IMS™

intelligent motion systems, inc.

Excellence in Motion™

MDRIVE 14™
MOTOR+DRIVER

OPERATING INSTRUCTIONS

Patent Pending

MDrive14 Operating Instructions
Revision 01.24.05

Table of Contents

List of Figures

List of Tables

Section 1

The MDrive14 Integral Motor+Driver

Section Overview

The purpose of this section is to introduce the user to the MDrive14 integrated high torque motor and half/full step driver. Covered are:

- Introduction to the MDrive14
- MDrive14 Features and Benefits

Introduction to the MDrive14

The MDrive NEMA 14 high torque Integrated Motor and Driver is ideal for designers who want the simplicity of a motor with on-board electronics, but without the expense of an indexer on each axis. The low cost MDrive14 offers the system designer the best method of control. The MDrive14's integrated electronics eliminates the need to run the motor cabling through the machine, reducing the potential for problems due to electrical noise.

The MDrive14 uses a NEMA 14 frame size 1.8° high torque motor combined with a half/full step drive. Setup parameters include Motor Resolution, Motor Direction with respect to the direction input, and Run/Hold currents. These settings may be downloaded and stored in nonvolatile memory with the use of a simple GUI (Graphical User Interface) which is provided. This eliminates the need for external switches or resistors. Parameters are changed via an SPI port located on connector P1. Operating voltage for the MDrive14 ranges from +12 to +48 VDC.

The versatile, compact MDrive14 is available in multiple configurations to fit various system needs. These options include: a single shaft stand-alone device, or a dual shaft rotary motor with optical encoder, a planetary gearbox, an Acme screw linear actuator, or with a control knob for hand operation of the motor. Interface connections are accomplished using a 12 position, pluggable keyed 2mm pin and receptacle (C Connector).

The MDrive14 is a compact, powerful and inexpensive solution that will reduce system cost, design and assembly time for a large range of stepping motor applications.

IMS Motor Interface Software

The IMS Motor Interface software is an easy to install and use graphical user interface (GUI) for configuring the MDrive14 from the parallel port on your computer. Access the GUI via the IMS SPI Interface included on the CD shipped with the product, or download at www.imshome.com. Optional parameter setup cables are also available for ease of connecting and configuring this MDrive product.

IMS Motor Interface features include:

- Easy installation.
- Automatic communication configuration.
- Will not set out-of-range values.
- Tool-tips display valid range setting for each option.
- Ease of use via single screen interface.

Features and Benefits of the MDrive14

- Integrated Half/Full Step Drive/NEMA 14 High Torque Motor
- +24 to +48 VDC Input Voltage
- Low Cost
- Extremely Compact
- Optically Isolated Logic Inputs will Accept +5 to +24VDC Signals, Sourcing or Sinking
- Automatic Current Reduction
- Configurable:
    - Motor Run/Hold Current
    - Motor Direction vs. Direction Input
    - Half/Full Step
- Available Configurations:
    - Single Shaft
    - Planetary Gearbox
    - Linear Actuator
    - Factory-Mounted Optical Encoder
    - Double Shaft End with Knob For Manual Positioning
- Single Supply
- Interface Uses 12-Position, Pluggable 2mm Pin and Receptacle
- Graphical User Interface (GUI) for Quick and Easy Parameter Setup

Section 2

MDrive14 Power and Thermal Requirements

Power Supply Current Specifications

Power supply current specifications per MDrive14 is **0.6A (MAX)**. Actual Power Supply Current will depend upon voltage and load.

MDrive Power Supply Specifications	
Recommended Supply Type	Unregulated DC
Ripple Voltage	±10%
Output Voltage	+12 to +48 VDC
Output Current	0.6A Peak

Table 2.1: Recommended Power Supply Specifications

WARNING! DO NOT connect or disconnect power leads when power is applied! Disconnect the AC power side to power down the DC power supply. For battery operated systems, connect a "transient suppressor" across the power switch to prevent arcs and high voltage spikes.

WARNING! The maximum +48 VDC Input Voltage of the MDrive14 includes Motor Back EMF, Power Supply Ripple and High Line.

A 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. Care should be taken so that the back EMF does not exceed the maximum input voltage rating of the MDrive14.

Recommended IMS Power Supplies

IP402 Unregulated Linear Supply

Input Range

120 VAC Version .... 102-132 VAC

240 VAC Version .... 204-264 VAC

Output

No Load Output Voltage* .... 39 VDC @ 0 Amps

Continuous Output Rating* .... 30 VDC @ 1 Amps

Peak Output Rating* .... 25 VDC @ 2 Amps

** All measurements were taken at 25°C, 120 VAC, 60 Hz.*

Thermal Specifications

The MDrive14 consists of two core components, a drive and a motor. Attention must be paid to the thermal specifications of both the motor and the electronics.

Heat Sink Temperature (Max) .... 85°C

Motor Temperature (Max) .... 100°C

Section 3

Rotary MDrive14 Specifications

Section Overview

This section contains mechanical, motor and electrical specifications specific to each version of the Rotary MDrive14. Shown are:

- Mechanical Specifications
- Motor Specifications
- Electrical Specifications

Mechanical Specifications

Dimensions in inches (mm)

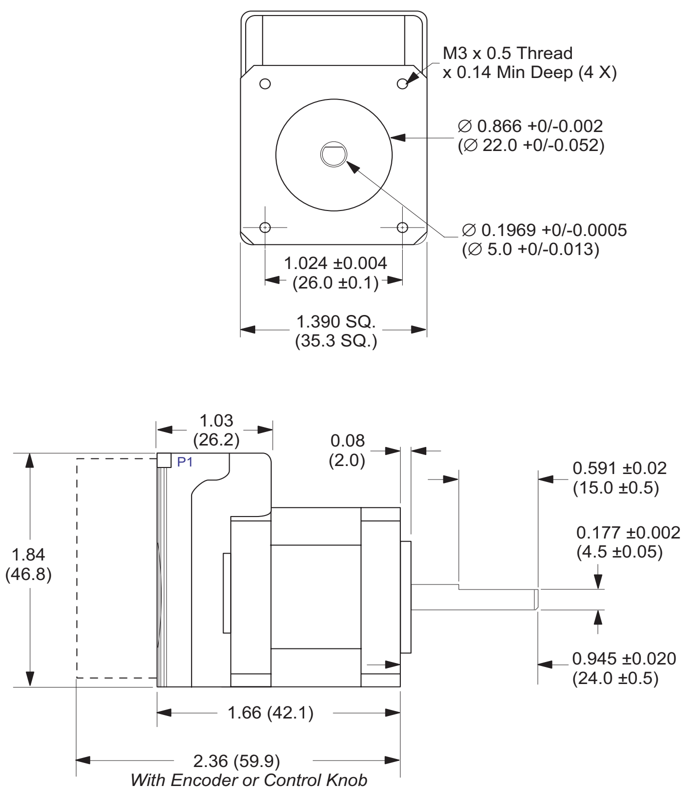


Figure 3.1: MDrive14 Mechanical Specifications

MDrive14 Mounting Screws

WARNING! The mounting holes in the MDrive14 mounting flange **are not through holes**. The maximum length of the screw threads into the motor flange is 0.130" (3.3 mm). This depth allows for 0.010" (0.254 mm) clearance.

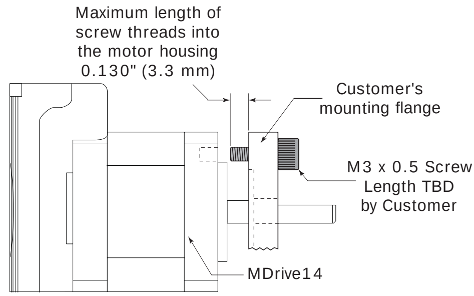


Figure 3.2: MDrive14 Mounting Screw Depth

MAXIMUM TORQUE! The maximum torque for the M3x0.5 screw is 7.8 lb-in (9 kg-cm) with a thread engagement of 6.5 threads (3.3 mm deep). A lesser thread engagement diminishes the maximum torque.

Securing MDrive14 Power & Encoder Leads

Some applications may require that the MDrive14 move with the axis motion. If this is a requirement of your application, the motor leads and the Optional Encoder leads (if equipped) must be properly anchored. This will prevent flexing and tugging which can cause damage at critical connection points in the MDrive14 electronics and the Encoder.

DO NOT bundle the Logic Leads or Optional Encoder Leads with the MDrive14 Power Leads.

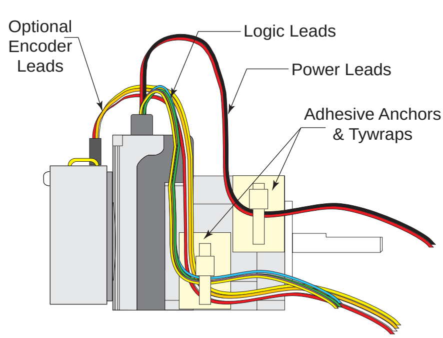


Figure 3.3: Secured Leads on MDrive14

Motor Specifications

MDrive1410 Motor Specifications and Speed / Torque Curves

MD1410 Single Stack	
Holding Torque oz-in (N-cm)	10 (7.0)
Detent Torque oz-in (N-cm)	1.4 (1.0)
Rotor Inertia oz-in-sec^2 (kg-cm^2)	0.00017 (0.012)
Weight (Motor&Driver) oz (g)	6.0 (170.1)

Table 3.1: MDrive1410 Motor Specifications

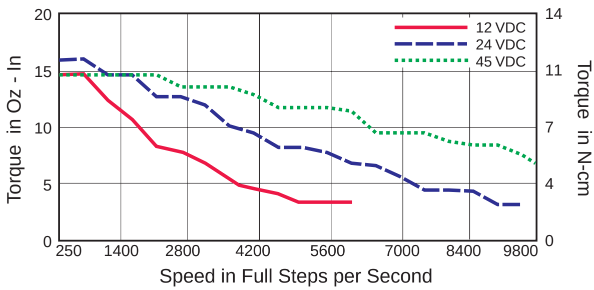


Figure 3.4: MDrive1410 Speed / Torque Curve (100% Current)

Electrical Specifications

Input Voltage Range* .... +12 to +48 VDC
Isolated Inputs .... Step Clock, Direction & Enable
Isolated Input Voltage Range (Sourcing or Sinking) .... +5 to +24VDC
Step Frequency (Max) .... 1 MHz
Steps per Revolution 200, 400,
Recommended Wire Size
    Logic Wiring .... 24 AWG
    Power and Ground .... See Appendix A "Recommended Cable Configurations"

* *Power supply current requirements = 0.6A (**MAX**) per MDrive14. Actual power supply current will depend on load and duty cycle.0*

> **WARNING!** The maximum +48 VDC Input Voltage of the MDrive14 includes Motor Back EMF, Power Supply Ripple and High Line.

