isel®
From Components to Systems

MD24 / MD28
Microstepping Driver

Instruction Manual

Hardware Description

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The information, technical data and dimensions contained in this manual correspond to the best available technology at the time of publication. Nevertheless existing misprints and errors cannot be excluded. We are always grateful for improvement suggestions and error hints.

We point out to the fact that software and hardware names of the respective companies that are used in our prints are generally subject to trademark or brand or patent protection.

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1 Introduction

The MD24 / MD28 are economical microstepping driver based on patented technology. It is suitable for driving 2-phase and 4-phase hybrid stepping motors. By using the advanced bipolar-current chopping technique, it can output more speed and torque from the same motor, compared with traditional drivers, 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
- Optically isolated input signals
- Pulse frequency up to 300 KHz
- Automatic idle-current reduction
- 3-state current control technology
- High resolution Microstepping
- Suitable for 2-phase and 4-phas motors
- DIP-Switch setting
- Over-voltage and short-circuit protection
  Small size

Suitable for a wide range of stepping motors from Nema size 17 to 34. It can be used in 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 desired with low vibration, high speed and high precision.

2 Safety Instructions

- The MD24 / MD28 modules are designed according to the current state of the art and the accepted safety-relevant rules.

- The devices may only be actuated in perfect technical condition. Failures are to be eliminated immediately. Children and persons that are not instructed may not put the device into operation.

- The equipment may only be used for the intended purpose.

- All work is to be accomplished exclusively by authorized technical personnel and with consideration of the regulations of the electrical industry as well as the rules for the prevention of accidents.

- Assembly and employment of the equipment is to be accomplished according to the standards of the declaration of conformity. The regulations and limit values kept by the manufacturer do not protect in case of inappropriate use of the equipment.

- The equipment may not be exposed to high air humidity and high vibrations (see technical data).

- Keep this operating instructions in a safe place and commit each user to its observance!

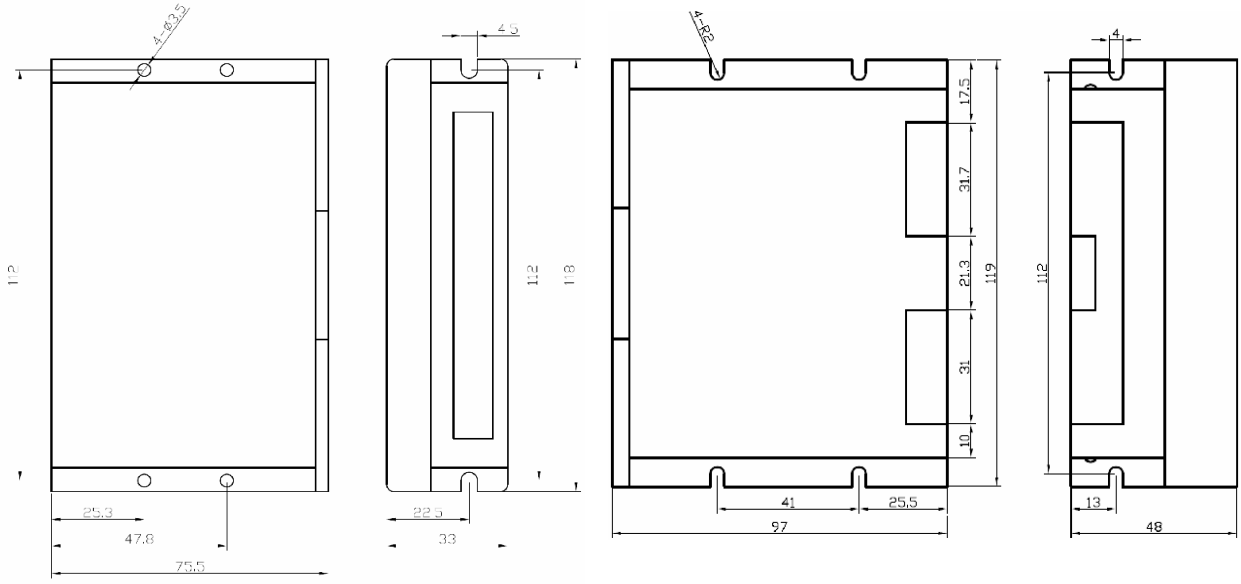
- Non-observance of this instruction manual can result in damages to property, heavy bodily injuries and death.

