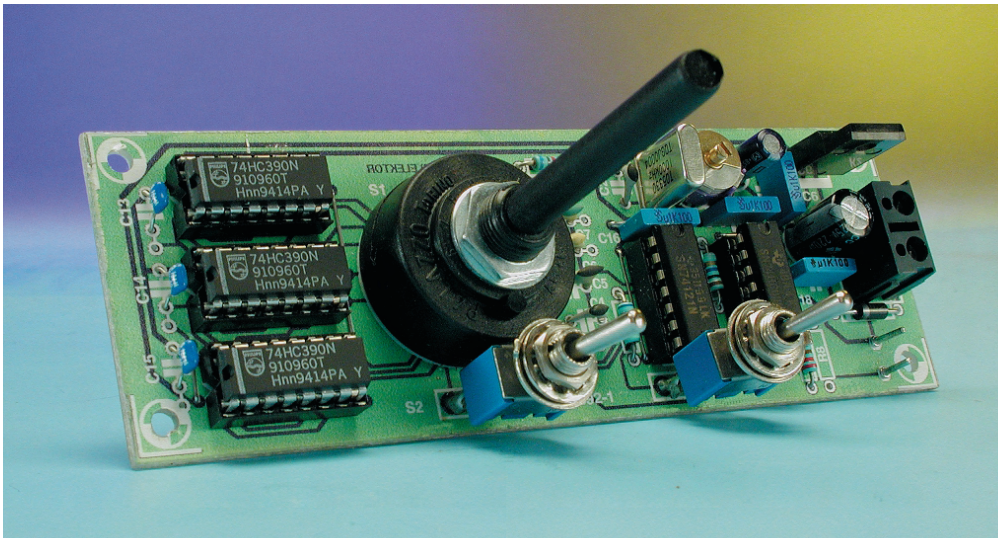
Economical Timebase Calibrator 032



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An external timebase calibrator is a useful accessory for any oscilloscope it provides precise, visible time markers on the scopes horizontal sweep. Basically the circuit is a pulse generator with accurate time intervals between pulses i.e. the pulse repetition frequency. If the pulse width is made relatively small compared to the repetition rate and the pulse edges are steep then the output signal will look like a series of illuminated dots. These can be conveniently used to measure time periods on the screen just as you use the graduation marks on a ruler to measure length.

The circuit diagram shown in **Figure 1** uses five commonly available ICs (excluding the power supply). A 1 MHz crystal provides an accurate time base for the oscillator circuit built around IC1A. Resistor R3 governs the switching threshold while trimmer C1 alters the loading on the crystal and allows its frequency to be

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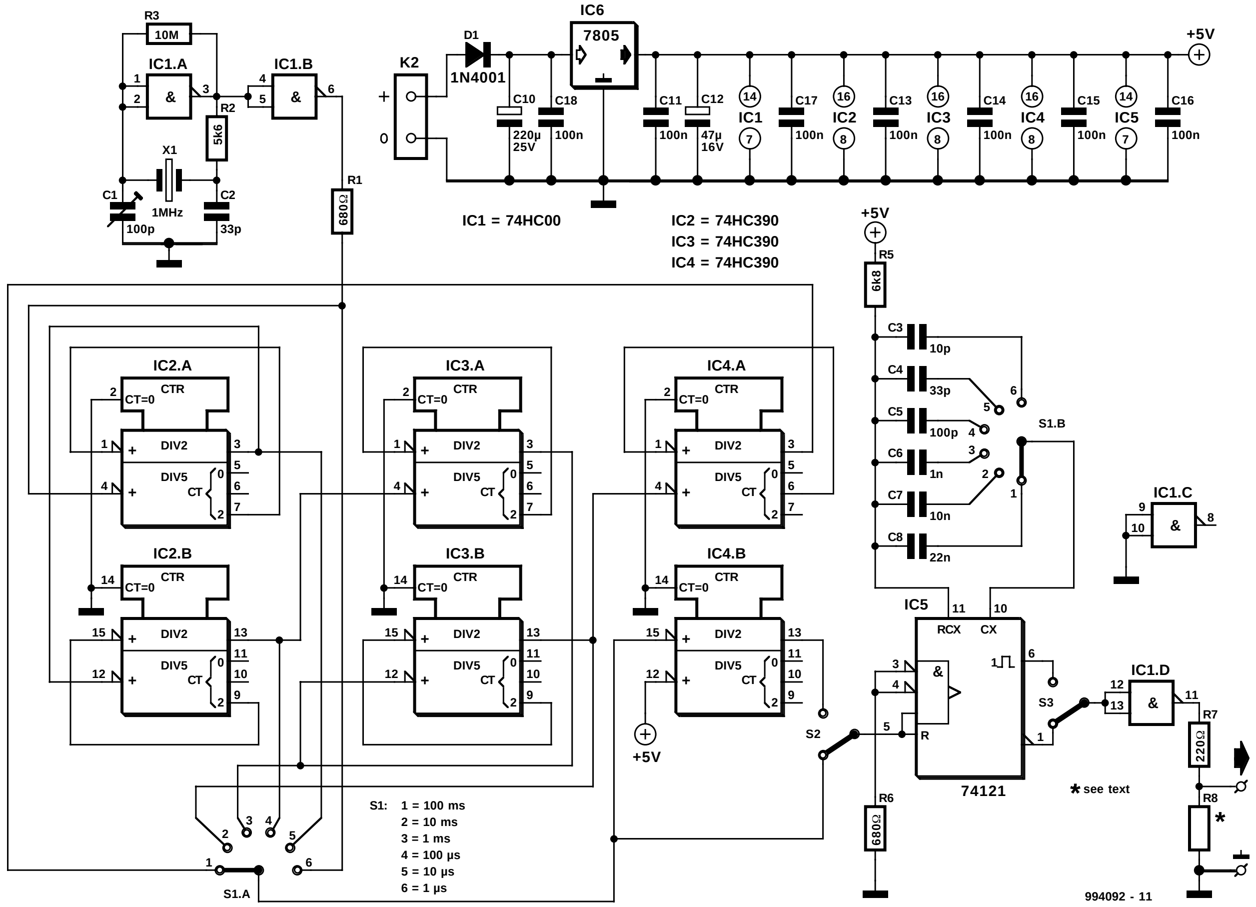

