Superior Electric Powerstat 22 Autotransformer

CERTIFICATION

ROD-L certifies that this instrument was thoroughly inspected and tested and found to meet its published specifications when it was shipped from the factory.

WARRANTY AND ASSISTANCE

All ROD-L Electronics' instruments are warranted against defects in materials and workmanship. This warranty applies for one year from date of delivery to the original purchaser. We will repair or replace instruments which prove to be defective during the warranty period provided they are returned to ROD-L Electronics.

For prompt, efficient service of your instrument, send it directly to ROD-L Electronics along with a statement describing the nature of the problem.

A Return Authorization Number must be obtained from ROD-L Electronics before returning any instruments for repair. Transportation must be prepaid. ROD-L Electronics will assume cost of surface transportation when returning equipment to customer. This warranty is void if the instrument has been modified or subject to gross misuse. No other warranty is expressed or implied. ROD-L Electronics is not liable for consequential damages.

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SECTION

INTRODUCTION

Section I

1-1 General

1-2 This publication, which provides operating and servicing instructions for the ROD-L Electronics Models M100AV, BV and M500AV, BV AC Hipot Testers is divided into five sections. Section I describes the Instruments and lists their specifications. Section II contains Installation Instructions and Operation Procedures. Section III contains Principles of Operation. Section IV contains Service Instructions. Section V contains Replacement Parts Information, Parts Location Diagrams and Schematics.

1-3 Models M100, 500, AV, BV AC Hipot Testers are high voltage leakage and breakdown testers with safety ground continuity test capability for performance of "dielectric withstand" tests in accordance with applicable UL, CSA, VDE, BSI, IEC and similar standards. The M100AV, 500AV tests and displays total current, while the M100BV, M500BV tests and displays total current and the resistive part of the AC current.

1-4 The "dielectric withstand" test is one of many tests required by many certification agencies (UL, CSA, VDE, BSI, IEC, etc) as proof of an instrument's ability to withstand AC power line spikes without becoming a hazard to itself or the user. For example, lightning, drastic load changes or power line outages can place short duration spikes on power lines of many times nominal line voltage.

1-5 Some specific examples of safety standards requiring dielectric withstand testing include UL 45, UL 114, UL 478, UL 506-508, UL 544, UL 674, UL 1012, UL 1244, IEC 380, IEC 348, MIL,STD 202, BSI 3361 as well as CSA 22.2, VDE 0806, etc. The specific standard should be consulted for voltage requirements and specific test procedures.

1-6 The ROD-L AC Hipot Testers apply high voltage to the device under test for a duration of time preset for one second to 90 seconds. The device under test plugs into the front panel test connector. Test limits for total current (and for Resistive part of the AC current with BVs) are preset by the user via a rear panel control. If the device under test is defective, automatic circuitry turns off the high voltage, lights the FAIL lamp and sets off an audible alarm. This audible and visual alarm must be manually reset (meets UL requirements).

1-7 All models incorporate a rapid, automatic solid state electronic shutdown circuit to turn off the high voltage within two milliseconds after a breakdown fault. To prevent turn on surges, the high voltage has an electronically controlled rate-of-rise.

1-8 For operator use, the test cycle is fully automatic; accidental test initiation is prevented by use of recessed start switch, for operator safety, a security "CHASSIS GROUND SENSE" voltage must be connected to a secure low resistance point on the device under test. Without this connection, the test will not enter the "READY" state. The "SAFETY GROUND" of the device under test is monitored and stressed electronically. If either the "SAFETY GROUND" or the "CHASSIS GROUND SENSE" connection fails during the test, the HIPOT TESTER automatically shuts down the high voltage and actuates visual and audible alarms.

1-9 The ROD-L AC testers are completely self contained rugged instruments designed for laboratory and production testing enviroments. All AC units are very similar in operation and construction. The primary exception is that BV model measures the resistive part of AC total current. Externally, the BV model has an extra control on the front and rear panels (see figure 2-2). Internally, the standard BV has five PCB assemblies (A2-1, A6-S5, A7-AV, A10, A21) and the standard AV has four PCB assemblies (A6-S5, A7-AV, A10, A21).

1-10 EQUIPMENT SUPPLIES

1-11 The ROD-L HIPOT TESTER is comprised of the following:

- a. HIPOT TESTER, ROD-L Model M100AV, M100BV, M500AV or M500BV.
- b. Six foot power cord, three pronged.
- c. Thirty-six inch (36") ground cable.
- d. This manual.
- e. Extra input line fuses.

1-12 STANDARD VERSIONS OF MODELS

The standard AC HIPOT TESTER is available with a full scale test voltage of 1500 VAC, 2800 VAC or 5000 VAC. Ammeters with F.S. up to 333mA are available depending on the Model. Standard F.S. values for the ammeter are 10, 25,40, 50, 100, 200 and 333mA. For the M100 models the maximum F.S. values are 50mA for the 1500 VAC unit, 40mA for the 2800 VAC and 25mA for the 5000 VAC. For the M500 model the maximum F.S. values are 333mA for the 1500 VAC, 200mA for the 2800 and 100mA for the 5000 VAC.

1-13 SPECIAL VERSIONS OF MODELS

Instruments with non-standard test voltages and ammeters are considered special versions of the basic models. In these applications, the customer specifies the voltage and ammeter full scale values. The Hipot Tester high voltage F.S. rating and the ammeter F.S. rating are readable from the Model number code on the serial number label on the rear panel. An example of the model number format is as follows:

M100AVS5-X.X-ZZZ

where X.X represents F.S. kilovolts and ZZZ represents FS current in mA.

1-14 IDENTIFICATION

1-15 The ROD-L AC Hipot Testers are identified by a Model Number as described in paragraph 1-13 and a serial number (see figure 2-2). The serial number is a manufacturer identification of the instrument.

1-16 SPECIFICATIONS

Table 1-1 lists the most important electrical, environmental and physical specifications of the Hipot Testers.

Table 1-1 SPECIFICATIONS

Test Voltage and Current	User adjustable up to 5000 VAC RMS, 50/60 Hz, 0-333mA. Note: Voltage and current range combinations are detailed in paragraphs 1-12 and 1-13.
High Voltage Shutdown	Within 2ms after a breakdown fault is detected (electronic shutdown circuit).
Automatic Test Cycle	One second to 90 seconds.
Initial Turn-on Period	Requires 2 seconds for safety ground test before H.V. is applied.
Saftey Ground Continuity	Reject level 0.5 ohm ± 0.1 ohm; operates whenever ground is connected. (Low current, 1.0 amp applied).
Volt Meter	Accurate to ±3% F.S.
Voltage Monitoring Circuitry	±1.0% through full range.
Ammeter	Accurate to ±3% F.S.
Current Monitoring Circuitry	±1.0% through full range.
Ammeter Resolution	Better than 3% F.S.
Current Circuitry Resolution	Better than 1.0% F.S.
Voltmeter Resolution	Better than 3% F.S.
Voltage Circuitry Resolution	Better than 0.1% F.S.
Input Power	110/240 VAC, 50/60 Hz, 500W max (30W typical); 115/230V switch.
Environmental Operating Conditions	0° to 50° C (32° to 122° F)
Physical Color	Mint grey/Olive grey
Weight	35lbs (15.9 kg) Net 38lbs (17.2 kg) Shipped
Dimensions	16 3/4 X 5 1/4 X 13 1/4 inches 43 X 13 X 34 centimeters

SAFETY FEATURES

- Sequences design of operation. • Loss of safety ground terminates Hipot Test cycle.
- No external HV leads. • recesses START button. • Visual and audible alarm at failure.
- High voltage lockout requiring manual reset.

INSTALLATION AND OPERATION

Section II

2-1 GENERAL

2-2 This section contains the recommended procedure for unpacking, inspection, installation, operation storage and reshipment.

2-3 UNPACKING AND INSPECTION

2-4 Any shipping carton that appears damaged should be unpacked with the carrier's agent present. Inspect the instrument for damage (scratches, dents, broken knobs or meters, etc.) If the instrument is damaged or fails to meet specifications (performance tests, Section IV), notify the carrier and ROD-L Electronics immediately. Retain the shipping carton and the padding material for the carrier's inspection.

2-5 INSTALLATION

2-6 The ROD-L AC Hipot Testers are suitable for either bench or rack mounting. To rack mount the instrument, use Rack Mounting Kit ROD-L Option #15, Part No. M100-5001. Order Rack Mounting Kit from factory.

2-7 POWER REQUIREMENTS

2-8 The AC Hipot Tester requires a power source of 115-230 volts AC single phase, 50 to 60 Hz. Insure that the power socket to which the instrument connects has a functioning safety ground.

2-9 POWER CABLE

To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the three-prong connector is the ground pin.

WARNING

This instrument to be used ONLY in three wire grounded outlets. It is recommended that periodic checks of the outlet and the ground cable be made to insure operator safety.

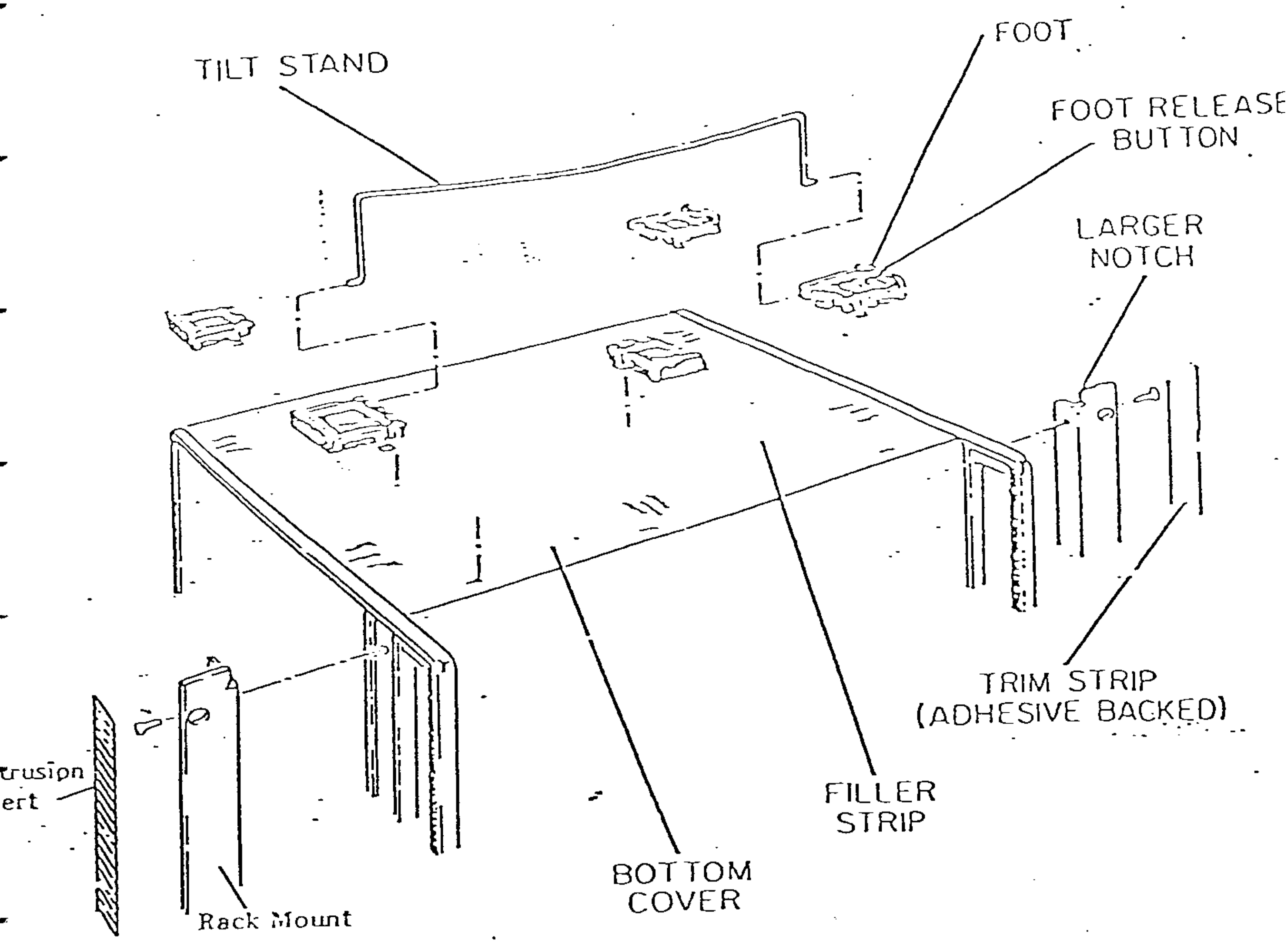


Figure 2-1 Rack Mounting Kit Installation

2-10 INITIAL INSTALLATION AND TURN-ON

2-11 This instrument is shipped ready for 115 VAC operation unless specifically requested by customer to be set at 230 VAC. Spare fuses are provided for 230 VAC. operation. Prior to applying power to the instrument, perform the following:

CAUTION

Disconnect the AC Hipot Tester from power source and install the proper rated fuses, otherwise damage to the instrument may result.

a. Set the TOTAL CURRENT control to full clockwise position.

b. Set the REAL or RESISTIVE CURRENT control to full clockwise position. (M100BV or M500BV only)

c. Set the rear panel AC LINE 115/230V voltage switch to indicate the number that corresponds to the line voltage being used. The number visible on the slide switch indicates the line voltage for which the primary circuit is connected.

d. With an AC voltmeter, check the primary power line for nominal line voltage condition.

e. Check to be sure that the proper fuses are installed in accordance with markings on rear panel.

f. Connect the 6-foot power cord between instrument and power source.

g. If this is the initial turn-on of the instrument, perform Operational Check procedure per paragraph 2-28.

2-12 STORAGE

2-13 It is strongly recommended that the equipment be packed as if for reshipment. Environmental conditions during storage and reshipment should be as follows:

a. Maximum temperature 167°F (75°C)

b. Minimum temperature-40°F (-40°C)

2-14 REPACKING FOR SHIPMENT

2-15 If possible, use the original shipping container and packing materials, or:

a. Wrap the instrument in heavy paper or plastic before placing it in the shipping container.

b. Use plenty of packing material around the instrument and protect the front panel with cardboard. Protect the instrument with 2 inch rubberized/foam padding placed along all surfaces of instruments, or with a layer of excelsior about 6-inches thick packed firmly against all surfaces of the instruments.

c. Use a strong, well sealed shipping container (350 lb/sq in. bursting test).

d. Mark the container FRAGILE-DELICATE INSTRUMENT.

2-16 Attach a tag to the instrument, giving the following information:

a. Type of service required

b. Instrument model number.

c. Full serial number.

d. Return address.

2-17 In any correspondence, refer to the instrument by model number and full serial number.

2-18 OPERATING CONTROLS

2-19 Figure 2-2 illustrates the front panel and rear panel controls for the AC Hipot Testers. Table 2-1 describes the functions of all the controls and indicators.

