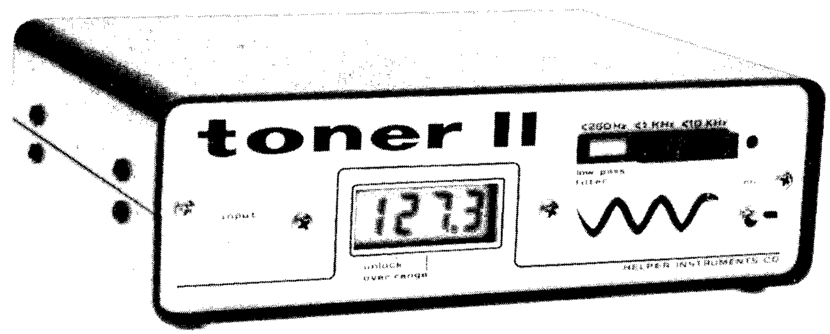
INSTRUCTION MANUAL

toner II™



HELPER INSTRUMENTS COMPANY

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TONER II™

SPECIFICATIONS:

FREQUENCY MEASUREMENT RANGE:	50 to 9,999 Hz in three ranges: 50 to 250 Hz, 50 to 999 Hz, 500 to 9,999 Hz.
ACCURACY AND RESOLUTION:	0.1 Hz for frequencies below 1,000 Hz 1.0 Hz for frequencies above 1,000 Hz
INPUT IMPEDANCE:	200,000 ohms in parallel with test cable capacitance.
INPUT VOLTAGE RANGE:	5 millivolts to 10 volts RMS automatically accommodated by AGC Amplifier voltages
INPUT FILTERING:	Six pole low pass filter on the 50 to 250 Hz scale reduces noise and speech interference for measuring CTCSS tones
INDICATION:	Four digit, LCD readout reads frequency directly in Hz
POWER REQUIREMENTS:	110/220 V, 220/240 V, 50/60 Hz, as chosen by transformer taps. Also operable from 12 VDC negative ground automotive supply
DIMENSIONS:	73 mm H x 225 mm W x 178 mm OD (2 7/8" H x 8 3/4" W x 6 7/8" OD)
WEIGHT:	5.7 kg (2.6 lb.)

General Description:

The TONER II is a specialized frequency counter for rapid measurement of frequencies from 50 Hz to 9,999 Hz.

Internal circuitry permits high resolution measurements to be made much faster than conventional counters. Frequencies below 1 KHz can be measured to resolutions of 0.1 Hz., with an updated readout every second. When switched to the range marked <250 Hz, a low pass filter is switched into the circuit. This facilitates the measurement of frequencies used for tone squelch systems (CTCSS) in the presence of voice and noise.

Operating Instructions

1. The TONER II™ can be operated from commercial A.C. power lines, or from a vehicular, 13.5 volt, D.C. negative grounded, battery system. Internal connections determine whether the instrument operates from 117 Volts or 240 Volts, 50/60 Hz. power supply. Before connecting your TONER II, be sure it has been connected for the voltage supply available in your country.

   The LED Indicator light, located just above the power switch indicates that the instrument power switch is "on", and that power is actually reaching the instrument.

2. Using a shielded lead, connect the signal to be measured to the BNC "input" jack on the TONER II front panel. Signal voltage may be between 5 millivolts and 10 volts.

   The shield side ("ground" connection) of the tone input lead is connected to the TONER II metal housing. The housing is also connected to the protective grounding wire of the three wire, grounding type power cord. When operated from A.C. power lines, therefore, you should realize that the shield side of the tone input lead is at ground potential.

   When the TONER II is operated from a 13.5 volt vehicular battery system, (negative ground) the shield side of the tone input lead is effectively connected to the negative battery potential, which is the same potential as the vehicle chassis.

3. For measurement of frequencies below 250 Hz, push the <250 Hz button. If the tone to be measured is below 1 KHz., but above 250 Hz., push the <1 KHz button. If the tone to be measured is between 1 KHz and 10 KHz, push the <10 KHz button.

4. The TONER II will provide a new readout once every second. Resolution of the readings is .1 Hz in the 250 Hz and 1 KHz ranges, 1 Hz in the 10 KHz range.

