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MASTER

10 - DECADE WIDE-RANGE
NEUTRON-MONITORING SYSTEM

FINAL TEST REPORT

W. K. Green

U.S. Atomic Energy Commission

Contract AT(04-3)-189

Project Agreement #49

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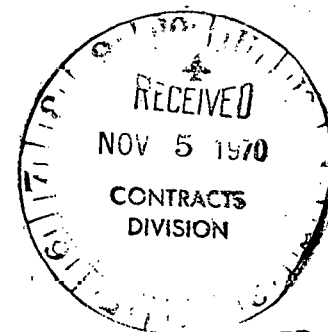
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I N T R O D U C T I O N

The objective of Project Agreement 49 was to design, fabricate, test and evaluate under actual nuclear reactor operating conditions, one prototype counting-Campbell wide-range type thermal neutron flux measurement channel.

This report describes the basic system designed for PA 49, and describes and presents the results of tests conducted on the system. Individual module descriptions and schematics are contained in the instruction manual which was issued with the system.

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SECTION I

GENERAL

I.1 SYSTEM DESCRIPTION

This Wide Range Neutron Monitoring System is designed to monitor ten decades of neutron flux when used with a General Electric Type NA04 (or equivalent) fission chamber. In order to obtain this wide range capability, two different monitoring techniques are employed. For the Low Range, Counting techniques are used; for the Intermediate and High Ranges, Campbell techniques are used. The outputs from the three ranges are applied to an Auction circuit whose output represents the largest of the three input signals. The output from the Auction circuit is applied to the final readout device (Meter, DVM, Recorder, etc.) and is proportional to neutron flux being monitored by the detector. The Auction circuit output is also monitored by a Period circuit to provide a rate of change indication of neutron flux level.

In addition to providing readouts for Percent Power and Period, three meters are added which make it possible to monitor all ranges continuously. Lights over these meters indicate which range is controlling the auction (being applied to the final readout device).

Six trip circuits are provided for indication of malfunction or abnormal conditions. One Upscale trip and one Downscale trip will indicate abnormal neutron flux conditions. One trip monitors the Period circuit output and will indicate when the time rate of change of neutron flux exceeds some preset level. One trip monitors the detector polarizing supply and indicates if this voltage drops below a present level. The remaining two trips monitor the outputs of the three ranges and during startup indicate improper gain setting or malfunctions in the Intermediate and High Ranges.

Internal calibration signals are provided for all three ranges. Each range has two calibration points which allows its slope to be set and monitored for drift. (Note, however, that these calibration signals are not

meant to provide an absolute system calibration of output versus neutron flux.)

Mechanically this system consists of two primary units, these being a preamplifier and a main chassis. The preamplifier is contained in a cast aluminum box which may be separated from the main chassis by as much as 250 feet of cable. The preamplifier is powered from the main chassis.

The main chassis consists of a steel frame housing two 7" X 19" card files and a 7" X 19" meter panel. All the electronic circuitry is plug-in module type except for the Main Amplifier and High Voltage Filter which are enclosed in an aluminum chassis mounted to the back panel. All modules are numbered corresponding to the card file slot in which they are to be mounted. In addition, all modules are mechanically keyed to prevent inserting them into the wrong location.

1.2 RANGE DESCRIPTION

A. Low Range Description

The Low Range of this system (10^{-8} to $10^{-3}\%$ power) employs Counting techniques for measuring neutron flux. Individual pulses generated by the fission chamber are amplified by the preamplifier and a section of the main amplifier. These amplified pulses are applied to a level discriminator which provides a means of rejecting amplifier noise and low level alpha pulses generated by the uranium in the fission chamber. The output from the discriminator is available at a rear panel connector for driving a scaler and is applied to a bistable flip-flop whose output goes to a Cook-Yarborough type Log-Integrator circuit. The DC output from the Log-Integrator is monitored by one section of the auction circuit and, if this signal is the largest of the three channels, applies it to the final readout device.

B. Intermediate Range Description

The Intermediate Range of this system (10^{-3} to $3 \times 10^{-1}\%$ power) employs the Campbelling technique for measuring neutron flux. The signal generated by the fission chamber is amplified by the preamplifier and a section of

the main amplifier. It is then applied to the Intermediate Range Amplifier-Rectifier where its bandwidth is first reduced to 8Kc - 16Kc, then amplified, then half wave rectified and smoothed with a 100ms time constant. The current output from this module is fed to the input of the Intermediate Range Log Ladder whose output is a current proportional to the log of the input current. This DC output from the Log Ladder is monitored by one section of the Auction circuit and, if this signal is the largest of the three channels, applies it to the final readout device.

C. High Range Description

The High Range of this system (3×10^{-1} to 100% power) employs the Campbell technique for measuring neutron flux. The signal generated by the fission chamber is amplified by the preamplifier and a section of the main amplifier. It is then applied to the High Range Amplifier-Rectifier where its bandwidth is first reduced to 300Kc - 600Kc, then amplified, then half-wave rectified and smoothed with a 10ms time constant. The current output from this module is fed to the input of the High Range Log Ladder whose output is a current proportional to the log of the input current. The DC output from the Log Ladder is monitored by one section of the Auction circuit and, if this signal is the largest of the three channels, applies it to the final readout device.

1.3 SPECIFICATIONS

1.0 Temperature and Humidity	5°C to 50°C 0 to 95% R.H.
2.0 Power	120VAC $\pm 10\%$ 60CPS $\pm 5\%$
3.0 Inputs	
3.1 Counting sensitivity and polarity	100 μ v negative pulse
3.2 Campbell sensitivity	20 μ v rms for 10 to 1 signal to noise ratio (Intermediate Range)
3.3 Maximum External capacity on input	2000 pf
4.0 Outputs	
4.1 Recorder	
4.1.1 Percent power	0 to -10mv f.s.
Output impedance	10 Ω

- | | | |
|-------|------------------|-----------------|
| 4.1.2 | Period | 0 to +10mv f.s. |
| | Output impedance | 10 Ω |
- 4.2 Monitor points (load limit $\sim$ 10K Ω).
- | | | |
|-------|------------------------------------|------------------|
| 4.2.1 | Percent power (J25-H) | 0 to -10Vdc f.s. |
| 4.2.2 | Period (J25-J) | 0 to +10Vdc f.s. |
| 4.2.3 | High range monitor (J25-E) | 0 to +10Vdc f.s. |
| 4.2.4 | Intermediate range monitor (J25-F) | 0 to +10Vdc f.s. |
| 4.2.5 | Low range monitor (J25-G) | 0 to +10Vdc f.s. |
| 4.2.6 | Ramp (J25-K) | 0 to -12Vdc |
- 4.3 Scaler (J36)
- 3 volt peak $\sim$ 300 Ω
output impedance
- 4.4 Trips (non-latching)
- | | | |
|-------|----------------------------|-------------------|
| 4.4.1 | UPSCALE | 2 Form C Contacts |
| 4.4.2 | Downscale | 2 Form C Contacts |
| 4.4.3 | Period | 2 Form C Contacts |
| 4.4.4 | High Range Failure | 2 Form C Contacts |
| 4.4.5 | Intermediate Range Failure | 2 Form C Contacts |
| 4.4.6 | Low High Voltage | 2 Form C Contacts |
| 4.4.7 | Inoperative | 1 Form C Contact |
- 4.5 Trips (Latching)(25ma each)
- | | | |
|-------|--------------------|---------------------------|
| 4.5.1 | Upscale | Transistor turn on to gnd |
| 4.5.2 | Downscale | Transistor turn on to gnd |
| 4.5.3 | Period | Transistor turn on to gnd |
| 4.5.4 | High Range Failure | Transistor turn on to gnd |
| 4.5.5 | Intermediate Range | Transistor turn on to gnd |
| 4.5.6 | Low High Voltage | Transistor turn on to gnd |
- 5.0 Controls and Indicators
- 5.1 Mode Switch
- | | |
|-------|--|
| 5.1.1 | Operate |
| 5.1.2 | Standby. Inoperative trip is tripped and range selection must be accomplished manually (Monitor Switch). |
| 5.1.3 | Zero. AC signals disconnected, DC circuitry can be zeroed. |
| 5.1.4 | Test. Provides signal for checking continuity of cables. |
| 5.1.5 | Calibrate. Allows selection of desired calibration signal (Calibrate Switch). |

5.2 Calibrate Switch

5.2.1 LR1 10cps

5.2.2 LR2 10^5 cps

5.2.3 IR1 } $\frac{10^5}{64}$ cps square wave. IR2 = 10 IR1. Used to
 5.2.4 IR2 } adjust slope of Intermediate Range.

5.2.5 HR1 } 10^5 cps square wave. HR2 = 20 HR1. Used to adjust
 5.2.6 HR2 } slope of High Range.

5.2.7 Period

5.2.7.1 Fixed. Used to adjust 10 Second Period Indication.

5.2.7.2 Variable. Can be adjusted to give any period indication greater than ten seconds.

5.3 Monitor Switch (effective in all Mode Positions except OPERATE)

5.3.1 High. Applies High Range output to Percent Power Indicator.

5.3.2 Intermediate. Applies Intermediate Range Output to Percent Power Indicator.

5.3.3 Low. Applies Low Range Output to Percent Power Indicator.

5.4 Trip Reset Switch. Resets all latching trips after cause of trip has been corrected.

5.5 Ramp Reset Switch. Resets Ramp Generator used in Period Calibration.

5.6 Meters

5.6.1 Percent Power

5.6.2 Period

5.6.3 High Range

5.6.4 Low Range

5.6.5 Intermediate Range

5.7 Lights

5.7.1 Upscale Trip (latching)

5.7.2 Downscale Trip (latching)

5.7.3 High Range Failure Trip (latching)

5.7.4 Intermediate Range Failure Trip (latching)

5.7.5 Period Trip (latching)

5.7.6 Low High Voltage Trip (latching)

5.7.7 Inoperative Trip (non-latching)

5.7.8 Auction Indicators

5.7.8.1 Low Range

5.7.8.2 Intermediate Range

5.7.8.3 High Range

6.0 Performance

6.1 Percent Power

6.1.1 Accuracy

 10^{-8} to 10^{-1} $\pm 4\%$ linear f.s. output 10^{-1} to 100 $\pm 2\%$ linear f.s. output

6.1.2 Response

 10^{-8} to 10^{-6} ~ 40 seconds 10^{-6} to 10^{-5} ~ 15 seconds 10^{-5} to 10^{-4} ~ 1.5 seconds 10^{-4} to 3×10^{-1} ~ 100 ms 3×10^{-1} to 100 ~ 10 ms

6.2 Period

6.2.1 Accuracy

 $\pm 4\%$ actual

6.2.2 Response

 ~ 8 seconds for 0 to 63%
of final for ramp input

7.0 Construction

Page type chassis

Modular electronic units

DATE 12-20-64

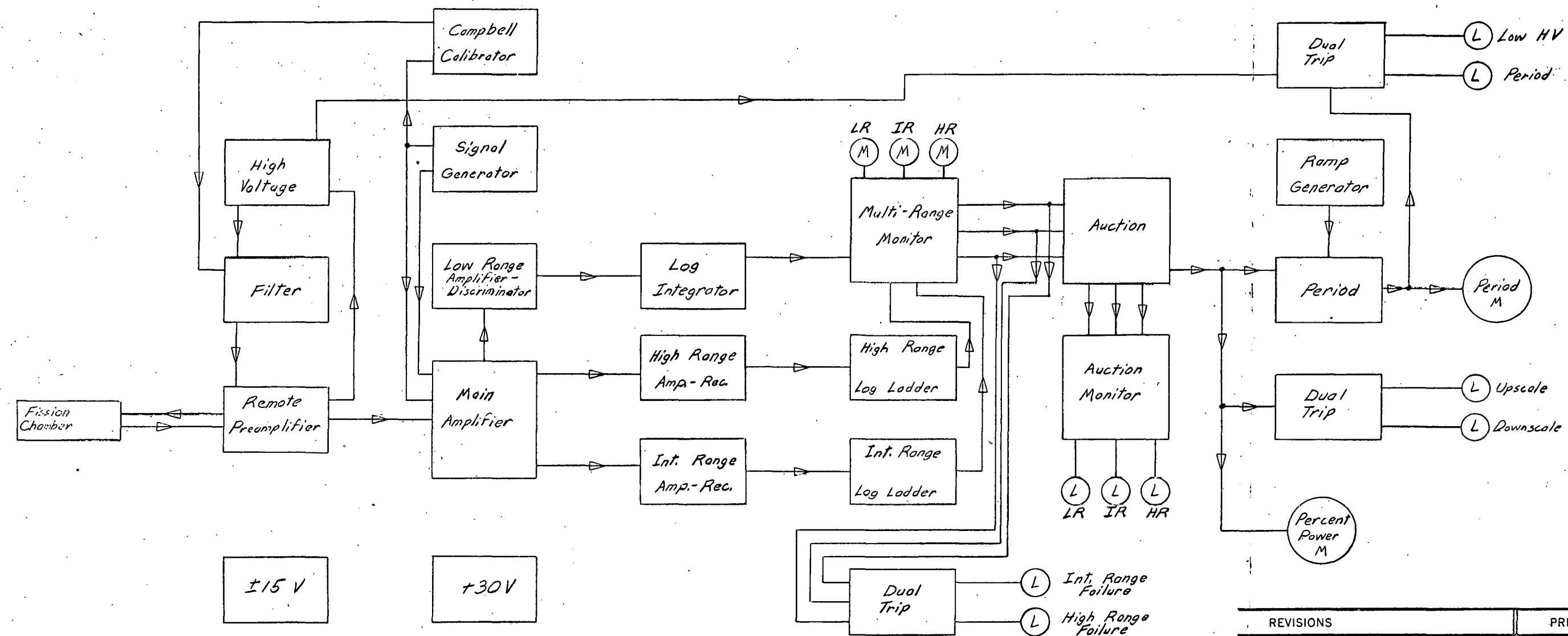
ON HS
CONT ON SHEET
DRAWING NO.

GENERAL ELECTRIC

Figure 1-1
CONT ON SHEET SH NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—					REV NO.
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS			CONT ON SHEET SH NO.
		FRACTIONS	DECIMALS	ANGLES	
	✓	+	+	+	

TITLE
10 DECADE LOG NEUTRON MONITOR
FIRST MADE FOR



M ~ Meter
L ~ Light
LR ~ Low Range
IR ~ Intermediate Range
HR ~ High Range

REVISIONS		PRINTS TO	

MADE BY: WGreen 1/5/68
ISSUED: APPROVALS: DIV OR DEPT: LOCATION: CONT ON SHEET SH NO. 6A

SECTION II

TEST DESCRIPTIONS AND RESULTS

2.1 ENVIRONMENTAL

The purpose of this test was to determine what effects, if any, variations in temperature, humidity and line voltage might have on operation of the WRM System.

During the test the WRM System was placed in an environmental chamber so that the temperature and humidity could be varied. The AC power to the system was controlled by means of a variac. Input signal sources consisted of 1) A pulser for Low Range tests and 2) A noise generator for the Intermediate and High Ranges tests. The pulser output was monitored by a scaler and the noise generator output was measured by a true RMS Voltmeter. A diagram of the test setup is shown in Figure 2-1.

Test data is provided in Tables 2-1 through 2-12 and shown graphically in Figures 2-2 through 2-4. These tests show the system accuracy to be $\pm 1\%$ full scale over the top three decades and $\pm 2\%$ full scale over the bottom seven decades. Period accuracy is $\pm 4\%$ full scale.

The only problems encountered during this test was with the Period circuit and Ramp Generator. Both units use hi-meg resistors and low leakage capacitors in their circuitry and both exhibited excessive drift at the high temperature, high humidity conditions. These problems were solved by spraying both boards with PT-107 (Moisture and Fungus Resistant Varnish) and keeping low current switching on the boards through the use of reed relays.

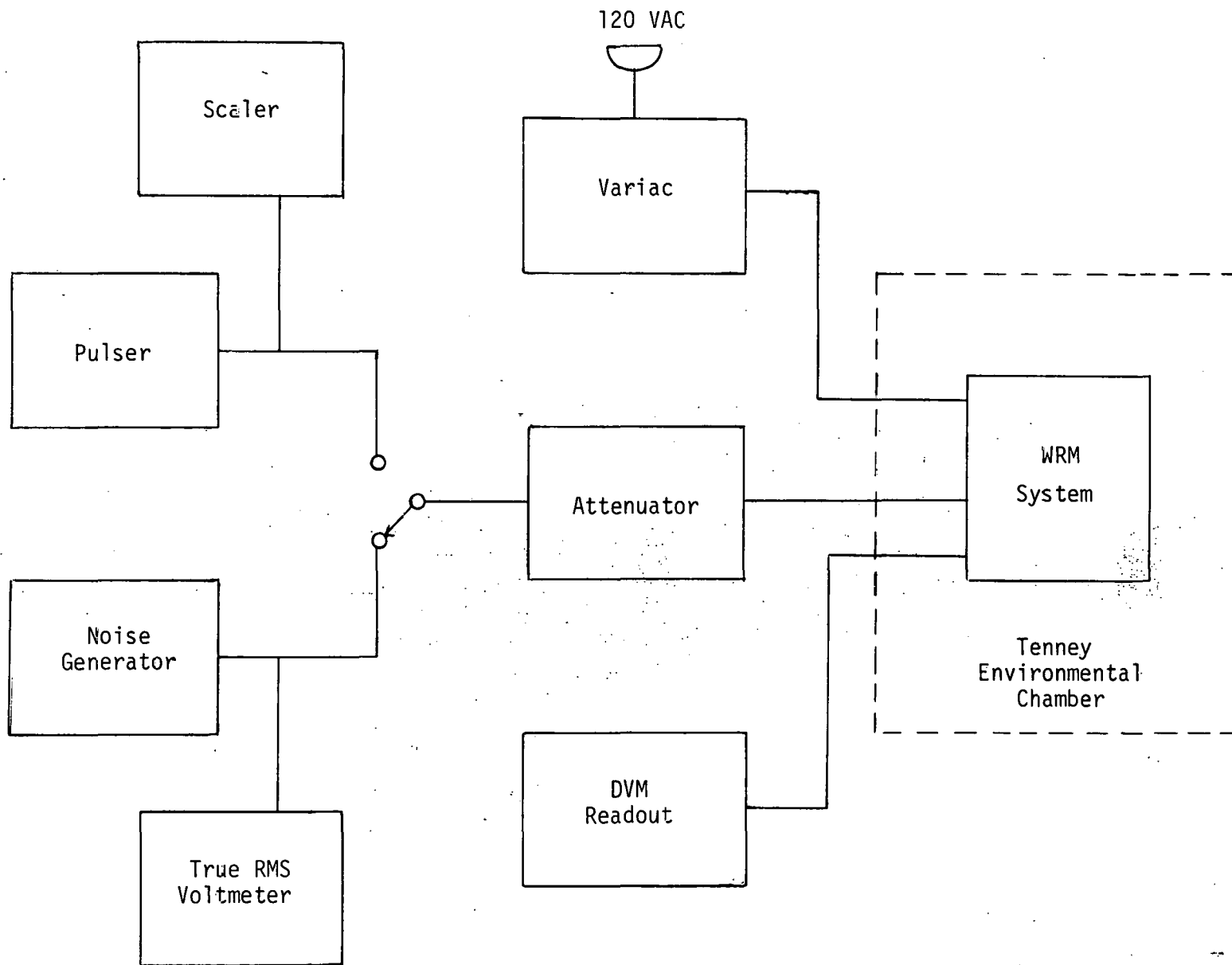


Figure 2-1 Environmental Test Setup

Relative Humidity (%)	Temperature (°F)	Line Voltage (Volts AC)	+15	-15	+30	High Voltage
---	20	120	15.00	14.99	29.79	385.5
---	20	108	14.99	14.98	29.75	385.5
---	20	132	15.00	14.99	29.77	385.5
---	40	120	15.00	14.99	29.84	404.5
---	40	108	15.00	14.99	29.84	404.5
---	40	132	15.00	14.99	29.84	404.5
50	60	120	14.98	14.98	29.90	408.0
50	60	108	14.98	14.98	29.90	408.0
50	60	132	14.98	14.98	29.90	408.0
50	80	120	15.00	14.98	29.99	409.6
50	80	108	15.00	14.98	29.99	409.6
50	80	132	15.00	14.98	29.99	409.6
95+	80	120	14.97	14.97	29.93	409.8
95+	80	108	14.97	14.97	29.93	409.8
95+	80	132	14.97	14.97	29.93	409.8
50	100	120	14.98	14.98	30.00	410.8
50	100	108	14.98	14.98	30.00	410.8
50	100	132	14.98	14.98	30.00	410.8
95+	100	120	14.98	14.97	30.01	411.0
95+	100	108	14.98	14.97	30.01	411.0
95+	100	132	14.98	14.97	30.01	411.0
50	120	120	14.99	14.99	30.10	410.8
50	120	108	14.99	14.99	30.10	410.8
50	120	132	14.99	14.99	30.10	410.8
95+	120	120	15.00	14.99	30.09	411.2
95+	120	108	14.99	14.99	30.09	411.2
95+	120	132	15.00	14.99	30.09	411.2

TABLE 2-1 Environmental Test (Power Supplies)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1		1.7	1.5	19.5	2.0
2	.325	2.0	2.9	23.0	4.0
4	.60	2.2	3.92	26.5	6.0
7	.86	2.28	4.0	48.7	7.0
10	1.01	3.04	4.3	69.0	7.3
20	1.33	4.1	4.6	95.0	7.6
40	1.62	5.3	4.8	124.0	7.8
70	1.86	6.7	5.0	156.0	8.6
100	2.02	9.2	5.3	226.0	8.3
200	2.32	13.6	5.6	321.0	8.6
400	2.63	16.7	5.8	390.0	8.8
700	2.88	21.0	6.0	505.0	9.0
10 ³	3.04	30.5	6.3	700.0	9.3
2 X 10 ³	3.35	41.3	6.6	1,000	9.6
4 X 10 ³	3.66	55.0	6.8	1,280	9.8
7 X 10 ³	3.91	68.5	7.0	1,560	10.0
10 ⁴	4.07	96.0	7.3	1,860	10.2
2 X 10 ⁴	4.38	139.0	7.6	2,080	10.3
4 X 10 ⁴	4.68	168.0	7.8	2,039	10.35
7 X 10 ⁴	4.92	200.0	7.9	2,048	10.36
10 ⁵	5.07	250.0	7.95		
2 X 10 ⁵	5.36	300.0	7.97		
4 X 10 ⁵	5.65				
7 X 10 ⁵	5.90				
10 ⁶	6.06				

TABLE 2-2 Environmental Test (20°F)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.05	1.7	7.5	2.2	2.0
2	.315	2.0	3.15	2.43	4.0
4	.61	2.2	3.97	2.77	6.0
7	.85	2.25	4.0	4.87	7.0
10	1.01	3.0	4.3	6.8	7.3
20	1.31	4.1	4.6	9.4	7.6
40	1.61	5.3	4.8	12.3	7.8
70	1.85	6.7	5.0	15.3	8.0
100	2.02	9.2	5.3	22.0	8.3
200	2.33	13.5	5.6	31.4	8.6
400	2.63	16.6	5.8	38.1	8.8
700	2.88	20.7	6.0	49.1	9.0
10 ³	3.04	30.0	6.3	68.5	9.3
2 X 10 ³	3.35	41.0	6.6	97.0	9.6
4 X 10 ³	3.66	53.0	6.8	124.0	9.8
7 X 10 ³	3.91	67.0	7.0	153.0	10.0
10 ⁴	4.07	92.0	7.3	173.0	10.2
2 X 10 ⁴	4.38	135.0	7.6	202.0	10.3
4 X 10 ⁴	4.68	167.0	7.8	217.0	10.34
7 X 10 ⁴	4.92	300.0	8.0	263.0	10.40
10 ⁵	5.07	350.0	8.01		
2 X 10 ⁵	5.37	400.0	8.02		
4 X 10 ⁵	5.66				
7 X 10 ⁵	5.90				
10 ⁶	6.06				

TABLE 2-3 Environmental Test (40°F)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.034	1.7	1.4	2.1	2.0
2	.31	2.0	3.1	2.43	4.0
4	.60	2.2	3.95	2.77	6.0
7	.84	2.24	4.0	4.8	7.0
10	1.00	3.0	4.3	6.7	7.3
20	1.30	4.0	4.6	9.2	7.6
40	1.60	5.3	4.8	12.0	7.8
70	1.85	6.7	5.0	15.0	8.0
100	2.01	9.1	5.3	21.3	8.3
200	2.32	13.3	5.6	30.7	8.6
400	2.63	16.3	5.8	37.5	8.8
700	7.88	20.3	6.0	47.7	9.0
10 ³	3.04	29.5	6.3	67.0	9.3
2 X 10 ³	3.35	40.0	6.6	94.0	9.6
4 X 10 ³	3.66	52.0	6.8	122.0	9.8
7 X 10 ³	3.91	66.0	7.0	151.0	10.0
10 ⁴	4.07	91.0	7.3	180.0	10.2
2 X 10 ⁴	4.38	132.0	7.6	197.0	10.3
4 X 10 ⁴	4.68	163.0	7.8	233.0	10.4
7 X 10 ⁴	4.92	240.0	8.0		
10 ⁵	5.07	300.0	8.03		
2 X 10 ⁵	5.36	350.0	8.04		
4 X 10 ⁵	5.66	400.0	8.05		
7 X 10 ⁵	5.90				
10 ⁶	6.07				

TABLE 2-4 Environmental Test (60°F, 50% R.H.)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.03	1.7	1.3	2.07	2.0
2	.31	2.0	3.1	2.43	4.0
4	.61	2.25	4.0	2.76	6.0
7	.84	3.0	4.3	4.75	7.0
10	.99	4.03	4.6	6.7	7.3
20	1.29	5.25	4.8	9.1	7.6
40	1.60	6.6	5.0	11.8	7.8
70	1.85	8.9	5.3	14.9	8.0
100	2.01	13.2	5.6	21.0	8.3
200	2.32	16.2	5.8	30.2	8.6
400	2.62	20.2	6.0	37.0	8.8
700	2.87	29.0	6.3	46.8	9.0
10 ³	3.04	40.0	6.6	66.0	9.3
2 X 10 ³	3.35	51.5	6.8	92.0	9.6
4 X 10 ³	3.66	65.5	7.0	119.0	9.8
7 X 10 ³	3.91	88.0	7.3	149.0	10.0
10 ⁴	4.07	130.0	7.6	179.0	10.2
2 X 10 ⁴	4.38	160.0	7.8	194.0	10.3
4 X 10 ⁴	4.68	219.0	8.0	222.0	10.4
7 X 10 ⁴	4.92	250.0	8.03	250.0	10.44
10 ⁵	5.07	300.0	8.05		
2 X 10 ⁵	5.37	350.0	8.07		
4 X 10 ⁵	5.66				
7 X 10 ⁵	5.91				
10 ⁶	6.08				

TABLE 2-5 Environmental Test (80°F, 50% R.H.)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.03	1.7	1.4	2.06	2.0
2	.34	2.0	3.0	2.42	4.0
4	.60	2.25	4.0	2.75	6.0
7	.84	3.0	4.3	4.7	7.0
10	1.00	4.0	4.6	6.6	7.3
20	1.30	5.2	4.8	9.0	7.6
40	1.59	6.6	5.0	11.8	7.8
70	1.81	8.9	5.3	14.9	8.0
100	2.00	13.2	5.6	21.0	8.3
200	2.32	16.3	5.8	30.0	8.6
400	2.63	20.1	6.0	36.6	8.8
700	2.87	29.0	6.3	47.0	9.0
10 ³	3.04	39.0	6.6	66.0	9.3
2 X 10 ³	3.35	51.0	6.8	92.0	9.6
4 X 10 ³	3.66	64.5	7.0	119.0	9.8
7 X 10 ³	3.91	89.0	7.3	148.0	10.0
10 ⁴	4.08	130.0	7.6	178.0	10.2
2 X 10 ⁴	4.38	160.0	7.8	192.0	10.3
4 X 10 ⁴	4.68	210.0	8.0	220.0	10.4
7 X 10 ⁴	4.93	250.0	8.03	243.0	10.44
10 ⁵	5.08	300.0	8.06		
2 X 10 ⁵	5.37	350.0	8.07		
4 X 10 ⁵	5.67				
7 X 10 ⁵	5.92				
10 ⁶	6.08				

TABLE 2-6 Environmental Test (80°F, 95% R.H.)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.03	1.2	1.3	2.6	2.0
2	.32	2.0	3.0	2.4	4.0
4	.60	2.2	3.9	2.75	6.0
7	.85	2.26	4.0	4.7	7.0
10	1.01	3.0	4.3	6.55	7.3
20	1.29	4.06	4.6	8.9	7.6
40	1.60	5.2	4.8	11.7	7.8
70	1.85	6.6	5.0	14.8	8.0
100	2.01	8.9	5.3	20.7	8.3
200	2.32	13.2	5.6	30.0	8.6
400	2.63	16.1	5.8	36.5	8.8
700	2.89	19.8	6.0	46.0	9.0
10 ³	3.05	28.8	6.3	65.0	9.3
2 X 10 ³	3.37	39.0	6.6	90.0	9.6
4 X 10 ³	3.68	50.0	6.8	117.0	9.8
7 X 10 ³	3.93	64.0	7.0	147.0	10.0
10 ⁴	4.09	88.0	7.3	176.0	10.2
2 X 10 ⁴	4.40	128.0	7.6	190.0	10.3
4 X 10 ⁴	4.70	158.0	7.8	212.0	10.4
7 X 10 ⁴	4.94	200.0	8.0	238.0	10.45
10 ⁵	5.10	250.0	8.05	259.0	10.47
2 X 10 ⁵	5.39	300.0	8.08		
4 X 10 ⁵	5.69	350.0	8.09		
7 X 10 ⁵	5.94				
10 ⁶	6.11				

TABLE 2-7 Environmental Test (100°F, 50% R.H.)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.03	1.7	1.3	2.06	2.0
2	.33	2.0	3.0	2.40	4.0
4	.60	2.2	3.9	2.75	6.0
7	.84	2.28	4.0	4.65	7.0
10	1.03	3.0	4.3	6.6	7.3
20	1.30	4.1	4.6	8.9	7.6
40	1.59	5.2	4.8	11.7	7.8
70	1.84	6.6	5.0	14.7	8.0
100	2.02	9.0	5.3	20.4	8.3
200	2.33	13.1	5.6	30.0	8.6
400	2.64	16.0	5.8	36.2	8.8
700	2.90	20.2	6.0	46.0	9.0
10 ³	3.06	29.0	6.3	64.5	9.3
2 X 10 ³	3.37	39.0	6.6	90.0	9.6
4 X 10 ³	3.68	50.5	6.8	127.0	9.8
7 X 10 ³	3.94	64.0	7.0	146.0	10.0
10 ⁴	4.10	87.0	7.3	175.0	10.2
2 X 10 ⁴	4.41	128.0	7.6	190.0	10.3
4 X 10 ⁴	4.71	158.0	7.8	210.0	10.4
7 X 10 ⁴	4.95	200.0	8.0	250.0	10.47
10 ⁵	5.11	250.0	8.06	264.0	10.48
2 X 10 ⁵	5.41	300.0	8.08		
4 X 10 ⁵	5.70	350.0	8.10		
7 X 10 ⁵	5.95				
10 ⁶	6.12				

TABLE 2-8 Environmental Test (100°F, 95% R.H.)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.03	1.7	1.3	2.05	2.0
2	.31	2.0	2.9	2.4	4.0
4	.60	2.2	3.9	2.65	6.0
7	.85	2.3	4.0	4.7	7.0
10	1.01	3.02	4.3	6.52	7.3
20	1.31	4.1	4.6	9.0	7.6
40	1.62	5.25	4.8	11.7	7.8
70	1.85	6.6	5.0	14.7	8.0
100	2.03	8.9	5.3	20.8	8.3
200	2.35	13.3	5.6	30.0	8.6
400	2.67	16.0	5.8	36.2	8.8
700	2.92	20.0	6.0	46.3	9.0
10 ³	3.09	28.8	6.3	65.0	9.3
2 X 10 ³	3.40	38.5	6.6	90.0	9.6
4 X 10 ³	3.72	49.0	6.8	117.0	9.8
7 X 10 ³	3.97	64.0	7.0	147.0	10.0
10 ⁴	4.13	86.0	7.3	175.0	10.2
2 X 10 ⁴	4.44	126.0	7.6	189.0	10.3
4 X 10 ⁴	4.75	156.0	7.8	210.0	10.4
7 X 10 ⁴	4.99	195.0	8.0	250.0	10.47
10 ⁵	5.15	228.0	8.05		
2 X 10 ⁵	5.44	250.0	8.07		
4 X 10 ⁵	5.74	300.0	8.09		
7 X 10 ⁵	6.00	350.0	8.11		
10 ⁶	6.17				

TABLE 2-9 Environmental Test (120°F, 50% R.H.)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.03	1.7	1.3	2.04	2.0
2	.32	2.0	3.0	2.39	4.0
4	.59	2.2	3.9	2.64	6.0
7	.84	2.3	4.0	4.67	7.0
10	1.02	3.02	4.3	6.55	7.3
20	1.31	4.1	4.6	9.0	7.6
40	1.60	5.3	4.8	11.7	7.8
70	1.85	6.6	5.0	14.7	8.0
100	2.04	9.0	5.3	20.6	8.3
200	2.36	13.1	5.6	29.8	8.6
400	2.68	16.2	5.8	36.0	8.8
700	2.92	20.0	6.0	46.0	9.0
10 ³	3.09	28.8	6.3	64.5	9.3
2 X 10 ³	3.41	38.8	6.6	90.0	9.6
4 X 10 ³	3.72	50.0	6.8	117.0	9.8
7 X 10 ³	3.98	63.5	7.0	146.0	10.0
10 ⁴	4.14	86.0	7.3	176.0	10.2
2 X 10 ⁴	4.45	125.0	7.6	189.0	10.3
4 X 10 ⁴	4.76	155.0	7.8	210.0	10.4
7 X 10 ⁴	5.01	197.0	8.0	250.0	10.47
10 ⁵	5.16	250.0	8.07	266.0	10.48
2 X 10 ⁵	5.46	300.0	8.09		
4 X 10 ⁵	5.76	350.0	8.11		
7 X 10 ⁵	6.01				
10 ⁶	6.18				

TABLE 2-10 Environmental Test (120°F, 95% R.H.)

Relative Humidity (%)	Temperature (°F)	LR1 (C/100 Sec)	LR2 (Kc)	IR1 (Volts DC)	IR2 (Volts DC)	HR1 (Volts DC)	HR2 (Volts DC)
---	20	1031	99.97				
---	40	1020	99.98	4.994 (5.004)	6.976 (6.996)	7.988 (8.028)	9.982 (10.022)
50	60	1009	99.98				
50	80	1003	99.98	4.999	7.004	8.005	9.999
95+	80	1001	99.98				
50	100	995	99.98				
95+	100	995	99.98				
50	120	994	99.98	5.018 (5.018)	7.047 (7.030)	8.048 (8.036)	10.048 (10.036)
95	120	993	99.98	5.015 (5.015)	7.045 (7.020)	8.043 (8.031)	10.047 (10.030)

NOTE: IR1, IR2, HR1 and HR2 were checked by processing them through the system in the normal manner. The numbers in () are corrected for system gain changes with temperature, and are normalized to conditions at 80°F, 50% R.H.

TABLE 2-11 Environmental Test (Calibration Signals)

Relative Humidity (%)	Temperature (°F)	Ramp (Volts/100 Sec)	Period* (Volts DC)
---	20	4.21	10.170 (10.52)
---	40	4.28	10.103 (10.29)
50	60	4.33	10.067 (10.13)
50	80	4.36	10.041
95	80	4.33	9.91 (9.97)
50	100	4.38	9.994 (9.93)
50	120	4.43	9.92 (9.75)
95	120	4.43	9.87 (9.70)

*NOTE: Unbracketed numbers represent measured period output for a ramp of the given rate. Bracketed numbers represent what the period would read if the ramp had been equal to that at 50% R.H., 80°F.

TABLE 2-12 Environmental Test (Ramp Generator and Period Circuit)

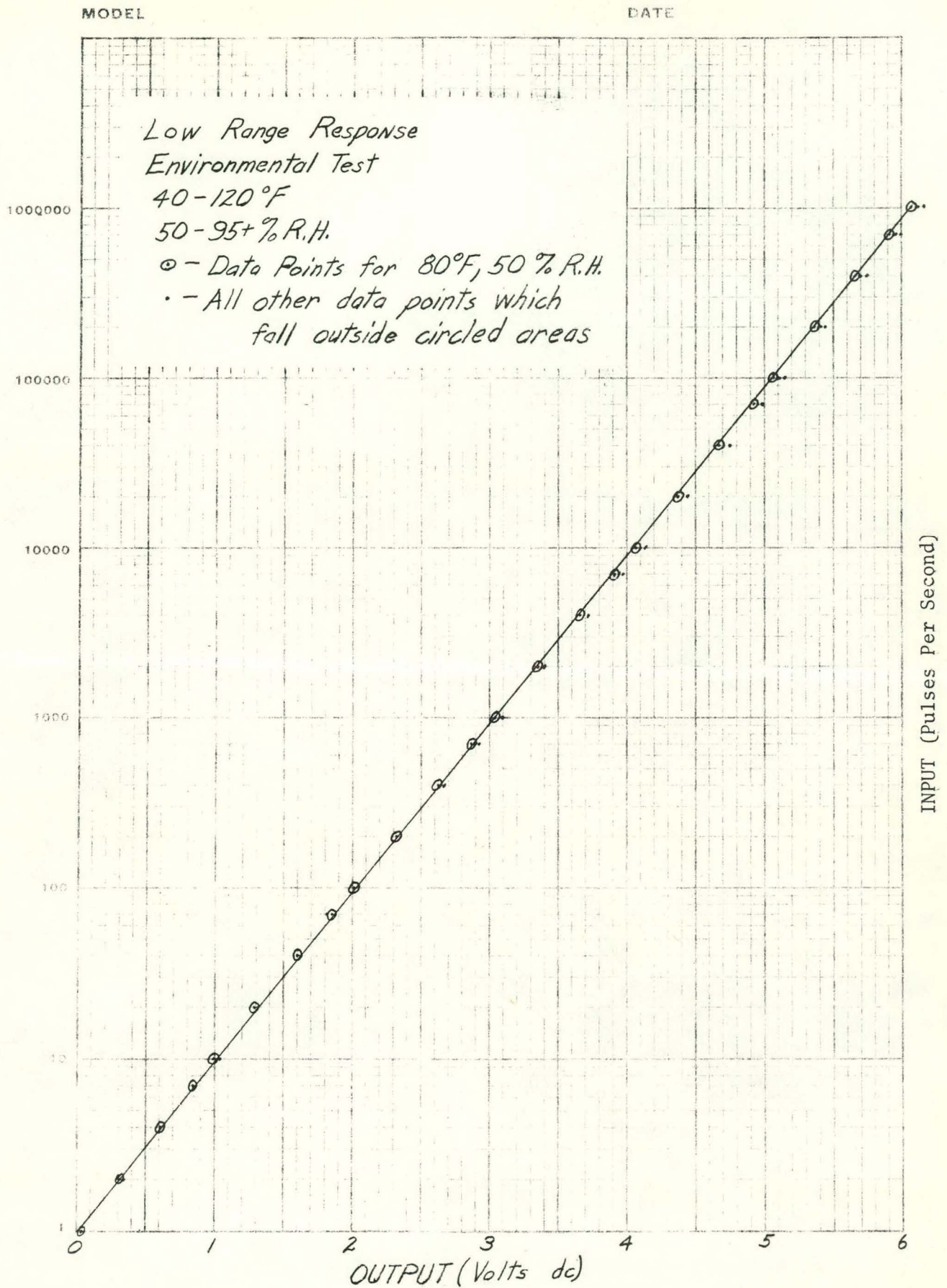
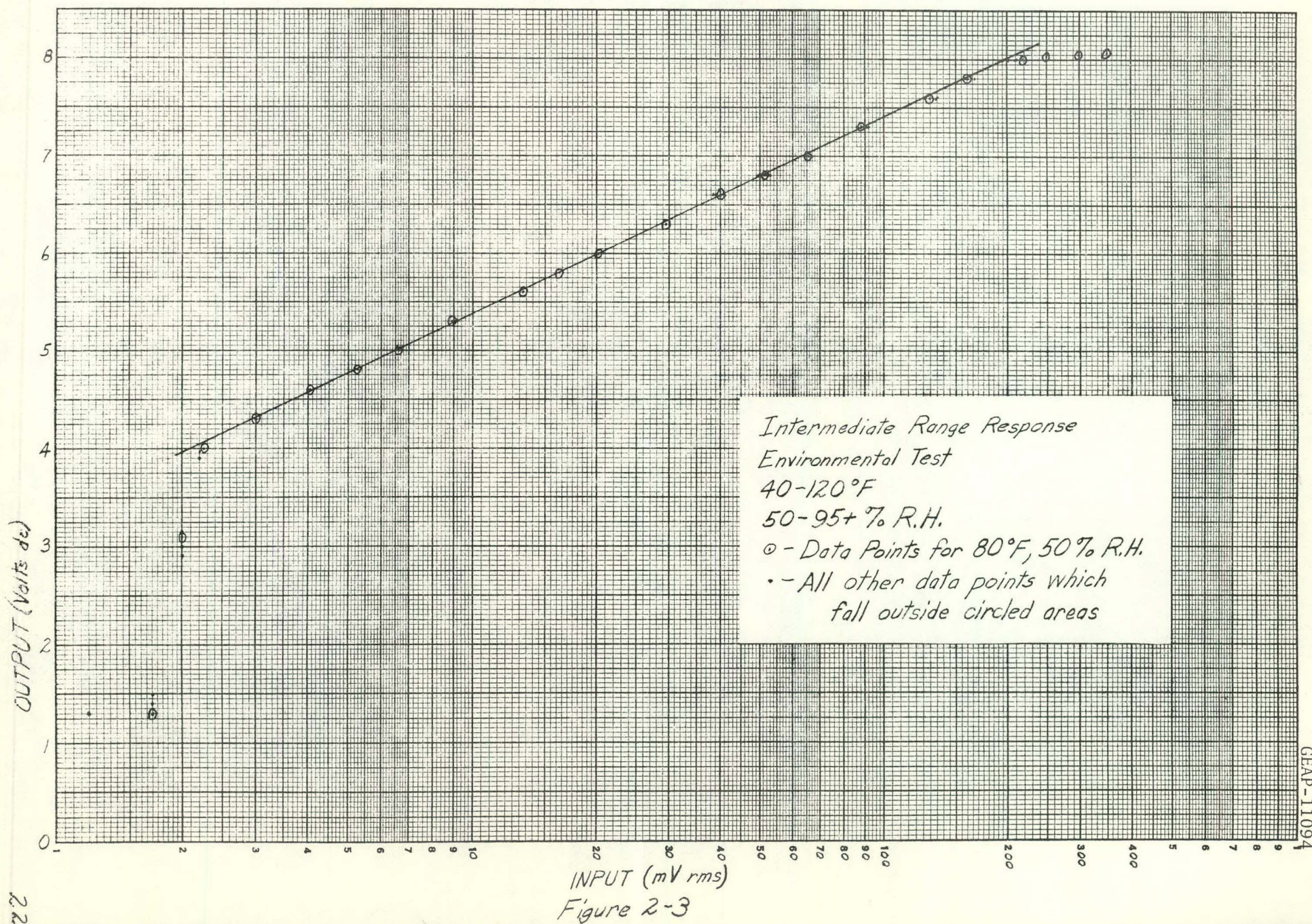
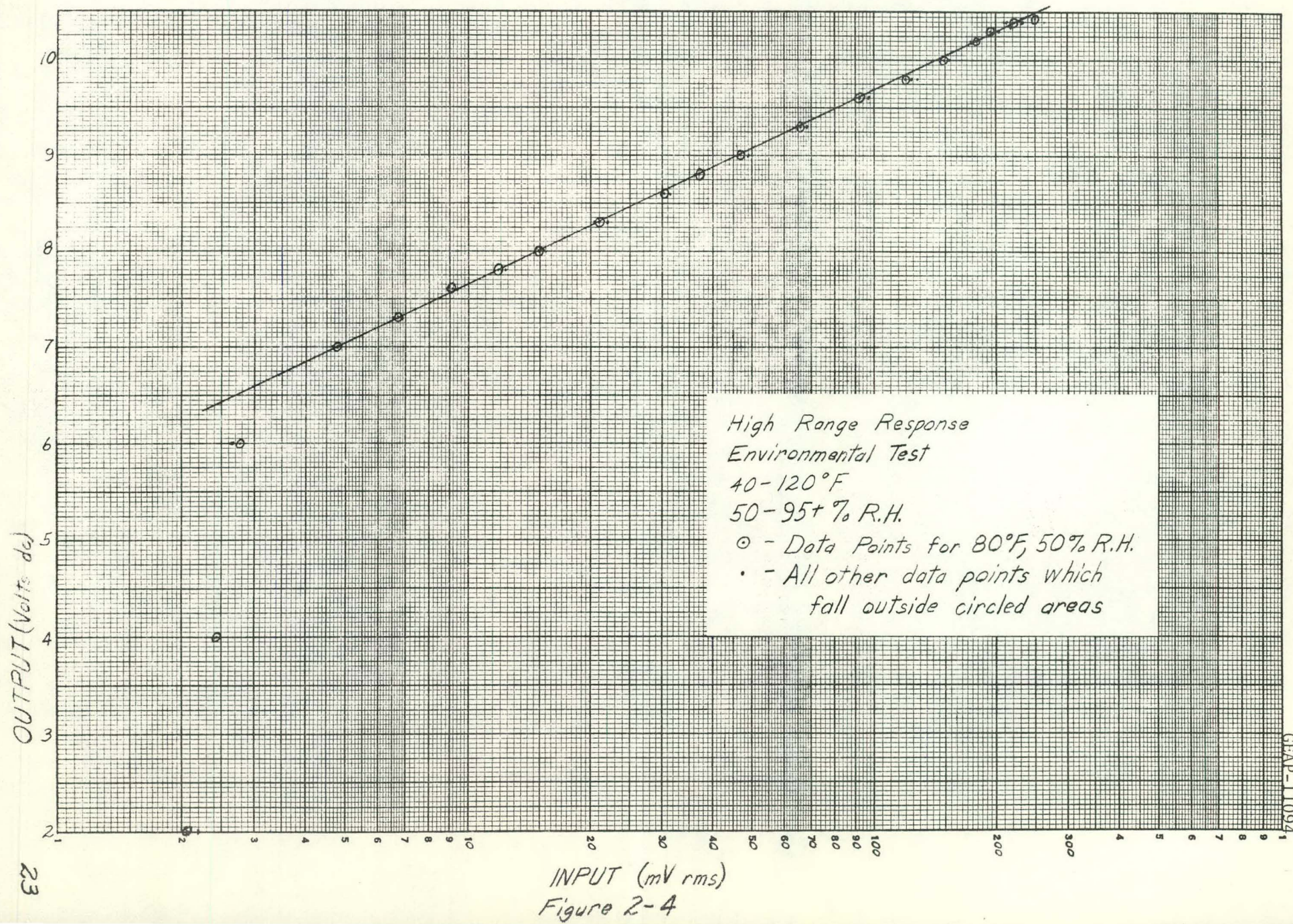


Figure 2-2





INPUT (mV rms)
Figure 2-4

2.2 ACCELERATED LIFE

This test was performed per D.O.D. Specification MIL-N-52334(M0), Paragraphs 4.6.12 and 4.6.13. The test setup for Paragraph 4.6.12 was the same as described under Environmental Test.

Figure 2-5 illustrates a typical temperature cycle. Note the two traces visible only during the transition periods. These represent the wet and dry bulb temperature readings. During steady state conditions, both temperatures read the same, thus indicating that the relative humidity inside the test chamber is nearly 100%.

Tables 2-13 through 2-15 and Figures 2-6 through 2-8 illustrate the results for the test described in Paragraph 4.6.12.

For the test described in Paragraph 4.6.13, some of the main chassis wiring in the WRM System had to be changed so that all calibration signals plus the High Voltage Power Supply could be turned on at once. All data was recorded by a DVM whose output was used to drive a combination printer and paper tape punch. The DVM input was switched to the desired measurement points by a scanner. The points monitored during this test were:

- +15 Volt Power Supply
- 15 Volt Power Supply
- +30 Volt Power Supply
- High Voltage Power Supply
- Low Range Output
- Intermediate Range Output
- High Range Output
- Signal Generator Frequency (100Kc)
- Period

All input signals to the three ranges and period circuit were from the system's calibration sources. The Low Range monitored the 100Kc output from the Signal Generator. The Intermediate and High Ranges monitored the 100Kc

output from the Campbell Calibrator. The Period circuit monitored the output of the Ramp Generator which was reset automatically at the beginning of each measurement cycle.

The AC voltage input to the WRM System was controlled by a sequencer. This sequencer also initiated the data taking process at the required three hour intervals. Figure 2-10 shows a section of the tape from the recorder used to monitor the AC voltage to the WRM System.

Data obtained during the test described in Paragraph 4.6.13 are presented in Tables 2-16 through 2-24.

Results

Throughout this test, the WRM System functioned within specifications and with no malfunctions. The drift of all measured parameters was within $\pm 1\%$ full scale.

After the test, some of the module cases were replaced because the old cases had corroded during the high temperature, high humidity exposure.

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.03	1.7	1.3	2.08	2.0
3	.31	2.0	3.0	2.41	4.0
4	.59	2.2	3.94	2.75	6.0
7	.84	2.27	4.0	4.84	7.0
10	1.01	3.0	4.3	6.75	7.3
20	1.30	4.07	4.6	9.3	7.6
40	1.60	5.3	4.8	12.2	7.8
70	1.85	6.65	5.0	15.2	8.0
100	2.02	9.0	5.3	21.7	8.3
200	2.33	13.2	5.6	31.0	8.6
400	2.64	16.2	5.8	37.8	8.8
700	2.89	20.1	6.0	48.5	9.0
10 ³	3.05	29.5	6.3	67.5	9.3
2 X 10 ³	3.37	40.0	6.6	95.5	9.6
4 X 10 ³	3.68	52.0	6.8	123.0	9.8
7 X 10 ³	3.92	66.0	7.0	152.0	10.0
10 ⁴	4.08	89.0	7.3	182.0	10.2
2 X 10 ⁴	4.39	131.0	7.6	198.0	10.3
4 X 10 ⁴	4.69	161.0	7.8	241.0	10.4
7 X 10 ⁴	4.94	230.0	8.0	278.0	10.43
10 ⁵	5.09	300.0	8.04		
2 X 10 ⁵	5.39	350.0	8.05		
4 X 10 ⁵	5.68	400.0	8.06		
7 X 10 ⁵	5.93				
10 ⁶	6.09				

TABLE 2-13 Accelerated Life Test (Humidity)
Start Reference Data (77°F, 50% R.H.)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.05	1.7	1.3	2.06	2.0
2	.34	2.0	2.9	2.4	4.0
4	.62	2.2	3.9	2.74	6.0
7	.85	2.28	4.0	4.8	7.0
10	1.02	3.03	4.3	6.7	7.3
20	1.31	4.1	4.6	9.1	7.6
40	1.70	5.25	4.8	11.9	7.8
70	1.89	6.6	5.0	15.0	8.0
100	2.04	9.0	5.3	21.0	8.3
200	2.35	13.1	5.6	30.4	8.6
400	2.67	16.2	5.8	36.7	8.8
700	2.93	19.9	6.0	46.7	9.0
10 ³	3.09	29.0	6.3	66.0	9.3
2 X 10 ³	3.41	39.0	6.6	92.0	9.6
4 X 10 ³	3.72	51.0	6.8	120.0	9.8
7 X 10 ³	3.97	64.0	7.0	150.0	10.0
10 ⁴	4.14	87.0	7.3	177.0	10.2
2 X 10 ⁴	4.45	126.0	7.6	192.0	10.3
4 X 10 ⁴	4.75	156.0	7.8	218.0	10.4
7 X 10 ⁴	5.00	197.0	8.0	250.0	10.45
10 ⁵	5.15	250.0	8.06	279.0	10.47
2 X 10 ⁵	5.45	300.0	8.09		
4 X 10 ⁵	5.75				
7 X 10 ⁵	6.01				
10 ⁶	6.17				

TABLE 2-14 Accelerated Life Test (Humidity)
Cycle 2 Data (120°F, 95% R.H.)

LOW RANGE		INTERMEDIATE RANGE		HIGH RANGE	
INPUT (cps)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)	INPUT (mv rms)	OUTPUT (Volts DC)
1	.03	1.7	1.35	2.1	2.0
2	.31	2.0	3.0	2.43	4.0
4	.60	2.2	3.9	2.77	6.0
7	.84	2.28	4.0	4.8	7.0
10	1.00	3.06	4.3	6.8	7.3
20	1.30	4.12	4.6	9.4	7.6
40	1.60	5.3	4.8	12.3	7.8
70	1.85	6.7	5.0	15.3	8.0
100	2.02	9.0	5.3	21.8	8.3
200	2.31	13.3	5.6	31.1	8.6
400	2.64	16.5	5.8	37.9	8.8
700	2.89	20.6	6.0	49.0	9.0
10 ³	3.06	29.7	6.3	68.0	9.3
2 X 10 ³	3.37	40.2	6.6	96.0	9.6
4 X 10 ³	3.68	52.5	6.8	124.0	9.8
7 X 10 ³	3.93	66.0	7.0	153.0	10.0
10 ⁴	4.09	90.0	7.3	183.0	10.2
2 X 10 ⁴	4.40	132.0	7.6	200.0	10.3
4 X 10 ⁴	4.70	163.0	7.8	244.0	10.4
7 X 10 ⁴	4.95	247.0	8.0	284.0	10.42
10 ⁵	5.09	300.0	8.04		
10 ⁵	5.38	350.0	8.05		
4 X 10 ⁵	5.68				
7 X 10 ⁵	5.93				
10 ⁶	6.09				

TABLE 2-15 Accelerated Life Test (Humidity)
Stop Reference Data (77°F, 50% R.H.)

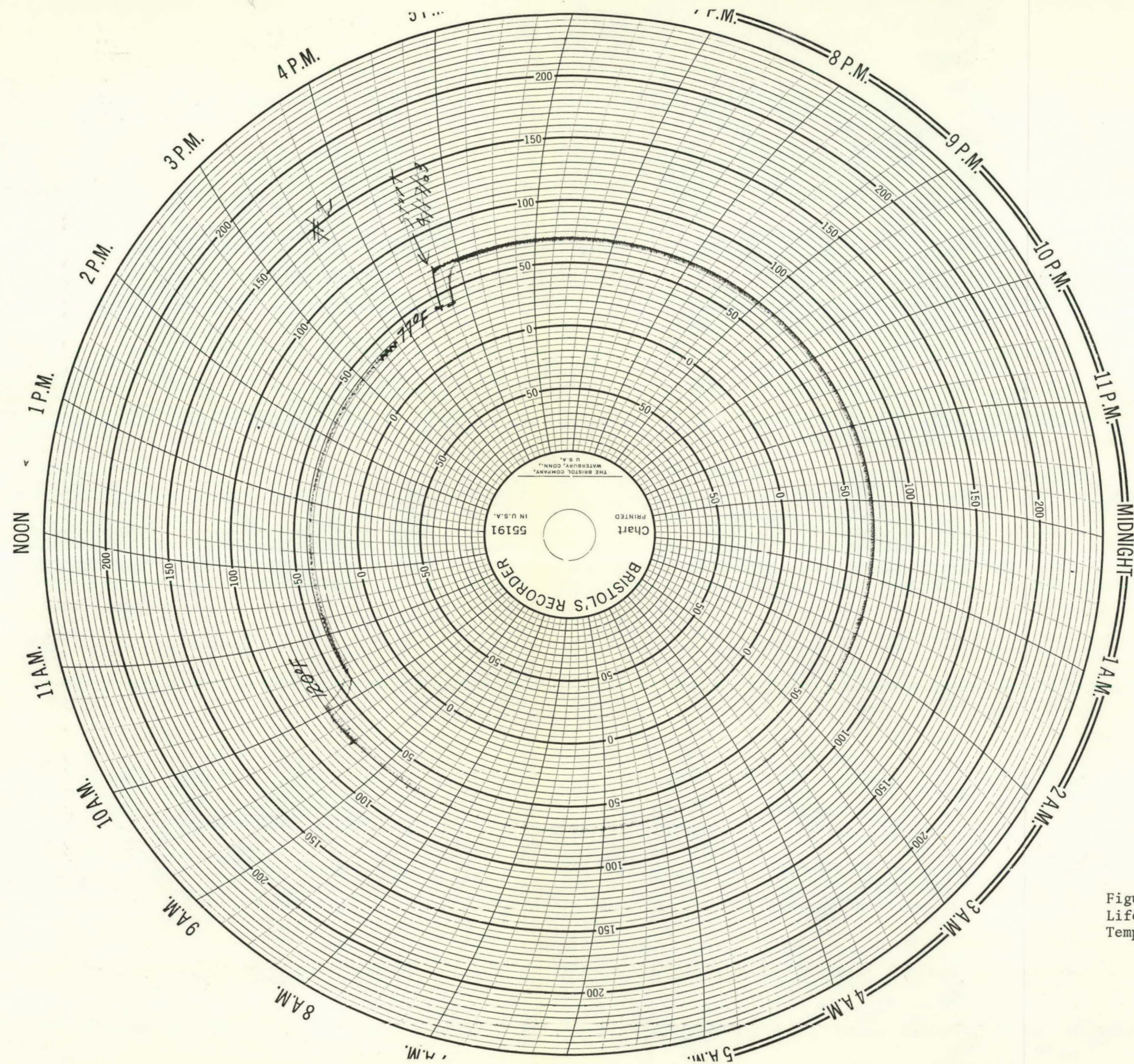


Figure 2-5 Accelerated
Life Test - Typical
Temperature Cycle

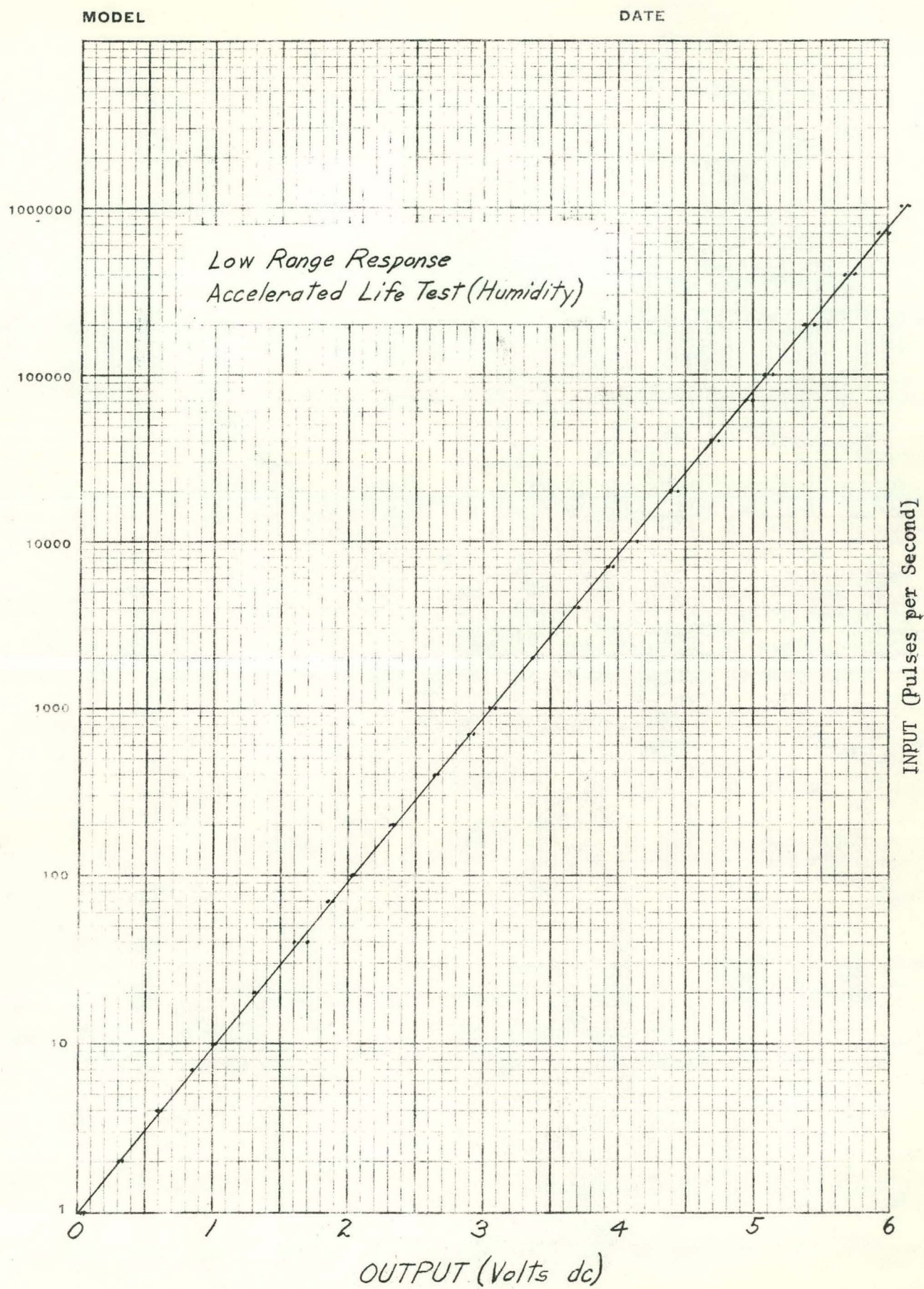
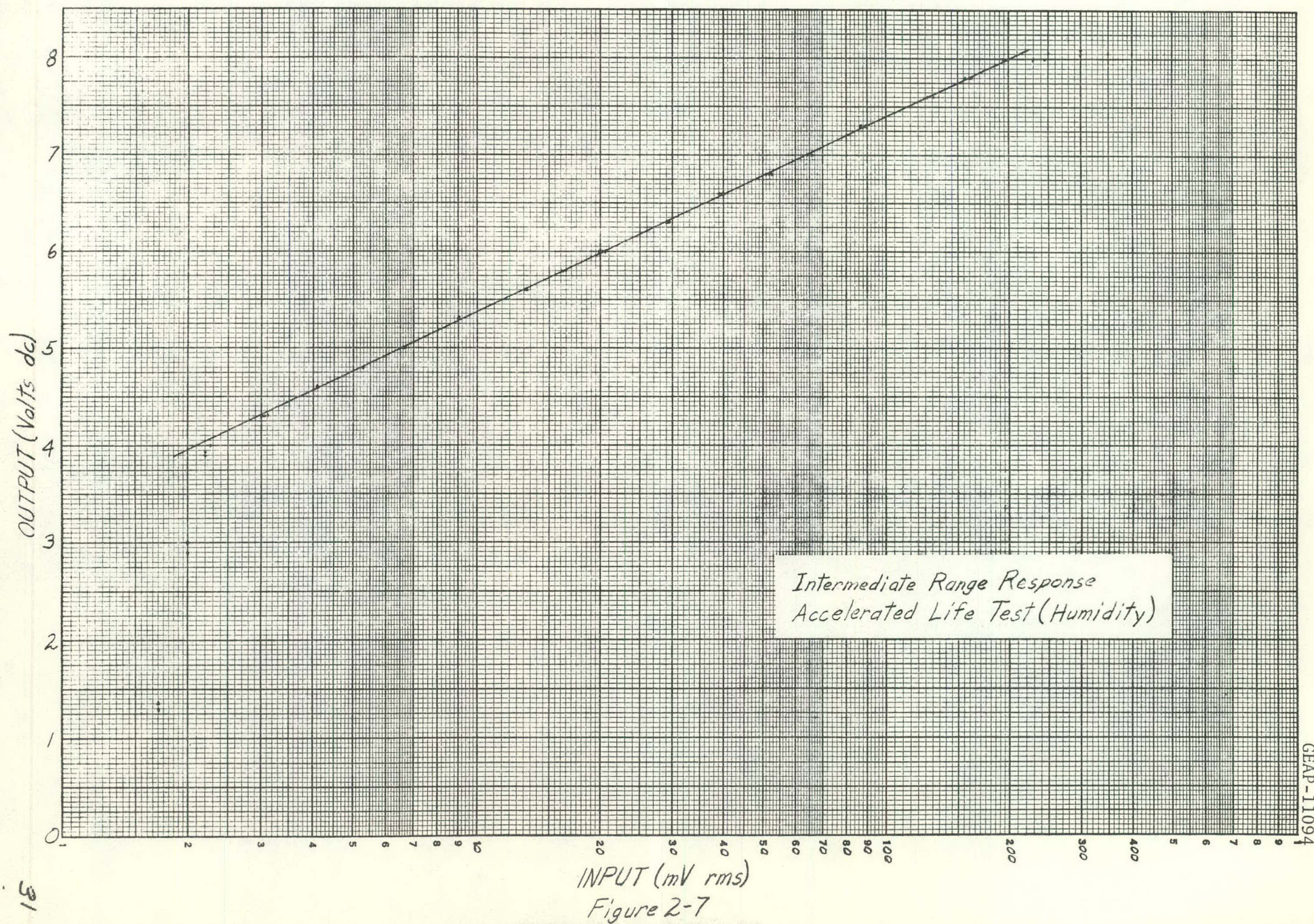
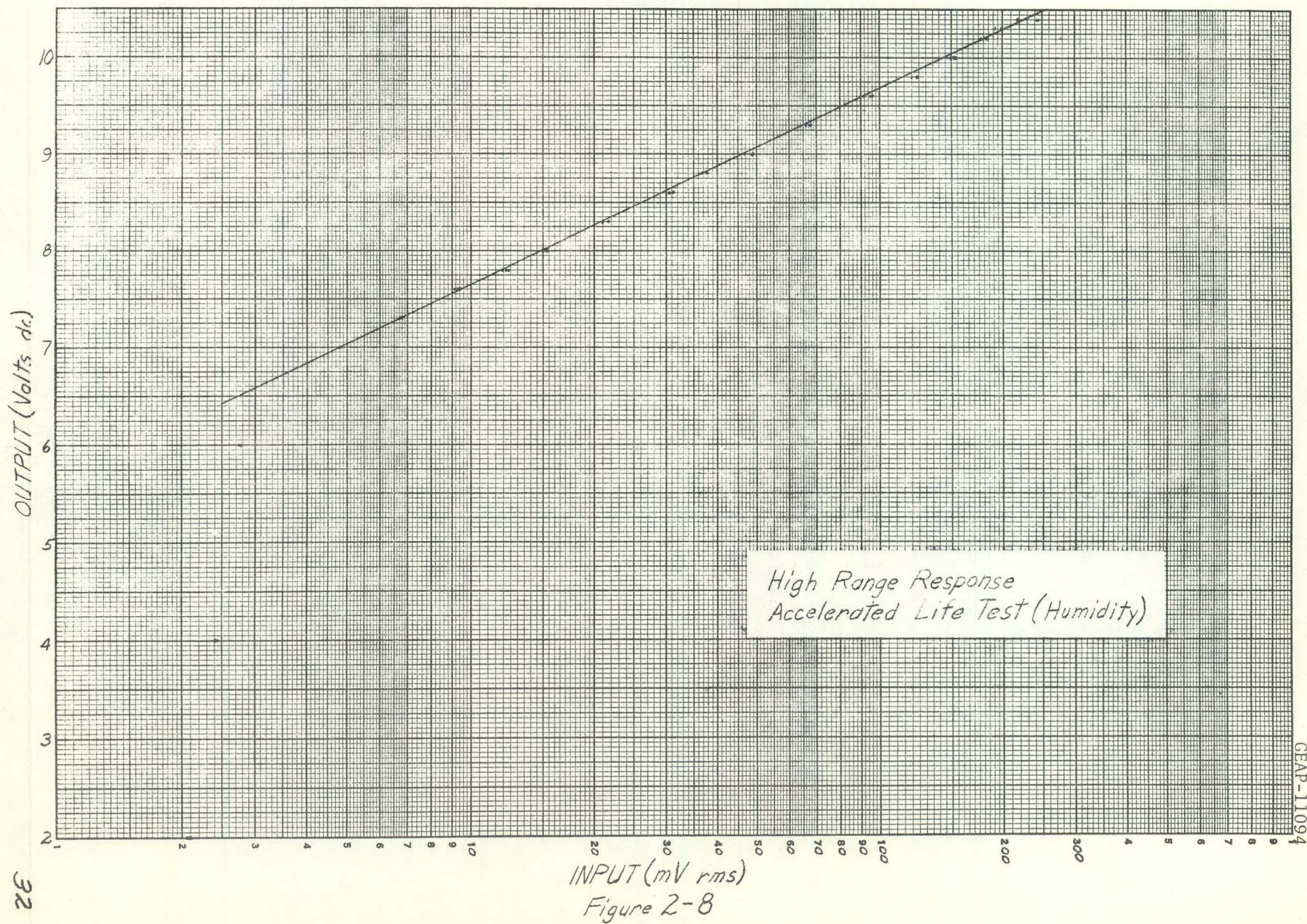


