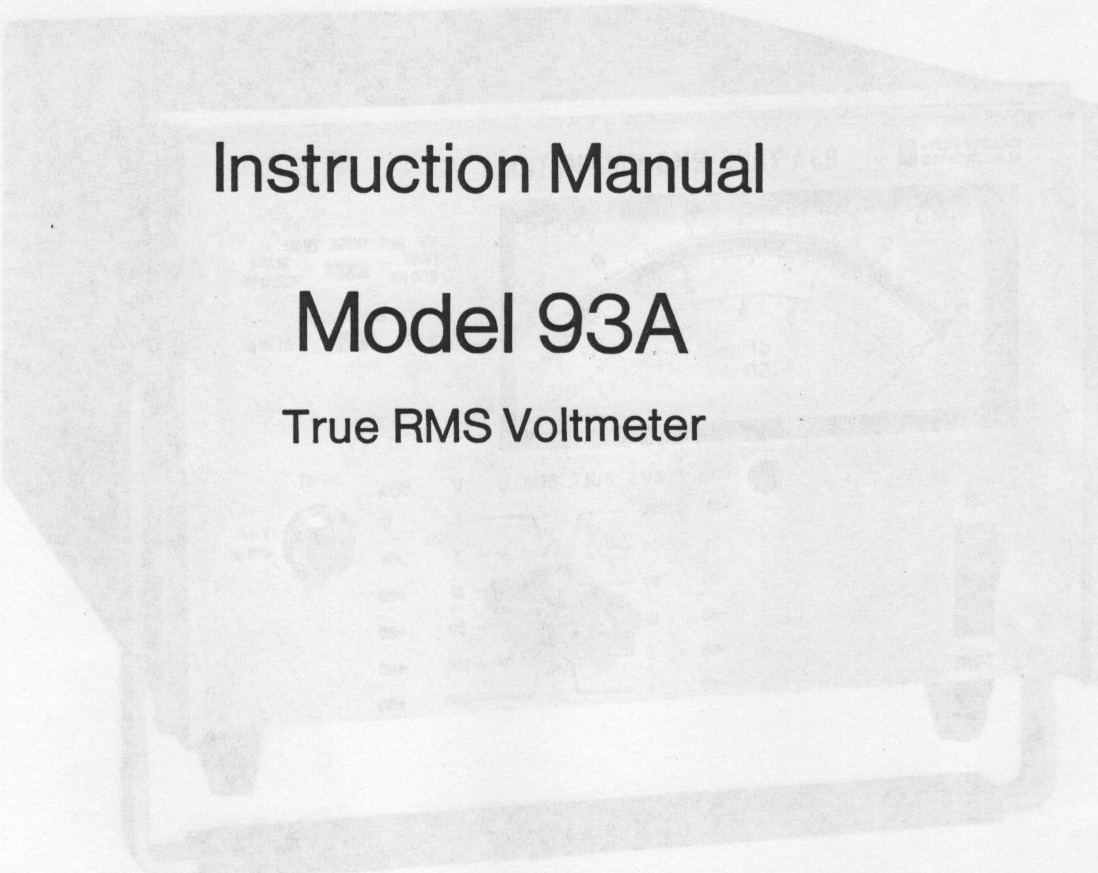
Instruction Manual

Model 93A

True RMS Voltmeter



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Model 93A True RMS Voltmeter

ADDENDUM

MODEL 93A

Table 4.2 should be replaced with the following:

TABLE 4.2 MIDBAND ACCURACY CHECK

SIGNAL LEVEL	MODEL 93A RANGE	MODEL 93A INDICATION	RECORDER OUTPUT
1.000 mV	1 mV	0.991 - 1.009 mV	9.95 - 10.05 V
3.000 mV	3 mV	2.973 - 3.027 mV	9.42 - 9.55 V
10.00 mV	10 mV	9.91 - 10.09 mV	9.95 - 10.05 V
30.00 mV	30 mV	29.73 - 30.27 mV	9.42 - 9.55 V
100.0 mV	100 mV	99.1 - 100.9 mV	9.95 - 10.05 V
300.0 mV	300 mV	297.3 - 302.7 mV	9.42 - 9.55 V
1.000 V	1 V	0.991 - 1.009 V	9.95 - 10.05 V
3.000 V	3 V	2.973 - 3.027 V	9.42 - 9.55 V
10.00 V	10 V	9.91 - 10.09 V	9.95 - 10.05 V
30.00 V	30 V	29.73 - 30.27 V	9.42 - 9.55 V
100.0 V	100 V	99.1 - 100.9 V	9.95 - 10.05 V
100.0 V	300 V	297.3 - 302.7 V	3.10 - 3.22 V
1.000 V	1 V	0.991 - 1.009 V	9.95 - 10.05 V
0.900 V	1 V	0.891 - 0.909 V	8.95 - 9.05 V
0.800 V	1 V	0.791 - 0.809 V	7.96 - 8.04 V
0.700 V	1 V	0.691 - 0.709 V	6.96 - 7.04 V
0.600 V	1 V	0.591 - 0.609 V	5.97 - 6.03 V
0.500 V	1 V	0.491 - 0.509 V	4.97 - 5.03 V
0.400 V	1 V	0.3928- 0.4072V	3.97 - 4.03 V
0.300 V	1 V	0.2946- 0.3054V	2.96 - 3.04 V
0.300 V	300 mV	0.2973- 0.3027V	9.42 - 9.55 V
0.200 V	300 mV	0.1973- 0.2027V	6.26 - 6.39 V
0.100 V	300 mV	0.0982- 0.1018V	3.10 - 3.22 V

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CHAPTER I

Equipment Description

1.1 INTRODUCTION

The Model 93A furnishes true rms voltage measurements of sine, complex, pulse and random waveforms over a voltage range of 300 µV to 300 V, and a frequency range of 10 Hz to 20 MHz. It is designed for easy integration into external test systems; an analog output is furnished, supplying up to 10 volts dc for full-scale reading on each range with a linearity of ±0.3% of fs and a source resistance of ≅ 5 Ω, and command inputs are provided for remote control of all essential functions.

Bandwidth and response time of the instrument are both selectable, by panel switches and remotely, to suit the measurement requirements. The input impedance of the 93A as supplied is 2 MΩ in parallel with 25 pF or less; a high-impedance probe (Model 93-1A) is available as an optional accessory. This probe has an input impedance of 10 MΩ in parallel with 11.5 pF or less. The signal-input BNC connector, normally mounted on the front panel, may be mounted on the rear panel as an option (Model 93A-08) to fit a particular installation.

The Model 93A is of completely solid-state design, including the chopper; this contributes to the reliability, stability, light weight and compact size of the instrument. The chopper operates at 94 Hz, reducing the susceptibility to line-frequency-related fields and enhancing the low-noise quality of this design.

The mechanical design of the 93A is simple and rugged, with easy access provided to all components. The extensive use of plug-in printed circuit board construction makes maintenance and adjustment relatively simple procedures. The sturdy bail provided serves as a comfortable carrying handle for the instrument, and as an adjustable mounting foot to tilt the case for easy viewing when it is at bench level.

Packaged in a compact half-rack case, the 93A may be rack-mounted, singly or in pairs, with an optional rack-mounting kit Model 92-1A or 92-1B.

1.2 SPECIFICATIONS

1.2.1 Range

	Voltage fs	dBm 1 mW, 600 Ω
1-	300 V	+50
2-	100 V	+40
3-	30 V	+30
4-	10 V	+20
5-	3 V	+10
6-	1 V	0
7-	300 mV	-10
8-	100 mV	-20
9-	30 mV	-30
10-	10 mV	-40
11-	3 mV	-50
12-	1 mV	-60

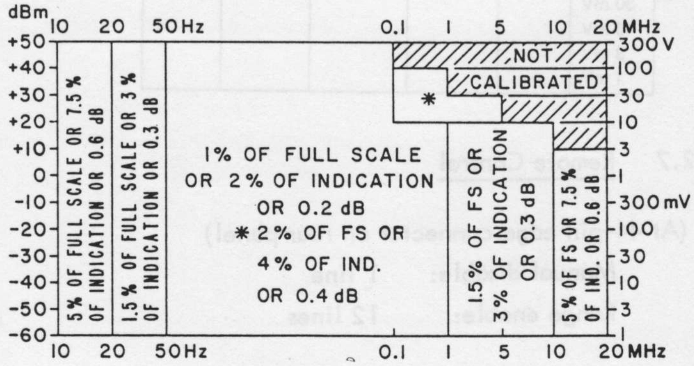
Lowest calibrated voltage = 300 µV
Lowest measurable voltage = 100 µV
Lowest detectable voltage = 70 µV

1.2.2 Bandwidths

10 Hz to 20 MHz
10 Hz to 100 kHz
(3 dB points, 3 Hz and 30 MHz, or 1 MHz)

1.2.3 Accuracy (at reference conditions)

Use % fs or % Ind., whichever is more accurate.
dB specifications apply to dB scale only.



.2.4 Stability

Reference conditions:

Line voltage:	115V - 120V
Line frequency:	50 Hz - 400 Hz
Warm-up period:	1 hour
Temperature	21 °C to 25 °C

Warm-up Time: Useable after 2 minutes:
0.3% drift after 1 hour.

Effect of ±10% line voltage change:
≤ 0.2% of indication

.2.5 Meter

Mirror-backed, knife-edge pointer, linear analog meter; voltage scales, 0 - 10 and 0 - 3; dBm scale -10 to +3 (ref. 1 mW into 600 Ω).

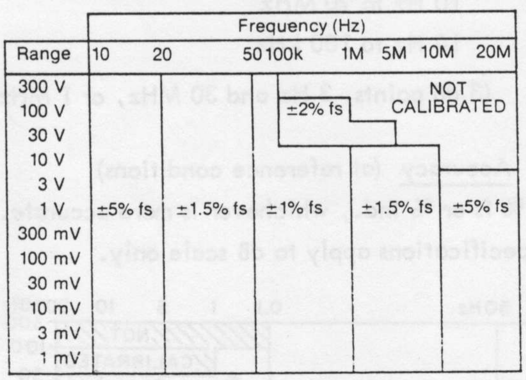
.2.6 Analog Output

Amplitude: +10V fs on "1" ranges;
+9.5V fs on "3" ranges (+10V for 3.16)

Function: linear with input voltage over a 10 dB range from fs

Source Resistance: Approx. 5 ohms. 1 mA max. loading for specified accuracy

Accuracy:



1.2.7 Remote Control

(At 44-pin edge connector on rear panel)

Manual disable:	1 line
Range enable:	12 lines
Response time:	1 line
Bandwidth:	1 line

Above commanded with logic low (0 to 0.7 V) referred to ground.

1.2.8 Input

Connector: BNC type, signal low at case ground.

Impedance: 2 MΩ, ≤ 25 pF. (See p.3)

Equivalent noise: < 35 μV.

Swinging: (60 Hz, 120 Hz, 180 Hz)
≤ +0.5% fs; ≤ +1.0% at 1/3 scale.

1.2.9 Response

Type: rms, calibrated in rms.

Crest factor: 6 at full scale;
18 at 1/3 scale.

Waveform: Sine, complex, pulse or random.

1.2.10 Response Time

Response Time	*Up Scale	*Down Scale
Fast > 200 Hz	1.5 Sec.	2.5 Sec.
Slow < 200 Hz	4 Sec.	6 Sec.

*Approximate time to arrive within ±1% of final indication.

1.2.11 Overload Recovery

Response Time	Overload at fs	Time*
Fast (> 200 Hz)	20 dB	5 sec.
"	40 dB	7 sec.
"	60 dB	9 sec.
"	80 dB	9 sec.
"	100 dB	9 sec.
Slow (< 200 Hz)	20 dB	5 sec.
"	40 dB	8 sec.
"	60 dB	10 sec.
"	80 dB	10 sec.
"	100 dB	10 sec.

*To within ±1% of final indication

1.2.12 Temperature Influence

Temperature Range		Influence
Reference	21°C to 25°C	0
Normal	18°C to 30°C	0.03%/°C of Indication
Severe	0°C to 50°C	0.04%/°C of Indication

1.2.13 Maximum Input

AC: 350 V at all frequencies for fs ranges 100 mV and higher; for all other ranges, 350 V up to 1 kHz reduced to 30 V at 20 MHz.

DC: 500 V all ranges.

1.2.14 Power Requirements

115 or 230 volts ±10%, 50 to 400 Hz.

1.2.15 Options and Accessories

Model 93-1A	High-impedance probe accessory. Input impedance is 10 MΩ, ≤ 11.5 pF; attenuation 10X.
Model 92-1A	Rack-mounting kit, single
Model 92-1B	Rack-mounting kit, dual
* Model 93A-08	Rear signal-input option
Model 93A-09	50Ω dBm display (-50 to +60 dBm)
Model 93A-10	75Ω dBm display (-50 to +60 dBm)

* Input capacitance is 45 pF with the rear signal-input option instrument.

1.2.16 Mechanical Specifications

Dimensions

5.2" high (without rubber feet), 8.3" wide, 12.5" deep (132 x 211 x 318 mm)

Weight

9.8 pounds net (4.4 kg)

TABLE 2.1

OPERATING CONTROLS AND INDICATORS

ITEM	FUNCTION
POWER ON Switch	Two-position rocker switch.
FULL Scale Switch	This 12-position rotary switch selects the desired range. Full-scale ranges from 1 mV to 300 V, and dBm ranges are available.
RESPONSE TIME Switch	This adjusts the response time of the instrument to suit the frequency of the signal being measured. For frequencies below 200 Hz the switch must be in the SLOW position; for frequencies higher than 200 Hz, the switch can be in either position.
BANDWIDTH Switch	This restricts the instrument's bandwidth to the range 10 Hz to 20 MHz in one position, and to 10 Hz to 100 kHz in the other position. Unless the high frequency range is required, it is adviseable to leave this in the 100 kHz position.
INPUT Connector	A BNC connector to accept the probe cable connector or signal input.
(The following items are on the rear panel)	
RECORDER Terminals	The dc analog voltage output is available at these terminals for connection to external systems. (Also available at the rear edge-connector.)
Line Voltage Switch	This slide switch changes the power transformer primary from 115 to 230 volts. The voltage selected appears in the center of the switch slide.
Fuse Holder	Contains the line fuse for the instrument; either an 0.10 A or an 0.20 A fuse, depending on the line voltage, is used. The proper fuse value is indicated by the position of the line voltage switch.
Edge Connector	All external control lines and outputs are available at this 44-pin connector. Mating connector recommended is an Amphenol 225-22221-101.

1.2.12 Temperature Influence

Temperature Range		Influence
Reference	21°C to 25°C	0
Normal	18°C to 30°C	0.03%/°C of Indication
Severe	0°C to 50°C	0.04%/°C of Indication

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Operation

2.1 INSTALLATION

The Model 93A has been inspected and tested at the factory for compliance with specifications before packing, and is shipped ready for operation. If there is any indication of shipping damage to the instrument, notify the carrier and the factory immediately.

2.2 EQUIPMENT OPERATION

2.2.1 See that the voltage selector switch on the rear panel is set to the correct value for the line voltage available, and that the proper fuse is in the fuse holder. Plug the power cable into a receptacle, turn the MODE switch to MANUAL, and allow the instrument to warm up for a few minutes.

2.2.2 Attach the input cable to the INPUT connector. Because of possible unwanted pickup from strong external fields, it is usually best to use coaxial or shielded cable for this, terminated, of course, in a BNC connector. When measurements are going to be made primarily at low frequencies, and it is desired to use wire leads rather than coaxial cable, a BNC-to-binding post adapter may be used here. These are available from several sources; a representative type would be the Pomona Electronics No. 1296.

2.2.3 Set the RESPONSE TIME switch to the position appropriate for the frequency being measured. (FAST for frequencies higher than 200 Hz, SLOW for those lower.) The effect of the SLOW response is to reduce the influence of noise, hum, and other extraneous factors. When measuring high-frequency signals with these unwanted components, it is helpful to use the SLOW position also, unless a fast response is wanted.

2.2.4 Set the BANDWIDTH switch to the desired position - 0.1 MHz or 20 MHz. It should be noted that, although a low-frequency signal can be measured with the switch in the 20 MHz position, using the 0.1 MHz position will help to filter out unwanted high-frequency components that may degrade the measurement.

2.2.5 Set the FULL SCALE range switch to the expected range and apply the signal voltage to the input.

2.3 OPERATING NOTES

2.3.1 AC Signal with DC Component

The Model 93A responds only to the ac component of a waveform. If it is necessary to include the dc component present in the signal, this dc should be measured separately with a dc voltmeter. After measuring the ac component with the 93A, the true rms value may be computed from:

$$E_{rms} = (E_{dc}^2 + E_{ac}^2)^{1/2}$$

The dc component is blocked by an input capacitor with a maximum rating of 500 volts. If a dc component of higher value is present, an external blocking capacitor with a suitable rating must be connected externally in series with the high input terminal, with a 20 MΩ resistor connected from the high terminal to ground. This capacitor must be at least 0.1 μF if it is desired to measure to the lowest specified frequency (10 Hz).

2.3.2 Effect of Crest Factor

The 93A has a crest factor (ratio of peak to rms amplitude) capability of 6 at full scale, increasing proportionally to 18 at 1/3 scale. This may be expressed as:

$$CF = \frac{6}{K}$$

where K = fraction of fs indication

2.3.3 Measurement of Complex Waveforms

The 93A measures the true rms value of complex waveforms independently of the phase relationship of the harmonics, provided that they lie within the instrument's frequency range. Harmonics falling outside this range can cause an error, which is a function of the relative energy of these harmonics and of the relative response of the instrument at these frequencies.

Although the calibrated range of the 93A is from 10 Hz to 20 MHz, response actually extends beyond these limits. To compute the rms value of a voltage when the rms magnitudes of its components are known (which would include these out-band harmonics) the following equation may be used:

$$E_{rms} = (E_1^{\,2} + E_2^{\,2} + E_3^{\,2} \, . \; . \; . \; E_n^{\,2})^{1/2}$$

where E_{rms} = rms amplitude of complex waveform

E E_1 = rms amplitude of the fundamental;

E_n = rms amplitude of n^{th} harmonic.

2.3.4 Measurement of RMS Current

The voltage drop caused by current flowing through a resistor can be measured with the Model 93A, and the rms value of the current computed. Precision low-inductance resistors must be used in this application; disk or coaxial types are recommended. The crest factor is the same as that for voltage measurements.

2.3.5 Possible Sources of Error

A common cause of error in low-level measurements is ground currents - currents of signal, power or other frequency flowing in a common lead impedance. This current flow results in a voltage, in addition to the desired voltage, appearing at the input terminal. Some of the methods for reducing or eliminating the effects of ground currents are:

a. A low-capacitance, high-resistance isolation transformer in the power-line leads. This is most effective in eliminating power and other low-frequency ground current loops.

b. Using coaxial signal leads, and keeping them as short as possible.

c. Making all known ground impedances as low as possible.

Another cause of error, which is apparent at high frequencies with long lengths of coaxial cable for signal connection, is a relatively high standing-wave ratio on the cable. This is best handled by using a matched system to operate the cable as a flat line.

A third possible source of error is the presence of strong magnetic or electrostatic fields, either around the leads or near the instrument. Shielding and/or spacing is usually effective in reducing this type of error.

2.3.6 High-Impedance Probe Accessory

The Model 93-1A High-Impedance Probe increases the input impedance to 10 MΩ, $\leq$ 11.5 pF, and introduces a 10X attenuation factor. When used with the instrument with which it was calibrated, the probe introduces an additional uncertainty of <1% to specified accuracy. It is important that the frequency/voltage limits below are observed:

Frequency	Peak Voltage (dc + ac)
10 Hz - 6 MHz	500
6 MHz - 7 MHz	400
7 MHz - 10 MHz	300
10 MHz - 20 MHz	150

CHAPTER III

Circuit Description

3.1 GENERAL

The basic circuitry of the Model 93A is shown in the Block Diagram (below). The major elements are the attenuator, the wide-band amplifier, mean-square detector, chopper, linear detector, square-root amplifier, and indicator circuits.

