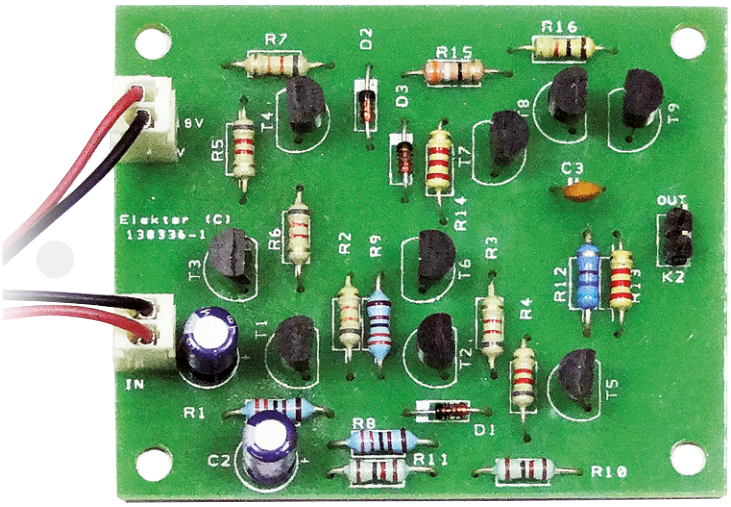
Peak Voltmeter

Plain simple & old skool



This 100-percent TUP & TUN circuit measures the peak value of an AC voltage up to 6 volts in amplitude, regardless of the waveform or if the peak occurs in the positive or negative excursion of the signal.

By **Elektor Labs India**

A peak voltmeter is useful to record the absolute peak value of an alternating voltage, usually aiming to determine whether any values occur over time that can be harmful to other equipment, or cause distortion. The instrument we're talking about is typically used in audio system measurements and telecoms where the measurand is not necessarily sinusoidal. A peak meter is not the same as a peak-to-peak meter, an rms meter or a true rms meter.

At this point, while the soldering iron heats up, read up on peak value (notation: $\hat{U}$ or V_p), peak-to-peak ($2\hat{U}$ or $V_{p\text{-}p}$), and rms (root-mean-square; $\hat{U}/\sqrt{2}$ or V_{rms}) on the Wikipedia page devoted to "amplitude" [1].

How it works

In the schematic pictured in **Figure 1**, the alternating input signal (max. 6 V) is applied to K1 and arrives at the base terminals of T1 and T3 via coupling capacitor C1. If voltages in excess of 6 V are to be measured a suitable resistive attenuator must be used ahead of K1. The sub-circuit built around T1, T2 and D1 is the rectifier for the positive excursion of the input signal. It's a differential amplifier with 'counteraction' through the action of diode D1. The rectifier for the negative excursion of the signal is organized in a complementary fashion around T3, T4 and D2. The adder circuit comprising T5 and T6 works on this principle: the voltage developed across R13 represents the difference between the two rectifier output voltages. The resulting current also flows through R14, and a voltage of the same value will be built up. If the voltage across R14 rises to about 600 mV—i.e. the threshold voltage of diode D3—capacitor C3 is rapidly charged via T7, and slowly discharged again via T8, T9 and R16. The voltage across R16—i.e. on output connector K2—closely matches the peak excursion (positive or negative) of the AC voltage applied to K1.

The circuit operates off two 9-V batteries connected in series, or a well regulated external power supply with an output voltage of 18 V_{DC}. Current consumption will be of the order of a few tens of milliamps.

Sunday Afternoon Construction

To allow over-the-weekend construction the project is built using the cheapest and commonest parts possible—just BC5xx transistors and 20 or so passive components, all through-hole and off the shelf, or ex junkbox. The board (**Figure 2**) is single-sided with a sumptuous 'ground' copper pour at the solder side to suppress noise and avoid interference from external sources. The DesignSpark files

