



**Arduino Uno:**

OUTPUT I/O Pin can Supply: 0V or 5V

**Maximum DC Current per I/O Pin: 40mA**

**Each Arduino Uno OUTPUT I/O Pins can only supply 0V or 5V to the connected device**

**Issue 1:** The devices that requires other than 0V/5V, will not work with the 0V/5V Arduino OUTPUT I/O Pins

**Each Arduino Uno OUTPUT I/O Pins can only handle 40mA**

**Issue 2:** The devices that requires more than 40mA, will not work with the 40mA limit at the OUTPUT I/O Pins

**We CANNOT connect devices that is not using 0V or 5V and devices that requires more than 40mA directly to any Arduino Uno OUTPUT I/O Pins**

**Is this “The End” for Arduino Uno with device which requires other than 0V or 5V and requires more than 40mA ?**

Not really, it is NOT the end yet

We can still control those devices from Arduino Uno by using “middle-man” hardware devices, one of them is a “Relay”

## - Arduino Uno / Mini DC Motor Example -

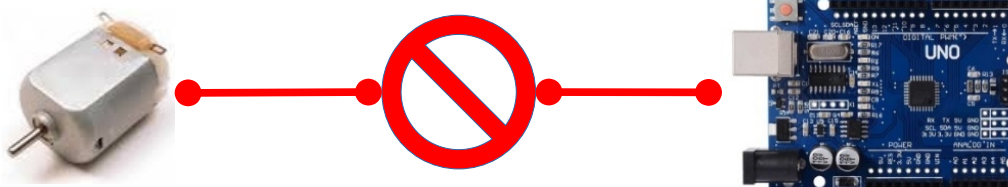
### Arduino Uno:

OUTPUT I/O Pin can Supply: 0V or 5V  
Maximum DC Current per I/O Pin: **40mA**



### Mini DC motor (type 130):

Operating Voltage: 3V to 6V  
No-Load Current: **70mA**  
Loaded Current: **250mA**

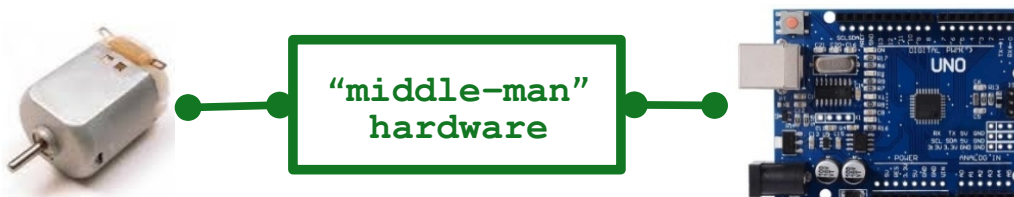


5V from Arduino Uno OUTPUT I/O Pin is fine for the DC-Motor  
**BUT**

**40mA Current Limit at the Arduino Uno OUTPUT I/O Pin is NOT enough for the DC-Motor ( 70mA to 250mA )**

Motor is required for "motion"  
No motion, No Robotics

What do we do now ?



The "middle-man" hardware device have distinct physical parts in them.

**Arduino Part:** Uses 0V or 5V and less than 40mA. The connectors on this part is connected to the Arduino Uno OUTPUT I/O Pins

