Build a
Basic Stamp Lightning Activity Monitor

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Prototype Construction by Andrew Bitson

When I moved to Tucson in the summer of '94, one of the first thing that left an impression was the summer thunderstorms or "monsoons". Having grown up in California, where lightning wasn't very common, I was in awe at the volume of electrical activity. Being an engineer at heart, I quickly began searching for ways to measure the lightning activity.

This article describes a simple and inexpensive way I've come up with to measure lightning activity. It uses a Basic Stamp 2 to display the number of lightning strikes per minute on a row of 8 LEDs. Depending on the mounting configuration, the lightning sensor is capable of detecting lightning strikes greater than 50 miles away.

There are 2 modules to the Basic Stamp Lightning Activity Monitor: the lightning sensor unit (LSU) and the Basic Stamp Display. Construction for both modules are provided along with the necessary Basic Stamp code to display the lightning activity.

The Lightning Sensor Unit

The lightning sensor unit performs the lightning detection. Referring to the schematic, energy from a lightning strike is received by the antenna and passes through the hi-gain Darlington transistor pair consisting of Q1, Q2, R2, and R3 allowing current to flow through Q2 during each lightning strike. The 9-volt battery provides the necessary drive through LSU Q2 to power the LED side of an opto-coupler on the Basic Stamp Display board, while resistor R1 limits the current through the LED. Because current only flows during a lightning detection, the battery should last well over 2 years. Resistor R4 limits the input current received by the antenna. Diode D2 provides protection in case the battery is inadvertently connected backwards.

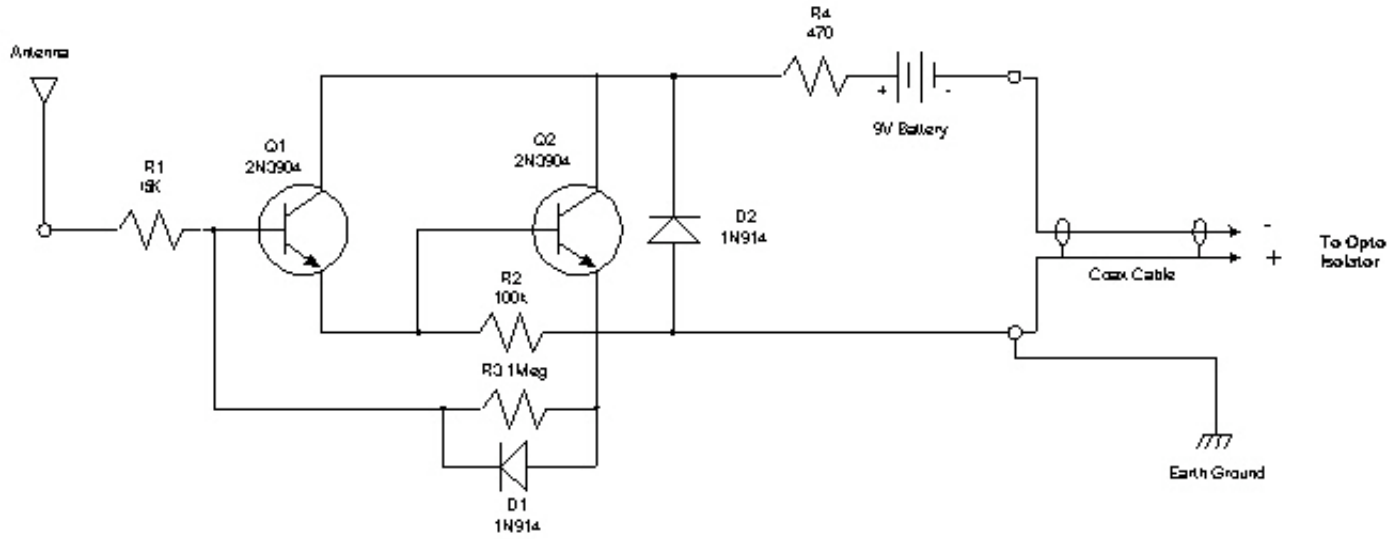


Figure 1 - Lightning Sensor Unit Schematic (Expanded)

The circuit can be assembled on a small piece of perf board. A suggested layout using point-to-point wiring is shown in figure 2, and the parts list is provided in table 1. The output is connected to the Basic Stamp Display board via a suitable length of coax cable. I had some RG133 laying around but you can use almost any good quality coax cable, such as RG-6 or RG-58. The shield is tied to the circuit return (or minus side).

