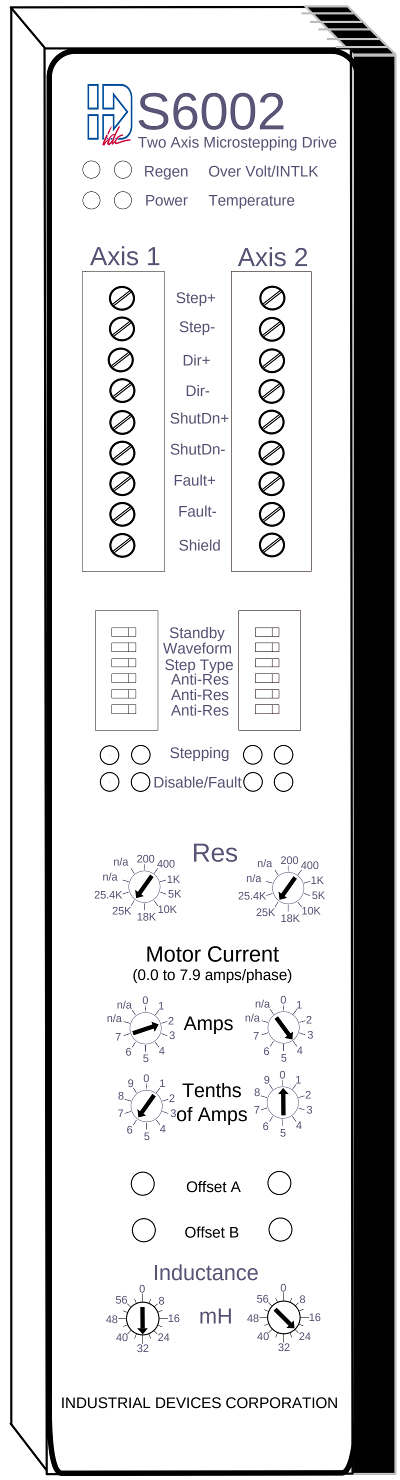
S6001 & S6002

Microstepping Drives
Operator's Manual

P/N PCW-4756 Rev. 1.7 5/98

This manual covers the following IDC Products:
S6001- 1 axis Microstepping Drive
S6002- 2 axis Microstepping Drive



INDUSTRIAL DEVICES CORPORATION

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Product and Manual Overview

Our standard S6000 microstepping drives are 6.0 amp, 160VDC, bipolar, recirculating, microstepping drives, designed to run two phase hybrid step motors. We also offer a 7.9 amp version of the S6001 and S6002. They have been carefully engineered for uncompromised motor performance, high reliability, ease of use, and exceptional value. We offer a single axis version (S6001) and a dual-axis version (S6002). The S6002 has two axes of independently selectable motor resolution and current settings.

The S6001 and S6002 are compatible with most motion controllers, or “indexers”, that generate Step & Direction signals, or Clockwise & Counterclockwise step pulses.

The S6000 drives are designed to operate permanent magnet hybrid, two-phase step motors with 4, 6 or 8 leads. IDC offers a range of competitive 17-42 frame step motors, precision gearmotors and linear actuators to operate with your S6000 drive.

If you are already a step motor user, you are probably familiar with mid-range instability, or resonance, which under some conditions can cause a step motor to stall around 13-18 revolutions per seconds. Microstepping technology alone does not address mid-range instability. However, our S6000 drives use advanced anti-resonance circuitry to virtually eliminate it, and dramatically improve the usable torque from the motor.

The S6000 Series Drive manual is divided into four main sections. The first section consists of a product overview and this 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, *Configuring Your Drive*, covers in detail the motor/drive setup and installation process. It includes all circuit connections, and mounting dimensions. The last section, *Troubleshooting*, provides a quick symptom/remedy guide to help track down setup errors and operating faults. If you can not find information that you need in this manual, please contact the Applications Department at IDC. [(800)747-0064 or (415) 883-3535]

S6000 Series Features

The standard S6000 drive offers the following features:

- Dial selectable motor current settings (0-6.0 Amps)
- 0.0-8.0 amp version available for NEMA 42 and larger applications
- 8 Amp versions include a factory installed fan kit
- Dial selectable motor inductance setting (2-60mH)
- Eight dial selectable motor resolutions (200-25,400 steps per revolution)
- Selectable waveform (Pure sine, or -4% 3rd harmonic) for optimum smoothness/step accuracy.
- Selectable auto-standby current reduction to reduce drive and motor heating
- Selectable anti-resonance compensation provides more usable motor torque
- Front panel adjustments for motor inductance and phase offsets
- Selectable step input format (Step & Direction, or CW & CCW)
- Internal power dump for regenerative applications
- Optional external power dump module (RPACK-1) available for large regenerative applications

- Integral thermal protection (shuts down at 70°C on heatsink)
- Interlocked motor connectors disable the drive if motor is disconnected during operation
- Front panel diagnostic indicators for power, regen, over temperature, over voltage, short circuit, open interlock, step signals being received, disabled, and fault condition.
- Optically isolated fault output, to inform your motion controller of a fault condition
- PWM, three state current control reduces motor heating
- Isolated switch mode power amplifier is highly efficient and emits less EMI than most drives.
- Full short circuit protection of motor outputs prevents drive failure due to damaged or mis-wired motors
- AC power input, 85-135 VAC, 50/60 Hz
- Internally fused power input
- Integral heatsink (1°C/Watt)
- Optional fan kit (-FK1 option) mounts to heatsink for high current or high ambient temperature applications
- All connections on removable screw terminals for easy wiring
- Compact 2.5 x 9 inch footprint, 5.9 inches deep. Same size for single or dual-axis versions.

Compatibility

IDC Step Motors	IDC Actuators	Options	Accessories
S12, S21, S22, S23, S32, S33, and S42	NS23, NMS, TS33, TS42, R2S23, R3S23, R3S33, R4S33, and R4S42	-FK1 fan kit	RPACK-1 regen module

Shipping Contents

Your S6001 or S6002 drive should include this Operator's Manual, a mounting bracket, and a six foot AC power cord.
S6000-8As, the 8 amp version of the S6001 and S6002, also include a factory installed fankit. A fankit is also required for applications that require 6 amps or more total motor current (sum of both axes on the S6002.)

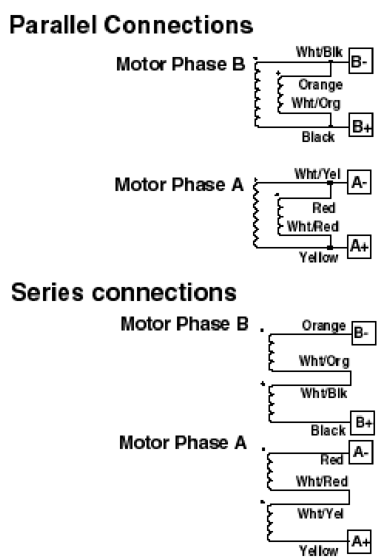
Quick Start

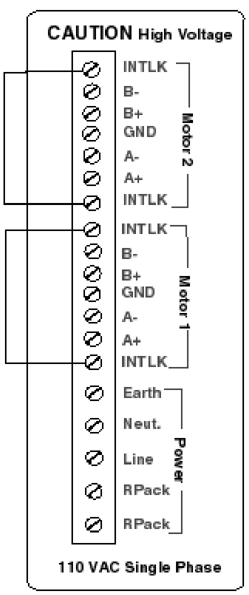
Objective

The purpose of the Quick Start chapter is to help an experienced motion control user quickly set-up and bench test a S6000 Series microstepping drive and IDC step motor. The following directions assume that the user is familiar with step motors, drives, indexers, and their related electrical connections. Please refer to Chapter 3, "*Installing and Configuring Your Drive*" if you have questions on any of these procedures.

Connect The Motor(s)

If using a non-IDC motor, see the "*Using a Non-IDC Motor*" section for connection information. The color codes for IDC's yellow "quick disconnect" cables can be found on the motor data sheets in the *Hardware Reference* section. For IDC motors with "flying leads", the proper connections are shown below.





Front Panel Settings

Use the table below to configure the current, inductance, and Anti-Res switches for the IDC motor you are using.. If using a non-IDC motor, please refer to Chapter 3.

