Universal Tacho Circuit Board Replacement

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The scope of this project was the design of a DIY universal replacement circuit board for electronic Veglia tachometers made in the late sixties to early eighties. The circuit is easy to assemble and based on standard 'wire through' electronic parts which should be easily available via electronic stores and mailorders. Cost of the electronic parts was around €5/$6 at the time of writing this article. Please be aware that this is a DIY project, i don't offer prebuild circuit boards.

This circuit will work with most **Veglia** tachometers as well as with **Smiths RVI/RVC** and Smiths derived tachometer designs.

Introduction

The circuit described here is a replacement for the electronic board installed in vintage electronic Veglia and Smiths tacho's. If your tacho is broken because of a board defect then it can be a more economic approach to exchange the circuit board instead of trying a repair. This is usually the case with early tacho's using out of production germanium transistors and later Veglia tacho's which use integrated tacho driver ICs such as the SN29736P or the 14 pin version of the SL494, as both ICs are difficult to source nowadays.

You can use this circuit board to

- repair a tacho with broken electronics by exchanging the circuit board
- adapt a tacho to a different input signal type (Coil input, Points Trigger, Electronic Ignition and ECU Signals)
- convert a 4 or 6 cylinder tacho to an 8 cylinder engine or vice versa

Features and Specifications

- Compatible with most moving coil tachometers
- Enables a tacho to be calibrated for a 4, 6 or 8 cylinder engine
- Trigger input via the coil 'minus' terminal, points or from an electronic ignition tacho signal
- Supply voltage input stabilized and protected against wrong polarity, voltage spikes and line noise
- Cleans and stabilizes the input signal via a Schmitt-Trigger circuit
- Drift (output variance) less than 2% in a temperature range of 0-80º C
- Minimum supply voltage 10V (typical 13.8V)
- Minimum input trigger signal voltage 4-5V (typical 12V), trigger signal duty cycle 2%-96% (typical 20%-50%)
- Pulse width for output signal can be set from 1.0-2.0 ms via R1 (Veglia requires 1.4-1.5ms, Smiths 1.8ms)

