Hardware Manual

MDrive® Motion Control

MDrive and Linear Actuator Products

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Schneider Electric Motion

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1 Introduction

The MDrive Motion Control integrated programmable motion control motor and step and direction driver is ideal for designers who want the simplicity of a motor with on-board electronics. The integrated electronics of the MDrivePlus eliminate the need to run motor cabling through the machine, reducing the potential for problems due to electrical noise

The MDrive Motion Control uses brushless step motors integrated with a high performance programmable motion controller and a microstepping driver, and accepts up to 20 resolution settings from full to 256 microsteps per full step, including: degrees, metric and arc minutes.

Programming is accomplished over RS-422/485 using the SEM Terminal software tool, which is provided.

The MDrive Motion Control is a compact, powerful and cost effective motion control solution that will reduce system cost, design and assembly time for a large range of brushless step motor applications.

1.1 MDrive Versions

MDrive

The MDrive is available in the following power ranges and flange sizes:

+12 to +48 VDC

- NEMA 14
- NEMA 17

+12 to +75 VDC

- NEMA 23 (Quad stack +12 to +60 VDC)
- NEMA 34

120 and 240 VAC

- NEMA 34

MDrive Linear Actuator

MDrive Linear Actuators are available in the following power ranges and flange sizes:

+12 to +48 VDC

- NEMA 14
- NEMA 17

+12 to +75 VDC

- NEMA 23

1.2 Documentation Reference

The following user's manuals are available for the MDrive:

- Product hardware manual, describes the technical data and installation of the product.
- Product software manual, describes the configuration and programming of the product.
- Quick Reference, describes the basic wiring, connection and use of this product.

This documentation is also available for download from: https://motion.schneider-electric.com/dloads/.

1.3 Product Software

1.3.1 Communication Converter Drivers

If using the communication converter, drivers are required. These drivers are available for download from: https://motion.schneider-electric.com/dloads/cable-drivers/.

1.3.2 SEM Terminal

The MDrive motion control can be configured and programmed using any standard ANSI terminal emulator and ASCII text editor.

The SEM Terminal provides an integrated terminal and program editor. The SEM Terminal features color-coded editor, multiple-function keys and is pre-configured to operate using the MDrive default settings

Installation and usage instructions are found in MCode software manual.

This software and supporting documentation can be downloaded from: https://motion.schneider-electric.com/dloads/user-interface-software/.

2 Safety

2.1 Qualification of Personnel

Only technicians who are familiar with and understand the contents of this manual and the other relevant documentation are authorized to work on and with this drive system. The technicians must be able to detect potential dangers that may be caused by setting parameters, changing parameter values and generally by the operation of mechanical, electrical and electronic equipment.

The technicians must have sufficient technical training, knowledge and experience to recognise and avoid dangers.

The technicians must be familiar with the relevant standards, regulations and safety regulations that must be observed when working on the drive system.

2.2 Intended Use

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment.

For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

In all cases the applicable safety regulations and the specified operating conditions, such as environmental conditions and specified technical data, must be observed.

The drive system must not be commissioned and operated until completion of installation in accordance with the EMC regulations and the specifications in this manual. To prevent personal injury and damage to property damaged drive systems must not be installed or operated.

Changes and modifications of the drive systems are not permitted and if made no warranty and liability will be accepted.

The drive system must be operated only with the specified wiring and approved accessories. In general, use only original accessories and spare parts.

The drive systems must not be operated in an environment subject to explosion hazard (ex area).

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2.3 Hazard Categories

Safety notes and general information are indicated by hazard messages in the manual. In addition there are symbols and instructions affixed to the product that warn of possible hazards and help to operate the product safely.

Depending on the seriousness of the hazard, the messages are divided into three hazard categories.

⚠ DANGER

DANGER indicates an imminently hazardous situation, which, if not avoided, **will result** in death, serious injury, or equipment damage.

⚠ WARNING

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

2.4 General Safety Instructions

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

LOSS OF CONTROL

- Observe the accident prevention regulations. (For USA see also NEMA ICS1.1 and NEMA ICS7.1)
- The system manufacturer must take the potential error possibilities of the signals and the critical functions into account to ensure a safe status during and after errors. Some examples are: emergency stop, final position limitation, power failure and restart.
- The assessment of error possibilities must also include unexpected delays and the failure of signals or functions.
- Suitable redundant control paths must be in place for dangerous functions.
- Check that measures taken are effective.

Failure to follow these instructions can result in death or serious injury.

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

3 Interfacing DC Power

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

MAXIMUM VOLTAGE INPUT

Do not exceed the maximum rated voltage of the device! Motor Back EMF, power supply ripple and high line must be taken into account when selecting a power supply voltage level.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

GENERAL POWER SUPPLY PRACTICE

Do not connect or disconnect the power supply while power is applied.

Disconnect the AC side to power down the DC supply.

For battery operated systems connect a “transient suppressor” across the switch to prevent arcs and high-voltage spikes.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect power, logic, or communication while the device is in a powered state without additional protection.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions may result in damage to system components!

Detailed specifications, voltage limits, current requirements and connectivity information are located in the product detail section corresponding to the MDrive model purchased.

3.1 Applicability

This section applies to all MDrive motion control products with a DC power input.

3.2 Selecting a Power Supply (+V)

Proper selection of a power supply to be used in a motion system is as important as selecting the drive itself. When choosing a power supply for a stepping motor driver, there are several performance issues that must be addressed. An undersized power supply can lead to poor performance and possibly even damage to the drive.

For information on sizing a DC power supply, refer to: https://motion.schneider-electric.com/application-note/sizing-dc-power-supply/

3.2.1 Power Supply — Motor Relationship

Motor windings can basically be viewed as inductors. Winding resistance (R) and inductance (L) result in an L/R time constant that resists the change in current. To effectively manipulate the rate of charge, the voltage applied is increased. When traveling at high speeds, there is less time between steps to reach current. The point where the rate of commutation does not allow the driver to reach full current is referred to as voltage mode. Ideally the drive should to be in current mode, which is when the drive is achieving the desired current between steps. Simply stated, a higher voltage will decrease the time it takes to charge the coil and, therefore, will allow for higher torque at higher speeds.

Another characteristic of all motors is back EMF. Back EMF is a source of current that can push the output of a power supply beyond the maximum operating voltage of the driver. As a result, damage to the stepper driver could occur over a period of time. This is especially prevalent with overhauling loads.

3.2.2 Power Supply — Driver Relationship

The MDrive is very current efficient as far as the power supply is concerned. Once the motor has charged one or both windings of the motor, all the power supply has to do is replace losses in the system. The charged winding acts as an energy storage in that the current will recirculate within the bridge and in and out of each phase reservoir. This results in a less than expected current draw on the power supply.

Stepping motor drivers are designed with the intent that a user's power supply output will ramp up to greater than or equal to the minimum operating voltage of the drive. The initial current surge is substantial and could damage the driver if the supply is undersized. The output of an undersized power supply could fall below the operating range of the driver upon a current surge. This could cause the power supply to start oscillating in and out of the voltage range of the driver and result in damage to either the supply, the driver, or both.

There are two types of supplies commonly used, regulated and unregulated, both of which can be switching or linear. Each have advantages and disadvantages.

3.2.3 Regulated vs Unregulated

An unregulated linear supply is less expensive and more resilient to current surges, however, the voltage decreases with increasing current draw. This may cause problems if the voltage drops below the working range of the drive.

Fluctuations in line voltage are also a point of concern. These fluctuations may cause the unregulated linear supply to be above or below the anticipated or acceptable voltage.

A regulated supply maintains a stable output voltage, which is good for high speed performance. These supplies are also not affected by line fluctuations. However, they are more expensive. Depending on the current regulation, a regulated supply may crowbar or current clamp and lead to an oscillation that, as previously stated, can cause damage to the driver and/or supply. Back EMF can cause problems for regulated supplies as well. The current regeneration may be too large for the regulated supply to absorb. This could lead to an over voltage condition which could damage the output circuitry of the MDrive.

Switching power supplies and regulated linear supplies with over current protection should not be done because of their inability to handle the surge currents inherit in stepping motor systems.

See the product detail section of the product installation document for specific power supply voltage, current requirements, and power supplies.

3.3 Power Supply Cabling

⚠ CAUTION

EMI and RFI

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

The length of the DC power supply cable to an MDrive should not exceed 50 ft (15.2 m).

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

Failure to follow these instructions may result in damage to system components!

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

Figure 3.1 illustrates the cable configuration for DC power supply cabling under 50 ft (15.2 m) long. If cabling of 50 ft (15.2 m) or longer is required, the additional length may be gained by adding an AC power supply cable (see Figures 3.2 and 3.3).

Correct AWG wire size is determined by the current requirement plus cable length. Refer to Table 3.1.

3.3.1 DC Cabling Under 50 ft (15.24 m)

Figure 3.1 DC Power Supply Cabling Under 50 ft (15.24 m)

3.3.2 AC Power to Full Wave Bridge

Figure 3.2 50 ft (15.2 m) or Greater, AC Power to Full Wave Bridge

3.3.3 AC Power DC Supply

Figure 3.3 50 ft (15.2 m) or Greater, AC Power to DC Supply

3.3.4 Wire Gauges

For cable lengths exceeding 50 ft (15.2 m), use the cable configurations shown in Figures 3.2 and 3.3.

Cable Length: Feet (meters)	10 (3.0)	25 (7.6)	50 (15.2)	75 (22.9)	100 (30.5)
Amps Peak			**Minimum AWG**		
1 Amp Peak	20	20	18	18	18
2 Amps Peak	20	18	16	14	14
3 Amps Peak	18	16	14	12	12
4 Amps Peak	18	16	14	12	12

Table 3.1 Power Supply Cable AWG

Detailed specifications, voltage limits and connectivity information are located in the product detail section of the product installation manual corresponding to the MDrive model purchased.

3.4 Switching DC Power (DPM75 Accessory)

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect power, logic, or communication while the device is in a powered state without additional protection.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions may result in damage to system components!

The function of the DPM75 Drive Protection Module is to limit the surge current and voltage to an acceptable level when DC input power is switched on and off to a motor drive. This provides the added protection necessary for reliable motor drive operation when switching the DC power. The device is designed to protect the motor drive when operating under all load conditions. This device does not protect the motor drive from wiring the power incorrectly.

The unit is capable of being used with 48, 60, and 75 volt rated motor drives. An external jumper selection is available so the user can match the circuit to their particular application. The DPM75 is capable of a steady state operating current of 4 amps.

The DPM75 can be used for any frame size motor drive, when properly configured. It can also be used for more than one unit provided the current and voltage do not exceed the DPM75's ratings. The maximum DPM75 ratings are 75 volts and 4 amps.

Power requirements and wiring details are available in the product detail section of the product installation manual pertaining to the MDrive product purchased.

* Do not switch negative side of supply
**Fuse = 6.3 Amp slow blow (recommended: Bussman S505-6.3A or Littelfuse 215006.3). The fuse is optional.

Figure 3.4 DPM75 Basic Wiring and Connection

4 Interfacing AC Power

This section is only applicable to MDrive devices with a 120 or 240 VAC input voltage.

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if power or signal wiring is exposed.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

MAXIMUM VOLTAGE INPUT

Do not exceed the maximum rated voltage of the device!

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Failure to follow these instructions may result in damage to system components!

Detailed specifications, voltage limits, current requirements and connectivity information are located in the product detail section corresponding to the MDrive model you purchased.

4.1 Interfacing AC Voltage

Figure 4.1 Euro AC connector (P3)

Signal	European (IEC) color code	US color code
Earth	Yellow/Green	Green
Line	Brown	Black
Neutral	Blue	White

Table 4.1 AC standard wire colors

4.2 MD-CS20x-000 Cordset

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

Straight Termination MD-CS200-000

Right Angle Termination MD-CS201-000

Figure 4.2 MD-CS20x-000

5 Interfacing Serial Communication

The MDrive communicates to the host using the RS-422/485 protocol. Communication 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 MDrive, or to address up to 62 individually named nodes in a multidrop system.

This section applies to all MDrive Motion Control models with an RS-422/485 communication interface.

5.1 USB to RS-422/485 Isolated Communication Converter Cables

To simplify the wiring and connection process an electrically isolated USB to RS-422/485 communication cables for the MDrive is available. These 12.0 ft (3.6 m) accessory cables connect a PC's USB port to the MDrive P2 connector. An in-line RS-422/485 converter enables parameter setting to a single MDrive.

There are four (4) communication converter cables available depending on the connector type:

10-pin Communication Convertor.....Part No. MD-CC400-001

USB to 5-pin M-12 circular .....Part No. MD-CC401-001

USB to 10-pin wire crimp.....Part No. MD-CC402-001

12-pin Communication Convertor.....Part No. MD-CC403-001

5.1.1 Driver Installation Procedure

The cable/VCP drivers should load automatically. If not, follow the procedure below to load the drivers manually. Once the drivers are loaded, proceed to "Determining the Virtual COM Port (VCP)" on page 19.

Installing the Cable/VCP Drivers

1) Download the MD-CC40x-001 communication converter drivers from: https://motion.schneider-electric.com/dloads/cable-drivers/.
2) Extract the compressed files to a folder on the hard drive.
3) Plug the USB converter cable into the USB port of the MD-CC40x-001.
4) Plug the other end of the USB cable into an open USB port on the PC.
5) The PC will recognize the new hardware and open the Hardware Update dialog.
6) 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".
7) 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".
   - Select "Search for the best driver in these locations."

- Check “Include this location in the search.”
- Browse to the download location on the hard drive.

8) Click Next. The drivers will begin to copy.
9) On the Dialog for Windows Logo Compatibility Testing, click “Continue Anyway”. The driver installation will proceed.
10) Once completed, the Found New Hardware Wizard dialog appears, Click “Finish”.
11) Upon finish, the Welcome to the Hardware Update Wizard will reappear to provide guidance through the second part of the install process. Repeat steps 1 through 9 above to complete the cable installation.
12) The MD-CC40x-001 is now ready to use.

Determining the Virtual COM Port (VCP)

The MD-CC40x-001 uses a Virtual COM Port to communicate through the USB port to the MDrive. A VCP is a software driven serial port which emulates a hardware port in Windows.

The drivers for the MD-CC40x-001 will automatically assign a VCP to the device during installation. The VCP port number will be needed when the embedded terminal is set up in order for SEM Terminal to know where to find the product and establish communication.

To locate the Virtual COM Port.

1) Right-Click the “My Computer” Icon and select “Properties”.
2) Browse to the Hardware Tab, Click the Button labeled “Device Manager”.
3) Look in the heading “Ports (COM & LPT)” USB to RS-422 converter cable (COMx) will be listed). The COM # will be the Virtual COM Port connected. Enter this number into the SEM Terminal configuration.

5.2 Interfacing Single Mode Communication

> ⚠ **CAUTION**
>
> **HOT PLUGGING!**
>
> Do not connect or disconnect communication while the device is in a powered state.
>
> **Failure to follow these instructions may result in damage to system components!**

5.2.1 Full Duplex (RS-422)

To interface the MDrive using RS-422 protocol one of the following is needed:

- A PC equipped with RS-422 Interface.
- A PC RS-232 to RS-422/485 converter.
- MD-CC40X-001 or equivalent communication converter.

Use the following diagram to connect RS-422 communication to the MDrive (not required if using SEM branded cables)

Figure 5.2 Full Duplex RS-422 Connection.

5.3.2 Half Duplex (RS-485)

The MDrive can be operated in a two wire RS-485 communication bus. Before connecting the two wire RS-485, download the program and setup instructions using the standard four wire RS-422 Communication cable. If a program is not being used, download and save any setup parameters. To ensure the MDrive responds only to commands specifically meant for it, set the unit in party mode

The Echo Mode command (EM) must be set to the value of 1 (EM=1). This will set the MDrive communication into “half duplex” mode. Connect the driver in the two wire RS-485 configuration. The following diagram illustrates how to connect the four wire RS-485 to operate as a two wire system.

Figure 5.3 Half Duplex RS-485 Connection.

5.3 Interfacing Party Mode Communication

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect communication while the device is in a powered state.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

COMMUNICATION GROUND LOOPS

To avoid ground loops in the system only connect communication ground to the first MDrive in the system. Do not connect communication ground on subsequent MDrives.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

SHIELDED CABLES

Do not use the MD-CC400-001 communication converter cable for multi-drop systems. Ribbon cables should not be used in multi-drop communication systems due to the lack of shielded cabling.

Failure to follow these instructions may result in damage to system components!

DEVICE NAME

Each unit in a party mode system must have a unique identifier, or device name. Each unit MUST be connected and communicated with in single mode communication and given a name using the DN command

Reference the MCode Programming and Software manual for more information.

5.3.1 Mutli-drop Communication using MD-CC402-001

Required:

- MD-CC402-001 communication converter cable
- PD10-1434-FL3 prototype development cable(s)

Used in conjunction with the MD-CC402-001 communication converter cable to facilitate multi-drop RS-422/485 communication.

Wire Colors	Function
White/Red Stripe	Aux-Logic
White/Blue Stripe	TX+
Blue/White Stripe	TX-
White/Orange Stripe	RX+
Orange/White Stripe	RX-
Green/White Stripe	GND

Figure 5.4 Multi-drop Communication using the PD10-1434-FL3

Procedure

1) Remove ground wire (unless this is the first system MDrive, green/white stripe)
2) Remove aux-logic (if not used, red/white stripe)
3) Connect pre-crimped flying leads as shown in Figure 5.7 below

Figure 5.5 Wiring a Second PD10-1434-FL3 into the 10-pin Wire Crimp Connector.

5.3.2 Multi-drop Communication Connection

Connecting RS-422 in party mode can be fraught with issues. Following a few simple best practices can save a good deal of time troubleshooting.

Configuring the MDrive

With a communication converter and the MDrive units planned to be used in Party Mode at hand, perform the following:

1) Connect in single mode RS-422 and initiate communication, download any programs if required.
2) Assign a device name (DN=”<A-Z, a-z or 0-9>”) i.e., DN=”A”.
3) Set the party flag to 1 (PY=1)
4) Press CTRL+J to activate party mode
5) Type in [Device Name]S and press CTRL+J (saves the DN and party configuration) ie AS CTRL+J
6) Remove power and label the drive with the assigned DN.
7) Repeat for each system MDrive.

Figure 5.6 illustrates the connection schematic for a multi-drop communication system, note that communication ground only connects to the first system MDrive.

*Optional terminating capacitor for blocking continuous DC currents. Use the characteristic impedence (Z_o) of the cable being used in the formula below to calculate the value of the capacitor:

C_T = (cable length in ft * 1.7nS/ft * 2) / Z_o*

Figure 5.6 Interface for Party-mode Operation

Data Cable Termination Resistors

Under 15 ft (4.5 m), no termination is required. Over 15 ft (4.5 m) The value of capacitance should be calculated using the formula above to find the cable round trip delay divided by the characteristic impedance of the cable (Zo).

5.3.3 System Power Connection for a Multi-drop System

The power connection schematic in Figure 5.7 represents the power configuration for avoiding communication ground loops

Note 1 Use AUX-PWR only if position information is needed when motor power is lost AND the MDrive has an encoder

Note 2 Use I/O Power only if sourcing outputs are required. I/O Power is only available on MDrives with expanded I/O

Note 3 The isolated communication converter's common MUST be connected to ONLY one MDrive.

Note 4 If Multiple motor power supplies are used connect the commons together and refer to note three.

Figure 5.7 Power Interface for Eliminating Communication Ground Loops.

5.3.4 Software Configuration

Party mode communication requires extensive software configuration and has a specific communication and response format.

This is documented in detail in the MCode software and programming manual, available for download from: https://motion.schneider-electric.com/dloads/.

6 Interfacing CANopen Communication

6.1 Features

- CANopen DS-301 and DS-402
- Galvanically isolated communication
- 3 Dynamically mappable process data objects (PDO)
- Layer Setting Services (LSS) to establish node id and baud
- Node guarding
- Heartbeat producer
- Emergency objects
- Upgradable software

6.2 Interfacing the CAN Bus

The MDrive communicates using the CAN 2.0B Active Protocol and the CiA DS-301 Application Layer and Communication Profile.

The full DS-301 V4.02 Specification may be downloaded free at: http://www.can-cia.org.

The default BAUD rate is 1 Mbit/Sec. The default Node ID is 41h.

6.2.1 CAN Bus Connections

*120Ω Termination Resistors are required between CAN High and CAN Low at both ends of the cabling per ISO-11828

Figure 6.1 Interfacing the CAN Bus

6.2.2 CANopen Dongle

In order to use the CANopen Tester tool and upgrade utility for the MDrive, the MD-CC500-000 communication cable is required. If purchased through Schneider Electric, the user interface software for upgrading and prototyping is included. This software is required to upgrade the firmware in the MDrive updates become available.

Interface Cable Construction

To connect the MD-CC500-000 dongle to the MDrive product, an interface cable will need to be constructed. The figure below shows the parts required.

Figure 6.2 MD-CC500-000 USB to CANopen Commissioning Cable

Installation Instructions

1) Install the MD-CC500-000 adapter.
2) Install the CANopen Tester software available for download from: https://motion.schneider-electric.com/dloads/user-interface-software/
3) Using the interface cable (not supplied), connect the MDrive product to the MD-CC500-000.
4) Apply power to the MDrive product.

6.3 CANopen Tester Quick Start

6.3.1 Installation

1) Download the most recent version of the CANopen Tester from the web site at: https://motion.schneider-electric.com/dloads/user-interface-software/
2) Extract the files from the archive file.
3) Browse to the extracted folder.
4) Double-Click the Setup.exe file.
5) Follow the prompts to install the program.

6.3.2 Getting Started with CANopen Tester

⚠ CAUTION

CANopen Tester Software

Do not use this software without accepting full responsibility of using the full tool.

Only technicians who are familiar with and understand the contents of the manual and the other relevant documentation are authorized to work with the full tool.

Damage and/or drive failure may be experienced without full knowledge of the device indexes and features.

The following brief tutorial will cover setting the MDrive in profile position. To place the software in advanced mode, select “Advanced Mode” from the tools menu in the main interface. A warning dialog will launch with the caution text. If qualified, click “yes” on the dialog. This will launch the advanced features screen.

With the MDrive powered and the CANopen Tester software launched, select through the following sequence.

See figure 5.3 for button locations.

A. Click CAN Init

B. Check “Cycle Reading of indexes.

C. Click Msg Window Scripts – This will open another window to allow the user to see data being sent to MDrive in the following steps.

D. Click Operation_Toggle three times (this steps through Index 0x6040 Control Word ending with Operation Enabled). This enables the output bridge of the driver.

E.. Enter the number “1” in the Modes of Operations field, this places the MDrive into Profile Position mode.

F. Enter 512000 into the IDX67AH field, strike the return (Enter) key on the keyboard, the motor should move 10 revolutions.

Figure 6.3 CANopen Tester

7 Interfacing I/O

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O points are TTL level and only tolerant to +5 VDC:

1) Step Clock
2) Direction
3) Capture/Trip
4) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions may result in damage to system components!

CONNECTOR OPTIONS

The MDrive motion control product family has an extensive set of connector options. The purpose of this section is to give a general overview of the I/O interface methods and practices.

Refer to the product detail section in the product installation document specific to the MDrive product purchased for connectors, pin configurations, and connectivity options.

I/O FUNCTIONS AND PARAMETERS

The functions and operational parameters of the MDrive Motion Control I/O MUST be configured in software.

For detailed specifications and instruction, reference the MCode Software and Programming manual, available for download from: https://motion.schneider-electric.com/dloads/

7.1 I/O Configurations

The MDrive Motion Control product line is available with the following I/O configuration.

I/O set	
General purpose	IO1, IO2, IO3, IO4, IO9, IO10, IO11, IO12 (Sinking or sourcing inputs or outputs
Dedicated	Capture input/trip output
Analog input	AIN1

Table 7.1 MDrive I/O Configurations

7.1.1 I/O States

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 MDrive Motion Control and standard sensors and switches.

7.2 General Purpose I/O

The general purpose +5 to +24 VDC I/O must be configured and programed to general or reserved functions in software. The I/O cannot be exercised without configuration parameters being set:

7.2.1 General Purpose Input Functions

Function	*Description*
User defined	Input function used to control program branches, subroutine calls or BCD functions when the input bank is used as a group.
Home	Homing input
Limit +	Positive limit input
Limit -	Negative limit input
G0	Executes program at memory address 1 on activation
Soft stop	Stops motion with deceleration and halts program execution
Pause	Pause/resume program execution with motion
Jog +	Jog positive direction
Jog -	Jog negative direction
Reset	Reset program, equivalent to a ^C terminal input.

Table 7.2 General Purpose Input Functions

7.2.2 General Purpose Output Functions

Function	*Description*
User defined	Output function which can be set to trigger external events from within a program
Moving	Input will be in an active state when the motor is moving
Fault	Activates on an error.
Stall	Activates when a stall is detected (encoder required)
Velocity changing	Activates when accelerating or decelerating

Table 7.3 General Purpose Output Functions

7.2.3 Interfacing Sinking Inputs

Figure 7.1 Sinking Input Equivalent Circuit and Interface Examples

7.2.4 Interfacing Sinking Outputs

Figure 7.2 Sinking Output Equivalent Circuit and Interface Examples

7.2.5 Interfacing Sourcing Inputs

Figure 7.3 Sourcing Input Equivalent Circuit and Interface Examples

7.2.6 Interfacing Sourcing Outputs

Figure 7.4 Sourcing Output Equivalent Circuit and Interface Examples

7.2.7 Mixed I/O Example

The application illustrated in Figure 7.5 shows an example of the I/O points being used as mixed inputs and outputs on an MDrive with the standard I/O configuration.

IO3 and IO4 are configured as sinking limit inputs, IO2 is set up as a sourcing G0 input with IO1 as a sinking user output. This circuit would operate as automatic reset, where and event inside the program would trigger the user output and run a program located at address 1 in program storage.

Figure 7.5 Mixed Inputs and Outputs, Standard MDrive.

7.2.8 Mixed I/O Example (Expanded)

Figure 7.6 Mixed Inputs and Outputs, Expanded MDrive.

7.2.9 Interfacing to a Bank of I/O Points

The I/O can be interfaced to as a bank of inputs or outputs. Available banks are:

Standard ..... Bank 1: IO1-O4

Expanded ..... Bank 1: IO1-IO4, Bank 2: IO9-IO12

Expanded + remote encoder ..... Bank 1: IO1-IO4

This feature gives the user to implement sophisticated process control applications by triggering events based upon the BCD state of the I/O.

Binary Coded Decimal Inputs

Figure 7.7 illustrates a TTL interface to I/O banks 1 and 2 on an MDrive with the expanded I/O set. These are set to be user defined inputs and the state is read using the following software commands as a binary number. When reading the state of the bank to a terminal, it will display as decimal:

- IL — will read the lower input group (IO1 - IO4) where IO1 is the LSB and IO4 is the MSB
- IH — will read the upper input group (IO9 - IO12) where IO9 is the LSB and IO12 is the MSB
- IT — will read both input groups (IO1 - IO12) where IO1 is the LSB and IO12 is the MSB

Figure 7.7 TTL Interface to I/O Banks as a Group for BCD Program Control

Binary Coded Decimal Outputs

Figure 7.8 illustrates an LED interface to I/O banks 1 and 2 on an MDrive with the expanded I/O set. This is one possible interface method for illustration purposes. A more practical application would be to interface the outputs to a PLC input module to control external processes from within an MDrive program. These are configured as user defined outputs and the state is set using the following software commands as a decimal number. When writing the state of the outputs, they will be set as a binary number.

- OL — will set the lower output group (IO1 - IO4) where IO1 is the LSB and IO4 is the MSB
- OH — will set the upper output group (IO9 - IO12) where IO9 is the LSB and IO12 is the MSB
- OT — will set both output groups (IO1 - IO12) where IO1 is the LSB and IO12 is the MSB

Figure 7.8 Output Interface to I/O Banks as a Group for BCD Process Control

7.3 Dedicated I/O

⚠ CAUTION

ELECTRICAL OVERSTRESS

The I/O points detailed in this subsection are TTL level and only tolerant to +5 VDC:

1) Capture/Trip
2) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

7.3.1 Capture Input/Trip Output

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 50 nS to 12.9 µS and has a resolution of 32 bits. The capture input needs to be pulled up to TTL using a 10 kohm resistor.

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

Figure 7.9 Input Equivalent Circuit, Capture/Trip I/O

7.4 Analog Input

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

The input can receive input from 0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA and 0 to 20 mA devices.

Figure 7.10 Analog Input Interface

Appendix A Specifications and Connectivity for MDrive Motion Control

This appendix details the specifications and connectivity of the MDrive 14, 17, 23, 34, and 34AC Motion Control Devices.

A.1 General Information

Documentation Reference

The following User's manuals are available for the MDrive:

- Product manuals, describes the technical data, installation, configuration and programming of the product.
- Quick Reference, describes the basic wiring, connection and use of this product.

This documentation is also available for downloaded from: https://motion.schneider-electric.com/dloads/product-literature/manuals-3/

Product Software

The MDrive motion control integrated motors and drivers may be programmed using any standard ASCII txt editor and ANSI terminal emulator. The recommended environment is the SEM Terminal Interface, which is a combined terminal/program editor tailored for use with motion control products. This software is available for download from: https://motion.schneider-electric.com/dloads/user-interface-software/.

Installation and usage instructions are to be found in the MCode Programming Manual, which is correlated to this document.

A.2 Layout and Interface Guidelines

Layout Information

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

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

Power supply leads to the MDrive need to be twisted. If more than one driver is to be connected to the same power supply, run separate power and ground leads from the supply to each driver. Do not daisy chain power from driver to driver.

Rules of Wiring

- Power supply and motor wiring should be shielded twisted pairs, and run separately from signal-carrying wires.
- A minimum of one twist per inch is recommended.
- Motor wiring should be shielded twisted pairs using 20 gauge, or for distances of more than 5 feet, 18 gauge or better.

- Power ground return should be as short as possible to established ground.
- Power supply wiring should be shielded twisted pairs of 18 gauge for less than 4 amps DC and 16 gauge for more than 4 amps DC.

Rules of Shielding

- The shield must be tied to earth ground.
- Do not assume that Earth ground is a true Earth ground. Depending on the distance from the main power cabinet, it may be necessary to sink a ground rod at the critical location.
- The shield must be connected so that shield currents drain to signal-earth connections.
- The number of separate shields required in a system is equal to the number of independent signals being processed plus one for each power entrance.
- The shield should be tied to a single point to prevent ground loops.
- A second shield can be used over the primary shield; however, the second shield is tied to ground at both ends.

Recommended Wiring

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

Logic Wiring..... 22 AWG

Wire Strip Length.....Dependent on connector

Power and Ground ..... See Table 3.1 Power Supply Cable AWG on page 14 of this document

A.3 MDrive 14 - Introduction and Overview

The **MDrive® 14 Motion Control** offers system designers a cost effective, full featured programmable motion controller integrated with a NEMA 14 high torque 1.8° brushless step motor and a +12 up to +48 VDC* micro-stepping driver.

The unsurpassed smoothness and performance delivered by the MDrive 14 Motion Control are achieved through 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 MDrive 14 accepts a broad input voltage range from +12 up to +48 VDC*, delivering enhanced performance and speed. Oversized input capacitors are used to minimize power line surges, reducing problems that can occur with long cable runs and multiple drive systems. An extended operating range of –40° to +85°C provides long life, trouble free service in demanding environments.

Standard features of all MDrive 14 Motion Control include four +5 to +24 volt general purpose I/O lines, one 10 bit analog input, 0 to 5MHz step clock rate, 20 microstep resolutions up to 51,200 steps per revolution, and full featured easy-to-program instruction set.

Expanded features of MDrive 14 versions include up to eight +5 to +24 volt general purpose I/O lines and the capability of electronic gearing by following a rotary or linear axis at an electronically controlled ratio, or an output clock can be generated fixed to the internal step clock.

All MDrive 14 Motion Control are available with optional encoder. This increases functionality by adding stall detection, position maintenance and find index mark.

The optional encoder is a 512 line (2048 edge) magnetic encoder with index mark, internal to the unit so there is no increase in length. Or, for an expanded choice of line counts and resolutions with MDrive 14 versions only, closed loop control is available with an interface to a remotely mounted user-supplied external encoder.

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

Optional communication protocols include CANopen. The CAN bus is 2.0B active (11 and/or 29 bit) and is capable of all standard frequencies from 10kHz to 1MHz. CANopen features include node guarding, heartbeat producer, SDOs and PDOs. Highlights include variable PDO mapping and extended node identifier.

Motor configurations include a single shaft rotary in two lengths, and linear actuators with long life modified Acme screw.

Numerous connector styles provide choices for the best fit and features. Select from 12.0” (30.5cm) flying leads, pluggable terminal strip, locking wire crimp connectors.

