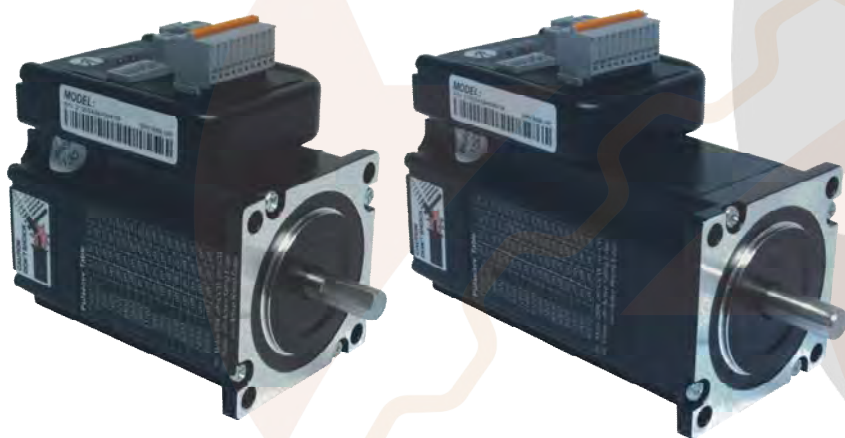


# Hardware Installation Manual

## IES Series Integrated Easy Servos



### Part Number

IES	-	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	-	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	-	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
		<b>Frame Size</b>	<b>Branch Series</b>	<b>Torque</b>		<b>Communication</b>		<b>Custom-built</b>
		17: 42mm	Blank: Standard	09: 0.9Nm		Blank: Standard		Blank: Standard
		23 :57mm	A: Branch Series A	20: 2.0Nm		485: RS485		...
		24: 60mm	B: Branch Series B	40: 4.0Nm		CAN: CANOpen		
			...	...		...		



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#### Change Log

Revision Date	Changes	Version
2012-4-11	Original Create	HWMN-ISS57-R20120411
2012-10-30	Change part number	HWMN-IES-R20121030

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## Safety Items

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Read this manual carefully before trying to install the stepper drive into your system. The person setup the stepper drive should have a better understanding on electronics and mechanics. Contact Leadshine technical guys when have questions on this document.

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Make sure the power supply voltage dose not exceed the drive's input range. Double check the connections and make sure the power lead polarity is correct.

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Do not set high current to small stepper motor. It is possible that the motor will be damaged.

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Disconnect the motor from the load if you are not sure the move direction. Adjust the axis in the middle before trying to run the motor.

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Never disconnect the motor lead when the power source is energized.

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## 1. Family Overview

### Introduction

Leadshine's IES integrated easy servo motor is a stepper motor integrated with a 1,000-line (4,000 PPR) encoder and a hybrid servo drive. At very compact size and with all components integrated, the IES can save mounting space, eliminate encoder connection & motor wiring time, reduce interference, and cut/reduce cable and labor costs.

By adopting Leadshine's latest hybrid servo control technology, the hybrid servo drive of the IES can drive the stepper motor with high starting torque, high precision, smooth movement, and extra low noise at low speed movement with no obvious resonance area. Different from constant-output-current output from a drive to a stepper motor in normal open-loop stepper controls, output current of the IES is dynamic and changes depending on load condition, same as servo controls. Therefore, it can significantly reduce motor heating and increase motor lifetime. The drive takes step & direction input commands, and is capable of outputting in-position and fault signals back to a motion controller or external devices, for complete system controls.

The integrated 1,000-line encoder can offer the real-time motor shaft position to the drive. Based on that position, the drive can then close the loop between the motor and drive, ensure no step is lost, and eliminate the possibility of stall or loss of movement synchronization which is often found in open-loop stepper systems. By getting rid of torque reservation in open-loop stepper systems, the IES can significantly improve high speed performance by as much as 30%. In addition, the IES performs much better in response time and speed acceleration over open-loop step systems.

Compared with brushless servo systems, the IES has much higher low speed torque, no overshooting & zero settling time, no overshooting, no hunting, and no/little tuning. Significant cost cutting also makes the IES ideal for the motion control systems in many applications.

### Applications

Leadshine's IES integrated easy servo motor offers an alternative solution to fill the gap between budget open-loop stepper systems, and expensive high performance brushless servo systems. It combines the features of high low-speed torque of open loop stepper, and closed-loop movements of traditional servo systems. Integration design with motor, drive, and encoder significantly reduces setup time and cut costs of your control systems.

