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# B4001

# Brushless

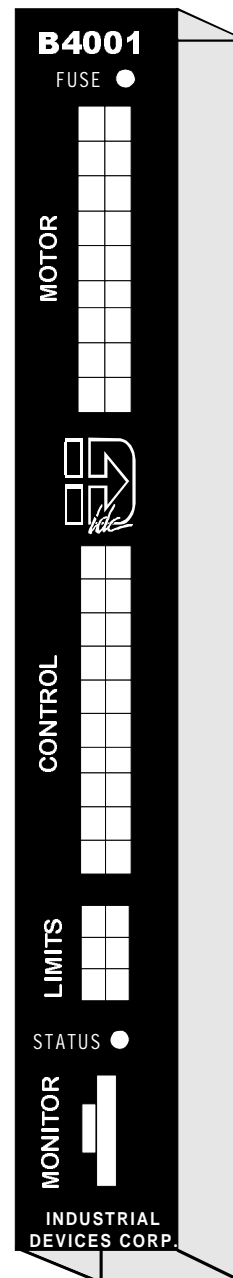
# Servo Drive

## Operator's Manual

P/N PCW-4818 Rev. 1.0 11/96

This manual covers the following IDC Products:  
B4001— Brushless Servo Drive

INDUSTRIAL  
DEVICES  
CORPORATION





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# Product and Manual Overview

The B4001 is a 9 amp continuous, 23 amp peak, digital brushless servo drive using state of the art DSP technology to provide high performance closed loop servo control to a wide variety of permanent magnet brushless servo motors offered by Industrial Devices Corporation. The B4001 design is based on the field proven DSP technology used in the IDC's higher power B8000 Series of brushless servo drives. The insures that the B4001 will deliver the same exceptional performance that our B8000 Series is known for. The B4001's bus-able, 24-75 VDC power input makes it economical for multi-axis motion control applications. Low cost cables and Molex style connectors make the B4001 a cost effective choice for OEM machine builders and system integrators.

Compact and easy to mount, the single axis drive is designed for easy setup and operation. The B4001 can be driven by a step and direction or analog command signal from a motion controller. The step and direction signal can control position, velocity, and torque, while the analog command signal controls torque or velocity.

The B4001 drive is fully software configurable. Optimized motor data files for IDC motors are supplied with the *IDCMotion*<sup>™</sup> disk set and can be further customized for a specific application using *Servo Tuner*, an advanced, yet easy to use tuning software. This MS-Windows<sup>™</sup> interface communicates with the B4001 via an RS232C serial link, allowing the user access to a clear and intuitive menu set. Through *Servo Tuner*, the user can upload and download motor configuration files as well as manually adjust the individual servo tuning parameters. On-board diagnostic monitors allow you to connect an oscilloscope to selectively view the dynamic response of your system. For repeat systems, tuning parameters can be stored on diskette and simply downloaded to subsequent B4001s.

The B4001 Servo drive manual is divided into four main sections. The first section consists of a product overview and a manual outline. The second, *Quick Start*, gives an abbreviated setup and test procedure to confirm the basic functionality of the drive/motor system. The third, *Installing and Configuring Your Drive*, covers in detail all the hardware connections needed for proper operation. It also covers the initial software setup and drive configuration, as well as details on DC power supply sizing. More information on using *Servo Tuner*<sup>™</sup> to optimize system performance can be found in the *Servo Tuner* manual. The last section, *Troubleshooting* provides a quick symptom / cause / remedy chart for tracking down setup errors and operating faults. If you cannot find the information that you need in this manual, please contact IDC's Applications Department . [(800) 747-0064 or (415) 883-3535]

## B4000 Series Features

- Expanded torque-speed leads to higher throughput
- Vector control offers improved torque and velocity control when compared to sinusoidal or hall effect commutation.
- High bandwidth, closed-loop operation for consistent performance
- Ease of integration speeds time-to-market
- Ease of setup during production lowers costs
- Smooth, non-resonant performance is easy on machinery
- Efficient, cool-running operation
- Enhanced reliability by design

## B4001 Compatibility

IDC's B4001 digital amplifier is compatible with most manufacture's brushed and brushless servo motors. The motors must be supplied with encoders and be rated for the B4001's 75 VDC maximum bus voltage. For a one time charge, IDC will create and supply the custom software configuration file that the B4001 will require.





# Quick Start

## Objective

The purpose of this 4 page “Quick Start” chapter is to help an experienced servo amplifier user quickly set up and bench test a standard IDC drive/motor system. It is not intended, nor should it be, a substitute to thoroughly reading and understanding the complete manual. Since the operation and tuning of the DSP based, vector controlled B4001 differs significantly from a traditional PID compensated analog servo amplifier, it is important for even experienced users to read the entire manual before connecting a load to any IDC motor.

IDC encourages first time B4001 users to purchase a B4001 evaluation kit to aid in a trouble free start up and system integration. These evaluation kits include an IDC motor, pre-wired cables, and a DC power supply. The following “Quick Start” procedures assume that the user has a fully functional cable set. While applicable to customer supplied cables, the directions assume that the user has access to IDC supplied and tested cables.

This procedure also assumes that the user has a PC available with MS Windows installed and running. The B4001 has no hardware accessible test functions. Without a PC and IDC’s Servo Tuner software, the amplifier can be powered up to confirm the proper function of the status LED, but no functional testing is possible.

### **Caution:**

When using the B4001 with a non-IDC motor please contact the IDC Applications department at (415) 883-3535 for start up assistance. The B4001 requires a motor specific data file to be downloaded for proper motor operation. The IDC motor files included on the IDCMotion disks could potentially damage other motors.

The “Quick Start” section consists of three main steps.

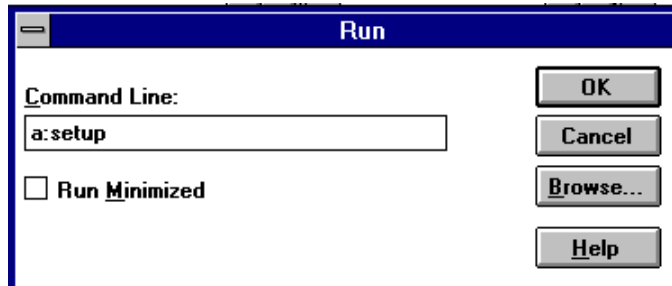
- Install IDCMotion™ on your computer.
- Connect the motor, encoder feedback, and power cables as shown in *Wiring*.
- Follow the directions in *Test Procedure* to power up the amplifier and confirm basic functionality of the drive/motor system in a non-loaded, bench top environment.

If you have any questions please consult the appropriate chapter with a full feature description later in the manual.



## Install IDCMotion™

After starting Microsoft's Windows (version 3.0 or later), insert Disk 1 of IDCMotion and from the **File** menu select **Run** and type *a:setup* as shown below and click on **OK**. From Windows '95, access this dialog box from **Start/ Run**.



The installation program will display a Welcome/Registration screen. Throughout the installation process, the program will prompt you to enter information, and then click on the **Next** button to continue the installation. At any point during the installation, you can hit **Cancel** to abort the process. Select the **Typical Installation** when prompted to do so. Please consult the Installation sheet that came with the IDCMotion™ disk set if you have any questions or problems.

## Test Procedure

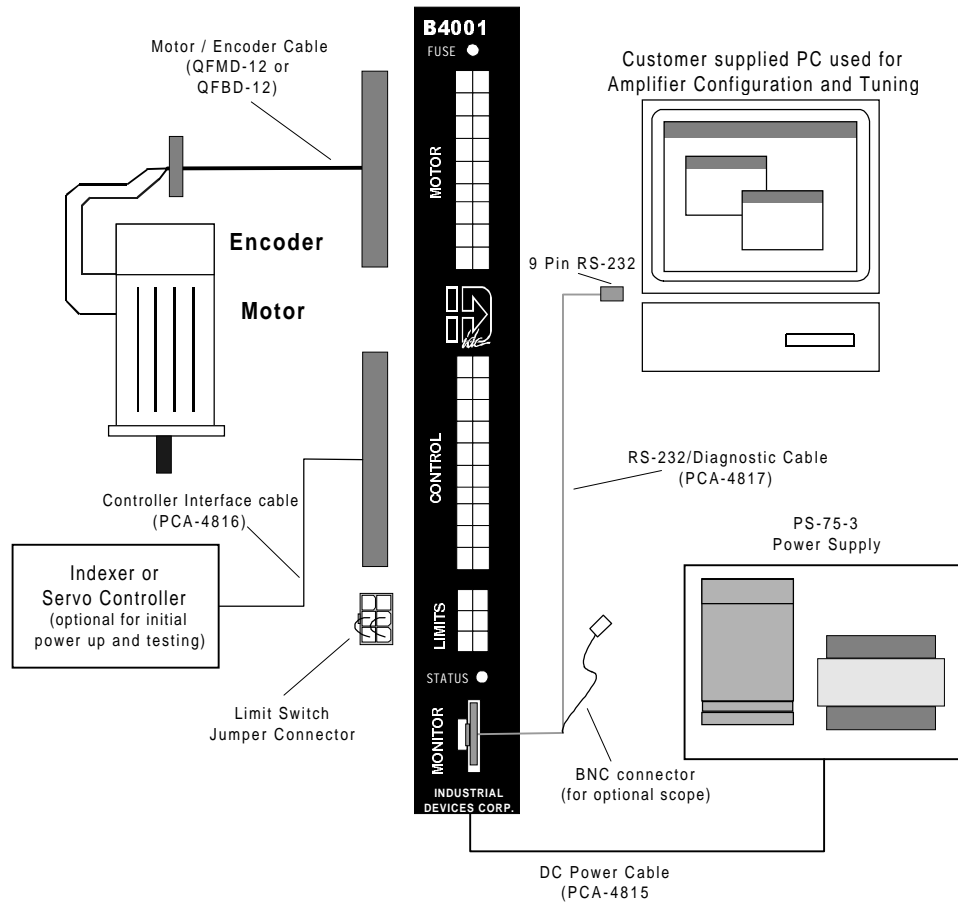
A PC running MS Windows will be needed to do any functional testing of the drive/motor system. If a PC is not available, just confirm that the drive powers up when power is applying. The power LED should flicker at 24 Hz. If the power LED blinks slowly, see the Fault Code list in the Troubleshooting chapter of this manual to resolve the problem.

### 1. Connect control and power cables.

Follow the diagram below in connecting all your B4001's cables, including the RS-232 line to your PC. IDC part numbers are shown in parentheses. All connectors are keyed and IDC cables are labeled to prevent mis-wiring. Connect the DC power cable, but don't connect AC to the power supply yet. Don't plug in the Motor / Encoder cable until the proper motor configuration file has been downloaded.



## Wiring



### 2. Configure the B4001 to your motor.

Start *Servo Tuner* by double clicking on the motor icon created by the installation program. After confirming that the motor/encoder cable is NOT connected, connect AC power to the PS75-3 DC power supply. As the drive powers up, the upper left hand corner of the *Servo Tuner* menu bar will change from OFFLINE to ONLINE as *Servo Tuner* establishes communication with the drive.

The drive must come ONLINE before any further tests or procedures can be carried out. If the drive doesn't come ONLINE, check to see that it has power (confirmed by the flickering STATUS light). Then check the COM PORT selection and confirm that the drive is connected to the COM port selected.

When *Servo Tuner* is ONLINE with the B4001, select **File/Load Configuration**. Select the B4001 directory. A list of motor model numbers will appear, followed by a letter designating the encoder option (I or X) and the voltage level. Select your motor and click on OK. The cursor will turn into a black square as motor data and tuning parameters are downloaded.

Example: Motor Model M3450-XI (Motor model numbers are on the motor case)  
The first letter in the suffix (X) indicates a face mounting option.  
The second letter (I) indicates the I encoder option. Configuration file M3450I75.mtr should be selected and downloaded.





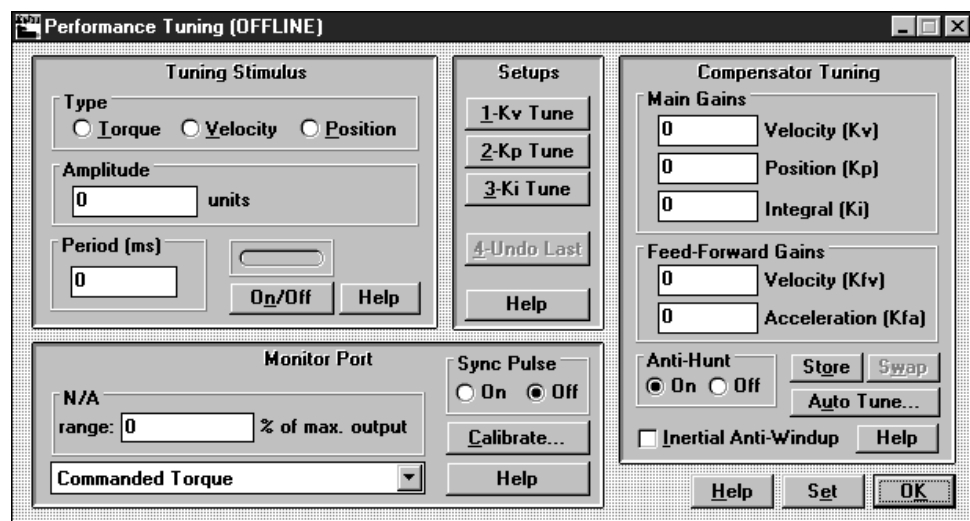
**3. Connect motor to the drive.**

Remove power from the drive and connect the motor/encoder cable. Power the drive back up, confirm the ONLINE status from Servo Tuner. Flip the black ENABLE switch found on the controller cable.(IDC supplied cable only) Confirm that Servo Tuner's yellow DISABLED changes to ENABLED. Make sure that the motor has holding torque.

