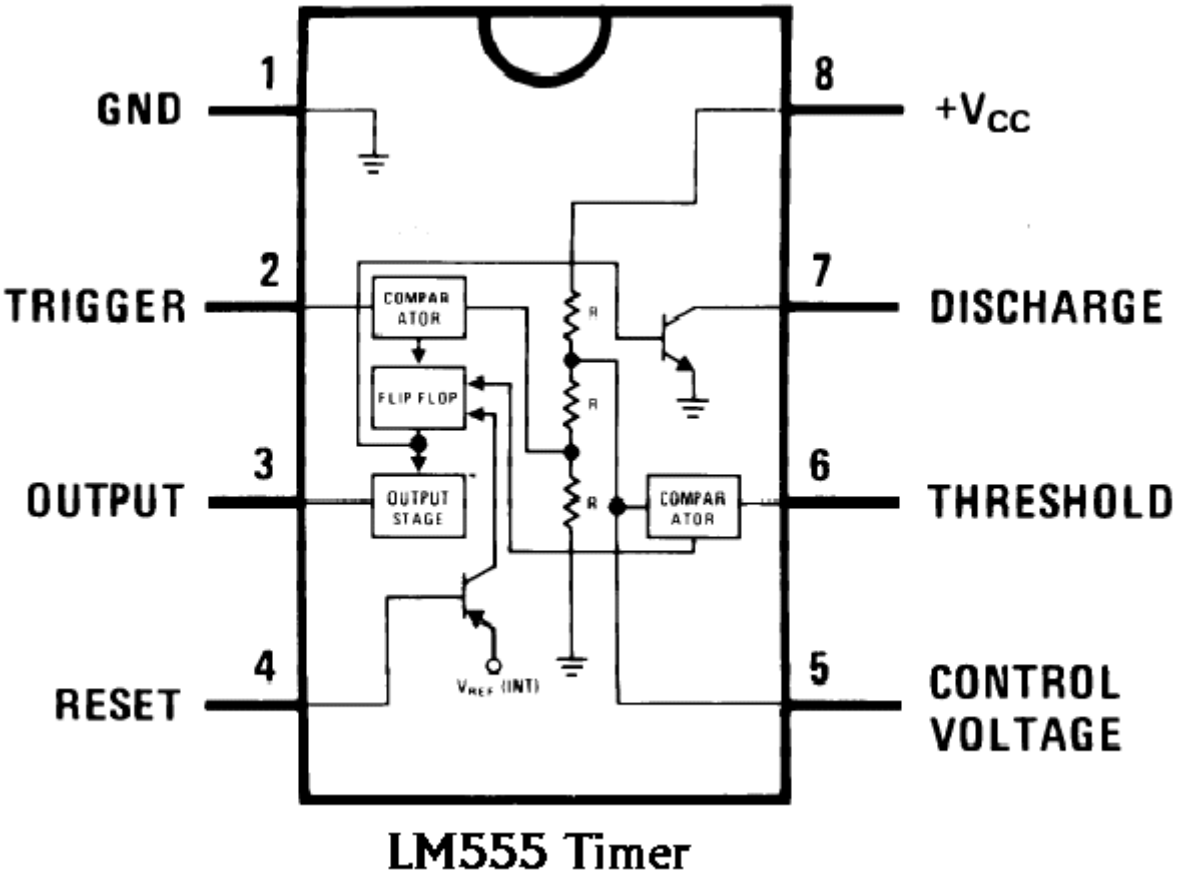
LM555 and LM556 Timer Circuits

LM555 TIMER INTERNAL CIRCUIT BLOCK DIAGRAM



LM555 Timer

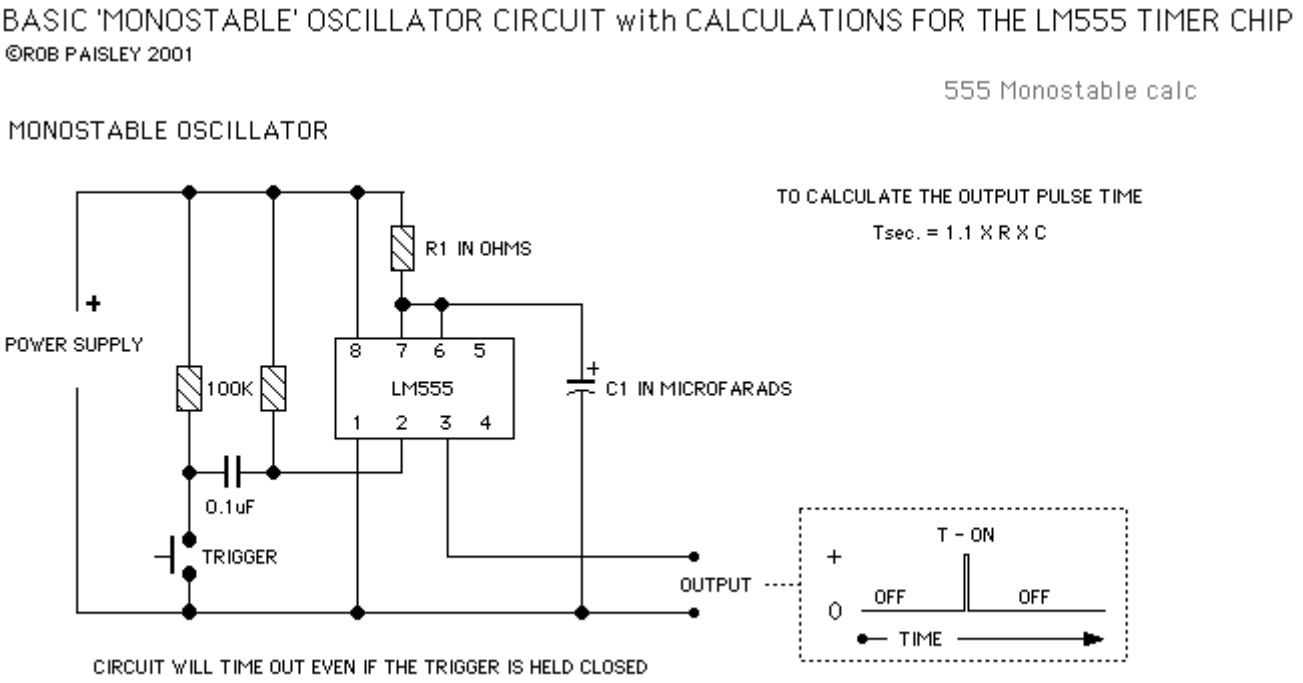
"RESET" And "CONTROL" Input Terminal Notes

Most of the circuits at this web site that use the LM555 and LM556 timer chips do not show any connections for the **"RESET"** and **"CONTROL"** inputs for these devices. This was done in order to keep the schematics as simple as possible

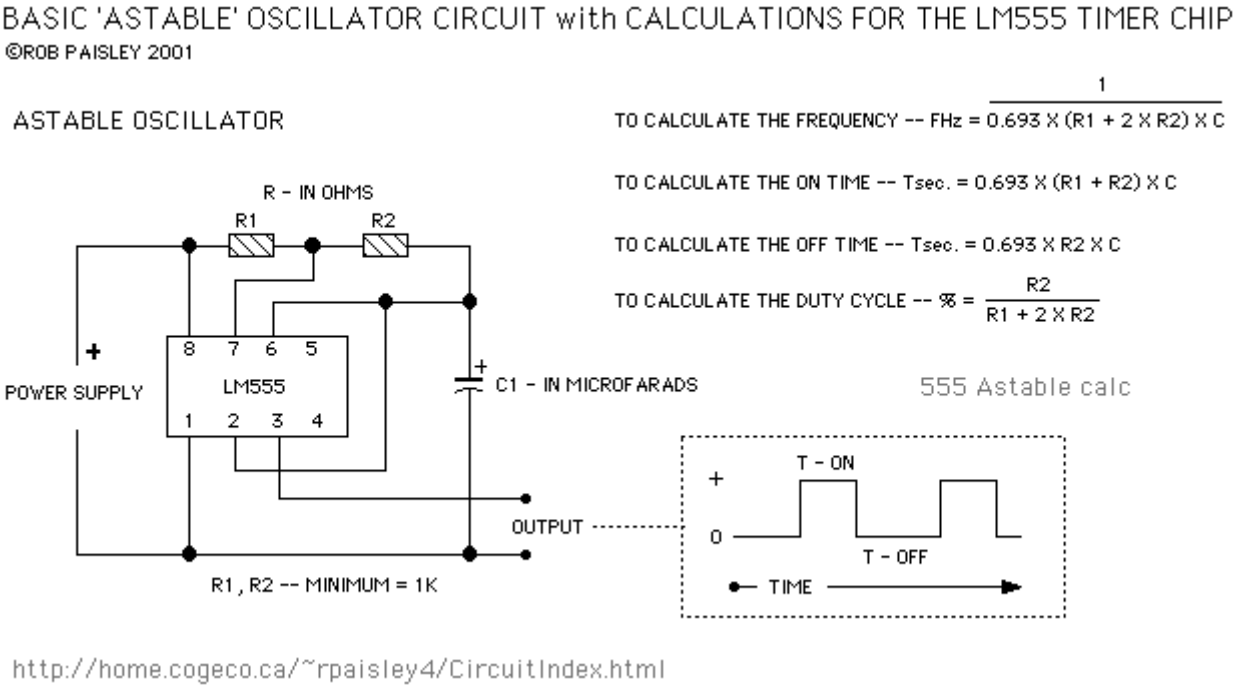
When the **"RESET"** terminal is not going to be used it is good practice to connect this input to the supply voltage. This is especially true when the CMOS version of these timers is used as the inputs of these devices are very sensitive.

In most cases the **"CONTROL"** input does not require a filtering capacitor when a well regulated power supply is used.

