LC Power, Control, and Electromechanical Troubleshooting

HMM-176-0
CRAY T3E Liquid-cooled System
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Figures

Tables

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Introduction

This document describes the power-on/power-off procedures and the warning and control system (WACS) used within the CRAY T3E liquid-cooled (LC) cabinet. It contains a logical overview of power distribution followed by a description of the main components within the power path. This document describes the procedures for powering on and powering off the CRAY T3E cabinet in both local mode and remote mode. Following the theory of power, the document describes the power, switches and displays, and display pages of the WACS. Other areas discussed relate to rail interlocks and power requirements for the heat exchanger unit (HEU). The last section of the document is a troubleshooting guide for both power and the WACS.

NOTE: Read *Safety and ESD Guidelines*, Cray Research publication number HGM-016-A, before you perform any power-related procedures.

This document provides service personnel with a single source of information about power and the WACS for the CRAY T3E LC cabinet.

Terms

You will need to know the following terms to fully understand the material discussed in this document:

Power-on: The sequence of events in which power is applied to a CRAY T3E LC cabinet and the various components within that cabinet.

Power-off: Removal of power from a CRAY T3E LC cabinet.

Start local: To apply power to all properly installed modules by sending the power enable signal from the WACS. The WACS must be powered on and running.

Stop local: To remove the power enable signal from the modules. The WACS continues to receive power.

Start remote: Same as start local but from a remote location.

Stop remote: Same as stop local but from a remote location.

Remote: This term refers to applying or removing power to the LC cabinet by any means other than physically pressing the start or stop switch. Remote access can occur within the same computer room or from a distance by accessing the WACS through the system workstation (SWS) and selecting the appropriate write switches.

Warning: A warning indicates a pending failure or cause for concern. If one of the three WACS scanners detects a warning-level reading from a primary or backup sensor, the WACS sends a warning indicator to the WACS display and to the system workstation (SWS).

Fault: A fault indicates that a component failed or an otherwise dangerous condition exists within the LC cabinet. If the CCS board detects a fault condition from a primary and backup sensor, in either scanner, the WACS sends a fault indicator to the WACS display and the system workstation (SWS). The CCS board can power off an individual component or the entire LC cabinet.

WACS Page: The WACS page displays information from WACS memory and reproduces it in a readable format on the WACS display.

Power Overview

A commercial power source supplies power to the system. Power cables are hardwired directly from the customer’s power panels to the power-box end of the LC cabinet. Power cables run under the floor and enter the LC cabinet through cutouts in the floor and the power distribution box.

Each LC cabinet is electrically independent and contains all the power equipment necessary to support its internal components.

Commercial 3-phase power is supplied in one of the following voltages as shown in Table 1:

Table 1. Power Requirements

Voltage	Phases	Frequency	Amps	Wiring
200–240 Vac	3	50/60 Hz (±5%)	225	3 phases and ground
389–416 Vac	3	50 Hz (±5%)	125	3 phases, neutral, and ground

Incoming power for the CRAY T3E LC cabinet is connected in either a delta or wye configuration.

In a delta configuration (phase-to-phase) the load is placed between any two phases. A delta configuration measures ~208 Vac across any two phases. In a wye configuration (phase-to-neutral) the load is placed between any phase and neutral. A wye configuration measures ~240 Vac between any phase and neutral.

The phase interchange assembly plate (PIAP) in the power distribution box is positioned to match the correct voltage configuration during cabinet installation.

Distributed Power

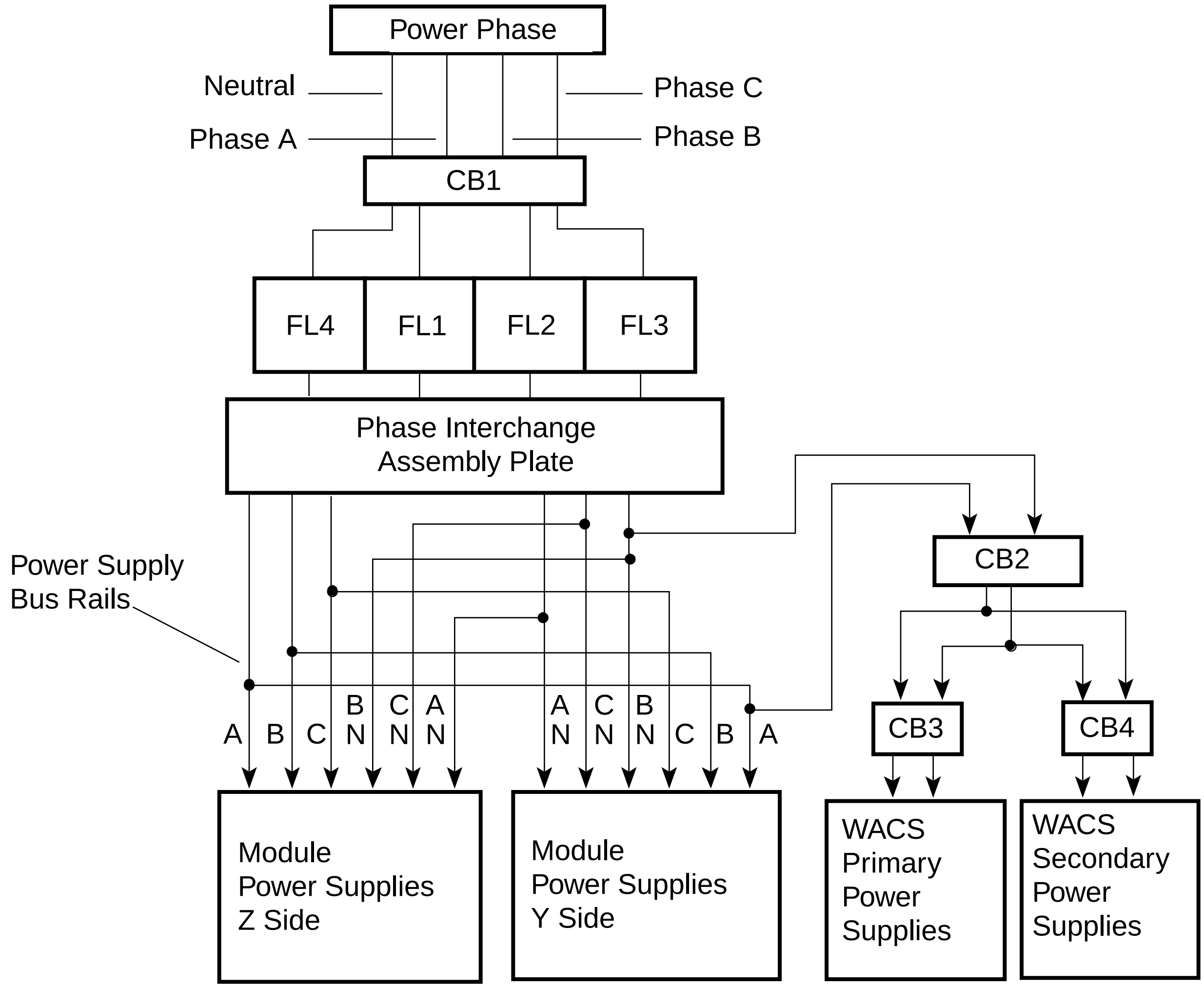
Incoming power is wired from the customer's power-panel connections directly into CB1, the main circuit breaker. Power continues from CB1, through four line filters (FL1 through FL4) into the phase interchange assembly plate (PIAP). The output of the PIAP is routed to the module power supply buses, which are located on the sides of the power distribution box.

Additionally, a tap from 2 phases or 1 phase and a neutral feeds circuit breaker CB2, the Operator On/Standby circuit breaker. This supplies incoming power to the WACS power supply groups.

Circuit breakers CB3 and CB4 protect the WACS power supply groups.

Figure 1 shows the path of incoming power from the customer's power panels to the WACS power supply groups and the module power supply bus rails. The bus rails are labeled as phases A, B, and C. The labels AN, BN, and CN represent either a phase (A, B, and C) or neutral (N).

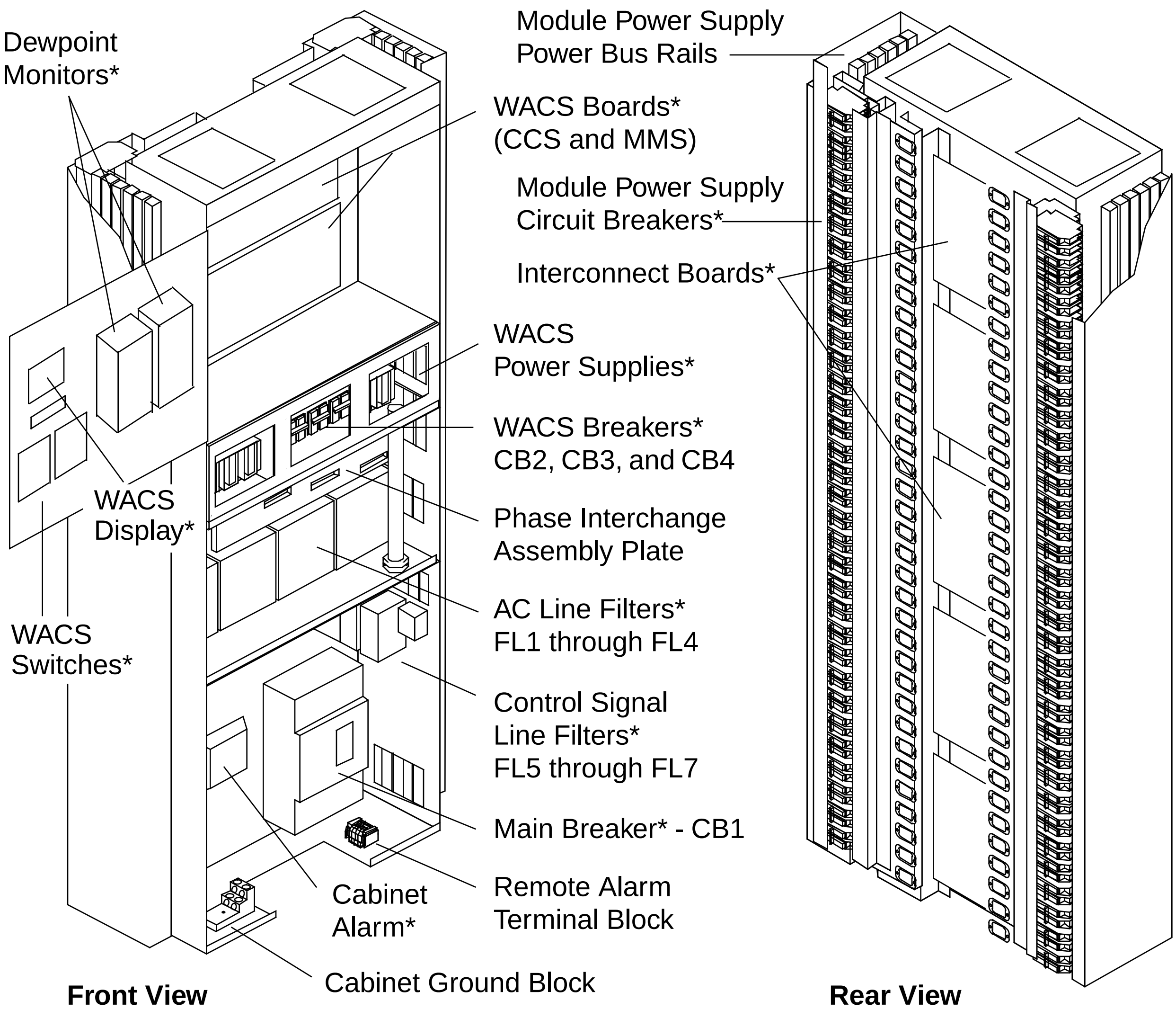
Figure 1. Incoming Power Flow



Power Distribution Box

Figure 2 shows the power distribution box, both front and rear views.

Figure 2. Power Distribution Box



NOTE: Items marked with an * are field replaceable units.

Circuit Breakers

The power distribution box contains four circuit breakers:

- CB1 - Main power (4-pole, single-throw, 600 amps)
- CB2 - Operator on/standby (2-pole, single-throw, 20 amps)
- CB3 - WACS primary power supply group (2-pole, single-throw, 10 amps)
- CB4 - WACS secondary power supply group (2-pole, single-throw, 10 amps)

During power-on and normal operation, breakers CB1, CB2, CB3, and CB4 are closed.

NOTE: Because CB3 and CB4 protect redundant power supplies, either (but not both) can be open and the WACS boards will still receive power.

Line Filters

Four AC line filters, FL1 through FL4, receive the three phases, or three phases and neutral, from CB1. These filters protect the incoming power circuits from electrical noise. The four filters are rated at 400 amps, 250 Vac, 0 – 60 Hz.

Three control signal line filters, FL5 through FL7, are located in the power distribution box.

FL5 is a 10-amp filter that connects to the cabinet horn.

FL6 is a 10-amp filter that connects the critical control system (CCS) board to the main circuit breaker, CB1.

FL7 is a 3-amp filter that connects to the remote alarm circuitry.

NOTE: Control filters FL5, FL6, and FL7 connect to the CCS and MMS board via multiple-connector cables 15223600 and 15224400.

Phase Interchange Assembly Plate

The PIAP is positioned at installation time to configure power as either delta or wye. In delta mode, the module power supplies are powered phase-to-phase. In wye mode, the module power supplies are powered phase-to-neutral.