3 Technische Daten

	MD 24			MD 28		
	Min.	Typ.	Max.	Min.	Typ.	Max.
Output current [A]	1	-	4,2	2,8	-	7,8
Supply voltage [V]	20	36	50	24	68	80
Logic signal current [mA]	7	10	16	7	10	16
Pulse input frequency [KHz]	0	-	300	0	-	300
Isolation resistance [MΩ]	500	-	-	500	-	-
Cooling	Natural Cooling or Forced cooling					
Environment	Avoid dust, oil fog and corrosive gases					
Ambient Temperature	0°C – 50°C					
Humidity	40% RH – 90% RH					
Operating Temperature	Max. 70°C					
Vibration	Max. 5,9m/s^2					
Storage Temperature	-20°C - 65°C					
Weight	Ca. 280 Gramm			Ca. 440 Gramm		
Dimensions	118 x 75,5 x 33mm			119 x 97 x 48mm		

4 Dimensions

MD24 MD28



(All units:mm)

5 Pin Assignment

5.1 P1 - Control-Signals

Phoenix 6-pin.

Pin	*Signal*	*Description*
1	PUL+(+5V)	Pulse signal: In single pulse (pulse/direction) mode, this input represents pulse signal, effective for each rising or falling edge (set by inside jumper J1); 4-5V when PUL-HIGH, 0-0.5V when PUL-LOW. In double pulse mode (pulse/pulse) , this input represents clockwise (CW) pulse, effective for high level or low level (set by inside jumper J1). For reliable response, pulse width should be longer than 1.5µs. Series connect resistors for current-limiting when +12V or +24V used.
2	PUL-(PUL)	
3	DIR+(+5V)	DIR signal: In single-pulse mode, this signal has low/high voltage levels, representing two directions of motor rotation; in double-pulse mode (set by inside jumper J2), this signal is counter-clock (CCW) pulse, effective for high level or low level (set by inside jumper J1). For reliable motion response, DIR signal should be ahead of PUL signal by 5µs at least. 4-5V when DIR-HIGH, 0-0.5V when DIR-LOW.
4	DIR-(DIR)	
5	ENA+(+5V)	Enable signal: This signal is used for enabling/disabling the driver. High level (NPN control signal, PNP and Differential control signals are on the contrary, namely Low level for enabling.) for enabling the driver and low level for disabling the driver. Usually left **UNCONNECTED (ENABLED)**
6	ENA-(ENA)	

5.2 P2 - Motor / Power-supply

Phoenix 6-pin.

Pin	*Signal*	*Description*
1	GND	DC power ground
2	+V	DC power supply (see techn. data)
3	A+	Motor-Phase A
4	A-	
5	B+	Motor-Phase B
6	B-	

6 Jumpers

There are two jumpers J1 and J2 inside the MD24 / MD28 specifically for the purpose of selecting effective pulse edge or effective level and control signal mode, as shown in figure 2. Default setting is PUL/DIR mode and upward-rising edge effective.

PUL/DIR mode and effective at upward-rising edge

PUL/DIR mode and effective at downward-falling edge

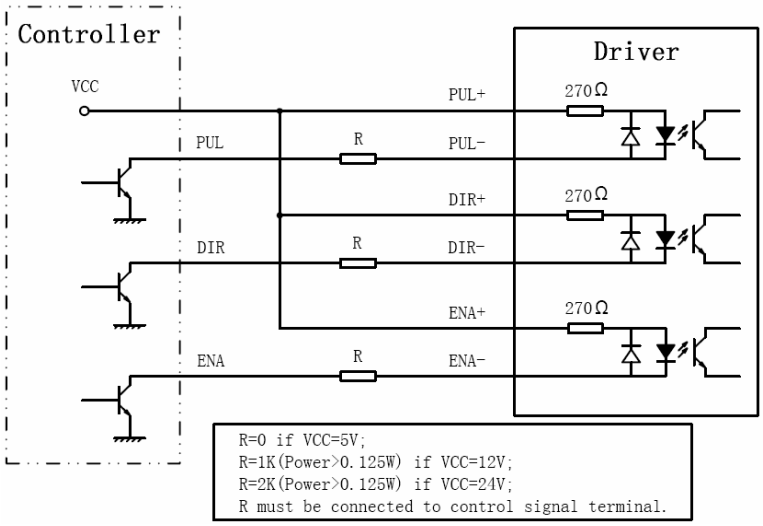
CW/CCW mode and effective
at high level (The fixed level)

