A High-Performance Flashbulb Firer – part 2

*Flashbulbs are still the professionals' choice for cave photography. This project by **David** Gibson – which is an update to his article in CREG journal 45 (Sept. 2001) – describes a compact, microprocessor-controlled bulb-firer that includes 'seated' and 'fired' indicators and a boost circuit to produce 24V from the 3V supply.*

This article describes a capacitor-discharge (CD) flashbulb firer that is currently under development. The unit has the following features…

- Manual firing button
- Input from camera or slave unit
- High energy output – 24V and over 100mJ
- LED indication of 'bulb seated'
- LED indication of 'firer triggered'
- Runs off single 3.6V lithium cell
- No on-off switch required
- Small design – matchbox-sized

A bulb-firer is not essential to fire flashbulbs – see (Gibson, 2003) where I describe how to use a 9V battery with my latest slave unit to fire bulbs directly. However, the advantages of using a CD bulb firer are

- Limited energy release (avoids problems with 'flip-flashes')
- Battery can be smaller and does not need to be fresh

Design Overview

As you can see from the circuit diagram, the design looks similar to that of a conventional CD bulb-firer, but with an added block of circuitry to the right of the dotted line. This provides the boost function from 3.6V to 24V, and controls the 'seated' LED. Technical info is given later in the text.

Functionality

Bulb-Seated Indication

When a flashbulb is connected, the red LED indicates that there is a good connection and the firing capacitor charges. The 'seated' indication only shows that there is circuit continuity – it is not necessarily an indication that the continuity is good enough for the flashbulb to fire. If your connectors, sockets, etc. are corroded you might have problems. Some suggestions on flashbulb sockets are given in (Gibson, 2001b).

Firer Triggered Indication

As with conventional CD firers, if it is triggered by a slave unit with a thyristor or triac output, the slave unit will remain latched on after the bulb-firer has discharged. That fact is made use of in this design, where it causes the green LED to illuminate.

Obviously you will know if the flashbulb has fired, but the purpose of the 'fired' indicator is to check that your slave unit was connected and working *before* you connect a flashbulb. The 'fired' indication functions even when a flashbulb is not connected to the firer and provides this useful indication. To reset the indication you just need to press the manual firing button, which shorts the output of the slave unit, diverting the latching current and turning it off.

If you use a slave unit that does not have a latchable output then this indication will not work. If your slave unit is of a design where it could be damaged by connection to circuitry of this sort then obviously you cannot use it either. My slave units are designed for this type of operation.

> ## Flashbulb Safety
>
> Even a small flashbulb can cause a nasty burn if it ignites in your hand. A large flashbulb can cause serious injury and there is always a small risk of the flashbulb exploding and causing damage to your eyes. Additionally, the heat generated can cause any nearby flashbulbs to fire in sympathy, so causing a serious fire risk. For these reasons you should always observe the following points. If you do not understand anything written here (e.g. 'antistatic precautions, 'indicator spot') then you might not be suitably qualified to use flashbulbs safely.
>
> - Wear eye protection
> - Wear gloves
> - Take anti-static precautions
> - Use a safety shield over the flashbulb
> - Keep flashbulbs in their original cartons until the time of use.
> - Do not use flashbulbs where the safety coating is damaged or where the indicator spot has turned pink. Such bulbs could explode when fired.
> - Do not use flashbulbs in a potentially explosive atmosphere
> - Do not store flashbulbs in areas prone to heat build up (e.g. in a car exposed to sunlight). Store in the original boxes.
> - Damaged or faulty bulbs should be immediately crushed to eliminate the danger of ignition.
> - Used or destroyed bulbs should be disposed of in a manner similar to the disposal of used electric light bulbs and in accordance with local regulations.

As explained above, the fired indication is most useful when a flashbulb is not connected. But even when a flashbulb *is* present, it can still give you useful information – e.g. that your flashbulb was too stubborn to fire, possibly due to a cracked envelope. Note that when the flashbulb *does* fire, the fired indication may not always occur. This is because the large currents that flow during the firing process can occasionally act to reset the slave unit.

