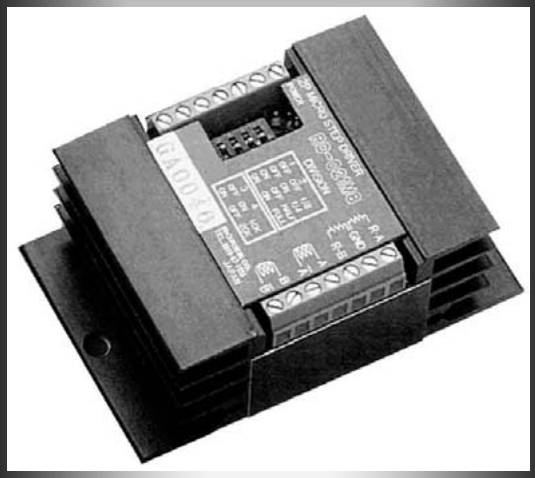
RORZE

RORZE

Instruction Manual



Selectable Microstep
2-ph Stepping Motor Driver

RD-021M8

RORZE RORZE CORPORATION

Be sure to read the following precautions for your safety.

This section describes safety precautions to avoid danger to you or someone else, to avoid damage of your property, and to use this product safely.

Precautions before using this product

This product is designed to be incorporated into general industrial machinery, and is NOT developed to be used in devices such as aerospace machines, security equipment, or other safety devices where a failure or malfunction of this product may directly threaten human lives or health.

Even if you use this product in a general device, make sure that you establish a sufficient level of safety in your device by incorporating a protection function into your machine and guarantee your products based on safety tests on the whole set.

If you will use this product in devices like the above, please contact us. It should be noted that RORZE will not be responsible for any damage caused by using a product in such a device without the consent of RORZE.

⚠ WARNING

Ignoring the following warnings may cause a death or a serious injury.

◇Use this product at places where no explosive or flammable stuff exist nearby and no water is splashed on the product. Otherwise it may cause a fire and/or an injury.
◇Turn off the power before moving or wiring the product. Otherwise you may suffer injuries or electric shocks.
◇Do not forcibly bend, pull, or nip lead wires. Otherwise they may cause an electric shock, fire, and/or failure.
◇Do not use lead wires with their sheath damaged. Otherwise they may cause an electric shock, fire, and/or failure.
◇Make sure that wires are correctly and securely connected at electrical terminals. Otherwise they may cause an electric shock, fire, and/or failure.
◇Do not touch the internal parts of this product.
◇Do not disassemble or modify this product.
◇Do not wire or operate a product with wet hands. Otherwise it may causes electric shocks.
◇Assign a qualified person to transport, install, connect, operate, maintenance, or check this product. Otherwise it may cause an electrical shock, a fire and/or an injury.

⚠ CAUTION

Ignoring the following cautions may result in personal injuries and/or property damages.

◇Make sure that the delivered product is the one you ordered. Installing the wrong product may cause a fire and/or a failure.

Check the following items before turning on the power.

◇The output voltage of the power supply is as described in the specifications.
◇The voltage/current of the input/output terminals conforms to the ratings in the specifications.
◇Input/output terminals are not incorrectly wired or accidentally short-circuited.
◇Do not short resistance terminals (R-A and R-B) to GND.
◇Do not use with the motor except the stepping motor.
◇Operate the rated current of stepping motor within the specified input current limits only.
◇Please use the wire rod with the cross-section area corresponding to current value.
◇Because this product generates heat, please make it stick to metal board etc. or put the fan and radiate enough. Keep the driver's maximum temperature below 60℃.
◇When connecting with terminal, use a screwdriver whose tip fits an adjustment slot. Tighten the screw less than 2.5kgf･cm(0.25N･m).
◇When you run a product for the first time, make sure that the operation can be stopped immediately under an emergency situation.
◇When motor is stalled at high speed, decelerated rapidly, or work at Z-axis etc. is getting down, the back electromotive force of motor make the supply voltage rise abnormally. Exceeding maximum rated voltage will result in the driver's failure.

Ignoring the above cautions may cause a fire and/or a failure.

◇Immediately turn off the power, if you hear an unusual noise. Otherwise it may cause a fire and/or an injury.
◇Do not touch this product when it is in operation, as a malfunction may occur.
◇Do not carry this product by holding its terminal blocks or lead wires. When the product is accidentally dropped, it may cause a personal injury.
◇Do not place this product in unstable positions. When the product is accidentally dropped, it may cause a personal injury.

