

Concord Instrument Division

INSTRUCTION MANUAL



MODEL 7004
DIGITAL MULTIMETER
SERIAL NO.

Ⓛ

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SYSTRON  DONNER
CORPORATION

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WARRANTY

Systron-Donner instruments are warranted during a period of one year from date of shipment to original purchaser to be free from defects in material and workmanship. This warranty does not apply to vacuum tubes, except as they are warranted by tube manufacturers. The liability of Seller under this warranty is limited to replacing or repairing any instrument or component thereof which is returned by Buyer at his expense during such period and which has not been subjected to misuse, neglect, improper installations, repair, alteration, or accident. Seller shall have the right of final determination as to the existence and cause of a defect. In no event shall Seller be liable for collateral or consequential damages. This warranty is in lieu of any other warranty, express, implied or statutory, and no agreement extending or modifying it will be binding upon Seller unless in writing and signed by a duly authorized officer.

RECEIVING INSPECTION

Every Systron-Donner instrument is carefully inspected and is in perfect working order at the time of shipment. Each instrument should be checked as soon as received. If the unit is damaged in any way or fails to operate, a claim should immediately be filed with the transportation company.

REPAIRS

Whenever a Systron-Donner instrument requires service, the nearest Systron-Donner representative should be contacted; all representatives will provide immediate service or arrange factory returns when necessary.

Please specify both model and serial number in all correspondence concerning Systron-Donner instruments. Address all inquiries on operation or applications to your nearest sales representative or Sales Manager, Instruments, Systron-Donner Corporation, 888 Galindo Street, Concord, California.

CONCORD, CALIFORNIA

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CHAPTER 1

GENERAL INFORMATION

1.1 INTRODUCTION

The SD Model 7004 Digital Multimeter is a full four-digit precision instrument. It offers the five selectable functions of dc voltage, dc current, ac voltage, ac current and resistance. The instrument utilizes an advanced Dual-Slope Integration design with an extremely low-noise input amplifier and a fully guarded, isolated input circuit. These features combine to provide high accuracy and stability, plus exceptional immunity to the effects of both common mode and normal mode noise.

All function and range selection is made from front-panel push-button controls. The readout features a nonblinking display of four full digits plus overrange, auto-positioned decimal point, and an indicator for off-scale readings. Polarity indication for dc voltage and current is automatic with a minus indicator display.

Model 7004 is light-weight and completely portable. It consumes less than 8 watts while operating at line frequencies from 48 to 440 Hz and at voltages of 115/230 V or 100/200 V. The Multimeter may be fitted with an optional built-in battery pack with no increase in size. Optional DTL/TTL compatible digital outputs can also be included for remote printout, digital limit comparison, or other automatic data system requirements.

1.2 SPECIFICATIONS

DC VOLTS

Range:	± 1.0000 V, ± 1.0000 V, ± 10.000 V, ± 100.00 V, ± 1000.0 V.
Resolution:	± 10 μ V to ± 0.1 V in decade steps depending on range.
Overrange:	30% on all ranges except on 1000 V range. Maximum readings are ± 1.3000 V, ± 13.000 V, ± 130.00 V and ± 1000.0 V at full accuracy.
Polarity Selection:	Automatic with minus indicator.
Input Impedance:	>1000 M Ω on 0.1 V, 1 V, and 10 V ranges. 10 M Ω on 100 V and 1000 V ranges.

DC VOLTS (Cont'd)

Accuracy: All ranges except 0.1 V range (25±5°C);
±0.01% rdg. ±0.01% f.s. for 1 month.
±0.02% rdg. ±0.01% f.s. for 3 months.
0.1 V range (25±1°C);
±0.02% rdg. ±0.02% f.s. for 1 month.

Temperature Stability (0°C to 50°C): All ranges except 0.1 V range;
±0.001% rdg. ±0.001% f.s./°C.
0.1 V range;
±0.005% rdg. ±0.01% f.s./°C.

Full-Scale Step Response: 1 second to rated accuracy.

Normal Mode Noise Rejection: >60 dB at 60 Hz.

Common Mode Noise Rejection: >120 dB at dc; 100 dB from 49 Hz to 1 kHz with 1 kΩ source unbalance.

Maximum Input: ±1000 volts on any range without damage.

DC CURRENT

Ranges: ±1.0000 mA, ±1.0000 mA, ±10.000 mA,
±100.00 mA, ±1000.0 mA.

Resolution: ±10 nA to ±0.1 mA in decade steps depending on range.

Overrange: 30% on all ranges. Maximum readings are ±1.3000 mA, ±1.3000 mA, ±13.000 mA, ±130.00 mA and ±1300.0 mA at full accuracy.

Polarity Selection: Automatic with minus indicator.

Configuration: Shunts, internal to instrument.

Accuracy: All ranges except 0.1 mA range (25±5°C):
±0.1% rdg. ±0.01% f.s. for 3 months.
0.1 mA range (25±1°C):
±0.1% rdg. ±0.04% f.s. for 3 months.

Temperature Stability (0°C to 50°C): ±0.005% rdg. ±0.002% f.s./°C.

Full Scale Step Response: 1 second to rated accuracy.

Normal Mode Noise Rejection: >60 dB at 60 Hz.

DC CURRENT (Cont'd)

Common Mode Noise Rejection: >120 dB at dc; 100 dB from 49 Hz to 1 kHz with 1 k Ω source unbalance.

Maximum Input: 100% above range selected without damage.

AC VOLTS

Ranges (rms value): .10000 V, 1.0000 V, 10.000 V, 100.00 V, 1000.0 V.

Resolution: 10 μ V to 0.1 V in decade steps depending on range.

Overrange: 30% on all ranges except 1000 V range. Maximum readings are .13000 V, 1.3000 V, 13.000 V, 130.00 V, and 500.00 V.

Input Impedance: 1 M Ω shunted by 100 pF.

Accuracy (50 Hz to 20 kHz, except 1000 V range is 50 Hz to 10 kHz.) All ranges except 0.1 V range (25 \pm 5 $^{\circ}$ C); \pm 0.2% rdg. \pm 0.02% f.s. for 3 months. 0.1 V range (25 \pm 1 $^{\circ}$ C); \pm 0.5% rdg. \pm 0.2% f.s. for 3 months.

Full-Scale Step Response: 3 seconds to rated accuracy.

Maximum Input: 500 volts rms on 10 V, 100 V, and 1000 V ranges. 150 volts rms on 0.1 V and 1 V ranges without damage.

AC CURRENT

Ranges: .10000 mA, 1.0000 mA, 10.000 mA, 100.00 mA, 1000.0 mA.

Resolution: 10 nA to 0.1 mA in decade steps depending on range.

Overrange: 30% on all ranges. Maximum readings are .13000 mA, 1.3000 mA, 13.000 mA, 130.00 mA, and 1300.0 mA.

Configuration: Shunts internal to instrument.

Accuracy (50 Hz to 20 kHz): All ranges except 0.1 mA range (25 \pm 5 $^{\circ}$ C); \pm 0.3% rdg. \pm 0.02% f.s. for 3 months. 0.1 mA range (25 \pm 1 $^{\circ}$ C); \pm 0.5% rdg. \pm 0.2% f.s. for 3 months.

AC CURRENT (Cont'd)

Full-Scale Step Response: 3 seconds to rated accuracy.
Maximum Input: 100% above range selected without damage.

RESISTANCE

RANGE	CURRENT THRU RX		RESOLUTION
1.0000 k Ω	5 mA	1 k Ω	0.1 ohm
10.000 k Ω	500 μ A	10 k Ω	1 ohm
100.00 k Ω	50 μ A	100 k Ω	10 ohms
1000.0 k Ω	5 μ A	1000 k Ω	100 ohms
10.000 M Ω	0.5 μ A	10 M Ω	1000 ohms

Overrange: 30% on all ranges. Maximum readings are 1.3000 k Ω , 13.000 k Ω , 130.00 k Ω , 1300.0 k Ω , and 13.000 M Ω at full accuracy.
Configuration: Two-wire measurement system.
Accuracy: All ranges (25 \pm 5 $^{\circ}$ C);
 \pm 0.1% rdg. \pm 0.01% f.s.
Full-Scale Step Response: Typical 1 second on all k Ω ranges;
3 seconds on 10 M Ω range.
Voltage Protection: 130 V rms without damage on any range.

GENERAL

Input Configuration: Fully floating and guarded in all functions.
Maximum Common Mode Voltage: \pm 500 V dc or peak V ac.
Range Selection: Manual by front-panel control.
Sample Rate: Continuously adjustable by front-panel control from 5 readings/second to 1 reading/10 seconds. Hold position enables external measurement command.

GENERAL (Cont'd)

Display:	Full four-digits plus overrange digit (gas discharge tubes); automatic decimal point positioning for all functions and ranges; negative polarity indicator; display storage for non-blinking readout; offscale indication.
Operating Temperature:	0°C to +50°C.
Humidity Range:	0 to 80% Relative Humidity (0°C to +35°C). 0 to 70% Relative Humidity (+35°C to +50°C).
Dimensions:	3-1/2" H x 8-1/2" W x 13" D half-rack size portable package, including two side-carry handles.
Weight:	8 lb (3.6 kg) net; 13 lb (6 kg) shipping. Optional battery pack adds 4 pounds.
Power:	115/230 ($\pm 10\%$) V ac, or 100/200 ($\pm 10\%$) V ac, 48-440 Hz, 8 watts maximum.

1.3 OPTIONAL FEATURES

DIGITAL OUTPUTS (OPTION 05)

Nonisolated 8-4-2-1 BCD outputs and recorder control signals with DTL/TTL compatible logic levels. DATA RECORDER COMMON MUST BE ISOLATED FROM MEASUREMENT SOURCE COMMON.

Note: Output signals are not short-circuit-proof.

Outputs:

4 digits of BCD, and "1" (true) bit for overrange, minus polarity, and print command. Binary "0" (false) = +2.4 to +5 V, 0.1 mA source. Binary "1" (true) = 0 to +0.5 V, 1.8 mA sink.

DIGITAL OUTPUTS (Cont'd)

Inputs:

Single line contact closure to P.S. Common for external READ-ON-DEMAND (single measurement per command), and RECORDER BUSY (inhibit).

INTERNAL BATTERY PACK (OPTION 09)

Provides 6 hours of continuous operation between charges; 14-hour recharge cycle through built-in charger. Charges from external power line with instrument in operation. Internal batteries do not increase size of instrument. Three-way battery power switch on rear panel:

- 1) BATTERY OFF - Operates from power and recharges batteries.
- 2) BATTERY ON - Operates from internal batteries or external floating +12 volt dc source which may be connected internally through rear-panel port. Instrument draws 0.7 ampere.
- 3) BATTERY TEST - Checks internal battery condition from front-panel display; also, verifies instrument performance.

CHAPTER 2 INSTALLATION

2.1 INTRODUCTION

The SD Model 7004 Digital Multimeter is shipped in an operational condition and is essentially ready for use as received. This chapter outlines the procedures for initial inspection and installation of the instrument. Instructions for reshipment are also included should the unit be returned to Systron-Donner Corporation for service or repair.

2.2 RECEIVING INSPECTION

Prior to accepting the meter from the shipper, inspect the condition of the shipping container for any indication of freight damage. Any sign of such damage must be noted by both the shipper and receiver and should be reported to the insurance investigator.

Immediately following removal of the instrument from the shipping carton, inspect for possible physical damage incurred during shipment. Check surfaces for scratches or dents and note condition of knobs and connectors. Should any damage be noted, notify your nearest Systron-Donner representative---DO NOT USE THE METER UNTIL INSTRUCTED TO DO SO BY THE REPRESENTATIVE.

2.3 RESHIPMENT

When the instrument is to be repackaged for shipment use the original packing materials. Your Systron-Donner field office can provide materials similar to those used for the original factory packaging, or repackage the instrument following these general instructions:

GENERAL PACKING INSTRUCTIONS

- 1) Attach a tag to the unit indicating the model number, serial number, name and address of the instrument owner, and a summary of the service or repairs required.
- 2) Wrap the instrument in heavy paper or plastic prior to placing it into the shipping container.
- 3) Select a strong carton or wooden box to house the instrument.
- 4) Use an adequate layer of shock-absorbing material on all sides of the instrument and protect the front panel with additional layers of cardboard. Be certain that there is no movement of the unit within the container.

GENERAL PACKING INSTRUCTIONS (Cont'd)

- 5) Seal the package with strong tape or metal bands.
- 6) Mark the shipping container "FRAGILE-DELICATE INSTRUMENT" to ensure careful handling.
- 7) Be certain that all correspondence refers to full instrument nomenclature (model and serial number).

2.4 POWER REQUIREMENTS

Model 7004 Digital Multimeter is equipped with a standard three-conductor power cord which, when plugged into an appropriate power receptacle, grounds the chassis to protect operating personnel from certain electrical hazards. Whenever the power cord is mated to a two-conductor outlet, a cord adapter-plug (properly installed) will provide the same protection.

The instrument operates from either 115 or 230 V at 48 to 440 Hz and consumes approximately 8 watts of power. A LINE switch on the rear panel adapts the unit for the local power line voltage. A 100/200 V tap on the primary of the power transformer is also provided to accommodate certain other power line requirements.

NOTE

The Model 7004 is shipped with a .25 ampere fuse (115 V operation). If 230 V operation is required, the .25 ampere fuse should be replaced with a .125 ampere fuse to adequately protect the meter.

2.5 ACCEPTANCE TEST PROCEDURE

The following procedure is performed to verify that no damage has occurred during transit and that the instrument is operative.

NOTE

Prior to performing the Acceptance Test Procedure it is recommended that the user become familiar with the instrument controls described in Section 3, OPERATION.

- 1) Check position of the LINE (115/230 V or 100/200 V) switch and connect ac power cord to an appropriate power source. If Internal Battery Pack (Option 09) is provided, turn BATTERY switch to the OFF position.
- 2) Turn POWER switch to the ON position; the display will illuminate.