Figure 2-6





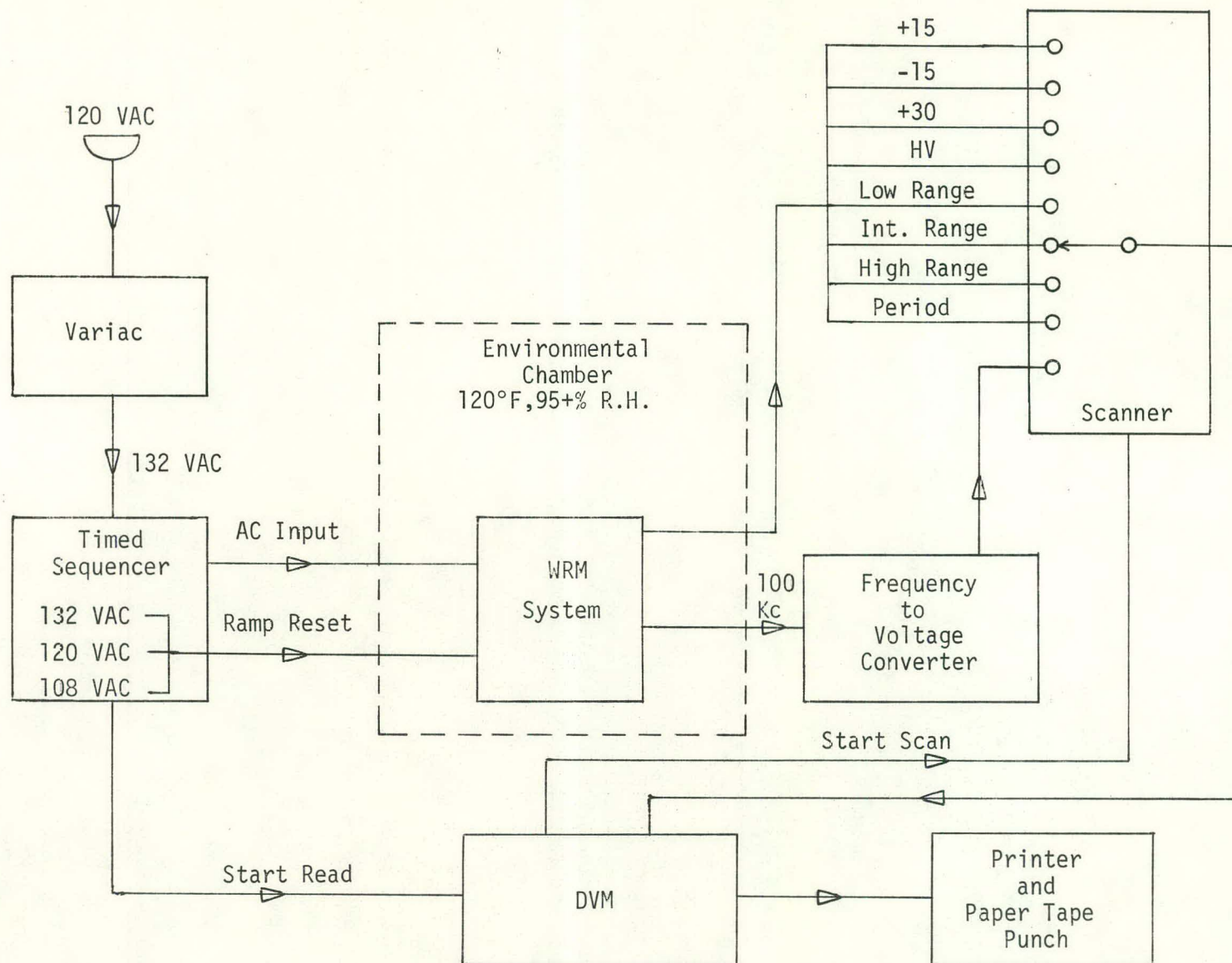


Figure 2-9 Accelerated Life Test Setup for 4.6.13

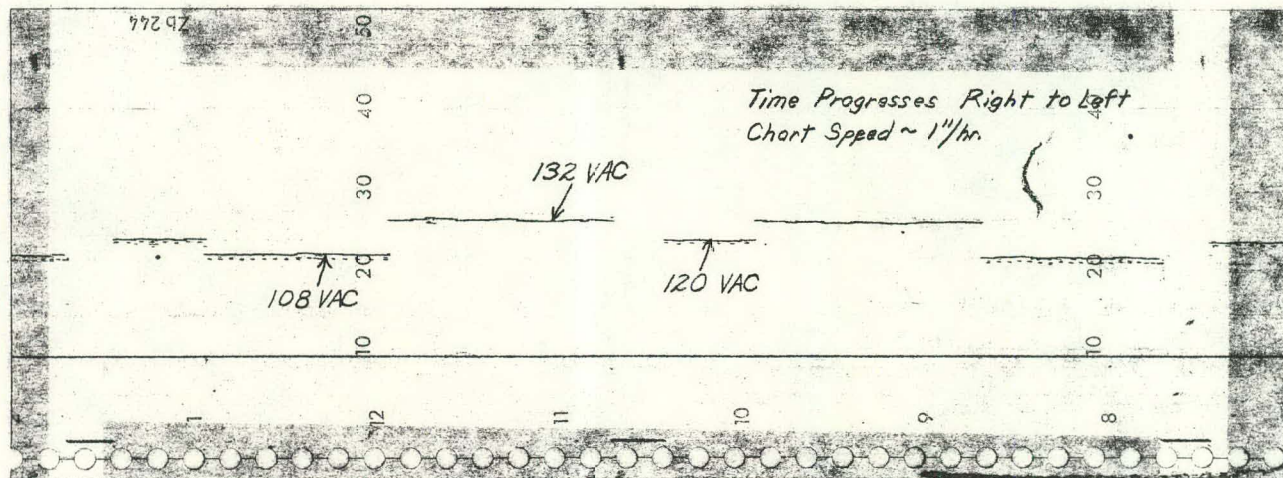


Figure 2-10 Accelerated Life Test - Typical ac Voltage Sequence

14.999 +	14.951	14.997	14.997	14.997
14.997	14.997	14.997	14.997	14.997
14.997	14.997	14.997	14.997	14.997
14.995	14.999	14.997	14.997	14.997
14.997	14.997	14.997	14.997	14.997
14.997	14.995	14.997	14.991	14.991
14.997	14.995	14.997	14.997	14.997
14.997	14.997	14.997	14.999	14.997
14.997	14.997	14.991	14.997	14.997
14.997	14.999	14.997	14.997	14.997
14.997	14.997	14.997	14.997	14.997
14.997	14.997	14.997	14.997	14.999
14.999	14.997	14.997	14.995	14.999
14.997	14.999	14.997	14.995	14.995
14.997	14.997	14.997	14.997	14.997
14.997	14.997	14.997	14.997	14.997
14.997	14.997	14.997	14.997	15.001
14.997	14.997	14.997	14.999	14.997
14.997	14.997	14.997	14.995	14.995
14.995	14.995	14.995	14.997	14.997
14.997	14.941	14.995	14.995	14.997
14.997	14.995	14.997	14.997	14.995
14.997	14.997	14.997	14.995	14.995
14.997	14.997	14.995	14.997	14.995
14.997	15.011	14.997	14.995	14.995
14.997	14.995	14.997	14.995	14.997
14.995	14.995	14.995	14.997	15.001 Δ

+ ~ Start Reference Datum

~ Stop Reference Datum

Table 2-16 Accelerated Life Test (4.6.13)
(+15 Volt Power Supply)

-14.991 +	-14.991	-14.991	-14.991	-14.991
-14.991	-14.991	-14.991	-14.993	-14.991
-14.993	-14.991	-14.991	-14.991	-14.993
-14.991	-14.991	-14.991	-14.993	-14.991
-14.991	-14.991	-14.991	-14.991	-14.991
-14.991	-14.991	-14.993	-14.993	-14.991
-14.991	-14.991	-14.993	-14.999	-14.991
-14.991	-14.991	-14.991	-14.991	-14.991
-14.991	-14.993	-14.991	-14.991	-14.993
-14.991	-14.991	-14.991	-14.991	-14.991
-14.991	-14.991	-14.991	-14.989	-14.989
-14.991	-14.993	-14.991	-14.991	-14.983
-14.991	-14.991	-14.991	-14.991	-14.991
-14.991	-14.991	-14.991	-14.991	-14.991
-14.991	-14.991	-14.989	-14.989	-14.989
-14.991	-14.991	-14.991	-14.989	-14.989
-14.991	-14.993	-14.991	-14.989	-14.989
-14.989	-14.989	-14.991	-14.991	-14.991
-14.991	-14.989	-14.989	-14.991	-14.989
-14.991	-14.989	-14.989	-14.991	-14.989
-14.991	-14.989	-14.989	-14.991	-14.989
-14.991	-14.981	-14.989	-14.991	-14.989
-14.989	-14.989	-14.989	-14.989	-14.989
-14.989	-14.989	-14.991	-14.989	-14.989
-14.989	-14.989	-14.989	-14.989	-14.989
-14.981	-14.991	-14.991	-14.991	-15.001
-14.989	-14.989	-14.989	-14.989	-14.989
-14.989	-14.991	-14.989	-14.981	-14.991 Δ

+~ Start Reference Datum

Δ~ Stop Reference Datum

Table 2-17 Accelerated Life Test (4.6.13)
(-15 Volt Power Supply)

29.955 +	30.141	30.111	30.143	30.117
30.139	30.113	30.137	30.111	30.133
30.111	30.137	30.109	30.137	30.113
30.137	30.111	30.135	30.115	30.141
30.111	30.137	30.109	30.139	30.113
30.151	30.131	30.133	30.109	30.133
30.107	30.131	30.107	30.131	30.105
30.129	30.109	30.131	30.105	30.129
30.105	30.137	30.103	30.125	30.107
30.131	30.105	30.131	30.109	30.135
30.107	30.131	30.107	30.131	30.121
30.129	30.105	30.133	30.107	30.131
30.105	30.133	30.107	30.127	30.105
30.141	30.101	30.119	30.101	30.123
30.101	30.123	30.101	30.125	30.095
30.117	30.091	30.127	30.105	30.133
30.109	30.141	30.111	30.137	30.109
30.137	30.109	30.129	30.101	30.127
30.121	30.117	30.089	30.117	30.089
30.115	30.087	30.115	30.085	30.115
30.087	30.151	30.085	30.109	30.085
30.109	30.083	30.109	30.083	30.111
30.085	30.107	30.087	30.109	30.081
30.103	30.085	30.113	30.087	30.111
30.141	30.111	30.083	30.141	30.121
30.113	30.087	30.109	30.087	30.113
30.083	30.131	30.117	30.141	30.027 Δ

+~Start Reference Datum

Δ~Stop Reference Datum

Table 2-18 Accelerated Life Test (4.6.13)
(+30 Volt Power Supply)

-599.99 +	-600.41	-600.27	-600.19	-600.23
-599.99	-600.03	-599.91	-600.13	-599.95
-599.89	-599.83	-599.93	-599.61	-599.37
-599.01	-599.51	-599.23	-599.07	-598.91
-599.33	-599.51	XXXXXX	-599.27	-599.15
-599.29	-599.43	-599.43	-599.29	-599.03
-599.11	-598.89	-599.03	-598.83	-598.97
-598.93	-599.01	-598.83	-599.05	-598.87
-599.33	-598.63	-599.25	-599.13	-599.11
-598.77	-598.95	-599.27	-599.15	-598.93
-599.13	-599.03	-599.21	-599.01	-598.93
-599.19	-599.17	-599.13	-599.29	-598.95
-599.11	-599.03	-599.09	-599.19	-598.95
-598.71	-600.17	-600.33	-600.21	-600.43
-600.65	-600.95	-601.27	-601.45	-601.69
-601.75	-601.99	-601.49	-601.53	-601.05
-601.11	-600.93	-601.01	-600.91	-600.85
-600.65	-600.67	-600.65	-600.67	-600.33
-600.71	-600.11	-600.37	-600.13	-600.15
-600.09	-600.25	-599.95	-600.29	-599.53
-600.07	-599.81	-600.15	-599.97	-600.11
-599.69	-600.05	-599.73	-599.93	-599.73
-599.69	-599.67	-599.47	-599.13	-599.55
-599.65	-599.75	-599.47	-599.59	-599.59
-599.41	-599.21	-599.51	-599.51	-599.71
-599.47	-599.67	-599.57	-599.61	-599.23
-599.91	-599.67	-598.93	-599.31	-602.69 Δ

+Start Reference Datum

ΔStop Reference Datum

Table 2-19 Accelerated Life Test (4.6.13)
(High Voltage Power Supply)

5.3539 +	5.4599	5.4477	5.4337	5.4453
5.3913	5.3995	5.3839	5.3759	5.4083
5.4309	5.4433	5.4501	5.4539	5.4519
5.4605	5.4631	5.4639	5.4651	5.4675
5.4699	5.4633	5.4493	5.4641	5.4757
5.4799	5.4801	5.4829	5.4841	5.4783
5.4771	5.4789	5.4781	5.4789	5.4759
5.4759	5.4757	5.4749	5.4159	5.3375
5.3483	5.4375	5.3317	5.3429	5.3439
5.3445	5.4359	5.4319	5.3715	5.3183
5.3479	5.3459	5.3545	5.3445	5.3471
5.2039	5.3603	5.3583	5.3577	5.2599
5.3441	5.3499	5.3469	5.3631	5.3935
5.3589	5.3415	5.3793	5.3255	5.3981
5.3839	5.3009	5.3269	5.3199	5.3861
5.3859	5.4117	5.3987	5.3079	5.4021
5.4219	5.4315	5.4331	5.4281	5.4265
5.4281	5.4339	5.4249	5.4203	5.4133
5.4291	5.4271	5.4231	5.3165	5.4169
5.4149	5.3347	5.3045	5.3193	5.3807
5.4419	5.4401	5.4439	5.4429	5.4465
5.4479	5.4401	5.4441	5.4455	5.4405
5.4469	5.4503	5.4419	5.4491	5.4409
5.4199	5.4481	5.4409	5.4059	5.4399
5.4411	5.4439	5.4375	5.4379	5.4399
5.3849	5.4135	5.4141	5.4223	5.4285
5.4399	5.4321	5.4385	5.4505	5.3881 Δ

+~ Start Reference Datum

Δ~ Stop Reference Datum

Table 2-20 Accelerated Life Test (4.6.13)
(Low Range)

7.7641 +	7.8641	7.8581	7.8659	7.8575
7.8605	7.8507	7.8559	7.8403	7.8499
7.8381	7.8367	7.8391	7.8437	7.8429
7.8511	7.8439	7.8783	7.8679	7.8661
7.8661	7.8683	7.8579	7.8451	7.8063
7.8403	7.8349	7.7609	7.8119	7.7289
7.7459	7.8239	7.7987	7.1999	7.7101
7.7181	7.7507	7.7815	7.7883	7.7727
7.7491	7.8079	7.7923	7.7951	7.7483
7.7597	7.7701	7.7569	7.7663	7.8121
7.7789	7.7861	7.7799	7.7859	7.7809
7.7889	7.7831	7.7611	7.7647	7.7493
7.7421	7.7509	7.7705	7.7745	7.7427
7.7505	7.7421	7.7421	7.8119	7.8203
7.8139	7.8231	7.8185	7.8249	7.8175
7.8229	7.8145	7.8337	7.8551	7.8629
7.8537	7.8599	7.8475	7.8489	7.8383
7.8089	7.7703	7.7539	7.7453	7.7531
7.7439	7.7489	7.7493	7.7709	7.7789
7.7515	7.7459	7.7529	7.7391	7.7469
7.7393	7.7761	7.7621	7.8099	7.7929
7.8101	7.7951	7.8089	7.7999	7.8111
7.7999	7.7405	7.7911	7.7411	7.7341
7.7945	7.7387	7.7975	7.7781	7.8023
7.7989	7.8015	7.7339	7.7001	7.7369
7.8073	7.7099	7.7889	7.7669	7.7001
7.7431	7.8509	7.8249	7.8471	7.7737 Δ

+~Start Reference Datum

Δ~Stop Reference Datum

Table 2-21 Accelerated Life Test (4.6.13)
(Intermediate Range)

8.6551 +	8.7035	8.7163	8.7177	8.6805
8.7127	8.7179	8.7243	8.7117	8.7197
8.7077	8.7075	8.7097	8.7137	8.7131
8.7233	8.7133	8.7279	8.7165	8.7163
8.7161	8.7195	8.7001	8.6997	8.6625
8.6969	8.6893	8.6225	8.6699	8.5939
8.6079	8.6833	8.6571	8.6609	8.5783
8.5859	8.6159	8.6445	8.6491	8.6357
8.6135	8.6699	8.6541	8.6581	8.6157
8.6279	8.6385	8.6279	8.6371	8.6829
8.6513	8.6583	8.6519	8.6589	8.6533
8.6625	8.6555	8.6365	8.6381	8.6241
8.6175	8.6257	8.6435	8.6477	8.6173
8.6249	8.6169	8.6383	8.7067	8.7171
8.7107	8.7241	8.7197	8.7269	8.7177
8.7025	8.6103	8.6205	8.6991	8.7095
8.6997	8.7037	8.6845	8.6789	8.6941
8.6751	8.6379	8.6225	8.6141	8.6223
8.6161	8.6219	8.6209	8.6441	8.6505
8.6253	8.6203	8.6279	8.6137	8.6229
8.6149	8.6509	8.6391	8.6875	8.6703
8.6885	8.6715	8.6879	8.6771	8.6899
8.6775	8.6197	8.6685	8.6201	8.6117
8.6735	8.6137	8.6769	8.6571	8.6821
8.6799	8.6829	8.6131	8.6209	8.6149
8.6881	8.6235	8.6619	8.6459	8.6209
8.6129	8.7339	8.7245	8.7319	8.6481 Δ

+~ Start Reference Datum

Δ~ Stop Reference Datum

Table 2-22 Accelerated Life Test (4.6.13)
(High Range)

4.9601 †	4.9611	4.9609	4.9609	4.9593
4.9611	4.9601	4.9611	4.9613	4.9611
4.9609	4.9591	4.9599	4.9607	4.9609
4.9611	4.9603	4.9613	4.9615	4.9611
4.9609	4.9615	4.9611	4.9611	4.9613
4.9607	4.9609	4.9609	4.9607	4.9601
4.9607	4.9601	4.9611	4.9611	4.9605
4.9605	4.9607	4.9607	4.9615	4.9613
4.9613	4.9603	4.9613	4.9601	4.9603
4.9607	4.9615	4.9615	4.9615	4.9615
4.9609	4.9611	4.9609	4.9611	4.9605
4.9601	4.9605	4.9571	4.9609	4.9613
4.9605	4.9581	4.9603	4.9611	4.9611
4.9571	4.9599	4.9601	4.9603	4.9603
4.9603	4.9605	4.9603	4.9599	4.9603
4.9605	4.9603	4.9605	4.9603	4.9609
4.9609	4.9609	4.9603	4.9607	4.9607
4.9607	4.9605	4.9609	4.9591	4.9603
4.9603	4.9603	4.9593	4.9601	4.9603
4.9607	4.9605	4.9605	4.9611	4.9603
4.9605	4.9605	4.9599	4.9593	4.9599
4.9599	4.9601	4.9599	4.9589	4.9575
4.9603	4.9603	4.9563	4.9599	4.9577
4.9599	4.9599	4.9599	4.9599	4.9599
4.9599	4.9599	4.9597	4.9599	4.9571
4.9595	4.9597	4.9599	4.9599	4.9599
4.9595	4.9599	4.9591	4.9599	4.9589 Δ

† ~ Start Reference Datum

Δ ~ Stop Reference Datum

Table 2-23 Accelerated Life Test (4.6.13)
(Signal Generator ~ 100Kc)

10.051 †	9.9261	9.9043	9.9579	9.9559
9.9175	9.9277	9.9371	9.9329	9.9613
9.9773	9.9679	9.9627	9.9835	9.9693
9.9499	9.9659	9.9791	9.9765	9.9673
9.9749	9.9749	9.9619	9.9449	9.9871
9.9743	9.9717	9.9531	9.9911	9.9837
9.9891	9.9875	9.9839	9.9487	9.9671
9.9777	9.9713	9.9815	9.9713	9.9837
9.9693	9.9937	9.9923	9.9495	9.9603
9.9853	9.9757	9.9837	9.9853	9.9753
9.9975	9.9827	9.9693	9.9803	9.9929
9.9841	9.9601	9.9891	9.9645	9.9975
9.9971	10.013	10.005	9.9773	9.9643
9.9737	10.013	10.029	10.035	10.027
10.029	10.027	10.023	10.027	10.035
10.027	10.027	10.015	10.015	10.007
10.007	10.015	9.9969	9.9859	9.9945
9.9955	10.013	9.9841	9.9829	10.011
9.9847	9.9983	10.017	10.013	10.009
10.007	10.007	10.011	9.9959	9.9829
9.9991	10.007	10.015	9.9897	9.9971
10.019	9.9867	10.017	10.023	10.023
10.019	10.027	10.025	10.005	10.027
10.013	10.007	10.007	10.031	10.011
10.011	10.021	10.011	10.011	9.9937
10.009	10.023	10.023	9.9987	10.025
10.025	10.045	10.071	10.029	10.049 Δ

† ~ Start Reference Datum

Δ ~ Stop Reference Datum

Table 2-24 Accelerated Life Test (4.6.13)
(Period Response)

2.3 VOLTAGE TRANSIENT

This test was performed in accordance with D.O.D. Specification MIL-N-52334(MO), Paragraph 3.3.1.3.1. The transient was induced by connecting the secondary of a 24 volt transformer in series with the AC input to the WRM System, and then manually switching in and out this extra 24 volts. The test setup is shown in Figure 2-11.

Tests were conducted for the two worst case conditions: 1) AC input = 132 VAC, Transient = +24 VAC; and 2) AC input = 108 VAC, Transient = -24 VAC. During both type transients, ringing was visible on the low voltage power supply lines (=15, -15, +30). However, no change in system output was noticed either during or after the transients.

2.4 FREQUENCY TRANSIENT

This test was performed in accordance with D.O.D. Specification MIL-N-52334(MO), Paragraph 3.3.1.3.2. The transient was induced by manually varying the frequency of a variable frequency power supply.

The power supply was initially set for 60 cps and then varied by ± 10 cps. These transients had no effect on the WRM System either during or after the transient.

2.5 SUSCEPTIBILITY

This test was performed in accordance with D.O.D. Specification MIL-N-52334(MO), Paragraph 4.6.11. The switching function was performed by a relay which was turned on and off at the required rate by an astable multivibrator. Another manually operated switch selected the desired noise source.

A certain degree of susceptibility was exhibited during this test. And, as would be suspected, the worst case was near the very bottom of the system's range ($10^{-8}\%$ Power). The AC noise source caused practically no indications on the system readouts while the full wave rectified noise source consistently caused a 2 to 3 percent upscale indication from the $10^{-8}\%$ Power level. Occasionally, an upscale indication in excess of four percent would be noticed.

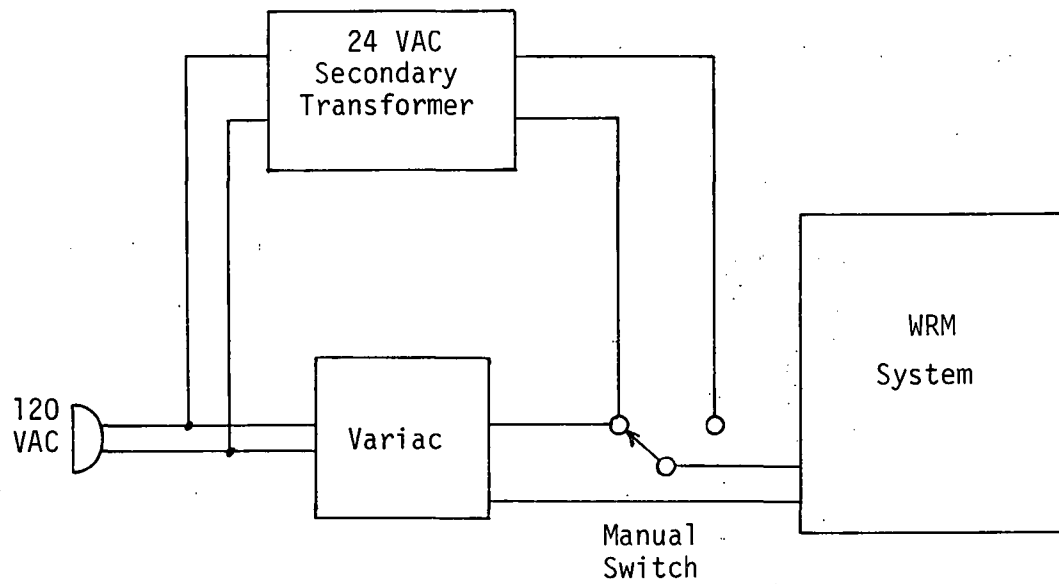


Figure 2-11 Voltage Transient Test Setup

The exact source of the susceptibility problem was not isolated, however, the noise spike did appear to be coming through the power supply lines rather than pickup through the signal leads and cables. It is therefore recommended that AC line filtering in conjunction with an isolation transformer be used for field installations.

2.6 SHORT TERM REACTOR TEST

The purpose of this test was to determine the combined response of the WRM System and a NA04 fission chamber. The test was performed at the General Electric Nuclear Test Reactor at Vallecitos Nuclear Center. The power level of this reactor can be readily varied. However, the range of adjustment over which the reactor's own instrumentation is linear is four to five decades. Therefore, two separate tests were conducted to insure that both overlap regions were covered sufficiently.

For the first test, the fission chamber was inserted into the maximum flux region and then the reactor power was increased until the neutron flux at the chamber location was about 2.5×10^{10} nv. This represented a reactor power level of about 2000 watts. Good overlap data between the Intermediate and High ranges was obtained.

The second test was carried out with the detector in such a position that when the reactor was at full power (30Kw), the WRM System was reading about $3 \times 10^{-1}\%$ Power. This gave good overlap data between the Low and Intermediate Ranges.

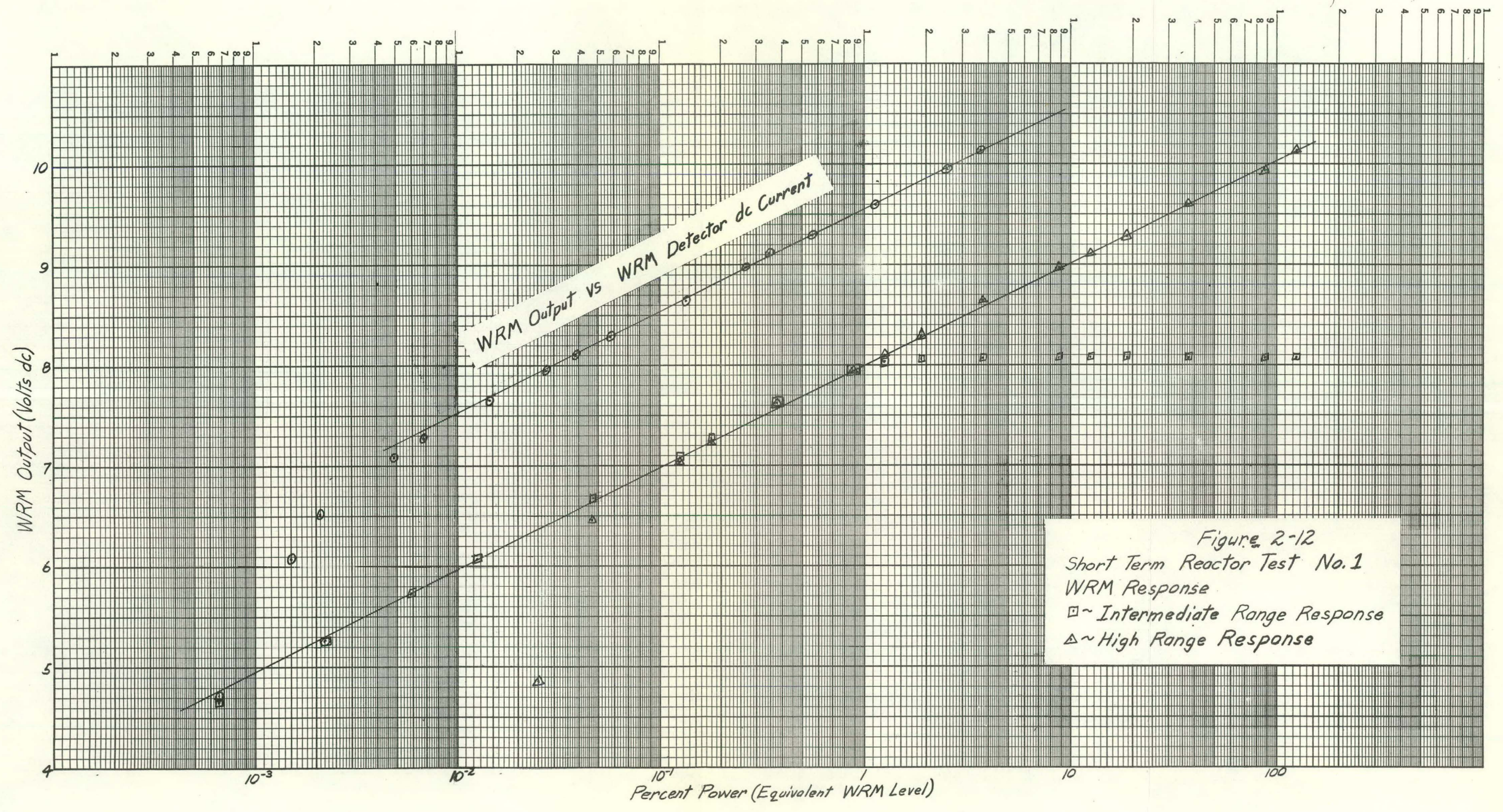
Data from both tests are presented in Tables 2-25, 26 and Figures 2-12, 13. All data points are well within the specified accuracy. Note that in Figure 2-12, an additional curve is shown which represents the relationship between the WRM output signal and DC current from the WRM detector. The points for this curve lie even closer to the ideal straight line. This gives rise to the belief that some of the error in the data points for output versus flux

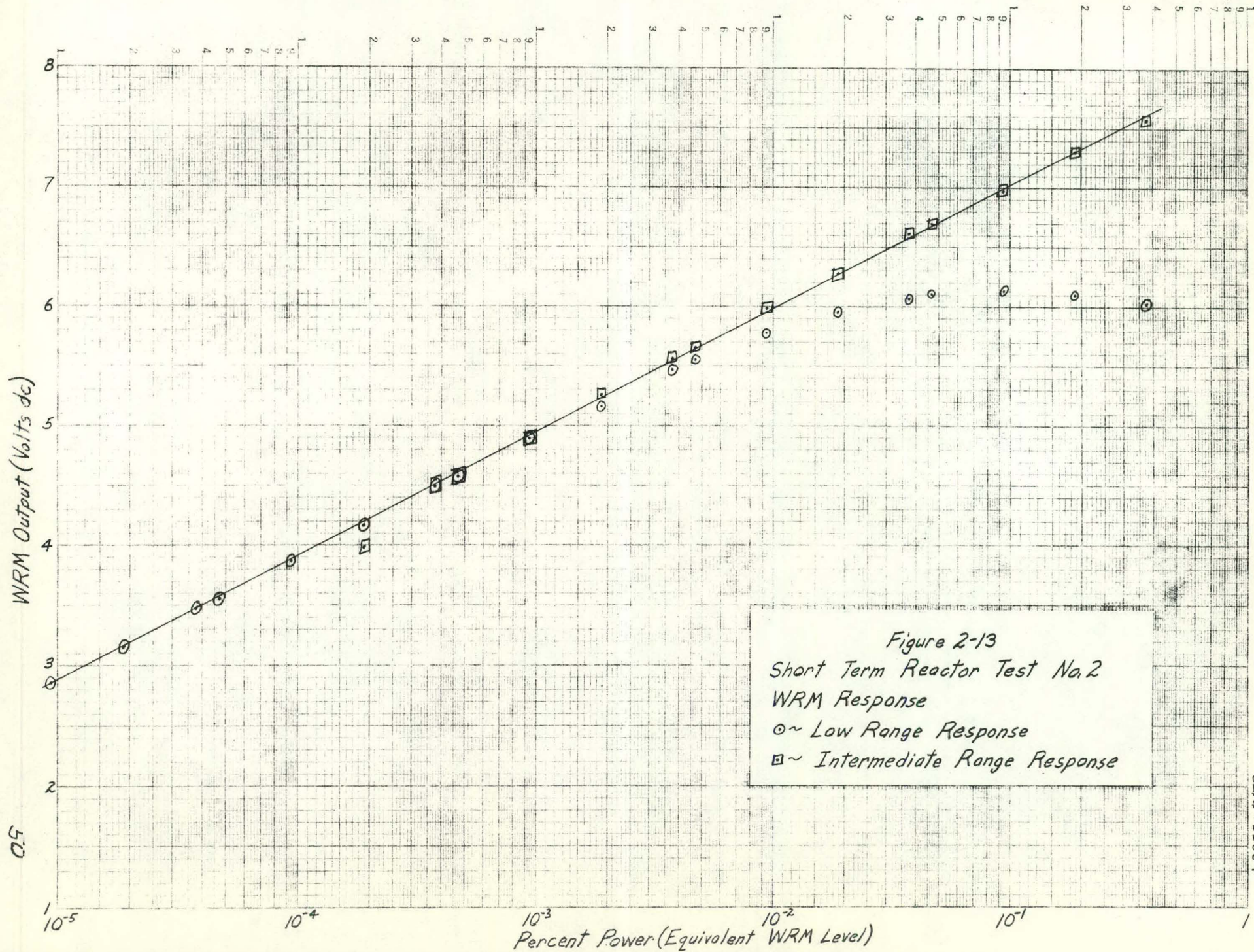
REACTOR INSTRUMENTATION				WIDE RANGE SYSTEM					
#1 CIC Current (Amps)	Power Level (Watts)	Neutron Flux (nv at WRM Detector)	Percent Power (Referred to WRM)	Auction Output (Volts DC)	Multirange Monitor Output			Scaler (Counts/Sec)	Detector Current (Milliamps DC)
					Low Range (Volts DC)	Int. Range (Volts DC)	High Range (Volts DC)		
$.18 \times 10^{-10}$	.011	1.3×10^5	6.6×10^{-4}	4.72	4.74	4.69	-0-	25200	.0012
$.06 \times 10^{-9}$	.038	4.7×10^5	2.2×10^{-3}	5.27	5.27	5.28	-0-	80000	
$.16 \times 10^{-9}$	.1	1.25×10^6	5.9×10^{-3}	5.73				198000	
$.34 \times 10^{-9}$	.2	2.5×10^6	1.25×10^{-2}	6.07	5.87	6.05	-0-	308000	.0015
$.68 \times 10^{-9}$	.4	5×10^6	2.5×10^{-2}	6.51	6.05	6.50	4.85	420000	.0021
$.34 \times 10^{-8}$	2	2.5×10^7	1.25×10^{-1}	7.08	6.09	7.07	7.03	445000	.0049
$.51 \times 10^{-8}$	3	3.9×10^7	1.88×10^{-1}	7.27	6.06	7.26	7.21	425000	.0068
1.02×10^{-8}	6	7.8×10^7	3.75×10^{-1}	7.66	5.95	7.60	7.61	342000	.0145
$.24 \times 10^{-7}$	14.1	1.76×10^8	8.8×10^{-1}	7.94	5.81	7.91	7.89	254000	.0274
$.34 \times 10^{-7}$	20	2.5×10^8	1.25	8.10	5.72	7.97	8.05	217000	.0384
$.5 \times 10^{-7}$	30	3.9×10^8	1.88	8.29	5.60	8.01	8.24	174000	.0573
1.02×10^{-7}	60	7.8×10^8	3.75	8.64	5.45	8.06	8.58	128000	.134
$.24 \times 10^{-6}$	141	1.76×10^9	8.8	8.97	5.37	8.06	8.91	112000	.265
$.34 \times 10^{-6}$	200	2.5×10^9	12.5	9.11	5.36	8.07	9.05	106000	.374
$.51 \times 10^{-6}$	300	3.9×10^9	18.8	9.27	5.32	8.07	9.22	101000	.561
1.02×10^{-6}	600	7.8×10^9	37.5	9.60	5.29	8.07	9.54	95000	1.12
$.24 \times 10^{-5}$	1410	1.76×10^{10}	88.0	9.94	5.25	8.07	9.88	87000	2.55
$.34 \times 10^{-5}$	2000	2.5×10^{10}	125.0	10.08	5.24	8.07	10.02	85000	3.48

TABLE 2-25 Short Term Reactor Test #1 (5/24/68)

REACTOR INSTRUMENTATION				WIDE RANGE SYSTEM					
#1 CIC Current (Amps)	Power Level (Watts)	Neutron Flux (nv at WRM Detector)	Percent Power (Referred to WRM)	Auction Output (Volts DC)	Multirange Monitor Output			Scaler (Counts/Sec)	Detector Current (Milliamps DC)
					Low Range (Volts DC)	Int Range (Volts DC)	High Range (Volts DC)		
.52 X 10 ⁻⁴	30,000	7.8 X 10 ⁷	.375	7.57	6.02	7.56	7.49	363000	12
.26 X 10 ⁻⁴	15,000	3.9 X 10 ⁷	.188	7.30	6.10	7.28	7.15	418000	6
.13 X 10 ⁻⁴	7,500	1.95 X 10 ⁷	.094	6.97	6.13	6.95	6.86	435000	3
.65 X 10 ⁻⁵	3,750	9.7 X 10 ⁶	.047	6.69	6.10	6.68	6.46	419000	1.55
.52 X 10 ⁻⁵	3,000	7.8 X 10 ⁶	.0375	6.61	6.08	6.59	5.2	404000	1.27
.26 X 10 ⁻⁵	1,500	3.9 X 10 ⁶	.0188	6.27	5.96	6.26	.62	332000	.66
.13 X 10 ⁻⁵	750	1.95 X 10 ⁶	9.4 X 10 ⁻³	5.98	5.87	5.97	-0-	238000	.36
.65 X 10 ⁻⁶	375	9.7 X 10 ⁵	4.7 X 10 ⁻³	5.64	5.54	5.64	-0-	146000	.22
.52 X 10 ⁻⁶	300	7.8 X 10 ⁵	3.75 X 10 ⁻³	5.55	5.46	5.55	-0-	124000	.19
.26 X 10 ⁻⁶	150	3.9 X 10 ⁵	1.88 X 10 ⁻³	5.26	5.17	5.25	-0-	65000	.13
.13 X 10 ⁻⁶	75	1.95 X 10 ⁵	9.4 X 10 ⁻⁴	4.89	4.89	4.88	-0-	32300	.10
.65 X 10 ⁻⁷	37.5	9.7 X 10 ⁴	4.7 X 10 ⁻⁴	4.58	4.60	4.57	-0-	16200	
.52 X 10 ⁻⁷	30.0	7.8 X 10 ⁴	3.75 X 10 ⁻⁴	4.49	4.44	4.44	-0-	13150	
.26 X 10 ⁻⁷	15.0	3.9 X 10 ⁴	1.88 X 10 ⁻⁴	4.17	4.19	3.99	-0-	6400	
.13 X 10 ⁻⁷	7.5	1.95 X 10 ⁴	9.4 X 10 ⁻⁵	3.86	3.87	.50	-0-	3130	
.65 X 10 ⁻⁸	3.75	9.7 X 10 ³	4.7 X 10 ⁻⁵	3.55	3.56	-0-	-0-	1510	
.52 X 10 ⁻⁸	3.0	7.8 X 10 ³	3.75 X 10 ⁻⁵	3.47	3.49	-0-	-0-	1280	
.26 X 10 ⁻⁸	1.5	3.9 X 10 ³	1.88 X 10 ⁻⁵	3.16	3.17	-0-	-0-	640	
.13 X 10 ⁻⁸	.75	1.95 X 10 ³	9.4 X 10 ⁻⁶	2.85	2.87	-0-	-0-	314	

TABLE 2-26 Short Term Reactor Test #2 (6/4/68)





level could be due in part to errors in the reactor's instrumentation. This belief is strengthened when one notes that the data points deviation from ideal varies periodically, the period being one decade. In previous tests, the WRM System electronics did not indicate this type deviation.

2.7 LONG TERM IRRADIATION TEST

The object of this test was to verify continuous operability of the WRM System for extended periods of time under normal environmental conditions. The test was conducted at Vallecitos Nuclear Center in the General Electric Test Reactor (GETR). The detector was located in such a position that at full reactor power, the neutron flux was about 2.5×10^{10} nv, and the gamma field was about 2×10^7 R/hr.

The detector test fixture was constructed of stainless steel and, in addition to housing the detector, contained a heater capable of maintaining the detector temperature at 500°F. The detector was connected to the preamplifier by seven feet of high temperature coaxial cable (solid stainless steel sheath, quartz fiber insulation) and 60 feet of low temperature coaxial cable (triple shielded R6-59 in the high voltage lead and triple shielded R6-114 in the signal lead). Connection between high temperature coax and detector and between high temperature coax and low temperature coax was by teflon insulated HN to HN adapters.

The WRM System and recorders was located on the instrumentation platform on the third floor of GETR. During most of the test the length of the cables between the preamplifier and main chassis was about ten feet. However, data was taken with about 250 feet of cable between the preamplifier and main chassis. This data is shown in Table 2-29. Note that the length of cable between preamplifier and main chassis has very little effect on system calibration. This is also true with the actual flux measurement (± 20 mv change).

Throughout the test, the neutron flux and period monitored by the WRM and the temperature of the detector, were continuously recorded. In addition, data was manually recorded intermittently to obtain a comparison of the GETR instrumentation with the WRM readout.

This test was conducted from August 15, 1968 through May 19, 1969. During this period of time, the reactor experienced 34 startups and was at full power (2.5×10^{10} nv at WRM detector) for about 5600 hours (see Tables 2-27 and 2-28).

At the beginning of the initial startup, the temperature of the detector was the same as the temperature of the ambient cooling water ($\sim 60^\circ\text{F}$). By the time full power conditions were reached, the detector temperature was 380°F . Some of this rise is due to an increase in cooling water temperature (105°F), but most of the rise is due to the self-heating of the detector. The data shown below was taken during the initial startup. Note that the output is linear even though the temperature was changing. Also compare this data with the data from the startups of November 6, 1968 and April 21, 1969 (500°F detector temperature for each) on Page 54. All results are consistent.

INITIAL STARTUP-AUGUST 15, 1968

<u>GETR Power</u>	<u>WRM Reading</u>	<u>Ideal Reading</u>
50 Kw	7.00	7.00
1 Mw	8.33	8.30
5 Mw	9.02	9.00
10 Mw	9.32	9.30
20 Mw	9.60	9.60

After the reactor had stabilized at full power, the detector temperature was increased to the required 500°F and remained at this temperature for most of the remainder of the test. The WRM System revealed no change in output as the detector temperature was increased (9.93 volts output at both 380°F and 500°F).

Throughout the test, only one alignment adjustment was necessary and this was because of an electronic change, not instrument drift. Due to the high gamma field during shutdown conditions, it was necessary to remove the lower half decade from the Intermediate Range response curve. This decreased the amount of overlap between the Low and Intermediate Ranges, but also meant that the neutron to gamma ratio was increased at the point at which the Intermediate Range began to control the WRM output. The adjustment made after completing this change was the only adjustment during the nine month test.

This decrease in range overlap will decrease very slightly the linearity of the system at the crossover point due to operating at a higher point on the counting curve. However, this decrease in linearity is not as great as would have been present had the overlap remained at its design value, in which case the Intermediate Range would have controlled the Auction even though its output signal represented almost entirely gamma radiation.

Twice during this test the WRM System exhibited an intermittent gain change which appeared to be caused by a faulty component. The first event occurred about the first of October 1968 and appeared as a reduction in output voltage equal to that which would be caused by a factor of four reduction in flux. By successively monitoring the signal path, the trouble was isolated within the input gain stage of the main chassis. However, before the problem was pinpointed, the fluctuations ceased and could not be made to reappear. This would seem to indicate a loose connection or a cold solder joint.

Then during April 1969, the fluctuations appeared again only with a greater amplitude. This time before any troubleshooting could be done, the fluctuations ceased. After the completion of the Long Term Irradiation Test, the main amplifier board was removed from the unit, all solder joints checked or resoldered, and the board cleaned. No further gain fluctuations were noticed.

Figures 2-14 through 2-24 are cutouts from the flux recorder connected to the WRM System. These sections of recorder data represent startups and shutdowns occurring at various dates throughout the long term test. Some of the graphs have the crossover or overlap region between ranges marked on them. In all cases the crossover of the Low and Intermediate Ranges occurs between five and six volts (50 and 60 on the graphs), and the crossover of the Intermediate and High Ranges occurs between seven and eight volts (70 and 80 on the graphs). For the shutdown and startup shown in Figures 2-20 and 2-21, the ranges were switched manually in order to record the response of all ranges. Note that in all charts where the range switching was done automatically, there are no noticeable discontinuities in the crossover regions. Discontinuities on these graphs were caused by switching of the detector heater relay.

It was not possible to obtain a real accurate comparison between the WRM readings and the GETR instrumentation readings because the detectors for the two systems were not located in the same area. This means the fluxes at the different detectors could vary by different amounts depending on which control rod was being pulled. However, the readings of the two systems still compare very favorably. The data shown below was obtained at two different startups, the first on November 6, 1968 and the second on April 21, 1969.

STARTUP-NOVEMBER 6, 1968

<u>GETR Power</u>	<u>WRM Reading</u>	<u>Ideal Reading</u>
32.5 Kw	6.80	6.80
650.0 Kw	8.05	8.10
13.0 Mw	9.35	9.40
20.0 Mw	9.56	9.586
40.0 Mw	9.83	9.886

STARTUP-APRIL 21, 1969

<u>GETR Power</u>	<u>WRM Reading</u>	<u>Ideal Reading</u>
50 Kw	7.00	7.00
1 Mw	8.27	8.30
20 Mw	9.56	9.60
30 Mw	9.70	9.776
40 Mw	9.81	9.90
48 Mw	9.90	9.98

Cycle	Dates	Hours at Full Power*	Startups
99	8/12/68 - 9/15/68	743.0	5
100	9/16/68 - 10/20/68	679.9	5
101	10/21/68 - 11/24/68	680.1	4
102	11/25/68 - 12/29/68	664.1	5
103	12/30/68 - 2/2/69	727.1	5
104	2/3/69 - 3/9/69	686.0	3
105	3/10/69 - 4/13/69	706.0	3
106	4/14/69 - 5/18/69	712.4	4
TOTAL		5,598.6	34

*Full Power = 2.5×10^{10} nv at WRM Detector

TABLE 2-27 GETR Operating History

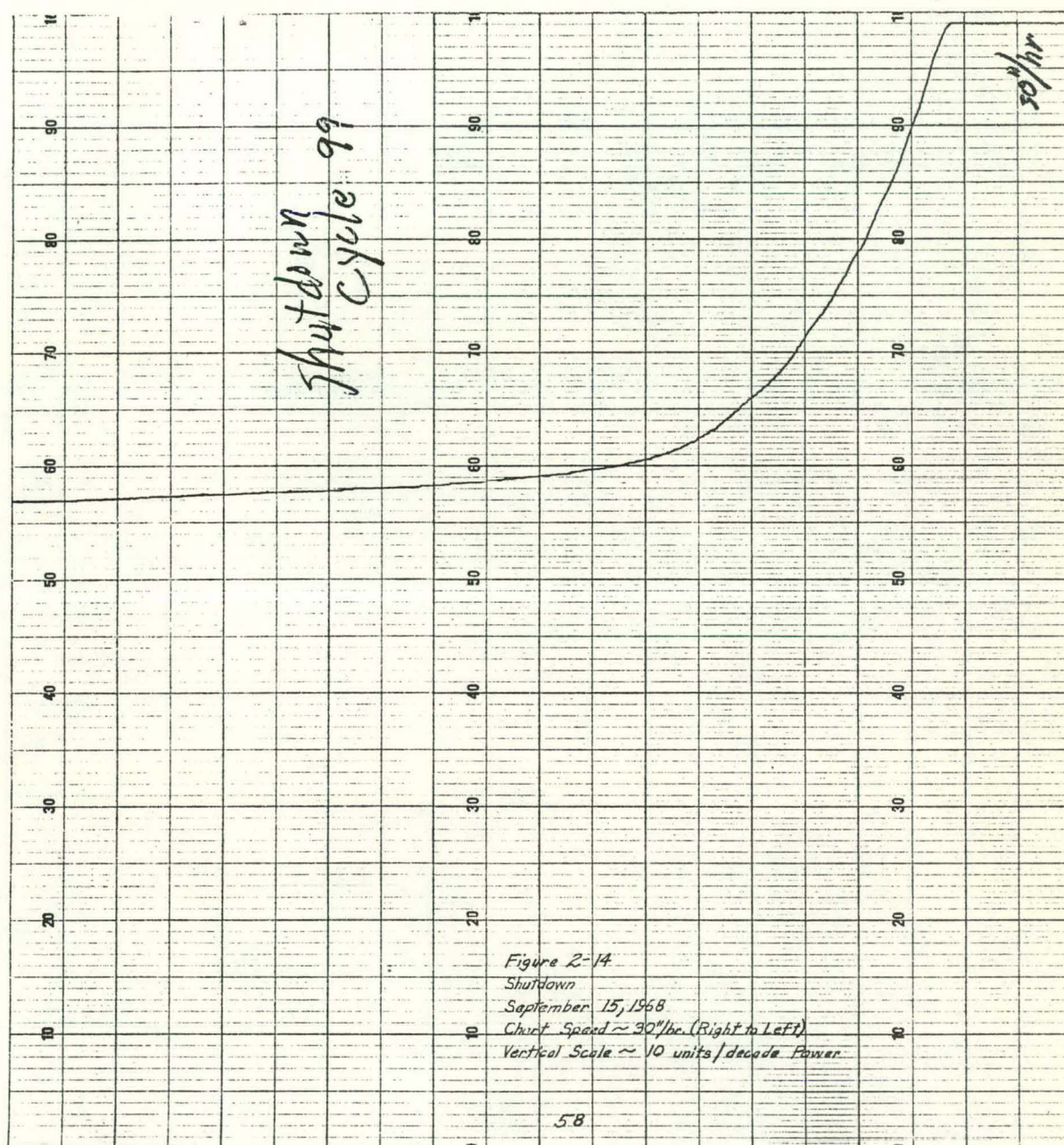
Startup Number	Date	Time	Detector Temp. (°F)	Hours Since Shutdown
1	8/15/68	0612	60	
2	8/15/68	0854	220	0.22
3	8/21/68	0634	480	0.38
4	8/30/68	0813	450	8.22
5	9/12/68	0941	450	5.68
6	9/22/68	0544	500	149.73
7	9/23/68	0031	500	0.93
8	10/5/68	2300	480	5.00
9	10/6/68	0224	490	0.32
10	10/14/68	0720	490	0.28
11	10/25/68	1820	480	114.33
12	11/6/68	1838	500	11.43
13	11/6/68	2215	500	1.50
14	11/19/68	0706	500	27.10
15	11/28/68	1255	480	84.92
16	12/5/68	1700	490	29.00
17	12/10/68	1215	490	34.25
18	12/19/68	1715	60	13.25
19	12/26/68	0600	60	8.00
20	1/1/69	0620	450	54.33
21	1/6/69	1820	460	12.33
22	1/11/69	2052	470	14.87
23	1/21/69	1044	480	17.92
24	1/29/69	1155	480	5.92
25	2/8/69	0132	470	121.53
26	2/24/69	1635	480	18.00
27	3/3/69	1731	480	8.00
28	3/13/69	1247	480	84.78
29	3/25/69	1220	440	26.08
30	4/4/69	2252	460	18.87
31	4/17/69	2056	420	92.93
32	4/21/69	1859	440	5.00
33	5/1/69	1758	460	14.00
34	5/13/69	1830	480	8.50

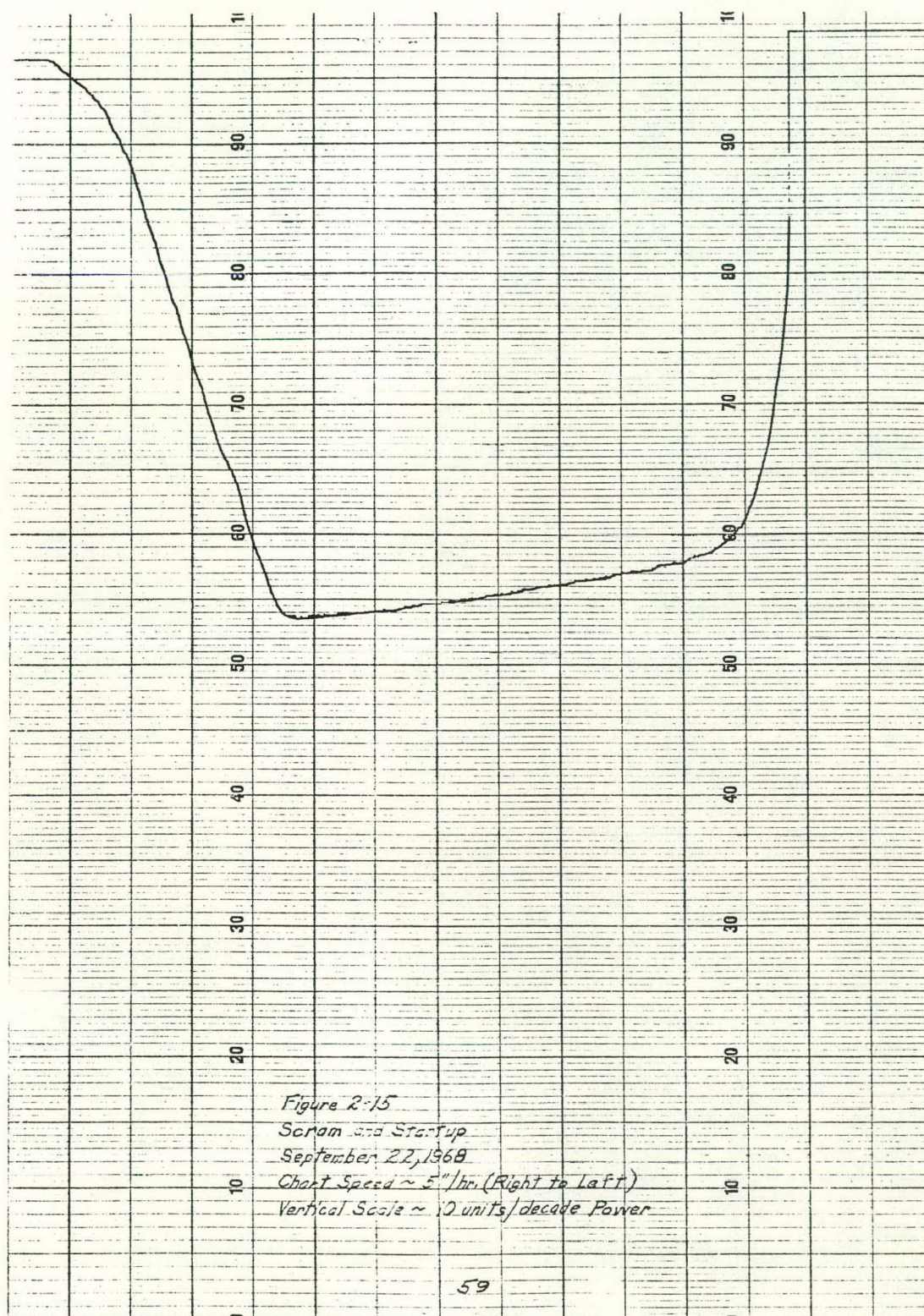
TABLE 2-28 GETR Startup History

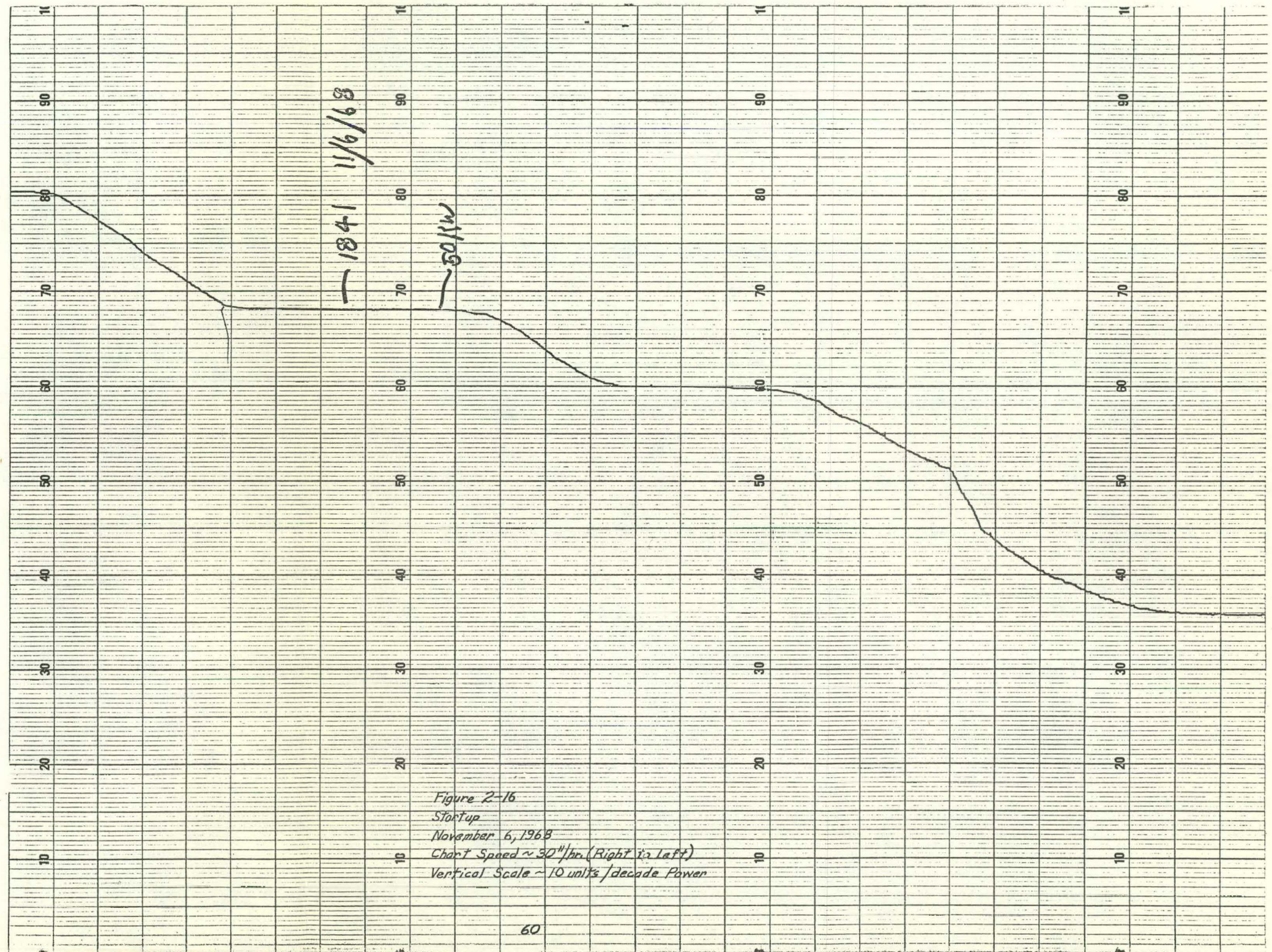
Date	Power Supplies			Period		LR1	LR2	IR1	IR2	HR1	HR2
	+15	-15	+30	Fixed	Variable						
8/30/68								5.512	7.502	7.802	9.802
9/5/68								5.506	7.497	7.799	9.800
9/11/68	14.99	15.00	29.90	10.022	5.051			5.504	7.496	7.795	9.798
9/15/68	14.98	15.01	29.96	10.026	5.054			5.492	7.481	7.782	9.784
10/2/68	14.97	15.01	29.99	10.010	5.049			5.505	7.501	7.800	9.801
10/9/68	14.99	15.00						5.504	7.501	7.803	9.807
10/18/68								5.522	7.517	7.816	9.818
10/20/68								5.536	7.529	7.827	9.831
11/6/68							5.713	5.516	7.520	7.804	9.808
11/24/68							5.642	5.485	7.499	7.808	9.811
12/26/68							5.645	5.485	7.499	7.810	9.814
1/9/69				10.031	5.055		5.670	5.490	7.508	7.817	9.821
1/11/69							5.667	5.490	7.507	7.816	9.820
2/2/69	15.00	14.99	29.93				5.639	5.484	7.499	7.810	9.815
2/24/69	15.00	15.00	29.93	10.030	5.055		5.613	5.478	7.494	7.803	9.806
3/12/69						1.70	5.688	5.481	7.497	7.807	9.811
3/24/69						1.71	5.661	5.486	7.500	7.811	9.814
4/3/69				10.037	5.051	1.71	5.685	5.487	7.500	7.811	9.814
5/1/69	15.01	14.97	29.93	10.040			5.638	5.485	7.495	7.806	9.809
5/7/69						1.71	5.658	5.488	7.504	7.815	9.817
*5.7/69							5.684	5.477	7.493	7.802	9.797
5/13/69							5.660	5.495	7.511	7.818	9.822
*5/18/69	15.01	14.97	29.97	10.046	5.062	1.718	5.621	5.476	7.495	7.806	9.801
Deviation	± 0.02	± 0.02	± 0.05	± 0.018	± 0.007	± 0.01	± 0.05	± 0.025	± 0.02	± 0.023	± 0.024

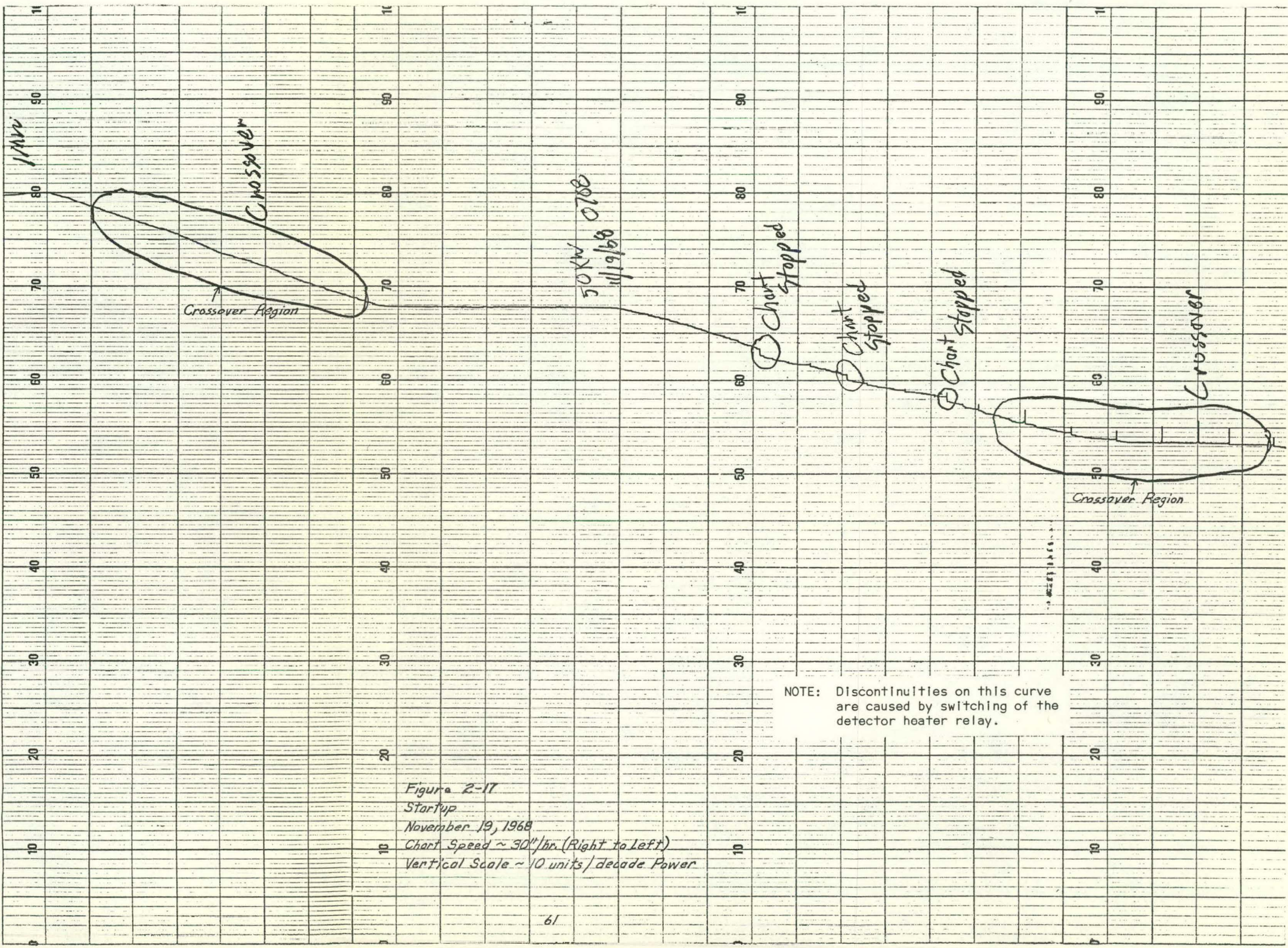
*250 feet of cable between preamplifier and main chassis. All other data taken using 10 feet of cable.

