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Section 1
The MDrive34 Integral Motor+Driver

Section Overview

The purpose of this section is to introduce the user to the MDrive34 integrated high torque motor and microstepping driver. Covered are:

- Introduction to the Microstepping MDrive34
- Microstepping MDrive34 Features and Benefits
- Introduction to the MDrive34 Speed Control
- MDrive34 Speed Control Features and Benefits

Introduction to the Microstepping MDrive34

The MDrive34 high torque Integrated Motor and Driver is ideal for designers who want the simplicity of a motor with on-board electronics. The low cost MDrive34 allows the system designer to decide the best method of control. The MDrive’s integrated electronics eliminates the need to run the motor cabling through the machine, reducing the potential for problems due to electrical noise.

The MDrive34 uses a NEMA 34 1.8° high torque motor combined with a microstepping drive, and accepts up to 14 resolution settings from 1/2 to 256 microsteps per step. Setup parameters include Microstep Resolution, Run and Hold Currents, and Motor Direction vs. Direction Input, and can be changed on-the-fly or downloaded and stored in nonvolatile memory with the use of a simple user interface program which is provided, eliminating the need for external switches or resistors. Parameters are changed via an SPI (Serial Peripheral Interface) port located on connector P2. This port connects to the Parallel/SPI port on your PC. Operating voltage for the MDrive34 ranges from +24 to +75 VDC.

The versatile, compact MDrive34 is available in multiple configurations to fit various system needs including a single shaft stand-alone device available with an internal optical encoder, a dual shaft rotary motor with control knob for manual positioning, a planetary gearbox, and a long life Acme screw linear actuator. The rotary MDrive34 is available in three different motor lengths: 24, 31 & 47. Interface connections are accomplished using 12” (30.5cm) flying leads.

The MDrive34 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 accessed through the IMS SPI Interface which is an easy to install and use software program. The SPI Interface is included on the CD that ships with the MDrive34 or is available for download at www.imshome.com. Use of this utility and the optional 6 foot MD-CC100-000 Parameter Setup Cable is the suggested method of configuring the MDrive34 Parameters from the Parallel/SPI port of your computer. Purchase of this cable is recommended with the first order as it includes built-in logic level shifting circuitry to make the MDrive34 SPI port compatible with all PC LPT (printer) port voltage levels. The Cable Part # is MD-CC100-000.

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 Microstepping MDrive34

- Integrated Microstepping Drive/NEMA 34 High Torque Motor
- +24 to +75 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
  - Microstep Resolution to 256 Microsteps/Full Step
- Available Configurations:
  - Factory-Mounted Internal Optical Encoder
  - Rear Knob For Manual Positioning
  - Planetary Gearbox
  - Long Life Linear Actuator
- Rotary Motor Available in Three Motor Lengths: 24, 31 & 47
- Current and Resolution May Be Switched On-The-Fly
- Single Supply
- Interface Uses 12” (30.5 cm) Flying Leads
- Graphical User Interface (GUI) for Quick and Easy Parameter Setup
Introduction to the MDrive34 Speed Control

The MDrive34 Speed Control offers the system designer low cost, intelligent velocity control integrated with a NEMA 34 high torque stepping motor and a +24 to +75 volt microstepping drive.

The MDrive34 Speed Control features a digital oscillator for accurate velocity control with an output frequency of up to 100 kilohertz. Output frequency will vary with the voltage level on the speed control input. The speed control input can be adjusted by using one of the following methods:

- 0 to +5V
- 15 - 25kHz (0 to 100% duty cycle) PWM
- 4 - 20mA or 0 - 20mA applied to input
- Optional 10k Potentiometer

Step Clock and direction output signals are available with the MDrive34 Speed Control. These outputs can be used to control a second microstepping MDrive. This secondary unit will follow the speed of the speed control unit. By using this feature, wiring and controlling machines with large tables or wide conveyors requiring two motors can be simplified.

There are two speed control inputs on the MDrive34 Speed Control. SPEED1 and SPEED2. This allows the user to have two preset speeds which can be selected digitally. The MDrive34 will then accelerate/decelerate to the new value.

There are two basic modes of operation: bidirectional and unidirectional. In bidirectional mode, both speed and direction are controlled by the analog speed control input. In unidirectional mode, only velocity is controlled by the speed control input; direction is controlled by a separate digital input.

The MDrive34 Speed Control has 12 setup parameters which are configured by using the included IMS Analog Speed Control Interface. These enable the user to configure all of the operational parameters of the MDrive34 which are stored in nonvolatile memory.

The versatile, compact MDrive34 Speed Control is available in multiple configurations to fit various system needs. These options include a single shaft stand-alone device, internal optical encoder, a control knob, a planetary gearbox, and a long life Acme screw linear actuator. The MDrive34 Speed Control rotary motor versions are available in three different motor lengths: 24, 31 and 47mm. Interface connections are accomplished using 12” (30.5cm) flying leads.
**Features and Benefits of the MDrive34 Speed Control**

- Integrated Speed Control, Driver and NEMA 34 High Torque Motor
- +24 to +75 VDC Input Voltage
- Digital Oscillator for Accurate Speed Control
- Optically Isolated Inputs will Accept +5 to +24 VDC Signals, Sourcing or Sinking
- Step Clock and Direction Outputs
- Low Cost
- Extremely Compact
- Rotary Motor Available in Three Motor Lengths
- Electronically Configurable (Eliminates Potentiometers):
  - Motor Run/Hold Current
  - Acceleration/Deceleration
  - Initial and Max Velocity
  - Speed Control Input Source (SPD1/2)
  - Microstep Resolution to 256 Microsteps/Full Step
  - Motor Direction vs. Direction Input
- Available Configurations:
  - Internal Optical Encoder
  - Rear Knob for Manual Positioning
  - Planetary Gearbox
  - Long Life Linear Actuator
- Selectable Speed Control Inputs from One of Two 0 to +5VDC Inputs (One Configurable as 4-20mA or 0-20mA) or 15 to 25kHz PWM Input, all with Programmable Center Point
- Single Supply
- Interface Uses 12” (30.5 cm) Flying Leads
- Graphical User Interface (GUI) for Quick and Easy Parameter Setup

**IMS Analog Speed Control Interface Software**

The IMS Speed Control Interface Software is accessed through the IMS SPI Interface which is easy to install and use graphical user interface (GUI) for configuring the MDrive34 from the parallel/SPI port on your computer. It is required for configuring your MDrive34 Speed Control and is included on a CD with the product, or it may be downloaded at www.imshome.com.

The IMS Speed Control Interface Software 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.
SECTION 2

MDrive34 Power & Thermal Requirements

Power Supply Current Requirements

Power supply current requirements per MDrive34 is **4A** (MAX). Actual power supply current will depend upon voltage and load.

<table>
<thead>
<tr>
<th>Motor Power Supply Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended Supply Type</td>
</tr>
<tr>
<td>Ripple Voltage</td>
</tr>
<tr>
<td>Output Voltage</td>
</tr>
<tr>
<td>Output Current*</td>
</tr>
</tbody>
</table>

Table 2.1: Recommended Power Supply Specifications

A characteristic of all motors is back EMF which is a source of current that can push the output of a power supply beyond the maximum operating voltage of the driver. Damage to the stepper driver may occur. Care should be taken so that the back EMF does not exceed the maximum input voltage rating of the MDrive34.

**WARNING!** The maximum +75 VDC Input Voltage of the MDrive34 includes Motor Back EMF, Power Supply Ripple and High Line.

**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.

Recommended IMS Power Supplies

**IP804 Unregulated Linear Supply**

Input Range

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

Output

No Load Output Voltage* ..................................................... 76 VDC @ 0 Amps
Continuous Output Rating* .................................................. 65 VDC @ 2 Amps
Peak Output Rating* ............................................................. 58 VDC @ 4 Amps

**ISP300-7 Unregulated Linear Supply**

Input Range

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

Output

No Load Output Voltage* ..................................................... 68 VDC @ 0 Amps
Continuous Output Rating* .................................................. 63 VDC @ 2 Amps
Peak Output Rating* ............................................................. 59 VDC @ 4 Amps

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

Thermal Specifications

The MDrive34 consists of two core components, a drive and a motor. The thermal specifications of both the motor and the electronics must be observed.

Heat Sink Temperature - Max ................................................ 85°C
Motor Temperature - Max ..................................................... 100°C
Section Overview

This section contains mechanical, motor and electrical specifications specific to each version of the Rotary MDrive34. Shown are:

- Mechanical Specifications
- Motor Specifications
- Electrical Specifications

Mechanical Specifications
Dimensions in inches [mm]

<table>
<thead>
<tr>
<th>Single Shaft or Encoder Version (LMAX⁵)</th>
<th>Stack</th>
<th>in (mm)</th>
<th>Stack</th>
<th>in (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3424</td>
<td>3.81 (96.8)</td>
<td>3424</td>
<td>4.97 (126.2)</td>
</tr>
<tr>
<td></td>
<td>3431</td>
<td>4.60 (116.8)</td>
<td>3431</td>
<td>5.76 (146.3)</td>
</tr>
<tr>
<td></td>
<td>3447</td>
<td>6.17 (156.7)</td>
<td>3447</td>
<td>7.34 (186.4)</td>
</tr>
</tbody>
</table>

Control Knob Version (LMAX⁵)

<table>
<thead>
<tr>
<th>Stack</th>
<th>in (mm)</th>
<th>Stack</th>
<th>in (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3424</td>
<td>4.97 (126.2)</td>
<td>3424</td>
<td>4.97 (126.2)</td>
</tr>
<tr>
<td>3431</td>
<td>5.76 (146.3)</td>
<td>3431</td>
<td>5.76 (146.3)</td>
</tr>
<tr>
<td>3447</td>
<td>7.34 (186.4)</td>
<td>3447</td>
<td>7.34 (186.4)</td>
</tr>
</tbody>
</table>

Figure 3.1: MDrive34 Mechanical Specifications
Motor Specifications

NOTE! The following specifications apply to all rotary MDrive34, the standard rotary as well as the encoder and control knob versions.

