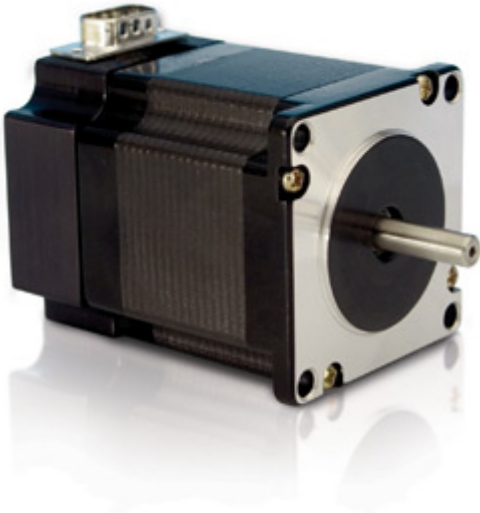


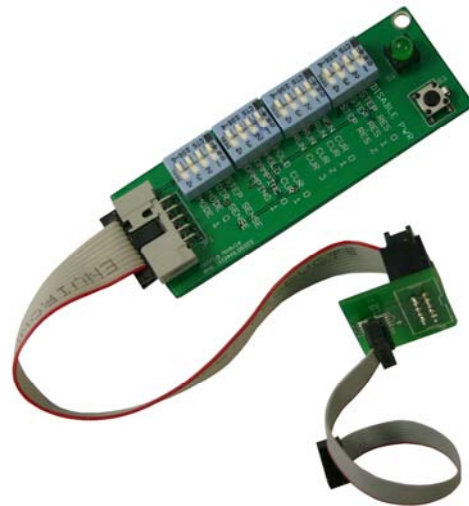
Silverpak 23D/ 23DE

Integrated NEMA 23 Motor and Drive With Encoder option

Plus with New Configuration Module



Silverpak 23D



Configuration Module (sold separately)

**User Manual
And Commands Guide**

Version 1.10

Thank you for purchasing the Silverpak 23D or Silverpak 23DE Integrated Motor and Driver. This product is warranted to be free of manufacturing defects for one (1) year from the date of purchase.

PLEASE READ BEFORE USING

Before you start, you must have a suitable step motor, a DC power supply suitable for the motor. The power supply voltage must be between 4 times and 20 times the motor's rated voltage.

DISCLAIMER

The information provided in this document is believed to be reliable. However, no responsibility is assumed for any possible inaccuracies or omissions. Specifications are subject to change without notice.

Lin Engineering reserves the right to make changes without further notice to any products herein to improve reliability, function, or design. Lin Engineering does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights, nor the rights of others.

PLEASE READ

Product Upgrade on New RoHS Compliant Driver Boards

Silverpak 23D or 23DE units shipped after August 31, 2007 or later have the new RoHS compliant driver boards.

During this change, the product was upgraded with several changes. No jumpers are available on the Silverpak unit for changing step resolution or damping modes. Instead, all settings are changed via a **New Configuration Module** board, which is separate from the Silverpak 23D or DE unit.

The Configuration Module allows users to change step resolution, run current, hold current, damping modes, choices of reading the step and direction signals on the rising or falling edge, and a choice of disabling the unit with no power or with limited holding current. ***The configuration module is sold separately and can be purchased under Lin part number: 083-00048.***

Other changes to the unit include:

- **12** to 48VDC (old revisions handled 15 to 48VDC)
- **Default step resolution setting of 8x microstepping** (old revision was 256x microstepping)

Please proceed to Section 7, Page 13, on how to use the configuration module.

Silverpak 23D/DE User Manual

Product: Silverpak 23D and Silverpak 23DE
Version: 1.10
Date: 12/3/2007

Version History		
Version	Date	Description of Changes
1.05	6/5/2006	
1.06	6/7/2007	Standardized user manual & updated description of configuration module & duty cycle
1.07	8/31/2007	Added configuration module info and RoHS compliant board info. Updated opto-isolation info.
1.08	10/26/2007	Added more troubleshooting guidelines
1.09	11/5/2007	Added limitation on volts & currents: 24VDC and 3 Amps OR 48VDC and 2 Amps
1.10	12/3/2007	Added images of config module and images for damping modes

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1 FEATURES

- NEMA Size 23, 2 Phase, 1.8° Bipolar Step Motor w/ Built-In Microstepping Driver
- Operates from +12 to 48 VDC with certain currents*
- Selectable phase currents from 0.3 to 3.0 Amp Peak with certain voltages*
- Selectable hold currents of 0%, 25%, 50%, or 100% of the run current
- Step Resolutions from Half Step to 256x Microstepping
- Four Selectable Damping modes (Fast decay, 17%, 37%, Slow decay)
- Disable Power feature to hold after disabling unit and inhibit stepping or to power off motor after disabling unit and inhibit stepping.
- Step and Direction sensing on the rising or falling edge of step pulse input
- Smooth motion
- Three optically isolated control inputs
- Pole Damping Technology™ integrated within driver board

***The Silverpak 23D can handle a 24VDC and 3 Amp system OR a 48VDC and 2 Amp system**

Pole Damping Technology™

Pole Damping Technology™ (PDT) enhances step motor performance by dampening each full step in order to create a more accurate and smooth motion profile. Microstepping the step motor will optimize Pole Damping Technology™. PDT outputs the correct amount of run and hold currents to the motor, at the right time. Thus, it will overcome the step motor's natural tendency to want to forcefully pull towards the full step ON position.