MDrive connectivity has never been easier with options ranging from all-inclusive QuickStart Kits to individual interfacing cables and mating connector kits to build custom cables.

The MDrive 14 is a compact, powerful and cost effective motion control solution that will reduce system cost, design and assembly time for a large range of brushless step motor applications.

A.3.1 Product Identification

MDrive® 14 Plus

P1: I/O, Power & Communication
C = 12-pin locking wire crimp connector

MDrive® 14 Plus²

P1: I/O & Power, and optional remote encoder
C = 16-pin locking wire crimp connector

P2: Communication
L = RS-422/485 with 10-pin friction lock wire crimp connector

Part numbers													
Example:	**K**	**M**	**D**	**I**	**1**	**C**	**R**	**Z**	**1**	**4**	**A**	**4**	**–EQ**
QuickStart Kit **K** = kit option, or leave blank if not wanted	**K**	M	D	I	1	C	R	Z	1	4	A	4	–EQ
MDrive Plus version **MDI** = Motion Control	K	**M**	**D**	**I**	1	C	R	Z	1	4	A	4	–EQ
Input **1** = Plus, standard features **3** = Plus², expanded features	K	M	D	I	**1**	C	R	Z	1	4	A	4	–EQ
P1 connector **C** = wire crimp	K	M	D	I	1	**C**	R	Z	1	4	A	4	–EQ
Communication **R** = RS-422/485	K	M	D	I	1	C	**R**	Z	1	4	A	4	–EQ
P2 connector **Z** = none (only for Plus products) **L** = wire crimp (only for Plus² products)	K	M	D	I	1	C	R	**Z**	1	4	A	4	–EQ
Motor size **14** = NEMA 14 (1.4" / 36 mm)	K	M	D	I	1	C	R	Z	**1**	**4**	A	4	–EQ
Motor length **A** = single stack **C** = triple stack	K	M	D	I	1	C	R	Z	1	4	**A**	4	–EQ
Drive voltage **4** = +12 to +48 VDC	K	M	D	I	1	C	R	Z	1	4	A	**4**	–EQ
Options Leave blank if not wanted Options may be combined, unless noted													**–EQ**
–EQ = internal encoder, 512-line internal magnetic encoder with index mark													
–EE = remote encoder interface, differential encoder to be provided by user *Available with Plus² versions only. May not be combined with internal encoder option.*													
–N = rear control knob for manual positioning													

Figure A3.1 Standard Product Options

A.4 MDrive 14 - Specifications

A.4.1 Mechanical Specifications

Motor Length	LMAX SINGLE SHAFT, INTERNAL ENCODER, or LINEAR ACTUATOR	LMAX2 CONTROL KNOB
Single	1.93 (49.02)	2.62 (66.55)
Triple	3.03 (76.96)	3.73 (94.74)

Figure A4.1 Standard and Expanded features mechanical specifications

A.4.2 Electrical Specifications

	Condition	Min	Typ	Max	Unit
Input voltage range **CAUTION**: Reverse polarity on the input power will likely damage the drive.	—	+12	—	+48	VDC
Power supply current	—	—	—	1	A
Aux-Logic Input Voltage	—	+12	—	+24	VDC
Max Aux-Logic Supply Current (Per MDrive)**	—	—	—	194	mA

**per MDrive 14, Actual current depends on voltage and load.*
*** Maintains power to control and feedback circuits [only] when input voltage is removed*

Table A4.1 Electrical Specifications

A.4.3 Standard I/O Specifications

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
=I/O Points 1-4	—	4 I/O points configurable as sinking or sourcing inputs or sinking outputs			
General Purpose I/O - Electrical					
Inputs	—	TTL	—	+24	VDC
Sinking Outputs	—	—	—	+24	VDC
Output Sink Continuous Current	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Logic Threshold	Logic 0	—	—	< 0.8	VDC
	Logic 1	—	—	> 2.2	VDC
Protection	Sinking	Over temp, short circuit			
	Sourcing	Transient Over Voltage, Inductive Clamp			
Analog Input					
Resolution	—		10		bits
Range	Voltage Mode	0 to +5 VDC, 0 to +10 VDC			
	Current Mode	4 to 20 mA, 0 to 20mA			

Table A4.2 I/O Specifications

A.4.4 I/O Specifications (Plus² Expanded Features)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
I/O Points 1-8	—	8 I/O points (4 if configured for remote encoder) configurable as sinking or sourcing inputs or outputs			
General Purpose I/O - Electrical					
Inputs	Sinking or Sourcing	TTL	—	+24	VDC
Outputs	Sinking	—	—	+24	VDC
	Sourcing	+12		+24	VDC
Output Sink Continuous Current **NOTE**: Output ratings apply to each bank of four I/O. First bank: Output 1-4 Second bank: Output 9-12	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Clock I/O (Step & Direction I/O)					
Types	—	Step/Direction, Up/Down, Quadrature			
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			
Trip Output/Capture Input					
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			
Motion I/O					
Electronic gearing (uses Clock I/O)	Range	0.001	—	2.000	
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Secondary clock out ratio				1:1
High speed position capture	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Resolution	—	—	32	bit
High speed trip output	Speed	—	—	150	nS
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
Optional remote encoder (closed loop)*					
Type		User supplied differential encoder			
Steps per revolution		See motion specifications table			
Resolution		User defined . Note: microsteps/rev = 2X the encoder counts/rev minimum.			

**Remote encoder inputs replace I/O points 4-8 and step and direction I/O*

Table A4.3 Expanded I/O Specifications

A.4.5 Communication Specifications

	Condition	Min	Typ	Max	Unit
RS-422/485 (standard)					
BAUD rate	—	4.8		115.2	kbps
CANopen (optional)					
Type					2.0B active
BAUD rate	—	10 kHz	—	1 MHz	—
Application layer	Version 3.0				DS-301
Device profile	Version 2.0				DSP-402
ID	—				11 or 29 bit
Isolation	—				Galvanic

Table A4.4 Communication Specifications

A.4.6 Thermal Specifications

		Min	Typ	Max	Unit
Heat sink temperature	non-condensing humidity	-40	—	+85	ºC
Motor temperature	non-condensing humidity	-40	—	+100	ºC

Table A4.5 Thermal Specifications

A.4.7 Motion Specifications

Microstep Resolution - Open Loop	
Number of microstep resolutions	20

Available microsteps per revolution

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

1=0.01 deg/µstep 2=1 arc minute/µstep *3=0.001 mm/µstep
** 1" per revolution lead screw*

Microstep resolution (closed loop configuration - (optional)	
Steps Per Revolution (Fixed)	51200
Position Resolution	2048
Optional encoder (internally mounted)	
Type	Internal, Magnetic
Resolution (Lines)	512
Resolution (Edges)	2048
Counters	
Counter 1 (C1) Type	Microstep
Counter 2 (C2) Type	Encoder
Resolution	32 bit
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.

Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5 x 10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

Table A4.6 Motion Specifications

A.4.8 Software Specifications

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

Table A4.7 Software Specifications

A.4.9 Motor Specifications

Specification	Single length	Triple length
Holding torque oz-in (N-cm)	18.0 (12.71)	36.0 (25.0)
Detent torque oz-in (N-cm)	2.0 (1.4)	4.4 (3.1)
Rotor inertia oz-in-sec^2 (kg-cm^2)	0.00024 (0.017)	0.000801 (0.0566)
Weight motor and driver oz (g)	5.29 (150.0)	12.8 (380.0)

Table A4.8 Microstepping Motor Specifications

A.4.10 Speed-Torque Performance Curves

Single Length Motor

Figure A4.2 Performance Curves - Single Length Motor

Triple Length Motor

Figure A2.3 Performance Curves - Triple Length Motor

A.5 MDrive 14 - Connectivity Specifications/Pin Assignments

A.5.1 RS-422/485 Communication Specifications

10-pin Friction Lock Wire Crimp

Connectivity Options
USB to RS-422 Converter:
MD-CC402-001

Mating connector kit:
CK-02

Mfg P/N:
Shell
Hirose DF11-2428SC

Pins
Hirose DF11-TA2428HC

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table A5.1 P2 Communication, 10-pin Friction Lock Wire Crimp

A.5.2 CANopen Communication Option (Plus² Expanded Features)

9-pin D-sub Female (DB-9F)

Connectivity Options
USB to CANopen converter:
MD-CC500-000

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table A5.2 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

A.5.3 Communication, Power and I/O - Standard I/O (Plus only)

Connectivity Options
USB to RS-422 Converter:
MD-CC403-001

Mating connector kit:
CK-08

Mfg P/N:
Shell
JST PADP-12V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	GND	Power, Auxiliary and Communication ground.
2	+V	+12 to +48 VDC Power Supply
3	I/O 2	0 to +24 VDC Programmable I/O Point 2
4	I/O 3	0 to +24 VDC Programmable I/O Point 3
5	I/O 4	0 to +24 VDC Programmable I/O Point 4
6	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
7	I/O 1	0 to +24 VDC Programmable I/O Point 1
8	AUX	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
9	TX +	Transmit +: Connects to Receive + of the Communication Host.
10	TX -	Transmit –: Connects to Receive – of the Communication Host.
11	RX -	Receive –: Connects to Transmit – of the Communication Host.
12	RX +	Receive +: Connects to Transmit + of the Communication Host.

Table A5.3 P1 Communication, Power and I/O, 12-pin Locking Wire Crimp

A.5.4 Power and I/O (Plus² Expanded Features)

16-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD16-1417-FL3

Mating connector kit:
CK-10

Mfg P/N:
Shell
JST PADP-16V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	I/O 9	0 to +24 VDC Programmable I/O Point 9
8	I/O 10	0 to +24 VDC Programmable I/O Point 10
9	I/O 11	0 to +24 VDC Programmable I/O Point 11
10	I/O 12	0 to +24 VDC Programmable I/O Point 12
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	Step/clock I/O	Step clock i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
14	Direction/ clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
15	+V	+12 to +48 VDC motor power supply input.
16	Power/aux ground	Power and auxiliary ground

Table A5.4 P1 Expanded I/O, 16-pin Locking Wire Crimp

A.5.5 Power and I/O (Plus² with Remote Encoder)

16-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD16-1417-FL3

Mating connector kit:
CK-10

Mfg P/N:
Shell
JST PADP-16V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	CH A+	Channel A+ encoder input. +5 VDC logic level
8	CH A-	Channel A- encoder input. +5 VDC logic level
9	CH B+	Channel B+ encoder input. +5 VDC logic level
10	CH B-	Channel B- encoder input. +5 VDC logic level
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	IDX+	Index mark + encoder input. +5 VDC logic level

14	IDX-	Index mark - encoder input. +5 VDC logic level
15	+V	+12 to +48 VDC motor power supply input.
16	Power/aux ground	Power and auxiliary ground

Table A5.5 I/O and Remote Encoder Interface - 16-pin Locking Wire Crimp

A.5.6 Options

Drive Protection Module

The function of the DPM75 Drive Protection Module is to limit the surge current and voltage to a safe level when DC input power is switched on and off to a motor drive.

Internal Encoder

Internal magnetic 512 line quadrature encoders with index mark are available.

Remote Encoder (Plus² Versions Only)

MDrive 14 Motion Control versions are available with differential encoder inputs for use with a remote encoder (not supplied).

Control Knob

The MDrive 14 is available with a factory-mounted rear control knob for manual shaft positioning.

A.5.7 Connectivity

QuickStart Kit

For rapid design verification, all-inclusive QuickStart Kits have communication converter, prototype development cable(s), instructions and CD for MDrive initial functional setup and system testing.

Communication Converters

Electrically isolated, in-line converters pre-wired with mating connectors to conveniently set/program communication parameters for a single MDrive product via a PC's USB port. Length 12.0' (3.6m).

Mates to connector:

P2 10-pin wire crimp.....MD-CC402-001

P1 12-pin wire crimp.....MD-CC403-001

Prototype Development Cables

Speed test/development with pre-wired mating connectors that have flying leads other end. Length 10.0' (3.0m).

Mates to connector:

P2 10-pin wire crimp..... PD10-1434-FL3

P1 12-pin wire crimp..... PD12B-1434-FL3

P1 16-pin wire crimp..... PD16-1417-FL3

Mating Connector Kits Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin wire crimp.....CK-02

P1 16-pin wire crimp.....CK-10

P1 12-pin wire crimp.....CK-08

A.6 MDrive 14 - Mounting and Connection Recommendations

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

LEAD RESTRAINT

Some MDrive mounting configurations require that the MDrive move along the screw. Ensure that all cabling is properly re-strained to provide strain relief on connection points..

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

THERMAL MANAGEMENT

The mounting plate material should offer sufficient mass and thermal conductivity to ensure that the motor temperature does not exceed 100°C.

Failure to follow these instructions can result in equipment damage.

A.6.1 Mounting

Care must be observed when installing the mounting screws on ALL MDrive 14Plus versions. The mounting holes on the flange are not drilled through and have a maximum depth of 0.150” (3.81 mm).

The warning note and Figure below illustrate the maximum safe thread length and maximum torque for mounting all versions of the MDrive 14.

Drill Pattern for Mounting Flange or Adapter Plate

Figure A6.1 MDrive 14 Mounting and Drill Pattern

A.6.2 Mating Connectors and Pin Information

Communication

10-pin Friction Lock (P2) ..... Hirose DF11-10DS-2C

Crimp Contact for 10-pin Friction Lock (22 AWG) DF11-22SC

Crimp Contact for 10-pin Friction Lock (24 - 28 AWG) DF11-2428SC

Crimp Contact for 10-pin Friction Lock (30 AWG) DF11-30SC

10-pin pressure-fit IDC ..... Samtec TCSD-05-01-N

Ribbon cable..... Tyco 1-57051-9

Power and I/O

The following mating connectors are recommended for the MDrive 14 Plus[2] Units ONLY! Contact a JST distributor for ordering and pricing information.

16-pin Locking Wire Crimp Connector Shell JST PN PADP-16V-1-S

Crimp Pins ..... JST PN SPH-001T-P0.5L

A.6.3 Securing Power Leads and Logic Leads

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

Figure A6.2 Securing Leads

A.7 MDrive 14 - Connection and Interface

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

A.7.1 Interfacing RS422-485 Communication

For general RS422/485 single and party mode communication practices, refer to Section 5 on page 18 of this document.

⚠ CAUTION

COMMUNICATION GROUND LOOPS

To avoid ground loops in the system only connect communication ground to the first MDrive in the system. Do not connect communication ground on subsequent MDrives.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect communication while the device is in a powered state.

Failure to follow these instructions may result in damage to system components!

P1 — 12-pin Locking Wire Crimp

Pin #	Function	Description
1	GND	Power/aux/communication ground
9	TX +	Transmit plus
10	TX -	Transmit minus
11	RX -	Receive minus
12	RX +	Receive plus

Table A7.1 Communication Connections, P1 - 12-pin Wire Crimp

Connectivity Accessories

Mating connector kit CK-08
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD12-1434-FL3

Communication converter cable (10'/3.0 m)..... MD-CC403-001

Manufacturer (JST) Part Numbers

Connector shell..... PADP-10V010S

Pins..... SPH-001T0.5L

P2 — 10-pin Friction Lock Wire Crimp

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table A7.2 P2 Communication, 10-pin Friction Lock Wire Crimp

Connectivity Accessories

Mating connector kit CK-02
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m)..... MD-CC402-001

A.7.2 Interfacing CANopen Communication

P2 — 9-pin D-sub Connector (Female)

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table A7.3 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

Connectivity Accessories

Communication converter cable MD-CC500-000

A.7.3 Interfacing DC Power

See Section 3 on page 10, for recommended power cable configurations.

For information on sizing a DC power supply, refer to: https://motion.schneider-electric.com/application-note/sizing-dc-power-supply/

⚠ CAUTION

OVER VOLTAGE

The DC voltage range for the MDrive 14 is +12 to +48 VDC. Ensure that motor back EMF is factored into the power supply size calculations to ensure that the power supply does not rise above 48 VDC.

Allow 3.0 A maximum power supply output current per MDrive in the system. Actual power supply current will depend on voltage and load.

Failure to follow these instructions can result in equipment damage.

Recommended Power Supply Characteristics

Voltage range	+12 to +48 VDC
Type	Unregulated linear
Ripple	± 5%
Output current	1.0 A (per MDrive 14)

Table A7.4 Recommended Power Supply Characteristics

Recommended Wire Gauge

Cable Length: Feet (meters)	10 (3.0)	25 (7.6)	50 (15.2)	75 (22.9)	100 (30.5)
Amps Peak	**Minimum AWG**				
1 Amp Peak	20	20	18	18	18

Table A7.5 Recommended Power Supply Wire Gauge

P1 — 12-pin Locking Wire Crimp Interface

Pin #	*Signal*	*Wire colors*	
		MD-CC305-001	PD12B-14340-FL3
1	Power ground	Black	See Section 3 for wire colors.
2	+12 to + 48 VDC	Red	
8	Aux-power +2 to +24 VDC	Red/black	

Table A7.6 Power and Ground Connections, 12-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-08
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD12B-1434-FL3

Manufacturer (JST) Part Numbers

Connector shell..... PADP-12V-1-S

Pins..... SPH-001T0.5L

P1 — 16-pin Locking Wire Crimp Interface

Pin Numbers	*Signal*	*Prototype development cable wire colors*
15	+12 to + 48 VDC	Red
16	Power and auxiliary ground	Black

Table A7.7 Power and ground connections, 16-pin locking wire crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell..... PADP-16V-1-S

Pins..... SPH-001T0.5L04
(contains 5 connector shells, ribbon cable not included)

A.7.4 Power Interface using Drive Protection Module DPM75

* Do not switch negative side of supply
**Fuse = 6.3 Amp slow blow (recommended: Bussman S505-6.3A or Littelfuse 215006.3). The fuse is optional.

Figure A7.1 DPM75 Drive Protection Module

A.7.5 Interfacing I/O

See Section 4 on page 16, for I/O interface configurations and methods.

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O point is TTL level and only tolerant to +5 VDC:

1) Capture/Trip
2) Step/Direction
3) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

P1 — 12-pin Locking Wire Crimp

Pin #	*Signal*	*Wire colors*	
		MD-CC403-001	PD12B-1434-FL3
3	I/O 2	White	See Section 3 for wire colors.
4	I/O 3	Green	
5	I/O 4	Orange	
6	Analog input	White/black	
7	I/O 1	Blue	

Table A7.8 Universal Input Connections, 12-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-08
(contains 5 connector shells and the appropriate quantity of pins

to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD12B-1434-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-12V-1-S

Pins..... SPH-001T0.5L

P1 — 16-pin Locking Wire Crimp Interface (Expanded I/O)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	General purpose I/O 9	Yellow	Pair
8	General purpose I/O 10	Black	
9	General purpose I/O 11	Blue	Pair
10	General purpose I/O 12	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Step clock I/O	White	Pair
14	Direction clock I/O	Black	

Table A7.9 I/O Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L

P1 — 16-pin Locking Wire Crimp Interface (Remote Encoder)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	

7	Channel A +	Yellow	Pair
8	Channel A -	Black	
9	Channel B +	Blue	Pair
10	Channel B -	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Index +	White	Pair
14	Index -	Black	

Table A7.10 I/O and Remote Encoder Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L

A.8 MDrive 14 - Connectivity Accessory Details

A.8.1 RS-422/485 Communication Converter Cables

USB to 10-pin wire crimp connector P2
P/N: MD-CC402-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure A8.1 MD-CC402-001 Communication Converter Cable

USB to 12-pin Circular Connector P1— MD-CC403-000

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters.

Pin #	*Wire Colors*	*Signal*
1	Black	GND
2	Red	+V
3	White	I/O 2
7	Blue	I/O 1
5	Green	I/O 3
5	Orange	I/O 4
6	Brown	Analog Input

Figure A8.2 MD-CC403-001 Communication Converter

A.8.2 Prototype Development Cables

Flying Leads to10-pin Wire Crimp Connector P2 -P/N: PD10-1434-FL3

Used in conjunction with the MD-CC402-001 communication converter cable to facilitate multi-drop RS-422/485 communication.

Wire Colors	Function
White/Red Stripe	Aux-Logic
White/Blue Stripe	TX+
Blue/White Stripe	TX-
White/Orange Stripe	RX+
Orange/White Stripe	RX-
Green/White Stripe	GND

Figure A8.3 Multi-drop communication using the PD10-1434-FL3

Procedure

1) Remove ground wire (unless this is the first system MDrive, green/white stripe)
2) Remove aux-logic (if not used, red/white stripe)
3) Connect pre-crimped flying leads as shown in Figure 5.7 below

Figure A8.4 Wiring a Second PD10-1434-FL3 into the 10-pin Wire Crimp Connector.

Flying Leads to12-pin Locking Wire Crimp Connector P1 - PD12B-3400-FL3

Description: Pre-wired mating connector interfaces to an MDrive's 12-pin wire crimp connector, with flying leads other end, for quick test/ development.

Function: I/O, Power & Communication Interface.

Pin #	*Wire Colors*	*Signal*	*Pairs*
1	Black	GND	X
2	Red	+V	
10	Black	TX-	X
9	White	TX+	
11	Black	RX-	X
12	Green	RX+	
3	Black	I/O 2	X
7	Blue	I/O 1	
5	Black	I/O 3	X
5	Yellow	I/O 4	
6	Black	Analog Input	X
8	Brown	Aux-Logic	

Figure A8.5 Prototype Development Cable PD12B-1434-FL3

Flying Leads to16-pin Locking Wire Crimp Connector P2 -P/N: PD16-1417-FL3

The PD16-1417-FL3 prototype development cable is used to rapidly interface the MDrive 14 to the users controller. This 10' (3.0 m) cable consists of a 16-pin locking wire crimp connector to plug directly into the MDrive P1 connector with flying leads on the opposite end to interface to power, i/o and/or remote encoder.

Pin #	*Wire Colors*	*Signal (Expanded features)*	*Signal (Remote encoder)*	*Pairs*
16	Black	GND	GND	X
15	Red	+V	+V	
14	Black	Step Clock I/O	Index –	X
13	White	Direction I/O	Index +	
12	Black	Analog Input	Analog Input	X
11	Green	Capture/Trip I/O	Capture/Trip I/O	
10	Black	I/O 12	Channel B –	X
9	Blue	I/O 11	Channel B +	
8	Black	I/O 10	Channel A –	X
7	Yellow	I/O 9	Channel A +	
6	Black	I/O 4	I/O 4	X
5	Brown	I/O 3	I/O 3	
4	Black	I/O 2	I/O 2	X
3	Orange	I/O 1	I/O 1	
2	White	I/O Ground	I/O Ground	X
1	Red	I/O Power	I/O Power	

Figure A8.6 Prototype Development Cable PD16-1417-FL3

Mating Connector Kits

Used to build cables, each kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin IDC.....CK-01

P2 10-pin wire crimp.....CK-02

P1 12-pin wire crimp.....CK-08

P1 16-pin wire crimp.....CK-10

A.9 MDrive 17 - Introduction and Overview

The **MDrive® 17 Motion Control** offers system designers a cost effective, full featured programmable motion controller integrated with a NEMA 17 high torque 1.8° brushless step motor and a +12 up to +48 VDC* micro-stepping driver.

The unsurpassed smoothness and performance delivered by the MDrive 17 Motion Control are achieved through Schneider Electric Motion'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 MDrive 17 accepts a broad input voltage range from +12 up to +48 VDC*, delivering enhanced performance and speed. Oversized input capacitors are used to minimize power line surges, reducing problems that can occur with long cable runs and multiple drive systems. An extended operating range of –40° to +85°C provides long life, trouble free service in demanding environments.

Standard features of all MDrive 17 Motion Control include four +5 to +24 volt general purpose I/O lines, one 10 bit analog input, 0 to 5MHz step clock rate, 20 microstep resolutions up to 51,200 steps per revolution, and full featured easy-to-program instruction set.

Expanded features of MDrive 17 versions include up to eight +5 to +24 volt general purpose I/O lines and the capability of electronic gearing by following a rotary or linear axis at an electronically controlled ratio, or an output clock can be generated fixed to the internal step clock.

All MDrive 17 Motion Control are available with optional closed loop control. This increases functionality by adding stall detection, position maintenance and find index mark.

The closed loop configuration is added via a 512 line (2048 edge) magnetic encoder with index mark, internal to the unit so there is no increase in length. Or, for an expanded choice of line counts and resolutions with MDrive 17 versions only, closed loop control is available with an interface to a remotely mounted user-supplied external encoder.

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

Optional communication protocols include CANopen. The CAN bus is 2.0B active (11 and/or 29 bit) and is capable of all standard frequencies from 10kHz to 1MHz. CANopen features include node guarding, heartbeat producer, SDOs and PDOs. Highlights include variable PDO mapping and extended node identifier.

Motor configurations include a single shaft rotary in four lengths, and linear actuators with long life modified Acme screw.

Numerous connector styles provides choices for the best fit and features. Select from 12.0" (30.5cm) flying leads, pluggable terminal strip, locking wire crimp connectors, and M12/M23 industrial connectors.

MDrive connectivity has never been easier with options ranging from all-inclusive QuickStart Kits to individual interfacing cables and mating connector kits to build cables.

The MDrive 17 is a compact, powerful and cost effective motion control solution that will reduce system cost, design and assembly time for a large range of brushless step motor applications.

A.9.1 Product Identification

MDrive® 17 Plus

P1: I/O & Power
F = 12" flying leads
P = non-locking spring clamp terminal strip

P2: Communication
D = RS-422/485 with 10-pin IDC non-locking connector
L = RS-422/485 with 10-pin friction lock wire crimp connector

MDrive® 17 Plus²

P1: I/O & Power, and optional remote encoder
C = 16-pin locking wire crimp connector

P2: Communication
D = RS-422/485 with 10-pin IDC non-locking connector
L = RS-422/485 with 10-pin friction lock wire crimp connector

MDrive® 17 Plus²
with industrial connectors

P2: Communication
Q = RS-422/485 with 5-pin M12 female industrial connector

P1: I/O & Power, and optional remote encoder
M = 19-pin M23 male industrial connector

Part numbers

Example:	K	M	D	I	1	F	R	D	1	7	A	4	–EQ
QuickStart Kit **K** = kit option, or leave blank if not wanted	**K**	M	D	I	1	F	R	D	1	7	A	4	–EQ
MDrive Plus version **MDI** = Motion Control	K	**M**	**D**	**I**	1	F	R	D	1	7	A	4	–EQ
Input **1** = Plus, standard features **3** = Plus², expanded features **4** = Plus², expanded features, with industrial connectors, IP54-rated	K	M	D	I	**1**	F	R	D	1	7	A	4	–EQ
P1 connector **F** = flying leads **P** = pluggable **C** = wire crimp *(1)* **M** = M23 industrial connector *(2)*	K	M	D	I	1	**F**	R	D	1	7	A	4	–EQ
Communication **R** = RS-422/485	K	M	D	I	1	F	**R**	D	1	7	A	4	–EQ
P2 connector **D** = IDC **L** = wire crimp **Q** = M12 industrial connector *(2)*	K	M	D	I	1	F	R	**D**	1	7	A	4	–EQ
Motor size **17** = NEMA 17 (1.7" / 42 mm)	K	M	D	I	1	F	R	D	**1**	**7**	A	4	–EQ
Motor length **A** = single stack **B** = double stack **C** = triple stack	K	M	D	I	1	F	R	D	1	7	**A**	4	–EQ
Drive voltage **4** = +12 to +48 VDC	K	M	D	I	1	F	R	D	1	7	A	**4**	–EQ
Options Leave blank if not wanted Options may be combined, unless noted **–EQ** = internal encoder, 512-line internal magnetic encoder with index mark **–EE** = remote encoder interface, differential encoder to be provided by user *Available with Plus² versions only. May not be combined with internal encoder option.* **–N** = rear control knob for manual positioning *(3)*													**–EQ**

(1) Only available with Plus² products without industrial connectors.
(2) Only available with Plus² products with industrial connectors.
(3) Not available with industrial connector products.

Figure A9.1 Standard Product Options

A.10 MDrive 17 - Specifications

A.10.1 Dimensional Information - Non-sealed Version

Motor stack length	Lmax	Lmax1 (1)	Lmax2
Single	2.20 (55.9)	2.45 (62.25)	2.79 (70.9)
Double	2.43 (61.7)	2.68 (68.05)	3.02 (76.7)
Triple	2.77 (70.4)	3.02 (76.75)	3.37 (85.6)

(1) Grounding screw is not present on all products.

Figure A10.1 Standard and Expanded Features Mechanical Specifications

A.10.2 Dimensional Information - Sealed Version (M12 Connection)

Sealed MDrive Lengths *Inches (mm)*

Motor Length	LMAX	LMAX2	LMAX3*
Single	2.48 (63.00)	3.15 (80.00)	3.08 (78.23)
Double	2.71 (68.83)	3.38 (85.85)	3.31 (85.10)
Triple	3.04 (77.22)	3.71 (94.23)	3.64 (92.46)

*CANopen increases measurement by 0.09"/2.0mm

Connectors

P1: 19-Pin M23 (Male) *P2: 5-Pin M12 (Female) (or CANopen – Male)*

Figure A10.2 Sealed Mechanical Specifications

A.10.3 Electrical Specifications

	Condition	Min	Typ	Max	Unit
Input voltage range **CAUTION**: Reverse polarity on the input power will likely damage the drive.	—	+12	—	+48	VDC
Power supply current	—	—	—	2	A
Aux-Logic Input Voltage	—	+12	—	+24	VDC
Max Aux-Logic Supply Current (Per MDrive)**	—	—	—	194	mA

**per MDrive 17, Actual current depends on voltage and load.*
*** Maintains power to control and feedback circuits [only] when input voltage is removed*

Table A10.1 Electrical Specifications

A.10.4 I/O Specifications

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
I/O Points 1-4	—	4 I/O points configurable as sinking or sourcing inputs or sinking outputs			
General Purpose I/O - Electrical					
Inputs	—	TTL	—	+24	VDC
Sinking Outputs	—	—	—	+24	VDC
Output Sink Continuous Current	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Logic Threshold	Logic 0	—	—	< 0.8	VDC
	Logic 1	—	—	> 2.2	VDC
Protection	Sinking	Over temp, short circuit			
	Sourcing	Transient Over Voltage, Inductive Clamp			
Analog Input					
Resolution	—				
Range	Voltage Mode	0 to +5 VDC, 0 to +10 VDC			
	Current Mode	4 to 20 mA, 0 to 20mA			

Table A10.2 I/O Specifications

A.10.5 I/O Specifications (Plus² Expanded Features)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
I/O Points 1-8	—	8 I/O points (4 if configured for remote encoder) configurable as sinking or sourcing inputs or outputs			
General Purpose I/O - Electrical					
Inputs	Sinking or Sourcing	TTL	—	+24	VDC
Outputs	Sinking	—	—	+24	VDC
	Sourcing	+12		+24	VDC
Output Sink Continuous Current **NOTE**: Output ratings apply to each bank of four I/O. First bank: Output 1-4 Second bank: Output 9-12	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Clock I/O (Step & Direction I/O)					
Types	—	Step/Direction, Up/Down, Quadrature			
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			
Trip Output/Capture Input					
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			

Motion I/O					
Electronic gearing	Range	0.001	—	2.000	
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz)	
	Secondary clock out ratio				1:1
High speed position capture	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz)	
	Resolution	—	—	32	bit
High speed trip output	Speed	—	—	150	nS
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
Optional remote encoder (closed loop)*					
Type				User supplied differential encoder	
Steps per revolution				See motion specifications table	
Resolution				User defined . Note: microsteps/rev = 2X the encoder counts/rev minimum.	

