

# M415B

## User`s Manual



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## 1. Introduction, Features and Applications

M415B is a very small size high performance microstepping driver based on most advanced technology in the world today. It is suitable for driving any 2-phase and 4-phase hybrid step motors. By using advanced bipolar constant-current chopping technique, it can output more speed and power from the same motor, compared with traditional technologies such as L/R drivers. Its 3-state current control technology allows coil currents to be well controlled, with relatively small current ripple and results in less motor heating.

### Features of this driver

- High performance, low cost
- Supply voltage up to +40VDC, current to 1.5A
- Inaudible 20kHz chopping frequency
- TTL compatible and optically isolated input signals
- Automatic idle-current reduction
- Mixed-decay current control for less motor heating
- 14 selectable resolutions in decimal and binary
- Microstep resolutions up to 12,800 steps/rev
- Suitable for 4,6,8 lead motors
- Over-current, over-voltage and short-circuit protection
- Small size: 86x55x20mm

### Applications of this driver

Suitable for a wide range of stepping motors of size Nema 16, 17 and 23, and usable for various kinds of machines, such as X-Y tables, labeling machines, laser cutters, engraving machines, and pick-place devices, particularly useful in applications with low vibration, high speed and high precision requirements.

## 2. Specifications and Operating Environment

### Electric Specifications ( $T_j = 25^\circ\text{C}$ )

	M415B
Supply voltage	+15 to 40 VDC
Rate Supply voltage	+24VDC
Output current peak value	0.1 to 1.5 A (adjustable)
Microstep Resolution (7 choices)	1 (200 step/rev), 2 (400 step/rev), 4 (800 step/rev), 8 (1600 step/rev), 16 (3200 step/rev), 32 (6400 step/rev), 64 (12800 step/rev).

### Operating Environment and Parameters

Cooling	Natural cooling or forced convection	
Environment	Space	Avoid dust, oil frost and corrosive gas
	Temperature	$0^\circ\text{C}$ □ $50^\circ\text{C}$
	Humidity	40 □ 90%RH
	Vibration	$5.9\text{m/s}^2$ Max
Storage Temp.	$-20^\circ\text{C}$ □ $+65^\circ\text{C}$	
Weight	About 0.15kg	

### Mechanical Dimensions (86x 55 x 20mm)

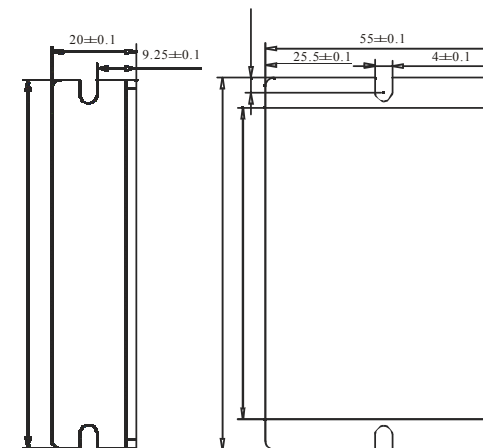


Figure 1: Mechanical dimensions

### 3. Driver Connectors, P1 and P2

The driver has two connectors, P1 for control signals, and P2 for power and motor connections.

The following is a brief description of the two connectors of the driver. More detailed descriptions of the pins and related issues are presented in section 4, 5, 6, 9.

#### Control Signal Connector P1-pins

Pin No.	Signal	Description
1(8)	PUL	Pulse signal: effective with rising edge, motor runs a step when the pulse changes from low to high
2(6)	DIR	Direction signal: used to change the motor rotating direction.
3(4)	OPTO	Opto-coupler drives power supply, $\Phi$ +5V typical.
4(2)	ENA	Function signal: permit or prohibit driver's work, prohibit with low level

*Remark:* Please note motion 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. (for example, reconnecting motor lead A+ to driver pin A- and motor lead A- to driver pin A+ will invert motion direction).

