

Controls and Troubleshooting

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GENERAL

Unit sizes 240, 270, and 300-420 are modular units which are shipped as separate sections (modules A and B). Installation instructions specific to these units are shipped inside the individual modules. See Table 1 for a listing of unit sizes and modular combinations. For modules 240B and 270B, follow all general instructions as noted for unit sizes 080-110. For all remaining modules, follow instructions for unit sizes 130-210.

SAFETY CONSIDERATIONS

Installing, starting up, and servicing this equipment can be hazardous due to system pressures, electrical components, and equipment location (roofs, elevated structures, etc.).

Only trained, qualified installers and service mechanics should install, start up, and service this equipment.

Untrained personnel can perform basic maintenance functions, such as cleaning coils. All other operations should be performed by trained service personnel.

When working on the equipment, observe precautions in the literature and on tags, stickers, and labels attached to the equipment.

- Follow all local safety codes.
- Wear safety glasses and work gloves.
- Use care in handling, rigging, and setting bulky equipment.
- Use care in handling electronic components.



ELECTRIC SHOCK HAZARD

Open all remote disconnects before servicing this equipment.

INTRODUCTION

This publication contains information on the electronic control system, and control system troubleshooting for the 30GT040-420 Flotronic™ liquid chillers and Flotronic units with factory-installed options (FIOP).

The Flotronic chillers are equipped with electronic expansion valves (EXVs) or, on 040-110 FIOP units, conventional thermostatic expansion valves (TXVs). The 040-110 FIOP chillers are also equipped with liquid line solenoid valves (LLSV).

Differences in operations and controls between standard and 040-110 FIOP units are noted in appropriate sections in this publication. Refer to the Installation, Start-Up and Service Instructions and the Wiring Diagrams for the appropriate unit for further details.

⚠ WARNING

This unit uses a microprocessor-based electronic control system. Do not use jumpers or other tools to short out or bypass components or otherwise depart from recommended procedures. Any short-to-ground of the control board or accompanying wiring may destroy the board or electrical component.

Table 1 – Unit Sizes and Modular Combinations

UNIT MODEL 30GT	NOMINAL TONS	SECTION A UNIT	SECTION B UNIT
40	40	—	—
45	45	—	—
50	50	—	—
60	60	—	—
70	70	—	—
80	80	—	—
90	90	—	—
100	100	—	—
110	110	—	—
130	125	—	—
150	145	—	—
170	160	—	—
190	180	—	—
210	200	—	—
225	225	—	—
240	225	30GT130	30GT100
250	250	—	—
270	260	30GT170	30GT100
280	280	—	—
300	285	30GT130	30GT170
330	325	30GT170	30GT170
360	350	30GT190	30GT190/30GT170*
390	380	30GT210	30GT190
420	400	30GT210	30GT210

*60 Hz units/50 Hz units.

FLOTRONIC™ CONTROL SYSTEM

General — The 30GT air-cooled reciprocating chillers contain a microprocessor-based electronic control system that controls and monitors all operations of the chiller, **except** as noted on 040-110 FIOP units.

The control system is composed of several components as listed below and identified in Fig. 1-3.

- processor board
- relay board
- electronic expansion valve driver board
- display board
- thermistors
- electronic expansion valves or FIOP thermostatic expansion valve (040-110)
- liquid line solenoid valve (FIOP 040-110 TXV and 225, 250, 280 units only)

- compressor protection control system (CPCS) (standard on size 070, 50 Hz, and on 080-110 sizes)
- ground fault protection system (130-210, and 225, 250, 280 sizes)
- accessory board (field installed)
- demand limit board (field installed)

The Flotronic control system monitors and controls the following:

- cooler leaving-water temperature control (compressor capacity control)
- electronic expansion valves
- condenser fans (head pressure control)
- demand limiting
- temperature reset
- pulldown control
- pumpdown on unit shutdown
- diagnostic display
- safety functions
- unit checkout (Quick Test)

Processor Board — The processor board, shown in Fig. 1, 2 and 3, is the chiller system's main control center. It contains the microprocessor, microprocessor memory, power supplies, analog-to-digital converters, electronic expansion valve drivers, relay drivers and display drivers.

The processor board is covered with a sheet metal cover that contains heaters that are used to keep the processor board above 32 F (0° C).

All electrical connections to the processor board are made through wire and ribbon cable connectors, located around the outside of the board. See Fig. 4A-4D and 5 for processor board wiring connections.

Connected to the microprocessor are 4 to 9 thermistors that are used to sense various temperatures throughout the system. See Table 2.

Table 2 – System Thermistors

J1 PIN CONNECTOR	THERMISTOR INPUT	THERMISTOR NO.
1, 2	Remote Thermistor	T10
6, 7	Compressor, Ckt B (EXV Only)	T8
8, 9	Compressor, Ckt A (EXV Only)	T7
10, 11	Evaporator, Ckt B (EXV Only)	T6
12, 13	Evaporator, Ckt A (EXV Only)	T5
14, 15	Saturated Condensing, Ckt B	T4
16, 17	Saturated Condensing, Ckt A	T3
18, 19	Cooler Entering Water	T2
20, 21	Cooler Leaving Water	T1

LEGEND

EXV — Electronic Expansion Valve

The microprocessor also monitors several status switches in the unit. These switches are listed in Table 3.

From one to 6 potentiometers are connected to the processor board. These potentiometers are used to input set points to the microprocessor. The potentiometers are listed in Table 4.

Table 3 – Status Switches

J2 PIN CONNEC- TOR	STATUS SWITCH	040-060 (50 Hz) 040-070 (60 Hz)	070 (50 Hz) 080	090-110	130 (60 Hz)	130 (50 Hz) 150	170,190	210	225,250,280
1, 2	Oil Pressure, Ckt B	Not Used	OPSB	OPSB	OPSB	OPSB	OPSB	OPSB	OPSB
3, 4	Oil Pressure, Ckt A	Not Used	OPSA	OPSA	OPSA	OPSA	OPSA	OPSA	OPSA
7, 8	Loss of Charge, Ckt B	LCSB	LCSB	LCSB	LCSB	LCSB	LCSB	LCSB	LCSB
9, 10	Loss of Charge, Ckt A	LCSA	LCSA	LCSA	LCSA	LCSA	LCSA	LCSA	LCSA
13, 14	Remote On/Off	Jumper	Jumper	Jumper	Jumper	Jumper	Jumper	Jumper	Jumper
15, 17	Compressor Fault Signal, B4	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	CR-B4
15, 18	Compressor Fault Signal, B3	Not Used	Not Used	Not Used	Not Used	Not Used	CR-B3	CR-B3	CR-B3
15, 19	Compressor Fault Signal, B2	Not Used	Not Used	CPCS-B2	CR-B2	CR-B2	CR-B2	CR-B2	CR-B2
15, 20	Compressor Fault Signal, B1	CPCS-B1	CPCS-B1	CPCS-B1	CR-B1	CR-B1	CR-B1	CR-B1	CR-B1
15, 21	Compressor Fault Signal, A4	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	CR-A4	CR-A4
15, 22	Compressor Fault Signal, A3	Not Used	Not Used	Not Used	Not Used	CR-A3	CR-A3	CR-A3	CR-A3
15, 23	Compressor Fault Signal, A2	Not Used	CPCS-A2	CPCS-A2	CR-A2	CR-A2	CR-A2	CR-A2	CR-A2
15, 24	Compressor Fault Signal, A1	CPCS-A1	CPCS-A1	CPCS-A1	CR-A1	CR-A1	CR-A1	CR-A1	CR-A1

LEGEND

CPCS – Compressor Protection Control System
CR – Control Relay
LCS – Loss-of-Charge Switch, Circuit A or B
OPS – Oil Pressure Switch, Circuit A or B

Table 4 – Potentiometers

POTENTI- METER	DESCRIP- TION	LOCATION	VALID RANGE	DEFAULT VALUE
P1	Cooler Leaving Water Set Point	Display Board	Water: 40 – 70 F (4.4 – 21 C) Brine: 15 – 70 F (- 9.4 – 21 C)	70 F (21 C) 42 F (5.6 C)
P3*	Reset Limit Set Point	Accessory Reset Board	0° – 80 F (0° – 44.4 C)	0° F (0° C)
P4†	Demand Limit Set Point	Field Supplied Potentiometer or Demand Limit Control Board	0-100%	0%
P5*	Reset Ratio Set Point	Accessory Reset Board	0-100%	0%
P6*	Reset Set Point	Accessory Reset Board	0° – 95 F (- 17.8 – 35 C)	0° F (- 17.8 C)

*Accessory reset board required for reset options.

†Accessory 2-Step Demand Limit Module is required for 2-step demand limit which has 2 potentiometers.

The microprocessor also controls several outputs. All relay outputs are controlled through the relay board which plugs into the processor board through a ribbon cable. The processor also controls a 2-digit LED (light-emitting diode) display located on the display board. The display board also plugs into the processor board with a ribbon cable. The electronic expansion valves are controlled by the microprocessor through the EXV driver board. See Fig. 4A-4D for wiring schematic of microprocessor inputs and outputs.

The microprocessor has been programmed to control a large variety of chillers. To configure processor for a unique chiller, 2 methods are used; a configuration header, and a DIP switch assembly. The configuration header is a small plastic header plugged into a chip socket. The header contains 8 small wire jumpers (see Tables 5 and 6) selectively broken to configure unit. The purpose of each jumper is outlined in Table 5. Do not change factory configuration as it could result in improper operation of unit.

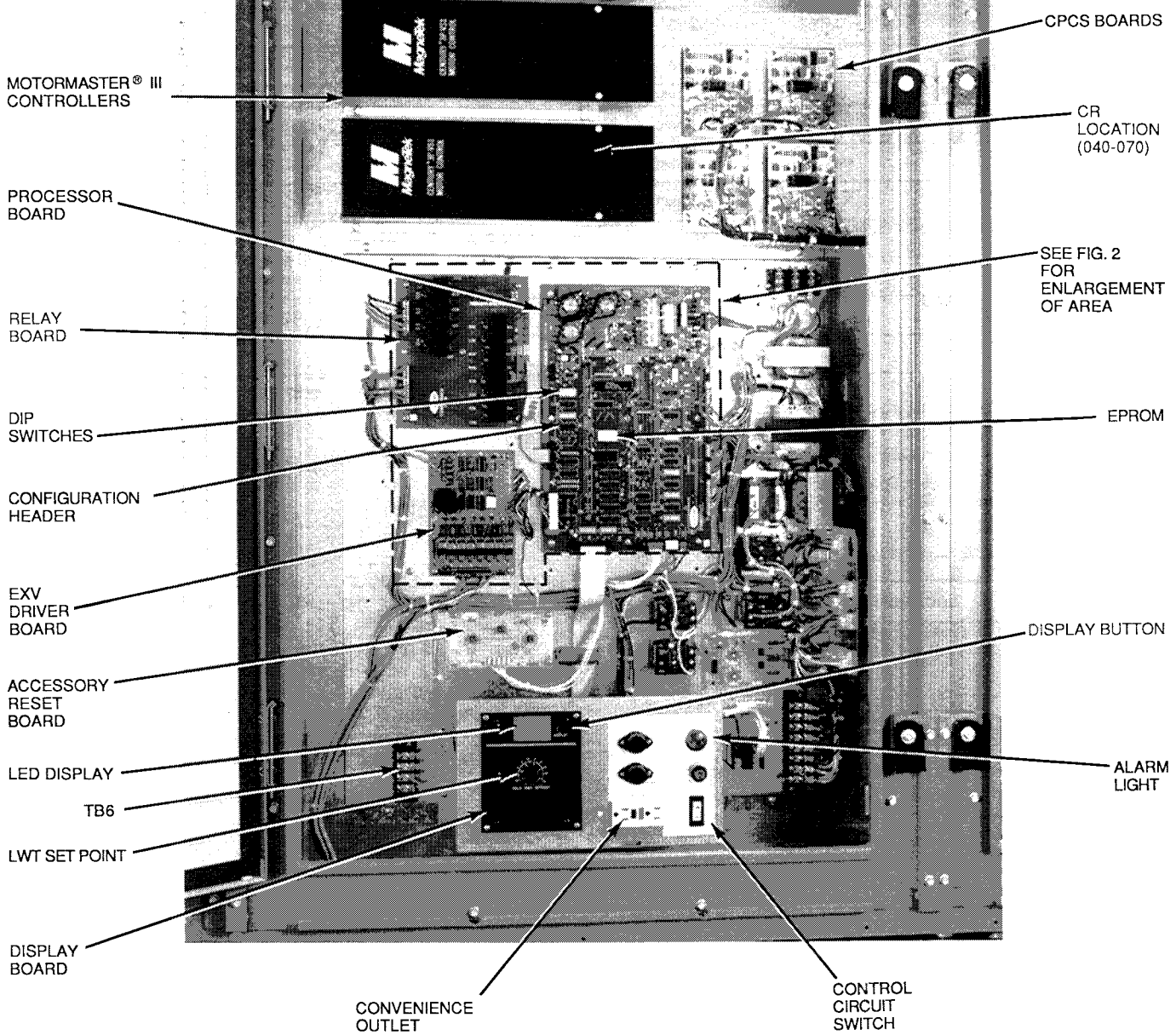
Table 5 – Configuration Header

JUMPER NO.	FUNCTION	SETTING	MEANING
1, 2	Unit Type	☐ ☐	Air-Cooled Chiller
3, 4, 5	Number of Compressors	☒ ☐ ☐ ☐ ☒ ☐ ☐ ☐ ☒ ☐ ☐ ☐ ☒ ☐ ☐ ☐ ☐ ☒ ☐ ☐ ☐ ☐ ☐ ☒ ☐ ☐ ☐ ☐ ☐ ☐ ☒ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☒	2 Compressors 3 Compressors 4 Compressors 5 Compressors 6 Compressors 7 Compressors 8 Compressors
6	Expansion Valve	☒ ☐	EXV TXV
7	Power Frequency	☐ ☒	60 Hz 50 Hz
8	Not Used	☒	No Significance

LEGEND

☐ – Broken Jumper (Open Circuit)
☒ – Unbroken Jumper (Closed Circuit)

30-278



LEGEND

- CPCS — Compressor Protection Control System
- CR — Control Relay
- DIP — Dual In-Line Package
- EPROM — Erasable, Programmable Read-Only Memory
- EXV — Electronic Expansion Valve
- LWT — Leaving-Water Temperature

Fig. 1 — Typical Control Box (080-110 Unit Shown)