5. A decimal point will appear between the least significant (furthest right) and the next least significant digits when either the 250 range or the KHz range is used. This decimal point is properly located for direct reading of the LCD readout.

6. Decimal points on the display, marked "over range" and "unlock" will light if the count is greater than can be indicated by the readout, or if the internal frequency multiplying circuit is not locking properly.

Readings taken when either of these decimal points appear are not reliable.

An "unlock" condition can be caused by the following:

1. Frequency being measured too high or too low for the range chosen.
2. Insufficient voltage of the input signal being measured.
3. Presence of hum, noise, or interfering speech in the signal being measured.

When the signal to be measured is close to the minimum rating of the instrument (5 millivolts) special care must be taken to avoid long, unshielded, test leads. Ground loops between the case of the TONER II and the chassis being measured can also introduce enough power line hum to create an "out of lock" condition, and/or erratic readings. Strong R.F. fields in the vicinity of the counter may also cause erratic readings.

About Frequency Counters, Count Periods, Resolution and Errors.

Frequency counters are marvelous instruments. They have added great precision and ease to frequency measurements, but sometimes their apparently precise numerical readouts can mislead one into believing the counter is telling the exact truth.

First Count Errors

The first count obtained when the signal is connected is likely to be incorrect, because the signal may not have been present during the entire counting period. Thus, one should wait until the count repeats itself once or twice before accepting the result.

Last Digit Errors

An error of plus or minus 1 in the least significant digit (the number furthest to the right) is to be expected. A reading of 125.6 Hz from your counter could represent 125.5, 125.6, or 125.7 Hz. Similarly, even though a constant frequency signal is being received, this last digit may change up and down on subsequent counts. This plus or minus 1 count uncertainty in the right hand digit is to be expected on all of the counter ranges, and regardless of the count period.

The count uncertainty can result in changes in other digits also when the last digit is 0 or 9. Thus, when reading a 1 KHz tone one might find the count changing from 999 to 1,000 to 1,001.

Count Periods and Resolution

Some counters have a front panel switch that permits the operator to control the time the counter spends on making each "count". Typical counting periods are .1 seconds, 1 second and 10 seconds. These counting periods determine the resolution that can be obtained from the counter's readout. If we are measuring a 120 Hz tone using a counting period of 1 second, the counter might read 120 Hz. It might also (for reasons pointed out earlier) read 119 Hz, or 121 Hz. Thus, the reading has a resolution of 1 Hz (meaning that when the counter reads 120 Hz, we do not know whether the input tone is 119, 120, or 121 Hz, or something between these figures).

To measure the frequency to a greater precision, we could allow for the counter to count more cycles. This can be done by increasing the counting period to say ten seconds. Assuming that the input is exactly 120 Hz, the counter would then have time to count 1200 cycles of the tone, and the readout would ideally read 120.0 Hz. Since we still have the plus and minus one count uncertainty, the readout might be 119.9, or 120.0 or 120.1. The resolution is now .1 Hz, and we can depend upon the reading to give an answer within .1 Hz of reality.

The TONER II obtains a .1 Hz resolution in a different way. Instead of increasing the length of the counting period, it multiplies the frequency by a factor of 20, giving the counter 2400 cycles to count every second.

In the TONER II, a counting period of one half second is used, which gives a resolution of .1 Hz. This .1 Hz resolution is adequate for communication tone measurements, and the half second counting period permits the counter to deliver a new display of the count once every second.

On the 10,000 Hz scale, the incoming frequency is multiplied by a factor of two. With the half second counting period, the display gives a resolution of 1 Hz.

Tone Frequency Measurements Using Your FM Monitor or Your Modulation Monitor:

Most FM monitors have a "scope" output jack, or other provision to obtain a connection to the demodulated audio. This output is usually suitable as a source for signal to the TONER II.

In general, connection to the loudspeaker on an FM monitor will not be satisfactory as a takeoff point for measuring tone squelch frequencies. The coupling condenser feeding the speaker amplifier will usually be too small to carry the tone squelch frequencies without loss.

