

David Kleinfeld

INSTRUCTION AND MAINTENANCE MANUAL

DL INSTRUMENTS MODEL 1211

CURRENT PREAMPLIFIER

MANUAL PRINTED JUNE 2000

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MANUAL CHANGES

SEPTEMBER 1991

DL INSTRUMENTS MODEL 1211 CURRENT AMPLIFIER

Make all changes in this manual according to the Errata below. Also check the following table for your instrument serial number and make the listed changes in your manual.

MODEL	SERIAL NO	MAKE MANUAL CHANGES	MODEL	SERIAL NO	MAKE MANUAL CHANGES
1211	74512	1, 2, 3			

1. To keep CR14 from failing when a large voltage (≈ 1000 VDC) is applied inadvertently to the 1211 input the following changes should be made:

Figure 7.3 Change Connection of CR14 B & E From E2 to E3

Figure 3.1 Change connection of CR14 (cathode end) **From** connected to junction of A1-J1/K2/K3 **To** connected to junction of R51/CR11

Figure 7.8 Change view of CR14 to reflect above changes

2. The Drawing Number for Figures 7.3, 7.4, 7.5 should be D42086 instead of D41086
3. Enclosed below is a detailed discussion of the above changes:

IMPROVED INPUT OVERVOLTAGE PROTECTION FOR MODEL 1211

The signal input of the Model 1211 employs a protection circuit consisting of R51 and dual FET diode CR11. The circuit prevents destruction of the input amplifier in the event of moderate level input overvoltages.

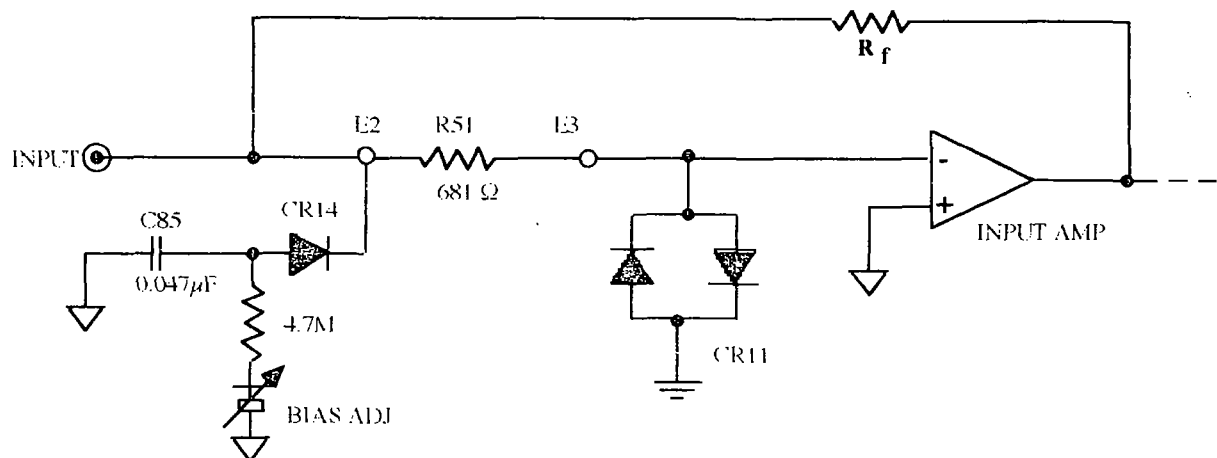


FIGURE 1 MODEL 1211 INPUT CIRCUIT (original version)

Unfortunately R51 does not protect input bias compensation FET diode CR14. CR14 develops a temperature dependent, reverse leakage current which absorbs the input bias current of the input amp. If a large input voltage step is applied to the input from a capacitive source (i.e. due to cable capacitance), C85 will provide a low impedance pulse path to ground. Even if the pulse forward biases CR14, it can be damaged by the large rate of rise across its terminals. A high value series input resistor (e.g., 100K) will not be effective by itself in preventing damage. If CR14 is damaged, the symptom will be an excessive input offset current with the 1211 input open circuited.

The solution is to move the cathode of CR14 to the other end of R51. This, in conjunction with a 100K Ω series input resistor, will offer greatly improved protection against kilovolt level input overvoltages. The change is made by moving the anode lead of CR14 from its original connection point at terminal post E2 to terminal post E3 (see 1211 Manual, Figure 7.8). The lead will need lengthening with a bit of bus wire and insulation with teflon sleeving. All 1211 units shipped with serial numbers 74512 and above will have this change and units sent in for calibration or repair will automatically receive the update. Units in the field should also be revised.

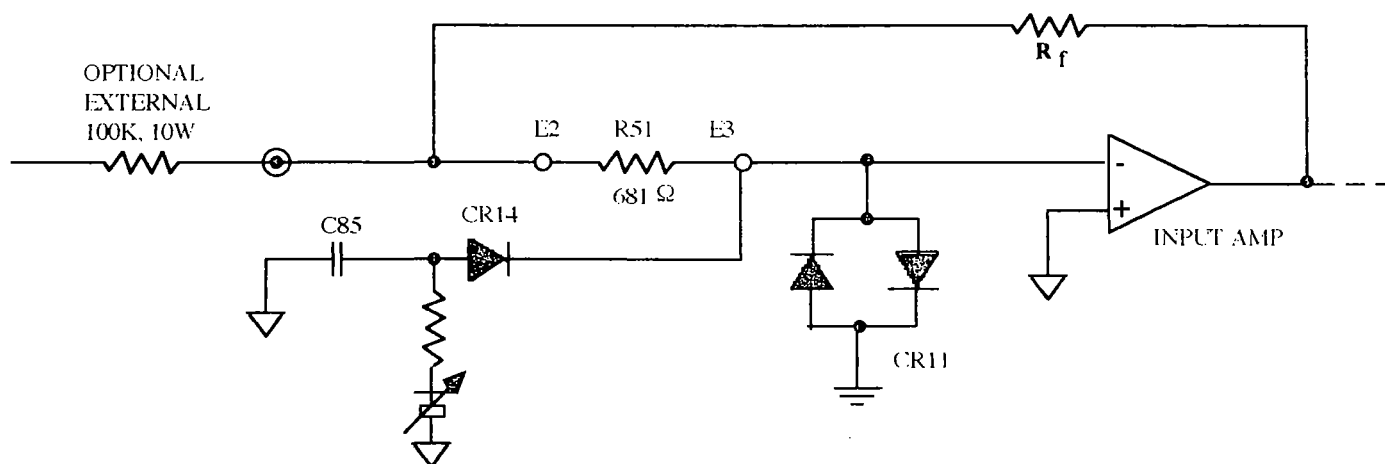


FIGURE 2 IMPROVED 1211 INPUT CIRCUIT

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SECTION 1

INTRODUCTION

1.1 DESCRIPTION

The DL Instruments Model 1211 Current Preamplifier is a precision, high performance electronic instrument designed to push measurement capability in the 10^{-3} to 10^{-11} ampere range as close to the theoretical limit as permitted by current moderate price technology. The Model 1211 combines high speed, low noise performance with convenience features not found in competing amplifiers.

Sensitivity from 10^{-3} to 10^{-11} amperes per volt is selected in decade steps by a front panel rotary switch. A post conversion gain multiplier permits extension of the basic range and allows the operator to make noise/speed trade offs, or extend the dynamic range.

Suppression of either positive or negative current from 10^{-3} to 10^{-10} amperes is provided in calibrated decade steps. The center knob of the suppression switch is a continuous adjustment.

Rise time from .01 milliseconds to 1 second is selected in a 1-3-10 sequence by rotating the Rise Time switch. The attenuation rate may be set at -6 dB per octave or 12 dB per octave by a slide switch located inside the unit. The higher (-12 dB) attenuation rate is useful when cable capacitance increases the high frequency noise gain of the input amplifier gain block.

Other front panel controls and indicators include a zero set pot and switch, a battery test switch, power switch, and overload indicator. Located on the rear panel are the battery/line and charge rate switch, the detector bias pot, and the gate signal input BNC connector.

Input is via a front panel BNC connector. Several output BNC connectors are provided. The front panel output is 600 ohms, while both 600 ohm and 25 ohm outputs are available on the rear panel. Also available on the rear panel is the direct output (buffered) of the input gain block.

These functions and features will be explained in greater detail in Section 3.0, "Operating Instructions".

1.2 SPECIFICATIONS

For applications information, ask for IAN 50 "*Noise Analysis and Gain Considerations in Selecting the Right Current Preamplifier*" and IAN 55 "*Applying the Model 1211 Current Preamplifier to Tunneling Microscopy*."

SENSITIVITY	10^{-3} to 10^{-11} ampere/volt with nine decade current gain ranges.
GAIN MULTIPLIER	Output gain multiplier varies sensitivity in 3 steps, X0.1, X1.0 and X10, for optimum dynamic range and overload capability.
GAIN ACCURACY	$\pm 2\%$ of reading (10^{-3} to 10^{-9} ampere/volt ranges); $\pm 3\%$ of reading 10^{-9} thru 10^{-11} ampere/volt ranges).

INPUT OFFSET CURRENT	Less than 0.5×10^{-13} ampere @ 50°C. Typically 1×10^{-14} @ 25°C.	
INPUT VOLTAGE DROP	Less than 200 microvolts, 10^{-5} to 10^{-11} ampere/volt ranges.	
RISE TIME (Low Pass Filter)	Front panel adjustable from 10 microseconds to 1 second in a 1-3-10 sequence; MIN position rise time is less than 5 microseconds. Standard rolloff is 12 dB/octave. Jumper option for 6 dB/oct when 1211 is applied in feedback control loops.	
OUTPUT	Four outputs (BNC) as follows: a) 600Ω outputs (2) b) Lo-Z output (to 25 mA, 50Ω) c) Unity gain output (X1)	
OUTPUT LEVEL	22Vpp into 1K load (Lo-Z out)	
OUTPUT POLARITY	Unity gain (X1) Lo-Z (50Ω) 600Ω	Non inverted Inverted Inverted
OUTPUT STABILITY	Output voltage offset stability better than 0.003% per °C.	
ZERO SET	Input offset nulling. Used to adjust for precisely zero bias voltage on detectors such as photovoltaic diodes. Alternatively, can adjust for zero d.c. offset on output.	
CURRENT SUPPRESSIONS	10^{-3} ampere to 10^{-10} ampere with eight decade ranges: front panel vernier (10-turn) allows continuous suppression with 0.1% resolution. Stability is better than .02%/°C or day (10^{-3} to 10^{-8} ampere); better than 0.2%/°C or day (10^{-9} and 10^{-10} ampere).	
DETECTOR BIAS	Zero to ± 5 volts, adjustable and polarity-selectable with rear panel vernier (10-turn) and switch. Stability is 100ppm/°C.	
GATING	TTL-compatible logic 0 or switch closure to ground (rear panel BNC input) provides gated operation of preamplifier signal path; maximum gating frequency is 5 kHz.	
POWER	100 to 130 or 200 to 260 VAC (switch-selectable), 50-60 Hz, 10 Watts.	
DIMENSIONS	3.5" high x 8.5" wide x 15" deep. (90 x 215 x 380mm)	
WEIGHT	8 lbs. 2 oz. (3.7 kg) less battery pack	
OPERATING TEMPERATURE	5°C to 50°C	
MOUNTING	Benchtop standard 19" rack mount via RM-2 (single unit) or RM-1 (dual unit) option.	

1211 RISE TIME, DYN RANGE, INPUT Z AND B.W.

Sensitivity (A/V)	Minimum Rise Time μ Sec	Dynamic Range ¹ dB (SNR)	Input Resistance Ohms	3dB BW ² kHz
10 ⁻³	10	96 (63000)	0.5	60
10 ⁻⁴	10	96 (63000)	0.5	50
10 ⁻⁵	10	96 (63000)	2	45
10 ⁻⁶	15	88 (25000)	20	30
10 ⁻⁷	25	78 (8000)	200	25
10 ⁻⁸	40	68 (2500)	2K	13
10 ⁻⁹	250	62 (1250)	20K	4
10 ⁻¹⁰	450	55 (560)	200K	.8
10 ⁻¹¹	1100	48 (250)	2M	.4

1 Dynamic Range values are given with gain multiplier setting of X1 and rise time control set to min. It equals the ratio of greatest peak-to-peak signal output (at least 22Vpp) to specified maximum wideband output noise with 100pF input shunt capacitance.

2 Measured at 50 Ω or 600 Ω output.

NOISE PERFORMANCE, REFERRED TO INPUT ³

Sensitivity A/V	Limited BW Noise at Indicated Rise Time Setting ⁴		Min. Rise Time Full BW Noise ⁴ A rms	Spectral Noise Density A rms/ $\sqrt{\text{Hz}}$
	A rms	Msec		
10 ⁻³	20 x 10 ⁻⁹	.1	50 x 10 ⁻⁹	75 x 10 ⁻¹²
10 ⁻⁴	2 x 10 ⁻⁹	.1	5 x 10 ⁻⁹	7.5 x 10 ⁻¹²
10 ⁻⁵	200 x 10 ⁻¹²	.1	500 x 10 ⁻¹²	1 x 10 ⁻¹²
10 ⁻⁶	30 x 10 ⁻¹²	.1	150 x 10 ⁻¹²	200 x 10 ⁻¹⁵
10 ⁻⁷	8 x 10 ⁻¹²	.1	40 x 10 ⁻¹²	60 x 10 ⁻¹⁵
10 ⁻⁸	700 X 10 ⁻¹⁵	1	15 x 10 ⁻¹²	15 x 10 ⁻¹⁵
10 ⁻⁹	60 x 10 ⁻¹⁵	10	3 x 10 ⁻¹²	5 x 10 ⁻¹⁵
10 ⁻¹⁰	4 x 10 ⁻¹⁵	100	600 x 10 ⁻¹⁵	2.5 x 10 ⁻¹⁵
10 ⁻¹¹	1 x 10 ⁻¹⁵	300	150 x 10 ⁻¹⁵	1.5 x 10 ⁻¹⁵

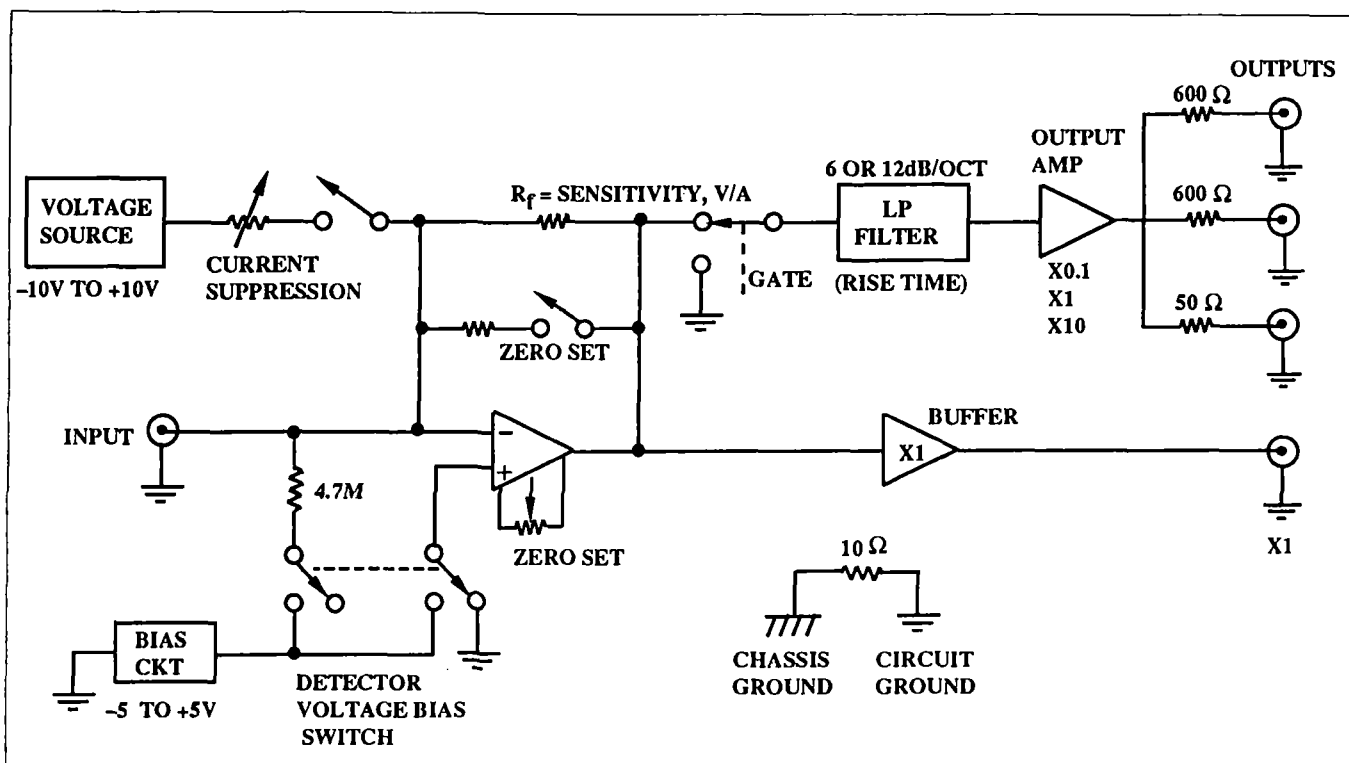
³ Noise at X1 gain multiplier setting using 50 Ω or 600 Ω output. For 10⁻³ to 10⁻⁵ sensitivity, the noise would be substantially lower using the direct 1X buffered output.

⁴ Broadband noise measured with 100 pF input shunt capacitance.

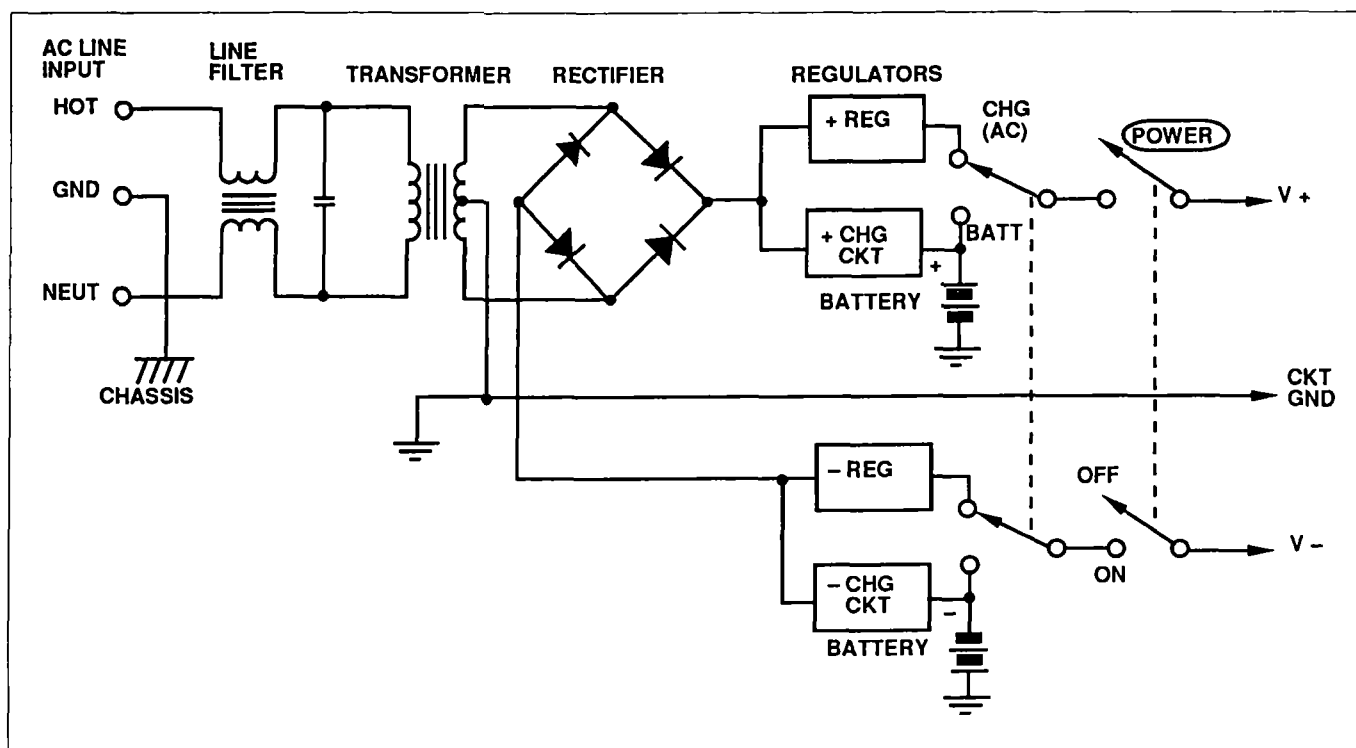
1211 OPTION 10 BATTERY PACK

The retrofittable Nickel Cadmium Battery Pack installs inside the chassis, and is charged from the 1211 power supply as shown on page 1-4.