30-279

PROCESSOR
BOARD

RELAY
BOARD

DIP
SWITCHES

EPROM

CONFIGURATION
HEADER

EXV
DRIVER
BOARD

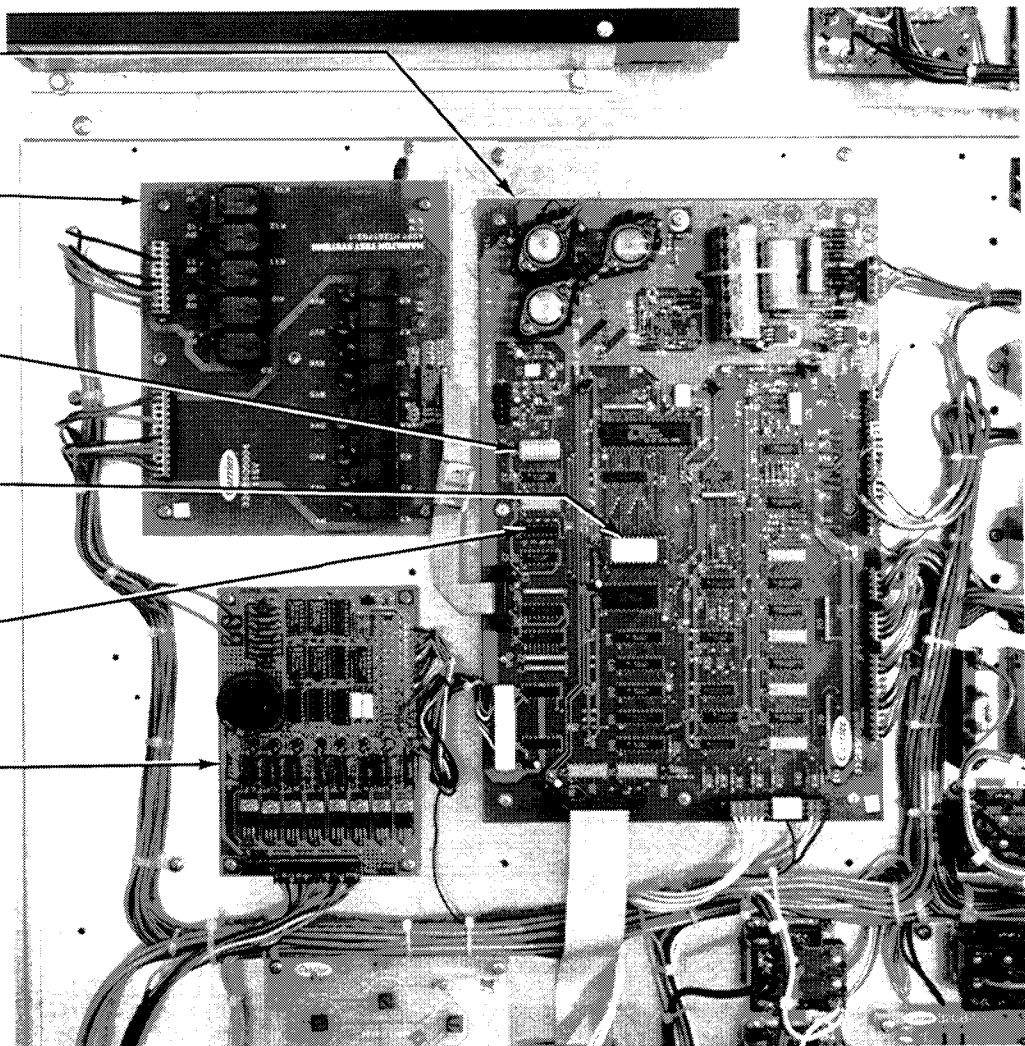
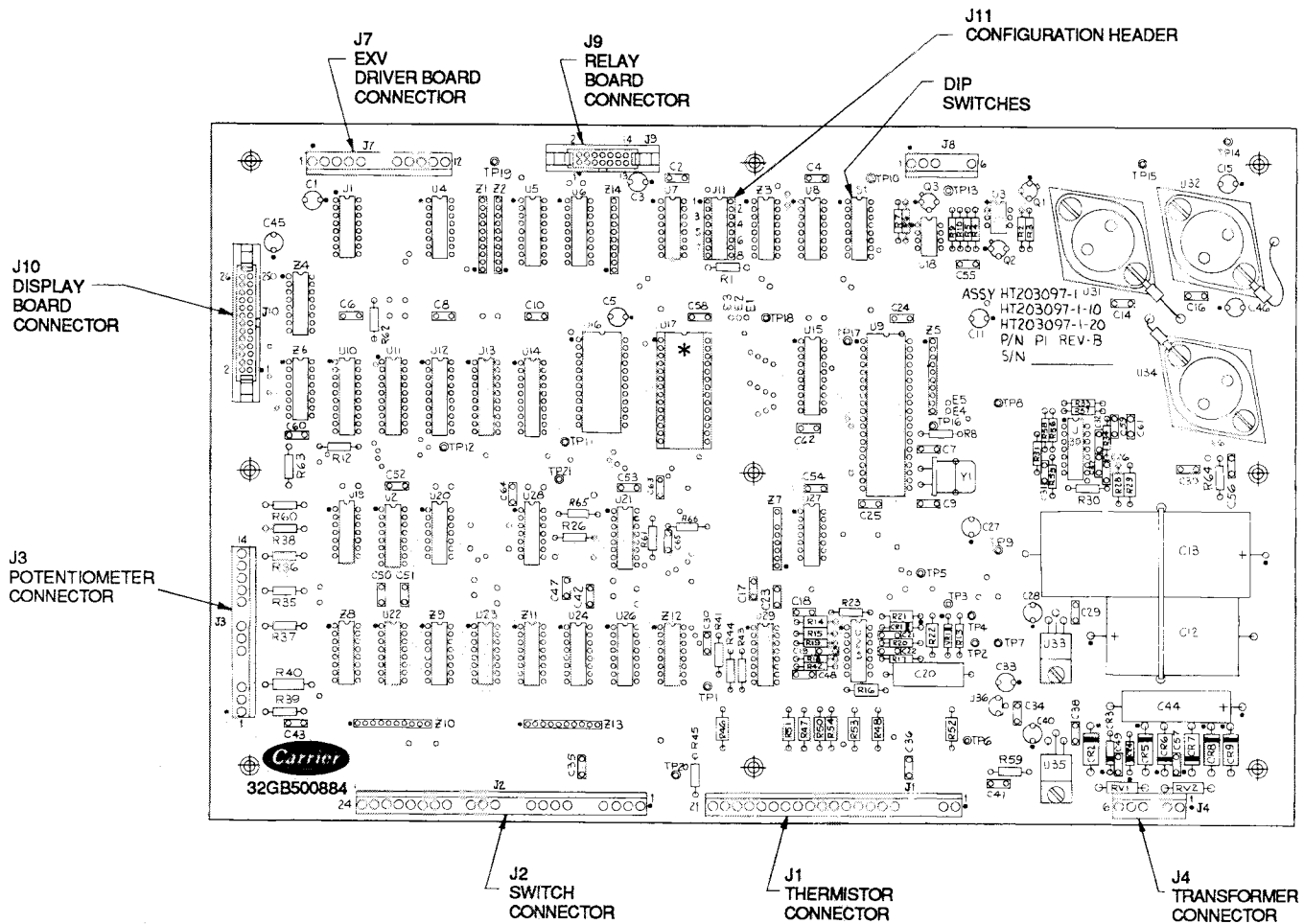


Fig. 2 — Photo Inset Enlargement for Fig. 1

A3C-924



⚠ WARNING

Do not remove label covering EPROM. Removal causes program to be erased.

*EPROM HT207101-1-XX (040-210) or HT204247-1-XX (225,250,280) where "XX" is the current revision number.

NOTE: Processor Board is positioned in unit with J3 and J10 connections at the bottom.

Fig. 3 – Processor Board

Table 6 – Configuration Header Settings

UNIT SIZE	CONFIGURATION HEADER							
	1	2	3	4	5	6	7	8
040,045,050,060 – 60 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒
040,045,050,060 – 50 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒
040,045,050,060 – 60 Hz (TXV)	☐	☐	☒	☐	☐	☒	☐	☒
040,045,050,060 – 50 Hz (TXV)	☐	☐	☒	☐	☐	☒	☐	☒
070 – 60 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒
070 – 50 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒
070 – 60 Hz (TXV)	☐	☐	☒	☐	☐	☒	☐	☒
070 – 50 Hz (TXV)	☐	☐	☒	☐	☐	☒	☐	☒
080 – 60 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒
080 – 50 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒
080 – 60 Hz (TXV)	☐	☐	☒	☐	☐	☒	☐	☒
080 – 50 Hz (TXV)	☐	☐	☒	☐	☐	☒	☐	☒
090-110 – 60 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒
090-110 – 50 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒

LEGEND

- ☐ – Broken Jumper (Open Circuit)
- ☒ – Unbroken Jumper (Closed Circuit)
- EXV – Electronic Expansion Valve
- TXV – Thermostatic Expansion Valve

UNIT SIZE	CONFIGURATION HEADER							
	1	2	3	4	5	6	7	8
090-110 – 60 Hz (TXV)	☐	☐	☒	☒	☐	☐	☐	☒
090-110 – 50 Hz (TXV)	☐	☐	☒	☒	☐	☐	☐	☒
130 – 50 Hz (EXV)	☐	☐	☒	☒	☐	☐	☐	☒
130 – 60 Hz (EXV)	☐	☐	☒	☒	☐	☐	☐	☒
150 – 50 Hz (EXV)	☐	☐	☐	☐	☒	☒	☒	☒
150 – 60 Hz (EXV)	☐	☐	☐	☐	☒	☒	☐	☒
170 – 50 Hz (EXV)	☐	☐	☒	☐	☐	☒	☒	☒
170 – 60 Hz (EXV)	☐	☐	☒	☐	☐	☒	☐	☒
190 – 50 Hz (EXV)	☐	☐	☒	☒	☐	☒	☒	☒
190 – 60 Hz (EXV)	☐	☐	☒	☒	☐	☒	☐	☒
210 – 50 Hz (EXV)	☐	☐	☒	☒	☐	☒	☐	☒
210 – 60 Hz (EXV)	☐	☐	☒	☒	☐	☒	☐	☒
225,250 – 50 Hz (EXV)	☐	☐	☒	☒	☐	☒	☐	☒
225,250,280 – 60 Hz (EXV)	☐	☐	☒	☒	☐	☒	☐	☒

To allow for field-selectable options, a second configuration method is used. A small DIP (dual in-line package) switch assembly is located on processor board. The header contains 8 DIP switches protected by a plastic cover. The cover must be removed to access switches. Always replace plastic cover after adjusting DIP switches. Switches should be adjusted only when control circuit switch is in the OFF position. Do not change DIP switch 8 in the field unless unit has been factory-modified for brine applications. Unit damage may occur due to expansion device being improperly sized for low flow conditions. See Table 7.

All units are shipped from factory with DIP switches in the following positions. Control circuit must be OFF before changing a DIP switch setting. See Table 8.

Table 7 – DIP Switches

SWITCH NO.	FUNCTION	FACTORY SETTING*	PURPOSE
1	Reset Mode	On Off	Return Reset Space or Outdoor Air Reset
2	Reset Select	On Off	Enable Reset Disable Reset
3	Pulldown Select	On Off	Enable Pulldown Disable Pulldown
4	Not Used	Off	—
5	Demand Limit	On Off	Enable Demand Limit Disable Demand Limit
6, 7	Unloaders	Off, Off On, Off Off, On	No Unloaders 1 Unloader 2 Unloaders
8	Brine Select	On Off	Brine Chiller Water Chiller

*Control Circuit switch must be in the OFF position before changing setting of DIP switches.

Table 8 – DIP Switch Settings

30GT040-070								
30GT	Factory DIP Switch Settings							
	1	2	3	4	5	6	7	8
Water	Off	Off	On	Off	Off	On	Off	Off
Brine	Off	Off	On	Off	Off	On	Off	On
30GT080-170								
30GT	Factory DIP Switch Settings							
	1	2	3	4	5	6	7	8
Water	Off	Off	On	Off	Off	Off	On	Off
Brine	Off	Off	On	Off	Off	Off	On	On
30GT190-210, and 225,250,280								
30GT	Factory DIP Switch Settings							
	1	2	3	4	5	6	7	8
Water	Off	Off	On	Off	Off	Off	Off	Off
Brine	Off	Off	On	Off	Off	Off	Off	On

Relay Board — The relay board is used to control 24-, 115-, or 230-v loads. The relay board is connected to processor board through a ribbon cable. See Fig. 6 for electrical connections. The relay board contains eight 24-v relays and five 115- or 230-v relays. The relays and their uses are listed in Table 9.

Display Board — The display board is located in the control box. The board is connected to J10 on processor board through a ribbon cable. The display board contains cooler leaving fluid temperature set point potentiometer, a 2-digit, 7-segment display, and display switch. The display is used to convey operating information and error codes.

Table 9 – Output Relay

RELAY NO.	DESCRIPTION
K1	Energize Compressor A1 and OFM1 (040-110) Energize Compressor A1, OFM5, and OFM7 (130-210) Energize Compressor A1, OFM7 and OFM8 (225) Energize Compressor A1, OFM7, OFM8, and OFM10 (250,280)
K2	No Action (040-060, 50 Hz; 040-070, 60 Hz) Energize Compressor A2 (070, 50 Hz; 080-210,225, 250,280)
K3	No Action (040-110; 130, 60 Hz) Energize Compressor A3 (130, 50Hz; 150-210, and 225,250,280)
K4	Energize Unloader A1 (040-170) No Action (190) Energize Compressor A4 (210,225,250,280)
K5	Energize Compressor B1 and OFM2 (040-110) Energize Compressor B1, OFM6, and OFM8 (130-210) Energize Compressor B1 (225,250,280)
K6	No Action (040-080) Energize Compressor B2 (090-210, and 225,250,280)
K7	No Action (040-150) Energize Compressor B3 (170-210, and 225,250,280)
K8	Energize Unloader B1 (040-170) No Action (190,210) Energize Compressor B4 (225,250,280)
K9	Energize Liquid Line Solenoid Valve for Circuit A (if used) (040-110, and 225,250,280) Not Used (130-210)
K10	Energize Liquid Line Solenoid Valve for Circuit B (if used) (040-110, and 225,250,280) Not Used (130-210)
K11	Energize First Stage of Condenser Fans: 040-050 — OFM3 060-090 — OFM3, OFM4 100,110 — OFM3, OFM4 130-210 — OFM3, OFM4, OFM9, OFM10 225 — OFM5, OFM6, OFM11, OFM12 250 — OFM5, OFM6, OFM11, OFM12, OFM19 280 — OFM5, OFM6, OFM11, OFM12, OFM19, OFM20
K12	Energize Second Stage of Condenser Fans: 040-050 — OFM4 060-090 — OFM5, OFM6 100,110 — OFM5, OFM6, OFM7, OFM8 130-170 — OFM1, OFM2 190,210 — OFM1, OFM2, OFM11, OFM12 225 — OFM1-4, OFM13-16 250 — OFM1-4, OFM13-16, OFM20 280 — OFM1-4, OFM13-16, OFM21, OFM22
K13	Alarm