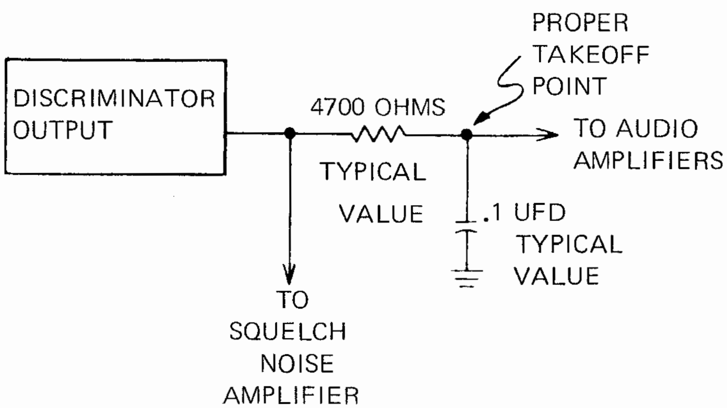
If the manufacturer does not provide a jack for connection to the demodulated audio, you can probably find a satisfactory point by referring to the circuit diagram of the equipment. The proper takeoff point is after the FM detector, preferably after the de-emphasis network. This is explained further in the following section.

Off-The-Air Tone Measurements:

The TONER II can be used for measuring tone frequencies off-the-air, using a monitor receiver.

Higher frequency tones can be satisfactorily measured by simply connecting a test lead between the "TONER II" input lead and the monitor receiver's loudspeaker.

Tone Squelch frequencies are greatly attenuated before they reach the loudspeakers, and it is better to make a special connection inside the receiver if off-the-air measurement of tone squelch frequencies is desired. The proper takeoff point for the connection is just after the audio de-emphasis network which usually follows the FM detector (discriminator). Since many monitors have similar circuits, the following diagram will help you locate this point:



You can check to see if you have picked a suitable point for the connection using your 'scope'. The TONER II needs at least 5 millivolts peak-to-peak of tone for reliable readings. Tune in a station using tone squelch. You can see the tone squelch during pauses in the speech. The amplitude of the tone squelch should be about 10% of the amplitude of the speech. Most monitor receivers will deliver far more tone level than the necessary minimum. While observing this point with your scope, check for any traces of 60 or 120 Hz hum. Some monitor receivers use skimpy filtering in their power supplies, and a little hum (which probably won't be noticed on the loudspeaker) can cause big problems in measuring tone squelch frequencies.

The connection as outlined above can also be used for the higher frequency tone systems.

When making tone squelch measurements off-the-air, the best accuracy will be obtained from strong, noise-free signals.

The <250 switch on the TONER should be used when possible since it has a 6 pole low pass filter that removes most of the higher frequency noise and speech.

Particularly when the talker on the station has a low pitched voice, the filter will not remove all traces of the speech, and the count will vary with the speech. Best accuracy is obtained by making the measurement when there is no speech modulation on the signal. The count may vary because of noise when a weak signal is being received. On weaker signals, the effects of noise can be averaged out, and a better count obtained if the cooperation of the station operator is obtained to get a few seconds of unmodulated signal.

Noise and Hum Errors

The accuracy of a count can be affected by noise and hum present in the incoming signal. The best way of assuring yourself that the count is accurate enough for your purposes is to be sure that it repeats itself several times at least to the number of significant digits you need for your measurement. Of course, you must expect the last digit to the right to vary by plus and minus one count.