MDrive3424 Motor Specifications and Speed/Torque Curves

<table>
<thead>
<tr>
<th></th>
<th>MD3424</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holding Torque oz-in (N-cm)</td>
<td>381 (269)</td>
</tr>
<tr>
<td>Detent Torque oz-in (N-cm)</td>
<td>10.9 (7.7)</td>
</tr>
<tr>
<td>Rotor Inertia oz-in-sec² (kg-cm²)</td>
<td>0.01416 (1.0)</td>
</tr>
<tr>
<td>Weight (Motor+Driver) oz (g)</td>
<td>67.4 (1909)</td>
</tr>
</tbody>
</table>

Table 3.1: MDrive3424 Motor Specifications

![Figure 3.2: MDrive3424 Speed/Torque Data (100% Current)](image)

MDrive3431 Motor Specifications and Speed/Torque Curves

<table>
<thead>
<tr>
<th></th>
<th>MD3431</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holding Torque oz-in (N-cm)</td>
<td>575 (406)</td>
</tr>
<tr>
<td>Detent Torque oz-in (N-cm)</td>
<td>14.16 (10.0)</td>
</tr>
<tr>
<td>Rotor Inertia oz-in-sec² (kg-cm²)</td>
<td>0.02266 (1.6)</td>
</tr>
<tr>
<td>Weight (Motor+Driver) oz (g)</td>
<td>92.1 (2609)</td>
</tr>
</tbody>
</table>

Table 3.2: MDrive3431 Motor Specifications
Figure 3.3: MDrive3431 Speed/Torque Data (100% Current)

**MDrive3447 Motor Specifications and Speed/Torque Curves**

<table>
<thead>
<tr>
<th></th>
<th>24 VDC</th>
<th>45 VDC</th>
<th>75 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque in Oz-In (N-cm)</td>
<td>1061 (749)</td>
<td>900 (579)</td>
<td>465 (323)</td>
</tr>
<tr>
<td>Detent Torque oz-in (N-cm)</td>
<td>19.83 (14.0)</td>
<td>10.7 (7.6)</td>
<td>5.5 (4.0)</td>
</tr>
<tr>
<td>Rotor Inertia oz-in-sec² (kg-cm²)</td>
<td>0.04815 (3.4)</td>
<td>0.02407 (1.7)</td>
<td>0.01238 (0.9)</td>
</tr>
<tr>
<td>Weight (Motor+Driver) oz (g)</td>
<td>148.5 (4209)</td>
<td>120 (336)</td>
<td>65 (182)</td>
</tr>
</tbody>
</table>

Table 3.3: MDrive3447 Motor Specifications

Figure 3.4: MDrive3447 Speed/Torque Data (100% Current)
**Electrical Specifications**

**MDrive34 Microstepping**

Input Voltage (+V) Range ........................................................... +24 to +75 VDC
Isolated Inputs .......................................................... Step Clock, Direction & Enable
Isolated Input Voltage Range (Sinking or Sourcing) .............. +5 to +24VDC
Isolated Current
  +5 Volt (Max) ................................................................. 8.7 mA
  +24 Volt (Max) ............................................................. 14.6 mA
Step Frequency (Max) .............................................................. 2 MHz
Step Frequency Minimum Pulse Width
  Sourcing (Low) ................................................................ 320 nS
  Sinking (High) .............................................................. 320 nS
Steps per Revolution .......................................................... 400, 800, 1000, 1600, 2000, 3200, 5000, 6400, 10000, 12800, 25000, 25600, 50000, 51200
Protection ................................................................. Over Voltage

**MDrive34 Speed Control**

Input Voltage ........................................................... +24 to +75 VDC
Speed Control Input 1 ........................................... 0 to +5 VDC, 0 to 20mA or 4 to 20mA
Speed Control Input 2 .............................................................. 0 to +5 VDC
A/D Resolution ................................................................. 10 bit
Speed Control Potentiometer Resistance ...................................... 10 k Ohm
Input Voltage (+V) Range ........................................................... +24 to +75 VDC
Step Clock, Direction Out (Drain Source Voltage Max) .............. 100 VDC
Step Clock, Direction Out (Continuous Drain Current) .............. 100 mA
Step Clock Output Pulse Width .............................................. 3.64µsec
Isolated Inputs .......................................................... Speed1/Speed2/PWM, Start/Stop, Direction
Isolated Input Voltage Range (Sinking or Sourcing) .............. +5 to +24 Volts
Isolated Current
  +5 Volt (Max) ................................................................. 8.7 mA
  +24 Volt (Max) ............................................................. 14.6 mA
PWM Input Frequency .............................................................. 15 to 25 kHz

**Recommended Wire Sizes**

Recommended Wire Size
  Logic Wiring ................................................................. 22 AWG
  Power and Ground ........................................ See Appendix A “Recommended Cable Configurations”

**WARNING!** The maximum +75 VDC Input Voltage of the MDrive34 includes Motor Back EMF, Power Supply Ripple and High Line.

A characteristic of all motors is back EMF which is a source of current that can push the output of a power supply beyond the maximum operating voltage of the driver. Damage to the stepper driver may occur. Care should be taken so that the back EMF does not exceed the maximum input voltage rating of the MDrive34.
Section Overview

This section contains mechanical, motor and electrical specifications specific to the Linear MDrive34. Shown are:

- Mechanical Specifications
- Motor Specifications
- Electrical Specifications

Mechanical Specifications

Dimensions in inches (mm)

![Figure 4.1: Linear Actuator MDrive34 Mechanical Specifications](image)

Table 4.1: Linear Actuator MDrive34 Motor Specifications

<table>
<thead>
<tr>
<th>MD3429 Linear Actuator</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Thrust  lbs (N)</td>
<td>500 (2224)</td>
</tr>
<tr>
<td>Maximum Screw Deflection</td>
<td>± 1°</td>
</tr>
<tr>
<td>Backlash  in (mm)</td>
<td>0.005 (0.127)</td>
</tr>
<tr>
<td>Weight (without screw) oz (g)</td>
<td>89.0 (2523)</td>
</tr>
</tbody>
</table>

WARNING: The maximum axial load limit for the MDrive34 Motor is 500 lbs (226.8 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 4.2: MDrive3429 Force/Speed Data - 24VDC (100% Current)

Figure 4.3: MDrive3429 Force/Speed Data - 48VDC (100% Current)

Figure 4.4: MDrive3429 Force/Speed Data - 75VDC (100% Current)

Table 4.2: Acme Screws for the MDrive34 Linear Actuator

<table>
<thead>
<tr>
<th>Screw</th>
<th>Travel/Full Step inches (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.005 (0.127)</td>
</tr>
<tr>
<td>B</td>
<td>0.0025 (0.0635)</td>
</tr>
<tr>
<td>C</td>
<td>0.000125 (0.03175)</td>
</tr>
<tr>
<td>D</td>
<td>0.000625 (0.015875)</td>
</tr>
<tr>
<td>E</td>
<td>0.0005 (0.0127)</td>
</tr>
</tbody>
</table>
**Electrical Specifications**

**MDrive34 Microstepping**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage (+V) Range</td>
<td>+24 to +75 VDC</td>
</tr>
<tr>
<td>Isolated Inputs</td>
<td>Step Clock, Direction &amp; Enable</td>
</tr>
<tr>
<td>Isolated Input Voltage Range (Sinking or Sourcing)</td>
<td>+5 to +24 VDC</td>
</tr>
<tr>
<td>Isolated Current</td>
<td></td>
</tr>
<tr>
<td>+5 Volt (Max)</td>
<td>8.7 mA</td>
</tr>
<tr>
<td>+24 Volt (Max)</td>
<td>14.6 mA</td>
</tr>
<tr>
<td>Step Frequency (Max)</td>
<td>2 MHz</td>
</tr>
<tr>
<td>Steps per Revolution</td>
<td>400, 800, 1000, 1600, 2000, 3200, 5000, 6400, 10000, 12800, 25000, 25600, 50000, 51200</td>
</tr>
<tr>
<td>Protection</td>
<td>Over Voltage</td>
</tr>
</tbody>
</table>

**MDrive34 Speed Control**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>+24 to +75 VDC</td>
</tr>
<tr>
<td>Speed Control Input 1</td>
<td>0 to +5 VDC, 0 to 20mA or 4 to 20mA</td>
</tr>
<tr>
<td>Speed Control Input 2</td>
<td>0 to +5 VDC</td>
</tr>
<tr>
<td>A/D Resolution</td>
<td>10 bit</td>
</tr>
<tr>
<td>Speed Control Potentiometer Resistance</td>
<td>10 k Ohm</td>
</tr>
<tr>
<td>Input Voltage (+V) Range</td>
<td>+24 to +75 VDC</td>
</tr>
<tr>
<td>Step Clock, Direction Out (Drain Source Voltage Max)</td>
<td>100 VDC</td>
</tr>
<tr>
<td>Step Clock, Direction Out (Continuous Drain Current)</td>
<td>100 mA</td>
</tr>
<tr>
<td>Step Clock Output Pulse Width</td>
<td>3.64µsec</td>
</tr>
<tr>
<td>Isolated Inputs</td>
<td>Speed1/Speed2/PWM, Start/Stop, Direction</td>
</tr>
<tr>
<td>Isolated Input Voltage Range (Sinking or Sourcing)</td>
<td>+5 to +24 Volts</td>
</tr>
<tr>
<td>Isolated Current</td>
<td></td>
</tr>
<tr>
<td>+5 Volt (Max)</td>
<td>8.7 mA</td>
</tr>
<tr>
<td>+24 Volt (Max)</td>
<td>14.6 mA</td>
</tr>
<tr>
<td>PWM Input Frequency</td>
<td>15 to 25 kHz</td>
</tr>
</tbody>
</table>

**Recommended Wire Sizes**

<table>
<thead>
<tr>
<th>Recommended Wire Size</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic Wiring</td>
<td>22 AWG</td>
</tr>
<tr>
<td>Power and Ground</td>
<td>See Appendix A “Recommended Cable Configurations”</td>
</tr>
</tbody>
</table>

**WARNING!** The maximum +75 VDC Input Voltage of the MDrive34 includes Motor Back EMF, Power Supply Ripple and High Line.

A characteristic of all motors is back EMF which is a source of current that can push the output of a power supply beyond the maximum operating voltage of the driver. Damage to the stepper driver may occur. Care should be taken so that the back EMF does not exceed the maximum input voltage rating of the MDrive34.
Section Overview

This section will acquaint the user with connecting and using the microstepping MDrive34 products. If your MDrive34 is equipped with a factory mounted encoder, also refer to Section 6: Interfacing an Encoder. Covered in this section are:

- Layout and Interface Guidelines
- Interfacing Power and Logic Inputs (Flying Leads)
- Interfacing the SPI Interface (Connector P2)

Layout and Interface Guidelines

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

Logic level cables must be shielded to reduce the chance of EMI induced noise. The shield needs to be grounded at the signal source to 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.

