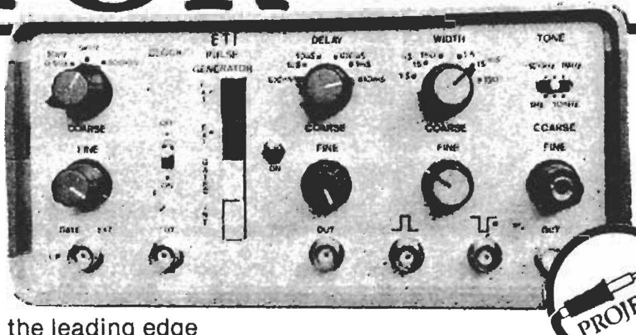
PULSE GENERATOR



A versatile piece of test gear that can be used as a single or dual pulse generator, a delayed-pulse generator, or a direct or delayed tone-burst generator.

PULSE GENERATORS HAVE a variety of applications in the modern electronics workshop/laboratory. In its simplest form, a pulse generator can be used for testing the performance characteristics of a common digital circuit or for testing the transient responses of AF or RF amplifiers. In a more advanced form, as a delayed-pulse/toneburst generator, the instrument can be used for simulating or implementing sophisticated systems such as ultrasonic movement detectors, range-finders, or RADAR systems.

The ETI pulse generator is the most versatile instrument that you could possibly wish for. It has two built-in pulse generators (a delay and a width generator), which can be effectively clocked in parallel or series. When parallel clocking is used, the unit simultaneously generates two independently controlled pulses from each clock pulse. When series clocking is used, the unit generates an output pulse that is delayed from the clock pulse by a period set by the delay generator. The pulse width and delay times are both fully variable over the range 100 nS to 150 mS.

The two pulse generators can be clocked from either internal or external signals. The internal clock generator spans the full range of 0.5 Hz to 500 kHz and can be used directly or can be gated by external signals. The clock signal is made available externally via an output socket.

The delay pulse of the unit is made externally available via a single output socket, while the main width pulse is available in direct and inverted form via a pair of sockets. The main pulse can also be used to trigger and gate an internally generated tone burst signal, which is available via another socket. The tone burst signal is fully synchronised to both the clock signal and the leading edge of the main pulse and is fully variable over the 1 Hz to 1 MHz range.

All outputs of the unit are buffered and short-circuit proof. The outputs are driven by TTL and are fixed-amplitude with typical rise and fall times of about 20 nS. The complete unit consumes a mean current of about 40 mA and can be powered from either a 6 V battery pack or from a line-derived 5 V regulated supply.

Construction

First, wire up the PCB as shown on the overlay, noting the use of a large number of Veropins for making external connections. Take the usual precautions over the polarity of semiconductors and electrolytics. Note that two connecting links are used on the top of the PCB and that, on the underside of the board, insulated wire links are made from pin 1 of IC3 to pins 1-2 of IC5 and from pin 6 of IC3 to pins 9-10 of IC5.

When construction of the PCB is complete, fit it into a suitable case, make the interconnections to all switches/pots/sockets, connect the circuit to a suitable power supply, and test/debug the circuit as follows.

Testing

Turn SW2 to the INT CLK position, monitor SK2 on channel 1 of a two-channel 'scope and switch SW7 on. If the clock generator circuitry is operating correctly, a rectangular clock signal should be visible on the 'scope and should be variable over the 0.5 Hz to 500 kHz range using RV1 and SW1. If a clock signal is not visible, check through the SW2-IC6 and IC1 circuitry to find the error. If all is well, turn SW2 to the GATED CLK position and check that the generator

PARTS LIST

Resistors all ¼ W 5%	
R1	22k
R2	10M
R3	1k0
R4	4k7
R5,7,10, 11,12	47R
R6,8	1k5
R9	10k
Potentiometers	
RV1	22k logarithmic
RV2,3	22k linear
RV4	2M2 logarithmic
Capacitors	
C1,8,14,16	1u0 polycarbonate
C2,6,12,17	10n polyester
C3,18	47p ceramic
C4,10	82p ceramic
C5,11	1n0 polycarbonate
C7,13,19,20	100n polyester
C9,15	10u 16 V tantalum
C21	1000u 10 V axial electrolytic
Semiconductors	
IC1,4	CD4046B
IC2,3	74121
IC5	7408
IC6	7414
Q1	2N4123
D1,2	1N4148
Miscellaneous	
SW1,3,5	1 pole rotary switch
SW2	2 pole changeover (4 off interlocking pushbutton type)
SW4	SPDT miniature toggle
SW6	3 position slide switch
SW7	SPDT slide switch
SK1,2,3, 4,5,6	BNC 50R sockets
7 knobs, Case	

can be gated on and off by SK1 signals. Finally, check that external clock signals (from SK1) are available at SK2 when SW2 is turned to the EXT CLK + or − positions.

Now, with SK2 still connected to channel 1 of the 'scope and with SW2 in the INT CLK position, monitor SK3 on channel 2 of the 'scope. With the 'scope synchronised to channel 1, check that a delay pulse is synchronously generated at SK3 and is fully variable by RV2 and SW3.

Next, monitor SK5 output on channel 2 of the 'scope, turn SW4 to the DELAY OFF position and check that a width pulse is synchronously generated at SK5 and is fully variable by RV3 and SW5. If all is well, turn SW4 to the DELAY ON position and check that the width pulse can be delayed relative to the clock using the RV2-SW3 delay controls. Check that an inverted version of the output pulse is available at SK6.

Finally, check that a tone burst pulse-controlled signal is available at SK4 and that the tone frequency is fully variable by the RV4-SW6 tone controls.

When making the above functional tests, note that the pulse period (or the sum of the pulse periods in the delay mode) must always be less than the period of the clock signal and that the period of the tone signal must be less than that of the width pulse.

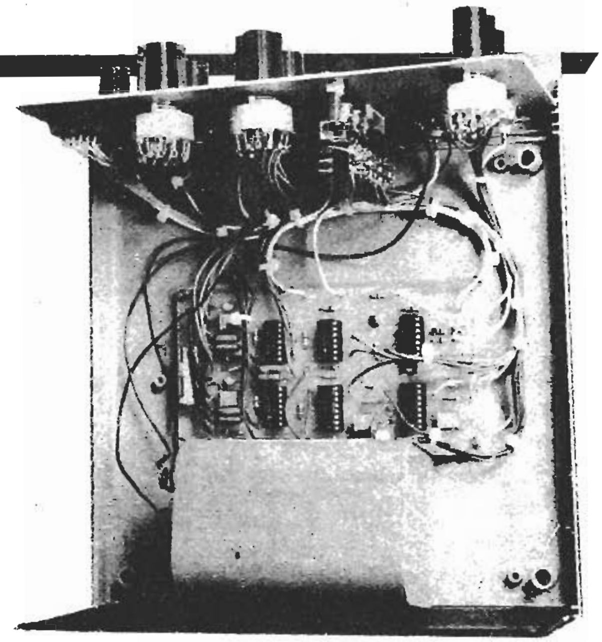


Fig. 3 Pulse timing diagram.