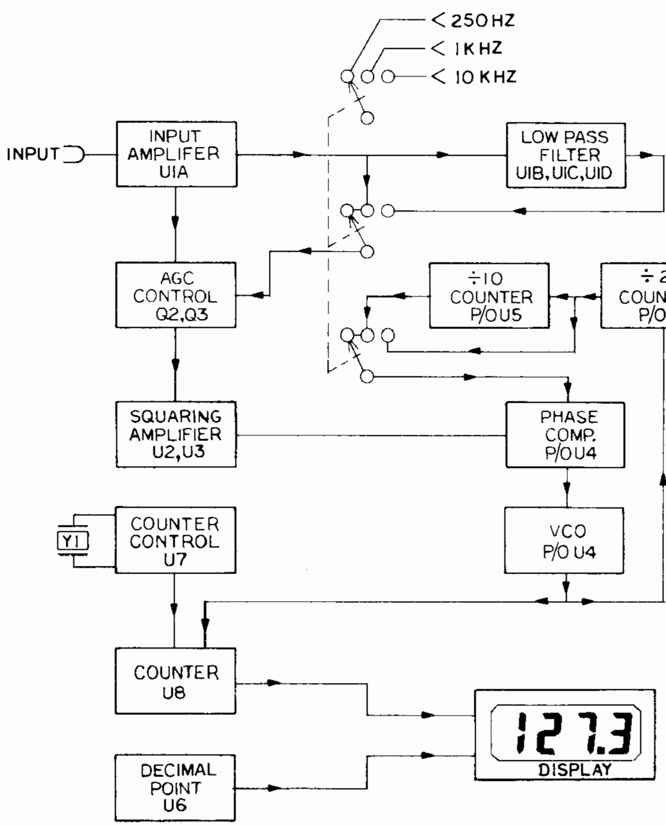
Measurement of CTCSS (Tone Squelch) Tones

One of the major uses of the TONER II is in the measurement of the tones used in Continuous Tone Controlled Squelch Systems. Accurate measurement of the tone frequency in a Tone Squelch system is essential for proper maintenance and adjustment. According to the EIA specifications for Tone Squelch systems, the Encoder frequency and the Decoder frequency should stay within .5% of the specified tone channel frequency, this means that for a system operating at 67 Hz, the permissible frequency tolerance is .335 Hz. For the 123.0 channel, this tolerance is .615 Hz. For the highest frequency channel, 250.3 Hz, the tolerance figures out to 1.25 Hz.

Many tone squelch systems, fail to work, or work erratically if any of the encoders or decoders deviate by amounts considerably less than the EIA specified .5%. Systems using reeds are particularly critical. Most of the problems in intermixing reed systems with the "all electronic" systems are caused by failure to keep the "electronic" units to the frequency accuracy demanded by the reed units.

In order to maintain tone systems so they will operate reliably, and to avoid the "mysterious" problems of intermittent tone operation, good practice dictates that tones be measured to an accuracy of at least plus or minus .2 Hz. Obtaining this accuracy with an ordinary frequency counter requires using the

10 second counting period. It goes without saying that a lot of time can be used up in waiting for the second count, then waiting until the counts repeat themselves. If you are trying to set an adjustable type tone, the procedure can be quite tedious. With the TONER II, tone squelch frequencies can be measured to the required accuracy in one or two seconds, using the TONER's "<250 Hz" position.



