Electronics Made Easy, Part 2
Controlling the Alternating Flashing Lights

A year ago we spend some time and built an electronic circuit that could be used for a railway grade crossing that would cause the lights to flash in an alternating fashion. The flash rate was also adjustable with the used of a potentiometer. The minimum and maximum flash rates could be adjusted by changing a couple of components, namely the resistors and capacitor. If you were adventuresome you could modify the circuit and convert this project into an adjustable strobe light. On its own this project was simple and a great introduction into the world of electronics.

Now has come the time to build an automatic control circuit to activate the flasher board. This circuit will build on what you learnt in part 1 but it is a completely separate project so if you did not complete the first project it doesn't matter and you can decide to build it later on you own.

What is it that we really want to do in this project?

The first thing we need to do is decide what we actually want to be able to accomplish in this project so let us start with that. It's great that we build the alternating flashing light circuit but the only way can control it is to apply power to the circuit and the lights start to flash. In the real world as a train approaches a grade crossing the alternating flashing lights come on automatically and shut off after the train has past. We should try to replicate that operation on our train layout.

This operation can be summed up by the following sequence of events.

- Sense the approaching train.
- Start the lights flashing.
- Maintain the lights flashing while in the crossing.
- Stop the lights flashing shortly after the train has cleared the crossing.

All in all this sounds simple and it really is simple. To accomplish this with electronics we will need to understand how to convert the above sequence of events into some electronics components that will do this for us over and over again with out any input from us. Here is that breakdown.

- Supply power to the electronics.
- Sense when the trains is near the crossing, from either direction.
- Turn on power to the flasher circuit.
- Maintain the power to the flasher circuit while a train is anywhere in the grade crossing zone.
- Turn off the power to the flasher board once the grade crossing zone is clear.

Let us look at each of these items one at a time to see how this happens.

Supplying power to the electronics.

This can be done in a number of ways. Last year we used a simple 9 volt battery to power the flasher circuit. Again this would be one option but eventually we will need to replace this battery as it will be drained to the point where it can no longer supply power to our circuits.

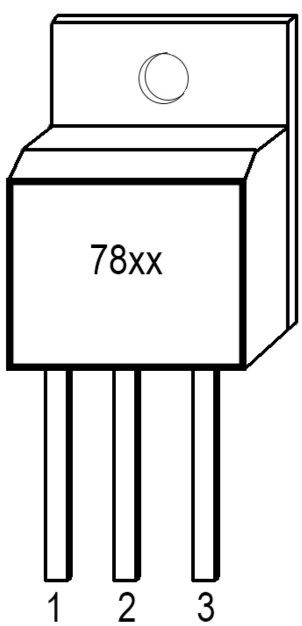
As an alternative I would suggest that we use a simple wall pack adapter that has an output voltage in the range of 6 to 18 volts AC or DC along with a minimum rating of 100 ma, milliamperes, to as much as 1 ampere, in other words 1000 ma. We will use this supply to operate the circuits on our layouts. For testing while working on the workbench or table we can continue to use the 9 volt battery.

Since we are dealing with a wide range of voltages and two different voltage types we need to condition this power into a consistent power supply for our circuits. The most common choice of voltages to use for these circuits would be 5 volts DC.

The circuit we build for this will only consist of a few components and they are listed here. A complete listing including part numbers is located at the end of this document.

- circuit board
- bridge rectifier
- IC socket (dip socket)
- 5 volt regulator
- 220 uf 25 volt capacitor
- 220 ohm resistor
- 3mm Red LED
- terminals (2)

78xx Voltage Regulator



The 78xx series of voltage regulators allow for a DC voltage to be applied to the input terminal as long as it is at least equal to the regulator rating on pin 1, and the fixed voltage of the regulated voltage is then available at the output, pin 3. To complete the connections pin 2 is connected to the common lead on the power supply. Pins are labelled from left to right.

These regulators are available in a number of possible output voltages.

7805 - 5 volts
7808 - 8 volts
7809 - 9 volts
7812 - 12 volts
and so on.