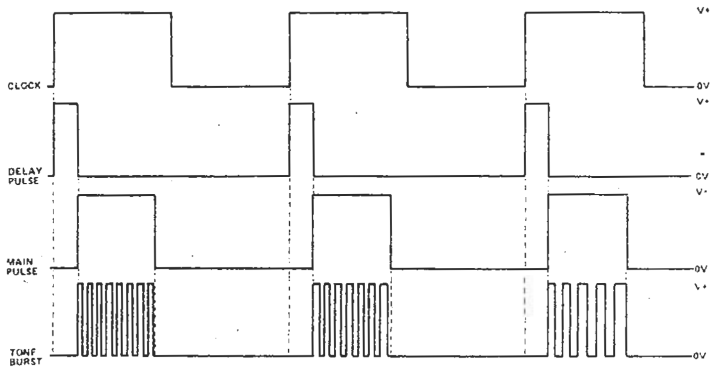
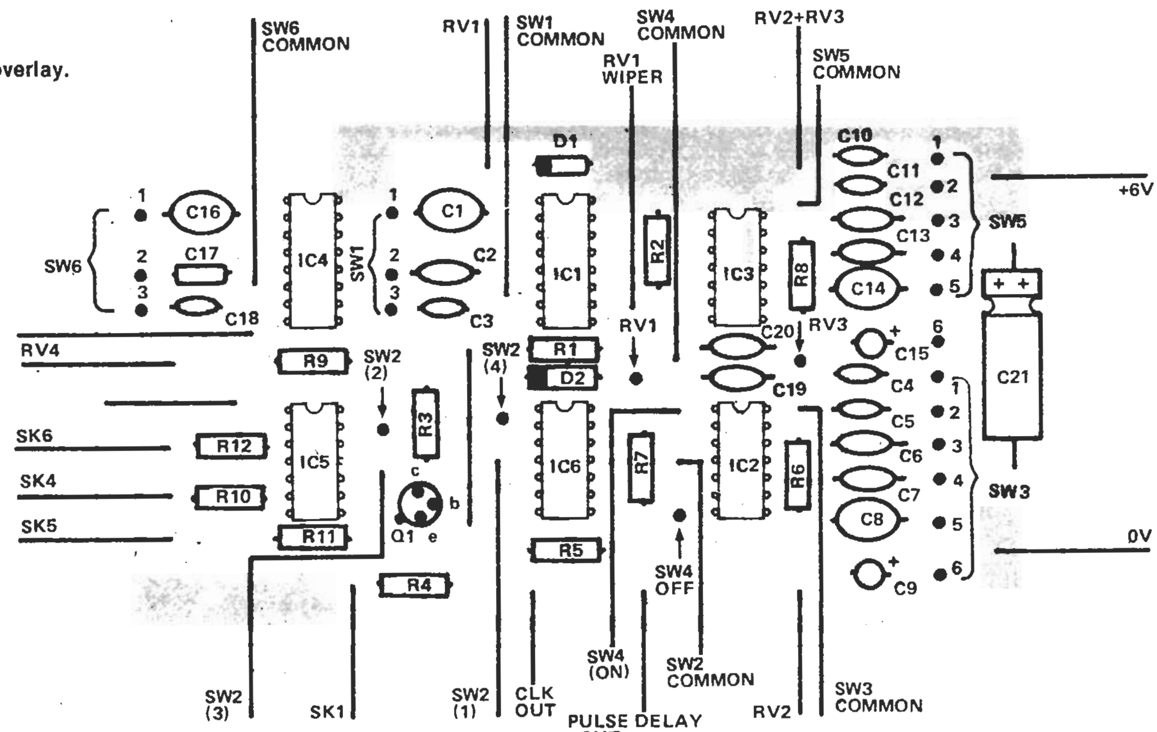


Fig. 1 Component overlay.



LINK UNDERSIDE OF PCB
PIN 6 OF IC3 TO PINS 9 AND 10 OF IC5
ALSO PIN 1 OF IC3 TO PINS 1 & 2 OF IC5

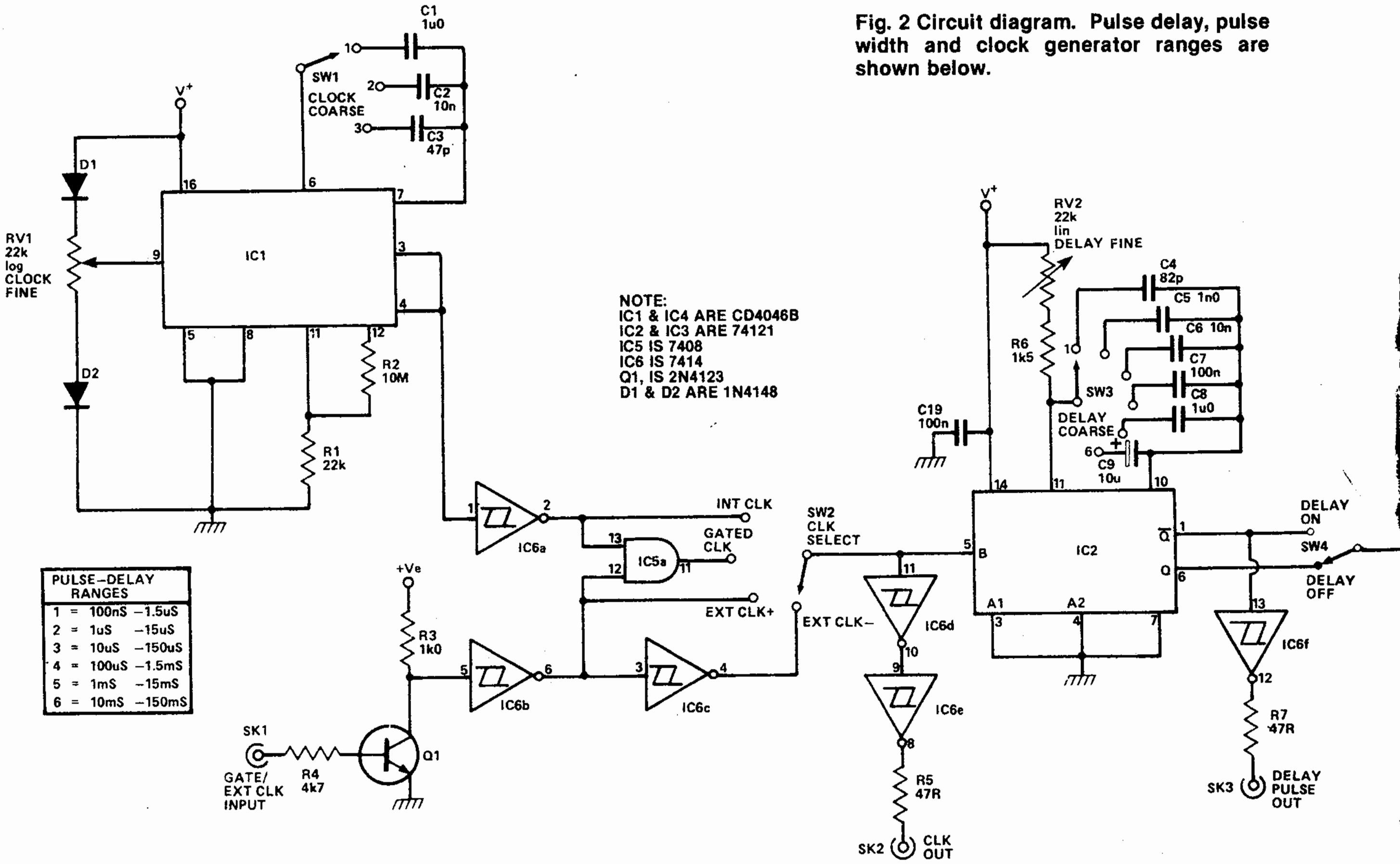


Fig. 2 Circuit diagram. Pulse delay, pulse width and clock generator ranges are shown below.

PULSE–DELAY RANGES	
1 =	100nS –1.5uS
2 =	1uS –15uS
3 =	10uS –150uS
4 =	100uS –1.5mS
5 =	1mS –15mS
6 =	10mS –150mS

HOW IT WORKS

The circuit comprises a clock generator (IC1), two pulse generators or monostables (IC2 and IC3), one gated tone generator (IC4) and a few gates and inverters. The most fundamental elements of the project are the two pulse generators, which are designed around 74121 TTL monostable ICs. In our particular application, these monos are triggered by the positive transition of a clock signal applied to pin 5 and then generate an output pulse with a duration determined by the R-C timing components connected to pins 10 and 11.

Note that these monostables generate a positive output pulse at pin 6 and an inverted or negative pulse at pin 1. Thus, if IC3 is triggered by pin 6 of IC2, both monos will effectively trigger at the same time (effective parallel clocking) and the IC3 pulse will not be delayed relative to the main clock signal. If IC3 is triggered by pin 1 of IC2, on the other hand, the IC3 pulse will be delayed relative to the main clock signal. In practice, both the delay and the main pulse widths are fully variable over the range 100 nS to 150 nS by independent controls.