LEGEND

OFM — Outdoor-Fan Motor

B30-599

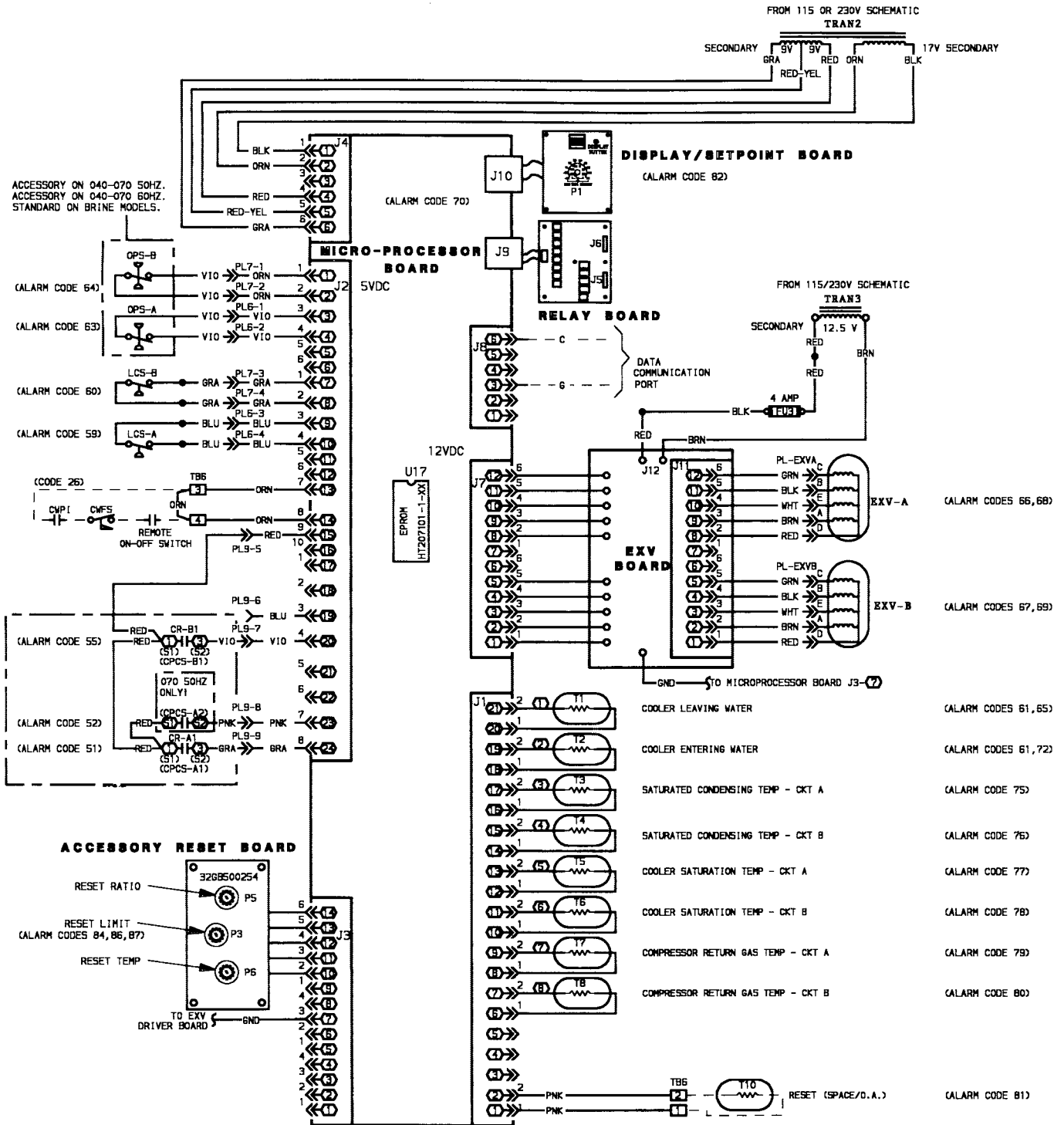


Fig. 4A – Processor Input/Output (040-070)

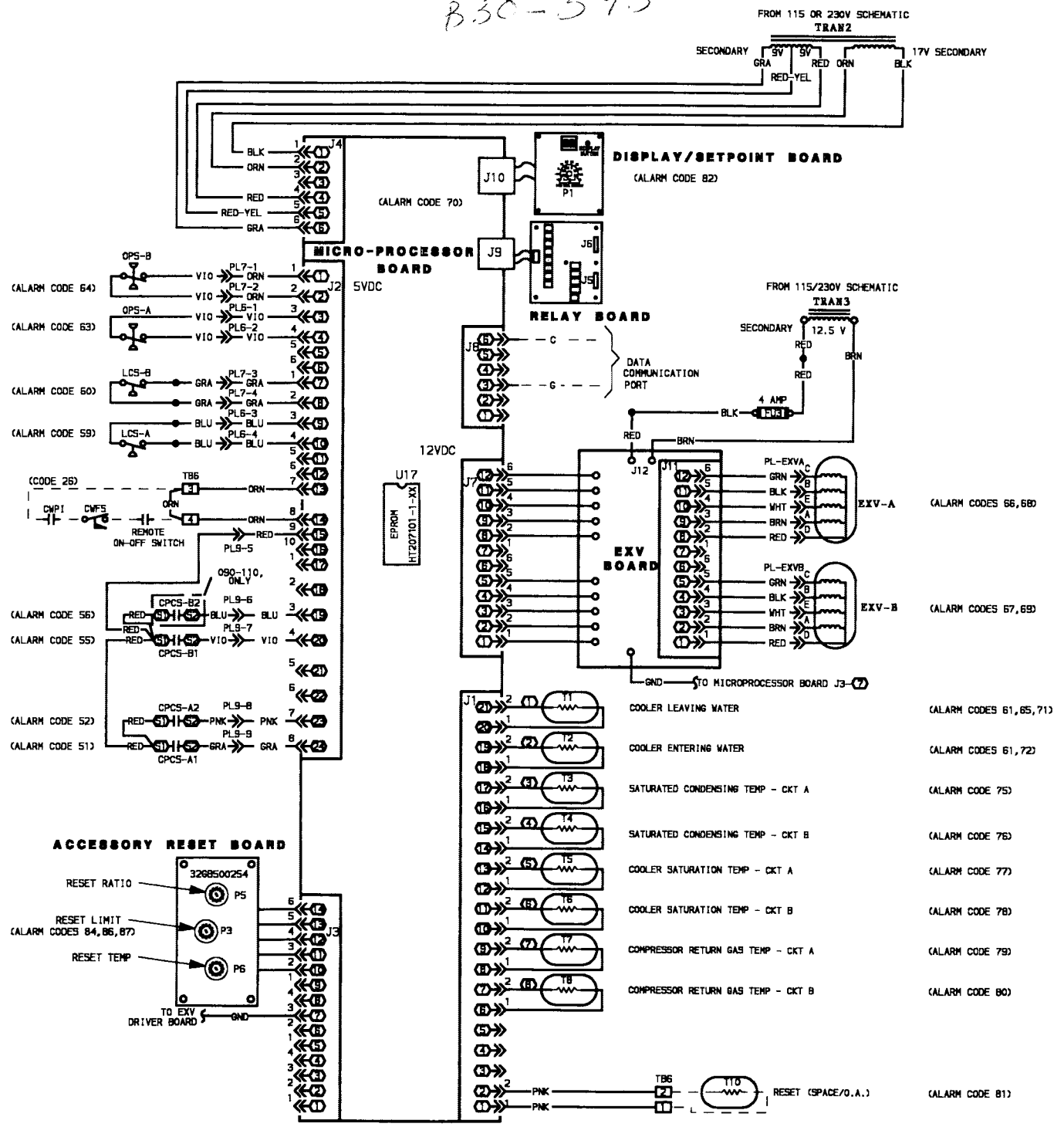


Fig. 4B — Processor Input/Output (080-110)

B30-741

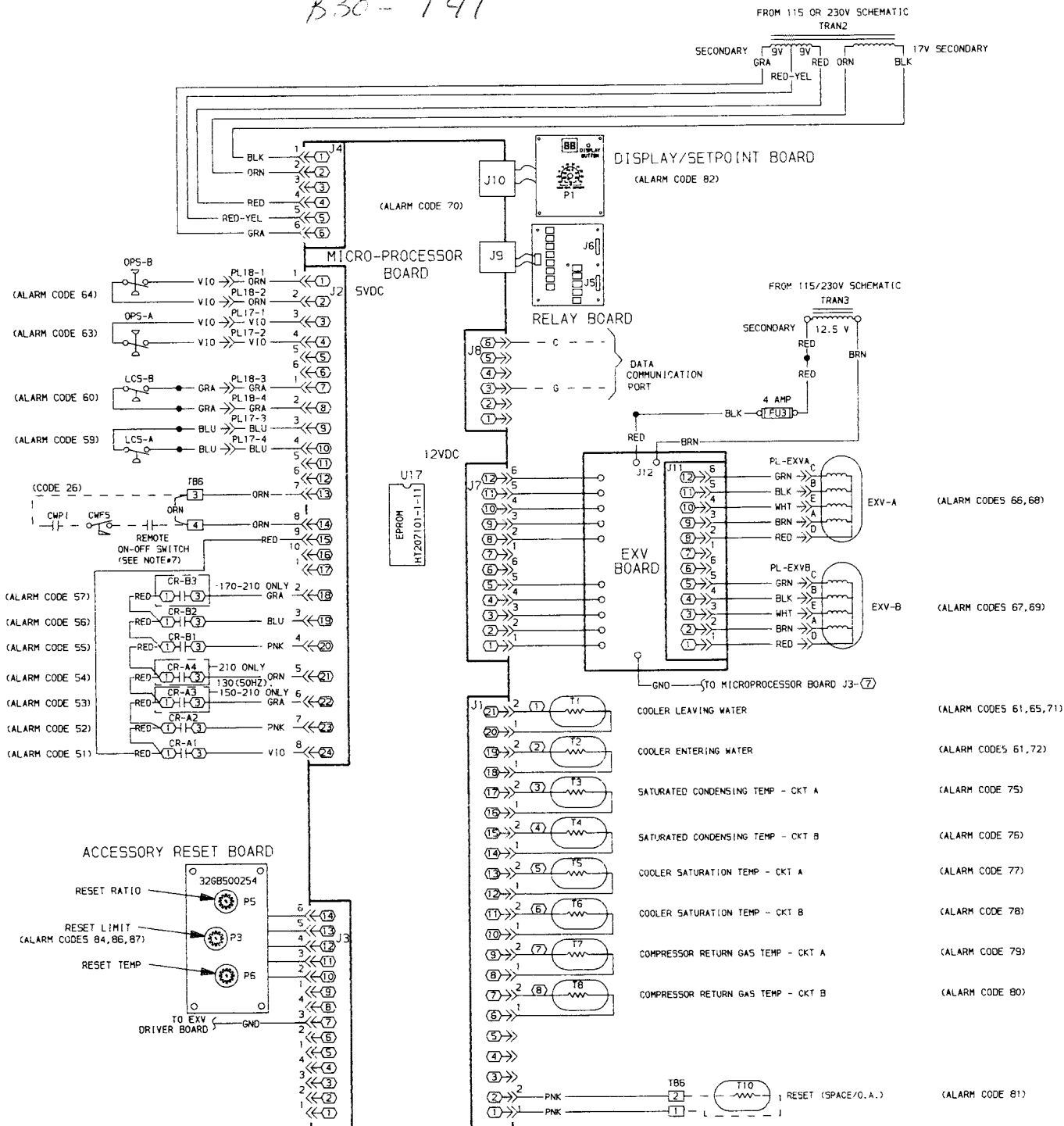


Fig. 4C — Processor Input/Output (130-210)

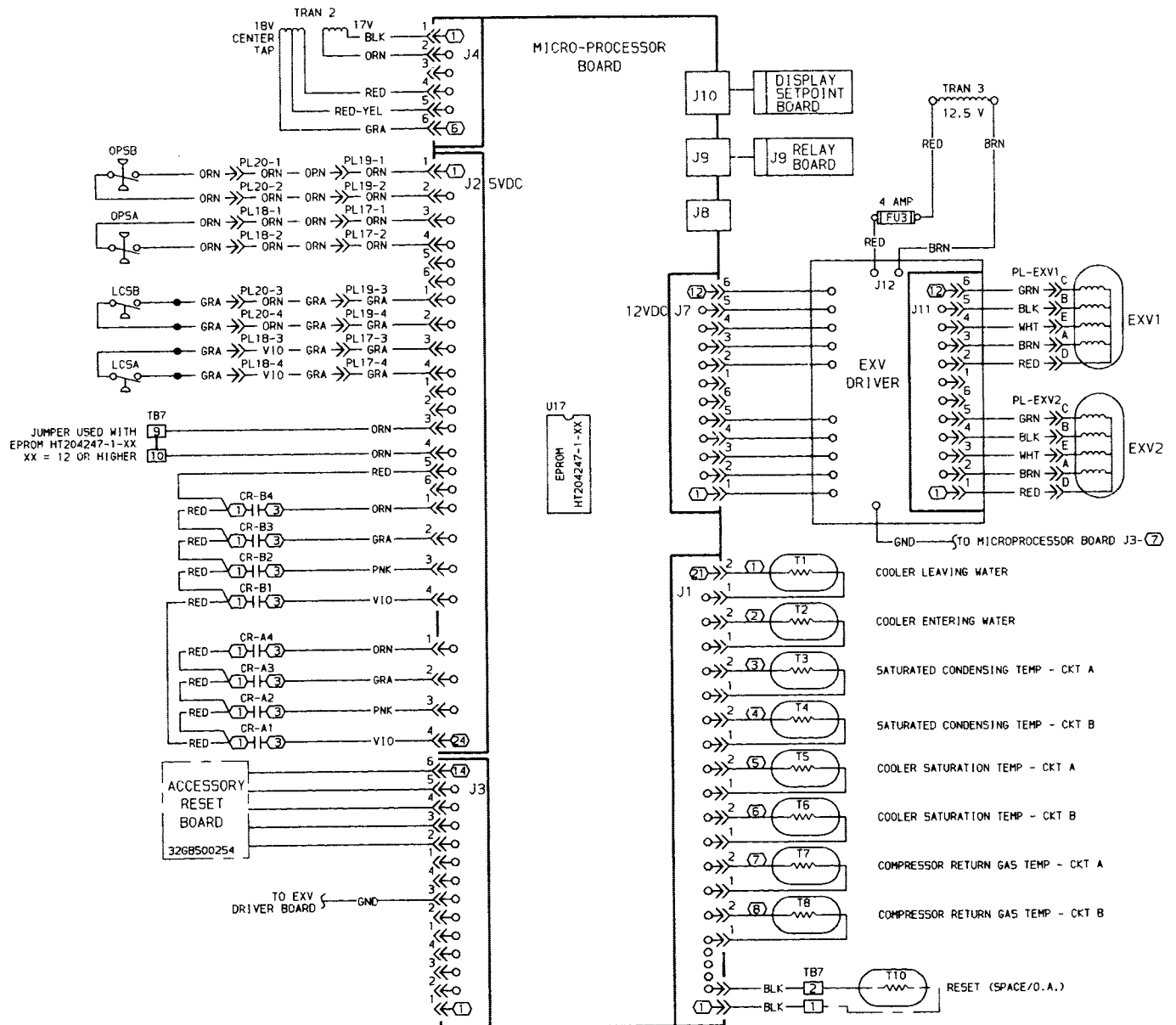
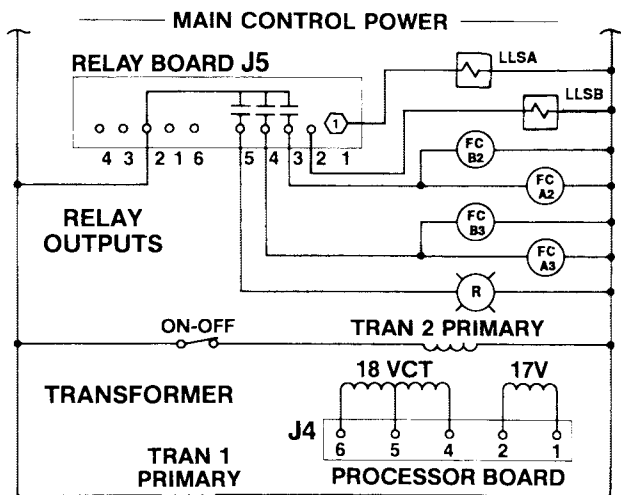


Fig. 4D – Processor Input/Output (225,250,280)

