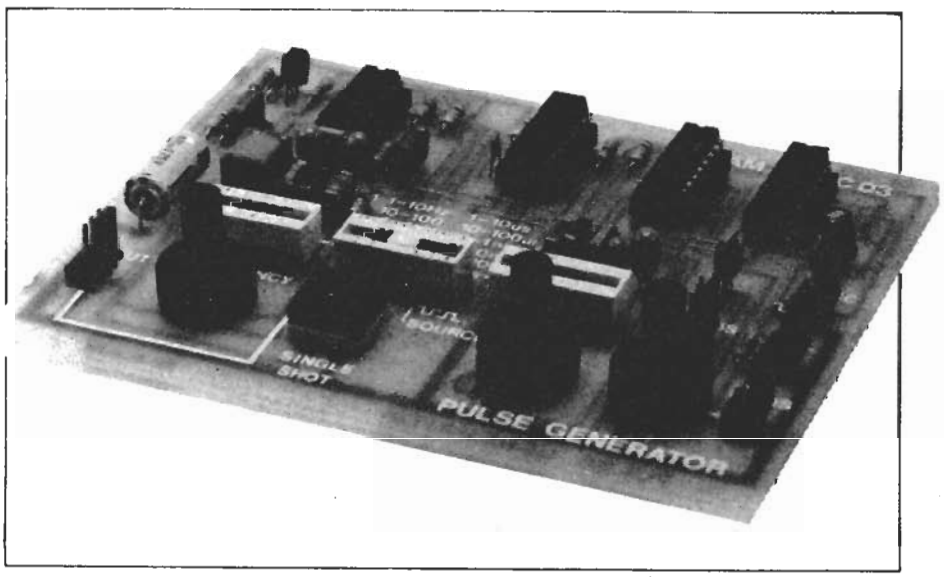
Pulse Generator

A versatile pulse generator board, ideal for logic testing.

By Mike Meakin



THIS pulse generator provides output pulses with widths variable from 1us to 1s at repetition rates from 1 Hz to 1 MHz. CMOS, TTL and open collector outputs are provided together with a sync output. The internal clock can be switched out when not required and the generator can then be driven from an external clock or operated in single shot mode. The design is inevitably a compromise between complexity and cost but it is felt that most of the facilities the average hobbyist is likely to require are provided. No power supply design is included; the board runs from a single 15V positive supply. It can be run from the bench supply, the power supply of another piece of equipment or a small 15V regulated supply.

The heart of any pulse generator is the monostable timing circuit, and a large number of IC devices are available to provide this function. However, obtaining a very wide timing range with sensible values of R and C limits the field.

The 555 timer would seem well suited to this application but the practical minimum pulse width obtainable from this device is about 10us. The 74121 series of TTL monostables require large values of timing capacitors and behave erratically at high duty cycles. The 74C221 chosen for this circuit is a CMOS device with a performance which is superior to that of both the 4528 and 4538 monostables from the 4000 series. A six decade timing range can be achieved with changes of capacitance only and it behaves well at high duty cycles.

Three outputs are available on the board. The TTL output is provided by five inverters in parallel and is capable of driving ten standard TTL loads. The input is driven from a 15V CMOS output but protection is given by an internal diode. A Schottky device must be used in this position. The 0 to 15V variable output is obtained from five paralleled CMOS buffers and a potential divider, giving a maximum source impedance of about 300R. some protection is provided by the 47R series resistor. Finally a VMOS transistor provides an 'open collector' or more correctly an open drain output. This sturdy device can sink up to 500mA and withstand 60V. It is ideal for use as a relay or LED driver.

Construction

Because the switches and potentiometers are all mounted directly onto the PCB, any labelling of functions and switch positions will also have to be done on the board itself. However, if you want a particularly neat end result you will have to either screen print the board or use rub-down lettering, and both of these processes must be undertaken before any other constructional work on the board is started.