3.1.1 The ac input signal is passed through the blocking capacitor to the input attenuator and then to the wide-band amplifier. A diode protective circuit across the amplifier input limits the input voltage to a safe value; the instrument is protected up to at least 350 volts rms to 1 kHz on the three lowest ranges. The amplifier provides a gain of 5 across the band of 10 Hz to more than 20 MHz; its output appears across the output attenuator. The input attenuator has 0, 40, and 80 dB steps, the output attenuator has 0, 10, 20 and 30 dB steps. The two sections, controlled by the range switching circuits, are connected in various combinations to yield a total attenuation range of 0 to 110 dB in 10 dB steps.

Both attenuator sections are of the resistance-capacitance type, using high-stability components. At low frequencies the attenuation ratio is determined by the resistors; at the higher frequencies, by the capacitors. The crossover from resistive to capacitive attenuation occurs at about 25 kHz.

3.1.2 The signal voltage from the wide-band amplifier and output attenuator enters the mean-square detector. This detector converts the input ac signal to a balanced dc signal whose amplitude corresponds to the mean value of the square of the input voltage. The RESPONSE TIME switch on the instrument panel controls the time constants of this detector circuit to provide fast or slow response time as needed.

3.1.3 From the mean-square detector the balanced dc signal goes to the chopper; this solid-state modulator converts the dc to a 94 Hz square wave ac signal which then goes to the following amplifier. The frequency of 94 Hz is used to reduce the effects of power-supply primary line frequencies, and to eliminate any dependence upon the line frequency for operation. This enables the instrument to operate on any of the standard power-line frequencies between 50 and 400 Hz.

3.1.4 The modulated signal from the chopper goes to the 94 Hz amplifier, with a voltage gain of 10^4. Broadly tuned to the chopper frequency, this amplifier reduces much of the wide-band noise which may be present.

3.1.5 The ac signal from the 94 Hz amplifier is rectified in the linear detector and passes, via the buffer amplifier, to the square-root amplifier. This is a non-linear shaping amplifier whose output is proportional to the square root of the input voltage ($E_o = KE^{1/2}$). The dc output of this amplifier appears at the RECORDER terminals on the rear panel, and goes as well to the panel meter and edge connector.

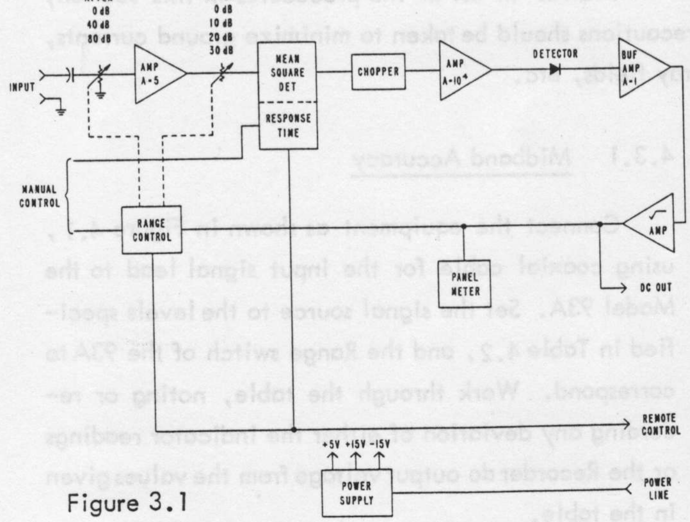


Figure 3.1

Maintenance

4.1 INTRODUCTION

The Model 93A is designed conservatively, and in normal usage should deliver good performance for long periods of time. However, as with any instrument of comparable accuracy and performance, it is advisable to check its calibration at regular intervals to ensure that the specified accuracy is maintained. This section contains the necessary information to make performance checks, adjustments when needed, and to perform trouble-shooting and servicing. Complete schematic drawings are to be found at the back of this manual, and should be referred to when servicing is performed.

4.2 TEST EQUIPMENT REQUIRED

The test equipment needed to check and maintain the instrument is listed in Table 4.1. Comparable equipment with equal or better specifications may be substituted for any of the items listed.

4.3 PERFORMANCE CHECKS

Before starting the performance check procedures, allow the Model 93A and the test equipment required to warm up for at least one hour. If the 93A has been inoperative for a long period, or has been stored under ambient conditions substantially different from 25°C and 50% RH, allow a longer warm up period.

NOTE: In all of the procedures in this section, precautions should be taken to minimize ground currents, stray fields, etc.

4.3.1 Midband Accuracy

Connect the equipment as shown in Figure 4.1, using coaxial cable for the input signal lead to the Model 93A. Set the signal source to the levels specified in Table 4.2, and the Range switch of the 93A to correspond. Work through the table, noting or recording any deviation of either the indicator readings or the Recorder dc output voltage from the values given in the table.

4.3.2 dBm Accuracy Check (93A, 93A-09, 93A-10)

Connect the equipment as shown in Figure 4.1. Set the signal source to the levels noted in Table 4.3; the dBm indications of the 93A should fall within the limits shown in the table.

4.3.3 High Frequency Response

NOTE: Before checking the high frequency response of the Model 93A, the midband accuracy should be verified as outlined in Section 4.3.1.

a. Connect the equipment as shown in Figure 4.2A. The dc blocking capacitor should be a high quality, low leakage type, of 10 µF or greater.

b. Table 4.4 gives the value of radial resistor vs. signal level and thermocouple current for the micropotentiometer used as the input signal level monitor. The micropotentiometer should be connected as closely as possible to the input of the Model 93A, and coaxial cables and connectors should be used for all ac signal leads.

c. To check the 1 mV range, set the signal source frequency to 1 kHz and advance the amplitude control until an indication of 1.000 mV is obtained on the 93A. Allow the micropotentiometer to stabilize and note the indication on the differential voltmeter. Successively set the frequency to 10 kHz, 100 kHz, 1 MHz, 2 MHz, 3 MHz, 5 MHz, 7 MHz, 10 MHz, and 20 MHz, adjusting the signal amplitude each time to give the same indication on the differential dc voltmeter as at 1 kHz. At each frequency, note the indication of the Model 93A. These indications should be in accordance with the limits specified in Table 4.5.

d. Follow the same procedure for the 10 mV through 100 mV ranges, using the appropriate micropotentiometer (Table 4.4).

TABLE 4.1 TEST EQUIPMENT

INSTRUMENT	CHARACTERISTICS	MODEL
AC Voltage Standard	100 µV to 300 V 1 kHz 0.1% Accuracy	Ballantine Labs Model 421A
DC Digital Voltmeter	1 V fs to 15 V 4 1/2 Digits 0.05% Accuracy	Fluke Model 8100A
Wide band Signal Source	10 Hz to 20 MHz 10 V RMS Output	Exact Model 7230
Oscilloscope	dc to 10 MHz y axis 50mV/div. x axis 1ms-10ms/div.	Tektronix Model 531
Micropotentiometer	dc to 20 MHz 1 mV to 100 mV	Ballantine Labs Model 440
High frequency Transfer Voltmeter	dc to 20 MHz 1 V to 10 V	Ballantine Labs Model 1394 - 394
Precision DC Source	0 V to ±10 V Rs ≅ 2 Ω 0.01% accuracy	Fluke Model 341
Differential dc voltmeter	100 µV full scale Null sensitivity	Fluke Model 881AB
Board Extender		Boonton Electronics Model 92-6A
Frequency Counter	5 Hz to 40 MHz	Monsanto Model 1003

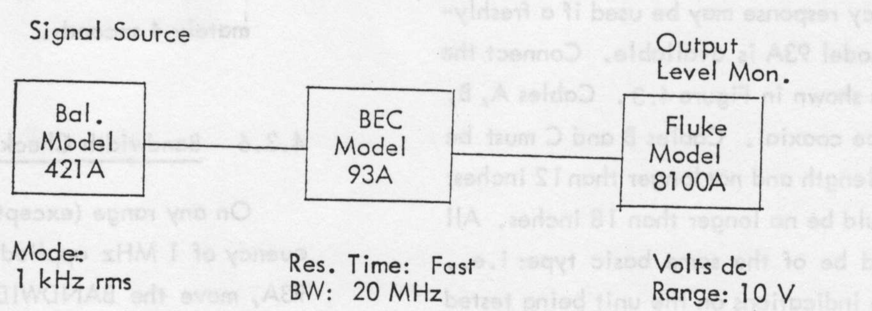


Figure 4.1. Midband Accuracy Checks

e. For the 300 mV through 10 V ranges, connect the equipment as shown in Figure 4.2B. The transfer probe should be connected as closely as possible to the input of the Model 93A; coaxial cables and connectors must be used for this. Table 4.5a lists the transfer probes to be used for each range.

f. To check the 300 mV range, set the signal source to 1 kHz and advance the signal amplitude to provide an indication of 300 mV on the Model 93A. Note the indication on the transfer voltmeter. Successively set the frequency to 10 kHz, 100 kHz, 1 MHz, 2 MHz, 3 MHz, 5 MHz, 7 MHz, 10 MHz and 20 MHz, adjusting the signal amplitude to provide the same indication on the transfer voltmeter as at 1 kHz. At each frequency, note the indication on the Model 93A; these indications should be within the limits specified in Table 4.5.

g. The highest range shown in Table 4.5 is the 10 V range. Special equipment is required to provide a source for higher levels at higher frequencies. However, for this application since all the attenuators, amplifiers, etc., used on the 30 V, 100 V and 300 V ranges have been checked when the ranges shown on Table 4.5 have been checked, it can be assumed that, if the instrument performance is within limits on the 1 mV through 10 V ranges, it will be within specified limits at the higher levels also.

h. A simpler and faster means of checking the high frequency response may be used if a freshly-calibrated Model 93A is available. Connect the equipment as shown in Figure 4.3. Cables A, B, and C must be coaxial. Cables B and C must be identical in length and not longer than 12 inches; Cable A should be no longer than 18 inches. All cables should be of the same basic type: i.e., RG58U. The indications on the unit being tested are compared with those of the unit serving as the standard.

4.3.4 Low Frequency Response

Before checking the low frequency performance of the Model 93A, the midband accuracy should be established as outlined in Section 4.3.1.

Connect the equipment as shown in Figure 4.4. Set the signal amplitude and range to 1 V, and the frequency to 1 kHz. Set the Model 93A RESPONSE TIME to SLOW. Adjust the signal amplitude until an indication of 1.000 V is obtained on the Model 93A, and note the indication on the level monitor. Set the signal frequency to 200 Hz, 70 Hz, 50 Hz, 30 Hz, 20 Hz and 10 Hz, adjusting the signal amplitude at each frequency to give the same indication on the level monitor as at 1 kHz. At each frequency, note the indication of the Model 93A. These indications should be within the limits specified in Table 4.6.

4.3.5 Response Time Check

a. On any range, apply a 1 kHz signal of 1/3 full-scale with the RESPONSE TIME switch set to FAST. Step the input signal level to full scale and note the time required for the indication to arrive at the full-scale reading. This time should be approximately 1 second.

b. Repeat this procedure with the RESPONSE TIME switch set to SLOW. The time required to arrive at the full-scale level should be approximately 4 seconds.

4.3.6 Bandwidth Check

On any range (except 300 V), with a signal frequency of 1 MHz applied to the input of the Model 93A, move the BANDWIDTH switch from 20 MHz to 0.1 MHz, and note the decrease in output indication. This should be approximately 30%, or 3 dB.

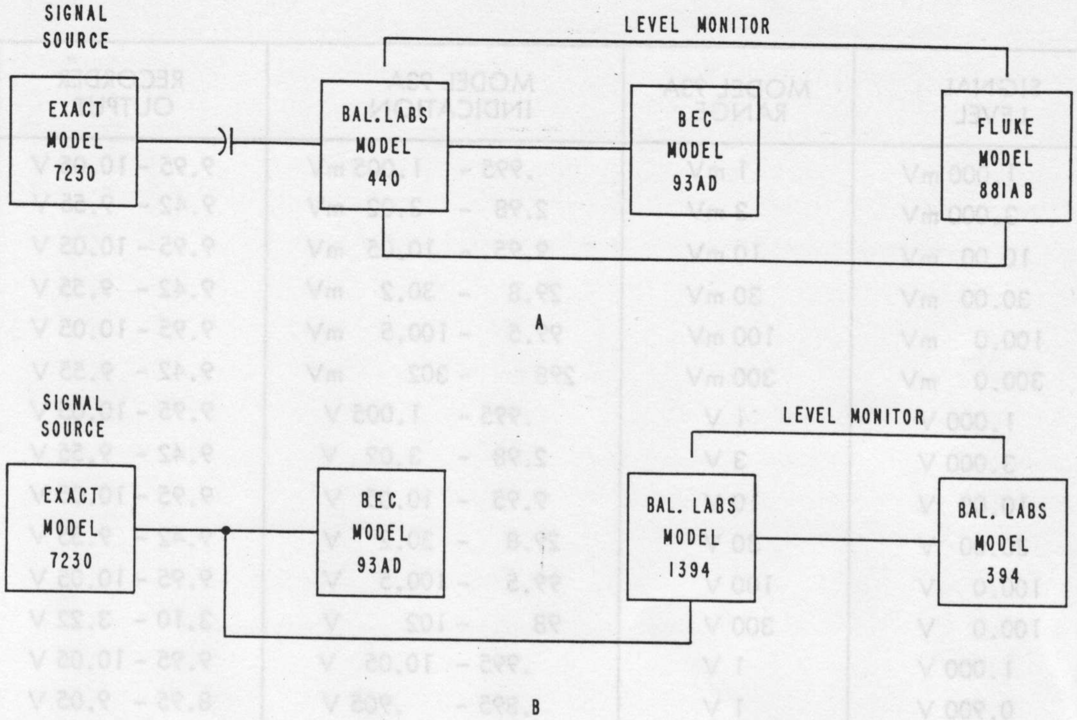


Figure 4.2 High Frequency Checks.

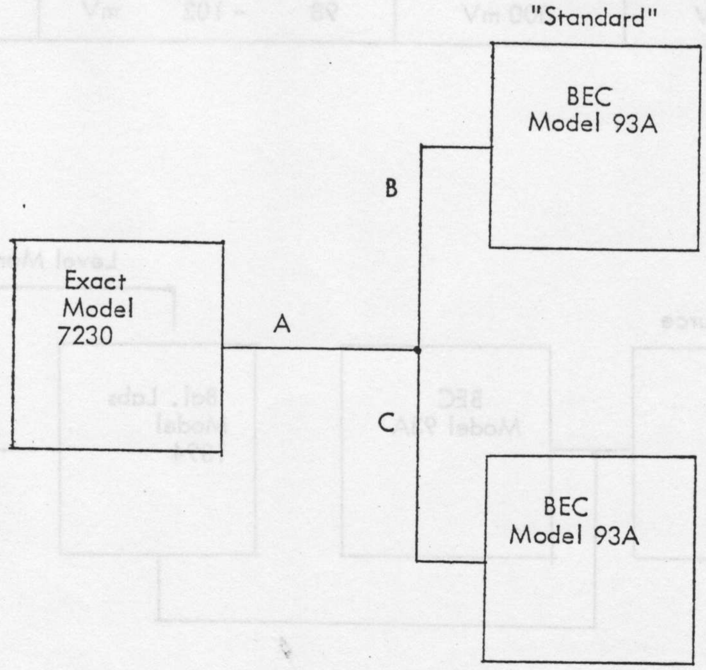


Figure 4.3. High Frequency Check

TABLE 4.2 MIDBAND ACCURACY CHECK

SIGNAL LEVEL	MODEL 93A RANGE	MODEL 93A INDICATION	RECORDER OUTPUT
1.000 mV	1 mV	.995 - 1.005 mV	9.95 - 10.05 V
3.000 mV	3 mV	2.98 - 3.02 mV	9.42 - 9.55 V
10.00 mV	10 mV	9.95 - 10.05 mV	9.95 - 10.05 V
30.00 mV	30 mV	29.8 - 30.2 mV	9.42 - 9.55 V
100.0 mV	100 mV	99.5 - 100.5 mV	9.95 - 10.05 V
300.0 mV	300 mV	298 - 302 mV	9.42 - 9.55 V
1.000 V	1 V	.995 - 1.005 V	9.95 - 10.05 V
3.000 V	3 V	2.98 - 3.02 V	9.42 - 9.55 V
10.00 V	10 V	9.95 - 10.05 V	9.95 - 10.05 V
30.00 V	30 V	29.8 - 30.2 V	9.42 - 9.55 V
100.0 V	100 V	99.5 - 100.5 V	9.95 - 10.05 V
100.0 V	300 V	98 - 102 V	3.10 - 3.22 V
1.000 V	1 V	.995 - 10.05 V	9.95 - 10.05 V
0.900 V	1 V	.895 - .905 V	8.95 - 9.05 V
0.800 V	1 V	.796 - .804 V	7.96 - 8.04 V
0.700 V	1 V	.696 - .704 V	6.96 - 7.04 V
0.600 V	1 V	.597 - .603 V	5.97 - 6.03 V
0.500 V	1 V	.497 - .503 V	4.97 - 5.03 V
0.400 V	1 V	.397 - .403 V	3.97 - 4.03 V
0.300 V	1 V	.296 - .304 V	2.96 - 3.04 V
0.300 V	300 mV	298 - 302 mV	9.42 - 9.55 V
0.200 V	300 mV	198 - 202 mV	6.26 - 6.39 V
0.100 V	300 mV	98 - 102 mV	3.10 - 3.22 V

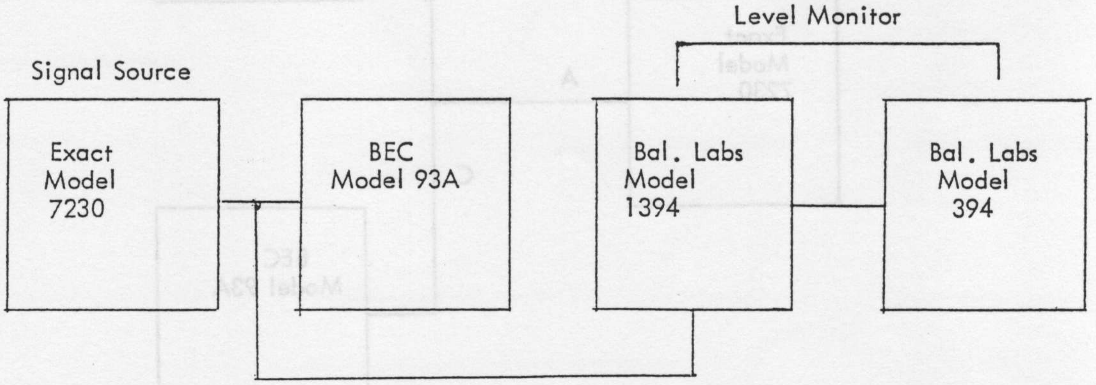


Figure 4.4. Low Frequency Check

TABLE 4.3 dBm ACCURACY CHECK (93A, 93A-09, 93A-10)

SIGNAL LEVEL	MODEL 93A RANGE	MODEL 93A dBm INDICATION 600 Ω REF	75 Ω REF	50 Ω REF
1.000 mV	1 mV	-57.6, -58.0	-48.6, -49.0	-46.8, -47.2
3.000 mV	3 mV	-48.0, -48.4	-39.0, -39.4	-37.3, -37.7
10.00 mV	10 mV	-37.6, -38.0	-28.6, -29.0	-26.8, -27.2
30.00 mV	30 mV	-28.0, -28.4	-19.0, -19.4	-17.3, -17.7
100.0 mV	100 mV	-17.6, -18.0	- 8.6, - 9.0	- 6.8, - 7.2
300.0 mV	300 mV	- 8.6, - 8.4	0.6, - 1.0	2.4, 2.8
1.000 V	1 V	2.0, 2.4	11.1, 11.5	12.8, 13.2
3.000 V	3 V	11.6, 12.0	20.6, 21.0	22.4, 22.8
10.00 V	10 V	22.0, 22.4	31.2, 31.5	32.8, 33.2
30.00 V	30 V	31.6, 32.0	40.6, 41.0	42.4, 42.8
100.0 V	100 V	42.0, 42.4	51.1, 51.5	52.8, 53.2
100.0 V	300 V	42.0, 42.4	51.1, 51.5	52.8, 53.2
1000 mV	1 V	2.0, 2.4	11.1, 11.5	12.8, 13.2
900 mV	1 V	1.1, 1.5	10.1, 10.5	11.9, 12.3
800 mV	1 V	.1, .5	9.1, 9.5	10.9, 11.3
700 mV	1 V	- .7, - 1.1	8.0, 8.4	9.7, 10.1
600 mV	1 V	- 2.0, - 2.4	6.6, 7.0	8.4, 8.8
500 mV	1 V	- 3.6, - 4.0	5.0, 5.6	6.8, 7.2
400 mV	1 V	- 5.5, - 5.9	3.1, 3.5	4.9, 5.3
300 mV	1 V	- 8.0, - 8.4	0.6, 1.0	2.4, 2.8

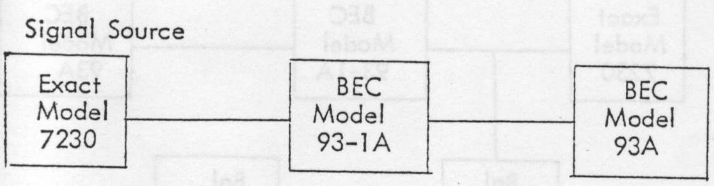


Figure 4.5. Probe Accuracy Check

TABLE 4.4 MODEL 440 RESISTOR vs SIGNAL LEVEL

SIGNAL LEVEL	5 mA	10 mA
1 mV	0.22 Ω	0.10 Ω
3 mV	0.68 Ω	0.33 Ω
10 mV	2.2 Ω	1.0 Ω
30 mV	6.8 Ω	3.3 Ω
100 mV	22 Ω	10.0 Ω
300 mV		22.0 Ω

4.3.7 Recorder Output Check

See Section 4.3.1 and Table 4.2.