IDC Motor	Series (T) Connection					Parallel (V) Connection				
	Current	Inductance	Unloaded Anti-Res			Current	Inductance	Unloaded Anti-Res		
			SW4	SW5	SW6			SW4	SW5	SW6
S12	1.1A	8	on	on	on	2.2	4	on	on	on
S21	1.2A	16	on	on	on	2.4	4	on	off	on
S22	1.5A	16	on	on	on	3.0	4	on	on	off
S23	1.7A	16	off	off	on	3.5	4	off	on	off
S32	2.8A	8	off	on	off	5.6	4	on	off	off
S33	3.5A	8	off	on	off	7.0*	4	on	off	off
S42	6.0A	8	on	off	off	7.9*	4	off	off	off

* S6000-8A option required for motor current greater than 6 Amps.

Apply power

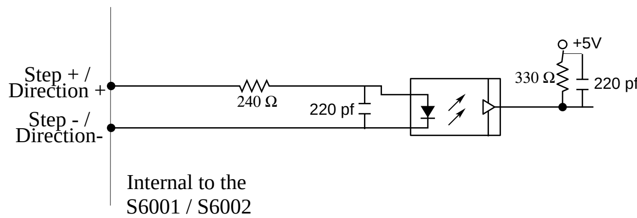
After the motor is connected, use the IDC supplied power cable to connect 115 VAC to the power connector on the bottom of the drive. Various LED indicators will illuminate and flicker for several seconds after power is applied to the drive. Once initialization is complete, only the Power LED should remain illuminated. If any of the fault lights are on, see Chapter 4, *Troubleshooting*, for procedures on resolving any faults.

Check for Motor Torque

At this point the motor is connected to the drive and the green Power LED is on. The motor should have full holding torque. If not, power down the drive and double check the motor connections and the current settings. Refer to Chapter 3, *Configuring Your Drive* and Chapter 4, *Troubleshooting* for more information.

Check for incoming step pulses and motion

After checking for motor holding torque, power down the drive and connect your indexer's step and direction lines to the STEP+/- and DIRECTION+/- screw terminals on the S6000 drive.



Power up the drive and indexer. Command a 1 revolution move from your indexer. (The S6000 defaults to 25,000 steps/rev). The *Stepping* light on the S6000 drive should illuminate while the motor is moving. Command a 1 revolution move in the opposite direction, and the other stepping light should illuminate while the motor moves the opposite direction. Refer to Chapter 4, *Troubleshooting*, if the motor doesn't move or the stepping lights do not illuminate.

Where To Go From Here?

You may want to refer to the following pages for more information:

Installing and Configuring Your Drive

Motor Wiring

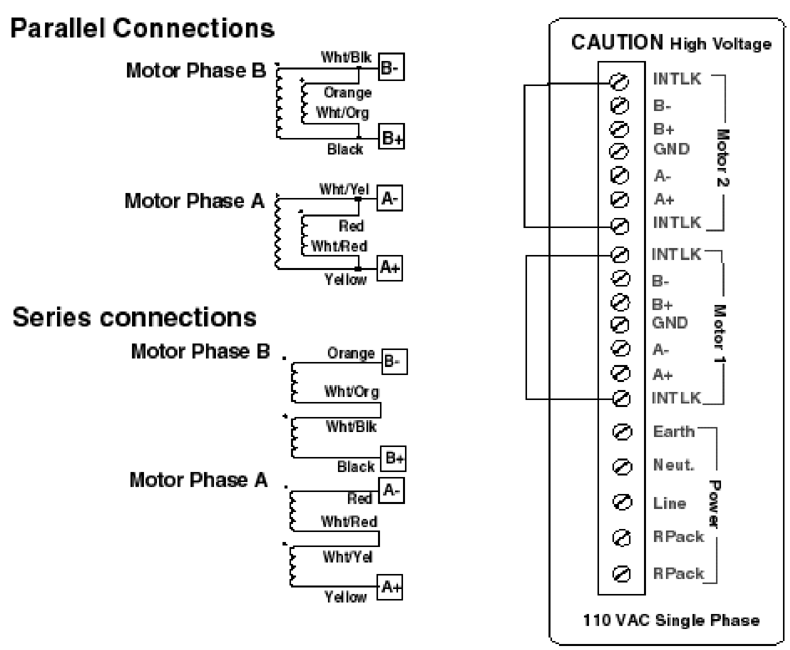
The **A+, A-, B+** and **B-** phase outputs power the motor windings.

The two **INTLK** pins must be jumpered together at the motor connector for the drive to apply power to the motor. If the interlock wire breaks, or the connector is removed, the current to the motor is immediately stopped, the drive faults (latched) and flashes the dual function LED labeled Over Volt./INTLK. Extending the interlock wire beyond about 5 inches can lead to noise generated shutdowns.

GND is internally connected to the Earth pin on the Power connector. This provides a convenient terminal for grounding the motor frame and a motor cable shield.

IDC Motors

Refer to the motor data sheets at the end of this manual for wiring IDC motors with Quick Disconnect cables. The figure below illustrates the drive connections to IDC motors with eight flying leads.



Non-IDC Motors

Bi-filar wound, 8-lead, non-IDC motors can be wired in series or parallel as shown in the drawing above (though the color code will probably be different). When using a 6-lead unipolar motor, the center taps are left unconnected from the drive and insulated from each other.

Indexer Connections

Step (+/-) Input

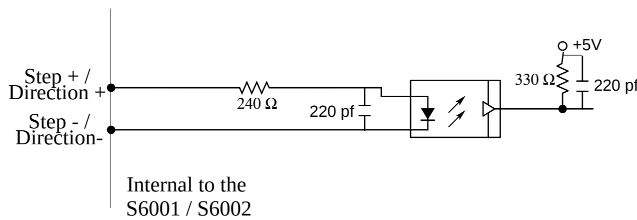
The motor will advance one step following each low-going transition on this input. The step pulse width should be at least 0.4 µsec.

When the drive is configured for CW/CCW Mode (see Front Panel Settings), this input causes the motor to step in the clockwise (CW) direction.

Direction (+/-) Input

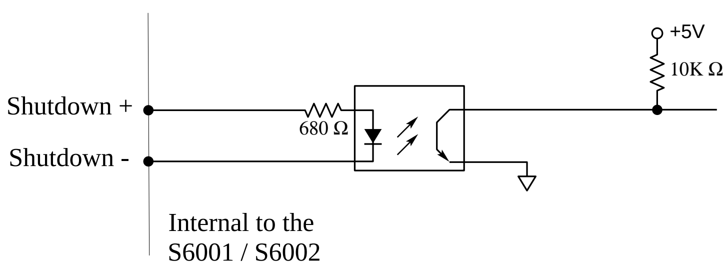
Logic high = CW rotation. Logic low = CCW rotation. The direction line must be stable for at least 0.4 µsec after a direction change to insure that the next step pulse turns the motor in the correct direction.

When in CW/CCW Mode (see Front Panel Settings), low-going transitions on this input cause the motor to step in the counterclockwise (CCW) direction.



Shutdown (+/-) Input

Activating the Shutdown Input (logic low) disables the drive amplifier and de-energizes the motor. When this input is off (logic high) the drive is enabled and the motor is energized.



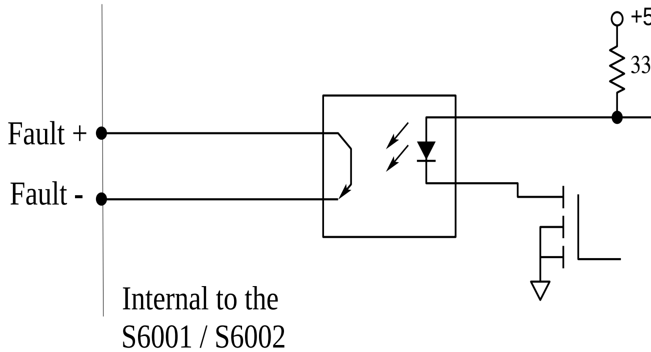
Fault (+/-) Output

The open collector Fault Output turns ON when any one of the following conditions occur:

- Overvoltage
- Undervoltage
- Interrupted Interlock
- OverTemperature/Shutdown
- Short Circuit Fault

The Fault Output is OFF when the unit is not faulted.

