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DESCRIPTION

Procedures for performing grounding and leakage current checks on the system.

1- GROUND RESISTANCE CHECKS

Ensure that all pre-installation and wiring is complete prior to starting these checks. This includes, but may not be limited to:

- Any required electrical code inspection
- Installation of the facility disconnect device
- EMERGENCY OFF wiring
- PDU primary wiring
- PDU subsystem power cables

If required, arrange for electrical code inspection when complete.

Initial Conditions

- Direction 2128854, Signa Horizon System Installation, Tab 1: POWER CABLE INSTALLATION INSTRUCTIONS.
- No hard wired signal cables connected to any subsystem cabinets. Fiber Optic cables may be connected and not impact this check.

Tools Required

- Bio-design MG5 meter (Microguard) with Milliohm Adapter.
- Dale 600 (120VAC) or Dale 600E (220VAC) Safety Analyzer
- Digital voltmeter (optional)

Note - Dale 600 or 600E Safety Analyzer

For those sites equipped with a Dale 600 or 600E Safety Analyzer, perform Section 1-2, otherwise perform section 1-1 using the Bio-design MG5 meter (Microguard) with Milliohm Adapter.

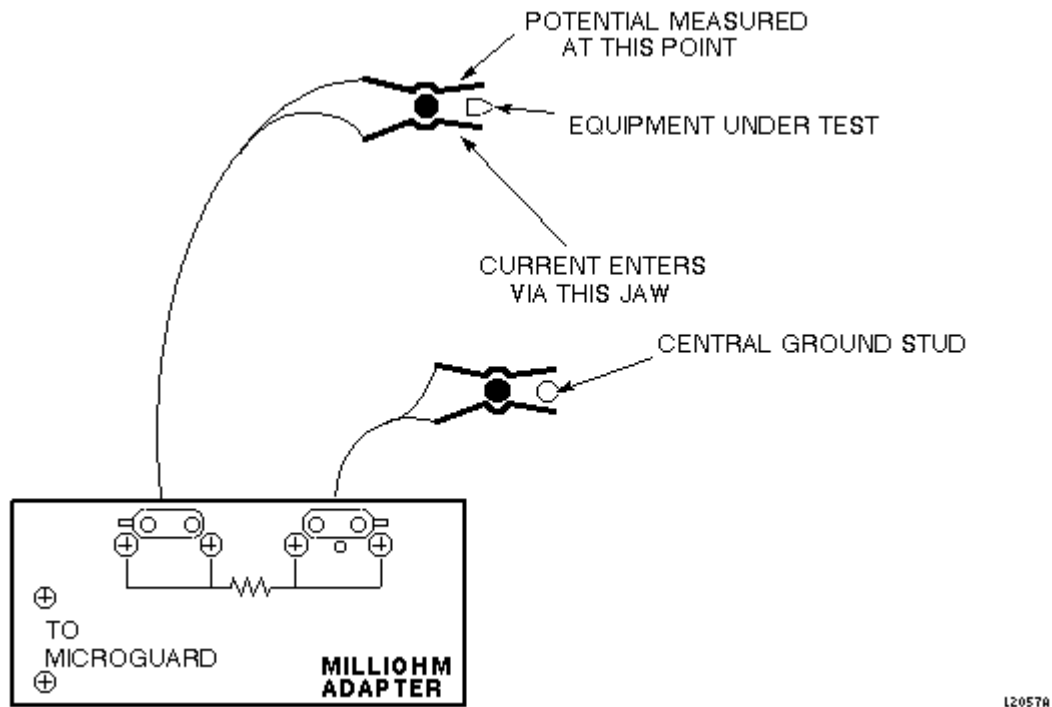
1-1 Ground Resistance Checks Using Microguard

Procedure



LIKELY FATAL PERSONAL INJURY!! LETHAL VOLTAGES ARE PRESENT WITHIN THE PDU EVEN WHEN ALL PDU BREAKERS ARE OFF. CHECK THAT POWER AT THE MAIN DISCONNECT IS OFF, LOCKED, AND TAGGED BEFORE PROCEEDING.

1. Ensure that **no** power is applied to PDU.
2. Notify all Field Service Engineers working at the site that PDU Main Disconnect will be shut off and locked out.
3. Locate and shut off the Main Disconnect supplying power to the PDU.
4. Lock out and tag the Main Disconnect using appropriate OSHA procedure. (Refer to *Procedure For Safety: Section 6.*)
5. Verify that the Main Disconnect and PDU indicator lights are off, and that power switches are inactive.
6. Plug milliohm adapter module into power outlet of the Microguard. See Illustration 1-1.