**Remote encoder inputs replace I/O points 4-8 and step and direction I/O*

Table A10.3 Expanded I/O Specifications

A.10.6 Communication Specifications

	Condition	Min	Typ	Max	Unit
RS-422/485 (standard)					
BAUD rate	—	4.8		115.2	kbps
CANopen (optional)					
Type					2.0B active
BAUD rate	—	10 kHz	—	1 MHz	—
Application layer	Version 3.0				DS-301
Device profile	Version 2.0				DSP-402
ID	—				11 or 29 bit
Isolation	—				Galvanic

Table A10.4 Communication Specifications

A.10.7 Thermal Specifications

		Min	Typ	Max	Unit
Heat sink temperature	non-condensing humidity	-40	—	+85	ºC
Motor temperature	non-condensing humidity	-40	—	+100	ºC

Table A10.5 Thermal Specifications

A.10.8 Motion Specifications

Microstep Resolution - Open Loop	
Number of microstep resolutions	20

Available microsteps per revolution

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

1=0.01 deg/µstep 2=1 arc minute/µstep *3=0.001 mm/µstep
** 1" per revolution lead screw*

Microstep resolution (closed loop configuration - (optional)	
Steps Per Revolution (Fixed)	51200
Position Resolution	2048
Optional encoder (internally mounted)	
Type	Internal, Magnetic
Resolution (Lines)	512
Resolution (Edges)	2048
Counters	
Counter 1 (C1) Type	Microstep
Counter 2 (C2) Type	Encoder
Resolution	32 bit
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

Table A10.6 Motion Specifications

A.10.9 Software Specifications

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

Table A10.7 Software Specifications

A.10.10 Motor Specifications

Specification	Single length	Double length	Triple length
Holding torque oz-in (N-cm)	32 (22.6)	60 (42.4)	74.9 (52.9)
Detent torque oz-in (N-cm)	1.66 (1.17)	2.08 (1.47)	3.47 (2.45)
Rotor inertia oz-in-sec^2 (kg-cm^2)	0.00053 (0.038)	0.00080 (0.057)	0.00116 (0.082)
Weight motor and driver oz (g)	10.4 (294.8)	12.0 (340.2)	15.2 (430.9)

Table A10.6 Microstepping Motor Specifications

A.10.11 Speed-Torque Performance Curves

Single Length Motor

Figure A10.3 Single Length Motor

Double Length Motor

Figure A10.4 Double Length Motor

Triple Length Motor

Figure A10.5 Triple Length Motor

A.11 MDrive 17 - Connectivity Specifications/Pin Assignments

A.11.1 RS-422/485 Communication Specifications

10-pin Friction Lock Wire Crimp

Connectivity Options
USB to RS-422/485 Converter:
MD-CC402-001

Mating connector kit:
CK-02

Mfg P/N:
Shell
Hirose DF11-10DS-2C

Pins
Hirose: DF11-2428SC

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table A11.1 P2 Communication, 10-pin Friction Lock Wire Crimp

10-pin Press-fit (IDC Style)

Connectivity Options
USB to RS-422/485 Converter:
MD-CC400-001

Mating connector kit:
CK-01

Mfg P/N:
Shell
SAMTEC: TCSD-05-01-N

Ribbon cable
Tyco: 1-57051-9

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table A11.2 P2 Communication, 10-pin Pressure Fit IDC/SAMTEC

5-pin M12 Industrial

Pin #	Function	Description
1	TX -	Transmit minus
2	TX +	Transmit plus
3	RX +	Receive plus
4	RX -	Receive minus
5	Communication Gnd	Communication ground

Table A11.3 P2 Communication, 5-pin M12 Industrial IDC/SAMTEC

A.11.2 CANopen Communication Option

9-pin D-sub female (DB-9F)

Connectivity Options
USB to CANopen converter:
MD-CC500-000

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table A11.4 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

5-pin M12 industrial

Connectivity Options
USB to CANopen converter:
MD-CC500-000

Pin #	Function	Description
1	Shield	Optional CAN shield
2	CAN +V	+7 to +30 VDC power supply
3	CAN -V	CAN communication ground
4	CAN high	CAN_H bus line (high dominant)
5	CAN low	CAN_L bus line (low dominant)

Table A11.5 CANopen Communication, P2: 5-pin D-sub Female

A.11.3 Power and I/O - Standard I/O (Plus)

12” (304.8 mm) Flying Leads

Wire Color	Function	Description
White/yellow	I/O 1	General purpose I/O point 1
White/orange	I/O 2	General purpose I/O point 2
White/violet	I/O 3	General purpose I/O point 3
White/blue	I/O 4	General purpose I/O point 4
Green	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
Black	GND	Power and auxiliary ground
Red	+V	Motor power

Table A11.6 Power and I/O Interface - 12” (308.8.mm) Flying Leads

7-pin Pluggable Terminal

Pin #	Function	Description
1	I/O 1	General purpose I/O point 1
2	I/O 2	General purpose I/O point 2
3	I/O 3	General purpose I/O point 3
4	I/O 4	General purpose I/O point 4
5	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
6	GND	Power and auxiliary ground
7	+V	Motor power

Table A11.7 Power and I/O interface - 7-pin Pluggable Terminal

A.11.4 Power and I/O - Expanded I/O (Plus²)

16-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD16-1417-FL3

Mating connector kit:
CK-10

Mfg P/N:
Shell
JST PADP-16V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	I/O 9	0 to +24 VDC Programmable I/O Point 9
8	I/O 10	0 to +24 VDC Programmable I/O Point 10
9	I/O 11	0 to +24 VDC Programmable I/O Point 11
10	I/O 12	0 to +24 VDC Programmable I/O Point 12
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	Step/clock I/O	Step clock i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
14	Direction/ clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
15	+V	+12 to +48 VDC motor power supply input.
16	Power/aux ground	Power and auxiliary ground

Table A11.8 P1 Expanded I/O, 16-pin Locking Wire Crimp

A.11.6 Power and I/O - Remote Encoder (Plus²)

16-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD16-1417-FL3

Mating connector kit:
CK-10

Mfg P/N:
Shell
JST PADP-16V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	CH A+	Channel A+ encoder input. +5 VDC logic level
8	CH A-	Channel A- encoder input. +5 VDC logic level
9	CH B+	Channel B+ encoder input. +5 VDC logic level
10	CH B-	Channel B- encoder input. +5 VDC logic level
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	IDX+	Index mark + encoder input. +5 VDC logic level
14	IDX-	Index mark - encoder input. +5 VDC logic level
15	+V	+12 to +48 VDC motor power supply input.
16	Power/aux ground	Power and auxiliary ground

Table A11.9 I/O and Remote Encoder Interface - 16-pin Locking Wire Crimp

A.11.7 DC Power and I/O - Expanded I/O (Plus²-65)

19-pin M23 Industrial

Outside: Pins 1 -12

Inside: Pins 13 -19

Connectivity Options

Prototype development cable:
MD-CS100-000 (straight)
MD-CS101-000 (right-angle)

Pin #	Function	Description
1	I/O 9	0 to +24 VDC Programmable I/O Point 9.
2	I/O 11	0 to +24 VDC Programmable I/O Point 11.
3	Step/Clock I/O	0 to +5 VDC Step Clock I/O. Can also be configured as Quadrature or Clock Up/Down.
4	I/O 1	0 to +24 VDC Programmable I/O Point 1.
5	Direction/clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
6	+V	Motor power input
7	Aux-Logic	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
8	Aux-Ground	Auxiliary Ground.
9	I/O 3	0 to +24 VDC Programmable I/O Point 3.
10	I/O GND	Non-isolated I/O ground. Common with power ground.
11	I/O PWR	I/O Power, used with sourcing inputs or outputs. See Section 5 for more details.
12	Shell	Shell connect
13	I/O 12	0 to +24 VDC Programmable I/O Point 12.
14	Capture/Trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
15	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
16	I/O 2	0 to +24 VDC Programmable I/O Point 2.
17	I/O 4	0 to +24 VDC Programmable I/O Point 4.
18	I/O 10	0 to +24 VDC Programmable I/O Point 10.
19	GND	Power ground

Table A11.10 P1 I/O and Aux Power, 19-pin IM23 Industrial Connector

A.11.8 DC Power and I/O - Remote Encoder (Plus²-65)

19-pin M23 industrial

Outside: Pins 1 -12

Inside: Pins 13 -19

Connectivity Options

Prototype development cable:
MD-CS100-000 (straight)
MD-CS101-000 (right-angle)

Pin #	Function	Description
1	CH A+	Channel A+ encoder input. +5 VDC logic level
2	CH B+	Channel B+ encoder input. +5 VDC logic level
3	IDX+	Index mark + encoder input. +5 VDC logic level
4	I/O 1	0 to +24 VDC Programmable I/O Point 1.
5	IDX-	Index mark - encoder input. +5 VDC logic level
6	+V	Motor power input
7	Aux-Logic	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
8	Aux-Ground	Auxiliary Ground.
9	I/O 3	0 to +24 VDC Programmable I/O Point 3.
10	I/O GND	Non-isolated I/O ground. Common with power ground.
11	I/O PWR	I/O Power, used with sourcing inputs or outputs. See Section 5 for more details.
12	Shell	Shell connect
13	CH B-	Channel B- encoder input. +5 VDC logic level
14	Capture/Trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
15	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
16	I/O 2	0 to +24 VDC Programmable I/O Point 2.
17	I/O 4	0 to +24 VDC Programmable I/O Point 4.
18	CH A-	Channel A- encoder input. +5 VDC logic level
19	GND	Power ground

Table A11.11 P1 I/O and Aux Power, 19-pin M23 Industrial Connector

A.11.9 Options

Drive Protection Module

The function of the DPM75 Drive Protection Module is to limit the surge current and voltage to a safe level when DC input power is switched on and off to the MDrive.

Internal Encoder

Internal magnetic 512 line quadrature encoders with index marks are available.

Remote Encoder (Plus² Versions Only)

MDrive 17 Motion Control versions are available with differential 5 VDC encoder inputs for use with a remote encoder (not supplied).

Control Knob

The MDrive 17 is available with a factory-mounted rear control knob for manual shaft positioning.

A.11.10 Connectivity

QuickStart Kit

For rapid design verification, all-inclusive QuickStart Kits have communication converter, prototype development cable(s), instructions and CD for MDrive initial functional setup and system testing.

Communication Converters

Electrically isolated, in-line converters pre-wired with mating connectors to conveniently set/program communication parameters for a single MDrive product via a PC's USB port. Length 12.0' (3.6m).

Mates to connector:

P2 10-pin pressure-fit IDC MD-CC400-001

P2 5-pin M12 industrial MD-CC401-001

P2 10-pin wire crimp MD-CC402-001

Prototype Development Cables

Speed test/development with pre-wired mating connectors that have flying leads other end. Length 10.0' (3.0m).

Mates to connector:

P2 10-pin wire crimp PD10-1434-FL3

P1 16-pin wire crimp PD16-1417-FL3

P1 19-pin M23 industrial (straight) MD-CS100-000

P1 19-pin M23 industrial (right-angle) MD-CS101-000

Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC CK-01

P2 10-pin wire crimp CK-02

P1 16-pin wire crimp CK-10

A.12 MDrive 17 - Mounting and Connection Recommendations

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

LEAD RESTRAINT

Some MDrive mounting configurations require that the MDrive move along the screw. Ensure that all cabling is properly restrained to provide strain relief on connection points..

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

THERMAL MANAGEMENT

The mounting plate material should offer sufficient mass and thermal conductivity to ensure that the motor temperature does not eceed 100°C.

Failure to follow these instructions can result in equipment damage.

A.12.1 Mounting

Care must be observed when installing the mounting screws on ALL MDrive 17 versions. The mounting holes on the flange are not drilled through and have a maximum depth of 0.150” (3.81 mm).

The warning note and Figure below illustrate the maximum safe thread length and maximum torque for mounting all versions of the MDrive 17.

Drill Pattern for Mounting Flange or Adapter Plate

Figure A12.1 MDrive 17 Mounting and Drill Pattern

A.12.2 Recommended Mating Connectors and Pins

Communication

10-pin Friction Lock (P2) ..... Hirose DF11-10DS-2C

Crimp pin for 10-pin Friction Lock (22 AWG)..... DF11-22SC

Crimp pin for 10-pin Friction Lock (24 - 28 AWG) DF11-2428SC

Crimp pin for 10-pin Friction Lock (30 AWG)..... DF11-30SC

10-pin pressure-fit IDC ..... Samtec TCSD-05-01-N

Ribbon cable..... Tyco 1-57051-9

Power and I/O

The following mating connectors are recommended for the MDrive 17 Plus^2 Units ONLY! Contact a JST distributor for ordering and pricing information.

16-pin Locking Wire Crimp Shell ..... JST PN PADP-16V-1-S

Crimp Pins ..... JST PN SPH-001T-P0.5L

A.12.3 Securing Power and Logic Leads

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

Figure A12.2 Securing Leads

A.13 MDrive 17 - Connection and Interface

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

A.13.1 Interfacing RS422/485 Communication

For general RS422/485 single and party mode communication practices, refer to Section 5 on page 18 of this document.

⚠ CAUTION

COMMUNICATION GROUND LOOPS

To avoid ground loops in the system only connect communication ground to the first MDrive in the system. Do not connect communication ground on subsequent MDrives.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect communication while the device is in a powered state.

Failure to follow these instructions may result in damage to system components!

P2 — 10-pin Pressure-fit IDC Style Connector

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table A13.1 Communication Connections, P2 - 10-pin IDC

Connectivity Accessories

Mating connector kit CK-01
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m)..... MD-CC400-001

P2 — 10-pin Friction Lock Wire Crimp

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table A13.2 P2 communication, 10-pin Friction Lock Wire Crimp

Connectivity Accessories

Mating connector kit CK-02
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m)..... MD-CC402-001

P2 — 5-pin M12 Industrial Connector

Pin #	Function	Description
1	TX -	Transmit minus
2	TX +	Transmit plus
3	RX +	Receive plus
4	RX -	Receive minus
5	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table A13.3 P2 Communication, 5-pin M12 Industrial Connector

Connectivity Accessories

Communication converter cable (10'/3.0 m).....MD-CC401-001

A.13.2 Interfacing CANopen Communication

P2 — 9-pin D-sub Connector (Female)

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table A13.4 CANopen communication, P2: 9-pin D-sub female (DB-9F)

Connectivity Accessories

Communication converter cable.....MD-CC500-000

P2 — 5-pin M12 Industrial Connector (Female)

Pin #	Function	Description
1	Shield	Optional CAN shield
2	CAN +V	+7 to +30 VDC power supply
3	CAN -V	Optional ground
4	CAN high	CAN_H bus line (high dominant)
5	CAN low	CAN_L bus line (low dominant)

Table A13.5 CANopen Communication, P2: 5-pin M12 Female

Connectivity Accessories

Communication converter cable MD-CC500-000

A.13.3 Interfacing DC Power

See Section 3 on page 10, for power cable configurations.

For information on sizing a DC power supply, refer to: https://motion.schneider-electric.com/application-note/sizing-dc-power-supply/

⚠ CAUTION

OVER VOLTAGE

The DC voltage range for the MDrive 17 is +12 to +48 VDC. Ensure that motor back EMF is factored into the power supply size calculations.

Allow 2.0 A maximum power supply output current per MDrive in the system. Actual power supply current will depend on voltage and load.

Failure to follow these instructions can result in equipment damage.

Power Supply Characteristics

Voltage range	+12 to +48 VDC
Type	Unregulated linear
Ripple	± 5%
Output current	2.0 A (per MDrive 17)

Table A13.6 Power Supply Characteristics

Power Supply Wire Gauge

Cable Length: Feet (meters)	10 (3.0)	25 (7.6)	50 (15.2)	75 (22.9)	100 (30.5)
Amps Peak	**Minimum AWG**				
1 Amp Peak	20	20	18	18	18
2 Amps Peak	20	18	16	14	14

Table A13.7 Power Supply Wire Gauge

P1 — 12' (30.5 cm) flying Leads Interface

Wire Color	
Red	Motor power supply
Black	Power ground

Table A13.8 Power and Ground Connections, Flying Leads

P1 — 7-pin Pluggable Terminal Interface

Pin #	
6	Power ground
7	Motor power supply

Table A13.9 Power and Ground Connections, 7-pin Terminal

P1 — 16-pin Locking Wire Crimp Interface

Pin Numbers	***Signal***	***Prototype development cable wire colors***
15	+12 to + 48 VDC	Red
16	Power and auxiliary ground	Black

Table A13.10 Power and Ground Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L04

P1 — 19-pin M23 Industrial Interface

Pin #	***Signal***	***Cable wire colors***
		MD-CS10x-000
6	Motor power supply	Blue
19	Power ground	Brown

Table A13.11 Power and Ground Connections, 12-pin Locking Wire Crimp

A mating connector kit is not available for this connector. Shop for compatible connectors at:

- Lumberg
- Phoenix
- Turck
- RDE Connectors

A.13.4 Power Interface using Drive Protection Module DPM75

The DPM75 Drive Protection Module will limit surge currents for up to three (3) MDrive 17 units at up to 48 VDC to allow switching DC Power.

* Do not switch negative side of supply
**Fuse = 6.3 Amp slow blow (recommended: Bussman S505-6.3A or Littelfuse 215006.3). The fuse is optional.

Figure A13.1 DPM75 Drive Protection Module

A.13.5 Interfacing I/O

See Section 4 on page 16, for I/O interface configurations and methods.

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O point is TTL level and only tolerant to +5 VDC:

1) Capture/Trip
2) Step/Direction
3) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

P1 — 12' (30.5 cm) Flying Leads Interface

Wire Color	*Signal*
White/yellow	General purpose I/O 1
White/orange	General purpose I/O 2
White/violet	General purpose I/O 3
White/blue	General purpose I/O 4
Green	Analog input

Table A13.12 I/O connections, Flying Leads

P1 — 7-pin Pluggable Terminal Interface

Pin number	*Signal*
1	General purpose I/O 1
2	General purpose I/O 2
3	General purpose I/O 3
4	General purpose I/O 4
5	Analog input

Table A13.13 I/O Connections, 7-pin Terminal

P1 — 16-pin Locking Wire Crimp Interface (Plus² Expanded Features)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	General purpose I/O 9	Yellow	Pair
8	General purpose I/O 10	Black	
9	General purpose I/O 11	Blue	Pair
10	General purpose I/O 12	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Step clock I/O	White	Pair
14	Direction clock I/O	Black	

Table A13.14 I/O Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L

P1 — 16-pin Locking Wire Crimp Interface (Remote Encoder)

Pin Numbers	***Signal***	***Prototype development cable wire colors (twisted pairs)***	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	Channel A +	Yellow	Pair
8	Channel A -	Black	
9	Channel B +	Blue	Pair
10	Channel B -	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Index +	White	Pair
14	Index -	Black	

Table A13.15 I/O and Remote Encoder Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L

P1 — 19-pin M23 Industrial Connector (Plus² Expanded Features)

Outside: Pins 1 -12

Inside: Pins 13 -19

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*
1	I/O 9	Violet
2	I/O 11	Red
3	Step/Clock I/O	Grey
4	I/O 1	Red/Blue
5	Direction I/O	Green
6	+VDC	Blue
7	Aux-Logic	Gray/Pink
8	Aux-Ground	White/Green
9	I/O 3	White/Yellow
10	I/O GND	White/Gray
11	I/O PWR	Black
12	Shell connect	Yellow/Green
13	I/O 12	Yellow/Brown
14	Capture/Trip I/O	Brown/Green
15	AIN	White
16	I/O 2	Yellow
17	I/O 4	Pink
18	I/O 10	Gray/Brown

Table A13.16 I/O Connections, 19-pin M23 Industrial

P1 — 19-pin M23 Industrial Connector (Remote Encoder)

Outside: Pins 1 -12

Inside: Pins 13 -19

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*
1	Channel A+	Violet
2	Channel B+	Red
3	Index +	Grey
4	I/O 1	Red/Blue
5	Index -	Green
6	+V	Blue
7	Aux-Logic	Gray/Pink
8	Aux-Ground	White/Green
9	I/O 3	White/Yellow
10	I/O GND	White/Gray
11	I/O PWR	Black
12	Shell connect	Yellow/Green
13	Channel B-	Yellow/Brown
14	Capture/Trip I/O	Brown/Green
15	AIN	White
16	I/O 2	Yellow
17	I/O 4	Pink
18	Channel A -	Gray/Brown

Table A13.17: I/O Connections, 19-pin M23 Industrial

A.14 MDrive 17 - Connectivity Accessory Details

A.14.1 RS-422/485 Communication Converter Cables

USB to 10-pin IDC Connector
P2 P/N: MD-CC400-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure A14.1 MD-CC400-000 Communication Converter Cable

USB to 10-pin Wire Crimp Connector
P2 P/N: MD-CC402-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure A14.2 MD-CC402-001 Communication Converter Cable

USB to 5-pin Industrial Connector P2— MD-CC401-000

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters.

No mating connector kit is available for this connector style. Compatible mating connectors may be purchased from the following suppliers:

- Phoenix
- Turck
- RDE Connectors

Figure A14.3 MD-CC401-001 Communication Converter

A.14.2 Prototype Development Cables

Flying Leads to10-pin Wire Crimp Connector P2 -P/N: PD10-1434-FL3

Used in conjunction with the MD-CC402-001 communication converter cable to facilitate multi-drop RS-422/485 communication.

Wire Colors	Function
White/Red Stripe	Aux-Logic
White/Blue Stripe	TX+
Blue/White Stripe	TX-
White/Orange Stripe	RX+
Orange/White Stripe	RX-
Green/White Stripe	GND

Figure A14.4 Multi-drop Communication using the PD10-1434-FL3

Procedure

1) Remove ground wire (unless this is the first system MDrive, green/white stripe)
2) Remove aux-logic (if not used, red/white stripe)
3) Connect pre-crimped flying leads as shown in Figure 5.7 below

Figure A14.5 Wiring a Second PD10-1434-FL3 into the 10-pin Wire Crimp Connector.

Flying Leads to16-pin Locking Wire Crimp Connector P2 -P/N: PD16-1417-FL3

The PD16-1417-FL3 prototype development cable is used to rapidly interface the MDrive 17 to the users controller. This 10’ (3.0 m) cable consists of a 16-pin locking wire crimp connector to plug directly into the MDrive P1 connector with flying leads on the opposite end to interface p

Pin #	*Wire Colors*	*Signal (Expanded features)*	*Signal (Remote encoder)*	*Pairs*
16	Black	GND	GND	X
15	Red	+V	+V	
14	Black	Step Clock I/O	Index –	X
13	White	Direction I/O	Index +	
12	Black	Analog Input	Analog Input	X
11	Green	Capture/Trip I/O	Capture/Trip I/O	
10	Black	I/O 12	Channel B –	X
9	Blue	I/O 11	Channel B +	
8	Black	I/O 10	Channel A –	X
7	Yellow	I/O 9	Channel A +	
6	Black	I/O 4	I/O 4	X
5	Brown	I/O 3	I/O 3	
4	Black	I/O 2	I/O 2	X
3	Orange	I/O 1	I/O 1	
2	White	I/O Ground	I/O Ground	X
1	Red	I/O Power	I/O Power	

Figure A14.6 Prototype Development Cable PD16-1417-FL3

A.14.3 Connectivity Option — 19 Conductor Cordset

19-pin M23 single-ended cordsets are offered to speed prototyping of the MDrive Accustep 34ac 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

Pin #	*Wire Colors*	*Signal (Expanded Features)*	*Signal (Remote encoder)*
1	Violet	I/O9	Channel A +
2	Red	I/O11	Channel B +
3	Gray	Step Clock	Index +
4	Red/Blue	I/O1	I/O1
5	Green	Direction	Index –
6	Blue	+V	+V
7	Gray/Pink	Aux-Logic	Aux-Logic
8	White/Green	Communication GND	Communication GND
9	White/Yellow	I/O3	I/O3
10	White/Gray	I/O GND	I/O GND
11	Black	I/O Power	I/O Power
12	Green/Yellow	Shell Connect	Shell Connect
13	Yellow/Brown	I/O12	Channel B –
14	Brown/Green	Capture/Trip	Capture/Trip
15	White	Analog In	Analog In
16	Yellow	I/O2	I/O2
17	Pink	I/O4	I/O4
18	Gray/Brown	I/O10	Channel A –
19	Brown	GND	GND

Figure A14.7 MD-CS10x-000 Cordset

A.14.4 Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC CK-01

P2 10-pin wire crimp CK-02

P1 16-pin wire crimp CK-10

P3 2-pin wire crimp CK-04

A.15 MDrive 23 - Introduction and Overview

The **MDrive® 23 Motion Control** offers system designers a cost effective, full featured programmable motion controller integrated with a NEMA 23 high torque 1.8° brushless step motor and a +12 up to +75 VDC* micro-stepping driver.

The unsurpassed smoothness and performance delivered by the MDrive 23 Motion Control are achieved through Schneider Electric Motion'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 MDrive 23 accepts a broad input voltage range from +12 up to +75 VDC*, delivering enhanced performance and speed. Oversized input capacitors are used to minimize power line surges, reducing problems that can occur with long cable runs and multiple drive systems. An extended operating range of –40° to +85°C provides long life, trouble free service in demanding environments.

Standard features of all MDrive 23 Motion Control include four +5 to +24 volt general purpose I/O lines, one 10 bit analog input, 0 to 5MHz step clock rate, 20 microstep resolutions up to 51,200 steps per revolution, and full featured easy-to-program instruction set.

Expanded features of MDrive 23 versions include up to eight +5 to +24 volt general purpose I/O lines and the capability of electronic gearing by following a rotary or linear axis at an electronically controlled ratio, or an output clock can be generated fixed to the internal step clock.

All MDrive 23 Motion Control are available with optional closed loop control. This increases functionality by adding stall detection, position maintenance and find index mark.

The closed loop configuration is added via a 512 line (2048 edge) magnetic encoder with index mark, internal to the unit so there is no increase in length. Or, for an expanded choice of line counts and resolutions with MDrive 23 versions only, closed loop control is available with an interface to a remotely mounted user-supplied external encoder.

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

Optional communication protocols include CANopen. The CAN bus is 2.0B active (11 and/or 29 bit) and is capable of all standard frequencies from 10kHz to 1MHz. CANopen features include node guarding, heartbeat producer, SDOs and PDOs. Highlights include variable PDO mapping and extended node identifier.

Motor configurations include a single shaft rotary in four lengths, and linear actuators with long life modified Acme screw.

Numerous connector styles provide choices for the best fit and features. Select from 12.0" (30.5cm) flying leads, pluggable terminal strip, locking wire crimp connectors, and M12/M23 industrial connectors.

MDrive connectivity has never been easier with options ranging from all-inclusive QuickStart Kits to individual interfacing cables and mating connector kits to build cables.

The MDrive 23 is a compact, powerful and cost effective motion control solution that will reduce system cost, design and assembly time for a large range of brushless step motor applications.

A.15.1 Product Identification

MDrive® 23 Plus

P1: I/O & Power
F = 12" flying leads
P = non-locking spring clamp terminal strip

P2: Communication
D = RS-422/485 with 10-pin IDC non-locking connector
L = RS-422/485 with 10-pin friction lock wire crimp connector

MDrive® 23 Plus²

P1: I/O, and optional remote encoder
C = 14-pin locking wire crimp connector

P3: Power
2-pin locking wire crimp connector

P2: Communication
D = RS-422/485 with 10-pin IDC non-locking connector
L = RS-422/485 with 10-pin friction lock wire crimp connector
R = Ethernet with RJ45 locking connector

MDrive® 23 Plus²
with industrial connectors

P2: Communication
Q = RS-422/485 with 5-pin M12 female industrial connector

P1: I/O & Power, and optional remote encoder
M = 19-pin M23 male industrial connector

Part numbers

Example:	K	M	D	I	1	F	R	D	2	3	A	7	–EQ
QuickStart Kit **K** = kit option, or leave blank if not wanted	**K**	M	D	I	1	F	R	D	2	3	A	7	–EQ
MDrive Plus version **MDI** = Motion Control	K	**M**	**D**	**I**	1	F	R	D	2	3	A	7	–EQ
Input **1** = Plus, standard features **3** = Plus², expanded features **4** = Plus², expanded features, with industrial connectors, IP54-rated	K	M	D	I	**1**	F	R	D	2	3	A	7	–EQ
P1 connector **F** = flying leads **P** = pluggable **C** = wire crimp *(1)* **M** = M23 industrial connector *(2)*	K	M	D	I	1	**F**	R	D	2	3	A	7	–EQ
Communication **R** = RS-422/485	K	M	D	I	1	F	**R**	D	2	3	A	7	–EQ
P2 connector **D** = IDC **L** = wire crimp **R** = RJ45 **Q** = M12 industrial connector *(2)*	K	M	D	I	1	F	R	**D**	2	3	A	7	–EQ
Motor size **23** = NEMA 23 (2.3" / 57 mm)	K	M	D	I	1	F	R	D	**2**	**3**	A	7	–EQ
Motor length *(3)* **A** = single stack **B** = double stack **C** = triple stack **D** = quad stack	K	M	D	I	1	F	R	D	2	3	**A**	7	–EQ
Drive voltage *(3)* **7** = +12 to +75 VDC **6** = +12 to +60 VDC	K	M	D	I	1	F	R	D	2	3	A	**7**	–EQ
Options Leave blank if not wanted Options may be combined, unless noted **–EQ** = internal encoder, 512-line internal magnetic encoder with index mark **–EE** = remote encoder interface, differential encoder to be provided by user *Available with Plus² versions only. May not be combined with internal encoder option.* **–N** = rear control knob for manual positioning *(4)*													**–EQ**

(1) Only available with Plus² products without industrial connectors.
(2) Only available with Plus² products with industrial connectors.
(3) Only quad stack motors have +12 to +60 VDC drives, all other motors have +12 to +75 VDC drives.
(4) Not available with industrial connector products.

Figure A13.1 Standard Product Options

A.16 MDrive 23 - Specifications

A.16.1 Dimensional Information - Standard and Expanded Features Version

Motor stack length	Lmax	Lmax1 (1)	Lmax2
Single	2.65 (67.31)	2.85 (72.39)	3.36 (85.34)
Double	3.02 (76.71)	3.22 (81.79)	3.73 (94.74)
Triple	3.88 (98.55)	4.08 (103.63)	4.59 (116.59)
Quad	5.28 (134.15)	5.48 (139.19)	5.99 (152.19)

(1) Grounding screw is not present on all products.

Figure A16.1 Standard and Expanded Features Mechanical Specifications

A.16.2 Dimensional Information - Sealed Version

Motor Length	LMAX	LMAX2	LMAX3*
Single	2.82 (71.63)	3.48 (88.39)	3.42 (86.87)
Double	3.16 (80.26)	3.82 (97.03)	3.76 (95.5)
Triple	4.02 (102.11)	4.67 (118.62)	4.62 (117.35)

*CANopen increases measurement by 0.09"/2.0mm

Figure A16.2 Sealed Mechanical Specifications

A.16.3 Electrical Specifications

	Condition	Min	Typ	Max	Unit
Input voltage range **CAUTION**: Reverse polarity on the input power will likely damage the drive.	Single, double and triple length motors	+12	—	+75	VDC
	Quad length motor	+12		+60	
Max power supply current*	Single, double and triple length motors				
	Quad length ,motor				
Aux-Logic Input Voltage	—	+12	—	+24	VDC
Max Aux-Logic Supply Current (Per MDrive)**	—	—	—	194	mA

**per MDrive 23, Actual current depends on voltage and load.*
*** Maintains power to control and feedback circuits [only] when input voltage is removed*

Table A16.1 Electrical Specifications

A.16.4 Standard I/O Specifications (Plus)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-4)	—	4 I/O points configurable as sinking or sourcing inputs or sinking outputs			
General Purpose I/O - Electrical					
Inputs	—	TTL	—	+24	VDC
Sinking Outputs (All)	—	—	—	+24	VDC
Output Sink Continuous Current	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Logic Threshold	Logic 0	—	—	< 0.8	VDC
	Logic 1	—	—	> 2.2	VDC
Protection	Sinking	Over temp, short circuit			
	Sourcing	Transient Over Voltage, Inductive Clamp			
Analog Input					
Resolution	—				
Range	Voltage Mode	0 to +5 VDC, 0 to +10 VDC			
	Current Mode	4 to 20 mA, 0 to 20mA			
Clock I/O					
Types	—	Step/Direction, Up/Down, Quadrature			
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			
Trip Output/Capture Input					
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			

Table A16.2 I/O Specifications

A.16.5 Expanded I/O Specifications (Plus^2)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-8)	—	8 I/O points (4 if configured for remote encoder) configurable as sinking or sourcing inputs or outputs			
General Purpose I/O - Electrical					
Inputs	Sinking or Sourcing	TTL	—	+24	VDC
Outputs	Sinking	—	—	+24	VDC
	Sourcing	+12		+24	VDC
Output Sink Continuous Current **NOTE**: Output ratings apply to each bank of four I/O. First bank: Output 1-4 Second bank: Output 9-12	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA

Motion I/O					
Electronic gearing	Ratio Range	0.001	—	2.000	
	Ratio Resolution	—	—	0.001	
	Threshold	—	—	TTL	VDC
	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz)	
	Secondary clock out ratio				1:1
High speed position capture	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz)	
	Resolution	—	—	32	bit
High speed trip output	Speed	—	—	150	nS
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
Optional remote encoder					
Type				User supplied differential encoder	
Steps per revolution				See motion specifications table	
Resolution	User defined . Note: microsteps/rev = 2X the encoder counts/rev minimum.				

