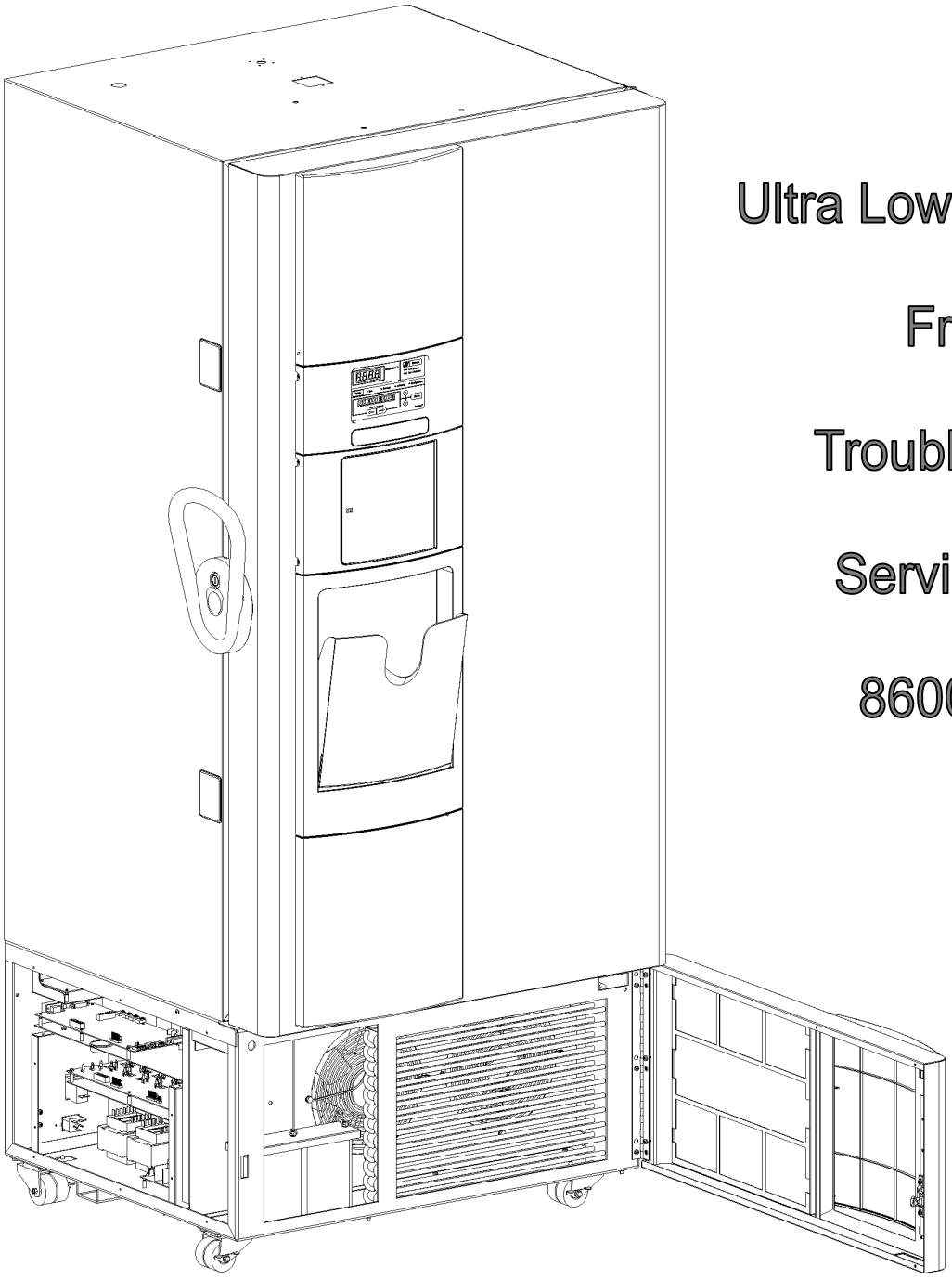
Thermo
ELECTRON CORPORATION

Controlled Environment Equipment



Ultra Low Temperature

Freezer

Troubleshooting

Service Guide

8600 Series

7998600 Rev. 4

MANUAL NO. 7998600

REV	ECR/ECN	DATE	DESCRIPTION	BY
4	FR-1789	6/27/05	Revised VRP troubleshooting section for Release 3	aks
3	22216	3/22/04	Added 120V 23 cu. ft. units	aks
2	22179	2/24/04	Revised electrical schematic, start capacitor part number	aks
--		8/21/03	Door gap, high stage revisions	aks
--		8/13/03	Revised compressor information page B-1	aks
--		6/27/03	Revisions per A. Thomas	aks
1	21605	5/29/03	Wrong power alarm modifications	aks
0		3/21/03	New manual	aks

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General Operation

1.1 Initial Start Up

1. Power Switch on.
2. Cabinet temperature 0.5°C or warmer than set point.
3. Fans 1 and 2 turn ON.
4. High stage compressor turns ON, after ten seconds delay.
5. Low stage compressor turns ON when:
    A. Thirty seconds after high stage starts and heat exchanger probe reads –41°C or colder or
    B. Five minutes after high stage starts and heat exchanger probe reads between –33°C to –40°C.

    If heat exchanger probe warms-up to –20°C or warmer, the low stage compressor shuts down until either condition 5A or 5B is met. After thirty minutes, if condition 5A or 5B is not met, the high stage system failure will be activated.
6. Once the cabinet temperature reaches –50°C, the*expansion tank solenoid is opened (de-energized). The vacuum relief heater and mullion heater on double door units, are energized and operate continuously until the cabinet is warmer than –50°C.
7. Set point achieved, fans and compressors cycle off.
8. Steps 2 though 7 repeat (cycle).

**Items or functions unique to this system*

1.2 Expansion Tank Assembly and Solenoid Valve

Location: Suction side of low stage system.

Purpose: Tank assembly increases low stage system refrigeration capacity. Prevents excessive low stage pressures at temperatures warmer than –50°.

Operation: The tank assembly solenoid valve is normally open. The solenoid valve is energized (closed) when the control probe senses temperature warmer than –50°C. The solenoid valve is de-energized (open) when the control probe senses temperature colder than –50°C.

1.3 Operating Pressure "High and low stage systems"

The suction side pressure for both systems typically runs in a vacuum. Prior to opening a system for a pressure reading, always purge your lines according to the manufacturer's recommended procedure. For further information, call Thermo Forma Service Department.

230 Volt Freezers

Only the compressors require 230 volts. The remaining high voltage components operate using 115 volts.

2.1 Symptom: Probe 1, 2, 3, or 4 Failure Alarm - SINGLE PROBE FAILURES

Order	Possible Cause	Verification	Action
1	Probe		
	Unplugged.	Re-seat connector.	Re-seat all connections.
	Not fully seated	Verify wires are fully seated in connectors and connectors are seated together	Replace probe if necessary.
2	Bad probe		
	Short. Open.	**Display reads 99.** Verify probe resistance. See *Temperature vs. Resistance Chart* (Page 3-2).	Replace probe.
	Wrong value.	Verify probe resistance. See *Temperature vs. Resistance Chart* (Page 3-2).	Replace probe.
3	Micro board.	Temporarily switch suspect probe with control or heat exchanger probe.	If the same error exists, replace micro board.

2.2 Symptom: Probe 1, 2, 3, and 4 Failure Alarm – (ALL PROBES FAIL)

Order	Possible Cause	Verification	Action
1	Control probe not installed. ***Startup only***.	Re-seat connector. Verify wires are fully seated in connectors and connectors are seated together.	Reinitialize (re-start) unit. Reseat all connections. Replace probe if necessary.
2	Bad control probe	**Display reads 99.** Bad control probe will also cause a high temperature alarm and lock both compressors on.	Replace probe.
	Short. Open. Wrong value.	Verify probe resistance with *Temperature vs. Resistance Chart* (page 3-2).	
3	Micro board.	Temporarily switch control probe with heat exchanger probe.	If the same error exists, replace micro board.
4	Micro board EEPROM	Problem still exists after re-initializing unit.	Re-initialize eeprom in test mode. If problem remains, replace the micro board. Note: all calibration, set points and configuration are set to default.

2.3 Symptom: Unit will not communicate with alarm system (Remote Alarm Contacts/Analog System/Serial communication)

Order	Possible Cause	Verification	Action
1	Remote Alarm Contacts	Check that all connections are tight and properly wired. Missing wires?	Tighten and / or correct wiring.
		Measure continuity of alarm contacts between pins 6 & 7 and 6 & 8 while toggling in test mode (pin 6 is common).	Replace micro board if contacts do not change state.
2	Analog Output	Verify the setting is correct in hidden calibration and corresponds to the dip switch settings on the micro board per the electrical schematic.	Make changes so the dip switch settings and hidden calibration settings match.
		Measure output. Compare with *Analog Output Reference Table* (page 3-1).	Call the factory service department 888-213-1790. See section 4.2.p Analog Calibration (page 4-3).
		Check that all connections are tight and properly wired. Missing wires?	Tighten and / or correct wiring.
3	Serial Communication	Verify address is correct in configuration menu and matches the 1535 address.	Change so that the unit address of the freezer matches the 1535 address.
		Verify the setting is correct in hidden calibration and corresponds to the dip switch settings on the micro board per the electrical schematic.	Make changes so that the dip switch settings and hidden calibration settings match.
		Check that all connections are tight and properly wired. Missing wires? Tighten and / or correct wiring.	Tighten and / or correct wiring.
		Verify that the cable is a DB9 (straight through) extension cable.	Replace cable if necessary.

2.4 Symptom: Display / Keyboard Not Functioning

Order	Possible Cause	Verification	Action
1	Turned battery on before AC power is applied. *(initial start up issue only)*	Ask customer/end user.	Turn unit power off. Turn battery off. Reapply AC power before the battery is turned on.
2	No AC power and no battery power.	Verify supply AC voltage is present.	Supply correct line voltage.
3	Micro board - Micro LED LD1 on micro board not functioning.	+14VDC on switching power supply.	If not, replace switching supply.
		+14VDC on micro board at connector labeled DC power from HV board (pins 1 and 6).	Check connector seating on ribbon cables. Replace if required.
		Is unit operating (fans, compressors)?	If no, replace micro board. If yes, continue to step 4.
4	Micro board - Micro LED LD1 functioning / no display LED LD2.	Turn unit off, then turn unit back on.	Miscellaneous characters displayed. Replace display board.
		Check connection of 25 pin D sub cable at both ends.	Waiting Comm is displayed. Replace micro and/or display as needed.
5	Display -		
	Missing segment	Visual.	Replace display board.
	Keys not responding	Check continuity for buttons on overlay.	Replace overlay.
	LEDs not functioning	Ohm out LEDs.	Replace overlay.
	No Alarm	Press any key on overlay.	If no audible, replace display board.

2.5 Symptom: Door Ajar Alarm

Order	Possible Cause	Verification	Action
1	No magnet	Visually inspect for magnet in door handle.	Replace magnet as required.
2	Worn door handle	Inspect inside of door latch for signs of metal (aluminum) wear (wobbly handle).	Replace latch if necessary and verify vacuum relief port operation, as well as the door alignment.
3	Improper connection		
	Wires loose from door switch connector.	Verify wires are properly seated in connector.	If required, re-seat the wire connection.
	Door switch connector not seated to board connector.	Verify connectors are seated together.	Re-seat connection.
	Installed in wrong connector	Verify the plug is in the correct receptacle.	Re-seat plug in correct receptacle.
4	Improper door alignment	Verify door gap. Single door .600” Double door .700”, both measured from the hinge side.	Make adjustment as required.
5	Bad door switch	Verify continuity on door switch by opening and closing door.	If no continuity of switch during opening and closing of door, replace door switch.
6	Defective micro board.	Short out door switch connector.	If alarm does not clear replace micro board. Or else repeat starting at Step 1.

