2
PROJECT RATING

XU23A

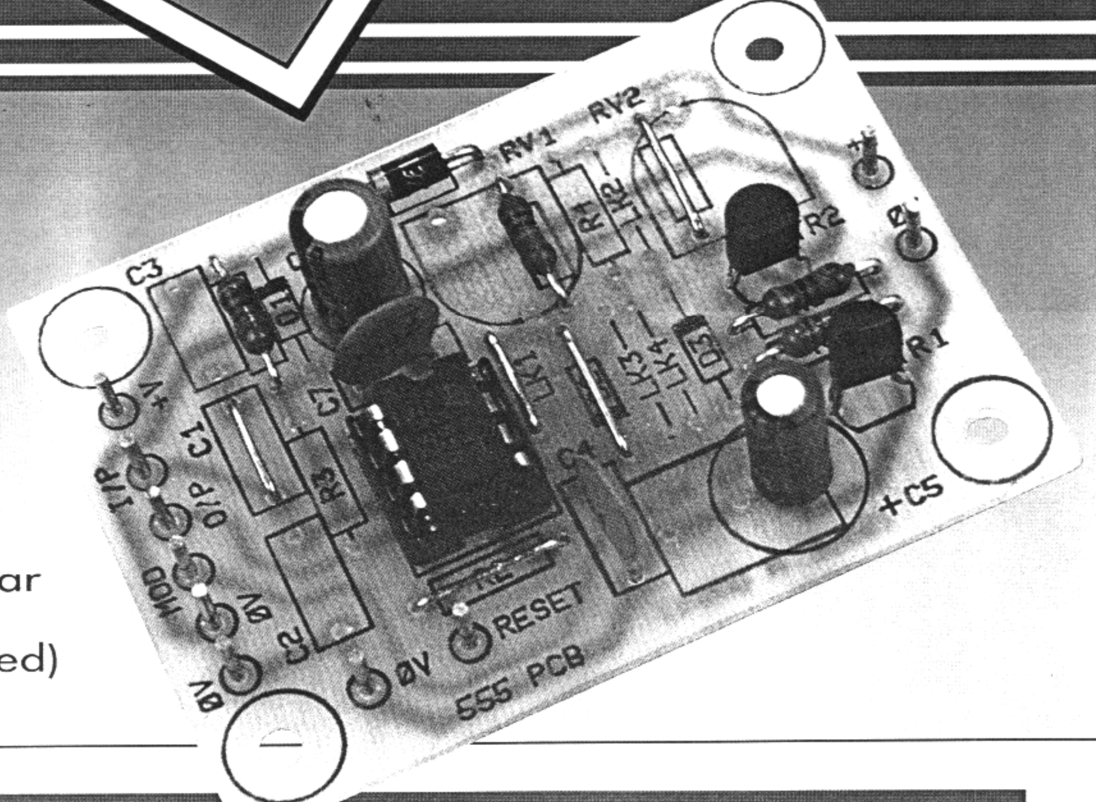
# MULTI-PURPOSE 555 TIMER CARD

by Alan Williamson

The 555 timer IC, shown in Figure 1, has been around since the early 1970s, and can be found in many circuits. Configurable as a monostable or an astable multivibrator, it can be used in many applications – for example, precision timing, pulse generation, sequential timing, time delay generation, pulse width modulation, pulse position modulation, missing pulse detection and oscillators. 'Real world' uses for the 555 therefore include logic pulsers, DC-DC converters, alarm systems, servo controllers and remote control systems. The general-purpose 'building block' project to be described here allows such circuits to be built up around this versatile 8-pin IC. The accompanying PCB is designed to incorporate all of these possible variations, by simply fitting components or wire links where required for a particular configuration. The full circuit of the PCB is given in Figure 2, while the PCB track and legend are reproduced in Figure 3. You should compare the circuit diagram of your intended configuration with that of Figure 2, since links may be required to complete the circuit – refer to the build schedule of Table 1 during construction.

## FEATURES

* Up to 11 configurations
* Monostable or astable operation
* Single PCB construction
* Uses the popular 555 IC (NE555 supplied)




KIT AVAILABLE (LT34M) [redacted]

## APPLICATIONS

* Timer circuits * Pulse width modulation * Square-wave generation * Reset pulse generation and watchdog circuits for microprocessors * Experimentation and circuit development * Education

## Power Supply Circuit

A simple power supply circuit, shown in Figure 4, is provided on-board. Diode D4 (1N4001) is used to protect the 555 and the polarised electrolytic capacitors from damage, in the event of accidental reverse- polarity connection of the power supply. The reservoir capacitor, C6 (100$\mu$F), is mounted close to the '+' supply pin, to counteract the 'crowbar' effect, in which the supply is effectively shorted to ground during the extremely brief output transition from low to (active) high (this applies to the NE555 variant only, which has a totem-pole output stage – CMOS versions do not suffer from this problem). C6 thus prevents collapse of the supply voltage. C7 (100nF disc ceramic), meanwhile, decouples any high-frequency noise on the supply. C6 and C7 are thus essential if this module is to be run from the same power supply as other circuitry.

## Circuit Configuration Options

For each circuit configuration, information is given which allows you to calculate circuit values where necessary. The components required are referenced in each circuit diagram, but links may also be needed, and so you should refer to the build schedule in Table 1 (on following page) before starting construction. There are two basic modes of operation – monostable and astable – but each can be configured slightly differently to suit a range of particular applications; these will also be described.

