

## Tech Note 7

2004/04/29

## An Inexpensive Remote Projector Shutter

### 1 The rationale

Video projectors are incapable of displaying a true black, i.e. an absence of projected light. Having any light projected when the projector is inactive is frequently unacceptable in the theater, such as in a blackout. Since projector lamps generally cannot be switched on and off without adequate warm-up and cool-down periods, the light must be physically blocked with a shutter. This is commonly done simply by manually placing a piece of paper in front of the lens. But this is impossible if the projector is far away. Various manufacturers will happily sell you a DMX-controlled shutter for \$275 or so [1]. Those of us without unlimited budgets are forced to be a bit more creative.

This note presents a design for a remotely-controllable motorized projector shutter that can be built for almost no cost — it requires only a (possibly broken) CD-ROM drive and some readily available electronic parts. It is based on an idea mentioned by two posters to the Stagecraft mailing list [2].

### 2 The design

A computer's CD drive can easily be converted into an effective projector shutter. The tray serves as the shutter; the hole in the tray will need to be covered with blackwrap or some other suitably opaque material. Helpfully, the CD drive already contains a motor that can open and close the tray. We need only control it ourselves, since we will not be using the drive electronics.

The first step is to take apart the drive. Exactly how to do this, and exactly what the innards of the drive will look like will vary depending on the model — and, given

that we're dealing with scrounged-up parts here, we really can't be too picky about what model drive we're using — but the general set of parts will be the same. At this point, it's possible to disembowel the drive if desired, removing the main circuit board, laser<sup>1</sup>, spindle motor, etc. It might also be useful to remove the front bezel, if adding the blackwrap makes the tray no longer open.

The tray motor is generally located near the front of the drive (though the exact position will vary with the drive), and should have two solderable contacts. Solder a long wire to each one; this will be the attachment from the CD drive to the electronics. It doesn't much matter which wire is which; the only effect will be to reverse which switch direction is forward and which is reverse.

A schematic for the electronics is provided in Figure 1 (also provided separately as a PDF file). The required components are listed in Table 1.

Num.	Component	Price
1	CD-ROM drive	— <sup>a</sup>
1	LMD18200 H-bridge <sup>b</sup>	\$11.69 [3]
1	74LS123 monostable	\$0.56 [3] <sup>c</sup>
1	LM7805 5V regulator	\$0.57 [3]
2	100 $\mu$ F capacitor	\$0.56 [3]
1	50 k $\Omega$ potentiometer	\$0.44 [3]
3	10 k $\Omega$ resistor, 0.25W	\$0.42 [3]
2	560 $\Omega$ resistor, 0.25W	\$0.42 [3]
2	LEDs, 1 red and 1 green	\$0.23 [3]
2	Push-buttons, normally-open	\$0.94 [3]
1	Selector switch, SPST	\$0.73 [3]
1	Power jack, 2.1 $\times$ 5.5 mm	\$0.42 [3]
1	12V 1.5A wall transformer	\$15.30 [3] <sup>d</sup>
<b>Total</b>		<b><math>\leq</math> \$36.48 <sup>e</sup></b>

<sup>a</sup>Conveniently found wherever old CD-ROM drives are disposed of

<sup>b</sup>It's cheaper and probably just as good to use something else instead — see the note

<sup>c</sup>Or “borrowed” from one of the Course VI labs — not that anyone would do anything like that, of course

<sup>d</sup>Or cannibalize a spare wall-wart from wherever you can find one — it can't be hard to find a cheaper one

<sup>e</sup>Generally much less, since so many of these parts can be found for (nearly) free if you look in the right places

Table 1: Required parts

<sup>1</sup>If power is on, do not look into laser with remaining eye.