2.6 Symptom: No Door Access

Order	Possible Cause	Verification	Action
1	Door locked.	Check to ensure door is not locked.	Unlock door.
2	Vacuum relief assembly is frozen over.	Visually inspect vacuum relief port for any restrictions.	Clean as necessary. Follow routine maintenance instructions in user's manual to periodically clean the port.
3	Release 3 unit: Vacuum relief not functioning. *Release 3 units(built after 6/2005 have vacuum relief port in door.*	Check voltage at J7 on the display board for +14V $\pm$ 0.5? *YES (+14V):* unplug heater harness from PCB and measure resistance across heater leads. Heater resistance should be between 9 and 30 Ohms.	If not between 9 and 30 Ohms, replace VRP assembly.
		NO: Check and reseat connections on heater harness. Measure DC voltage at the switching power supply. On the 6 pin connector, measure between pins 1 and 6 (+14V $\pm$ 0.5V)	Check and reseat connectors between switching power supply and high voltage board. Also check and reseat connections between high voltage board and micro board.
	Release 1 unit: Vacuum relief not functioning. *Release 2 units built between May 2003 and June 2005 do not use a heated vacuum relief assembly.*	Verify unit is colder than –50°C.	Cabinet temperature must be colder than –50°C to activate vacuum relief heater.
		90-130VAC at heater? *YES*: Ohm out heater. Heater to be 1037-1210 Ohms	Replace heater if required.
		NO: Check connections	Re-seat connection(s). If problem still exists, continue troubleshooting.
	Blown fuse	Check fuse.	Ohm out fuse, replace fuse as required.
	Micro board	Check voltage between U16-13 and J11-1 on micro board.	If voltage is greater than 10VDC, replace micro board.
	High voltage board.	Check DC voltage across D15 on high voltage.	If voltage is less than 10VDC, replace high voltage board.

2.7 Symptom: Low Battery Alarm

Order	Possible Cause	Verification	Action
1	New battery / new unit or freezer just placed into service?	Ask customer/end user. Complete steps 2,3, & 4.	If yes, batteries required 36 hours for charging. If no, continue to step 5.
2	Missing battery	Visually look for battery.	Install battery.
3	Battery switch turned off.	Verify switch is "on".	Turn switch on after AC power is applied.
4	Connection – Wires making connection. Battery wired backwards.	Ensure connections are tight at the battery, battery switch, and micro board. Verify the red wire is connected to the positive terminal.	Tighten and change wiring as needed.
5	Battery switch defective.	Verify continuity with multimeter.	Replace switch.
6	Battery Calibration	Measure voltage at the battery and compare to the value displayed in hidden calibration.	Match values.
7	Battery voltage < 12.1 during battery test.	Check voltage at the battery during battery test after 2 days (48 hours) of operation.	If voltage < 12.1, replace battery and continue to step 8.
8	Micro board – Battery test circuit. Battery charging circuit	Disconnect battery and measure voltage at the battery wires.	If 13.5 - 13.8 VDC is present, replace battery. If not present replace micro board and battery.

2.8 Symptom: Noise

Order	Possible Cause	Verification	Action
1	Loose screws on panels or compressors.	Ensure all screws and bolts are tightly secure.	Tighten as needed.
2	Missing or no sound insulation.	Remove side panels to ensure insulation is present. Inspect the bottom of cabinet to verify insulation is present.	Add foam panels if necessary.
3	Start capacitor on compressor.	Ensure capacitor is not touching the compressor body and capacitor bracket securely holds the capacitor.	Adjust as needed.
4	Electrical cover on compressors.	Ensure cover is tight.	Tighten as needed.
5	Vibrating refrigeration lines.	Inspect for lines that are touching.	Adjust as necessary.
6	Solenoid	Ensure that the solenoid base sits on presstite tape and is tie wrapped to the freezer base.	Replace presstite tape and tie wraps, if necessary.

2.9 Symptom: Hot Condenser Alarm

Order	Possible Cause	Verification	Action
1	High ambient.	Measure ambient temperature. Is ambient above 33°C? Alarm will cycle with compressors. If ambient is above 37°C, alarm is on constantly.	Move to cooler location / lower ambient. Educate customer.
2	Restricted / reduced airflow.	Check filter.	Change / clean filter.
		Check for condenser blockage.	Remove blockage.
		Verify clearance specifications of 5 inches are met.	Install stand-offs.
		Check for open front panel.	Close front panel.
3	Fan(s) not running.	Confirm High stage is on (fans should be running)	Start unit to continue, if off.
		Identify problem fan(s)	Method (tie wrap…)
		Confirm voltage to each fan by verifying voltage at pins J29-1 to J29-7 and J29-2 to J29-8 on the high voltage board.	If no voltage, check voltage between U13-10 and J11-1, U16-10 and J11-1 on micro board. If less than 10VDC, replace micro board. Else if DC voltage across D11 and D14 on high voltage board is less than 10VDC, check ribbon cable. If ribbon cable OK, replace high voltage board.
			If voltage exists, measure Ohms for fans at connector that plus into J29 on high voltage board. First column of black wires for fan in front of high stage, second column of black wires for fan in front of low stage. Ohms should be 130 to 145 in 23°C. Replace fan(s) with improper Ohms.
4	Defective probe.	See: Probe 1,2,3, or 4 failure alarm troubleshooting chart. Condenser probe plus into J4 of micro board.	

2.10 Symptom: High Stage System Failure Alarm

Order	Possible Cause	Verification	Action
1		Clear HS System Failure Alarm in Configuration Mode.	
2	Fan(s) not running.	See procedure for troubleshooting fans under "Hot Condenser" alarm.	
3	High stage compressor not starting or not running.		
	Inadequate power at the customer's site.	Check voltage at the wall and monitor for large voltage drop during start-up.	If voltage drops below 90V for 120V units or 180V for 230V units, contact customer.
	AC power to high stage compressor. If required, go into test mode; turn both fans and high stage compressor on.	No voltage at compressor. LD2 and LD4, on high voltage board, are not on.	Line voltage is within specified limits For LD2 measure voltage between U13-12 and J11-1, for LD4 measure voltage between U13-14 and J11-1, on micro board. If voltage is less than 10VDC, replace micro board. If voltage is greater than 10VDC, for LD2 measure voltage from right side of D3 to right side of D4, for LD4 measure from right D7 & right side of D8 on high voltage board. If voltage is less than 10VDC, check ribbon cable. Ribbon cable OK, replace high voltage board.
		No voltage at compressor, LD5 (HS) on high voltage board is on.	Check connections: enclosure, high pressure cutout switch. Ohm out pressure switch. Switch to be closed. Switch OK, measure voltage between pins 4 and 5 of J30. If no voltage, replace high voltage board. Switch defective; jumper around switch and continue to test.
		No voltage at compressor LD5 (HS) is off and should be on.	If voltage between U13-15 and J11-1, on micro board, is less than 10VDC, replace micro board. Else, if DC voltage across D12 on high voltage board is greater than 10VDC, check ribbon cable. If ribbon cable OK, go to previous verification. Else, if D12 voltage less than 10VDC, replace high voltage board.
		Voltage at compressor	Check continuity of compressor thermal switch. Check winding resistance of compressor. See Appendix B Check compressor-starting hardware. Replace parts as needed.
	HS compressor cycles on high-pressure cutout.	Install pressure gauges on high stage and verify that high-pressure cutout is functioning normally.	Replace defective high-pressure cutout.
4	HX probe reading incorrectly.	Compare T/C reading on interstage heat exchanger to resistance of HX probe and display value. See *Resistance to Temperature Chart* (page 3-2).	If T/C differs from resistance and displayed value, defective probe. If displayed value differs from T/C and resistance value, replace micro board.

2.10 Symptom: High Stage System Failure Alarm (continued)

Order	Possible Cause	Verification	Action
5	Restriction in high stage capillary tube.	Measure the temperature at the heat exchanger. If a restriction exists, the heat exchanger will be warmer than normal.	Recondition high stage.

2.11 Symptom: Power Failure Alarm

Order	Possible Cause	Verification	Action
1	Unplugged line cord.	Check that line cord is properly seated in wall connection and relay enclosure.	Re-attach line cord and install strain relief per user's manual, if required.
2	Unit circuit breaker (power switch).	Verify switch / circuit breaker (power switch) by continuity or test for line voltage on high voltage board where wires from switch are connected to board.	Replace if required.
		Verify switch / circuit breaker does not trip below amperage rating.	Replace if required. If trips above rating, go to step 5.
3	Loose wires Circuit Breaker/ Power switch. High voltage board. Switching power supply.	Verify line voltage connection from circuit breaker/power switch to high voltage board inputs and ribbon cable connection from high voltage board to DC switching power supply.	Seat or replace as required.
4	Defective switching power supply.	Verify input line voltage and output voltage, +14 VDC, is present at switching power supply.	Replace if required.
5	Damaged components or wiring.	Inspect relay enclosure for damaged components and wiring.	Replace as required.
6	Defective starting hardware or compressor(s).	Check both stages for L.R.A.	If compressor attempts to run and draws L.R.A., check start relay for proper operation and values on start and run capacitors. Ohm compressor windings and compare to nominal values (Appendix B).
7	Facility Wiring Circuit breaker Wire.	Dedicated circuit and correct rating?	Advise customer.
		Connections, gauge size, and length.	Try a different circuit. Fix as required.

2.12 Symptom: Wrong Power

Order	Possible Cause	Verification	Action
1	Sequence that battery and power switch was turned on *(start-up only)*	Was battery switch turned on before power switch was turned on?	Turn both switches off. Turn power switch on, then turn battery switch on.
2	Facility wiring incorrect. 230V receptacle 115 supply	Proper line voltage.	Need correct operation voltage.
3	Wrong line cord set.	Verify correct line cord plug : P5-15 (120V,15A), P5-20 (120V,20A), P6-15 (230V,15A).	Contact manufacturer.
4	Ribbon cable connection between high voltage and micro board.	Cables properly seated.	Reseat connections.
		Ribbon cables damaged.	Replace cable(s).
5	High voltage board failure.	Measure AC voltage between left side F1 and left side of R9. Voltage should be between .25 and .95 VAC.	If incorrect voltage, replace high voltage board.
		Measure frequency between pins 4 and 5 of U1.	Frequency is not twice the frequency of wall outlet. Replace high voltage board.
6	Micro board failure.	Measure AC voltage across R40 on micro board. Voltage should be between .25 and .95 VAC.	No voltage: replace ribbon cable. Good voltage: replace micro board.
		Measure frequency between pin 10 of U14 and pin 8 of U28..	No measurement, check ribbon cable. If ribbon cable is ok, replace micro board.

2.13 Symptom: Low Temperature Alarm

Order	Possible Cause	Verification	Action
1	Relays on high voltage board not being turned off.	Verify that LEDs (LD5 and LD6) on the high voltage board are illuminated and voltage across D12 and D13 is greater than 10VDC.	IF LD5 and LD6 on and voltage is greater than 10DC, replace micro board. If LD5 and LD6 are off and voltage is less than 10VDC, replace high voltage board.
2	Wrong probe value	Verify probe resistance with *Temperature vs. Resistance Chart* (page 3-2).	Replace as required.