Silverpak 23DE – Encoder Features

- 32-1250 cycles per revolution (CPR)
- 128 to 5000 pulses per revolution (PPR)
- 2 Channel Quadrature
- TTL Squarewave Outputs and optional index (3rd Channel)
- E2 US Digital Encoder

Default Settings

Default Settings of the Silverpak 23D or DE	
Direction of rotation	Counterclockwise
Disable Power	On – motor power is disabled when disabling unit
Step Resolution	8x step (3200 steps/rev)
Run Current	Motor's rated current or up to 3 Amps Peak if motor is rated for 3 or higher.
Holding Current	25% of motor's rated Current
Damping Mode	37% damping
Step signal sensing	Senses on the Falling edge or Negative edge
Direction signal sensing	Senses on the Falling edge or Negative edge

2 ELECTRICAL SPECIFICATIONS

Power Supply Requirements

Voltage +12 VDC to 48 VDC*

Driver

Peak Current: 0.3 to 3.0 Amps*

Motor Specifications

NEMA Size 23

Holding Torque:

DO-5718X-XX 100 oz-in

DO-5718M-XX 182 oz-in

DO-5718L-XX 294 oz-in

Steps per Revolution (1.8° Motor)

400, 800, 1600, 3200, 6400, 12800, 25600, 51200

I/O Specifications

3x Optically Isolated Inputs

*** The Silverpak 23D can handle a 24VDC and 3 Amp system OR a 48VDC and 2 Amp system**

3 OPERATING SPECIFICATIONS

Maximum Step Frequency:

2.5 MHz

Operating Temperature*:

Low end – 0° C

High end – Dependent on case temperature,
bottom of unit must not exceed 45° C

100% duty cycle is OK as long as the bottom of the unit does not exceed 45°C (the bottom is the flat side of the unit, opposite the mounting & shaft).

* Lin Engineering integrated motor and drive products are designed and fully tested to withstand the rated operating temperature ranges at 24VDC and 3 Amp Peak, or 48VDC and 2 Amp Peak.

Logic Timing

Minimum Step Pulse Width 200 nanoseconds

Minimum Step Low Time 200 nanoseconds

Maximum Power-Down Recovery Time 20 milliseconds

4 MECHANICAL SPECIFICATIONS

Motor Front Shaft Extension Length

Standard length is 0.81".

Motor Shaft Diameter

Standard shaft diameter is 0.25".

Overall Body Length (A)

Motor body length is available in various lengths

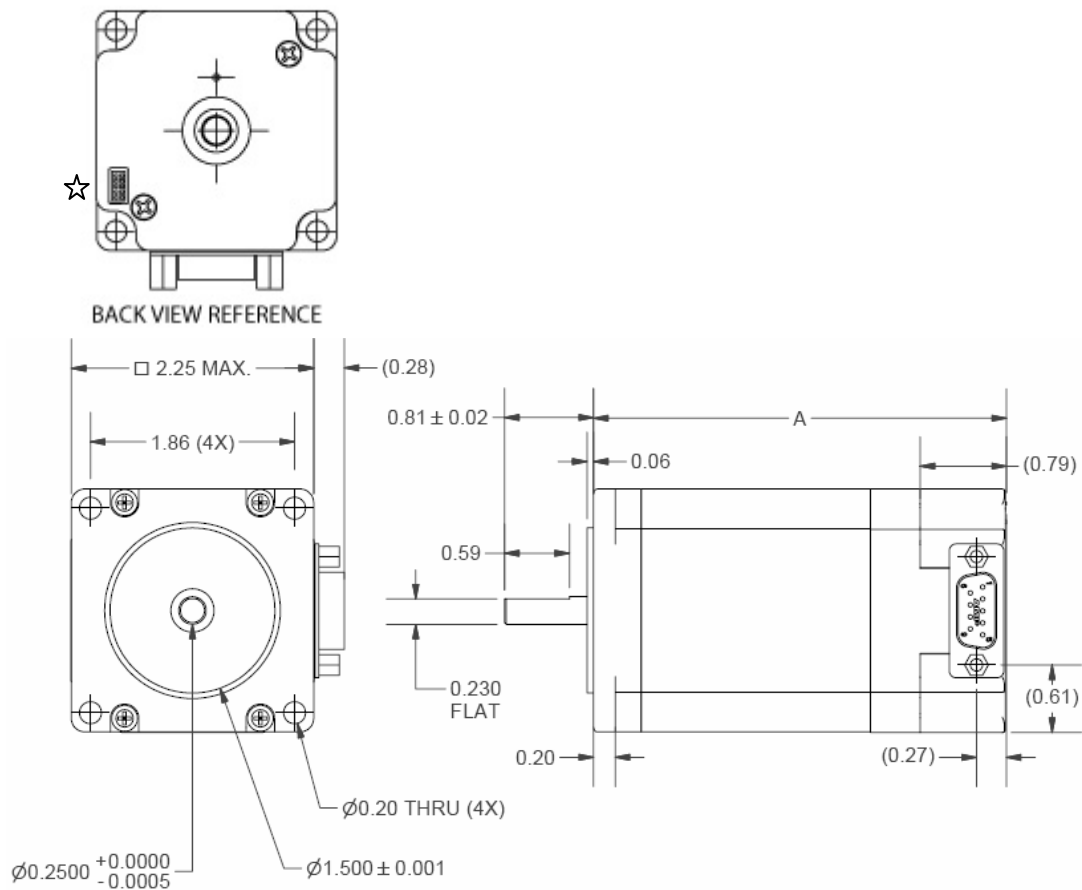
DO-5718X-XX (2.52")

DO-5718M-XX (2.96")

DO-5718L-XX (3.89")

☆Note: This plug is for the new configuration module, ***sold separately***. It enables you to update the run, hold currents, step resolution, and other settings.

Dimensions



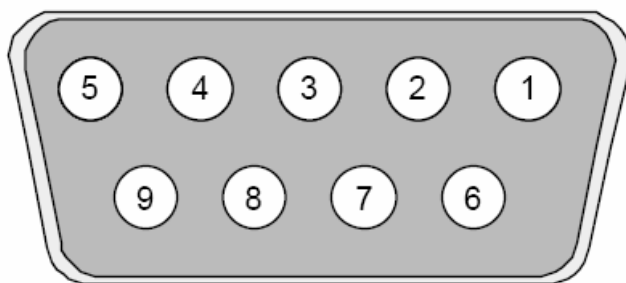
Dimensions Diagram

5 PIN ASSIGNMENTS

A female DB-9 connector cable receives power and provides the control connections for the Silverpak 23D unit. Active signals are optically isolated. An open collector drive is required to provide pulses for Step, levels for Direction, and Disable/Enable.

All of these signals are optically isolated. Open-collector drives are required to provide pulses for Step, levels for Direction, and Disable. The common +ve supply can be +ve 5 to 30 VDC with respect to the signal input; however if the supply is greater than 5 VDC then a resistor must be inserted in series with each signal line to limit the current to 10 mA.

As you may have noticed, Pins 1 & 6 are connected to power positive and Pins 2 & 7 are connected to the negative. It is recommended that both sets of pins be used to connect to the power supply.