Advanced features over open-loop stepper systems, such as much higher high-speed torque, no loss of movement synchronization, much lower motor heating, no obvious resonance area, etc., make the IES ideal product for upgrading stepper systems to get performance boost for many stepper applications such as CNC routers, CNC laser cutting machines, CNC milling machines, CNC lathes, medical / biotech equipments, lab automation instruments, etc.

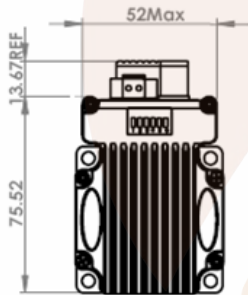
Features over traditional brushless servo systems, such as significant lower costs, no hunting, no overshooting, easy setup, etc., make the IES ideal products in many traditional servo applications such as short distance movement boding type machines and vision applications. Its natural feature of high low-speed torque makes the IES a perfect product for replacing many high-cost servo applications with gear head speed reduction.

## Product Covered

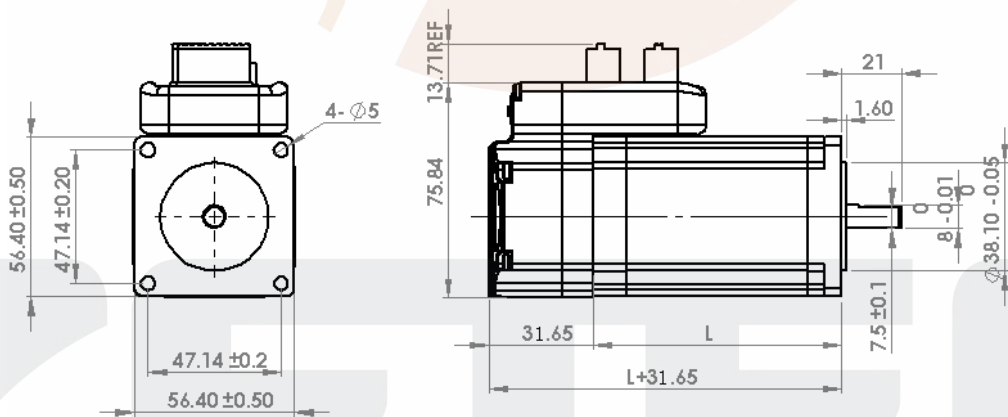
This manual covers the Leadshine integrated easy servo products as shown in the following table:

Part Number	Input Voltage	Pulse Voltage	Control Mode	Output	Pulse Frequency	Motor Holding Torque
IES-2309	DC (20-50)V	DC (0-24)V	Pulse/Direction CW/CCW(Optional)	In-position Alarm	200K(Default) 500K(Optional)	0.9Nm
IES-2320	DC (20-50)V	DC (0-24)V	Pulse/Direction CW/CCW(Optional)	In-position Alarm	200K(Default) 500K(Optional)	2.0Nm

## Mechanical Specifications



Part Number	Holding Torque	Motor Length ( L )	Length of Motor + Drive	Weight
IES-2309	0.9Nm	56mm	87.65mm	800g
IES-2320	2.0Nm	80mm	111.65mm	1280 g