⚠️ 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.
Interfacing Power and Logic Inputs (Flying Leads)

![Diagram of Microstepping MDrive34 Block Diagram]

Figure 5.1: Microstepping MDrive34 Block Diagram

<table>
<thead>
<tr>
<th>Flying Lead</th>
<th>Wire Size</th>
<th>Function and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>AWG 22</td>
<td>+5 VDC Optocoupler Reference: This input is used to supply power to the isolated logic inputs. A higher voltage may be used but care must be taken to limit the current through the Optocoupler.</td>
</tr>
<tr>
<td>Orange</td>
<td>AWG 22</td>
<td>Step Clock Input: A positive going edge on this input advances the motor one increment. The size of the increment is dependant on the Microstep Resolution Setting.</td>
</tr>
<tr>
<td>Blue</td>
<td>AWG 22</td>
<td>CW/CCW Direction Input: This input changes the direction of the motor logic. A HIGH state (open) = Clockwise.</td>
</tr>
<tr>
<td>Brown</td>
<td>AWG 22</td>
<td>Enable/Disable Input: This input enables or disables the output section of the driver. A logic HIGH (open) enables the outputs. However, this input does not inhibit the Step Clock. The outputs will update by the number of clock pulses (if any) applied while the driver was disabled.</td>
</tr>
<tr>
<td>Black</td>
<td>AWG 18*</td>
<td>Power Ground (Return)</td>
</tr>
<tr>
<td>Red</td>
<td>AWG 18*</td>
<td>+V: +24 to +75 VDC</td>
</tr>
</tbody>
</table>

* For supplies 10 feet or less.

Table 5.1: Microstepping MDrive34 Lead Colors and Assignments

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

Interfacing the Microstepping Logic Inputs

Optically Isolated Logic Inputs

The Microstepping MDrive34 has 3 optically isolated logic inputs which are accessed using the flying leads. These inputs are isolated to minimize or eliminate electrical noise coupled onto the drive control signals. Each input may be configured as either sinking inputs or sourcing inputs based upon using the Optocoupler Reference (White) lead. This allows your Microstepping MDrive34 to be interfaced to a variety of controllers. These inputs are:

1] Step Clock (Orange)
2] Direction (Blue)
3] Enable (Brown)

Of these inputs, only step clock and direction are required to operate the Microstepping MDrive34.
**Sinking Configuration**

When using the inputs as sinking inputs, a reference voltage between +5 and +24VDC is connected to the Optocoupler Reference (White) lead. To maintain isolation, this power source should not be connected to the motor power source. The isolated inputs are then interfaced to a sinking output (which utilizes the same supply as the optocoupler reference input) such as a switch, open collector, or PLC output.

![Figure 5.2: Sinking Input Configuration](image)

**Sourcing Configuration**

When using the inputs as sourcing inputs, the Optocoupler Reference (White) lead will be connected to ground. To maintain isolation, this power source should not be connected to the motor power source. The isolated inputs are then sourced to between +5 to +24VDC (which utilizes the same supply as the optocoupler reference input) and interfaced using a switch, open collector, or PLC output.

![Figure 5.3: Sourcing Input Configuration](image)
Isolated Logic Input Characteristics

Step Clock (Orange)
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 upon the state of the direction input) on the step clock edge that causes the opto to be active. The size of this increment or decrement will depend on the microstep resolution setting.

Direction (Blue)
The direction input controls the CW/CCW direction of the motor. May be configured as sinking or sourcing based upon the state of the Optocoupler Reference.

The CW/CCW rotation, based upon the state of the input may be set using the IMS Motor Interface software included with the MDrive34. See Section 6 of this document.

Enable (Brown)
This input can be used to enable or disable the driver output circuitry. Leaving the enable switch open for sinking or sourcing configuration (see the figures on the previous page) the driver outputs will be enabled and step clock pulses will cause the motor to advance. When this input switch is closed in both sinking and sourcing configurations, 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 MDrive34.

This input is asynchronous to any other input and may be changed at any time.

Input Timing
The direction input and the microstep resolution inputs are internally synchronized to the positive going edge of the step clock input. When a step clock transitions from low to high on the positive going edge, the state of the direction input and microstep resolution settings are latched. Any changes made to the direction and/or microstep resolution will occur on the rising edge of the step clock pulse following this change.

Run and Hold Current changes are updated immediately.

Table below lists the timing specifications.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Input</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Pulse Width</td>
<td>Step Clock</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sourcing</td>
<td>High: 320 ns, Low: –</td>
</tr>
<tr>
<td></td>
<td>Sinking</td>
<td>320 ns</td>
</tr>
<tr>
<td>Maximum Frequency</td>
<td>Step Clock</td>
<td>2.0 MHz</td>
</tr>
</tbody>
</table>

Table 5.2: Logic Input Timing
Interface Options

Open Collector Interface

![Open Collector Interface Diagram]

Figure 5.4: Open Collector Interface

Switch Interface

![Switch Interface Diagram]

Figure 5.5: Switch Interface
Interfacing the MDrive34 SPI Interface (Connector P2)

The MDrive’s SPI communications connector is a 10 pin IDC header. The recommended means of connecting to the header is with the 6 foot (1.8m) Parameter Setup Cable MD-CC100-000. The setup cable eliminates the need for the user to wire communications to the MDrive. In addition to offering ease of connection, this cable features a built-in logic level shifter for PC’s that run on 3.3V output ports. This cable plugs in easily to connect a standard DB-25 PC Parallel/SPI port to the MDrive’s 10 pin pin-header (P2).

![Figure 5.6: Parameter Setup Cable for MDrive 34](image)

**WARNING!** The +5VDC output on connector P2 is used for the setup cable ONLY! This output 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)

Try the SPI connection using the default parallel port setting first. If necessary, the Parallel/SPI port may be configured in the bios of your PC.

![Figure 5.7: SPI Interface Wiring and Connections](image)

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Pin Name</th>
<th>Wire Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N/C</td>
<td>AWG 22</td>
<td>No Connect</td>
</tr>
<tr>
<td>2</td>
<td>N/C</td>
<td>AWG 22</td>
<td>No Connect</td>
</tr>
<tr>
<td>3</td>
<td>N/C</td>
<td>AWG 22</td>
<td>No Connect</td>
</tr>
<tr>
<td>4</td>
<td>CS</td>
<td>AWG 22</td>
<td>Chip Select</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>AWG 22</td>
<td>Communications Ground</td>
</tr>
<tr>
<td>6</td>
<td>+5 VDC</td>
<td>AWG 22</td>
<td>+5 VDC Output (See Warning Below)</td>
</tr>
<tr>
<td>7</td>
<td>MOSI</td>
<td>AWG 22</td>
<td>Master Out/Slave In</td>
</tr>
<tr>
<td>8</td>
<td>CLK</td>
<td>AWG 22</td>
<td>Clock</td>
</tr>
<tr>
<td>9</td>
<td>N/C</td>
<td>AWG 22</td>
<td>No Connect</td>
</tr>
<tr>
<td>10</td>
<td>MISO</td>
<td>AWG 22</td>
<td>Master In/Slave Out</td>
</tr>
</tbody>
</table>

![Table 5.3: P2 Pin Assignment and Description](image)
Minimum Required Connections

The connections shown are the minimum required to operate the Microstepping MDrive34.

* MD-CC100-000 cable or equivalent required only when setting up or changing parameters.

Figure 5.8: SPI Logic Level Shifting and Conditioning Schematic

NOTE: If making your own parameter setup cable, be advised the 3.3V output parallel ports on some laptop PC’s may not be sufficient to communicate with the device without use of a logic level shifting and conditioning Interface.

Figure 5.9: Minimum Required Connections
Securing MDrive34 Power & Encoder Leads

Some applications may require that the MDrive34 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 MDrive34 electronics and the Encoder. DO NOT bundle the Logic Leads or Optional Encoder Leads with the MDrive34 Power Leads.

*Figure 5.10: Secured Power, Logic and Encoder Leads on MDrive34*
Section 6

Interfacing An Encoder

Section Overview

This section will cover interfacing the Internal Optical Encoder version of both the Microstepping MDrive34 and the MDrive34 Speed Control. Included are the lead configurations for both the single-end and differential models.

Note that this encoder is internally mounted. The footprint of the encoder version is the same as the standard MDrive34. Interfacing is accomplished via flying leads.

Factory-Mounted Encoder

The MDrive34 is available with a factory-mounted internal 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, 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.

Lead Configuration

The encoder has the following lead configurations:

Single-End Encoder

- Yellow/Black - Ground
- Yellow/Violet - Index
- Yellow/Blue - Channel A
- Yellow/Red - +5 VDC Input
- Yellow/Brown - Channel B

Differential Encoder

- Yellow/Black - Ground
- Yellow/Violet - Index +
- Yellow/Blue - Channel A+
- Yellow/Red - +5 VDC Input
- Yellow/Brown - Channel B+
- Yellow/Gray - Index –
- Yellow/Green - Channel A–
- Yellow/Orange - Channel B–

NOTE: Wire and insulation type are subject to the user’s application and environment.
SECTION 7

Configuring The Microstepping MDrive34

Section Overview

This section is specific to all MDrive34 Microstepping versions. For the MDrive34 Speed Control version refer to Section 9 for configuration details. This section will acquaint the user with the following:

- The IMS Motor Interface
- Installing the IMS SPI Interface
- The IMS Motor Interface Configuration Utility
- Configuration Parameters

The IMS Motor Interface Software

The IMS Motor Interface Software is accessed through the IMS SPI Interface which is an easy to install and use software program. Use of this utility and the optional MD-CC100-000 Parameter Setup Cable (See Section 5) is the suggested method of configuring the MDrive34. The SPI Interface is included on the CD that ships with the MDrive or is available for download at www.imshome.com. This utility features the following:

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

Installing the IMS SPI Interface Software

NOTE: If you have previously installed the IMS SPI Interface Software, IMS recommends that you install the latest version which is backward compatible and ensures compatibility with the latest MDrives.

System Requirements

- A Pentium Class or Higher IBM Compatible PC.
- Windows 9x (95/98) or Windows NT (Windows NT4.0 SP6, Windows 2000 SP1, Windows XP).
- 10 MB hard drive space.
- A free parallel communications port.

Installation

Insert the IMS Product CD into your CD-ROM Drive. The CD should autostart to the IMS Main Index Page. If the CD does not autostart, click “Start > Run” and type “x:\IMS.exe” in the “Open” box and click OK.

NOTE: “x” is your CD ROM drive letter.
1) After the CD starts, the IMS Main Index Page will be displayed.

![Figure 7.1: The IMS CD Main Index Page](image)

2) Place your mouse pointer over the MDrive Icon. The Icon will be highlighted and the text message “MDrive Integrated Motor & Electronics” will be displayed. This verifies you have selected the correct software.