View on Face of Mating Socket

Pin	Function	Description
1 & 6	PWR +ve	Motor Supply Voltage. +12 to 48 VDC
2 & 7	PWR -ve	The ground or return of the power supply connects here
3	+5VDC Out	Used to power the optos (unit will not be opto-isolated if using this 5V to supply the opto with power)
4	Step	Connects to the open collector drive.
5	Disable	This input is used to enable/disable the output of the driver
8	Opto Supply	+5 VDC input used to supply power to the isolated logic inputs. A resistor must be used on all inputs if the supply is greater than 5 VDC*
9	Direction	This input is used to change the rotation direction of the motor

Pin Assignments

*Place resistors on all inputs: step (pin 4), direction (pin 9) and disable (pin 5) if your supply is greater than 5VDC in order to limit the current to 10mAmps. It is the customer's preference to either optically isolate the inputs (using a separate supply) or to jumper pins 3 & 8 for ease of use. No harm will be done by connecting the unit in either way.

6 CONNECTION SPECIFICATIONS

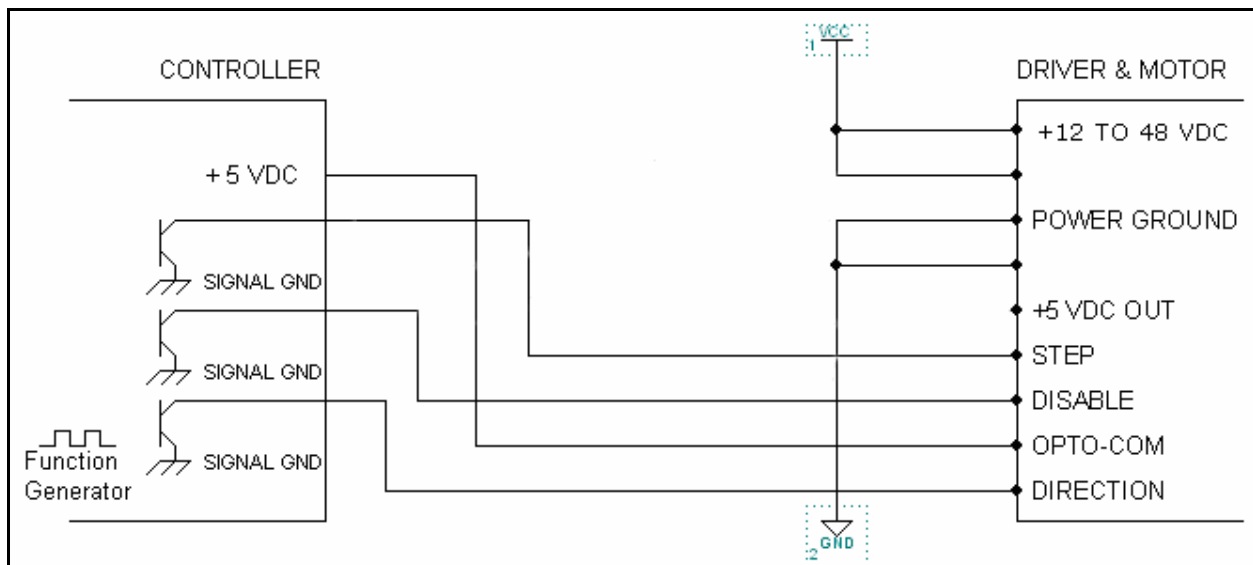
In order to properly connect your new Silverpak 23D unit, examine the figure below.

Connecting the Silverpak 23D to a Controller

List of components needed to spin the motor:

- +12 to 48 VDC Power Supply
- Additional +5 VDC Volt Power Supply
- Signal Generator

1. Ensure that the Silverpak 23D is not connected to the Main Power Supply until the following procedures have been properly carried out.
2. Connect Pin 8 to the Positive Terminal of the +5 VDC Power Supply.
3. Connect the Negative Terminal of the +5 VDC Power Supply to the Negative Terminal of the Signal Generator. This will be referred to as the Signal Ground.
4. Connect Pin 1 & Pin 6 to the Positive Terminal of the Main Power Supply and Pin 2 & Pin 7 to the Negative Terminal.
5. Adjust the Frequency of the Signal Generator to achieve the desired operating speed.



Connection Schematic – Connecting to a Controller

Pin 4 (Step): Use a pulse generator or function generator to receive pulses into the Silverpak 23D. Connect the POSITIVE end of the pulse generator to Pin 4. The NEGATIVE end will be connected to the NEGATIVE end of the +5VDC supply if using a separate power source. If using the internal +5VDC supply, connect the NEGATIVE end of the pulse generator to Power GROUND.

Pin 9 (Direction): To switch the direction of motor rotation; connect Pin 9 with Pin 2 & 7, Power Ground. An open or closed connection to Power Ground will change the direction.

Pin 3: This is the internal +5VDC. Use this for testing purposes or if optical isolation of the I/O's is not desired.

Pin 5 (Disable): To enable and disable the drive, connect Pin 5 with Pin 2 & 7, Power Ground. An open or closed connection to Power Ground will enable and disable the drive, respectively.

Pin 2 & 7: Connect the NEGATIVE of the Power Supply to this terminal.

Pin 1 & 6: Connect the POSITIVE of the Power Supply to this terminal. (+12 to 48VDC)

Note: Remember to only use a max voltage and current setting of: 24VDC and 3 Amps OR 48VDC and 2 Amps.

WARNING! DO NOT DISCONNECT THE DB-9 CABLE FROM THE Silverpak 23D UNIT WHILE POWER IS STILL BEING SUPPLIED. THIS MAY CAUSE DAMAGE TO THE INTERNAL DRIVER BOARD.