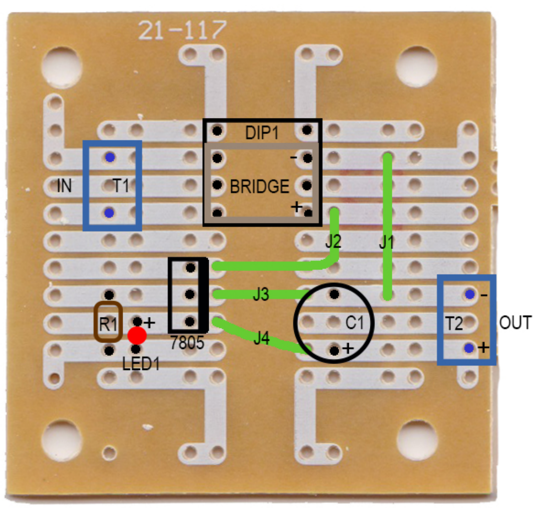
Bridge Rectifier

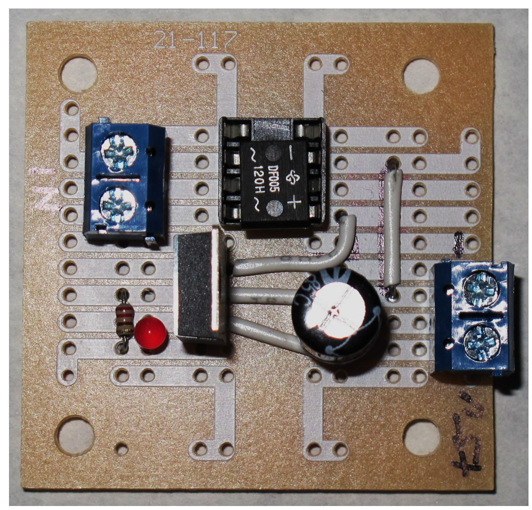
A bridge rectifier is a simple device and is simply used to take a supply voltage, AC or DC, and convert to a DC voltage with the correct polarity. A bridge rectifier is nothing more that four diodes that have been connect in a particular pattern.

Other Items

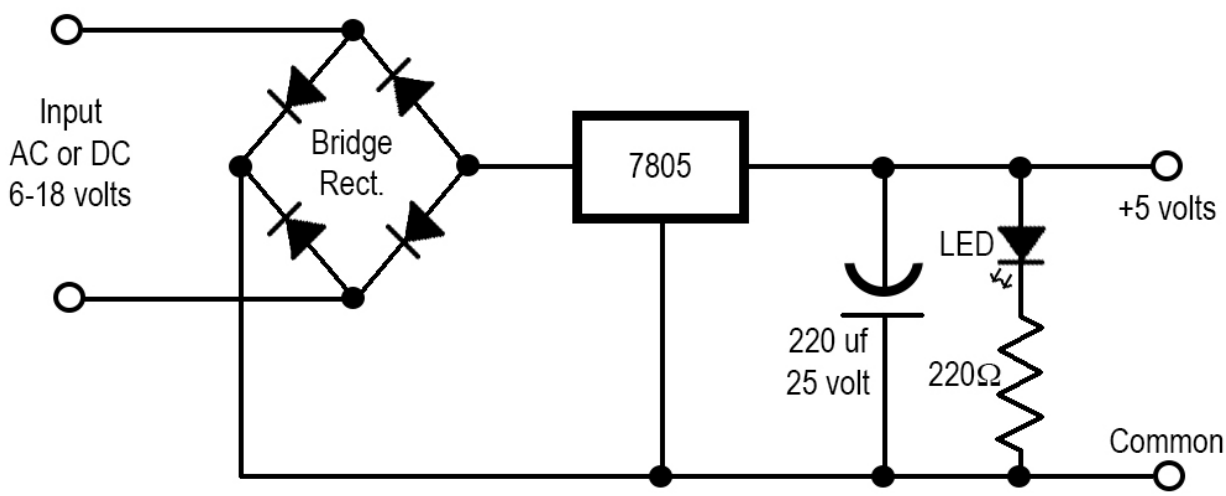
The other items we are using for this circuit are all items that have encountered before in the first electronic project, the alternating flashing lights. There is no real need to review these parts at this time.

Sown here on the left is the printed circuit board showing the component layout including the jumpers. On the right is the completed board.





The circuit is simple and the schematic diagram is shown below.



As shown in the diagram the wall pack adapter or battery is connected to the input terminals. From here the power passes through the bridge rectifier where the incoming electrical power is conditioned from its original state to a dc voltage with the proper polarity. The positive lead is connected to the input lead of the voltage regulator. Common is connected to the negative lead and the output lead is exactly that, the +5 volt lead. At this point the 5 volts we see at the output of the regulator may not be a very steady voltage so have one more step to the conditioning to perform. An electrolytic capacitor, which is polarity sensitive is connected to the output lead and common connection points. This will smoothen out most if not all of output voltage so that have a steady 5 volt supply. The output leads are connected to the output terminals so that we have a location to connect wires to other circuits.