3) Click the MDrive Motor Icon. This opens the MDrive Software Selection Page.

![Figure 7.2: The IMS CD Software Selection Page](image)

4) Place the mouse pointer over the menu and select SPI Interface (Win9x) or SPI Interface (WinNT). The displayed text will again verify your selection. Click your selection and the “Setup” dialog box will be displayed.

![Figure 7.3: The SPI Setup Dialog Box](image)

5) Click SETUP in the Setup dialog box and follow the on-screen instructions.

Once the SPI Interface is installed and started the Communications Settings will be set automatically.
**Startup**

Select “Start>Programs>IMS SPI Interface>IMS SPI Interface”. The IMS Motor Interface will automatically scan your LPT ports for the connected MDrive and configure the communications. The connection status and port are displayed at the bottom of the configuration screen. The Version Number of the Firmware in your MDrive will also be displayed at the top of the configuration utility as shown below.

**The IMS Motor Interface GUI Configuration Utility**

The IMS Motor Interface GUI (Graphical User Interface) simplifies use with a single screen interface for configuring the MDrive34. All of the parameters and commands are controlled from this single screen.

The designation for the MDrive34 Microstepping is MDMF.

*MDMF - MDrive Microstepping with Flying Leads.*

![Figure 7.4: Typical GUI for MDrive34](image)

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 7.5: Changing the Parameter Settings

Returning to Factory Defaults

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

Figure 7.6: Returning to Factory Defaults

If a fault occurs it will be displayed in the Fault window. If more than one fault occurs each one will be displayed with the + (plus sign) between them. The Table below lists the faults and the characters displayed for each.

<table>
<thead>
<tr>
<th>Binary Code*</th>
<th>Display</th>
<th>Fault Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
<td>No Fault</td>
</tr>
<tr>
<td>4</td>
<td>CS</td>
<td>SPI Write to Settings Check Sum</td>
</tr>
<tr>
<td>8</td>
<td>CS</td>
<td>SPI Write to Defaults Check Sum</td>
</tr>
<tr>
<td>16</td>
<td>DFLT</td>
<td>Defaults Check Sum</td>
</tr>
<tr>
<td>32</td>
<td>DATA</td>
<td>EEPROM Check Sum Fault</td>
</tr>
</tbody>
</table>

*NOTE: All fault codes are "OR"ed together.

Table 7.1: Fault Indication
Description of the Faults

NONE
No Faults exist in the MDrive

CS - SPI Write Check Sum
Check Sum indicates an error or problem with the last transmission of data to the MDrive. A RECALL will clear the fault and the screen will display the stored parameters.

DFLT & DATA
These faults indicate a Driver failure. Contact the factory.

Configuration Parameters

There are 4 configuration parameters for the MDrive34. Parameter settings are automatically saved to memory when the “SET” button is clicked on the IMS Motor Interface screen. These parameters may all be changed on-the-fly.

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

<table>
<thead>
<tr>
<th>NAME</th>
<th>FUNCTION</th>
<th>RANGE</th>
<th>UNITS</th>
<th>DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHC</td>
<td>Hold Current</td>
<td>0 to 100</td>
<td>percent</td>
<td>5</td>
</tr>
<tr>
<td>MRC</td>
<td>Run Current</td>
<td>1 to 100</td>
<td>percent</td>
<td>25</td>
</tr>
<tr>
<td>MSEL</td>
<td>Microstep Resolution</td>
<td>2, 4, 5, 8, 10, 16, 25, 32, 50, 64, 125, 128, 250, 256</td>
<td>µsteps per step</td>
<td>256</td>
</tr>
<tr>
<td>DIR</td>
<td>Motor Direction Override</td>
<td>0/1</td>
<td>–</td>
<td>CW</td>
</tr>
</tbody>
</table>

Table 7.2: 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 hold current setting becomes active 200ms following the last step clock pulse.

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 MDrive34 driver section.

Microstep Resolution Select (MSEL)

The MSEL parameter specifies the microstep resolution of the MDrive34. See the Table on the following page for valid MSEL parameter settings.

Motor Direction Override (DIR)

The DIR parameter changes the motor direction relative to the direction input signal, adapting the direction of the MDrive to operate as your system expects.
**Microselect Values**

<table>
<thead>
<tr>
<th>MDrive Microstep Resolution Settings (MSELL)</th>
<th>Steps/Rev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Binary Microstep Resolution Settings</strong></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>4</td>
<td>800</td>
</tr>
<tr>
<td>8</td>
<td>1,600</td>
</tr>
<tr>
<td>16</td>
<td>3,200</td>
</tr>
<tr>
<td>32</td>
<td>6,400</td>
</tr>
<tr>
<td>64</td>
<td>12,800</td>
</tr>
<tr>
<td>128</td>
<td>25,600</td>
</tr>
<tr>
<td>256</td>
<td>51,200</td>
</tr>
</tbody>
</table>

| **Decimal Microstep Resolution Settings** |
| 5   | 1,000 |
| 10  | 2,000 |
| 25  | 5,000 |
| 50  | 10,000|
| 125 | 25,000|
| 250 | 50,000|

*Table 7.3: Microstep Resolution Settings*

**Configuring the MDrive34 With User Defined SPI**

The MDrive34 may be configured and operated through the end user’s SPI interface without using the previously discussed IMS Motor Interface GUI (see the beginning of this section) or the optional Parameter Setup Cable (see Section 5).

If the optional cable is not being used you will need to make one using the diagram (SPI Interface Wiring and Connections) shown in Section 5 of this document for MDrive34.

**Timing Notes**

1) MSb (most significant bit) and MSB (most significant byte) first
2) 8 bit bytes
3) 25kHz SCK
4) Data In (MOSI) on rising clock
5) Data Out (MISO) on falling clock
## SPI Commands

### SPI Commands and Parameters

<table>
<thead>
<tr>
<th>CMD/PRM</th>
<th>HEX</th>
<th>RANGE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WRITE ALL</strong></td>
<td>0x80</td>
<td>------</td>
<td>Writes the hex value to the following parameters</td>
</tr>
<tr>
<td><strong>READ ALL</strong></td>
<td>0x40</td>
<td>------</td>
<td>Reads the hex value of all parameters</td>
</tr>
</tbody>
</table>

### Data READ

| *M* | 0x4D | ------ | M Character precedes every READ |
| **Version_MSB** | 0x10 | <1-8><0-9> | Firmware Version Subversion, eg 1.0 |
| **Version_LSB** | 0x00 | <0-99> | Firmware Version Appends to Version mSB, eg .00 |
| **USR_ID1** | 0x49 | ------ | Upper Case Letter < I > |
| **USR_ID2** | 0x4D | ------ | Upper Case Letter < M > |
| **MRC** | 0x19 | 1-100% | Motor Run Current |
| **MHC** | 0x05 | 0-100% | Motor Hold Current |
| **MSEL** | 0x00 | 0*, 2-250 | Microstep Resolution |
| **DIR** | 0x00 | 0/1 | 1 Complements Hardware Direction |
| **DFLT_MRC** | 0x19 | 1-100% | Default Motor Run Current |
| **DFLT_MHC** | 0x05 | 0-100% | Default Motor Hold Current |
| **DFLT_MSEL** | 0x00 | 0*, 2-250 | Default Microstep Resolution |
| **DFLT_DIR** | 0x00 | 0/1 | Default Direction Override |
| **FAULT** | 0x00 | ------ | (See Fault Table) |

### DATA WRITE

| **MRC** | 0x19 | 1-100% | Motor Run Current |
| **MHC** | 0x05 | 0-100% | Motor Hold Current |
| **MSEL** | 0x00 | 0*, 2-250 | Microstep Resolution |
| **DIR** | 0x00 | 0/1 | 1 Complements Hardware Direction |
| **CKSUM** | 0x62 | ------ | 2s Complement of all WRITES including Command |

### Notes
- The READ and WRITE commands in shaded areas apply only to Firmware Versions <2.0.00. All of the Commands apply to Firmware Versions ≥ 2.0.00, <3.00.00.
- *Zero (0) = 256 Microsteps Resolution.

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

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

Try the SPI connection using the default parallel port setting first. If necessary, the Parallel/SPI port may be configured in the bios of your PC.

---

Table 7.4: Microstepping MDrive34 SPI Command Summary
**SPI Read/Write Example**

**READ ALL**

MOSI: 40 FF FF FF FF FF FF FF FF FF FF

MISO: XX 4D 10 00 49 4D 53 19 05 00 00 00 00

**WRITE ALL**

MOSI: 80 19 05 00 00 62

MISO: XX FF FF FF FF FF

---

Figure 7.7: SPI Read/Write Examples

---

**Check Sum Calculation for SPI**

The values in the example above are 8-bit binary hexadecimal conversions for the following SPI parameters: MRC=25%, MHC=5%, MSEL=256.

The Check Sum is calculated as follows:

\[ \text{Sum} = 80 + 19 + 05 + 00 + 00 = 9E \]

1's complement = 1110 1111 1111 1111 1111 1111 1111 1111

2's complement = 0110 0001

Send the check sum value of 62

Note: 80 is always the first command on a write.

Note: Once a write is performed, a read needs to be performed to see if there is a fault. The fault is the last byte of the read.
Figure 7.8: SPI Waveforms & Timing Diagram
Section Overview

This section covers the hardware interface of the MDrive34 versions with integrated speed control electronics. Refer to Section 9 for parameter setup and configuration. Covered in the section are:

- Layout and Interface Guidelines
- Interfacing Power and Speed Control Inputs (Flying Leads)
- Interfacing the SPI Interface (Connector P2)

Layout and Interface Guidelines

Logic level cables must not run parallel to power cables. Power cables will introduce noise into the logic level cables and make your system unreliable. Logic level cables must be shielded to reduce the chance of EMI induced noise. The shield needs to be grounded at the signal source to 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 driver need to be twisted. If more than one MDrive34 is to be connected to the same power supply, run separate power and ground leads from the supply to each MDrive34.

Interfacing Power and Speed Control Inputs (Flying Leads)

![Diagram](image)

Figure 8.1: MDrive34 Speed Control Block Diagram
The MDrive34 Speed Control has 3 logic inputs. These inputs control the ON/OFF state of the internal clock pulse generator, direction of motor rotation, select the active speed control input, or provide a PWM input. Each input is optically isolated and may be configured as sinking or sourcing and can be controlled using a +5 to +24 VDC level.