**4. Confirm motor/encoder operation.**

From *Servo Tuner* select **Setup/Performance Tuning**. The upper left hand quadrant of the Performance Tuning window contains the Tuning Stimulus controls.

- i. In the Toggle Generator section select the Position radio button, change the Period to 500 ms, and change the amplitude to 500 steps or ½ motor revolution.



- ii. Connect the Enable input on the drive to Common. There should now be holding torque at the motor shaft and Servo Tuner should show the drive as ONLINE and ENABLED.
- iii. Click on the ON/OFF button in the toggle section. The motor will now move back and forth 500 msec.
- iv. Click on the ON/OFF button to stop the toggle generator and power down the drive.

You have now confirmed that the power, motor, feedback, limit, and enable inputs are all functional on the B4001. If any of these steps were unsuccessful, check the trouble shooting section of the manual, or the installation section for more detailed information. You are ready to go on to the Installation section of this manual.

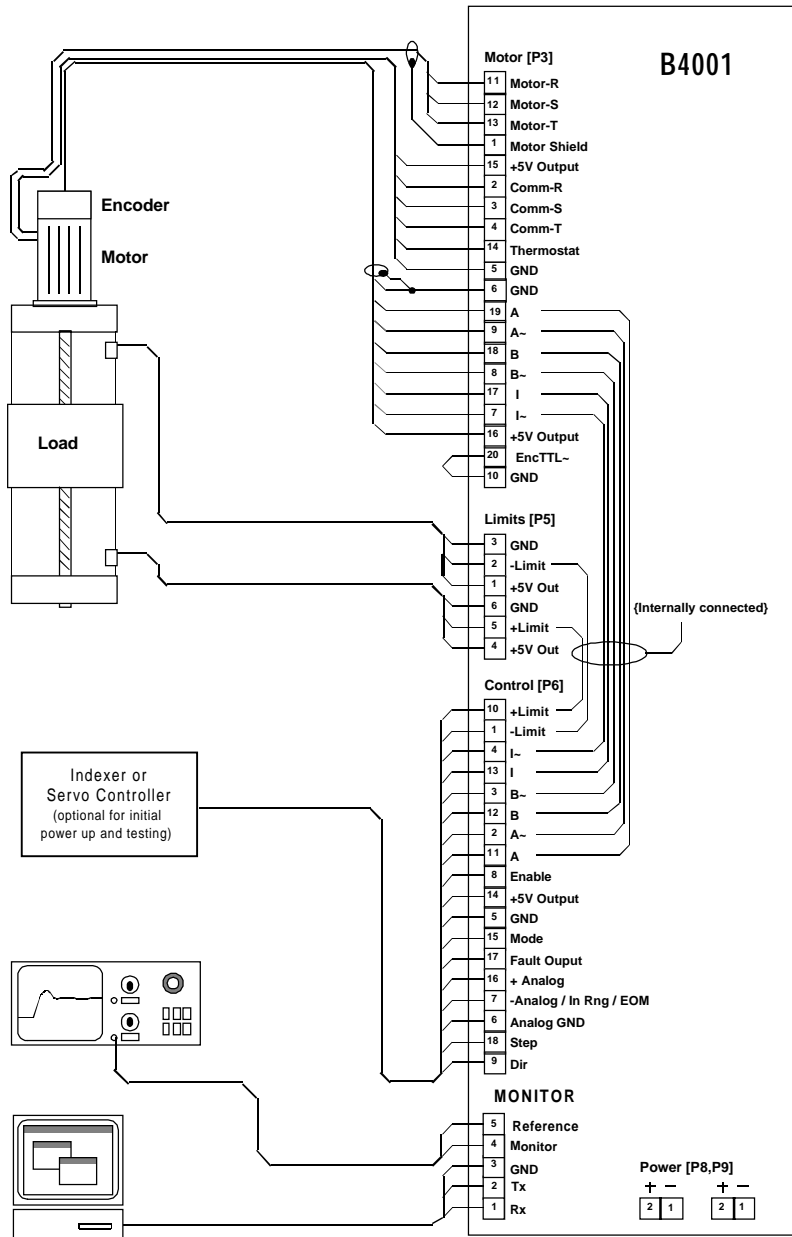
**Where to go from here:**

Controller interface cable signal descriptions and color codes	p.10	
Servo Tuner software configuration		p.15
Motor mounting dimensions	p.45	
Power Supply sizing and specification	p.30	
Drive Input and Output descriptions	p.13	
Troubleshooting	p.43	



## Installing and Configuring Your Drive

The design of the B4001 minimizes the amount of wiring necessary. Pre-wired cables are available for the Motor, Feedback and AC Power connections. In most cases, a single additional cable connecting to the limit switches and another connecting to the motion controller is all that is required. The following pages in this section describe the necessary wiring and the available hardware features. A physical layout of the drive hardware connections is shown below. Drawings showing the drives dimensions can be found under the *Drive Mounting* heading at the end of this chapter.





The installation and configuration of the B4001 can be divided into Hardware and Software categories.

The specific hardware connections needed will vary with the application and the controller being used. Though every application will obviously require power, motor, and encoder wiring, most of the other inputs and outputs are optional. Hall effect commutation sensors are optional, though they come standard with all IDC supplied servo motors and cables.

The control inputs and outputs used will vary with the type of controller, and the specific application requirements. What follows are some guidelines as to the minimum connections required for analog and digital control schemes, as well as some suggestions as how to best utilize the optional I/O to meet your unique application requirements. A more complete description of the I/O signal and functions are later in this chapter. The following lists are intended to give a broad overview of the required, and available, control and feedback signals.

### **Important:**

Both analog and step and direction control schemes require the user to download the appropriate software parameters to the drive before any motor motion is possible. See the *Software Configuration* section later in this chapter.

## **Step and Direction Control Hardware Connections**

### **Required Hardware Connections:**

1. Enable input from the indexer's shutdown output
2. Step Input from indexer's step output
3. Direction Input from indexer's direction output

### **Optional Hardware Connections:**

1. +/- Limit Ins from the End-of-Travel switches. Please note that these inputs require a Normally Closed type switch for amplifier operation.
2. Fault output to the indexer's fault input. Used to signal the indexer of a fault condition. With the exception of a thermal fault, fault conditions disable the B4001. All fault conditions can be cleared by toggling the Enable input.
3. Range Out / Move Done output. This output can be used to coordinate sequential moves or operations. For example, a stamping operation would require that the motor be in position and settled before the actual stamping.
4. Mode input, used to toggle the drive between position and torque mode. When left open, the drive defaults to position mode.
5. +/- Limit output to the Indexer End of Travel limit inputs. These outputs are hardwired to the B4001's Limit Inputs.
6. Encoder outputs to the indexer encoder inputs. The encoder signal is the actual hardware encoder signal from the encoder. It is not software buffered, or scaled, and does not *necessarily* match the software scaleable input resolution of the drive

## **Analog Torque/Velocity Hardware Connections**

### **Required Hardware Connections:**

1. Enable input from the servo controller's enable output.
2. The **Mode** input must be jumpered to **Common** to run in torque mode. The amplifier will run in velocity mode if this input is left open. The velocity scale used in velocity mode can be changed from the **Inputs and Limits** screen in Servo Tuner.



## Chapter 3 - Installing and Configuring Your Drive

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3. Analog +/- inputs from the servo controller's +/-10VDC torque or velocity command signal.
4. Encoder output signals from the B4001 to the servo controller's encoder inputs.

### **Optional Hardware Connections:**

1. +/- Limit Ins from the End-of-Travel switches. Please note that these inputs require a Normally Closed type switch for amplifier operation.
2. Fault output to the controller's fault input. Used to signal the controller of a fault condition. With the exception of a thermal fault, fault conditions disable the B4001. All fault conditions can be cleared by toggling the Enable input.
3. +/- Limit Outs to the Indexer EOT limit inputs. These outputs are hardwired to the B4001's Limit Inputs.

Please see the detailed explanations later in this chapter for the specific I/O hardware details needed for interfacing the B4001 to your indexer or servo controller.



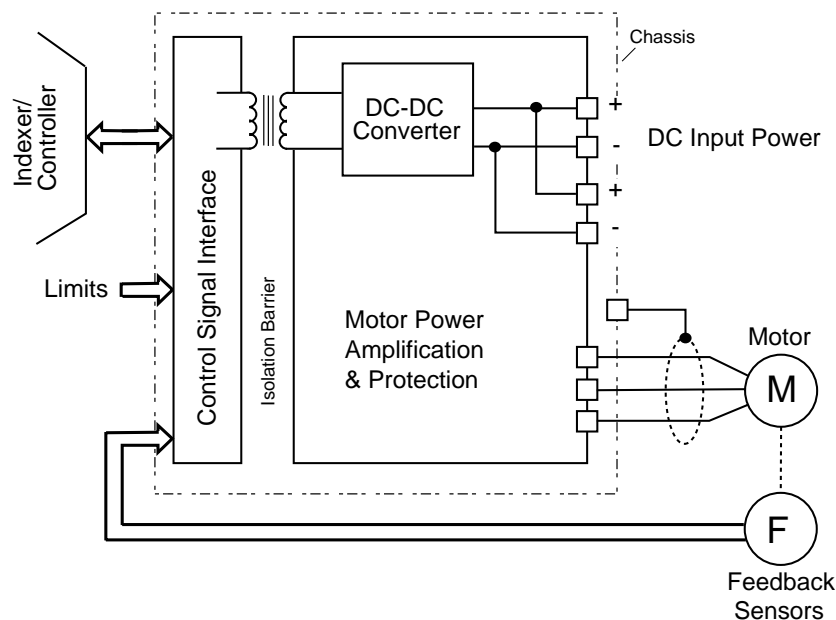
## Important Notes Before Installing the B4001

### Static Precautions

When installing a B4001 drive you should observe the same static sensitive procedures as you would for any piece of electronic equipment. Although most of the B4001 inputs are protected from small amounts of electrostatic discharge (ESD), it should not be considered immune to ESD. The use of wrist straps is preferred during installation. Note that both the control signal ground and the case ground should be used for grounding the unit for ESD protection purposes during installation.

### Electrical Isolation

In order to eliminate the possibility of ground loops in B4001 systems, the control signal ground (GND), power circuits and chassis are each electrically isolated from each other as shown below.



All of the control signals used by the indexer/controller are electrically isolated from the B4001's DC power input and motor output circuits as well as the B4001 chassis (Case Ground). This feature insures that currents will not be induced into the indexer/controller wiring by motor and/or power supply currents.

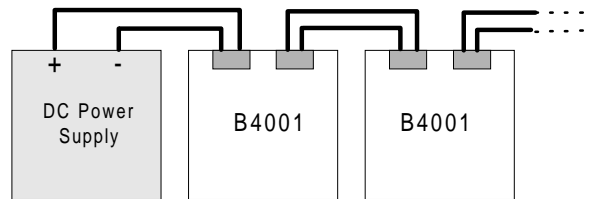


# B4001 Installation and Wiring

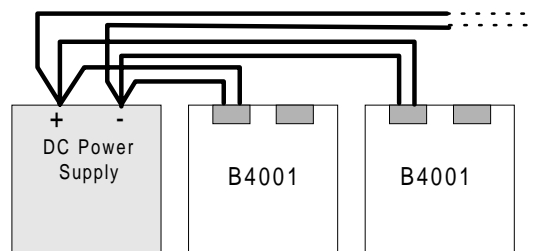
## Power Supply

The B4001 runs off unregulated DC voltages from 24 to 75 volts. A bulk, linear supply (essentially a transformer, bridge rectifier and capacitor) with a large output capacitance (for minimum droop at high current draw) is best. Aside from being inexpensive, this kind of supply can source large peak currents relative to its RMS rating. This is exactly what is required by a high-performance servo system. Most regulated power supplies have current limiting to protect themselves in case of an overload. When high current is drawn from the supply, the voltage drops until the current ceases. This will cause reduced performance at best, and, if the voltage drops below 24 volts, may cause the B4001 to cycle off and on. Most switching supplies are ill-suited to servo applications for two reasons: (1) they usually have identical peak and continuous current ratings, forcing you to purchase a large but under-worked supply and (2) when motors are de-accelerated they pump current back into the supply. Most switchers are not built to accept this and may shutdown or, in the worst case, fail.