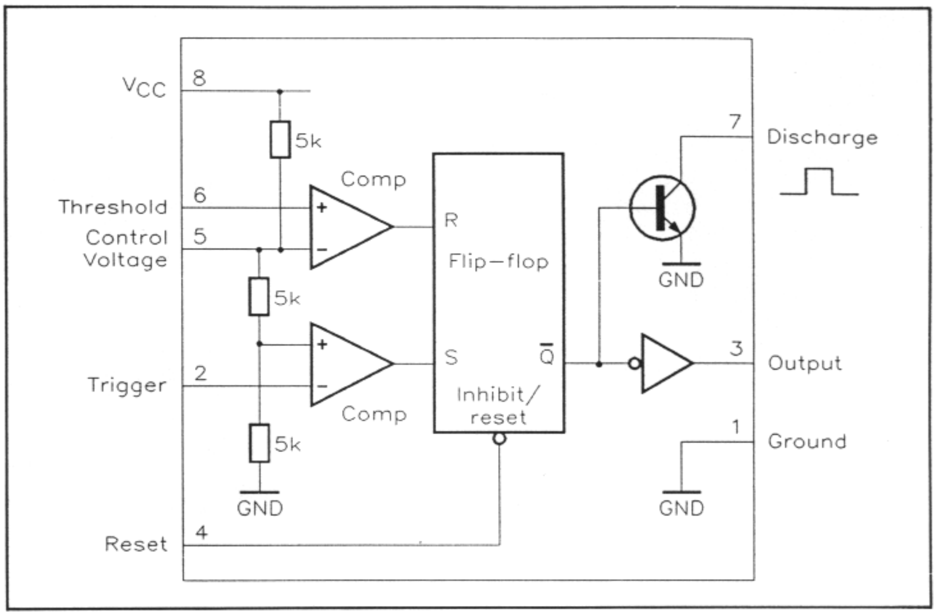
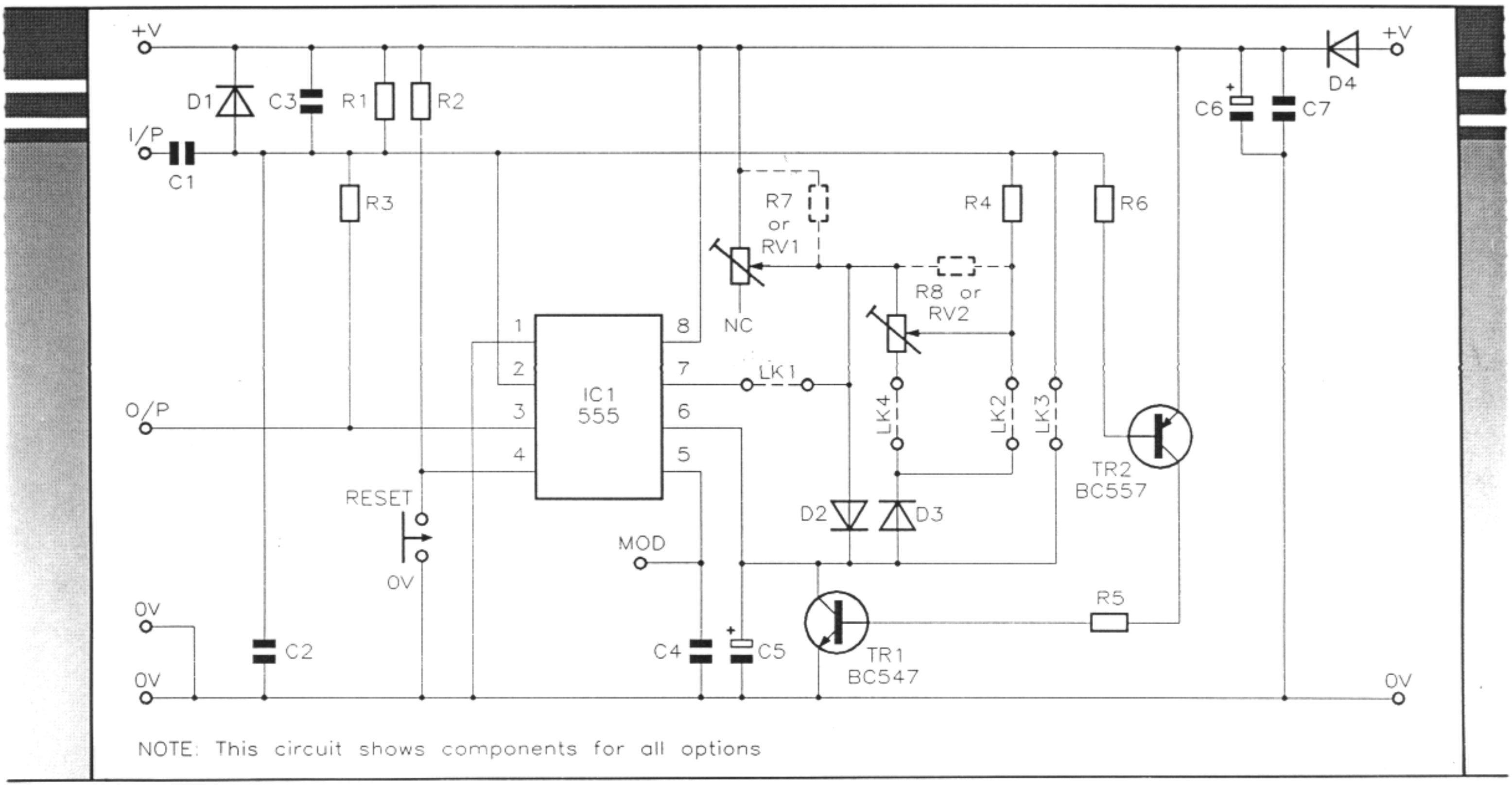
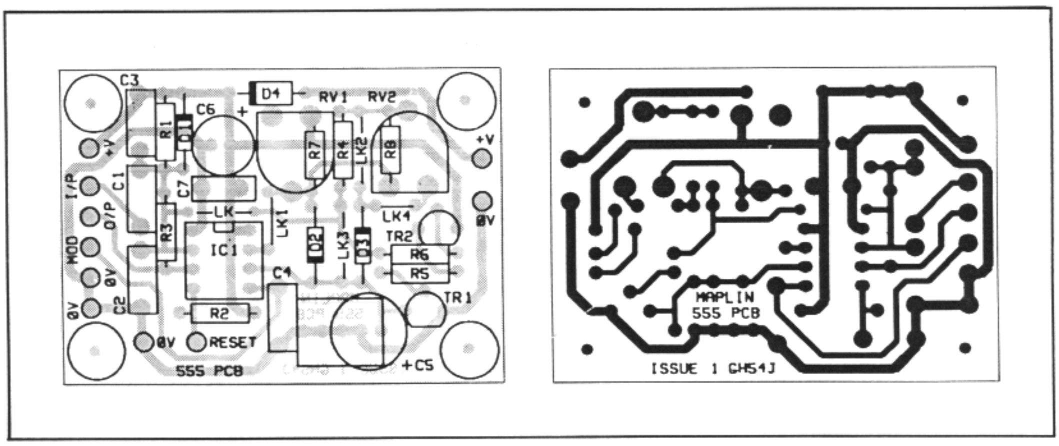