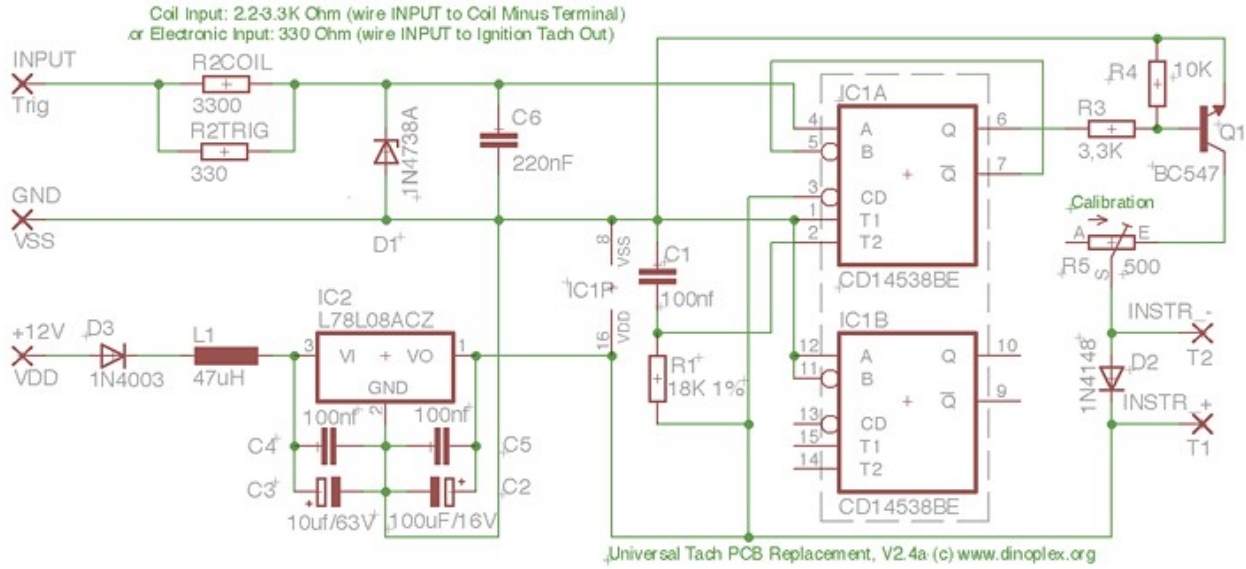
Files for downloading

- Square shaped circuit board (Eagle)
- Veglia shaped tacho board design (Eagle)

Circuit Diagram

The circuit is based on the industry standard CD14538 chip, which features two independent precision monostable multivibrators (IC1A and IC1B). The second monostable multivibrator is not used so the input pins are wired to ground.

'IC1P' are the two power supply pins on the CD14538 chip (GND/VSS: pin 8 and VCC/VDD: pin 16).



Circuit Board Assembly

Components

Here is the list of the required components:

#	Part	Code	Part Description
1x	100nF	C1	NP0 (zero drift) grade Ceramic or SMD capacitor, 2,54 mm grid
2x	100nF	C4, C5	Radial ceramic capacitor, 2,54 mm grid, or SMD ceramic capacitor 0805
1x	100uF/16V	C2	Electrolytic capacitor, 2,54 mm grid radial
1x	10uF/63V	C3	Electrolytic capacitor, 2,54 mm grid radial
1x	220nF	C6	Radial ceramic capacitor, 2,54 mm grid, or SMD ceramic capacitor 0805 (only required for a Coil (-) connection setup)
1x	1N4738A	D1	Zener Diode 8,2V, axial
1x	1N4148	D2	Standard Rectifier Diode, DO-35
1x	1N3070	D3	Standard Rectifier Diode
1x	CD14538BE	IC1	CMOS dual precision monostabile multivibrator, DIP package
1x	DIP Socket	for IC1	16-pin DIP Socket for IC1
1x	L78L08ACZ	IC2	Low Drop fixed voltage regulator 8V, TO-92
1x	47uH	L1	Inductor 47uH 200mA, axial
1x	BC547	Q1	NPN Transistor, TO-92
1x	15KΩ 1%	R1	10/15/18KΩ (Veglia) or 18KΩ (Smiths) Resistor, 1%, 0.125W 0204 axial
1x	3300Ω 5%	R2COIL	3300Ω resistor, 5%, 1 Watt, 250V, axial (for coil minus terminal connection)
1x	330Ω 5%	R2TRIG	330Ω resistor, 5%, 0.25W, 0207 axial (for electronic ignition tach out)
1x	3300Ω 5%	R3	3300Ω resistor, 5%, 0.125W 0204 axial
1x	10K	R4	10KΩ resistor, 5%, 0.125W 0204 axial
1x	500Ω Trimmer	R5	500Ω sealed trimmer vertical mount

1. Tacho Type Configuration

Adapting the circuit to different tacho types/manufacturers only requires changing R1, which controls the output signals pulse width:

- Veglia: 4 Cyl: 18K, 6 Cyl: 15K, 8 Cyl: 10K resistor at R1
- Smiths: Install a 18KΩ resistor at R1
- Others: Start with a 15K resistor. If the tacho needle won't reach the maximum RPM on the dial when calibrating, try a 18KΩ resistor instead.

The R1 pulse width resistor for the output signal is calculated by multiplying the desired width in ms * 10 = K Ohm of R1. Example 1.5 ms * 10 = 15K.