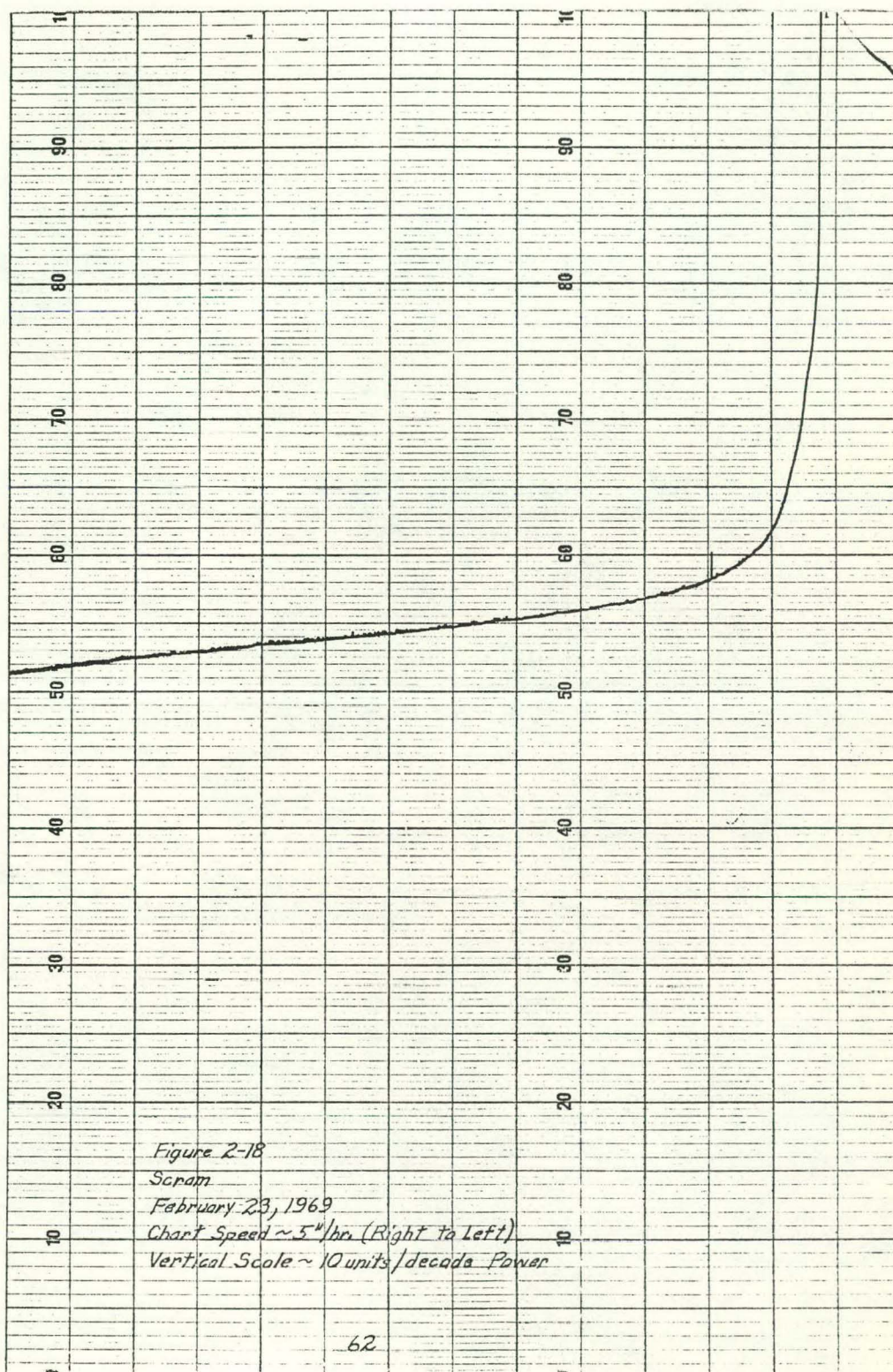
TABLE 2-29 Calibration and Drift Measurements

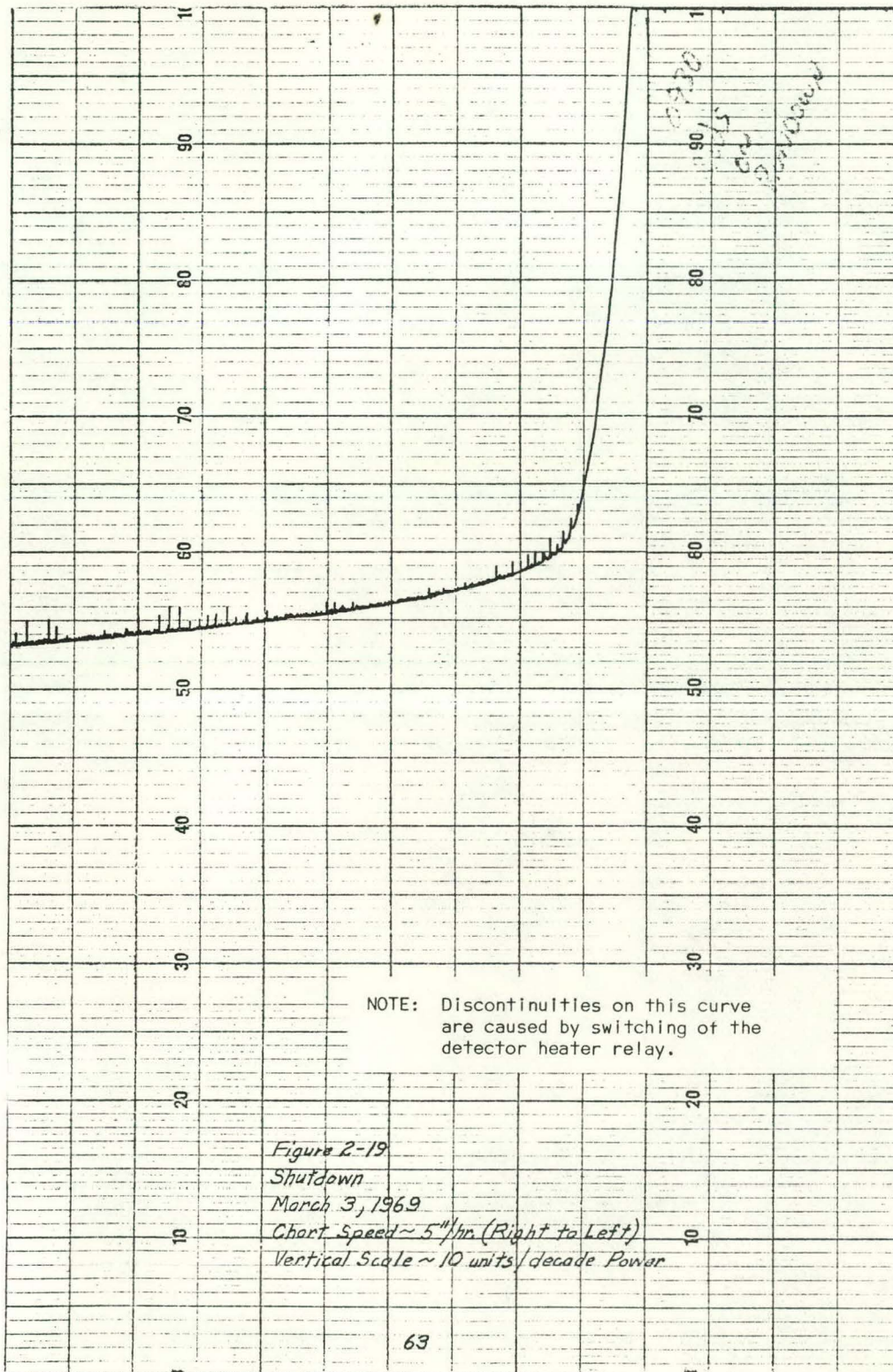












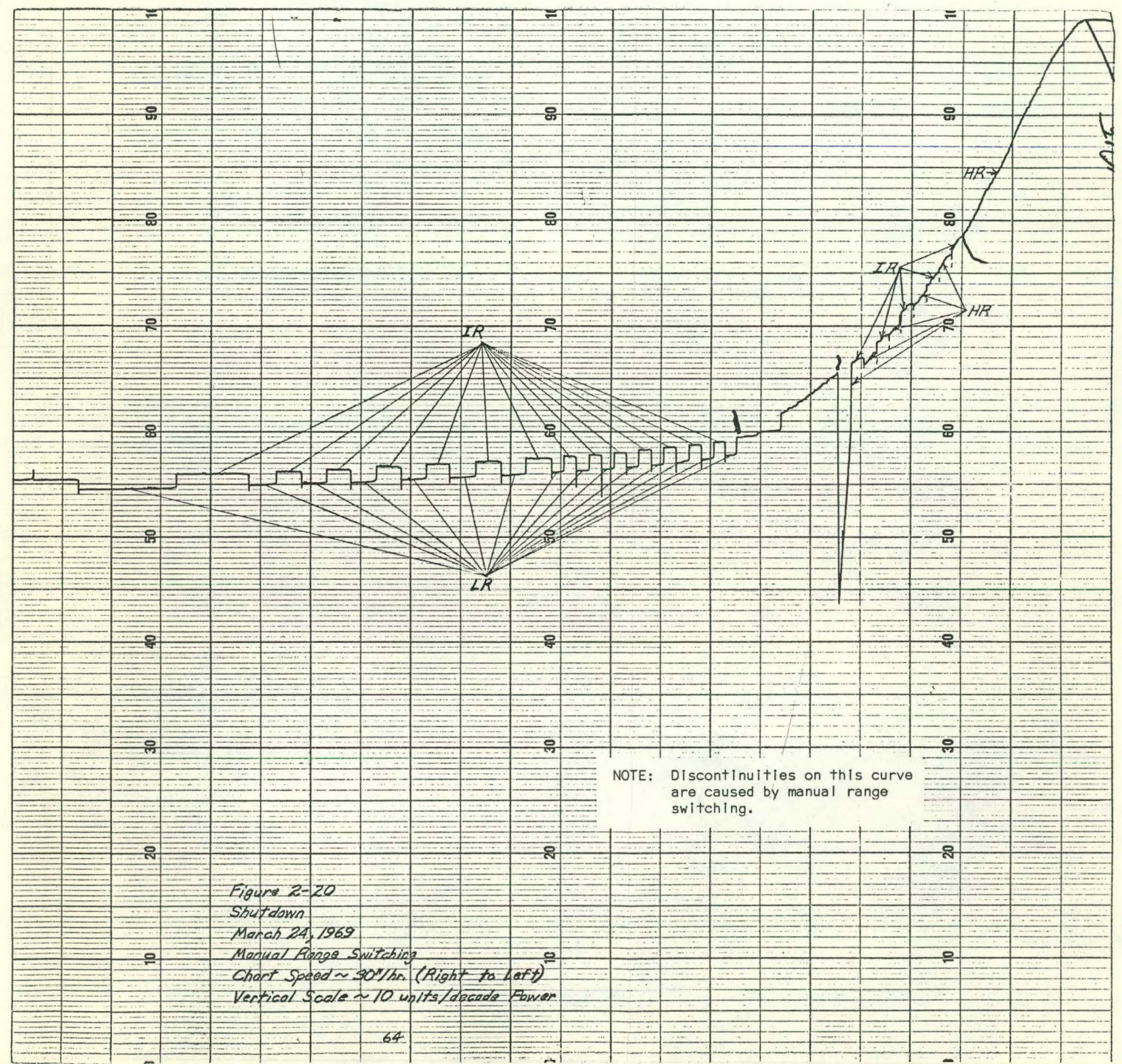
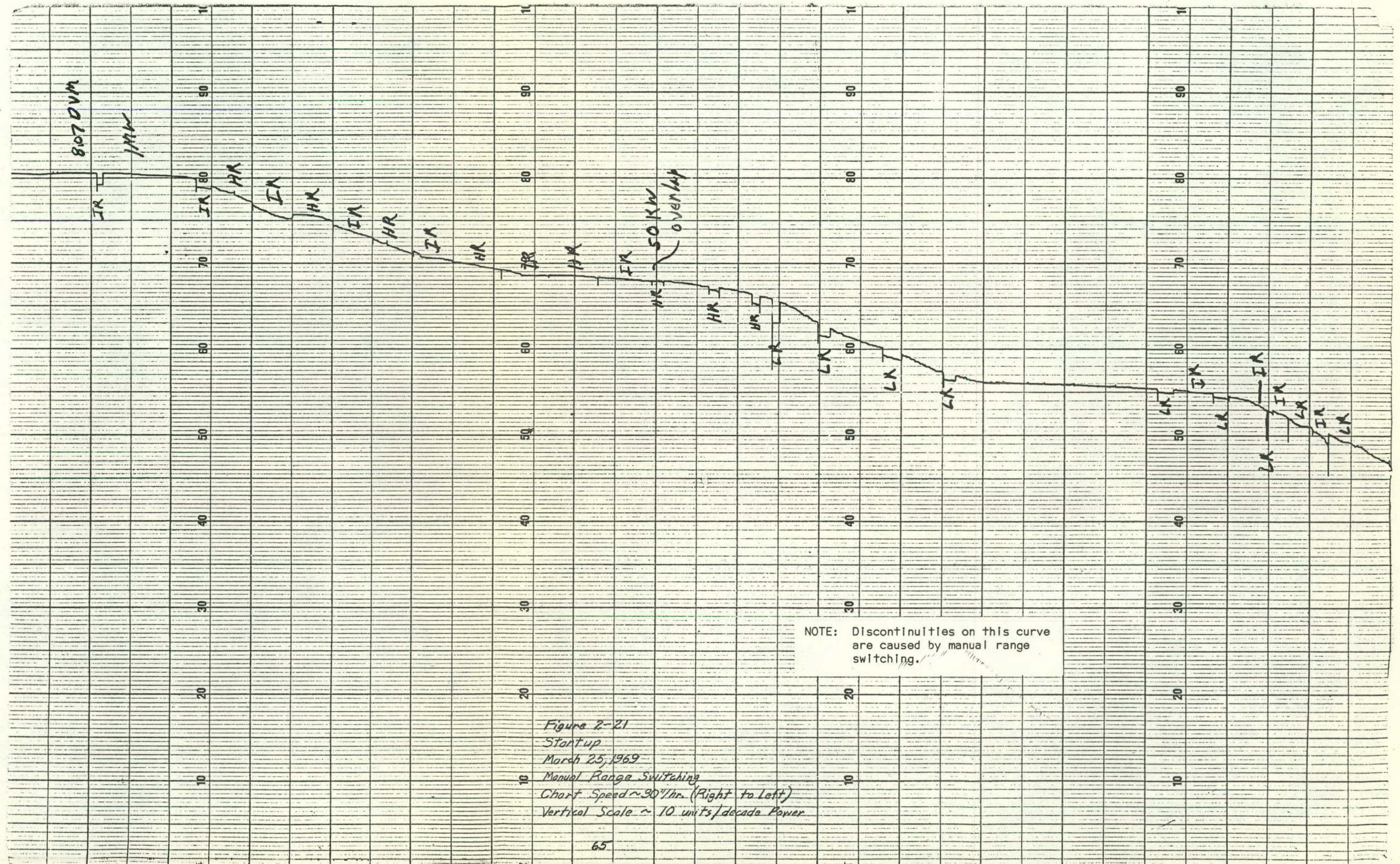
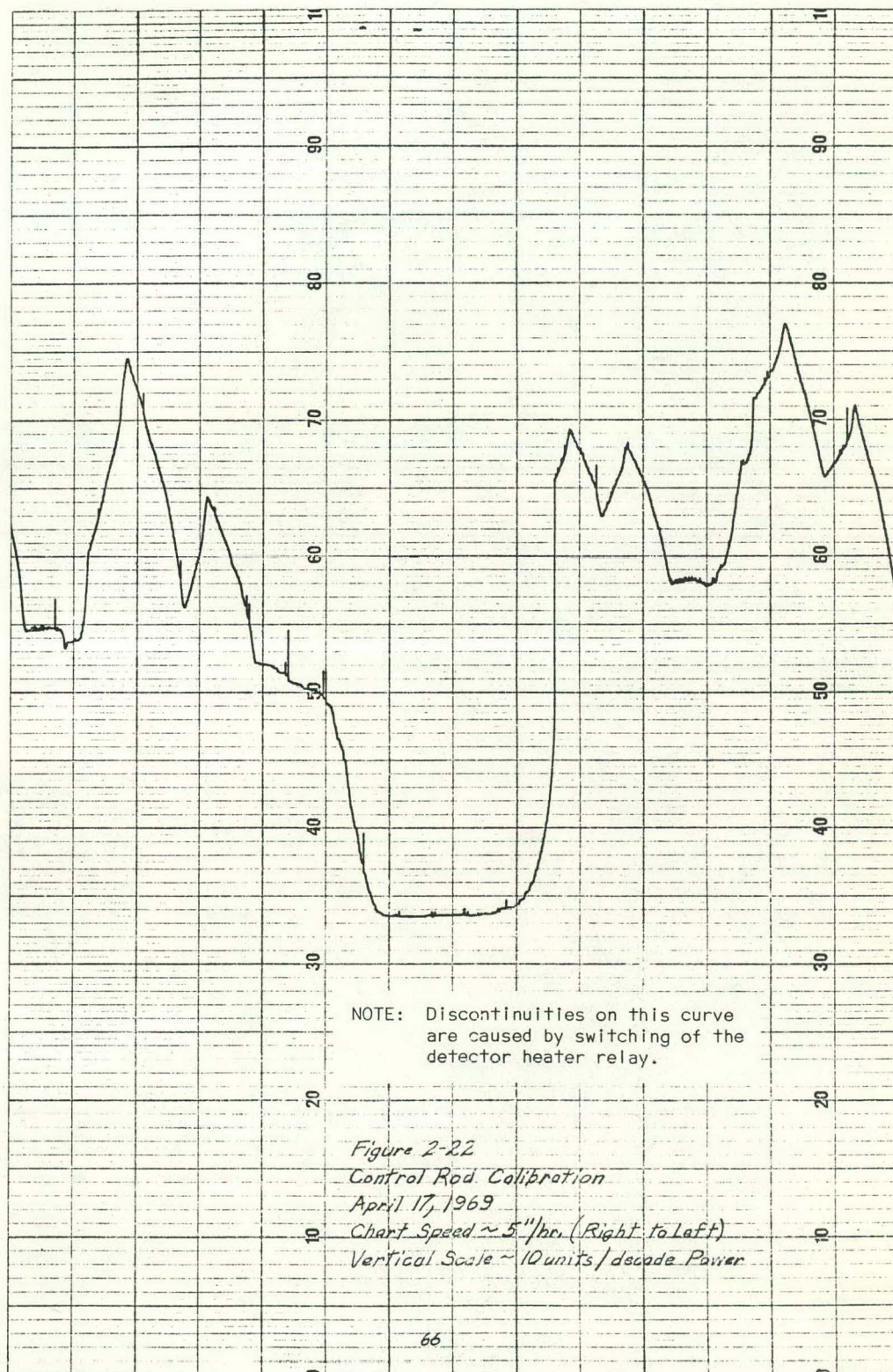
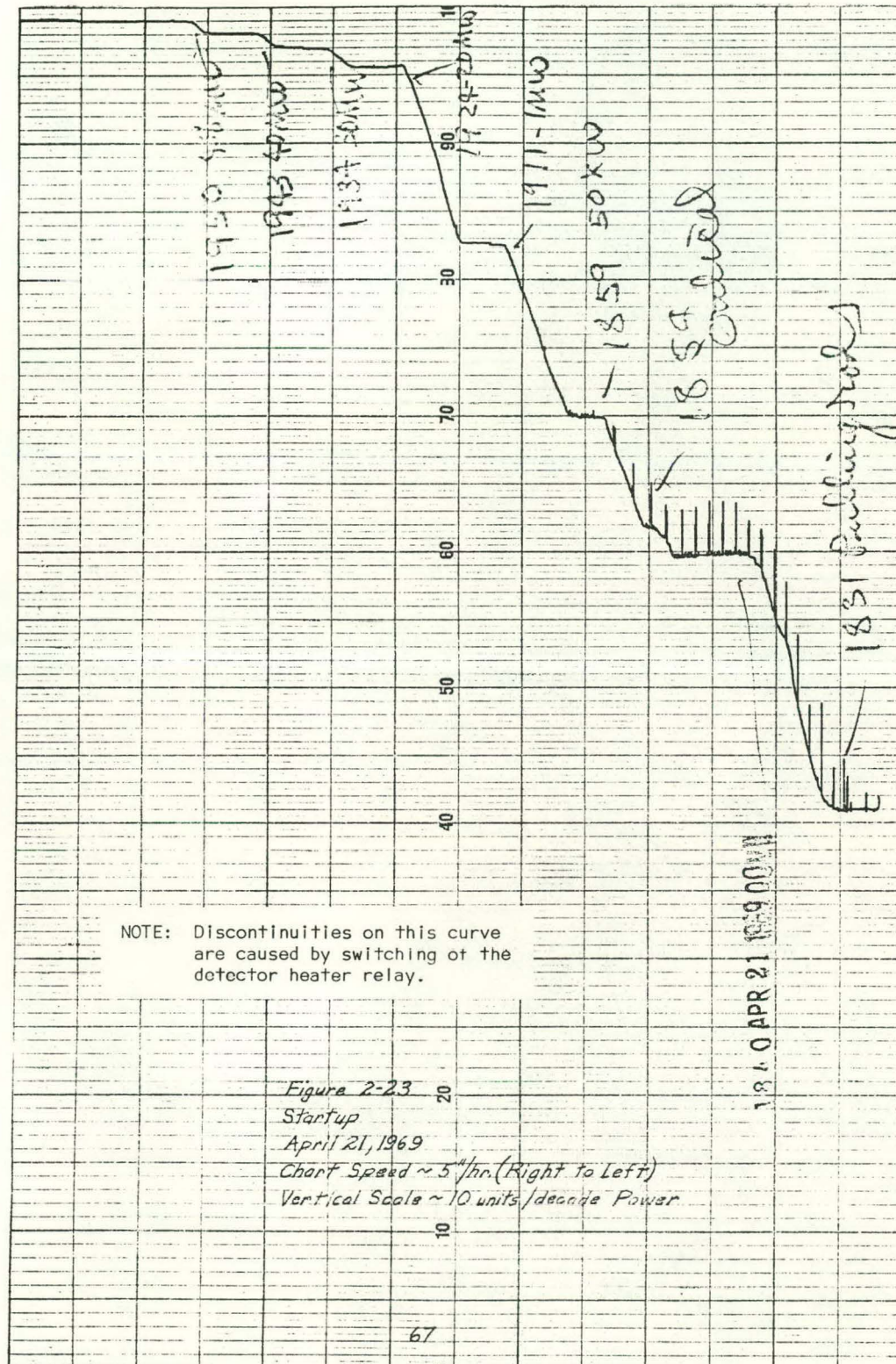
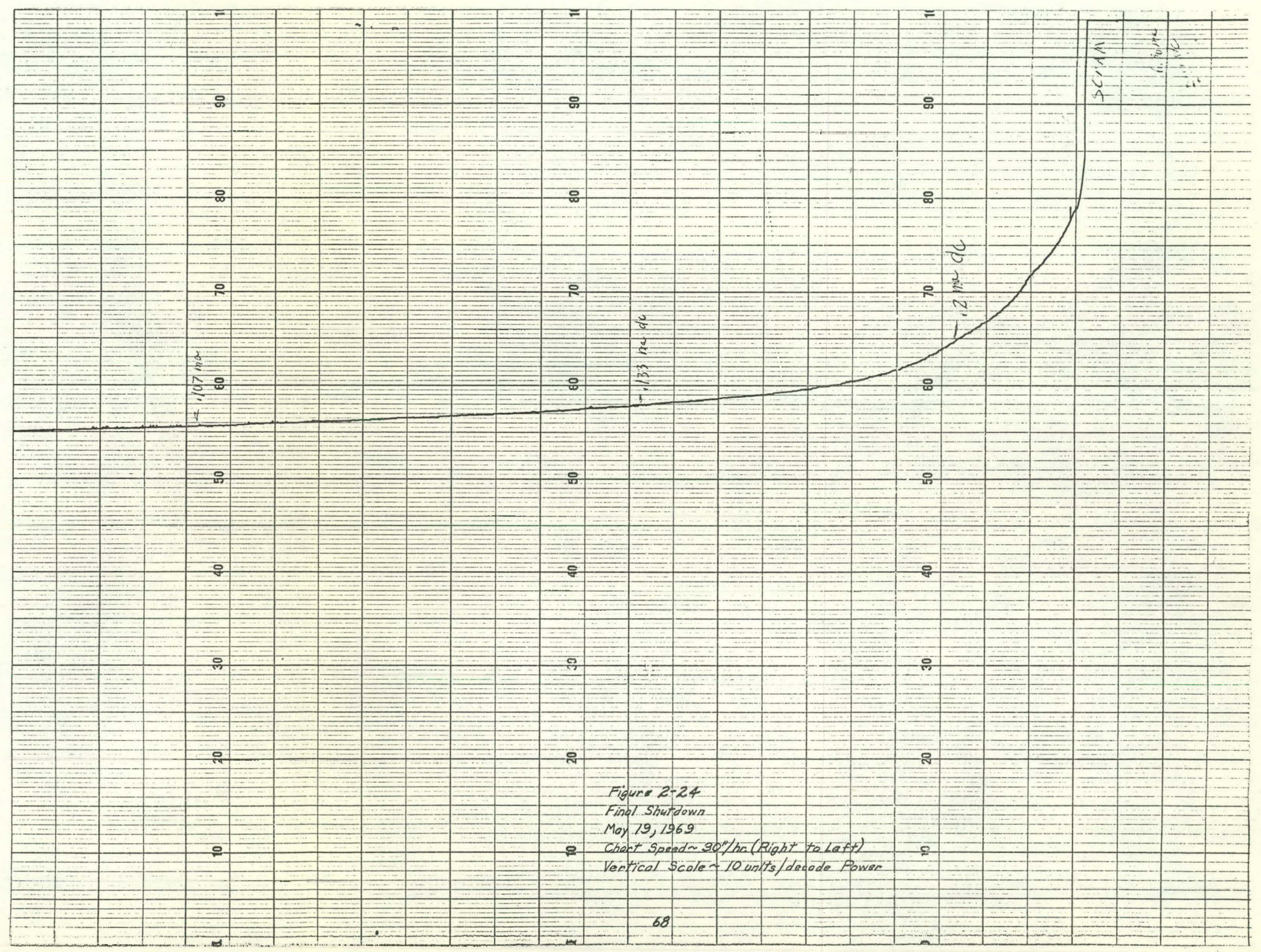


Figure 2-20
Shutdown
March 24, 1969
Manual Range Switching
Chart Speed ~ 30"/hr. (Right to Left)
Vertical Scale ~ 10 units/decade Power

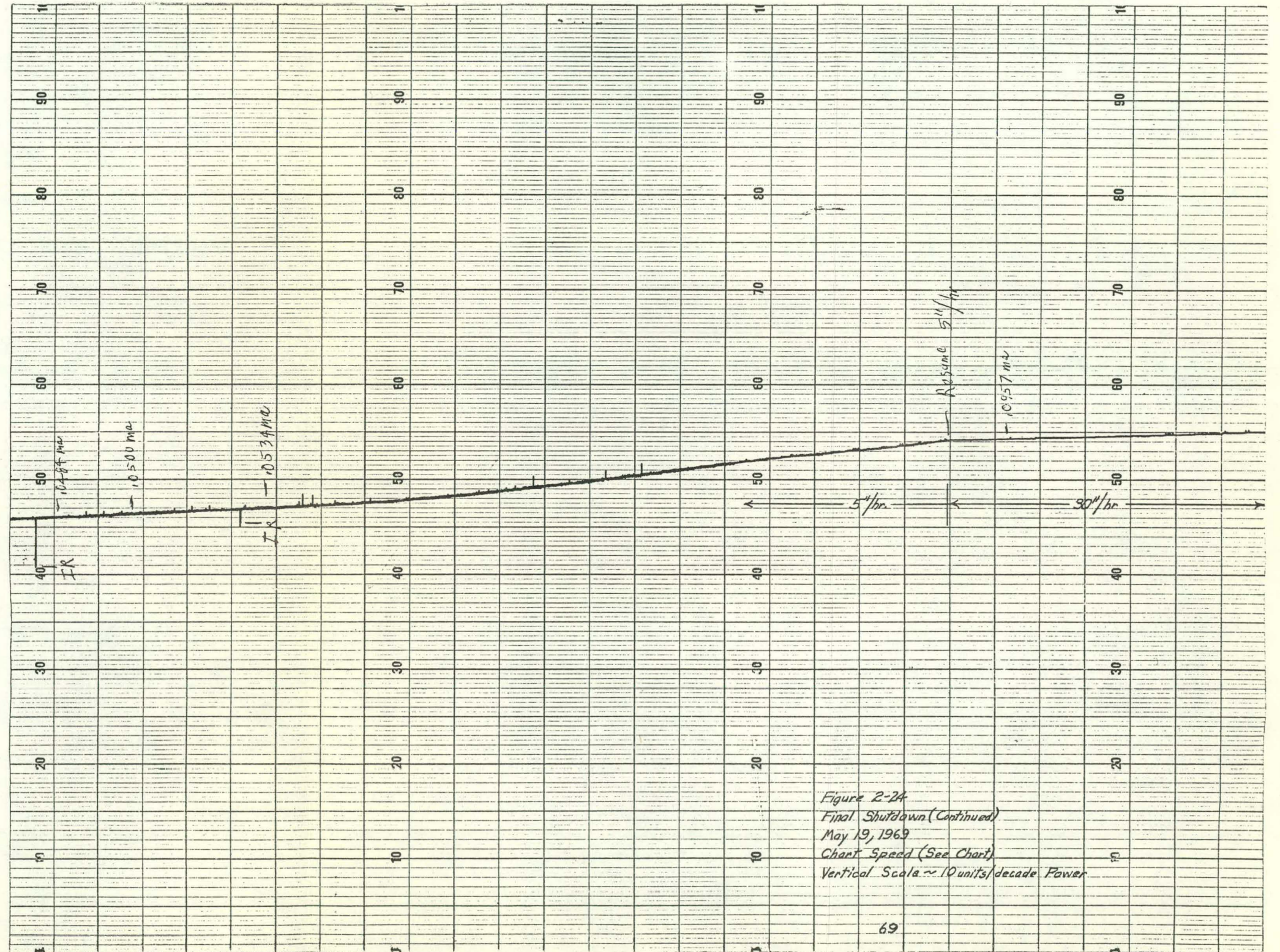








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APPENDIX A
FAILURE MODE ANALYSIS

I. INTRODUCTION

The purpose of this analysis is to determine a Mean Time Between Failure number for the WRM System. The failure rate data contained in MIL-HNDBK-217A was used wherever possible. Items not using failure rates from this source were:

Modular Components (Op Amps, Power Supplies)

Cermet Potentiometers (used vendor's data)

The ± 15 Volt Power Supply is not included in this analysis since it is manufactured by another vendor and the instruction manual does not include enough data on some of the components to determine the applicable failure rates.

II. ASSUMPTIONS

- A. Unsafe Failure: Any failure resulting in a blockage of a scram or alarm output or a fixed or decreased output.
- B. If the result of a failure is the actuation of a trip circuit which is displayed to the operator, the failure is considered a safe failure.
- C. A failure which leaves a channel operative but results in an increased output (less margin to trip) is considered a safe failure.
- D. It is assumed that all parts are per mil-spec's. In reality a good percentage of the parts are, indeed, manufactured to mil-spec's. This permits us to use MIL-HNDBK-217A as our basic reference for all reliability values. Where necessary, additional assumptions are made and noted in the Analysis.
- E. Although worst case ambient is specified as 50°C, it is assumed the components may reach 60°C ambient. All stress calculations are made on this basis.
- F. Component failures are assumed random (neglecting infant and wearout failures).
- G. Failures are assumed independent.

II. ASSUMPTIONS (Continued)

H. When the open and shorted failure mode produce separate results, the unsafe failure rates are calculated as follows:

OPEN MODE	SHORT MODE	UNSAFE FAILURE RATE
0	0	0
X	0	$\frac{2}{3} \times \text{Failure Rate}$
0	X	
X	X	1X Failure Rate

III. RESULTS

This analysis shows the WRM System to have a failure rate of about 16,780 failures per million hours or a MTBF of about 59.6 hours. It is interesting to note that 16,500 failures per million hours are contributed by the 30 reed relays in the system. If the reed relay failure rate is subtracted from the total, the remainder is 280 failures per million hours or a MTBF of 3,570 hours. This figure seems much more reasonable and is in better agreement with our test results. If one subtracts the reed relay failure rate from the total unsafe failure rate, the result is a MTBF of 6,940 hours for unsafe failures.

In order to reduce the failure rate, one can look into replacing the reed relays with other relays or solid state switches. In the Preamplifier and High Voltage Filter there are seven (7) relays which cannot be replaced by solid state switches due to the high voltage requirement. Therefore, if one assumes that it is necessary to keep these seven (7) relays, but replace them with a Type J Armature Relay, the failure rate per relay

III. RESULTS (Continued)

would be reduced to about 110 failures/million hours. If the other twenty-three (23) reed relays are replaced by solid state switches with an assumed failure rate equal to a nominal semiconductor failure rate (about one failure/million hours), the overall failure rate for the system reduces to about 1,073 failures/million hours, or a MTBF of about 930 hours.

<u>Module</u>	<u>Safe & Unsafe (Failures/10⁶ Hrs.)</u>	<u>Unsafe (Failures/10⁶ Hrs.)</u>
Preamplifier	2210.7631	554.1903
Main Amplifier	1666.3899	379.4659
High Voltage Filter	1652.2604	.2840
30 Volt Power Supply	5.2600	.2600
High Voltage Power Supply	20.5578	.2650
Campbell Calibrator	3309.4990	---
Signal Generator	2.6528	---
Pulse Height Discriminator	33.7358	22.7540
Log Integrator	6.6190	6.4330
Intermediate Range Amplifier- Rectifier	12.7192	10.5444
Intermediate Range Log Ladder	7.4569	5.3634
High Range Amplifier- Rectifier	12.2274	4.7361
High Range Log Ladder	7.5589	5.7984
Multirange Monitor	1666.1558	1110.5632
Auction	1674.1742	1119.2094
Auction Monitor	1659.6490	---
Period Module	1112.1509	1108.9431
Ramp Generator	1657.3860	---
Dual Trip (3 Units)	62.4432	35.1012
TOTAL	16779.6593	4360.9093

TABLE A Failure Rates By Module

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

REV
NO

TITLE

E Preamplifier

FAILURE RATE DATA SHEET

FIRST MADE FOR *PA 49*

CONT ON SHEET

SH ND

ITEM NO	PART NO	DESCRIPTION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS					
				OPEN	SHORT	DRIFT	(a) P(OP.) / P (RATED)	(b) V(OP.) / V (RATED)	(c) I(OP.) / I (RATED)	T _J MAX (°C)	T _R °C/MW	ΔT _J (°C)	T(N)	SAFE & UNSAFE	UNSAFE FAILURE						
1	J1	Connector UG-496/U		O	O									.06		Assume	1 mating/1000 hrs.				
2	J2	Connector UG-931/U		X	O									.06	.04	"					
3	J4	Connector UG-496/U		X	O									.06	.04	"					
4	J3	Connector UG-931/U		O	O									.06		"					
5	J5	Connector 8 Pin MS		X	X									.34	.34	"		7 Active Pins			
6	C1	Cap.	Mylar	O	X			30/100						.0028	.0018						
7	C2	"	Tant.	O	X			5/20						.004	.0027						
8	C3	"	"	X	O			10/20						.013	.009						
9	C4	"	"	O	O			15/20						.08							
10	C5	"	"	X	O			6/20						.004	.0026						
11	C6	"	Mica	O	X			0/500						.026	.018						
12	C7	"	Tant.	O	O			5/20						.004							
13	C8	"	"	O	O			5/20						.004							
14	C9	"	"	X	O			12/20						.03	.02						
15	C10	"	"	O	X			10/35						.004	.0026						
16	C11	"	"	O	O			15/35						.04							
17	C12	"	"	O	O			15/35						.04							
18	C13	"	"	O	O			15/35						.04							
19	C14	"	Paper	O	X			650/1500						.38	.26						
NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE														PAGE SUB TOTAL		1.2518	.7367				

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

PAGE SUB TOTAL

1.2518	7367
--------	------

~~REVISIONS~~

PRINTS 5

DATE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

**DIV OR
DEPT**

LOCATION

CONT ON SHEET

A-5

2014 2013

NEBS

ON HS

133MS NO 1N00

ON 0N1MVB0

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO.

CONT ON SHEET

SH NO.

TITLE

Preamplifier

FAILURE RATE DATA SHEET

FIRST MADE FOR

PA 49

CONT ON SHEET 3

SN NO. 2

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS					
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR							
							P(OP.) / P (RATED)	V(OP.) / V(RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T _J R. (°C/MW)	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE						
20	C15	Cop.	Tant.	0	X			15/35						.04	.026						
21	C16	"	"	0	X			15/35						.013	.009						
22	C17	"	"	0	0			15/25						.09							
23	C18	"	"	0	0			15/35						.013							
24	C19	"	"	0	X			15/35						.013	.009						
25	FL1	Filter		0	0				.05/2					.10		Assumed					
26	FL2	"		X	X				.05/2					.10	.1	Assumed					
27	L1	Choke		0	0				50/160					.21							
28	L2	"		X	0				50/160					.21	.14						
29	R1	Res.	Comp.	0	0		35/500							.021							
30	R2	"	"	0	0		35/500							.021							
31	R3	"	Metal Film	0	X		200/250							.0078	.0052						
32	R4	"	"	0	X		50/250							.0057	.0038						
33	R5	"	Comp.	0	X		10/500							.021	.014						
34	R6	"	"	X	0		10/500							.021	.014						
35	R7	"	"	0	0		.5/500							.021							
36	R8	"	Metal Film	0	0		1/250							.0054							
37	R9	"	Comp.	0	0		7/500							.021							
38	R10	"	"	0	0		10/500							.021							
NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE														PAGE SUB TOTAL		.9449	.3210				

MADE BY

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APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SN NO.

FF-808-P (11-6-77)

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NEBS

A-6

ON MS

CONT ON SHEET 4

ON DRAWING

SH NO. 3

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV. NO.

CONT ON SHEET

SH NO.

TITLE

PREAMPLIFIER

FAILURE RATE DATA SHEET

FIRST MADE FOR

PA 49

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

ISSUED

APPROVAL

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

PRINTS TO

A-7

NEBS

PRINTED IN U.S.A.

ON HS

133MS NO 1M03

ON DIMENSIONS

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV. NO.

CONT ON SHEET

SH. NO.

TITLE

Main Amplifier

FAILURE RATE DATA SHEET

FIRST MADE FOR

PA 49

CONT ON SHEET 3

SH. NO. 2

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS	
				OPEN	SHORT	DRIFF	(a)	(b)	(c)	TA = 60°C				SAFE & UNSAFE	UNSAFE FAILURE		
							P(OP.) / P (RATED)	V(OP.) / V (RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T _J R. PC/MW	ΔT _J (°C)	T (N)				
20	CH 3	111914	Silicon	O	X			13/100		150			.24	.333	.222		
21	CP 4	"	"	O	O			13/100		150			.24	.333			
22	CP 5	"	"	O	O			13/100		150			.24	.333			
23	L1	Choke		X	O				75/160					.21	.14		
24	L2	"		X	O				75/160					.21	.14		
25	P 1	Res	Metal Film	O	O		15/250							.0054			
26	R 2	"	Comp.	O	O		20/500							.021			
27	R 3	"	"	O	O		19/500							.021			
28	R 4	"	"	O	O		4/500							.021			
29	R 5	"	Metal Film	O	O		10/250							.0054			
30	R 6	"	Comp.	O	O		15/500							.021			
31	R 7	"	Metal Film	O	X		10/250							.0054	.0036		
32	R 8	"	Comp.	O	O		50/500							.021			
33	R 9	"	"	X	O		150/500							.027	.018		
34	R 10	"	"	O	O		300/500							.09			
35	R 11	"	"	O	O		300/500							.09			
36	R 12	"	"	X	O		5/500							.021	.014		
37	R 13	"	Metal Film	O	O		5/250							.0054			
38	R 14	"	"	X	O		0/250							.0054	.0036		
NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE										PAGE SUB TOTAL		1,7790		.5412			

MADE BY

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APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH. NO.

REVISIONS

PRINTS TO

A-10

NEBS

ON HS		132MS NO 1N00		ON SHIMMS		UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:		REV NO.		TITLE <i>Main Amplifier</i>		CONT ON SHEET 4		SH NO. 3	
APPLIED PRACTICES		SURFACES		TOLERANCES ON MACHINED DIMENSIONS		FRACTIONS		DECIMALS		ANGLES		CONT ON SHEET		SH NO.	
		✓		+		+		+							
FIRST MADE FOR <i>PA 49</i>															

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR		
							P(OP.) / P (RATED)	V(OP.) / V (RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T. R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE	
39	R 15	Res.	Metal Film	0	X		5/250							.0054	.0036	
40	R 16	"	Comp.	0	0		10/500							.021		
41	R 17	"	"	X	X		6/500							.021	.021	
42	R 18	"	"	X	X		8/500							.021	.021	
43	R 19	"	"	X	X		12/500							.021	.021	
44	R 20	"	Metal Film	X	0		1/250							.0054	.0036	
45	R 21	"	Comp.	0	X		5/500							.021	.014	
46	R 22	"	"	X	0		5/500							.021	.014	
47	R 23	"	Metal Film	X	X		5/250							.0054	.0054	
48	R 24	"	Comp.	X	0		2/500							.021	.014	
49	R 25	"	"	X	X		6/500							.021	.021	
50	R 26	"	"	X	X		8/500							.021	.021	
51	R 27	"	"	X	X		35/500							.021	.021	
52	R 28	"	Metal Film	X	0		1/250							.0054	.0036	
53	R 29	"	Comp.	0	X		5/500							.021	.014	
54	R 30	"	"	X	0		5/500							.021	.014	
55	R 31	"	Metal Film	X	X		5/250							.0054	.0054	
56	R 32	"	Comp.	0	X		7/500							.021	.014	
57	R 33	"	"	X	X		50/500							.021	.021	
PAGE SUB TOTAL														3210	3012	

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY	APPROVALS	SNO	DIV OR DEPT	LOCATION	CONT ON SHEET	SH NO.
ISSUED				SAN JOSE, CALIF		A-11
			NEBS			

CONT ON SHEET

ON DRAWING

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV. NO.

CONT ON SHEET

SH. NO.

GENERAL ELECTRIC

CONT ON SHEET F

SH. NO. 4

TITLE Main Amplifier

FAILURE RATE DATA SHEET

FIRST MADE FOR PA 49

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR		
							P(OP.) / P (RATED)	V(OP.) / V(RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T(N)	SAFE & UNSAFE	UNSAFE FAILURE	
58	R 34	Res.	Comp	X	O		50/500							.021	.014	
59	R 35	"	"	O	O		50/500							.021		
60	R 36	"	"	O	O		50/500							.021		
61	R 37	"	"	O	O		80/500							.021		
62	K1	Relay		X	O		160/225	5/300	25/125					550	367	Type F
63	K2	"		O	O		160/225	5/300	25/125					550		"
64	K3	"		O	O		160/225	5/300	25/125					550		"
65	QA 1	Op Amp		X	X									4.38	4.38	Assumed
66	Q1	2N2484	Silicon	O	O		15/360	10/60		175	.49	8	.29	.372		
67	Q5	"	"	X	X		10/360	10/60		175	.49	5	.27	.352	.352	
68	Q7	"	"	X	X		10/360	10/60		175	.49	5	.27	.352	.352	
69	Q2	2N2905	"	O	O		150/600	25/60		175	.29	45	.53	2.04		
70	Q4	"	"	X	X		200/600	25/60		175	.29	58	.62	2.60	2.60	
71	Q6	"	"	X	X		10/600	10/60		175	.29	3	.25	.84	.84	
72	Q3	2N2219	"	X	X		200/800	25/60		175	.19	38	.49	.601	.601	
73	Q9	"	"	X	X		35/800	10/60		175	.19	7	.28	.363	.363	
74	Q8	2N3799	"	X	X		10/360	10/60		175	.49	5	.27	.906	.906	
75	C 18	Cap.	Tant.	X	X			10/20						.013	.013	
PAGE SUB TOTAL														1662.	377.	
UNIT TOTAL														9030	4210	
														1666.	379.	
														3899	4659	

NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE

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SAN JOSE, CALIF

LOCATION

CONT ON SHEET

SH. NO.

A-12

NEBS

FF-606-P (10-67)

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ON HS

CONT ON SHEET NO 1

ON DNIMVRO

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV. NO.

CONT ON SHEET

SH NO.

GENERAL ELECTRIC

TITLE

High Voltage Power Supply

FAILURE RATE DATA SHEET

FIRST MADE FOR

PA 49

CONT ON SHEET 2

SH NO. 1

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR		
							P (OP.) / P (RATED)	V (OP.) / V (RATED)	I (OP.) / I (RATED)	T _J MAX (°C)	T. R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE	
1	C1	Cap.	Plastic	0	0			1000/2000						.054		
2	C2	"	Paper	0	0			675/1500						.52		
3	C3	"	"	0	0			650/1500						.52		
4	T1	Trans-former		0	0									.5		
5	RD	2N1046	Ge	0	0		5/50			100	1/W	5	.7	7.2		50°C
6	R1	Pot	Cermet	0	0		250/1000							.2		Manufacturers Data
7	CR 1	1N5181	Silicon	0	0			1000/4000	10/100	175			.23	.318		
8	CR 2	"	"	0	0			1000/4000	10/100	175			.23	.318		
9	R1	Res.	Film	0	0		1280/1000							.3		
10	R2	"	"	0	0		175/1000							.075		
11	R3	"	"	0	0		50/1000							.069		
12	R4	"	Comp	0	X		70/1000							.021	.014	
13	R5	"	"	0	X		70/1000							.021	.014	
14	R6	"	"	X	0		2/500							.021	.014	
15	CR 1	1N4148	Silicon	0	0			0/75	0/10	175			.23	.318		
16	CR 2	"	"	0	0			0/75	0/10	175			.23	.318		
17	C1	Cap.	Tant.	0	0			15/50						.21		
18	C2	"	"	0	0			15/50						.21		
19	C3	"	"	0	0			15/35						.009		
NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE										PAGE SUB TOTAL		10.6620	.0420			

MADE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH NO.

A-15

NEBS

PP-808-P (10-67)

PRINTED IN U.S.A.

ON HS

132MS NO 1NOC

ON DIMENSIONS

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO.

CONT ON SHEET

SH NO.

TITLE

High Voltage Power Supply

FAILURE RATE DATA SHEET

FIRST MADE FOR

PA 49

CONT ON SHEET 3

SH NO. 2

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

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APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH NO.

A-16

NEBS

FF-806-P (10-67)

PRINTED IN U.S.A.

ON MS

CONT NO SHEET

ON SHEET

REV NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

CONT ON SHEET

SH NO.

TITLE

HIGH VOLTAGE POWER SUPPLY
FAILURE RATE DATA SHEET

ON SHEET 4

SH NO. 3

FIRST MADE FOR

PA 49

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				SAFE & UNSAFE	UNSAFE FAILURE	
							P(OP.) / P (RATED)	V(OP.) / V (RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T. R. °C/MW	ΔT _J (°C)	T (N)			
39	R 13	Res.	Film	0	0		3/500							.069		
40	R 14	"	"	0	0		8/500							.069		
41	R 15	"	"	0	0		15/500							.069		
42	R 16	"	"	0	0		10/500							.069		
43	R 17	"	"	0	0		15/500							.069		
44	R 18	"	"	0	0		3/500							.069		
45	R 19	"	"	0	0		8/500							.069		
46	R 20	"	Comp.	0	0		5/500							.021		
47	R 21	"	Film	0	0		10/500							.069		
48	R 22	Pot.	Cermet	0	0		5/1000							.2		Manufacturers Data
49	R 23	Res.	Comp	0	0		100/500							.021		
50	R 24	"	"	0	0		750/1000							.18		
51	R 25	"	"	0	0		750/1000							.18		
52	L1	Choke		0	0									.48		
53	L2	"		0	0									.48		
54	Q1	2N1711	Silicon	0	0		100/800			175	.22	22	.38	.467		
55	Q2	2N491	"	0	0		1/450							.50		Assumed
56	Q3	2N1711	"	0	0		100/800			175	.22	22	.38	.467		
57	Q4	"	"	0	0		5/800			175	.22	1	.24	.326		
NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE													PAGE SUB TOTAL		3.8740	

MADE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH NO.

A-17

NEBS

ON HS		CONT ON SHEET NO 1		GENERAL ELECTRIC										CONT ON SHEET 2		SH NO. 1					
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:				REV NO.		TITLE <i>Campbell Calibrator</i>										FIRST MADE FOR <i>PA 49</i>					
APPLIED PRACTICES		SURFACES		TOLERANCES ON MACHINED DIMENSIONS			CONT ON SHEET										SH NO.				
		✓		FRACTIONS + DECIMALS + ANGLES +																	
ITEM NO	PART NO	DESCRIPTION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS					
				OPEN	SHORT	DRIFT	(a) P(OP.)/P (RATED)	(b) V(OP.)/V (RATED)	(c) I(OP.)/I (RATED)	TA = 60°C				/10 ⁶ HR							
1	C1	Cap.	Tant.					5/35							.003						
2	C2	"	"					5/35							.003						
3	C3	"	"					15/35							.014						
4	C4	"	"					15/35							.14						
5	C5	"	"					5/20							.0.1						
6	C6	"	"					2/35							.002						
7	C7	"	"					2/35							.002						
8	CR1	1N4004	Silicon					0/400				175		.23	.318						
9	CR2	"	"					0/400				175		.23	.318						
10	CR3	"	"					2/400				175		.23	.318						
11	FF1	IC													2.0		Assumed				
12	FF2	"													2.0		"				
13	FF3	"													2.0		"				
14	R1	Res	Comp.					1/250							.021						
15	R2	"	"					15/250							.021						
16	R3	"	"					2/250							.021						
17	R4	Pot	Cermet					15/1000							.2		Manufacturers Data				
18	R5	Res	Metal Film					2/100							.0054						
19	R6	"	"					1/100							.0054						
														PAGE SUB TOTAL		73/98					

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH NO.

A-19

NEBS

FF-806-7 (10-67)
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ON HS

LEADS NO 1N00

ON DINMVBG

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO.

CONT ON SHEET

SH NO.

TITLE

Campbell Calibrator

FAILURE RATE DATA SHEET

FIRST MADE FOR

PA 49

CONT ON SHEET

3

SH NO.

2

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				SAFE & UNSAFE	UNSAFE FAILURE	
							P(OP.) / P (RATED)	V(OP.) / V(RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T(N)			
20	R 7	Res	Metal Film				20/100							.0054		
21	R 8	"	"				2/100							.0054		
22	R 9	"	Comp.				25/250							.021		
23	R 10	"	"				2/250							.021		
24	R 11	Pot	Cermet				25/1000							.2		Manufacturers Data
25	R 12	Res.	Comp.				.1/250							.021		
26	R 13	"	"				4/250							.021		
27	R 14	"	"				4/250							.021		
28	R 15	"	"				5/250							.021		
29	R 16	"	Metal Film				1/100							.0054		
30	R 17	"	"				1/100							.0054		
31	R 18	"	Comp.				2/250							.021		
32	R 19	Pot	Cermet				25/1000							.2		Manufacturers Data
33	R 20	Res.	Comp.				4/250							.021		
34	R 21	"	"				4/250							.021		
35	R 22	"	Metal Film				1/100							.0054		
36	R 23	"	Comp				1/250							.021		
37	R 24	"	Metal Film				0/100							.0054		
38	R 25	"	"				0/100							.0054		
PAGE SUB TOTAL														.6478		

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

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APPROVALS

SNO

DIV OR DEPT

SAN JOSE, CALIF

LOCATION

CONT ON SHEET

SH NO.

A-20

NEBS

ON HS		132MS NO 1M03		ON DN1MVB0		UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—		REV NO.		TITLE		CONT ON SHEET		SH NO.	
APPLIED PRACTICES		SURFACES		TOLERANCES ON MACHINED DIMENSIONS		FRACTIONS		DECIMALS		ANGLES		CONT ON SHEET		SH NO.	
		✓		+		+		+				Campbell Calibrator		F	
												FAILURE RATE DATA SHEET		SH NO. 3	
												FIRST MADE FOR		PA 49	

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS					
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR							
							P(OP.) / P (RATED)	V(OP.) / V(RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T _J R. (°C/MW)	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE						
39	R 26	Res.	Comp.				200/250							.216							
40	R 27	"	"				1000/2000							.06							
41	PS 1	Voltage Reg.							200/500					2.0		Assumed					
42	VR 1	IN752A	Silicon				0/400			175			.23	.634							
43	Q1	2N3417	"				10/360	1/50		125	.38	4	.39	.476							
44	Q2	"	"				10/360	1/50		125	.38	4	.39	.476							
45	Q3	"	"				10/360	1/50		125	.38	4	.39	.476							
46	Q4	"	"				10/360	1/50		125	.38	4	.39	.476							
47	Q5	"	"				10/360	1/50		125	.38	4	.39	.476							
48	Q6	"	"				10/360	1/50		125	.38	4	.39	.476							
49	Q7	"	"				10/360	1/50		125	.38	4	.39	.476							
50	Q8	2N2484	"				2/360	1/60		175	.49	1	.24	.327							
51	Q9	2N2905	"				225/600	1/60		175	.29	65	.67	2.93							
52	K1	Relay						0/300	0/125					550							
53	K2	"						0/300	0/125					550							
54	K3	"						0/300	0/125					550							
55	K4	"						0/300	0/125					550							
56	K5	"						0/300	0/125					550							
57	K6	"						15/300	300/125					550							
NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE														PAGE SUB TOTAL		3309.4990		UNIT TOTAL 3317.4666			

MADE BY	APPROVALS	SNO	DIV OR DEPT	LOCATION	CONT ON SHEET	SH NO.
ISSUED				SAN JOSE, CALIF		A-21
NEBS						

CONT ON SHEET 2 SH NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

REV
NO

TITLE	SIGNAL GENERATOR FAILURE RATE DATA SHEET
-------	---

FIRST MADE FOR PA 49

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS:

CONT ON SHEET

SH MD

ITEM NO	PART NO	DESCRIPTION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS			
				OPEN	SHORT	DRIFT	(a) P(OP.)/P (RATED)	(b) V(OP.)/V(RATED)	(c) I(OP.)/I (RATED)	T _J MAX (°C)	T. R. °C/MW	ΔT _J (°C)	T (°C)	SAFE & UNSAFE	UNSAFE FAILURE				
1	C1	Cap.	Ceramic					15/500							.008				
2	C2	"	Mylar					10/100							.0022				
3	C3	"	"					15/100							.0023				
4	C4	"	Mica					10/500							.026				
5	C5	"	Mylar					15/100							.0023				
6	C6	"	"					15/100							.0023				
7	C7	"	Mica					15/500							.026				
8	C8	"	Mylar					15/100							.0023				
9	R1	Res	Comp.					1/500							.021				
10	R2	"	"					5/500							.021				
11	R3	"	"					2/500							.021				
12	R4	"	"					20/500							.021				
13	R5	"	"					5/500							.021				
14	R6	"	"					50/500							.021				
15	R8	"	"					5/500							.021				
16	R9	"	"					5/500							.021				
17	R11	Pot.	Cermet					10/1000							.2				
18	R12	"	Metal Film					10/250							.0054				
19	R13	"	Comp.					5/500							.021				

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

PAGE SUB TOTAL

.4658

MADE IN U.S.A.

ISSUED

APPROVALS

SNO

DIV OR

SAN JOSE, CALIF

LOCATION

CONT ON SHEET

A-22

94 100

NEBS

ON HS		CONT ON SHEET		DRAWING NO.		UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:		REV NO.		TITLE		CONT ON SHEET		SH NO.	
APPLIED PRACTICES		SURFACES		TOLERANCES ON MACHINED DIMENSIONS		FRACTIONS		DECIMALS		ANGLES		PULSE HEIGHT Disc.		SH NO. 1	
		✓		+		+		+				FAILURE RATE DATA SHEET			
												FIRST MADE FOR PA 49			

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR		
							P(OP.) / P (RATED)	V(OP.) / V (RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T. R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE	
1	C1	Cap.	Tant	X	0			10/20						.013	.009	
2	C2	"	Mylar	0	0			15/100						.0024		
3	C3	"	Tant	0	X			10/20						.013	.009	
4	C4	"	Mylar	0	0			10/200						.0022		
5	C5	"	Tant	0	X			10/20						.013	.009	
6	C6	"	"	0	X			8/20						.007	.005	
7	C7	"	Mylar	0	0			15/200						.0022		
8	C8	"	Mica	0	0			25/500						.026		
9	C9	"	Mica	0	0			15/500						.026		
10	C10	"	"	0	0			10/500						.026		
11	C11	"	"	0	0			10/500						.026		
12																
13																
14	R1	Res.	Comp.	0	0		25/500							.021		
15	R2	"	"	X	0		150/500							.027	.018	
16	R3	"	"	0	0		10/500							.021		
17	R4	"	"	0	0		150/500							.027		
18	R5	SENSOR	Silicon	0	X		20/250							.4	.267	Assumed
19	R6	Res.	Metal Film	0	X		100/250							.015	.010	
PAGE SUB TOTAL														.6678	.3270	

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY	APPROVALS	SNO	DIV OR DEPT	LOCATION	CONT ON SHEET	SH NO.
ISSUED				SAN JOSE, CALIF		A-24

NEBS

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES	SURFACES ✓	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS +	DECIMALS +	ANGLES +

REV NO. CONT ON SHEET SH NO.

TITLE PULSE HEIGHT DISC.
FAILURE RATE DATA SHEET
FIRST MADE FOR PA 49

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS		
				OPEN	SHORT	DRIFT	P(OP.) / P (RATED)	V(OP.) / V (RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE			
20	R 7	Pot.	Cermet	X	X		200/750							.2	.2	Manufacturers Data		
21	R 8	Res.	Comp	X	O		25/500							.021	.014			
22	R 9	"	"	O	X		250/1000							.024	.016			
23	R 10	"	"	X	O		225/500							.051	.034			
24	R 11	"	"	X	O		25/500							.021	.014			
25	R 12	"	"	O	O		150/500							.027				
26	R 13	"	"	O	O		25/500							.021				
27	R 14	"	"	O	O		5/500							.021				
28	R 15	"	"	O	O		25/500							.021				
29	R 16	"	"	X	O		25/500							.021	.014			
30	R 17	"	"	O	O		250/500							.060				
31	R 18	"	"	O	O		125/500							.024				
32	R 19	"	"	O	O		25/500							.021				
33	R 20	"	"	X	O		125/500							.024	.016			
34	R 21	"	"	X	O		120/500							.024	.016			
35	R 22	"	"	X	O		80/500							.021	.014			
36	R 23	"	"	O	O		125/500							.024				
37	R 24	"	"	O	O		10/500							.021				
38	R 25	"	"	O	O		20/500							.021				

NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE

PAGE SUB TOTAL .4880 .3380

MADE BY
ISSUED

APPROVALS

SNO
SAN JOSE, CALIF

DIV OR DEPT
LOCATION

CONT ON SHEET

A-25
SH NO.

CONT ON SHEET 4		SH NO. 3																				
GENERAL ELECTRIC		TITLE PULSE HEIGHT DISC. FAILURE RATE DATA SHEET																				
FIRST MADE FOR PA 49																						
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:		REV. NO.																				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS																				
	✓	FRACTIONS	DECIMALS																			
		+	+																			
		-	-																			
CONT ON SHEET		SH NO.																				
ITEM NO.		PART NO.																				
DESCRIPTION		MATERIAL																				
FAILURE MODE		STRESS MODE																				
OPEN SHORT DRIFT		(a) (b) (c)																				
P(OP.) / P (RATED)		V(OP.) / V (RATED)																				
I(OP.) / I (RATED)		THERMAL STRESS																				
T _J MAX (°C)		TA = 60°C																				
T.R. °C/MW		ΔT _J (°C)																				
T(N)		FAILURE RATE																				
SAFE & UNSAFE		/10 ⁶ HR																				
UNSAFE FAILURE		COMMENTS																				
39	R 26	Res.	Comp.	X	O		5 / 500								.021	.014						
40	R 27	"	"	X	O		5 / 500								.021	.014						
41	R 28	"	"	O	O		20 / 500								.021							
42	R 29	"	"	O	O		125 / 500								.024							
43	R 30	"	"	O	O		10 / 500								.021							
44	R 31	THER-MISTER		X	O		200 / 500								.4	.267	Assumed					
45	R 32	Res	Comp	X	O		70 / 2000								.021	.014						
46	R 33	"	"	O	O		5 / 500								.021							
47																						
48	Q 1	2N708	Silicon	O	X		75 / 360	/40			175	.49	37	.48	3.00	2.0						
49	Q 2	2N3251	"	O	X		40 / 360	/50			175	.49	20	.37	1.95	1.30						
50	Q 3	2N708	"	O	X		100 / 360	/40			175	.49	49	.56	3.70	2.46						
51	Q 4	"	"	O	X		100 / 360	/40			175	.49	49	.56	3.70	2.46						
52	Q 5	"	"	O	X		5 / 360	/40			175	.49	3	.25	1.57	1.05						
53	Q 6	"	"	O	X		5 / 360	/40			175	.49	3	.25	1.57	1.05						
54	Q 7	2N3251	"	O	X		30 / 360	/50			175	.49	15	.33	1.70	1.12						
55	Q 8	2N708	"	O	O		5 / 360	10 / 40			175	.49	3	.25	1.57	1.05						
56	Q 9	"	"	O	O		5 / 360	10 / 40			175	.49	3	.25	1.57	1.05						
57	Q 10	"	"	O	X		40 / 360	/40			175	.49	20	.37	2.30	1.52						
NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE										PAGE SUB TOTAL					23. 1800		13. 5690					
MADE BY										APPROVALS					SNO		DIV OR DEPT		SAN JOSE, CALIF		LOCATION	
ISSUED																						
PRINTED IN U.S.A.																					A-26	
																					NEBS	

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

REV
NO

FIRST MADE FOR PA 49

CONT ON SHEET

SH NO.

~~REVISION~~

~~PRINTS~~

UNIT [REDACTED] TOTAL

33. 7358	22. 7540
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MADE BY

ISSUED

APPROVAL 2

SNO

DIV OR

SAN JOSE, CALIF

LOCATION

CONT. ON SHEET

A-2

311

NEBS

ON HS

132MS NO 1M00

ON DIMENSIONS

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO.

CONT ON SHEET

SH NO.

GENERAL ELECTRIC

TITLE

Log Integrator

FAILURE RATE DATA SHEET

FIRST MADE FOR

PA 49

CONT ON SHEET

2

SH NO.

1

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				SAFE & UNSAFE	UNSAFE FAILURE	
							P(OP.) / P (RATED)	V(OP.) / V(RATED)	I(OP.) / I(RATED)	T _J MAX (°C)	T. R. °C/MW	ΔT _J (°C)	T(N)			
1	C1	Cap.	Tant.	X	X			8/20						.007	.007	
2	C2	"	"	X	X			8/10						.078	.078	
3	C3	"	"	X	X			8/20						.007	.007	
4	C4	"	"	X	X			8/10						.78	.078	
5	C5	"	"	X	X			8/35						.026	.0036	
6	C6	"	"	X	X			8/10						.078	.078	
7	C7	"	Mylar	X	X			8/100						.0022	.0022	
8	C8	"	Tant	X	X			8/10						.078	.078	
9	C9	"	Mylar	X	X			8/100						.0022	.0022	
10	C10	"	Tant.	X	X			8/20						.007	.007	
11	C11	"	Mica	X	X			8/500						.026	.026	
12	C12	"	Tant.	X	X			8/35						.0036	.0036	
13	C13	"	Mica	X	X			8/500						.026	.026	
14	C14	"	Mylar	X	X			8/100						.0022	.0022	
15	C15	"	Glass	X	X			8/300						.017	.017	
16	C16	"	Mylar	X	X			8/100						.0022	.0022	
17	CR1	1N914	Silicon	X	X			8/100		150			.28	.363	.363	
18	CR2	"	"	X	X			8/100		150			.28	.363	.363	
19	CR3	"	"	X	X			8/100		150			.28	.363	.363	
PAGE SUB TOTAL														1.5170	1.5170	

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

A-28

SH NO.

FF-406-P (12-67)

PRINTED IN U.S.A.

NEBS

ON HS 132MS NO 1N00		FOLD										GENERAL ELECTRIC		CONT ON SHEET 3 SH NO. 2	
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—												REV NO.		TITLE <i>Log Integrator</i>	
APPLIED PRACTICES			SURFACES ✓			TOLERANCES ON MACHINED DIMENSIONS FRACTIONS DECIMALS ANGLES + — + — + —			CONT ON SHEET		SH NO.		FIRST MADE FOR <i>PA 49</i>		

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS	
				OPEN	SHORT	DRIFT	(a) P(OP.)/P (RATED)	(b) V(OP.)/V(RATED)	(c) I(OP.)/I(RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T(N)	SAFE & UNSAFE	UNSAFE FAILURE		
20	CR 4	IN914	Silicon	X	X			8/100		150			.28	.363	.363		
21	CR 5	"	"	X	X			8/100		150			.28	.363	.363		
22	CR 6	"	"	X	X			8/100		150			.28	.363	.363		
23	CR 7	"	"	X	X			8/100		150			.28	.363	.363		
24	CR 8	"	"	X	X			8/100		150			.28	.363	.363		
25	CR 9	"	"	X	X			8/100		150			.28	.363	.363		
26	CR 10	"	"	X	X			8/100		150			.28	.363	.363		
27	CR 11	"	"	X	X			8/100		150			.28	.363	.363		
28	CR 12	"	"	X	X			8/100		150			.28	.363	.363		
29	CR 13	"	"	X	X			8/100		150			.28	.363	.363		
30	CR 14	"	"	X	X			8/100		150			.28	.363	.363		
31	CR 15	"	"	X	X			8/100		150			.28	.363	.363		
32	CR 16	"	"	X	X			8/100		150			.28	.363	.363		
33	R 1	Res.	Comp.	X	O		100/500							.021	.014		
34	R 2	"	"	X	O		100/500							.021	.014		
35	R 3	"	"	X	O		100/500							.021	.014		
36	R 4	"	"	X	O		100/500							.021	.014		
37	R 5	"	"	X	O		100/500							.021	.014		
38	R 6	"	"	X	O		100/500							.021	.014		
PAGE SUB TOTAL												44820	44400				

NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY _____

ISSUED _____

APPROVALS _____

SNO _____

SAN JOSE, CALIF

DIV OR DEPT _____

LOCATION _____

CONT ON SHEET _____

SH NO. **A-29**

NEBS

CONT ON SHEET *F* SN NO. *3*

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
-----	✓	+ —	+ —	+ —

REV NO.	
CONT ON SHEET	SH NO.

TITLE *Log Integrator*
FAILURE RATE DATA SHEET
FIRST MADE FOR *PA 49*

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS		
				OPEN	SHORT	DRIFT	(a) P(OP.) / P (RATED)	(b) V(OP.) / V(RATED)	(c) I(OP.) / I (RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE			
39	R7	Res	Comp	X	0		100/500							.021	.014			
40	R8	"	"	X	0		100/500							.021	.014			
41	R9	"	"	X	0		1/500							.021	.014			
42	R10	"	"	X	0		1/500							.021	.014			
43	R11	"	"	X	0		1/500							.021	.014			
44	R12	"	"	X	0		1/500							.021	.014			
45	R13	"	"	X	0		1/500							.021	.014			
46	R14	"	"	X	0		1/500							.021	.014			
47	R15	"	"	X	0		1/500							.021	.014			
48	R16	"	"	X	0		1/500							.021	.014			
49	R17	"	"	0	X		1/500							.021	.014			
50	R18	"	"	X	0		1/500							.021	.014			
51	R19	Pot	Cermet	0	X		1/1000							.2	.14	Manufacturers Data		
52	P1	Connector		X	X									.168	.168	5 Active Pins 1 mating / 500 hrs.		
										</								

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

UNIT	TOTAL	6.6190	6.4330
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MADE BY

ISSUED

APPROVAL 2	SNO	DIV OR DEPT
	SAN JOSE, CALIF	LOCATION

CONT ON SHEET SH NO.

ON SHEET 132MS NO 1MCO

ON DRAWING

GENERAL ELECTRIC

CONT ON SHEET 2 SH NO. 1

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO.

CONT ON SHEET

SH NO.

TITLE

FAILURE RATE DATA SHEET

FIRST MADE FOR

INT RANGE AMPLIFIER-RECTIFIER

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR		
							P(OP.) / P (RATED)	V(OP.) / V (RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T _J R. (°C)	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE	
1	C1	1	MYLAR	X	0			0/100						.0022	.0015	MIL-C-27287
2	C2	.047	"	0	0			0/100						.0022		"
3	C3	1	"	X	0			2/100						.0022	.0015	"
4	C4	100	SOLID TANT	0	0			15/20						.07		MIL-C-26655
5	C5	100	"	0	0			15/20						.07		"
6	C6	10	"	0	X			15/35						.192	.128	"
7	C7	10	"	0	X			15/35						.192	.128	"
8	C8	.02	MYLAR	0	X			1/100						.0022	.0015	MIL-C-27287
9	C9	.01	"	X	0			1/100						.0022	.0015	"
10	OA1	KM61	PCB OF-AMP	X	X									4.38	4.38	ASSUMED
11	CA2	PP45U	"	X	X									4.38	4.38	"
12	R1		COMP	0	X		0/500							.021	.014	MIL-R-11
13	R2		"	0	X		0/500							.021	.014	"
14	R3		FILM	0	X		1/250							.0054	.0036	MIL-R-10509
15	R4		"	0	X		1/250							.0054	.0036	"
16	R5		"	X	0		0/250							.0054	.0036	"
17	R6		"	X	0		1/250							.0054	.0036	"
18	R7		COMP	X	0		75/500							.021	.014	MIL-R-11
19	R8		FILM	X	0		5/250							.0054	.0036	MIL-R-10509
PAGE SUB TOTAL														9.4246	9.0820	

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH NO.

PRINTS TO

NEBS

A-31

77-SUB-P (110-97) PRINTED IN U.S.A.

ON MS		CONT ON SHEET		DRAWING NO.		UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:		REV NO.		TITLE		CONT ON SHEET 2		SH NO. 1					
APPLIED PRACTICES		SURFACES		TOLERANCES ON MACHINED DIMENSIONS		FRACTIONS		DECIMALS		ANGLES		CONT ON SHEET		SH NO.					
		✓		+		+		+											
FAILURE RATE DATA SHEET												FIRST MADE FOR INTERMEDIATE LOG LADDER							
ITEM NO	PART NO	DESCRIPTION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS			
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR					
							P(OP.) / P (RATED)	V(OP.) / V (RATED)	I(OP.) / I (RATED)	T _J MAX (°C)	T _R (°C)	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE				
1	CR1	IN914	SILICON	0	X			10/100		150			.28	.363	.242				
2	R1		FILM	0	X		2/250							.0054	.0036	MIL-R-10509			
3	R2		"	0	X		2/250							.0054	.0036	"			
4	R3		"	0	X		2/250							.0054	.0036	"			
5	R4		"	0	X		2/250							.0054	.0036	"			
6	R5		"	0	X		2/250							.0054	.0036	"			
7	R6		"	0	X		2/250							.0054	.0036	"			
8	R7		"	X	0		8/250							.0054	.0036	"			
9	R8		"	0	X		2/250							.0054	.0036	"			
10	R9		"	X	0		40/250							.0057	.0038	"			
11	R10		"	X	0		40/250							.0057	.0038	"			
12	R11		"	X	0		40/250							.0057	.0038	"			
13	R12		"	X	0		40/250							.0057	.0038	"			
14	R13		"	X	0		40/250							.0057	.0038	"			
15	R14		"	X	0		40/250							.0057	.0038	"			
16	R15		"	X	0		45/250							.0057	.0038	"			
17	R16		"	0	X		5/250							.0054	.0036	"			
18	R17		"	0	X		5/250							.0054	.0036	"			
19	R18		"	0	X		5/250							.0054	.0036	"			
NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE														PAGE SUB TOTAL		.4623 .3120			
MADE BY										APPROVALS		SNO		DIV OR DEPT		A-33			
ISSUED												SAN JOSE, CALIF		LOCATION		CONT ON SHEET			
PRINTED IN U.S.A.														NEBS					

CONT ON SHEET 3		SN NO. 2																	
GENERAL ELECTRIC		TITLE																	
FAILURE RATE DATA SHEET		FIRST MADE FOR INTERMEDIATE LOG LADDER																	
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—		REV. NO.																	
APPLIED PRACTICES		SURFACES																	
TOLERANCES ON MACHINED DIMENSIONS		FRACTIONS DECIMALS ANGLES																	
+		+																	
CONT ON SHEET		SN NO.																	
ITEM NO		PART NO																	
DESCRIP TION		MATERIAL																	
FAILURE MODE		STRESS MODE																	
OPEN SHORT DRIFT		(a) (b) (c)																	
P(OP.)/P (RATED)		V(OP.)/V(RATED)																	
I(OP.)/I(RATED)		TJ MAX (°C)																	
T.R. (°C/MW)		ΔTJ (°C)																	
T(N)		FAILURE RATE /10 ⁶ HR																	
SAFE & UNSAFE		UNSAFE FAILURE																	
COMMENTS																			
20	R19	FILM	0 X	5/250									.0054	.0036	MIL-R-10509				
21	R20	"	0 X	5/250									.0054	.0036	"				
22	R21	"	0 X	5/250									.0054	.0036	"				
23	R22	"	0 X	7/250									.0054	.0036	"				
24	R23	POT	CERMET	X 0	1/1000								.2	.14		0.2/10 ⁶ HR GIVEN BY VENDOR			
25	R24	"	"	X X	10/1000								.2	.2		"	"		
26	R25	"	"	X X	10/1000								.2	.2		"	"		
27	R26	"	"	X X	10/1000								.2	.2		"	"		
28	R27	"	"	X X	10/1000								.2	.2		"	"		
29	R28	"	"	X X	10/1000								.2	.2		"	"		
30	R29	"	"	X X	10/1000								.2	.2		"	"		
31	R30	"	"	X X	13/1000								.2	.2		"	"		
32	Q1	2N3417 NPN	SILICON	0 X	3/360	9/50			125	380	61	360	.488	.326					
33	Q2	"	"	0 X	4/360	9/50			"	"	62	370	.488	.326					
34	Q3	"	"	0 X	6/360	10/50			"	"	63	380	.488	.326					
35	Q4	"	"	0 X	11/360	11/50			"	"	65	400	.488	.326					
36	Q5	"	"	0 X	16/360	12/50			"	"	67	420	.548	.366					
37	Q6	"	"	0 X	18/360	12/50			"	"	67	420	.548	.366					
38	Q7	"	"	0 X	28/360	14/50			"	"	71	460	.615	.410					
NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE												PAGE SUB TOTAL		5.2846 3.6314					
MADE BY												APPROVALS		SNO		DIV OR DEPT		A-34	
ISSUED														SAN JOSE, CALIF		LOCATION		CONT ON SHEET	
PRINTED IN U.S.A.																NEBS			

REV
NO

TITLE
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45. [REDACTED]
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54. [REDACTED]
55. [REDACTED]
56. [REDACTED]
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58. [REDACTED]
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60. [REDACTED]
61. [REDACTED]
62. [REDACTED]
63. [REDACTED]

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

CONT ON SHEET

SH NO

FAILURE RATE DATA SHEET

FIRST MADE FOR INTERMEDIATE LOG LADDER

REVISIONE

PRINTED

NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE

UNIT XXXXXXXXXX TOTAL

7.4569	5.3634
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MADE BY

ISSUED

APPROVALS

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OTV OT

SAN JOSE, CALIF

LOCATION

CONT ON SHEET

A-35

NEBS

ON HS

CONT ON SHEET

ON DIMENSIONS

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO.

CONT ON SHEET

SH NO.