MICROGUARD CONNECTIONS
ILLUSTRATION 1-1

Note

Since the Microguard is being used solely as a voltmeter in this application, any other meter capable of resolving 0.1 millivolts can be substituted in the next step. Meters other than the Microguard are currently in use. Refer to the appropriate tool catalog for further information.

7. Attach Microguard red and black leads to meter posts of milliohm module.
8. Set Microguard Patient Lead Tester switch to "All Other Tests."
9. Set Microguard Selector switch to "20 Microamps/Millivolts."
10. Set Microguard Input switch to "Red and Black Probes."
11. Attach the Kelvin leads as shown in Illustration 1-1. (Connect one lead to PDU ground bus bar, and the other lead to frame of subsystem cabinet under test.)
12. The meter reads voltage across ground resistance in millivolts. To obtain resistance in milliohms, multiply meter reading by 2.
13. Verify that measured resistance is less than 100 milliohms (corresponding to a meter reading of 50 millivolts).
14. Perform steps 11 through 13 for each subsystem cabinet.

System Restoration

1. Turn Microguard power off.
2. Remove leads and milliohm adapter from Microguard.
3. Close all subsystem cabinets and PDU cabinet.

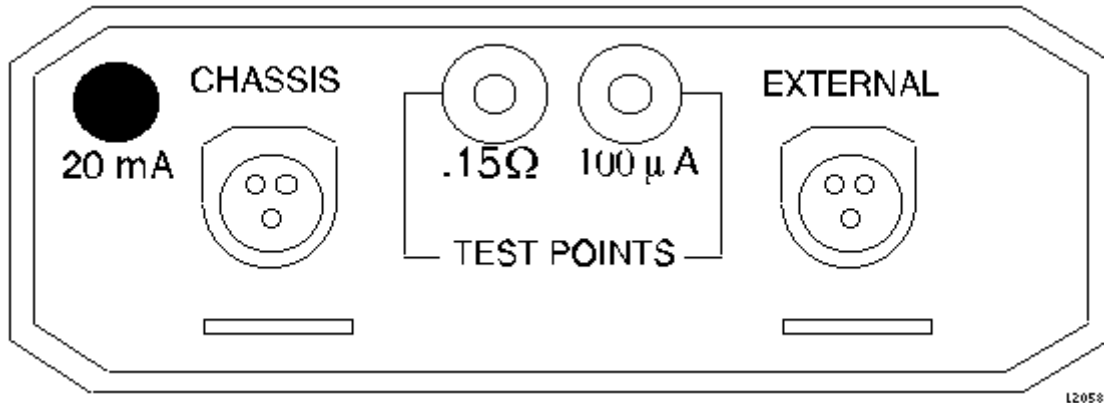
1-2 Ground Resistance Checks Using Dale

Procedure



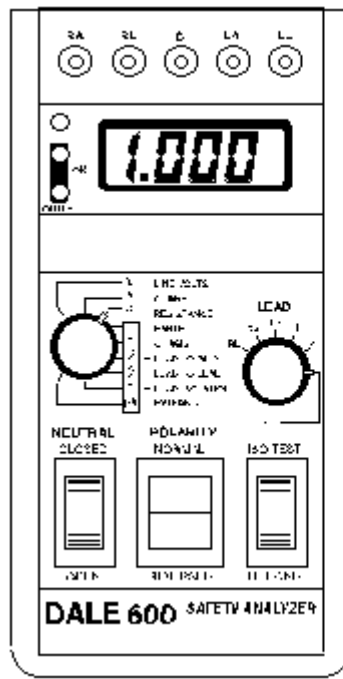
LIKELY FATAL PERSONAL INJURY!! LETHAL VOLTAGES ARE PRESENT WITHIN THE PDU EVEN WHEN ALL PDU BREAKERS ARE OFF. CHECK THAT POWER AT THE MAIN DISCONNECT IS OFF, LOCKED, AND TAGGED BEFORE PROCEEDING.