**Figure 1. Block diagram of 555 timer.**




**Above: Figure 2. Full circuit diagram of the Multi-Purpose 555 Timer Card.**

**Left: Figure 3. PCB legend and component overlay.**

| Configuration → / Component ↓ | Basic Monostable | Basic Monostable with Edge Triggering | Basic Monostable with Noise Immunity | Initiation by Power Supply | Retriggered Monostable | Adding Reset | Basic Astable | Duty Cycle ≤50% | Mark/space ratio adjustment | Mark/space ratio equal | PWM of control input* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R1 | √ | √ | √ | √ | √ | | – | – | – | – | – |
| R2 | Link | Link | Link | Link | Link | | Link | Link | Link | Link | Link |
| R3 | – | – | – | – | – | | – | – | – | √ | – |
| R4 | – | – | – | – | – | | – | – | √ | – | – |
| R5 | – | – | – | – | √ | | – | – | – | – | – |
| R6 | – | – | – | – | √ | | – | – | – | – | – |
| RV1 | R7 | R7 | R7 | R7 | R7 | Fit R4. Wire a push-to-make switch between P9 and P10. | R7 | R7 | – | – | R7 |
| RV2 | – | – | – | – | – | | R8 | R8 | √ | – | √ |
| C1 | Link | √ | √ | – | Link | | – | – | – | – | – |
| C2 | – | – | – | √ | – | | – | – | – | – | – |
| C3 | – | – | √ | – | – | | – | – | – | – | – |
| C4 | – | – | √ | – | – | | – | – | – | – | √ |
| C5 | √ | √ | √ | √ | √ | All other components fitted as normal, for intended application | √ | √ | √ | √ | – |
| C6 | √ | √ | √ | √ | √ | | √ | √ | √ | √ | √ |
| C7 | √ | √ | √ | √ | √ | | √ | √ | √ | √ | √ |
| D1 | – | √ | √ | √ | – | | – | – | – | – | – |
| D2 | Link | Link | Link | Link | Link | | – | √ | √ | – | – |
| D3 | – | – | – | – | – | | Link | √ | √ | – | – |
| D4 | √ | √ | √ | √ | √ | | √ | √ | √ | √ | √ |
| TR1 | – | – | – | – | √ | | – | – | – | – | – |
| TR2 | – | – | – | – | √ | | – | – | – | – | – |
| LK1 | √ | √ | √ | √ | √ | | √ | √ | – | – | – |
| LK2 | – | – | – | – | – | | √ | √ | – | – | – |
| LK3 | – | – | – | – | – | | √ | √ | √ | √ | – |
| LK4 | – | – | – | – | – | | – | – | √ | – | – |

* If a DC control voltage is to be derived from RV2, its wiper should be connected to the 'MOD' pin, using some insulated wire. The RV2 side of LK5 should then be connected to ground.

**Table 1. Build schedule.**

# 1. Basic Monostable Multivibrator

A basic monostable is shown in Figure 5. When the input pin of the 555 is taken below a third of the supply voltage (representing a 'low' logic state; the 555's input is active low), the output (pin 3) will become (active) high. The period of time for which the output will remain high is determined by the time constant of R7 and C5 multiplied by 1·1 (1·1 × R × C); if the input pin is held low for a longer period than the predetermined time, the output will remain 'high' until the input itself is taken high. Resistor R1 is used as a 'pull up', the value should be 1kΩ or greater (2MΩ max); very high values may cause problems with noise.

The minimum value for R7 is 2kΩ in monostable mode (and 1kΩ in the astable configuration). Its maximum value is 3·9MΩ (5V supply), or 10MΩ (15V supply); note, however, that accuracy will suffer with values over 1M; and environmental noise may prove to be a problem with false triggering – particularly when low supply voltages are used. There are no limits on value for C5; but if electrolytic capacitors are used, leakage current may be a problem when used with high values of R7. The voltage rating of the electrolytic capacitor should be *just* above the supply rail voltage – this is because an electrolytic will only become a capacitor with at least 10% of the rated voltage across it. A 100V electrolytic working on a 5V supply, for example, will possibly pose a problem.