2.14 Symptom: High Temperature Alarm or System is not maintaining temperature

Order	Possible Cause	Verification	Action
1	Door	Inspect gasket for ice or excessive frost.	Clear ice or frost from door and gasket.
		Check door adjustment: fit and gasket compression.	Adjust door to restore uniform gasket compression.
		Frequency and duration of door openings and product loading (size of load and temperature of introduced product. If customer usage is high or suspected as high, then verify actual performance with a datalogger.	Work with customer to communicate effects of loading.
2	Load – evaluate customer usage.	Install thermocouple at control sensor and verify control RTD temperature is accurate.	Troubleshoot control probe with "Probe 1,2,3 & 4 failure procedure".
3	Defective control probe	See procedure for troubleshooting probes "Probe 1,2,3 or 4 Failure (Single Probe).	
4	Normal relay(s) on high voltage board	LD 2 and LD 4 on high voltage board are not lit 120v units: Line voltage 105 - 140 230V/60Hz units: Line voltage 210 - 260 230V/50Hz units: Line voltage 190- 230	Line voltage is within specified limits For LD2 check voltage between U13-12 and J11-1 on micro board, for LD4 measure between U13-14 and J11-1, if voltage is less than 10VDC, replace micro board. If voltage is greater than 10, then check DC voltage from right side of D3 to right side of D4 (LD2), from right D7 & right side of D8 (LD4) on high voltage board. If is less than 10VDC, check ribbon cable. If ribbon cable OK, replace high voltage board.

2.14 Symptom: High Temperature Alarm or System is not maintaining temperature (continued)

5	AC power to low stage compressor.	No voltage at compressor, LD6 (LS) on high voltage board is on.	Check connections: enclosure, high-pressure cutout switch. Ohm out pressure switch. Switch to be closed. Switch OK, measure voltage between pins 1 and 2 of J30. If no voltage, replace high voltage board. Switch defective; jumper around switch and continue to test.
		No voltage at compressor LD6 (LS) is off and should be on.	If voltage between U13-16 and J11-1, on micro board, is less than 10VDC, replace micro board. If voltage greater than 10, check DC voltage across D13 on high voltage board is less than 10VDC, check ribbon cable. If ribbon cable OK, go replace high voltage board If D13 voltage greater than 10VDC, . Go to previous verification, LD6 maybe defective.
		Voltage at compressor	Check continuity of compressor thermal switch. Check winding resistance of compressor. See Appendix B Check compressor-starting hardware. Replace parts as needed.
	LS compressor cycles on high-pressure cutout.	Install pressure gauges on low stage and verify that high-pressure cutout is functioning normally.	Replace defective high-pressure cutout.
6	High stage refrigeration system failure	Verify interstage heat exchanger temperature is above –33°C.	Troubleshoot with “Troubleshooting Compressor”.
7	Low Stage refrigeration system failure	Verify interstage heat exchanger temperature is below –33°C.	Troubleshoot with “Troubleshooting Compressor”.

2.15 Symptom: Troubleshoot compressor

Order	Possible Cause	Verification	Action
1	Low suction pressure problem	Verify compressor starts and run continuously.	If yes, install gauges and go to next step. If no, go to order 3 of "Compressor starting problem".
		Verify suction pressure is above: High Stage – 0 psig Low Stage – 10" vac If suction pressure is "ok", proceed to next step.	If suction pressure is below limits, conduct equalization test: if equalization test fails – blocked cap tube; recondition refrigeration system. If equalization test passes, warm unit, go order 2 "unit at room temp, heat exchanger at room temp".
		Verify discharge pressure is below 175 psig – conduct efficiency test.	Suspect bad compressor (values): replace compressor…recondition refrigeration system.
		If discharge pressure is above: LS 175 psig HS 250 psig	Suspect non-condensables: recondition the refrigeration system in question.
2	Unit at room temperature, heat exchanger at room temperature	Verify static pressures are acceptable.	Recondition low stage (suspect partial restriction in cap tube).
		Compare high stage static and low stage static pressures. Are the static pressures on high and low stages identical?	Yes, replace interstage and recondition both the high and low stages. No, go to next verification.
		Static pressure unacceptable.	Suspect under- or overcharge. Recondition refrigeration system for system in question.
3	Compressor Starting Problem	Measurements of wall voltage Unit off Unit at start-up.	If unacceptable, work with customer to correct. If acceptable, go to next step.
		Verify compressor attempts to start (draws L.R.A. or turns over briefly). If no attempt to start – Check voltage to compressor No voltage at compressor LD5 (HS) or LD6 (LS) is on. No voltage at compressor LD5 (HS) or LD6 (LS) is off.	If compressor attempts to run and draws L.R.A., check start relay for proper operation and values on start and run capacitors. If voltage at compressor, isolate compressor. Ohm compressor windings at compressors and compare to nominal values (Appendix B). Check connections: enclosure, high pressure cutout switch. Ohm out pressure switch. Switch to be closed. Voltage between U13-15 (HS) or U13-16 (LS) and J11-1 on micro board is less than 10VDC, replace micro board. Else if DC voltage across D12 (HS) or D13 (LS) on high voltage board is less than 10VDC, replace high voltage board.

2.15 Symptom: Troubleshoot compressor continued

Order	Possible Cause	Verification	Action
3		Verify if compressor tripping on high pressure switch and confirm that discharge is reaching 375 psig (± 25 psi).If tripping on pressure switch and discharge pressure is high, then troubleshoot why discharge pressure is high.	If tripping on high pressure switch and pressure is not running at 375 psig (±25), then replace pressure switch.
		Verify if compressor is tripping on thermal switch.	If yes, recondition low stage. If no, troubleshoot high voltage board (board turning compressor off).

2.16 Symptom: Voltage Compensation Failure

1	**Voltage Compensation Failure** *Unit will operate normally*	Turn unit off, and then back on. If unit goes into Boost (LD2 & LD3) or Buck (LD1 & LD4), unit does not function and then goes into Normal mode (LD2 & LD4).	Check wiring between transformer(s) and high voltage board Check transformer Check relay contacts. Restart unit. Take following readings when LD1 or LD3 should be on. LD1: Line voltage should be read between J5 and J22 Replace high voltage board as required
		Turn unit off, and then back on. If unit goes into Boost (LD2) or Buck (LD4), unit does not function and then goes into Normal mode (LD2 & LD4). *LD1 or LD3 does not turn on.*	For LD3, measure voltage between U13-11 and J11-1, for LD1 measure between U13-13 and J11-1, on micro board. If voltage is less than 10VDC, replace micro board. If voltage was greater than 10VDC, for LD1 measure voltage from right side of D1 to right side of D2, for LD3 measure voltage from right D5 & right side of D6 on high voltage board. If the voltage is less than 10VDC, check ribbon cable. If ribbon cable is OK. Replace high voltage board. If voltage between diodes was greater than 10VDC, go to previous verification, LD1 or LD3 maybe defective.

Analog Output Reference Table

Temp°C	4-20 mA	4-0mA with 250 Ohm resistor	0-1V	0-5V
50	20.000	5.000	1.000	5.000
49	19.893	4.973	0.993	4.967
48	19.787	4.947	0.987	4.933
47	19.680	4.920	0.980	4.900
46	19.573	4.893	0.973	4.867
45	19.467	4.867	0.967	4.833
44	19.360	4.840	0.960	4.800
43	19.253	4.813	0.953	4.767
42	19.147	4.787	0.947	4.733
41	19.040	4.760	0.940	4.700
40	18.933	4.733	0.933	4.667
39	18.827	4.707	0.927	4.633
38	18.720	4.680	0.920	4.600
37	18.613	4.653	0.913	4.567
36	18.507	4.627	0.907	4.533
35	18.400	4.600	0.900	4.500
34	18.293	4.573	0.893	4.467
33	18.187	4.547	0.887	4.433
32	18.080	4.520	0.880	4.400
31	17.973	4.493	0.873	4.367
30	17.867	4.467	0.867	4.333
29	17.760	4.440	0.860	4.300
28	17.653	4.413	0.853	4.267
27	17.547	4.387	0.847	4.233
26	17.440	4.360	0.840	4.200
25	17.333	4.333	0.833	4.167
24	17.227	4.307	0.827	4.133
23	17.120	4.280	0.820	4.100
22	17.013	4.253	0.813	4.067
21	16.907	4.227	0.807	4.033
20	16.800	4.200	0.800	4.000
19	16.693	4.173	0.793	3.967
18	16.587	4.147	0.787	3.933
17	16.480	4.120	0.780	3.900
16	16.373	4.093	0.773	3.867
15	16.267	4.067	0.767	3.833
14	16.160	4.040	0.760	3.800
13	16.053	4.013	0.753	3.767
12	15.947	3.987	0.747	3.733
11	15.840	3.960	0.740	3.700
10	15.733	3.933	0.733	3.667
9	15.627	3.907	0.727	3.633
8	15.520	3.880	0.720	3.600
7	15.413	3.853	0.713	3.567
6	15.307	3.827	0.707	3.533
5	15.200	3.800	0.700	3.500
4	15.093	3.773	0.693	3.467
3	14.987	3.747	0.687	3.433
2	14.880	3.720	0.680	3.400
1	14.773	3.693	0.673	3.367
0	14.667	3.667	0.667	3.333

Temp°C	4-20 mA	4-20mA with 250 Ohm resistor	0-1V	0-5V
-1	14.560	3.640	0.660	3.300
-2	14.453	3.613	0.653	3.267
-3	14.347	3.587	0.647	3.233
-4	14.240	3.560	0.640	3.200
-5	14.133	3.533	0.633	3.167
-6	14.027	3.507	0.627	3.133
-7	13.920	3.480	0.620	3.100
-8	13.813	3.453	0.613	3.067
-9	13.707	3.427	0.607	3.033
-10	13.600	3.400	0.600	3.000
-11	13.493	3.373	0.593	2.967
-12	13.387	3.347	0.587	2.933
-13	13.280	3.320	0.580	2.900
-14	13.173	3.293	0.573	2.867
-15	13.067	3.267	0.567	2.833
-16	12.960	3.240	0.560	2.800
-17	12.853	3.213	0.553	2.767
-18	12.747	3.187	0.547	2.733
-19	12.640	3.160	0.540	2.700
-20	12.533	3.133	0.533	2.667
-21	12.427	3.107	0.527	2.633
-22	12.320	3.080	0.520	2.600
-23	12.213	3.053	0.513	2.567
-24	12.107	3.027	0.507	2.533
-25	12.000	3.000	0.500	2.500
-26	11.893	2.973	0.493	2.467
-27	11.787	2.947	0.487	2.433
-28	11.680	2.920	0.480	2.400
-29	11.573	2.893	0.473	2.367
-30	11.467	2.867	0.467	2.333
-31	11.360	2.840	0.460	2.300
-32	11.253	2.813	0.453	2.267
-33	11.147	2.787	0.447	2.233
-34	11.040	2.760	0.440	2.200
-35	10.933	2.733	0.433	2.167
-36	10.827	2.707	0.427	2.133
-37	10.720	2.680	0.420	2.100
-38	10.613	2.653	0.413	2.067
-39	10.507	2.627	0.407	2.033
-40	10.400	2.600	0.400	2.000
-41	10.293	2.573	0.393	1.967
-42	10.187	2.547	0.387	1.933
-43	10.080	2.520	0.380	1.900
-44	9.973	2.493	0.373	1.867
-45	9.867	2.467	0.367	1.833
-46	9.760	2.440	0.360	1.800
-47	9.653	2.413	0.353	1.767
-48	9.547	2.387	0.347	1.733
-49	9.440	2.360	0.340	1.700
-50	9.333	2.333	0.333	1.667