LM555 MONOSTABLE OSCILLATOR CIRCUIT DIAGRAM



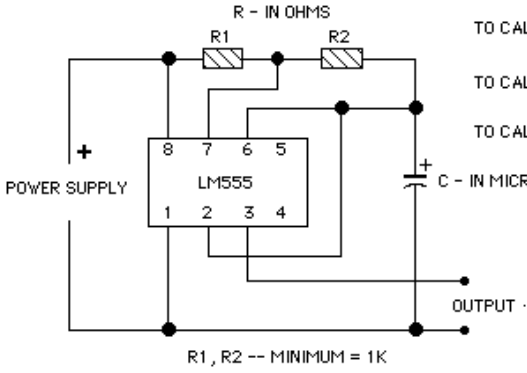
LM555 ASTABLE OSCILLATOR CIRCUIT DIAGRAM



BASIC CIRCUITS and CALCULATIONS FOR THE LM555 TIMER CHIP

555 Basics

ASTABLE OSCILLATOR

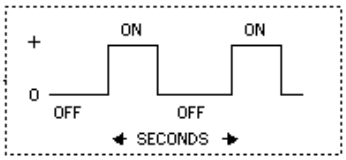


TO CALCULATE THE FREQUENCY -- $F = \frac{1}{0.693 \times (R1 + 2 \times R2) \times C}$

TO CALCULATE THE ON TIME -- Tsec. = 0.693 X (R1 + R2) X C

TO CALCULATE THE OFF TIME -- Tsec. = 0.693 X R2 X C

TO CALCULATE THE DUTY CYCLE -- % = $\frac{R2}{R1 + 2 \times R2}$



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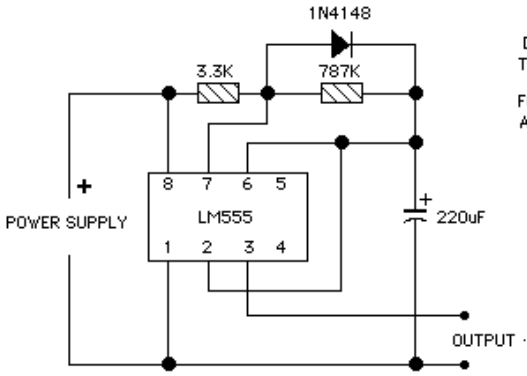
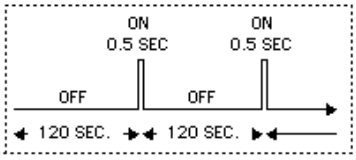
120 SECONDS OFF / 0.5 SECONDS ON - 555 OSCILLATOR



DUE TO THE DIODE IN THE TIMING CIRCUIT
THE ABOVE FORMULAS DO NOT WORK DIRECTLY

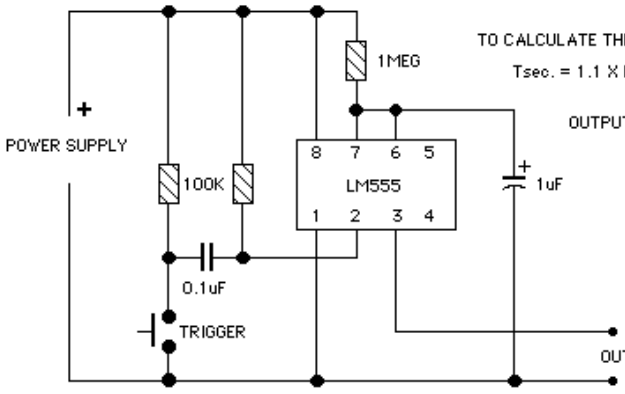
FOR THE 'ON' TIME USE 0 OHMS
AS THE VALUE OF R2 IN THE CALCULATION



RESISTOR VALUES ARE CALCULATED TO GIVE THE DESIRED OUTPUT TIMES.

---

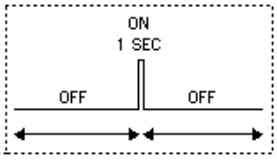
1 SECOND ONESHOT MONOSTABLE OSCILLATOR



TO CALCULATE THE ON TIME

Tsec. = 1.1 X R X C

OUTPUT IS HIGH FOR 1 SECOND AFTER SWITCH CLOSES



CIRCUIT WILL TIME OUT EVEN IF THE TRIGGER IS HELD CLOSED

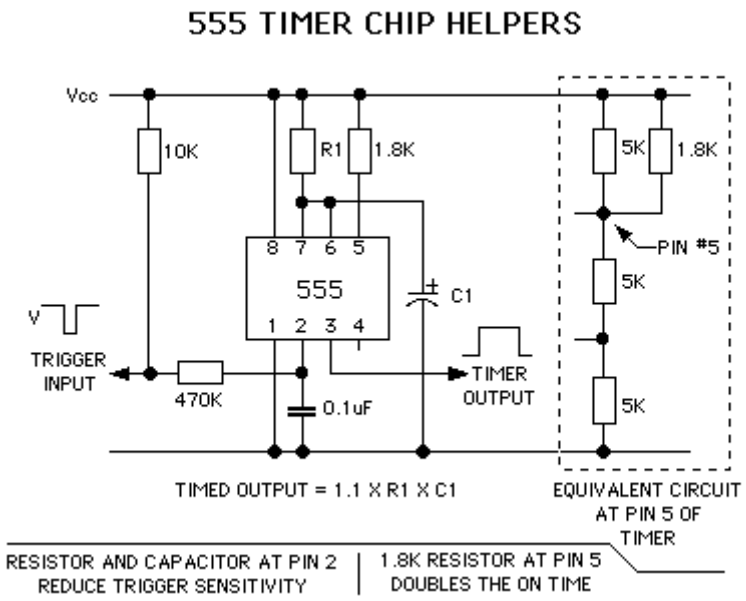
http://home.cogeco.ca/~rpaisley4/CircuitIndex.html

CIRCUITO ESQUEMATICO BASICO LM555

Triggering And Timing Helpers For Monostable Timers

The venerable LM555 timer chip and its twin brothers the LM556 have been a cornerstones of model railroad electronics but the sensitivity of the trigger input gives rise to many false triggering problems. The addition of a 470K ohm resistor and a 0.1uF capacitor at the trigger input (Pin 2) will provide a time delay of 1/20th of a second from the time the input goes to zero volts until the trigger threshold is reached (1/3Vcc). This can eliminate false triggering in most cases and if the problem persists the size of the capacitor can be increased.

The following schematic shows two additions to the basic 555 timer circuit. One reduces the trigger sensitivity and the other will double the output pulse duration without increasing the R1 and C1 values.



555 TIMER HELPERS SCHEMATIC

The addition of a capacitor to the trigger will not work for short output pulses as there is also a short delay in the recovery of the trigger terminal voltage.

The second 555 timer helper will extend the timers output duration without having to use large values of R1 and/or C1. By connecting a 1.8K ohm resistor between the supply voltage and pin 5 of the 555 timer chip the output pulse duration will approximately be doubled.

To achieve long output times electrolytic capacitors are used for C1 and the value of R1 may be as high as 1 Meg. However with high resistance values for R1 the leakage current of the timing capacitor (C1) becomes a significant factor in the operation of the timer.

The circuit will run much longer than expected and may never time out if the leakage current is equal to the current through the resistor at some voltage. Tantalum capacitors

could be used as they have very low leakage currents but these are expensive and not available in large capacitance values.

The boxed in area of the drawing shows the internal circuit at pin 5 of the timer with the 1.8K resistor added. The voltage at pin 5 will be increased from 0.66Vcc to 0.84Vcc which is equal to the voltage across the capacitor after two time constants. This allows the same output time to be achieved with a smaller resistance or capacitance value thus reducing the error caused by the capacitor leakage current. Conversely, for a given value of R1 and C1 the output time will be doubled. (One time constant is equal to R1 times C1).

The trigger voltage level of the timer will also be increased with the addition of the resistor to pin 5 but this should have no effect for most applications.

This is not an ideal solution to solving long duration timing situations but will be OK for times of less than five minutes.

CONTROLLING CIRCUITS FOR LM555 TIMERS

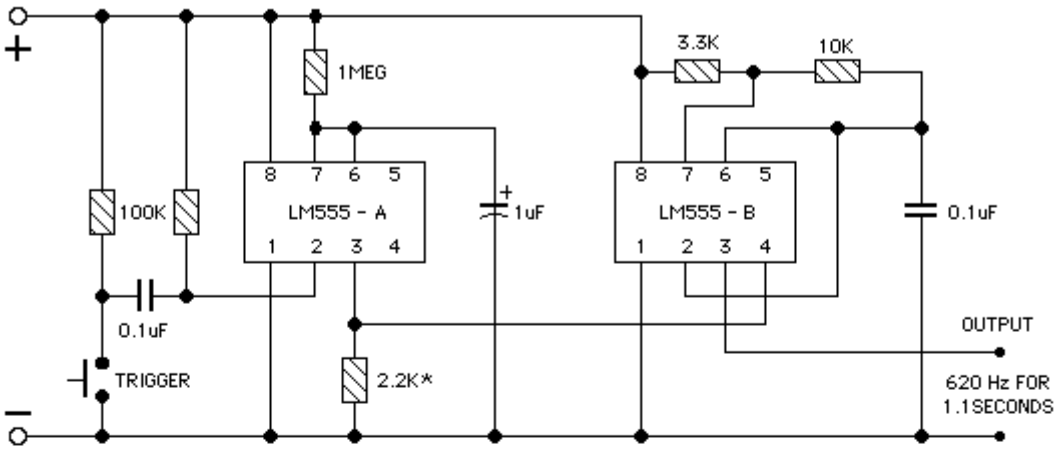
The following diagrams show some methods of using one timer to control a second timer. Some of these are unusual but still practical and can provide ideas for other control schemes.

In the following diagrams a ONESHOT oscillator controls an ASTABLE oscillator. Three methods are shown.

CONTROL METHODS FOR LM555 / LM556 TIMERS - #1

ONESHOT CONTROLLING AN ASTABLE OSCILLATOR

CIRCUIT #1

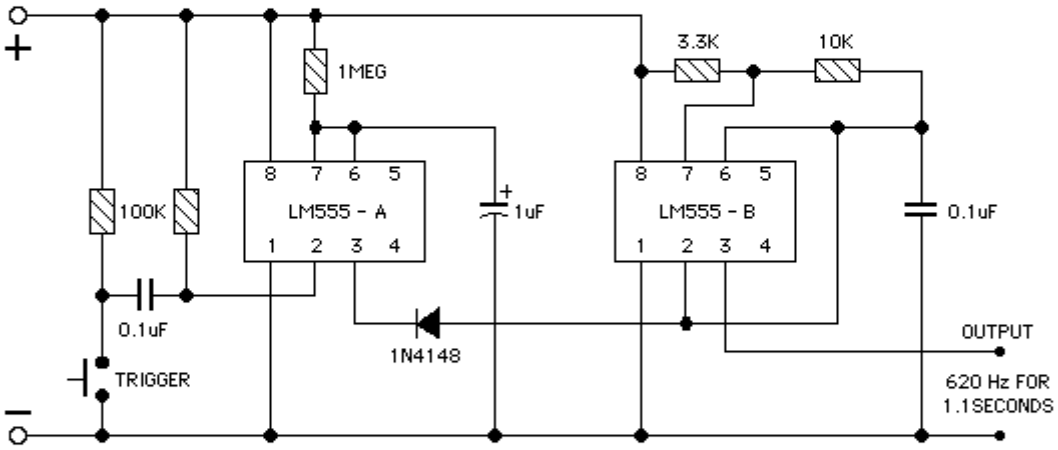


-CIRCUIT #1- TIMER 'A' CONTROLS THE "RESET" OF TIMER 'B'.

-WHEN TIMER 'A' IS LOW THE OUTPUT OF TIMER 'B' IS LOW.