The front panel LEDs provide a means to visually resolve the source of the fault. These are all latched conditions. Power must be cycled on the drive to clear the fault. See "LED Diagnostic Indicators" in this chapter for more information on these indicators.



Shield

Grounded connection for the shield on the indexer/drive cable. If the shield is connected at the indexer end of the cable, do not connect it at the drive end.

AC Power

AC power is supplied via the **Earth, Line,** and **Neutral** terminals on the bottom of the drive. Line and Neutral are internally fused (8A slo-blo). Voltage must be in the range 85 - 132 VAC rms, 50/60 Hz. Low voltage will fault the drive. High voltage will fault the drive and possibly blow the internal fuse.
The drive can draw up to 1200 VA per axis. (Current setting, and duty cycle dependent)
The **Earth** terminal should be connected to ground. For safety and best grounding results, use a 14 gauge, braided wire to provide a low impedance path to earth ground.

Operation at supply voltage lower than 115 VAC will result in reduced high speed torque compared with published performance curves.

Front Panel Settings

The purpose and operation of the front panel rotary and dip switch settings are described in detail in this section. The front panel adjustments fall into two categories. The first are the motor dependent settings such as current and inductance. These settings should be made before power is applied to the drive. The second group of settings are application dependent. These include the anti-resonance and current waveform settings. They should be optimized while the drive and motor are loaded and running.

Before Applying Power

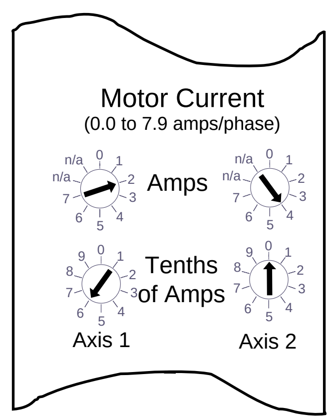
Prior to applying power to your S6000 drive, the motor current, inductance, step type and resolution settings must be made. The other settings (waveform, standby current, anti-resonance, and phase offset adjustments can be made while the drive is powered and the motor is moving.

Motor Current

The S6000 drive has a **Motor Current** range of 0.0-6.0 Amps (peak) per motor phase. The S6000-8A option has 0.0-7.9 Amps available. Each axis has two, 10 position rotary switches for setting the current independently in each motor. The top switch sets the integer current value, and the bottom switch sets the tenths of amps value.

The example shows the current set to 2.6 Amps on Axis 1 and 4.0 Amps on Axis 2.

WARNING: IF THE CURRENT IS SET TOO HIGH THE MOTOR MAY BE DESTROYED.



IDC Motor Current

The following table shows the S6000 current settings for IDC step motors. When using step motor wired in parallel, at speeds above 5 revs per seconds, the duty cycle of the motor must be limited to 60% to prevent motor overheating.

IDC Motor	Series (T) Connection	Parallel (V) Connection
S12	1.1A	2.2A
S21	1.2A	2.4A
S22	1.5A	3.0A
S23	1.7A	3.5A
S32	2.8A	5.6A
S33	3.5A	7.0A*
S42	6.0A	7.9A*

* S6000-8A option required for motor current greater than 6 Amps.

Non-IDC Motor Current

IDC's S Series motors have custom windings to provide optimum dynamic performance with our S6000 drives. If you need to use another manufacturer's motors, they should meet the following guidelines:

1. 2 phase, hybrid, permanent magnet step motor
2. 4, 6, or 8 lead motor
3. Series or parallel inductance rating between 2-60 mH. Higher inductance motors will not damage the drive, but they will have limited dynamic performance.
4. A minimum high-pot test rating of 500 VDC

If possible, use the manufacturer's 160 VDC, bipolar current rating. With **4-lead motors**, the manufacturer's (bipolar) current rating translates directly to the S6000 current setting.

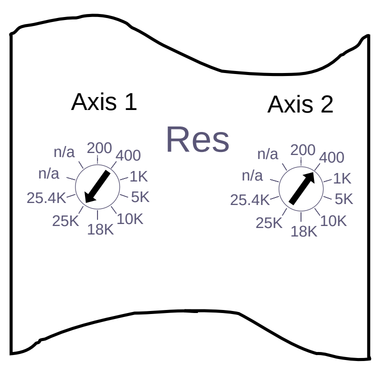
For the proper current setting for **6-lead (unipolar) motors**, use 70% of the manufacturer's rating.

For **8-lead motors**, you have the choice of wiring the motor in series or parallel (see Motor Wiring). In Series, set the current to the manufacturer's bipolar rating. In Parallel, double the bipolar current rating. Care should be taken when running a step motor in parallel to avoid overheating the motor windings. A step motor in parallel may be duty cycle and speed limited. Check with the motor manufacturer for temperature guidelines.

Motor Resolution

Your S6000 Drive has eight selectable motor resolutions (200, 400, 1,000, 5,000, 10,000, 18,000, 25,000 and 25,400 steps per motor revolution.) Other resolutions are available as specials from IDC. Please contact the factory for details.

The motor resolution setting, labeled **Resolution** (S6001) or **RES** (S6002) on your drive, will determine the number of incoming step pulses per revolution of your motor. This resolution setting assumes you are using a step motor with 1.8° per full step. The example shows Axis 1 set to 25k steps/rev and Axis 2 set to 400 steps/rev.



Motor resolution is most often set to the maximum that your indexer can handle (i.e. such that the maximum step rate of the indexer provides the maximum motor speed you require). In other applications, you may want to choose your motor resolution to achieve a desired number of steps per engineering unit (per inch, degree, mm, etc.). Resolution also affects velocity smoothness to a degree. Above 10,000 steps per revolution however you will notice little improvement in smoothness, unless you are moving only a few steps per second.

Motor Inductance

The S6000 drive has a dial-in **Motor Inductance** range of 2-60 mH per phase, with 16 settings over that range. The 16 position rotary inductance setting switch has inductance settings from 0 to 60 mH, in multiples of 4 mH. To get the proper inductance setting from the motor inductance specification, round to the nearest multiple of 4 mH. (When using motors with an inductance less than 4 mH, always set the **Motor Inductance** switch to 4mH.) For example when using an IDC model number S33 wired in series, the inductance is 10 mH. Rounding to the nearest inductance setting gives 8mH.

IDC Motor	Series (T) Inductance (mH)	Parallel (V) Inductance (mH)
S12	10	2.5
S21	18	4.5
S22	18	4.5
S23	18	4.5
S32	10	2.5
S33	10	2.5
S42	7	1.8

If you are installing and configuring a S6000 Series drive that shipped from IDC before August 1st, 1996, (the serial number is date coded) you will need to set the inductance switch to *3 times* the value shown above to get cataloged performance from your system.

The S6000 will operate motors with inductance up to 100 mH per phase, but dynamic performance with high inductance motors will be limited. If you are not using an IDC supplied step motor, look for the motor manufacturer's inductance rating.

If the exact inductance of the motor is not known, initially set the inductance to 32 mH. The inductance switch is much more of an adjustment than a setting. Because of the variety of different ways that manufactures specify motor inductance, it is difficult relate a spec sheet number to an actual drive setting, so some adjustment may be needed. If the S6000 Inductance is set too low, the motor will not run at its rated torque and speed. You will experience premature stalling. Setting the Inductance switch too high will produce an audible hum from the motor, and increase motor heating. Between these two extremes, there are generally 2 or 3 inductance settings that are "right".

With 4-lead motors, the manufacturer's inductance rating usually translates directly to the S6000 inductance setting. To determine the 6-lead unipolar motor inductance setting, we normally use 4X the manufacturer's rating. For 8-lead (bi-filar wound) motors in series, set the inductance to 4X the manufacturer's rating. In parallel, use the manufacturer's rating. Again, please check with the motor manufacturer to be sure.

Standby Current

The automatic current standby function allows your motor and drive to operate cooler if the motor is not required to move a significant percentage of the time. Drive losses, which produce heat in the drive, are directly proportional to motor current. While, in the motor, using the **Standby** feature will reduce motor heating by 49% will when no motion is being commanded.

Setting the **Standby** current DIP switch to ON reduces motor current by 30% when the drive has not received a step pulse for 250 msec. Full current is restored when the next step pulse is received.