A 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. Care should be taken so that the back EMF does not exceed the maximum input voltage rating of the MDrive14.

> ***NOTE:** Wire and insulation type are subject to the user's application and environment.*

Section 4

Linear MDrive14 Specifications

Section Overview

This section contains mechanical, motor and electrical specifications specific to the Linear MDrive14. Shown are:

- Mechanical Specifications
- Motor Specifications
- Electrical Specifications

Mechanical Specifications

Dimensions in inches (mm)

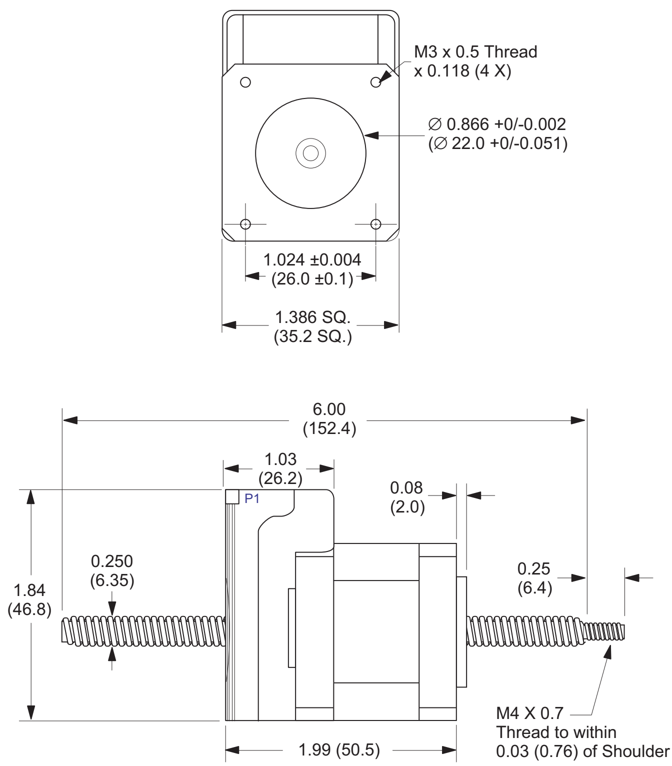


Figure 4.1: Linear Actuator MDrive14 Mechanical Specifications

MDrive14 Mounting Screws

> **WARNING!** The mounting holes in the MDrive14 mounting flange **are not through holes**. The maximum length of the screw threads into the motor flange is 0.130" (3.3 mm). This depth allows for 0.010" (0.254 mm) clearance.

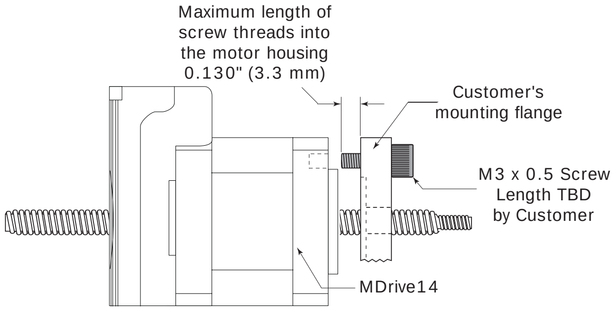


Figure 4.2: MDrive14 Mounting Screw Depth

> **MAXIMUM TORQUE!** The maximum torque for the M3x0.5 screw is 7.8 lb-in (9 kg-cm) with a thread engagement of 6.5 threads (3.3 mm deep). A lesser thread engagement diminishes the maximum torque.

Motor Specifications

MDrive1414 Linear Actuator Specifications and Torque Curves

MD1414 Linear Actuator	
Maximum Thrust lbs (N)	50 (222)
Maximum Screw Deflection	± 1°
Backlash in (mm)	0.005 (0.127)
Weight (without screw) oz (g)	6.4 (181.4)

Table 4.1: MDrive1414 Linear Actuator Specifications

> **WARNING:** The maximum axial load limit for the MDrive17 Motor is 50 lbs (22.7 kg). Do not exceed this rating!

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

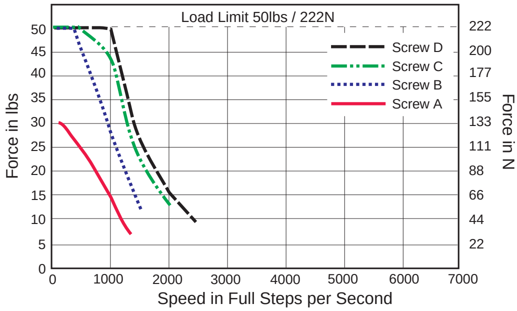


Figure 4.3: Force / Speed Curve - 12VDC (100% Current)

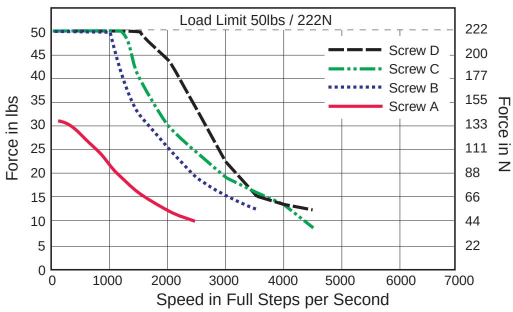


Figure 4.4: Force / Speed Curve - 24VDC (100% Current)

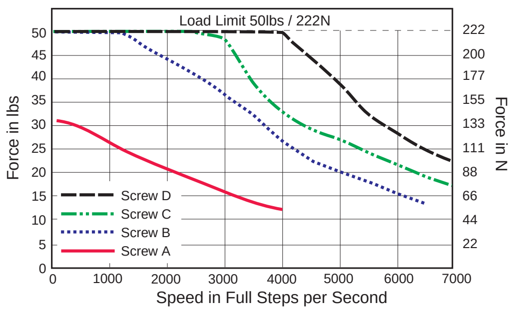


Figure 4.5: Force / Speed Curve - 45VDC (100% Current)

Acme Screws for MDrive14	
Screw	**Travel/Full Step inches (mm)**
A	0.00125 (0.03175)
B	0.000625 (0.015875)
C	0.0003125 (0.0079375)
D	0.00015625 (0.00396875)

Table 4.2: Acme Screws for the MDrive14 Linear Actuator

Electrical Specifications

Input Voltage Range* .... +12 to +48 VDC
Isolated Inputs .... Step Clock, Direction & Enable
Isolated Input Voltage Range (Sourcing or Sinking) .... +5 to +24VDC
Step Frequency (Max) .... 1 MHz
Steps per Revolution 200, 400,
Recommended Wire Size
    Logic Wiring .... 24 AWG
    Power and Ground .... See Appendix A "Recommended Cable Configurations"

* *Power supply current requirements = 0.6A (**MAX**) per MDrive14. Actual power supply current will depend on load and duty cycle.0*

WARNING! The maximum +48 VDC Input Voltage of the MDrive14 includes Motor Back EMF, Power Supply Ripple and High Line.

A 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. Care should be taken so that the back EMF does not exceed the maximum input voltage rating of the MDrive14.

***NOTE:** Wire and insulation type are subject to the user's application and environment.*

Section 5

Interfacing The MDrive14

Section Overview

This section will acquaint the user with connecting and using the MDrive14 which has a 12-position, keyed and locking pin and receptacle (C Connector). If your MDrive14 is equipped with a factory-mounted encoder, also refer to Section 5: Interfacing an Encoder. Covered in this section are:

- Interface Guidelines
- Interfacing the I/O
- Interfacing the SPI Interface

Interface Guidelines

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

Logic level cables must be shielded to reduce the chance of EMI induced noise. The shield needs to be grounded at the signal source to AC ground. 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 MDrive is to be connected to the same power supply, run separate power and ground leads from the supply to each driver.

Interfacing the I/O

MDrive14 utilizes a 12 Position, Keyed and Locking Pin and Receptacle for interfacing the I/O. For quick connection and setup of the MDrive14, the following cables are available from IMS.

Parameter Setup Cable and Adapter

A low cost accessory which eliminates the need for the user to wire communications. Included in this cable is built-in logic level shifting circuitry to accommodate the 3.3v ports on some PCs. The Parameter Setup Cable is 6 feet long.

Order Cable Part No. ***MD-CC100-000*** plus Adapter Cable Part No. ***MD-ADP-14C*** to connect the MDrive to a standard DB-25 PC Parallel/SPI port.

Prototype Development Cable

To expedite interfacing to MDrive14, order Cable Part No. ***ADP-2012-FL*** which connects to Adapter MD-ADP-14C described above.

> **WARNING! DO NOT** connect or disconnect power leads when power is applied! Disconnect the AC power side to power down the DC power supply. For battery operated systems, connect a "transient suppressor" across the power switch to prevent arcs and high voltage spikes.

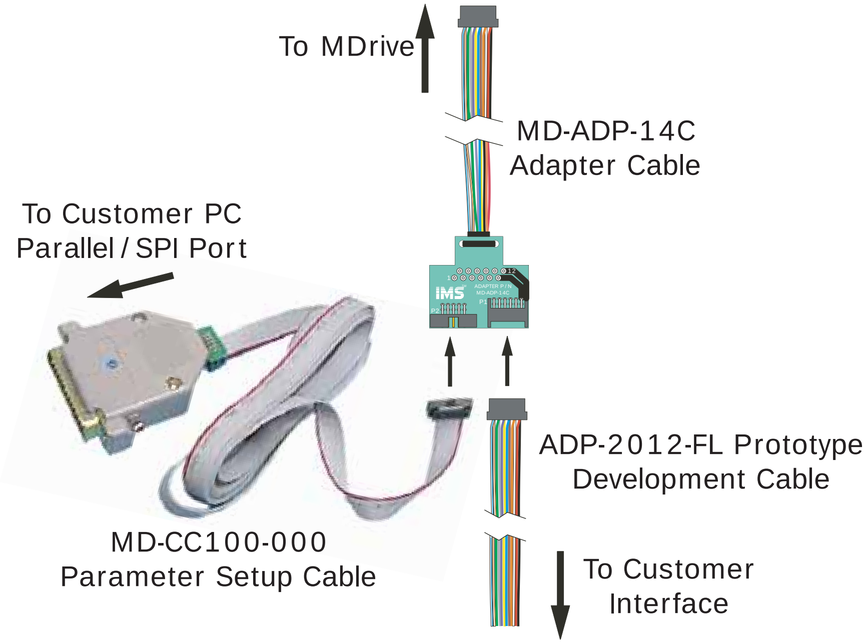


Figure 5.1: Typical Parameter Setup, Adapter, and Prototype Development Cable Connections for MDrive14

Parameter Setting

The MD-CC100-000 Parameter Setup Cable is 6 feet long and connects to the MD-ADP-14C Adapter Cable and to the Customer's PC Parallel/SPI Port. The Adapter Cable plugs directly into the the MDrive14. This allows the customer to setup the desired parameters of the MDrive14.

