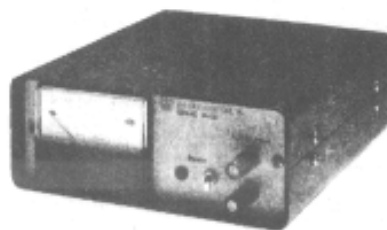
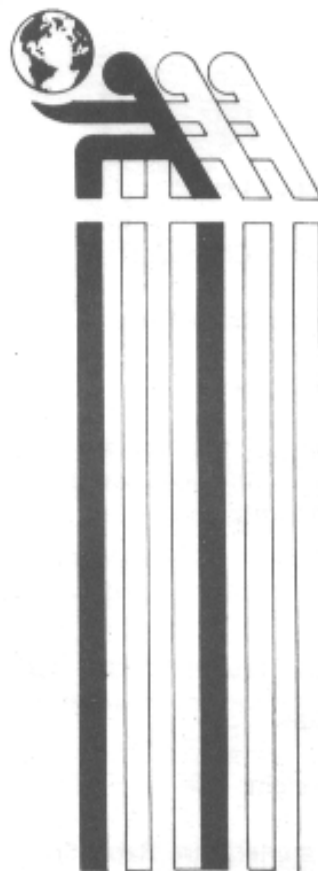


 **MOTOROLA**  
test equipment

# SINAD METER



R - 1013A

68-81069A81

## SPECIFICATIONS

### R-1013 A SINAD Meter

Input Level:	40 millivolts to 10 volts RMS
Input Connector:	Six way binding posts
Input Impedance:	100K OHM in parallel with 50 pf
Accuracy:	$\pm 1$ DB
Power:	115VAC/230VAC $\pm 20\%$ , 50-60 Hz Strap Selectable 13.8 VDC $\pm 20\%$ On-Off Switch with LED Indicator
Size:	7" x 7-3/16" x 2-3/4"
Weight:	2.75 LBS (1.25 Kg)
Temperature Range:	0 <sup>o</sup> C to + 45 <sup>o</sup> C (Operating) -10 <sup>o</sup> C to + 55 <sup>o</sup> C (With Accuracy Degradation to $\pm 2$ DB) -40 <sup>o</sup> C to + 85 <sup>o</sup> C (Storage)

## SINAD METER R-1013A



### General Description

The SINAD meter is a specialized distortion meter for making SINAD measurements on radio receivers. Special circuit design speeds and simplifies the SINAD measurement by eliminating all distortion meter adjustments.

The null circuits of the SINAD meter are internally set to the 1000 Hz tone used in SINAD measurements, and an automatic gain control eliminates the need for setting input gain to the meter.

The automatic gain control feature permits the SINAD meter to be used as a receiver alignment tool, providing rapid alignment of receivers for optimum performance.

### Circuit Description

A block diagram of the SINAD meter is given in figure 1. The input circuits of the SINAD meter are connected to the audio output circuits of the receiver being tested. The signal appearing at the input to the SINAD meter consists of the wanted 1,000 Hz "Signal" frequency, and other frequencies representing the noise and distortion created in the receiver. This composite Signal, Noise, and Distortion signal is amplified by two cascaded AGC amplifiers. The output of the second AGC amplifier is a replica of the input signal, but is at a constant average level, regardless of input signal level changes from 40 millivolts to 10.0 volts RMS.

The composite, constant level signal, is then fed into a 1,000 Hz band reject filter, which removes the 1,000 Hz "Signal" component, leaving only the Noise and Distortion components. These components are amplified and rectified by a precision average value rectifier circuit and then used to drive the indicator meter. Since the input signal to the reject filter is held constant, the meter can be directly calibrated in SINAD values.