Under some circumstances, ignoring the precaution described in the CAUTION section may also result in a death or a severe injury. Follow the above precautions described in both the WARNING and the CAUTION section.

Table of Contents

INSTRUCTION MANUAL FOR RD-021M8

1. Caution

The value of external resistance varies depending on the excitation method (in Full step or in Micro step) even if RD-021M8 is used with the same motor. (Refer to the chapter 12 “Current Adjustment” further more details.)

In this manual, “Full step” means that a full step drive was chosen and “Microstep” means that any of half step, 1/4 step, and 1/8 step drive was chosen.

When a motor is stalled at high speed or decelerated rapidly, the back electromotive force of motor make the supply voltage rise abnormally.
Exceeding 40VDC will result in failure.

2. Description

The RD-021M8 is a high resolution stepping motor driver featuring selectable microstep. Microstep drive is the drive method to resolve a basic step angle of motor by controlling the current applying to the motor. The user can select from 1 to 8 microsteps/step.

Steps for 1.8° motor in full step mode is 200 steps/revolution (1.8°/pulse), but if you select 8 microsteps/step in microstep mode, it can be 1,600 steps/revolution (0.225°/pulse).
Microstepping can provide low speed drive and accurate positioning.
Also, a significant weakness of full step driving is the vibration and resonance but microstepping can reduce amplitude of resonance.

3. Features

- Extremely compact
- Large supply voltage range (10 to 40VDC)
- Selectable microstep (full step, half step, 1/4 step, 1/8 step)
- Photo-isolated inputs (photo-coupler)
- Selectable clock – 1clk. or 2clk. Input
- Selectable current setting with external resistance
- Auto current down circuit to reduce heat generation when motor is stationary

4. Specifications

Supply voltage	Single 10 to 40VDC (including ripple)
Supply current	Approx. 1.2 times rated coil current of motor (max.)
Motor current	0.1 to 1.5A/phase (Can change current by external resistance)
Drive method	Bipolar, constant current chopper method
Excitation method	Microstep
Microstep resolution	Up to 8 microsteps/step
Position repeatability	±1 microstep with no load in one direction (with 8 microsteps/step)
Auto. current down	50% of the rated current after about 0.3 seconds of inactivity. Even if the motor rotation is stationary, the auto. current down doesn't work under the condition applying voltage between clock input terminals.
Protective circuitry	Low voltage protection, over voltage absorption
Response frequency	100 kpps max. (at 4.5V to 5.5V)
Weight	Approx. 150g (5.3oz.)
Outside dimensions	32H x 50W x 80Dmm (1.25"H x 1.97"W x 3.15"D)

5. Part Name

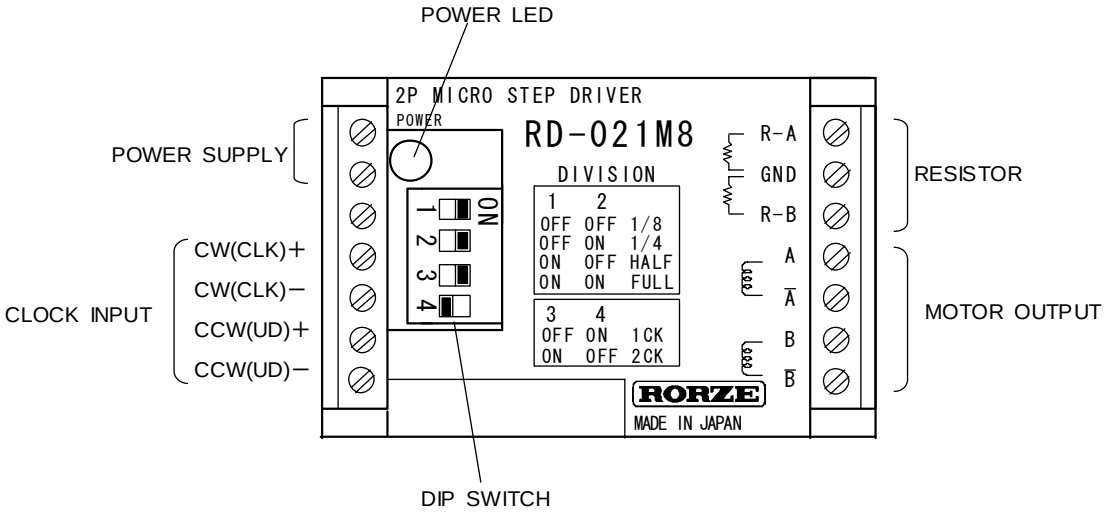


Fig.1. Name plate

6. Terminals

6-1 Clock Input and Direction Input (CW/CLK, CCW/UD)