ACCEPTANCE TEST PROCEDURE (Cont'd)

- 3) Select controls indicated in Table 2.1 and observe the display readings.

TABLE 2.1 ACCEPTANCE TEST PROCEDURE

FUNCTION	RANGE	INPUT	DISPLAY
V	1000	HI/LO/GUARD SHORTED	0000.0±3 DIGITS
V & AC	1000	" " "	" "
mA	1000	" " "	" "
mA & AC	1000	" " "	" "
KΩ	1000	" " "	" "
KΩ	1000	HI/LO OPEN	OFFSCALE READING WITH OFFSCALE IN- DICATOR ENERGIZED.

- 4) After completion of the Acceptance Test Procedure, refer to Section 3, OPERATION for additional operating information.

CHAPTER 3 OPERATION

3.1 INTRODUCTION

This chapter describes general operation of the Model 7004 Digital Multimeter. Front panel and rear panel functions are described in Tables 3.1 and 3.2. Operating procedures are given in Table 3.3. Also included is information concerning factors which affect measurement accuracy.

3.2 CONTROLS, CONNECTORS AND INDICATORS

3.2.1 Front Panel

Front Panel control functions for Model 7004 are described in this section (see Figure 3.1 and Table 3.1).

TABLE 3.1 FRONT PANEL FUNCTIONS

INDEX	NAME	FUNCTION
1	POWER-OFF (switch)	Applies power to the instrument when turned in the clockwise direction.
2	SAMPLE RATE and HOLD (Potentiometer and Switch)	Controls measurement sample-rate of 5 readings/second to 1 reading/10 seconds as knob is turned in clockwise direction. When in HOLD position, measurement cycle is interrupted until externally commanded by remote programmer ($\overline{\text{Read}}$).
3	HI/LO (Post Connectors)	Input terminals for all measurement functions.
4	GUARD (Post Connector)	Internal guard circuit may be left open (unconnected), or can be bused to the LO terminal. It may also be connected to an external guard potential. The guard circuit, when utilized, provides increased ac/dc common mode rejection of spurious or undesired signal currents.

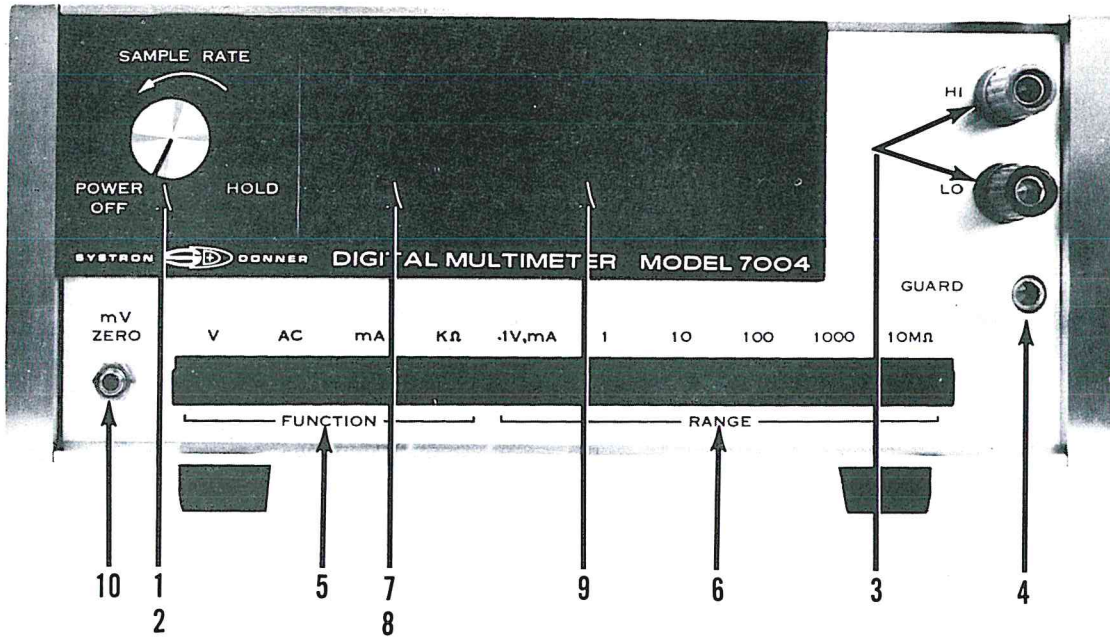


FIGURE 3.1 FRONT PANEL, MODEL 7004

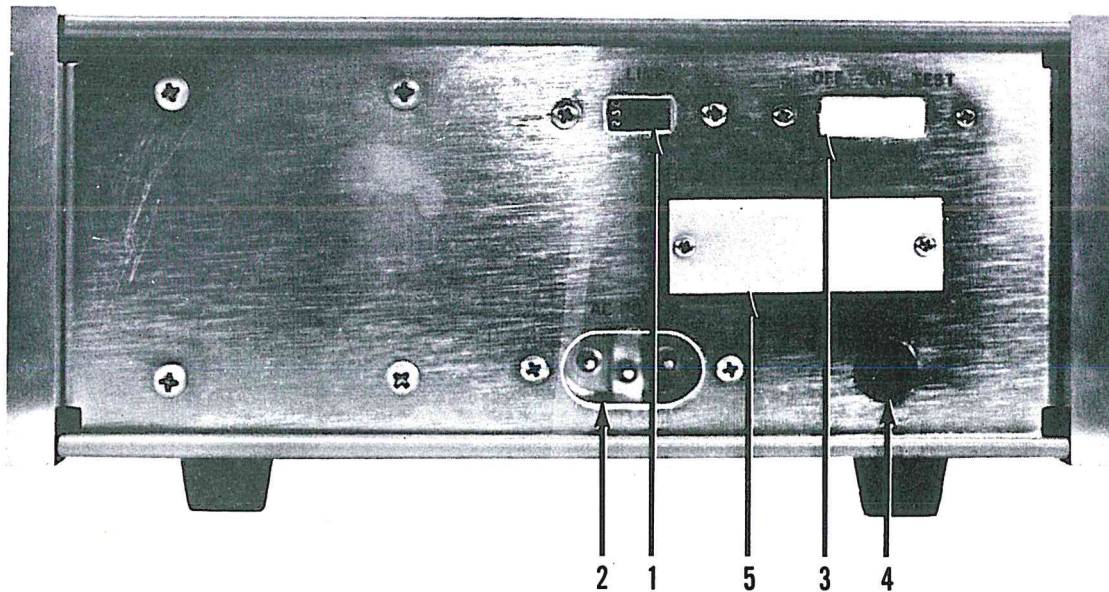


FIGURE 3.2 REAR PANEL, MODEL 7004

TABLE 3.1 FRONT PANEL FUNCTIONS (Cont'd)

5	FUNCTION (Pushbutton Switches)	Pushbutton switches initiate the following measurements:																												
		<table border="0" style="margin-left: 40px;"> <tr> <td style="text-align: left;">FUNCTION</td> <td style="text-align: left;">PUSHBUTTON</td> </tr> <tr> <td>dc voltage</td> <td>depress V</td> </tr> <tr> <td>dc current</td> <td>depress mA</td> </tr> <tr> <td>ac voltage</td> <td>depress V & AC</td> </tr> <tr> <td>ac current</td> <td>depress mA & AC</td> </tr> <tr> <td>resistance</td> <td>depress KΩ</td> </tr> </table>	FUNCTION	PUSHBUTTON	dc voltage	depress V	dc current	depress mA	ac voltage	depress V & AC	ac current	depress mA & AC	resistance	depress K Ω																
FUNCTION	PUSHBUTTON																													
dc voltage	depress V																													
dc current	depress mA																													
ac voltage	depress V & AC																													
ac current	depress mA & AC																													
resistance	depress K Ω																													
6	RANGE	Pushbutton switches select the following ranges:																												
		<table border="0" style="margin-left: 40px;"> <tr> <td style="text-align: left;">RANGE</td> <td style="text-align: left;">AC/DC VOLTS</td> <td style="text-align: left;">AC/DC CURRENT</td> <td style="text-align: left;">KΩ RESISTANCE</td> </tr> <tr> <td>.1V, mA</td> <td>X</td> <td>X</td> <td>No</td> </tr> <tr> <td>1</td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>10</td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>100</td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>1000</td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>10 MΩ</td> <td>No</td> <td>No</td> <td>X</td> </tr> </table>	RANGE	AC/DC VOLTS	AC/DC CURRENT	K Ω RESISTANCE	.1V, mA	X	X	No	1	X	X	X	10	X	X	X	100	X	X	X	1000	X	X	X	10 M Ω	No	No	X
RANGE	AC/DC VOLTS	AC/DC CURRENT	K Ω RESISTANCE																											
.1V, mA	X	X	No																											
1	X	X	X																											
10	X	X	X																											
100	X	X	X																											
1000	X	X	X																											
10 M Ω	No	No	X																											
7	Off-Scale Indicator	LED display, when lighted, indicates an off-scale condition.																												
8	Polarity Indicator	Negative polarity dc measurements are indicated with a (-) sign. Positive polarity levels have no sign indication.																												
9	Readout Tubes	Full four-digit display, with over-range (1), provides full scale readout and 30% overrange capability. Decimal point indication is determined by the range selected.																												
10	mV ZERO (Screwdriver Adjustment)	Fine (screwdriver) adjustment for zeroing low-range mV readings when high-resolution accuracy is desired.																												

3.2.2 Rear Panel

Rear Panel control functions for Model 7004 are described in this section (see Figure 3.2):

3.2.2 REAR PANEL (Cont'd)

TABLE 3.2 REAR PANEL FUNCTIONS

INDEX	NAME	FUNCTION
1	LINE (Switch)	Slide switch selects 115/230 ($\pm 10\%$) V ac, 48 to 440 Hz operation. Power transformer tap (modification) converts unit to 100/200 ($\pm 10\%$) V ac operation.
2	AC POWER (Three-conductor power receptacle)	Power receptacle mates with standard three-conductor power cord (supplied).
3	BATTERY (Switch)	Option 09, Internal Battery Pack-permits field operation of Model 7004. <i>OFF Position:</i> Instrument operates from ac power line while batteries are charging continuously. <i>ON Position:</i> Disconnects ac power line; instrument operates from internal battery pack. <i>TEST Position:</i> Internal battery voltage is indicated on front-panel readout. Instrument accuracy will be impaired if internal battery pack voltage drops below 11 V dc.
4	EXTERNAL BATTERY (Cable Port)	Provision included for connecting external 12 V dc (nominal) power supply into the instrument. <i>Do not exceed 13.5 V dc or damage may result.)</i>
5	BCD Output (Connector)	Option 05, Digital Outputs - provides non-isolated 8-4-2-1 BCD levels and DTL/TTL compatible recorder control logic levels. Mating connector is Amphenol #57-30240 (24 pins).

TABLE 3.2 REAR PANEL FUNCTIONS (Cont'd)

5	BCD Output (Cont'd)	BCD Connector Pin Assignments (J201)		
		READOUT	BCD	PIN
		10^3	1 2 4 8	7 8 19 20
		10^2	1 2 4 8	5 6 17 18
		10^1	1 2 4 8	3 4 15 16
		10^0	1 2 4 8	1 2 13 14
		Recorder Control Pin Assignments(J201)		
		FUNCTION		PIN
		P.S. Common (Gnd)		24
		Minus Polarity		21
		Overrange		9
		Print Command		23
		<u>Read</u>		22
		Inhibit		10

3.3 OPERATING PROCEDURES

The general method for operating Model 7004 is indicated in Table 3.3. All inputs are applied between HI/LO terminals; with the GUARD circuit connected to the LO terminal whenever possible.

3.3 OPERATING PROCEDURES (Cont'd)

TABLE 3.3 OPERATING PROCEDURES

FUNCTION	OPERATION	DISPLAY
DC VOLTS	Select V and desired RANGE 0.1, 1, 10, 100, or 1000.	Read display directly in dc volts.
DC CURRENT	Select mA and desired RANGE 0.1, 1, 10, 100, or 1000.	Read display directly in dc milliamperes.
AC VOLTS	Select V and AC with desired RANGE 0.1, 1, 10, 100, or 1000.	Read display directly in ac volts.
AC CURRENT	Select mA and AC with desired RANGE 0.1, 1, 10, 100, or 1000.	Read display directly in ac milliamperes.
RESISTANCE	Select $K\Omega$ and desired RANGE 1, 10, 100, 1000, or 10 $M\Omega$	Read display directly in kilohms on the 1, 10, 100, 1000 ranges, and in megohms on the 10 $M\Omega$ range.

3.3.1 Sample Rate and Hold Control

This control varies the measurement sample rate over the range of 5 readings/second to 1 reading/10 seconds. When set to the HOLD position, the last reading is displayed until the control is returned to the SAMPLE RATE position; or, a remote command is received on READ line (Pin 22) of connector J201.

3.3.2 Guard Terminal

The instrument contains two isolated inner chassis (top and bottom guard covers) connected to the GUARD terminal on the front panel. With the GUARD/LO terminals bused together, measurement errors due to ac or dc normal mode currents are reduced significantly. Although the GUARD terminal is usually bused to the LO terminal, in certain applications it may be advantageous to connect it to a separate Guard Voltage.

3.3.3 Overload Protection

Overload protection is provided on all ranges to the extent indicated below:

- 1) DC VOLTS - ± 1000 V (maximum allowable input) on all ranges.

3.3.3 Overload Protection (Cont'd)

- 2) AC VOLTS - 500 V rms on 10 V, 100 V, 1000 V ranges.
150 V rms on 0.1 V, 1 V ranges.
- 3) DC CURRENT - 100% above selected range, on all ranges.
- 4) AC CURRENT - 100% above selected range, on all ranges.
- 5) RESISTANCE - 130 V rms on all ranges.

3.3.4 mV Zero Adjustment

Located on the Model 7004 front panel is the mV ZERO adjustment. This control permits the user to accurately zero the instrument when low-level, high-resolution measurements are to be made on the 0.1 V range.