Each B4001 has two identical bussed power connectors. The power circuitry is electrically isolated from both signal ground (GND) and the chassis. This allows power to be daisy-chained from one B4001 to the next for a minimized wiring harness without fear of creating ground loops in the system. The power connectors are rated at 15A RMS. If the RMS current for a group of B4001s is less than 15A (see the section on Power Supply Current Requirements), they can safely be daisy-chained. Otherwise traditional “star” power distribution is required. In typical incremental positioning applications, at least five B4001’s can be wired in a daisy-chained manner.



"Daisy Chain" Power Distribution



"Star" Power Distribution

The power wiring should be constructed with 14AWG wire or lower gauge (larger) wire. The AMP Universal Mate-N-Lock power connectors will accept wire as large as 10AWG. The wire should be sized to limit the voltage drop to less than 2V under peak current demand.



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If you are using a power supply without an AMP Universal Mate-N-Lock power connector, you can simply cut off one of the connectors on an IDC DC power extension cable and connect the white wire to the positive output terminal of your supply and the black wire to the negative terminal.

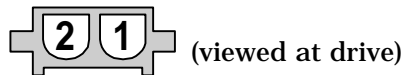
### Caution:

**Use care when connecting to your power supply. Reversing the supply polarity can damage your drive. Polarity is shown below for use in making your own cables.**

Power Connector on Drive (not cable connector)

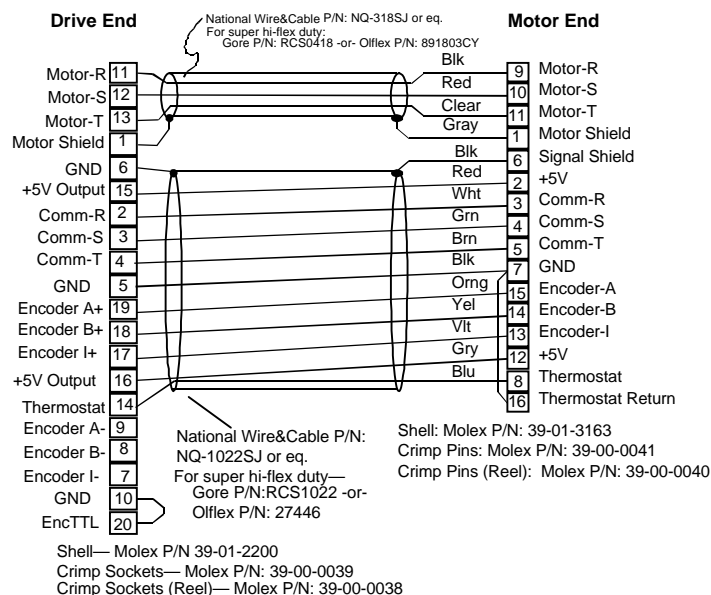
AMP Universal Mate-N-Lock, mates with  
p/n 1-480-698-0

1. Power Return
2. Power + (24-75VDC)



## Motor and Feedback Wiring

Each IDC M Series Motor used with the B4001 comes with a short cable and connector containing motor power, hall effect and encoder signals. Industrial Devices can supply pre-wired 12 ft cable(s) (longer cable length are available, contact IDC for details) and mating connectors with each motor. Details on this motor cable are shown below for customers who plan on supplying their own motor cables. Information on the B23-W motor cable used with the B4001 can be found in the Hardware Reference section of this manual.





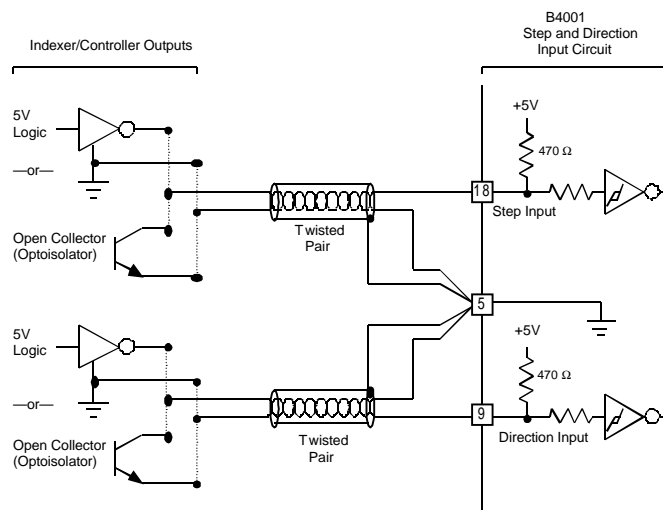
### Input Command Signals

The B4001 can be driven by a step and direction or analog command signal from a motion controller. The step and direction signal can control position, velocity, and torque, while the analog command signal controls velocity or torque. See the **Hardware Reference** section for complete electrical specifications.

#### Step and Direction Inputs

The step and direction command inputs are designed to connect directly to industry standard TTL level or open collector step and direction output signals provided by indexers or PLC's. Twisted pair wiring should be used for these signals with shielded twisted pair wiring being preferred.

The maximum step input frequency is 1.5Mhz. (A 2Mhz input frequency option is available. Please contact the factory for details.) The motor will be commanded to take one step for every rising transition on the step line when the *MODE* line is not grounded. When the *MODE* line is pulled to ground, the frequency of the signal on the step input is proportional to the torque of the motor. Information on the use of the *MODE* input is available later in this chapter.



Because The B4001 responds to Step and Direction signals as fast as 1.5MHz they will also respond to fast pulses that can be generated by noise as well. The most common source of spurious Step and Direction pulses is conducted noise due to several digital signals sharing a ground path with the Step and Direction signals, therefore:

CARE SHOULD BE TAKEN TO GROUND THE TWISTED PAIR WIRING FOR THE STEP AND DIRECTION SIGNALS DIRECTLY AT THE INDEXER CARD'S OUTPUT CONNECTOR, NOT AT A CENTRAL SYSTEM GROUND, FRAME GROUND OR OTHER GROUND POINT. USING A "BREAKOUT BOARD" SHOULD ALSO BE AVOIDED BECAUSE THE CABLE BETWEEN THE INDEXER BOARD AND THE "BREAKOUT BOARD" TYPICALLY SHARES THE STEP AND DIRECTION SIGNAL'S GROUND PATH WITH OTHER DIGITAL SIGNALS.





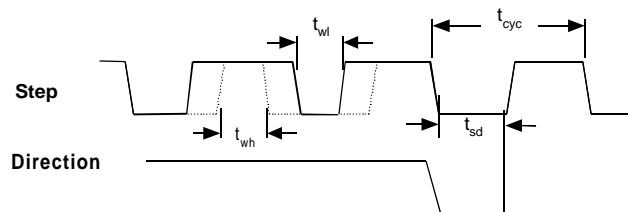
**Note on making reliable connectors:** Several of the wiring diagrams show multiple wires connected to one crimp pin (generally the logic ground, pin 5). When doing this, it is helpful to crimp only one wire into the pin (or, at most, two wires) and then solder additional wires to that. Don't attempt to crimp more than two wires to one pin—it will be an unreliable connection.

If your system exhibits any “walking”, drifting or repeatability problems it is likely that the Step and Direction wiring is at fault. Recommended wiring and termination is shown above for these signals.

In cases where the above wiring recommendations have been followed and “walking” or drifting is still a problem, a small capacitor may be added across the Step and Direction inputs to suppress the noise. A typical value for these capacitors is 1,000pF (.001μF). This usually works well for indexers that put out signals up to 200,000 steps/second. This capacitor should only be added, however after the proper grounding and shielding detailed above has been implemented and this fails to cure the problem.

### Step Polarity and Timing

The B4001 will be commanded to rotate one step when the Step line makes a transition from a low level to a high level (known as “positive edge triggered”). The required timing for both the Step and Direction signals is shown below.



The minimum time for  $t_{wl}$  and  $t_{wh}$ , is 400nS. The minimum time for  $t_{cyc}$  is 800nS. There is no maximum limit for any of these timing variables. The direction line must be stable at least 400nS before steps can be taken in the new direction.

### Direction Polarity

With a standard motor cable the Direction line will have the following effect: With Direction at a high level, the motor will rotate clockwise (when viewing the output shaft of the motor) for each pulse of the Step line. When the Direction line is at a low level the motor will rotate counter-clockwise.



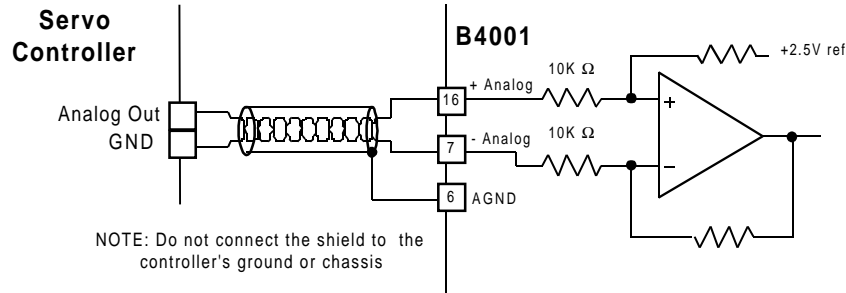
## Chapter 3 - Installing and Configuring Your Drive

### Analog Command Inputs Analog +, Analog -, Analog GND

An analog command input is provided on the B4001 for use with analog servo controllers. The analog input responds to +/-10Vdc input signal which can be used to control torque or velocity. When the analog signal is used to control velocity the maximum speed which corresponds to a full 10V input can be scaled using *Servo Tuner*. The *MODE* line configures the analog input as a velocity or torque signal. The analog input is a differential input which reduces the effect of common-mode noise. For optimum noise immunity shielded twisted pair cable wiring should be used with the shield terminated at the drive end only.

Note:

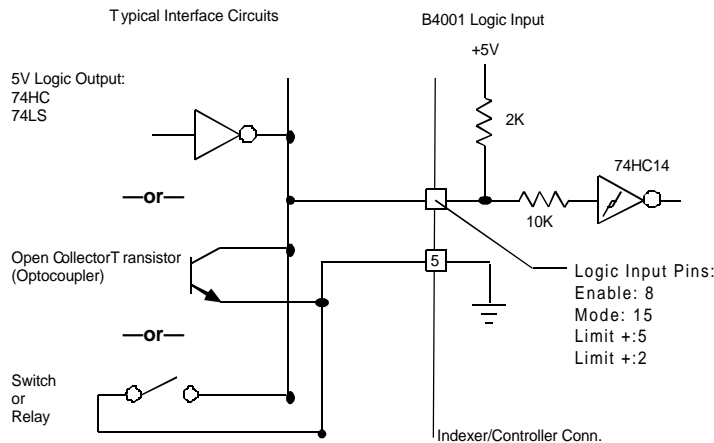
Due to the digital nature of the B4001, when running in analog velocity mode, a “commanded position” set-point is derived from the velocity command signal. Therefore the Tracking Limit, set from the **Input and Limits** screen of *Servo Tuner* is still an active safety shutdown feature. A servo controller is still required to close the position loop.



### Digital Control Inputs

All of the logic control inputs: Enable, Mode, Limit + and Limit- on the B4001 have the identical input circuit shown below.

### Digital Input Schematic- Input wiring diagram showing typical connection types



This circuit can be driven by TTL & 5V CMOS logic outputs, open collector outputs, opto-isolator outputs from your indexer (controller), or a simple switch or relay. Wiring for interfacing to each of these inputs is shown above.



### Enable

The Enable input is used to enable the power stage of the drive. When the input is on (connected to ground), power will be applied to the motor. When the input is off (open circuit high), the motor will be de-energized (allowing the motor shaft to spin freely). In the event of a fault shutdown, the Enable input can be used to clear the fault. Toggling the input off and on will clear the fault and re-enable the drive.

### Mode

The Mode input switches the B4001 between two operating modes, position/velocity control mode and torque control mode. When the input is on (connected to ground), the drive will be in torque control mode. When the input is off (open circuit high), the drive will be in Position mode if being controlled by a step and direction signal. It will be in velocity mode if being controlled by an analog signal. For more information on toggling the drive between step mode and analog mode, see the *Inputs and Limits* section of the *Servo Tuner* manual.

The state of the Mode signal can be changed at any time. The B4001 responds to a signal level change within 120 $\mu$ S. If you want to switch between the two modes “on the fly,” the MODE input should be controlled by an output from your indexer or servo controller. If the Mode of control is to be permanent, the input should be left disconnected when using position/velocity control, and should be hard wired permanently to common if using the torque mode.

### +Limit In, - Limit In

The +Limit and -Limit inputs are provided for safety shutdown of the motor in case of over travel. The inputs are configured to operate with normally closed switches only, so that under normal operating conditions, the inputs should always be active (connected to ground). When an input is off (open circuit high) via a tripped limit switch or a break in the circuit elsewhere, motor motion will cease.

