

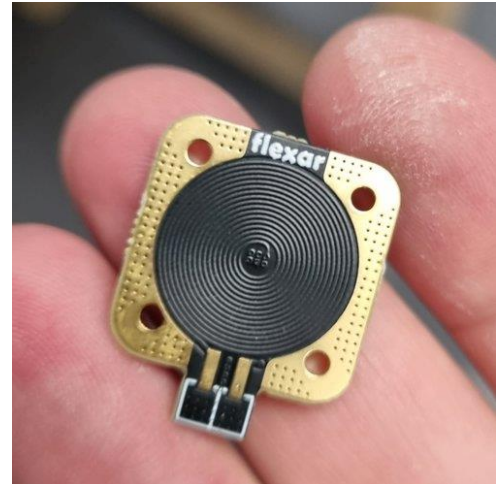
# flexar

## PCB Actuator

### 1. How it works?

This is a simple and customizable actuator that is made from a 12-layer spiral PCB coil. When current flows through the planar copper windings, it can generate a magnetic field strength of up to 12mT. This can be used to attract or repel N52 grade neodymium magnets and create custom PCB actuators, which can be ideal to actuate lightweight objects, like thin 3d-printed plastic models or paper-sculptures.

This PCB actuator is around 4.6 times more powerful than the [Sticker Actuator](#). This resulted from using 2oz copper thickness for each layer, which reduced the resistive elements of the track and allowed more turns to fit.

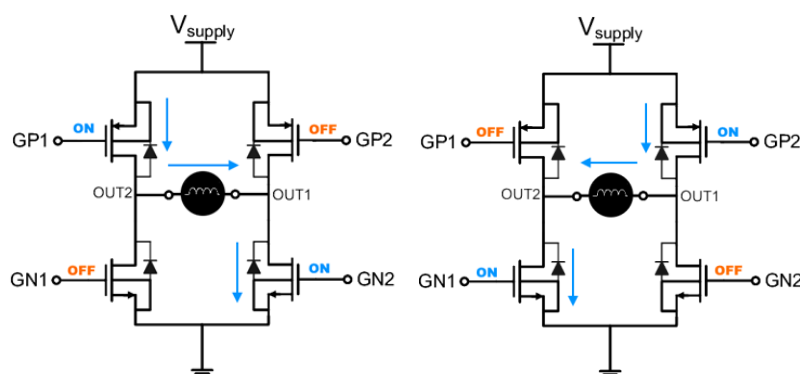


### 2. Applications

#### 2.1. Linear Actuator

This PCB was design to be used as a voice-coil-actuator. In the open-source example files you can find the 3d-model of a linear actuator and flip-dot. To control these actuators, you need to drive the coil with

an h-bridge, such as the [Flexar Driver](#). The image below shows an h-bridge circuit which can drive and control the current flowing through the windings.



The linear actuator can be driven with a maximum frequency of 30Hz. Driving it with a higher frequency can make it buzz or vibrate.

[Linear Actuator Example Files](#)  
[FlipDot Example Files](#)

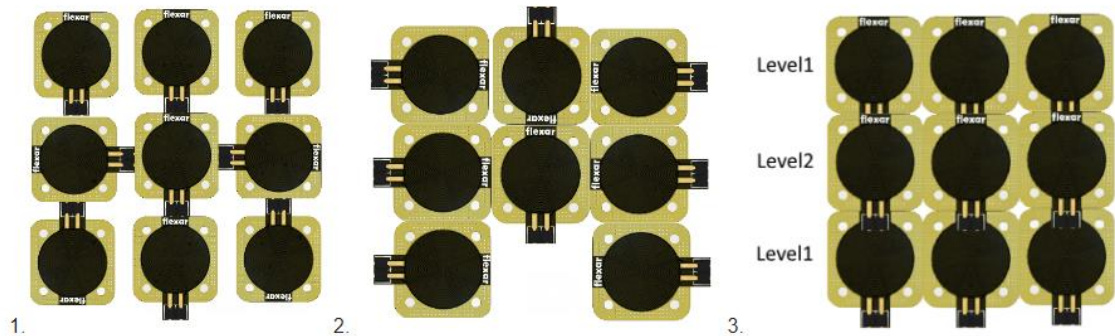


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## 2.2. Actuator Array

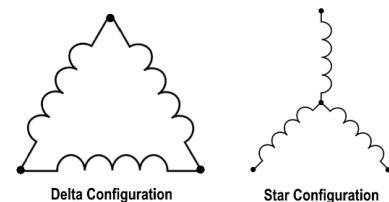
To use multiple actuators in an array side-by-side, one choose from the following options:

1. Leave a minimum gap of 4.3mm between each sample, to allow space for the connector. This small gap will be a 'weak-area' for the coil's magnetic field, but it might still manage to attract and repel some N52 neodymium magnets – depending on their size and weight.
2. Put the connector area on the outer side. This option will limit you to use a maximum of 8 actuators.
3. Another option is to have the actuators mounted on two different levels. The coils on the first-level will generate a weaker magnetic field but this can still be suitable for some applications.



## 2.3. Motor Prototyping

PCB coils can also be used for motor prototyping. Each coil can act as a single phase so connecting multiple in a star or a delta configuration can make a rotor spin. To drive this 3-phase motor, one needs to use a triple half-bridge driver (such as the STSPIN230) and use a six-step commutation waveform.



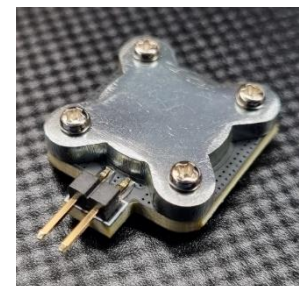
When connecting the coils, make sure to use the right-hand-grip rule to confirm current flows in right direction.

[Example Files](#)

## 2.4. Electromagnet

The magnetic field strength of the PCB coil can be further improved by adding a back-plate. It can be iron, steel or other materials with high permeability. With this change the magnetic field strength can go up to 20mT which is suitable for attracting lightweight metal or ferrofluid.

[Example Files](#)



## 2.5. Buzzer

Driving the coil with higher frequencies will make the magnet buzz! This works like every other buzzer/speaker – the magnet will push and pull the surrounding air to create sound waves. Adding a diaphragm with the magnet can improve the quality and audio level of the PCB buzzer.

[Example Files](#)



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## 2.6. LC Oscillator

By adding a capacitor in parallel with the coil you can create an LC oscillator. Driving this LC circuit with its resonant frequency, allows you to turn this PCB coil into a Metal-detector or a wireless transmitter/receiver

## 3. Specifications

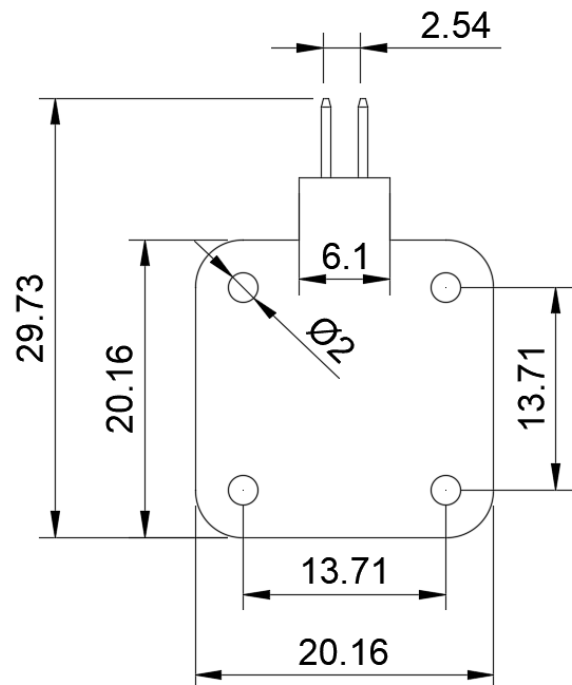
PCB Specifications	
Dimensions	24mm x 20mm
Connector Pitch	2.54mm
PCB Thickness	2mm
Weight	2.7 grams
Tg Rating	170°C
Layers	12
Soldermask	Black
Silkscreen	White
Copper Thickness	2oz

Coil Specifications	
Track (Thickness/Pitch)	8/8mil
Turns	200 turns
Resistance	9.4Ω ± 1
Inductance	180uH ± 2
Recommended Maximum Constant Power	1.5W
Absolute Maximum Constant Power	2.4W
Absolute Maximum Operating Constant Voltage	6V
Maximum Operating Temperature	140°C
Peak Magnetic Field Strength	12mT

