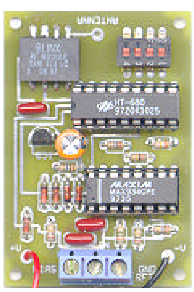
GLOLAB

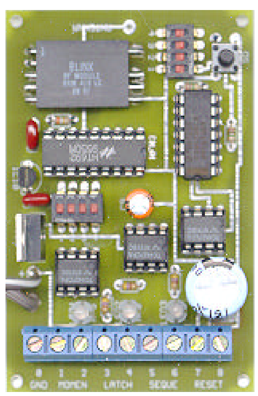
Wireless Control

Introduction

This project was published in the April 1999 issue of Popular Electronics magazine.

Today wireless is used almost everywhere for almost everything. Devices are available to send audio, video, security data, computer data, to open garage doors and turn on lights. However, for a specific control or pulse application not covered by one of these available devices you usually have to build your own. In the past, building a simple and reliable RF transmitter and sensitive receiver was not easy. And after building them some difficult adjustments and measurements would have to be made to set operating frequency, minimize harmonic radiation and maximize sensitivity.





But now, thanks to new transmitter and receiver modules from Linx Technologies, all of those problems are things of the past. You simply apply power to the transmitter which is SAW (Surface Acoustic Wave) based for accurate frequency control and attach an 6.7 inch whip antenna to send data. The same is done for the receiver which is a SAW based superhetrodyne having excellent stability and sensitivity. Absolutely no adjustments of any kind are required. The modules operate at 418 Mhz with a range of better than 300 feet. This WIRELESS CONTROL project uses these modules to send and receive control signals that can be used for a variety of purposes.

Most wireless devices that are not dedicated to, or a part of a video, audio or computer system simply indicate the pressing of a push button or closing of a switch. But the WIRELESS CONTROL transmitter circuits will accept inputs from switches, electronic devices such as photo transistors, microprocessors, computers and other devices that produce conduction or voltage levels. It will send data indicating both the closing and opening of a switch, both the conduction and turn off of an electronic device and both the rise and fall of an input voltage. The receiver has three complementary outputs that cover almost any application. One is momentary, another latched and another sequential. You are no longer bound by those push button devices that were the only thing available until now!

How it works

Transmitter

Figure 1 is a schematic of the transmitter. IC1 is a Maxim MAX934 quad micropower comparator with a built in voltage reference. C1 filters any RF that may enter the input from the antenna. IC1A receives an input through R3 which adds isolation allowing the input to accept high overdrive voltages without damage. Electrostatic discharge protection diodes built into the MAX934 inputs are rated at 20ma and can easily clamp the overdrive from R3. Hysteresis feedback through R4 adds switch debounce and noise immunity. R2 is a 1.6 microampere current source that pulls the input to an up level turning IC1A on. The input is very sensitive because of this low pull up current and can be pulled down below the switching threshold by an input device having an impedance of about 1 megohm. It can be pulled down by closing a switch, by a photocell, a water detector or by other sensing elements. An external voltage can also be applied to the input to switch it on and off. The switching threshold is approximately equal to the internal reference voltage of 1.2 volts. One end of 100 Kohm resistor R1 is brought out to a bias terminal so it can be connected to the input through an external potentiometer or resistor to provide sensitivity and threshold adjustment when used with a photocell or similar device. The maximum current available from the bias terminal is 50 microamperes.

IC1B inverts the output of IC1A making both phases of the input signal available. A positive transition from IC1A will couple through C2 and D1 into IC1C and a positive transition from IC1B will couple through C3 and D2 also into IC1C, therefore, whenever the input goes either up or down, a positive pulse is coupled into IC1C. The time constants of either C2 and R5 or C3 and R5 turn IC1C on for about 2 seconds as C2 or C3 discharges. D3 recharges C2 and D4 recharges C3 during negative transitions. R6 and R7 add hysteresis feedback to IC1C for stability during the slow discharge of C2 and C3. The output of IC1C triggers the transmit module on for about 2 seconds through inverter IC1D and Holtek HT680 encoder IC2. Upon being triggered by IC1D, the encoder generates three groups of bits containing data and address information and serially sends them to the transmit module. These three groups are repeatedly transmitted during the 2 second duration of the trigger pulse. Both phases of the input signal are also sent to data pins 3 and 4 of the encoder to transmit unique codes for an input opening and closing.