Normally the SINAD meter is connected to the loudspeaker terminals of the receiver under test. The 10.0 volts RMS maximum input will accommodate audio power levels up to 31.2 watts into a 3.2 ohm speaker. Since 10.0 volts RMS amounts to 28 volts peak-to-peak, levels greater than this voltage are not expected in radios operating from 12 volts supplies. On the low side, the 40 millivolts RMS permits the connection to be made as early in the circuit as the discriminator output. For absolute SINAD measurements the connection must be made after the de-emphasis circuit, but connections ahead of the de-emphasis circuit will give meaningful relative readings.

## **Operating Instructions**

If you are not familiar with SINAD measurements be sure to read the section "A few words about SINAD" beginning on page 4.

Before using the SINAD meter with a specific signal generator, check the 1000Hz modulating tone of the generator to be certain it is accurate enough to fall in the center of the SINAD Meter's null circuit —  $1000\text{Hz} \pm 5\text{Hz}$ . If the generator makes the modulating signal available on an output jack, simply connect it to the SINAD meter test leads, and see if the SINAD meter indicator goes into the black portion at the left of the scale. If the modulating frequency is not within the  $1000\text{Hz} \pm 5\text{Hz}$  spec, it must be re-adjusted to ensure accurate SINAD readings. Some signal generators have a front panel dial for adjusting the modulating signal frequency; in these cases, tune it for minimum indication on the SINAD meter and mark the spot on the dial for future reference.

The Motorola R-1200A series service monitor and R-1201A series signal generator have an internal 1000Hz modulating tone that is accurate to within  $\pm 0.1\text{Hz}$ . To obtain the best possible SINAD measurement with an accurate sensitivity correlation the usage of one of these two generators is highly recommended.

To make a SINAD measurement: Connect the leads from the SINAD meter to the loudspeaker output of the receiver, with the black lead going to the speaker ground terminal. Connect the signal generator to the receiver and set its modulation and frequency as shown in figure 2. That's all there is to it; the SINAD meter is now measuring SINAD for you.

Turn the signal generator up to a strong, noise free signal, if the receiver has low distortion, and if the generator and receiver agree on channel frequency, the SINAD meter indicator will swing into the black area at the left of the meter scale. Removing the signal from the receiver, and setting the squelch control to let the set roar, the SINAD meter indicator will swing into the black area at the right of the meter scale. To determine the 12 dB SINAD sensitivity of the receiver, adjust the signal generator output attenuator until the SINAD meter indicates 12 dB. The microvolts output of the signal generator is the 12 dB SINAD sensitivity of the receiver.

## Using the SINAD Meter for Receiver Alignment

Improvements in receiver sensitivity by a few dB are possible just by touching up the front end alignment adjustments, using the SINAD meter as an indicator of optimum performance.

Set the signal generator level so the SINAD meter reads about 12 dB. Then adjust the various front end adjustments to make the meter swing as far to the left as you can. If you get below the 20 mark, reduce signal generator output to bring the meter reading back to about 12 dB. Even if a receiver has been accurately aligned using the traditional limiter meter methods, this touch-up of the front end section will typically gain an improvement in sensitivity.

If realignment is needed on a receiver for which an instruction manual is unavailable, the following method is recommended. Set the signal generator to about the 12 dB SINAD meter reading, and tweak away at the alignment screws. Do not move any adjustment very far from its original setting. Use caution for sets with AFC circuits. If the realignment doesn't leave the AFC voltage properly centered, the receiver may "rest" off to one side of the channel.

## A few words about SINAD Measurements

The term SINAD is an abbreviation for the following ratio:

$$\frac{\text{Signal plus Noise and Distortion}}{\text{Noise plus Distortion}}$$

The signal level at which a receiver produces a 12 dB SINAD ratio is referred to as the 12 dB SINAD sensitivity of the receiver. In practice, a 12 dB SINAD signal is a reasonably intelligible and useful signal for speech transmission.

Since a SINAD measurement gives a more meaningful measure of a receiver's useful sensitivity than is obtained by other methods, it has become the preferred method of specifying and measuring receiver sensitivity in FM receivers used in land mobile and marine services.

