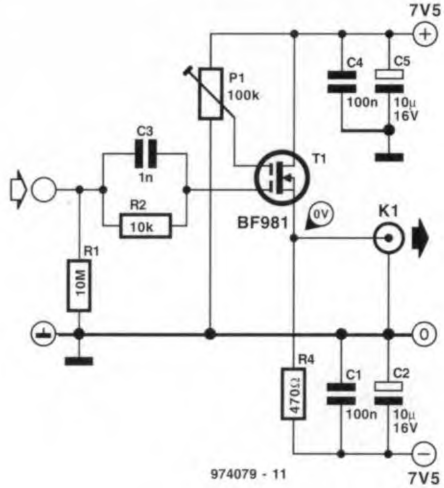
FET scope probe

Reliable measurement of an electrical quantity is possible only if the circuit in which the measurement is carried out is not loaded by the measurement instrument. The higher the input impedance of the instrument, the closer an accurate measurement is approached. The proposed probe may be used to increase the input impedance to about 10 MΩ.

A field-effect transistor (FET) is used to design a high-impedance voltage follower. In this circuit, R_1 determines the input impedance. The resistor is shunted by a parasitic capacitance of 3 pF. The output impedance depends on T_1 and R_4: with values as specified in the diagram, it is about 65 Ω.



The potential at the second gate (U_{g2s}) is set with P_1 such that the d.c. offset at the output is 0 V.

Unfortunately, a small price has to be paid for the simplicity of the circuit: since the overall amplification is ×0.8, the value measured by the oscilloscope must be corrected as appropriate.

The bandwidth of the probe is ≥ 15 MHz.

The probe draws a current of about 10 mA.

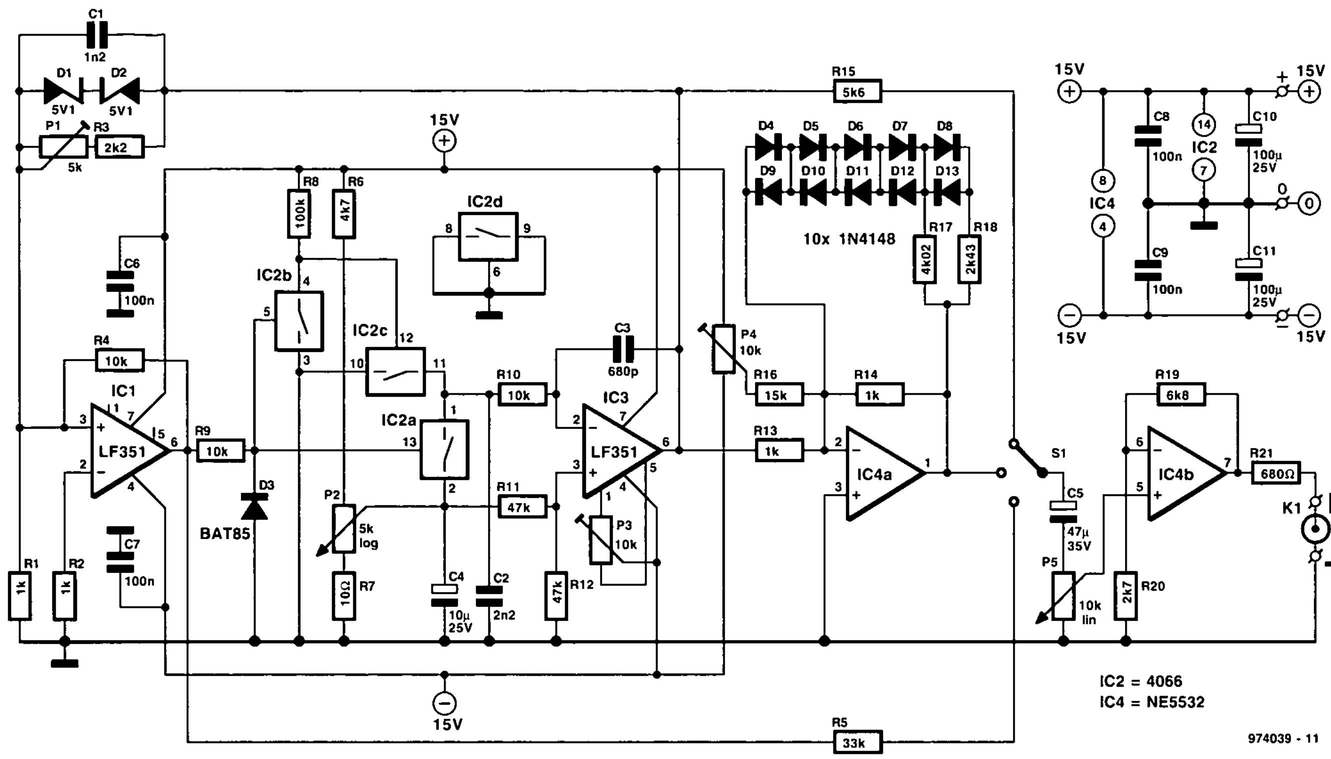
[Bonekamp - 974079]