CW/CCW mode and effective
at low level (The fixed level)

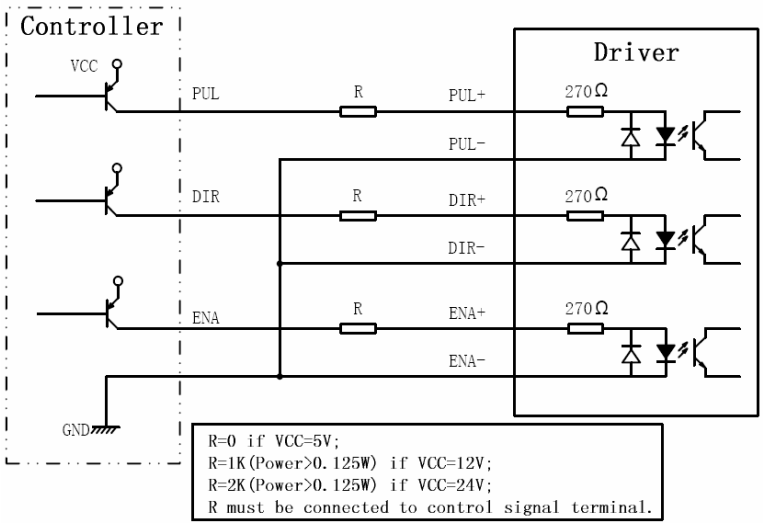
7 Control Signal Connector (P1) Interface

The MD24 / MD28 can accept differential and single-ended inputs (including open-collector and PNP output). The MD24 / MD28 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.

a) Common-anode



b) Common-cathode

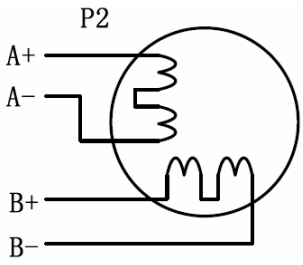


8 Connecting the Motor (P2)

The ME542 driver can drive any 2-pahse and 4-pahse hybrid stepping motors.

8.1 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.



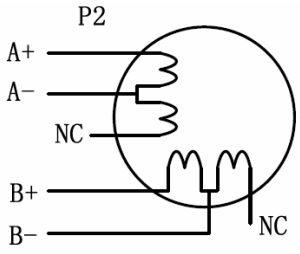
4-lead Motor Connections

8.2 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.

8.2.1 Half Coil Configurations

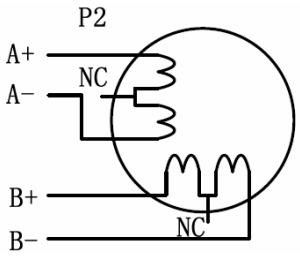
As previously stated, the half coil configuration uses 50% of the motor phase windings. This gives lower inductance, hence, lower torque output. Like the parallel connection of 8 lead motor, the torque output will be more stable at higher speeds. This configuration is also referred to as half chopper.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



6-lead motor half coil (higher speed) connections

8.2.2 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 overheating.



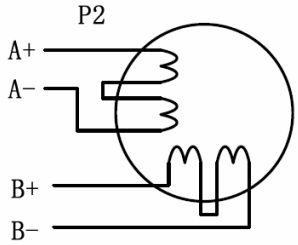
6-lead motor half coil (higher speed) connections

8.3 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.

8.3.1 Series Connections

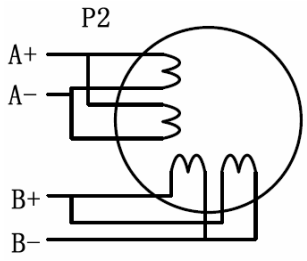
A series motor configuration would typically be used in applications where a higher torque at lower speeds is required. Because this configuration has the most inductance, the performance will start to degrade at higher speeds. In series mode, the motors should also be run at only 70% of their rated current to prevent overheating.



8-lead motor series connections

8.3.2 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.



8-lead motor parallel connections

9 Power Supply Selection

The MD24 / MD28 can match medium and small size stepping motors (from Nema size 17 to 34) made by any 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). 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.

9.1 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.

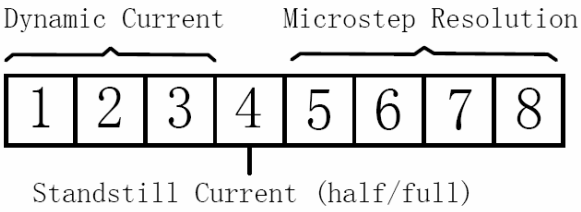
9.2 Multiple Drivers

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.)

