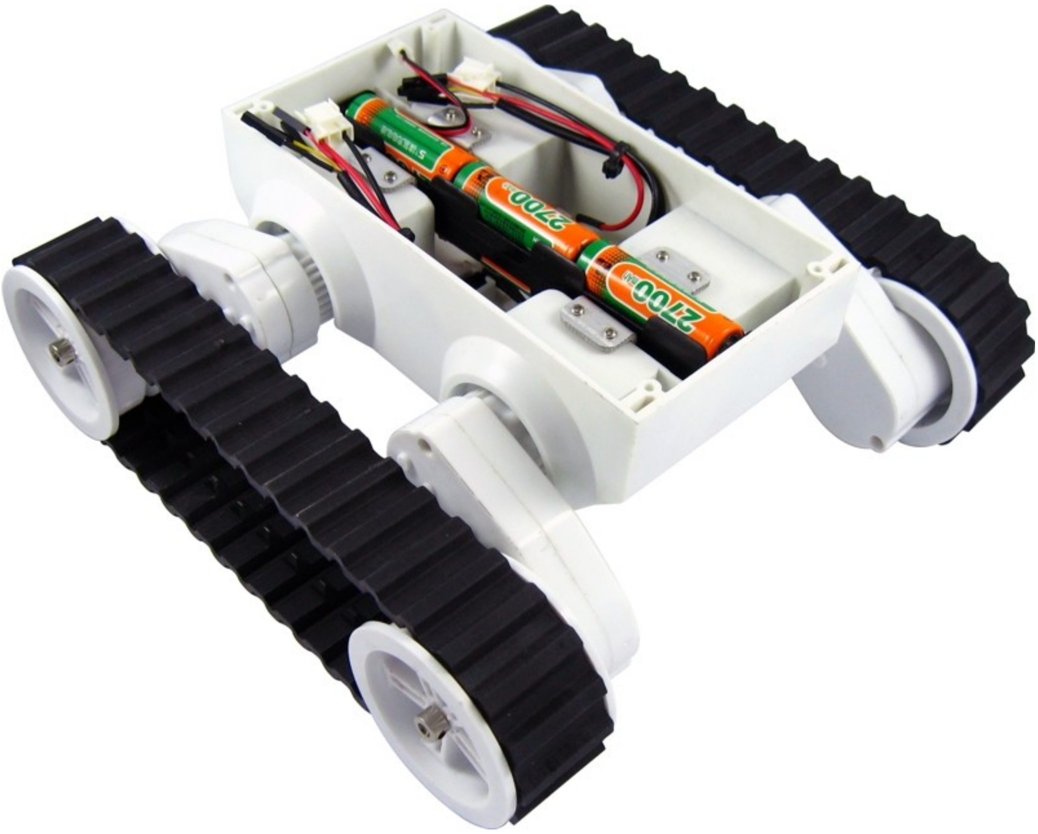
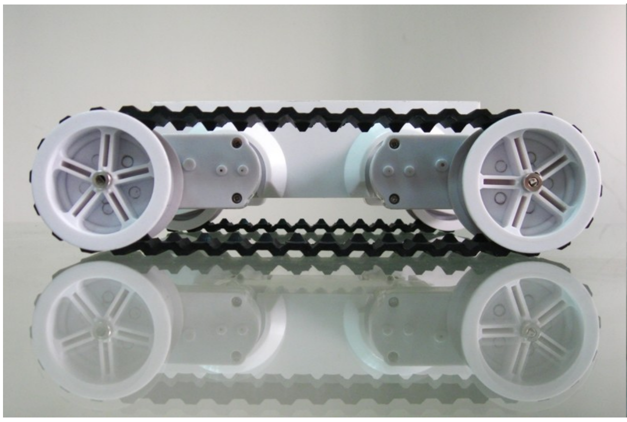
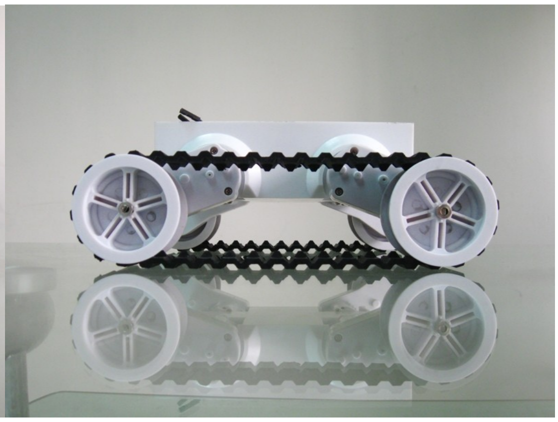
Rover 5

