A universal process timer

Phil Wait

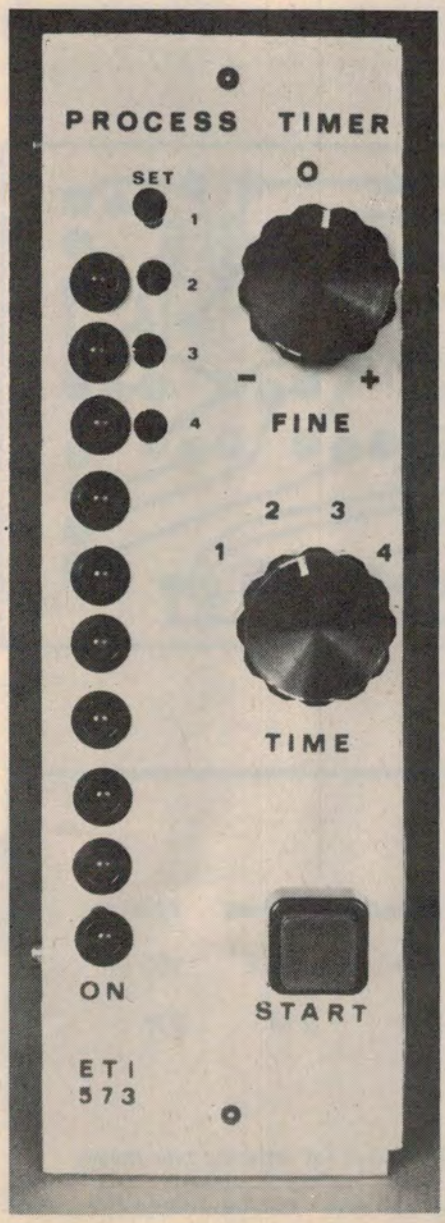
This simple timer has myriad applications in electronic and photographic work. It features a LED display that "counts down", indicating elapsed time, that is readily visible in daylight or in a darkroom.

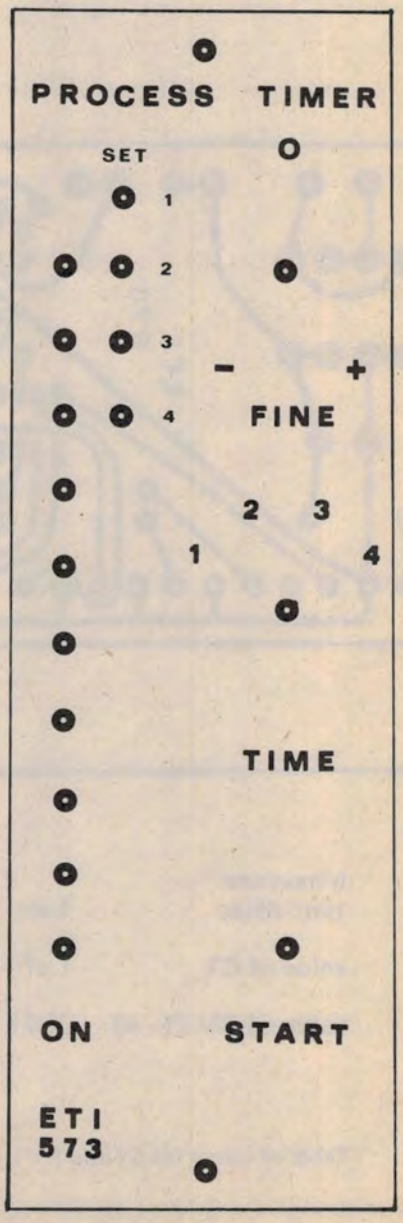
VARIOUS PROCESSES in fabricating electronic projects require timing a chemical reaction or process – developing photoresist in making printed circuit boards being a prime example.

Following the completion of our darkroom here at ETI which we use for making negatives and printed circuit boards, it was decided a simple timer was needed to control the light source used for exposure. Because different times are used for exposing film, printed circuit photoresist and Scotchcal, the timer had to have switchable ranges which could be pre-set between a fraction of a second and ten minutes. Some form of elapsed time indication was considered necessary for the longer exposures as was some form of fine adjustment for either slightly under- or over-exposing the film. Finally, the unit had to switch 240 volts at several amps to control a bank of UV-fluoro tubes used for exposing photoresist.

Someone then suggested it would make a good project – after all, there's very little we do here that many of our readers don't do themselves at home.