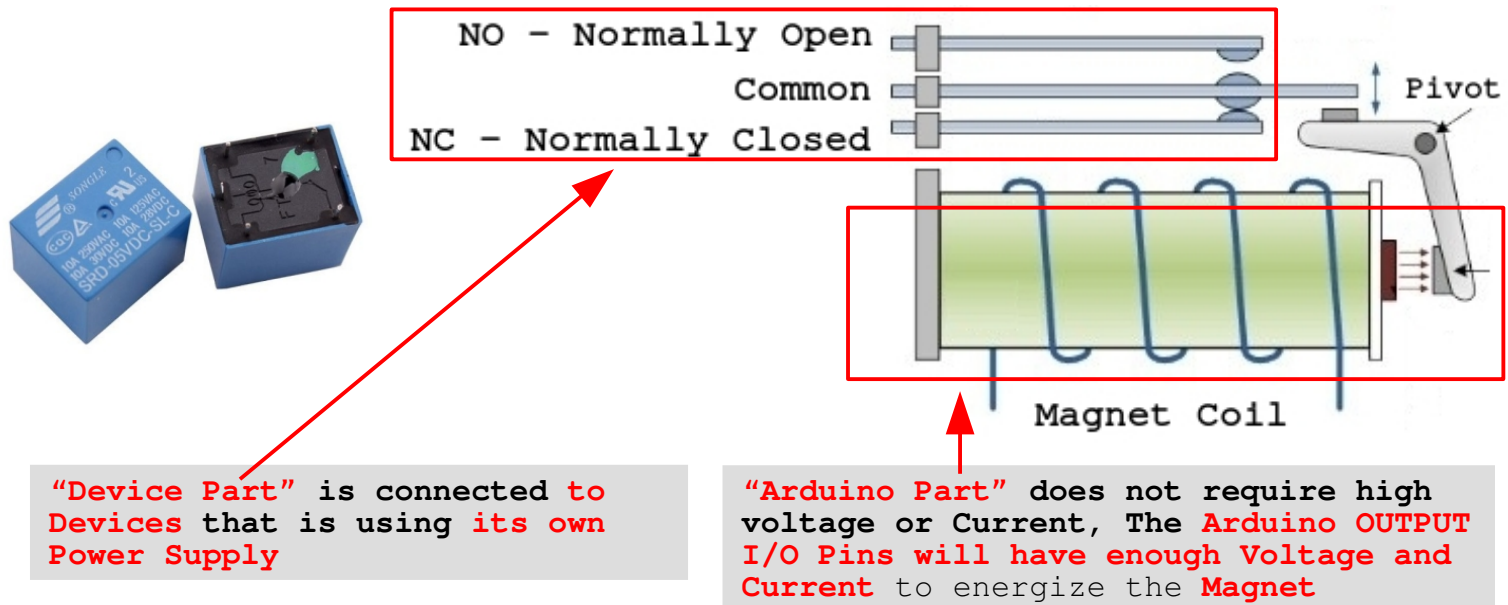
**Device Part:** A separate Power Supply that can supply more than 5V or more than 40mA will be connected here, together with the device that requires other than 0V, 5V and more than 40mA Current

Example of a "middle-man" hardware: A Relay  
The relay on the right, can handle up to 30V DC And 250V AC and 10000mA Current. Apart from Relays, there are many other "middle-man" hardware devices we can use, depending on what we want to do.

For DC-Motor, ideally, we should use a "Motor-controller" device. If you dont have one, Then we can still use relays or transistors



## Raw Relay Device



## On the "Device Part",

When there **IS NO POWER** supply to the Coil, magnet is disabled.

**"Common"** and **"NC"** is **connected** while **"Common"** and **"NO"** is **disconnected**

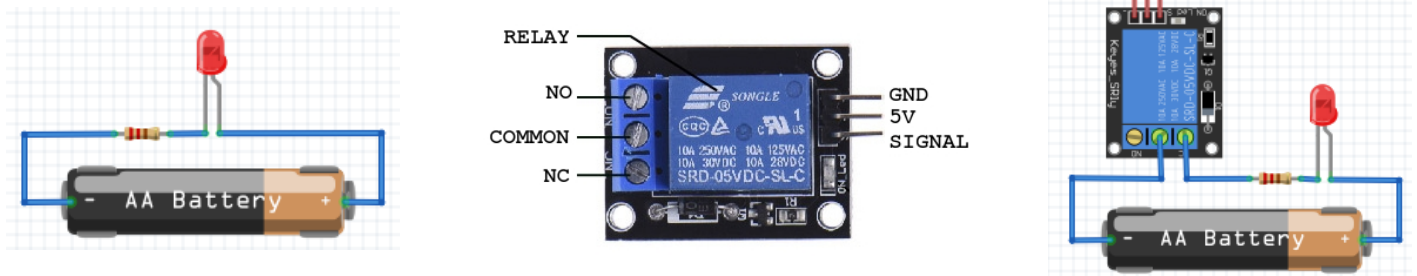
When there **IS POWER** supply to the Coil, magnet is enabled.

