

# Junk Box Audio Test Generator

*This scavenged helper is easy to build and fun to use.*

*I designed this device to be a junk box home-brew project. Some of the parts were scavenged from old computer boards — only the chip was bought new. Among many other things, it could be used for modularly testing a transmitter or for troubleshooting commercial radio sets.*

**T**his is an AF function generator covering the frequency range between 25 and 25,000 Hz in three bands. It has sine, square, and triangular or sawtooth outputs; output sufficient to drive any amplifier; and distortion low enough to make it useful in high precision test measurements.

## How it works

The frequency generator uses a dual op amp IC, the TL082 or an LF353, to produce the basic waveforms. The first of the two op amps in the IC is used as an oscillator, the frequency of which can be set by means of potentiometer P2; its range depends on the value of the capacitor C3 and is selected by means of switch S1. Trimpot P1 is used to adjust the duty cycle of the oscillator. The second op amp is an integrator that converts the triangular waveform produced by the oscillator to a square one, a 50% duty cycle. Potentiometer P4 is used to adjust the amplitude of the squarewave signal. Potentiometer P3 is used to adjust the amplitude of the triangular waveform. The signal from the output of the oscillator is taken to the circuit designed around the two transistors to be con-

verted from a triangular wave to a sinusoidal wave. The two trimpots P5 and P6 are used to adjust the symmetry shape of the positive half and the negative half portions of the sine wave signal for the best symmetry and minimum distortion. P7 is the potentiometer that adjusts the output level for this waveform.

As you can see, the circuit consists of fairly basic building blocks with independent adjustments for every one of them, which makes this a very versatile and easy-to-operate instrument. The power supply is also incorporated on the circuit board in two ways. If you want to use a 12 VAC @ 0.05 A or more, use diodes D4, D5 and capacitors C13, C14 as shown. If you want to use a 24 VAC @ 0.05 A or more transformer, use all four diodes D4, D5, D6, and D7 as shown and omit C13, C14.

## Construction

I assembled my prototype on a PC board, but a perfboard can also be used.

First of all, let us consider a few basics in building electronic circuits on a printed circuit board. The board is made of a thin insulating material clad

with a thin layer of conductive copper that is shaped in such a way as to form the necessary conductors between the various components of the circuit. The use of a properly designed printed circuit board is very desirable, as it speeds up construction considerably and reduces the possibility of making errors.

Soldering the components to the board is the only way to build your circuit, and your success or failure depends on the way you do the job. This work is not very difficult, and if you stick to a few basic rules, you should have no problems. The soldering iron that you use must be light, and its power should not exceed the 25–30 watt range. The tip should be fine, and must be kept clean at all times. For this purpose, you can use some very handy specially made sponges that are kept wet, and from time to time you can wipe the hot tip on them to remove all the residues that tend to accumulate. DO NOT file or sandpaper a dirty or wornout tip. If the tip cannot be cleaned, replace it. There are many different types of solder on the market, and you should choose a good quality one that contains the necessary flux in