The encoder can be programmed by 4 position DIP switch SA for 16 different addresses so that more than one pair of transmitters and receivers can be used in close proximity without interference. The circuits are powered with 5 volts through reverse polarity protection diode D5 and Telcom TC55RP5002EZB low dropout micropower regulator IC3 by a 6 or 9 volt battery.

Receiver

Figure 2 is a schematic of the receiver. The output from the receive module feeds through level shift diode D6 into Holtek HT692 decoder IC4 which can be programmed by DIP switch SB for 16 different addresses to match the transmitter. The decoder sequentially receives the three groups of bits containing data and address information, stores them and compares them with each other. If two of them match, the decoder data output pins 3 or 4, depending on the transmitter input, go to an up level and remain there as long as a valid data stream is being received. This coding technique ensures that only valid data will get through and random noise pulses will be rejected.

The two outputs from the decoder pins 3 and 4 that correspond to the encoded data in the transmitter are fed into a Telcom TC4427 dual, level translating power driver IC5 and into CD4013 flip flops IC6A and IC6B.

IC5A and IC5B supply complementary 12 volt momentary pulses at up to 200ma source or sink to whatever loads you may want to drive. A set-reset push button and three, status LEDs are mounted on the board for easy testing. LED1 is a dual color LED that shows momentary data being received.

Flip flop IC6A can be programmed by SC to be both set and reset by the decoder outputs or to be set by one of the outputs and reset by push button SD. It can also be reset by one of the outputs and set by SD. The latched outputs of IC6A feed into power driver IC7 that provides complementary 12 volts at 200 ma source or sink. LED2 indicates the state of IC6A.

Flip flop IC6B is triggered by the decoder output that represents a transmitter input going down. It will alternately flip each time the input goes down. The latched outputs of IC6B feed into power driver IC8 that also provides complementary 12 volts at 200ma source or sink. LED3 indicates the state of IC6B.

The receive module, IC4 and IC6 are powered by 5 volts through regulator IC10 while IC5, IC7 and IC8 are powered by 12 volts through regulator IC9 from DC wall transformer T1.

The six outputs give great flexibility in the type of loads that you can drive. The momentary outputs from IC5 at terminals 1 and 2 will give a short beep if a piezo buzzer is used. It can indicate a transmitter input closing or opening, or both if two buzzers are used with different tones. The outputs from IC7 at terminals 3 and 4 will latch in different states and thus exactly correspond to an input closing and opening or it can be programmed to latch on closing only or opening only and be manually set or reset by SD. This is useful to store the results of temporary event such as a mailbox door being opened by the postman. The outputs from IC8 at terminals 5 and 6 can be used to sequentially turn a lamp on and off through a relay each time a contact is closed at the transmitter. Since the power drivers supply 12 volts and can source or sink 200ma continuous and more than 1 amp peak, many different types of loads can be driven either directly or through mechanical or solid state relays.

Construction

Boards

Because the transmit and receive modules are of the surface mount type they are already mounted on PC boards. Both of the boards are double sided to provide a good ground plane for the modules and to keep all components on the same side of the board.

Sockets are used for all of the DIP ICs. To assemble the boards mount all of the small components first, then add the sockets and terminal blocks. Connections for a remote set-reset button at terminals 7 and 8 and all outputs are available on the terminal block. Mount the LEDs with the long lead on the bottom when the board is viewed from the component side with the receive module at the top. After all components are mounted solder the leads from a 9 volt battery connector or from a four or six cell holder to the transmitter board holes marked plus v and minus v. Connect and solder the wall transformer leads to the holes marked plus and minus on the receive circuit board near IC9. Connect the positive lead with the white tracer to plus hole. The boards may be installed in enclosures of your choice or used without enclosures. Mounting holes for 2-56 screws are provided in the corners of each board. If an enclosure is used for the receiver, a set-reset button and one or more LEDs may be mounted in the enclosure panel for easier button access and LED viewing. The antennas are stiff pieces of wire 6.7 inches long connected to the antenna terminals. The transmitter is powered by a 9 volt battery or four to six AA or AAA cells. The larger number of cells will extend battery life by providing a reserve voltage above that which is required.

Testing

Connect a 9 volt battery or four to six 1.5 volt cells to the transmitter. Plug the receiver wall transformer into a receptacle. Set switches SA in the transmitter and SB in the receiver for all positions OFF, all ON or anywhere in between. However you set them, they must be the same in each transmitter - receiver pair. Connect a temporary SPST test switch from the transmitter input to ground.

