especially at lower speeds (300 RPM or 1000 Full Steps/Second), the torque generated will exceed the maximum torque for the Planetary Gearbox. Precautions must be taken to ensure there are no obstructions in the system.

Determining the Operating Factor (C_B)				
Direction of Rotation	Load (Shocks)	Daily Operating Time		
		3 Hours	8 Hours	24 Hours
Constant	Low*	C_B=1.0	C_B=1.1	C_B=1.3
	Medium**	C_B=1.2	C_B=1.3	C_B=1.5
Alternating	Low†	C_B=1.3	C_B=1.4	C_B=1.6
	Medium††	C_B=1.6	C_B=1.7	C_B=1.9

* Low Shock = Motor turns in one direction and has ramp up at start.
** Medium Shock = Motor turns in one direction and has no ramp up at start.
† Low Shock = Motor turns in both directions and has ramp up at start.
†† Medium Shock = Motor turns in both directions and has no ramp up at start.

Table C.1: Planetary Gearbox Operating Factor

System Inertia

System inertia must be included in the selection of an MDrive and Planetary Gearbox. Inertia is the resistance an object has relative to changes in velocity. Inertia must be calculated and matched to the motor inertia. The Planetary Gearbox ratio plays an important role in matching system inertia to motor inertia. There are many variable factors that affect the inertia. Some of these factors are:

- The type of system being driven.
- Weight and frictional forces of that system.
- The load the system is moving or carrying.

The ratio of the system inertia to motor inertia should be between 1:1 and 10:1. With 1:1 being ideal, a 1:1 to 5:1 ratio is good while a ratio greater than 5:1 and up to 10:1 is the maximum.

Type of System

There are many systems and drives, from simple to complex, which react differently and possess varied amounts of inertia. All of the moving components of a given system will have some inertia factor which must be included in the total inertia calculation. Some of these systems include:

- Lead screw
- Rack and pinion
- Conveyor belt
- Rotary table
- Belt drive
- Chain drive

Not only must the inertia of the system be calculated, but also any load that it may be moving or carrying. The examples below illustrate some of the factors that must be considered when calculating the inertia of a system.

Lead Screw

In a system with a lead screw, the following must be considered:

- The weight and preload of the screw
- The weight of the lead screw nut
- The weight of a table or slide
- The friction caused by the table guideways
- The weight of any parts

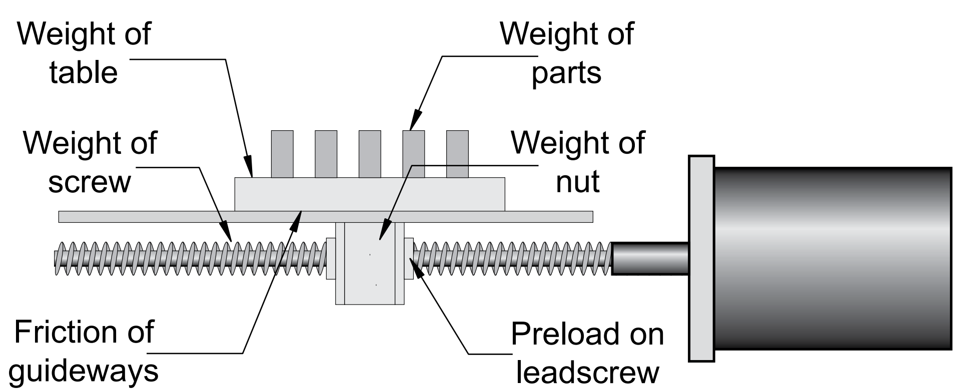


Figure C.2: Lead Screw System Inertia Considerations

Rack and Pinion

In a system with a rack and pinion, the following must be considered:

- The weight or mass of the pinion
- The weight or mass of the rack
- The friction and/or preload between the pinion and the rack
- Any friction in the guidance of the rack
- The weight or mass of the object the rack is moving

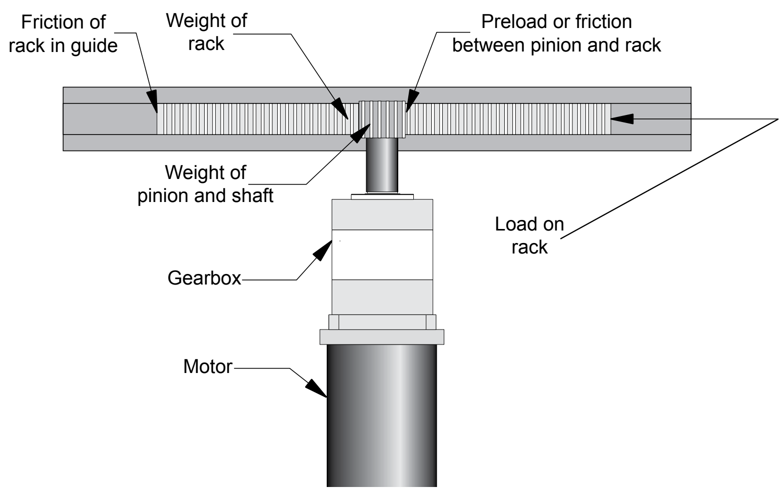


Figure C.3: Rack and Pinion System Inertia Considerations

Conveyor Belt

In a system with a conveyor belt, the following must be considered:

- The weight and size of the cylindrical driving pulley or roller
- The weight of the belt
- The weight or mass and size of the idler roller or pulley on the opposite end
- The angle or elevation of the belt
- Any load the belt may be carrying

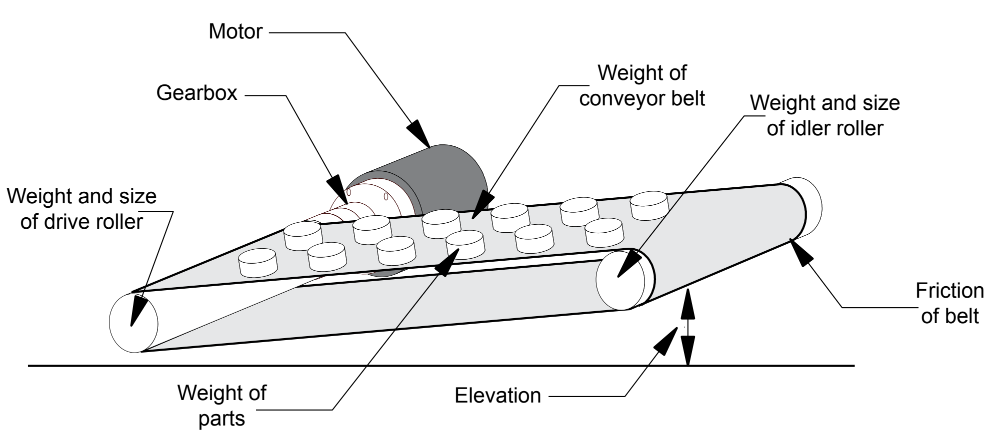


Figure C.4: Conveyor System Inertia Considerations

Rotary Table

In a system with a rotary table, the following must be considered:

- The weight or mass and size of the table
- Any parts or load the table is carrying
- The position of the load on the table, the distance from the center of the table will affect the inertia
- How the table is being driven and supported also affects theinertia

Belt Drive

In a system with a belt drive, the following must be considered:

- The weight or mass and size of the driving pulley
- The tension and/or friction of the belt
- The weight or mass and size of the driven pulley
- Any load the system may be moving or carrying

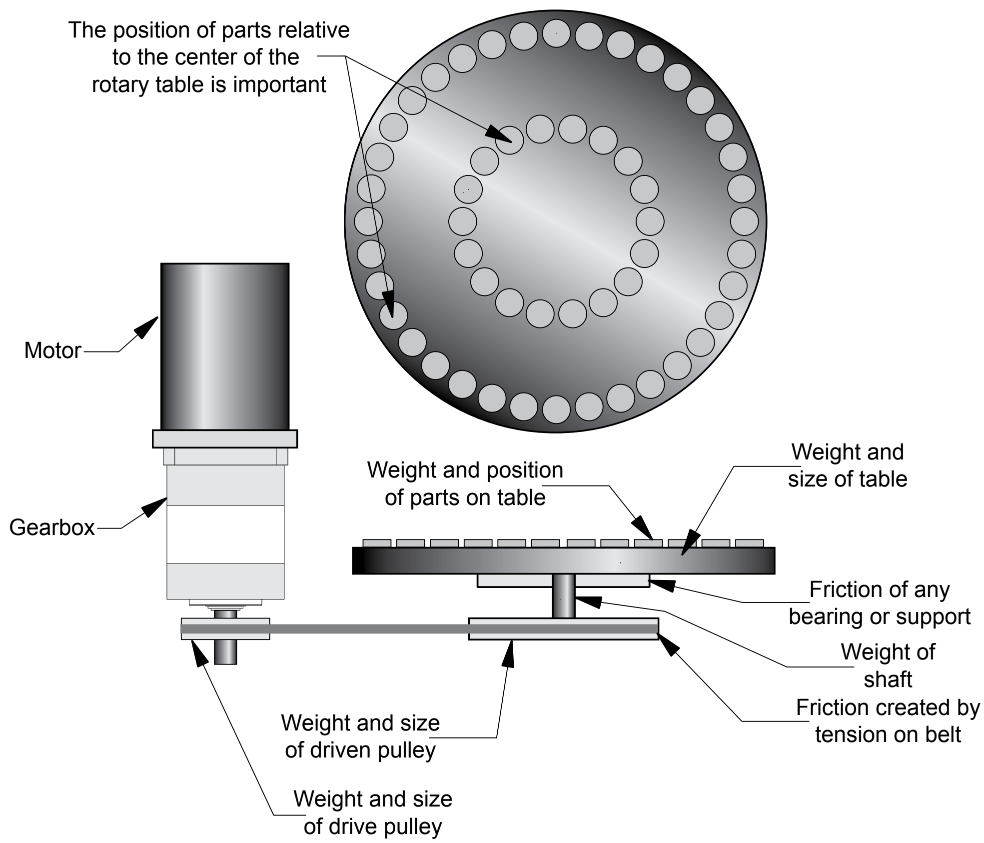


Figure C.5: Rotary Table System Inertia Considerations

Chain Drive

In a system with a chain drive, the following must be considered:

- the weight and size of drive sprocket and any attaching hub
- the weight and size of the driven sprocket and shaft
- the weight of the chain
- the weight of any material or parts being moved

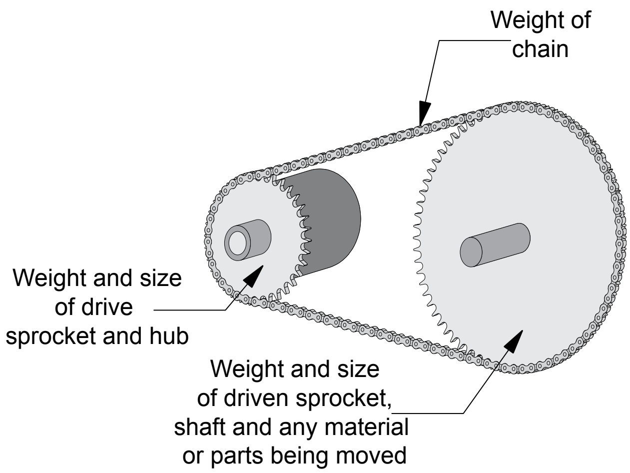


Figure C.6: Chain Drive System Inertia Considerations

Once the system inertia (J_L) has been calculated in oz-in-sec^2, it can be matched to the motor inertia. To match the system inertia to the motor inertia, divide the system inertia by the square of the gearbox ratio. The result is called Reflected Inertia or (J_{ref}).

$$J_{ref} = J_L \div Z^2$$

Where:

J_L = System Inertia in oz-in-sec^2

J_{ref} = Reflected Inertia in oz-in-sec^2

Z = Gearbox Ratio

The ideal situation would be to have a 1:1 system inertia to motor inertia ratio. This will yield the best positioning and accuracy. The reflected inertia (J_{ref}) must not exceed 10 times the motor inertia.

Your system may require a reflected inertia ratio as close to 1:1 as possible. To achieve the 1:1 ratio, you must calculate an Optimal Gearbox Ratio (Z_{opt}) which would be the square root of J_L divided by the desired J_{ref}. In this case since you want the system inertia to match the motor inertia with a 1:1 ratio, J_{ref} would be equal to the motor inertia.

$$Z_{opt} = \quad J_L \div J_{ref}$$

Where:

Z_{opt} = Optimal Gearbox Ratio

J_L = System Inertia in oz-in-sec^2

J_{ref} = Desired Reflected Inertia in oz-in-sec^2 (Motor Inertia)

Planetary Gearbox Inertia

In addition to System Inertia, the Planetary Gearbox inertia must also be included when matching system inertia to motor inertia. The Planetary Gearbox inertia varies with the ratio and the number of stages. The table below lists the inertia values for the MDrive14, 17, 23 and 34 Planetary Gearbox. The values are in oz-in-sec^2 (ounce-inches-second squared). To calculate the inertia in kg-cm^2 (kilograms-centimeter squared) multiply oz-in-sec^2 by 70.6154.