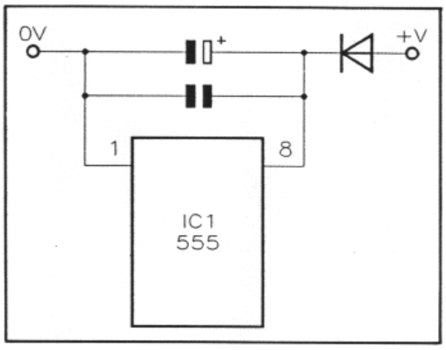


**Figure 4. PSU circuitry.**

## Edge Triggering

The 555 timer, in its normal state, is DC coupled. As a result, the output will remain high if the input remains low beyond the timed period, and will continue to do so

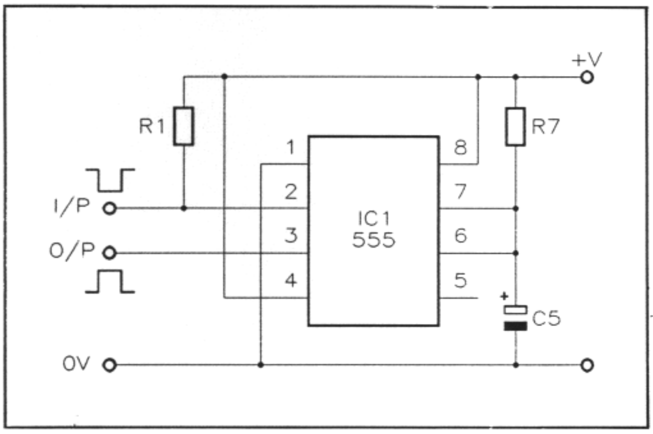


**Figure 5. Basic monostable circuit.**

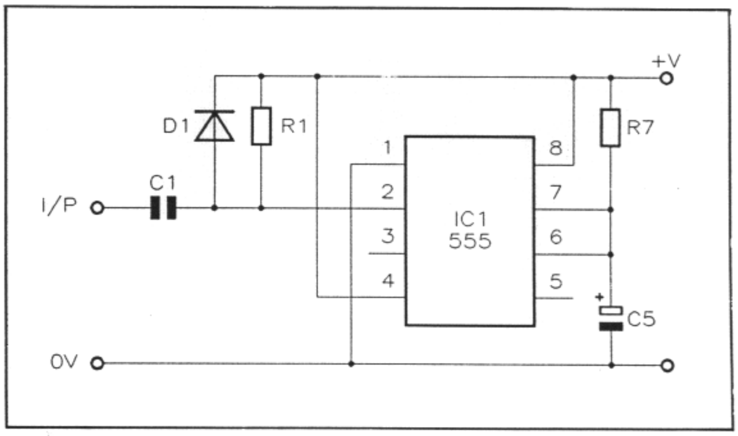


**Figure 6. Edge-triggering the monostable.**

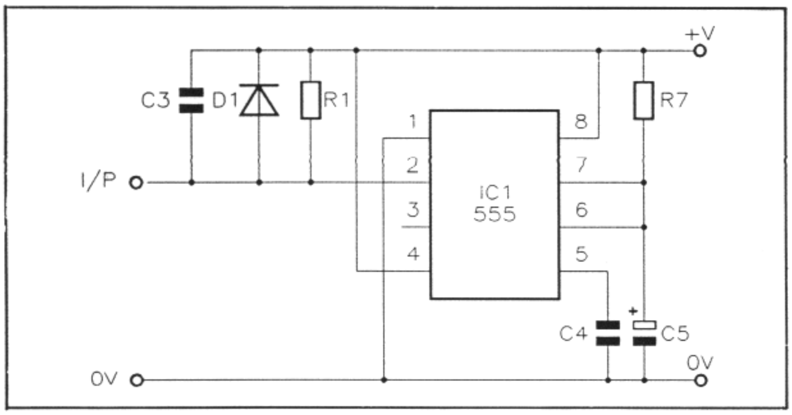


**Figure 7. Improving noise immunity.**

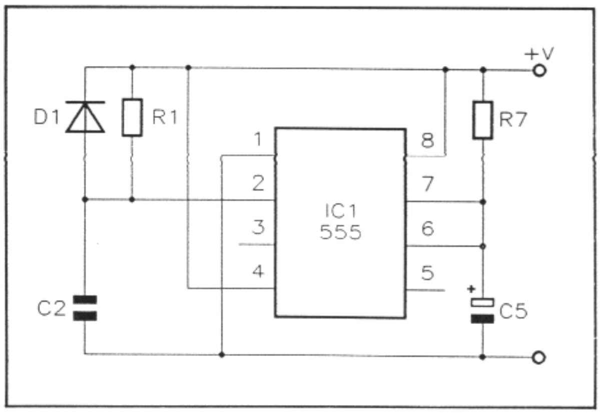
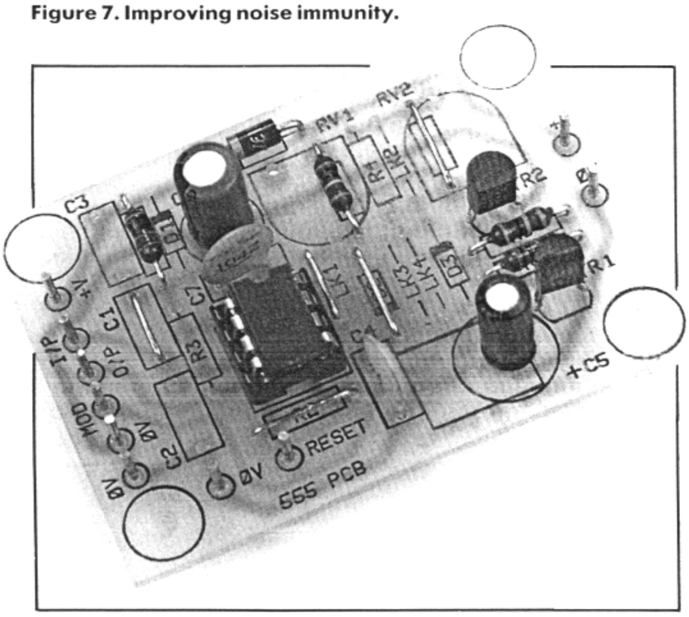