Set SC1, SC2 ON and SC3, SC4 OFF. LED1 should not be lit. Both LED2 and LED3 should be either red or green. Close the input switch and LED1 should momentarily light red (blink) for two seconds and then turn off, LED2 should light red and remain lit and LED3 should change color. Open the input switch and LED1 should blink green, LED2 should light green and remain lit and LED3 should remain as it was.

Set SC1 OFF, SC2 ON, SC3 ON and SC4 OFF. Press SD to change LED2 to green if it is not already green. Close the input switch and LED1 should blink red, LED2 should light red and remain lit and LED3 should change color. Open the input switch and LED1 should blink green, LED2 should remain red and LED3 should not change.

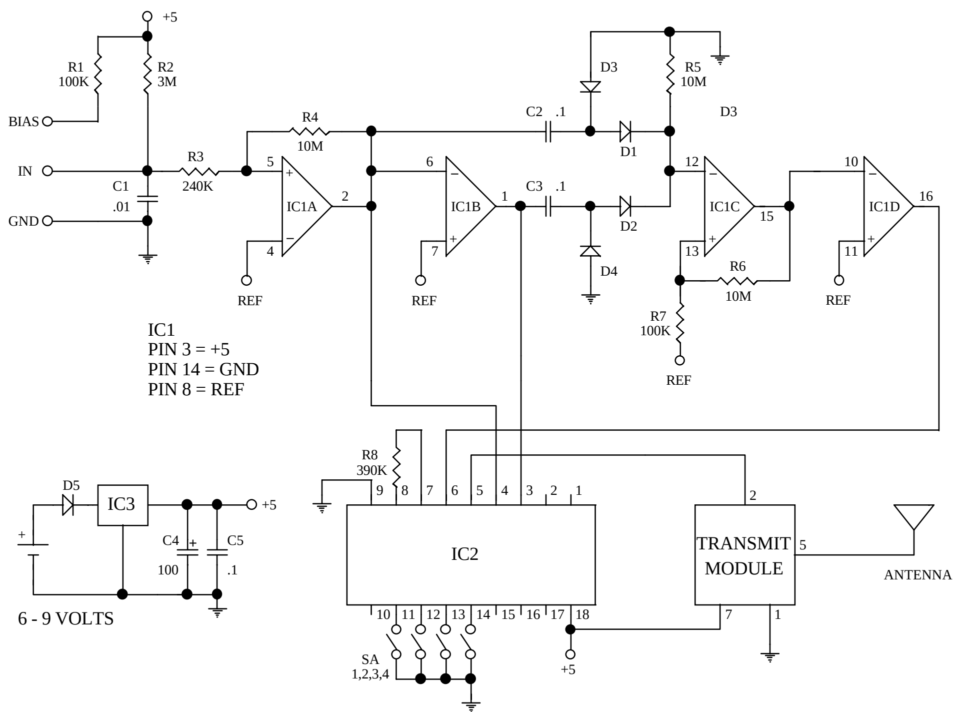
Press push button SD and LED2 should change to green.

Set SC1 ON SC2 OFF, SC3 OFF and SC4 ON. Press SD to change LED2 to red if it is not already red. Close the input switch and LED1 should blink red, LED2 should remain red and LED3 should change color. Open the input switch and LED1 should blink green, LED2 should change to green and LED3 should not change. Press SD and LED2 should change to red.

Repeat each of the above tests a few times after changing the SC switch settings as some toggling of the latch may occur during the setting of the switches.

Table 1 shows SC switch settings for input and output conditions.

NOTE: The transmitter and receiver modules used in these kits are not certified by the Federal Communications Commission. Assembled kits cannot be sold as a product without being FCC certified. The kits are intended for personal or experimental use.