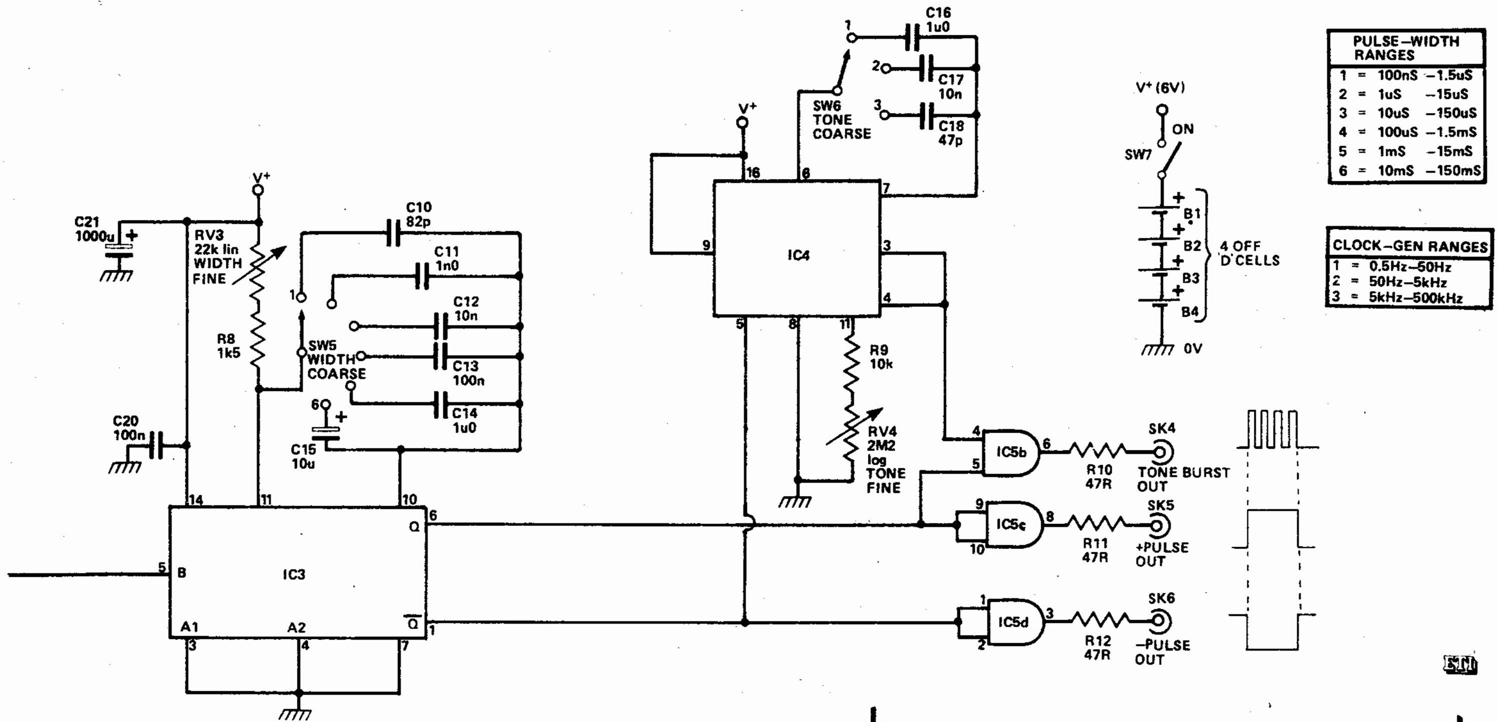
The pulse generators can be clocked by an internal clock generator (IC1) or by external clock signals. The internal clock generator is designed around the VCO section of a 4046B phase-locked loop and can span the range 0.5 Hz to 500 kHz in three switch-selected overlapping bands. Each band spans a range of roughly 200:1 controlled by RV1. The output of this generator is buffered by IC6a (a TTL Schmitt inverter) and can be used to clock the pulse generators either directly or by AND gate IC5a. In the latter case, the gate signal must be gated on by an external signal applied to socket SK1.

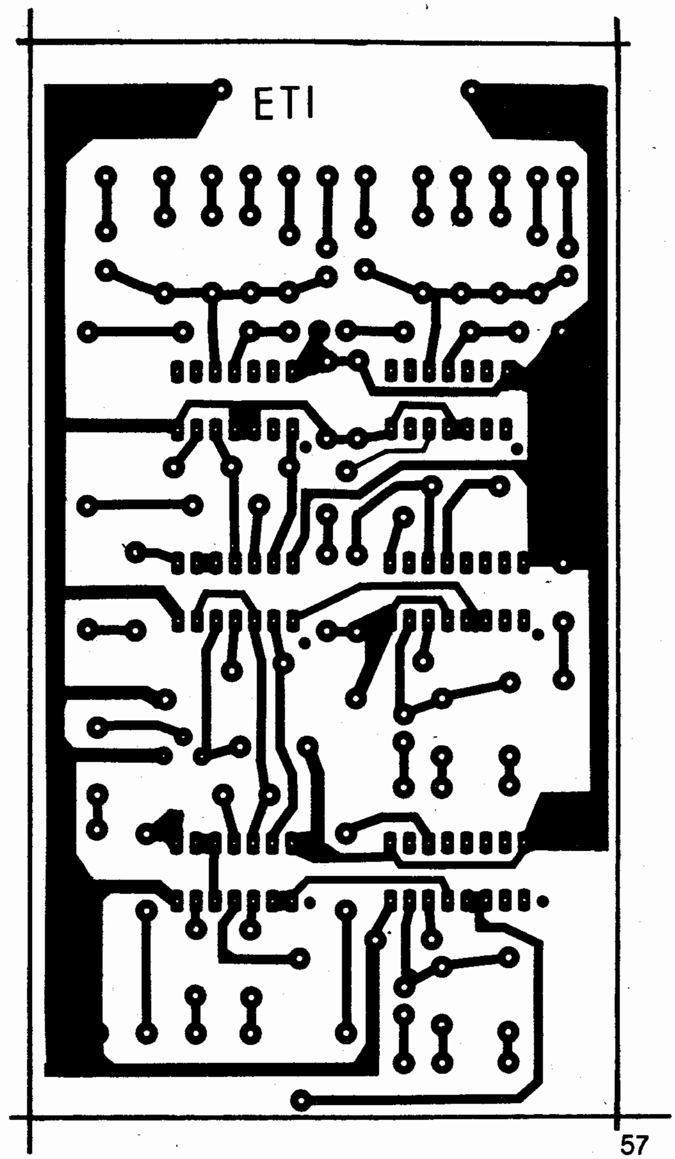
External gate or clock signals can be applied to SK1. These signals are amplified and inverted by Q1 and re-inverted and cleaned up by IC6b. The resulting signals can be used either to gate the internally-generated clock signals via IC5a or to directly clock the pulse generators via SW2. In the latter case, the pulses are generated in phase with the external clock signals when SW2 is in the EXT CLK + position, or in antiphase in the EXT CLK − position. The final clock signals to IC2 are double-inverted by IC6d-IC6e and made externally available at SK2.

The pulse output of the IC2 delay circuit is buffered and made externally available at SK3 by IC6f. Simultaneously, the direct and inverted main-pulse outputs of IC3 are made available at sockets SK5 and SK6 respectively by buffer stages IC5c and IC5d. A tone burst signal is also available at SK4 and is generated as follows.

IC4 is a wide-range square-wave generator designed around the VCO section of a 4046B CMOS IC. This generator can span the range 1 Hz to 1MHz in three switch-selected overlapping ranges, with each range spanning a 200:1 band controlled by RV4. The output of this oscillator is fed to one input of AND gate IC5b and the positive pulse output of IC3 is fed to the other input of the AND gate. IC4 is enabled only when pin 5 is pulled low. In our circuit, pin 5 is coupled directly to the inverted pulse output of IC3. consequencly, the IC4 signals and have a burst duration equal to the pulse width of IC3.

The complete pulse generator project consumes a mean current of about 40 mA and can be powered from a 6 V battery pack or from an external 5 V regulated supply.


PULSE–WIDTH RANGES
1 = 100nS –1.5uS
2 = 1uS –15uS
3 = 10uS –150uS
4 = 100uS –1.5mS
5 = 1mS –15mS
6 = 10mS –150mS
CLOCK–GEN RANGES
1 = 0.5Hz–50Hz
2 = 50Hz–5kHz
3 = 5kHz–500kHz
C16 1u0
C17 10n
C18 47p
SW6 TONE COARSE
V+
V+ (6V)
ON
SW7
B1
B2
B3
B4
4 OFF 'D' CELLS
0V
IC4
C21 1000u
RV3 22k lin WIDTH FINE
C10 82p
C11 1n0
C12 10n
C13 100n
C14 1u0
C15 10u
SW5 WIDTH COARSE
R8 1k5
C20 100n
R9 10k
RV4 2M2 log TONE FINE
IC5b
IC5c
IC5d
R10 47R
R11 47R
R12 47R
SK4 TONE BURST OUT
SK5 +PULSE OUT
SK6 –PULSE OUT
IC3
ETI


ETI

PULSE-MATE

This single-shot and continuous-pulse generator is inexpensive and easy to build, yet it offers automatic level setting and both positive and negative pulses.

DAVID PLANT

THERE IS AN OLD AXIOM THAT A MAN'S work is only as good as his tools—and a good pulse generator is always a good tool to have. Those of us who don't often need pulse generators—the technician working at home on a project, for example—can usually get by with a 555 timer added to a prototype board and used as a trigger. But there's not always enough room on the board to do that, and it is always a pain in the neck.

The solution to that problem is our Pulse-Mate, a compact single-shot and continuous-pulse generator. The easy-to-use design has automatic level setting and positive and negative pulse output. It can be powered from the device under test in the range from 4.5 to 18 volts DC, and has short-circuit protection for itself and the device under test.