**Remote encoder inputs replace I/O points 4-8 and step and direction I/O*

Table A16.3 Expanded I/O Specifications

A.16.6 Communication Specifications

	Condition	Min	Typ	Max	Unit
RS-422/485 (standard)					
BAUD rate	—	4.8		115.2	kbps
CANopen (optional)					
Type					2.0B active
BAUD rate	—	10 kHz	—	1 MHz	—
Application layer	Version 3.0				DS-301
Device profile	Version 2.0				DSP-402
ID	—				11 or 29 bit
Isolation	—				Galvanic

Table A16.4 Communication Specifications

A.16.7 Thermal Specifications

		Min	Typ	Max	Unit
Heat sink temperature	non-condensing humidity	-40	—	+85	ºC
Motor temperature	non-condensing humidity	-40	—	+100	ºC

Table A16.5 Thermal Specifications

A.16.8 Motion Specifications

Microstep Resolution - Open Loop	
Number of microstep resolutions	20

Available microsteps per revolution

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

1=0.01 deg/µstep 2=1 arc minute/µstep *3=0.001 mm/µstep
** 1" per revolution lead screw*

Microstep resolution (closed loop configuration - (optional)	
Steps Per Revolution (Fixed)	51200
Position Resolution	2048
Optional encoder (internally mounted)	
Type	Internal, Magnetic
Resolution (Lines)	512
Resolution (Edges)	2048
Counters	
Counter 1 (C1) Type	Microstep
Counter 2 (C2) Type	Encoder
Resolution	32 bit
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

Table A16.6 Motion Specifications

A.16.9 Software Specifications

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

Table A16.7 Software Specifications

A.16.10 Motor Specifications

Specification	Single length	Double length	Triple length	Quad length
Holding torque oz-in (N-cm)	90.0 (64)	144 (102)	239 (169)	283 (200)
Detent torque oz-in (N-cm)	3.9 (2.7)	5.6 (3.92)	9.7 (6.86)	14.2 (10.0)
Rotor inertia oz-in-sec^2 (kg-cm^2)	0.0025 (0.18)	0.0037 (0.26)	0.0065 (0.46)	0.0108 (0.76)
Weight motor and driver oz (g)	21.6 (612.3)	26.4 (784.4)	39.2 (1111.3)	61.6 (1746.3)

Table A16.8 MDrive 23 Motor Specifications

A.16.11 Speed-Torque Performance Curves

Single Length Motor

Figure A16.3 Motor Performance Curve — Single Length Motor

Double Length Motor

Figure A16.4 Motor Performance Curve — Double Length Motor

Triple Length Motor

Figure A16.5 Motor Performance Curve — Triple Length Motor

Quad Length Motor

Figure A16.6 Motor Performance Curve — Quad Length Motor

A.17 MDrive 23 - Connectivity Specifications/PIN Assignments

A.17.1 RS-422/485 Communication

10-pin Friction Lock Wire Crimp

Connectivity Options
USB to RS-422/485 Converter:
MD-CC402-001

Mating connector kit:
CK-02

Mfg P/N:
Shell
Hirose DF11-10DS-2C

Pins
Hirose: DF11-2428SC

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table 17.1 P2 Communication, 10-pin Locking Wire Crimp

10-pin Press-Fit (IDC Style)

Connectivity Options
USB to RS-422/485 Converter:
MD-CC400-001

Mating connector kit:
CK-01

Mfg P/N:
Shell
SAMTEC: TCSD-05-01-N

Ribbon cable
Tyco: 1-57051-9

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table 17.2 P2 Communication, 10-pin Pressure Fit IDC/SAMTEC

5-pin M12 Industrial

Pin #	Function	Description
1	TX -	Transmit minus
2	TX +	Transmit plus
3	RX +	Receive plus
4	RX -	Receive minus
5	Communication Gnd	Communication ground

Table A17.3 P2 Communication, 5-pin Industrial IDC/SAMTEC

Connectivity Options
USB to RS-422/485 Converter:
MD-CC401-001

A.17.2 CANopen Communication Option

9-pin D-sub Female (DB-9F)

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table A17.4 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

Connectivity Options
USB to CANopen converter:
MD-CC500-000

5-pin M12 Industrial

Pin #	Function	Description
1	Shield	Optional CAN shield
2	CAN +V	+7 to +30 VDC power supply
3	CAN -V	CAN communication ground
4	CAN high	CAN_H bus line (high dominant)
5	CAN low	CAN_L bus line (low dominant)

Table A17.5 CANopen Communication, P2: 5-pin D-sub Female

Connectivity Options
USB to CANopen converter:
MD-CC500-000

A.18 MDrive 23 - Connectivity Specifications/Pin Assignments

A.18.1 Power and I/O - Standard I/O (Plus)

12” (304.8 mm) Flying Leads

Wire Color	Function	Description
White/yellow	I/O 1	General purpose I/O point 1
White/orange	I/O 2	General purpose I/O point 2
White/violet	I/O 3	General purpose I/O point 3
White/blue	I/O 4	General purpose I/O point 4
Green	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
Black	GND	Power and auxiliary ground
Red	+V	Motor power

Table A18.1 Power and I/O Interface - 12” (308.8.mm) Flying Leads

7-pin Pluggable Terminal

Pin #	Function	Description
1	I/O 1	General purpose I/O point 1
2	I/O 2	General purpose I/O point 2
3	I/O 3	General purpose I/O point 3
4	I/O 4	General purpose I/O point 4
5	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
6	GND	Power and auxiliary ground
7	+V	Motor power

Table 18.2 Power and I/O Interface - 7-pin Pluggable Terminal

A.18.2 DC Motor Power

2-pin Friction Lock Wire Crimp

Pin #	Function	Description
1	+V	+12 to +60 VDC motor power
2	Ground	Power supply return (ground)

Table 18.3 P3 DC Power, 2-pin Locking Wire Crimp

Connectivity Options
Prototype development cable *PD-02-2300-FL3*

Mating connector kit:
CK-04

Mfg P/N:
Shell
Tyco 794617-2

Pins
Tyco 794610-1

A.18.3 I/O - Expanded I/O (Plus[2])

14-pin Locking Wire Crimp

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	I/O 9[1]	0 to +24 VDC Programmable I/O Point 9
8	I/O 10[1]	0 to +24 VDC Programmable I/O Point 10
9	I/O 11[1]	0 to +24 VDC Programmable I/O Point 11
10	I/O 12[1]	0 to +24 VDC Programmable I/O Point 12
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input
13	Step/clock I/O	Step clock I/O. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
14	Direction/ clock I/O	Direction I/O. Can also be configured as quadrature or clock up/down. +5 VDC logic level.

Table 18.4 P1 Expanded I/O, 14-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD14-2334-FL3

Mating connector kit:
CK-09

Mfg P/N:
Shell
JST PADP-14V-1-S

Pins
JST SPH-001T0.5L

A.18.4 I/O - Remote Encoder (Plus²)

14-pin Locking Wire Crimp

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	CH A+	Channel A+ encoder input. +5 VDC logic level
8	CH A-	Channel A- encoder input. +5 VDC logic level
9	CH B+	Channel B+ encoder input. +5 VDC logic level
10	CH B-	Channel B- encoder input. +5 VDC logic level
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	IDX+	Index mark + encoder input. +5 VDC logic level
14	IDX-	Index mark - encoder input. +5 VDC logic level

Table A18.6 I/O and Remote Encoder Interface - 14-pin Locking Wire Crimp

A.18.5 DC Power and I/O - Expanded I/O (Plus² with Industrial Connectors)

19-pin M23 Industrial

Outside: Pins 1 -12

Inside: Pins 13 -19

Connectivity Options

Prototype development cable:
MD-CS100-000 (straight)
MD-CS101-000 (right-angle)

Pin #	Function	Description
1	I/O 9	0 to +24 VDC Programmable I/O Point 9.
2	I/O 11	0 to +24 VDC Programmable I/O Point 11.
3	Step/Clock I/O	0 to +5 VDC Step Clock I/O. Can also be configured as Quadrature or Clock Up/Down.
4	I/O 1	0 to +24 VDC Programmable I/O Point 1.
5	Direction/clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
6	+V	Motor power input
7	Aux-Logic	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
8	Aux-Ground	Auxiliary Ground.
9	I/O 3	0 to +24 VDC Programmable I/O Point 3.
10	I/O GND	Non-isolated I/O ground. Common with power ground.
11	I/O PWR	I/O Power, used with sourcing inputs or outputs. See Section 5 for more details.
12	Shell	Shell connect
13	I/O 12	0 to +24 VDC Programmable I/O Point 12.
14	Capture/Trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
15	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
16	I/O 2	0 to +24 VDC Programmable I/O Point 2.
17	I/O 4	0 to +24 VDC Programmable I/O Point 4.
18	I/O 10	0 to +24 VDC Programmable I/O Point 10.
19	GND	Power ground

Table A18.7 P1 I/O and Aux Power, 19-pin IM23 Industrial Connector

A.18.6 DC Power and I/O - Remote Encoder (Plus² with Industrial Connectors)

19-pin M23 Industrial

Outside: Pins 1 -12

Inside: Pins 13 -19

Connectivity Options

Prototype development cable:
MD-CS100-000 (straight)
MD-CS101-000 (right-angle)

Pin #	Function	Description
1	CH A+	Channel A+ encoder input. +5 VDC logic level
2	CH B+	Channel B+ encoder input. +5 VDC logic level
3	IDX+	Index mark + encoder input. +5 VDC logic level
4	I/O 1	0 to +24 VDC Programmable I/O Point 1.
5	IDX-	Index mark - encoder input. +5 VDC logic level
6	+V	Motor power input
7	Aux-Logic	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
8	Aux-Ground	Auxiliary Ground.
9	I/O 3	0 to +24 VDC Programmable I/O Point 3.
10	I/O GND	Non-isolated I/O ground. Common with power ground.
11	I/O PWR	I/O Power, used with sourcing inputs or outputs. See Section 5 for more details.
12	Shell	Shell connect
13	CH B-	Channel B- encoder input. +5 VDC logic level
14	Capture/Trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
15	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
16	I/O 2	0 to +24 VDC Programmable I/O Point 2.
17	I/O 4	0 to +24 VDC Programmable I/O Point 4.
18	CH A-	Channel A- encoder input. +5 VDC logic level
19	GND	Power ground

Table A18.8 P1 I/O and Aux Power, 19-pin M23 Industrial Connector

A.18.7 Options

Internal Encoder

Internal magnetic 512 line quadrature encoders with index mark are available:

Remote Encoder (Plus² Versions Only)

MDrive 23 Motion Control versions are available with differential encoder inputs for use with a remote encoder (not supplied).

Control Knob

The MDrive 23 is available with a factory-mounted rear control knob for manual shaft positioning.

A.18.8 Connectivity

QuickStart Kit

For rapid design verification, all-inclusive QuickStart Kits have communication converter, prototype development cable(s), instructions and CD for MDrive initial functional setup and system testing.

Communication Converters

Electrically isolated, in-line converters pre-wired with mating connectors to conveniently set/program communication parameters for a single MDrive product via a PC's USB port. Length 12.0' (3.6m).

Mates to connector:

P2 10-pin pressure-fit IDC MD-CC400-001

P2 5-pin M12 industrial MD-CC401-001

P2 10-pin wire crimp MD-CC402-001

Prototype Development Cables

Speed test/development with pre-wired mating connectors that have flying leads other end. Length 10.0' (3.0m).

Mates to connector:

P2 10-pin wire crimp PD10-1434-FL3

P1 14-pin wire crimp PD14-2334-FL3

P1 19-pin M23 industrial (straight) MD-CS100-000

P1 19-pin M23 industrial (right-angle) MD-CS101-000

P3 2-pin wire crimp PD02-2300-FL3

Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC CK-01

P2 10-pin wire crimp CK-02

P1 14-pin wire crimp CK-09

P3 2-pin wire crimp CK-04

A.19 MDrive 23 - Mounting and Connection Information

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

LEAD RESTRAINT

Some MDrive mounting configurations require that the MDrive move along the screw. Ensure that all cabling is properly re-strained to provide strain relief on connection points..

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

THERMAL MANAGEMENT

The mounting plate material should offer sufficient mass and thermal conductivity to ensure that the motor temperature does not exceed 100°C.

Failure to follow these instructions can result in equipment damage.

A.19.1 Mounting

Figure A19.1 MDrive 23 Mounting and Drill Pattern

A.19.2 Recommended Mating Connectors and Pins

Communication

10-pin Friction Lock (P2) ..... Hirose DF11-10DS-2C

Crimp Contact for 10-pin Friction Lock (22 AWG) DF11-22SC

Crimp Contact for 10-pin Friction Lock (24 - 28 AWG) DF11-2428SC

Crimp Contact for 10-pin Friction Lock (30 AWG) DF11-30SC

I/O

The following mating connectors are recommended for the MDrive 17 Plus^2 Units ONLY! Contact a JST distributor for ordering and pricing information.

14-pin Locking Wire Crimp Connector Shell .....JST PN PADP-14V-1-S

Crimp Pins .....JST PN SPH-001T-P0.5L

Power

2-pin Locking Wire Crimp Connector Shell ..... Tyco 794617-2

Crimp Pins ..... Tyco 794610-1

A.19.3 Securing Power Leads and Logic Leads

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

Figure A19.2 Securing leads

A.20 MDrive 23 - Connection and Interface

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

A.20.1 Interfacing RS422/485 Communication

For general RS422/485 single and party mode communication practices, refer to Section 5 on page 18 of this document.

⚠ CAUTION

COMMUNICATION GROUND LOOPS

To avoid ground loops in the system only connect communication ground to the first MDrive in the system. Do not connect communication ground on subsequent MDrives.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect communication while the device is in a powered state.

Failure to follow these instructions may result in damage to system components!

P2 — 10-pin Pressure-Fit IDC Style Connector

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table A20.1 Communication Connections, P2 - 10-pin IDC

Connectivity Accessories

Mating connector kit CK-01
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m).....MD-CC400-001

P2 — 10-pin Friction Lock Wire Crimp

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table A20.2 P2 Communication, 10-pin Friction Lock Wire Crimp

Connectivity Accessories

Mating connector kit CK-02
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m).....MD-CC402-001

P2 — 5-pin M12 Industrial Connector (Male)

Pin #	Function	Description
1	TX -	Transmit minus
2	TX +	Transmit plus
3	RX +	Receive plus
4	RX -	Receive minus
5	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table A20.3 P2 Communication, 5-pin M12F Industrial Connector

Connectivity Accessories

Communication converter cable (10'/3.0 m).....MD-CC401-001

A.20.2 Interfacing CANopen Communication

P2 — 9-pin D-sub Connector (Female)

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table A20.5 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

Connectivity Accessories

Communication converter cable.....MD-CC500-000

P2 — 5-pin M12 Industrial Connector (Female)

Pin #	Function	Description
1	Shield	Optional CAN shield
2	CAN +V	+7 to +30 VDC power supply
3	CAN -V	Optional ground
4	CAN high	CAN_H bus line (high dominant)
5	CAN low	CAN_L bus line (low dominant)

Table A20.6 CANopen Communication, P2: 5-pin M12 Female

Connectivity Accessories

Communication converter cable MD-CC500-000

A.20.3 Interfacing DC Power

See Section 3 on page 10, for recommended power cable configurations.

For information on sizing a DC power supply, refer to: https://motion.schneider-electric.com/application-note/sizing-dc-power-supply/

⚠ CAUTION

OVER VOLTAGE

The DC voltage range for the MDrive 23 is +12 to +60 VDC. Ensure that motor back EMF is factored into the power supply size calculations.

Allow 3.0 A maximum power supply output current per MDrive in the system. Actual power supply current will depend on voltage and load.

Failure to follow these instructions can result in equipment damage.

Recommended Power Supply Characteristics

Voltage range	+12 to +75 VDC
Type	Unregulated linear
Ripple	± 5%
Output current	3.0 A (per MDrive 23

Table A20.7 Recommended Power Supply Characteristics

Recommended Wire Gauge

Cable Length: Feet (meters)	10 (3.0)	25 (7.6)	50 (15.2)	75 (22.9)	100 (30.5)
Amps Peak	**Minimum AWG**				
1 Amp Peak	20	20	18	18	18
2 Amps Peak	20	18	16	14	14
3 Amps Peak	18	16	14	12	12

Table A20.8 Recommended Power Supply Wire Gauge

P1 — 12' (30.5 cm) Flying Leads Interface

Wire Color	
Red	Motor power supply
Black	Power ground

Table A20.9 Power and Ground Connections, Flying Leads

P1 — 7-pin Pluggable Terminal Interface

Pin #	
6	Power ground
7	Motor power supply

Table A20.10 Power and Ground Connections, 7-pin Terminal

P1 — 7-pin Wire Crimp Interface

Pin #		PD02-2300-FL3 wire colors
6	Power ground	Black
7	Motor power supply	Red

Table A20.11 Power and Ground Connections, 7-pin Terminal

Connectivity Accessories

Prototype development cable PD02-2300-FL3

Mating connector kit CK-04
(contains 5 connector shells, ribbon cable not included)

P1 — 19-pin M23 Industrial Interface

Pin #	Signal	Cable wire colors
		MD-CS10x-000
6	Motor power supply	Blue
19	Power ground	Brown

Table A20.12 Power and Ground Connections, 19-pin Locking Wire Crimp

A mating connector kit is not available for this connector. Shop for compatible connectors at:

- Lumberg
- Phoenix
- Turck
- RDE Connectors

A.20.4 Interfacing I/O

See Section 4 on page 16, for I/O interface configurations and methods.

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O point is TTL level and only tolerant to +5 VDC:

1) Capture/Trip
2) Step/Direction
3) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

P1 — 12' (30.5 cm) Flying Leads Interface

Wire Color	*Signal*
White/yellow	General purpose I/O 1
White/orange	General purpose I/O 2
White/violet	General purpose I/O 3
White/blue	General purpose I/O 4
Green	Analog input

Table A20.13 I/O Connections, Flying Leads

P1 — 7-pin Pluggable Terminal Interface

Pin number	*Signal*
1	General purpose I/O 1
2	General purpose I/O 2
3	General purpose I/O 3
4	General purpose I/O 4
5	Analog input

Table A20.14 I/O Connections, 7-pin Terminal

P1 — 14-pin Locking Wire Crimp Interface (Expanded I/O)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	Black	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	General purpose I/O 9	Yellow	Pair
8	General purpose I/O 10	Black	
9	General purpose I/O 11	Blue	Pair
10	General purpose I/O 12	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Step clock I/O	White	Pair
14	Direction clock I/O	Black	

Table A20.15 I/O Connections, 14-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-09
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD14-2334-FL3

Manufacturer (JST) Part Numbers

Connector shell..... PADP-14V-1-S

Pins..... SPH-001T0.5L

P1 — 14-pin Locking Wire Crimp Interface (Remote Encoder)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	Channel A +	Yellow	Pair
8	Channel A -	Black	
9	Channel B +	Blue	Pair
10	Channel B -	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Index +	White	Pair
14	Index -	Black	

Table A20.17 I/O and Remote Encoder Connections, 14-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-09
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD14-2334-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-14V-1-S

Pins..... SPH-001T0.5L

P1 — 19-pin M23 Industrial Connector (Expanded I/O)

Outside: Pins 1 -12

Inside: Pins 13 -19

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*
1	I/O 9	Violet
2	I/O 11	Red
3	Step/Clock I/O	Grey
4	I/O 1	Red/Blue
5	Direction I/O	Green
6	+VDC	Blue
7	Aux-Logic	Gray/Pink
8	Aux-Ground	White/Green
9	I/O 3	White/Yellow
10	I/O GND	White/Gray
11	I/O PWR	Black
12	Shell connect	Yellow/Green
13	I/O 12	Yellow/Brown
14	Capture/Trip I/O	Brown/Green
15	AIN	White
16	I/O 2	Yellow
17	I/O 4	Pink
18	I/O 10	Gray/Brown

Table A20.18 I/O Connections, 19-pin M23 Industrial

P1 — 19-pin M23 Industrial Connector (Remote Encoder)

Outside: Pins 1 -12

Inside: Pins 13 -19

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*
1	Channel A+	Violet
2	Channel B+	Red
3	Index +	Grey
4	I/O 1	Red/Blue
5	Index -	Green
6	+V	Blue
7	Aux-Logic	Gray/Pink
8	Aux-Ground	White/Green
9	I/O 3	White/Yellow
10	I/O GND	White/Gray
11	I/O PWR	Black
12	Shell connect	Yellow/Green
13	Channel B-	Yellow/Brown
14	Capture/Trip I/O	Brown/Green
15	AIN	White
16	I/O 2	Yellow
17	I/O 4	Pink
18	Channel A -	Gray/Brown

Table A20.19 I/O Connections, 19-pin M23 Industrial

A.21 MDrive 23 - Connectivity Accessory Details

A.21.1 RS-422/485 Communication Converter Cables

USB to 10-pin IDC Connector P2
P/N: MD-CC400-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure A21.1 MD-CC400-000 Communication Converter Cable

USB to 10-pin Wire Crimp Connector P2
P/N: MD-CC402-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure A21.2 MD-CC402-001 Communication Converter Cable

USB to 5-pin Industrial Connector P2—MD-CC401-000

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters.

No mating connector kit is available for this connector style. Compatible mating connectors may be purchased from the following suppliers:

- Phoenix
- Turck
- RDE Connectors

Figure A21.3 MD-CC401-001 Communication Converter

A.21.2 Prototype Development Cables

Flying Leads to10-pin Wire Crimp Connector P2 -P/N: PD10-1434-FL3

Used in conjunction with the MD-CC402-001 communication converter cable to facilitate multi-drop RS-422/485 communication.

Wire Colors	Function
White/Red Stripe	Aux-Logic
White/Blue Stripe	TX+
Blue/White Stripe	TX-
White/Orange Stripe	RX+
Orange/White Stripe	RX-
Green/White Stripe	GND

Figure A21.4 Multi-drop Communication using the PD10-1434-FL3

Procedure

1) Remove ground wire (unless this is the first system MDrive, green/white stripe)
2) Remove aux-logic (if not used, red/white stripe)
3) Connect pre-crimped flying leads as shown in Figure 5.7 below

Figure A21.5 Wiring a Second PD10-1434-FL3 into the 10-pin Wire Crimp Connector.

Flying Leads to14-pin Locking Wire Crimp Connector P2 -P/N: PD14-2334-FL3

The PD14-2334-FL3 prototype development cable is used to rapidly interface the MDrive 23 to the users controller. This 10’ (3.0 m) cable consists of a 14-pin locking wire crimp connector to plug directly into the MDrive P1 connector with flying leads on the opposite end to interface

Pin #	*Wire Colors*	*Signal (Expanded features)*	*Signal (Remote encoder)*	*Pairs*
14	Black	Step Clock I/O	Index –	X
13	White	Direction I/O	Index +	
12	Black	Analog Input	Analog Input	X
11	Green	Capture/Trip I/O	Capture/Trip I/O	
10	Black	I/O 12	Channel B –	X
9	Blue	I/O 11	Channel B +	
8	Black	I/O 10	Channel A –	X
7	Yellow	I/O 9	Channel A +	
6	Black	I/O 4	I/O 4	X
5	Brown	I/O 3	I/O 3	
4	Black	I/O 2	I/O 2	X
3	Orange	I/O 1	I/O 1	
2	Black	I/O Ground	I/O Ground	X
1	Red	I/O Power	I/O Power	

Figure A21.6 Prototype Development Cable PD14-2334-FL

Flying Leads to 2-pin Locking Wire Crimp Connector P2 -P/N: PD02-2300-FL3

The PD02-2300-FL3 prototype development cable is used to rapidly interface the MDrive 23 to the users DC power supply. This 10’ (3.0 m) cable consists of a 2-pin locking wire crimp connector to plug directly into the MDrive P3 connector with flying leads on the opposite end to interface to DC power.

Pin #	***Wire Colors***	***Signal (Expanded features)***
2	Black	Ground
1	Red	+V

Figure A21.7 Prototype Development Cable PD02-2300-FL3

A.21.3 Connectivity Option — 19 Conductor Cordset

19-pin M23 single-ended cordsets are offered to speed prototyping. 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

Pin #	*Wire Colors*	*Signal (Expanded Features)*	*Signal (Remote encoder)*
1	Violet	I/O9	Channel A +
2	Red	I/O11	Channel B +
3	Gray	Step Clock	Index +
4	Red/Blue	I/O1	I/O1
5	Green	Direction	Index –
6	Blue	+V	+V
7	Gray/Pink	Aux-Logic	Aux-Logic
8	White/Green	Communication GND	Communication GND
9	White/Yellow	I/O3	I/O3
10	White/Gray	I/O GND	I/O GND
11	Black	I/O Power	I/O Power
12	Green/Yellow	Shell Connect	Shell Connect
13	Yellow/Brown	I/O12	Channel B –
14	Brown/Green	Capture/Trip	Capture/Trip
15	White	Analog In	Analog In
16	Yellow	I/O2	I/O2
17	Pink	I/O4	I/O4
18	Gray/Brown	I/O10	Channel A –
19	Brown	GND	GND

Figure A21.8 MD-CS10x-000 Cordset

A.21.4 Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC CK-01

P2 10-pin wire crimp CK-02

P1 14-pin wire crimp CK-09

P3 2-pin wire crimp CK-04

A.22 MDrive 34 - Introduction and Overview

The **MDrive® 34 Motion Control** offers system designers a cost effective, full featured programmable motion controller integrated with a NEMA 34 high torque 1.8° brushless step motor and a +12 up to +75 VDC* micro-stepping driver.

The unsurpassed smoothness and performance delivered by the MDrive 34 Motion Control are achieved through 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 MDrive 34 accepts a broad input voltage range from +12 up to +75 VDC*, delivering enhanced performance and speed. Oversized input capacitors are used to minimize power line surges, reducing problems that can occur with long cable runs and multiple drive systems. An extended operating range of –40° to +85°C provides long life, trouble free service in demanding environments.

Standard features of all MDrive 34 Motion Control include four +5 to +24 volt general purpose I/O lines, one 10 bit analog input, 0 to 5MHz step clock rate, 20 microstep resolutions up to 51,200 steps per revolution, and full featured easy-to-program instruction set.

Expanded features of MDrive 34 versions include up to eight +5 to +24 volt general purpose I/O lines and the capability of electronic gearing by following a rotary or linear axis at an electronically controlled ratio, or an output clock can be generated fixed to the internal step clock.

All MDrive 34 Motion Control are available with optional closed loop control. This increases functionality by adding stall detection, position maintenance and find index mark.

The closed loop configuration is added via a 512 line (2048 edge) magnetic encoder with index mark, internal to the unit so there is no increase in length. Or, for an expanded choice of line counts and resolutions with MDrive 34 versions only, closed loop control is available with an interface to a remotely mounted user-supplied external encoder.

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

Optional communication protocols include CANopen. The CAN bus is 2.0B active (11 and/or 29 bit) and is capable of all standard frequencies from 10kHz to 1MHz. CANopen features include node guarding, heartbeat producer, SDOs and PDOs. Highlights include variable PDO mapping and extended node identifier.

Numerous connector styles provide choices for the best fit and features. Select from 12.0” (30.5cm) flying leads or locking wire crimp connectors.

MDrive connectivity has never been easier with options ranging from all-inclusive QuickStart Kits to individual interfacing cables and mating connector kits to build cables.

The MDrive 34 is a compact, powerful and cost effective motion control solution that will reduce system cost, design and assembly time for a large range of brushless step motor applications.

A.22.1 Product Identification

MDrive® 34 Plus
flying leads interface

P1: I/O & Power
F = 12" flying leads

P2: Communication
D = RS-422/485 with 10-pin IDC non-locking connector
L = RS-422/485 with 10-pin friction lock wire crimp connector

MDrive® 34 Plus²
pluggable interface

P1: I/O, and optional remote encoder
C = 14-pin locking wire crimp connector (20-pin with remote encoder option)

P3: Power
2-pin locking wire crimp connector

P2: Communication
L = RS-422/485 with 10-pin friction lock wire crimp connector

Part numbers

Example:	K	M	D	I	1	F	R	D	3	4	A	7	–EQ
QuickStart Kit **K** = kit option, or leave blank if not wanted	**K**	M	D	I	1	F	R	D	3	4	A	7	–EQ
MDrive Plus version **MDI** = Motion Control	K	**M**	**D**	**I**	1	F	R	D	3	4	A	7	–EQ
Input **1** = Plus, standard features **3** = Plus², expanded features	K	M	D	I	**1**	F	R	D	3	4	A	7	–EQ
P1 connector **F** = flying leads *(1)* **C** = pluggable *(2)*	K	M	D	I	1	**F**	R	D	3	4	A	7	–EQ
Communication **R** = RS-422/485	K	M	D	I	1	F	**R**	D	3	4	A	7	–EQ
P2 connector **D** = IDC *(1)* **L** = wire crimp	K	M	D	I	1	F	R	**D**	3	4	A	7	–EQ
Motor size **34** = NEMA 34 (3.4" / 86 mm)	K	M	D	I	1	F	R	D	**3**	**4**	A	7	–EQ
Motor length **A** = single stack **B** = double stack **C** = triple stack	K	M	D	I	1	F	R	D	3	4	**A**	7	–EQ
Drive voltage **7** = +12 to +75 VDC	K	M	D	I	1	F	R	D	3	4	A	**7**	–EQ
Options Leave blank if not wanted Options may be combined, unless noted													**–EQ**

–EQ = internal encoder, 512-line internal magnetic encoder with index mark

–EE = remote encoder interface, differential encoder to be provided by user
Available with Plus² versions only. May not be combined with internal encoder option.

–N = rear control knob for manual positioning

(1) Only available with Plus products.
(2) Only available with Plus² products.

Figure A22.1 Standard Product Options

A.23 MDrive 34 - Specifications

A.23.1 Mechanical Specifications - Standard and Expanded Features Version

MDrive Lengths *Inches (mm)*

Motor Length	L_{MAX} SINGLE SHAFT, INTERNAL ENCODER	L_{MAX2} CONTROL KNOB VERSION
Single	3.81 (96.77)	4.52 (114.81)
Double	4.60 (116.84)	5.31 (134.87)
Triple	6.17 (156.72)	6.88 (174.75)

L_{MAX2} Option

Control Knob

Connector Options

Figure A23.1 Standard and Expanded Features Mechanical Specifications

A.23.2 Electrical Specifications

	Condition	Min	Typ	Max	Unit
Input voltage range **CAUTION**: Reverse polarity on the input power will likely damage the drive.	—	+12	—	+75	VDC
Max power supply current*	—	—	—	3	A
Aux-Logic Input Voltage	—	+12	—	+24	VDC
Max Aux-Logic Supply Current (Per MDrive)**	—	—	—	194	mA

**per MDrive 34, Actual current depends on voltage and load.*
*** Maintains power to control and feedback circuits [only] when input voltage is removed*

Table A23.1 Electrical Specifications

A.23.3 Standard I/O Specifications (Plus)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-4)	—	4 I/O points configurable as sinking or sourcing inputs or sinking outputs			
General Purpose I/O - Electrical					
Inputs	—	TTL	—	+24	VDC
Sinking Outputs (All)	—	—	—	+24	VDC
Output Sink Continuous Current	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Logic Threshold	Logic 0	—	—	< 0.8	VDC
	Logic 1	—	—	> 2.2	VDC
Protection	Sinking	Over temp, short circuit			
	Sourcing	Transient Over Voltage, Inductive Clamp			
Analog Input					
Resolution	—				
Range	Voltage Mode	0 to +5 VDC, 0 to +10 VDC			
	Current Mode	4 to 20 mA, 0 to 20mA			
Clock I/O					
Types	—	Step/Direction, Up/Down, Quadrature			
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			
Trip Output/Capture Input					
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			

Table A23.2 I/O Specifications

A.23.4 Expanded I/O Specifications (Plus²)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-8)	—			8 I/O points (4 if configured for remote encoder) configurable as sinking or sourcing inputs or outputs	
General Purpose I/O - Electrical					
Inputs	Sinking or Sourcing	TTL	—	+24	VDC
Outputs	Sinking	—	—	+24	VDC
	Sourcing	+12		+24	VDC
Output Sink Continuous Current **NOTE**: Output ratings apply to each bank of four I/O. First bank: Output 1-4 Second bank: Output 9-12	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Motion I/O					
Electronic gearing	Range	0.001	—	2.000	
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Secondary clock out ratio				1:1
High speed position capture	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Resolution	—	—	32	bit
High speed trip output	Speed	—	—	150	nS
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
Optional remote encoder (closed loop)*					
Type				User supplied differential encoder	
Steps per revolution				See motion specifications table	
Resolution	User defined . Note: microsteps/rev = 2X the encoder counts/rev minimum.				