Temp°C	4-20 mA	4-0mA with 250 Ohm resistor	0-1V	0-5V
-51	9.227	2.307	0.327	1.633
-52	9.120	2.280	0.320	1.600
-53	9.013	2.253	0.313	1.567
-54	8.907	2.227	0.307	1.533
-55	8.800	2.200	0.300	1.500
-56	8.693	2.173	0.293	1.467
-57	8.587	2.147	0.287	1.433
-58	8.480	2.120	0.280	1.400
-59	8.373	2.093	0.273	1.367
-60	8.267	2.067	0.267	1.333
-61	8.160	2.040	0.260	1.300
-62	8.053	2.013	0.253	1.267
-63	7.947	1.987	0.247	1.233
-64	7.840	1.960	0.240	1.200
-65	7.733	1.933	0.233	1.167
-66	7.627	1.907	0.227	1.133
-67	7.520	1.880	0.220	1.100
-68	7.413	1.853	0.213	1.067
-69	7.307	1.827	0.207	1.033
-70	7.200	1.800	0.200	1.000
-71	7.093	1.773	0.193	0.967
-72	6.987	1.747	0.187	0.933
-73	6.880	1.720	0.180	0.900
-74	6.773	1.693	0.173	0.867
-75	6.667	1.667	0.167	0.833
-76	6.560	1.640	0.160	0.800
-77	6.453	1.613	0.153	0.767
-78	6.347	1.587	0.147	0.733
-79	6.240	1.560	0.140	0.700
-80	6.133	1.533	0.133	0.667
-81	6.027	1.507	0.127	0.633
-82	5.920	1.480	0.120	0.600
-83	5.813	1.453	0.113	0.567
-84	5.707	1.427	0.107	0.533
-85	5.600	1.400	0.100	0.500
-86	5.493	1.373	0.093	0.467
-87	5.387	1.347	0.087	0.433
-88	5.280	1.320	0.080	0.400
-89	5.173	1.293	0.073	0.367
-90	5.067	1.267	0.067	0.333
-91	4.960	1.240	0.060	0.300
-92	4.853	1.213	0.053	0.267
-93	4.747	1.187	0.047	0.233
-94	4.640	1.160	0.040	0.200
-95	4.533	1.133	0.033	0.167
-96	4.427	1.107	0.027	0.133
-97	4.320	1.080	0.020	0.100
-98	4.213	1.053	0.013	0.067
-99	4.107	1.027	0.007	0.033
-100	4.000	1.000	0.000	0.000

RTD Temperature vs. Resistance Table

For European Curve, Alpha = .00385, ITS-90 1° Celsius Increments
Source: http://www.omega.com/temperature/Z/pdf/z252-254.pdf

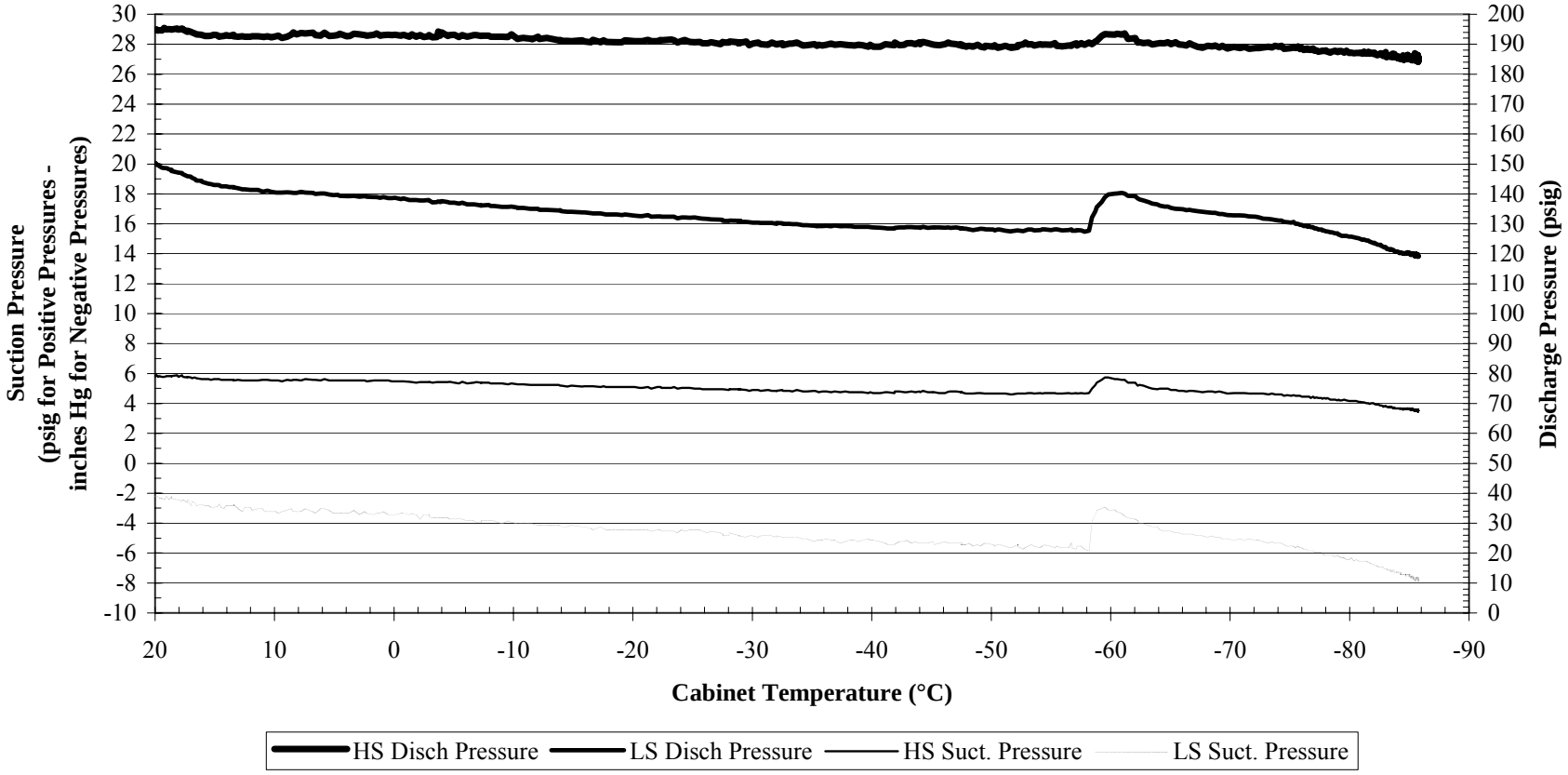
°C	Ohms	Difference
-100	602.60	4.10
-99	606.70	4.10
-98	610.70	4.00
-97	614.80	4.10
-96	618.70	4.10
-95	622.90	4.20
-94	626.90	4.00
-93	631.00	4.10
-92	635.00	4.00
-91	639.10	4.10
-90	643.00	3.90
-89	647.00	4.00
-88	651.10	4.10
-87	655.10	4.00
-86	659.10	4.00
-85	663.10	4.00
-84	667.20	4.10
-83	671.20	4.00
-82	675.20	4.00
-81	679.20	4.00
-80	683.30	4.10
-79	687.30	4.00
-78	691.30	4.00
-77	695.30	4.00
-76	699.30	4.00
-75	703.30	4.00
-74	707.30	4.00
-73	711.30	4.00
-72	715.30	4.00
-71	719.30	4.00
-70	723.30	4.00
-69	727.30	4.00
-68	731.30	4.00
-67	735.30	4.00
-66	739.30	4.00
-65	743.30	4.00
-64	747.30	4.00
-63	751.30	4.00
-62	755.30	4.00

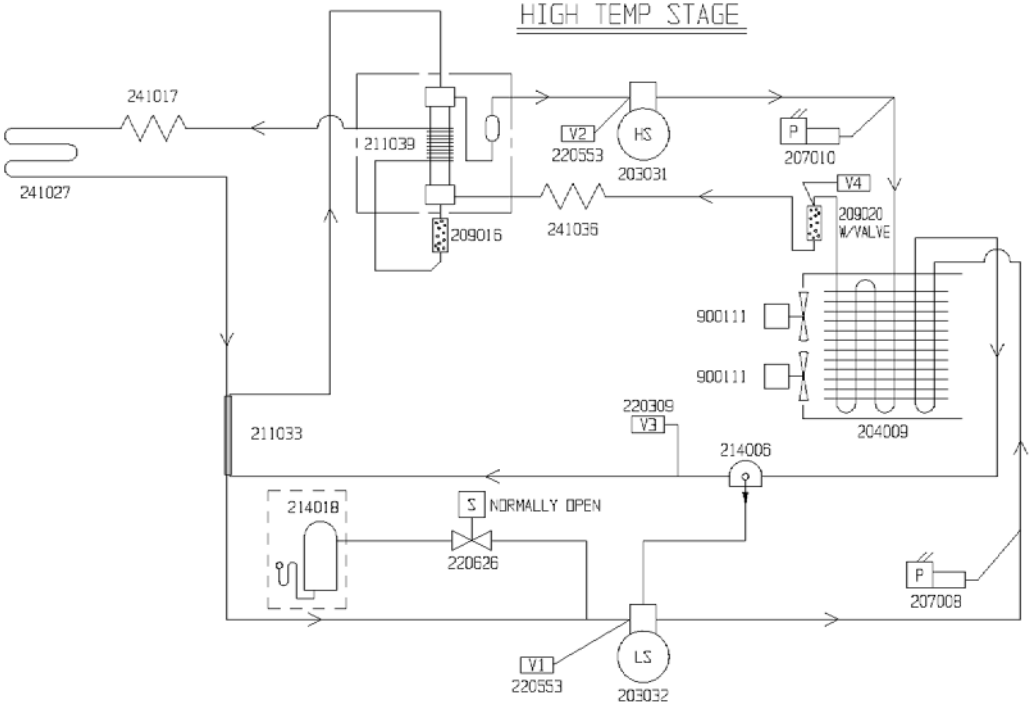
°C	Ohms	Difference
-61	759.30	4.00
-60	763.30	4.00
-59	767.30	4.00
-58	771.30	4.00
-57	775.20	3.90
-56	779.20	4.00
-55	783.20	4.00
-54	787.20	4.00
-53	791.10	3.90
-52	795.10	4.00
-51	799.10	4.00
-50	803.10	4.00
-49	807.00	3.90
-48	811.00	4.00
-47	815.00	4.00
-46	818.90	3.90
-45	822.90	4.00
-44	826.90	4.00
-43	830.80	3.90
-42	834.80	4.00
-41	838.80	4.00
-40	842.70	3.90
-39	846.70	4.00
-38	850.60	3.90
-37	854.60	4.00
-36	858.50	3.90
-35	862.50	4.00
-34	866.40	3.90
-33	870.40	4.00
-32	874.30	3.90
-31	878.30	4.00
-30	882.20	3.90
-29	886.20	4.00
-28	890.10	3.90
-27	894.00	3.90
-26	898.00	4.00
-25	901.90	3.90
-24	905.90	4.00
-23	909.80	3.90

°C	Ohms	Difference
-22	913.70	3.90
-21	917.70	4.00
-20	921.60	3.90
-19	925.50	3.90
-18	929.50	4.00
-17	933.40	3.90
-16	937.30	3.90
-15	941.20	3.90
-14	945.20	4.00
-13	949.10	3.90
-12	953.00	3.90
-11	956.90	3.90
-10	960.90	4.00
-9	964.80	3.90
-8	968.70	3.90
-7	972.60	3.90
-6	976.50	3.90
-5	980.40	3.90
-4	984.40	4.00
-3	988.30	3.90
-2	992.20	3.90
-1	996.10	3.90
0	1000.00	3.90
1	1003.90	3.90
2	1007.80	3.90
3	1011.70	3.90
4	1015.60	3.90
5	1019.50	3.90
6	1023.40	3.90
7	1027.30	3.90
8	1031.20	3.90
9	1035.10	3.90
10	1039.00	3.90
11	1042.90	3.90
12	1046.80	3.90
13	1050.70	3.90
14	1054.60	3.90
15	1058.50	3.90
16	1062.40	3.90