Module Power Supply Bus Rails

Six bus rails are located on each side of the power distribution box. The module power supply circuit breakers connect to the bus rails.

Module Power Supply Circuit Breakers

Each PCB within the LC cabinet has an individual power supply. Each power supply is protected by a 2-pole, single throw, 20-amp breaker. The six power buses route power to these breakers. During power-on and normal operation all power supply circuit breakers for modules installed are closed. All other module circuit breakers should be open.

To facilitate field upgrades, the cabinet comes equipped with all module power supply circuit breakers installed.

Module Power Supply Power Cable Rails

The power cable rails are between the module power supply circuit breakers and the interconnect boards. Each power supply is cabled directly to the cable rails and receives ~208 Vac. The LC cabinet ships with all power supplies installed for the modules present. Additional power supplies are sent as part of the field-upgrade package.

Figure 3. Power Supply Connection

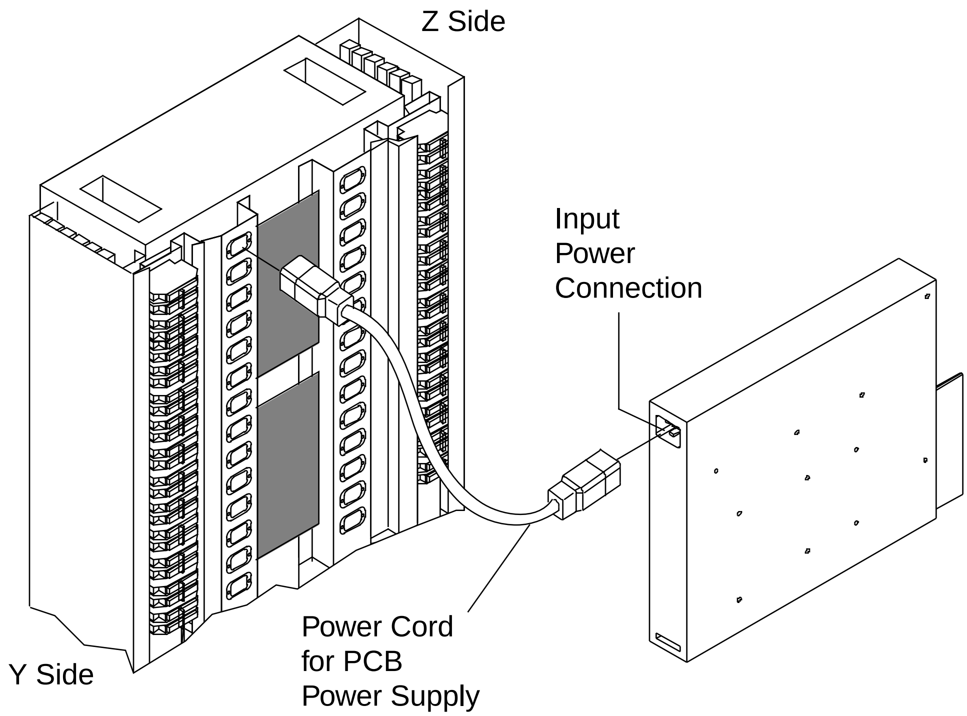
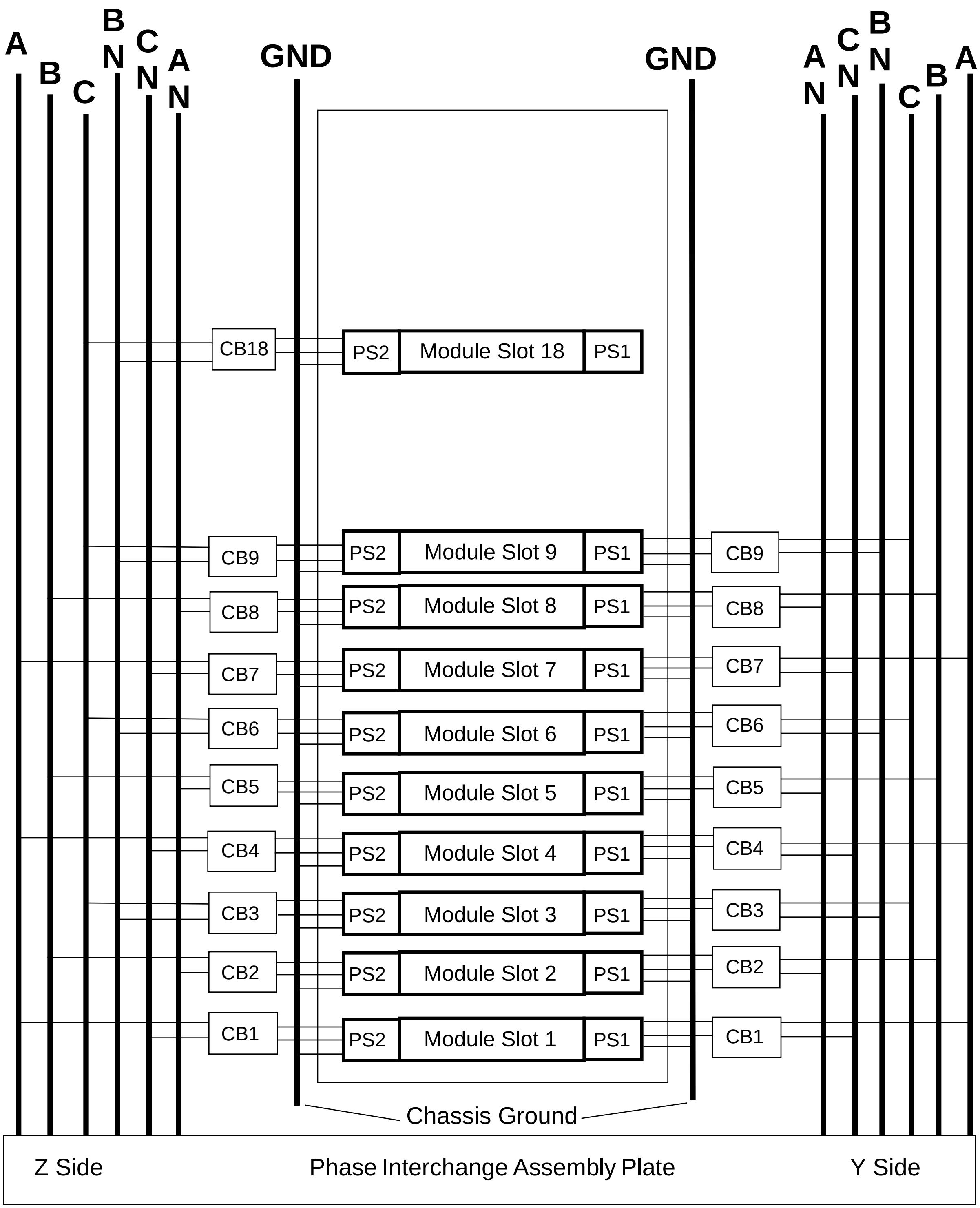


Figure 3 shows the power connection from the power cable rails to the power supply and Figure 4 shows the path for incoming power from the PIAP to the module power supplies for a standard configuration of 64 user PEs.

Figure 4. Power Distribution Path



Module Power Supply

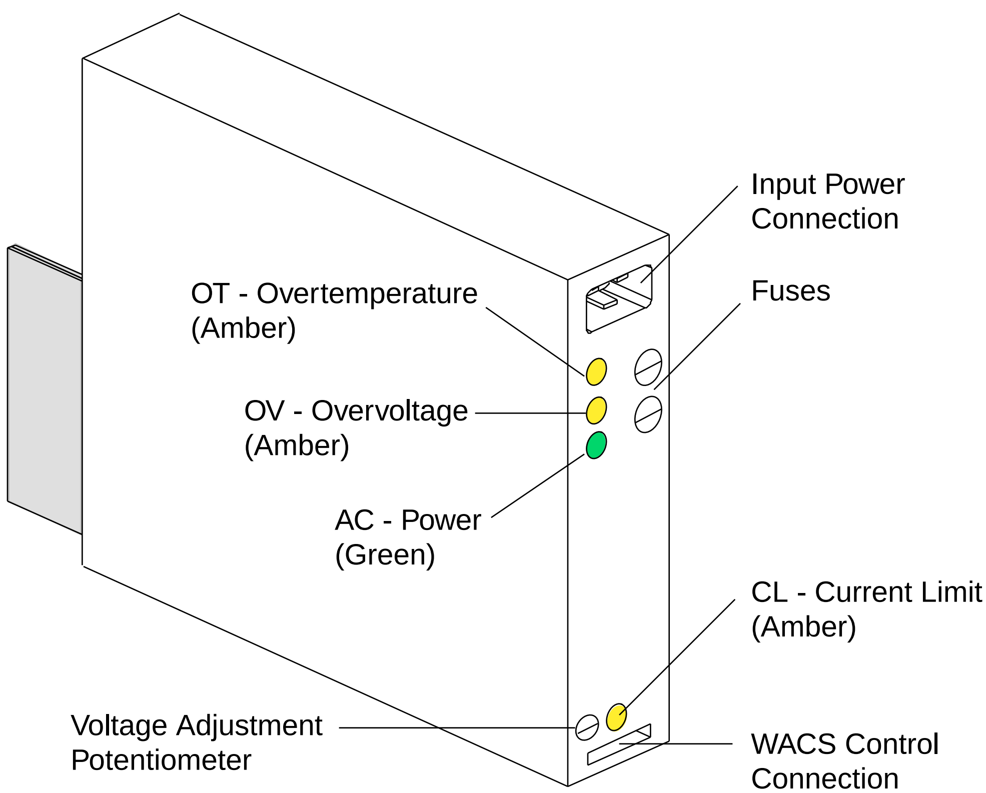
Each PCB within the LC cabinet has its own power supply. Power is routed from individual circuit breakers to each power supply. Figure 5 shows the power supply.

The power supply receives ~208 Vac; it outputs –3.3 Vdc at 400 amps and an auxiliary voltage of ~10.5 Vdc at 0.6 amps. All PCBs within the cabinet require the –3.3 Vdc. The auxiliary voltage is also sent to each PCB. The clock module uses the ~10.5 Vdc to power the oscillators. The clock module regulates the auxiliary voltage down to –4.5 Vdc. Each PCB that uses the newer EV5.6 option requires 2.5 Vdc. These PCBs regulate the ~10.5 Vdc auxiliary voltage down to 2.5 Vdc on the PCB.

The power supply has four light-emitting diode (LED) indicators.

- The AC LED illuminates while the power supply is receiving input power.
- The OT LED indicates that internal overtemperature of the power supply caused it to power off.

Figure 5. Power Supply



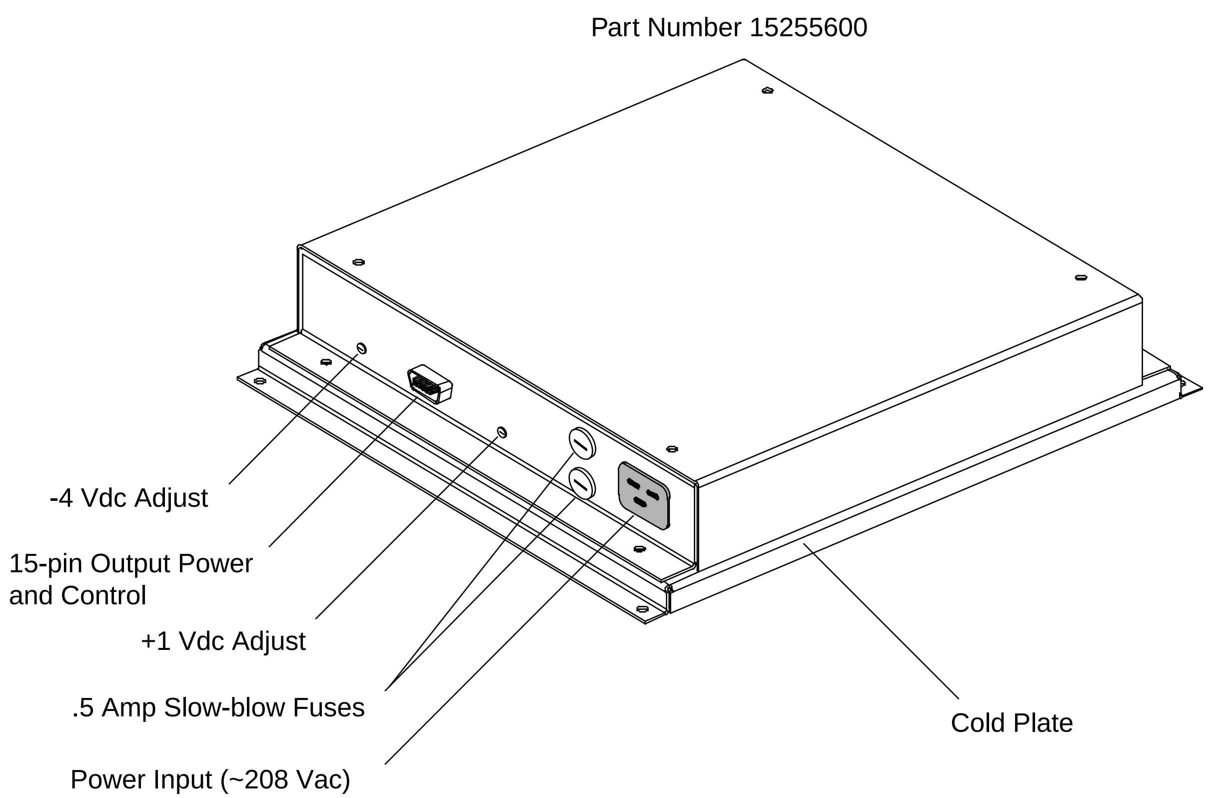
- The OV LED indicates that an overvoltage of the power supply caused it to power off.
- The CL LED indicates that an overcurrent or short occurred that caused the power supply to power off. The power supply will return to operation when the problem is corrected.

