| g GE Energy | **Functional Testing Specification** |
|---|---|
| ***Parts & Repair Operations***<br>***Louisville, KY*** | **LOU–GEF-PWMC7/C8** |

**Test Procedure for a PWMC7 & PWMC8 card**

**DOCUMENT REVISION STATUS: Determined by the last entry in the "REV" and "DATE" column**

| REV. | DESCRIPTION | SIGNATURE | REV. DATE |
|---|---|---|---|
| A | Initial release | | |
| B | Converted to new template | JCW | 11/15/06 |
| C | Clarification of switch setting to page five, section 6.4.1 | JCW | 12/04/06 |
| D | Corrected grammar, redundancy and inconsistency of language and terminology and for overall clarity of operation. | CRE | 05/19/09 |
| E | During the time of my first revision, I did not have the time to actually go through the revision in its final form. Upon finally having the time to do so, I found that further revision was necessary. Edited order of operations so as to facilitate better workflow management. Added missing steps. Removed redundancy except where needed for the sake of proper operation of the test itself. Corrected placement of prerequisite information from step to step. Separated steps where there were multiple steps within a single operation allocated as one "step". | CRE | 06/03/09 |
| F | Added differentiation in section 6.12 between PWMC7 and PWMC8 functional testers, which previously were only assumed. Corrected a typographical error and an incomplete sentence. | CRE | 06/19/09 |



| PREPARED BY | REVIEWED BY | REVIEWED BY | QUALITY APPROVAL |
|---|---|---|---|
| Charlie Wade | Jamie Francis | Cristyn Edlin | Charlie Wade |
| **DATE** | **DATE** | **DATE** | **DATE** |
| 11/15/2006 | 12/04/2006 | 06/19/09 | 06/2/09 |

## 1. SCOPE

**1.1** This is a functional testing procedure for a Card.

## 2. STANDARDS OF QUALITY

**2.1** Refer to the current revision of the IPC-A-610 standard for workmanship standards.

## 3. APPLICABLE DOCUMENTS

**3.1** The following document(s) shall form part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue shall apply.
**3.1.1**

## 4. ENGINEERING REQUIREMENTS

**4.1** Equipment Cleaning
**4.1.1** Equipment should be clean and free of debris prior to applying power unless performing an initial check. Refer to the local documented procedures for cleaning guidelines.
**4.2** Equipment Inspection
**4.2.1** Equipment should be visually inspected for any defects prior to applying power. This inspection should include the following as a minimum:
**4.2.1.1** Wires - broken, cracked, or loosely connected
**4.2.1.2** Terminal strips / connectors - broken or cracked
**4.2.1.3** Components - visually damaged
**4.2.1.4** Capacitors - bloated or leaking
**4.2.1.5** Solder joints - damaged or cold
**4.2.1.6** Circuit board - burned or de-laminated
**4.2.1.7** Printed wire runs / Traces - burned or damaged

## 5. EQUIPMENT REQUIRED

**5.1** The following equipment is required to perform the process requirements. Equipment may be substituted provided that all accuracy's and test ratios are equivalent or better.

| Qty | Reference # | Description |
|---|---|---|
| 4 | | Fluke 77 DMM or equivalent |
| 1 | | TEK 465 or equivalent |
| 1 | | PWMT1 for testing PWMC7 Cards<br>PWMT2 for testing PWMC8 Cards |
| 1 | | PWMC7/8 Test Fixture |
| 1 | | 200VDC Power Supply |
| 1 | | PWMC7 or PWMC8 Functional Test Fixture |

## 6. TESTING PROCESS

### 6.1 Setup

**6.1.1** If the customer shipped the card with additional gain components, remove them.

**6.1.2** Remove the LSI chip or LSI card and connect the LSI cable assembly in its place.

**6.1.3** Check for shorts on the card before powering up.

**6.1.4** Hookup the cable assemblies to 1PL, 2PL, 3PL, 4PL, 5PL, 6PL accordingly.

**6.1.5** Verify that 6PL has berg jumpers connected in the B/H and A/J settings.

**6.1.6** Apply a jumper across C16 and C7. C7 can also be jumped via T1 to T2.

**6.1.7** Connect a meter to the main DC buss supply output.

**6.1.8** Connect a meter to the reference and ground jacks (located at the top right corner of the fixture).

**6.1.9** The ISENSE+ and ISENSE- jacks are located at the top of the fixture, near the top left corner of the UUT. They are labeled TP-Y/CC for + and TP-Z/DD for -.