2.2K* IS A PULL DOWN RESISTOR FOR OUTPUT OF TIMER 'A'

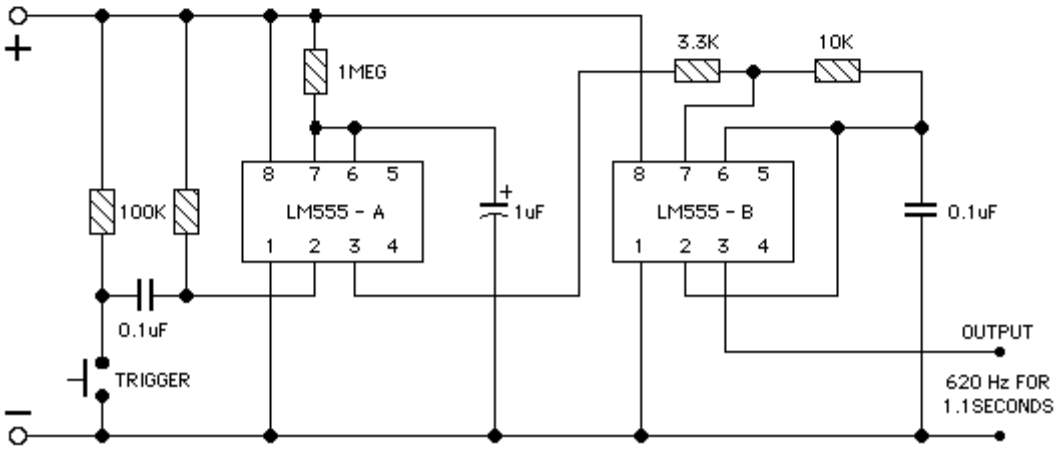
CIRCUIT #2



-CIRCUIT #1- TIMER 'A' DISCHARGES THE CAPACITOR OF TIMER 'B'.

-WHEN TIMER 'A' IS LOW THE OUTPUT OF TIMER 'B' IS HIGH.

CIRCUIT #3



ADVANCED CIRCUITS FOR THE LM555 TIMER

The following diagrams show some advanced circuits for the LM555 timer. These circuits were developed to provide certain functions that are not usually associated with this device.

The parts values in these circuits were selected for testing purposes and can be adjusted to suit the needs of a particular application as long as the normal operating parameters of the LM555 are maintained.

These circuits should be viewed as experimental. Before using any of them for specific applications they should be tested to determine the best values for the components and the practicality of their use.

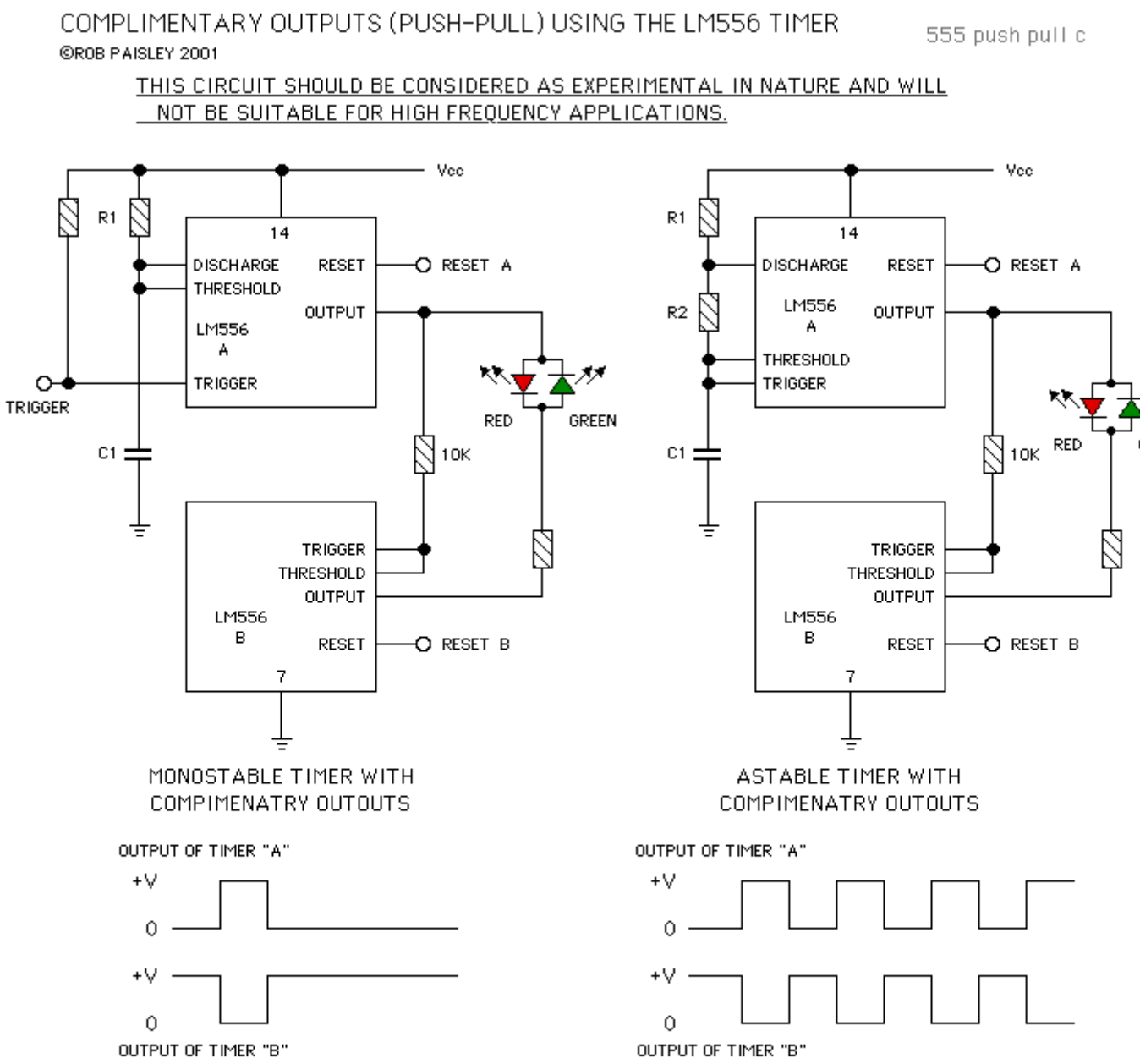
LM556 TIMERS WITH COMPLIMENTARY OR PUSH-PULL OUTPUTS

In the next circuit an LM556 - dual timer IC is configured so that the output of the second timer is 180 degrees out of phase with the first.

This is done by connecting the OUTPUT of the "A" timer to the TRIGGER and THRESHOLD terminals of the "B" timer. The 10K ohm resistor in this connection limits the current that can flow into the THRESHOLD terminal of the "B" timer.

Due to the current source or sink capability of the timer outputs the current from one timer's output can flow in to the other timers output depending on which output is HIGH or LOW. The usual outputs that are referenced to ground or supply are also available and in fact all three could be used at the same time.

Circuits for both Astable and Monostable versions of this method are shown on the diagram.



LM555 COMPLIMENTARY OUTPUTS SCHEMATIC

Timer "B" in this method acts as a voltage comparator and has no timing function. It is a slave to the "A" timer.

Normal triggering schemes and timing lengths are not affected by this method.

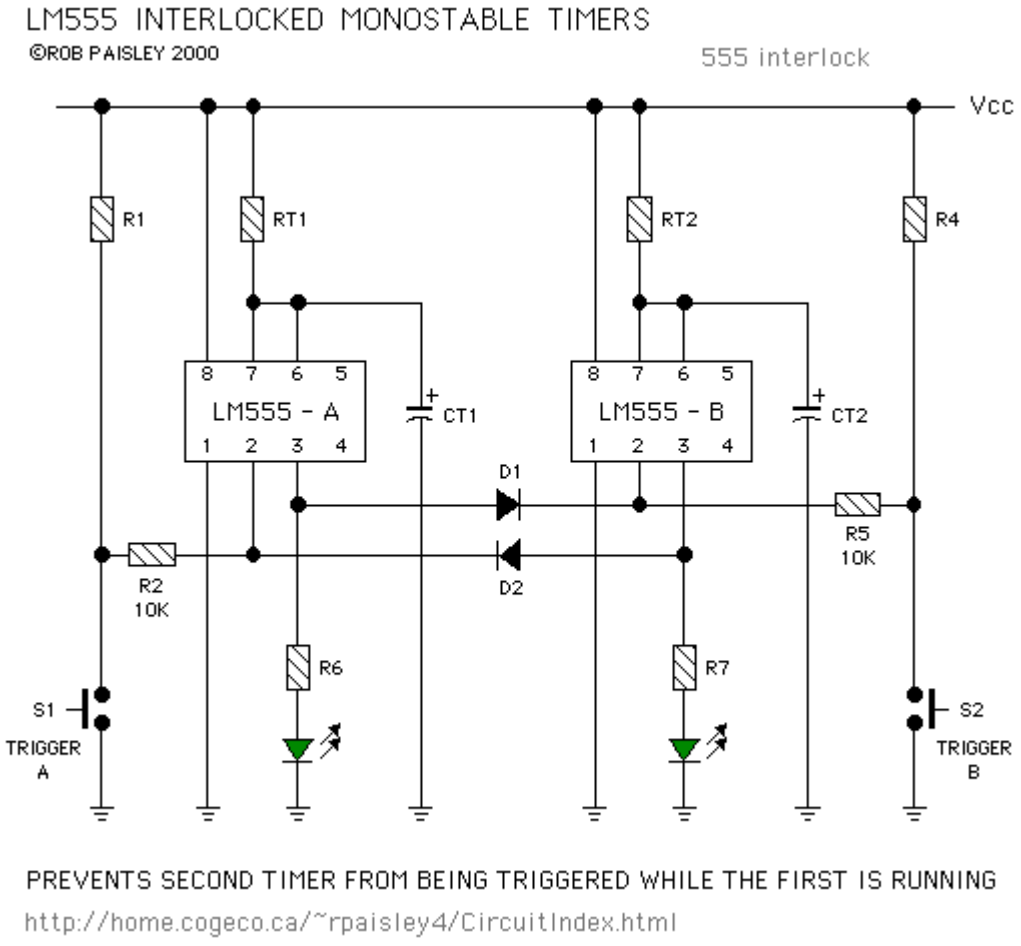
The timer RESET terminals are available and can be used individually or together if desired.

Due to the unusual nature of this type of circuit testing should be done to determine if it is suitable for the use intended. The circuit is usable at frequencies below 1000Hz.

INTERLOCKED MONOSTABLE TIMERS

In the following circuit the timers are "Interlocked" so that when one timer is running the second timer cannot be triggered.

This is done by connecting the OUTPUT of each timer to the TRIGGER of the other via a diode and placing a resistor in the trigger circuit. The resistor limits the current that can flow from the opposite timers output when the trigger is closed on the stopped timer.