BATTERY CHARGE TIME (fast charge)	<15 hr.
BATTERY OPERATING TIME	>25 hr.
WEIGHT	2 lb. 10 oz. (1.2 kg)



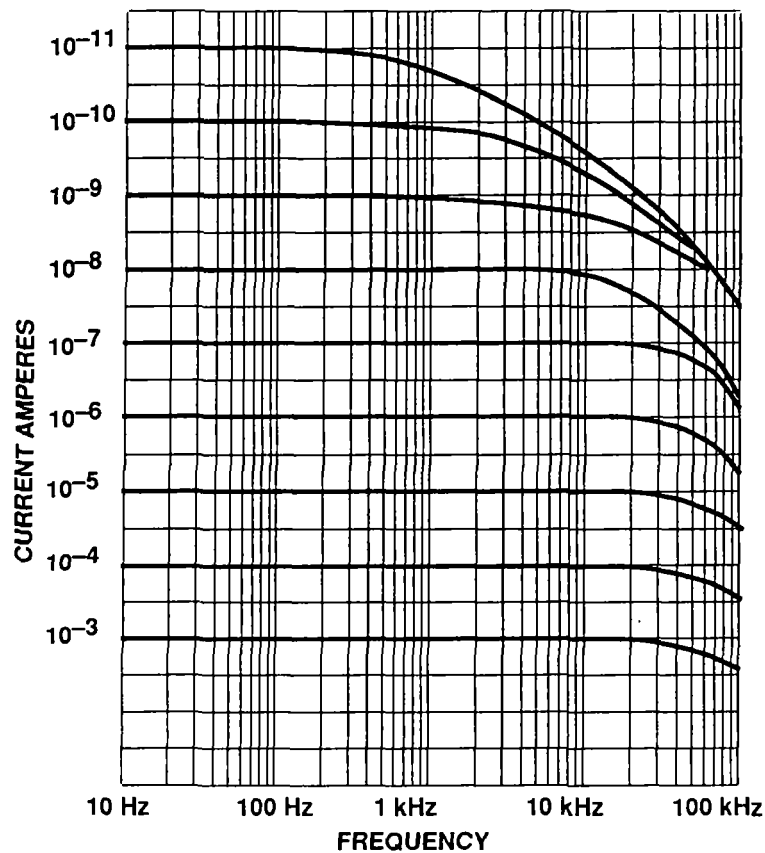
1211 BLOCK DIAGRAM



LINE POWER AND BATTERY CIRCUIT FOR 1211 PREAMPLIFIER

TYPICAL OVERSHOOT VS INPUT SHUNT CAPACITANCE

Sensitivity A/V	Capacitance pf	Overshoot on Step Input
10^{-3}	33,000	6%
10^{-4}	10,000	2%
10^{-5}	5,700	10%
	4,300	4%
	3,200	2%
10^{-6}	1,000	4%
	500	0%
10^{-7}	500	8%
	350	4%
10^{-8}	220	20%
	110	10%
10^{-9}	330	14%
	110	0%
10^{-10}	500	6%
	225	0%
10^{-11}	225	6%
	150	2%



MODEL 1211 FREQUENCY RESPONSE

SECTION 2

INSTALLATION

2.1 INSPECTION

2.1.1 Before shipment, the Model 1211 was found to be free of electrical and mechanical defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing material until the inspection is complete. If damaged in any way, a claim should be filed with the carrier and a copy forwarded to DL Instruments. DL Instruments will then advise you as to the disposition of the equipment and will arrange for repair or replacement of the equipment without waiting for a settlement of a claim against the carrier.

2.1.2 VISUAL INSPECTION

A visual check should be made to conform that there are no broken knobs or connectors, that the case and panel surfaces are free of dents and scratches and that the frame, transformer, and battery pack are undamaged.

2.1.3 ELECTRICAL INSPECTION.

The instrument should be checked against its electrical specifications (see Section 1).

2.2 INSTALLATION

The 1211 Current Amplifier needs only to be connected to a power source for normal bench top use. See Section 2.3 "Power and Grounding".

For those installations where rack mounting is desired, two rack mounting kits are available: Model RM-1 for two 1211's side by side; Model RM-2 for a single 1211 in a 19" rack.

2.3 POWER AND GROUNDING

Unless otherwise specified, all units are shipped with a six foot, three conductor power cord equipped with a grounded plug. Normally, the 1211 should be connected to a grounded power source.

Before connecting the 1211 to the line, check that the line voltage switch (inside rear panel connector) is in the proper position.

50-400 Hz Setting	Voltage Range	Recommended Slo-Blow Fuse
100	90-110 VAC	0.25A
120	105-130 VAC	0.25A
220	195-240 VAC	0.125A
240	210-260 VAC	0.125A

To change the power setting, first turn off the unit. Remove the power cord and slide the plastic window to one side. Remove the fuse by pulling out on the "fuse pull" lever. Remove the small printed circuit board by hooking a stiff wire in the hole at the rear of the board and pulling straight out. Select the proper voltage setting from the above table and orient the board so the desired setting will be visible through the window when the board is reinserted. Reinsert the board in the desired orientation, install the proper fuse and push the "fuse pull" lever back. Slide the window back and reconnect the power cord.

For Battery Operation (Option 10), see Section 4 "Battery Operation and Maintenance".

SECTION 3

OPERATING INSTRUCTIONS

3.1 GENERAL

Before using the Model 1211 for the first time, or moving the instrument to a new location where ac power may be different, check the window on the fuse holder (rear panel) to be certain that the instrument matches the available ac power. If it is necessary to change the ac line voltage setting of the 1211, refer to Section 2.3.

The functions of all controls and indicators are for the most part, self explanatory. The following descriptions define these functions and show where possible how they interact to determine the overall performance of the instrument.

3.2 INPUTS

3.2.1 SIGNAL INPUT

Signal input to the Model 1211 is via a front panel BNC connector. In order to minimize peaking and high frequency noise, cable capacitance and other sources of shunt capacitance should be minimized. The high loop gain of the 1211 assures that the input port is at virtual ground under all normal operating conditions.

3.2.2 GATE INPUT

When the gate BNC on the rear panel is left open, the gating circuit is inactive and signals pass normally from input to output. When the gate input is grounded (0V up to approximately 0.8V), the gating circuit is activated and interrupts the signal path, preventing an active output.

The gating feature is especially useful when strong overloading signals are present at the amplifier input at a predetermined time. For example: in fluorescence decay studies or DLTS experiments, it is often desirable to prevent strong excitation signals from overloading electronic signal conditioners or read out devices. This is readily accomplished using the gating feature of the Model 1211.

3.3 OUTPUTS

Three of the output ports, all BNC, are driven from a common amplifier. The front panel has a single 600 ohm port. The rear panel has a 600 ohm port and a 50 ohm port capable of driving up to 25mA. Source resistors for all three ports are independent.

The output of the current to voltage converter is buffered and appears on a rear panel BNC connector. This low source impedance output is not gated, thereby allowing the user to observe signals "masked" by the gate.

3.4 CONTROLS

3.4.1 SENSITIVITY SWITCH

The Sensitivity switch provides for selection of sensitivity in decade increments from 10^{-3} to 10^{-11} amperes per volt. This switch selects the feedback resistor used in the input gain block, and therefore determines the noise and speed performance of the amplifier.

3.4.2 MULTIPLIER SWITCH

This switch controls the gain of the output stage in decade steps from 10^{-1} to 10. Because noise and speed performance are determined by the sensitivity switch, the multiplier may be used to increase speed at the expense of noise performance. See Noise/Rise Time specifications (Section 1.2). The Multiplier switch may also be used in conjunction with the Rise Time switch to increase the dynamic reserve (i.e. ability to handle noise).

3.4.3 SUPPRESSION SWITCH AND VERNIER

The Model 1211 is equipped with a calibrated Current Suppression switch. Covering the range from 10^{-3} to 10^{-10} amperes in decade steps, the suppression circuit supplies a positive or negative current to the summing junction of the input gain block. Polarity is determined by the position of the center off toggle switch located immediately below the Suppression switch. In addition, a 10 turn vernier is provided on the center knob of the Suppression switch. A "Cal/Var" switch, located to the right of the Polarity switch, permits the vernier to be switched in and out without disturbing the vernier setting.

3.4.4 RISE TIME SWITCH

The function of this switch is to set the low pass filter for optimum noise performance. It is calibrated in milliseconds and covers a range from 10^{-5} seconds to 1 second in a 1, 3, 10 sequence. The filter is disabled when the switch is in the "min" position. For most applications, the filter should be used in the 12 dB/octave mode. However, if the 1211 is to be used in a closed loop, it is necessary to switch to the 6 dB/octave mode in order to maintain a stable loop. The 6 dB/12 dB Mode switch is located on the PC board. It is therefore necessary to remove the top cover in order to change filter mode. Front panel Rise Time calibration is valid only for the 12 dB/octave position.

3.4.5 ZERO SET

The Zero Set switch places the input gain block in a gain of 10 configuration to permit voltage balance of the instrument. The screwdriver adjustable zero pot is located immediately above the Zero Set switch. In order to properly zero the instrument, the input must be open, the Current Suppression off, and the Detector Bias (Section 3.4.6) off.

For convenience of operation, The Zero Set toggle switch locks in the up position, and is momentary contact in the down position. The center position is off.

3.4.6 DETECTOR BIAS

Located on the rear panel, the Detector Bias pot (recessed screwdriver adjust) provides up to ± 5 volt offset of the 1211 input summing junction. Polarity is selected by a center off toggle switch located immediately to the left of the Bias pot.

To set the Detector Bias, set the Sensitivity switch to the 10^{-8} amperes per volt scale, Multiplier to X1, Current Suppression off, and Zero Set on. The input should not be connected. While monitoring the output with a suitable readout device (e.g. DVM), adjust the Bias pot for the desired level. Once adjusted, the bias setting is valid for all sensitivity ranges. It is important, however, that the 10^{-8} , 10^{-9} or 10^{-10} range is used in the set procedure.

3.4.7 POWER SWITCH

This switch applies power to the 1211 single processing circuits. The Battery pack (Option 10) charges even when the Power switch is off as long as the line cord is connected to ac power.

3.4.8 BATTERY SWITCH (BATT, C/25, C/10) (applies only if Option 10 is installed)

C/25 The amplifier will probably be received from the factory with the switch in this position. With the line cord plugged in, the internal batteries trickle-charge. The 1211 electronics operate from the internal power supply.

C/10 The batteries charge at the fast rate in this position. This instrument is provided with cooling holes but the user should not charge the batteries at C/10 (fast rate) for long periods at an unusually high ambient temperature or if the case has no air circulation. The build up of heat inside the case may shorten battery life. (See Section 4)

In both C/25 and C/10 positions, the batteries charge at the selected rate provided the line cord is connected to a power source. The amplifier receives power from the internal power supply.

BATT In this switch position the batteries charge at the C/25 (slow) rate provided the line cord is connected to a power source. The amplifier receives power from the batteries, whether or not the line is plugged in.

To prevent excessive battery drain when operating in the battery mode, do not operate for long periods of time with the overload light turned on. Also, try to avoid high load currents on the outputs, as this will reduce battery life.

3.5 INDICATORS

3.5.1 OVERLOAD

The output circuits of the input gain block and the output amplifier are monitored for overload. If an overload occurs in either circuit, the front panel overload lamp is illuminated. When correcting an overload condition, it is necessary to keep the gain distribution and filter setting in mind (see Figure 1.1). Recall from Section 3.4.2 that noise and/or speed performance can be traded for dynamic reserve.

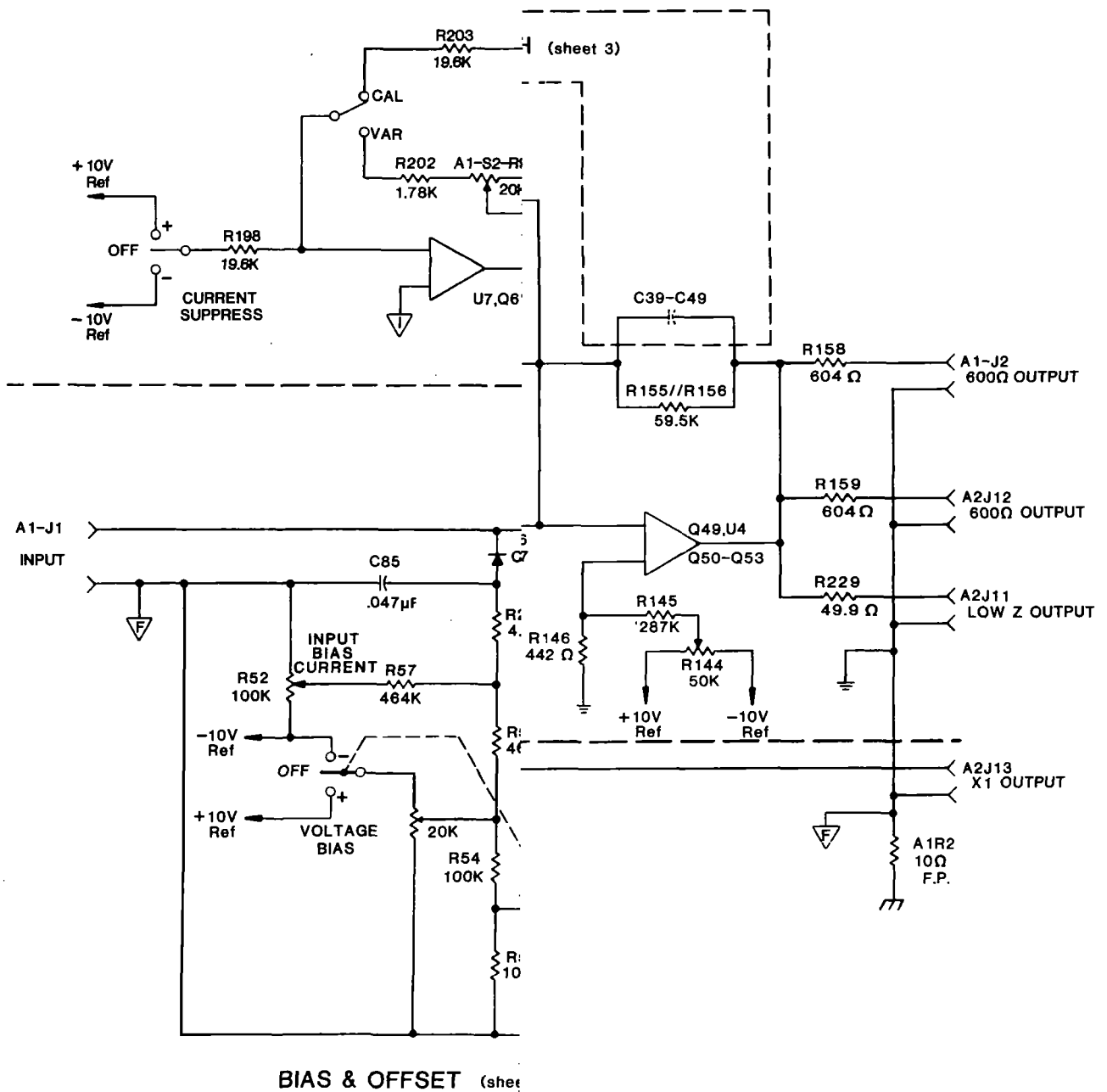
3.5.2 BATTERY TEST (applies only if Option 10 is installed)

The Battery Test light illuminates when the BATT test switch is operated and the battery voltages are at 11.2 volts or more.

In the + position, the light indicates positive amplifier battery condition and in the – position the light indicates negative amplifier battery condition.

The battery test light does not indicate the amount of battery charge, but only whether there is a voltage over 11.2 volts. Therefore, the lamp will light even though the batteries are approaching the end of their useful charge life. To insure adequate battery charge after receipt from the factory, charge overnight before using at the C/10 rate. The batteries will charge at the selected rate even with the power switch off as long as the line cord is connected to a power source. See Section 4.

I SUPPRESS (sheet 4)



BIAS & OFFSET (sheet 4)

FIGURE 3.1
SIMPLIFIED SCHEMATIC
MODEL 1211

SECTION 4

BATTERY OPTION AND MAINTENANCE (OPTION 10 ONLY)

4.1 GENERAL DESCRIPTION

Your DL Instruments 1211 Current Amplifier with Option 10 is equipped with two rechargeable nickel-cadmium 1.2A-hr battery packs. When fully charged, they can be expected to operate the 1211 under normal conditions for time periods of well over 25 hours. However, to maintain your battery's capability for several years requires care and attention on your part.

4.2 REAR PANEL BATTERY SWITCH

The rear panel switch provides a charge rate control as well as a choice of power supply mode. In the C/10 and C/25 positions, the preamplifier operates from the internal power supply. In the battery position, the preamplifier draws power from the batteries. If the preamplifier is plugged into a live power output, the battery receives charging current no matter what position the rear panel switch is in. NOTE THAT THE CHARGE RATE, IN THE BATTERY POSITION, is C/25.

4.3 DUAL RATE CHARGING SYSTEM

The dual rate charging system is designed to prolong the battery life. Either the C/10 or C/25 charge rate may be selected via the rear panel. The term C is the ampere-hour rating of the battery. Thus if $C = 1.2\text{A-hr}$, then C/10 implies a maximum charge current of 120mA. At C/10 the battery should fully charge in 14-15 hours (charge efficiency is less than 100%). However, nickel-cadmium batteries should not be charged at the C/10 rate over long periods of time.

It is expected that a number of users will not use the battery on a routine continuous basis, but will only call upon the battery occasionally. In that case, it is not necessary to maintain the battery charge rate at the C/10 limit. The C/25 position is recommended for the standby applications. The C/25 rate is high enough to charge a deep discharged battery after several days. It is high enough to amply supply the normal internal discharge current of the battery, but low enough so that it will not stress the overcharge mechanism of the battery. In addition, battery temperature rise will be reduced.

4.4 BATTERY TEMPERATURE

Another lifetime battery consideration is temperature. The 1211 is vented for cooling. The unit is designed for sufficient cooling for use, at room temperature on an open bench, at any charge rate. If the unit is installed in a closed rack where temperatures are high and air flow is restricted, it is recommended that the battery be removed for maximum life. If the battery is required, it is recommended that the charge rate be limited to C/25.

4.5 CHARGING THE BATTERY

When you receive your 1211 from the factory, the charge rate in the BATT position will be C/25. It is recommended that you use the rear panel selector switch to control the charge current. At the end of a day of using battery power, plug the 1211 into an outlet and switch to C/10 for a full overnight recharge.