**6.1.10** Connect a meter to the ISENSE+ and ISENSE- jacks accordingly.

**6.1.11** With the main DC buss supplies output disconnected from the fixtures input, turn on the DC buss supply and adjust its output for 150VDC.

**6.1.12** Turn off the main DC buss supply.

**6.1.13** While keeping the meter connected to the supply output, connect the main DC buss supply to the fixtures 150VDC input.

**6.1.14** Connect a scope to the left and right armature outputs of the test fixture.

**6.1.15** For the initial switch settings, position 2 is down except for S15, in which case 2 is center. Position 1 is up and position 3 is down. See table 1 next page.

| Switch | Position | Switch | Position |
|---|---|---|---|
| S1 | 2 | S20 | 1 |
| S2 | 2 | S21 | 1 |
| S3 | 2 | S22 | 1 |
| S4 | 2 | S23 | 2 |
| S5 | 2 | S24 | 2 |
| S6 | 1 | S25 | 2 |
| S7 | Open | S26 | 1 |
| S8 | Open | S27 | 2 |
| S9 | Open | S28 | 2 |
| S10 | Open | S29 | 2 |
| S11 | 1 | S30 | 2 |
| S12 | 1 | SA | LSI 1-10 |
| S13 | 2 | SB | LSI 21-30 |
| S14 | Open | SC | LSI 1-20 |
| S15 | 2 (Center) | SD | RS-5PL |
| S19 | Open | | |

Table 1

### 6.2 Testing Procedure (Op Amp Section)

**6.2.1** Turn on the 20VDC logic supply.

**6.2.2** The rotary switch labeled RSW 5PL is located in the top right corner of the test fixture and provides selections for 5PL and 4PL.

**6.2.3** Using RSW 5PL, verify that 5PL-A measures –12VDC.

**6.2.4** Verify that 5PL-G measures +12VDC.

**6.2.5** Turn on the main DC buss supply.

**6.2.6** Verify that the signal reference output measures 0VDC at 4PL-E.

**6.2.7** Switch S5 to position 1.

**6.2.8** Verify that the signal reference output at 4PL-E ranges from +5.5VDC to –5.5VDC as the SIG REF (signal reference) pot is swung through its entire range.

**6.2.9** Switch S5 to position 2 and RSW 5PL to 4PL-D.

**6.2.10** Switch S2 to position 1.

**6.2.11** Verify that the velocity loop output at 4PL-D ranges from +6.8VDC to –6.8VDC as the VEL CMD (velocity command) pot is swung through its entire range. Having any additional gain resistors will give different readings.

**6.2.12** Switch S2 to position 2 and S1 to position 1.

**6.2.13** Verify that the velocity loop output at 4PL-D ranges from +7VDC to – 7VDC as the TACH pot is swung through its entire range.

**6.2.14** Switch S1 to position 2 and S3 to position 1.

**6.2.15** Verify that the velocity loop output ranges from +8.6VDC to – 8.6VDC as the CUR LIMIT (current limit) pot is swung through its entire range.

**6.2.16** Switch S3 to position 2.

**6.2.17** Turn off the 20V logic and main DC buss supplies.

### 6.3 Testing Procedure (PWC Op Amp)

**6.3.1** Turn on only the 20V logic supply.

**6.3.2** Switch S2 to position 1.

**6.3.3** Switch RSW 5PL to 4PL-B. This monitors the PWC Op Amp's output.

**6.3.4** Verify that the PWC Op Amp's output measures 0V as the VEL CMD Pot is swung through its entire range.

**6.3.5** Switch S4 to position 1.

**6.3.6** Verify that the PWC Op Amp's output ranges from +7.1VDC to –7.1VDC as the VEL CMD pot is swung through its entire range.