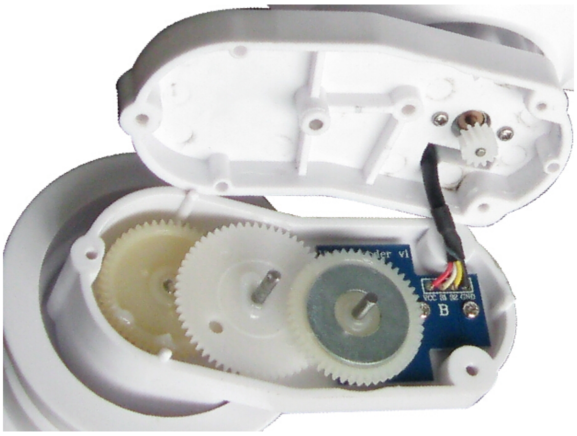


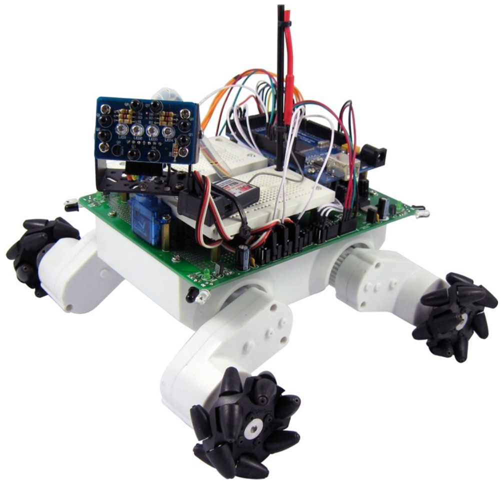
Rover 5 is a new breed of tracked robot chassis designed specifically for students and hobbyist. Unlike conventional tracked chassis's the clearance can be adjusted by rotating the gearboxes in 5-degree increments. "Stretchy" rubber treads maintain tension as the clearance is raised.