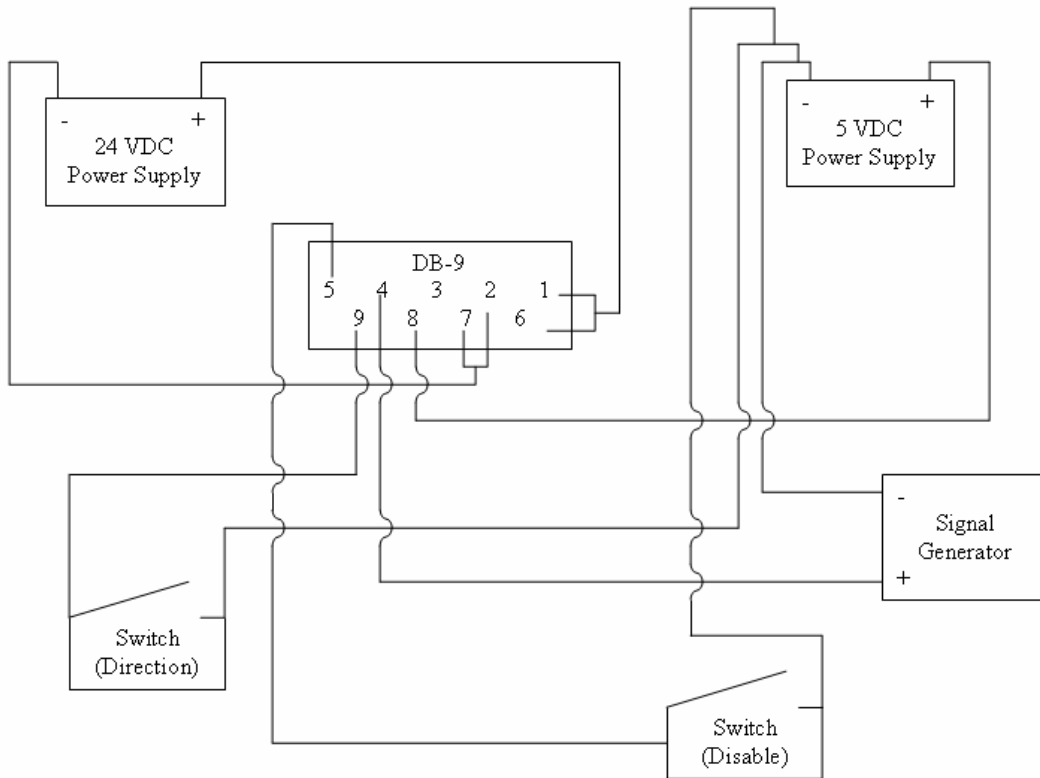
WARNING! If you do not have a +5 VDC Power Source, use a Resistor in series to limit the current of the opto isolators. See following page for Resistor values. **If the current exceeds 10 mA, the opto couplers cease to function.**

Resistor Values for the Opto Supply

The optocouplers must be powered by an external power supply to maintain isolation. The Opto Supply for the optocouplers can be between +5 to 24 VDC with respect to the signal input. It is recommended to use a +5 VDC Opto Supply in order to limit the current going into the optocouplers to 10 mA. However, if the supply is greater than +5 VDC then a resistor must be connected in series with each signal line to maintain 10 mA of current running through the optocouplers (step, direction, and disable lines). **Do NOT provide more than 10 mA or damage may occur to the driver.**

Step, Direction, and Disable lines have a 470 ohm internal resistor

Voltage:	5V	10V	15V	24V
Ohms needed:	0	500	1000	2000
Wattage rating:	0	¼ watt	¼ watt	½ watt



Example Connection Schematic – Connecting to a Signal Generator

Connecting the Power

The Silverpak 23D requires a supply voltage of +12-48 VDC. First, connect the positive end of the power supply to Power (Pins 1 & 6), and then connect the negative of the power supply to the Ground (Pins 2 & 7) on the Silverpak 23D.

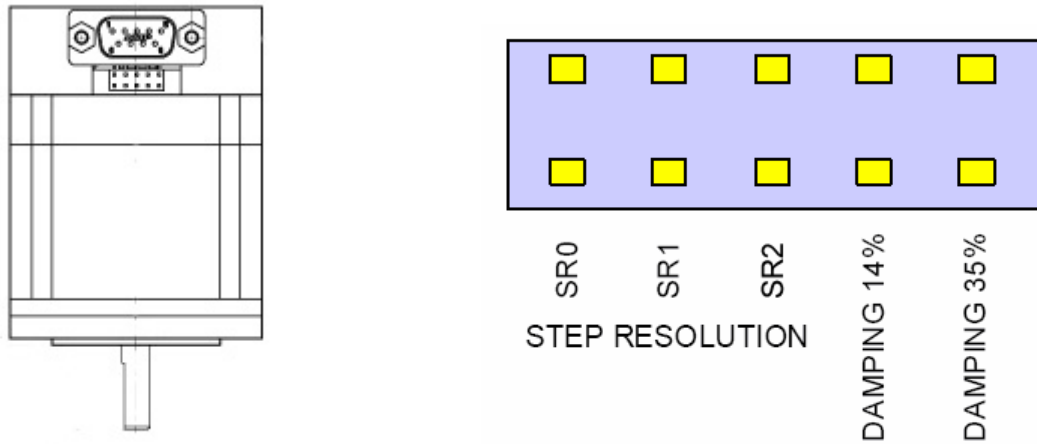
WARNING! Be careful not to reverse the polarity from the power supply to the driver. Reversing the connection will destroy your driver and void the warranty.

7 Configuring The Settings

PLEASE READ

As of August 31, 2007, the Silverpak 23D and 23DE units have new RoHS compliant boards along with a few upgrades. Below describes the jumpers on the old revision:

Configuring Settings using Jumpers (for old non-RoHS products)



Orientation of Jumpers in relation to Silverpak unit

Jumper Pin Layout

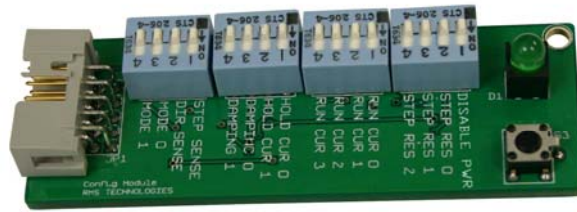
RESOLUTION	SR0	SR1	SR2
2X	OFF	OFF	OFF
4X	ON	OFF	OFF
8X	OFF	ON	OFF
16X	ON	ON	OFF
32X	OFF	OFF	ON
64X	ON	OFF	ON
128X	OFF	ON	ON
256X	ON	ON	ON