**6.3.7** Switch S4 and S2 to position 2.

### 6.4 Testing Procedure (Logic Chip).

**6.4.1** Using switch D, select the RS LSI position.

**6.4.2** Monitor pins on the chip socket and compare with values listed in table below.

| PIN | OUTPUT | | DESCRIPTION |
|---|---|---|---|
| 1 | 0 | | RMS Overcurrent |
| 2 | 0 | | RMS Overcurrent |
| 3 | -7.5(+-0.5) | | IANALOG |
| 4 | 0 | | Compensation Cap. |
| 5 | -6.1(+-0.5) | | ISENSE+ |
| 6 | -7.5(+-0.5) | | ISENSE- |
| 7 | -5.2(+-0.5) | | ILIMIT- |
| 8 | +5.2(+-0.5) | | ILIMIT+ |
| 9 | 0 | | Current Limit |
| 10 | 0 | | Frequency Set |
| Switch “A” | To LSI 11-20 | | |
| 11 | 0 | | PWC |
| 12 | 0 | | Inhibit Delay |
| 13 | 0 | | Deadband Set |
| 14 | 0 | | Deadband Set |
| 15 | +12.3(+-0.5) | | AA Driver |
| 16 | +12.3(+-0.5) | | VV Driver |
| 17 | 0 | | Inhibit- |
| 18 | 0 | | Inhibit+ |
| 19 | 0 | | 0V |
| 20 | +12.3(+-0.5) | | BB Driver |
| Switch “A” | To LSI 1-10 | Switch “C” | To LSI 21-40 |
| 21 | +12.3(+-0.5) | | UU Driver |
| 22 | 0 | | Deadband |
| 23 | +11(+-0.5) | | LED2 |
| 24 | +11(+-0.5) | | LED1 |
| 25 | 0 | | Fault Trip |
| 26 | 0 | | Inst. Overcurrent Daly |
| 27 | 0 | | Power On Reset |
| 28 | 0 | | Fault Trip |
| 29 | 0 | | Aux. Clamp |
| 30 | 0 | | Inst. Overcurrent |
| Switch “B” | To LSI 31-40 | | |
| 31 | -12.3(+-0.5) | | -8V |
| 32 | 0 | | OV |
| 33 | -12.3(+-0.5) | | +8V |
| 34 | 0 | | Clamp In |
| 35 | 0 | | Clamp Out |
| 36 | -1.13 | | -12UV |
| 37 | 6.85 | | +12V |
| 38 | 6.22 | | 6.2 Reference |
| 39 | 0 | | +150V Overvoltage Sense |
| 40 | 0 | | RMS Overcurrent |

**6.4.3** Return switches SA to LSI 1-10, SB to LSI 21-30, SC to LSI 1-20, and SD to RS 5PL

**6.4.4** Turn off the 20V logic supply.

### 6.5 Testing Procedure (Power Switching Circuitry)

**6.5.1** The left and right armature outputs should already be setup for monitoring with a scope. See step 6.1.12.

**6.5.2** Turn on the 20V logic and main DC buss supplies.

**6.5.3** Slowly increase main DC buss supply to 175VDC. The armature voltages should remain at 40% of the bus voltage level.

**6.5.4** Press S7 - left armature will rise to 175V, LED 6 lights, UL Quad.

**6.5.5** Press S8 - left armature will drop to 0V, LED 4 lights, LL Quad.

**6.5.6** Press S9 - right armature will drop to 0V, LED 3 lights, LR Quad.

**6.5.7** Press S10 - right armature will rise to 175V, LED 5 lights, UR Quad.

**6.5.8** Turn off both power supplies.

**6.5.9** Disconnect the main DC supply's output form the fixtures DC input.

### 6.6 Testing Procedure (Triangle Waveform – Only seen with the LSI Chip)

**6.6.1** Disconnect the LSI cable assembly.

**6.6.2** If the UUT has the LSI card instead of the chip, skip to step 6.7.1.

**6.6.3** if the UUT has the LSI chip instead of the card, reinsert LSI chip.

**6.6.4** Turn on the 20V logic and main DC buss supplies.

**6.6.5** The triangle wave at 5PL-B should measure 12V peak to peak, and oscillate at 1750HZ +/-150Hz.

### 6.7 Testing Procedure (Fault Bus)

**6.7.1** Turn on the main DC supply.

**6.7.2** Adjust the main DC supply's output to 0VDC.

**6.7.3** Turn off and reconnect the main DC supply.

**6.7.4** Reinsert the LSI card.

**6.7.5** Disconnect the reference lead from the reference-to-ground meter.

**6.7.6** Using a clip lead, connect the meter from ground to the Fault Bus at 2PL-G.

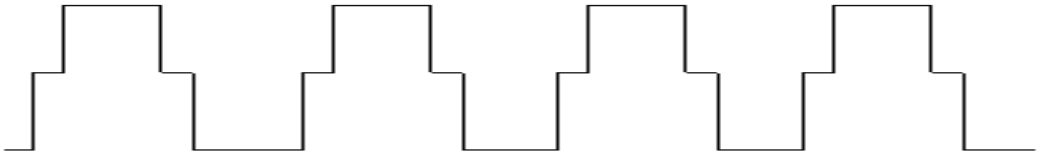
**6.7.7** Turn on the 20V logic and main DC buss supplies.