A30-926



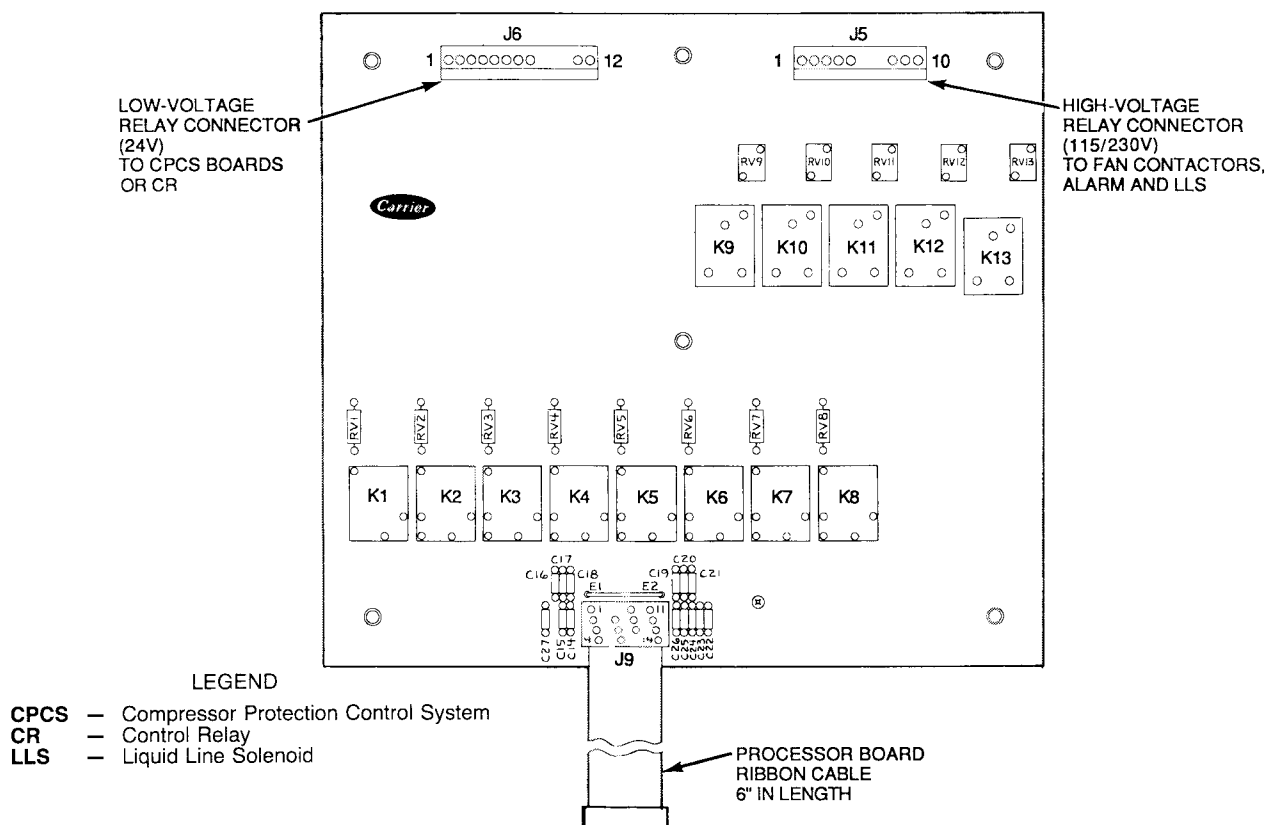
LEGEND

- FC — Fan Contactor
- LLS — Liquid Line Solenoid (FIOP and 225,250,280 units only)
- R — Red (Light)
- VCT — Voltage Center Tap

Fig. 5 — Printed-Circuit Board Connectors

Thermistors — The electronic control uses 4 to 9 thermistors to sense temperatures for controlling chiller operation. These sensors are outlined on page 13. See Fig. 7-10 for thermistor locations. All thermistors are identical in temperature versus resistance and voltage drop performance. See Thermistor Troubleshooting section on page 45 for temperature-resistance-voltage drop characteristics.

A30-927



LEGEND

- CPCS — Compressor Protection Control System
- CR — Control Relay
- LLS — Liquid Line Solenoid

Fig. 6 — Relay Board

T1 — COOLER LEAVING WATER/BRINE SENSOR — This thermistor is located in the leaving water nozzle. The thermistor probe is immersed directly in the water.

T2 — COOLER ENTERING WATER/BRINE SENSOR — This thermistor is located in the cooler shell in the first baffle space in close proximity to the cooler tube bundle.

T3, T4 — SATURATED CONDENSING TEMPERATURE SENSORS — These 2 thermistors are clamped to the outside of a return bend of the condenser coils.

T5, T6 — EVAPORATOR REFRIGERANT TEMPERATURE SENSORS — These thermistors are located next to the refrigerant inlet in the cooler head. On 040-210 units, the thermistors are inserted into a friction-fit well. The sensor well is located directly in the refrigerant path. On 225,250,280 units, the thermistors are placed directly into the refrigerant. These thermistors are not used on units with TXVs.

T7, T8 — COMPRESSOR RETURN GAS TEMPERATURE SENSORS — These thermistors are located in the lead compressor in each circuit in a suction passage after the refrigerant has passed over the motor and is about to enter the cylinders. On 040-210 units, these thermistors are inserted into friction-fit wells. The sensor wells are located directly in the refrigerant path. On 225,250,280 units, the thermistors are placed directly into the refrigerant. These thermistors are not used on units with TXVs.

T10 — REMOTE SENSOR — This is an accessory sensor and is mounted remotely from the unit. It is used for outdoor air or space temperature reset.

All thermistors are checked by the processor board to see that they are not open or shorted, and that they have a valid resistance range value.

Electronic Expansion Valves (EXV) — See description of electronic expansion valve in Electronic Expansion Valve section on page 23.

Electronic Expansion Valve Driver Board — The processor board controls the operation of the electronic expansion valves through the EXV driver board. The EXV driver board amplifies the signal from processor board to electronic expansion valve by increasing the voltage to the EXV stepper motor. This results in an increase in the available torque output of the stepper motor. The EXV driver board is powered by a separate 12.5-v transformer. See Fig. 2.

Thermostatic Expansion Valves (TXV) — Model 30GT040-110 units are available from the factory with conventional thermostatic expansion valves with liquid line solenoids. The liquid line solenoid valves are not intended to be a mechanical shut-off. When service is required, use the liquid line service valve to pump down the system.

The TXV is set at the factory to maintain approximately 8 to 12° F (4.4 to 6.7° C) suction superheat leaving the cooler by monitoring the proper amount of refrigerant into the cooler. All TXVs are adjustable, *but should not be adjusted unless absolutely necessary*. When TXV is used, thermistors T5, T6, T7, and T8 are not required.

The TXV is designed to limit the cooler saturated suction temperature to 55 F (12.8 C). This makes it possible for unit to start at high cooler water temperatures without overloading the compressor.

Compressor Protection Control System (CPCS) or Control Relay (CR) — Each compressor has its own CPCS module or CR. See Fig. 11. The CPCS or CR is used to control and protect the compressors and crankcase heaters. The CPCS and CR provide the following functions:

- compressor contactor control/crankcase heater
- crankcase heater control
- compressor ground current protection (CPCS only)
- status communication to processor board
- high-pressure protection

One large relay is located on the CPCS board. This relay controls the crankcase heater and compressor contactor, and also provides a set of signal contacts that the microprocessor monitors to determine the operating status of the compressor. If the processor board determines that the compressor is not operating properly through the signal contacts, it will lock the compressor off by deenergizing the proper 24-v control relay on the relay board. The CPCS board contains logic that can detect if the current-to-ground of any compressor winding exceeds 2.5 amps. If this condition occurs, the CPCS module shuts down the compressor.

A high-pressure switch is wired in series with the compressor board. If this switch opens during operation of a compressor, the compressor will be stopped, the failure will be detected through the signal contacts, and the compressor will be locked off. If the lead compressor in either circuit is shut down by the high-pressure switch, ground current protector, or oil safety switch, all compressors in that circuit are blocked via the oil pressure switch.

NOTE: The CR control relay operates the same as the CPCS, except the ground current refrigerant circuit protection is not provided.

Compressor Ground Current (CGF) Protection Board and Control Relay (CR) — The 30GT 130-210, and 225,250,280 units contain one ground current protection board (CGF) for each refrigeration circuit. The CGF board contains logic that can detect if the current-to-ground of any compressor winding exceeds 2.5 amps. If this occurs, the lead compressor in that circuit is shut down along with other compressors in that circuit.

A high-pressure switch is wired in series with a control relay (CR) for each compressor. The lead compressor in each circuit also has the CGF contacts described above. If any of these switches open during operation of a compressor, the CR relay is deenergized, stopping the compressor and signaling the processor at the J2 inputs to lock out the compressor. If the lead compressor in either circuit is shut down by these safeties, all compressors in that circuit are also shut down.

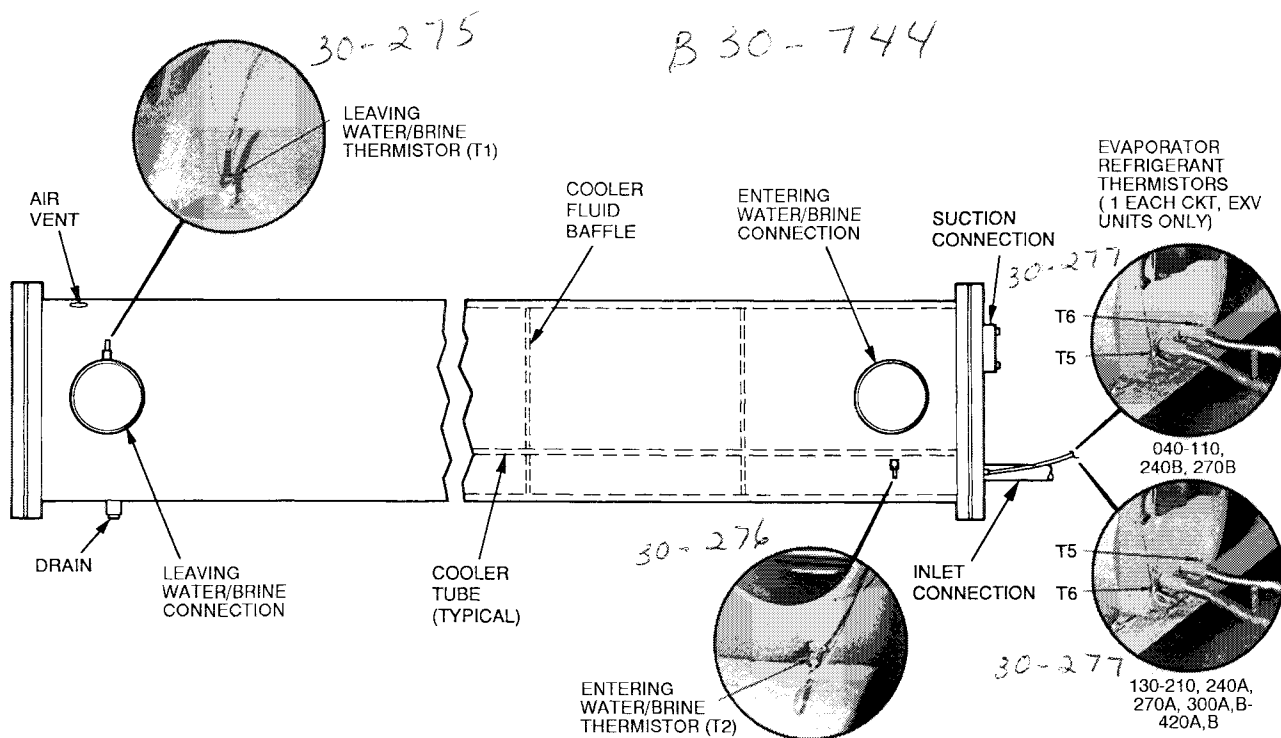


Fig. 7 – Cooler Thermistor Locations

Accessory Reset Board (See Fig. 1 and 12) –

The processor board is programmed to handle several types of temperature reset. The following 3 types of reset may be used:

- return water reset
- outdoor-air temperature reset
- space temperature reset

The accessory board is required to use temperature reset. The board contains the following potentiometers:

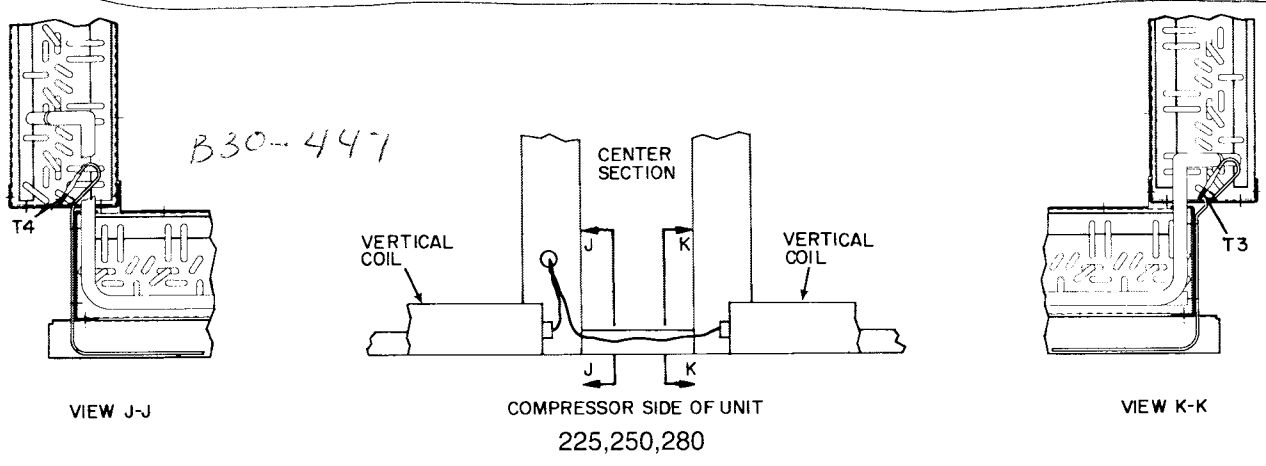
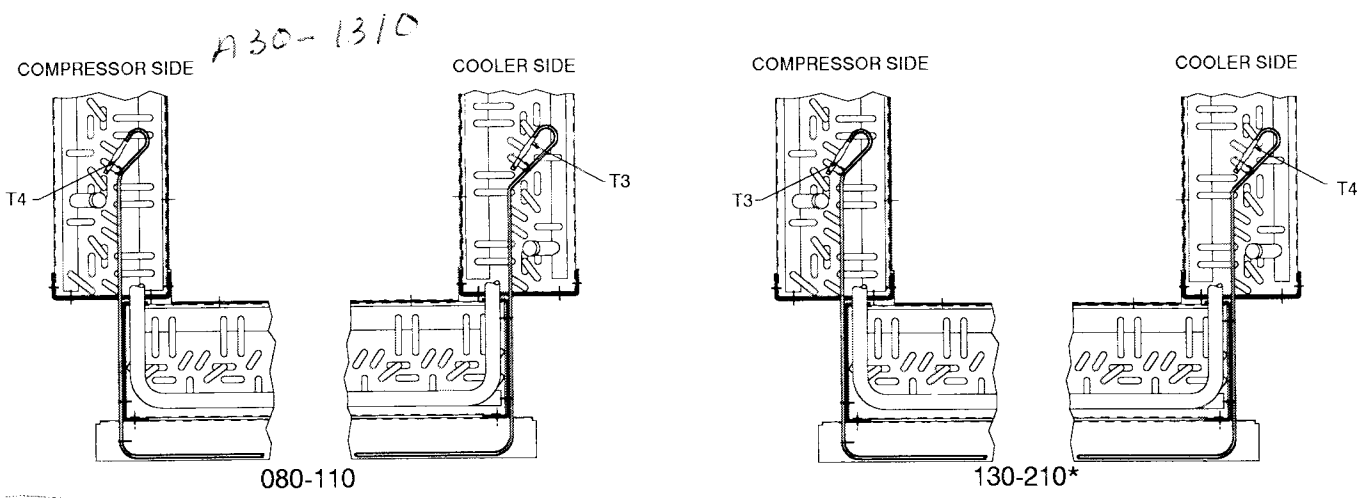
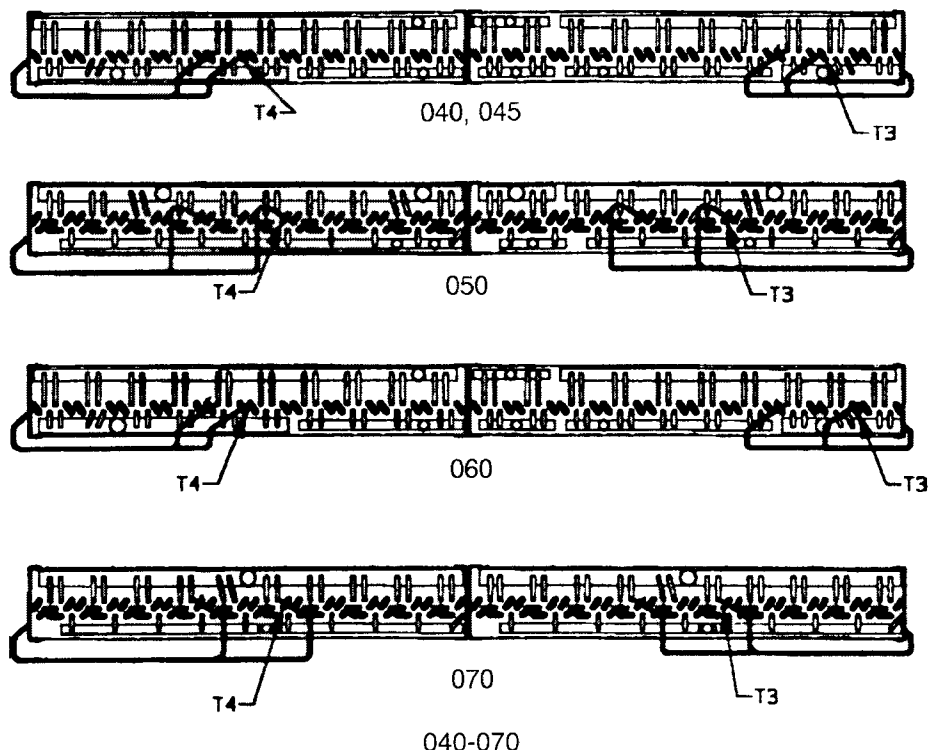
CODE NAME	DESCRIPTION	RANGE
P3	Reset Limit Set Point	0° to 80 F (0° to 44.4 C)
P5	Reset Ratio Set Point	0° to 100%
P6	Reset Set Point	0° to 95 F (-17.8 to 35 C)

The board is equipped with a prewired cable and connector, and the control panel in the control box is predrilled to accept the board.