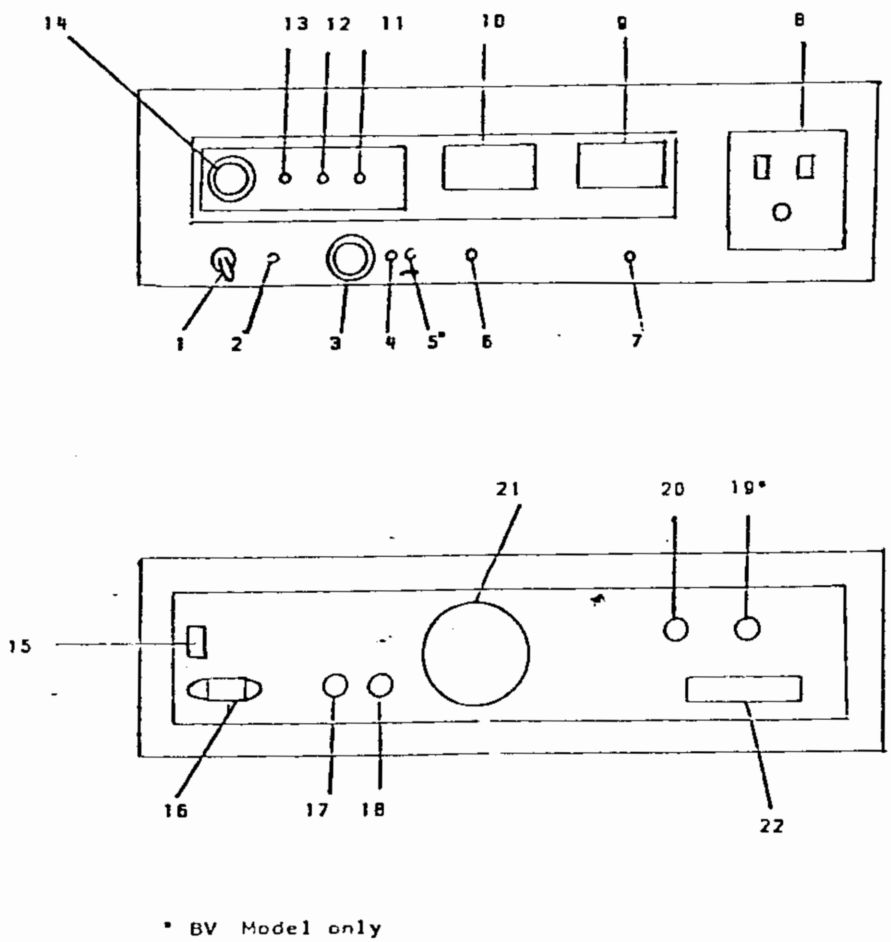


Figure 2-2 Controls and Indicators

Fig. 2-2 INDEX NO.	CONTROLS	FUNCTIONS
1	LINE POWER (S1)	This switch applies or removes power from the instrument.
2	AC ON lamp (I1)	When lit, it indicates power is applied to the instrument even if fuses are blown or out.
3	START Pushbutton (S2)	When depressed, the test sequence begins if the instrument is grounded properly and not already indicating grounded test failure.
4	RESET Pushbutton (S3)	Resets a failure indication when depressed; also terminates a test early.
5	TIMING Select Switch A or B (S4)	Selects preset test times and ramp rates assigned to position A and B. Standard factory setting are at full scale voltage: RAMP — DWELL Position A: 200V/sec* — 60 sec Position B: 200V/sec* — 1 sec * For 5KVAC F.S. Models the ramp is 500V/sec.
6	Real Part Pushbutton (S5-BV) (Model BV only)	Expands the current meter scale by ten to indicate the real part of the AC current flow when depressed during a test.
7	CHASSIS GROUND SENSE post (BP1)	Connect the chassis of the device under test to this terminal. The lead used should be of low resistance and preferably as short as possible (36" cable supplied).
8	High Voltage Connector (J1)	An instrument to be tested for leakage is to be plugged into this outlet. Only three pronged AC line plugs for three-wire cords are to be inserted (unless adaptor is required).
9	OUTPUT VOLTAGE meter (M1)	Provides a direct reading of the AC test voltage applied to the instrument under test.

Fig. 2-2 INDEX NO.	CONTROL	FUNCTION
10	MILLIAMMETER (M2)	Indicates amount of AC leakage current (in mA) flow during a test.
11	FAIL Indicator lamp (I4)	Displays a visual warning that DUT failed test.
12	TESTING Indicator lamp (I3)	Indicates a test in process.
13	READY Indicator lamp (I2)	Indicates proper ground is established between the tested instrument and the HIPOT TESTER. Instrument will not operate if READY lamp is not on. Also indicates acceptable impedance during Ohm Sense test.
14	Audible Warning (AL-1)	Emits a warning sound when a test results in failure.
15	AC LINE Voltage Switch (S7)	Slide switch to select either 115 VAC or 230 VAC. The exposed number indicates the line voltage selected.
16	AC LINE power (J2)	Connects to power cable supplied with instruments.
17	High Voltage Line Fuse (F2)	Provides overcurrent protection for the primary circuit of the high voltage transformer. At 115 VAC is 2A fast blow and at 230 VAC use 1A fast blow fuse (unless otherwise noted).
18	Power Line Supply Fuse (F1)	Provides overload protection for low voltage transformer primary circuitry. Use 1A for 115 VAC and ½A for 230 VAC operation.
19	REAL CURRENT FAILURE SETPOINT potentiometer (R3)	Establishes a maximum level for resistive current flow which cannot be exceeded during a test. If this value is exceeded, a failure indication is given.
20	TOTAL CURRENT FAILURE SETPOINT potentiometer (R2)	Allows the user to specify a maximum value AC current flow during a test. If this value is exceeded, a failure indication is given.
21	VARIAC CONTROL (T3)	Allows Manual Control for the high voltage output.
22	Indentification Label	Contains instrument model and serial number information.

2-23 SAFETY FEATURES

2-24 The safety features built the ROD-L AC Hipot Testers are as follow:

a. The security CHASSIS GROUND SENSE wire must be connected from the AC Hipot Tester to the chassis or expose metal to secure low resistance point on the unit under test. This will allow the READY light to turn on and the AC Hipot Tester to operate. This wire parallels the normal ground wire in the power cord. To insure that both wires are secure, 1 amp rms at 1.5 volt AC is passed through both wires at all times. If the total path resistance proves greater than .5 ohm, the READY lamp will not light. (.10 ohm optional).

b. When the FAIL lamp is activated after a breakdown the AC high voltage is immediately removed from the AC Hipot Tester HV output connectors withing 2 msec. The FAIL lamp can activated if any of the following conditions occur: Real or Total AC current exceeds the preset value; the security CHASSIS GROUND SENSE connection becomes faulty while the high voltage is applied; an arcing occurs. If a failure is indicated, the device did not pass and should be investigated for reason, repaired and retested.

c. To prevent surges, the AC test voltage is turned on slowly using electronic circuitry.

d. The START pushbutton is recessed to prevent accidental triggering.

e. The RESET pushbutton can be used to prematurely stop the test if desired and must used whenever the device under test has failed (unless auto reset option is used).

2-26 USER RESPONSIBILITY

2-27 The user is responsible for determining the applicable test voltage and test duration for their product in accordance with certification agency (UL, CSA, VDE, BSI, IEC, etc) requirements. User also determines the normal total leakage current (or the maximum allowed agency) from a representative sample of products under test conditions. From this the user establishes the maximum total leakage considered acceptable for the device. This then is the TOTAL CURRENT FAILURE SETPOINT for the device. In a similar manner, the REAL CURRENT FAILURE SETPOINT is established for the ROD-L Model BV.

2-28 OPERATIONAL CHECK FOR STANDARD AC HIPOT TESTERS

2-29 This is an operator oriented procedure which allows operational check of the ROD-L AC Hipot Tester without test equipment. Operational procedure is as follows:

a. Set *LINE POWER* switch to *OFF*.

b. Connect 36" ground sense cable to the CHASSIS GROUND sense terminal. Attach the cable clip end to the AC hipot tester on the metal portion of the handle . Ensure grounded power cord of DUT is plugged into front panel receptacle of Hipot Tester.

c. Set line POWER switch to ON and AC power lamp should glow. After approximately two seconds, the green READY lamp should light.

d. If the READY lamp does not light, insure the ground sense connection is secure.

e. With READY lamp lit, push the start button (amber TESTING lamp should light) and quickly disconnect the ground sense cable. The red FAIL lamp should light and the audible alarm should be heard. Also the READY lamp is extinguished.

f. Push the RESET button to extinguish the FIAL lamp and audible alarm.

g. Reconnect the ground sense cable per step "b" and the ready lamp should light.

WARNING

High voltage is present at HV output connectors when TESTING Lamp is lit and may be extremely harmful to operator if contacted.

h. *Push start button: Amber TESTING lamp* should light and the OUTPUT VOLTAGE meter should indicate the proper voltage under normal operation. (Depends on setting of variac).

i. If OUTPUT VOLTAGE meter does not indicate proper voltage adjust the VARIAC CONTROL in the proper position.

2-30 TOTAL CURRENT PROCEDURE

2-31 To set total leakage current trip point for device under test (DUT), proceed as follows.

a. Set test time per applicable agency specification if different from standard factory setting (Refer to Table 2-1, Index #6)

b. Set TOTAL CURRENT control fully clockwise.

c. Connect DUT to AC Hipot Tester and start test. Record TOTAL CURRENT reading for unit.

d. While the high voltage is on, slowly rotate the TOTAL CURRENT pot counter clockwise until the FAIL lamp and audible alarm are activated.

e. Note the position of the TOTAL CURRENT pot. This position is proportional to the total current reading on the front panel meter.

f. Calculate the position in which you want to leave the potentiometer using the formula:

$$\text{Setting Desired} = \text{Setting in step e} \times \frac{\text{max current acceptable}}{\text{step c measured current}}$$

g. Reset the TOTAL CURRENT FAILURE SETPOINT control to position calculated above. This control can be used to set a current between a meter F.S. reading and approximately 0.05 x F.S.

2-32 REAL CURRENT (BV ONLY PROCEDURE)

This procedure is identical to that above, except the REAL CURRENT pot is adjusted and the "PUSH FOR CURRENT-REAL PART - 10" pushbutton is depressed to read real current.

2-34 TEST TIME ADJUSTMENT PROCEDURE

2-35 The Test Time Adjustment potentiometer is set as outlined in Table 2-1, Index #6, at the factory. The user should set this control in accordance with the regulatory agency's suggested test time for the device under test if different from standard factory setting. To reset the test time duration, proceed as follows:

CAUTION- HV EXPOSURE

a. Turn off power to the AC Hipot Tester.

b. Remove top cover and locate Test Time Adjustment potentiometer R37 on A21 board. Set TIMING Switch on Front Panel "A".

c. Re-apply power to the AC Hipot Tester.

d. With top cover removed from Hipot Tester, use a stopwatch to time the duration the TESTING lamp remains ON.

e. By adjusting the Test Time Adjustment trimpot and timing the TESTING lamp duration with a stopwatch, you should be able to set any duration desired between one second and 90 seconds.

f. Set TIMING switch on front panel to "B" and set potentiometer R_2 on board A21 per steps (b) thru (e).

CAUTION

Do not touch any of the other potentiometers on the PC Boards, otherwise the calibration of the instrument will be ruined.

2-36 AUTOMATIC TEST PROCEDURE

2-37 The following procedure assumes the ROD-L Hipot Tester has been calibrated and adjusted for normal operation. Proceed as follows:

a. Place device under test (DUT) next to Hipot Tester.

b. Plug the power cord of DUT into high voltage connector of Hipot Tester.

c. Connect Ground Sense cable between DUT and Chassis Ground Sense terminal. If ground is less than 0.5 ohm, the READY lamp will light (0.1 ohm optional).

d. Press the START pushbutton. The TESTING lamp should light. (If ohm sense option is used refer to the correspondent description).

WARNING

High Voltage applied to the device under test. Do not touch the DUT power cord or chassis while the TESTING lamp is lit, or extreme shock may result.

e. Check that the OUTPUT VOLTAGE meter indicates the test selected voltage. If voltage is high or low adjust rear panel VARIAC CONTROL appropriately to compensate.

f. Restart the test. Observe the total current indication. (Model BV has an additional feature: press the "PUSH FOR REAL CURRENT PART ÷ 10" pushbutton to observe the 'real part' current). *The test will automatically abort, giving a failure* indication if one of the preset current failure setpoints is exceeded, the ground sense connection is interrupted or an arcing condition occurs due to dielectric insulation breakdown. The operator should investigate to determine which failure occurred in the event a FAIL indication is given. For this reason the ammeter should be continuously monitored during the test.

g. For a normal test, the TESTING lamp will extinguish after a completion of the preset test time duration. If a test results in a failure condition, the FAIL lamp will light and the audible alarm will sound. The operator must then manually press the RESET pushbutton before a test can be repeated.

NOTE

At least 5 seconds must elapse between *TURN-ON* and the first *Hipot Test* and 3 second must elapse between successive Hipot tests or random "FAIL" indications will occur.

THEORY OF OPERATION

SECTION III

3-1 THEORY OF "DIELECTRIC WITHSATND TESTING

3-2 The dielectric withstand test is the test required by many certification agencies (UL, CSA, BSI, VDE, IEC, ect.) as "PROOF" of an instrument's ability to withstand excess surges on the AC power lines without becoming a hazard to itself or the user. It is well known that lightning, drastic load changes or power line outages can place short duration spikes on the AC power line of many times the nominal line voltage; and devices should be designed with this in mind. Thus, testing laboratories require that each instrument certified by them be tested for dielectric withstand requirements.

A test at 1500 VAC is required of most instruments having a 115/230 volt switch and for sale in both U.S. and Europe. However, instruments designed for some different uses may have other requirements.

The ROD-L AC series tester applies a sine wave at 60 Hz or 50 Hz of the required voltage between the two current carrying leads of "device under test" (i.e. the "Hot and "Neutral" conductors tied together) and the "Ground" conductor of the "device under test". An additional "Safety Ground" connection must be made to insure grounding integrity. The "Device under test" must "withstand" this application of voltage without displaying any indication of deterioration archover, sparking, overheating or other type of failure. Visual inspection of most of these characteristics is precluded in a closed instrument. An ammeter is provided on the AC series instruments for displaying actual leakage current.

It may be thought that if there is no physical connection between the AC power line and the chassis of the instrument under test there can be no current flow. This is not, in general, true. There are always parasitic capacitances and resistances present which allow some current to flow. At 1500 VAC, 60 Hz, every 1770 pf of stray capacitance allows 1 mA of current flow. If a power transformer is contained in the circuit interwinding leakage capacitances of from 100 pf to 1000 pf are common.