**"Common"** and **"NO"** is **connected** while **"Common"** and **"NC"** is **disconnected**

## Relay Modules

As you can see from the Raw Relay above, there is only a coil for the non-permanent magnet. To turn the relay magnet ON/OFF from our Arduino OUTPUT I/O Pins with our PROGRAM will require a few additional components. At minimum; an additional diode, resistor and a transistor (we can make our own)

That is what the Relay Modules in the picture below has,



**On the Left, LED is connected to the Battery Without Relay**

Power Supply -ve Terminal connect to Device -ve Terminal

Device +ve Terminal connect to Power Supply -ve Terminal

**On the right, LED is connected to the Battery With Relay**

Power Supply -ve Terminal connect to "COM"

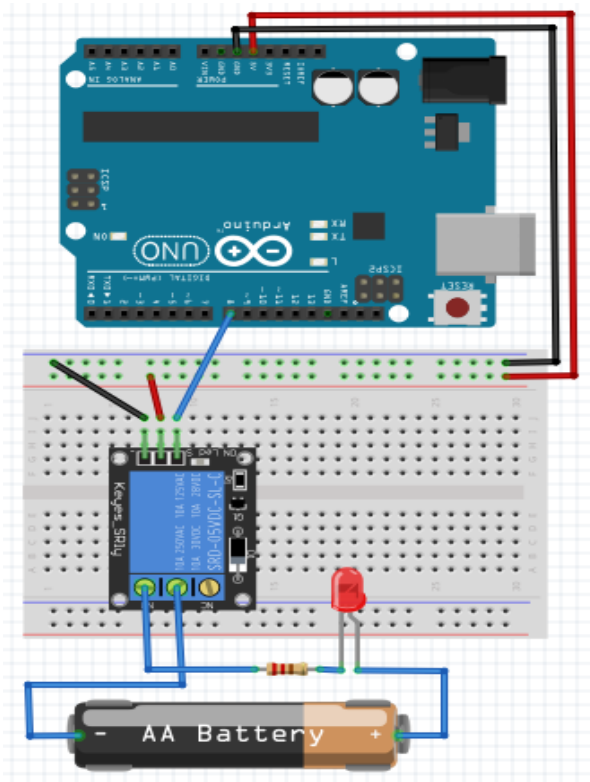
"NC" connect to Device -ve Terminal

Device +ve Terminal connect to Power Supply -ve Terminal

There is NO Arduino Uno yet in the picture above. The Relay can work without the Arduino Uno, it is just a SPDT Switch controlled by electro-magnet

## ATMEGA328/Arduino Uno - I/O Pin - OUTPUT - RELAY - LED

<https://github.com/teaksoon/lmaewapm>



1x Computer with Arduino IDE Software  
1x USB 2.0 Type A/B Data Cable  
1x Arduino Uno Board  
Jumper Wires

1x Solderless Breadboard  
1x 5mm bulb LED  
1x 220 Ohm resistor

1x Relay Module

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### Device Part:

Power Supply(-ve) to Relay "COM"  
Relay "NO" to Resistor to LED(-ve)  
LED(+ve) to Power Supply(+ve)

### Arduino Part:

Arduino Uno GND to Relay GND(-ve)  
Arduino Uno 5V to Relay VCC(+ve)  
Arduino Uno Pin 8 to Relay IN/SIG

Program: io\_output\_relay\_led

```
uint8_t proc_ctr = 0;

void setup() {
  pinMode(8, OUTPUT);
  // OUTPUT I/O Pin default value = LOW
}

void loop() {
  if (proc_ctr < 5) {
    proc_ctr = proc_ctr+1;
    digitalWrite(8,HIGH);
    delay(1000);
    digitalWrite(8,LOW);
    delay(2500);
  }
}
```

This Program set I/O Pin 8 as OUTPUT Pin. Since the default Voltage for an OUTPUT Pin is 0V, 0V goes to the Relay Module "IN" Pin

When **Relay Module "IN" Pin received 0V(digitalWrite(8,LOW))**, the MAGNET is not energized(NO MAGNET), the Relay "NO" Pin is not physically connected to the "COMMON" Pin. LED will not have any power supply from the Battery, LED is OFF