The circuit

Referring to Fig. 1, the circuit basically has three sections. Foremost is the actual pulse generator built around the ubiquitous 555 timer, which can be switched from monostable mode (one shot) to astable mode by S2. The value of R8 is selected to create an approximate square wave at mid frequency range and R11 selects the actual rate desired. With S2 in the "astable" position, R11 and C2 give a range of about 5- to 200-Hz., which will satisfy most needs. (Note that S2 is part of potentiometer R11.) If you need to generate higher frequencies, a reduction of C2 can bring the range up well above audio, but at a loss of the low-frequency pulsing which can be quite handy.

With S2 in the "one shot" position, pushbutton S1 will trigger IC1 for as long as it is held down. The timer's trigger input (pin 2) is held high by R1 to prevent false triggering from hand capacitance. When the trigger pin is brought to ground by S1 or keyed by the discharge pin (pin 7) in the astable mode, pin 3 goes high to about 3.3 volts (when IC1 is powered from 5 volts). For better circuit stability, power to IC1 is regulated.

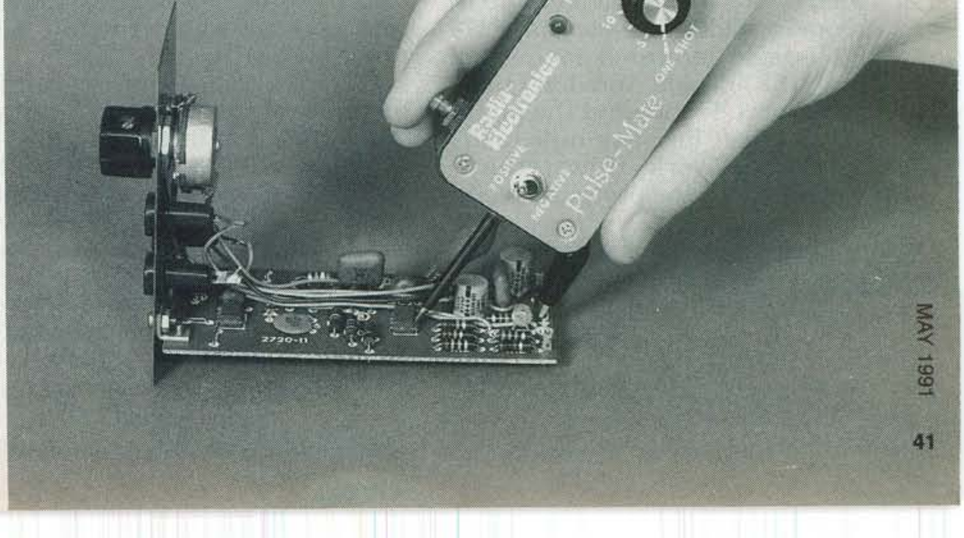
The second section of the circuit consists of Q1 and Q2 which provide the high-rise-time pulse required for digital work. When Q1 is turned on by the positive output of IC1, its collector goes low, giving a negative output pulse at the probe if S3 is in the "low" position. The low output from Q1 also turns Q2 off; Q2's collector now goes high, which provides a positive pulse at the probe if S3 is in the "high" position. Transistor Q2 also drives Q3, which drives indicator LED1.

Because Q1–Q3 operate at the incoming supply voltage, we strongly recommend that you use 2N4400 or equivalent transistors rather than garden-variety NPN's, as their base-emitter drop is less and they have a faster rise-time. The Pulse-Mate's output waveform is shown in Fig. 2. The probe current is limited to under 5 mA by R6 to protect both the device under test and the Pulse-Mate.

The third section consists of a voltage regulator consisting of Zener-diode D1 and Q4. That configuration was used rather than the popular three-terminal devices, such as the 7805, because, when powered from 5 volts, the regulator's internal voltage drop wouldn't leave enough to power IC1. As the supply voltage increases beyond 6.2 volts, the Zener diode conducts and limits Q4's output to 6 volts for IC1.

Construction

A parts-placement diagram is shown in Fig. 3, and we have provided the foil pattern for the PC board if you would like to make



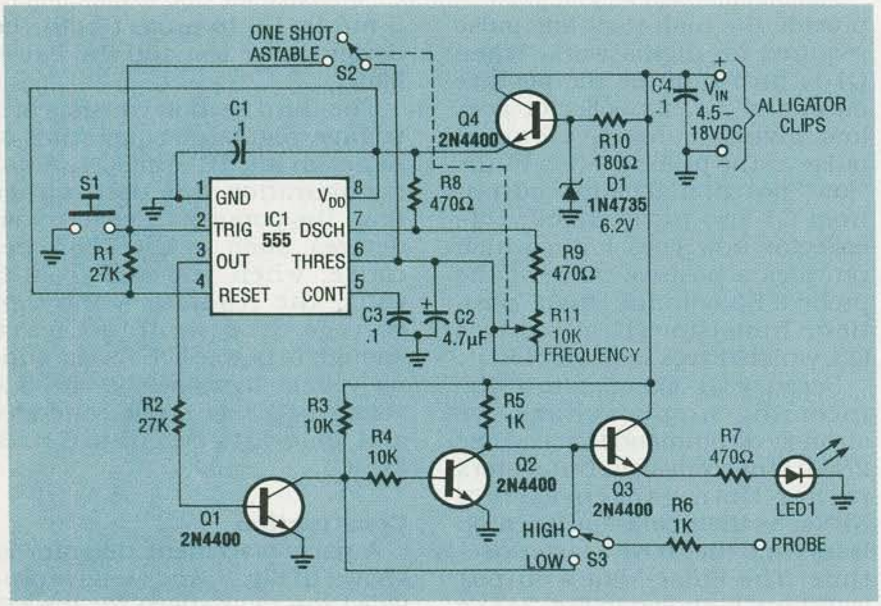


FIG. 1—THE CIRCUIT HAS THREE SECTIONS: the pulse generator built around the 555 timer, Q1 and Q2 which provide the high-rise-time pulse required for digital work, and a voltage regulator consisting of Zener-diode D1 and Q4.

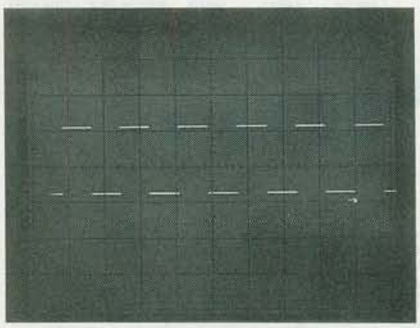


FIG. 2—THE 2N4400 TRANSISTORS have a fast rise-time; here's what the output waveform looks like.

your own—there's also a drilled and plated PC board available separately or as part of a kit.

With the exception of S1, S3, and the probe, all parts mount on the PC board. Note that LED1 is mounted on the foil side of the board so that it can protrude through the front panel as shown in Fig. 4. (Mount the LED 3/16-inch above the board so there is room to solder it.) Note that R11-S2 is also mounted facing up from the foil side. You don't have to connect S1, S3, and the probe at this time. Take a minute to inspect your work; if everything looks alright, the project is ready for initial testing.

Observing proper polarity, connect 5 volts DC to the board. With R11-S2 in the "off" position, LED1 should be off. Shorting the S1 inputs with a clip lead will turn on the LED. If there is no light, check the LED's polarity and the mounting of Q1–Q4. Pin 8 of IC1 should show 4.5 VDC, Q1's collector should be low (100 mV or less), and Q2's collector should be high (roughly 5 volts). Now check the output pulse by putting S2 in the "on" position. The LED will flash at about 5 Hz, and advancing potentiometer R11 will increase the flash rate to the point where the LED will appear to be continuously lit. If there is no flashing, check the output of IC1 pin 3 for a positive pulse (or a continuous high of about 3.3 volts if the S1 inputs are shorted).

Final assembly

The prototype is installed in a case that fits well in one's hand. However, any enclosure measuring 2×4 inches or larger will do. Also, because the case is a hand-held size, the probe is mounted directly to it. If you use a larger case, you may want to mount the probe off-board.