NOTE: To restart the power supply after an OT or OV fault, if the green power-on LED is on, press the system START switch. If the power-on LED is not on, recycle the power supply circuit breaker. If the LED comes on, press the START switch. If the LED does not come on, replace the power supply.

Clock Power Supplies

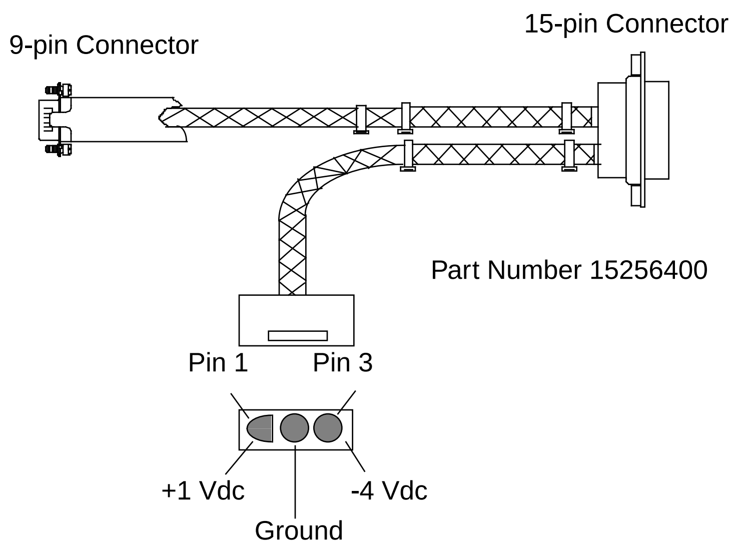
In addition to the PCB power supply that drives the clock module, each clock module uses a second power supply to provide power to the GR_DRV1 board assembly, which provides a fanout of up to twenty-125 Mhz GigaRing clock source-terminated differential signals. This power supply outputs two voltages (-4 Vdc and +1 Vdc). The power supply resides on the Y side of the cabinet in slot 18. Refer to Figure 6.

Figure 6. Dual-output Clock Module Power Supply



The power supply receives ~208 Vac at the input. Output wiring from the power supply attaches to a 15-pin connector via a split cable. Power wires route through the wiremat to the module area of the cabinet and connect directly to the clock module via a 3-pin connector. The remaining output cable wires connect to the interconnect board and therefore the WACS. Refer to Figure 7.

Figure 7. Clock Module Power Supply Output Cable



The output of the power supply drives the GR_DRV1 board assembly that is mounted directly to the clock module. The GR_DRV1 board assembly is used on revision 2 clock module PCBs. The revision 3 clock PCB incorporates the GR_DRV1 board.

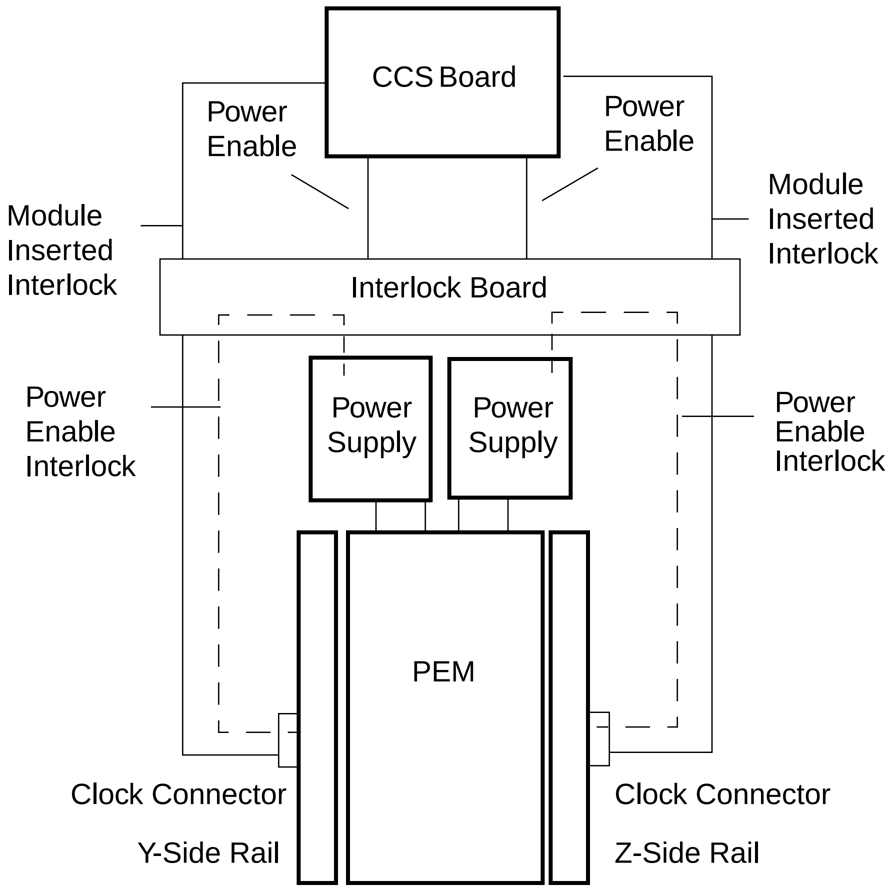
Because of its low output power, the power supply does not require coolant; the power supply is air cooled.

Module Interlocks

Each of the module rails contains two interlock switches. One interlock switch informs the WACS that the module is installed. The other interlock switch is wired in series with the power enable signal that the WACS sends to the module power supply. The module must be cammed correctly for the interlock switches to close and for the power supply to power up. It is possible that a single PCB power supply may not power up because the module is not properly cammed.

Figure 8 shows a block diagram of the module rail interlock switches.

Figure 8. Interlock Switches



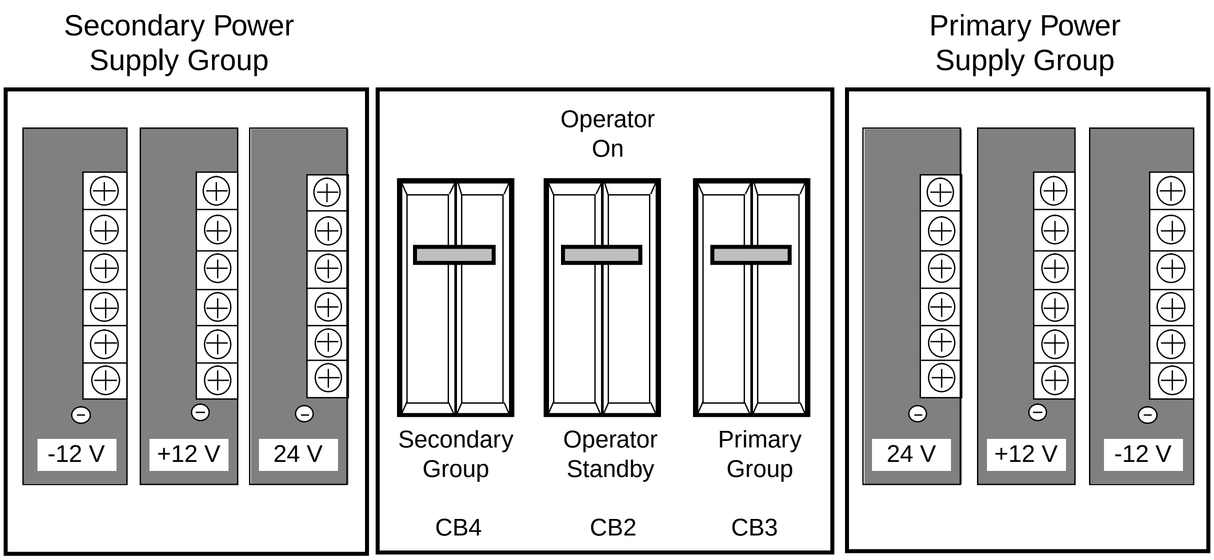
The WACS monitors the –3.3 Vdc output to the PCB power supply and indicates that a PCB did not power on. This does not prevent the system from powering on.

WACS Power Supplies

The WACS boards receive power from redundant power supply groups. Circuit breakers CB3 and CB4 protect these power supply groups. Each power supply group provides +12 Vdc, –12 Vdc, and +24 Vdc power to the two WACS boards (the CCS and the MMS).

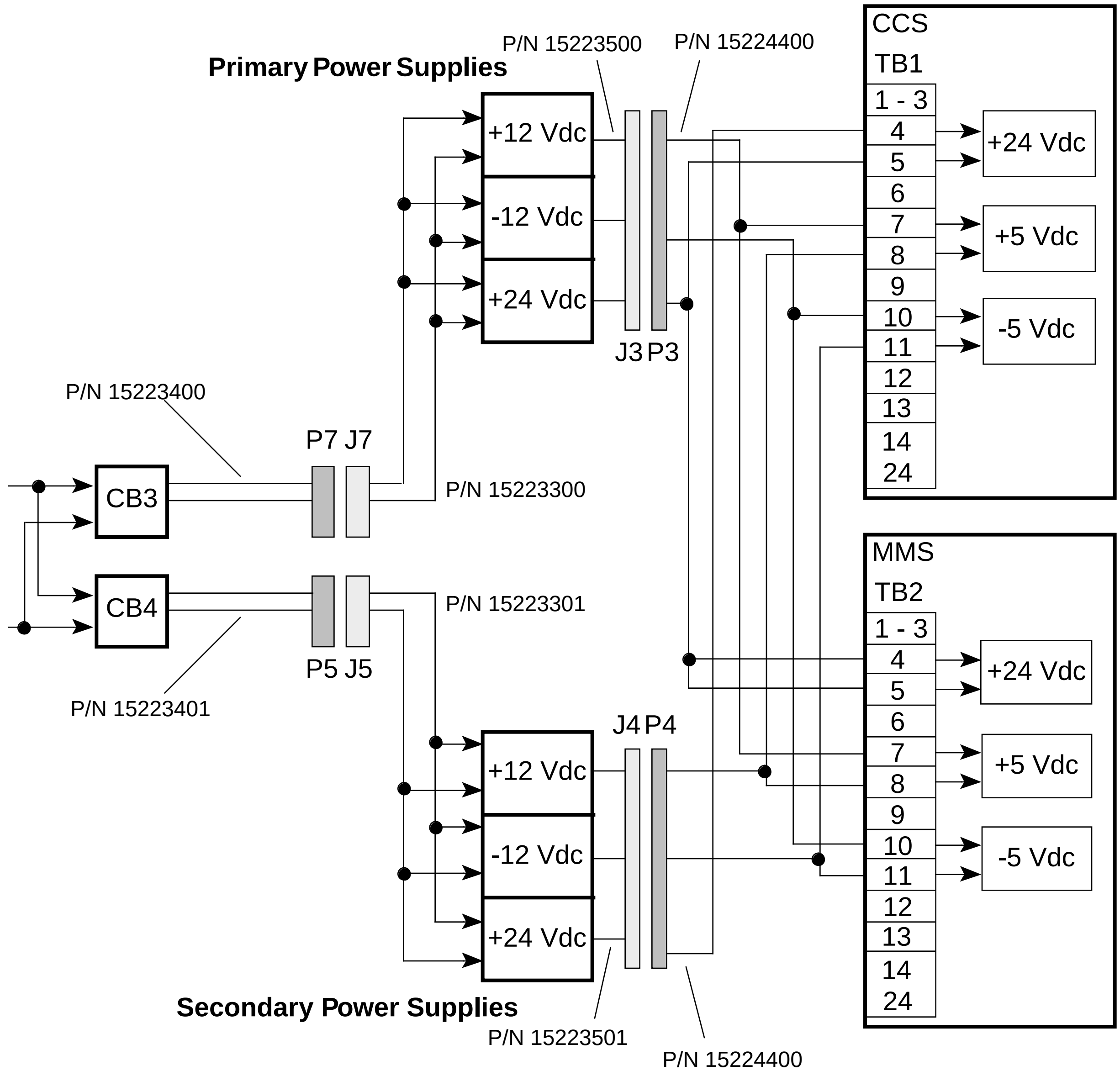
Figure 9 shows the power supply groups and Figure 10 shows the distribution of power from the WACS power supply groups to the CCS and MMS boards.

Figure 9. WACS Power Supplies



NOTE: Labels CB2, CB3, and CB4 do not appear on the actual breaker panel.

Figure 10. WACS Distributed Power



NOTE: Cable assembly P/N15224400 provides the power interconnect between the primary and secondary power supply groups and the CCS and MMS boards.

The WACS boards receive the three DC voltages and regulate the +12 Vdc and –12 Vdc down to +5 Vdc and –5 Vdc respectively. The +24 Vdc is filtered but remains at the same level. Table 2 lists the cables used to route power to the power supplies and then to the CCS and MMS boards.

Table 2. WACS Power Supply Cables

Source	Destination	Part Number
CB3	P7	15223400
J7	Primary power supplies	15223300
Primary power supplies	J3	15223500
P3	CCS and MMS boards	15224400
CB4	P5	15223401
J5	Secondary power supplies	15223301
Secondary power supplies	J4	15223501
P4	CCS and MMS board	15224400

The MMS board can be replaced while the system is powered on. If the CCS board fails, power off the system before you replace the board.

