C H A P T E R 5
MAINTENANCE

Copley Controls amplifier systems should be serviced only by highly trained and qualified personnel.

WARNING

Adhere to all precautions listed in the Safety Summary section located at the beginning of this manual.

Dangerous voltages capable of causing loss of life are present both inside and outside this amplifier system. Use extreme caution when accessing, handling, testing and adjusting.

Work under extremely clean conditions: If a single loose particle of metal remains inside an amplifier or falls in through an opening it may cause a failure. Do not perform soldering or metal working operations where there is a danger of particles getting into the amplifier. Keep unused assemblies in clean containers or bags.

Limited Servicing

Field servicing should be limited to adjustments and changing field-replaceable units (FRUs) such as the 601S Power Supply, the Axis Amplifier Assemblies, the Capbank Assembly, and the ADCI Assembly. Table 5-1 lists the FRU support parts and provisioning for the 281 Amplifier system.

Not only is internal servicing dangerous to personnel, if it is not performed with proper procedures, equipment, and cleanliness comparable with factory manufacture, the reliability may be impaired.

Routine Maintenance

In a normal operating environment, perform the following tasks at least at six-month intervals:

1. Clean the front panel fan filters
2. Vacuum the openings in the cabinet, HV Power Supply, Capbank Assembly, and amplifier openings to assure a normal flow of cooling air.

In dusty or dirty environments, routine maintenance should be performed more often.

TABLE 5-1. FIELD REPLACEABLE UNIT (FRU) PART NUMBERS

FRU NAME	PART NO.
281 Axis Amplifier Assembly	05-00819-000
Capbank Assembly	(+) 05-00854-000 (-) 05-00855-000
ADCI Assembly	05-00747-000
601S Power Supply	05-00829-000
Axis I/O Assembly	02-00882-000
601S Power Supply I/O Assembly	02-00912-000
601S I/O Assembly	02-00998-000

Maintenance Schedule for Liquid Coolant (DOWTHERM SR-1) in Copley Controls 281 Amplifier Systems

DOWTHERM SR-1

Ethylene Glycol-based Fluid

Temperature Range:

-60 °F to 250 °F (50% by volume) Operating Temperature

-30 °F (50% by volume) Freeze Protection

-60 °F (50% by volume) Burst Protection

Dow Technical Assistance 1-800-447-4369 Extension DOWTHERM

REF. Engineering and Operating Guide for DOWTHERM SR-1

Analytical Tools for Self-Testing

Misco Products refractometer, model 7084VP (°F) and 7064VP (°C)

Note:

1. Copley Controls Amplifier Systems are supplied with DOWTHERM SR-1 fluid.

2. Distilled or deionized water is recommended to dilute DOWTHERM SR-1 to the appropriate concentration. If good quality water is unavailable, pre-diluted solutions of DOWTHERM fluids are available from Dow. Dilution water quality requirements are: Chlorides – 25 ppm, max, Sulfates – 25 ppm, max, Calcium – 50 ppm, max, and Magnesium – 50 ppm, max.

Recommended Yearly Maintenance of DOWTHERM SR-1 in Copley Control 281 Amplifier Systems

Note: For systems containing more than 250 gallons of DOWTHERM SR-1, contact Dow Chemical Company for a free fluid analysis service.

1. On-site fluid analysis is available using Misco Products refractometers (see above) for operators of systems containing less than 500 gallons of DOWTHERM SR-1. Use the refractometer to measure the glycol concentration (50% by volume) of the DOWTHERM fluid to ensure that corrosion and freeze protection is maintained. To adjust the concentration of glycol solution, add more DOWTHERM SR-1 to increase protection against cold weather or add distilled or deionized water as specified in note 2 above to replace fluid lost by leakage.

2. Test the fluid's pH level to maintain a pH reading between 8 and 10 to minimize corrosion and glycol degradation. Use of a narrow range pH paper such as pHydrion Control paper is recommended. A pH tester can also be used and can give an indication of the alkalinity or inhibitor level of the fluid. Since Glycol tends to turn acidic in the presence of oxygen, adjustments can be made by using a 50% solution of sodium hydroxide or potassium hydroxide if the pH is approaching the acidic range (below 8.0).

3. Determine the condition of the fluid by examining its appearance and odor. Any drastic variation from the initial fluid specifications, such as black or dark-gray color, presence of an oily layer, burnt odor, or any heavy sludge in the fluid may indicate the need for fluid replacement.

