

# Build a Boston Bomb!

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At the end of January 2007, I saw a great huff had been created in the city of Boston (USA), caused by a disappointing combination of a heightened state of terror alert, mixed with media frenzy and a simple case of confusion from a member of the public. The end result was that the city was shut down for half a day, while the local bomb squad spent the morning 'disarming' bombs.

It all started when the owners of an American cartoon show decided to advertise their production by using small (12" x 7") LED lightboards that glowed when it was dark. In all, about 180 boards were created and deployed in about 8 cities across America.

The boards were powered by 4 alkaline D cells so that they could glow intermittently for about a month. Powerful magnets were glued to the back that allowed them to be stuck onto anything metal. The people installing the boards were asked to install them high enough so they were not trivially stolen, and to install them in places that were easily seen.

After a few weeks, one concerned Boston citizen decided that there was a 'suspicious device' hanging from a bridge. They dutifully contacted the Metro police, who promptly, in this 'state of heightened terror alert', contacted the Boston police. The Boston police then sent out the bomb squad who did what they do best – they made the device safe by blowing it up. The media latched onto the story, delivering a swathe of OB vans, news reporters and helicopters. In no time at all, Boston had its own 9/11 and a flood of callers promptly provided information about where other devices were located.

Sadly, members of the public paid attention to the media phrase 'suspected bomb' and called in more bomb reports, causing the entire event to mushroom out of control. Unfortunately, it took the police some time to analyse the result of the controlled explosions, and when they did, they discovered that they were simply light boards.

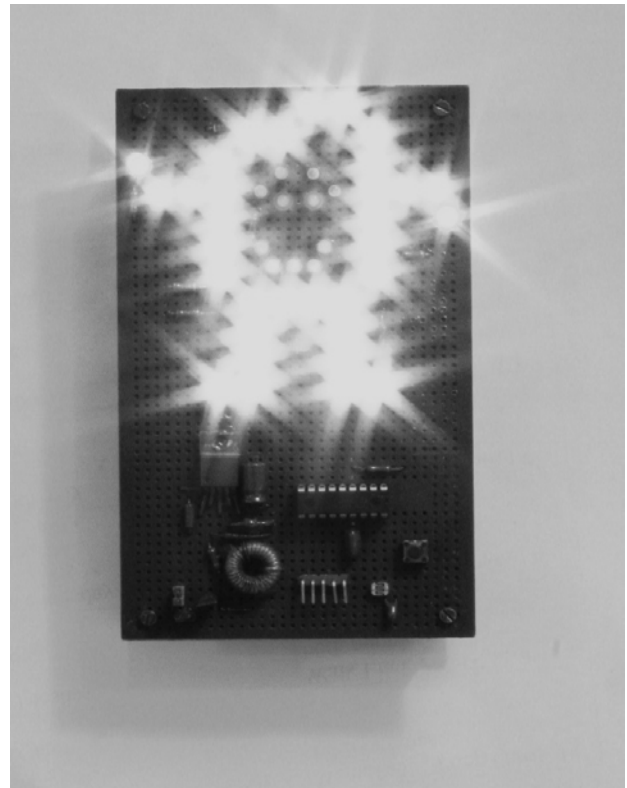


Figure 1 - Early Veroboard Prototype

In all, the event cost the city approximately \$400,000, and much inconvenience was experienced by all. Public officials were outraged that anybody would place 'hoax devices' around the city, and the police eventually arrested that people who were contracted to place the devices. Eventually, the network which owned the cartoon being advertised contacted the city, explaining that the entire event was simply an advertising campaign, and entered into negotiations to pay for the damage. In all, they paid \$1 million for inconvenience, and \$1 million for 'Homeland Security', which was probably a codeword for an awareness campaign so that the people in the city were more aware of what was, and was not, a bomb.

In the aftermath, it is worthwhile noting that a video of the bomb squad blowing up a 'suspicious package' on a street appeared on the Internet about 4 weeks later. It turned out that the package was a simple traffic counter placed by the Roads Department. Given that little snippet, I suspect that their behaviour in dealing with the light boards is entirely predictable.

Anyway, I thought the levels of stupidity that was demonstrated by the public; the media and the city officials over the entire handling of the incident was deplorable. This included the fact that the individuals who placed the devices were charged by the Boston Police initially for placing a bomb, then for creating a bomb hoax. And I decided that I needed one of the light boards as a fridge magnet, to remind my children of the need to apply some analysis to a problem, before simply blowing it up. I couldn't find any on eBay that were affordable, so I decided to construct my own miniature.