#### Power connector P2 pins

Pin No.	Signal	Description
1	GND	DC power ground
2	+V	DC power positive, typical value 24V
3,4	A+A-	Motor phase A
5,6	B+B-	Motor phase B

### 4. Control Signal Connector (P1) Interface

This driver uses differential inputs to increase noise immunity and interface flexibility. Single-ended control signals from the indexer/controller can also be accepted by this interface. The input circuit has built-in high-speed opto -coupler, and can accept signals in the format of line driver, open-collector, or PNP output. Line driver (differential) signals are suggested for reliability. In the following figures, connections to open-collector and PNP signals are illustrated.

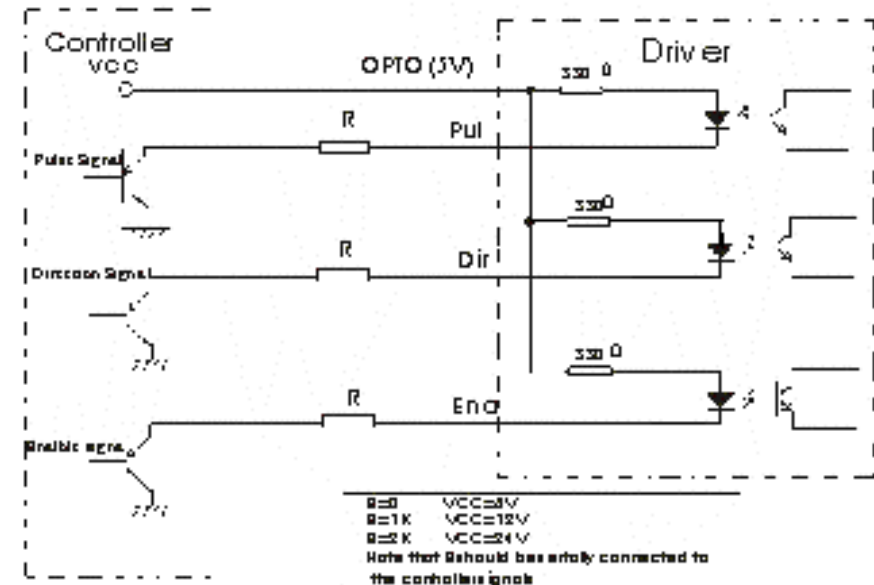


Figure 2:Control Signal Connector Interface

### 5. Driver Connection to Step Motors

M415B driver can drive any 4, 6, 8 lead hybrid step motors. Phase A of step motor is connected to pin 3, 4 of P2 connector of the driver, while phase B connected to pin 5, 6. The following diagrams illustrate connection to various kinds of motor leads:

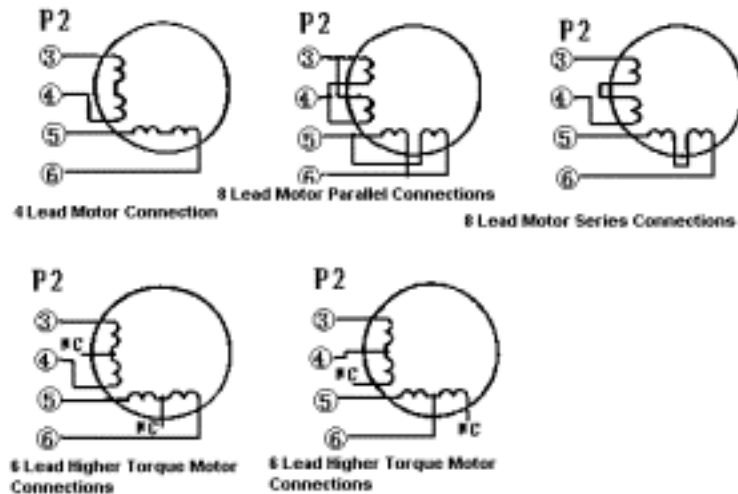


Figure 3: Driver Connection to Step Motor

Note that when two coils are parallelly connected, coil inductance is reduced by half and motor speed can be significantly increased. Serial connection will lead to increased inductance and thus the motor can be run well only at lower speeds.