4. Check and clean or replace the filter as necessary to maintain the water quality as specified in note 2 above and to insure continued removal of foreign solids.

Look at the Diagnostic Displays

Observe what messages are displayed on the high voltage power supply, or any of the axis amplifier front panels regarding system or device status or faults. Extensive monitoring signals are also available via the real time cables to the host to assist in pinpointing the problem areas. In addition, the RS232 interface can interrogate the system I²C bus through the ADCI Controller.

For the axis amplifiers, status of the devices, mode settings, device faults and system messages are constantly being monitored and displayed on the diagnostic display located on the front panel each of the axis amplifiers. A monitor signal is also available from each axis amplifier through the real time cable, which allows access, at the user system interface, to outputs of a 16 channel analog multiplexer. This analog multiplexer is located on the Modulator Board of the amplifier, and provides selectable monitoring of the following signals: Output Current, Output Voltage, Input Signal, Control Signal into the PWM stage, Error, +IfeedbackA, -IfeedbackA, +IfeedbackB, -IfeedbackB, +PSAError, -PSAError, +PSBError, -PSBError, Proportional, Integral and Derivative outputs.

As on the amplifiers, a digital display on the power supply provides status and fault messages that may tell you the cause of the problem. At the host, extensive information is available on the digital diagnostic bus. In addition, a two channel analog multiplexer is accessible for monitoring of Output Voltage and Output Current of the high voltage power supply through the real time cable to the host system.

Diagnosis

Use the diagnostic outputs to determine whether the problem is in an amplifier or a Power Supply. Amplifiers will not operate unless externally enabled, the INHIBIT switch is OFF, the high voltage is above 300VDC and below 425VDC. If the high voltage is much less than 425 VDC, voltage clipping and resultant distortion of the current waveform may occur at high current ramp rates.

Tables 5-2, 5-3, and 5-4 recommend what to check based upon which diagnostic outputs show a fault.

Available Diagnostic tools

Available on special order from Copley Controls Corp. is software for personal computers (PCs) and laptops, which can display all the diagnostic bus information for quick analysis of problems. The software allows custom configuration to suit individual use preferences. All that is required on the PC, is Windows 95/98/ME/2000 or NT4, and an RS232 port.

Reduce Supply Power

When looking for a problem it is safer for both personnel and equipment to operate at reduced power mode. Do not expect perfect waveforms at low voltages unless the rise time is reduced to avoid voltage clipping. Note also the PWM amplifier requires more power supply current for a given output when operated at reduced voltage.

Power-up After FRU Replacement

To minimize the possibility of damage after replacing an FRU, start in low power mode. Follow the procedures detailed for major FRUs on page 5-11. In general use the **Functional Tests After FRU Replacement** procedure on page 5-15 after servicing other parts. Be sure to monitor output voltage and current output.

Finding Troubles

Use Table 5-2 as an aid in solving AC and DC power problems. Table 5-3 lists the fault messages that may be received on the diagnostic displays on any of the axes. By taking note of the 601S diagnostic display messages, table 5-4 can aid in solving problems in the HV Power Supply. The "Comment" column indicates possible reasons for the problem and cautionary procedures. Following the fault tables is a section which contains removal and replacement (R/R) procedures for the following major FRUs.

- Capbank Assembly
- ADCI Controller
- 601S High Voltage Power Supply
- Axis Amplifier Assembly

TABLE 5-2 AC AND DC POWER FAULTS

PROBLEM	ACTION	COMMENTS
With power supply breaker ON, Amplifier displays are not lit.	Check system power switch on Capbank Assembly. Check ±415 bus connections.	**Warning!** If power bus is found disconnected, do not reconnect unless AC outlet mains breaker is OFF.
HV supply breaker is ON. Display is not energized. HV Power Supply is off.	Check rear door interlock. If door is open, check if switch plunger is enabled. Check that the AC Power is connected properly.	Interlocks interrupt 28 VDC to coil. Power supply will not operate without the AC Power properly connected.
Amplifier display lit up, but no fans on that Amplifier operate.	Check fan connector at front panel. If OK check the fan assembly wiring.	
Power Supply display lit up, but no fans on that supply operate.	Check fan connector at front panel. If OK, check the fan assembly wiring.	
Loss of phase message indicated on the HV power supply display.	Check for open wall fuse. Check for proper wiring of AC power to terminal block. Check wiring from terminal block to supply.	HV Power Supply cannot operate if one phase is lost.