Planetary Gearbox Inertia Moments (oz-in-sec^2)		
Stages	Rounded Ratio	MDrive 34 Gearbox
1-Stage	4:1	0.00233660
	5:1	0.00154357
	7:1	0.00128867
2-Stage	14:1	0.00219499
	16:1	0.00179847
	18:1	0.00182679
	19:1	0.00141612
	22:1	0.00148693
	25:1	0.00177015
	27:1	0.00148693
	29:1	0.00124619
	35:1	0.00126035
	46:1	0.00126035
3-Stage	51:1	0.00218082
	59:1	0.00178431
	68:1	0.00179847
	71:1	0.00147276
	79:1	0.00179847
	93:1	0.00124619
	95:1	0.00147276
	100:1	0.00148693
	107:1	0.00124619
	115:1	0.00148693
	124:1	0.00124619
	130:1	0.00124619
	139:1	0.00144444
	150:1	0.00124619
	169:1	0.00126035
	181:1	0.00124619
	195:1	0.00126035
	236:1	0.00126035
	308:1	0.00126035

Table B.2: Planetary Gearbox Inertia Moments

MDrive34Plus Motion Control with Planetary Gearbox

Planetary Gearbox Parameters

	Permitted Output Torque (oz-in/Nm)	Gearbox Efficiency	Maximum Backlash	Output Side with Ball Bearing			
				Maximum Load (lb-force/N)		Weight (oz/g)	
				Radial	Axial	Gearbox	with Flange
1-STAGE	2832/20.0	0.80	1.0°	90/400	18/80	64.4/1827	66.7/1890
2-STAGE	8496/60.0	0.75	1.5°	135/600	27/120	89.5/2538	92.6/2625
3-STAGE	16992/120.0	0.70	2.0°	225/1000	45/200	92.6/2625	118.5/3360

Table B.3: Planetary Gearbox Specifications

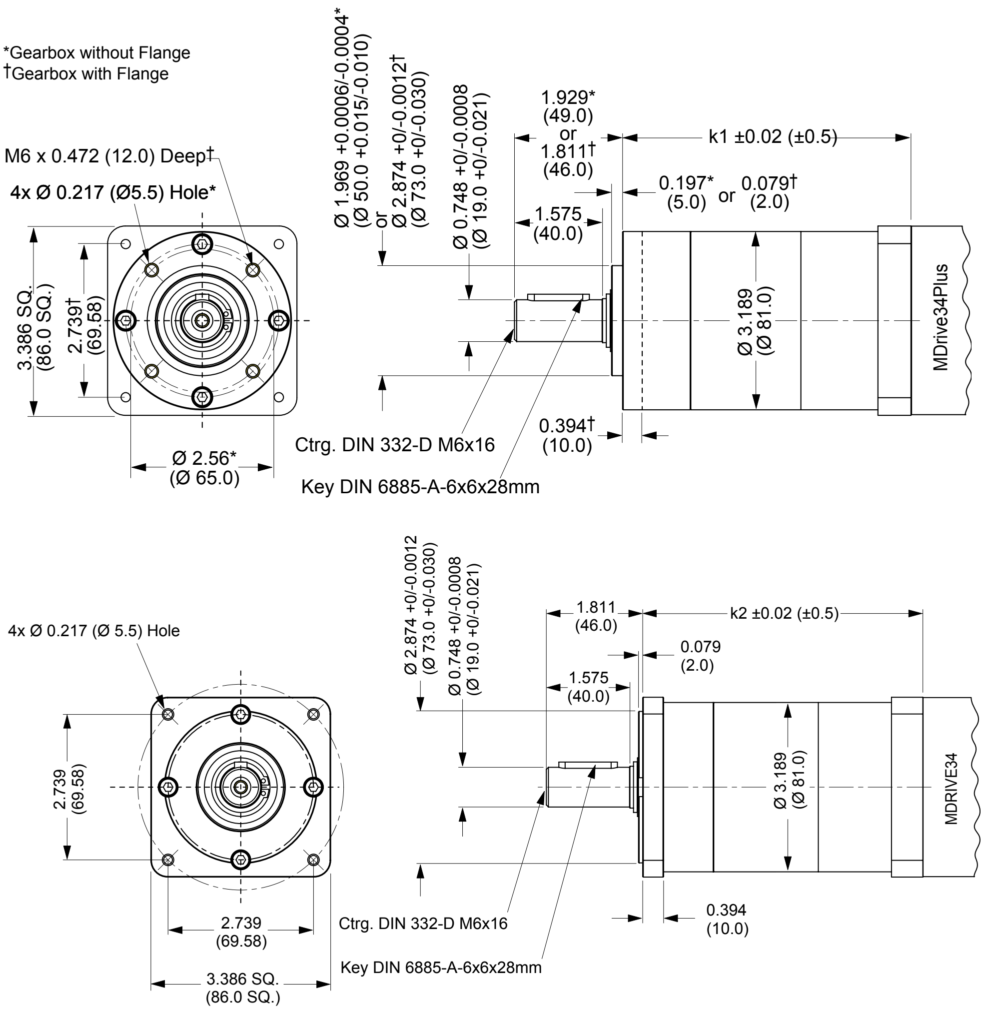
Ratios and Part Numbers

Planetary Gearbox	Ratio (Rounded)	Part Number
1-Stage	3.71:1	G1A1
1-Stage	5.18:1	G1A2
1-Stage	6.75:1	G1A3
2-Stage	13.73:1	G1A4
2-Stage	15.88:1	G1A5
2-Stage	18.37:1	G1A6
2-Stage	19.20:1	G1A7
2-Stage	22.21:1	G1A8
2-Stage	25.01:1	G1A9
2-Stage	26.85:1	G1B1
2-Stage	28.93:1	G1B2
2-Stage	34.98:1	G1B3
2-Stage	45.56:1	G1B4
3-Stage	50.89:1	G1B5
3-Stage	58.86:1	G1B6
3-Stage	68.07:1	G1B7
3-Stage	71.16:1	G1B8
3-Stage	78.72:1	G1B9
3-Stage	92.70:1	G1C1
3-Stage	95.18:1	G1C2
3-Stage	99.51:1	G1C3
3-Stage	107.21:1	G1C4
3-Stage	115.08:1	G1C5
3-Stage	123.98:1	G1C6
3-Stage	129.62:1	G1C7
3-Stage	139.14:1	G1C8
3-Stage	149.90:1	G1C9
3-Stage	168.85:1	G1D1
3-Stage	181.25:1	G1D2
3-Stage	195.27:1	G1D3
3-Stage	236.10:1	G1D4
3-Stage	307.55:1	G1D5

Table B.4: Planetary Gearbox Ratios and Part Numbers

Planetary Gearbox Mechanical Specifications

Dimensions in Inches (mm)



