Project 1 – Blinking LEDs

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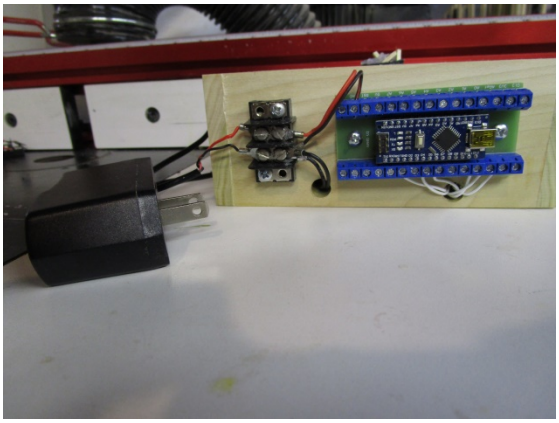
In this project we are going to build upon what we learned in Chapters 4, 5 and 6. We are going to add a blinking LED to a tow truck, two blinking LEDs to a police car, and using Pulse Width Modulation, add 6 LEDs to create a dumpster fire.

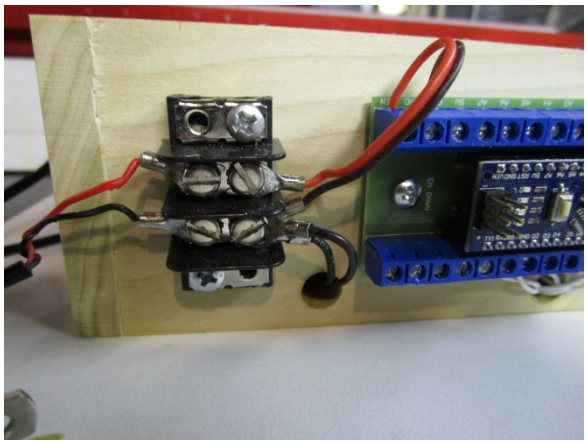
The tow truck I am using is Walthers Scene Master, part number 949-11531, which retails for $13. I like this truck because there is a screw under the cab, which if removed gives me direct access to the interior for drilling a hole for the LED. I am using a 3mm yellow LED for this application.

I started by cutting off a bit of the cathode (the short lead), retaining about 1/2”, and then soldered a 8” long piece of black 24 gauge wire to the cathode. Likewise I clipped the anode (long wire) to 1/2" and soldered a similarly sized yellow wire to it. Heat Shrink wrap would be too visible and inflexible in this application, so I covered the joints with Liquid Electrical Tape (AMAZON ASIN: B0000AXNOD) and let it dry overnight. I drilled a pilot hole from the exterior using a #55 drill bit, then the final hole using a #29 bit and passed the wires through the roof. From the inside, I used a drop of Cyanoacrylate (CA) to glue the LED in place.

I thought there would be enough space behind the driver’s seat and steps to run the wires but “no such luck”, so I drilled a small hole between the seats and passed the wired through. I attached the cab to the frame with the screw. But before I ran the wires through my layout, I spliced a 220Ω resistor into the black wire and soldered a spade connector in the end of the black wire. I stripped off about 1/4" of the yellow wire and tinned its end. I then ran the wires through my layout board, and the mechanical installation of the truck was complete.

Now for the hardware; let's start by attaching a 2 position barrier strip to the fascia board. For power, I used a 12VDC "wall wart" and immediately off the connector at the end of the wire (this project uses just a small amount of power, so if you have a wall wart hanging around that provides at least 9V and 200ma, use it; no need to buy a bigger one just for this project). I soldered spade connectors to the positive and ground wires of the wall wart, and connected the 5V and Ground wires to positions 1 and 2 of the barrier strip, respectively. I mounted an Arduino Nano Expansion board (described in Chapter 7) next to the barrier strip. Next, I took a red jumper wire with a male pin on one end, and snipped off the other end; I did the same thing to a black jumper wire. I then soldered a spade connector to the ends I just cut off. Then, I took the red wire and attached its spade connector to the positive voltage of the barrier strip and its pin to the VIN socket on the expansion board. Similarly, I connected the black wire to the barrier strip's Ground position and the GND socket on the expansion board. Our Arduino expansion board now has power. Yes, if this was the only animation I would run from this Arduino, I could have wired the ends of the Wall Wart directly into the VIN and GND points of the expansion board and eliminated the barrier strip, but I have other plans and need space to attach more ground wires. I ALWAYS use a barrier strip when connecting a power supply to an expansion board.