TABLE 5-3. AXIS AMPLIFIER FAULT DIAGNOSIS

FAULT MESSAGE	ACTION	COMMENTS
+5V Out Of Tol	Replace Axis	Internally generated 5V is out of specified tolerance. Should be between 4.75V and 5.25V.
+16V Out Of Tol	Replace Axis	Internally generated +16V is out of specified tolerance. Should be between 15.4V and 17.2V.
+15V Out Of Tol	Replace Axis	Internally generated +15V is out of specified tolerance. Should be between 14.5V and 17.2V.
-15V Out Of Tol	Replace Axis	Internally generated –15V is out of specified tolerance. Should be between –14.5V and –17.2V.
+28V Out Of Tol	Replace Axis	Internally generated +28V is out of specified tolerance. Should be between 25V and 29V.
+415V Out Of Tol	Adjust HV power supply voltage or replace axis	High Voltage Power Supply is out of specified tolerance (the lower limit is (+)350V and the upper limit is (+)425V, or internal fuse is open.
-415V Out Of Tol	Adjust HV power supply voltage or replace axis or replace rack fuse	High Voltage Power Supply is out of specified tolerance (the lower limit is (-)350V and the upper limit is (-)425V, or internal fuse is open or rack fuse is open..
Over Current +A Out	Reduce output current	Current out of positive leg of A power stage is too high.
Over Current -A Out	Reduce output current	Current out of negative leg of A power stage is too high.

TABLE 5-3. AXIS AMPLIFIER FAULT DIAGNOSIS (continued)

FAULT MESSAGE	ACTION	COMMENTS
Over Current +B Out	Reduce output current	Current out of positive leg of B power stage is too high.
Over Current –B Out	Reduce output current	Current out of negative leg of B power stage is too high.
Current Error	Check for open or intermittent load, too fast input rise, or improper load impedance.	Output Current does not match input command.
ColdplateTmp Fault	Check for proper flow and temperature of the cooling water.	Power stage coldplate temperature out of specified range. Temperature range is limit is 8˚C to 56˚C.
Danf Fault	Reduce output current or replace Axis.	Overall output current sense operating range exceeded, or sensor has failed.
Magnetic A Temp	Allow axis to cool down.	Magnetics for A side power stage is out of specified range. Temperature. range is over 8˚C to 125˚C.
Magnetic B Temp	Allow axis to cool down.	Magnetics for B side power stage is out of specified range. Temperature. range is over 8˚C to 125˚C.
SwMode IGBT Temp	Allow axis to cool down.	Temperature on power supply switch mode IGBT is out of range of 8˚C to 75˚C.

NOTE: Coldplate, MagneticsA, MagneticsB, and SwModeIGBT can generate a fault for temperatures less than 8˚C. If this occurs under normal temperatures, the sensor or sensor cable is open.

TABLE 5-3. AXIS AMPLIFIER FAULT DIAGNOSIS (continued)

FAULT MESSAGE	ACTION	COMMENTS
+ Inp Clipping Fault	Reduce input command or adjust clipping level.	Axis + input has exceeded the programmable clipping threshold.
- Inp Clipping Fault	Reduce input command or adjust clipping level.	Axis - input has exceeded the programmable clipping threshold.
AmbientTemp	Adjust ambient temperature to fall within specified range.	Ambient temperature out of tolerance. Range is from 8˚C to 57˚C.
DSP Fault	Replace Axis	Communications error has occurred with the internal DSP.
I2Long +A Fault	Reduce input command, or lower input command duty cycle.	Current in A power stage positive leg excessive.
I2Long –A Fault	Reduce input command, or lower input command duty cycle.	Current in A power stage negative leg excessive.
I2Long +B Fault	Reduce input command, or lower input command duty cycle.	Current in B power stage positive leg excessive.
I2Long –B Fault	Reduce input command, or lower input command duty cycle.	Current in B power stage negative leg excessive.
Invalid PwrUp State	Disable Axis and apply Reset.	Axis was powered up with the RTCEnable signal True.
Invalid Mode	Change mode selection to a valid mode.	Mode selection is not one of the defined modes.