A 30% reduction in motor current during standby correlates to approximately 30% reduction in motor holding torque. You will not be able to use standby mode in applications where you need more than 70% of the motor's torque to hold a load stationary (e.g. holding a vertical load against gravity with a ball screw). You also should not use this function in applications that use an encoder to perform end-of-move position maintenance.

Input Step Type

You have two format choices for the command input; Step/Direction (**Step Type** DIP switch OFF), and Clockwise/Counterclockwise (Step Type DIP switch ON).

In Step & Direction mode, the motor will advance one step with each low going transition on the Step input. The level of the Direction input determines the direction that the motor steps.

In Clockwise/Counterclockwise mode, the motor will advance one step clockwise for each low going transition on the Step input, and advance on step counter-clockwise for each low going transition on the Direction input.

After Applying Power

After you have applied power to your S6000 drive and have established a valid step command source, the following front panel adjustments can be made to "fine adjust" the performance of your motor/drive system.

Phase Offset

Microstepping a step motor requires producing sinusoidal currents in the two phase windings of the motor. Motor to motor manufacturing variances can result in a DC offset in either or both windings that produce a small torque ripple which can result in two problems:

1. A small cyclic step error arises which repeats itself every 7.2 degrees of rotation.
2. At a particular speed, the torque ripple occurs at the resonant frequency of the motor and results in noticeable velocity ripple.

The S6000 drive provides phase **Offset A** and **Offset B** potentiometers on the front panel to adjust DC offset in each of the windings, so as to optimize the velocity smoothness and step-to-step accuracy of each individual motor/drive system.

Here is a simple balancing procedure:

1. Run the motor continuously, unloaded, at the speed "V" given in the chart below.
2. This should produce a noticeable amount of velocity ripple which may be audible and can be felt by lightly touching the motor case or shaft.
3. Alternately adjust Offset pots A and B off center for best smoothness.

IDC Motor	V (RPS)
S12	5.4
S21	4.6
S22	3.9
S23	3.6
S32	3.0
S33	2.8
S42	2.1

The required speed "V" depends on the motor torque and total system inertia. We use an unloaded motor because you can then accurately find the torque and inertia from the motor data sheets. If you are using another manufacturer's motor, the speed may be calculated from this formula:

$$V = 0.0225\sqrt{\frac{T_m}{J}}$$

Where: V = speed (RPS)
T_m = holding (stall) torque (N m)
J = rotor moment of inertia (kg m^2)

The formula will yield a value between 2 and 5 RPS depending on the type of motor.

Current Waveform

Depending on motor design and the current level at which it is being driven, it may be advantageous to distort the sinusoidal waveform to achieve better low speed smoothness and step-to-step accuracy. The S6000 drive allows you to select between a -4% 3rd harmonic distortion (Waveform dip switch ON) and a pure sine wave (Waveform dip switch OFF). The motor design IDC uses run best with the Waveform switch OFF.

To determine the best setting for your motor:

1. Operate the unloaded motor continuously at speed "V/4" as shown in the chart to the right.
2. While touching the shaft lightly, change the Waveform switch back and forth to determine which setting produces the smoothest motion.

IDC Motor	V/4 (RPS)
S12	1.35
S21	1.15
S22	.98
S23	.9
S32	.75
S33	.7
S42	.53

This setting does not change from production motor to motor. Only if the motor type or manufacturer is changed should you have to repeat this test. With skewed rotors or 50-48 tooth geometry pure sine will usually produce the best results.

Note: Selecting the -4% 3^{rd} Harmonic setting (Waveform dip switch ON) will result in a 4% loss in available motor torque.

Anti-Resonance Compensation

The S6000's Anti-Resonance Compensation improves motion performance in two ways. First, it prevents motor stalls due to mid-range step motor resonance and yields higher usable shaft power. Second, it reduces the amount of transient ringing that occurs at the end of a move. These phenomena combine to produce faster move times and therefore higher machine throughput.

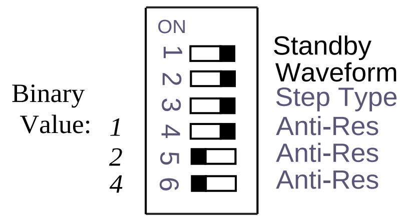
Three **Anti-RES** switches provide eight settings (0-7) to adjust the gain of the compensation circuit in the S6000. The gain required is a function of the motor winding and load inertia (gain will be inversely proportional to load inertia).

If you know your load inertia, you can use the following formula to calculate the gain value (**N**) needed in your application.

$$N = \frac{.45}{V\sqrt{T(J_L + J_M)}}$$

Where: J_M = Rotor moment of inertia (kg m^2)
J_L = Load moment of inertia (kg m^2)
T = Motor stall torque (N-m) less 10%
V = Motor speed (rps) at which torque has fallen off 10% from its stall value. This speed/torque point is located just beyond the "knee" of the motor's speed torque curve.

The value of **N** will usually be between 0 and 10. To get the proper Anti-Res setting, round to the nearest available value (0-7) and set the corresponding binary weighted DIP switches (On=1, Off=0). The example shows a setting of N=6.



If you don't know your load inertia, use the following procedure to empirically adjust the Anti-Resonance gain for optimum performance.

1. Set the gain to 0 (all switches Off).
2. With the load attached, repeatedly command the most demanding move your application requires. If the motor successfully completes this move, further adjustment is not necessary.
3. If the motor stalls before you achieve the speed or acceleration you seek, or if you notice the motor "ringing" excessively at the end of the moves, increase the gain setting by one, try the move again, and see if the performance improves.
4. Repeat step 3. until the ringing again gets worse or the motor stalls. The compensation gain is now too high. Decrease the gain setting by one.

The following table shows the proper Anti-Res setting for an unloaded IDC motor. Since adding inertia reduces the gain required, your Anti-Res setting should never exceed these values.

Unloaded IDC Motor	Series (T) Gain Setting				Parallel (V) Gain Setting			
	Value	**SW4**	**SW5**	**SW6**	**Value**	**SW4**	**SW5**	**SW6**
S12	7	on	on	on	7	on	on	on
S21	7	on	on	on	5	on	off	on
S22	7	on	on	on	3	on	on	off
S23	4	off	off	on	2	off	on	off
S32	2	off	on	off	1	on	off	off
S33	2	off	on	off	1	on	off	off
S42	1	on	off	off	0	off	off	off

NOTE:
The **Resolution** and **Step Mode** settings are read only at power up. Subsequent adjustments have no effect until power is cycled. The other adjustments (**Current, Waveform, Standby, Inductance, Anti-Resonance**, and **Phase Offsets**) can be changed while the motor is energized and moving.

LED Diagnostic Indicators

Power

The green **Power** LED indicates that the internally regulated logic supplies are operating. If 120 VAC power is applied at the line/neutral terminals and the Power LED does not illuminate immediately, the drive is defective.

For several seconds after power is applied to the drive, various LED indicators will illuminate and flicker. This is a normal initialization sequence. Once complete, only the Power LED should remain illuminated.

Regen

The yellow **Regen** LED illuminates whenever the internal power dump circuitry is shunting energy from the High Voltage DC Supply to a regen resistor. This occurs when the regenerative energy transferred from the motor surpasses a level set by the drive. If the Regen activity is modest, the indicator may flicker very briefly.

Over Volt./INTLK

The RED dual-function **Overvoltage / Interlock** LED illuminates when either of two Fault conditions occur.

1. Overvoltage on the internal high voltage power bus due to regen activity that overwhelms the power dump capacity. This latched condition is indicated by continuous illumination and is cleared by recycling power to the drive.
2. Loss of continuity in the Interlock circuit. A missing Interlock jumper at either motor connector will invoke this latched condition which flashes the indicator. This condition is cleared by cycling power.

Temperature

The red **Temperature** LED illuminates when the drive has faulted due to an over-temperature condition (approximately 60°C/140°F on the heatsink). The fault is latched and must be cleared by recycling power.

If over-temperature occurs once, it will probably occur again unless steps are taken to increase cooling or reduce throughput. Lowering the ambient temperature, circulating air past the heatsink, installing a -FK1 fan kit, or using the Standby current setting all help to lower the temperature of the heatsink.

Stepping

The two green **Stepping** LEDs indicate that the drive is receiving CW (right LED) or CCW (left LED) step pulses. The LEDs are driven by digital one-shots to clearly indicate the receipt of even a single step pulse. Above several steps per second the LED becomes continuously illuminated.