If you have been keeping track of the components you would have noticed that there is a resistor and a LED remaining. These two items are connected in series with each other and are connected to output leads, +5 and common. This LED serves two purposes first is to indicate that there is 5 volts at the output terminals and secondly if no circuits are connected to the output terminals this will allow the capacitor to discharge the stored energy when the supply voltage has been stopped.

That completes building the voltage regulator portion of this project.

Building the detection circuit.

Now we need to build the detection circuit which can be broken down into four sections.

- Supply an invisible light source
- Detect when the invisible light source is interrupted
- Turn on the output
- Turn off the output after a delay

For the detection circuit we will again need some components and there are more than the a few. A new integrated circuit, IC, is a dual channel comparator that will be used in the detection portion of the circuit. An IC that we are familiar with will be used to create a time delay, the common 555 timer. This is the same IC we used in the grade crossing flasher project.

To build this project there are a few new pieces that we haven't used in the previous circuits. We will take a look at these pieces now.

IR Emitter

The IR emitter is a LED very similar to what we have used in the past but this one produces non-visible light, inferred. This is a light that is above the visual light spectrum and in our project the light produces a light wave frequency of 940 nanometers.

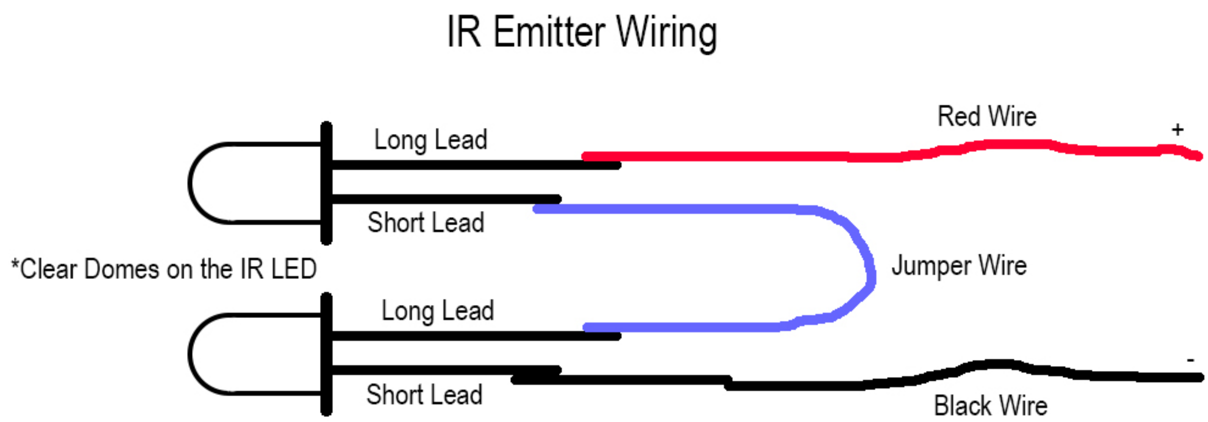
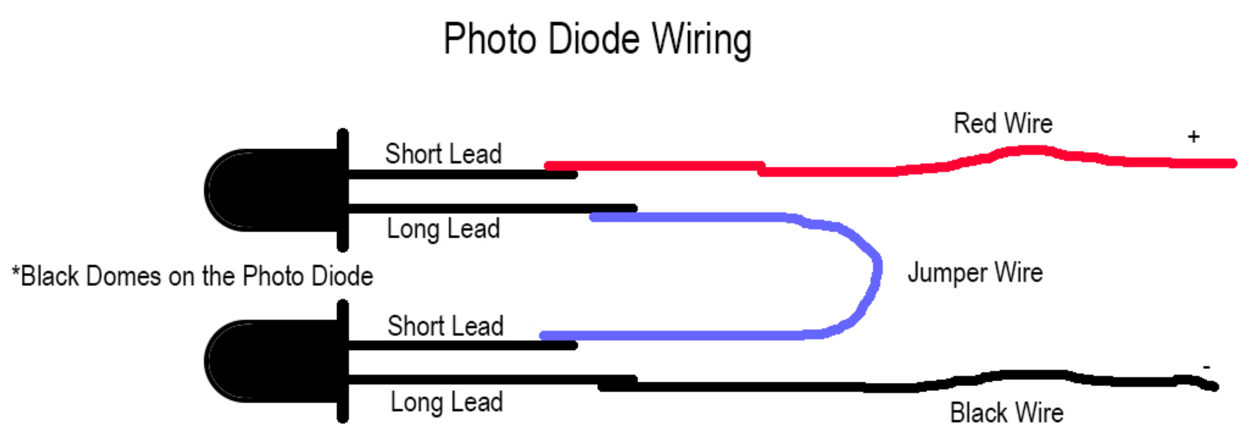


