INTELLIGENT MOTION SYSTEMS, INC.

Excellence in Motion™

MDRIVE™ MOTOR+DRIVER AC Plus²

MOTION CONTROL

HARDWARE REFERENCE

MDRIVE 34™ MOTOR+DRIVER AC Plus²

MDRIVE 42™ MOTOR+DRIVER AC Plus²

www.imshome.com

MDrivePlus Motion Control Hardware Reference Change Log		
Date	Revision	Changes
03/07/2006	R030706	Initial Release
03/31/2006	R033106	Added CANopen Hardware Sections, 1.5, 1.6. Changed page numbering scheme.
05/05/2006	R050406	Removed Ambient Temperature Specification, Added Cordset information to Appendix E.
05/25/2006	R052506	Replaced MD-CC401-000 USB to RS-422 driver installation instructions with instructions relevant to Windows XP Service Pack 2 in Appendix E, pages A-28 and A-29.

MDriveAC Plus^2 Motion Control Software Reference
Revision R052506

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Getting Started - MDriveAC Plus^2 Motion Control

> WARNING! Please ensure that you read the sections of the product manual pertaining to the MDriveAC Plus^2 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 MDriveAC Plus^2 Motion Control. The following examples will help you get the motor turning for the first time and introduce you to Immediate and Program modes of operation.

Tools and Equipment Required

- MDriveAC Plus^2 Motion Control Unit.
- Communications MD-CC401-000 or equivalent (USB to RS-422).
- MDriveAC Plus^2 Product CD or Internet access to www.imshome.com.
- MD-CS10x-000 Single-End cordset (or equivalent).
- 120 VAC or 240 VAC, Power Cable with Euro AC Connector.
- Basic Tools: Wire Cutters / Strippers / Screwdriver.
- A PC with Windows 9x, Windows 2000, Windows XP Service Pack 2.
- 10 MB hard drive space.
- A free USB port.

Connecting Power

Connect 120 VAC or 240 VAC, depending on the input voltage of you MDriveAC Plus^2 Motion Control to connector P3 3-pin Euro AC.

Install IMS USB Communications Cable (Appendix E)

See Appendix E for detailed installation instructions for the MD-CC401-000

Connecting Communications

Connect host PC's USB port to the MDriveAC Plus^2 Motion Control 5-pin M12 connector using the MD-CC401-000 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.

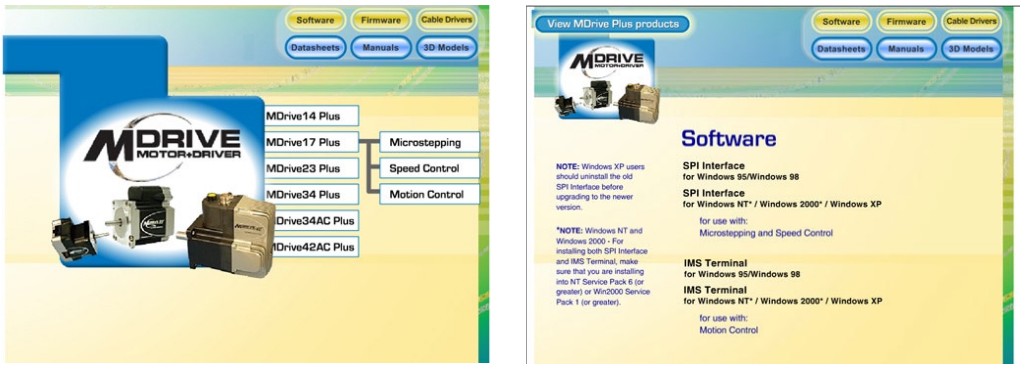

Figure GS.1: MDrive CD Screens

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

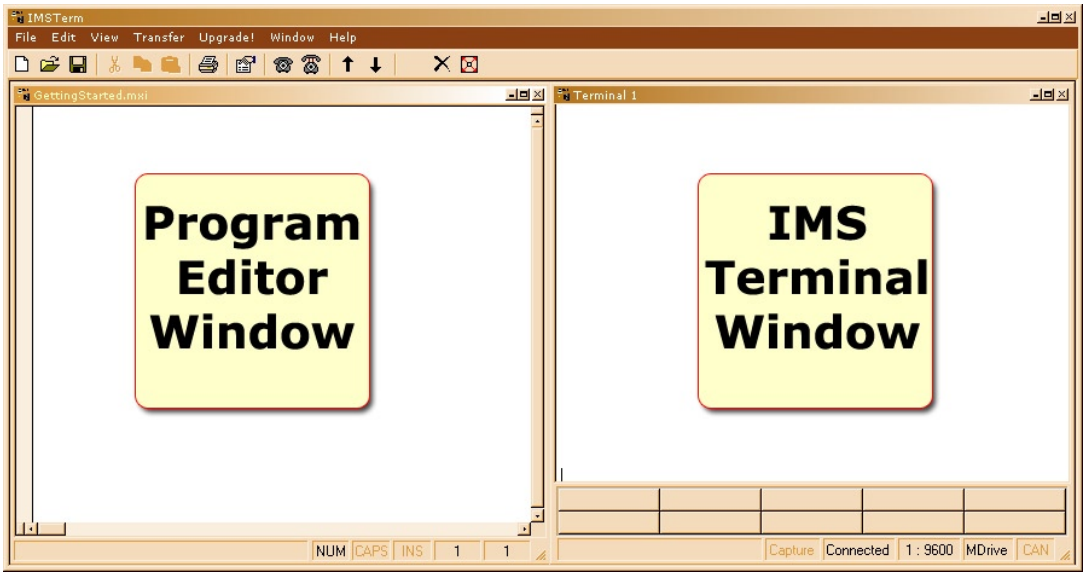

Figure GS.2: IMS Terminal Main Screen

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".

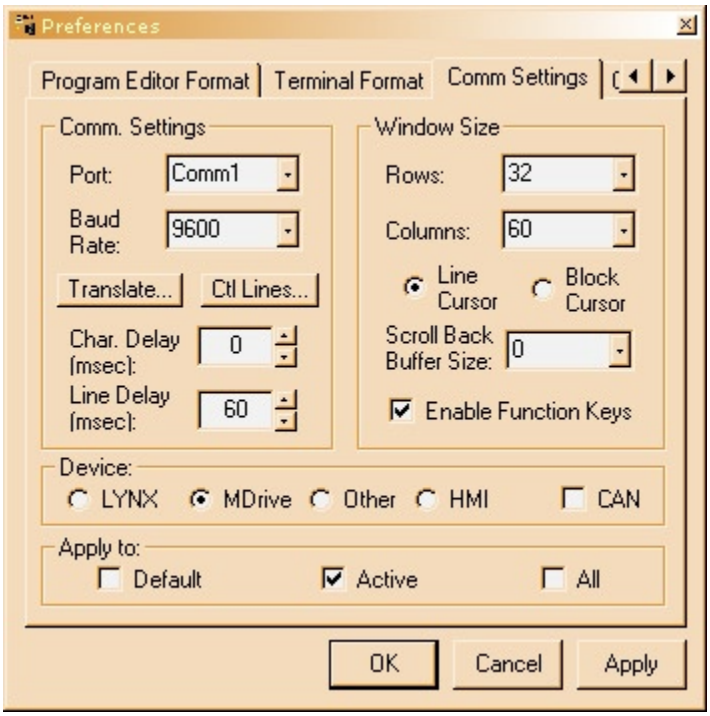

Figure GS.3: IMS Terminal Preferences

Apply Power to the MDriveAC Plus^2 Motion Control

1. Verify that all connections have been made, then apply power to the MDriveAC Plus^2 Motion Control. Click on the Phone icon or the Disconnect status box to establish communications between IMS Terminal and the MDriveAC Plus^2. 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 MDriveAC Plus^2 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 MDriveAC Plus^2 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.

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

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

Warning: If you have installed the MDriveAC Plus 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.

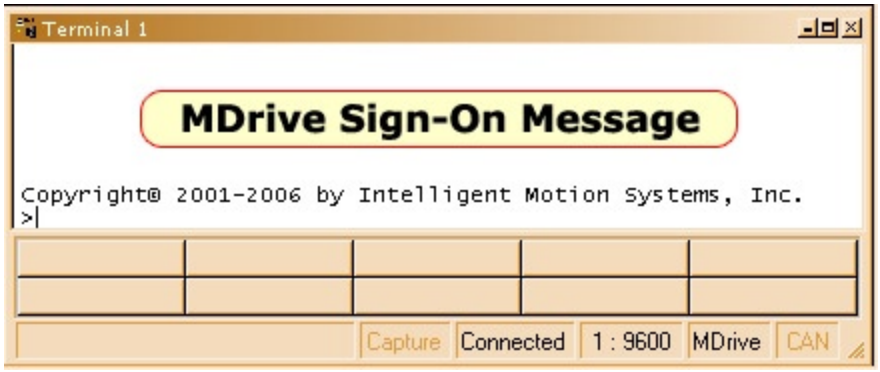

Figure GS.4: IMS Terminal Sign-On Message

Testing the MDriveAC Plus^2 Motion Control

1. Click in the Terminal Window, and type (followed by ENTER):
   PR VM
2. The MDriveAC Plus^2 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 MDriveAC Plus^{2}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.

Make the MDriveAC Plus^2 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 MDriveAC Plus^2 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 MDriveAC Plus^2 Motion Control should decelerate to a full stop.

NOTE: Entering MDriveAC Plus 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 "GettingStarted.mxt" 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/sec2
D=100000         'set deceleration to 100000 steps/sec2
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, or the "Down Arrow" on the menu bar, 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.)

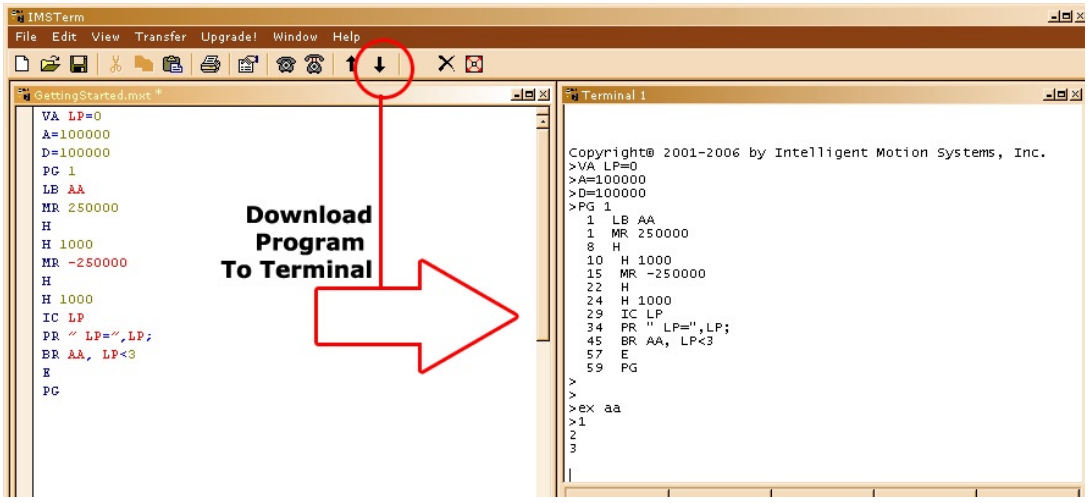

Figure GS.5: Downloading the Program

7. The MDriveAC Plus^2 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.

Programming Notes

The example above demonstrates basic commands that verify that your MDriveAC Plus^2 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 MDriveAC Plus^2 Motion Control Software Reference for details.

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

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MOTION CONTROL

PART 1: HARDWARE SPECIFICATIONS

Section 1.1: MDrive34AC Plus² Motion Control Product Introduction

Section 1.2: MDrive34AC Plus² Motion Control Specifications

Section 1.3: MDrive42AC Plus² Motion Control Product Introduction

Section 1.4: MDrive42AC Plus² Motion Control Specifications

Note: The MDriveAC Plus Motion Control is available in a CAN communications configuration. For more information see the IMS Website.

SECTION 1.1

MDrive34AC Plus^2 Motion Control Product Introduction

Introduction to the MDrive34AC Plus^2 Motion Control System

The MDrive34AC Plus^2 Motion Control system offers designers a low cost, intelligent motion controller integrated with a NEMA 34 high torque brushless motor and microstepping drive operating at 120 or 240 VAC.

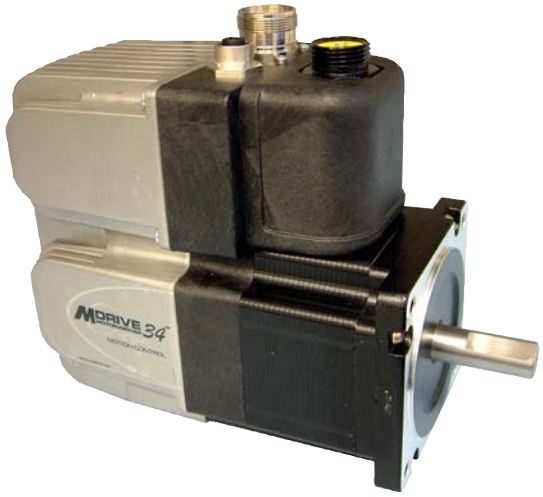


Figure 1.1.1: MDrive34AC Plus^2 Motion Control

Unsurpassed smoothness and performance delivered by the MDrive34AC are achieved through IMS's advanced 2nd generation current control. By applying innovative techniques to control current flow through the motor, resonance is significantly dampened over the entire speed range and audible noise is reduced.

The MDrive34AC accepts a broad input voltage range from 95 to 264 VAC, 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.

The MDrive34AC Plus^2 Motion Control system adds a versatile array of functions by combining a complete programmable motion controller with our compact and cost effective MDrive34AC Microstepping Drive, adding little cost and no increase in size. Standard offerings include up to 8 general purpose I/O lines (sourcing or sinking) that operate to +24 VDC, one 10 bit analog input, electronic gearing, high speed position capture input/trip output, microstep resolutions up to 51,200 steps per revolution, 0 to 5 MHz step clock rate, and a full featured easy-to-program instruction set.

The MDrive34AC Plus^2 Motion Control system communicates over RS-422/485 which allows for point-to-point or multiple unit configurations utilizing one communication port. Addressing and hardware support multiple uniquely addressed units communicating over a single line.

The MDrive34AC Plus^2 Motion Control is 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) optical encoder with index mark, internal to the MDrive34AC so there is no increase in length. Or, for an expanded choice of line counts and resolutions, closed loop control is available with an interface to a remotely mounted user-supplied external encoder.

In addition to encoder options, the MDrive34AC Plus^2 Motion Control has 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.

A sealed version designed to meet IP65 specifications is also available. The sealed assembly allows the MDrive34AC to be used in environments where exposure to dust and liquids may occur.

Available rotary motor configurations include three motor lengths, an optional rear control knob for manual positioning and an integrated planetary gearbox. Interface connections are accomplished using standard industrial connectors.

Standard Feature Summary

- Highly Integrated Microstepping Driver/Motion Controller with Optional Encoder/NEMA 34 Brushless High Torque Motor
- Advanced 2nd Generation Current Control for Exceptional Performance and Smoothness
- Single Supply: 120 or 240 VAC
- Low Cost
- Extremely Compact
- High Positioning Accuracy
- No Tuning Required
- Stable at Low Speeds
- No Dithering at Zero Speed
- High Starting Torque
- Allows for Greater Inertia Mismatch
- Built-in Regeneration Circuitry
- Available Options:
  - ✓ Integral Optical Encoder for Closed Loop Control
  - ✓ Remote Encoder (not supplied) for Closed Loop Control
  - ✓ Control Knob for Manual Positioning
  - ✓ Integrated Planetary Gearbox
  - ✓ IP65 Sealed Configuration
- Three Motor Lengths Available
- Auxiliary Logic Power Supply Input
- Up to 5 MHz Step Clock Rate
- 20 Microstep Resolutions up to 51,200 Steps Per Rev Including: Degrees, Metric, Arc Minutes
- Open or Optional Closed Loop Control
- Programmable Motor Current
- Up to Eight +24 VDC Tolerant I/O Lines, Sourcing or Sinking
- One 10 Bit Analog Input Selectable: 0 to +5 VDC, 0 to +10 VDC, 0-20 mA, 4-20 mA
- RS-422/485 Communications
- 62 Software Addresses for Multi-Drop Communications
- High Speed Position Capture Input or Trip Output
- Electronic Gearing

SECTION 1.2

WARNING! Because the MDriveAC Plus^2 consists of three core components, a power supply, a drive and a motor, close attention must be paid to the thermal environment where the device is used. See Thermal Specifications.