**Remote encoder inputs replace I/O points 4-8 and step and direction I/O*

Table A23.3 Expanded I/O Specifications

A.23.5 Communication Specifications

	Condition	Min	Typ	Max	Unit
RS-422/485 (standard)					
BAUD rate	—	4.8		115.2	kbps
CANopen (optional)					
Type					2.0B active
BAUD rate	—	10 kHz	—	1 MHz	—
Application layer	Version 3.0				DS-301
Device profile	Version 2.0				DSP-402

ID	—	11 or 29 bit
Isolation	—	Galvanic

Table A23.4 Communication Specifications

A.23.6 Thermal Specifications

		Min	Typ	Max	Unit
Heat sink temperature	non-condensing humidity	-40	—	+75	ºC
Motor temperature	non-condensing humidity	-40	—	+90	ºC

Table A23.5 Thermal Specifications

A.23.7 Motion Specifications

Microstep Resolution - Open Loop	
Number of microstep resolutions	20

Available microsteps per revolution

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

1=0.01 deg/µstep 2=1 arc minute/µstep *3=0.001 mm/µstep
** 1" per revolution lead screw*

Microstep resolution (closed loop configuration - (optional)	
Steps Per Revolution (Fixed)	51200
Position Resolution	2048
Optional encoder (internally mounted)	
Type	Internal, Magnetic
Resolution (Lines)	512
Resolution (Edges)	2048
Counters	
Counter 1 (C1) Type	Position
Counter 2 (C2) Type	Encoder
Resolution	32 bit
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

Table A23.6 Motion Specifications

A.23.8 Software Specifications

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

Table A23.7 Software Specifications

A.23.9 Motor Specifications

Specification	Single length	Double length	Triple length
Holding torque oz-in (N-cm)	381 (269)	575 (406)	1061(749)
Detent torque oz-in (N-cm)	10.9 (7.7)	14.16 (10.0)	19.83 (14.0)
Rotor inertia oz-in-sec^2 (kg-cm^2)	0.01416 (1.0)	0.02266 (1.6)	0.04815 (3.4)
Weight motor and driver lb (kg)	4.1 (1.90)	5.5 (2.5)	8.8 (4.0)

Table A23.8 Motor Specifications

A.23.10 Performance Curves

Single Length Motor

Figure A23.2 Performance Curves - Single Length Motor

Double Length Motor

Figure A23.3 Performance Curves - Double Length Motor

Triple Length Motor

Figure A23.4 Performance Curves - Triple Length Motor

A.24 MDrive 34 - Connectivity Specifications/Pin Assignments

A.24.1 RS-422/485 Communication

10-pin Friction Lock Wire Crimp (Available on Pluggable Connector Versions)

Connectivity Options
USB to RS-422/485 Converter:
MD-CC402-001

Mating connector kit:
CK-02

Mfg P/N:
Shell
Hirose DF11-10DS-2C

Pins
Hirose: DF11-2428SC

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table A24.1 P2 Communication, 10-pin Friction Lock Wire Crimp

10-pin Pressure Fit - IDC style (Available on Flying Leads Versions)

Connectivity Options
USB to RS-422/485 Converter:
MD-CC400-001

Mating connector kit:
CK-01

Mfg P/N:
Shell
SAMTEC: TCSD-05-01-N

Ribbon cable
Tyco: 1-57051-9

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table A24.2 P2 Communication, 10-pin Pressure Fit IDC/SAMTEC

A.24.2 CANopen Communication Option

9-pin D-sub Female (DB-9F)

Connectivity Options
USB to CANopen converter:
MD-CC500-000

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table A24.3 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

A.24.3 Power and I/O - Standard I/O (Plus)

12” (304.8 mm) Flying Leads

Wire Color	Function	Description
White/yellow	I/O 1	General purpose I/O point 1
White/orange	I/O 2	General purpose I/O point 2
White/violet	I/O 3	General purpose I/O point 3
White/blue	I/O 4	General purpose I/O point 4
Green	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
Black	GND	Power and auxiliary ground
Red	+V	Motor power

Table A24.4 Power and I/O Interface - 12” (308.8.mm) Flying Leads

A.24.4 DC Motor Power

2-pin friction Lock Wire Crimp

Pin #	Function	Description
1	+V	+12 to +60 VDC motor power
2	Ground	Power supply return (ground)

Table A24.5 P3 DC Power, 2-pin Locking Wire Crimp

Connectivity Options
Prototype development cable *PD-02-3400-FL3*

Mating connector kit:
CK-05

Mfg P/N:
Shell
Molex 751067-0200

Pins
Molex 750217-9101

A.24.5 I/O - Expanded I/O (Plus^2)

14-pin Locking Wire Crimp

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	I/O 9	0 to +24 VDC Programmable I/O Point 9
8	I/O 10	0 to +24 VDC Programmable I/O Point 10
9	I/O 11	0 to +24 VDC Programmable I/O Point 11
10	I/O 12	0 to +24 VDC Programmable I/O Point 12
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input
13	Step/clock I/O	Step clock i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
14	Direction/ clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.

Table A24.6 P1 Expanded I/O, 14-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD14-2334-FL3

Mating connector kit:
CK-09

Mfg P/N:
Shell
JST PADP-14V-1-S

Pins
JST SPH-001T0.5L

A.24.6 I/O - Remote Encoder (Plus²)

20-pin Locking Wire rimp

Connectivity Options
Prototype development cable::
PD20-3400-FL3

Mating connector kit:
CK-11

Mfg P/N:
Shell
JST PADP-20V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	I/O 9	0 to +24 VDC Programmable I/O Point 9
8	I/O 10	0 to +24 VDC Programmable I/O Point 10
9	I/O 11	0 to +24 VDC Programmable I/O Point 11
10	I/O 12	0 to +24 VDC Programmable I/O Point 12
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input
13	Step/clock I/O	Step clock i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
14	Direction/ clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
15	CH A+	Channel A+ encoder input. +5 VDC logic level
16	CH A-	Channel A- encoder input. +5 VDC logic level
17	CH B+	Channel B+ encoder input. +5 VDC logic level
18	CH B-	Channel B- encoder input. +5 VDC logic level
19	IDX+	Index mark + encoder input. +5 VDC logic level
20	IDX-	Index mark - encoder input. +5 VDC logic level

Table A24.7 I/O and Remote Encoder Interface - 20-pin Locking Wire Crimpl

A.24.7 Options

Internal Encoder

Internal magnetic 512 line quadrature encoders with index mark are available:

Remote Encoder (Plus² Versions Only)

MDrive 34 Motion Control versions are available with differential encoder inputs for use with a remote encoder (not supplied).

Control Knob

The MDrive 34 is available with a factory-mounted rear control knob for manual shaft positioning.

A.24.8 Connectivity

QuickStart Kit

For rapid design verifi cation, all-inclusive QuickStart Kits have communication converter, prototype development cable(s), instructions and CD for MDrive initial functional setup and system testing.

Communication Converters

Electrically isolated, in-line converters pre-wired with mating connectors to conveniently set/program communication parameters for a single MDrive product via a PC's USB port. Length 12.0' (3.6m).

Mates to connector:

P2 10-pin pressure-fit IDC MD-CC400-001

P2 5-pin M12 circular..... MD-CC401-001

P2 10-pin wire crimp..... MD-CC402-001

P2 9-pin DSub (CANopen) MD-CC500-000

Prototype Development Cables

Speed test/development with pre-wired mating connectors that have flying leads other end. Length 10.0' (3.0m).

Mates to connector:

P2 10-pin wire crimp..... PD10-1434-FL3

P1 14-pin wire crimp..... PD14-2334-FL3

P1 19-pin M23 circular (straight) MD-CS100-000

P1 19-pin M23 circular (right-angle) MD-CS101-000

P3 2-pin wire crimp..... PD02-2300-FL3

Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC CK-01

P2 10-pin wire crimp..... CK-02

P1 14-pin wire crimp..... CK-09

P3 2-pin wire crimp..... CK-04

A.25 MDrive 34 - Mounting and Connection Recommendations

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

LEAD RESTRAINT

Some MDrive mounting configurations require that the MDrive move along the screw. Ensure that all cabling is properly re-strained to provide strain relief on connection points..

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

THERMAL MANAGEMENT

The mounting plate material should offer sufficient mass and thermal conductivity to ensure that the motor temperature does not eceed 100°C.

Failure to follow these instructions can result in equipment damage.

A.25.1 Mounting

Figure A25.1 MDrive 34 Mounting and Drill Pattern

A.25.2 Recommended Mating Connectors and Pins

Communication

Press-Fit IDC - P2 (MDrive 34 Only)

10-Pin IDC ..... Samtec: TCSD-05-01-N

Ribbon Cable ..... Tyco: 1-57051-9

Friction Lock Wire Crimp - P2

10-pin Friction Lock (MDI34Plus2) ..... Hirose DF11-10DS-2C

Crimp Contact for 10-pin Friction Lock (22 AWG) DF11-22SC

Crimp Contact for 10-pin Friction Lock (24 - 28 AWG) DF11-2428SC

Crimp Contact for 10-pin Friction Lock (30 AWG) DF11-30SC

I/O, Power and Encoder

The following mating connectors are recommended for the MDrive 34 Units ONLY! Contact a JST distributor for ordering and pricing information.

Manufacturer PNs

14-pin Locking Wire Crimp Connector Shell JST PN PADP-14V-1-S

Crimp Pins ..... JST PN SPH-001T-P0.5L

20-pin Locking Wire Crimp Shell ..... JST PN PADP-20V-1-S

Crimp Pins ..... JST PN SPH-001T-P0.5L

2-pin Locking Wire Crimp Connector Shell..... Molex 51067-0200

Crimp Pins ..... Molex 50217-9101 Brass

A.25.3 Securing Power Leads and Logic Leads

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

Figure A25.2 Securing leads

A.26 MDrive 34 - Connection and Interface

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

A.26.1 Interfacing RS422-485 Communication

For general RS422/485 single and party mode communication practices, refer to Section 5 on page 18 of this document.

⚠ CAUTION

Communication GROUND LOOPS

To avoid ground loops in the system only connect communication ground to the first MDrive in the system. Do not connect communication ground on subsequent MDrives.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect communication while the device is in a powered state.

Failure to follow these instructions may result in damage to system components!

P2 — 10-pin Pressure Fit IDC-style Connector

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table A26.1 Communication connections, P2 - 10-pin IDC

Connectivity Accessories

Mating connector kit CK-01
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m)..... MD-CC400-001

P2 — 10-pin Friction Lock Wire Crimp

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table A26.2 P2 Communication, 10-pin Friction Lock Wire Crimp

Connectivity Accessories

Mating connector kit CK-02
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m)..... MD-CC402-001

A.26.2 Interfacing CANopen Communication

P2 — 9-pin D-sub Connector (Female)

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table A26.3 CANopen communication, P2: 9-pin D-sub female (DB-9F)

Connectivity Accessories

Communication converter cable MD-CC500-000

A.26.3 Interfacing DC Power

See Section 3 on page 10, for recommended power cable configurations.

For informattion on sizing a DC power supply, refer to: https://motion.schneider-electric.com/application-note/sizing-dc-power-supply/

⚠ CAUTION

OVER VOLTAGE

The DC voltage range for the MDrive 23 Plus is +12 to +60 VDC. Ensure that motor back EMF is factored into the power supply size calculations.

Allow 3.0 A maximum power supply output current per MDrive in the system. Actual power supply current will depend on voltage and load.

Failure to follow these instructions can result in equipment damage.

Recommended Power Supply Characteristics

Voltage range	+12 to +75 VDC
Type	Unregulated linear
Ripple	± 5%
Output current	4.0 A (per MDrive 34

Recommended Wire Gauge

Cable Length: Feet (meters)	10 (3.0)	25 (7.6)	50 (15.2)	75 (22.9)	100 (30.5)
Amps Peak	**Minimum AWG**				
1 Amp Peak	20	20	18	18	18
2 Amps Peak	20	18	16	14	14
3 Amps Peak	18	16	14	12	12
4 Amps Peak	16	14	12	12	12

Table A26.5 Recommended Power Supply Wire Gauge

P1 — 12' (30.5 cm) Flying Leads Interface

Wire Color	
Red	Motor power supply
Black	Power ground

Table A26.6 Power and Ground Connections, Flying Leads

P3 — 2-pin Locking Wire Crimp Interface

Pin #	***Signal***	***SEM cable wire colors***
		PD02-3400-FL3
1	+12 to +75 VDC supply	Red
2	Power ground	Black

Table A26.7 Power and Ground Connections, 2-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-05
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD02-3400-FL3

Manufacturer (Molex) Part Numbers

Connector shell.....51067-0200

Pins.....50217-9101

A.26.4 Interfacing I/O

See Section 4 on page 10, for I/O interface configurations and methods.

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O point is TTL level and only tolerant to +5 VDC:

1) Capture/Trip
2) Step/Direction
3) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

P1 — 12' (30.5 cm) Flying Leads Interface

Wire Color	*Signal*
White/yellow	General purpose I/O 1
White/orange	General purpose I/O 2
White/violet	General purpose I/O 3
White/blue	General purpose I/O 4
Green	Analog input

Table A26.8 I/O Connections, Flying Leads

P1 — 14-pin Locking Wire Crimp Interface (Expanded I/O)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	Black	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	General purpose I/O 9	Yellow	Pair
8	General purpose I/O 10	Black	
9	General purpose I/O 11	Blue	Pair
10	General purpose I/O 12	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Step clock I/O	White	Pair
14	Direction clock I/O	Black	

Table A26.9 I/O Connections, 14-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-09
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD14-2334-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-14V-1-S

Pins..... SPH-001T0.5L

A.27 MDrive 34 - Connectivity Accessory Details

A.27.1 Communication Converter Cables

USB to 10-pin IDC Connector P2
P/N: MD-CC400-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure A27.1 MD-CC400-000 Communication Converter Cable

USB to 10-pin Wire Crimp Connector P2
P/N: MD-CC402-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure A27.2 MD-CC402-001 Communication Converter Cable

CANopen Communication Converter Cable
MD-CC500-000

See Section 6 on page 27 of this document for CANopen connectivity instructions and MD-CC500-000 details.

A.27.2 Prototype Development Cables

Flying leads to10-pin Wire Crimp Connector P2 -P/N: PD10-1434-FL3

Used in conjunction with the MD-CC402-001 communication converter cable to facilitate multi-drop RS-422/485 communication.

Wire Colors	Function
White/Red Stripe	Aux-Logic
White/Blue Stripe	TX+
Blue/White Stripe	TX-
White/Orange Stripe	RX+
Orange/White Stripe	RX-
Green/White Stripe	GND

Figure A27.3 Multi-drop Communication using the PD10-1434-FL3

Procedure

1) Remove ground wire (unless this is the first system MDrive, green/white stripe)
2) Remove aux-logic (if not used, red/white stripe)
3) Connect pre-crimped flying leads as shown in Figure 5.7 below

Figure A27.4 Wiring a Second PD10-1434-FL3 into the 10-pin Wire Crimp Connector.

Flying Leads to 14-pin Locking Wire Crimp Connector P1 -P/N: PD14-2334-FL3

The PD14-2334-FL3 prototype development cable is used to rapidly interface the MDrive 34 to the users controller. This 10’ (3.0 m) cable consists of a 14-pin locking wire crimp connector to plug directly into the MDrive P1 connector with flying leads on the opposite end to interface

Pin #	*Wire Colors*	*Signal (Expanded features)*	*Signal (Remote encoder)*	*Pairs*
14	Black	Step Clock I/O	Index –	X
13	White	Direction I/O	Index +	
12	Black	Analog Input	Analog Input	X
11	Green	Capture/Trip I/O	Capture/Trip I/O	
10	Black	I/O 12	Channel B –	X
9	Blue	I/O 11	Channel B +	
8	Black	I/O 10	Channel A –	X
7	Yellow	I/O 9	Channel A +	
6	Black	I/O 4	I/O 4	X
5	Brown	I/O 3	I/O 3	
4	Black	I/O 2	I/O 2	X
3	Orange	I/O 1	I/O 1	
2	Black	I/O Ground	I/O Ground	X
1	Red	I/O Power	I/O Power	

Figure A27.5 Prototype Development Cable PD14-2334-FL3

Flying Leads to 20-pin Locking Wire Crimp Connector P1 -P/N: PD20-3400-FL3

The PD20-3400-FL3 prototype development cable is used to rapidly interface the MDrive 34 to the users controller. This 10' (3.0 m) cable consists of a 20-pin locking wire crimp connector to plug directly into the MDrive P1 connector with flying leads on the opposite end to interface to I/O devices.

Pin #	*Wire Colors*	*Signal (Expanded features)*	*Pairs*
14	Black	Step Clock I/O	X
13	White	Direction I/O	
12	Black	Analog Input	X
11	Green	Capture/Trip I/O	
10	Black	I/O 12	X
9	Blue	I/O 11	
8	Black	I/O 10	X
7	Yellow	I/O 9	
6	Black	I/O 4	X
5	Brown	I/O 3	
4	Black	I/O 2	X
3	Orange	I/O 1	
2	Black	I/O Ground	X
1	Red	I/O Power	
Cable 2 - Encoder signals			
20	Green/White	Index –	X
19	White/Green	Index +	
18	Orange/White	Channel B –	X
17	White/Orange	Channel B +	
16	Blue/White	Channel A –	X
15	White/Blue	Channel A +	

Figure A27.6 Prototype Development Cable PD20-3400-FL3

Flying Leads to 2-pin Locking Wire Crimp Connector P2 -P/N: PD02-3400-FL3

The PD02-3400-FL3 prototype development cable is used to rapidly interface the MDrive 34 to the users DC power supply. This 10' (3.0 m) cable consists of a 2-pin locking wire crimp connector to plug directly into the MDrive P3 connector with flying leads on the opposite end to interface to DC power.

Wire Colors	Function
Black	Power Ground
Red	+V

Figure A27.7 Prototype Development Cable PD02-3400-FL3

A.24.3 Mating Connector Kits

Use this kit to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC.....CK-01

P2 10-pin wire crimp.....CK-02

P1 14-pin wire crimp.....CK-09

P3 2-pin wire crimp.....CK-05

A.28 MDrive 34AC - Introduction and Overview

The **MDrive 34AC Motion Control** system offers designers a cost effective, full featured programmable motion controller integrated with a NEMA 34 high torque 1.8° brushless step motor and a microstepping driver operating at 120 or 240 VAC.

Unsurpassed smoothness and performance delivered by the MDrive 34AC are achieved through 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 MDrive 34AC 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 cable runs and multiple drive systems. An extended operating range of –40° to +75°C provides long life, trouble free service in demanding environments.

The MDrive 34AC Motion Control system adds a versatile array of functions by combining a full featured programmable motion controller with the compact and cost effective MDrive 34AC Microstepping products, 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 MDrive 34AC 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.

Optional communication protocols include CANopen. The CAN bus is 2.0B active (11 and/or 29 bit) and is capable of all standard frequencies from 10 kHz to 1 MHz. CANopen features include node guarding, heartbeat producer, SDOs and PDOs. Highlights include variable PDO mapping and extended node identifier.

The MDrive 34AC 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 MDrive 34AC 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 MDrive 34AC 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.

Interface connections are accomplished using standard industrial industrial connectors. And connectivity has never been easier with options ranging from all-inclusive QuickStart Kits to individual interfacing cables.

A.28.1 Product Identification

MDrive® 34ac Plus²

Part numbers													
Example:	**K**	**M**	**D**	**I**	**4**	**M**	**R**	**Q**	**3**	**4**	**A**	**1**	**–E**
QuickStart Kit **K** = kit option, or leave blank if not wanted	**K**	M	D	I	4	M	R	Q	3	4	A	1	–EC
MDrive Plus version **MDI** = Motion Control	K	**M**	**D**	**I**	4	M	R	Q	3	4	A	1	–EC
Input **4** = Plus², expanded features, with industrial connectors, IP54-rated	K	M	D	I	**4**	M	R	Q	3	4	A	1	–EC
P1 connector **M** = M23 industrial connector	K	M	D	I	4	**M**	R	Q	3	4	A	1	–EC
Communication **R** = RS-422/485	K	M	D	I	4	M	**R**	Q	3	4	A	1	–EC
P2 connector **Q** = M12 industrial connector	K	M	D	I	4	M	R	**Q**	3	4	A	1	–EC
Motor size **34** = NEMA 34 (3.4" / 86 mm)	K	M	D	I	4	M	R	Q	**3**	**4**	A	1	–EC
Motor length **A** = single stack **B** = double stack **C** = triple stack	K	M	D	I	4	M	R	Q	3	4	**A**	1	–EC
Drive voltage **1** = 120 VAC **2** = 240 VAC	K	M	D	I	4	M	R	Q	3	4	A	**1**	–EC
Options Leave blank if not wanted Options may be combined, unless noted **–EQ** = internal encoder, 512-line internal magnetic encoder with index mark **–EE** = remote encoder interface, differential encoder to be provided by user *May not be combined with internal encoder option.* **–N** = rear control knob for manual positioning *(1)*													**–EC**

(1) Not IP54-rated.

Figure A28.1 Standard Product Options

A.29 MDrive 34AC - Specifications

A.29.1 Mechanical Specifications

MDrive AccuStep lengths Inches (mm)

Motor length	LMAX with single shaft or internal encoder	LMAX2 with control knob
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)

Figure A29.1 MDrive 34AC Mechanical Dimensions

A.29.2 Electrical Specifications

		Condition	Min	Typ	Max	Unit
Input voltage range **CAUTION**: Reverse polarity on the input power will likely damage the drive.	120 VAC	—	95	—	132	VAC
	240 VAC	—	95		264	VAC
Aux-Logic Input Voltage*		—	+12	—	+24	VDC
Max Aux-Logic Supply Current (Per MDrive)**		—	—	—	194	mA

** Maintains power to control and feedback circuits [only] when input voltage is removed*

Table A29.1 Electrical Specifications

A.29.3 I/O Specifications

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
I/O Points 1-8	—	8 I/O points configurable as sinking or sourcing inputs or outputs			
General Purpose I/O - Electrical					
Inputs	Sinking or Sourcing	TTL	—	+24	VDC
Outputs	Sinking	—	—	+24	VDC
	Sourcing	+12		+24	VDC
Output Sink Continuous Current	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Motion I/O					
High speed position capture	Filter range	50 nS to 12.9 µS (10 MHz to 38.8 kHz)			
	Resolution	—	—	32	bit
High speed trip output	Speed	—	—	150	nS
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
Analog input					
Resolution		—	—	10	bit
Range	Voltage	0	—	5	VDC
		0	—	10	VDC
	Current	0	—	20	mA
		4	—	20	mA

Table A29.2 I/O Specifications

A.29.4 Communication Specifications

	Condition	Min	Typ	Max	Unit
RS-422/485 (standard)					
BAUD rate	—	4.8		115.2	kbps
CANopen (optional)					
Type					2.0B active
BAUD rate	—	10 kHz	—	1 MHz	—
Application layer	Version 3.0				DS-301
Device profile	Version 2.0				DSP-402
ID	—				11 or 29 bit
Isolation	—				Galvanic

Table 29.3 Communication Specifications

A.29.5 Thermal Specifications

		Min	Typ	Max	Unit
Heat sink temperature	non-condensing humidity	-40	—	+75	ºC
Motor temperature	non-condensing humidity	-40	—	+90	ºC

Table A29.4 Thermal Specifications

A.29.6 Motion Specifications

Microstep resolution (closed loop)	
Steps Per Revolution	51200
Position Resolution	2048
Encoder type	Internal magnetic
Resolution (Lines)	512
Resolution (Edges)	2048
Counters	
Counter 1 (C1) Type	Microsteps
Counter 2 (C2) Type	Encoder
Resolution	32 bit
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

Table A29.5 Motion Specifications

A.29.7 Software Specifications

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

Table A29.6 Software Specifications

A.29.8 Motor Specifications

Specification	Single length	Double length	Triple length
Holding torque oz-in (N-cm)	330 oz-in (233)	500 (353)	700 (529)
Detent torque oz-in (N-cm)	10.9 (7.7)	14.16 (10.0)	19.83 (14.0)
Rotor inertia oz-in-sec^2 (kg-cm^2)	0.0142 (1.0)	0.0227 (1.6)	0.0482 (3.4)
Weight motor and driver lb (kg)	6.4 (2.9)	7.7 (3.5)	11.0 (5.0)

Table A29.7 MDrive 34AC Motion Control Motor Specifications

A.29.9 Speed-Force Performance Curves

S120 VAC Motor Performance

Figure A29.3 Motor Performance Curve — 120 VAC

240 VAC Motor Performance

Figure A29.4 Motor Performance Curve — 240 VAC

A.30 MDrive 34AC - Connectivity Specifications/Pin Assignments

A.30.1 RS-422/485 Communication

5-pin M12 Industrial Connector (Female)

Connectivity Options
USB to RS-422/485 Converter:
MD-CC401-001

Pin #	Function	Description
1	TX -	Transmit minus
2	TX +	Transmit plus
3	RX +	Receive plus
4	RX -	Receive minus
5	Communication Gnd	Communication ground

Table A30.1 P2 Communication, 5-pin M12F Industrial Connector

A.30.2 CANopen Communication Option

5-pin M12 Industrial

Connectivity Options
USB to CANopen converter:
MD-CC500-000

Pin #	Function	Description
1	Shield	Optional CAN shield
2	CAN +V	+7 to +30 VDC power supply
3	CAN -V	CAN communication ground
4	CAN high	CAN_H bus line (high dominant)
5	CAN low	CAN_L bus line (low dominant)

Table A30.2 CANopen Communication, P2: 5-pin D-sub Female

A.30.3 AC Power

3-pin Euro AC

Pin #	Function	Description
1	Earth	Chassis (earth) ground
2	Line	AC line
3	Neutral	AC neutral

Table A30.3 P3 DC Power, 2-pin Locking Wire Crimp

Connectivity Options
Cordset
Straight MD-CS200-000
Right-angle: MD-CS201-000

A.30.4 Expanded I/O

19-pin M23 Industrial

Outside: Pins 1 -12

Inside: Pins 13 -19

Connectivity Options
Cordset
Straight MD-CS100-000
Right-angle: MD-CS101-000

Pin #	Function	Description
1	I/O 9	0 to +24 VDC Programmable I/O Point 9.
2	I/O 11	0 to +24 VDC Programmable I/O Point 11.
3	Step/Clock I/O	0 to +5 VDC Step Clock I/O. Can also be configured as Quadrature or Clock Up/Down.
4	I/O 1	0 to +24 VDC Programmable I/O Point 1.
5	No Connect	No Connect.
6	No Connect	No Connect.
7	Aux-Logic	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
8	Aux-Ground	Auxiliary Ground.
9	I/O 3	0 to +24 VDC Programmable I/O Point 3.
10	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
11	I/O PWR	I/O Power, used with sourcing inputs or outputs.
12	Shell	Shell connect
13	I/O 12	0 to +24 VDC Programmable I/O Point 12.
14	Capture/Trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
15	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
16	I/O 2	0 to +24 VDC Programmable I/O Point 2.
17	I/O 4	0 to +24 VDC Programmable I/O Point 4.
18	I/O 10	0 to +24 VDC Programmable I/O Point 10.
19	No Connect	No Connect.

Table A30.4 P1 I/O and Aux Power, 19-pin IM23 Industrial Connector

A.30.5 I/O and Remote Encoder

19-pin M23 Industrial

Outside: Pins 1 -12

Inside: Pins 13 -19

Connectivity Options
Cordset
Straight MD-CS100-000
Right-angle: MD-CS101-000

Pin #	Function	Description
1	CH A+	Channel A+ encoder input. +5 VDC logic level
2	CH B+	Channel B+ encoder input. +5 VDC logic level
3	IDX+	Index mark + encoder input. +5 VDC logic level
4	I/O 1	0 to +24 VDC Programmable I/O Point 1.
5	IDX-	Index mark - encoder input. +5 VDC logic level
6	N/C	Not connected
7	Aux-Logic	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
8	Aux-Ground	Auxiliary Ground.
9	I/O 3	0 to +24 VDC Programmable I/O Point 3.
10	I/O GND	Non-isolated I/O ground. Common with power ground.
11	I/O PWR	I/O Power, used with sourcing inputs or outputs.
12	Shell	Shell connect
13	CH B-	Channel B- encoder input. +5 VDC logic level
14	Capture/Trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
15	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
16	I/O 2	0 to +24 VDC Programmable I/O Point 2.
17	I/O 4	0 to +24 VDC Programmable I/O Point 4.
18	CH A-	Channel A- encoder input. +5 VDC logic level
19	N/C	Not connected

Table A30.5 P1 I/O and Aux Power, 19-pin IM23 Industrial Connector

A.30.6 Encoder

Internal Encoder

MDrive 34ACI products include a 1000 line internal magnetic encoder with index mark.

A.30.7 Connectivity

QuickStart Kit

For rapid design verifi cation, all-inclusive QuickStart Kits have communication converter, prototype development cable(s), instructions and CD for MDrive 34ACI initial functional setup and system testing.

Communication Converters

Electrically isolated, in-line converters pre-wired with mating connectors to conveniently set/program communication parameters for a single MDrive product via a PC's USB port. Length 12.0' (3.6m).

Mates to connector:

P2 5-pinM12 industrial.....MD-CC401-001

Prototype Development Cables

Speed test/development with pre-wired mating connectors that have flying leads other end. Length 10.0' (3.0m).

Mates to connector:

P1 19-pin M23 (straight).....MD-CS100-000

P1 19-pin M23 (right-angle).....MD-CS101-000

P3 Euro AC (straight) MD-CS200-000

P3 Euro AC (right-angle) MD-CS201-000

A.31 MDrive 32AC - Connection and Interface

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

A.31.1 Interfacing I/O

Refer to Section 6 on page 27 for I/O interface configurations and methods.

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O point is TTL level and only tolerant to +5 VDC:

1) Capture/Trip
2) Step/direction I/O
3) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

P1 — 19-pin M23 Industrial Connector (Expanded I/O)

Outside: Pins 1 -12

Inside: Pins 13 -19

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*
1	I/O 9	Violet
2	I/O 11	Red
3	Step/Clock I/O	Grey
4	I/O 1	Red/Blue
5	No Connect	Green
6	No Connect	Blue
7	Aux-Logic	Gray/Pink
8	Aux-Ground	White/Green
9	I/O 3	White/Yellow
10	I/O GND	White/Gray
11	I/O PWR	Black
12	Shell connect	Green/Yellow*
13	I/O 12	Yellow/Brown
14	Capture/Trip I/O	Brown/Green
15	AIN	White
16	I/O 2	Yellow
17	I/O 4	Pink
18	I/O 10	Gray/Brown
19	No Connect	Brown

Table A31.1 I/O Connections, 19-pin M23 Industrial

P1 — 19-pin M23 Industrial Connector (Remote Encoder)

Outside: Pins 1 -12

Inside: Pins 13 -19

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*
1	Channel A+	Violet
2	Channel B+	Red
3	Index +	Grey
4	I/O 1	Red/Blue
5	Index -	Green
6	No connect	Blue
7	Aux-Logic	Gray/Pink
8	Aux-Ground	White/Green
9	I/O 3	White/Yellow
10	I/O GND	White/Gray
11	I/O PWR	Black
12	Shell connect	Blue
13	Channel B-	Yellow/Brown
14	Capture/Trip I/O	Brown/Green
15	AIN	White
16	I/O 2	Yellow
17	I/O 4	Pink
18	Channel A -	Gray/Brown

Table A31.2 I/O Cconnections, 19-pin M23 Industrial

A.31.2 Connectivity Option — 19 Conductor Cordset

19-pin M23 single-ended cordsets are offered to speed prototyping. Measuring 13.0’ (4.0 m) 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

Pin #	*Wire Colors*	*Signal (Expanded Features)*	*Signal (Remote encoder)*
1	Violet	I/O9	Channel A +
2	Red	I/O11	Channel B +
3	Gray	Step Clock	Index +
4	Red/Blue	I/O1	I/O1
5	Green	Direction	Index –
6	Blue	Not connected	Not connected
7	Gray/Pink	Aux-Logic	Aux-Logic
8	White/Green	Communication GND	Communication GND
9	White/Yellow	I/O3	I/O3
10	White/Gray	I/O GND	I/O GND
11	Black	I/O Power	I/O Power
12	Green/Yellow	Shell Connect	Shell Connect
13	Yellow/Brown	I/O12	Channel B –
14	Brown/Green	Capture/Trip	Capture/Trip
15	White	Analog In	Analog In
16	Yellow	I/O2	I/O2
17	Pink	I/O4	I/O4
18	Gray/Brown	I/O10	Channel A –
19	Brown	Not connected	Not connected

Figure A31.1 MD-CS10x-000 Cordset

A.31.3 Interfacing RS-422/485 Communication

P2 — 5-pin M12 Industrial Connector (Male)

Pin #	Function	Description
1	TX -	Transmit minus
2	TX +	Transmit plus
3	RX +	Receive plus
4	RX -	Receive minus
5	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table A31.3 P2 Communication, 5-pin M12F Industrial Connector

A.31.4 Communication Converter — MD-CC401-000

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters.