Because the MMS board is not a cabinet-critical component, the cabinet can power on without the MMS board in place. However, without the MMS board, the WACS display does not work.

NOTE: Cable assembly P/N 15224400 provides the power interconnect between the primary and secondary power supply groups and the CCS and MMS boards.

Power-on/off Conditions

Individual LC Cabinet Power-on

Unlike other Cray Research computer equipment, the CRAY T3E LC cabinet does not contain various sizes of power supplies or transformers to change or modify incoming power. The CRAY T3E LC cabinet uses one style of module power supply.

Service personnel apply power to the modules in a three-step process as follows:

1. Close the customer’s commercial power circuit breaker(s).
2. Close the LC cabinet main circuit breaker, CB1.
3. Close circuit breakers CB2, CB3, and CB4.

Power Path

When you close CB1:

- Incoming power flows from the circuit breaker to the four line filters (FL1 through FL4).
- Power flows from the line filters to the phase interchange assembly plate (PIAP).
- From the PIAP, power is distributed to the module power supply bus rails on the outside of the power distribution box. Additionally, from the PIAP, power from two phases or a phase and neutral is sent to CB2, the operator on/standby circuit breaker. Refer again to Figure 1 if necessary.
- From the bus rails, power flows through any closed module circuit breakers to the power cord bus rail.
- For every module power supply that is installed, power flows from the power cord bus rail to the power supply.

NOTE: Once CB1 is closed, ~208 Vac power is available at the module power supplies. No voltage or current changes occur in the power path from the customer’s power panel to the module power supplies to alter incoming voltage.

WACS Power Path

When you close CB2:

- Power flows to CB3 and CB4, the WACS power supply group circuit breakers.
- Closing CB3 and CB4 provides ~208 Vac at the inputs to the +12Vdc, –12 Vdc, and +24 Vdc WACS power supplies.

- DC voltages from the primary and secondary power supply groups are now present at the WACS boards. The WACS is now powered on.

NOTE: To this point you have applied power to the WACS and the module power supplies. Module power supplies do not output power until you press the START switch.

HEU Power-on

Because the LC cabinet's modules and power supplies are cooled by a dielectric coolant, you must also power on the HEU as follows:

1. Close the customer's commercial power-panel circuit breakers.
2. Close circuit breaker CB1 on the HEU control box.

The HEU is now ready to start. The WACS within the HEU is running and is monitoring specified conditions within the HEU. When you press the START switch on the LC cabinet, the HEU starts.

NOTE: Service personnel can activate the COOLING BYPASS switch on the LC cabinet, which turns on the HEU and allows coolant to flow between the HEU and the LC cabinet.

Individual LC Cabinet Power-off

To remove all power from the LC cabinet:

1. Press the STOP switch - this removes the power enable signal from all the module power supplies.

2. Open CB1 - this removes power to the module power supply rails.

The LC cabinet in now fully powered off. However, because the cabinet uses customer-supplied commercial power, voltage is still present at the input to the main circuit breaker, CB1. To remove this potential, open the customer’s circuit breakers at the wall panels.

NOTE: To perform maintenance on the LC cabinet at this time, follow the *Lockout/Tagout Procedures*, Cray Research publication HR-04034.

In a multiple-cabinet system, removing power from cabinet 0 also disables the master clock signal to all remaining cabinets.

HEU Power-off

To bring the HEU to an idle state:

Press the STOP switch on the LC cabinet - this causes the temperature-regulating module to close the water inlet valve and to stop the circulation pump.

NOTE: Because one HEU can supply coolant to two LC cabinets, the HEU does not reach an idle state until the STOP switch is pressed on both LC cabinets.

To power off the HEU:

Open circuit breaker CB1.

The HEU is now powered off. However, because the HEU uses customer-supplied commercial power, voltage is still present at the input to the main circuit breaker. To remove this potential, open the customer’s circuit breakers at the wall panels.

Local Power-on (START)

Before you press the START switch, ensure that:

- Circuit breakers CB1, CB2, CB3, and CB4 are closed
- All modules are properly cammed
- All module power supply circuit breakers are closed (for modules that are installed)
- The remote enable switch on the WACS panel is in **local** mode (LED is NOT on)
- WACS indicators show no warnings or faults

Sequence of Events

If all prestart conditions are correct, press the START switch. When you press the START switch, the CCS board provides a start signal to the HEU. The HEU then activates the water inlet valve actuator to begin water flow and starts the pump to begin coolant flow.

After a half-second delay, during which the HEU comes up to speed, the CCS board sends a power enable signal to all module power supplies that are properly cammed.

Check for Power-on

To verify whether all installed modules have power, view the bottom half of the WACS display; modules with power are identified with the number 1. You can also open the rear door of the LC cabinet and visually inspect the PCB LEDs. All LEDs should be on.

Remote Power-on (START)

Before you can activate the LC cabinet remotely, ensure that:

- Circuit breakers CB1, CB2, CB3, and CB4 are closed
- All modules are properly cammed
- All module power supply circuit breakers are closed (for modules that are installed)
- The remote enable switch on the WACS panel is in **remote** mode (LED is on)

System Workstation Commands

Before remote power-on, service personnel must configure the nwacs program *nwacscfg* on the SWS to meet the criteria of the CRAY T3E system. To configure the CRAY T3E system, refer to document *xelog, xcfg, and nwacs User Information*, Cray Research publication HDM-012-D.

Perform the following steps:

1. Ensure that the WACS indicators show no warnings or faults.
2. In nwacs, click on the Power Up button.
3. In nwacs, click on the Write Switches button.

Use nwacs and check the LC cabinet for any warnings or faults, correct voltages, and HEU WACS status.

Local Power-off (STOP)

To remove power from the modules, press the STOP switch. This causes the CCS board to remove the power enable signal to all installed module power supplies.

To remove all power from the LC cabinet, open circuit breaker CB1.

NOTE: If you open circuit breaker CB2, you remove power only to the WACS boards. This terminates the power enable signal from the CCS board to the power supplies. However, incoming power is still present at the module power supplies.

Remote Power-off (STOP)

To stop the LC cabinet remotely, perform the following steps via the system workstation:

1. Bring down the operating system.

2. In nwacs, click on the Power Down button.

3. In nwacs, click on the Write Switches button.

Sequence of Events

The WACS removes the power enable signal from all module power supplies. However, the WACS still receives power and power is still present at the module power supplies.

NOTE: It is not possible to completely remove power from the cabinet via the remote sequence. The only way to remove all power is to open CB1, the main circuit breaker.

Control Overview

The WACS monitors the LC cabinet for any deviations in power, temperature, or coolant flow. The WACS reports all monitored conditions to the system workstation (SWS). The WACS powers off the cabinet if necessary. Each LC cabinet has a WACS, which is independent from the WACS in every other cabinet in a multiple-cabinet configuration.

The WACS consists of the following components:

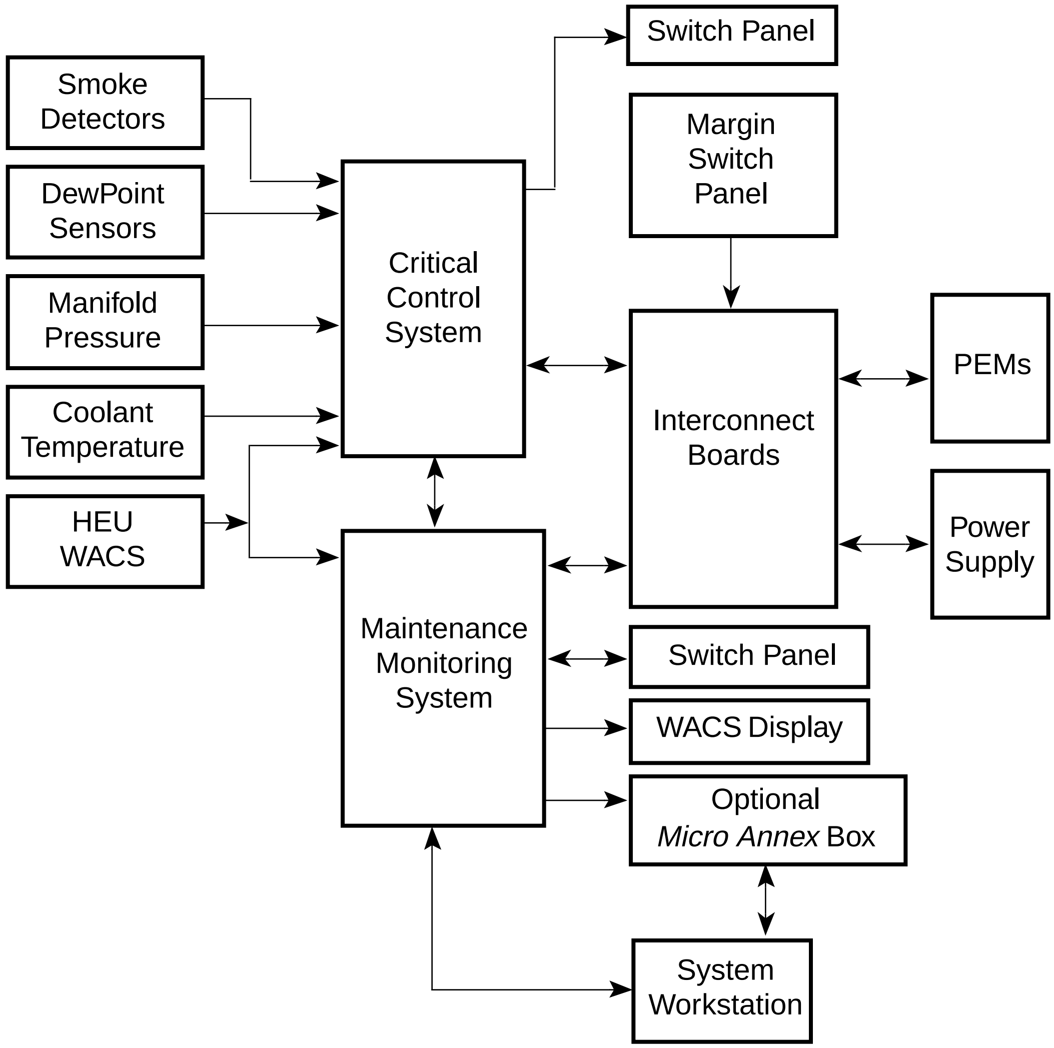
- Critical control system (CCS) board
- Maintenance monitoring system (MMS) board
- CCS and MMS switch panel
- WACS display
- Interconnect boards
- HEU WACS
- Clock/margin switch panel
- WACS cabling

Additionally, the following components enable remote connection to the WACS:

- System workstation (SWS)
- *Micro Annex* box (optional)
- Modem
- Customer remote alarm (optional)

Figure 11 shows a block diagram of the WACS for an LC cabinet.

Figure 11. WACS Block Diagram



WACS Scanners

The CCS board contains two scanners (A and B); the MMS board contains a single display scanner. The scanners on the CCS board monitor cabinet-critical conditions and can power off the LC cabinet. The scanner on the MMS board also monitors LC cabinet conditions but cannot power off the cabinet. Additionally, the MMS scanner communicates with the system workstation (SWS) and the WACS display.

The CCS scanners monitor the LC cabinet against a predetermined set of limits: OFF limits and ON limits. The LC cabinet cannot power up unless both scanners on the CCS board determine that cabinet conditions are within the OFF limits. After power-on, the CCS scanners monitor ON limits and if ON limits are exceeded, indicate either a warning or fault.

Each CCS scanner works independently from the other. For a power-off fault condition to occur, either the A scanner or the B scanner of the CCS board must show the same fault condition on both the primary and backup sensor.

To facilitate a full cabinet power-off, the CCS board is wired directly via a shunt trip circuit to CB1 in the power distribution box. Opening CB1 removes all power from the cabinet.

Warning and Fault Indicators and Limits

The WACS scanners receive inputs from temperature sensors, pressure transducers, and other sensors located throughout the LC cabinet. The LC cabinet also receives inputs from the warning and control system of the HEU. The WACS monitors the following conditions within the LC cabinet:

- Module temperature
- Module power
- Coolant temperature
- Coolant pressure
- Presence of smoke (smoke detectors)
- Dewpoint (in HEU/RCU configurations)
- HEU warnings and faults

Only problems with the following monitored conditions prevent power-on:

- Coolant temperature
- Coolant pressure
- Smoke
- Dewpoint
- HEU faults

In addition to the WACS, each module power supply monitors its internal voltage, current, and temperature. The power supply powers off if it detects a significant deviation from the normal range. View the LED indicators on the power supply to determine the nature of the fault.

The WACS compares cabinet and HEU conditions against preset values. If a condition exists that may cause damage to the LC cabinet, the WACS issues a warning. If the condition becomes worse the WACS issues a fault. Based on the fault condition, the WACS either powers off a component or powers off the entire cabinet.

Table 3 lists the fault and warning limits for cabinet and module conditions that the WACS monitors.