Furthermore, many instruments require capacitors to be connected between the AC power line and chassis to eliminate any RF energy being transmitted through the line cord. The circuit schematic of the "device under test" should be inspected and leakage current for any capacitors of this type should be computed using this formula:

$$I_C = V_C(2\pi fC)$$

$$= 1500 \times 377 \times C \quad \text{(at 1500 VAC) (at 60Hz)}$$

and these currents considered "normal" for that instrument.

The above formula assumes that the capacitors being tested are "perfect", i.e. linear and have "zero" dissipation. The real world is never so obliging. Ceramic capacitors (these normally used for this purpose) have tolerances of 20% or worse, have very nonlinear I-V responses at high voltages and have dissipation factors at high voltages of 30% or more. Thus, the actual current flow may be 150% or more of the theoretical flow for that capacitor. Actual currents can only be confirmed by testing of a large number of instruments and computing tables of expected and worst case values. Then any current above this "worse case" value can be considered a cause for rejection.

The BV tester measures the "Real Part" of the AC current as well as the total current. Nonlinear operations (sparks, arcovers, etc.) invariably influence the "Real Part" of the current much more than they influence the total current. Thus, these effects can be more easily detected on the BV testers.

Resistive parasitic effects can occur as well. These can be caused by moisture or dust between conductors, rosin or acid flux "bridges" between PC board traces, leaky insulating materials, etc. Considerable power can be concentrated in these leakage paths. Only 1 mA of current at 1500 volts means that some point must dissipate 1.5 watts of power. That much power concentrated in the very small area of flux "bridge" can easily cause a fire hazard.

Real current also flow due to non-ideal filter capacitors. The "Real Current" flow in a capacitor can be computed by multiplying the capacitor dissipation factor by the total current flow, and as has been stated, this can be appreciable and very nonlinear. The published low voltage dissipation factors of capacitors gives only a limited projection of what to expect at high voltages and actual results are invariably high.

3-3 INSTRUMENT FUNCTIONAL DIAGRAM

Functionally, the AC Hipot Tester is divided into three sections: The HV generator, the HV control and the General Control. A remote control option can be added to the total system. (As shown in Fig 3-1).

3-4 The HV Generator consists of an AC HV transformer (50/60 Hz) specially designed to provide the high voltage and current needed in Hipot Testing.

3-5 The HV Control is the most important part of the system, it contains: The unique solid state HV Amplitude Control and the Ramp Up Control Circuitry. The HV Amplitude Control operates under the principle of generating an adjustable amount of blocking voltage to the input line voltage coming out from the Variac as shown in Fig 3-2

AC HIPOT TESTER

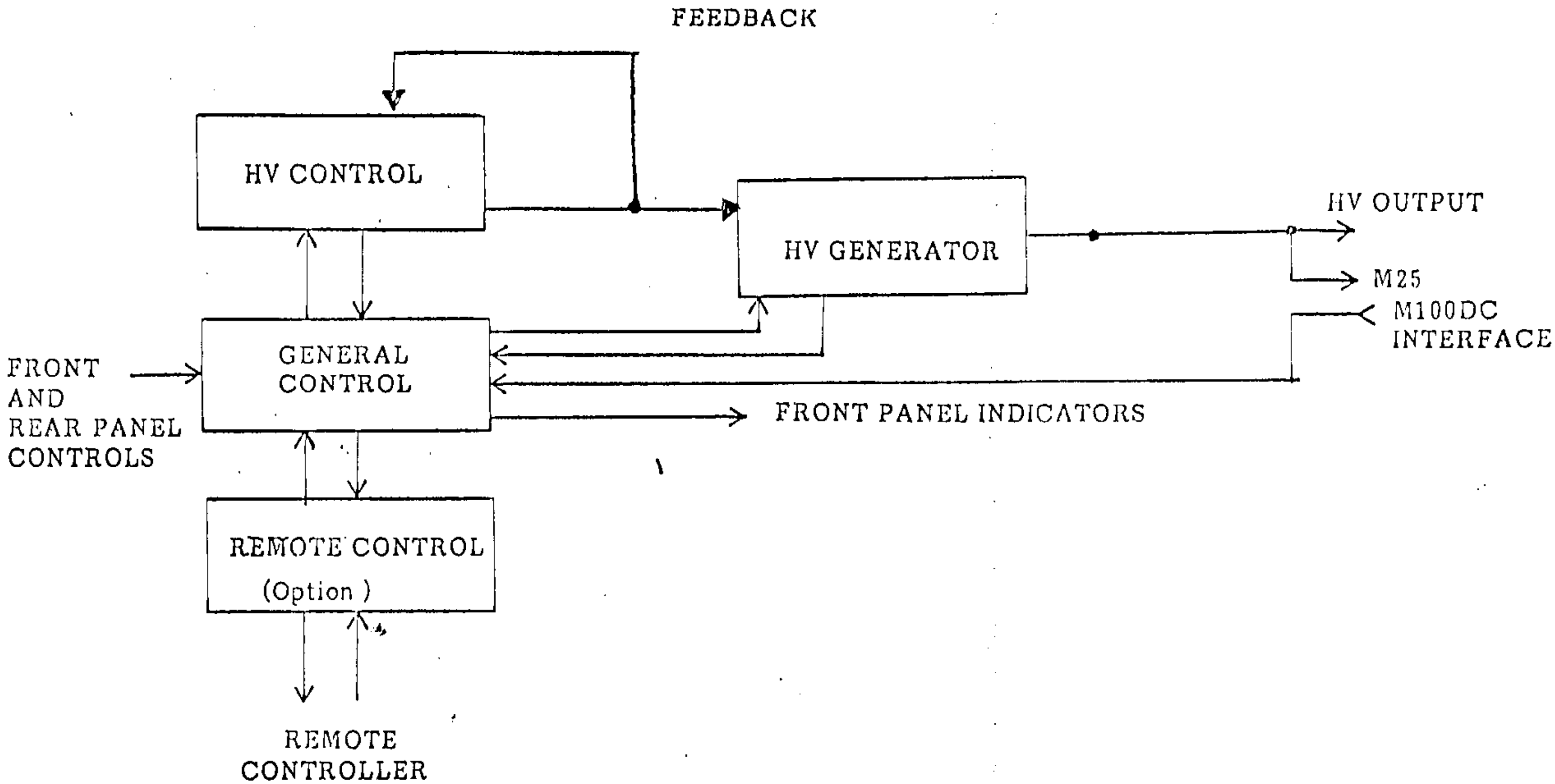


Fig. 3-1 Functional Diagram

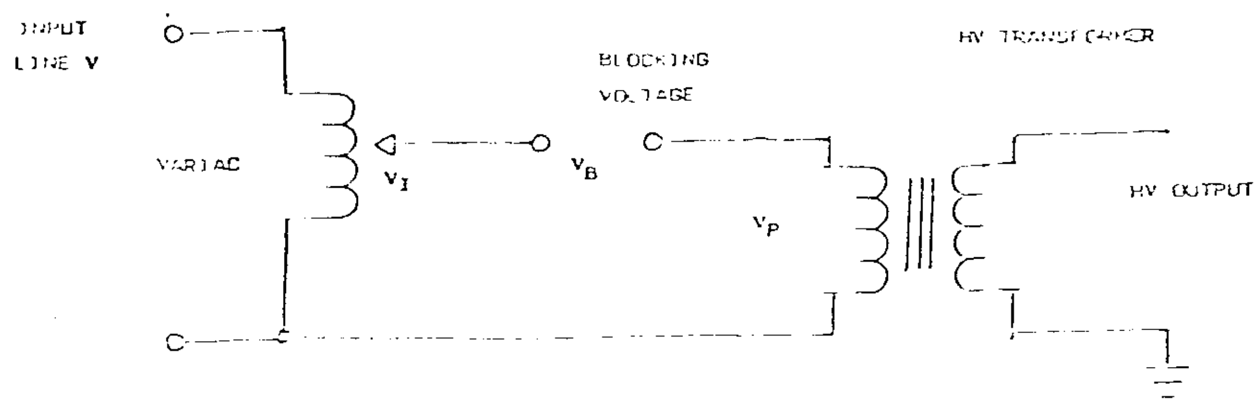


Fig. 3-2 HV Amplitude Control

The HV output is directly proportional to V_P. Where V_P is the voltage V_I given by the variac minus the blocking voltage V_B generated across the HV amplitude control. When the blocking voltage V_B equals or exceeds the voltage across V_I, V_P is zero as is the HV output. As V_B decreases V_P begins to be different from zero producing HV in the output of the HV transformer. This unique system has proved to be the most efficient solid state way to control the HV amplitude not only in terms of dissipating power but in terms of invariance of blocking voltage V_B with respect to the nature of the load connected at the HV output, which makes HV amplitude practically independent of the load and sinusoidal through all linear Ramp-Up to full voltage.

The Ramp Up Control circuitry integrates the difference between the ramp up reference signal with the voltage feedback producing a controlling signal. This signal controls key parameters in the HV Amplitude Control causing the HV output to follow the Ramp up signal as shown in Fig. 3-3.

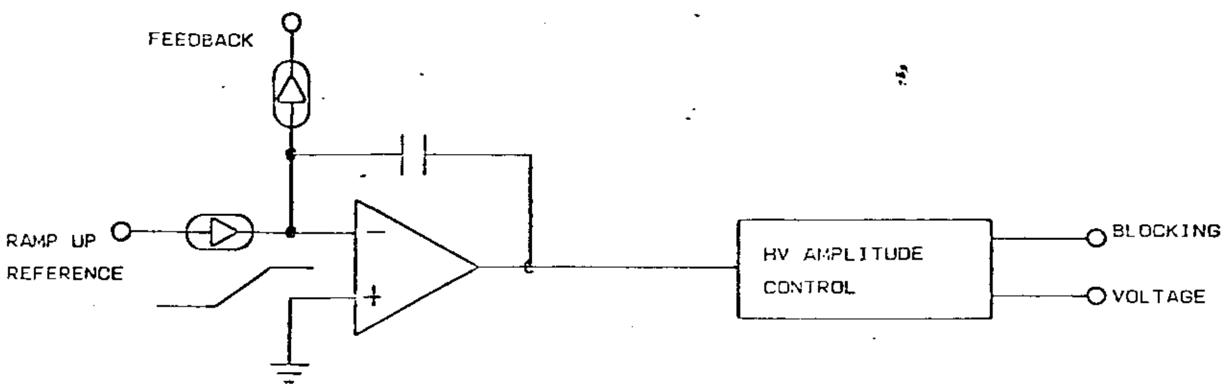


Figure 3-3 – Ramp Up Control

3-6 The General Control performs the coordination of the different activities and monitoring. As shown in Fig. 3-4

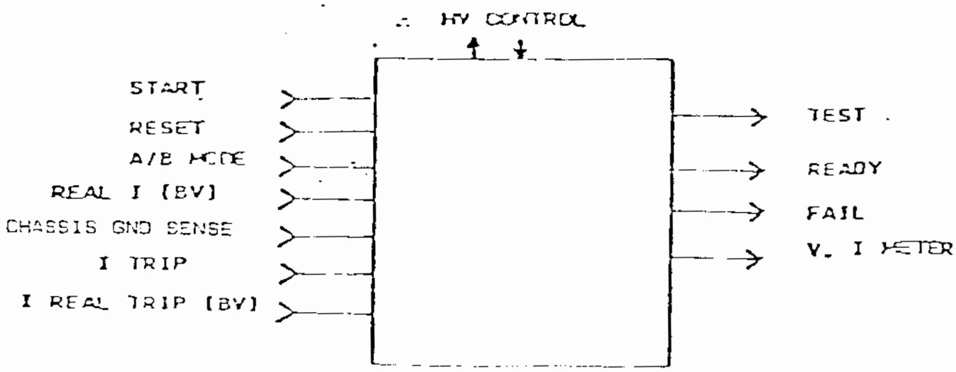


Fig. 3-4 General Control

The General Control can be commanded from the different front and rear panel controls shown on the left side of the diagram. It takes care of coordinating the different activities of the HV Control and sensing the status of the operation. It provides continuous monitoring through the front panel lights, buzzer and meter shown on the right side of the diagram.

The remote option is an isolated interface for most of the control and monitor signals.

3-7 INSTRUMENT ASSEMBLY DIAGRAM

The instrument is divided in two major subassemblies as shown in Fig 3-5

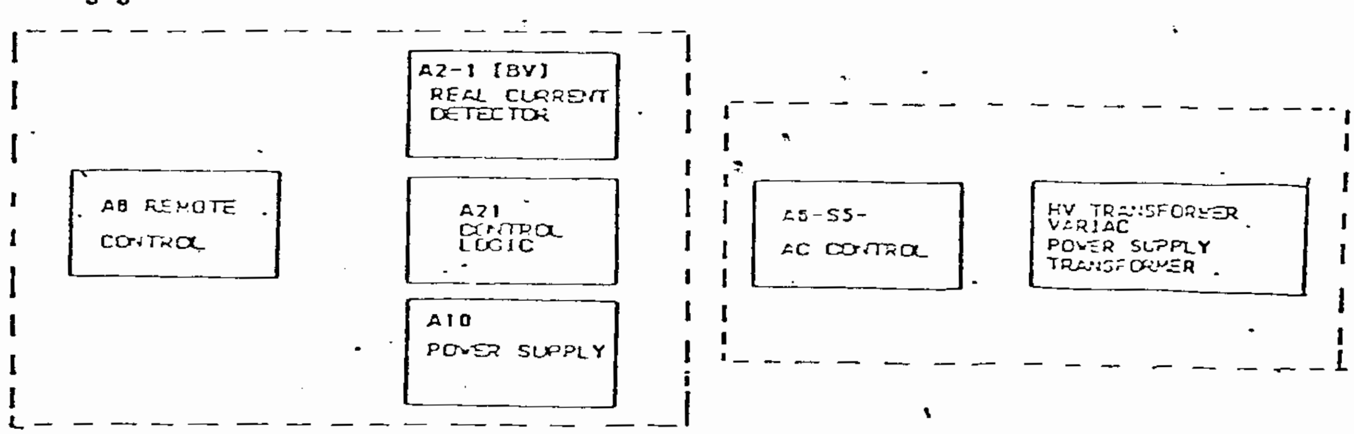


Fig. 3-5 Assembly Diagram

The right side subassembly is physically separated and contains the A6-S5 board and the electrical transformers needed for the operation. The left side subassemblies contains the A10, A21 and options A2-1 for BV models and A8 REMOTE (all low voltage circuitry).