No mating connector kit is available for this connector style. Compatible mating connectors may be purchased from the following suppliers:

- Phoenix
- Turck
- RDE Connectors

Figure A31.2 MD-CC401-001 Communication Converter

A.31.5 Interfacing CANopen Communication

P2 — 5-pin M12 Industrial Connector (Female)

Pin #	Function	Description
1	Shield	Optional CAN shield
2	CAN +V	+7 to +30 VDC power supply
3	CAN -V	Optional ground
4	CAN high	CAN_H bus line (high dominant)
5	CAN low	CAN_L bus line (low dominant)

Table A31.4 CANopen Communication, P2: 5-pin M12 Female

Connectivity Accessories

Communication converter cable MD-CC500-000

A.31.6 MD-CC500-000 USB to CANopen Converter

The MD-CC500-000 will not natively interface to the P2 connector of the device. An interface cable must be constructed as illustrated below.

M12F

Connector Front View

Figure A31.3 MD-CC500-000 and Interface Cable

A.31.7 Interfacing AC Power

P3 — 3-pin Euro AC

3-Pin Euro AC Connector

Pin number	Signal	European (IEC) color code
1	Earth	Yellow/Green
2	Line	Brown
3	Neutral	Blue

Table A31.5 AC standard wire colors

MD-CS20x-000 Cordset

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. IEC color code, oil-resistant yellow PVC jacket, IP68 and NEMA 6P rated.

Straight Termination MD-CS200-000

Right Angle Termination MD-CS201-000

Figure A31.4 MD-CS20x-000

Appendix B Specifications and Connectivity for MDrive Linear Actuators

This appendix details the specifications and connectivity of the MDrive 14, 17, and 23 Linear Actuator Motion Control Devices.

MDrive® linear actuators combine leading all-in-one integrated motion technology with linear motion to deliver high accuracy, unsurpassed repeatability and long life, all in a package that is extremely compact and affordable.

B.1 General Information

Linear Actuator Styles

Two (2) linear actuator styles of MDrive integrated motor + driver solutions are available:

- **Non-captive shaft** — a screw runs through the MDrive and moves axially as the motor rotates
- **External shaft** — a rotating screw, integral to the motor shaft, moves a screw-mounted nut axially

Precision rolled lead screws used with MDrive linear actuators are designed specifically for motion control applications to deliver maximum life and quiet operation. Corrosion resistant and non-magnetic, screws are manufactured from premium grade stainless steel and available with optional coating.

Documentation Reference

The following User's manuals are available for the MDrive Plus:

- Product manual, describes the technical data, installation, configuration and programming of the product.
- Quick Reference, describes the basic wiring, connection and use of this product.

This documentation is also available for download from the Schneider Electric Motion (SEM) web site at https://motion.schneider-electric.com/dloads/product-literature/manuals-3/

Product Software

The MDrive Linear Actuator motion control integrated motor and driver may be programmed using any standard ASCII txt editor and ANSI terminal emulated. The recommended environment is the SEM Terminal Interface, which is a combined terminal/program editor tailored for use with SEM motion control products. This free software may be downloaded from https://motion.schneider-electric.com/dloads/user-interface-software/

Installation and usages instructions are to be found in the MCode Programming Manual, which is correlated to this document.

B.2 Layout and Interface Guidelines

Layout Guidelines

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

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

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

Rules of Wiring

- Power supply and motor wiring should be shielded twisted pairs, and run separately from signal-carrying wires.
- A minimum of one twist per inch is recommended.
- Motor wiring should be shielded twisted pairs using 20 gauge, or for distances of more than 5 feet, 18 gauge or better.
- Power ground return should be as short as possible to established ground.
- Power supply wiring should be shielded twisted pairs of 18 gauge for less than 4 amps DC and 16 gauge for more than 4 amps DC.

Rules of Shielding

- The shield must be tied to earth ground.
- Do not assume that Earth ground is a true Earth ground. Depending on the distance from the main power cabinet, it may be necessary to sink a ground rod at the critical location.
- The shield must be connected so that shield currents drain to signal-earth connections.
- The number of separate shields required in a system is equal to the number of independent signals being processed plus one for each power entrance.
- The shield should be tied to a single point to prevent ground loops.
- A second shield can be used over the primary shield; however, the second shield is tied to ground at both ends.

Recommended Wiring

The following wiring/cabling is recommended for use with the MDrive14:

Logic Wiring .....22 AWG

Wire Strip Length .....0.25” (6.0 mm)

Power and Ground .....See Table 3.1 in Section 3 of this document

B.3 MDrive 14 Linear Actuator - Introduction and Overview

B.3.1 MDrive 14 Linear Versions

Two (2) MDrive 14 integrated versions provide a choice of features and capabilities:

- **Microstepping** — motor + driver
- **Motion Control** — motor + driver + controller

MDrive14 linear actuators feature high torque 1.8° brushless NEMA 14 single length step motors with integrated electronics, providing the leading technology solution for all-in-one linear motion applications.

Unsurpassed smoothness and performance delivered by MDrive 14 products are achieved through SEM'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 MDrive 14 accepts a broad input voltage range from +12 to +48 VDC, delivering enhanced performance and speed. Oversized input capacitors are used to minimize power line surges, reducing problems that can occur with long cable runs and multiple drive systems. An extended operating range of –40° to +85°C provides long life, trouble free service in demanding environments. mapping and extended node identifier.

Motor configurations include a single shaft rotary in four lengths, and linear actuators with long life modified Acme screw.

B.3.2 Product Identification

P1

I/O, power & communication connector:

C = locking wire crimp (separate Comm connector on Plus² versions)

P2

Communication connectors Plus² versions only:

L = 10-pin friction locking wire crimp
B = DB9, only with CANopen Comm

Optional encoder

For NO encoder, omit any –E specification from part number

P1

MLI1 [C] [R] Z14A4 – **EQ** – **L** linear actuator

RS-422/485 comm

Internal magnetic encoder with 512-line count and index mark.

P1 P2

Plus² **MLI3 [C] [R] [L] 14A4** – **EQ** (see above) or – **EE** – **L** linear actuator

RS-422/485 comm

Plus² **MLI3 [C] [C] [B] 14A4** – **L** linear actuator

CANopen comm

Plus² version only: optional inputs for differential remote encoder (not supplied). May not be combined with internal encoder.

See details at bottom of page for complete linear actuator part numbers.

Non-captive shaft

– L [ ] 1 [ ] [ ] [ ] [ ] Z [ ]

Screw lead
travel per rev
A = 0.250" (6.35mm)
B = 0.125" (3.175mm)
C = 0.063" (1.588mm)

Screw end
M = metric
U = UNC
S = smooth
Z = none

Screw length
3.0 to 18.0"
in 0.1 increments
ex. 12.5" = 125
10.0" = 100

Coating
T = teflon*
Z = none

Screw length calculation = desired stroke length + 1.40" (35.56mm) + mounting surface plate thickness

*Contact factory for availability.

External shaft

– L [ ] 3 [ ] [ ] [ ] [ ] [ ] [ ]

Screw lead
travel per rev
A = 0.250" (6.35mm)
B = 0.125" (3.175mm)
C = 0.063" (1.588mm)

Screw end
M = metric
U = UNC
S = smooth
Z = none

Screw length
3.0 to 18.0"
in 0.1 increments
ex. 12.5" = 125
10.0" = 100

Nut
G = general purpose (dynamic load limit to 25lbs/11kg)
A = anti-backlash (dynamic load limit to 5lbs/2kg)

Coating
T = teflon*
Z = none

Screw length calculation = desired stroke length + nut length + mounting surface plate thickness

Figure B3.1 Standard Product Options

Revision R080720

B.4 MDrive 14 Linear Actuator - Specifications

B.4.1 Non-captive Shaft

Load limit

Nominal load limit: 50 lbs (22 kg)*

Screw Specifications

Screw material

MDrive Linear Actuator precision rolled lead screws are designed specifically for motion control applications to deliver maximum life and quiet operation. Corrosion resistant and non-magnetic, screws are manufactured from premium grade stainless steel.

Screw coating

An optional teflon screw coating is available for smooth operation and extended life.

Standard screw

Dimensions in inches (mm)

Lead options

inches (mm)	travel per revolution	travel per full step
Screw A	0.250 (6.350)	0.00125 (0.0317)
Screw B	0.125 (3.175)	0.00063 (0.0158)
Screw C	0.063 (1.588)	0.00031 (0.0079)

Screw end options

Threaded end	Metric end: M4 x 0.7mm thread to within 0.03" (0.76mm) of shoulder	UNC end: #8-32 UNC-2A thread to within 0.03" (0.76mm) of shoulder
Smooth end	Ø 0.1967" ±0.001 (Ø 5mm ±0.003)	
None	—	

Cantilevered Loads

Unsupported loads and side loading are not recommended for non-captive shaft MDrive® linear actuator products.

Calculating Screw Length

Screw length = [mounting surface plate thickness] + [1.40" (35.56mm)] + [desired stroke length]

Figure B4.1 Non-captive Shaft Mechanical Specifications

B.4.2 External Shaft

Nut detail

General purpose nut
Flange shape: round
Load limit: 25 lbs (11 kg)
Purpose: for applications not requiring anti-backlash and wear compensation.

Anti-backlash nut
Flange shape: triangle
Load limit: 5 lbs (2 kg)
Purpose: backlash free operation for high accuracy and low drag torque.

inches (mm)	A	B	D	E	F	BCD	*load limit*	*drag torque*
General purpose	0.50 (12.7)	0.75 (19.1)	1.0 (25.4)	0.14 (3.6)	0.15 (3.81)	0.75 (19.1)	25lbs/ 11 kg	free wheeling
Anti-backlash	0.50 (12.7)	0.9max (22.86)	1.0 (25.4)	0.143 (3.63)	0.18 (4.57)	0.75 (19.1)	5lbs/ 2 kg	< 1.0 oz-in < 0.7 N-cm

Screw Specifications

Screw material
MDrive Linear Actuator precision rolled lead screws are corrosion resistant and non-magnetic, manufactured from premium grade stainless steel.

Screw coating
An optional teflon screw coating is available for smooth operation and extended life.

Standard screw
Dimensions in inches (mm)

Lead options

inches (mm)	travel per revolution	travel per full step
Screw A	0.250 (6.350)	0.00125 (0.0317)
Screw B	0.125 (3.175)	0.00063 (0.0158)
Screw C	0.063 (1.588)	0.00031 (0.0079)

Screw end options

Threaded end	Metric end: M4 x 0.7mm thread to within 0.03" (0.76mm) of shoulder	UNC end: #8-32 UNC-2A thread to within 0.03" (0.76mm) of shoulder
Smooth end	Ø 0.1967" ±0.001 (Ø 5mm ±0.003)	
None	—	

Cantilevered Loads
Loads for external shaft MDrive® linear actuator products MUST BE supported. Side loading is not recommended.

Calculating Stroke Length
Available stroke length = [screw length] – [nut length] – [mounting surface plate thickness]

Figure B4.2 External shaft mechanical specifications

B.4.3 Electrical Specifications

	Condition	Min	Typ	Max	Unit
Input voltage range **CAUTION**: Reverse polarity on the input power will likely damage the drive.	—	+12	—	+48	VDC
Power supply current	—	—	—	1	A
Aux-Logic Input Voltage	—	+12	—	+24	VDC
Max Aux-Logic Supply Current (Per MDrive)**	—	—	—	194	mA

**per MDrive 14 Plus, Actual current depends on voltage and load.*
*** Maintains power to control and feedback circuits [only] when input voltage is removed*

Table B4.1 Electrical Specifications

B.4.4 Standard I/O Specifications (Plus)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-4)	—	4 I/O points configurable as sinking or sourcing inputs or sinking outputs			
General Purpose I/O - Electrical					
Inputs	—	TTL	—	+24	VDC
Sinking Outputs (All)	—	—	—	+24	VDC
Output Sink Continuous Current	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Logic Threshold	Logic 0	—	—	< 0.8	VDC
	Logic 1	—	—	> 2.2	VDC
Protection	Sinking	Over temp, short circuit			
	Sourcing	Transient Over Voltage, Inductive Clamp			
Analog Input					
Resolution	—				
Range	Voltage Mode	0 to +5 VDC, 0 to +10 VDC			
	Current Mode	4 to 20 mA, 0 to 20mA			
Clock I/O					
Types	—	Step/Direction, Up/Down, Quadrature			
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			
Trip Output/Capture Input					
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			

Table B4.2 I/O Specifications

B.4.5 Expanded I/O Specifications (Plus²)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-8)	—	8 I/O points (4 if configured for remote encoder) configurable as sinking or sourcing inputs or outputs			
General Purpose I/O - Electrical					
Inputs	Sinking or Sourcing	TTL	—	+24	VDC
Outputs	Sinking	—	—	+24	VDC
	Sourcing	+12		+24	VDC
Output Sink Continuous Current **NOTE**: Output ratings apply to each bank of four I/O. First bank: Output 1-4 Second bank: Output 9-12	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Motion I/O					
Electronic gearing	Range	0.001	—	2.000	
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Secondary clock out ratio				1:1
High speed position capture	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Resolution	—	—	32	bit
High speed trip output	Speed	—	—	150	nS
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
Optional remote encoder (closed loop)*					
Type				User supplied differential encoder	
Steps per revolution				See motion specifications table	
Resolution	User defined . Note: microsteps/rev = 2X the encoder counts/rev minimum.				

**Remote encoder inputs replace I/O points 4-8 and step and direction I/O*

Table B4.3 Expanded I/O Specifications

B.4.6 Communication Specifications

	Condition	Min	Typ	Max	Unit
RS-422/485 (standard)					
BAUD rate	—	4.8		115.2	kbps
CANopen (optional)					
Type					2.0B active
BAUD rate	—	10 kHz	—	1 MHz	—
Application layer	Version 3.0				DS-301
Device profile	Version 2.0				DSP-402

ID	—	11 or 29 bit
Isolation	—	Galvanic

Table B4.4 Communication Specifications

B.4.7 Thermal Specifications

		Min	Typ	Max	Unit
Heat sink temperature	non-condensing humidity	-40	—	+85	ºC
Motor temperature	non-condensing humidity	-40	—	+100	ºC

Table B4.5 Thermal Specifications

B.4.8 Motion Specifications

Microstep Resolution - Open Loop	
Number of microstep resolutions	20

Available microsteps per revolution

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

1=0.01 deg/µstep 2=1 arc minute/µstep *3=0.001 mm/µstep
** 1" per revolution lead screw*

Microstep resolution (closed loop configuration - (optional)	
Steps Per Revolution (Fixed)	51200
Position Resolution	2048
Optional differential encoder (internally mounted)	
Type	Internal, Magnetic
Resolution (Lines)	512
Resolution (Edges)	2048
Counters	
Counter 1 (C1) Type	Position
Counter 2 (C2) Type	Encoder
Resolution	32 bit
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

Table B4.6 Motion Specifications

B.4.9 Software Specifications

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

Table B4.7 Software Specifications

B.4.10 Motor Specifications

Holding torque		18 oz-in (13 N-cm)
Rotor inertia		0.0003 oz-in-sec^2 (0.021 kg-cm2)
Maximum thrust (Non-captive)	General purpose	50 lbs (22 kg)
	With anti-backlash nut	—
Maximum thrust (External)	General purpose	25 lbs (11 kg)
	With anti-backlash nut	5 lbs (2 kg)
Maximum repeatability (Non-captive)	General purpose	0.005” (0.127 mm)
	With anti-backlash nut	—
Maximum repeatability (External)	General purpose	0.005” (0.127mm)
	With anti-backlash nut	0.0005” (0.0127 mm)
Maximum screw misalignment		± 1°
Weight without screw		8.0 oz (230.0 g)

Table B4.8 Actuator Specifications

B.4.11 Speed-force Performance Curves

*For non-captive shaft linear actuators. Load limit for external shaft linear actuators is determined by selected nut.

Figure B4.3 Performance Curves

B.5 MDrive 14 Linear Actuator - Connectivity Specifications/Pin Assignments

B.5.1 RS-422/485 Communication

10-pin Friction Lock Wire Crimp

Connectivity Options
USB to RS-422 Converter:
MD-CC402-001

Mating connector kit:
CK-02

Mfg P/N:
Shell
Hirose DF11-2428SC

Pins
Hirose DF11-TA2428HC

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table B5.1 P2 Communication, 10-pin Friction Lock Wire Crimp

B.5.2 CANopen Communication Option (Plus² Only)

9-pin D-sub Female (DB-9F)

Connectivity Options
USB to CANopen converter:
MD-CC500-000

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table B5.2 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

B.5.3 Communication, Power and I/O - Standard I/O (Plus Only)

Connectivity Options
USB to RS-422 Converter:
MD-CC403-001

Mating connector kit:
CK-08

Mfg P/N:
Shell
JST PADP-12V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	GND	Power, Auxiliary and Communication ground.
2	+V	+12 to +48 VDC Power Supply
3	I/O 2	0 to +24 VDC Programmable I/O Point 2
4	I/O 3	0 to +24 VDC Programmable I/O Point 3
5	I/O 4	0 to +24 VDC Programmable I/O Point 4
6	AIN	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
7	I/O 1	0 to +24 VDC Programmable I/O Point 1
8	AUX	+12 to +24 VDC Auxiliary Logic Supply Input. This provides power to control and logic circuits if main power is removed.
9	TX +	Transmit +: Connects to Receive + of the Communication Host.
10	TX -	Transmit –: Connects to Receive – of the Communication Host.
11	RX -	Receive –: Connects to Transmit – of the Communication Host.
12	RX +	Receive +: Connects to Transmit + of the Communication Host.

Table B5.3 P1 Communication, Power and I/O, 12-pin Locking Wire Crimp

B.5.4 Power and I/O - Expanded I/O (Plus²)

16-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD16-1417-FL3

Mating connector kit:
CK-10

Mfg P/N:
Shell
JST PADP-16V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	I/O 9	0 to +24 VDC Programmable I/O Point 9
8	I/O 10	0 to +24 VDC Programmable I/O Point 10
9	I/O 11	0 to +24 VDC Programmable I/O Point 11
10	I/O 12	0 to +24 VDC Programmable I/O Point 12
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	Step/clock I/O	Step clock i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
14	Direction/ clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
15	+V	+12 to +48 VDC motor power supply input.
16	Power/aux ground	Power and auxiliary ground

Table B5.4 P1 Expanded I/O, 16-pin Locking Wire Crimp

B.5.5 Power and I/O - Remote Encoder (Plus²)

16-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD16-1417-FL3

Mating connector kit:
CK-10

Mfg P/N:
Shell
JST PADP-16V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	CH A+	Channel A+ encoder input. +5 VDC logic level
8	CH A-	Channel A- encoder input. +5 VDC logic level
9	CH B+	Channel B+ encoder input. +5 VDC logic level
10	CH B-	Channel B- encoder input. +5 VDC logic level
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	IDX+	Index mark + encoder input. +5 VDC logic level
14	IDX-	Index mark - encoder input. +5 VDC logic level
15	+V	+12 to +48 VDC motor power supply input.
16	Power/aux ground	Power and auxiliary ground

Table B5.5 I/O and Remote Encoder Interface - 16-pin Locking Wire Crimp

B.5.6 Options

Internal encoder

Internal differential magnetic 512 line differential encoders with index mark are available:

Remote Encoder (Plus2 versions only)

MDrive14 Plus² Motion Control versions are available with differential encoder inputs for use with a remote encoder (not supplied).

Control Knob

The MDrive 14 Plus is available with a factory-mounted rear control knob for manual shaft positioning.

Planetary Gearbox

Efficient, low maintenance planetary gearboxes are offered assembled with the MDrive 14 Plus.

B.5.7 Connectivity

QuickStart Kit

For rapid design verifi cation, all-inclusive QuickStart Kits have communication converter, prototype development cable(s), instructions and CD for MDrive initial functional setup and system testing.

Communication Converters

Electrically isolated, in-line converters pre-wired with mating connectors to conveniently set/program communication parameters for a single MDrive product via a PC's USB port. Length 12.0' (3.6m).

Mates to connector:

P2 10-pin wire crimp.....MD-CC402-001

P1 12-pin wire crimp.....MD-CC403-001

Prototype Development Cables

Speed test/development with pre-wired mating connectors that have flying leads other end. Length 10.0' (3.0m).

Mates to connector:

P2 10-pin wire crimp..... PD10-1434-FL3

P1 12-pin wire crimp.....PD12B-1434-FL3

P1 16-pin wire crimp..... PD16-1417-FL3

Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin wire crimp.....CK-02

P1 16-pin wire crimp.....CK-10

P1 12-pin wire crimp.....CK-08

B.6 MDrive 14 Linear Actuator - Mounting and Connection Recommendations

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

LEAD RESTRAINT

Some MDrive mounting configurations require that the MDrive move along the screw. Ensure that all cabling is properly restrained to provide strain relief on connection points..

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

THERMAL MANAGEMENT

The mounting plate material should offer sufficient mass and thermal conductivity to ensure that the motor temperature does not exceed 100°C.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

SCREW MISALIGNMENT

Ensure that support for the screw is in place as to not exceed the maximum misalignment of ±1°.

Failure to follow these instructions can result in equipment damage.

> ⚠ **CAUTION**
>
> **CANTILEVER LOADS**
>
> Loads for external shaft MDrive linear actuator products MUST BE supported. Side loading is not recommended.
>
> **Failure to follow these instructions can result in equipment damage.**

B.6.1 Mounting

Care must be observed when installing the mounting screws on ALL MDrive 14Plus versions. The mounting holes on the flange are not drilled through and have a maximum depth of 0.150” (3.81 mm).

The warning note and Figure below illustrate the maximum safe thread length and maximum torque for mounting all versions of the MDrive14Plus.

Figure B6.1 MDrive 14 Linear Actuator Mounting and Drill Pattern

B.6.2 Recommended Mating Connectors and Pins

Communication

10-pin Friction Lock (P2) ..... Hirose DF11-10DS-2C

Crimp Contact for 10-pin Friction Lock (22 AWG) DF11-22SC

Crimp Contact for 10-pin Friction Lock (24 - 28 AWG) DF11-2428SC

Crimp Contact for 10-pin Friction Lock (30 AWG) DF11-30SC

10-pin pressure-fit IDC ..... Samtec TCSD-05-01-N

Ribbon cable ..... Tyco 1-57051-9

Power and I/O

The following mating connectors are recommended for the MDrive142 Units ONLY! Contact a JST distributor for ordering and pricing information.

16-pin Locking Wire Crimp Connector Shell ..... JST PN PADP-16V-1-S

Crimp Pins ..... JST PN SPH-001T-P0.5L

B.6.3 Securing Power Leads and Logic Leads

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

Figure B6.2 Securing Leads

B.7 MDrive 14 Linear Actuator - Anti-Backlash Nut Assembly and Installation

B.7.1 Notes and Warnings

- Do not use a wrench on the stainless steel cam of the nut.
- Do not oil the mechanism of the nut.
- Do not install the note into an interference fit bore (mechanism will not work).

B.7.2 Installation

To install threaded model nuts, simply hand tighten until shoulder is flush with mounting surface. A small amount of Loctite thread compound such as #277 can be used to prevent loosening. Alternatively, a pin can be installed to mechanically lock the threads.

Flanged models can be mounted to either the front or rear face of the flange.

Before use, it is recommended that the stainless steel preload mechanism be turned so that the caming surfaces move down the ramps. Once play is felt, allow the mechanism to slowly unwind again to establish the proper preload. (It is possible in assembly to inadvertently twist the cam creating excessive drag torque. This procedure will correct this.)

Using lubricant on the lead screw threads is recommended. This extends the life of the nut and reduces heat generation, noise and vibration. TriGEL-300S or TriGEL-1200SC is recommended.

B.7.3 Removal from Screw

If it is necessary to remove the nut from the screw, lock the mechanism so that it can be immediately reinstalled without re-setting the preload. This can be done by wrapping tape around the junction between the stainless steel cam and the plastic nut halves. This will prevent the cam from turning when the nut is removed from screw. Remember to remove tape after installation.

For immediate transfer from one screw to another, hold the nut together between the thumb and forefinger so that it cannot expand axially. Remove the nut and install it on the second screw. It may be helpful to prevent the cam from turning with the remaining fingers to transfer. If the nut becomes disassembled or looses its preload for any reason, follow the steps listed in the assembly procedure below.

B.7.4 Assembly Procedure

1) Insert spring tang into cam slot.

Figure B7.1 Insert Spring Tang

2) Ensure that the spring is engaged.

Figure B7.2 Spring Engaged

3) Insert opposite tang into front nut slot or hole (dependant on size). Use the slot or hole that will allow the the cam to be positioned closest to the bottom of the ramp.

Figure B7.3 Insert Opposite Tang

4) With washer installed, insert the back nut into the front nut.

Figure B7.4 Inserting the back nut

5) With the cam held at the bottom of the ramp, thread the entire nut onto the screw starting with the front nut. After the entire nut is threaded onto the screw, release the cam to observe the gap distance (X on the drawing). The gap distance (X) should be about one-third of the full ramp distance, but no more than half.

Figure B7.5 Measuring the Gap Distance

6) If the gap distance is incorrect, unthread the nut just enough to allow the back nut to disengage from the screw. Pull the back nut off and rotate to the next index position and reinsert back into the front nut. With the cam held at the bottom of the ramp, thread the entire nut back onto the screw. Release the cam and verify the correct gap distance. If still not correct repeat this step.

7) Once the back nut has been properly clocked to yield the correct gap distance, unthread the nut again just enough to disengage the back nut from the screw, but do not remove from the nut. Pull the cam away from the ramp and rotate in the clockwise direction for two ramp settings, then hold the cam at the bottom of the second ramp. Be careful not to allow the back nut to rotate with respect to the front nut while completing this task. With the cam held at the bottom of the second ramp, push the back nut into the front nut and thread the entire nut onto the screw.

Figure B7.6 Pre-loading the Nut

8) The anti-backlash nut is now pre-loaded and fully assembled.

Figure B7.7 Nut Pre-loaded and Fully Assembled

B.8 MDrive 14 Linear Actuator - Connection and Interface

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

B.8.1 Interfacing RS422-485 Communication

For general RS422/485 single and party mode communication practices, see Section 5 page 18 of this document.

⚠ CAUTION

COMMUNICATION GROUND LOOPS

To avoid ground loops in the system only connect communication ground to the first MDrive in the system. Do not connect communication ground on subsequent MDrives.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect communication while the device is in a powered state.

Failure to follow these instructions may result in damage to system components!

P1 — 12-pin Locking Wire Crimp

Pin #	Function	Description
1	GND	Power/aux/communication ground
9	TX +	Transmit plus
10	TX -	Transmit minus
11	RX -	Receive minus
12	RX +	Receive plus

Table B8.1 Communication Connections, P1 - 12-pin Wire Crimp

Connectivity Accessories

Mating connector kit CK-08
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD12-1434-FL3

Communication converter cable (10'/3.0 m).....MD-CC403-001

Manufacturer (JST) Part Numbers

Connector shell..... PADP-10V010S

Pins..... SPH-001T0.5L

P2 — 10-pin Friction Lock Wire Crimp

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table B8.2 P2 Communication, 10-pin Friction Lock Wire Crimp

Connectivity Accessories

Mating connector kit CK-02
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m)..... MD-CC402-001

B.8.2 Interfacing CANopen Communication

P2 — 9-pin D-sub Connector (Female)

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table B8.3 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

Connectivity Accessories

Communication converter cable..... MD-CC500-000

B.8.3 Interfacing DC Power

See Section 3 on page 10 for recommended power cable configurations.

⚠ CAUTION

OVER VOLTAGE

The DC voltage range for the MDrive 14 Plus is +12 to +48 VDC. Ensure that motor back EMF is factored into the power supply size calculations.

Allow 3.0 A maximum power supply output current per MDrive in the system. Actual power supply current will depend on voltage and load.

Failure to follow these instructions can result in equipment damage.

Recommended Wire Gauge

Cable Length: Feet (meters)	10 (3.0)	25 (7.6)	50 (15.2)	75 (22.9)	100 (30.5)
Amps Peak	**Minimum AWG**				
1 Amp Peak	20	20	18	18	18

Table B8.4 Recommended Power Supply Wire Gauge

P1 — 12-pin Locking Wire Crimp Interface

Pin #	***Signal***	***SEM cable wire colors***	
		MD-CC305-001	PD12B-14340-FL3
1	Power ground	Black	See Section 3 for wire colors.
2	+12 to + 48 VDC	Red	
8	Aux-power +2 to +24 VDC	Red/black	

Table B8.5 Power and Ground Connections, 12-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-08
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD12B-1434-FL3

Manufacturer (JST) Part Numbers

Connector shell..... PADP-12V-1-S

Pins..... SPH-001T0.5L

P1 — 16-pin Locking Wire Crimp Interface

Pin Numbers	*Signal*	*Prototype development cable wire colors*
15	+12 to + 48 VDC	Red
16	Power and auxiliary ground	Black

Table B8.6 Power and ground connections, 16-pin locking wire crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L04
(contains 5 connector shells, ribbon cable not included)

B.8.4 Interfacing I/O

See Section 4 on page 16, for I/O interface configurations and methods.

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O point is TTL level and only tolerant to +5 VDC:

1) Capture/Trip
2) Step/Direction
3) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

P1 — 12-pin Locking Wire Crimp

Pin #	*Signal*	*SEM cable wire colors*	
		MD-CC403-001	PD12B-1434-FL3
3	I/O 2	White	See Section 5 for wire colors.
4	I/O 3	Green	
5	I/O 4	Orange	
6	Analog input	White/black	
7	I/O 1	Blue	

Table B8.7 Universal Input Connections, 12-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-08
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD12B-1434-FL3

Manufacturer (JST) Part Numbers

Connector shell..... PADP-12V-1-S

Pins..... SPH-001T0.5L

P1 — 16-pin Locking Wire Crimp Interface (Expanded I/O)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	General purpose I/O 9	Yellow	Pair
8	General purpose I/O 10	Black	
9	General purpose I/O 11	Blue	Pair
10	General purpose I/O 12	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Step clock I/O	White	Pair
14	Direction clock I/O	Black	

Table B8.8 I/O Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

P1 — 16-pin Locking Wire Crimp Interface (Remote Encoder)

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	Channel A +	Yellow	Pair
8	Channel A -	Black	
9	Channel B +	Blue	Pair
10	Channel B -	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Index +	White	Pair
14	Index -	Black	

Table B8.9 I/O and Remote Encoder Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L

B.9 MDrive 14 Linear Actuator - Connectivity Accessory Details

B.9.1 RS-422/485 Communication Converter Cables

USB to 10-pin Wire Crimp Connector P2
P/N: MD-CC402-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure B9.1 MD-CC402-001 Communication Converter Cable

USB to 12-pin Circular Connector P1—
MD-CC403-000

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters.

Pin #	*Wire Colors*	*Signal*
1	Black	GND
2	Red	+V
3	White	I/O 2
7	Blue	I/O 1
5	Green	I/O 3
5	Orange	I/O 4
6	Brown	Analog Input

Figure B9.2 MD-CC403-001 Communication Converter

B.9.2 Prototype Development Cables

Flying Leads to 10-pin Wire Crimp Connector P2 -P/N: PD10-1434-FL3

Used in conjunction with the MD-CC402-001 communication converter cable to facilitate multi-drop RS-422/485 communication.

Wire Colors	Function
White/Red Stripe	Aux-Logic
White/Blue Stripe	TX+
Blue/White Stripe	TX-
White/Orange Stripe	RX+
Orange/White Stripe	RX-
Green/White Stripe	GND

Figure B9.3 Multi-drop Communication using the PD10-1434-FL3

Procedure

1) Remove ground wire (unless this is the first system MDrive, green/white stripe)
2) Remove aux-logic (if not used, red/white stripe)
3) Connect pre-crimped flying leads as shown in Figure 5.7 below

Figure B9.4 Wiring a Second PD10-1434-FL3 into the 10-pin Wire Crimp Connector.

Flying Leads to 12-pin Locking Wire Crimp Connector P1 - PD12B-3400-FL3

Description: Pre-wired mating connector interfaces to an MDrive's 12-pin wire crimp connector, with flying leads other end, for quick test/ development.

Function: I/O, Power & Communication Interface.

Pin #	*Wire Colors*	*Signal*	*Pairs*
1	Black	GND	X
2	Red	+V	
10	Black	TX-	X
9	White	TX+	
11	Black	RX-	X
12	Green	RX+	
3	Black	I/O 2	X
7	Blue	I/O 1	
5	Black	I/O 3	X
5	Yellow	I/O 4	
6	Black	Analog Input	X
8	Brown	Aux-Logic	

Figure B9.5 Prototype Development Cable PD12B-1434-FL3

Flying Leads to 16-pin Locking Wire Crimp Connector P2 -P/N: PD16-1417-FL3

The PD16-1417-FL3 prototype development cable is used to rapidly interface the MDrive 14 to the users controller. This 10’ (3.0 m) cable consists of a 16-pin locking wire crimp connector to plug directly into the MDrive P1 connector with flying leads on the opposite end to interface to power, i/o and/or remote encoder.