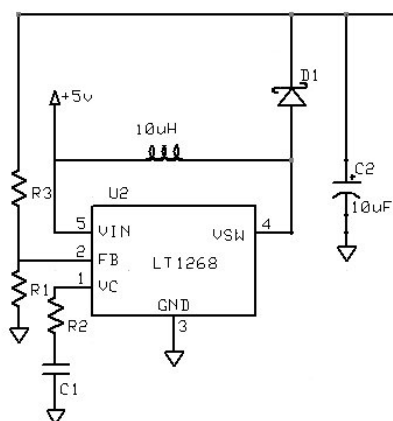
I chose a PIC 16F84 as the microcontroller (I have a box full, so as far as I am concerned, any project is able to be solved with a 16F84). This created an interesting sideline that had to be solved because the PIC didn't have an ADC, so I synthesised one by measuring the charge/discharge time for a RC circuit (an LDR and .22uF Cap). It works reasonably well, and certainly allows me to detect when it is dark.

A simple software timer has been implemented that flashes the character a couple of times when the thing is turned on. The project then waits till it is dark, when it has a little flash then waits for day before waiting for night to repeat it all over. And, of course, there's a button attached that can generate an interrupt to resets the device, making it flash, so that you can show that it flashes when a friend asks what the thing on the fridge is.

### ***The DC-DC Converter***

The first interesting thing about this project was the DC-DC converter. White LEDs have a forward voltage drop of about 4v, which means that I needed greater than 20V to drive a string of 5 LEDs. Clearly, I couldn't simply connect my 6v battery supply, so I used a Linear Devices LT1268, which is a switching regulator that can be used in 'Boost' mode. The device is capable of taking a 4v input, and increasing it up to 30v. My junk box had a small 10uH toroidal inductor that was exactly what was required and the problem was solved.

According to the Linear Technologies data sheet, D1 should be a high speed Schottky diode. I didn't have one in stock, but I had a junk box full of high speed silicon diodes salvaged from computer switchmode computer power supplies. The efficiency may not be as high as it could be, but it certainly operates as intended.



**Figure 2 - DC - DC Converter**



## ***White LEDs are insanely bright!***

When I constructed the prototype, I initially used 180R current limiting resistors as R4 through R10, and was impressed by the brightness that the 15000mCd 5mm white LEDs provided. I decided that I didn't need enough brightness to provide a clearly visible display at 2km, so I settled on 8K2 resistors as providing enough brightness that they could be clearly seen, while limiting the ability of the device to blind me when I raid the fridge at midnight.

Obviously, I didn't have the same problem with the small face within the outline. This was created using 3mm red and green LEDs that were in the order of 15 – 20mCd, so are not as bright as the white LEDs.

## ***What about the software?***

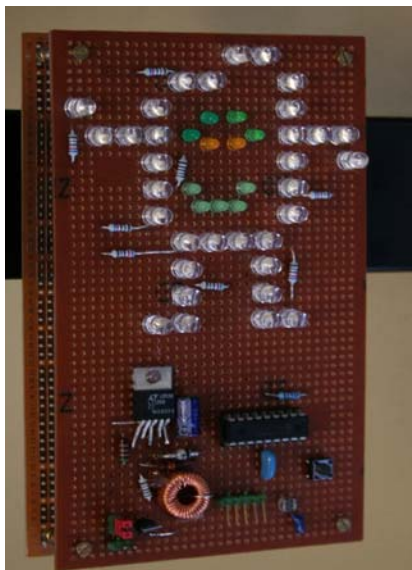
As you can see, the hardware is trivial. The most complex part of the project has been the DC-DC converted, and that was constructed with about 6 components. Now all we need is a little software and we have completed our project.

If you download the software from the website, you can see that it consists of fairly simple program segments that cause various flashing modes to be selected. The most interesting component is the Analogue to Digital Converted (ADC), which was implemented using a single I/O pin of the PIC.

The ADC operates by charging the 0.22uF capacitor by setting the I/O pin to output mode, and driving a logic 1 for 200ms. A loop is then entered where the pin is set to input; sampled to see if it is low. If it is not low, the pin is set to output mode, and driven low for 200uS then set to input mode and re-sampled. This cycle continues, each time discharging the capacitor a little at a time, while counting the number of cycles it takes to actually be discharged. If the LDR is dark, its resistance will be low (under 1000 Ohms), so the discharge cycle will be completed fairly quickly. If the LDR is light, its resistance will be high (greater than 20,000 Ohms), so the discharge cycle time will be fairly long.