1] Start/Stop (Violet)
2] Direction (Blue)
3] Speed 1/2 or PWM (White/Brown)

There are also four connections used for connecting an analog speed control device such as a 10k potentiometer or a joystick. These are:

1] Speed Control Input 1 (Green)
2] Speed Control Input 2 (White/Green)
3] +5V Output (Yellow)
4] Logic Ground (Gray)

The Speed Control inputs may also be interfaced to a 4 - 20mA or 0-20mA output analog device (Speed 1 ONLY). If a 4 - 20mA or 0-20mA device is used the corresponding input mode MUST be selected on the Analog Speed Control Interface software.

The two figures on the following page illustrate interface options for the Speed Control version of the MDrive34.
Figure 8.2: Interfacing the Speed Control Using Switches and a Potentiometer — Sinking Configuration

*MD-CC100-000 cable or equivalent required only when setting up or changing parameters.
† Example Part: 10k ohm, 1/2 W potentiometer such as the Bourns 53AAA-B28-B15 is available from Digi-Key No. 53AAA-B28-B15-ND or Newark Electronics No. 90F6563.

Figure 8.3: Interfacing the Speed Control Using a PWM Output and a PLC — Sourcing Configuration

*MD-CC100-000 cable or equivalent required only when setting up or changing parameters.
**Input Characteristics**

**Start/Stop Input [Violet]**

When the start/stop switch is open sinking or sourcing, the internal step clock generator will be off. When the switch is closed sourcing or sinking, the internal step clock oscillator will be enabled.

**Direction [Blue]**

The direction input controls the CW/CCW direction of the motor. May be configured as sinking or sourcing based upon the state of the Optocoupler Reference.

The CW/CCW rotation, based upon the state of the input, may be set using the IMS Speed Control Interface software included with the MDrive34. See Section 9 of this document.

![NOTE: The physical direction of the motor with respect to the direction input will depend upon the CW/CCW Setting in the Speed Control Interface Software.]

**Speed 1/2 Select — PWM Input [White/Brown]**

This input is used to select which speed control input (Speed 1 or 2) is used to control the velocity of the axis if the device is in voltage mode. If PWM Mode is selected in the Speed Control Interface software, then this input will be a 15 to 25 kHz PWM Input and is the input by which the internal step clock frequency, hence the velocity of the motor, is controlled.

When the circuit is closed, the velocity of the axis will be controlled by Speed Control Input #1. When the circuit is open, velocity will be controlled Speed Control Input #2.

Configure as either sinking or sourcing, based upon the state of the Optocoupler Reference.

**Speed Control Input 1 [Green]**

The Speed Control Input is the input by which the internal step clock frequency, hence the velocity of the motor, is controlled.

This 0 - +5 volt analog input may be interfaced using an optional 10k potentiometer (see the previous figure “Interfacing the Speed Control using Switches and a Potentiometer”), a joystick wiper, or a 4 - 20 mA / 0 - 20mA analog output. If a constant velocity is desired, the speed control input can be connected directly to the +5VDC output and the desired velocity set using the VM parameter. When the input is 1 count greater than DB (value of the potentiometer deadband parameter) the step clock frequency will begin at the value specified by the initial velocity (VI) parameter. When at FS (the value specified by the full scale parameter), it will be at the value specified by the maximum velocity (VM) parameter. See Setting the Initial/Maximum Velocity in Section 8, for more details.
**Speed Control Input 2 (White/Green)**

The Speed Control Input is the input by which the internal step clock frequency, hence the velocity of the motor, is controlled.

This 0 - 5 volt analog input may be interfaced using a 10kΩ potentiometer (see the previous figure “Interfacing the Speed Control using Switches and a Potentiometer”), or a joystick wiper. If a constant velocity is desired, the speed control input can be connected directly to the +5VDC output and the desired velocity set using the VM parameter. When the input is 1 count greater than DB (value of the potentiometer deadband parameter) the step clock frequency will begin at the value specified by the initial velocity (VI) parameter. When at FS (the value specified by the full scale parameter), it will be at the value specified by the maximum velocity (VM) parameter. See Setting the Initial/Maximum Velocity in Section 9, for more details.

**Example Potentiometer**

Bourns 53AAA-B28-B15. This is available from Digikey (P/N 53AAA-B28-B15-ND) and Newark Electronics (Stock No. 90F6563).

**WARNING:** The +5 VDC Output (P1:4) is intended to control velocity **ONLY**! It is not to be used to power external devices!
Interfacing the Speed Control Outputs

The MDrive34 Speed Control features two logic outputs, Step Clock and CW/CCW Direction. This enables the user to cascade additional drives which will follow the master MDrive.

**Step Clock (White/Orange)**

The Step Clock output is buffered through an open-drain N-channel FET. This output will follow the step clock signal used internally to step the speed control motor.

**Note:** The Step Clock Output pulse width is 3.64 Microseconds.

**Direction Output (White/Blue)**

The Direction output is buffered through an open-drain N-channel FET. This output will follow the direction signal used internally to control the direction of the speed control motor.

![Figure 8.4: Controlling Speed and Direction on a Second MDrive](image-url)
Interfacing the MDrive34 SPI Interface
(Connector P2)

The MDrive’s SPI communications connector is a 10 pin IDC header. The recommended means of connecting to the header is with the 6 foot (1.8m) Parameter Setup Cable MD-CC100-000. The setup cable eliminates the need for the user to wire communications to the MDrive. In addition to offering ease of connection, this cable features a built-in logic level shifter for PC’s that run on 3.3V output ports. This cable plugs in easily to connect a standard DB-25 PC Parallel/SPI port to the MDrive’s 10 pin pin-header (P2).

Figure 8.5: Parameter Setup Cable for MDrive 34

<table>
<thead>
<tr>
<th>MDrive Connector P2 (SPI Interface)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin #</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

Table 8.2: P2 Pin Assignment and Description

WARNING! The +5VDC output on connector P2 is used for the setup cable ONLY! This output 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)

Try the SPI connection using the default parallel port setting first. If necessary, the Parallel/SPI port may be configured in the bios of your PC.

Figure 8.6: SPI Interface Wiring and Connections
Securing MDrive34 Power & Encoder Leads

Some applications may require that the MDrive34 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 MDrive34 electronics and the Encoder. DO NOT bundle the Logic Leads or Optional Encoder Leads with the MDrive34 Power Leads.

NOTE: If making your own parameter setup cable, be advised the 3.3V output parallel ports on some laptop PC’s may not be sufficient to communicate with the device without use of a logic level shifting and conditioning interface.
Section Overview

This section applies only to the MDrive34 Speed Control. The software utility is the only method for configuring your MDrive34 Speed Control. This section will acquaint the user with the following:

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

The IMS Analog Speed Control Utility

The IMS Analog Speed Control is accessed through the IMS SPI Interface which is an easy to install and use software program. Use of this utility and the optional 6 foot MD-CC100-000 Parameter Setup Cable is the suggested method of configuring the MDrive34 Speed Control. The SPI Interface is included on the CD that ships with the MDrive or is available for download at www.imshome.com.

Installing the IMS SPI Interface Software

**NOTE:** IMS recommends that you install the latest version of the SPI Interface which is backward compatible and ensures compatibility with the latest MDrives.

**System Requirements**

- A Pentium Class or Higher IBM Compatible PC.
- Windows 9x (95/98) or Windows NT (Windows NT4.0 SP6, Windows 2000 SP1, Windows XP).
- 10 MB hard drive space.
- A free parallel communications port.

**Installation**

Please refer to Section 7 “Installing the IMS SPI Interface Software” and follow steps 1 through 5.
Start-up

Select “Start>Programs>Analogue Speed Control>Analogue Speed Control”. The configuration utility will automatically scan your LPT ports for the connected MDrive and configure communications. The connection status and port are displayed at the bottom of the configuration screen as shown below.

![Connection Status & Port](image)

**Figure 9.1: Speed Control Configuration Utility Screen**

Configuration Parameters Explained

There are 12 configuration parameters for the MDrive. Parameter settings are automatically saved to memory when the “SET” button is clicked on the configuration utility screen.

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
<th>Range</th>
<th>Units</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Joystick Center Position</td>
<td>0 to 1022 (0.005 to 4.995)</td>
<td>Counts (Volts)</td>
<td>0 (0.000)</td>
</tr>
<tr>
<td>DB</td>
<td>Potentiometer/Joystick Deadband</td>
<td>0 to 255 (0.000 to 1.245)</td>
<td>Counts (Volts)</td>
<td>1 (0.005)</td>
</tr>
<tr>
<td>DCLT</td>
<td>Deceleration Type</td>
<td>Decelerate/Do Not Decelerate</td>
<td>–</td>
<td>Decel</td>
</tr>
<tr>
<td>IMODE</td>
<td>Source</td>
<td>Speed A1/A2/PWM</td>
<td>–</td>
<td>Speed A1/A2</td>
</tr>
<tr>
<td></td>
<td>Analog Input</td>
<td>Volts/0-20mA/4-20mA</td>
<td>–</td>
<td>Volts</td>
</tr>
<tr>
<td>MSEL</td>
<td>Resolution Select Parameter</td>
<td>See Table</td>
<td>per step divisor</td>
<td>256</td>
</tr>
<tr>
<td>FS</td>
<td>Full Scale of the Potentiometer/Joystick</td>
<td>1 to 1023 (0.005 to 4.995)</td>
<td>Counts (Volts)</td>
<td>1023 (4.995)</td>
</tr>
<tr>
<td>MHC</td>
<td>Motor Holding Current</td>
<td>0 - 100</td>
<td>Percent</td>
<td>5</td>
</tr>
<tr>
<td>MRC</td>
<td>Motor Run Current</td>
<td>1 - 100</td>
<td>Percent</td>
<td>25</td>
</tr>
<tr>
<td>VI</td>
<td>Initial Velocity</td>
<td>1-1000000</td>
<td>Steps/sec.</td>
<td>400</td>
</tr>
<tr>
<td>VM</td>
<td>Maximum Velocity</td>
<td>1-1000000</td>
<td>Steps/sec.</td>
<td>20000</td>
</tr>
</tbody>
</table>

**Table 9.1: Speed Control Parameter Summary**
**Acceleration (ACCL)**

The ACCL parameter sets the acceleration and deceleration in steps per second^2.

**Joystick Center Position (C)**

The parameter sets the center position of the joystick. It can be set by two methods. Using method one the user will manually enter a value between 0 (default) and 1022 into the parameter box. This count will represent the voltage that the MDrive34 Speed Control will interpret as the zero-reference position. Any voltage seen on the speed control input will accelerate from 0 to the maximum set velocity. The second method is to select Analog>Initialize from the menu bar of the configuration utility. Move the joystick or rotate the pot to the end of travel in both directions, move or rotate the input device to the desired center and click the “Accept” button. See the setup procedure located in “Setting the Configuration Parameters”, the next subsection of this document.