TABLE 5-3. AXIS AMPLIFIER FAULT DIAGNOSIS (continued)

FAULT MESSAGE	ACTION	COMMENTS
M/S Conn Open	Check to make sure that the Master/Slave cable is connecting J8 of the Master Axis I/O Assembly to J8 of the Slave Axis I/O Assembly.	Master/Slave connector on Axis I/O Assembly is open.
Ext/Int Clk Changed	Confirm whether internal or external clock is desired. If external supply clock, check cabling	5MHz clock on X Axis amplifier changed from external to internal, or from internal to external.
Slave RTC Conn Open	Check for proper wiring of parallel rack. J5 of Slave Axis I/O Assembly should be connected to J6 of Master Axis I/O Assembly.	RTC connector on Axis I/O Assembly is open.
Ready & Available	Normal system start-up operational message.	Displayed momentarily on power up until communications with the ADCI controller is established.
Waiting ADCI Enable!	Normal system start-up operational message.	Displayed while waiting for ADCI controller to Enable the device..
Rack Fault	Check other rack devices for additional messages.	Fault in this rack other than this device.

TABLE 5-4 POWER SUPPLY FAULT DIAGNOSIS

FAULT MESSAGE	ACTION	COMMENTS
+5V Out Of Tol	Replace Power Supply	Internally generated 5V is out of specified tolerance. Should be between 4.75V and 5.25V.
+16V Out Of Tol	Replace Power Supply	Internally generated +16V is out of specified tolerance. Should be between 15.8V and 17.2V.
+15V Out Of Tol	Replace Power Supply	Internally generated +15V is out of specified tolerance. Should be between 14.5V and 17.2V.
-15V Out Of Tol	Replace Power Supply	Internally generated –15V is out of specified tolerance. Should be between –14.5V and –17.2V.
+28V Out Of Tol	Replace Power Supply	Internally generated +28V is out of specified tolerance. Should be between 25V and 29V.
SSV Out Of Tol	Replace Power Supply	Soft switching bias voltage on power stage is out of specified tolerance.
Cold Plate Tmp Fault	Check for proper flow and temperature of the cooling water.	Power stage coldplate temperature out of specified range. Temperature range is from 8˚C to 48˚C.
Transformer Tmp Flt	Allow power supply to cool down.	Magnetics for power stage is out of specified range. Temperature range is from 0˚C to 110˚C.
Ambient Tmp Fault	Restore room temperature to within acceptable range.	Ambient temperature is out of temperature range of 8˚C to 50˚C
M/S Dual Conn Open	Check to make sure that the Master/Slave cable is connecting J3 of the Master PS I/O Assembly to J3 of the Slave PS I/O	Master/Slave cable between master and slave rack 601S Power Supply I/O Assemblies is missing or one of the connectors is bad.

	Assembly.	

TABLE 5-4. POWER SUPPLY FAULT DIAGNOSIS (continued)

FAULT MESSAGE	ACTION	COMMENTS
Ext/Int Clk Changed	Confirm whether internal or external clock is desired. If external supply clock, check cabling	5MHz clock on X Axis amplifier changed from external to internal, or from internal to external.
Pwr Stg V Undr Tol	Check input mains.	Power stage bridge voltage is under specified tolerance. Caused by line variations.
Pwr Stg V Ovr Tol	Check input mains.	Power stage bridge voltage is over specified tolerance. Caused by line variations.
Int Interlock Flt	Cycle mains. If it reoccurs, replace Power supply.	The interlock loop within the power supply has been broken.
Loss Of Phase	Check for open wall fuse. Check for proper wiring of AC power to terminal block. Check wiring from terminal block to the power supply.	One or more of the phases or neutral has been lost.
Frnt Panel Sw Off	Reset switch.	Front Panel Switch Of CapBank Off

TABLE 5-4. POWER SUPPLY FAULT DIAGNOSIS (continued)

FAULT MESSAGE	ACTION	COMMENTS
Cap Dis Over Temp	Let cool down. If it reoccurs, replace the Capbank.	Capacitor discharge circuit failed or overheated.
Rack Intlk Open	Check to make sure that the rack door is closed	Interlock Switch is open in cabinet.
Cap Discharge Open	Replace Capbank Assembly.	Capacitor Discharge failed..
VOut+ Out Of Tol	Adjust voltage.	Output voltage + out of specified range. Voltage range is from 0V to 435V.
Inval PwrUp State	Power down and restart in proper sequence.	Main power was turned on with the high voltage on and the RTCOn/Off selecting ON.
Over Current	Cycle mains and see if it reoccurs. If so, replace Power supply.	Power stage bridge primary current is excessive.
IGBT Temp Fault	Replace Power Supply	Excessive temp on power supply switch mode IGBT.
SS Resistor Fault	Replace Power Supply	Soft Start Resistor Fault
Internal Fault		Hardware fault interrupt occurred, but no faults were detected.