GENERAL ELECTRIC

CONT ON SHEET

F

SH NO. 2

TITLE

FAILURE RATE DATA SHEET

FIRST MADE FOR

HIGH RANGE AMPLIFIER-RECTIFIER

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				SAFE & UNSAFE	UNSAFE FAILURE	
							P(OP.) / P (RATED)	V(OP.) / V(RATED)	I(OP.) / I (RATED)	TJ MAX (°C)	T.R. °C/MW	ΔTJ (°C)	T(N)			
20	R8		COMP	0	0		60/500							.021		MIL-R-11
21	R9		"	X	0		95/500							.021	.014	"
22	R10		"	X	0		95/500							.021	.014	"
23	R11		"	X	0		1/500							.021	.014	"
24	R12		"	0	X		5/500							.021	.014	"
25	R13		FILM	0	X		25/250							.0054	.0036	MIL-R-10509
26	R14		"	0	0		0/250							.0054		"
27	R15		"	0	0		0/250							.0054		"
28	R16		COMP	0	0		25/500							.021		MIL-R-11
29	R17	POT	CERMET	0	X		5/1000							.2	.14	Q2/10 ⁶ HR GIVEN BY VENDOR
30	R18	POT	"	0	0		20/1000							.2		" " " " "
31	Q1	2N2219 NPN	SILICON	0	0		40/800	10/30		175	187	68	286	.383		
32	Q2	2N2484 NPN	"	0	0		4/360	10/60		200	475	62	211	.333		
33	Q3	"	"	0	0		40/360	30/60		"	"	79	280	.383		
34	Q4	2N2905 PNP	"	0	X		250/600	30/40		"	290	132	611	2.78	1.86	
35	Q5	2N3799 PNP	"	X	X		55/360	15/60		"	485	87	354	1.38	1.38	
36	Q6	2N2219 NPN	"	X	X		55/800	10/30		175	181	71	306	.435	.435	
37	QAI	POTTED OP-AMP		0	0									4.38		ASSUMED
PAGE SUB TOTAL														10.6162	38746	
UNIT TOTAL														12.2274	4.7361	

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH NO.

A-36

NEBS

PP-806-P 110-871
PRINTED IN U.S.A.

CONT ON SHEET 2

SH NO. 1

GENERAL ELECTRIC

2

SH NO. 1

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV. NO.

CONT ON SHEET

SH NO.

TITLE

FAILURE RATE DATA SHEET

FIRST MADE FOR HIGH RANGE AMPLIFIER-RECTIFIER

ITEM NO	PART NO	DESCRIPTION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR		
							P (OP.) / P (RATED)	V (OP.) / V (RATED)	I (OP.) / I (RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE	
1	C1	0.47	MYLAR	X	0			10/100						.0022	.0015	MIL-C-27287
2	C2	30 pf	MICA	0	X			20/500						.32	.22	MIL-C-5
3	C3	10	SOLID TANT	X	0			15/35						.009	.006	MIL-C-26655
4	C4	10	"	X	0			15/35						.009	.006	"
5	C5	10	"	X	0			15/35						.009	.006	"
6	C6	10	"	0	0			15/35						.009		"
7	C7	10	"	0	0			15/35						.009		"
8	C8	10	"	0	X			15/35						.009	.006	"
9	C9	360 pf	MICA	0	X			2/500						.32	.22	MIL-C-5
10	C10	150 pf	"	X	0			2/500						.32	.22	"
11	C11	10	SOLID TANT	0	X			15/35						.131	.088	MIL-C-26655
12	C12	10	"	0	X			15/35						.131	.088	"
13	R1		COMP	0	0		50/500							.021		MIL-R-11
14	R2		"	0	0		35/500							.021		"
15	R3		FILM	0	0		5/250							.012		MIL-R-10509
16	R4		COMP	0	0		25/500							.021		MIL-R-11
17	R5		"	0	0		30/500							.021		"
18	R6		"	0	0		35/500							.021		"
19	R7		"	0	0		400/500							.216		"
PAGE SUB TOTAL														1.6112	.8615	

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH NO.

A-37

NEBS

77-006-P (10-67)

PRINTED IN U.S.A.

CONT ON SHEET		DRAWING NO.		UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:		REV. NO.		TITLE		CONT ON SHEET 2		SH. NO. 1					
APPLIED PRACTICES		SURFACES		TOLERANCES ON MACHINED DIMENSIONS		FRACTIONS		DECIMALS		ANGLES		FIRST MADE FOR HIGH LOG LADDER					
		✓		+		+		+									
ITEM NO	PART NO	DESCRIPTION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS	
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				SAFE & UNSAFE	UNSAFE FAILURE		
							P(OP.) / P (RATED)	V(OP.) / V (RATED)	I(OP.) / I (RATED)	TJ MAX (°C)	T.R. °C/MW	ΔTJ (°C)	T(N)				
1	CR1	IN914	SILICON	0	X			10/100		150			.28	.363	.242		
2	R1		FILM	0	X		2/250							.0054	.0036	MIL-R-10509	
3	R2		"	0	X		2/250							.0054	.0036	"	
4	R3		"	0	X		4/250							.0054	.0036	"	
5	R4		"	0	X		2/250							.0054	.0036	"	
6	R5		"	0	X		2/250							.0054	.0036	"	
7	R6		"	0	X		2/250							.0054	.0036	"	
8	R7		"	X	0		8/250							.0054	.0036	"	
9	R8		"	0	X		2/250							.0054	.0036	"	
10	R9		"	X	0		35/250							.0057	.0038	"	
11	R10		"	X	0		35/250							.0057	.0038	"	
12	R11		"	X	0		35/250							.0057	.0038	"	
13	R12		"	X	0		35/250							.0057	.0038	"	
14	R13		"	X	0		35/250							.0057	.0038	"	
15	R14		"	X	0		35/250							.0057	.0038	"	
16	R15		"	X	0		40/250							.0057	.0038	"	
17	R16		"	0	X		9/250							.0054	.0036	"	
18	R17		"	0	X		9/250							.0054	.0036	"	
19	R18		"	0	X		9/250							.0054	.0036	"	
PAGE SUB TOTAL														.4623	.3120		
NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE																	
MADE BY																	
ISSUED																	
APPROVALS																	
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DIV OR DEPT																	
SAN JOSE, CALIF																	
LOCATION																	
CONT ON SHEET																	
SH. NO.																	
A-38																	
NEBS																	

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UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—
APPLIED PRACTICES
SURFACES
TOLERANCES ON MACHINED DIMENSIONS
FRACTIONS
DECIMALS
ANGLES
REV NO.
CONT ON SHEET
SH NO.

TITLE
FAILURE RATE DATA SHEET
FIRST MADE FOR
HIGH LOG LADDER

CONT ON SHEET 3
SH NO. 2

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS			
				OPEN	SHORT	DRIFT	(a) P(OP.)/P (RATED)	(b) V(OP.)/V(RATED)	(c) I(OP.)/I(RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T(N)	SAFE & UNSAFE	UNSAFE FAILURE				
20	R19		FILM	0	X		9/250							.0054	.0036	MIL-R-10509			
21	R20		"	0	X		9/250							.0054	.0036	"			
22	R21		"	0	X		9/250							.0054	.0036	"			
23	R22		"	0	X		11/250							.0054	.0036	"			
24	R23	POT	CERMET	X	0		1/1000							.2	.14		0.2/10 ⁶ HR GIVEN BY VENDOR		
25	R24	"	"	X	X		9/1000							.2	.2		"	"	
26	R25	"	"	X	X		9/1000							.2	.2		"	"	
27	R26	"	"	X	X		9/1000							.2	.2		"	"	
28	R27	"	"	X	X		9/1000							.2	.2		"	"	
29	R28	"	"	X	X		9/1000							.2	.2		"	"	
30	R29	"	"	X	X		9/1000							.2	.2		"	"	
31	R30	"	"	X	X		11/1000							.2	.2		"	"	
32	Q1	2N3417 NPN	SILICON	0	X		5/360	11/50			125	380	62	370	.488	.326			
33	Q2	"	"	0	X		6/360	12/50			"	"	63	380	.488	.326			
34	Q3	"	"	0	X		10/360	12/50			"	"	64	390	.488	.326			
35	Q4	"	"	0	X		16/360	13/50			"	"	66	410	.548	.366			
36	Q5	"	"	0	X		21/360	13/50			"	"	67	420	.548	.366			
37	Q6	"	"	0	X		30/360	14/50			"	"	72	470	.615	.410			
38	Q7	"	"	0	X		45/360	15/50			"	"	78	530	.690	.460			
NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE										PAGE SUB TOTAL		5.4866	4.1344						
										MADE BY		APPROVALS		SNO		DIV OR DEPT			
										ISSUED				SAN JOSE, CALIF		LOCATION			
																CONT ON SHEET			
																SH NO.			

77-006-P (10-67)
PRINTED IN U.S.A.

21

NEBS

A-39

CONT ON SHEET 2

SH NO. 1

GENERAL ELECTRIC

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO.

CONT ON SHEET

SH NO.

TITLE

FAILURE RATE DATA SHEET

FIRST MADE FOR MULTIRANGE MONITOR

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS				FAILURE RATE		COMMENTS
				OPEN	SHORT	DRIFT	(a)	(b)	(c)	TA = 60°C				/10 ⁶ HR		
							P(OP.)/P (RATED)	V(OP.)/V(RATED)	I(OP.)/I(RATED)	T _J MAX (°C)	T.R. PC/MW	ΔT _J (°C)	T(N)	SAFE & UNSAFE	UNSAFE FAILURE	
1	C1	100 pf	MICA	0	0			4/500						.026		MIL-C-5
2	C2	"	"	0	0			4/500						.026		"
3	C3	"	"	0	0			10/500						.026		"
4	C4	10 μf	SOLID TANT	0	X			15/35						.192	.128	MIL-C-26655
5	C5	"	"	0	X			15/35						.192	.128	"
6	CR1	1N914	SILICON	0	0			15/100		150			.28	.363		
7	CR2	"	"	0	0			15/100		"			.28	.363		
8	CR3	"	"	0	0			15/100		"			.28	.363		
9	K1	REED RELAY		0	X			15/16						550	367	
10	K2	"		0	X			15/16						550	367	
11	K3	"		0	X			15/16						550	367	
12	OA1	PP65 AHU	POTTED OF-AMP	0	X									4.38	2.92	ASSUMED
13	OA2	"	"	0	X									4.38	2.92	"
14	OA3	"	"	0	X									4.38	2.92	"
15	R1		FILM	0	0		7/250							.0054		MIL-R-10509
16	R2		"	0	0		10/250							.0054		"
17	R3		"	0	0		7/250							.0054		"
18	R4		"	0	0		0/250							.0054		"
19	R5		"	0	X		0/250							.0054	.0036	"
PAGE SUB TOTAL														1664.	1110.	
														7234	0196	

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

MADE BY

ISSUED

APPROVALS

SNO

SAN JOSE, CALIF

DIV OR DEPT

LOCATION

CONT ON SHEET

SH NO.

A-41

NEBS

FIRST MADE FOR MULTIRANGE MONITOR

PAGE	SUB	TOTAL	1,4324	.5436
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PAGE SUB TOTAL

1666.	1110.
1558	5632

~~REVISIONS~~

~~PRINTS TO~~

MADE BY

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APPROVALS

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**DIV ON
RECEIPT**

SAN JOSE, CALIF

LOCATION CONT ON SHEET

4-47

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ON HS
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 DRAWING NO.

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GENERAL ELECTRIC
 CONT ON SHEET 3 SH NO. 2

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—
 APPLIED PRACTICES
 SURFACES ✓
 TOLERANCES ON MACHINED DIMENSIONS
 FRACTIONS +
 DECIMALS +
 ANGLES +

REV NO.
 CONT ON SHEET SH NO.

TITLE
FAILURE RATE DATA SHEET
 FIRST MADE FOR *AUCTION*

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS	
				OPEN	SHORT	DRIFT	(a) P(OP.) / P (RATED)	(b) V(OP.) / V (RATED)	(c) I(OP.) / I (RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE		
20	CR15	IN914	SILICONE	0	0				13/75	150				.28	.363		
21	K1	Relay		X	0		170/225	20/300	2/125						550	367	
22	K2	"		X	0		170/225	20/300	2/125						550	367	
23	K3	"		X	0		170/225	20/300	2/125						550	367	
24	041	Op Amp		X	X										4.38	4.38	
25	042	"		X	X										4.38	4.38	
26	043	"		X	X										4.38	4.38	
27	R1	Res	FILM	X	0		0/250								.0054	.0036	
28	R2	"	"	0	X		4/250								.0054	.0036	
29	R3	"	"	X	0		0/250								.0054	.0036	
30	R4	"	"	0	X		4/250								.0054	.0036	
31	R5	"	"	0	X		3/250								.0054	.0036	
32	R6	"	"	X	0		0/250								.0054	.0036	
33	R7	"	"	X	0		3.5/250								.0054	.0036	
34	R8	"	"	X	0		3.5/250								.0054	.0036	
35	R9	"	"	X	0		3/250								.0054	.0036	
36	R10	"	COMP	X	0		35/500								.0210	.014	
37	R11	"	"	X	0		35/500								.0210	.014	
38	R12	"	"	X	0		35/500								.0210	.014	
													PAGE SUB TOTAL		1663. 6146	1114. 2144	

NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

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SH NO. 3

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SURFACES

TOLERANCES ON MACHINED DIMENSIONS

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SH NO

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FAILURE RATE DATA SHEET

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A-45

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TITLE	Auction Monitor
FAILURE RATE DATA SHEET	

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APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

CONT ON SHEET

SH NO

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS			
				OPEN	SHORT	DRIFT	(a) P (OP.) / P (RATED)	(b) V (OP.) / V RATED	(c) I (OP.) / I (RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE				
1	CR 1	1N914	Silicon					0/100	40/75	150			.28	.363					
2	CR 2	"	"					0/100	40/75	150			.28	.363					
3	CR 3	"	"					0/100	40/75	150			.28	.363					
4	CR 4	"	"					13/100		150			.28	.363					
5	CR 5	"	"					7/100		150			.28	.363					
6	CR 6	"	"					13/100		150			.28	.363					
7	CR 7	"	"					7/100		150			.28	.363					
8	CR 8	"	"					13/100		150			.28	.363					
9	CR 9	"	"					7/100		150			.28	.363					
10	R 1	Res.	Comp.				15/500							.021					
11	R 2	"	"				5/500							.021					
12	R 3	"	"				15/500							.021					
13	R 4	"	"				5/500							.021					
14	R 5	"	"				15/500							.021					
15	R 6	"	"				5/500							.021					
16	R 7	"	"				30/500							.021					
17	R 8	"	"				3/500							.021					
18	R 9	"	"				30/500							.021					
19	R 10	"	"				3/500							.021					

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CONT ON SHEET

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CONT ON SHEET *F* SN NO. *2*

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APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

REV
NO.

TITLE Auction Mon...

FAILURE RATE DATA SHEET

FIRST MADE FOR *PA 49*

ITEM NO	PART NO	DESCRIPTION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS			
				OPEN	SHORT	DRIFT	(a) P(OP.) / P (RATED)	(b) V(OP.) / V (RATED)	(c) I(OP.) / I (RATED)	T _J MAX (°C)	T _J MIN (°C)	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE				
20	R11	Res.	Comp.				30/500								.021				
21	R12	"	"				3/500								.021				
22	Q1	2N3417	Silicon				40/360	15/50				125	.38	15	.50	.615			
23	Q2	"	"				1/360	15/50				125	.38	1	.36	.446			
24	Q3	"	"				1/360	15/50				125	.38	1	.36	.446			
25	Q4	"	"				0/360	15/50				125	.38		.35	.435			
26	Q5	"	"				40/360	15/50				125	.38	15	.50	.615			
27	Q6	"	"				1/360	15/50				125	.38	1	.36	.446			
28	Q7	"	"				1/360	15/50				125	.38	1	.36	.446			
29	Q8	"	"				0/360	15/50				125	.38		.35	.435			
30	Q9	"	"				40/360	15/50				125	.38	15	.50	.615			
31	Q10	"	"				1/360	15/50				125	.38	1	.36	.446			
32	Q11	"	"				1/360	15/50				125	.38	1	.36	.446			
33	Q12	"	"				0/360	15/50				125	.38		.35	.435			
34	K1	Relay					170/225	15/300	40/125							550			
35	K2	"					170/225	15/300	40/125							550			
36	K3	"					170/225	15/300	40/125							550			
37	P1	Connector														.304		11 Active Pins	1 mating / 500 hrs.
										PAGE SUB TOTAL				1656. 1720					
										UNIT TOTAL				1659. 6490					

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A-47

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APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
	✓	FRACTIONS	DECIMALS	ANGLES
		+	+	+
		-	-	-

REV NO. _____
CONT ON SHEET _____ SH NO. _____

TITLE *Period Module*
FAILURE RATE DATA SHEET
FIRST MADE FOR *PA 49*

ITEM NO	PART NO	DESCRIP TION	MATERIAL	FAILURE MODE			STRESS MODE			THERMAL STRESS TA = 60°C				FAILURE RATE /10 ⁶ HR		COMMENTS		
				OPEN	SHORT	DRIFT	(a) P(OP.) / P (RATED)	(b) V(OP.) / V (RATED)	(c) I(OP.) / I (RATED)	T _J MAX (°C)	T.R. °C/MW	ΔT _J (°C)	T (N)	SAFE & UNSAFE	UNSAFE FAILURE			
1	C1	Cap	Mylar	O	X			15/100						.0023	.0016			
2	C2	"	"	O	X			15/100						.0023	.0016			
3	C3	"	Poly Styrene	X	O			15/30						.038	.026			
4	C4	"	Mylar	O	X			15/100						.0023	.0016			
5	C5	"	"	O	X			0/100						.0022	.0015			
6	CR 1	1N3575	Silicon	O	X			10/60		150			.28	.363	.242			
7	CR 2	"	"	O	X			13/60		150			.28	.363	.242			
8	CR 3	1N914	"	O	X			15/100		150			.28	.363	.242			
9	CR 4	"	"	O	X			15/100		150			.28	.363	.242			
10	R 1	Res.	Comp.	X	O		30/500							.021	.014			
11	R 2	"	"	O	O		30/500							.021				
12	R 3	"	Metal Film	X	O		1/250							.0054	.0036			
13	R 4	Pot	Cermet	X	X		1/1000							.2	.2	Manufacturers Data		
14	R 5	Res	Metal Film	O	X		4/250							.0054	.0036			
15	R 6	"	Comp.	X	O		0/500							.021	.014			
16	R 7	"	Metal Film	O	O		10/250							.0054				
17	R 8	Pot	Cermet	O	O		1/1000							.2				
18	R 9	Res.	Carbon	O	X		0/1000							1.02	.68			
19	R 10	"	Comp.	X	O		0/500							.021	.014			

NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE

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SURFACES

TOLERANCES ON MACHINED DIMENSIONS

REV

TITLE	Period Module
FAILURE RATE DATA SHEET	

FIRST MADE FOR *PA 49*

CONT ON SHEET

SH NO.

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NOTE: 0 = SAFE FAILURE: X = UNSAFE FAILURE

UNIT	NUMBER	TOTAL
1	1	1
2	1	2
3	1	3
4	1	4
5	1	5
6	1	6
7	1	7
8	1	8
9	1	9
10	1	10
11	1	11
12	1	12
13	1	13
14	1	14
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16	1	16
17	1	17
18	1	18
19	1	19
20	1	20
21	1	21
22	1	22
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24	1	24
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26	1	26
27	1	27
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91	1	91
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98	1	98
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100	1	100

1112.	1108.
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A-49

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SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO.

CONT ON SHEET

SH NO.

TITLE

Dual Trip

FAILURE RATE DATA SHEET

FIRST MADE FOR

PA 49

CONT ON SHEET

2

SH NO.

1

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NEBS

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A-51

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ON HS

432HS NO JMCQ

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SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

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TITLE

Dual Trip

CONT ON SHEET 3

SH NO. 2

CONT ON SHEET

SH NO.

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PA 49

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DIV OR DEPT

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TITLE	Dual Trip
FAILURE RATE DATA SHEET	

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CONT ON SHEET

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NOTE: O = SAFE FAILURE: X = UNSAFE FAILURE

UNIT	TOTAL
1	1
2	2
3	3
4	4
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99	99
100	100

20.	11.
8144	7004

11.	7004
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SAN JOSE, CALIF

DEPT	LOCATION
100	100
200	200
300	300
400	400
500	500
600	600
700	700
800	800
900	900
1000	1000
1100	1100
1200	1200
1300	1300
1400	1400
1500	1500
1600	1600
1700	1700
1800	1800
1900	1900
2000	2000
2100	2100
2200	2200
2300	2300
2400	2400
2500	2500
2600	2600
2700	2700
2800	2800
2900	2900
3000	3000
3100	3100
3200	3200
3300	3300
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3500	3500
3600	3600
3700	3700
3800	3800
3900	3900
4000	4000
4100	4100
4200	4200
4300	4300
4400	4400
4500	4500
4600	4600
4700	4700
4800	4800
4900	4900
5000	5000
5100	5100
5200	5200
5300	5300
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5800	5800
5900	5900
6000	6000
6100	6100
6200	6200
6300	6300
6400	6400
6500	6500
6600	6600
6700	6700
6800	6800
6900	6900
7000	7000
7100	7100
7200	7200
7300	7300
7400	7400
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7900	7900
8000	8000
8100	8100
8200	8200
8300	8300
8400	8400
8500	8500
8600	8600
8700	8700
8800	8800
8900	8900
9000	9000
9100	9100
9200	9200
9300	9300
9400	9400
9500	9500
9600	9600
9700	9700
9800	9800
9900	9900
10000	10000

CONT ON SHEET

A-53

24 NO.

NEBS

A P P E N D I X B

I N S T R U C T I O N M A N U A L

F O R

10 D E C A D E N E U T R O N M O N I T O R I N G
S Y S T E M

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I. System Description

This Wide Range Neutron Monitoring System is designed to monitor ten decades of neutron flux when used with a General Electric Type NA04 (or equivalent) fission chamber. In order to obtain this wide range capability, two different monitoring techniques are employed. For the Low Range, Counting techniques are used; for the Intermediate and High Ranges, Campbell techniques are used. The outputs from the three ranges are applied to an Auction circuit whose output represents the largest of the three input signals. The output from the Auction circuit is applied to the final readout device (Meter, DVM, Recorder, etc.) and is proportional to neutron flux being monitored by the detector. The Auction circuit output is also monitored by a Period circuit to provide a rate of change indication of neutron flux level.

In addition to providing readouts for Percent Power and Period, three meters are added which make it possible to monitor all ranges continuously. Lights over these meters indicate which range is controlling the auction (being applied to the final readout device).

Six trip circuits are provided for indication of malfunction or abnormal conditions. One Upscale trip and one Downscale trip will indicate abnormal neutron flux conditions. One trip monitors the Period circuit output and will indicate when the time rate of change of neutron flux exceeds some preset level. One trip monitors the detector polarizing supply and indicates if this voltage drops below a preset level. The remaining two trips monitor the outputs of the three ranges and during startup indicate improper gain setting or malfunctions in the Intermediate and High Ranges.

Internal calibration signals are provided for all three ranges. Each range has two calibration points which allows its slope to be set and monitored for drift. (Note, however, that these calibration signals are not meant to provide an absolute system calibration of output versus neutron flux.)

Mechanically this system consists of two primary units, these being a preamplifier and a main chassis. The preamplifier is contained in a cast aluminum box

I. System Description (Continued)

which may be separated from the main chassis by as much as 250 feet of cable. The preamplifier is powered from the main chassis.

The main chassis consists of a steel frame housing two 7" X 19" card files and a 7" X 19" meter panel. All the electronic circuitry is plug-in module type except for the Main Amplifier and High Voltage Filter which are enclosed in an aluminum chassis mounted to the back panel. All modules are numbered corresponding to the card file slot in which they are to be mounted. In addition, all modules are mechanically keyed to prevent inserting them into the wrong location.

II. Specifications

1.0	Temperature and Humidity	5°C to 50°C 0 to 95% R.H.
2.0	Power	120VAC $\pm 10\%$ 60cps $\pm 5\%$
3.0	Inputs	
3.1	Counting sensitivity and polarity	100 μ v negative pulse
3.2	Campbell sensitivity	20 μ v rms for 10 to 1 signal to noise ratio (Intermediate Range)
3.3	Maximum External capacity on input	2000 pf
4.0	Outputs	
4.1	Recorder	
4.1.1	Percent power Output impedance	0 to -10mv f.s. 10 Ω
4.1.2	Period Output impedance	0 to +10mv f.s. 10 Ω
4.2	Monitor points (load limit $\sim 10K\Omega$)	
4.2.1	Percent power (J25-H)	0 to -10Vdc f.s.
4.2.2	Period (J25-J)	0 to +10Vdc f.s.
4.2.3	High range monitor (J25-E)	0 to +10Vdc f.s.
4.2.4	Intermediate range monitor (J25-F)	0 to +10Vdc f.s.
4.2.5	Low range monitor (J25-G)	0 to +10Vdc f.s.
4.2.6	Ramp (J25-K)	0 to -12Vdc
4.3	Scaler (J36)	-3 volt peak $\sim 300\Omega$ output impedance
4.4	Trips (non-latching)	
4.4.1	UPSCALE	2 Form C Contacts
4.4.2	Downscale	2 Form C Contacts
4.4.3	Period	2 Form C Contacts
4.4.4	High Range Failure	2 Form C Contacts
4.4.5	Intermediate Range Failure	2 Form C Contacts
4.4.6	Low High Voltage	2 Form C Contacts
4.4.7	Inoperative	1 Form C Contact

II. Specifications (Continued)

4.0 Outputs (Continued)

4.5 Trips (Latching)(25ma each)

- | | |
|--------------------------|---------------------------|
| 4.5.1 Upscale | Transistor turn on to gnd |
| 4.5.2 Downscale | Transistor turn on to gnd |
| 4.5.3 Period | Transistor turn on to gnd |
| 4.5.4 High Range Failure | Transistor turn on to gnd |
| 4.5.5 Intermediate Range | Transistor turn on to gnd |
| 4.5.6 Low High Voltage | Transistor turn on to gnd |

5.0 Controls and Indicators

5.1 Mode Switch

- 5.1.1 Operate
- 5.1.2 Standby. Inoperative trip is tripped and range selection must be accomplished manually (Monitor Switch).
- 5.1.3 Zero. AC signals disconnected, DC circuitry can be zeroed.
- 5.1.4 Test. Provides signal for checking continuity of cables.
- 5.1.5 Calibrate. Allows selection of desired calibration signal (Calibrate Switch).

5.2 Calibrate Switch

- 5.2.1 LR1 10cps
- 5.2.2 LR2 10^5 cps
- 5.2.3 IR1 } $\frac{10^5}{64}$ cps square wave. IR2 = 10 IR1. Used to adjust
- 5.2.4 IR2 } slope of Intermediate Range.
- 5.2.5 HR1 } 10^5 cps square wave. HR2 = 10 HR1. Used to adjust slope
- 5.2.6 HR2 } of High Range.
- 5.2.7 Period
 - 5.2.7.1 Fixed. Used to adjust 10 Second Period Indication.
 - 5.2.7.2 Variable. Can be adjusted to give any period indication greater than ten seconds.

5.3 Monitor Switch (effective in all Mode Positions except OPERATE)

- 5.3.1 High. Applies High Range output to Percent Power Indicator.
- 5.3.2 Intermediate. Applies Intermediate Range Output to Percent Power Indicator.
- 5.3.3 Low. Applies Low Range Output to Percent Power Indicator.

II. Specifications (Continued)

5.0 Controls and Indicators (Continued)

- 5.4 Trip Reset Switch. Resets all latching trips after cause of trip has been corrected.
- 5.5 Ramp Reset Switch. Resets Ramp Generator used in Period Calibration.
- 5.6 Meters
 - 5.6.1 Percent Power
 - 5.6.2 Period
 - 5.6.3 High Range
 - 5.6.4 Low Range
 - 5.6.5 Intermediate Range
- 5.7 Lights
 - 5.7.1 Upscale Trip (latching)
 - 5.7.2 Downscale Trip (latching)
 - 5.7.3 High Range Failure Trip (latching)
 - 5.7.4 Intermediate Range Failure Trip (latching)
 - 5.7.5 Period Trip (latching)
 - 5.7.6 Low High Voltage Trip (latching)
 - 5.7.7 Inoperative Trip (non-latching)
 - 5.7.8 Auction Indicators
 - 5.7.8.1 Low Range
 - 5.7.8.2 Intermediate Range
 - 5.7.8.3 High Range

6.0 Performance

6.1 Percent Power

- 6.1.1 Accuracy

10^{-8} to 10^{-1}	$\pm 4\%$ linear f.s. output
10^{-1} to 100	$\pm 2\%$ linear f.s. output
- 6.1.2 Response

10^{-8} to 10^{-6}	~40 seconds
10^{-6} to 10^{-5}	~15 seconds
10^{-5} to 10^{-4}	~1.5 seconds
10^{-4} to 3×10^{-1}	~100ms
3×10^{-1} to 100	~10ms

II. Specifications (Continued)

6.0 Performance (Continued)

6.2 Period

6.2.1 Accuracy

$\pm 4\%$ actual

6.2.2 Response

~ 4 seconds for 0 to 65%
of final for ramp input.

7.0 Construction

Page type chassis

Modular electronic units

III. Range Description

A. Low Range Description

The Low Range of this system (10^{-8} to $10^{-3}\%$ power) employs Counting techniques for measuring neutron flux. Individual pulses generated by the fission chamber are amplified by the preamplifier and a section of the main amplifier. These amplified pulses are applied to a level discriminator which provides a means of rejecting amplifier noise and low level alpha pulses generated by the uranium in the fission chamber. The output from the discriminator is available at a rear panel connector for driving a scaler and is applied to a bi-stable flip-flop whose output goes to a Cook-Yarborough type Log-Integrator circuit. The DC output from the Log-Integrator is monitored by one section of the auction circuit and, if this signal is the largest of the three channels, applies it to the final readout device.

B. Intermediate Range Description

The Intermediate Range of this system (10^{-3} to $3 \times 10^{-1}\%$ power) employs the Campbell technique for measuring neutron flux. The signal generated by the fission chamber is amplified by the preamplifier and a section of the main amplifier. It is then applied to the Intermediate Range Amplifier-Rectifier where its bandwidth is first reduced to 8Kc - 16Kc, then amplified, then half wave rectified and smoothed with a 100ms time constant. The current output from this module is fed to the input of the Intermediate Range Log Ladder whose output is a current proportional to the log of the input current. This DC output from the Log Ladder is monitored by one section of the Auction circuit and, if this signal is the largest of the three channels, applies it to the final readout device.

C. High Range Description

The High Range of this system (3×10^{-1} to 100% power) employs the Campbell technique for measuring neutron flux. The signal generated by the fission chamber is amplified by the preamplifier and a section of the main amplifier. It is then applied to the High Range Amplifier-Rectifier where its bandwidth is first reduced to 300Kc - 600Kc, then amplified, then half-wave rectified and smoothed with a 10ms time constant. The current output from this module

III. Range Description (Continued)

C. High Range Description (Continued)

is fed to the input of the High Range Log Ladder whose output is a current proportional to the log of the input current. The DC output from the Log Ladder is monitored by one section of the Auction circuit and, if this signal is the largest of the three channels, applies it to the final readout device.

IV. Description of Switch Functions

A. Mode Switch

Determines what type of operation is desired. Positions available are: OPERATE, STANDBY, ZERO, TEST, CALIBRATE.

1. OPERATE

All modules are energized except those used as calibration signal sources (Campbell Calibrator, Signal Generator, Ramp Generator). A polarizing potential is applied to the detector via the High Voltage Filter and the Preamplifier. Signals produced by the detector are amplified by the Preamplifier and Main Amplifier and routed simultaneously to all three Ranges. Each Range operates on its portion of the signal, converting the signal to a DC level which is proportional to the log of the neutron flux as monitored by the detector. The DC outputs from the three Ranges are applied to the Multirange Monitor which drives the individual range meters thus making it possible to monitor the level of all three Ranges continuously and simultaneously. Outputs from the Multirange Monitor also go to the Auction circuit which monitors the levels of the three Ranges and applies the highest level to the Percent Power indicator. This final output signal is monitored by the Period module, whose output indicates the time rate of change of the Percent Power signal, and the Upscale and Downscale trip circuits (Module 18).

Internal operation of the Auction circuit is monitored by the Auction Monitor circuit which then energizes a light over the meter of that range which is controlling the Auction.

2. STANDBY

All circuit functions are identical to those described for the OPERATE position except that the auctioning function is de-energized. Control of which range's signal is applied to the Percent Power indicator is now controlled manually by the Monitor Switch. Also the Inoperative trip is tripped.

3. ZERO

The High Voltage Power Supply is de-energized and all AC signals are disconnected. All DC amplifiers may be zeroed. Automatic auction de-energized.

IV. Description of Switch Functions (Continued)

A. Mode Switch (Continued)

4. TEST

The purpose of this mode is to provide a check on the continuity of all signal cables. The High Voltage Power Supply, the auctioning function, and the Low Range are de-energized in this position.

A 100Kc square wave is generated by the Campbell Calibrator and applied to the High Voltage Cable via the High Voltage Filter. The signal then follows the same path as the detector polarizing current, is capacitively coupled to the signal cable by the detector capacity, and is then amplified and processed in the normal manner. Presence of this signal indicates the cables in the signal path are neither open nor shorted, and that the detector is not open.

5. CALIBRATE

This mode allows calibration of each of the system's three ranges and the Period circuitry. The High Voltage Power Supply and the auctioning function are de-energized. All calibration signal sources are energized. The Calibration Switch controls what portion of the system is to be calibrated.

B. Calibrate Switch

1. LR-1

A 10-pulse per second signal is applied to the Low Range Amplifier-Discriminator from the Signal generator via the Main Amplifier module. The resulting DC level will be indicated on the Low Range meter and, if the Monitor Switch is in the Low position, on the Percent Power meter.

2. LR-2

Same as LR-1 except the calibration signal is 10^5 pulses per second.

3. IR-1

A $\frac{10^5}{64}$ cps square wave is applied to the input of the Preamplifier from the Campbell Calibrator via the High Voltage Filter. The resulting DC level will be indicated on the Intermediate Range meter and, if the Monitor Switch is in the INT position, on the Percent Power meter.

IV. Description of Switch Functions (Continued)

B. Calibrate Switch (Continued)

4. IR-2

Same as IR-1 except that the magnitude of the square wave is ten times that of IR-1 (represents a factor of 100 increase in power).

5. HR-1

A 10^5 cps square wave is applied to the input of the Preamplifier from the Campbell Calibrator via the High Voltage Filter. The resulting DC level will be indicated on the High Range meter and, if the Monitor Switch is in the HIGH position, on the Percent Power meter.

6. HR-2

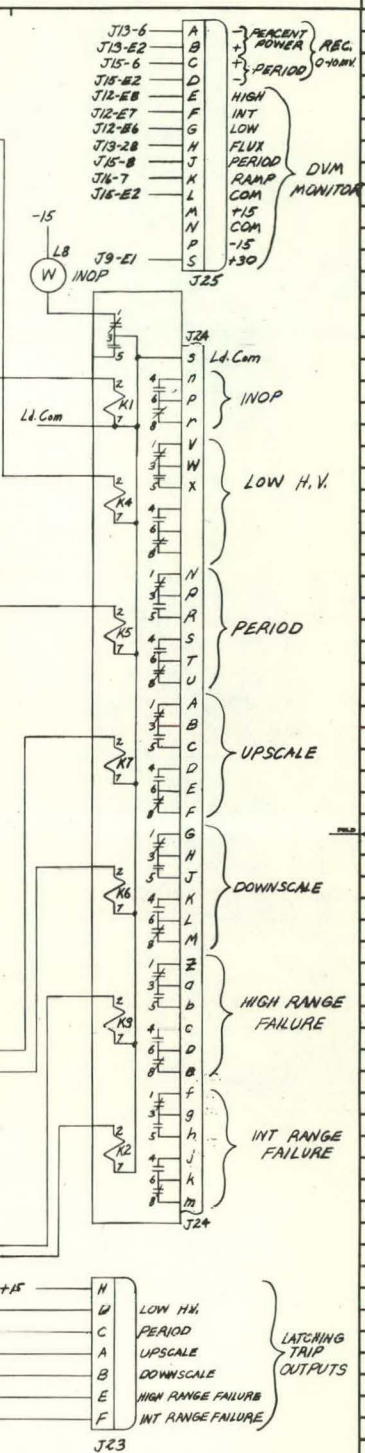
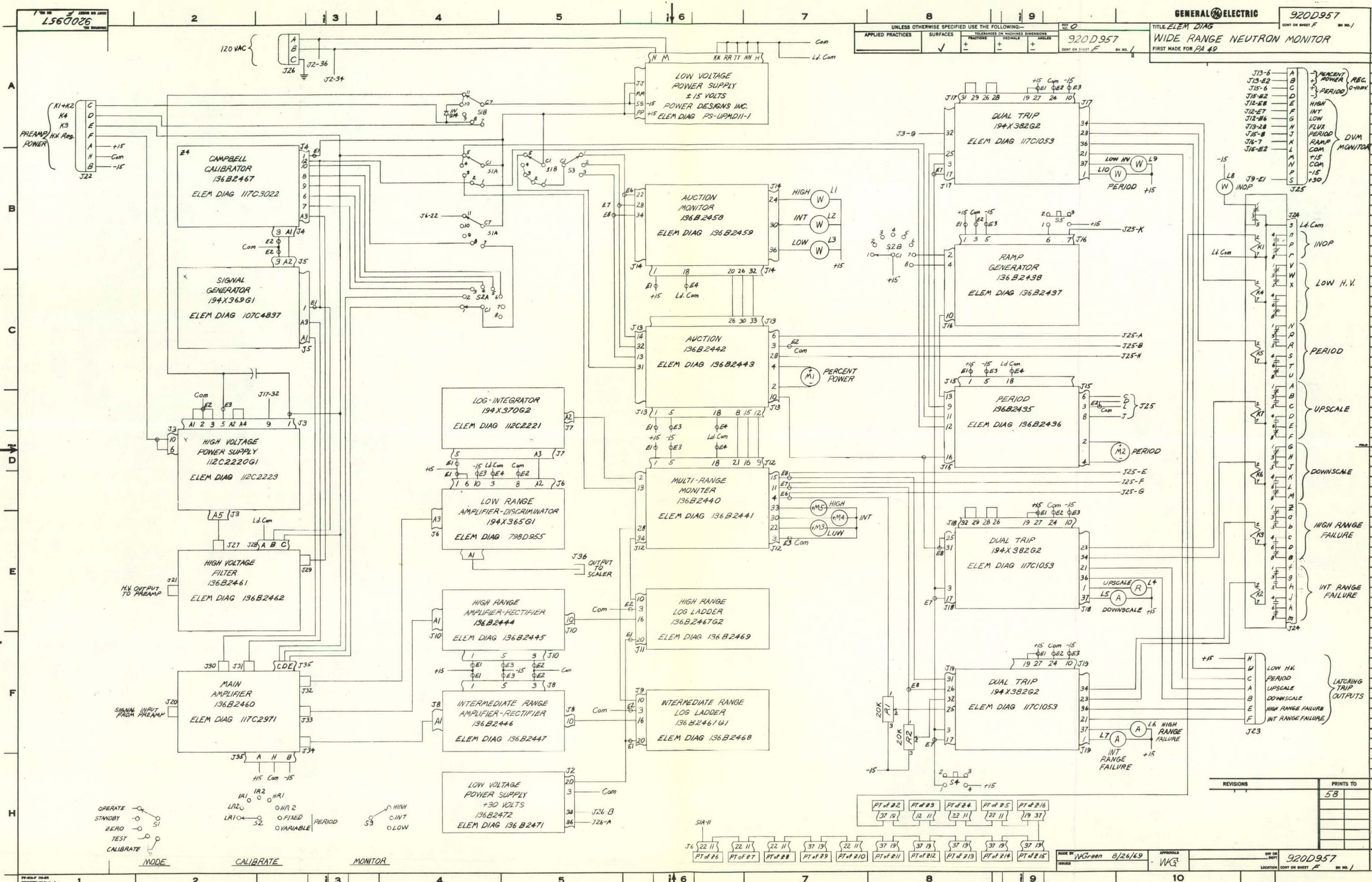
Same as HR-1 except that the magnitude of the square wave is ten times that of HR-1 (represents a factor of 100 increase in power).

7. PERIOD

The input to the period circuitry is connected to the output of the Ramp Generator. In the FIXED position a ramp is generated which simulates the rate of change caused by a ten second period. In the VARIABLE position, the ramp may be adjusted to simulate any rate of change with a period greater than ten seconds.

C. Monitor Switch

This switch is inoperative when the Mode Switch is in the OPERATE position. In all other Mode Switch positions, this switch allows the output of the chosen range to be applied to the final readout device (Percent Power meter).



V. Module Description

A. Preamplifier (Elementary Diagram 136B2448)

The preamplifier used in the WRM System is a low voltage gain (7), high current gain (450) amplifier capable of driving a 75Ω load with ± 1 volt swings. Its input impedance is about 5000Ω and its output impedance about 330Ω .

Resistors R3 and R4 make up the 5000Ω input impedance in addition to a DC return path for the fission chamber. The input signal across R3 and R4 is monitored by the input doublet consisting of Q1 and Q2. The current gain of this stage is about 23. Its output is applied to output doublet consisting of Q3 and Q4. The current gain of this stage is about 25. However, not all of the collector current in Q4 is delivered to the load, the exact percentage dependent on the load resistance. In this system, the load resistance is 75Ω so that 80% of Q4's collector current is delivered to the load. Therefore, the overall current gain of this amplifier is $23 \times 25 \times 0.8 = 460$.

During normal operation, relays K1, K2, and K3 are energized. The fission chamber polarizing potential comes into the preamplifier chassis via J3, is filtered by R29 and C14, and is fed to the detector via J2.

When the system is in the TEST condition, relays K1 and K2 are energized and K3 is de-energized. A 100Kc test signal is applied to J3, divided by R29 and R27, and fed to the detector via J2. If both detector cables and the detector are in good condition, the test signal will be passed through the chamber and to the preamplifier input via J1.

When the system is in the CALIBRATE position, relays K1, K2, and K3 are de-energized and K4 is energized. The appropriate calibration signal is applied through J3, divided by R29 and R27, and transmitted to the preamplifier input by K4.

Operational amplifier OA1 monitors the DC current from the detector. The output of OA1 is applied to the High Voltage Power Supply and represents a correction signal used to compensate for the resistance in series with the High Voltage Power Supply. Thus the voltage across the detector is held constant

V. Module Description (Continued)

A. Preamplifier (Elementary Diagram 136B2448)(Continued)

even though the full power current is more than 6 ma, and the total DC resistance in series with the High Voltage Power Supply is about 6500 Ω .

GENERAL ELECTRIC

PARTS LIST FOR 117C3009
CONT ON SHEET 2 SH NO. 1

REV NO. 0
PARTS LIST FOR 117C3009
CONT ON SHEET 2 SH NO. 1

TITLE ASSEMBLY
PREAMPLIFIER
FIRST MADE FOR PA 49

GROUP NO. AND QUANTITY						PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT
						1	ELEM DIAG	136B2448
				1		2	BOX	
				1		3	COVER	
				1		4	BRACKET	
				1		5	BRACKET	
				2		6	SHIELD	159A2603P001
				1		7	PLATE	
				1		8	SHIELD	
				1		9	COMP BD "A"	
				1		10	COMP BD "B"	
				3		11	RECP, J1, J2	
							£ J4	UG-496/U
				1		12	RECP, J3	UG-931/U
				1		13	RECP, J5	MS-3102A-18-8P
				1		14	CAP, C14	TMKBIH105K, 1µf, 1500V
				7		15	CAP, C11, 12, 13	
							15, 16, 18 & 19	CS13BF106K, 10µf, 35V
				1		16	CAP, C17	TE1209, 50µf, 25V, SPRAGUE
				2		17	FILTER, FL1 & 2	CZ24BEB105, SPRAGUE
				2		18	CHOKE, LI1 & 2	5 mh, 160 ma MILLER 6304
				1		19	RES, R29	RNG5C1001F, 1KΩ, 1/4W, 5
				2		20	FH SCR	117C1001P13032 #6-32 X 2.00
				2		21	HEX NUT	175AB000P013 #6
				2		22	SPGLK WASH	175AB015P007 #6
				2		23	F WASH	175AB010P007 #6
				5		24	TERMINAL	145A5770P001
				17		25	PAN HD SCR	117C1000P9006 #4-40 X .37

DESCRIPTION OF GROUPS	REVISIONS	PRINTS TO
		58

MADE BY *W. Schmale*
ISSUED
APPROVALS *W. K.* 8/27/69
NID
SAN JOSE CALIF. LOCATION
DIV. OR DEPT.
PARTS LIST FOR 117C3009
CONT ON SHEET 2 SH NO. 1



117C3009

REV NO 000000

TITLE ASSEMBLY
PREAMPLIFIER
FIRST MADE FOR PA 49

PARTS LIST FOR 117C3009

CONT ON SHEET **F** SH NO. **2**

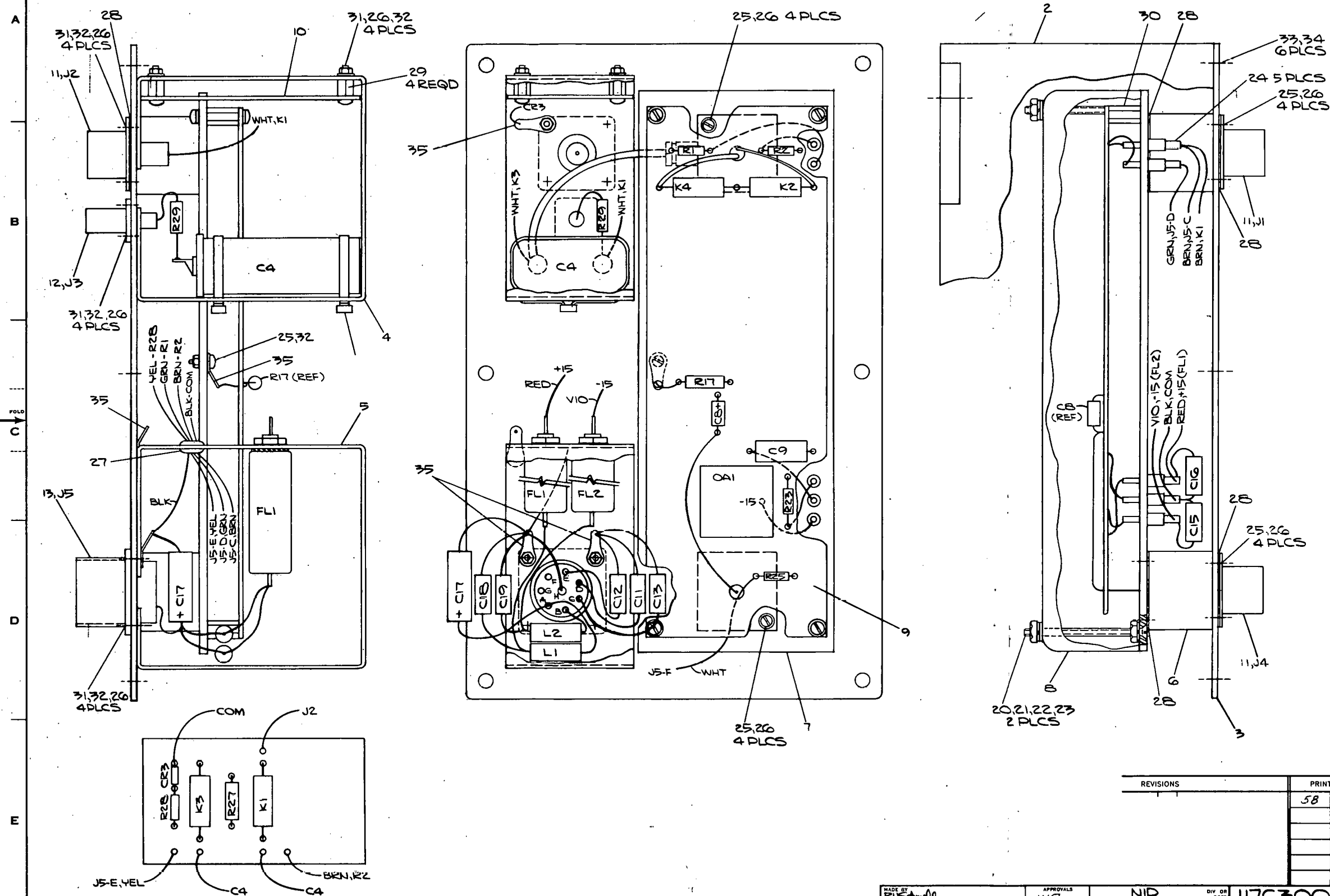
FIRST MADE FOR PA 49

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DESCRIPTION OF GROUPS	REVISIONS	PRINTS TO	
		58	

NAME <i>W. J. Schmale</i>	APPROVALS <i>WJS</i>	NID	DIV. OR DEPT.	PARTS LIST FOR <i>117C3009</i>
ISSUED	<i>8/27/69</i>	SAN JOSE, CALIF	LOCATION	CONT. ON SHEET <i>F</i> SH NO. <i>2</i>

TITLE ASSEMBLY
DREAMPLIFIER
FIRST MADE FOR PA 49



GENERAL ELECTRIC

PARTS LIST FOR 136B2473

REV. NO. 0		TITLE ASSEMBLY		CONT ON SHEET 2 SH NO. 1	
PARTS LIST FOR 136B2473		COMPONENT BOARD "A"			
CONT ON SHEET SH NO.		FIRST MADE FOR FA 49			
GROUP NO. AND QUANTITY		PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT	
		1	ELEM DIAG	136B2448	
		2			
		3			
		4			
		5			
	1	6	BOARD		
	100	7	EYELET		
		8			
		9			
		10			
		11			
	2	12	RES, R1 & 2	RC20GF201J, 200Ω, 1/2W, 5%	
	1	13	RES, R3	RN65C4021F, 4.02KΩ, 1/4W, 1%	
	1	14	RES, R4	RN65C1001F, 1KΩ, 1/4W, 1%	
	1	15	RES, R5	RC20GF752J, 7.5KΩ, 1/2W, 5%	
	1	16	RES, R6	RC20GF622J, 6.2KΩ, 1/2W, 5%	
	1	17	RES, R7	RC20GF393J, 39KΩ, 1/2W, 5%	
	1	18	RES, R8	RN65C2000F, 200Ω, 1/4W, 1%	
	1	19	RES, R9	RC20GF162J, 1.6KΩ, 1/2W, 5%	
	1	20	RES, R10	RC20GF222J, 2.2KΩ, 1/2W, 5%	
	1	21	RES, R11	RN65C1000F, 100Ω, 1/4W, 1%	
	1	22	RES, R12	RC20GF331J, 330Ω, 1/2W, 5%	
	2	23	RES, R13 & 24	RC20GF512J, 5.1KΩ, 1/2W, 5%	
	2	24	RES, R14 & 15	RC20GF242J, 2.4KΩ, 1/2W, 5%	
	1	25	RES, R16	RC20GF822J, 8.2KΩ, 1/2W, 5%	
	1	26	RES, R17	RN65C3320F, 332Ω, 1/4W, 1%	
	1	27	RES, R18	RN65C2430F, 243Ω, 1/4W, 1%	
DESCRIPTION OF GROUPS		REVISIONS		PRINTS TO	
				58	
MADE BY <i>W. Schnel</i>		APPROVALS <i>WES</i>		PARTS LIST FOR 136B2473	
ISSUED		8/27/69		CONT ON SHEET 2 SH NO. 1	
		NID		DIV. OR DEPT.	
		SAN JOSE, CALIF		LOCATION	

GENERAL ELECTRIC

PARTS LIST FOR 136B2473

CONT ON SHEET 1 SH NO. 2

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GENERAL ELECTRIC

PARTS LIST FOR 136B2474

REV. NO. 0
PARTS LIST FOR 136B2474
CONT ON SHEET SH NO.

TITLE ASSEMBLY
COMPONENT BOARD "B"
FIRST MADE FOR PA 49

GROUP NO. AND QUANTITY						PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT
						1	ELEM DIAG	136B2448
						2		
						3		
				1		4	BOARD	
				10		5	EYELET	
						6		
						7		
				1		8	RES, R27	RN05C57RGF, 57.6Ω, 1/4W, 1%
				1		9	RES, R28	RC20GF201J, 200Ω, 1/2W, 5%
				1		10	DIODE, CR3	1N914
				2		11	RELAY, KI&3	176A1405P2

DESCRIPTION OF GROUPS

REVISIONS

PRINTS TO

MADE BY
Schmule
ISSUED

APPROVAL
WJ
8/27/69

NID
SAN JOSE CALIF
LOCATION

PARTS LIST FOR 136B2474
CONT ON SHEET SH NO.

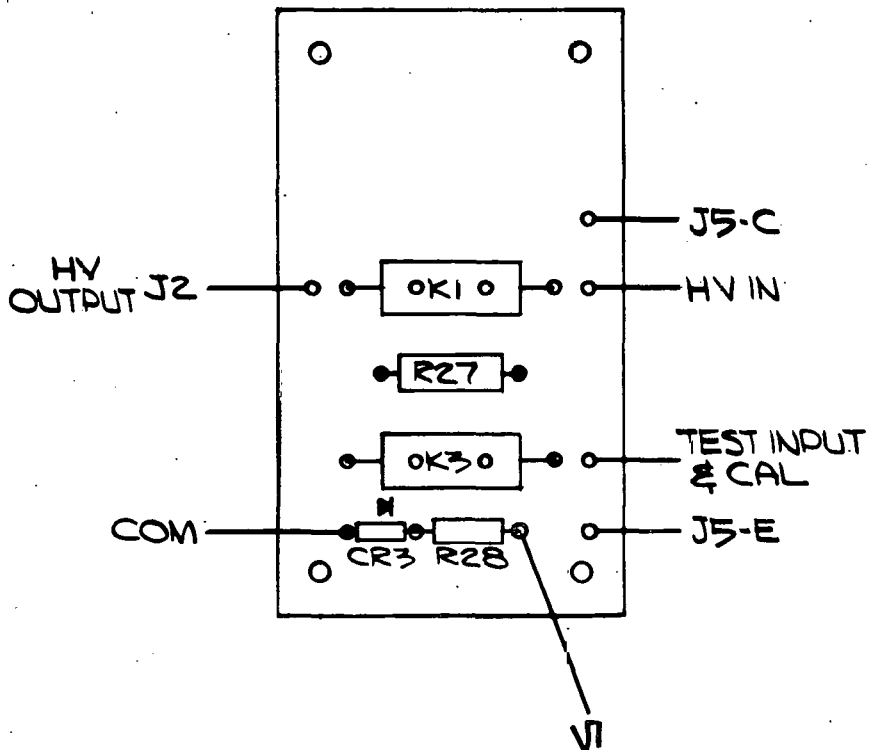
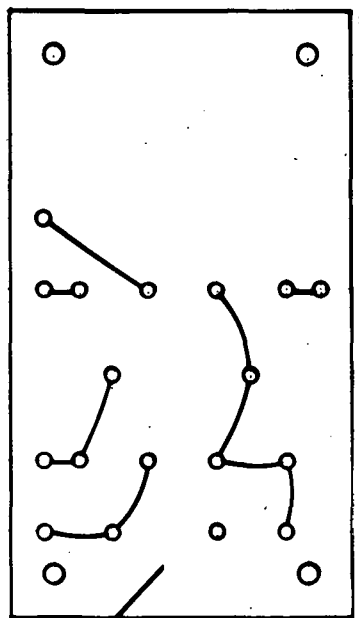
ON HS
CONT ON SHEET
DRAWING
136B2474

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—			
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS	
		FRACTIONS	DECIMALS
	✓	+	+

REV NO.
136B2474
CONT ON SHEET
SH NO.

TITLE
ASSEMBLY
COMPONENT BOARD "B"
FIRST MADE FOR PA 49

GENERAL ELECTRIC
136B2474
CONT ON SHEET
SH NO.



REVISIONS	PRINTS TO
	58

MADE BY R. Schmidt	APPROVALS W. E.	NID	REV. OR DEPT	136B2474
ISSUED	8/27/69	SAN JOSE CALIF	LOCATION	SH NO.

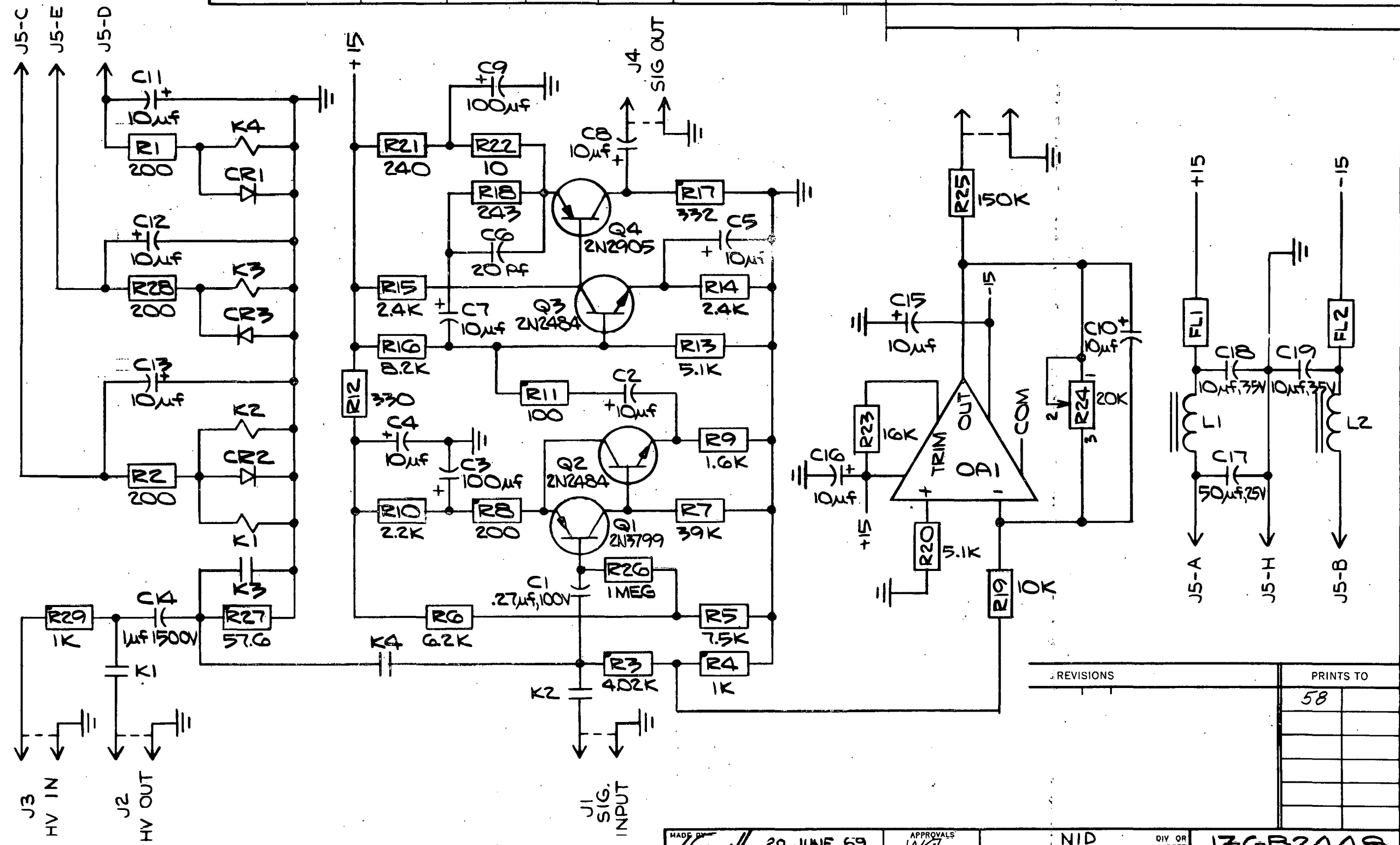
136B2448
DRAWING NO. 136B2448
CONT ON SHEET SH NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
	✓	FRACTIONS	DECIMALS	ANGLES
		+	+	+
		—	—	—

REV NO. 0
136B2448
CONT ON SHEET SH NO.

GENERAL ELECTRIC
TITLE ELEM DIAG
PREAMPLIFIER
FIRST MADE FOR PA 49

136B2448
CONT ON SHEET SH NO.



V. Module Description (Continued)

B. Main Amplifier (Elementary Diagram 117C2971)

The Main Amplifier is mounted in a chassis which is bolted to the rear panel of the system's chassis. In addition to providing additional gain to the preamplifier signal, this unit splits the signal into the three ranges used for neutron flux monitoring.

The first stage of amplification consists of a standard doublet amplifier with a push-pull emitter follower output within the feedback loop. The input impedance is 75Ω which terminates the signal cable from the preamplifier, its gain is 10, and its output capability is ± 10 volts, 150ma at a frequency of 1.5 megacycles.

The output of this stage is fed to the High Range Amplifier-Rectifier via J33, to the Intermediate Range Amplifier-Rectifier via operational amplifier OA1 (which provides another gain of ten for the Intermediate Range signal) and J34, and to the Low Range pulse amplifier.

The Low Range pulse amplifier consists of two doublet stages. The gain of the first doublet (Q5 and Q6) is about 11. The second stage is a modified doublet (Q7, Q8 and Q9). Its voltage gain as measured between the base of Q7 and emitter of Q9 is about 11. However, the output taken from the collector is a current and is approximately equal to the current through R31 (the load external to this module and seen by the collector of Q9 is 75Ω).

GENERAL ELECTRIC

PARTS LIST FOR **136B2460**
CONT ON SHEET **2** SH NO. **1**

REV. NO. 0		TITLE ASSEMBLY			
PARTS LIST FOR 136B2460		MAIN AMPLIFIER			
CONT ON SHEET 2 SH NO. 1		FIRST MADE FOR PA 49			
GROUP NO. AND QUANTITY		PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT	
		1	ELEM DIAG		
		2	BOARD		
		3	EYELET	159A1969D1	
		4			
		5			
		6			
		7			
		2 8	CHOKE, L1 & 2	5 mh, ma MILLER 6304	
		3 9	TRAN, Q1, Q5, Q7	2N2484	
		3 10	TRAN, Q2, Q4, Q6	2N2905	
		2 11	TRAN, Q3, Q9	2N2219	
		1 12	TRAN, Q8	2N3799	
		7 13	CAP, C1, 15, 6,		
			9, 10, 13, 18	CS13BE106K, 10μf, 20V, 5%	
		1 14	CAP, C3	CM15ED100JN3, 10pf, 500WV, 5%	
		1 15	CAP, C14	CM15ED500JN3, 51 pf, 500WV, 5%	
		1 16	CAP, C11	CM15ED910JN3, 91pf, 500WV, 5%	
		1 17	CAP, C12	CM15ED121JN3, 120pf, 500WV, 5%	
		1 18	CAP, C7	G1F10AA103, .01μf, 100V, 5%	
		5 19	CAP, C2, 4,		
			5, 8 & 17	CS13BF106K, 10μf, 35V, 5%	
		1 20	CAP, C16	OZE1-274, .27μf, 100V, 10%	
		1 21	RES, R37	RC20GF510J, 51Ω, 1/2W, 5%	
		2 22	RES, R10 & 11	RC20GF100J, 10Ω, 1/2W, 5%	
		4 23	RES, R8, 34		
			35 & 36	RC20GF201J, 200Ω, 1/2W, 5%	
		1 24	RES, R27	RC20GF751J, 750, 1/2W, 5%	
DESCRIPTION OF GROUPS		REVISIONS		PRINTS TO	
				58	
MADE BY B. Schmelt		APPROVALS WGA		PARTS LIST FOR 136B2460	
ISSUED		8/27/69		CONT ON SHEET 2 SH NO. 1	
		NID		DIV. OR DEPT.	
		SAN JOSE, CALIF		LOCATION	

GENERAL ELECTRIC

PARTS LIST FOR 136B2460
CONT ON SHEET F SH NO. 2

REV NO. 0						TITLE ASSEMBLY								CONT ON SHEET F				SH NO. 2											
PARTS LIST FOR 136B2460						MAIN AMPLIFIER																							
CONT ON SHEET						FIRST MADE FOR PA 49																							
GROUP NO. AND QUANTITY						PART NO.	NAME							DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT															
						1	25	RES, 33							RC20GF102J, 1KΩ, 1/2W, 5%														
						1	26	RES, R9							RC20GF152J, 1.5KΩ, 1/2W, 5%														
						2	27	RES, R24																					
								E 12							RC20GF202J, 2KΩ, 1/2W, 5%														
						1	28	RES, R19							RC20GF222J, 2.2KΩ, 1/2W, 5%														
						1	29	RES, R4							RC20GF242J, 2.4KΩ, 1/2W, 5%														
						2	30	RES, R22 E 30							RC20GF472J, 4.7KΩ, 1/2W, 5%														
						2	31	RES, R21 E 29							RC20GF512J, 5.1KΩ, 1/2W, 5%														
						3	32	RES, R17, 25																					
								E 32							RC20GF562J, 5.6KΩ, 1/2W, 5%														
						3	33	RES, R2, 18																					
								E 26							RC20GF113J, 11KΩ, 1/2W, 5%														
						1	34	RES, R3							RC20GF123J, 12KΩ, 1/2W, 5%														
						1	35	RES, R6							RC20GF153J, 15KΩ, 1/2W, 5%														
							36																						
						1	37	RES, R16							RC20GF243J, 24KΩ, 1/2W, 5%														
						1	38	RES, R28							RN65C10R0F, 10Ω, 1/4W, 1%														
						3	39	RES, R5, 20,																					
								E 31							RN65C1000F, 100Ω, 1/4W, 1%														
						1	40	RES, R7							RN65C9090F, 909Ω, 1/4W, 1%														
						1	41	RES, R1							RN65C75R0F, 75Ω, 1/4W, 1%														
						1	42	RES, R23							RN65C1001F, 1KΩ, 1/4W, 1%														
						1	43	RES, R13							RN65C2001F, 2KΩ, 1/4W, 1%														
						2	44	RES, R14 E 15							RN65C2002F, 20KΩ, 1/4W, 1%														
						5	45	DIODE, CR1, 2, 3, 4 E 5							IN914														
						3	46	RELAY, K1, 2 E 3							176A1405P2														
						1	47	OP AMP, OA1							KM61 K&M ELECTRONICS														
DESCRIPTION OF GROUPS						REVISIONS										PRINTS TO													
																58													
MADE BY <i>R. Schuele</i>						APPROVALS <i>WR</i> 8/27/69						NID SAN JOSE, CALIF						DIV. OR DEPT. LOCATION						PARTS LIST FOR 136B2460					
ISSUED																		CONT ON SHEET F SH NO. 2											

136B2460
DRAWING NO.
CONT ON SHEET
SH NO.

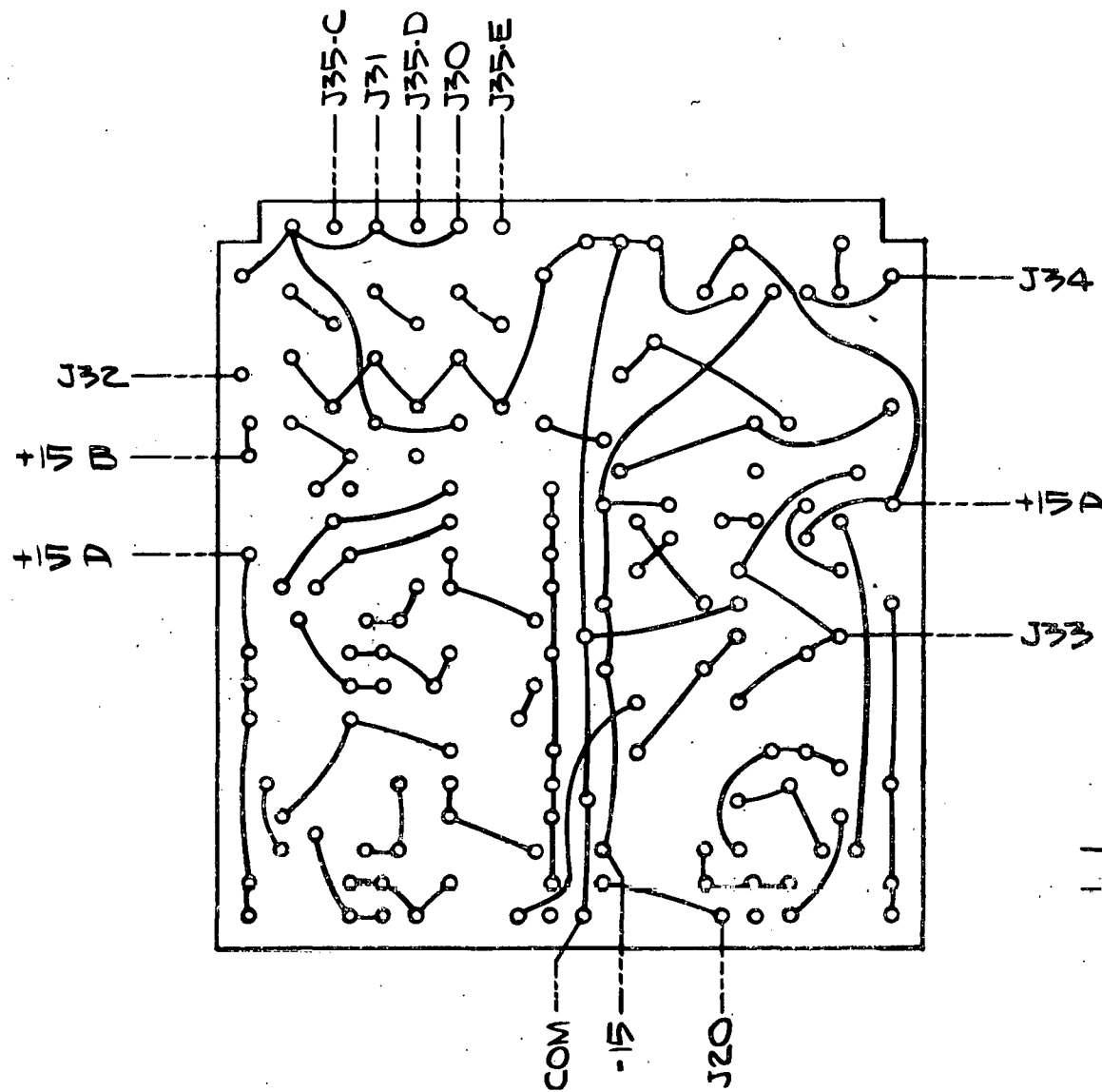
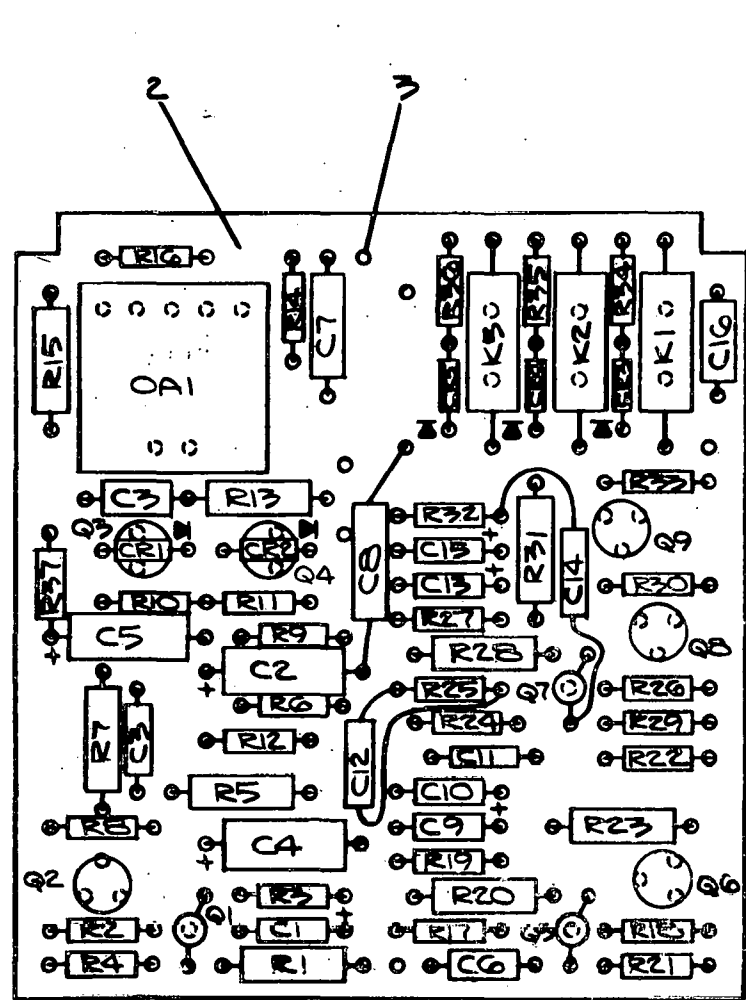
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV. 0
136B2460
CONT ON SHEET
SH NO.