Before adjusting this control, allow the instrument to stabilize for at least 1/2 hour after turn-on. Connect a zero-ohm shorting bus across the HI/LO terminals and adjust the mV ZERO control until a reading of .00000 V \pm 2 counts is obtained.



CHAPTER 4 MAINTENANCE

4.1 INTRODUCTION

This section contains basic maintenance and calibration procedures for maintaining Model 7004 performance parameters. Information in this section includes: Factory Service, Routine Maintenance, Printed-Circuit Board Repair, Test Equipment, and Calibration Procedures.

4.2 FACTORY SERVICE

Whenever a Systron-Donner instrument requires service, the nearest S-D representative should be contacted. He can provide field service, or arrange factory service when necessary. Address all inquiries concerning service, operation, or application to your nearest sales representative; or, to Sales Manager:

*SYSTRON-DONNER CORPORATION
CONCORD INSTRUMENT DIVISION
10 Systron Drive
Concord, California 94518
Phone: (415) 682-6161
TWX: 910-481-9479
Cable: SYSTRONDONNER*

4.3 ROUTINE MAINTENANCE

A regular program for maintenance and inspection every four to six months is recommended for this unit. As part of these regular procedures, the instrument should be checked in the following manner:

- 1) Disconnect ac power and remove the top and bottom covers.
- 2) Make a thorough visual inspection of all wiring and cables. Check for frayed, loose, or burned wires.
- 3) Check the physical integrity of all components. Look for burned or cracked components, loose solder connections, leakage of insulation compounds, and general physical damage. When a printed-circuit board contains integrated-circuit packages, ensure that all packages are firmly mounted. Never unnecessarily remove and replace a package.
- 4) Check front panel switches and controls for loose or broken terminals, sticking shafts, etc.

4.3 ROUTINE MAINTENANCE (Cont'd)

- 5) If the internal panel surfaces and components have accumulated an excessive amount of dust, use a soft brush and low-pressure stream of air to remove the foreign material.

CAUTION

Do not clean P.C. boards or small internal components with a stiff brush or solvents since damage to the circuits may result. A high-powered vacuum cleaner device should never be used on small internal components.

- 6) Wipe the external surfaces of the instrument with a soft, damp cloth to remove dirt, fingerprints, and other foreign materials.
- 7) Replace the top and bottom covers and reconnect ac power. Perform the operational test procedures given in Section 4.6. If performance does not match or exceed the specifications listed in Chapter 1 of this manual, corrective maintenance is in order.

4.4 PRINTED-CIRCUIT BOARD REPAIR

When replacing integrated circuits or other electronic components soldered to printed-circuit boards, the procedures indicated below must be followed or damage to the board may result:

- 1) Determine by troubleshooting techniques, which integrated circuit or discrete component(s) has failed.
- 2) Remove the defective component(s) from the board by cutting the pins or leads with a small diagonal clipping tool. (Always remove and replace the entire component.)
- 3) Apply heat (40-50 W soldering iron) sparingly to each of the cut pins or leads and remove from the board; clean the hole(s) with a toothpick or solder suction tool.
- 4) Form the tinned leads of the replacement part and insert in the printed circuit holes; solder, then trim leads to extend 1/16-inch beyond the back surface of the board. (Use only 63-37 solder with maximum 1/16-inch diameter.)

CAUTION

Always trim semiconductor leads only after soldered installation is complete. This procedure greatly lessens the possibility of component failure due to shock-wave damage caused by the trimming tool.

4.4 PRINTED CIRCUIT BOARD REPAIR (Cont'd)

- 5) When soldering semiconductor devices and all small components, be sure to use a heat sink tool or long-nosed plier connected to the component lead(s) while each is being soldered. Allow the soldered connection to cool before removing the heat sink.
- 6) Clean all dirt and solder-flux from the printed-circuit traces by liberal application of a freon-type solvent.

4.5 TEST EQUIPMENT

Listed in Table 4.1 is the inventory of test equipment required for maintenance and calibration of the Model 7004 Digital Multi-meter. In the event these specific items are not available, units of equal, or greater accuracy and capability may be used.

TABLE 4.1 TEST EQUIPMENT FOR MODEL 7004

NOMENCLATURE	TYPE	USAGE
DC Voltage/Current Calibrator	Fluke Model 382A & 332B	dc voltage & current calibration
AC Voltage Calibrator	HP Model 745A (Use 0.1% resistors for ac current calibration)	ac voltage & current calibration
Resistance Standard	ESI Model RS925C	resistance calibration
Digital Voltmeter	Systron-Donner Model 7005A	calibration & troubleshooting
Oscilloscope	Tektronix Model 535 with Type D Plug-in	calibration & troubleshooting

4.6 CALIBRATION PROCEDURES

This section contains step-by-step calibration procedures for the Model 7004. Perform these procedures in listed order since earlier steps may affect later ones.

Test and calibration tolerances listed in these procedures do not include specification variances of the test/calibration equipments listed in Table 4.1.

7004-8-72

4.6 CALIBRATION PROCEDURES (Cont'd)

Unless otherwise indicated, all calibration procedures may be conducted while at room ambient temperature and at nominal power-line voltage and frequency.

For best results use high-quality test leads of 36-inch maximum length. Undesirable noise may be eliminated during the calibration procedures by grounding the LO/GUARD terminals to the test/calibration equipment.

4.6.1 Power Supply Voltages

- 1) Remove bottom instrument cover (rear end-trim; slide cover off), apply power, and check power supply voltages (bottom side, P.C. board) as follows:

TABLE 4.2 POWER SUPPLY VOLTAGES

VOLTAGE	TEST POINT	ADJUSTMENT	TOLERANCE
+17 V dc	Green	Fixed	Nominal
-18 V dc	Yellow	Fixed	Nominal
Ground	Red/Black	-	-

- 2) Turn OFF power; replace instrument cover.

4.6.2 Calibration

- 1) Apply power to instrument and allow at least 1/2-hour warm-up.
- 2) Remove bottom instrument cover

- 3) **TRANSFORMER UNBALANCE COMPENSATION:** Compensation for transformer unbalance has been made at the factory to eliminate display "noise" or uncertainty. This compensation is adequate for most ac power sources at the point of manufacture. When this unit is used with differing or special power sources, it may be desirable to rebalance the power transformer. This may be done using the following procedure:

Short across the HI, LO, and GUARD inputs. Remove side panel cover and set FUNCTION switch to V and RANGE switch to .1 V, mA. Monitor ripple voltage across Main Amplifier output TP-6, with respect to LO terminal. Connect a capacitor across guard post 22 and Main Amplifier supply post 23 or 24 for a minimum output. The value of the capacitor may vary between 10 pF to 400 pF (typical value is 56 pF). The output

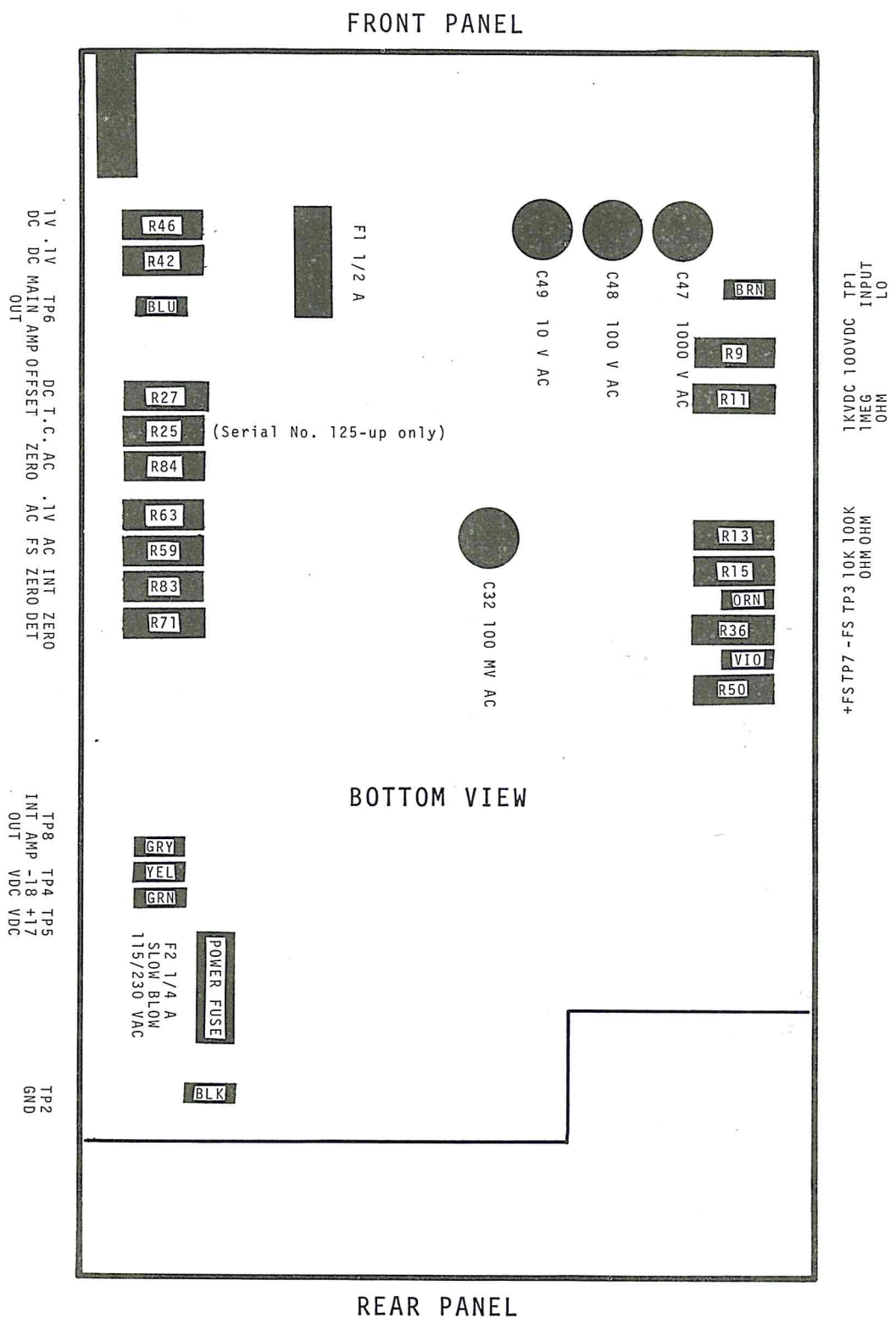


FIGURE 4.1 LOCATION, CALIBRATION CONTROLS

4.6.2 Calibration (Cont'd)

should be minimum but no more than 50 mV p-p. Occasionally the transformers are well balanced and may not require any capacitance.

- 4) DETECTOR ZERO: Set RANGE switch to 10 V and adjust DETECTOR ZERO A2R71 for flashing (-) polarity sign.
- 5) INTEGRATOR ZERO: Remove short across the input, and apply +10 mV (10 counts) from the DC Voltage/Current Calibrator. Adjust INTEGRATOR ZERO potentiometer A2R83 to read +10 counts. Now apply -10 mV input, the output should read -10 counts; if not, repeat steps 4) and 5) until both polarities read 10 counts.
- 6) INPUT MAIN AMPLIFIER ZERO¹: This adjustment is done in two parts. First DC OFFSET is adjusted for minimum output at the room temperature and then the T.C. pot (Temperature Compensation) is calibrated at 75°C. In order to obtain the proper setting, the procedure described below should be followed:
 - a) Place the FUNCTION and RANGE switches in V and .1 V, mA position, and SAMPLE RATE at maximum. Short the HI and LO input terminals and GUARD together.
 - b) Set the mV ZERO pot (front panel control) to the electrical center of its range. Procedure: Adjust to both mechanical extremes observing the maximum zero offset in each direction. Readjust to the number midway between the extremes.
 - c) Set the T.C. pot A2R25 to the electrical center of its range. Procedure: Adjust to both mechanical extremes observing the maximum zero offset in each direction. Re-adjust to the number midway between the extremes.
 - d) With short across the inputs, monitor voltage across the output of integrating amplifier A2TP-8 on the scope. Adjust the DC OFFSET pot A2R27 for minimum amplitude of 5 mV/div scale. Repeat steps 4) and 5) as necessary to zero the instrument.
 - e) Adjust the T.C. pot A2R25 to produce a reading of $+.00200 \pm 1$ count.
 - f) Place a thermal probe, stabilized at 75°C, on dual FET A2Q1 for a period of approximately one minute.
 - g) Remove the thermal probe and record the first reading (r_1) after the probe is removed. (Typically more positive than $+.00200$)

¹ This is factory adjusted and need not be performed unless parts have been replaced in the Input Main Amplifier.

4.6.2 Calibration (Cont'd)

- h) Adjust the T.C. pot A2R25 to produce a reading of $-.00200 \pm 1$ count. Observe that the FET has cooled to approximately room temperature and that the reading remains stable.
- i) Place the 75°C thermal probe on Dual FET A2Q1 again for approximately one minute.
- j) Remove the thermal probe and record the first reading (r_2) after removal (typically more negative than $-.00200$).
- k) Determine the CHANGE of each reading (y_1, y_2) and plot the points on linear graph paper with XY scales. Two typical curves are plotted in the example to demonstrate positive and negative compensation settings.