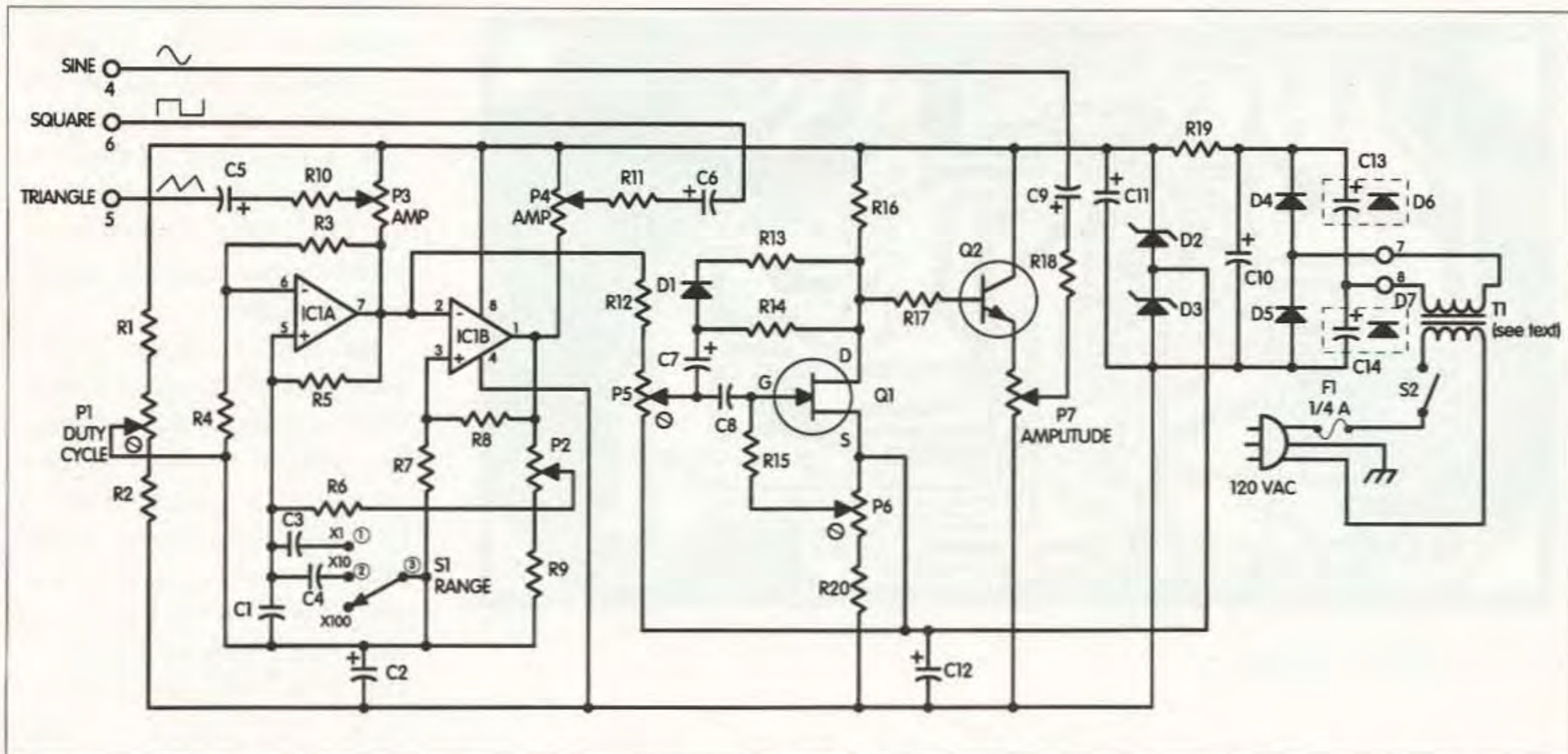


Fig. 1. Schematic. P2 is frequency control. Not shown are C15 (0.1  $\mu$ F, 200 V) and a bidirectional red-red LED that can be mounted off the board in series across (ahead of) the primary windings of T1.

its core, to ensure a perfect joint every time. DO NOT use soldering flux apart from that which is already included in your solder. Too much flux can cause many problems, and is one of the main causes of circuit malfunctions. Nevertheless, if you have to use extra flux, as is the case when you have to tin copper wires, clean the area very thoroughly after you finish your work.

In order to solder a component correctly, you should do the following:

- Clean the component leads with a small piece of emery paper.

- Bend them at the correct distance from the component's body, and insert the component in its place on the board.

- You may sometimes find a component with heavier gauge leads than usual, that are too thick to enter in the holes of the PC board. In this case, use a mini-drill to enlarge the holes slightly. Do not make the holes too large, as this is going to make soldering difficult afterwards.

- Take the hot iron and place its tip on the component lead while holding the end of the solder wire at the point where the lead emerges from the board. The iron tip must touch the lead slightly above the PC board.

- When the solder starts to melt and flow, wait till it evenly covers the area

around the hole and the flux boils and gets out from underneath the solder. The whole operation should not take more than 5 seconds. Remove the iron and let the solder cool naturally, without blowing on it or moving the component. If everything was done properly, the surface of the joint will have a bright metallic finish to it, and its edges should be smoothly ended on the component lead and the board track. If the solder looks dull or

cracked, or has the shape of a blob, then you have made a dry joint and should remove the solder (with a solder pump, or a solder wick) and redo it again.

- Take care not to overheat the tracks, as it is very easy to lift them from the PC board and break them.

- When soldering a sensitive component, it is good practice to hold the lead from the component side of the board with a pair of long-nose pliers,