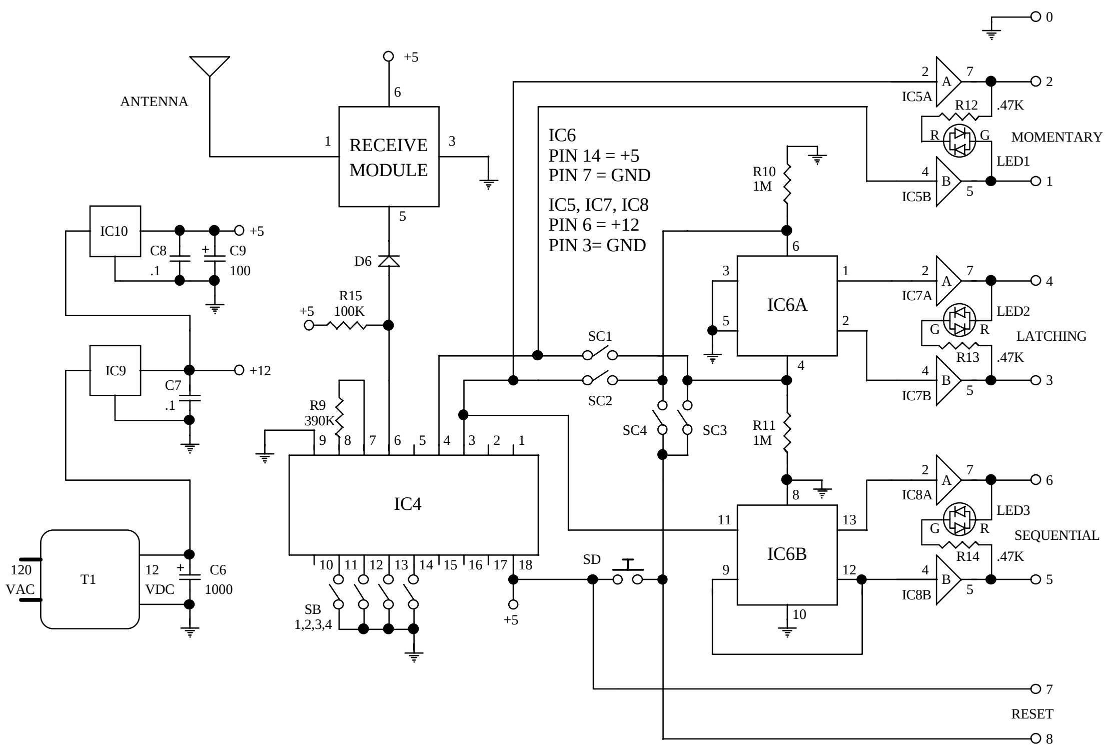


WIRELESS CONTROL TRANSMITTER

FIGURE 1

Glolab Corporation
134 Van Voorhis
Wappingers Falls, NY 12590

http://www.glolab.com
email kits@glolab.com
fax (914) 297-9772



WIRELESS CONTROL RECEIVER

FIGURE 2

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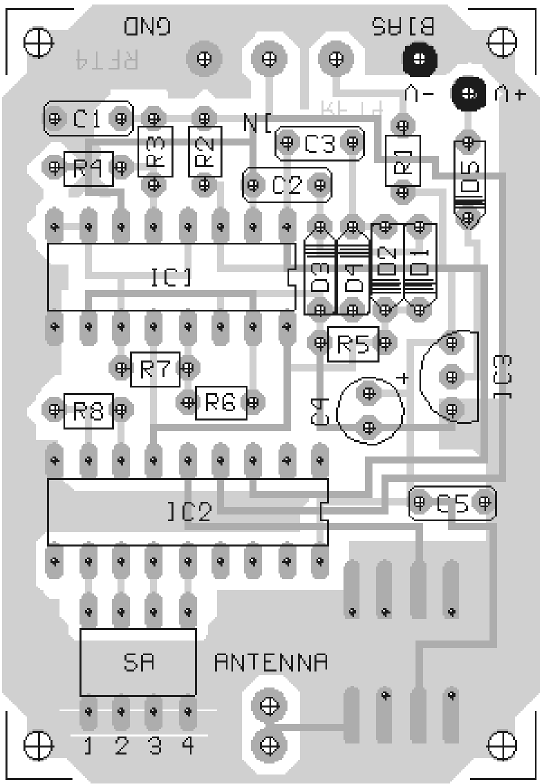
Wireless Control

Receive board 2.2" X 3.2"

Transmit board 1.6" X 2.3"