**Figure 8. Initiation by supply.**



**Completed PCB, (configured as a retriggerable monostable).**

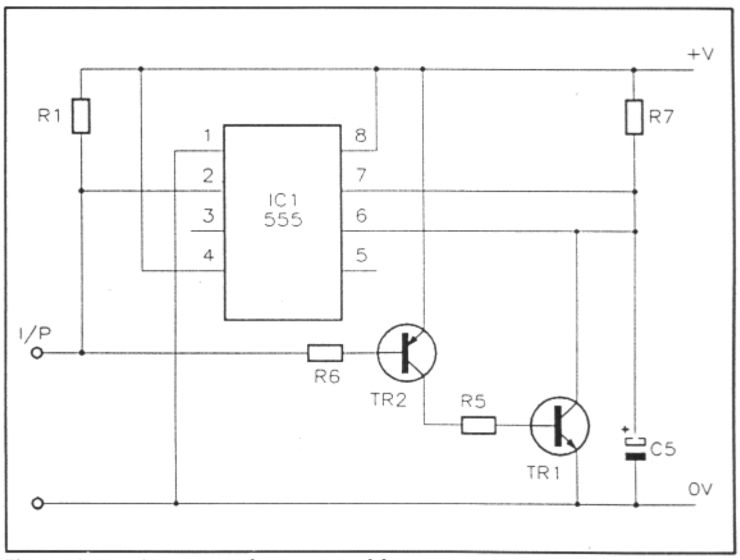


**Figure 9. Retriggering of a monostable.**

until the input reverts to a high condition. This can be a real pain if the output pulse *must* be of shorter duration than that of the input pulse. This phenomenon can, however, be prevented if the 555 can be triggered by the falling *edge* of the input pulse (remember that it's active low!). The modification is shown in Figure 6; a capacitor (C1) is added to the input – the smaller the capacitor, the sharper the pulse the better (a value of between 1 and 10nF would be ideal). Diode D1 is required to clip the input capacitor pulse above the positive supply rail voltage, thus protecting the input.

## Adding Noise Immunity

C3 will help to prevent false triggering by decoupling the input to the positive supply rail (refer to Figure 7). C4 will also help to prevent false triggering, by decoupling the internal resistor chain that is connected to the threshold comparator's input (refer back to Figure 1). The values of C3 and C4 should lie between 10 and 100nF.

Increasing the supply voltage (absolute maximum 18V) is another method of preventing false triggering, as the noise spike will also have to be proportionally larger in order to trigger the device.

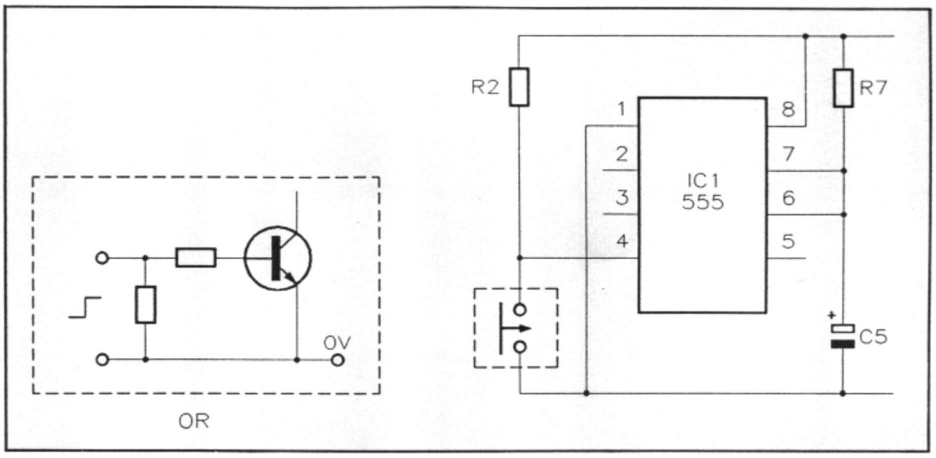



**Figure 10. Reset.**

## Initiation by Supply

The monostable can be triggered as the supply voltage is applied. This can be achieved simply by fitting C2, as shown in Figure 8. The time constant (of R1 and C2) should be long enough to allow the power supply to establish, but shorter than the chosen monostable period.

This type of circuit has a multitude of uses from loudspeaker connection delay on a transistor audio amplifier, delayed HT connection in valve amplifiers (allowing heater and bias to be established), and automatic power-up reset of microprocessor-based equipment.