**Potentiometer Deadband (DB)**

The DB parameter sets the deadband of the potentiometer. The range for this parameter is a relative term as the actual deadband value is based upon the settings of the VI and VM parameters. The deadband is the amount of deflection seen on the potentiometer until the velocity is changed. With DB=1 it is possible that the motor will oscillate between two velocities. This can be eliminated by setting the deadband to a higher value.

Note that when the voltage seen at the speed control input is ≤ 0.005V, the step clock output of the oscillator will be 0. When the potentiometer or joystick deflects to the level specified by the DB parameter the axis will start to accelerate, beginning at the velocity specified by the VI or initial velocity parameter.

**Deceleration Type (DCLT)**

This parameter sets the motor deceleration to an ON/OFF state. If Decel is selected on the speed control utility, the motor will decelerate to stop at the rate specified by the ACCL parameter. If No Decel is selected, the motor will hard stop.

**Input Mode (IMODE)**

There are three conditions for the Input Mode Parameter. This parameter specifies the input mode for the speed control. These conditions are:

1] Source

This selects the input source for the speed control, either A1/A2 which will sense the speed control inputs, or PWM which will select the PWM input.
2] Analog Input
This condition specifies whether the speed control inputs will be in voltage mode (0-5V) or current mode (4-20mA/0-20mA).

3] CW/CCW Direction
This selects the direction of motor rotation.

**Full Scale (FS)**
The full scale parameter sets the deflection of the potentiometer or joystick. While the min/max range of the speed control input is 0 to 1023 counts (0.005 to 4.995 volts) (0 counts = no motion, 1023 counts = max velocity, or VM) the user has the option of setting the full scale to a different value. For instance, setting FS=500 counts (2.411 volts) will cause the MDrive34’s oscillator to output the appropriate step clock frequency set for VM when the voltage on the speed control input is 2.411V.

**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 will disable when the hold current setting becomes active. The hold current setting becomes active 200ms following the last step clock pulse.

**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.

**Microstep Resolution Select (MSEL)**
The MSEL parameter specifies the microstep resolution of the MDrive34 Speed Control. See table at right for valid MSEL parameter settings.

**Velocity Range (RANGE)**
The RANGE parameter specifies the maximum ranges available for the initial velocity (VI) and the maximum velocity (VM). When the range is set to a value, the VI and VM parameters will automatically default to the value specified by the range setting. The value of VI and VM can then be set within the range specified by RANGE. The table above illustrates the range settings.

<table>
<thead>
<tr>
<th>MSEL Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSEL</td>
</tr>
<tr>
<td>Binary MSEL Settings</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td>32</td>
</tr>
<tr>
<td>64</td>
</tr>
<tr>
<td>128</td>
</tr>
<tr>
<td>256</td>
</tr>
<tr>
<td>Decimal MSEL Settings</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>125</td>
</tr>
<tr>
<td>250</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RANGE PARAMETER SETTINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANGE</td>
</tr>
<tr>
<td>VI</td>
</tr>
<tr>
<td>VM</td>
</tr>
</tbody>
</table>

*Table 9.2: MSEL Parameter Settings*  
*Table 9.3: RANGE Parameter Settings*
**Initial Velocity (VI)**
The VI parameter establishes the initial velocity of the controlled axis in steps per second. The setting of this parameter represents the slowest speed the motor will turn. This is the velocity of the axis when the voltage on the speed control input = 0V. The valid settings for VI is dependent on the RANGE setting.

**Maximum Velocity (VM)**
The VM parameter establishes the maximum velocity of the controlled axis in steps per second. The setting of this parameter represents the highest speed that the motor will turn. This is the velocity of the axis when the voltage on the speed control input = 5V. The valid setting for VM is dependent on the RANGE setting.

---

**Setting the Configuration Parameters**

In order to follow the procedures set forth in this subsection, the following is necessary:

- The 6 foot Parameter Setup Cable (MD-CC100-000) or equivalent must be connected between your PC Parallel (Printer) Port and the 10 pin IDC connector (P2) on the MDrive34.
- The Analog Speed Control configuration utility must be installed and operating on your PC. Correct connection of the device and operation of the software will be indicated by a “Connected - LPTx” message at the bottom of the configuration screen.
- The Stop/Start input must be in a HIGH (Disconnected, Stopped) state.

**Configuring the MDrive34 Speed Control for Unidirectional Operation**

When operating as a unidirectional device, the internal clock pulse generator will output step clock pulses to the MDrive34 Speed Control’s driver section. The initial and maximum frequency of these pulses, and the rate which they accelerate between these values, is established by the following four parameters:

1] Initial Velocity (VI)
2] Maximum Velocity (VM)
3] Acceleration (ACCL)
4] Velocity Range (RANGE)

Set the Run Current (MRC) and Holding Current (MHC) to the desired value. The changed parameters will appear in blue. After making changes they will not take affect until the “Set” button is clicked.

When using the MDrive34 Speed Control in velocity mode the settings for FS, C and DB will likely be left in their default state. These three parameters may be displayed as either counts or volts. The displayed value is changed by clicking the “Cts” to the right of the parameter’s text box. It may be changed from volts back to counts by clicking “volts”.

---

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Illegal Parameters

When certain parameters such as the Range is changed, other parameters adopt different min/max values. If a parameter is illegal it will be displayed in red. To determine a legal parameter value place your mouse pointer over the parameter in question. A “Tool Tips” dialog will appear and show the legal range of that parameter. **NOTE:** The Tool Tips are always functional.
Returning to the Default Parameters

To return to the Default Parameters, click the “Defaults” button and then click the “Set” button.

Figure 9.4: Returning to Default Parameters

If the motor oscillates between frequencies, increase the potentiometer deadband (DB). If desired, these may be changed. For example: setting the FS parameter to 511 would configure the MDrive34 Speed Control such that it will be at maximum velocity when the potentiometer is at 1/2 of its full deflection.

Test the settings by pulling the Stop/Start input to ground by means of a switch or sinking output. Turn the potentiometer between its stops, the motor should accelerate and decelerate between the VI and VM settings. Note that there will be no motion at the zero reference point of the potentiometer. The motion will not start until the speed control input sees the voltage equivalent of 0 + DB.

Fine-tune the ACCL, VI, VM and RANGE settings to the requirements of your application. Clicking the “Set” button saves the parameter settings to nonvolatile memory.
When setting the MDrive34 Speed Control for bidirectional operation, it is necessary that the joystick or pot be calibrated. First, a center position must be established, as well as the full scale range of the input device in two directions. The following steps outline the calibration procedures.

1] With the input device in the center position, click “Analog=Initialize” on the menu bar.
2] Move the input device to its full scale position, first in the max direction, then in the min direction. Re-center the input device.
3] Click the “Accept” button.
4] Set the other parameters to the desired value.
5] Click the “Set” button to save the parameter settings to non-volatile memory.

---

![Figure 9.5: Initialization Mode](image-url1)

![Figure 9.6: Accepting the Analog Initialization Values](image-url2)
If a fault occurs it will be displayed in the Fault window. If more than one fault occurs each one will be displayed with the + (plus sign) between them. The Table below lists the faults and the characters displayed for each.

### Table 9.4 Fault Indication

<table>
<thead>
<tr>
<th>Binary Code*</th>
<th>Display</th>
<th>Fault Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
<td>No Fault</td>
</tr>
<tr>
<td>4</td>
<td>CS</td>
<td>SPI Write to Settings Check Sum</td>
</tr>
<tr>
<td>8</td>
<td>CS</td>
<td>SPI Write to Defaults Check Sum</td>
</tr>
<tr>
<td>16</td>
<td>DFLT</td>
<td>Defaults Check Sum</td>
</tr>
<tr>
<td>32</td>
<td>DATA</td>
<td>EEPROM Check Sum Fault</td>
</tr>
</tbody>
</table>

*NOTE: All fault codes are "OR"ed together.

### Description of the Faults

**NONE**
No Faults exist in the MDrive

**CS - SPI Write Check Sum**
Check Sum indicates an error or problem with the last transmission of data to the MDrive. A RECALL will clear the fault and the screen will display the stored parameters.

**DFLT & DATA**
These faults indicate a Driver failure. Contact the factory.

---

### Configuring the MDrive34 Speed Control With User Defined SPI

The MDrive34 Speed Control may be setup and operated without the included IMS Motor Interface GUI.

If the optional cable is not being used you will need to make one using the diagram (SPI Interface Wiring and Connections) shown in Section 5 of this document.

### Timing Notes

1) MSb (most significant bit) and MSB (most significant byte) first
2) 8 bit bytes
3) 25kHz SCK
4) Data In (MOSI) on rising clock
5) Data Out (MISO) on falling clock

---

**WARNING!** The Parallel/SPI Port on your PC must be set to one of the following:
- output only
- bi-directional
- EPP (Extended Parallel Port)

Try the SPI connection using the default parallel port setting first. If necessary, the Parallel/SPI port may be configured in the bios of your PC.
# SPI Commands

## SPI COMMANDS AND PARAMETERS

<table>
<thead>
<tr>
<th>SPI Commands</th>
<th>HEX/DEFAULT</th>
<th>RANGE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>READ ALL</td>
<td>0x40</td>
<td></td>
<td>Reads the hex value of all parameters</td>
</tr>
<tr>
<td>WRITE ALL</td>
<td>0x80</td>
<td></td>
<td>Writes the hex value to the following parameters</td>
</tr>
</tbody>
</table>