Prototype Testing

The ADP-2012-FL Prototype Development Cable connects to the MD-ADP-14C Adapter Cable and has 12 inch "flying leads" for the customer to make connections to their interface for testing and development of the MDrive14. The Prototype Development Cable may also be connected directly to the MDrive14 as a permanent interface.

WARNING! DO NOT connect or disconnet the MD-CC100-000 Parameter Setup Cable, the MD-ADP-14C Adapter Cable, or the ADP-2012-FL Prototype Development Cable while power is applied!

Mating Connector Information

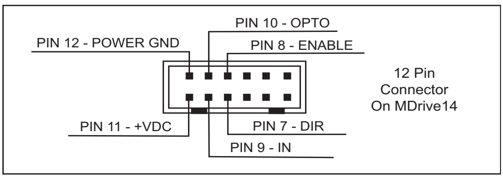
In production situations, customers specify socket type and type of wire termination and purchase directly from the Connector Distributor. The following information is provided as an aid in this process.

Manufacturer: Hirose Electric Co., Ltd.
www.hirose.com

Part #'s: DF11-12DS-2R26(xx)*
DF11-12DS-2C(xx)*

*Please refer to manufacturer's data sheets for additional information.

Description of the I/O



C CONNECTOR PINS 7-12 ASSIGNMENT				
PIN #	**WIRE COLOR***	**WIRE SIZE**	**FUNCTION**	**PRODUCT LABEL**
7	Blue	AWG 24	CW/CCW DIRECTION INPUT	DIR
8	Brown	AWG 24	ENABLE INPUT	EN
9	Orange	AWG 24	STEP CLOCK INPUT	IN
10	White	AWG 24	+5 to +24 VDC OPTO SUPPLY	OPTO
11	Red	AWG 24†	+12 TO +48 VDC	+V
12	Black	AWG 24†	POWER GROUND (RETURN)	PWR-G
PINS 1 to 6			*SEE SPI SECTION*	

* The wire colors refer to the ADP-2012-FL Prototype Development Cable. † For supplies 10 feet or less.

Table 5.1: I/O Pin Assignment and Description

The I/O interfaces to the MDrive14 through pins 7-12. A brief description of each signal follows.

NOTE: Wire and insulation type are subject to the user's application and environment.

Pin 7 - Directon (Input)

The Direction Input controls the Clockwise/Counterclockwise direction of the motor. It may be configured as sinking or sourcing depending on the state of the Optocoupler Reference. The direction, based on the state of the input, may be set using the IMS Motor Interface software accessed through the IMS SPI Interface on the CD included with the MDrive14. The direction input may be connected by means of a switch between Pin 7 and logic ground when the Optocoupler reference is +5 to +24 VDC (sinking) or between Pin 7 and the +5 to +24 VDC when the Optocoupler reference is logic ground (sourcing). (See the figure “Sourcing or Sinking” on the following page.)

NOTE: This signal must be fully HIGH (or LOW) 35 microseconds before and 15 microseconds after the rising edge of the Step Clock to ensure the proper direction of motion.

Pin 8 - Enable (Input)

The Enable Input can be used to enable or disable the driver output circuitry. When open, for either sinking or sourcing, the driver outputs will be enabled and the step clock pulses will cause the MDrive14 to advance. When the input is closed, the driver output circuitry will be disabled. Please note that the internal sine/cosine position generator will continue to increment or decrement as long as step clock pulses are being received by the MDrive14. This input is asynchronous to any other input and may be changed at any time. (See the figure “Sourcing or Sinking” on the following page.)

PIN 9 - Step Clock (Input)

The Step Clock Input is where the motion clock from your control circuitry will be connected. The motor will advance one microstep in the plus or minus direction (based on the state of the direction input) on the transition of the input from closed to open. The size of this increment or decrement will depend on the microstep resolution setting. (See the figure “Sourcing or Sinking” on the following page.)

Pin 10 - Optocoupler Reference

The Optocoupler Reference supplies +5 to +24 VDC for sinking or logic ground for sourcing. (See the figure “Sourcing or Sinking” on the following page.)

Pin 11 - +12 to +48 VDC

This is the Input Voltage to the MDrive14 from the power supply.

Pin 12 - Power Ground

This is the Power Ground from the power supply to the MDrive.

NOTE: You cannot communicate with the MDrive14 while it is in motion. The MDrive14 must be stopped to communicate.

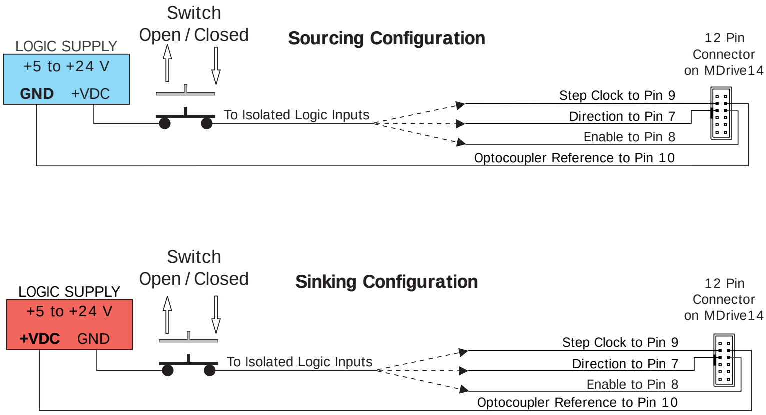


Figure 5.2: Sourcing or Sinking the MDrive14 Isolated Inputs

In the illustration above, when the circuit(s) are closed the Optocoupler will be Active. When the circuit(s) are open the Optocoupler will be inactive.

NOTE: The mechanical switch shown is for illustration purposes. The actual switching of the circuits can be done mechanically or electronically.

Minimum Required Connections

The connections shown in the figure below are the minimum required to operate the MDrive14.

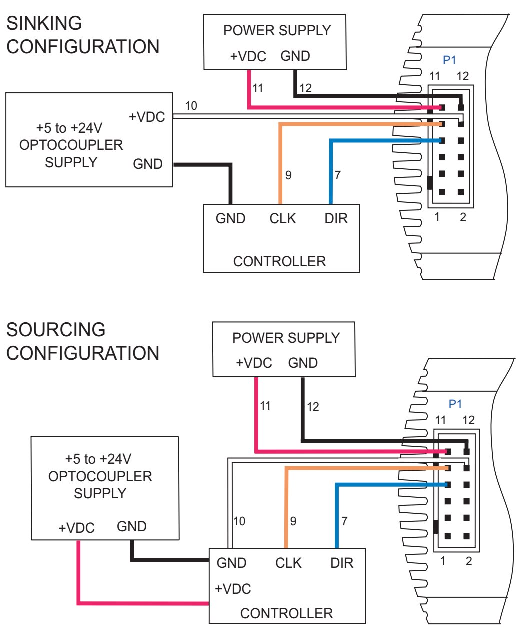


Figure 5.3: Minimum Required Connections

Connecting the MDrive14 SPI Interface

The SPI (Serial Peripheral Interface) communications connector uses a 12-Position, Keyed and Locking Pin and Receptacle. The recommended method of connecting to this receptacle is the Parameter Setup Cable. This is a low cost accessory which eliminates the need for the user to wire communications. Included in this cable is built-in logic level shifting circuitry to accommodate the 3.3v ports on some PCs. This cable is 6 feet long and plugs in easily to connect a standard DB-25 PC parallel/SPI port to the 12 pin MDrive connector. Order Cable Part Number **MD-CC100-000** plus Adapter Part Number **MD-ADP-14C.**

NOTE: Should you choose to make your own parameter setup cable, be advised the 3.3V output parallel ports on some PCs may not be sufficient to communicate with the MDrive14 device.

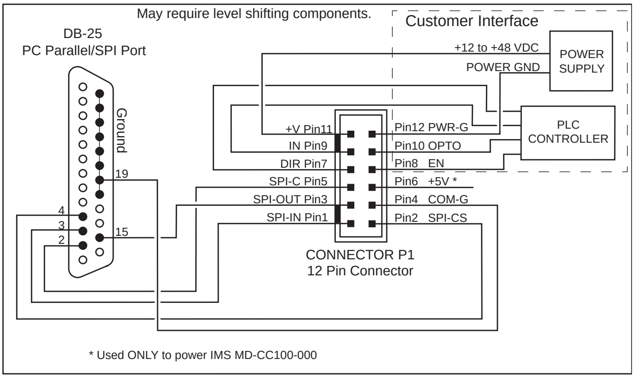


Figure 5.4: SPI Interface Wiring and Connections

C CONNECTOR PINS 1-6 ASSIGNMENT				
PIN #	WIRE COLOR*	WIRE SIZE	FUNCTION	PRODUCT LABEL
1	White/Blue	AWG 24	SPI MASTER OUT/SLAVE IN	SPI-IN
2	White / Orange	AWG 24	SPI CHIP SELECT	SPI-CS
3	Green	AWG 24	SPI MASTER IN/SLAVE OUT	SPI-OUT
4	Grey	AWG 24	COMMUNICATION GROUND	COM-G
5	Violet	AWG 24	SPI CLOCK	SPI-C
6	Yellow	AWG 24	+5 VDC OUTPUT	+5 V
PINS 7 to 12			*SEE I/O SECTION*	

* The wire colors refer to the ADP-2012-FL Prototype Development Cable.

Table 5.2: SPI Pin Assignment and Description

NOTE: Wire and insulation type are subject to the user's application and environment.

NOTE: You cannot communicate with the MDrive14 while it is in motion. The MDrive14 must be stopped to communicate.

WARNING! The +5VDC output on Pin 6 on connector P1 is used for the setup cable **ONLY**! It is not designed to power external devices!

WARNING! The Parallel/SPI Port on your PC must be set to one of the following:

- output only
- bi-directional
- EPP (Extended Parallel Port)

The Parallel/SPI Port is configured in the bios of your PC. Contact your PC supplier if you need assistance making this change.

Pin 1 - MOSI (Master Out / Slave In)

Carries output data from the SPI Master to the MDrive14.

Pin 2 - CS (SPI Chip Select)

This signal is used to turn multiple MDrive14 on or off.

Pin 3 - MISO (Master In / Slave Out)

Carries output data from the MDrive14 back to the SPI Master. Only one MDrive14 can transmit data during any particular transfer.

Pin 4 - Logic Ground

Pin 5 - SPI Clock

The Clock is driven by the Master and regulates the flow of the data bits. The Master may transmit data at a variety of baud rates. The Clock cycles once for each bit that is transferred.

Pin 6 - +5 VDC (Output)

This output is a voltage supply for the setup cable only. It is not designed to power any external devices.

