Tacho calibrator

A handy test instrument for the motoring enthusiast. Installing and calibrating a new tacho is a pain in the exhaust. Here's the pill for the pain.

Graeme Teesdale

THIS PROJECT was developed initially to calibrate Smiths impulse tachometers, but with the addition of a transformer and diode can be used with peak reading or pulse types. The unit has also been useful in testing transistor-assisted ignitions by simulating the pulses from the distributor breaker points.

The calibrator is locked to the mains frequency — 50 Hz. It provides a selection of 14 different pulse rates from 25 Hz to 450 Hz in 25 or 50 Hz steps. Using the conversion chart, the pulse rate can be converted into RPM for the number of cylinders in the vehicle's engine.

Construction

Two printed circuit boards are used and the whole unit is housed in a low cost ABS plastic case which is locally produced by Sigea in Melbourne (case model EC.1001). We 'dressed up' the front panel with Scotchcal.

One pc board holds the power supply and most of the circuitry, with the exception of one IC and the rotary switch, which are located on another smaller board along with a few other components. This board mounts behind the front panel of the case and connects to the main board via two lengths of ribbon cable.

Commence construction by using the larger pc board as a template to mark out mounting holes on the case bottom. Also mark out the mains cable inlet grommet hole and terminating block position. The front panel can be marked out using the Scotchcal as a template.

Drill the case, then mount and terminate the mains cable as indicated in the drawings.

Now you can start assembling the pc boards. Note the three links on the small pc board. LED1 actually mounts on this board, as does SW2. Make sure you cut the shaft of this switch to suit the knob you're using. Leave the leads of LED1 long and don't solder it in place until you have determined how long they should be by making a trial assembly once all the other components are mounted. SW1 is wired to the board after mounting to the panel.

When assembling the larger pc board, leave T1 and C1 till last. Watch orientation of the ICs, transistors, diodes and polarised capacitors, as usual. Note that the ICs are CMOS types, so observe the usual handling precautions. Don't handle the pins, pick them up with thumb and forefinger on the ends of the package; solder the power supply pins first.

When mounting T1, secure it in place with two PK screws before soldering to the pins to avoid straining the pins and possibly breaking the wires terminated to them.

When both boards have been assembled and checked, wire them together with two lengths of 5-way ribbon cable about 130 mm long each. Solder flying leads to the 240 Vac input terminals on the board (use mains cable).

Then, mount the larger pc board in the case and terminate the 240 Vac input wires to the mains terminal block.

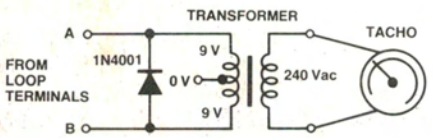
Attach the Scotchcal to the front panel of the case and mount SW1. Take care of the Scotchcal when tightening the nut. Solder three wires to its terminals and terminate them on the appropriate place on the small pc board. Then mount the small board. Take care when tightening the nut on the shaft of the rotary switch that you don't damage the Scotchcal.

After a careful final check, you're ready to switch on.

Testing it out

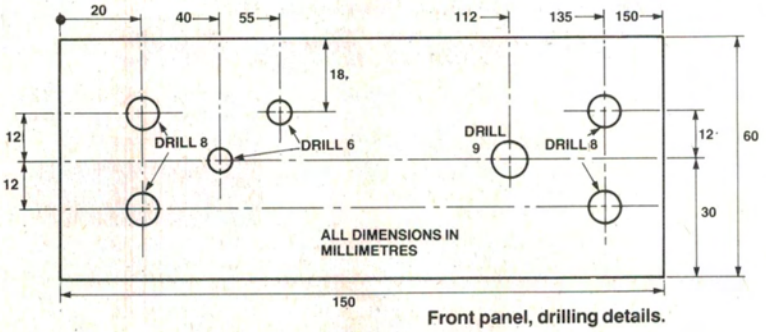
Set the range switch to position 1 and switch on. The pulse LED will flash at a rate of one second on, one second off. As you vary the range switch, the LED will flash at an increasing rate. If nothing's happening, then switch off and check your wiring, component orientation etc. See that supply voltage exists on the small pc board. Otherwise, you'll need either a logic probe or a CRO to fault-find.