1. Ensure that **no** power is applied to PDU.
2. Notify all Field Service Engineers working at the site that PDU Main Disconnect will be shut off and locked out.
3. Locate and shut off the Main Disconnect supplying power to the PDU.
4. Lock out and tag the Main Disconnect using appropriate OSHA procedure. (Refer to *Procedure For Safety: Section 6.*)
5. Verify that Main Disconnect and PDU indicators lights are off and power switches are inactive.
6. Connect one clamp-type lead to the External jack on the top of the Dale 600/600E. Connect the other clamp-type lead to the Chassis jack on the top of the Dale 600/600E. See Illustration 1-2.



TOP OF DALE 600/600E ANALYZER
ILLUSTRATION 1-2

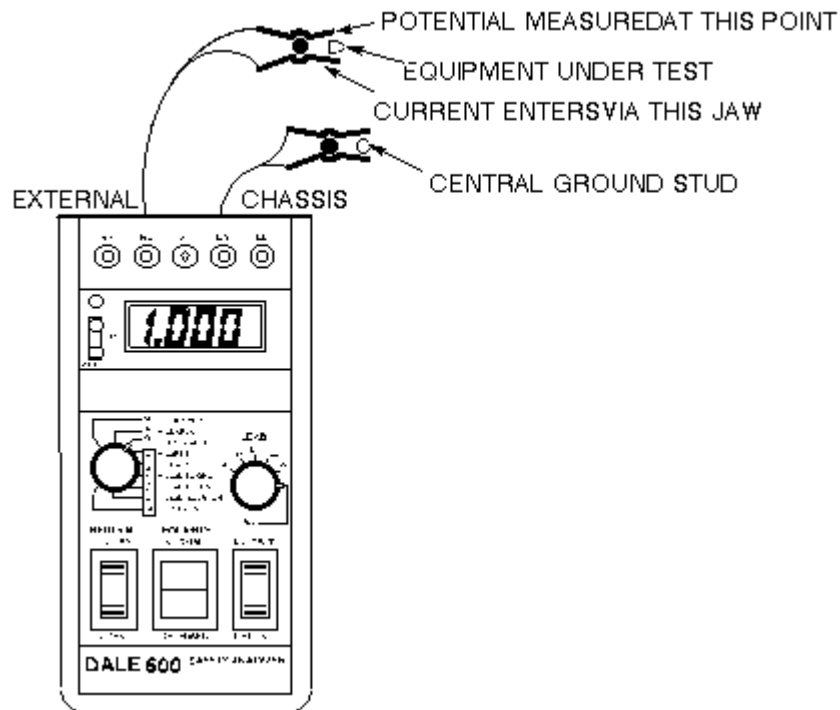
7. On the Dale 600/600E, set the main selector switch to Ω - Resistance. See Illustration 1-3.



DALE 600/600E ANALYZER
ILLUSTRATION 1-3

8. Plug the Dale into an AC outlet.
9. On the Dale 600/600E, verify that the two OK LEDs light up, indicating proper wiring of the AC outlet. See Illustration 1-3.
10. With leads not touching each other, the display should read 1.00. With the leads touching (copper to copper) the display should read 0.00 to 0.02.

11. Attach the leads as shown in Illustration 1-4. (Connect one lead to PDU ground bus bar and the other lead to bare frame of subsystem cabinet under test.)



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DALE 600/600E ANALYZER
ILLUSTRATION 1-4

12. The Dale 600/600E reads resistance in ohms. For example, a reading of 0.50 equals 500 milliohms.
13. Verify that measured resistance is less than 100 milliohms. If this fails, add an additional ground wire.
14. Perform steps 11 through 13 for each subsystem cabinet.

System Restoration

1. Unplug Dale from the ac outlet.
2. Remove leads from the Dale.
3. Close all subsystem cabinets and PDU cabinet.

2- GROUND LEAKAGE CURRENT TEST

Initial Conditions

- Section 1- Ground Resistance Checks (previous section) completed.
- All cable installation complete.
- Facility disconnect off.
- PDU secondary power circuit breakers off.
- Standard PDU only: CB18 (400A) in PDU is on.
- All subsystem cabinet circuit breakers and subsystem power switches are on.

Equipment Required

- One 1kOhm precision resistor
- Digital voltmeter
- Dale 600 (120VAC) or Dale 600E (220Vac) Safety Analyzer
- One set of jumper leads

Note - Sites with Dale 600 or 600E Safety Analyzer

For those sites equipped with a Dale 600 or 600E Safety Analyzer, perform Section 2-2, otherwise perform Section 2-1 using the 1kohm precision resistor and digital voltmeter.