Demand Limit Control Module – The demand limit board or demand limit control module (DLCM) provides a 2-step demand limit control with an external switch to enable the device. The first step is between 50 and 100% of the maximum compressor displacement. The second step is between 0 and 49% of the maximum compressor displacement. (The exact percentage differs, depending on the number of capacity steps of the machine.) The external switching device controls the 2 steps and determines when to limit unit capacity.

Two adjustable potentiometers are used to set the 2 demand limit points. Potentiometer P1 is used to set the first step and P2 sets the second step. Also refer to Operating Information and Fig. 13. See separate accessory Demand Limit Control Module Installation Instructions.

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*When thermistor is viewed from perspective where the compressor is on the left and the cooler is on the right.

Fig. 8 - Thermistor T3 and T4 Locations

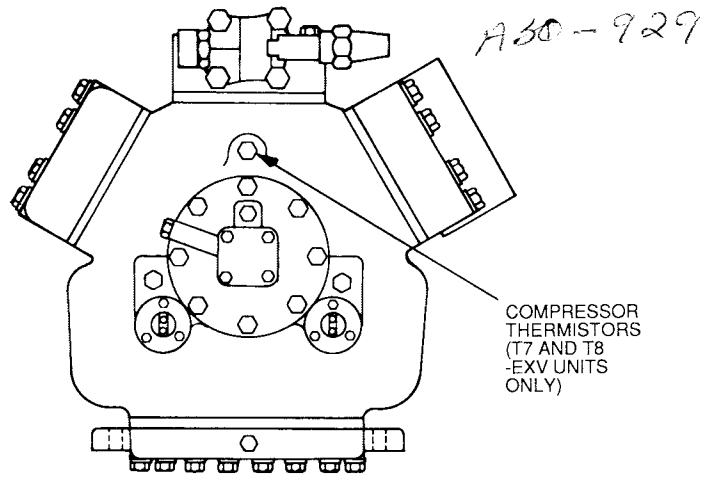


Fig. 9 – Compressor Thermistor Locations (T7 and T8)

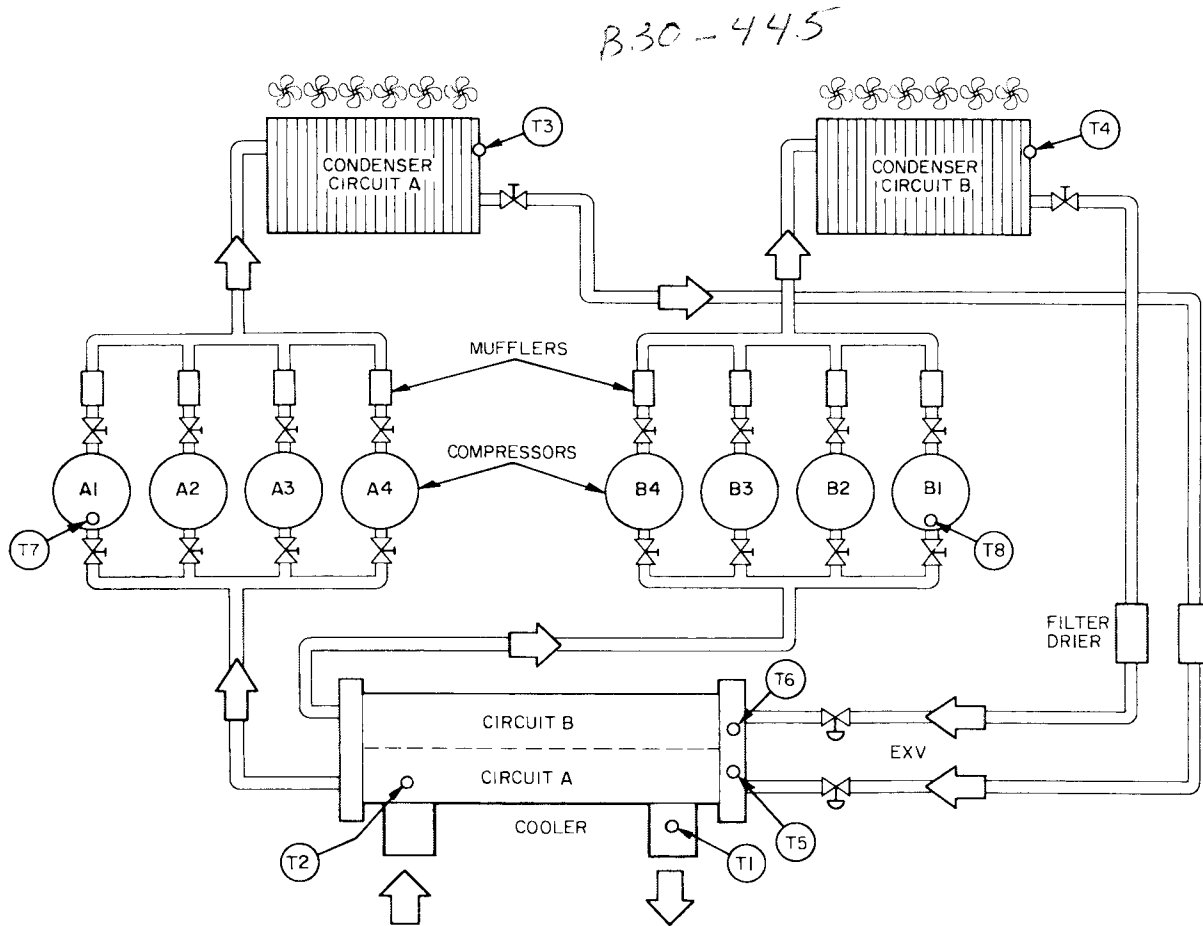


Fig. 10 – Typical Thermistor Location (30GT225,250,280 Shown)

30-154

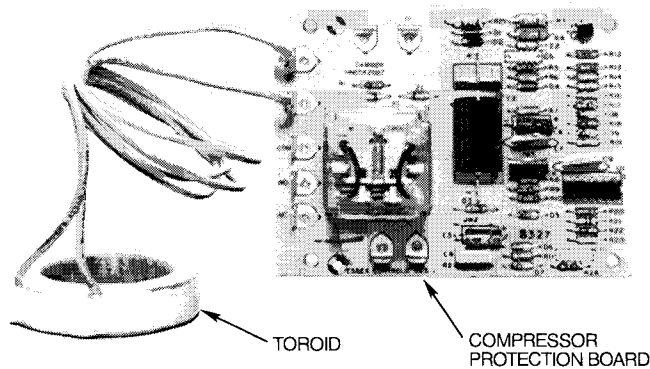


Fig. 11 - Compressor Protection Control System Module

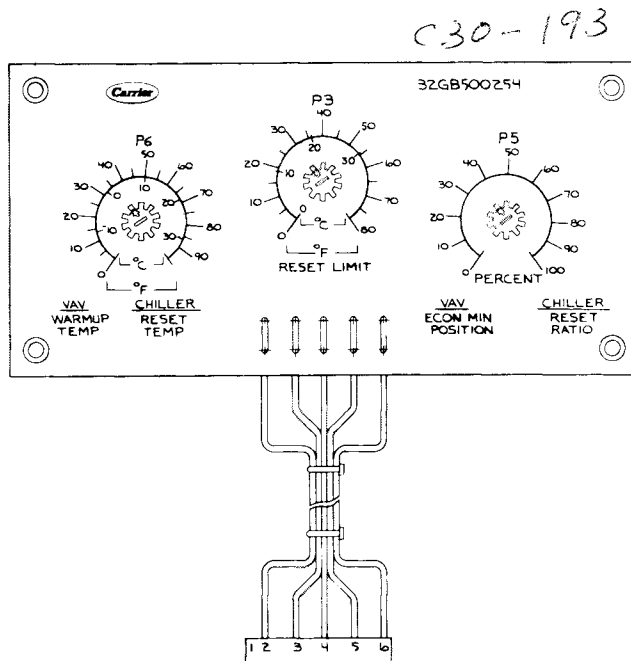


Fig. 12 - Accessory Reset Board

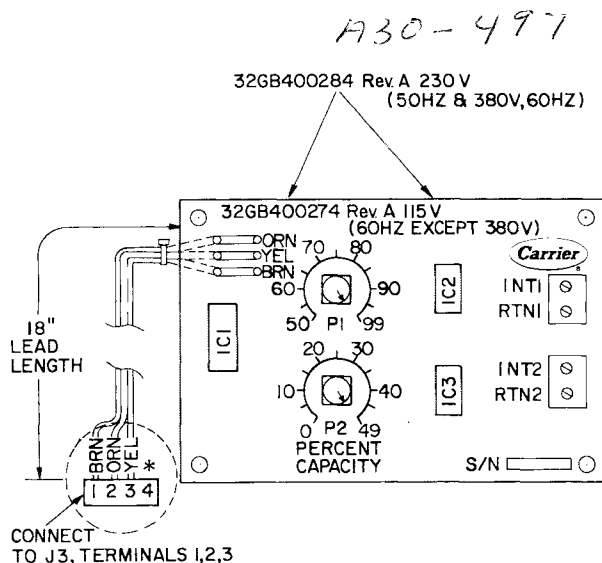


Fig. 13 - Accessory Demand Limit Control Module

OPERATING INFORMATION

Digital Display — The electronic control system uses a 2-digit LED display located on the display board (see Fig. 1) to display operational information and diagnostic codes.

When the control ON-OFF switch is turned to the ON position, the display shows a **20** for 2 minutes to indicate that the control is in the initialization mode. During this period, the electronic expansion valve position is closed and initialized. The water temperatures are allowed to stabilize.

IMPORTANT: If the display button is pressed during the 2-minute period, the control goes into Quick Test mode. See Quick Test section on page 18 for details.

After the 2-minute period, the display turns off and the unit is allowed to start approximately 90 seconds after the display is shut off. If the button is pressed after the **20** has been removed from the display, the diagnostic information is shown as long as the button is held in. The numbers that are shown in the display have the following significance:

CODE NO.	OPERATIONAL STATUS
0-12	Capacity Stage
20-26	Operational Codes
51-87	Diagnostic Display Codes

Refer to the unit label diagram and the Diagnostic Display Codes section on page 34 for more details.

Under normal operation, only the capacity stage number is displayed when display button is pressed. If a status code or an overload code is displayed, the display will rotate every 2 seconds and will display up to 3 codes. Diagnostic display information takes priority over all other codes. The codes are stored by the microprocessor as long as the board remains energized.

IMPORTANT: The memory is cleared when power is removed from the processor board.

DISPLAY CODES — The digital display shows up to 3 codes as described in the digital display section above. There are categories of display codes shown during normal operation. During Quick Test, these codes do not apply.

0-12 CAPACITY STAGE NUMBER — The capacity stage number is always displayed when the display button is pressed unless there are 3 diagnostic codes. Diagnostic codes override the stage number and operating information codes.

Refer to Capacity Control — Operating Sequence sections on page 23 for the number of stages and loading sequence for the chiller.

20-26 OPERATIONAL CODES — The operational codes are displayed to indicate that the unit is operating in a special mode of operation. During these special modes of operation, the set point and number of active stages may be controlled by another signal other than just the cooler leaving water temperature. The operational codes are listed in Table 10.

Table 10 — Operational Codes

CODE NO.	DESCRIPTION
20	Initialization Mode
21	Temperature Reset in Effect
22	Demand Limit in Effect
24	Pulldown Control in Effect
26	Remote On/Off in Effect, Open CWFS, or CWPI

LEGEND

CWFS — Chilled Water Flow Switch
CWPI — Chilled Water Pump Interlock

Initialization Mode — Code **20** is displayed only during the first 2 minutes of operation after the power ON-OFF switch has been turned to the ON position. The display is always lighted. If the display button is pressed during this period, the unit goes into Quick Test.

Temperature Reset — Code **21** indicates that the unit is using temperature reset to adjust the set point. The leaving water temperature may not equal the cooler leaving-water temperature set point potentiometer setting. The set point can be adjusted based on 3 different temperatures; return water, outdoor-air temperature or space temperature.

Demand Limit — Code **22** indicates that the capacity staging of the unit is being limited by the demand limit potentiometer. The unit may not be able to produce the desired leaving water temperature, nor load to its full capacity.

Pulldown Control — Code **24** indicates this option is being used, the cooler water temperature is warm, and unit is limiting the capacity staging so that the water temperature leaving the cooler does not decrease faster than 1° F (0.6° C) per minute. This option is selected in the factory, but may be turned off in the field.

Remote On-Off — Code **26** indicates unit is under control of a field-installed remote ON-OFF switch, or an open CWFS (chilled water flow switch) or CWPI (chilled water pump interlock) is detected.

51-87 DIAGNOSTIC DISPLAY CODES — The control contains extensive diagnostic capabilities. If something is not functioning properly, the control will energize the alarm light (see Fig. 1) and will display a diagnostic code from **51** to **87**. These codes, the action to be taken and the reset method are described in the Controls Troubleshooting and Servicing section, page 33.

Quick Test (Table 11) — The Quick Test is a 42-step program that provides a means of checking all input and output signals of the microprocessor control prior to unit start-up. This check ensures that all control options, thermistors and switches are in proper working order. The Quick Test utilizes the 2-digit LED display (Fig. 1 and 2) on the display set point board.

To initiate the Quick Test program, first turn the unit control switch to the ON position. When a **20** appears in the display, immediately press the display button *once*. An **88** will appear in the display and the alarm light will be energized. This indicates that the microprocessor in the control system is ready to run the Quick Test program.

IMPORTANT: Do not allow the unit control circuit to remain energized with **20** showing in the display for more than 2 minutes. If the display button is not pressed within this time, the control will attempt to start the unit.

For each step of the 42-step program, the display button must be pressed *twice*. On the first press, the step number is displayed; the second press initiates the required action, and the appropriate Quick Test code is displayed.