Table: Step Resolution Jumper Settings

Damping Mode	Damping 14%	Damping 35%
14%	ON	OFF
35%	OFF	ON

Table: Damping Mode Jumper Settings

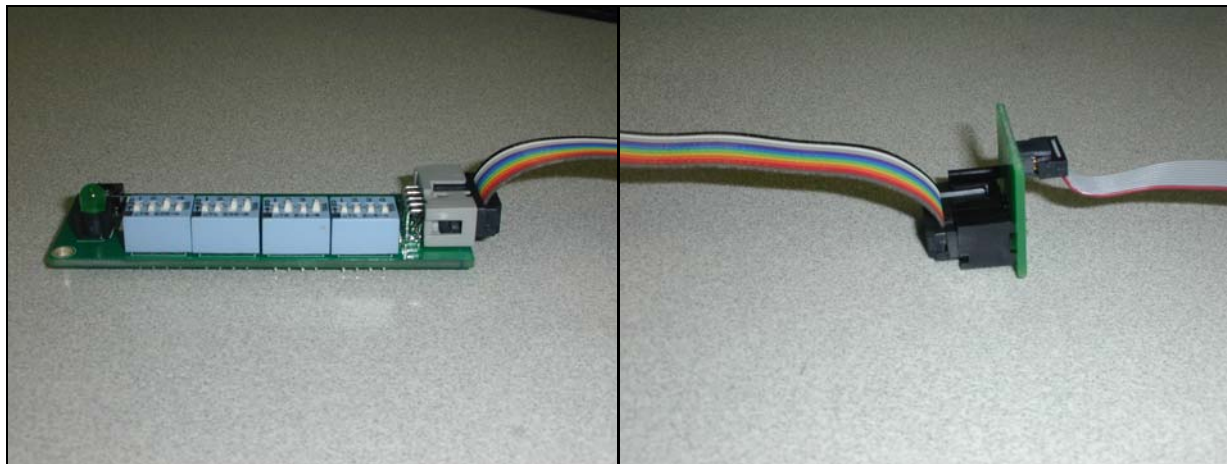
Configuring Settings using Configuration Module (for new RoHS products)



Default Settings of the Silverpak 23D or DE	
Direction of rotation	Counterclockwise
Disable Power	On – motor power is disabled when disabling unit
Step Resolution	8x step (3200 steps/rev)
Run Current	Motor's rated current or up to 3 Amps Peak if motor is rated for 3 or higher.
Holding Current	25% of motor's rated Current
Damping Mode	37% damping
Step signal sensing	Senses on the Falling edge or Negative edge
Direction signal sensing	Senses on the Falling edge or Negative edge

How to Connect the Configuration Module

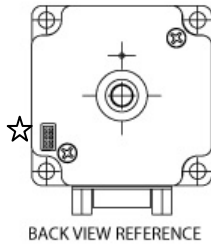
Align configuration module and small adapter board in the following orientation, and insert ribbon cable without twisting the cable:



Instructions on Using the Configuration Module

1. Power Off the power supply and Opto Supply and disconnect or power off any step, direction, and disable/enable signals. If using the internal opto supply, disconnect it.
2. Set all the DIP switches on the **Config Module** to the required positions

- Connect the **Config Module** to the SilverPak 23D or DE using the provided cable. Connector is located on bottom of the motor unit shown where the star is here:



- Only power on the MAIN Power Supply. Do not power the Opto Supply and no function generator or step pulses either. Module LED should not light up.
- Press and HOLD the black button on the **Config Module** (S3). When Black button is pressed and held the GREEN LED on the **Config Module** should light. This indicates that the settings have been stored. (Hold button for 1 to 2 seconds)
- Power Off the Silverpak 23D or DE unit. Disconnect the **Config Module** from the SilverPak 23D or DE. Reconnect all signals or power on all signals
- Power On the Power Supply and Opto Supply. (The new settings are now in effect)

Configuration Module Dip Switches

Switch	Abbreviation	Description of Function
SW1-1	Disable PWR	Disable Power On: Motor powers off when disabling unit and step is inhibited Off: Motor receives current from the last step pulse input prior to disabling the unit and step is inhibited.
SW1-2	Step Res 0	Step Resolution: A combination of these three dipswitches sets the step resolution from half step to 256x microstepping.
SW1-3	Step Res 1	
SW1-4	Step Res 2	
SW2-1	Run Cur 0	Run Current: A combination of these four dipswitches sets the run current from 0.2 Amps to 3.0 Amps Peak current.
SW2-2	Run Cur 1	
SW2-3	Run Cur 2	
SW2-4	Run Cur 3	
SW3-1	Hold Cur 0	Holding Current: A combination of these two dipswitches sets a percentage of the run current as holding current: 0%, 25%, 50%, 100%
SW3-2	Hold Cur 1	
SW3-3	Damping 0	Damping Modes: A combination of these two dipswitches sets four different damping modes for smoother operation.
SW3-4	Damping 1	
SW4-1	Step Sense	Step Sense: Step pulses entered into the driver can be read on the rising or falling edge of the pulse. On: reads on the positive or rising edge. Off: reads on the negative or falling edge.
SW4-2	Dir Sense	Direction Sense: Changes direction upon seeing a rising edge (dipswitch ON) or seeing a falling edge (dipswitch OFF)
SW4-3	Mode 0	Not activated
SW4-4	Mode 1	Not activated

*Note: Dipswitches are switched "ON" when switches are towards the RIGHT when looking at the configuration module and reading the silk screen descriptions upright. There is also a marking labeled as "ON".

Disable Power

When a driver is disabled by pulling the enable/disable pin low, the motor will stop movement and remember the location of the current waveform, such that, when enabling the unit, the step sequence is not lost and the waveform continues on.

The disable power function has two options:

ON: The motor receives no current, and is therefore considered completely disabled

OFF: The motor receives the current supplied to it at the time it is disabled, and will hold in place.

Step Resolution

Three switches are used together in order to change the motor's step resolution:

STEP RES 0	STEP RES 1	STEP RES 2	Resulted Resolution
OFF	OFF	OFF	2X
ON	OFF	OFF	4X
OFF	ON	OFF	8X
ON	ON	OFF	16X
OFF	OFF	ON	32X
ON	OFF	ON	64X
OFF	ON	OF	128X
ON	ON	ON	256X

Run Current

Four switches are used together in order to change the motor's rated current in Amps Peak.