Building the Unit

I intend to supply kits of parts for this project, as well as ready-built units, but please check at **caves.org.uk/flash/newsletter.html** for availability, because the project has progressed slower than I anticipated, and is still under development at the moment.

Eventually, later in the spring, I will be supplying a circuit diagram and components list that will give you all the information you require to construct this project. The IC is a programmed micro-controller, which I will also supply. I can also supply a printed circuit board, but please note that the board is small and you will need some skill in electronics to use it. In particular, you must use a fine-tipped soldering iron and take anti-static precautions when handling the IC.

Cautions and *Caveats*

Flashbulbs are potentially injurious to your health and safety. It is not my intention to encourage any non-competent person to use this bulb-firer. Please read the shaded boxes on Flashbulb Safety and Bulb-Firer Precautions.

Even if you purchase a ready-built unit off me, it is not intended to be a finished 'consumer' product, and I expect you to have a requisite knowledge of electronics in order to understand its use.

I am supplying kits of parts purely as a favour to you, to save you the trouble of tracking them down. If any are faulty then I will replace them, but what you do with them is entirely up to you and I do not guarantee to be able to provide any after-sales service to help you to debug your horribly burnt and welded mess of copper and fibreglass.

References

Gibson, David (1996), *An Improved Circuit for Firing Flashbulbs*, CREGJ **23**, p5, March 1996.

Gibson, David (2001a), *A High-Performance Slave Unit and Flashbulb Firer – Part 1*, CREGJ **45**, pp11-12, Sept. 2001.

Gibson, David (2001b), *Flashbulb Sockets*, CREGJ **46**, pp28-29, Dec. 2001.

Gibson, David (2003), *Bulb Firer: Progress Report*, CREGJ **53**, pp22-23, Sept. 2003.

Rushton, Richard (1998), *A Practical Flashbulb Firer*, CREGJ **31**, pp17-19, March 1998.

Appendix: Technical Info.

Background

This article is a 'part 2' to my article (Gibson, 2001a) in which I described a combination slave unit and bulb firer, where the bulb firer used a step-up regulator to generate a suitable firing voltage, and gave 'seated' and 'fired' indications.

I did not like the design given in the above article – it used too many components and it did not seem satisfyingly 'neat and tidy' as a good design should. I went back to the drawing board and came up with a few basic principles that I wanted to adhere to...

- No on-off switch required
- A 'fired' indicator that operates when the unit is switched off
- A 'seated' indicator

I wonder whether sticking rigidly to those points was a good idea, because it has taken me a long time to solve the problems that they introduce. For example, if we accept that there *will* be an on-off switch then earlier designs by myself (1996) and Richard Rushton (1998) are available.

The first two points are fulfilled by a conventional CD bulb-firer (Gibson 2001); and points (1) and (3) are fulfilled by Nigel Jennings' (of Firefly Electronics) slight variation on the traditional design, although Nigel's 'seated' indication is not the 'well-seated' indication of the (Gibson, 1996; Rushton, 1998) designs.

The difficulty comes when we try to incorporate all three features. I found this to be an immensely difficult task. Several times I nearly got there, by using a messy handful of transistors but the problems remained, They were subtle ones – for example, under certain conditions, the firing capacitor C1 could become reverse-charged (not advisable for electrolytic capacitors), and the 'seated' indication would not revert to 'unseated' when a bulb was removed, if the firing capacitor (C1) remained charged.

In the end, the design presented here has emerged. It doesn't use too many components, but it does still have some shortcomings, which are…

- The main capacitor can become reverse-charged.
- The 'seated' indication is not a 'well-seated' indication.

For the former, I have taken steps to reduce the problem. It would be possible to eliminate it entirely but this requires additional components. I'm still thinking about this – it is probably OK.

For the latter problem, I'm not convinced that a 'well-seated' indication is merited. The salient point is that although the bulb can be making electrical contact, that contact might not be good enough to fire the bulb. Only a good deal of 'user feedback' will solve that one, I think.