Photo Diode

The photo diode, IR detector, is a light sensitive switch. In this case the photo diode we are using is most sensitive to 940 nanometers. Some photo diodes like the one we are using has a dark outer coating which is a ND, neutral density, filter. This blocks most of the visible light so that the photo diode will ignore other light sources.

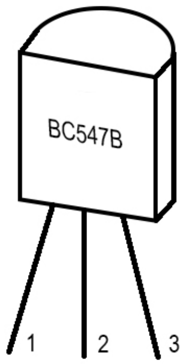


Dual Channel Comparator

This is an IC chip, LM2903, that will look at voltage supplied to two inputs and will compare these voltages to each other. If the voltage difference between these two inputs is great enough the out pin is triggered. For this project use this output pin to trigger the 555 timer IC.

NPN Transistor

This is the last new piece to our project, BC547B, and it is nothing more than an electronic switch similar in operation to a relay. The output from the 555 timer is used to turn on this transistor allowing the electrical path of the common to be connected to the output terminals. Connected to the output terminals is our alternating flashing light project that we built in part 1. We could connect the alternating flashing light project

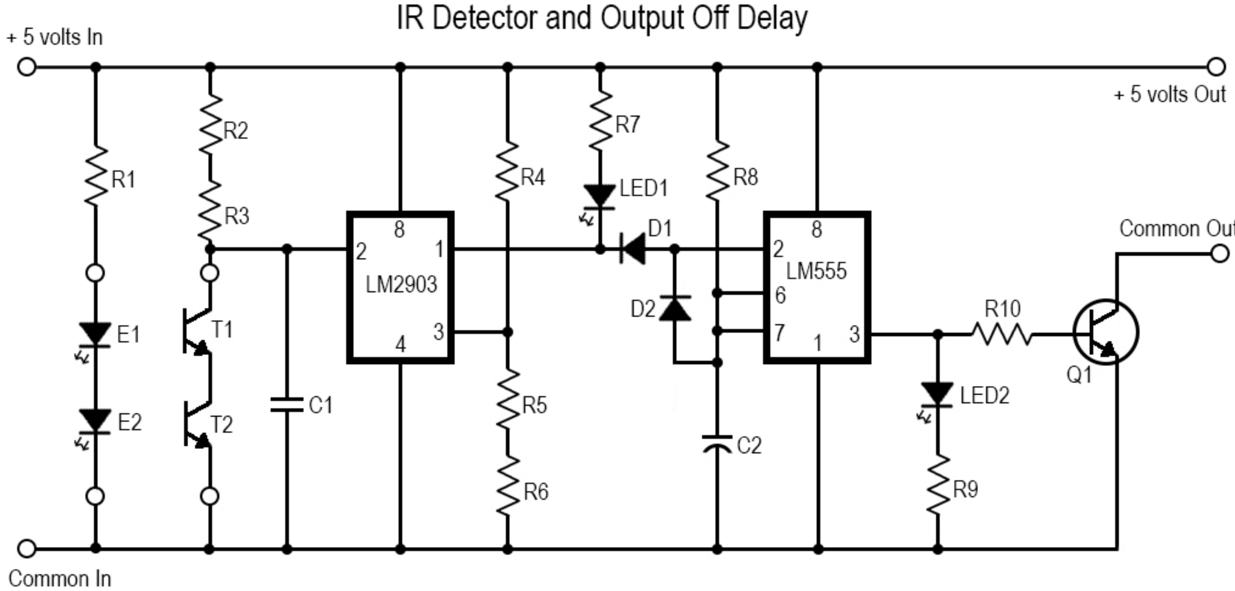


directly to the 555 timer but the amount of current that is required for this flashing circuit could damage the 555 timer. The transistor is capable of handling the needed current with out damage.

Pin 1 is the Common Out.
Pin 2 is connected to the output from the 555.
Pin 3 is connected to the circuit common.