Installation of the components should begin with the wire links and progress in the normal fashion through hardware devices (switches, sockets, etc.), passive components (resistors and capacitors) and finally the active components (the ICs, transistors and diodes). Take care that tantalum and electrolytic capacitors and the various active components are all inserted into the board the right way around. It is best to use sockets

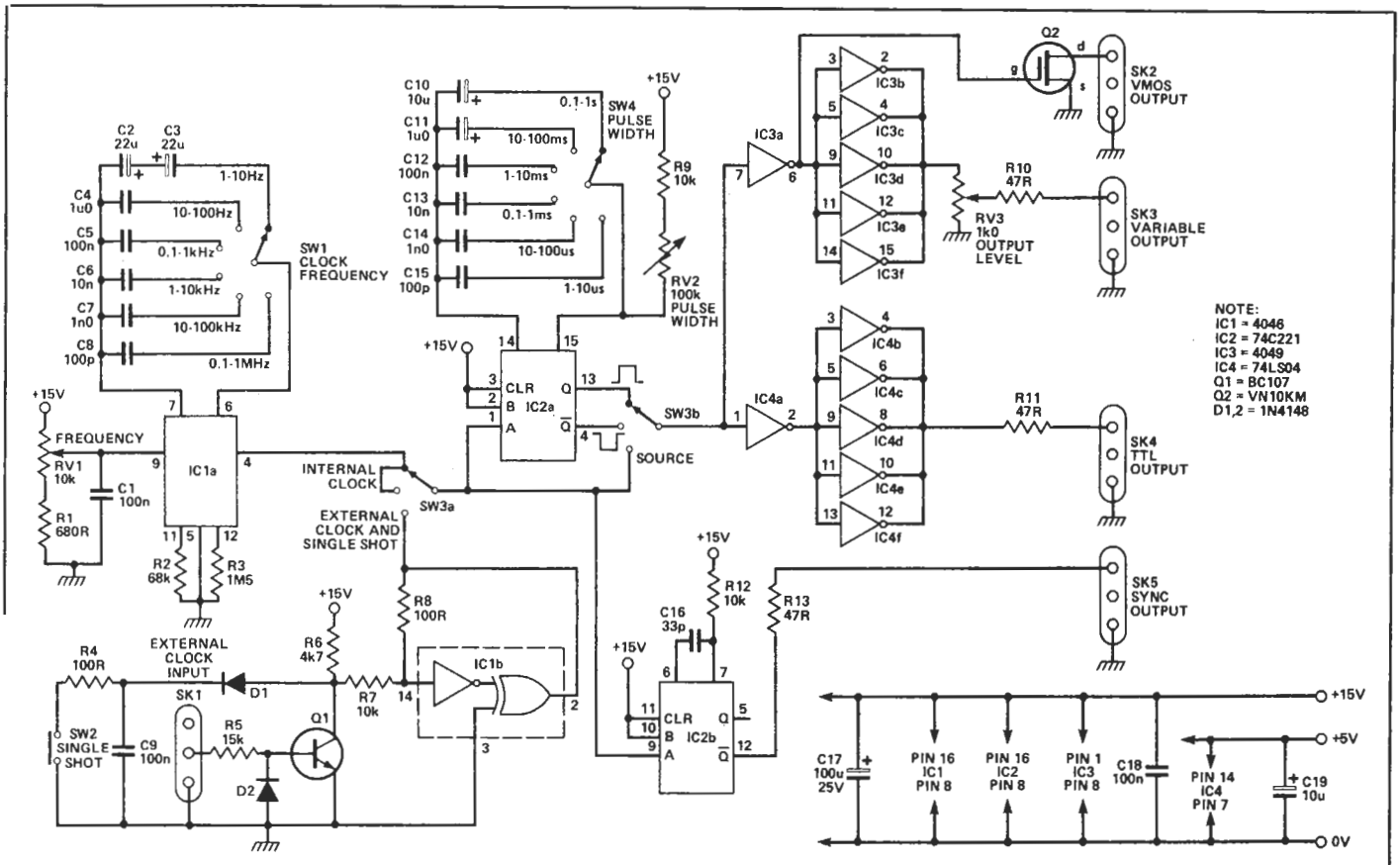


Fig. 1 Complete circuit diagram of the pulse generator. The board is intended for use with a 15V power supply so no PSU circuitry is shown here.