***Gearbox Lengths** Inches (mm)*

	k1	
	GEARBOX*	with FLANGE†
1-Stage	4.315 (109.6)	4.433 (112.6)
2-Stage	5.169 (131.3)	5.287 (134.3)
3-Stage	6.024 (153.0)	6.142 (156.0)

Figure C.7: Planetary Gearbox Specifications for MDrive34Plus Motion Control

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I/O Application Guide

Standard I/O Set Interfacing and Application

NPN Sinking Input

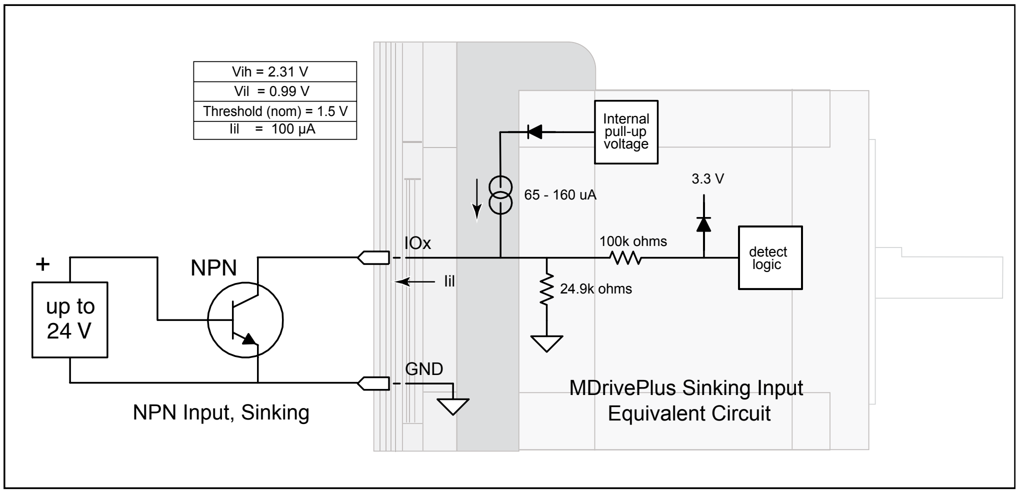

Figure D.1: NPN Interface to an MDI Sinking Input

Application Example

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

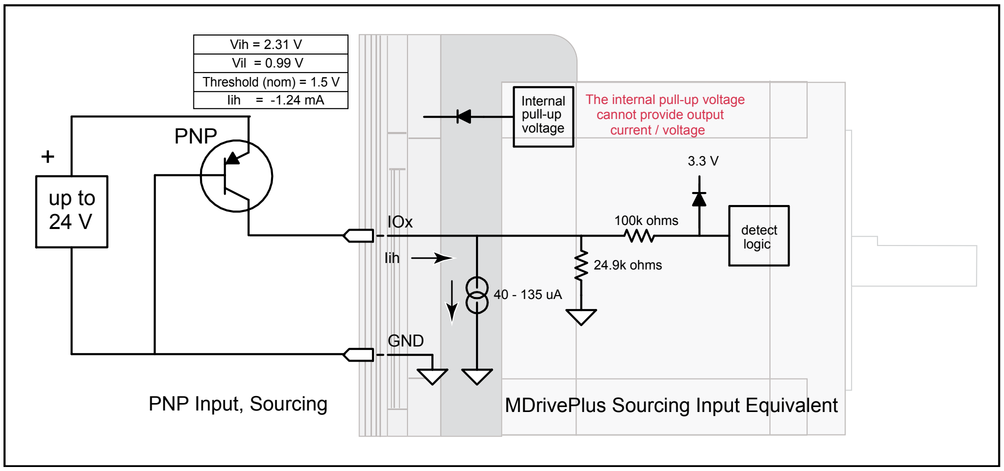

Figure D.2: PNP Interface to a Sourcing Input

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

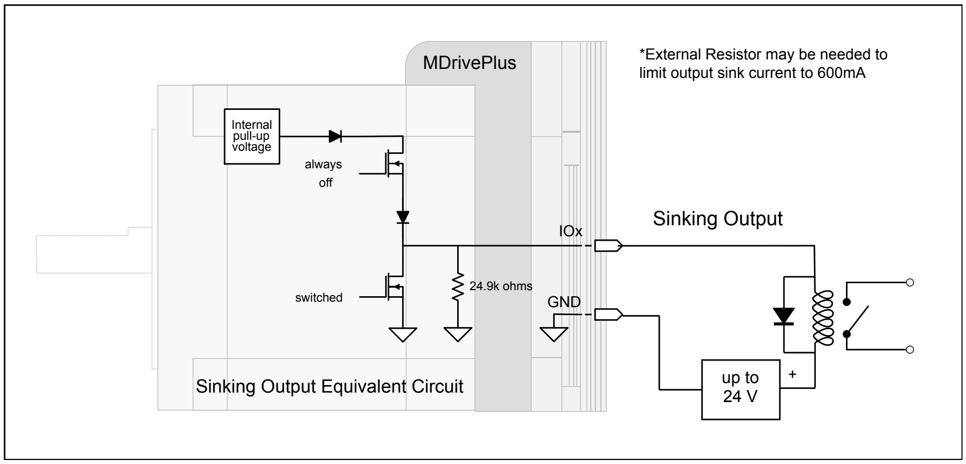

Figure D.3: Sinking Output to Relay

NOTE: On the Standard MDrivePlus, 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