I took the spade connector from the black wire of the LED and connected it to the ground of the barrier strip. I took the tinned end of the yellow LED wire and inserted it into pin D2 of the expansion board (if it doesn't want to go into the socket, take the point of some decal scissors, insert it into the socket and lift up the flap at the bottom of the tightening screw; a small piece of 3/32" brass rod will work as well).

I inserted an Arduino Nano in the expansion board, making sure that the pin labels on the Nano match the labels on the expansion board, and I was ready to download code.

I have written a simple Arduino sketch to blink the yellow LED at 1.6 second intervals, and it you can find it on my “Amazing Arduino Animations” web site at https://daackm.github.io, under the “Tow Truck” heading for “Project 1”. Highlight the code and use a “Control/C” to copy the code to the Windows clipboard. Now open the Arduino IDE, click on “File” then “New”, highlight the default code and delete it with the delete key on the keyboard, then use a “Control/V” to paste my code into the sketch; save the sketch to a location of your choice, then download and execute the code. The LED should have a nice, regular beat.

While it is not necessary to understand the sketch to run it, it’s worth a paragraph to describe what is going on. Like any Arduino sketch, it is composed of a “setup” function and a “loop” function. In the setup, the “pinMode” statement tells the Arduino that pin number 2 will be used for output purposes (we want to use the pin to drive an LED). The sketch would run without the pinMode statement, but the LED would be much dimmer. In the loop function, we turn pin number 2 on by setting its value to “HIGH”, we wait 800 miliseconds (or 8/10 of a second), then turn pin number 2 off and wait another 8/10 of a second, then repeat the process ad infinitum. Pretty simple. Just remember, if you want to modify the sketch, Arduino code is case sensitive, and most executable statements (other than “voids” and curly braces) end in a semi colon.

```
Tow_Truck
void setup()
 {
  pinMode(2,OUTPUT);
 }

void loop() {
digitalWrite(2,HIGH);
delay(800);
digitalWrite(2,LOW);
delay(800);
}
```

The second part of this project is a police car with red and blue “bubble gum” lights on its roof (prototypical or not, I wanted two lights). The car I am using is 1955 Buick Century, California Highway Patrol from Oxford Diecast Models, Walthers part number 553-87BC55003 , which retails for $10. Like the Tow Truck, I can unscrew the underframe and remove it and the interior seating, leaving just the roof to drill through when mounting the two LEDs.

And speaking of LED, the ones I used are 3mm LEDs, and eventually I will use a single 220Ω resistor on a common cathode; no need to run a 4th wire when 3 will do. 3mm in HO comes out to a bit over 10” scale inches, which seemed better to me than anything smaller or larger.

I started by clipping off the cathode (the short wire) on each LED to about a 1/2", and then bent back about 1/8” into a hook. I interlocked the hooks and compressed them tightly to make a fairly strong mechanical joint. I took an 8” black 24 gauge wire and stripped one end about half an inch, wrapped it around the common cathode and soldered the joint.

I did not have any blue 24 gauge wire, so I took red and green wires and soldered them to the red and blue anodes (the long wires) respectively. Again, I insulated the leads with Liquid Electrical Tape. I painted about 2” of the wires near the LEDs a black color, to match the car interior.

