A TRIGGER INTERFACE

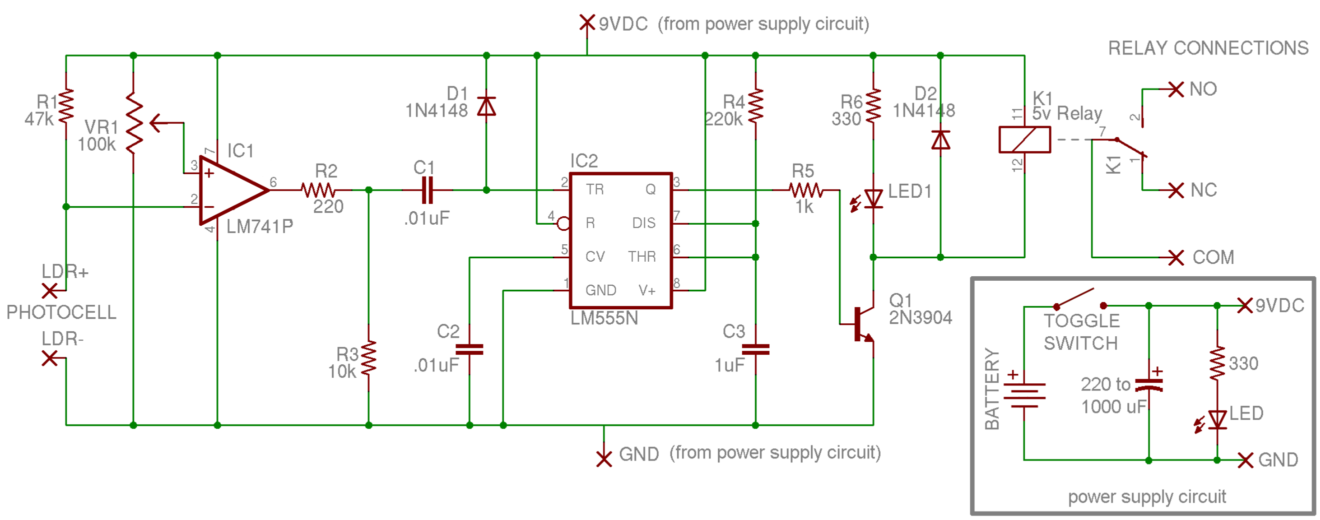
by ZLP 12-07-2007 – (v1.0)

Whenever an object breaks a light beam this circuit virtually presses a button on a hacked device of your choice. (You will trigger one button-press at the moment that you break the light beam. No more triggering will occur until you leave and re-enter the beam.) A laser pointer is suggested as a light-source, but any bright light will do. With slight modifications the circuit can also be triggered by sound via line-level audio input.

You might want to package multiple sensor circuits in one box, so the power-supply circuit is shown separately. Nine volts DC is required, via batteries or a plug-in transformer. Everything is available at Radio Shack, so part numbers are included. (If you have electronics experience, online sources like digikey.com will charge about ¼ of what RS does, but require a certain familiarity with electronics jargon.)

Drawings for a printed circuit board (PCB) are attached. Ask about PCB fabrication. It can be done with household products like a laser printer, clothing iron, and powerful acid chemistry.

THE SCHEMATIC



The Photocell *(or LDR: Light Dependent Resistor)* forms half of a voltage-divider that controls the voltage at pin 2 of the 741 chip. The 741 is used as a "comparator", so its output (pin 6) is dependent on the difference between its 2 inputs. If the light on the photocell is interrupted, the voltage at pin 2 will rise. Whenever voltage rises higher than the threshold set by VR1 (sensitivity control) the output of the 741 will fall from high (near 9v) to low (near 0v). When that transistion occurs, capacitor C1 and diode D1 produce a short low pulse. The pulse triggers the 555 timer chip to begin its work. The timer's output (pin 3) goes from low to high for a preset length of time, set by C3. (in this case about ¼ second.) Transistor Q1 uses this pulse to drive the 5v relay and the indicator LED. (D2 prevents voltage spikes from damaging Q1 when the relay coil de-energizes.) When the light is shining, relay terminals NO (normally open) and COM (common) are normally not connected to each-other, but when the relay is energized they connect together like a pushbutton. (Insert button wires from hacked product here.)

THE PARTS LIST

For each Sensor Circuit

Laser pointer (eBay?) less than $5 each.

Light-shield / Diffuser (I used a translucent white Fuji film canister)

Copper Clad board 276-1499 4.50
(To etch the PCB using the included drawings. See "bulk" section below.)

or…

Multipurpose PC Board 276-150 2.00
(To connect things by hand if you are not making a PCB)

C1, C2: **.01 uF ceramic capacitor** (2pk) 272-131 1.50
(each sensor circuit needs a 2-pack, or see "bulk" section below.)

5VDC/1A SPDT Micro Relay 275-240 4.70

IC1: **LM741CN Op Amp IC** 276-007 1.00

IC2: **555 Timer IC** 276-1718 1.70
(There are 2 types of 555 timer at Radio Shack (555CN and TLC555CP). Either is fine.)