single-range function generator

This function generator is traditional in as far as it consists of a comparator, an integrator and a triangle/sine wave shaper. However, a special variant of the comparator is employed to be able to cover the traditional frequency range of 20 Hz to 25 kHz in one go.

At the heart of the circuit we find integrator IC3, an LF351, which uses integration network R10-C4. Unconventionally, the +input of the integrator is not connected to ground, so that the output signal is not just determined by the instantaneous level of the rectangular input voltage (and, of course, the RC network). The main function of comparator IC1 is to control electronic switch IC2a. Using this switch and IC2b, the integrator input (R10) is pulled between ground and a positive potential which is adjustable with the frequency control potentiometer, P2. This corresponds to a positive-only rectangular voltage. However, R11 and R12 also hold the +input of IC3 at half the potential on the CMOS switches. The fact that the output signal of the differentiating integrator is determined by the voltages at both opamp inputs allows a single capacitor, C4, to cover well over three frequency decades without problems. Resistors R6 and R7 determine the extreme frequencies that may be set on the generator.

Assuming that IC2b is closed, the linearly falling ramp voltage at the integrator output drops until the zener voltage of D1 or D2 is reached. When one of the zeners starts to conduct, the comparator toggles and its output swings negative. Schottky diode D3 and resistor R9 then prevent a negative voltage at the control inputs of IC2, which is only powered off the positive supply rail. IC2b then opens, IC2a is closed via inverter IC2c, and the ramp voltage at the integrator output starts to rise until the zener voltage is reached again. Next, the comparator toggles and the



COMPONENTS LIST

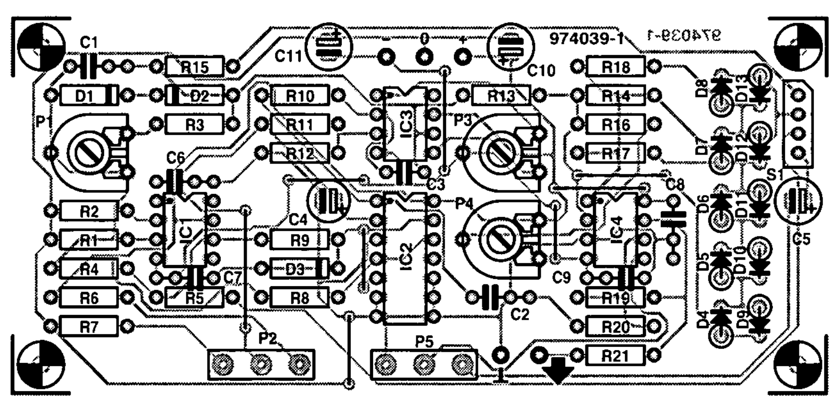
Resistors:
R1,R2,R13,R14 = 1kΩ
R3 = 2kΩ2
R4,R9,R10 = 10kΩ
R5 = 33kΩ
R6 = 4kΩ7
R7 = 10Ω
R8 = 100kΩ
R11,R12 = 47kΩ
R15 = 5kΩ6
R16 = 15kΩ
R17 = 4kΩ02
R18 = 2kΩ43
R19 = 6kΩ8
R20 = 2kΩ7
R21 = 680Ω