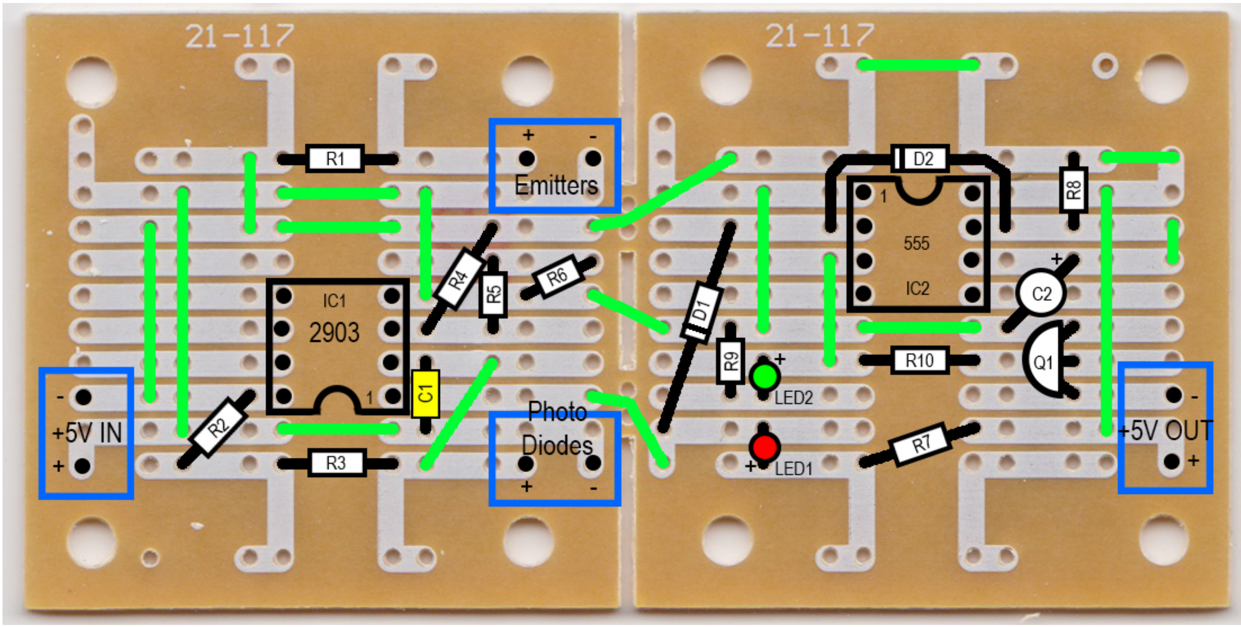
The Circuit

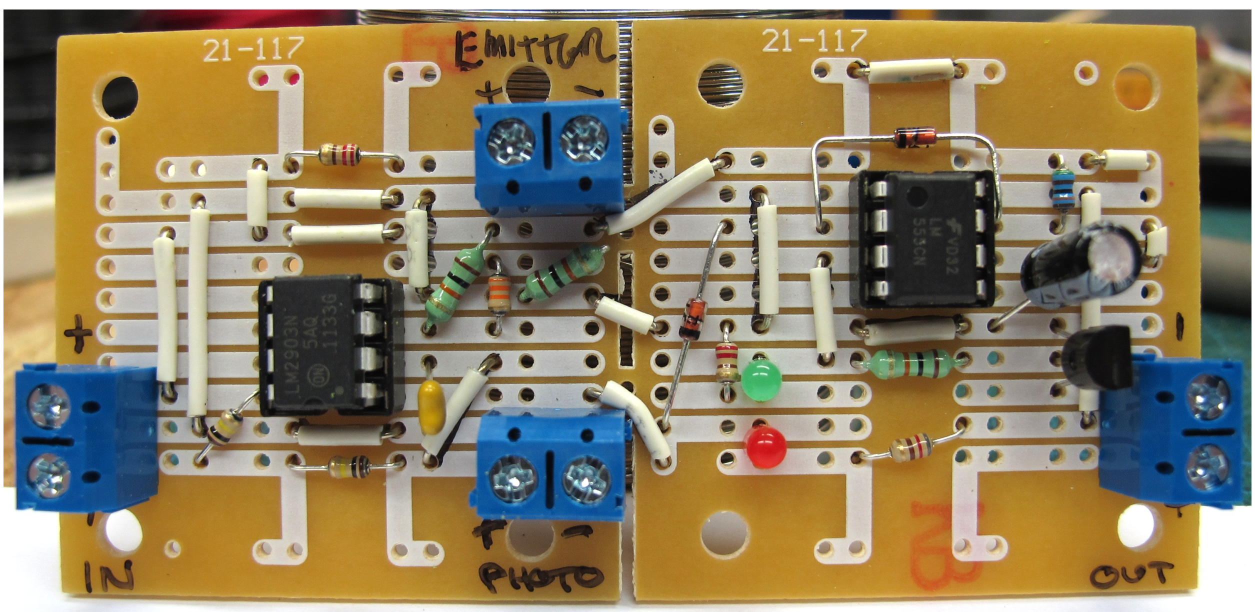
IR Detector and Output Off Delay



Part	Value	Part	Value	Part	Value	Part	Value
R1	220Ω	R6	10KΩ	C1	0.1μf	E1,2	OLF-5102
R2	100KΩ	R7	820Ω	C2	10μf	T1,2	BPV10NF
R3	100KΩ	R8	510KΩ	D1	1N914	LED1	Red
R4	10KΩ	R9	220Ω	D2	1N914	LED2	Green
R5	33KΩ	R10	10KΩ	Q1	BC547B		

Board Layout





Sometimes it helps to install the different components in an order that makes them easier to solder on the bottom side. As an example if you were to install capacitor C1 first and then tried to install the jumpers the board would not lay down flat when you turn it over to solder the leads. Here is a list of the components in the order that I would suggest would make it easier to build.

- All 18 Jumpers, two of the jumpers that cross the middle of the board need slight kinks in the wires.
- All Resistors, R1 to R10. Leave R6 until the end.
- Add the 2 DIP8 sockets for IC1 and IC2. Note the notches to orient them to pin 1.
- Add LED1 and LED2. Note the + lead, longer lead, connects to the correct location.
- Add D1 and D2. Note the black stripe on one end of the diode.
- Add C1.
- Add the 4 blue terminal blocks. Opens for the wires should face to the boards edges.
- Add Q1.
- Add C2. Note the + terminal and connect properly.
- Insert the 2903 and 555 IC's. Note the location of pin 1 for each.
- Add any writing to the board to identify the connections.

This is the list, take your time and you should be fine.

Inside the kit