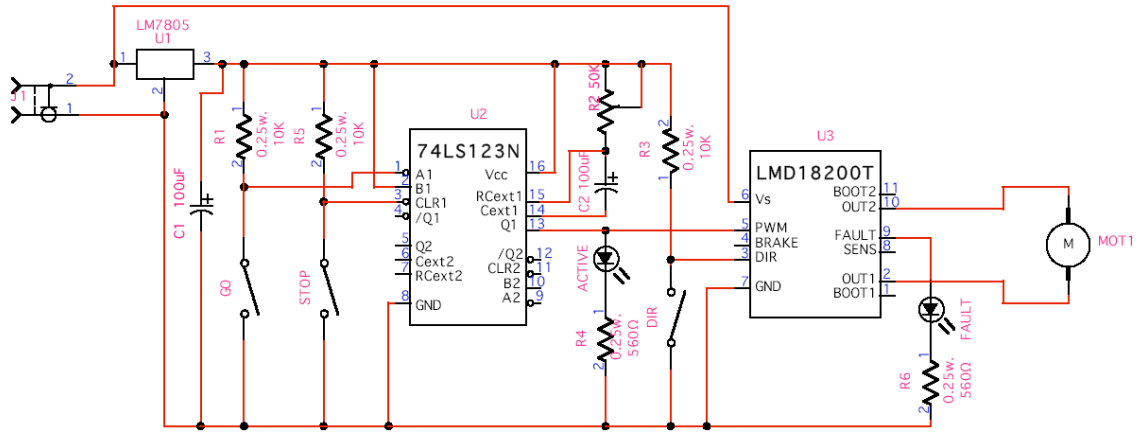


Figure 1: Schematic diagram

### 3 Some notes on the electronics

This circuit provides three controls to the user: a Position switch and Go and Stop buttons. When the Go button is pressed, the shutter moves to the position selected by the Position switch. The Stop button can be used to stop the tray (it’s not totally clear to me why you’d want to stop the tray while it’s partially opened, but you can do it.)

Power is supplied via a 12-volt AC adapter (“wall-wart”) through a female 2.3 mm power jack. This seemed appropriate, since this would likely be used in a semi-permanent environment, and it would be easier to connect it to AC power rather than have to deal with changing batteries. It could be easily converted to run on battery power (e.g. a 9V battery). The only complication is that the particular H-bridge used here, the LMD18200, requires at least 12V power. Also, the tray motor is designed to run on 5V power, but seems to work for me at 12V (and very quickly!). The speed of the motor operation is proportional to the voltage applied, so it’s necessary to adjust the operation time of the motor accordingly (see below).

A voltage regulator is used to provide a regulated 5V supply to power some of the electronics. A bypass capacitor connecting the 5V supply to ground is necessary to eliminate transient noise when the motor is activated (this would interfere with the monostable operation). I used a 100 µF electrolytic capacitor because it was what I had around, but a smaller capacitor should work too.

The circuit controls the motor using a “H-bridge” chip. This chip, whose internals are roughly like the circuit in Figure 2, controls a DC motor by connecting each motor terminal to either power or ground. This means the direction of the motor is reversible, which is essential to this application. The chip I used for this purpose was a LMD18200 H-bridge chip. This chip provides some nifty features like thermal sensing and current overload protection — none of which can reasonably be claimed to be necessary here. That is, it’s total overkill for this application; I just used it because I happened to have one. Alternatives would be to use a cheaper H-bridge, or to build one from discrete transistors as in Figure 2.

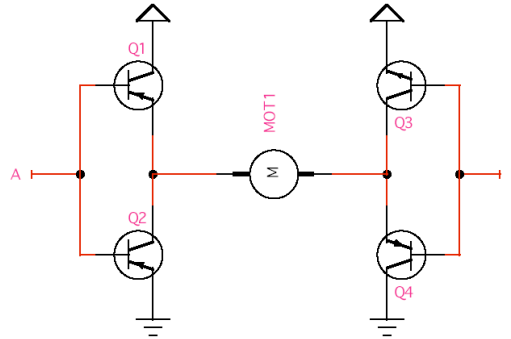


Figure 2: H-bridge internals

A 74LS123 monostable multivibrator<sup>2</sup> (“one-shot”) solves the problem of how long to turn on the motor. The ideal solution would be to detect when the tray is fully open or closed, but I just couldn’t bear the thought of poking at the drive electronics to find out how to do this (also, it would probably be different on different drives). Instead, the monostable serves as a timer — whenever the Go button is pressed, it runs the motor for about one second. The exact time depends on the resistance of  $R_2$  and capacitance of  $C_2$ ;  $R_2$  is a potentiometer in order to make this time adjustable.

## References

- [1] Wahlberg light & motion design. <http://www.wahlberg.dk/video/shutter.htm>.
- [2] J. Kanyuk and D. Farmer, “Projector dowsers,” Stagecraft mailing list posts, Mar. 2004.

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<sup>2</sup>This is not obscene. Really.

- [3] Digi-Key Corporation. <http://www.digi-key.com>.
- [4] P. Scherz, *Practical Electronics for Inventors*. New York: McGraw Hill, 2000.
- [5] P. Horowitz and W. Hill, *The Art of Electronics*, 2nd ed. Cambridge, UK: Cambridge University Press, 1989.