⚠ Caution

Please set the current between clock input terminals in the range of 8 to 20mA.
Do not exceed 20mA because of the danger of failure.
Do not set the current to 8mA or less because of the danger of malfunction.

Two Clock Input (2CK)
(Inputs two clock pulses - CW clock pulse and CCW clock pulse)

CW+/-
Motor rotates in CW direction with a pulse current of 8 to 20mA from CW+ to CW- terminal.

CCW+/-
Motor rotates in CCW direction with a pulse current of 8 to 20mA from CCW+ to CCW- terminal.

One Clock Input (1CK)
(Inputs clock pulse and direction (CW, CCW))

CLK+/-
Motor rotates in CW direction with a pulse current of 8 to 20mA from CLK+ to CLK- terminal and UD input off.

UD+/-
Motor rotates in CCW direction with a pulse current of 8 to 20mA from CLK+ to CLK- terminal and UD input turned ON.

The current at 4.5 to 5.5V is 10 to 15mA.

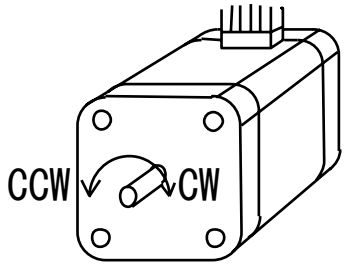


Fig.2. Direction of Rotation

6-2 Resistor Terminals (R-A, GND, R-B)

⚠ Caution

Do not short or mis-wiring terminals between R-A, GND and between R-B, GND.
There is danger of failure or fire.

These terminals connect with resistances suitable for the motor rated current.

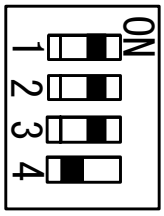
7. POWER LED

This will light whenever the voltage is supplying.

8. Dip Switches

Caution

Do not set the Dip switches except the below table.
Do no select × setting.
Do not change the Dip switch during turning ON the power.
There is a danger of malfunction and failure.



DIVISION

1	2	
OFF	OFF	1/8
OFF	ON	1/4
ON	OFF	HALF
ON	ON	FULL

3	4	
OFF	ON	1CK
ON	OFF	2CK

Fig.3. Dip switches

8-1 Microstep Resolution Selection Switch

You can select microstep resolution from among 4 selections using two dip switches, Bit 1 and Bit 2.

$$\text{Step angle} = \text{Motor basic step angle} \times \frac{1}{\text{Microstep resolution}}$$

Dip switch setting table:

Bit 1	Bit 2	Microstep Resolution(M)
OFF	OFF	8
OFF	ON	4
ON	OFF	2 (Half)
ON	ON	1 (Full)

8-2 Clock Input Selection Switch (1CK/2CK)

You can select pulse input method, two clock input method (2CK) or Pulse & Direction input method (1CK).

Dip switch setting table:

Bit 3	Bit 4	Clock Input
OFF	OFF	×
OFF	ON	1CK
ON	OFF	2CK
ON	ON	×

×: invalid setting

9. Timing Diagrams

Switching Direction of Rotation

Two clock input (2CK):

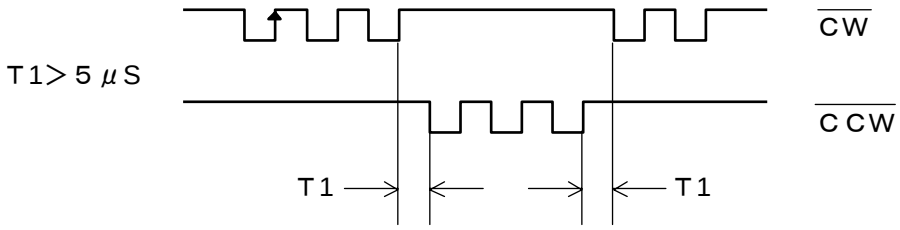


Fig.4. Two Clock Timing Diagram

One clock input (1CK):