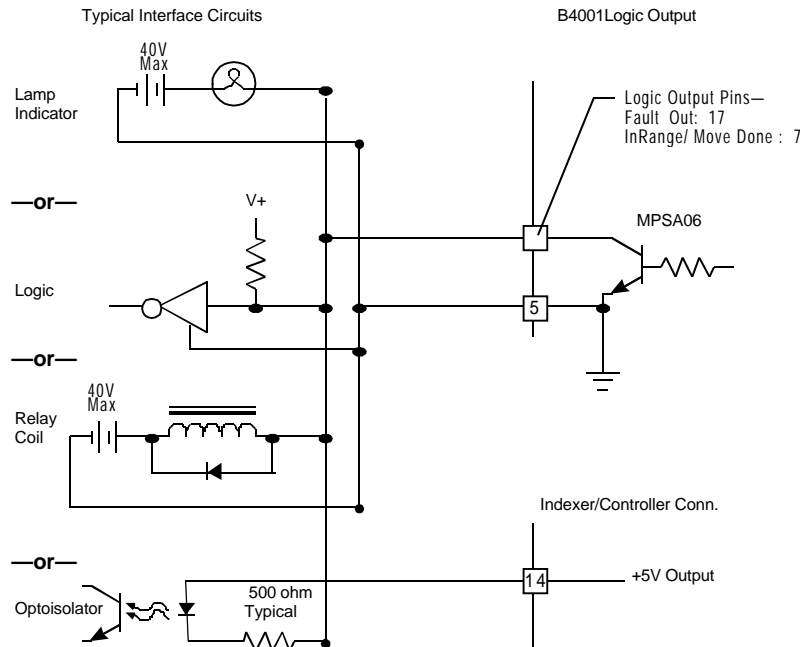
Two limit modes are available. In the default mode, when a limit switch is made, motor torque in that direction is clamped to zero. This will cause the motor to coast to a stop. A second mode is available, where the motor position is latched when that limit is made. The B4001 then servos the motor to this position. This mode is most often used in vertical ballscrew applications where the load would otherwise back-drive into a physical end of travel. Because of the instantaneous commanded velocity change this optional operating mode should be used with caution. Please contact IDC for details if your application requires a position limit. *If limit switches are not used in the B4001 application, both limit inputs must be connected to ground.*



### Digital Outputs

Both the In-Range / Move Done and Fault output circuits are open collector outputs without pull-up resistors, they are rated for switching non-inductive loads up to 40V at a maximum of 100mA. These outputs are compatible with TTL and CMOS logic inputs when a pull-up resistor is used. They can also be used directly to switch non-inductive loads such as lamps or LEDs. If you wish to use these outputs with an inductive load such as a relay coil, a snubber diode across the winding must be connected, as shown below, across the coil to prevent the inductive spike from damaging the output transistor.

### Logic Output Schematic-Internal Circuit Diagram of Outputs



### Range Out / End of Move

The Range Out signal is turned on (sinks to ground) when the following-error (instantaneous difference between the commanded position and the actual position) of the B4001 is more than a pre-programmed limit. This limit is set, in user units, from the **Inputs and Limits** screen in Servo Tuner. It can be used as a synchronizing signal when making point-to-point moves or it can be used as a following-error flag to alert your indexer/controller to reduce the feed-rate in contouring applications.

When the B4001 is in Step and Direction positioning mode this output can also be configured as an End-of-Move signal. In the **Inputs and Limits** screen of Servo Tuner, the user can specify an end of move position window and settling time. After the motor is within this position window for the time specified by the *time qualifier*, the End of Move signal will turn on.

The *time qualifier* is intended to allow end of move ringing to settle before signaling another device that the move is actually over. The End of Move option can not be used during ultra-slow speed moves if the period of the pulses the B4001 is receiving is longer than settling time specified.



### **Fault**

The Fault output signal is a normally active (sinking) output. When a fault is detected in the B4001 drive or motor, this output is turned off. The drive is shut down immediately if the fault was caused by over current, over voltage, or RMS over-current. However, if the fault is caused by a motor or drive thermal overload, Fault Out will turn off immediately, but the drive will not be shut down for 5 seconds. This gives your indexer/controller time to bring the axis to controlled stop during a thermal fault.

### **Limit + Out, Limit - Out**

The Limit + and Limit - outputs are hardwired directly to the B4001's limit inputs. These pins are provided as a wiring convenience only.



### Encoder Interface

Incremental encoders can be furnished with one of two types of output drive circuits: Single-ended or differential. Single-ended outputs are usually TTL driven lines or open collector outputs. Differential output circuits have two driven balanced output lines for each signal. The B4001 can accept either single-ended or differential encoder signals.

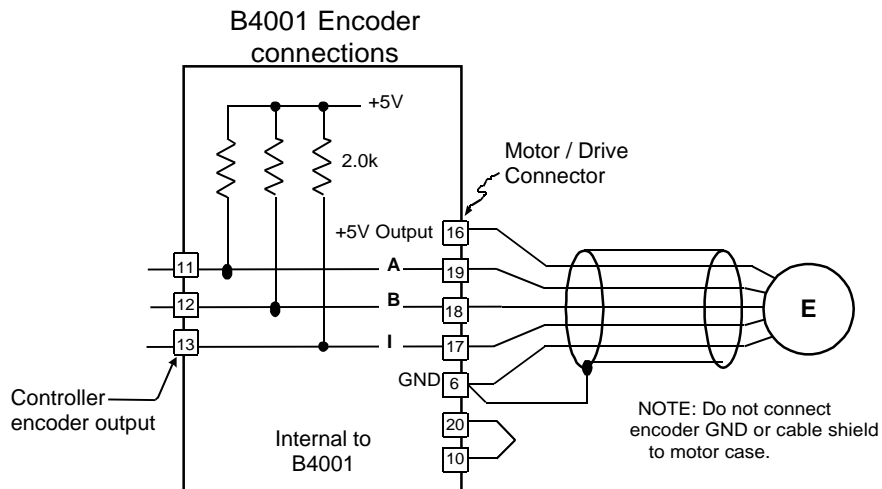
### Single-Ended Encoders

All standard IDC M series motors incorporate a single-ended encoder for position/velocity feedback. The particular encoders used on our motors have rugged mylar optical disks and fault-tolerant read sensors for high reliability.

Encoders with single-ended outputs are the most common and least expensive type of encoder. Properly terminated and shielded, this signaling method provides excellent fidelity for cable runs up to 25 feet. In some industrial circles, however, single-ended encoders have an *undeserved* reputation as being noise susceptible. Yet they are no more noise susceptible than any other TTL digital device. Most problems occur with single-ended encoder signaling because of poor termination, shielding or ground loops. If you follow the recommendations for cable wiring shown below, you will be very unlikely to encounter any problems.

To configure the B4001 for use with a single-ended encoder connect pin 20 to GND (pin 10). (This has already been done in on IDC motor extension cables.) The circuit shown in the diagram below will then be used to receive signals from the encoder. The diagram below also shows typical encoder cabling. Take care to construct this cabling literally and do not connect the cable shield or the encoder ground to the motor or chassis as this is likely to induce noise.

Note: The shielding in the pigtailed of IDC M series motors is left disconnected at the motor end as shown below. When constructing a motor extension cable, therefore, the shielding should be connected at both ends, thus providing shielding to the very end of the motor cable.

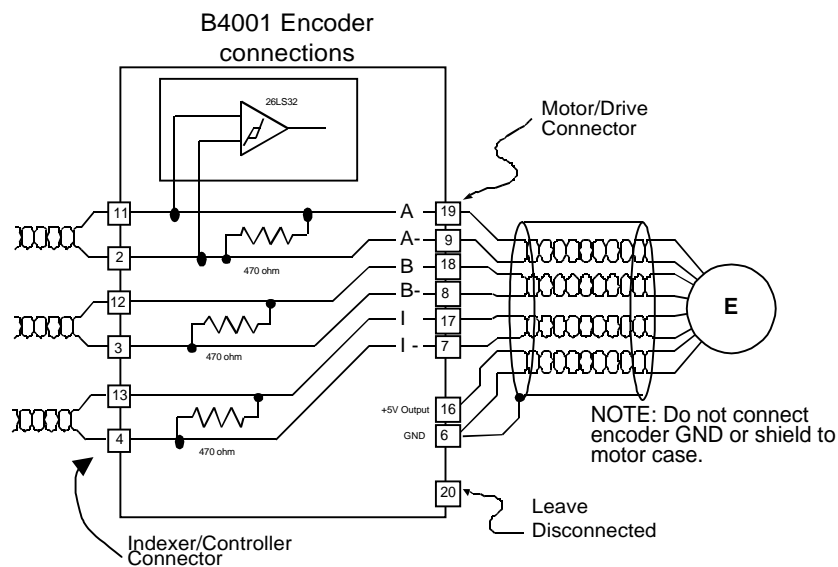




## Differential Encoders

The B4001 can accept signals from differentially driven signals from encoders. Differential encoders have balanced (symmetrical, inverted) driven outputs intended to drive terminated, twisted pair transmission lines. This type of signaling method has high noise immunity and will function well when high common-mode noise would otherwise be a problem. They are also well suited to signals in excess of 200kHz and long cable runs.

To configure a B4001 for use with a differential encoder leave pin 20 open (disconnected) on the Motor connector. The circuit shown in the diagram below will then be used to receive signals from the encoder. The diagram below also shows typical encoder cabling. Take care to construct this cabling literally and do not connect the cable shield or the encoder ground to the motor or chassis as this is likely to induce noise.



## Encoder Output

### A+/- Output, B+/- Output, Z+/- Output

The encoder output signals provide a quadrature output which can be routed to an external indexer or controller.

Using the encoder feedback is optional when the B4001 is in Step and Direction mode. When being routed back to an indexer, be sure that any position maintenance features are disabled. The B4001 will close the position loop. The Range Out/End of Move output can be used to signal the indexer that motor is in position.

The encoder output signals can be routed to a servo controller or indexer and are required when the B4001 is in analog velocity or torque mode. In this case, the analog servo controller will close the position and/or velocity loops.

The signals tap off (internally) the corresponding encoder input lines on the motor/feedback connector. Each balanced pair of encoder input lines has a 470 ohm termination resistor to prevent the overloading of the encoder's drivers when routing to an indexer/controller.



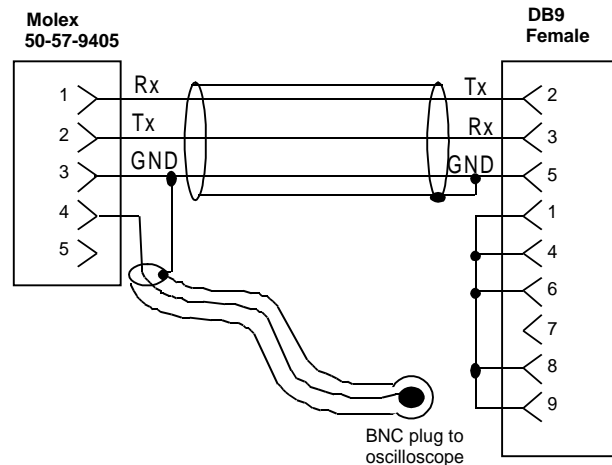
### Encoder Termination Resistors

The B4001 can accept encoder signals to 500kHz (2MHz count rate after quadrature multiplication), if your application calls for using encoder signals above 200kHz with long cable runs you should consider using termination resistors for maximum noise immunity and signal fidelity. Proper termination matches the termination resistor value with the characteristic impedance of the wiring used. Typical twisted pair cable has a characteristic impedance ( $R_c$ ) of 100 $\Omega$  to 200 $\Omega$ . (Your cable manufacturer should be able to tell you the characteristic impedance of your twisted pair cable.)

The B4001 has 470 $\Omega$  termination resistors on each balanced pair of encoder input lines. This is typically a slight mismatch with popular twisted pair cables. Although in general this is not optimum, it was done specifically so that if the encoder lines continue on to an indexer/controller, they can be terminated there as well without overloading the encoder's drivers. If you are not routing the encoder signal to your indexer/controller you can precisely match the termination resistance to your cable by adding external termination resistors at the B4001 end of the motor-encoder cable. The value of these resistors should be  $470R_c/[470-R_c]$  ohms. Alternately, if you are routing the encoder signals to your indexer/controller, then termination resistors should be installed at the controller equal to  $R_c$ .

### RS-232C Interface

An RS-232C serial interface is provided for configuring the B4001 using *IDCMotion™ Servo Tuner*. Since the B4001 is software configurable, RS-232 must be used for initial system setup, but, there is no need to install this interface permanently unless constant status is required from the B4001 system. RS-232C handshaking signals are not provided or used by the B4001. The communication protocol is 8 bit, asynchronous, half duplex with a single start bit, a single stop bit and no parity. The communication rate is fixed at 9,600 Baud. The RS232 port is a 5 pin, Molex connector. RS-232 /diagnostic cables are available from IDC(part # PCA4817), or users can build their own cable using the pin out shown below.