The exact method of measuring 12 dB SINAD sensitivity is given in the Electronic Industries Association's Standard #RS-204-A, which is quoted here:

"A 1000 microvolt test signal from a standard input signal source with standard test modulation shall be connected to the receiver antenna input terminals. A standard output load and distortion meter incorporating a 1000 hertz band elimination filter shall be connected to the receiver audio output terminals. The receiver volume control (low level) shall be adjusted to give rated audio output. The standard input signal level shall be reduced until the SINAD is 12 dB. At this value of signal input, the audio output shall be at least 50% of the rated audio output without readjustment of the volume control. If the audio output is less than 50% of the rated audio output, the input signal level shall be increased until 50% of full rated audio output is obtained, and this value of input signal level shall be used in specifying sensitivity.

NOTE: A receiver with more than one volume control shall be adjusted utilizing a control preceding the audio power amplifier."

Standard RS-204-A specifies that the receiver shall be operated into a resistive load equivalent to the load into which the receiver normally operates. It also specifies standard test modulation as being 60% of the peak modulation used. (3 KHz peak for typical communications systems using 5 KHz maximum peak modulation.)

Since the SINAD definition includes the distortion created by the receiver's audio output stage, a precise measurement of SINAD should be made at the rated audio output. However, in Motorola products designed with low distortion amplifiers, an approximate SINAD measurement can be made with the audio output merely set at a comfortable listening level, using the loudspeaker of the receiver as the audio load.

NOTE: SINAD should not be measured with audio output levels exceeding the maximum rated audio spec of the particular receiver under test.

## **About Accuracy**

For a precise determination of the ratio implied by the SINAD definition, the measurement circuits of the distortion meter should measure the RMS values of the composite signal, noise, and distortion waves. However, almost all commercially available distortion meters are based upon average measuring, but RMS calibrated, metering circuits. At the low distortion and noise percentages involved in the typical 12 dB SINAD measurements, the error created by the use of average metering circuits instead of RMS metering circuits is negligible. The metering circuits of the SINAD meter are average measuring in nature, to provide optimum correlation with commonly used distortion meters.

The width of the null in commercial distortion meters varies considerably from one model to another. While this will not create any discrepancy in simple distortion measurements, the width of the null will affect readings on noise measurements. Therefore perfect correlation between SINAD indications may not be obtained between different model distortion meters, although they agree perfectly on ordinary distortion measurements.

Although different model distortion meters may give slightly different SINAD readings on the same composite signal, the SINAD method of measuring receiver sensitivity is remarkably precise. This is because the 12 dB SINAD performance of a typical FM receiver falls in a place on the FM improvement curve where a small percentage change in incoming signal will create a large change in SINAD reading. Thus, distortion meters differing by two or three dB in their SINAD reading will result in 12 dB SINAD sensitivity measurements which correlate to better than 1 dB. 12 dB SINAD sensitivity measurements made with the SINAD meter will correlate within 1 dB to the sensitivity measurements obtained by the use of the most popular distortion meters.