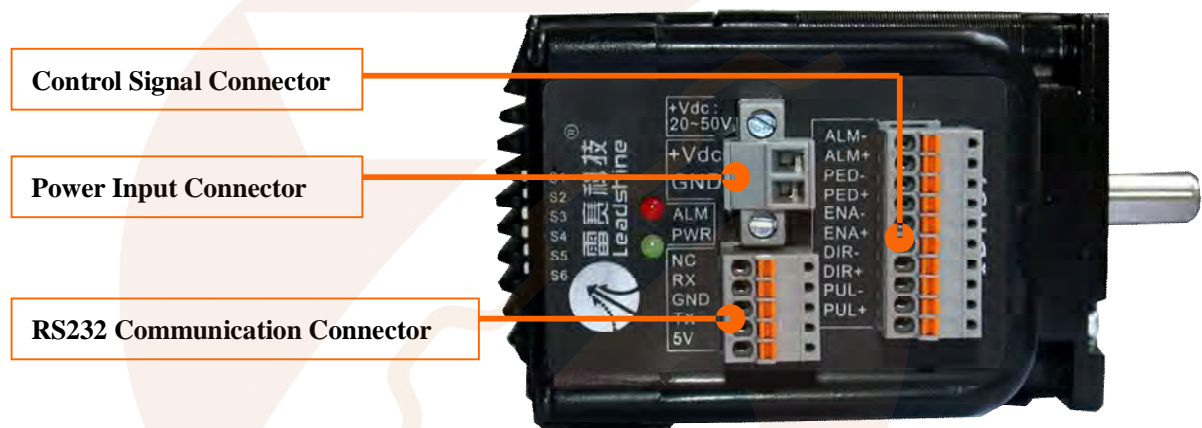
## Elimination of Heat

- Drive board's reliable working temperature(case) should be  $<70^{\circ}\text{C}$  ( $158^{\circ}\text{F}$ ), and motor working temperature(surface) should be  $<80^{\circ}\text{C}$  ( $176^{\circ}\text{F}$ );
- It is recommended to set 40% holding current percentage and use automatic idle-current mode, namely current automatically reduce to 40% when motor stops, so as to reduce driver heating and motor heating;
- Refer to the software operating manual for how to set holding current.

- It is recommended to mount the integrated in a space allowing air flow for good heat conduction. Use forced cooling method to cool the system if necessary.

## 2. Connectors and Pin Assignment

The IES23 has three connectors, a connector for control signals connections, a connector for RS232 communication connections and a connector for power connections.



The control signal inputs include PULSE, DIRECTION and ENABLE and the control signal outputs include PED (In-position) and ALARM. All the above control signals are integrated into one connector.

Control Signal Connector			
Pin	Name	I/O	Description
1	PUL+	I	<u>Pulse Signal:</u> In single pulse (pulse/direction) mode, this input represents pulse signal, active each rising or falling edge (Set by DIP switch S6); In double pulse mode (software configurable), this input represents clockwise (CW) pulse, active both at high level and low level. 4.5-24V when PUL-HIGH, 0-0.5V when PUL-LOW. For reliable response, pulse width should be longer than 2.5 $\mu$ s for 200K MAX input frequency or 1 $\mu$ s for 500K MAX input frequency.
2	PUL-	I	
3	DIR+	I	<u>Direction Signal:</u> In single-pulse mode, this signal has low/high voltage levels, representing two directions of motor rotation. In double-pulse mode (software configurable), this signal is counter-clock (CCW) pulse, active both at high level and low level. For reliable motion response, DIR signal should be ahead of PUL signal by 5 $\mu$ s at least. 4.5-24V when DIR-HIGH, 0-0.5V when DIR-LOW. The motor direction can also be changed by DIP switch S5. Please note that rotation direction is also related to motor-driver wiring match. Exchanging the connection of two wires for a coil to the driver will reverse motion direction.
4	DIR-	I	



**Control Signal Connector(Continued)**

Pin	Name	I/O	Description
5	ENA+	I	<b>Enable signal:</b> This signal is used for enabling/disabling the driver. In default, high level (NPN control signal) for enabling the driver and low level for disabling the driver. Usually left <b>UNCONNECTED (ENABLED)</b> . Please note that the PNP and Differential control signals are on the contrary, namely Low level for enabling. The active level of ENA signal is software configurable.
6	ENA-	I	
7	PED+	O	<b>In-position Signal:</b> OC output signal, activated when actual motor position reaches to the target. This port can sink or source MAX 20mA current at 24V. In default, the impedance between PED+ and PED- is high impedance in normal operation and becomes low when the target is reached. The active impedance of in-position signal can be software configurable (see software manual).
8	PED-	O	
9	ALM+	O	<b>Alarm Signal:</b> OC output signal, activated when one of the following protection is activated: over-voltage, over current and position following error. This port can sink or source MAX 20mA current at 24V. In default, the impedance between ALM+ and ALM- is low impedance in normal operation and becomes high when any protection is activated. The active impedance of alarm signal is software configurable.
10	ALM-	O	

The power input connector is a two pin screw terminal. It has the +Vdc and GND inputs which corresponding to the positive and negative output the power supply, respectively.

**Power Connector**

Pin	Name	I/O	Description
1	+Vdc	I	Power Supply Input (Positive), 20-45VDC recommended, leaving rooms for voltage fluctuation and back-EMF during deceleration.
2	GND	GND	Power Ground (Negative)

The RS232 communication connector is used to configure the programmable parameters like micro step, holding current percentage, active edge/level of control signal, etc. A PC with at least one serial port is required. You can copy the software either from <http://www.leadshine.com> or form Leadshine CD. See the detail in software manual.