### Diagnostic Monitor Port

The BNC connector on the RS-232 / diagnostic cable provides access to the B4001's analog monitor output (diagnostic output port) for viewing system parameters on an oscilloscope or for use with a data logger. The monitor output is a 0.5 - 4.5 volt signal





centered around a 2.5 volt “zero” reference, with a 2kHz update frequency. This tool provides objective, real time torque, velocity, and position data. It is invaluable as a tuning and system bench marking utility.

Please note that the BNC plug included on the RS-232 cable is NOT a 10x probe. More information on using and configuring the Monitor Port can be found in *Servo Tuner Help* or in the Servo Tuner manual.



### B4001 Software Configuration

Since the B4001 is a fully digital drive, motor data must be downloaded to it prior to operation. On the IDCMotion disk set that came with this drive are motor data files (ex. M2330i75.mtr) that supply the drive all the necessary motor data. This data includes motor winding information, pole count, and encoder resolution. These files also contain default tuning parameters. The tuning parameters have been optimized for use with IDC motors. They work very well with inertia ratios up to about 15 to 1. Most applications running in Step and Direction mode require **NO ADDITIONAL TUNING**. If your application does require higher performance than the default tuning parameters provide, please refer to the tuning procedure detailed in the *Servo Tuner* manual.

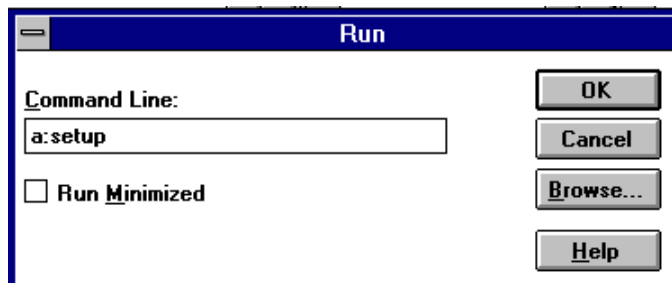
The rest of this section gives a quick overview of what *Servo Tuner* can do, and how to download the correct motor file. After this procedure the drive will be ready to be installed in the application. If further tuning is required, please follow the procedures and application descriptions in the *Servo Tuner* manual.

*Servo Tuner* does all the configuration of a B4001 electronically, there are no DIP switches or jumpers. All configurations can be stored on your computer for quick transfer into other B4001's, minimizing set-up and troubleshooting time during production. Each B4001 has a unique electronic serial number so individual configurations can be tracked easily.

*Servo Tuner* also allows you to monitor the performance of the drive during machine integration and setup. You can view position and velocity error in user defined units and monitor the status of the B4001. *Servo Tuner* also allows you to set up the B4001's internal signal generator and analog monitor port. These built-in instruments within the B4001 can be used in conjunction with your oscilloscope to stimulate and monitor the performance of your entire electromechanical system.

### IDCMotion Installation Procedure

After starting Microsoft's Windows (version 3.0 or later), from the **File** menu select **Run** and type *a:setup* as shown below and click on **OK**. From Windows '95, access this dialog box from **Start/ Run**.



The installation program will display the Welcome screen shown below. Throughout the installation process, the program will prompt you to enter information, and then click on the **Next** button to continue the installation. At any point during the installation, you can hit **Cancel** to abort the process.

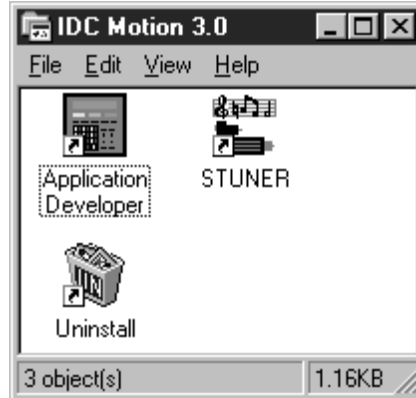


The installation program will take you through a series of screens to verify user information and destination directories. Please note that this installation program will over-write any existing versions of Application Developer and Servo Tuner. If you want to save the older versions of these programs, install the new versions to a different directory, or rename the older files.

The screen shown below will prompt you to select an installation type. Select Typical unless a partial installation is required. Selecting Custom allows you to select/de-select applications and various IDCMotion support files. Application Developer and Servo Tuner may not run properly if these support files are not installed.



The installation program will then prompt you to select a program group (or program folder in Win'95) in which install the program icons. The default program group is shown below.



The install program will also create a series of sub-directories containing Application Developer, Servo Tuner, and an icon list. It will also create a series of sub-directories under Servo Tuner containing B4000, B8000, and B8501 series motor files.

### Common Installation Errors and Remedies

IDC recommends closing all applications, including MS-Mail and MS-Office, before running **SETUP** to help avoid file conflicts.

There are no known installation problems with IDCMotion 4.0. Please call the IDC Applications Department at (800) 747-0064 or (415) 883-3535 for assistance.

### Servo Tuner runtime errors

When running Servo Tuner without a B4001 drive connected and **ONLINE** a 'Type mismatch' error message may be displayed. This error window can be closed, and the program will run normally.

Problems occur when a computer tries to share a communication port between a mouse and Servo Tuner. The program requires a dedicated communications port.

### Configuring the B4001 with an IDC motor

Before you attempt to communicate with your B4001, make sure that you have connected COM 1, 2, 3 or 4 of your computer to the drive via the RS232C connections shown in the "Installation and Hardware" section of this manual. Apply power to the B4001 and start the Servo Tuner program. The B4001 can be powered up and configured with no motor connected.

After communication is established with the B4001, indicated by the **ONLINE** in the Servo Tuner status bar, the drive needs to be configured to run with a specific motor.

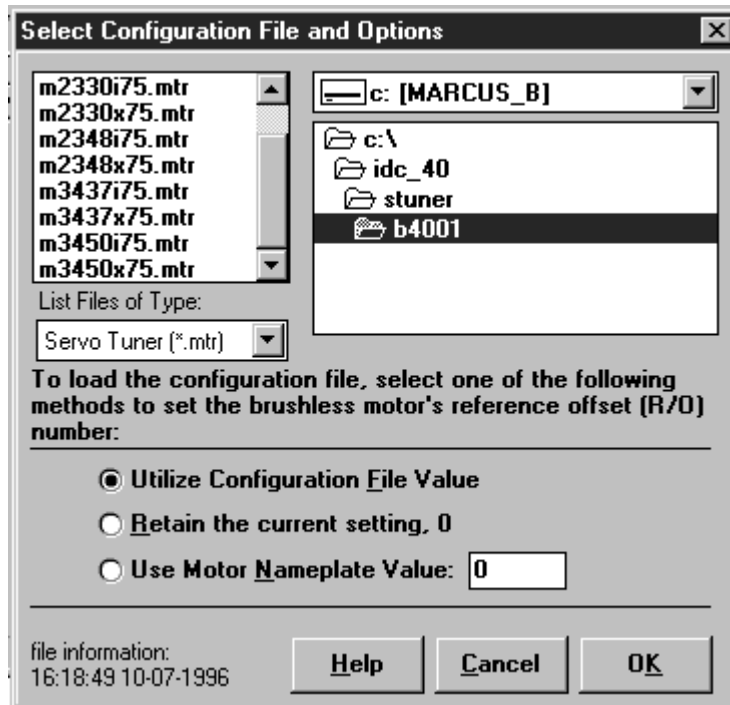




## Chapter 3 - Installing and Configuring Your Drive

### 1. Select **File, Load Configuration**.

A list of IDC motor and voltage levels will appear.



2. Select the appropriate motor and voltage level file. For example B32\_220.mtr is the file that must be loaded for a B32 motor running at 220 VAC. B32\_110.mtr is used when running at 110VAC.

3. Then click the **OK** button to download the motor file.

This operation loads all motor parameters, and default tuning gains. To customize these gains to your mechanical system and move profiles, see the “Tuning for Performance” section of the *Servo Tuner* manual.

### Command Input Type Selection

After the proper motor file has been downloaded, the drive needs to be told what command signal (analog or step and direction) it should respond to, and what DC voltage level it is running at. The default setup is for a Step and Direction controlled system running at 75VDC.

From the **Inputs and Limits** screen of *Servo Tuner* select the Input Type (Analog or Step and Direction). If running in analog velocity mode, the +/-10 V command signal can be scaled from this screen as well. Analog Torque mode is selected by picking an Analog input type and by pulling the MODE input low. (See the Required Hardware Connection section at the beginning of this chapter for more information.)

Also from the Inputs and Limits screen, Power Supply Voltage setting may need to be changed. To optimize system performance, this setting should reflect the no load voltage level of your DC power supply.



## DC Power Supply Sizing

### Power Supply Current Requirements

To properly size a power supply to work with your B4001 system you will need to calculate the maximum peak and RMS current requirements for each B4001 in your system. The peak rating of your supply should then be the instantaneous sum of all of the individual B4001's maximum peak currents. The continuous rating of your supply should be the sum of all the individual B4001's maximum RMS currents.

The peak and RMS current drawn by an B4001 are less than the peak and RMS current supplied to the motor. This is not magic. The B4001's output amplifier acts as a very efficient *power switching converter*. The output amplifier ensures that the input power from the supply is equivalent to the power supplied to the motor. Because the power supply voltage is greater than the voltage supplied to the motor windings, the current drawn from the supply is less than that supplied to the motor. (This conserves power which is equal to Volts *times* Amperes.)

### Sizing a Supply Quickly

The following procedures carefully calculate the supply requirements for an B4001 operating under various loading from an arbitrary supply voltage with any motor. If you want to avoid these calculations and you are operating the B4001 from a 75V supply using IDC supplied M series motors, the worst case RMS current is 3A and the worst case peak current is 12A. This assumes that you are operating the motors within their rated torque-speed curves, for an incremental positioning application. These numbers are conservative. For most incremental positioning applications, the RMS current will be substantially less than 3A and the peak current can be less than 12A if the motor is operated below peak speed.

### Supply Peak Current Requirement

To calculate peak supply current demand from any B4001 you need to know three things: [1] the supply voltage ( $V_s$ ), [2] the phase to phase resistance of the motor ( $R_t$ ), and [3] the peak *shaft* power ( $S_{pmax}$ ) in Watts available from the motor when the B4001 is supplied by  $V_s$ . The peak current demand,  $I_{smax}$ , for brushless motors is then:

$$I_{smax} = [0.75I_p^2R_t + S_{pmax}]/V_s,$$

where  $I_p$  for an B4001 is 23 Amperes.

Peak shaft power of a vector driven brushless motor is highly dependent upon the inductance of the motor, the number of motor poles, supply voltage, drive peak current and the winding resistance. It cannot, in general, be easily calculated. Worst case peak shaft power values have been pre-calculated and verified for M Series standard motors when operated with a 75V supply and you should use these in figures your calculations. If you are using a custom motor or a different supply voltage, contact IDC for an estimate of the peak shaft power that will be produced using an B4001 drive.

### Peak Current when Using Less Than Full Output

If you are planning on using the motor at a peak speed below the speed at which maximum power is produced and/or if you plan to limit the torque to some value ( $T_p$ ) less



than the peak rated torque<sup>1</sup> ( $T_r$ ), then calculate  $S_{pmax}$  and  $I_p$  as follows for use in the  $I_{smax}$  formula above:

$$S_{pmax} = T_p V_{max}/1352, \text{ and}$$

$$I_p = 23T_p/T_r$$

where  $V_{max}$  is the maximum speed in RPM.

### Supply RMS Current Requirement

The RMS current demand from the supply is dependent upon the application type. Two sets of calculations are provided below. If the application is for incremental positioning, as in a “pick and place” machine, then calculation method (1) or (1a.) should be used. If the application is a continuous velocity type, such as running a conveyor, then calculation method (2.) should be used<sup>2</sup>.

#### 1. Incremental Positioning Applications

If the application is incremental positioning, then we assume that the torque is being used primarily to accelerate the motor and load from zero to a maximum speed and then to decelerate it back to zero speed again.

We can also assume that the current used to decelerate the load is not drawn from the supply (part of it is actually pumped back into the supply during deceleration). Given this assumption, the maximum RMS current demand from an B4001 is:

$$I_{RMS} = \sqrt{\frac{\frac{t_{dc}}{2} \left[ (S_{pmax} + \frac{3}{4} I_p^2 R_t)^3 - (\frac{3}{4} I_p^2 R_t)^3 \right]}{3V_s^2 S_{pmax}}}$$

where  $t_{dc}$  is the *torque* duty cycle defined as:

$$t_{dc} \equiv \frac{\text{torque on time}}{\text{torque on time} + \text{torque off time}}$$

Torque on time should not be confused with the *running time* of the motor. It is the time that torque is being used to accelerate or decelerate the motor and can be a small portion of the running time when trapezoidal velocity move profiles are used. (It is equivalent to the motor running time when *only* triangular velocity type move profiles are used.)