4.3.8 Remote Operation Check

Chapter V: Interface Information, gives complete information on the remote operation of the instrument.

4.3.9 Model 93-1A Probe Accuracy Check

To check the accuracy of the Model 93-1A High Impedance Probe, connect the equipment as shown in Figure 4.5. With a signal level of 100 mV, ±0.1%, at a frequency of 40 Hz, note the indication on the Model 93A. This should be 10.00 mV, ±1%.

4.3.10 Model 93-1A Probe Frequency Response Check

a. Connect the equipment as shown in Figure 4.6. Before making this check, be sure that the frequency response of the Model 93A itself has been verified as being within specifications.

b. Set the Model 93AD to the 100 mV range. At a signal frequency of 40 Hz, advance the signal amplitude until the Model 93A indication is 100.0 mV. Note the indication of the level monitor (Model 1394-394). Successively set the signal frequency to 200 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz, 3 MHz, 5 MHz, 10 MHz and 20 MHz, in each case adjusting the amplitude for the same indication on the level monitor as was obtained at 40 Hz. At each frequency note the indication of the Model 93A; these indications should be within the limits shown in Table 4.7.

4.4 ADJUSTMENTS

The adjustment procedure outlined in this section should be followed only if the performance checks of the preceding section indicate that the instrument is not within specifications.

Access to all calibration adjustments may be reached by removing the top and bottom covers of the instrument. As the detector portion of the 93A is sensitive to temperature gradients, however, the covers should be removed only long enough to make each adjustment and then replaced to maintain operating temperature. All calibration adjustment controls are shown in Figure 4.9.

4.4.1 Supply Voltage Adjustments

Test points for the +15 V, -15 V, and +5 V supplies are located near the rear of the main board. Check each of these voltages (reference, signal ground) with an accurate digital dc voltmeter. Both the +15 V and -15 V values should be within 15.00 ± 1 count. If not, adjust the +15 V supply with R121, and the -15 V supply with R128. The +5 V value should be within 5% (4.75 to 5.25 V); no adjustment for this voltage is available. If it is outside these limits, refer to Section 4.5, Troubleshooting.

4.4.2 Midband Accuracy Adjustment

a. Refer to Section 4.3.1, Figure 4.1, and Table 4.2. With 10.00 mV input on the 10 mV range, note the Recorder output. If it is outside the limits, adjust R539. Note the panel indicator reading; if this is outside the specified limits, adjust R903.

b. With 30.0 mV input on the 30 mV range, note the panel indicator reading. If it is outside specified limits, readjust R 903 for best distribution of error between the 10 mV and 30 mV indications. These adjustments should restore midband accuracy. After completing them, recheck the per-

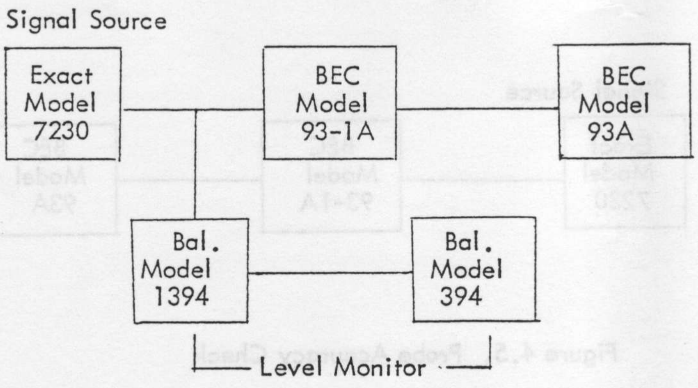


Figure 4.6. Model 93-1A Frequency Response Check

TABLE 4.5 HIGH FREQUENCY RESPONSE CHECK

RANGE \ f Hz	1 k	10 k	100 k	1 M	2 M	3 M	5 M	7 M	10 M	20 M
1 mV	1.000	1.002 .998	1.004 .996	1.005 .995	1.008 .992	1.008 .992	1.008 .992	1.008 .992	1.010 .992	1.040 .960
3 mV	3.00	3.01 2.99	3.02 2.98	3.02 2.98	3.03 2.97	3.03 2.97	3.03 2.97	3.03 2.97	3.03 2.97	3.12 2.88
10 mV	10.00	10.02 9.98	10.04 9.96	10.05 9.95	10.08 9.92	10.08 9.92	10.08 9.92	10.08 9.92	11.00 9.92	10.40 9.60
30 mV	30.0	30. 29.9	30.2 29.8	30.2 29.8	30.3 29.7	30.3 29.7	30.3 29.7	30.3 29.7	30.0 29.7	31.2 28.8
100 mV	100.0	100.2 99.8	100.4 99.6	100.5 99.5	100.8 99.2	100.8 99.2	100.8 99.2	100.8 99.2	101.0 99.2	104.0 96.0
300 mV	300	301 219	302 298	303 298	303 297	303 297	303 297	303 297	303 297	312 288
1 V	1.000	1.002 .998	1.004 .996	1.005 .995	1.008 .992	1.008 .992	1.008 .992	1.008 .992	1.010 .992	1.040 .960
3 V	3.00	3.01 2.99	3.02 2.98	3.02 2.98	3.03 2.97	3.03 2.97	3.03 2.97	3.03 2.97	3.03 2.97	3.12 2.88
10 V	10.00	10.02 9.98	10.04 9.96	10.05 9.95	10.08 9.92	10.08 9.92	10.08 9.92	10.08 9.92	10.10 9.92	----

formance against Table 4.2.

4.4.3 High Frequency Response Adjustments

Refer to Section 4.3.3, Figure 4.2, and Table 4.5. If the high frequency response is outside the specified limits on all ranges, the response on the 1 mV range must be re-established first before proceeding to the other ranges:

a. With 1.0 mV input on the 1.0 mV range, adjust C229 at 10 MHz, and L201 at 20 MHz for the flattest response. In general, this range should be adjusted for a rise of about +0.5% at 10 MHz, and about +1.5% at 20 MHz. This adjustment establishes the high frequency response on the 1 mV, 3 mV, 10 mV and 30 mV ranges.

b. If the high frequency response is normal on the 1 mV through 30 mV ranges, but is outside the specified limits on the 100 mV through 3 V ranges, make the following adjustments:

c. With 100 mV input on the 100 mV range, adjust C207 for the flattest response through 20 MHz or the best agreement with the 1 mV range. This adjustment establishes the high frequency response on the 100 mV, 300 mV, 1 V, and 3 V ranges. Recheck performance against Table 4.5.

d. If the high frequency response is satisfactory on the 1 mV through 30 mV ranges, but is outside the specified limits on the 10 V range, proceed as follows:

e. With 10 volts input on the 10 V range, adjust C208 at 1 MHz, and C211 at 10 MHz for the flattest response. This adjustment establishes the high frequency response on the 10 V, 30 V, 100 V, and 300 V ranges. Recheck the performance against Table 4.5.

4.4.4 Low Frequency Response

Refer to Section 4.3.4, Figure 4.4, and Table 4.6. The low frequency response of this instrument is inherently flat (within the limits of Table 4.6) and there are no adjustments provided. If it is established that the low frequency response is outside the limits specified, consult Section 4.5: Troubleshooting.

TABLE 4.5a

MODEL 1394 TRANSFER PROBE vs SIGNAL LEVEL

SIGNAL LEVEL	TRANSFER PROBE	VOLTAGE RANGE
300 mV	Model 1394-.5	0.25 V - 1 V
1 V	Model 1394-2	1 V - 2 V
3 V	Model 1394-5	2 V - 5 V
10 V	Model 1394-10	5 V - 10 V

NOTE

Section 4.4.1 through 4.4.4 covers the normal calibration adjustments. The adjustments that follow are considered factory adjustments, and should not normally require readjustment, except in the event of component replacement.

4.4.5 Chopper Adjustment

a. With power off, remove the green lead at the right-hand side of the Detector-Amp board. Remove the Detector-Amp board, install a Model 92-6A Card Extender in its place, and plug the Detector-Amp card into the Extender. With a short clip lead reconnect the green lead removed in the first step above.

b. Connect the equipment as shown in Figure 4.7. With an input signal of 10 mV on the 10 mV range, note the frequency on the counter. This should be 94 Hz; if a different frequency is found, adjust R510 for the correct frequency.

NOTE

In the following checks and adjustments, the Detector-Amp board must be free of temperature gradients. If it has been removed from a warm instrument it should be allowed to stabilize in the board extender for at least one hour, with the instrument operating. The rear of the Detector-Amp board must be shielded against stray pick-up. A piece of aluminum at least as large as the board should be placed close to the rear of the board, but must not touch any of the circuitry. This shield should be connected to signal ground. The instrument's top cover, painted side toward the board, may be used for this purpose.

c. Reduce the input signal level to zero and note the display on the oscilloscope. The trace should appear as shown in Figure 4.8C. If spiking occurs as in Figure 4.8A, adjust R522 and R527 to reduce or eliminate the spiking. If an offset shows as in Figure 4.8B, adjust C521 (using a plastic adjustment tool) to eliminate the offset. Repeat these adjustments as necessary. A small negative-going pulse which moves from left to right on the waveform as input level is increased from zero is normal; it has been omitted from the waveforms shown in Figure 4.8 for clarity.

d. With the input signal level at zero and input shorted, check the dc output at TP-2; this should be = 0.012 V or less. With the input signal level at 10 mV (10 mV range), the dc output should be -10.00 V; if not, adjust R539 for this value. With the input signal level at 3.000 mV, the dc output at TP-3 should be 0.900 V; if not, adjust R544 for this value. Repeat these last two steps as necessary.

e. With power off, remove the board and the card extender. Replace the board in its normal receptacle, replace the instrument cover, and check the midband accuracy as outlined in Section 4.3.1. If this check shows that adjustment is necessary, follow the procedures in Section 4.4.2.

4.4.6 Shaping Board Adjustments

a. With the power off, remove the Shaping Board, and mount the Model 92-6A Card Extender in its place. Insulate Pin No. 1 (both sides) of the Shaping Board connector with a sliver of tape. Attach a wire lead to Pin No. 1, and another lead to Pin No. 22, Signal Ground. Insert the

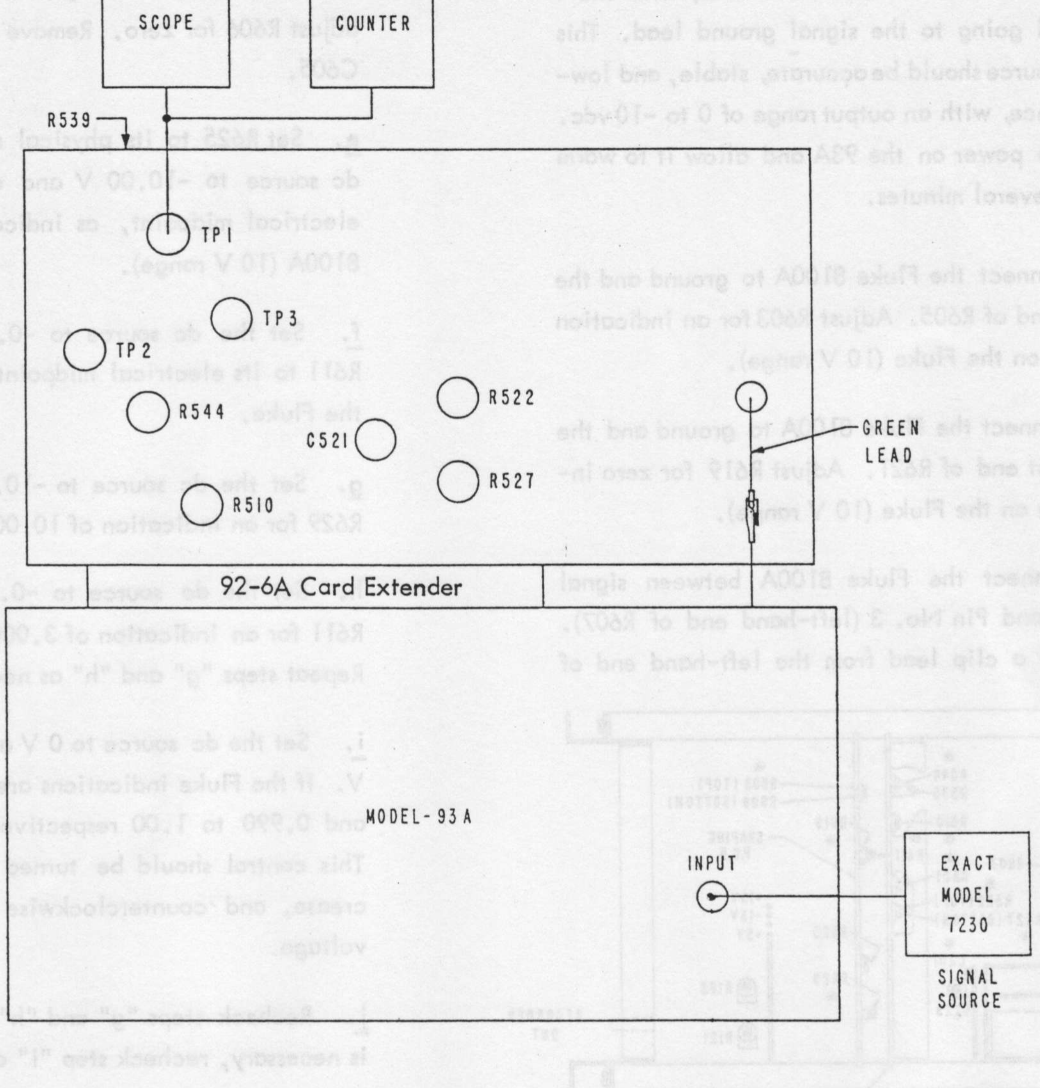
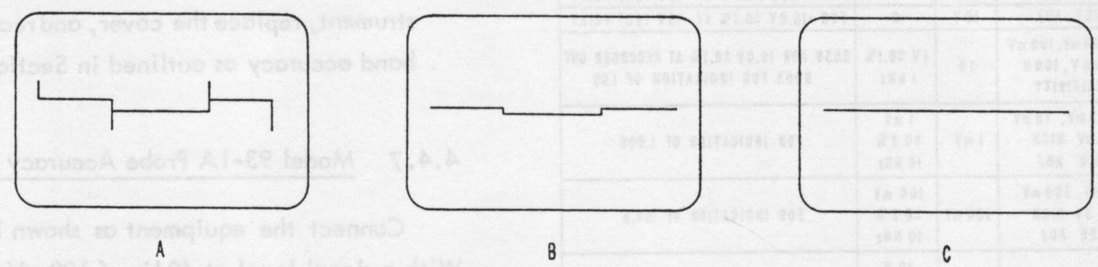


Figure 4.7 Chopper Adjustment



OSCILLOSCOPE SETTINGS

- VERTICAL — AC, 0.5 V / CM
- HORIZONTAL — 1ms / CM
- TRIG MODE — EXT (FROM PIN 10 ON DET AMP BD)
- TRIG SLOPE — +

Figure 4.8 Chopper Adjustment Waveforms

Shaping Board in the Model 92-6A. Connect a dc power source to these two leads, with the + terminal going to the signal ground lead. This power source should be accurate, stable, and low-impedance, with an output range of 0 to -10 vdc. Turn the power on the 93A and allow it to warm up for several minutes.

b. Connect the Fluke 8100A to ground and the lower end of R605. Adjust R603 for an indication of zero on the Fluke (10 V range).

c. Connect the Fluke 8100A to ground and the left-most end of R621. Adjust R619 for zero indication on the Fluke (10 V range).

d. Connect the Fluke 8100A between signal ground and Pin No. 3 (left-hand end of R607). Connect a clip lead from the left-hand end of C605 to signal ground, and observe the indication on the Fluke (10 V range). If this is not zero, adjust R606 for zero. Remove the clip lead from C605.

e. Set R625 to its physical midpoint. Set the dc source to -10.00 V and adjust R629 to its electrical midpoint, as indicated on the Fluke 8100A (10 V range).

f. Set the dc source to -0.900 V and adjust R611 to its electrical midpoint, as indicated on the Fluke.

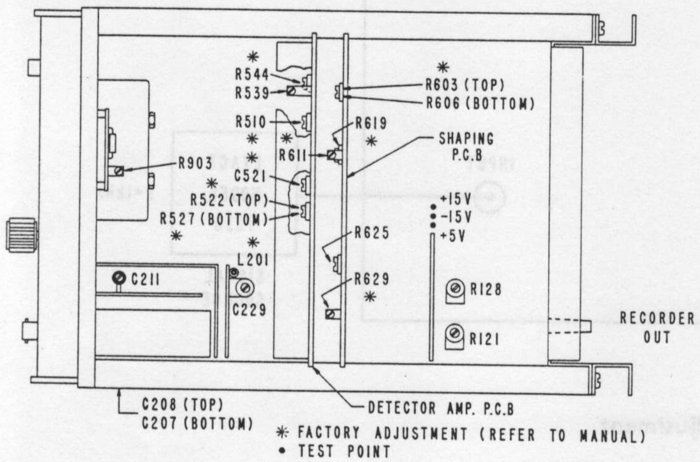
g. Set the dc source to -10.000 V and adjust R629 for an indication of 10.000 V on the Fluke.

h. Set the dc source to -0.900 V and adjust R611 for an indication of 3.000 V on the Fluke. Repeat steps "g" and "h" as necessary.

i. Set the dc source to 0 V and then to -0.100 V. If the Fluke indications are not 0 to 0.0010, and 0.990 to 1.00 respectively, adjust R625. This control should be turned clockwise to increase, and counterclockwise to decrease the voltage.

j. Recheck steps "g" and "h". If readjustment is necessary, recheck step "i" after adjusting.

k. As a final step, check all voltages against those in Table 4.8. Remove power, remove the Shaping Board tape and added leads, remove the Card Extender, replace Shaping Board in the instrument, replace the cover, and recheck the mid-band accuracy as outlined in Section 4.3.1.