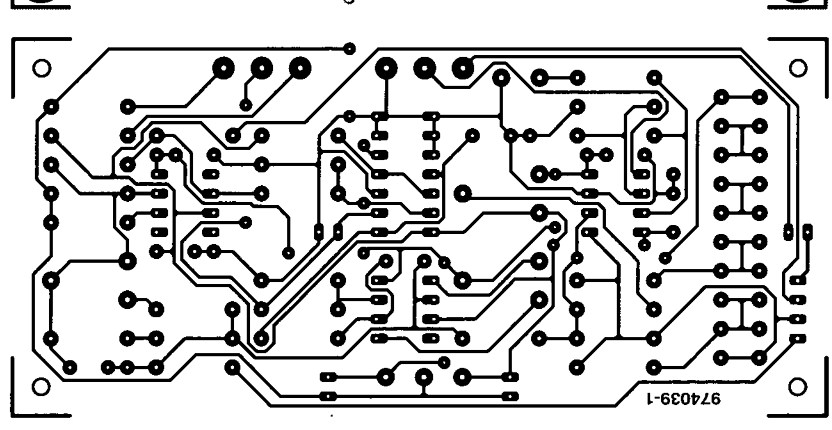
P1 = 5kΩ preset H
P2 = 5kΩ logarithmic potentiometer
P3,P4 = 10kΩ preset H
P5 = 10kΩ linear potentiometer

Capacitors:
C1 = 1nF2 (see text)
C2 = 2nF2
C3 = 680pF
C4 = 10µF 25V radial
C5 = 47µF 35V radial
C6-C9 = 100nF
C10,C11 = 100µF 25V radial

Semiconductors:
D1,D2 = 5V1 400mW
D3 = BAT85
D4-D13 = 1N4148 (matched pairs)
IC1,IC3 = LF351
IC2 = 4066
IC4 = NE5532

Miscellaneous:
K1 = BNC socket
S1 = rotary switch, 1 pole, 3 positions





oscillation cycle starts again, creating a triangular and a rectangular signal at the output of IC3 and IC1 respectively. Because the triangle-to-sinewave converter requires a virtually constant drive signal, the reference level created with the zener diodes can be tweaked with preset P1. Capacitor C1 eliminates a small rise of the triangle signal at higher frequencies, depending on component tolerances and construction.

The triangle-to-sinewave converter uses an NE5532 opamp and matched diode pairs. Details on its operation may be found in the April 1995 issue of *Elektor Electronics*.

The values of resistors R5 and R15 ensure roughly equal peak-to-peak values of the generator output voltage at all three positions of waveform selector switch S1. The generator output impedance is about 600 Ω, the maximum (no-load) output voltage, about 20 V_{pp}.

The generator is powered by a symmetrical, regulated, 15-volt supply. The General Purpose Power Supply described in the April 1997 issue is perfect for the job if you use the 7815/7915 voltage regulator pair. Current consumption is about 22 mA on each voltage rail.

The only critical parts in the circuit are the high-frequency compensation capacitor, C1, and the frequency control pot, P2. The optimum value of C1 may have to be established empirically, while a good-quality logarithmic potentiometer has to be used for P2. If at all possible, go for a real gear and dial assembly, because the full frequency range is compressed into a span of 270 degrees. As regards the level control, P5, a logarithmic pot may be preferred over a linear one if you want to be able to set small output levels accurately.

The generator is adjusted with the aid of a dual-beam oscilloscope and presets P1, P3 and P4 on the board. Initially, set P2 and P5 to mid-travel, and connect one scope channel to the output of IC3. Next, turn down the frequency with P2, and carefully adjust P3 for optimum symmetry of the triangular wave. Move the probe to the output of IC4a, and set the generator to a frequency of about 1 kHz. Adjust P1 and P4 for the best possible sinewave shape. For these adjustments, it is convenient to have the other scope channel display the triangular signal (at the same sensitivity), and move the trace onto the sinewave. In this way, any asymmetry of the sinewave is easily detected and eliminated.

Monitor the output of IC3 again, this time for stability of the output level across the full frequency range. If necessary change the exact (equivalent) value of C1 until the level is virtually constant.

Finally, check the upper and lower frequency extremes, which should be a little over 25 kHz and a little under 20 Hz respectively. If necessary, modify R6 and/or R7.

The printed circuit board shown here is unfortunately not available ready-made through the Readers Services.

(974039 - F. Hueber)