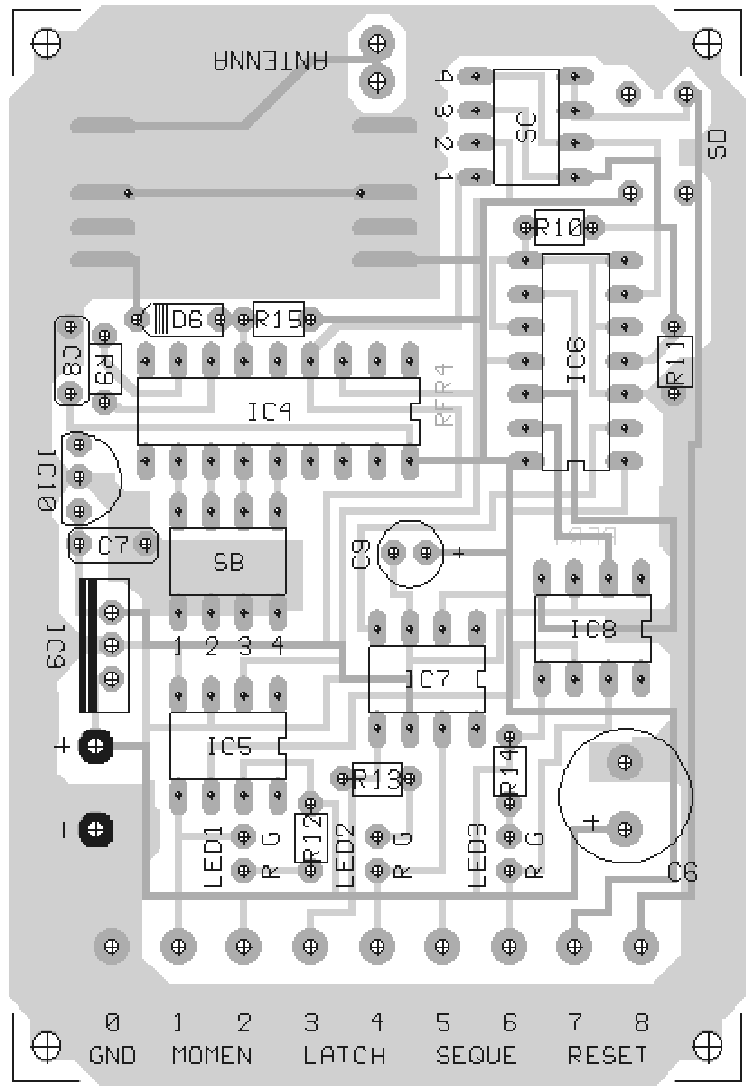


FIGURE 3

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Wireless Control

XMIT	SC SWITCH SETTINGS				TERMINAL BLOCK NUMBERS					
INPUT	**SC1**	**SC2**	**SC3**	**SC4**	**1 ***	**2 ***	**3**	**4**	**5**	**6**
CLOSED	ON	ON	OFF	OFF		R		R	TOG	TOG
OPEN	ON	ON	OFF	OFF	G		G		NC	NC
CLOSED	OFF	ON	ON	OFF		R		R **	TOG	TOG
OPEN	OFF	ON	ON	OFF	G		NC	NC	NC	NC
CLOSED	ON	OFF	OFF	ON		R	NC	NC	TOG	TOG
OPEN	ON	OFF	OFF	ON	G		G **		NC	NC

CLOSED = Transmitter input at a down level
OPEN = Transmitter input at an up level
R, G = Red or Green LED indicates a terminal at an up level
* = Momentary - terminal at up level for two seconds
** = Can be reset to opposite color by pressing SD
TOG = Toggles to opposite color
NC = No change