RUN CUR 0	RUN CUR 1	RUN CUR 2	RUN CUR 3	Resulted Current (Amps Peak)
ON	ON	ON	ON	3.0 Amps
OFF	ON	ON	ON	2.8 Amps
ON	OFF	ON	ON	2.6 Amps
OFF	OFF	ON	ON	2.4 Amps
ON	ON	OFF	ON	2.3 Amps
OFF	ON	OFF	ON	2.1 Amps
ON	OFF	OFF	ON	1.9 Amps
OFF	OFF	OFF	ON	1.7 Amps
ON	ON	ON	OFF	1.5 Amps
OFF	ON	ON	OFF	1.3 Amps
ON	OFF	ON	OFF	1.1 Amps
OFF	OFF	ON	OFF	1.0 Amps
ON	ON	OFF	OFF	0.8 Amps
OFF	ON	OFF	OFF	0.5 Amps
ON	OFF	OFF	OFF	0.4 Amps
OFF	OFF	OFF	OFF	0.2 Amps

Hold Current

The motor changes from run current to hold current 2.25 seconds after the motor stops stepping. Four percentage selections are available for hold current. It is a percentage of the selected run current.

HOLD CUR 0	HOLD CUR 1	Holding %
OFF	OFF	0%
ON	OFF	25%
OFF	ON	50%
ON	ON	100%

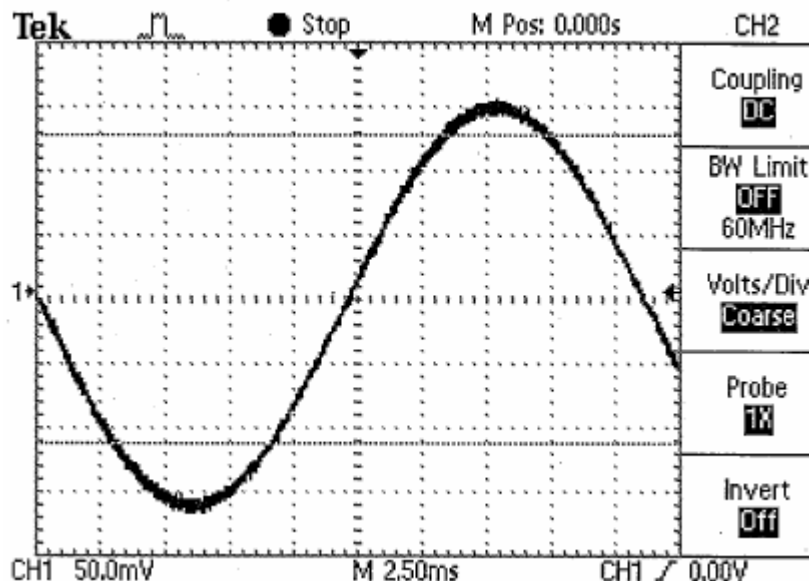
Damping

A total of four damping modes are provided in order to aid in resonance and vibration within the motor. This is also known as mixed decay. The current waveform is dampened to create a smoother motion profile. The most effective damping mode is motor dependent.

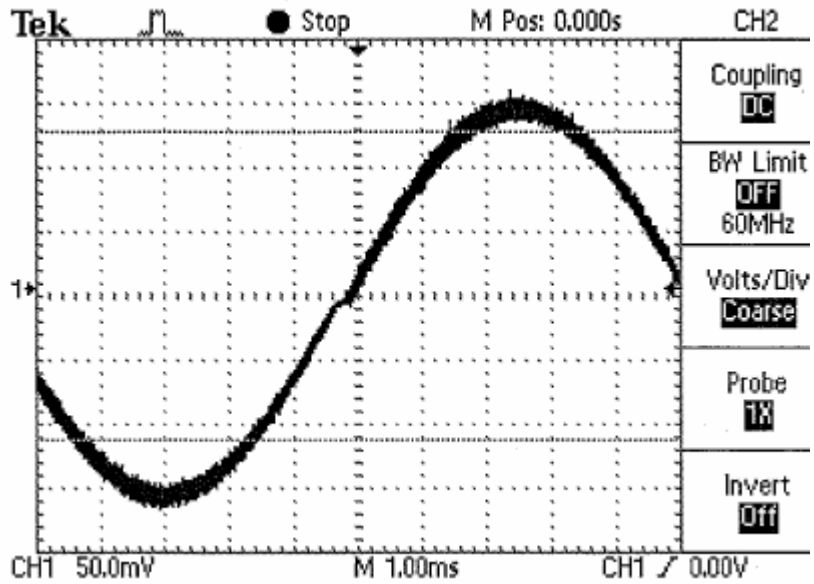
DAMPING 0	DAMPING 1	Decay type
OFF	OFF	Fast decay
ON	OFF	17% mixed decay
OFF	ON	37% mixed decay
ON	ON	Slow decay

Generally speaking, applications that run at slow speeds are recommended to use a damping factor of 17% or "fast decay". Fast speeds should use a damping mode of 37% or "slow decay". Since the best value is dependent on the motor winding, loads, power supply voltage, and other factors, it is best to use an oscilloscope and a current probe device to view the current waveform and try different PF values. The following examples show good and bad waveforms when choosing different PF values.

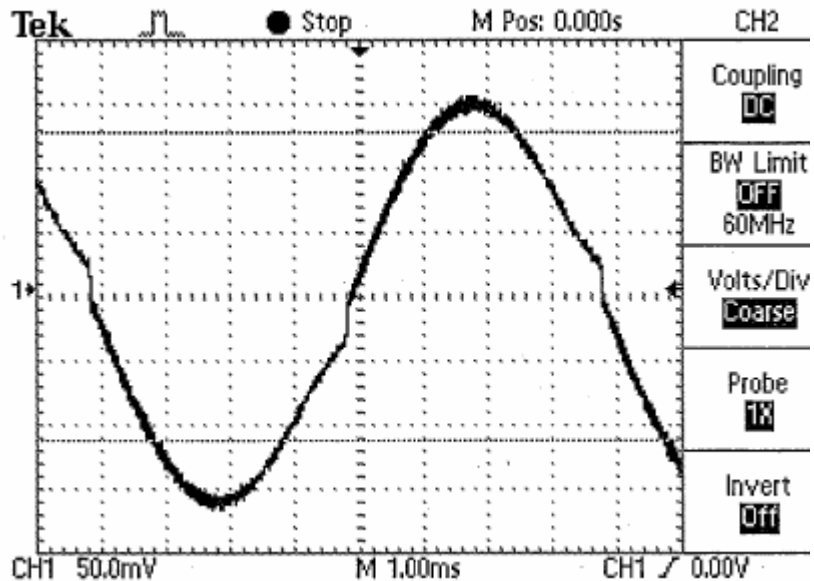
- PF value 1
- Slow speeds
- Good waveform



- PF value 2
- Slow speeds
- Bad waveform



- PF value 1
- Fast speeds
- Bad waveform



Step Sense

This feature allows for more compatibility with controllers and PLC's. The Silverpak 23D driver board receives step pulses from a pulse train, normally a TTL signal, sensing each pulse, one by one.