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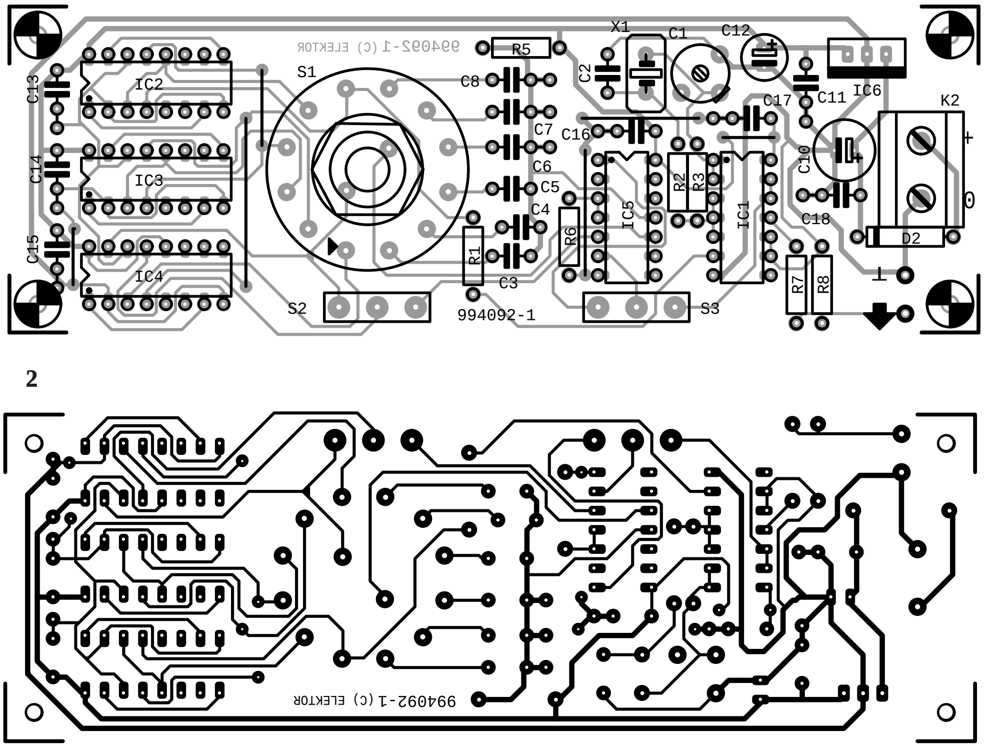


‘pulled‘ slightly which is necessary when calibrating the circuit. IC1B buffers the oscillator from the rest of the circuitry and R1 cleans up the square wave output by reducing any overshoot on the clock edges. The output signal is connected to five cascaded decade counters type 74HC390 (IC2 to IC4A) each counter divides its input frequency by 10. Switch S1A selects one of the frequencies or time intervals from 1 MHz (1 µS) to 10 Hz (100 ms) to route it to a pulse generator formed by IC5. The second half of counter IC4 is used to provide a divide-by-two function, this can be bypassed by switch S2. In total this gives 12 possible pulse repetition rates from 1 µS to 200 ms.

The output timing pulse is generated by IC5. This is a standard TTL monostable type 74121. Standard TTL devices can be interfaced directly with HC devices without any problem. The output pulse width of the monostable is a function of the resistor/capacitor value at pins 10 and 11. As the repetition rate is changed by switching the counter outputs with S1A so the second half of the switch (S1B) also switches different R-C components to the monostable. This ensures that the marker pulses shown on the oscilloscope screen will be the correct width for each selected range. The output stage of a standard TTL IC does not drive symmetrically so IC1D is used as a buffer to give a better output performance. Switch S3 allows the polarity of the output pulse to be switched and resistor R7 provides short circuit protection for the output buffer. Unfortunately in combination with the capacitance of the output lead, this resistor also forms a low pass filter that has the effect of rounding off the sharp edges of the output signal. Socket K2 is used for connection of an external 9 V mains unit to power the circuit and IC6 regulates this to 5 V for use on board. Current consumption is only a few milliamps so a heatsink is unnecessary.