<ul style="list-style-type: none"> <li>• DIP switch programmable</li> <li>• Miniature in size</li> <li>• 37 EIA tones, 27 non-standard tones from 33.0 to 254.1 Hz included</li> <li>• Reverse Burst built-in</li> <li>• Easy 3 wire hookup</li> </ul> <p>SS-64 CTCSS Encoder .66" x 1.08" x .21"</p> <p><b>SS-64 DIP Switch Programmable CTCSS Encoder \$28.95</b></p>		<ul style="list-style-type: none"> <li>• Fully enclosed CTCSS encoder</li> <li>• All 32 EIA tones from 67.0 to 203.5 Hz included</li> <li>• Perfect for mobile / base applications</li> </ul> <p>TE-32 5.25" x 3.3" x 1.7"</p> <p><b>TE-32 Multi-Tone CTCSS Encoder \$49.95</b></p>	
<ul style="list-style-type: none"> <li>• 51 CTCSS Tones</li> <li>• 106 DCS Codes</li> <li>• Supports 157 Repeater Subscribers</li> <li>• On-Line Computer Help</li> <li>• Repeater CW ID</li> <li>• Air Time Loading &amp; Analysis Graphs</li> <li>• Signalling Formats: CTCSS, DCS &amp; DTMF</li> </ul> <p>TP-3200 Shared Repeater Tone Panel</p> <p>TP-3200D Table Top Version \$269.95 each</p> <p>TP-3200RM-A Single Rack Mount version \$279.95 each</p> <p>TP-3200RM-B Triple Rack Mount version \$279.95 each</p> <p>*Holds up to three TP-3200s</p>		<ul style="list-style-type: none"> <li>• Eight programmable, selectable messages</li> <li>• Fully field programmable via included keypad</li> <li>• Meets all FCC identification requirements</li> </ul> <p>ID-8 Automatic Morse Code Identifier 1.85" x 1.12" x .35"</p> <p><b>ID-8 Automatic Morse Station Identifier \$69.95</b></p>	

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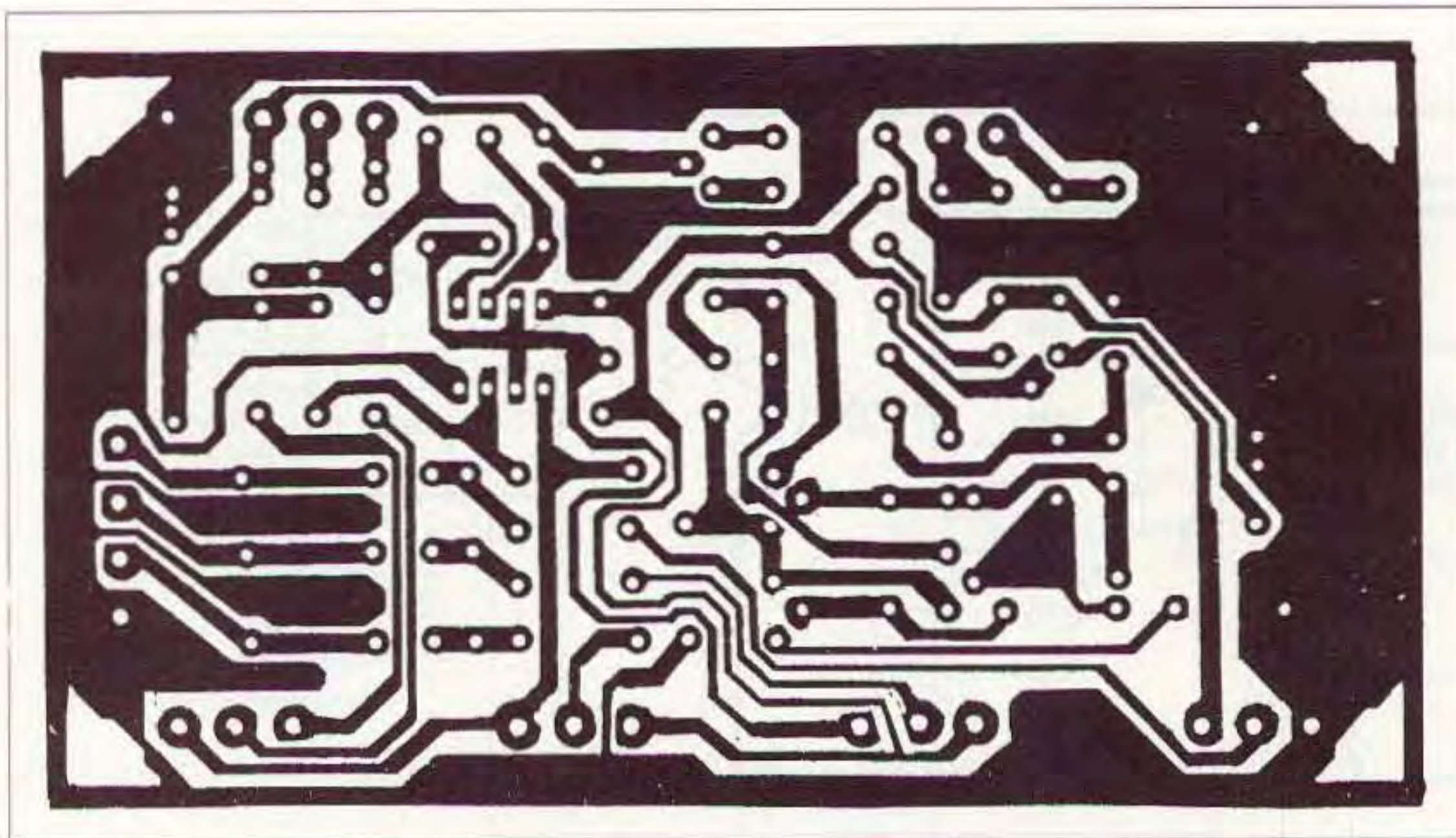