### 5.1 Connecting to 8-Lead Motors

8 lead motors offer a high degree of flexibility to the system designer in that they may be connected in series or parallel, thus satisfying a wide range of applications.

#### Series Connection

A series motor configuration would typically be used in applications where a higher torque at lower speeds is required. Because this configuration has the most inductance, the performance will start to degrade at higher speeds. Use the per phase (or unipolar) current rating as the peak output current, or multiply the bipolar current rating by 1.4 to determine the peak output current.

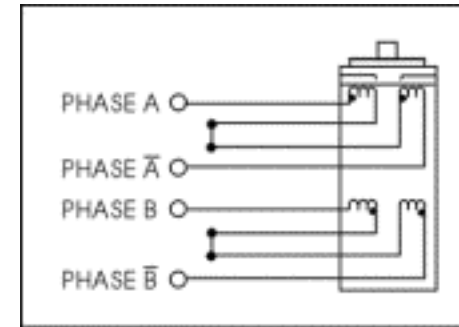


Figure 4: 8 Lead Motor Series Connections

#### Parallel Connection

An 8 lead motor in a parallel configuration offers a more stable, but lower torque at lower speeds. But because of the lower inductance, there will be higher torque at higher speeds. Multiply the per phase (or unipolar) current rating by 1.96, or the bipolar current rating by 1.4, to determine the peak output current.

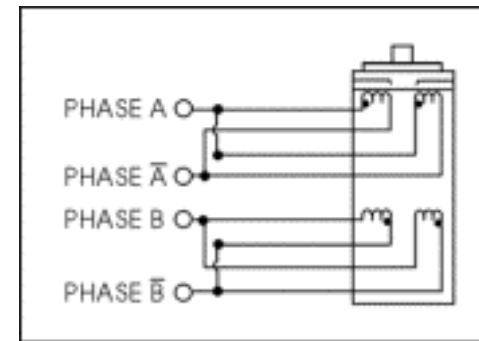


Figure 5: 8 Lead Motor Parallel Connections

### 5.2 Connection to 6-Lead Motors

Like 8 lead stepping motors, 6 lead motors have two configurations available for high speed or high torque operation. The higher speed configuration, or half coil, is so described because it uses one half of the motor's inductor windings. The higher torque configuration, or full coil, use the full windings of the phases.

### Half Coil Configuration

As previously stated, the half coil configuration uses 50% of the motor phase windings. This gives lower inductance, hence, lower torque output. Like the parallel connection of 8 lead motor, the torque output will be more stable at higher speeds. This configuration is also referred to as bal copper. In setting the driver output current multiply the specified per phase (or unipolar) current rating by 1.4 to determine the peak output current.

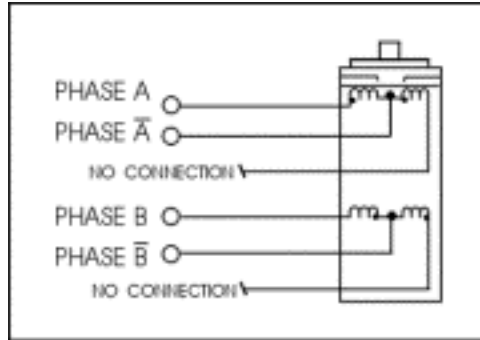


Figure 6: 6 Lead Half Coil (Higher Speed) Motor Connections

### Full Coil Configuration

The full coil configuration on a six lead motor should be used in applications where higher torque at lower speeds is desired. This configuration is also referred to as full copper. Use the per phase (or unipolar) current rating as the peak output current.

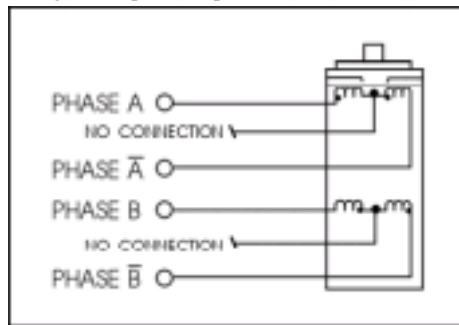


Figure 7: 6 Lead Full Coil (Higher Torque) Motor

### 5.3 Connection to 4-Lead Motors

4 lead motors are the least flexible but easiest to wire. Speed and torque will depend on winding inductance. In setting the driver output current, multiply the specified phase current by 1.4 to determine the peak output current.