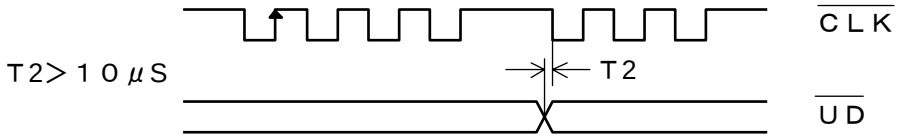


Fig.5. One Clock Timing Diagram

Note1: The above diagrams indicate voltage waveform of "－" terminal (negative logic) in case of connecting external power supply to each "＋" terminal, and open-collector output of external controller to "－" terminal.

Note2: The pulse count will not be lost as long as parameters T1 and T2 are within the spec.

Note3: Motor will rotate 1 step at the rising edge of pulse ($\overline{CW}$·$\overline{CCW}$·$\overline{CLK}$).
(When the clock current will change from ON to OFF)

１０. Input Circuits

Caution

Do not exceed max. rated current･voltage of each I/O circuit.
It causes failure or malfunction.

10-1 Clock Input Circuits (CW/CLK, CCW/UD)

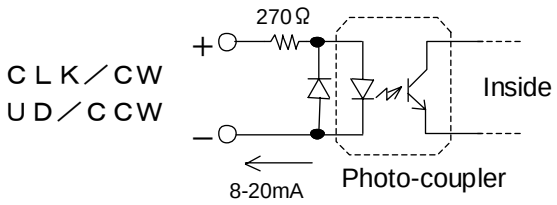


Fig.6. Clock Inputs

Please operate with a pulse current of 8 to 20mA. (10 to15mA at 4.5 to 5.5VDC)
If the current exceeds 20mA by connecting with power supply of high voltage (24V etc.) directly, please place resistance in series so that current can be set to 8 to 20mA.

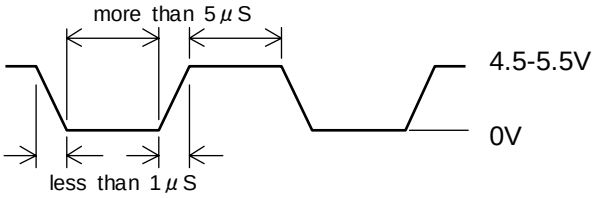


Fig.7. Pulse Specification

１１．Wiring Diagram

Caution

Make sure that there are no mis-wiring and short-circuiting and do not turn power on before wiring correctly. There is danger of fire or failure.
Please tighten the terminals with the torque of less than 2.5kgf･cm (0.25N･m).

Please use the wire rod with the cross-section area corresponding to current value.

※In microstep mode, a sine curve current which made effective value the run current value set by run current adjustment trimmer flows. The maximum current value which runs on the lead wire of motor is run current × $\sqrt{2}$.

ex.) Run current: 1.5A → Max. current value is 2.1A. （$1.5(\mathrm{A})\times\sqrt{2}=2.1(\mathrm{A})$）

Use twisted wire pair for the signal input wiring. Please tighten the terminals less than 2.5kgf･cm (0.25N･m).