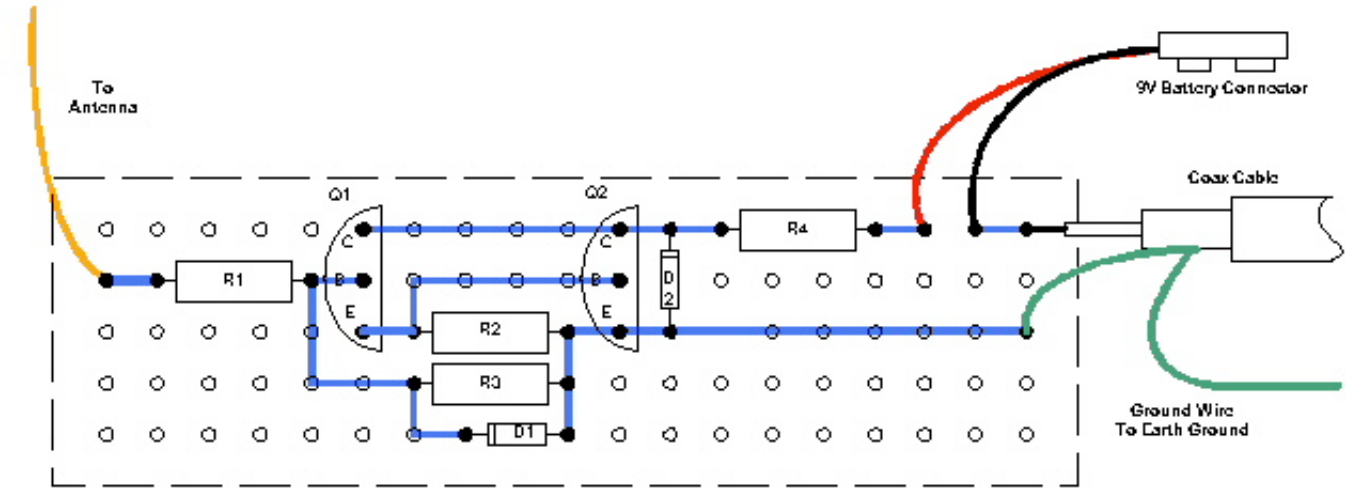


Figure 2 - LSU Circuit Board Layout (Expanded)

Qty	Part	Description	Available From	Part Number
1	R1	15K ohm 1/4w Resistor	Radio Shack	271-1337
1	R2	100K ohm 1/4w Resistor	Radio Shack	271-1347
1	R3	1Meg ohm 1/4w Resistor	Radio Shack	271-1356
1	R4	470 ohm 1/4w Resistor	Radio Shack	271-1317
1	Q1,Q2	2N3904 Transistor	Radio Shack	276-2016
2	D1, D2	1N914 Diode	Radio Shack	276-1122

1	-	9V Battery Connector	Radio Shack	270-324
1	-	Perf Board	Radio Shack	276-1395
1	-	Red LED (for test)	Radio Shack	276-307
TBD	-	RG58 Coax	Radio Shack	278-1314

Table 1 - LSU Circuit Board Parts List

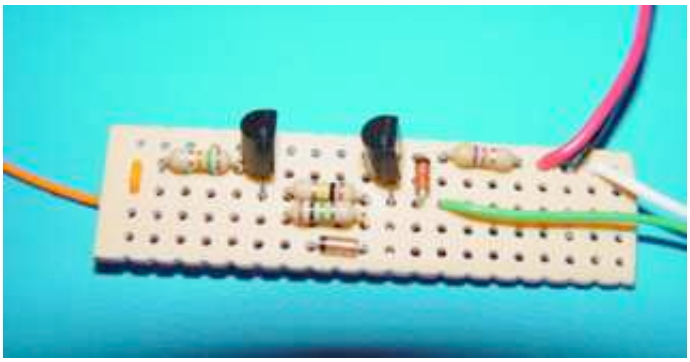


Figure 3 - Completed LSU Circuit Board (Expanded)

The antenna is constructed of a 12" length of 3/4" copper pipe. Solder a 6 to 10" wire to the inside of the pipe using a large wattage soldering iron or small torch.