4.6 CONVERTING THE CHARGE RATE TO C/10

If it is inconvenient or annoying to use the rear panel switch to control the charge rate and you would prefer the C/10 charge rate in the BATT position, you may easily convert the 1211. Simply add four wires to the rear panel selector switch. Wire pin 5 to pin 9, pin 7 to pin 11, pin 1 to pin 13 and pin 3 to pin 15 right on the switch. This will convert the charge rate in the battery position from C/25 to C/10.

4.7 PROLONGING BATTERY LIFE

The following rules for prolonging battery life should be followed:

1. Upon receipt of the instrument from the factory, charge overnight at C/10.
2. Select C/25 for standby battery charge maintenance.
3. Avoid temperature extremes and cycles as much as possible.
4. For rack mounted use, remove the battery. If battery is required, limit the charge rate to C/25 as much as possible. The consideration here is one of high temperatures.
5. If the battery (in or out of the 1211) is in storage, perform an overnight recharge at C/10 at approximately 3 month intervals.
6. Avoid repeated charge/discharge cycles of the same duration. Nickel-cadmium cells display a memory effect which means that they will eventually provide only the capacity asked from them on a routine basis. If your cells do appear to have a degraded capacity, they need replacing. Try an overnight C/10 recharge to erase any memory effect. If the batteries still appear weak, as a last resort, unplug the 1211 and leave it "on" in the battery mode for several days to completely discharge the packs. Then recharge overnight at C/10. Sometimes battery capacity can be restored by cycling the pack in this manner. NOTE: Do not attempt to rush this process by discharging at high currents as cell reversal phenomenon will be aggravated leading to more permanent cell damage.
7. Recharge the battery after use even though the battery test light comes on. Nickel-cadmium batteries maintain a constant output voltage until they are almost completely discharged. The battery test light indicates that the battery has sufficient voltage to operate the 1211 not that it has ample reserves of energy.

SECTION 5

CALIBRATION

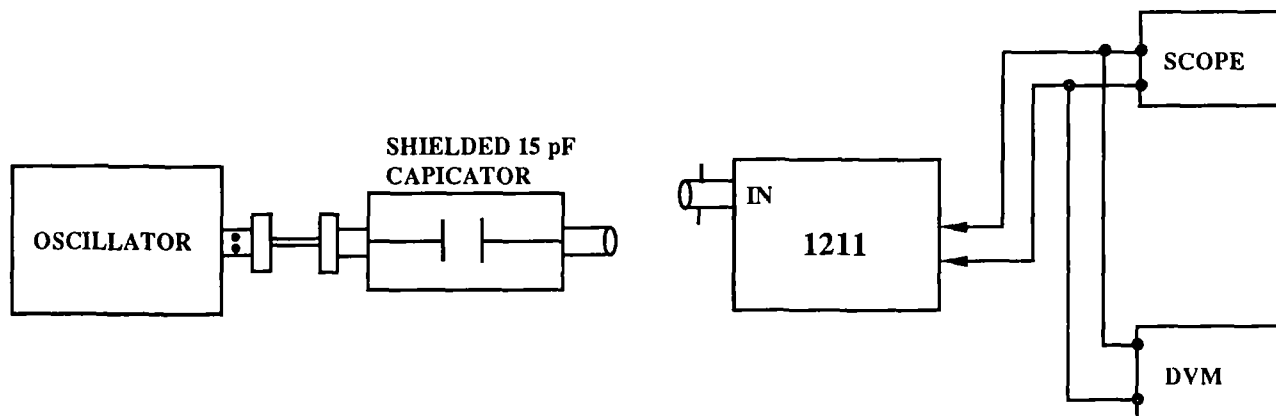
5.1 SCOPE

The purpose of this procedure is to align the 1211 prior to specifications check. Fault isolation to the functional block level is also provided.

5.2 INSTRUMENTATION

- a. Oscilloscope
- b. DVM – 100 μ V resolution, true rms
- c. Audio Oscillator, sine and triangle wave output, 50 Ω
- d. Shorting cap, BNC
- e. Non-shorting cap, BNC
- f. 10" jumper wire – .025" square ends
- g. Low noise 40 dB amplifier
- h. Step Attenuator, 50 Ω
- i. Shielded 15 pF capacitor
- j. 56 Ω Resistor

5.3 TEST SETUP



Note: it is recommended to look at all points with both scope and DVM during alignment.

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS			COMMENTS
				MIN	TYP	MAX	

WARNING: THIS UNIT CONTAINS HIGH IMPEDANCE CIRCUITRY

5.4 PROCEDURE

NOTE: R13 (A3) and R5, R22 (A4) are adjusted during Sub-assembly board tests. No realignment should be necessary.

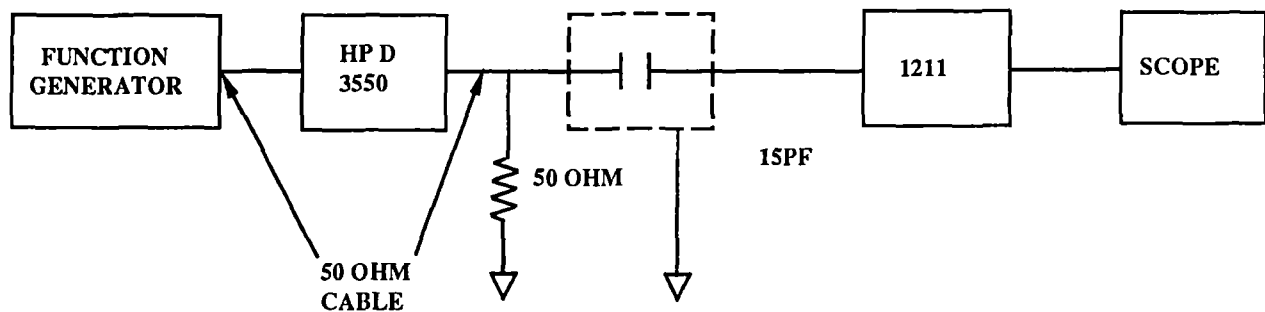
5.4.1 REFERENCE VOLTAGES -10V REF	I. Supp. : Neg : CAL	N/A	2. DVM : PIN 36 3. Adjust R185	-10.010	-10.000	-9.090	D.C.V
	I. Supp. • POS • CAL		2. Deviation from -10V . 3. Readjust R185 to evenly distribute ±Ref Voltage around 10 volts	0	± .150	± .250	D.C.V ±10V Ref is the calibrated supply for the I suppress and should be adjusted only for that purpose
5.4.2 OFFSET AND GAINS X1 OFFSET		1. disconnect pins 85, 86 (P21) 2. Short pin 86 to pin 97 (GND) 5. Reconnect pins 85, 86 (P21)	3. DVM : J13 (X1 out) 4. Adjust R88	-.2	0	+.2	D.C.V.

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS			COMMENTS
				MIN	TYP	MAX	
2nd L.P. OFFSET	1. Rise Time: 10 (ms) 2. Sens. Mult. :X.1	3. Gate input: Install shorting cap 4. Disconnect pins 94, 95 (P22) 5. Connect a 56Ω resistor between TP19 and TP20 8. Remove 56Ω resistor between TP19 and TP20 9. Reconnect pins 94, 95 (P22)	6. DVM; 600Ω out 7. Adjust R144	-100mV	0	+100mV	D.C.V.
1st L.P. OFFSET			1. DVM: 600Ω out 2. Adjust R113 3. Remove gate input shorting cap	-3mV	0	+3 mV	D.C.V.
INPUT AMP OFFSET	1. Sens. : 10 ⁻³ A/V 2. Sens. mult.: X0.1 3. V. BIAS : OFF 4. I. Supp.: OFF 5. Zero Set: OFF		6. DVM: 600Ω out 7. Adjust A1-R1 throughout range 8. Adjust A1-R1	±600mV -10mv	 0	±700mv +10mv	

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS			COMMENTS
				MIN	TYP	MAX	
GAIN ADJUST	1. Sens. Mult. :X1	2. Disconnect pins 83, 84 (P20) 3. Connect pin 84 to TP11 (-10V)	4. DVM : TP11	-10.110	-10.000	-9.890	Remember reading
			5. DVM: Lo-Z out 6. Adjust R129 7. Reconnect pins 83, 84 (P20)			±1mv	Adjust for same reading as at TP11
5.4.3 BIAS COMPENSATION	1. I. Supp.:OFF 2. V.BIAS: OFF 3. Sens: 10^{-3} A/V 4. Sens. Mult.: X.1 5. A3-S1: 12dB 6. Rise time: 300(ms) 8. Sens: 10^{-11} A/V		7. DVM : Lo-Z out 9. Adjust R52 for same reading as 7 above			±.2V*	Remember dc reading *0±0.2Vdc change from 7 (10^{-3} A/V setting)

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS			COMMENTS
				MIN	TYP	MAX	
5.4.4 RISE TIME ADJUST							
2nd L.P. RISETIME	1. A3-S1: 6 dB 2. V. BIAS: OFF 3. Rise Time: .01(ms) 4. Sens. Mult.: X1 5. I. Supp.: OFF	6. Disconnect pins 83, 84 (P20) 7. Connect 60.0kHz ≈1Vrms, sine wave to pin 84.	8. DVM - TP13 (A.C.V.) 9. Adjust oscillator amplitude for 1.000V rms 10. DVM: Lo-Z out (ACV) 11. Adjust C64	650mv	655mv	660mv	rms
1st L.P. RISETIME	1. A3-S1: 12 dB 2. V. BIAS: OFF 3. Rise Time: .01(ms) 4. Sens. Mult.: X1 5. I. Supp.: OFF	6. Connect 60.0kHz, ≈1Vrms, sine wave to pin 84	7. Adjust oscillator amplitude for 1.00Vrms 8. DVM: TP 13 9. Adjust C56	670mv	675mv	680mv	rms

INPUT RISE TIME SETUP



- Feed a 3C p-p triangle wave into HP attenuator. Make sure the triangle wave *has no spikes* at the top and bottom.
- Connect the attenuator output to the 1211 through a shielded 15pF capacitor. Connections must be as short as possible. Do not use coax.

SENSITIVITY	$10^{-8} \times 1$	$10^{-9} \times 1$	$10^{-10} \times 1$	$10^{-11} \times 1$
1) Adjust frequency and attenuator for 2.5V p-p output from 1211.	$\approx 1.6 \text{ kHz}$ @20 dB	$\approx 160 \text{ Hz}$ @20 dB	$\approx 16 \text{ Hz}$ @20 dB	$\approx 16 \text{ Hz}$ @40 dB
2) Adjust pots on side rail mounted board for critically damped square wave with fastest rise time possible. See Figure 5.1		R2 then R1 repeat as often as necessary	R5 then R4 repeat as often as necessary	R8 then R7 repeat as often as necessary
3) Rise time nominal	24 μs	80 μs	580 μs	750 μs
4) Rise time spec	40 μs	250 μs	750 μs	1.1 ms

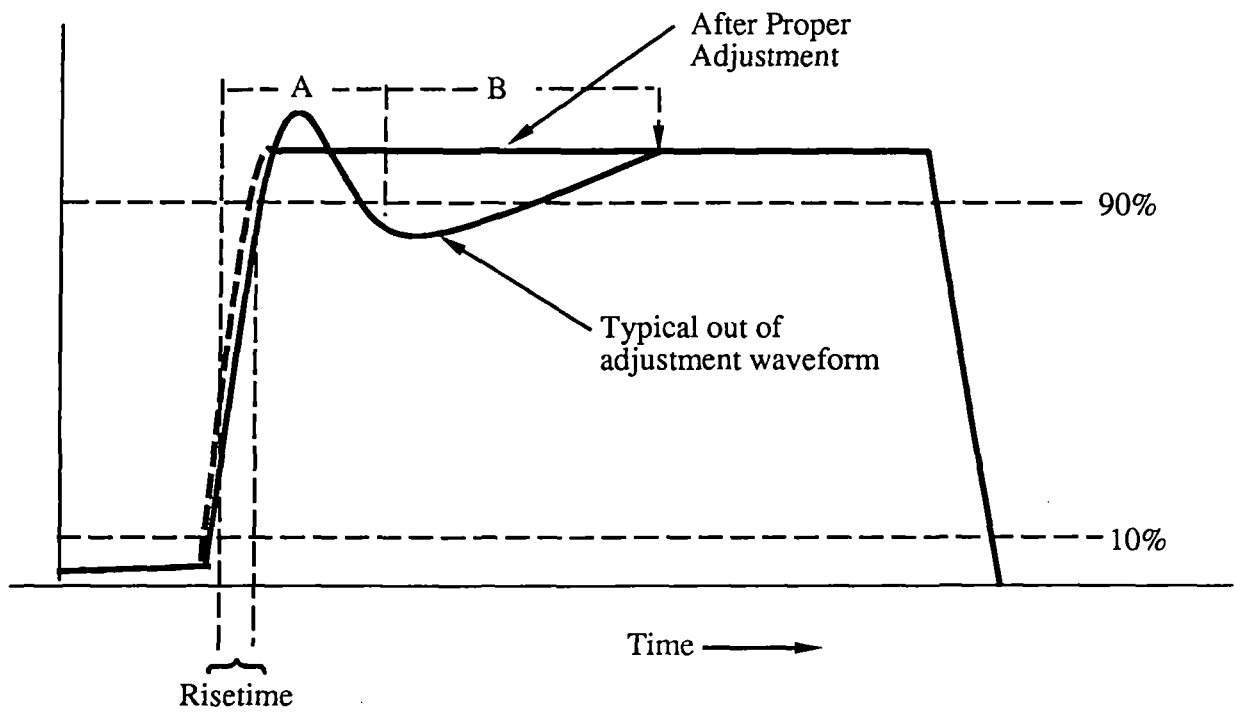
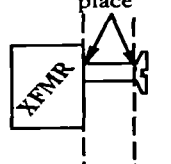


FIGURE 5.1 WAVEFORM

The area around Section A is controlled by R2, R5, R8.

The area around Section B is controlled by R1, R4, R7.

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS			COMMENTS
				MIN	TYP	MAX	
5.4.5 TRANSFORMER HUM	1. Sens: 10^{-6} A/V 2. Sens. Mult: X1 3. Risetime: 10 (msec) 4. I. Supp. : OFF 5. A3-S1: 12dB 6. V. Bias: OFF	7. Non-Shorting Cap on Input (J1)	8. Connect scope to Lo-Z out through a X100 AMP 9. Rotate XFMR for minimum hum at line related frequencies 10. Apply Loctite <i>sparingly</i> to threads and head of XFMR screw and tighten <div data-bbox="1106 1159 1319 1484"> <p>A drop or two on each place</p>  <p>CASE</p> </div>				

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TESTS	ACTION
5.5 FAULT ISOLATION	-10V REF	1. Check TP12 for +10Vdc capability when R185 is adjusted. 2. Check PIN 37 for +10Vdc capability when R185 is adjusted	1. If not, check A1-57 and wiring
	±10V DISTRIBUTION	1. Check PIN 37 for 220mV deviation between I+I and I-I I suppresses (switch positions). 2. Check TP11 and TP12 for <220mV deviation between I+I and I-I voltages	1. If OK, check A1-S7 and wiring for shorts (normal and high impedance), open or miswiring.
	X1OFFSET	1. Check voltage swing across RB6 for ±6.6mV	1. If not, check ±10V reference (TP11, TP12)
	1st L.P. AMP	1. Disconnect Pins 83,84 (P20) and ground Pin 84 to pin 97, reattempt alignment. 2. Remove BNC cap on gate and reattempt alignment.	

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TESTS	ACTION
5.5 (continued)	Input AMP offset (insufficient swing)	1. Check A1-R1 wiring. 2. Check voltage across R21 for 1.12V to 1.31 Vdc 3. Check swing at PIN 83 (while turning A1-R1) for 60 to 70mV p-p. 4. Check swing at TP18 (while turning A1-R1) for 60 to 70 mV p-p. 5. Check swing at TP13 for 60 to 70mvV p-p	----- ----- ----- -----
	Input AMP offset (too much swing)	1. Check voltage across R21 for 1.12V to 1.31Vdc 2. Leave current suppress switch OFF and turn UP current suppress. Check 600μ out for NO change	----- 1. If not, check K3 for short. -----
	Input AMP (offset will not adjust)	1. Leave I.SUPP:OFF. Turn I.SUPP UP and check 600μ out for NO change	----- 1. If not, check K3 for short. -----
	Gain Adjust	NOTE: Readings assume -10V at TP11; correct readings accordingly. 1. Check TP18 for -9.992V to -9.975Vdc 2. Check TP13 for +9.936V to +10.356V dc 3. See TSP 1534 (2nd L.P. AMP).	-----

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TEST	ACTION
5.5 (continued)	BIAS Compensation	1. Check Pin 35 for $0 \pm 15 \text{ mV}$	1. If not, check reference circuits
		2. Output should not change when changing I suppress (I. suppress off)	1. If not, check for K3 short
		3. Check TP15 for $0 \pm 1 \text{ mV}$	1. If not, check V. BIAS circuit
		4. Check CR14—ANODE (while turning R52) for 0 V to -5 Vdc range	1. If not, check CR14 and leakage circuit
		5. CR14 and/or Q6 leakage incorrect.	
	2nd LP Risetime	1. Check L.P. switch wiring	
	1st LP Risetime	1. Check L.P. switch and 6/12 dB switch	
	Input Risetime [Higher Ranges (10^{-11})]	1. Check ground plate to circuit ground for 0Ω .	
		2. Check shield closure to circuit ground for 0Ω .	
		3. Check accelerator plate to:	
		a. Pin 83 for 100Ω (10^{-8} thru 10^{-10})	
		b. Pin 74 for 100Ω (10^{-11} A/V)	
		4. Disconnect cables and check chassis ground to Pin 97 for 10Ω .	
		5. Reconnect signal and check Q29 drain for 2 mV ac max.	
		6. Connect TP11 to E6 and check Pin 83 for 100 mV max.	
		7. Check for ungrounded components going through the accelerator plate	
		8. Check any wire entering the front end 2 mV ac max.	

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TESTS	ACTION
5.5 (continued)	Input Risetime [Lower ranges (10^{-8})]	1. Make certain input test jig (shielded capacitor) is connected directly to input – NO COAX ALLOWED.	
		2. Check Q29 drain for 2mVac max.	
		3. Check continuities as in (higher ranges) above.	
		4. Check for ungrounded components going through the accelerator plate.	
	Transformer Hum	1. Check chassis ground to circuit ground for 10Ω .	
		2. Check battery charge current (\pm) for 120 ma max.	
		3. Remove transformer from 1211 case and check hum	1. If ok, or better, try new XFMR.
		4. Activate gate input (shorting cap) and check hum	1. If ok, check if Q28 drains is $0-5\Omega$ to ground.
		5. Disconnect Pins 94, 95 (P22) and ground pin 95 at TP20, then check hum.	

SECTION 6

REPLACEABLE PARTS

6.1 INTRODUCTION

This section contains the information needed for ordering replacement parts.

6.2 REFERENCE DESIGNATIONS AND ABBREVIATIONS

Table 6.1 is a list of reference designations and abbreviations.

6.3 REPLACEABLE PARTS

Table 6.2 lists parts in alphabetical order of their reference designations with locations and descriptions for each part.

6.3.1 EXPLANATION OF LOCATION COLUMN

Each page of Table 6.2 has at the top of the page the description and the ITHACO Drawing Number for the parts listed.

The location code is broken down as follows:

LOCATION	The first digit or (digits) is the page number of the
Sch Asm	schematic. The letter and digit following locate the
3D9 C9	part on that particular schematic.

The letter and number under the assembly column locate the part on the assembly drawing.