°C	Ohms	Difference
17	1066.30	3.90
18	1070.20	3.90
19	1074.00	3.80
20	1077.90	3.90
21	1081.80	3.90
22	1085.70	3.90
23	1089.60	3.90
24	1093.50	3.90
25	1097.30	3.80
26	1101.20	3.90
27	1105.10	3.90
28	1109.00	3.90
29	1112.80	3.80
30	1116.70	3.90
31	1120.60	3.90
32	1124.50	3.90
33	1128.30	3.80
34	1132.20	3.90
35	1136.10	3.90
36	1139.90	3.80
37	1143.80	3.90
38	1147.70	3.90
39	1151.50	3.80
40	1155.40	3.90
41	1159.30	3.90
42	1163.10	3.80
43	1167.00	3.90
44	1170.80	3.80
45	1174.70	3.90
46	1178.50	3.80
47	1182.40	3.90
48	1186.20	3.80
49	1190.10	3.90
50	1194.00	3.90

Pressures vs. Cabinet Temperature
Thermo Forma Model 8695 (23ft^3 Upright ULT - 230V, 50Hz)





CASCADE REFRIGERATION

HIGH TEMP. STAGE REFRIGERANT: R-404A, 24 OZ. (680g) ±1/2 OZ. (14g)

HIGH TEMPERATURE STAGE OIL: MOBILE EAL ARCTIC 22CC POLYOL ESTER OIL COMPRESSOR, 24 OZ.(710ml)

LOW TEMP. STAGE REFRIGERANT: R-290 1.0 OZ. (28g) MAX. ; VAC TO 5 PSIG
R-508B 17.3 OZ. (490g) ± 1/4 OZ. (7g)
OR 5 PSIG TO 152 PSIG ± 3 PSIG

LOW TEMPERATURE STAGE OIL: ZEROL 150T WITH 2% ADDITIVE
COMPRESSOR: 24 OZ.(710ml)
OIL SEPARATOR: 15 OZ. (444ml)

* ALL PSIG MEASUREMENTS WHEN SYSTEM IS AT 23°C

1. COMMON TO: 706, 906, 995, 8606, 8695, 5706 & 5605 23 CU.FT. FREEZERS (230 V)

REV	ECR NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
4	FR-1729	08-27-03	RDS	KDG	MAH	220554 ROTOLOCK VALVE TO 220553
3	N/A	01-07-03	MAH	PDK	MAH	CORRECTED COMPRESSOR STOCK NUMBERS
2	FR-1664	12-17-02	MAH	KDG	MAH	CHANGED 900111 FANS TO 900113
1	FR-1615	10-02-02	DHG	KDG	LDN	REMOVE CAP TUBING TO EXP. TANK
0	N/A	07-22-02	MAH	KDG	MAH	RELEASED FOR PRODUCTION

DATE 05-14-02	DWN MAH	CAD KDG	APPD MAH	SCALE NONE

CUSTOMER

JOB TITLE -86°C 23 CU. FT. UPRIGHT FREEZERS (230 V)

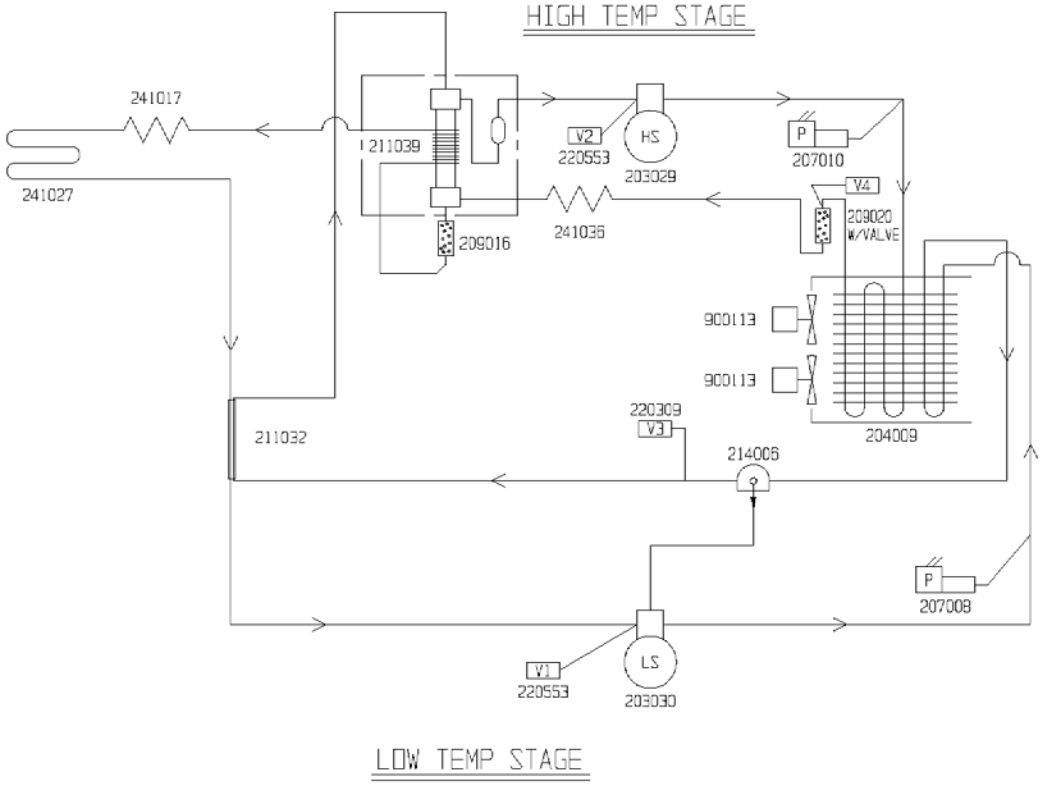
DWG TITLE REFRIGERATION SCHEMATIC

LOCATION	JOB NUMBER	DRAWING NUMBER
		8606-90-0-B

Thermo ELECTRON CORPORATION

DRAWING NUMBER: 8656-90-0-B

REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
0	FR-1776	03-09-04	ADT	pdk	LDN	RELEASED FOR PRODUCTION



CASCADE REFRIGERATION

HIGH TEMPERATURE STAGE REFRIGERANT:

23 CUFT UNITS: R-404A 24 OZ. (680g) ±1/2 OZ (14g)

HIGH TEMPERATURE STAGE OIL: MOBILE EAL ARCTIC 22CC POLYOL ESTER OIL COMPRESSOR, 24 OZ.(710ml)

LOW TEMPERATURE STAGE REFRIGERANT:

23 CUFT UNITS: R-290 0.9 OZ. (14g) MAX, ; VAC TO 4 PSIG
R-508B 15 OZ (369g) ± 1/4 OZ.(7g) OR
4 PSIG TO 133 PSIG ± 3 PSIG

LOW TEMPERATURE STAGE OIL: ZEROL 150T WITH 2% ADDITIVE
COMPRESSOR: 24 OZ.(710ml)
OIL SEPARATOR: 15 OZ. (444ml)

* ALL PSIG MEASUREMENTS WHEN SYSTEM IS AT 23°C

1. COMMON TO: 756, 956, 990, 8656, 8690, 5756 & 5656 23 CU. FT. FREEZERS (120 V)

Thermo
ELECTRON CORPORATION
Controlled Environment Equipment
Box 549, Marietta, Oh 45750

MODEL/PART NAME: -86° 23 CU. FT. UP-RIGHT FREEZERS (120 VOLT)