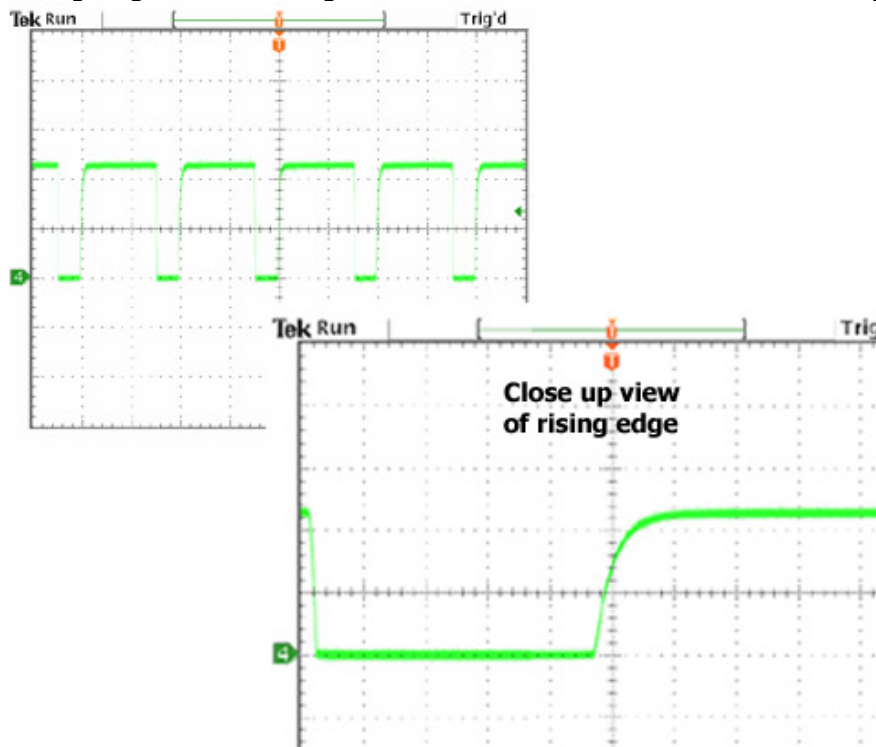
The "step sense" feature can choose where to sense each pulse: on the rising edge of the step or the falling edge (also known as the positive or negative edge).

The switch has two options:

ON: Reads the step signal on the rising edge or positive edge
OFF: Reads the step signal on the falling edge or negative edge

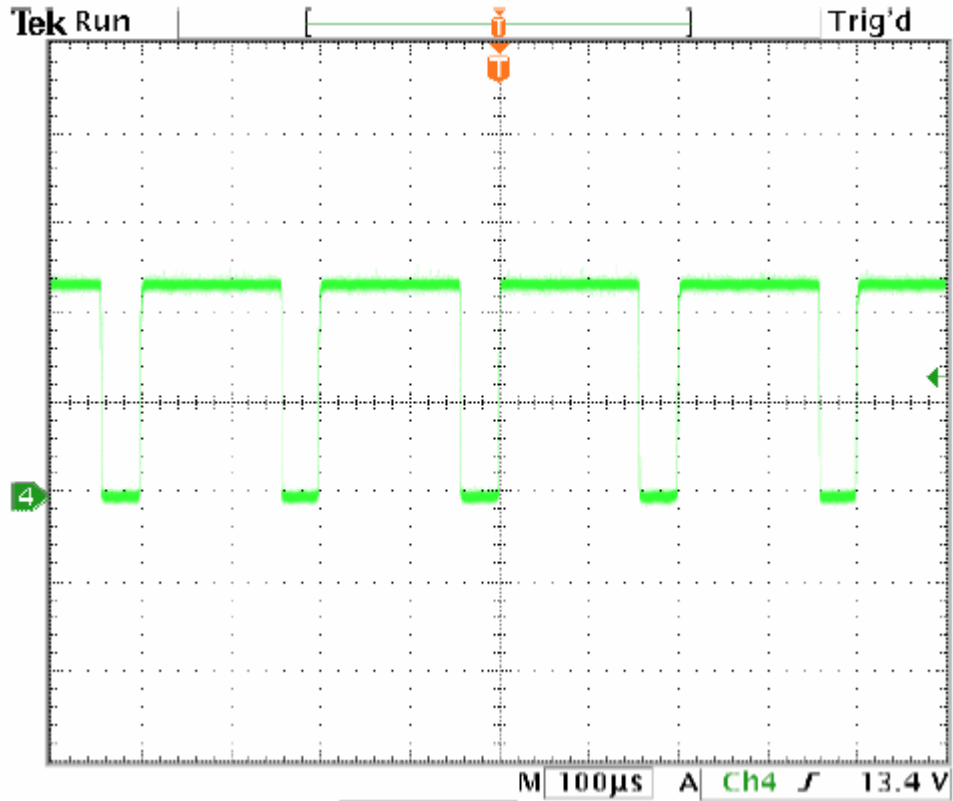
Below depicts a step pulse train waveform where the rising edge is more of a curve. If the Silverpak 23D and configuration module is set to read this type of signal on the rising edge, inaccurate steps and unsmooth motion may occur.

It is best to switch the step sensing to the negative edge, or falling edge. Notice in this example, the falling edge is a clear signal and a definite difference between high to low.



Example of a bad rising edge waveform

Below is an example of a good step pulse waveform where sensing the step on either edge would be fine:



Example of a good waveform

Direction Sense:

This is similar to the "step sense" feature where the direction of rotation can change upon seeing the rising edge of a signal or the falling edge of a signal.