Table 3. Warning and Fault Limits

Monitored Condition	Limits	Low Fault LF	Low Warning LW	High Warning HW	High Fault HF
Module Temperature	On Limits	50 °F 10 °C	60 °F 16 °C	100 °F 38 °C	110 °F 43 °C
	Off Limits	40 °F 4.4 °C	50 °F 10 °C	100 °F 38 °C	110 °F 43 °C
Input Manifold Coolant Temperature	On Limits	50 °F 10 °C	60 °F 16 °C	90 °F 32 °C	100 °F 38 °C
	Off Limits	40 °F 4.4 °C	50 °F 10 °C	90 °F 32 °C	100 °F 38 °C
Input Manifold Coolant Pressure	On Limits	10 psi 68.9 kPa	20 psi 137.8 kPa	100 psi 689 kPa	120 psi 826.80 kPa
	Off Limits	-20 psi -137.8 kPa	-10 psi -68.9 kPa	100 psi 689 kPa	120 psi 826.80 kPa
Output Manifold Coolant Pressure	On Limits	-20 psi -137.8 kPa	-10 psi -68.9 kPa	90 psi 620.1 kPa	100 psi 689 kPa
	Off Limits	-20 psi -137.8 kPa	-10 psi -68.9 kPa	90 psi 620.1 kPa	100 psi 689 kPa
HEU Pump Pressure	On Limits	-20 psi -137.8 kPa	-10 psi -68.9 kPa	150 psi 1,033.5 kPa	160 psi 1,102.4 kPa
	Off Limits	-20 psi -137.8 kPa	-10 psi -68.9 kPa	150 psi 1,033.5 kPa	160 psi 1,102.4 kPa
Dewpoint	On Limits	10 °F -12 °C	15 °F -9 °C	75 °F 24 °C	80 °F 27 °C
	Off Limits	10 °F -12 °C	15 °F -9 °C	75 °F 24 °C	80 °F 27 °C
Smoke		Under normal conditions, the CCS reads 5 Vdc from the smoke detector		A fault condition exists when the CCS reads 0 Vdc from the smoke detector	

NOTE: 1 pound per square inch (psi) equals 6.89 kiloPascals (kPa).

In addition, the WACS monitors power outputs as defined in Table 4.

Table 4. Power Sensing Limits

Monitored Condition	On/Off Limits	High Fault	High Warning	Low Warning	Low Fault*
3.3 Vdc	On Limits	4.0 Vdc	3.7 Vdc	2.5 Vdc	None
	Off Limits	2.0 Vdc	1.0 Vdc	None	None
4.5 Vdc	On Limits	5.4 Vdc	4.9 Vdc	3.6 Vdc	None
	Off Limits	2.0 Vdc	1.0 Vdc	None	None
Ground	On Limits	.25 Vdc	.16 Vdc	None	None
	Off Limits	.25 Vdc	.16 Vdc	None	None
4/2 Reference Voltage	On Limits	5.0 Vdc	4.5 Vdc	3.5 Vdc	3.0 Vdc
	Off Limits	5.0 Vdc	4.5 Vdc	3.5 Vdc	3.0 Vdc

When the WACS detects a warning or fault condition, the display indicates the type of condition by showing a 2-character abbreviation.

Table 5 lists the warning and fault conditions, the indicator that the WACS displays, and the actions of the WACS system.

Table 5. Warning and Fault Indicators and Actions

Condition	Display Indicator	WACS Action
High-temperature warning:	HW	Display only
Low-temperature warning	LW	Display only
High-pressure warning	HW	Display only
Low-pressure warning	LW	Display only
High- or low-temperature module fault	HF / LF	Removes power from the associated module power supply
High- or low-temperature coolant fault	HF / LF	Removes the power enable signal from all module power supplies
High- or low-coolant pressure fault	HF / LF	Removes power to the HEU and the module power supplies; if condition does not improve, power off the cabinet by opening the main circuit breaker CB1
Dewpoint warning	HW or LW	Display only
Dewpoint fault	HF or LF	Removes power from all module power supplies
Smoke detector		Removes power to the cabinet by opening the main circuit breaker CB1
HEU warning	WN	Display only
HEU fault	WN	Causes an HEU fault in the LC cabinet; powers off the HEU and removes the power enable signal from the module power supplies

NOTE: The WACS sounds an alarm on a warning if the correct DIP switch is set.

WACS Switches

The WACS includes two switch panels that are located inside the front door of the cabinet on the WACS access panel. In this document, the two switch panels are referred to as: the WACS switch panel and the margin switch panel. The WACS switch panel consists of five switches that connect directly to the CCS board and five switches that connect directly to the MMS board. The margin switch panel, which contains the voltage margin, clock margin, and boundary scan enable switches, connects to the clock module and the MMS board and daisy chains through the interconnect boards.

Figure 12 shows the locations of the switch panels and the WACS display. Figure 13 shows a detailed view of the switch panels.

Figure 12. WACS Switch and Display Locations

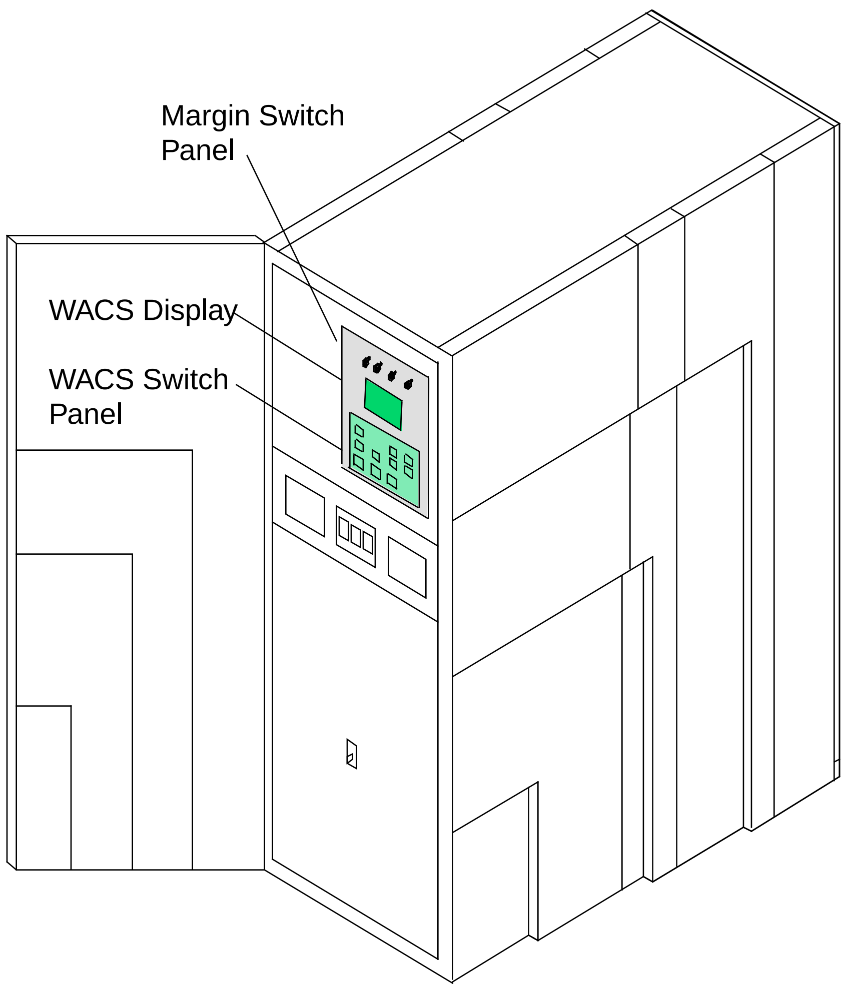
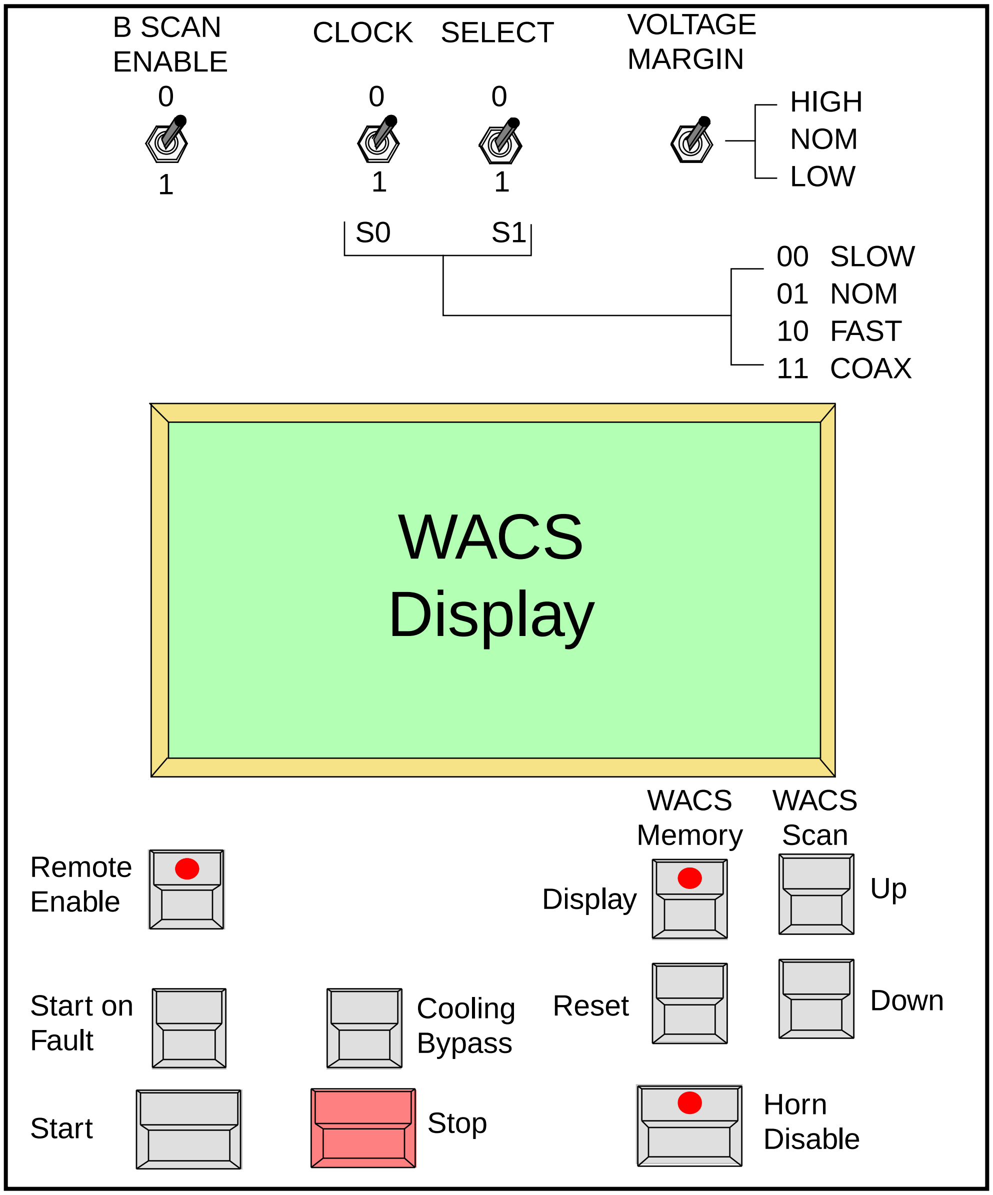


Figure 13. WACS Switch Panel



CCS Switches

WACS switches connect to either the CCS board or the MMS board. The following switches are wired directly to the CCS board:

- **Remote Enable** - remote start/stop operation. Disable this switch when you perform service. (The LED is on when WACS is in a remote enable state.)
- **Start on Fault** - used with the start switch to power on the cabinet when a fault exists. (Remote enable must be off.)
- **Cooling Bypass** - turns on the circulation pump in the HEU to force coolant through the module cabinet without activating the module power supplies.
- **Start** - provides the Power Enable signal to all module power supplies with properly installed modules. In addition, this switch is used to restart a module that has been powered off. (Remote enable must be off.)
- **Stop** - removes the Power Enable signal from all module power supplies. (This switch functions whether remote enable is on or off.)

MMS Switches

The following switches are wired directly to the MMS board.

- **Memory Display** - displays the contents of WACS memory since the last reset
- **Scan Up** - shows the next WACS page
- **Scan Down** - shows the previous WACS page
- **Memory Reset -** clears the contents of WACS memory
- **Horn Disable** - disables the audible alarm (the horn is disabled when the LED is on)

Margin/Clock Switches

The following clock and voltage margin switches are also on the WACS switch panel above the CCS and MMS switches:

- **Boundary Scan Enable** - hardware enable or disable for boundary scan
- **Clock Select** - wired directly to the clock module to vary clock speed

  NOTE: Clock select switches affect the master clock module in Cabinet 0 (CKM0) only. The clock select switches for cabinets 1 through 7 have no effect on the clock signal for those cabinets.

- **Voltage Margin** - wired via the interconnect board to all module power supplies to vary output voltage; select either high or low to vary the module power supply by 6% to -3.5 Vdc or -3.1 Vdc

  NOTE: Voltage margins run on individual cabinets. To run margins on more than one cabinet, set the switch on each cabinet.

WACS Board Switches

The CCS board has one bank of user selectable switches.