**RS232 Communication Connector**

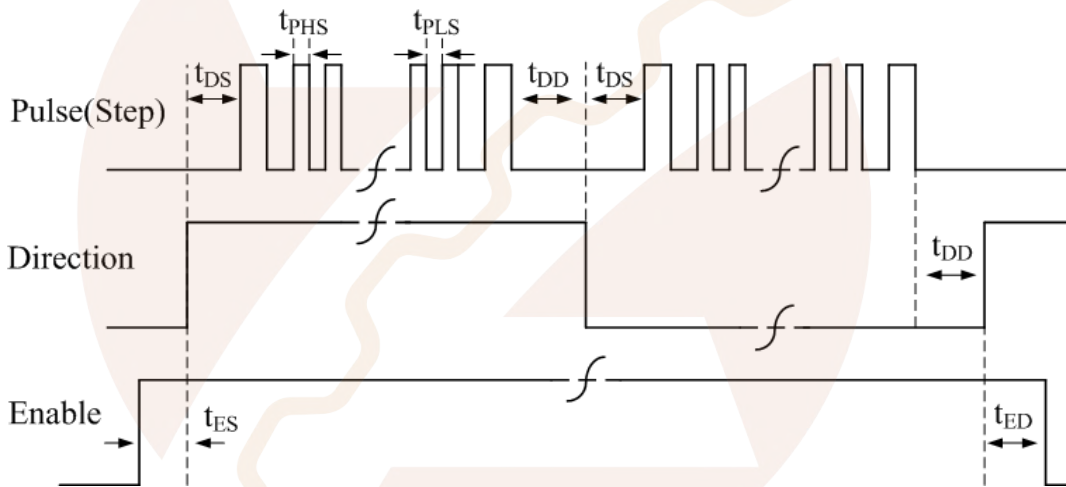
Pin	Name	I/O	Description
1	+5V	O	+5V power output ( Note: Do not connect it to PC's serial port)
2	TxD	O	RS232 transmit.
3	GND	GND	Ground.
4	RxD	I	RS232 receive.
5	NC	-	Not connected.



### 3. Control Signal Requirement

#### Control Mode and Sequence Chart

By default the IES integrated motor supports Pulse/Direction control mode. If CW/CCW control mode is needed, you can use the PC software to change it. See more information in the software manual. In order to avoid problems such as motor not moving, losing steps and only running at low speed, the PULSE, DIRECTION and ENABLE signal must have the following sequence:



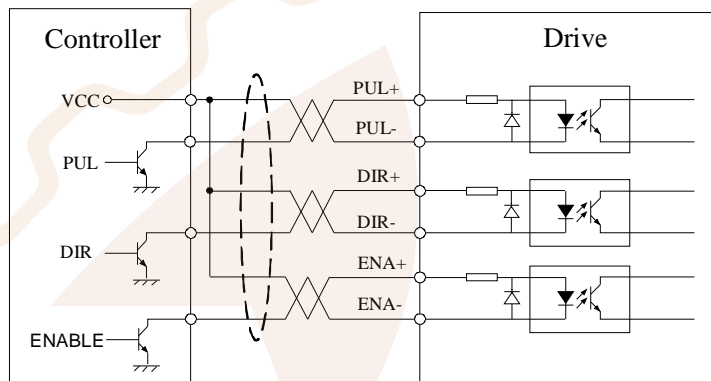
Symbol	Description	Requirement
$t_{DS}$	Direction Setup Time	>2us
$t_{PHS} / t_{PLS}$	Pulse High Level Setup Time / Pulse Low Level Setup Time	>2.5us, (For 200K MAX frequency) >1.0us, (For 500K MAX frequency)
$t_{DD}$	Direction DelayTime	-
$t_{ES}$	Enable Setup Time	>42.1ms
$t_{ED}$	Enable Delay Time	>5us

## 4. Connecting Control Signal

The IES accepts both differential and single-ended inputs (including open-collector and PNP output). Choose suitable connections type according to the controller type. Make sure the output port of the controller can sink or source at least 10mA current for the input isolated opto-coupler. If the cable length is greater than 50cm, it is recommended to use twisted shielded pair cable for these signal. Do not put the control signal cable together with the cables which is used for high power or high current equipment, in case of electronic interference coupled into the IES through air.

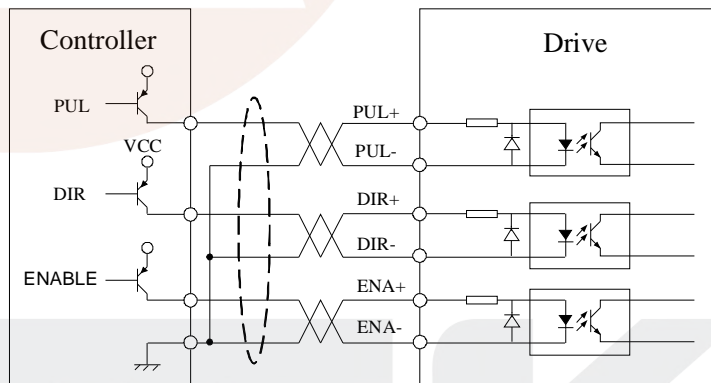
### NPN Signal Connections

If the motion controller is not differential output type, recommended to select motion controller with NPN type output as it can sink more current than source current. In this connection, Pulse, Direction and Enable signal share the same VCC (Positive) terminal.