NOTE: The step number is a numeral followed by a decimal point (a 2-digit number has a decimal point after *each* numeral). The action code number is one or 2 digits with no decimal point(s). Example: A "1." or "1.6." is a step number. A "1" or "0" or "00" is an action number.

IMPORTANT: Once the Quick Test is initiated, the display button must be pressed at least once every 10 minutes for the control to remain in the Quick Test mode. If the button is not pressed within this time, the control will attempt to start the unit.

To recheck any step in the Quick Test, the control must be recycled by turning the unit control circuit switch OFF for a few seconds, then ON again. Restart the Quick Test program as described above and proceed through the Quick Test steps. Press the display button *twice* for each step until the step to be rechecked is reached.

The Quick Test program is divided into 3 sections as described below.

A. QUICK TEST STEPS 1.-1.5. — UNIT CONFIGURATION — The microprocessor in the unit control system is programmed by 2 switch assemblies located on the processor board (Fig. 1). The configuration header is factory set (Tables 5 and 6) and must not be changed in the field. The DIP switch assembly contains 8 microswitches that must be factory set in accordance with various options and accessories selected by the customer. All DIP switches should be verified in the field for proper position for options selected during the Quick Test. See Fig. 1 and Tables 7 and 8.

This section of the Quick Test also checks the loss-of-charge switches and the low oil pressure switches, located on the lead compressor of each circuit.

B. QUICK TEST STEPS 1.6.-3.0. — THERMISTORS AND SET POINT POTENTIOMETERS — In these steps, the microprocessor checks the resistance values of all sensors and set point potentiometers to ensure they are functional, connected properly, and set within the proper range for the unit configuration.

Nominal resistance values for all sensors range from 363,000 to 216 ohms. Normal display code for a good sensor or potentiometer is **1**. Display code **0** indicates a faulty potentiometer, thermistor, or wiring. A **0** display could also indicate the option is not being used.

Ohm settings within 10% to 90% of full-scale resistance are within acceptable range limits.

C. OUTPUT RELAYS, STEPS 3.1.-4.2. — These Quick Test steps allow the microprocessor to check the output signals from the various relay boards in the unit control system. In addition, the operation of all condenser fans and compressors is checked at each step.

Normal display code for steps **3.1.** through **3.4.** is **1**. In steps **3.5.** through **4.2.**, where appropriate, each compressor is started and allowed to run for approximately 10 seconds. At start-up, **0** will appear, followed by a **1** in a few seconds. At the end of the 10-second test, code **0** returns to the display, indicating that the test step has been successfully completed. The code **1** indicated that the compressor protection circuit was tested.

Fan and compressor operating sequence for Quick Test steps **3.1.** through **4.2.** are shown in Table 11 and Fig. 14.

If Quick Test steps do not operate as described, a defect exists in one or more of the following: Relay being tested, the electronic control, and unit wiring.

Table 11 — Quick Test 88
SECTION A. — Configuration and Switch Check

QUICK TEST STEP NO.	NORMAL DISPLAY	STEP DESCRIPTION	CONTROL SWITCH
1	00	Type Unit — Air-Cooled Chiller	Configuration Header
2	2 to 8	Number of Compressors	Configuration Header
3	0, 1 or 2	Number of Unloaders 0 — Switches 6 and 7 off 1 — Switch 6 on; Switch 7 off 2 — Switch 6 off; Switch 7 on	DIP Switches 6 and 7
4	0 or 1	0 — Standard Chiller (Switch off) 1 — Brine Chiller* (Switch on)	DIP Switch 8
5	1 or 0	1 — EXV 0 — TXV	Configuration Header
6	50 or 60	50 — 50-Hertz Power 60 — 60-Hertz Power	Configuration Header
7	0 or 1	0 — External Reset (Switch off) 1 — Return Water Reset (Switch on)	DIP Switch 1
8	0 or 1	0 — No Reset (Switch off) 1 — Reset Used (Switch on)	DIP Switch 2
9	0 or 1	0 — Pulldown Not Used (Switch off) 1 — Pulldown Used (Switch on)	DIP Switch 3
10	0 or 1	0 — Demand Limit Not Used (Switch off) 1 — Demand Limit Used (Switch on)	DIP Switch 5
11 †	0 or 1	0 — Remote On/Off (Switch open or jumper not in place) 1 — Remote On/Off (Switch closed, or jumper in place)	TB6-3 and TB6-4 (040-210) TB7-9 and TB7-10 (225,250,280)
12	1	1 — Loss-of-Charge Switch Closed 0 — Loss-of-Charge Switch Open	Circuit A Loss-of-Charge Switch
13	1	1 — Loss-of-Charge Switch Closed 0 — Loss-of-Charge Switch Open	Circuit B Loss-of-Charge Switch
14	0 **	1 — Low Oil Pressure Switch Closed 0 — Low Oil Pressure Switch Open	Circuit A Low Oil Pressure Switch
15	0 **	1 — Low Oil Pressure Switch Closed 0 — Low Oil Pressure Switch Open	Circuit B Low Oil Pressure Switch

LEGEND

CPCS — Compressor Protection Control System
CR — Control Relay
EXV — Electronic Expansion Valve
FIOP — Factory-Installed Option
OPS — Oil Pressure Switch
TXV — Thermal Expansion Valve

*Do not change select switch to brine on units that do not have modifications for brine. Special modifications are required. Contact Carrier for details.

†Jumper must be used to connect terminals TB6-3 and TB6-4 (040-210) or TB7-9 and TB7-10 (225,250,280) on the processor board whenever an EPROM HT207101-1-10 or higher (040-210) or an HT204247-1-12 or higher (225,250,280) is installed on the processor board. In some cases the EPROMs are labeled Code 328, Code 329, Code 331. If a new processor board is installed, be sure to

check part number of the EPROM on the board. If EPROM is one of the above, a jumper must be installed if not already installed.

IMPORTANT: If jumper is not installed, chiller remains in standby mode. No compressors or fans start and Code 26 is displayed. This is not a fault code. If circuit between pins 3 and 4 or 9 and 10 is open, processor is programmed to initiate a shutdown and hold machine in standby. This feature makes remote shutdown of chiller easier.

If jumper is installed when older software is in unit, chiller operates normally except alarm light remains on and Code 83 is displayed. To remove alarm light and Code 83 display, remove jumper.

**Will always display 1 for 30GT040-060 unless accessory OPS is installed.

Table 11 – Quick Test 88 (cont)
SECTION B. – Thermistor and Potentiometer Checkout

QUICK TEST STEP NO.	NORMAL DISPLAY	STEP DESCRIPTION	THERMISTOR OR POTENTIOMETER
1.6.	1	1 – Thermistor OK 0 – Thermistor Faulty	T1 – Cooler Leaving Water Thermistor
1.7.	1	1 – Thermistor OK 0 – Thermistor Faulty	T2 – Cooler Entering Water Thermistor
1.8.	1	1 – Thermistor OK 0 – Thermistor Faulty	T3 – Saturated Condensing Thermistor, Circuit A
1.9.	1	1 – Thermistor OK 0 – Thermistor Faulty	T4 – Saturated Condensing Thermistor, Circuit B
2.0.	1 or 0	1 – Thermistor OK †† 0 – Thermistor Faulty or Not Used	T5 – Cooler Thermistor, Circuit A (EXV Units)
2.1.	1 or 0	1 – Thermistor OK †† 0 – Thermistor Faulty or Not Used	T6 – Cooler Thermistor, Circuit B (EXV Units)
2.2.	1 or 0	1 – Thermistor OK †† 0 – Thermistor Faulty or Not Used	T7 – Compressor Thermistor, Circuit B (EXV Units)
2.3.	1 or 0	1 – Thermistor OK †† 0 – Thermistor Faulty or Not Used	T8 – Compressor Thermistor, Circuit B (EXV Units)
2.4.	1 or 0	1 – Thermistor OK 0 – Thermistor Faulty or Not Used	T10 – Accessory Remote Thermistor
2.5.	1	1 – Potentiometer OK 0 – Potentiometer Faulty	P1 – Leaving Fluid Set Point Potentiometer
2.6.	0	No Significance	—
2.7.	1 or 0	1 – Potentiometer OK 0 – Potentiometer Faulty or Option Not Used	P3 – Accessory Reset Limit Potentiometer
2.8.	1 or 0	1 – Potentiometer(s) OK 0 – Potentiometer(s) Faulty or Option Not Used	P4 – Accessory Demand Limit Potentiometer(s)
2.9.	1 or 0	1 – Potentiometer OK 0 – Potentiometer Faulty or Option Not Used	P5 – Accessory Reset Ratio Potentiometer
3.0.	1 or 0	1 – Potentiometer OK 0 – Potentiometer Faulty or Option Not Used	P6 – Accessory Reset Set Point Potentiometer

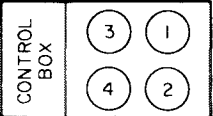
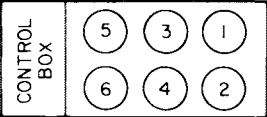
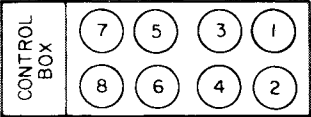
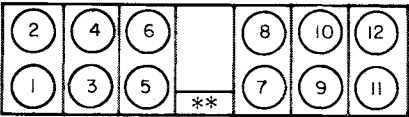
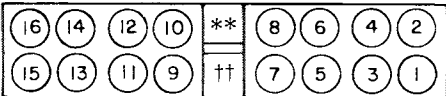
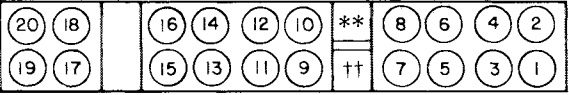
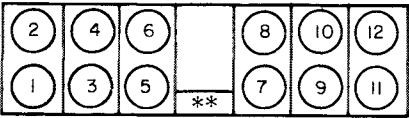
††Display is 1 for Flotronic™ EXV units only.

Display is 0 for 040-110 Flotronic FIOP units and 225,250,280 units (with TXV).

Table 11 – Quick Test 88 (cont)
SECTION B. – Thermistor and Potentiometer Checkout

QUICK TEST STEP NO.	NORMAL DISPLAY	STEP DESCRIPTION	CONTROL SWITCH
3.1	1	Energize First Stage of Condenser Fans 040-050 – OFM3 060-110 – OFM3, OFM4 130-210 – OFM3, OFM4, OFM9, OFM10 225 – OFM5, OFM6, OFM11, OFM12 250 – OFM5, OFM6, OFM11, OFM12, OFM19	K11
3.2	1	Energize Second Stage of Condenser Fans 040-050 – OFM4 060-090 – OFM5, OFM6 100,110 – OFM5, OFM6, OFM7, OFM8 130-170 – OFM1, OFM2 190-210 – OFM1, OFM2, OFM11, OFM12 225 – OFM1-OFM4, OFM13-OFM16 250 – OFM1-OFM4, OFM13-OFM16, OFM20 280 – OFM1-OFM4, OFM13-OFM16, OFM21, OFM22	K12
3.3	1	Energize Liquid Line Solenoid Valve (040-110 TXV only, 225,250,280), Circuit A	K9
3.4	1	Energize Liquid Line Solenoid Valve (040-110 TXV only, 225,250,280), Circuit B	K10
3.5	0 → 1 → 0	Energize Compressor A1 and OFM1 (040-110) Energize Compressor A1, OFM5, and OFM7 (130-210) Energize Compressor A1, OFM7, and OFM8 (225) Energize Compressor A1, OFM7, OFM8, and OFM10 (250,280)	K1
3.6	0 → 1 → 0	No Action (040-060 [50 Hz], 040-070 [60 Hz]) Energize Compressor A2 (All Others)	K2
3.7	0	No action (040-110, 130 [60 Hz])	K3
	0 → 1 → 0	Energize Compressor A3 (130 [50 Hz], 150-210, 225,250,280)	
3.8	0	Energize Unloader A1 (040-170)	K4
	0 → 1 → 0	Energize Compressor A4 (210,225,250,280)	
3.9	0 → 1 → 0	Energize Compressor B1, OFM2 (040-110) Energize Compressor B1, OFM6, and OFM8 (130-210) Energize Compressor B1, OFM9, and OFM10 (225) Energize Compressor B1, OFM9, OFM17, and OFM18 (250,280)	K5
4.0	0 → 1 → 0	No action (040-080) Energize Compressor B2 (090-210,225,250,280)	K6
4.1	0	No action (040-150)	K7
	0 → 1 → 0	Energize Compressor B3 (170-210,225,250,280)	
4.2	0	Energize Unloader B1 (040-170) No action (190-210) Energize Unloader B4 (225,250,280)	K8

||Compressors will be energized for 10 seconds. 0 indicates open CPCS or CR module contacts (compressor deenergized). 1 indicates closed CPCS or CR contacts (compressor energized).

FAN ARRANGEMENT	FAN NO.	CONTROLLED BY	
		During Quick Test*	Normal Control
30GT040-050 <i>A30-942</i> 	1	3.5.	Compressor No. A1
	2	3.9.	Compressor No. B1
	3	3.1.	First Stage of Condenser Fans
	4	3.2.	Second Stage of Condenser Fans
30GT060-090 <i>A30-922</i> 	1	3.5.	Compressor No. A1
	2	3.9.	Compressor No. B1
	3, 4	3.1.	First Stage of Condenser Fans
30GT100,110 <i>A30-923</i> 	5, 6	3.2.	Second Stage of Condenser Fans
	1	3.5.	Compressor No. A1
	2	3.9.	Compressor No. B1
	3, 4	3.1.	First Stage of Condenser Fans
30GT130-210† POWER <i>A30-1309</i> 	5, 6, 7, 8	3.2.	Second Stage of Condenser Fans
	5, 7	3.5.	Compressor No. A1
	6, 8	3.9.	Compressor No. B1
	3, 4, 9, 10	3.1.	First Stage of Condenser Fans
30GT225 <i>A30-876</i> 	1, 2, 11, 12	3.2.	Second Stage of Condenser Fans
	7, 8	3.5.	Compressor A1
	9, 10	3.9.	Compressor B1
	5, 6, 11, 12	3.1.	First Stage of Microprocessor
30GT250 <i>A30-877</i> 	1, 2, 3, 4, 13, 14, 15, 16, 20	3.2.	Second Stage of Microprocessor
	5, 6, 11, 12, 19	3.1.	First Stage of Microprocessor
	9, 17, 18	3.9.	Compressor B1
	7, 8, 10	3.5.	Compressor A1
30GT280 <i>A30-878</i> 	1, 2, 3, 4, 13, 14, 15, 16, 21, 22	3.2.	Second Stage of Microprocessor
	5, 6, 11, 12, 19, 20	3.1.	First Stage of Microprocessor
	9, 17, 18	3.9.	Compressor B1
	7, 8, 10	3.5.	Compressor A1

*Quick Test display numbers.

†Fan numbers 11 and 12 do not apply to 30GT130-170.

**Control box.

††Power box.

Fig. 14 — Condenser Fan Sequence

Capacity Control — Operating Sequence (040-210 units) —

During the off cycle, each compressor's crankcase heater is energized. If the ambient temperature is below 36 F (2.2 C), cooler heaters and the micro-processor heater strips will be energized. When the ON-OFF switch is turned to the ON position, the control will first go through a 2-minute initialization period. During this period, the display will continuously be energized with a **20** for a short period of time, and then will go blank. During initialization, the processor checks all potentiometers and thermistors for valid readings. Once the initialization is complete, the control will not start any compression for 90 seconds. During this time, the control is monitoring the water temperatures to determine the steady-state temperature of the water. Once the 90-second period is complete, the control will start the first stage of compression, if required.

The temperatures are monitored and the rate at which additional compressors are brought on depends on the leaving water temperature, how fast the temperature is changing, and the number of compressor stages on. With the automatic lead-lag feature in the unit, the control determines randomly which circuit will start first, A or B. At the first call for cooling, the lead compressor crankcase heater will be deenergized, a condenser fan will start, and the compressor will start unloaded.