Disable

The yellow **Disable** LED is illuminated when the Shutdown input is activated by an external controller. The Shutdown signal also activates the Fault output, but does not turn on the Fault LED. See the description under the Fault LED and the Fault output for a complete description of these signals.

Fault

The red **Fault** LED indicates that a Short Circuit or Undervoltage condition has occurred. A short circuit problem can occur because of shorted or miswired motor leads, or because of an internal drive defect. This fault is cleared by recycling power.

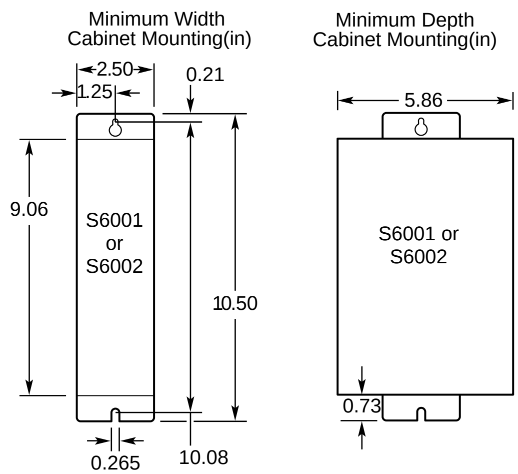
If the cause persists, repeated faults may occur. To isolate the problem, disconnect the motor leads from the drive connector, but leave the Interlock jumper installed. Apply power and step pulses. If the drive does not invoke the short circuit fault, then it is likely that the defect is in the motor, its cabling, or the connections at the drive.

NOTE:
Though similarly named, the **Fault** LED and **Fault** Output do NOT activate the same. The Fault Output indicates that one of several fault conditions has occurred (Overvoltage, Undervoltage, Interlock, Over temperature, Shutdown or Short Circuit Fault), and the front panel LEDs provide a means of resolving the source of the fault.

Drive Mounting

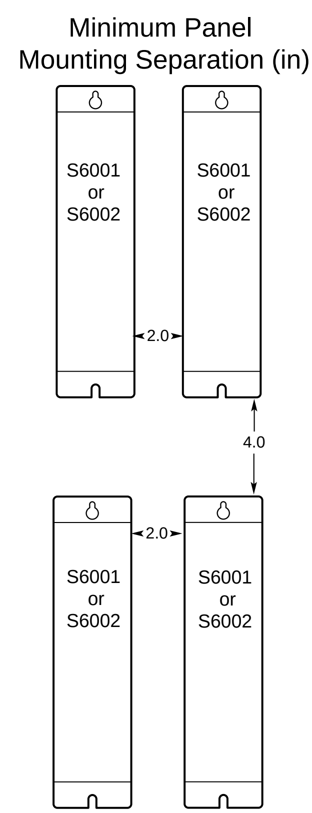
Drive dimensions are shown to the right.

Your S6000 drive arrived ready for a minimum width mounting. By moving the mounting bracket to the wide side of the heatsink, you can mount the S6000 in a minimum depth configuration.



The S6000 depends on air flow for cooling. In all but the least demanding applications, the following mounting guidelines should be observed:

- Allow clearance (approximately one inch) for a -FK1 fan kit if the available airflow appears marginal.
- The heat sink fins should be oriented vertically for convection currents to flow along the fins.
- The vertical clearance between an S6000 drive and other equipment or surfaces of the enclosure should be a minimum of 4.0 inches, and horizontal clearance should be a minimum of 2.0 inches. See drawing.
- High heat-generating equipment should not be mounted directly below the S6000.



Forced air cooling may be necessary if air flow is extremely poor, or if the ambient temperature is excessive (above 35°C). See *-FK1 Fan Kit* below.

FK1 Fan Kit

The -FK1 Fan Kit Option may be necessary if air flow across the S6000 drive heat sink is extremely poor, or if the ambient temperature is excessive. The -FK1 is required by IDC for all applications where the total drive current (axis one current plus axis two current in the case of the S6002) exceeds 6.0 Amps.
A fan kit comes standard on all 8 Amp versions (-8A) of the S6000 drives and controls.

See the 1996 IDC catalog for additional information on the fan kit, including mounting dimensions.

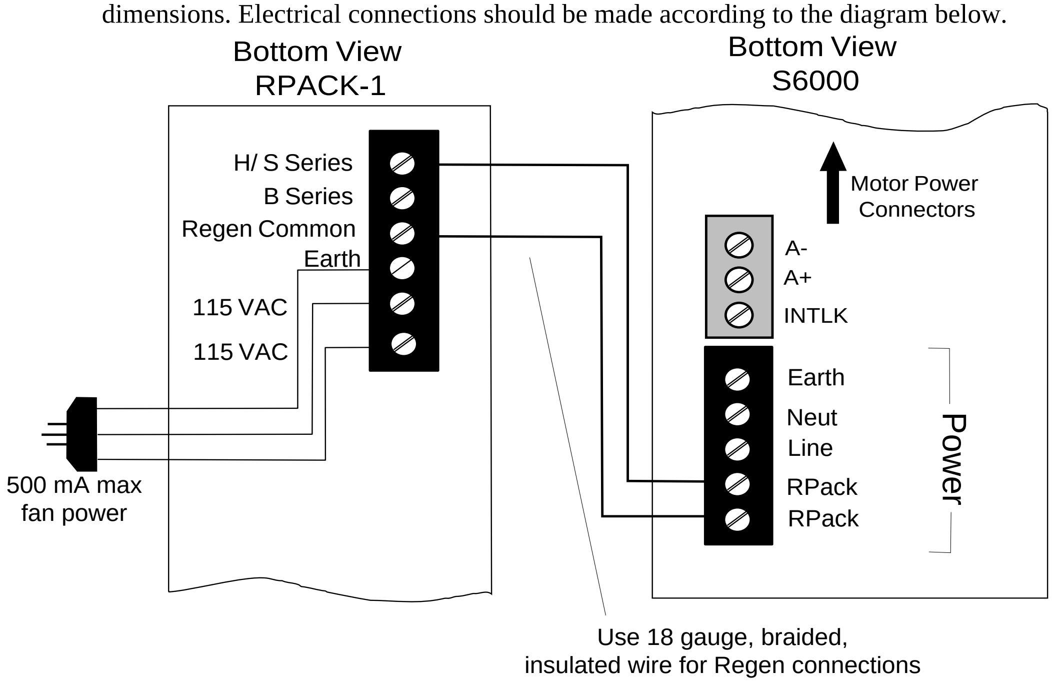
If your S6001 drive shuts down repeatedly due to an over temperature condition, you will have to take steps to increase cooling. The FK1 fan kit can be purchased as a field retrofit kit. The 115 VAC power for the fan is supplied by the S6000 drive. Please consult IDC for more information.

RPACK-1 Mounting and Installation

The RPACK-1 is a packaged power dump device consisting of high voltage power resistors, a heatsink and a cooling fan. It is an accessory to IDC's S, H and B Series controls.

The RPACK-1 is typically used when it is necessary to very rapidly decelerate heavy vertical loads or large inertial loads. The RPACK-1 dissipates the kinetic and potential energy that would otherwise cause the drive to shutdown due to an Over-Voltage or Regen fault. Using an RPACK-1 can help reduce overall cycle time by allowing a higher deceleration rate than would be possible without it.

The RPACK-1 mounting dimensions are the same as the S6000 drive mounting dimensions. Electrical connections should be made according to the diagram below.



Hardware Reference

S6000 Drive Specifications

AC Power

105-135 VAC single phase, 50/60 Hz.

S6001:	1,000 VA max. at 7.9 Amp setting.
S6002:	2,000 VA max. at 7.9 Amp setting per motor.

Motor Output

Voltage	160 VDC bus, with 115 VAC input
Current	Switch selectable. 0.1-7.9 Amps/phase
Waveform	Switch selectable. Pure sine or -4% 3rd harmonic distortion.
Resolutions	Switch selectable. 200, 400, 1000, 5000, 10000, 18000, 25000, 25400 (1.8° per full step motor)
Stand-by	Switch selectable. Reduces motor current to 70% of nominal if no step pulses are received for 250 ms. Full current is restored upon next step pulse.
Protection	Drive is shut down due to short circuits (phase to phase and phase to ground), Open circuits, Brownout, and Over temperature
Anti- Res Compensation	Switch selectable (0-7) gain setting for motor resonance compensation.