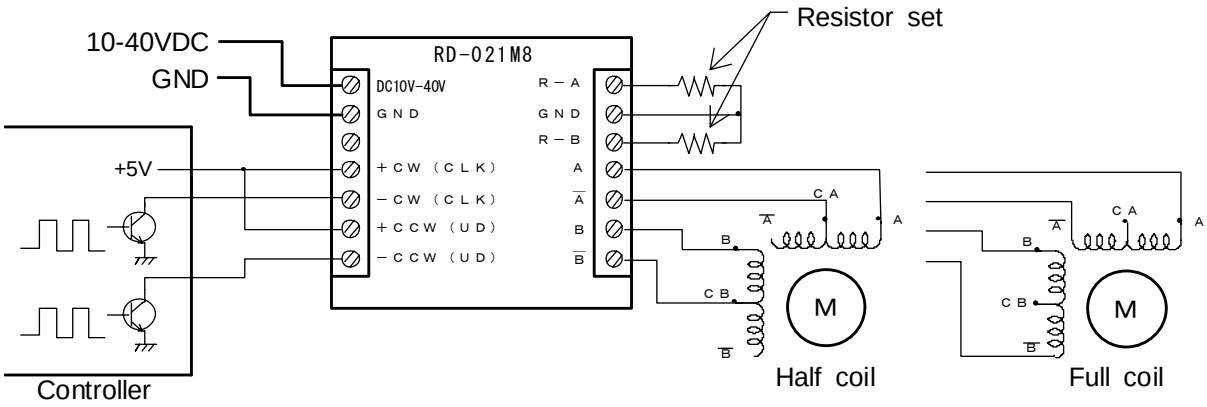


Fig.8. Wiring Diagram

Half coil wiring

Connect the lead wires of motor, A, CA, B and CB to the terminals of driver, A, $\overline{A}$, B and $\overline{B}$ respectively.

Full coil wiring

Connect the lead wires of motor, A, $\overline{A}$, B and $\overline{B}$ to the terminals of driver, A, $\overline{A}$, B and $\overline{B}$ respectively.
This wiring provides the rated torque with half of current of motor rated current.
However, the maximum of RPM decreases approx. half as compared with half coil drive using COM terminal.

(Note)
Please isolate lead wires that aren't used in either of wirings.

11-1 Suitable Motor

You can use any HB(hybrid) or PM(permanent magnet) stepping motor with rating of 0.1 to 3A/ph. Select motors with rating of less than supply voltage × 0.7(V).

RORZE 2-Ph Stepping Motors (Torque -- 1kgf·cm = 13.9oz·in Inertia -- 1g·cm² = 5.46745×10^{-3}oz·in²)

ModelNo.	Holding Torque		FullStep Angle (Degree)	Rated Current (A/ph)	Rotor Inertia (g·cm²)	Resistance (Ω)	Inductance (mH)
	(kgf·cm)	(N·m)					
RM2414S/D	1.4	0.14	1.8	1.5	30	1.3	0.96
RM2424S/D	2.4	0.24	1.8	1.5	53	1.75	2.2
RM2621S/D	2.1	0.21	1.8	3.0	57	0.36	0.48
RM2640S/D	4.0	0.39	1.8	3.0	100	0.6	0.8
RM2690S/D	8.0	0.78	1.8	3.0	210	0.77	1.58
RM26A3S/D	13.0	1.3	1.8	3.0	360	0.9	2.2

Color of RORZE motor's wire

	Terminal			
	A	$\overline{A}$	B	$\overline{B}$
Half coil wiring	Red	Black	Blue	White
Full coil wiring	Red	Yellow	Blue	Orange

Color of ORIENTAL motor's wire

	Terminal			
	A	$\overline{A}$	B	$\overline{B}$
Half coil wiring	Black	Yellow	Red	White
Full coil wiring	Black	Green	Red	Blue

１２. Current Adjustment

(Caution)
"Full step" means that a full step drive chosen, "Microstep" means that any of half step, 1/4 step, and 1/8 step drive was chosen.

⚠ Caution

Please use after adjusting the current within the rated current of stepping motor. Exceeding the rated current causes the failure of motor or fire.

12-1 Resistance selection table

RORZE MOTOR	Rated Current (A/ph)	Resistance(Ω)		Wiring
		Full step	Microstep	
RM2414S/D	1.5	0.56	0.33	Half coil
RM2424S/D	1.5	0.56	0.33	Half coil
RM2621S/D	3.0	0.56	0.39	Full coil
RM2640S/D	3.0	0.56	0.39	Full coil
RM2690S/D	3.0	0.51	0.33	Full coil
RM26A3S/D	3.0	0.51	0.33	Full coil

ORIENTAL MOTOR	Rated Current (A/ph)	Resistance(Ω)		Wiring
		Full step	Microstep	
PK243-01	0.95	0.91	0.62	Half coil
PK243-02	0.4	3.3	1.8	Half coil
PK244-01	1.2	0.68	0.43	Half coil
PK244-02	0.8	1.1	0.68	Half coil
PK244-03	0.4	3.3	1.8	Half coil
PK245-01	1.2	0.68	0.43	Half coil
PK264-01	1.0	0.82	0.51	Half coil
PK266-01	1.0	0.82	0.51	Half coil
PK268-01	1.0	0.82	0.51	Half coil

12-2 Resistance formula

As for the motors that have not listed in 12-1 Resistance selection table, please find current (I) on the basis of rated current (Ir) of a motor according to the following table, and determine resistance value by the formula. The resistance value calculated by the below formula includes the error by the kind of motor and driver supply voltage.
Also, the error inside of driver is approx. ±10%.
When you want to calculate resistance value with precision, please determine resistance value according to the measurement circuit of 12-3.