2-1 Ground Leakage Current Test Using DVM and 1kOhm Resistor

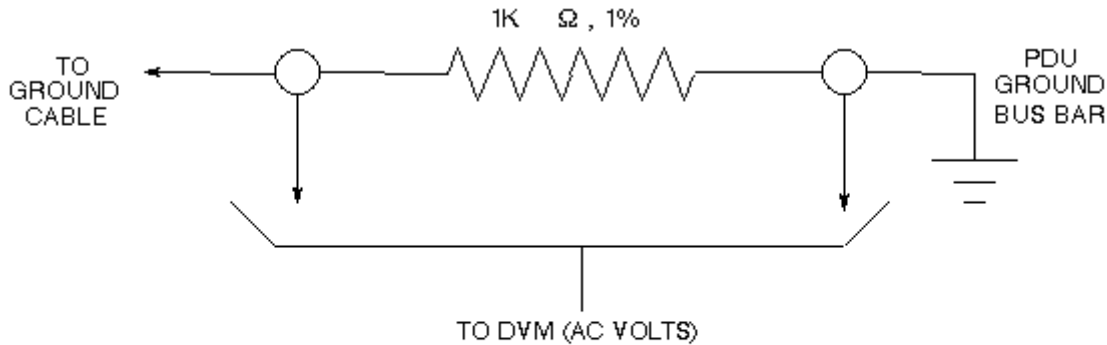
Procedure



LIKELY FATAL PERSONAL INJURY!! LETHAL VOLTAGES ARE PRESENT WITHIN THE PDU EVEN WHEN ALL PDU BREAKERS ARE OFF. CHECK THAT POWER AT THE MAIN DISCONNECT IS OFF, LOCKED, AND TAGGED BEFORE PROCEEDING.

1. Ensure that **no** power is applied to PDU.
2. Notify all Field Service Engineers working at the site that PDU Main Disconnect will be shut off and locked out.
3. Locate and shut off Main Disconnect supplying power to the PDU.

4. Lock out and tag the Main Disconnect using appropriate OSHA procedure. (Refer to *Procedure For Safety: Section 6.*)
5. Verify that Main Disconnect and PDU indicators lights are off, and that power switches are inactive.
6. Connect 1-kOhm resistor to PDU ground bus bar. See Illustration 2-1



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LEAKAGE CURRENT RESISTOR HOOKUP

ILLUSTRATION 2-1

Note

Some subsystem cabinets have one ground connection at the PDU bus bar, while other subsystem cabinets have two. If two ground connections exist, be sure that both are disconnected in the following step.

Note

Most subsystem cabinet grounds are incorporated within power cables. Refer to the "System Interconnects" illustration provided in the Signa installation manual for locating subsystem cabinet grounds.

7. At PDU bus bar, disconnect ground connection(s) of subsystem cabinet under test.

Note

In the following step, only one ground cable should be connected to the 1k ohm resistor. If a second ground cable exists, leave it disconnected during test.

8. Using jumper, connect one of the ground cables disconnected in step 7 to unconnected end of 1-kOhm resistor. See Illustration 2-1.
9. Connect DVM across 1-kOhm resistor (to measure AC volts).
10. Turn on facility disconnect.
11. Turn on PDU power (CB10 for standard PDU, Main Circuit Breaker for compact PDU).
12. Standard PDU only: Select FULL ON mode on PDU Control Board.

13. When mode sequencing finishes, (when all relays stop clicking on standard PDU), turn on CB6 (applies to both standard PDU and compact PDU).
14. Measure voltage across 1kOhm resistor.

Note

500mV corresponds to 500 μ A of leakage current.

- a. If subsystem cabinet under test only had one ground connection at PDU ground bus bar, verify that less than 500 mV (500 μ A) is measured. If more than 500 mV (500 μ A) is measured, a second ground cable must be added between subsystem cabinet under test and PDU ground bus bar. Furthermore, if more than 5000 mV (5000 μ A) is measured, a serious leakage current problem exists which must be corrected. Use appropriate procedures to troubleshoot system.
 - b. If subsystem cabinet under test had two ground connections at PDU ground bus bar, verify that less than 5000 mV (5000 μ A) is measured. If more than 5000 mV (5000 μ A) is measured, a serious leakage current problem exists which must be corrected. Use appropriate procedures to troubleshoot system.
15. Turn CB6 off (applies to both standard PDU and compact PDU).
 16. Standard PDU only: Select Full Off mode on PDU Control Board.
 17. Turn off PDU power (CB10 for standard PDU, Main Circuit Breaker for Compact PDU).
 18. Turn off facility disconnect.