## Calibration Checks:

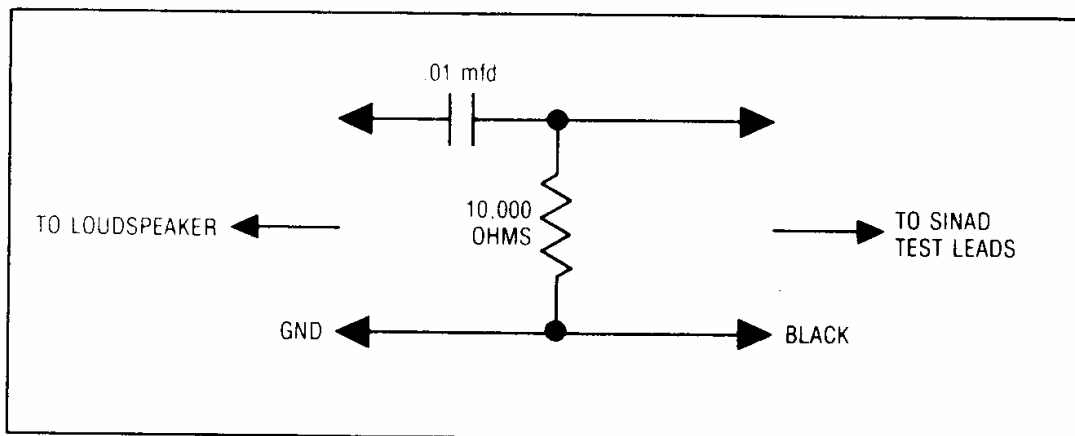
The following procedure can be used to check the calibration of the SINAD meter:

Connect the SINAD meter input leads to a 2000 Hz audio source. The SINAD meter indicator should go to the black area to the right of the scale, and should stay there as the voltage of the audio source is varied from 40 millivolts to 10.0 volts RMS. If not, adjust R45 to set the meter to the right edge of the black segment with the input signal set at about 1 volt. Connect the SINAD meter input leads to a 1000 Hz source. This source must be accurate to within 5 Hz. Adjust the source to 1 volt RMS output. The SINAD meter indicator should go into the black portion at the left of the scale. If not, adjust R32 and R33 for minimum meter deflection.

## About that Meter Flicker

The flickering of the meter pointer is caused by the statistical nature of the noise in the receiver output. Since this flickering is a basic fact the only way to reduce it (and still make a true SINAD measurement) would be to slow down the meter response time. This response is, in fact, slowed down by the circuit, but further slowing would result in an annoying lag between an adjustment on the radio and resulting meter indication.

When the SINAD meter is used as a receiver alignment aid, the amount of flicker can be greatly reduced by the use of an auxiliary filter circuit, connected between the loudspeaker terminals and the SINAD meter test leads. This filter circuit reduces the lower frequency noise components, which contribute most of the flicker. When the circuit is in use, however, the SINAD meter calibration should be considered only relative, and the circuit should be removed for any quantitative measurements. This method, although given, is not recommended.