Pair	Wire Colors	Function	Encoder Function
1	Black	Direction	IDX+
	White	Step Clock	IDX-
2	Black	Analog In	Analog In
	Green	Capt/Trip	Capt/Trip
3	Black	I/O12	CH B-
	Blue	I/O11	CH B+
4	Black	I/O10	CH A-
	Yellow	I/O9	CH A +
5	Black	I/O4	I/O4
	Brown	I/O3	I/O3
6	Black	I/O2	I/O2
	Orange	I/O1	I/O1
7	White	I/O Ground	I/O Ground
	Red	I/O Power	I/O Power
8	Black	Power GND	Power GND
	Red	+V	+V

Pin #	*Wire Colors*	*Signal (Expanded features)*	*Signal (Remote encoder)*	*Pairs*
16	Black	GND	GND	X
15	Red	+V	+V	
14	Black	Step Clock I/O	Index –	X
13	White	Direction I/O	Index +	
12	Black	Analog Input	Analog Input	X
11	Green	Capture/Trip I/O	Capture/Trip I/O	
10	Black	I/O 12	Channel B –	X
9	Blue	I/O 11	Channel B +	
8	Black	I/O 10	Channel A –	X
7	Yellow	I/O 9	Channel A +	
6	Black	I/O 4	I/O 4	X
5	Brown	I/O 3	I/O 3	
4	Black	I/O 2	I/O 2	X
3	Orange	I/O 1	I/O 1	
2	White	I/O Ground	I/O Ground	X
1	Red	I/O Power	I/O Power	

Figure B9.6 Prototype Development Cable PD16-1417-FL3

B.9.3 Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer’s crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC.....CK-01

P2 10-pin wire crimp.....CK-02

P1 12-pin wire crimp.....CK-08

P1 16-pin wire crimp.....CK-10

B.10 MDrive 17 Linear Actuator - Introduction and Overview

B.10.1 MDrive 17 Versions

Two (2) MDrive 17 integrated versions provide a choice of features and capabilities:

- **Microstepping** — motor + driver
- **Motion Control** — motor + driver + controller

MDrive 17 linear actuators feature high torque 1.8° brushless NEMA 17 (1.7”/43mm sq.) single length step motors with integrated electronics, providing the leading technology solution for all-in-one linear motion applications.

Unsurpassed smoothness and performance delivered by MDrive17 products are achieved through SEM’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 MDrive 17 accepts a broad input voltage range from +12 to +48 VDC, delivering enhanced performance and speed. Oversized input capacitors are used to minimize power line surges, reducing problems that can occur with long cable runs and multiple drive systems. An extended operating range of –40° to +85°C provides long life, trouble free service in demanding environments.

B.10.2 Product Identification

P1

I/O & power connectors:

F = flying leads
P = pluggable terminal
C = locking wire crimp (includes Comm on Microstepping version)

P2

Communication connectors:

D = 10-pin IDC
L = 10-pin friction lock wire crimp
B = DB9, only with CANopen Comm
Z = None (when C used at P1 on Microstepping version)

	P1		P2			
MLI1	F,P	R (RS-422/485 comm)	D,L	17A4	– EQ (Internal magnetic encoder with 512-line count and index mark.)	– L linear actuator
MLI1	F,P	C (CANopen comm)	B	17A4	– EQ	– L linear actuator
Plus2 MLI3	C	R (RS-422/485 comm)	D,L	17A4	– EQ (see above) or – EE (Plus2 version only: optional inputs for differential remote encoder (not supplied). May not be combined with internal encoder.)	– L linear actuator
Plus2 MLI3	C	C (CANopen comm)	B	17A4	– EQ	– L linear actuator

See details at bottom of page for complete linear actuator part numbers.

Linear Actuator Options

Non-captive shaft

– L □1 □ □□□Z □

Screw lead
travel per rev
A = 0.250" (6.35mm)
B = 0.125" (3.175mm)
C = 0.063" (1.588mm)

Screw end
M = metric
U = UNC
S = smooth
Z = none

Screw length
3.0 to 18.0"
in 0.1 increments
ex. 12.5" = 125
10.0" = 100

Coating
T = teflon*
Z = none

Screw length calculation = mounting surface plate thickness + 1.40" (35.56mm) + desired stroke length

*Contact factory for availability.

External shaft

– L □3 □ □□□ □ □

Screw lead
travel per rev
A = 0.250"/6.35mm
B = 0.125"/3.175mm
C = 0.063"/1.588mm

Screw end
M = metric
U = UNC
S = smooth
Z = none

Screw length
3.0 to 18.0"
in 0.1 increments
ex. 12.5" = 125
10.0" = 100

Nut
G = general purpose (dynamic load limit to 25lbs/111N)
A = anti-backlash (dynamic load limit to 5lbs/22N)

Coating
T = teflon*
Z = none

Stroke length calculation = screw length – nut length – mounting surface plate thickness

Figure B10.1 Standard Product Options

Revision R080720

B.11 MDrive 17 Linear Actuator - Specifications

B.11.1 Mechanical Specifications - External Shaft

Side view

Front view

Nut detail

General purpose nut
Flange shape: round
Load limit: 25 lbs (11.3 kg)
Purpose: for applications not requiring anti-backlash and wear compensation.

Anti-backlash nut
Flange shape: triangle
Load limit: 5 lbs (2.3 kg)
Purpose: backlash free operation for high accuracy and low drag torque.

inches (mm)	A	B	D	E	F	BCD	*load limit*	*drag torque*
General purpose	0.50 (12.7)	0.75 (19.1)	1.0 (25.4)	0.14 (2.6)	0.15 (2.81)	0.75 (19.1)	25lbs/ 11.3kg	free wheeling
Anti-backlash	0.50 (12.7)	0.9max (22.86)	1.0 (25.4)	0.143 (2.63)	0.18 (4.57)	0.75 (19.1)	5lbs/ 2.3kg	< 1.0 oz-in < 0.7 N-cm

Screw Specifications

Modified Acme-style rolled screw

Lead options

inches (mm)	Travel/revolution	Travel/full step
Screw A	0.250 (6.35)	0.00125 (0.0317)
Screw B	0.125 (2.175)	0.00063 (0.0158)
Screw C	0.063 (1.588)	0.00031 (0.0079)

Screw end options

Smooth	Dimensions Ø 0.1967" ±0.001 (Ø 5mm ±0.003)
None	—

Screw coating

An optional teflon screw coating is available for smooth operation and extended life. *Contact factory for availability.*

Figure B11.1 External shaft mechanical specifications - dimensions in inches (mm)

Cantilevered loads

Loads for external shaft MDrive® linear actuator products MUST BE supported. Side loading is not recommended.

Calculating screw/stroke length

Available stroke length = [6.0” screw] – [nut length] – [mounting surface plate thickness]

B.11.2 Mechanical Specifications - Non-Captive Shaft

Side view

Front view

Screw Specifications

Modified Acme style rolled screw

Lead options

inches (mm)	Travel/revolution	Travel/full step
Screw A	0.250 (6.35)	0.00125 (0.0317)
Screw B	0.125 (2.175)	0.00063 (0.0158)
Screw C	0.063 (1.588)	0.00031 (0.0079)

Screw end options

	Dimensions
Metric	M4 x 0.7mm thread to within 0.03" (0.76mm) of shoulder
UNC	#8-32 UNC-2A thread to within 0.03" (0.76mm) of shoulder
Smooth	Ø 0.1967" ±0.001 (Ø 5mm ±0.003)
None	—

Figure B11.2 Non-captive Shaft Mechanical Specifications - Dimensions in inches (mm)

Cantilevered Loads

Unsupported loads and side loading are not recommended for non-captive shaft MDrive® linear actuator products.

Calculating Screw/Stroke Length

Screw length = [mounting surface plate thickness] + [1.40” (35.56mm)] + [desired stroke length]]

B.11.3 Electrical Specifications

	Condition	Min	Typ	Max	Unit
Input voltage range **CAUTION**: Reverse polarity on the input power will likely damage the drive.	—	+12	—	+48	VDC
Max power supply current	—	—	—	2.0*	A
Aux-Logic Input Voltage	—	+12	—	+24	VDC
Max Aux-Logic Supply Current (Per MDrive 17)**	—	—	—	161	mA

**per MDrive 17, Actual current depends on voltage and load.*
*** Maintains power to control and feedback circuits [only] when input voltage is removed*

Table B11.1 Electrical Specifications

B.11.4 Standard I/O Specifications (Plus)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-4)	—	4 I/O points configurable as sinking or sourcing inputs or sinking outputs			
General Purpose I/O - Electrical					
Inputs	—	TTL	—	+24	VDC
Sinking Outputs (All)	—	—	—	+24	VDC
Output Sink Continuous Current	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Logic Threshold	Logic 0	—	—	< 0.8	VDC
	Logic 1	—	—	> 2.2	VDC
Protection	Sinking	Over temp, short circuit			
	Sourcing	Transient Over Voltage, Inductive Clamp			
Analog Input					
Resolution	—				
Range	Voltage Mode	0 to +5 VDC, 0 to +10 VDC			
	Current Mode	4 to 20 mA, 0 to 20mA			
Clock I/O					
Types	—	Step/Direction, Up/Down, Quadrature			
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			
Trip Output/Capture Input					
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			

Table B11.2 Standard I/O specifications

B.11.5 Expanded I/O Specifications (Plus²)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-8)	—	8 I/O points (4 if configured for remote encoder) configurable as sinking or sourcing inputs or outputs			
General Purpose I/O - Electrical					
Inputs	Sinking or Sourcing	TTL	—	+24	VDC
Outputs	Sinking	—	—	+24	VDC
	Sourcing	+12		+24	VDC
Output Sink Continuous Current **NOTE**: Output ratings apply to each bank of four I/O. First bank: Output 1-4 Second bank: Output 9-12	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Motion I/O					
Electronic gearing	Range	0.001	—	2.000	
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Secondary clock out ratio				1:1
High speed position capture	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Resolution	—	—	32	bit
High speed trip output	Speed	—	—	150	nS
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
Optional remote encoder (closed loop)*					
Type		User supplied differential encoder			
Steps per revolution		See motion specifications table			
Resolution	User defined . Note: microsteps/rev = 2X the encoder counts/rev minimum.				

**Remote encoder inputs replace I/O points 4-8 and step and direction I/O*

Table B11.3 Expanded I/O specifications

B.11.6 Communication Specifications

	Condition	Min	Typ	Max	Unit
RS-422/485 (standard)					
BAUD rate	—	4.8		115.2	kbps
CANopen (optional)					
Type					2.0B active
BAUD rate	—	10 kHz	—	1 MHz	—
Application layer	Version 3.0				DS-301
Device profile	Version 2.0				DSP-402

ID	—	11 or 29 bit
Isolation	—	Galvanic

Table B11.4 Communication Specifications

B.11.7 Thermal Specifications

		Min	Typ	Max	Unit
Heat sink temperature	non-condensing humidity	-40	—	+85	ºC
Motor temperature	non-condensing humidity	-40	—	+100	ºC

Table B11.5 Thermal Specifications

B.11.8 Motion Specifications

Microstep Resolution - Open Loop	
Number of microstep resolutions	20

Available microsteps per revolution

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

1=0.01 deg/µstep 2=1 arc minute/µstep *3=0.001 mm/µstep
** 1" per revolution lead screw*

Microstep resolution (closed loop configuration - (optional)	
Steps Per Revolution (Fixed)	51200
Position Resolution	2048
Optional differential encoder (internally mounted)	
Type	Internal, Magnetic
Resolution (Lines)	512
Resolution (Edges)	2048
Counters	
Counter 1 (C1) Type	Position
Counter 2 (C2) Type	Encoder
Resolution	32 bit
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

Table B11.6 Motion Specifications

B.11.9 Software Specifications

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

Table B11.7 Software Specifications

B.11.10 Actuator Motor Specifications

Holding torque		29.16 oz-in (20.6 N-cm)
Rotor inertia		0.0005 oz-in-sec^2 (0.035 kg-cm^2)
Maximum thrust	General purpose	50 lbs (222 N)
	With anti-backlash nut	25 lbs (111 N)
Maximum repeatability	General purpose	0.005” (0.127 mm)
	With anti-backlash nut	0.0005” (0.0127 mm)
Maximum screw misalignment		± 1°
Wieght without screw		9.6 oz (272.2 g)

Table B11.8 Linear Actuator Motor Specifications

B.11.11 Speed-Force Performance Curves

12 VDC Curves

Figure B11.3 12 VDC Speed-Force Curves

24 VDC Curves

Figure B11.4 24 VDC Speed-Force Curves

48VDC Curves

Figure B11.5 48 VDC Speed-Force Curves

B.12 MDrive 17 Linear Actuator - Connectivity Specifications/Pin Assignments

B.12.1 RS-422/RS-485 Communication

10-pin Pressure Fit IDC

Connectivity Options
USB to RS-422/485 Converter:
MD-CC400-001

Mating connector kit:
CK-01

Mfg P/N:
Shell
SAMTEC: TCSD-05-01-N

Ribbon cable
Tyco: 1-57051-9

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table B12.1 P2 Communication, 10-pin Pressure Fit IDC/SAMTEC

10-pin Friction Lock Wire Crimp

Connectivity Options
USB to RS-422/485 Converter:
MD-CC402-001

Mating connector kit:
CK-02

Mfg P/N:
Shell
Hirose DF11-10DS-2C

Pins
Hirose: DF11-2428SC

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table B12.2 P2 Communication, 10-pin Friction Lock Wire Crimp

B.12.2 CANopen Communication Option (Connector P2)

9-pin D-sub Female (DB-9F)

Connectivity Options
USB to CANopen converter:
MD-CC500-000

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	VAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table B12.3 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

B.12.3 Power and I/O - Standard I/O (Plus)

12” (304.8 mm) Flying Leads

Wire Color	Function	Description
White/yellow	I/O 1	General purpose I/O point 1
White/orange	I/O 2	General purpose I/O point 2
White/violet	I/O 3	General purpose I/O point 3
White/blue	I/O 4	General purpose I/O point 4
Green	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
Black	GND	Power and auxiliary ground
Red	+V	Motor power (+12 to +48VDC

Table B12.4 Power and I/O Interface - 12” (308.8.mm) Flying Leads

7-pin Pluggable Terminal

Pin #	Function	Description
1	I/O 1	General purpose I/O point 1
2	I/O 2	General purpose I/O point 2
3	I/O 3	General purpose I/O point 3
4	I/O 4	General purpose I/O point 4
5	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
6	GND	Power and auxiliary ground
7	+V	Motor power (+12 to +48VDC

Table B12.5 Power and I/O Interface - 7-pin Pluggable Terminal

B.12.4 Power and I/O - Expanded I/O (Plus²)

16-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD16-1417-FL3

Mating connector kit:
CK-10

Mfg P/N:
Shell
JST PADP-16V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	I/O 9	0 to +24 VDC Programmable I/O Point 9
8	I/O 10	0 to +24 VDC Programmable I/O Point 10
9	I/O 11	0 to +24 VDC Programmable I/O Point 11
10	I/O 12	0 to +24 VDC Programmable I/O Point 12
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	Step/clock I/O	Step clock i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
14	Direction/ clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
15	+V	+12 to +48 VDC motor power supply input.
16	Power/aux ground	Power and auxiliary ground

Table B12.6 Power and I/O Interface - 16-pin Locking Wire Crimp

B.12.5 Power and I/O - Remote Encoder (Plus²)

16-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD16-1417-FL3

Mating connector kit:
CK-10

Mfg P/N:
Shell
JST PADP-16V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	CH A+	Channel A+ encoder input. +5 VDC logic level
8	CH A-	Channel A- encoder input. +5 VDC logic level
9	CH B+	Channel B+ encoder input. +5 VDC logic level
10	CH B-	Channel B- encoder input. +5 VDC logic level
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	IDX+	Index mark + encoder input. +5 VDC logic level
14	IDX-	Index mark - encoder input. +5 VDC logic level
15	+V	+12 to +48 VDC motor power supply input.
16	Power/aux ground	Power and auxiliary ground

Table B12.7 Power, I/O and Remote Encoder Interface - 16-pin Locking Wire Crimpl

B.12.6 Options

Internal Encoder

Internal differential magnetic encoders with index mark are available with the MDrive14Plus Microstepping.

Line counts available: 100, 200, 250, 256, 400, 500, 512, 800,1000

B.12.7 Connectivity

QuickStart Kit

For rapid design verifi cation, all-inclusive QuickStart Kits have communication converter, prototype development cable(s), instructions and CD for MDrive linear actuator initial functional setup and system testing.

Communication Converters

Electrically isolated, in-line converters pre-wired with mating connectors to conveniently set/program communication parameters for a single MDrive product via a PC's USB port. Length 12.0' (3.6m).

Mates to connector:

P2 10-pin IDC MD-CC400-001

P2 10-pin wire crimp MD-CC402-001

Prototype Development Cables

Speed test/development with pre-wired mating connectors that have flying leads other end. Length 10.0' (3.0m).

Mates to connector:

P2 10-pin wire crimp PD10-1434-FL3

P1 16-pin wire crimp PD16-1417-FL3

Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin wire crimp CK-02

P1 16-pin wire crimp CK-10

Kit contains 5 mating connectors that press fit onto ribbon cable. Cable not supplied.

P2 10-pin IDC CK-01

B.13 MDrive 17 Linear Actuator - Mounting and Connection Recommendations

⚠ CAUTION

LEAD RESTRAINT

Some linear actuator mounting configurations require that the MDrive move along the screw. Ensure that all cabling is properly restrained to provide strain relief on connection points..

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

SCREW MISALIGNMENT

Ensure that support for the screw is in place as to not exceed the maximum misalignment of ±1°.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

CANTILEVER LOADS

Loads for external shaft MDrive linear actuator products MUST BE supported. Side loading is not recommended.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

MOUNTING SCREW TORQUE

When mounting the MDrive, do not exceed the maximum recommended tightening torque of 7.8 lb-in (9 kg-cm).

Failure to follow these instructions can result in equipment damage.

B.13.1 Mounting

Care must be observed when installing the mounting screws on ALL MDrive 17 linear actuator versions. The mounting holes on the flange are not drilled through and have a maximum depth of 0.150” (3.81 mm).

The warning note and Figure below illustrate the maximum safe thread length and maximum torque for mounting all versions of the MDrive 17 linear actuator.

Drill Pattern for Mounting Flange or Adapter Plate

Figure B13.1 Mdrive Linear Actuator Mounting and Drill Pattern

B.13.2 Recommended Mating Connectors and Pins

Communication

10-pin Friction Lock (P2) ..... Hirose DF11-10DS-2C

Crimp Contact for 10-pin Friction Lock (22 AWG) DF11-22SC

Crimp Contact for 10-pin Friction Lock (24 - 28 AWG) DF11-2428SC

Crimp Contact for 10-pin Friction Lock (30 AWG) DF11-30SC

Logic and Power

The following mating connectors are recommended for the MDrive 17 Plus[2] Units ONLY! Contact a JST distributor for ordering and pricing information.

16-pin Locking Wire Crimp Connector Shell JST PN PADP-16V-1-S

Crimp Pins ..... JST PN SPH-001T-P0.5L

B.13.3 Securing Power Leads and Logic Leads

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

Figure B13.2 Securing Leads

B.14 MDrive 17 Linear Actuator - Anti-Backlash Nut Assembly and Installation

B.14.1 Notes and Warnings

- Do not use a wrench on the stainless steel cam of the nut.
- Do not oil the mechanism of the nut.
- Do not install the note into an interference fit bore (mechanism will not work).

B.14.2 Installation

To install threaded model nuts, simply hand tighten until shoulder is flush with mounting surface. A small amount of Loctite thread compound such as #277 can be used to prevent loosening. Alternatively, a pin can be installed to mechanically lock the threads.

Flanged models can be mounted to either the front or rear face of the flange.

Before use, it is recommended that the stainless steel preload mechanism be turned so that the caming surfaces move down the ramps. Once play is felt, allow the mechanism to slowly unwind again to establish the proper preload. (It is possible in assembly to inadvertently twist the cam creating excessive drag torque. This procedure will correct this.)

Using lubricant on the lead screw threads is recommended. This extends the life of the nut and reduces heat generation, noise and vibration. TriGEL-300S or TriGEL-1200SC is recommended.

B.14.3 Removal from Screw

If it is necessary to remove the nut from the screw, lock the mechanism so that it can be immediately reinstalled without re-setting the preload. This can be done by wrapping tape around the junction between the stainless steel cam and the plastic nut halves. This will prevent the cam from turning when the nut is removed from screw. Remember to remove tape after installation.

For immediate transfer from one screw to another, hold the nut together between the thumb and forefinger so that it cannot expand axially. Remove the nut and install it on the second screw. It may be helpful to prevent the cam from turning with the remaining fingers to transfer. If the nut becomes disassembled or looses its preload for any reason, follow the steps listed in the assembly procedure below.

B.14.4 Assembly Procedure

1) Insert spring tang into cam slot.

Figure B14.1 Insert Spring Tang

2) Ensure that the spring is engaged.

Figure B14.2 Spring Engaged

3) Insert opposite tang into front nut slot or hole (dependant on size). Use the slot or hole that will allow the the cam to be positioned closest to the bottom of the ramp.

Figure B14.3 Insert Opposite Tang

4) With washer installed, insert the back nut into the front nut.

Figure B14.4 Inserting the Back Nut

5) With the cam held at the bottom of the ramp, thread the entire nut onto the screw starting with the front nut. After the entire nut is threaded onto the screw, release the cam to observe the gap distance (X on the drawing). The gap distance (X) should be about one-third of the full ramp distance, but no more than half.

Figure B14.5 Measuring the Gap Distance

6) If the gap distance is incorrect, unthread the nut just enough to allow the back nut to disengage from the screw. Pull the back nut off and rotate to the next index position and reinsert back into the front nut. With the cam held at the bottom of the ramp, thread the entire nut back onto the screw. Release the cam and verify the correct gap distance. If still not correct repeat this step

7) Once the back nut has been properly clocked to yield the correct gap distance, unthread the nut again just enough to disengage the back nut from the screw, but do not remove from the nut. Pull the cam away from the ramp and rotate in the clockwise direction for two ramp settings, then hold the cam at the bottom of the second ramp. Be careful not to allow the back nut to rotate with respect to the front nut while completing this task. With the cam held at the bottom of the second ramp, push the back nut into the front nut and thread the entire nut onto the screw.

Figure B14.6 Pre-loading the Nut

8) The anti-backlash nut is now pre-loaded and fully assembled.

Figure B14.7 Nut Pre-loaded and Fully Assembled

B.15 MDrive 17 Linear Actuator - Connection and Interface

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

B.15.1 Interfacing Communication

Communication interface, connector pin configuration and specifications are common to all NEMA sizes of the MDrive linear actuator. Connectivity information is located in Part 1 of this document, Section 1.4

B.15.2 Interfacing DC Power

See Section 3 on page 10 for recommended power cable configurations.

⚠ CAUTION

OVER VOLTAGE

The DC voltage range for the MDrive17 linear actuator is +12 to +48 VDC. Ensure that motor back EMF is factored into the power supply size calculations.

Allow 2.0 A maximum power supply output current per MDrive17 in the system. Actual power supply current will depend on voltage and load.

Failure to follow these instructions can result in equipment damage.

B.15.3 Recommended SEM Power Supplies

IP402 Unregulated Linear Supply

Input Range

120 VAC Versions ..... 102-132 VAC

240 VAC Versions ..... 204-264 VAC

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

No Load Output Voltage .....39 VDC @ 0 Amps

Continuous Output Rating .....30 VDC @ 1.0 Amps

Peak Output Rating .....25 VDC @ 2.0 Amps

IP404 Unregulated Linear Supply

Input Range

120 VAC Versions ..... 102-132 VAC

240 VAC Versions ..... 204-264 VAC

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

No Load Output Voltage .....43 VDC @ 0 Amps

Continuous Output Rating .....32 VDC @ 1.5 Amps

Peak Output Rating .....26 VDC @ 3 Amps

ISP200-4 Unregulated Switching Supply

Input Range

120 VAC Versions ..... 102-132 VAC

240 VAC Versions ..... 204-264 VAC

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

No Load Output Voltage .....41 VDC @ 0 Amps

Continuous Output Rating .....38 VDC @ 1.5 Amps

Peak Output Rating ..... 35 VDC @ 3 Amp

Recommended Wire Gauge

1 Ampere (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	20	20	18	18	16
2 Amperes (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	20	18	16	14	14

Table B15.1 Recommended Power Supply Wire Gauge

P1 — 12' (30.5 cm) Flying Leads Interface

Wire Color	
Red	+12 to + 48 VDC
Black	Power and auxiliary ground

Table B15.2 Power and Ground Connections, Flying Leads

P1 — 7-pin Pluggable Terminal Interface

Pin Numbers	
6	Power and auxiliary ground
7	+12 to + 48 VDC

Table B15.3 Power and Ground Connections, 7-pin Terminal

P1 — 16-pin Locking Wire Crimp Interface

Pin Numbers	***Signal***	***Prototype development cable wire colors***
15	+12 to + 48 VDC	Red
16	Power and auxiliary ground	Black

Table B15.4 Power and Ground Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L

B.15.4 Interfacing I/O

See Section 4 on page 16 for I/O interface configurations and methods.

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O points are TTL level and only tolerant to +5 VDC:

1) Step Clock
2) Direction
3) Capture/Trip
4) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

P1 — 12’ (30.5 cm) Flying Leads Interface

Wire Color	*Signal*
White/yellow	General purpose I/O 1
White/orange	General purpose I/O 2
White/violet	General purpose I/O 3
White/blue	General purpose I/O 4
Green	Analog input

Table B15.5 I/O connections, Flying Leads

P1 — 7-pin Pluggable Terminal Interface

Pin number	*Signal*
1	General purpose I/O 1
2	General purpose I/O 2
3	General purpose I/O 3
4	General purpose I/O 4
5	Analog input

Table B15.6 I/O Connections, 7-pin Terminal

P1 — 16-pin Locking Wire Crimp Interface (Expanded I/O)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	General purpose I/O 9	Yellow	Pair
8	General purpose I/O 10	Black	
9	General purpose I/O 11	Blue	Pair
10	General purpose I/O 12	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Step clock I/O	White	Pair
14	Direction clock I/O	Black	

Table B15.7 I/O Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10’/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-16V-1-S

Pins..... SPH-001T0.5L

P1 — 16-pin Locking Wire Crimp Interface (Remote Encoder)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	Channel A +	Yellow	Pair
8	Channel A -	Black	
9	Channel B +	Blue	Pair
10	Channel B -	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Index +	White	Pair
14	Index -	Black	

Table B15.7 I/O and Remote Encoder Connections, 16-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-10
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD16-1417-FL3

Manufacturer (JST) Part Numbers

Connector shell..... PADP-16V-1-S

Pins..... SPH-001T0.5L

B.16 MDrive 17 Linear Actuator - Connectivity Accessory Details

B.16.1 RS-422/485 Communication Converter Cables

USB to 10-pin IDC Connector P2
P/N: MD-CC400-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure B16.1 MD-CC400-000 Communication Converter Cable

USB to 10-pin Wire Crimp Connector P2
P/N: MD-CC402-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure B16.2 MD-CC402-001 Communication Converter Cable

B.16.2 Prototype Development Cables

Flying Leads to10-pin Wire Crimp Connector P2 -P/N: PD10-1434-FL3

Used in conjunction with the MD-CC402-001 communication converter cable to facilitate multi-drop RS-422/485 communication.

Wire Colors	Function
White/Red Stripe	Aux-Logic
White/Blue Stripe	TX+
Blue/White Stripe	TX-
White/Orange Stripe	RX+
Orange/White Stripe	RX-
Green/White Stripe	GND

Figure B16.3 Multi-drop Communication using the PD10-1434-FL3

Flying Leads to16-pin Locking Wire Crimp Connector P2 -P/N: PD16-1417-FL3

The PD16-1417-FL3 prototype development cable is used to rapidly interface the MDrive17 to the users controller. This 10’ (3.0 m) cable consists of a 16-pin locking wire crimp connector to plug directly into the MDrive P1 connector with flying leads on the opposite end to interface to power, I/O and/or remote encoder.

Pair	Wire Colors	Function	Encoder Function
1	Black	Direction	IDX+
	White	Step Clock	IDX-
2	Black	Analog In	Analog In
	Green	Capt/Trip	Capt/Trip
3	Black	I/O12	CH B-
	Blue	I/O11	CH B+
4	Black	I/O10	CH A-
	Yellow	I/O9	CH A +
5	Black	I/O4	I/O4
	Brown	I/O3	I/O3
6	Black	I/O2	I/O2
	Orange	I/O1	I/O1
7	White	I/O Ground	I/O Ground
	Red	I/O Power	I/O Power
8	Black	Power GND	Power GND
	Red	+V	+V

Pin #	*Wire Colors*	*Signal (Expanded features)*	*Signal (Remote encoder)*	*Pairs*
16	Black	GND	GND	X
15	Red	+V	+V	
14	Black	Step Clock I/O	Index –	X
13	White	Direction I/O	Index +	
12	Black	Analog Input	Analog Input	X
11	Green	Capture/Trip I/O	Capture/Trip I/O	
10	Black	I/O 12	Channel B –	X
9	Blue	I/O 11	Channel B +	
8	Black	I/O 10	Channel A –	X
7	Yellow	I/O 9	Channel A +	
6	Black	I/O 4	I/O 4	X
5	Brown	I/O 3	I/O 3	
4	Black	I/O 2	I/O 2	X
3	Orange	I/O 1	I/O 1	
2	White	I/O Ground	I/O Ground	X
1	Red	I/O Power	I/O Power	

Figure B16.4 Prototype Development Cable PD16-1417-FL3

B.16.3 Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer’s crimp tool recommended.

Mates to connector:

P2 10-pin wire crimp.....CK-02

P1 16-pin wire crimp.....CK-10

Kit contains 5 mating connectors that press fit onto ribbon cable. Cable not supplied.

P2 10-pin IDC.....CK-01

B.17 MDrive 23 Linear Actuator - Introduction and Overview

B.17.1 MDrive 23 Linear Versions

Two (2) MDrive 23 integrated versions provide a choice of features and capabilities:

- **Microstepping** — motor + driver
- **Motion Control** — motor + driver + controller

MDrive 23 linear actuators feature high torque 1.8° brushless NEMA 23 single length step motors with integrated electronics, providing the leading technology solution for all-in-one linear motion applications.

Unsurpassed smoothness and performance delivered by MDrive 23 products are achieved through SEM'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 MDrive 23 accepts a broad input voltage range from +12 to +75 VDC, delivering enhanced performance and speed. Oversized input capacitors are used to minimize power line surges, reducing problems that can occur with long cable runs and multiple drive systems. An extended operating range of –40° to +85°C provides long life, trouble free service in demanding environments mapping and extended node identifier.

Motor configurations include a single shaft rotary in four lengths, and linear actuators with long life modified Acme screw.

B.17.2 Product Identification

P1
I/O & power connectors:
F = flying leads
P = pluggable terminal
C = locking wire crimp

P2
Communication connectors:
D = 10-pin IDC
L = 10-pin friction lock wire crimp
B = DB9, only with CANopen Comm

Optional encoder
For NO encoder, omit any –E specification from part number

	P1		P2				
MLI1	F,P	R (RS-422/485 comm)	D,L	23A7	– EQ (Internal magnetic encoder with 512-line count and index mark.)	– L	linear actuator
MLI1	F,P	C (CANopen comm)	B	23A7		– L	linear actuator
Plus² MLI3	C	R (RS-422/485 comm)	D,L	23A7	– EQ (see above) or – EE (Plus² version only: optional inputs for differential remote encoder (not supplied). May not be combined with internal encoder.)	– L	linear actuator
Plus² MLI3	C	C (CANopen comm)	B	23A7		– L	linear actuator

See details at bottom of page for complete linear actuator part numbers.

Non-captive shaft

– L□1□ □□□ Z□

Screw lead
travel per rev
G = 0.375" (9.525mm)
A = 0.200" (5.08mm)
B = 0.167" (4.233mm)
D = 0.083" (2.116mm)

Screw end
M = metric
U = UNC
S = smooth
Z = none

Screw length
3.0 to 24.0"
in 0.1 increments
ex. 12.5" = 125
10.0" = 100

Coating
T = teflon*
Z = none

Screw length calculation = desired stroke length + 1.8" (45.7mm) + mounting surface plate thickness

External shaft

– L□3□ □□□ □ □

Screw lead
travel per rev
G = 0.375" (9.525mm)
A = 0.200" (5.08mm)
B = 0.167" (4.233mm)
D = 0.083" (2.116mm)

Screw end
M = metric
U = UNC
S = smooth
Z = none

Screw length
3.0 to 24.0"
in 0.1 increments
ex. 12.5" = 125
10.0" = 100

Nut
G = general purpose (dynamic load limit to 60lbs/22kg)
A = anti-backlash (dynamic load limit to 25lbs/11kg)

Coating
T = teflon*
Z = none

Screw length calculation = desired stroke length + nut length + mounting surface plate thickness

Figure B17.1 Standard Product Options

B.18 MDrive 23 Linear Actuator - Specifications

B.18.1 Mechanical Specifications - Non-Captive Shaft

Side view

Front view

Load limit
Nominal load limit: 200 lbs (91 kg)

Screw Specifications

Screw material

MDrive Linear Actuator precision rolled lead screws are designed specifically for motion control applications to deliver maximum life and quiet operation. Corrosion resistant and non-magnetic, screws are manufactured from premium grade stainless steel.