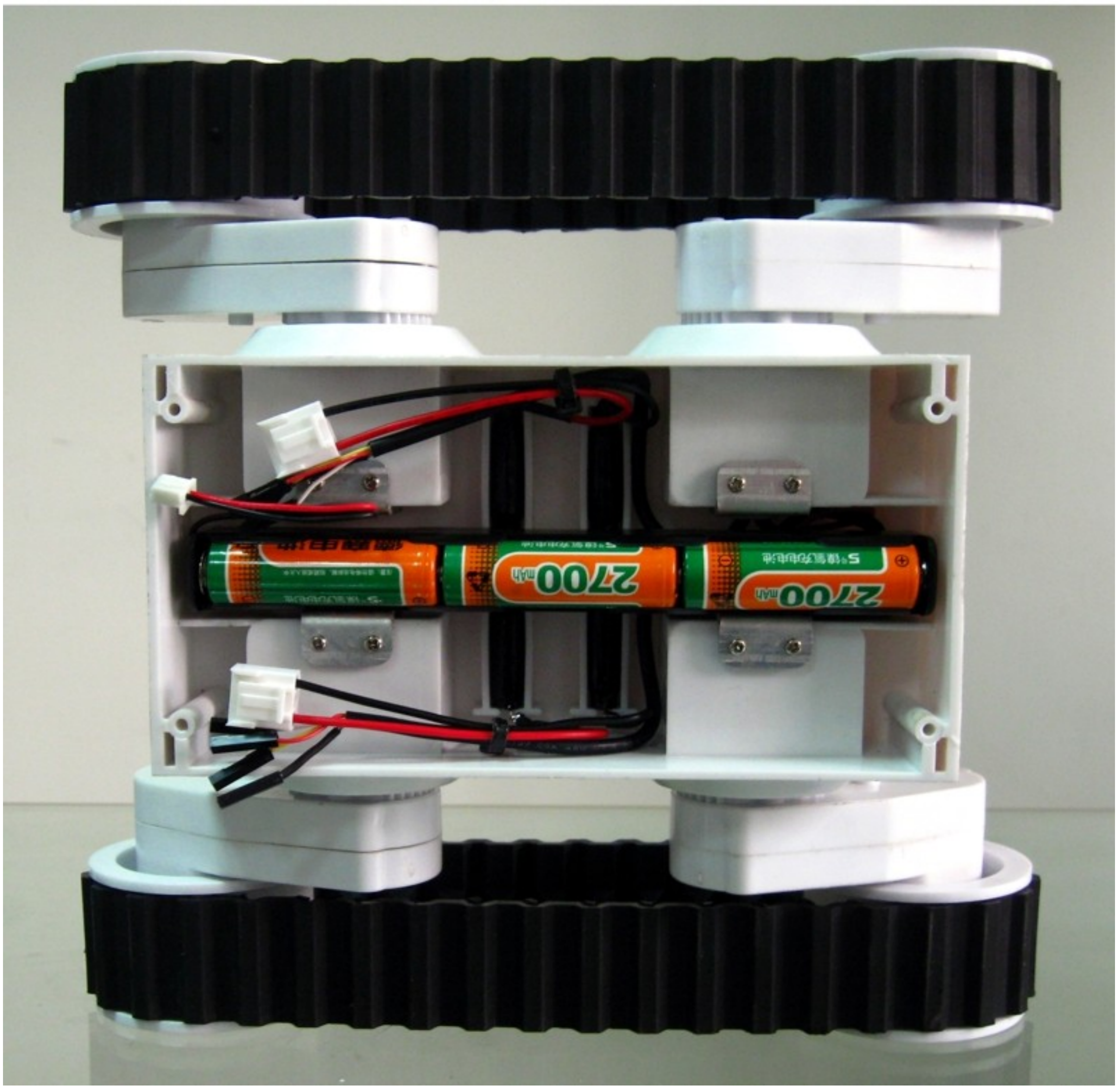


Each gearbox has an 87:1 ratio includes a hall effect quadrature encoder that gives 1000 pulses over 3 revolutions of the output shaft. The chassis can be upgraded to include four motors and encoders making it ideal for mecanum wheels.