### Data READ

- **"u"**: 0x75
  - "u" character precedes every read
- **Version MSB**: 0x80
- **Version LSB**: 0x12
- **ACCL, MSB**: 0x07
  - 2000-65000
  - Defines the SPI Version and revision number (i.e., Version 1.2 Rev. 02)
- **ACCL, LSB**: 0x00
- **DB**: 0x01
  - 0-255
  - Potentiometer/Joystick Deadband
- **RANGE**: 0x03
  - 1-8
  - VI/VM Range Setting
- **VI, MSB**: 0x00
- **VI, MB**: 0x01
  - 1-100000
  - Establishes the maximum velocity [highest speed] of the controlled axis in steps per second
- **VI, LSB**: 0x90
- **VM, MSB**: 0x00
- **VM, MB**: 0x04
  - 1-100000
  - Establishes the maximum velocity [highest speed] of the controlled axis in steps per second
- **VM, LSB**: 0x20
- **FULLSCALE, MSB**: 0x03
  - 1-1023
  - Sets the deflection of the potentiometer or joystick
- **FULLSCALE, LSB**: 0xFF
- **CENTER, MSB**: 0x00
  - 1-1022
  - Sets the center position of the joystick
  - The default is 0.0000
- **CENTER, LSB**: 0x00
- **MRC**: 0x19
  - 1-100%
  - Motor Run Current - Default = 25
- **MHC**: 0x05
  - 0-100%
  - Motor Hold Current - Default = 5
- **DCLT**: 0x00
  - 0-1
  - Deceleration [On/Off] Default = 0
- **MSEL**: 0x00
  - 0, 2-250
  - Microstep Resolution Default = 256
- **TYPE**: 0x01
  - 1-Microstep
  - Fixed
- **FCB**: 0x00
  - Defined by the following parameters ...
  - A1 and A2 or PWM
  - Volts or Current
  - 0 to 20 mA or 4 to 20 mA
  - Direction Override
  - See Fault Table

### Data WRITE

- **ACCL, MSB**: 0x07
- **ACCL, LSB**: 0x00
- **DB**: 0x01
  - 0-255
  - Potentiometer/Joystick Deadband
- **RANGE**: 0x03
  - 1-8
  - VI/VM Range Setting
- **VI, MSB**: 0x00
- **VI, MB**: 0x01
  - 1-100000
  - Establishes the initial velocity [lowest speed] of the controlled axis in steps per second
  - The default is 800
- **VI, LSB**: 0x90
- **VM, MSB**: 0x00
- **VM, MB**: 0x04
  - 1-100000
  - Establishes the maximum velocity [highest speed] of the controlled axis in steps per second
  - The default is 20000
- **VM, LSB**: 0x20
- **FULLSCALE, MSB**: 0x03
  - 1-1023
  - Sets the deflection of the potentiometer or joystick
- **FULLSCALE, LSB**: 0xFF
- **CENTER, MSB**: 0x00
  - 1-1022
  - Sets the center position of the joystick
  - The default is 0.0000
- **CENTER, LSB**: 0x00
- **MRC**: 0x19
  - 1-100%
  - Motor Run Current - Default = 25
- **MHC**: 0x05
  - 0-100%
  - Motor Hold Current - Default = 5
- **DCLT**: 0x00
  - 0-1
  - Deceleration [On/Off] Default = 0
- **MSEL**: 0x00
  - 0, 2-250
  - Microstep Resolution Default = 256
- **TYPE**: 0x01
  - 1-Microstep
  - Fixed
- **FCB**: 0x00
  - Defined by the following parameters ...
  - A1 and A2 or PWM
  - Volts or Current
  - 0 to 20 mA or 4 to 20 mA
  - Direction Override
  - See Fault Table

## Table 9.5: MDrive34 Speed Control SPI Command Summary
**Check Sum Calculation for SPI**

The values in the example above are 8-bit binary hexadecimal conversions for the WRITE ALL commands.

**The Check Sum is calculated as follows:**

\[ 80 + 07 + D0 + 01 + 03 + 00 + 01 + 90 + 00 + 4E + 20 + 03 + FF + 00 + 00 + 19 + 05 + 00 + 00 + 00 \]

Sum = 37A

Truncate the Sum = 7A 0111 1010

1’s complement = 85 1000 0101 (invert binary)

2’s complement = 86 1000 0110 (add 1)

Send the check sum value of 86

Note: 80 is always the first command on a write.

Note: Once a write is performed, a read needs to be performed to see if there is a fault. The fault is the last byte of the read.
Figure 9.7: SPI Waveforms & Timing Diagram
**Recommended Cable Configurations**

Cable length, wire gauge and power conditioning devices play a major role in the performance of your MDrive34.

**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 MDrive34 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 MDrive34 Supply Cable AWG Table at the end of this Appendix.

**Example A – Cabling Under 50 Feet, DC Power**

- **To MDrive**
  - π Type RFI Filter
  - \(\geq\) Required Current
  - Ferrite Beads
  - Shielded Twisted Pair
    - (Wire Size from MDrive Supply Cable AWG Table)
  - Cable Length less than 50 Feet
  - DC Voltage from Power Supply
    - Shield to Earth Ground on Supply End Only
    - 500 \(\mu\)F Per Amp
**Example B – Cabling 50 Feet or Greater, AC Power to Full Wave Bridge**

- **Shield to Earth Ground on Supply End Only**
- **Shielded Twisted Pair** (Wire Size from MDrive Supply Cable AWG Table)
- **π Type RFI Filter**
- **Transformer**:  
  - 0 to 28 VAC RMS for 48 VDC Systems
  - 20 to 48 VAC RMS for 75 VDC Systems
- **Full Wave Bridge**
- **To Cable A**
- **Cable Length as required**
- **NOTE:** Connect the cable illustrated in Example A to the output of the Full Wave Bridge
- **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:
Connect the cable illustrated in Example A to the output of the Power Supply

DC Volts Out To Cable A

Shielded Twisted Pair (Wire Size from MDrive Supply Cable AWG Table)

π Type RFI Filter \( \geq \) Required Current

Shield to Earth Ground on Supply End Only

120 or 240 VAC Dependent on Power Supply

Cable Length as required

Power Supply

NOTE: Connect the cable illustrated in Example A to the output of the 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.

### MDrive Supply Cable AWG Table

<table>
<thead>
<tr>
<th></th>
<th>1 Ampere (Peak)</th>
<th>2 Amperes (Peak)</th>
<th>3 Amperes (Peak)</th>
<th>4 Amperes (Peak)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (Feet)</td>
<td>10 25 50* 75* 100*</td>
<td>10 25 50* 75* 100*</td>
<td>10 25 50* 75* 100*</td>
<td>10 25 50* 75* 100*</td>
</tr>
<tr>
<td>Minimum AWG</td>
<td>20 20 18 18 16</td>
<td>20 18 16 14 14</td>
<td>18 16 14 12 12</td>
<td>18 16 14 12 12</td>
</tr>
</tbody>
</table>

* Use the alternative methods illustrated 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.

**MDrive Wire Size**

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

<table>
<thead>
<tr>
<th>Gearbox Diameter</th>
<th>MDrive</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 mm</td>
<td>MDrive14</td>
</tr>
<tr>
<td>42 mm</td>
<td>MDrive17</td>
</tr>
<tr>
<td>52 mm</td>
<td>MDrive23</td>
</tr>
<tr>
<td>81 mm</td>
<td>MDrive34</td>
</tr>
</tbody>
</table>

**Selecting a Planetary Gearbox**

There are many variables and parameters that must be considered when choosing an appropriate reduction ratio for an MDrive with Planetary 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.
- \( \eta \) = 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: \( i = \frac{n_M}{n_{AB}} \) 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.

\[ \begin{align*}
2000 \text{ full steps/second} & \div 200 = 10 \text{ RPS (revolutions per second)} \\
\times 60 \text{ Seconds} & = 600 \text{ RPM}
\end{align*} \]
For the Reduction Ratio (i), divide the MDrive’s speed by the required Planetary Gearbox output speed.

$$600 \text{ RPM} \div 90 = 6.67:1 \text{ Reduction Ratio}$$

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 ($\eta$) 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 $\times$ reduction ratio $\times$ gear efficiency $\div$ safety factor = nominal output torque.

For gear efficiency ($\eta$) 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 \( \eta = 80\% \) from the appropriate table for the Planetary Gearbox which is used with an MDrive23.

Nominal output torque would be:

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

\[
35 \times 6.75 \times 0.8 \div 0.5 = 378 \text{ oz-in nominal output torque } (T_N)
\]

or

\[
35 \times 6.75 \times 0.8 \div 0.7 = 270 \text{ oz-in nominal output torque } (T_N)
\]

With the safety factor \( s_f \) and gear efficiency \( \eta \) 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.

\[
\text{The nominal output torque } (T_N) \times \text{the operating factor } (C_B) = \text{shock load or maximum output torque } (T_{AB}).
\]

With a 0.5 safety factor, the shock load output torque is greater than the maximum output torque specification of the MDrive23 Planetary Gearbox. \((378 \times 1.9 = 718.2 \text{ oz-in.})\)

With a 0.7 safety factor the shock load output torque is within maximum output torque specification of the MDrive23 Planetary Gearbox. \((270 \times 1.9 = 513 \text{ oz-in.})\)

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.

<table>
<thead>
<tr>
<th>Direction of Rotation</th>
<th>Load (Shocks)</th>
<th>Daily Operating Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3 Hours</td>
</tr>
<tr>
<td>Constant</td>
<td>Low*</td>
<td>$C_B=1.0$</td>
</tr>
<tr>
<td></td>
<td>Medium**</td>
<td>$C_B=1.2$</td>
</tr>
<tr>
<td>Alternating</td>
<td>Low†</td>
<td>$C_B=1.3$</td>
</tr>
<tr>
<td></td>
<td>Medium††</td>
<td>$C_B=1.6$</td>
</tr>
</tbody>
</table>

* 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 ($J_{ref}$).

$$J_{ref} = J_L + Z^2$$

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.

$$Z_{opt} = \sqrt{\frac{J_L}{J_{ref}}}$$

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-sec² (ounce-inches-second squared). To calculate the inertia in kg-cm² (kilograms-centimeter squared) multiply oz-in-sec² by 70.6154.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Planetary Gearbox Inertia Moments (oz-in-sec²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rounded Ratio</td>
</tr>
<tr>
<td>1-Stage</td>
<td></td>
</tr>
<tr>
<td>4:1</td>
<td>0.00002181</td>
</tr>
<tr>
<td>5:1</td>
<td>0.00001614</td>
</tr>
<tr>
<td>7:1</td>
<td>0.00001260</td>
</tr>
<tr>
<td>14:1</td>
<td>0.00002110</td>
</tr>
<tr>
<td>16:1</td>
<td>0.00001770</td>
</tr>
<tr>
<td>18:1</td>
<td>0.00001784</td>
</tr>
<tr>
<td>19:1</td>
<td>0.00001586</td>
</tr>
<tr>
<td>22:1</td>
<td>0.00001586</td>
</tr>
<tr>
<td>25:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>27:1</td>
<td>0.00001600</td>
</tr>
<tr>
<td>29:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>35:1</td>
<td>0.00001374</td>
</tr>
<tr>
<td>46:1</td>
<td>0.00001388</td>
</tr>
<tr>
<td>51:1</td>
<td>0.00002110</td>
</tr>
<tr>
<td>59:1</td>
<td>0.00001770</td>
</tr>
<tr>
<td>68:1</td>
<td>0.00001784</td>
</tr>
<tr>
<td>71:1</td>
<td>0.00001586</td>
</tr>
<tr>
<td>79:1</td>
<td>0.00001784</td>
</tr>
<tr>
<td>93:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>95:1</td>
<td>0.00001586</td>
</tr>
<tr>
<td>100:1</td>
<td>0.00001600</td>
</tr>
<tr>
<td>107:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>115:1</td>
<td>0.00001600</td>
</tr>
<tr>
<td>124:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>130:1</td>
<td>0.00001374</td>
</tr>
<tr>
<td>139:1</td>
<td>0.00001600</td>
</tr>
<tr>
<td>150:1</td>
<td>0.00001374</td>
</tr>
<tr>
<td>169:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>181:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>195:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>236:1</td>
<td>0.00001359</td>
</tr>
<tr>
<td>308:1</td>
<td>0.00001359</td>
</tr>
</tbody>
</table>
Mechanical Specifications