ADJ NO	CONT	FUNCTION	RANGE	INPUT	ADJUST
1	R121	+15 V ADJ	10 V	0	FOR +15.0 V ±0.1% AT +15 V TEST POINT
2	R128	-15 V ADJ	10 V	0	FOR -15.0 V ±0.1% AT -15 V TEST POINT
3	R539 R903	1 mV, 10 mV, 100 mV 1 V, 10 V, 100 V SENSITIVITY	1 V	1 V ±0.1% 1 kHz	R539 FOR 10.0 V ±0.1% AT RECORDER OUT R903 FOR INDICATION OF 1.00
4	C229	1 mV, 3 mV, 10 mV 30 mV HIGH FREQ ADJ	1 mV	1 mV ±0.2% 10 MHz	FOR INDICATION OF 1.005
5	C207	100 mV, 300 mV 1 V, 3 V HIGH FREQ ADJ	100 mV	100 mV ±0.2% 10 MHz	FOR INDICATION OF 100.5
6	C211	10 V, 30 V 100 V, 300 V HIGH FREQ ADJ	10 V	10 V ±0.2% 700 kHz	FOR INDICATION OF 10.00
	C208			10 V ±0.2% 10 MHz	FOR INDICATION OF 10.05

Figure 4.9

4.4.7 Model 93-1A Probe Accuracy Adjustment

Connect the equipment as shown in Figure 4.5. With a signal level at 40 Hz of 100 mV±0.1%, change the value of R104 (in the Model 93-1A compensating box) until the indication is 10.00 mV ±0.5%. Access to the compensating box is gained by turning the locking nut counterclockwise until free, and sliding the compensating box cover back on the cable. Care should be taken not to disturb the position of components and leads when changing the value of R104.

4.4.8 Model 93-1A Probe Frequency Response

Connect the equipment as shown in Figure 4.6. Check the response as outlined in Section 4.3.10. Adjust C (accessible through the access hole in the compensating box cover) for the flattest response, or until it falls within the limits shown in Table 4.7.

4.5 TROUBLESHOOTING PROCEDURE

4.5.1 General

If a malfunction exists which cannot be corrected by following the adjustment procedures in Section 4.4, the actions described in this section may prove helpful. Many times the nature of the difficulty itself will pinpoint the location of the problem. If this is not the case, the logical first step is to make a visual examination of the instrument. Remove the top and bottom covers, and inspect the interior for unseated circuit boards or connections, loose components or fasteners, obviously defective components, such as charred resistors, leaking capacitors, broken leads, or pieces of foreign material. If this procedure fails to locate the trouble it will be necessary to follow the steps outlined in the following sections.

4.5.2 Signal Flow Diagram

Figure 4.10 shows in block form the signal-flow through the instrument, with measuring points indicated. In conjunction with the schematic diagrams at the rear of the manual, make the measurements indicated in Table 4.9 and 4.10. Table 4.9 shows the signal level for full-scale input on each range, and also gives the character of the signal (dc, 94 Hz, etc.). This procedure may serve to isolate a malfunction to a specific section of the instrument.

4.5.3 Ranging Problems

Ranging of the Model 93A is done with attenuators selected by reed-relay switches. Current to the reed-relay coils is turned on and off with transistors, which are controlled by the ranging logic section. The logic section itself is controlled by the logic level on twelve control lines (one for each range) located on the main board. At the front panel, the range selection is done with a rotary selector switch; this selection can be disabled at the rear edge connector to permit remote selection. In either case, a logic level 0 on the desired range line is required.

If the instrument does not range properly on one or more ranges, the troubleshooting chart in Figure 4.11 should be helpful in locating the difficulty.

TABLE 4.6 LOW FREQUENCY CHECK

RANGE \ f Hz	1 K	200	70	50	20	10
1 V	1.000	1.002 .998	1.003 .997	1.003 .997	1.010 .990	1.040 .960

TABLE 4.7 MODEL 93-1A PROBE FREQUENCY RESPONSE

RANGE \ f Hz	40	200	1 k	10 k	100 k	1 M	3 M	5 M	10 M	20 M
100 mV	100.0	101.5 98.5	101.5 98.5	101.5 98.5	101.5 98.5	101.5 98.5	102.0 98.0	102.0 98.0	102.0 98.0	105.0 95.0

4.5.4 Response Time and Bandwidth

a. The selection of these functions is similar to the range selection discussed in Section 4.5.3, with a control line for each, but with several differences. No reed switches are involved (solid state switches are used), and there is no complete deselection when Manual Disable is brought to a logic level 0. In this latter case, the Response Time reverts to Fast, and the Bandwidth reverts to 20 MHz. A line on the Main Board for each may be used to select the alternate function by bringing it to a logic level 0.

b. If it is found to be impossible to select Slow Response Time or 0.1 MHz Bandwidth, check the associated line for a logic level 0. If this is present, proceed to the associated logic gate, inverters, and solid state switches. If the associated line is not a logic 0, check the front panel switch and its connectors; if remote operation is being used, check Manual Disable for logic level 0, and the external programmer for the line involved.

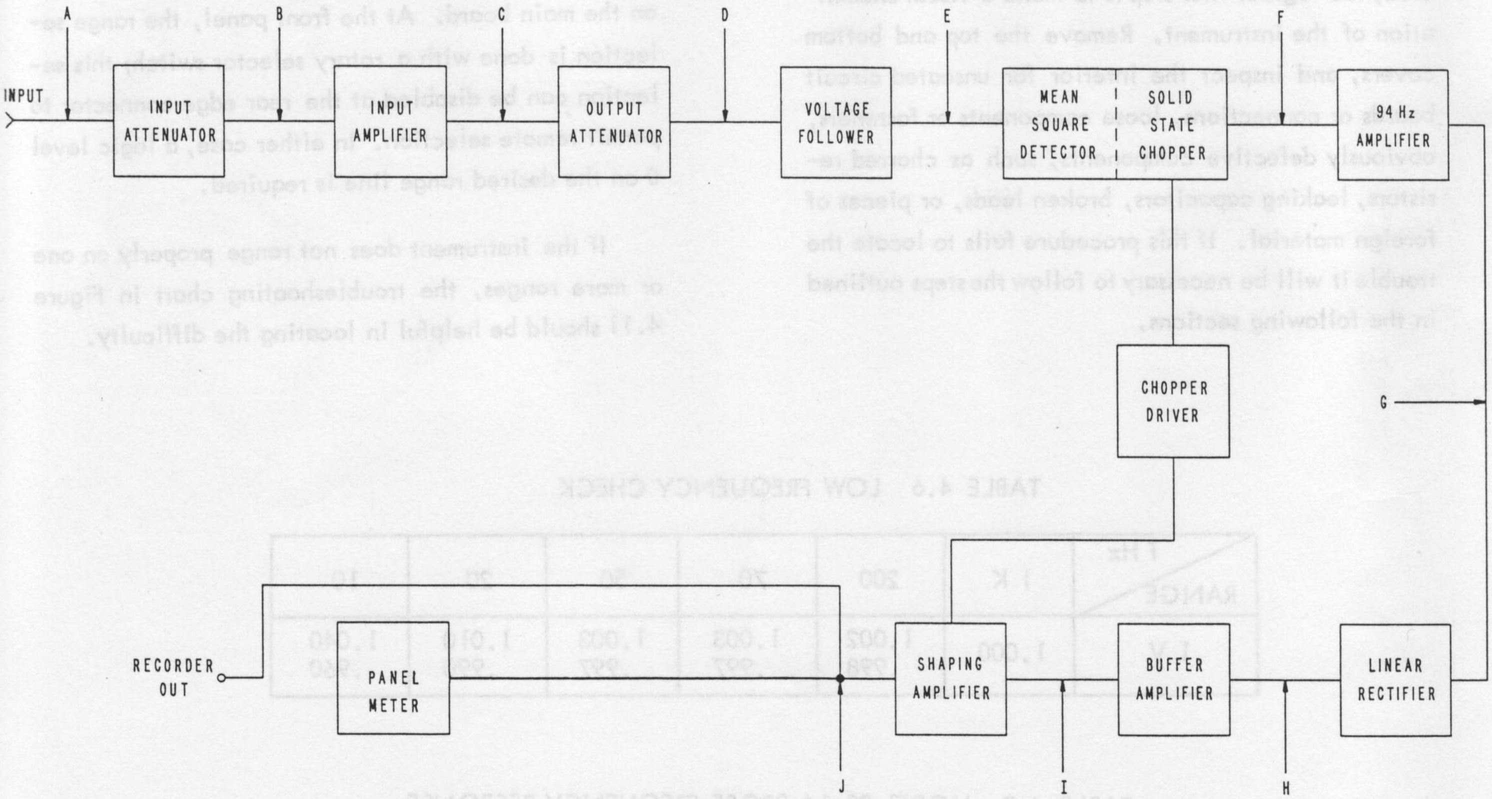


Figure 4.10 Signal Flow Diagram

TABLE 4.8
SHAPING BOARD INPUT vs OUTPUT VOLTAGE

DC SOURCE	FLUKE 8100A INDICATION
-10,000 V	10.000 V, ±1C*
- 8.100 V	9.000 V, ±1C
- 6.400 V	8.000 V, ±1C
- 4,900 V	7.000 V, ±1C
- 3.600 V	6.000 V, ±1C
- 2.500 V	5.000 V, ±1C
- 1.600 V	4.000 V, ±1C
- 0.900 V	3.000 V, ±1C
- 0.400 V	2.000 V, +0C, -4C
- 0.100 V	1,000 V, +0C, -10C
0 V	0.000 V, +10C, -0C

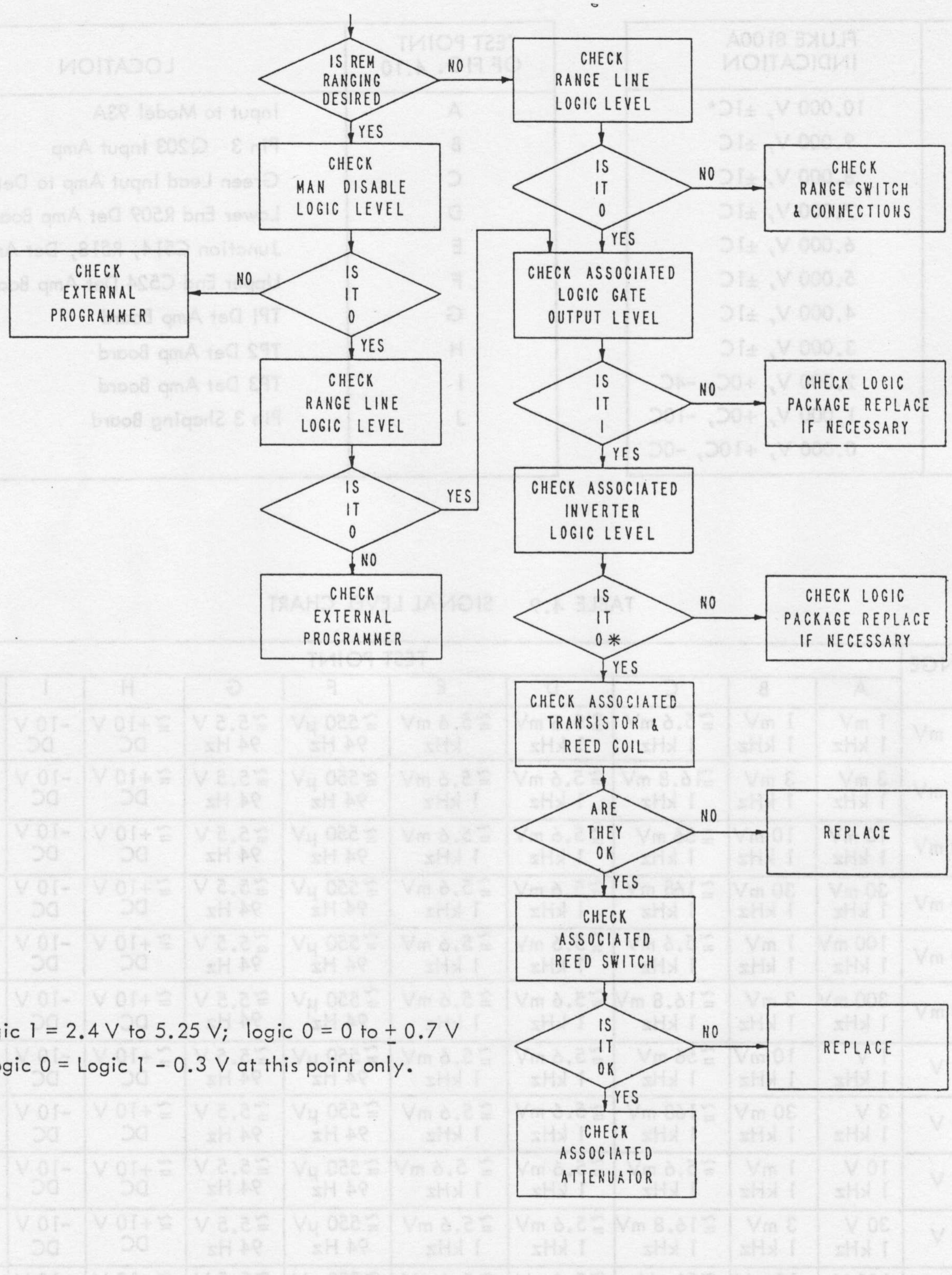
*C = counts

TABLE 4.10 TEST POINT LOCATION

TEST POINT OF FIG. 4.10	LOCATION
A	Input to Model 93A
B	Pin 3 Q203 Input Amp
C	Green Lead Input Amp to Det Amp
D	Lower End R509 Det Amp Board
E	Junction C514, R518, Det Amp Board
F	Upper End C524 Det Amp Board
G	TPI Det Amp Board
H	TP2 Det Amp Board
I	TP3 Det Amp Board
J	Pin 3 Shaping Board

TABLE 4.9 SIGNAL LEVEL CHART

INPUT 1 kHz	RANGE	TEST POINT									
		A	B	C	D	E	F	G	H	I	J
1 mV	1 mV	1 mV 1 kHz	1 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
3 mV	3 mV	3 mV 1 kHz	3 mV 1 kHz	≅16.8 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
10 mV	10 mV	10 mV 1 kHz	10 mV 1 kHz	≅56 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
30 mV	30 mV	30 mV 1 kHz	30 mV 1 kHz	≅168 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
100 mV	100 mV	100 mV 1 kHz	1 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
300 mV	300 mV	300 mV 1 kHz	3 mV 1 kHz	≅16.8 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
1 V	1 V	1 V 1 kHz	10 mV 1 kHz	≅56 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
3 V	3 V	3 V 1 kHz	30 mV 1 kHz	≅168 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
10 V	10 V	10 V 1 kHz	1 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅ 5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
30 V	30 V	30 V 1 kHz	3 mV 1 kHz	≅16.8 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
100 V	100 V	100 V 1 kHz	10 mV 1 kHz	≅56 mV 1 kHz	≅5.6 mV 1 kHz	≅5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC
300 V	300 V	300 V 1 kHz	30 mV 1 kHz	≅168 mV 1 kHz	≅5.6 mV 1 kHz	≅ 5.6 mV 1 kHz	≅550 µV 94 Hz	≅5.5 V 94 Hz	≅+10 V DC	-10 V DC	10 V DC



Logic 1 = 2.4 V to 5.25 V; logic 0 = 0 to ± 0.7 V

*Logic 0 = Logic 1 - 0.3 V at this point only.

Figure 4.11 Ranging Troubleshooting Chart

CHAPTER V

Interface Information

5.1 PROGRAMMING INPUTS

Pin No.	Function	Comment	Command Log. Level	Unit Loading
10	Man. disable	Disables front panel range selection; selects fast response time; selects 20 MHz bandwidth	0	2
7	Slow response enable	Selects slow response time*	0	0.5
6	0.1 MHz bw enable	Selects 100 kHz bandwidth*	0	0.5
22	1 mV range	Selects range provided manual disable has also been selected. Selecting more than one range will result in incorrect indications. Range lines must be deselected for manual ranging.	0	1.0
21	3 mV "		0	2.0
20	10 mV "		0	1.5
19	30 mV "		0	2.5
18	100 mV "		0	2.0
17	300 mV "		0	2.5
16	1 V "		0	2.0
15	3 V "		0	6.0
14	10 V "		0	1.5
13	30 V "		0	2.5
12	100 V "		0	1.5
11	300 V "		0	4.0

*Assumes that Man. Disable has also been selected

5.1.1 Input Characteristics

TTL Series	Logic Level	Voltage Level	Current per Unit Load
Standard Power 54/74	0	≤ 0.7 V	-1.6 mA*
	1	2.4 to 5.25 V	40 μA

*The - current indicates current out of the input (external command device must sink this current). A standard power (Series 54/74) TTL output will sink and source 10 unit loads.

5.1.2 Input Pull-Up

All input terminals have internal pull-up. The current sourced by this pull-up when the input is brought to a logic level) is included in the loading shown in the "Unit Loading" column of the chart in 5.1.

5.1.3 Analog Output

Source resistance is ≦ 5 ohms, with maximum permissable load current of 1 mA at full scale, or minimum load resistance of 10 kΩ.