The LSU is installed in PVC pipe to weather proof the unit. The antenna is housed in a 12" length of 3/4" schedule 20 pipe. Use a small amount of RTV to glue the antenna inside the PVC pipe. During assembly, splice the wire from the antenna to the antenna wire on the LSU. The battery and circuit board sit loosely inside the 1 x 3/4 x 1 inch tee. You can secure the battery board with some foam if desired. The coax and ground wire are routed through a hole drilled in the bottom of the 1" cap installed on the bottom of the tee. Don't use PVC glue on the bottom cap so that the battery can be changed if necessary. An exploded view of the LSU housing is shown in figure 4. Figure 5 shows the layout of how the components fit inside the PVC pipe.

Since the energy received at the antenna is relative to earth, it is imperative to connect the coax shield (and LSU return) to a good earth ground. For safety reasons, this should be done close to where the LSU is mounted. A metal water pipe or a ground rod near the installation will work fine. A coax type lightning protector/grounding block (Radio Shack #15-909) is also advised.

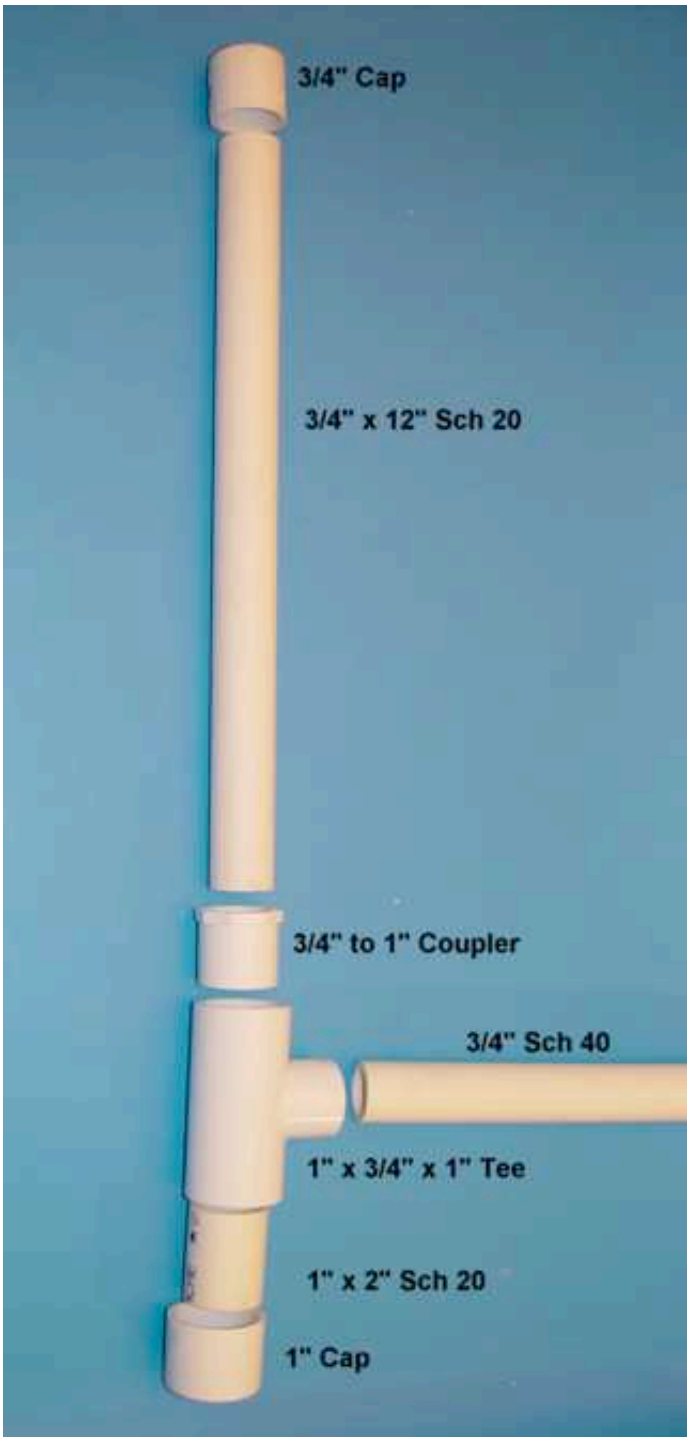


Figure 4 - LSU Housing Exploded View (Expanded)