MDrive14 with Planetary Gearbox

Dimensions in Inches (mm)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>k1</th>
<th>k2</th>
<th>k3</th>
<th>k4</th>
<th>k5</th>
<th>k6</th>
<th>k7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Stage</td>
<td>1.969 (50.0) ±0.02 (0.5)</td>
<td>2.008 (51.0) ±0.02 (0.5)</td>
<td>0.787 (20.0)</td>
<td>0.787 (20.0) +0/-0.0013 (+0/-0.033)</td>
<td>0.866 (22.0) +0/-0.0013 (+0/-0.033)</td>
<td>0.394 (10.0)</td>
<td></td>
</tr>
<tr>
<td>2-Stage</td>
<td>2.343 (59.5) ±0.02 (0.5)</td>
<td>2.382 (60.5) ±0.02 (0.5)</td>
<td>2.756 (70.0) ±0.02 (0.5)</td>
<td>2.756 (70.0) ±0.02 (0.5)</td>
<td>2.756 (70.0) ±0.02 (0.5)</td>
<td>2.756 (70.0) ±0.02 (0.5)</td>
<td></td>
</tr>
<tr>
<td>3-Stage</td>
<td>2.717 (60.0) ±0.02 (0.5)</td>
<td>2.756 (70.0) ±0.02 (0.5)</td>
<td>2.756 (70.0) ±0.02 (0.5)</td>
<td>2.756 (70.0) ±0.02 (0.5)</td>
<td>2.756 (70.0) ±0.02 (0.5)</td>
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<table>
<thead>
<tr>
<th>Parameters</th>
<th>1-Stage</th>
<th>2-Stage</th>
<th>3-Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Output Torque</td>
<td>106 oz-in (0.75 Nm)</td>
<td>318 oz-in (2.25 Nm)</td>
<td>637 oz-in (4.5 Nm)</td>
</tr>
<tr>
<td>Efficiency</td>
<td>80%</td>
<td>75%</td>
<td>70%</td>
</tr>
<tr>
<td>Max Backlash</td>
<td>1.5°</td>
<td>2.0°</td>
<td>2.5°</td>
</tr>
<tr>
<td>Max Radial Load</td>
<td>9.0 lb-force (40 N)</td>
<td>15.7 lb-force (70 N)</td>
<td>22.0 lb-force (100 N)</td>
</tr>
<tr>
<td>Max Axial Load</td>
<td>2.2 lb-force (10 N)</td>
<td>4.5 lb-force (20 N)</td>
<td>6.7 lb-force (30 N)</td>
</tr>
<tr>
<td>Weight</td>
<td>Gearbox Only</td>
<td>5.7 oz (162 gm)</td>
<td>7.5 oz (213 gm)</td>
</tr>
<tr>
<td></td>
<td>Gearbox w/NEMA Flange</td>
<td>5.9 oz (168 gm)</td>
<td>7.8 oz (221 gm)</td>
</tr>
</tbody>
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Planetary Gearbox Specifications for MDrive14
MDrive17 with Planetary Gearbox

Dimensions in Inches (mm)

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

<table>
<thead>
<tr>
<th>Length</th>
<th>MDrive17</th>
<th>Size 1713</th>
<th>Size 1715</th>
<th>Size 1719</th>
</tr>
</thead>
<tbody>
<tr>
<td>lMAX1</td>
<td>Single Shaft Version</td>
<td>2.20 (55.9)</td>
<td>2.43 (61.7)</td>
<td>2.75 (69.8)</td>
</tr>
<tr>
<td>lMAX2</td>
<td>Encoder or Control Knob Version</td>
<td>2.92 (74.2)</td>
<td>3.15 (80.0)</td>
<td>3.47 (88.1)</td>
</tr>
</tbody>
</table>

Planetary Gearbox Specifications for MDrive17
## MDrive23 with Planetary Gearbox

Dimensions in Inches (mm)

### Planetary Gearbox Specifications for MDrive23

<table>
<thead>
<tr>
<th>Parameters</th>
<th>1-Stage</th>
<th>2-Stage</th>
<th>3-Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Output Torque</td>
<td>566 oz-in (4.0 Nm)</td>
<td>1699 oz-in (12.0 Nm)</td>
<td>3540 oz-in (25.0 Nm)</td>
</tr>
<tr>
<td>Efficiency</td>
<td>80%</td>
<td>75%</td>
<td>70%</td>
</tr>
<tr>
<td>Max Backlash</td>
<td>0.70°</td>
<td>0.75°</td>
<td>0.80°</td>
</tr>
<tr>
<td>Max Radial Load</td>
<td>45 lb-force (200 N)</td>
<td>72 lb-force (320 N)</td>
<td>101 lb-force (450 N)</td>
</tr>
<tr>
<td>Max Axial Load</td>
<td>13 lb-force (60 N)</td>
<td>22 lb-force (100 N)</td>
<td>34 lb-force (150 N)</td>
</tr>
<tr>
<td>Gearbox Only</td>
<td>25.0 oz (711 gm)</td>
<td>32.2 oz (914 gm)</td>
<td>39.4 oz (1117 gm)</td>
</tr>
<tr>
<td>Gearbox w/NEMA Flange</td>
<td>25.9 oz (735 gm)</td>
<td>33.3 oz (945 gm)</td>
<td>40.7 oz (1155 gm)</td>
</tr>
</tbody>
</table>

### Lengths (inches)

<table>
<thead>
<tr>
<th>MDrive23</th>
<th>Size 2218</th>
<th>Size 2222</th>
<th>Size 2231</th>
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</thead>
<tbody>
<tr>
<td>LMAX1</td>
<td>2.63 (66.8)</td>
<td>3.00 (76.2)</td>
<td>3.86 (98.0)</td>
</tr>
<tr>
<td>LMAX2</td>
<td>3.35 (85.1)</td>
<td>3.70 (94.0)</td>
<td>4.57 (116.1)</td>
</tr>
</tbody>
</table>
**Planetary Gearbox Specifications for MDrive34**

### Dimensions in Inches (mm)

<table>
<thead>
<tr>
<th>Planetary Gearbox</th>
<th>1-Stage</th>
<th>2-Stage</th>
<th>3-Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>k1 Standard Gearbox</td>
<td>4.315 (109.6) ±0.02 (0.5)</td>
<td>5.169 (131.3) ±0.02 (0.5)</td>
<td>6.024 (153.0) ±0.02 (0.5)</td>
</tr>
<tr>
<td>k2 with NEMA Flange</td>
<td>4.433 (112.6) ±0.02 (0.5)</td>
<td>5.287 (134.3) ±0.02 (0.5)</td>
<td>6.142 (156.0) ±0.02 (0.5)</td>
</tr>
<tr>
<td>k3 Standard Shaft</td>
<td>1.929 (49.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k4 Shaft with NEMA Flange</td>
<td>1.811 (46.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k5 Standard Locator Diameter</td>
<td>1.969 (50.0) +0.0006/-0.0004 (+0.015/-0.010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k6 Locator Diameter with NEMA Flange</td>
<td>2.874 (73.0) +0/-0.0012 (+0/-0.030)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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"

**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)

**Gearbox Only**
- 64.4 oz (1827 gm)
- 89.5 oz (2538 gm)
- 114.6 oz (3248 gm)

**Gearbox with NEMA Flange**
- 66.7 oz (1890 gm)
- 92.6 oz (2625 gm)
- 118.5 oz (3360 gm)

### MDrive34

<table>
<thead>
<tr>
<th>Size</th>
<th>3424</th>
<th>3431</th>
<th>3447</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMAX1 Single Shaft or Encoder Version</td>
<td>3.81 (96.8)</td>
<td>4.60 (116.80)</td>
<td>6.17 (156.7)</td>
</tr>
<tr>
<td>LMAX2 Control Knob Version</td>
<td>4.97 (126.2)</td>
<td>5.76 (146.3)</td>
<td>7.34 (186.4)</td>
</tr>
</tbody>
</table>

**Cttrg. DIN 332-D M6x16**

**Key DIN 6885-A-6x6x28mm**

**Front View**
- Planetary Gearbox
- Optional NEMA 34 Output Flange for Planetary Gearbox
**Available Ratios**

**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.

---

### Installing a Driving Device on a Planetary Gearbox

<table>
<thead>
<tr>
<th>Stages</th>
<th>Rounded Ratio</th>
<th>Fractional Ratio</th>
<th>Decimal Ratio*</th>
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<tbody>
<tr>
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<td>5:1</td>
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<td>7:1</td>
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<tr>
<td></td>
<td>14:1</td>
<td>3969 / 289</td>
<td>13.7335640134808304</td>
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<td>16:1</td>
<td>270 / 17</td>
<td>15.8823529411764705</td>
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<td>18:1</td>
<td>900 / 49</td>
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<td>19:1</td>
<td>3591 / 187</td>
<td>19.2032085561497326</td>
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<td>22:1</td>
<td>1710 / 77</td>
<td>22.2077922077922077</td>
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<td>25:1</td>
<td>1701 / 68</td>
<td>25.0147058623529411</td>
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<td>27:1</td>
<td>3249 / 121</td>
<td>26.8512396694215000</td>
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<td>29:1</td>
<td>405 / 14</td>
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<td>124:1</td>
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<td>139:1</td>
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<td>150:1</td>
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<td>149.9025974205974025</td>
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<td>169:1</td>
<td>45927 / 272</td>
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<td>181:1</td>
<td>87723 / 484</td>
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<td>195:1</td>
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<td>236:1</td>
<td>41553 / 176</td>
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<td>308:1</td>
<td>19683 / 64</td>
<td>307.5468750000000000</td>
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</table>

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