6.4 CODE LIST OF MANUFACTURERS

Table 6.3 is a Code List of Manufacturers. The manufacturer's code is given with each part. If a code number is missing, the part is a standard designation and is available from many manufacturers.

REFERENCE DESIGNATIONS

A	assembly subassembly, separable or repairable		insulator		oscilloscope	RT	lamp, resistance
AR	amplifier		loop antenna		recorder, elapsed time		resistor, current regulating
AT	attenuator		magnet, permanent		register, message		resistor, thermal
	pad		part, miscellaneous		strain gage	RV	thermistor
	termination		electrical		thermometer		resistor, voltage sensitive
B	blower		post, binding	MK	timer, electric		varistor, symmetrical
	motor		shield, electrical	MP	microphone	S	switch
	synchro		terminal (individual)		frame		thermostat
BT	battery	F	fuse		gyroscope	T	transformer
C	capacitor	FL	filter		interlock, mechanical	TB	strip, terminal
CB	circuit breaker	G	chopper, electronic		mechanical part		terminal board
CP	adapter, connector		generator		mounting (not electrical	TC	thermocouple
	coupling (aperture, loop or	H	hardware		circuit, not a socket)	TP	test point
	probe) junction (coaxial or	HR	heater		part, miscellaneous	U	integrated circuit package
	waveguide)		lamp, infrared		mechanical (bearing,	V	cell, light-sensitive,
		HS	handset		coupling, gear, shaft)		photoemissive
CR	diode	HY	network, hybrid circuit		part, structural		electron tube
	rectifier	J	connector, receptacle,		reed, vibration	W	cable
			electrical		tuning fork		cable assembly (with
DS	alarm		disconnecting device	MT	transducer		connectors)
	indicator (excluding meter)		jack		transducer, mode	WT	wire
E	antenna		receptacle (connector,	P	connector, plug, electrical	X	tiepoint, wiring
	arrestor, lightning		stationary portion)		disconnecting device		fuseholder
	bimetallic strip	K	Relay		(connector, plug)		lampholder
	cell, aluminum or electro-	L	coil (all not classified as		plug, electrical (connector,		socket
	lytic contact		transformers)		movable portion	Y	crystal unit, piezoelectric
	core, inductor	M	clock	PS	power supply		
	core, memory		counter, electrical	Q	transistor		
	core, transformer		meter	R	potentiometer		
	Hall effect device		oscillograph		resistor		

ABBREVIATIONS

A	ampere	GE	germanium	N	nano (10 ⁻³⁰)	S-B	slow-blow
AC	alternating	GL	glass	N/C	normally closed	SCR	screw
	current	GND	ground	NE	neon	SE	selenium
ALUM	aluminum			N/O	normally open	SEC	second
AMPL	amplifier	H	henries	NPO	negative positive	SECT	section(s)
ASSY	assembly	HPF	high-pass filter		zero	SEMICON	semiconductor
		HR	hour	NSR	not separately	SI	silicon
BP	bandpass	Hz	Hertz		replaceable	SIL	silver
						SL	slide
CAL	calibration	IF	intermediate	OSC	oscillator	SOL	solid
CAR	carbon		frequency	OP	operational	SPL	special
CCW	counterclockwise						
CER	ceramic	INS	insulation(ed)	PC	printed circuit	TA	tantalum
CKT	circuit	INT	internal	PF	picrofarads	TGL	toggle
COMP	composition				10 ⁻¹² farads	TOL	tolerance
CRT	cathode-ray tube	K	kilo = 1000	PIV	peak inverse volt	TRIM	trimmer
CW	clockwise				voltage		
		LED	light emitting	P/P	part of		
dB	decibel	diode		PPM	parts per million	μ	micro 10 ⁻⁶
DC	direct current	LIN	linear taper	POLY	polystyrene	V	volt
DET	detector	LOG	logarithmic	POLYCARB	poly carbonate	VAR	variable
DVM	digital voltmeter		taper	POS	position(s)	CDCW	dc working
		LPF	low-pass filter	POT	potentiometer		volts
				P-P	peak-to-peak	VCO	voltage
ELECT	electrolytic						controlled
ENCAP	encapsulated	M	Millo 10 ⁻³	RC	resistor capacitor		oscillator
EXT	external	MEG	meg 10 ⁶		network	W/	with
		METFLM	metal film	RECT	rectifier	W	watts
F	farads	MFR	manufacturer	REF	reference	WW	wirewound
FET	field effect	MINAT	miniature	RF	radio frequency	W/O	without
	transistor	MOM	momentary	RMS	root-means-		
FREQ	frequency	MTG	mounting		square		
FXD	fixed	MYFLM	"mylar" film				

Table 6.1 List of Reference Designations and Abbreviations

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			CAPICATORS			
C2	1-C1	B3	5pF, 500V, \pm pF	811581038		
C3	1-C2	B3	15pF, 500V, 5%	811581029		
C4	1-B3	C3	47pF, 1000V, 20%	811572005	48	10TS-Q47
C5	1-D2	D3	15 μ F, 20V, 10%	811504020	48	196D-156X9020KA1
C6	1-H1	B5	.01 μ F, 500V, 2%	811570019	48	5GAS-S10
C7	1-G2	B5	47 μ F, 20V, 10%	811504021	48	196D-476-9020-LA3
C8	1-B6	C4	.01 μ F, 500V, 20%	811570019	48	5GAS-S10
C9	1-F5	D3	470pF, 1000V, 20%	811572015	48	10TS-T47
C10	1-E5	D4	100pF, 500V, 5%	811581008	17	CD15FD101J03
C11	1-B7	C5	47 μ F, 20V, 10%	811504021	48	196D-476-9020-LA3
C12	1-B8	C5	0.47 μ F, 35V, 10%	811501191	48	150D474X9035A2
C13	1-E6	D5	.01 μ F, 500V, 20%	811570019	48	5GAS-S10
C14	1-E8	D5	0.47 μ F, 35V, 10%	811501191	48	150D474X9035A2
C15	1-G7	D5	47 μ F, 20V, 10%	811504021	48	196D-476-9020-LA3
C16	2-D2	B3	1.5 μ F, 100V, 5%	811553022	104	D1-155D
C17	2-F5	E4	470 μ F, 500V, 5%	811581014	17	CD15FD471J03
C18	2-G4	B3	.1 μ F, 200V, 10%	811540065	22	626B1C104K
C19	2-G6	B4	.01 μ F, 500V, 20%	811570019	48	5GAS-S10
C20	2-B7	B6	150pF, 1000V, 20%	811572012	48	10TS-T15
C21	2-C7	B6	100pF, 500V, 5%	811581008	17	CD15FD101J03
C22	2-C7	B6	270pF, 500V, 5%	811581025	17	CD15FD271J03
C23	2-C8	B6	.01 μ F, 500V, 20%	811570019	48	5GAS-S10
C24	2-C9	B7	.01 μ F, 500V, 20%	811570019	48	5GAS-S10
C25	2-D7	B6	.01 μ F, 500V, 20%	811570019	48	5GAS-S10
C26	2-E8	B7	.01 μ F, 500V, 20%	811570019	48	5GAS-S10
C27	2-E9	B7	.01 μ F, 500V, 20%	811570019	48	5GAS-S10
C28	3-A2	F6	2200pF, 250V, 10%	811570028	48	2SS-D22
C29	3-A2	F6	120pF, 500V, 1%	811581080	79	DM15D121F
C30	3-A3	F5	470pF, 500V, 5%	811581014	17	CD15FD471J03
C31	3-A3	F6	1500pF, 500V, 1%	811581070	17	CD19FD157F03
C32	3-A3	F6	.005 μ F, 400V, 5%	811553026	57	D4-502
C33	3-A4	F6	.015 μ F, 100V, 5%	811551037	28	61F10AC332
C34	3-A4	F6	.05 μ F, 200V, 5%	811553025	57	D2-503
C35	3-A4	F6	0.15 μ F, 200V, 5%	811553024	57	D2-1540

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS	MANUFACTURER	
	SCH	ASM		PART NUMBER	CODE	PART NUMBER
			CAPACITORS (continued)			
C36	3-A4	F5	0.,5μF, 200V, 5%	811553023	57	D2-504D
C37	3-A4	F6	1.5μF, 100V, 5%	811553022	104	D1-155D
C38	3-A5	F5	5μF, 100V, 5%	811553027	57	D1-505D
C39	3-A6	F4	18pF, 500V, 5%	811581027	17	CD15CD180J03
C40	3-A6	F4	120pF, 500V, 1%	811581080	79	DM15D121F
C41	3-A6	F3	470pF, 500V, 5%	811581014	17	CD15FD471J03
C42	3-A6	F3	1500pF, 500V, 1%	811581070	17	CD19FD157F03
C43	3-A7	F3	.005μF, 400V, 5%	811553026	57	D4-502
C44	3-A7	F2	.015μF, 100V, 5%	811551037	28	61F10AC332
C45	3-A7	F3	.05μF, 200V, 5%	811553025	57	D2-503
C46	3-A7	F2	0.15μF, 200V, 5%	811553024	57	D2-154D
C47	3-A8	F2	0.5μF, 200V, 5%	811553023	57	D2-504D
C48	3-A8	F3	1.5μF, 100V, 5%	811553022	104	D1-155D
C49	3-A8	F2	5μF, 100V, 5%	811553027	57	D1-505D
C50	3-C1	E7	.01μF, 500V, 20%	811570019	48	5GAS-S10
C51	3-C2	E7	22pF, 1000V, 20%	811572003	48	10TS-Q22
C52	3-D3	F7	22pF, 1000V, 20%	811572003	48	10TS-Q22
C53	3-C4	E5	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C54	3-C4	E5	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C55	3-B4	E4	10pF, 1000V, 20%	811572001	48	10TS-Q10
C56	3-C4	E4	VAR 5.5–18pF	811590008	25	538-002A5.5-18
C57	3-E2	F7	100pF, 1000V, 20%	811572011	48	10TS-T10
C58	3-F2	F8	.01μF, 500V, 20%	811570019	48	5GAS-S10
C59	3-F5	F7	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C60	3-C7	G3	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C61	3-C7	G4	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C62	3-D7	G3	22pF, 500V, ±1/2pF	811581066	17	CD10ED220D03
C63	3-D8	G3	.1μF, 200V, 10%	811540065	22	626BIC104K
C64	3-C8	F4	VAR 5.5–18pF	811590008	25	538-002A5.5-18
C65	3-C8	F4	5pF, 1000V, 20%	811572021	48	10TS-Q10
C66	3-C9	G3	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C67	3-E7	F3	.01μF, 500V, 20%	811570019	48	5GAS-S10
C68	3-E9	G3	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C69	5-F2	B8	.01pF, 500V, 20%	811570019	48	5GAS-S10
C70	5-H2	B8	.01μF, 500V, 20%	811570019	48	5GAS-S10

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS	MANUFACTURER	
	SCH	ASM		PART NUMBER	CODE	PART NUMBER
			CAPACITORS (Continued)			
C71	5-G3	B9	.01μF, 500V, 20%	811570019	48	5GAS-S10
C72	4-D3	D9	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C73	4-C4	D9	.047μF, 100V, 5%	811551013	48	61F19AC473
C74	4-D6	D7	15μF, 20V, 10%	811504020	48	196D-156X9020KA
C75	4-D6	C8	.01μF, 500V, 20%	811570019	48	5GAS-S10
C76	4-E6	D7	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C77	4-E6	D7	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C78	4-D7	D8	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C79	4-D7	C7	470pF, 1000V, 20%	811572015	48	10TS-T47
C80	4-F7	C6	470pF, 1000V, 20%	811572015	48	10TS-S10
C81	4-E2	D9	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C82	1-D1	D5	100pF, 1000V, 20%	811572011	48	10TS-T10
C83	2-G4	D6	100pF, 1000V, 20%	811572011	48	10TS-T10
C84	4-G5	D5	.01μF, 500V, 20%	811570019	48	5GAS-S10
C85	2-H2	C2	.047μF, 50V, 20%	811570020	25	8121-050-651-473M
C86	1-A7	B5	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C87	2-G5	B4	.01μF, 500V, 20%	811570019	48	5GAS-S10
C89	2-F5	D4	.68μF, 200V, 5%	811553005		
C90	1-E5	D4	22pF, 500V, ±1/2pF	811581066	17	CD10ED220D03
C91	2-G5	B4	470pF, 1000V, 20%	811572015	48	10TS-T47
C117			.01μF, 500V, 20%	811570019	48	5GAS-S1
			DIODES			
CR1	1-C1	B4	IN4148	818100003		IN4148
CR2	1-C2	C3	IN4148	818100003		IN4148
CR3	1-B2	C3	IN4148	818100003		IN4148
CR4	1-G2	B5	IN4148	818100003		IN4148
CR5	1-G2	B5	IN4148	818100003		IN4148
CR6	1-H2	B5	IN4148	818100003		IN4148
CR7	1-H2	B5	IN823A (6.2V)	818175002		IN823A
CR8	1-C5	C4	IN4148	818100003		IN4148
CR9	1-C6	C5	IN4148	818100003		IN4148
CR10	1-D6	C5	IN4148	818100003		IN4148

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			DIODES (Continued)			
CR11	2-D2	D3	Selected (D PAD 50)	A86153P1	31	A86153P1
CR12	2-D2	B5	IN4005	818100007		IN4005
CR13	2-D2	B5	IN4005	818000007		IN4005
CR14	2-H3	C2	Selected (2N5087)	A86193P1	31	A86193P1
CR15	2-G3	D6	IN4148	818100003		IN4148
CR16	2-H6	B4	IN4148	818100003		IN4148
CR17	2-D8	B6	IN4148	818100003		IN4148
CR18	2-D8	B6	IN4148	818100003		IN4148
CR19	2-D8	B6	IN4148	818100003		IN4148
CR20	2-D8	B6	IN4148	818100003		IN4148
CR21	2-D8	B6	IN4148	818100003		IN4148
CR24	3-F2	F8	IN4148	818100003		IN4148
CR25	3-F2	F8	IN4148	818100003		IN4148
CR26	3-D8	G3	IN4148	818100003		IN4148
CR27	3-D8	G3	IN4148	818100003		IN4148
CR28	3-D8	G3	IN4148	818100003		IN4148
CR29	3-D8	G3	IN4148	818100003		IN4148
CR30	3-D8	G3	IN4148	818100003		IN4148
CR31	5-E1	B8	IN4148	818100003		IN4148
CR32	5-E1	B8	IN4148	818100003		IN4148
CR34	5-G1	C8	IN4148	818100003		IN4148
CR35	5-G1	C8	IN4148	818100003		IN4148
CR37	5-F3	B9	IN4148	818100003		IN4148
CR38	5-F3	B9	IN4148	818100003		IN4148
CR39	5-G3	C9	IN4148	818100003		IN4148
CR40	5-G3	C9	IN4148	818100003		IN4148
CR42	4-C2	D8	IN827A (6.2V) ZENER	818175003		IN827A
CR43	4-F4	D5	IN4148	818100003		IN4148
CR44	4-F4	D5	IN4148	818100003		IN4148
CR45	4-D9	D5	IN4148	818100003		IN4148

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			DIODES (continued)			
CR46	3-G5	D6	IN4148	818100003		IN4148
CR47	3-G5	E6	IN4148	818100003		IN4148
CR48	2-G5	D6	IN4148	818100003		IN4148
CR49	3-G6	E6	IN4148	818100003		IN4148
J1		F6	Socket, 14 pin dip	812129113	101	CA-14S-105D
J2		E6	Socket, 14 pin dip	812129113	101	CA-14S-105D
K1	1-C2	B3	Relay	814500022	106	IA12AHH-X
K2-L	2-G3	E2	Coil, Relay Shielded	A88493P1	31	A88493P1
K2-S	2-G3	E2	Reed Switch	A88630P1	31	A88630P1
K3-L	4-D9	E2	Coil, Relay Shielded	A88493P1	31	A88493P1
K3-S	4-D9	E2	Reed Switch	A88630P1	31	A88630P1
			TRANSISTORS			
Q1	1-B2	C3	2N3906	818203906		2N3906
Q2	1-D1	D5	TIS97	818700046		TIS97
Q3	1-D1	D5	2N3904	818203904		2N3904
Q4	1-C3	D2	2N3958	818203958		2N3958
Q5	1-C4	C3	AD821 (selected)	A86197P1	31	A86197P1
Q6	1-D3	D2	2N6484 (select)	A86152P2	31	A86152P2
Q7	1-E2	D3	2N5087	818205087		2N5087
Q8	1-E3	B3	2N3906	818203906		2N3906
Q9	1-F2	B2	2N3904	818203904		2N3904
Q10	1-F3	C2	2N3904	818203904		2N3904
Q11	1-G2	B5	2N3906	818203906		2N3906
Q12	1-G2	B5	2N3904	818203904		2N3904
Q13	1-D5	C4	AD821 (selected)	A86197P1	31	A86197P1
Q14	1-D4	C4	2N3906	818203906		2N3906
Q15	1-D5	C4	2N3906	818203906		2N3906

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			TRANSISTORS (Continued)			
Q16	1-E4	D4	2N3904	818203904		2N3904
Q17	1-E5	D4	2N3904	818203904		2N3904
Q18	1-F5	C4	2N3904	818203904		2N3904
Q19	1-B5	C4	2N3904	818203904		2N3904
Q20	1-B6	C5	2N3906	818203906		2N3906
Q21	1-B7	C5	2N2219	818202219		2N2219
Q22	1-G7	C5	2N3904	818203904		2N3904
Q23	1-C7	C5	2N3906	818203906		2N3906
Q24	1-D6	D4	2N3906	818203906		2N3906
Q25	1-D7	C5	2N2905	818202905		2N2905
Q26	2-G4	D6	2N3904	818203904		2N3904
Q27	2-G4	C6	TIS97	818700046	55	TIS97
Q28	2-E2	B4	TIS75	818700009	55	TIS75
Q29	2-H4	B3	TIS75	818700009	55	TIS75
Q30	2-H5	B4	2N3904	818203904		2N3904
Q31	2-G6	B4	TIS75	818700009	55	TIS75
Q32	2-G6	B5	2N5089	818205089		2N5089
Q33	2-C8	B7	2N2219	818202219		2N2219
Q34	2-E8	B7	2N3904	818203904		2N3904
Q35	2-E8	B7	2N2905	818202905		2N2905
Q36	3-C1	E7	2N3904	818203904		2N3904
Q37	3-C2	E6	TIS75	818700009	55	TIS75
Q38	3-C2	E6	TIS75	818700009	55	TIS75
Q39	3-D1	E7	2N3906	818203906		2N3906
Q40	3-D2	E7	2N3906	818203906		2N3906
Q41	3-E1	F7	2N3904	818203904		2N3904
Q42	3-E2	F7	2N3904	818203904		2N3904
Q43	3-G1	F9	2N3904	818203904		2N3904
Q44	3-D5	G4	TIS75	818700009	55	TIS75
Q45	3-D6	G4	TIS75	818700009	55	TIS75
Q46	3-D6	G4	TIS75	818700009	55	TIS75
Q47	3-E6	G4	TIS75	818700009	55	TIS75
Q48	3-E5	G4	TIS75	818700009	55	TIS75
Q49	3-C6	G4	U402	818700043	108	U402
Q50	3-E7	F4	2N3904	818203904		2N3904