Figure 5 - LSU Assembly (Expanded)

To test the LSU module, connect a red LED across the unconnected end of the coax. Be sure to get the polarity correct: the anode (+) connects to the shield and the cathode (-) connects to the center conductor. Install a fresh 9V Alkaline battery. An inexpensive long-reach electric butane light makes a great "lightning simulator". Hold the "lightning simulator" within a couple of inches from the LSU antenna and pull the trigger. The LED should flash when the lighter sparks. If not, retrace the circuit making sure the LED is connected correctly and the battery is good.

Figure 6 - Inexpensive "Lightning Simulator"

The pole mount is fabricated using a 1 x 3/4 x 1 inch tee that has been cut in half lengthwise. Use wire ties or hose clamps to secure the LSU to the mast as shown in Figure 7.

Figure 7 - LSU Mount (Expanded)

The Basic Stamp Board

The Basic Stamp Display board is built using a BS2 and a BS2 carrier board. The schematic for the board is shown in figure 8. I chose to wire-wrap the connections, but point-to-point wiring would work equally well.

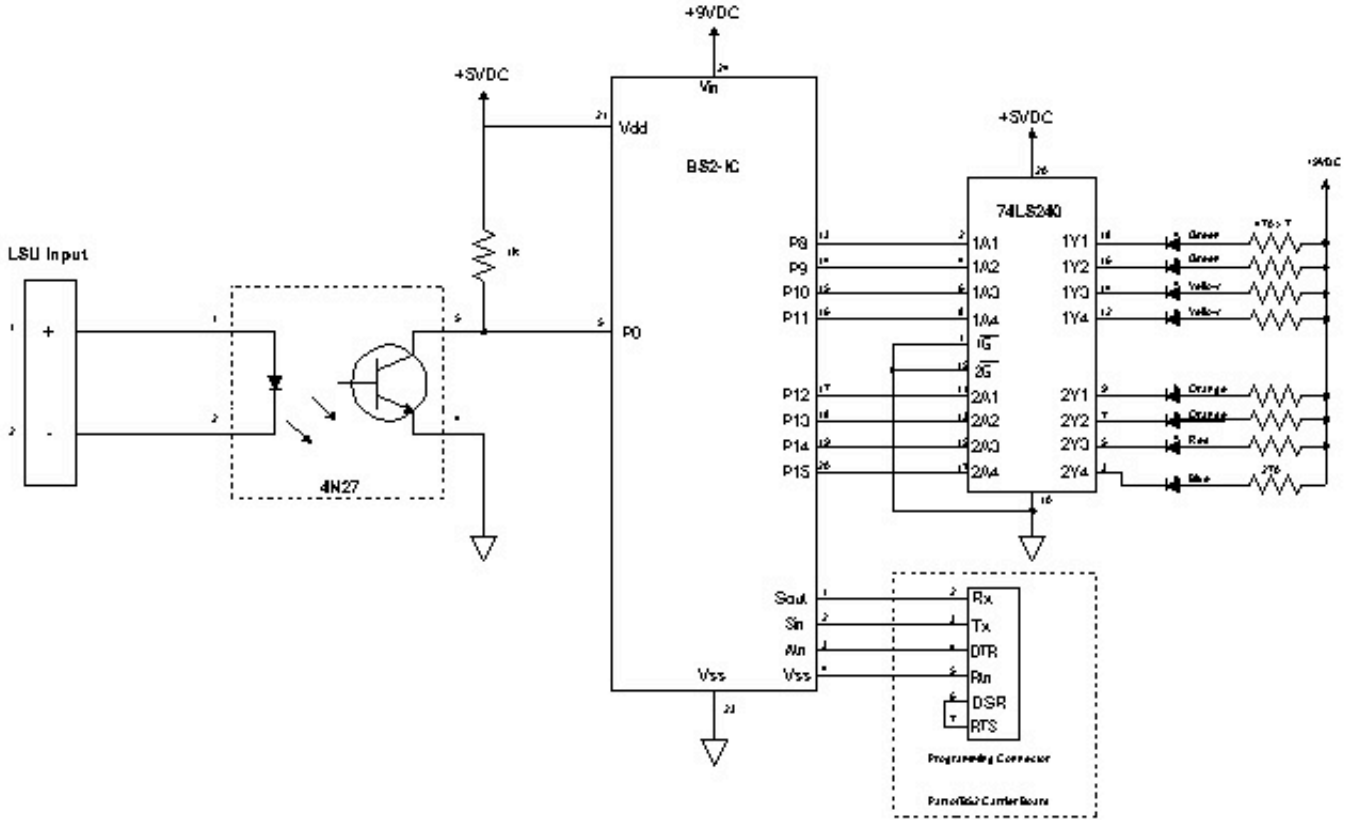


Figure 8 - Basic Stamp Display Board Schematic (Expanded)

Figure 9 - Completed BS2 Board (Expanded)

To provide ground isolation and ESD protection, an opto-isolator is used to couple the LSU to the basic stamp. The LED side of the opto-coupler is connected to the LSU, and the opto-transistor side is used to toggle an input pin on the BS2. Since the BS2 can not supply the required current for all 8 LEDs, a SN74LS240 driver IC is used. This allows the LEDs to run on the Vin (+9v) power.

Qty	Part	Description	Available From	Part Number
1	IC1	BS2/BS2E/BS2P Basic Stamp	Parallax	BS2-IC
1	-	Basic Stamp 2 Carrier Board	Parallax	27120
1	IC2	4N27 Opto-Isolator	Digikey	4N27-ND
1	IC3	SN74LS240N Octal Buffer	Digi-Key	296-1651-5-ND
1	R1	1K ohm 1/4w Resistor	Radio Shack	271-1321
7	R2-R7	470 ohm 1/4w Resistor	Radio Shack	271-1317
1	R8	270 ohm 1/4w Resistor	Radio Shack	271-1314