$t_{dc}$  can be a maximum of 0.15 for an B4001 that uses full output torque to accelerate and decelerate the load (at this duty cycle the output current is 9A RMS which is the rated limit of the Motor connector). You should attempt to estimate  $t_{dc}$  for your application if possible, otherwise use 0.15 as a conservative estimate if you plan to use the full output torque capability for acceleration (although this will probably cause you to over-specify your supply requirements).

#### 1a. Incremental Positioning with Reduced Output

If you are planning on using the motor at a peak speed below the speed at which maximum power is produced and/or if you plan to limit the torque to some value ( $T_p$ ) less than the peak rated torque ( $T_r$ ), then calculate  $S_{pmax}$ ,  $I_p$  and  $t_{dcmax}$  as follows:

$$S_{pmax} = T_p V_{max}/1352,$$

$$I_p = 23T_p/T_r, \text{ and}$$

<sup>1</sup> This can be accomplished explicitly by setting a torque limit parameter within the B4001 using *Servo Tuner™* or by reducing the acceleration demand so less torque is required.

<sup>2</sup> CNC cutting type applications usually are a hybrid of both incremental positioning and constant velocity applications so the higher of the two calculated RMS current figures should be used to determine the worst case maximum RMS current.





$$tdc_{\max} = \min \left[ 1, \left( \frac{9T_r}{23T_p} \right)^2 \right]$$

where  $V_{\max}$  is the maximum speed in RPM.

Now use these  $I_p$ , and  $S_{p\max}$  values and your estimate of  $tdc$  to calculate  $I_{RMS}$  using the formula above. If you can't estimate  $tdc$  in your application then use the  $tdc_{\max}$  calculated above as a conservative estimate (although this will probably cause you to over-specify your supply requirements).

## 2. Continuous Velocity Applications

If the application is for a continuous velocity application such as running a conveyor at some constant speed ( $V_{cont}$ ) then we assume that the drag load ( $T_d$ ) is predominant. For these applications you can calculate the RMS supply current required based upon the continuous output power as follows:

$$I_{RMS} = [0.75I_c^2R_t + S_{pcont}] / V_s,$$

where:

$$S_{pcont} = T_d V_{cont} / 1352, \text{ and}$$

$$I_c = 23T_d / T_r$$



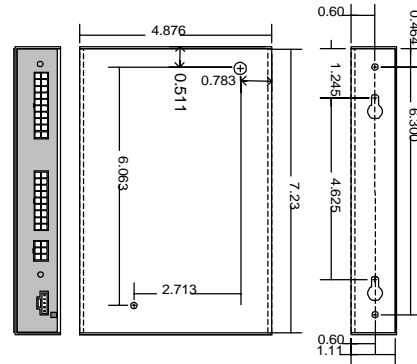
### Drive Mounting

Drive dimensions are shown to the right.

Your B4001 drive arrived ready for a minimum width mounting. By moving the mounting bracket to the wide side of the heatsink, you can mount the B4001 in a minimum depth configuration.

The B4001 depends on air flow for cooling. In all but the least demanding applications, the following mounting guidelines should be observed:

- A minimum .75 air gap should be maintained between adjacent B4001 to allow proper air flow.
- High heat-generating equipment should not be mounted directly below the B4001.



MOUNTING OPTIONS:  
(4) #8-32UNF-2B, [2 on back, 2 on side]  
extending no longer than 0.20 in into bracket,  
or (2) keyhole slots for #10 screws.





## Troubleshooting

Most problems encountered during the startup and operation of a B4001 based servo system can be traced to a few basic causes such as mechanical problems, incorrect or noisy signal wiring, attempting to operate beyond the systems capabilities, or incorrect or non-optimal software configuration parameters. A combination of these underlying problems can present an overwhelming variety of symptoms that make it very difficult to track down the root cause of the difficulties.

A logical and methodical approach to trouble shooting is essential to isolating and resolving these problems. The B4001 provides a number of tools to make this task easier. The Status LED and it's associated fault code will usually be the first clue in tracking down any problems. The next step is connecting a PC to the drive and running Servo Tuner. The **Status / Show** screen displays the current fault status of the drive as well as the current motor position and velocity. It can also be configured to log faults as they occur. For more information on using Servo Tuner, press F1 to access help while running Servo Tuner, or consult the Servo Tuner manual shipped with the B4001. The monitor output port is also a powerful troubleshooting tool. It can be configured to show actual and commanded velocity to help resolve controller difficulties. Configuring the port to output actual torque can be helpful in determining when a move's torque demands are starting to approach your systems theoretical limits. This mode can also be used to document your machine's torque safety margin. Again more details are available in the Servo Tuner manual or from Servo Tuner Help.

### Power/Fault LED

The B4001 is equipped with a green power/fault indicator LED. This LED blinks at 24Hz (a fast flicker) when the drive operation is normal. If the digital signal processor (DSP) fails, this LED will be illuminated continuously. If the LED does not illuminate at all when power is supplied, the B4001 internal power connections have failed.

This LED indicates faults by blinking error codes. These codes are blinked in a Morse code-like fashion and repeated continuously until the "Enable" line is toggled or the power on the B4001 is cycled. For example, error code 3 would blink the LED:

\*\*\* \*\* ...

In the event of multiple faults, the codes repeat in a cyclic manner. For example, the combination of error codes 2 and 3 would blink the LED:

\*\* \*\*\* \*\* ...

The DSP checks the internal subsystems of the B4001. If it detects an error with this internal hardware it will not allow the drive to operate. The fault chart on the next page decodes the Fault LED blink codes. All faults require the drive to be reset before further operation is possible. The drive can be reset by cycling power, toggling the state of the Enable input, or by sending a reset command over RS-232 via *Servo Tuner*. After decoding the blink code, check the Symptom / Remedy chart at the end of this chapter for possible fault causes. Please call IDC's Application Engineering Department at (800) 747-0064 or (415) 883-3535 if you have further questions or problems.



**Fault Codes**

Fault #	Description	Requires Reset
2	Over Current, Over Voltage	YES
3	Thermal Shutdown	YES
4	Tracking Error Shutdown	YES
5	RMS Over Current	YES
6	Encoder Counter Over Speed	YES
7	Step Counter Over Speed	YES
8	Serial Character Receive Overrun	YES
9	A/D Failure	Hardware failure
10	Can't Initialize EEPROM	Hardware failure
11	EEPROM Hardware Failure	Hardware failure
12	Motor Parameter Error	Hardware failure
13	Current Sensor Failure	Hardware failure

The status register activated from the **Status / Show** window of Servo Tuner usually contains a more detailed description of the error. Please check the **HELP** utility from Servo Tuner or Servo Tuner for more details on reading error conditions in the amplifier.

**Symptoms and Solutions**

The following table will help you isolate some of the more common application problems when using B4001 drives.

Symptoms	Probable Causes	Possible Remedies
Power/Fault LED is on	24 Hz "flicker" is normal. Steadily illuminated LED Slow blinking, followed by a pause.	This indicates an internal hardware failure. Contact IDC. Count the "blinks" and check the Fault code chart above
I/V Fault	Overvoltage due to excessive regen energy from the motor. DC Voltage exceeds 86VDC Over current due to a motor short. Over current due over tuned current loop gain parameters.	Add more capacitance to the DC power supply or reduce the deceleration rate. Reduce input voltage to allow for surges or spikes caused by other equipment. Replace shorted motor. Down load the correct motor file for the motor AND operating voltage.
Thermal Shutdown	Motor winding temperature exceeded 155C Drive heatsink temperature exceeded 55C	Increase cooling: circulate more air past heatsink, or reduce duty cycle.
Tracking Error Shutdown	Too narrow a tracking shutdown window. Commanded moves too aggressive for system. Mechanical binding causing excessive following error. Poor or "soft" tuning allowing excessive following error.	Set the tracking error shutdown range from the <b>Inputs and Limits</b> screen in Servo Tuner. Check for unusual binding Follow the tuning procedure outlined in the Servo Tuner manual, or download the default tuning parameters



Symptoms	Probable Causes	Possible Remedies
RMS shutdowns (DSP V1.7 or later)	Mechanical jam, amplifier shut down to prevent motor overheating or the RMS current limit exceeded. Wrong motor file loaded	Check for binding or reduce acceleration and duty cycle.  Load correct *.mtr file via Servo Tuner.
Motor will not move/ has no holding torque.	Drive not enabled  Command input type configured wrong  End of travel limit switches are active  The B4001 is not configured to motor.	The enable input must be pulled low for drive operation. The command input type, step and direction or analog must be configured the <b>Input and Limits</b> screen of Servo Tuner. Drive requires Normally Closed limit switches. Inputs should be jumpered if not being used. The default drive configuration is "NONE". The correct motor file must be loaded via Servo Tuner prior to operation.
Motor "jerks" on power up	Hall effect sensors mis-wired  Wrong motor.mtr file downloaded to the B4001	Check feedback cabling  Load the correct configuration file with Servo Tuner.
Motor "whines"	Highly resonant mechanical system  Tuning parameters are set too "hot"	Stiffen the mechanical transmission  Reduce the gain parameters. $K_i$ is often a strong contributor to this instability.
Motor moves the wrong distance.	Drive and control resolution don't match.	From the <b>Inputs and Limits</b> screen check that drive input resolution setting coincides with the indexer.
Motor won't change direction or moves only in one direction.	One EOT limit switch is active  Direction signal not connected or working properly.	Check status of limit switches from the <b>Status / Show</b> window of Servo Tuner Check control signal wiring.
Motor moves when no command signal is given.	Noise on the step lines  Incorrect offset voltage command from the servo controller. (analog input only)	Use properly grounded, shielded, twisted pair step and direction cabling Properly close the position loop at the servo controller. See the controllers documentation for adjusting offset voltages.
Motor moves in the wrong direction.	Control and Drive directions conflict with each other.	Change the indexer's sense of direction (polarity of direction bit).
Motor runs hot	High accelerations and duty cycles. IDC motors are rated up to a case temp of 100C, and are protected by a thermostat.	Reduce duty cycle. Motor heating is not normally a problem unless it causes Thermal Shutdowns.

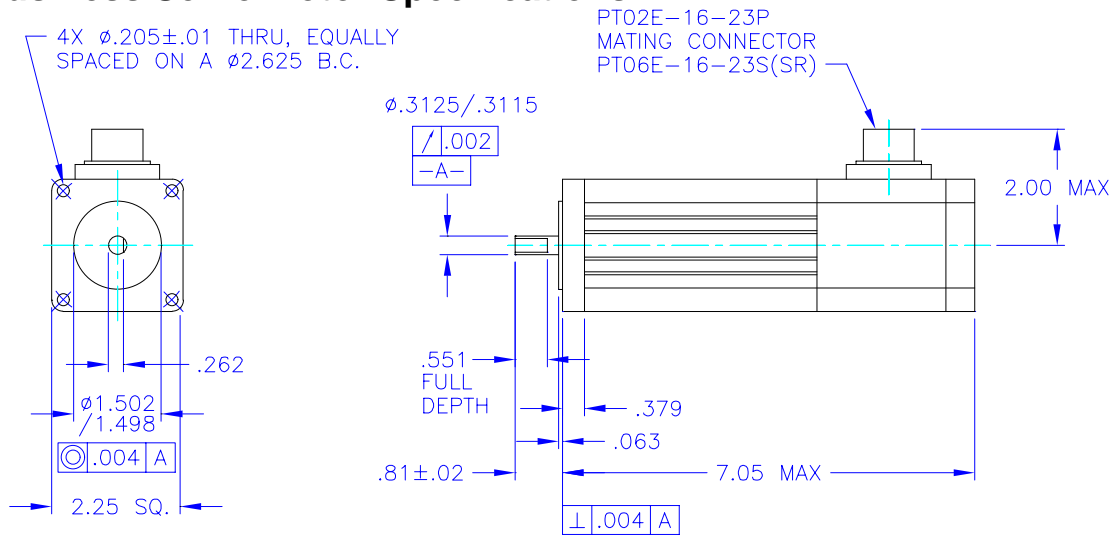


## Hardware Specifications

<b>General</b> Mounting dimensions: Weight:	7.3" x 4.9" x 1.1" 20 oz
<b>Environmental</b> Operating Temp: Motor Temperature:  Humidity:	0-40 degrees C Max winding temp 155C (thermostat protected) 0 - 90% non-condensing
<b>Power</b> Input Voltage: Input Current:	24-75 Volts DC 150 mA to power drive logic, peak current demand is application dependent
<b>Motor Output</b> Current: Protection:	9 amps continuous, 23 amps peak Protected against phase to phase shorts and shorts to ground. Internally fused.
<b>Encoder Input</b> Type: Max Rate: Power:	Incremental, TTL or differential signal compatible 2.0 MHz 5VDC @220ma
<b>RS232C</b> Data Format:	RS232C Serial Interface, half-duplex, 9600 Baud, 8 data bits, no parity, 1 stop bit Three wire implementation(no handshaking)
<b>Diagnostic Output</b> Format: Variables	.5 to 4.5VDC analog signal(centered @2.5v) Velocity, position error, velocity error, programmable scaling
<b>Logic</b> Power: Inputs: Outputs:	5VDC @220ma +/- End of travel limits, Servo Enable, Mode Drive Fault, Encoder, In-Range/End of move
<b>Command Signal</b> Step & Direction: Max frequency: Resolution:  Analog:  Resolution:	TTL with 470 ohm pull-up 1.5 MHz , min. pulse width 400 nsec 200-65,534 steps/revolution (programmable) Even numbers only +/-10VDC differential velocity or torque signal, 10Kohm input impedance, scale is digitally programmable Velocity mode: 12 bits Torque mode: 10 bits