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS	MANUFACTURER	
	SCH	ASM		PART NUMBER	CODE	PART NUMBER
			TRANSISTORS (Continued)			
Q51	3-E8	F3	2N3904	818203904	55	2N3904
Q52	3-C8	G3	2N2219	818202219		2N2219
Q53	3-D9	F3	2N2905	818202905		2N2905
Q54	5-E1	B8	2N3904	818203904		2N3904
Q55	5-F2	B8	2N3904	818203904		2N3904
Q56	5-G1	C8	2N3906	818203906	55	2N3906
Q57	4-C2	D8	2N3904	818203904		2N3904
Q58	4-E3	D9	2N3906	818203906		2N3906
Q59	4-E3	E9	2N3904	818203904		2N3904
Q60	4-D4	D9	TIS75	818700009		TIS75
Q61	4-E6	C8	2N3904	818203904	55	2N3904
Q62	4-E7	C7	2N3904	818203904		2N3904
Q63	4-D7	C7	2N3906	818203906		2N3906
Q64	4-F6	C8	2N3906	818203906		2N3906
Q65	4-E7	C7	2N3906	818203906		2N3906
Q66	4-F7	C7	2N3904	818203904	55	2N3904
Q67	4-G5	D5	2N3904	818203904		2N3904
Q68	4-G5	D5	TIS97	818700046		TIS97
Q69	3-C3	E7	2N3904	818203904		2N3904
Q70	1-D5	C4	2N3906	818203906		2N3906
Q71	2-H5	B4	2N3904	818203904	55	2N3904
Q72	1-B7	B5	2N3904	818203904		2N3904
Q73	1-F7	C5	2N3906	818203906		2N3906

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS			
			All resistors not otherwise designated are 1/4W, 5%, Comp * 1/8W, 1%, Metflm ** 1/8W, 0.1%, Metflm *** 1/10W, 1%, Temp Stable, Metflm			
R1	1-B3	C3	75.0Ω *	817219750		RN60D
R2	1-B3	C3	7.50K *	817211750		RN60D
R3	1-B2	C3	7.50K *	817211750		RN60D
R4	1-B2	C3	7.50K *	817211750		RN60D
R5	1-C3	C3	56Ω	817007560		RCR07
R6	1-B2	C3	75.0Ω *	817219750		RN60D
R7	1-B3	C3	11.0K *	817212110		RN60D
R8	1-B4	C3	11.0K *	817212110		RN60D
R9	1-C3	C3	56Ω	817007560		RCR07
R10	1-D1	D4	33K	817007333		RCR07
R11	1-D1	D5	133Ω *	817210133		RN60D
R12	1-D2	D3	1.62K *	817211162		RN60D
R13	1-D2	D3	20K (Pot)	817801138	29	72PR20K
R14	1-E2	D2	100Ω	817007101		RCR07
R15	1-E2	D2	42.2Ω *	817219422		RN60D
R16	1-E2	D2	42.2Ω *	817219422		RN60D
R17	1-E3	B3	1.47K *	817211147		RN60D
R18	1-F2	B2	1.47K *	817211147		RN60D
R19	1-F3	B2	1.47K *	817211147		RN60D
R20	1-G2	B5	5.11K *	817211511		RN60D
R21	1-G2	B5	1.62K *	817211162		RN60D
R22	1-G2	B5	10K	817007103		RCR07
R23	1-H2	B5	8.25K *	817211825		RN60D
R24	1-H2	B5	8.25K *	817211825		RN60D
R25	1-D4	C3	12Ω	817007120		RCR07
R26	1-B4	C4	422Ω *	817210422		RN60D
R27	1-B5	C4	1K	817007102		RCR07
R28	1-B5	C4	5.11K *	817211511		RN60D
R29	1-C5	C4	42.2Ω *	817219422		RN60D
R30	1-C5		42.2Ω *	817219422		RN60D

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R31	1-C5	C4	33K	817007333		RCR07
R32	1-C5	C3	12Ω	817007120		RCR07
R33	1-D5	C4	1K	817007102		RCR07
R34	1-D6	D4	100Ω	817007101		RCR07
R35	1-D6	D4	681Ω *	817210681		RN60D
R36	1-F4	D4	511Ω *	817210511		RN60D
R37	1-F5	D4	511Ω *	817210511		RN60D
R38	1-F5	D4	12.1K *	817212121		RN60D
R39	1-B6	C4	681Ω *	817210681		RN60D
R40	1-B7	C5	4.7K	817007472		RCR07
R41	1-B6	C5	1K	817007102		RCR07
R42	1-B7	C5	12Ω	817007120		RCR07
R43	1-B6	C5	100Ω	817007101		RCR07
R44	1-B6	C4	100Ω	817007101		RCR07
R45	1-C7	C5	12Ω	817007120		RCR07
R46	1-C7	C5	12Ω	817007120		RCR07
R47	1-D6	C5	100Ω	817007101		RCR07
R48	1-E6	D5	681Ω *	817210681		RN60D
R49	1-E7	D5	56Ω	817007560		RCR07
R50	1-F7	D5	4.7K	817007472		RCR07
R51	2-C2	C2	681Ω *	817210681	29	RN60D
R52	2-H2	B3	100K, 10% (Pot)	817801136		72PR100K
R53	2-G5	B4	33K	817007333		RCR07
R54	2-G2	B3	100K, 1/8W, 1%, 25ppm	817200052		RN55E-1003F
R55	2-G2	B3	100K, 1/8W, 1%, 25ppm	817200052		RN55E-1003F
R56	2-H2	B3	464K *	817213464		RN60D
R57	2-H2	B2	464K *	817213464		RN60D
R58	2-G3	C6	100Ω	817007101		RCR07
R59	2-G3	B3	470Ω	817007471		RCR07
R60	2-G4	C6	33K	817007333		RCR07
R61	2-F4	D4	8.2Ω	817007829		RCR07
R62	2-F4	D4	6.282K, 1/8W, 0.1%, 100ppm	817261185	57	CEA-TO-6282 1/8 1%
R63	2-F4	D4	10Ω *	817219100		RN60D
R64	2-F5	D4	690.2Ω, 1/4W, 0.1%, 50ppm	817200037	57	CCA-T2-690.2Ω
R65	2-F5	D4	614.8Ω, 1/4W, 0.1%, 50ppm	817200038	57	CCA-T2-614.8Ω

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R66	2-F5	D4	292.1Ω, 1/4W, 0.1%, 25ppm	817200039	57	CCA-T9-292.1Ω
R67	2-F6	D4	698.0Ω, 1/4W, 0.1%, 50ppm	817200040	57	CCA-T2-698.0Ω
R68	2-E2	B4	220K	817007224		RCR07
R69	2-G5	B4	4.7K	817007472		RCR07
R70	2-G5	B4	1M	817007105		RCR07
R71	2-G5	B4	1K	817007102		RCR07
R72	2-G5	B5	1M	817007105		RCR07
R73	2-G5	B5	220K	817007224		RCR07
R74	2-H5	B4	220K	817007224		RCR07
R75	2-G6	B4	100Ω	817007101		RCR07
R76	2-H6	B4	100K	817007104		RCR07
R77	2-B7	B7	2.162K, 1/8W, 0.1%, 100ppm	817261016	63	REA 1/8, 2.162KC1
R78	2-B8	D7	100Ω	817007101		RCR07
R79	2-C7	B6	22Ω	817007220		RCR07
R80	2-C8	B6	100Ω	817007101		RCR07
R81	2-C8	B7	100Ω	817007101		RCR07
R82	2-C7	B6	1K	817007102		RCR07
R83	2-C7	B7	100Ω	817007101		RCR07
R84	2-C7	B6	464K *	817213464		RN60D
R85	2-D7	B6	2.162K, 1/8W, 0.1%, 100ppm	817261016	63	REA 1/8, 2.162KC1
R86	2-C7	B6	316Ω *	817210316		RN60D
R87	2-C7	B6	100Ω	817007101		RCR07
R88	2-D7	B6	100K, 10%, (Pot)	817801136	29	72PR100K
R89	2-C8	B7	18Ω	817007180		RCR07
R90	2-D9	B7	18Ω	817007180		RCR07
R91	2-D9	B7	18Ω	817007180		RCR07
R92	2-D8	B7	18Ω	817007180		RCR07
R93	2-D8	B7	100Ω	817007101		RCR07
R94	2-E7	B7	1K	817007102		RCR07
R95	2-E8	B7	4.7K	817007472		RCR07
R96	2-E9	B7	100Ω	817007101		RCR07
R97	3-A5	F5	470K	817007474		RCR07
R98	3-A5	G5	470K	817007474		RCR07
R99	3-A8	F2	470K	817007474		RCR07
R100	3-A8	F2	470K	817007474		RCR07

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R101	3-C1	E7	22Ω	817007220		RCR07
R102	3-D1	E8	10K	817007103		RCR07
R103	3-C2	E7	18K	817007183		RCR07
R104	3-C2	E7	100K	817007104		RCR07
R105	3-D2	E7	220K	817007224		RCR07
R106	3-D2	E8	10K	817007103		RCR07
R107	3-C2	E5	19.6K *	817212196		RN60D
R108	3-C3	E5	19.6K *	817212196		RN60D
R109	3-C2	E7	18K	817007183		RCR07
R110	3-C3	E5	316Ω *	817210316		RN60D
R111	3-C3	F5	464K *	817213464		RN60D
R112	3-D3	E7	220K	817117224		RCR07
R113	3-C3	F4	50K (POT)	817801135	29	68WR50K
R114	3-B4	E5	100Ω	817007101		RCR07
R115	3-C4	E5	100Ω	817007101		RCR07
R116	3-B4	E5	19.6K *	817212196		RN60D
R117	3-B4	E5	316Ω *	817210316		RN60D
R118	3-E1	F7	33K	817007333		RCR07
R119	3-E2	F7	33K	817007333		RCR07
R120	3-F1	F9	100K	817117104		RCR07
R121	3-F2	F9	47K	817007473		RCR07
R122	3-F2	F9	4.7K	817007472		RCR07
R123	3-G2	F9	33K	817007333		RCR07
R124	3-G2	E8	10Ω, 1W, 5%, FP	817003100	57	BW 20F-10Ω
R125	3-F2	F8	4.7K	817007472		RCR07
R126	3-F3	F8	100Ω	817007101		RCR07
R127	3-F3	F8	33K	817007333		RCR07
R128	3-F3	F8	33K	817007333		RCR07
R129	3-C5	F4	500Ω (POT)	817801137	29	72PR500Ω
R130	3-C5	F4	75.03K, 1/8W, 0.1%, 100ppm	817261132	63	RE 1/4 C-1 75.03K
R131	3-C6	F4	80.00K, 1/8W, 0.1%, 100ppm	817261085	64	CEA, T-O, 80.0K
R132	3-C5	F4	14.07K, 1/8W, 0.1%, 100ppm	817261112	57	RE 1/4C-114.07K
R133	3-C5	F5	64.60K, 1/8W, 0.1%, 100ppm	817261184	57	CEA-TO-64.6K1/81%
R134	3-D5	G5	33K	817007333		RCR07
R135	3-D5	F4	33K	817007333		RCR07

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R136	3-D5	F5	6.448K, 1/8W, 0.1%, 100ppm	817261190	57	CEA-TO-6.4481/8 1%
R137	3-E5	G7	33K	817007333		RCR07
R138	3-F5	G7	33K	817007333		RCR07
R139	3-F5	F7	100Ω	817007101		RCR07
R140	3-F4	F7	33K	817007333		RCR07
R141	3-G4	F7	33K	817007333		RCR07
R142	3-F4	F7	33K	817007333		RCR07
R143	3-F5	F7	33K	817007333		RCR07
R144	3-D6	F4	50K (POT)	817801135	29	68WR50K
R145	3-D6	G4	287K *	817213287		RN60D
R146	3-C6	G4	422Ω *	817210422		RN60D
R147	3-D6	F4	7.50K *	817211750		RN60D
R148	3-C7	G3	56Ω	817007560		RCR07
R149	3-C7	G4	100Ω	817007101		RCR07
R150	3-D7	F4	7.50K *	817211750		RN60D
R151	3-C8	G3	470Ω, 1/2W, 5%	817020471		RC20
R152	3-E7	F4	2.61K *	817211261		RN60D
R153	3-E7	F3	1K	817007102		RCR07
R154	3-E8	F3	1K	817007102		RCR07
R155	3-B8	G3	75.0K *	817212750		RN60D
R156	3-B8	G3	287K *	817213287		RN60D
R157	3-C9	G3	56Ω	817007560		RCR07
R158	3-B9	G2	604Ω, 1W, 1%	817200045	57	CEC-TO-604-1%
R159	3-C9	G2	604Ω, 1W, 1%	817200045	57	CEC-TO-604-1%
R160	3-C8	G3	100Ω	817007101		RCR07
R161	3-D9	G3	18Ω	817007180		RCR07
R162	3-D9	G2	22Ω	817007220		RCR07
R163	3-D8	F3	100Ω	817007101		RCR07
R164	3-E8	F3	2.2K	817007222		RCR07
R165	3-E9	F3	56Ω	817007560		RCR07
R166	3-D8	G3	18Ω	817007180		RCR07
R167	5-F2	B8	100Ω	817007101		RCR07
R168	5-F2	B8	1M	817007105		RCR07
R169	5-E2	B8	19.6K *	817212196		RN60D
R170	5-G2	C8	7.50K *	817211750		RN60D

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R171	5-G2	C8	100Ω	817007101		RCR07
R172	5-H2	C8	1M	817007105		RCR07
R173	5-G2	C9	287K *	817213287		RN60D
R174	5-G2	C9	470K	817007474		RCR07
R175	5-G2	C9	220K	817007224		RCR07
R176	5-H2	C8	19.6K *	817212196		RN60D
R177	5-F3	B9	220K	817007224		RCR07
R178	5-G3	B9	18K	817007183		RCR07
R179	5-G4	B9	1M	817007105		RCR07
R180	5-F4	B9	2.2K, 1W, 5%	817032222		RC32
R181	4-C2	D8	12.1K *	817212121		RN60D
R182	4-D2	D8	1.47K *	817211147		RN60D
R183	4-D1	D8	22K	817007223		RCR07
R184	4-C3	D9	19.6K, 1/4W, 1%, 25ppm	817200055		RN60E1962F
R185	4-C3	D9	5K (POT)	817801133	29	68WR5K
R186	4-C3	D9	31.6K, 1/4W, 1%, 25ppm	817200043		RN60E3162F
R187	4-E3	D9	31.6K, 1/4W, 1%, 25ppm	817200043		RN60E3162F
R189	4-C4	D9	31.6K, 1/4W, 1%, 25ppm	817200043		RN60E3162F
R190	4-C4	D9	22Ω	817007220		RCR07
R191	4-D4	E8	18K	817007183		RCR07
R192	4-D2	D9	22K	817007223		RCR07
R193	4-D3	D9	6.8K	817007682		RCR07
R194	4-E2	D9	10K	817007103		RCR07
R195	4-E3	D9	10K	817007103		RCR07
R196	4-F3	E8	100K	817007104		RCR07
R197	4-F3	E8	100K	817007104		RCR07
R198	4-E5	D7	19.6K, 1/4W, 1%, 25ppm	817200055		RN60E1962F
R199	4-E5	D7	22Ω	817007220		RCR07
R200	4-E5	D7	22Ω	817007220		RCR07
R201	4-D6	D8	100Ω	817007101		RCR07
R202	4-C6	D7	1.78K, 1/4W, 1%, 25ppm	817200044		RN60E1781F
R203	4-C6	D8	19.6K, 1/4W, 1%, 25ppm	817200055		RN60E1962F
R204	4-D6	D8	22Ω	817007220		RCR07
R205	4-D6	C8	10K	817007103		RCR07

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R206	4-D7	C8	22Ω	817007220		RCR07
R207	4-D7	C7	1K	817007102		RCR07
R208	4-E7	C7	56Ω	817007560		RCR07
R209	4-E6	C8	22K	817007223		RCR07
R210	4-E7	C8	6.8K	817007682		RCR07
R211	4-F6	D6	10K	817007103		RCR07
R212	4-F7	D6	22Ω	817007220		RCR07
R213	4-F7	C7	1K	817007102		RCR07
R214	4-E7	C7	56Ω	817007560		RCR07
R215	4-F5	D5	33K	817007333		RCR07
R216	4-G5	D5	100Ω	817007101		RCR07
R217	3-F1	F9	100K	817007104		RCR07
R218	3-D3	E7	100K	817007104		RCR07
R219	3-G3	E7	22K	817007223		RCR07
R221	2-C7	B6	1K	817007102		RCR07
R222	2-H2	B2	4.7M	817007475		RCR07
R223	1-A7	C5	75.0Ω *	817219750		RN60D
R224	1-A7	B5	1K	817007102		RCR07
R225	1-B7	B5	1K	817007102		RCR07
R226	1-E5	D4	100Ω	817007101		RCR07
R227	1-F6	C5	1K	817007102		RCR07
R228	1-G6	C5	1K	817007102		RCR07
R229	3-C9	G2	49.9K *	817219499		RN60D
S1	3-B2	E4	Switch, Slide	815188009	2	MSS2250
			OP AMPS			
U1	2-C7	B6	NE5534	816400071	71	NE5534
U2	3-C4	E5	TL071ACP	816400073	55	TL071ACP
U3	3-D4	G7	MC14069BCP	816374069		MC14069BCP
U4	3-C7	G4	NE5534	816400071	71	NE5534
U5	5-G2	B9	μA340PC	816400072	26	μA340PC
U6	4-D4	D8	μA340PC	816400072	26	μA340PC
U7	4-E6	D7	TL071ACP	816400073	55	TL071ACP
U8	3-F2	F8	CD4093B	816374093		CD4093B

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			CAPICATORS			
C1			0.022μF, 100V, 10%, Myflm	811551017	28	61F15AA223
C2			0.22μF, 200V, 10%, Mylar	811553008	22	W230B1C-224K
C3			0.22μF, 200V, 10%, Mylar	811553008	22	W230B1C-224K
			RESISTORS			
R1			10K, Pot, Cermet	817804103	7	3386W-1-103
R2			10K, Pot, Cermet	817804103	7	3386W-1-103
R3			4.7K	817007472		RCR07
R4			10K, Pot, Cermet	817804103	7	3386W-1-103
R5			10K, Pot, Cermet	817804103	7	3386W-1-103
R6			4.7K	817007472		RCR07
R7			10K, Pot, Cermet	817804103	7	3386W-1-103
R8			10K, Pot, Cermet	817804103	7	3386W-1-103
R9			4.7K	817007472		RCR07

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
DS1	5-G4	F6	LED, RED	818149006	78	521-9165
DS2	5-F6	F7	LED, GREEN	818149007	78	521-9203
J1	2-C1	F6	Connector, BNC	812130110	19	30355-1
J2	3-B10	F7	Connector, BNC	812130110	19	30355-1
P6	4-E5	D3	Connector Block, 10 pos	812122510	81	65486-010
P16	4-E5	D4	Connector Block, 10 pos	812122510	81	65486-010
R1	1-F2	F6	Resistor (POT) 1K	817801115	29	78SBWR1K
S4	3-F5	F6	Switch, Rotary	815128006		
S6	2-F3	F6	Switch, Toggle, SPDT	815111005	14	7107
S7	4-E5	F7	Switch, Toggle, DPDT	815111008	14	7203
S9	4-C5	F7	Switch, Toggle, DPDT	815111007	14	7201

TABLE 6.2 REPLACEABLE PARTS

MODEL 1211

REAR PANEL ASSEMBLY

D42137 G1

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
A1	5-C3	E6	Connector, Volt Select	812120009	16	6J1
F1	5-C2	E6	Fuse 1/4A, 250V, SB	815183014	9	MDL 1/4 250V
J10	3-G1	E6	Connector, BNC	812130110	19	30355-1
J11	3-C10	E7	Connector, BNC	812130110	19	30355-1
J12	3-C10	E7	Connector, BNC	812130110	19	30355-1
J13	3-D10	E8	Connector, BNC	812130110	19	30355-1
P17	2-F1	D3	Connector Block, 6 pos	812122506	81	65486-006
R10	2-F2	E7	Resistor (POT) 20K, 15 turn	817801111	84	89PB20K
S11	2-G1	E6	Switch, Toggle, DPDT	815111008	14	7203