If all is well, connect the primary loop of the pickup coil of a tachometer to the loop terminals. Vary the number of turns in the loop until the tachometer gives a reading. Use the accompanying table to determine the RPM, knowing the pulse rate and number of cylinders. Alternatively, if a peak reading or pulse type tacho is used, connect up the following additional circuitry:



Beware of the high voltage pulses on the secondary of the transformer in this circuit.

A little experimentation will show you how versatile this pulse generator can be. ▶



Front panel, drilling details.

PARTS LIST — ETI-165

Resistors ..... all ½ W, 5% unless noted
- R1 ..... 22k
- R2 ..... 8k2
- R3 ..... 1k5
- R4 ..... 100R
- R5 ..... 470k
- R6 ..... 27k
- R7 ..... 100k
- R8 ..... 10k
- R9 ..... 560R
- R10 ..... 1k
- R11 ..... 22R, 5 W

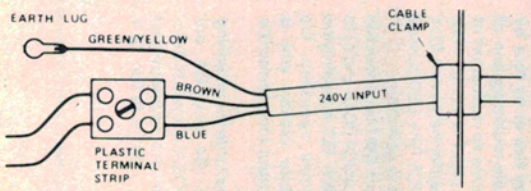
Capacitors
- C1 ..... 1000u/25 V axial electro.
- C2 ..... 10n greencap
- C3 ..... 1n greencap
- C4 ..... 1u/16 V tant.
- C5 ..... 22u/16 V RB electro.

Semiconductors
- D1, 2, 3, 4 ..... 1N4001, EM401 etc.
- IC1 ..... LM340T/12, 7812
- IC2 4046
- IC3 4017
- IC4 4093
- IC5 4040
- LED1 ..... TIL220R red LED
- Q1, Q2 ..... BC548
- Q3 ..... BD266 or similar

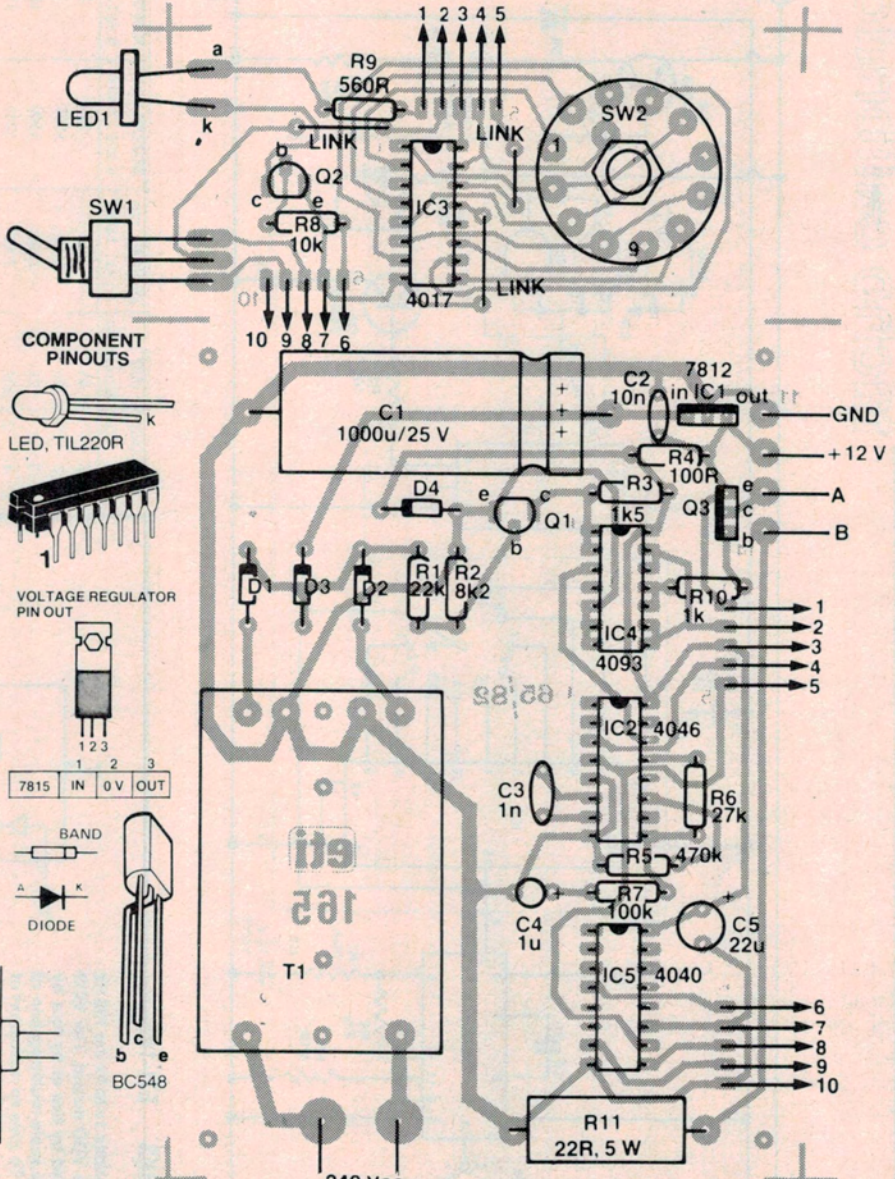
Miscellaneous
- TR1 ..... PL24/5 VA, Ferguson
- SW1 ..... SPDT switch
- SW2 ..... 1-pole, 9-position rotary C&K Lorlin or similar.