LM555 Interlocked Timers schematic

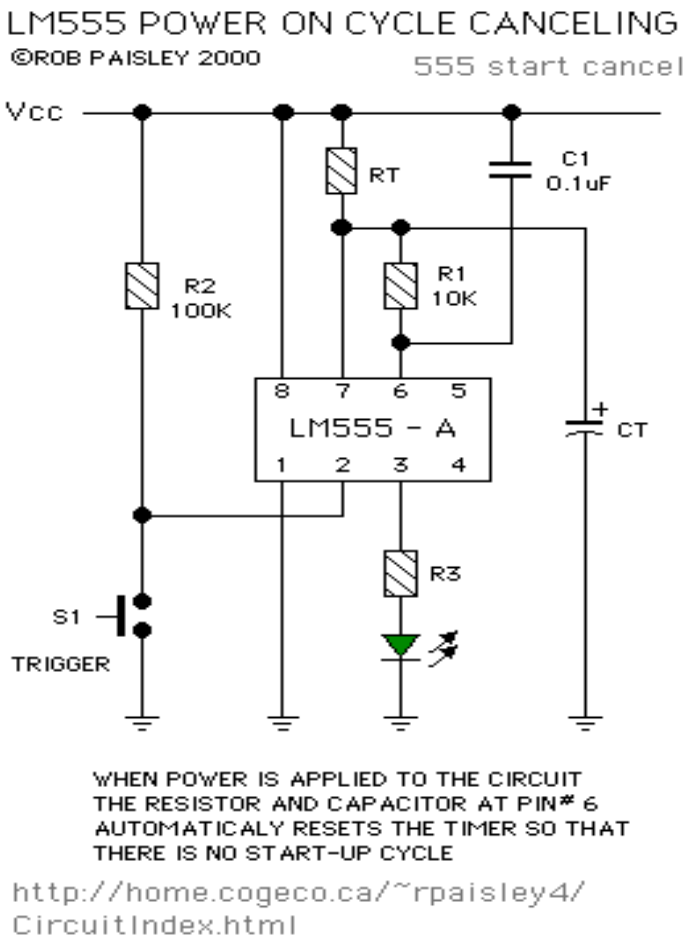
Normal triggering and timing lengths are not affected by this method.

POWER-UP RESET FOR MONOSTABLE TIMERS

When the power is applied to an LM555 circuit the timer will immediately be triggered and start a cycle. This can be a undesirable if the time is long and there is no other way to stop the cycle.

To prevent this a resistor and capacitor have been added to the THRESHOLD terminal (PIN 7). When the power is applied to the circuit the timer is automatically RESET by the charge flowing through the 0.1 microfarad capacitor.

When power is applied to the circuit the output of the LM555 will stay LOW except for a very brief pulse.



LM555 Power-Up Reset schematic

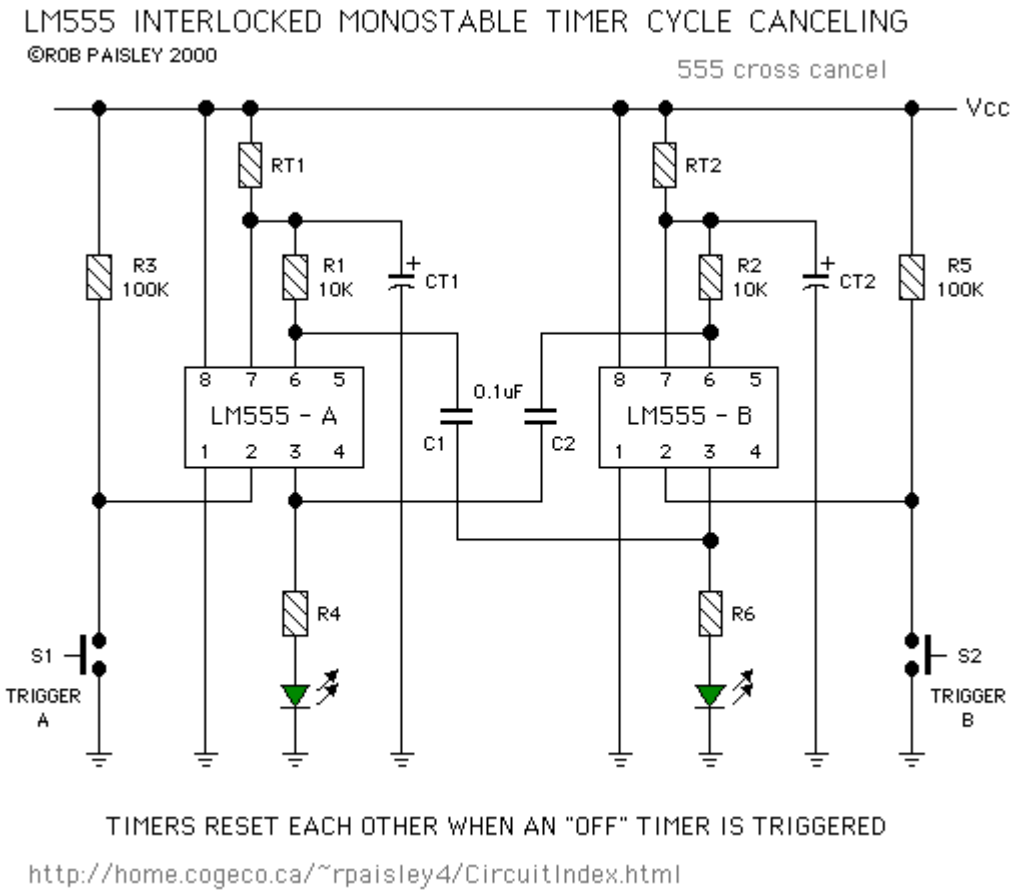
Normal triggering and timing lengths should not be affected by this method unless a unregulated power supply is used.

CROSS CANCELING FOR MONOSTABLE TIMERS

The following diagram shows a method that allows one LM555 timer to RESET another timer so that, for example, if timer 'A' is running; When timer 'B' is activated the 'A' timer is reset.

This means that only one timer can be running at any time.

As with the 'Power-Up Reset For Monostable Timers' circuit above, when the power is applied to the circuit both timers are RESET.



LM555 CROSS CANCELING TIMERS SCHEMATIC

Normal triggering and timing lengths should not be affected by this method.

The trigger switch of the running timer must be OPEN for the RESET to occur.

RS - Flip-Flop Made With A LM556 Timer

The circuit on this page is for a hybrid - SET / RESET type of logic Flip-Flop that is constructed from an LM556 - Dual Timer integrated circuit.

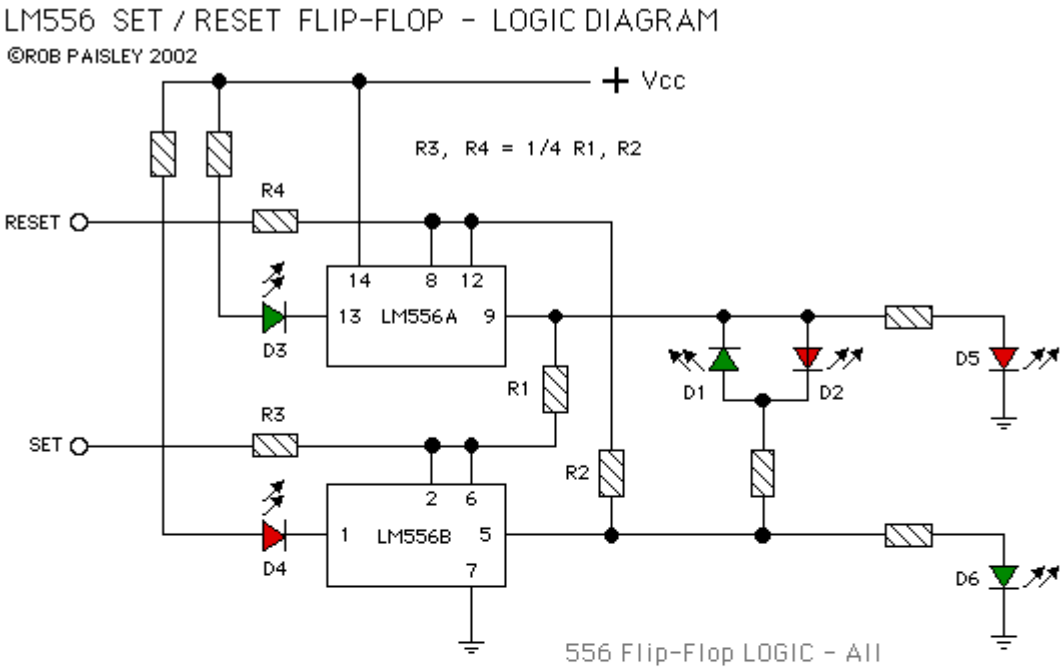
The design is crude but effective for very low speed applications. Its greatest asset is that the outputs of the LM556 are capable of driving current loads of up to 200 milliamps with a minimal voltage loss.

This circuit was originally developed to drive "Stall Motor" type switch machines that are used on model railroads. These motors use low voltage DC and pass approximately 15 milliamps when they are in a stalled condition.

Due to the design of the LM556 timer chip there are multiple output options available in this design. These include the normal timer outputs which are bipolar and the 'DISCHARGE' terminals, (PINS 1 and 13), that are open collector circuits.

LM556 Flip-Flop Truth Table

The following diagram is for a testing version of the circuit used to create a "Truth Table" that shows the OUTPUT states for a given INPUT state.



TRUTH TABLE FOR THE LM556 FLIP-FLOP CIRCUIT ABOVE

	INPUT		PIN		LED					
STATE	SET	RESET	9	5	D1	D2	D3	D4	D5	D6
1	LOW	HIGH	LOW	HIGH	ON	OFF	ON	OFF	OFF	ON
2	HIGH	LOW	HIGH	LOW	OFF	ON	OFF	ON	ON	OFF
3	LOW	LOW	HIGH	HIGH	OFF	OFF	OFF	OFF	ON	ON
4	HIGH	HIGH	LOW	LOW	OFF	OFF	ON	ON	OFF	OFF