BLOCK DIAGRAM

Circuit Description

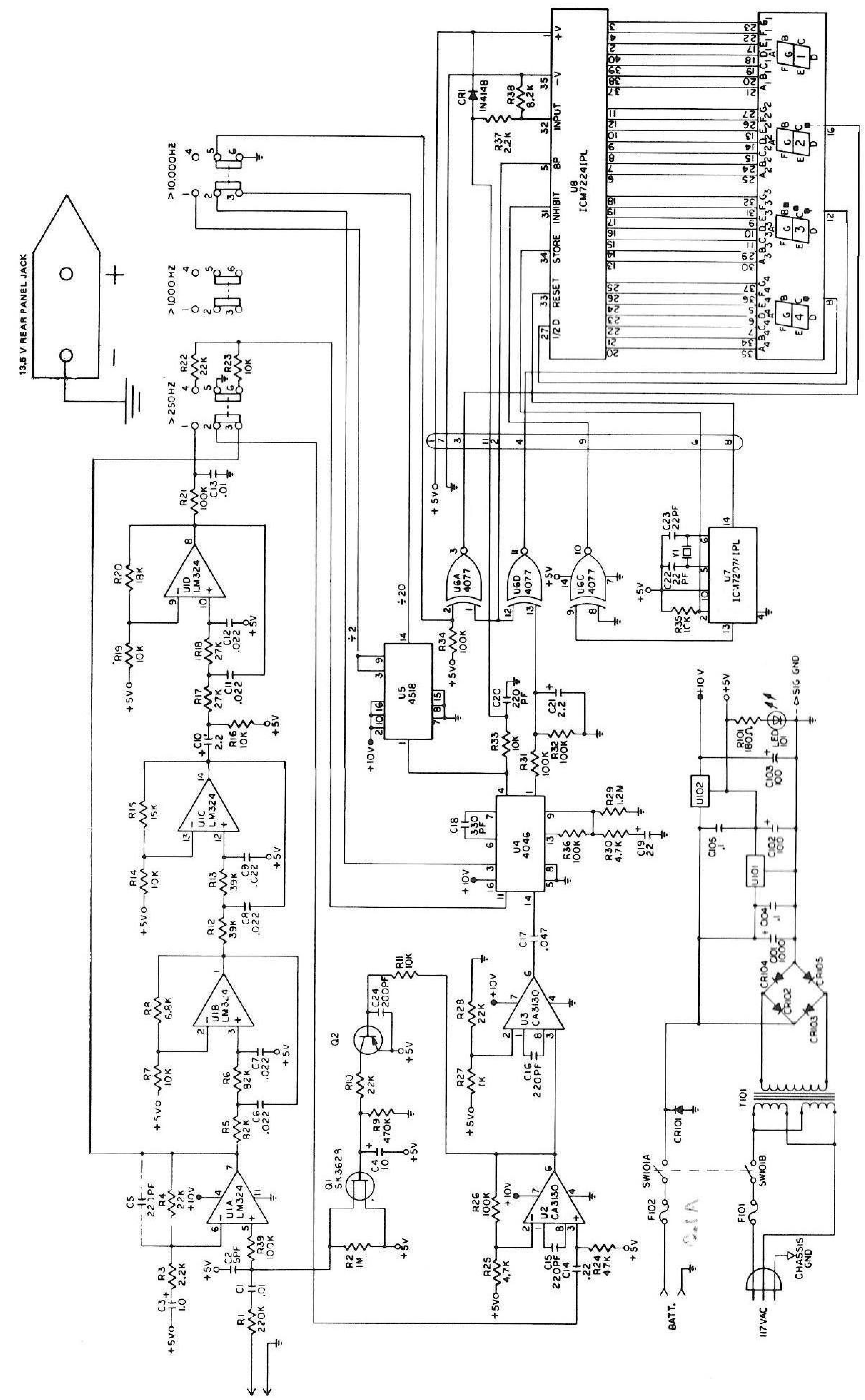
The input circuits of the TONER II are connected to the source of the tone frequency to be measured. The TONER II input circuits include an automatic gain controlled amplifier (UIA) that adjusts its gain automatically to accommodate input voltages from 5 millivolts to 10 volts RMS. Since this range of voltage is greater than normally encountered in tone measurement work, no manual attenuator or threshold control is required.

When the function switch labled "<10 KHz" is pushed in, the incoming tone signal is amplified by the input amplifier (UIA) in the TONER, then further amplified and limited by the squaring amplifier (U2, U3). The output of the squaring amplifier is a square wave, having the same frequency as the input tone signal, and this square wave is fed into one of the inputs of the phase comparator (U4). The phase comparator controls the frequency of the Voltage Controlled Oscillator, (part of U4) (VCO). The output of the VCO is fed back into the other input of the phase comparator. The action of the phase comparator and the VCO is such that the output of the VCO becomes locked to a frequency exactly 2 times the frequency of the input tone signal. This VCO output is then delivered to the counting section. Although the counting section is actually counting a signal that is two times the frequency of the input tone signal, the counting period is only one half of a second. Thus, the display reads the value of the input tone signal.