The probe is made from a 2-inch screw that is ground to a point after first fitting on an appropriate nut; removing the nut will then deburr the screw after the tip is ground down. With one washer fitted over the screw, it is passed through a hole in the case and the nut then secures it in place (don't tighten it right now). By the way, be careful when drilling the holes in the case; once a hole is made, it's there to stay. The leads of R6 should be insulated with heat-shrink tubing,

PARTS LIST

All resistors are 1/4-watt, 5%
R1, R2—27,000 ohms
R3, R4—10,000 ohms
R5, R6—1000 ohms
R7–R9—470 ohms
R10—180 ohms
R11—10,000-ohm linear potentiometer with switch

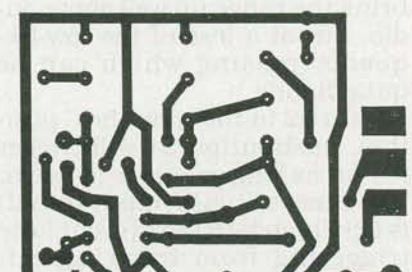
Capacitors
C1, C3, C4—0.1 µF, ceramic disc
C2—4.7 µF, 16 volts, electrolytic

Semiconductors
IC1—LM555 timer
Q1–Q4—2N4400 NPN switching transistor
D1—1N4735 6.2-volt Zener diode, or equivalent
LED1—any color light-emitting diode

Other components
S1—momentary pushbutton switch
S2—SPST switch (part of R11 in prototype)
S3—SPDT toggle switch

Miscellaneous: project case (Radio Shack #270-220 or equivalent), knob for R11, 2-inch screw with washer and nut for probe assembly, red and black insulated alligator clips, rubber grommet, heat-shrink tubing, wire, solder, etc.

Note: The following items are available from Project-Mate, 2727 West Manor Pl., Suite 207, Seattle, WA 98199 (206) 283-4700: A kit containing a PC board and all parts including probe hardware, grommet, heat-shrink tubing, alligator-clip assemblies, and front-panel artwork (does not include S1, S3, project case, and knob) is $24.50 plus $2.50 shipping and handling. A PC board only is $6.00 plus $2.50 shipping and handling. WA residents must add 8% sales tax.



HERE'S THE FOIL PATTERN for the Pulse-Mate's single-sided PC board.

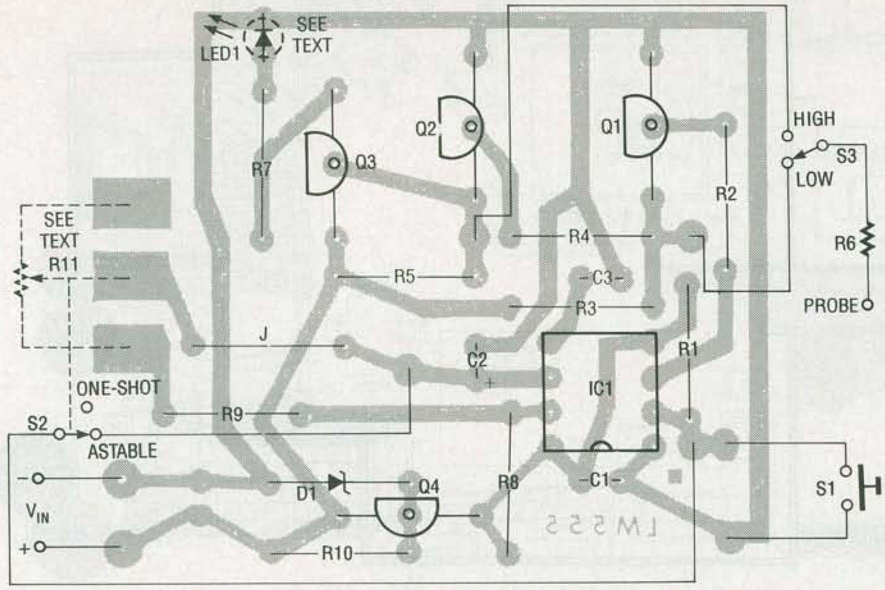


FIG. 3—PARTS-PLACEMENT DIAGRAM. Note that LED1 and R11-S2 mount on the foil side of the board.

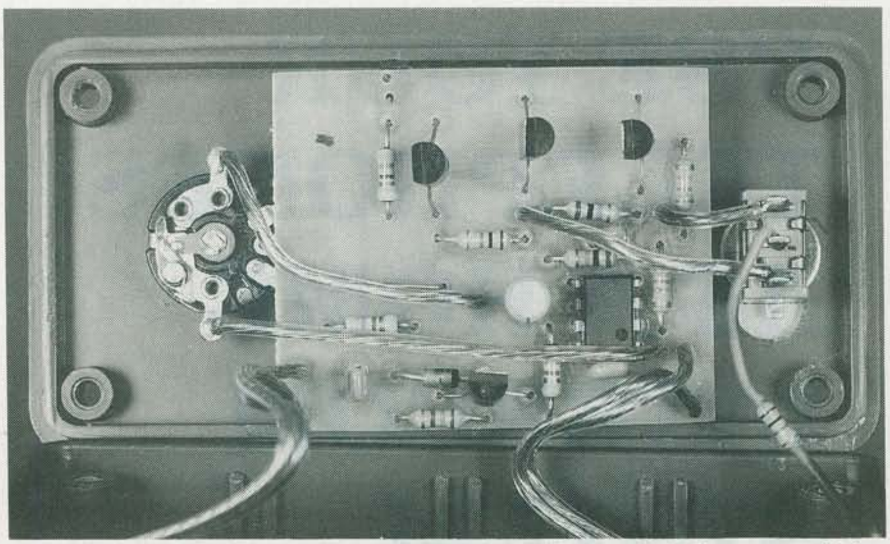


FIG. 4—IT'S A TIGHT FIT, but you end up with a neat little handheld instrument. Notice how LED1 is mounted on the foil side of the board and protrudes through the front panel.

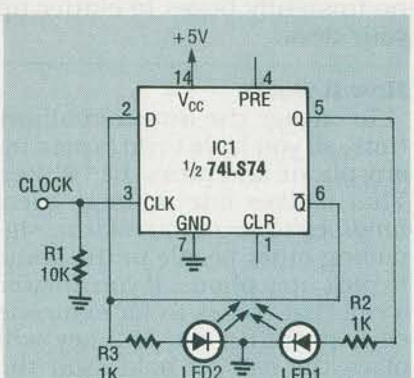


FIG. 5—THIS TEST CIRCUIT uses a 74LS74 positive-edge-triggered flip-flop. Triggering the clock input by hand causes the LED's to change state in an erratic manner. Triggering it with the Pulse-Mate causes the LED's to switch back and forth predictably.

except for the ends; one end is secured between the head of the probe screw and the washer, and the nut can then be tightened. The other end of R6 is soldered directly to the common terminal of S3. Leaving the sharpened tip of the probe screw exposed, cover the length of it with heat-shrink tubing.

Connect S3 and S1 to the board; the lead length depends on the case you use. The power leads on the prototype are arbitrarily 24 inches long. They are soldered to the board then passed through a grommet in the case. Attach the alligator clips to the power leads; use red and black insulators for positive and negative, respectively. The circuit board is secured to the front panel of the case by the mounting hardware of potentiometer R11 and the wiring to S3. You can also use separate mounting hardware if you like.

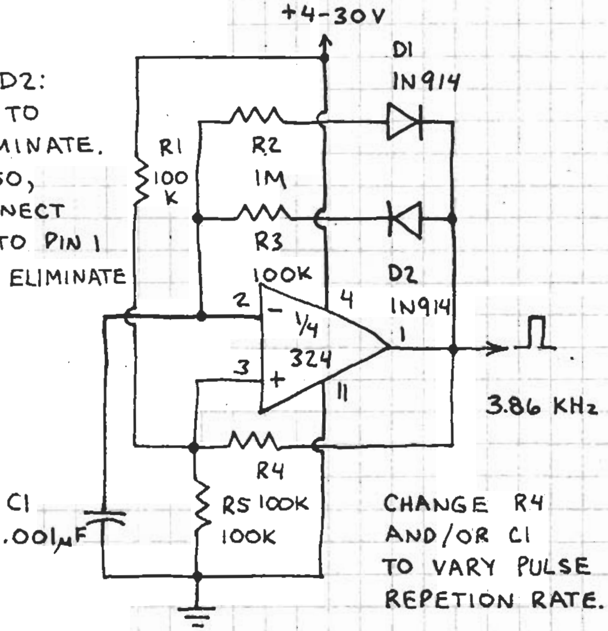
You may want to make a nameplate as a finishing touch for the project, although it's best to make sure the circuit is working properly before labeling. At any rate, the one on the prototype was made using an aluminum nameplate kit sold by Kepro Circuit Systems, Inc. (630 Axminister Dr., Fenton, MO 63026). With it, a full-sized positive is made by transferring black press-on type and other designs to a clear piece of acetate. A blue panel (cut to 1/2" over-size) is contact exposed—like a photosensitized PC board—and developed. The unexposed portions under the transfer patterns are washed away leaving a blue panel with white lettering. Of course labeling can also be done in a variety of other ways including engraving, rub-on decals, adhesive labels, etc.

Application

The device can be tested using a spare LED. For a positive-pulse test, connect the cathode of an LED to ground and connect the probe to its anode. Pressing S1 will light the diode. For a negative-pulse test, connect the LED's anode to 5 volts and its cathode to the probe and press S1 to light. (Note that the LED will not light to full brightness in this part of the test because R6 limits the probe current to 5 mA.)

