Featuring discrete devices and conventional IC's, the wide-range function generator in Fig. 4 offers serious experimenters more of a challenge than do simplified designs using special-purpose devices, such as the XR-2206. It is described by Robert C. Dobkin in Application Note AN-115, published by the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051). The instrument is capable of supplying sine, square and triangular waveforms at ampli-

tudes up to ±10 V from 10 Hz to 1 MHz *without band switching*. Usable outputs are available to as high as 2 MHz, but of reduced amplitude and waveform quality. It requires three IC's, a dual pnp transistor, two dual npn transistors, two conventional npn transistors, and seven standard diodes. With both trigger and signal outputs, the instrument has two semi-fixed adjustments and three operating controls in addition to its power switch: a three-position FUNCTION switch, a FREQUENCY control, and an AMPLITUDE control.

The basic generator comprises an LM319 dual voltage comparator, current-source switching transistors *Q1-Q2* and *Q3-Q4*, timing capacitor *C1*, and an LH-0033C FET-input voltage follower buffer amplifier. A triangular signal waveform is generated by alternately charging and discharging timing capacitor *C1* through switching current-source transistors *Q1-Q2* and *Q3-Q4* and diodes *D1* and *D2*. The resulting signal is amplified by the LH0033C voltage follower and coupled back through voltage-divider *R8-R9-R10* as inputs to the LM319 dual voltage comparator which forms part of the feedback network. The triangular signal also is applied to function switch *S1* through series isolating resistor *R18*. Control dc voltages obtained from voltage-dividers *R20-R32* and *R23-R31* set the threshold at the other inputs of the voltage comparators, thus establishing the peak-to-peak amplitudes of the comparator outputs. Connected in parallel, the comparator output signals are applied to emitter follower *Q5*, which serves both to supply a square-wave output signal to function switch *S1* through series isolating resistor *R24* and to provide a drive signal to the current-source switching transistors, *Q1-Q2* and *Q3-Q4*.

The generator's frequency of operation depends on *C1*'s charge and discharge currents. Ranging from 5 nA to 5 mA, these are controlled by the emitter bias applied to the switch-

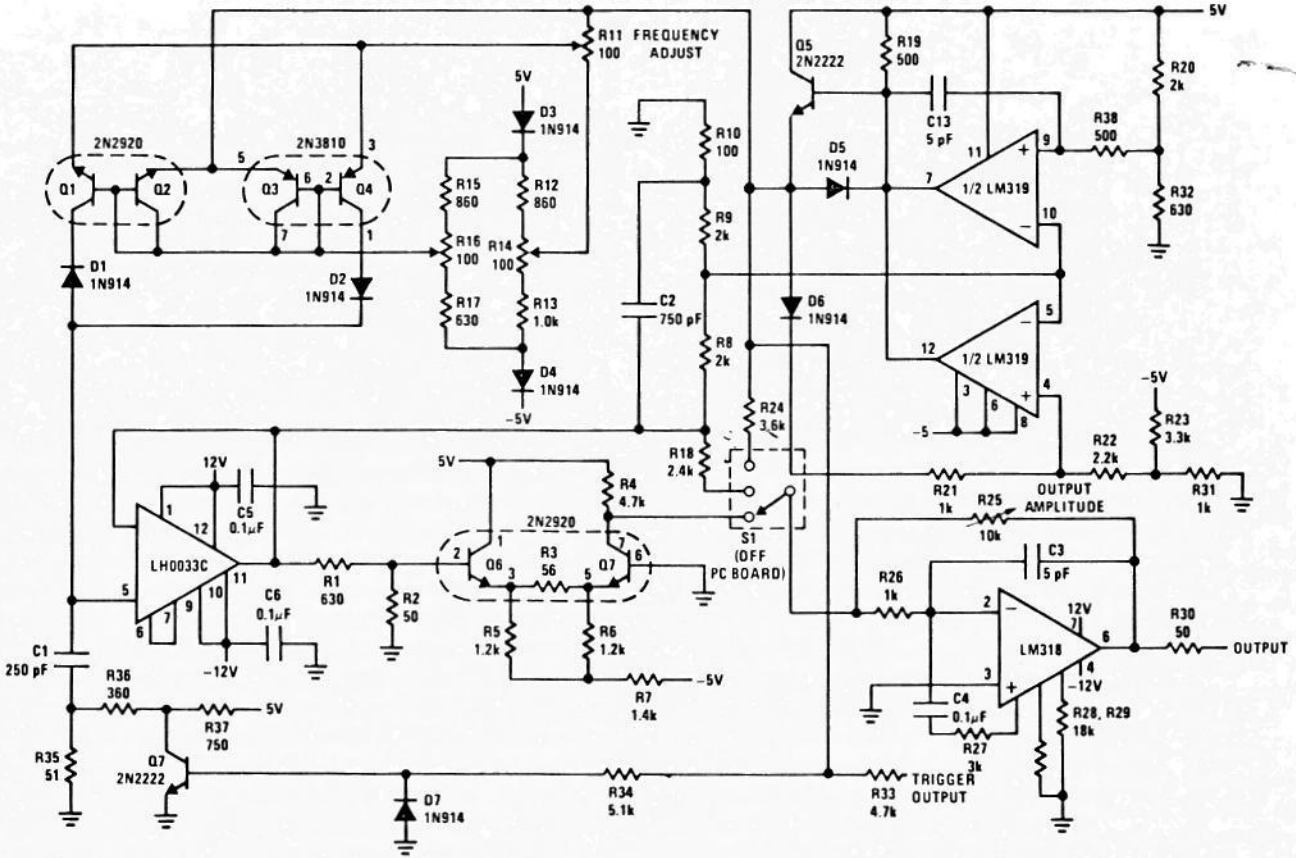

Fig. 4. National Semiconductor's wide-range function generator circuit.

ing transistors through frequency control *R11*. Differential amplifier *Q6-Q7*, operated with degenerative emitter feedback, serves to modify the triangular signal delivered by the buffer amplifier through voltage-divider *R1-R2*. This develops a close approximation to a sine wave across output load *R4* which is applied directly to function switch *S1*. From *S1*, the selected signal waveform is coupled through series resistor *R26* to the LM318 serving as the output amplifier. The output amplitude is controlled by *R25*, which provides inverse feedback across the op amp.