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			CAPICATORS			
C1	1-D4	C4	1000 μ F, 50V	811530020	17	BR-1000-50
C2	1-C5	E4	1000 μ F, 50V	811530020	17	BR-1000-50
C3	1-C5	D3	2.2 μ F, 20V, 10%	811501146	48	150D225x9020A2
C4	1-D6	D4	470pF. 1000V. 10%	811572015	17	10TS-T47
C5	1-D6	D2	2.2 μ F, 20V, 10%	811501146	48	150D225x9020A2
C6	1-F4	D4	33pF, 1000V, 10%	811572004	17	10TS-Q33
C7	1-F4	C5	.01 μ F, 500V, 20%	811570019	17	5GA-D10
C8	1-G4	C3	15 μ F, 20V, 10%	811501156	48	150D225x9020A2
C9	1-E9	C2	33pF, 1000V, 10%	811572004	17	10TS-Q33
C10	1-F9	C3	2.2 μ F, 20V, 10%	811501146	17	150D225x9020A2
C11	1-A7	D3	470pF, 1000V, 10%	811570015	17	10TS-T47
C12	1-F7	C2	470pF, 1000V, 10%	811572015	17	10TS-T47
C13			470pF, 1000V, 10%	811572015	17	10TS-T47
			DIODES			
CR1	1-B4	D5	IN4005	818100007		IN4005
CR2	1-C4	D5	IN4005	818100007		IN4005
CR3	1-C4	C5	IN4005	818100007		IN4005
CR4	1-D4	C5	IN4005	818100007		IN4005
CR5	1-B7	D3	IN4005	818100007		IN4005
CR6	1-B8	E2	IN4005	818100007		IN4005
CR7	1-D7	D2	IN4005	818100007		IN4005
CR8	1-G3	C3	IN4005	818100007		IN4005
CR10	1-F5	C3	IN4005	818100007		IN4005
CR11	1-F8	C2	IN4005	818100007		IN4005
CR12	1-E8	C3	IN5234	818150023		IN5234
F1	1-C8	D2	Fuse 1.5A FA	815183013	9	AGC
F2	1-F6	D2	Fuse 1.5A FA	815183013	9	AGC

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			TRANSISTORS			
Q2	1-B7	E2	2N3904	812203904		2N3904
Q4	1-G3	C4	2N3904	812203904		2N3904
Q6	1-F4	C4	2N3906	812203906		2N3906
Q7	1-E7	C2	2N3904	812203904		2N3904
			RESISTORS			
			All resistors not otherwise designated are 1/4W, 5%, Comp * 1/8W, 1%, Metflm ** 1/8W, 0.1%, Metflm *** 1/10W, 1%, Temp Stable, Metflm			
R1	1-C5	D3	4.7K	817007472		RCR07
R2	1-C6	D4	1.2Ω	817003129	57	BW20F1.2Ω
R3	1-C6	D3	10.0K *	817212100		RN60D
R4	1-D6	D3	6.65K *	817211665		RN60D
R5	1-D6	D3	2K Pot	817801110	84	72PR2K
R6	1-D7	D2	4.7K	817007472		RCR07
R7	1-A7	E3	3.3K	817020332		RC20
R8	1-B8	E2	8.2Ω	817007829		RCR07
R9	1-B8	E2	6.8Ω	817007689		RCR07
R10	1-B6	D4	75K	817007753		RCR07
R11	1-E6	C4	10.0K *	817212100		RN60D
R12	1-G3	C3	1.2Ω	817003129	57	BW20F1.2Ω
R13	1-F3	C4	4.7K	817007472		RCR07
R14	1-F4	C4	10.0K *	817212100		RN60D
R15	1-E4	C4	15K	817007153		RCR07
R16	1-E5	C4	15K	817007153		RCR07
R17	1-E5	C4	15K	817007153		RCR07
R18	1-F6	C4	4.7K	817007472		RCR07
R19	1-F7	C2	8.2K	817007822		RCR07
R20	1-E7	C2	8.2Ω	817007829		RCR07

TABLE 6.2 REPLACEABLE PARTS

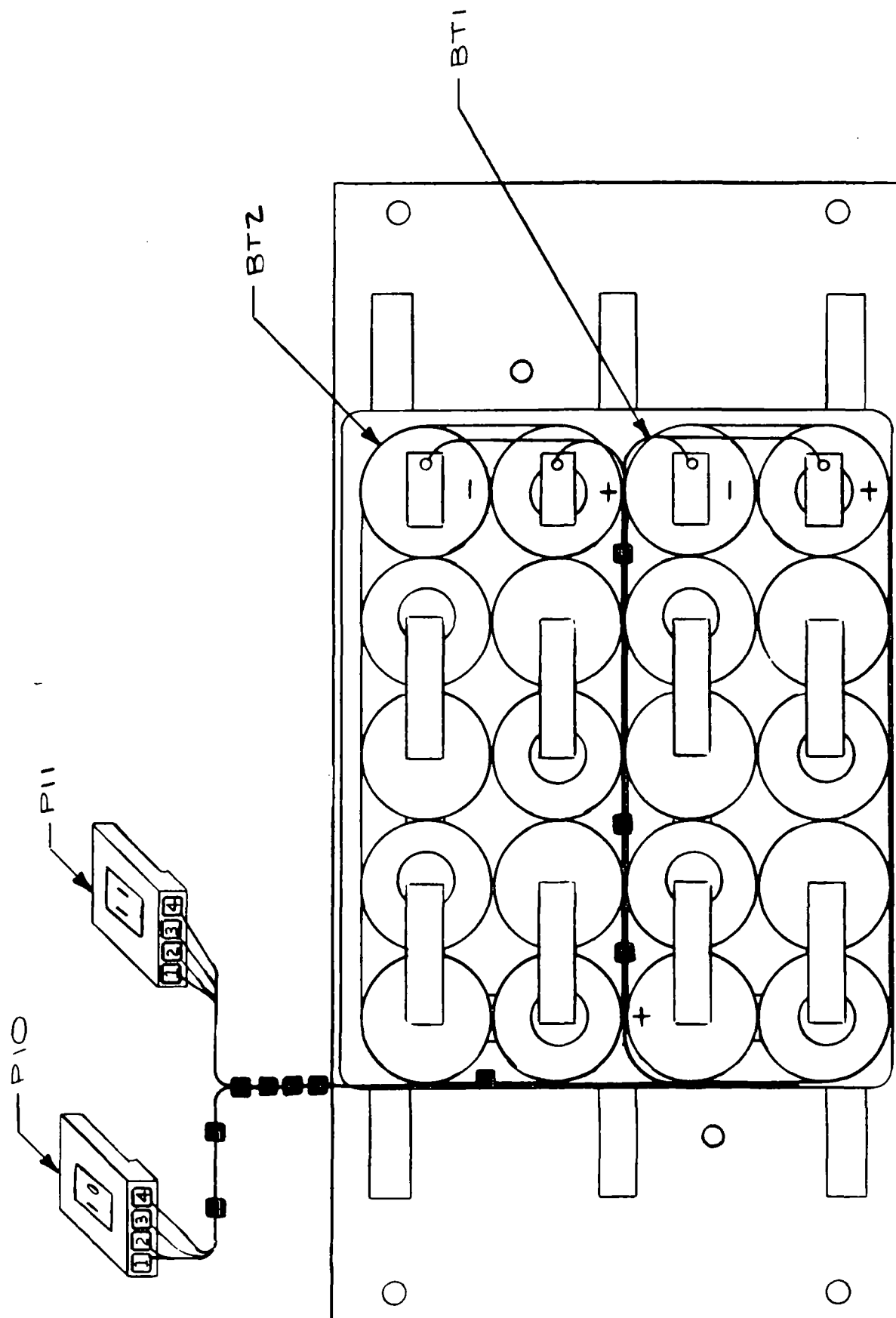
REFERENCE DESIGNATION	LOCATION		DESCRIPTION	DL INSTRUMENTS PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
R21	1-E8	C2	5.6Ω	817007569	84	RCR07
R22	1-D8	C3	2K Pot	817801110		72PR2K
R23	1-E9	C3	3.3K	817007332		RCR07
R24	1-E8	C3	1K	817007102		RCR07
R25	1-E8	C3	680Ω	817007681		RCR07
R26	1-F8	C3	3.3K	817007332		RCR07
R27	1-E9	C2	180K	817007184		RCR07
R28	1-E9	C2	470Ω	817020471		RC20
R29	1-C6	D4	1K	817007102		RCR07
R30	1-G3	C4	1K	817007102		RCR07
R31	1-F3	C4	75K	817007753		RCR07
R32	1-B7	E2	1K	817007102		RCR07
R33	1-E7	C2	1K	817007102		RCR07
U1	1-C5	D4	Regulator LM723CN	816400074	31	LM723CN
U2	1-E4	C4	Op Amp LM301A	A86050-P4		LM301A
U3	1-E9	C2	Op Amp LM301A	A86050-P4		LM301A

TABLE 6.2 REPLACEABLE PARTS

CODE LIST OF MANUFACTURERS

1	AEROVOX	53	TELEDYNE SEMICON DUCTOR	110	W-K
2	ALCO ELECTRONIC PROD	54	TELEDYNE WESTERN WIRE/CABLE	111	3M
3	ALLEN BRADLEY	55	TEXAS INSTRUMENTS	112	EECO
4	AMPHENOL CONNECTOR	56	THERMALLOY	113	HAMLIN
5	ANALOG DEVICES	57	TRM	114	IMB
6	BELDEN	58	UNITED TRANSFORMER	115	JOHANSON
7	BOURNS	59	USECO	116	GAYHILL
8	BUCKEYE STAMPING			117	AVX
9	BUSSMAN MFG	60	VACTEC	118	KEMET
10	CAMBION			119	VERNATRON
11	CANNON, ITT	61	WINCHESTER ELECTRONIC	120	FERRONICS
12	CENTRALAB	62	VISHAY	121	DIGI KLIP
13	CINCH MFG	63	ACE	122	POLYTRON
14	C & K COMPONENTS	64	IRC	123	FAIR-RITE
15	CONTINENTAL-WIRT ELEC	65	EAL	124	PCI
16	CORCOM	66	AMP	125	SELECTRO
17	CORNELL DUBILIER ELEC	67	CLAROSTAT MFG	126	YUASA
18	CTS	68	GOULD INC	127	J S TERMINAL
19	DAGE ELECTRONIC	69	LITTLEFUSE INC	128	SIGNAL
20	DELEVAN ELECTRONICS			129	TRW
21	DRESSER SYSTEMS	70	GENERAL ILLUMINATION	130	DALE
22	ELECTROCUBE	71	SIGNETRICS	131	PMI
23	ELECTRO MOTIVE MFG	72	SEMICONDUCTOR CIR	132	SIEMENS
24	ELECTRONICS APPLICATIONS	73	STATEK	133	ROBINSON-NUGENT
25	ERIE TECHNOLOGICAL PROD	74	BENDIX		
26	FAIRCHILD SEMICONDUCTOR	75	BURNDY		
27	FEDERAL SCREW PROD	76	AMERICAN HANDLE SALES		
28	GENERAL ELECTRIC	77	VARO SEMICONDUCTOR		
29	HELIPOT	78	DIALCO		
30	HEYMAN MFG	79	ELMENCO		
31	DL INSTRUMENTS	80	AMP INCORPORATED		
32	E F JOHNSON	81	BERG		
33	LITRONIX	82	COMP CORP		
34	MARCO-OAK INDUSTRIES	83	HEWLETT-PACKARD		
35	MOTOROLA SEMICONDUCTOR	84	BECKMAN HELIPOT		
36	NATIONAL SEMICONDUCTOR	85	RAYTHEON		
37	OHMITE MFG	86	INTERSIL		
38	PAKTRON	87	A H & H		
39	PANDUIT	88	ADC PRODUCTS		
40	POMONA ELECTRONICS	89	SCANBE		
41	PRODUCT COMPONENTS	90	DRAKE		
42	PYROFILM	91	VECTOREEN		
43	RCL ELECTRONICS	92	FROST		
44	REMBRANDT	93	SIGMA		
45	ROGAN	94	DECON		
46	SCHAUER MGG	95	MICROSWITCH		
47	H H SMITH	96	WAVETEWK		
48	SPRAGUE ELECTRIC	97	ELECTRONICS CONCEPTS		
49	SPECTROL ELECTRONICS	98	AMELCO		
50	STANCOR	99	MEMPCO		
51	D M STEWARD MFG	100	RCA		
52	SWITCHCRAFT	101	CIRCUIT ASM CORP		
		102	MONSANTO		
		103	AINSLEY		
		104	KEYSTONE CARBON		
		105	JFD		
		106	EAC		
		107	DOUGLAS RANDALL		
		108	SILICONIX		
		109	VITRAMON		