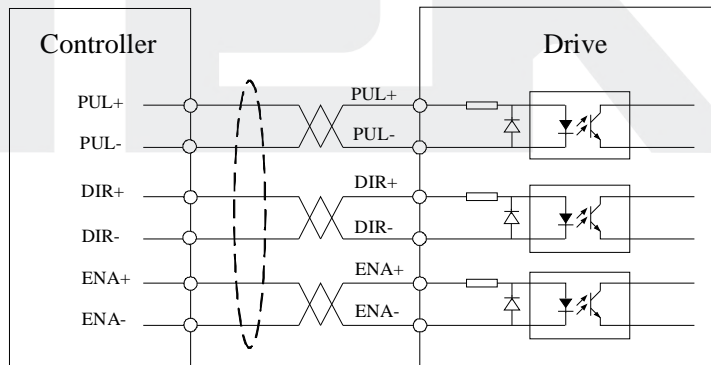
### PNP Signal Connections

In this connection, Pulse, Direction and Enable signal share the same ground (negative) terminal.



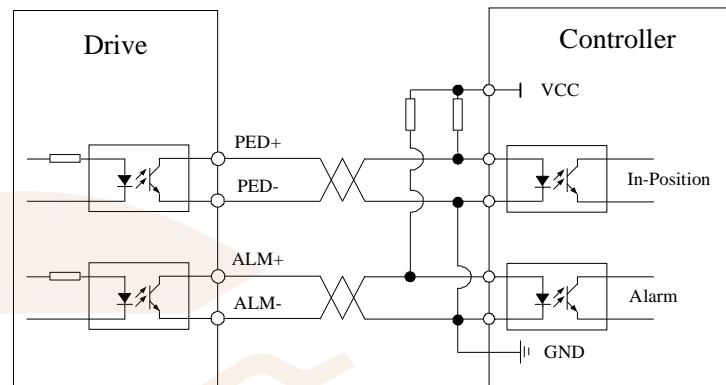
### Differential Signal Connections

For differential output controller, connect to the integrated stepper accordingly.



## Output Signal Connections

The IES integrated stepper offers the PED (in-position) signal to indicate the achievement of target position. The ALM signal will be active when the integrated stepper goes into error. The output of PED and ALM is isolated and you can connect them to the inputs of the controller as shown in the right figure.



## 5. Power Supply Selection

To achieve good driving performances, it is important to select supply voltage and output current properly. Generally speaking, supply voltage determines the high speed performance of the motor, while output current determines the output torque of the driven motor (particularly at lower speed). Higher supply voltage will allow higher motor speed to be achieved, at the price of more noise and heating. If the motion speed requirement is low, it's better to use lower supply voltage to decrease noise, heating and improve reliability.

### Regulated or Unregulated Power Supply

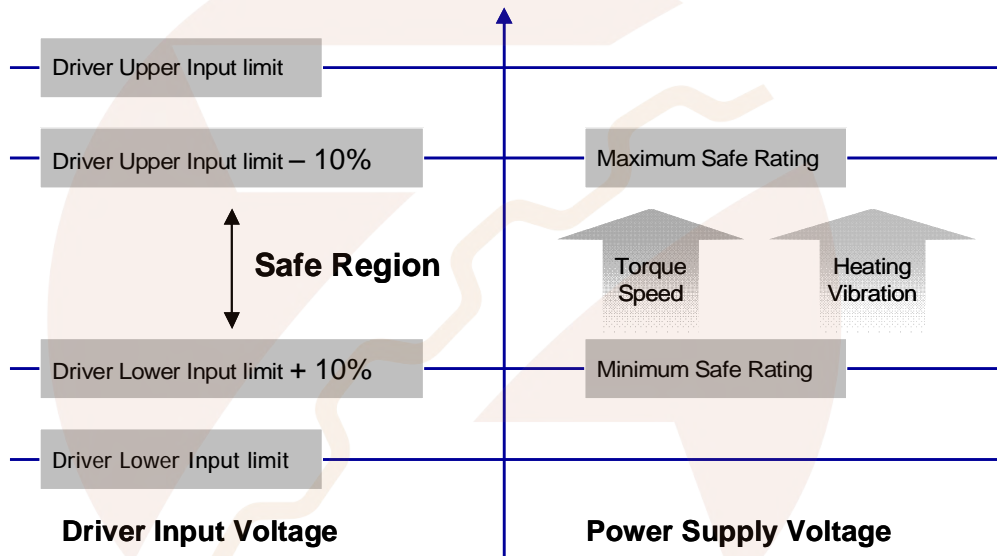
Both regulated and unregulated power supplies can be used to supply the drive. If regulated power supplies (such as most switching supplies.) are indeed used, it is important to have large current output rating to avoid problems like current clamp, for example using 4A supply for 3A motor-drive operation. On the other hand, if unregulated supply is used, one may use a power supply of lower current rating than that of motor (typically 50%~70% of motor current). The reason is that the drive draws current from the power supply capacitor of the unregulated supply only during the ON duration of the PWM cycle, but not during the OFF duration. Therefore, the average current withdrawn from power supply is considerably less than motor current. For example, two 3A motors can be well supplied by one power supply of 4A rating.