Magnet Specifications	
Dimensions	5mm x 2.5mm
Shape	Disk
Grade	N52
Weight	0.36 grams
Coating	Nickel-Copper-Nickel
Pull	950 grams
Vertical Hold	190 grams
Maximum Temperature	80°C

### Other information:

- PCB is ROHS Compliance
- PCB meets IPC-A-600 II standard requirements
- Optional M20-8890245R soldered connector
- Optional 5mm x 2.5mm Disk shaped N52 magnet



Please note that, the exposed copper on the PCB is used for heat dissipation. This must not be grounded or connected to any other signal. If connected to a signal, one might see a drop in the coil's magnetic field strength.

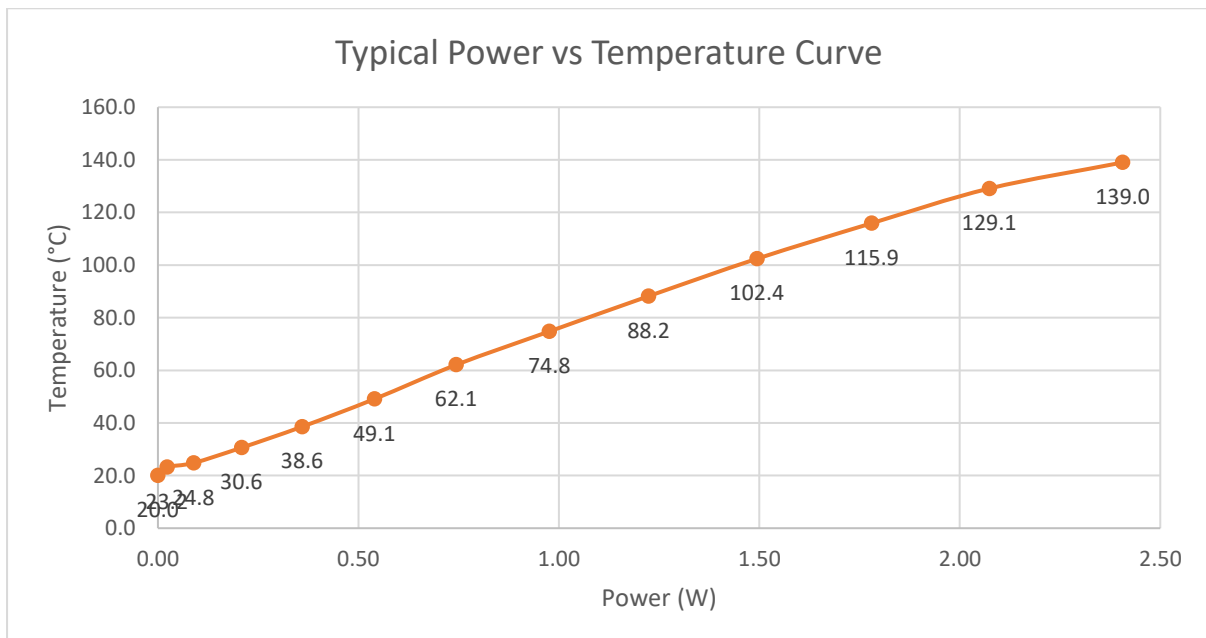
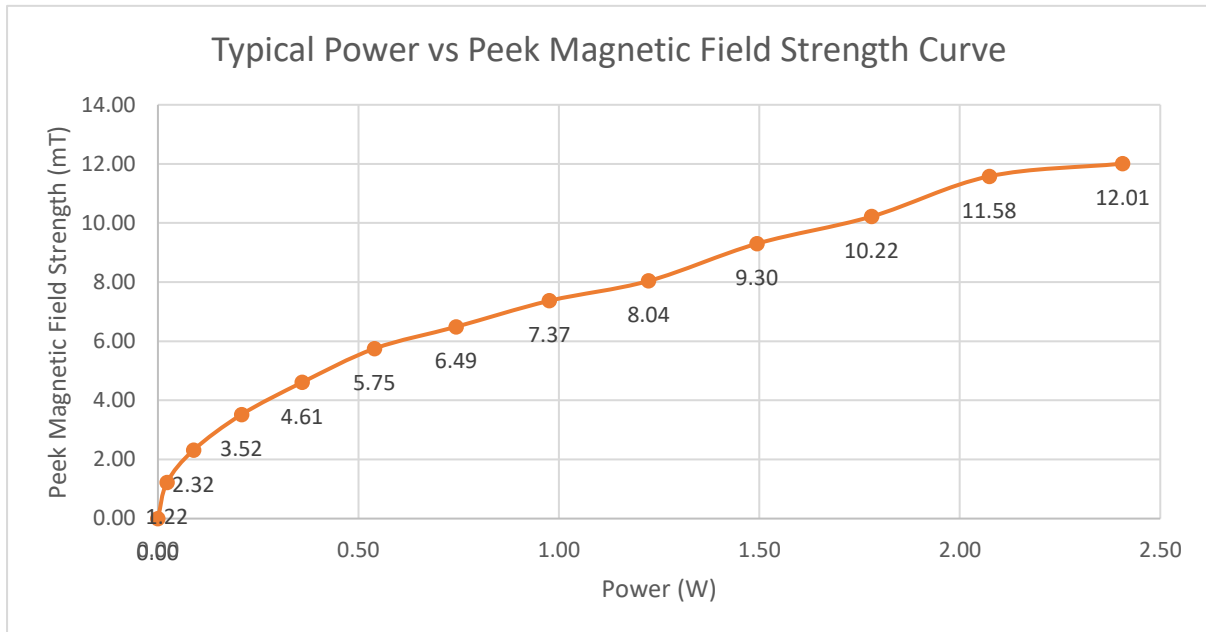