A more detailed diagram of the board's functions is shown in Fig. 3-6

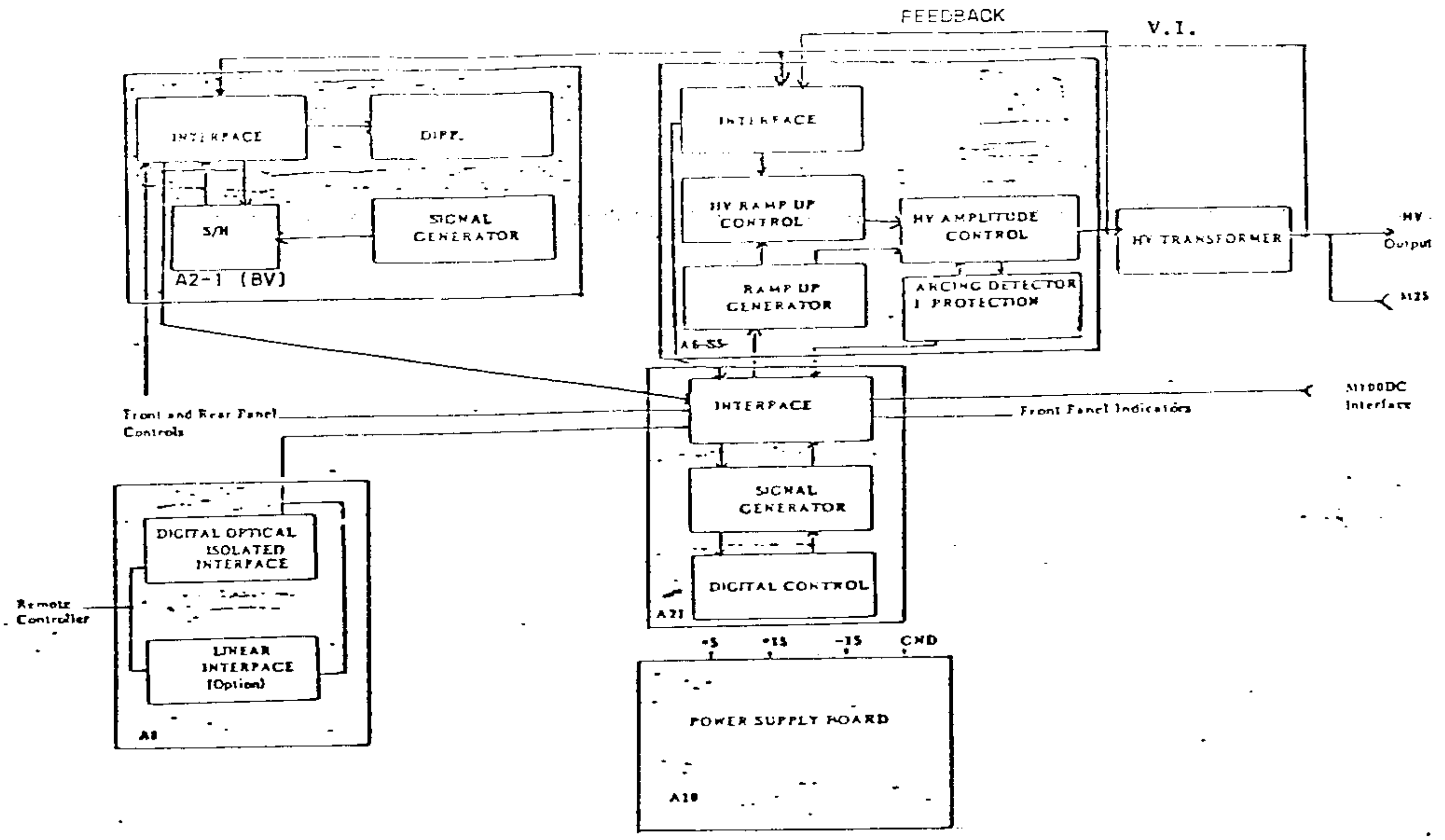


Fig. 3-6 Detail Assembly Diagram

3-8 POWER SUPPLY CIRCUIT (A10)

3-9 Power generated in the A10 assembly board, HV CONTROL consists of +15 VDC and -15 VDC regulated for the analog curcuits.

The digital electronics requires +5 VDC regulated. As seen in the schematic (Dwg. 00475-08) of the wiring diagram.

3-10 HIGH VOLTAGE CONTROL/SLOW TURN ON (A6-S5)

3-11 This board contains the most important parts of the systems: The HV CONTROL and RAMP UP CONTROL. Supporting them are the RAMP UP GENERATOR and the VOLTAGE FEEDBACK. The output CURRENT and VOLTAGE monitoring circuit and the PROTECTION and ARC DETECTION are also included (See Dwg. 00239-01).

HV CONTROL (A6S5)

The amount of blocking voltage depends on the resistance of the photo resistance PC-1. **Q1** and **Q2** are used to drive the primary of the HV transformer. When the realy K1 closes, the gate **Q3** is enabled allowing the input line voltage to go through and to set the circuitry in an initial condition prior to the driving of the HV transformer.

VOLTAGE FEEDBACK AND MONITORING

The voltage at the primary of HV transformer is fedback through the optical isolators **U3** and **R4** producing a full wave rectified current proportional to that voltage. The HV output is fedback through precision resistors **R3** and **R6** to produce an average current through the voltmeter proportional to the RMS value. The resistor **R12** is also in series to provide a HV monitoring.

RAMP UP GENERATOR

When the TEST signal at TP2 gets low, the voltage at the input of CR1 becomes negative and no current flows through it, so only the current flowing through R29 and determined by one of the pots R30, R4 goes through the capacitor C2 charging it. Since the charging current is constant the output of U1 (6) is a linear RAMP UP.

RAMP UP CONTROL

U2 compares the current produced through R10 and R11 with the full wave recitified current U3 and U4 and integrates the difference. An amount of voltage appears at the primary of the HV transformer such that a certain value of voltage different from the initial +5V is produced at pin 6 of U2 permitting an increase in the amount of current sunk by LED1. This value of current determines the resistance of PC-1 to produce the amount of HV at equilibrium.

ARC DETECTION

U5 senses for currents several times higher than the full scale value. This condition comes up during the arcing and it is transmitted to the A21 board.

3-12 REAL CURRENT DETECT CIRCUIT (A2-1)

3-13 The A2-1 board (Dwg. 00442-01) receives at pin 5 the voltage generated across the voltage sense resistor on the A6-S5 board. The first half of U1 operates as a buffer. The first half of U2 makes the derivative of the voltage signal which is proportional to the HV output and the second half of U2 converts this signal to a square wave signal which rises and falls at the peaks of the voltage signal. U8 produces a small pulse of approximately 10µs width coincident with the negative peak of the voltage signal. U4 is a sampler and holder of the current waveform which provides the necessary filtering along C13.

The second half of U1 is a leading circuit which is adjusted to provide the exact triggering at the negative peak of the voltage signal to compensate for the circuit delays.

The output 10 of U3 is the amplified value given by U4, calibrated by R7 for giving RMS current values to the ammeter through R18. The second half of U3 is comparing the actual current with the real current trip-point to identify overcurrent failures. Severe non-linearities in a DUT can produce a false reading on the Hipot ammeter. For avoiding this, U7 times the generation of the 10 µs pulse only for transitions of the waveform at U2 (12) occuring near the peak of the voltage waveform. U6 provides buffering for external tripping programming. U5 is an analog switch for selecting remote tripping output meter operation.

3-14 A21 CONTROL BOARD

3-15 TOTAL CURRENT DETECTOR/COMPARATORS

The A21 Board (DWG 462-01) receives the voltage across the current sense resistor, rectifies and filters it and sends it to a comparator that triggers when preset limits of total current are exceeded. The A21 board has a ground loop circuit to detect safety ground violation.

Active Rectifier-Filter: U5 (board A21) functions as a precision full wave rectifier of the AC voltage present on current sense resistor during test. U5 overcomes diode non-linearities by placing the rectifying elements CR2 and CR3 in the feedback path. Summing this signal with ½ the input signal provides a full wave rectified output. C6 on A21 board filters the signal with U4. The output is passed through the "Total Current Metal Cal" pot R19 to the ammeter.

Current Comparators: U1 is used as high gain amplifier with weak negative feedback and acts as a comparator. R22 and R21 provide common mode protection. C7 provides extra filtering.

3-16 SAFETY GROUND DETECT CIRCUIT

On the A21 board the circuit composed of R24, R25, CR4, CR5 and U8 half wave rectifies the voltage between ground and the "chassis ground sense" binding post. This voltage is 1.5 VAC if the "chassis ground sense" post is OPEN. When the "Device Under Test" completes the circuit through its ground wire to ground, the voltage at the post is proportional to the resistance of the ground wire in the device under test. R26, R27 and C20 on A21 board determine the trip point for the darlington pair, Q3, Q4 on the A21. The resistors are selected such that a 0.5 ohm loop resistance leaves the transistors OFF. Q3 then operates the READY lamp and controls the START button.

3-17 LOGIC CONTROL

3-18 This assembly receives all push button inputs and sense outputs from the fail comparators and the ground sense logic. When the proper conditions are satisfied, a test sequence is permitted. The duration is set by a timing circuit. In the event of an operator reset or fail condition, the test is aborted. If there is a failure, a warning is presented until manually reset by the user. This assembly includes a zero crossing detector, a timer and a set-reset latch with associated logic.

3-19 INPUT/OUTPUT LINES: There are three digital inputs: OVERLOAD, START, and RESET.

An OVERLOAD signal is produced whenever an arcing condition is detected in the A6-S5 board, (or a failure is produced by the A2-1 Real Current Board). This signal combines with the overcurrent signal generated by U1 and the ground failure signal generated by pin 3 of U4 to set the fail latch at pin 5 of U7. The ground fail is generated only when a faulty ground is detected during a Test. This gating is produced by pin 2 of U7.

The START signal is produced by the START switch which is tied externally to the ground test signal. If this is low, a start signal is produced at pin 13 of U3. U3 pin 8 gives start pulses synchronized with the AC line's zero crossings if no failure has been latched and we are not in a test. The timer U2 controls the total test time with R2, R3, R37 and C2. It can be reset by the fail latch.

The RESET signal resets the timer U2 and the fail latch. There are 3 outputs: GND TEST, TESTING, and ALARM.

The GND TEST signal goes low whenever the CHASSIS GROUND SENSE loop does not exceed the resistance tripping value.

The ALARM signal goes low whenever the fail latch is set.

The TESTING signal is delivered in parallel by Q8 and Q1 and are low whenever we are in a test. All the above signal drive also the correspondent lamps.

3-20 Timer and Enable Circuits: To trigger a timing period at U2 on the A21 a start pulse must occure and no failure can be present. The AC hipot tester also requires a zero crossing on the 60Hz AC line. U3 detects this and passes it to U2, R37, R2, R3 and C2 on A21 determines test time. Parts of U6 drive the reset input of the timer if a test abort is required.

3-21 FAIL LATCH: U7 on A2 are cross coupled to form the FAIL latch. The latch shows a ground fail condition only during a test cycle attempt gated by U7 pin 2. Also shows a failure whenever an arcing or overcurrent conditions are produced. Pins 9 and 10 of U7 sense for the above conditions.

MAINTENANCE AND SERVICE

Section IV

4-1 INTRODUCTION

4-2 This section provides maintenance and service for the AC series Hipot Testers. Included are: tables of recommended test equipment, calibration procedures, troubleshooting procedures, plus repair and adjustment data.

4-3 CALIBRATION

4-4 Nine major calibration points are required for the AC series Hipot Testers. They are:

1. Meter Mechanical Zero.
2. "Total Ammeter" Cal.
3. Test Time Cal.
4. "Real Current" Ammeter Cal.*
5. Voltmeter Cal.
6. Fail Pots Cal.
7. Safety Ground Ohms Cal.
8. Ramp Rate Calibration.

Table No. 1

TYPE	MFR	USE
AC/DC Digital Ammeter Voltmeter (floating input)	Data Tech Model 31 or equivalent.	General Purpose and Calibration of voltmeter and ammeter.
AC Variac	General Radio W8MT3VM or equivalent	AC Line voltage set-up.
120-240 VAC Line Step Up Transformer		220/240 tests
Oscilloscope	HP 175 or equivalent	General Purpose
High Voltage Probe	Simpson #0161 cal test	Voltage Measurements (alternate = Ross Engr. #VMP-15-C.1)
Standard Resistor Box 0.6 ohm and 0.4 ohm 1%	General Radio 510-A or equivalent	Safety Gnd Ohms Check
High Voltage Loads	See Table No. 2	Calibration of ammeters.

* BV Model only.

4-5 SET UP

4-6 The equipment should be set up to ensure testing at 115 VAC plus or minus 1% (low line switch = "Normal") unless otherwise noted. Foreign users may want to recalibrate on their standard voltages and frequencies. If line frequency is different from 60Hz, remember that required capacitor values will change.

4-7 METER MECHANICAL ZERO

4-8 With the Hipot tester turned OFF, note the positions of the voltage and ammeter pointers on the front panel. They should read zero plus or minus one minor division. If they do not, adjust the zero screw.

4-9 TOTAL CURRENT AMMETER CALIBRATION

4-10 Turn the Hipot Tester on and note that the total current ammeter position is at zero (plus or minus one minor division). Connect "Safety Ground Sense" wire to the chassis in all models so that the "READY" lamp lights. The meter should still be zero. If not, troubleshoot the "Full Wave Total Current Detect" circuit. Insure that no load is placed in the High Voltage Output Socket.

Push the "START" button:

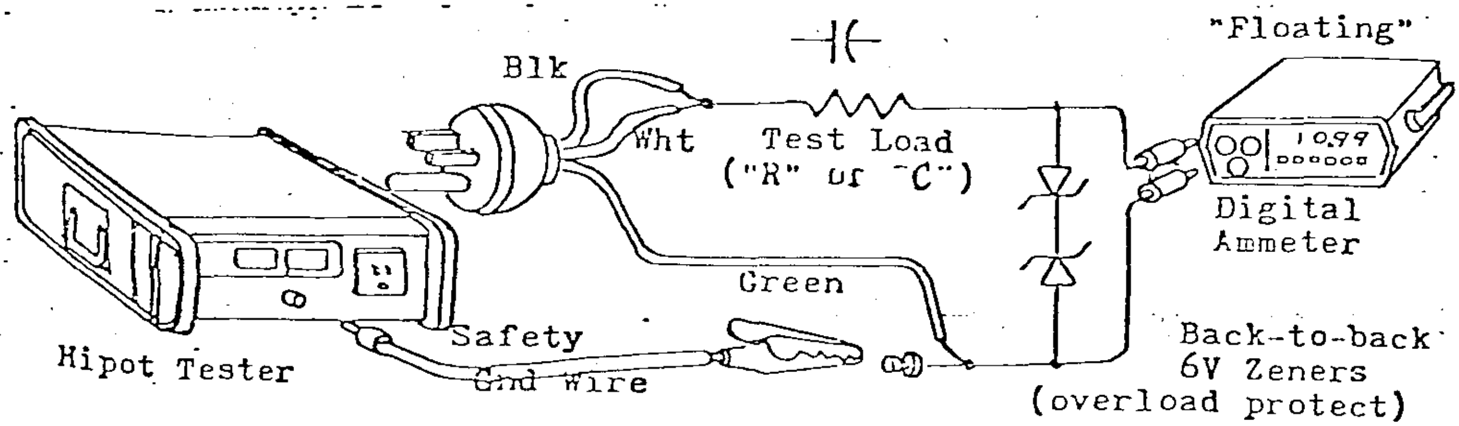
WARNING

HIGH VOLTAGE NOW APPEARS ON OUTPUT SOCKET

Note the meter reading. It should be zero (plus or minus one division).