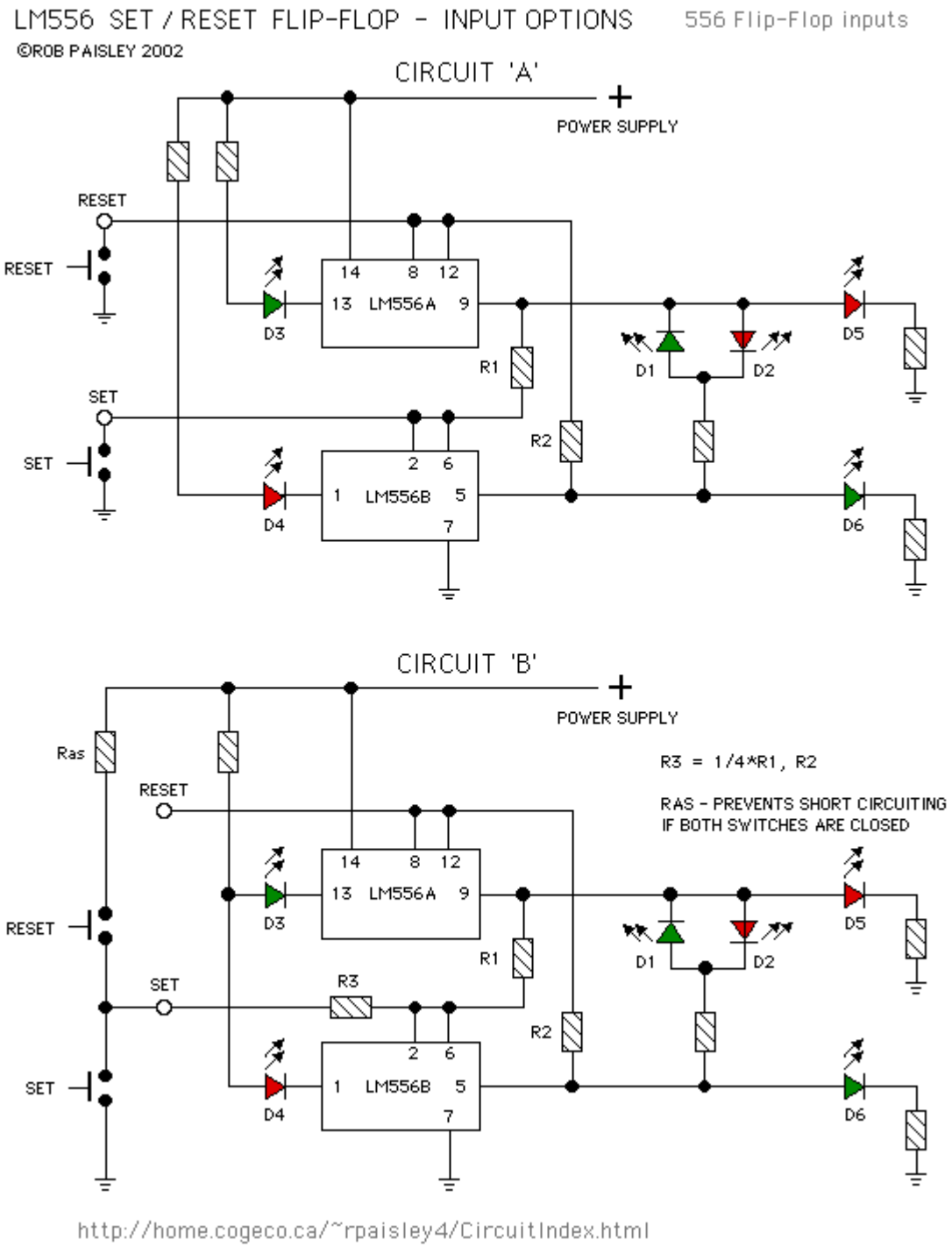
INPUTS - HIGH = Vcc / LOW = 0 Volts

http://home.cogeco.ca/~rpaisley4/CircuitIndex.html

Logic Function diagram

LM556 FLIP-FLOP INPUT OPTIONS

The next diagram shows the basic input options that can be used with the LM556 Flip-Flop circuit. In actual applications the push buttons would be replaced by or supplemented with electronic input devices.



Input Options schematic

In CIRCUIT 'A' the SET and RESET inputs would be brought to '0' Volts to change the state of the Flip-Flop.

In CIRCUIT 'B' the SET input would be switched between '0' Volts and the supply voltage to change the state of the Flip-Flop. The RESET terminal is unconnected.

In both CIRCUITS 'A' and 'B' when the push buttons are 'OPEN' the Flip-Flop will remain in its last state until another INPUT signal is applied.

Circuits 'A' and 'B' also show two methods of connecting the LED's at terminals 1 and 3. The method in circuit 'B' would not be practical for the STATE '3' condition shown in the "Truth Table".

LM556 Flip-Flop Notes

- **If you would like to make use of this type of circuit, please take the time to build one and do some experimenting to determine if the design will suit your needs.**
- This circuit was developed for very low speed operation. It was found however to operate satisfactorily at clock speeds in excess of 10KHz under less than ideal circumstances and using the input method shown in circuit #2 above.

  The values of R1 and R2 in this test were 100K ohms. The value of R3 was 22K ohm.

- As can be seen in the schematics, the OUTPUT of one timer is fed, through a 10K ohm current limiting resistor (R1 and R2), to the TRIGGER and THRESHOLD inputs of the other. The value of this resistor is not critical and is largely dependant on the impedance of the INPUT devices used to trigger the stage changes.

  If resistors R1 and R2 are not used the operation of the circuit becomes unstable.

- Due to the internal circuitry at THRESHOLD terminals (PINs 6 and 12) of the LM556 timers, resistors R3 and R4 are needed to limit the current that can flow into these terminals to a reasonable level. The value of resistors R3 and R4 should be approximately 1/4 the value of resistors R1 and R2 so that the proper voltage ratios for changing states can be achieved.

  The R3 resistors are not required if the inputs are not going to be driven to a HIGH state.

- The cross coupling of the timers OUTPUT and TRIGGER/THRESHOLD terminals gives the circuit its FLIP-FLOP action and causes the outputs of the timers to be forced alternately HIGH or LOW. This action only applies to states 1 and 2 in the truth table shown above.
- For this circuit to have a 'memory function' such as that of a SET / RESET type Flip-Flop the input terminals must "float" when no input signal is present. They cannot be held HIGH or LOW as is the case with TTL devices.
- The maximum current the the outputs of the LM556 timers can source or sink is 200 milliamps.
- These circuits do not need a regulated power supply but the voltage should be well filtered.
- Any of the LED's in the circuit could be replaced by an optoisolator, small relay or low current DC motor.

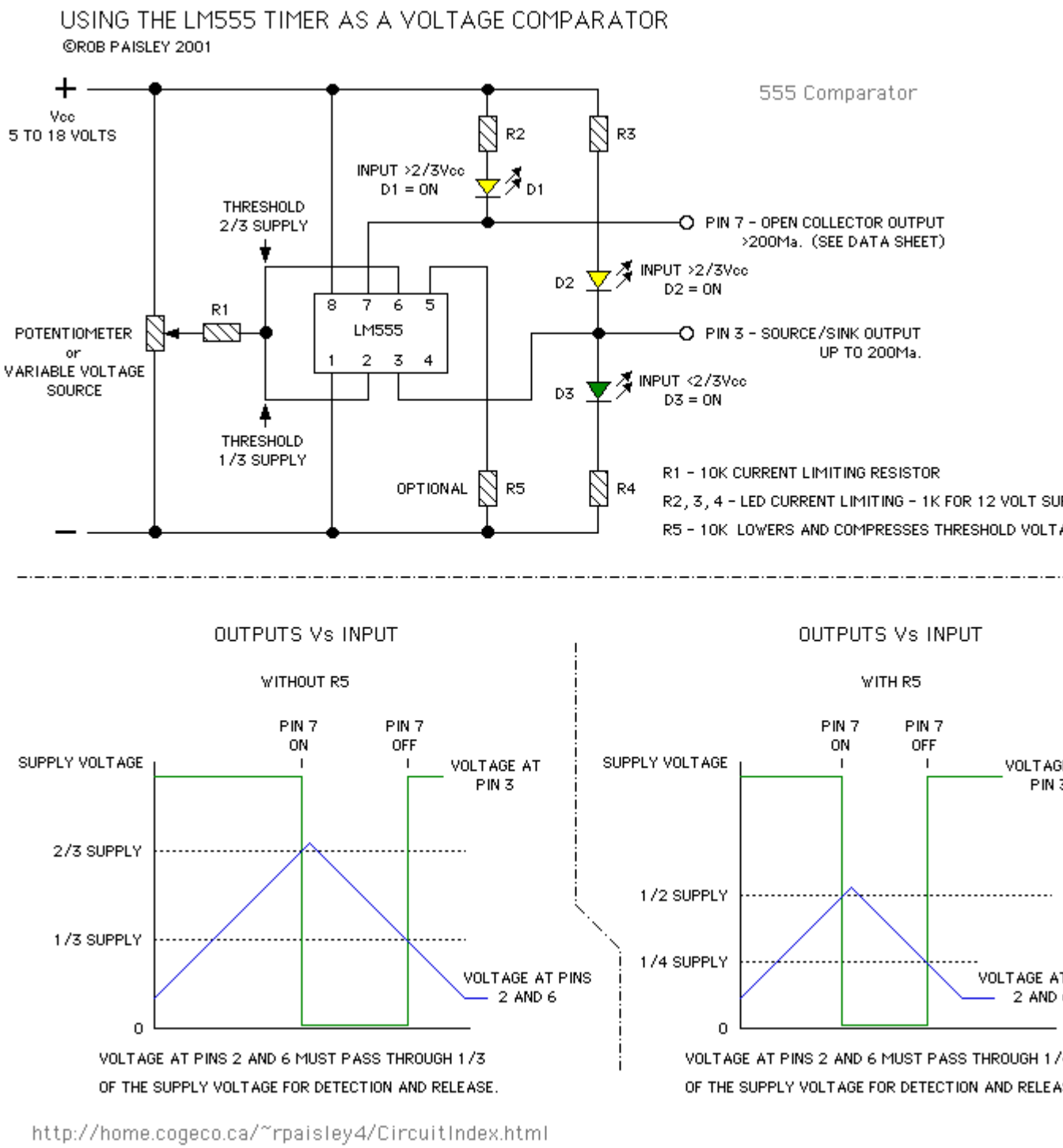
LM555 Timer Used As A Voltage Comparator

The next section shows how the LM555 timer could be used as a voltage comparator. An application for which it is not particularly well suited but one that is in wide use with model railroaders.

Shown on the schematic is a secondary output that uses the open collector at the DISCHARGE terminal (Pin 7) of the timer. This output can sink up to 200 milliamps and would be ideal for driving relays.

The main disadvantage to using this circuit is the the large dead-band (1/3Vcc) between upper and lower threshold voltages. An optional resistor, R5, can be added to the circuit to lower and compress the detection voltage range but this only partially alleviates the problem.

LM555 VOLTAGE COMPARATOR SCHEMATIC



The two graphs at the bottom of the diagram show the input voltages at which the OUTPUT of the LM555 will change states. The effect that resistor R5 has on the circuit can be seen in the right hand graph.