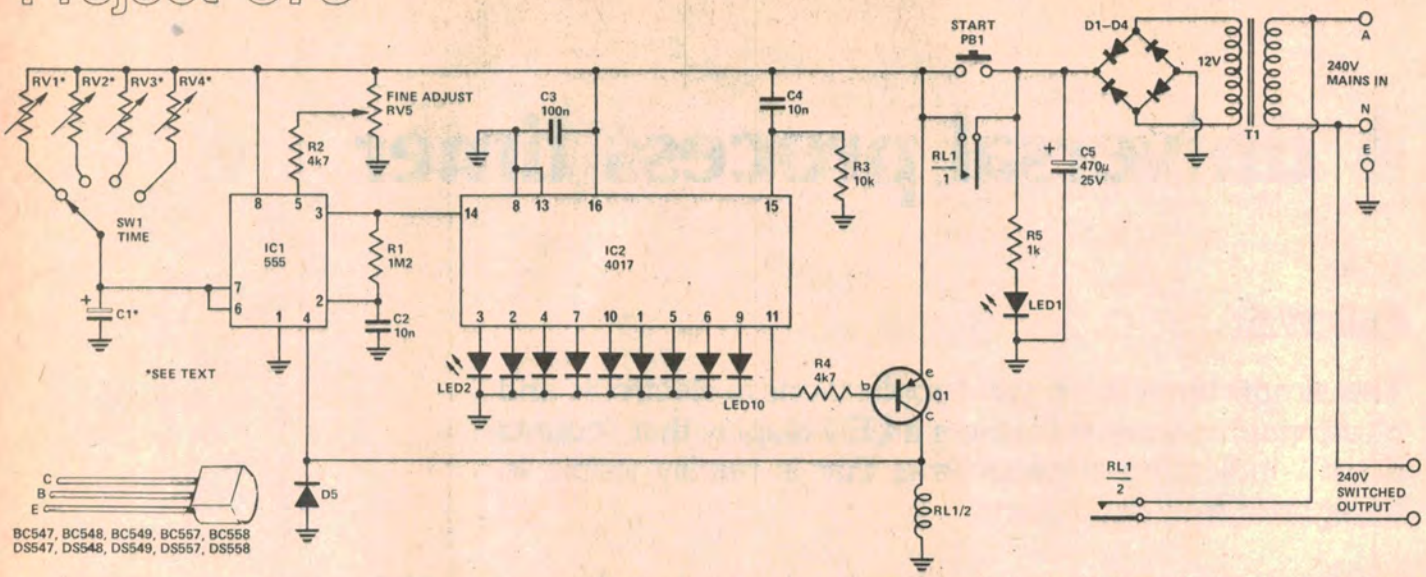
In fact, this timer is not just limited to the applications we use it for, but can be used to control anything from an egg timer to an injection moulding machine. Judging from some of the calls we get from readers, this timer should find its way into all sorts of applications.

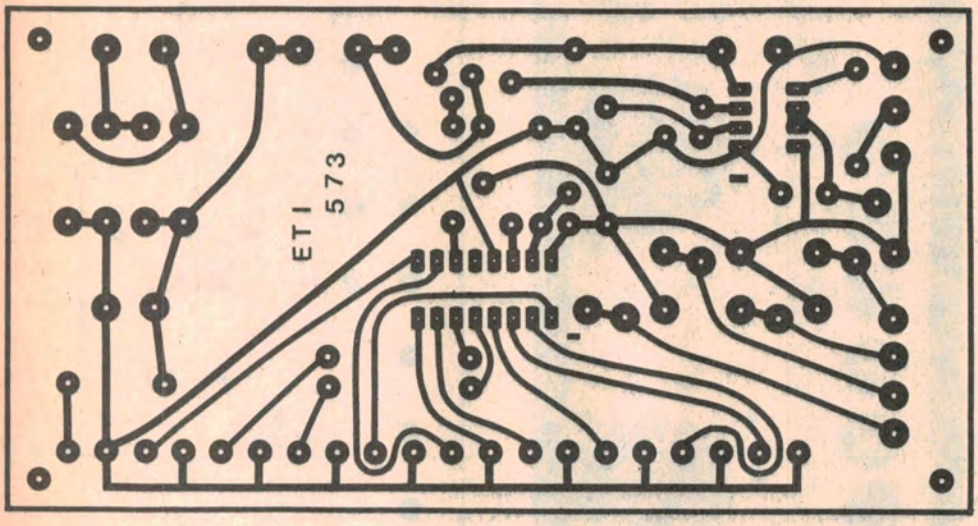




The technique

The easiest way of producing a time delay is by using a 555 timer IC, but a glance at the data sheet shows that it should not be used for periods in excess of 100 seconds. By using the 555 as an oscillator and feeding its output into a 4017 counter/decoder IC the maximum





timing period can be increased ten fold. The unused decoded outputs can then be connected to a column of LEDs which will give an indication of elapsed time.