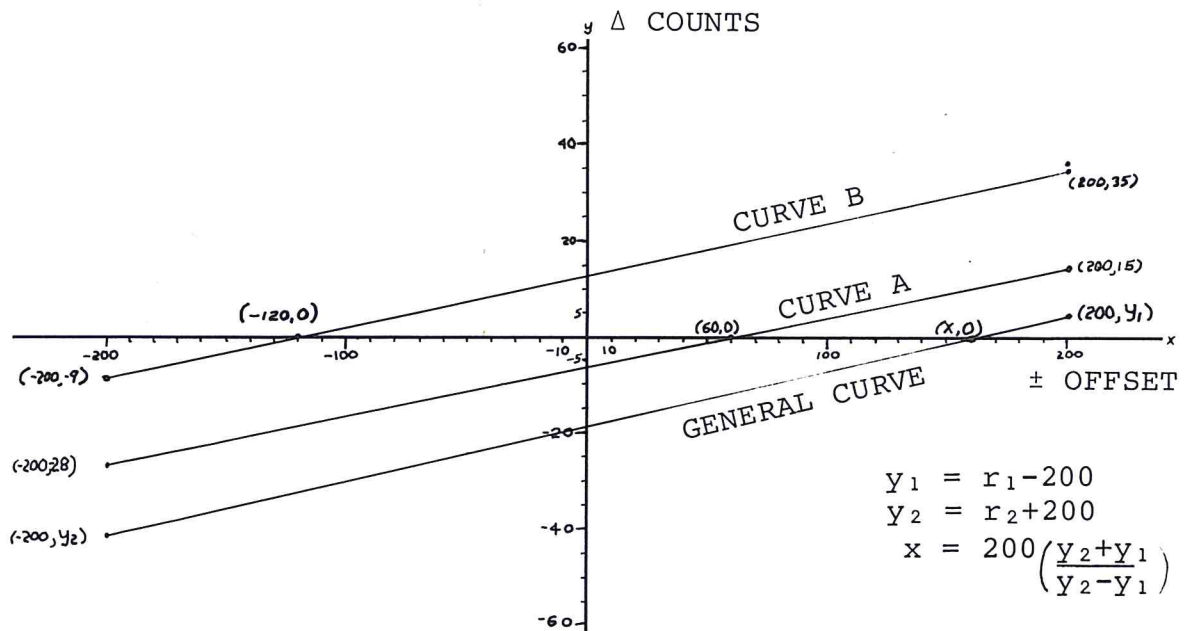


FIGURE 4.2 TYPICAL TEMP. COMP. GRAPH

- l) Draw a straight line curve through the two points, and note the point of intersection with the $\pm\text{OFFSET}$ scale, x-axis.
- m) Adjust T.C. pot A2R25 to produce a reading equal to the number of counts shown by the intersection on the graph. In the above example the reading should be $+.00060$ for Curve A and $-.00120$ for Curve B.
- n) Readjust DC OFFSET pot A2R27 to zero the instrument.
- o) Verification of proper temperature compensation may now be performed. Observe the reading at $.00000 \pm 1$ count, if not, adjust the front panel mV ZERO adjustment to produce this reading. Place the 75°C thermal probe on Dual FET Q1 for approximately one minute. Remove the probe and observe the

4.6.2 Calibration (Cont'd)

reading is still .00000 ± 20 counts. This procedure will typically compensate the FET to ± 5 counts (± 50 mV) for a 50°C change in temperature. If the 25°C to 75°C zero stability of the FET is not less than ± 20 after compensation, it may be due to improper performance of the compensation procedure, or a defective device with excessive gate leakage current.

- 7) +FS (TP7-violet): Apply +10 V dc across the inputs and adjust +FULL SCALE potentiometer A2R50 to read 10.000 ± 1 count.
- 8) -FS (TP3-orange): Apply -10 V dc across the inputs and adjust -FULL SCALE potentiometer A2R36 to read -10.000 ± 1 count.
- 9) OHMS CALIBRATION: Set FUNCTION switch to $\text{K}\Omega$ and select RANGE as indicated in Table 4.3:

TABLE 4.3 RESISTANCE CALIBRATION

RANGE	CALIBRATOR INPUT	ADJUST	DISPLAY	(INITIAL) (ADJUSTMENT)	(FINAL) (CALIB)
1	1 $\text{k}\Omega$	No adjustment	1.0000	± 11 counts	± 11 counts
10	10 $\text{k}\Omega$	A2R15	10.000	± 1 count	± 11 counts
100	100 $\text{k}\Omega$	A2R13	100.00	± 1 count	± 11 counts
1000	1000 $\text{k}\Omega$	A2R11	1000.0	± 1 count	± 11 counts
10 $\text{M}\Omega$	10 $\text{M}\Omega$	No adjustment	10.000	± 11 counts	± 11 counts

- 10) DC VOLTAGE CALIBRATION: Set FUNCTION switch to V and select RANGE as indicated in Table 4.4:

TABLE 4.4 DC VOLTAGE CALIBRATION

RANGE	CALIBRATOR INPUT	ADJUST	DISPLAY
.1	± 100 mV	A2R42	.10000 ± 2 counts
1	± 1 V	A2R46	1.0000 ± 1 count
10	± 10 V	Same as 6) & 7)	10.000 ± 1 count
100	± 100 V	A2R9	100.00 ± 1 count
1000	± 1000 V	A2R13	1000.0 ± 2 counts

NOTE

If adjustment of A2R13 is necessary, the Resistance ranges may be slightly affected, but these will continue to be within specified tolerances. Also, do not attempt at this point, to readjust the Resistance ranges back to ± 1 count since the DC Voltage calibration will then be affected.

4.6.2 Calibration (Cont'd)

- 11) AC VOLTAGE CALIBRATION: (*Perform DC VOLTAGE CALIBRATION first*).
 - a) AC ZERO: Set FUNCTION switches to V and AC. Set RANGE switch to 0.1 V mA. Short the HI/LO input terminals with a bus jumper. (Do not use long test lead which will pick up noise.) Adjust AC ZERO A2R84 so that display reads a minimum, but no higher than 15 counts.
 - b) Apply a 0.1 V rms, 200 Hz input signal from the AC Voltage Calibrator across the HI/LO input terminals. Adjust A2R63 until the readout is .10000 ± 1 count.
 - c) Apply a 0.1 V rms, 20 kHz input signal across the HI/LO input terminals. Adjust frequency compensation capacitor A2C32 until the readout is .10000 ± 1 count.
 - d) Set the RANGE switch to the 1 V range. Apply a 1.0 V rms, 200 Hz input signal across the HI/LO input terminals. Adjust A2R59 until the readout is 0.9995 ± 2 counts.
 - e) Set the RANGE switch to the 10 V range. Apply a 10 V rms, 200 Hz input signal across the HI/LO input terminals. Observe that the readout is 10.000 ± 22 counts.
 - f) Apply a 10 V rms, 20 kHz input signal across the HI/LO input terminals. Adjust attenuator frequency compensation capacitor A2C49 for a reading of 09.990 ± 2 counts.
 - g) Set the RANGE switch to the 100 V range. Apply a 100 V rms, 200 Hz input signal across the HI/LO input terminals. Observe that the readout is 100.00 ± 22 counts.
 - h) Apply a 100 V rms, 10 kHz input signal across the HI/LO input terminals. Adjust attenuator frequency compensation capacitor A2C48 for a reading of 099.90 ± 2 counts.
 - i) Set the RANGE switch to the 1000 V range. Apply a 500 V rms, 200 Hz input signal across the HI/LO input terminals. Observe that the readout is 500.0 ± 12 counts.
 - j) Apply a 500 V rms, 20 kHz input signal across the HI/LO input terminals. Adjust attenuator frequency compensation capacitor A2C47 for a reading of 0499.5 ± 1 count.
 - k) In the event that an AC Voltage Calibrator with an output capability of 500 V rms is not available, the following procedure will provide adequate frequency compensation. Apply a 100 V rms, 200 Hz input signal across the HI/LO input terminals. Observe that the readout is 100.0 ± 4 counts.

4.6.2 Calibration (Cont'd)

1) Apply a 100 V rms, 10 kHz input signal across the HI/LO input terminals. Adjust attenuator frequency compensation capacitor A2C47 to observe a reading of 99.8 \pm 1 count.

12) DC/AC CURRENT CALIBRATION

a) DC CURRENT: Set FUNCTION switch to mA and RANGE switch as indicated below. Connect DC Current Calibrator output across the HI/LO input terminals. Observe display, no adjustment is required.

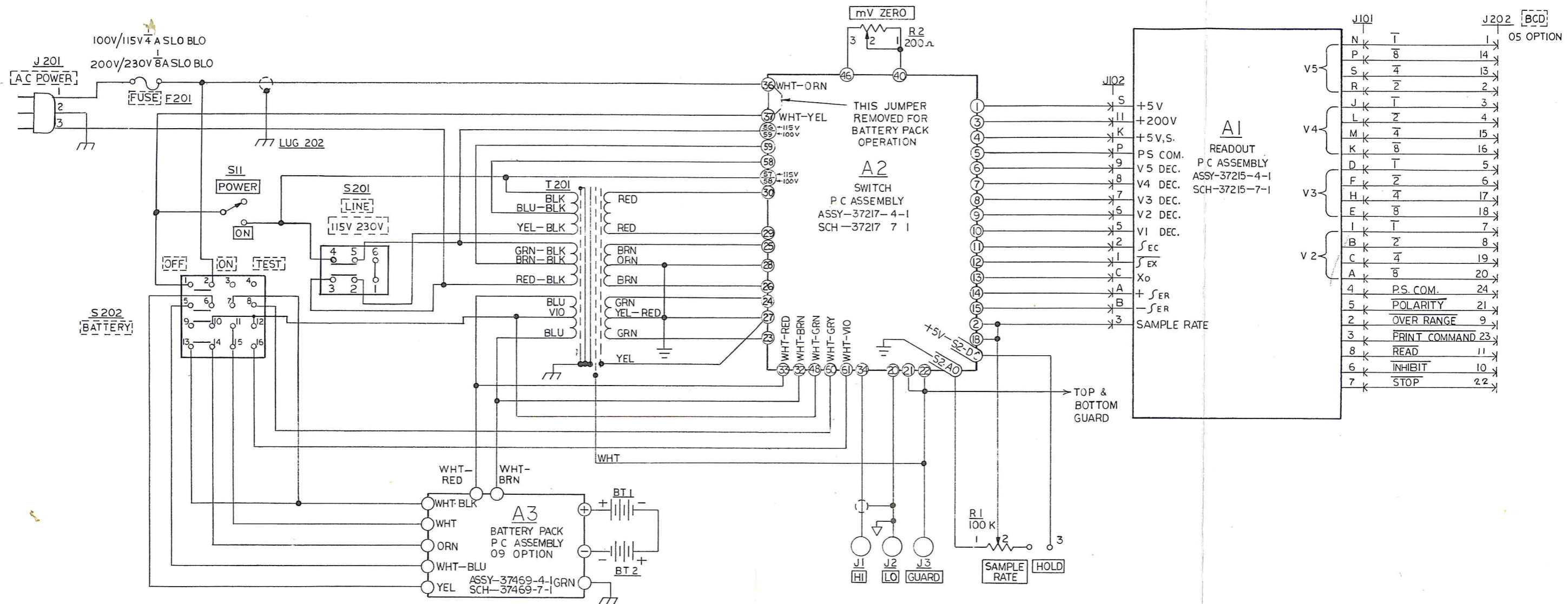
TABLE 4.5 DC CURRENT CALIBRATION

RANGE	CALIBRATOR INPUT	DISPLAY	
.1	\pm 100 μ A	.10000	\pm 14 counts
1	\pm 1 mA	1.0000	\pm 11 counts
10	\pm 10 mA	10.000	\pm 11 counts
100	\pm 100 mA	100.00	\pm 11 counts
1000	\pm 1000 mA	1000.0	\pm 11 counts

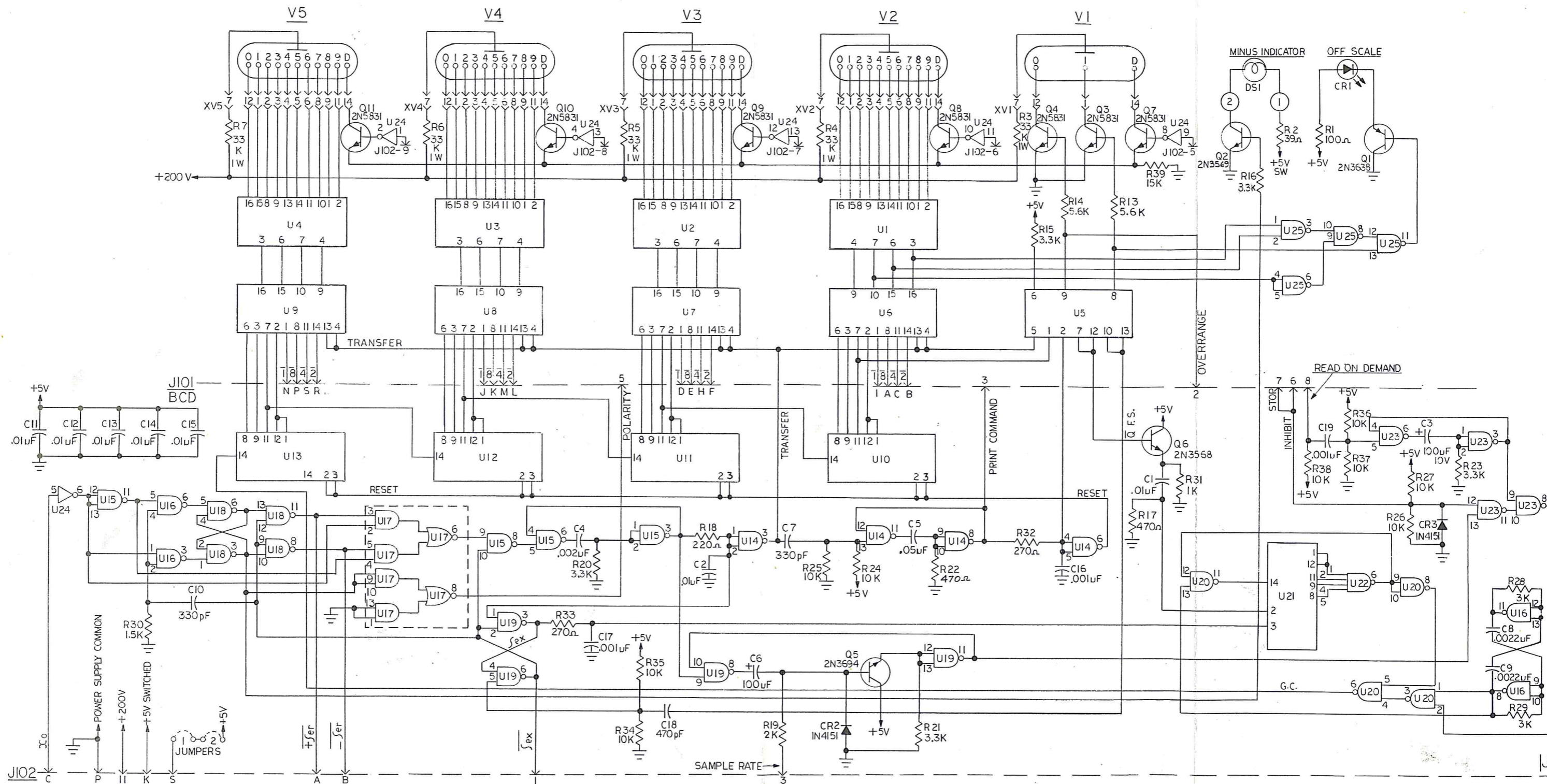
b) AC CURRENT: Set FUNCTION switch to AC and mA; then, repeat Step 11a. Use AC Current Calibrator. If not available, apply ac voltage across precision resistors to obtain proper currents.