FRU REPLACEMENT AND TEST

WARNING

Follow the instructions in the Safety Summary section at the beginning of this manual.

The large internal capacitor bank maintains voltage on power inputs and outputs even after the power is shut off. Do not perform service until this voltage is completely discharged.

Exercise extreme caution when working near live power. Do not work alone.

If any test steps fail to produce correct results, stop and investigate before proceeding.

281 Axis Amplifier R/R

COPLEY 05-00819-000

1. Power down rack by switching mains breaker OFF. Wait until the internal capacitor bank has completely discharged.
2. Measure the voltage on the output of the high voltage power supply. To ensure that the capacitors have sufficiently discharged before proceeding with amplifier removal.
3. Turn off the heat exchanger and ensure that the coolant has stopped flowing.

Note: The amplifier is very heavy, and requires a special lifting apparatus. To remove axis, use axis lift (Copley Controls Corporation # 84-00061-000), and carefully follow procedures detailed in the USER INSTRUCTIONS FOR THE 281 LIFT (Copley Controls Corporation # 97-00104-000).

4. Refer to USER INSTRUCTIONS FOR THE 281 LIFT (Copley Controls Corp. # 97-00104-000). A single red lever lock handle is located at the middle of the front panel of each of the axes. Remove pin from the handle, grip the handle, pull forward and down to release the amplifier from the locked position. A click will be heard, which is the coolant fittings being released.

5. Continue to pull the amplifier handle, slowly sliding the amplifier forward on the amplifier shelf until the safety latch engages. Do not lift up, or the safety latch may be overridden. Do not pull out past the line indicated on the cover.
6. To remove the amplifier assembly, use axis lift (CCC# 84-00061-000), and carefully follow 281 lift instructions (CCC # 97-00104-000).
   NOTE: After the lift is properly positioned, and the lift hook is attached to the lifting bar as per the lift instructions, the axis safety latch can be released by pushing up the button on the left of the underside of the axis.
7. To install an amplifier, support the weight of the amplifier with the axis lift (CCC # 84-00061-000), using 281 lift instructions(CCC # 97-00104-000). Pull the locking handle forward and down, and slide the amplifier onto the amplifier shelf, pushing it backward carefully along the shelf slides.
8. When the high voltage input and output pins engage the output blocks, and the Axis I/O Assembly connector engages the Modulator connector J1, the hook on the bottom of the lever handle should be in a position directly over a pivot latch. Push up and forward on the handle to engage the latch with the lever hook and lock the amplifier in place. Reinstall pin in latch handle.
9. Turn on heat exchanger before energizing the amplifier system.
10. Perform the **Functional Tests After Axis FRU Replacement** procedure specified in the next section.

601S High Voltage Power Supply R/R

COPLEY 05-00829-000

1. Power down the rack by turning the main AC breaker OFF. Disconnect the AC power plug from the wall receptacle. Wait until the capacitors in the power supply output have completely discharged. Measure the voltage on the output of the high voltage power supply to ensure that the output has discharged to a sufficiently low voltage.
2. Turn off the heat exchanger and ensure that the coolant has stopped flowing.
3. A single lever lock handle is located at the middle of the front panel of the power supply. Grip the handle, pull forward and down to release the power supply assembly from the locked position. A click will be heard, which is the coolant fittings being released.
4. Grip the two handles on the sides of the front panel. Pull the power supply forward, and release the power supply from connections to the 601S I/O board and the power pin connections to the output blocks.

5. After pin release, continue to pull the power supply forward, sliding the supply toward the front of the rack on the power supply shelf.

Note: The power supply is very heavy, and requires a second person and/or a lift to provide support during removal, installation, and alignment.

6. To install the power supply, support the weight of the supply with a lift or an additional person. Slide the power supply onto the shelf along the slide guides carefully toward the rear of the rack.
7. When the high voltage output pins engage the output blocks, continue to push the power supply toward the rear of the cabinet until the hook on the bottom of the lever handle on the front panel is in a position directly over the pivot latch. Push up and forward on the handle to engage the latch with the hook, and lock the supply in place.
8. Turn on the heat exchanger before energizing the power supply.
9. Perform the 'Functional Tests After FRU Replacement' tests toward the end of this chapter.