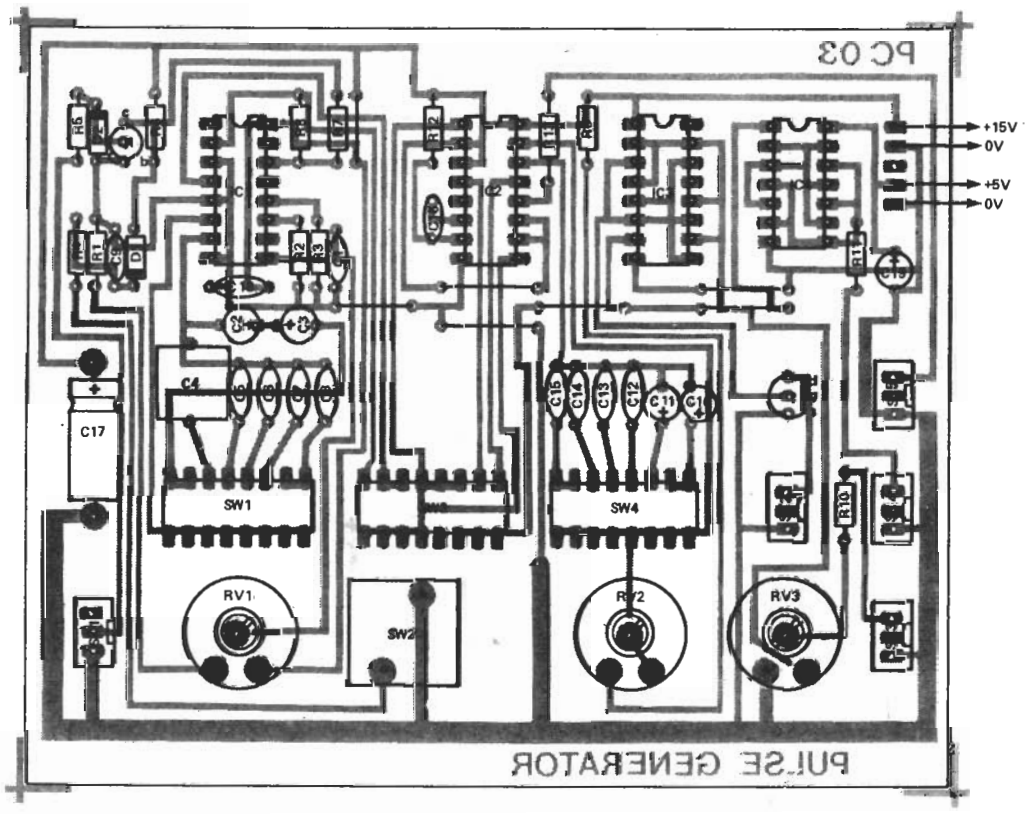
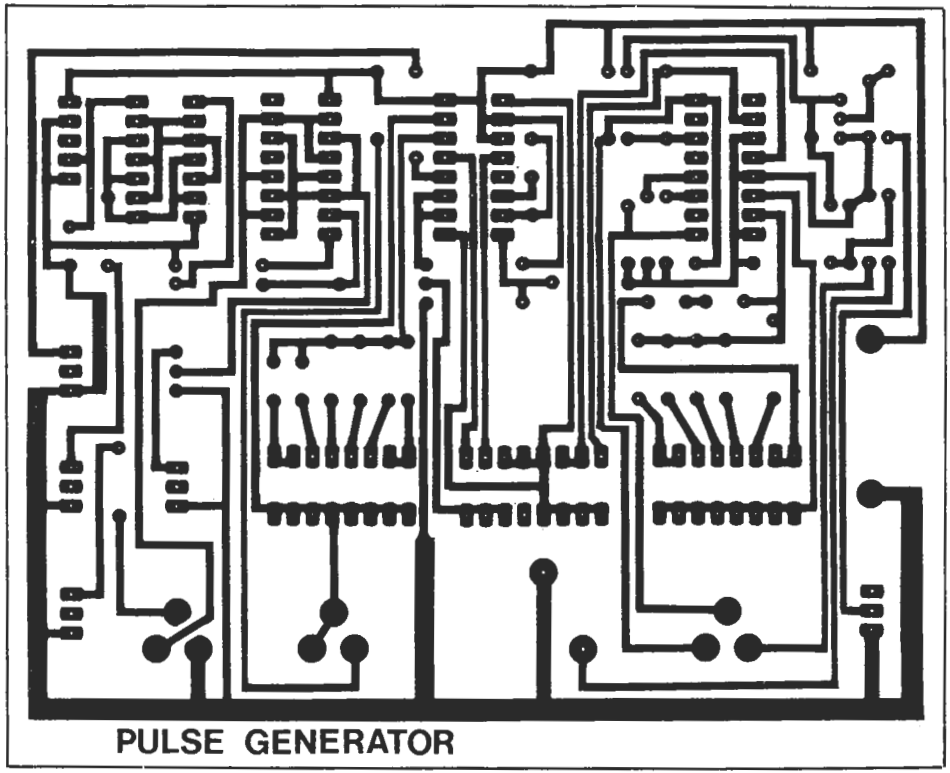