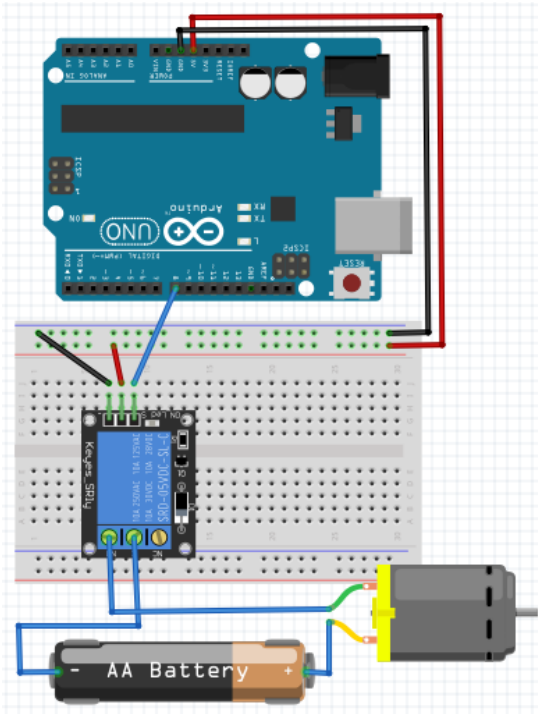
When **Relay Module "IN" Pin received 5V(digitalWrite(8,HIGH))**. The MAGNET is energized (MAGNET), causing the Relay "NO" Pin connected to the "COMMON" Pin. LED will get power supply from the Battery, LED is ON

From Program Codes, we can see that we will get the LED to display for 1 seconds, then turned off for 2.5 seconds, and will repeated for 5 times

For a single LED, there is no need for a RELAY, the Arduino OUTPUT I/O Pin can handle it without any issues. However, if this is a high-power LED or a DC-Motor, we will need this RELAY or some other "middle-man" device

## ATMEGA328/Arduino Uno - I/O Pin - OUTPUT - RELAY - DC-MOTOR

<https://github.com/teaksoon/lmaewapm>



1x Computer with Arduino IDE Software  
1x USB 2.0 Type A/B Data Cable  
1x Arduino Uno Board  
Jumper Wires

1x Solderless Breadboard  
1x DC-Motor

1x Relay Module

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### Device Part:

Power Supply(-ve) to Relay "COM"  
Relay "NO" to DC-Motor(-ve)  
DC-Motor(+ve) to Power Supply(+ve)

### Arduino Part:

Arduino Uno GND Pin to Relay GND(-ve)  
Arduino Uno 5V Pin to Relay VCC(+ve)  
Arduino Pin 8 Relay Module IN/SIG

Program: io\_output\_relay\_dc-motor

```
uint8_t proc_ctr = 0;

void setup() {
  pinMode(8, OUTPUT);
  // OUTPUT I/O Pin default value = LOW
}

void loop() {
  if (proc_ctr < 5) {
    proc_ctr = proc_ctr+1;
    digitalWrite(8,HIGH);
    delay(1000);
    digitalWrite(8,LOW);
    delay(2500);
  }
}
```

This Program set I/O Pin 8 as OUTPUT Pin. Since the default Voltage for an OUTPUT Pin is 0V, 0V goes to the Relay Module "IN" Pin

When **Relay Module "IN" Pin received 0V(digitalWrite(8,LOW))**, the MAGNET is not energized(NO MAGNET), the Relay "NO" Pin is not physically connected to the "COMMON" Pin. DC-Motor will not have any power supply from the Battery, DC-Motor will not Spin

When Relay Module "IN" Pin received 5V(digitalWrite(8,HIGH)). The MAGNET is energized (MAGNET), causing the Relay "NO" Pin connected to the "COMMON" Pin. DC-Motor will get power supply from the Battery, DC-Motor will Spin

From Program Codes, we can see that we will get the DC-Motor to spin for 1 seconds, then turned off for 2.5 seconds, and will repeated for 5 times