Capbank Assembly R/R

COPLEY (+)05-00554-000
(-) 05-00555-000

1. Power down rack by turning mains breaker off. Disconnect AC power from wall. Wait until internal capacitance has completely discharged before proceeding. Measure the voltage on the output of the high voltage power supply to ensure that the capacitors have discharged to a sufficiently low voltage before proceeding further.
2. Remove the four screw fasteners from front panel.
3. Remove the cable from connector J7/J8 of the 601S Power Supply I/O Assembly.
4. Remove the two 2 AWG cables that attach the Capbank Assembly to the applicable power supply output and RTN busbars.
5. Disconnect the interlock connector located along the right rear rail (as viewed from the cabinet rear), near the amplifier output terminal block.
6. Replace with new Capbank Assembly.
7. Push the Capbank Assembly back into position.
8. Connect the Capbank Assembly cables to the ±415V and RTN bussbars.
9. Reconnect the cable from the Capacitor Discharge Circuit to J7/J8 of the power supply I/O Board.

10. Reconnect the interlock connector at the right rear of the cabinet.
11. Install the four jackscrew fasteners on the front panel.
12. Check that AC mains power is properly connected.
13. The input signals must be zero.
14. At the user system interface, switch the RTCHi/Lo to LO to select the low power mode of operation.
15. Switch the MAINS circuit breaker to ON.
16. Switch the circuit breaker on the high voltage power supply to ON.
17. Switch the system power switch on the Capbank Assembly to ON.
18. The green SYSTEM POWER indicator should light on the Capbank Assembly front panel.
19. Check that all fans are operating.
20. The display on each Amplifier should light.
21. Switch the circuit breaker on the high voltage power supply to OFF. The supply voltage should decay to 25 V within 15 seconds.
22. Switch the RTCHi/Lo to HI to select the high power mode of operation.
23. The system is now ready for normal operation.

ADCI Controller R/R

COPLEY 05-00747-000

1. Power down rack by turning mains breaker off. Disconnect AC power from wall. Wait until internal capacitance has completely discharged before proceeding. Measure the output of the high voltage power supply to ensure that the capacitors have discharged to a sufficiently low voltage before proceeding further.
2. Remove diagnostics cable from connector (J1), and if using in dual mode, also remove (J2).
3. Remove RS232 cable from (J3) of the ADCI Controller.
4. Loosen and remove two screws supporting the ADCI Controller to the support panel that spans top of the rack at the rear.
5. Remove the ADCI Controller from the cabinet.
6. Install new ADCI Controller.

7. Install and tighten two screws to support the ADCI Controller on the panel at the top rear of the cabinet.
8. Install connector J1, and if using in dual mode, reinstall connector J2 from the Slave rack.
9. Reinstall the RS232 connector into J3 of the ADCI Controller.

Rack Fuses R/R

COPLEY

1. Turn off rack using mains breaker.
2. Fuse(s) are located behind rear door, to the left of the output terminal assembly.
3. Using a voltmeter check there is no voltage present on either side of the fuse(s).
4. Using 8mm wrench or socket remove both nuts on the fuse(s).
5. Remove fuse(s) and discard.
6. Replace fuse(s), make sure wires are underneath fuse connections.
7. Tighten Nuts on fuse(s), Torque to 11 Nm (97 in./lbs.).
8. Perform Functional Tests outlined next section after fuse replacement.

FUNCTIONAL TESTS AFTER FRU REPLACEMENT

Before operating amplifiers after the replacement of a unit, perform the following functional tests on the repaired axis. A monitor output is available for both the voltage and current as well as various other parameters through the real time connectors attached to J5 of the Axis I/O Assemblies of each of the amplifiers. The Monitor selection is made from the AMUX list on the user interface Control Panel for each of the Axes as well as the Power Supply. See Figure 3-5 for an example of the Control Panel option selections.

To avoid damage in case something is wrong, perform the tests in the order outlined. Stop and investigate when any step fails. Do not proceed without solving the problem.

WARNING

Treat power inputs and outputs as hazardous. Protect operators and service personnel from contact.

Before proceeding be sure to read the front section of this manual which deals with safety requirements.

Throughout the testing sequence, the Control Panel will be referred to for selections and waveform adjustments. Figure 3-9 is a representation of that Control Panel and its available options.

After selecting the desired device, the monitor output selection can be made from the Mux selection bar. For the axis amplifiers, this monitor output allows selection of inputs to a 16 channel analog multiplexer. For the power supply, the scaled output voltage and scaled output current are available for monitoring. As can be seen, the selection can then be made of one of five currently available operating modes. Within the operating modes, adjustments are available as inputs to the digital pots for clipping, gain, offset, delay through the amplifier, proportion, integral, and derivative.