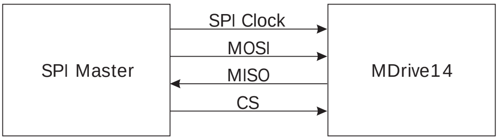


Figure 5.5: SPI Master and MDrive14 (Single Configuration)

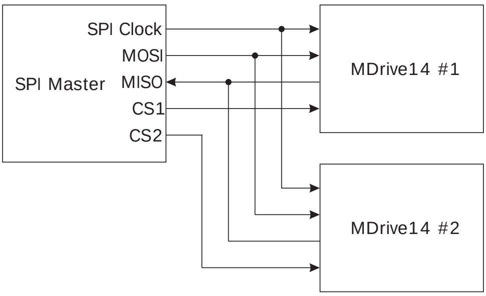


Figure 5.6: SPI Master and MDrive14 (Multiple Configuration)

Section 6

Interfacing An Encoder

Section Overview

This section will cover interfacing the Factory-Mounted Encoder version of the MDrive14. Included are the pin configurations for both the single-end and differential models.

Note that this encoder is externally mounted. The footprint of the encoder version will change relative to the standard MDrive14.

Factory-Mounted Encoder

The MDrive14 is available with a factory-mounted external optical encoder. Available line counts:

- 100
- 200
- 250
- 400
- 500
- 1000

Encoders are available in both single-end and differential configurations. All encoders, except for the 1000 line encoder, have an index mark.

Use of the encoder feedback feature of this product requires a controller such as an IMS LYNX or PLC.

The encoder has a 100kHz maximum output frequency.

General Specifications

	Min	Typ	Max	Units
Supply Voltage (Vcc)	-0.5		7	Volts
Supply Current	30	57	85	mA
Output Voltage	-0.5		Vcc	Volts
Output Current (Per Channel)	-1.0		5	mA
Maximum Frequency				100kHz

Inertia .... 0.565 g-cm^2 (8.0 x 10^{-6} oz-in-sec^2)

Temperature

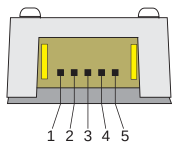
Operating .... -40 to +100° C

Storage .... -40 to +100° C

Humidity .... 90% (noncondensing)

Pin Configuration

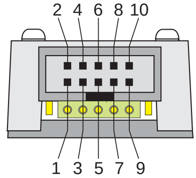
Single-End Encoder



Pin 1: Ground
Pin 2: Index
Pin 3: Channel A
Pin 4: +5VDC Input
Pin 5: Channel B

Figure 6.1: Single-End Encoder Pin Configuration

Differential Encoder



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

Figure 6.2: Differential Encoder Pin Configuration

Single-End Encoder

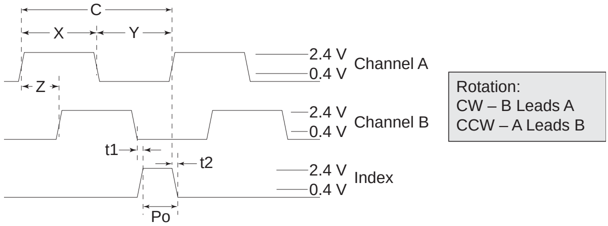


Figure 6.3: Single-End Encoder Signal Timing

Differential Encoder

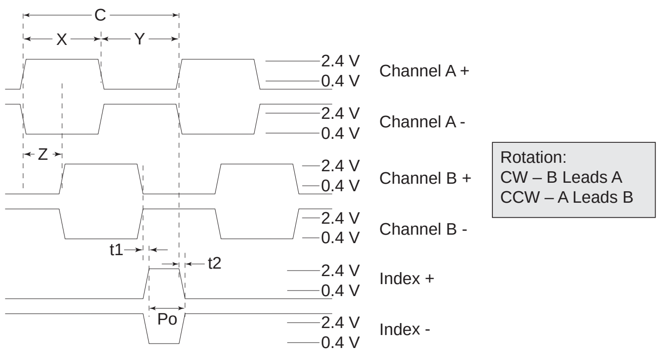


Figure 6.4: Differential Encoder Signal Timing

Note: Rotation is as viewed from the cover side.

(C) One Cycle: 360 electrical degrees (°e)

(X/Y) Symmetry: A measure of the relationship between X and Y, nominally 180°e.

(Z) Quadrature: The phase lag or lead between channels A and B, nominally 90°e.

(Po) Index Pulse Width: Nominally 90°e.

Characteristics

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

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

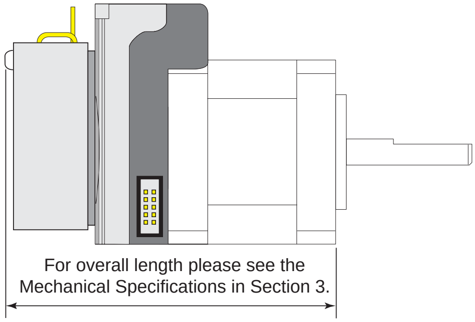


Figure 6.5: MDrive14 with Single-End Encoder Profile

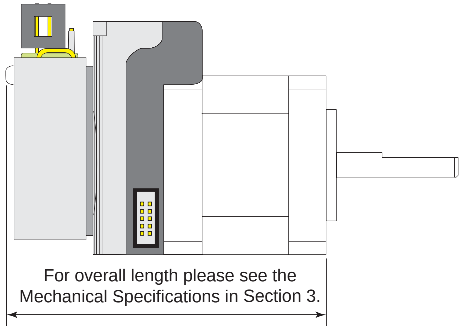


Figure 6.6: MDrive14 with Differential Encoder Profile

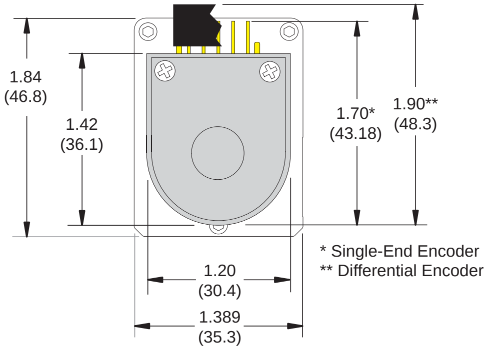


Figure 6.7: MDrive14 Rear View with Encoder

Encoder Cables

IMS offers assembled cables for both the Single-End and Differential Encoders. The IMS Part Numbers are listed below.

Single-End Encoder Cable (12” leads) ES-CABLE-2

Differential Encoder Cable (36” leads) ED-CABLE-2

Recommended Encoder Mating Connectors

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

Single-End Encoder

AMP 5 Pin Connector Shell 1-87175-2
Pins* (5 required) AMP Part Number 87165-1
* For AWG 22-26 wires.

AMP MTA 0.1 IDC Loaded Connector
AWG 22 (Red) 640440-5
AWG 24 (Natural) 640441-5
AWG 26 (Blue) 640442-5
AWG 28 (Green) 640443-5

Differential Encoder

AMP Connector with 10 Preloaded IDC Pins* 102694-3
Shell with Polarizing Key 102537-3
Back Cover 102536-3
* For AWG 22-26 wires.

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

Section 7

Configuring The MDrive14

Section Overview

This section is general to all MDrive14 versions. This section will acquaint the user with the following:

- The IMS Motor Interface
- Configuration Parameters Explained

The IMS Motor Interface Software

The Configuration Utility

The IMS Motor Interface software is an easy to install and use graphical user interface (GUI) for configuring the MDrive14 from the parallel port on your computer. Access the GUI via the IMS SPI Interface included on the CD shipped with the product, or download at www.imshome.com. Optional parameter setup cables are also available for ease of connecting and configuring this MDrive product.

Configuration utility features include:

- Easy installation.
- Automatic detection of MDrive version and communication configuration.
- Will not set out-of-range values.
- Tool-tips display valid range setting for each option.
- Ease of use via single screen interface

Installation

To install and use the IMS Motor Interface, you need a Pentium class or higher PC running Windows 95/98. If you are using Windows NT 4.0 (SP6 or greater), Windows 2000 (SP2 or greater) or Windows XP use the NT version of this software. The installation procedure is:

1] Place the IMS CD in your CD-ROM drive.

2] The CD Front End should automatically start, if not, click Start>Run on the Start Menu. Browse to your CD-ROM Drive and select “IMS.exe”

3] On the screen that will open click the MDrive button.

4] Select the SPI Interface. Follow the onscreen prompts to complete installation.

Start-up

Select "Start>Programs>IMS SPI Interface>IMS SPI Interface". The configuration utility will automatically scan your LPT ports for the connected MDrive14 and configure communications. The connection status and port are displayed at the bottom of the configuration screen as shown below.

Graphical User Interface

The IMS Motor Interface GUI (Graphical User Interface) simplifies use with single screen interface for configuring the MDrive. All of the parameters and commands are controlled from this single screen.

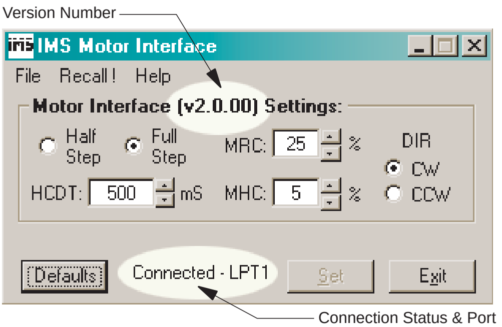


Figure 7.1: Graphical User Interface (GUI) Screen

Your GUI may appear slightly different than the example shown above due to different versions of MDrive Firmware. The Firmware is not upgradable but the IMS Motor Interface will configure itself to your current Firmware version. The Version Number will be displayed as indicated above.

The Factory Default settings are shown in the figure above. These settings may be changed to suit the user's application.

Changing Parameters

When a Parameter is changed, the font color will change to blue and the "Set" button will be activated. The change will not take place until Set is clicked.

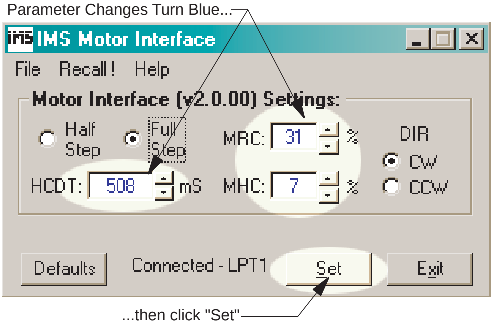


Figure 7.2: Changing the Parameter Settings

Illegal Parameters / Tool Tips

If an illegal parameter is entered it will be displayed in red. By placing the mouse pointer over the parameter the “Tool Tips” dialog will be displayed. The legal range for that parameter will be shown in the dialog box.

NOTE: The Tool Tips are always functional.