NOTE: The automatic lead-lag feature is only operative when an even number of unloaders is present. The 040-070 units will require an accessory unloader for the lead-lag feature to be in effect.

If the circuit has been off for 15 minutes, and the unit is a TXV unit, liquid line solenoid will remain closed for that circuit for 10 seconds while the cooler and suction lines are purged of any liquid refrigerant. For units with EXVs, the process is essentially the same. The lead compressor will be signaled to start. The EXV will remain closed for 10 seconds before it is allowed to modulate.

After the purge period, the electronic expansion valve will begin to meter the refrigerant, or the liquid line solenoid will open allowing the thermostatic expansion device to meter the refrigerant to the cooler. If the off-time is less than 15 minutes, the electronic expansion valve or liquid line solenoid will be opened as soon as the compressor starts.

The electronic expansion valves will open gradually to provide a controlled start-up to prevent liquid flood-back to the compressor. During start-up, the oil pressure switch is bypassed for one minute to allow for the transient changes during start-up. As additional stages of compression are required, the processor control will add them. See Tables 12A and 12B.

If a circuit is to be stopped, the control will first start to close the electronic expansion valve or close the liquid line solenoid valve.

For units with TXVs, the lag compressor will be shut down and the lead compressor will continue to operate for 10 seconds to purge the cooler of any refrigerant.

For units with EXVs, the lag compressor will be shut down and the lead compressor will continue to run. After the lag compressor has shut down, the EXV is signaled to close. The lead compressor will remain on until the EXV is less than 300 steps open, and the saturated suction temperature is less than 25 F (–4 C) as sensed by the cooler thermistor T5 or T6, or one minute has elapsed.

During both algorithms (TXV and EXV), all diagnostic conditions will be honored. If a safety trip or alarm condition is detected before pumpdown is complete, the circuit will be shut down.

Capacity Control — Operating Sequence (225,250,280 Units)

When the ON-OFF switch is turned to the ON position, the control will first go through a 2-minute initialization period. During this period, the display will continuously be energized with a **20** for a short period of time. When the **20** disappears from the display, the control will begin to bring compressors on when necessary.

The rate at which the compressors are turned on will depend on the leaving-water temperature difference from the set point, the rate of change of leaving water temperature, the return water temperature, and the number of compressor stages on. The control is based primarily on leaving water temperature and the other factors are used as compensation. Because the control is from leaving water, the chiller is independent of cooler gpm and outdoor-air temperature. It is a true droopless control.

When compressor capacity is first added, the control will randomly select either circuit A or circuit B.

If circuit has been off for 15 minutes, the electronic expansion valve or LLS will not open for 10 seconds while the cooler and suction lines are purged of any liquid refrigerant. The EXV and/or LLS will then open. Otherwise, the EXV and/or LLS will be opened when the compressor starts.

The EXV will open gradually to provide a controlled start-up to prevent liquid floodback to the compressor. Also during this period, the low oil pressure switch will be bypassed for two minutes.

As additional stages of compression are required, the control will add compressors and as shown in Table 12C.

If a circuit is to be stopped, the control will first start to close the EXV and/or close LLS. The compressor will continue to run for 10 seconds to purge the cooler of any liquid refrigerant.

Electronic Expansion Valve (EXV) (See Fig. 15)

— Standard 040-210 and 225 units are equipped with a bottom seal EXV. The use of this device eliminates the use of the liquid line solenoid pumpdown at unit shutdown. An O-ring has been added to bottom of orifice assembly to complete a seal in the valve on shutdown. This is not a mechanical shut-off. When service is required, use the liquid line service valve to pump down the system.

High pressure refrigerant enters bottom of valve where it passes through a group of machined slots in side of orifice assembly. As refrigerant passes through orifice, it drops in pressure. To control flow of refrigerant, the sleeve slides up and down along orifice assembly, modulating the size of orifice. The sleeve is moved by a linear stepper motor that moves in increments controlled directly by the processor. As stepper motor rotates, the motion is translated into linear movement of lead screw. There are 760 discrete steps with this combination. The valve orifice begins to be exposed at 160 steps (30GT040-210) or 145 steps (30GT225,250,280). Since there is not a tight seal with the orifice and the sleeve, the minimum position for operation is 60 steps.

Two thermistors are used to determine suction superheat. One thermistor is located in the cooler and the other is located in the cylinder end of the compressor after refrigerant has passed over the motor. The difference between the 2 thermistors is the suction superheat. These machines are set up to provide approximately 5 to 7 F (2.8 to 3.9 C) superheat leaving the cooler. Motor cooling accounts for approximately 22 F (12.2 C), resulting in a superheat entering compressor cylinders of approximately 30 F (16.7 C). This increases performance of cooler by reducing the amount of superheat needed.

Table 12A — Capacity Control Steps

040-070

UNIT SIZE	CONTROL STEPS	LOADING SEQUENCE A		LOADING SEQUENCE B	
		% Displacement (Approx)	Compressors	% Displacement (Approx)	Compressors
040 (60 Hz) A1†	1	25	A1*	25	A1*
	2	50	A1	50	A1
	3	75	A1*, B1	75	A1*, B1
	4	100	A1, B1	100	A1, B1
040 (60 Hz) A1†, B1**	1	25	A1*	25	B1*
	2	50	A1	50	B1
	3	75	A1*, B1	75	A1, B1*
	4	100	A1, B1	100	A1, B1
040 (50 Hz) 045 (60 Hz) A1†	1	21	A1*	21	A1*
	2	42	A1	42	A1
	3	99	A1*, B1	99	A1*, B1
	4	100	A1, B1	100	A1, B1
040 (50 Hz) 045 (60 Hz) A1†, B1**	1	22	A1*	38	B1*
	2	59	A1*, B1*	59	A1*, B1*
	3	78	A1*, B1	81	A1, B1*
	4	100	A1, B1	100	A1, B1
045 (50 Hz) 050 (60 Hz) A1†	1	32	A1*	32	A1*
	2	48	A1	48	A1
	3	84	A1*, B1	84	A1*, B1
	4	100	A1, B1	100	A1, B1
045 (50 Hz) 050 (60 Hz) A1†, B1**	1	31	A1*	36	B1*
	2	67	A1*, B1*	66	A1*, B1*
	3	84	A1*, B1	82	A1, B1*
	4	100	A1, B1	100	A1, B1
050 (50 Hz) 060 (60 Hz) A1†	1	29	A1*	29	A1*
	2	43	A1	43	A1
	3	86	A1*, B1	86	A1*, B1
	4	100	A1, B1	100	A1, B1
050 (50 Hz) 060 (60 Hz) A1†, B1**	1	29	A1*	38	B1*
	2	67	A1*, B1*	67	A1*, B1*
	3	86	A1*, B1	81	A1, B1*
	4	100	A1, B1	100	A1, B1
060 (50 Hz) 070 (60 Hz) A1†	1	33	A1*	33	A1*
	2	50	A1	50	A1
	3	83	A1*, B1	83	A1*, B1
	4	100	A1, B1	100	A1, B1
060 (50 Hz) 070 (60 Hz) A1†, B1**	1	33	A1*	33	B1*
	2	50	A1	50	B1
	3	83	A1*, B1	83	A1, B1*
	4	100	A1, B1	100	A1, B1
070 (50 Hz) A1†	1	19	A1*	19	A1*
	2	29	A1	29	A1
	3	62	A1*, B1	62	A1*, B1
	4	72	A1, B1	72	A1, B1
	5	90	A1*, A2, B1	90	A1*, A2, B1
	6	100	A1, A2, B1	100	A1, A2, B1
070 (50 Hz) A1†, B1**	1	19	A1*	29	B1*
	2	48	A1*, B1*	48	A1*, B1*
	3	62	A1*, B1	57	A1, B1*
	4	72	A1, B1	72	A1, B1
	5	90	A1*, A2, B1	90	A1*, A2, B1
	6	100	A1, A2, B1	100	A1, A2, B1

*Compressor unloaded.

†Compressor unloader, standard.

**Compressor unloader, accessory.

NOTES:

- The microprocessor selects loading sequence A or B, which in turn determines the compressor circuit that is energized first. This evens out operating hours on each circuit over an extended period of time. This lead-lag function is only in effect on units with an even number of unloaders. Therefore, an additional unloader must be installed on 040-070 units to implement the lead-lag function.
- If unit operation is anticipated with system load below minimum unloaded capacity of chiller:
 - Consider using 2 smaller units in place of the larger unit.
 - Increase *water loop volume* to ensure adequate run time (see Application Data in Product Data literature).
 - Consider adding accessory hot gas bypass package.

**Table 12B — Capacity Control Steps
080-210**

UNIT SIZE	CONTROL STEPS	LOADING SEQUENCE A		LOADING SEQUENCE B	
		% Displacement (Approx)	Compressors	% Displacement (Approx)	Compressors
080 (60 Hz)	1	22	A1*	29	B1*
	2	52	A1*,B1*	52	A1*,B1*
	3	67	A1*, B1	63	A1,B1*
	4	78	A1,B1	78	A1,B1
	5	89	A1*,A2,B1	89	A1*,A2,B1
	6	100	A1,A2,B1	100	A1,A2,B1
080 (50 Hz)	1	16	A1*	25	B1*
	2	42	A1*,B1*	42	A1*,B1*
	3	54	A1*,B1	50	A1,B1*
	4	62	A1,B1	62	A1,B1
	5	92	A1*,A2,B1	92	A1*,A2,B1
	6	100	A1,A2,B1	100	A1,A2,B1
090 (60 Hz)	1	18	A1*	18	B1*
	2	35	A1*,B1*	35	A1*,B1*
	3	44	A1*,B1	44	A1,B1*
	4	53	A1,B1	53	A1,B1
	5	65	A1*,A2,B1	71	A1,B1*,B2
	6	73	A1,A2,B1	80	A1,B1,B2
	7	91	A1*,A2,B1,B2	91	A1,A2,B1*,B2
	8	100	A1,A2,B1,B2	100	A1,A2,B1,B2
090 (50 Hz)	1	14	A1*	14	B1*
	2	29	A1*,B1*	29	A1*,B1*
	3	36	A1*,B1	36	A1,B1*
	4	43	A1,B1	43	A1,B1
	5	68	A1*,A2,B1	60	A1,B1*,B2
	6	75	A1,A2,B1	67	A1,B1,B2
	7	93	A1*,A2,B1,B2	93	A1,A2,B1*,B2
	8	100	A1,A2,B1,B2	100	A1,A2,B1,B2
100,240B,270B (60 Hz)	1	15	A1*	15	B1*
	2	31	A1*,B1*	31	A1*,B1*
	3	39	A1*,B1	39	A1,B1*
	4	46	A1,B1	46	A1,B1
	5	65	A1*,A2,B1	65	A1,B1*,B2
	6	73	A1,A2,B1	73	A1,B1,B2
	7	92	A1*,A2,B1,B2	92	A1,A2,B1*,B2
	8	100	A1,A2,B1,B2	100	A1,A2,B1,B2
100,240B,270B (50 Hz)	1	13	A1*	13	B1*
	2	26	A1*,B1*	26	A1*,B1*
	3	33	A1*, B1	33	A1,B1*
	4	40	A1,B1	40	A1,B1
	5	63	A1*,A2,B1	63	A1,B1*,B2
	6	70	A1,A2,B1	70	A1,B1,B2
	7	93	A1*,A2,B1,B2	93	A1,A2,B1*,B2
	8	100	A1,A2,B1,B2	100	A1,A2,B1,B2
110 (60 Hz)	1	14	A1*	14	B1*
	2	29	A1*,B1*	29	A1*,B1*
	3	36	A1*,B1	36	A1,B1*
	4	43	A1,B1	43	A1,B1
	5	68	A1*,A2,B1	60	A1,B1*,B2
	6	75	A1,A2,B1	67	A1,B1,B2
	7	93	A1*,A2,B1,B2	93	A1,A2,B1*,B2
	8	100	A1,A2,B1,B2	100	A1,A2,B1,B2
110 (50 Hz)	1	17	A1	17	B1*
	2	33	A1*,B1*	33	A1*,B1*
	3	42	A1*,B1	42	A1,B1*
	4	50	A1,B1	50	A1,B1
	5	67	A1*,A2,B1	67	A1,B1*,B2
	6	75	A1,A2,B1	75	A1,B1,B2
	7	92	A1*,A2,B1,B2	92	A1,A2,B1*,B2
	8	100	A1,A2,B1,B2	100	A1,A2,B1,B2

*Compressor unloaded.

†One additional, field-supplied unloader on compressor A1.

**Two additional, field-supplied unloaders; one on compressor A1 and one on compressor B1.

NOTES:

- The microprocessor selects loading sequence A or B, which in turn determines the compressor circuit that is energized first. This evens out operating hours on each circuit over an extended period of time.
- The staging of modular units (30GT240-420) will be random due to variables within the system. The loading sequence of each individual module will be as listed.
- If unit operation is anticipated with system load below minimum unloaded capacity of chiller:
 - Consider using 2 smaller units in place of the larger unit.
 - Increase *water loop volume* to ensure adequate run time (see Application Data in Product Data literature).
 - Consider adding accessory hot gas bypass package.

Table 12B – Capacity Control Steps (cont)
080-210 (cont)

UNIT SIZE	CONTROL STEPS	LOADING SEQUENCE A		LOADING SEQUENCE B	
		% Displacement (Approx)	Compressors	% Displacement (Approx)	Compressors
130 (60 Hz)	0	0	—	0	—
	1	14	A1*	14	B1*
	2	29	A1*,B1*	29	A1*,B1*
	3	36	A1*,B1	36	A1,B1*
	4	43	A1,B1	43	A1,B1
	5	64	A1*,A2,B1	64	A1,B1*,B2
	6	72	A1,A2,B1	72	A1,B1,B2
	7	93	A1*,A2,B1,B2	93	A1,A2,B1*,B2
	8	100	A1,A2,B1,B2	100	A1,A2,B1,B2
130 (50 Hz)	0	0	—	0	—
	1	10	A1*	16	B1*
	2	21	A1*,B1*	21	A1*,B1*
	3	29	A1*,B1	32	A1,B1*
	4	34	A1,B1	34	A1,B1
	5	47	A1*,A2,B1	56	A1,B1*,B2
	6	58	A1,A2,B1	64	A1,B1,B2
	7	77	A1*,A2,B1,B2	74	A1,A2,B1*,B2
	8	82	A1,A2,B1,B2	82	A1,A2,B1,B2
	9	95	A1*,A2,A3,B1,B2	92	A1,A2,A3,B1*,B2
	10	100	A1,A2,A3,B1,B2	100	A1,A2,A3,B1,B2
150 (60 Hz)	0	0	—	0	—
	1	11	A1*	17	B1*
	2	19	A1*,B1*	19	A1*,B1*
	3	28	A1*,B1	33	A1,B1*
	4	33	A1,B1	33	A1,B1
	5	44	A1*,A2,B1	58	A1,B1*,B2
	6	58	A1,A2,B1	67	A1,B1,B2
	7	78	A1*,A2,B1,B2	75	A1,A2,B1*,B2
	8	83	A1,A2,B1,B2	83	A1,A2,B1,B2
	9	94	A1*,A2,A3,B1,B2	92	A1,A2,A3,B1*,B2
	10	100	A1,A2,A3,B1,B2	100	A1,A2,A3,B1,B2
150 (50 Hz)	0	0	—	0	—
	1	13	A1*	13	B1*
	2	27	A1*,B1*	27	A1*,B1*
	3	33	A1*,B1	33	A1,B1*
	4	40	A1,B1	40	A1,B1
	5	53	A1*,A2,B1	53	A1,B1*,B2
	6	60	A1,A2,B1	60	A1,B1,B2
	7	73	A1*,A2,B1,B2	73	A1,A2,B1*,B2
	8	80	A1,A2,B1,B2	80	A1,A2,B1,B2
	9	93	A1*,A2,A3,B1,B2	93	A1,A2,A3,B1*,B2
	10	100	A1,A2,A3,B1,B2	100	A1,A2,A3,B1,B2
170 (60 Hz)	0	0	—	0	—
	1	11	A1*	11	B1*
	2	22	A1*,B1*	22	A1*,B1*
	3	28	A1*,B1	28	A1,B1*
	4	33	A1,B1	33	A1,B1
	5	44	A1*,A2,B1	44	A1,B1*,B2
	6	50	A1,A2,B1	50	A1,B1,B2
	7	61	A1*,A2,B1,B2	61	A1,A2,B1*,B2
	8	67	A1,A2,B1,B2	67	A1,A2,B1,B2
	9	78	A1*,A2,A3,B1,B2	78	A1,A2,B1*,B2,B3
	10	83	A1,A2,A3,B1,B2	83	A1,A2,B1,B2,B3
	11	94	A1*,A2,A3,B1,B2,B3	94	A1,A2,A3,B1*,B2,B3
	12	100	A1,A2,A3,B1,B2,B3	100	A1,A2,A3,B1,B2,B3
170 (50 Hz)	0	0	—	0	—
	1	10	A1*	10	B1*
	2	24	A1*,B1*	24	A1*,B1*
	3	29	A1*,B1	24	A1,B1*
	4	29	A1,B1	28	A1,B1
	5	43	A1*,A2,B1	43	A1,B1*,B2
	6	43	A1,A2,B1	48	A1,B1,B2
	7	57	A1*,A2,B1,B2	57	A1,A2,B1*,B2
	8	62	A1,A2,B1,B2	62	A1,A2,B1,B2
	9	76	A1*,A2,A3,B1,B2	76	A1,A2,B1*,B2,B3
	10	81	A1,A2,A3,B1,B2	81	A1,A2,B1,B2,B3
	11	95	A1*,A2,A3,B1,B2,B3	95	A1,A2,A3,B1*,B2,B3
	12	100	A1,A2,A3,B1,B2,B3	100	A1,A2,A3,B1,B2,B3

*Compressor unloaded.