### Multiple Drives

It is recommended to have multiple drives to share one power supply to reduce cost, if the supply has enough capacity. To avoid cross interference, DO NOT daisy-chain the power supply input pins of the drives. Instead, please connect them to power supply separately.

## Selecting Supply Voltage

Higher supply voltage can increase motor torque at higher speeds, thus helpful for avoiding losing steps. However, higher voltage may cause bigger motor vibration at lower speed, and it may also cause over-voltage protection or even drive damage. Therefore, it is suggested to choose only sufficiently high supply voltage for intended applications, and it is suggested to use power supplies with theoretical output voltage of drive's minimum + 10% to drive's maximum - 10%, leaving room for power fluctuation and back-EMF.



## Recommended Supply Voltage

Both Leadshine's regulated and unregulated power supply has been designed specially for motion control.

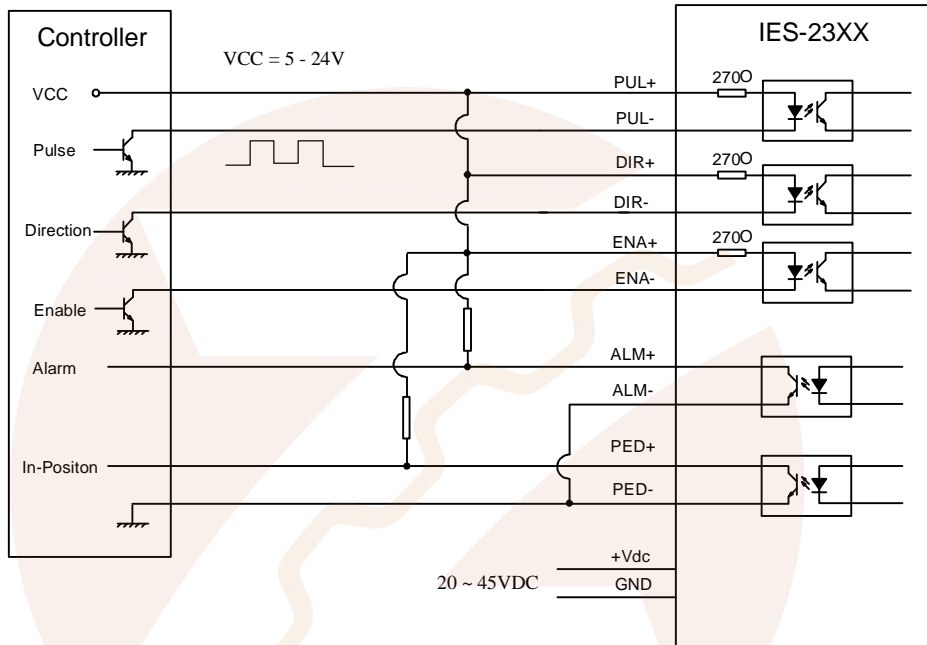
Model	Voltage Range	Typical Voltage	Leadshine Power Supply
IES-2309	DC(20-50)V	DC 24V	RPS2410(RPS2410-L)
IES-2320	DC(20-50)V	DC 36V	RPS369



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## 6. Typical Connections

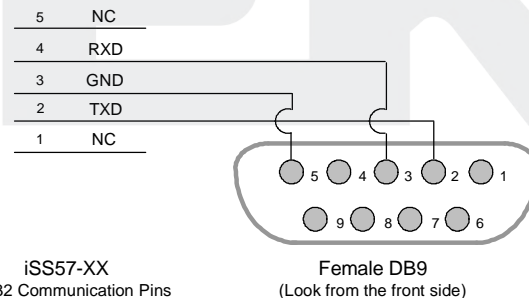
Typical connections of IES-23xx for NPN control signal is as follows.