ETI-165 pc board(s); two lengths of five-conductor ribbon cable (or hookup wire); case to suit; mains cord and clamp; etc.

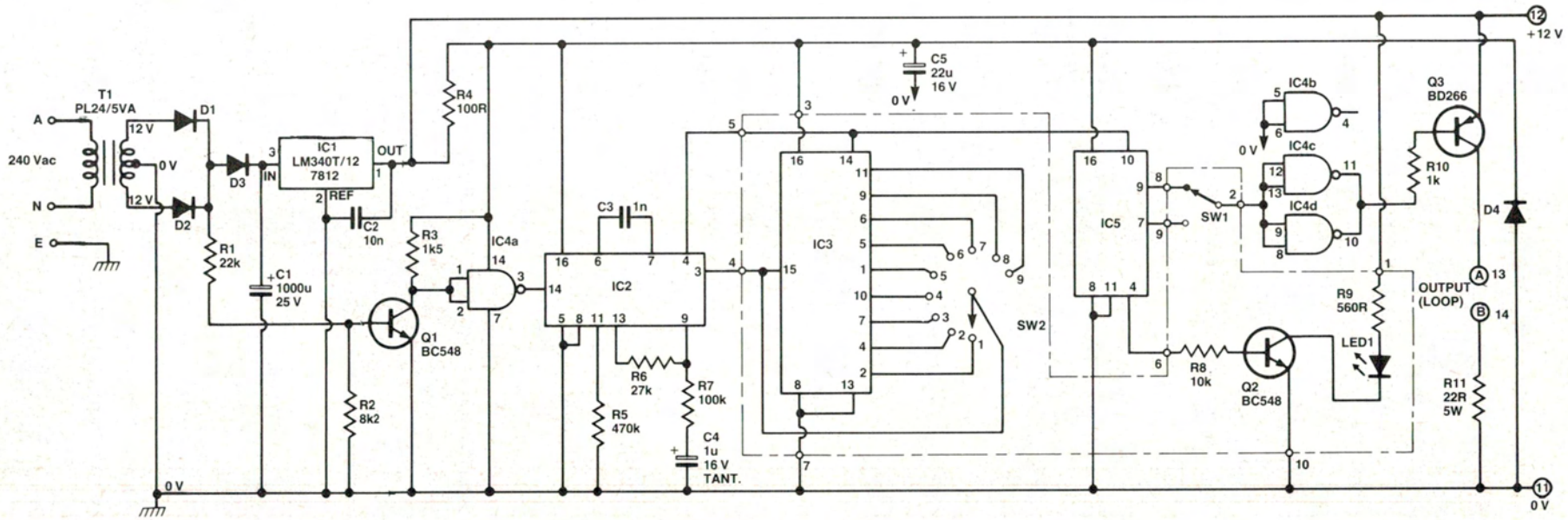
Price estimate $36-$40



MAINS INPUT WIRING



Project 165 tacho calibrator



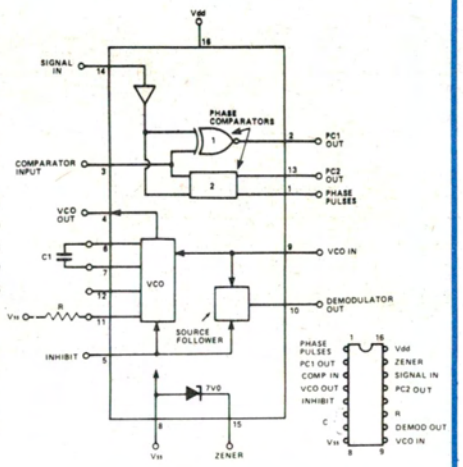
HOW IT WORKS ETI-165

Diodes D1 and D2 are a full wave rectifier, delivering half-sine pulses of 17 V peak at their cathodes. These half-sine pulses are coupled to a smoothing capacitor, C1, via D3 and also to the base of Q1 via R1. D3 serves to isolate the smoothing effect of C1. A 12 V regulated supply rail for the rest of the circuitry is provided by a 7812 three-terminal regulator.

The half-sine pulses coupled to the base of Q1 turn it on and off 100 times per second, the 100 Hz pulses on Q1's collector driving the input of IC4a, a Schmitt NAND gate connected as a buffer (4093). The output of IC4a drives the 'signal' input of IC2, a 4046 CMOS phase-locked loop (PLL). Its internal block diagram is shown in Figure 1. The VCO centre frequency of the PLL is determined by R5 and C3. An error signal from the phase comparator 2 (PC2) output (pin 13) is fed back to the VCO input (pin 9) via a second order low-pass filter consisting of R6, R7 and C4. Between the VCO output (pin 4) and the phase comparator input (pin 3) a divider having selectable outputs (IC3 — a 4017) is connected. This provides 1x to 9x the 