Step Motor Specifications

IDC's S Series motors have custom windings to provide optimum dynamic performance with our S6000 drives. If you need to use another manufacturer's motor, it should meet the following guidelines:

2 phase, hybrid, permanent magnet step motor

4, 6, or 8 lead motor

Series or parallel inductance rating between 2-60 mH. Higher inductance motors will not damage the drive, but they will have limited dynamic performance.

A minimum high-pot test rating of 500 VDC

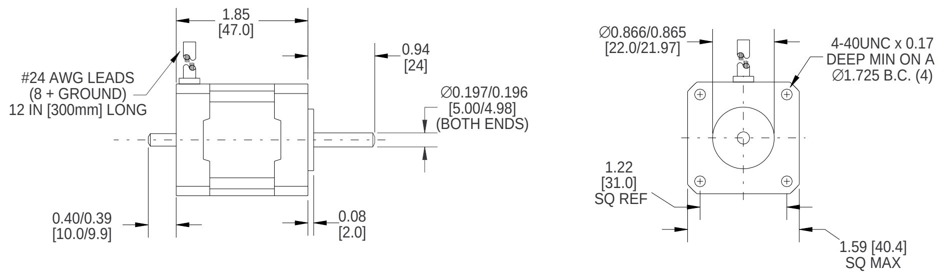
Controller Interface

All Inputs	Optically isolated, 6.5 mA min, 15 mA max.
Step	400 nsec min. pulse width, 1.25 Mhz max. pulse rate, triggered on rising edge.
Direction	Logic High = Clockwise, Low = Counterclockwise motor rotation. Must be stable 400 nsec before arrival of next step pulse when changing direction.
Shutdown	Logic high = drive enabled, Logic low = drive disabled
Fault Output	Optically isolated NPN, open collector and emitter available (Fault + and -). Output Off = drive not faulted, Output On = drive faulted

Environmental

Operating Temperature:	Thermal shutdown occurs if the heat sink temperature exceeds 65°C (149°F).
Storage Temperature:	-40 to 80°C (-40 to 176°F)
Humidity	90% max., non-condensing

S12 Hybrid Step Motor Specifications



Motor Data

Electrical

		Series	Parallel
Continuous Stall Torque	oz-in [N-m]	35 [0.25]	
Recommended Current/Phase	Amps	1.0	2.0
Winding Resistance @ Ambient	Ohms	5.52	1.38
Inductance	mH	8.8	2.2
Max. Winding Temperature	°F [°C]	212 [100]	

Mechanical

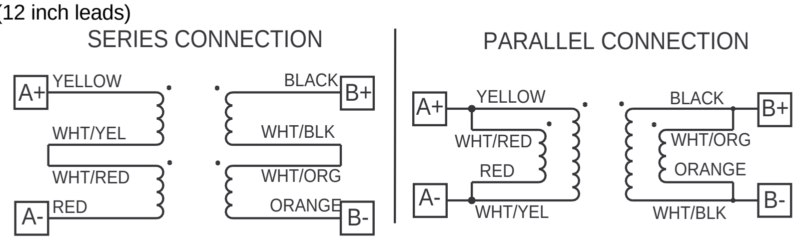
Rotor Inertia	oz-in-s^2 [kg-m^2]	5.1×10^{-4} [3.6×10^{-6}]
Axial Shaft Load	lbs [N]	10 [45]
Radial Shaft Load - @ 0.5"	lbs [N]	5 [22]
Motor Weight	lbs [kg]	0.66 [0.3]
Step Angle (full step)	degrees	1.8

- Parallel (V) Wiring: 60% Duty Cycle Max. Above 5 rps (300 rpm).
- Always use at least 50% torque safety margin when applying step motors.

Motor Wiring

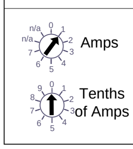
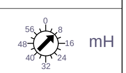
Wire Leads :

(12 inch leads)

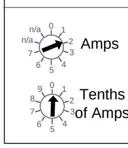
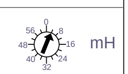


S6000 Drive Settings

S12 - Series

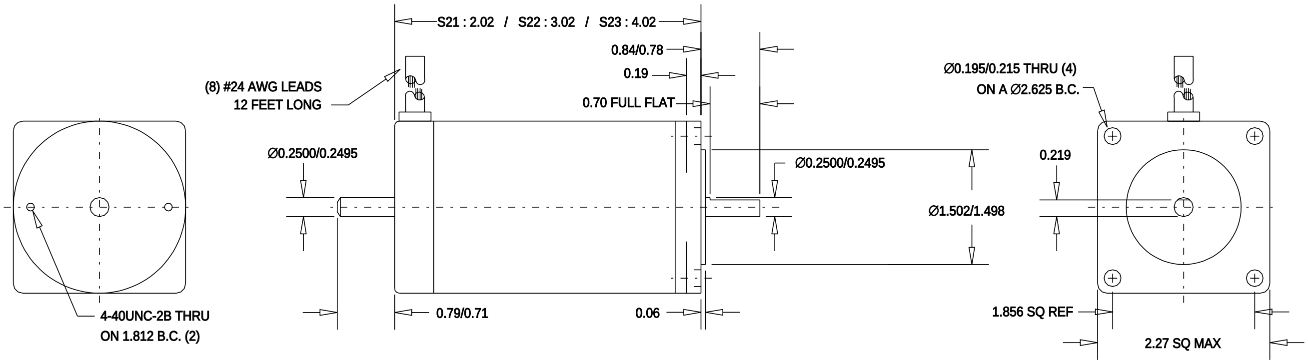
Motor Current	Inductance
1.0 Amps	**8* mH**
	

S12 - Parallel

Motor Current	Inductance
2.0 Amps	**4* mH**
	

*****Drive setting closest to actual motor specifications.

S21/S22/S23 Hybrid Step Motor Specifications



Motor Data

Electrical

		S21T (Series)	S21V (Parallel)	S22T (Series)	S22V (Parallel)	S23T (Series)	S23V (Parallel)
Continuous Stall Torque	oz-in [N-m]	65 [0.46]		100 [0.71]		125 [0.88]	
Recommended Current/Phase	Amps	1.2	2.4	1.5	3.0	1.75	3.5
Winding Resistance @ Ambient	Ohms	5.4	1.35	4.8	1.2	4.4	1.1
Inductance	mH	18	4.5	18	4.5	18	4.5
Max. Winding Temperature	°F [°C]	212 [100]		212 [100]		212 [100]	

Mechanical

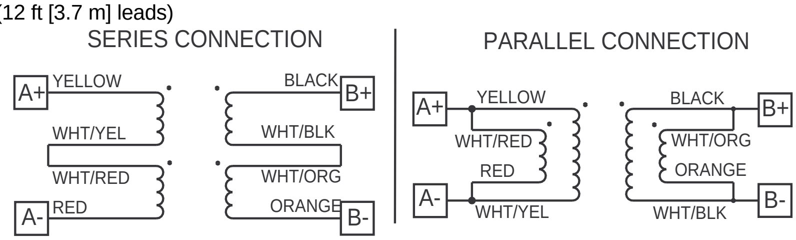
		S21	S22	S23
Rotor Inertia	oz-in-s^2 [kg-m^2]	1.66×10^{-3} [1.17×10^{-5}]	3.31×10^{-3} [2.34×10^{-5}]	4.97×10^{-3} [3.51×10^{-5}]
Axial Shaft Load	lbs [N]	25 [111]	25 [111]	25 [111]
Radial Shaft Load - @ 0.5"	lbs [N]	5.6 [25]	5.6 [25]	5.6 [25]
Motor Weight	lbs [kg]	1.6 [0.73]	2.4 [1.1]	3.2 [1.5]
Step Angle (full step)	degrees	1.8	1.8	1.8

- Parallel (V) Wiring: 60% Duty Cycle Max. Above 5 rps (300 rpm).
- Always use at least 50% torque safety margin when applying step motors.