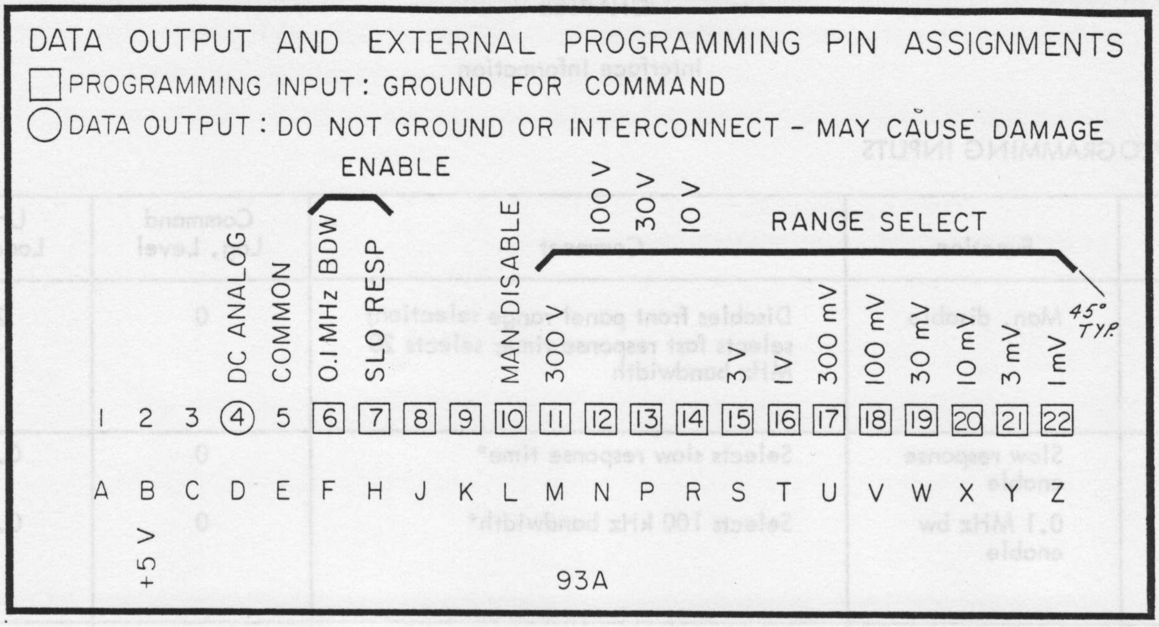


Figure 5.1. External Connections

TABLE OF REPLACEABLE PARTS

Reference	Description		BEC Part No.
	MASTER PC BOARD		
C101	Capacitor, Elec.	250 µF 40 V	283207
C102	Capacitor, Elec.	100 µF 25 V +75/-10%	283105
C103	Capacitor, Cer.	10 nF 100 V	224119
C104	Capacitor, Elec.	1000 µF 16 V +50/-10%	283223
C105	Capacitor, Elec.	250 µF 40 V	283207
C106	Capacitor, Elec.	100 µF 25 V +75/-10%	283105
C107	Capacitor, Cer.	10 nF 100 V	224119
C108	Capacitor, Elec.	1000 µF 15 V +150/-10%	283221
CR101	Bridge, Rectifier	KBP-02	532013
CR102	Bridge, Rectifier	KBP-02	532013
CR103	Bridge, Rectifier	KBP-02	532013
IC101	Integrated Circuit	SN74L10N (NAND Gate)	534029
IC102	Integrated Circuit	SN74L20N (NAND Gate)	534030
IC103	Integrated Circuit	SN74L20N (NAND Gate)	534030
IC104	Integrated Circuit	SN74L04N (Hex Inverter)	534028
IC105	Integrated Circuit	SN74L04N (Hex Inverter)	534028
IC106	Integrated Circuit	MFC6030A (Regulator)	535007
IC107	Integrated Circuit	SN74L04N (Hex Inverter)	534028
IC108	Integrated Circuit	MFC6030A (Regulator)	535007
J101	Connector P/C	Amphenol 143-022-03 (22 Pin)	479231
J102	Connector P/C	Amphenol 143-022-03 (22 Pin)	479231
J901	Terminal	Molex	479320
J902	Terminal	Molex	479320
Q101 through Q108	Transistor, PNP	MPS3638	528064
Q109	Transistor, NPN	2N4921	528034
Q110	Transistor, PNP	MPS3638	528064
Q111	Transistor, NPN	2N4921	528034
R101 through R116	Resistor, Comp.	10 kΩ 5%	343400
R117	Resistor, WW	10 Ω 5% 2W	310008
R118	Resistor, Comp.	100 Ω 5%	344200
R119	Resistor, MF	4.53 kΩ 1%	341363
R120	Resistor, Comp.	2.2 kΩ 5%	344333
R121	Resistor, Var.	500 Ω 20% 1/2 W	311296
R122	Resistor, Comp.	2.2 kΩ 5%	344333
R123	Resistor, MF	1.47 kΩ 1%	341316
R124	Resistor, Comp.	100 Ω 5%	344200
R125	Resistor, WW	10 Ω 5% 2 W	310008
R126	Resistor, Comp.	100 Ω 5%	344200
R127	Resistor, MF	4.53 kΩ 1%	341363
R128	Resistor, Var.	500 Ω 20% 1/2 W	311296
R129	Resistor, MF	1.47 kΩ 1%	341316
	PRE AMPLIFIER, INPUT AMPLIFIER, INPUT ATTENUATOR PC BOARDS		
C201	Capacitor, PE	33 nF 5% 600 V	234106
C202	Capacitor, Cer.	1 nF GMV 500 V	224114

OBSOLETE PART 10/19/76
CAN ONLY GET FROM
BOONTON @ $1.65
EC

Reference	Description		BEC Part No.
	PRE AMPLIFIER, INPUT AMPLIFIER, INPUT ATTENUATOR PC BOARDS (CONTINUED)		
C203	Capacitor, Cer.	1 nF GMV 500 V	224114
C204	Capacitor, Cer.	1 nF GMV 500 V	224114
C205	Capacitor, Cer.	8.2 pF ±0.5 pF 500 V	220125
C206	Capacitor, Cer.	8.2 pF ±0.5 pF 500 V	220125
C207	Capacitor, Var.	0.7 - 3 pF 350 V	279122
C208	Capacitor, Var.	0.7 - 3 pF 350 V	279122
C209	Capacitor, Mica	300 pF 5% 500 V	200077
C210	Capacitor, Mica	300 pF 5% 500 V	200077
C211	Capacitor, Var.	0.7 - 3 pF 350 V	279109
C212	Capacitor, Mica	430 pF 5% 500 V	200082
C213	Capacitor, Cer.	1 nF GMV 500 V	224114
C214	Capacitor, Cer.	1 nF GMV 500 V	224114
C215	Capacitor, Cer.	1 nF GMV 500 V	224114
C216	Not Used		
C217	Capacitor, Elec.	6.8 µF 10% 35 V	283217
C218	Capacitor, Elec.	6.8 µF 10% 35 V	283217
C219	Capacitor, Elec.	6.8 µF 10% 35 V	283217
C220	Capacitor, Cer.	1000 pF 20% 500 V	227105
C221	Capacitor, Cer.	1000 pF 20% 500 V	227105
C222	Capacitor, Cer.	1000 pF 20% 500 V	227105
C223	Capacitor, Elec.	47 µF 10% 20 V	283219
C224	Capacitor, Elec.	470 µF -10/+50% 6.3 V	283220
C225	Capacitor, Elec.	27 µF 10% 25 V	283218
C226	Capacitor, Elec.	6.8 µF 10% 35 V	283217
C227	Capacitor, Elec.	1 µF 10% 35 V	283216
C228	Capacitor, Elec.	47 µF 10% 20 V	283219
C229	Capacitor, Var.	4.5 - 50 pF 250 V	281006
C230	Capacitor, Elec.	47 µF 10% 20 V	283219
C231	Capacitor, Elec.	6.8 µF 10% 35 V	283217
CR201	Diode, Sig.	1N914	530124
CR202	Diode, Sig.	1N914	530124
CR203	Diode, Sig.	1N914	530058
CR204	Diode, Sig.	1N914	530058
J201	BNC Connector	Dage	479123
K201	Reed Switch	Gordos Corp.	471012
K202	Reed Switch	Gordos Corp.	471012
K203	Reed Switch	Gordos Corp.	471012
K204	Reed Switch	Gordos Corp.	471012
K205	Reed Switch	Gordos Corp.	471013
K206	Reed Switch	Gordos Corp.	471013
L201	Coil	Cambion	400254
Q201	Transistor, PNP	MPS3638	528064
Q202	Transistor, PNP	MPS3638	528064
Q203	Transistor, FET	2N4221A	528063
Q204	Transistor, NPN	Selected, Pair	528067
Q205	Transistor, NPN	Selected, Pair	528067
R201	Resistor Network	1.98 MΩ 1% P/O 345000	
R202	Resistor Network	1.98 MΩ 1% P/O 345001	
R203	Resistor, Comp.	3.3 Ω 5%	343050
R204	Not Used		
R205	Resistor, MF	1 MΩ 1%	342600
R206	Resistor, MF	1 MΩ 1%	342600

Reference	Description		BEC Part No.
	PRE AMPLIFIER, INPUT AMPLIFIER, INPUT ATTENUATOR PC BOARDS (CONTINUED)		
R207	Resistor Network	20.02 kΩ 1% P/O 345000	
R208	Resistor Network	19.8 kΩ 1% P/O 345001	
R209	Resistor Network	200 Ω 1% P/O 345001	
R210	Resistor, Comp.	470 Ω 5%	344265
R211	Resistor, Comp.	150 Ω 5%	343217
R212	Resistor, MF	2.74 kΩ 1%	341342
R213	Resistor, MF	1.00 kΩ 1%	341300
R214	Resistor, MF	27.4 Ω 1%	341142
R215	Resistor, Comp.	47 Ω 5%	343165
R216	Resistor, MF	82.5 kΩ 1%	341488
R217	Resistor, Comp.	47 Ω 5%	343165
R218	Resistor, MF	3.09 kΩ 1%	341347
R219	Resistor, Comp.	47 Ω 5%	343165
R220	Resistor, Comp.	47 Ω 5%	343165
R221	Resistor, Comp.	47 Ω 5%	343165
R222	Resistor, Comp.	22 kΩ 5%	343433
R223	Resistor, Comp.	180 Ω 5%	343225
R224	Resistor, MF	1.00 kΩ 1%	341300
R225	Resistor, Comp.	47 Ω 5%	343165
R226	Resistor, Comp.	220 Ω 5%	343233
	REAR PANEL, SUB PANEL, REGULATOR PC BOARDS		
C301	Capacitor, Cer.	1 nF GMV 500 V	224114
C302	Capacitor, Cer.	1 nF GMV 500 V	224114
F301	Fuse, Slo-Blo	1/10 Amp 250 V	545519
F301	Fuse	2/10 Amp 250 V	545508
IC301	Regulator, Voltage	µA7805	535011
M301	Meter & Scale	A.P.I.	554278
S301	Switch, Slide	Switchcraft	465134
S302	Switch, Rotary	Ledex	466220
S303	Switch, Rocker	UID	465165
S304	Switch, Slide	Continental Wirt	465171
S305	Switch, Slide	Continental Wirt	465171
T301	Power Transformer	Boonton Electronics	446061
	MSD PC BOARD		
C401	Capacitor, Elec.	15 µF Selected	283300
C402	Capacitor, Elec.	15 µF Selected	283300
C403	Capacitor, Elec.	1 µF 10% 35 V	283216
C404	Capacitor, Elec.	1 µF 10% 35 V	283216
C405	Capacitor, Elec.	4.7 µF 10% 10 V	283226
C406	Capacitor, Elec.	4.7 µF 10% 10 V	283226
CR401	Diode) Matched Pair	HU5A	530121
CR402	Diode)	HU5A	530121
Q401	Transistor, FET	HDGP1000	528066
Q402	Transistor, FET	HDGP1000	528066
Q403	Transistor, FET	HDGP1001	528057
Q404	Transistor, FET	HDGP1001	528057
Q405	Transistor, FET	MFE-3003) Matched Pair	528069
Q406	Transistor, FET	MFE-3003)	528069

Reference		Description	BEC Part No.
		MSD PC BOARD (CONTINUED)	
R401	Resistor, MF	100 kΩ 1%	341500
R402	Resistor, MF	100 kΩ 1%	341500
		DETECTOR-AMPLIFIER PC BOARD	
A501	Op. Amp.	LM301AN	535012
A502	Op. Amp.	U5T7725-393	535008
A503	Op. Amp.	LM301AN	535012
A504	Op. Amp.	LM301AN	535012
A505	Op. Amp.	LM301AN	535012
C501	Capacitor, Mica	24 pF ±5% 500 V	200009
C502	Capacitor, Mica	750 pF ±5% 300 V	200081
C503	Capacitor, Mica	6 pF ±0.5 pF 500 V	200078
C504 through C507	Capacitor, Cer.	1 nF GMV 500 V	224114
C508	Capacitor, Mica	36 pF ±5% 500 V	200079
C509 through C512	Capacitor, Elec.	4 μF 50 V +75/-10%	283304
C513	Capacitor, PE	10 nF 5% 200 V	234061
C514	Capacitor, Elec.	47 μF ±10% 20 V	283219
C515	Capacitor, Cer.	10 nF 100 V	224119
C516	Capacitor, Elec.	250 μF −10% +50% 16 V	283224
C517	Capacitor, Cer.	33 pF ±5% 500 V	224139
C518	Capacitor, Cer.	10 nF 100 V	224119
C519	Capacitor, Elec.	250 μF −10% +50% 16 V	283224
C520	Capacitor, Cer.	1 nF GMV 500 V	224114
C521	Capacitor, Var.	6 - 70 pF	281010
C522	Capacitor, Cer.	33 pF ±5% 500 V	224139
C523	Capacitor, PE	100 nF 20% 250 V	234080
C524	Capacitor, Elec.	1 μF 20% 35 V	283199
C525	Capacitor, Elec.	56 μF ±10% 6 V	283228
C526	Capacitor, Cer.	10 nF 100 V	224119
C527	Capacitor, Cer.	10 nF 100 V	224119
C528	Capacitor, Cer.	10 nF 100 V	224119
C529	Capacitor, Elec.	6.8 μF ±10% 35 V	283217
C530	Capacitor, Elec.	4.7 μF 10% 10 V	283226
C531	Capacitor, Cer.	10 nF 100 V	224119
C532	Capacitor, Cer.	10 nF 100 V	224119
C533	Capacitor, Cer.	33 pF ±5% 500 V	224139
C534	Capacitor, Cer.	10 nF 100 V	224119
C535	Capacitor, Mica	75 pF ±5% 500 V	200059
C536	Capacitor, Cer.	10 nF 100 V	224119
C537	Capacitor, Cer.	10 nF 100 V	224119
C538	Capacitor, PE	220 nF ±10% 250 V	234088
C539	Capacitor, Cer.	10 nF 100 V	224119
C540	Capacitor, Cer.	10 nF 100 V	224119
C541	Capacitor, Cer.	33 pF ±5% 500 V	224139
C542	Capacitor, Cer.	10 nF 100 V	224119
CR501	Diode, Sig.	1N914	530058
CR502	Diode, Sig.	1N914	530058
CR503	Diode, Zener	1N5743B (20 V)	530142
CR504	Diode, Zener	1N5743B (20 V)	530142
CR505 through CR508	Diode, Sig.	1N914	530058

Reference		Description	BEC Part No.

DETECTOR-AMPLIFIER PC BOARD (CONTINUED)

K501	Reed Relay	Gordos Corp.	471014
K502	Reed Relay	Gordos Corp.	471013
K503	Reed Relay	Gordos Corp.	471013
K504	Reed Relay	Gordos Corp.	471013
Q501	Transistor, FET	2N5653	528056
Q502	Transistor, FET	2N5949	528019
Q503	Transistor, NPN	SE3005	528065
Q504	Transistor, FET	2N5653	528056
Q505	Transistor, NPN	MPSA20	528043
Q506	Transistor, NPN	MPSA20	528043
Q507	Transistor, PNP	MPS3638	528064
R501	Resistor, Comp.	150 kΩ 5%	344517
R502	Resistor, MF	93.42 Ω)	345002
R503	Resistor, MF	93.42 Ω)	345002
R504	Resistor, MF	63.88 Ω) Part of Network	345002
R505	Resistor, MF	138.12 Ω)	345002
R506	Resistor, MF	138.12 Ω)	345002
R507	Resistor, MF	138.12 Ω)	345002
R508	Not Used		
R509	Resistor, Comp.	330 Ω 5%	344250
R510	Resistor, Var.	1 MΩ 20% 1/2 W	311299
R511	Resistor, MF	1 MΩ 1%	342600
R512	Resistor, Comp.	68 Ω 5%	344180
R513	Resistor, Comp.	68 Ω 5%	344180
R514	Resistor, Comp.	3.3 kΩ 5%	344350
R515	Resistor, Comp.	510 Ω 5%	344268
R516	Resistor, MF	174 kΩ 1%	341523
R517	Resistor, MF	162 kΩ 1%	341520
R518	Resistor, Comp.	10 kΩ 5%	344400
R519	Resistor, Comp.	510 Ω 5%	344268
R520	Resistor, Comp.	620 kΩ 5%	344576
R521	Resistor, MF	2 kΩ 1%	341329
R522	Resistor, Var.	5 kΩ 20% 1/2 W	311297
R523	Resistor, MF	6.04 kΩ 1%	341375
R524	Resistor, MF	634 kΩ 1%	342577
R525	Resistor, MF	634 kΩ 1%	342577
R526	Resistor, MF	2 kΩ 1%	341329
R527	Resistor, Var.	5 kΩ 20% 1/2 W	311297
R528	Resistor, MF	6.04 kΩ 1%	341375
R529	Resistor, Comp.	10 MΩ 5%	344700
R530	Resistor, Comp.	1.2 MΩ 5%	344608
R531	Resistor, Comp.	100 kΩ 5%	344500
R532	Resistor, Comp.	100 kΩ 5%	344500
R533	Resistor, MF	100 Ω 1%	341200
R534	Resistor, CF	2 MΩ 1% 1/2 W	306719
R535	Resistor, CF	2 MΩ 1% 1/2 W	306719
R536	Resistor, Comp.	47 Ω 5%	344165
R537	Resistor, MF	1 MΩ 1%	342600
R538	Resistor, MF	1.69 kΩ 1%	341322
R539	Resistor, Var.	500 Ω 10% 1/2 W	311281
R540	Resistor, Comp.	10 kΩ 5%	344400
R541	Resistor, MF	10 kΩ 1%	341400
R542	Resistor, Comp.	240 kΩ 5%	344537
R543	Resistor, MF	499 kΩ 1%	341567
R544	Resistor, Var.	500 kΩ 20% 1/2 W	311298
R545	Resistor, MF	499 kΩ 1%	341567
R546	Resistor, Comp.	4.7 MΩ 5%	343665

Reference		Description	BEC Part No.

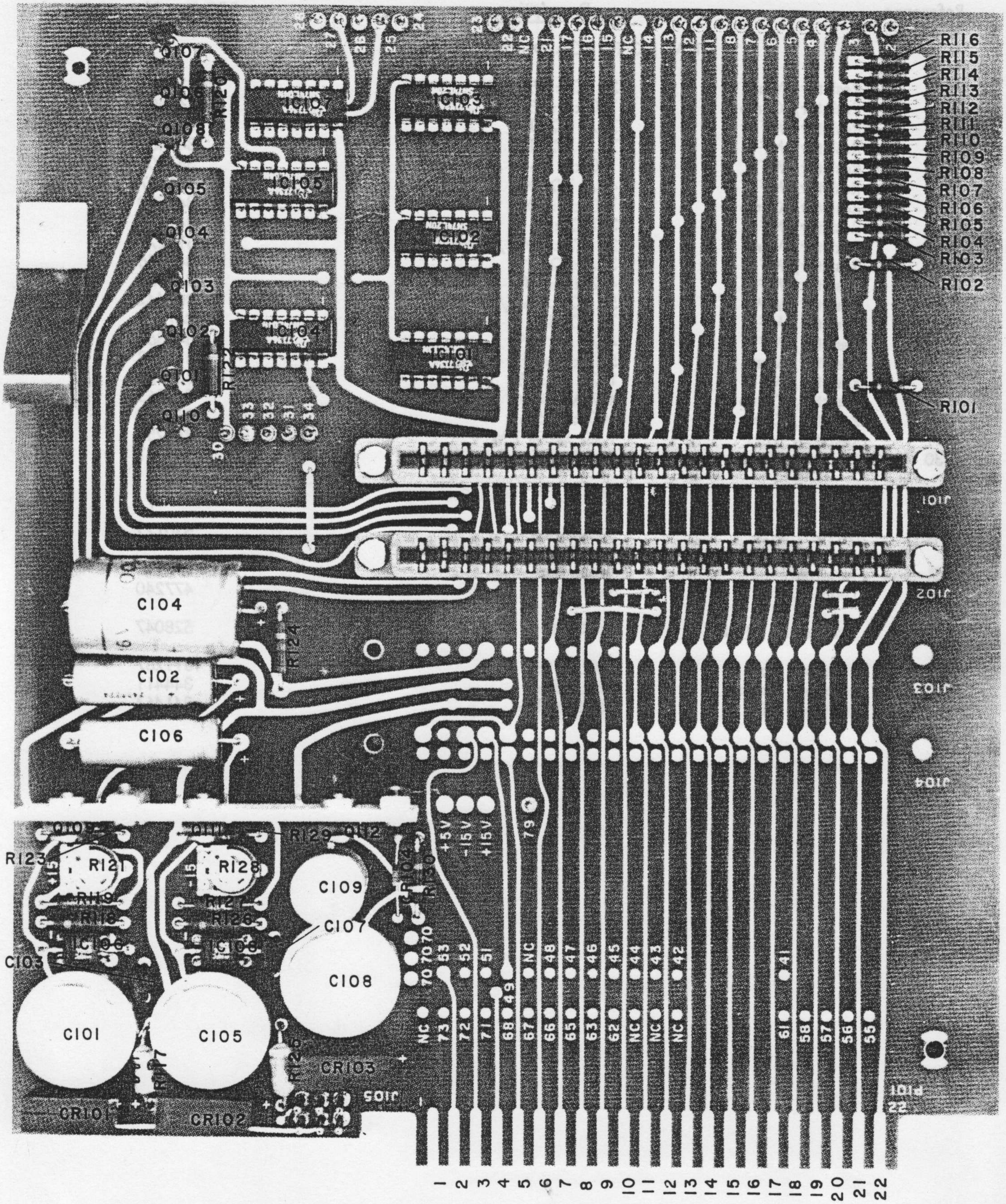
DETECTOR-AMPLIFIER PC BOARD (CONTINUED)