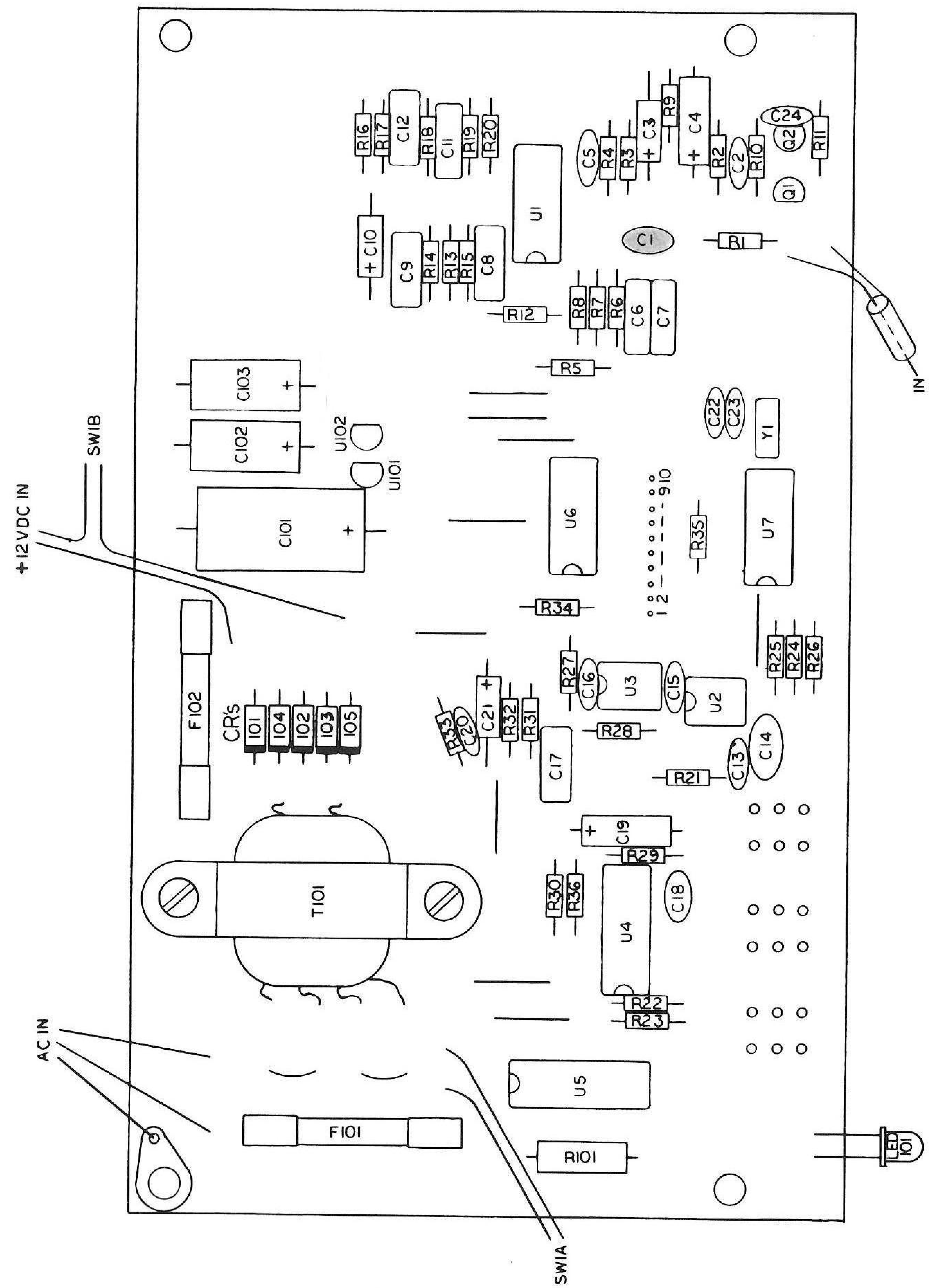
When the function switch labled <IKH$_2$ or the function switch labled <250 Hz is pushed in, a divide-by-ten counter (part of U5) is connected in cascade with the divide-by-two counter. The action of the phase comparator then causes the VCO to be locked to a frequency exactly 20 times the frequency of the incoming tone signal.

In addition to the change in multiplication, these function switches also light a decimal point on the display, so that the number displayed on the liquid crystal readout is the actual tone frequency.

When the function switch labled <250 Hz is pushed in, a 6 pole low pass filter (U4B, U4C, U4D) is connected between the input amplifier and the squaring amplifier. This filter cuts off sharply at about 300 Hz, and is used to remove noise and speech components when frequencies below 250 Hz are being measured.



CIRCUIT DIAGRAM



COMPONENT PLACEMENT