Motor Wiring

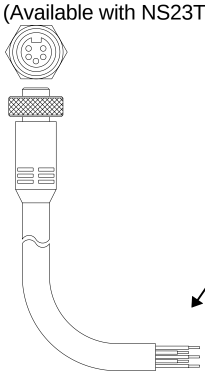
Wire Leads : S21N / S22N / S23N

(12 ft [3.7 m] leads)



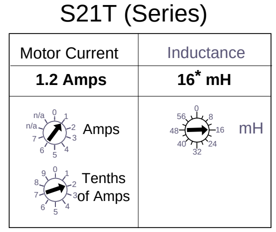
Quick-Disconnect : S21(T/V) / S22(T/V) / S23(T/V)

(Available with NS23T/V and R2S23T/V actuators only)

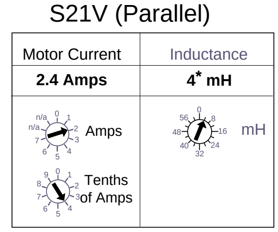


Quick-Disconnect Wire Color	Drive Connection
RED	A+
RED w/ ORANGE	A-
RED w/ WHITE	B+
RED w/ BLACK	B-
GREEN	GND

S21T (Series)

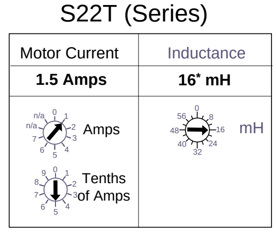


S21V (Parallel)

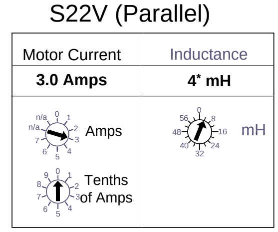


*Drive setting closest to actual motor specifications.

S22T (Series)

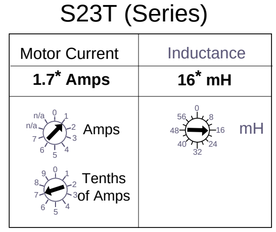


S22V (Parallel)

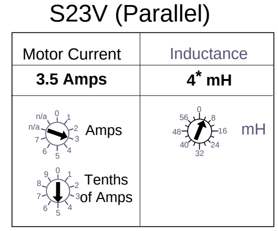


*Drive setting closest to actual motor specifications.

S23T (Series)

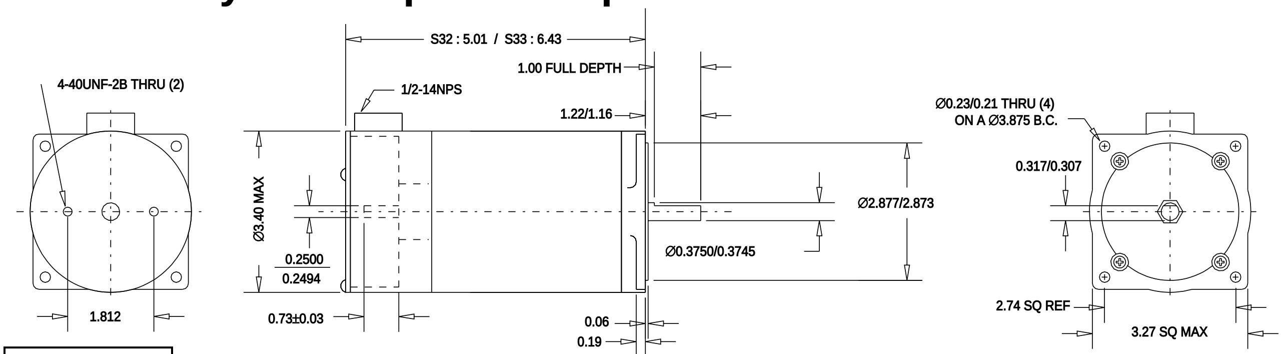


S23V (Parallel)



*Drive setting closest to actual motor specifications.

S32/S33 Hybrid Step Motor Specifications



Motor Data

Electrical

		S32T (Series)	S32V (Parallel)	S33T (Series)	S33V (Parallel)
Continuous Stall Torque	oz-in [N-m]	300 [7.1]		400 [5.3]	
Recommended Current/Phase	Amps	2.8	5.6	3.5	7.0
Winding Resistance @ Ambient	Ohms	1.03	.26	.96	.24
Inductance	mH	10	2.5	10	2.5
Max. Winding Temperature	°F [°C]	212 [100]		212 [100]	

Mechanical

		S32(T/V)	S33(T/V)
Rotor Inertia	oz-in-s^2 [kg-m^2]	0.017 [3.51×10^{-5}]	0.0265 [3.51×10^{-5}]
Axial Shaft Load	lbs [N]	50 [222]	50 [222]
Radial Shaft Load - at .5 in	lbs [N]	14.5 [64.4]	14.5 [64.4]
Motor Weight	lbs [kg]	5.1 [2.3]	8.3 [3.8]
Step Angle (full step)	degrees	1.8	1.8

- Parallel (V) Wiring: 60% Duty Cycle Max. Above 5 rps (300 rpm).
- Always use at least 50% torque safety margin when applying step motors.

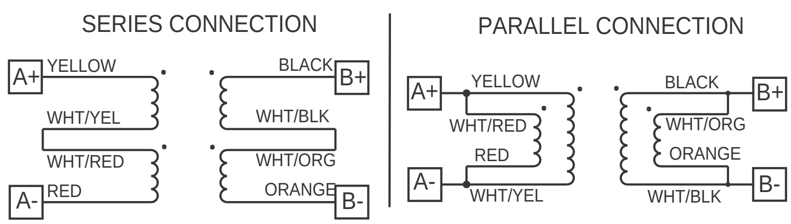
Motor Wiring

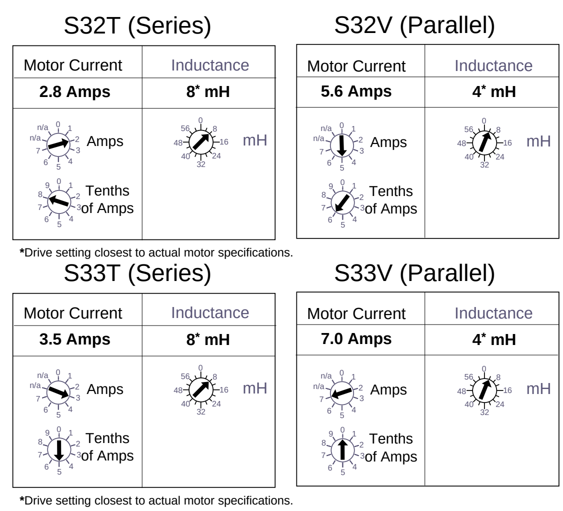
S6000 Drive Settings

S6000 Drive Settings

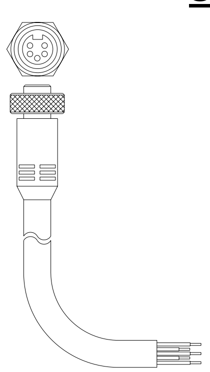
Wire Leads : S32N/S33N

(12 inch leads)





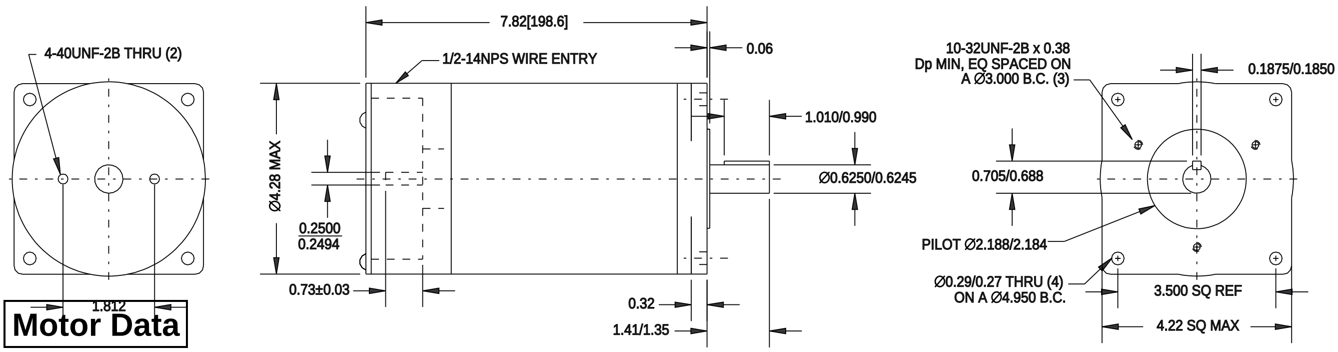
Quick-Disconnect : S32(T/V) / S33(T/V)



Quick-Disconnect Wire Color	Drive Connection
RED	A+
RED w/ ORANGE	A-
RED w/ WHITE	B+
RED w/ BLACK	B-
GREEN	GND

S42 Hybrid Step Motor Specifications

Motor Data



Electrical

		S42T (Series)	S42V (Parallel)
Continuous Stall Torque	oz-in [N-m]	1000 [7.1]	725 [5.1]
Recommended Current/Phase	Amps	6.0	7.9
Winding Resistance @ Ambient	Ohms	.36	.09
Inductance	mH	7	1.75
Max. Winding Temperature	°F [°C]	212 [100]	

- Parallel (V) Wiring: 60% Duty Cycle Max. Above 5 rps (300 rpm).
- Always use at least 50% torque safety margin when applying step motors.