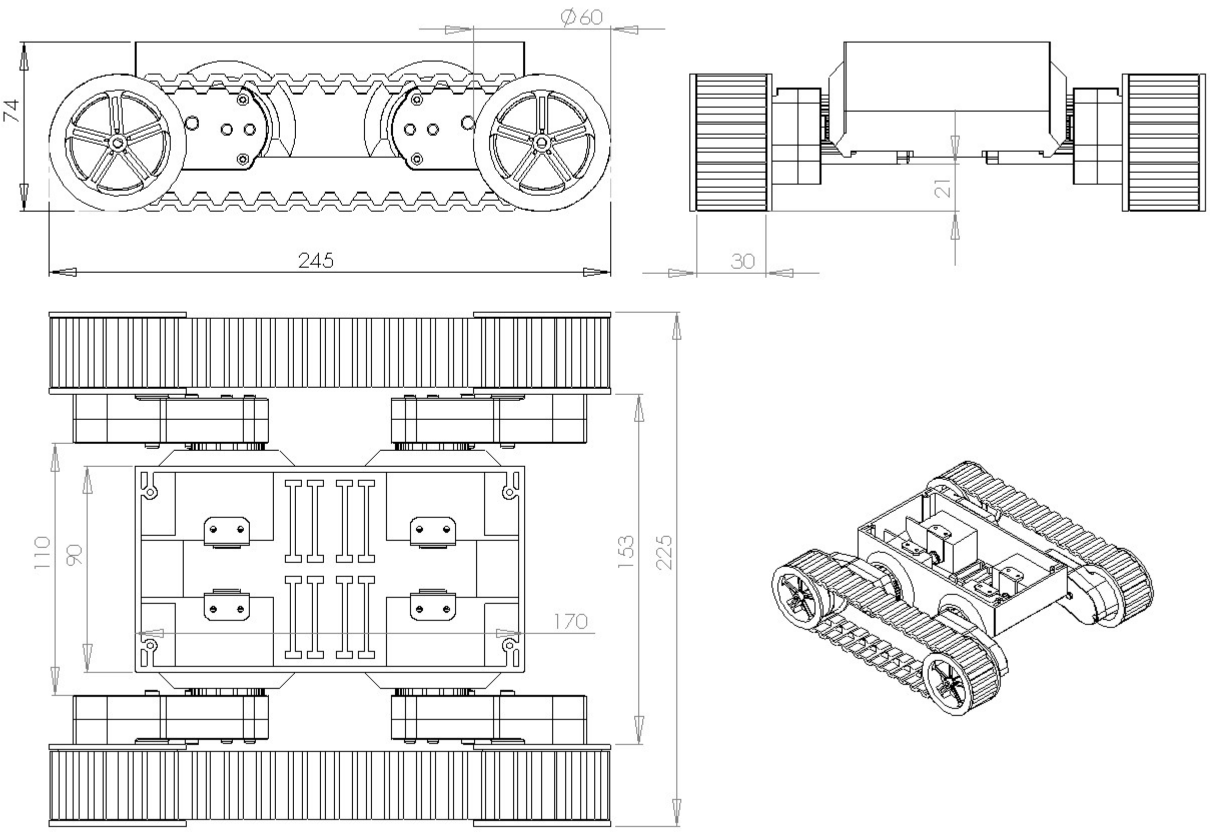


Inside of the chassis are 4 noise suppression coils at the bottom and a battery holder that accepts 6x AA batteries. It is recommended to use NiMh batteries as they last longer and have a higher current output than Alkaline batteries.



Video of the chassis in action can be seen here:
Video indoors autonomous: http://v.youku.com/v_show/id_XMjE5NzkwODA0.html
Video outdoors RC mode: http://v.youku.com/v_show/id_XMjIwMTkxODk2.html

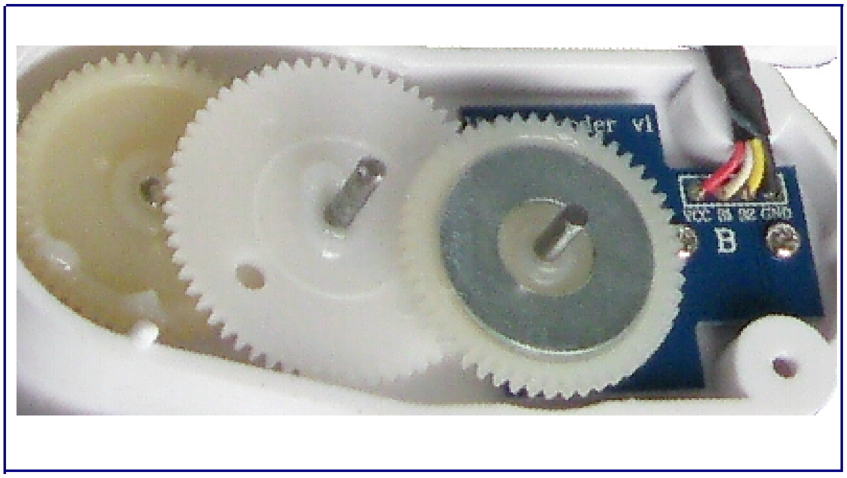
Dimensions:



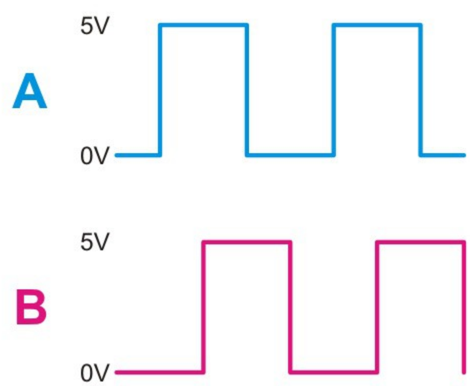
Specifications:

Motor rated voltage: 7.2V
Motor stall current: 2.5A
Output shaft stall torque: 10Kg/cm
Gearbox ratio: 86.8:1
Encoder type: hall encoder
Encoder resolution: 1000 state changes per 3 wheel rotations
Speed: 1Km/hr

How to use a quadrature encoder



A quadrature encoder, also known as an incremental rotary encoder measures the speed and direction of a rotating shaft. Quadrature encoders can use different types of sensors, optical and hall effect are both commonly used. The photo shows inside of a Rover 5 gearbox. There are two hall effect sensors on the PCB that respond to an 8-pole disc magnet mounted on one of the gears. No matter what type of sensors are used the output is typically two square waveforms 90° out of phase as shown below.



If you only wish to monitor the speed of rotation then you can use either output and simply measure the frequency. The reason for having two outputs is that you can also determine the direction of shaft rotation by looking at the pattern of binary numbers generated by the two outputs.