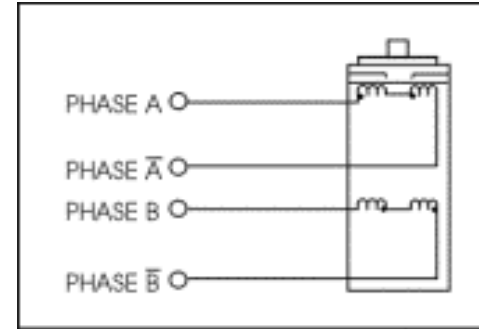


Figure 8: 4 Lead Motor Connections

## 6. Power supply Selection, Driver Voltage and Current Selection

### 6.1 Power Supply Selection

It is important to choose appropriate power supply to make the driver operate properly and deliver optimal performance

#### Maximum Voltage Input:

The power MOSFETS inside the driver can actually operate within 15V□40VDC, including power input fluctuation and back EMF voltage generated by motor coils during motor shaft deceleration. Higher voltage may damage the driver. Therefore, it is suggested to use power supplies with theoretical output voltage of no more than +40V, leaving room for power line fluctuation and Back EMF.

#### Regulated or Unregulated power supply:

Both regulated and unregulated power supplies can be used to supply DC power to the driver. However, unregulated power supplies are preferred due to their ability to withstand current surge. If regulated power supply (such as most switching supplies,) needs to be used, it should have large

current output rating to avoid problems like current clamp, for example, using 2A supply for 1.2A motor-driver 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 driver draws current from the power supply capacitor of the unregulated supply only during the ON duration of the PWM cycle, but not during 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 unregulated power supply of 4A rating.

#### Multiple drivers:

It is recommended to have multiple drivers to share one power supply to reduce cost, provided that the supply has enough capacity. To avoid cross interference, **DO NOT** daisy-chain the power supply input pin of the drivers(connect them to power supply separately)

Higher supply voltage will allow higher motor speed to be achieved, at the price of more noise and heating. If motion speed requirement is low, it's better to use lower supply voltage to improve noise, heating and reliability.

NEVER connect power and ground in the wrong direction, as it will damage the driver.

## 6.2 Driver Voltage and Current Selection

This driver can match small and medium size step motors (NEMA 16, 17 and 23) made by Leadshine or other motor manufactures from around the world. To achieve good driving results, it is important to select supply voltage and output current properly. Generally, 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).

#### ● Selecting Supply Voltage:

Higher supply voltage can increase motor torque at higher speeds, thus helpful for avoiding losing steps. However, higher voltage may cause more motor vibration at lower speed, and it may also cause over-voltage protection and even driver damage. Therefore, it is suggested to choose only sufficiently high supply voltage for intended applications.

#### ● Setting Proper Output Current

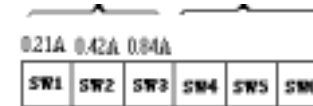
- For a given motor, higher driver current will make the motor to output more torque, but at the same time causes more heating in the motor and driver. Therefore, output current is generally set to be such that the motor will not overheat for long time operation.
- Since parallel and serial connections of motor coils will significantly change resulting inductance and resistance, it is therefore important to set driver output current depending on motor phase current, motor leads and connection methods.

- Phase current rating supplied by motor manufacturer is important to selecting driver current, but the selection also depends on leads and connection.