TABLE 4.6 AC CURRENT CALIBRATION

RANGE	CALIBRATOR INPUT	DISPLAY	
.1	100 μ A	.10000	\pm 52 counts
1	1 mA	1.0000	\pm 32 counts
10	10 mA	10.000	\pm 32 counts
100	100 mA	100.00	\pm 32 counts
1000	1000 mA	1000.0	\pm 32 counts



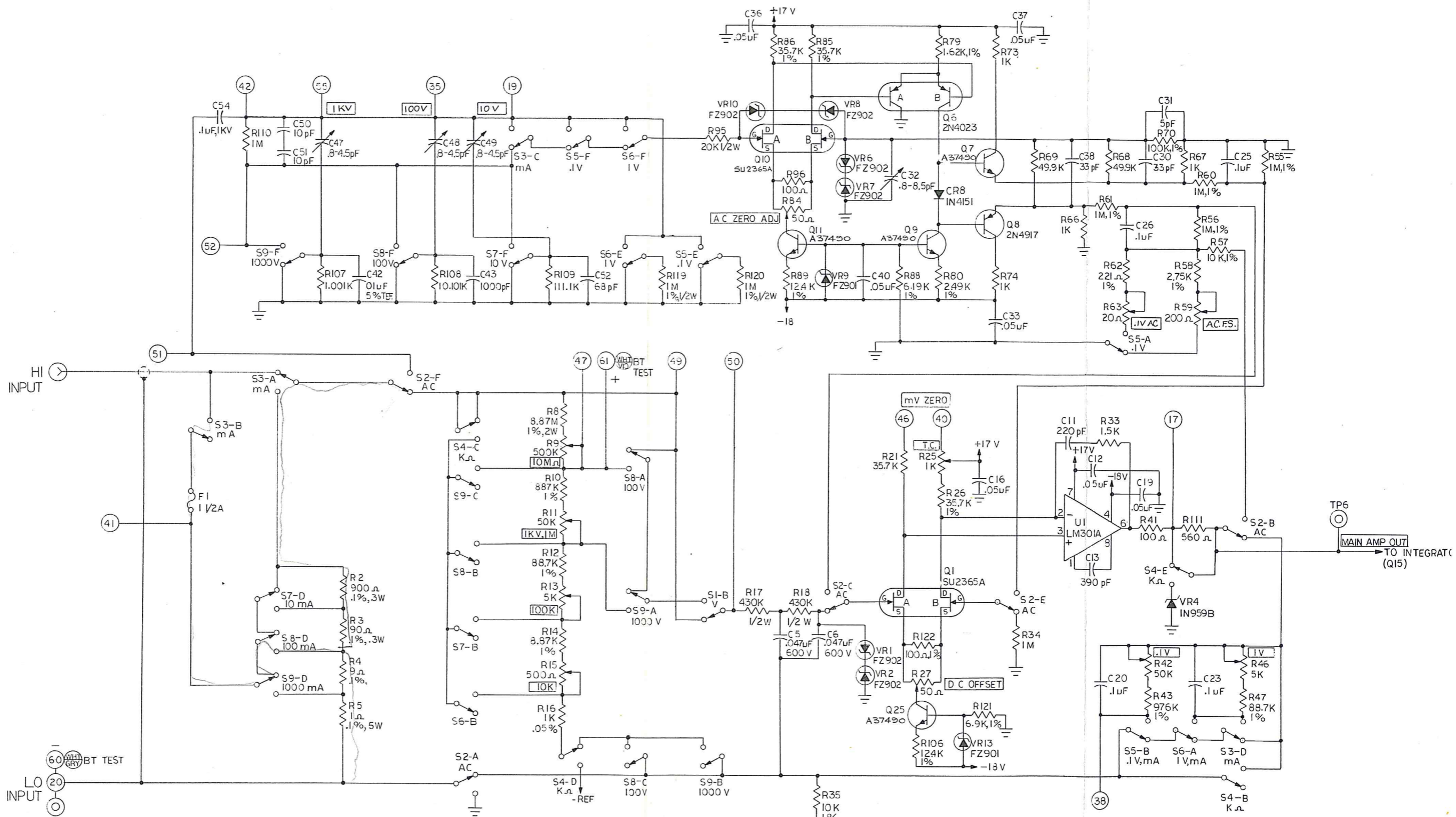
MODEL 7004
 BLOCK DIAGRAM #D37190-7-1D



NOTE:
 I. ALL RESISTORS 1/4 W UNLESS OTHERWISE SPECIFIED.

U	TYPE	GND PIN	+5V PIN
1,2,3,4	SN7441AN	12	5
5	SN74L73N	11	3,4,14
6,7,8,9	SN74L75N	12	5
10,11,12,13	SN74L90N	6,7,10	5
14	SN7400N	7	14
15,16,18,19,20,23,25	SN74L00N	7	14
17	SN74L51N	1,7,13	14
21	SN7493N	10	5
22	SN74L20N	7,9,10,12,13	14
24	SN74L04N	7	14

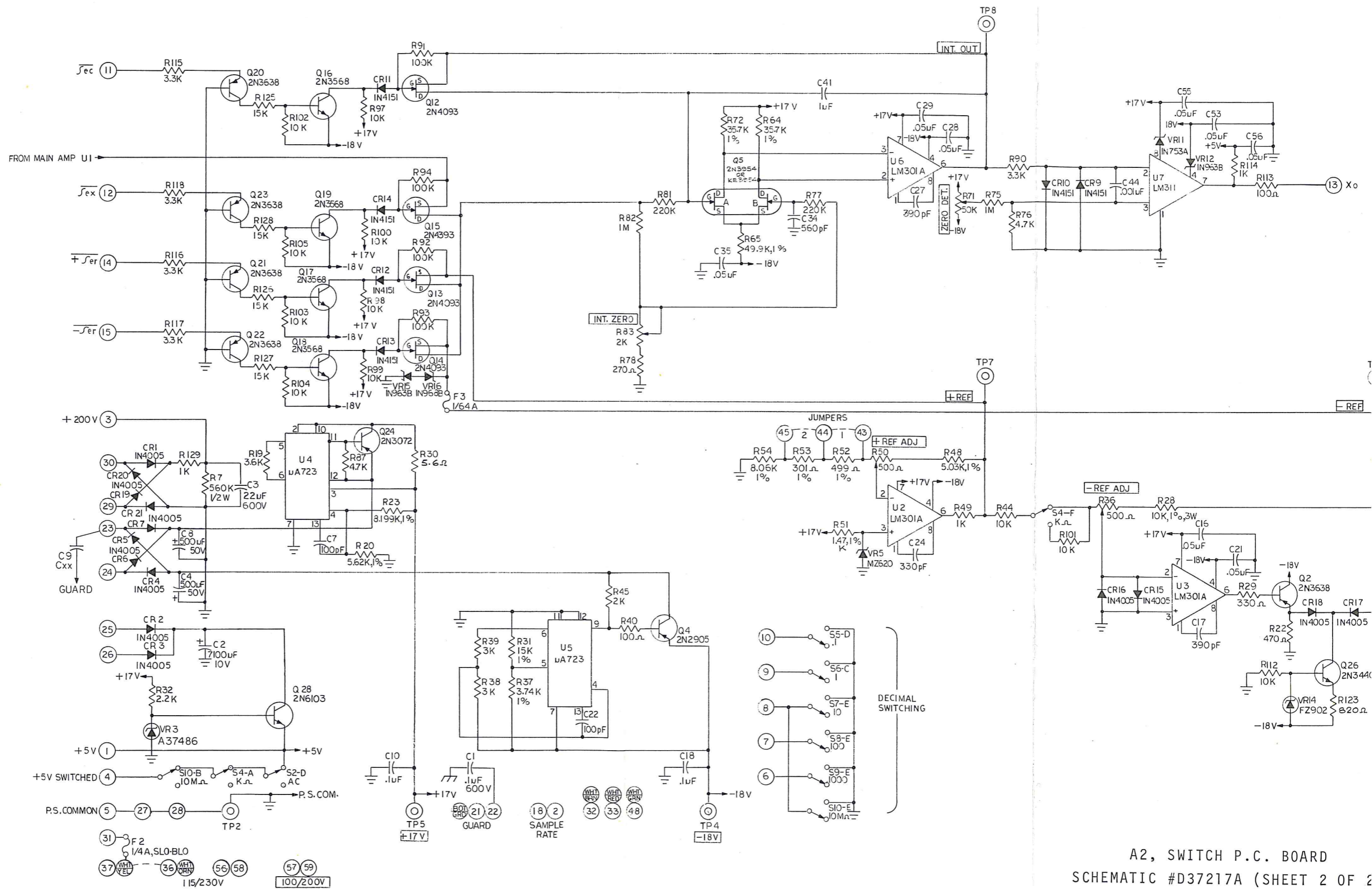
A1, COUNT CHAIN & READOUT P.C. BO
 SCHEMATIC #D37215A



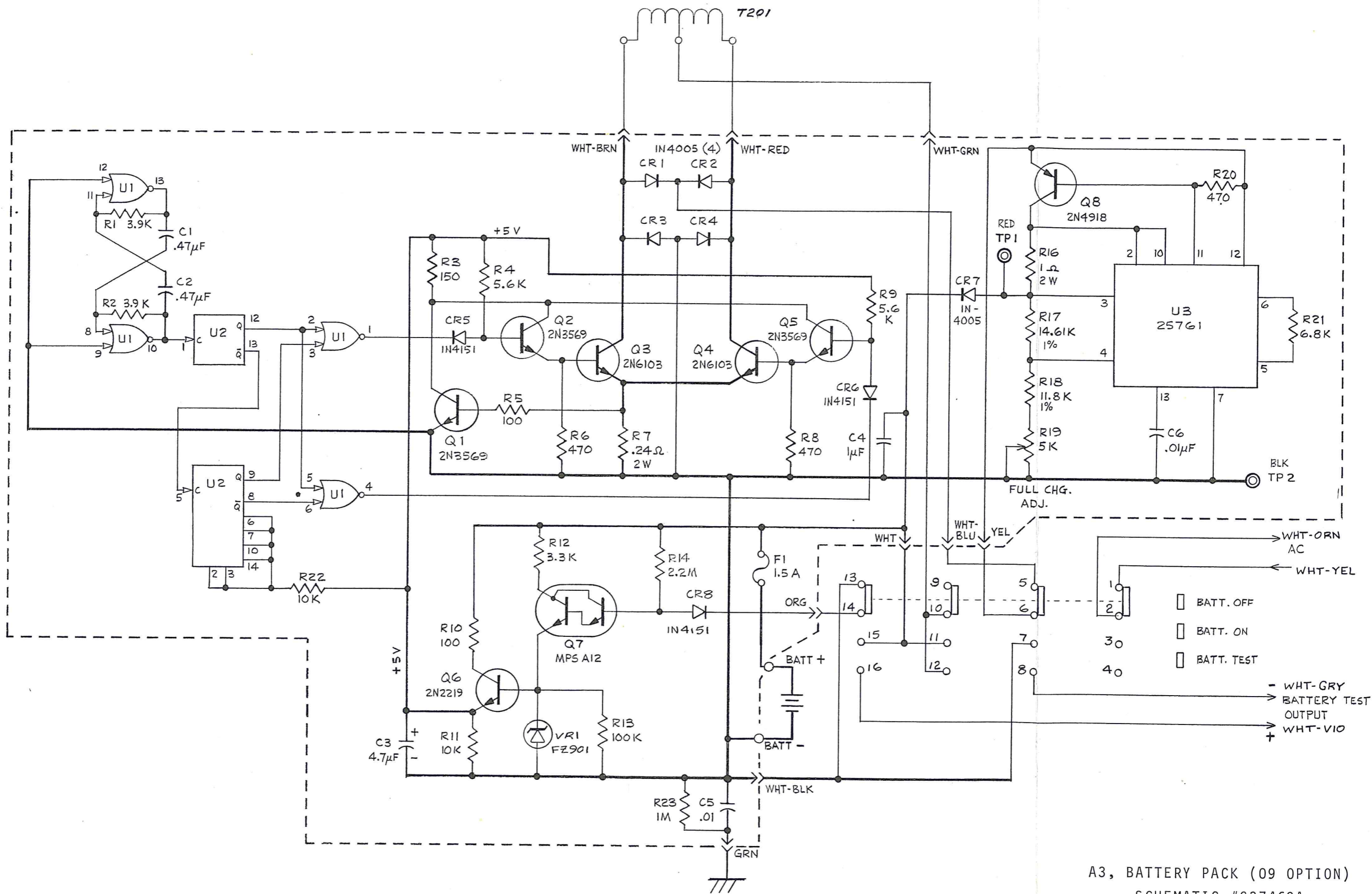
NOTE:
 1. UNLESS SPECIFIED RESISTORS ARE 5%, 1/4W.
 2. R107, R108 & R109 ARE MATCHED TO R110 WITHIN .05%.
 3. SWITCHES SHOWN IN "OUT" POSITION.