MDrive34AC Plus^2 Detailed Specifications

Standard Electrical Specifications

Input Voltage (+VAC)

120V MDrive .....95 to 132 VAC @ 50/60 Hz
240V MDrive .....95 to 264 VAC @ 50/60 Hz

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 to 20mA, 0 to 20mA

General Purpose I/O

Number/Type

Standard..... 8 Sourcing or Sinking Inputs/Outputs
Remote Encoder Option ..... 4 Sourcing or Sinking Inputs/Outputs - 4Encoder I/O

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 (sinking), Transient Over Voltage, Inductive Clamp (sourcing)

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 MDriveAC Plus^2 Motion Control I/O

Thermal Specifications

Motor Temperature .....100°C (maximum)
Heat Sink Temperature .....85°C (maximum)
Operating Temperature .....-40°C to +85°C

Sealing Specifications (-65 Sealed Versions Only)

IP Specification IP-65

Standard Motion Specifications

Microstep Resolution – Open Loop Configuration

Number of Settings 20
Steps per Revolution ..... 200, 400, 800, 1000, 1600, 2000, 3200, 5000, 6400,10000, 12800, 20000, 25000, 25600, 40000, 50000, 51200, 36000 (0.01 deg/µstep), 21600 (1 arc minute/µstep), 25400 (0.001 mm/µstep)

Encoder (Optional)

Type ..... Internal Differential, Optical
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 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.

WARNING!
When using the MDriveAC Plus^2 Motion Control with optional internal optical encoder, no axial force may be applied to the motor shaft without use of a load bearing isolation coupling.

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 ..... 330 oz-in/233 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) ..... 3.8 lb/2.9 kg

Double Length

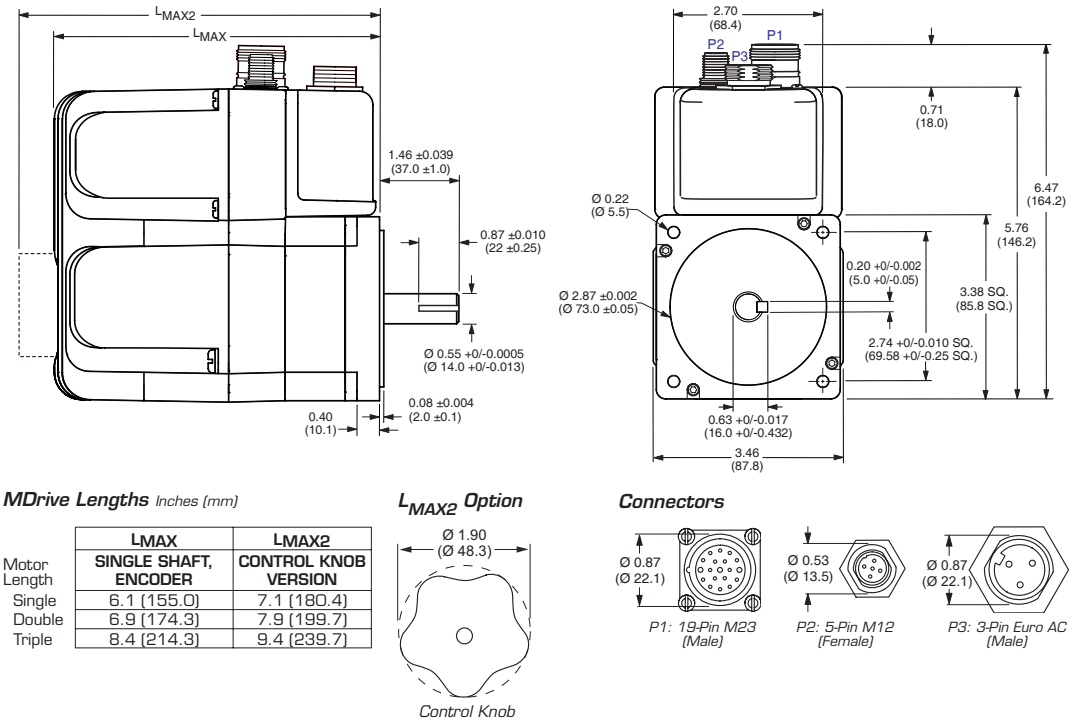
Holding Torque ..... 500 oz-in/353 N-cm
Detent Torque ..... 14.16 oz-in/14.0 N-cm
Rotor Inertia ..... 0.02266 oz-in-sec^2/1.6 kg-cm^2
Weight (Motor + Driver) ..... 5.2 lb/3.5 kg

Triple Length

Holding Torque ..... 750 oz-in/529 N-cm
Detent Torque ..... 19.83 oz-in/10.0 N-cm
Rotor Inertia ..... 0.04815 oz-in-sec^2/3.4 kg-cm^2

Weight (Motor + Driver)..... 8.6 lb/5.0 kg

Mechanical Specifications



MDrive Lengths *Inches (mm)*

Motor Length	LMAX SINGLE SHAFT, ENCODER	LMAX2 CONTROL KNOB VERSION
Single	6.1 (155.0)	7.1 (180.4)
Double	6.9 (174.3)	7.9 (199.7)
Triple	8.4 (214.3)	9.4 (239.7)

L_{MAX2} Option

Control Knob

Connectors

P1: 19-Pin M23 (Male) *P2: 5-Pin M12 (Female)* *P3: 3-Pin Euro AC (Male)*

Figure 1.2.1: MDrive34AC Plus2 Motion Control Mechanical Specifications

Dimensions in Inches (mm)

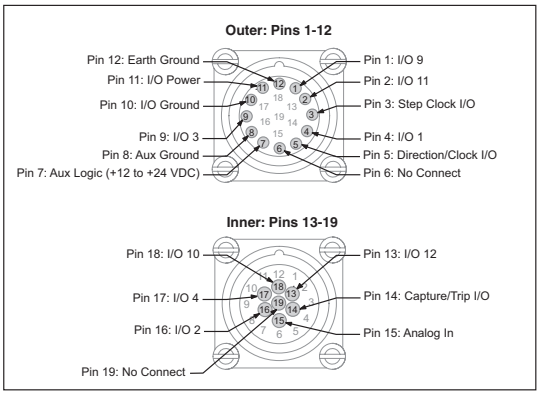


Figure 1.2.2: P1 19-Pin M23 (male) - 8 I/O Configuration

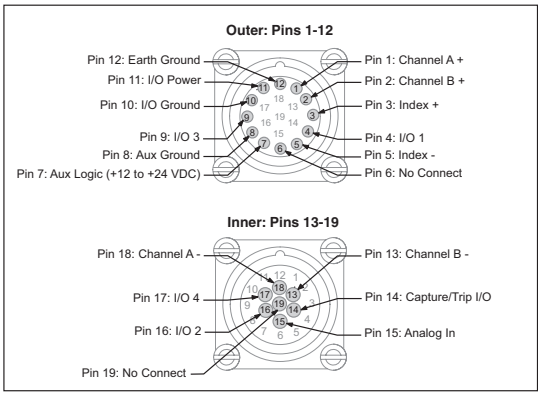


Figure 1.2.3: P1 19-Pin M23 (male) - Optional Remote Encoder Configuration

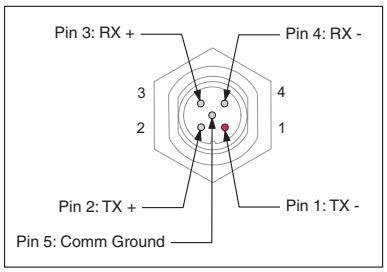


Figure 1.2.4: P2 5-Pin M12 (female) RS-422/485 Communications Connector

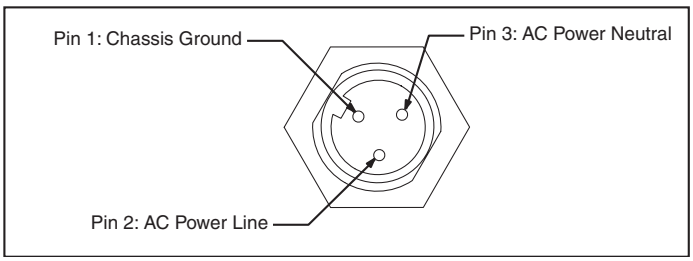


Figure 1.2.5: P3 3-Pin Euro AC Connector

P1: I/O CONNECTOR		
M23 Circular (Male)	Function	
	Expanded I/O	Remote Encoder Closed Loop Control
Pin 1	I/O 9	Channel A +
Pin 2	I/O 11	Channel B +
Pin 3	Step/Clock I/O	Index +
Pin 4	I/O 1	I/O 1
Pin 5	Direction/Clock I/O	Index –
Pin 6	No Connect	No Connect
Pin 7	Aux Logic (+12 to +24 VDC)	Aux Logic (+12 to +24 VDC)
Pin 8	Aux Ground	Aux Ground
Pin 9	I/O 3	I/O 3
Pin 10	I/O Ground	I/O Ground
Pin 11	I/O Power	I/O Power
Pin 12	Earth Ground	Earth Ground
Pin 13	I/O 12	Channel B –
Pin 14	Capture/Trip I/O	Capture/Trip I/O
Pin 15	Analog In	Analog In
Pin 16	I/O 2	I/O 2
Pin 17	I/O 4	I/O 4
Pin 18	I/O 10	Channel A –
Pin 19	No Connect	No Connect

Table 1.2.1: Connector P1 Pin Configuration

P2: COMM CONNECTOR	
RS-422/485	
M12 Circular (Female)	Function
Pin 1	TX –
Pin 2	TX +
Pin 3	RX +
Pin 4	RX –
Pin 5	Comm Ground

Table 1.2.2: P2 - RS-422/485 Communications

P3: AC POWER CONNECTOR	
Euro AC Circular (Male)	Function
Pin 1	Chassis Ground
Pin 2	AC Power Line
Pin 3	AC Power Neutral

Table 1.2.3: P3 - AC Power

WARNING! Because the MDriveAC Plus^2 Motion Control DOES NOT have a Pin Configuration label on the body of the device please ensure that all wiring connections are cross-checked against these tables and figures.

Pin/Wire Assignments

Options and Accessories

Control Knob

The MDrive34AC Plus2 Motion Control is available with a factory-mounted rear control knob for manual shaft positioning. Not available on sealed -65 versions.

Planetary Gearbox

Efficient, low maintenance Planetary Gearboxes are offered assembled with the MDrive34AC Plus^2. (For specifications and details see Appendix C: Planetary Gearbox Specification.)

Internal Encoder

The MDrive34AC Plus2 Motion Control is available with an internal 512-line (2048 count) differential optical encoder with index mark.

Remote Encoder

The MDrive34AC Plus2 Motion Control is available with differential encoder inputs for use with a remote, user-defined encoder. (Encoder not supplied by IMS.)

Communication Converter Cables

These convenient 12.0' (3.6m) accessory cables connect a PC's USB Port to the MDriveAC Plus^2 P2 Connector. An in-line RS-422 converter enables parameter setting to a single MDriveAC Plus^2 Motion Control. Cable purchase recommended with first orders. Versions include:

USB to 5-Pin M12.....MD-CC401-000

Cordsets

M23 single-ended cordsets are offered to speed prototyping of MDrive34AC Plus^2 Motion Control units. Measuring 13.0' (4.0m) long, they are available in either straight or right angle termination. PVC jacketed cables come with a foil shield and unconnected drain wire.

Straight Termination..... Part No. MD-CS100-000

Note: The MDriveAC Plus Motion Control is available in a CAN communications configuration. For more information see the IMS Website.

SECTION 1.3

MDrive42AC Plus^2 Motion Control Product Introduction

Introduction to the MDrive42AC Plus^2 Motion Control System

The MDrive42AC Plus^2 Motion Control system offers designers a low cost, intelligent motion controller integrated with a NEMA 42 high torque brushless motor and microstepping drive operating at 120 or 240 VAC.

Figure 1.3.1: MDrive42AC Plus^2 Motion Control

Unsurpassed smoothness and performance delivered by the MDrive42AC 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.

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In addition to encoder options, the MDrive42AC Plus^2 Motion Control has 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.

A sealed version designed to meet IP65 specifications is also available. The sealed assembly allows the MDrive42AC to be used in environments where exposure to dust and liquids may occur.

Available rotary motor configurations include two motor lengths, an optional rear control knob for manual positioning and an integrated planetary gearbox. Interface connections are accomplished using standard industrial connectors.

Standard Feature Summary

- Highly Integrated Microstepping Driver/Motion Controller with Optional Encoder/NEMA 42 Brushless High Torque Motor
- Advanced 2nd Generation Current Control for Exceptional Performance and Smoothness
- Single Supply: 120 or 240 VAC
- Low Cost
- Extremely Compact
- High Positioning Accuracy
- No Tuning Required
- Stable at Low Speeds
- No Dithering at Zero Speed
- High Starting Torque
- Allows for Greater Inertia Mismatch
- Built-in Regeneration Circuitry
- Available Options:
  - ✓ Integral Optical Encoder for Closed Loop Control
  - ✓ Remote Encoder (not supplied) for Closed Loop Control
  - ✓ Control Knob for Manual Positioning
  - ✓ Integrated Planetary Gearbox
  - ✓ IP65 Sealed Configuration
- Three Motor Lengths Available
- Auxiliary Logic Power Supply Input
- Up to 5 MHz Step Clock Rate
- 20 Microstep Resolutions up to 51,200 Steps Per Rev Including: Degrees, Metric, Arc Minutes
- Open or Optional Closed Loop Control
- Programmable Motor Current
- Up to Eight +24 VDC Tolerant I/O Lines, Sourcing or Sinking
- One 10 Bit Analog Input Selectable: 0 to +5 VDC, 0 to +10 VDC, 0-20 mA, 4-20 mA
- RS-422/485 Communications
- 62 Software Addresses for Multi-Drop Communications
- High Speed Position Capture Input or Trip Output
- Electronic Gearing

WARNING! Because the MDriveAC Plus consists of three core components, a power supply, a drive and a motor, close attention must be paid to the thermal environment where the device is used. See Thermal Specifications.

SECTION 1.4

MDrive42AC Plus^2 Detailed Specifications

Standard Electrical Specifications

Input Voltage (+VAC)

120V MDrive .....95 to 132 VAC @ 50/60 Hz
240V MDrive .....95 to 264 VAC @ 50/60 Hz

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

Standard..... 8 Sourcing or Sinking Inputs/Outputs
Remote Encoder Option ..... 4 Sourcing or Sinking Inputs/Outputs - 4Encoder I/O

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 (sinking), Transient Over Voltage, Inductive Clamp (sourcing)

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 MDriveAC Plus Motion Control I/O

Thermal Specifications

Motor Temperature.....100°C (maximum)
Heat Sink Temperature .....85°C (maximum)
Operating Temperature .....-40°C to +85°C

Sealing Specifications (-65 Sealed Versions Only)

IP Specification IP-65

Standard Motion Specifications

Microstep Resolution – Open Loop Configuration

Number of Settings..... 20
Steps per Revolution ..... 200, 400, 800, 1000, 1600, 2000, 3200, 5000, 6400,10000, 12800, 20000, 25000, 25600, 40000, 50000, 51200, 36000 (0.01 deg/µstep), 21600 (1 arc minute/µstep), 25400 (0.001 mm/µstep)

Encoder (Optional)

Type ..... Internal Differential, Optical
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 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.

WARNING!
When using the MDriveAC Plus 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.