Auxiliary Filter Circuit

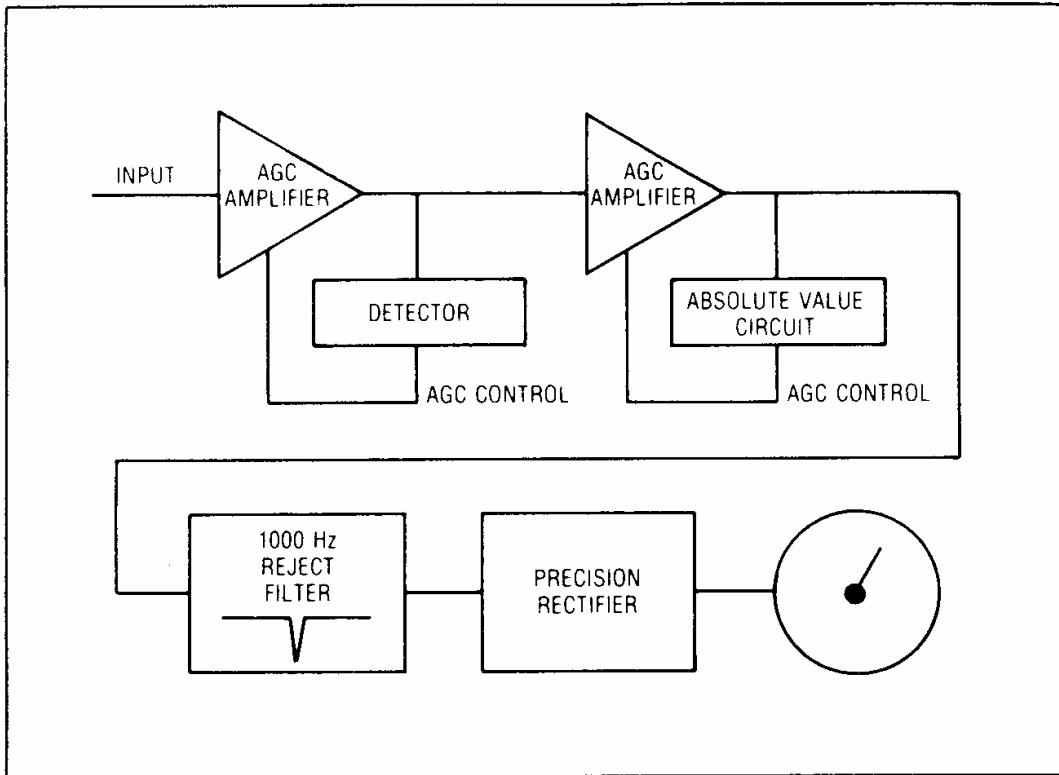


Figure 1. SINAD Meter Block Diagram