Note

Some subsystem cabinets have one ground connection at the PDU bus bar, while other subsystem cabinets have two. If two ground connections exist, be sure that both are reconnected in the following step.

19. At PDU ground bus bar, reconnect ground connection(s) of subsystem cabinet under test.
20. Perform steps 1 through 19 for each subsystem cabinet.

System Restoration

1. Remove DVM leads.
2. Remove 1-kOhm resistor and jumper.
3. Turn on all PDU secondary power circuit breakers (CB1 through CB17).
4. Close PDU cabinet.

2-2 Ground Leakage Current Test Using Dale

Procedure



LIKELY FATAL PERSONAL INJURY!! LETHAL VOLTAGES ARE PRESENT WITHIN THE PDU EVEN WHEN ALL PDU BREAKERS ARE OFF. CHECK THAT POWER AT THE MAIN DISCONNECT IS OFF, LOCKED, AND TAGGED BEFORE PROCEEDING.

1. Ensure that **no** power is applied to PDU from main disconnect.
2. Notify all Field Service Engineers working at the site that PDU Main Disconnect will be shut off and locked out.
3. Locate and shut off Main Disconnect supplying power to the PDU.
4. Lock out and tag the Main Disconnect using appropriate OSHA procedure. (Refer to *Procedure For Safety: Section 6.*)
5. Verify that Main Disconnect and PDU indicators lights are off, and that power switches are inactive.
6. Connect one clamp-type lead to the External jack on the top of the Dale 600/600E. Connect the other clamp-type lead to the Chassis jack on the top of the Dale 600/600E. See Illustration 1-2.
7. On the Dale 600/600E set the main selector switch to Leakage μ A - External.
8. Connect the Chassis clamp-type lead to PDU ground bus bar.

Note

Some subsystem cabinets have one ground connection at the PDU bus bar, while other subsystem cabinets have two. If two ground connections exist, be sure that both are disconnected in the following step.

Note

Most subsystem cabinet grounds are incorporated within power cables. To locate the PDU or Compact PDU interconnects, select Interconnects from the Topics screen, then select PDU, and then choose either Compact PDU Locations/Connections or PDU Locations/Connections, for locating subsystem cabinet grounds.

Note

In the following step, only one ground cable should be connected to the External clamp-type lead. If a second ground cable exists, leave it disconnected during test.

9. At PDU bus bar, disconnect ground connection(s) of subsystem cabinet under test. See Table 2-1. (Ground leads on the PDU bus can best be reached by opening the front cover of the PDU. The ground leads can be removed using appropriate deep sockets.)

TABLE 2-1
PDU GROUND LEAD AND CIRCUIT BREAKER CONNECTIONS

Subsystem Cabinet	Ground Leads	Circuit Breaker	Output Voltage	Output Phases
GRADIENT AMPLIFIER CABINET	1, 2, 3	CB 6 WITH SHUNT	208	3
BROADBAND RF AMPLIFIER CABINET (OPTION)	4, 5, 6	CB 7 WITH SHUNT	208	3
SPARE (OPTION)	7, 8, 9,	CB 13 WITH SHUNT	208	3
RF AMPLIFIER CABINET	10, 11, 12	CB 17 WITH SHUNT	208	3
OPERATOR CONSOLE	13, 14, 15	CB1	208	3
SYSTEM/COMPUTER CABINETS	16, 17, 18	CB 11	208	3
MULTI-FORMAT CAMERA	19	CB 2	120	1
SPARE (OPTION)	20	CB 3	120	1
SPARE (OPTION)	21	CB 4	120	1
INDEPENDENT CONSOLE	22, 23, 24	CB 5	208	3
SPARE (OPTION)	25	CB 12	120	1
RESISTIVE SHIM POWER SUPPLY (OPTION)	26, 27	CB 18 WITH SHUNT	208	2
PENETRATION CABINET	31	CB 8 WITH SHUNT	120	1
SERVICE OUTLETS	32	CB 9	120	1
SUPERCONDUCTING SHIM SERVICE RECEPTACLE	33, 34, 35	CB 16	208	3
MAGNET SERVICE RECEPTACLE	36, 37, 38	CB 15	208	3

10. Connect one of the ground cables disconnected in the previous step to External clamp-type lead.
11. Turn on facility disconnect.
12. Turn on PDU power (CB10 for standard PDU, main circuit breaker for compact PDU).