**6.7.8** Adjust the main DC buss supply's output to 100VDC.

**6.7.9** For the LSI chip, the fault buss should switch from 0.6VDC to +7.4DCV at 70 to 80VDC. This is the enabled condition for the card. Switching starts at this point.

**6.7.10** For the LSI board, the fault buss should switch from 0.6VDC to +11.83VDC at 70 to 80VDC.

**6.7.11** You should see the following waveform on the left and right armatures.



**6.7.12** Once the waveform has been verified, turn off the main DC buss supply.

**6.7.13** Disconnect the main DC supply's output form the fixtures DC input.

**6.7.14** Turn on the main DC supply.

**6.7.15** Adjust the main DC supply's output to 150VDC.

**6.7.16** Turn off and reconnect the main DC supply.

### 6.8 Testing Procedure (Current Analog & Current Limit)

**6.8.1** Disconnect the clip lead from 2PL-G.

**6.8.2** Connect the clip lead to 2PL-C.

**6.8.3** Switch S15 to position 1.

**6.8.4** Press and hold S14.

**6.8.5** While holding S14, adjust P3 so that 2PL-C measures 0VDC.

**6.8.6** Release S14.

**6.8.7** Verify that the measurement at 2PL-C switches from 0VDC to 5VDC.

**6.8.8** Verify that the measurement at 2PL-C switches from 5VDC to 0VDC when S15 is switched to position 2.

**6.8.9** Turn on the main DC buss supply.

**6.8.10** Switch S15 to position 1 (Up).

**6.8.11** Adjust the CUR ANALOG (current analog) pot so that the meter at terminals TP-Z/DD and TP-Y/CC reads -1.47VDC.

**6.8.12** Verify that the left and right armature signals are present.

**6.8.13** If the left and right armature signals are not present, adjust P4 until the armatures signals appear then adjust P4 about ¼ turn further.

**6.8.14** Switch S15 to position 3 (Down).

**6.8.15** Adjust the CUR ANALOG pot so that the meter at terminals TP-Z/DD and TP-Y/CC reads 1.47VDC.

**6.8.16** Verify that the left and right armature signals are still present.

**6.8.17** If the left and right armature signals are not present, adjust P5 until the armatures signals appear then adjust P4 about ¼ turn further.

### 6.9 Testing Procedure (RMS Overcurrent Sense)

**6.9.1** Adjust the CUR ANALOG pot so that 2PL-C reads -3.0VDC.

**6.9.2** Disconnect the clip lead from 2PL-C.

**6.9.3** Connect the clip lead to 6PL-G.

**6.9.4** Increasing the voltage measured at 6PL-G and adjusted by turning P6 increases the trip time.

**6.9.5** For the LSI Chip, adjust P6 for an output voltage of –1.13V.

**6.9.6** For the LSI Board, adjust P6 for an output voltage of –1.2V.

**6.9.7** Switch S15 to position 1.

**6.9.8** Disconnect the clip lead from 6PL-G.

**6.9.9** Connect the clip lead to 2PL-A.

**6.9.10** Adjust the CUR ANALOG pot so that the meter at terminals TP-Z/DD and TP-Y/CC reads -1.47VDC.

**6.9.11** The RMS over-current trip should take about 90 seconds +/- 30 seconds.

**6.9.12** To time the RMS over-current trip, disconnect one side of the C16 jumper.

**6.9.13** When the voltage at 2PL-A reaches 6.2VDC, LED1 should light.

**6.9.14** Turn off the 20VDC logic and main DC buss supplies.

**6.9.15** Reconnect the side of the C16 jumper, which was previously disconnected.

**6.9.16** Turn on the 20VDC logic and main DC buss supplies.

**6.9.17** Switch S15 to position 3.

**6.9.18** Looking for LED 2 to light instead of LED1 and while adjusting CUR ANALOG for +1.47VDC rather than –1.47VDC, repeat steps 6.9.10 - 6.9.15.