If you want to further test the device, build the simple circuit shown in Fig. 5 using a 74LS74 positive-edge-triggered flip-flop. When power is applied, one of the LED's will light. Stroking the clock input with +5 volts in series with a 1K resistor should cause the LED's to change state. (They will, but in an erratic way because it's virtually impossible to generate a clean clock pulse by hand. Now connect the Pulse-Mate's probe (positive mode) directly to the circuit and the LED's will switch back and forth predictably. You now have a useful piece of test equipment for troubleshooting, project building, digital experimenting, and whatever else you can think of. **R-E**

PULSE GENERATOR



D1-D2:
OK TO
ELIMINATE.
IF SO,
CONNECT
R2 TO PIN 1
AND ELIMINATE
R3.

CHANGE R4
AND/OR C1
TO VARY PULSE
REPETION RATE.

hobby corner

Part II. *Homebrew breadboard that's inexpensive, easy to build and versatile. The basic design can be easily modified.*

EARL R. SAVAGE, *K4SDS.*

IN LAST MONTH'S COLUMN, WE PROVIDED schematics for several of circuits of the breadboard system. This month, the column concludes with the rest of the schematics and the construction details.

Pulser switch

The trouble with the logic switches previously described is that they tend to "bounce" when making or breaking a connection. In fact, all mechanical switches have contact bounce. It usually doesn't matter because you don't care if something is turned on and off five or ten times very rapidly every time you throw the switch. In some circuits this bouncing can cause serious problems.

Suppose you are working with counters, for example, and you use one of the logic switches for a trigger. You throw the switch from LO to HI and the counter shows that you did it *eight times.* Surely that is no way to test a counter circuit!

The pulser switch (See Fig. 6) is "bounceless." The mechanical switch S1 is not connected to the output. Instead, it causes the two gates (7400) to change the state of the output. The gates don't bounce.

The two LED's, one red and one green, indicate the state of the output (LO or HI). Switch S1 is an SPDT type that was not used in the prototype. The prototype used two normally open momentary SPST pushbutton switches instead. Either arrangement is satisfactory.

Pulse generator

After the power supply, without which none of these circuits would operate, the pulse generator (See Fig. 7) is the most useful device in the breadboard. A pulse generator is often called a clock because its output "clocks" back and forth between a LO and HI level.

The generator is a 555 timer IC with an approximate squarewave output. The frequency is changed by selecting various capacitors with switch S1. The four values shown produce pulses at rates of about 0.1, 1, 10 and 100 pulses-per-second. These have been found adequate to meet all needs to date. Of course, you may change the values or increase or decrease the number of frequencies available.

The LED is included in order that the operation and state of the output of the clock can be monitored directly. This is an advantage when working with some types of circuits. Note, too, that the stated frequencies are only approximations because resistors R1 and R2, and the timing capacitors are not precision units. All you need is to be in the right ballpark—the expense of precision is unjustifiable.

Construction

Construction is greatly simplified by using a plastic parts box (6 × 11 × 2-inches) instead of a conventional metal cabinet. Mounting holes and even rectangular openings for the slide switches are easily made and there is no worry about insulating parts from the chassis. There are, however, disadvantages.

The box is clear plastic and it would be confusing at best to look through the panel. This was solved by painting the *inside* of the box *after* making all the holes but *before* mounting the parts. In fact, I made the various sections different colors—red, yellow, black, white, blue, silver.

The greatest disadvantage of this box

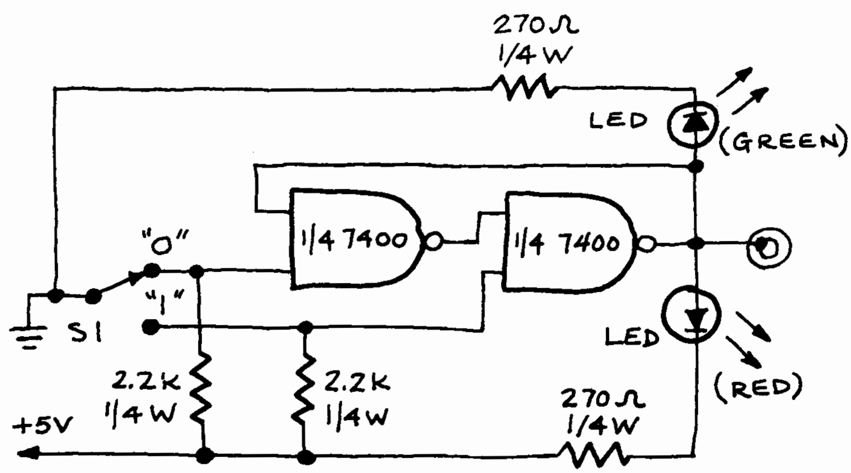


FIG. 6—PULSE SWITCH provides bounceless switching.

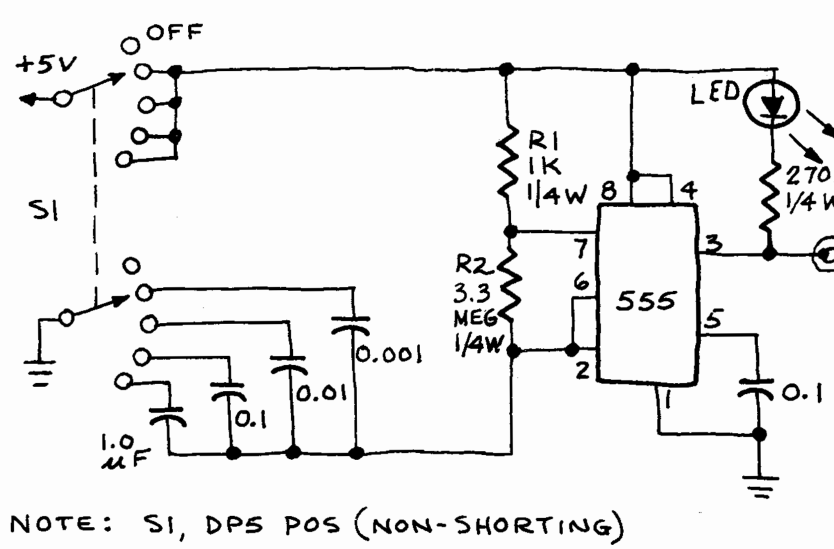


FIG. 7—PULSE GENERATOR produces squarewaves at frequencies of 0.1, 1, 10 and 100 hertz.

stopped most conveniently by putting an SPDT switch on pin 4 of the 555 circuit. When pin 4 is grounded, the counter stops; when it is connected to V_s (+5), the counter runs.

The 7490 circuit can be reset to 0 by connecting pins 2 or 3 to V_s; it can be reset to 9 by also connecting pins 6 or 7 to V_s. The reset and start/stop functions can be combined in a single DPDT switch.

Things to try

1. You can have an audible time signal by connecting a Sonalert between pin 3 of the 555 circuit and ground. If the Sonalert is connected between pin 11 of the 7490 and ground, it will sound a tone warning at count 8.

2. A second digit can be added so that the counter indicates up to 99 intervals. This will require a second 7490 circuit and four LED's for binary; or a second 7490, a 7448 circuit and a 7-segment digital unit for Arabic. In either case, connect the input (pin 14) of the second 7490 to pin 11 of the first 7490. Of course, a third, fourth and more digits can be added similarly.

3. A common anode digit and a 7447 circuit can be substituted for the 7448 and common-cathode digit.

4. Follow the 7490 with a 74145 (BCD-to-decimal decoder-driver) and 10 LED's to make a 0-to-9 sequential light counter. If interval T is made short, the light will appear to sweep up the line of LED's.

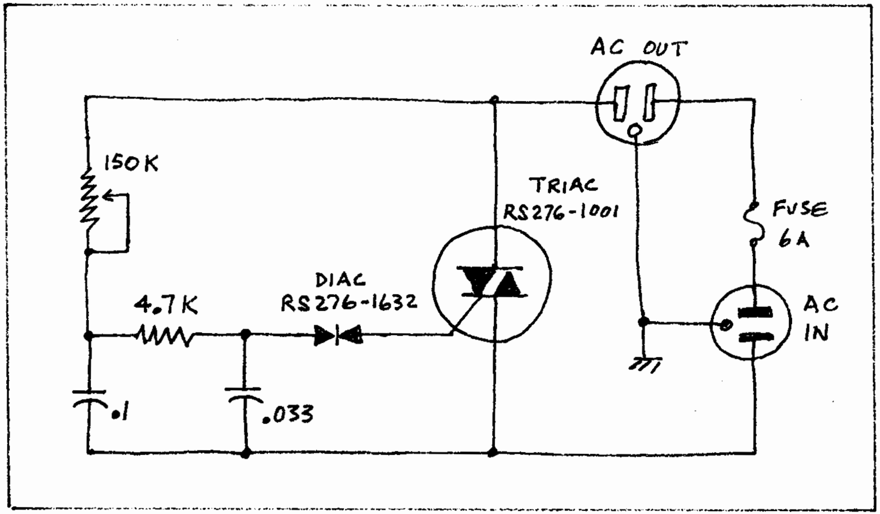


FIG. 5

Troublesome circuits

If you have trouble with any of these circuits, there could be three causes:

1. You may have made a wiring error, which is easy to correct unless something went up in smoke when you applied power. That's why wiring should *always* be checked before throwing the ON switch—we all make wiring errors from time to time.