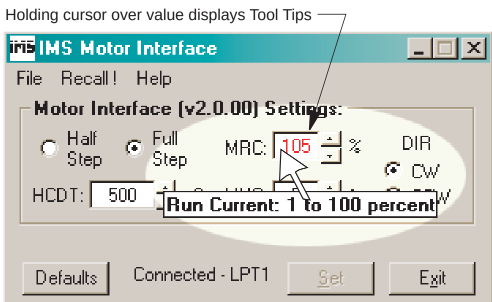


Figure 7.3: Illegal Parameters / Tool Tips

Restoring Factory Defaults

To return to the Factory Defaults, click the “Default” button and the “Set” button. The Factory Defaults will be restored.

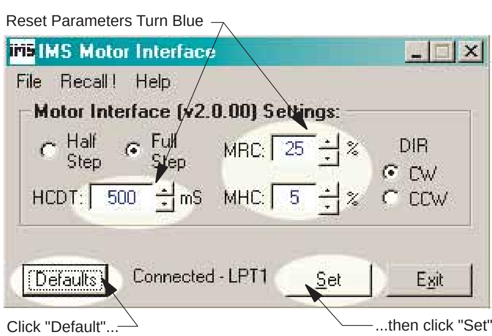


Figure 7.4: Restoring Factory Defaults

NOTE: You cannot communicate with the MDrive14 while it is in motion. The MDrive14 must be stopped to communicate.

Configuration Parameters Explained

There are 5 configuration parameters for the MDrive14. Parameter settings are automatically saved to memory when the “SET” button is clicked on the IMS Motor Interface screen. These parameters **may not** be changed on-the-fly.

The table below summarizes the parameters and their function, range, units and default setting.

SETUP PARAMETERS				
NAME	**FUNCTION**	**RANGE**	**UNITS**	**DEFAULT**
MHC	Hold Current	0 to 100	percent	5
MRC	Run Current	1 to 100	percent	25
HALF/ /FULL	Half Step / Full Step	0 / 1	–	FULL STEP
HCDT	Hold Current Delay Time	2 to 65535, or 0	m Sec.	500 m Sec.
DIR	Motor Direction	0 / 1	–	CW

Table 7.1: Half / Full Step Setup Parameters

Motor Holding Current (MHC)

The MHC parameter sets the motor holding current as a percentage of the full output current of the driver. If the hold current is set to 0, the output circuitry of the driver section will disable when the hold current setting becomes active.

The time in which the hold current setting becomes active is set by the HCDT (Hold Current Delay Time) command.

Motor Run Current (MRC)

The Motor Run Current (MRC) parameter sets the motor run current to a percentage of the full output current of the driver section.

Half / Full Step (HFUL)

The Half/Full Step (HFUL) parameter sets the motor to run in a Half Step or a Full Step configuration.

Hold Current Time Delay (HCDT)

The Hold Current Time Delay (HCDT) allows the user to set the amount of time (in mSec.) that the motor will wait before switching to the hold current setting.

Direction Select (DIR)

The DIR parameter reverses the motor direction with respect to the direction input signal, adapting the direction of the drive to operate as your system expects.

SPI Commands

SPI COMMANDS AND PARAMETERS				
	CMD / PRM	**HEX / DEFAULT**	**RANGE**	**NOTES**
SPI Commands	READ ALL	0X40		Reads the hex value of all parameters.
	WRITE ALL	0X80		Writes the hex value to the following parameters.
Data READ	"u"	0x75		"u" Character precedes every read.
	Version MSB	0x10		Defines the SPI Version Number. ie., Version 1.0, Rev. 01
	Version LSB	0x01		
	MHC	0x05	0 to 100%	Motor Hold Current - Default = 5
	MRC	0x19	1 to 100%	Motor Run Current - Default = 25
	HFUL	0x01	0-1	Half or Full Step - Default = Full Step
	HCDT	0x01F4	0 to 65,000	Hold Current Delay Time - Default = 500 m Sec.
	DIR	0x01	CW / CCW	Direction - Default = CW
Data WRITE	MHC	0x05	0 to 100%	Motor Hold Current - Default = 5
	MRC	0x19	1 to 100%	Motor Run Current - Default = 25
	HFUL	0x01	0-1	Half or Full Step - Default = Full Step
	HCDT	01xF4	0 to 65,000	Hold Current Delay Time - Default = 500 m Sec.
	DIR	0x01	CW / CCW	Direction - Default = CW

Table 7.2: MDrive14 SPI Command Summary

Example

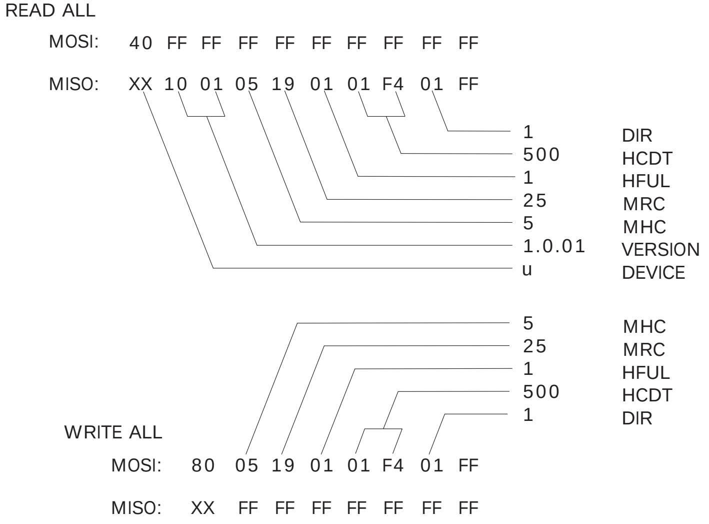


Figure 7.5: SPI Read / Write Example

APPENDIX A

Recommended Cable Configurations

Cable length, wire gauge and power conditioning devices play a major role in the performance of your MDrive14.

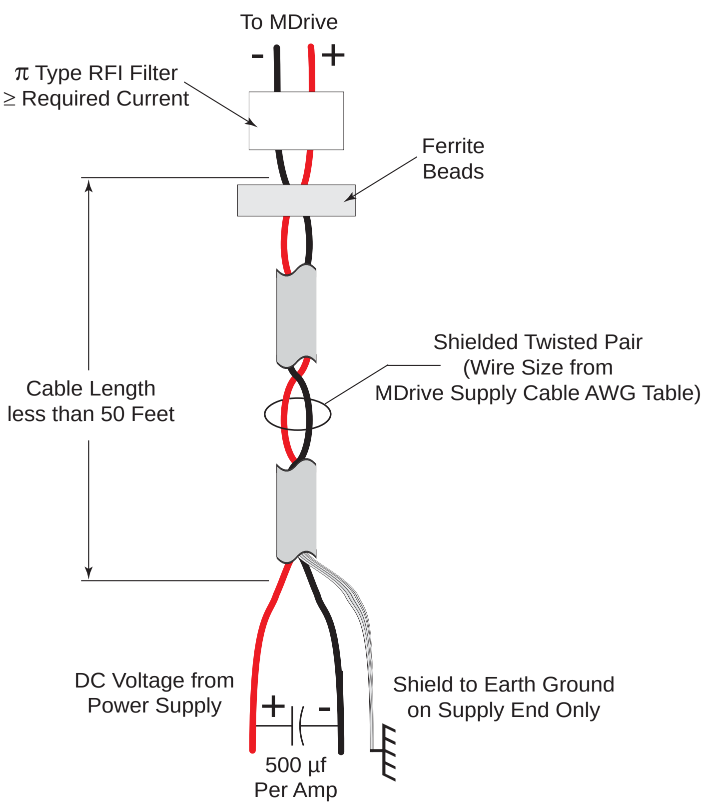
NOTE: These recommendations will provide optimal protection against EMI and RFI. The actual cable type, wire gauge, shield type and filtering devices used are dependent on the customer's application and system.

NOTE: The length of the DC power supply cable to an MDrive14 should not exceed 50 feet.

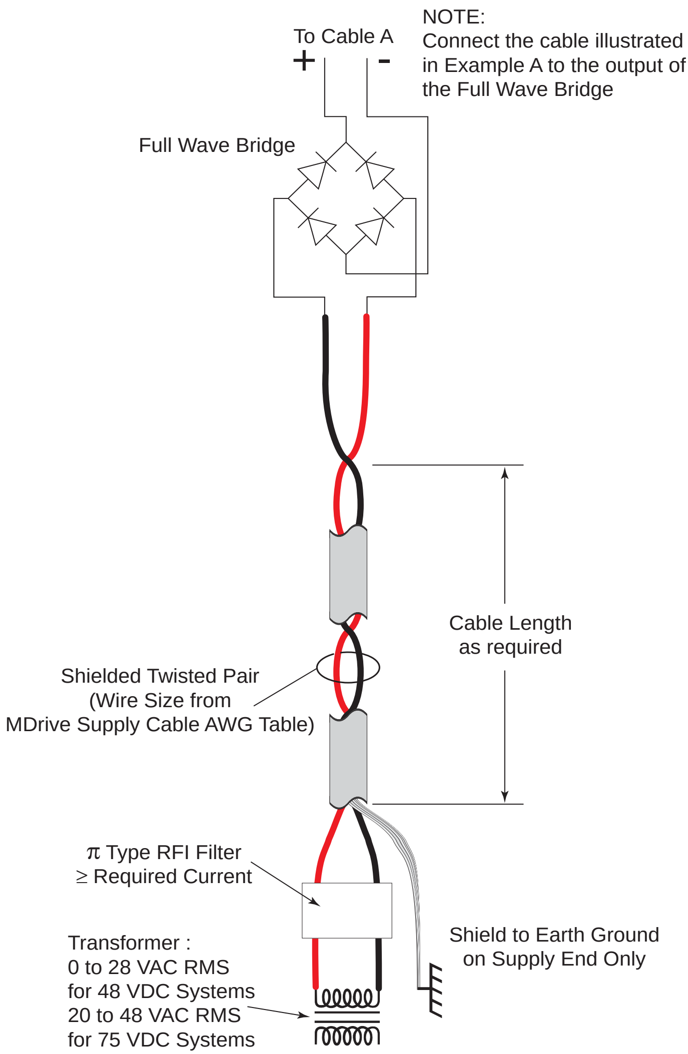
Example A demonstrates the recommended cable configuration for DC power supply cabling under 50 feet long. If cabling of 50 feet or longer is required, the additional length may be gained by adding an AC power supply cable (see Examples B & C).

Correct AWG wire size is determined by the current requirement plus cable length. Please see the MDrive14 Supply Cable AWG Table at the end of this Appendix.