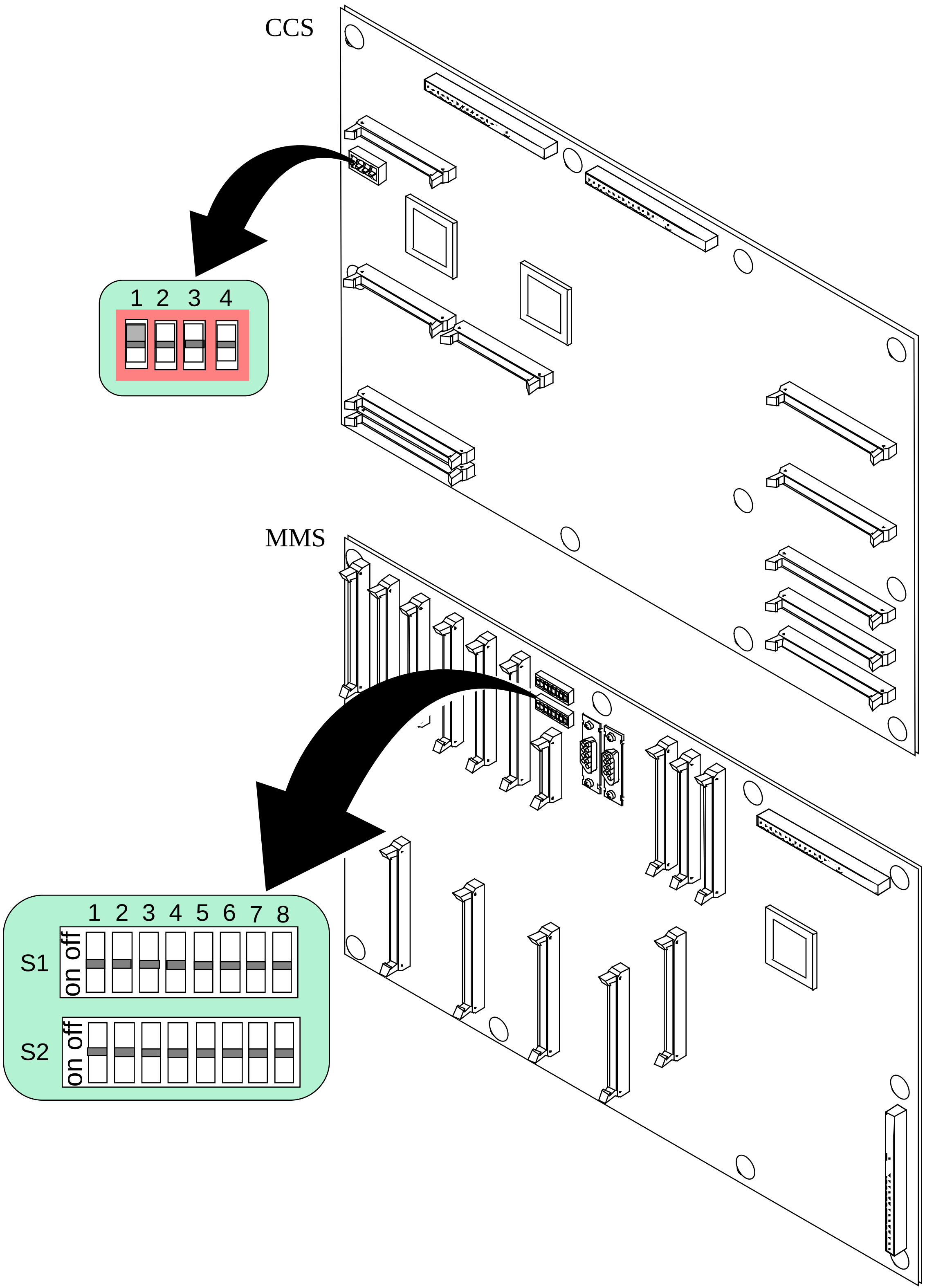
- S1 - ON = Clock sequencing; powers on the clock module ~5 seconds before the PEMs
- S2 - S4 = Undefined

The MMS board has two banks of user selectable switches, S1 and S2. The switches for S2 currently are undefined. The individual switch definitions for S1 are:

- S1 - ON = Local horn: sound alarm on warning indication; the alarm sounds on a fault regardless of the switch position
- S2 - ON = Local horn disable; never comes on
- S3 - ON = Remote horn; sound on warning
- S4 - ON = Remote alarm relay; de-energizes for warning or fault
- S5 - ON = Metric; OFF = English (output of the WACS display)
- S6 - Undefined
- S7 - Undefined
- S8 - ON = HEU/RCU combination; OFF = HEU WC-1

Figure 14 shows the switches on the CCS and MMS boards.

Figure 14. CCS and MMS Board Switches



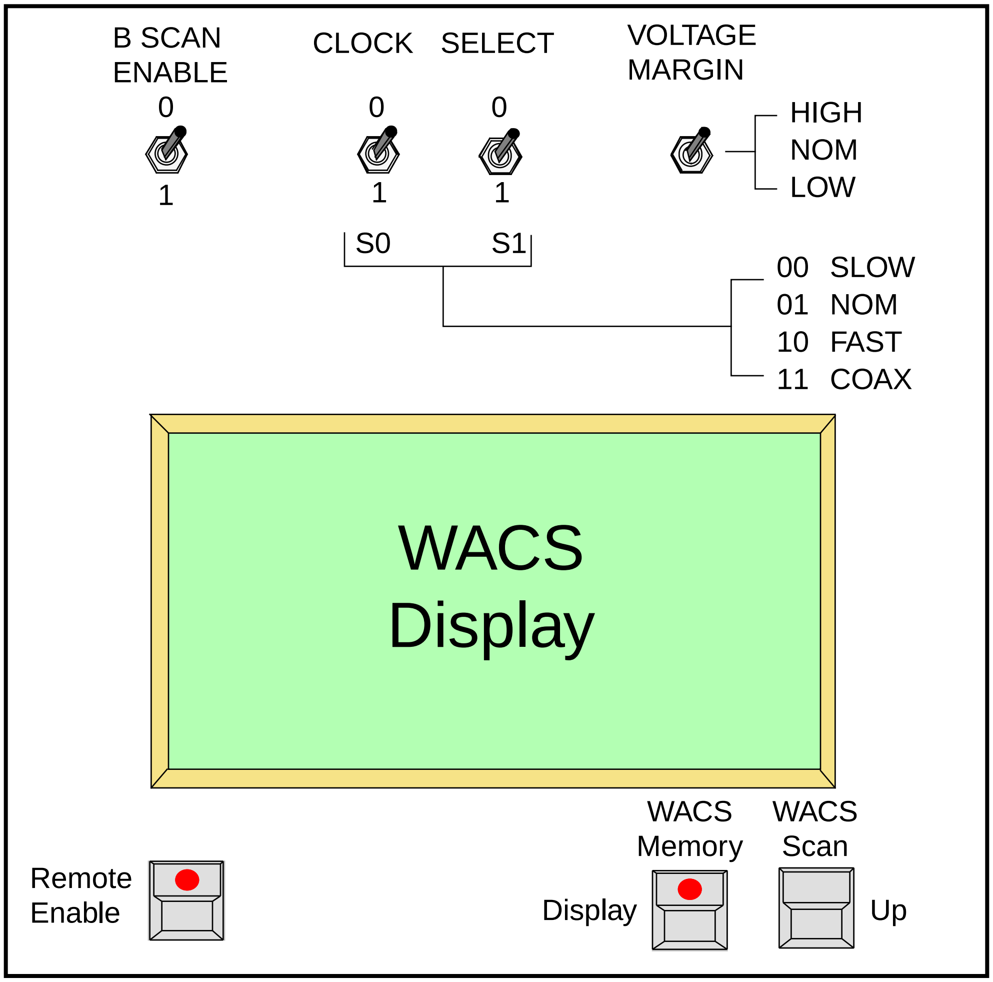
WACS LCD Display

The WACS LCD display is on the WACS access panel inside the front door of the LC cabinet. The WACS LCD display shows pages of information that are contained in the WACS memory. The WACS LCD display shows the following types of pages:

- Module pages
- HEU pages
- Manifold page
- System page
- WACS power supply page
- WACS help pages
- WACS self-checks page

The 128 x 248-dot display, Figure 15, is cabled directly to the MMS board, is field replaceable, and can be replaced while the system is powered on.

Figure 15. WACS Display Panel



The WACS page has two parts. The top half of the page gives specific information on conditions within the LC cabinet. The bottom half of the page shows the module insertion status, on/off status for all module locations, and warning or fault conditions.

Figure 16 shows the standard page display for the module that is in location slot 4. The top half of the display page represents the status of the module. Scan A, Scan B, and Main refer to the readings from the two scanners on the CCS board and the scanner on the MMS board.

Figure 16. WACS Module Page Display

MODULE 4

	SCAN A	SCAN B	MAIN
UPR Temp	76 - -	77 - -	
LWR Temp	66 - -	67 - -	
UPR Volt	3.3 - -	3.3 - -	3.3 - -
LWR Volt	3.2 - -	3.2 - -	3.2 - -
	SUP Enabled	SUP Enabled	

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1F	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

Module insertion status and warning/fault information make up the bottom half of the page display. Module status is indicated as:

- 1 - Module is turned on
- 0 - Module is turned off
- x - Module is not installed

If a warning or fault occurs on a module, the letter W or F appears next to the module status indicator, as shown for module 9 in Figure 16. The module does not power off unless both thermistors detect a fault condition. When only one thermistor detects a fault condition, the module stays powered on and the WACS displays the “1” indication and the “F” indication. If both module thermistors detect a fault, there is a 10-second delay before power-off. During this timeout, the display shows “1F.”

The bottom half of the display indicates whether a warning or fault occurred in selected areas. The display uses the following abbreviations:

- MAN - Manifold
- SYS - System conditions
- HEU - Heat exchanger unit

- SEL - Self checks
- WAC - WACS
- CAB - Cabinet cooling and power

Dashes appear to the right of the indicators unless a fault or warning occurs. If a warning or fault occurs the dash lines are replaced by one of the indicators in Table 6.

Table 6. Fault and Warning Indicators

Condition	Display Indicator
High Fault	HF
Low Fault	LF
Fault	FT
High Warning	HW
Low Warning	LW
Warning	WN

The bottom half of the display page remains the same as you toggle through the various WACS display pages.

Module Page

Figure 17 shows the module page display for the module in slot 7. Each module location (1 through 35) has a dedicated page display and each contains the same type of information.

Scanner A and scanner B (SCAN A and SCAN B on the display) of the CCS board receive the same information from the module. The information consists of module temperature from the upper PCB and the lower PCB and primary voltage readings from the upper PCB and the lower PCB. The primary voltage reading is also sent to the display scanner (MAIN on the display) on the MMS board.

NOTE: Because modules are inserted upright or upside down, the upper board refers to the top board of the module for that slot position.

For the clock module in slot 18, the LWR Volt reading represents the auxiliary voltage that the clock PCB uses (–4.5 Vdc).

Figure 17. WACS Module Page Display (Slot 7)

MODULE 7

	SCAN A	SCAN B	MAIN
UPR Temp	76 - -	76 - -	
LWR Temp	66 - -	66 - -	
UPR Volt	3.3 - -	3.3 - -	3.3 - -
LWR Volt	3.2 - -	3.2 - -	3.2 - -
	SUP Enabled	SUP Enabled	

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - WN

CAB - Cooling and Power On

If a module is not installed, the WACS display shows upper and lower Temp as LOW LF, the upper and lower Volt readings are 0.0. The CCS board does not receive any information so it registers open thermistors, which causes a fault. In addition, the SUP indicator shows N Enable.

Table 7 lists the indicators on the module page display and their meanings.

Table 7. WACS Module Page Display

Indicator	Description
UPR Temp	Represents the temperature of the upper board on a module
LWR Temp	Represents the temperature of the lower board on a module
UPR Volt	Represents the voltage reading from the upper board on a module
LWR Volt	Represents the voltage reading from the lower board on a module
Sup Enable	Indicates that the power enable signal was sent from the CCS board to the module power supply (both PCBs) The SUP Enabled indicators show the upper board on the left and the lower board on the right.

HEU Page

The WACS in the HEU sends information to the WACS in the LC cabinet. The HEU does not communicate directly with the SWS. The amount of information from the HEU depends on whether a site has an HEU WC-1 or HEU/RCU. Figure 18 and Figure 19 show the WACS page displays for the HEU. Table 8 describes the WACS indicators and their descriptions.

NOTE: Status indicators shown in italics do not appear on the HEU display pages when the LC cabinet is running with the HEU WC-1, water-cooled HEU.

Figure 18. WACS HEU (1 of 2)

HEU 1 of 2

	SCAN A	SCAN B
Pmp P Pres	88 - -	87 - -
Pmp B Pres	88 - -	87 - -
HEU Status	- -	- -
HEU Level	- -	- -
RCU Status	- -	- -

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

Use position 8 of switch 1 on the MMS board to choose the HEU/RCU or HEU WC-1 configuration.

Figure 19. WACS HEU (2 of 2)

HEU 2 of 2

	MAIN PRI	MAIN BAK
WHEU Warn	- -	- -
Evap Pres	- -	- -
Evap Temp	- -	- -
Sup Temp	- -	- -
Liq Temp	- -	- -

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

Table 8. HEU WC-1 Page Display

Indicator	Description
Pmp P Pres	Pump pressure reading from primary pressure transducer
Pmp B Pres	Pump pressure reading from backup pressure transducer
HEU Status	Pump motor stopped indicator; shows only the fault condition
HEU Level	Not shown with HEU WC-1
RCU STATUS	Not shown with HEU WC-1
WHEU Warn	Status of HEU water; shows either a blank, warning, or fault
Evap Pres	Not shown with HEU WC-1
Evap Temp	Not shown with HEU WC-1
Sup Temp	Not shown with HEU WC-1
Liq Temp	Not shown with HEU WC-1

NOTE: MAIN PRI and MAIN BAK refer to the WACS primary and backup scanners of the HEU, not the LC cabinet MMS board.