Screw coating

An optional teflon screw coating is available for smooth operation and extended life.

Standard screw

Dimensions in inches (mm)

Lead options

inches (mm)	Travel/revolution		Travel/full step	
Screw G	0.3750	(9.525)	0.001875	(0.0476)
Screw A	0.200	(5.08)	0.001	(0.0254)
Screw B	0.1670	(4.233)	0.000835	(0.0212)
Screw D	0.0833	(2.116)	0.0004165	(0.0106)

Screw end options

Threaded end	Metric end: M6 x 1.0mm thread to within 0.03" (0.76mm) of shoulder	UNC end: 1/4-20 UNC-2A thread to within 0.05" (1.3mm) of shoulder
Smooth end	Ø 0.2362" ±0.001 (Ø 6mm ±0.003)	
None	—	

Cantilevered Loads

Unsupported loads and side loading are not recommended for non-captive shaft MDrive® linear actuator products.

Calculating Screw Length

Screw length = [mounting surface plate thickness] + [1.8" (45.7mm)] + [desired stroke length]

Figure B18.1 Non-Captive ShAft Mechanical Specifications

B.18.2 Mechanical Specifications - External Shaft

Nut detail/load limit

General purpose nut
Flange shape: round
Load limit: 60 lbs (27 kg)
Purpose: for applications not requiring anti-backlash and wear compensation.

Anti-backlash nut
Flange shape: triangle
Load limit: 25 lbs (11 kg)
Purpose: backlash free operation for high accuracy and low drag torque.

inches (mm)	A	B	D	E	F	BCD	*load limit*	*drag torque*
General purpose	0.71 (18.0)	1.50 (38.1)	1.5 (38.1)	0.20 (5.08)	0.20 (5.08)	1.125 (28.6)	60lbs/ 27kg	free wheeling
Anti-backlash	0.82 (20.8)	1.875 (47.63) max	1.5 (38.1)	0.20 (5.08)	0.20 (5.08)	1.125 (28.6)	25lbs/ 11kg	1–3

Screw Specifications

Screw material
MDrive Linear Actuator precision rolled lead screws are corrosion resistant and non-magnetic, manufactured from premium grade stainless steel.

Screw coating
An optional teflon screw coating is available for smooth operation and extended life.

Standard screw
Dimensions in inches (mm)

Lead options

inches (mm)	Travel/revolution		Travel/full step	
Screw G	0.3750	(9.525)	0.001875	(0.0476)
Screw A	0.200	(5.08)	0.001	(0.0254)
Screw B	0.1670	(4.233)	0.000835	(0.0212)
Screw D	0.0833	(2.116)	0.0004165	(0.0106)

Screw end options

Threaded end	Metric end: M6 x 1.0mm thread to within 0.03" (0.76mm) of shoulder	UNC end: 1/4-20 UNC-2A thread to within 0.05" (1.3mm) of shoulder
Smooth end	Ø 0.2362" ±0.001 (Ø 6mm ±0.003)	
None	—	

Cantilevered Loads
Loads for external shaft MDrive® linear actuator products MUST BE supported. Side loading is not recommended.

Calculating Stroke Length
Available stroke length = [screw length] – [nut length] – [mounting surface plate thickness]

Figure B18.2 Sealed Mechanical Specifications

B.18.3 Electrical Specifications

	Condition	Min	Typ	Max	Unit
Input voltage range **CAUTION**: Reverse polarity on the input power will likely damage the drive.	Single, double and triple length motors	+12	—	+75	VDC
Max power supply current*	Single length motors				
Aux-Logic Input Voltage	—	+12	—	+24	VDC
Max Aux-Logic Supply Current (Per MDrive)**	—	—	—	194	mA

*per MDrive 23, Actual current depends on voltage and load.
** Maintains power to control and feedback circuits [only] when input voltage is removed

Table B18.1 Electrical Specifications

B.18.4 Standard I/O Specifications (Plus)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-4)	—	4 I/O points configurable as sinking or sourcing inputs or sinking outputs			
General Purpose I/O - Electrical					
Inputs	—	TTL	—	+24	VDC
Sinking Outputs (All)	—	—	—	+24	VDC
Output Sink Continuous Current	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Logic Threshold	Logic 0	—	—	< 0.8	VDC
	Logic 1	—	—	> 2.2	VDC
Protection	Sinking	Over temp, short circuit			
	Sourcing	Transient Over Voltage, Inductive Clamp			
Analog Input					
Resolution	—				
Range	Voltage Mode	0 to +5 VDC, 0 to +10 VDC			
	Current Mode	4 to 20 mA, 0 to 20mA			
Clock I/O					
Types	—	Step/Direction, Up/Down, Quadrature			
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			
Trip Output/Capture Input					
Logic Threshold	—	+5 VDC TTL Input, TTL Output (with 2 kΩ Load to Ground			

Table B18.2 I/O Specifications

B.18.5 Expanded I/O Specifications (Plus²)

	Condition	Min	Typ	Max	Unit
General Purpose I/O - Number and Type					
Plus (I/O Points 1-8)	—	8 I/O points (4 if configured for remote encoder) configurable as sinking or sourcing inputs or outputs			
General Purpose I/O - Electrical					
Inputs	Sinking or Sourcing	TTL	—	+24	VDC
Outputs	Sinking	—	—	+24	VDC
	Sourcing	+12		+24	VDC
Output Sink Continuous Current **NOTE**: Output ratings apply to each bank of four I/O. First bank: Output 1-4 Second bank: Output 9-12	One output on	—	—	550	mA
	Two outputs on			390	mA
	Three outputs on			320	mA
	Four outputs on			275	mA
Motion I/O					
Electronic gearing	Range	0.001	—	2.000	
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Secondary clock out ratio				1:1
High speed position capture	Filter range			50 nS to 12.9 µS (10 MHz to 38.8 kHz	
	Resolution	—	—	32	bit
High speed trip output	Speed	—	—	150	nS
	Resolution	—	—	32	bit
	Threshold	—	—	TTL	VDC
Optional remote encoder (closed loop)*					
Type		User supplied differential encoder			
Steps per revolution		See motion specifications table			
Resolution	User defined . Note: microsteps/rev = 2X the encoder counts/rev minimum.				

**Remote encoder inputs replace I/O points 4-8 and step and direction I/O*

Table B18.3 Expanded I/O Specifications

B.18.6 Communication Specifications

	Condition	Min	Typ	Max	Unit
RS-422/485 (standard)					
BAUD rate	—	4.8		115.2	kbps
CANopen (optional)					
Type					2.0B active
BAUD rate	—	10 kHz	—	1 MHz	—
Application layer	Version 3.0				DS-301
Device profile	Version 2.0				DSP-402

ID	—	11 or 29 bit
Isolation	—	Galvanic

Table B18.4 Communication Specifications

B.18.7 Thermal Specifications

		Min	Typ	Max	Unit
Heat sink temperature	non-condensing humidity	-40	—	+85	ºC
Motor temperature	non-condensing humidity	-40	—	+100	ºC

Table B18.5 Thermal Specifications

B.18.8 Motion Specifications

Microstep Resolution - Open Loop	
Number of microstep resolutions	20

Available microsteps per revolution

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

1=0.01 deg/µstep 2=1 arc minute/µstep *3=0.001 mm/µstep
** 1" per revolution lead screw*

Microstep resolution (closed loop configuration - (optional)	
Steps Per Revolution (Fixed)	51200
Position Resolution	2048
Optional differential encoder (internally mounted)	
Type	Internal, Magnetic
Resolution (Lines)	512
Resolution (Edges)	2048
Counters	
Counter 1 (C1) Type	Position
Counter 2 (C2) Type	Encoder
Resolution	32 bit
Maximum Edge Rate	5 MHz
Velocity	
Range	±5,000,000 Steps/Sec.
Resolution	0.5961 Steps/Sec.
Acceleration/Deceleration	
Range	1.5×10^9 Steps/Sec.^{2}
Resolution	90.9 Steps/Sec.^{2}

Table B18.6 Motion Specifications

B.18.9 Software Specifications

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

Table B18.7 Software Specifications

B.18.10 Motor Specifications

Holding torque		90 oz-in (64 N-cm)
Rotor inertia		0.0025 oz-in-sec^2 (0.18 kg-cm^2)
Maximum thrust (Non-captive)	General purpose	200 lbs (91 kg)
	With anti-backlash nut	—
Maximum thrust (External)	General purpose	60 lbs (27 kg)
	With anti-backlash nut	25 lbs (11 kg)
Maximum repeatability (Non-captive)	General purpose	0.005” (0.127 mm)
	With anti-backlash nut	—
Maximum repeatability (External)	General purpose	0.005” (0.127mm)
	With anti-backlash nut	0.0005” (0.0127 mm)
Maximum screw misalignment		± 1°
Wieght without screw		22.0 oz (625.0 g)

Table B18.8 MDrive 23 Linear Actuator Specifications

B.18.11 Speed-Force Performance Curves

+24 VDC

Figure 2.3 Motor performance curve — +24 VDC

+48 VDC

Figure 2.4 Motor performance curve — +48 VDC

+75 VDC

Figure B18.3 Motor Performance Curve — +75 VDC

B.18.12 RS-422/485 Communication

10-pin Friction Lock Wire Crimp

Connectivity Options
USB to RS-422/485 Converter:
MD-CC402-001

Mating connector kit:
CK-02

Mfg P/N:
Shell
Hirose DF11-10DS-2C

Pins
Hirose: DF11-2428SC

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Ground Aux power to the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table B18.9 P2 Communication, 10-pin Friction Lock Wire Crimp

10-pin Press-Fit (IDC Style)

Connectivity Options
USB to RS-422/485 Converter:
MD-CC400-001

Mating connector kit:
CK-01

Mfg P/N:
Shell
SAMTEC: TCSD-05-01-N

Ribbon cable
Tyco: 1-57051-9

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table B18.10 P2 Communication, 10-pin Pressure Fit IDC/SAMTEC

B.18.13 CANopen Communication Option

9-pin D-sub Female (DB-9F)

Connectivity Options
USB to CANopen converter:
MD-CC500-000

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table B18.11 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

B.19 MDrive 23 Linear Actuator - Connectivity Specifications/Pin Assignments

B.19.1 Power and I/O - Standard I/O (Plus)

12” (304.8 mm) Flying Leads

Wire Color	Function	Description
White/yellow	I/O 1	General purpose I/O point 1
White/orange	I/O 2	General purpose I/O point 2
White/violet	I/O 3	General purpose I/O point 3
White/blue	I/O 4	General purpose I/O point 4
Green	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
Black	GND	Power and auxiliary ground
Red	+V	Motor power

Table B19.1 Power and I/O Interface - 12” (308.8.mm) Flying Leads

7-pin Pluggable Terminal

Pin #	Function	Description
1	I/O 1	General purpose I/O point 1
2	I/O 2	General purpose I/O point 2
3	I/O 3	General purpose I/O point 3
4	I/O 4	General purpose I/O point 4
5	Analog input	0 to +5 VDC, 0 to +10 VDC, 4 to 20 mA, 0 to 20 mA
6	GND	Power and auxiliary ground
7	+V	Motor power

Table B19.2 Power and I/O Interface - 7-pin Pluggable Terminal

B.19.2 DC Motor Power

2-pin Friction Lock Wire Crimp

Pin #	Function	Description
1	+V	+12 to +60 VDC motor power
2	Ground	Power supply return (ground)

Table B19.3 P3 DC Power, 2-pin Friction Lock Wire Crimp

Connectivity Options
Prototype development cable *PD-02-2300-FL3*

Mating connector kit:
CK-04

Mfg P/N:
Shell
Tyco 794617-2

Pins
Tyco 794610-1

B.19.3 I/O - Expanded I/O (Plus²)

14-pin Locking Wire Crimp

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	I/O 9	0 to +24 VDC Programmable I/O Point 9
8	I/O 10	0 to +24 VDC Programmable I/O Point 10
9	I/O 11	0 to +24 VDC Programmable I/O Point 11
10	I/O 12	0 to +24 VDC Programmable I/O Point 12
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input
13	Step/clock I/O	Step clock i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.
14	Direction/ clock I/O	Direction i/o. Can also be configured as quadrature or clock up/down. +5 VDC logic level.

Table B19.4 P1 Expanded I/O, 14-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD14-2334-FL3

Mating connector kit:
CK-09

Mfg P/N:
Shell
JST PADP-14V-1-S

Pins
JST SPH-001T0.5L

B.19.4 I/O - Remote Encoder (Plus²)

14-pin Locking Wire Crimp

Connectivity Options
Prototype development cable::
PD14-2334-FL3

Mating connector kit:
CK-09

Mfg P/N:
Shell
JST PADP-14V-1-S

Pins
JST SPH-001T0.5L

Pin #	Function	Description
1	I/O power	I/O Power, used with sourcing inputs or outputs.
2	I/O GND	Non-isolated I/O Ground. Common with Power Ground.
3	I/O 1	0 to +24 VDC Programmable I/O Point 1
4	I/O 2	0 to +24 VDC Programmable I/O Point 2
5	I/O 3	0 to +24 VDC Programmable I/O Point 3
6	I/O 4	0 to +24 VDC Programmable I/O Point 4
7	CH A+	Channel A+ encoder input. +5 VDC logic level
8	CH A-	Channel A- encoder input. +5 VDC logic level
9	CH B+	Channel B+ encoder input. +5 VDC logic level
10	CH B-	Channel B- encoder input. +5 VDC logic level
11	Capture/trip I/O	High Speed Capture Input or Trip Output. +5 VDC Logic Level.
12	Analog in	0 to 10 V / 4 to 20 mA / 0 to 20 mA Analog Input.
13	IDX+	Index mark + encoder input. +5 VDC logic level
14	IDX-	Index mark - encoder input. +5 VDC logic level

Table B19.5 I/O and Remote Encoder Interface - 14-pin Locking Wire Crimp

B.19.5 Options

Internal Encoder

Internal differential magnetic 512 line differential encoders with index mark are available:

Remote Encoder (Plus2 Versions Only)

MDrive 23 Linear Actuator Motion Control versions are available with differential encoder inputs for use with a remote encoder (not supplied).

B.19.6 Connectivity

QuickStart Kit

For rapid design verification, all-inclusive QuickStart Kits have communication converter, prototype development cable(s), instructions and CD for MDrive initial functional setup and system testing.

Communication Converters

Electrically isolated, in-line converters pre-wired with mating connectors to conveniently set/program communication parameters for a single MDrive product via a PC's USB port. Length 12.0' (3.6m).

Mates to connector:

P2 10-pin pressure-fit IDC.....MD-CC400-001

P2 10-pin wire crimp.....MD-CC402-001

Prototype Development Cables

Speed test/development with pre-wired mating connectors that have flying leads other end. Length 10.0' (3.0m).

Mates to connector:

P2 10-pin wire crimp..... PD10-1434-FL3

P1 14-pin wire crimp..... PD14-2334-FL3

P3 2-pin wire crimp..... PD02-2300-FL3

Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC.....CK-01

P2 10-pin wire crimp.....CK-02

P1 14-pin wire crimp.....CK-09

P3 2-pin wire crimp.....CK-04

B.20 MDrive 23 Linear Actuator - Mounting and connection recommendations

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

LEAD RESTRAINT

Some MDrive mounting configurations require that the MDrive move along the screw. Ensure that all cabling is properly restrained to provide strain relief on connection points..

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

THERMAL MANAGEMENT

The mounting plate material should offer sufficient mass and thermal conductivity to ensure that the motor temperature does not exceed 100°C.

Failure to follow these instructions can result in equipment damage.

B.20.1 Mounting

Drill Pattern

Figure B20.1 MDrive 23 Mounting and Drill Pattern

B.20.2 Recommended Mating Connectors and Pins

Communication

10-pin Friction Lock (P2) ..... Hirose DF11-10DS-2C

Crimp Contact for 10-pin Friction Lock (22 AWG) DF11-22SC

Crimp Contact for 10-pin Friction Lock (24 - 28 AWG) DF11-2428SC

Crimp Contact for 10-pin Friction Lock (30 AWG) DF11-30SC

I/O

The following mating connectors are recommended for the MDrive 23 Units ONLY! Contact a JST distributor for ordering and pricing information.

14-pin Locking Wire Crimp Connector Shell .....JST PN PADP-14V-1-S

Crimp Pins .....JST PN SPH-001T-P0.5L

Power

2-pin Locking Wire Crimp Connector Shell ..... Tyco 794617-2

Crimp Pins ..... Tyco 794610-1

B.20.3 Securing Power Leads and Logic Leads

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

Figure B20.2 Securing Leads

B.21 MDrive 23 Linear Actuator - Anti-Backlash Nut Assembly and Installation

B.21.1 Notes and Warnings

- Do not use a wrench on the stainless steel cam of the nut.
- Do not oil the mechanism of the nut.
- Do not install the note into an interference fit bore (mechanism will not work).

B.21.2 Installation

To install threaded model nuts, simply hand tighten until shoulder is flush with mounting surface. A small amount of Loctite thread compound such as #277 can be used to prevent loosening. Alternatively, a pin can be installed to mechanically lock the threads.

Flanged models can be mounted to either the front or rear face of the flange.

Before use, it is recommended that the stainless steel preload mechanism be turned so that the caming surfaces move down the ramps. Once play is felt, allow the mechanism to slowly unwind again to establish the proper preload. (It is possible in assembly to inadvertently twist the cam creating excessive drag torque. This procedure will correct this.)

Using lubricant on the lead screw threads is recommended. This extends the life of the nut and reduces heat generation, noise and vibration. Dupont Crytox is recommended.

B.21.3 Removal from Screw

If it is necessary to remove the nut from the screw, lock the mechanism so that it can be immediately reinstalled without re-setting the preload. This can be done by wrapping tape around the junction between the stainless steel cam and the plastic nut halves. This will prevent the cam from turning when the nut is removed from screw. Remember to remove tape after installation.

For immediate transfer from one screw to another, hold the nut together between the thumb and forefinger so that it cannot expand axially. Remove the nut and install it on the second screw. It may be helpful to prevent the cam from turning with the remaining fingers as transfering. If the nut becomes disassembled or looses its preload for any reason, follow the steps listed in the assembly procedure below.

B.21.4 Assembly Procedure

1) Insert spring tang into cam slot.

Figure B21.1 Insert Spring Tang

2) Ensure that the spring is engaged.

Figure B21.2 Spring Engaged

3) Insert opposite tang into front nut slot or hole (dependant on size). Use the slot or hole that will allow the the cam to be positioned closest to the bottom of the ramp.

Figure B21.3 Insert Opposite Tang

4) With washer installed, insert the back nut into the front nut.

Figure B21.4 Inserting the Back Nut

5) With the cam held at the bottom of the ramp, thread the entire nut onto the screw starting with the front nut. After the entire nut is threaded onto the screw, release the cam to observe the gap distance (X on the drawing). The gap distance (X) should be about one-third of the full ramp distance, but no more than half.

Figure B21.5 Measuring the Gap Distance

6) If the gap distance is incorrect, unthread the nut just enough to allow the back nut to disengage from the screw. Pull the back nut off and rotate to the next index position and reinsert back into the front nut. With the cam held at the bottom of the ramp, thread the entire nut back onto the screw. Release the cam and verify the correct gap distance. If still not correct repeat this step.

7) Once the back nut has been properly clocked to yield the correct gap distance, unthread the nut again just enough to disengage the back nut from the screw, but do not remove from the nut. Pull the cam away from the ramp and rotate in the clockwise direction for two ramp settings, then hold the cam at the bottom of the second ramp. Be careful not to allow the back nut to rotate with respect to the front nut while completing this task. With the cam held at the bottom of the second ramp, push the back nut into the front nut and thread the entire nut onto the screw.

Figure B21.6 Pre-loading the Nut

8) The anti-backlash nut is now pre-loaded and fully assembled.

Figure B21.7 Nut Pre-loaded and Fully Assembled

B.22 MDrive 23 Linear Actuator - Connection and Interface

⚠ DANGER

EXPOSED SIGNALS

Hazardous voltage levels may be present if using an open frame power supply to power the product.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

SWITCHING DC POWER/HOT PLUGGING

Do not connect or disconnect power, logic, or communication while the device is in a powered state.

Remove DC power by powering down at the AC side of the DC power supply.

Failure to follow these instructions can result in equipment damage.

B.22.1 Interfacing RS422-485 Communication

For general RS422/485 single and party mode communication practices, see Section 5 page 18 of this document.

⚠ CAUTION

COMMUNICATION GROUND LOOPS

To avoid ground loops in the system only connect communication ground to the first MDrive in the system. Do not connect communication ground on subsequent MDrives.

Failure to follow these instructions may result in damage to system components!

⚠ CAUTION

HOT PLUGGING!

Do not connect or disconnect communication while the device is in a powered state.

Failure to follow these instructions may result in damage to system components!

P2 — 10-pin Pressure-fit IDC-Style Connector

Pin #	Function	Description
1	TX +	Transmit plus
2	TX -	Transmit minus
3	RX +	Receive plus
4	RX -	Receive minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX -	Receive minus
8	TX -	Transmit minus
9	TX +	Transmit plus
10	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.

Table B22.1 Communication Connections, P2 - 10-pin IDC

Connectivity Accessories

Mating connector kit CK-01
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m)..... MD-CC400-001

P2 — 10-pin Friction Lock Wire Crimp

Pin #	Function	Description
1	TX +	Transmit plus
2	Communication GND	Communication ground only. Do not ground aux-logic to this pin. Common for Aux power is the Main Power common.
3	RX -	Receive minus
4	TX -	Transmit minus
5	Aux-Logic	Auxiliary logic maintains power to the logic circuitry in the absence of motor power. +12 to +24 VDC input. Common for Aux power is the Main Power common.
6	RX +	Receive plus
7	RX +	Receive plus
8	RX -	Receive minus
9	TX +	Transmit plus
10	TX -	Transmit minus

Table B22.2 P2 Communication, 10-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-02
(contains 5 connector shells, ribbon cable not included)

Communication converter cable (10'/3.0 m)..... MD-CC402-001

B.22.2 Interfacing CANopen Communication

P2 — 9-pin D-sub Connector (Female)

Pin #	Function	Description
1	N/C	Not connected
2	CAN low	CAN_L bus line (low dominant)
3	CAN -V	CAN communication ground
4	N/C	Not connected
5	Shield	Optional CAN shield
6	CAN -V	Optional ground
7	CAN high	CAN_H bus line (high dominant)
8	N/C	Not connected
9	CAN +V	+7 to +30 VDC power supply

Table B22.3 CANopen Communication, P2: 9-pin D-sub Female (DB-9F)

Connectivity Accessories

Communication converter cable..... MD-CC500-000

B.22.3 Interfacing DC Power

See Section 3 on page 10 for recommended power cable configurations.

⚠ CAUTION

OVER VOLTAGE

The DC voltage range for the MDrive 23 is +12 to +60 VDC. Ensure that motor back EMF is factored into the power supply size calculations.

Allow 3.0 A maximum power supply output current per MDrive in the system. Actual power supply current will depend on voltage and load.

Failure to follow these instructions can result in equipment damage.

B.22.4 Recommended SEM Power Supplies

IP404 Unregulated Linear Supply

Input Range

120 VAC Versions ..... 102-132 VAC

240 VAC Versions ..... 204-264 VAC

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

No Load Output Voltage .....43 VDC @ 0 Amps

Continuous Output Rating .....32 VDC @ 1.5 Amps

Peak Output Rating .....26 VDC @ 3 Amps

ISP300-4 Unregulated Switching Supply

Input Range

120 VAC Versions ..... 102-132 VAC

240 VAC Versions ..... 204-264 VAC

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

No Load Output Voltage .....42 VDC @ 0 Amps

Continuous Output Rating .....39 VDC @ 3.0 Amps

Peak Output Rating ..... 37 VDC @6.0 Amp

Recommended Wire Gauge

Cable Length: Feet (meters)	10 (3.0)	25 (7.6)	50 (15.2)	75 (22.9)	100 (30.5)
Amps Peak	**Minimum AWG**				
1 Amp Peak	20	20	18	18	18
2 Amps Peak	20	18	16	14	14
3 Amps Peak	18	16	14	12	12

Table B22.4 Recommended Power Supply Wire Gauge

P1 — 12' (30.5 cm) Flying Leads Interface

Wire Color	
Red	Motor power supply
Black	Power ground

Table B22.5 Power and Ground Connections, Flying Leads

P1 — 7-pin Pluggable Terminal Interface

Pin #	
6	Power ground
7	Motor power supply

Table B22.6 Power and Ground Connections, 7-pin Terminal

P1 — 2-pin Wire Crimp Interface

Pin #		***PD02-2300-FL3 wire colors***
6	Power ground	Black
7	Motor power supply	Red

Table B22.7 Power and Ground Connections, 7-pin Terminal

Connectivity Accessories

Prototype development cable PD02-2300-FL3

Mating connector kit CK-04
(contains 5 connector shells, ribbon cable not included)

B.22.5 Interfacing I/O

See Section 4 on page 16 for I/O interface configurations and methods.

⚠ CAUTION

ELECTRICAL OVERSTRESS

The general purpose I/O is tolerant to +24 VDC. The following listed I/O point is TTL level and only tolerant to +5 VDC:

1) Capture/Trip
2) Step/Direction
3) Remote encoder inputs

Do not exceed +5 VDC on these points.

Failure to follow these instructions can result in equipment damage.

P1 — 12' (30.5 cm) Flying Leads Interface

Wire Color	*Signal*
White/yellow	General purpose I/O 1
White/orange	General purpose I/O 2
White/violet	General purpose I/O 3
White/blue	General purpose I/O 4
Green	Analog input

Table B22.8 I/O Connections, Flying Leads

P1 — 7-pin Pluggable Terminal Interface

Pin number	*Signal*
1	General purpose I/O 1
2	General purpose I/O 2
3	General purpose I/O 3
4	General purpose I/O 4
5	Analog input

Table B22.9 I/O Connections, 7-pin Terminal

P1 — 14-pin Locking Wire Crimp Interface (Expanded I/O)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	Black	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	General purpose I/O 9	Yellow	Pair
8	General purpose I/O 10	Black	
9	General purpose I/O 11	Blue	Pair
10	General purpose I/O 12	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Step clock I/O	White	Pair
14	Direction clock I/O	Black	

Table B22.10 I/O Connections, 14-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-09
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD14-2334-FL3

Manufacturer (JST) Part Numbers

Connector shell..... PADP-14V-1-S

Pins..... SPH-001T0.5L

P1 — 14-pin Locking Wire Crimp Interface (Remote Encoder)

Pin Numbers	*Signal*	*Prototype development cable wire colors (twisted pairs)*	
1	I/O power	Red	Pair
2	I/O ground	White	
3	General purpose I/O 1	Orange	Pair
4	General purpose I/O 2	Black	
5	General purpose I/O 3	Brown	Pair
6	General purpose I/O 4	Black	
7	Channel A +	Yellow	Pair
8	Channel A -	Black	
9	Channel B +	Blue	Pair
10	Channel B -	Black	
11	Capture output/trip input	Green	Pair
12	Analog input	Black	
13	Index +	White	Pair
14	Index -	Black	

Table B22.11 I/O and Remote Encoder Connections, 14-pin Locking Wire Crimp

Connectivity Accessories

Mating connector kit CK-09
(contains 5 connector shells and the appropriate quantity of pins to make 5 cables)

Prototype development cable (10'/3.0 m)..... PD14-2334-FL3

Manufacturer (JST) Part Numbers

Connector shell.....PADP-14V-1-S

Pins..... SPH-001T0.5L

B.23 MDrive 23 Linear Actuator - Connectivity Accessory Details

B.23.1 RS-422/485 Communication Converter Cables

USB to 10-pin IDC Connector P2
P/N: MD-CC400-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure B23.1 MD-CC400-000 Communication Converter Cable

USB to 10-pin Wire Crimp Connector P2
P/N: MD-CC402-001

Electrically isolated in-line USB to RS-422/485 converter pre-wired with mating connector to conveniently program and set configuration parameters

Figure B23.2 MD-CC402-001 Communication Converter Cable

B.23.2 Prototype Development Cables

Flying Leads to10-pin Wire Crimp Connector P2 -P/N: PD10-1434-FL3

Used in conjunction with the MD-CC402-001 communication converter cable to facilitate multi-drop RS-422/485 communication.

Wire Colors	Function
White/Red Stripe	Aux-Logic
White/Blue Stripe	TX+
Blue/White Stripe	TX-
White/Orange Stripe	RX+
Orange/White Stripe	RX-
Green/White Stripe	GND

Figure B23.3 Multi-drop Communication using the PD10-1434-FL3

Procedure

1) Remove ground wire (unless this is the first system MDrive, green/white stripe)
2) Remove aux-logic (if not used, red/white stripe)
3) Connect pre-crimped flying leads as shown in Figure 5.7 below

Figure B23.4 Wiring a Second PD10-1434-FL3 into the 10-pin Wire Crimp Connector.

Flying Leads to14-pin Locking Wire Crimp Connector P2 -P/N: PD14-2334-FL3

The PD14-2334-FL3 prototype development cable is used to rapidly interface the MDrive 23 to the users controller. This 10' (3.0 m) cable consists of a 14-pin locking wire crimp connector to plug directly into the MDrive P1 connector with flying leads on the opposite end to interface to I/O devices.

Pin #	*Wire Colors*	*Signal (Expanded features)*	*Signal (Remote encoder)*	*Pairs*
14	Black	Step Clock I/O	Index –	X
13	White	Direction I/O	Index +	
12	Black	Analog Input	Analog Input	X
11	Green	Capture/Trip I/O	Capture/Trip I/O	
10	Black	I/O 12	Channel B –	X
9	Blue	I/O 11	Channel B +	
8	Black	I/O 10	Channel A –	X
7	Yellow	I/O 9	Channel A +	
6	Black	I/O 4	I/O 4	X
5	Brown	I/O 3	I/O 3	
4	Black	I/O 2	I/O 2	X
3	Orange	I/O 1	I/O 1	
2	Black	I/O Ground	I/O Ground	X
1	Red	I/O Power	I/O Power	

Figure B23.5 Prototype Development Cable PD14-2334-FL3

Flying Leads to 2-pin Locking Wire Crimp Connector P2 -P/N: PD02-2300-FL3

The PD02-2300-FL3 prototype development cable is used to rapidly interface the MDrive 23 to the users DC power supply. This 10' (3.0 m) cable consists of a 2-pin locking wire crimp connector to plug directly into the MDrive P3 connector with flying leads on the opposite end to interface to DC power.

Wire Colors	Function
Black	Power Ground
Red	+V

Pin #	*Wire Colors*	*Signal (Expanded features)*
2	Black	Ground
1	Red	+V

Figure 4.7 Prototype development cable PD02-2300-FL3

B.23.3 Mating Connector Kits

Use to build cables. Kit contains 5 mating shells with pins. Cable not supplied. Manufacturer's crimp tool recommended.

Mates to connector:

P2 10-pin pressure-fit IDC.....CK-01

P2 10-pin wire crimp.....CK-02

P1 14-pin wire crimp.....CK-09

P3 2-pin wire crimp.....CK-04

Warranty

For the latest warranty and product information, visit http://motion.schneider-electric.com.

Document Revision History

MDrive® Motion Control: MDI.pdf R080720		
Date	**Revision**	**Changes**
07/15/2009	R082409	Integrated all NEMA sizes into a single document. Added Linear Actuators
08/24/2009	R082409	Removed details and specifications for the MDrive42AC Plus Motion Control, as it is discontinued.
11/16/2009	R111609	Added support for size 14 and 23 linear actuator.
03/16/2010	R031610	Updated Linear actuator sections with assembly instructions for the anti-backlash nut.
07/02/2010	R070210	Minor corrections throughout
09/07/2010	R090710	Changed party mode connecting to reflect termination capacitance equation.
11/02/2010	R110210	Added support for Ethernet communication interface.
02/07/2011	R020711	Modified dimensioned drawing for NEMA size 17 models with industrial connectors to reflect a 0.07” (1.8 mm) increase in length. Added pin numbers to cable detail drawings.
04/22/2014	R042214	Modified dimensioned drawing for NEMA size 14 models to reflect an increased tolerance to the length of the motor shaft.
06/23/2020	R062320	Update for Ethernet and Hybrid discontinue
08/07/2020	R080720	Update to correct Thermal Specifications for the NEMA 34 devices.

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As standards, specifications, and designs change from time to time, please ask for confirmation of the information given in this publication.
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