Rated Current	Drive current		Wiring	Remark
	Full step	Microstep		
3A＜Ir	RD-021M8 cannot be used	RD-021M8 cannot be used	－ －	RD-021M8 is likely to be damaged by back EMF
1.5A＜Ir≦3A	I＝Ir/2	I＝Ir/1.414	Full coil	
Ir≦1.5A	I＝Ir	I＝1.414×Ir	Half coil	

① $X = \{I/(0.1108 \times Ir + 0.66)\}^{\{-1/(0.75+0.023 \times V)\}}$

② $R = 8.2 \times X/(8.2 - X)$

You can find resistance R by the above formula.

I: Drive current
Ir: Rated current of the motor
V: Rated voltage of the motor

Example:
Excitation method: Full step
Rated current (Ir): 1.2A
Rated voltage (V): 2V
Drive current (I): I＝Ir＝1.2A

① $X = \{1.2/(0.1108 \times 1.2 + 0.66)\}^{\{-1/(0.75+0.023 \times 2)\}}$
$= 0.594$
② $R = 8.2 \times 0.594/(8.2 - 0.594)$
$\fallingdotseq$ 0.64Ω

(Remarks)
Although the error of motor current value increases, the approximate value of resistance is available by the following formula.

①′ $X = 0.8/I$ (I: Drive current)

②′ $R = 8.2 \times X/(8.2 - X)$

12-3 Current Measure Circuit

Using Half coil wiring

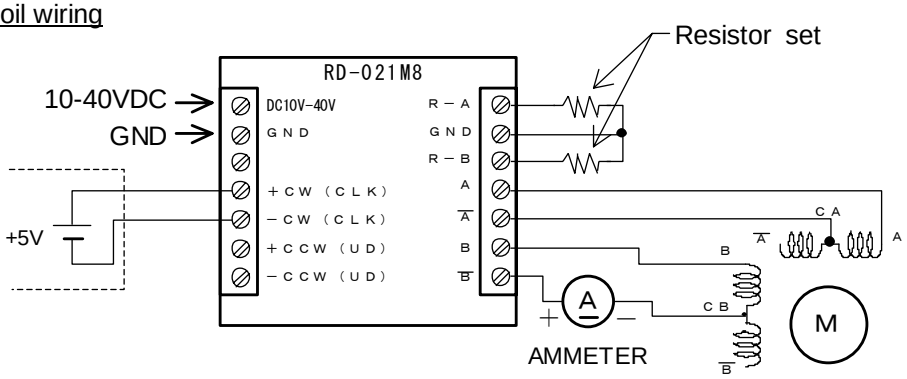


Fig.9. Half coil wiring

- Wire as the above diagram.
- Connect an ammeter between $\overline{B}$(Driver side) and CB(Motor side) in series.
- Set the DIP SWITCHes to the Full STEP.
- Turn ON the power and read the current value.

◎In full step mode, determine the resistance value as the ammeter reading will become the motor rated current.

◎In microstep mode, the ammeter reading/1.414 will become a motor current value.
Therefore, in microstep mode, please select the resistance value to make the ammeter reading/1.414 into the motor rated current.

Using Full coil wiring

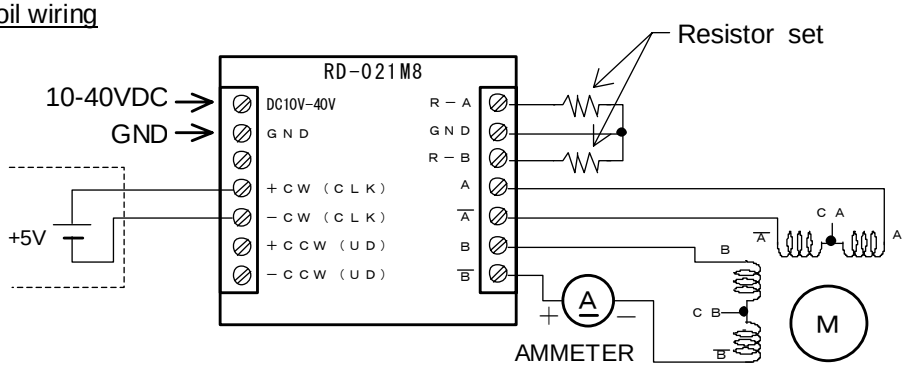


Fig.10. Full coil wiring

- Wiring like the above diagram.
- Connect an ammeter between $\overline{B}$(Driver side) and $\overline{B}$(Motor side) in series.
- Set DIP SWITCHes to Full STEP.
- Turn ON the power and read the current value.