GENERAL ELECTRIC

TITLE ASSEMBLY
MAIN AMPLIFIER
FIRST MADE FOR PA 49

136B2460
CONT ON SHEET
SH NO.



REVISIONS		PRINTS TO	
		58	

MADE BY *W. K. Schell* APPROVALS *W. K. Schell* 8/27/69
ISSUED
NID
DIV OR DEPT
SAN JOSE, CALIF LOCATION
136B2460
CONT ON SHEET
SH NO.

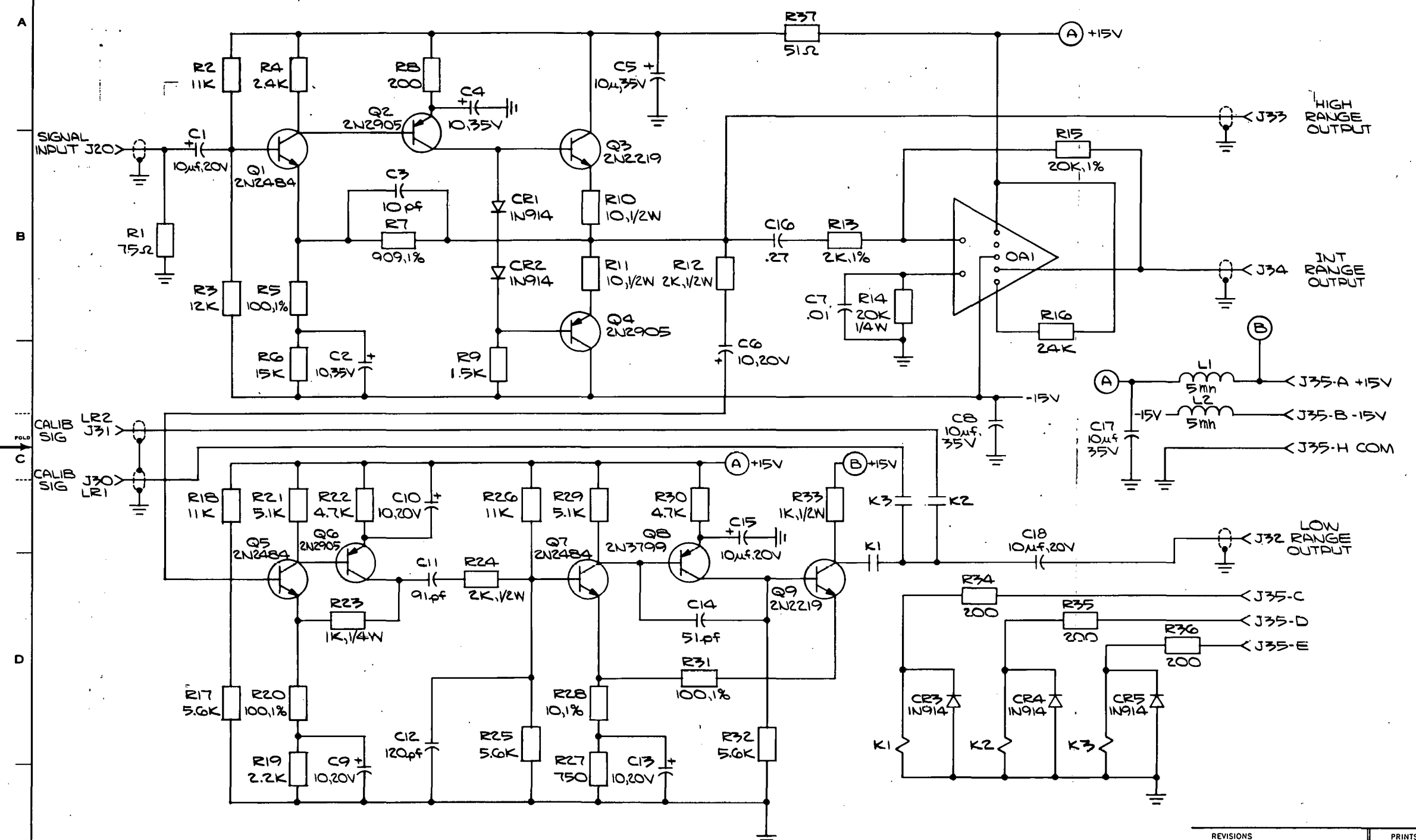
12629711

GENERAL ELECTRIC

117C2971

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:			
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS	ANGLES
	✓	FRACTIONS +	+
		DECIMALS +	+
			+

TITLE ELEM DIAG
MAIN AMPLIFIER
FIRST MADE FOR PA 49



REVISIONS		PRINTS TO	
		58	

MADE BY: *[Signature]* APPROVALS: *[Signature]* NID: *[Signature]* DIV OR: *[Signature]* 117C2971
ISSUED: 8/27/69 SAN JOSE, CALIF. LOCATION: CONT ON SHEET SH NO.

V. Module Description (Continued)

C. Low Range Amplifier-Discriminator (Elementary Diagram 798D955)

The Low Range Amplifier-Discriminator receives current pulses from the Low Range pulse amplifier, provides adjustable level discrimination, and supplies two outputs, one capable of driving a scaler, and one for the purpose of driving the Cook-Yarborough type log-integrator.

Transistor Q1 acts as a terminating stage with a unity current gain and an impedance of approximately 75Ω .

Transistor Q2 is a constant current source for diode CR1. If the magnitude of the current pulse (negative pulse) from the collector of Q1 is less than the DC current through CR1, no signal is applied to the base of Q3. However, when the magnitude of the negative current pulse from the collector of Q1 is greater than the DC current through CR1, CR1 ceases to conduct and the pulse is transmitted to the base of Q3, and amplified by Q5 and Q6. Q7 is an emitter follower which provides both the drive for the bistable flip-flop and the output for driving a scaler. The output of the flip-flop receives power amplification by Q11, Q12, Q13, Q14 and is used to drive the Log-Integrator circuit.



NID

SAN JOSE, CALIF.

TITLE			SPARES	GROUP NO. AND QTY								U/M	PL 104B2477			SH NO	CONT ON SH	REV
ASM COMPONENT BOARD													FCF	1	2	//		
FIRST MADE FOR PULSE HEIGHT DISCRIMINATOR																		
ITEM NO.	IDENTIFICATION NO.	NAME		1	2	3	4	5				REMARKS	REV					
1	104B2476P001	BOARD																
2	112C3791P019	CONN				1	1											
3	175A8382P001	COAX CONTACT	B			1												
4	159A1969P001	EYELET		1	2	1	2	126	11				//					
5	175A7209P001	EYELET			0	8	10											
6	175A7209P002	EYELET			4	4	2											
7	145A5898P008	CLIP			0	8	10											
8	145A5898P006	CLIP			4	4	2											
9	175A8289P001	TERMINAL				1	1											
10	107C5488P001	CAPACITOR			3	3	3	3	3			C9, C10, C11						
11	112C2277P006	CAPACITOR				1	1					C2						
12	112C2277P061	CAPACITOR			2	2	2	2	2			C4, C7						
13	112C2642P028	CAPACITOR			3	4	3	4	4			C3, C5, C6, C12, C1	//					
14	112C2642P028	CAPACITOR			1		1					C1	//					
15	175A7485P001	DIODE			4	3	10					CR1, CR2, CR3, CR4						
16	175A8890P006	POT				1	1					R7						
17	112C2674P081	RESISTOR			3	2	3	3	2			R1, R8, R13						
18	112C2674P049	RESISTOR			6	4	7	6	4			R2, 4, 10, 21, 22, 23, R29	//					
19	112C2674P071	RESISTOR				1	1					R3						
20	112C2674P083	RESISTOR				1	1	1				R11						
21	112C2674P041	RESISTOR			2	2	2	2				R12, R17						
22	112C2674P061	RESISTOR	B		1	1	1	1	1			R14						

9 | *Red Bush* Jan 19-68 | JB

RETRACED-UPDATED FOR CMPIR

10 | *Red Bush* MAR 20 68 | PP

ADDED G4 & G5 TO REPLACE G1 & G2

11 | *Red Bush* Aug 26 68 | PR

EN707408

SUPERSEDED BY G4

SUPERSEDED BY G5

G3- SEFOR
G4- PLUG-IN
G5- WIRE-IN (PULSE AMPL)

PRINTS TO

A13

7 RE

REVISION CODE

1. ITEM ADDED 2. ITEM DELETED 3. ITEM REVISED

MADE BY KE BULLER FEB 10-64
ISSUED *Red Bush* Jan 19-68

APPROVALS HWP
2-12-64

PL 104B2477

SH NO 1
CONT ON SH 2

REVISIONS

DESCRIPTION OF GROUPS

GENERAL ELECTRIC

TITLE ASM COMPONENT BOARD			SPARES	NID SAN JOSE, CALIF.		PL 104B2477		SH NO. 2	CONT ON SH 3	REV 11	
FIRST MADE FOR PULSE HEIGHT DISCRIMINATOR				GROUP NO. AND QTY						U/M	FCF
ITEM NO.	IDENTIFICATION NO.	NAME								REMARKS	REV CODE
23	112C2674P053	RESISTOR	B			3	3	3		R15, R26, R27	
24	112C2674P057	RESISTOR				2	2	2		R16, R18	
25	112C2674P025	RESISTOR				1	1	1		R19	
26	112C2674P055	RESISTOR				1	1	1		R20	
27	112C2674P037	RESISTOR				1	1	1		R21, R22	
28	112C2674P021	RESISTOR				2	2	2		R24, R30	
29	112C2674P073	RESISTOR				2	2	2		R25, R28	
30	112C3157P162	RESISTOR				1	1			R6	
31	112C2676P029	RESISTOR					1	1		R32	
32	175A7613P001	SENSISTOR				1	1			R5	
33	175A7612P001	THERMISTOR					1	1		R31	
34	175A7496P001	TRANSISTOR				8				Q1,3,4,5,6,8,9, Q10	
35	175A7497P001	TRANSISTOR				2				Q2, Q7	
36	175A7495P001	TRANSISTOR				1				Q11, Q13	
37	175A7499P001	TRANSISTOR				1				Q12, Q14	
38	175A7480P016	ZENER				1					
39	112C2675P025	RESISTOR				1	1	1		R9	11
40	175A8292P002	TERMINAL				2	2				
41	175A8382P004	COAX CONTACT				1					
42	175A8382P002	COAX CONTACT				1	2				
43	107C5488P003	CAPACITOR				1	1	1		C8	
44	112C2674P020	RESISTOR	B			1	1			R33	

9. *Jan. 19-68* *13* *PR*
RETRACED-UPDATED
FOR CMPTR

10. *AUG 13 1968* *13*
ITEM 33 WAS 176A7612P1

11. *MAR 20 1968* *PR*
ADDED G4 & G5 TO
REPLACE G1 & G2
E NE706108

SUPERSEDED BY G4

SUPERSEDED BY G5

REVSIONS

DESCRIPTION OF GROUPS

PRINTS TO
A13
7 RE

REVISION CODE
1. ITEM ADDED 2. ITEM DELETED 3. ITEM REVISED

MADE BY
K.E. BULLER FEB 10-64

ISSUED
Jan. 19-68

APPROVALS
H.W.P.
2-12-64

PL 104B2477

SH NO. 2 CONT ON SH 3

GENERAL ELECTRIC

[illegible]

104B2477
DRAWING NO. 1
CONT ON SHEET 2

GENERAL ELECTRIC

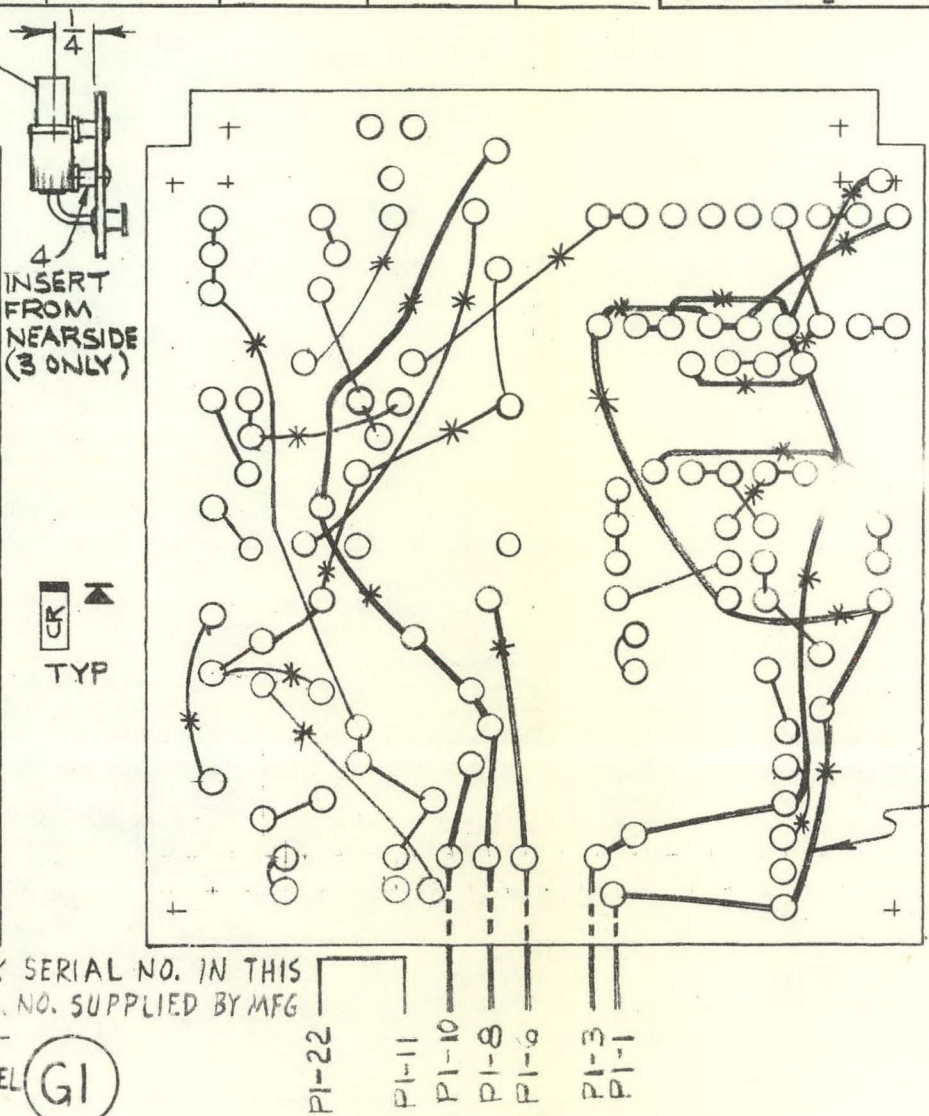
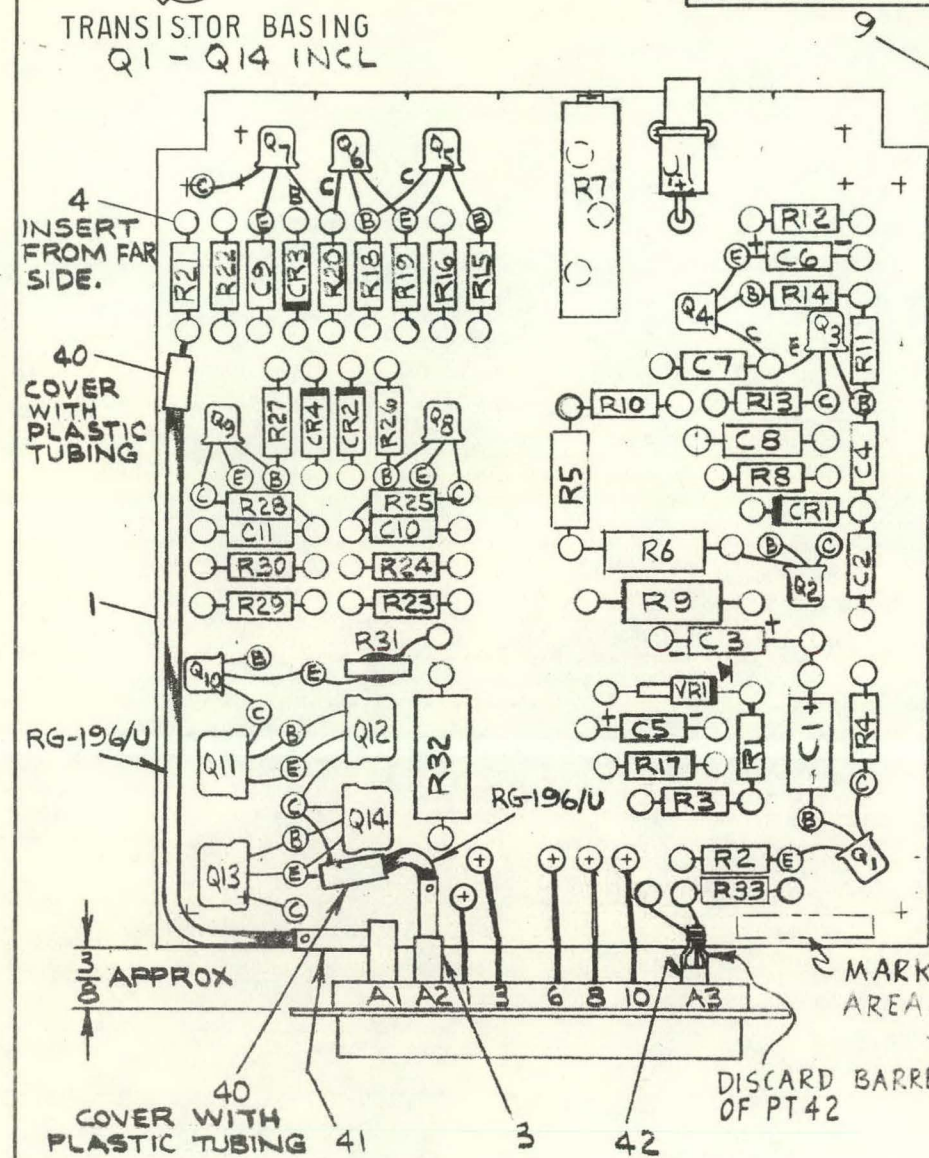
104B2477
CONT ON SHEET 2
SH NO. 1

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:-				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
	✓	FRACTIONS	DECIMALS	ANGLES
		+	+	+
		-	-	-

REV NO. 0123456789
104B2477
CONT ON SHEET 2
SH NO. 1

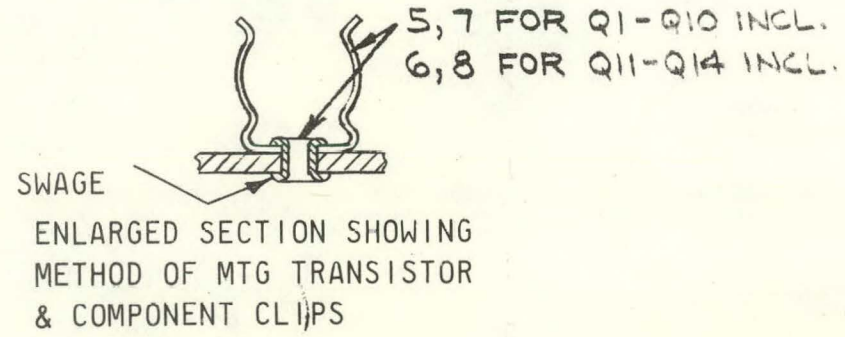
TITLE
COMPONENT BOARD
FIRST MADE FOR PULSE HEIGHT DISCRIMINATOR

- PARTS LIST ISSUED FCF 194X365
- NOTES
- THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:
1D, 2, 3, 4.
 - MARK REF DESIGNATIONS OF THE FOLLOWING COMPONENTS ADJACENT TO COMPONENTS. LETTERING TO BE PER 175A7656
Q1 - Q14 INCL., R7, J1.
 - ALL WIRING TO BE ROUTED AS SHOWN & TO BE OF MINIMUM LENGTH.



HEAVY LINES INDICATE WIRES TO BE #20AWG SOLID COPPER TINNED.

PT NO	REFERENCE DESIGNATION	PT NO	REFERENCE DESIGNATION
10	C9, -10, -11	30	R6
11	C2	31	R32
12	C4, -7	32	R5
13	C3, -5, -6	33	R31
14	C1	34	Q1, -3, -4, -5, -6, -8, -9, -10
15	CR1, -2, -3, -4	35	Q2, -7
16	R7	36	Q11, -13
17	R1, -8, -13	37	Q12, -14
18	R2, -4, -10, -21, -23, -29	38	VR1
19	R3	39	R9
20	R11	43	CB
21	R12, -17	44	R33
22	R14		
23	R15, -26, -27		
24	R16, -18		
25	R19		
26	R20		
27	R22		
28	R24, -30		
29	R25, -28		



REVISIONS				PRINTS TO	
10	NOV 8-1965	KEB	4	MARCH 31-1965	W.K.
7	NE12645			NE10595	
8	APR 5-1966	W.K.	5	APR 17-65	W.K.
	NE13630			ADDED SH.2	
9	AUG 11-1966	W.K.	6	OCT 12-1965	KEB
	NE14252			NE12556	
	MADE BY K.E. Buller Feb 12, 1964			APPROVALS	
	ISSUED W.K. Feb 12 '64			W.K.	
				NID	
				SAN JOSE	
				LOCATION	
				CONT ON SHEET 2	
				SH NO. 1	

V. Module Description (Continued)

D. Log-Integrator (Elementary Diagram 112C2221)

The Log-Integrator is a frequency sensitive digital to analog conversion circuit of the Cook-Yarborough type. It consists of eight parallel diode pump circuits. The output from each of the diode pump circuits is dependent upon its coupling capacitor value and the input pulse rate. Each of the eight parallel circuits is designed to provide one half its maximum output at an input pulse frequency one decade above the preceeding circuit. Thus collectively the circuits cover an input range of from 10^{-1} pps to 10^6 pps or seven decades. The summation of the output currents of the separate circuits results in a composite current output which varies by a discrete amount (approximately 40μ amps) for each decade change in input frequency. Since the output current varies a fixed amount for a 10:1 change in frequency, a common logarithmic ($\log_{10}$) relation exists between output current and input frequency. Changes in input pulse amplitude are not considered because the pulse height discriminator provides input pulses of constant amplitude.

GENERAL ELECTRIC

TITLE ASM COMPONENT BOARD			NID SAN JOSE CALIF		PL 104B2494		SH NO. 1	CONT ON SH 2	REV 10		
FIRST MADE FOR LOGARITHMIC INTEGRATOR			GROUP NO. AND QTY						U/M	FCF 194X370	
ITEM NO.	IDENTIFICATION NO.	NAME	1	2	3					REMARKS	REV
1	104B2495P001	BOARD	1								
2	112C3791P019	CONNECTOR	1	1							
3	175A8382P001	COAX CONT	1	1							
4	175A8382P002	COAX CONT	1	1							
5	175A8292P002	TERMINAL	B 1	1							
6	159A1969P001	EYELET	80	80	80						
7	112C2674P035	RESISTOR	8	8	8					R1 THRU R8	
8	112C2674P113	RESISTOR	1		1					R17	
9	112C2674P025	RESISTOR	1	1	1					R18	
10	112C3157P414	RESISTOR	7	7	7					R9 THRU R15	
11	112C3157P373	RESISTOR	1	1	1					R16	
12	112C2642P018	CAPACITOR	1	1	1					C1	
13	209A6197P027	CAPACITOR	2	4	4					C2, C4, C6, C8	10
14	112C2642P028	CAPACITOR	1	1	1					C3	
15	112C2642P051	CAPACITOR	1	1	1					C5	
16	112C2642P031	CAPACITOR	1							C6	
17	112C2277P121	CAPACITOR	1	1	1					C7	
18	112C2642P043	CAPACITOR	1							C8	
19	112C2277P061	CAPACITOR	1	1	1					C9	
20	112C2603P156	CAPACITOR	1							C10	
21	107C5489P046	CAPACITOR	1	1	1					C11	
22	112C2603P096	CAPACITOR	B 1							C12	

9 *Jan 18-64* 1 *JB*
RETRACED-UPDATED
FOR CMPTR

10 *FEB 12-64* *R. SUGGS* *RRS*

NE1957Z

G3-FOR USE WITH TIC

PRINTS TO
A13
7 RE
6

REVISION CODE

1. ITEM ADDED 2. ITEM DELETED 3. ITEM REVISED

MADE BY
R. SUGGS FEB.13-64

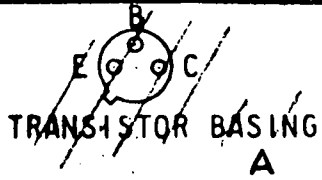
APPROVALS
Jan 18-64 2-17-64

SH NO. 1 CONT ON SH 2

ATOMIC POWER EQUIPMENT DEPT.
SAN JOSE, CALIF.

NEBS-PL-8 REV 7-67

104B2494
DRAWING NO.
CONT ON SHEET 3



UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:

APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV NO. 018345
104B2494
CONT ON SHEET 3 SH NO. 2

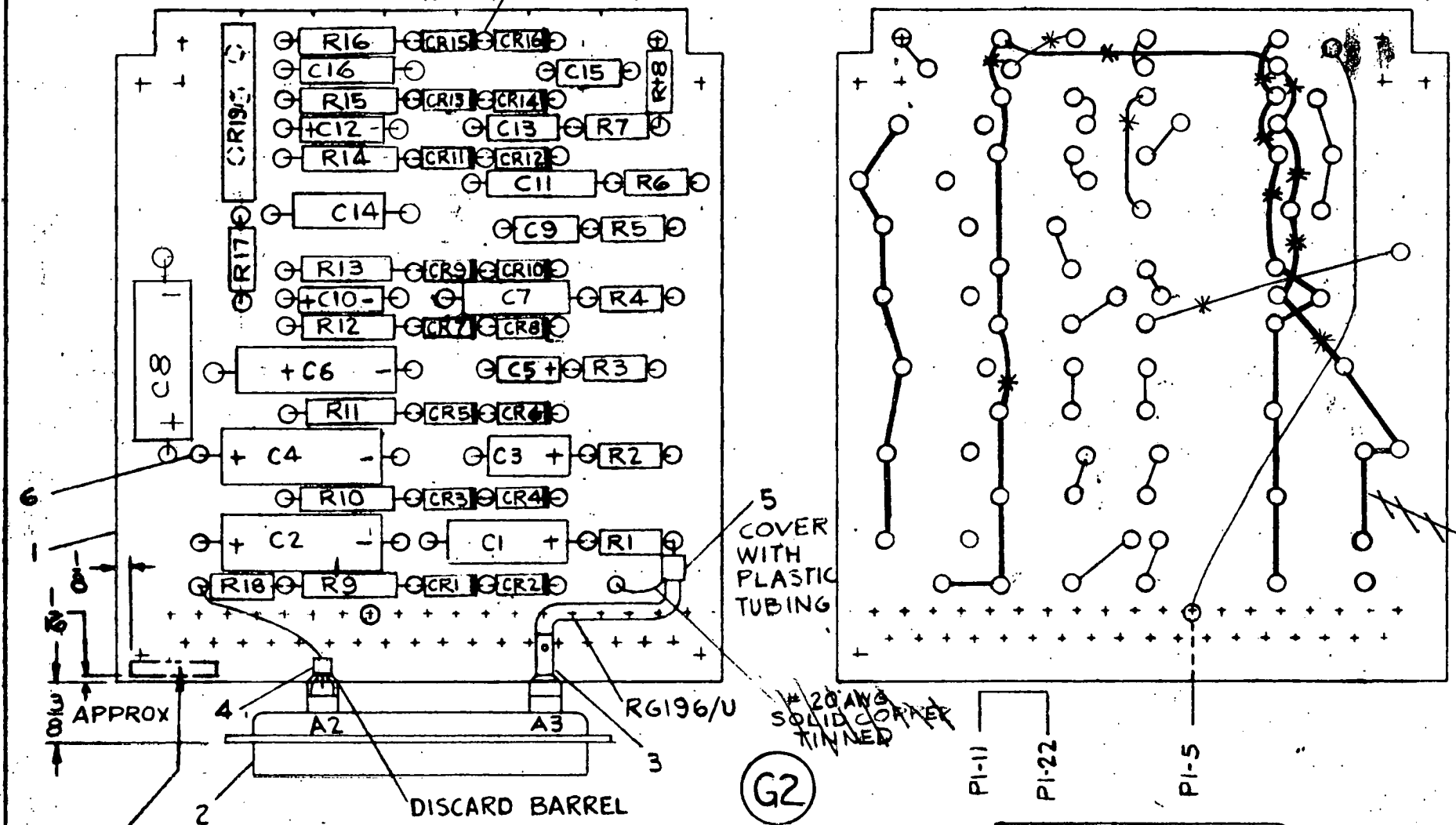
GENERAL ELECTRIC

104B2494
CONT ON SHEET 3 SH NO. 2

TITLE ASM
COMPONENT BOARD
FIRST MADE FOR LOGARITHMIC INTEGRATOR

PARTS LIST ISSUED FCF 194X370

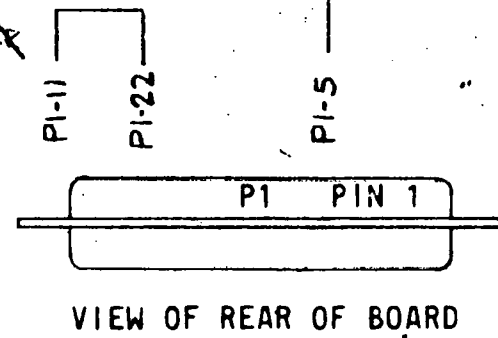
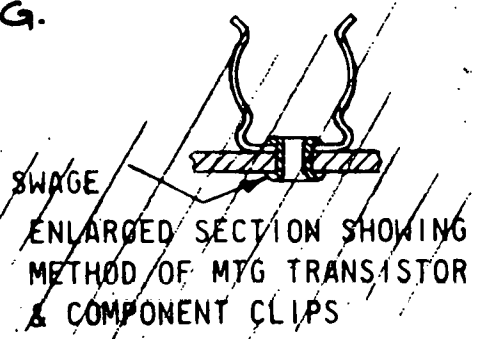
- NOTES
- THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:
1D, 2, 3, 4
 - ALL WIRING TO BE ROUTED AS SHOWN & TO BE OF MINIMUM LENGTH



HEAVY LINES
INDICATE WIRES
TO BE #20 AWG
SOLID COPPER
TINNED

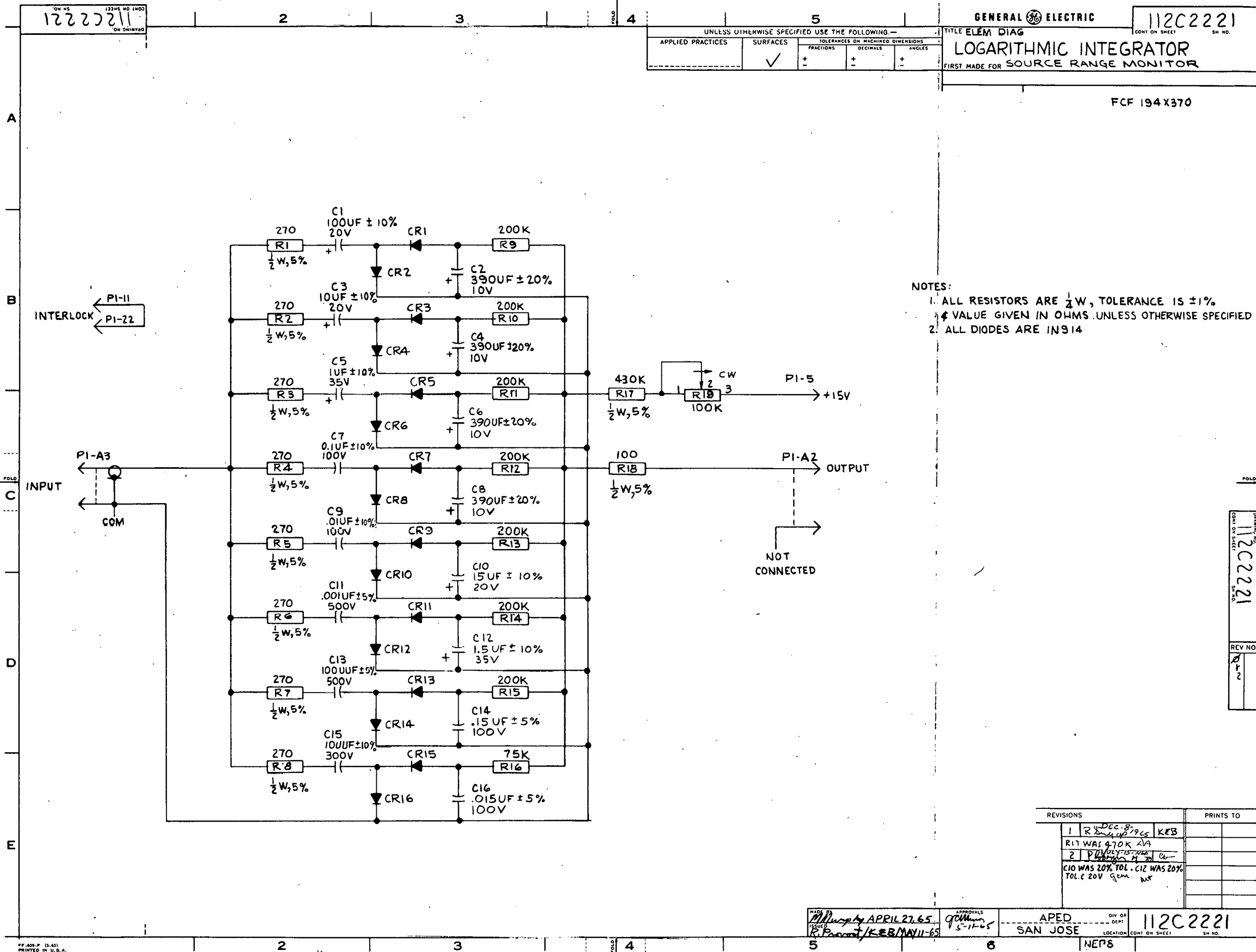
PT NO	REFERENCE DESIGNATION	PT NO	REFERENCE DESIGNATION
7	R1 THRU R8	27	R19
8	R17	28	CR1 THRU CR16
9	R18	29	C10
10	R9 THRU R15	30	C12
11	R16	31	C14
12	C1	32	C16
13	C2, C4, C6, C8	35	R17
14	C3		
15	C5		
17	C7		
19	C9		
21	C11		
23	C13		
25	C15		

MARK
SERIAL NO.
IN THIS AREA
NUMBER TO BE SUPPLIED
BY MFG.



REVISIONS				PRINTS TO	
4	PDV JULY-15-1966 R. P. ...	1	MM JULY-14-65 KES	A14	
NE14140			NE11642	6	
5	CT 10-1966 R. P. ...	2	PDV AUG-19-65 WAK		
CHG #20 WIRE TO #22			ADDED SHEET 3		
		3	R DEC-8-1965 KES		
			NE12779		

MADE BY K. E. Buller May 5, 1965
ISSUED R. P. ... KES MAY 11-65
APPROVALS G. M. ... 5-11-65
A PED SAN JOSE
DIV OR DEPT LOCATION
104B2494
CONT ON SHEET 3 SH NO. 2



REVISIONS			PRINTS TO	
1	R. B. M. W. 11-65	KEB		
2	R. B. M. W. 11-65	KEB		
3	R. B. M. W. 11-65	KEB		
4	R. B. M. W. 11-65	KEB		
5	R. B. M. W. 11-65	KEB		
6	R. B. M. W. 11-65	KEB		
7	R. B. M. W. 11-65	KEB		
8	R. B. M. W. 11-65	KEB		
9	R. B. M. W. 11-65	KEB		
10	R. B. M. W. 11-65	KEB		

V. Module Description (Continued)

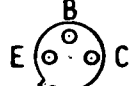
E. Intermediate Range Amplifier-Rectifier (Elementary Diagram 136B2447)

This unit consists of a band pass filter with a low cutoff frequency of 8Kc and an upper cutoff frequency of 16Kc, an amplifier (OA1) with an adjustable gain range of about 1 to 11, and a half wave rectifier consisting of OA2 and its associated feedback circuitry. Operation of the rectifier is as follows: transistors Q1 and Q2 are inside OA2's feedback loop. Therefore, the closed loop gain between the input (the point between C3 and R6) and the emitters of Q1 and Q2 is one, and it is linear for input voltages greater than about 5mv. Since Q1 and Q2 conduct alternately the current in each transistor's collector represents a half wave rectified version of the input signal. After being smoothed by C4 and R7, the current is buffered by Q3 and Q4 and applied to the input of the Intermediate Range Log Ladder. C4 and R7 determine the time constant for the Intermediate Range (100 milliseconds).



NEWS-PL-8 REV 3-58

136B2446
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:



TRANSISTOR BASING

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:			
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS	
		FRACTIONS	DECIMALS
	✓	+	+

REV. 0
136B2446
CONT. ON SHEET F SH. NO. 1

GENERAL ELECTRIC

136B2446
CONT. ON SHEET F SH. NO. 1

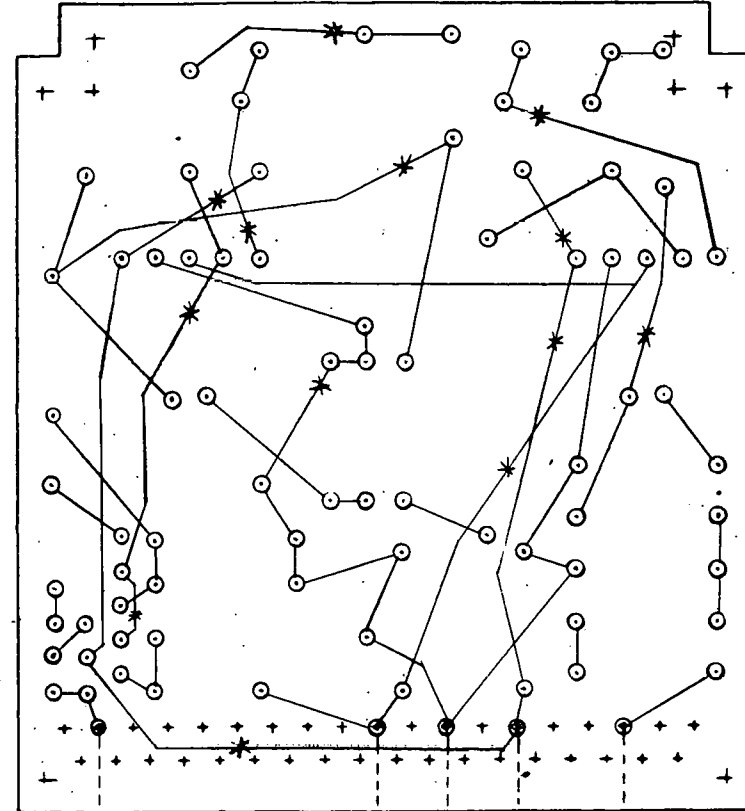
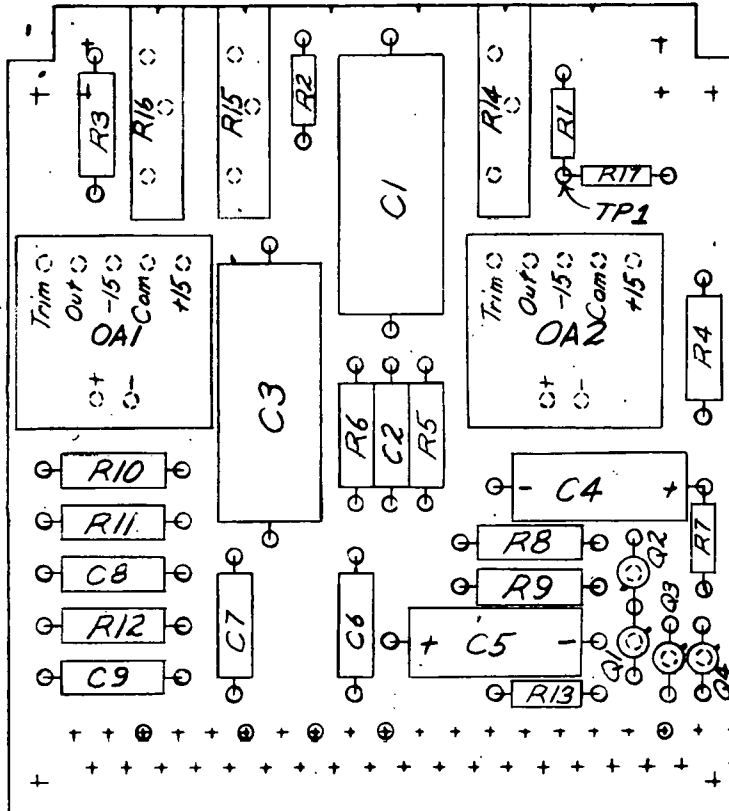
TITLE ASM
COMPONENT BOARD
FIRST MADE FOR INTERMEDIATE RANGE AMP-REC

PARTS LIST ISSUED

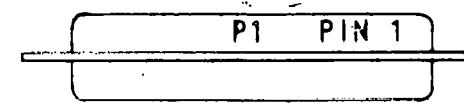
FCF

NOTES

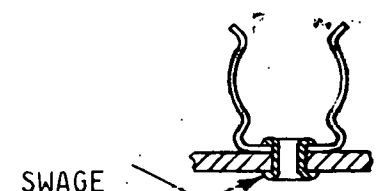
1. THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:



G1



VIEW OF REAR OF BOARD



SWAGE
ENLARGED SECTION SHOWING
METHOD OF MTG TRANSISTOR
& COMPONENT CLIPS

PT NO	REFERENCE DESIGNATION	PT NO	REFERENCE DESIGNATION
2	P1		
3	C1, C3		
4	C2		
5	C4, C5		
6	C6, C7		
7	C8		
8	C9		
9	OA1		
10	OA2		
11	Q1		
12	Q2, Q3, Q4		
13	R1, R2		
14	R3, R4, R6, R10-12		
15	R5		
16	R7, R13		
17	R8, R9		
18	R17		
19	R14, R15		
20	R16		

REVISIONS

PRINTS TO

58

DATE BY WGreen 8/26/69
ISSUED

APPROVALS
WQ

NID
SAN JOSE

DIV OR DEPT
LOCATION

136B2446
CONT. ON SHEET F SH. NO. 1

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

REV. NO. 0

TITLE *ELEM. DIAG.*

INTERMEDIATE RANGE AMP-REC.

FIRST MADE FOR: *PA 49*

FCF 136B2446

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

136 B2447

CONT. ON SHEET. *F* SH NO. *1*



PRINTS TO

58

MADE BY *WJGreen* *8/26/69*
ISSUED

APPROVALS
WKE

DIV OR
-----DEPT
LOCATION

136B2447

ON CONT ON SHEET *F* SH NO. /

V. Module Description (Continued)

F. Intermediate Range Log Ladder (Elementary Diagram 136B2468)

This unit is simply a piecewise linear circuit whose components have been chosen so that the output current is proportional to the log of the input current. Transistors are used rather than diodes so that the impedances of the biasing strings do not affect the characteristic of the log curve. Resistors R8 and R23 provide an offset current so that no output is obtained until the signal level of the Intermediate Range has reached its linear portion. The voltage between the anode of VR1 and the input (P1-16) is proportional to the log of the input current. Q8 converts this voltage to an output current proportional to the log of the input current, and its emitter-base diode helps temperature compensate for the emitter-base diodes of Q1 - Q6. Q7 acts as a clamp to limit the output current.

GENERAL ELECTRIC

TITLE ASM LOG LADDER			SPARES		NID SAN JOSE CALIF										PL 136B2467		SH NO 1	CONT ON SH 2	REV 0
FIRST MADE FOR PA 49			GROUP NO. AND QTY										FCF						
ITEM NO.	IDENTIFICATION NO.	NAME	/	2											U/M		REMARKS	REV	
1	136B2468	ELEM. DIAG.	X																
2	DCC-37P	Connector	1	1													PI		
3	1N914	Diode	1	1													CR-1		
4	2N3417	Transistor	7	7													Q1-7		
5	2N3799	"	1	1													Q8		
6	RN65C1302F	Resistor	1														R1 13.0KΩ 1%		
7	RN65C1052F	"	1														R2 10.5KΩ 1%		
8	RN65C4871F	"	1														R3 4.87KΩ 1%		
9	RN65C2261F	"	1														R4 2.26KΩ 1%		
10	RN65C1051F	"	1														R5 1.05KΩ 1%		
11	RN65C4870F	"	1														R6 487Ω 1%		
12	RN65C2002F	"	1	1													R7 20KΩ 1%		
13	RN65C1783F	"	1														R8 178KΩ 1%		
14	RN65C8061F	"	6	6													R9-14 8.06KΩ 1%		
15	RN65C6811F	"	1	1													R15 6.81KΩ 1%		
16	RN65C1001F	"	7														R16-22 1.00KΩ 1%		
17	55P-100K	Potentiometer	1	1													R23 100KΩ Beckman		
18	55P-2K	"	7	7													R24-30 2KΩ Beckman		
19	RN65C7501F	Resistor		1													R1 7.50KΩ 1%		
20	RN65C6191F	"		1													R2 6.19KΩ 1%		
21	RN65C2871F	"		1													R3 2.87KΩ 1%		
22	RN65C1331F	"		1													R4 1.33KΩ 1%		
			G1 INTERMEDIATE LOG LADDER G2 HIGH LOG LADDER										PRINTS TO		USE PL REVISION NO. ON LINE OF ITEM BEING REVISED.				
													58		MADE BY WGreen 8/26/69		APPROVALS WGE		
															ISSUED				
															PL 136B2467		SH NO 1		CONT ON SH 2
REVISIONS			DESCRIPTION OF GROUPS																

[illegible]

136B2467
DRAWING NO.
CONT ON SHEET F



TRANSISTOR BASING

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV NO. 0
136B2467
CONT ON SHEET F SH NO. 1

GENERAL ELECTRIC

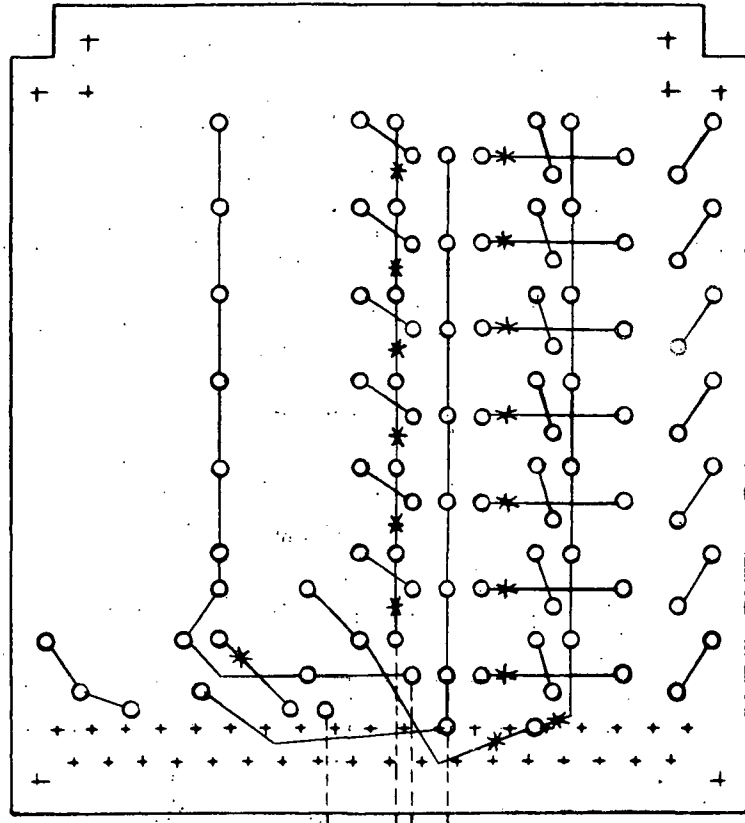
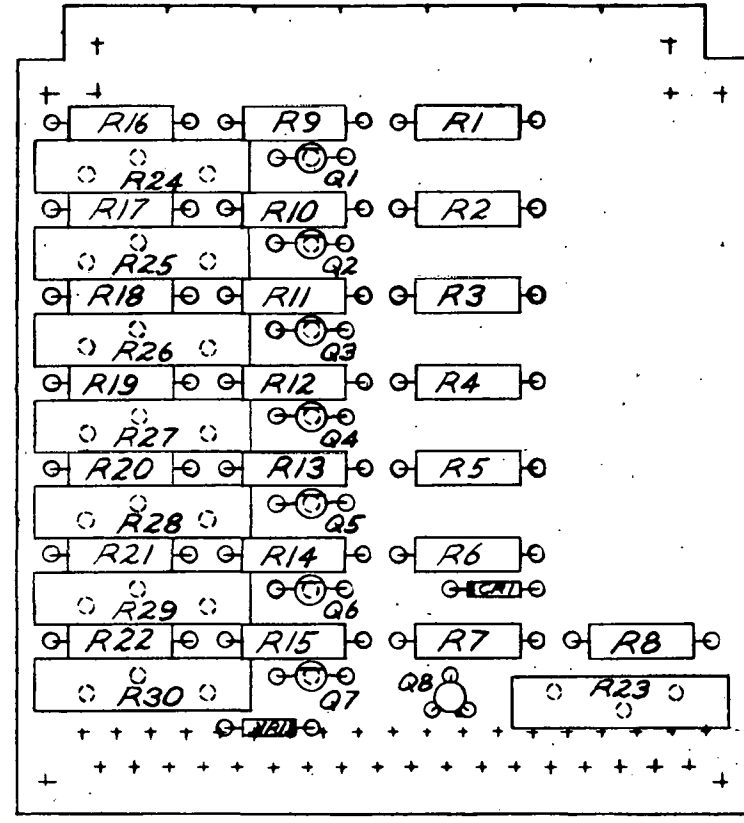
136B2467
CONT ON SHEET F SH NO. 1

TITLE ASM
COMPONENT BOARD
FIRST MADE FOR LOG LADDER

PARTS LIST ISSUED FCF

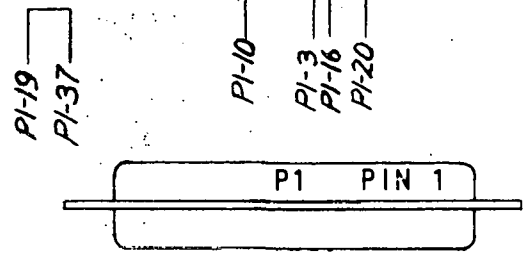
NOTES

1. THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:



G1

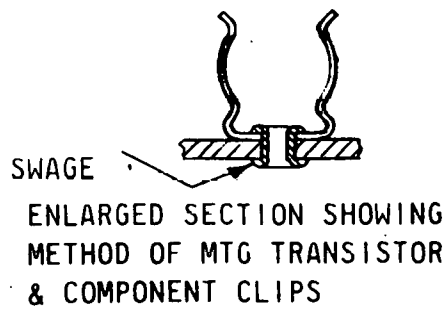
G2



VIEW OF REAR OF BOARD

PT NO	REFERENCE DESIGNATION
2	P1
3	CR1
4	Q1-Q7
5	Q8
6	R1
7	R2
8	R3
9	R4
10	R5
11	R6
12	R7
13	R8
14	R9-R14
15	R15
16	R16-R22
17	R23
18	R24-R30
19	R1
20	R2
21	R3

PT NO	REFERENCE DESIGNATION
22	R4
23	R5
24	R6
25	R8
26	R16-R22
27	VR1



SWAGE
ENLARGED SECTION SHOWING
METHOD OF MTG TRANSISTOR
& COMPONENT CLIPS

REVISIONS

PRINTS TO

58

MADE BY WGreen 8/26/69
ISSUED

APPROVALS
WKE

NID
SAN JOSE

DIV OR DEPT
LOCATION

136B2467
CONT ON SHEET F SH NO. 1

V. Module Description (Continued)

G. High Range Amplifier-Rectifier (Elementary Diagram 136B2469)

This unit consists of a band pass filter with a low cutoff frequency of 300Kc and an upper cutoff frequency of 600Kc, an amplifier (OA1) with an adjustable gain range of about 5 to 15, and a half wave rectifier circuit. Operation of the rectifier is as follows: Transistors Q3 and Q4 are connected as a doublet amplifier with push-pull emitter followers Q5 and Q6 inside the feedback loop. Since Q5 and Q6 are inside the feedback loop, most of the signal current through R3 is supplied by their emitters, Q6 supplying the current during positive half cycles and Q5 supplying the current during negative half cycles. The collector current of Q6 therefore represents one half wave rectified portion of the input signal. Q6's collector current is then smoothed by C6 and R10 and applied to the input of the High Range Log Ladder. C6 and R10 determine the time constant of the High Range (ten milliseconds).



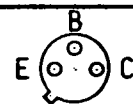
TITLE <i>ASM</i>			NID SAN JOSE CALIF										PL <i>136B2444</i>		SH NO. <i>1</i>	CONT ON SH <i>2</i>	REV <i>0</i>
FIRST MADE FOR <i>PA 49</i>			GROUP NO. AND QTY										FCF				
ITEM NO.	IDENTIFICATION NO.	NAME											U/M	REMARKS	REV		
<i>1</i>	<i>136B2445</i>	<i>Elem. Diag.</i>															
<i>2</i>	<i>DCM-25W3P</i>	<i>Connector</i>	<i>1</i>											<i>PI</i>			
<i>3</i>	<i>D2E1-474E</i>	<i>Capacitor</i>	<i>1</i>											<i>C1 0.47μf 100V. Marshall</i>			
<i>4</i>	<i>CM15ED300JN3</i>	<i>"</i>	<i>1</i>											<i>C2 30pf 500WV ±5%</i>			
<i>5</i>	<i>CS13BF106K</i>	<i>"</i>	<i>8</i>											<i>C3-8, C11,12 10μf ±10% 35WV</i>			
<i>6</i>	<i>CM15ED361JN3</i>	<i>"</i>	<i>1</i>											<i>C9 360pf ±5% 500WV</i>			
<i>7</i>	<i>CM15ED151JN3</i>	<i>"</i>	<i>1</i>											<i>C10 150pf ±5% 500WV</i>			
<i>8</i>	<i>147</i>	<i>Op. Amp.</i>	<i>1</i>											<i>OA1 Zeltex</i>			
<i>9</i>	<i>2N2219</i>	<i>Transistor</i>	<i>2</i>											<i>Q1,6</i>			
<i>10</i>	<i>2N2484</i>	<i>"</i>	<i>2</i>											<i>Q2,3</i>			
<i>11</i>	<i>2N2905</i>	<i>"</i>	<i>1</i>											<i>Q4</i>			
<i>12</i>	<i>2N3799</i>	<i>"</i>	<i>1</i>											<i>Q5</i>			
<i>13</i>	<i>RC20GF102J</i>	<i>Resistor</i>	<i>4</i>											<i>R1,7,9,10 1KΩ 5%</i>			
<i>14</i>	<i>RC20GF123J</i>	<i>"</i>	<i>1</i>											<i>R2 12KΩ 5%</i>			
<i>15</i>	<i>RN65C1000F</i>	<i>"</i>	<i>1</i>											<i>R3 100Ω 1%</i>			
<i>16</i>	<i>RC20GF153J</i>	<i>"</i>	<i>1</i>											<i>R4 15KΩ 5%</i>			
<i>17</i>	<i>RC20GF203J</i>	<i>"</i>	<i>3</i>											<i>R5,11,12 20KΩ 5%</i>			
<i>18</i>	<i>RC20GF362J</i>	<i>"</i>	<i>1</i>											<i>R6 3.6KΩ 5%</i>			
<i>19</i>	<i>RC20GF271J</i>	<i>"</i>	<i>1</i>											<i>R8 270Ω 5%</i>			
<i>20</i>	<i>RN65C5111F</i>	<i>"</i>	<i>1</i>											<i>R13 5.11KΩ 1%</i>			
<i>21</i>	<i>RN65C1001F</i>	<i>"</i>	<i>1</i>											<i>R14 1KΩ 1%</i>			
<i>22</i>	<i>RN65C3011F</i>	<i>"</i>	<i>1</i>											<i>R15 3.01KΩ 1%</i>			

PRINTS TO <i>58</i>		USE PL REVISION NO. ON LINE OF ITEM BEING REVISED	
MADE BY <i>WGreen 8/26/69</i>		APPROVALS <i>WGreen</i>	
ISSUED			
PL <i>136B2444</i>		SH NO. <i>1</i>	CONT ON SH <i>2</i>

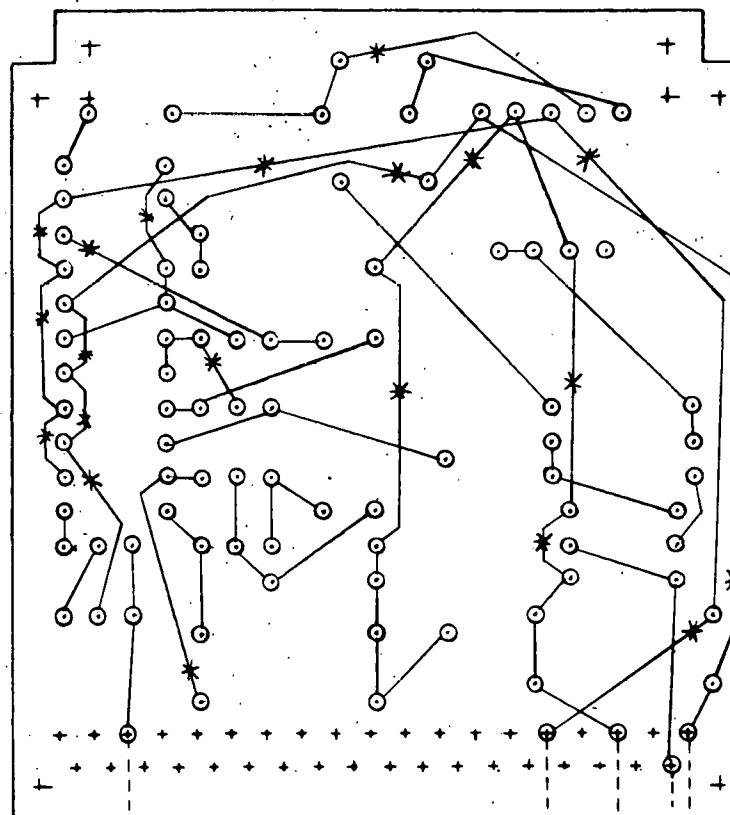
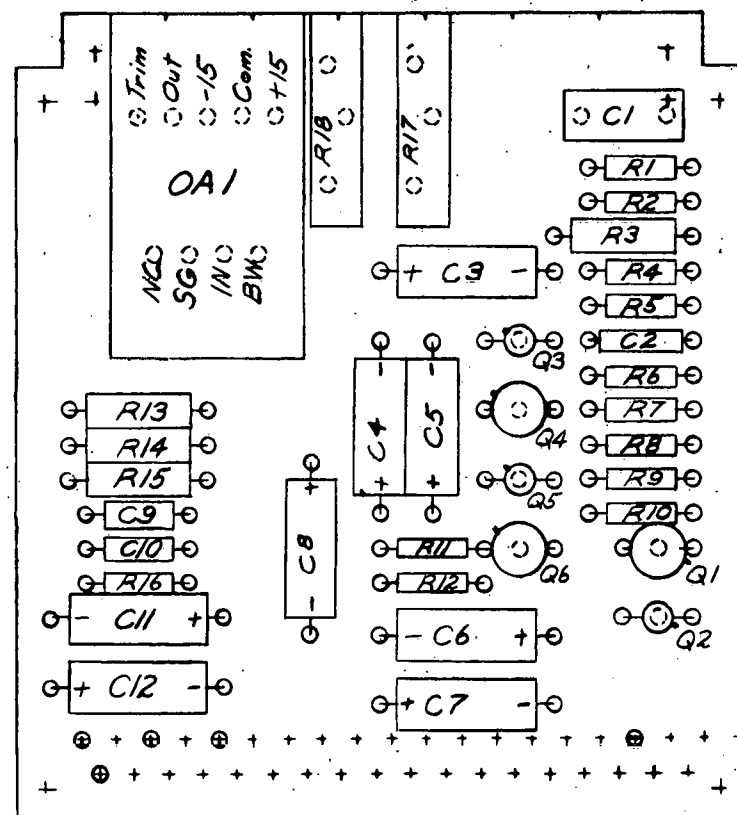
REVISIONS	DESCRIPTION OF GROUPS
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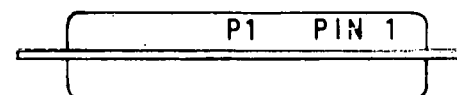
136B2444
CONT ON SHEET F
SH NO. 1



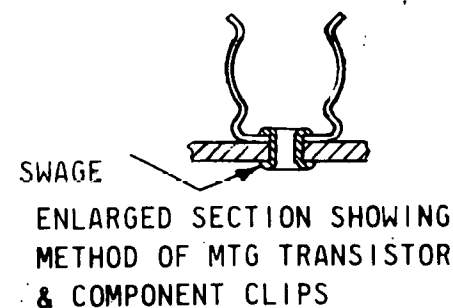
TRANSISTOR BASING



G1



VIEW OF REAR OF BOARD



SWAGE

ENLARGED SECTION SHOWING
METHOD OF MTG TRANSISTOR
& COMPONENT CLIPS

GENERAL ELECTRIC

136B2444

CONT ON SHEET F SH NO. 1

REV. 0

136B2444

CONT ON SHEET F SH NO. 1

TITLE ASM

COMPONENT BOARD

FIRST MADE FOR HIGH RANGE AMPLIFIER-RECTIFIER

PARTS LIST ISSUED

FCF

NOTES

1. THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:

PT NO	REFERENCE DESIGNATION	PT NO	REFERENCE DESIGNATION
2	P1	22	R15
3	C1	23	R16
4	C2	24	R17
5	C3-C8	25	R18
6	C9		
7	C10		
8	OA1		
9	Q1, Q6		
10	Q2, Q3		
11	Q4		
12	Q5		
13	R1, R7, R9, R10		
14	R2		
15	R3		
16	R4		
17	R5, R11, R12		
18	R6		
19	R8		
20	R13		
21	R14		

REVISIONS

PRINTS TO

58

MADE BY WGreen 8/26/69

ISSUED

APPROVALS

WJ

NID:
SAN JOSE

DIV OR
DEPT
LOCATION

136B2444

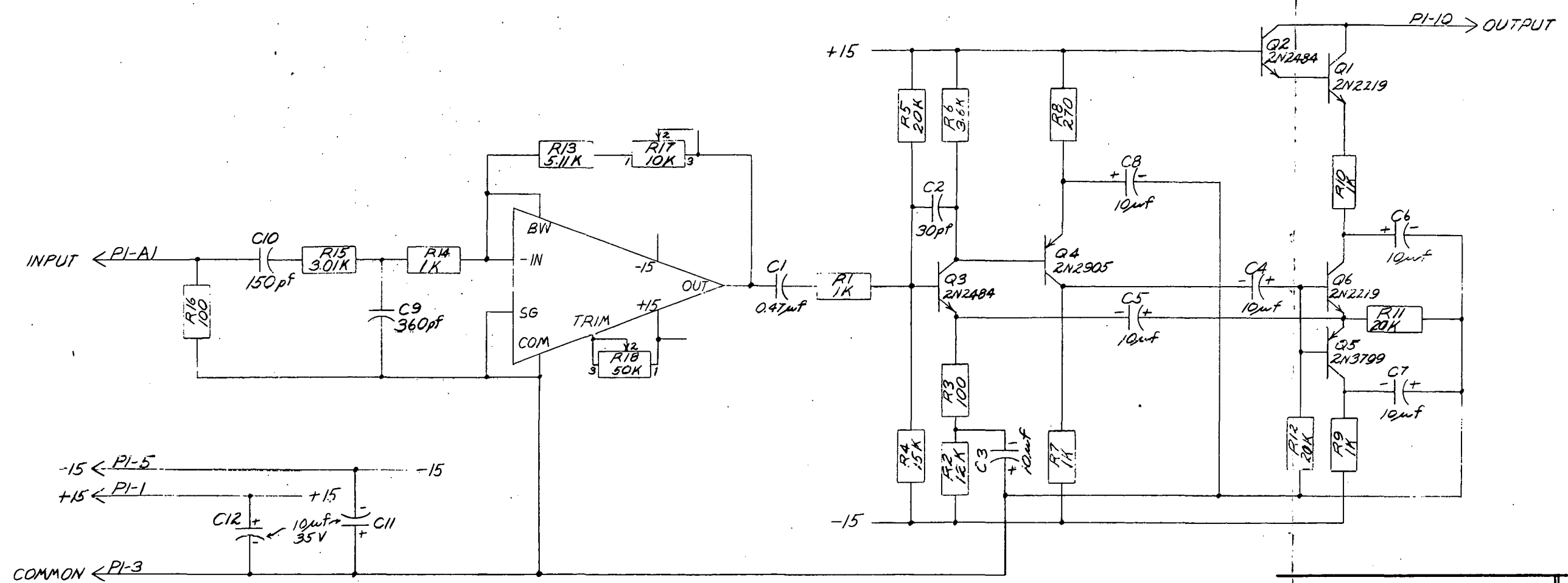
CONT ON SHEET F SH NO. 1

136B2445
CONT ON SHEET F
DRAWING NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV NO.
136B2445
CONT ON SHEET F SH NO. 1

GENERAL ELECTRIC
136B2445
CONT ON SHEET F SH NO. 1
TITLE ELEM. DIAG.
HIGH RANGE AMPLIFIER-RECTIFIER
FIRST MADE FOR PA. 49
FCF 136B2444



REVISIONS	PRINTS TO
	58

MADE BY WGreen 8/26/69
ISSUED
APPROVALS WK
DIV OR DEPT
LOCATION
136B2445
CONT ON SHEET F SH NO. 1

V. Module Description (Continued)

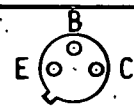
H. High Range Log Ladder (Elementary Diagram 136B2469)

This unit is simply a piecewise linear circuit whose components have been chosen so that the output current is proportional to the log of the input current. Transistors are used rather than diodes so that the impedance of the biasing strings do not affect the characteristic of the log curve. Resistors R8 and R23 provide an offset current so that no output is obtained until the signal level of the High Range has reached its linear portion. The voltage between the anode of VR1 and the input (P1 - 16) is proportional to the log of the input current. Q8 converts this voltage to an output current proportional to the log of the input current, and its emitter-base diode helps temperature compensate for the emitter-base diodes of Q1 - Q6. Q7 acts as a clamp to limit the output current.

GENERAL ELECTRIC

TITLE ASM LOG LADDER			SPARES		NID SAN JOSE CALIF										PL 136B2467		SH NO. 1	CONT ON SH 2	REV 0
FIRST MADE FOR PA 49					GROUP NO. AND QTY										U/M		FCF		
ITEM NO.	IDENTIFICATION NO.	NAME	/	2												REMARKS		REV	
1	136B2468	ELEM. DIAG.	X																
2	DCC-37P	Connector	1	1													PI		
3	1N914	Diode	1	1													CR-1		
4	2N3417	Transistor	7	7													Q1-7		
5	2N3799	"	1	1													Q8		
6	RN65C1302F	Resistor	1														R1 13.0KΩ 1%		
7	RN65C1052F	"	1														R2 10.5KΩ 1%		
8	RN65C4871F	"	1														R3 4.87KΩ 1%		
9	RN65C2261F	"	1														R4 2.26KΩ 1%		
10	RN65C1051F	"	1														R5 1.05KΩ 1%		
11	RN65C4870F	"	1														R6 487Ω 1%		
12	RN65C2002F	"	1	1													R7 20KΩ 1%		
13	RN65C1783F	"	1														R8 178KΩ 1%		
14	RN65C8061F	"	6	6													R9-14 8.06KΩ 1%		
15	RN65C6811F	"	1	1													R15 6.81KΩ 1%		
16	RN65C1001F	"	7														R16-22 1.00KΩ 1%		
17	55P-100K	Potentiometer	1	1													R23 100KΩ Beckman		
18	55P-2K	"	7	7													R24-30 2KΩ Beckman		
19	RN65C7501F	Resistor		1													R1 7.50KΩ 1%		
20	RN65C6191F	"		1													R2 6.19KΩ 1%		
21	RN65C2871F	"		1													R3 2.87KΩ 1%		
22	RN65C1331F	"		1													R4 1.33KΩ 1%		
			G1 INTERMEDIATE LOG LADDER G2 HIGH LOG LADDER										PRINTS TO 58		USE PL REVISION NO. ON LINE OF ITEM BEING REVISED.				
													MADE BY WGreen 8/26/69		APPROVALS WJ				
													ISSUED		PL 136B2467		SH NO. 1	CONT ON SH 2	
REVISIONS			DESCRIPTION OF GROUPS																

136B2467
CONT ON SHEET F
DRAWING NO.