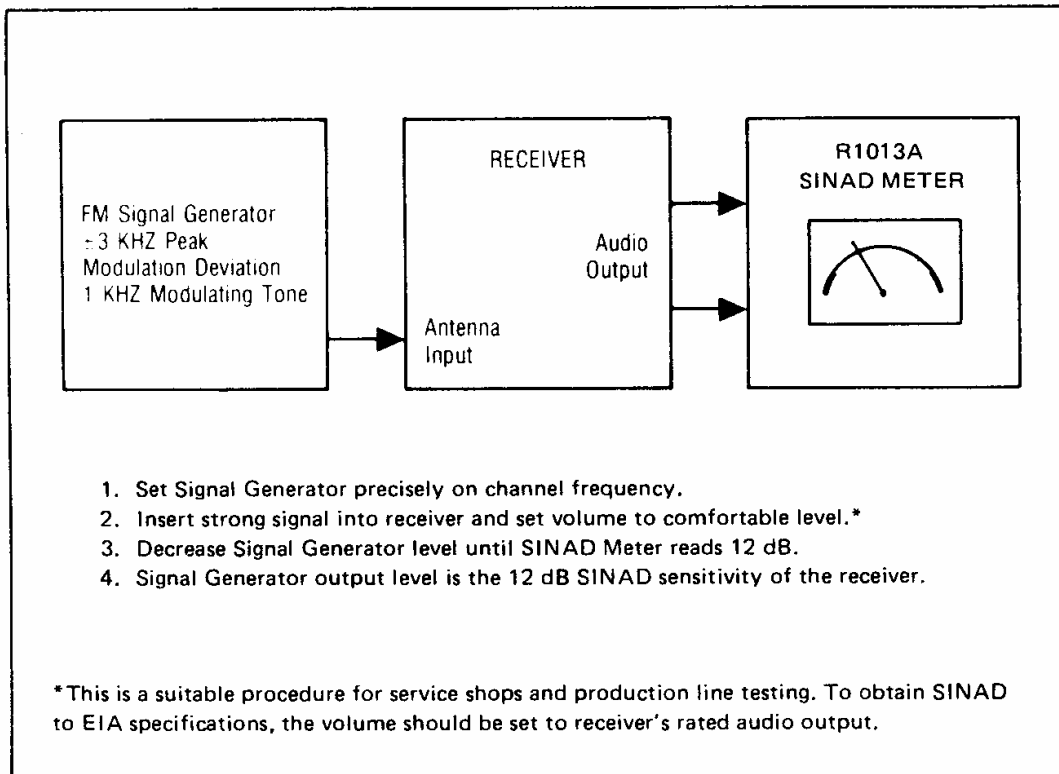
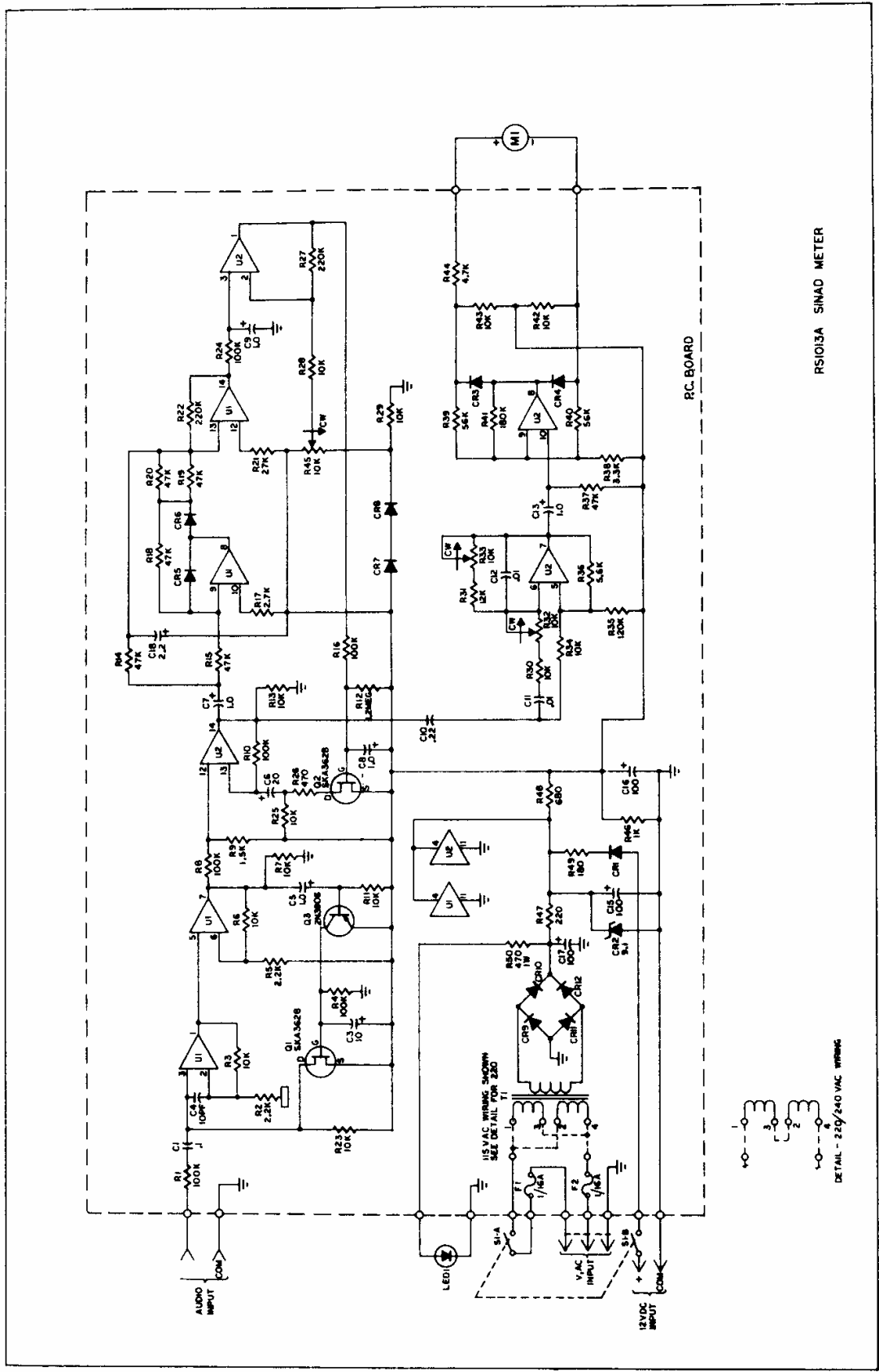