DWG TITLE: REFRIGERATION SCHEMATIC

DWN: ADT	CAD: pdk	APPD:	DATE: 03-09-04	SCALE: NONE

MATERIAL: N/A

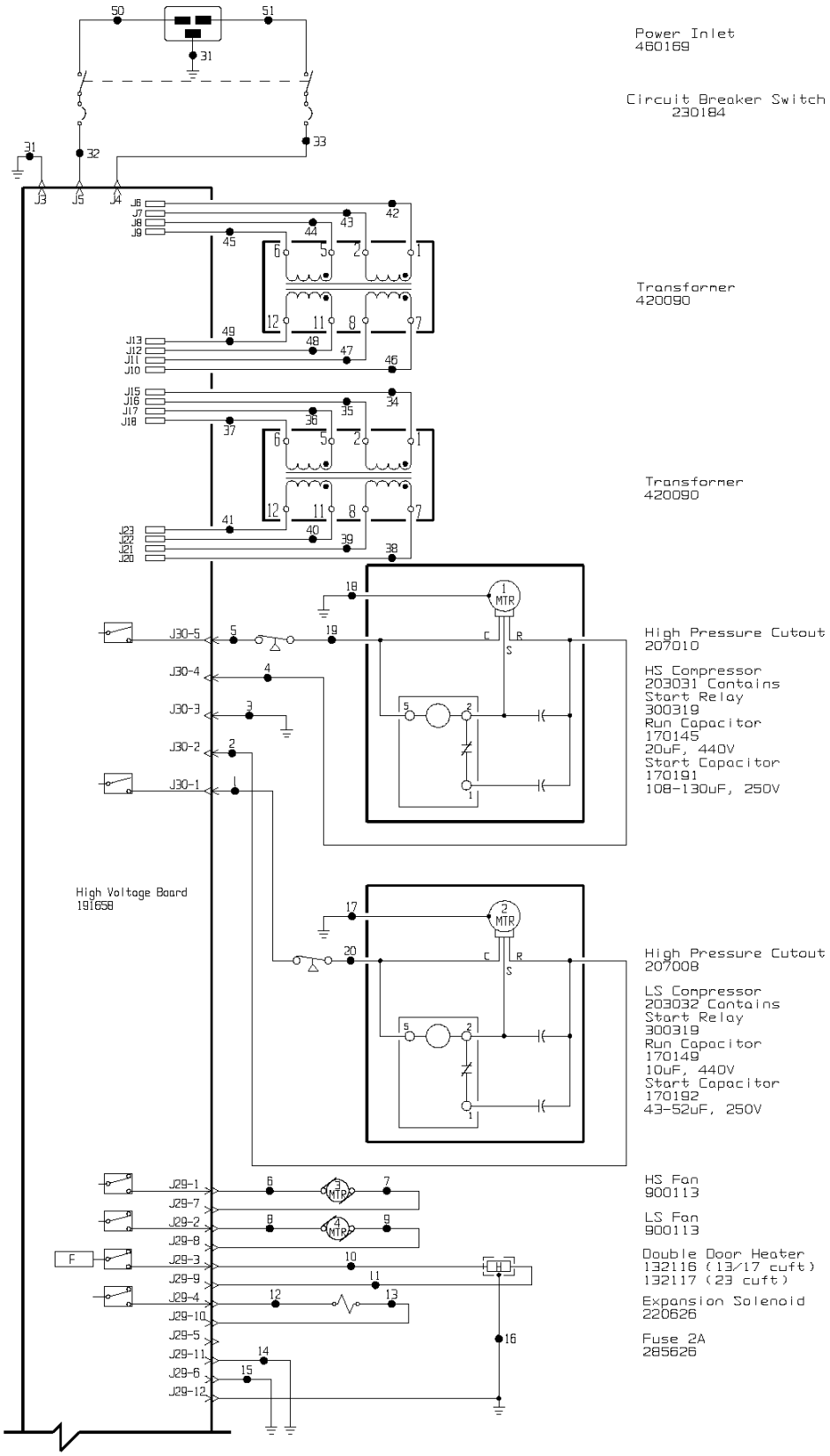
PAINT COLOR: N/A

TOLERANCE UNLESS OTHERWISE SPECIFIED
ANGLES: DECIMAL: .XX=±, .XXX=±

DRAWING NUMBER: 8656-90-0

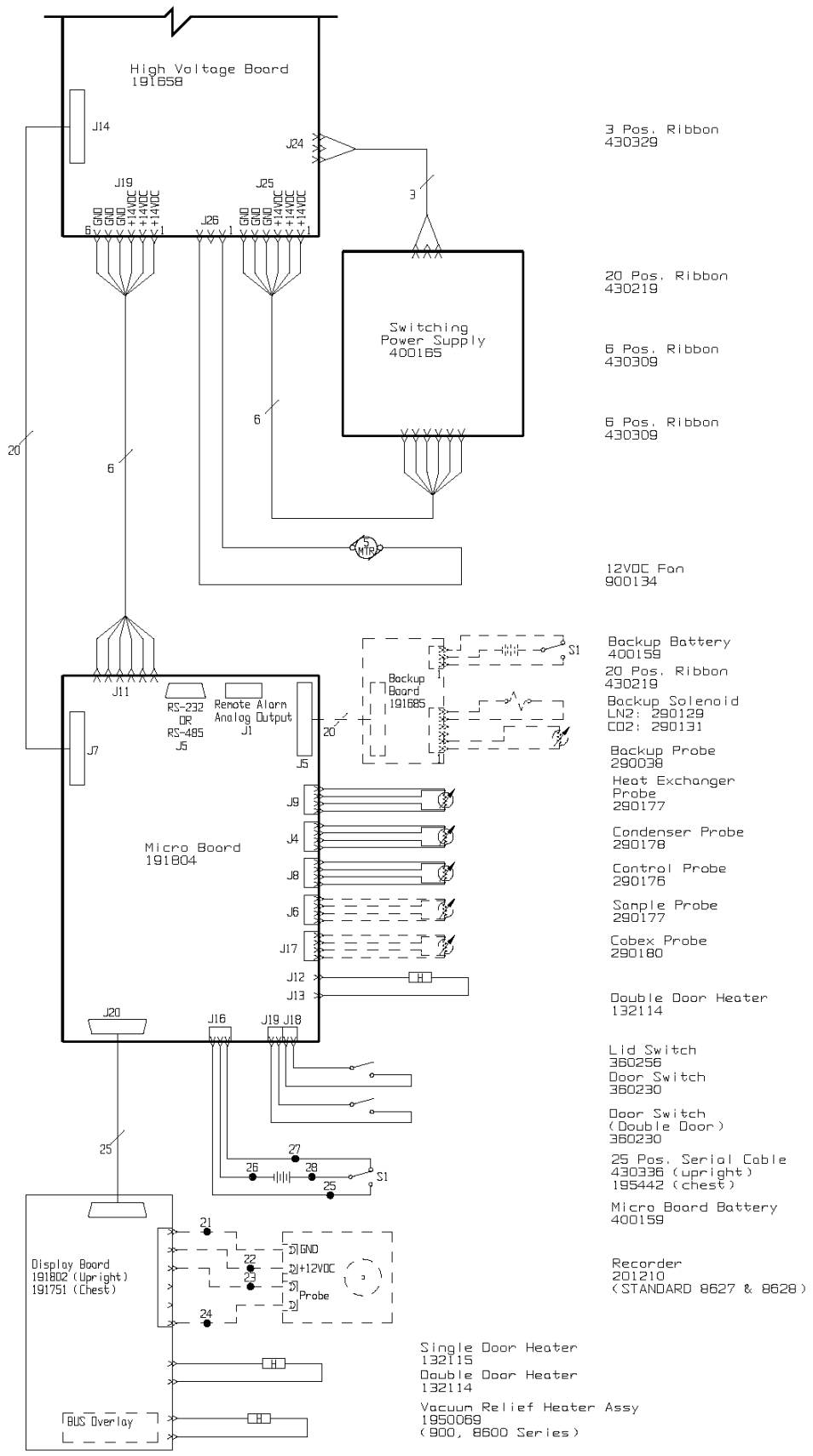
SIZE: B

POWER CONNECTION
230V, 1Ø, 2W, 50/60HZ,12.0 FLA
(OPERATING RANGE 208-240)



Models:
5602,5605,5606,5612
5619,5620,8602,8605
8606,8607,8612,8619
8620,8627,8628,8691
8694,8695

8602-70-1-D Rev.8
Page 1 of 3



Models:
5602,5605,5606,5612
5619,5620,8602,8605
8606,8607,8612,8619
8620,8627,8628,8691
8694,8695

8602-70-1-D Rev.8
Page 2 of 3

WIRE #	COLOR	GAUGE
1	BLK	14
2	RED	14
3	GRN/YEL	14
4	RED	14
5	BLK	14
6	BLK	18
7	BLK	18
8	BLK	18
9	BLK	18
10	BLK	18
11	BLK	18
12	BLK	18
13	BLK	18
14	GRN/YEL	18
15	GRN/YEL	18
16	GRN/YEL	18
17	GRN/YEL	14
18	GRN/YEL	14
19	BLK	14
20	BLK	14
21	BLK	18
22	RED	18
23	BLK	18
24	RED	18

WIRE #	COLOR	GAUGE
25	WHT	18
26	BLK	18
27	BLK	18
28	RED	18
29		
30		
31	GRN/YEL	14
32	BLK	14
33	BLU	14
34	BLK	14
35	BLU	14
36	BLK	14
37	BLU	14
38	BLK	14
39	BLU	14
40	BLK	14
41	BLU	14
42	BLK	14
43	BLU	14
44	BLK	14
45	BLU	14
46	BLK	14
47	BLU	14
48	BLK	14
49	BLU	14
50	BLK	14
51	BLU	14

Uprights

SIZE	THERMO	THERMO	VWR
13	8602	8691	5602
17	8605	8694	5605
23	8606	8695	5606
28	8607		
13	8627		

Chests

SIZE	THERMO	VWR
12.7	8612	5612
17	8619	5619
20	8620	5620
20	8628	

REMOTE CONTACTS/ANALOG OUTPUT
PIN# 1 Analog Output +
PIN# 2 Analog Output -
PIN# 3 Not Connected
PIN# 4 Not Connected
PIN# 5 Normally Closed
PIN# 6 Common.
PIN# 7 Normally Open

CONTACT RATING: 1A @ 30V
CONTACTS IN ALARM STATE

RS-232 SPECIFICATION

BAUD = 1200
PARITY = N
BITS = 8
STOP BITS = 2

RS-232 PORT
PIN# 2 TXD
PIN# 3 RXD
PIN# 5 GND

SW1 Settings for Analog Output

4-20mA Output

0-1V Output

0-5V Output

SW2 Settings for Communication Output

RS-485

RS-232

1. Schematic represents single & double door upright models and chest models. All heaters are on uprights only. Expansion solenoid on 17, 23 & 28 uprights only.
2. Door switches shown in open position.
3. Battery switch shown in the OFF position.
4. Circuit breaker switch shown in OFF position.
5. Options and acessories shown in dashed lines.

REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
8	FR-1854	06-13-05	HCE	GLS	AKS	REV. BATTERY CIRCUIT WIRING
7	FR-1789	06-13-05	RTB	KDG	LON	ADD VACUUM RELIEF HEATER & CHG. DISPLAY BD.
6	FR-1766	11-09-04	AOT	KDG	LON	CHANGED DISPLAY BD. 191751 FROM 191715
5	FR-1789	08-14-04	AOT	KDG	LON	CHANGED MICRO BOARD 191656 TO 191804

Models:
5602,5605,5606,5612
5619,5620,8602,8605
8606,8607,8612,8619
8620,8627,8628,8691
8694,8695

MODEL/PART NAME: 8600 SERIES, 230V, ULT FREEZERS

DWG TITLE: UNIT SCHEMATIC

DWN: AOT	CAD: AOT	APPD: MAH	DATE: 3-22-02	SCALE: NONE

MATERIAL:

PAINT COLOR:

TOLERANCE UNLESS OTHERWISE SPECIFIED
ANGLES: DECIMAL: .XX=±, .XXX=±

DRAWING NUMBER: 8602-70-1

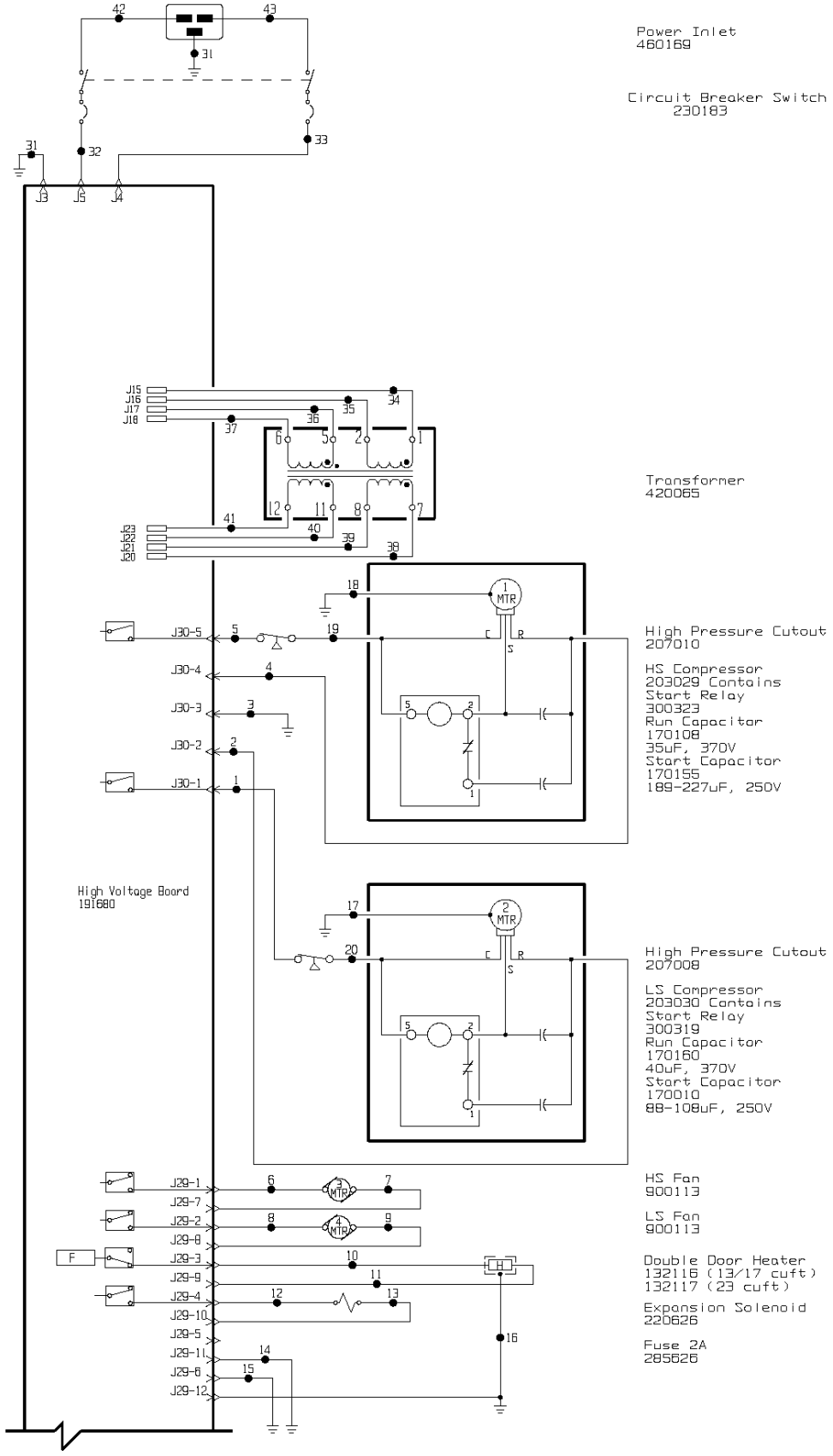
SIZE: D

8602-70-1-D Rev.8
Page 3 of 3

ATTENTION
OBSERVE PRECAUTIONS
ELECTROSTATIC
SENSITIVE DEVICES

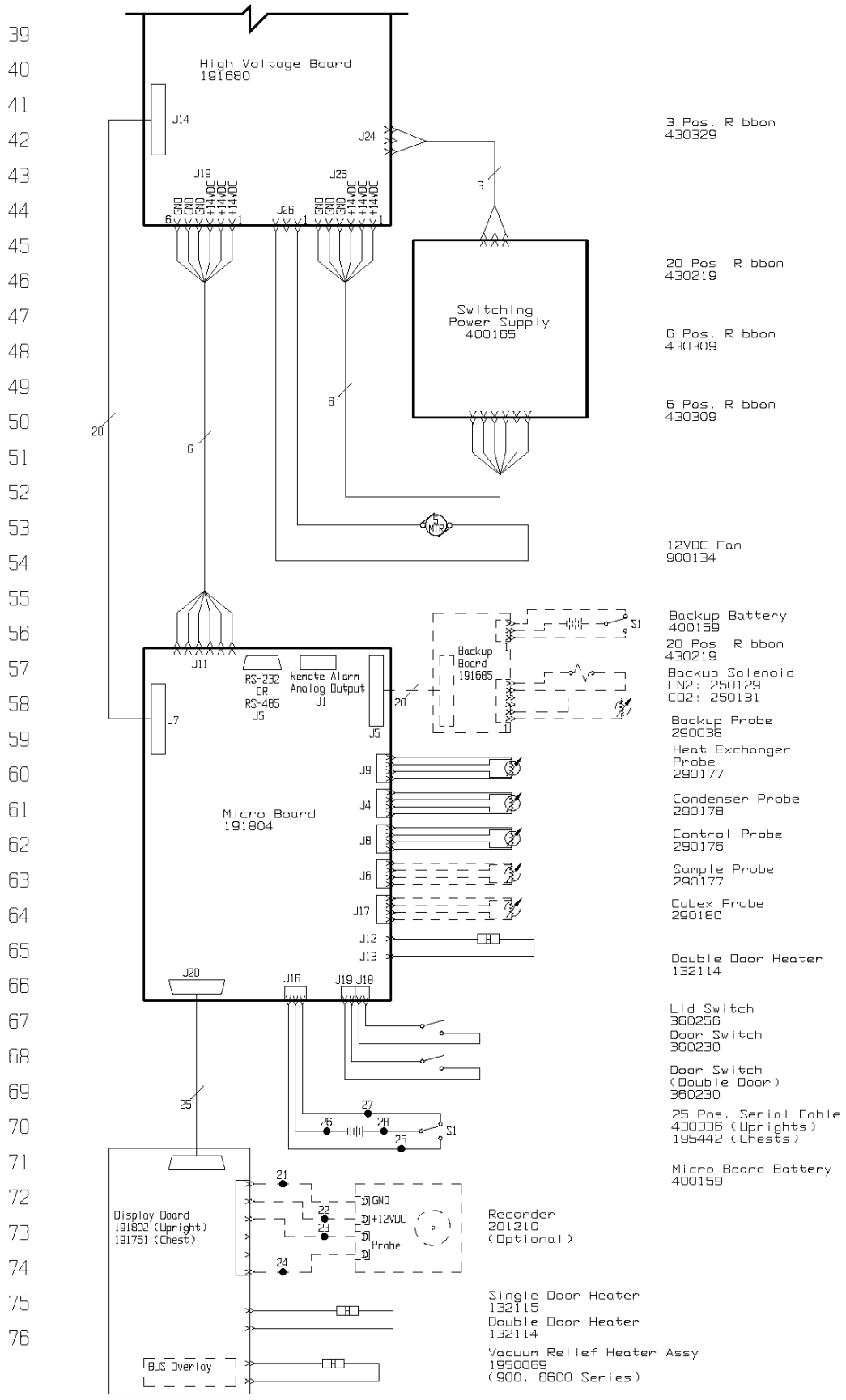
Thermo
ELECTRON CORPORATION
Controlled Environment Equipment
Box 649, Marietta, Oh 45750

POWER CONNECTION
120V, 1Ø, 2W, 60HZ, 16.0 FLA
(OPERATING RANGE 108-130V)



Models:
5603,5604,5615,5618
5621,5656,8603,8604
8615,8618,8621,8656
8690,8692,8693

8603-70-1-0 Rev. 8
Page 1 of 3



Models:
5603,5604,5615,5618
5621,5656,8603,8604
8615,8618,8621,8656
8690,8692,8693

8603-70-1-D Rev. 8
Page 2 of 3

WIRE #	COLOR	GAUGE	WIRE #	COLOR	GAUGE
1	BLK	14	25	WHT	18
2	RED	14	26	BLK	18
3	GRN/YEL	14	27	BLK	18
4	RED	14	28	RED	18
5	BLK	14	29		
6	BLK	18	30		
7	BLK	18	31	GRN/YEL	14
8	BLK	18	32	BLK	14
9	BLK	18	33	BLU	14
10	BLK	18	34	BLK	14
11	BLK	18	35	BLU	14
12	BLK	18	36	BLK	14
13	BLK	18	37	BLU	14
14	GRN/YEL	18	38	BLK	14
15	GRN/YEL	18	39	BLU	14
16	GRN/YEL	18	40	BLK	14
17	GRN/YEL	14	41	BLU	14
18	GRN/YEL	14	42	BLK	14
19	BLK	14	43	BLU	14
20	BLK	14			
21	BLK	18			
22	RED	18			
23	BLK	18			
24	RED	18			

Uprights

SIZE	THERMO	THERMO	VWR
13	8603	8692	5603
17	8604	8693	5604
23	8656	8690	5656

Chests

SIZE	THERMO	VWR
12.7	8615	5615
17	8618	5618
20	8621	5621

REMOTE CONTACTS/ANALOG OUTPUT

PIN# 1	Analog Output +
PIN# 2	Analog Output -
PIN# 3	Not Connected
PIN# 4	Not Connected
PIN# 5	Normally Closed
PIN# 6	Common.
PIN# 7	Normally Open

CONTACT RATING: 1A @ 30V
CONTACTS IN ALARM STATE

RS-232 SPECIFICATION

BAUD = 1200
PARITY = N
BITS = 8
STOP BITS = 2

RS-232 PORT	
PIN# 2	TXD
PIN# 3	RXD
PIN# 5	GND

SW1 Settings for Analog Output

4-20mA Output

0-1V Output

0-5V Output

SW2 Settings for Communication Output

RS-485

RS-232

1. Schematic represents single & double door upright models and chest models. All heater are for uprights only. Expansion solenoid on 17 & 23 cuft uprights only.
2. Door switches shown in open position.
3. Battery switch shown in the OFF position.
4. Circuit breaker switch shown in OFF position.
5. Options and acessories shown in dashed lines.

REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
8	FR-1854	08-13-05	HCE	GLS	AKS	REV. BATTERY CIRCUIT WIRING
7	FR-1789	08-13-05	RTB	KDG	LDN	ADD VACUUM RELIEF HEATER & CHG. DISPLAY BD.
6	FR-1768	11-09-04	ADT	KDG	LDN	CHANGED DISPLAY BD. 191751 FROM 191715
5	FR-1789	08-14-04	ADT	KDG	LDN	CHANGED MICRO BOARD 191658 TO 191804

MODEL/PART NAME: 8600 SERIES, 120V, ULT FREEZERS

DWG TITLE: UNIT SCHEMATIC

DWN: ADT	CAD: ADT	APPD: MAH	DATE: 3-22-02	SCALE: NONE

MATERIAL:

PAINT COLOR:

TOLERANCE UNLESS OTHERWISE SPECIFIED
ANGLES: DECIMAL: .XX=±, .XXX=±

DRAWING NUMBER: 8603-70-1

SIZE: D

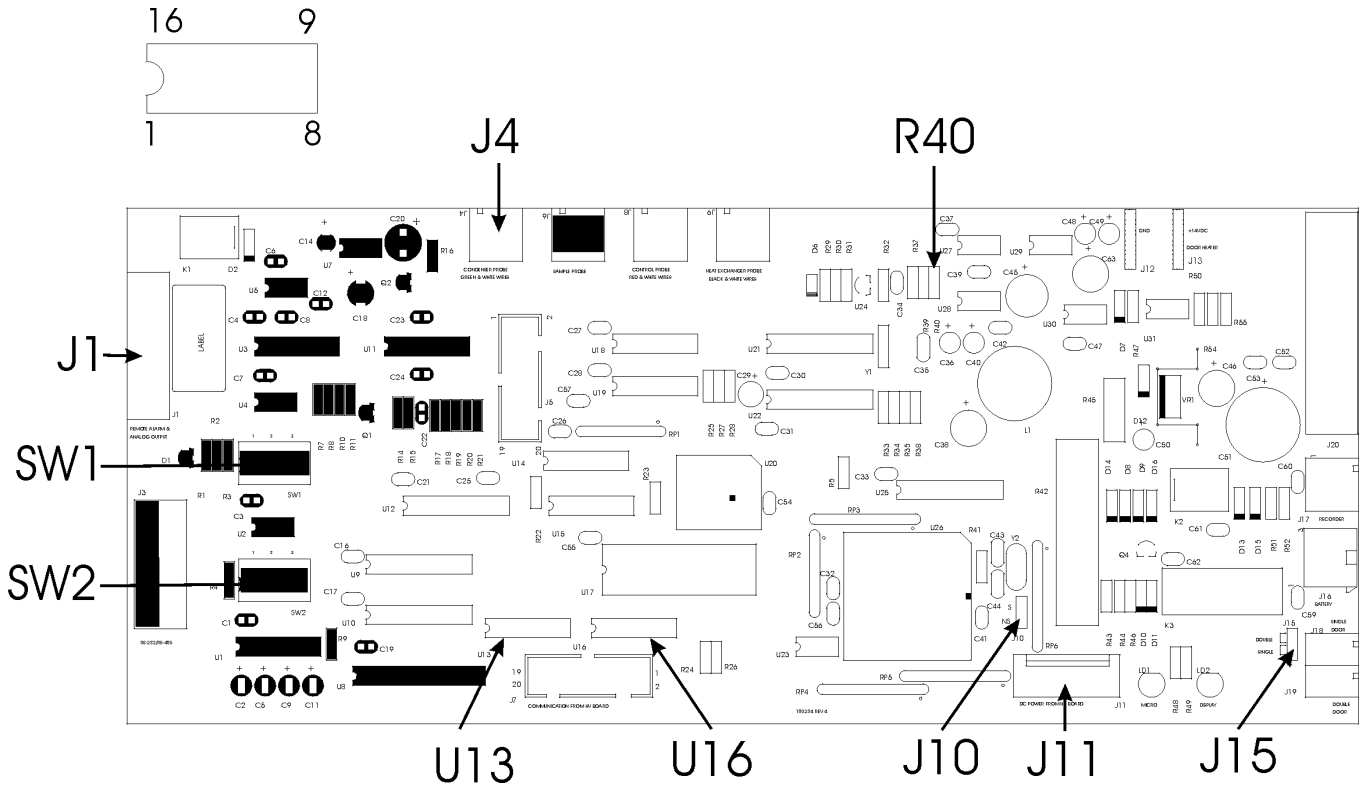
ATTENTION
OBSERVE PRECAUTIONS
ELECTROSTATIC
SENSITIVE DEVICES

Thermo
ELECTRON CORPORATION
Controlled Environment Equipment
Box 649, Marietta, Oh 45750