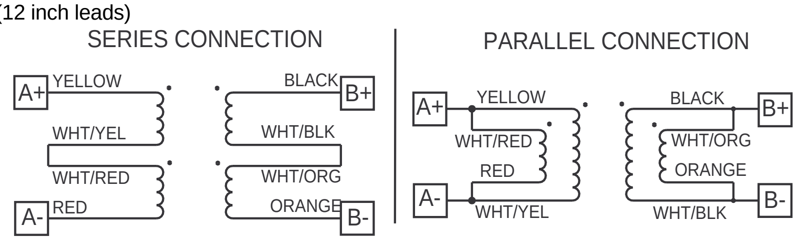
Mechanical

		S42 (T/V)
Rotor Inertia	oz-in-s^2 [kg-m^2]	114×10^{-3} [80.5×10^{-5}]
Axial Shaft Load	lbs [N]	65 [289]
Radial Shaft Load - @ 0.5"	lbs [N]	23.6 [105]
Motor Weight	lbs [kg]	19.1 [8.66]
Step Angle (full step)	degrees	1.8

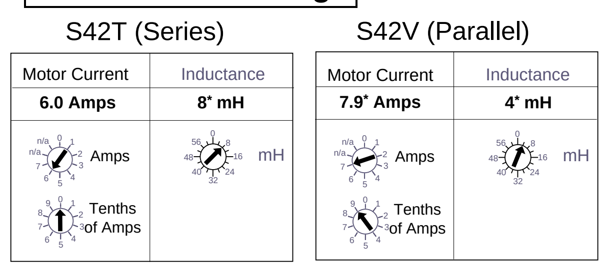
Motor Wiring

Wire Leads : S42N

(12 inch leads)

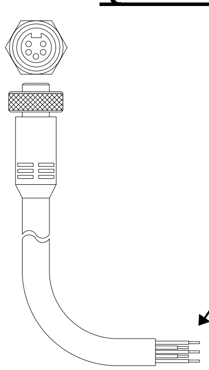


S6000 Drive Settings



*Drive setting closest to actual motor specifications.

Quick-Disconnect : S42(T/V)



Quick-Disconnect Wire Color	Drive Connection
RED	A+
RED w/ ORANGE	A-
RED w/ WHITE	B+
RED w/ BLACK	B-
GREEN	GND

Troubleshooting

The following table will help you isolate some of the more common application problems when using S6000 drives. For more information on the function of the front panel LEDs see "LED Diagnostic Indicators in the Chapter 3, *Installing and Configuring Your Drive.*

Symptoms	Probable Causes	Possible Remedies
Fault LED is on	Miswired motor, or short circuit in motor. AC voltage below 85 Volts. Defective drive.	Isolate problem by disconnecting motor leads from the motor connector, but leave interlock installed. Apply power and step pulses. If fault does not occur, the motor or its wiring is defective. Verify AC line voltage well above 85 volts. If fault still occurs, the drive is defective. Return to IDC for repair.
Temperature LED is on	Drive heatsink temperature went above 70°C.	Increasing cooling: circulate more air past heatsink, add -FK1 fan kit, use Standby mode, or reduce duty cycle.
Regen LED is fully illuminated.	Means regen circuit is active. This alone is NOT a problem. Higher deceleration or load may cause a problem.	Adding an RPACK-1 may reduce drive heating.
Over Volt./Interlock LED is on, and Regen LED was fully illuminated before fault occurred.	Overvoltage due to excessive regen energy from the motor.	Install an RPACK-1 module for additional regen dissipation capacity.
Over Volt./Interlock LED is flashing.	INTLK connection on one or both axes has been broken.	Check continuity between interlock terminals. Check that motor connector is fully seated. Cycle power.
Little or no holding torque on the motor, the power LED is on and the Fault LED is off.	Drive is disabled by Shutdown input. Disable LED should be on. Motor is disconnected. Current is set to low.	Enable drive by removing Shutdown signal. Check motor wiring. Check current setting rotary switches.
Motor stalls between 12-18 rps	Wrong Anit-Res setting Too high an acceleration.	See Anti-resonance settings Reduce load or acceleration
Motor runs rough at low speeds (1-5 RPS)	You're running at 200 or 400 steps per rev. Considered normal. Phase Offsets or Waveform may need to be adjusted. Motor current is set too high. Step pulses being received are erratic.	Increase resolution setting. See Front Panel Adjustments. Check motor current setting. Check for constant step pulse rate with an oscilloscope.

Symptoms (continued)	Probable Causes	Possible Remedies
Motor seems to be "losing steps".	Control is overdriving or underdriving the step input.	Verify that the input current is at least 6.5 mA but less than 15 mA.
	The step pulses are coming too fast or are too narrow.	Pulses must not exceed 1.25 MHz, or be less than 0.2 µsec in width.
	The motor is stalling.	See motor stall symptoms.
	The mechanical system is slipping.	Check that couplings, belts, pulleys, etc. are not slipping. Test the motor unloaded.
Motor moves the wrong distance.	Drive and control resolution don't match.	Check that drive resolution setting coincides with the indexer.
Motor stalls at high speeds	Commanded velocity is too high for system capability.	Check motor current setting. May have to reduce velocity. Also see "Anti-resonance settings"
Motor stalls during acceleration	Motor current is incorrect. Acceleration rate is too high for the system capability.	Check motor current setting. Reduce your acceleration, or use a motor with higher torque.
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). Or, with AC power off, change motor direction by swapping A+ with A-. on the motor connector.
Motor won't change direction.	You're in CW/CCW mode and you want to be in Step/Direction mode, or vice versa.	Check the Step Type dip switch.
	Control is overdriving or underdriving the step input.	Verify that the input current is at least 6.5 mA but less than 15 mA.
The motor runs very hot	Step motors can run at up to 100°C, may not be a problem.	Use Standby mode if your application allows it. Reduce cycle rate.
Motor has torque, steps are being received (Stepping LED is on) but motor doesn't turn.	Motor is stalled, or load is jammed mechanically.	Reduce the load or the speed of the move.

Warranty & Repairs

Industrial Devices Corporation (IDC) warrants this product to be free of defects in material and workmanship for a period of two (2) years from the date of shipment to the end user. Products that have been improperly used or damaged, in the opinion of IDC, are not subject to the terms of this warranty.

IDC maintains a repair facility at its factory in Novato, California for products manufactured by IDC. Prior approval by IDC is required before returning any product for any reason. All returned packages must be accompanied by an RMA# (Return Material Authorization number).

To obtain return authorization, contact your local IDC distributor or IDC. Please note the following procedure:

1. Obtain the model and serial number of the defective unit.
2. Prepare a purchase order for possible repair cost, in the event that the unit is not warranted.
3. Contact your IDC distributor or IDC (1-800-747-0064) for an RMA#.
4. Provide information describing the nature of the failure. The better the information, the faster we'll have your problem resolved.
5. Ship unit prepaid to:

   Industrial Devices Corporation
   64 Digital Drive
   Novato, CA 94949
   Attn.: RMA#____________

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64 Digital Drive • Novato, CA USA 94949-5704
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E-mail: INFO@IDCMOTION.com
World Wide Web: http://www.idcmotion.com
S6001/S6002 Operator's Manual, PCW-4756
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