◎In full step mode, determine the resistance value as the ammeter reading will become the half value of motor rated current.

◎In microstep mode, the ammeter reading/ 1.414 is a motor current value.
Therefore, in microstep mode, please select the resistance value to make the ammeter reading/1.414 into the half value of motor rated current.

(Reference)
Since only turning on the power will not prevent auto. current down working, you should connect CW＋ to 5V and CW－ to GND.

１３．Resistor

13-1 Resistor Model No. List

Model No.	Resistance	
	Ω	Watts
R30	0.30	3
R33	0.33	3
R39	0.39	3
R43	0.43	3
R47	0.47	3
R51	0.51	3
R56	0.56	3
R62	0.62	3
R68	0.68	2
R75	0.75	2
R82	0.82	2
R91	0.91	2
1R0	1.00	2

Model No.	Resistance	
	Ω	Watts
1R1	1.10	2
1R2	1.20	2
1R3	1.30	1
1R5	1.50	1
1R6	1.60	1
1R8	1.80	1
2R0	2.00	1
	2.20	1
2R4	2.40	1
2R7	2.70	0.5
	3.00	0.5
3R3	3.30	0.5
3R9	3.90	0.5

Model No.	Resistance	
	Ω	Watts
4R3	4.30	0.5
4R7	4.70	0.5
	5.10	0.5
5R6	5.60	0.25
6R2	6.20	0.25
6R8	6.80	0.25
	7.50	0.25
8R2	8.20	0.25
	9.10	0.25
	10.00	0.25
	11.00	0.125
	12.00	0.125
13R	13.00	0.125

(Note)
- All resisters attached to the product are more than 2W.
- We don't have resistors which model numbers are blank in stock. If need, please purchase by yourself. (Watts = 0.8 × 0.8／R × Safety factor)

Model RD-021M8-□□□

Please put the resistance model No. in □□□, the last part of model No.
As for the resistance model No., please refer to the above list and then appoint resistance model No.
(We attach a pair of resistances (the same model no.) for a RD-021M8 with no charge.)

Ex.) External resistances: 2.0Ω → RD-021M8-2R0
If you don't need resistances → RD-021M8-000.

13-2 Resistor set (RD-RK01)

Combined resistance (Ω)	Resistance(Ω)			
	1.1	2.0	4.7	8.2
8.2	—	—	—	○
4.7	—	—	○	—
3.0	—	—	○	○
2.0	—	○	—	—
1.6	—	○	—	○
1.4	—	○	○	—
1.2	—	○	○	○
1.1	○	—	—	—
0.97	○	—	—	○
0.89	○	—	○	—
0.80	○	—	○	○
0.71	○	○	—	—
0.65	○	○	—	○
0.62	○	○	○	—
0.57	○	○	○	○

In case of using sample set, please select combination of resistances according to the left table.
There are four kinds of resistances in the sample set.
(1.1, 2.0, 4.7 and 8.2Ω 2 pcs. each)
＜How to use＞
Combining 4 kinds of resistances in parallel can make the resistance value from 8.2 to 0.57Ω.
Before using, confirm the current value by current measurement circuit (Refer to12-3) and then determine the combination of resistances.

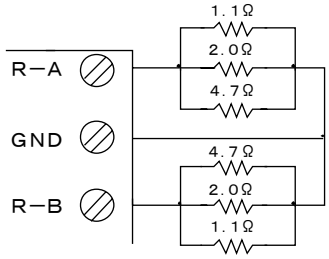


Fig.11. Combined resistance＝0.62Ω

１４. Heat Dissipation

Caution

Please dissipate heat generated by driver and motor enough.
If it is insufficient, temperature rise causes malfunction, failure or fire.

Keep the motor's maximum case temperature below 100℃ and driver's below 60℃ by adjusting the drive current or by installing a cooling fin, fan, etc.