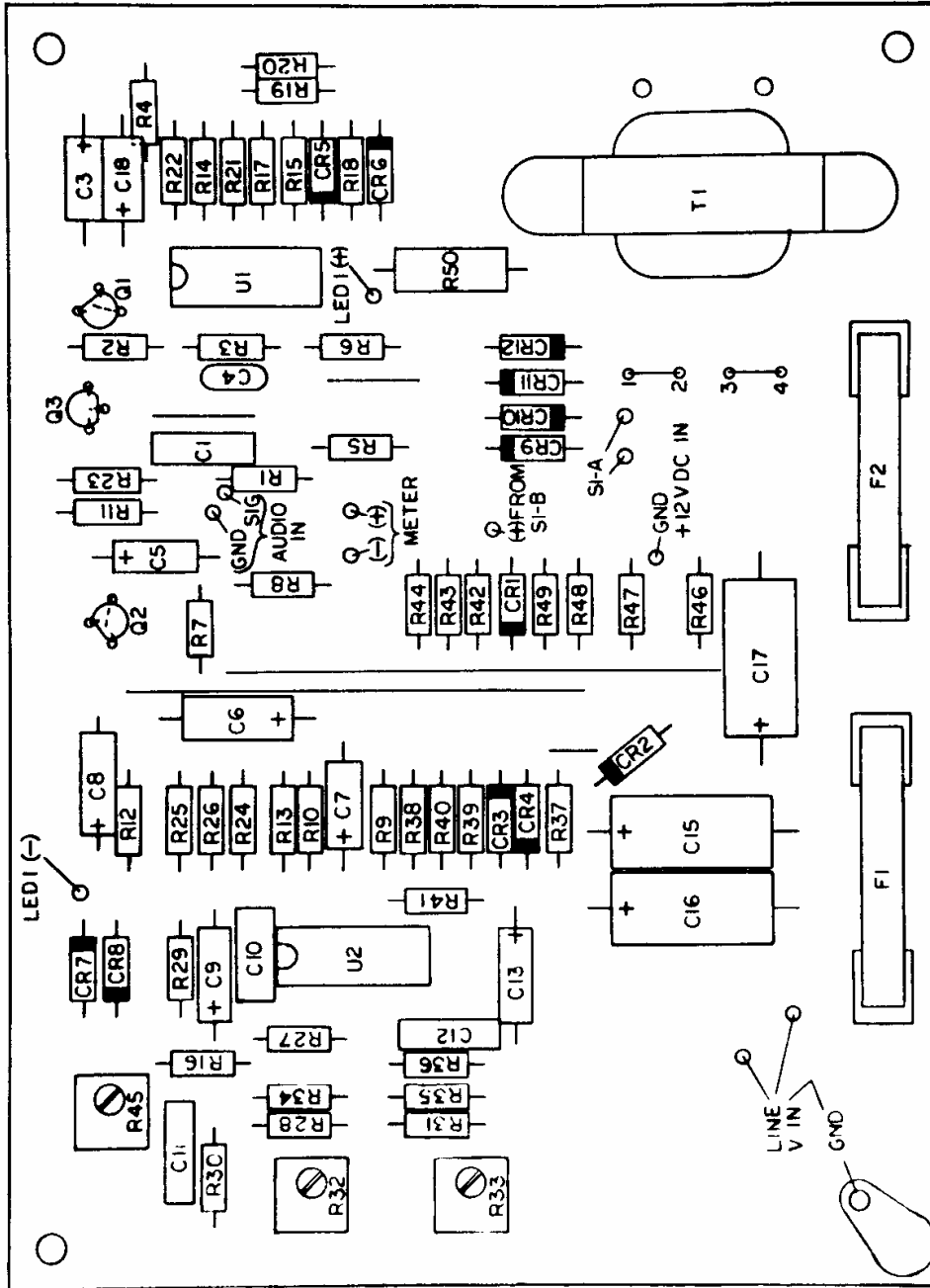
Figure 2.