- In order to improve anti-interference performance of the drive, it is recommended to use twisted pair shield cable.
- To prevent noise incurred in PUL/DIR signal, pulse/direction signal wires and motor wires should not be tied up together. It is better to separate them by at least 10 cm, otherwise the disturbing signals generated by motor will easily disturb pulse direction signals, causing motor position error, system instability and other failures.
- If a power supply serves several drives, separately connecting the drives is recommended instead of daisy-chaining.
- It is prohibited to pull and plug power connector while the drive is powered ON, because there is high current flowing through motor coils (even when motor is at standstill). Pulling or plugging power connector with power on will cause extremely high back-EMF voltage surge, which may damage the drive.

## 7. RS232 Communication Connections

The RS232 communication only use Transmit, Receive and ground signals. Connect them to the serial port accordingly. The right drawing shows the RS232 communication cable with a 9-pin D-Shell female connector.



## 8. Configuring the Drive

### Introduction

There is only one DIP switch to select the micro step resolution, change motor direction and active edge of pulse edge. The motor current will be adjusted dynamically according to load condition.

Micro step resolution of the IES can be configured via a 4-bit DIP switch, or Leadshine's tuning software ProTuner. When all bits of the DIP switch are at "ON" positions, the integrated hybrid servo drive board will take the micro step resolution setting set by the software (4000 by default). In this case, a user can re-configure the resolution to any value between 200 and 102,400 (increased by 1) through software. If any bit of the DIP switch is at "OFF" position, the integrated drive board will take micro step resolution setting determined by bit positions of the DIP switch. Use the following table for their resolution settings via the DIP switch.

Micro Step Resolution				
Steps/Revolution	S1	S2	S3	S4
Software Configured (Default 4000)	On	On	On	On
800	Off	On	On	On
1600	On	Off	On	On
3200	Off	Off	On	On
6400	On	On	Off	On
12800	Off	On	Off	On
25600	On	Off	Off	On
51200	Off	Off	Off	On
1000	On	On	On	Off
2000	Off	On	On	Off
4000	On	Off	On	Off
5000	Off	Off	On	Off
8000	On	On	Off	Off
10000	Off	On	Off	Off
20000	On	Off	Off	Off
40000	Off	Off	Off	Off



#### Motor Rotation Direction

**S5** DIP switch S5 is used for changing motor shaft rotation direction. Changing position from "ON" to "OFF", or "OFF" to "ON" will reverse IES-2309 rotation direction.

#### Pulse Active Edge

S6	On	Off
	Active rising edge of input pulse	Active falling edge of input pulse



## Micro step Resolution Selection

The stepper motor moves one step when one pulse is applied to the stepper drive. If microstep is 1, the step angle is a full step which is 1.8 degree for 2-phase stepper motor and 1.2 degree for 3-phase stepper motor. Microstep can be taken as the divisions of one full step. For example, stepper motor moves half of the full step when the microstep is 2. For 2-phase stepper motor and drive, we have the following formula to calculate the microstep resolution, or pulse counts of one motor shaft revolution:

$$\text{Microstep Resolution} = 200 \times \text{Microstep}$$

The motor speed can be calculated as follows:

$$\text{Motor Speed(RPS)} = \frac{\text{Pulse Input Frequency}}{\text{Microstep Resolution}}$$

When selecting the drive's micro step resolution for the system:

- Consider the MAX speed needed, MAX input frequency of driver and MAX output frequency of the controller.
- Micro step resolution of 1600 pulses/revolution (8 micro step) is suitable for most application.
- Micro step resolution of greater than 1600 only increases smoothness but not resolution.

## Current Control Detail

Leadshine's IES integrated step servo motor is integrated with a high-resolution 1,000-line optical incremental encoder. That encoder can send the real-time shaft position back to the integrated drive of the IES. Like traditional servo controls, the drive can automatically adjust the output current to the motor. The output current ranges between the holding current and the close-loop current. When there is no pulse sent to the drive, the IES goes into idle mode and the actual motor current is determined by the holding current percentage (similar to "idle current" of open loop stepper drives). In normal working mode, the IES monitors the actual shaft position all the time. The current outputted to the motor changes dynamically based on the tracking error between the actual position and the commanded position.

Low holding current can reduce motor heating however also reduces the holding torque which is used to lock the motor shaft at standstill. It is recommended to determine the holding current by whether or not there is big vibration at start-up and how much lock torque is required, based on your actual applications.