2. Trigger Input Configuration

Depending on the desired input type (coil connection or electronic tacho signal) type you need *either* R2COIL or R2TRIG installed at R2:

R2COIL Resistor

- Points/Coil setups (Coil "minus" terminal)
- Transistor ignitions without a dedicated tacho output (Crane XR700/XR3000/XRi, 123 Ignition, Pertronix, Lumenition etc.) (Coil "minus" terminal)
- Marelli Microplex and Digiplex ECUs (Coil "minus" terminal)

R2TRIG Resistor

- MSD 6/6A/7 CDI Ignitions (grey wire)
- Crane Fireball Hi-6 CDI Ignitions (green wire)
- Haltech ECUs (User output port, configured to tacho signal with a 50% duty cycle, 12V)
- Megajolt and Megasquirt ECU units (Tacho output wire)
- Marelli Dinoplex AEC101/AEC102/AEC103/AEC104 (Tacho output wire)
- Any ECU/Engine control unit which can supply a 6-12V square wave tacho output

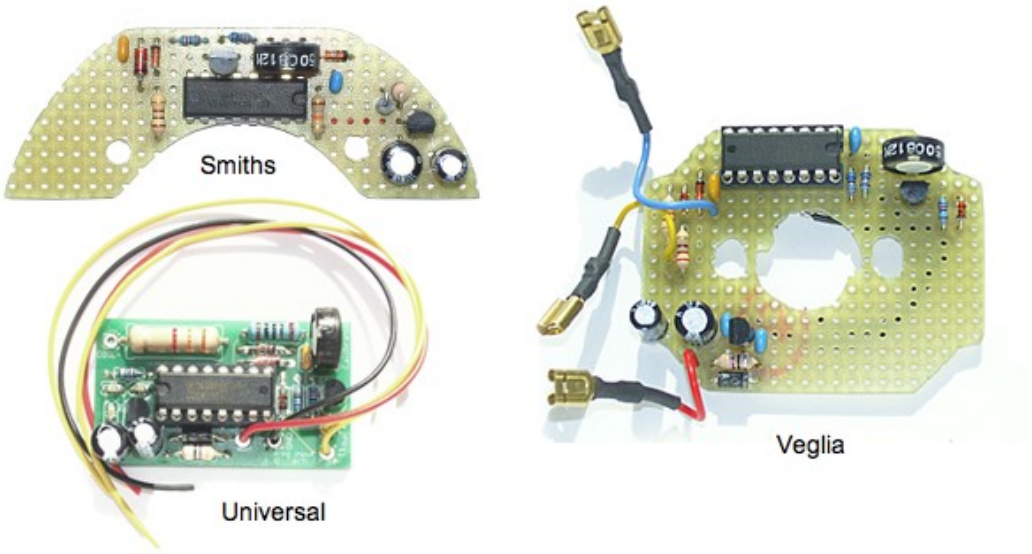
In general, a dedicated tach out signal is preferred as input over a coil connection if both are available. Never use a direct coil connection with a CDI ignition as this can damage the tach circuit and will lead to erroneous readings with multiple spark discharge ignitions such as the MSD 6A.

3. Cylinder Configuration

The calibration range of the standard circuit with a 500Ω trimmer (R5) should be sufficient to calibrate a tach for either a four, six or eight cylinder engines if R1 is properly set.

4. Assembly

Use one of the Eagle CAD board design files from the download links above to have a layouted PCB created, or simply solder everything to a prototype board. Below are some examples of assembled tacho circuit boards. Veglia tacho's use the following wire colors: blue for ground, red for +12V and yellow for trigger in.



For the installation, check which of the two small wires going from the old circuit board to the instrument coil terminals (behind the dial face) is the positive wire. Connect T1 on the new circuit board to the coil terminal where the positive wire was installed, and T2 to the other instrument coil terminal.
On **older Veglia tachs** where the original PCB board had two transistors, the positive terminal is at the six o'clock position (lower terminal) as seen from the front. **Newer Veglia tachs** using an IC instead of transistors on the PCB have the positive terminal on the twelve o'clock position (upper terminal). On Smiths tachs, the positive terminal is on the right side as seen from the front.