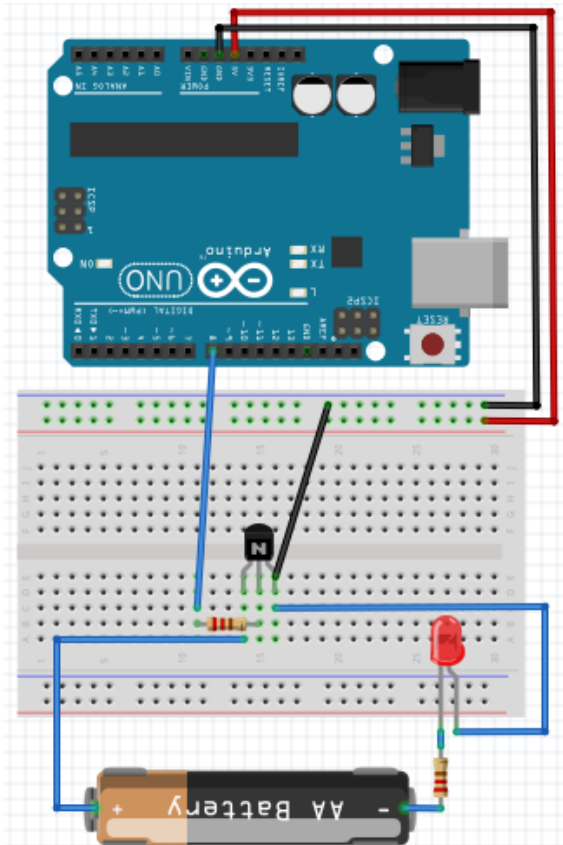
You will probably noticed that, this is exactly the same as the previous LED-Relay-Arduino Uno example. In both cases, they are drawing Power from the Battery and not from the Arduino OUTPUT I/O Pin. This is what exactly the DC-Motor needs since it cant take power from the Arduino OUTOUT I/O Pins.

For DC-Motor we should consider using a "Motor-Controller" instead of a Relay



## ATMEGA328/Arduino Uno - I/O Pin - OUTPUT - NPN TRANSISTOR - LED

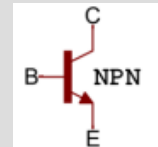
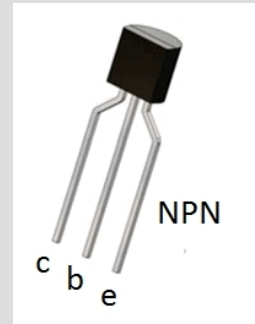
<https://github.com/teaksoon/lmaewapm>



1x Computer with Arduino IDE Software  
1x USB 2.0 Type A/B Data Cable  
1x Arduino Uno Board  
Jumper Wires

1x Solderless Breadboard  
1x 5mm bulb LED  
1x 220 Ohm resistor

1x NPN Transistor  
1x 220 Ohm resistor



Always check the NPN  
Transistor Current Specs  
Before using it to  
replace the Relay

External Power Supply(+ve) to NPN(c)  
NPN(b) to Resistor to Arduino Pin 8  
NPN(e) to Arduino GND  
NPN(e) to LED(+ve)  
LED(-ve) to Resistor to External Power  
Supply(-ve)

Program: io\_output\_npn\_led

```
uint8_t proc_ctr = 0;

void setup() {
  pinMode(8, OUTPUT);
  // OUTPUT I/O Pin default value = LOW
}

void loop() {
  if (proc_ctr < 5) {
    proc_ctr = proc_ctr+1;
    digitalWrite(8,HIGH);
    delay(1000);
    digitalWrite(8,LOW);
    delay(2500);
  }
}
```

This Program set I/O Pin 8 as OUTPUT Pin. Since the default Voltage for an OUTPUT Pin is 0V, 0V goes to the NPN(b)

When NPN(b) is 0V( digitalWrite(8,LOW) ). A path is cut-off for Electricity to flow to LED from Battery. LED have no power supply from the Battery and the LED is turned OFF

When NPN(b) is 5V( digitalWrite(8,HIGH) ). A path for Electricity to flow to LED from Battery. LED will get power supply from the Battery and the LED is turned ON

From that, we will get the LED to display for 1 seconds, then turned off for 2.5 seconds, and will repeated for 5 times

This NPN Transistor "Switch" works exactly like our RELAY, difference is that NPN Transistor "Switch" have no moving parts and is triggered by VOLTAGE, while RELAY has mechanical parts and is triggered by electro-magnet