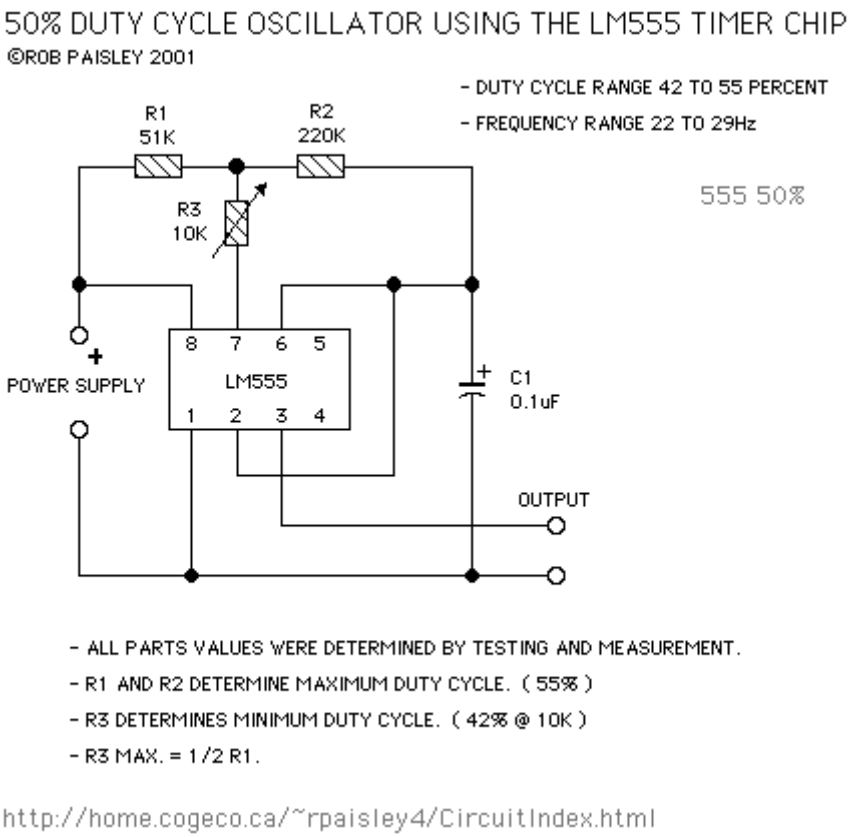
LM555 With A 50% Duty Cycle (Adjustable)

The LM555 timer can achieve a 50 percent duty cycle as shown in the next diagram. The duty cycle adjustment range of this circuit is from 42 to 55 percent.

Resistors R1 and R2 were selected first and then resistor R3 was selected to give the best control range based on measurements at the output of the timer.

The major disadvantage of using the LM555 for this application is that the output frequency changes as the duty cycle changes.

50% Duty Cycle schematic

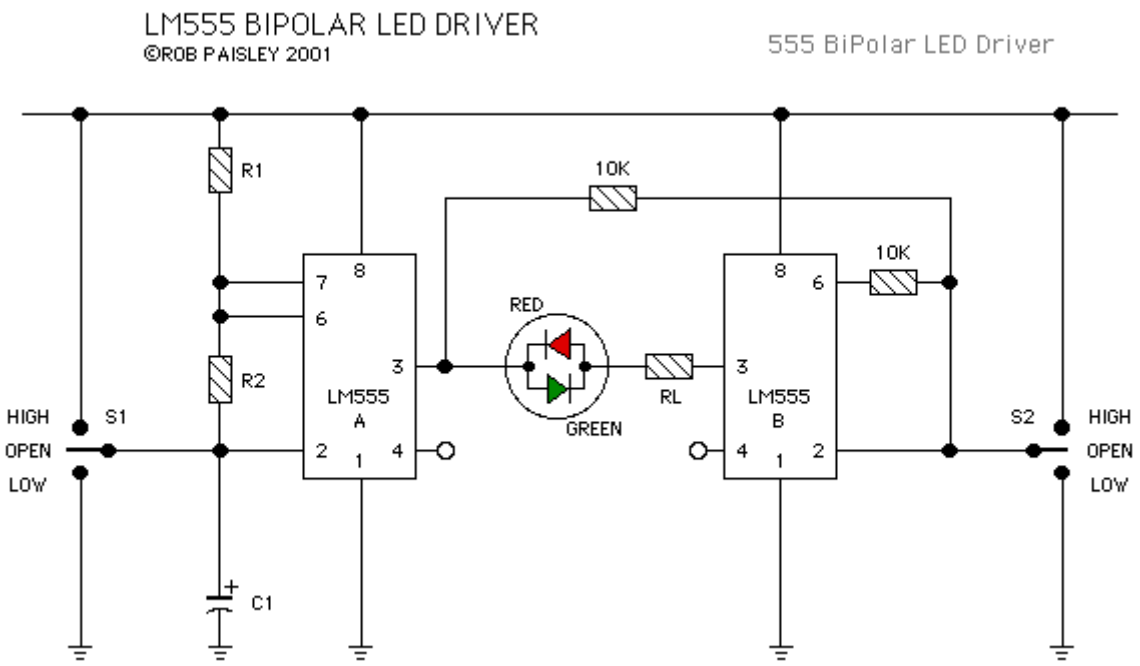


BIPOLAR LED DRIVER

This circuit uses two timers to drive Bipolar LEDs and give all of the possible output states.

Two SPDT switches are used to set the input conditions but these could be replaced by electronic controls if desired.

Bipolar LED Driver schematic



CIRCUIT TRUTH TABLE

	SWITCH POSITIONS		LED	TIMER OUTPUTS	
STATE	S1	S2	INDICATION	A	B
1 -	0	0	RED+GREEN	OSC	OSC
2 -	H	0	RED	L	H
3 -	L	0	GREEN	H	L
4 -	0	H	FLASH/GREEN	OSC	L
5 -	0	L	FLASH/RED	OSC	H
6 -	H	H	NONE	L	L
7 -	L	L	NONE	H	H

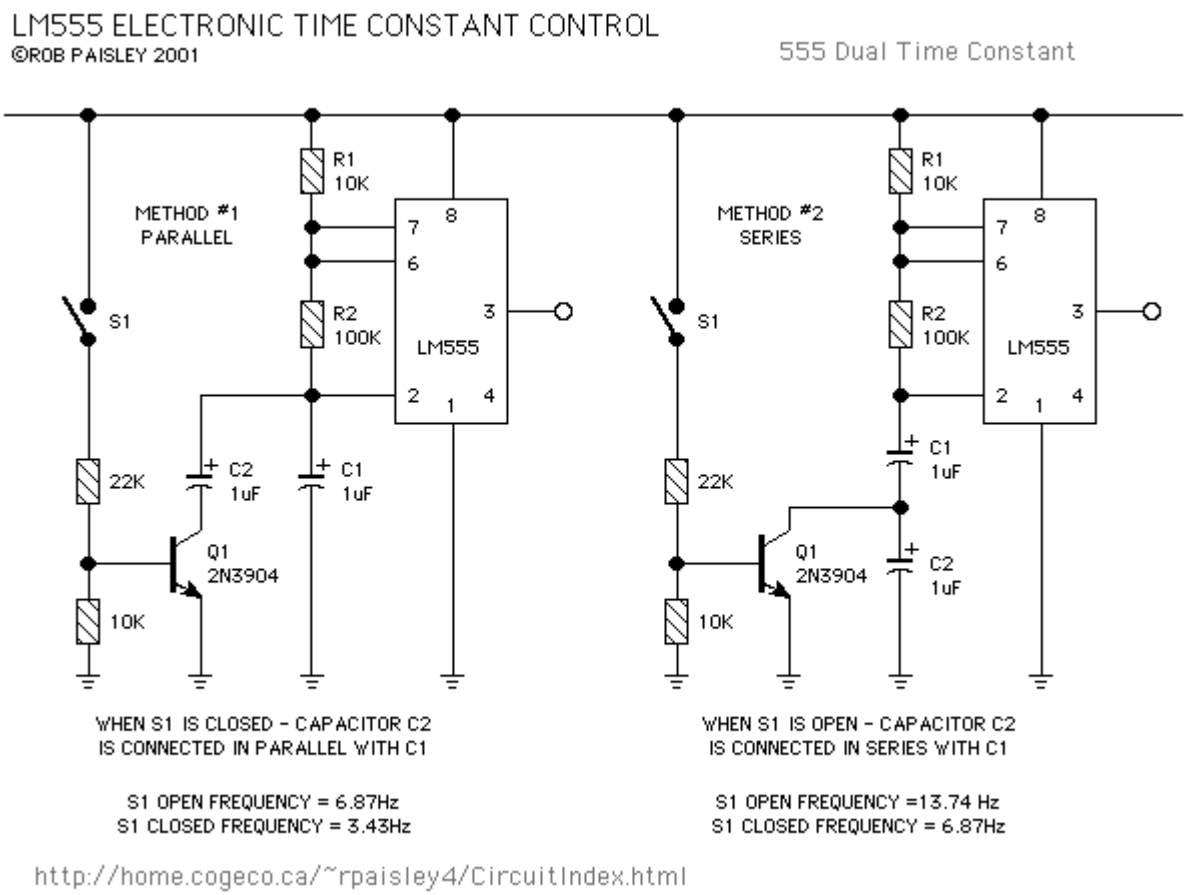
- IF BOTH RESET TERMINALS ARE LOW BOTH TIMER OUTPUTS WILL BE LOW AND THE LEDS WILL BE OFF.
- THE RESET TERMINALS COULD BE USED INDEPENDANTLY FOR ADDITIONAL CIRCUIT STATES.

http://home.cogeco.ca/~rpaisley4/CircuitIndex.html

Electronic Time Constant Control

These circuits show methods of changing the operating frequency of astable LM555 timers electronically. Any source that can drive the base of transistor Q1 can control these circuits.

The advantage of using this type of frequency control is that the duty cycle of the timer is not affected when the frequency is changed.



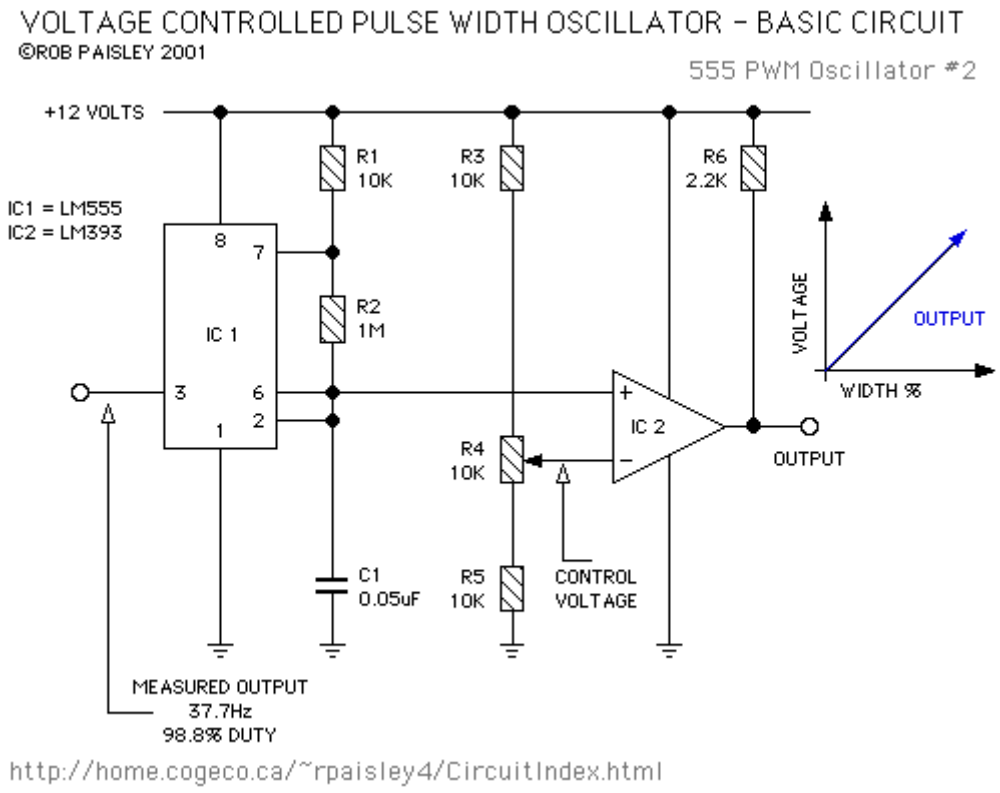
Voltage Controlled Pulse Width Oscillator

The basic circuit operates at a frequency determined by R1, R2 and C1 and has a pulse width range of 0 to 100 percent.