5. Calibration

The tacho calibration is handled via the trimmer R5. Set the trimmer to a middle position before you start the calibration. For the calibration it is recommended to have access to a square wave generator, which can generate frequencies between 10-500 Hz and has a variable output amplitude up to 12 Volts. You can also calibrate the tacho while it is installed in the car by comparing the readout of a digital strobe gun or RPM counter and then set the tacho accordingly, but it is much more comfortable and more precise to do this with a square wave generator.

Calibrate the tach for the RPM which is displayed at the twelve o'clock position of the dial for best results.

Here is the conversion from RPM to HZ for setting the square wave generator output frequency:

- 4 Cyl: HZ = RPM / 30
- 6 Cyl: HZ = RPM / 20
- 8 Cyl: HZ = RPM / 15

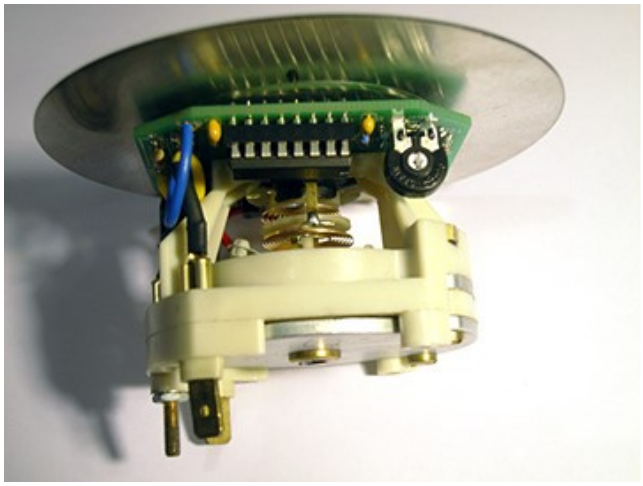
Example, when the RPM value indicated at the twelve o'clock position of your tacho is 4000 for a six cylinder engine, set the frequency generator to 200 HZ (4000/20).

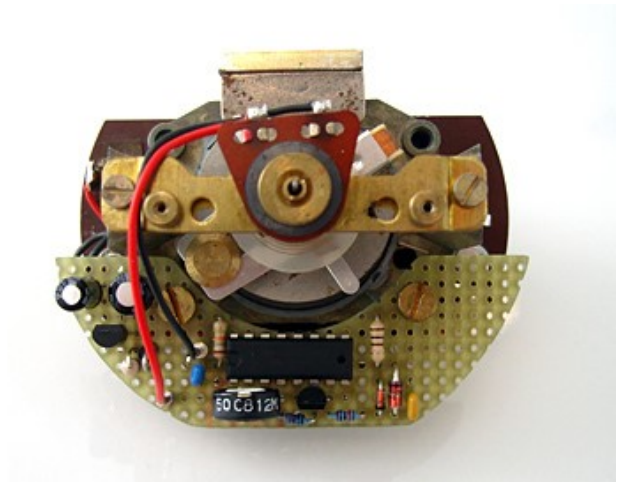
- R2TRIG configuration: set the output amplitude of the square wave generator to 10-12 volts. Connect the square wave generator outputs to ground and tacho circuit input.
- R2COIL configuration: set the output voltage of the square wave generator to 8 volts. Connect the square wave generator output after resistor R2COIL.

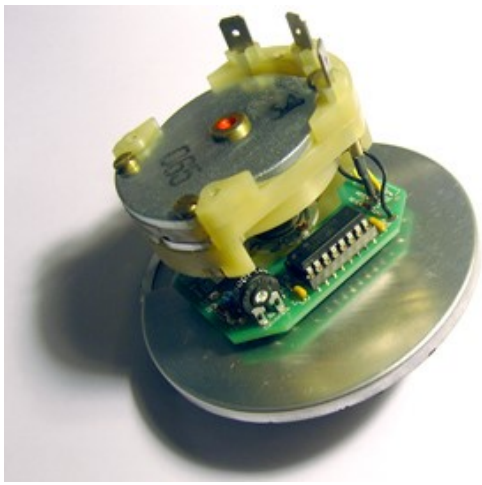
Now adjust the tacho by varying trimmer R5 until the tacho needle is in line with the RPM value you set on the square wave generator. With a mechanically good tacho you should be able to get a display error of 5% or less.