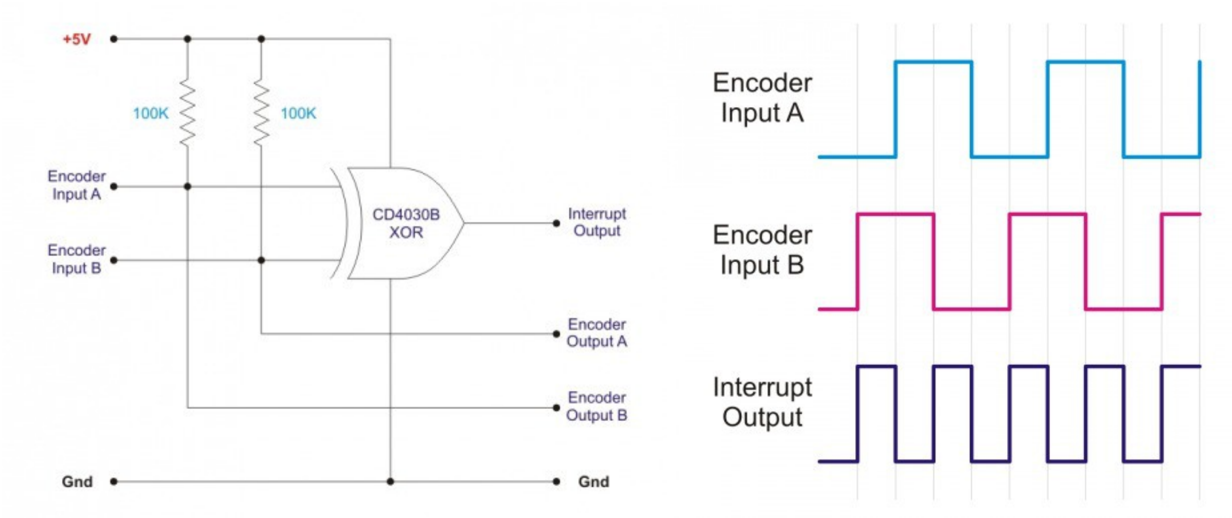
Depending on the direction of rotation you will get either:

00 = 0
01 = 1
11 = 3
10 = 2

or

00 = 0
10 = 2
11 = 3
01 = 1

By feeding both outputs into an XOR gate (exclusive OR) you will get a square wave with twice the frequency regardless of direction. This can be useful as it allows one interrupt pin to monitor both encoder inputs.



I was looking at how to write efficient code to convert these binary inputs into a simple "forward or backward" output. I ended up with a 2 dimensional array (matrix) that made the code quick and easy.

The binary values above convert to 0,1,3,2 or 0,2,3,1 depending on the direction. This pattern repeats continuously. By using the current value from the encoder to index one dimension of the array and the previous value to index the other dimension you can quickly get a -1, 0, or +1 output. My array looks like this.

Old Value \ Current Value	0	1	2	3
0	0	-1	+1	X
1	+1	0	X	-1
2	-1	X	0	+1
3	X	+1	-1	0

As you can see, if the value has not changed then the output is 0.
The sequence of 0, 1, 3, 2 gives an output of -1.
The sequence of 0, 2, 3, 1 gives an output of +1.

X represents a disallowed state and would most likely occur if the encoder outputs are changing too quickly for your code to keep up. Normally this should not happen. In my code I put a 2 here. When I get an output of 2 I know that I got an error, perhaps due to electrical noise or my code being too slow. If you replace X with 0 then the disallowed state will be ignored.

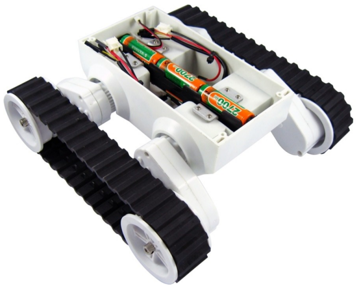
In my Arduino code I make this a 1 dimensional array. that looks like this:

```
int QEM [16] = {0,-1,1,2,1,0,2,-1,-1,2,0,1,2,1,-1,0};              // Quadrature Encoder Matrix
```

To read the array my index is: Old * 4 + New
So my code reads like this:

```
Old = New;
New = digitalRead (inputA) * 2 + digitalRead (inputB);          // Convert binary input to decimal value
Out = QEM [Old * 4 + New];
```

Good luck and enjoy.



Rover 5

Encoder Upgrade

Dear customer,

Recently DAGU has upgraded the encoders in the Rover 5 chassis from an optical encoder to a hall-effect encoder with the same or better specifications. The new encoder is wired in the same manner as the old encoder and will work with the same code. The end user should notice no difference in operation.