2	LED1, LED2	Green LED	Radio Shack	276-304
2	LED3, LED4	Yellow LED	Radio Shack	276-301
2	LED5, LED6	Orange LED	Radio Shack	276-306
1	LED7	Red LED	Radio Shack	276-307
1	LED8	Blue LED	Radio Shack	276-311
1	P1	Terminal Connectors	Radio Shack	276-1388

Table 2 - Basic Stamp Display Parts List

The Basic Stamp Software

The software for the Basic Stamp displays the lightning activity in strikes-per-minute. This allows the user to gauge the amount of lightning activity. Download the software here.

To maximize LED activity, rather than counting lightning activity for 60 seconds, the software counts the number of lightning strikes in a 6 second period and stores the results in element 0 of a 10-element array. After each 6 second count period, all 10 array elements are summed and compared to a list of LOOKDOWN values. This returns an index value between 0 and 8. The index is then passed to a LOOKUP command to get the LED port value with 0 activating all 8 LEDs and 8 turning them all off.
Next, the contents of each array element is shifted up, discarding the 10th (oldest) element. i.e. array(9) get copied to array(10), array(8) gets copied to array(9) and so on. This keeps a running average of the lightning counts over the last 10 elements * 6 seconds or 60 second period.

There is also a variable to keep track of the peak counts. Each time the array is summed, the results are compared to the last recorded peak. It the new peak is larger, it replaces the old peak value.

Installation and Use

Once the LSU is mounted on the mast, run the coax cable inside to the Basic Stamp Display Board. Note: Connect the center conductor to the NEGATIVE terminal on P1 and the center conductor to the POSITIVE terminal. Apply power to the Display board. The 8 LEDs should all light up and the go out one-by-one to verify circuit operation. Next, hold the "lightning simulator" within a few inches of the LSU and spark the igniter. Within a few seconds, one or more LEDs should light up. Now wait for a thunderstorm and watch

the LEDs light up!