## B23-W Brushless Servo Motor Specifications



### Motor Data

Continuous Stall Torque	oz-in	120
Cont. Torque at Rated Speed	oz-in	97.6
Winding Resistance @ Ambient	ohms	.7
Winding Resistance @ T <sub>max</sub>	ohms	.925
Inductance	mH	1.0
Phase to Phase Peak K <sub>t</sub>	oz-in/A	14.4
K <sub>v</sub>	V <sub>p-p</sub> /kRPM	11.3
Rotor Inertia	oz-in-s <sup>2</sup>	0.0024
Static Friction	oz-in	6.4
Dynamic Friction	oz-in/kRPM	0.5
Thermal Resistance	°C/W	3.0
Max. Winding Temperature	°C	155
Motor Constant	oz-in/√W	19.124
0 Ohm Damping	oz-in/kRPM	270.63
Mechanical Time Constant	ms	0.991
Electrical Time Constant	ms	1.42
Number of Poles		4

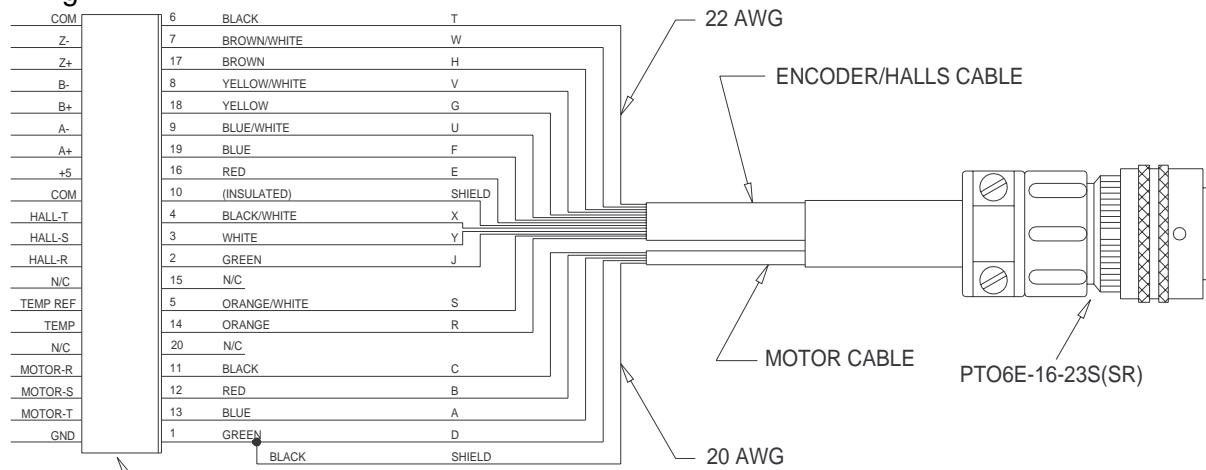
### Notes:

- Axial Shaft Load - 15lb max.
- Radial Shaft Load - 40 LB @ 1/2 in
- Motor Weight - 3.4lbs (1.8kg)

### Drive/System Data with B4001 75VDC

Max. Speed	RPM	5000
Drive Bus Voltage	V	75
Drive Peak Current	A	23
Ambient Temperature	°C	25
RMS Output Power	W	200
Nominal Peak Power	W	900
Nominal Peak Stall Torque	oz-in	300

### Motor Wiring

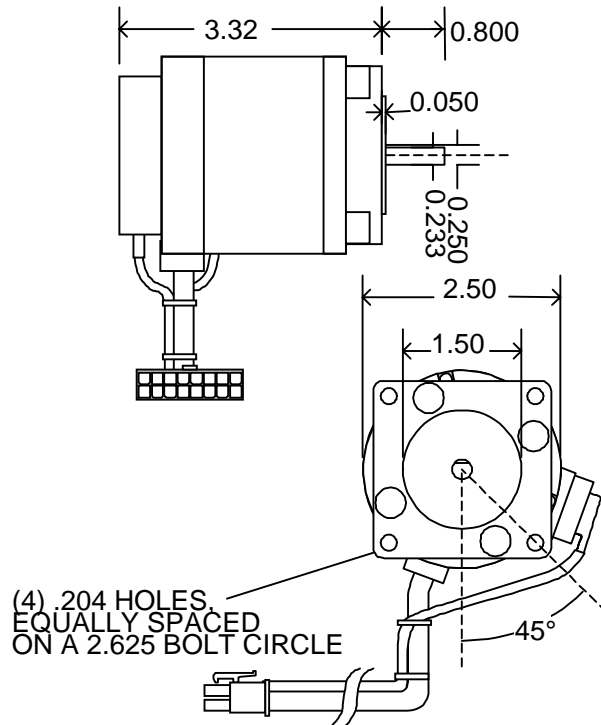
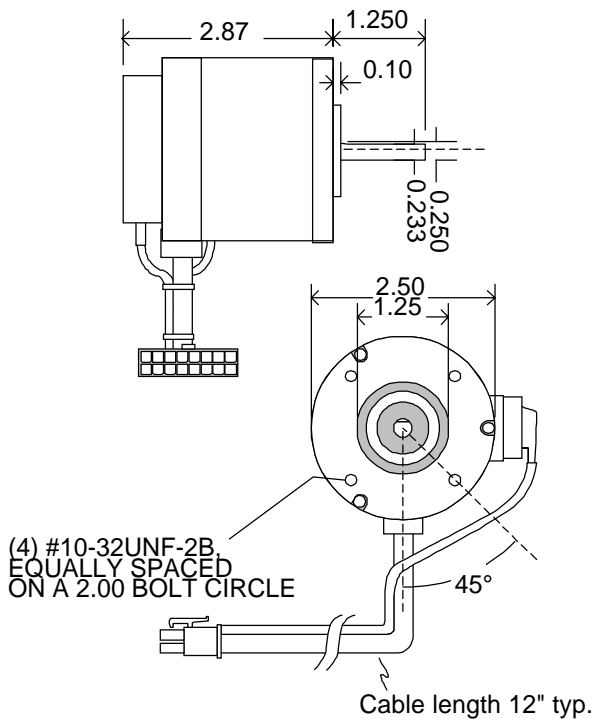


Housing - IDC# PCB-1363 (Molex #39-01-2200 or Equiv.)  
 Pins - IDC# PCB-1367 (Molex #39-00-0056 or Equiv.)





# M2330 Motor Specifications



## Motor Data

Continuous Stall Torque	oz-in	60
Cont. Torque at Rated Speed	oz-in	45
Winding Resistance @ Ambient	ohms	.96
Winding Resistance @ $T_{max}$	ohms	1.26
Inductance	mH	.91
$K_t$ , Phase to Phase Peak	oz-in/A	8.22
$K_v$	$V_{p-p}/kRPM$	6.08
Rotor Inertia	oz-in-s <sup>2</sup>	.0019
Static Friction	oz-in	.4
Dynamic Friction	oz-in/kRPM	0.04
Thermal Resistance	°C/W	1.15
Max. Winding Temperature	°C	155
Motor Constant	oz-in/ $\sqrt{W}$	8.39
0 Ohm Damping	oz-in/kRPM	52.1
Mechanical Time Constant	mS	3.82
Electrical Time Constant	mS	.948
Number of Poles		8

## Notes:

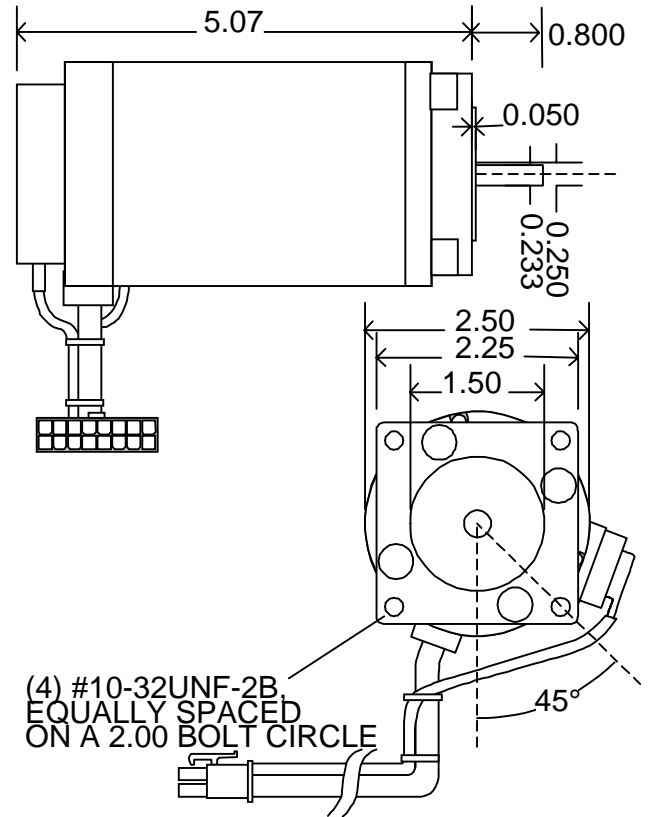
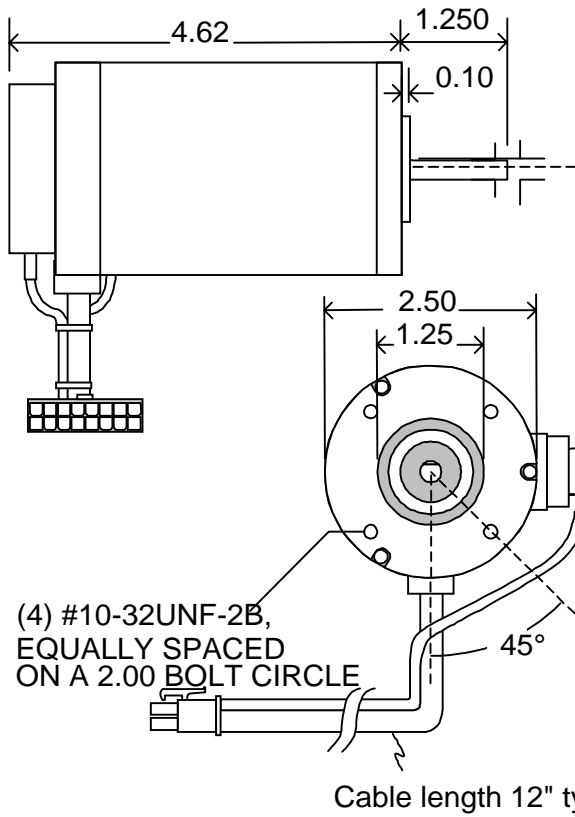
- Axial Shaft Load - 25lb max.