The switch has two options:

ON: Changes direction on a rising edge signal (looks for a low to high transition)

OFF: Changes direction on a falling edge signal (looks for a high to low transition)

BASIC STEP AND DIRECTION OPERATION

The three control signals *Step*, *Direction*, and *Disable*, are optically isolated, with a common positive connection (usually 5 VDC).

The common positive connection (Pin 8) is typically 5 VDC. Each of the inputs is set to TRUE by supplying a signal level 5V below the common positive connection powering the optical isolators. The input is set FALSE by putting the signal within 0.5 VDC below the common positive value.

Example: If 5 VDC is supplied to Pin 8 (common positive connection), TRUE is 0V, and FALSE is any value between 4.5 VDC to 5 VDC.

For test purposes, and some applications where input isolation is not required, the internal 5 VDC supply at Pin 3 of the I/O connector can be used as the common positive connection, by linking pins 3 and 8 on the connector.

If this is done then each input is set TRUE by bringing the voltage level at the input equal to, or more negative than the Power Supply negative connection at Pin 2 and 7.

With this arrangement *Direction* and *Disable* control can be effected by simple switch closure between the input and the power negative connection at Pin 2 and 7.

If the *Step* input is obtained from a Function Generator, then careful adjustment of the Offset control is needed to ensure that the negative level of the input signal is equal to, or more negative than, the power negative connection at Pin 2 and 7.

The minimum duration of the active (negative) *Step* input signal level is 200 nanoseconds and also this is the minimum for the inactive (positive) level. This limits the maximum usable step rate to 2.5 MHz.

The optimum operating arrangement (minimum power usage) is for a constant width negative going pulse of 200 nanoseconds with the pulse interval varying with pulse rate.

For test purposes, setting the Function Generator duty cycle to 50%, and just varying frequency is satisfactory.

8 TROUBLESHOOTING

The motor is not functioning correctly

Check if power is being supplied to the unit. If the shaft of the motor is hard to turn, power is on. Next, check if the signal generator is supplying pulses correctly. Verify that the 5V is being supplied to the opto couples either via a separate power source or the internal 5V from Pin 3.

The motor is not moving

Verify that the 5V is being supplied to Pin 8.

The configuration module did not save my settings

Verify that you only have the main power on (12 to 48VDC). Even if the function generator is powered on but no step pulses are being sent, the configuration module will not work with the 23D unit. Be sure that nothing else is connected but the main power on pins 1 & 6 together for +PWR, and 2 & 7 are connected together for power GROUND.

My driver overheated and does not operate anymore

Be sure that you only used a maximum combination of voltage and current settings of 24VDC and 3 Amp Peak OR 48VDC and 2 Amp Peak. Going beyond these two combinations will overheat the driver board and are no longer under warranty.

9 Appendix A

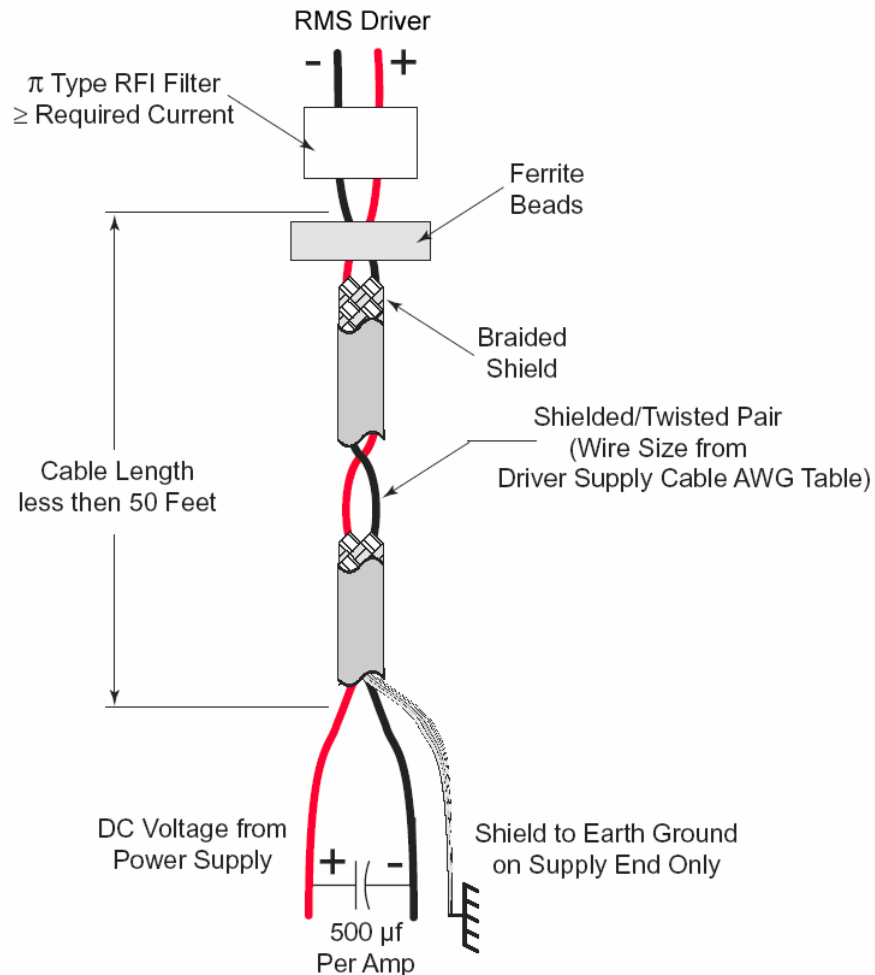
Recommended Cable Configurations: DC Supply to Driver

Cable length, wire gauge and power conditioning devices play a major role in the performance of your Lin Engineering Driver and Motor.

NOTE: The length of the DC power supply cable to the Driver 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 Driver Supply Cable AWG Table in this Appendix.



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.

Driver Supply Cable AWG Table					
1 Amp (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	20	20	18	18	16
2 Amp (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	20	18	16	14	14
3 Amp (Peak)					
Length (Feet)	10	25	50*	75*	100*
Minimum AWG	18	16	14	12	12
* Use the alternative methods illustrated in Examples B and C when the cable length is \geq 50 feet. Also, use the same current rating when the alternate AC power is used					

Driver Supply Cable Wire Size

NOTE: Always use Shielded/Twisted Pairs for the Driver DC Supply Cable, the AC Supply Cable and the Driver to Motor Cable.