Table 6.3 Code List of Manufacturers



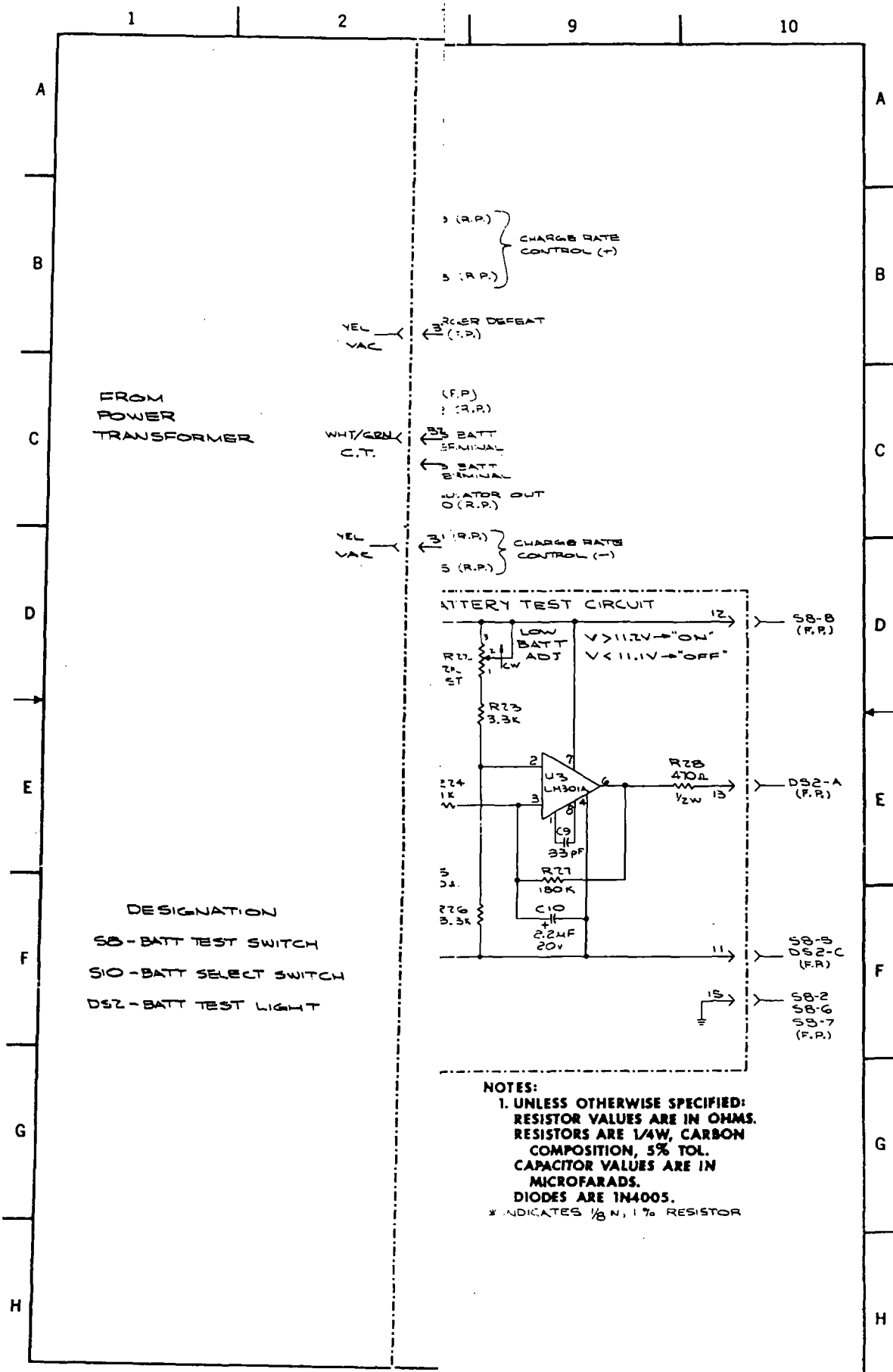


FIGURE 7.9A
SCHEMATIC - POWER SUPPLY CARD
1211 PREAMPLIFIER

6

5

4

3

2

1

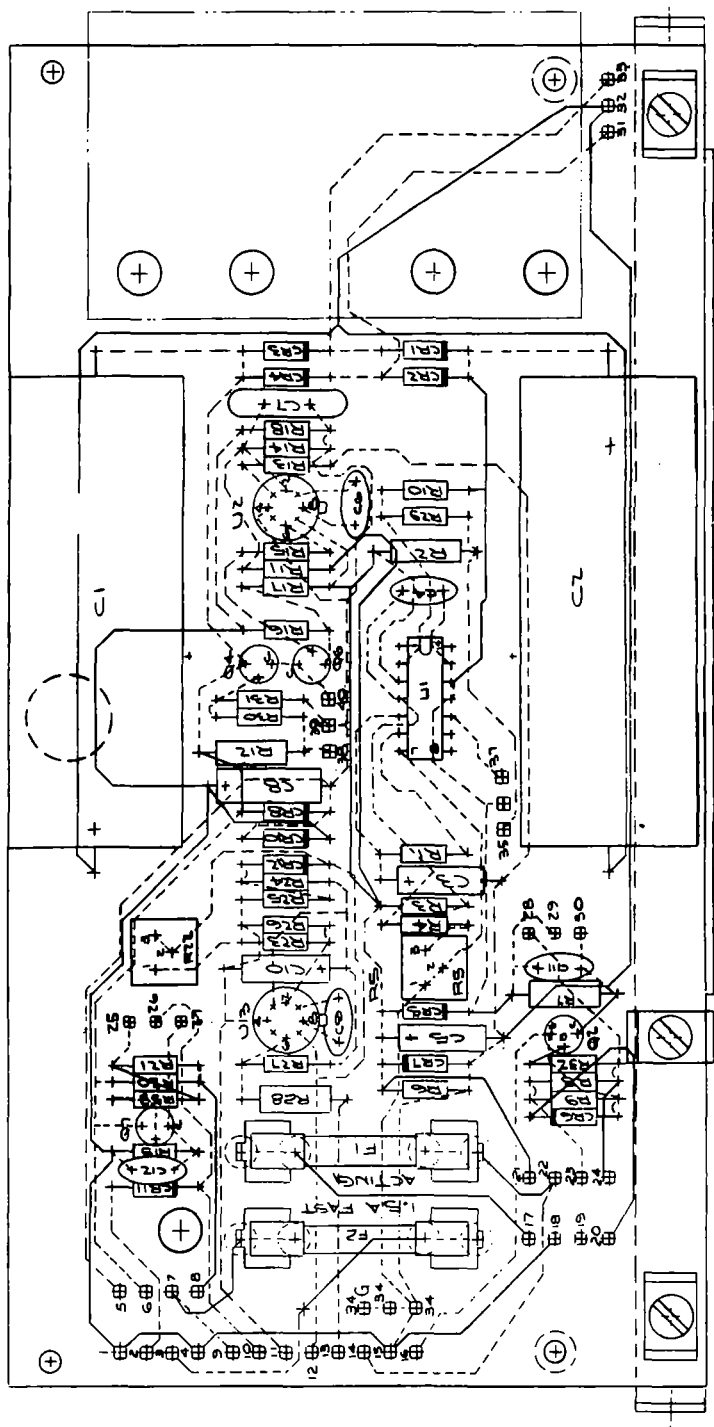
A

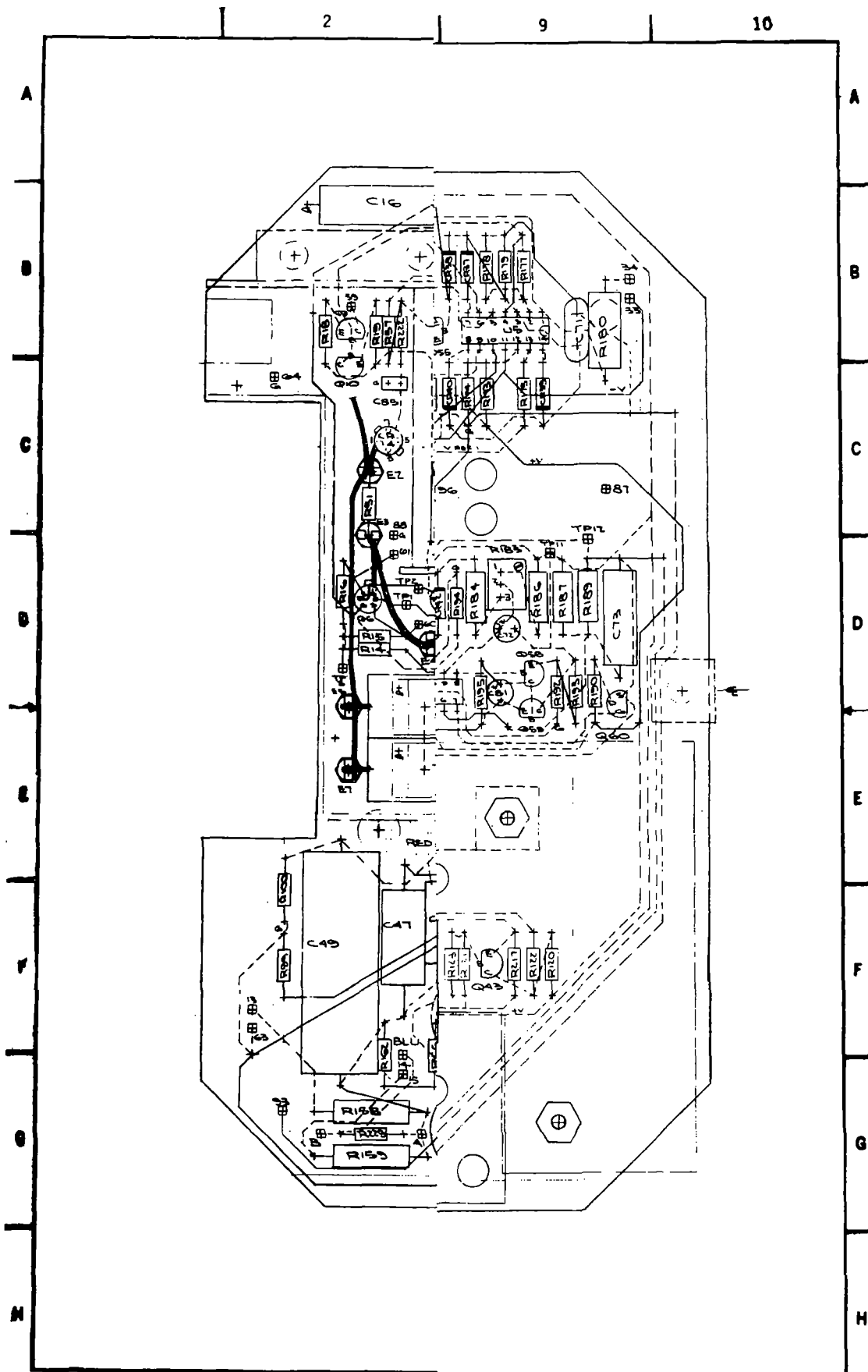
B

C

D

E





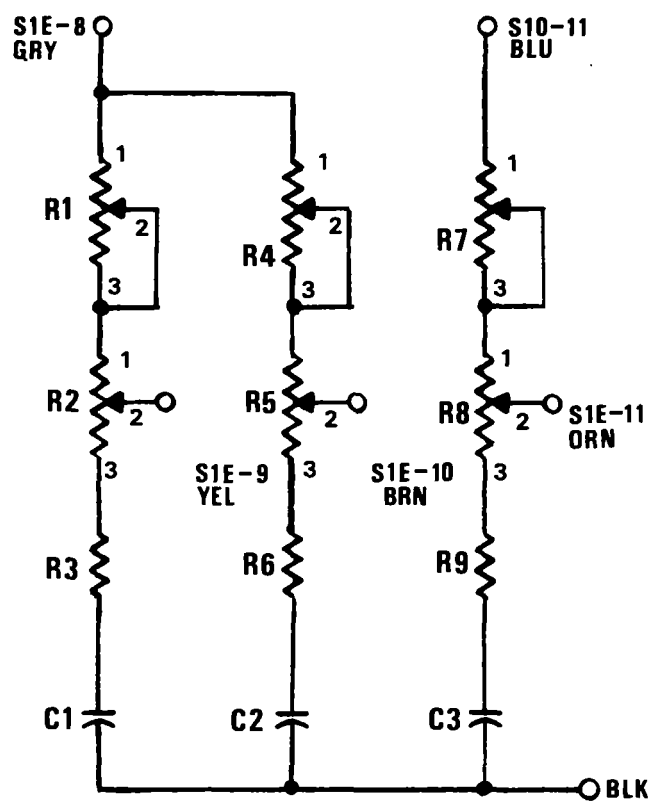


FIGURE 7.7 SCHEMATIC - A5 CARD MODEL 1211

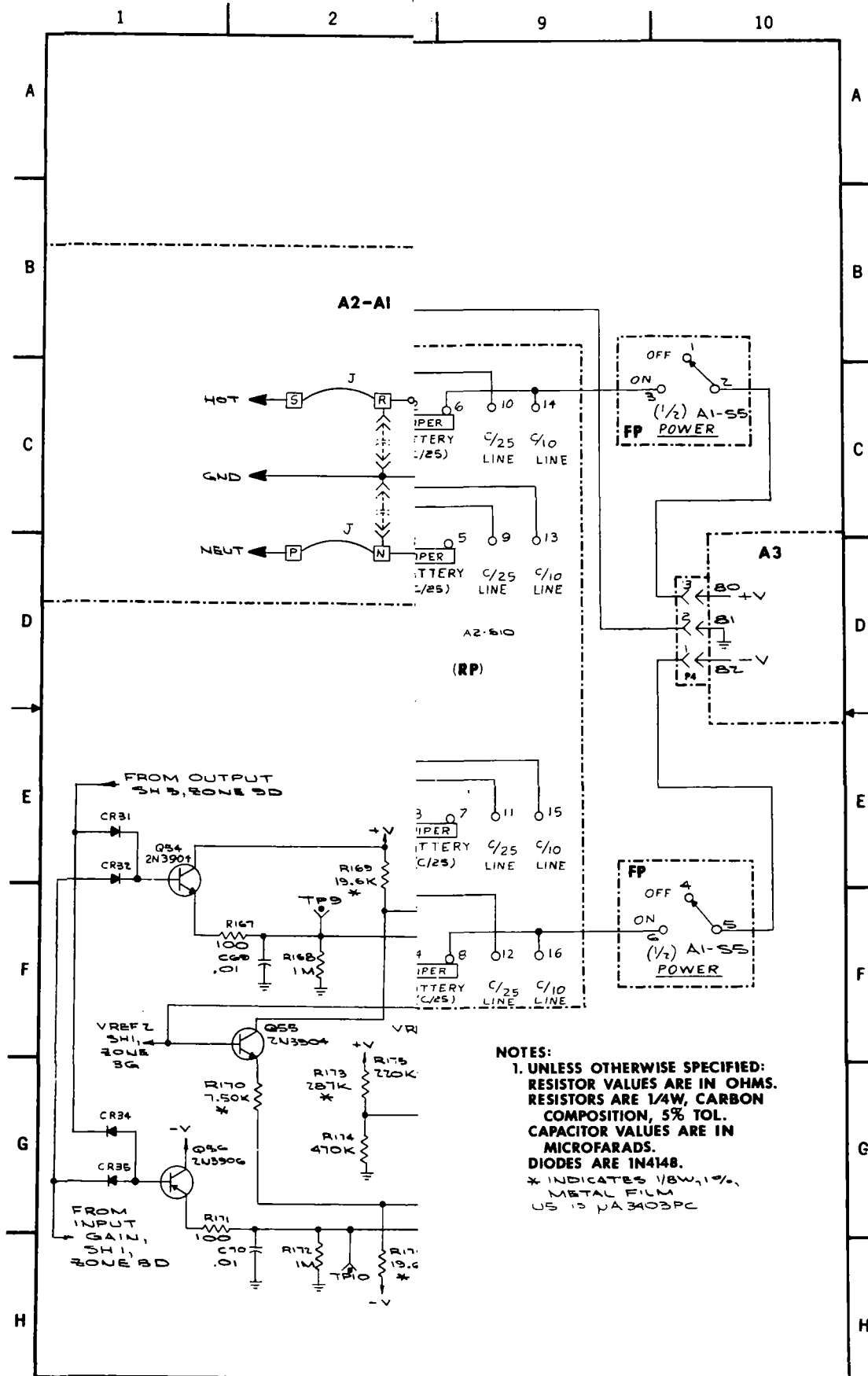


FIGURE 7.6
 SCHEMATIC - POWER SUPPLY/OVLD
 MODEL 1211

APPENDIX A

MODEL 1211 INSTRUCTION MANUAL

MODEL 1211 SIGNAL BANDWIDTH AND CORNER FREQUENCY

The Model 1211 Preamplifier front panel lowpass filter control is calibrated in terms of 10%-90% risetime for a 12 dB/octave rolloff. The question arises, what is the corresponding lowpass time constant so that bandwidth can be known?

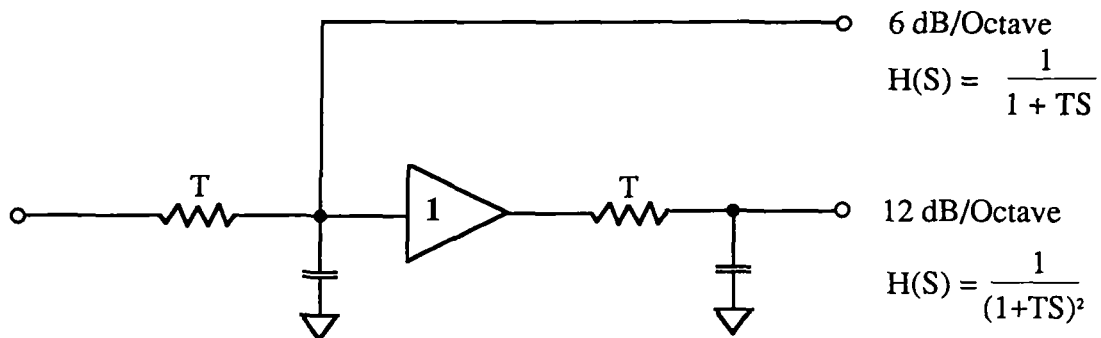


FIGURE A-1 MODEL 1211 OUTPUT FILTER

For the 12 dB output:

$$v = V (1 - [1 + v/T] e^{-v/T})$$

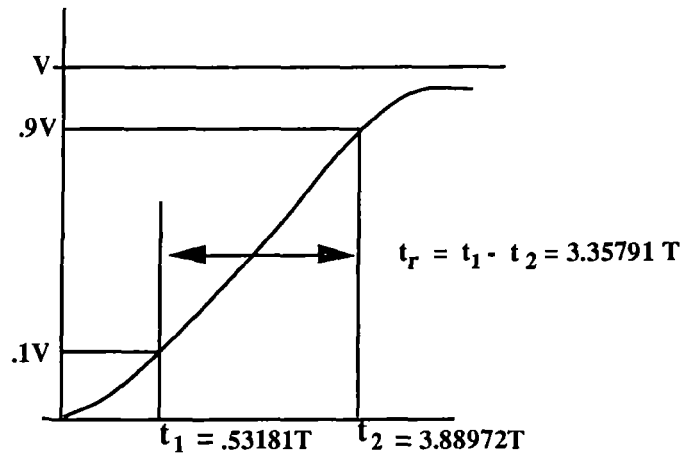


FIGURE A-2

Therefore the time constant T as a function of the risetime control t_r is given by:

$$T = .2978 t_r$$

The actual risetime for a 6 dB rolloff differs from the front panel dial markings. For this case:

$$v = V (1 - e^{-t/T})$$

$$t_r = t_2 - t_1 = T \ln \left(\frac{1 - v_1/V}{1 - v_2/V} \right)$$

For 10% - 90% risetime:

$$t_r = T \ln 9 = (.2978) (\text{Dial Setting}) \ln 9$$

$$t_r = .6543 (\text{Dial Setting}), 6 \text{ dB rolloff}$$

Model 1211 Risetime Control Setting (msec)	12 d/b/Octave Rolloff			6 dB/Octave Rolloff		
	3 dB (f_b) bandwidth (Hz)	6 dB (f_c) corner (Hz)	Equiv NBW (1/8T Hz)	3 dB (f_c) bandwidth (Hz)	Equiv NBW (1/4T Hz)	Actual 10%-90% Risetime (msec)
.01	34,400	53,400	42,000	53,400	84,000	.00654
.03	11,500	17,800	14,000	17,800	28,000	.00196
.1	3,440	5,340	4,200	5,340	8,400	.0654
.3	1,150	1,780	1,400	1,780	2,800	.0196
1	344	534	420	534	840	.654
3	115	178	140	178	280	.196
10	34.4	53.4	42.0	53.4	84.0	6.54
30	11.5	17.8	14.0	17.8	28.0	19.6
100	3.44	5.34	4.20	5.34	8.40	65.4
300	1.15	1.78	1.40	1.78	2.80	196

The bandwidths in Table A-1 are valid assuming they are narrower than the values given in Table A-2 for the various gain selections. Similarly, the risetime values in Table A-1 are valid only if the panel control setting is slower than the values listed in Table A-2.

SENSITIVITY CONTROL SETTING (A/V)	TYPICAL WIDE OPEN BANDWIDTH (kHz)	SPECIFICATION FOR MIN RISETIME (Msec)
10^{-3}	65	.010
10^{-4}	60	.010
10^{-5}	55	.010
10^{-6}	32	.015
10^{-7}	20	.025
10^{-8}	15	.040
10^{-9}	4	.250
10^{-10}	1.5	.450
10^{-11}	.5	1.10

TABLE A-2 MODEL 1211 MAXIMUM BANDWIDTH AND MINIMUM RISETIME VERSUS SENSITIVITY

BANDWIDTH f_b AND CORNER FREQUENCY f_c FOR 12 dB/OCTAVE ROLLOFF CASE

Normalizing the transfer function for $\omega_o = \frac{1}{T} = 1$ and substituting $j\omega$ for S , we have:

$$H(j\omega) = \frac{1}{(1-\omega^2) + j2\omega}$$

$$G(\omega) = \frac{1}{\omega^2 + 1}$$

dB loss	G	ω	Frequency $f = \omega/2\pi T = \omega/2\pi (.2978 t_r)$
1	.8912	.3493	$f_b = .10243/T = .34395/t_r$ $f_c = .15915/T = .53443/t_r$
3	.707	.6423	
6	.5	1.000	

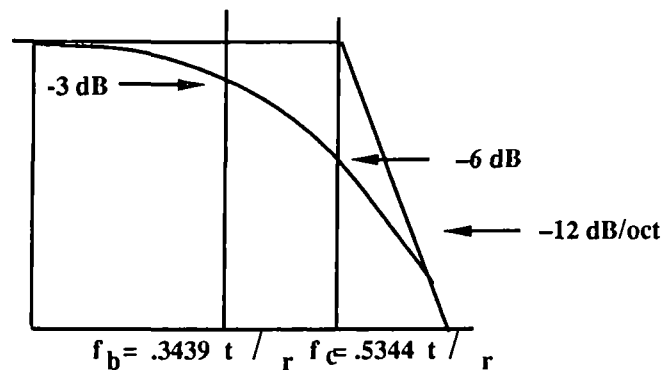


FIGURE A-3 MODEL 1211 ROLLOFF @ 12 dB/OCTAVE

ROLLOFF AND RISETIME FOR 6 dB MODE

In this simple case, we are down 3 dB @ $\omega = 1$ or $f = 1/2\pi T = 1/2\pi (.2978 t_r) = .53443/t_r$,