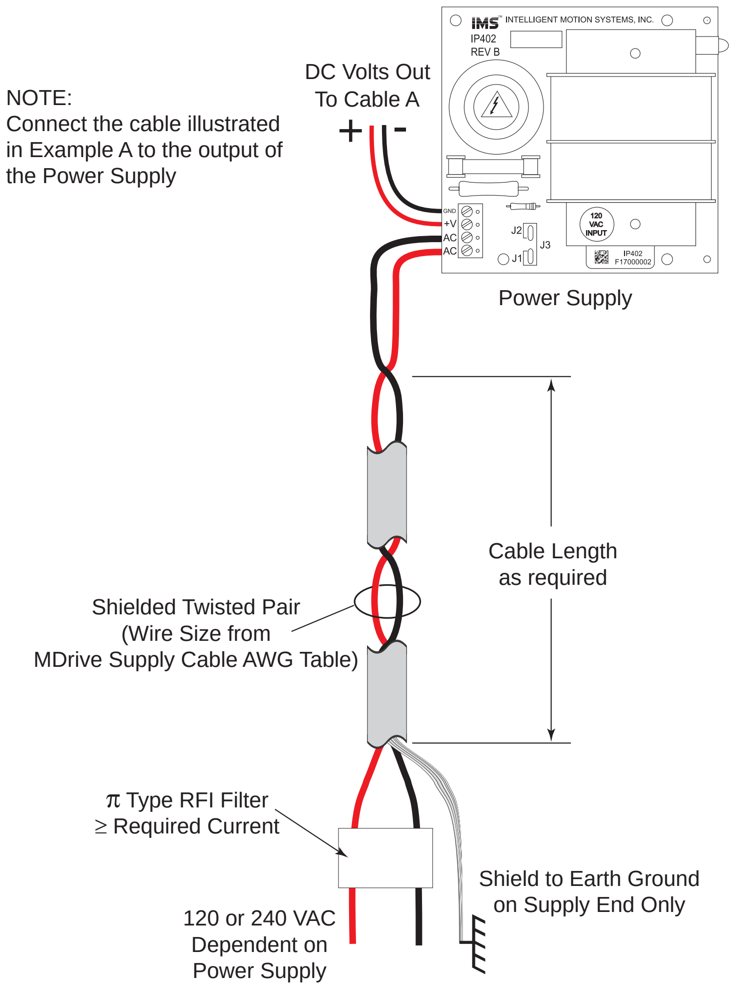
Example A – Cabling Under 50 Feet, DC Power



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



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



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

MDrive14 Supply Cable AWG Table					
1 Ampere (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	20	20	18	18	16
* Use the alternative methods innustrated in Examples B and C when the cable length is ≥ 50 feet. Also, use the same current rating when the alternate AC power is used.					

MDrive14 Wire Size

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

a d d e n d u m

MDrive with Planetary Gearbox

Section Overview

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

Shown are:

- Product Overview
- Selecting a Planetary Gearbox
- Mechanical Specifications

Product Overview

All gearboxes are factory installed.

Mode of Function

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

Service Life

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

Lubrication

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

Mounting Position

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

Operating Temperature

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

Overload Torque

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

Available Planetary Gearbox

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

Gearbox Diameter	MDrive
32 mm	MDrive14
42 mm	MDrive17
52 mm	MDrive23
81 mm	MDrive34

Selecting a Planetary Gearbox

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

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

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

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

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

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

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

Factors

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

Reduction Ratio

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

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

Example:

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

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

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

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

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

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

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

600 RPM ÷ 90 = 6.67:1 Reduction Ratio

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

Nominal Output Torque

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

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

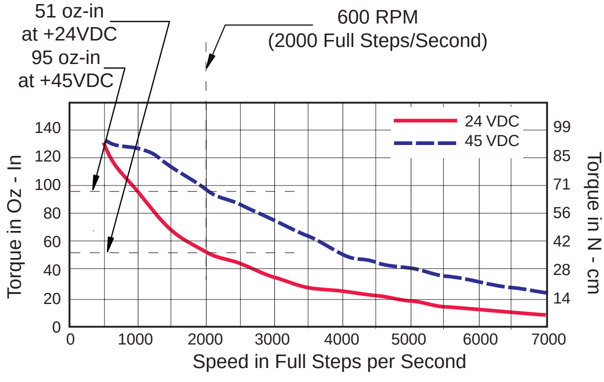
$T_N = T_M \times i \times \eta \div s_f$ or:

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

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

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

The Speed/Torque Table above is for an MDrive 2222. This MDrive will produce a torque range of 51 to 95 oz-in in the full voltage range at the speed of 2000 Full Steps/Second (600 RPM).



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

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

Example:

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

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

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

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

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

Nominal output torque would be:

Motor torque ($T_M = 35$) $\times$ reduction ratio ($i = 6.75$) $\times$ gear efficiency ($\eta = 0.8$) $\div$ safety factor ($s_f = 0.5$ or 0.7)

$35 \times 6.75 = 236.25 \times 0.8 = 189 \div 0.5 = 378$ oz-in nominal output torque (T_N)

or

$35 \times 6.75 = 236.25 \times 0.8 = 189 \div 0.7 = 270$ oz-in nominal output torque (T_N)

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

Shock Load Output Torque

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

Each Planetary Gearbox has a maximum specified output torque. In this example a 7:1 single stage MDrive23 Planetary Gearbox is being used. The maximum specified output torque is 566 oz-in. By calculating the shock load output torque (T_{AB}) you can verify that value is not exceeding the maximum specified output torque.

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

- direction of rotation (constant or alternating)
- load (shocks)
- daily operating time

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

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

> The nominal output torque (T_N) × the operating factor (C_B) = shock load or maximum output torque (T_{AB}).
>
> With a 0.5 safety factor, the shock load output torque is greater than the maximum output torque specification of the MDrive23 Planetary Gearbox. (378 × 1.9 = 718.2 oz-in.)
>
> With a 0.7 safety factor the shock load output torque is within maximum output torque specification of the MDrive23 Planetary Gearbox. (270 × 1.9 = 513 oz-in.)

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

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

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

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

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

System Inertia

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

The type of system being driven.

Weight and frictional forces of that system.

The load the system is moving or carrying.

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

Type of System

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

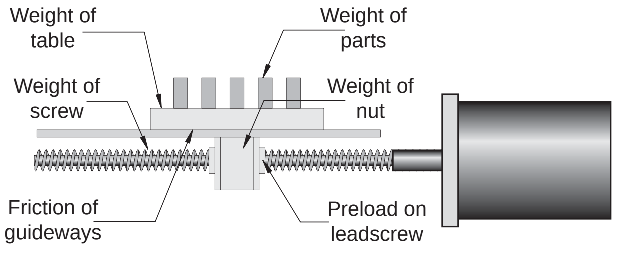
❒ lead screw
❒ rack and pinion
❒ conveyor belt
❒ rotary table
❒ belt drive
❒ chain drive

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

Lead Screw

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

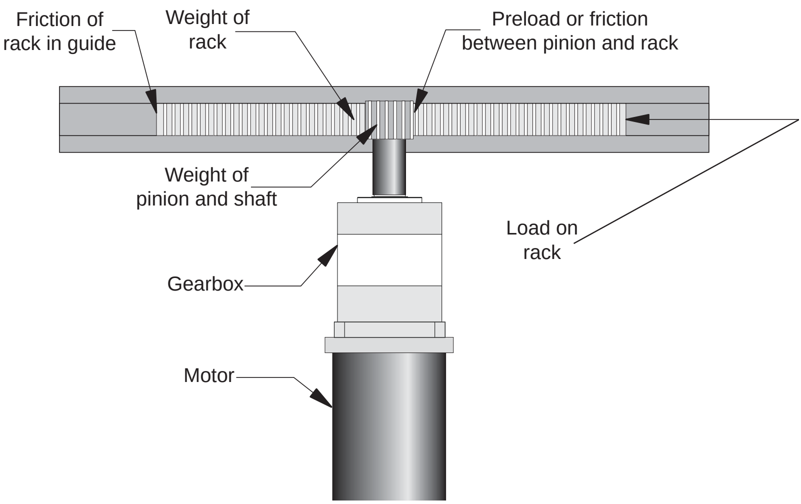
❒ the weight and preload of the screw
❒ the weight of the lead screw nut
❒ the weight of a table or slide
❒ the friction caused by the table guideways
❒ the weight of any parts



Rack and Pinion

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

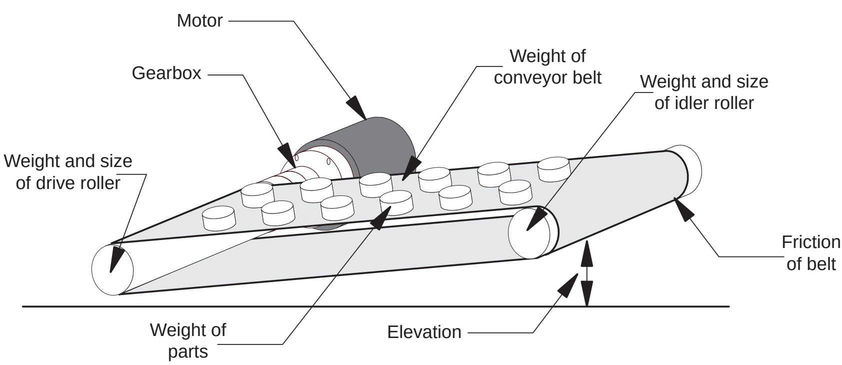
- ❐ the weight or mass of the pinion
- ❐ the weight or mass of the rack
- ❐ the friction and/or preload between the pinion and the rack
- ❐ any friction in the guidance of the rack
- ❐ the weight or mass of the object the rack is moving



Conveyor Belt

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

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



Rotary Table

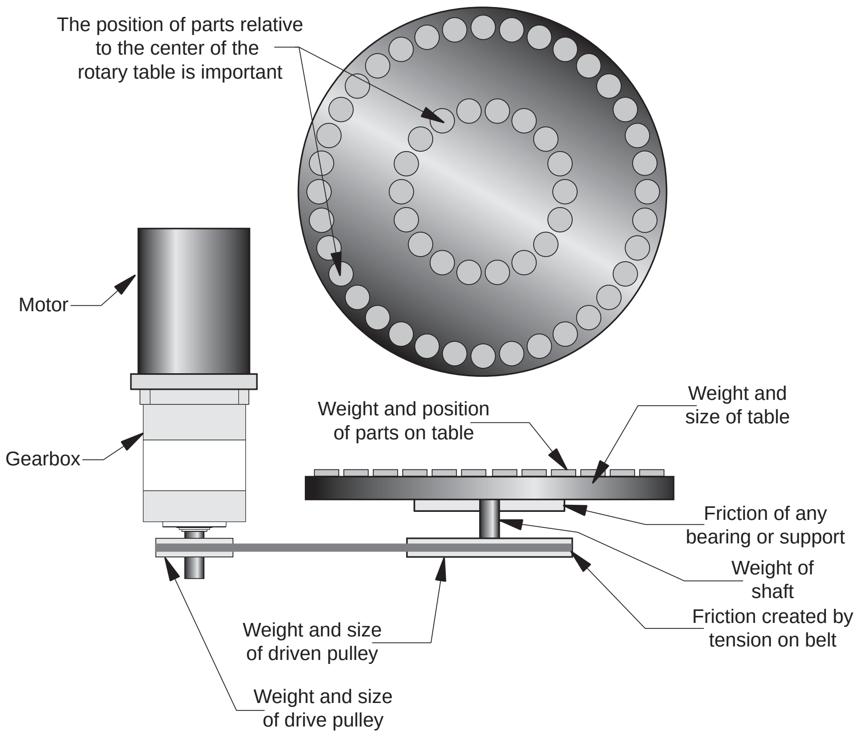
In a system with a rotary table, the following must be considered:

- ❒ the weight or mass and size of the table
- ❒ any parts or load the table is carrying
- ❒ the position of the load on the table, the distance from the center of the table will affect the inertia
- ❒ how the table is being driven and supported also affects the inertia

Belt Drive

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

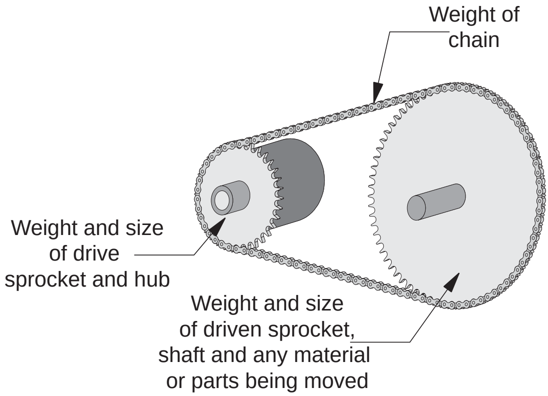
- ❒ the weight or mass and size of the driving pulley
- ❒ the tension and/or friction of the belt
- ❒ the weight or mass and size of the driven pulley
- ❒ any load the system may be moving or carrying



Chain Drive

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

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



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

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

Where:

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

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

Z = Gearbox Ratio

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

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

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

Where:

Z_{opt} = Optimal Gearbox Ratio

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

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

Planetary Gearbox Inertia

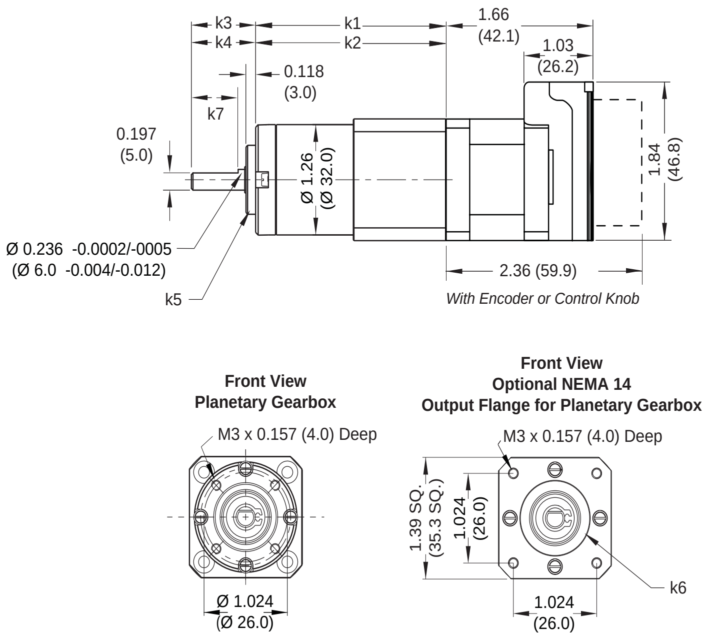
In addition to System Inertia, the Planetary Gearbox inertia must also be included when matching system inertia to motor inertia. The Planetary Gearbox inertia varies with the ratio and the number of stages. The table below lists the inertia values for the MDrive14, 17, 23 and 34 Planetary Gearbox. The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

Planetary Gearbox Inertia Moments (oz-in-sec^2)					
Stages	Rounded Ratio	MDrive 14 Gearbox	MDrive 17 Gearbox	MDrive 23 Gearbox	MDrive 34 Gearbox
1-Stage	4:1	0.00002181	0.00006627	0.00025986	0.00233660
	5:1	0.00001614	0.00004362	0.00017461	0.00154357
	7:1	0.00001260	0.00003328	0.00016030	0.00128867
2-Stage	14:1	0.00002110	0.00006245	0.00024230	0.00219499
	16:1	0.00001770	0.00005084	0.00020406	0.00179847
	18:1	0.00001784	0.00005070	0.00020335	0.00182679
	19:1	0.00001586	0.00004149	0.00016512	0.00141612
	22:1	0.00001586	0.00004135	0.00016469	0.00148693
	25:1	0.00001359	0.00003200	0.00013453	0.00177015
	27:1	0.00001600	0.00004121	0.00016441	0.00148693
	29:1	0.00001359	0.00003186	0.00013425	0.00124619
	35:1	0.00001374	0.00003186	0.00013411	0.00126035
	46:1	0.00001388	0.00003186	0.00013411	0.00126035
3-Stage	51:1	0.00002110	0.00006245	0.00024230	0.00218082
	59:1	0.00001770	0.00005084	0.00020406	0.00178431
	68:1	0.00001784	0.00005070	0.00020335	0.00179847
	71:1	0.00001586	0.00004149	0.00016512	0.00147276
	79:1	0.00001784	0.00005070	0.00020335	0.00179847
	93:1	0.00001359	0.00003200	0.00016441	0.00124619
	95:1	0.00001586	0.00004135	0.00020335	0.00147276
	100:1	0.00001600	0.00004121	0.00016441	0.00148693
	107:1	0.00001359	0.00003186	0.00013425	0.00124619
	115:1	0.00001600	0.00004121	0.00016441	0.00148693
	124:1	0.00001359	0.00003186	0.00013425	0.00124619
	130:1	0.00001374	0.00003186	0.00013411	0.00124619
	139:1	0.00001600	0.00004121	0.00016441	0.00144444
	150:1	0.00001374	0.00003186	0.00013411	0.00124619
	169:1	0.00001359	0.00003186	0.00013411	0.00126035
	181:1	0.00001374	0.00003186	0.00013411	0.00124619
	195:1	0.00001359	0.00003186	0.00013411	0.00126035
	236:1	0.00001359	0.00003186	0.00013411	0.00126035
	308:1	0.00001359	0.00003186	0.00013411	0.00126035

Mechanical Specifications

MDrive14 with Planetary Gearbox

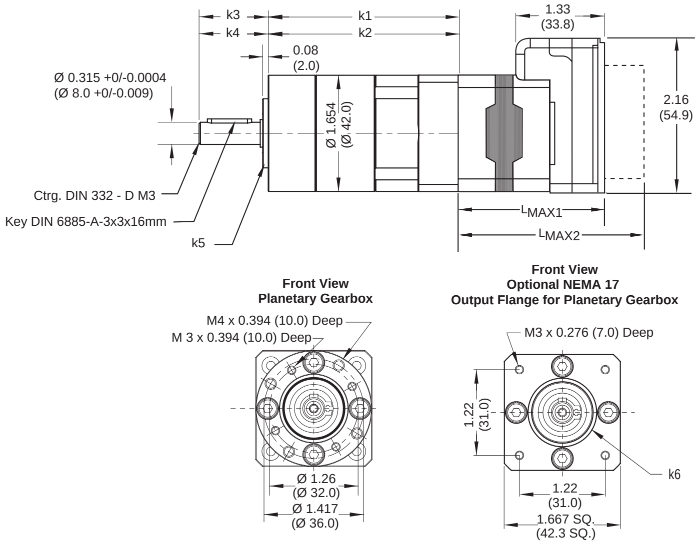
Dimensions in Inches (mm)



		Planetary Gearbox	1-Stage	2-Stage	3-Stage
Dimensions Inches (mm)	k1	Standard Gearbox	1.969 (50.0) ±0.02 (0.5)	2.343 (59.5) ±0.02 (0.5)	2.717 (60.0) ±0.02 (0.5)
	k2	w/NEMA Flange	2.008 (51.0) ±0.02 (0.5)	2.382 (60.5) ±0.02 (0.5)	2.756 (70.0) ±0.02 (0.5)
	k3	Standard Shaft	0.787 (20.0)		
	k4	Shaft w/NEMA Flange	0.748 (19.0)		
	k5	Standard Locator Diameter	0.787 (20.0) +0/-0.0013 (+0/-0.033)		
	k6	Locator Diameter w/NEMA Flange	0.866 (22.0) +0/-0.0013 (+0/-0.033)		
	k7	Length of Flat on Shaft	0.394 (10.0)		
Parameters		Max Output Torque	106 oz-in (0.75 Nm)	318 oz-in (2.25 Nm)	637 oz-in (4.5 Nm)
		Efficiency	80%	75%	70%
		Max Backlash	1.5°	2.0°	2.5°
Loads		Max Radial Load	9.0 lb-force (40 N)	15.7 lb-force (70 N)	22.0 lb-force (100 N)
		Max Axial Load	2.2 lb-force (10 N)	4.5 lb-force (20 N)	6.7 lb-force (30 N)
Weight		Gearbox Only	5.7 oz (162 gm)	7.5 oz (213 gm)	9.3 oz (264 gm)
		Gearbox w/NEMA Flange	5.9 oz (168 gm)	7.8 oz (221 gm)	9.6 oz (273 gm)

Planetary Gearbox Specifications for MDrive14

Dimensions in Inches (mm)