RS1013A SINAD METER

115V AC WIRING SHOWN  
SEE DETAIL FOR 220  
DETAIL - 220/240 VAC WIRING



JUMPER PTS. 1 TO 2 AND 3 TO 4 FOR 115 VAC,  
 FOR 220 VAC REMOVE 115 VAC JUMPERS AND  
 JUMPER PTS. 2 TO 3

SINAD METER PARTS LIST

REFERENCE	PARTS #	DESCRIPTION
	64-80332A24	Front Panel (Screened)
	64-80332A25	Rear Panel (Screened)
	7-80332A26	Side Bracket (Pair)
	15-80332A27	Top Cover (Painted)
	15-80332A28	Bottom Cover (Painted)
	75-83247K01	Rubber Foot
M-1	72-80332A29	Meter (D B SINAD)
S-1A, S-1B	40-84204D70	Switch
T-1	25-80332A30	Transformer
U-1, U-2	51-80332A31	LM348 Integrated Circuit
Q-1, Q-2	48-80332A32	SK3628 FET
Q-3	48-83358H10	2N3906 Transistor
CR-1, 3-12	48-82466H03	1N4002 Diode
CR-2	48-82256C18	9.1V Zener Diode
C11, C12	8-80332A33	.01 Mylar Cap. (Matched)
C1	8-82905G24	.1 Mylar Cap.
C10	8-82095G17	.22 Mylar Cap.
C4	21-847088	10 pf Cap.
C5, 7, 8, 9, 13	23-80332A35	1 uf - 25V Cap.
C18	23-80332A36	2.2 uf - 25V Cap.
C3	23-868502	10 uf - 25V Cap.
C6	23-80332A37	22 uf - 25V Cap.
C15, 16, 17	23-80332A38	100 uf - 25V Cap.
R49	6-124A17	47 ohm $\frac{1}{4}$ W 5% Res.
R47	6-124A32	220 ohm $\frac{1}{4}$ W 5% Res.
R26	6-124A41	470 " " " "
R48	6-124A45	680 " " " "
R46	6-124A49	1K " " " "
R9	6-124A53	1.5K " " " "
R2, 5	6-124A57	2.2K " " " "
R17	6-124A59	2.7K " " " "
R38	6-124A61	3.3K " " " "
R44	6-124A65	4.7K " " " "
R36	6-124A67	5.6K " " " "
R7, 11, 13, 23, 25, 28, 29, 30, 34, 42, 43	6-124A73	10K " " " "
R31	6-124A75	12K " " " "
R3, 6	6-124A81	22K " " " "
R21	6-124A83	27K " " " "
R14, 15, 18, 19, 20, 37	6-124A89	47K " " " "
R39, 40	6-124A91	56K " " " "
R1, 4, 8, 10, 16, 24	6-124A97	100K " " " "
R35	6-124A99	120K " " " "
R41	6-124B04	180K " " " "
R22, 27	6-124B06	220K " " " "
R12	6-124B24	1.2 Meg. " " "
R32, 33, 45	18-80332A39	10K ohm Trimmer Pot
R50	6-126C41	470 ohm 1W 10% Res.
F1, 2	65-61668	Fuse 1/16 Amp
	30-82494J03	Power Cord
LED-1	48-88245C05	MV5054-1 LED
P-1		Socket, 12V input
P-2	46-863925	6-Way post, red
P-3	46-863924	6-Way post, black
	3-129605	#6/32 x 1/4 selftap screw
	3-80311A24	#6/32 x 3/8 phil pan screw
	3-80332A40	#6/32 x 3/8 black inhex screw
	2-7005	#6/32 nut
	4-7669	#6 int. tooth lockwasher
	29-867964	#10 lug, 20 G wire
		#8 lug
	68-81069A81	Manual