Starting the Power Supply

1. Check that AC mains power is properly connected.
2. Ensure that the loads are disconnected.
3. Check that the RS232 cable is properly connected to J3 of the ADCI Controller.
4. Check that the X Axis Real Time input cable is connected to J5 of the X Axis I/O Assembly at the rear of the system rack.
5. Check that the Y Axis Real Time input cable is connected to J5 of the Y Axis I/O Assembly at the rear of the system rack.
6. Check that the Z Axis Real Time input cable is connected to J5 of the Z Axis I/O Assembly at the rear of the system rack.
7. Check that the Power Supply Real Time input cable is connected to J4 of the I/O Assembly for the 601S Power Supply at the rear of the system rack.
8. Ensure that the 5MhZ clock input is provided to the X axis amplifier at J3.
9. The input signal must be zero. Apply a short across the inputs to ensure that the input voltage is zero volts.
10. At the user interface Control Panel, select the OPEN CIRCUIT operational mode: (Mode0=1, Mode 1=1, Mode2=1) for each of the axes.
11. With the RTCOn/Off set to 'Off', set the high voltage power supply for Low Power Mode. The power supply circuit breaker should be OFF.
12. Power up the heat-exchanging unit to provide coolant through the power amplifier and power supply coldplates.

Note: The heat exchanger coolant must be circulating at all times during any system operations. Failure to provide proper cooling to the system will result in coldplate overheating, and consequent system shutdown.

Functional Test (No Load)

Stop and investigate if any of the following steps do not work properly.

1. Disable all axis amplifiers.
2. Switch the MAINS circuit breaker to ON.
3. Switch the System Power switch on the Capbank Assembly to ON (1).
4. Switch the breaker of the 601S Power Supply front panel to ON.

5. Switch the RTC On/Off at the user interface to 'ON'.
6. Axis and Power Supply fans should start circulating air through the cabinet.
7. Check that all fans are operating.
8. The green 'HIGH VOLTAGE' light on the Capbank Assembly should light. The digital display on the front of the power supply should indicate the device identification ('601S Power Supply') in the upper left, the firmware version in the upper right corner, and the bottom message should indicate 'LO' for low voltage mode, and 'V' for voltage mode. Under proper operating conditions, no faults should be indicated at this time.
9. The display on each amplifier front panel should light and indicate the device identification ('281 X, Y, or Z Axis') in the upper left of the display, the firmware version in the upper right, and the bottom line of the display should read 'Bi Short'.
10. Select Mode Bank 1 using the system interface software. The front panel displays of each amplifier should now read 'Open' on the second line. Open the Control Panel and select Output Voltage from the MUX selection list of the X-axis amplifier. Enable the amplifier. The front panel display should now read 'Enabled.'
11. Press the red INHIBIT button at the top left of the front panel on all of the three amplifiers. The diagnostic display of all of the axes should show the message 'Inhibited' on the display bottom character line.
12. Enable all amplifiers.
13. Release the INHIBIT switch on the top X amplifier. The message 'Inhibited' should change to 'Enabled'. If not, disconnect the AC mains power, wait for the capacitors to discharge, and check all interface connections. If necessary refer to the servicing procedures in Chapter 5.
14. Due to the fact that the load is open, the OUTPUT CURRENT should read 0 V ±10 mV. The OUTPUT VOLTAGE should read 0 V.
15. Press INHIBIT on the X amplifier. The display message should change back to 'Inhibited'.
16. Select Mode Bank 1 using the system interface software. The front panel displays of each amplifier should now read 'Open' on the second line. Open the Control Panel and select Output Voltage from the MUX selection list of the X-axis amplifier. Enable the amplifier. The front panel display should now read 'Enabled.'
17. Release the INHIBIT switch on the top Y amplifier. The message 'Inhibited' should change to 'Enabled'.
18. Due to the fact that the load is open, the OUTPUT CURRENT should read 0 V ±10 mV. The OUTPUT VOLTAGE should also read 0V.
19. Press INHIBIT on the Y amplifier. The display message should change back to 'Inhibited'.