１５. Other Functions

15-1 Auto. current down

After about 0.3 seconds of inactivity, current will be reduced to 50% of running current. This reduces driver and motor heat generation during idle periods.
Also even if the motor rotation is stationary, the auto. current down doesn't work under the condition applying the voltage between clock input terminals.

15-2 Low voltage protection circuit

The driver has a built-in low voltage protection circuit to prevent current overload. The low supply voltage condition normally occurs when power is turned ON.

15-3 Over voltage absorption circuit

This acts when the voltage exceeds 40.8V owing to the regenerative electric power etc. generated by the deceleration of motor.

１６. Consumption Current

The current consumed by driver and motor varies, depending on the supply voltage, pulse (clock) frequency, motor's inductance, rated current and holding torque. Also, the ripple according to the cycle of PWM and RPM is added into the consumption current. Please use the power supply which current is more than 1.2 times the rated current of the motor as a standard.

If other devices share the same power supply and voltage change can't be allowed, then use the power supply that can flow 1.7 times of the max value of the supply current, or incorporate a large capacitor.

１７. Relationship between Frequency(pps) and Motor speed(rpm)

“pps” is about pulse speed and stands for the number of pulses per second.
Formula to calculate rpm:

$$\text{Motor speed(rpm)} = \frac{\text{Step Angle} / \text{Microstep resolution(M)} \times \text{Frequency} \times 60}{360\text{(degree)}}$$

Example

Step Angle: 1.8degree, Microstep resolution(M): 8, Frequency: 10,000pps

$$\text{Motor speed(rpm)} = \frac{1.8 / 10 \times 10{,}000 \times 60}{360} = \underline{375 \text{ rpm}}$$

１８. Dimensions

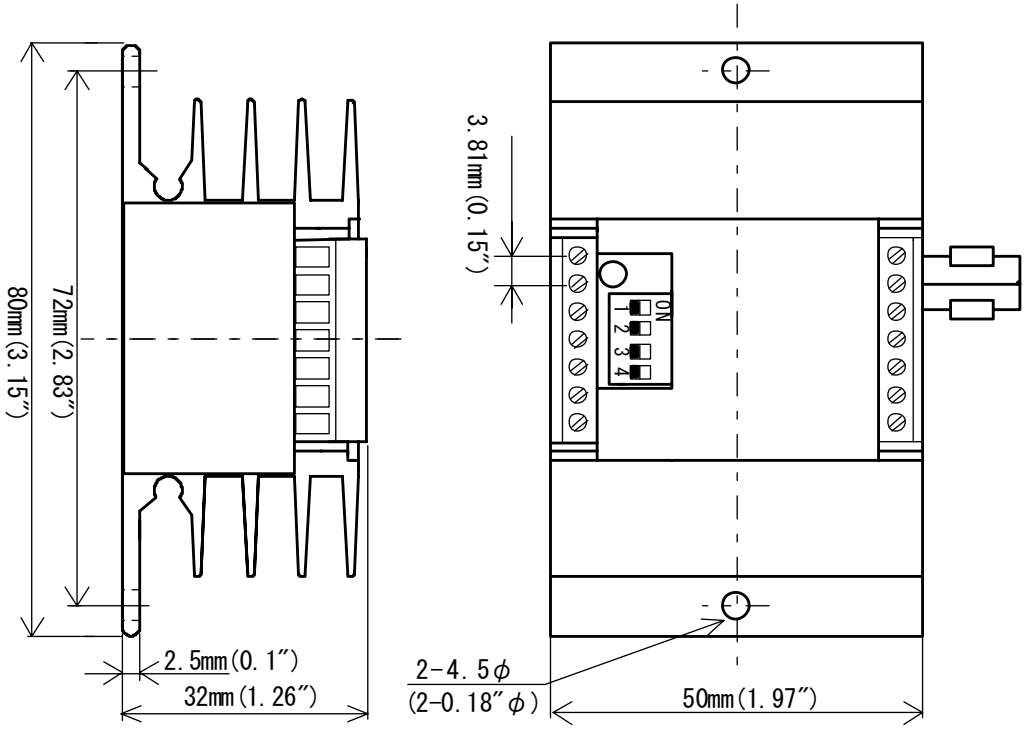


Fig.12. Dimensions

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