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

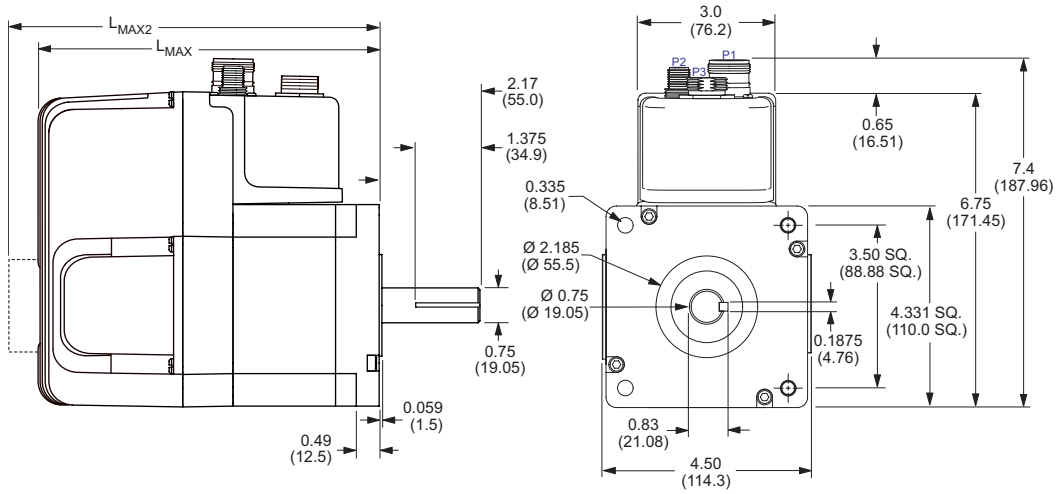
Holding Torque ..... 1147 oz-in/810 N-cm
Detent Torque ..... 35 oz-in/25 N-cm
Rotor Inertia ..... 0.0917 oz-in-sec^2/6.5 kg-cm^2
Weight (Motor + Driver) ..... 14.07 lb/6.38 kg

Double Length

Holding Torque ..... 2294 oz-in/1620 N-cm
Detent Torque ..... 84 oz-in/59 N-cm
Rotor Inertia ..... 0.1833 oz-in-sec^2/13 kg-cm^2
Weight (Motor + Driver) ..... 21.25 oz/9.64 kg

Mechanical Specifications

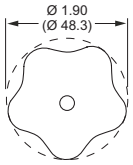
Dimensions in Inches (mm)



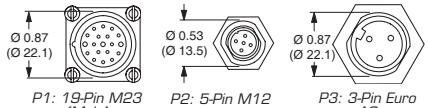
MDrive Lengths *Inches (mm)*

Motor Length	LMAX SINGLE SHAFT or ENCODER VERSION	LMAX2 CONTROL KNOB VERSION
Single	7.4 (187.96)	9.4 (238.76)
Double	8.4 (213.36)	10.4 (264.16)

Control Knob



Connectors



P1: 19-Pin M23 (Male) *P2: 5-Pin M12 (Female)* *P3: 3-Pin Euro AC (Male)*

Figure 1.4.1: MDrive42AC Plus2 Motion Control Mechanical Specifications

Pin/Wire Assignments

Options and Accessories

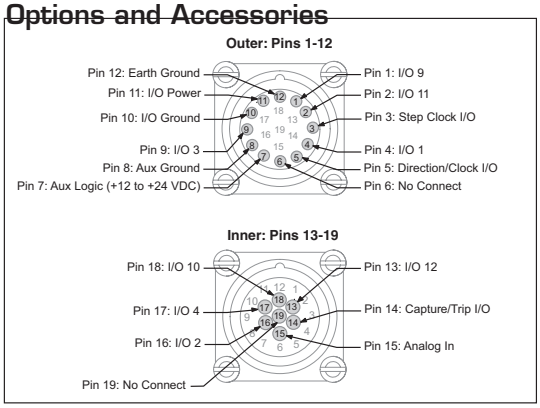


Figure 1.4.2: P1 19-Pin M23 (male) - Enhanced I/O Configuration

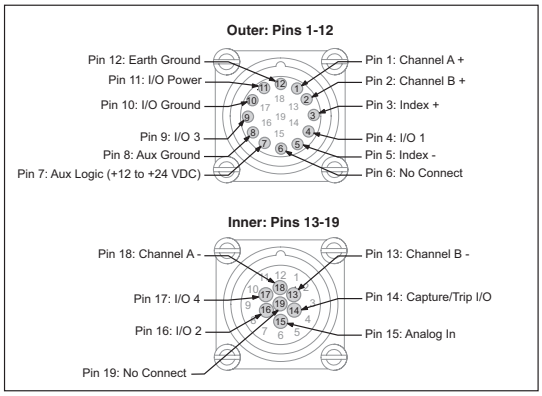


Figure 1.4.3: P1 19-Pin M23 (male) - Optional Remote Encoder Configuration

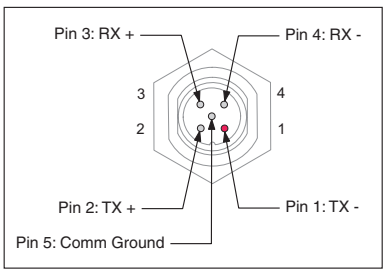


Figure 1.4.4: P2 5-Pin M12 (Female) RS-422/485 Communications Connector

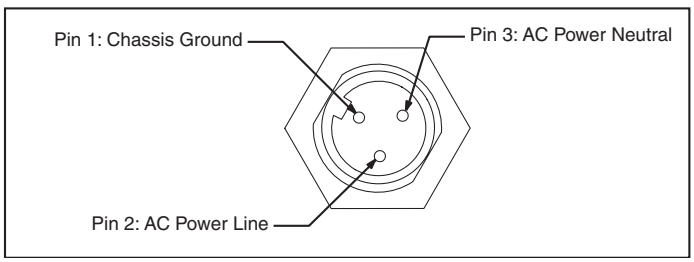


Figure 1.4.5: P3 3-Pin Euro AC Connector

P1: I/O CONNECTOR		
M23 Circular (Male)	Function	
	Expanded I/O	Remote Encoder Closed Loop Control
Pin 1	I/O 9	Channel A +
Pin 2	I/O 11	Channel B +
Pin 3	Step/Clock I/O	Index +
Pin 4	I/O 1	I/O 1
Pin 5	Direction/Clock I/O	Index –
Pin 6	No Connect	No Connect
Pin 7	Aux Logic (+12 to +24 VDC)	Aux Logic (+12 to +24 VDC)
Pin 8	Aux Ground	Aux Ground
Pin 9	I/O 3	I/O 3
Pin 10	I/O Ground	I/O Ground
Pin 11	I/O Power	I/O Power
Pin 12	Earth Ground	Earth Ground
Pin 13	I/O 12	Channel B –
Pin 14	Capture/Trip I/O	Capture/Trip I/O
Pin 15	Analog In	Analog In
Pin 16	I/O 2	I/O 2
Pin 17	I/O 4	I/O 4
Pin 18	I/O 10	Channel A –
Pin 19	No Connect	No Connect

Table 1.4.1: Connector P1 Pin Configuration

P2: COMM CONNECTOR	
RS-422/485	
M12 Circular (Female)	Function
Pin 1	TX –
Pin 2	TX +
Pin 3	RX +
Pin 4	RX –
Pin 5	Comm Ground

Table 1.4.2: P2 - RS-422/485 Communications

P3: AC POWER CONNECTOR	
Euro AC Circular (Male)	Function
Pin 1	Chassis Ground
Pin 2	AC Power Line
Pin 3	AC Power Neutral

Table 1.4.3: P3 - AC Power

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

Control Knob

The MDrive42AC Plus2 Motion Control is available with a factory-mounted rear control knob for manual shaft positioning. Not available with sealed -65 versions.

Planetary Gearbox

Efficient, low maintenance Planetary Gearboxes are offered assembled with the MDrive42AC Plus2. (For specifications and details see Appendix C: Planetary Gearbox Specification.)

Internal Encoder

The MDrive42AC Plus2 Motion Control is available with an internal 512-line (2048 count) differential optical encoder with index mark.

Remote Encoder

The MDrive42AC Plus2 Motion Control is available with differential encoder inputs for use with a remote, user-defined encoder. (Encoder not supplied by IMS.)

Communication Converter Cable

This convenient 6.0' (1.8m) accessory cable connects a PC's USB Port to the MDriveAC Plus P2 5-pin M12 Connector. An in-line RS-422 converter enables parameter setting to a single MDriveAC Plus Motion Control. Cable purchase recommended with first orders.

USB to 5-Pin M12.....MD-CC401-000

Cordsets

19-pin M23 single-ended cordsets are offered to speed prototyping of MDrive42AC Plus2 Motion Control units. Measuring 13.0' (4.0m) long, they are available in either straight or right angle termination. PVC jacketed cables come with a foil shield and unconnected drain wire.

Straight Termination..... Part No. MD-CS100-000
Right Angle Termination ..... Part No. MD-CS101-000

SECTION 1.5

MDrive34AC Plus^2 CANopen Detailed Specifications

Standard Electrical Specifications

Input Voltage (+VAC)

120V MDrive .....95 to 132 VAC @ 50/60 Hz
240V MDrive .....95 to 264 VAC @ 50/60 Hz

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 to 20mA, 0 to 20mA

General Purpose I/O

Number/Type

Standard..... 8 Sourcing or Sinking Inputs/Outputs
Remote Encoder Option ..... 4 Sourcing or Sinking Inputs/Outputs - 4Encoder I/O

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 (sinking), Transient Over Voltage, Inductive Clamp (sourcing)

CAN V+ Input Voltage

Range.....+7 to +30 VDC
(Maintains power to control and feedback circuits [only] when input voltage is removed)

Communication

Protocol (Standard) .....CANopen DSP-402 (V2.0), DS-301 (V3.0), 2.0B Active
ID ..... 11 and/or 29 Bit
Isolation .....Galvanic
Features.....Node Guarding, Heartbeat, SDOs, PDOs (Variable Mapping)
Baud Rate .....10kbps - 1Mbps

* See I/O Ratings on In Section 2.3: Interfacing the MDriveAC Plus^2 Motion Control I/O

Thermal Specifications

Motor Temperature*.....100°C (maximum)
Heat Sink Temperature .....85°C (maximum)
Operating Temperature .....-40°C to +85°C
Ambient Temperature.....50°C (maximum, 100% duty cycle)
*Adequate mounting is required to assure that the motor temperature does not exceed 100° C.

Sealing Specifications (-65 Sealed Versions Only)

IP Specification IP-65

Motor Specifications

Single Length

Holding Torque..... 330 oz-in/233 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)..... 3.8 lb/2.9 kg

Double Length

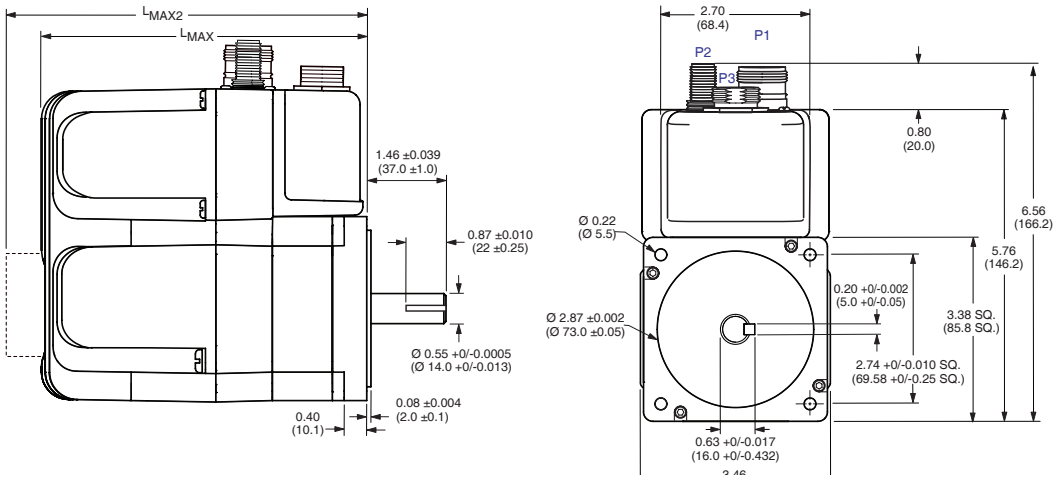
Holding Torque..... 500 oz-in/353 N-cm
Detent Torque..... 14.16 oz-in/14.0 N-cm
Rotor Inertia .....0.02266 oz-in-sec^2/1.6 kg-cm^2
Weight (Motor + Driver)..... 5.2 lb/3.5 kg

Triple Length

Holding Torque..... 750 oz-in/529 N-cm
Detent Torque..... 19.83 oz-in/10.0 N-cm
Rotor Inertia .....0.04815 oz-in-sec^2/3.4 kg-cm^2
Weight (Motor + Driver)..... 8.6 lb/5.0 kg

Mechanical Specifications

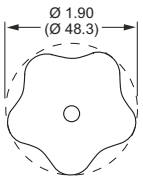
Dimensions in Inches (mm)



MDrive Lengths *Inches (mm)*

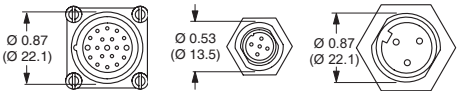
Motor Length	LMAX SINGLE SHAFT, ENCODER	LMAX2 CONTROL KNOB VERSION
Single	6.1 (155.0)	7.1 (180.4)
Double	6.9 (174.3)	7.9 (199.7)
Triple	8.4 (214.3)	9.4 (239.7)

L_{MAX2} Option



Control Knob

Connectors



P1: 19-Pin M23 (Male) *P2: 5-Pin M12 (Male)* *P3: 3-Pin Euro AC (Male)*

Figure 1.5.1: MDrive34AC Plus^2 Motion Control Mechanical Specifications

Pin/Wire Assignments

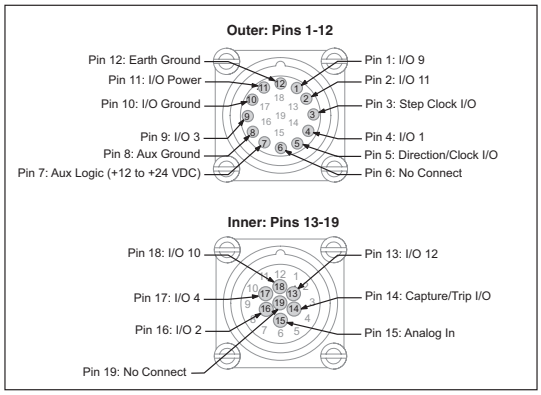


Figure 1.5.2: P1 19-Pin M23 (male) - 8 I/O Configuration

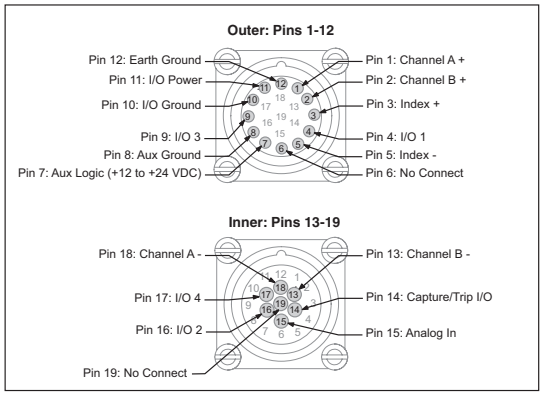


Figure 1.5.3: P1 19-Pin M23 (male) - Optional Remote Encoder Configuration

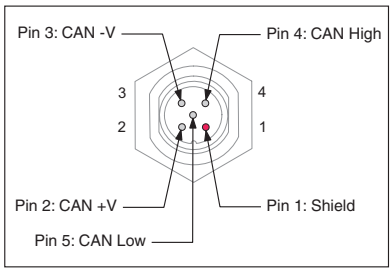


Figure 1.5.4: P2 5-Pin M12 (Male) CANopen Communications Connector

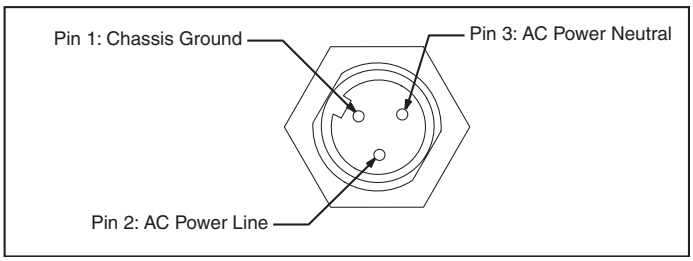


Figure 1.5.5: P3 3-Pin Euro AC Connector

P1: I/O CONNECTOR		
M23 Circular (Male)	Function	
	Expanded I/O	Remote Encoder Closed Loop Control
Pin 1	I/O 9	Channel A +
Pin 2	I/O 11	Channel B +
Pin 3	Step/Clock I/O	Index +
Pin 4	I/O 1	I/O 1
Pin 5	Direction/Clock I/O	Index –
Pin 6	No Connect	No Connect
Pin 7	Aux Logic (+12 to +24 VDC)	Aux Logic (+12 to +24 VDC)
Pin 8	Aux Ground	Aux Ground
Pin 9	I/O 3	I/O 3
Pin 10	I/O Ground	I/O Ground
Pin 11	I/O Power	I/O Power
Pin 12	Earth Ground	Earth Ground
Pin 13	I/O 12	Channel B –
Pin 14	Capture/Trip I/O	Capture/Trip I/O
Pin 15	Analog In	Analog In
Pin 16	I/O 2	I/O 2
Pin 17	I/O 4	I/O 4
Pin 18	I/O 10	Channel A –
Pin 19	No Connect	No Connect

Table 1.5.1: Connector P1 Pin Configuration

P2: COMM CONNECTOR	
CANopen	
M12 Circular (Male)	Function
Pin 1	Shield
Pin 2	CAN +V
Pin 3	CAN -V
Pin 4	CAN High
Pin 5	CAN Low

Table 1.5.2: P2 - CANopen Communications

P3: AC POWER CONNECTOR	
Euro AC Circular (Male)	Function
Pin 1	Chassis Ground
Pin 2	AC Power Line
Pin 3	AC Power Neutral

Table 1.5.3: P3 - AC Power

SECTION 1.6

MDrive42AC Plus^2 CANopen Detailed Specifications

Standard Electrical Specifications

Input Voltage (+VAC)

120V MDrive .....95 to 132 VAC @ 50/60 Hz
240V MDrive .....95 to 264 VAC @ 50/60 Hz

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 to 20mA, 0 to 20mA

General Purpose I/O

Number/Type

Standard..... 8 Sourcing or Sinking Inputs/Outputs
Remote Encoder Option ..... 4 Sourcing or Sinking Inputs/Outputs - 4Encoder I/O

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 (sinking), Transient Over Voltage, Inductive Clamp (sourcing)

CAN V+ Input Voltage

Range.....+7 to +30 VDC
(Maintains power to control and feedback circuits [only] when input voltage is removed)

Communication

Protocol (Standard) .....CANopen DSP-402 (V2.0), DS-301 (V3.0), 2.0B Active
ID ..... 11 and/or 29 Bit
Isolation .....Galvanic
Features.....Node Guarding, Heartbeat, SDOs, PDOs (Variable Mapping)
Baud Rate .....10kbps - 1Mbps
* See I/O Ratings on In Section 2.3: Interfacing the MDriveAC Plus^2 Motion Control I/O

Thermal Specifications

Motor Temperature*.....100°C (maximum)
Heat Sink Temperature .....85°C (maximum)
Operating Temperature .....-40°C to +85°C
Ambient Temperature.....50°C (maximum, 100% duty cycle)
*Adequate mounting is required to assure that the motor temperature does not exceed 100° C.