The function generator requires regulated dual ±5- and ±12-volt dc sources for proper operation. Suggested by National Semiconductor in its Application Note, the ac line operated power supply in Fig. 5 will provide the correct voltages. A conventional design, it comprises a spst ON-OFF switch, fuse, 24-volt step-down transformer, bridge rectifier, two filter capacitors (*C7* and *C8*), positive and negative 5- and 12-volt regulator IC's, and four bypass capacitors (*C9, C10, C11* and *C12*). All of the regulators are standard 3-terminal devices.

Though standard parts are specified in the instrument's design, some care must be exercised in the choice of components to insure optimum performance. A standard potentiometer may be used for frequency control *R11*, for example, but a vernier type or 10-turn pot is preferred due to the unit's six-decade frequency coverage. The output level control, *R25*, can be a standard potentiometer, with trimmer types used for semi-fixed adjustments *R14* and *R16*. All fixed resistors may be either quarter- or half-watt types, but should have a 5% tolerance rating except for *R1, R2, R5, R6* and *R7*, which should

carry a 1% tolerance. Good quality ceramic or plastic film capacitors should be used in the generator circuit, 25-volt electrolytics as power supply filters *C7* and *C8*, and solid tantalum types for the power supply bypass units (*C9, C10, C11* and *C12*). Function switch *S1* is a 3-position, single-pole, nonshorting rotary switch.

If a separate power supply is used, bypass capacitors *C9* through *C12* should be wired within the function generator. However, with careful planning the entire circuit, including the power supply (except for the power transformer and ac line components), can be assembled on a single pc board. A common heat sink should be used to couple switching transistors *Q1-Q2* and *Q3-Q4* to insure thermal tracking. After assembly and check-out, two simple adjustments are required. With the function switch in mid-position (triangular wave output), *R11* is set for a 1-MHz signal and *R16* is adjusted for perfect waveform symmetry. Next, *R11* is set for a 10-Hz output and *R14* is adjusted for perfect symmetry. ◇

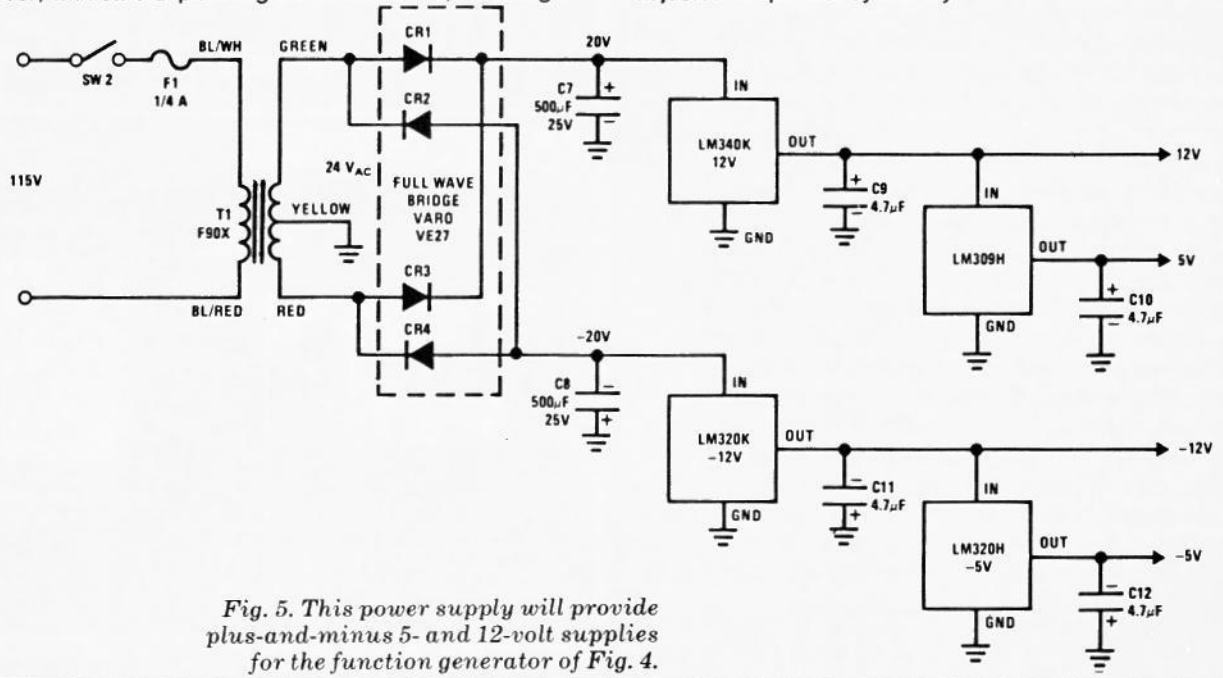

Fig. 5. This power supply will provide plus-and-minus 5- and 12-volt supplies for the function generator of Fig. 4.