100 Hz input frequency at the VCO output. The VCO output is further divided by two or by four by IC5 (a 4040) to provide scale multiplication of x1 (÷ 4) and x2 (÷ 2). To give an indication of the unit's operation, an output is taken from pin 4 on IC5. Q2 acts as a buffer between LED1 and the pin 4 output from IC5. The LED pulses on and off to show the unit is operating.

The selectable output from SW1 is connected to two paralleled sections of IC4 (IC4c and d) to interface to the 'loop' switch, Q3, a Darlington PNP transistor. For impulse operation, the primary loop of the tacho pickup coil is connected between the output loop terminals A and B.

The 12 V supply rail is available for powering any external equipment. R4 and D4 are included to protect the CMOS ICs against damage from negative spikes and unintentional application of an external voltage to the 12 V rail the wrong way round.



RANGE x1	RANGE x2	OUTPUT pulses/sec.	READING. rpm 4 cyl. tacho	READING. rpm 6 cyl. tacho	READING. rpm 8 cyl. tacho
1		25	750	509	375
2	1	50	1500	1000	750
3		75	2250	1500	1125
4	2	100	3000	2000	1500
5		125	3750	2500	1875
6	3	150	4500	3000	2250
7		175	5250	3500	2625
8	4	200	6000	4000	3000
9		225	6750	4500	3375
	5	250	7500	5000	3750
	6	300	9000	6000	4500
	7	350	10 500	7000	5250
	8	400	12 000	8000	6000
	9	450	13 500	9000	6750

NOTE: Printed circuit board and front panel artwork is located on page 127.