Sealing Specifications (-65 Sealed Versions Only)

IP Specification IP-65

Motor Specifications

Single Length

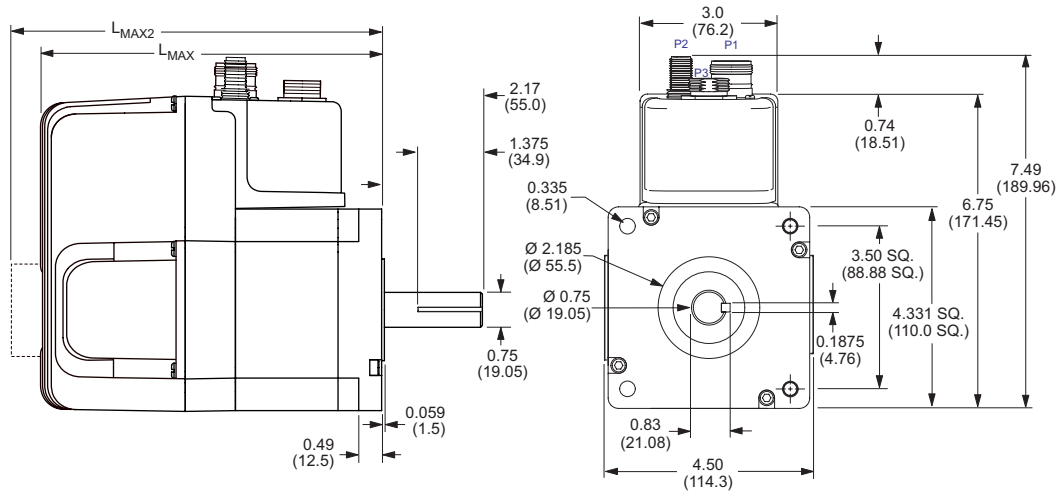
Holding Torque..... 1147 oz-in/810 N-cm
Detent Torque..... 35 oz-in/25 N-cm
Rotor Inertia .....0.0917 oz-in-sec^2/6.5 kg-cm^2
Weight (Motor + Driver)..... 14.07 lb/6.38 kg

Double Length

Holding Torque..... 2294 oz-in/1620 N-cm
Detent Torque..... 84 oz-in/59 N-cm
Rotor Inertia .....0.1833 oz-in-sec^2/13 kg-cm^2
Weight (Motor + Driver)..... 21.25 oz/9.64 kg

Mechanical Specifications

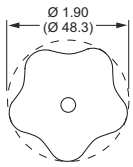
Dimensions in Inches (mm)



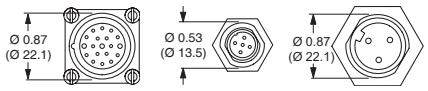
MDrive Lengths *Inches (mm)*

Motor Length	LMAX SINGLE SHAFT or ENCODER VERSION	LMAX2 CONTROL KNOB VERSION
Single	7.4 (187.96)	9.4 (238.76)
Double	8.4 (213.36)	10.4 (264.16)

Control Knob



Connectors



P1: 19-Pin M23 (Male)
P2: 5-Pin M12 (Female)
P3: 3-Pin Euro AC (Male)

Figure 1.6.1: MDrive42AC Plus^2 Motion Control Mechanical Specifications

Pin/Wire Assignments

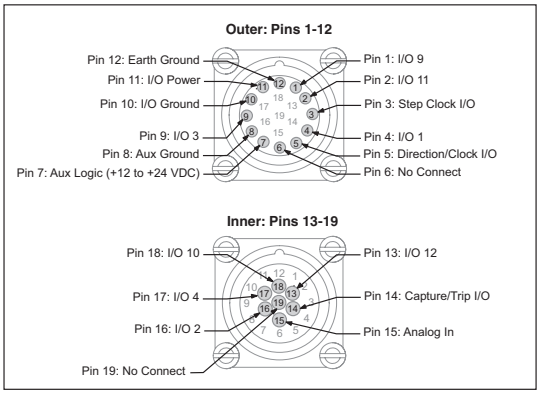


Figure 1.6.2: P1 19-Pin M23 (male) - 8 I/O Configuration

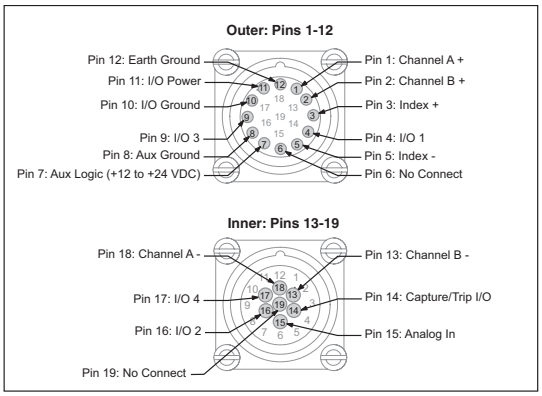


Figure 1.6.3: P1 19-Pin M23 (male) - Optional Remote Encoder Configuration

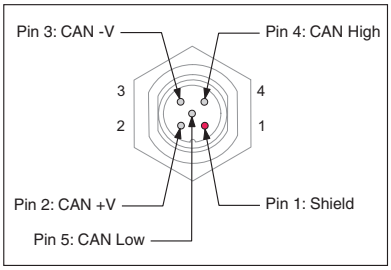


Figure 1.6.4: P2 5-Pin M12 (Male) CANopen Communications Connector

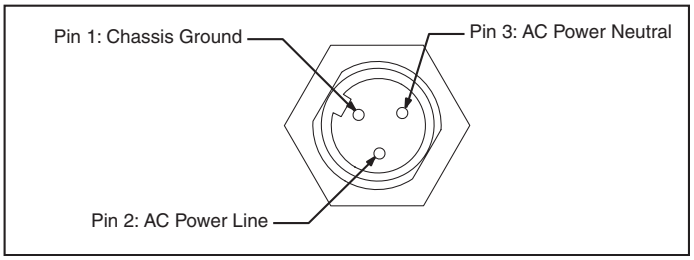


Figure 1.6.5: P3 3-Pin Euro AC Connector

P1: I/O CONNECTOR		
M23 Circular (Male)	Function	
	Expanded I/O	Remote Encoder Closed Loop Control
Pin 1	I/O 9	Channel A +
Pin 2	I/O 11	Channel B +
Pin 3	Step/Clock I/O	Index +
Pin 4	I/O 1	I/O 1
Pin 5	Direction/Clock I/O	Index –
Pin 6	No Connect	No Connect
Pin 7	Aux Logic (+12 to +24 VDC)	Aux Logic (+12 to +24 VDC)
Pin 8	Aux Ground	Aux Ground
Pin 9	I/O 3	I/O 3
Pin 10	I/O Ground	I/O Ground
Pin 11	I/O Power	I/O Power
Pin 12	Earth Ground	Earth Ground
Pin 13	I/O 12	Channel B –
Pin 14	Capture/Trip I/O	Capture/Trip I/O
Pin 15	Analog In	Analog In
Pin 16	I/O 2	I/O 2
Pin 17	I/O 4	I/O 4
Pin 18	I/O 10	Channel A –
Pin 19	No Connect	No Connect

Table 1.6.1: Connector P1 Pin Configuration

P2: COMM CONNECTOR	
CANopen	
M12 Circular (Male)	Function
Pin 1	Shield
Pin 2	CAN +V
Pin 3	CAN -V
Pin 4	CAN High
Pin 5	CAN Low

Table 1.5.2: P2 - CANopen Communications

P3: AC POWER CONNECTOR	
Euro AC Circular (Male)	Function
Pin 1	Chassis Ground
Pin 2	AC Power Line
Pin 3	AC Power Neutral

Table 1.6.3: P3 - AC Power

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INTELLIGENT MOTION SYSTEMS, INC.

Excellence in Motion™

MDRIVE™ MOTOR+DRIVER

AC Plus²

MOTION CONTROL

PART 2: CONNECTING AND INTERFACING

Section 2.1: Interfacing Communications

Section 2.2: Interfacing and Using the MDriveAC Plus² Motion Control I/O

SECTION 2.1

Interfacing MDriveAC Plus^2 Communications

Note: See the Specifications Section of this document specific to the MDriveAC Plus^2 model you purchased for detailed connector and pin information.

WARNING! Do not connect or disconnect the MD-CC401-000 Communications Converter Cable while power is applied!

Available Communications Cables/Converters

To simplify the wiring and connection process IMS offers a USB to RS-422 communications cable for the MDriveAC Plus^2 Motion Control. This convenient 6.0' (1.8m) accessory cable connects a PC's USB Port to the MDriveAC Plus^2 P2 5-pin M12 Connector. An in-line RS-422 converter enables parameter setting to a single MDriveAC Plus^2 Motion Control. Cable purchase recommended with first orders.

USB to M12 .....Part No. MD-CC401-000

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

Interfacing Single Mode Communications

The MDriveAC Plus^2 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 MDriveAC Plus^2 Motion Control, or to address up to 62 individually named MDriveAC Plus^2 nodes in a multidrop system.

Single Mode Communications Full Duplex (RS-422)

To interface the MDriveAC Plus^2 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 MDriveAC Plus^2 Motion Control model.

Use the following diagram to connect RS-422 communications to the MDriveAC Plus^2 Motion Control.

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

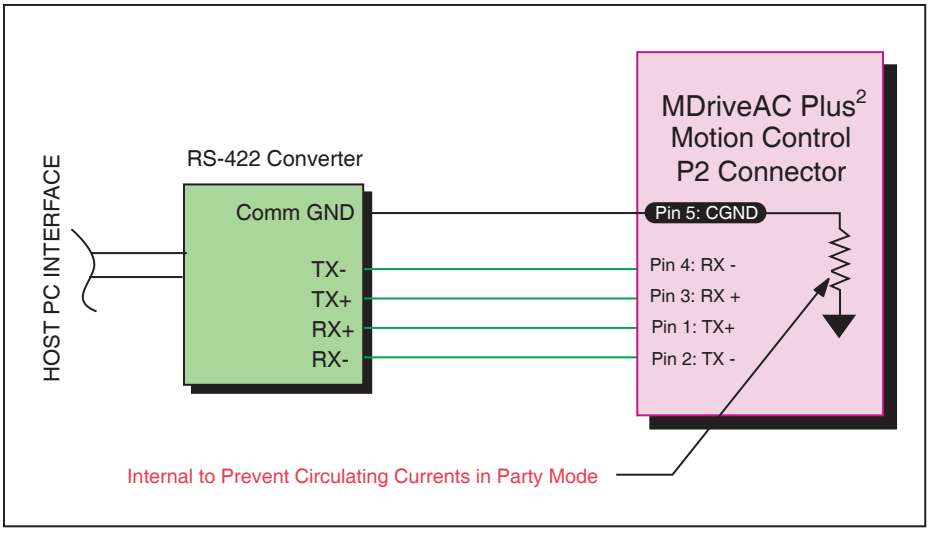

Figure 2.1.1: Full Duplex Communications (RS-422)

Single Mode Communications Half Duplex (RS-485)

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

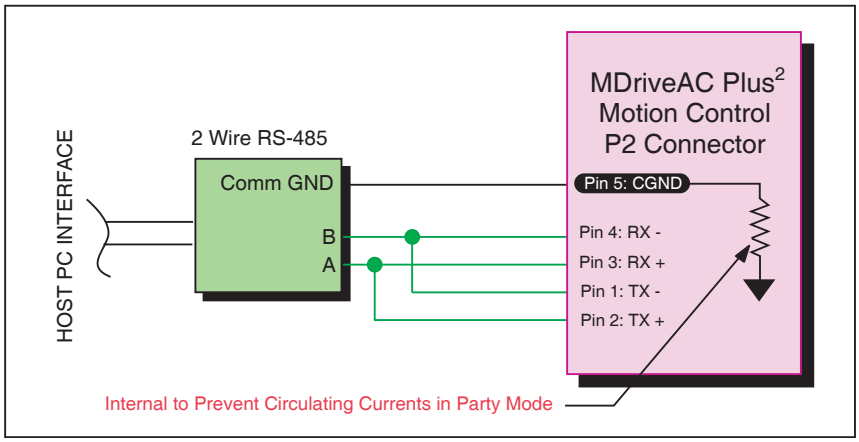

Figure 2.1.2: Half Duplex 2 Wire Communications (RS-485)

Interfacing Party Mode Communications

In systems with multiple controllers it is necessary to communicate with the control modules using party mode (PY=1). The MDriveAC Plus^2 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 B 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 MDriveAC Plus^2 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 MDriveAC Plus^2 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.

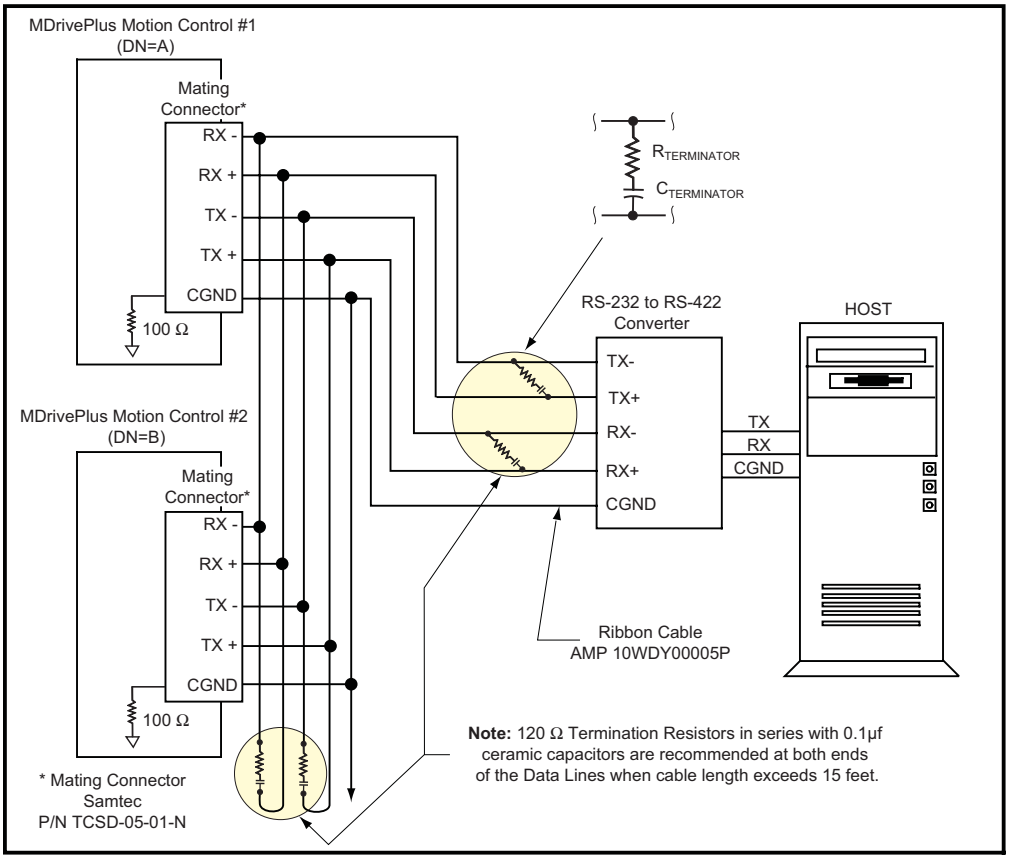

Figure 2.1.3: RS-485 Interface, Multiple MDriveAC Plus^{2}Motion Control System

Data Cable Termination Resistors

Data Cable lengths greater than 15 feet (4.5 meters) are susceptible to signal reflection and/or noise. IMS recommends 120 Ω termination resistors in series with 0.1µf capacitors at both ends of the Data Cables. An example of resistor placement is shown in Figure 2.1.3 above. For systems with Data Cables 15 feet (4.5 meters) or less, the termination resistors are generally not required.

MDriveAC Plus^2 Motion Control Communication Format

The following communication formats, used by MDriveAC Plus^2 Motion Control (MDI) units, began with firmware version 1.043.

```
{}          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.

MDriveAC Plus^2 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 2.1.1: 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 2.1.2: 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 2.1.3: 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 2.1.4: 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.

MDriveAC Plus^2 Motion Control Party Mode Sample Codes

1. Download this segment of code into the first MDriveAC Plus^2 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 MDriveAC Plus^2 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 MDriveAC Plus^2 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
```

MDriveAC Plus^2 Motion Control Immediate Party Mode Sample Codes

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

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.

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.

Once Party Mode has been defined and set up as previously described under the heading “Multiple MDriveAC Plus^2 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.