Each pulse from a 555 clocks the 4017, moving a high level along its ten decoder outputs, lighting each of the LEDs in turn. When the high level reaches the last output it is used to operate the relay and thus the time delay has been multiplied by ten.

A permanently-lit LED has been included at the bottom of the row to show when the unit is on. This also gives a better indication of elapsed time in a darkroom, as the LEDs can be seen to step towards a reference light.

Four time ranges have been provided with a trim pot on each one for easy adjustment. The table gives the values for each trim pot and C1, for a variety of times. The minimum time is limited by the time taken for the relay to operate, maximum time by the limitation of the 555. In practice, times from 100 mS to twenty minutes can be achieved. For very short times the time elapsed indication will not be much use and the LEDs can be left off the board.

Fine adjustment of the timing is achieved by adjusting the threshold voltage on pin 5 of the 555. When the voltage on pin 5 reaches a set value, the output (pin 3) of the 555 goes 'low' (i.e: the 555 triggers). This voltage is normally set at two-thirds the value of the supply rail, fixing the time during the charging cycle of C1 when the 555 triggers.

If the threshold voltage is increased, the time taken for C1 to charge to the required value increases, and the frequency of oscillation decreases. Thus, the total timing period is increased.

What device you want to control

Maximum time delay	1 sec	10 sec	100 sec	1000 sec
value of C1	1 µF	1 µF	10 µF	100 µF
value of RV (1 - 4)	200 k	2 M	2 M	2 M

Table of values for C1 and RV1 - RV4 required for differing time delays

HOW IT WORKS – ETI573

The timer consists of a 555 timer IC used as an oscillator driving a 4017 counter/decoder IC, the decoded outputs being used to drive a row of LEDs and switch a relay.

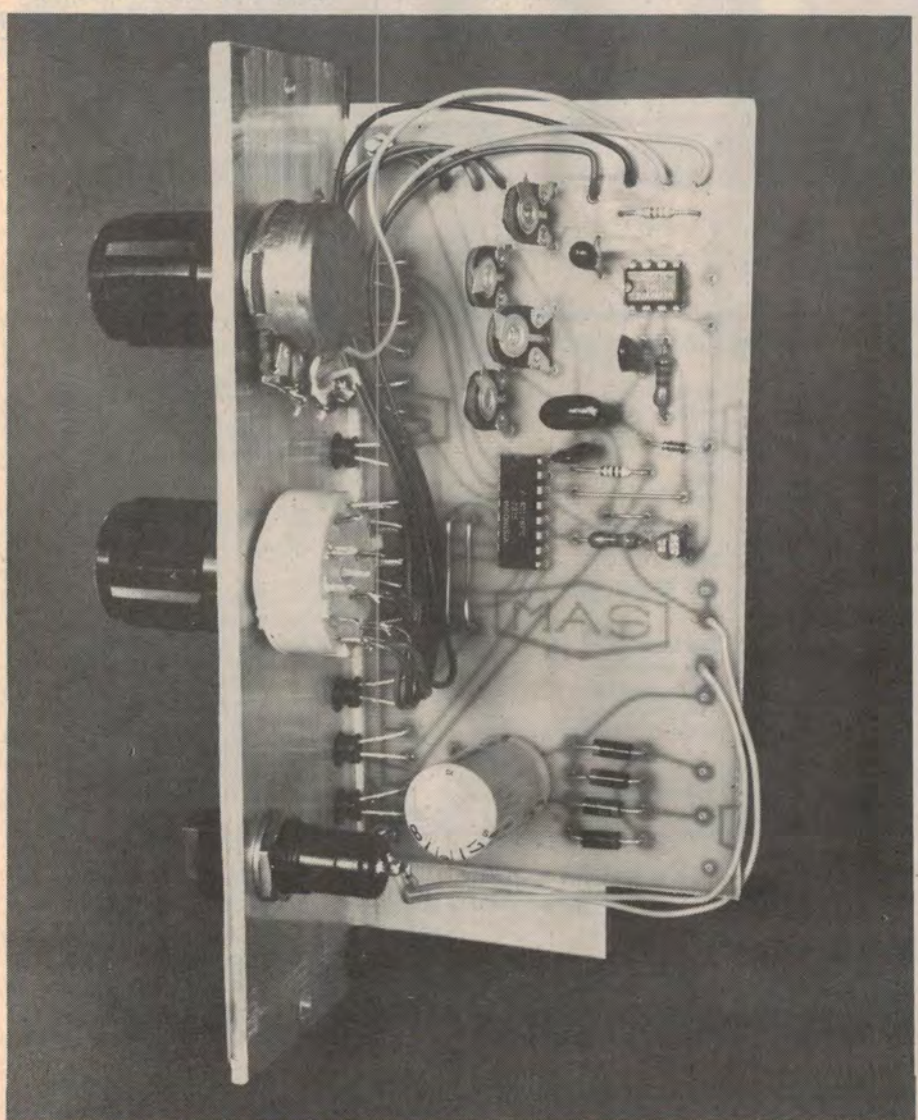
The timing period is set by the frequency of oscillation of IC1. This is dependent on the time constant of RV1-RV4 and C1. As either of these components are increased in value the time constant will increase and the frequency of oscillation decrease. Fine frequency adjustment is provided by RV5 which adjusts the threshold voltage on pin 5 of the 555. This voltage is normally set at two thirds of the supply voltage, but here it is adjusted varying the required voltage across C1 to the 555.