**6.9.19** Turn off the 20VDC logic and main DC buss supplies.

**6.9.20** For troubleshooting reference, compare the values in the following table to the outputs of 6PL-E/F/G.

LSI Chip Reading

| I analog | 1PL-Y/Z | 6PL-E | 6PL-G | 6PL-F | Time |
|---|---|---|---|---|---|
| S15 (1) | | | | | |
| +-3.0V | 0.83 | +-1.48(+-0.2) | -1.13 | 0 | |
| +-5.3V | 1.47 | +-4.8(+-0.4) | -3.5(+-0.4) | -4.7(+-0.5) | ~80 seconds |
| | | | | | |
| S15 (2) | | | | | |
| +-3.0V | -0.83 | 1.27 | -2.84 | 0 | |
| +-5.3V | -1.47 | 3.9 | -8.62 | -4.48 | ~80 seconds |

LSI Daughter Board Reading

| I analog | 1PL-Y/Z | 6PL-E | 6PL-G | 6PL-F | Time |
|---|---|---|---|---|---|
| S15 (1) | | | | | |
| +-3.0V | 0.83 | 0.97 | -2.2 | 0 | |
| +-5.3V | 1.47 | 3.4 | -7.44 | -2.75 | ~100 seconds |
| | | | | | |
| S15 (2) | | | | | |
| +-3.0V | -0.83 | 1.27 | -2.84 | 0 | |
| +-5.3V | -1.47 | 3.9 | -8.62 | -4.48 | ~80 seconds |

### 6.10 Testing Procedure (150V Overvoltage Sense)

**6.10.1** Disconnect the clip lead from 2PL-A.

**6.10.2** Connect the clip lead to 2PL-G.

**6.10.3** Turn on the 20VDC logic and main DC buss supplies.

**6.10.4** The overvoltage trip fault should occur at about 192VDC.

**6.10.5** Slowly increase main DC buss supply to 200VDC.

**6.10.6** Both LED1 and LED2 should light to indicate an overvoltage fault.

**6.10.7** Turn off the 20VDC logic and main DC buss supplies.

**6.10.8** Disconnect the main DC supply's output form the fixtures DC input.

**6.10.9** Turn on the main DC supply.

**6.10.10** Adjust the main DC supply's output to 150VDC.

**6.10.11** Turn off and reconnect the main DC supply.

### 6.11 Testing Procedure (Armature Switching)

**6.11.1** Attach scope leads to 1PL-A & D, Quad Drivers

**6.11.2** Switch S27 through S30 to position 1.

**6.11.3** Turn on the 20VDC logic and main DC buss supplies.

**6.11.4** You should see the following waveform on a PWMC7 1PL-A & D or on a PWMC8 1PL-A & E.

.2ms @5V per div

150 Volts

0 Volts

**6.11.5** If this signal is bad check C23, C25 R88 and R111.

**6.11.6** Verify that one armature pulse disappears when S11 is switched to position 2.

**6.11.7** Return S11 to position 1.

**6.11.8** Verify that the other armature pulse disappears when S12 is switched to position 2.

**6.11.9** Return S12 to position 1.

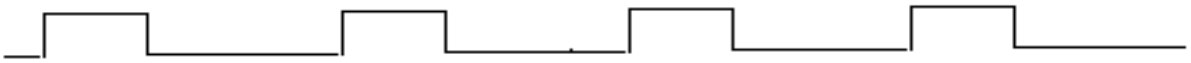
**6.11.10** Verify that both armature pulses disappear when S13 is switched to position 1.

**6.11.11** Verify that both armature pulses reappear when S13 is returned to position 2.

**6.11.12** Verify waveforms on a PWMC7 at 1PL-K, & U, they should be like this. Waveforms on a PWMC8 will be at 1PL-M, N, X, & Y.

.2ms @5V per div

50 Volts



0 Volts

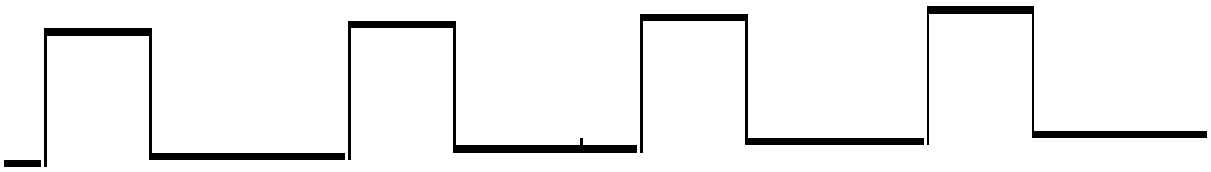
**6.11.13** Return S27 through S30 back to position 1.

