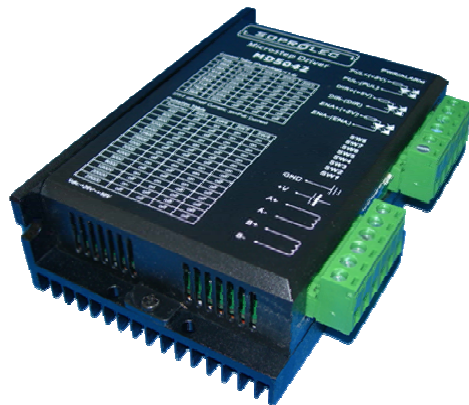# User's Manual

For

SD5042

Economical Microstepping Driver

Version 1.0

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Attention: Please read this manual carefully before using the driver!

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1. Introduction, Features and Applications

Introduction

The SD5042 is an economical microstepping driver based on patented technology of SOPROLEC. It is suitable for driving 2-phase and 4-phase hybrid stepping motors. By using the advanced bipolar constant-current chopping technique, it can output more speed and torque 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 and with relatively small current ripple, therefore less motor heating is achieved.

Features

- Low cost and good high-speed torque
- Supply voltage up to +50VDC
- Output current up to 4.2A
- Optically isolated input signals
- Pulse frequency up to 400 KHz
- Automatic idle-current reduction
- 3-state current control technology

- 15 selectable resolutions
- Suitable for 2-phase and 4-phas motors
- DIP switch current setting with 8 different values
- CW/CCW mode available (optional)
- Over-voltage and short-circuit protection
- Small size (118x75.5x33mm)

Applications

Suitable for a wide range of stepping motors from Nema size 17 to 34. Usable for various kinds of machines, such as X-Y tables, labeling machines, laser cutters, engraving machines, pick-place devices, and so on. Particularly adapt to the applications which expected to be low vibration, high speed and high precision.

2. Specifications and Operating Environment

Electrical Specifications $(T_j = 25℃)$

Parameters	SD5042			
	Min	Typical	Max	Unit
Output Current	0.54	-	4.2 (3.0A RMS)	A
Supply voltage	20	36	50	VDC
Logic signal current	7	10	16	mA
Pulse input frequency	0	-	400	Khz
Isolation resistance	500			MΩ

Operating Environment and other Specifications

Cooling	Natural Cooling or Forced cooling	
Operating Environment	Environment	Avoid dust, oil fog and corrosive gases
	Ambient Temperature	0°C to 50°C
	Humidity	40%RH to 90%RH
	Operating Temperature	70°C Max
	Vibration	5.9m/s² Max
Storage Temperature	-20°C － 65°C	
Weight	Approx. 280 gram (9.9 oz)	

Mechanical Specifications (unit:mm, 1 inch = 25.4 mm)
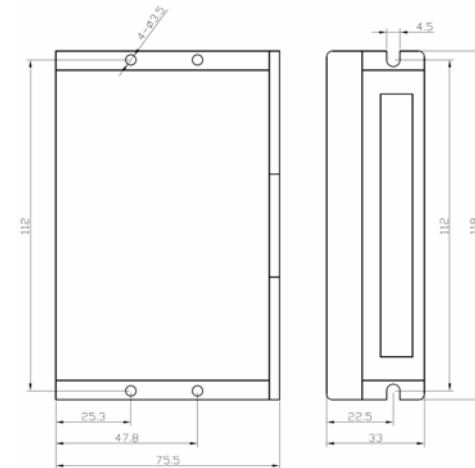
Front View   Side View