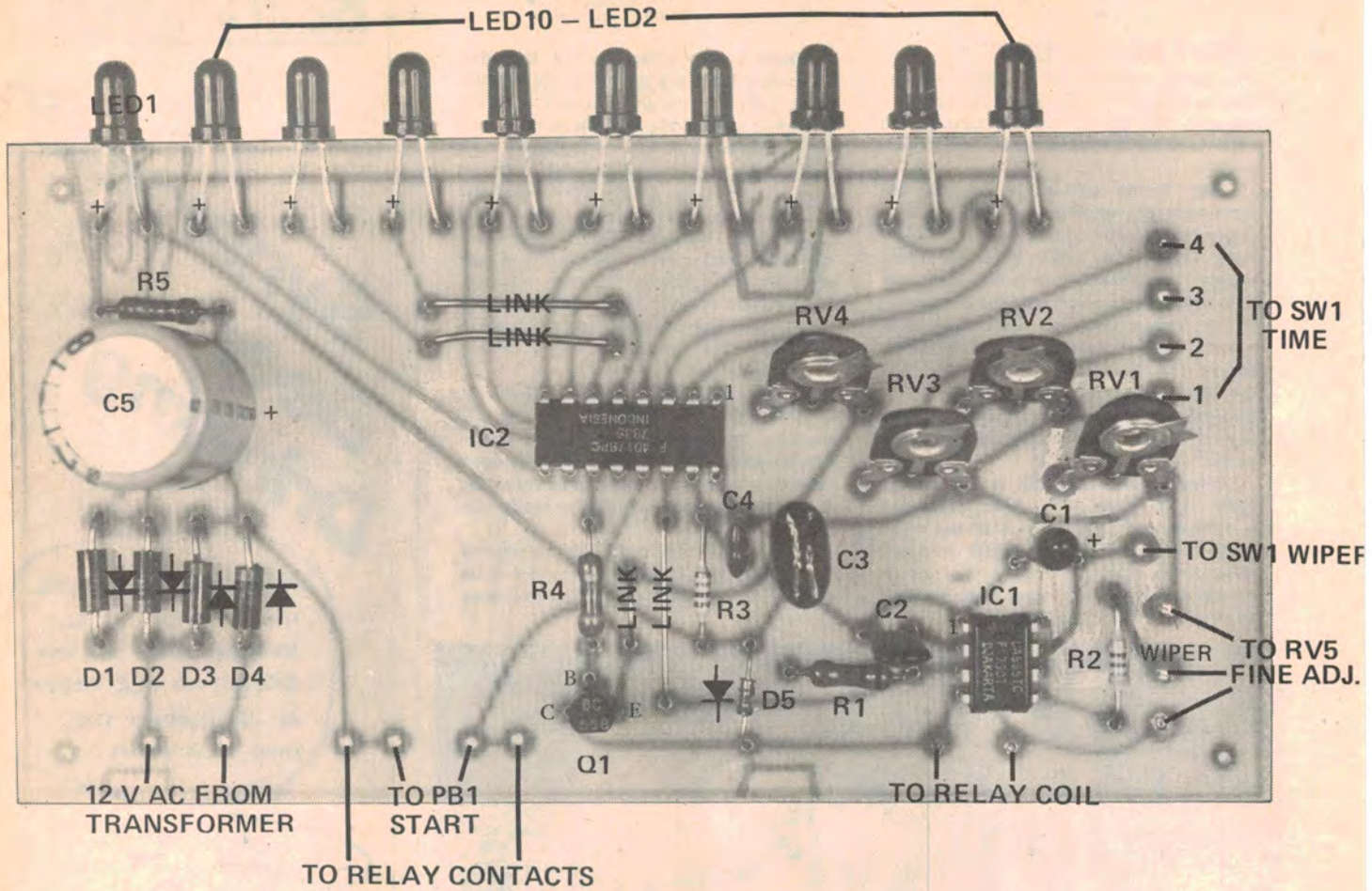
Output from the 555 is fed to the clock input of the 4017. After each pulse a different decoded output of the 4017 goes high, lighting each LED in turn. After the tenth clock pulse the output on pin 11 of the 4017 goes high. We shall come to what that does shortly.