**6.11.14** 1PL-A & D should measure 150VDC

**6.11.15** On a PWMC7, the waveform at 1PL-G, H, J, K, S, T, U, & V or left and right armatures should look like the following representation.

**6.11.16** On a PWMC8, the waveform should be on 1PL-J, K, L, M, N, V, W, X, Y, & Z.

150Volts



0 Volts

**6.11.17** Turn off the 20VDC logic and main DC buss supplies.

**6.11.18** To move on to the next part of this procedure, remove the UUT from this test fixture.

**6.11.19** Note: The following section pertains to two separate functional testers. The PWMC7 uses one and the PWMC8 uses the other. However, the operational steps for each are the same.

**6.12 Testing Procedure (PWMC7/8 Drive Test)**

**6.12.1** Clip a 4.7K ½ watt resistor across T2-T9.

**6.12.2** Install the UUT into the PWMC7/8 functional tester.

**6.12.3** Connect the scope probes, current probes and meters.

**6.12.3.1.1** Note: The PWMC8 tester provides dedicated cable loops for connection of the current probes. These loops are located on the back of the tester. On the PWMC7, these cables go directly to the terminal blocks.

**6.12.3.1.2** Connect one current probe to the cable of the “Upper” terminal and the other current probe to the cable of the “Lower” terminal in the polar opposite direction.

**6.12.3.1.3** Connect one scope probe to the “Upper” terminal and the other scope probe to the “Lower” terminal.

**6.12.3.1.4** Note: This step and the next two apply only to the PWMC7. The PWMC8 tester has a meter built in for this purpose. If testing a PWMC7, connect the ground jack of the scope to the ground jack of the meter.

**6.12.3.1.5** Connect the ground jack of the meter to the ground terminal of the terminal block.

**6.12.3.1.6** Connect the hot jack of the meter to the 150VDC terminal.

**6.12.3.1.7** If testing a PWMC8, connect the ground jack of the scope to the ground terminal on the face of the tester.

**6.12.3.1.8** Connect one meter to each of the current probes.

**6.12.4** Plug the drive fixture in to a 230VAC outlet.

**6.12.5** Turn on the 110VAC fan supply.

**6.12.6** Be sure that the enable switches are in the off position.

**6.12.7** Turn on the drive's logic power supply.

**6.12.8** Engage the main DC buss disconnect.

**6.12.9** Verify that the waveforms come up to 38% percent of the drives main DC buss voltage.

**6.12.10** If the signals are present, enable the drive switch.

**6.12.11** Verify that two square-wave signals appear on the scope.

**6.12.12** Enable the velocity control.

**6.12.13** Verify that the waveforms have not become noisy or distorted and are consistent in both positive and negative directions.

**6.12.14** To look for a linear increase of current in both directions, swing the speed/velocity adjustment pot through a 100Amp range from -50Amps to +50Amps.

**6.12.15** If the waveforms remain consistent within the aforementioned current range, verify that they remain consistent with an increase in velocity command to +85Amps and -85Amps for 1-2 seconds each.

**6.12.16** Readjust the velocity command to +10Amps.

**6.12.17** Allow the card to burn in for 15 minutes at +10Amps.

**6.12.18** After a successful 15-minute burn in at +10Amps, readjust the velocity command to -10Amps.

**6.12.19** Allow the card to burn in for 15 minutes at -10Amps.

**6.12.20** Readjust the velocity command to 0Amps.

**6.12.21** Disable the velocity control.

**6.12.22** Disable the drive switch.

**6.12.23** Disengage the main DC buss disconnect.

**6.12.24** Turn off the drive's logic power supply.

**6.12.25** Turn off the 110VAC fan supply.

**6.12.26** Test complete.

## 7. NOTES

**7.1** If the customer shipped the card with additional gain components, be sure to reinstall them.

**7.2** Pull the maintenance and LSI card installation documentation and ship the aforementioned documentation with the card.

## 8. ATTACHMENTS

**8.1** None at this time