Interfacing and Using the MDriveAC Plus^2 Motion Control I/O

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

The MDriveAC Plus^2 Motion Control Digital I/O

The MDriveAC Plus^2 Motion Control product line is available with two digital I/O configurations: 8 Point General Purpose I/O and Optional Remote Encoder.

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 MDriveAC Plus^2 Motion Control and standard sensors and switches.

8 I/O Configuration

Low I/O Group	IO1, IO2, IO3, IO4 (Sinking Sourcing, Outputs/Inputs)
High I/O Group	IO9, IO10, IO11, IO12 (Sinking Sourcing, Outputs/Inputs)
Dedicated I/O	Step/Clock Input, Step/Direction I/O, Capture Input/Trip Output

Remote Encoder Configuration

Low I/O Group	IO1, IO2, IO3, IO4 (Sinking Sourcing, Outputs/Inputs)
Encoder Inputs	Differential Encoder
Dedicated I/O	Step/Clock Input, Step/Direction I/O, Capture Input/Trip Output

8 I/O Configuration

The MDriveAC Plus^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.

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 MDriveAC Plus^2 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).

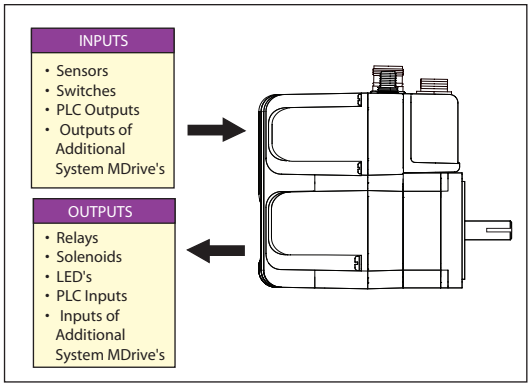

Figure 2.2.1: Uses for the Digital I/O

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 MDriveAC Plus^2 Motion Control and standard sensors and switches.

MDriveAC Plus2 Motion Control Digital Input Functions

The MDriveAC Plus2 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.

MDriveAC Plus2 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 2.2.1: Programmable Input Functions

Dedicated Input Functions

MDriveAC Plus2 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 2.2.2: 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).

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
```

MDriveAC Plus^2 Motion Control Digital Output Functions

The MDriveAC Plus^2 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 MDriveAC Plus^2 Motion Control Output functions may be programmed to be a general purpose user output or to one of five output functions.

MDriveAC Plus^2 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 2.2.3: Programmable Output Functions

Dedicated Output Functions

MDriveAC Plus^2 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 2.2.4: Dedicated Output Functions

WARNING!
External Current Limiting may be required to ensure that the current per I/O point does not exceed rated limits.

Be aware that the current rating is dependant on the number of active points in the group. If all 4 I/O, either 1-4 or 9-12 are active the max continuous current is 275mA..

MDriveAC Plus^2 Motion Control I/O Ratings

MDriveAC Plus^2 I/O Ratings			
MDriveAC Plus^2 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 2.2.5: MDriveAC Plus^2 Motion Control I/O and Protection Ratings

MDriveAC Plus^2 Motion Control I/O Connection Map

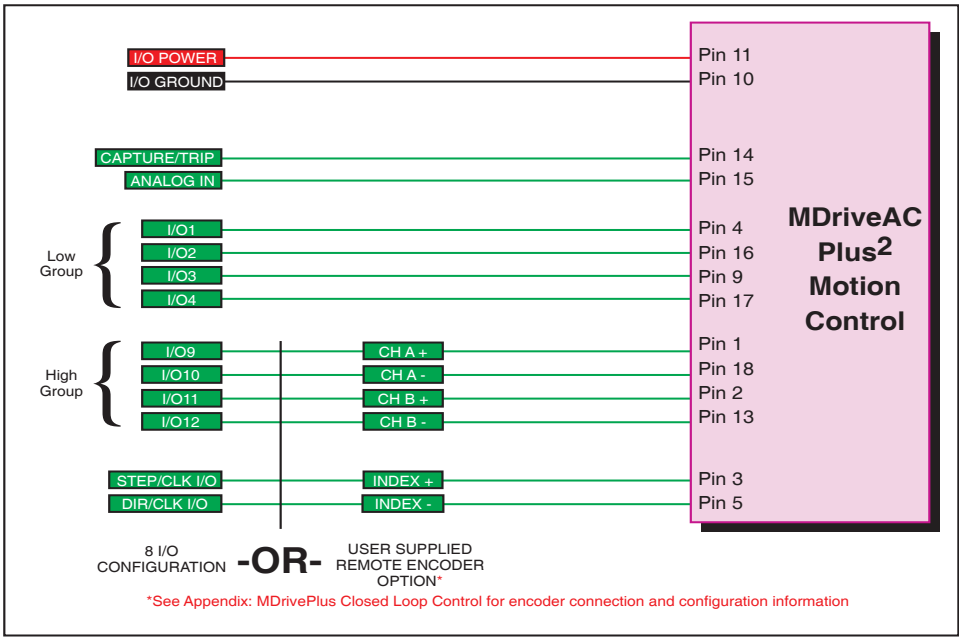

Figure 2.2.2: I/O Connection Map

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

The MDriveAC Plus^2 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 MDriveAC Plus^2 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 MDriveAC Plus Motion Control programming. Please reference the MDrive Motion Control (MDI) software reference 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 Applications 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.

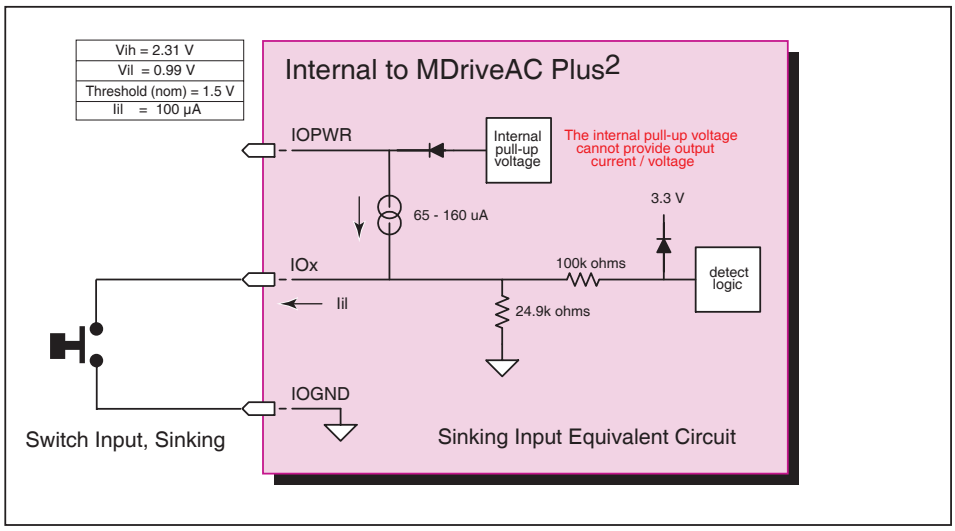

Figure 2.2.3: Switch Interface to Input, Sinking

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.

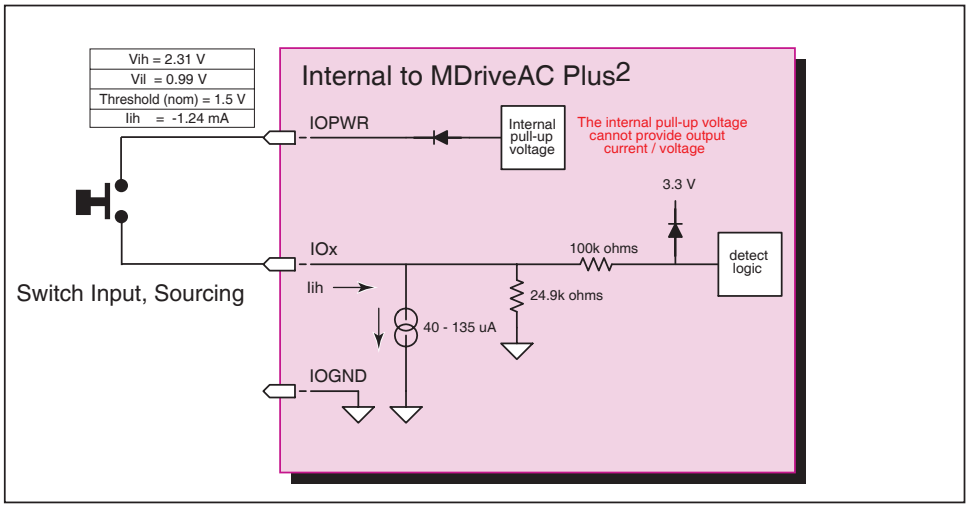

Figure 2.2.4 Sourcing Input Example using a Push Button Switch

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.

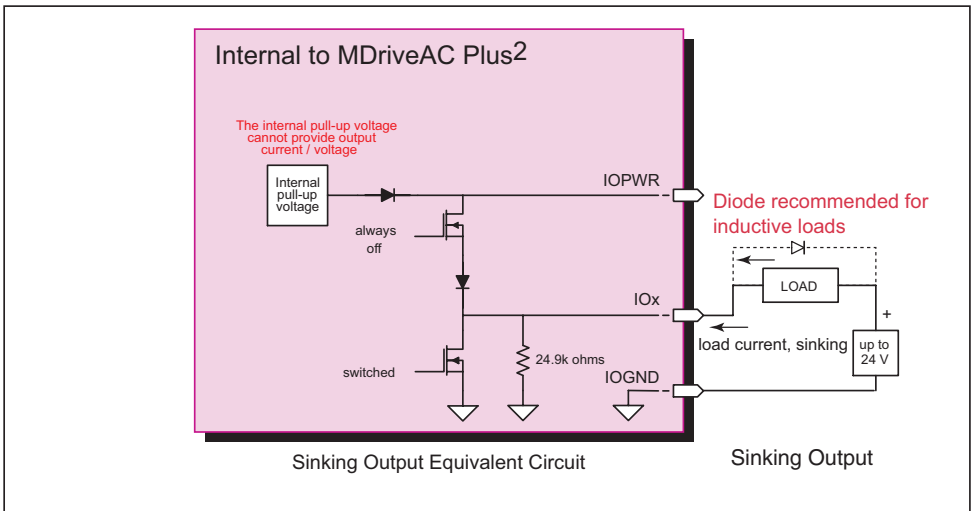

Figure 2.2.5: Sinking Output Example

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.

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.

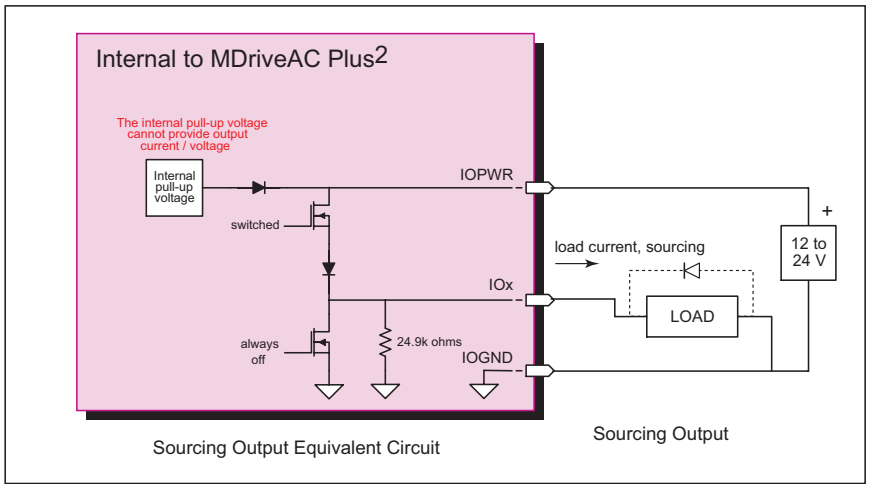

Figure 2.2.6: Sourcing Output Example

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.

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 MDriveAC Plus^2 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

Step/Direction

The Step/Direction function would typically be used to receive step and direction instructions from a second system MDriveAC Plus^2 or secondary controller. When configured as outputs the MDriveAC Plus^2 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 MDriveAC Plus^2 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.

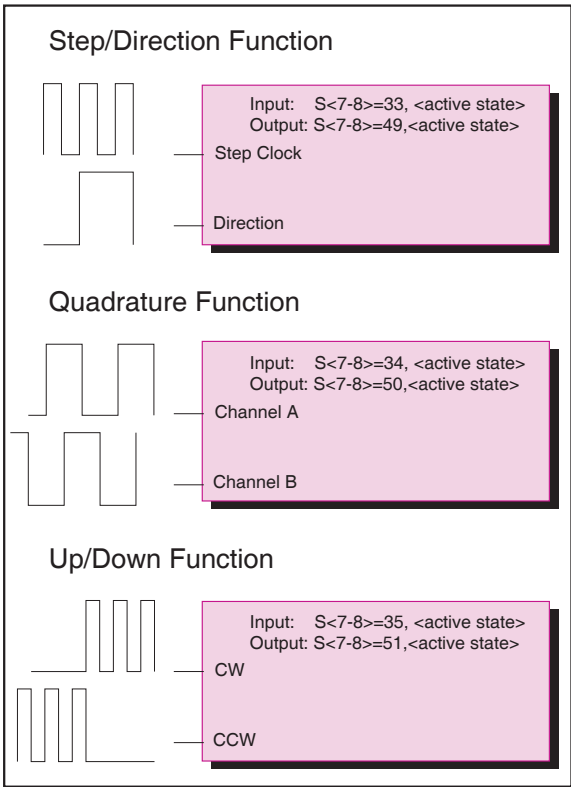

Figure 2.2.7: MDriveAC Plus^2 Motion Control Clock Functions

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>
```

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

NOTE: When using the MDriveAC Plus^2 with the external encoder option, the step an direction I/O are not available! These I/O points become Index + and Index-. See Appendix: MDriveAC Plus^2 Motion Control Closed Loop Control for encoder connection and configuration information.