## Retriggering

To retrigger a monostable, in order to make the time-out period appear continuous, use the circuit of Figure 9. A pulse applied to the input of the 555 will turn on TR2, which turns on TR1 and discharges C5. C5, as part of the monostable's time constant network, will

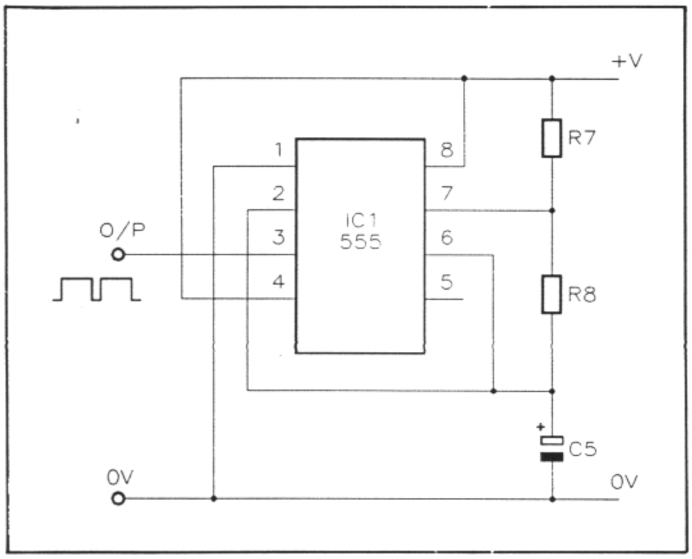



**Figure 11. Basic astable circuit.**

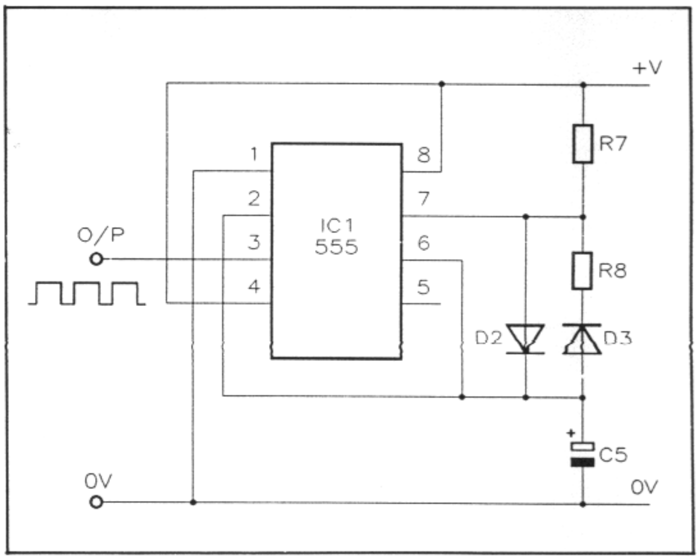



**Figure 12. Achieving a duty cycle of 50% or less.**

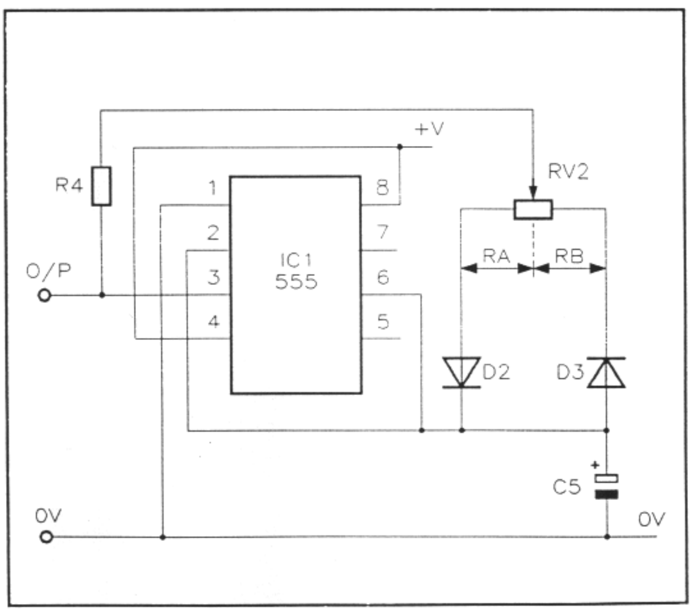



**Figure 13. Mark/space adjustment with constant frequency.**

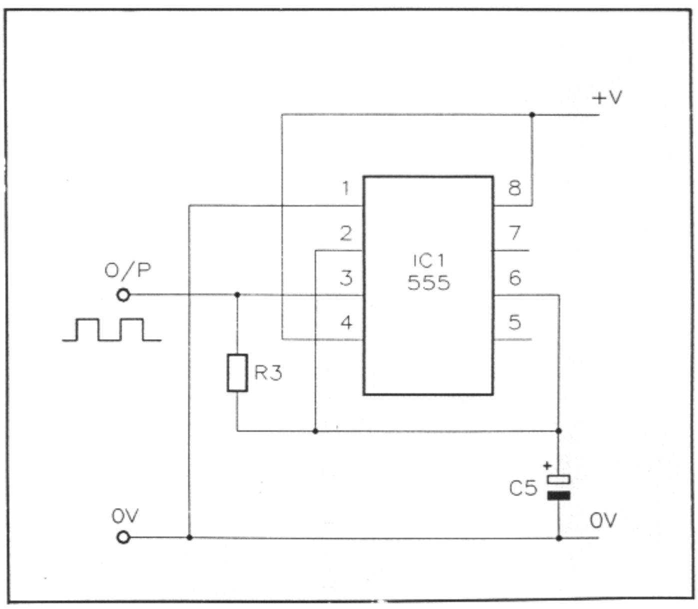



**Figure 14. Maintaining a 50% duty cycle with one resistor.**

then have to charge up again to time out. Care must be taken that the instantaneous current pulse from C5 does not exceed the maximum collector current of TR1.

This type of circuit can be used as a 'watchdog'. The sole purpose of this type of circuit is to detect failure of a microprocessor system (caused by, for example, a power supply glitch or peripheral problem). The circuit would, of course, have to be edge-triggered, since you cannot predict the state in which the microprocessor will lock up.