TRANSISTOR BASING

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:			
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS	
	✓	FRACTIONS	DECIMALS
		+	+
		-	-

REV. 0
136B2467
CONT ON SHEET F
SH NO. 1

GENERAL ELECTRIC

136B2467

TITLE ASM

COMPONENT BOARD

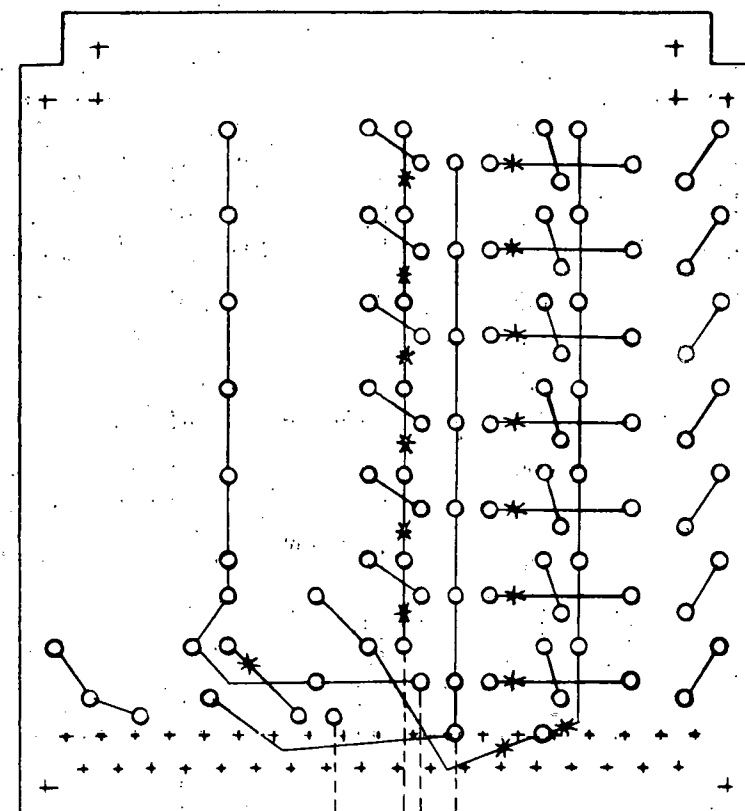
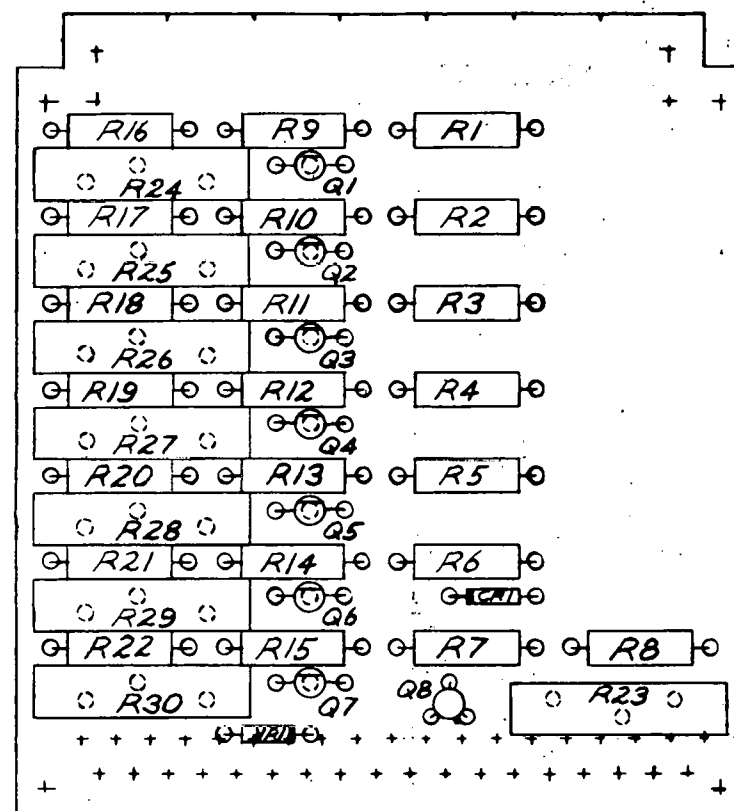
FIRST MADE FOR LOG LADDER

PARTS LIST ISSUED

FCF

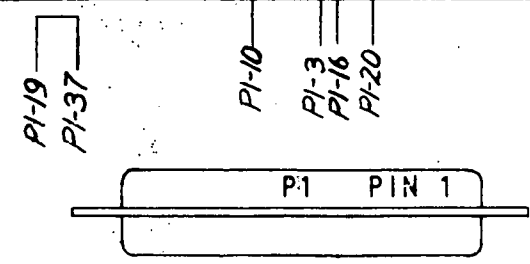
NOTES

1. THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:



G1

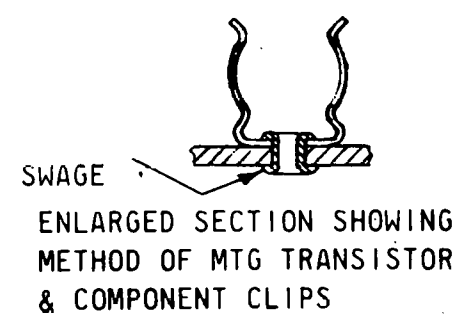
G2



VIEW OF REAR OF BOARD

PT NO	REFERENCE DESIGNATION
2	P1
3	CR1
4	Q1-Q7
5	Q8
6	R1
7	R2
8	R3
9	R4
10	R5
11	R6
12	R7
13	R8
14	R9-R14
15	R15
16	R16-R22
17	R23
18	R24-R30
19	R1
20	R2
21	R3

PT NO	REFERENCE DESIGNATION
22	R4
23	R5
24	R6
25	R8
26	R16-R22
27	VR1



SWAGE

ENLARGED SECTION SHOWING
METHOD OF MTG TRANSISTOR
& COMPONENT CLIPS

REVISIONS

PRINTS TO

58

MADE BY WKGreen 8/26/69
ISSUED

APPROVED WK

NID
SAN JOSE

DIV OR DEPT
LOCATION

136B2467
CONT ON SHEET F
SH NO. 1

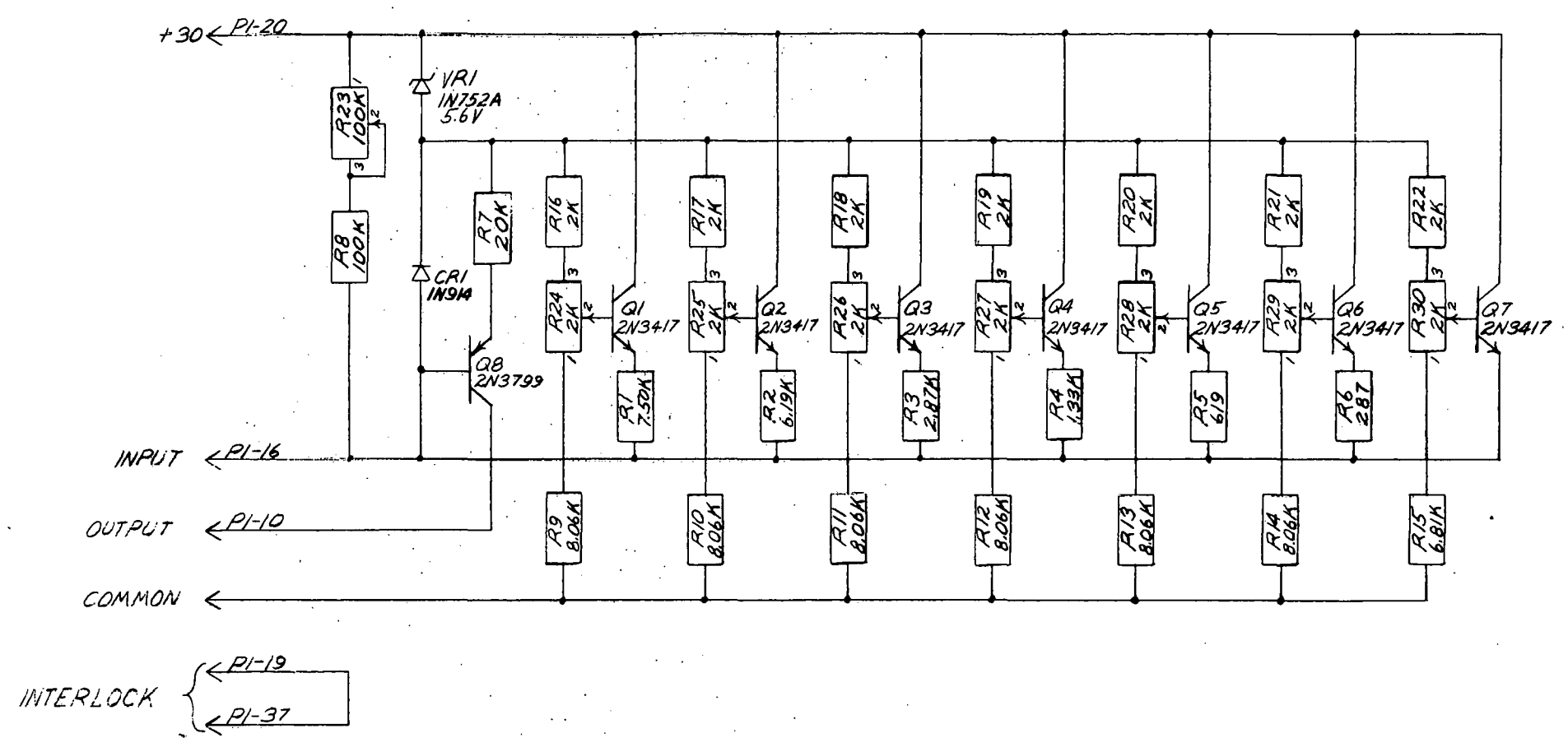
CONT ON SHEET F
136B2469
DRAWING NO.

GENERAL ELECTRIC

136B2469
CONT ON SHEET F SH NO. 1

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—					REV. NO. 0
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS			136B2469 CONT ON SHEET F SH NO. 1
		FRACTIONS	DECIMALS	ANGLES	
	✓	+	+	+	

TITLE ELEM. DIAG.
HIGH LOG LADDER
FIRST MADE FOR PA 49
FCF 136B2467



REVISIONS		PRINTS TO	
		58	

MAILED 11	WG 11/11	9/26/69	APPROVAL	WG 11/11	DIV OR DEPT	136B2469	CONT ON SHEET F SH NO. 1
ISSUED					LOCATION		

V. Module Description (Continued)

I. Auction (Elementary Diagram 136B2443)

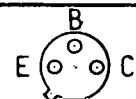
The function of this unit is to monitor up to three positive valued signals and apply the largest of these to the output. Three operational amplifiers and their associated feedback circuitry are used to accomplish this function. Since all three stages are virtually identical, only the components around OA1 will be described.

The feedback loop of OA1 consists of two parallel branches, one containing a resistance ($R2 + R16$) in series with a diode (CR1) and the other a diode (CR4) in series with a zener diode (VR1). The signal at the anode of CR1 is linear with respect to the input signal, and it is from this point that the signal is taken to drive the final readout device. The function of CR1 is to isolate this output signal from the output of the operational amplifier (OA1). The function of CR4 and VR1 is to limit the positive output saturation level to the value of the zener plus one diode drop (about 6.4 volts).

The output signal at the anode of CR1 is normally a negative value. If a externally generated signal of a more negative value than that caused by the input signal is applied to this point, the feedback current becomes greater than the input current causing the output of OA1 to change to a positive value. In this unit the external signal source takes the form of another operational amplifier stage. If K1, K2 and K3 are energized, the anodes of all three isolation diodes are connected together and the output signal is that of the most negative range. The operational amplifier outputs of the other two ranges will be about 6.4 volts positive.

[illegible]

136B2442
CONT ON SHEET F
133 SHEETS
ON DIMENSIONS
ON HS



TRANSISTOR BASING

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV NO. 0
136B2442
CONT ON SHEET F SH NO. 1

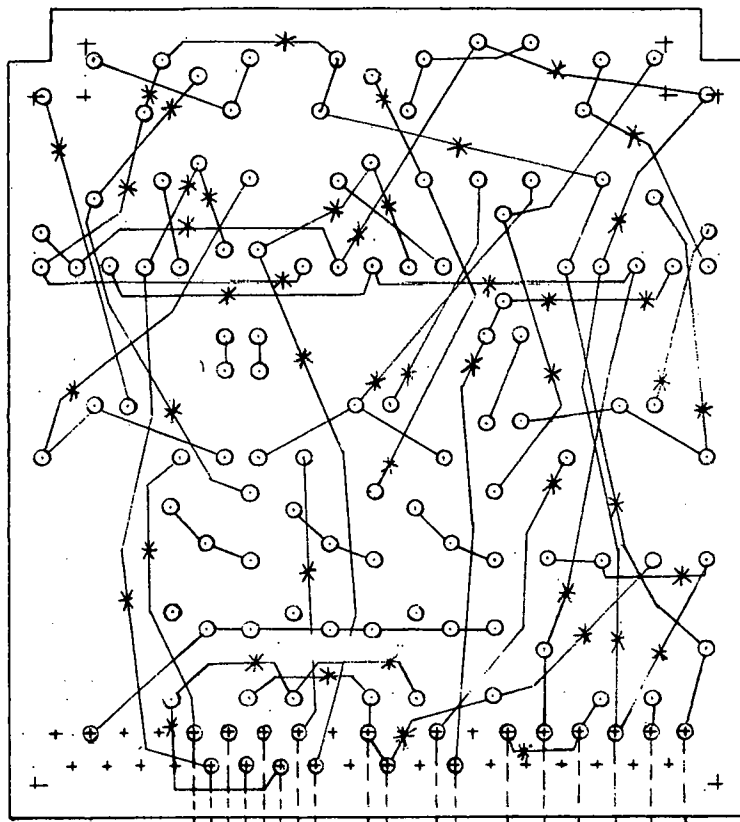
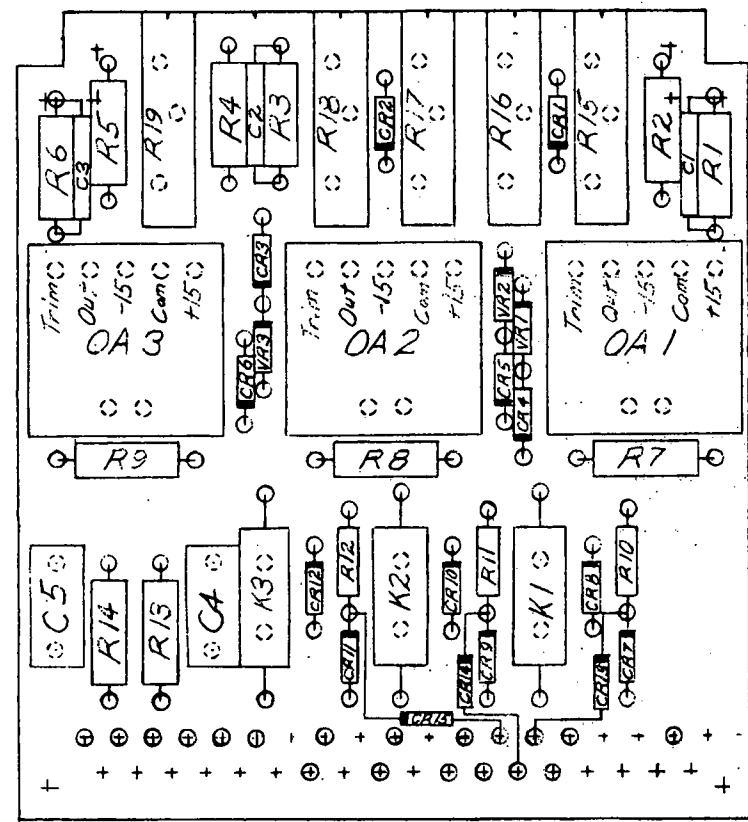
GENERAL ELECTRIC

136B2442
CONT ON SHEET F SH NO. 1

TITLE ASM
COMPONENT BOARD
FIRST MADE FOR AUCTION

PARTS LIST ISSUED FCF

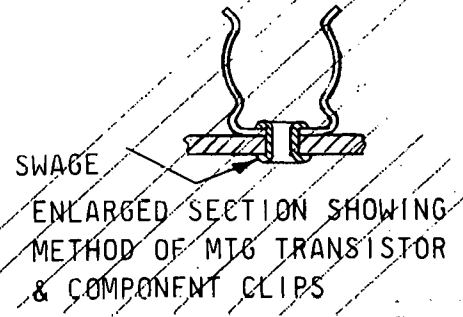
NOTES
1. THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:



G1

P1 PIN 1
VIEW OF REAR OF BOARD

PT NO	REFERENCE DESIGNATION	PT NO	REFERENCE DESIGNATION
3	C1, C2, C3		
4	R1, R3, R7, R8		
5	R2, R4		
6	R5, R9		
7	R6		
8	R10, R11, R12		
9	R13		
10	R14		
11	R15, R17, R19		
12	R16, R18		
13	CR1 - CR12		
14	VR1, VR2, VR3		
15	K1, K2, K3		
16	OA1, OA2, OA3		
17	C4, C5		



SWAGE
ENLARGED SECTION SHOWING
METHOD OF MOUNTING TRANSISTOR
& COMPONENT CLIPS

REVISIONS		PRINTS TO	
		58	

MADE BY WJ3 rec'd 8/26/69
ISSUED
APPROVALS WJ3
A P E D
SAN JOSE
DIV OR DEPT
LOCATION
136B2442
CONT ON SHEET F SH NO. 1

NEPS

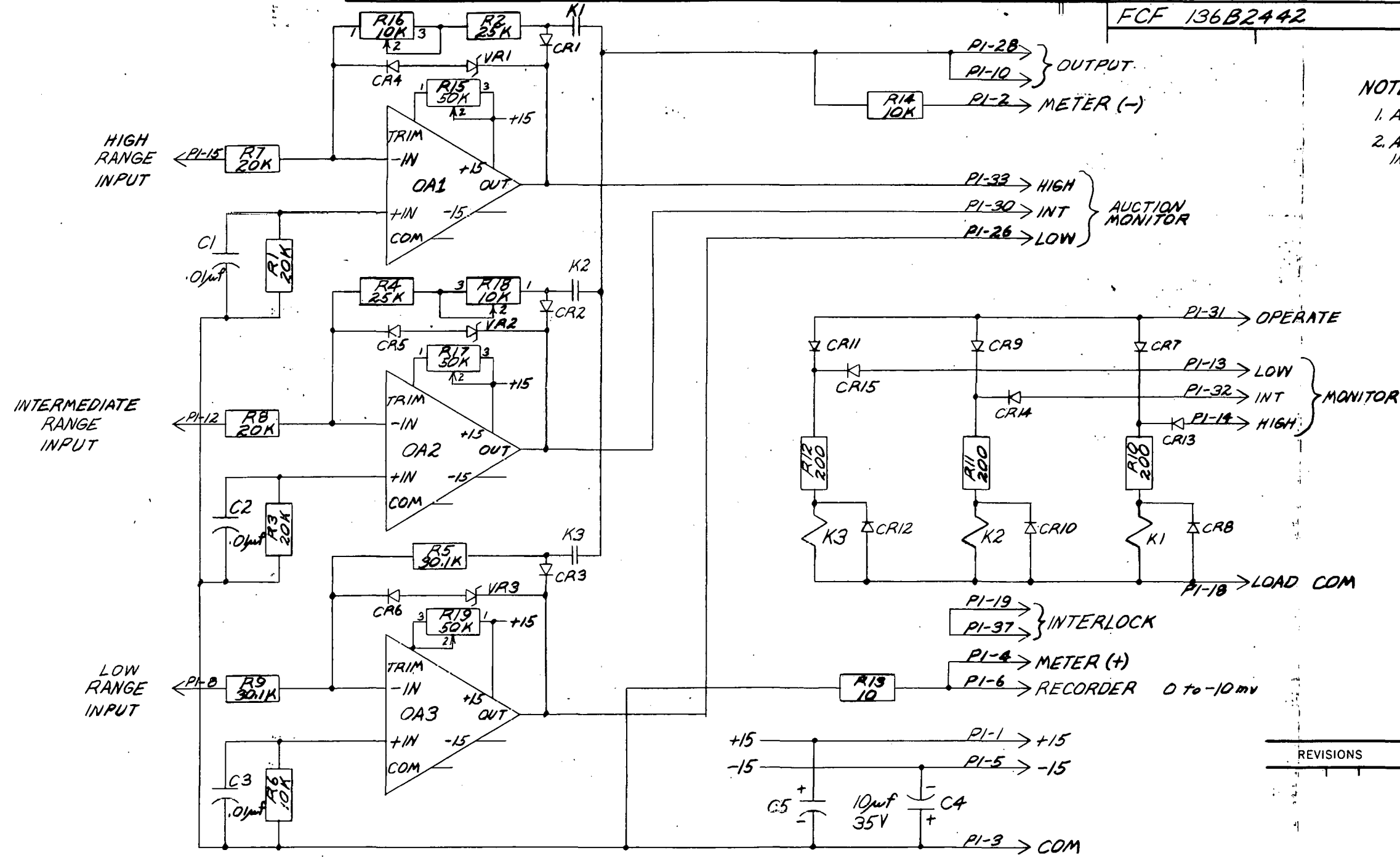
136B2443
CONT ON SHEET F
DRAWING NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
	✓	FRACTIONS	DECIMALS	ANGLES
		+	+	+

REV. NO. 0
136B2443
CONT ON SHEET F SH. NO. 1

GENERAL ELECTRIC
136B2443
CONT ON SHEET F SH. NO. 1
TITLE ELEM. DIAG.
AUCTION
FIRST MADE FOR PA.49
FCF 136B2442

NOTES:
1. ALL DIODES ARE TYPE 1N914
2. ALL ZENERS ARE TYPE 1N752A, 5.6V, 400 mw.



REVISIONS		PRINTS TO	
		58	

MADE BY WKJran 8/26/69
ISSUED
APPROVALS WKJ
DIV. OR DEPT.
LOCATION
136B2443
CONT ON SHEET F SH. NO. 1

V. Module Description (Continued)

J. Multirange Monitor (Elementary Diagram 136B2441)

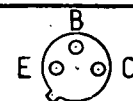
The function of this module is to provide continuous readouts of all three ranges before the signals have been auctioned. OA1 and OA2 are non-inverting amplifier stages which monitor the voltage across the input resistors of OA1 and OA2 of the Auction unit. OA3 is connected as an inverting amplifier, the reason being that the output current from the Log-Integrator is of opposite polarity to that from the Intermediate and High Log Ladders and all signal inputs to the Auction unit must be of the same polarity. Therefore the output of OA3 both drives the Low Range meter and acts as the Low Range's input to the Auction circuit. Relays K1, K2 and K3 short the input signals to ground so that the amplifiers may be zeroed. Note, however, that K3 shorts the feedback to ground, so that the zero condition of OA3 is indicated by an unstable output. If OA3 is off zero its output will saturate either positive or negative when K3 is energized.

The resistors R5, R7 and R14 provide an additional offset adjustment in case the offset range of the Log Integrator is insufficient. However, in all our tests it has not been necessary to use this extra offset. Therefore, R14 is adjusted so that pins 1 and 2 are shorted.



NEBS-PL-8 REV 3-68

136B2440
CONT ON SHEET F
SH NO. 1



TRANSISTOR BASING

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+
		-	-	-

REV NO C

136B2440

CONT ON SHEET *F* SH NO

TITLE	ASM
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COMPONENT BOARD

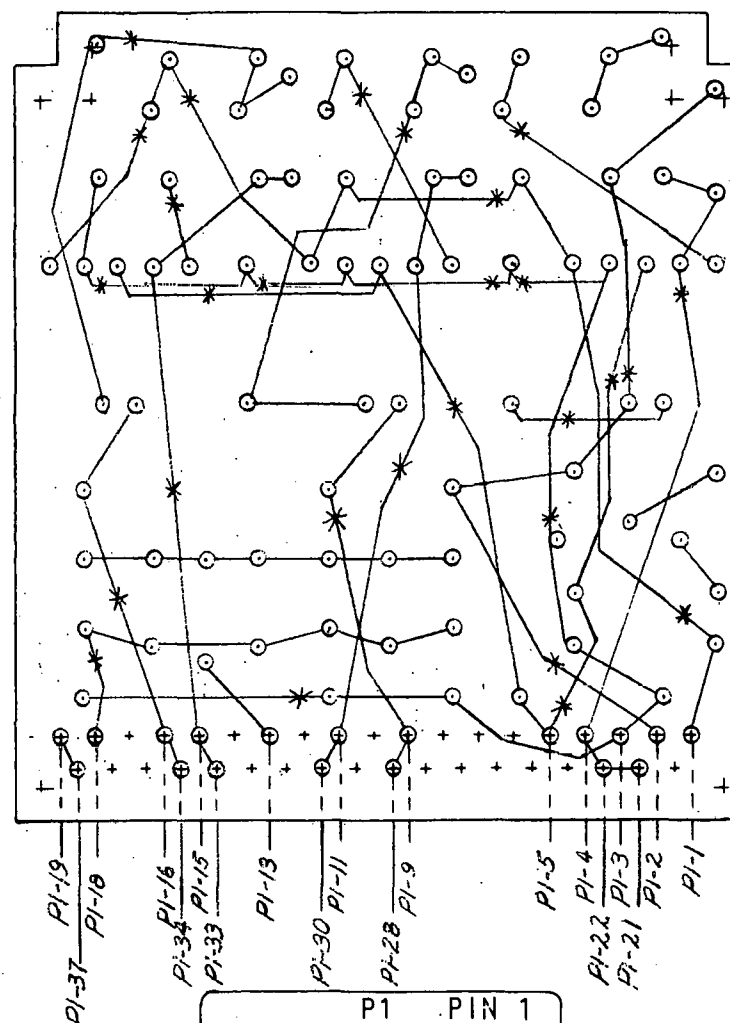
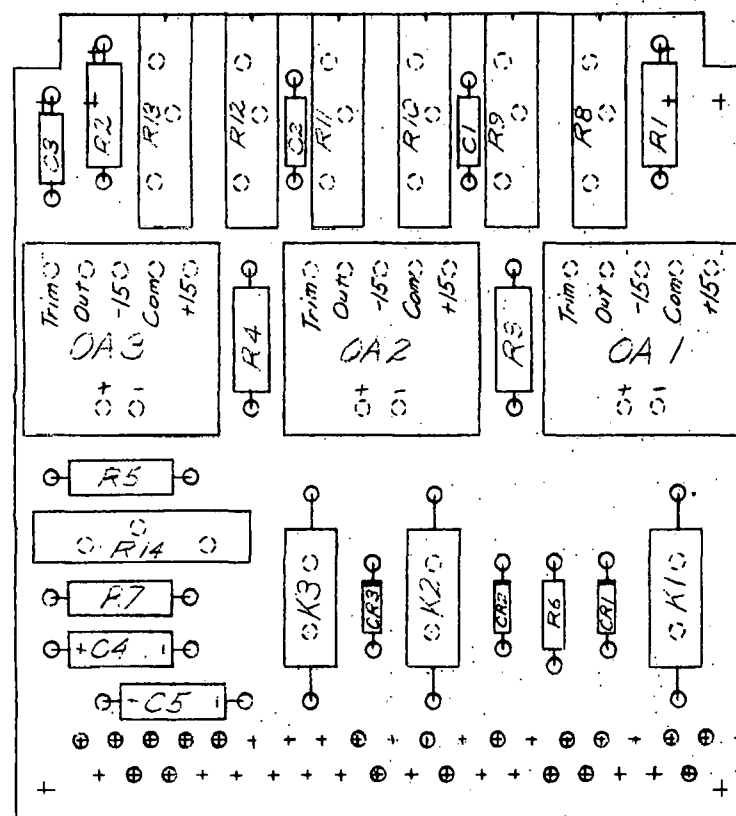
FIRST MADE FOR *MULTIRANGE MONITOR*

PARTS LIST ISSUED

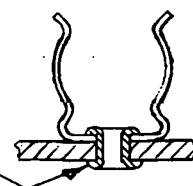
FCF

NOTES

1. THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:



VIEW OF REAR OF BOARD



SWAGE

ENLARGED SECTION SHOWING
METHOD OF MTG TRANSISTOR
& COMPONENT CLIPS

[illegible]

REVISIONS

PRINTS TO

58

MADE BY *WGreen 8/26/69*
ISSUED

APPROVALS
WKE

A P E D
SAN JOSE

DIV OR
-----DEPT
LOCATION

136B2440

NEPS

136B2441
CONT ON SHEET F
DRAWING NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

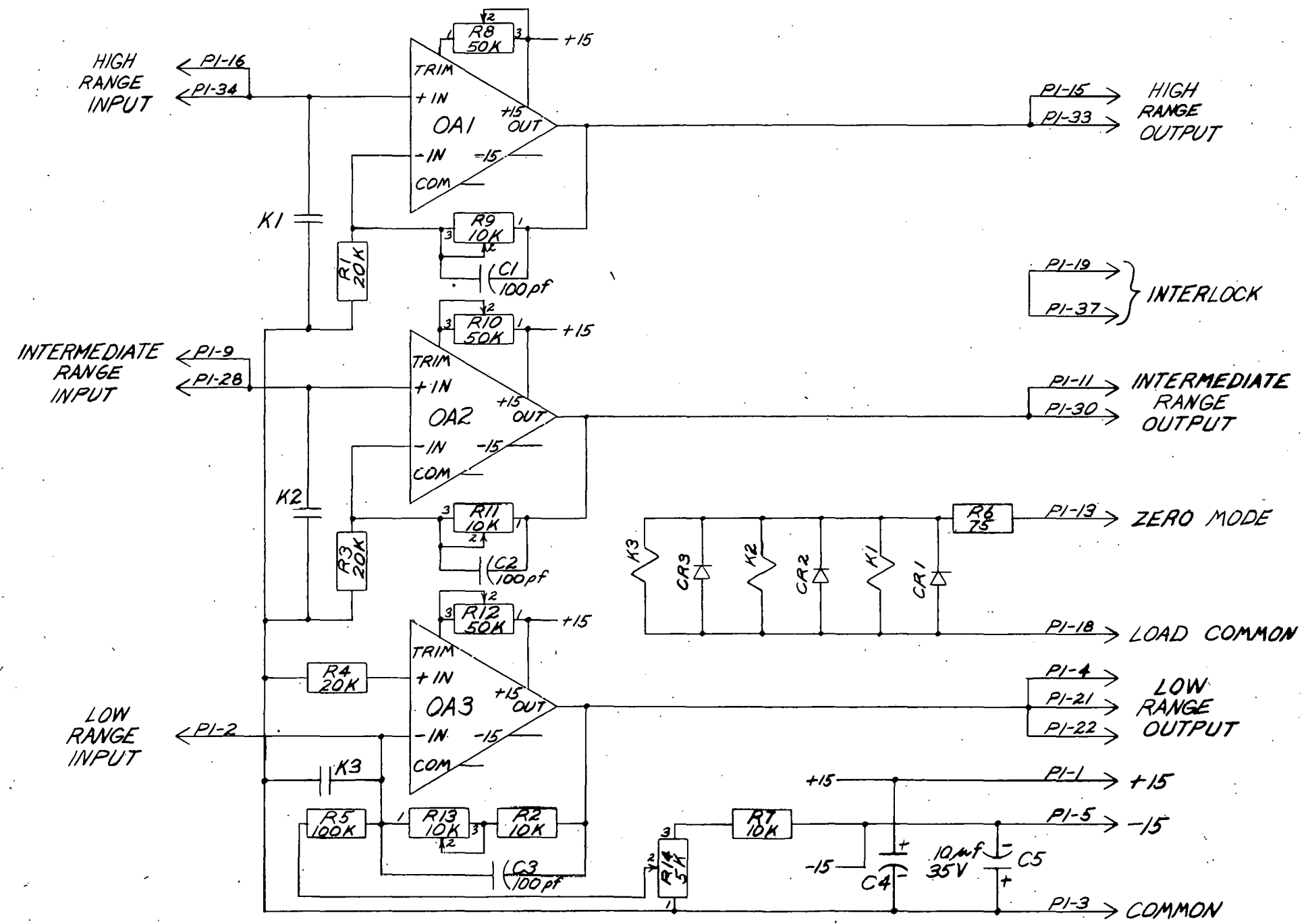
REV NO. 0
136B2441
CONT ON SHEET F SH NO. 1

GENERAL ELECTRIC

TITLE *ELEM DIAG*
MULTIRANGE MONITOR
FIRST MADE FOR PA 49
FCF 136B2440

136B2441
CONT ON SHEET F SH NO. 1

- NOTES:
1. ALL RESISTORS ARE TYPE RN65C, 1% EXCEPT R6 WHICH IS 1/2 W. 5% CARBON
 2. ALL DIODES ARE TYPE 1N914
 3. ALL OP. AMPS ARE TYPE PP65AHU (PHILBRICK-NEXUS)



REVISIONS		PRINTS TO	
		58	

MADE BY *WGreen* B/26/69
ISSUED
APPROVAL *WGreen*
DIV OR DEPT
LOCATION
136B2441
CONT ON SHEET F SH NO. 1

V. Module Description (Continued)

K. Auction Monitor (Elementary Diagram 136B2459)

The function of this unit is to determine which range is controlling the output of the Auction circuit, and to display this information by energizing the proper light over one of three front panel range meters.

Transistors Q4, Q8 and Q12 monitor the operational amplifier outputs of the Auction unit. One of the outputs of the Auction unit will be a negative signal, and two will be about 6.4 volts positive. Thus one of the input transistors will be off, the other two turned on. The collectors of these input transistors are monitored by what amounts to three two-input and gates, the outputs of which drive the indicator lights on the front panel. The following example will best illustrate this unit's operation:

Suppose the WRM System is reading 100% power so that the High Range is controlling the auction. Then the input to Q4 will be about -10 volts, and the inputs to both Q8 and Q12 will be about +6.4 volts. Therefore Q4 is off, and Q8 and Q12 are on. Since Q4 is off, Q2 and Q6 will be turned on, thus turning off Q1 and Q5. Q8 is on thus turning off Q3 and Q10, and Q12 is on thus turning off Q7 and Q11. Since both Q10 and Q11 are turned off, Q9 will be turned on resulting in illumination of the light over the High Range meter.

Since the auction circuit only functions when the Mode Switch is in the OPERATE position, relays K1, K2 and K3 are activated by the Monitor Switch to provide a light indication of which range is selected.



NEBS-PL-8 REV 3-68

TRANSISTOR BASING

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—

APPLIED PRACTICES

SURFACES

TOLERANCES ON MACHINED DIMENSIONS

FRACTIONS

DECIMALS

ANGLES

REV NO. 0

196B2458

CONT ON SHEET *F* SN NO. *1*

TITLE	ASM
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COMPONENT BOARD

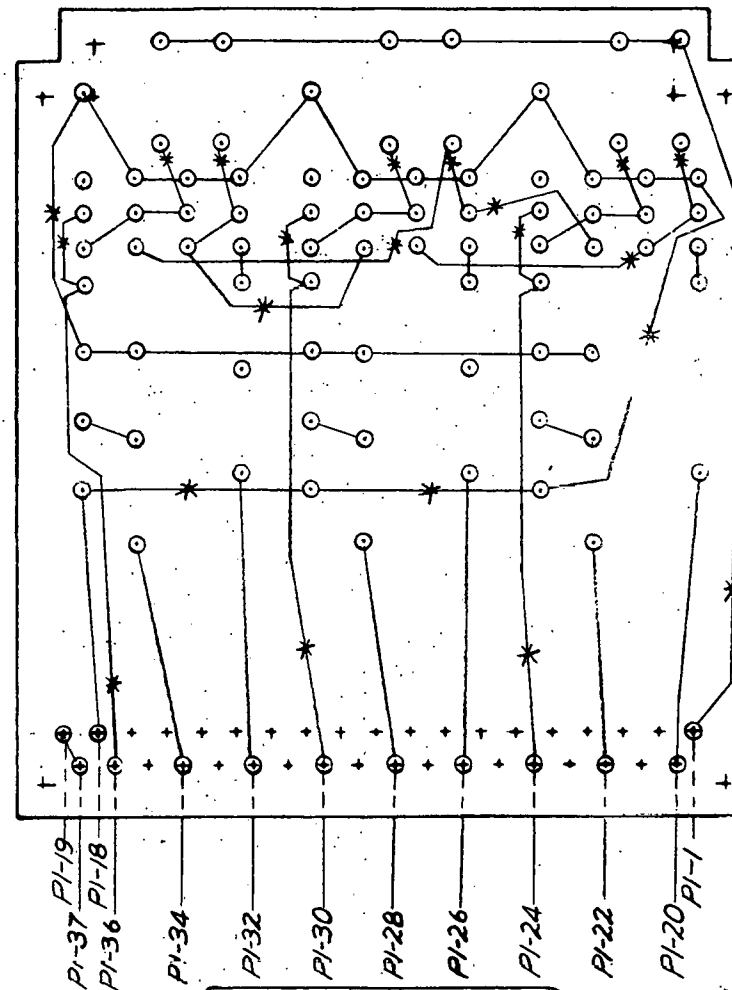
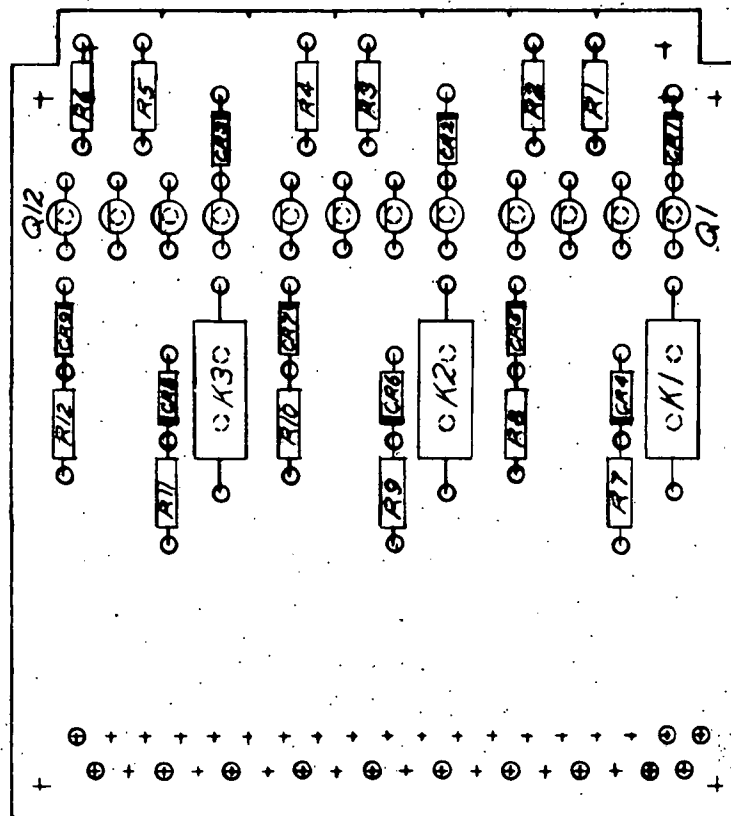
FIRST MADE FOR *AUCTION MONITOR*

PARTS LIST ISSUED

FCF

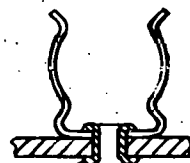
NOTES

1. THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:



GI

Diagram showing the rear of the board with the P1 PIN 1 connector labeled.



SWAGE

ENLARGED SECTION SHOWING
METHOD OF MTG TRANSISTOR
& COMPONENT CLIPS

[illegible]

REVISIONS

PRINTS TO

58

NAME *W Green* *8/26/69*

APPROVALS
INKS

NID
SAN JOSE

DIV OR
DEPT
LOCATION

136B2458

CONT ON SHEET *F* SH NO. /

136B2459
CONT ON SHEET F
DRAWING NO.

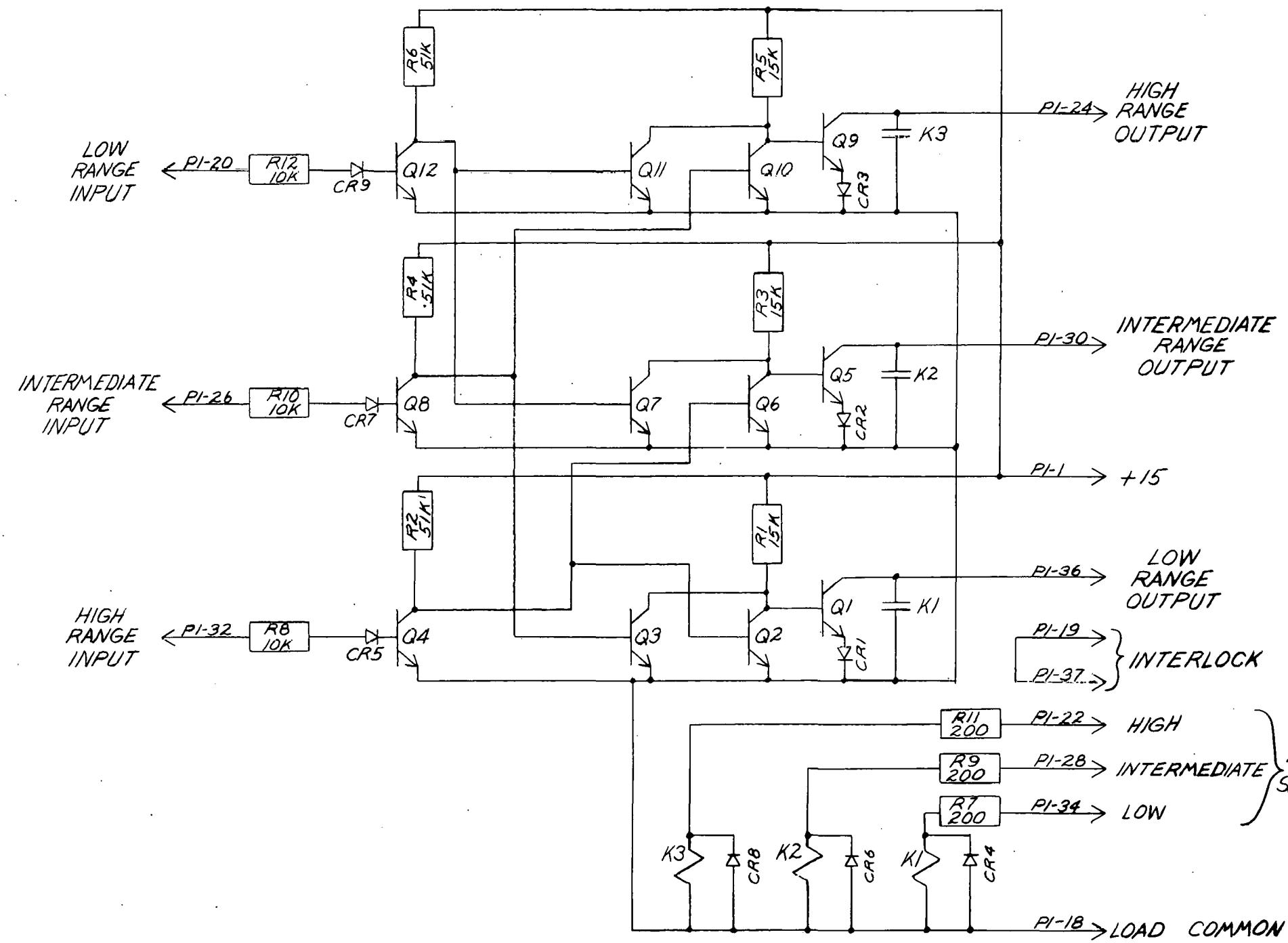
GENERAL ELECTRIC

136B2459
CONT ON SHEET F
SH NO. 1

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV. NO. 0
136B2459
CONT ON SHEET F
SH NO. 1

TITLE ELEM. DIAG.
AUCTION MONITOR
FIRST MADE FOR PA 49
FCF 136B2458



- NOTES:
- 1. ALL TRANSISTORS ARE TYPE 2N3417
 - 2. ALL DIODES ARE TYPE 1N914

REVISIONS	PRINTS TO
	58

MADE BY WKGreen 8/26/69
ISSUED
APPROVALS WK
DIV OR DEPT
LOCATION
136B2459
CONT ON SHEET F
SH NO. 1

V. Mode Description (Continued)

L. Period Monitor (Elementary Diagram 136B2436)

The function of this unit is to provide an indication of the time rate of change of the Percent Power signal. The circuit consists mainly of an operational amplifier used as a differentiator. The differentiating time constant is determined by C3 and R9 plus R15.

R3, R4 and R5 make up the gain adjusting string that allows the output of OA1 to be made equal to ten volts when input signal is increasing with a ten second period.

R8 and R14 provide an offset current to the meter so that infinite period (0 volts on the output of OA1) is an upscale meter indication.

R19, R12 and CR3 provide an additional feedback path to prevent amplifier hang-up for long periods should the input be exposed to a large negative transient. In this case, the output is clamped to about +11 volts.

R7, R13, and CR4 provide an additional feedback path to prevent amplifier hang-up for long periods should the input be exposed to a large positive transient. In this case, the output is clamped to about -2 volts. Both CR3 and CR4 are special low leakage diodes.

Small transients and noise are filtered by C4 and the combination of R10 and C5.

GENERAL ELECTRIC

PARTS LIST FOR **136B2435**
CONT ON SHEET **2** SH NO. **1**

REV NO. **0**
PARTS LIST FOR
136B2435
CONT ON SHEET **2** SH NO. **1**

TITLE **ASSEMBLY**
PERIOD MODULE
FIRST MADE FOR **PA 49**

GROUP NO. AND QUANTITY						PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT
						1	ELEM DIAG	136B2436
					1	2	ENCLOSURE	104B24336001
					2	3	PAN HD SCR	117C1000P9006 #4-40 X 38
					2	4	HEX NUT	175A8000P009 #4-40
					2	5	SPG LK WASH	175A8015P005 #4
						6		
						7		
						8		
						9		
					1	10	BOARD	
					1	11	CONNECTOR	DCC-37D
					88	12	EYELET	159A1969D1
					1	13	RES, R18	RB55AE10R008, 10Ω, 1%
					2	14	RES, R12	RC20GF201J, 200Ω, 5%
					1	15	RES, R13	RN65C3011F, 3.01K, 1%
					1	16	RES, R3	RN65C4991F, 4.99, 1%
					1	17	RES, R17	RB55AE1101B, 11K, 1%
					1	18	RES, R12	RN65C2212F, 22.1K, 1%
					3	19	RES, R5, 7, 19	RN65C3012F, 30.1K, 1%
					1	20	RES, R14	RN65C1543F, 154K, 1%
					1	21	RES, R10	RC20GF105J, 1M, 5%
					1	22	RES, R6	RC20GF395J, 3.9M, 5%
					1	23	RES, R9	159A2980P2, 1.3 X 10 ⁸ , 1%
					2	24	RES, R11 & 15	159A2980P3, 4.3 X 10 ⁸ , 1%
					1	25	RES, R16	55P-500, POT
					1	26	RES, R4	55P-5K, POT
					1	27	RES, R8	55P-20K, POT

DESCRIPTION OF GROUPS	REVISIONS	PRINTS TO
		58

MADE BY	APPROVALS <i>WKS</i> 8/27/69	NID SAN JOSE, CALIF. LOCATION	DIV. OR DEPT. PARTS LIST FOR 136B2435 CONT ON SHEET 2 SH NO. 1
ISSUED			

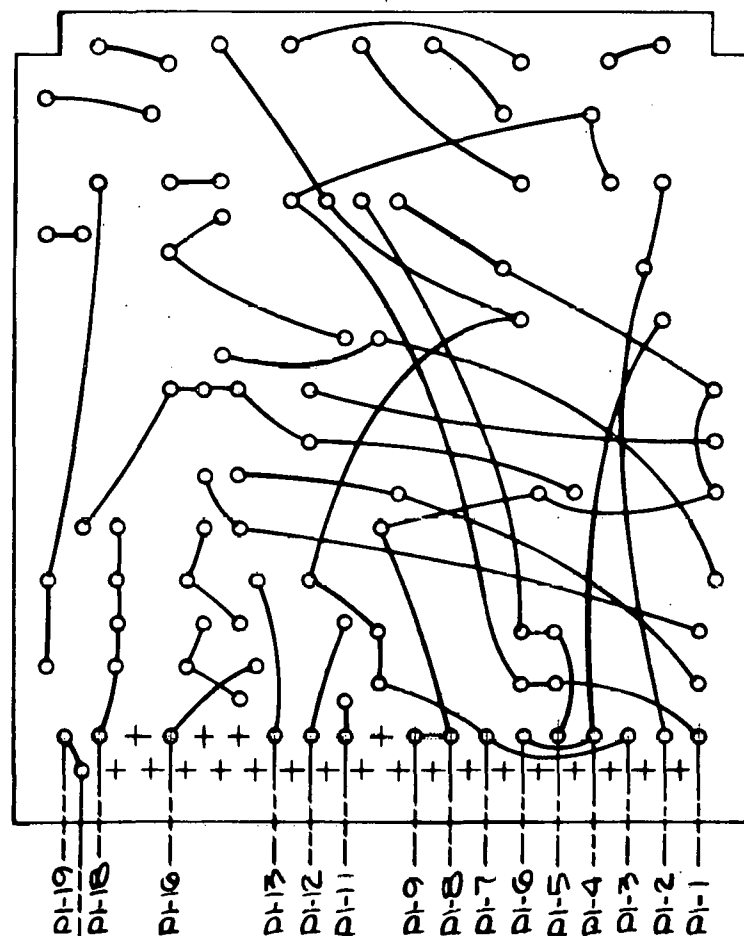
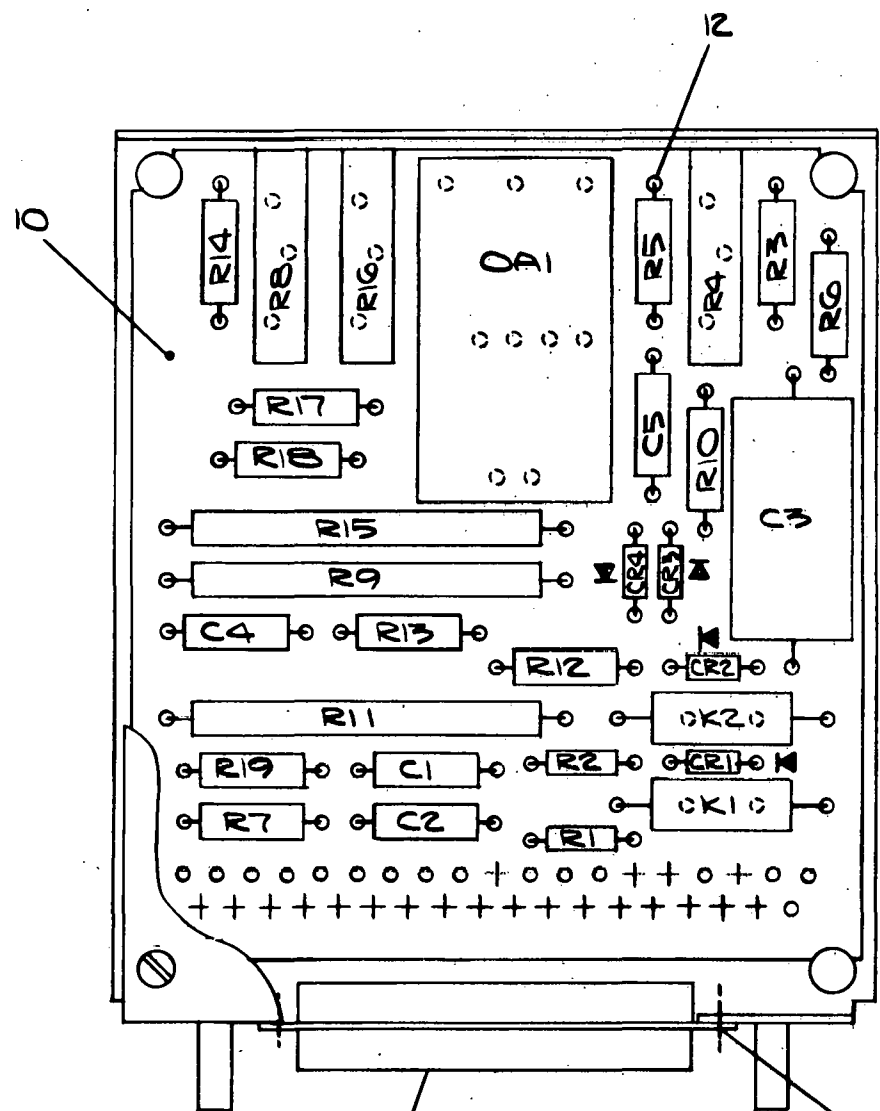
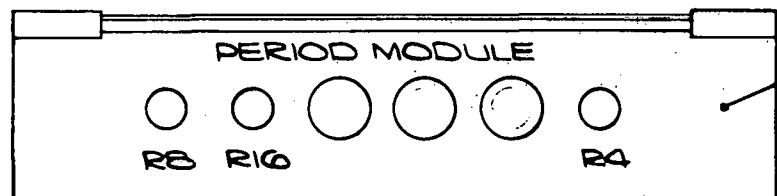
136B2435
DRAWING NO.
CONT ON SHEET
SH NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+ —	+ —	+ —

REV. NO. 0
136B2435
CONT ON SHEET
SH NO.

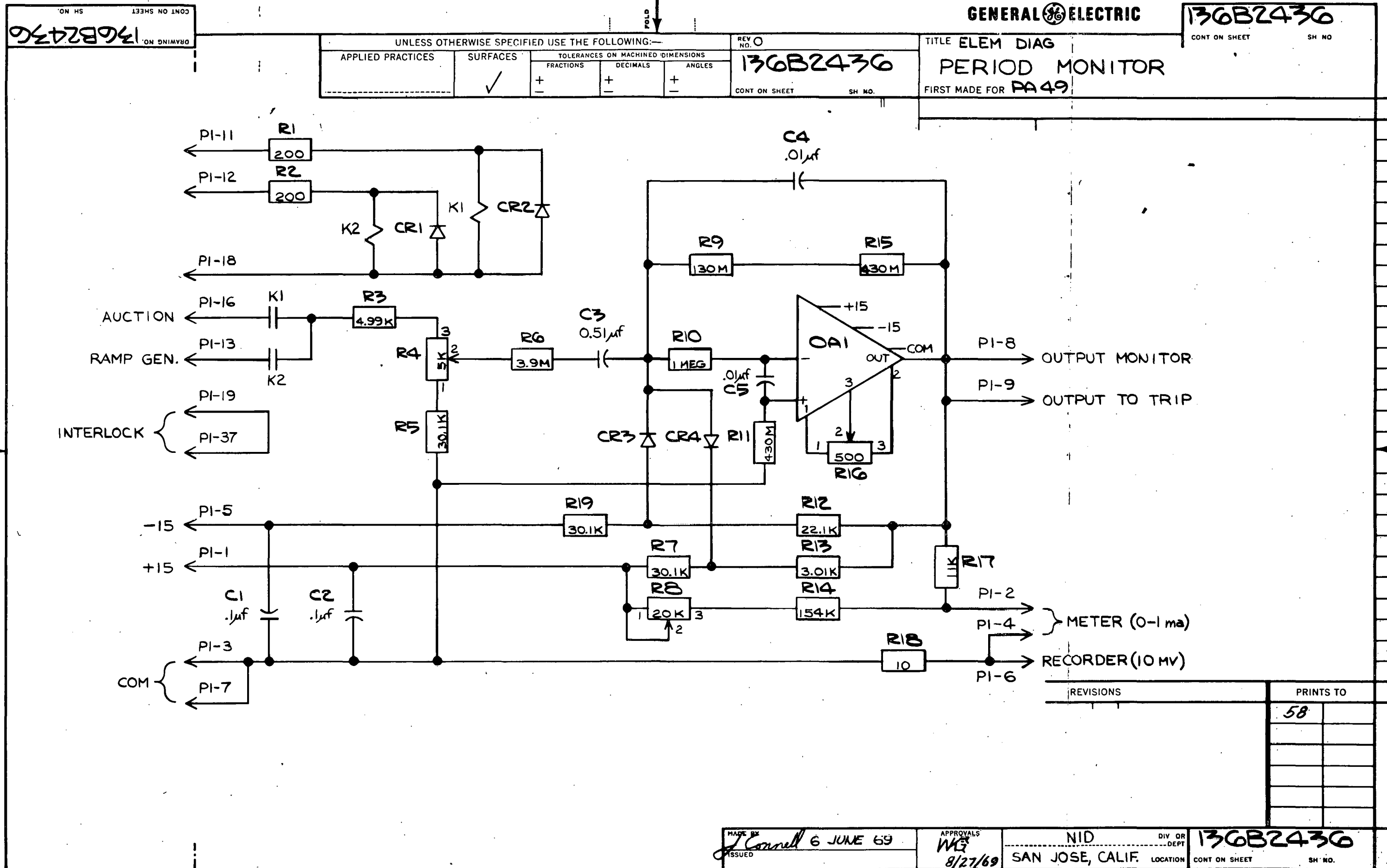
GENERAL ELECTRIC
TITLE ASSEMBLY
PERIOD MODULE
FIRST MADE FOR PA 49

136B2435
CONT ON SHEET
SH NO.



REVISIONS		PRINTS TO	
		58	

MADE BY: *[Signature]*
ISSUED: *[Signature]*
APPROVALS: *[Signature]*
NID
8/27/69
SAN JOSE, CALIF
136B2435
CONT ON SHEET
SH NO.



V. Mode Description (Continued)

M. Ramp Generator (Elementary Diagram 136B2437)

The function of this module is to provide a means for calibrating the period circuitry. The basic circuit is an operational amplifier with a constant current input and a feedback capacitor which integrates this constant current to generate a linear ramp output. R1 is adjusted so that the output voltage is changing at a rate of one volt every 23 seconds which simulates the Percent Power changing with a ten second period. R2 may be adjusted to provide an intermediate period calibration ramp.

With the Calibrate Switch in the FIXED PERIOD position, K3 is energized. K2 is energized in the VARIABLE PERIOD position. Depressing the Ramp Reset push button energized K1 which discharges C1 and C2 through R4.

GENERAL ELECTRIC

PARTS LIST FOR
136B2438
CONT ON SHEET SH NO.

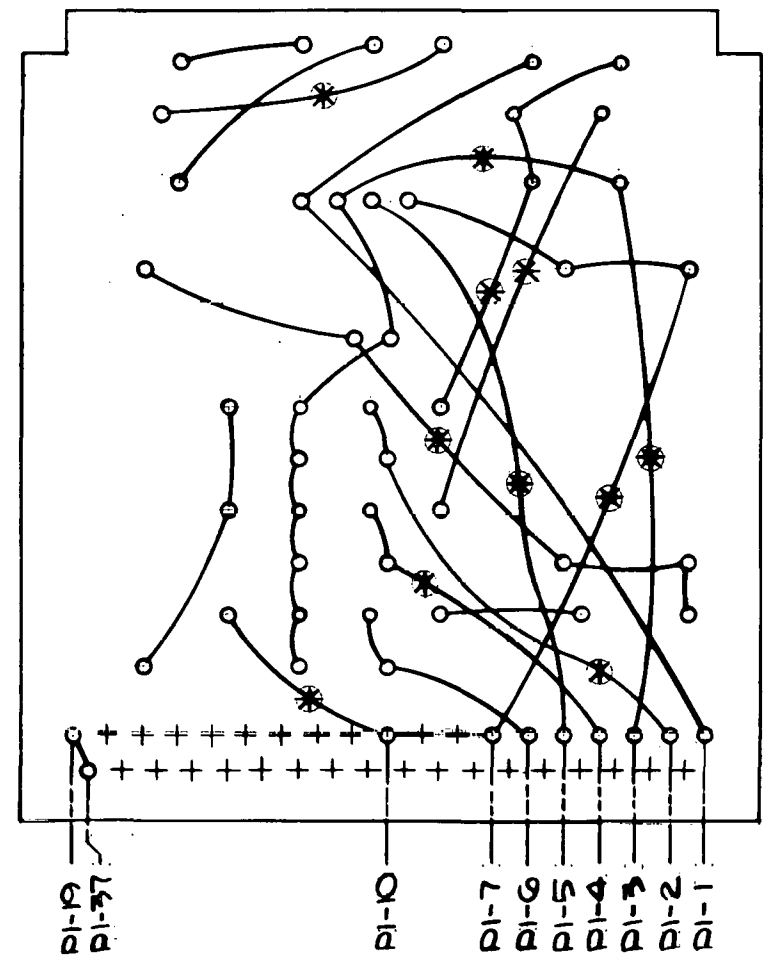
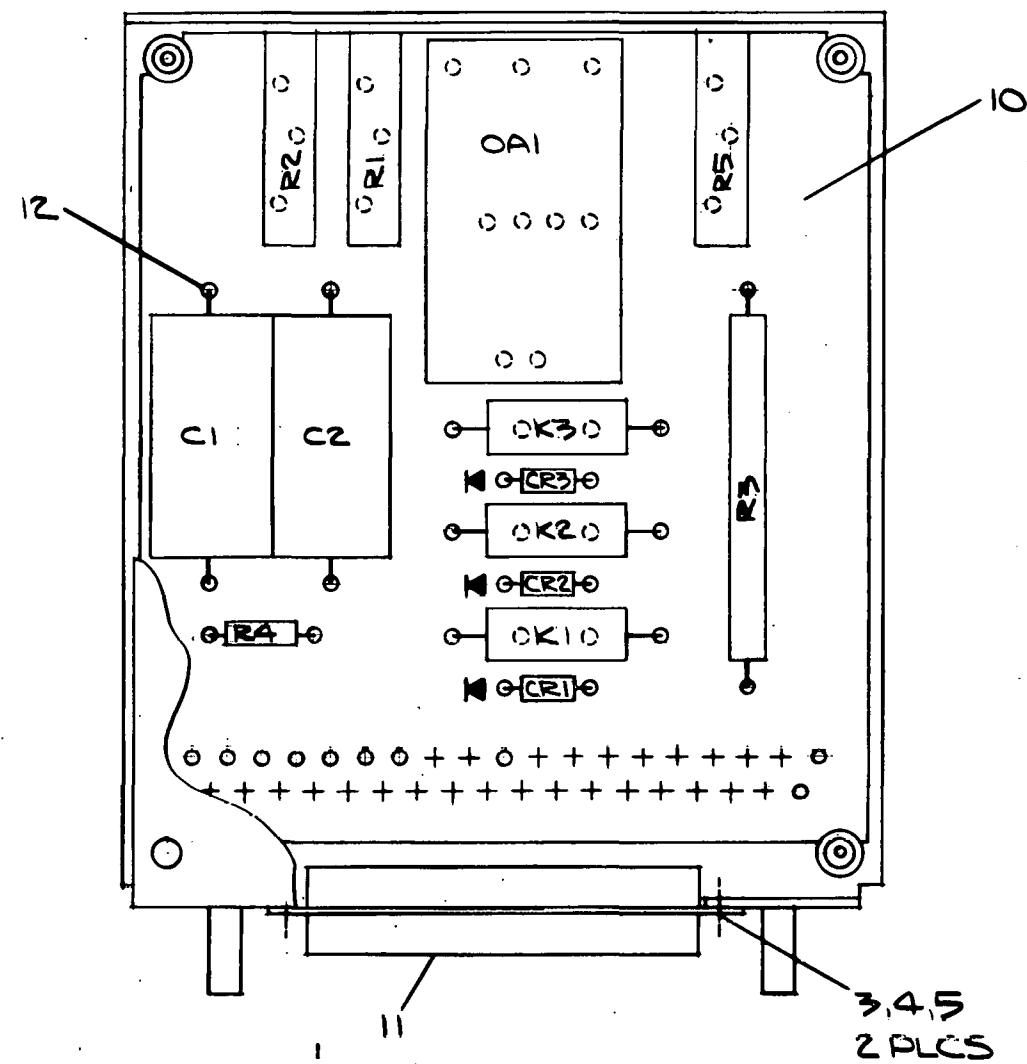
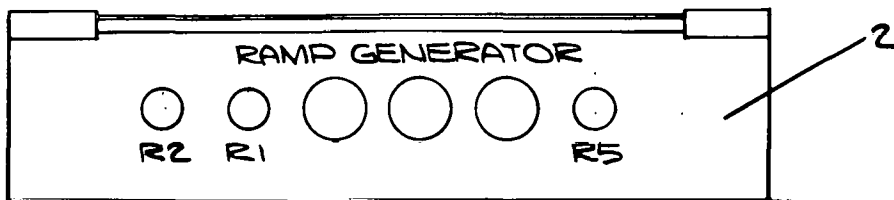
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136B2438
CONT ON SHEET

GENERAL ELECTRIC

136B2438
CONT ON SHEET

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				REV. NO. 0	TITLE ASSEMBLY RAMP GENERATOR FIRST MADE FOR PA 49
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS			
	✓	FRACTIONS +	DECIMALS +	ANGLES +	
				136B2438	



REVISIONS	PRINTS TO
	58

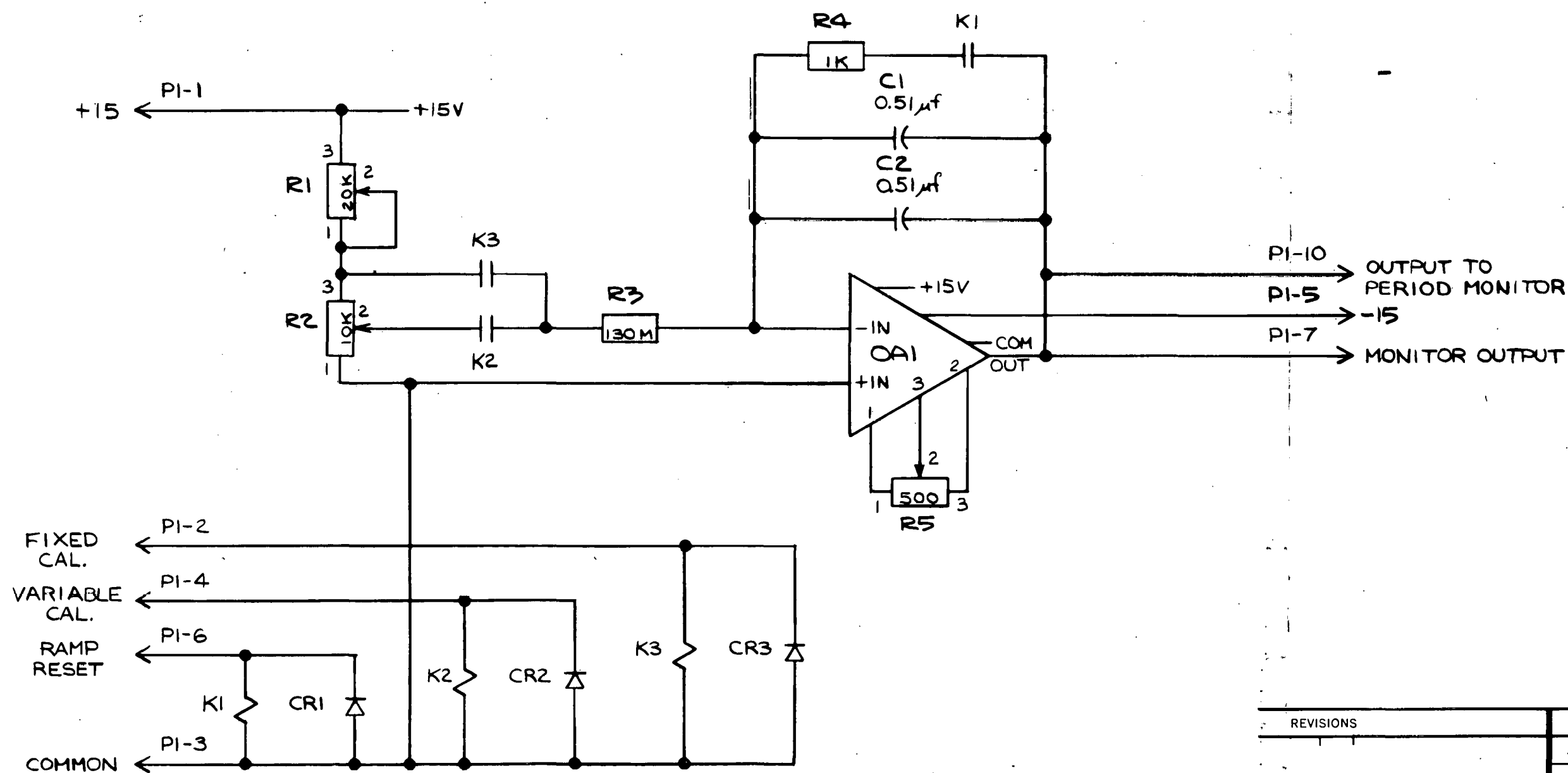
MADE BY <i>WAG</i>	APPROVALS <i>WAG</i>	DIV OR DEPT NID	136B2438 CONT ON SHEET
ISSUED	8/27/69	SAN JOSE CALIF	SH NO.

136B2437
DRAWING NO. 136B2437
CONT. ON SHEET 133HS NO. 1W00

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:-				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV. NO. 0
136B2437
CONT. ON SHEET SH. NO.

GENERAL ELECTRIC
136B2437
CONT. ON SHEET SH. NO.
TITLE ELEM DIAG
RAMP GENERATOR
FIRST MADE FOR PA 49



REVISIONS		PRINTS TO	
		58	

MADE BY: 5 JUNE 69
ISSUED: 8/27/69
APPROVAL: NID
DIV. OR DEPT: SAN JOSE, CAL
LOCATION: 136B2437
CONT. ON SHEET SH. NO.

V. Module Description (Continued)

N. Dual Trip Unit (Elementary Diagram 117C1053)

Each dual trip unit consists of two independent trip circuits. Each trip circuit consists of a differential comparator stage (Q1 - Q5), a non-latching output stage (Q7), and two outputs that may or may not be latching (Q8 and Q9). If the reset line (Pin 3 or 17) is returned directly to the positive supply voltage, the bistable flip-flop will be self resetting. If the reset line is returned to the positive supply voltage through a normally open switch contact, the bistable will reset only when the switch is closed.

Each trip circuit may function as either downscale or upscale sensors for either positive or negative signals. See table on elementary diagram for proper connection of inputs and references.



TITLE ASM		SPARES
COMPONENT BOARD		
FIRST MADE FOR GEN USE		

NID
SAN JOSE, CALIF.