Fig. 2 The component overlay for the pulse generator PCB.

for the ICs but there is no reason why they should not be soldered directly into the board if you prefer and are careful. Since the DIP switches may suffer slight movement when operated, it is best to avoid sockets and solder them directly into place.

When the board is complete, connect up the +5V and +15V rails from the power supply module or from another regulated power supply. The current drawn from the main supply rail, the +15V one, will be about 25mA. Set SW3a to internal clock, the frequency control potentiometer to mid position and the frequency range to 0.1-1kHz. Select source and then apply power to the board.

Both the variable and the TTL outputs can be monitored either with an audio amplifier or a piezo sounder. The positive and negative going pulses should be checked with the width switch set to 0.1-1ms to confirm that the monostable is operating. Finally, a LED in series with a 1k0 resistor should be connected between the VMOS output and the plus 15V supply, observing the correct polarity of the LED. Select negative going output pulse, external clock and pulse width range 0.1-1s. If the single shot switch is pressed the LED should momentarily illuminate.



Those who have access to a scope can of course test the board more comprehensively.

How It Works

The VCO section of a 4046 phase lock loop IC is used as a clock. This circuit gives a 50-duty cycle square wave output at pin 4 of IC1. The six decade timing capacitors are selected by SW1. For the lowest frequency range two 22u tantalum capacitors are connected back to back to give a non-polarized capacitor whose value should ideally be 10u. The timing resistors R2 and R3 in conjunction with the voltage obtained from RV1 set a 1:10 frequency range.

SW3A selects either the VCO output or the external and single shot inputs. The section of the 4046 normally used as a phase comparator is connected as a Schmitt trigger to clean up the input pulses. These are obtained from an external clock via a transistor buffer whose input is protected by a series current limit resistor R5 and reverse polarity protection diode D2. The external clock input will operate either from a pulse source or an AC signal as long as it crosses the 0.6V turn-on potential of the transistor. The single shot of manual pulse is obtained by shorting the Schmitt trigger input to 0V with SW2. It is de-bounced by the R6, C9 time constant.

Half of the 74C221 is connected as a negative-edge non-retriggerable monostable. SW4 selects the timing capacitor and RV2, R9 alter the time period over a 1:10 range. The input pulse also triggers the other half of IC2 to give a negative going sync pulse of about 500ms at SK5. This is coincident with the leading edge of the output pulse and can be used to trigger an oscilloscope. SW3B directs either a positive going pulse, a negative going pulse or the source signal to the output stage. The VCO square wave signal, the external clock or manual pulses can thus be sent directly to the output.

PARTS LIST

Resistors

R1	680R
R2	68k
R3	1M5
R4	100R
R5	15k
R6	4k7
R7,9,12	10k
R8	100k
R10,11,13	47R
RV1 10k	trimpot
RV2	100k trimpot
RV3	1k trimppot

Capacitors

C1,5,9,12,18	100n film
C2,3	22u 16V
C4 1u	film
C6,13	10n film
C7,14	1n film
C8,15	100p
C10,19	10u 16V
C11	1u 35V
C16	33p
C17	100u 25V

Semiconductors

IC1	4046
IC2	74C221
IC3	4049
IC4	74LS04
Q1	2N3904 or equiv
Q2	VN10KM or equiv
D1,2	1N4148

Miscellaneous

SK1-5	3-way Molex PCB plug
SW1-4	1-pole, 6-way DIP slide switch
SW2	PCB keyboard switch
SW3	2-pole, 3-way DIP slide switch

PCB, IC sockets if desired.