Time for some drilling. I took a piece of masking tape and ran it from side of the car to the other. Taking a square, I marked the tape so that I got a good line, perpendicular to the main axis of the car, and over the back of the front seat. I marked the center of the line, and then marked each side about 4 mm from the center, which would be where I would drill for the LEDs (if I had this to do over, I might make them 3mm from center). As with the Tow Truck, I drilled #55 pilot holes, and #29 for the final holes. I attached the LEDs from the inside with CA glue. I drilled a hole behind the front seat and through the underframe and passed the wires through, then reattached the underframe to the body. I took the black wire coming from the LEDs and spliced in a 220Ω resistor, then covered the joint with heat-shrink wrap. I soldered a spade connector to the end of the ground wire. I drilled a placement hole through the layout and passed the wires through.

I did make a rookie mistake with my drilling, which caused the LEDs to be offset. When using a thin drill bit, like a #55, they tend to deflect from their desired location, especially if more than a 1/4" of the bit extends from the chuck. I use a drill press to drill these holes, and if too much pressure is used, especially in the beginning, the bit will also deflect. I did both, and my LED pilot holes did not line up as I intended. So, when drilling through metal with thin bits, don’t expose more than a 1/4” more of the bit than needed, and start drilling the pilot bit slowly. Some cutting oil might not hurt either.

I connected the space connector from the black wire of the LEDs to the ground position of the barrier strip. Finally, I tinned the ends of the red and green (blue) wires and inserted them into positions D7 and D8 of the expansion board (it doesn’t matter which goes where).

I have also written a simple Arduino sketch to blink the red and blue LEDs at 0.2 second intervals, and it you can find it on my “Amazing Arduino Animations” web site at https://daackm.github.io, under the “Police Car” heading for “Project 1”. As before, highlight the code and use a “Control/C” to copy the code to the Windows clipboard. Now open the Arduino IDE, click on “File” then “New”, highlight the default code and delete it with the delete key on the keyboard, then use a “Control/V” to paste my code into the sketch; save it to a location of your choice, then download and execute the code.

Again, let's analyze the code; it's not necessary, but worth the time. Like before, the "setup" function declares that digital pins 7 and 8 will be used for OUTPUT. In the "loop" function we turn pin number 7 on and pin number 8 off, which results in one of the red or blue lights illuminating and the other going dark. We then wait 200 milliseconds and then turn the first light off and the second one on, then wait another 200 milliseconds and repeat the process forever. RED-BLUE-RED-BLUE forever. Again, pretty simple.

Police_Car

```
void setup()
 {
  pinMode(7,OUTPUT);
  pinMode(8,OUTPUT);
 }

void loop() {
   digitalWrite(7,HIGH);
   digitalWrite(8,LOW);
   delay(200);
   digitalWrite(7,LOW);
   digitalWrite(8,HIGH);
   delay(200);
}
```

SURPRISE! I also wrote a sketch that will blink both the Tow Truck and the Police Car at the same time. Make sure the Tow Truck is wired into pin 2 and the Police Car into pins 7 and 8. Then download the sketch and see if you like it. We won't analyze this sketch.

Our last basic application of LEDs is to create a dumpster fire. I hope you remember from Chapter 6 that certain digital pins of an Arduino (pins 3, 5, 6, 9, 10, and 11) are capable of Pulse Width Modulation, which is the ability to turn themselves on and off in "pulses" between 490 (pins 3, 9, 10, 11) and 980 (pins 5 and 6) times a second, which lets us make them appear brighter or dimmer programmatically, giving the whole mass a random, vibrating effect. Through judicious use of random numbers in the sketch, we can use LEDs on PWM pins to get some nice "fire" effects.

I decided to use 4 yellow and 2 red LEDs to make the fire. Initially I tried to make an orange LED by dunking a clear one in Tamiya "clear orange" paint, but when I fired up the LED the brightness of the LED overpowered the paint and it still looked white. I need to work this out some time in the future. Tamiya has other clear colors I'd like to try, or maybe the non-clear colors might work better. If you find a better way, let me know.

On each short lead of the LEDs (the cathode) I soldered an 8" length of black 24 gauge wire; this will eventually be connected to a ground point on the Arduino. Into each wire I spliced in a 150 Ω resistor and covered the joint with heat-shrink tubing. I also soldered white or red wires to the long LED leads, the anodes. Again, I insulated the wires next to the actual light with liquid electrical tape.