13. Standard PDU only: Select Full On mode on PDU Control Board.
14. When mode sequencing has completed (when all relays stop clicking on standard PDU), turn on CB6 for gradient cabinet (applies to both standard PDU and compact PDU).
15. Measure leakage current.
 - a. If subsystem cabinet under test had only one ground connection at PDU ground bus bar, verify that less than 500 μA is observed. If more than 500 μA is measured, a second ground cable must be added between subsystem cabinet under test and PDU ground bus bar. Furthermore, if more than 5000 μA is measured, a serious leakage current problem exists which must be corrected. Use appropriate procedures to troubleshoot system.
 - b. If subsystem cabinet under test had two ground connections at PDU ground bus bar, verify that less than 5000 μA is measured. If more than 5000 μA is measured, a serious leakage current problem exists which must be corrected. Use appropriate procedures to troubleshoot system.
16. Turn CB6 (for gradient) off (applies to both standard PDU and compact PDU).
17. Standard PDU only: Select Full Off mode on PDU Control Board.
18. Turn off PDU power (CB10 for standard PDU, Main Circuit Breaker for compact PDU).
19. Turn off facility disconnect.

Note

Some subsystem cabinets have one ground connection at the PDU bus bar, while other subsystem cabinets have two. If two ground connections exist, be sure that both are reconnected in the following step.

20. At PDU ground bus bar, reconnect ground connection(s) of subsystem cabinet under test.
21. Perform steps 1 through 20 turning on appropriate circuit breakers for each subsystem cabinet under test per Table 1.

System Restoration

1. Remove leads from Dale 600/600E Safety Analyzer.
2. Turn on all PDU secondary power circuit breakers (CB1 through CB17).
3. Close PDU cabinet.

3- PHYSICAL ACQUISITION CONTROLLER (PAC-II) LEAKAGE CURRENT TEST

Initial Conditions

- System in Standby or Idle Operating Condition

Equipment required

- Dale 600 (120VAC) or Dale 600E (220VAC) Safety Analyzer (46-328406G1)

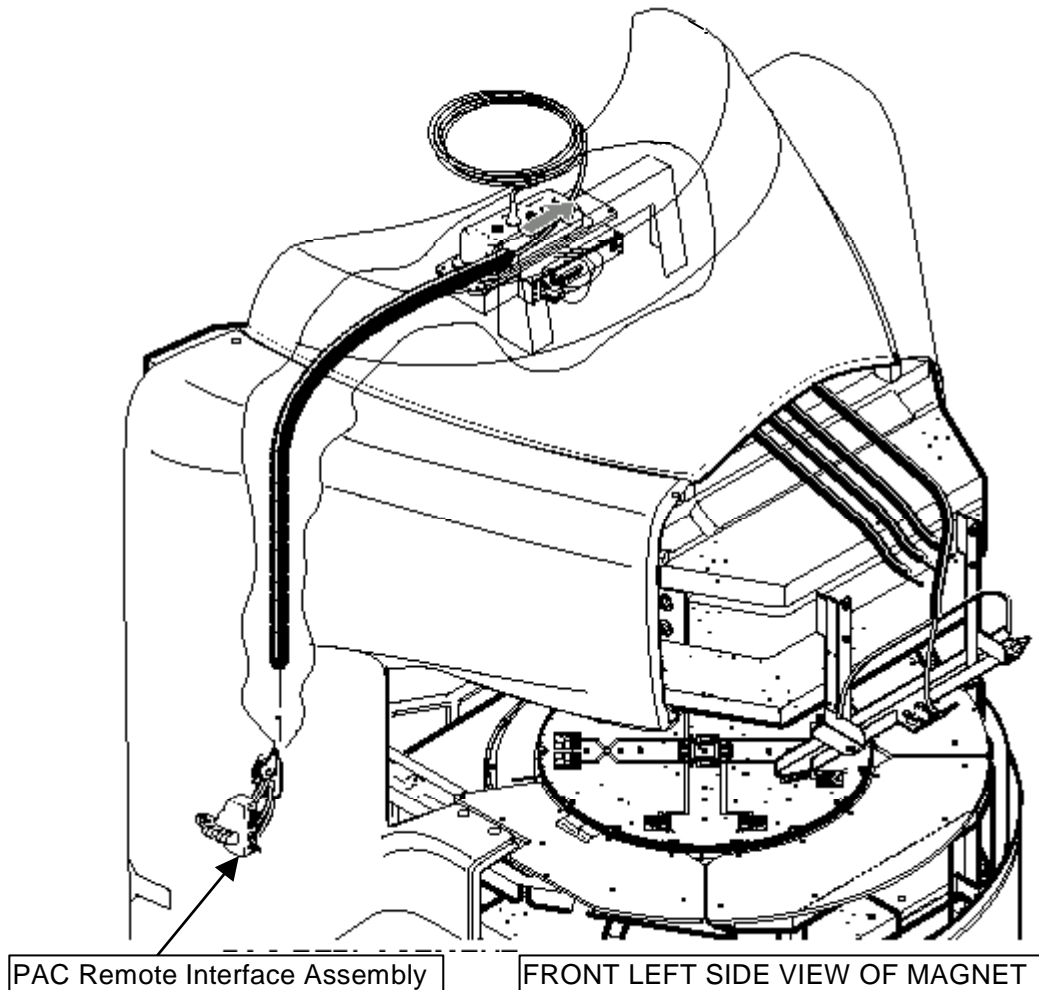
3-1 PAC-II Leakage Current Test Using Dale 600/600E Safety Analyzer