The following diagram shows a basic circuit with an open collector output that would require a pull up resistor at its output. The parts values are the nominal values of the components used.

Note: This circuit is not suitable for high frequency operation, especially when using a second timer as the output stage.

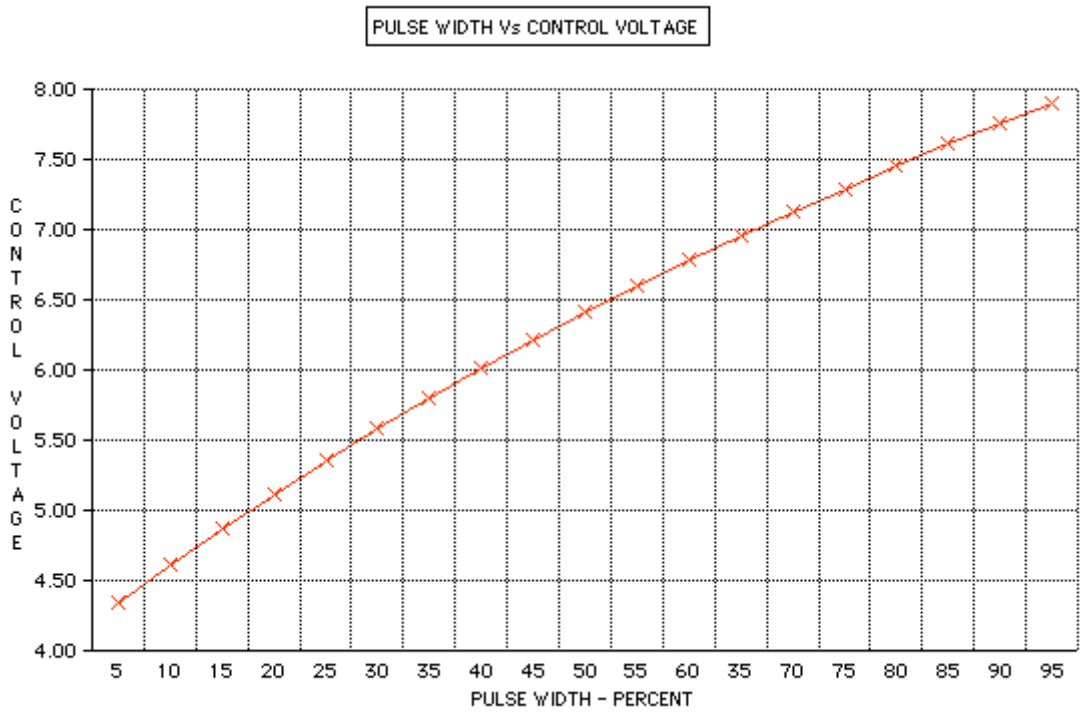
Variable Pulse Width Oscillator



The following is a graph of the output pulse width of the basic circuit for a given control voltage input. All measurements were made with a good quality multimeter.

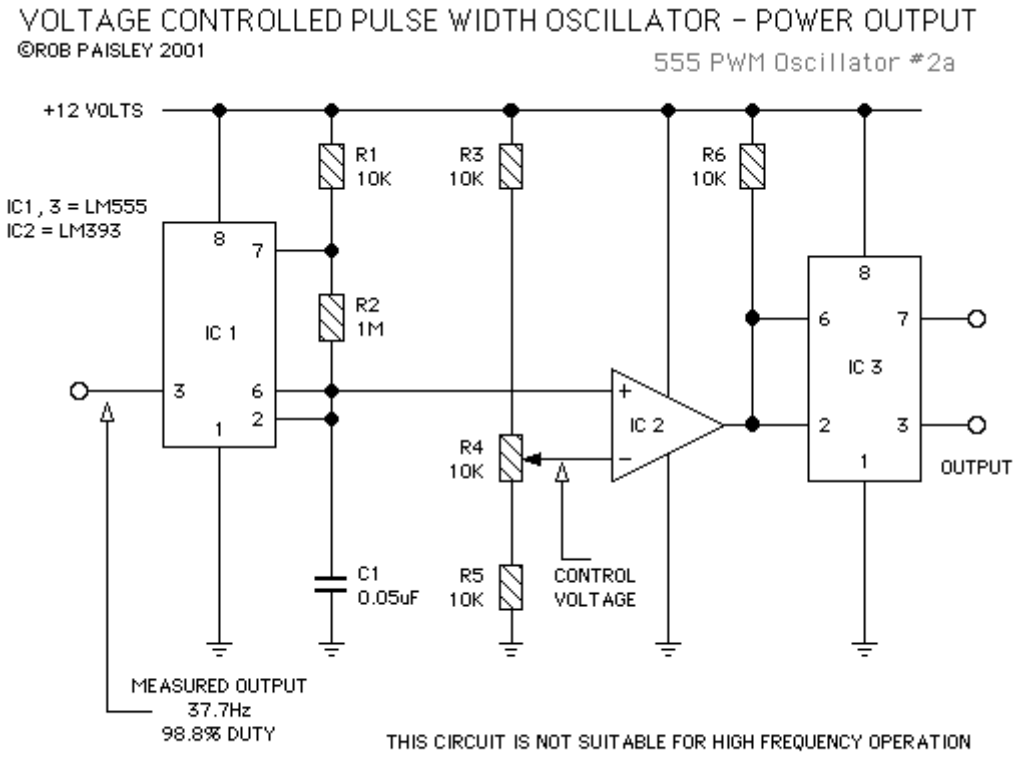
The PLUS and MINUS inputs of IC 2 can be reversed to produce a decreasing pulse width for an increasing control voltage.

Variable Pulse Width Oscillator Output Graph



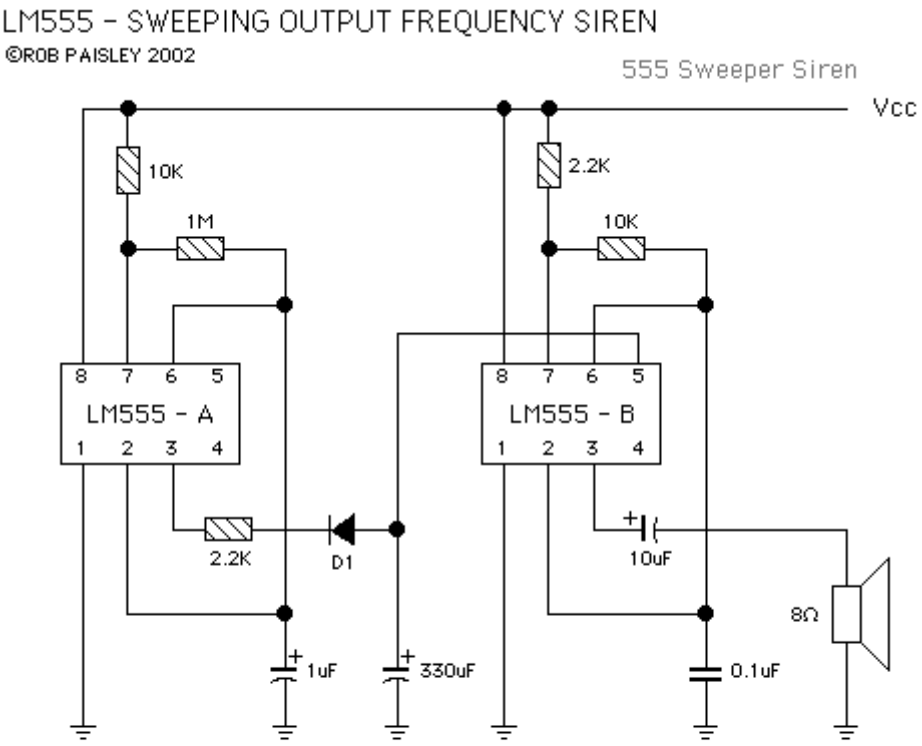
The next diagram uses a second LM555 timer as a power output stage for the basic oscillator. The output stage also has an open collector output at the Discharge terminal, PIN 7, that could be used.

VARIABLE PULSE WIDTH OSCILLATOR WITH LM555 OUTPUT



SWEEPING OUTPUT FREQUENCY SIREN

This circuit is a variation of the Two Tone siren that is a standard for the LM555 timer. The circuit allows the output frequency of the 'B' timer to sweep between to frequencies rather than switching between two fixed frequencies.



D - Flip-Flop Made With A LM556 Timer

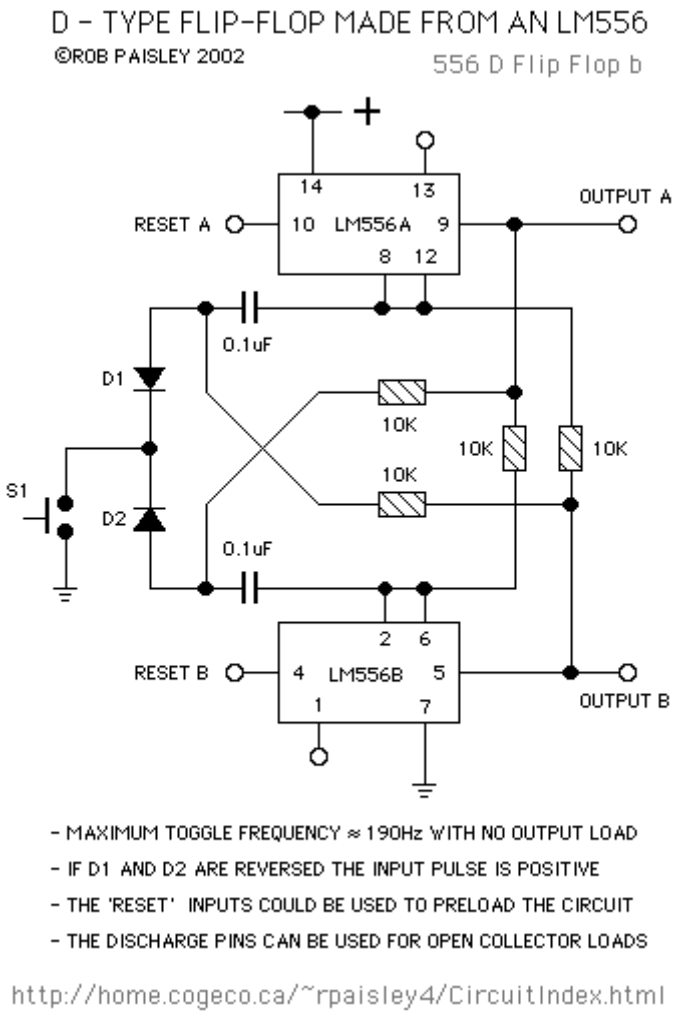
The circuit on this page is for a hybrid - D type Flip-Flop that is constructed from an LM556 - Dual Timer integrated circuit. The circuit is essentially a High-Tech version of the classic transistor flip-flop.