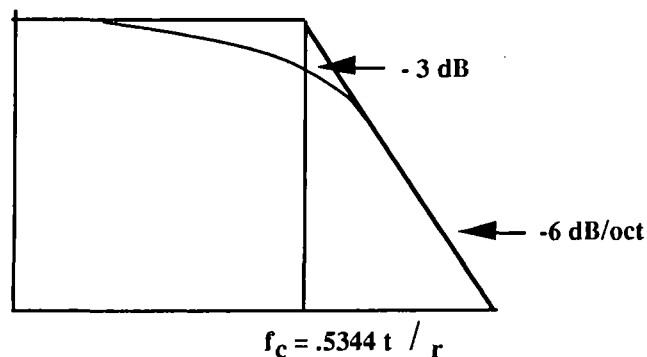


FIGURE A-4 MODEL 1211 ROLLOFF @ 6 dB/OCTAVE

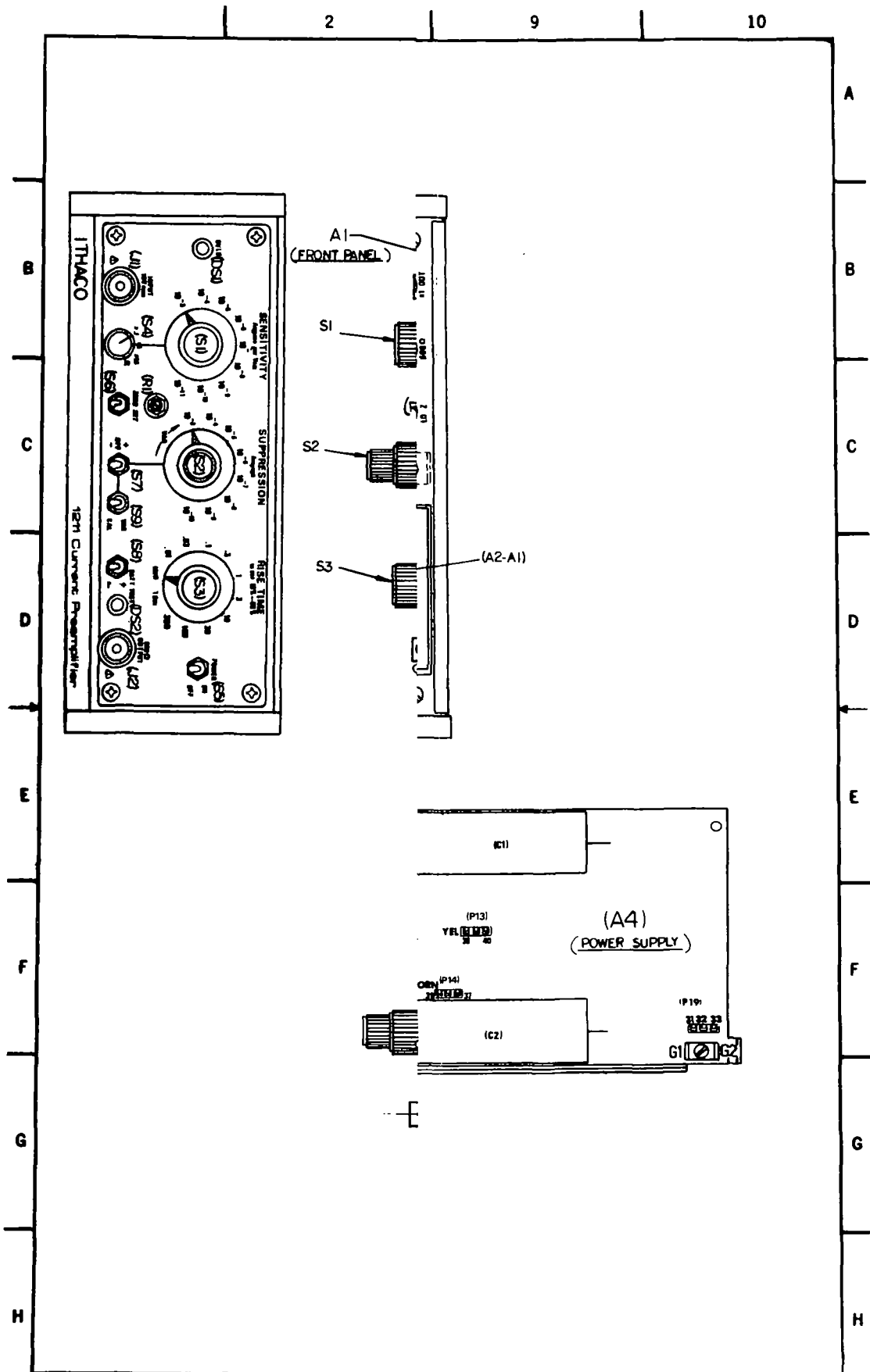


FIGURE 7.1
MAJOR ASSEMBLY
MODEL 1211

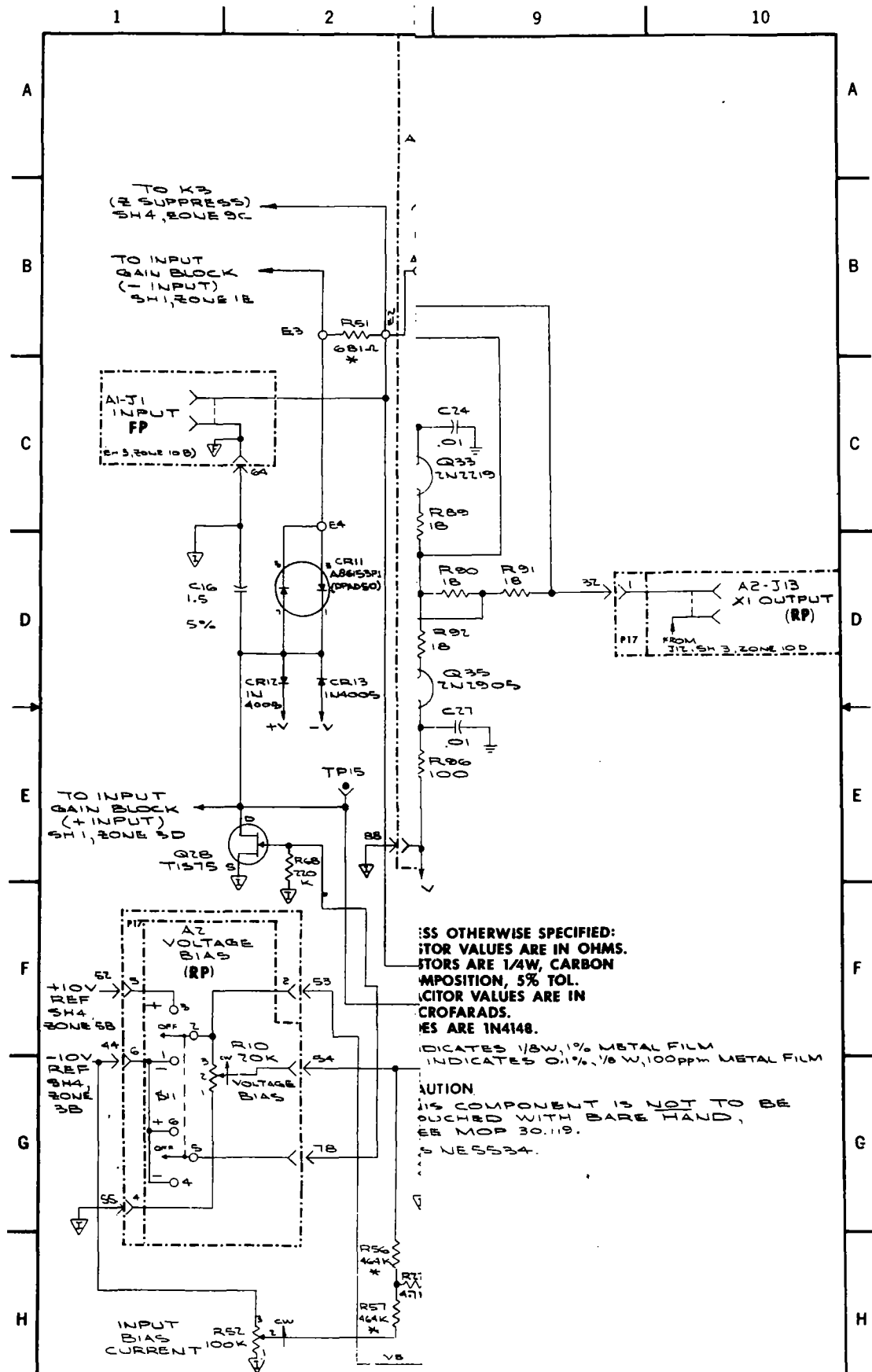
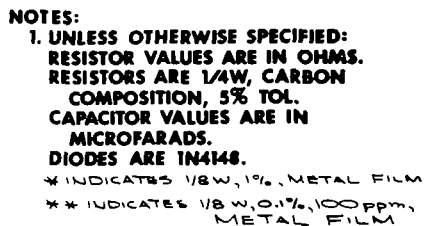


FIGURE 7.3
SCHEMATIC - SENSITIVITY SWITCH & BUFFER
MODEL 1211



ITHACO DWG D41086, SH 3, REV A, 11/79

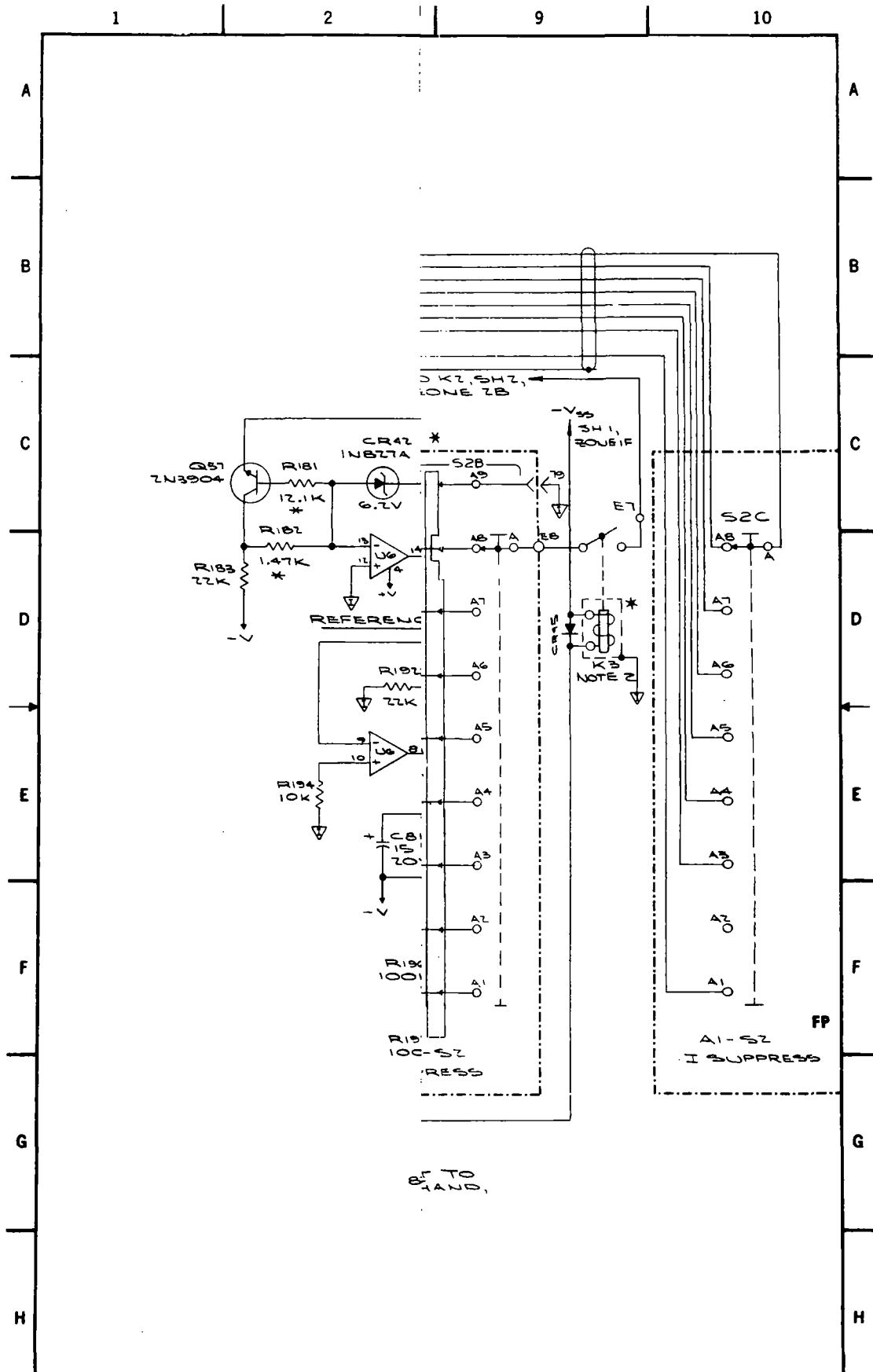
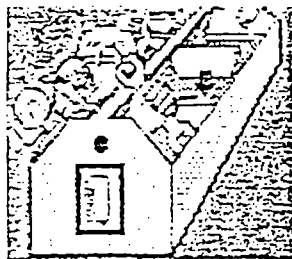


FIGURE 7.5
SCHEMATIC - REF CIRCUITS
MODEL 1211



RES

Work Orc

NAME: Onar Clay

DATE: Aug 29/00

Prin. Inv. Kleinfeld

Tele# 834 3562 (menda)

Index no. _____

MANF AND MODEL NO.: Ithaco 124 Current Pre Am

BRIEF AND CONCISE NATURE OF THE PROBLEM OR SERVICES NEEDED:

Not Amplifying

File # 2796
pm 3353

RECOMMENDED HANDLING PROCEDURES FOR STATIC SENSITIVE DEVICES

IP Instruments

PO Box 1886 • 176 Lake Rd.
Dryden, NY 13813
607-844-3725

735 W. Clinton St. • Box 6437 • Ithaca, New York 14851-6437

GENERAL

Static Sensitive Devices (Insulated Gate), due to their extremely high input resistance, are subject to potential damage by the accumulation of excess static charge. To avoid possible damage to the devices during handling, testing, or actual operation, these procedures should be followed:

NOTE: Dry weather (relative humidity less than 30%) tends to multiply the accumulation of static charges on any surface. In a low humidity environment, the handling precautions take on added importance and should be adhered to without exceptions.

Various electrical and electronic parts which have been determined to be sensitive to electrostatic discharge include: microelectronic and semiconductor devices, thick and thin film resistors, chips and hybrid devices, and piezoelectric crystals. Additionally, all subassemblies, assemblies and equipment containing these parts not having adequate protective circuitry are also electrostatic discharge sensitive (ESDS).

PROCEDURE

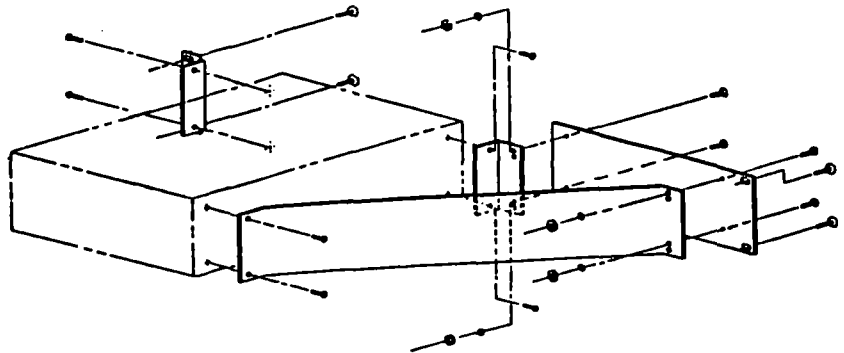
- A. The leads of the devices should be in contact with a conductive material except when being tested or in actual operation, to avoid the build-up of static charge.
 1. The conductive material may be a conductive foam, metal foil, conductive rings or other suitable material.
- B. Devices should not be inserted in non-conductive containers such as conventional styrofoam, plastic bubble paper, or trays.
- C. When devices are removed from their conductive material, the hand being used should be grounded by a metal wrist strap which has a 1 megohm resistor in series with the wire between the strap and around.
- D. All soldering iron tips, test equipment, tools and fixtures must be grounded. Table tops and work surfaces should be conductive and grounded.
- E. All grounds must be common and should be made as close together as possible.
- F. Devices should not be inserted into or removed from circuits with the power on.
- G. Signals should not be applied to the inputs while the device power supply is off.

INSTALLATION INSTRUCTIONS FOR ITHACO RACK MOUNTING KITS RM1 AND RM-2-2

RM -1 FOR 17' WIDE FULL RACK CHASSIS

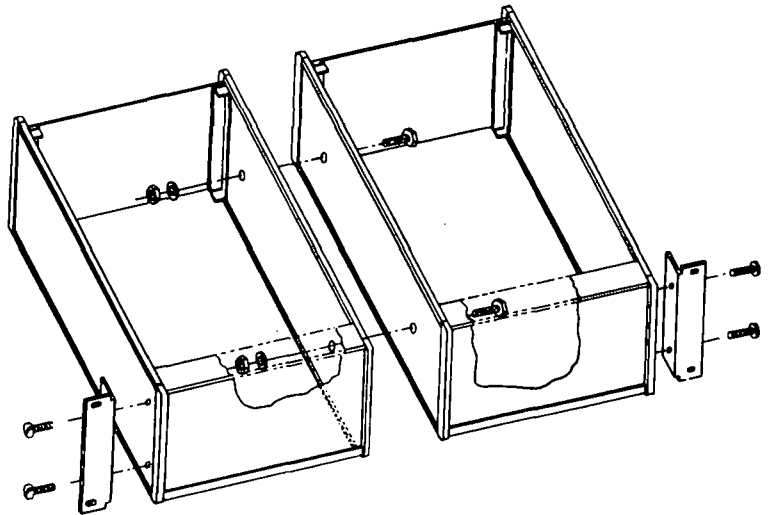
Remove the two screws at the front of each side cover. Install mounting ears and secure using screws previously removed or screws supplied.

Install front panel on desired side of unit and install angle bracket from front panel to side of unit using hardware supplied.



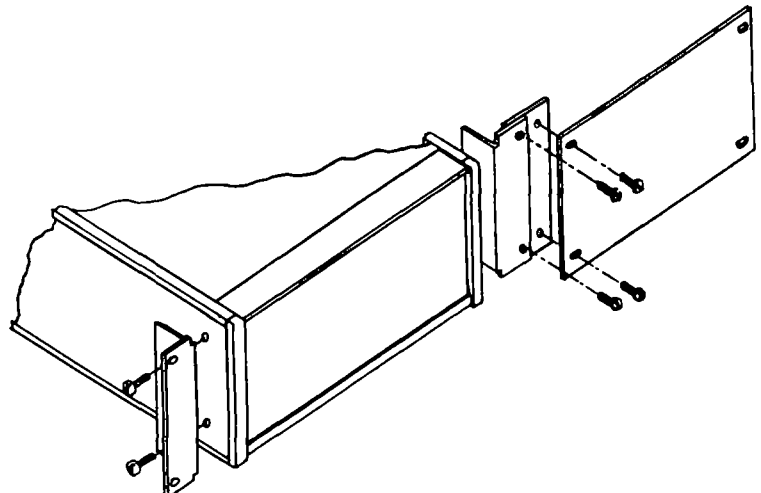
RM-1 FOR TWO 8 1/2" WIDE HALF RACK CHASSIS

Remove opposite side covers from each unit. Remove top covers from each unit, secure the units together side by side, using nuts and bolts supplied. Replace the top covers, attach mounting ears in the same manner as a full rack unit.



RM-2-2 FOR A 8 1/2" WIDE HALF RACK UNIT

Remove the two screws at the front of each side cover. Place mounting ears in place and secure, using the screw previously removed. Attach extender plate to mounting ear on the desired side of the unit, secure using the threaded nut bar and hardware supplied.



WARRANTY

DL Instruments warrants each instrument to be free of defect in material and workmanship for a period of one year; unless otherwise specified, after shipment to the original purchaser; batteries and light beam choppers are specifically excluded. Liability under this warranty is limited to repairing or adjusting any instrument returned to the factory for that purpose. The warranty of this instrument is void if the instrument has been modified other than in accordance with written instructions from DL Instruments, or if defect or failure is judged by DL Instruments to be caused by abnormal conditions of operation, storage or transportation.

This warranty is subject to verification by DL Instruments, that a defect or failure exists, and to compliance by the original purchaser with the following instructions:

1. Before returning the instruments, notify DL Instruments with full details of the problem; including the model number and serial number of the instrument involved.
2. After receiving the above information, DL Instruments will give you shipping instructions or service instructions. After receipt of the shipping instructions, ship the instrument to DL Instruments. Full liability for damage during shipment is borne by the purchaser. It is recommended that instruments shipped to DL Instruments be fully insured and packed surrounded by at least 2 inches of shock-absorbing material.

DL Instruments reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

DL Instruments shall not be liable for consequential or incidental damages of a commercial nature resulting from the use of its products or the sale thereof. DL Instruments makes no warranty, and expressly excludes any warranty, as to the merchantability or fitness for any particular purpose or end application. DL Instruments makes no warranty, either expressed or implied, other than that stated herein.

This warranty is expressly in lieu of all other obligations or liabilities on the part of DL Instruments, and DL Instruments neither assumes, nor authorizes any other person to assume for it, any liability in connection with the sale of DL Instruments' products.

DL INSTRUMENTS, LLC
233 Cecil A. Malone Drive
Ithaca, New York 14850
Phone: (607) 277-8498 FAX: (607) 277-8499
URL: <http://www.dlinstruments.com>



Battery Pack Installation Instructions for DL Instruments Model 1211 Preamplifier

1. To remove top cover:
 - A. Loosen 2 slotted screws at front of cover
 - B. Remove 2 phillips screws at back of cover
 - C. Slide out cover to back of unit
2. With top cover removed and facing front of unit:
 - A. Remove two small screws from front corners of small printed circuit board. This circuit card will now tip up.
 - B. Set battery pack into amplifier with power leads in back left corner. Install screws in corners.
 - C. Tip up circuit board and plug battery cable into bottom of circuit board as follows.
 - D. Connect J-11 of battery pack to pins 17 through 20 of circuit board; located directly under left fuse. Connect J-10 of battery pack to pins 1 through 4 of the circuit board; located on upper left corner.
 - E. Tip board down. Install screws and put unit cover back on.

Push rear panel switch to battery to use in battery mode.

For fast charge of batteries, set switch to C/10 with unit plugged in and power/on switch to off.

Unit will slow charge in line position.