Figure 1: Mechanical specifications

*Recommended to use side mounting for better heat dissipation

Elimination of Heat

- Driver's reliable working temperature should be <65°C, and motor working temperature should be <80°C;
- It is recommended to use automatic idle-current mode, namely current automatically reduce to 60% when motor stops, so as to reduce driver heating and motor heating;
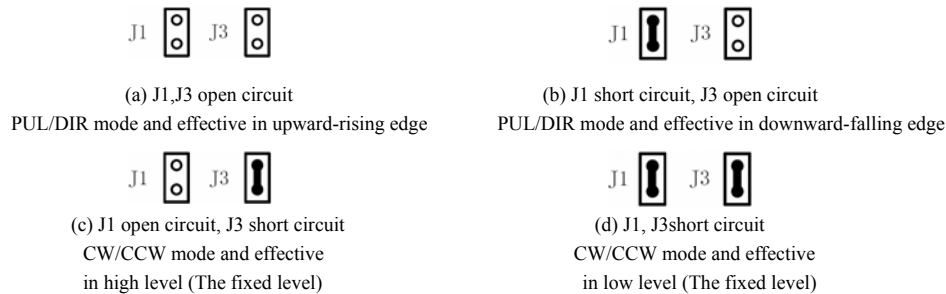- Please mount the driver vertically to maximize heat sink area.

(e) Positions of J1 and J3

Figure 2: J1 and J3 jumpers

Connector P2 Configurations

Pin Function	Details
Gnd	DC power ground
+V	DC power supply, 20~50VDC, Including voltage fluctuation and EMF voltage.
A+, A-	Motor Phase A
B+,B-	Motor Phase B

4. Control Signal Connector (P1) Interface

The SD5042 can accept differential and single-ended inputs (including open-collector and PNP output). The SD5042 has 3 optically isolated logic inputs which are located on connector P1 to accept line driver control signals. These inputs are isolated to minimize or eliminate electrical noises coupled onto the drive control signals. Recommend use line driver control signals to increase noise immunity of the driver in interference environments. In the following figures, connections to open-collector and PNP signals are illustrated.
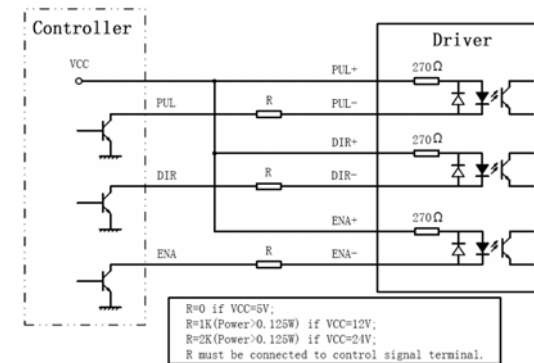

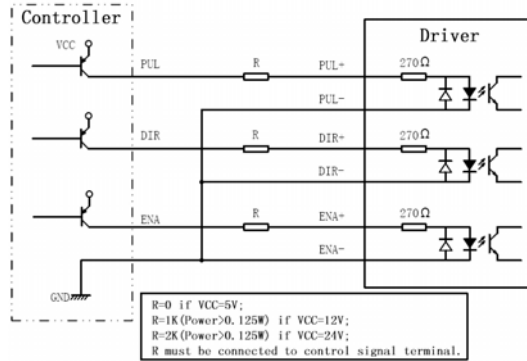Figure 3: Connections to open-collector signal (common-anode)

Figure 4: Connection to PNP signal (common-cathode)

5. Connecting the Motor

The SD5042 driver can drive any 2-pahse and 4-pahse hybrid stepping motors.

Connections 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.
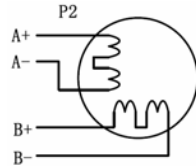
Figure 5: 4-lead Motor Connections

Connections 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, uses the full windings of the phases.

Half Coil Configurations

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 half chopper. In setting the driver output current multiply the specified per phase (or unipolar) current rating by 1.4 to determine the peak output current.
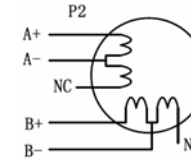
Figure 6: 6-lead motor half coil (higher speed) connections

Full Coil Configurations

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. In full coil mode, the motors should be run at only 70% of their rated current to prevent over heating.
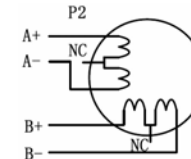
Figure 7: 6-lead motor full coil (higher torque) connections

Connections 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 Connections

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. In series mode, the motors should also be run at only 70% of their rated current to prevent over heating.

Figure 8: 8-lead motor series connections

Parallel Connections

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.