## Drive/System Data with B4001 75 VDC

Max. Speed	RPM	6000
Drive Bus Voltage	V	75
Drive Peak Current	A	23
Ambient Temperature	°C	25
RMS Output Power	W	140
Nominal Peak Power	W	600
Nominal Peak Stall Torque	oz-in	160



# M2348 Motor Specifications



Notes:

- Axial Shaft Load - 50lb max.
- Radial Shaft Load - 110 lb @ 1/2 in
- Motor Weight - 20lbs (9.1kg)

### Motor Data

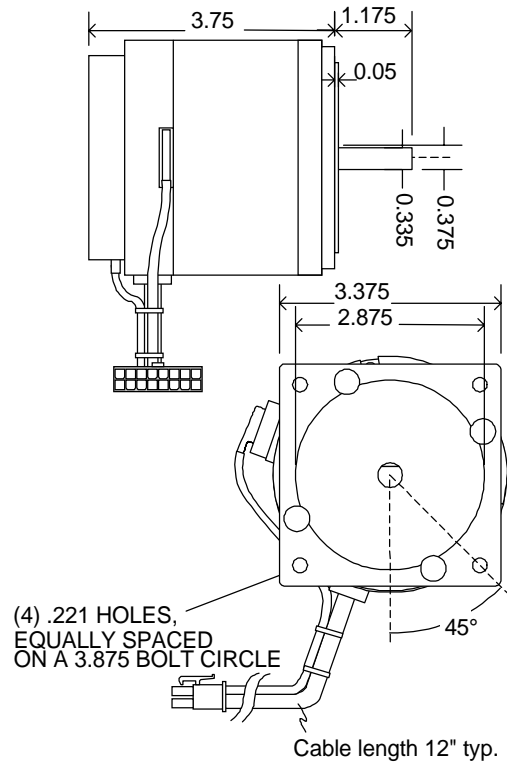
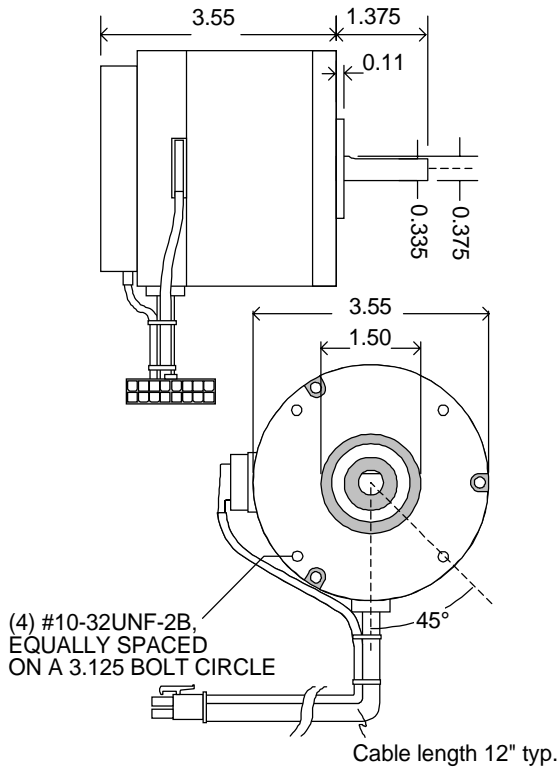
Continuous Stall Torque	oz-in	108
Cont. Torque at Rated Speed	oz-in	90
Winding Resistance @ Ambient	ohms	1.15
Winding Resistance @ T <sub>max</sub>	ohms	1.5
Inductance	mH	1.36
Phase to Phase Peak K <sub>t</sub>	oz-in/A	15
K <sub>v</sub>	V <sub>P-P</sub> /kRPM	11.1
Rotor Inertia	oz-in-s <sup>2</sup>	.0046
Static Friction	oz-in	1.3
Dynamic Friction	oz-in/kRPM	.12
Thermal Resistance	°C/W	1.00
Max. Winding Temperature	°C	155
Motor Constant	oz-in/√	14.0
0 Ohm Damping	oz-in/kRPM	145
Mechanical Time Constant	mS	3.32
Electrical Time Constant	mS	1.18
Number of Poles		8

### Drive/System Data with B8000 75VDC

Max. Speed	RPM	6000
Drive Bus Voltage	V	75
Drive Peak Current	A	23
Ambient Temperature	°C	25
RMS Output Power	W	250
Nominal Peak Power	W	620
Nominal Peak Stall Torque	oz-in	300



# M3447 Motor Specifications



## Motor Data

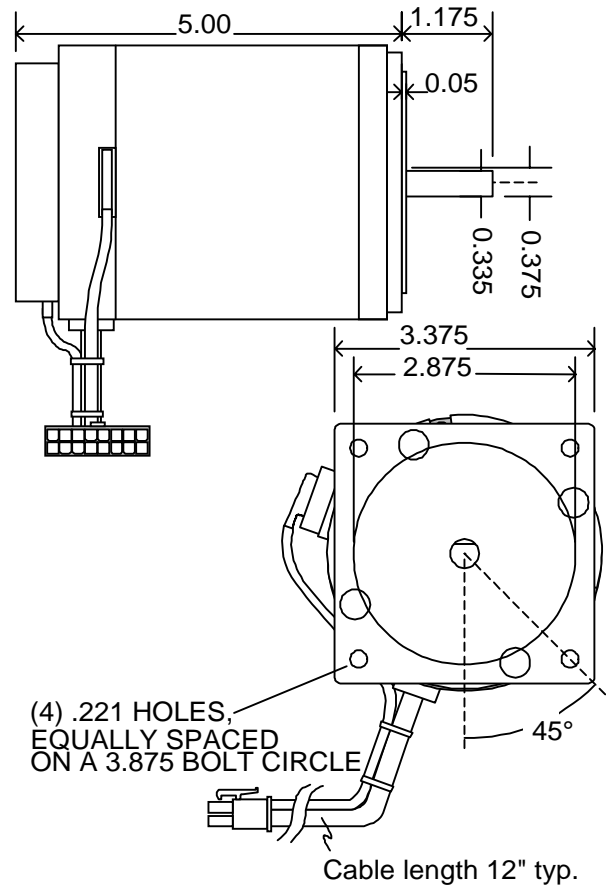
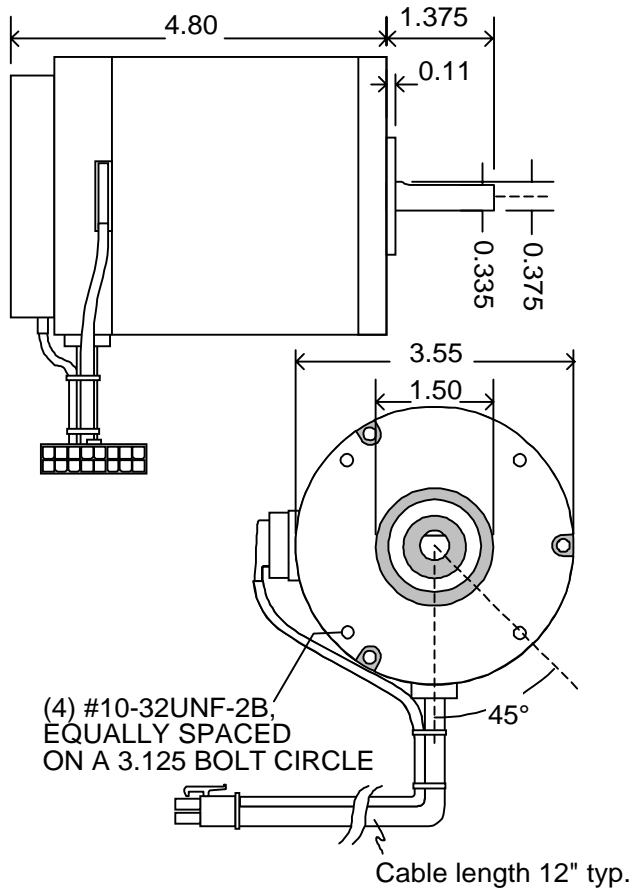
Continuous Stall Torque	oz-in	136
Cont. Torque at Rated Speed	oz-in	120
Winding Resistance @ Ambient	ohms	1.2
Winding Resistance @ $T_{max}$	ohms	1.6
Inductance	mH	1.8
Phase to Phase Peak $K_t$	oz-in/A	19.9
$K_v$	$V_{pp}/kRPM$	14.7
Rotor Inertia	oz-in-s <sup>2</sup>	0.02
Static Friction	oz-in	2.15
Dynamic Friction	oz-in/kRPM	.24
Thermal Resistance	°C/W	1.05
Max. Winding Temperature	°C	155
Motor Constant	oz-in/ $\sqrt{W}$	18.1
0 Ohm Damping	oz-in/kRPM	243
Mechanical Time Constant	mS	8.6
Electrical Time Constant	mS	1.5
Number of Poles		8

## Drive/System Data with B8000 75VDC

Max. Speed	RPM	3000
Drive Bus Voltage	V	75
Drive Peak Current	A	23
Ambient Temperature	°C	25
RMS Output Power	W	220
Nominal Peak Power	W	602
Nominal Peak Stall Torque	oz-in	375



# M3450 Motor Specifications



## Motor Data

Continuous Stall Torque	oz-in	200
Cont. Torque at Rated Speed	oz-in	180
Winding Resistance @ Ambient	ohms	1.5
Winding Resistance @ $T_{max}$	ohms	1.9
Inductance	mH	2.5
Phase to Phase Peak $K_t$	oz-in/A	30
$K_v$	$V_{p-p}/kRPM$	22.3
Rotor Inertia	oz-in-s <sup>2</sup>	0.036
Static Friction	oz-in	4.5
Dynamic Friction	oz-in/kRPM	.5
Thermal Resistance	°C/W	0.9
Max. Winding Temperature	°C	155
Motor Constant	oz-in/ $\sqrt{W}$	24.7
0 Ohm Damping	oz-in/kRPM	452
Mechanical Time Constant	mS	8.3
Electrical Time Constant	mS	1.7
Number of Poles		8

## Drive/System Data with B8000 75VDC

Max. Speed	RPM	3000
Drive Bus Voltage	V	75
Drive Peak Current	A	23
Ambient Temperature	°C	25
RMS Output Power	W	300
Nominal Peak Power	W	550
Nominal Peak Stall Torque	oz-in	600



## Appendix A: Connectors

**Note:** These are the connector pinouts on the B4001 drive, and *not* those on the cables—they are not necessarily the same. Your motor, encoder and controller cables may have different mating pinouts depending on the connector used on the end of the cable away from the drive. For example, see page 16 for the motor-side connector pin-out for an IDC supplied motor.

### Motor/Encoder

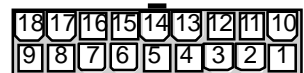
Molex Minifit type, mates with  
P/N 39-01-2200



- |                         |                                     |
|-------------------------|-------------------------------------|
| 1. Motor Shield         | 11. Motor R                         |
| 2. Comm-R               | 12. Motor S                         |
| 3. Comm-S               | 13. Motor T                         |
| 4. Comm-T               | 15. Comm. Sensor power output (+5V) |
| 5. Comm. Sensor return  | 14. Thermostat input.               |
| 6. Encoder Return (GND) | 16. Encoder power output (+5V)      |
| 7. Encoder I-           | 17. Encoder I                       |
| 8. Encoder B-           | 18. Encoder B                       |
| 9. Encoder A-           | 19. Encoder A                       |
| 10. GND                 | 20. EncTTL                          |

### Controller

Molex Minifit type, mates with  
P/N 39-01-2180

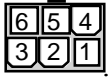


- |                           |                        |
|---------------------------|------------------------|
| 1. -Limit (output)        | 10. + Limit (output)   |
| 2. Encoder A- (output)    | 11. Encoder A (output) |
| 3. Encoder B- (output)    | 12. Encoder B (output) |
| 4. Encoder I- (output)    | 13. Encoder I (output) |
| 5. GND                    | 14. +5V output         |
| 6. Analog Input GND       | 15. Mode               |
| 7. -Analog Input/In Range | 16. +Analog Input      |
| 8. Enable (input)         | 17. Fault (output)     |
| 9. Direction              | 18. Step               |



### Limits

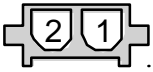
Molex Minifit type, mates with 39-01-2060



- |                              |                              |
|------------------------------|------------------------------|
| 1. -Limit power (+5V output) | 4. +Limit power (+5V output) |
| 2. -Limit input              | 5. +Limit input              |
| 3. -Limit return (GND)       | 6. +Limit return (GND)       |

### Power

AMP Universal Mate-N-Lock, mates with 1-480-698-0



1. Power Return
2. Power+ (24-75VDC)

### Serial Port & Monitor Out

Molex .120" pocket header, mates with 50-57-9405



1. Data Rx
2. Data Tx
3. Data return (GND)
4. Diagnostic Monitor
5. Diagnostic Reference (2.5V)



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## Warranty

Industrial Devices Corporation warrants this product to be free of defects in workmanship for a period of two years from the date of shipment to the end user. Products that have been improperly used or damaged, in the opinion of Industrial Devices Corporation, are not subject to the terms of the warranty.

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Industrial Devices Corporation maintains a repair facility at its factory in Novato, California for products manufactured by Industrial Devices Corporation. A complete inventory of parts is maintained for fast turn around.

## Return Procedure

Prior approval by Industrial Devices Corporation is required before returning a product for any reason.

All returned packages must be accompanied by an RMA (Return Material Authorization) number. To obtain an RMA number, contact your local IDC distributor or Industrial Devices Corporation.

- ✓ Model/Serial Number      Obtain the model and serial number of the defective unit.
- ✓ Purchase Order            Prepare a purchase order for possible repair cost, in the event the unit is not covered by warranty.
- ✓ RMA Number                Contact your local IDC distributor or Industrial Devices Corporation (1-800-747-0064) to obtain an RMA number.
- ✓ Description of Failure      Provide detailed information in writing describing the nature of the failure. A **RMA Data Form** is available from IDC for this purpose.
- ✓ Ship to IDC                      Ship unit and RMA Data Form prepaid to:  
Industrial Devices Corporation  
64 Digital Drive  
Novato, CA 94949-5704  
USA  
Attn. RMA #\_ \_ - \_ \_ \_ \_ \_





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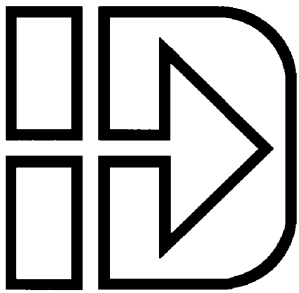
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### **CAD Library**

All IDC actuator, motor, and gear motor CAD drawings, in a .DXF format, are available to save you valuable design time and prevent transcription errors. Low volume request are complimentary.



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