20. Select Mode Bank 1 using the system interface software. The front panel displays of each amplifier should now read 'Open' on the second line. Open the Control Panel and select Output Voltage from the MUX selection list of the X-axis amplifier. Enable the amplifier. The front panel display should now read 'Enabled.'
21. Release the INHIBIT switch on the top Z amplifier. The message 'Inhibited' should change to 'Enabled'.
22. Due to the fact that the load is open, the OUTPUT CURRENT should read 0V ±10 mV. The OUTPUT VOLTAGE should also read 0V.
23. Press the INHIBIT button on the Z Axis amplifier. The display message should change back to 'Inhibited'.

Triangular Wave Test; Output Clipping (Open Load Test)

1. Be sure that the INHIBIT button is depressed on the front panel of the three axis amplifiers. The display on all three amplifiers should read 'Inhibited'.
2. Confirm the RTCHiLo is set for Low Power Mode for the 601S power supply.
3. At the user interface Control Panel, select Output Voltage to monitor for all three of the axes, making the selection from the Mux list.
4. Remove the short from the inputs of the three axes.
5. Apply a low level 200Hz triangular wave at the X Axis input via the RTC connector.
6. Release the INHIBIT button on the X Axis front panel. The display should now read 'Enabled'.
7. Monitor the output voltage on a two channel oscilloscope, with one channel on the input signal applied, and the other channel looking at the output voltage.
8. Slowly increase the input drive triangle wave while monitoring both input and output waveforms on the oscilloscope. Ensure that the waveform on the output is a replica of the input waveform with no distortion or oscillations.
9. Continue to increase the input waveform to the point of output clipping. The output waveform should clip cleanly.
10. Decrease the input signal.
11. Press the INHIBIT button on the X Axis front panel. The amplifier display should read 'Inhibited'.
12. Perform steps 5 through 11 on the Y and Z axes.

Triangular Wave Tests (Shorted Load Test)

Stop and investigate if any of the following steps do not work properly.

1. Be sure the INHIBIT button is depressed on all three amplifiers. The display message on all three amplifiers should read 'Inhibited
2. Switch RTC On/Off to OFF.
3. Switch the system power control switch on the Capbank Assembly front panel to OFF.
4. Switch the circuit breaker on the power supply to OFF.
5. Switch off the main circuit breaker for AC power to the system. Remove the plug from the main AC power receptacle. Wait for the capacitor banks on the +/-415V power busses to discharge before attempting to make any load changes.
6. Open the rear cabinet door to gain access to the output power terminals.
7. Measure from the high voltage bus to the high voltage bus return to be sure that the supply capacitors have discharged too less than 2VDC.
8. Once the supply has discharged sufficiently, apply a short across each of the X, Y, and Z amplifier outputs. Be sure that the connections are tightened before energizing the system.
9. Close the rear door and lock the cabinet.
10. Apply a short across the three axis amplifier input signal lines at the RTC cable at the user interface.
11. Plug the AC power cable into the main power circuit receptacle. Switch the main power circuit ON.
12. Energize the power supply by switching the power supply front panel circuit breaker ON.
13. Switch the system power switch to ON.
14. At the user control panel, set all of the amplifiers to Short Circuit Mode (Mode0=0, Mode1=0, Mode2=0) via the RTC connector to the respective amplifiers. Also, disable all three of the axis amplifiers.
15. At the control panel, select OUTPUT CURRENT from the Mux selection bar to monitor for each of the three amplifiers.
16. Select High power mode by switching the RTC Hi/Lo to HI.
17. Connect a two-channel oscilloscope with one channel monitoring the input signal, and the other to monitor the output current through the analog multiplexer of the amplifiers.
18. Switch the RTC On/Off to ON.

19. Enable all three-axis amplifiers.
20. Feed a 1V RMS, 200 Hz triangular wave into all three amplifiers simultaneously.
21. Release the INHIBIT switch on the X amplifier.
22. The CURRENT MONITOR should show a 1V RMS triangular waveform, corresponding to a 70A output (70A/V).
23. Depress INHIBIT button on the X Axis front panel.
24. Repeat steps 21 through 23 for the Y and Z axis amplifiers.
25. Be sure the INHIBIT button is depressed on all three of the Axis amplifiers.
26. Release the INHIBIT on the X Axis amplifier.
27. Increase the input signal level to produce a 4.28V RMS (70A/V) waveform out of the monitor output of the analog multiplexer, which is currently measuring OUTPUT CURRENT. This output level corresponds to 300 A RMS output current.
28. Depress the INHIBIT button on the X Axis amplifier.
29. Repeat steps 26 through 28 for the Y and Z Axis amplifiers.

System Ready

After successfully passing all the above tests the system is now ready for normal operation.