Fitting the PCB into a case is greatly simplified by mounting the single-sided PCB directly to the back of the front panel switches.

Mounting the components on the board is begun by first soldering the six wires bridges and the smaller components to the board. It’s worth taking a little care here to ensure that the polarised capacitors and diode are correctly fitted. This design will produce RF interference so it is advisable to fit the unit inside a metal case or at least a screened plastic case, the screen or case should be connected to the power supply ground.

To test the circuit, first check that 5 V is available from the power supply. Next, connect a frequency counter to resistor R1 and adjust trimmer C1 until 1.000 MHz is achieved. If there is insufficient adjustment in C1 then try a different value for C2. If you do not have access to a frequency counter then just set the trimmer to mid-position or replace it with a 56 pF fixed capacitor.

The output of the calibrator can be connected to the scope input channel via a short length of 50-Ω coax cable. An output series resistor (R8) is used to dampen ringing on the output pulses introduced by the cable capacitance. R8 can be fitted directly to the output BNC socket and its value will be in the range of 220 Ω to 470 Ω.

The best output pulses will be produced by hooking the tip of a 10x scope probe directly on the output pin of the

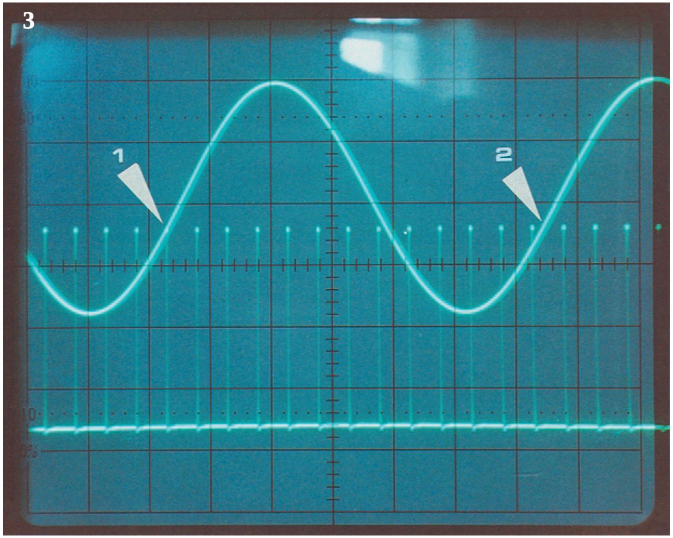
COMPONENTS LIST

Resistors:
R1,R6 = 680Ω
R2 = 5kΩ6
R3 = 10MΩ
R5 = 6kΩ8
R7 = 220Ω
R8 = *

Capacitors:
C1 = 100pF trimmer
C2,C4 = 33pF
C3 = 10 pF
C5 = 100pF
C6 = 1nF
C7 = 10nF
C8 = 22nF
C10 = 220µF 25V radial
C11,C13-C18 = 100nF
C12 = 47µF 16V radial

Semiconductors:
D1 = 1N4001
IC1 = 74HC00
IC2,IC3,IC4 = 74HC390
IC5 = 74121
IC6 = 7805

Miscellaneous:
S1 = rotary switch, 2 poles, 6 contacts
X1 = 1MHz quartz crystal
S2,S3 = toggle switch,1-change-over contact
K2 = 2-way PCB terminal block, lead pitch 5mm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BNC connector, most scope probes will be able to manage this without any problem. A useful addition to the front panel next to the BNC output would be a solder/test point connected to the circuit earth. This provides a convenient parking spot for the scope probe earth clip.

To check the horizontal timebase of an oscilloscope first make sure that and variable time base controls are set to the ‘calibrate‘ position then select a sweep speed so that each output pulse corresponds to one square of the screen graticule. Use the horizontal position adjustment to place the pulses exactly under the graticule lines Check carefully that the pulses occur exactly at each graticule line intersection across the full width of the screen. This will not always be the case with budget priced oscilloscopes!

If you have a two-channel scope it is also possible to use the calibrator to perform quick and easy frequency measurements so that in many cases you will not need a frequency counter at all. First of all connect the signal to be measured to channel A of the scope input and the calibrator output to channel-B input. Adjust the scope timebase generator so that one whole period of the unknown frequency is displayed on the screen. With the scope trigger mode set to ’alternating’ adjust the vertical positions of the channels until they are superimposed and the edge of one of the pulses coincides exactly with a point on the channel A waveform (see (1) in **Figure 3**). Now to find the frequency just count the number of pulses that occur until the channel-A waveform has completed one complete period (2). In the screen shot shown here there are 12.3 intervals of 1.0 µs therefore the frequency is given by

$$f = 1/\ 12.3\times10^{-6}\ \text{s} = 81.3008\ \text{kHz}.$$

These are only two applications of this versatile circuit, no doubt you will find many more.

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