Fig. 2. Circuit board foil pattern.

to divert any heat that could possibly damage the component.

- Make sure that you do not use more solder than is necessary, as you are running the risk of short-circuiting adjacent tracks on the board, especially if they are very close together.

- After you finish with your work, cut off the excess of the component leads on the foil side and clean the board thoroughly with a suitable solvent to remove all of the excess flux residues that still remain on it.

The function generator is relatively easy to build, and if you follow the instructions carefully, you should have no difficulties. Once you have the board and all of the components, you can begin by following the parts placement diagram. Mount all the resistors, then all the capacitors, then the diodes and semiconductors. Connect shielded cable from the board to the potentiometers, as well as to the output terminals and the range switch (S1). Then the rest of the wiring can be done.

adaptor rated at a suitable current will do, and you're in business.

The only difficulty you may have is with the components that are not mounted on the printed circuit board, namely the potentiometers, the switches, and the outputs. As mentioned, these should be connected with the rest of the circuit with shielded cables which should be kept as short as possible to avoid introducing noise and distortion to the output signal.

Again, start building the circuit from the least sensitive components to make sure that you don't damage any components during soldering. The first components to be soldered should be the output pins and the IC socket. Identify the resistors and solder them one by one into their places. Do the same with the capacitors, taking care to insert the electrolytics the right way in. Solder the trim pots, the diodes, and the transistors, taking care to put them in the right way and not to overheat them.

Make a careful visual inspection of the board to ensure that you have not made any mistakes, then insert the IC carefully so as not to bend the leads as you put it in its socket. Connect the potentiometers, the range selector