Reference		Description	BEC Part No.
R547	Resistor, MF	100 kΩ 1%	341500
R548	Resistor, Comp.	1 kΩ 5%	344300
R549	Resistor, Comp.	2.2 MΩ 5%	343633
R550	Resistor, MF	113 kΩ 1%	341505
R551	Resistor, MF	100 kΩ 1%	341500
R522	Resistor, Comp.	300 Ω 5%	344246

SHAPING PC BOARD

Reference		Description	BEC Part No.
A601	Op. Amp.	LM310 Only	535005
A602	Op. Amp.	LM301AN	535012
A603	Op. Amp.	LM301AN	535012
A604	Op. Amp.	LM301AN	535012
C601	Capacitor, Cer.	10 nF 100 V	224119
C602	Capacitor, Cer.	10 nF 100 V	224119
C603	Capacitor, Cer.	10 nF 100 V	224119
C604	Capacitor, Cer.	33 pF 5% 500 V	224139
C605	Capacitor, PC	100 nF ±10% 50 V	234046
C606	Capacitor, Cer.	10 nF 100 V	224119
C607	Capacitor, PC	(Matched Pair)	234090
C608	Capacitor, PE	10 nF 5% 200 V	234061
C609	Capacitor, Cer.	10 nF 100 V	224119
C610	Capacitor, PC	(Matched Pair)	234090
C611	Capacitor, Cer.	33 pF 5% 500 V	224139
C612	Capacitor, Cer.	10 nF 100 V	224119
C613	Capacitor, Mica	100 pF ±5% 500 V	200001
C614	Capacitor, Cer.	10 nF 100 V	224119
C615	Capacitor, Cer.	10 nF 100 V	224119
C616	Capacitor, Cer.	1 nF GMV 500 V	224114
CR601	Diode, Zener	1N821 (6.2 V)	530050
CR602	Diode, Sig.	1N914	530058
CR603	Diode, Zener	1N5736B (10 V)	530117
CR604	Diode, Sig.	1N914	530058
CR605	Diode, Sig.	1N914	530058
CR606	Diode, Zener	1N5738B (12 V)	530132
CR607	Diode, Sig.	1N914	530058
IC601	Integrated Circuit	CD4001AE (Input Gates)	534023
IC602	Integrated Circuit	CD4013AE (Flip-Flop)	534021
Q601	Transistor, FET	HDGP1000	528066
Q602	Transistor, FET	TIS58	528038
Q603	Transistor, FET	TIS58	528038
Q604	Transistor, NPN	MPSA20	528043
Q605	Transistor, FET	HDGP1000	528066
R601	Resistor, Comp.	910 Ω ±5%	344292
R602	Resistor, MF	71.5 kΩ ±1%	341482
R603	Resistor, Var.	20 kΩ ±20% 1/2 W	311279
R604	Resistor, WW	50 kΩ 0.1% 1/2 W	309442
R605	Resistor, CF	2 MΩ 1% 1/2 W	306719
R606	Resistor, Var.	1 kΩ ±20% 1/2 W	311301
R607	Resistor, MF	100 kΩ 1%	341500
R608	Resistor, Comp.	910 Ω ±5%	344292
R609	Resistor, MF	1.10 kΩ ±1%	342304
R610	Resistor, Comp.	100 kΩ ±5%	344500

Reference		Description	BEC Part No.
		SHAPING PC BOARD (CONTINUED)	
R611	Resistor, Var.	20 kΩ ±10% 1 W	311266
R612	Resistor, Comp.	100 kΩ ±5%	344500
R613	Resistor, MF	71.5 kΩ ±1%	341482
R614	Resistor, MF	71.5 kΩ ±1%	341482
R615	Resistor, MF	100 kΩ 1%	341500
R616	Resistor, MF	49.9 kΩ 1%	341467
R617	Resistor, Comp.	100 kΩ ±5%	344500
R618	Resistor, MF	301 Ω ±1%	341246
R619	Resistor, Var.	20 kΩ ±20% 1/2 W	311279
R620	Resistor, MF	30.1 kΩ ±1%	341446
R621	Resistor, MF	487 kΩ ±1%	341566
R622	Resistor, WW	50 kΩ 0.1% 1/2 W	309442
R623	Resistor, MF	10 kΩ ±1%	341400
R624	Resistor, MF	4.75 kΩ ±1%	341365
R625	Resistor, Var.	500 kΩ ±20% 1/2 W	311298
R626	Resistor, MF	1.78 kΩ ±1%	341324
R627	Resistor, Comp.	4.7 MΩ ±5%	344665
R628	Resistor, Comp.	100 kΩ ±5%	344500
R629	Resistor, Var.	1 kΩ ±20% 1 W	311256
R630	Resistor, Comp.	13 kΩ ±5%	344411
		METER PC BOARD	
CR901	Diode, Sig.	5082-2800	530122
P901	Terminal	Sealectro	477240
P902	Terminal	Sealectro	477240
Q901	Transistor, NPN	2N5088	528047
R901	Resistor, Var.	10 kΩ 10%	311267
R902	Resistor, Comp.	13 kΩ 5%	344411
R903	Resistor, MF	46.4 kΩ 1%	341464



Q107
Q106
Q108
Q105
Q104
Q103
Q102
Q101
Q110
R120
R122
IC107
IC105
IC104
IC103
IC102
IC101
R116
R115
R114
R113
R112
R111
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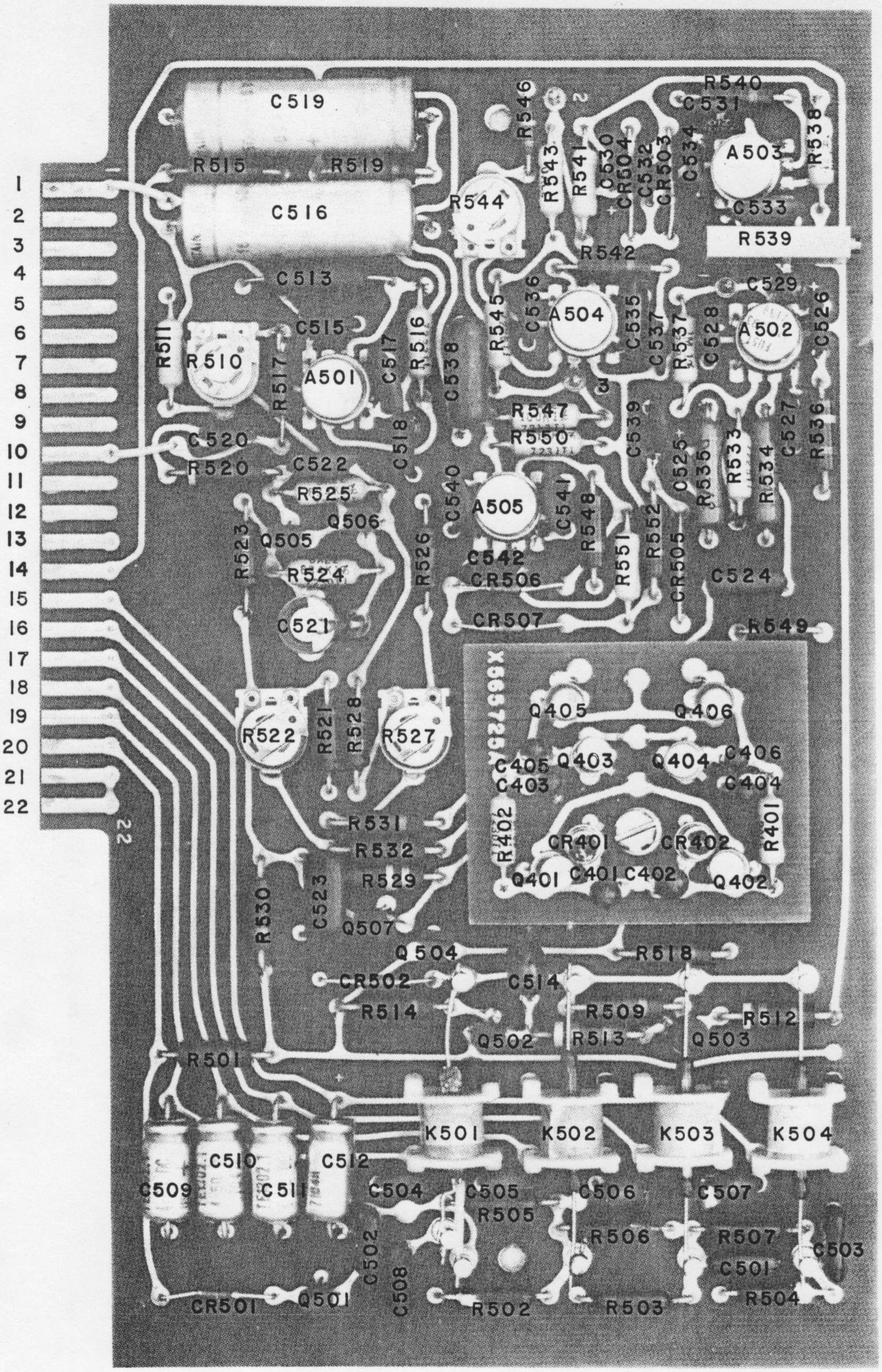
R109
R108
R107
R106
R105
R104
R103
R102
R101
J101
J102
J103
J104
J105
C104
C102
C106
R124
Q109
Q111
Q112
R123
R121
R128
R129
R130
CR104
R119
R127
R118
R126
IC106
IC108
C103
C109
C107
C108
C101
C105
R117
R125
CR101
CR102
CR103
P101
+5V
-15V
+15V
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22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C519
R546
R540
C531
R538
R515
R519
R543
R541
C530
CR504
C532
CR503
C534
A503
C516
R544
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R539
R542
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R545
A504
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R537
C528
A502
R511
R510
R517
A501
C517
C538
R547
R536
C520
C518
R550
C539
C525
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C527
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A505
C541
R548
R552
R523
Q505
Q506
R526
C542
R551
CR505
R524
CR506
C524
C521
CR507
R549
X565725A
Q405
Q406
R522
R521
R528
R527
C405
Q403
Q404
C406
C403
C404
R402
R401
R531
CR401
CR402
R532
R529
Q401
C401
C402
Q402
C523
R530
Q507
Q504
R518
CR502
C514
R514
R509
R512
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C512
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C511
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R505
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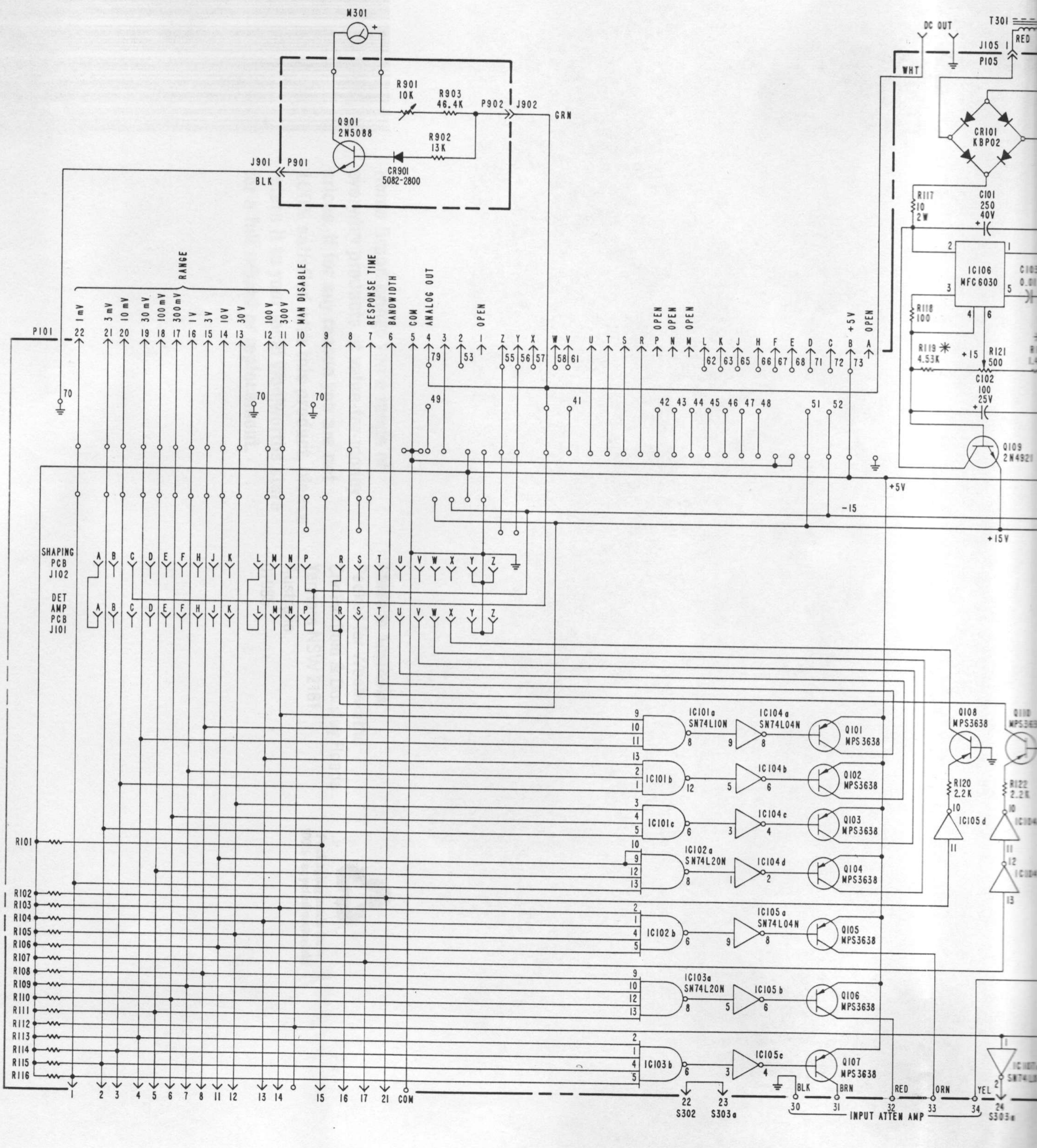
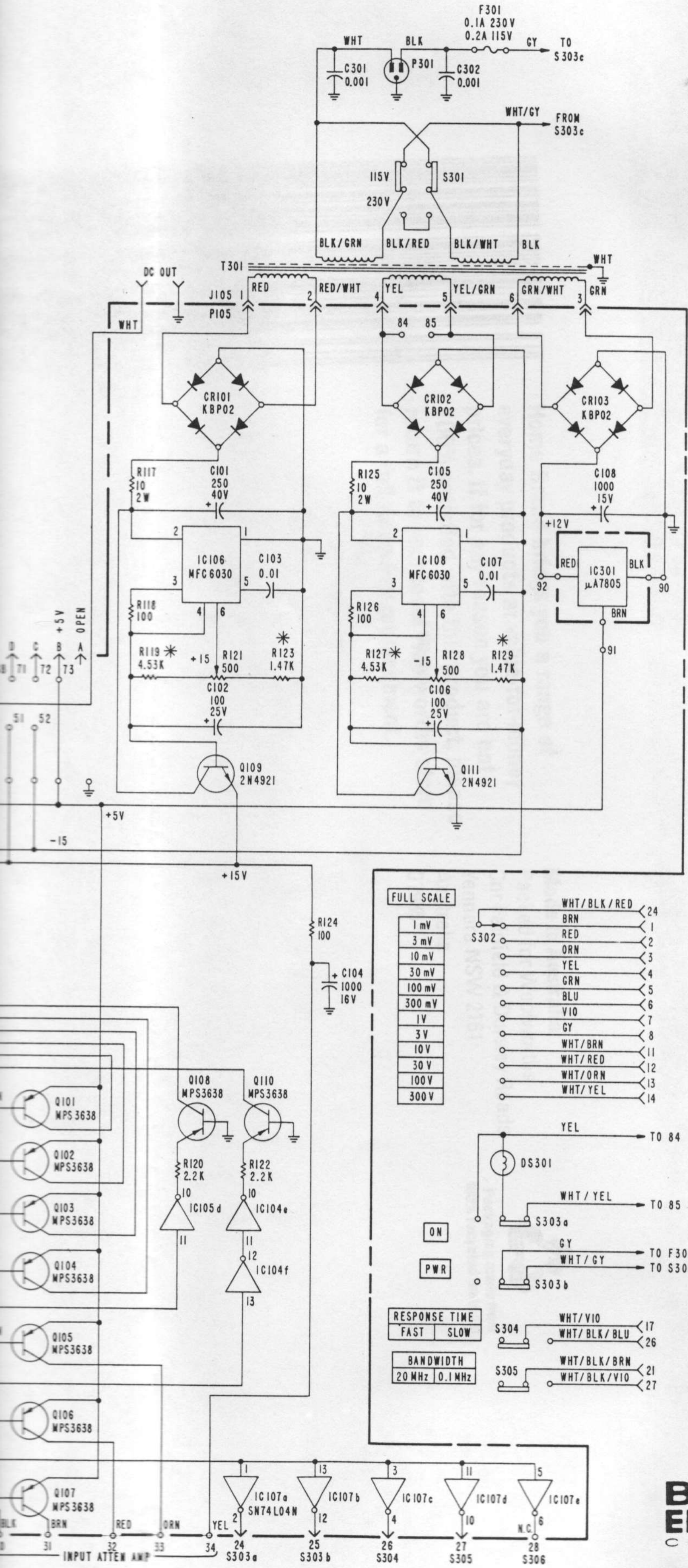
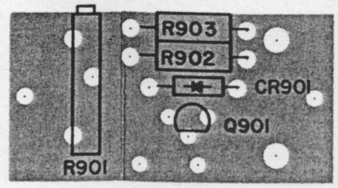
R507
C502
C503
C501
C508
CR501
Q501
R502
R503
R504



M301
R901 10K
R903 46.4K
P902
J902
GRN
Q901 2N5088
R902 13K
CR901 5082-2800
J901
P901
BLK
P101
RANGE
1 mV
3 mV
10 mV
30 mV
100 mV
300 mV
1 V
3 V
10 V
30 V
100 V
300 V
MAN DISABLE
RESPONSE TIME
BANDWIDTH
COM
ANALOG OUT
OPEN
+5V
SHAPING PCB J102
DET AMP PCB J101
DC OUT
T301
J105
P105
RED
WHT
CR101 KBP02
R117 10 2W
C101 250 40V
IC106 MFC6030
R118 100
R119 4.53K
R121 500
C102 100 25V
Q109 2N4921
-15
+15V
IC101a SN74L10N
IC104a SN74L04N
Q101 MPS3638
IC101b
IC104b
Q102 MPS3638
IC101c
IC104c
Q103 MPS3638
IC102a SN74L20N
IC104d
Q104 MPS3638
IC102b
IC105a SN74L04N
Q105 MPS3638
IC103a SN74L20N
IC105b
Q106 MPS3638
IC103b
IC105c
Q107 MPS3638
Q108 MPS3638
R120 2.2K
IC105d
R122 2.2K
R101
R102
R103
R104
R105
R106
R107
R108
R109
R110
R111
R112
R113
R114
R115
R116
S302
S303a
INPUT ATTEN AMP
BLK
BRN
RED
ORN
YEL