Manifold Page

The WACS monitors both coolant temperature and coolant pressure. The WACS checks coolant temperature using a primary and backup thermistor in the supply manifold to the power supplies. The WACS checks coolant pressure on the supply and return (in and out) power supply manifolds via primary and backup pressure transducers in each manifold. Figure 20 shows the WACS manifold page and Table 9 lists the indicators and their descriptions.

Figure 20. WACS Manifold Page

MANIFOLD

	SCAN A	SCAN B
IN P Temp	71 - -	70- -
IN B Temp	65 - -	66 - -
IN P Pres	25 - -	23 - -
IN B Pres	23 - -	22 - -
OUT P Pres	21- -	19 - -
OUT B Pres	23- -	23- -

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

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Table 9. WACS Manifold Page Display

Indicator	Description
IN P Temp	Coolant temperature at the power supply input (supply) manifold - primary thermistor
IN B Temp	Coolant temperature at the power supply input (supply) manifold - backup thermistor
IN P Pres	Coolant pressure reading at the power supply input (supply) manifold - primary pressure transducer
IN B Pres	Coolant pressure reading at the power supply input (supply) manifold - backup pressure transducer
OUT P Pres	Coolant pressure reading at the power supply output (return) manifold - primary pressure transducer
OUT B Pres	Coolant pressure reading at the power supply output (return) manifold - backup pressure transducer

System Page

The system page shows the status of the smoke detectors and the dewpoint monitors (if dewpoint monitors are installed). The dewpoint monitors are required when the LC cabinet is connected to an HEU/RCU cooling configuration. The display shows the actual dewpoint temperature. For the smoke detector portion, the display will show dashes in the scan A and scan B columns unless a fault (FT) or warning (WN) occurs. Figure 21 shows the WACS system page and Table 10 describes the indicators.

Figure 21. WACS System Page

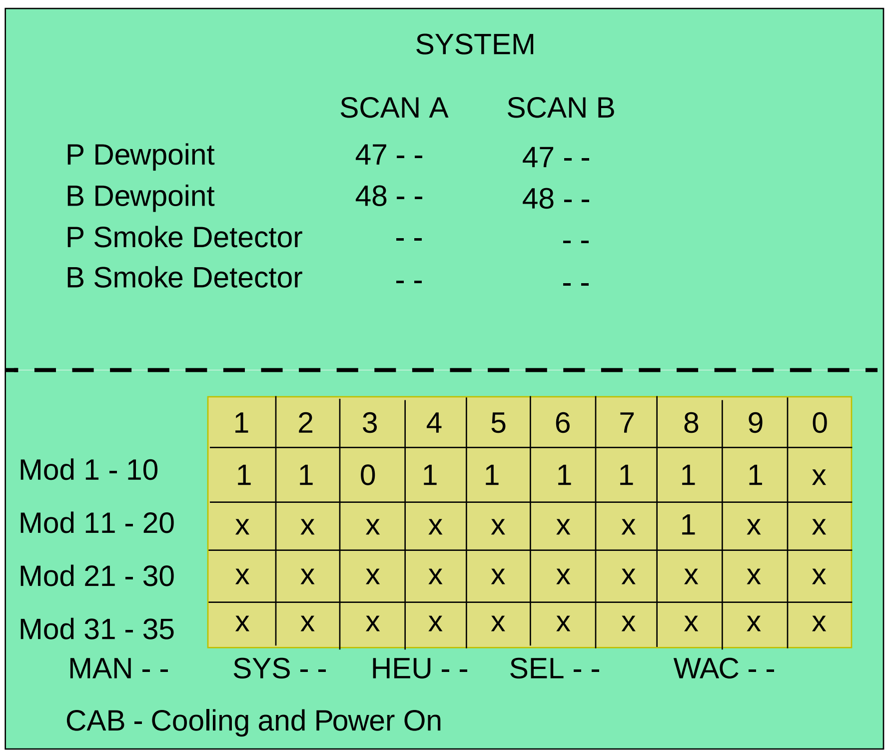


Table 10. WACS System Page Display

Indicator	Description
P Smoke Detector	Primary smoke detector
B Smoke Detector	Backup smoke detector
P Dewpoint	Primary dewpoint monitor (if installed)
B Dewpoint	Backup dewpoint monitor (if installed)

WACS Power Supply Page

The WACS power supply page (refer to Figure 22) gives output readings from the redundant WACS power supply groups. Two groups of AC-to-DC power supplies output +12 Vdc, -12 Vdc, and +24 Vdc to both the CCS and MMS boards. With redundant inputs, either power supply group can be idled for repair while the WACS retains power. On this page display, #1 represents the primary power supply group; #2 represents the secondary group.

Figure 22. WACS Power Supply Page

WACS POWER SUPPLY

	MAIN
#1 +12V	+11.9
#2 +12V	+11.9
#1 -12V	-12.0
#2 -12V	-12.0
#1 +24V	+23.9
#2 +24V	+23.8

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

Self Check

The self-check page (refer to Figure 23) displays reference voltage readings from the CCS and MMS boards. The scanners continue to run diagnostic routines and background tests as they monitor the LC cabinet.

Figure 23. WACS Self Check Page

SELF CHECKS

	SCAN A	SCAN B	MAIN
P Ref	4.0 - -	4.0 - -	
B Ref	4.0 - -	4.0 - -	
P Gnd	- -	- -	
B Gnd	- -	- -	
M Gnd			- -
M +5V			+5.05 - -

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

The +5 Vdc indication on the MMS board shows the internal board voltage that the processor uses.

The +4 Vdc indication on the CCS board is a reference voltage that the A - D converters on the board use. All temperature and voltage signals are scaled against this voltage.

WACS Help Page

The display pages contain three WACS help pages. Figure 24, Figure 25, and Figure 26 show the WACS help pages.

Figure 24. WACS Help Page # 1

HELP #1 Module Faults and Warnings

HF = High Fault
HW = High Warning
LF = Low Fault
LW = Low Warning
UPR = Upper PCB on the Module
LWR = Lower PCB on the Module

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

Figure 25. WACS Help Page #2

HELP #2 Module Faults and Warnings

FT = Either high or low fault
WN = Either high or low warning
Enable = Power supply enabled = ON
N Enable = Power supply NOT enabled = Off

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

Figure 26. WACS Help Page # 3

HELP #3 Module Faults and Warnings

1 = Module ON
0 = Module OFF
E = Supply enabled but low output (1.25 Vdc or less)
X = Module NOT installed
F = Either high or low fault or both
W = Either high or low warning or both

	1	2	3	4	5	6	7	8	9	0
Mod 1 - 10	1	1	0	1	1	1	1	1	1	x
Mod 11 - 20	x	x	x	x	x	x	x	1	x	x
Mod 21 - 30	x	x	x	x	x	x	x	x	x	x
Mod 31 - 35	x	x	x	x	x	x	x	x	x	x

MAN - - SYS - - HEU - - SEL - - WAC - -

CAB - Cooling and Power On

Using NWACS to View WACS Information via the SWS

Use NWACS (and NWACSUSER) to view the WACS parameters via the SWS. Refer to *xelog, xcfg, and nwacs User Information*, publication HDM-012-D, for a description of the NWACS software application and how to use NWACS.

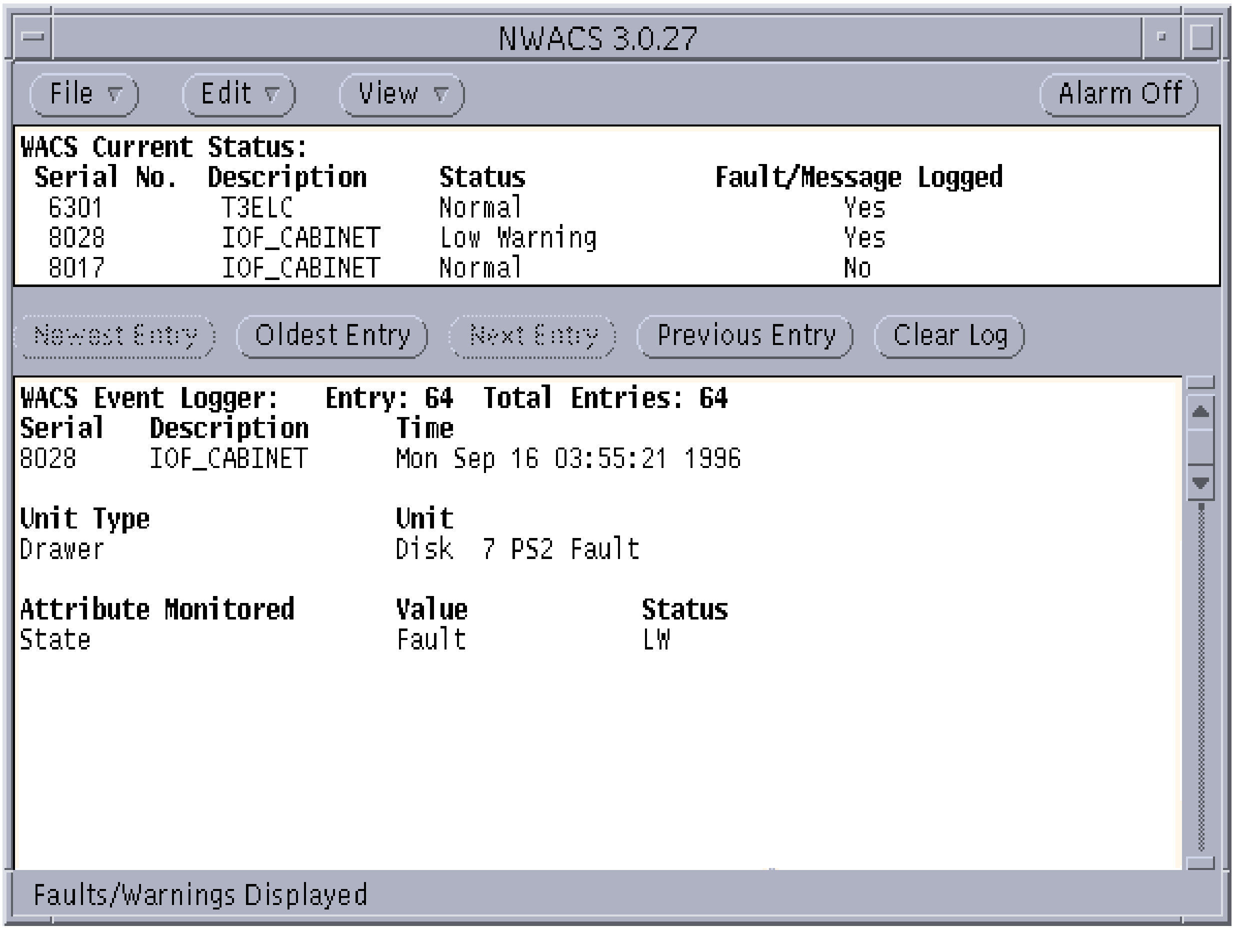
You will use three major screen displays to view WACS information:

- The main NWACS display screen, which shows system components
- A WACS dump for the LC cabinet that shows all WACS statuses
- The soft switches display screen

Figure 27 shows the main NWACS screen and Figure 28 shows the soft switches screen. Table 11 shows a WACS dump for an LC cabinet. The dump has been modified to show data for modules in locations 1 through 3 and 35. Each module location has a multiple-line entry and each entry shows the same type of information.

For multiple-cabinet configurations, both the soft switch screen display and the WACS dump screen display indicate system serial number and cabinet number. The header for these displays reads: T3ELC: sn6301-00, T3ELC: sn6301-01, etc.

Figure 27. NWACS - Main Screen



In Table 11, a D in the module status column indicates that the module is not installed. In the HEU portion of the dump, a D refers to data that is not required for the HEU WC-1 heat exchanger.

On the header row, the A/Main represents either the A scanner of the CCS board or the MMS (MAIN) board scanner. B scanner refers to the B scanner on the CCS board.

Only the MMS board displays polarity for voltage readings.