I had an old HO metal dumpster, and I drilled a 3/8” hole in the center, plus and several 1/8” holes around the center hole. I passed the ground wires through the center hole and the powered wires through the smaller holes, which helped hold them in place. I also used some small nylon ties on the underside of the dumpster, again to hold the bunch in place.

Trying to connect all six cathode wires to a single position of a barrier strip would be problematic, so I took three of them, bundled them together, and then soldered a 4” “pigtail” wire to the bundle, and covered the entire joint with heat-shrink. I did the same thing with the other 3 cathode wires. I soldered spade connectors to the other end of the pigtail wires and attached the connectors to the ground position of the barrier strip. I did occur to me that instead I might have eliminated the 150Ω, 1/4 watt resistors from the individual ground wired, and then bundled ALL of them together with a 6” pigtail, and then placed a 150Ω, 2 watt resistor within the pigtail; I might try that next time, but I would need to buy some larger heat-shrink tubing!

Assuming that we are still using the same Arduino and expansion board as we used for the Tow Truck and Police car, we will not need to wire in another “wall wart”; if not, then again use a barrier strip and wire the power supply in to positions 1 and 2, and from the barrier strip to the “VIN” and “GND” pins of the Nano’s expansion board.

I tinned the ends of the six anode leads and inserted them into pin positions 3, 5, 6, 9, 10 and 11 of the expansion board and inserted an Arduino Nano.

The LEDs were still not mechanically stable enough inside the dumpster, so I applied a layer of clear silicone caulk over and around them. The caulk also served as a diffuser for the LEDs. I added a few pieces of thin balsa strips into the dumpster.

As before, I have placed the code in the “Amazing Arduino Animations” web site, under the “Dumpster Fire” heading. Give it a try.

The code for the dumpster fire is a bit different than the beacons on the vehicles, because it uses “Pulse Width Modulation” (aka: “PWM”) to turn the LEDs on to less than full power. Also, each LED is turned on to a different power level than the others, based on a random number. And finally, we change the power levels each 1/10th of a second. In the “setup” function we declare these six pins for OUTPUT (remember, only these particular pin numbers of an Arduino Nano are capable of Pulse Width Modulation). Then in the “loop” function we give each pin a power level somewhere between 50 and 255 (I like to keep some base level of illumination on each pin, and the give some additional random number between 0 and 205). We wait a 10th of a second and re-assign the values all over again, to achieve a nice flicker effect). If you want a brighter effect, just change the base value and the random range, so that the total possible value does not exceed the maximum allowed of 255.

Dumpster

```
void setup()
 {
  pinMode(3,OUTPUT);
  pinMode(5,OUTPUT);
  pinMode(6,OUTPUT);
  pinMode(9,OUTPUT);
  pinMode(10,OUTPUT);
  pinMode(11,OUTPUT);
 }

void loop()
 {
  analogWrite(3, 50+random(205));
  analogWrite(5, 50+random(205));
  analogWrite(6, 50+random(205));
  analogWrite(9, 50+random(205));
  analogWrite(10, 50+random(205));
  analogWrite(11, 50+random(205));
  delay(100);
 }
```

I suppose that since we now know how to make a small fire, we could combine all three applications in this project and have the police attending to a car fire accident, while the second car is being towed away. Maybe add a fire truck with a beacon, or emergency flares. How about a camp fire, fire pit or fireplace? Maybe you want to burn down an out-house, attend to a forest fire or put an observation point over an active volcano. We could even add a smoke generator. The possibilities are endless.

I would like to acknowledge Ron Marsh whose YouTube channel “Ron’s Trains and Things” gave me the foundation for the dumpster fire. His video “Arduino Model Railroad Projects – Campfire” (https://www.youtube.com/watch?v=wBn7pHEldWI) is a really good video for anyone creating their first Arduino project; the campfire part begins around 14:45.