TABLE 1

Parts List

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Wireless Control

Wireless Control Transmitter parts	Wireless Control Receiver parts
R1, R7 - 100K 1/8 watt 5%	R9 - 390K 1/8 watt 5%
R2 - 3 MEG 1/8 watt 5%	R10, R11 - 1 MEG 1/8 watt 5%
R3 - 240K 1/8 watt 5%	R12, R13, R14 - .47K 1/8 watt 5%
R4, R5, R6 - 10 MEG 1/8 watt 5%	R15 - 100K 1/8 watt 5%
R8 - 390K 1/8 watt 5%	C6 - 1000 MFD 25 volt electrolytic
C1 - .01 MFD 100 volt polyester film	C7, C9 - .1 MFD 50 volt metalized film
C2, C3, C5 - .1 MFD 50 volt metalized film	C8 - 100 MFD 10 volt electrolytic
C4 - 100 MFD 10 volt low leakage electrolytic	D6 - 1N914 diode
D1, D2, D3, D4, D5 - 1N914 diode	LED1, LED2, LED3 - red-green dual-color
SA - 4 position DIP switch	LED standoff - three
3 position terminal block	SB, SC - 4 position DIP switch
IC socket 16 pin	SD - momentary push button switch
IC socket 18 pin	9 position terminal block (3 - 3 pos. blocks)
IC1 - Maxim MAX934 micropower comparator	IC sockets three 8 pin
IC2 - Holtek HT680 encoder	IC socket 14 pin
IC3 - Telcom TC55RP5002EZB 5 volt regulator	IC socket 18 pin
9 volt battery connector	IC4 - Holtek HT692 decoder
Antenna terminal block	IC5, IC7, IC8 - Telcom TC4427 power driver
6.7 inch antenna wire	IC6 - National CD4013 dual D flip flop
Circuit board with transmit module	IC9 - National 7812T 12 volt 1 amp regulator
	IC10 - National 78L05 5 volt 100 ma regulator
	T1 - 12 volt 200 MA DC wall transformer
	Antenna terminal block
	6.7 inch antenna wire
	Circuit board with receive module

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Applications

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Wireless Control

The transmitter sends a unique digital code when the input goes from a down level to an up level and another unique digital code when the input goes from an up level to a down level. A down level is defined as any voltage lower than the threshold voltage of +1.2 volts down to -50 volts. An up level is defined as any voltage higher than +1.2 volts up to +50 volts. The input range is limited only by the voltage rating of C1. Since the transmitter sends information to the receiver telling it both when the input is going up and when it is going down, it is not necessary to be concerned about whether your input device is normally open or normally closed. One of the many receiver output options can be chosen to give the desired response.

The input terminals may be driven by TTL or CMOS levels from a computer, microprocessor or logic circuit as shown in Figure 1.

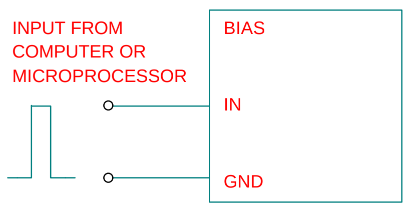

Figure 1

A simple input device is the push button switch shown in figure 2. When the switch is open, the input is pulled up to 5 volts by internal resistor R2. When it is closed, the input is connected to ground.

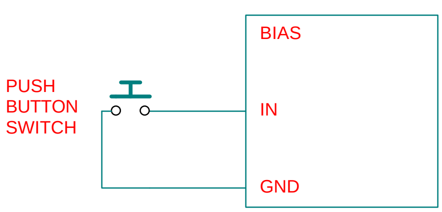

Figure 2

Another switch is the magnetic reed in figure 3 which is activated by a magnet being placed close to it. This is good for non contact applications such as placing the switch on a window frame and the magnet on the window so that the switch will activate when the window is opened. Another useful application is to use the switch to signal when the mail man opens the mailbox door.

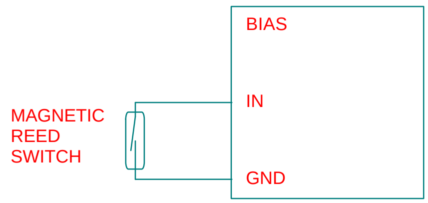

Figure 3

And yet another form of switch is the thermostat in figure 4. It can either close or open in response to hot or cold and be used to signal a below freezing condition or as a remote control for an air conditioner , oil burner or electric heater when used with the appropriate output configuration at the receiver.

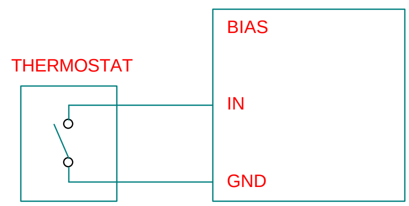

Figure 4

Figure 5 shows a water level detector that can be used to signal a leak in the basement. The probes can be placed on the floor near the water softner or heater tank. Probes can also be placed in soil near a plant to indicate when it should be watered.

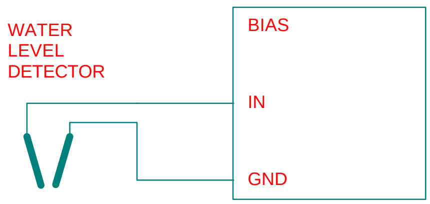

Figure 5

Figure 6 is also a water detector but is more sensitive because the detection area is larger. A piece of printed circuit board with interleaved traces detects small quantities of water. This probe can be placed near a window or patio door to signal rain entering.