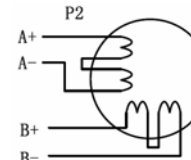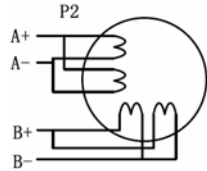Figure 9: 8-lead motor parallel connections

6. Power supply Selection

The SD5042 can match medium and small size stepping motors (from Nema size 17 to 34) made by SOPROLEC or other motor manufactures around the world. 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).

Regulated or Unregulated power supply

Both regulated and unregulated power supplies can be used to supply the driver. However, unregulated power supplies are preferred due to their ability to withstand current surge. 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-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 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 drivers

It is recommended to have multiple drivers 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 drivers. (Instead, please 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 the motion speed requirement is low, it's better to use lower supply voltage to decrease noise, heating and improve reliability.

Attention: NEVER connect power and ground in the wrong direction, as it will damage the SD5042.

Selecting Supply Voltage

The power MOSFETS inside the SD5042 can actually operate within +20V－+50VDC, including power input fluctuation and back EMF voltage generated by motor coils during motor shaft deceleration. 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 driver 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 +24～+ 45V, leaving room for power fluctuation and back-EMF.

7. Selecting Microstep Resolution and Driver Output Current

This driver uses an 8-bit DIP switch to set microstep resolution, and motor operating current, as shown below:
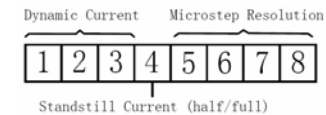
Microstep Resolution Selection

Microstep resolution is set by SW5, 6, 7, 8 of the DIP switch as shown in the following table:

Microstep	Steps/rev.(for 1.8°motor)	SW5	SW6	SW7	SW8
2	400	OFF	ON	ON	ON
4	800	ON	OFF	ON	ON
8	1600	OFF	OFF	ON	ON
16	3200	ON	ON	OFF	ON
32	6400	OFF	ON	OFF	ON
64	12800	ON	OFF	OFF	ON
128	25600	OFF	OFF	OFF	ON
5	1000	ON	ON	ON	OFF
10	2000	OFF	ON	ON	OFF
20	4000	ON	OFF	ON	OFF
25	5000	OFF	OFF	ON	OFF

40	8000	ON	ON	OFF	OFF
50	10000	OFF	ON	OFF	OFF
100	20000	ON	OFF	OFF	OFF
125	25000	OFF	OFF	OFF	OFF

Current Settings

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 in selecting driver current, however the selection also depends on leads and connections.

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

Dynamic current setting

Peak current (A)	RMS (A)	SW1	SW2	SW3
1.4	1.0	OFF	OFF	OFF
2.1	1.5	ON	OFF	OFF
2.7	1.9	OFF	ON	OFF
3.2	2.3	ON	ON	OFF
3.8	2.7	OFF	OFF	ON
4.3	3.1	ON	OFF	ON
4.9	3.5	OFF	ON	ON
5.6	4.0	ON	ON	ON

Notes: Due to motor inductance, the actual current in the coil may be smaller than the dynamic current settings, particularly under high speed condition.

Standstill current setting

SW4 is used for this purpose. OFF meaning that the standstill current is set to be half of the dynamic current, and ON meaning that standstill current is set to be the same as dynamic current.

The current automatically reduced to 60% of dynamic current setting one second after the last pulse. Theoretically, this will reduce motor heating to 36% (due to $P=I^2*R$) of the original value. If the application needs a different standstill current, please contact SOPROLEC.

8. Wire Connection

- In order to improve anti-interference performance of the driver, 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 drivers, separately connecting drivers is recommended instead of daisy-chaining.

- It is prohibited to pull and plug connector P2 while the driver is powered ON, because there is high current flowing through motor coils (even when motor is at standstill). Pulling or plugging connector P2 with power on will cause extremely high back-EMF voltage surge, which may damage the driver.