It is interesting to note that if I had used a more modern 16F88, the microprocessor would have been cheaper, and it would have had an ADC built in.

The pushbutton drives the RB0 interrupt. When an interrupt occurs, the software is designed to simply restart. That way, the LEDs will immediately flash the startup sequence.



**Figure 4 - Veroboard Prototype**

## ***Construction***

Construction is simple; first, we examine the PCB carefully for broken, or shorted tracks, repairing them as required.

Start assembly by installing the resistors and capacitors, ensuring that the leads are bent carefully prior to insertion. Next, install a socket for the PIC. Then install the LEDs, paying careful attention to their orientation. Insert a pre-programmed PIC into the socket, and solder on the battery snap.

Use a piece of aluminium to act as a backing board, and mount the magnet and battery holder onto it. I used a magnet salvaged from a faulty microwave oven magnetron, which was attached with hot melt glue.

Install batteries into the battery holder, bolt the PCB to the backing board, connect the battery snap to the battery holder and that's it. The unit should immediately start flashing.

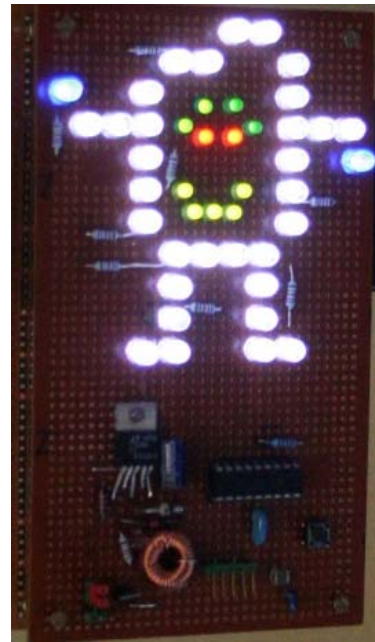
In the case of the prototype, I used a couple of pieces of 3" x 5" project board, to construct the project. All wiring was point to point on the back of the board, out of the way

Best fridge magnet in the street!!!

### ***Testing***

Testing this project is fairly simple – if the device does not light up as soon as power is applied, simply unplug the PIC, and connect the VN10 Gate to +5v. The LEDs should light – if they don't, then there is a problem with the DC-DC converter. If they do, there is a problem with the PIC.

If you find that part of the character does not light up, then you may find that one of the LEDs is installed backwards, or you may have missed a solder joint.



### ***Conclusion***

In all, another weekend well spent. The kids are stoked. My wife Megan has been able to demonstrate her never ending patience yet again, and I have ended up with another talking topic when in the kitchen at parties.