Push the RESET button. Insert the Digital Ammeter in series with a 0.95% of full scale HV load resistor (AV Only) or HV load capacitor (AV and BV) per the schematic shown on the next page. Select the value of this load from Table No. 2.

INSTRUMENT	REQUIRED LOAD
M100AV-15-10	160K ohm 3%, 3kV, 20 watt resistor or 0.016µF, 2kVAC capacitor
M100AV-15-50 (was opt 001)	28k ohm 3%, 3kV, 100 watt resistor or 0.08µF, 2kVAC capacitor
M100BV-15-10	0.016µF, 2kVAC capacitor and 1.5 megohm 3%, 3 watt resistor 3kV operating voltage, non-inductive
M100BV-15-50	0.080µF, 2kVAC capacitor and 300k ohm, 3% 3kV, non inductive 10 watt resistor
Other M100AV and M500AV Units	Calculate Resistor Value from this formula: $R = \frac{\text{Hipot Voltage}}{0.95 \times \text{Full Scale Current}}$ 3% Voltage Tolerance > Operating voltage $C = \frac{0.95 \times \text{Full Scale Current (total I meter cal)}}{2\pi f \times \text{Hipot Voltage}}$
All BV Models	$R = \frac{\text{Hipot Voltage}}{0.095 \times \text{Full Scale Current (real meter)}}$ 3% voltage tolerance > Operating voltage



WARNING

Ammeter must be inserted on low voltage side of resistor or capacitor or the ammeter's breakdown voltage to ground may be exceeded. Resistor or capacitor should be tested first to insure that it can withstand rated voltage.

Set ammeter to 100mA full scale. Push START button. Ammeter's current reading should agree with the reading on the Total Leakage Current ammeter with 3% plus or minus of full scale (e.g. for 10 mA FS ammeter the two readings should be within 0.30 mA of each other).

If they do not, adjust the "Total Current Ammeter Cal" pot - R19 on the A21 board until it agrees with the Digital Ammeter reading with 1%. See Dwg. 00462-01 for pot positions.

Push "RESET" to end test.

4-11 TEST TIME CALIBRATION

4-12 Set a specific test time per instructions of paragraph 2-35. To check test time limits, turn "Test Time" pot to minimum and maximum. Minimum should be 1 second and maximum greater than 90 seconds. If not, troubleshoot timer or call ROD-L Applications Engineer for assistance.

4-13 A2-1 CALIBRATION

4-14 OFFSET ADJUSTMENT

1. Take the A21 Board out.
2. Short Pins 5 and 13 of the A2-1 Real Current board to Gnd.
3. Turn R1 to get OV DC at TP2.
4. Short Pins 5 and 13 of the A2-1 Real Current board to +5V.
5. Turn R37 to get OV DC at TP2.
6. Turn R3 fully counterclockwise. Remove +5V from pin 5 and 13 and connect it back to Gnd.
7. Adjust R2 to read OV DC at TP3.
8. Adjust R6 to read OV DC at TP12 (20mV scale).
9. Adjust R4 to read OV DC at TP4 (20mV scale).
10. Adjust R5 and notice level change from about OV to 15V at TP11. Leave R5 exactly where level change occurs.
11. Turn R7 fully clockwise.
12. Short TP8 to ground (U4 Pin 3).
13. Adjust R29 to read OV at TP9.
14. Adjust R8 to read OV DC at TP7 (20mV scale).
15. Short (tie) TP5 and TP6 together.
16. Adjust R9 to produce a level change from 15V to about -15V at TP10 (5V scale). Leave R9 exactly where the level change occurs.

NOTE

Be sure to check zero everytime the reference scale is changed on the oscilloscope and throughout the procedure. After a 20mV scale is used a 5mV scale is advised.

4-15 TRIGGER AND METER CALIBRATION

1. Turn R7 three times counterclockwise.
2. Connect a resistor with a value equal to $\frac{\text{High Voltage}}{\text{Full Scale Current}} \text{x10}$ or 200K +3% ohm 5KV when no other is available to output with an external ammeter in series in the low side.

3. Push the **START** button to generate HV. Push the **REAL** button and turn **R3** slowly clockwise until the ammeter deflects in the positive direction. Continue slowly turning **R3** just until the ammeter slows down its relatively fast ascending trip. Slowly turn up the variac if necessary to get a reading on the ammeter equal to full scale when the **REAL** button is pushed.

4. Adjust **R7** to read the same current on the Front Panel Meter on the external ammeter. Push the **RESET** button.

5. Connect a capacitor (typically 0.016µF 5KV) in parallel to the resistor, push the **START** button and check that the reading on the ammeter is about the same as before, if not, adjust **R3** slowly to get a reading about 3% above the reading when the resistor was alone.

6. Take the resistor out and push the **START** button. Check the real current reading after the ramp up. This value added to the one when the resistor is alone gives the real current value when both capacitor and resistor are in place. If not, repeat step 4 accordingly.

4-16 <u>VOLTMETER CALIBRATION</u>

4-17 Disconnect all loads from the HIPOT TESTER. Connect the High Voltage probe (connected as a 1000 to one voltage divider by shunting the output with a 50k ohm resistor, trim value to compensate for DVM input impedance, system accuracy to be 1% or better) to the DVM used, Connect the ground lead of the prove and the SAFETY GROUND wire from the HIPOT TESTER to the HIPOT TEST frame.

Push "START" button.

WARNING

HIGH VOLTAGES APPEAR ON OUTPUT PANEL BLOCK

The voltmeter should rise slowly from zero after an initial delay. Note the voltage reading. Insert the probe into the OUTPUT SOCKET and read the voltage from the Digital Voltmeter. The two should agree within plus or minus 3% of full scale (or 90 volts.). If they do not change the value of R6 on the A6-S5 board until they do.

4-18 **FAIL POTS CALIBRATION**

4-19 Turn all Failure Setpoint Pots fully clockwise. Insert the Calibration Load listed in table No. 2 to pull nearly Full Scale Current into the HIPOT TESTER *Output Socket. NOTE: Digital ammeter shown on Page 4-3* is not needed in this test. However, the dual banana jacks should be shorted together.

Push "START" button.

WARNING

HIGH VOLTAGES APPEAR ON THE TEST LOAD

While the high voltage is ON, slowly turn the TOTAL CURRENT FAILURE SETPOINT POT counter-clockwise until the FAIL lamp comes ON. Push RESET. Note the position of the slot on the potentiometer. It should be near ten (10) on the scale. If it is less that eight (8), *troubleshoot the A21 board or call* ROD-L Application Engineer for assistance.

To check the REAL CURRENT *FAILURE SETPOINT pot, the resistor* load used in paragraph 4-15 is required (BV only). The Digital Ammeter is not necessary for this test. If it is deleted, short the dual banana plug. Reset all SETPOINT POTS fully clockwise, Set up the load and plug into HIPOT TESTER.

Push "START" button.

WARNING

HIGH VOLTAGES APPEAR ON THE TEST LOAD

While the high voltage is ON, slowly turn the REAL CURRENT FAILURE SETPOINT POT counter-clockwise until the FAIL lamp comes on. Push RESET. Note the position of the slot on the potentiometer. If it is less than six (6), troubleshoot the A21 board or call ROD-L Application Engineer.

Repeat the test but turn the TOTAL CURRENT FAILURE SETPOINT POT until the FAIL lamp comes on. It should be near one (1) on the scale. AV users may also want to do this by constructing the appropriate load.

4-20 **SAFETY GROUND OHMS CALIBRATION**

4-21 Disconnect all loads from the HIPOT TESTER. Connect a 0.5 ohm resistor between the CHASSIS GROUND SENSE terminal on the front panel and the handle of the HIPOT TESTER. Make sure that the contact resistance of the Safety Ground wire is negligible.

Turn on the HIPOT TESTER. The READY lamp should come ON. Push the START button.

WARNING

HIGH VOLTAGES APPEAR ON THE TEST CIRCUIT

The High voltage should come up normally and no FAIL condition should occur. Push the RESET button.

Replace the 0.5 ohm resistor with a 0.6 ohm resistor. Insert this test circuit into the OUTPUT SOCKET and connect the GROUND SENSE as above. The READY lamp should NOT come on. Push RESET if necessary. The limits on the SAFETY GROUND TEST circuit have been verified. If the limits are not correct, troubleshoot the SAFETY GROUND DETECT circuit or call ROD-L Application Engineer.

Finally, Disconnect load to HIPOT TESTER. Connect GROUND SENSE wire to the frame of the HIPOT TESTER. The READY lamp should come ON. Push the START button.

WARNING

HIGH VOLTAGES APPEAR ON THE TEST CIRCUIT

While the high voltage is on, disconnect the Ground Sense wire. The FAIL lamp should immediately come ON and the high voltage should drop to zero. Push RESET. The READY lamp should NOT light until the Ground Sense wire is again connected to the Hipot Tester.

4-22 RAMP RATE CALIBRATION

4-23 Proper operation of the Ramp Up Control on the A6-S5 board should be verified by watching the OUTPUT VOLTAGE METER. Check the delay time (i.e. the time between pushing the START button and the beginning of the rising voltage) and the rise time (i.e. the time between the minimum point and the 100% point of the rising voltage) of the output voltage waveform. Delay time should be between 0.5 and 1.5 seconds. Rise time should be dependent of the Ramp Rate adjustment. No spurious oscillations should be seen. At the end of the turn-on-period, the voltage waveform should be sinusoidal except for very small amounts of crossover distortion (assuming a low distortion AC power line).

Under full load conditions (use test load from Table No. 2) the output voltage should vary less than 8% for capacitive loads. If not, troubleshoot A6-S5 board. The waveform should still look essentially sinusoidal (with actually less distortion than the one received at the input line.

4-24 INITIAL CALIBRATION OF A6-S5.

Without Running a TEST cycle, adjust the following:

1. Adjust R9 to read approximately negative 100mV at TP7.
2. R30 fully clockwise. Select mode A on the front panel and adjust TEST TIME for approx. 30 sec.
3. Adjust R30 clockwise until the rate of rise is as quick as desired
4. Repeat for R4 selecting mode B on the front panel.

4-25 **RAMP RATE ADJUSTMENT**

Fig 4-2 shows the relation between the different parameters of control.

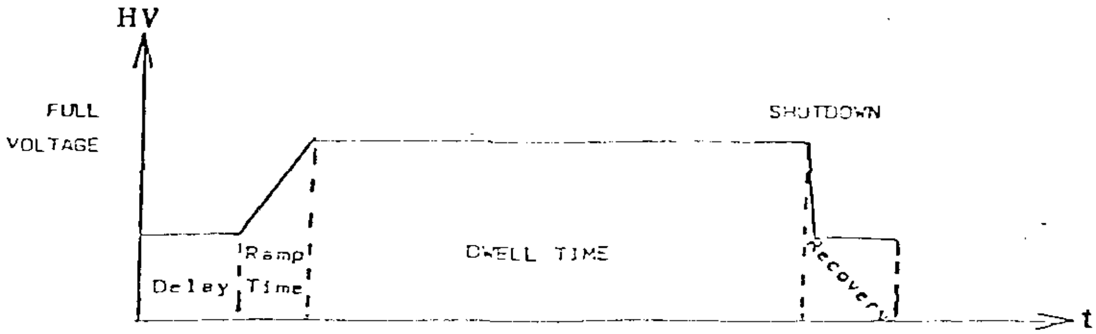


Fig. 4-2 Test Cycle Parameter

The delay time is given by approximately

DELAY = 0.5 + K (RAMP RATE ÷ Full Scale Voltage Sec)

The Ramp Rate is a controllable parameter adjusted by R 30 and R 4 for Mode A and B respectively. For each instrument the Ramp Rate varies from about FULL SCALE VOLTAGE/Sec to FULL SCALE VOLTAGE ÷ 30/sec. For example, for a 5kV unit the Ramp Rate is adjustable from 5000 V/sec to 166/V sec. K is an instrument constant and varies from about 30 msec to 40 msec. So the expected delay time is about from 0.54 sec to 1.54 sec.

The RAMP TIME depends on the selected RAMP RATE and the FULL VOLTAGE selected.

$$\text{RAMP TIME} = \frac{\text{Full Voltage}}{\text{RAMP RATE}}$$

If the same RAMP TIME is to maintained when the FULL VOLTAGE is changed with the VARAIC CONTROL, the RAMP RATE has to be readjusted.

Test time is the total DELAY plus RAMP plus DWELL time. The recovery time is about 0.5 sec. So, for a 5kV unit with 5000 V/sec Ramp Rate, 5kV full voltage, 1 sec dwell time, the TEST TIME selected has to be 0.54 sec + 1 sec + 1 sec = 2.54 sec and the total test cycle time is 2.54 + 0.5 sec (recovery time) = 3.04 sec.

4-26 For readjusting a RAMP RATE, the following procedure is suggested

1. Select the correspondent mode A or B.

2. Select a large TEST TIME accordingly to RAMP TIME desired adjusting pots A or B in the A21 board and running the test.

3. Push the RESET button and adjust the pot R 30 or R 4 for RAMP RATE A or B. Clockwise decreases the RAMP RATE.

4. Push START button and check the RAMP TIME. Repeat Step #4 if necessary. R20 is factory adjusted for waveform simmetry.

5. Adjust the TEST TIME back position.

4-27 TROUBLESHOOTING

4-27 Equipment Required: The required equipment is the same as that listed in Table No. 1.

4-29 TROUBLESHOOTING TREE PROBLEM LIST

4-30 The following is a list of problems and potential causes.

A. NO AC POWER.

1. Check fuses F1 and F2
2. Check for bad AC Power Lamp (I1) ON-OFF Switch (S1), line filter (L1-L2).
3. Measure for line voltage between A6-S5, TP6 and TP7

B. Instrument blows fuses.

1. Is F1 only blowing? Check for shorted M10V1 or M0V2. Check for shorted T1. Troubleshoot A10 board.
2. Does F2 or F3 only blow? If so, check for shorted output power transistors. Check for internal short on T2.

C. High voltage meter does not turn on slowly.

1. Check for shorted output transistors. Check for leaky Q2 on A6-S5 board.

D. Ready lamp does not work.

1. Check for burned out bulb.
2. Check for bad connection at BP1 or bad 1 ohm 3W resistor on A6-S5.
3. Troubleshoot safety ground ohms detect circuit on A21.

E. No High Voltage

1. Check for bad fuses F2 and F3.
2. Check for bad START switch
3. Check wiring harness for frayed wiring.
4. Troubleshoot A6-S5 board digital logic.

F. Failure indicators do not work or work erratically.

1. Check to see if the leakage current ammeter works.
2. Check signals given by U5 on A6-S5.
3. Determine which of four possible failure modes is being detected. That is, safety ground fault, total current overload, or T2 primary current greater than 1.2 amp (overload). Troubleshoot appropriate functional block.
4. Check initial condition voltage at the base of Q1 (A6-S5).