- S1 = V
- S2 = AC
- S3 = mA
- S4 = K Ω
- S5 = .1V, mA
- S6 = I
- S7 = 10
- S8 = 100
- S9 = 1000
- S10 = 10M Ω

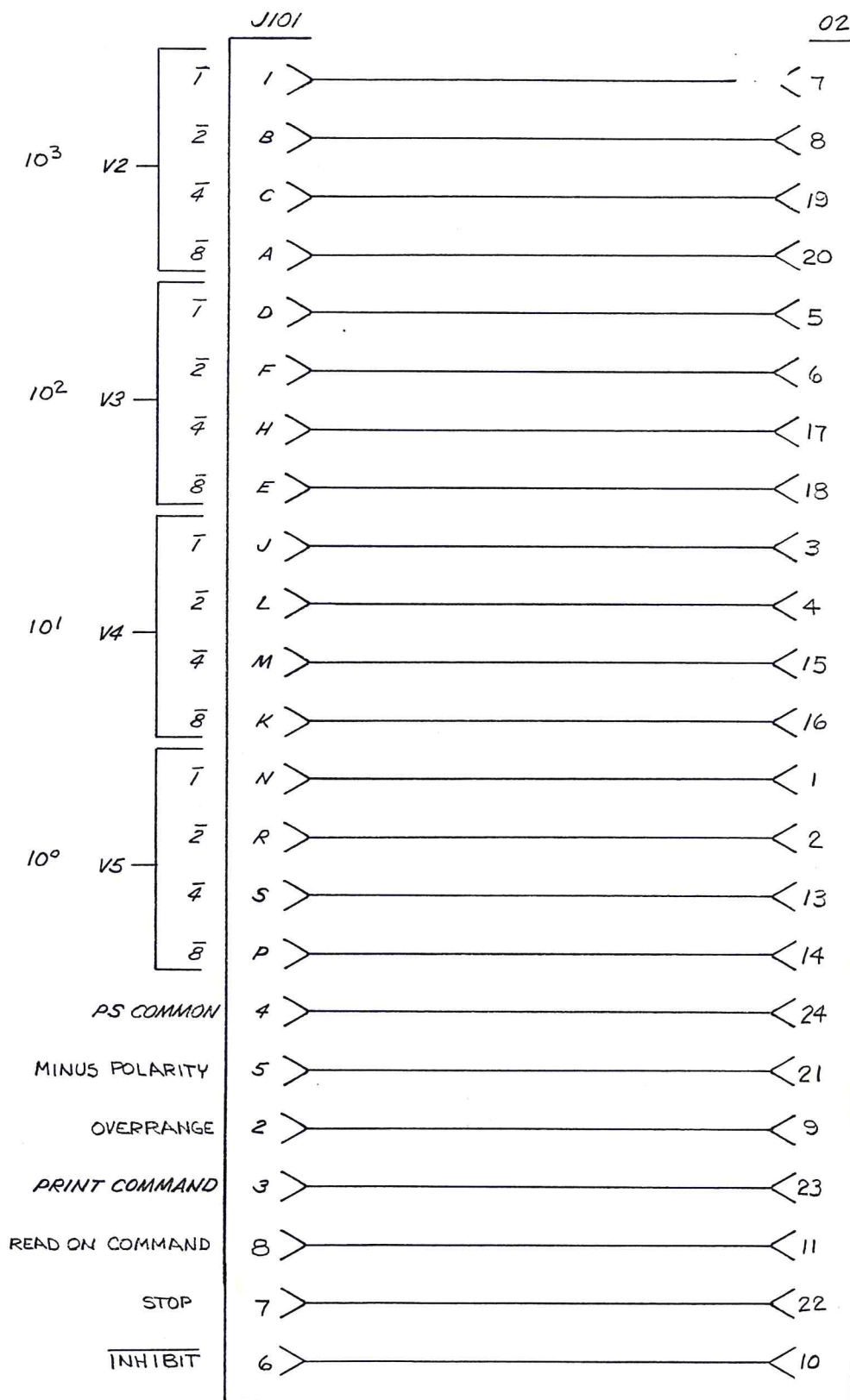
A2, SWITCH P.C. BOARD
 SCHEMATIC #D37217A (SHEET 1 OF 2)



A2, SWITCH P.C. BOARD
 SCHEMATIC #D37217A (SHEET 2 OF 2)

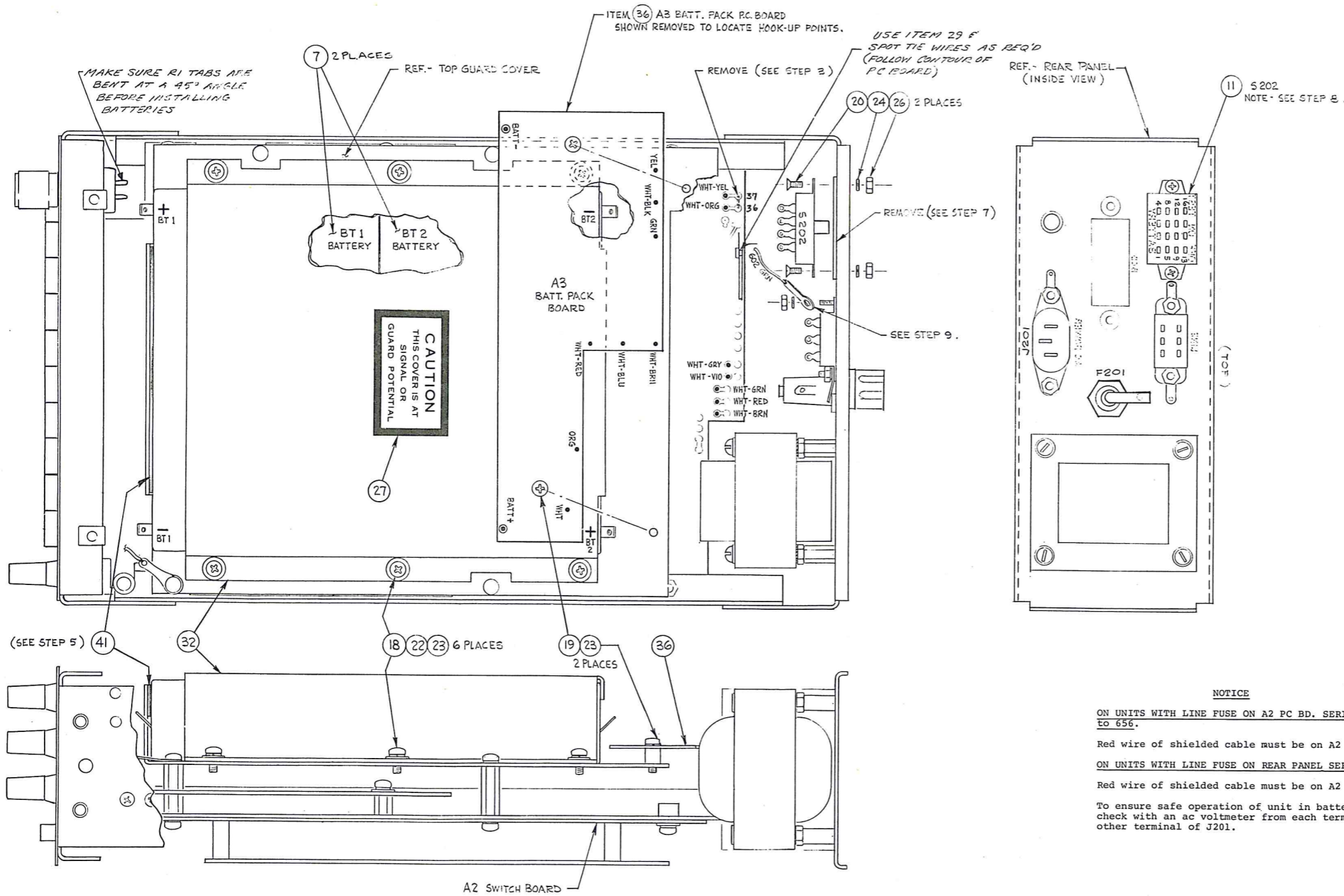


A3, BATTERY PACK (09 OPTION)
SCHEMATIC #C37469A



AMPHENOL
57-40240

BCD (05 OPTION) SCHEMATIC #C37218A



BATTERY PACK HOOKUP

WIRE No.	COLOR	FROM	TO
701	WHT-YEL	C202 - 1	A2 WHT-YEL
702	WHT-ORG	- 2	A2 WHT-ORG
703	WHT-BLU	- 5	A2 WHT-BLU
704	YEL	- 6	A3 WHT-YEL
705	WHT-GRN	- 10	A2 WHT-GRN
706	WHT-ELK	- 13	A3 WHT-BLK
707	ORG	- 14	A3 ORG
708	WHT	- 15	A3 WHT
709	WHT-VIO	- 16	A2 WHT-VIO
710	WHT-GRY	Y - 8	A2 WHT-GRY
601	BLU	BT1 - -	BT2 - +
602	GRN	A3 - GRN	CHASSIS GROUND
603	WHT-BRN	A3 WHT-BRN	A2 WHT-BRN
604	WHT-RED	A-3 WHT-RED	A2 WHT-RED
503	BLK	A3-BATT -	BT2 - -
504	RED	A3-BATT +	BT1 - +

INSTALLATION PROCEDURE

1. REMOVE THE AC LINE CORD.
2. REMOVE THE TOP AND BOTTOM UNIT COVERS.
3. REMOVE JUMPER WIRE BETWEEN TERMINALS NO. 36 & 37 ON A2 SWITCH BOARD. SEE NOTICE.
4. RE-INSTALL THE BOTTOM UNIT COVER.
5. APPLY ITEM 41, FOAM TAPE; BEHIND AND ALONG TOP FLANGE OF THE TOP GUARD COVER.
6. POSITION BATTERIES BT1 & BT2 ON THE TOP GUARD COVER; NOTE + & - TABS ON EACH BATTERY. SECURE THE BATTERIES IN PLACE AND BACK-TO-BACK WITH THE BATTERY CLAMP ASSEMBLY, ITEM NO. 32.
7. REMOVE SWITCH PLATE ON THE REAR PANEL.
8. INSTALL SWITCH (S202) ASSEMBLY, ITEM NO. 11 ON THE REAR PANEL. SWITCH MUST BE MOUNTED WITH THE WHT-YEL WIRE AT LUG #1. SEE REAR PANEL VIEW. SET SWITCH TO "OFF".
9. REMOVE NUT AND WASHER OF THE "LINE" SWITCH AND INSTALL THE GROUND LUG OF WIRE NO. 602 (GRN). BEND LUG AS REQUIRED.
10. CONNECT ALL WIRE ENDS WHICH GO TO A2 SWITCH BOARD. SEE HOOK-UP TABLE ABOVE.
11. REMOVE THE 1.5 AMP. FUSE (F4) ON THE BATTERY PACK P.C. ASSEMBLY A3, ITEM NO. 36. SET THIS FUSE ASIDE.
12. MOUNT THE BATTERY PACK P.C. BOARD ASSEMBLY A3 ON THE TOP GUARD COVER AS INDICATED.
13. HOOK UP THE REMAINING TERMINATIONS PER THE ABOVE TABLE.
14. RE-INSTALL THE 1.5A FUSE ON THE BATTERY PACK P.C. BOARD ASSEMBLY A3. IN HOUSE UNITS (SYSTRON DONNER) INSTALL AT TEST. SEE NOTICE.
15. APPLY THE "CAUTION" LABEL, ITEM NO. 27 AS SHOWN.
16. RE-INSTALL THE TOP COVER ON THE UNIT.
17. MARK THE IDENTIFICATION LABEL ON THE REAR PANEL AS MODEL "7004-09 OPT."
18. RE-INSTALL THE AC LINE CORD.

NOTICE

ON UNITS WITH LINE FUSE ON A2 PC BD. SERIAL #101 TO 656.
Red wire of shielded cable must be on A2 terminal 36.

ON UNITS WITH LINE FUSE ON REAR PANEL SERIAL #657 ON.
Red wire of shielded cable must be on A2 terminal 37.

To ensure safe operation of unit in battery mode, check with an ac voltmeter from each terminal to the other terminal of J201.