Circuit Description

The circuit shows, to the left of the dotted line, a conventional CD bulb firer. LED1 provides the 'fired' indication, and the additional series diode, D1, is included to protect the LED against the high reverse voltage when C1 is charged to 24V. Note that if LED is omitted, D1 is still needed precisely to allow C1 to charge to a voltage higher than the supply rail.

When a bulb is inserted, IC1 detects it and turns on LED2. At the same time, it causes C1 to quickly charge to 24V by means of the boost converter around L1, D4 and Q1. The boost converter's feedback to IC1 is via D5. The reason for using a Zener diode here is that this will also clamp the voltage should anything go wrong.

A boost converter has a current path from input to output when it is off. This would normally cause a current drain because of the leakage through its output capacitor C1. However, in this design, the leakage path through C1 is conveniently broken when there is no flashbulb present.

If the bulb is removed, IC1 detects this and turns off LED2. But for this to happen it is essential that C1 is able to float above the input to IC1 so, even without LED1 or the boost converter, D1 is still essential.

When the firer is triggered, the positive end of C1 becomes connected to ground. This means that it can reverse-charge via R2, which is the pull-up to allow IC1 to sense when a flashbulb is inserted. To prevent damage, R2 has a high value and C1 is clamped with D2.

IC1 can generate an internal reset signal so an external R/C network is not essential. However, I thought it prudent to be able to reset the IC externally, so this function is provided by D3 when the manual firing button is pressed. Because this exposes the ~MCLR pin to noise, an R/C reset circuit is probably prudent and is built around C1, R3 and R4. R4 is probably redundant.

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Bulb Firer Precautions

Using a flashbulb with a slave unit means that it can be subject to accidental firing. The bulb-firer described here includes a microprocessor control unit and is therefore also subject to the slight risk of a malfunction. I do not advise that the bulb firer should be used 'out of the box' by anybody who is not fully aware of an appropriate safe operating procedure. With your knowledge of electronics and photography, you must devise this operating procedure for yourself. The list below is suggested as a starting point. You must remember that this bulb-firer is intended for use as part of your own home-constructed photography equipment and is not a 'stand-alone' fully-functional unit by itself. If you loan your unit to someone, you owe it to them (and to yourself) to make sure that are aware of these facts.

Remember that although slave units may have some immunity to cap-lamp beams, it is still possible to trigger them by suddenly sweeping a bright beam across them. Additionally, a slave unit (and possibly the bulb firer too) can be triggered by proximity to the electromagnetic interference given off by a flashgun, and by poor battery contacts, which can cause the unit to switch off and on at random times.

A suggested operating procedure is …

- Disconnect the bulb firer from the slave unit and the flashbulb holder. (You may be using plugs and sockets, or you may have wired switches for these functions).
- Insert the flashbulb into its socket, check that it is well-seated and fit its safety shield.
- With the flashbulb pointing away from you and not directly at another person, attach the flashbulb socket to the slave unit. (If you are using a switch for this function, you can arrange for it to short the flashbulb contacts together when it is in the 'disconnected' position, thereby protecting the bulb against electrostatic discharges).
- Check that the LED indicates the bulb is seated.
- Warn everyone that you are ready to take a photo and that they must not fire a flashgun or shine their cap lamps directly on your slave unit.
- Turn your cap lamp off and remove any powered flashguns from the vicinity of the slave unit and bulb firer.
- Connect the slave unit to the bulb firer.
- Take the photograph.
- Check that the flashbulb has fired. But approach the firer with caution because, if the bulb has not fired, it may do so as you approach, if you accidentally trigger the slave with your lamp beam.
- If the bulb does not fire, use the red and green LEDs to diagnose the problem. For example, if the green LED is lit then the firer was not powerful enough to fire the bulb.

You may think that this procedure is excessively cautious. That is a judgement that you, as a person experienced in electronics and cave photography, must make for yourself.

Circuit Diagram:
On the left is a conventional CD bulb-firer. To the right of the dotted line the microprocessor adds features, including a boost from 3.6V to 24V.