## Fine Tuning

Leadshine already loads default current-loop parameters and position-loop parameters. Those default parameter values have been optimized. They should be good enough for most industrial applications, and there is no need to tune them. However, if you want to fine tune the IES for best performance for your applications, Leadshine also offers tuning software, ProTuner, which allows you to adjust those current-loop and position-loop parameters (see software manual).



## 9. Protection Functions

To improve reliability, the IES incorporates some built-in protection functions. The Integrated stepper uses one red LED to indicate the protection type. The periodic time of red is 4 s (seconds), and the blinking times of red LED indicates what protection has been activated. Because only one protection can be displayed by red LED, so the drive will decide what error to display according to their priorities. See the following Protection Indications table for displaying priorities.

### Over-current Protection

Over-current protection will be activated when continuous current exceeds 18A or in case of short circuit between motor coils or between motor coil and ground, and RED LED will blink once within each periodic time.

### Over-voltage Protection

When power supply voltage exceeds 60VDC, protection will be activated and red LED will blink twice within each periodic time.

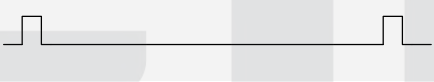




When above protections are active, the motor shaft will be free or the LED will blink. Reset the drive by repowering it to make it function properly after removing above problems. Since there is no protection against power leads ( + , - ) reversal, it is critical to make sure that power supply leads correctly connected to drive. Otherwise, the drive will be damaged instantly.

### Position Error Protection

When the position error exceeds the limit (software configurable, see software manual), position, protection will be activated and red LED will blink seven times within each periodic time.

### Protection Indications

Priority	Time(s) of Blink	Sequence wave of red LED	Description
1st	1		Over-current protection activated when peak current is greater than 18A
2nd	2		Over-voltage protection activated when drive working voltage is greater than 60VDC
3rd	7		Position following error activated when position following error limit exceeded the pre-set value (1000 pulses by default, or value set value by a customer)

## 10. Frequently Asked Questions

In the event that your drive doesn't operate properly, the first step is to identify whether the problem is electrical or mechanical in nature. The next step is to isolate the system component that is causing the problem. As part of this process you may have to disconnect the individual components that make up your system and verify that they operate independently. It is important to document each step in the troubleshooting process. You may need this documentation to refer back to at a later date, and these details will greatly assist our Technical Support staff in determining the problem should you need assistance.

Many of the problems that affect motion control systems can be traced to electrical noise, controller software errors, or mistake in wiring.

### Problem Symptoms and Possible Causes

Symptoms	Possible Problems
Motor is not rotating	No power
	Microstep resolution setting is wrong
	Fault condition exists
	The drive is disabled
Motor rotates in the wrong direction	The Direction signal level is reverse
The drive in fault	Power supply voltage beyond drive's input range
	Something wrong with motor coil
	Wrong connection
Erratic motor motion	Control signal is too weak
	Control signal is interfered
	Something wrong with motor coil
	Motor is undersized for the application
	Acceleration is set too high
Excessive motor and drive heating	Power supply voltage too low
	Inadequate heat sinking / cooling
	Load is too high

## Warranty

Leadshine Technology Co., Ltd. warrants its products against defects in materials and workmanship for a period of 12 months from shipment out of factory. During the warranty period, Leadshine will either, at its option, repair or replace products which proved to be defective.

## Exclusions

The above warranty does not extend to any product damaged by reasons of improper or inadequate handlings by customer, improper or inadequate customer wirings, unauthorized modification or misuse, or operation beyond the electrical specifications of the product and/or operation beyond environmental specifications for the product.

## Obtaining Warranty Service

To obtain warranty service, a returned material authorization number (RMA) must be obtained from customer service at e-mail: before returning product for service. Customer shall prepay shipping charges for products returned to Leadshine for warranty service, and Leadshine shall pay for return of products to customer.

## Warranty Limitations

Leadshine makes no other warranty, either expressed or implied, with respect to the product. Leadshine specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Some jurisdictions do not allow limitations on how long and implied warranty lasts, so the above limitation or exclusion may not apply to you. However, any implied warranty of merchantability or fitness is limited to the 12-month duration of this written warranty.

## Shipping Failed Product

If your product fail during the warranty period, e-mail customer service at to obtain a returned material authorization number (RMA) before returning product for service. Please include a written description of the problem along with contact name and address. Send failed product to distributor in your area or: Leadshine Technology Co., Ltd. 3/F, Block 2, Nanyou Tianan Industrial Park, Nanshan Dist, Shenzhen, China. Also enclose information regarding the circumstances prior to product failure.



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