Interfacing the Analog Input

The analog input of the MDriveAC Plus^2 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 MDriveAC Plus^2 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
```

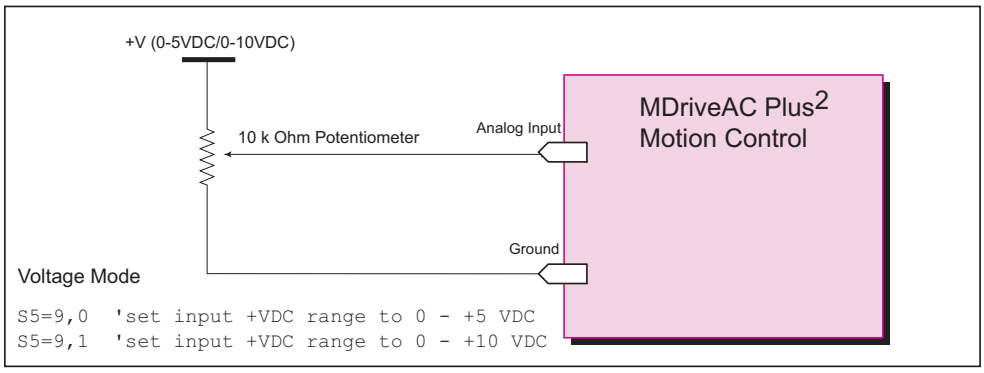

Figure 2.2.8: Analog Input - Voltage Mode

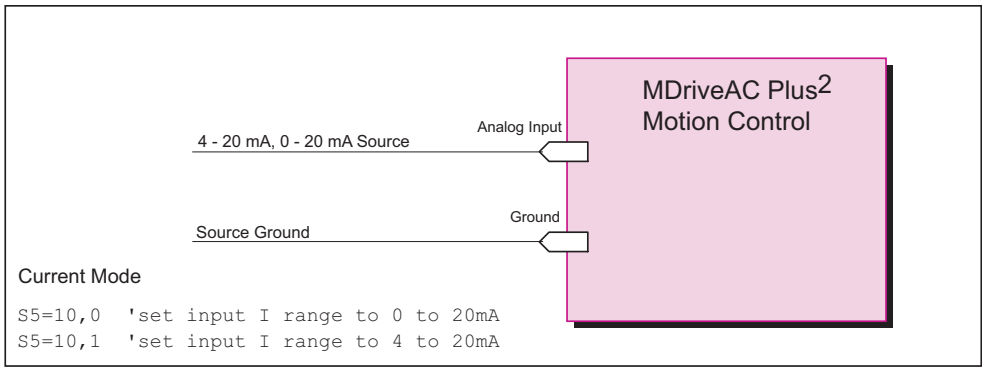

Figure 2.2.9: Analog Input - Current Mode

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INTELLIGENT MOTION SYSTEMS, INC.

Excellence in Motion™

MDRIVE™ MOTOR+DRIVER

AC Plus²

MOTION CONTROL

APPENDICES

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APPENDIX A

MDriveAC Plus^2 Motion Control Motor Performance

MDrive34AC Plus^2 Motion Control

Speed-Torque Curves

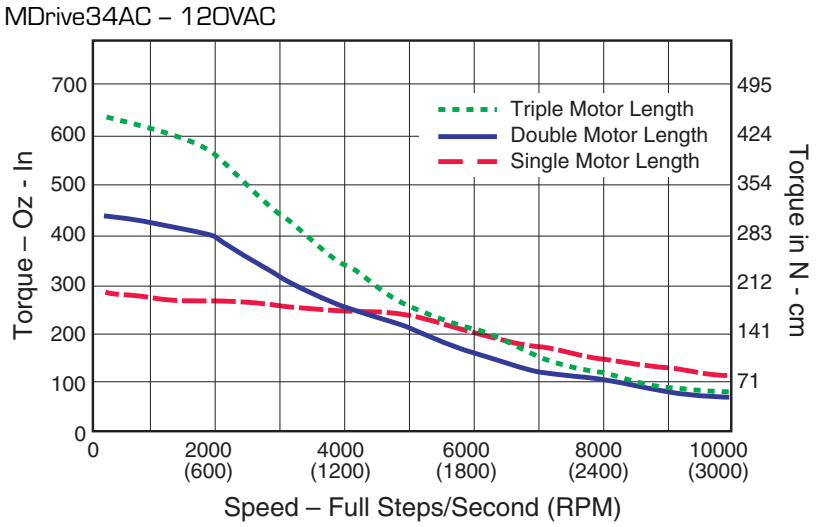


Figure A.1: MDrive34AC Plus^2 120VAC Motion Control Speed-Torque Curves

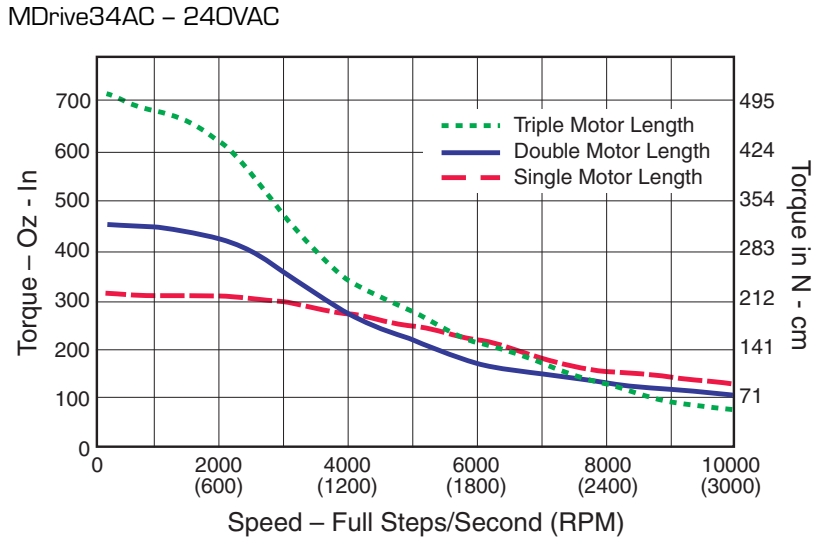


Figure A.2: MDrive34AC Plus^2 240VAC Motion Control Speed-Torque Curves

Motor Specifications

Single Length

Holding Torque..... 330 oz-in/233 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)..... 3.8 lb/2.9 kg

Double Length

Holding Torque..... 500 oz-in/353 N-cm
Detent Torque..... 14.16 oz-in/14.0 N-cm
Rotor Inertia .....0.02266 oz-in-sec^2/1.6 kg-cm^2
Weight (Motor + Driver)..... 5.2 lb/3.5 kg

Triple Length

Holding Torque..... 750 oz-in/529 N-cm
Detent Torque..... 19.83 oz-in/10.0 N-cm
Rotor Inertia .....0.04815 oz-in-sec^2/3.4 kg-cm^2
Weight (Motor + Driver)..... 8.6 lb/5.0 kg

MDrive42AC Plus^2 Motion Control

Speed-Torque Curves

MDrive42AC – 120VAC

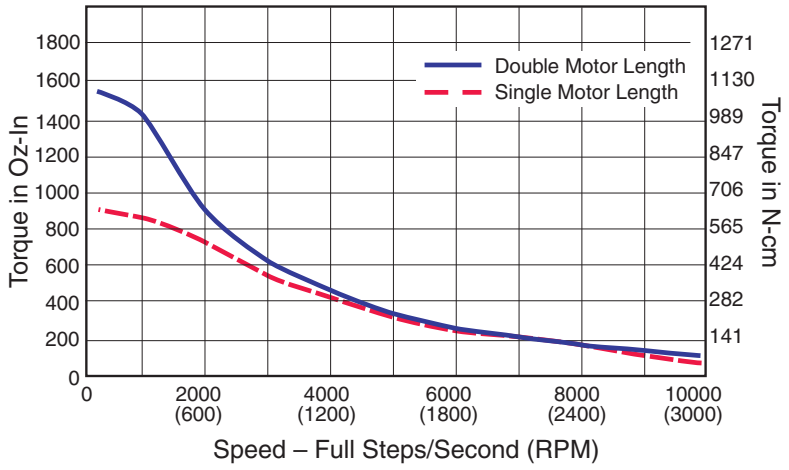


Figure A.3: MDrive42AC Plus^2 120VAC Motion Control Speed-Torque Curves

MDrive42AC – 240VAC

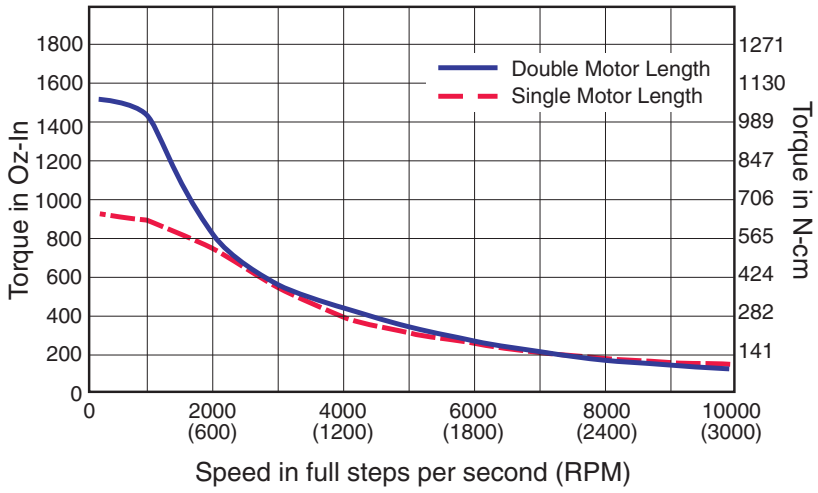


Figure A.4: MDrive42AC Plus^2 240VAC Motion Control Speed-Torque Curves

Motor Specifications

Single Length

Holding Torque..... 1147 oz-in/810 N-cm
Detent Torque..... 35 oz-in/25 N-cm
Rotor Inertia .....0.0917 oz-in-sec^2/6.5 kg-cm^2
Weight (Motor + Driver)..... 14.07 lb/6.38 kg

Double Length

Holding Torque..... 2294 oz-in/1620 N-cm
Detent Torque..... 84 oz-in/59 N-cm
Rotor Inertia .....0.1833 oz-in-sec^2/13 kg-cm^2
Weight (Motor + Driver)..... 21.25 oz/9.64 kg

APPENDIX B

MDrive with Planetary Gearbox

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
105 or 120 mm	MDrive42

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.

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.

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.

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.)

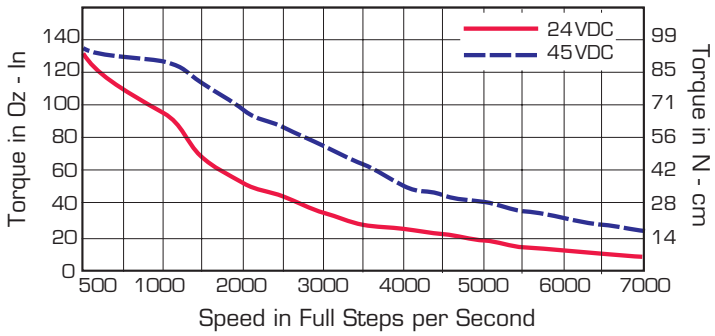


Figure B.1: MDrive23 Torque-Speed Curve

The Speed/Torque Table above is for an MDrive 23 Frame Double Length Motor. 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 B.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

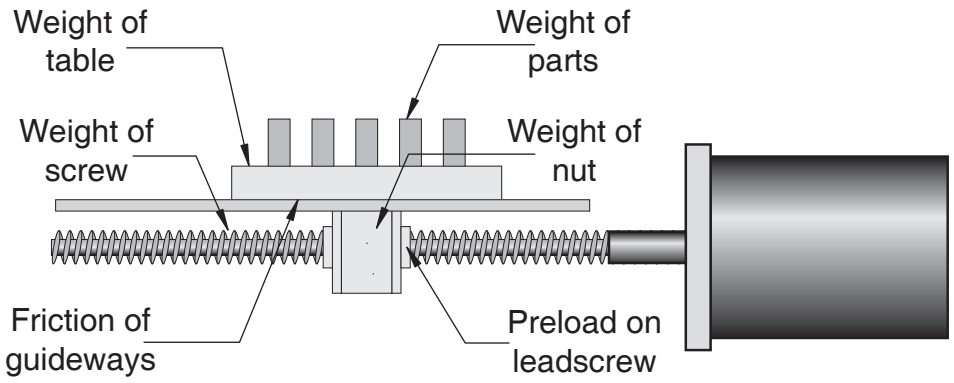


Figure B.2: Lead Screw System Inertia Considerations

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

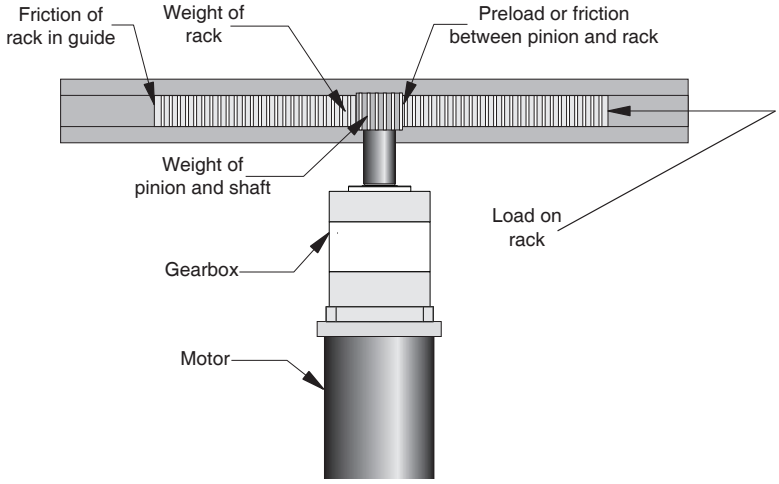


Figure B.3: Rack and Pinion System Inertia Considerations

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

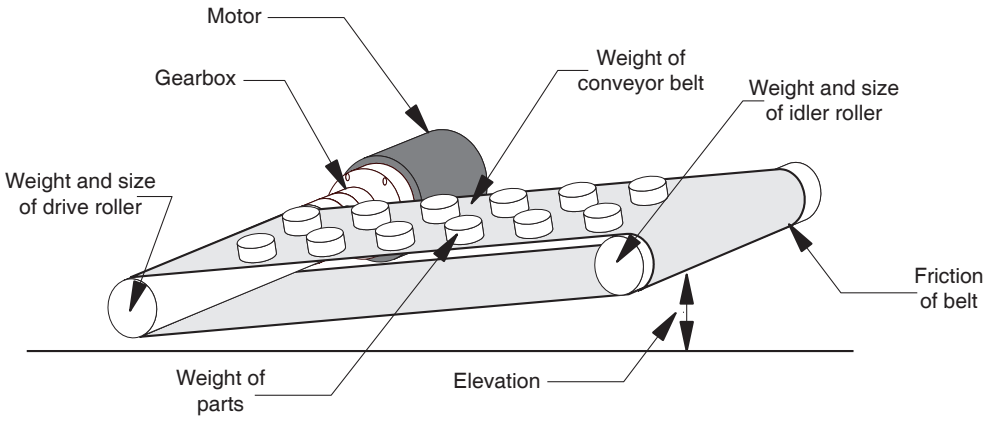


Figure B.4: Conveyor System Inertia Considerations

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 effect 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

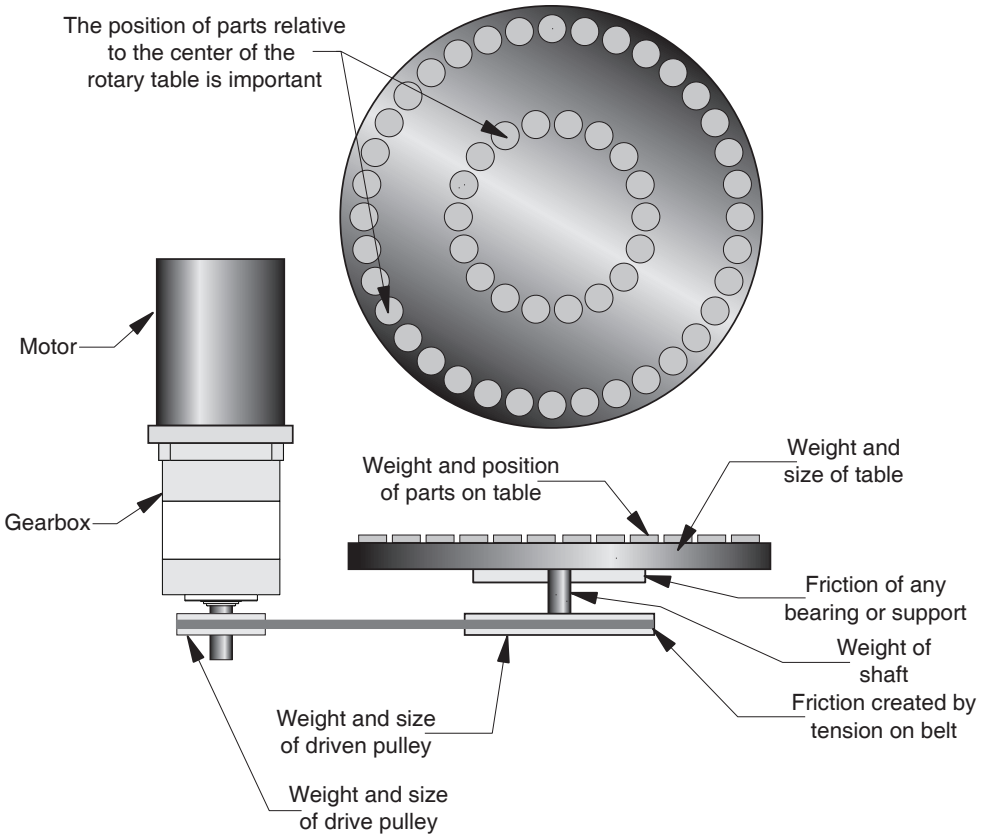


Figure B.5: Rotary Table System Inertia Considerations

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

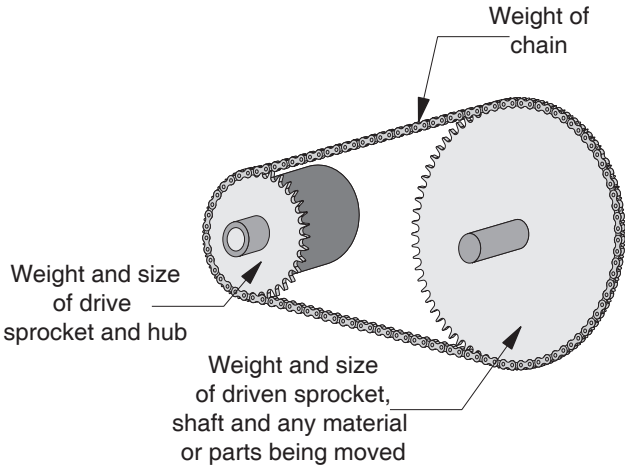


Figure B.6: Chain Drive System Inertia Considerations

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.

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

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	MDrive 42 Gearbox
1-Stage	4:1	0.00233660	TBD
	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

Dimensions in Inches (mm)

Planetary Gearbox Parameters

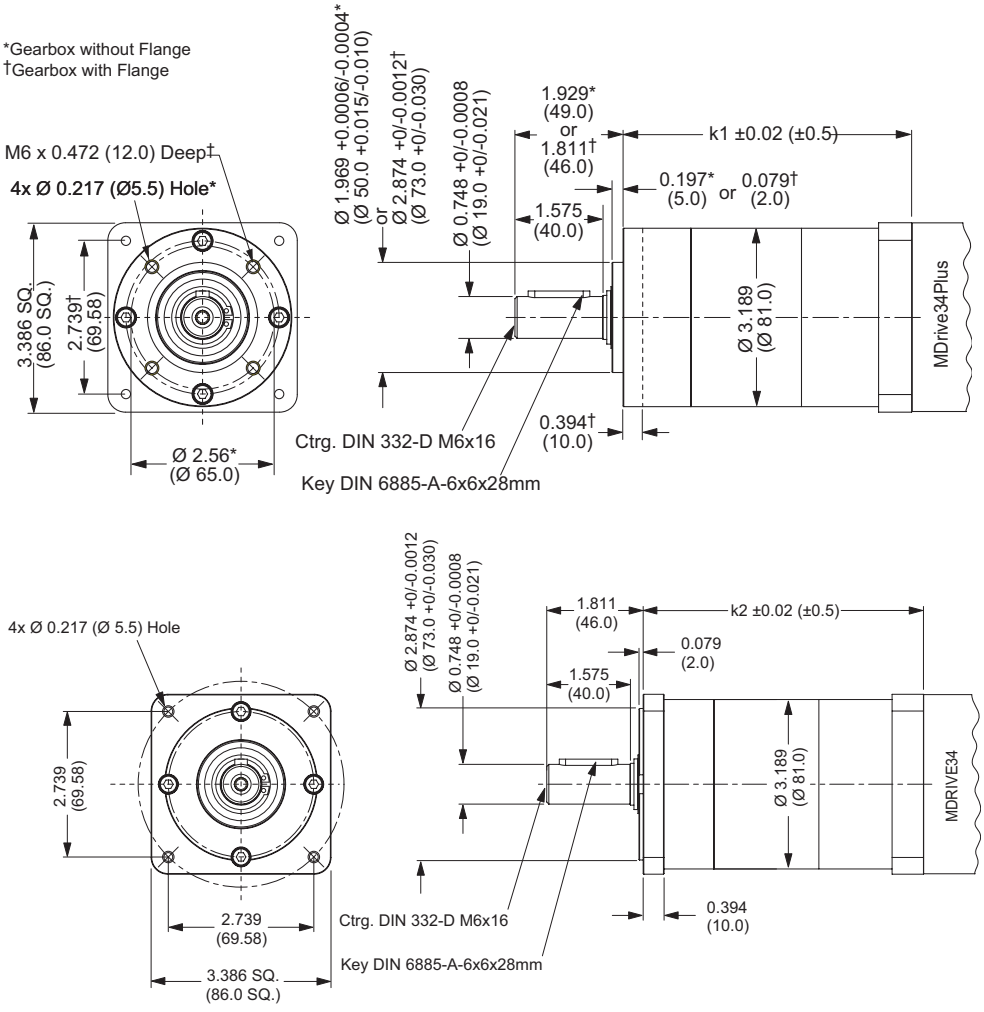
	Permitted Output Torque (oz-in/Nm)	Gearbox Efficiency	Maximum Backlash	Output Side with Ball Bearing			
				Maximum Load (lb-force/N)		Weight (oz/g)	
				Radial	Axial	Gearbox	with Flange
1-STAGE	2832/20.0	0.80	1.0°	90/400	18/80	64.4/1827	66.7/1890
2-STAGE	8496/60.0	0.75	1.5°	135/600	27/120	89.5/2538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



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 B.7: Planetary Gearbox Specifications for MDrive34AC Plus^2

Installing a Driving Device on a Planetary Gearbox

WARNING!

The MDrive and its Heat Sink must not be subjected to any axial or other pressing force as damage may result to the unit and void the Warranty.

When installing a gear, pulley, coupling or other driving device to the output shaft of the Planetary Gearbox, IMS recommends that it be “slip-fit” onto the shaft and properly secured, i.e. with set screws.

DO NOT press fit the device onto the shaft.

NEVER tap or hammer a driving device onto the output shaft of the Planetary Gearbox.

Disconnecting the Planetary Gearbox from the MDrive may void the Warranty.

Standard I/O Set Interfacing and Application

NPN Sinking Input

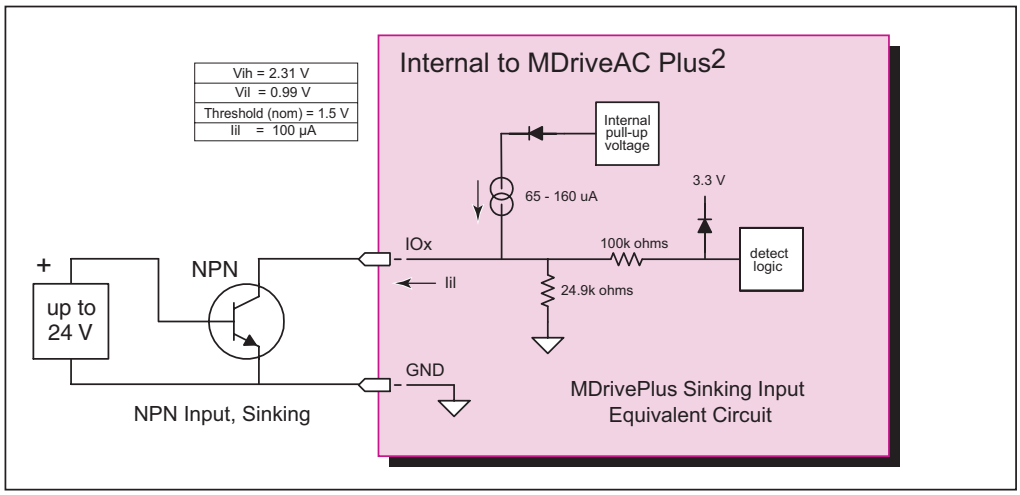


Figure C.1: NPN Interface to an MDI Sinking Input

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

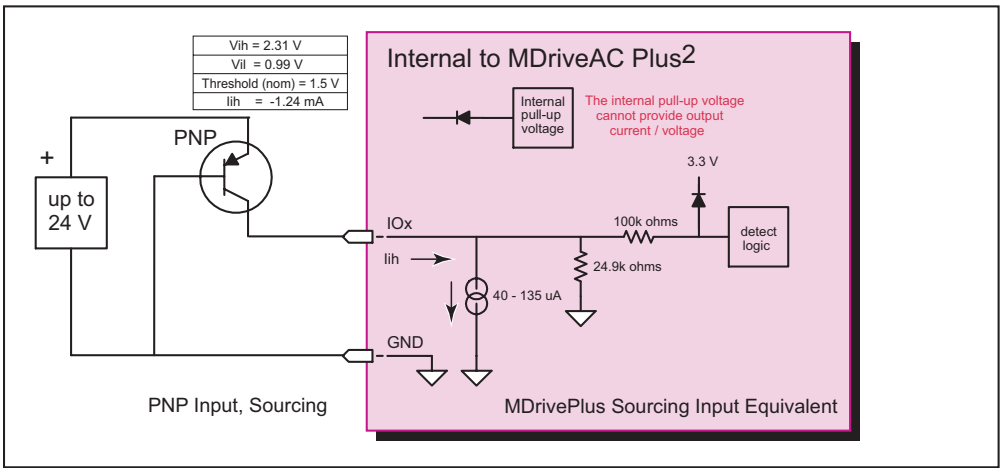


Figure C.2: PNP Interface to a Sourcing Input

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

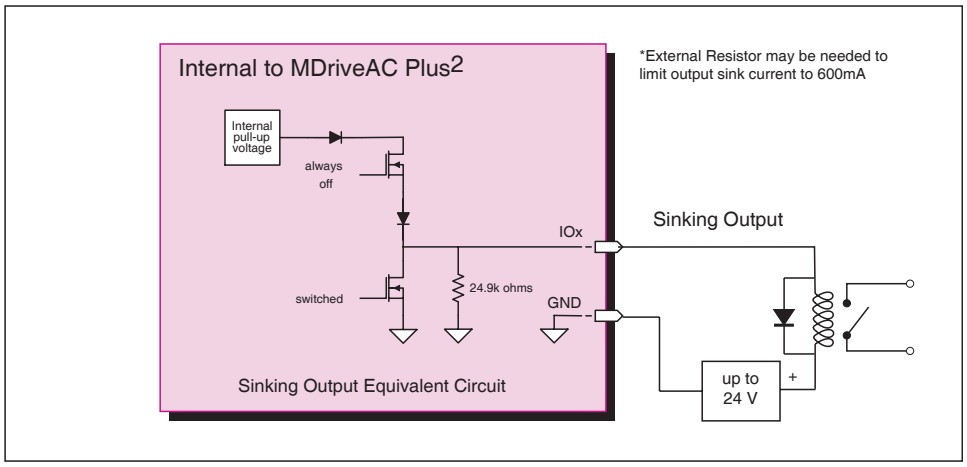


Figure C.3: Sinking Output to Relay

Application Example

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

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

Mixed Input/Output Example

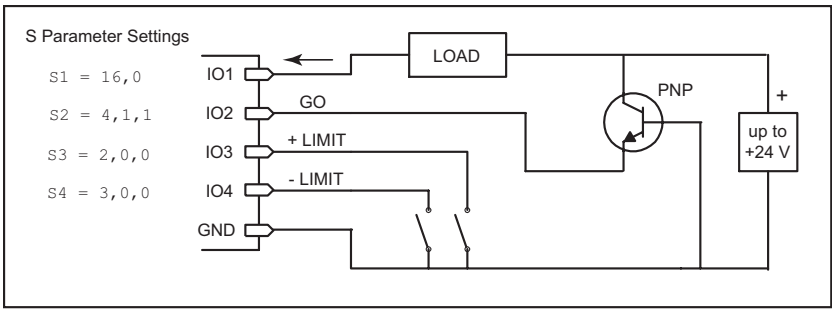


Figure C.4: Mixed Output Example; Standard I/O Set

NPN Sinking Input

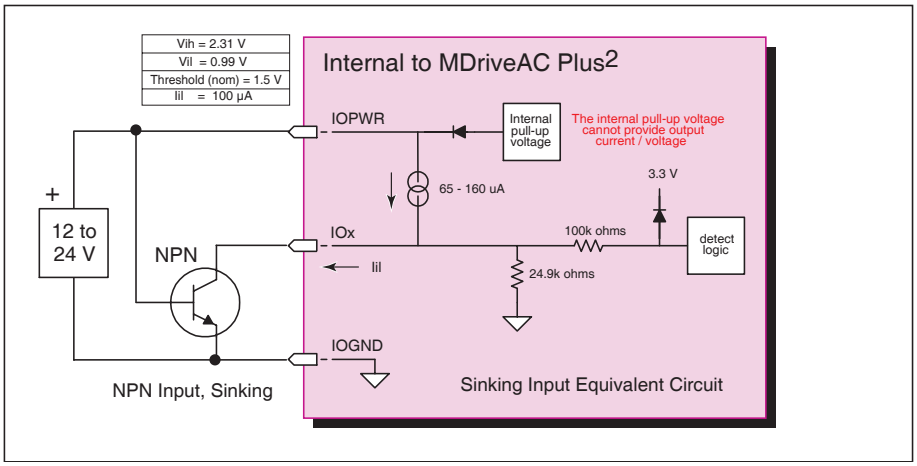


Figure C.5: NPN Sinking Input on an MDriveAC Plus2 Motion Control

Application Example

Sensor using the HOME function.

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

Enter to IMS Terminal in Immediate mode or in a Program

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

PNP Sourcing Input

Application Example

Sensor using the Jog+ function.

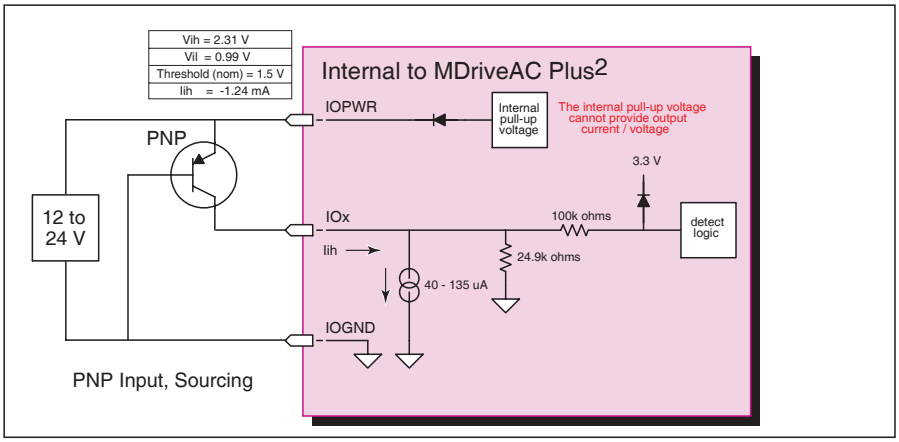


Figure C.6: PNP Sourcing Input on an MDriveAC Plus2 Motion Control

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

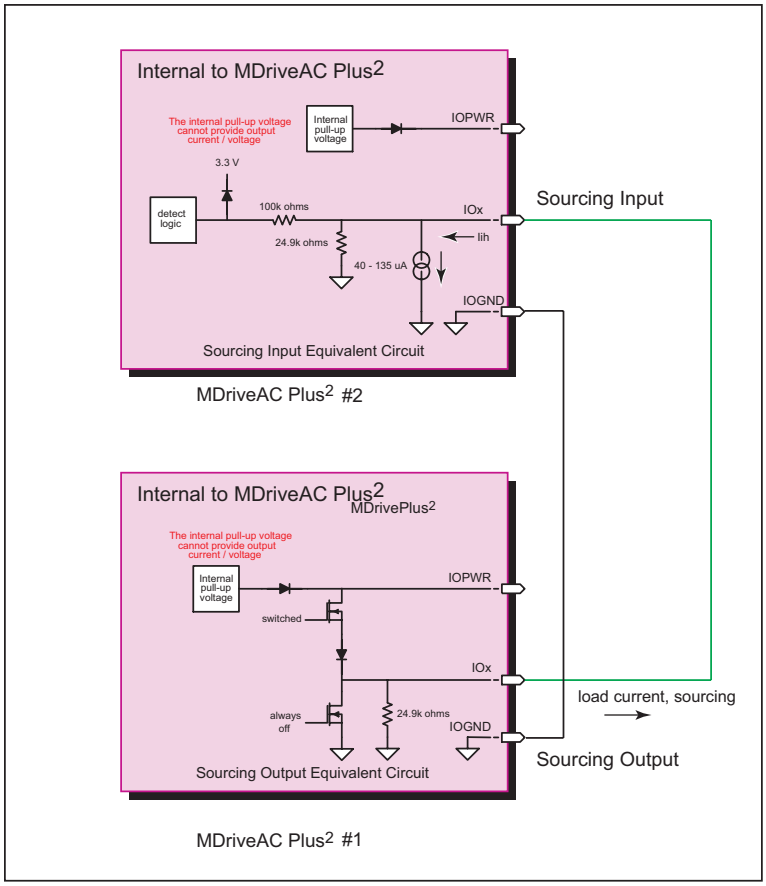


Figure C.7: Sourcing Output to Sourcing Input