If a continuous train of pulses (e.g., system timer derived interupt) from the computer is fed into the input of the 555, the output will remain high until the processor fails. The 555 would then time out; the output would then revert to a low condition, and operate a DIL or reed relay. The coil of the relay is connected to the positive supply rail and the output pin (3) of the 555; a diode is wired in parallel with the relay coil to protect the 555 (cathode to the positive supply rail). The relay switch contacts are then wired in parallel with the computer's reset switch.

### Forced Reset

Resetting a monostable, before it has timed out, can be achieved by fitting a resistor (R2) and push-to-make switch, as shown in Figure 10. A value of 10kΩ would be suitable for most applications. An alternative to the switch could be a transistor, operated by a logic circuit or microprocessor.
The reset function could also be used to gate an astable multivibrator.

## 2. Basic Astable Circuit

A basic astable multivibrator is shown in Figure 11. Its output frequency can be calculated from the following equation

$$f = \frac{1.44}{(R7 + (2 \times R8)) \times C5}$$

The time period for the 'high' output (or charge time) can be found from the following equation:

$$T_H = 0.69 \times (R7 + R8) \times C5$$

The time period for the 'low' output (or discharge time), meanwhile, is:

$$T_L = 0.69 \times R7 \times C5$$

These equations show that the high output period is longer than the low output period; this effect can be minimised by making the value of R7 at least 100 times greater than the value of R8. The maximum value for the sum of R7 and R8 is 3M9 (with a 5V supply voltage), or 10M (with a 15V supply voltage).

### Duty Cycle

To achieve a duty cycle of 50% or less, the timing capacitor should be charged by R7 only, and discharged through R8 as normal. This can be accomplished by fitting a diode (D2) in parallel with R8, as shown in Figure 12. However, D2 has a voltage drop across it, and this will affect the mark/space ratio; diode D3 should therefore be included for compensation in the discharge path. Fitting RV1 and RV2 in place of R7 and R8 will allow independent adjustment of the individual mark and space timing; however, the frequency will also be altered.

Figure 13 shows how the mark/space ratio can be altered without changing the output frequency; which can be calculated from the following equation:

$$f = \frac{1}{1.44 \times RV2 \times 2 \times R4 \times C5}$$

This circuit could form the basis of a PWM (pulse width modulation) driver for use with racing car servos, or the electromechanical polarity controllers used with satellite TV receiving systems.

Figure 14 shows an alternative method of achieving an equal mark/space ratio, this time using only one resistor. In this example, the frequency of the oscillator is determined by the following equation:

$$f = \frac{1}{1.44 \times R3 \times C5}$$

This latter circuit is ideal for square wave oscillators, sounders and flashers.

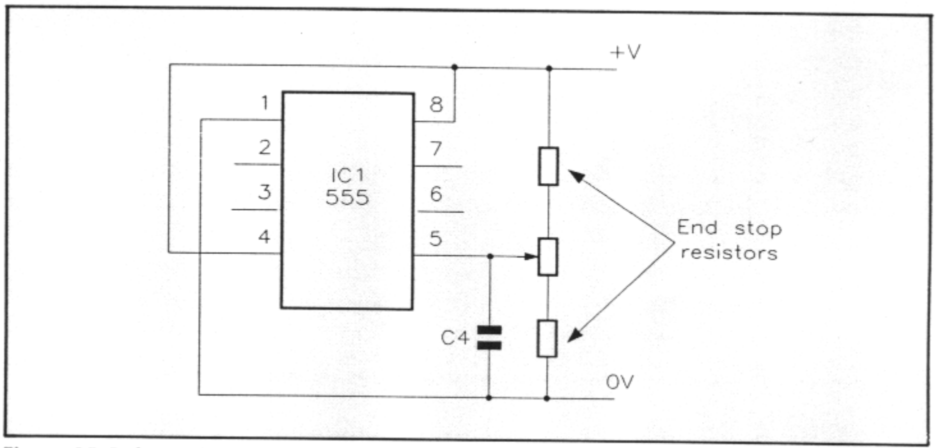



**Figure 15. Pulse width modulation.**

## More on Pulse Width Modulation

Applying a DC voltage to the control input (pin 5), as shown in Figure 15, will alter the threshold and trigger comparator input levels. If the 555 is configured as a monostable, the pulse width will therefore be altered; the pulses will be wider if the input modulation voltage to pin 5 is above two-thirds of the supply voltage, and narrower if below; refer to Figure 16a. The control voltage input could be used to trim the pulse width. If choosing this option, by mounting PCB pins instead of RV2, wires could be brought out to an external potentiometer. Alternatively, the control voltage could be a suitably-processed *AC-coupled* audio signal.
A connection on the PCB, 'MOD', can be used for this purpose – it is connected *directly* to the control input of the IC. Note that AC coupling, therefore, will have to take place off-board.