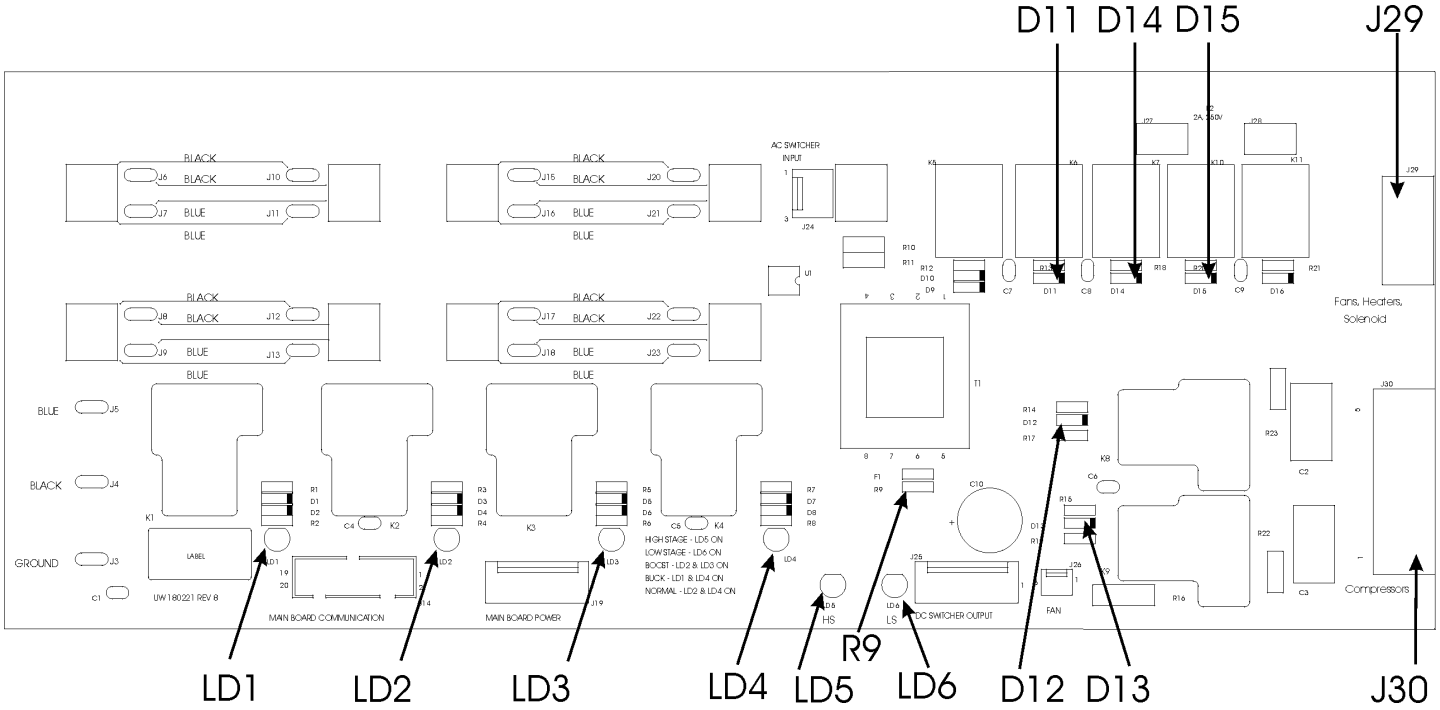
Models:
5603,5604,5615,5618
5621,5656,8603,8604
8615,8618,8621,8656
8690,8692,8693

8603-70-1-D Rev. 8
Page 3 of 3

MICRO BOARD



HIGH VOLTAGE BOARD



Section 4 - Hidden Functions
4.1 Hidden Test

The Hidden Test Mode is used for testing freezer components. The test functions are listed and described below. To enter Hidden Test mode, press the left and right arrow keys simultaneously. Press the right or left arrow until the appropriate function appears in the message center.

a. High Stage Compressor

To test the high stage compressor:
1. Press the right arrow until HS COMPRESR ON is displayed in the message center.
2. Press up/down arrow to toggle to OFF.
3. Press enter to initiate the test.

High Stage compressor will manually be turned ON as used in normal operation. To deactivate an on-going test press up/down to toggle to OFF and then press Enter.

To exit test mode, press the mode key and the freezer will resume normal operation. If no keys are pressed within a one hour interval, the freezer will return to Run mode.

b. Low Stage Compressor
The low stage compressor is manually turned ON/OFF as used in normal operation.

c. Fan 1
Fan 1 is manually turned ON/OFF as used in normal operation.

d. Fan 2
Fan 2 is manually turned ON/OFF as used in normal operation.

e. Heaters
The freezer heaters are manually turned ON/OFF as used in normal operation.

f. High Stage Heat Exchange Temperature
Displays the temperature.

g. High Stage Condenser Temperature
Displays the temperature.

h. Toggle Remote Alarm Contacts
The remote alarm contacts are toggled ON/OFF. ON places the contacts in alarm condition, OFF represents no alarm condition. Press enter.

i. Serial Port Data Burst
The freezer transmits a 2 second data stream from the RS-232/RS-485 port.

j. EEPROM Initialize
This function is used for field software updates. All settings will be reset to factory default settings upon initialization.
1. Press the right arrow until EEPROM INIT is displayed in the message center.
2. Press enter.
3. OK EE INIT? will be displayed in the message center.
4. Press enter to begin initialization.

k. Refrigeration Tank Solenoid
The refrigeration tank solenoid is manually opened/closed, OPN/CLS as used in normal operation.

4.2 Hidden Calibration

The Hidden Calibration Mode is used for calibrating freezer control and voltage components. These calibration functions listed below, should be performed by qualified service technicians.

To enter Hidden Calibration mode, press the up and down arrow keys simultaneously. The message center will display CAL MODE. Press the right or left arrow until the appropriate function appears in the message center.

To exit hidden calibration mode, press the mode key and the freezer will resume normal operation. If no keys are pressed within a one hour interval, the freezer will return to Run mode.

a. Manual Calibration

1. Press the left arrow key until the MANUAL CAL is displayed in the message center.
2. Attach 1000 Ohms resistance. Press enter.
3. Attach 806 Ohms resistance. Press enter.

b. Reset Control Probe Offset

1. Press the right arrow until RST CONT OST is displayed in the message center.
2. Press Enter to save to memory.

The control probe offset is reset to factory default.

c. Reset Sample Probe Offset (optional)

1. Press the right arrow until RST SAMP OST is displayed in the message center.
2. Press Enter to save to memory.

The sample probe offset is reset to factory default.

d. Reset Line Voltage Offset

1. Press the right arrow until RST LV OFSET is displayed in the message center.
2. Press Enter to save to memory.

The line voltage offset is reset to factory default.

e. Reset Battery Voltage Offset

1. Press the right arrow until RST BAT OFST is displayed in the message center.
2. Press Enter to save to memory.

The battery voltage offset is reset to factory default.

f. Reset BUS Battery Voltage Offset (optional)

1. Press the right arrow until RST BBAT OFS is displayed in the message center.
2. Press Enter to save to memory.

The battery voltage offset is reset to factory default.

g. Reset Analog Calibration Offset

1. Press the right arrow until RST DAC OFST is displayed in the message center.
2. Press Enter to save to memory.

The analog calibration offset is reset to factory default.

h. Serial RS232/RS485

1. Press the right arrow until SERIAL RS232 is displayed in the message center.
2. Press up/down arrow to toggle to RS485.
3. Press Enter to save to memory.

This option must match the serial output dip switch settings on the micro board. See unit schematic, page 3-7.

i. Line Voltage Calibration

1. Press the right arrow until LINE=XXXVAC is displayed in the message center.
2. Press up/down arrow to increase/decrease the line voltage to match a digital volt meter.
3. Press Enter to save to memory.

j. Battery Voltage Calibration

1. Press the right arrow until BAT=XX.XVDC is displayed in the message center.
2. Press up/down arrow to increase/decrease the line voltage to match a digital volt meter.
3. Press Enter to save to memory.

Digital volt meter is connected across freezer battery.

k. BUS Battery Voltage Calibration (optional)

1. Press the right arrow until BBAT=XX.XVDC is displayed in the message center.
2. Press up/down arrow to increase/decrease the line voltage to match a digital volt meter.
3. Press Enter to save to memory.

Digital volt meter is connected across BUS battery.

Note: to differentiate between the BUS battery and freezer unit battery, trace the battery harness from the BUS battery to BUS board.

l. Display Brightness

1. Press the right arrow until D BRIGHT is displayed in the message center.
2. Press the mode key to adjust the brightness level.

The adjustment result is immediately visible by viewing the display.

m. Control Probe Zero Offset

1. Press the right arrow until CONT T = X.X is displayed in the message center.
2. Press Enter or right arrow key.

This function displays the amount of offset the control probe currently carries. The amount is displayed in degrees Celsius with a .1 degree of accuracy.

n. Sample Probe Zero Offset (optional)

1. Press the right arrow until SAM OF = ±XX.X is displayed in the message center.
2. Press Enter or right arrow key.

This function displays the amount of offset the sample probe currently carries. The amount is displayed in degrees Celsius with a .1 degree of accuracy. This option is only available if there is a sample probe installed.

Note: the freezer must be powered up with J10 of the micro board jumpered in the S position to activate the menu.

o. Analog Type

1. Press the right arrow until ALG OUT is displayed in the message center.
2. Press up/down arrow to toggle between VOLT for 0 to 1 volt or 0 to 5 volt; or CRNT for 4 to 20mA.
3. Press Enter to save to memory.

This option must match the analog output dip switch settings on the micro board.

p. Analog Calibration

Connect a decade box set at 250 Ohms to pin 1 positive and pin 2 negative on the remote alarm/analog connector on the freezer. Connect a digital volt meter across the decade box.

1. Press the right arrow until ANALOG CAL is displayed in the message center.
2. Press enter.
3. Observe the temperature display. Using the analog output reference table, find the display temperature. Locate the appropriate output for the temperature. Using the up/down arrows and enter key on the freezer control panel, adjust the reading until the meter reading is equal to the output shown on the chart. Press enter.

Note: You must press enter for the output to change.

Appendix A - Glossary

Display board – customer interface for entering and displaying information. All settings are sent to micro board for storage.

High stage system – removes heat from the interstage heat exchanger and transfers heat to condenser.

High voltage board – distributes AC power to boost/buck transformers, compressors, fans, solenoids, and heaters. Generates signal for micro board to identify line voltage. Supplies DC power to micro board.

Interstage heat exchanger – device that transfers heat from low stage system to the high stage system.

Low stage system – removes heat from cabinet and transfers heat to interstage heat exchanger.

Micro board – receives input from temperature sensors and signals high voltage board to turn on compressors, solenoid, fans, and heaters. Initializes communication with display board. The micro board stores all set points, receives signal from high voltage board to indicate line voltage and then signals high voltage board to engage or disengage boost/buck.

Probe 1 – Control probe. A defective control probe will cause a probe failure and a high temperature alarm. Both compressors will lock on.

Probe 2 - Heat Exchanger Probe. A defective heat exchanger probe will cause a probe failure. Unit will continue to operate normally. Low stage will start 5 minutes after high stage starts.

Probe 3 – Condenser Probe.

Probe 4 – Optional Sample Probe.

Unit battery – supplies DC power to micro and display boards, so that cabinet temperature can be displayed, alarms can be activated, and optional recorder can operate.

Vacuum relief assembly – allows pressure inside freezer cabinet to equalize after a door opening

Compressor Information

Compressor	Resistance @ 25°C ± 7%		Compressor Hardware		
	Start Winding	Run Winding	Start capacitor	Run capacitor	Start relay
RF40C1E-CAA	2.800Ω	0.510Ω	88-106uf, 250VAC	40uf, 370VAC	3ARR3CT10V5
RF41C1E-CAA	3.220Ω	0.415Ω	189-227uf, 250VAC	35uf, 370VAC	3ARR3CT10S5
RF40C1E-CAV	18.300Ω	2.100Ω	43-52uf, 250VAC	10uf, 440VAC	3ARR3CT10V5
RF41C1E-CAV	6.300Ω	1.650Ω	108-130uf, 250VAC	20uf, 440VAC	3ARR3CT10V5
KALB-010L-CAV	4.525Ω	1.370Ω	145-174uf, 370VAC	40uf, 370VAC	3ARR3CT24ES
AFE13C3E-IAA	7.32±5%	1.09±5%	189-227uf, 165VAC	---------	041-147
AFE13C3E-IAZ	34.40±5%	5.00±5%	50-60uf, 330VAC	---------	041-183