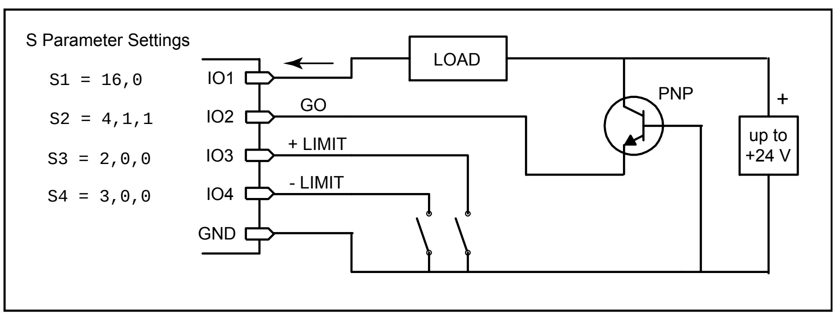

Figure D.4: Mixed Output Example- Standard I/O Set

Enhanced I/O Set Interfacing and Application

NPN Sinking Input

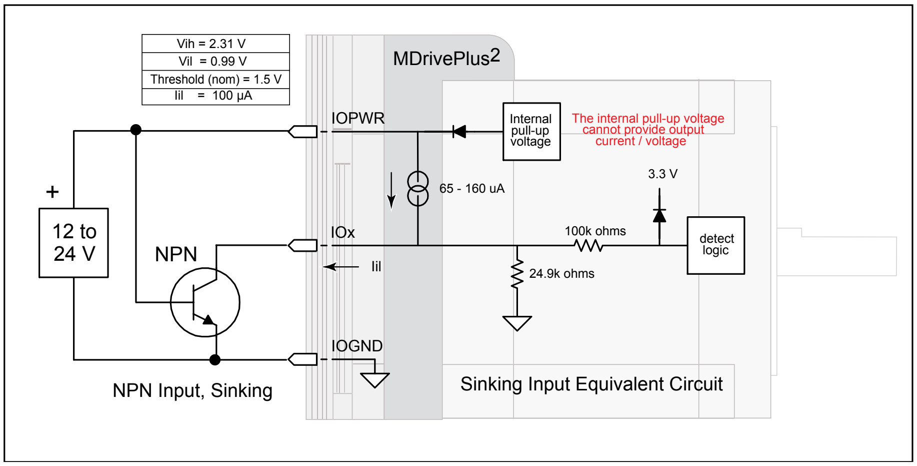

Figure D.5: NPN Sinking Input on an MDrivePlus2 Motion Control

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.

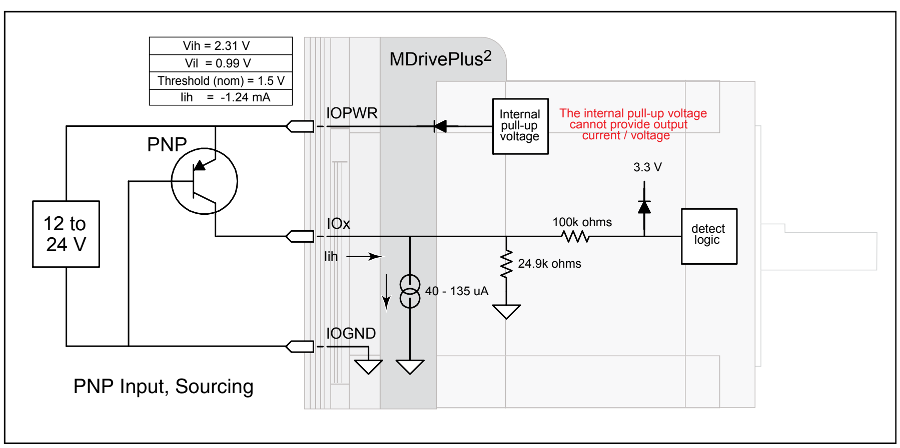

Figure D.6: PNP Sourcing Input on an MDrivePlus2 Motion Control

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

Sourcing Output

Application Example

This application example will illustrate two MDrivePlus2 units in a system. In the program example MDrivePlus2 #1 will be configured as a Fault Output, which when HIGH will trip an input on MDrivePlus2 #2 which will be configured as a Pause Input.

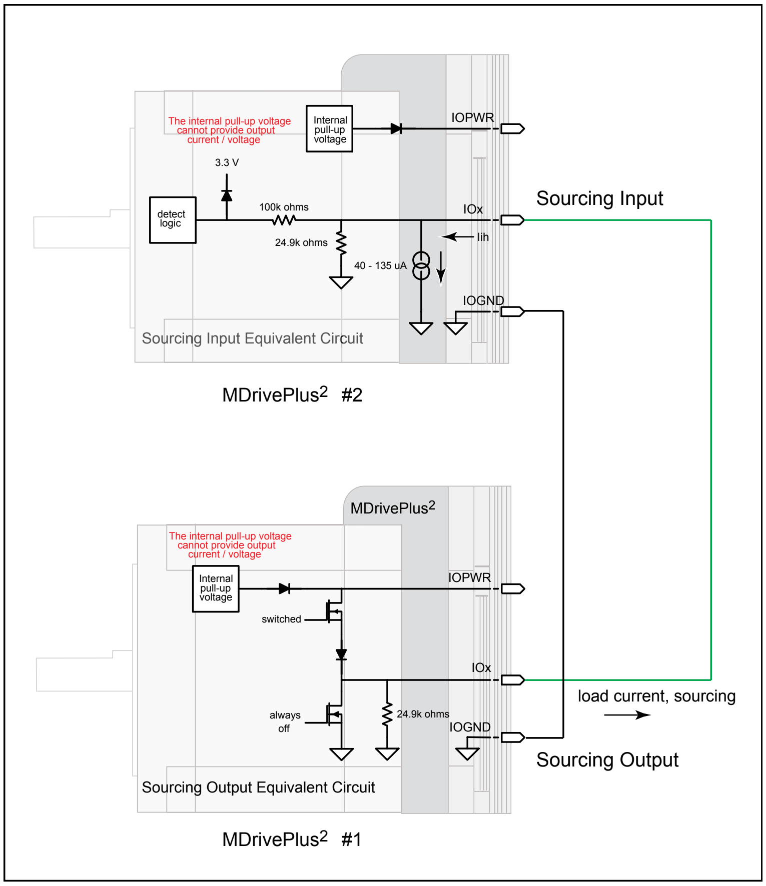

Figure D.7: Sourcing Output to Sourcing Input

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

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

Mixed Input/Output Example

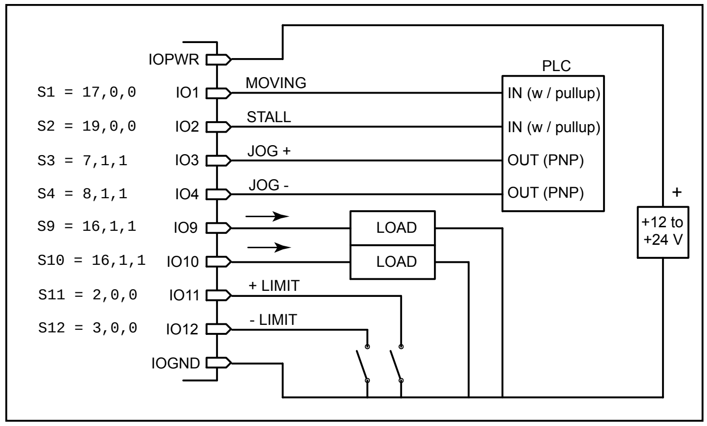

Figure D.8: Mixed Input/Output Example - Enhanced I/O

Interfacing Inputs as a Group Example

The MDrivePlus 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 MDrivePlus[2] models. The IN keyword will function on the Standard MDrivePlus but will only read inputs 1 - 4. Inputs will be configured as user inputs (S<point>=0).