2. One of the components may be bad or it may have a value outside of acceptable tolerance. Since sometimes this information is difficult to find, we'll try to call your attention to any parts that seem critical.

3. Typographical errors do occur on rare occasions. This is a toughie to correct in your project. About all we can say is that a correction will be printed as soon as possible.

continued on page 89

Two-chip pulse generator operates at 75 MHz

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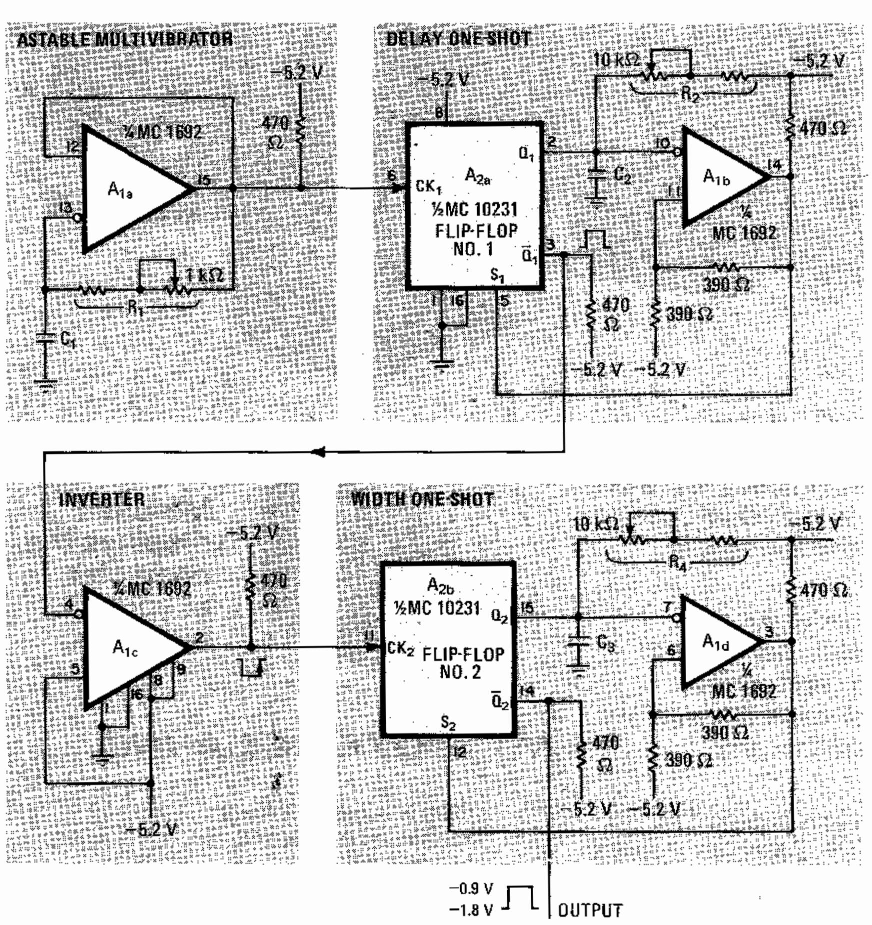
Built from integrated circuits in the emitter-coupled-logic family, this pulse generator can provide independent control of delay and width (variable from 5 nanoseconds to 0.1 second) over the frequency range of 10 hertz to 75 megahertz. Only two chips are required—a quad line receiver and a dual D-type flip-flop.

The MC1692 line receiver, A_{1a}, configured as an astable multivibrator, provides a steady stream of pulses, at a frequency determined by R_1C_1, to the delay portion of the circuit. This section, which uses a second line receiver and one half of the MC10231 dual flip-flop, generates a corresponding pulse at the output of A_{2a} whose duration is proportional to R_2C_2. Its maximum duty cycle is greater than 80% at 10 MHz and decreases progressively to about 50% at 75 MHz. After inversion by A_{1c}, the signal is introduced to flip-flop A_{2b}.

A_{2b} is triggered on the positive-going edge of the signal, and so pin 15 of the flip-flop moves high after a time proportional to R_2C_2, thus effecting the delay time. The duration of the pulse emanating from A_{2b} (that is, its width) is set by the A_{2b}–A_{1d} combination, which is identical to the A_{2a}–A_{1b} configuration. Note that the polarity of the output appearing at Q_2 of A_{2b} matches that of the input signal, because the width-determining one-shot works on an inverted version of that signal.

If the flip-flops are replaced by two MC1670 types, the circuit will work beyond 100 MHz. In either case, the circuits used should be mounted on suitable heat sinks. □



FREQUENCY	C_1	R_1 (Ω)
75–10 MHz	10–40 pF	47–1,047
10–1 MHz	360 pF	47–1,047
1–0.1 MHz	0.004 µF	82–1,082
100–10 kHz	0.04 µF	
10–1 kHz	0.4 µF	
1–0.1 kHz	4 µF	
100–10 Hz	40 µF	↓

DURATION	C_2, C_3	R_2, R_3 (Ω)
*5–30 ns	4–20 pF	330–10,330
10–100 ns	68 pF	330–10,330
0.1–1 µs	0.001 µF	820–10,820
1–10 µs	0.01 µF	
10–100 µs	0.1 µF	
0.1–1 ms	1 µF	
1–10 ms	10 µF	
10–100 ms	100 µF	↓

*AT HALF AMPLITUDE

Fast and flexible. A simple ECL pulse generator provides independent control of pulse width and delay and works to 75 MHz. The tables outline the component values. Operation can be extended to 100 MHz by substituting an MC1670 flip-flop for A_2.

Pulse generator

This pulse generator was designed to provide clock pulses of variable width and p.r.f. for t.t.l. circuits at a relatively low cost. It uses a versatile 74123 dual monostable i.c. which can be triggered from a positive or negative going edge and can be cleared or re-triggered if desired. The pulse width is determined by an external CR combination, the recommended maximum and minimum resistance being 50kΩ and 5kΩ respectively.

With the switch set to "internal," the monostables are connected in an astable configuration with each monostable being on for its own time period and off for that of the other monostable. The output is taken from an emitter-follower for low output impedance. The on time of each monostable is determined by its variable external resistor and one of a bank of six capacitors, giving on or off times between 100ms and 100ns. Therefore, it is not possible, as with some pulse generators, to set the pulse width greater than 1/p.r.f. — which gives no output.

With the switch in the "external" position the on-time monostable is driven by three transistors arranged as a Schmitt trigger. This gives a pulse of the same frequency as the input waveform, the pulse width being determined by the on-time variables. Potentiometer VR_1 determines the trigger level.

The circuit of a suitable power supply is shown.

Performance is above expectations, but wire lengths must be kept to a minimum if good pulse shapes are to be obtained at the highest frequency.