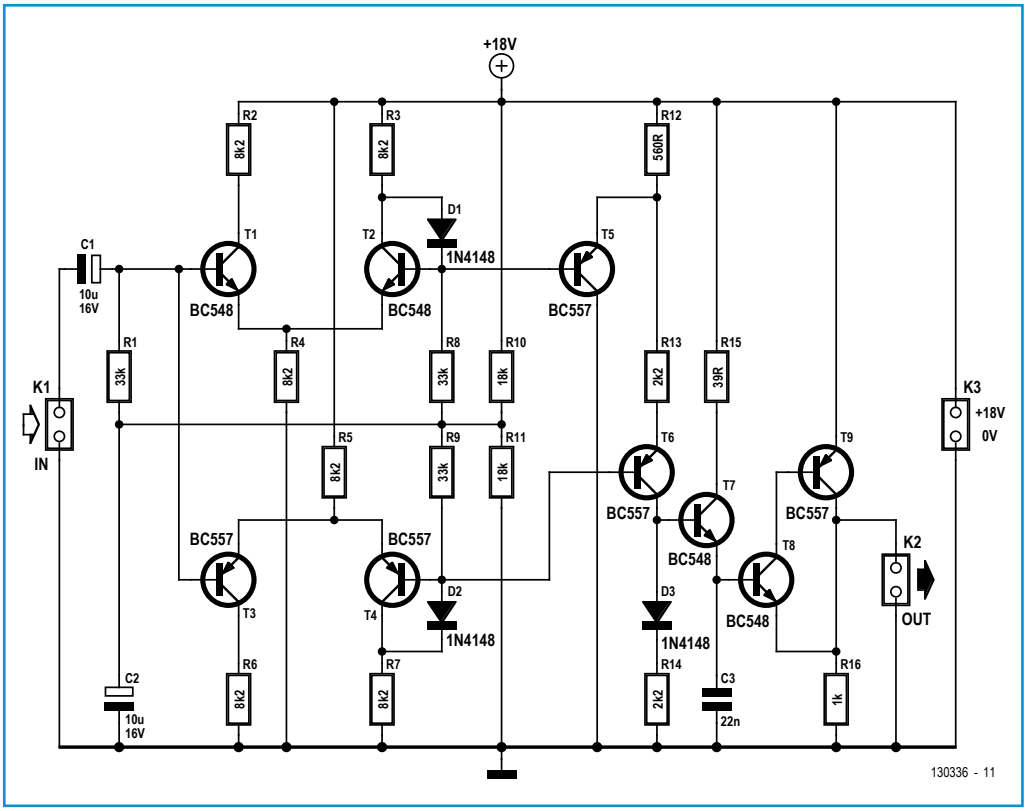


Figure 1.
Left to right: two differential amplifiers (T1/T2/D1; T3/T4/D2), one adder (T5-T6), one peak hold detector (D3/T7/T8/T9).

to produce your own board for the project are available for free downloading [2].

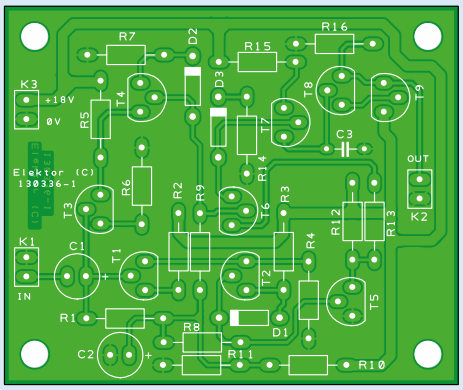
If you work carefully on the PCB stuffing, especially minding the difference between the n-p-n type BC548 (TUN—anyone remember these) and the p-n-p type BC557 (TUP) then the circuit should be operational in less than an hour. You can test the meter by applying a possibly pure sinewave of, say, 5 volts peak-to-peak to the input (use a scope!) and see if the readout on your multimeter connected to K2 tallies with the explanations and the arithmetic at [1].

Spurred on by the instant success, write a short summary interspersed with some equations and derivations like

Component List

Resistors

R1,R8,R9 = 33kΩ 5%



R2,R3,R4,R5,R6,R7 = 8.2kΩ 1%
R10,R11 = 18kΩ 5%
R12 = 560Ω 5%
R13,R14 = 2.2kΩ 5%
R15 = 39Ω 5%
R16 = 1kΩ 5%

Capacitors

C1,C2 = 10µF 16V
C3 = 22nF

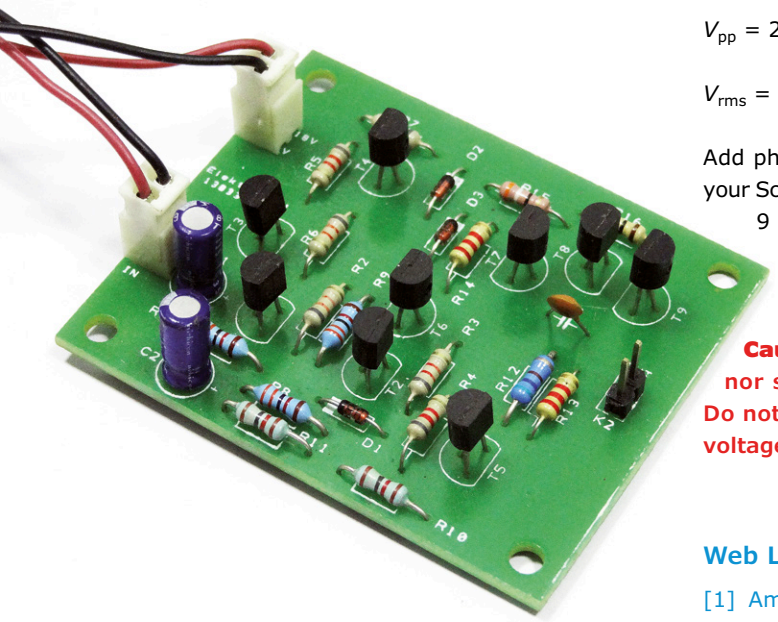
Semiconductors

T1,T2,T7,T8 = BC548
T3,T4,T5,T6,T9 = BC557
D1,D2,D3 = 1N4148

Miscellaneous

K1,K2,K3 = 2-pin pinheader, 0.1" pitch
2 pcs. 9V battery with clip-on leads
PCB # 130336; design files at [2]

Figure 2.
Printed circuit board designed for the Peak Voltmeter.



$V_{pp} = 2\ V_p = 2\sqrt{2}\ V_{rms}$ (pure sinewave only)

$V_{rms} = V_p / \sqrt{2}$ (pure sinewave only)

Add photos, a Youtube video and *hey presto* your Science Project due for delivery on Monday 9 am sharp is ready. Don't forget to link to Elektor dot POST [2]; it may get you extra credits.

Caution. The instrument is neither safe nor suitable for AC line measurements. Do not exceed 6 volts average alternating voltage at the input.

(130336)

Web Links

[1] Amplitude: http://en.wikipedia.org/wiki/Amplitude

[2] PCB design files: www.elektor-magazine.com/post