Attention: NEVER connect power and ground in the wrong direction, as it will damage the M24/MD28.

10 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:



10.1 Microstep Resolution Selection

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

10.1.1 MD24

Microstep	Steps/rev.	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

10.1.2 MD28

Mikrostep	Schritte/Umdr.	SW5	SW6	SW7	SW8
2	400	ON	ON	ON	ON
4	800	OFF	ON	ON	ON
8	1600	ON	OFF	ON	ON
16	3200	OFF	OFF	ON	ON
32	6400	ON	ON	OFF	ON
64	12800	OFF	ON	OFF	ON
128	25600	OFF	OFF	OFF	ON
256	51200	ON	OFF	OFF	ON
5	1000	ON	ON	ON	OFF
10	2000	OFF	ON	ON	OFF
20	4000	OFF	OFF	ON	OFF
25	5000	ON	OFF	ON	OFF
40	8000	ON	ON	OFF	OFF
50	10000	OFF	ON	OFF	OFF
100	20000	ON	OFF	OFF	OFF
200	40000	OFF	OFF	OFF	OFF

10.2 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.

10.2.1 MD24

Peak current [A]	RMS [A]	SW1	SW2	SW3
1,00	0,71	ON	ON	ON
1,46	1,04	OFF	ON	ON
1,91	1,36	ON	OFF	ON
2,37	1,69	OFF	OFF	ON
2,84	2,03	ON	ON	OFF
3,31	2,36	OFF	ON	OFF
3,76	2,69	ON	OFF	OFF
4,20	3,00	OFF	OFF	OFF

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

10.2.2 MD28

Peak current [A]	Nennstrom [A]	SW1	SW2	SW3
2,80	2,00	ON	ON	ON
3,50	2,50	OFF	ON	ON
4,20	3,00	ON	OFF	ON
4,90	3,50	OFF	OFF	ON
5,70	4,10	ON	ON	OFF
6,40	4,53	OFF	ON	OFF
7,00	5,00	ON	OFF	OFF
7,80	5,57	OFF	OFF	OFF

Achtung: Durch die Induktivität des Motors, kann der aktuelle Motorstrom kleiner sein, als der eingestellte Ausgangsstrom, insbesondere bei hohen Drehzahlen!

10.3 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.

11 Wiring Notes

- In order to improve anti-interference performance of the driver, it is recommended to use twisted pair shield cable.

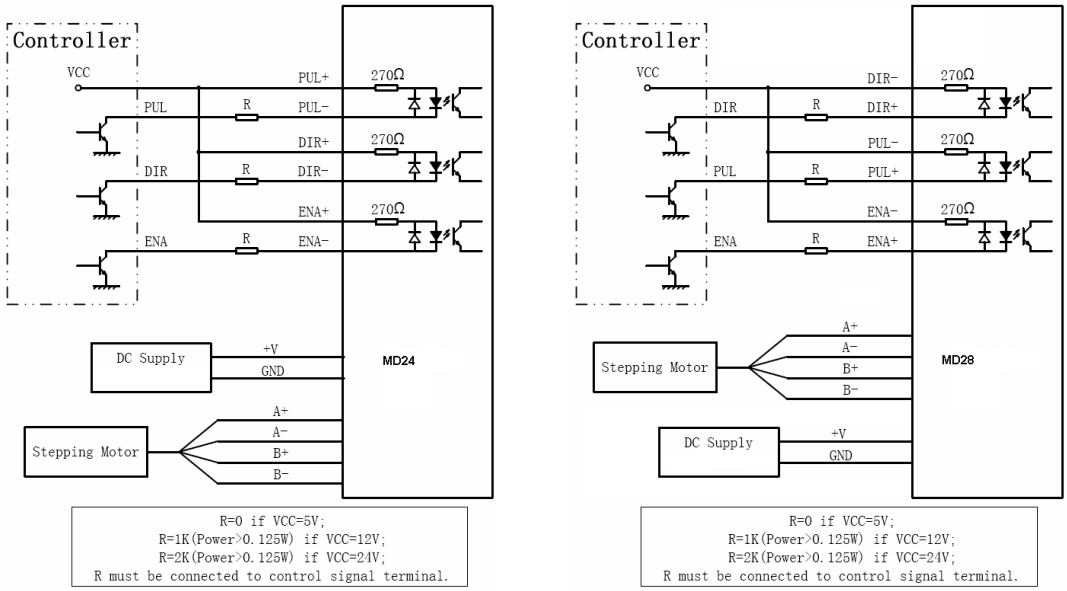
- To prevent noise incurred in PUL/DIR signal, pulse/direction signal wires and motor wires should not be tied up together. It is better to separate them by at least 10 cm, otherwise the disturbing signals generated by motor will easily disturb pulse direction signals, causing motor position error, system 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.