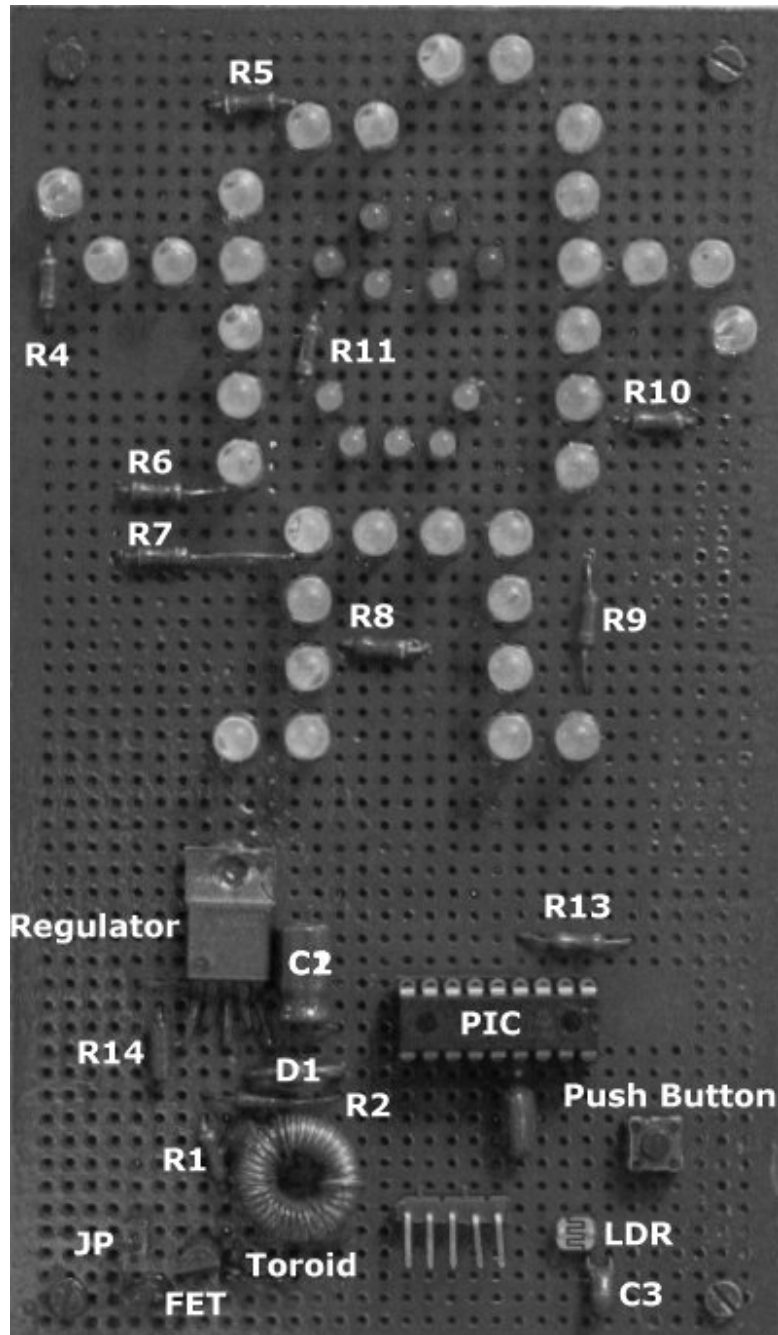
You don't have to create the little character shown here. You can create a name, another picture, or anything – your imagination can provide ideas.

Finally, while it is sorely tempting, please don't ask for trouble by attaching it to an airport fence for a photo... After all, it is a bomb, - just ask the Boston Bomb Squad...

## ***Prototype Component Layout***

The following picture is a guide for the placement of components on the Veroboard prototype.

Note that the Veroboard version has a small face created using 3mm LEDs that the PCB version does not have.



As mentioned in the article, the prototype was wired using point to point wiring on the back of the board.

## PCB Version Component Layout

The following picture is a guide for the placement of components on the PCB version.