The strikes-per-minute method allows the users to not only determine the magnitude of the lightning activity, but also if the storm is approaching or traveling away. By monitoring the LEDs, increasing values indicate that the storms getting closer, while decreasing values (LEDs) indicate the storm is moving away.

A typical lightning stroke can contain many individual flashes. This is why lightning sometimes appears to flicker. The lightning sensor design used in this project is highly sensitive and will detect each flash in a stroke. This may be noticeable when visually comparing lightning activity with the Lightning Activity Monitor. I have registered as many as 22 detects for a single lightning flash.

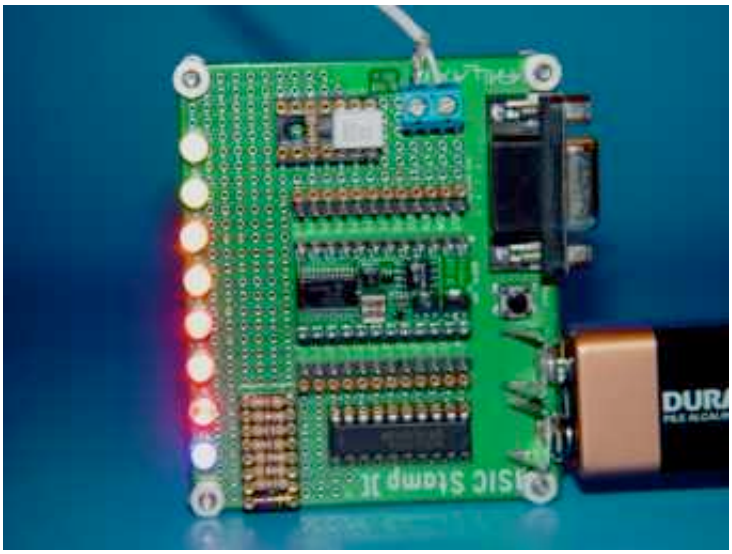
The strikes per minute values used in the LOOKDOWN statement can be adjusted to your location. The values are stored as strikes per minute with the largest number (Blue LED 8) first, ending with 0 (all LEDs off). With smaller numbers, the LEDs light with less activity.

```
LOOKDOWN sum, >=[400, 200, 100, 50, 25, 10, 5, 1, 0], index
```

Here in Tucson, some of the summer thunderstorms produce over 1000 strikes per minute. The values I use in the LOOKDOWN are:

```
LOOKDOWN sum, >=[1500, 1000, 500, 250, 100, 50, 10, 1, 0], index
```

Feel free to change the values until the Basic Stamp Lightning Activity Display works to your satisfaction.



Completed Basic Stamp Display Board

The sensitivity of the lightning sensor is in direct proportion to the height at which it is mounted. At 10 feet, lightning can be detected as far away as 50 miles. I have my LSU mounted at 5 feet because I'm mostly interested in local activity. The LSU will detect cloud-to-ground as well as cloud-to-cloud lightning.

An interesting option is to install a small piezo-buzzer such as a Radio Shack #273-074 across the opto-isolator input. This will provide an audio indication of the lighting activity as well. Be sure to observe the proper polarity of the piezo buzzer.

Since the Basic Stamp Lightning Activity Monitor is designed to be powered constantly, an inexpensive 9 volt AC adapter is recommended. Parallax sells a 9V 300ma AC adapter #750-00008 for under $10. To use with the BS2 Carrier board, install a 9-volt battery clip in place of the barrel-type plug.

Experiment with different mounting heights and display options. You can e-mail me at tim@timbitson.com if you have any suggestions or questions. You can also subscribe to the Basic Stamp Discussion list to share your results and improvement suggestions.

Disclaimer

This project is for experimental use only. The user assumes all responsibilities for assembly, installation, and use. This circuit is provided without warranty and the author makes no claim that this device will work in any particular application. Having an antenna up in the air with a cable running into your house during a thunderstorm could invite trouble. Keep a safe distance away from the display during thunderstorms. Do not use in applications where failure or incorrect operation could jeopardize someone's safety. Always exercise caution when working outdoors during a thunderstorm. This schematic is provided for noncommercial use only. Batteries not included.