Note

The Dale 600/600E Safety Analyzer may only be taken 51 cm or 20 inches from the PAC Remote Interface Assembly. The gauss field closer will affect the Dale Safety Analyzer, thereby altering the tool's ability to take an accurate measurement.

3-1 PAC-II Leakage Current Test Using Dale 600/600E Safety Analyzer (continued)

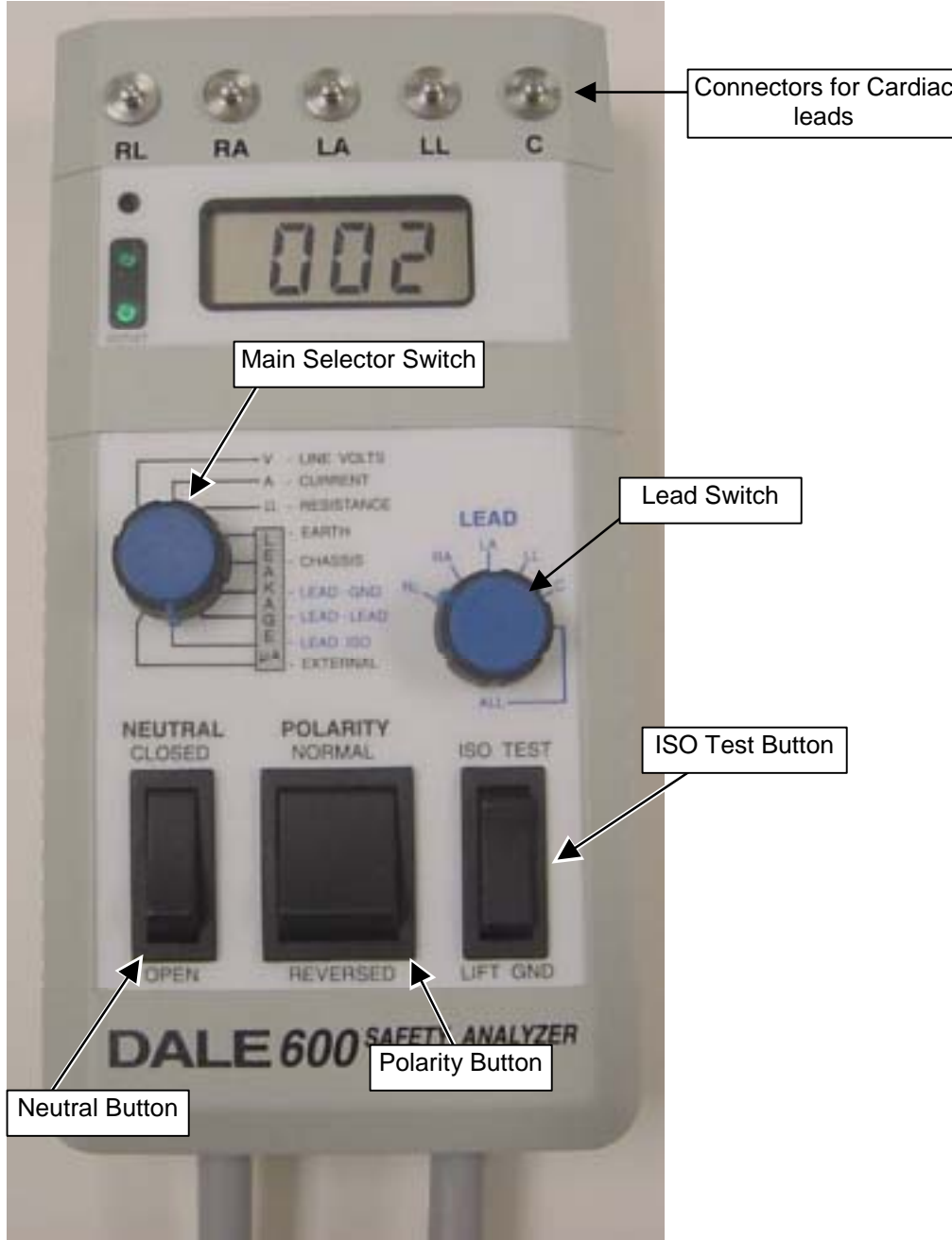
1. Plug the Analyzer into a power source in the magnet room, which allows access to the PACII Remote Interface Assembly while maintaining distance (see Note above) from the magnet.
2. At Physiological Acquisition Controller (PAC-II) Remote Interface Assembly, connect the Patient Lead cable and the Cardiac Lead Set at the ECG connector. See Illustration 1-14.