Everything listed in the L2 column of the parts list is included in the kit along with a length of #22 awg solid wire and a length of fine solder.

The hardest parts to identify are the resistors so here are the colour codes for the resistors that are in the kit.

220 ohm	Red, Red, Brown
820 ohm	Gray, Red, Brown
10K ohm	Brown, Black, Orange
33K ohm	Orange, Orange, Orange
100K ohm	Brown, Black, Yellow
510K ohm	Green, Brown, Black, Orange (Green, Black Yellow)

Parts List

L1 = Power Conditioner
L2 = Detection Circuit

L1	L2	Description	Part #	Newark #
1/2	1	PC Board	MCM21-4610	38C9104
1	2	220 ohm Resistor, 1/8 watt	MCRE000029	24R6883
	1	820 ohm Resistor, 1/8 watt	MCRE000036	24R6890
	3	10K ohm Resistor, 1/8 watt	MCRE000049	24R6903
	1	33K ohm Resistor, 1/8 watt	MCRE000055	24R6909
	2	100K ohm Resistor, 1/8 watt	MCRE000061	24R6915
	1	510K ohm Resistor, 1/8 watt	MF12 510K	38K5492
	1	0.1 μf Capacitor	SR205E104MTR	98K1025
	1	10 μf, 16 volt Capacitor	MCRH16V106M5X11	70K9740
1		220 μf, 25 volt Capacitor	MCGPR25V227M8X11	70K9684
	2	Diode	1N914	58K9617
1	1	3mm Red LED	MCL514MD	14N9470
	1	3mm Green LED	MCL514GD	14N9469
	2	5mm IR Emitter, 940nm	OLF-5102	15R2144
	2	Photo Diode (Detector)	BPV10NF	32C9136
2	4	2 Post Terminal	MC24356	14N5685
1		Voltage Regulator, +5 volt	MC7805CTG	88H4758
	1	Dual Channel Comparator	LM2903NG	45J0726
	1	555 Timer	LM555CN	58K8943
	1	NPN Transistor	BC547B	08N8056
1		Bridge Rectifier	DF005M-E3/45	65K2441
1	2	8 pin DIP Socket	DILB8P-223TLF	53K0893
as needed		Jumper Wire, #22 awg solid	WHS-09-100	25P9318

Newark Canada can be found on the Internet at http://canada.newark.com