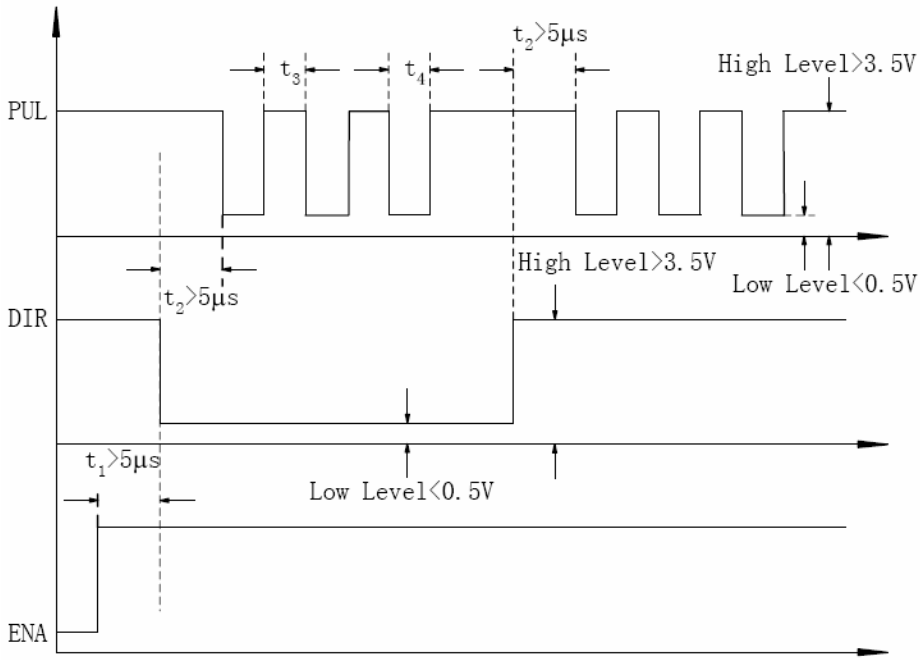
12 Typical Connection

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



13 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):



Remark:

- t_1 - ENA must be ahead of DIR by at least 5µs. Usually, ENA+ and ENA- are NC (not connected). See “Connector P1 Configurations” for more information.
- t_2 **-** DIR must be ahead of PUL effective edge by at least 5µs to ensure correct direction;
- t_3 **-** Pulse width not less than 1.5µs
- t_4 **-** low level width not less than 1.5µs.

14 Protection Functions

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

Over-voltage protection

When power supply voltage of the MD24 exceeds +52VDC or of the MD28 exceeds +96VDC, protection will be activated and power indicator LED will turn red. When power supply voltage is lower than +22VDC, 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.

Over-current Protection (only MD28)

Protection will be activated when continuous current reaches to 14A.

Wrong Motor Connection Protection (nur MD28)

Protection will be activated when the motor is connected in a wrong way.

Note: When above protections are active, the motor shaft will be free or the LED will turn red. Reset the driver by repowering it to make it function properly after removing above problems.

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

15 Problem Symptoms and Possible Causes

Symptoms	**Possible problem**
Motor is not rotating	No power
	Microstep resolution setting is wrong
	DIP switch current setting is wrong
	Fault condition exists
	The driver is disabled
Motor rotates in the wrong direction	Motor phases may be connected in reverse
The driver in fault	DIP switch current setting is wrong
	Something wrong with motor coil
	Control signal is too weak
	Control signal is interfered
Erratic motor motion	Wrong motor connection
	Something wrong with motor coil
	Current setting is too small, losing steps
	Current setting is too small
Motor stalls during acceleration	Acceleration is set too high
	Power supply voltage too low
	Inadequate heat sinking / cooling
Excessive motor and driver heating	Automatic current reduction function not being utilized
	Current is set too high