G. Excessive power disspation on A6-S5.

1. Check for shorts, low beta, etc.
2. Check for internal shorts, corona, etc.
3. Measure volgate between TP6 and TP7 on A6 board with high voltage OFF. This voltage should equal line voltage. With high voltage **ON**, this voltage should be less than 5 VAC-RMS fully loaded after the Ramp Up. If not, check troubleshoot A6-S5.

H. Arcing shutdown does not work.

1. Connect oscilloscope to A21 pin 7 which is optoisolator output. Short Hipot Tester output. Adjust trigger for a single sweep as optoisolator switches from +5V to 0V and back.
2. Push **START**. The **FAIL** lamp should go on after an approximate delay of 1 sec when the HV comes up. The oscilloscope should show a 0.2 to one millisecond negative pulse from the optoisolator thus verifying operation.
3. If no pulse appears or pulse does not fall below one volt, repair optoisolator or associated circuitry.
4. If it appears, check with the factory for increased sensitivity for low level energy arcing.

PARTS LIST

SECTION V

ASSEMBLY DESCRIPTION: A10 POWER SUPPLY
ASSEMBLY NUMBER: 00459-02 REV.A

ITEM	REFERENCE	DESCRIPTION	RATING AND/OR MFR. NUMBER	QTY.
1	A10	PCB, RAW	00459-02 ROD-L	1
2	C4,C5	CAPACITOR, EL	470uf 35V	2
3	C1	CAPACITOR, EL	3300uf 16V	1
4	C2,C3,C6	CAPACITOR, EL	1uf 35V	3
5	U1-U3	DIODE BRIDGE	CSB05, COLLMER	3
6	VR1	5V REGULATOR	7805, CLM340T5	1
7	VR2	-15V REGULATOR	7915, LM320T-15	1
8	VR3	+15V REGULATOR	7815, LM340T15	1
9	CR1-CR3	DIODE	1N4002	3
10	F1	FUSE	275004	1

ASSEMBLY DESCRIPTION: A21 CONTROL LOGIC BOARD
ASSEMBLY NUMBER:00462-02 REV. G

ITEM	REFERENCE	DESCRIPTION	RATING AND/OR MFR. NUMBER	QTY.
1	A21	RAW PCB	ROD-L 00462-02	1
2	TP1-7	TEST POINT		7
3	C1,3,4,7,8, C9,11,12,13,15	CAPACITOR CERAMIC	.01uf 25V	10
4	C14	CAPACITOR	.47uf	1
5	C2	CAPACITOR TANT/ELYTIC	150UF 16V	1
6	C5	CAPACITOR TANT/ELYTIC	10UF 16V	1
7	C6	CAPACITOR TANT/ELYTIC	4.7UF 35V	1
8	C10	CAPACITOR TANT/ELYTIC	22UF 15V	1
9	R1,4-9,R30,R44	RESISTOR CARBON	4.7K 1/4W 5%	9
10	R3	RESISTOR CARBON	6.8K 1/4W 5%	1
11	R10,11,33,34,40	RESISTOR CARBON	1K 1/4W 5%	5
12	R43	RESISTOR CARBON	8.2K 1/4W 5%	1
13	R18,20	RESISTOR CARBON	3.3K 1/4W 5%	2
14	R21	RESISTOR CARBON	10MEG 1/4W 5%	1
15	R22,23,24,28 R29,35	RESISTOR CARBON	10K 1/4W 5%	6
16	R25,R36,R41	RESISTOR CARBON	68K 1/4W 5%	3
17	R26	RESISTOR CARBON	18K 1/4W 5%	1
18	R27,39	RESISTOR CARBON	100K 1/4W 5%	2
19	R38	RESISTOR CARBON	56K 1/4W 5%	1
20	R12-17	RESISTOR METAL FILM	20K 1/4W 1%	6
21	R2,37	POTENTIOMETER	500K 20 TURN 3006P-1-504	2
22	R19	POTENTIOMETER	2K 20 TURN 3006P-1-203	1
23	Q1,2,3,7,8,9	TRANSISTOR, NPN	2N2222	6
24	Q4,5	TRANSISTOR, NPN	2N3904	2
25	Q6	TRANSISTOR, PNP	2N2907	1
26	CR6	DIODE, ZENER	4.7V 1N750A	1
27	CR2-5,8,9	DIODE, SIGNAL	1N914B	6
28	U1,4,5,8	IC, OP AMP	UA741	4
29	U2	IC, TIMER	NE555 8PIN DIP	1
30	U3	IC, 4 INPUT NAND	SN7420N	1
31	U6	IC, HEX INVERTER	SN7405 14 PIN DIP	1
32	U7	IC, 2 INPUT NAND	DM7400 14 PIN DIP	1
33	X	IC SOCKET	8PIN LOW PROFILE	5
34	X	IC SOCKET	14PIN LOW PROFILE	3
35	CR1,CR7	NOT USED IN DRAWING		
36	R42	NOT USED IN DRAWING		
37				

ASSEMBLY DESCRIPTION: A6-S5 SLOW RISE CONTROL BOARD
ASSEMBLY NUMBER: 00238-02 REV. B

ITEM	REFERENCE	DESCRIPTION	RATING AND/OR MFR. NUMBER	QTY.
1	A6S5	RAW PCB	00238-02 ROD-L	1
2		TEST PIN		5
3	C1	CAPACITOR, ALUM	10UF 12V	1
4	HS-1	HEAT SINK DANGER SIGN	MOUNT	1
5	C2	CAPACITOR TANT	220UF 6V	1
6		INSULATOR, RUBBER		2
7	C3	CAPACITOR	22UF 35V	1
8		LABEL, DANGER		1
9	C8	CAPACITOR	.01UF 25V	1
10	C6	CAPACITOR	33UF 10V	1
11	C7	CAPACITOR, DISC	.01UF 1KV	1
12	CR1-8,CR11-13	DIODE	1N914B	11
13	CR9,CR10	DIODE	1N5245B	2
14	CR14-17	DIODE	1N4005 600V 1AMP	4
15	K1	REED RELAY	GORDOS F81-5053A	1
16	U1,U2	IC	UA741TC OP AMP	2
17	U3-U5	OPTICAL COUPLER	MCT2E	3
18	PC-1	PHOTOCELL RESISTOR		1
19		PHOTOCELL HOUSING ASSMBLY		1
20	Q1	TRANSISTOR	2N3439	1
21	Q2	TRANSISTOR	2N5416	1
22	Q3	TRIAC	T2700D	1
23	R1	RESISTOR	1.62K 1/4W 1%	1
24	R2	RESISTOR	15K 1/4W 1%	1
25	R3	RESISTOR	1.2MEG 2W 1%	1
26	R4,R30	RESISTOR, VARIABLE	1MEG	2
27	R5	RESISTOR	1.21K 1/4W 1%	1
28	R6,R18,R19	RESISTOR	330K 1/2W 5%	3
29	R7,R8	RESISTOR	4.64K 1/4W 1%	2
30	R9	RESISTOR, VARIABLE	20K	1
31	R10	RESISTOR	3.48K 1/8W 1%	1
32	R12	RESISTOR	3.3K 1/2W 5%	1
33	R13	RESISTOR	1 OHM 3W 1%	1
34	R14,R21	RESISTOR	68 OHM 1/2W 5%	2
35	R16,R22,R28	RESISTOR	100 OHM 1/2W 5%	3
36	R15	RESISTOR	3.6K 1/2W 5%	1
37	R17	RESISTOR	7.5K 1/2W 5%	1
38	R29	RESISTOR	20K 1/4W 1%	1
39	R20	RESISTOR, VARIABLE	25K	1
40	R23	RESISTOR	1K 1/2W 5%	1
41	R24,R27	RESISTOR	.33 OHM 2W 1%	2
42	R25	RESISTOR	82K 1W 1%	1
43	R26	RESISTOR	100K 1W 1%	1
44	C4,C5	NOT USED IN DRAWING		

ASSEMBLY DESCRIPTION: A2-1 REAL CURRENT BOARD
ASSEMBLY NUMBER:00442-02 REV. D

ITEM	REFERENCE	DESCRIPTION	RATING AND/OR MFR. NUMBER	QTY.
1	A2-1	RAW PCB	00442-02 ROD-L	1
2	TP1-12	TERMINAL TEST PIN	KEYSTONE 1405-3	10
3	C1,3-12,16,17	CAPACITOR CERAMIC	.01UF 25V	13
4	C2	CAPACITOR MONLYTHIC	.47UF 50V	1
5	C13,14,15,21,22	CAPACITOR EL	47UF 25V	5
6	C18,19	CAPACITOR TANT/EL	1UF 20V	2
7	C20	CAPACITOR CERAMIC	.002UF 25V	1
8	C23	CAPACITOR, MONOLYTHIC	2.2UF	1
9	CR1-4,7,8	DIODE, SIGNAL	1N914B	6
10	CR5,9,10	DIODE, ZENER	4.7V 1N750	3
11	CR6	DIODE, ZENER	1N5245B	1
12	Q1,2	TRANSISTOR, RCA	2N2222	2
13	Q3	TRANSISTOR, RCA	2N2907	1
14	U1-3	IC, NAT	LM747	3
15	U4	IC, NAT	LF398	1
16	U5	IC, MOT QUAD ANLG SW	MC14066B	1
17	U6	IC, NAT QUAD OP AMP	LM324	1
18	U7	IC, SIG TIMER	NE558	1
19	U8	IC, RCA 2 INPUT NAUD	CD4011	1
20	R1,2,5-9	POTENTIOMETER BOU	10K 3006P-1-103	7
21	R3	POTENTIOMETER BOU	1MEG 3006P-1-105	1
22	R4	POTENTIOMETER BOU	20K 3006-1-203	1
23	R10,14	RESISTOR CARBON	100K 1/4W 5%	2
24	R11,16,17,19,20	RESISTOR CARBON	1K 1/4W 5%	5
25	R30	RESISTOR CARBON	15K 1/4W 5%	1
26	R12	RESISTOR CARBON	680K 1/4W 5%	1
27	R13,18,23,24	RESISTOR CARBON	10K 1/4W 5%	4
28	R28,32	RESISTOR CARBON	4.7K 1/4W 5%	2
29	R29	RESISTOR VARIABLE	1K 3006P-1-102	1
30	R21,15	RESISTOR CARBON	1K 1/4W 5%	2
31	R22,26	RESISTOR CARBON	47K 1/4W 5%	2
32	R25	RESISTOR CARBON	100 OHM 1/4W 5%	1
33	R27	RESISTOR CARBON	20K 1/4W 5%	1
34	R31	RESISTOR CARBON	56K 1/4W 5%	1
35	R33	RESISTOR CARBON	10M 1/4W 5%	1
36	R34-36	RESISTOR, MF	100K 1/4W 1%	3
37	R37	POTENTIOMETER	25K 3006-1-253	1
38	R38	RESISTOR CARBON	87K 1/4W 5%	1
39	RN1	RESISTOR SIP	4.7K 1% MSP08-A-03-472G	1
40	RN2,3	RESISTOR SIP	1K 1% MSP08-A-03-102G	2
41	RN4,5	RESISTOR SIP	100K 1% MSP08-A-03-104G	2
42	RN6	RESISTOR SIP	10K 1% MSP08-A-03-103G	1
43	RN7	RESISTOR SIP	2.2K 1% MSP08-A-03-222G	1
44		SOCKET, IC	14PIN DIP LOW PROFILE	5
45		SOCKET, IC	16PIN DIP LOW PROFILE	1
46		SOCKET, IC	8PIN DIP LOW PROFILE	1

OPTIONS

SECTION VII

BV THEORY OF OPERATION

HIGH VOLTAGE CONFIGURATION

The high voltage configuration will be essentially the one used in the standard AV models as shown in the wiring diagram of the high voltage configuration. R1 is a set of high voltage resistors for limiting the current through the ammeter to 1mA. Rv is a factory selected resistor for producing a voltage of about 3 volts RMS for monitoring the high voltage output. RI is the current sense resistor and is also factory selected for producing about 5 volts RMS max for monitoring the leakage current. Assuming a pure resistive load the current monitoring waveform is 180° out of phase with respect to the voltage monitoring waveform.

REAL CURRENT DETECT BOARD

The former revision level C of the real current detect board is an upgraded version of the former real current detect board where an extra immunity to noise and distortion is included as well as real current remote monitoring and trip point programming. The board is revised to revision level D for adapting it to the high voltage configuration described above.

DETERMINATION OF THE RESISTIVE LOAD OR REAL COMPONENT OF THE CURRENT

The high voltage waveform is mainly a sinusoidal one with a certain percentage of distortion. The AC input line voltage is already a 5 to 6% distorted waveform. The primary effect is that the peak of the voltage waveform does not necessarily correspond with the 90° position and does not necessarily remain stable.

Since the real component of interest during the hipot testing is the one reflecting dissipation and not those of the harmonics with respect to the 60 Hz pure sinusoidal it is of primary importance to determine where exactly the peak of the voltage waveform occurs under any circumstance. The integration of the waveform is not practically advised because the undesirable offset effects and the low pass filtering version of the integration would provide only a predetermined amount of phase shift which does not necessarily correspond to the location of the peak voltage waveform where we know that with a capacitive load the current waveform has to be zero and any value different from zero is directly reflecting a resistive component that can be modelled as a resistive element in parallel with the ideal capacitance. This approach permits us to determine a dissipative current component which can tolerate a large amount of distortion in the voltage waveform. One big limitation of the circuitry, however, is the sensitivity of the differentiator to uncommon amounts of noise and distortion. The revision level C of the real current detect board already upgraded the immunity with extra filtering and timing circuitry which permits the sampling of the leakage current waveform only when the peak of the voltage waveform occurs around the 90° where ideally it should be.

The approach described above permits us to look at the dissipative component of the leakage current under conditions very far from the ideally linear ones, like distored voltage and current waveforms and non-linear capacitances. However, if distortion and nonlinearities become more severe, a totally different approach to the problem has to be taken different to the linearizing one, but in this case the resistive component would lose its meaning giving ground to another concept like dissipating power instead, which we are prepared to take into development.

REAL CURRENT DETECT CIRCUITRY REVISION LEVEL D

The voltage across the voltage monitoring resistor Rv is connected to a differential amplifier and its output at pin 12 of U1 is fed to the phase shifter so that the output at pin 10 of U1 is leading a small amount for compensating for the different delays in the circuitry. The output is applied to the differentiator where we obtain the inverse of the derivative with the leading zero crossing being coincident with the positive peak of the voltage waveform, the output of the differentiator is applied to the squaring amplifier for obtaining a square waveform in phase with the derivative but with the rising edge being coincident with the negative peak of the high voltage monitoring waveform and this is because the leakage current we want to look at is out of phase with respect to high voltage by 180°.