Standard MDrivePlus Motion Control

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

Enhanced MDrivePlus2

```
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)
```

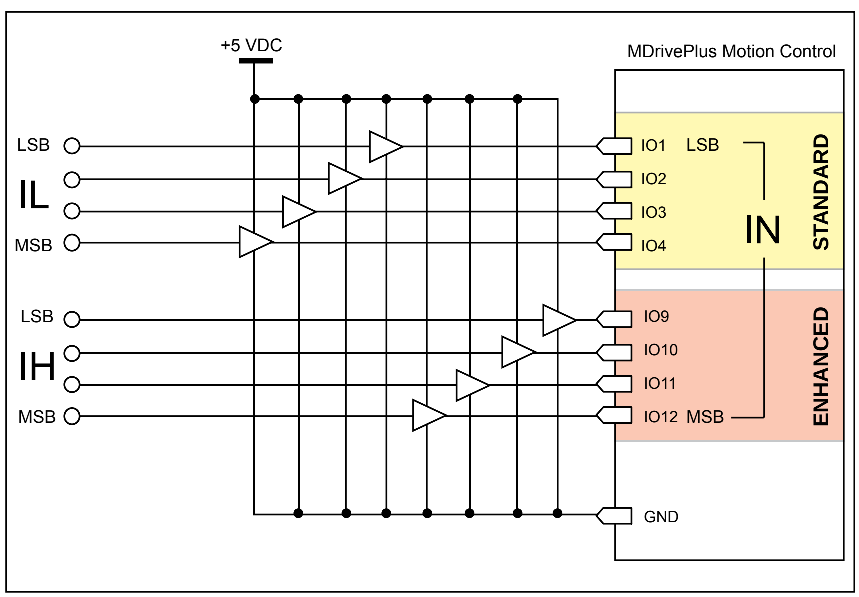

Figure D.9: TTL Interface to an Input Group

Interfacing Outputs as a Group Example

The MDrivePlus 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 MDrivePlus^2 models. The OT keyword will function on the Standard MDrivePlus but will only set inputs 1 - 4. Outputs will be configured as user outputs (S<point>=16).

Standard MDrivePlus 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 MDrivePlus2

```
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
```

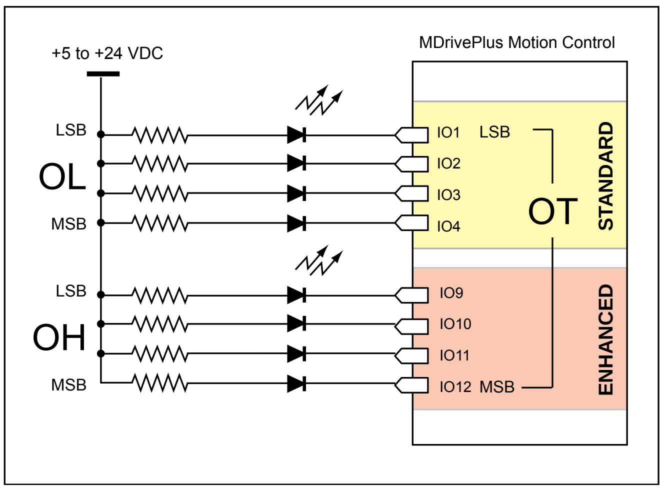

Figure D.10: Outputs Interfaced to LED's as a Group

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

APPENDIX E

MDrivePlus Motion Control Closed Loop Control

MDrive Motion Control Closed Loop Options

The MDrive Motion control has two closed loop options: Internal magnetic encoder on all MDrivePlus models or interface to a remote user supplied encoder on MDrivePlus^2 models.

Internal Encoder

All models of the MDrivePlus motion control are available with an internal magnetic encoder, which adds the functionality of Stall Detection, Position Maintenance and Home to Index.

The encoder itself has a resolution of 512 lines or 2048 edges per revolution.

Remote Encoder - MDrive34Plus² (20-Pin Locking Wire Crimp)

The MDrivePlus² 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.

Set Up and Configuration

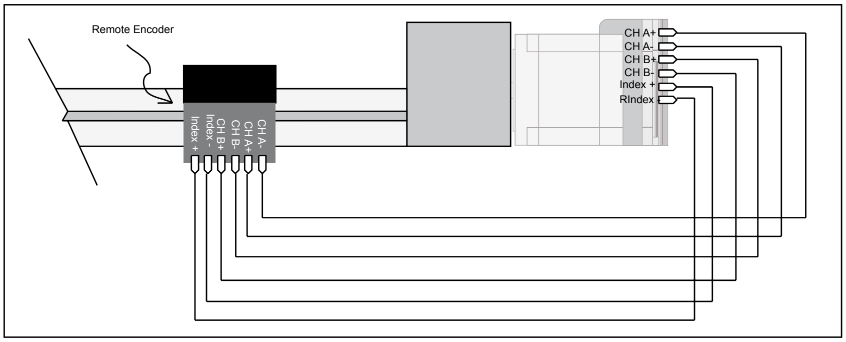

Figure E.1: Connecting a Remote Encoder

NOTE: The USB drivers must be installed before the Communications Converter Cable is plugged into the computer.

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

APPENDIX F

Optional Cables and Cordsets

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 MDrive Motion Control Device. The included components will allow you to connect the USB port of a PC* directly to the MDrive Motion Control.

Figure F.1: MD-CC400-000

The MD-CC400-000 communications converter cable is designed to be used with all MDrive, MDrivePlus and MDrivePlus2 Motion Control devices that utilize an RS-422 ten pin connector interface.

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

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

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 F.1: MD-CC400-000 Electrical Specifications

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

Electrical Specifications

Mechanical Specifications

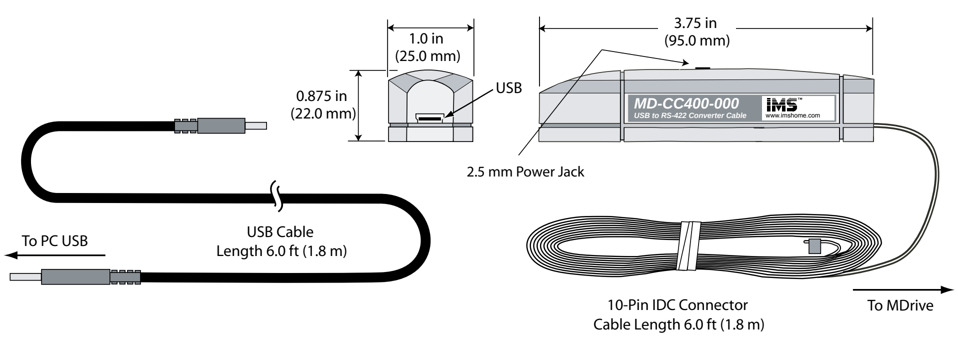

Figure F.2: MD-CC400-000 Mechanical Specifications

MD-CC400-000 Power Jack

The 2.5mm power jack located on top of the converter housing can be used to maintain logic power for MDrives that have an Aux-Power-Supply connection.