PL 798D964	SH NO. 1	CONT ON SH 2	REV 11
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GROUP NO. AND QTY			U/M				REMARKS	REV
ITEM NO.	IDENTIFICATION NO.	NAME	1	2	3	4		
1	798D963P001	PC BOARD	1	1				
2	112C3791P010	CONNECTOR	1		1	1		
3	175A7453P001	CAPACITOR	B	4	4	4		C1,C2
4	175A7485P002	DIODE		14	8	18	18	CR1 THRU CR5, CR8 THRU CR13
5	112C2674P057	RESISTOR		8	8	8	8	R7,R8,R11,R12
6	112C2674P059	RESISTOR		2		2	2	R4
7	112C2674P061	RESISTOR		4		4	4	R20,R21
8	112C2674P067	RESISTOR		8	2	8	8	R10,R17,R19,R22
9	112C2674P069	RESISTOR		2		2	2	R6
10	112C2674P073	RESISTOR		6		4	4	R13,R14,R15
11	112C2674P079	RESISTOR		2		2	2	R5
12	112C2674P121	RESISTOR		2	2	2	2	R9
13	112C2675P049	RESISTOR		4		4	4	R18, R23
14	112C3162P056	RESISTOR		4		4		R1,R3
15	175A8890P010	POT		2	2	2		R2
17	175A7495P001	TRANSISTOR		10	6	10	10	Q1,Q2,Q3,Q8,Q9
18	175A7499P001	TRANSISTOR		6	4	8	8	Q4,Q5,Q6,Q7
19	175A8807P001	TRANSISTOR		18	12	18	18	
21	112C3162P068	RESISTOR			6			R1,R3,R4
22	112C2674P083	RESISTOR			2			R5
23	112C2674P078	RESISTOR			4			R6,R13
24	112C2674P077	RESISTOR	B		2			R19

9	APR 16-1968	RRS
RETRACED		
10	Aug 23 1968	RRS
CHG REMARKS		
ITEM 4 & 13		

G1-FOR PLUG-IN APPLICATION G2-FOR WIRE-IN APPLICATION G3-FOR PLUG-IN APPLICATION G4-FOR PLUG-IN APPLICATION	11 Young FEB. 20 1969 RRS ITEM 4 WAS 175A7485P001
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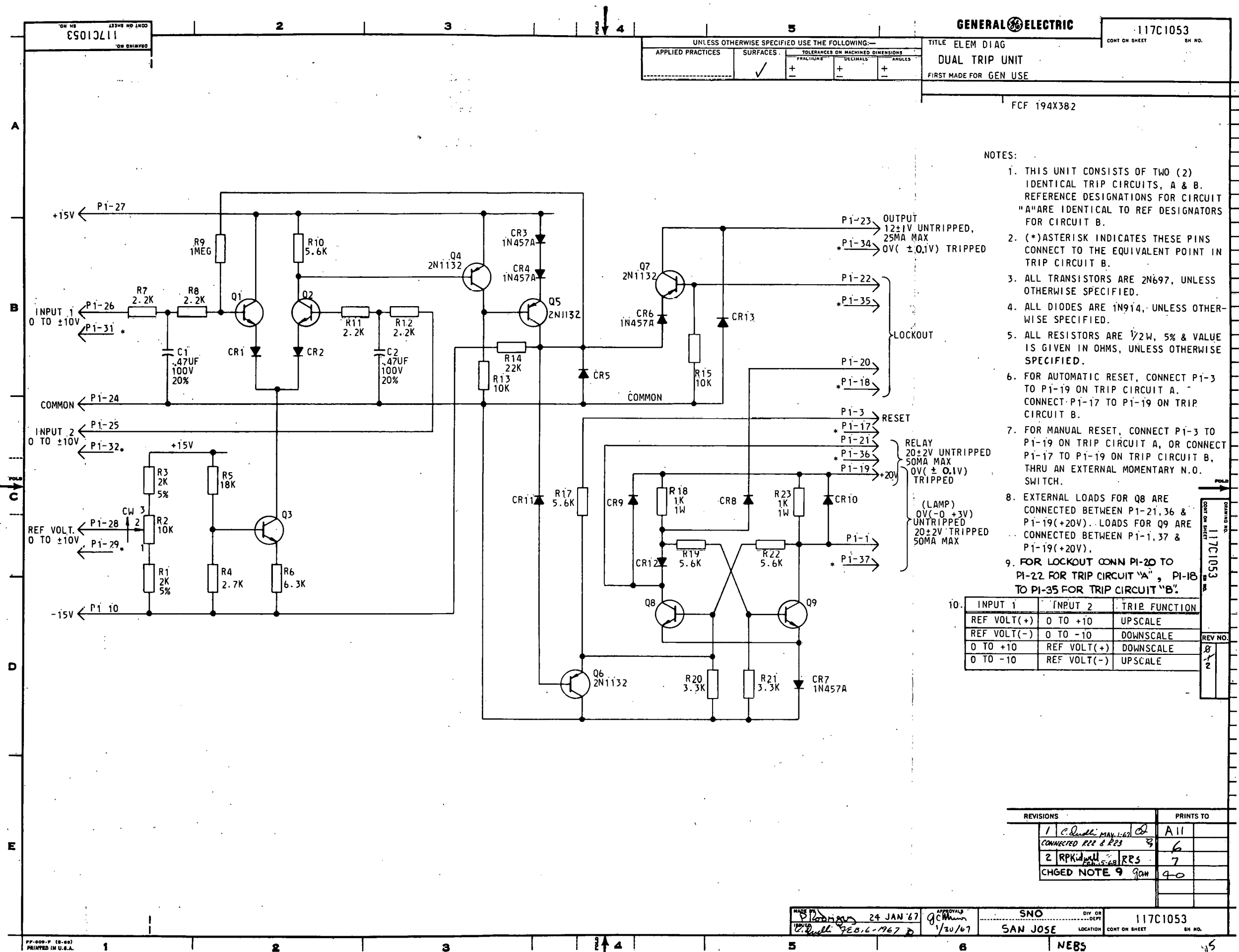
PRINTS TO	USE PL REVISION NO. ON LINE OF ITEM BEING REVISED	
A13	MADE BY K.E. BULLER MARCH 3-64	APPROVALS JAC
6	ISSUED Aug 90 APR 16-1968	3-25-64
7	PL 798D964	SH NO. 1 CONT ON SH 2

NID

~~SAN~~ JOSE, CALIF.

NEBS-PL-8 REV 3-68

13



V. Module Description (Continued)

O. High Voltage Filter (Elementary Diagram 136B2462)

This unit has two functions. During normal system operation it provides two stages of filter for the detector polarizing voltage. When the Mode Switch is in the TEST or CALIBRATE positions, it serves as a coupling for connecting the calibration signals to the high voltage cable.

When the system is in the Operate or Standby modes, K2 and K3 are energized. With R5 and R7 shorted by K2 and K3, the detector polarizing voltage is filtered by R4, C1, R6 and C2.

When the system is in the Test or Calibrate modes, only K1 is energized. This applies the calibration signal across R7 where it is then coupled to the high voltage cable by C2.



136B2461

SH NO.

PARTS LIST FOR

136B2461

SH NO.

HIGH VOLTAGE FILTER

FIRST MADE FOR PA 49

[illegible]

REVISIONS.

58

ISSUED

APPROVALS

WKE

8/27/69

NID

DIV. OR
— MEET.

SAN JOSE, CALIF LOCATION

PARTS LIST FOR

R 136B24G

CONT ON SHEET

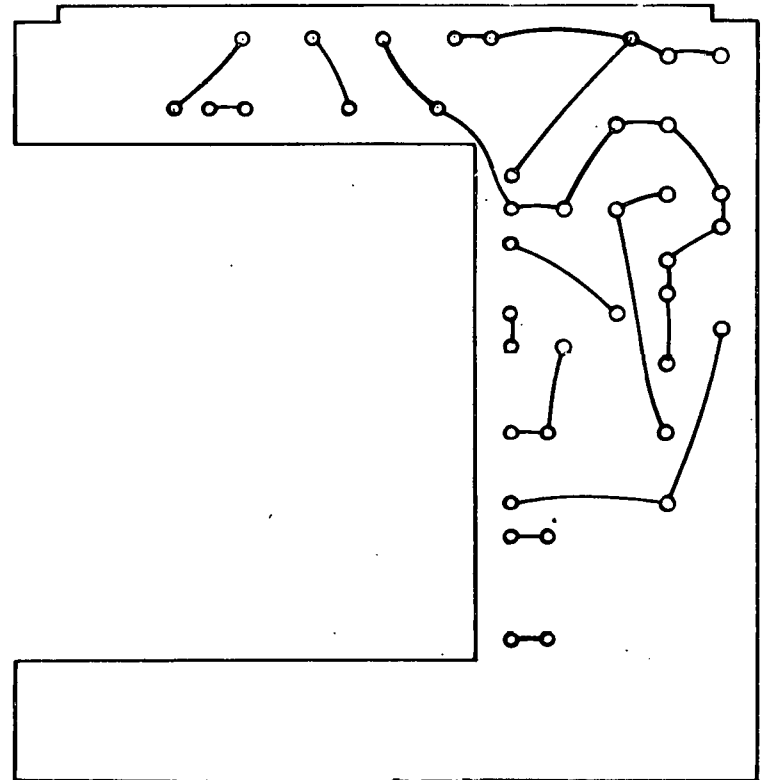
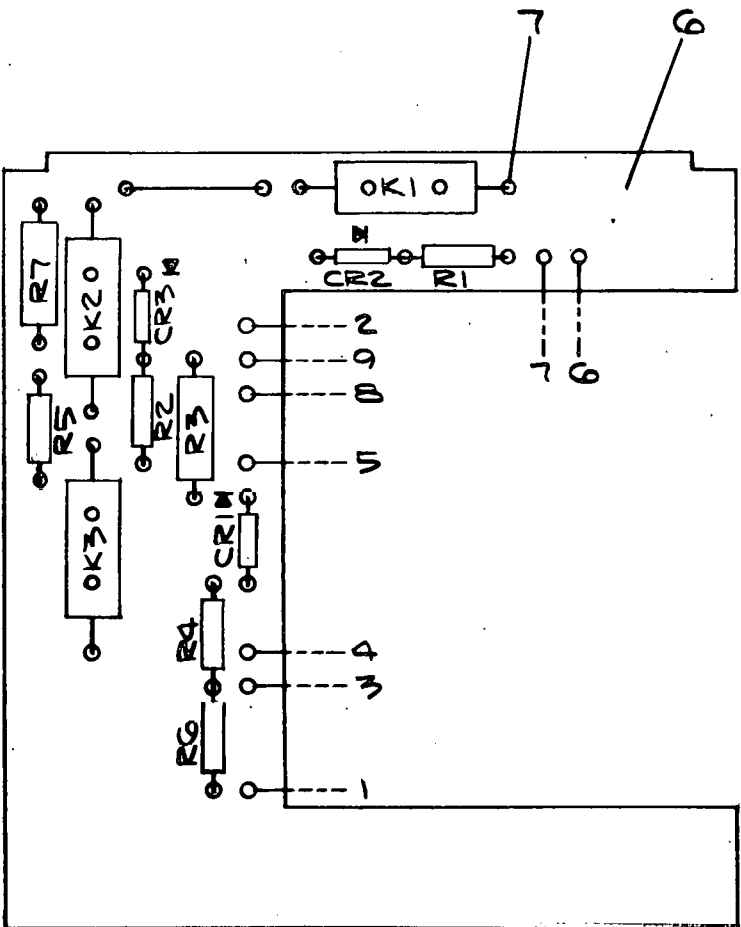
SH NO.

CONT ON SHEET
SH NO.
DRAWING NO.

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+ —	+ —	+ —

REV NO. 0
136B2461
CONT ON SHEET SH NO.

GENERAL ELECTRIC
136B2461
CONT ON SHEET SH NO.
TITLE ASSEMBLY
HIGH VOLTAGE FILTER
FIRST MADE FOR PA 49



REVISIONS		PRINTS TO	
		58	

MADE BY: [Signature]
ISSUED: [Signature]
APPROVAL: [Signature]
8/27/69
NID
SAN JOSE, CALIF
DIV OR DEPT
LOCATION
136B2461
CONT ON SHEET SH NO.

V. Module Description (Continued)

P. Signal Generator (Elementary Diagram 107C4837)

The Signal Generator is comprised of two oscillators, Q1 and Q4, and a pulse shaping circuit formed by Q2 and Q3. Unijunction transistor Q4 and its associated components make up a free-running relaxation oscillator that operates at a frequency of 10cps. Transistor Q1 and its associated circuitry form a crystal controlled oscillator which operates at a frequency of 100Kc. The outputs of these oscillators are negative pulses which are used as test and calibration signals.

GENERAL ELECTRIC

TITLE ASM COMPONENT BOARD			SPARES	NID SAN JOSE, CALIF.										PL 104B2491		SH NO 1	CONT ON SH 2	REV 8	
FIRST MADE FOR SIGNAL GENERATOR				GROUP NO. AND QTY										U/M	FCF 194X369				
ITEM NO.	IDENTIFICATION NO.	NAME		1												REMARKS	REV		
1	104B2490P001	BOARD		/													8		
2	112C3791P019	CONNECTOR		1															
3	175A8382P002	COAX CONTACT		2															
4	159A1969P001	EYELET	B	5													8		
5	175A7209P001	EYELET		/													8		
6	175A7209P002	EYELET		2													8		
7	145A5898P008	CLIP		/													8		
8	145A5898P006	CLIP	B	/													8		
9	175A8806P001	SOCKET		1															
10	112C2674P049	RESISTOR	B	4												R1, R5, R6, R9			
11	112C2674P085	RESISTOR		1												R2			
12	112C2674P073	RESISTOR		2												R3, R8			
13	112C2674P003	RESISTOR		1												R4			
18	112C2674P025	RESISTOR		1												R13			
19	112C3157P366	RESISTOR		1												R12			
20	175A7464P001	CAPACITOR		1												C1			
21	112C2277P041	CAPACITOR		2												C2, C3			
22	107C5489P046	CPACITOR		1												C4			
23	112C2277P201	CAPACITOR		1												C6			
24	107C5488P006	CAPACITOR		1												C7			
26	175A7493P001	TRANSISTOR		1												Q4			
27	209A4127P001	TRANSISTOR	B	3												Q1, Q2, Q5	8		

7 *Test Bush 4* 16

RETRACED-UPDATED FOR CMPTR

8 *10/1/64* *11/1/64*

EN 706352

PRINTS TO

A13

6 RE

11

REVISION CODE

1. ITEM ADDED 2. ITEM DELETED 3. ITEM REVISED

MADE BY
R. SUGGS FEB 17-64

APPROVALS
HWP
2-19-64

PL 104B2491

SH NO 1 CONT ON SH 2

GENERAL ELECTRIC

TITLE ASM			COMPONENT BOARD										SIGNAL GENERATOR										NID SAN JOSE, CALIF.										PL 104B2491										SH NO. 2 CONT ON SH F REV 9																																																																																																																																																																																																																																																																																																																																																																																																																			
FIRST MADE FOR			GROUP NO. AND QTY										U/M										FCF 194X369																																																																																																																																																																																																																																																																																																																																																																																																																																							
ITEM NO.	IDENTIFICATION NO.	NAME	SPARE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	44

104B2491
DRAWING NO.
CONT ON SHEET

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:

APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV NO. 8710
104B2491
CONT ON SHEET SH NO.

GENERAL ELECTRIC

104B2491
CONT ON SHEET SH NO.

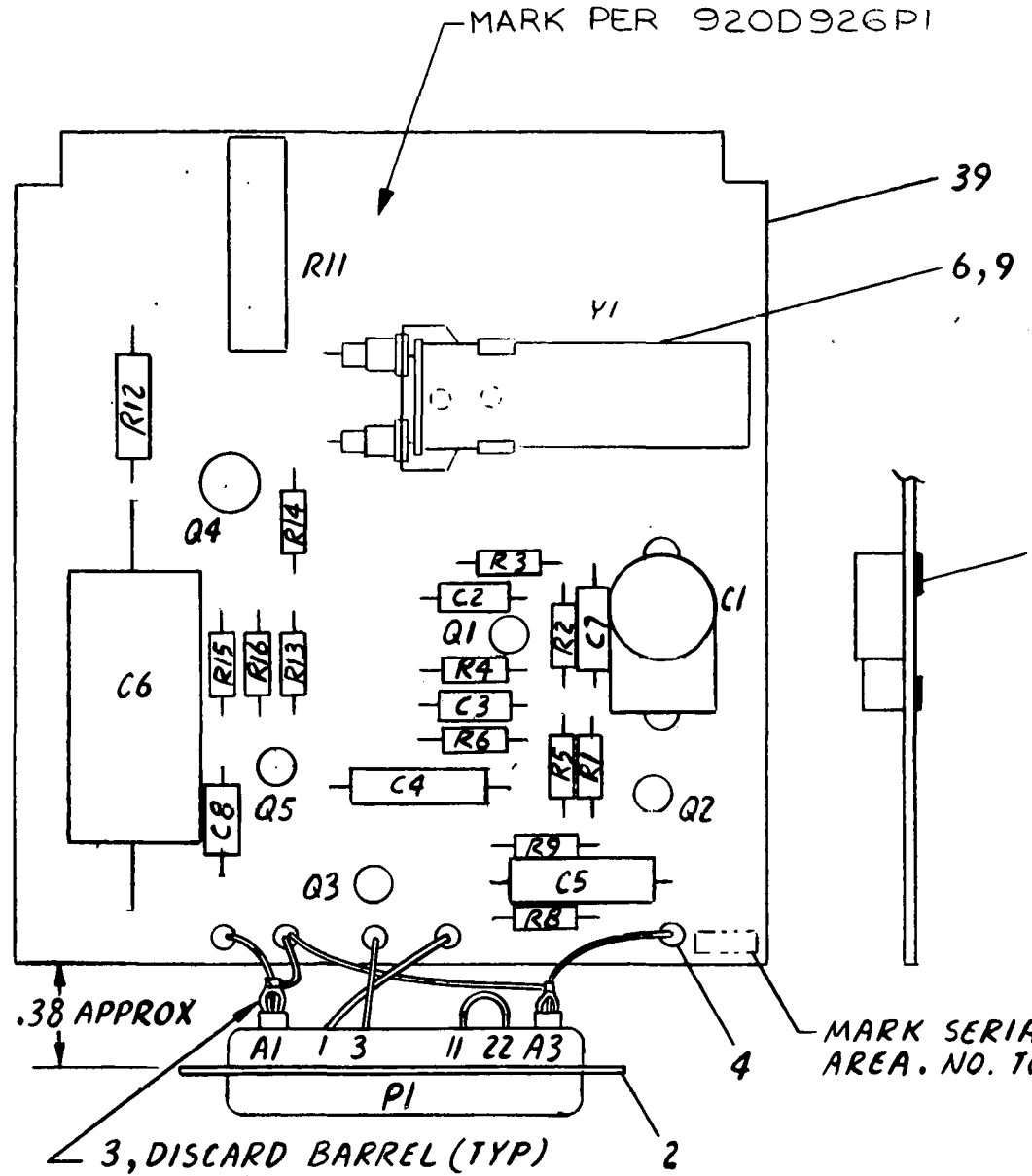
TITLE ASM
COMPONENT BOARD
FIRST MADE FOR SIGNAL GENERATOR

PL ISSUED FCF 194X369

NOTE
1. USE #22 AWG WIRE PER ITEM 40.

ITEM NO.	REF DESIG
10	R1, R5, R6, R9
11	R2
12	R3, R8
13	R4
18	R13
19	R12
20	C1
21	C2, C3
22	C4
23	C6
24	C7

ITEM NO.	REF DESIG
26	Q4
27	Q1, Q2, Q5
28	Y1
29	R11
34	R14
35	C5
36	Q3
37	R15, R16
38	C8



REVISIONS	PRINTS TO
8 P1000000 PR	
REDRAWN & EN706352	
9 Kennell PR	
EN706784	
10 W. Blott PR	
EN710399	

MADE BY R.E. BULLER 17 FEB '64 APPROVALS H.W.P. 2/19/64 DIV OR DEPT NID SAN JOSE, CALIF LOCATION
104B2491
CONT ON SHEET SH NO.

107C4837

2

3

4

5

GENERAL ELECTRIC

107C4837

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
	✓	FRACTIONS	DECIMALS	ANGLES
		+	+	+

TITLE ELEM DIAG
SIGNAL GENERATOR
FIRST MADE FOR SOURCE RANGE MONITOR

FCF 194X369

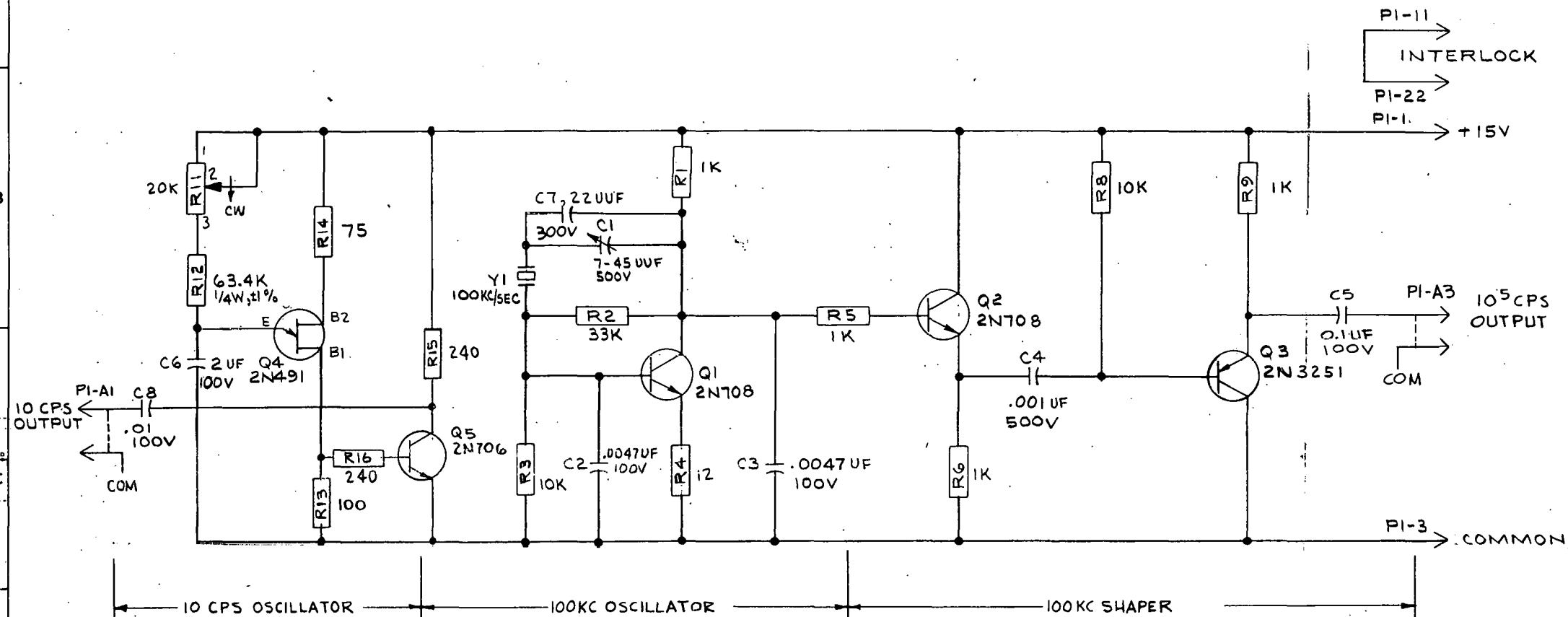
A

B

C

D

E



NOTES;

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE
1/2W, ±5% & VALUE GIVEN IN OHMS.

REVISIONS				PRINTS TO	
6	DESIGN	10/15/64	WAK	1	8/1/64
5	DESIGN	10/15/64	WAK	2	8/1/64
4	DESIGN	10/15/64	WAK	3	8/1/64
3	DESIGN	10/15/64	WAK	4	8/1/64
2	DESIGN	10/15/64	WAK	5	8/1/64
1	DESIGN	10/15/64	WAK	6	8/1/64
MADE BY X. E. Bullen Feb 13, 1964				NID	
ISSUED NCK, FEB. 19 '64				SAN JOSE	
APPROVED 2/19/64				107C4837	
DIV OR DEPT				LOCATION	
CONT ON SHEET				SH NO.	

JUN 64

APR 64

FEB 64 14

V. Module Description (Continued)

Q. Campbell Calibrator (Elementary Diagram 117C3022)

This unit provides alignment signals for the Intermediate and High Ranges. The High Range calibration signal is a 100Kc rectangular wave. The Intermediate Range calibration signal is a $\frac{100}{64}$ Kc square wave. There are two output amplitudes available for each range, the amplitudes differing by a factor of 10. A separate 100Kc rectangular wave is generated for the purpose of checking continuity of the signal cables.

A 100Kc input is received from the Signal Generator, amplified and sharpened by Q1, and then used to drive three signal stages.

For the Intermediate Range calibration stage the 100Kc signal is divided by 64 by the use of six flip-flops. The amplitude of the resulting square wave is controlled by R4, attenuated by R5 and R6 and applied to emitter follower Q3. When K1 is energized, the signal at Point A has the same magnitude as the signal at the base of Q3. When K2 is energized, the magnitude of the signal at Point A is equal to the signal at the base of Q3 multiplied by the resistive divider ratio in the emitter of Q3 $[R8 / (R8 + R25 + R7)]$.

The High Range calibration stage uses directly the 100Kc rectangular wave from the collector of Q1. The amplitude is varied by R11 and applied to emitter follower Q5. The discussion concerning the amplitudes of the two signals at the output of Q5 is the same as was discussed above for Q3.

The stage consisting of Q6 and Q7 is used to provide a variable amplitude test signal. Only one output is derived from this stage.

Transistors Q8 and Q9 and their associated components constitute a unity gain driver stage. R24 is used to match the impedance of the cable being driven.

GENERAL ELECTRIC

PARTS LIST FOR 136B2466

REV NO. 0
PARTS LIST FOR 136B2466
CONT ON SHEET 2 SH NO. 1

TITLE ASSEMBLY
CAMBELL CALIBRATOR
FIRST MADE FOR PA 49

CONT ON SHEET 2 SH NO. 1

GROUP NO. AND QUANTITY						PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT
						1	ELEM DIAG	117C3022
						1	2	ENCLOSURE 104B24336001
						2	3	PAN HD SCR 117C1000P9006 #4-40 X.38
						2	4	HEX NUT 175A8000P009 #4-40
						2	5	SPG LK WASH 175A8015P005 #4
							6	
							7	
							8	
							9	
						1	10	BOARD
						1	11	CONNECTOR DCM-25W3D
							12	EYELET
						4	13	CAP,C1,2,6E7 CS13BF105K, 1uf, 35V
						2	14	CAP,C3E4 CS13BF106K, 10uf, 35V
						1	15	CAP,C5 CS13BE107K, 100uf, 20V
						1	16	DIODE,VR1 ZENER, 1N752A, 5.6V, 5%, 400MW
						3	17	DIODE,C1,2E3 1N4004
						1	18	VOLT REG,PS1 805-V5 BECKMAN
						7	19	TSTR,Q1,2,3,4, 5,6E7 2N3417
						1	20	TSTR,Q9 2N2905
						1	21	TSTR,Q8 2N2484
						6	22	RELAY,K1, 2,3,4,5E6
						3	23	DUAL FLIP FLOP,FF1,2E3 SN7473N TEXAS INSTRUMENT
							24	

DESCRIPTION OF GROUPS	REVISIONS	PRINTS TO
		58

MADE BY *Ed Schmitt* APPROVALS *WKS* 8/27/69 DIV OR DEPT. *NID* PARTS LIST FOR 136B2466
ISSUED SAN JOSE, CALIF. LOCATION CONT ON SHEET 2 SH NO. 1

GENERAL ELECTRIC

PARTS LIST FOR 136B2466
CONT ON SHEET F SH NO. 2

[illegible]

136B2466
DRAWING NO.
CONT ON SHEET
SH NO.

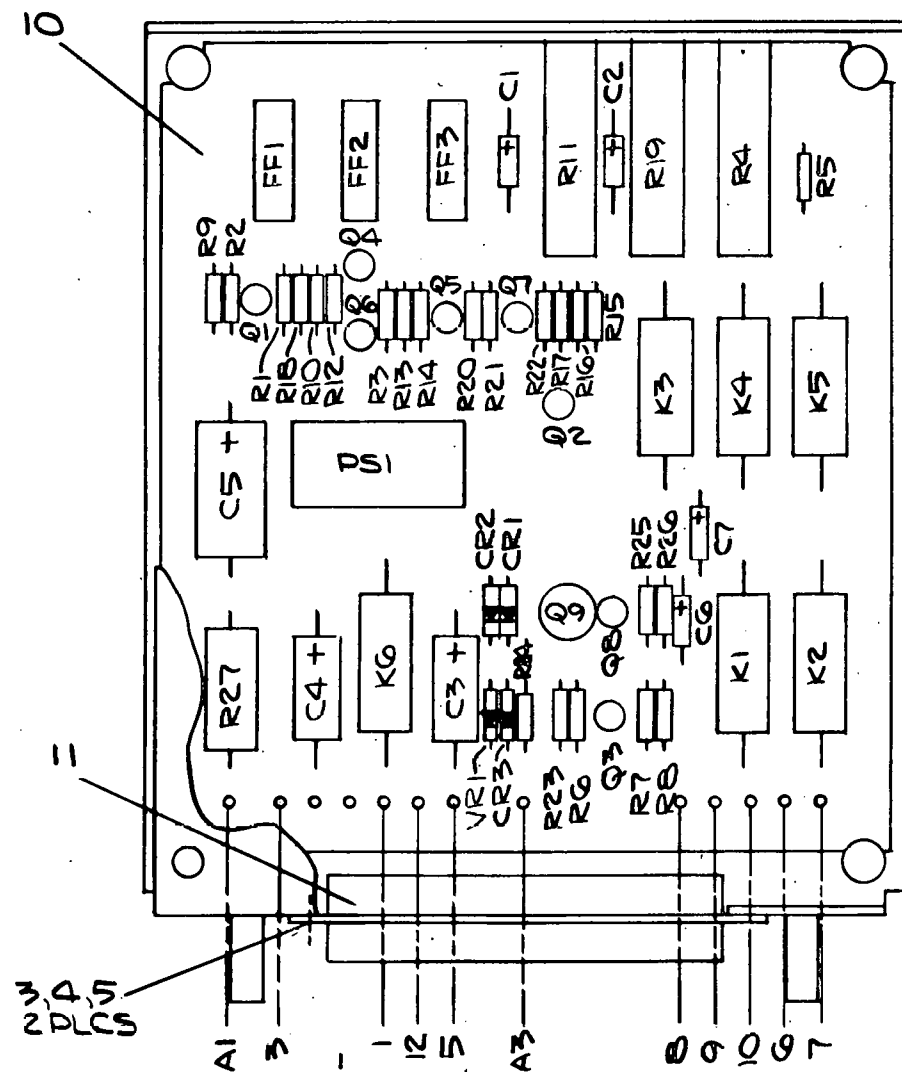
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV. 0
136B2467
CONT ON SHEET
SH NO.

GENERAL ELECTRIC

136B2466
CONT ON SHEET
SH NO.

TITLE ASSEMBLY
CAMBELL CALIBRATOR
FIRST MADE FOR PA 49



REVISIONS	PRINTS TO	
	58	

MADE BY
ISSUED
WGS

APPROVALS
8/27/69
NID
SAN JOSE, CALIF

DIV OR DEPT
LOCATION
136B2466
CONT ON SHEET
SH NO.

V. Module Description (Continued)

R. High Voltage Power Supply (Elementary Diagram 112C2223)

The high voltage power supply is a DC to DC converter comprised of a chopper, a step-up transformer, a voltage doubler, and regulating circuitry. It can produce either a positive or negative output voltage which is continuously variable over the range of 100 to 350 or 350 to 600 volts DC. Output voltage polarity and power supply range are determined by the intra-connection of the module mating connector. A table of mating connector intra-connection information is provided on 112C2223.

The high voltage output is produced by using a power transistor (Q10) as a chopper in series with the primary of a step-up transformer (T1). When the chopper transistor is on, heavy current flows through the primary of T1. When the chopper transistor is cut-off, this current flow is interrupted. When current is flowing through the primary, the voltage across the secondary rises to several hundred volts. Then when the current through the primary is interrupted, the transformer field collapses. The collapse of the transformer field induces a negative voltage of several hundred volts amplitude across the secondary of T1. The voltage doubler circuit, comprised of C1, C2, CR1, and CR2, utilizes the total voltage excursion of both the positive and negative pulses to provide a high voltage output. The high voltage output is then applied through a filter to output connector pin A5.

Regulation of the high voltage output is accomplished by varying the frequency of the chopper. The "on time" of the chopper is fixed at approximately 40 microseconds; thus, as the frequency of the chopper increases, the average power increases because the chopper is "on" for more 40 microsecond periods within a given length of time. Conversely, as the chopper is operated at lower frequencies, the average power applied to the T1 primary decreases because the chopper conducts for fewer 40 microsecond intervals within a given period of time. Thus as the chopper frequency is varied, the power coupled through T1 can be changed. The regulating circuits, comprised of transistors Q1 through Q9 and their associated components, accomplish this regulating function by sampling the output voltage and using it to control the frequency of the chopper.

GENERAL ELECTRIC

ATOMIC POWER EQUIPMENT DEPT. SNO
SAN JOSE, CALIF.

TITLE ASM POWER SUPPLY			SPARES	GROUP NO. AND QTY								U/M	PL 112C2220			SH NO. 1	CONT ON SH 2	REV 8
ITEM NO.	IDENTIFICATION NO.	NAME		1	2	3	4						REMARKS	REV CODE				
1	112C2223	ELEM DIAG		X														
2	117C1514P020	KEY ORIENT		X														
3	129B2808G001	COMP BOARD		1								21						
4	167A1488P001	BRACKET		1	1	1	1											
5	159A2118P001	HANDLE		1	1	1	1											
6	159A2117P001	HINGE		2	2	2	2											
7	159A1230P002	POST		4	4	4	4											
8	167A1492P001	INSULATION		1	1	1	1											
9	159A1959P001	COVER		1	1	1	1											
10	159A1985P001	KEY		2	2	2	2											
12	175A8388P001	DR SCR		2	2	2	2											
13	117C1000P9004	PAN HD SCR		12	12	12	12					#4-40 x .250.						
14	117C1000P9006	PAN HD SCR		4	4	4	4					#4-40 x .375						
15	117C1000P5004	PAN HD SCR		2	2	2	2					#2-56 x .250						
16	175A8015P005	SPG LK WASH		12	12	12	12					#4						
17	175A8015P003	SPG LK WASH		2	2	2	2					#2						
18	167A1489P001	COVER		1	1	1	1											
19	175A8190P028	SPACER		2	2	2	2											
20	175A8000P013	HEX NUT		8	8	8	8					#6-32						
21	167A1490P001	PLATE		1	1	1	1											
22	104B2794P001	TRANSFORMER	B	1	1	1	1											
23	129B2833P001	FRAME		1	1	1	1											

7 *Red Bush* 23-168 *11* *13*

RETRACED-UPDATED
FOR CMPTR

8 *RPH* *12-20* *11* *11*

ADDED G344 *44*

G1-100-V600V
G2-600V-1200V
G3-100V-600V
G4-600V-1200V

PRINTS TO
A13
6 RE
7
11 *40*

REVISION CODE
1. ITEM ADDED 2. ITEM DELETED 3. ITEM REVISED

MADE BY
P. RODRIGUEZ APRIL 29-65
Red Bush Jan. 23-68

APPROVALS
GC MINOR
4-29-65

SH NO.
1

CONT
ON SH
2

REVISIONS

DESCRIPTION OF GROUPS

GENERAL ELECTRIC

ATOMIC POWER EQUIPMENT DEPT. SNO
SAN JOSE, CALIF.

TITLE ASM. POWER SUPPLY			SPARES	GROUP NO. AND QTY								U/M	PL 112C2220			SH NO. 2	CONT ON SH 3	REV 11
FIRST MADE FOR GEN USE													FCF					
ITEM NO.	IDENTIFICATION NO.	NAME		1	2	3	4						REMARKS	REV CODE				
24	145A5934P001	TRANSISTOR	B	1	1	1	1											
25	175A7498P001	TRANSISTOR	B	1	1	1	1											
27	167A1494P001	SHELF		2	2	2	2											
28	167A1495P001	CLAMP		2	2	2	2											
29	175A7462P002	CAPACITOR	B	2	2	2	2						C2, C3					
30	175A7451P002	CAPACITOR	B		1		1						C1					
31	167A2090P001	DIODE	B	2	2	2	2											
32	145A5424P003	GROMMET	B	4	4	4	4											
33	145A5769P001	TERMINAL	B	6	6	6	6											
34	167A1487G001	COMP BOARD		1									22					
35	175A8000P009	HEX NUT		10	10	10	10						#4-40					
36	175A7209P004	EYELET	B	2	2	2	2											
37	145A5429P001	SPACER		2	2	2	2											
38	117C1000P13008	PAN HD SCR		2	2	2	2						#6-32 x .500					
39	117C1001P13010	FH SCR		2	2	2	2						#6-32 x .625					
40	117C1001P130C6	FH SCR		6	6	6	6						#6-32 x .375					
41	117C1000P130G4	PAN HD SCR		2	2	2	2						#6-32 x .250					
42	175A8015P007	SPG LK WASH		10	10	10	10						#6					
44	175A8891P016	POT	B	1		1							R1					
45	117C1000P13006	PAN HD SCR		2	2	2	2						#6-32 x .375					
46	175A8892P001	POT BRACKET	B	1	1	1	1											
47	112C2231	ELEM DIAG			X													

10 *Red Bush* 123-456

RETRACED-UPDATED FOR CMPTR

11 *RPKidwell* 1968

ADDED G364

PRINTS TO A13

6 RE-

7

11 40

REVISION CODE

1. ITEM ADDED 2. ITEM DELETED 3. ITEM REVISED

MADE BY P. RODRIGUEZ APRIL 29-65

APPROVALS GC MINOR 4-29-65

Red Bush Jan. 23-68

PL 112C2220

SH NO. 2 CONT ON SH 3

REVISIONS

DESCRIPTION OF GROUPS

15 NEBS

GENERAL ELECTRIC

~~ATOMIC POWER EQUIPMENT DEPT~~ SNO
SAN JOSE CALIF

TITLE ASM POWER SUPPLY	SPARES
FIRST MADE FOR GEN USE	

PL 112C2220	SH NO 3	CONT ON SH 4	REV 2
-------------	------------	--------------------	----------

FIRST MADE FOR GEN-0000														U/M	REMARKS	REV
ITEM NO.	IDENTIFICATION NO.	NAME		1	2	3	4									
48	117C1514P025	KEY ORIENT			X											
49	167A1904G001	COMP BOARD			1									Z2		
50	129B2841P001	CONN DIAG		X												
51	129B2841P002	CONN DIAG			X											
52	175A7451P001	CAPACITOR	B	1		1								C1		
53	175A8891P017	POT	B		1		1							R1		
54	129B2808G002	COMP BOARD			1									Z1		
55	117C2108	ELEM DIAG				X										
56	117C1514P026	KEY ORIENT				X										
57	129B2808G003	COMP BOARD				1								Z1		
58	167A1487G002	COMP BOARD				1								Z2		
59	117C2109	ELEM DIAG					X									
60	117C1514P027	KEY ORIENT					X									
61	129B2808G004	COMP BOARD					1							Z1		
62	167A1904G002	COMP BOARD					1							Z2		
63	129B2841P003	CONN DIAG				X									2	
64	129B2841P004	CONN DIAG					X								2	
65	167A2923P001	WIRE		1	1	1	1					FT	#18 AWG			
66	167A1298P003	WIRE		1	1	1	1					FT	#20 AWG			
67	175A8227P006	TUBING		6	6	6	6					IN	FOR ITEM 66			
68	175A8227P021	TUBING		6	6	6	6					IN	FOR ITEM 53			
69	107C5496P095	WIRE		1	1	1	1					FT	WHT-GRN			

1 RPKidwell APR 20 1968
ADDED 6364, AND
ITEMS 55 THRU 69
ADDED SH 4
2 NOV 25-68
ITEM 63 WAS QTY 1 G3
ITEM 64 WAS QTY 1 G4

PRINTS TO A13	REVISION CODE 1. ITEM ADDED 2. ITEM DELETED 3. ITEM REVISED	
6	MADE BY <i>Ed Bush</i> JAN 18, 68 ISSUED <i>Ed Bush</i> JAN 23-68	APPROV. gcm 1-18-68
7		
11	40	PL 112C2220
		SH NO 3 CONT ON SH 4

REVISIONS

DESCRIPTION OF GROUPS

NID

SAN JOSE CALIF

NEBS-PL-8 REV 3-58

STANDARD G.E. CO. MONOGRAM
3/8 DIA, USE DURABLE BLACK INK

APPROPRIATE GROUP NO.
TO BE SUPPLIED BY MFG

MARK DWG NO. USING
 $\frac{1}{8}$ HIGH CHARACTERS.

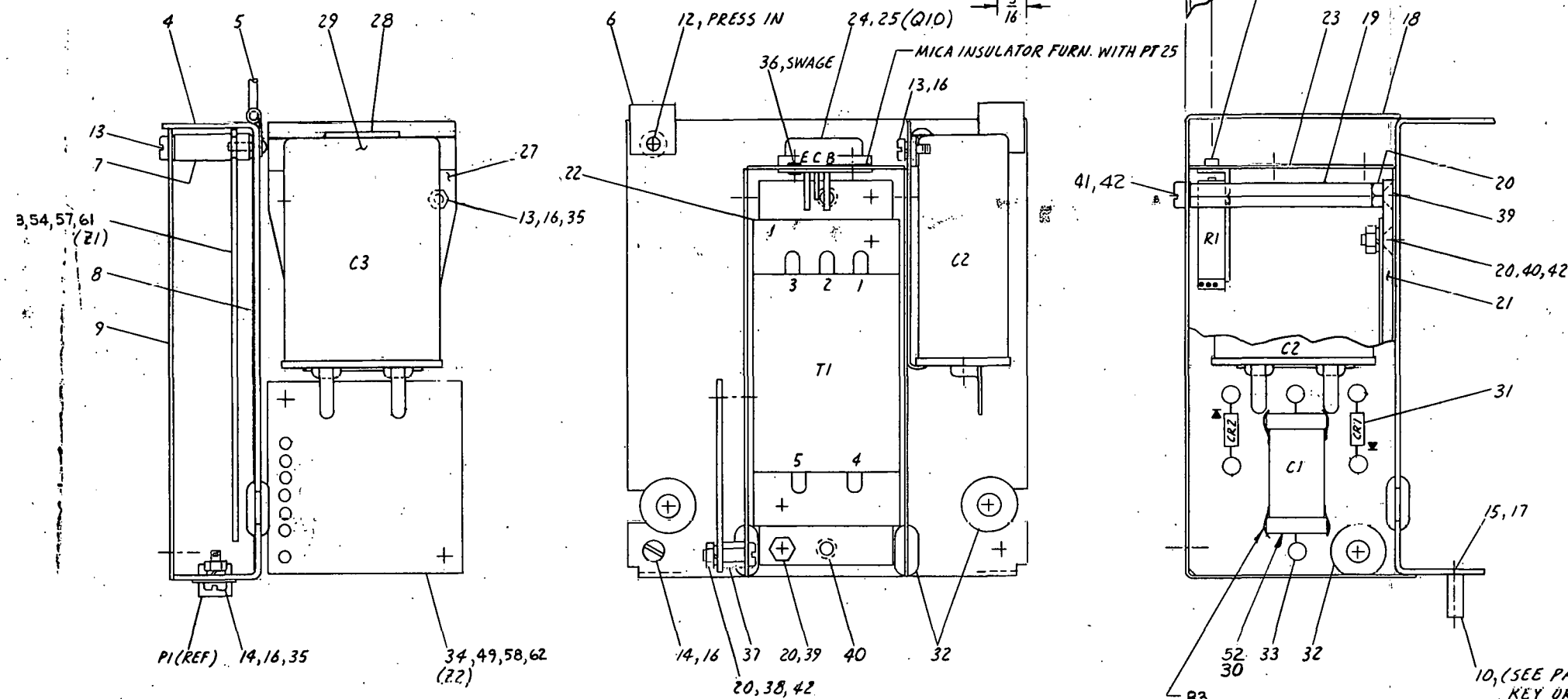
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—			
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS	
		FRACTIONS	DECIMALS
—	✓	+	+
—		—	—

TITLE *ASM* POWER SUPPLY
FIRST MADE FOR *GEN USE*

PL ISSUED

SEE NOTE 1.

44,46,53(DISCARD RUBBER WASHER UNDER MOUNTING NUT)



NOTES:

1. MARK RICHIO ADJACENT TO
COMP ON FRAME, ITEM 23, PER
175A7656.

(GI)

(G2)

63

G4

DIFFERENT COMPONENT BOARD (22) PT.49; CAPACITOR, PT30; POT., PT53; COMP BOARD, PT54;
 & KEY ORIENTATION, REPLACE ITEM 84 WITH BLUE WIRE OTHERWISE SAME AS 61.

DIFFERENT COMPONENT BOARDS (Z31) PT 57 ; (Z2) PT 58 ; KEY ORIENTATION, OTHERWISE SAME AS G1.

DIFFERENT COMPONENT BOARDS (231) PT 61; (22) PT 62; CAPACITOR, PT 30; POT, PT 53, & KEY ORIENTATION, REPLACE ITEM 84 WITH BLUE WIRE OTHERWISE SAME AS G1

REVIEWS	PRINTS TO
10 RPK ^{APR 20} 1968 ¹¹ 11	A14
ADDED G34 ^{APR 20} 1968 ¹¹ 11	11
11 ^{APR 20} 1968 ¹¹ RRS	4
CHG ^{APR 20} 1968 ¹¹ RRS	6.
17 AD ^{APR 20} 1968 ¹¹ RRS	
12 ^{APR 20} 1968 ¹¹ RRS	
EN709059	

MADE BY <i>P. K. R. 26 APRIL '85</i>	APPROVALS <i>gcm</i>
ISSUED <i>16 APRIL 30 1965</i>	<i>4-29-</i>

NID
SAN JOSE

112C2220

GENERAL ELECTRIC

NID

SAN JOSE, CALIF.

[illegible]

167A1487

REV NO. 23

TITLE ASM

CONT ON SHEET 2 SH NO. 1

167A1487

CONT ON SHEET 2 SH NO. 1

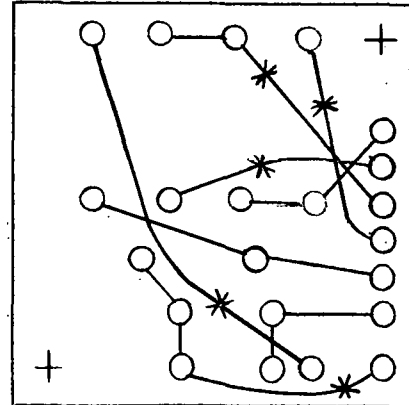
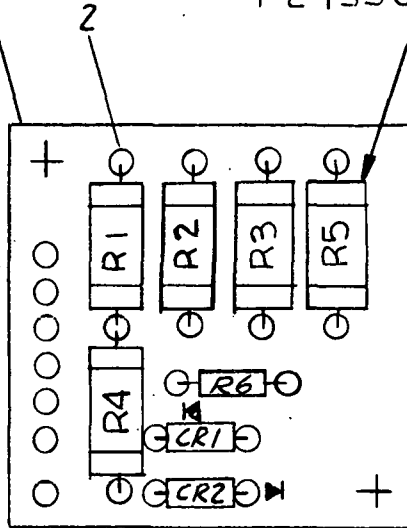
COMPONENT BOARD

FIRST MADE FOR POWER SUPPLY (100V - 600V)

PL ISSUED

FCF 112C2220

INSULATE ENDS OF R1 THRU R5 WITH ITEM 12.



NOTE

1. ALL WIRE TO BE PER ITEM 10.
- INSULATE WIRES MARKED THUS (*) WITH ITEM 11.

PT. NO.	COMPONENT
3	CR1, CR2
4	R1
5	R2
6	R3
7	R4, R5
8	R6

61

UNLESS OTHERWISE SPECIFIED USE	APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
			FRACTIONS	DECIMALS	ANGLES
		✓	+	+	+

REVISIONS

PRINTS TO

1	MAY 11-1965 RPM/emp/ky	KEB	ALL	
	NE10785	qcm	6	
2	RPKidwell APR. 20 1965	INT		
	ADDED SHEET 2			
3	RPKidwell APR 16 1965	RRS		
	ENT08854			

MADE BY P12 NAP	23 APRIL '65	APPROVALS gethman 4-30-65	NID	DIV OR DEPT.	167A1487
ISSUED	APRIL-30-1965		SAN JOSE	LOCATION	CONT ON SHEET 2 SH NO. 1

GENERAL ELECTRIC

167A1487
CONT ON SHEET F SH NO. 2

REV. NO. 0

TITLE ASM

167A1487

CONT ON SHEET F

SH NO. 2

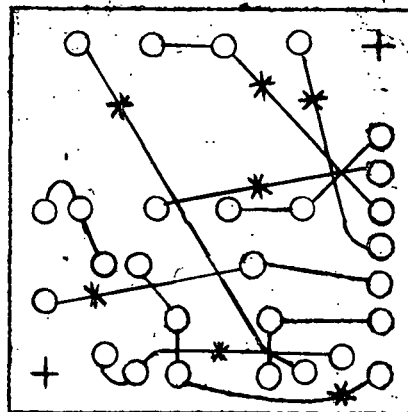
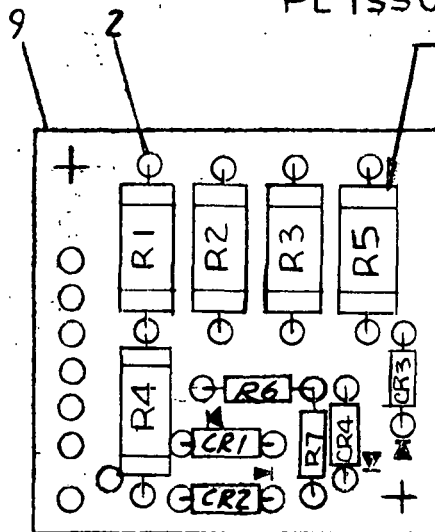
COMPONENT BOARD

FIRST MADE FOR POWER SUPPLY (100V - 600V)

PL ISSUED

FCF 112C2220

INSULATE ENDS OF
R1 THRU R5 WITH ITEM 12



NOTE

1. ALL WIRE TO BE PER ITEM 10.
- INSULATE WIRES MARKED THUS (*) WITH ITEM 11.

ITEM NO	COMPONENT
3	CR1 THRU CR4
4	R1
5	R2
6	R3
7	R4, R5
8	R6, R7

G2

UNLESS OTHERWISE SPECIFIED USE	APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
			FRACTIONS	DECIMALS	ANGLES
		✓	+	+	+

REVISIONS

PRINTS TO

1	RPKidwell 16 APR 68	RRS	A14
	EN708854		6

MADE BY RPKidwell 16 APRIL 68

APPROVALS

NID

DIV OR DEPT.

167A1487

APR 20 - 1968

4-18-68

SAN JOSE

LOCATION

CONT ON SHEET F

SH NO. 2

GENERAL ELECTRIC

TITLE ASM COMPONENT BOARD			SPARES	NID SAN JOSE, CALIF.								PL 129B2808		SH NO. 1	CONT ON SH 2	REV 9
POWER SUPPLY				GROUP NO. AND QTY								FCF 112C2220				
ITEM NO.	IDENTIFICATION NO.	NAME		1	2	3	4					U/M	REMARKS	REV		
1	129B2807P001	BOARD		1												
2	112C3791P016	CONNECTOR		1	1	1	1						P1			
3	175A8383P002	HV CONTACT	B	5	5	5	5									
4	159A1969P001	EYELET	A	84	85	94	93							9		
5	175A7209P002	EYELET		8	8	8	8									
6	175A7209P001	EYELET		1	1	3	3									
7	209A6156P001	CAPACITOR		2	2	2	2						C1, C2			
8	112C2642P051	CAPACITOR		2	2	2	2						C3, C5			
9	112C2277P101	CAPACITOR		1	1	1	1						C4	9		
10	175A7485P001	DIODE		2	2	2	2						CR1, CR2			
11	175A7476P002	ZENER		2	2	2	2						VR1, VR2			
12	112C2674P033	RESISTOR		2	2	2	2						R1, R4			
13	112C2675P036	RESISTOR		1	1	1	1						R2	9		
14	112C2674P073	RESISTOR		2		2							R3, R5			
15	112C2674P061	RESISTOR		4	4	4	4						R6, R8, R23, R7			
16	112C2674P057	RESISTOR		1	1	1	1						R9			
17	112C2674P058	RESISTOR		2	2	2	2						R10, R20			
18	112C3162P077	RESISTOR		2	2	2	2						R12, R21			
19	112C2674P075	RESISTOR		2	2	2	2						R13, R18			
20	112C2674P085	RESISTOR		2	2	2	2						R14, R19			
21	112C2674P083	RESISTOR		2	2	2	2						R15, R17			
22	112C2674P082	RESISTOR	B	1	1	1	1						R16			

6 *Ed Bush* 12/31/65 13

RETRACED-UPDATED FOR CMPTR

7 *RPK* 12/31/65 14

ADDED G324, ITEM WAS QTY 1 IN G12.

8 *Bygones* 12/31/65 15

NE 19319

9 *Bygones* 12/31/65 16

EN 706371

NE 19495

PRINTS TO

A13

7

6

40

REVISION CODE

1. ITEM ADDED 2. ITEM DELETED 3. ITEM REVISED

MADE BY P. RODRIGUEZ APRIL 29-65

RE-ISSUED *Ed Bush* JAN 21 1968

APPROVALS GC MINOR 4-29-65

SH NO. 1 CONT ON SH 2

REVISIONS

DESCRIPTION OF GROUPS

SAN JOSE, CALIF.

NEBS-PL-8 REV 7-67

129B2808
CONT ON SHEET 2
DRAWING NO.

TRANSISTOR BASING
FOR Q1, Q3 THRU Q9

B1
B2
FOR Q2

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+

REV NO. 018348089
129B2808
CONT ON SHEET 2 SH NO. 1

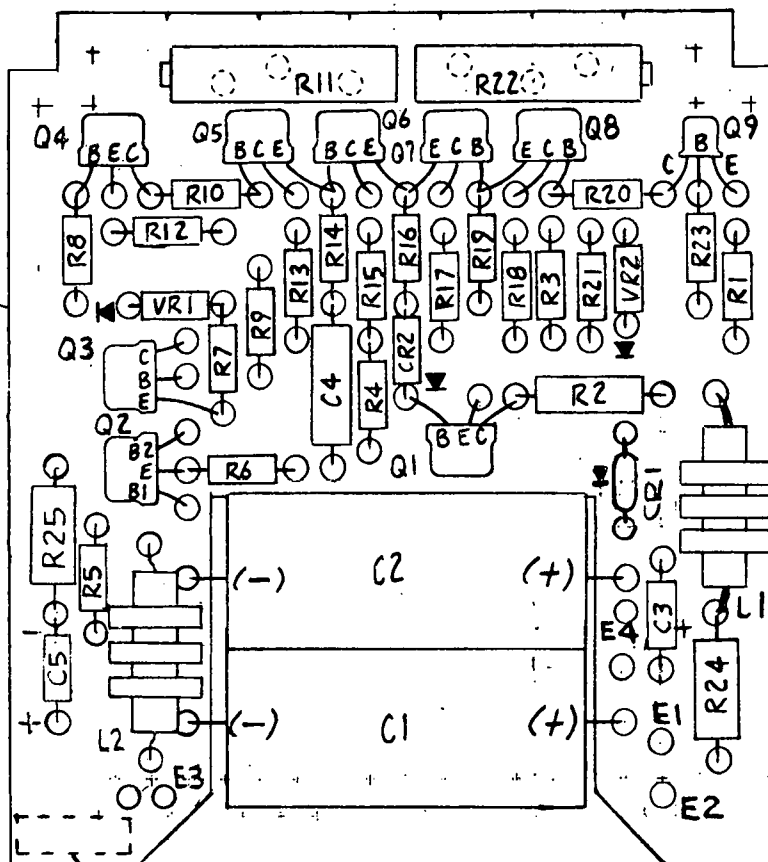
GENERAL ELECTRIC

129B2808
CONT ON SHEET 2 SH NO. 1

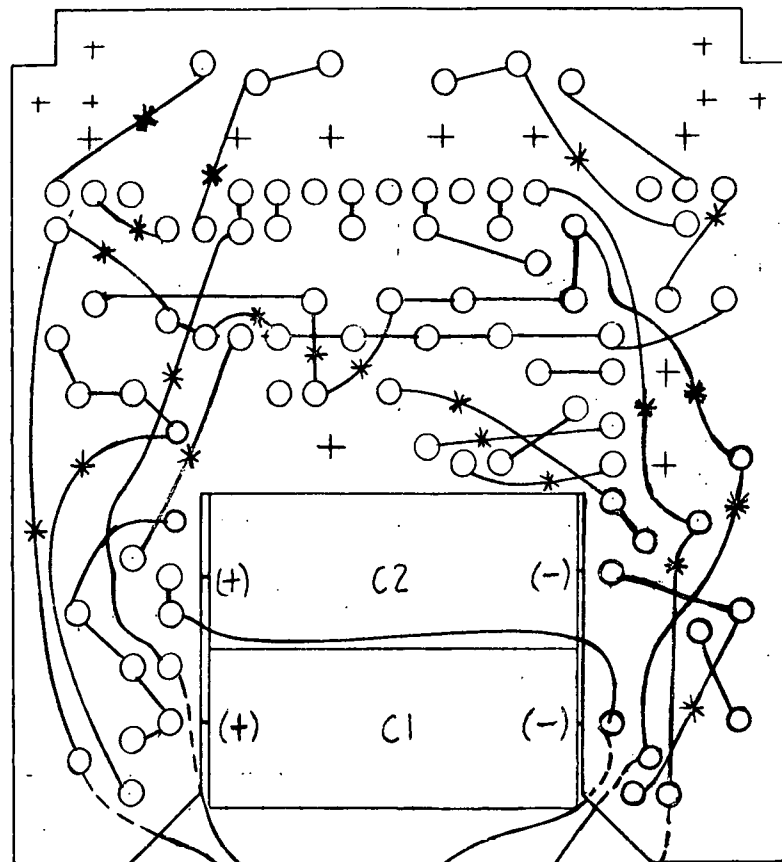
TITLE ASM
COMPONENT BOARD
FIRST MADE FOR POWER SUPPLY

PARTS LIST ISSUED FCF 112C2220

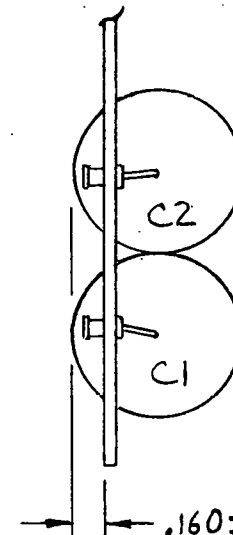
- NOTES
- THE FOLLOWING NOTES FOUND ON 159A1955 APPLY:
1D, 2, 3
 - MARK "R11, R22, E1, E2, E3, E4, Q1 THRU Q9"
INCLUSIVE AS SHOWN WITH 1/8 HIGH (APPROX)
CHARACTERS.



MARK SERIAL NO. IN THIS AREA.
NO. TO BE SUPPLIED BY MFG.



VIEW OF REAR OF BOARD



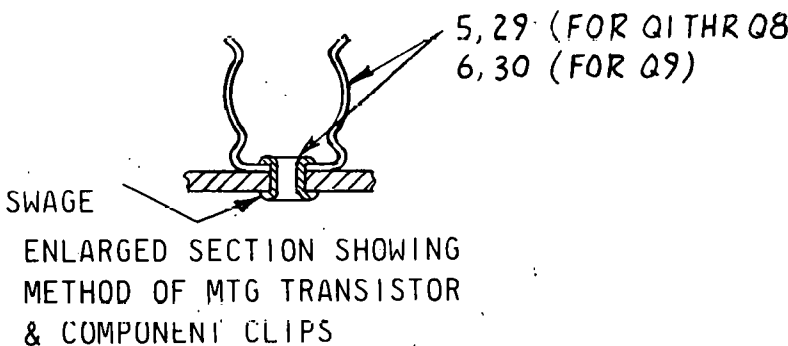
PT NO	REFERENCE DESIGNATION
7	C1, C2
8	C3, C5
9	C4
10	CR1, CR2
11	VR1, VR2
12	R1, R4
13	R2
14	R3, R5
15	R6, R7, R8, R23
16	R9
17	R10, R20
18	R12, R21
19	R13, R18
20	R14, R19
21	R15, R17
22	R16
23	R11, R22
24	R24, R25
25	L1, L2
26	Q1, Q3 THRU Q8 INCL

PT NO	REFERENCE DESIGNATION
27	Q2
28	Q9

REVISIONS

7	SEPT. 3-65 D. Brandt	KEB	4	JULY-15-65 R. W. Brandt	KEB	1	MAY 11-1965 M. H. Brandt	KEB
NE 11838			NE 11657			NE 10787		
8	SEPT. 21-65 K. E. Brandt	KEB	5	AUG. 18-65 D. Brandt	KEB	2	JULY-7-1965 D. Brandt	KEB
ADD INSUL FOR SEVERAL JUMPERS.			ADDED NOTE FOR SER NO.			NE 11518		
9	SEPT. 24-65 P. Brandt	KEB	6	AUG. 27-65 D. Brandt	KEB	3	JULY-7-1965 K. E. Brandt	KEB
NE 11940			NE 11798			NE 11601		

PRINTS TO



SWAGE
ENLARGED SECTION SHOWING
METHOD OF MTG TRANSISTOR
& COMPONENT CLIPS

MADE BY P. Brandt	6 APRIL 65	APPROVALS D. Brandt	4-30-65	NID	DIV OR DEPT	SAN JOSE	LOCATION	129B2808	CONT ON SHEET 2	SH NO. 1
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129B2841
CONT ON SHEET 2
SH NO. 1

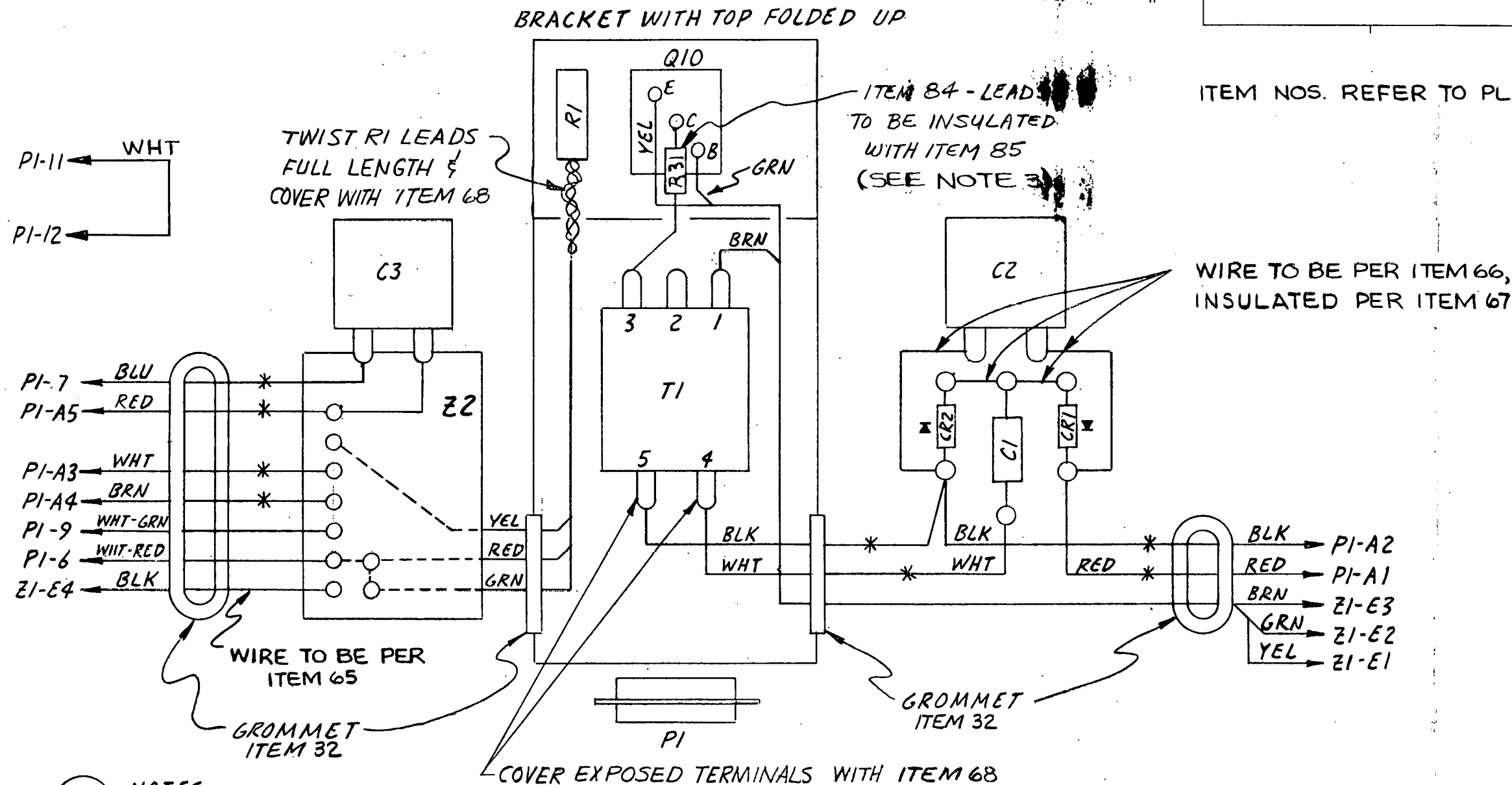
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
	✓	FRACTIONS	DECIMALS	ANGLES
		+	+	+

REV. NO. 10
129B2841
CONT ON SHEET 2
SH NO. 1

GENERAL ELECTRIC
129B2841
CONT ON SHEET 2
SH NO. 1
TITLE CONN DIAG
POWER SUPPLY
FIRST MADE FOR GEN USE

FCF 112C2220

ITEM NOS. REFER TO PL 112C2220.



1

NOTES

1. ALL WIRE TO BE PER ITEMS 69 THRU 77.
2. WIRES MARKED THUS (*) TO BE PER ITEMS 78 THRU 82.
3. R31 IS USED ONLY WHEN "T1" IS MADE BY SAE. WHEN "T1" IS MADE BY PAECO, CONNECT Q10-C TO T1-3 WITH ITEM 75.

REVISIONS				PRINTS TO	
10	RPKidwell	4/30/65	RRS		
EN709806					

MADE BY P. Rodriguez
ISSUED 29 APRIL 65
WAX. APRIL-30-65

APPROVALS
4-30-65

NID
SAN JOSE
DIV OR DEPT
LOCATION

129B2841
CONT ON SHEET 2
SH NO. 1

112C2223

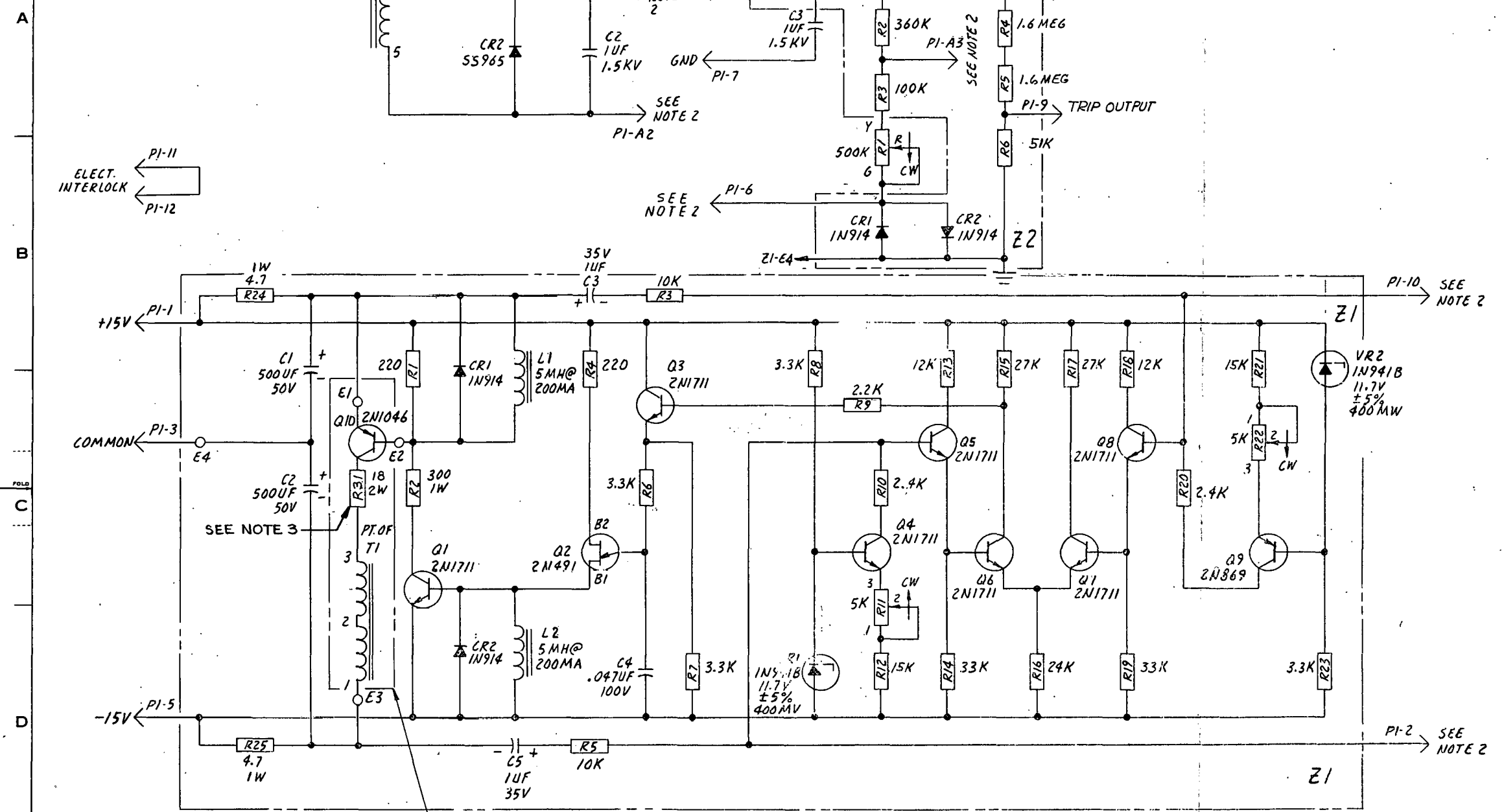
GENERAL ELECTRIC

112C2223

ELEM DIAG
POWER SUPPLY (100V-600V)
FIRST MADE FOR GEN USE

FCF 112C2220G1

UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:				
APPLIED PRACTICES	SURFACES	FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+



- NOTE
1. ALL RESISTORS ARE $\frac{1}{2}$ W, $\pm 5\%$ TOLERANCE & VALUES GIVEN IN OHMS UNLESS OTHERWISE SPECIFIED.
 2. THIS POWER SUPPLY IS CAPABLE OF SUPPLYING 100V TO 600V POSITIVE OR NEGATIVE. SEE TABLE 1 FOR CONNECTIONS TO BE MADE EXTERNALLY FOR DIFFERENT VOLTAGE RANGES & POLARITIES.
 3. R31 IS USED ONLY WHEN "T1" IS MADE BY SAE. WHEN "T1" IS MADE BY PAECO, CONNECT COLLECTOR OF Q10 DIRECTLY TO T1-3.