NOTES :

1. A MODEL 7004 IS SHOWN WITHOUT COVERS, AC LINE CORD, AND A SECTIONAL SIDE VIEW; ONLY REQUIRED DETAILS ARE SHOWN.

CHAPTER 6

7004 FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	7004 Final Assembly	37190-4-1
	7004 Schematic	37190-7-1
	Test Assembly	37197-4-1
	Bottom Cover Assembly	45065-3
	End Trim	39033
	Top Trim	39859-3
	Handle	33570-3
	Front Trim	37230-6-1
	Readout Window	37202-1-1
	Trim Strip	37203-1-1
	Foil Cal. Trim Strip	37203-6-1
	Label	23456
	Line Cord	50303270
	Cover Mtg. Bracket	39857
	Cover Top	33567-3
	100 V Assembly	37473-4-1
	BCD Option 05 Assembly	37218-4-1
	Battery Pack Option 09 Assembly	37219-4-1
	Front Cover Assembly	37229-4-1
	Test Probe Ket	37232-4-1
	Rack Mount Kit Single	45410-3
	Rack Mount Kit Dual	

A1 COUNT CHAIN & READOUT P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A1	Count Chain & Readout P.C. Assembly Count Chain & Readout Schematic	D37215-4-1 D37215-7-1
C1	Capacitor, 01 μ F, Disc	C0556
C2	Capacitor, 01 μ F, Disc	C0556
C3	Capacitor, 100 μ F, 10 V, Electro	C0660
C4	Capacitor, .002 μ F, 500 V	C0328
C5	Capacitor, .05 μ F, 100 V	C0708
C6	Capacitor, 100 μ F, 25 V	C0832
C7	Capacitor, 330 pF, 500 V	C0898
C8	Capacitor, .0022 μ F, 200 V	C0687
C9	Capacitor, .0022 μ F, 200 V	C0687
C10	Capacitor, 330 pF, 500 V	C0898
C11	Capacitor, 01 μ F, Disc	C0556
C12	Capacitor, 01 μ F, Disc	C0556
C13	Capacitor, 01 μ F, Disc	C0556
C14	Capacitor, 01 μ F, Disc	C0556
C15	Capacitor, 01 μ F, Disc	C0556
C16	Capacitor, .001 μ F, 500 V	C0424
C17	Capacitor, .001 μ F, 500 V	C0424
C18	Capacitor, 470 pF, 300 V	C0542
C19	Capacitor, .001 μ F, 500 V	C0424
CR1	Diode, Light Emitting	CR0367
CR2	Diode, 1N4151	CR0150
CR3	Diode, 1N4151	CR0150
Q1	Transistor, 2N3638	Q0181
Q2	Transistor, 2N3569	Q0318
Q3	Transistor, 2N5831	26004021
Q4	Transistor, 2N5831	26004021
Q5	Transistor, 2N3694	26012660
Q6	Transistor, 2N3568	Q0180
Q7	Transistor, 2N5831	26004021
Q8	Transistor, 2N5831	26004021
Q9	Transistor, 2N5831	26004021
Q10	Transistor, 2N5831	26004021
Q11	Transistor, 2N5831	26004021
R1	Resistor, 470 Ω , 1/4, 5%	R1044
R2	Resistor, 39 Ω , 1/4 W, 5%	R1552
R3	Resistor, 33 k, 1 W, 5%	R1263
R4	Resistor, 33 k, 1 W, 5%	R1263
R5	Resistor, 33 k, 1 W, 5%	R1263

AI COUNT CHAIN & READOUT P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R6	Resistor, 33 k, 1 W, 5%	R1263
R7	Resistor, 33 k, 1 W, 5%	R1263
R8	Not Used	
R9	Not Used	
R10	Not Used	
R11	Not Used	
R12	Not Used	
R13	Resistor, 5.6 k, 1/4 W, 5%	R0821
R14	Resistor, 5.6 k, 1/4 W, 5%	R0821
R15	Resistor, 3.3 k, 1/4 W, 5%	R0742
R16	Resistor, 820 Ω , 1/4 W, 5%	R0762
R17	Resistor, 470 Ω , 1/4 W, 5%	R1044
R18	Resistor, 220 Ω , 1/4 W, 5%	R0760
R19	Resistor, 2 k, 1/4 W, 5%	R0734
R20	Resistor, 3.3 k, 1/4 W, 5%	R0742
R21	Resistor, 3.3 k, 1/4 W, 5%	R0742
R22	Resistor, 470 Ω , 1/4 W, 5%	R1044
R23	Resistor, 3.3 k, 1/4 W, 5%	R0742
R24	Resistor, 10 k, 1/4 W, 5%	R0766
R25	Resistor, 10 k, 1/4 W, 5%	R0766
R26	Resistor, 10 k, 1/4 W, 5%	R0766
R27	Resistor, 10 k, 1/4 W, 5%	R0766
R28	Resistor, 3 k, 1/4 W, 5%	R0711
R29	Resistor, 3 k, 1/4 W, 5%	R0711
R30	Resistor, 1.5 k, 1/4 W, 5%	R0783
R31	Resistor, 1 k, 1/4 W, 5%	R0765
R32	Resistor, 270 Ω , 1/4 W, 5%	R0694
R33	Resistor, 270 Ω , 1/4 W, 5%	R0694
R34	Resistor, 10 k, 1/4 W, 5%	R0766
R35	Resistor, 10 k, 1/4 W, 5%	R0766
R36	Resistor, 10 k, 1/4 W, 5%	R0766
R37	Resistor, 10 k, 1/4 W, 5%	R0766
R38	Resistor, 10 k, 1/4 W, 5%	R0766
R39	Resistor, 15 k, 1/4 W, 5%	R0728
U1	Integrated Circuit, SN7441AN	019707
U2	Integrated Circuit, SN7441AN	019707
U3	Integrated Circuit, SN7441AN	019707
U4	Integrated Circuit, SN7441AN	019707
U5	Integrated Circuit, SN74L73N	045200
U6	Integrated Circuit, SN74L75N	045201
U7	Integrated Circuit, SN74L75N	045201

A1 COUNT CHAIN & READOUT P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
U8	Integrated Circuit, SN74L75N	045201
U9	Integrated Circuit, SN74L75N	045201
U10	Integrated Circuit, SN74L90N	045202
U11	Integrated Circuit, SN74L90N	045202
U12	Integrated Circuit, SN74L90N	045202
U13	Integrated Circuit, SN74L90N	045202
U14	Integrated Circuit, SN7400N	019705
U15	Integrated Circuit, SN74L00N	025796
U16	Integrated Circuit, SN74L00N	025796
U17	Integrated Circuit, SN74L51N	025799
U18	Integrated Circuit, SN74L00N	025796
U19	Integrated Circuit, SN74L00N	025796
U20	Integrated Circuit, SN74L00N	025796
U21	Integrated Circuit, SN7493N	25715
U22	Integrated Circuit, SN74L20N	025798
U23	Integrated Circuit, SN74L00N	025796
U24	Integrated Circuit, SN74L04N	045204
U25	Integrated Circuit, SN74L04N	045204
V1	Tube, Readout	V0132
V2	Tube, Readout	V0132
V3	Tube, Readout	V0132
V4	Tube, Readout	V0132
V5	Tube, Readout	V0132
XV1	Socket Readout Tube	X0179
XV2	Socket Readout Tube	X0179
XV3	Socket Readout Tube	X0179
XV4	Socket Readout Tube	X0179
XV5	Socket Readout Tube	X0179
XU1	IC Sockets	X0185
XU2	IC Sockets	X0185
XU3	IC Sockets	X0185
XU4	IC Sockets	X0185
DS1	Lamp	10050

A2 SWITCH P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
A2	Switch P.C. Board Assembly Switch P.C. Schematic	D37217-4-1 D37217-7-1
C1	Capacitor, .1 μ F, 600 V	03285090
C2	Capacitor, 7100 μ F, 10 V	C1188
C3	Capacitor, .22 μ F, 600 V	03286700
C4	Capacitor, 500 μ F, 50 V	C1243
C5	Capacitor, .047 μ F, 600 V	C0793
C6	Capacitor, .047 μ F, 600 V	C0793
C7	Capacitor, 100 pF, 500 V	C0536
C8	Capacitor, 500 μ F, 50 V	C1243
C9	Capacitor, Factory Selected	Cxxx
C10	Capacitor, .1 μ F, 50 V	C0881
C11	Capacitor, 200 μ F, 500 V	C0538
C12	Capacitor, .05 μ F, 100 V	C0708
C13	Capacitor, 390 pF, 500 V	C0871
C14	Capacitor, .05 μ F, 100 V	C0708
C15	Not Used	
C16	Capacitor, .05 μ F, 100 V	C0708
C17	Capacitor, 390 pF, 500 V	C0871
C18	Capacitor, .1 μ F, 50 V	C0881
C19	Capacitor, .05 μ F, 100 V	C0708
C20	Capacitor, .1 μ F, 200 V, Met. Myl	C0382
C21	Capacitor, .05 μ F, 100 V	C0708
C22	Capacitor, 100 pF, 500 V	C0536
C23	Capacitor, .1 μ F, 200 V Met. Myl.	C0382
C24	Capacitor, 390 pF, 500 V	C0871
C25	Capacitor, .1 μ F, 200 V, Met. Myl.	C0382
C26	Capacitor, .1 μ F, 200 V, Met. Myl.	C0382
C27	Capacitor, 390 pF, 500 V	C0871
C28	Capacitor, .05 μ F, 100 V	C0708
C29	Capacitor, .05 μ F, 100 V	C0708
C30	Capacitor, 33 pF, 500 V	C0531
C31	Capacitor, 5 pF, 500 V	C1071
C32	Capacitor, .8-8.5 pF, Trimmer	C1291
C33	Capacitor, .05 μ F, 100 V	C0708
C34	Capacitor, 560 pF, 300 V	C0644
C35	Capacitor, .05 μ F, 100 V	C0708
C36	Capacitor, .05 μ F, 100 V	C0708
C37	Capacitor, .05 μ F, 100 V	C0708
C38	Capacitor, 33 pF, 500 V	C0531
C39	Not Used	

A2, SWITCH P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
C40	Capacitor, .05 μ F, 100 V	C0708
C41	Capacitor, 1 μ F, 50 V	C1272
C42	Capacitor, .01 μ F, 100 V, 5%	C1295
C43	Capacitor, 1000 pF, 300 V	C1144
C44	Capacitor, .001 μ F, 1 KV	C0235
C45	Not Used	
C46	Not Used	
C47	Capacitor, .8-4.5 pF, Trimmer	03270200
C48	Capacitor, .8-4.5 pF, Trimmer	03270200
C49	Capacitor, .8-4.5 pF, Trimmer	03270200
C50	Capacitor, 10 pF, 500 V	C0527
C51	Capacitor, 10 pF, 500 V	C0527
C52	Capacitor, 68 pF, 500 V	C0635
C53	Capacitor, .05 μ F, 100 V	C0708
C54	Capacitor, .1 μ F, 1.2 KV	03286130
C55	Capacitor, .05 μ F, 100 V	C0708
C56	Capacitor, .05 μ F, 100 V	C0708
CR1	Diode, IN4005	CR0284
CR2	Diode, IN4005	CR0284
CR3	Diode, IN4005	CR0284
CR4	Diode, IN4005	CR0284
CR5	Diode, IN4005	CR0284
CR6	Diode, IN4005	CR0284
CR7	Diode, IN4005	CR0284
CR8	Diode, IN4151	CR0150
CR9	Diode, IN4151	CR0150
CR10	Diode, IN4151	CR0150
CR11	Diode, IN4151	CR0150
CR12	Diode, IN4151	CR0150
CR12	Diode, IN4151	CR0150
CR13	Diode, IN4151	CR0150
CR14	Diode, IN4151	CR0150
CR15	Diode, IN4005	CR0284
CR16	Diode, IN4005	CR0284
CR17	Diode, IN4005	CR0284
CR18	Diode, IN4005	CR0284
CR19	Diode, IN4005	CR0284
CR20	Diode, IN4005	CR0284
CR21	Diode, IN4005	CR0284
VR1	Diode, Zener, FZ902	26015850

A2 SWITCH P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
VR2	Diode, Zener, FZ902	26015850
VR3	Diode, Zener, 2N3640, Selected	37486
VR4	Diode, Zener, 1N959B	CR0346
VR5	Diode, Zener, MZ620	CR0371
VR6	Diode, Zener, FZ902	26015850
VR7	Diode, Zener, FZ902	26015850
VR8	Diode, Zener, FZ902	26015850
VR9	Diode, Zener, FZ901	26015340
VR10	Diode, Zener, FZ902	26015850
VR11	Diode, Zener, 1N753A	26014210
VR12	Diode, Zener, 1N963B	CR0174
VR13	Diode, Zener, FZ901	26015340
VR14	Diode, Zener, FZ902	26015850
VR15	Diode, Zener, 1N963B	CR0174
VR16	Diode, Zener, 1N968B	CR0265
Q1	Transistor, S _μ 2365A	Q0302
Q2	Transistor, 2N3638	Q0181
Q3	Not Used	
Q4	Transistor, 2N2905	Q0259
Q5	Transistor, SN3954	26013160
Q6	Transistor, 2N4023	26013950
Q7	Transistor, 2N3693, Selected	37490
Q8	Transistor, 2N4917	26014620
Q9	Transistor, 2N3693, Selected	37490
Q10	Transistor, S _μ 2365A	Q0302
Q11	Transistor, 2N3693, Selected	37490
Q12	Transistor, 2N4093	Q0301
Q13	Transistor, 2N4093	Q0301
Q14	Transistor, 2N4093	Q0301
Q15	Transistor, 2N4393	Q0316
Q16	Transistor, 2N3568	Q0180
Q17	Transistor, 2N3568	Q0180
Q18	Transistor, 2N3568	Q0180
Q19	Transistor, 2N3568	Q0180
Q20	Transistor, 2N3638	Q0181
Q21	Transistor, 2N3638	Q0181
Q22	Transistor, 2N3638	Q0181
Q23	Transistor, 2N3638	Q0181
Q24	Transistor, 2N3072	26008560
Q25	Transistor, 2N3693, Selected	37490
Q26	Transistor, 2N3440	Q0319
Q27	Not Used	