Center Pin+12 to 24 VDC unregulated Outer Contact Ground.

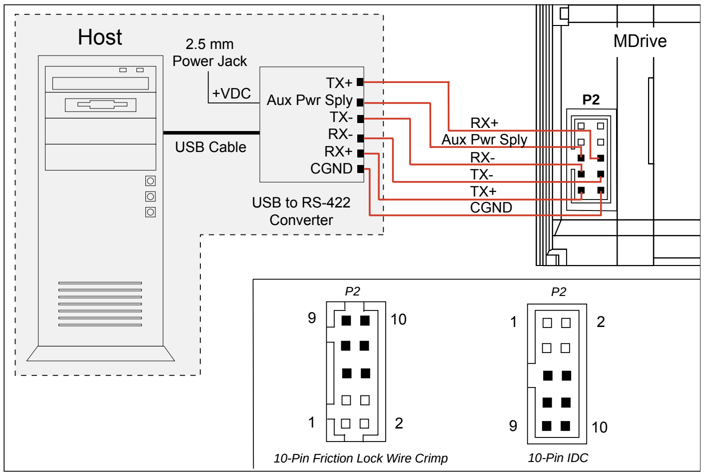

Figure F.3: Typical Communications Interface

Installation Procedure for the MX-CC40x-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-CC40x-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.

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.

Installing the Cable/VCP Drivers

1) Plug the USB Converter Cable into the USB port of the MD-CC40x-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 F.4: Hardware Update Wizard

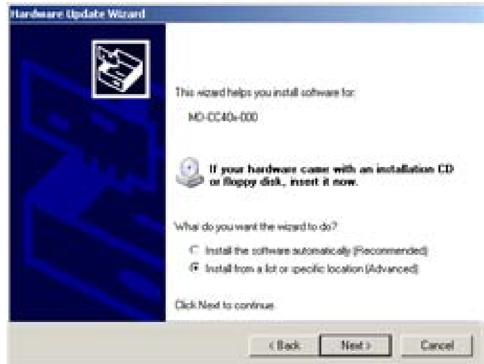

Figure F.5: Hardware Update Wizard Screen 2

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

Figure F.6: 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-CC40x-000 is now ready to use.

Figure F.7: Windows Logo Compatibility Testing

Figure F.8: Hardware Update Wizard Finish Installation

Determining the Virtual COM Port (VCP)

The MD-CC40x-000 uses a Virtual COM Port to communicate through the USB port to the MDrive. A VCP is a software driven serial port which emulates a hardware port in Windows.

The drivers for the MD-CC40x-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 F.9), 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 F.10). The COM # will be the Virtual COM Port connected. You will enter this number into your IMS Terminal Configuration.

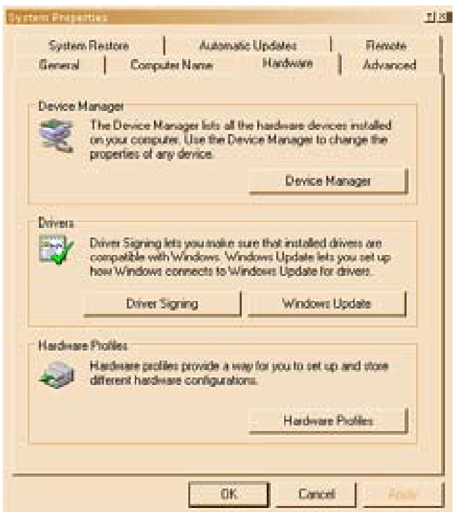

Figure F.9: Hardware Properties

Figure F.10: Windows Device Manager

Prototype Development Cables

$Plus^2$ Enhanced I/O (14-Pin Locking Wire Crimp)	PD14-2334-FL3
$Plus^2$ Enhanced I/O+Remote Encoder (20-Pin Locking Wire Crimp)	PD20-3400-FL3
$Plus^2$ Power	PD02-3400-FL3
$Plus^2$ Communications	PD10-1434-FL3

Prototype Development Cable PD14-2334-FL3

IMS recommends the Prototype Development Cable PD14-2334-FL3 for interfacing I/O and Logic to the MDrive34Plus² Motion Control. IMS recommends the Prototype Development Cable PD14-2334-FL3 with the first order of an MDrive34Plus² Motion Control to mate with the 14-pin locking wire crimp connector P1. 14 (7 Twisted Pair) Flying Leads interface to the user's control electronics at the un-terminated end of the cable.

Care should be observed to ensure that the black leads are connected in the correct location in relation to their paired color.

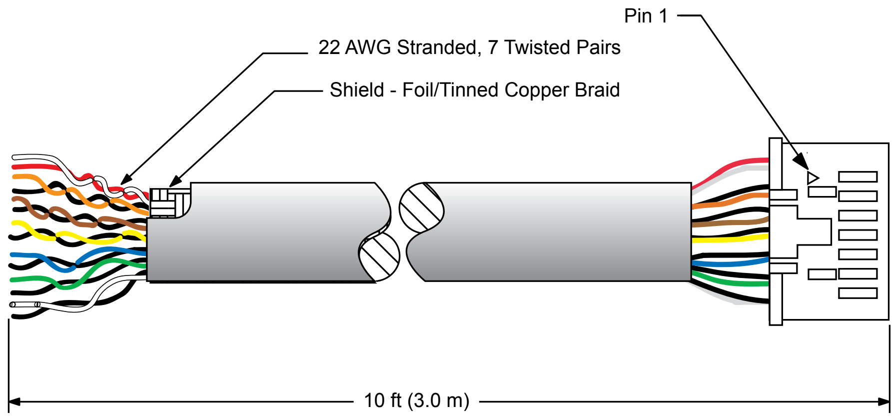

Figure F.11: PD14-2324-FL3

Wire Color Code		
Pair Number	Color Combination	Signal Name (Color)
1	Black Paired with White	Direction (Black) / Step Clock (White)
2	Black Paired with Green	Analog In (Black) / Capture-Trip (Green)
3	Black Paired with Blue	I/O 12 (Black) / I/O 11(Blue)
4	Black Paired with Yellow	I/O 10 (Black) / I/O 9 (Yellow)
5	Black Paired with Brown	I/O 4 (Black) / I/O 3 (Brown)
6	Black Paired with Orange	I/O 2 (Black) / I/O 1 (Orange)
7	White Paired with Red	I/O GND (White) / I/O PWR (Red)

Table F.2: PD16-2334-FL3 Wire Color Codes

Prototype Development Cable PD02-2300-FL3

IMS recommends the Prototype Development Cable PD02-3400-FL3 for interfacing power to the MDrive-34Plus² Motion Control.