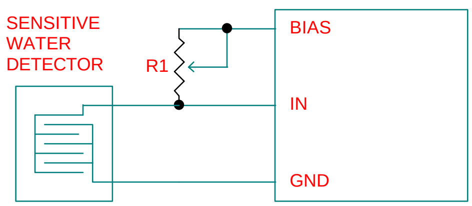

Figure 6

A resistive photocell of cadmium sulphide or other photo sensitive material connected to the input as shown in figure 7 forms a very simple light sensor. It can be used to signal a basement or attic light left on or an emergency exit light failure. 10 mfd capacitor C1 reduces 60 Hz pickup from fluorescent lights.

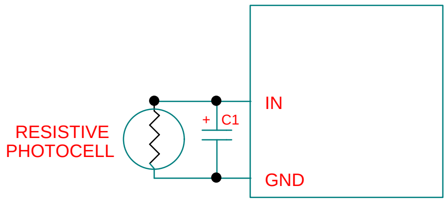

Figure 7

Figure 8 shows a similar photocell but with the addition of a variable resistor connected from the bias terminal to the input to vary the sensitivity of the photocell to light. This is useful to adjust for the amount of light needed to switch the circuit, such as when using it to sense daylight and turn a lamp off. The bias terminal will supply up to 50 microamperes through its internal 100 Kohm resistor.

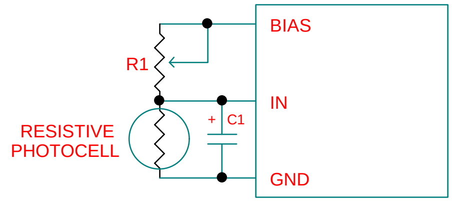

Figure 8

Figure 9 is similar to figure 8 except a photo transistor is used in place of the resistive photocell. It can be used as a robot proximity or direction sensor.

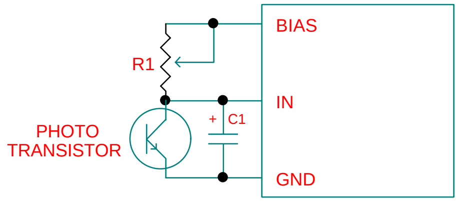

Figure 9

A single Light Emitting Diode may be connected from any output pin to ground with a series current limiting resistor as shown in figure10. Resistor R1 can be about 470 ohms for a LED current of about 20 milliamperes.

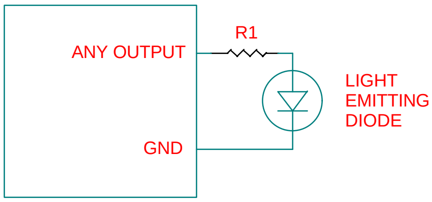

Figure 10

Figure 11 shows how to connect a three lead dual color LED to an output. The two anode leads may be connected to any output pins 1 and 2, 3 and 4, or 5 and 6. Current limiting resistor R1 can be about 470 ohms for an LED current of about 20 milliamperes.

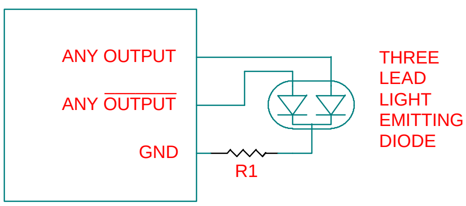

Figure 11

Figure 12 shows how to connect a two lead dual color LED. The polarity must be reversed to change color so you must connect to the two complementary outputs of an output pair such as pins 1 and 2, 3 and 4 or 5 and 6. Current limiting resistor R1 can be about 470 ohms for about a 20 milliampere current.

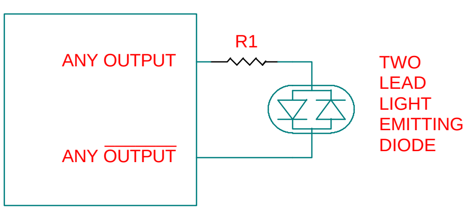

Figure 12

A piezo buzzer may be connected from any output to ground to produce an audible alarm as shown in figure 13. The best connection is to a momentary output which will produce a two second beep whenever it is activated. You can connect two buzzers with different tones to the two complementary momentary outputs to signal a transmitter input going up and down.