## 7. Selecting Microstep Resolution and Driver Current Output

This driver uses an 6-bit DIP switch to set microstep resolution, and motor operating current, as shown below:

Current during motion      Microstep resolution



### 7.1 Microstep Resolution Selection

Microstep resolution is set by SW4, 5, 6 of the DIP switch or MS0, MS1, MS2 of the DIP switch as shown in the following table:

Microstep	usteps/rev.( 1.8°/rev)	SW4/MS0	SW5/MS1	SW6/MS2
1	200	ON	ON	ON
2	400	OFF	ON	ON
4	800	ON	OFF	ON
8	1600	OFF	OFF	ON
16	3200	ON	ON	OFF
32	6400	OFF	ON	OFF
64	12800	ON	OFF	OFF
Subject to external	Change microstep Resolution one-the-fly / work is prohibit	OFF	OFF	OFF

### 7.2 Current Setting

The first three bits (SW1, 2, 3) of the DIP switch are used to set the current during motion (dynamic current). Select a setting closest to your motor's required current.

#### M415B DIP Setting for current during motion:

Current	SW1	SW2	SW3
0.21A	OFF	ON	ON
0.42A	ON	OFF	ON
0.63A	OFF	OFF	ON
0.84A	ON	ON	OFF
1.05A	OFF	ON	OFF
1.26A	ON	OFF	OFF
1.5A	OFF	OFF	OFF

Remarks:

1) Due to motor inductance the actual current in the coil may be smaller than the dynamic current settings, particularly at higher speeds.

2) Static current setting

The current automatically reduced to 60% of dynamic current setting 1 second after the last pulse. This will, theoretically, reduce motor heating to 36% (due to  $I^2t$ ) of the original value. If the application needs a different idle current, please contact Leadshine for minor modification of circuit.

Example: the following settings are for an application of 1.05A, 32 microsteps:

### ● Function of JUMP 1 and JUMP 2

In order to make the driver match various motors perfectly with different pulse frequency, set up the JP1, JP2 especially to improve the driver's function. JP1, JP2 is effective only change before power is on. JP1, JP2 has four operation mode, details as the table:

(ON: JUMP is connected, OFF: JUMP is cut)

Mode	JP1	JP2	Function
1	ON	ON	Pulse input frequency less 1000 Hz, select this mode
2	OFF	ON	Pulse input frequency between 1000-2000Hz, select this mode
3	ON	OFF	Pulse input frequency between 2000-5000Hz, select this mode
4	OFF	OFF	Pulse input frequency between 5000-100000Hz, select this mode

JP1, JP2 factory configured default value is the second mode, the end user can select different mode according to special request to reach the best effect. If change is needed, open the lid and select as requested.

## 8. Connection Diagram for Driver, Motor, Controller

A complete stepping system should include stepping motor, stepping driver, power supply and controller (pulse generator).

A typical connection is shown below:

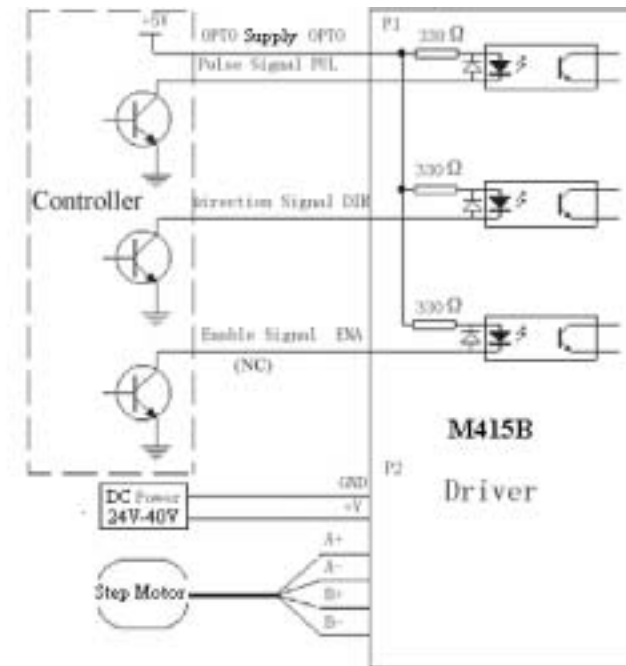


Figure 4: Driver connection in a stepping system