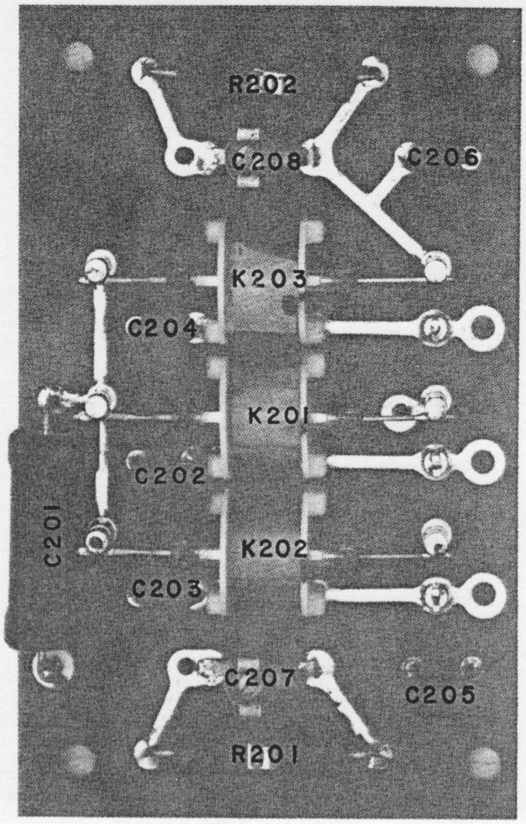


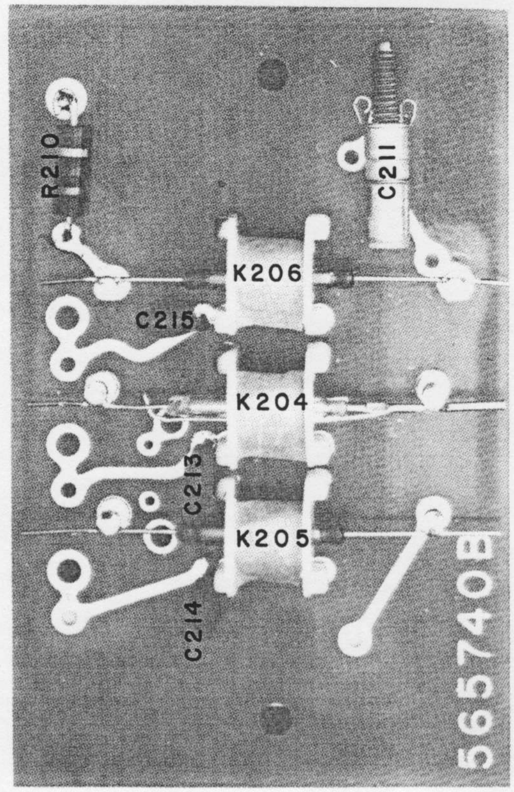
NOTES:

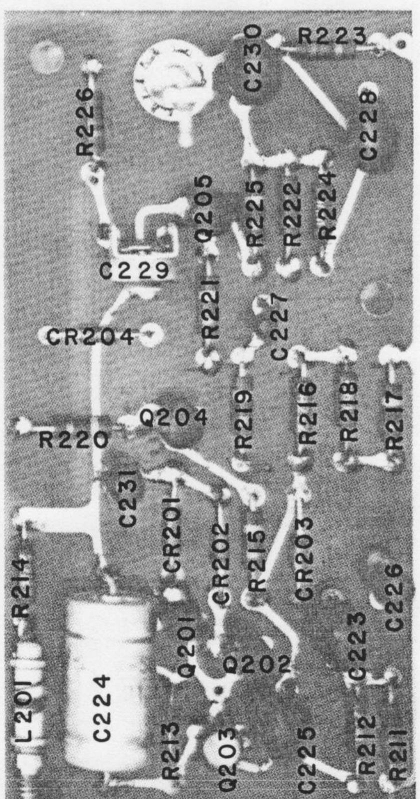
1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/2 WATT, UNLESS OTHERWISE SPECIFIED.
3. RESISTORS R101 THROUGH R116 TO BE 10K, 1/4 WATT
4. ✳ PRECISION RESISTOR, 3/8 WATT.
5. ▭ EXTERNAL MARKINGS.
6. LAST NUMBERS USED: R129 C108 Q111 IC108 C302
7. NUMBERS NOT USED: R130 C109 Q112 CR104

BOONTON ELECTRONICS CORPORATION

MODEL 93A
Schematic Master PC Board
E830582F Sheet 1 of 2


R202
C208
C206
K203
C204
K201
C202
C201
K202
C203
C207
C205
R201


R210
C211
K206
C215
K204
C213
K205
C214
565740B


R223
C230
R226
C228
Q205
R225
R222
R224
C229
R221
C227
CR204
Q204
R219
R216
R218
R217
R220
C231
CR201
CR202
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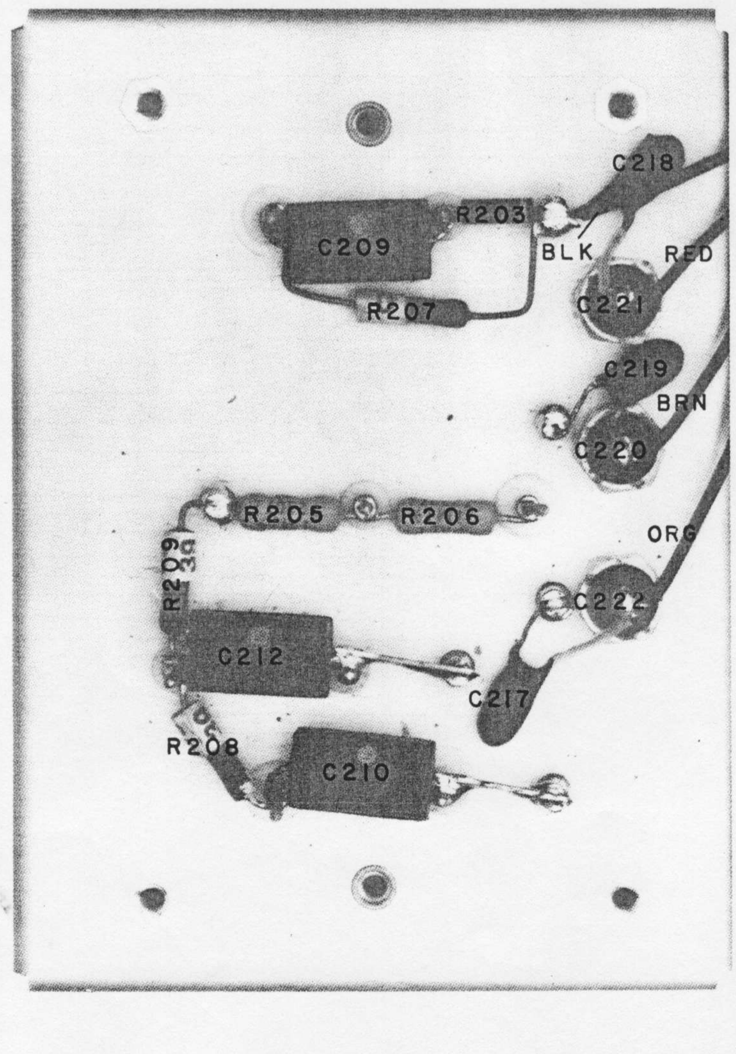
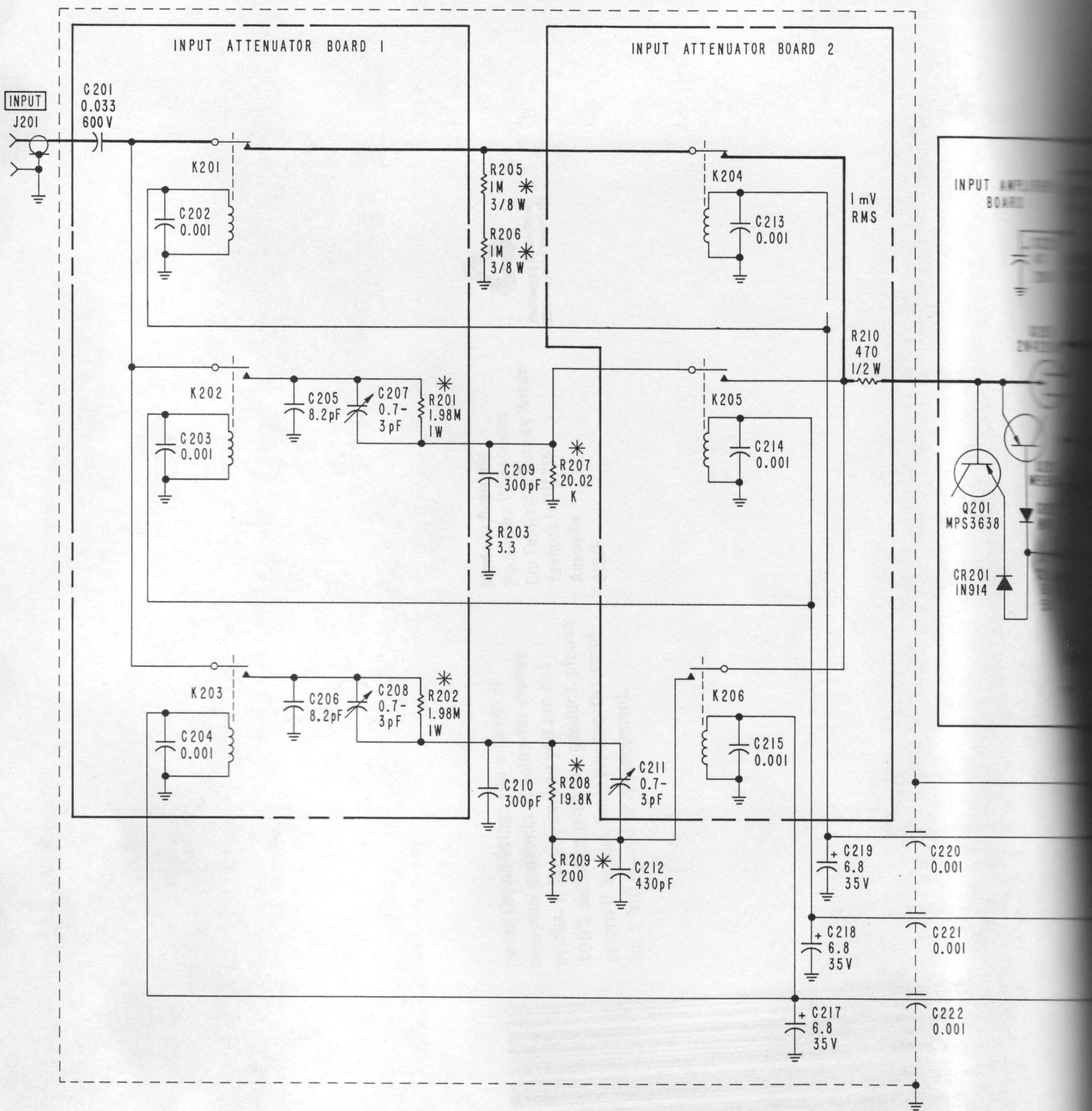
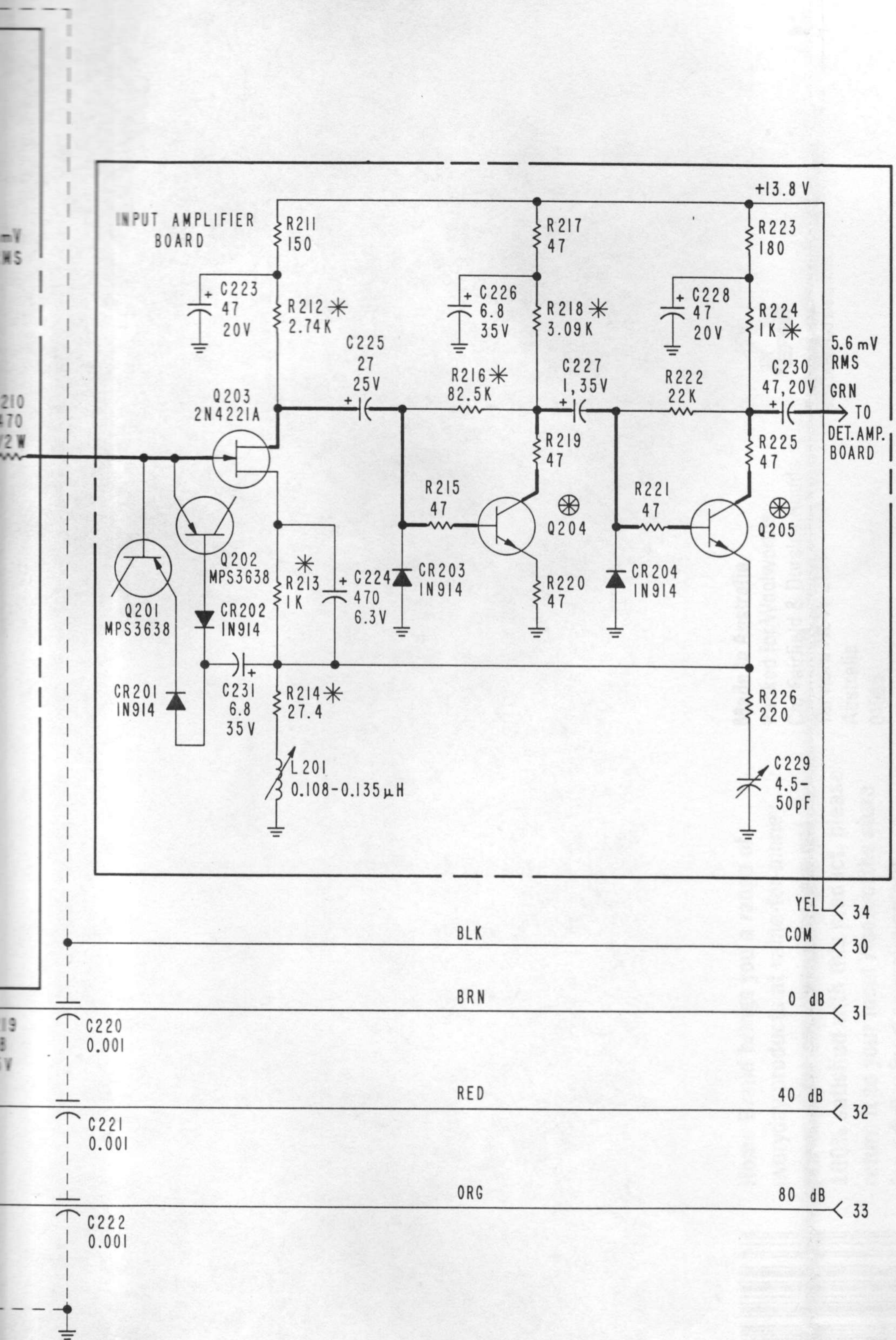
R214
C226
Q201
Q202
C223
L201
C224
R213
Q203
C225
R212
R211


C218
R203
C209
BLK
RED
R207
C221
C219
BRN
C220
R205
R206
ORG
R209
C222
C212
C217
R208
C210



NOTES:

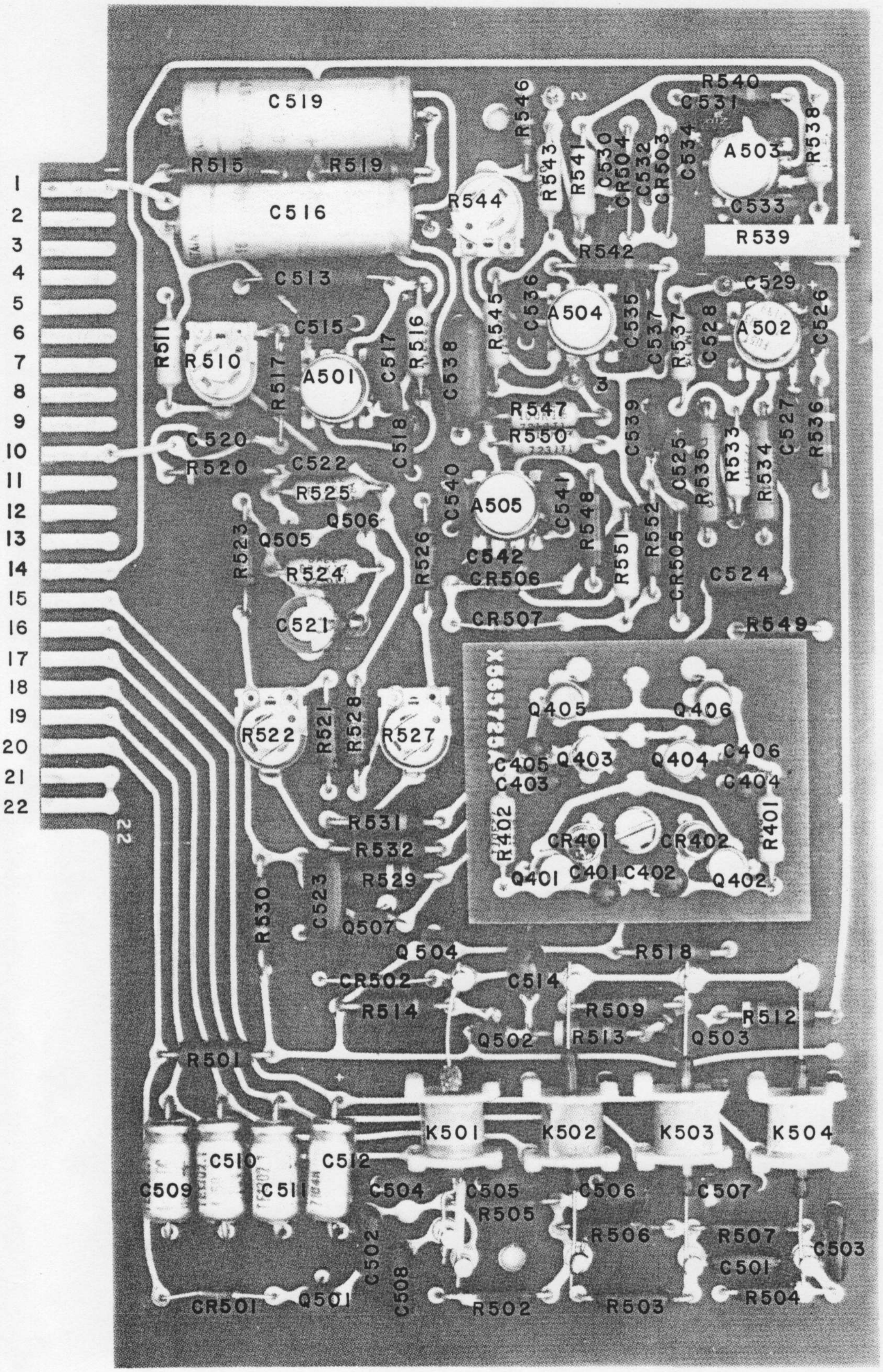
1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/4 WATT, UNLESS OTHERWISE SPECIFIED.
3. ✳ PRECISION RESISTOR.
4. ⊛ FACTORY SELECTED.
5. LAST NUMBERS USED: R226 C231
6. ▭ EXTERNAL MARKINGS.
7. TEST CONDITIONS: ALL MEASUREMENTS MADE WITH 1 kHz 1 mV INPUT. ALL VALUES NOMINAL.
8. ——— SIGNAL PATH.
9. NUMBERS NOT USED: R204 C216