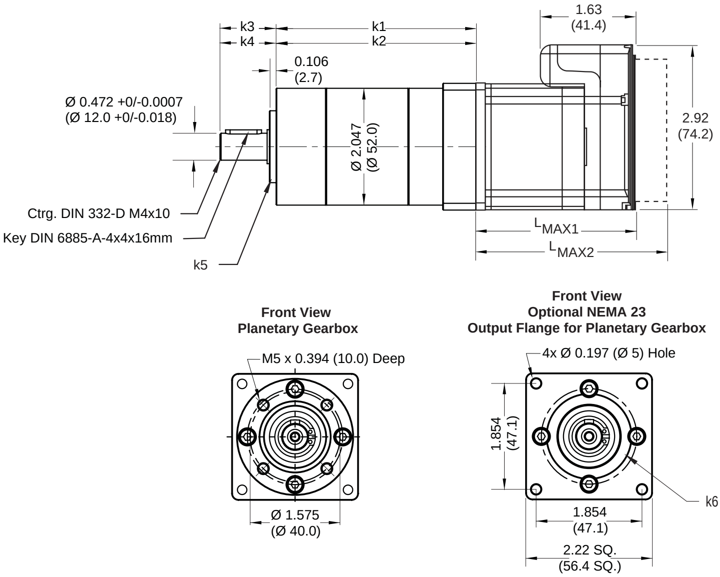


		Planetary Gearbox	1-Stage	2-Stage	3-Stage
Dimensions Inches (mm)	k1	Standard Gearbox	2.736 (69.5) ±0.02 (0.5)	3.248 (82.5) ±0.02 (0.5)	3.760 (95.5) ±0.02 (0.5)
	k2	w/NEMA Flange	2.858 (72.6) ±0.02 (0.5)	3.370 (85.5) ±0.02 (0.5)	3.882 (98.6) ±0.02 (0.5)
	k3	Standard Shaft	0.984 (25.0)		
	k4	Shaft w/NEMA Flange	0.846 (21.5)		
	k5	Standard Locator Diameter	0.984 (25.0) +0/-0.002 (+0/-0.052)		
	k6	Locator Diameter w/NEMA Flange	0.866 (22.0) +0/-0.002 (+0/-0.052)		
Parameters		Max Output Torque	425 oz-in (3.0 Nm)	1062 oz-in (7.5 Nm)	2124 oz-in (15.0 Nm)
		Efficiency	80%	75%	70%
		Max Backlash	0.80°	0.85°	0.90°
Loads		Max Radial Load	36 lb-force (160 N)	52 lb-force (230 N)	67.5 lb-force (300 N)
		Max Axial Load	11 lb-force (50 N)	18 lb-force (80 N)	25 lb-force (110 N)
Weight		Gearbox Only	14.3 oz (406 gm)	17.9 oz (508 gm)	21.5 oz (609 gm)
		Gearbox w/NEMA Flange	14.8 oz (420 gm)	18.5 oz (525 gm)	22.2 oz (630 gm)

	MDrive17	Size 1713	Size 1715	Size 1719
Length Inches (mm)	L_{MAX1} Single Shaft Version	2.20 (55.9)	2.43 (61.7)	2.75 (69.8)
	L_{MAX2} Encoder or Control Knob Version	2.92 (74.2)	3.15 (80.0)	3.47 (88.1)

Planetary Gearbox Specifications for MDrive17

Dimensions in Inches (mm)

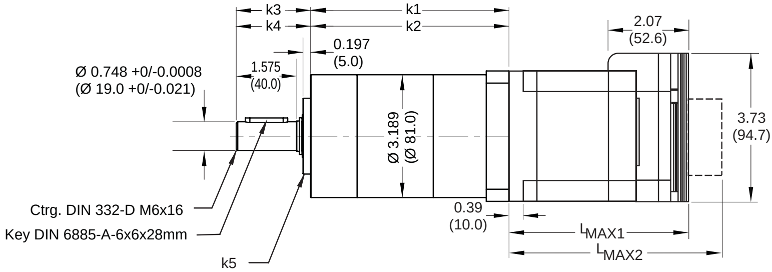


		Planetary Gearbox	1-Stage	2-Stage	3-Stage
Dimensions Inches (mm)	k1	Standard Gearbox	2.976 (75.6) ±0.02 (0.5)	3.531 (89.7) ±0.02 (0.5)	4.087 (103.8) ±0.02 (0.5)
	k2	w/NEMA Flange	3.036 (77.1) ±0.02 (0.5)	3.590 (91.2) ±0.02 (0.5)	4.146 (105.3) ±0.02 (0.5)
	k3	Standard Shaft	0.984 (25.0)		
	k4	Shaft w/NEMA Flange	0.925 (23.5)		
	k5	Standard Locator Diameter	1.260 (32.0) +0/-0.0015 (+0/-0.039)		
	k6	Locator Diameter w/NEMA Flange	1.50 (38.1) +0/-0.0015 (+0/-0.039)		
Parameters		Max Output Torque	566 oz-in (4.0 Nm)	1699 oz-in (12.0 Nm)	3540 oz-in (25.0 Nm)
		Efficiency	80%	75%	70%
		Max Backlash	0.70°	0.75°	0.80°
Loads		Max Radial Load	45 lb-force (200 N)	72 lb-force (320 N)	101 lb-force (450 N)
		Max Axial Load	13 lb-force (60 N)	22 lb-force (100 N)	34 lb-force (150 N)
Weight		Gearbox Only	25.0 oz (711 gm)	32.2 oz (914 gm)	39.4 oz (1117 gm)
		Gearbox w/NEMA Flange	25.9 oz (735 gm)	33.3 oz (945 gm)	40.7 oz (1155 gm)

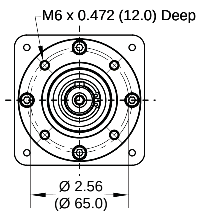
	MDrive23	Size 2218	Size 2222	Size 2231
Length Inches (mm)	L_{MAX1} Single Shaft Version	2.63 (66.8)	3.00 (76.2)	3.86 (98.0)
	L_{MAX2} Encoder or Control Knob Version	3.35 (85.1)	3.70 (94.0)	4.57 (116.1)

Planetary Gearbox Specifications for MDrive23

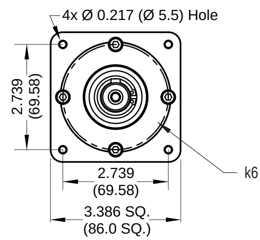
Dimensions in Inches (mm)



Front View
Planetary Gearbox



Front View
Optional NEMA 34
Output Flange for Planetary Gearbox



		Planetary Gearbox	1-Stage	2-Stage	3-Stage
Dimensions Inches (mm)	k1	Standard Gearbox	4.315 (109.6) ±0.02 (0.5)	5.169 (131.3) ±0.02 (0.5)	6.024 (153.0) ±0.02 (0.5)
	k2	w/NEMA Flange	4.433 (112.6) ±0.02 (0.5)	5.287 (134.3) ±0.02 (0.5)	6.142 (156.0) ±0.02 (0.5)
	k3	Standard Shaft	1.929 (49.0)		
	k4	Shaft w/NEMA Flange	1.811 (46.0)		
	k5	Standard Locator Diameter	1.969 (50.0) +0.0006/-0.0004 (+0.015/-0.010)		
	k6	Locator Diameter w/NEMA Flange	2.874 (73.0) +0/-0.0012 (+0/-0.030)		
Parameters		Max Output Torque	2832 oz-in (20.0 Nm)	8496 oz-in (60.0 Nm)	16992 oz-in (120.0 Nm)
		Efficiency	80%	75%	70%
		Max Backlash	1.0°	1.5°	2.0°
Loads		Max Radial Load	90 lb-force (400 N)	135 lb-force (600 N)	225 lb-force (1000 N)
		Max Axial Load	18 lb-force (80 N)	27 lb-force (120 N)	45 lb-force (200 N)
Weight		Gearbox Only	64.4 oz (1827 gm)	89.5 oz (2538 gm)	114.6 oz (3248 gm)
		Gearbox w/NEMA Flange	66.7 oz (1890 gm)	92.6 oz (2625 gm)	118.5 oz (3360 gm)

	MDrive34	Size 3424	Size 3431	Size 3447
Length Inches (mm)	L_{MAX1} Single Shaft or Encoder Version	3.81 (96.8)	4.60 (116.80)	6.17 (156.7)
	L_{MAX2} Control Knob Version	4.97 (126.2)	5.76 (146.3)	7.34 (186.4)

Planetary Gearbox Specifications for MDrive34

Available Ratios

Available Ratios for Planetary Gearbox			
Stages	Rounded Ratio	Fractional Ratio	Decimal Ratio*
1-Stage	4:1	63 / 17	3.7058823529411764
	5:1	57 / 11	5.1818181818181818
	7:1	27 / 4	6.7500000000000000
2-Stage	14:1	3969 / 289	13.7335640138408304
	16:1	270 / 17	15.8823529411764705
	18:1	900 / 49	18.3673469387755102
	19:1	3591 / 187	19.2032085561497326
	22:1	1710 / 77	22.2077922077922077
	25:1	1701 / 68	25.0147058823529411
	27:1	3249 / 121	26.8512396694215000
	29:1	405 / 14	28.9285714285714876
	35:1	1539 / 44	34.9772727272727272
	46:1	729 / 16	45.5625000000000000
3-Stage	51:1	250047 / 4913	50.8949725218807246
	59:1	17010 / 289	58.8581314878892733
	68:1	8100 / 119	68.0672268907563025
	71:1	226223 / 3179	71.1616860648002516
	79:1	27000 / 343	78.7172011661807581
	93:1	107163 / 1156	92.7015570934256055
	95:1	51300 / 539	95.1762523191094619
	100:1	204687 / 2057	99.5075352455031599
	107:1	3645 / 34	107.2058823529411764
	115:1	97470 / 847	115.0767414403778040
	124:1	6075 / 49	123.9795918367346938
	130:1	96957 / 748	129.6216577540106951
	139:1	185193 / 1331	139.1382419233658903
	150:1	23085 / 154	149.9025974025974025
	169:1	45927 / 272	168.8492647058823529
	181:1	87723 / 484	181.2458677685950413
	195:1	10935 / 56	195.2678571428571428
	236:1	41553 / 176	236.0965909090909090
	308:1	19683 / 64	307.5468750000000000

* The Decimal Ratio shown here has been limited to 16 places.

Installing a Driving Device on a Planetary Gearbox

WARNING!

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

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

DO NOT press fit the device onto the shaft.

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

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

WARRANTY

TWENTY-FOUR (24) MONTH LIMITED WARRANTY

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

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

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

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

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

OBTAINING WARRANTY SERVICE

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

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

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

INTELLIGENT MOTION SYSTEMS, INC.

Excellence in Motion™

P.O. Box 457, 370 North Main Street
Marlborough, CT 06447 U.S.A.

Phone: 860/295-6102
Fax: 860/295-6107
E-mail: info@imshome.com
Home Page: www.imshome.com

TECHNICAL SUPPORT
Eastern U.S.
Phone: 860/295-6102
Fax: 860/295-6107
E-mail: etech@imshome.com
Western U.S.
Phone: 760/966-3162
Fax: 760/966-3165
E-mail: wtech@imshome.com

IMS MOTORS DIVISION
105 Copperwood Way, Suite H
Oceanside, CA 92054
Phone: 760/966-3162
Fax: 760/966-3165
E-mail: motors@imshome.com

IMS EUROPE GmbH
Hahnstrasse 10, VS-Schwenningen
Germany D-78054
Phone: +49/7720/94138-0
Fax: +49/7720/94138-2
E-mail: info@imseuropehome.com
European Sales Management
4 Quai Des Etroits
69005 Lyon, France
Phone: +33/4 7256 5113
Fax: +33/4 7838 1537
E-mail: bmartinez@imshome.com
German Sales/Technical Support
Phone: +49/35205/4587-8
Fax: +49/35205/4587-9
E-mail: hruland@imshome.com