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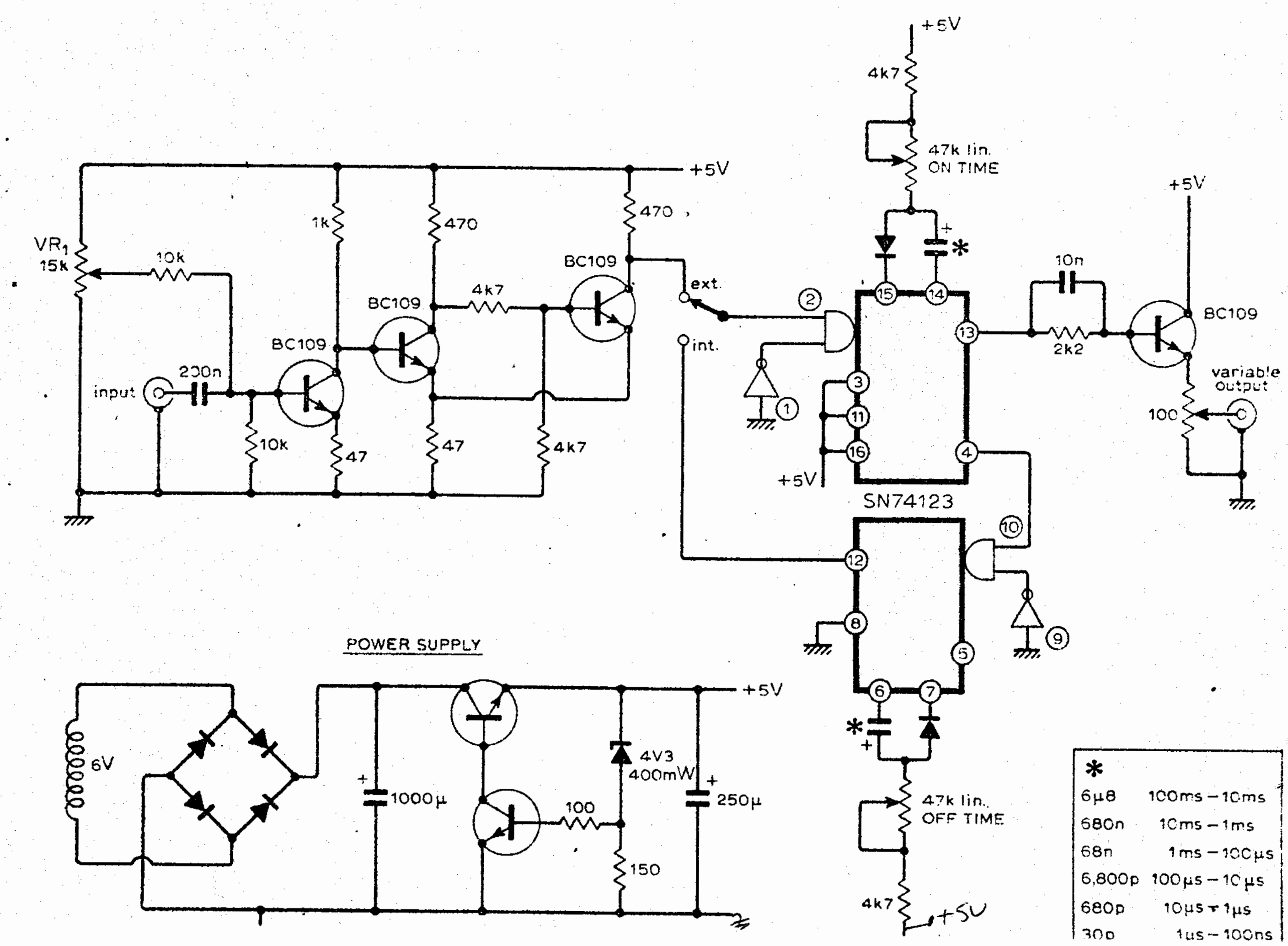
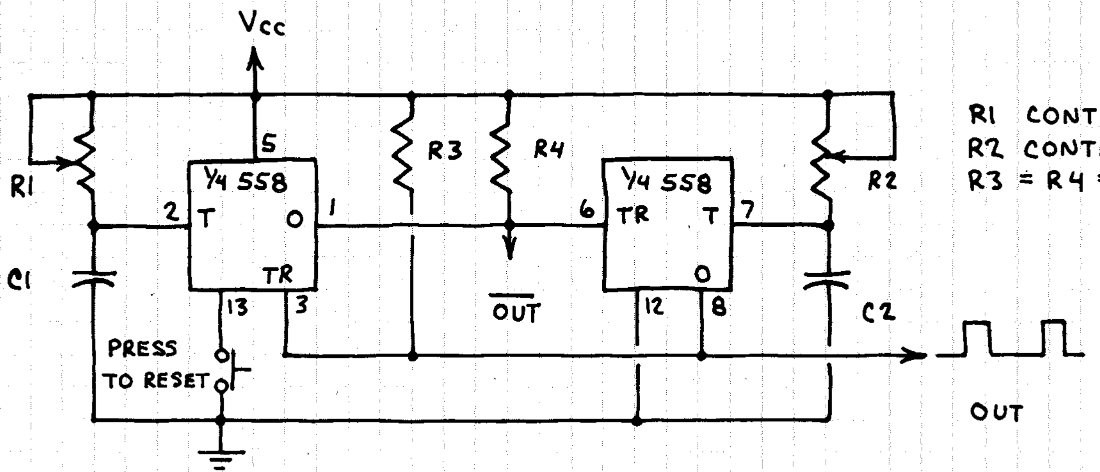
Eire



QUAD TIMER (CONTINUED)
558

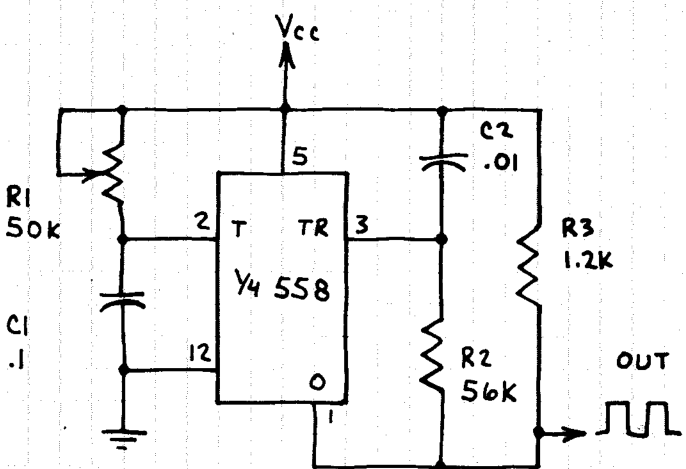
FULLY ADJUSTABLE PULSE GENERATOR



R1 CONTROLS PULSE RATE.
R2 CONTROLS PULSE WIDTH.
R3 = R4 = 1.5 TO 4.7K.

VERY USEFUL CIRCUIT! PULSE RATE AND WIDTH TOTALLY INDEPENDENT. SEE BELOW FOR MORE INFORMATION.

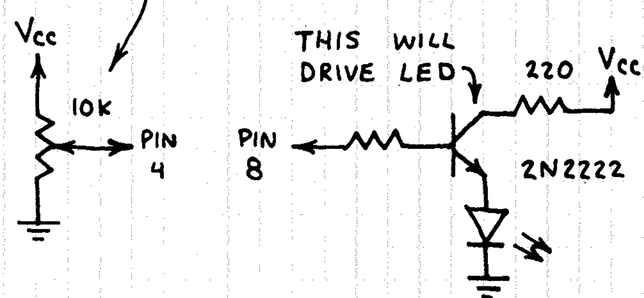
SIMPLE OSCILLATOR



R1 CONTROLS FREQUENCY

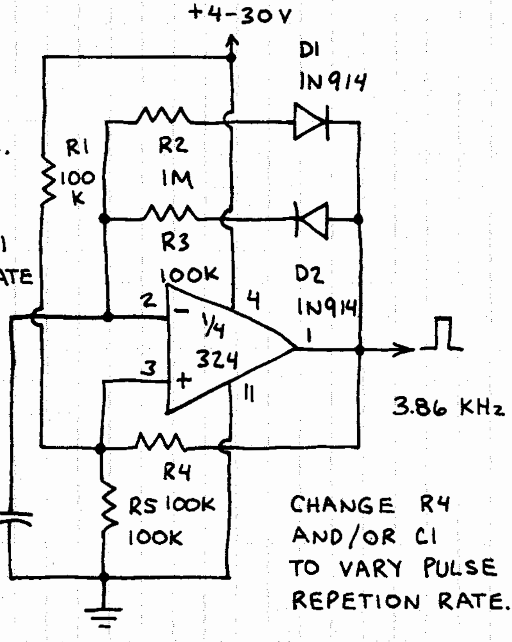
FIXED DUTY CYCLE PULSER

SEE ABOVE CIRCUIT. ADD THIS VOLTAGE DIVIDER TO KEEP DUTY CYCLE CONSTANT WHEN RATE IS CHANGED



LONG DURATION TIMER

PULSE GENERATOR



D1-D2: OK TO ELIMINATE. IF SO, CONNECT R2 TO PIN 1 AND ELIMINATE R3.

CHANGE R4 AND/OR C1 TO VARY PULSE REPETION RATE.

Pulse train generator

The circuit shown will generate a pulse train in which the pulse duration, pulse interval, and number of pulses can be varied independently by setting the time-constants R_1C_1, R_2C_2 and R_3C_3, respectively. When a negative-going trigger pulse is applied, timers 1 and 3 are activated. With A high, T_2 is triggered at the end of T_1 timing interval, and T_1 is triggered at the end of T_2 timing interval. A train of pulses is generated at the output. When A goes low at the end of T_3 timing interval, T_2 can no longer be triggered by T_1. The pulse train ends when T_1 completes its last timing cycle.

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