Table 11. WACS Dump

T3ELC: Serial 6301			
Unit	**Measurement**	**A/Main Scanner**	**B Scanner**
Module			
Temp Module 1 Upr	Temperature (F)	N 75.714	N 76.012
Temp Module 1 Lwr		N 65.806	N 67.004
Temp Module 2 Upr		N 75.714	N 76.429
Temp Module 2 Lwr		N 65.804	N 66.000
Temp Module 3 Upr		N 76.429	N 77.143
Temp Module 3 Lwr		N 66.000	N 66.667
↓ Modules 4 through 35		↓	↓
Temp Module 35 Upr		D	D
Temp Module 35 Lwr		D	D
Volts			
Volts Module 1 Upr	DC Volts	N 3.328	N 3.264
Volts Module 1 Lwr		N 3.328	N3.296
Volts Module 1 Upr (main)		N -3.399	
Volts Module 1 Lwr (main)		N -3.405	
Volts Module 2 Upr		N 3.328	N 3.328
Volts Module 2 Lwr		N 3.315	N 3.267
Volts Module 2 Upr (main)		N -3.296	
Volts Module 2 Lwr (main)		N -3.309	
Volts Module 3 Upr		N 3.328	N 3.328
Volts Module 3 Lwr		N 3.315	N 3.267
Volts Module 3 Upr (main)		N -3.296	
Volts Module 3 Lwr (main)		N -3.309	
↓ Modules 4 through 35		↓	↓
Volts Module 35 Upr		D	D
Volts Module 35 Lwr		D	D
Volts Module 35 Upr (main)		D	D

Table 11. WACS Dump (continued)

T3ELC: Serial 6301			
Unit	**Measurement**	**A/Main Scanner**	**B Scanner**
Volts Module 35 Lwr (main)		D	D
Manifold			
Input Temp Pri	Temperature (F)	N 70.000	N 70.714
Input Temp Bak		N 65.333	N 65.333
Input Pres Pri	Pressure (PSI)	N 25.536	N 22.966
Input Pres Bak		N 22.966	N 21.601
Output Pres Pri		N 21.681	N 19.111
Output Pres Bak		N 22.966	N 22.966
System			
Dewpoint Pri	Temperature (F)	N 48.077	N 47.274
Dewpoint Bak		N 48.880	N 48.077
Smoke Detector	Smoke	Not Detected	Not Detected
Smoke Detector		Not Detected	Not Detected
Remote Power Pri	State	Disabled	Disabled
Remote Power Bak		Disabled	Disabled
Heat Exchanger Unit			
Pump Pres Pri	Pressure (PSI)	N 88.502	N 87.216
Pump Pres Bak		N 88.502	N 87.216
HEU Status Pri	State	N Normal	N Normal
HEU Status Bak		N Normal	N Normal
HEU Level Pri		N Normal	N Normal
HEU Level Bak		N Normal	N Normal
RCU Status Pri		N Normal	N Normal
RCU Status Bak		N Normal	N Normal
Evaporator Pres Pri (main)	Pressure (PSI)	D	
Evaporator Pre Bak (main		D	
Evaporator Temp Pri (main)	Temperature (F)	D	
Evaporator Temp Bak (main)		D	
Superheat Temp Pri (main)		D	
Superheat Temp Bak (main)		D	
Liquid Temp Pri (main)		D	
Liquid Temp Bak (main)		D	
WHEU Warning (main)	Status	N Normal	
Self Test			
Reference Check Volts Pri	DC volts	N 4.032	N 4.096

Table 11. WACS Dump (continued)

T3ELC: Serial 6301			
Unit	**Measurement**	**A/Main Scanner**	**B Scanner**
Reference Check Volts Bak		N 4.043	N 4.096
Ground Check Pri	State	N Normal	N Normal
Ground Check Bak		N Normal	N Normal
Ground Check (main)		N Normal	
WACS Power Supplies			
+5V Power Supply (main)	DC Volts	N 4.971	
#1 +12V Pwr Sup (main)		N 12.001	
#2 +12V Pwr Sup (main)		N 11.971	
#1 -12V Pwr Sup (main)		N -11.966	
#2 -12V Pwr Sup (main)		N -11.976	
#1 +24V Pwr Sup (main)		N 23.878	
#2 +24V Pwr Sup (main)		N 23.968	
WACS PROM			
Byte 0 & 1	Part Number	1513.000	
Byte 2 & 3		5301.000	

Soft Switches

The NWACS software includes the following soft switches:

- Power UP
- Power DOWN
- TCK Select
- Soft Scan Enable (boundary scan enable/disable)

The Power UP switch causes the CCS board within the WACS to send the power enable signal to all properly installed modules.

The Power DOWN switch causes the CCS board within the WACS to drop the power enable signal.

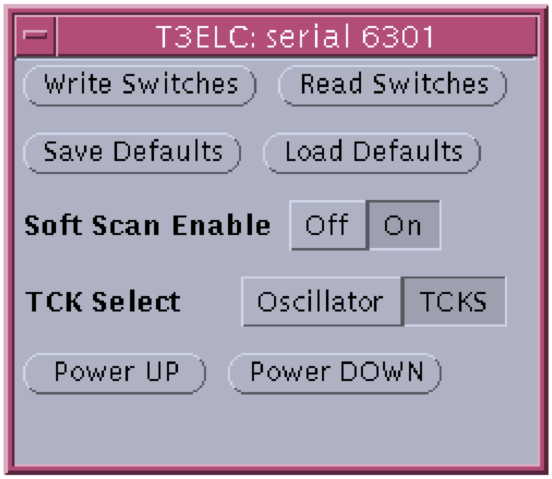
The TCK Select switch determines whether to use the TCK signal from the scan master or from one of the clock oscillators. It is used to reset the clock after running boundary scan.

The Soft Scan Enable switch enables (On) and disables (Off) the boundary scan feature. This soft switch is controlled by the hard switch on the WACS panel of the LC cabinet.

NOTE: T3EMS calls a program *gateclk* which changes the state of this switch automatically.

Figure 28 shows the NWACS soft-switches menu. As in other versions of NWACS, you must click on the Write Switches button to apply your switch selections.

Figure 28. NWACS Soft Switches



Heat Exchanger Unit (HEU)

Main Power Requirements

Commercial 3-phase power for the heat exchanger unit is supplied in one of the voltages listed in Table 12. Incoming power is hardwired directly from the customer's power panels into the HEU.

Table 12. HEU Incoming Power Requirements

Voltage	Phase	Frequency	Amps	Wiring
200–230 Vac	3	50/60	80–70	3 phases and ground
400–460 Vac	3	50/60	40–35	3 phases and ground

Warning and Control System (WACS)

The HEU WC-1 WACS system monitors the HEU for warning or fault conditions. Out-of-range conditions are indicated on the HEU WACS display panel. In addition, the HEU WACS sends warning and fault condition information to the WACS boards of the CRAY T3E LC cabinet.

During power-on, the WACS of the CRAY T3E LC cabinet sends a start signal to the HEU to apply power. If a fault conditions exists within the HEU, the CRAY T3E cabinet does not power on.

For more information on the HEU WC-1, refer to *HEU-WC1 Operation, Maintenance, and Repair*, Cray Research publication number HMM-022-0.

Electromechanical Troubleshooting

This subsection provides troubleshooting tips for the following potential problems:

Power troubleshooting

- No cabinet power (no WACS indication)
- No cabinet power (WACS fault)
- PCB for the module at slot xx does not power-on
- Power supply for the PCB at slot xx drops power

WACS troubleshooting

- WACS coolant fault
  - Temperature
  - Pressure
- WACS power fault
- HEU fault
- Module temperature fault
  - High temp
  - Low temp
- Smoke detector fault
- Dewpoint fault

No Cabinet Power (No WACS Indication)

For this problem, it may be necessary to meter power inside the power distribution box. Observe all electrical safety procedures.

Table 13. Cabinet Power Problem

Possible Causes	Symptom/Action
The circuit breaker(s) that supplies customer power is open	Check the customer’s power panel
The main circuit breaker, CB1, is open	The WACS CCS board constantly puts out a power-off signal
A bad control line filter (FL6) exists between CB1 and the CCS board	Replace the filter
Circuit breaker CB2 is open	Replace the breaker
Loss of 208 Vac at circuit breaker CB2	Check for 208 Vac at the circuit breaker
Two sensors in the LC cabinet will trip CB1; either a smoke detector fault or a low pressure fault	Replace either the smoke detector or the pressure sensor

No Cabinet Power (WACS Fault)

The LC cabinet loses all power; CB1 trips open.

Table 14. WACS Fault - Power Problem

Possible Causes	Symptom/Action
A voltage surge occurred in CB1	Verify incoming power
Smoke detector fault Low coolant pressure	The CCS board powered down the LC cabinet
High coolant pressure	
Pump pressure fault	A clogged strainer in the HEU Verify the operation of the pump
Power supply stays enabled after the machine is shut down	Replace the bad power supply

Module PCB at Slot xx Does Not Power On

You press the START switch on the WACS panel and all modules power on except one PCB on the module at slot xx. You check the WACS page display for that module and find that the WACS shows no power on the PCB. Additionally, the power-on LED on the PCB is not on.

Table 15. PCB Power Problem

Possible Causes	Symptom/Action
The PCB was not properly cammed	Recam the PCB
The PCB power supply failed	Check the AC indicator for incoming power Check the power cord connections Check the power supply circuit breaker Check the fuses on the power supply Check the power supply LEDs for overcurrent or overvoltage
WACS cable connections are faulty	Check the power supply control cable connections Check the control cable connections for the PEM-to-WACS cable
The interconnect board	Check cable connections at the interconnect board
Temperature fault	Check the module coolant hoses Check for a bad thermistor

PCB Power Supply at Slot xx Drops Power

The customer informs you that there is a problem with some PE nodes. The WACS page display shows that the top or bottom PCB at slot xx no longer has power. Check the LED on the PCB to confirm what the WACS display shows.

Table 16. Module Power Supply Problem

Possible Causes	Symptom/Action
The cable connections from the power supply and interconnect board are faulty	Check the power cord connections
The power supply has an overvoltage or current-limit problem	Power supply circuit breaker tripped open
No incoming power to the supply	One or both of the power supply fuses opened Check voltage at the circuit breaker
Temperature fault	Check the WACS page display for module temperatures

WACS Power Supply(s) Does Not Power On:

What indications did the WACS page display show?

Table 17. WACS Power Supply Problem

Possible Causes	Symptom/Action
May be a WACS fault or customer power problem	CB1 is open or tripped
No power is present to CB3 and CB4	CB2 is open Meter the voltage output of CB2
Bad WACS DC power supply	CB3 and CB4 are open or tripped Check the WACS power supply page display Check the output lights on the DC power supplies
Bad or loose power cable to the power supplies	Check cable connections for primary and secondary power supply groups

WACS Display Does Not Work

The WACS display is driven from the display scanner on the MMS board.

Table 18. A Bad WACS Display

Possible Causes	Symptom/Action
A loose or bad cable connection	Check all cable connections
A bad display or display card	Replace the bad component
A bad MMS board	Replace the MMS board
A bad CCS board	Replace the CCS board
Circuit breakers CB2, CB3 and/or CB4 are open	Check TB2 for incoming DC voltage

HEU Does Not Power On

Commercial 3-phase power is wired directly from the customer's panel into the HEU. If the HEU is not receiving input power, check the source.

Table 19. HEU Power-on Problem

Possible Causes	Symptom/Action
A loose cable between the LC cabinet and the HEU	Check all cable connections
A loose cable between the CCS board of the LC cabinet and the WACS access panel (connector J11 on the access panel)	Check all cable connections
A bad switch on the LC cabinet	Replace the faulty switch
A bad CCS board in the LC cabinet (controls the switch)	Replace the CCS board
Power problem in the HEU	Check the voltage to the transformer Check the fuses on the power box; **open the wall breaker before doing this step**

WACS Coolant Pressure Fault

Input and output coolant pressure is monitored at the power supply manifolds by a set of primary and backup pressure transducers.

Table 20. Coolant Pressure Fault

Possible Causes	Symptom/Action
A coolant leak	Leak check the coolant system
A blocked or restricted manifold	
A blocked or restricted coolant hose	Check that all control valves are open
A dirty coolant strainer in the HEU	Replace the HEU strainer
A bad transducer	Replace the faulty transducer
A bad or loose cable	Check all cable connections
A bad CCS board, which results in a false pressure sensor fault	Replace the CCS board

WACS Coolant Temperature Fault

The HEU is set to provide a coolant temperature of 75° F at the inlet of the manifolds. The temperature-regulating module of the HEU controls the mixing valve, which in turn produces the correct coolant output temperature.

Table 21. Coolant Temperature Fault

Possible Causes	Symptom/Action
A bad mixing valve in the HEU	Replace the mixing valve
A bad temperature-regulating module in the HEU	Replace the temperature-regulating module
A bad water supply to the HEU	Check water flow pressure differential at the HEU Check the inlet water temperature
An improper coolant temperature setting	Reset the coolant temperature control

Module Temperature Fault

Each PCB has a single 10K-ohm thermistor that monitors temperature. The WACS reads the output from these thermistors. One PCB on a module may have a temperature fault. The WACS indicates this fault on the display but does not power off the module until the second thermistor indicates a fault.

Table 22. Module Temperature Fault

Possible Causes	Symptom/Action
A bad PCB thermistor	Replace the bad thermistor
Bad cables from the rail to the WACS CCS board	Check the cable connections Replace any bad cables
A bad CCS board	Replace the CCS board
A bad module coolant hose, which restricts coolant flow	Check the module coolant hoses Replace the coolant hose
A bad or blocked manifold, which restricts coolant flow	
A bad component on the PCB, which causes excess heat	Replace the module

Dewpoint Fault

Two dewpoint monitors are located on the inside of the WACS access panel. Either or both can produce a dewpoint warning or fault.

Table 23. Dewpoint Problem

Possible Causes	Symptom/Action
A computer room humidity/temperature problem	Contact site personnel to correct the problem
Dirty dewpoint monitor	Clean and calibrate the dewpoint monitor
A bad dewpoint monitor	Replace the faulty monitor
A bad CCS board	Replace the CCS board
A bad or loose cable	Check the cable connections between the dewpoint monitors and the CCS board

Smoke Detector Fault

Two smoke detectors are located in the LC cabinet. If the sensors detect smoke, the LC cabinet will power off; the CCS board trips CB1. If the cabinet powers off when there is no smoke in the computer room, check the following conditions.

Table 24. Smoke Detector Fault

Possible Causes	Symptom/Action
Bad smoke detector	Replace the smoke detector
Bad CCS board	Replace the CCS board
Bad or loose cable	Check all cable connections Replace the defective cable