A2 SWITCH P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
Q28	Transistor, 2N6103	Q0317
R1	Not Used	
R2	Resistor, 900 Ω , .1%, 3 W	R2807
R3	Resistor, 90 Ω , .1%, 3 W	R2808
R4	Resistor, 9 Ω , .1%, 3 W	R2809
R5	Resistor, 1 Ω , 1%, 3 W	R2810
R6	Not Used	
R7	Resistor, 560 k, 5%, 1/2 W	02031140
R8	Resistor, 8.87 M, 1%, 2 W	R2851
R9	Resistor, 500 k, Potentiometer	R2847
R10	Resistor, 887 k, 1%, 1/4 W	R2848
R11	Resistor, 50 k, Potentiometer	R2783
R12	Resistor, 88.7 k, 1%, 1/4 W	R2845
R13	Resistor, 5 k, Potentiometer	01111360
R14	Resistor, 8.87 k, 1%, 1/4 W	R2840
R15	Resistor, 500 Ω , Potentiometer	R2821
R16	Resistor, 1 k, .05%, 1/4 W	R2832
R17	Resistor, 430 k, 5%, 1/2 W	R0276
R18	Resistor, 430 k, 5%, 1/2 W	R0276
R19	Resistor, 3.6 k, 5%, 1/4 W	R0938
R20	Resistor, 5.62 k, 1%, 1/8 W	R2837
R21	Resistor, 35.7 k, 1%, 1/4 W	R2853
R22	Resistor, 470 Ω , 5%, 1/4 W	R1044
R23	Resistor, 8.199 k, 1%, 1/4 W	R2839
R24	Not Used	
R25	Resistor, 1 k, Potentiometer	R2816
R26	Resistor, 35.7 k, 1%, 1/4 W	R2853
R27	Resistor, 50 Ω , Potentiometer	R2822
R28	Resistor, 10 k, 1%, 3 W	02421000
R29	Resistor, 330 Ω , 5%, 1/4 W	R0662
R30	Resistor, 5.6 Ω , 5%, 1/4 W	R2498
R31	Resistor, 15 k, 1%, 1/4 W	R2073
R32	Resistor, 2.2 k, 5%, 1/4 W	R0749
R33	Resistor, 1.5 k, 5%, 1/4 W	R0783
R34	Resistor, 1 M, 5%, 1/4 W	R0962
R35	Resistor, 10 k, 1%, 1/4 W	R2455
R36	Resistor, 500 Ω , Potentiometer	R2821
R37	Resistor, 3.74 k, 1%, 1/4 W	R2824
R38	Resistor, 3 k, 5%, 1/4 W	R0711
R39	Resistor, 3 k, 5%, 1/4 W	R0711
R40	Resistor, 100 Ω , 5%, 1/4 W	R0966

A2, SWITCH P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R41	Resistor, 100 Ω , 5%, 1/4 W	R0966
R42	Resistor, 50 k, Potentiometer	R2783
R43	Resistor, 976 k, 1%, 1/4 W	R2849
R44	Resistor, 10 k, 1%, 1/4 W	R2455
R45	Resistor, 2 k, 5%, 1/4 W	R0734
R46	Resistor, 5 k, Potentiometer	01111360
R47	Resistor, 88.7 k, 1%, 1/4 W	R2845
R48	Resistor, 5.03 k, 1%, 1/4 W	R2530
R49	Resistor, 1 k, 5%, 1/4 W	R0765
R50	Resistor, 500 Ω , Potentiometer	R2821
R51	Resistor, 1.47 k, 1%, 1/4 W	R2833
R52	Resistor, 499 Ω , 1%, 1/4 W	R2831
R53	Resistor, 301 Ω , 1%, 1/4 W	R2830
R54	Resistor, 8.06 k, 1%, 1/4 W	R2570
R55	Resistor, 1 M, 1%, 1/4 W	02394780
R56	Resistor, 1 M, 1%, 1/4 W	02394780
R57	Resistor, 10 k, 1%, 1/4 W	R2455
R58	Resistor, 2.74 k, 1%, 1/4 W	R1981
R59	Resistor, 200 Ω , Potentiometer	R2722
R60	Resistor, 1 M, 1%, 1/4 W	02394780
R61	Resistor, 1 M, 1%, 1/4 W	02394780
R62	Resistor, 221 Ω , 1%, 1/4 W	R2829
R63	Resistor, 20 Ω , Potentiometer	R2784
R64	Resistor, 35.7 k, 1%, 1/4 W	R2853
R65	Resistor, 49.9 k, 1%, 1/4 W	R2844
R66	Resistor, 1 k, 5%, 1/4 W	R0765
R67	Resistor, 1 k, 5%, 1/4 W	R0765
R68	Resistor, 49.9 k, 1%, 1/4 W	R2844
R69	Resistor, 49.9 k, 1%, 1/4 W	R2844
R70	Resistor, 100 k, 1%, 1/4 W	R2846
R71	Resistor, 50 k, Potentiometer	R2783
R72	Resistor, 35.7 k, 1%, 1/4 W	R2853
R73	Resistor, 1 k, 5%, 1/4 W	R0765
R74	Resistor, 1 k, 5%, 1/4 W	R0765
R75	Resistor, 1 M, 5%, 1/4 W	R0962
R76	Resistor, 4.7 k, 5%, 1/4 W	R0892
R77	Resistor, 220 k, 5%, 1/4 W	R0967
R78	Resistor, 270 Ω , 5%, 1/4 W	R0694
R79	Resistor, 1.62 k, 1%, 1/4 W	R2834
R80	Resistor, 2.49 k, 1%, 1/4 W	R2835
R81	Resistor, 220 k, 5%, 1/4 W	R0967

A2, SWITCH P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R82	Resistor, 1 M, 5%, 1/4 W	R0962
R83	Resistor, 2 k, Potentiometer	R2721
R84	Resistor, 50 Ω , Potentiometer	R2822
R85	Resistor, 35.7 k, 1%, 1/4 W	R2853
R86	Resistor, 35.7 k, 1%, 1/4 W	R2853
R87	Resistor, 4.7 k, 5%, 1/4 W	R0892
R88	Resistor, 6.19 k, 1%, 1/4 W	R2838
R89	Resistor, 12.4 k, 1%, 1/4 W	R2841
R90	Resistor, 3.3 k, 5%, 1/4 W	R0742
R91	Resistor, 100 k, 5%, 1/4 W	R0741
R92	Resistor, 100 k, 5%, 1/4 W	R0741
R93	Resistor, 100 k, 5%, 1/4 W	R0741
R94	Resistor, 100 k, 5%, 1/4 W	R0741
R95	Resistor, 20 k, 1%, 1/2 W	02379680
R96	Resistor, 100 Ω , 1%, 1/4 W	R2620
R97	Resistor, 10 k, 5%, 1/4 W	R0766
R98	Resistor, 10 k, 5%, 1/4 W	R0766
R99	Resistor, 10 k, 5%, 1/4 W	R0766
R100	Resistor, 10 k, 5%, 1/4 W	R0766
R101	Resistor, 10 k, 5%, 1/4 W	R0766
R102	Resistor, 10 k, 5%, 1/4 W	R0766
R103	Resistor, 10 k, 5%, 1/4 W	R0766
R104	Resistor, 10 k, 5%, 1/4 W	R0766
R105	Resistor, 10 k, 5%, 1/4 W	R0766
R106	Resistor, 12.4 k, 1%, 1/4 W	R2841
R107	Resistor, 1.0010 k, Part of Set	37225-6-1
R108	Resistor, 10.101 k, Part of Set	37225-6-1
R109	Resistor, 111.11 k, Part of Set	37225-6-1
R110	Resistor, 1 M, Part of Set	37225-6-1
R111	Resistor, 560 Ω , 5%, 1/4 W	R0819
R112	Resistor, 10 k, 5%, 1/4 W	R0766
R113	Resistor, 100 Ω , 5%, 1/4 W	R0966
R114	Resistor, 1 k, 5%, 1/4 W	R0765
R115	Resistor, 3.3 k, 5%, 1/4 W	R0742
R116	Resistor, 3.3 k, 5%, 1/4 W	R0742
R117	Resistor, 3.3 k, 5%, 1/4 W	R0742
R118	Resistor, 3.3 k, 5%, 1/4 W	R0742
R119	Resistor, 1 M, 1%, 1/2 W	02381310
R120	Resistor, 1 M, 1%, 1/2 W	02381310
R121	Resistor, 6.19 k, 1%, 1/4 W	R2838
R122	Resistor, 100 Ω , 1%, 1/4 W	R2620

A2, SWITCH P.C. ASSEMBLY PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R123	Resistor, 820 Ω , 5%, 1/4 W	R0762
R124	Resistor, 1 Ω , 5%, 2 W	R2855
R125	Resistor, 15 k, 5%, 1/4 W	R0728
R126	Resistor, 15 k, 5%, 1/4 W	R0728
R127	Resistor, 15 k, 5%, 1/4 W	R0728
R128	Resistor, 15 k, 5%, 1/4 W	R0728
R129	Resistor, 1 k, 5%, 1/4 W	R0765
U1	Integrated Circuit, LM301A	25745
U2	Integrated Circuit, LM301A	25745
U3	Integrated Circuit, LM301A	25745
U4	Integrated Circuit, μ A723	25761
U5	Integrated Circuit, μ A723	25761
U6	Integrated Circuit, LM301A	25745
U7	Integrated Circuit, LM311	25792
TP1	Test Point, Brown	E0235
TP2	Test Point, Black	E0234
TP3	Test Point, Orange	E0237
TP4	Test Point, Yellow	E0238
TP5	Test Point, Green	E0239
TP6	Test Point, Blue	E0240
TP7	Test Point, Violet	E0241
TP8	Test Point, Grey	E0242
F1	Fuse, 1 1/2 A	F0046
F2	Fuse, 1/4 A Slo Blo	F0067
F3	Fuse, 1/64 A Pigtail	F0069
S1	Switch, 10 Positive Pushbutton	S0411
S2	Switch, 10 Positive Pushbutton	S0411
S3	Switch, 10 Positive Pushbutton	S0411
S4	Switch, 10 Positive Pushbutton	S0411
S5	Switch, 10 Positive Pushbutton	S0411
S6	Switch, 10 Positive Pushbutton	S0411
S7	Switch, 10 Positive Pushbutton	S0411
S8	Switch, 10 Positive Pushbutton	S0411
S9	Switch, 10 Positive Pushbutton	S0411
S10	Switch, 10 Positive Pushbutton	S0411

05 OPTION BCD ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	05 Option BCD Assembly	37218-4-1
	05 Option BCD Schematic	37218-7-1
J101	Connector, 30 Pin	J0504
J202	Connector, 24 Pin	J0298
P201	Mating Connector	J0244

09 OPTION BATTERY PACK ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	09 Option Battery Pack Assembly	37219-4-1
BT1	Battery, 6 V, 4.5 A. Hr.	BT0005
BT2	Battery, 6 V, 4.5 A. Hr.	BT0005
S202	Switch, 4P3T Slide	S0415
	Battery Switch Assembly	37228-4-1
	Battery Pack P.C. Board Assembly	37469-4-1

BATTERY PACK P.C. BOARD PARTS LIST

Ref.	Description	SD Part No.
	Battery Pack P.C. Board Assembly	37469-4-1
	Battery Pack P.C. Board Schematic	37469-7-1
C1	Capacitor, .47 μ F, 200 V	03284010
C2	Capacitor, .47 μ F, 200 V	03284010
C3	Capacitor, 4.7 μ F, 25 V	03287820
C4	Capacitor, 1 μ F, 25 V	C0879
C5	Capacitor, .01 μ F, 500 V, Disc.	C0423
C6	Capacitor, .01 μ F, 100 V, Disc.	C0556
CR1	Diode, 1N4005	CR0284
CR2	Diode, 1N4005	CR0284
CR3	Diode, 1N4005	CR0284
CR4	Diode, 1N4005	CR0284
CR5	Diode, 1N4151	CR0150
CR6	Diode, 1N4151	CR0150
CR7	Diode, 1N4005	CR0284
CR8	Diode, 1N752A, 5.6 V, Zener	CR0064
CR9	Diode, 1N4151	CR0150
F3	Fuse, 1.5 A, F Blo, 8AG	F0046
Q1	Transistor, 2N3569	Q0318
Q2	Transistor, 2N3569	Q0318
Q3	Transistor, 2N6103	Q0317
Q4	Transistor, 2N6103	Q0317
Q5	Transistor, 2N3569	Q0318
Q6	Transistor, 2N2219	Q0246
Q7	Transistor, MPS A12	Q0286
Q8	Transistor, 2N4918	Q0268
R1	Resistor, 3.9 k, 5%, 1/4 W	R0939
R2	Resistor, 3.9 k, 5%, 1/4 W	R0939
R3	Resistor, 150 Ω , 5%, 1/4 W	R0983
R4	Resistor, 5.6 k, 5%, 1/4 W	R0821
R5	Resistor, 100 Ω , 5%, 1/4 W	R0966
R6	Resistor, 470 Ω , 5%, 1/4 W	R1044
R7	Resistor, .24 Ω , 5%, 2 W	02394000
R8	Resistor, 470 Ω , 5%, 1/4 W	R1044
R9	Resistor, 5.6 k, 5%, 1/4 W	R0821
R10	Resistor, 100 Ω , 5%, 1/4 W	R0966
R11	Resistor, 10 k, 5%, 1/4 W	R0766
R12	Resistor, 3.3 k, 5%, 1/4 W	R0742
R13	Resistor, 100 k, 5%, 1/4 W	R0741

BATTERY PACK P.C. BOARD PARTS LIST (Cont'd)

Ref.	Description	SD Part No.
R14	Resistor, 2.2 M, 5%, 1/4 W	R1014
R15	Not Used	
R16	Resistor, .68 Ω , 5%, 2 W	R2291
R17	Resistor, 14.61 k, 1%, 1/4 W	R0859
R18	Resistor, 11.8 k, 1%, 1/4 W	R1003
R19	Resistor, 5 k, Potentiometer	R2697
R20	Resistor, 470 Ω , 5%, 1/4 W	R1044
R21	Resistor, 6.8 k, 5%, 1/4 W	R0696
R22	Resistor, 10 k, 5%, 1/4 W	R0766
R23	Resistor, 1 M, 5%, 1/4 W	R0962
TP1	Test Point, Red	E0279
TP2	Test Point, Black	E0280
U1	Integrated Circuit, SN74L02N	25797
U2	Integrated Circuit, SN74L73N	45200
U3	Integrated Circuit, μ 723	25761
	Heat Sink, (Q8)	H1956

TEST PROBE KIT PARTS LIST

Ref.	Description	SD Part No.
	Test Probe Kit	37232-4-1
	Test Probe Red	E0313
	Alligator Clip Black	E0311
	Plug, Banana Red	J0528
	Plug, Banana Black	J0529
	Wire, Belden 8899 Red	W0090
	Wire, Belden 8899 Black	W0089
	Alternate Assembly Complete Red	Pomona 1986-36
	Alternate Assembly Complete Black	Pomona 1959-36