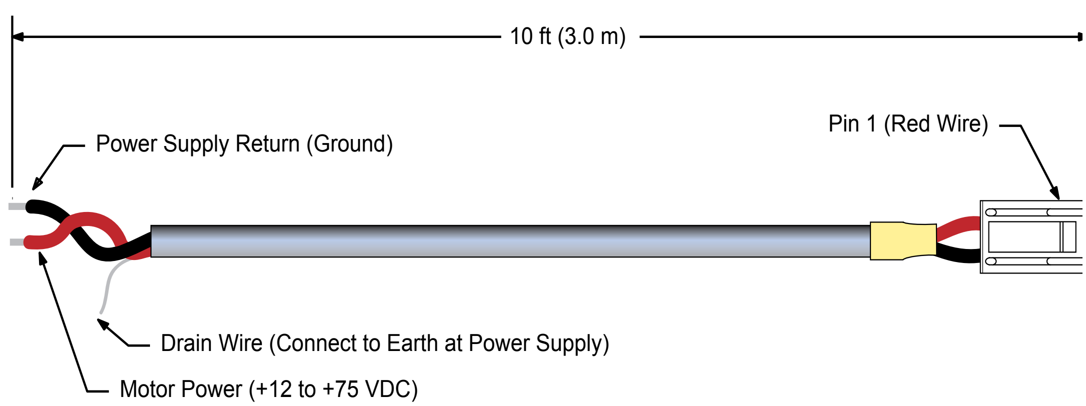

Figure F.12: PD02-3400-FL3

Prototype Development Cable PD10-1434-FL3 (All MDrivePlus 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 and additional cable attached for multi-drop communications systems.

It is important to note that Cable 1 will connect to the Communications host. Cable 2 will be used to interface additional MDrivePlus Motion Control Units. A PD10-1434-FL3 is required for each MDrivePlus in the system. The second, and subsequent MDrivePlus units are interface by connecting Cable 1 of the second PD10-1434-FL3 to Cable 2 of the first. The cables will connect wire color to wire color (See Figure F.13).

Cable 3 contains a single wire which is used to optionally connect a +12 to +24 VDC supply for Auxiliary Power. This supply must be grounded at Motor Power ground. In multi-drop systems each usage of cable 3 must connect to the +VDC output of the Auxiliary Supply. Do not daisy chain this connection.

Wire Color Code			
Pair Number (Cable/Pair)	Color Combination	Communications Host Connection	MDrive Wire Crimp Connection
1/1	White/Blue	RX+	TX+
	Blue/White	RX+	TX-
1/2	White/Orange	TX+	RX+
	Orange/White	TX-	RX-
1/3	White/Green	NC	NC
	Green/White	COMM GND	COMM GND
2/1	White/Blue	TX+	TX+
	Blue/White	TX-	TX-
2/2	White/Orange	RX+	RX+
	Orange/White	RX-	RX-
2/3	White/Green	NC	NC
	Green/White	COMM GND	COMM GND
3		AUX Power	AUX Power

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

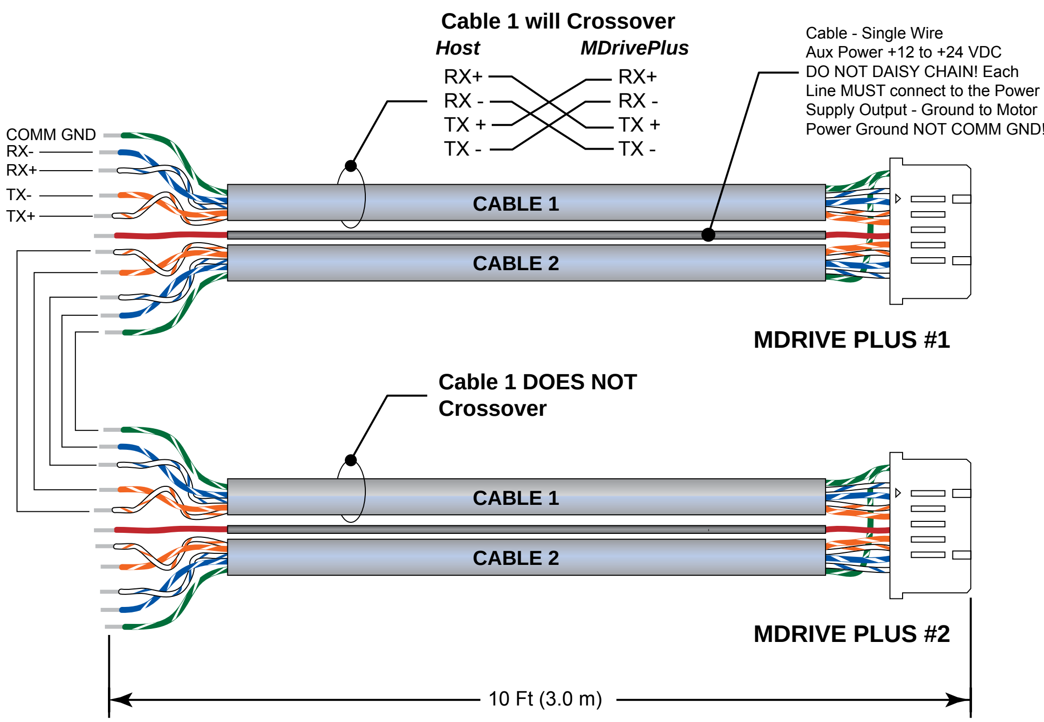

Figure F.13: PD10-1434-FL3

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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.”

> **NOTE:** MDrive Motion Control electronics are not removable from the motor in the field.
> The entire unit must be returned to the factory for repair.

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.

IMS HEREBY DISCLAIMS ALL OTHER WARRANTIES, WHETHER WRITTEN OR ORAL, EXPRESS OR IMPLIED BY LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION, **ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE**. CUSTOMER’S SOLE REMEDY FOR ANY DEFECTIVE PRODUCT WILL BE AS STATED ABOVE, AND IN NO EVENT WILL THE IMS BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, SPECIAL OR INDIRECT DAMAGES IN CONNECTION WITH THE PRODUCT.

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.

IMS and its directors, officers, employees, subsidiaries and affiliates shall not be liable for any damages arising from any loss of equipment, loss or distortion of data, loss of time, loss or destruction of software or other property, loss of production or profits, overhead costs, claims of third parties, labor or materials, penalties or liquidated damages or punitive damages, whatsoever, whether based upon breach of warranty, breach of contract, negligence, strict liability or any other legal theory, or other losses or expenses incurred by the Customer or any third party.

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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