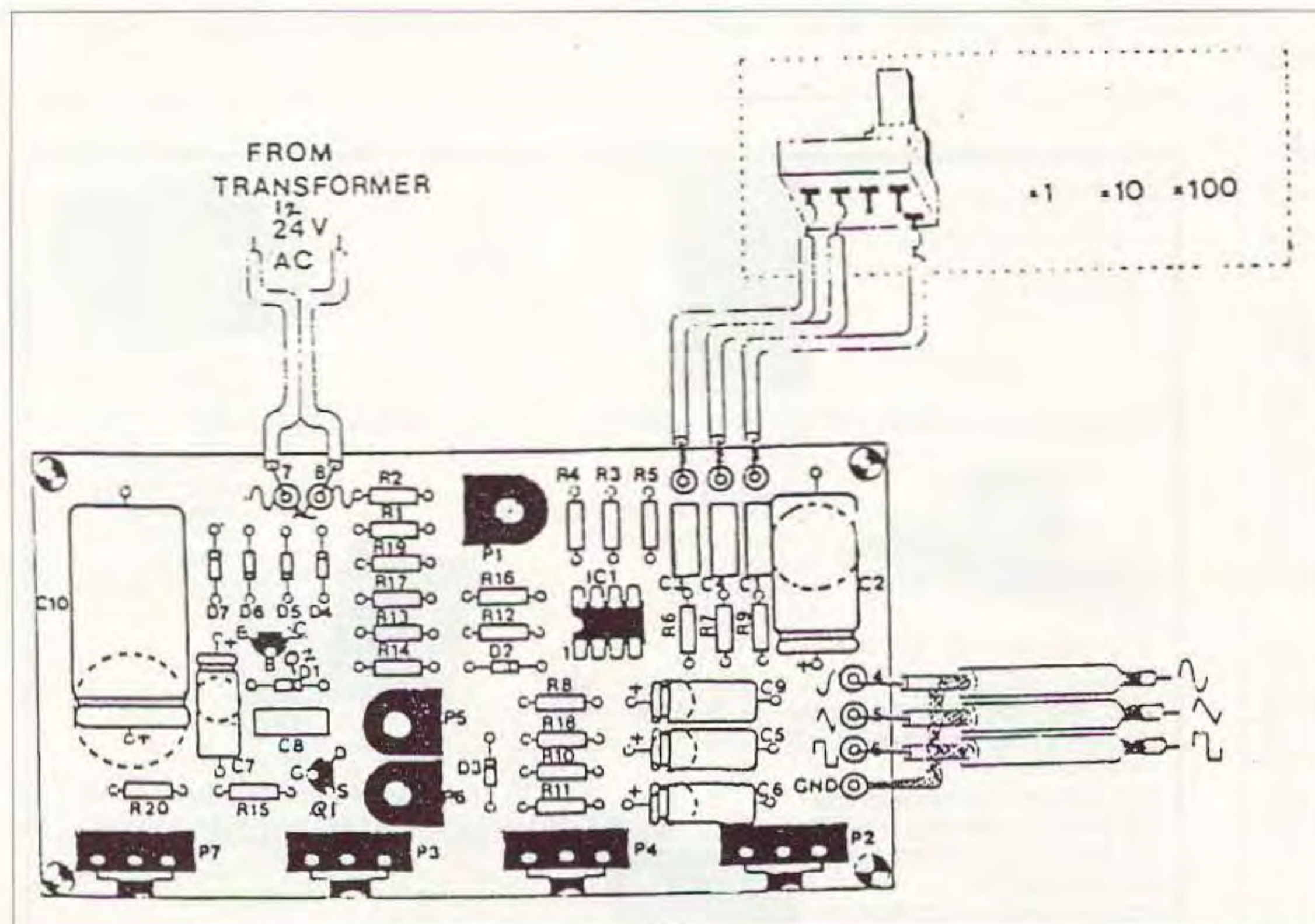


Fig. 3. Parts layout.

Technical Specifications	
Frequency Response 25–25,000 Hz in 3 ranges	
Range A	25–250 Hz
Range B	250–2500 Hz
Range C	2500–25,000 Hz
Distortion	0.5% max.
Output Voltage	
Sine & Triangular	4 V RMS (10 V PP)
Square wave	10 V RMS (16 V PP)
Output impedance @ 600 ohms	

Table 1. Technical specifications.

switch, and the output pins as we described above, and the function generator is ready for testing.

### Calibration

If you have an oscilloscope handy, connect the output of the generator to its input. Use a 12 V or a 24 V transformer to supply the generator with power, and adjust the trimpots to get the best possible waveshape on the screen. The potentiometer P1 should be adjusted first, till the square wave is perfectly adjusted for a 50-50% duty cycle. Then, by means of trimpots P5 and P6, you should adjust the waveshape of the sinusoidal waveform till it is symmetrical and as smoothly shaped as possible.

If you do not have an oscilloscope on hand and you only want to use the instrument as a general purpose audio generator, you will not be very wrong if you set the trimpots in their middle position. However, if you do so, distortion is likely to be higher and the instrument is no longer reliable for precision measurements.

### If it doesn't work

- Check your work for possible dry joints, bridges across adjacent tracks, or soldering flux residues that usually cause problems.

- Check again all the external connections to and from the circuit board to see if there is a mistake somewhere.

- See that there are no components

Parts List		
All resistors are 1/4 W 5% unless otherwise noted, values in ohms		
R1, R2	4.7k	
R3, R4, R7, R8, R16, R20	10k	
R5, R6	33k	
R9	390	
R10, R11, R17, R18	1.8k	
R12	27k	
R13	330k	
R14	270k	
R15	1 meg	
R19	560	
P1	1k	
P2	5k	linear pot (front panel)
P3, P4	10k	log pot (front panel)
P5	25k	trimpot
P6	10k	trimpot
P7	5k	log pot (front panel)
All capacitors are 50 W VDC unless otherwise noted, values in $\mu$ F		
C1	0.001 (1000 pF)	polyester or mylar
C2	100	25 V electrolytic
C3, C8	0.1	polyester or mylar
C4	0.01	polyester or mylar
C5-C7, C9	10	25 V electrolytic
C10	220	35 V electrolytic
C11	100	35 V electrolytic
C12	50	16 V electrolytic
C13*, C14*	100	25 V electrolytic
D1		1N4148 or 1N914
D2, D3	10 V 0.5 W	zener 1N961B, 1N5240B, 1N4740A
D4, D5		gen. purp. 1N4001, 1N914, 1N4148, 1N34, 1N270
D6*, D7*		same as above
IC1		dual op amp TL082, LF353
Q1		FET 2N3819, 2N3820, MPF-102
Q2		NPN 2N3903, 2N3904, 2N2222
Miscellaneous: PCB or perfboard, pins, IC socket, case, line fuse, xfmr, solder.		
*Note: Use C13, C14 with 12 VAC transformer. Use D6, D7 with 24 VAC transformer.		

Table 2. Parts list.