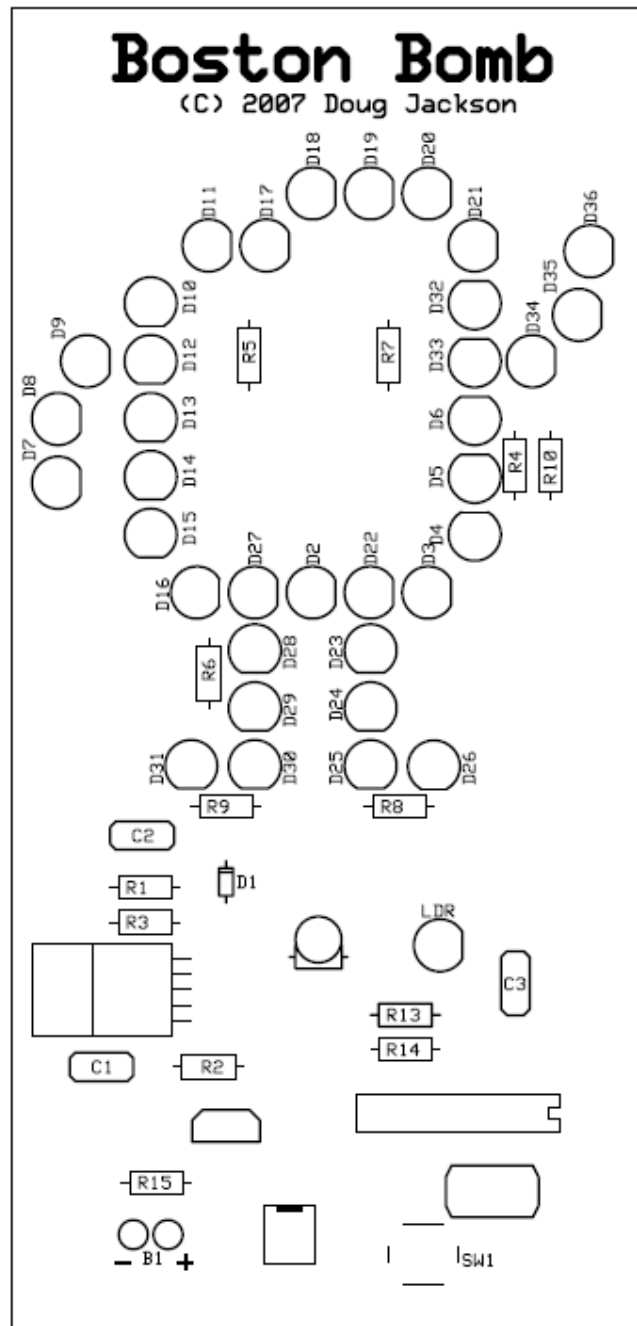


Figure 5 - PCB Component Layout

**PCB Drawing**

The following picture is the PCB, allowing you to manufacture your won PCB.

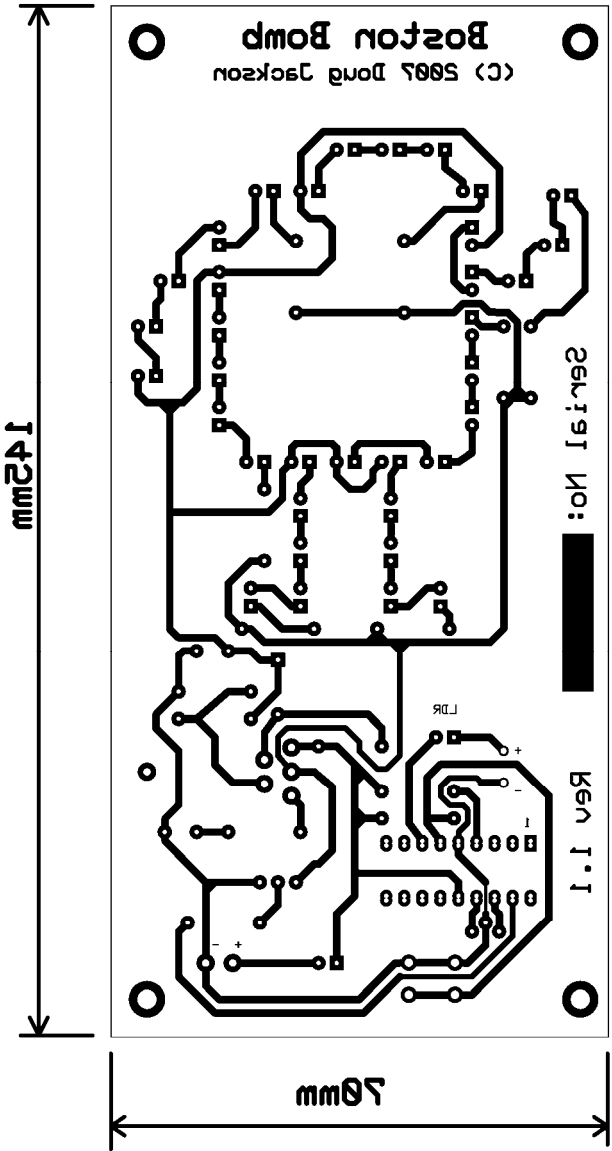


Figure 6 - PCB Layout

## Parts List

D1	High Speed Switching Diode – 2A
D2-D32	5mm White LED 15000mCd
D33-D41	3mm Green LED 20mCd
D42,D43	3mm Red LED 20mCd
D44-D47	5mm Blue LED 10000mCd
U1	LT1268 Switching Regulator
U2	PIC 16F84
Q1	VN10KM FET
XTAL1	4Mhz Resonator
R1	1k0
R2	20K
R3	1k0 (Note R3 on rear of prototype)
R4-R9	8K2
R10	10K
R11,R12	1K (Note R12 on rear of prototype)
R13,R14	4k7
R15-R18	1k0
LDR	3mm LDR
C1	0.002uF (Note C1 on rear of prototype)
C2	10uF 35V Electrolytic
C3	0.22uF Tantalum
SW1	Small pushbutton switch
JP1	0.1" Jumper
B1	4 way battery holder (AA)
Magnet	12cm diameter magnetron magnet or similar
PCB	2 * Dick Smith H5616 33 x 58 holes Or Boston Bomb PCB – PCB Layout included in Article.
Hardware	3mm screws x8
Hardware	3mm spacers (20mm) x4
Hardware	9v battery snap suitable for B1 Battery holder