On the other hand, the voltage monitoring signal is fed to U6, a timing circuitry, through pin 1 of RN3 which squares the waveform and produces the triggering of the monoastable U7 to set a single pulse out of pin 8 of U8 around the negative peak of the voltage monitoring signal. This pulse allows the zero crossing signal represented by the rising edge of the output of 10 of U2 to go through U8 and produces a signal pulse of about 7 microseconds out of the output 4 of U8 coincident with the negative peak of the voltage monitoring signal. This pulse is used in the sample and holder U4 to sample the leakage current waveform which gets in through U8 coincident with the negative peak of the voltage monitoring signal. This pulse is used in the sample and holder U4 to sample the leakage current waveform which gets in through pin 3 of U4 after being buffered by U6. Any positive value which is sampled is reflecting a dissipative current and is fed to the non-inverting amplifier for driving the ammeter. R7 adjsuts the gain of this amplifier U3. The other half of U3 is used to compare the tripping value with the actual current giving a failure signal if this exceeds the former.

The dissipative value given by U3 is also given externally for monitoring purposes.

U6 also can accept external trip point programming which is selected through the remote board activating the **REMOTE** signal through the pin 6 of the board. The analog switch U5 permits the driving of the ammeter while we are in a test situation and while the component of current in phase with the negative peak of the voltage monitoring signal reflects a dissipative current, in other words, is positive.

A25 HANDS OFF/SWITCH SELECTABLE FAILURE POINTS

THEORY OF OPERATION

The board was designed to contain two options: **HANDS OFF** and **SWITCH SELECTABLE FAILURE Points.**

The **HANDS OFF** requires the operator or controller to hold the **START** line low during a Hipot Test. If a Hipot Test is initiated and the **START** line is found high or released, a **RESET** and **FAIL** signal of about 1 second is produced. The **FAIL** signal activates both fail light and buzzer. At the end of the fail indication the unit is completely reset if no restart is attempted.

The **SELECTABLE FAILURE POINTS** provide 5 extra potentiometers for 5 extra total current failure points. Any of the 6 pots can be selected by a 6 position switch on the front panel. The sixth pot is the standard external pot on the rear panel.

CIRCUIT DESCRIPTION

This prototype board contains five 100K potentiometers for giving out corresponding voltage through pin 6, 8, 10, 12, 14 to the 6 selectable position switch on the front panel. This switch connects one of the above voltages to pin J of the A21 board for comparison with the actual total current value for failure tripping purposes. Every one of the pots can be calibrated for tripping at operator defined value. The hands **off** consists of a comparator and a set of timer which provides failure, reset and start signals to the rest of the systems.

The start switch is connected to pin 9 of the edge connector. The comparator U2 inverts and cleans the start signal giving a high level output when the start switch is held down. The test signal is also inverted giving a high level output when the test is on. The inverted start and test signals are given to the inputs of the monoastable U3.

While the test signal in the monoastable is low, the output through pin 1 of U3 is high. If the test signal in the monoastable goes high due to a test in progress, the monoastable is gated to accept triggering from the start signal. If the start signal goes low during a test in progress, the monoastable will be triggered and a low level pulse of about 100 microseconds is produced through pin 1, detecting the condition when the start switch is released during a test.

This pulse from pin 1 of U3 triggers one of the two timers in U1 through pin 6 of U1. A high level pulse is produced at pin 5 of U1 of about 1 second which gives a failure and reset signal to the rest of the unit through Q1 and Q2. At the end of the 1 second the unit will be reset and a start can be reattempted.

The start switch is also connected to the second timer through C2, producing a high level pulse at pin 9 of U1 on the falling edge of the start switch signal, that is when the switch is depressed. This pulse drives Q3 giving a start pulse to the rest of the system and getting started.

When this board is combined with the Ohms Sense Option, the start pulse is given by **A24** board instead. It has to be noticed that even when this option is used with **A8 REMOTE** Control Option, the start signal has to be held down during a test.

A24 OHMS SENSE CIRCUIT

FUNCTIONAL DESCRIPTION

The ohms sense option was developed to detect if the device under test presents a minimum amount of impedance between HOT and NEUTRAL leads before a HIPOT TEST is actually performed.

Before a HIPOT TEST is started the **HOT** and **NEUTRAL** leads are untied. The **HOT** lead which is normally connected to the HIGH VOLTAGE is momentarily connected to GROUND and a small voltage of 1.5 VAC RMS is applied to the **NEUTRAL** lead.

The **CHASSIS GND SENSE** in the **A21** board is used to process the voltage across **HOT** and **NEUTRAL** leads during this operation, the reference resistance used normally for the ground sense test is also momentarily changed to an adjusted pot to provide tripping for impedances in the 1500 ohms range. If the READY signal given by the ground sense circuitry during the test goes high we will have an ohms sense failure at the end of the ohms sense test cycle. This failure resets the board and operates the BUZZER in a pulsing mode.

If the test is passed, the **HOT** and **NEUTRAL** are tied back together, the reference resistance for the ground sense test is reconnected and a start pulse is delivered to the **A21** board to start a Hipot Test.

CIRCUIT DESCRIPTION

When Hipot Tester is initially turned on K4 is activated, contacts "A" and "D" of K_4 are closed, K_2 is closed. The **"READY"** light is on and normal ground sense is performed on A_{21} board. When the start switch is depressed, pins 1 and 2 of U_2 go low pin 11 goes low. U_1 is triggered-and the output at pin 1 goes high for 1 second. The pulse deactivates K_4 opening contacts "A" and "D", normal ground sense is interrupted. K_2 is open.

The 1 sec. pulse places a high on pin 1 and 2 of U_4 which cause a low output at pin 3, which activates (closes) K_1 and K_3.

At this time, the 1.5 VAC is applied across R ohm, current flows thru R ohm and K_3 to W_3 which is connected to the Neutral wire of the device under test (DUT). Current will return fom DUT thru the HV return which is tied to chassis. The **HOT** wire is momentarily connected to HV return with K_1 contacts.

One side of R ohm is connected to the chassis volt sense pin 13 of A_{21}. This cicuitry senses that the impedance of the DUT is approximately $\frac{1}{2}$ of the resistance of R ohm. If this is not true, a high level will appear at A_{21}-10 (READY). At the end of the 1 second pulse a pulse is produced at pin 8 of U_1. If **"READY"** is high, the Fail Latch U_3 will be set. The FAIL Latch is set, U_5 will be unreset and give out pulses to sound the sonalert. The fail output at Q_2 is connected back to the reset cicuitry so any kind of failure can reset the board.

If the resistance of the DUT is equal to or less than 1500 ohms, the negative edge of a pulse generated at pin 8 of U_1 will trigger U_1-11. A 1 second pulse at U_1-9 is generated to allow the normal ground sense circuitry to settle down. When the 1 second pulse at U_1 ended, K_4 and K_2 are activated and K_1 and K_3 opened.

The trailing edge of the 1 second at U_1-9 triggers a 20 msec pulse at U_1-16 which will start the normal cycle of the Hipot Tester. R_{15} is used to adjust the timing of the fail pulsing signal.

A8 REMOTE CONTROL

FUNCTIONAL DESCRIPTION

The A8 Remote Control contains two options:

AUTOMATIC RESET

DIGITAL REMOTE CONTROL

The AUTOMATIC RESET option is supposed to generate a short duration FAIL and RESET pulse after a failure is latched in the A21 Control Logic Board. At the end of the FAIL pulse the system is completely reset if no restart is attempted.

The DIGITAL REMOTE CONTROL option provides optical isolated control and monitoring of the main functions of the unit. The inputs are: START and RESET, SELECT A and the outputs are: READY, TEST and FAIL (ALARM).

There are two revision level boards, D and F. Revison D provides high active current driven inputs (25mA) and low active TTL outputs.

Revision F provides low active TTL inputs and low active TTL outputs.

CIRCUIT DESCRIPTION

AUTOMATIC RESET OPTION

While on TEST, a FAIL produces one shot negative pulse in U4. The falling edge produces one shot pulse U5, this pulse drives the alarm through pin B with Q2 and resets the system through the board pin 5 with U1. At the end of the pulse U5, the system is reset and the alarm is off. U1 also resets the system when remote reset is produced. If this option is not needed, A, B, and C,D jumpers are placed so that the FAIL signal drives the alarm as normal and the reset from the remote goes directly to the RESET line.

OPTICAL ISOLATED CONTROL

This part provides 3 inputs: RESET, START, and SELECT "A" and 3 outputs: READY, TEST, and FAIL.

The input current requirements are:

REV F	**HIGH LEVEL:**	40 µA @ +5V	**REV D** **HIGH LEVEL:**	18mA @ +5V
	LOW LEVEL:	1.6 mA for 0.4V	**LOW LEVEL:**	0mA

The output current capabilities are:

HIGH LEVEL:	2.27mA @ +5V
LOW LEVEL:	2.27mA max @+5V

When U3 is driven, a reset signal is produced at pin 5 of the board either directly through C, D jump or through U1 when the automatic reset option is in.

When U2 is driven, a start signal goes out through pin 9 of the board.

When U9 is driven, the voltage at pin 5 of U9 is low and Q1 does not drive the realy K1 so the connection is the one shown "stand by" and A rise time and test time sare selected. If U9 is not driven pin 5 of U9 goes high and Q1 driven activating the relay, so B rise time and test time are selected.

When GROUND TEST signal through pin 10 is low, U6 is activated and a low level is available from pin L of the board to the remote connector.

When TEST is low, through pin11, in other words, when a TEST is in progress U7 is activated and a low level is available from pin M to the remote connector.

When U8 is activated with the FAIL signal either from pin 12 or pin B when the automatic reset option is used, a low level is available from pin N to the remote connector.

The remote controller's 5V and GND are fed through pins K and 15 respectively.

REMOTE CONTROL OPTION 25 PIN CONNECTOR ASSIGNMENT

1,16	GND (ISOLATED)	13	RESISTANCE
4	GND (CHASSIS)	15	AC/$\overline{\text{DC}}$
5	EXT V REF	17	REM
6	EXT I TRIP	18	RESET
7	EXT V TEST	19	START
8	EXT V RISE	20	+5V (REMOTE)
9	V OUT	21	$\overline{\text{READY}}$
10	I OUT	22	$\overline{\text{TEST}}$
11	EXT IR OUT	23	$\overline{\text{FAILURE}}$
12	IR OUT	25	SELECT A

A11 UNDER CURRENT AND HANDS OFF OPTION

FUNCTIONAL DESCRIPTION

The undercurrent option enables the detection of a minimum amount of current required during a hipot test. If not, it is interpreted that the device under test is not connected and a failure and reset signal are produced.

The hands off option requires the start signal to be held down during a hipot test, otherwise a failure and reset signal are produced. Even when this option is used with the A8 Remote option, the start signal given by the remote controller has to be held down during a test.

CIRCUIT DESCRIPTION

The A11 board contains three circuits: the power supply, the under current detection and the hands off.

POWER SUPPLY

Through pins 10 and 11 we feed 18 VAC to the full wave bridge rectifier CR1, 2, 3, 4. C1 and C2 are the filtering capacitors and the regulator 7815 provides the +15V, while U4 on Q1 combination provides the -15V. The operation of this combination is tied up with the performance of the +15V regulator and the precision of R2 and R3 because pin 2 of U4 is obligated to be practically zero.

UNDER CURRENT

The start switch is connected between pin N ENABLE of the board and the pin 9 READY of the board. This READY signal is low if the chassis ground test passes, and only then we can produce a low level ENABLE when the start switch is depressed. Depressing the switch also produces a high level at pin 3 of U1 while the switch is depressed. This high level temporarily drives the transistor Q7 to produce a start pulse out from pin 8 of the board to start the hipot test.

The TESTING signal is fed through the pin 12 of the board and goes low when the hipot testing begins. While this signal is high, in other words, not performing a test, the transistor Q3 is driven through CR13 continuously holding down the capacitor C10. Also through CR14, pin 2 of the timer U2 is held high so no pulse can be produced out of it.

The Capacitor C10 is part of the timer U3 and its charging up time determines the length of the pulse produced by U3. U3 is triggered when the TEST signal gets low, in other words, when the test begins and a high level is produced at the output (pin 3) of U3. That output will remain high until the capacitor C10 charges up to 2/3 the +5V supply but even though the capacitor C10 is now free to charge up because the TEST signal is not driving through CR13 during a test, the comparator U5 has to drive Q3 after a certain time and discharge C10 otherwise the output of U3 will fall triggering U2 timer which gives a pulse driving the FAIL and RESET of the system. In other words the comparator U3 has to sense the presence of current higher than the tripping point before C10 charges up to 2/3 of the +5V supply.

The tripping value is fed through pin R of the board. The return of the ammeter is fed through pin E of the board and the current produces correspondent potential across R4 to be compared to the tripping value.

HANDS OFF

If during a test the start switch is released the ENABLE line will go up and the trigger input of U1 will not hold the output 3 of U1 high anymore. The falling transition will trigger U2 through C16 producing a FAIL and RESET pulse.

UNDER CURRENT FAILURE SET

The under current detect feature requires a minimum of three (3) seconds to react. That is the tester will not sense for under current until the high voltage has reached a certain voltage. To select the under current fail point:

1. Set *under current pot to maximum* counter-clockwise position to start off.

2. Follow the procedure for setting total current fail point. Remember, **FAIL** will be indicated at all current levels below selected level.