LOCATION OF THE PAC REMOTE INTERFACE ASM FOR OVATION MAGNET
ILLUSTRATION 1-14

3-1 PAC-II Leakage Current Test Using Dale 600/600E Safety Analyzer (continued)

3. Connect cardiac leads to Dale 600/600E (46-328406G1). See Illustration 1-15.



DALE 600 ANALYZER
ILLUSTRATION 1-15

4. Place the Neutral Button in the CLOSED position.

3-1 PAC-II Leakage Current Test Using Dale 600/600E Safety Analyzer (continued)

5. Place the POLARITY switch in the NORMAL position.
6. On the Dale 600/600E set the main selector switch to LEAKAGE - LEAD-GND.
7. Move LEAD switch through the positions shown in Table 1-1 and verify leakage current displayed on meter is less than 50 micro amps.

Note

Typically the Lead to Ground and Lead to Lead readings are minimal or zero. Measurements exceeding the 50 micro amps indicate an issue in the corresponding lead.

TABLE 1-1
LEAKAGE CURRENT MEASUREMENTS

LEAD SELECT POSITION
RL
RA
LA
LL

Note

Record data for steps 7 through 13 in Data Table 1-1, Gated Studies Module Leakage Current Check. Do not write on Master. Make Photo Copy.

8. On the Dale 600/600E set the main selector switch to LEAKAGE - LEAD-LEAD.
9. Move LEAD switch through the positions shown in Table 1-1 and verify leakage current displayed on meter is less than 50 micro amps.
10. On the Dale 600/600E set the main selector switch to LEAKAGE - LEAD-ISO.
11. Make sure that the leads are not touching the floor.
12. Move the LEAD switch to ALL LEADS.
13. Press button ISO TEST and record the meter reading in Data Table. This reading must be less than 50 micro amps. Record meter reading in Data Table.
14. Repeat Steps 6 - 13 with the POLARITY switch in the REVERSED position.

Restoration

1. Disconnect the Cardiac Lead Set from Dale Safety Analyzer.
2. Remove the Patient Lead cable from the ECG Connector.
3. Unplug the Dale Safety Analyzer.

Data Sheet- PAC-II LEAKAGE CURRENT

DATA TABLE 1-1
PAC-II LEAKAGE CURRENT MEASUREMENTS

LEAD SELECT POSITION	METER READING NORMAL POSITION (microamps)	METER READING REVERSE POSITION (microamps)
Lead to Ground		
Right Leg (RL)		
Right Arm (RA)		
Left Arm (LA)		
Left Leg (LL)		
Lead to Lead		
RL		
RA		
LA		
LL		
ISOLATION Tests		
ALL LEADS ISO Test		

REVISION HISTORY

REV	DATE	AUTHOR	PRIMARY REASONS FOR CHANGE
0	May 27, 2002	Y.Masumo	Added information of PACII leakage for MFO