```
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

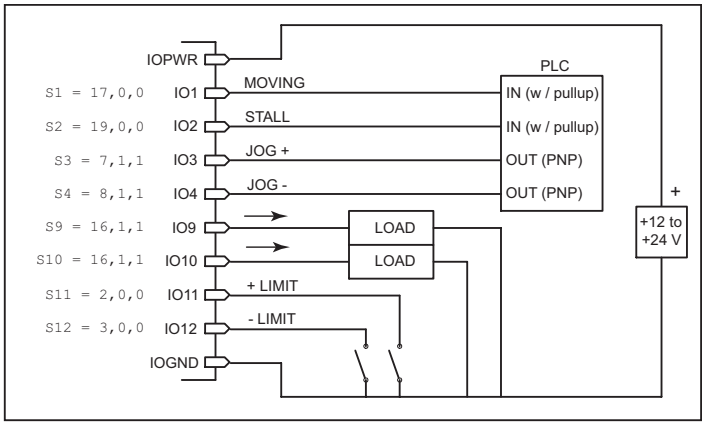


Figure C.8: Mixed Input/Output Example - Enhanced I/O

Interfacing Inputs as a Group Example

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

Standard MDriveAC Plus Motion Control

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

Enhanced MDriveAC Plus2

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

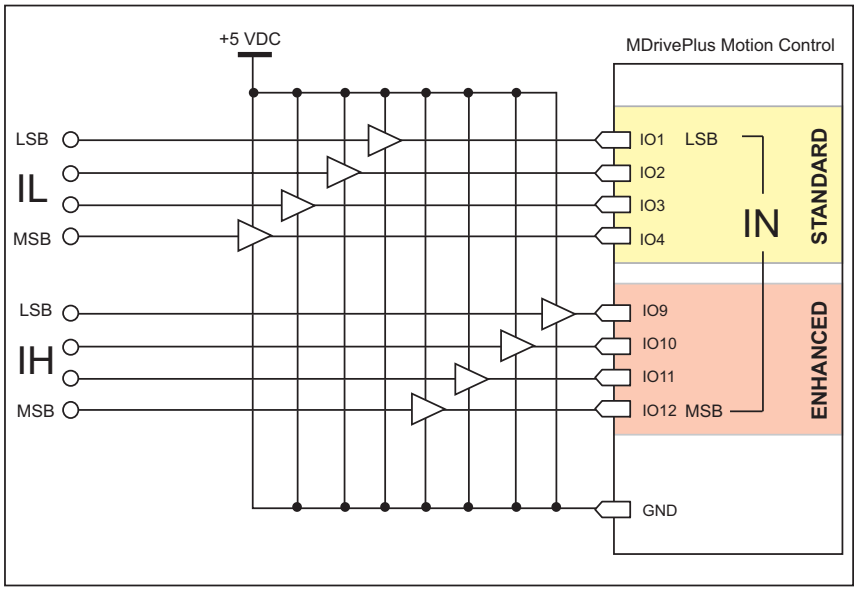


Figure C.9: TTL Interface to an Input Group

Interfacing Outputs as a Group Example

The MDriveAC Plus^2 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 8 I/O models. The OT keyword will function on the MDriveAC Plus^2 with remote encoder option but will only set inputs 1 - 4. Outputs will be configured as user outputs (S<point>=16).