3. The start switches must be depressed and held due to the **HANDS OFF OPTION** used in conjunction.

4. Under current failure is indicated by:

   a. Fail light comes on for one second

   b. Audible alarm is on for one second

   c. High voltage automatically shuts down

   d. Tester resets itself

5. Ground fault failure is indicated by:

   a. Fail light is on for one second

   b. Audible alarm on for one second

   c. High voltage automatically shuts down

   d. Ready lamp goes off

   e. Requires manual reset

6. High current (over current) failure is indicated by:

   a. Fail lamp continuously on

   b. Audible alarm continuously on

   c. High voltage shuts down

   d. Requires manual reset

ASSEMBLY DESCRIPTION: A25 HANDS-OFF/CURRENT FAIL
ASSEMBLY NUMBER: 00433-02 REV. C

ITEM	REFERENCE	DESCRIPTION	RATING AND/OR MFR. NUMBER	QTY.
1	A25	RAW PCB	00433-02 ROD-L	1
2	C1	CAPACITOR	.10uf	1
3	C2	CAPACITOR	1000pf	1
4	C3-9	CAPACITOR	.01uf	7
5	C10-11	CAPACITOR	10uf 25V	2
6	C12	CAPACITOR	.47uf	1
7	CR1,2	DIODE	1N914	2
8	Q1-4	TRANSISTOR	2N2222	4
9	R1-5	RESISTOR, CARBON	47K 1/4W 5%	5
10	R6-10	RESISTOR, VARIABLE	100K	5
11	R11,12	RESISTOR, CARBON	10M 1/4W 5%	2
12	R13,19,23,24	RESISTOR, CARBON	10K 1/4W 5%	4
13	R14-16,20-22,25	RESISTOR, CARBON	4.7K 1/4W 5%	7
14	R17	RESISTOR, CARBON	1K 1/4W 5%	1
15	R18	RESISTOR, CARBON	3K 1/4W 5%	1
16	R26	RESISTOR, CARBON	56K 1/4W 5%	1
17	U1	IC	NE556	1
18	U2	IC	LM311	1
19	U3	IC	74121	1

ASSEMBLY DESCRIPTION: A24 OHM SENSE BOARD
ASSEMBLY NUMBER: 00434-02 REV. C

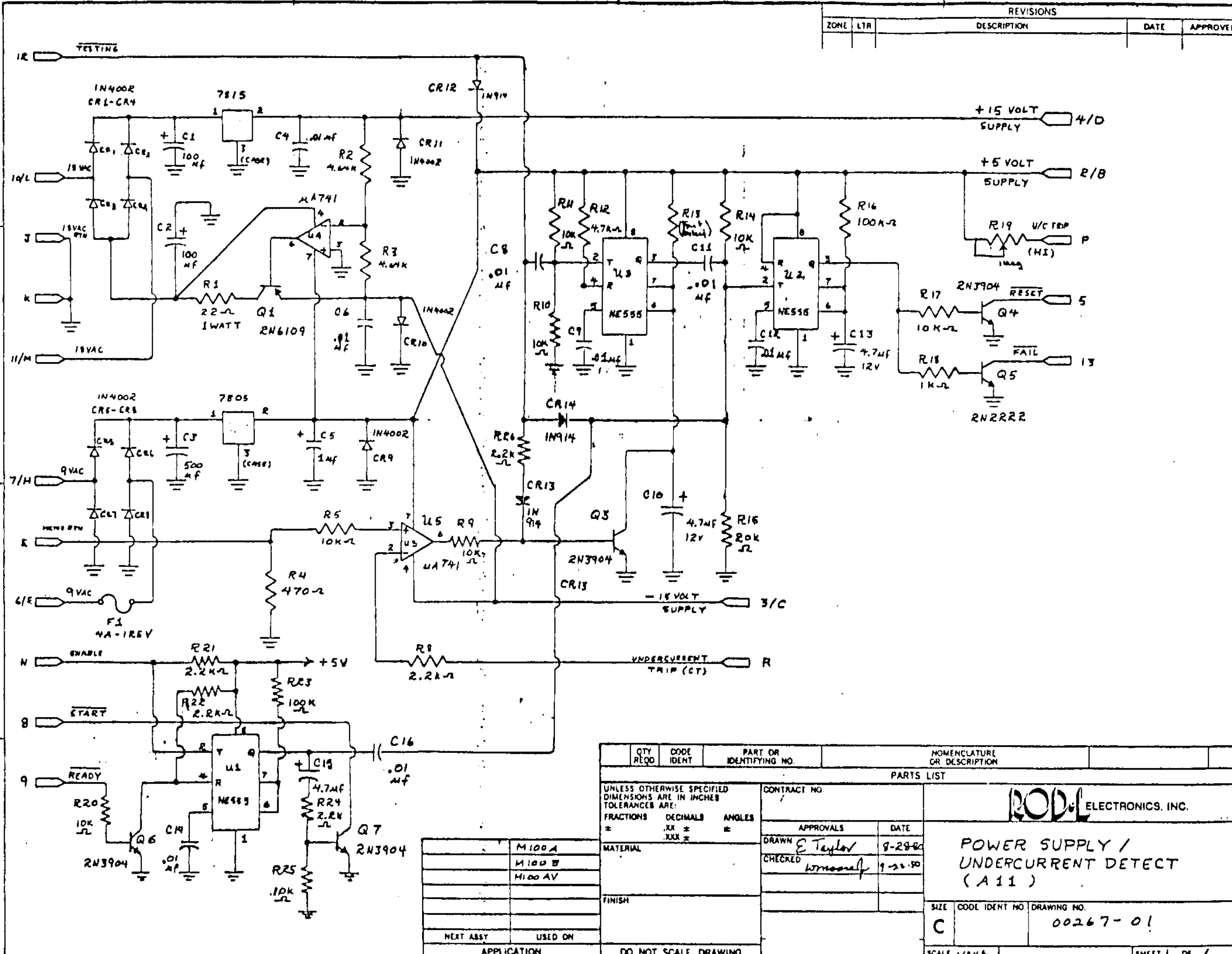
ITEM	REFERENCE	DESCRIPTION	RATING AND/OR MFR. NUMBER	QTY.
1	A24	RAW PCB	00434-02 ROD-L	1
2	C1	CAPACITOR	10uf 25V	1
3	C2,C16	CAPACITOR	.33uf	2
4	C3-C6,8,9,11, C12,15,17,18	CAPACITOR	.01uf	11
5	C7	CAPACITOR	.001uf	1
6	C10	CAPACITOR	.47uf	1
7	C14	CAPACITOR	.1uf	1
8	R1,R9,R10,R13, R14	RESISTOR, CARBON	4.7K 1/4W 5%	5
9	R2	RESISTOR, CARBON	7M 1/4W 5%	1
10	R3-R5 R8,R12,R17	RESISTOR, CARBON	10K 1/4W 5%	6
11	R6,R11	RESISTOR, CARBON	10M 1/4W 5%	2
12	R7	RESISTOR, CARBON	1M 1/4W 5%	1
13	R15	RESISTOR, VARIABLE	1M	1
14	R16	RESISTOR, VARIABLE	3K	1
15	U1	IC TIMER	NE558	1
16	U2,U3	IC	7400	2
17	U4	IC	SN75452P	1
18	U5	IC	NE555	1
19	Q1,Q2	TRANSISTOR	2N2222	2
20	CR1-CR4	DIODE	1N4005	4
21	K1-K3	RELAY DOUG-RAND	378992	3
22	K4	RELAY P & B	HP11D	1
23	C13	NOT USED		

ASSEMBLY DESCRIPTION: A8 REMOTE CONTROL LOGIC W/ AUTO-RESET
ASSEMBLY NUMBER: 00445-02 REV. F

ITEM	REFERENCE	DESCRIPTION	RATING AND/OR MFR. NUMBER	QTY.
1	A8	RAW PCB	00445-02 ROD-L	1
2	C1,C2	CAPACITOR	10uf 25V TANT	2
3	C4	CAPACITOR	6.8uf 10V TANT	1
4	C5-C7	CAPACITOR	.01uf	3
5	C3	CAPACITOR	.1uf 10V TANT	1
6	U2,U3,U6,U7	IC	H11B1 OR H11B3	6
	U8,U9	IC		
7	U4	IC	SN74122	1
8	U5	IC, TIMER 8 PINS	NE555	1
9	U10	IC, TTL HEX INVERTER	SN7416	1
10	U11	IC	747	1
11	U1	IC	7403	1
12	R4-R6	RESISTOR, CARBON	330 OHM 1/4W 5%	3
13	R7,R12	RESISTOR, CARBON	1K 1/4W 5%	2
14	R8-R10	RESISTOR, CARBON	100K 1/4W 5%	3
15	R1-R3	RESISTOR, CARBON	2K 1/4W 5%	3
16	R13,R17-R2	RESISTOR, CARBON	4.7K 1/4W 5%	7
17	R14	RESISTOR, CARBON	20K 1/4W 5%	1
18	R15	RESISTOR, CARBON	330K 1/4W 5%	1
19	R16	POTENTIOMETER	1M	1
20	R23,R24,R27	RESISTOR, CARBON	10K 1/4W 5%	4
	R29			
21	R25	POTENTIOMETER	10K	1
22	R11	RESISTOR, CARBON	2.2K 1/4W 5%	1
23	R26,R28	POTENTIOMETER	50K	2
24	Q1	TRANSISTOR	2N3904	1
25	Q2	TRANSISTOR NPN	2N2222	1
26	K1	RELAY	1495 DPDT 5VDC	1
27	CR1	DIODE	1N914	1

ASSEMBLY DESCRIPTION: A11 UNDERCURRENT BOARD
ASSEMBLY NUMBER: 00294-02

ITEM	REFERENCE	DESCRIPTION	RATING AND/OR MFR. NUMBER	QTY.
1	A11	RAW PCB	00294-02 ROD-L	1
2	C1,C2	CAPACITOR	100uf 25V TANT	2
3	C3	CAPACITOR	500uf 16V	1
4	C4,6,8,9,11,12, C14,16	CAPACITOR	.01uf 100V CERAMIC	8
4	C5	CAPACITOR	1uf 12V	1
5	C10,13,15	CAPACITOR	4.7uf 12V	3
6	CR1-11	DIODE	1N4002	11
7	CR12-14	DIODE	1N914	3
8	F1	FUSE	4 AMP 125V	1
9	Q1	TRANSISTOR	2N6109	1
10	Q3,4,6,7	TRANSISTOR	2N3904	4
11	Q5	TRANSISTOR	2N2222	1
12	R1	RESISTOR	22 OHM 1W 10%	1
13	R2,3	RESISTOR	4.64K 1/8W 1%	2
14	R4	RESISTOR	470 OHM 1/4W 1%	1
15	R5,9-11,14,17, R20,25	RESISTOR	10K 1/4W 5%	8
16	R8,21,22,24,26	RESISTOR	2.2K 1/4W 5%	5
17	R12	RESISTOR	4.7K 1/4W 5%	1
18	R13	RESISTOR	470K 1/4W 5%	1
19	R15	RESISTOR	20K 1/4W 5%	1
20	R16,23	RESISTOR	100K 1/4W 5%	2
21	R18	RESISTOR	1K 1/4W 5%	1
22	R19	POTENTIOMETER	1MEG	1
23	U7	IC	UA7815	1
24	U4,U5	IC	UA741	2
25	U6	IC	UA7805	1
26	U1-U3	IC	NE555	3


REVISIONS
ZONE LTR DESCRIPTION DATE APPROVED
TESTING
1N4002 CR1-CR4
7815
1N914
CR12
+15 VOLT SUPPLY 4/D
+5 VOLT SUPPLY 2/B
CR11 1N4002
R2 4.64K
R3 4.64K
µA741 U4
R1 22Ω 1WATT
Q1 2N6109
C1 100µf
C2 100µf
C4 .01µf
C6 .01µf
C8 .01µf
CR10 1N4002
7805
1N4002 CR5-CR8
C3 500µf
C5 1µf
CR9 1N4002
9VAC
15VAC
15VAC RTN
F1 4A-125V
R4 470Ω
R5 10KΩ
U5 µA741
R9 10K Ω
R8 2.2kΩ
R6 2.2k Ω
CR13 1N914
CR14 1N914
Q3 2N3904
C10 4.7µf 12V
R15 20k Ω
-15 VOLT SUPPLY 3/C
UNDERCURRENT TRIP (CT) R
R10 10K Ω
R11 10K Ω
R12 4.7kΩ
R13
R14 10K Ω
C9 .01µf
C11 .01µf
U3 NE555
U2 NE555
C12 .01µf
C13 4.7µf 12V
R16 100kΩ
R19 1meg
U/C TRIP (HI) P
R17 10kΩ
R18 1kΩ
Q4 2N3904
RESET 5
Q5 2N2222
FAIL 13
ENABLE
START
READY
R21 2.2kΩ
R22 2.2kΩ
R23 100K Ω
+5V
U1 NE555
C14 .01µf
C15 4.7µf
R24 2.2K Ω
R25 .10K Ω
Q7 2N3904
C16 .01µf
R20 10K Ω
Q6 2N3904
1R 10/L J K 11/M 7/H E 6/E N 8 9
QTY REQD | CODE IDENT | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION
PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±
MATERIAL
FINISH
DO NOT SCALE DRAWING
CONTRACT NO.
APPROVALS DATE
DRAWN E Taylor 8-29-80
CHECKED 9-30-80
M100A
M100B
M100AV
NEXT ASSY USED ON
APPLICATION
ROD-L ELECTRONICS, INC.
POWER SUPPLY / UNDERCURRENT DETECT (A11)
SIZE C CODE IDENT NO. DRAWING NO. 00267-01
SCALE NONE SHEET 1 OF 1
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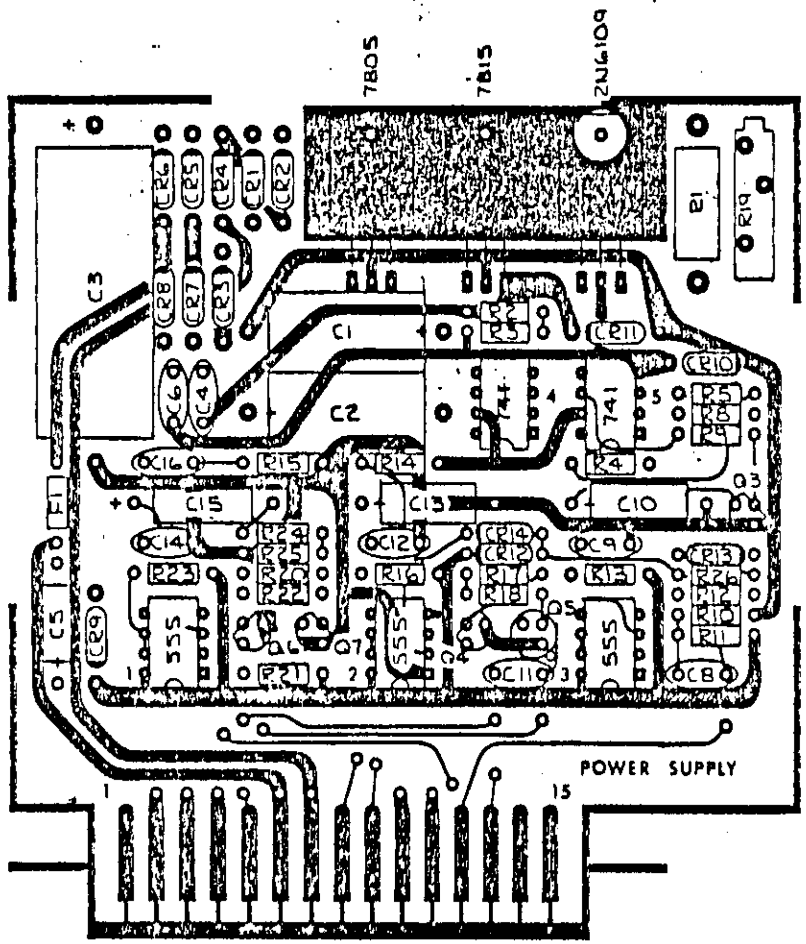

NOTES
1. COMPONENT SIDE SHOWN
2. INSULATE 2N6109 FROM HEAT SINK

ROD-L ELECTRONICS INC.		
SCALE: 2X	APPROVED BY: [signature]	DRAWN BY: EAI
DATE: 9-80		REVISED
POWER SUPPLY / UNDERCURRENT Detect		
ASSEMBLY DRAWING		DRAWING NUMBER: 00294-02