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### 3. Testing

During these tests:

- All temperature readings were taken from the hottest point of the board
- All tesla readings were taken from the center of the coil
- Measurements were taken at room temperature (20°C)
- Measurements were taken at 100% Duty Cycle (Constant Voltage)

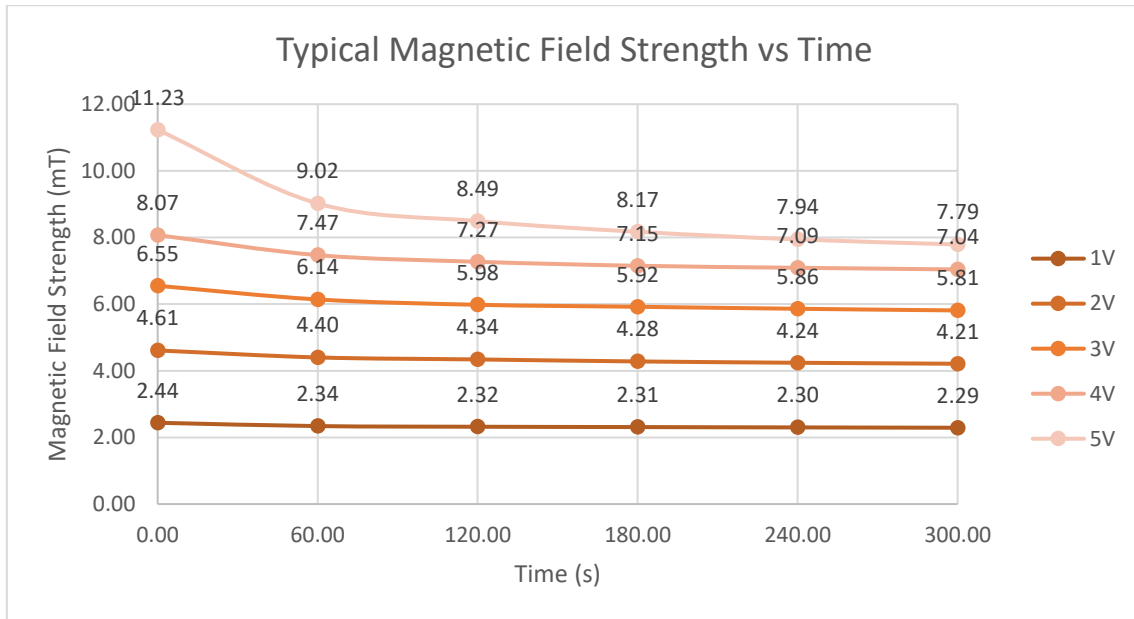


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Driving the coil with a constant voltage will increase its temperature. This will also increase the resistance and thus lower the current flowing through the coil. The below graphs show how the current and magnetic field strength changes over time. This effect can be resolved by controlling the coil with a constant current driver.



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