Each time the push button switch (S1) is closed the outputs of the timers will reverse so that one is HIGH and the other is LOW and vice versa.

The circuit has some output switching time lag due to the RC time constants at the inputs and the different Trigger and Threshold voltage levels of the timers themselves.

This circuit is not very useful but would make a good Push On / Push Off switch circuit and has a reasonably high sink or source output current level.

D - Flip-Flop



LED Blinker Circuit #1

The circuit uses independent timers to flash two light emitting diodes. Any time that light emitting diode D1 is lit__light emitting diode D2 will be switched off. Light emitting diode D3 is on if both D1 and D2 are off.

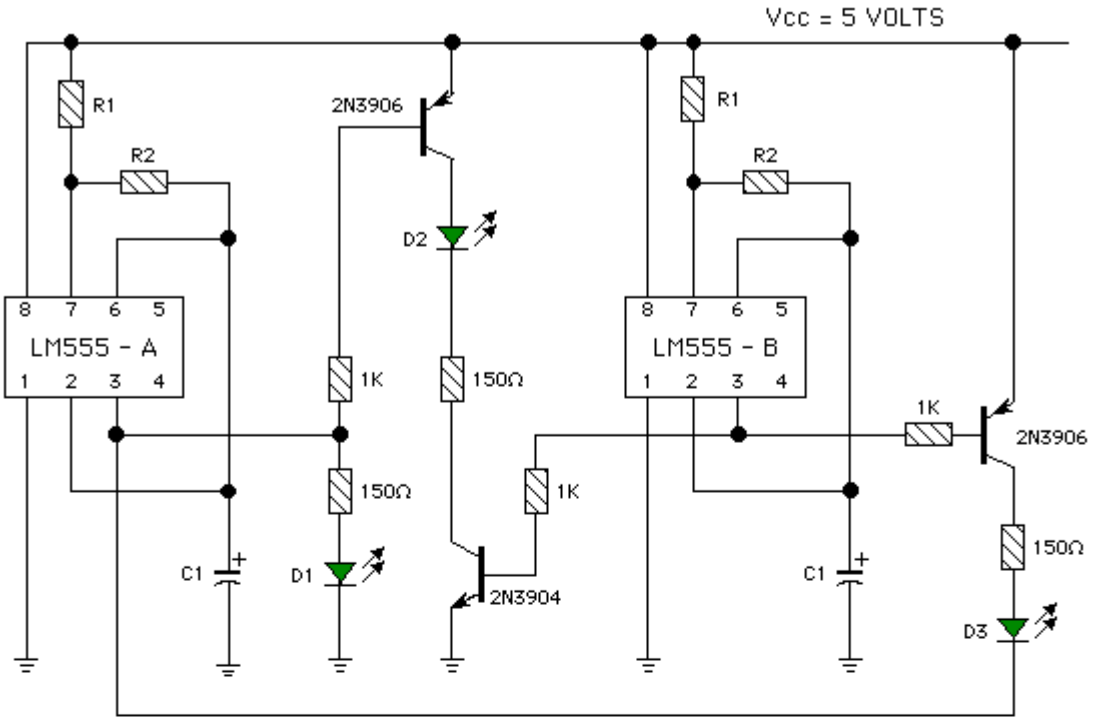
Two versions of the circuit are shown. The second circuit uses fewer components by taking advantage of the bipolar outputs of the timers.

If the supply voltage is increased a 1N4148 diode should be placed in series with light emitting diode D3. The values of the resistors should also be increased proportionatly.

LED Blinker Circuit #1

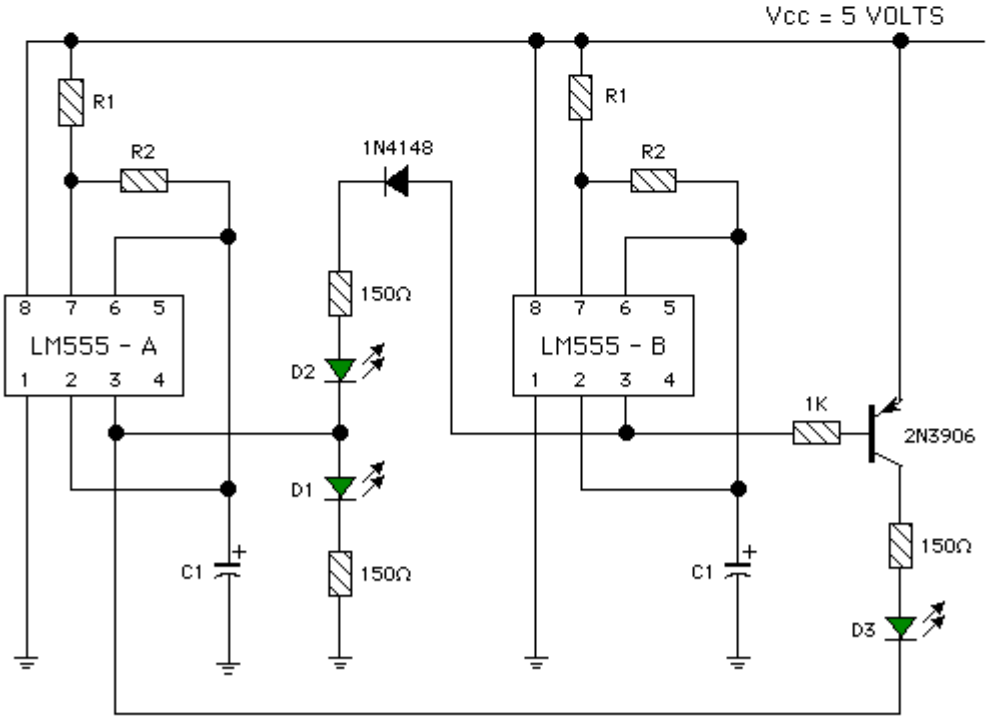
LM555 - LED BLINKER CIRCUIT #1a

555 Blinker #1ab



- ANY TIME D1 IS ON - D2 IS OFF
- D3 IS ON IF D1 AND D2 ARE BOTH OFF
- BOTH TIMERS RUN INDEPENDENTLY
- MAXIMUM DUTY CYCLE IS 50%

LM555 - LED BLINKER CIRCUIT #1b

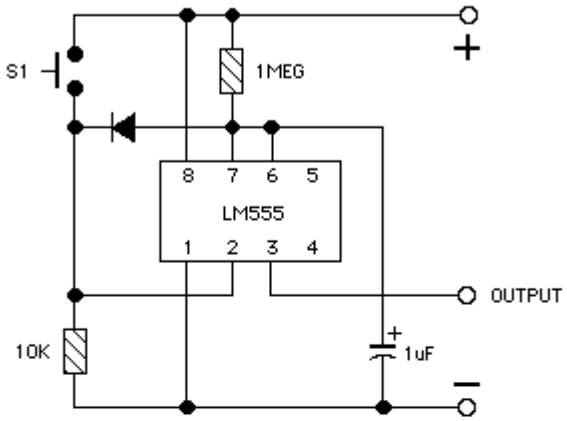


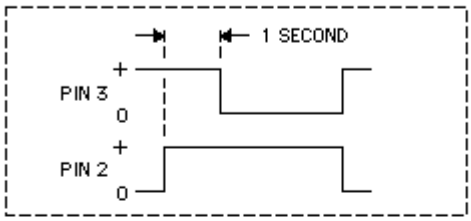
- ANY TIME D1 IS ON - D2 IS OFF
- D3 IS ON IF D1 AND D2 ARE BOTH OFF
- BOTH TIMERS RUN INDEPENDENTLY
- MAXIMUM DUTY CYCLE IS 50%

TIME DELAY CIRCUITS

TIME DELAY CIRCUITS FOR THE LM555 TIMER

CIRCUIT #1 - DELAYED RECOVERY

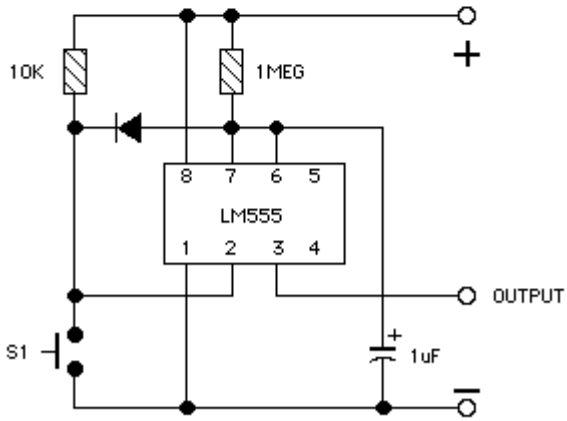


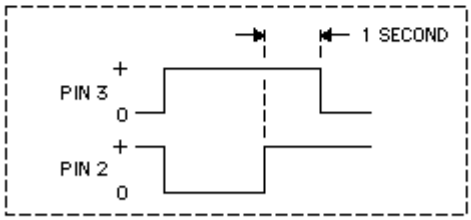


TO CALCULATE THE APPROXIMATE
DELAY TIME Tsec. = 1.1 X R X C

- PIN 3 WILL REMAIN LOW IF S1 IS HELD CLOSED

CIRCUIT #2 - NEGATIVE RECOVERY





TO CALCULATE THE APPROXIMATE
DELAY TIME Tsec. = 1.1 X R X C

- PIN 3 WILL REMAIN HIGH IF S1 IS HELD CLOSED

Please Read Before Using These Circuit Ideas

The explanations for the circuits on these pages cannot hope to cover every situation on every layout. For this reason be prepared to do some experimenting to get the results you want. This is especially true of circuits such as the "Across Track Infrared Detection" circuits and any other circuit that relies on other than direct electronic inputs, such as switches.

If you use any of these circuit ideas, ask your parts supplier for a copy of the manufacturers data sheets for any components that you have not used before. These sheets contain a wealth of data and circuit design information that no electronic or print article could approach and will save time and perhaps damage to the components themselves. These data sheets can often be found on the web site of the device manufacturers.

Although the circuits are functional the pages are not meant to be full descriptions of each circuit but rather as guides for adapting them for use by others. If you have any questions or comments please send them to the email address on the Circuit Index page.