When power is first applied, the relay contacts RL1/1 are open and the bottom LED (LED 1) is lit. When the 'start' button is pressed the 4017 is reset to zero by a positive pulse applied to pin 15. This pulse is provided from R3 and C4. Pin 11 goes low, turning on the PNP transistor Q1, and the relay operates. The now closed relay contacts (RL1/1) short out the start button and sustain the power after the start button has been released. The transistor also drives the reset line of the 555 (pin 4) which commences to oscillate. This ensures accurate timing of the first cycle.

On the tenth pulse from the 55 pin 11 of the 4017 goes high, turning off Q1, stopping the oscillator, and the relay is de-energised. The contacts RL1/1 open removing the supply to the timer returning it to its original condition, ready for the next sequence.

During the timing period, the second set of contacts RL1/2 close and can be used to switch up to 5A using the relay specified.





with the timer will determine the type of relay you use. This unit is capable of driving quite large relays, however, we used a commonly available Omron type having contacts rated at 10 amps.

Construction

First, you will have to determine from the table the correct values of RV1-RV4 and C1 to provide the times you want for your application.

Next, mount all the components taking care to correctly orientate the semiconductors. The LEDs are best mounted by inserting them into their holes and bending them over flush with the edge of the pc board. The photo shows the way I mounted the LEDs.

The completed unit can be mounted in a variety of ways to suit individual applications. Either in a box, together with its relay and a mains female output socket for the switched output, or on a panel with a remote transformer and relay as I did.

To mount the unit against a front panel, drill a row of ten holes for the LEDs and four holes to line up with the trim pots for screwdriver adjustment of the timing. The start button, timing switch and fine adjustment pot can be mounted anywhere convenient. The pc board should be mounted against the panel so the LEDs protrude through the holes.

PARTS LIST - ETI 573

Resistors all ½W, 5%
- R1 . . . . . 1M2
- R2 . . . . . 4k7
- R3 . . . . . 10k
- R4 . . . . . 4k7
- R5 . . . . . 1k

Potentiometers
- RV1–RV4. . . See text
- RV5 . . . . . 10k lin pot

Capacitors
- C1. . . . . See text
- C2. . . . . 10n greencap
- C3. . . . . 100n greencap
- C4. . . . . 10n greencap
- C5. . . . . 470µ 25V electro

Semiconductors
- D1–D4. . . . IN4004 or sim Power Diode
- D5 . . . . . IN914 or sim
- Q1 . . . . . BC558, BC178, DS558
- IC1 555
- IC2 4017
- LED1–LED10 . . . . . TIL220R or sim LED

Miscellaneous
- SW1. . . . . One pole, four pos. oak switch
- PB1. . . . . Momentary Push Button
- T1. . . . . 12V, one amp transformer (Ferguson type PS12/15 VA or sim.)
- RL1. . . . . 12V relay with two changeover contacts, Omron type LY2 or sim

ETI 573 pc board, knobs, suitable box or bracket.

Setting up

Having assembled the unit, all that remains is to calibrate the ranges. This is easily done with the aid of the second hand of a watch. For shorter times, say under five seconds, an oscilloscope is best.

Simply monitor the positive supply after the relay contacts RL1/1 and measure the time the contacts operate. For other purposes it may be best to set the ranges by trial and error, such as when the unit is being used for a pc board or Scotchcal development timer. In either case, the fine adjustment control should be set in its mid position when calibrating. ●