POLARITY	RANGE			
	100V TO 350V		350V TO 600V	
POSITIVE	A1	TO A4	A1	TO A4
	A2	GND	A2	GND
	A3	A5	A3	NOT CONNECTED
	PIN 2	PIN 6	PIN 2	PIN 6
NEGATIVE	PIN 10	GND	PIN 10	GND
	A1	GND	A1	GND
	A2	A4	A2	A4
	A3	A5	A3	NOT CONNECTED
	PIN 2	GND	PIN 2	GND
	PIN 10 TO PIN 6		PIN 10 TO PIN 6	

TABLE 1

REVISIONS		PRINTS TO	
5	RPK	RR3	A10
ADDED NOTE 3			

27 APRIL '65
NID

SAN JOSE

112C2223

V. Module Description (Continued)

S. 30 Volt Power Supply (Elementary Diagram 136B2471)

This unit consists of a modular ± 15 volt supply which operates from 115 VAC. However, as used in the WRM System, the -15 terminal is grounded and the secondary common is left floating. Thus the output between the -15 terminal and the +15 terminal is +30 volts. The voltage is adjusted by varying R1 and R2.

GENERAL ELECTRIC

PARTS LIST FOR **136B2472**

CONT ON SHEET . SH NO.

REV NO. 0		TITLE ASSEMBLY		CONT ON SHEET		SH NO.	
PARTS LIST FOR 136B2472		30VOLT POWER SUPPLY					
CONT ON SHEET		FIRST MADE FOR PA 49					
GROUP NO. AND QUANTITY		PART NO.	NAME	DRAWING NO., DESCRIPTION, MATERIAL, WEIGHT			
		1	ELEM DIAG	136B2471			
		1	2 ENCLOSURE	104B24336001			
		2	3 PAN HD SCR	117C1000P9006, #4-40 X .38			
		2	4 HEX NUT	175A8000P0009, #4-40			
		2	5 SPG LK WASH	175A8015P0005, #4			
			6				
			7				
			8				
			9				
		1	10 BOARD				
		1	11 CONNECTOR	DCC-37P			
		29	12 EYELET	159A1969P1			
		2	13 RES, R1 & 2	55P-5K BECKMAN			
		1	14 P.S., PS1	MPD 15/100, PASTORIZA ELECTRONICS INC.			
		1	15 CAP, C1	CL25BJ101UP3, 100µf, 50V, G.E.			
		2	16 TEST JACK				
			J1 & J2	SKT-0802-White SEAELECTRO CORP.			
DESCRIPTION OF GROUPS		REVISIONS			PRINTS TO		
					58		
MADE BY [Signature]		APPROVALS [Signature]		DIV. OR DEPT. NID		PARTS LIST FOR 136B2472	
ISSUED 8/27/69		SAN JOSE, CALIF		LOCATION		CONT ON SHEET SH NO.	

CONT ON SHEET DRAWING NO. 136B2472		UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:			REV. NO. 0 136B2472	TITLE ASSEMBLY 30 VOLT POWER SUPPLY FIRST MADE FOR PA 49		CONT ON SHEET SH NO.	
APPLIED PRACTICES		SURFACES		TOLERANCES ON MACHINED DIMENSIONS					
		✓		FRACTIONS	DECIMALS	ANGLES			
				+	+	+			
				-	-	-			

30 VOLT POWER SUPPLY

R1 J1 J2 R2

PS1

C1

3,4,5
2 PLCS

36 34 20 3

REVISIONS		PRINTS TO	
		58	

MADE BY ISSUED	APPROVALS NID 8/27/69	DIV. OR DEPT. SAN JOSE, CALIF.	CONT ON SHEET SH NO.
		136B2472	

136B2471
DRAWING NO. 136B2471
CONT ON SHEET

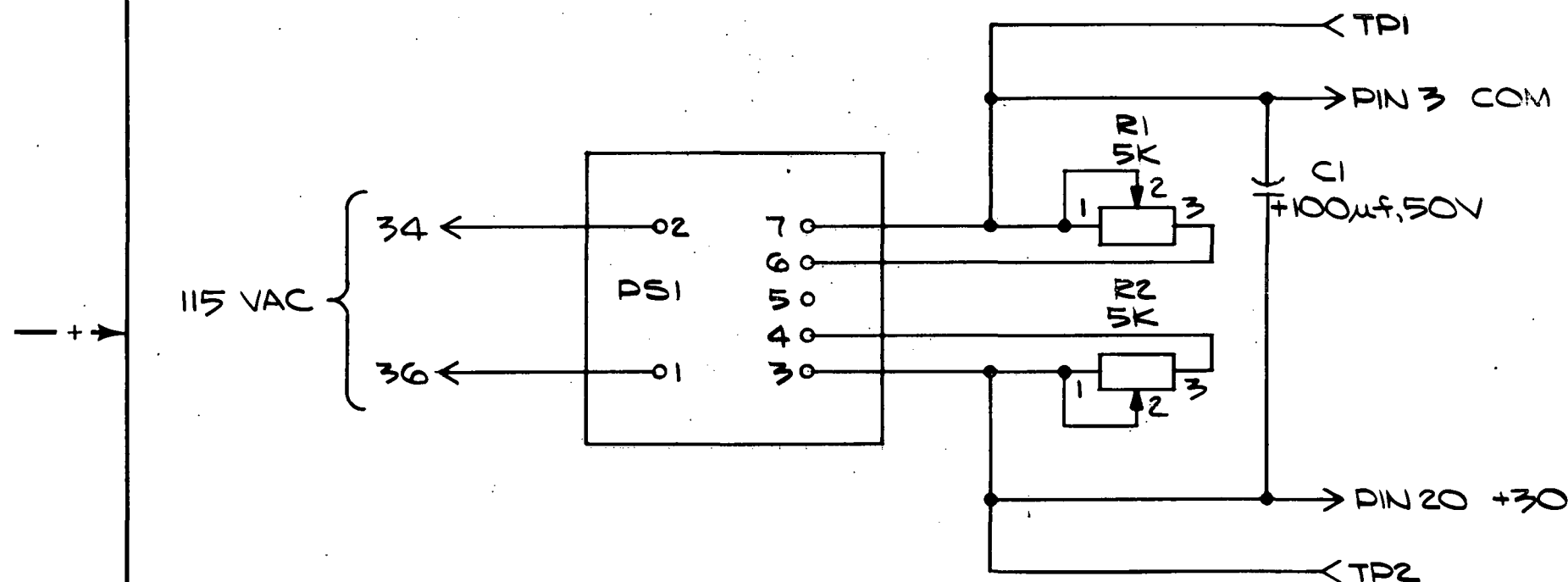
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING:—				
APPLIED PRACTICES	SURFACES	TOLERANCES ON MACHINED DIMENSIONS		
		FRACTIONS	DECIMALS	ANGLES
	✓	+	+	+
		—	—	—

REV. 0
136B2471
CONT ON SHEET SH. NO.

GENERAL ELECTRIC

136B2471
CONT ON SHEET SH. NO.

TITLE ELEM DIAG
30 VOLT POWER SUPPLY
FIRST MADE FOR PA 49



REVISIONS	PRINTS TO
	58

MADE BY *B. Schmidt*
ISSUED

APPROVALS
WES
8/27/69

NID
SAN JOSE CALIF

DIV. OR DEPT.
LOCATION
136B2471
CONT ON SHEET SH. NO.

V. Module Description (Continued)

T. ±15 Volt Power Supply

PRECISION OPERATIONAL AMPLIFIER POWER SOURCE



- FOR "SAMPLE AND HOLD" AND SIMILAR APPLICATIONS
- MOUNTS IN ANY PLANE TO ANY SURFACE
- NO HEAT SINKS OR FORCED AIR COOLING

The Model UPMD-11 is a modular, plug-in power supply containing two precision 15 volt, 1 ampere sources. Utilizing a master-slave tracking feature, this module is ideally suited for high stability operational amplifier applications. Both sources maintain their voltage levels to within 10 millivolts per week.

ELECTRICAL SPECIFICATIONS**OUTPUT:**

Master Supply: -15 VDC ± 50 MV, 1 A
 Slave Supply: +15 VDC ± 10 MV, 1 A

INPUT: 105 to 125 V, 55 to 440 Hz, single phase

REGULATION: Load: 150 microvolts
 Line: 100 microvolts

RIPPLE AND NOISE: Less than 150 microvolts peak-to-peak to 50 MHz

STABILITY: ± 1 millivolt in 8 hours, 10 millivolts per week, after 2 hour warm-up under constant ambient temperature, line and load conditions

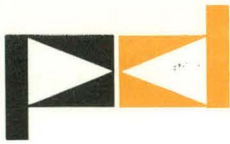
OPERATING TEMPERATURE RANGE:
 0°C to 50°C ambient (derated 4% per °C to 65°C)

TEMPERATURE COEFFICIENT: 0.001% per °C after warm-up

RESPONSE TIME: 50 microseconds for step changes in load from 10% to 100% or 100% to 10%

TRACKING: When set to zero at 25°C, the maximum deviation for combined effects of line, load and temperature is less than 2 millivolts.

SERIAL NO: _____



CURRENT LIMIT POINT: 1.5 A maximum

LOCAL OR REMOTE SENSING: Selection available at mating connector.

CIRCUIT PROTECTION: Current Limiter for DC output shorts and overloads. A thermostat protects the supply against excessive operating temperatures.

MECHANICAL SPECIFICATIONS

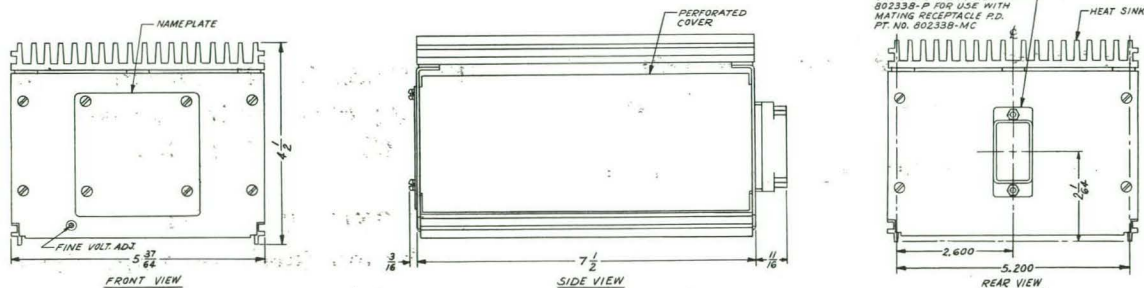
WEIGHT: 7-1/2 lbs.

FINISH: All surfaces finished in gold iridite except heat sink which is red anodized

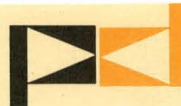
Mating Connector: Available as accessory.
Power Designs' Part No. 00-8016-038-217-016. \$3.85 each

PRICE: \$275.00 FOB Westbury, New York

MOUNTING: Mounts in any plane to any surface. The module may be mounted on 5-1/4" card bin guides, chassis mounted or panel mounted with a simple bracket assembly. Modular bins are available for mounting up to two modules and one single width (UPM) module on a standard 5-1/4" x 19" panel.



MECHANICAL DIMENSIONS



A D D E N D A

POWER SUPPLY

MODEL UPMD-11

The Electrical Parts List and/or Schematic Diagram have been modified as follows:

1. Capacitors C8 and C16 are 260 uf, 15 vdc.
2. Capacitor C18 has been eliminated and capacitors C22 and C23, 0.02 uf, 500 vdc, added to the terminals of transformer T1.
3. Diodes CR1 thru CR4 and CR7 thru CR10 are part number GI88.
4. Diode CR13 is part number SV359ET.
5. Transistors Q4, Q10 and Q11 are part number MS1028A.
6. Transistor Q5 is part number GI696.
7. Transistors Q6 and Q12 are part number MS2916R/Y (manufacturen 98095).
8. Resistor R13 is precision, metal film, 120 k ohms, 1%, $\frac{1}{4}$ w.
9. Resistor R43 is precision, metal film, 125 ohms, 1%, $\frac{1}{4}$ w, part number RD-1250-1QA (manufacturer 98095).

POWER SUPPLY MODEL UPMD-11

SECTION 1 GENERAL DESCRIPTION

1-1. DESCRIPTION

The Model UPMD-11 is a modular, silicon, solid-state DC power supply containing two regulated 15-volt, 1-ampere supplies. The supplies are interconnected so that the +15 volt supply tracks the -15 volt supply. The supply is capable of local or remote sensing through the selection of jumper arrangements on the mating receptacle. The output voltage of each supply is adjustable over a 50 millivolt range.

Each supply is protected against overload by a current limiting circuit and may be operated continuously into a short circuit without damage. This circuit is automatically reset when the overload or short circuit is removed. A thermostat protects the supplies against excessive temperature.

1-2. ELECTRICAL SPECIFICATIONS

Table 1 lists the electrical specifications of the UPMD-11.

1-3. MECHANICAL SPECIFICATIONS

The steel rear, front and side panels of the Model UPMD-11 are cadmium plated and finished in gold iridite. The aluminum base is finished in alodine 1200 and the aluminum heat sink is red anodized. The dimensions and weight of the Model UPMD-11 are as follows:

Width: 5-37/64 inches
Height: 4-1/2 inches
Depth: 7-1/2 inches (excluding 11/16 inch rear connector)
Weight: 7-1/2 lbs.

TABLE 1. ELECTRICAL SPECIFICATIONS

<u>Parameter</u>	<u>Specification</u>	
Input	105 to 125 volts, 57 to 440 Hz, single ϕ	
	<u>-15 VDC Supply (Master)</u>	<u>+15 VDC Supply (Slave)</u>
Output	-15 VDC ± 50 MV 1 ampere	+15 VDC ± 10 MV 1 ampere
Regulation		
Load	150 microvolts	150 microvolts
Line	100 microvolts	100 microvolts
Ripple and Noise	150 microvolts peak-to-peak	150 microvolts peak-to-peak
Current Limit	1.5 amperes, max.	1.5 amperes, max.
Response Time	30 microseconds for turn on 10% to full load; 50 microseconds for turn off full load to 10%, to recover to within 2 MV of regu- lated output voltage.	30 microseconds for turn on 10% to full load; 50 micro- seconds for turn off full load to 10%, to recover to within 2 MV of regulated output voltage.
Temperature Coefficient	0.001%/°C after 1 hour warm-up.	0.001%/°C after 1 hour warm-up.
Stability	10 MV per week; ± 1 MV in 8 hours after 2 hour warm-up.	10 MV per week; ± 1 MV in 8 hours after 2 hour warm-up.
Tracking	2 MV for all conditions.	2 MV for all conditions.

SECTION 2 INSTALLATION AND OPERATION

2-1. INSTALLATION

The Model UPMD-11 can be inserted into either a standard $5\frac{1}{4}$ inch card bin enclosure in the same manner as a printed card, or it can be bolted to the rear of the card bin. The supply can also be mounted on a standard 19 inch rack panel or used as a bench supply.

2-2. PROGRAMMING AND OPERATING INSTRUCTIONS

The Model UPMD-11 can be programmed at the mating receptacle for local or remote sensing. Table 2 provides a cross reference between function, schematic designation and mating receptacle pin number. Table 3 lists the types of operation which can be programmed and the connections required for each. Figure 1 is a diagram showing the mating receptacle connected to provide local sensing.

a. Local and Remote Sensing - The points to which the sensing leads are connected are the points between which the output voltage is maintained constant. Remote sensing should be used when large voltage drops are anticipated in the leads connecting the load and power supply due to their length. Local sensing should be used when the increase in regulation is tolerable. If the voltage is sensed at the output (V_o) of the supply, the voltage across the load (V_l) can be determined as follows:

$$V_l = V_o - I_l \times R_{lw}$$

where: I_l = load current

R_{lw} = resistance of both leads between
the power supply and load

TABLE 2

<u>+15 VDC SUPPLY</u>			<u>-15 VDC SUPPLY</u>		
	<u>Function</u>	<u>Mating Receptacle Pin No.</u>	<u>Function</u>	<u>Mating Receptacle Pin No.</u>	
OUTPUT	Positive	+15 VDC	+ common	TT	
	Negative	-common	-15 VDC	SS	
	Chassis	--	--	H	
SENSING	Positive	+S	+S common	NN	
		-S common	-S	MM	
AC INPUT			M and N		

CAUTION: A one ampere, "Slo-Blo" fuse MUST be connected in the "hot" side of the AC line. NEVER OPERATE THE MODULE WITHOUT AN EXTERNAL FUSE OF THE PROPER RATING.

TABLE 3. PROGRAMMING INSTRUCTIONS

<u>Operation</u>	<u>Supply</u>	<u>Mating Receptacle Pin Connections</u>
LOCAL SENSING (see Fig. 1)	Both	Connect: PP to JJ, RR to KK, NN to TT, KK to NN, MM to SS.
	+15 VDC (Slave)	Connect: PP to positive side of load, RR to negative side of load.
	-15 VDC (Master)	Connect: SS to negative side of load, TT to positive side of load.
REMOTE SENSING (use tightly twisted sensing leads)	Both	Connect: RR to TT, KK to NN.
	+15 VDC (Slave)	Connect: PP to positive side of load, RR to negative side of load, JJ to plus sensing point, KK to minus sensing point.
	-15 VDC (Master)	Connect: SS to negative side of load, TT to positive side of load, MM to minus sensing point, NN to plus sensing point.

UPMD-11

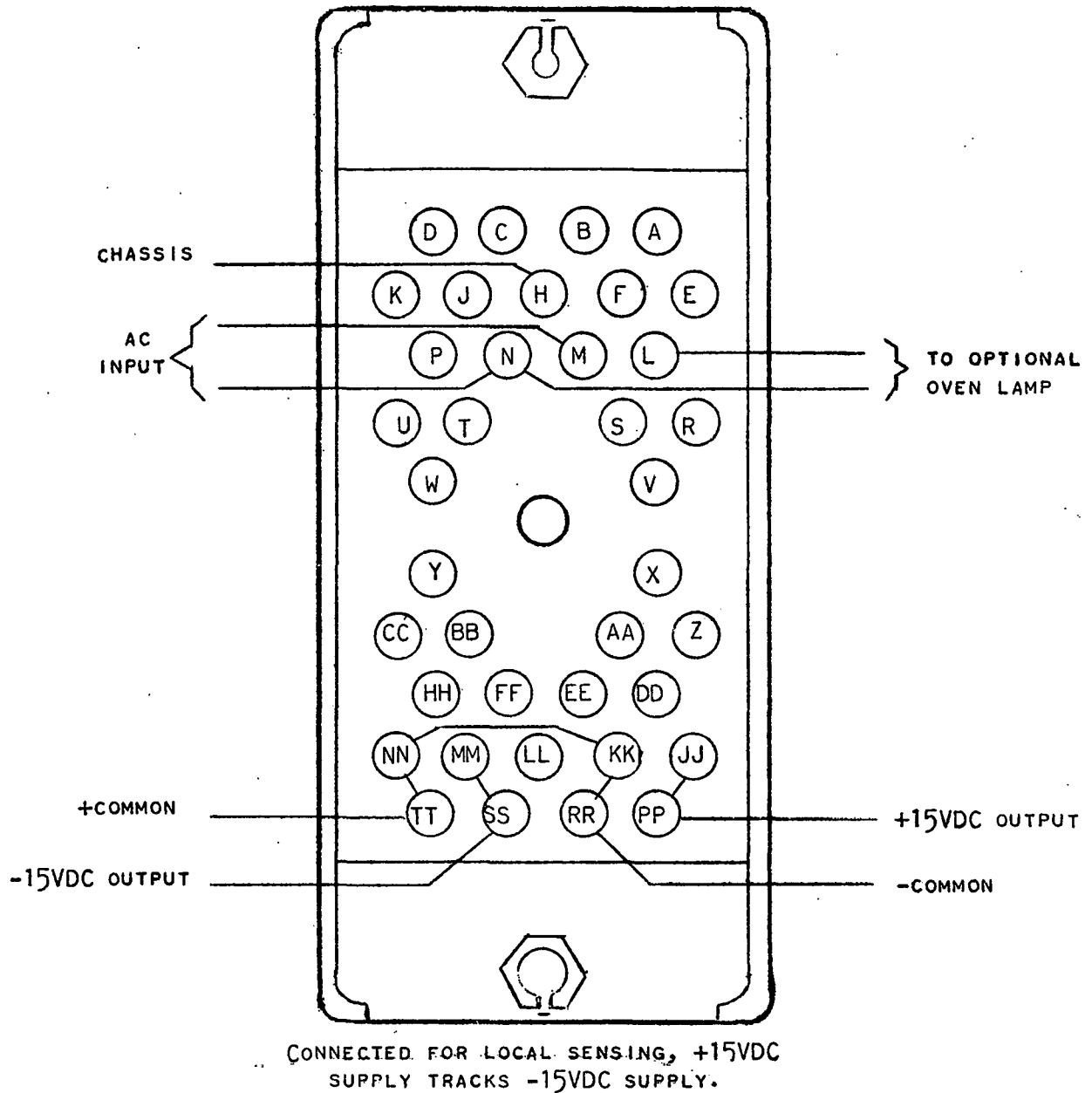


FIGURE 1. MODEL UPMD-11 MATING RE-
CEPTACLE PROGRAMMING CON-
NECTIONS

POWER DESIGNS, INC.
WESTBURY, NEW YORK

SECTION 3 MAINTENANCE

3-1. GENERAL

Under normal conditions, no special maintenance of the Model UPMD-11 is required. The unit is designed for easy disassembly; only a screwdriver is needed.

3-2. DISASSEMBLY AND ASSEMBLY

To disassemble the Model UPMD-11:

- a. Remove the five screws holding each side plate to the base and end plates.
- b. Remove the six screws holding the heat sink assembly. The heat sink can be lifted and the thermostat and power transistors removed and serviced.
- c. Remove the two screws on the underside of the bottom plate holding each end plate. The power transformer is attached to the base plate by four screws.
- d. Remove each of the screws holding the component boards to the base plate and pull the boards clear for inspection or component replacement.

NOTE

When soldering or unsoldering any semiconductor components, a heat sink must be used to prevent thermal damage. A long-nose pliers applied between the semiconductor and solder joint is generally adequate.

- e. Reassemble the unit by replacing the boards, end plates, heat sink assembly and side plates.

3-3. TROUBLESHOOTING

Faults can be isolated rapidly by measuring the voltage at the circuit components. A schematic diagram following this section gives the operating potentials of all semiconductors as well as component locations. Comparison of these potentials should be the first step when servicing the unit.

CAUTION

DO NOT OPERATE THE SUPPLY WITH ANY DISCONNECTED LEADS OR COMPONENTS. BE VERY CAREFUL WHEN SERVICING THE SUPPLY AS TRANSISTORIZED HIGH GAIN AMPLIFIERS ARE EXTREMELY SUSCEPTIBLE TO CHAIN REACTION BURN-OUTS OF TRANSISTORS, DIODES, ETC.

Before beginning step-by-step fault isolation using the voltages given on the schematic diagram, make the following quick checks:

NOTE

Actual voltages may vary 10% from those given on the schematic diagram.

a. No output - Check the receptacles for proper programming connections. Check the collector to emitter voltage of the series pass transistor. No voltage indicates a fault in the rectifier circuit or over-temperature thermostats may have operated.

b. No regulation - If the programming connections and transistor voltages are correct, check that the supply is not overloaded and the line voltage is within the limits.

3-4. SEMICONDUCTOR IN-CIRCUIT TEST

Should a defective semiconductor be suspected, make the following rapid check:

a. Using an ohmmeter set to its low resistance scale, measure the forward/reverse resistance ratio of each junction in the semiconductor by reversing the meter leads.

b. A ratio of less than 1:5 indicates a defective device, and the device should be tested on a transistor or diode tester.

NOTE

This test is not recommended for high frequency or low current devices in other instrumentation as the currents from some ohmmeters may be sufficient to damage the semiconductor junctions.

3-5. CALIBRATION

No calibration is required.

APPENDIX

1. INTRODUCTION

This Appendix contains an electrical parts list, schematic diagram, parts location diagram and equipment warranty.

2. ELECTRICAL PARTS LIST

All electrical and electronic parts are listed in the sequence of their circuit numbers as shown on the schematic diagram. A brief description of each part is given, followed by the code number of the manufacturer and his part number. All manufacturers' code numbers are taken from Cataloging Handbooks H4-1 and H4-2, Federal Supply Code for Manufacturers. These handbooks are available through Federal Agencies. They may also be ordered directly from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

We recommend that all parts having the code number 98095 be ordered directly from Power Designs Inc. The commercial equivalents of these parts have either wide parameter tolerances or require special factory inspection or modification before they are suitable for use in the power supply.

All components used in the power supply or supplied as replacements are carefully inspected at the factory. Inspections are performed on a 100% basis or at AQL levels to Military Specification MIL-Q-9858 under which Power Designs Inc. has been qualified.

All semiconductors are inspected on a 100% basis. They are inspected not only for operating parameters, but also for critical characteristics related to reliability and predictable life expectancy. Some of these characteristics are observed when the device is taken beyond its normal operating regions. These test techniques have been developed under a "predictable reliability" program in operation at Power Designs Inc. for the past twelve years. Under this program, quality control procedures are constantly reevaluated and updated as new advances are made in solid state technology and additional experience is gleaned from field history.

Semiconductor manufacturers are constantly modifying their products. Complete lines are frequently discontinued to be replaced by devices having improved gain, operating voltage levels and frequency response. The high gain, closed loop DC amplifiers used in regulator circuits are particularly sensitive to slight changes in these parameters. Commercial or military "equivalent" transistors used as replacements may affect the power supply performance. Compliance with the original specifications can be assured if replacement semiconductors are ordered from the factory.

All replacement semiconductors are processed and stocked at the factory to insure complete interchangeability with the devices in the original equipment. To insure that proper replacements are provided, the original devices are coded with a Power Designs Inc. part number as follows:

<u>MS</u>	<u>1028</u>	<u>A</u>
Semiconductor Manufacturer's Code	Power Designs Inc. Type	Suffix Identifying Special Parameters

When ordering replacements, please identify the device as completely as possible, listing the model and serial number if available.

In some cases the replacement part received may have a different part number from that given in the Electrical Parts List. This can be due to several factors:

a. A different prefix indicates that Power Designs Inc. is using a different vendor source. The operating characteristics of the devices are identical.

b. A completely different part number indicates:

1. The original vendor discontinued manufacture of the item or could no longer manufacture it to the original specifications.
2. A better device for use in the particular circuit has been substituted.
3. Tighter controls for interchangeability have provided greater assurance of improved reliability with the new replacement.

ELECTRICAL PARTS LIST

NOTE: When replacing semiconductors or investigating their part numbers, note the information in paragraph 2 above.

<u>Circuit Number</u>	<u>Description</u>	<u>Mfr Code Number</u>	<u>Part Number</u>
C1	Capacitor, electrolytic, 900 uf, 50 vdc	98095	CE-98-.5
C3 thru C5	Capacitor, plastic film, 0.01 uf, 200 vdc	98095	CP-16-2
C6	Capacitor, plastic film, 0.22 uf, 80 vdc	98095	CP-29-.8
C7	Capacitor, electrolytic, 10 uf, 35 vdc	98095	CE-106-.35
C8	Capacitor, electrolytic, 260 uf, 15 vdc	98095	CEX-260-15
C9	Capacitor, electrolytic, 900 uf, 50 vdc	98095	CE-98-.5
C12 thru C14	Capacitor, plastic film, 0.01 uf, 200 vdc	98095	CP-16-2
C15	Capacitor, electrolytic, 10 uf, 35 vdc	98095	CE-106-.35
C16	Capacitor, electrolytic, 260 uf, 15 vdc	98095	CEX-260-15
C17	Capacitor, plastic film, 0.01 uf, 200 vdc	98095	CP-16-2
C19	Capacitor, ceramic disc, 0.01 uf, 1 kvdc	98095	CC-13-10
C20	Capacitor, dual, ceramic disc, 0.02 uf, 500 vdc, each section	98095	CC-23-5
C21	Capacitor, ceramic disc, 0.0022 uf, 1kvdc	98095	CC-19-10
C22, C23	Capacitor, ceramic disc, 0.02 uf, 500 vdc	98095	CC-23-5
CR1 thru CR4	Diode, silicon	98095	GI88
CR5, CR6	Diode, silicon	98095	GI44
CR7 thru CR10	Diode, silicon	98095	GI88
CR11, CR12	Diode, silicon	98095	GI44
CR13	Diode, silicon, zener	98095	AC359DT
J1	Connector	91662	00-8016-038-000-002
Q1	Transistor, silicon, NPN	98095	RC1700
Q2	Transistor, silicon, NPN	98095	2N2270
Q3, Q4	Transistor, silicon, PNP	98095	MS1028A
Q5	Transistor, silicon, NPN	98095	MS2270/U
Q6	Transistor, dual, silicon, NPN	98095	AS2056
Q7	Transistor, silicon, NPN	98095	RC1700
Q8	Transistor, silicon, NPN	98095	2N2270
Q9 thru Q11	Transistor, silicon, PNP	98095	MS1028A
Q12	Transistor, dual, silicon, NPN	98095	AS2056
R1	Resistor, composition, 270 ohms, 10%, $\frac{1}{2}$ w	01121	EB2711
R2	Resistor, composition, 33 ohms, 5%, $\frac{1}{2}$ w	01121	EB3305
R3	Resistor, wirewound, 600 ohms, 5%, 3 w	98095	RW-601-3KA
R4	Resistor, composition, 82 ohms, 10%, $\frac{1}{2}$ w	01121	EB8201
R5	Resistor, wirewound, 600 ohms, 5%, 3 w	98095	RW-601-3KA
R6	Resistor, wirewound, 2 ohms, 5%, 3 w	98095	RW-020-3KA
R7	Resistor, composition, 4.7 k ohms, 10%, $\frac{1}{2}$ w	01121	EB4721
R8	Resistor, composition, 1 k ohm, 10%, $\frac{1}{2}$ w	01121	EB1021
R9	Resistor, composition, 100 ohms, 10%, $\frac{1}{2}$ w	01121	EB1011
R10	Resistor, composition, 4.7 k ohms, 10%, $\frac{1}{2}$ w	01121	EB4721
R11	Resistor, composition, 2.7 k ohms, 5%, $\frac{1}{2}$ w	01121	EB2725
R12	Resistor, composition, 5.6 k ohms, 10%, $\frac{1}{2}$ w	01121	EB5621
R13	Resistor, precision, wirewound, 120 k ohms, 1%, $\frac{1}{4}$ w	98095	RW-124-1QA
R14	Resistor, precision, metal film, 66.5 k ohms, 1%, $\frac{1}{4}$ w	98095	RD-6652-1QA
R15	Resistor, composition, 100 ohms, 10%, $\frac{1}{2}$ w	01121	EB1011

UPMD-11

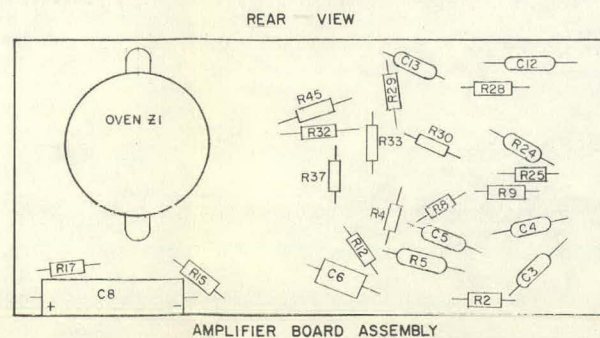
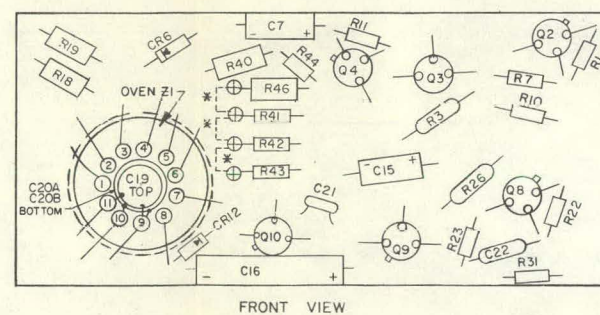
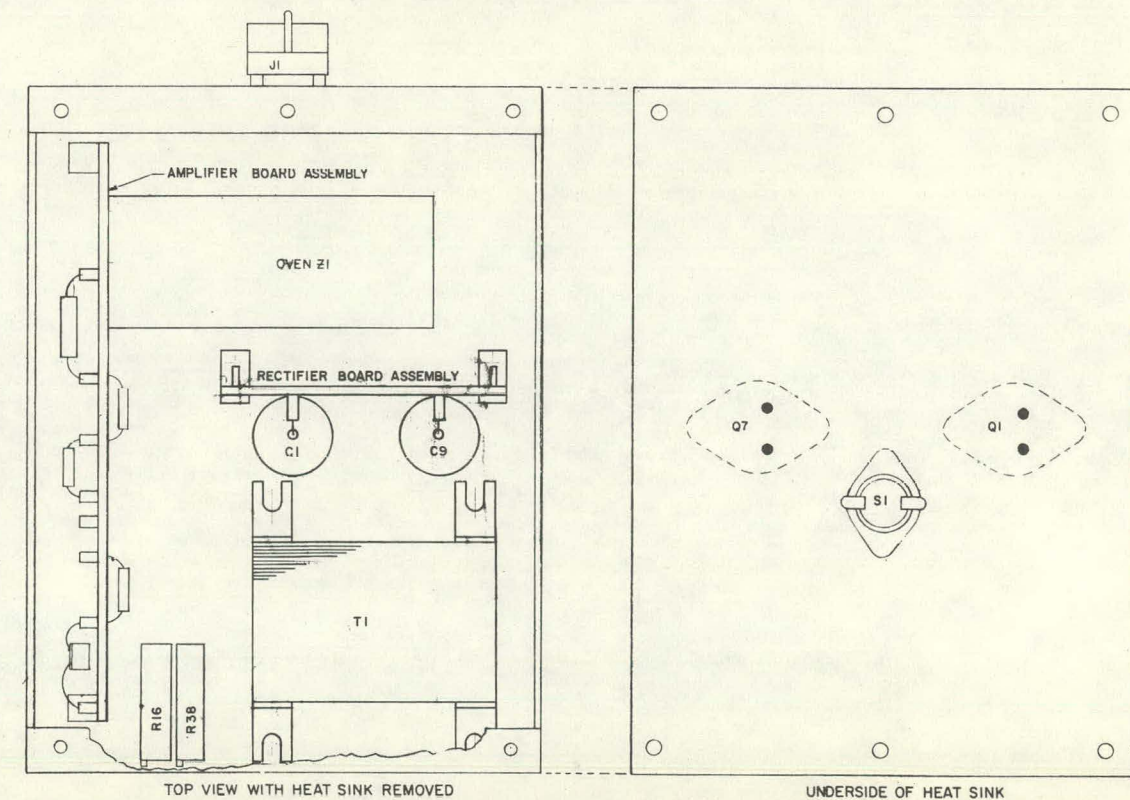
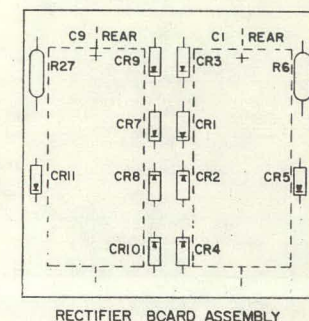
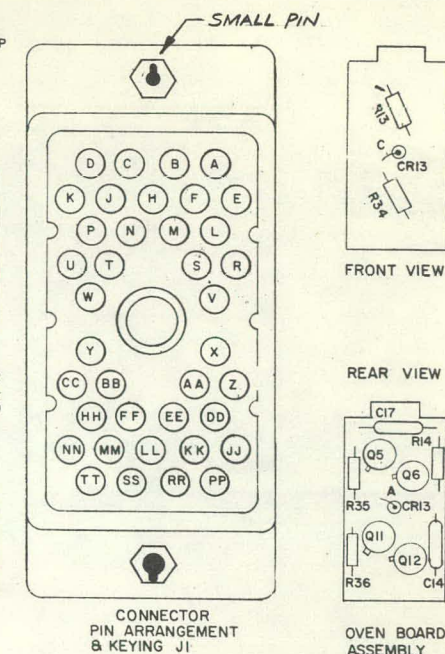
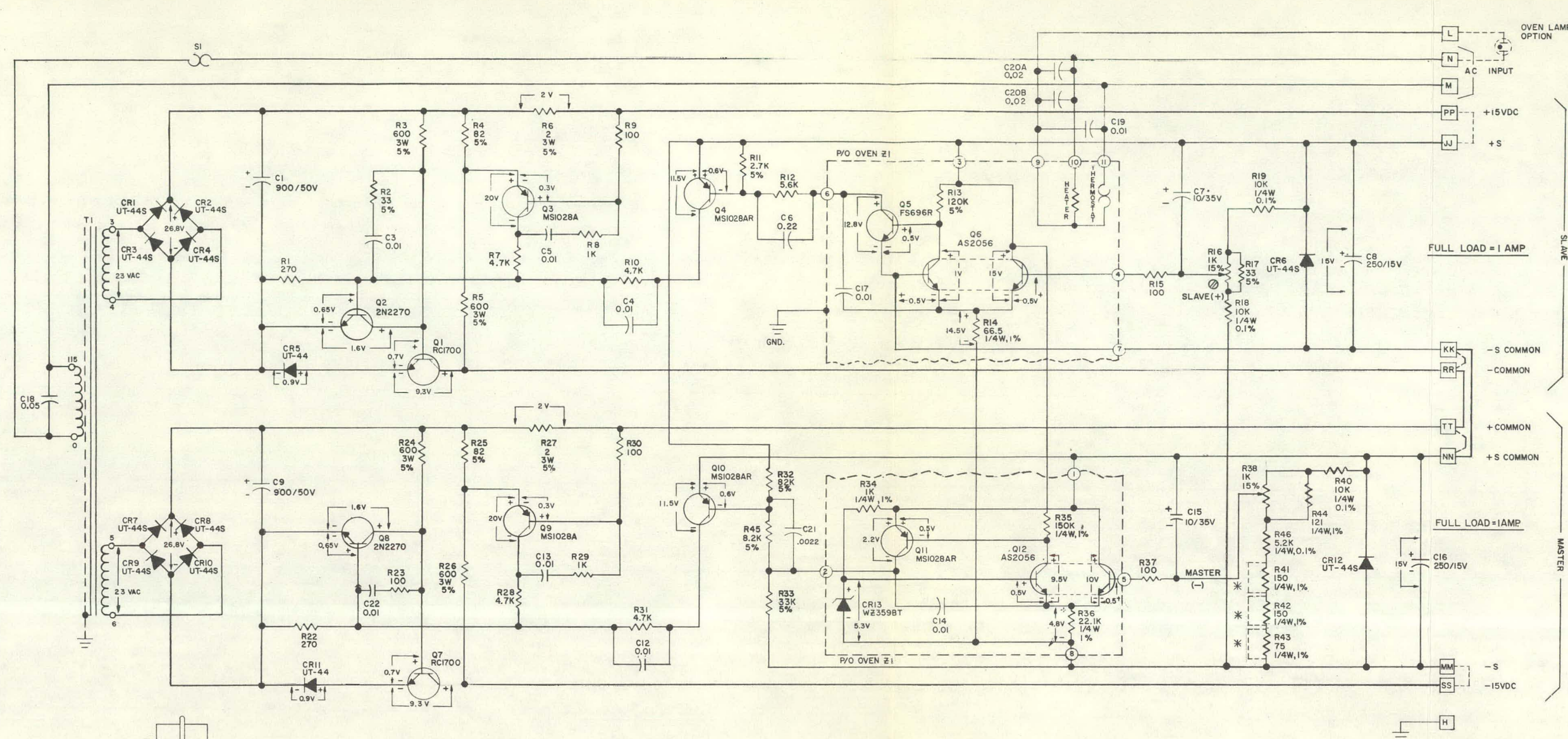
<u>Circuit Number</u>	<u>Description</u>	<u>Mfr Code Number</u>	<u>Part Number</u>
R16	Resistor, variable, wirewound, 1 k ohm, 15%, $\frac{1}{4}$ w	98095	RWT-102-Q10
R17	Resistor, composition, 33 ohms, 5%, $\frac{1}{2}$ w	01121	EB3305
R18, R19	Resistor, precision, wirewound, 10 k ohms, 0.1%, $\frac{1}{4}$ w	98095	RW-103-8QA
R22	Resistor, composition, 270 ohms, 10%, $\frac{1}{2}$ w	01121	EB2711
R23	Resistor, composition, 100 ohms, 10%, $\frac{1}{2}$ w	01121	EB1011
R24	Resistor, wirewound, 600 ohms, 5%, 3 w	98095	RW-601-3KA
R25	Resistor, composition, 82 ohms, 10%, $\frac{1}{2}$ w	01121	EB8201
R26	Resistor, wirewound, 600 ohms, 5%, 3 w	98095	RW-601-3KA
R27	Resistor, wirewound, 2 ohms, 5%, 3 w	98095	RW-020-3KA
R28	Resistor, composition, 4.7 k ohms, 10%, $\frac{1}{2}$ w	01121	EB4721
R29	Resistor, composition, 1 k ohm, 10%, $\frac{1}{2}$ w	01121	EB1021
R30	Resistor, composition, 100 ohms, 10%, $\frac{1}{2}$ w	01121	EB1011
R31	Resistor, composition, 4.7 k ohms, 10%, $\frac{1}{2}$ w	01121	EB4721
R32	Resistor, composition, 82 k ohms, 5%, $\frac{1}{2}$ w	01121	EB8235
R33	Resistor, composition, 33 k ohms, 5%, $\frac{1}{2}$ w	01121	EB3335
R34	Resistor, precision, metal film, 1 k ohm, 1%, $\frac{1}{4}$ w	98095	RD-102-1QA
R35	Resistor, precision, metal film, 150k ohms, 1%, $\frac{1}{4}$ w	98095	RD-154-1QA
R36	Resistor, precision, metal film, 22.1k ohms, 1%, $\frac{1}{4}$ w	98095	RD-2212-1QA
R37	Resistor, composition, 100 ohms, 10%, $\frac{1}{2}$ w	01121	EB1011
R38	Resistor, variable, wirewound, 1 k ohm, 15%, $\frac{1}{4}$ w	98095	RWT-102-Q10
R40	Resistor, precision, wirewound, 10k ohms, 0.1%, $\frac{1}{4}$ w	98095	RW-103-8QA
R41, R42	Resistor, precision, metal film, 150 ohms, 1%, $\frac{1}{4}$ w	98095	RD-151-1QA
R43	Resistor, precision, metal film, 75 ohms, 1%, $\frac{1}{4}$ w	98095	RD-750-1QA
R44	Resistor, precision, metal film, 121 ohms, 1%, $\frac{1}{4}$ w	98095	RD-1210-1QA
R45	Resistor, composition, 8.2 k ohms, 5%, $\frac{1}{2}$ w	01121	EB8225
R46	Resistor, precision, wirewound, 5.2 k ohms, 0.1%, $\frac{1}{4}$ w	98095	RW-522-8QA
S1	Thermostat	98095	STH-2
T1	Transformer	98095	TTM-UPMD11
Z1	Oven Assembly	98095	PS-UPMD-11-12

Accessory

P1	Connector (mates with J1)	91662	00-8016-038-217-008
----	---------------------------	-------	---------------------

CODE LIST OF MANUFACTURERS

<u>Code Number</u>	<u>Manufacturer</u>	<u>Address</u>
01121	Allen-Bradley Company	Milwaukee Wisconsin
91662	Elco Corporation	Willow Grove, Pennsylvania
98095	Power Designs Inc.	Westbury, New York



UNLESS OTHERWISE SPECIFIED:
ALL RESISTORS ARE IN OHMS, 1/2W, 10%
ALL CAPACITORS ARE IN MICROFARADS

VOLTAGES INDICATED ARE MEASURED WITH 120VAC, 60~ INPUT
WITH OUTPUT VOLTAGES AS SHOWN, MEASUREMENTS MADE AT FULL
LOAD WITH 20,000~VOLT METER FOR DC AND 1000~VOLT
METER FOR AC. VOLTAGES ARE DC EXCEPT WHERE OTHERWISE
INDICATED.

* TRIMMING JUMPERS, ADDED IN TEST AS REQUIRED.

NOTICE
PATENTS HAVE BEEN GRANTED. PATENT APPLICATIONS
ARE PENDING OR IN PROCESS OF PREPARATION ON THE
PROPRIETARY PORTIONS OF THE CIRCUITS SHOWN ON
THIS DRAWING. REPRODUCTION IN WHOLE OR IN PART
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C	REVISED, ECN 939	REV	10-65
B	REVISED, ECN 938	REV	10-65
A	RELEASED	REV	10-65
SYM.	DESCRIPTION	APPRO	DATE
	REVISIONS		
DRAWING NO. PS-UPMD11-1			
TITLE SCHEMATIC, UPMD-11			
POWER SUPPLY			
DRAWN	ET	CHECKED	APPROVED
DATE	8-18-65	DATE	8-18-65
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NEW YORK			

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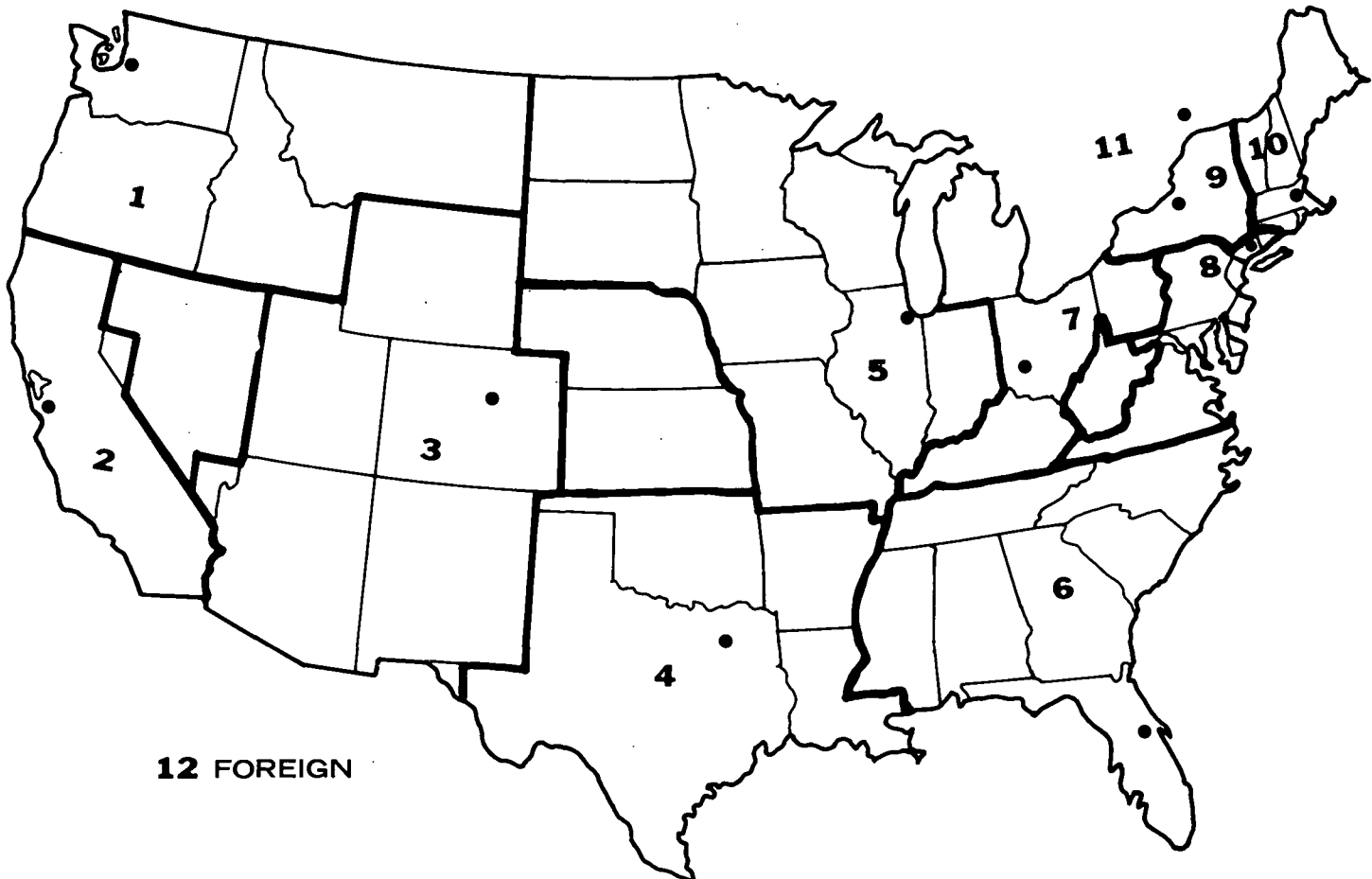
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 Vestal, New York 13850
 Vestal Parkway East
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12 ROCKE INTERNATIONAL CORPORATION
 • Melville, Long Island, New York 11746
 80 Marcus Drive
 (516) 694-7800



12 FOREIGN

POWER DESIGNS INC.
 1700 SHAMES DR. • WESTBURY, N. Y. 11590
 516 EDgewood 3-6200 TWX: 510-222-6561

POWER DESIGNS PACIFIC INC.
 3381 MIRANDA AVE. • PALO ALTO, CAL. 34304
 415-321-6111 TWX: 910-373-1251

W A R R A N T Y

POWER DESIGNS INC., warrants to the original purchaser, each instrument sold by us, or our authorized agents, and all the parts thereof, to be free from defects in material or workmanship under normal use and service within the specified ratings and operating conditions.

Its obligation under this warranty is hereby limited to the repair or replacement of any instrument, or part thereof, which is returned to us within one year after delivery, and which shall prove, after our examination, to be thus defective.

This warranty does not include the cost of transportation charges to and from the factory and/or the cost of packaging or crating of instruments for return to the factory, unless such instrument is returned within thirty (30) days from the date of original shipment as shown on the packing list or shipping documents, and prior written authorization for such costs is obtained from the factory.

The repair or replacement of an instrument, or any part thereof, does not void or extend the original warranty.

POWER DESIGNS INC., reserves the right to discontinue any instrument without notice, or to make modifications in design at any time, without incurring any obligation to make these modifications in instruments previously sold.

POWER DESIGNS INC.

Westbury, L. I., New York

POWER DESIGNS PACIFIC, INC.

Palo Alto, California

VI. Detector and Cable Information

A. Detector

This system was tested using a General Electric type NA04 fission chamber. This type detector or an equivalent should be used.

B. Detector to Preamplifier Signal Cable

Cable capacitance should be kept to a minimum, the maximum being 2000pf. During the Long Term Irradiation Test, this cable consisted of 7 Feet high temperature cable (~ 30 pf/ft.) and 60 Feet triple shielded RG-114 (~ 6.5 pf/ft.), for a total input capacitance of about 600pf.

C. Detector to Preamplifier High Voltage Cable

Triple shielded RG-59 or equivalent.

D. Preamplifier to Main Chassis High Voltage and Signal Cables

RG-6A/U or equivalent (2 - 250 Feet sections supplied with system). Tests were conducted with a maximum of 250 Feet between preamplifier and main chassis.

E. Preamplifier to Main Chassis Power Cable

Belden 8467 (7 Conductor, #18)

500 Feet supplied with system.

VII. Operating Instructions

A. Preliminary

1. Plug each module into the slot whose number matches the module number. (Modules are keyed mechanically and cannot be inserted into the wrong slot.)
2. Connect cables between preamplifier and main chassis (See Detector and Cable Information sheet).
3. Place Mode Switch in Zero position.
4. Connect cables between preamplifier and detector.
5. Apply AC power to system. (Unit does not have ON-OFF Switch so power is applied when AC cord is connected.)

NOTE: All voltages were adjusted and the alignment checked before shipment. No adjustment should be necessary upon receipt of equipment.

If not already done so, now would be a good time to read the descriptions of the WRM System and the various switches functions.

B. Procedure for Initial Startup

1. Place Mode Switch in OPERATE position.
2. Adjust the discriminator level (Pot on Module 6) so that pulses monitored by the WRM System exclude preamplifier noise and gamma signal from detector.
3. As the reactor power increases and the WRM System reading approaches $2 \times 10^{-3}\%$ power, adjust the gain of the Intermediate Range (G pot on Module 8) until the outputs of the Low and Intermediate Ranges are equal (lights over the Low and Intermediate Range meters will begin to flicker on and off, the on light indicating which range is controlling the output).
4. As the reactor power increases and the WRM System reading approaches $5 \times 10^{-1}\%$ power adjust the gain of the High Range (G pot on Module 10) until the outputs of the Intermediate and High Ranges are equal (lights over the Intermediate and High Range meters will begin to flicker on and off, the on light indicating which range is controlling the output).

When the reactor has reached its 100% power level, the WRM System, as it

VII. Operating Instructions (Continued)

B. Procedure for Initial Startup (Continued)

4. is now adjusted, will most likely not read 100% power. The final alignment is accomplished by the following steps, which are to be performed while the reactor is maintaining a constant 100% power.

5. Connect a DVM between pins H (% power output) and L (common) of J25.

Place Mode Switch in CALIBRATE position.

Place Calibrate Switch in HR-2 position.

Place Monitor Switch in HIGH position.

Adjust HR pot on Module 4 for an indication on the DVM of -9.00 volts.

Place Calibrate Switch in IR-2 position, and Monitor Switch in INT position.

Adjust IR pot on Module 4 for an indication of -6.50 volts on the DVM.

Place Calibrate Switch in LR-2 position, and Monitor Switch in LOW position. Record DVM reading.

Place Mode Switch in OPERATE position.

Adjust the High Range Gain (G pot on Module 10) until 100% power is indicated (-10.00 volts on DVM).

Place Mode Switch in CALIBRATE position, Calibrate Switch in HR-2 position, and Monitor Switch in HIGH position.

Note new DVM reading. The difference between this new reading and the old one (-9.00 volts) must now be applied to the other two ranges.

EXAMPLE: If the new DVM reading is -9.30 volts, a -.30 volts must be added to the Intermediate and Low Ranges also. The new Intermediate Range reading should be adjusted to be -6.80 volts.

Place Calibrate Switch in IR-2 position and Monitor Switch in INT position.

Adjust the gain of the Intermediate Range (G pot on Module 8) to achieve the new desired reading on the DVM (-6.80 volts in the Example above).

VII. Operating Instructions (Continued)

B. Procedure for Initial Startup (Continued)

5. Place Calibrate Switch in the LR-2 position, and Monitor Switch in LOW position.

Adjust the pot on Module 7 until the desired new reading is obtained (old reading $-.30$ volts in the Example above).

This completes System alignment. However, before returning to OPERATE position, proceed to the following steps, the purpose of which are to set the calibration signals to their normal levels.

6. Place Calibrate Switch in IR-2 position, and Monitor Switch in INT position.

Adjust IR pot on Module 4 until DVM reads -7.70 volts. IR-1 position should now read about -5.7 volts.

Place Calibrate Switch in HR-2 position, and Monitor Switch in HIGH position.

Adjust the HR pot on Module 4 until DVM reads -10.00 volts. HR-1 position should now read about -8.0 volts.

Return instrument to OPERATE condition.

C. Alignment

1. Power Supplies

a. ± 15 Volt Adjustment

Connect DVM between J25-P(-15) and J25-N (common). Adjust minus potentiometer on the side of Module 1 (Low Voltage Power Supply) for -15 volts ± 20 millivolts.

Connect DVM between J25-M($+15$) and J25-N (common). Adjust plus potentiometer for $+15$ volts ± 20 millivolts.

b. $+30$ Volt Adjustment

Connect DVM between J25-S($+30$) and J25-N (common). Adjust either or both potentiometers on the front of Module 2 (30 volt Power Supply) for $+30$ volts ± 20 millivolts.

VII. Operating Instructions (Continued)

C. Alignment (Continued)

1. Power Supplies (Continued)

c. Detector Polarizing Voltage Adjustment

Connect a DVM between the center conductor of J2 on the preamplifier and the preamplifier case. Turn Mode Switch to Standby position. Adjust potentiometer on the front of Module 3 (High Voltage Power Supply) for about 600 volts. Return Mode Switch to Zero position. Proceed to next step below.

d. High Voltage Filter Compensation

Remove Preamplifier from cast box. Remove cover from Preamplifier section. Connect a 200K Ω , 2 Watt resistor between the center conductors of J2 and J1. Connect a DVM across this 200K Ω resistor. Turn Mode Switch to Standby position. Adjust the potentiometer on the Preamplifier board so that the DVM reads the same voltage as was set in previous section C. Return Mode Switch to Zero position. Replace Preamplifier cover and cast box.

NOTE: All further alignment from this point on (except zeroing) is done with the Mode Switch in the Calibrate position.

2. Signal Generator Check

Set Calibrate Switch to LR-1.

Connect scaler to J36.

Adjust R11 on Signal Generator (Module 5) for 10 counts per second on scaler.

Signal Generator is now aligned.

3. Low Range

Connect DVM between pins G and L of J25.

Set Mode Switch to Zero position.

Adjust LZ pot on Module 12 (Multirange Monitor) for near zero reading on DVM (for Low Range zero, DC amp input is shorted to ground so stable zero reading is not attainable).

Set Mode Switch to Calibrate position.

VII. Operating Instructions (Continued)

C. Alignment (Continued)

3. Low Range (Continued)

Set Calibrate Switch to LR-1.

Set Monitor Switch to LOW.

Record DVM reading (allow ten minutes for reading to stabilize). This reading will be defined as V_{LR-1} .

Set Calibrate Switch to LR-2. Record DVM reading. This reading will be defined as V_{LR-2} .

If $|V_{LR-2}| - |V_{LR-1}| = 4 \pm .05$ no slope adjustment is necessary.

If $|V_{LR-2}| - |V_{LR-1}| \neq 4$ apply the following equation:

$$\frac{4|V_{LR-2}|}{|V_{LR-2}| - |V_{LR-1}|} = |V'_{LR-2}|$$

Adjust Pot LS on Multirange Monitor (Module 12) so DVM reads $-|V'_{LR-2}|$. This completes the slope adjustment of the Low Range.

Adjust R19 on Log Integrator (Module 7) for about -5.6 volts on DVM.

This completes the Low Range alignment.

4. Intermediate Range

Remove Intermediate Range Amplifier-Rectifier (Module 8) from chassis. Remove cover and reinsert unit using appropriate card extender. Connect DVM between rectifying amplifier output TP1 and common (See ASM Drawing 136B2447 for location of TP1). Adjust Rec. Z potentiometer for 0 volts ± 2 millivolts on DVM. Replace module cover, remove card extender, but do not insert module into chassis.

Adjust G potentiometer fully counterclockwise (minimum gain).

Remove Intermediate Range Log Ladder (Module 9) from chassis. Remove cover and reinsert unit using appropriate card extender. Connect common lead of DVM to anode of VR1 (NOTE: Common lead of DVM must be floating). Using ASM Drawing 136B2467 to locate the appropriate potentiometers and transistors, make the following adjustments:

VII. Operating Instructions (Continued)

C. Alignment (Continued)

4. Intermediate Range (Continued)

Adjust:

R24	Base of Q1 = -3.22
R25	Base of Q2 = -3.65
R26	Base of Q3 = -4.14
R27	Base of Q4 = -4.62
R28	Base of Q5 = -5.09
R29	Base of Q6 = -5.57
R30	Base of Q7 = -6.07

Connect plus lead of DVM to the base of Q8. Using the test points on the card extender, connect the following:

The minus terminal of a 0 - 30 volt DC variable supply to pin 3 (common). The negative side of a 100 μ a meter to the positive terminal of the variable power supply.

A 100K Ω resistor between the positive side of the 100 μ a meter and pin 16.

Set the output of the power supply to around 20 volts DC.

Now alternately adjust the power supply and R23 so as to obtain 0.00 volts on the DVM for a reading of 25 μ a on the μ a meter.

NOTE: The location (GETR) in which this instrument was tested had a very high residual gamma field (7×10^6 R/hr.). This made it necessary to change the Intermediate Log Ladder so as to decrease the overlap between Low and Intermediate Ranges. In the existing module R8 = 51.1K, R23 = 50K and R1 is disconnected. The offset current adjustment is 66 μ a. If the instrument is used at a location where the sensor sees less than 10^5 R/hr. residual gamma, reconnect R1, replace R8 and R23 per schematic, and adjust offset current to 25 μ a per alignment procedure.

VII. Operating Instructions (Continued)

C. Alignment (Continued).

4. Intermediate Range (Continued)

This completes alignment of the Intermediate Range Log Ladder. Remove external circuitry and card extender, replace cover, and insert this unit and the Intermediate Range Amplifier-Rectifier into their proper locations.

Connect a DVM between pins F and L (common) of J25. Place Mode Switch in the Zero position. Adjust the IZ pot on Module 12 (Multi-range Monitor) for a DVM reading of 0 volts ± 5 millivolts.

Place Mode Switch in Calibrate position, Calibrate Switch in IR-1 position, and Monitor Switch in INT position. Adjust the IR pot on Module 4 (Campbell Calibrator) until the DVM reads 5.70 volts.

Set Calibrate Switch to IR-2 position. Adjust IS pot on Module 12 until DVM reads 7.7 volts.

Set Calibrate Switch to IR-1 position. Adjust the IR pot on Module 4 until DVM reads 5.7.

Repeat the previous two steps until the difference in DVM readings between the IR-1 position and IR-2 position is 2 volts ± 30 millivolts.

Connect the DVM between pins H and L (common) of J25. Place Calibrate Switch in IR-2 position. Adjust the IS pot on Module 13 (auction) until DVM reading is -7.7 volts.

Set Calibrate Switch to IR-1 position. DVM should read -5.7 volts ± 30 millivolts. If out of tolerance, adjust the IS pot on Module 13 until the difference in DVM readings between the IR-1 position and IR-2 position is 2 volts ± 30 millivolts.

This completes the alignment of the Intermediate Range.

VII. Operating Instructions (Continued)

C. Alignment (Continued)

5. High Range

On High Range Amplifier-Rectifier (Module 10) adjust the G potentiometer fully counterclockwise (minimum gain).

Remove Module 10 from chassis.

Remove the High Range Log Ladder (Module 11) from chassis. Remove cover and reinsert unit using appropriate card extender. Connect common lead of DVM to anode of VR1 (NOTE: Common lead of DVM must be floating). Using ASM Drawing 136B2467 to locate the appropriate potentiometers and transistors, make the following adjustments:

Adjust:

R24	Base of Q1 = -5.19
R25	Base of Q2 = -5.47
R26	Base of Q3 = -5.98
R27	Base of Q4 = -6.46
R28	Base of Q5 = -6.94
R29	Base of Q6 = -7.41
R30	Base of Q7 = -8.10

Connect plus lead of DVM to the base of Q8. Using the test points on the card extender, connect the following:

The minus terminal of a 0-30 volt DC variable supply to pin 3 (common). The negative side of a 100 μ a meter to the positive terminal of the variable power supply.

A 100K Ω resistor between the positive side of the 100 μ a meter and pin 16.

Set the output of the power supply to around 20 volts DC.

Now alternately adjust the power supply and R23 so as to obtain 0.00 volts on the DVM for a reading of 42 μ a on the μ a meter.

VII. Operating Instructions (Continued)

C. Alignment (Continued)

5. High Range (Continued)

This completes alignment of the High Range Log Ladder. Remove external circuitry and card extender, replace cover, and insert this unit and the High Range Amplifier-Rectifier into their proper locations.

Connect a DVM between pins E and L (common) of J25. Place Mode Switch in the Zero position. Adjust the HZ pot on Module 12 (Multirange Monitor) for a DVM reading of 0 volts ± 5 millivolts.

Place Mode Switch in the Calibrate position, Calibrate Switch in the HR-1 position, and Monitor Switch in HIGH Position. Adjust the HR pot on Module 4 (Campbell Calibrator) until the DVM reads 8.00 volts.

Set Calibrate Switch to HR-2 position. Adjust HS pot on Module 12 until DVM reads 10.00 volts.

Set Calibrate Switch to HR-1 position. Adjust the HR pot on Module 4 until DVM reads 8.00 volts.

Repeat the previous two steps until the difference in DVM readings between the HR-1 position and HR-2 position is 2 volts ± 30 millivolts.

Connect the DVM between pins H and L (common) of J25. Place Calibrator Switch in HR-2 position. Adjust the HS pot on Module 13 (auction) until the DVM reading is -10.00 volts.

Set Calibrate Switch to HR-1 position. DVM should read -8.00 volts ± 30 millivolts. If out of tolerance, adjust the HS pot on Module 13 until the difference in DVM readings between the HR-1 position and HR-2 position is 2 volts ± 30 millivolts.

This completes the alignment of the High Range.

VII. Operating Instructions (Continued)

C. Alignment (Continued)

6. Ramp Generator

Set Mode Switch to Calibrate.

Set Calibrate Switch to FIXED PERIOD.

Connect a DVM between pins K and L (common) of J25.

Reset Ramp.

Adjust the F pot on Module 16 (Ramp Generator) so as to obtain a negative going ramp whose rate of change is -1 volt per 23 seconds. This ramp is used to simulate a changing signal whose period is ten seconds.

Set Calibrate Switch to VARIABLE PERIOD.

Reset Ramp.

Adjust the V pot on Module 16 to obtain the desired ramp rate (this ramp rate will always be less than or equal to the ramp rate controlled by the F pot).

This completes the Ramp Generator adjustment.

7. Period

With power removed from the instrument, adjust the mechanical zero of the meter to read -100.

Connect a DVM between pins J and L (common) of J25.

Set Mode Switch to ZERO.

Adjust the Z pot on Module 15 (Period) for 0 volts ± 5 millivolts on the DVM.

Adjust the M pot on Module 15 so that the meter pointer indicates infinity.

Set Mode Switch to CALIBRATE.

VII. Operating Instructions (Continued)

C. Alignment (Continued)

7. Period (Continued)

Set Calibrate Switch to FIXED PERIOD.

Adjust the G pot on Module 15 to obtain a reading of 10 volts ± 20 millivolts on the DVM. Meter should indicate a period of ten seconds.

This completes the Period adjustments.

8. Trip Adjustments

a. Upscale

Place Mode Switch in CALIBRATE position.

Place Calibrate Switch in HR-2 position.

Place Monitor Switch in HIGH position.

Using either the front panel meter (Percent Power) or a DVM connected between pins H and L (common) of J25 as an indicator, adjust the HR pot on the Campbell Calibrator (Module 4) until the indicator used reads the desired value (-10 volts on DVM = 100% power). If Upscale light is on, press Trip Reset Switch and adjust HI pot on Module 18 until light goes out. Now slowly adjust HI pot until Upscale light is energized. Upscale Trip is now set.

Return HR-2 pot to its pre-adjustment level.

b. Downscale

Place Mode Switch in CALIBRATE position.

Place Calibrate Switch in whichever position will provide a signal nearest to the desired trip level.

Place Monitor Switch in appropriate position based on Calibrate Switch position.

VII. Operating Instructions (Continued)

C. Alignment (Continued)

8. Trip Adjustments (Continued)

b. Downscale (Continued)

Using the same indicator as in the Upscale trip adjustment, adjust the desired signal source level (HR pot, Module 4 for High Range; IR pot Module 4 for Intermediate Range; R19 on Module 7 for Low Range) until the indicator used reads the desired value. If Downscale light is on, press Trip Reset Switch and adjust DN pot on Module 18 until light goes out. Now slowly adjust DN pot until Downscale light is energized. Downscale trip is now set. Return signal source to its pre-adjustment level.

c. Intermediate Range Failure

Place Mode Switch in CALIBRATE position.

Place Calibrate Switch in LR-2 position.

Place Monitor Switch in LOW position.

Using either the Percent Power meter or a DVM connected between pins H and L (common) of J25 as an indicator, adjust R19 on Module 7 for a reading of $2 \times 10^{-3}\%$ power (-5.3 volts on DVM). Now adjust the Intermediate Range Failure pot (below Module 19) until trip light is just energized. Trip level is now set. Return R19 to its pre-adjustment level.

d. High Range Failure

Place Mode Switch in CALIBRATE position.

Place Calibrate Switch in IR-2 position.

Place Monitor Switch in INT position.

Using either the Percent Power meter or a DVM connected between pins H and L (common) of J25 as an indicator, adjust the IR pot on Module 4 for a reading of (-7.5 volts on DVM). Now adjust

VII. Operating Instructions (Continued)

C. Alignment (Continued).

8. Trip Adjustments (Continued)

d. High Range Failure (Continued)

the High Range Failure pot (below Module 19) until the trip light is energized. Trip level is now set. Return IR pot to its pre-adjustment level.

e. Period

Place Mode Switch in CALIBRATE position.

Place Calibrate Switch in either FIXED PERIOD (10 seconds) or VARIABLE PERIOD position.

Press Ramp Reset Switch.

Obtain the desired period indication on Period meter. Adjust PE pot on Module 17 until trip light just energizes. Trip level is now set.

f. Low High Voltage

Place Mode Switch in ZERO position.

Disconnect HV cable from rear of main chassis (J21).

Connect DVM to J21.

Place Mode Switch in Standby position.

Adjust pot on Module 3 (High Voltage Power Supply) to desired trip level. Now adjust HV pot on Module 17 until trip light is just energized. Trip is now set. Return high voltage to its pre-adjustment level.

Place Mode Switch in ZERO position.

Disconnect DVM from J21 and reconnect HV cable.