9. Typical Connection

A complete stepping system should include stepping motor, stepping driver, power supply and controller (pulse generator). A typical connection is shown as figure 10.
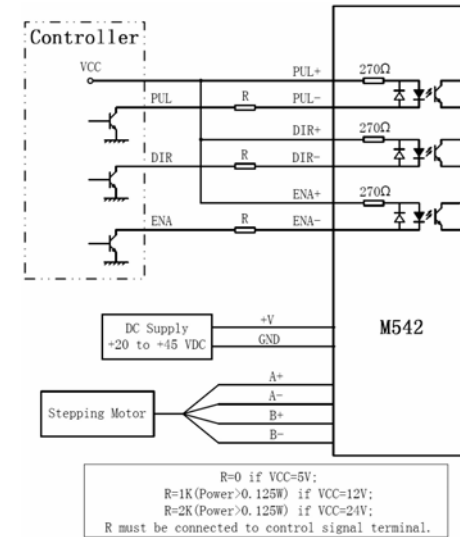

Figure 10: Typical connection

10. Sequence Chart of Control Signals

In order to avoid some fault operations and deviations, PUL, DIR and ENA signals must abide by some rules, as shown in the following diagram (assuming J1 default setting is upward-rising edge effective):
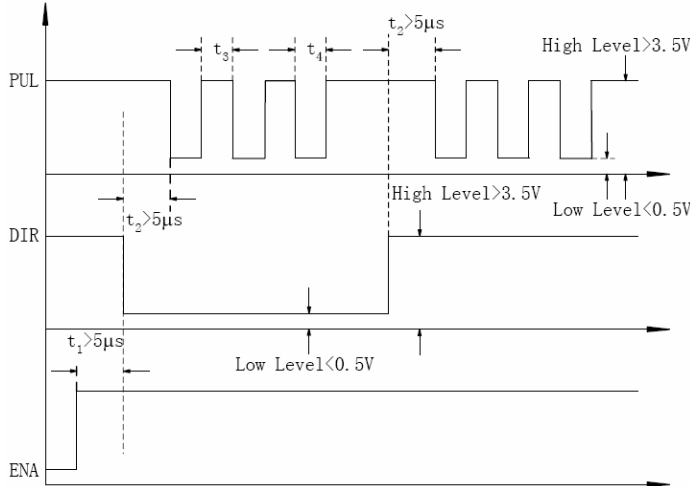

Figure 11: Sequence chart of control signals

Remark:

(1) t_1: ENA must be ahead of DIR by at least 5μs, logic HIGH as valid. Generally ENA+ and ENA- is NC (not connected).

(2) t_2: DIR must be ahead of PUL effective falling edge by at least 5μs to ensure correct direction;

(3) t_3: Pulse width not less than 1.5μs;

(4) t_4: low level width not less than 1.5μs.

11. Protection Functions

To improve reliability, the driver incorporates some built-in protections features.

Over-voltage protection

When power supply voltage exceeds +52VDC, protection will be activated and power indicator LED will turn red. When power supply voltage is lower than +20VDC, the driver will not works properly.

Coil-ground Short Circuit Protection

Protection will be activated in case of short circuit between motor coil and ground.

Attention: Since there is no protection against power leads (+ ，－) reversal, it is critical to make sure that power supply leads correctly connected to the driver. Otherwise, the driver will be damaged instantly.

12. Frequently Asked Questions

In the event that your SD5042 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 not rotating	No power
	Invalid microstep resolution select setting
	DIP switch current setting is wrong
	Fault condition exists
	Unit is disabled
Motor rotating in the wrong direction	Motor phases may be connected in reverse
Unit in fault	DIP switch current setting is wrong
	Motor phase winding shorted
Erratic motor motion	Motor or power wiring unshielded or not twisted pair
	Logic wiring next to motor/power wiring
	Ground loop in system
	Open winding of motor
	Phase bad on driver
Motor stalls during acceleration	Current setting is to small
	Motor is undersized for application
	Acceleration on controller is set too high
	Power supply voltage too low
Excessive motor and driver heating	Inadequate heat sinking / cooling
	Automatic current reduction function not being utilized
	Current is set too high

APPENDIX

Twelve month limited warranty

SOPROLEC warrants its products against defects in materials and workmanship for a period of 12 months from shipment out of factory. During the warranty period, SOPROLEC 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: contact@soprolec.com before returning product for service. Customer shall prepay shipping charges for products returned to SOPROLEC for warranty service, and SOPROLEC shall pay for return of products to customer.

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