Resolution:
DAGU have produced a custom 8-pole magnet to replace the optical encoder sticker within the gearbox to ensure the same resolution.

Output:
The new encoder still produces the same dual square wave output with a 90 degree phase shift. The output is now a sharper, cleaner square wave for better reliability.

Power:
The new hall-effect sensors being used will operate from 3V to 24V making the encoder compatible with 3.3V and 5V controllers.

Lower power consumption (6mA typical per encoder) will give longer battery life. A Rover 5 chassis with 4 encoders will draw less than 25mA.

Reliability:
Unlike the previous optical sensor, these hall-effect sensors require no factory calibration and provide a stable output over a wide temperature range.

Durability:
The new sensors have built in reverse polarity protection, which combined with the high voltage rating will prevent any accidental damage by the user.

Best regards from DAGU.

2. STANDARD OPERATING CONDITIONS

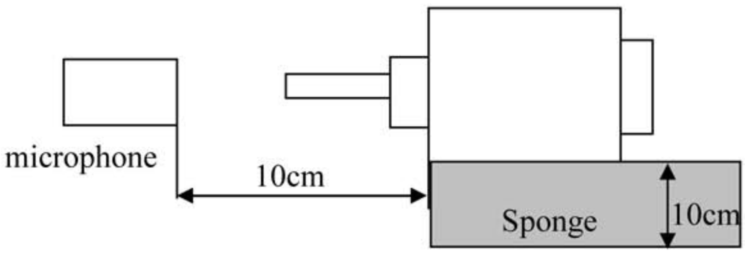
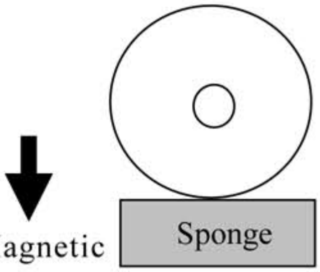
ITEM	SPECIFICATION
a. Rated Voltage	DC 7.2VDC
b. Operating Voltage range	DC 5V~7.5VDC
c. No Load Current	Below 160mA
d. No Load Speed	8804±10%RPM
e. Operating Environment	1. Working temperature: -30°C and +40°C Working humidity: 15%~90% RH
f. Storage Environment	1. Storage temperature: -30°C and +70°C 2. Storage humidity: 10%~90% RH (No condensation of moisture)

3. MEASURING CONDITION

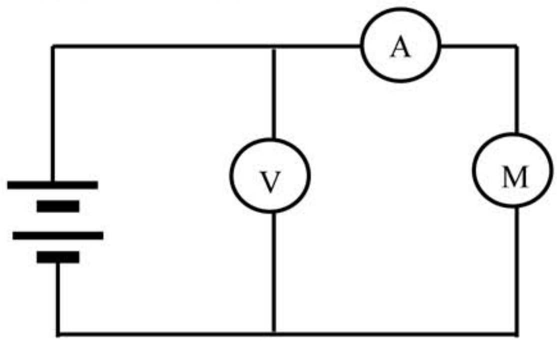
ITEM	SPECIFICATION
a. Temperature	20±2°C
b. Humidity	65±5%RH
c. Motor Position	Shaft Horizontal

ALL DATA ARE BASED ON THE MEASUREMENT UNDER THE TEMPERATURE OF 25°C AND HUMIDITY 65%RH. HOWEVER, IT IS ALSO APPLICABLE AT THE RANGES OF TEMPERATURE 10~35°C AND HUMIDITY 30~95% RH.

4. MECHANICAL SPECIFICATION

ITEM	SPECIFICATION
a. Shaft end play	0.02mm~0. 5mm
b. Shaft vibration	Below 0.03mm
c. Mechanical noise	68dB (max) with the following condition
	No load rated voltage, motor horizontally held, measured by JIS-A (RMS) at 10cm away from metal housing on protruded shaft side. Motor should be put on the sponge as shown with the arrow downward, Background noise: 26dB   Direction of Magnetic Force attracting the armature

5. ELECTRICAL CHARACTERISTICS

ITEM	SPECIFICATION
a. Rate Voltage	7.2V DC
b. No Load Speed	8804±10%RPM
c. No Load Current	Below 160mA
d. Insulation Resistance	1MΩ Min (DC 100V)
e. Testing Circuit	Testing circuit operated at 7.2V, 0Ω 

Mechanical Dimension
TFK280SC-21138-45