Standard MDriveAC Plus Motion Control

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

Enhanced MDriveAC Plus2

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

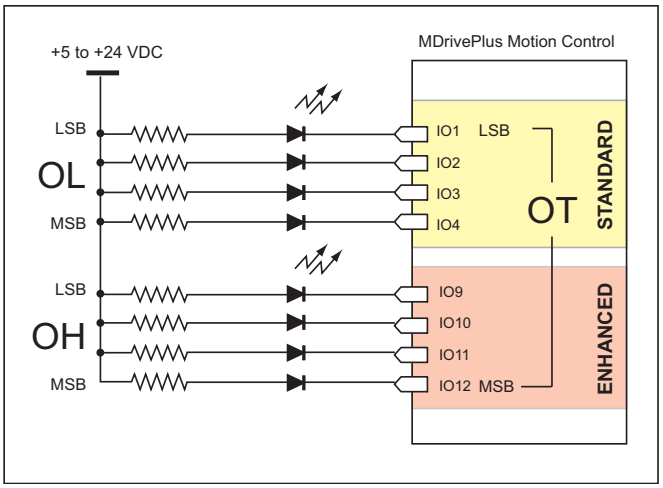


Figure C.10: Outputs Interfaced to LED's as a Group

Output Bit Weight Examples								
I/O Set	High I/O Group (8 I/O)				Low I/O Group			
	IO12 (MSB)	IO11	IO10	IO9	IO4	IO3	IO2	IO1 (LSB)
OL=13 OT=13	NOT AVAILABLE WITH REMOTE ENCODER OPTION				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 C.1: Output Bit Weight Examples - Outputs set as a group

APPENDIX D

MDriveAC Plus 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 MDriveAC Plus models or interface to a remote user supplied encoder on MDriveAC Plus^2 models.

Internal Encoder

All models of the MDriveAC Plus 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

The MDriveAC Plus^2 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

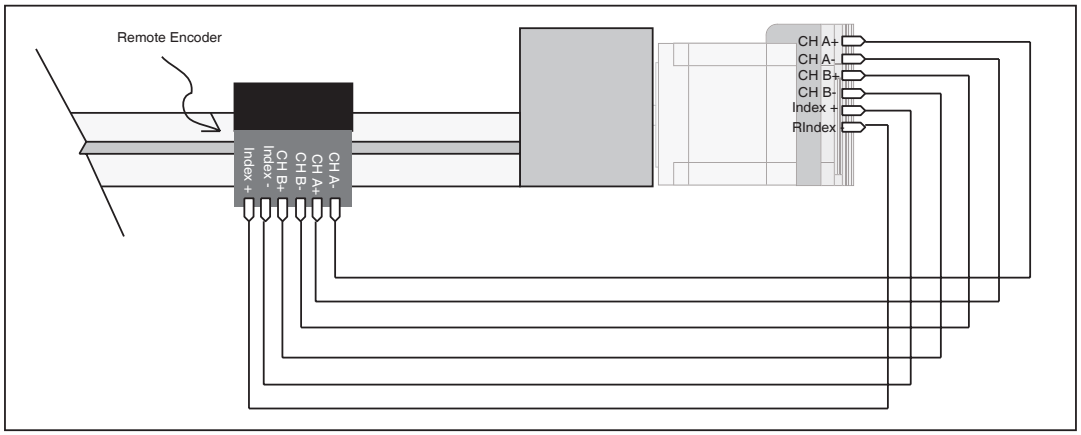


Figure D.1: Connecting a Remote Encoder

Communications Converter Cable USB to 5-Pin M12 (MD-CC401-000)

WARNING! DO NOT connect or disconnect the MD-CC401-000 Communications Converter Cable from MDrive while power is applied!

The MD-CC401-000 is an in-line USB to RS-422 converter with integrated cable. This product is used to communicate to a single MDriveAC Plus^2 Motion Control device. The included components will allow you to connect the USB port of a PC directly to sealed versions of the MDriveAC Plus^2 Motion Control.

Figure E.1: MD-CC401-000

The MD-CC401-000 communications converter cable is designed to be used with all MDriveAC Plus^2-65 utilizing an M12 5-pin connector interface.

Supplied Components: MD-CC401-000 Communications Converter Cable, USB Cable, USB Drivers, IMS Terminal Interface Software.

Electrical Specifications

MD-CC401-000 Specifications	
BAUD Rate	Up to 115 kbps
Connectors:	
USB	
RS-422 Side	5 Pin M12
Cable Length	6 feet (1.8 meters)
Power Requirement	Power from USB

Table E.1: MD-CC401-000 Electrical Specifications

Mechanical Specifications

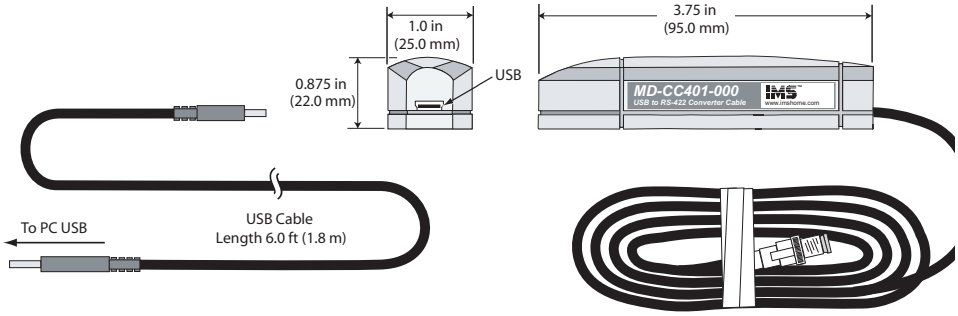


Figure E.2: MD-CC401-000 Mechanical Specifications

MD-CC401-000 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 ContactGround

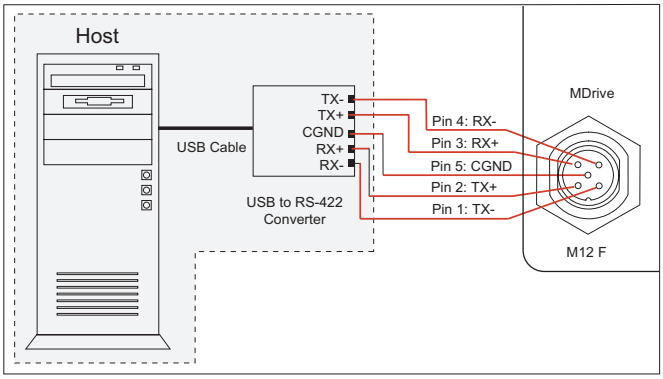


Figure E.3: Typical Communications Interface

Installation Procedure for the MX-CC401-000

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-CC401-000 requires the installation of two sets of drivers:

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

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

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

Installing the Cable/VCP Drivers

1) Plug the USB Converter Cable into the USB port of the MD-CC401-000.
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 E.4).

Figure E.4: Hardware Update Wizard

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 E.5).

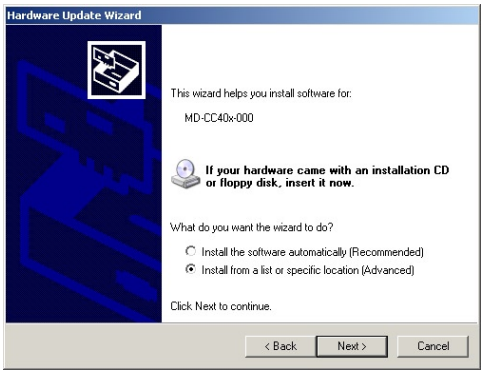


Figure E.5: Hardware Update Wizard Screen 2

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 E.6).

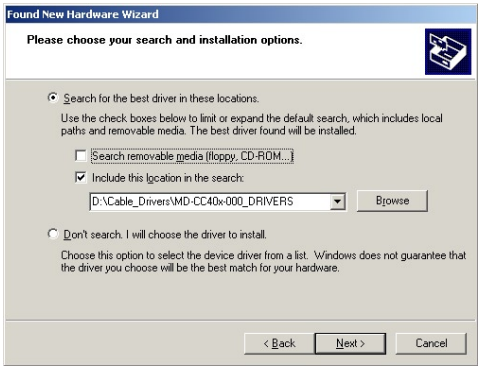


Figure E.6: Hardware Update Wizard Screen 3

7) The drivers will begin to copy.
8) On the Dialog for Windows Logo Compatibility Testing, click "Continue Anyway" (Figure E.7).
9) The Driver Installation will proceed. When the Completing the Found New Hardware Wizard dialog appears, Click "Finish" (Figure E.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-CC401-000 is now ready to use.

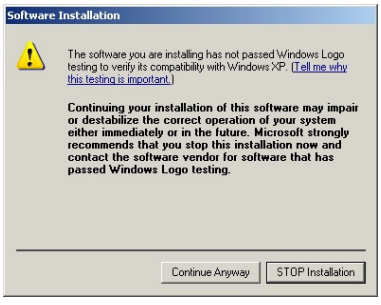


Figure E.7: Windows Logo Compatibility Testing

Figure E.8: Hardware Update Wizard Finish Installation

Determining the Virtual COM Port (VCP)

The MD-CC401-000 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-CC401-000 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 6), Click the Button labeled “Device Manager”.
3) Look in the heading “Ports (COM & LPT)” IMS USB to RS422 Converter Cable (COMx) will be listed. The COM # will be the Virtual COM Port connected. You will enter this number into your IMS Terminal Configuration.

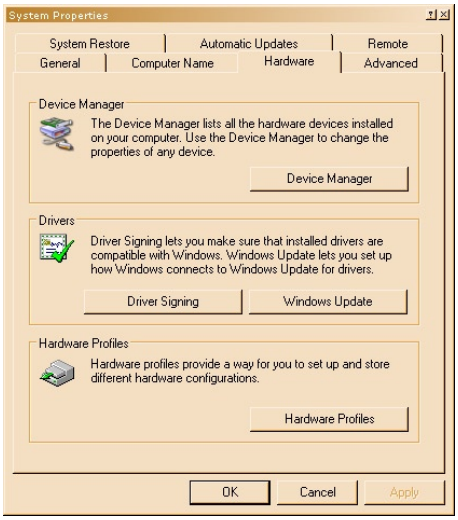


Figure E.9: Hardware Properties

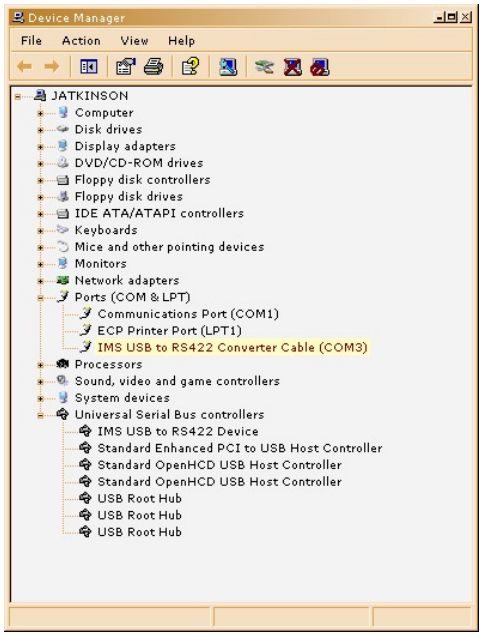


Figure E.10: Windows Device Manager

Cordsets

MD-CS10x-000

19-pin M23 single-ended cordsets are offered to speed prototyping of the MDriveAC Plus Motion Control. Measuring 13.0' (4.0m) long, they are available in either straight or right angle termination. PVC jacketed cables come with a foil shield and unconnected drain wire.

Straight Termination MD-CS100-000
Right Angle MD-CS101-000

M23 Cordset			
M23 Circular	M23 Cordset DC Color Code	M23 Circular	M23 Cordset DC Color Code
Pin 1	Violet	Pin 11	Black
Pin 2	Red	Pin 12 *	Green/Yellow
Pin 3	Grey	Pin 13	Yellow/Brown
Pin 4	Red/Blue	Pin 14	Brown/Green
Pin 5	Green	Pin 15	White
Pin 6	Blue	Pin 16	Yellow
Pin 7	Grey/Pink	Pin 17	Pink
Pin 8	White/Green	Pin 18	Grey/Brown
Pin 9	White/Yellow	Pin 19	Brown
Pin 10	White/Grey		

* Pin 12 makes an electrical contact to the M23 connector shell.

Table E.2: MD-CS10x-000 Wire Color Chart

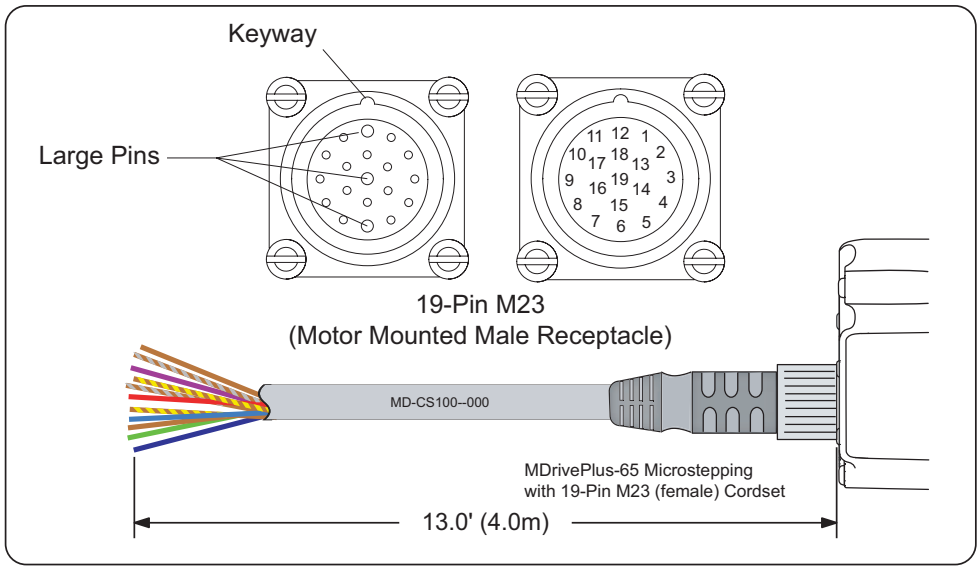


Figure E.11: MD-CS10x-000

MD-CS20x-000

The single-end three conductor cordsets are used with the MDrive AC. Measuring 13.0' (4.0m) long, they are available in either straight or right angle termination. Euro AC Color Code, Oil-resistant yellow PVC jacket, IP68 and NEMA 6P rated.

Euro AC Cordset	
Euro AC	Euro Cordset Color Code
Pin 1	Yellow/Green
Pin 2	Brown
Pin 3	Blue

Table E.3: Euro AC Wire Color Chart

Straight Termination.....MD-CS200-000
Right Angle Termination MD-CS201-000

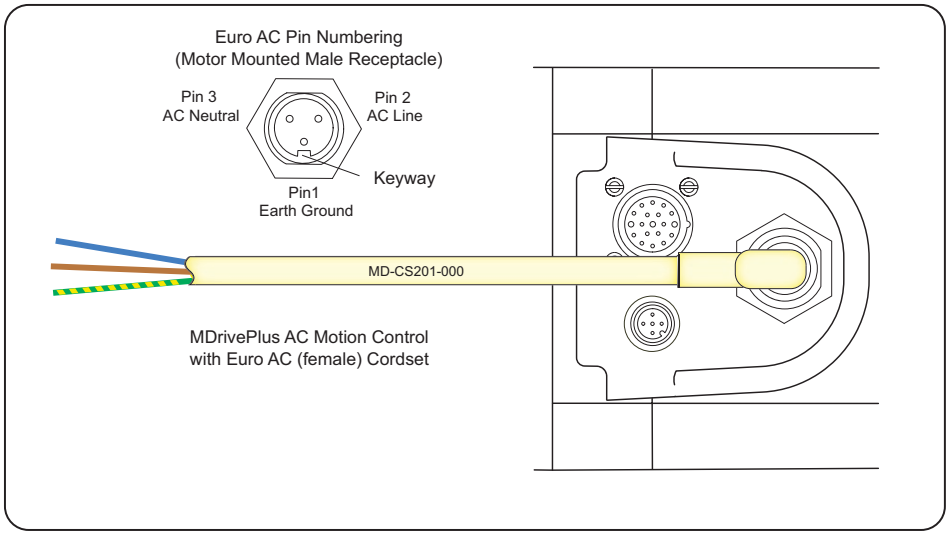


Figure E.12: MD-CS20x-000

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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