VR1: **100K-Ohm Trimmer potentiometer** 271-284 1.50

Photoresistor *AKA* **CdS Cell** *AKA* **Photocell** *AKA* **LDR** (see "bulk" section below.)

Resistors: (one each per circuit, 1/8 Watt is fine, ¼ Watt is OK too. **Sold in packs of 5**)

R1:	47k-Ohm	(Yellow-Violet-Orange)
R2:	220 Ohm	(Red-Red-Brown)
R3:	10k-Ohm	(Brown-Black-Orange)
R4:	220k-Ohm	(Red-Red-Yellow)
R5:	1k-Ohm	(Brown-Black-Red)
R6:	330 Ohm	(Orange-Orange-Brown)

An LED of your choice to indicate the trigger pulse
(blue or white might use too much current, choose another color. See "bulk" section below.)

D1, D2: **2 diodes** (see "bulk" section below.)

Q1: **NPN transistor** (tested with 2N3904) (see "bulk" section below.)

C3: **1uF dipped tantalum capacitor** 272-1434 1.60
(any 1uF capacitor will do: tantalum, metalized-film, electrolytic, polarized or not)

A box to put it in (each sensor PCB is designed to fit Radioshack enclosure 270-1802.)

A terminal strip to attach external wires (see "bulk" section below.)

For the power-supply circuit:
(Multiple sensors only need one power-supply)

Battery holder and battery
The circuit requires 9 volts, and it will run great on a 9 volt battery. If you make more than 2 or 3 circuits, you might want to use AA batteries for longer run-times.
9V battery clips 270-324 (sturdier construction) or 270-325 2.00
8 AA battery holder 270-387 2.00
(you only need to hold 6 batteries, perhaps combine a 4AA and a 2AA?)

A toggle switch to turn it off and on
(you need the simplest kind ("SPST") but any will do, like 275-613 $3.80)

Electrolytic capacitor for the power-supply circuit.
(Each sensor needs at least 100uF, so 10 sensors need 1000uF. More is OK.)

An **LED** and **330 Ohm resistor** to indicate main power

Things you should buy in bulk:

Copper Clad board 276-1499 4.50
(Each of these is big enough to create about 4 sensor PCBs)

a **spool of wire** for the light-detectors and such
(any 18-24 gauge 2-conductor stranded cable)

1N914/4148 Diodes (10-pack) 276-1122 1.49

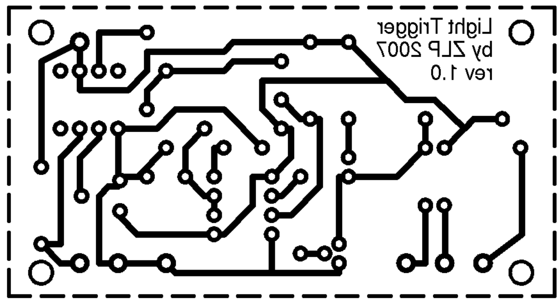
NPN Transistors (15-Pack) 276-1617 2.60

CdS Photoresistors (5-Pack) 276-1657 3.00
(one each per sensor, but some will work better than others.)

Ceramic Capacitor Assortment 272-801 4.50
(There may be enough .01uF caps in here for multiple sensor circuits.)

12-Position European-Style Mini Terminal Strip 274-680 2.60
(This provides a convenient place on the outside of your box to screw in the light-detector wires. Depending on how you organize your wiring, you might only need a few of those 12 terminals for each sensor circuit.)

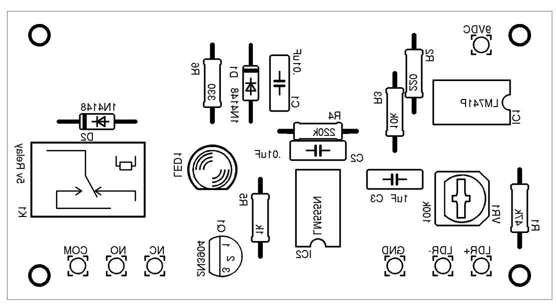
THE PCB PATTERNS



This is the **bottom** side of the PCB.

(check size! From center to center, the corner holes are 2.5" apart horizontally.)

It is ready to print with a laser printer and iron onto a **clean** copper-clad board until the toner transfers. Then dissolve the paper with water and **gentle** rubbing. Make corrections with a Sharpie marker. Etch in a bath of ferric chloride *(safety precautions folks!)* until the excess copper disappears. Then clean the board with denatured alcohol and lightly sand off excess toner with steel wool.



This is the top side of the PCB.

After etching the bottom side, the top should have no copper on it. Drill out the corner holes, wash it down with alcohol, and align the top side printout with the holes.

Check to make sure it's rotated the right direction!

There's no etching on this side. The toner that is transfered onto the board will be your guide when you place the components on the board. Drill the holes for each solder-pad with a tiny #60 bit. You will break bits unless you use some sort of jig or dremel drill-press.

For step-by-step instructions, go here:

http://www.instructables.com/id/Cheap-and-Easy-Toner-Transfer-for-PCB-Making

(You won't need to flip your image or use special paper like they did.)