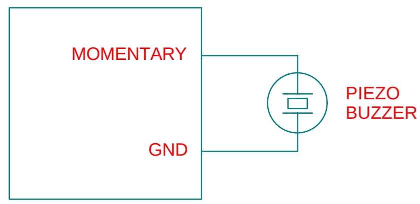

Figure 13

An opto coupler may be connected to any output with a current limiting series resistor as shown in Figure 14. The coupler can have a transistor, logic or SCR output depending on the type of circuit it interfaces.

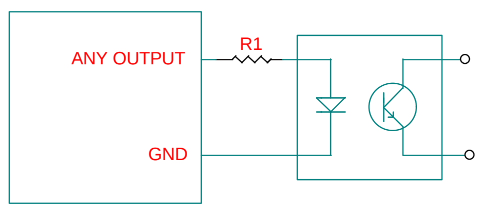

Figure 14

Figure 15 shows how to drive a power FET such as an International Rectifier HEXFET. The driver circuits can both source and sink high peak currents and were intended for driving highly capacitive loads like this.

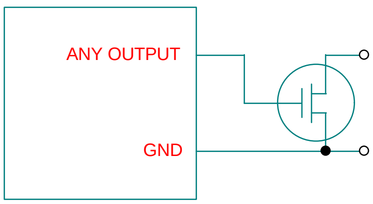

Figure 15

You can interface to 5 volt TTL logic circuits using the voltage divider in figure 16. Optional diode D1 will improve turn off of the TTL circuit. R1=6.8K R2=4.7K

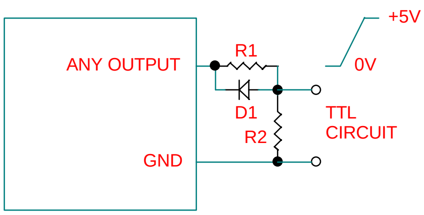

Figure 16

Figure 17 shows a 12 volt relay that can be used to control any voltage including a 120 volt AC circuit. This is a simple way to control a lamp or floodlight. The relay may be connected to any output. A 15 volt 500 milliwatt or 1 watt zener diode D1 prevents damage to the driver circuits from inductive spikes. Observe safety precautions when working with line voltage.

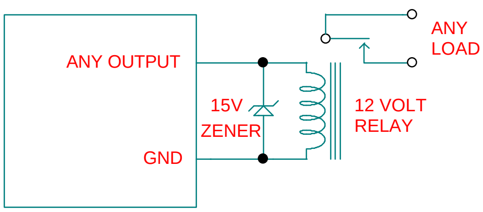

Figure 17

Solid state relays have built in current limiting resistors and can be driven directly as shown in figure 18. These relays have a triac output for switching alternating current loads.

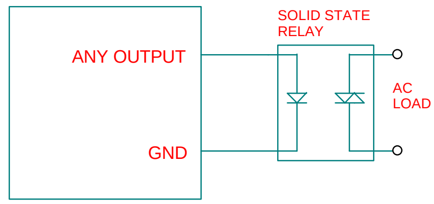

Figure 18

The circuit in figure 19 can be used to produce a momentary output with a duration that is controlled by the values of R2 and C1 which form a time constant circuit. Maximum pulse width that can be achieved is limited by leakage current through C1. D2 is a 4.7 volt zener diode that limits the reset voltage to less than 5 volts. R1 can be connected to either pin 3 or 4 of the latching output. Reset must be connected to pin 8. If latch output pin 3 is used then program switches SC1 and SC4 must be ON and if pin 4 is used then SC2 and SC3 must be ON. This circuit can be used when the two second momentary output is too short or too long for your application. The value of R1 should be a minimum of 1K and a maximum of 1MEG. The pulse width is approximately R kohms X C microfarads / 4 = TIME milliseconds. D1 is a 1N4001 that discharges C1 for fast recovery. 10 ohm resistor R1 limits discharge current.

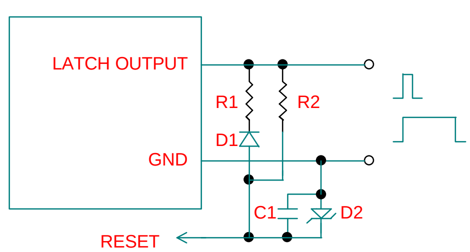

Figure 19