Examples

Top left: '69 Veglia tach (Fiat Dino), top right: '68 four cylinder Smiths RVI tach, lower left: '78 Veglia tach (Ferrari 308 GTB), lower right: '72 Datsun tach (Datsun 240Z).





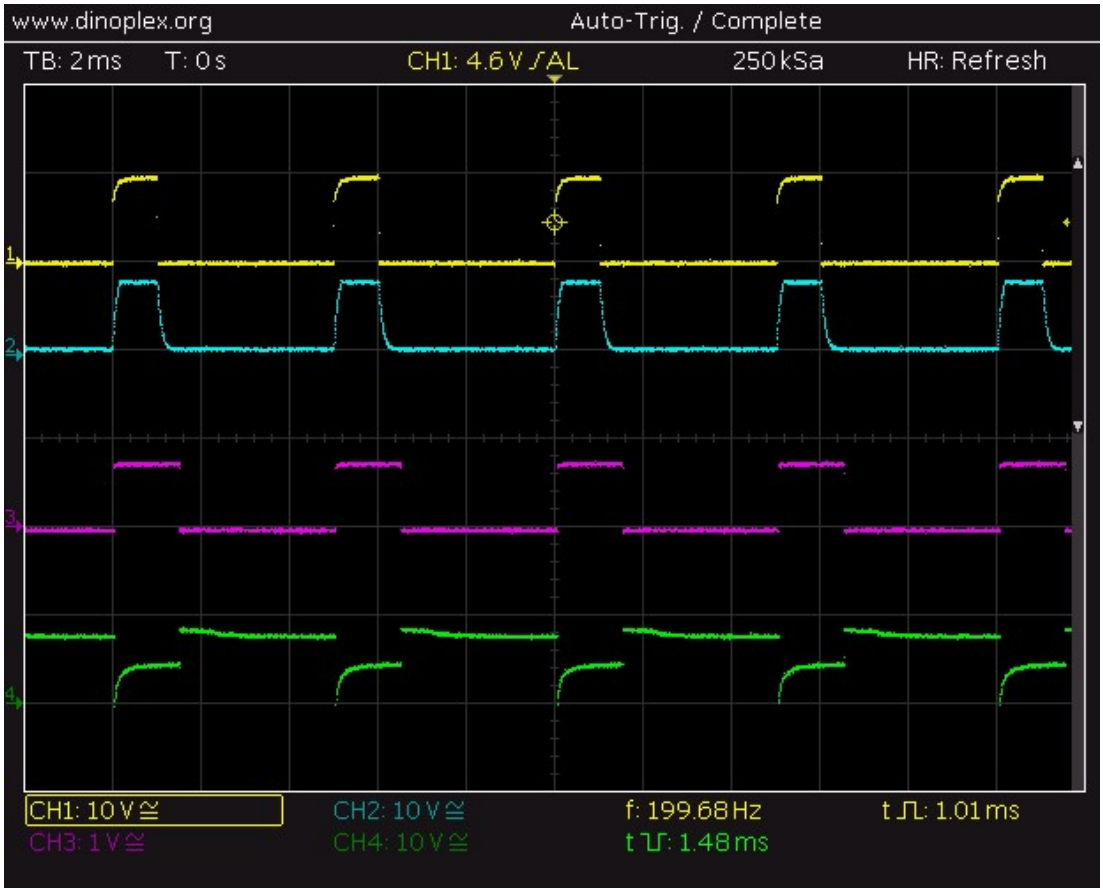


Appendix: Troubleshooting

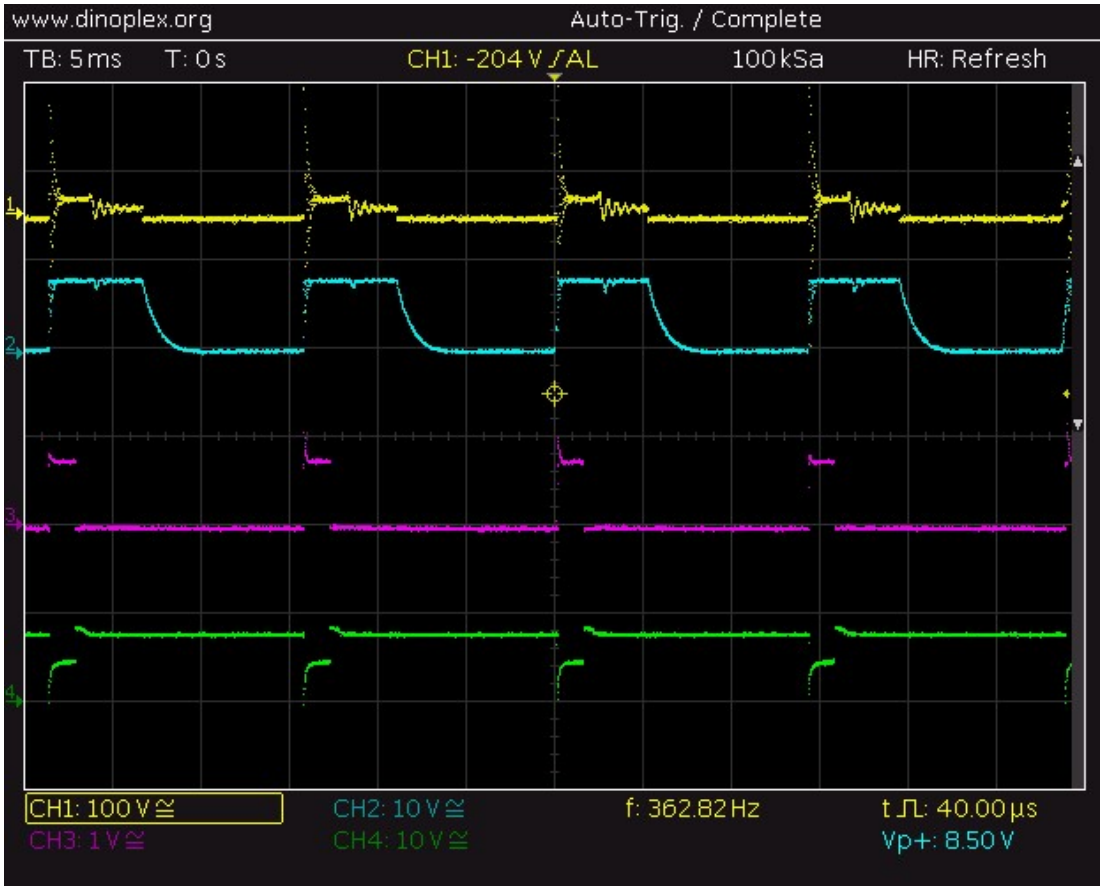
If the needle does not move when testing the assembled tacho, check that T1 (+) and T2 (-) are wired to the corresponding terminals on the instrument coil, and that the input signal matches the input configuration (R2TRIG or R2COIL). Also check that IC1 receives 8V supply voltage on pin 16.If you don't see 8V, check the input and output pins of the 7808 voltage regulator.

Below are two scope screenshot of the input signals at different stages for easy diagnosis:

1: Electronic Tach input Signal
2: Input signal after Zener Diode/input filtering
3: Q1 Base, coming from CD14538BE (pin 6)
4: Output signal (shown inverted), driving a Veglia tacho



1: Coil (-) terminal (Coil and Points setup)
2: Input signal after Zener Diode/input filtering
3: Q1 Base, coming from CD14538BE (pin 6)
4: Output signal (shown inverted), driving a Veglia tacho



Questions, corrections and comments: info@dinoplex.org