COMPONENT NUMBERS
200 SERIES

BOONTON ELECTRONICS CORPORATION

MODEL 93A,93AD
Schematic, Input Atten
D830547G Sheet 2



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A504
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C541
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R533
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Q503
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K501
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C512
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R504
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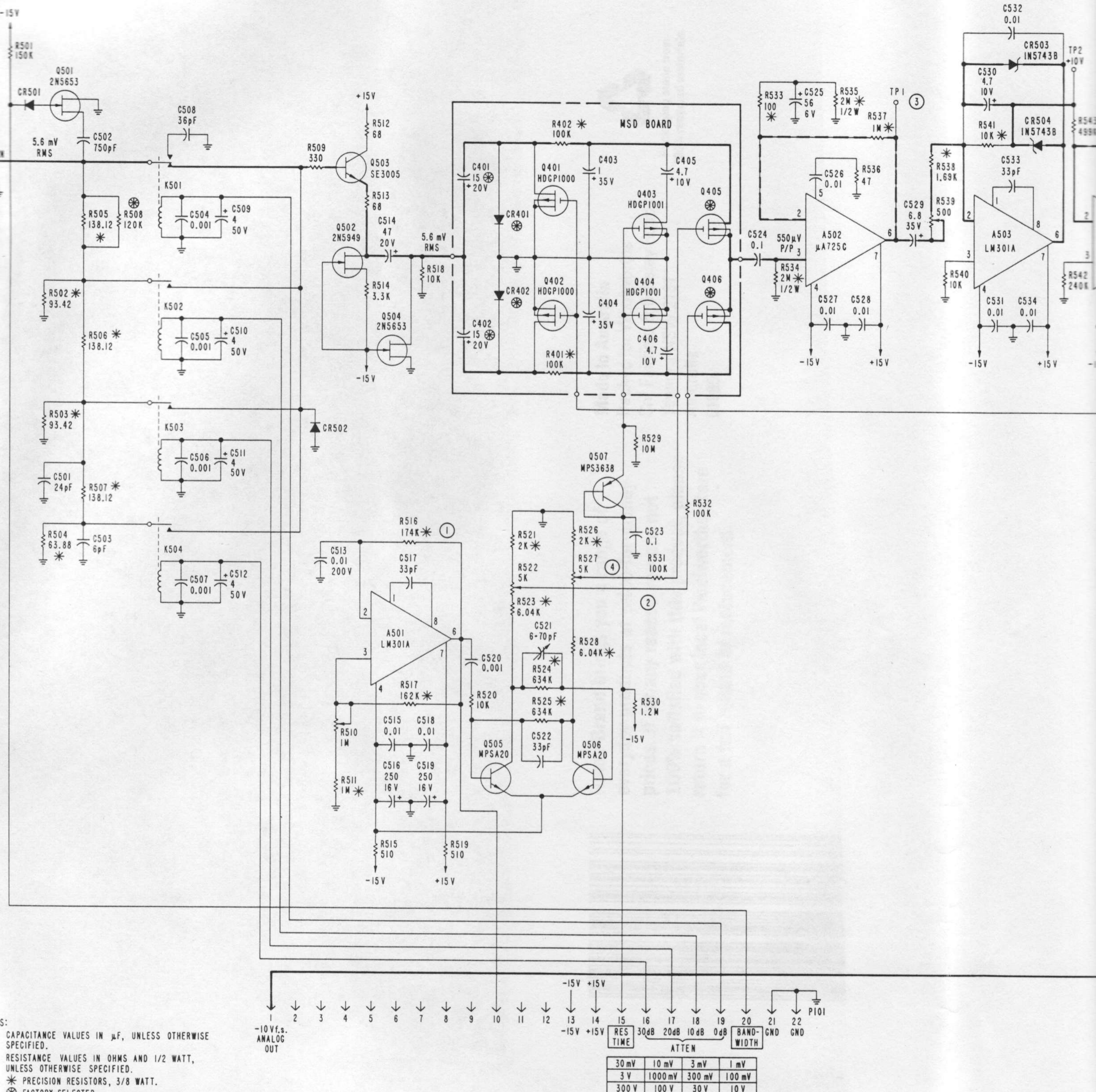
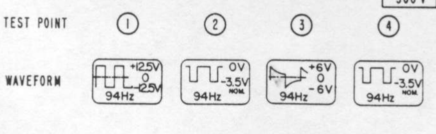
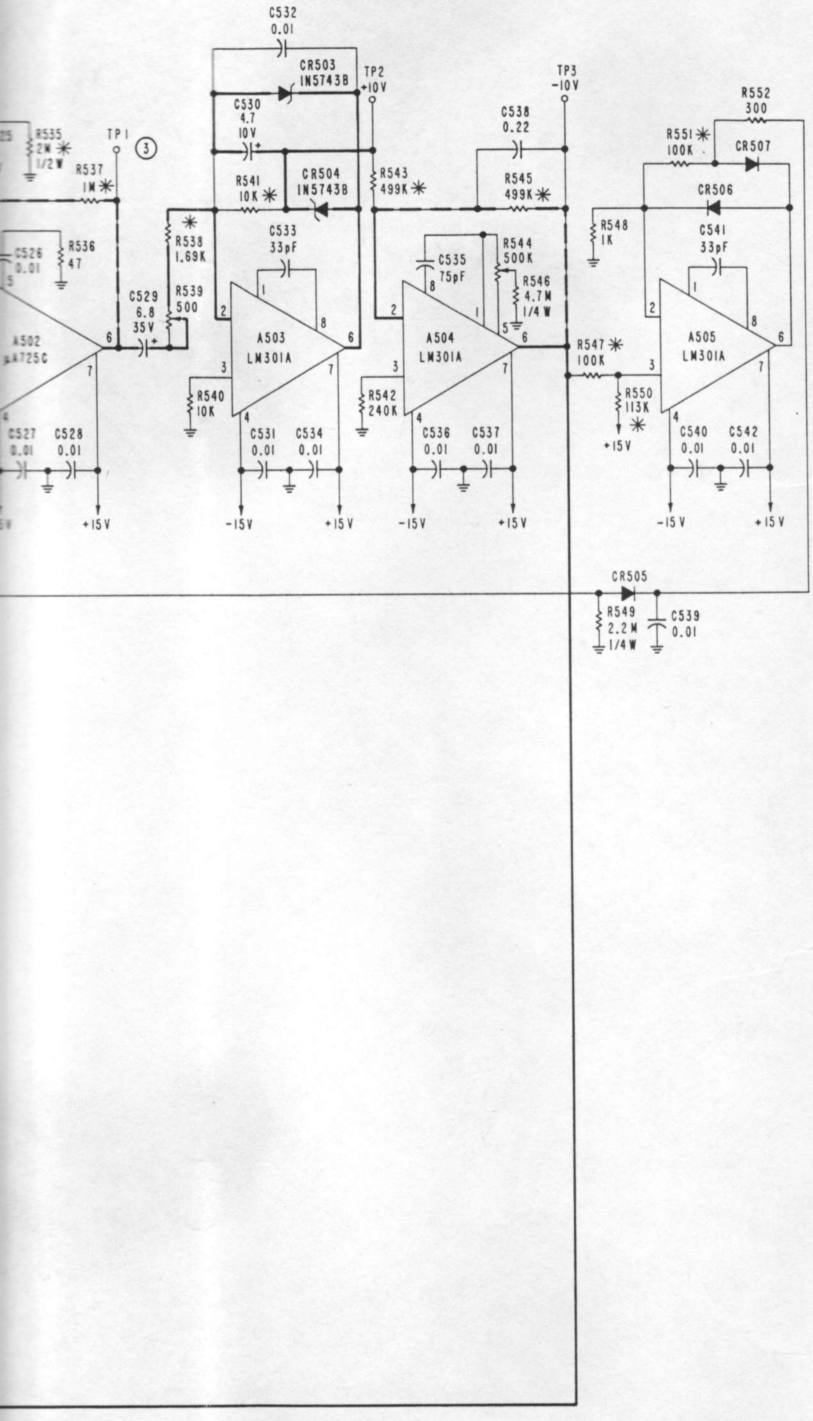


NOTES:

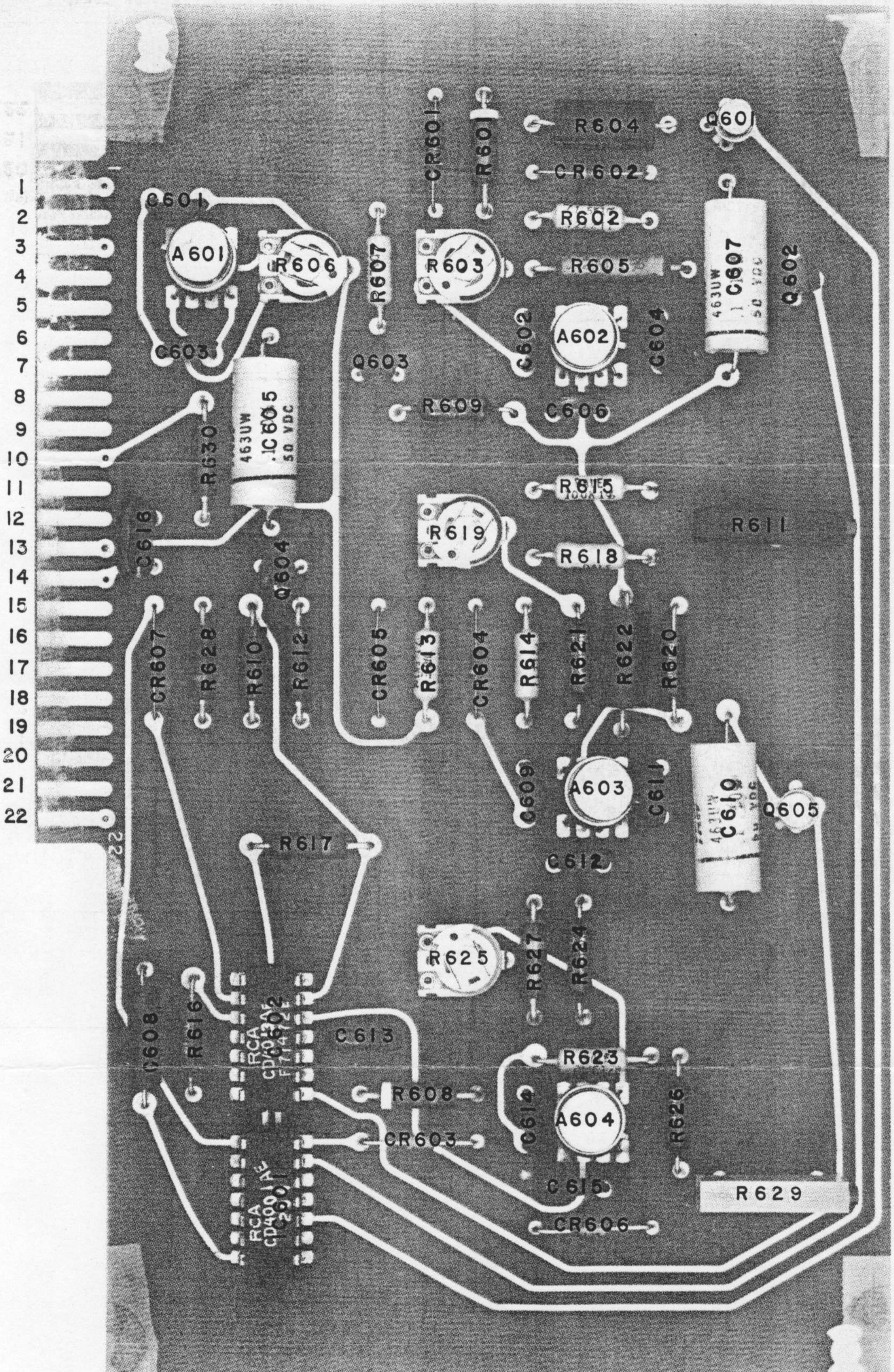
1. CAPACITANCE VALUES IN µF, UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/2 WATT, UNLESS OTHERWISE SPECIFIED.
3. ✳ PRECISION RESISTORS, 3/8 WATT.
4. ⊛ FACTORY SELECTED.
5. ALL DIODES TO BE TYPE IN914, UNLESS OTHERWISE SPECIFIED.
6. TEST CONDITIONS:
   ALL MEASUREMENTS MADE WITH 1kHz 1.0mV INPUT.
   ALL VALUES NOMINAL.
7. LAST NUMBERS USED:
   R402 C406 Q406 CR402
   R552 C542 Q507 CR507 A505 K504
8. ——— SIGNAL PATH
9. — — — FEED BACK PATH
10. ☐ EXTERNAL MARKINGS





BOONTON ELECTRONICS CORPORATION

MODEL 93A
Schematic, Det. Amp.
E830582B Sheet 2 of 2



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Q604
CR607
R628
R610
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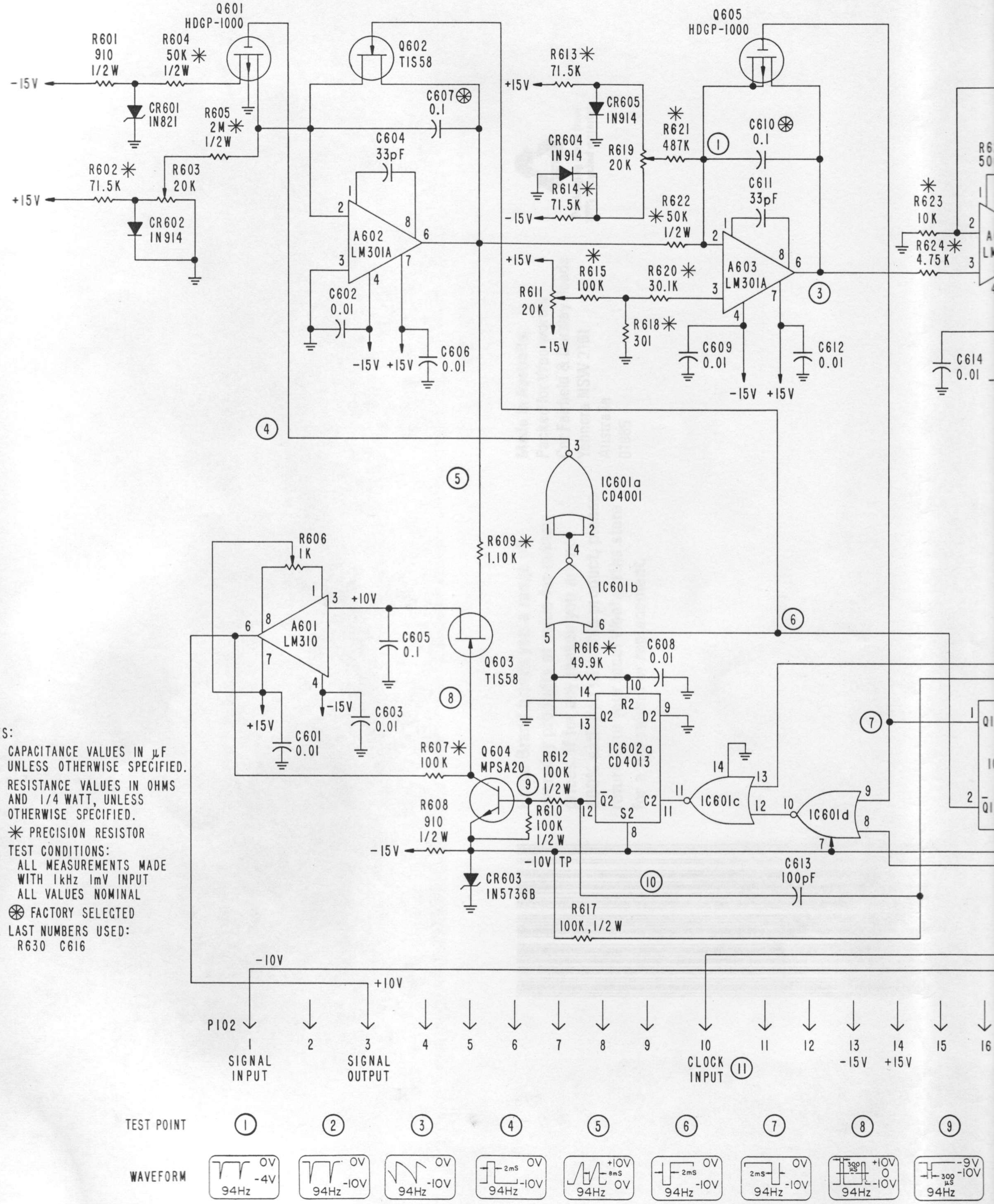
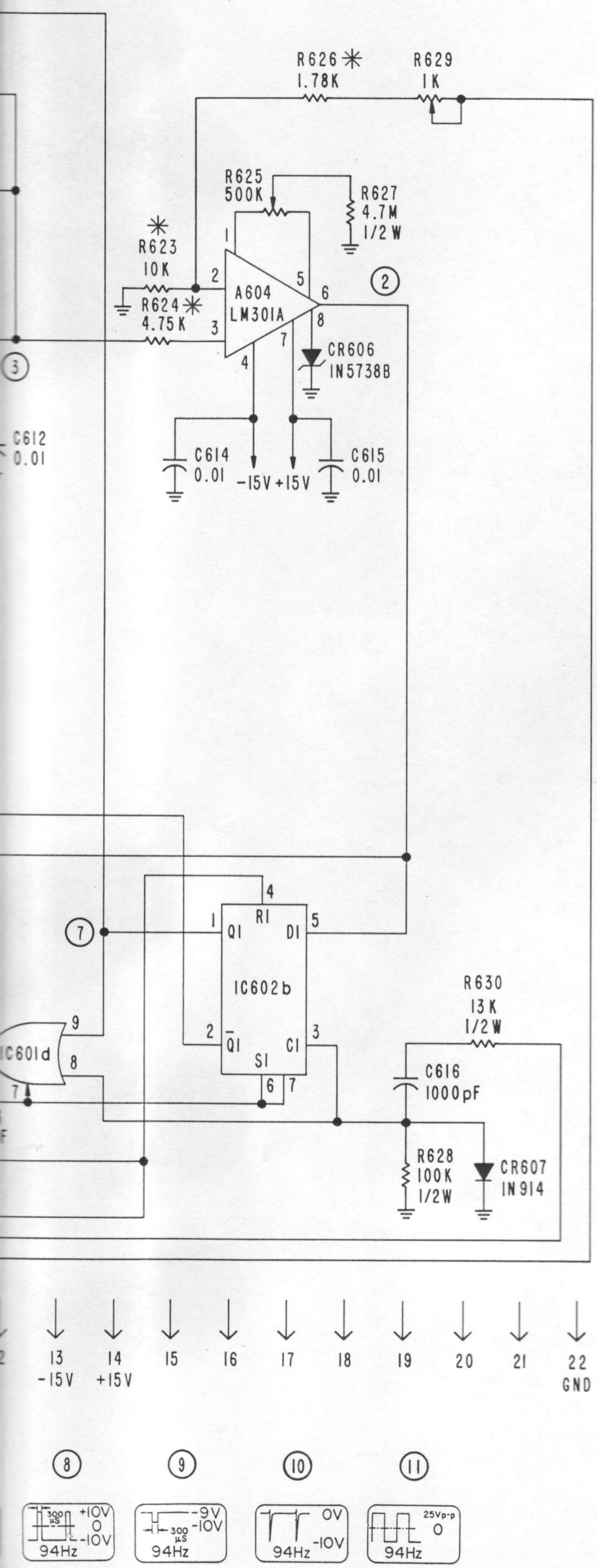
RCA



NOTES:

1. CAPACITANCE VALUES IN μF UNLESS OTHERWISE SPECIFIED.
2. RESISTANCE VALUES IN OHMS AND 1/4 WATT, UNLESS OTHERWISE SPECIFIED.
3. ✳ PRECISION RESISTOR
4. TEST CONDITIONS: ALL MEASUREMENTS MADE WITH 1kHz 1mV INPUT ALL VALUES NOMINAL
5. ⊛ FACTORY SELECTED
6. LAST NUMBERS USED: R630 C616



COMPONENT NUMBERS
600 SERIES

BOONTON ELECTRONICS CORPORATION

MODEL 93A,AD
SCHEMATIC, Shaping Board
D830547D, Sheet 4

WARRANTY

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty. Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

BOONTON
ELECTRONICS
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