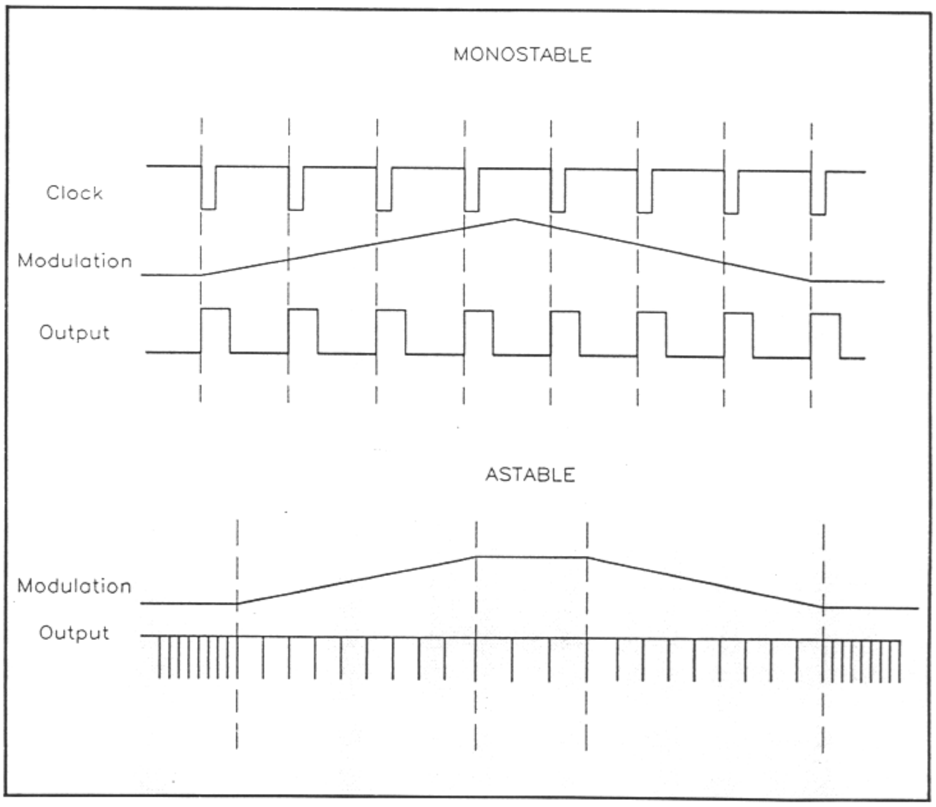



**Figure 16a. Modulation with a monostable. Figure 16b. Modulation with an astable.**

Figure 16b, meanwhile, shows the effect of the control voltage on an astable multivibrator. The control voltage input could, in this case, be used to trim the mark/space ratio.

## Kit Available

A complete kit of parts is available, including a high-quality fibreglass PCB which will accommodate all the circuit configurations discussed here. Also supplied, NE555 timer IC apart, is a range of components (refer to Parts List), from which you can select suitable values for your intended circuit. A list of recommended values for each component is given in Table 2. Once again, we refer you to Table 1, which tells you which items to fit to the PCB, for your chosen application. All links, by the way, can be derived from component lead offcuts.

A DC supply of between 6V and 18V DC can be used to power the circuit. The device itself consumes 10mA, but its output can source or sink up to 200mA and this should be taken into consideration.

All connections are brought out to PCB pins on the side of the board; these are the monostable trigger input, modulation input, output, DC supply and ground. For flexibility, the DC supply and ground connections are also brought out to PCB pins on the opposite side of the board.

| Component | Recommended Value |
|---|---|
| R1 | 1k to 100k |
| R2 | 0Ω (i.e. wire link) to 100k |
| R3 | 1k to 1M |
| R4 | 1k to 100k |
| R5 | 10k |
| R6 | 47k |
| RV1 or R7 | 2k to 100k (Maximum 3M9 (5V supply) or 10M (15V supply) for monostable operation) |
| RV1 + RV2, or R7 + R8 | 1k to 100k (Maximum 3M9 (5V supply) or 10M (15V supply) for astable operation) |
| C1 to C3 | 1nF to 100nF Polyester Layer |
| C4 | 10nF to 100nF Polyester Layer |
| C5 | 100pF to 100μF Polyester Layer |
| C6 | 47μF to 100μF Electrolytic |
| C7 | 100nF ceramic |

**Table 2. Suggested practical component values.**

## MULTI-PURPOSE 555 TIMER CARD PARTS LIST

**(Refer to Table 1)**

| | | | |
|---|---|---|---|
| RESISTORS: All 1% Metal Film (Unless specified) | | | |
| | 1k | 3 | (M1K) |
| | 4k7 | 2 | (M4K7) |
| | 10k | 3 | (M10K) |
| | 47k | 2 | (M47K) |
| | 100k | 3 | (M100K) |
| | 1M | 1 | (M1M) |
| | Hor Encl Preset 10k | 1 | (UH03D) |
| | Hor Encl Preset 100k | 1 | (UH06G) |
| CAPACITORS | | | |
| | 1nF Polyester Layer | 1 | (WW22Y) |
| | 10nF Polyester Layer | 1 | (WW29G) |
| | 100nF Polyester Layer | 3 | (WW41U) |
| | 1μF 100V PC Electrolytic | 1 | (FF01B) |
| | 10μF 50V PC Electrolytic | 1 | (FF04E) |
| C6 | 100μF 25V PC Electrolytic | 2 | (FF11M) |
| C7 | 100nF 50V Disc Ceramic | 1 | (BX03D) |
| SEMICONDUCTORS | | | |
| | 1N4148 | 3 | (QL80B) |
| D4 | 1N4001 | 1 | (QL73Q) |
| | BC547 | 1 | (QQ14Q) |
| | BC557 | 1 | (QQ16S) |
| | NE555 | 1 | (QH66W) |
| MISCELLANEOUS | | | |
| | 8-Pin DIL Socket | 1 | (BL17T) |
| | Pin 2145 | 8 | (FL24B)★ |
| | PCB | 1 | (GH54J) |
| | Instruction Leaflet | 1 | (XU23A) |
| | Constructors' Guide | 1 | (XH79L) |

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.
***The above items are available as a kit.***
**Order As LT34M (Multi-Purpose 555 Timer Card)**
Please Note: Items in the Parts List marked with a ★ are supplied in 'package' quantities (e.g., packet, strip, reel, etc.), see current Maplin Catalogue for full ordering information.
The following new item is available.
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