†One additional, field-supplied unloader on compressor A1.

**Two additional, field-supplied unloaders; one on compressor A1 and one on compressor B1.

NOTES:

- The microprocessor selects loading sequence A or B, which in turn determines the compressor circuit that is energized first. This evens out operating hours on each circuit over an extended period of time.
- The staging of modular units (30GT240-420) will be random due to variables within the system. The loading sequence of each individual module will be as listed.
- If unit operation is anticipated with system load below minimum unloaded capacity of chiller:
 - Consider using 2 smaller units in place of the larger unit.
 - Increase *water loop volume* to ensure adequate run time (see Application Data in Product Data literature).
 - Consider adding accessory hot gas bypass package.

Table 12B – Capacity Control Steps (cont)
080-210 (cont)

UNIT SIZE	CONTROL STEPS	LOADING SEQUENCE A		LOADING SEQUENCE B	
		% Displacement (Approx)	Compressors	% Displacement (Approx)	Compressors
190 (60 Hz)	0	0	—	0	—
	1	14	A1	14	B1
	2	27	A1,B1	27	A1,B1
	3	43	A1,A2,B1	43	A1,B1,B2
	4	59	A1,A2,B1,B2	59	A1,A2,B1,B2
	5	79	A1,A2,A3,B1,B2	79	A1,A2,B1,B2,B3
	6	100	A1,A2,A3,B1,B2,B3	100	A1,A2,A3,B1,B2,B3
190 (60 Hz) A1†	0	0	—	0	—
	1	9	A1*	9	A1*
	2	14	A1	14	A1
	3	23	A1*,B1	23	A1*,B1
	4	27	A1,B1	27	A1,B1
	5	38	A1*,A2,B1	38	A1*,A2,B1
	6	43	A1,A2,B1	43	A1,A2,B1
	7	54	A1*,A2,B1,B2	54	A1*,A2,B1,B2
	8	59	A1,A2,B1,B2	59	A1,A2,B1,B2
	9	75	A1*,A2,A3,B1,B2	75	A1*,A2,A3,B1,B2
	10	79	A1,A2,A3,B1,B2	79	A1,A2,A3,B1,B2
	11	95	A1*,A2,A3,B1,B2,B3	95	A1*,A2,A3,B1,B2,B3
	12	100	A1,A2,A3,B1,B2,B3	100	A1,A2,A3,B1,B2,B3
190 (60 Hz) A1 & B1**	0	0	—	0	—
	1	9	A1*	9	B1*
	2	18	A1*,B1*	18	A1*,B1*
	3	23	A1*,B1	23	A1,B1*
	4	27	A1,B1	27	A1,B1
	5	38	A1*,A2,B1	38	A1,B1*,B2
	6	43	A1,A2,B1	43	A1,B1,B2
	7	54	A1*,A2,B1,B2	54	A1,A2,B1*,B2
	8	59	A1,A2,B1,B2	59	A1,A2,B1,B2
	9	75	A1*,A2,A3,B1,B2	75	A1,A2,B1*,B2,B3
	10	79	A1,A2,A3,B1,B2	79	A1,A2,B1,B2,B3
	11	95	A1*,A2,A3,B1,B2,B3	95	A1,A2,A3,B1*,B2,B3
	12	100	A1,A2,A3,B1,B2,B3	100	A1,A2,A3,B1,B2,B3
190 (50 Hz)	0	0	—	0	—
	1	17	A1	17	B1
	2	33	A1,B1	33	A1,B1
	3	50	A1,A2,B1	50	A1,B1,B2
	4	67	A1,A2,B1,B2	67	A1,A2,B1,B2
	5	83	A1,A2,A3,B1,B2	83	A1,A2,B1,B2,B3
	6	100	A1,A2,A3,B1,B2,B3	100	A1,A2,A3,B1,B2,B3
190 (50 Hz) A1†	0	0	—	0	—
	1	11	A1*	11	A1*
	2	17	A1	17	A1
	3	28	A1*,B1	28	A1*,B1
	4	33	A1,B1	33	A1,B1
	5	44	A1*,A2,B1	44	A1*,A2,B1
	6	50	A1,A2,B1	50	A1,A2,B1
	7	61	A1*,A2,B1,B2	61	A1*,A2,B1,B2
	8	67	A1,A2,B1,B2	67	A1,A2,B1,B2
	9	78	A1*,A2,A3,B1,B2	78	A1*,A2,A3,B1,B2
	10	83	A1,A2,A3,B1,B2	83	A1,A2,A3,B1,B2
	11	94	A1*,A2,A3,B1,B2,B3	94	A1*,A2,A3,B1,B2,B3
	12	100	A1,A2,A3,B1,B2,B3	100	A1,A2,A3,B1,B2,B3
190 (50 Hz) A1 & B1**	0	0	—	0	—
	1	11	A1*	11	B1*
	2	22	A1*,B1*	22	A1*,B1*
	3	28	A1*,B1	28	A1,B1*
	4	33	A1,B1	33	A1,B1
	5	44	A1*,A2,B1	44	A1,B1*,B2
	6	50	A1,A2,B1	50	A1,B1,B2
	7	61	A1*,A2,B1,B2	61	A1,A2,B1*,B2
	8	67	A1,A2,B1,B2	67	A1,A2,B1,B2
	9	78	A1*,A2,A3,B1,B2	78	A1,A2,B1*,B2,B3
	10	83	A1,A2,A3,B1,B2	83	A1,A2,B1,B2,B3
	11	94	A1*,A2,A3,B1,B2,B3	94	A1,A2,A3,B1*,B2,B3
	12	100	A1,A2,A3,B1,B2,B3	100	A1,A2,A3,B1,B2,B3
210 (60 Hz)	0	0	—	0	—
	1	12	A1	14	B1
	2	26	A1,B1	26	A1,B1
	3	37	A1,A2,B1	44	A1,B1,B2
	4	56	A1,A2,B1,B2	56	A1,A2,B1,B2
	5	68	A1,A2,A3,B1,B2	74	A1,A2,B1,B2,B3
	6	86	A1,A2,A3,B1,B2,B3	86	A1,A2,A3,B1,B2,B3
	7	100	A1,A2,A3,A4,B1,B2,B3	100	A1,A2,A3,A4,B1,B2,B3
210 (50 Hz)	0	0	—	0	—
	1	10	A1	16	B1
	2	26	A1,B1	26	A1,B1
	3	37	A1,A2,B1	42	A1,B1,B2
	4	52	A1,A2,B1,B2	52	A1,A2,B1,B2
	5	68	A1,A2,A3,B1,B2	68	A1,A2,B1,B2,B3
	6	84	A1,A2,A3,B1,B2,B3	84	A1,A2,A3,B1,B2,B3
	7	100	A1,A2,A3,A4,B1,B2,B3	100	A1,A2,A3,A4,B1,B2,B3

See Legend on page 26.

**Table 12C — Capacity Control Steps
225,250,280**

UNIT 30GT	CONTROL STEPS	% DISPLACEMENT (Approx)	LOADING SEQUENCE A		LOADING SEQUENCE B	
			Operating		Operating	
			Compressor No.		Compressor No.	
			Circuit A	Circuit B	Circuit A	Circuit B
225	1	12	A1	—	—	B1
	2	23	A1	B1	A1	B1
	3	35	A1,A2	B1	A1	B1,B2
	4	46	A1,A2	B1,B2	A1,A2	B1,B2
	5	58	A1,A2,A3	B1,B2	A1,A2	B1,B2,B3
	6	69	A1,A2,A3	B1,B2,B3	A1,A2,A3	B1,B2,B3
	7	85	A1,A2,A3,A4	B1,B2,B3	A1,A2,A3	B1,B2,B3,B4
	8	100	A1,A2,A3,A4	B1,B2,B3,B4	A1,A2,A3,A4	B1,B2,B3,B4
250	1	11	A1	—	—	B1
	2	22	A1	B1	A1	B1
	3	32	A1,A2	B1	A1	B1,B2
	4	43	A1,A2	B1,B2	A1,A2	B1,B2
	5	57	A1,A2,A3	B1,B2	A1,A2	B1,B2,B3
	6	72	A1,A2,A3	B1,B2,B3	A1,A2,A3	B1,B2,B3
	7	86	A1,A2,A3,A4	B1,B2,B3	A1,A2,A3	B1,B2,B3,B4
	8	100	A1,A2,A3,A4	B1,B2,B3,B4	A1,A2,A3,A4	B1,B2,B3,B4
280	1	13	A1	—	—	B1
	2	25	A1	B1	A1	B1
	3	38	A1,A2	B1	A1	B1,B2
	4	50	A1,A2	B1,B2	A1,A2	B1,B2
	5	63	A1,A2,A3	B1,B2	A1,A2	B1,B2,B3
	6	75	A1,A2,A3	B1,B2,B3	A1,A2,A3	B1,B2,B3
	7	88	A1,A2,A3,A4	B1,B2,B3	A1,A2,A3	B1,B2,B3,B4
	8	100	A1,A2,A3,A4	B1,B2,B3,B4	A1,A2,A3,A4	B1,B2,B3,B4

NOTES:

1. The microprocessor has a random number generator that selects loading sequence A or B, which in turn determines the compressor circuit that is energized first. This evens out operating hours on each circuit over an extended period of time.
2. If unit operation is anticipated with system load below minimum unloaded capacity of chiller:

- a. Consider using 2 smaller units in place of the larger unit.
- b. Increase *water loop volume* to ensure adequate run time (see Application Data).
- c. Consider adding accessory hot gas bypass package.

3. Accessory unloaders cannot be added to 30GT225,250,280 units.

Because the valves are controlled by the processor, it is possible to track the position of the valve. Valve position is used to control head pressure and system refrigerant charge.

During initial start-up, the valve is initialized by cycling valve fully closed. After initialization period, valve position is monitored by the processor.

The EXV is used to limit the maximum cooler saturated suction temperature to 55 F (12.8 C). This makes it possible for chiller to start at high cooler fluid temperatures without overloading the compressor.

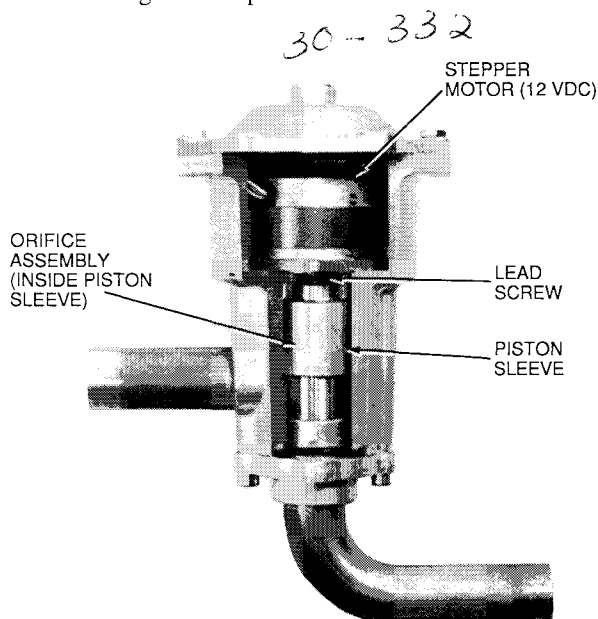


Fig. 15 — Electronic Expansion Valve (EXV)

Head Pressure Control

FLOTTRONIC™ UNITS (WITH EXV) — The microprocessor controls the condenser fans to maintain the lowest condensing temperature possible, and thus the highest unit efficiency. Instead of using the conventional pressure method, the fans are controlled by the position of the EXV and the saturated condensing temperature. When the position of the EXV is fully open, T3 and T4 are less than 78 F (25.6 C), and superheat is greater than 40 F (22.2 C), fan stages will be removed. When the valve is approximately 1/2 open, or T3 and T4 are greater than 113 F (45 C), fan stages will be added. At each change of the fan stage, the system will wait one minute to allow the head pressure to stabilize unless either T3 or T4 is greater than 125 F (51.6 C), in which case all microprocessor-controlled fans will start immediately. This method allows the unit to run at very low condensing temperatures at part load.

During unit start-up, microprocessor-controlled fans are turned on to prevent excessive discharge pressure during pull-down. If outdoor ambient temperature is between 50 and 70 F (10 and 21 C) as sensed by T3 or T4, first-stage condenser fans are turned on. If ambient is above 70 F (21 C), second-stage fans also are turned on. Fan sequences are shown in Fig. 14.

UNITS WITH TXV — The logic to cycle microprocessor-controlled fans is based on saturated condensing temperature only, as sensed by thermistors T3 and T4 (see Fig. 8 and 10). When either T3 or T4 is greater than 113 F (45 C), the microprocessor will turn on an additional stage of fans. It will turn off a fan stage when T3 and T4 are both below 73 F (22.8 C). At each change of a fan stage the control will wait for one minute for head pressure to stabilize unless T3 and T4 is greater than 125 F (51.6 C), in which case all microprocessor-controlled fans start immediately.

During unit start-up, microprocessor-controlled fans are turned on to prevent excessive discharge pressure during pulldown. If outdoor ambient is between 50 and 70 F (10 and 21 C) as sensed by T3 or T4, first-stage fans are turned on. If ambient is above 70 F (21 C), second-stage fans also are turned on. Fan sequences are shown in Fig. 14.

Return Temperature Reset — The control system is capable of handling leaving-water temperature reset based on return cooler water temperature. Because the change in temperature through the cooler is a measure of the building load, the return temperature reset is in effect an average building load reset method.

To use the return reset, the accessory reset board must be added to the unit. Refer to Accessories and Optional Controls Installation section, page 31. Also, DIP switch 1 (reset mode select) and DIP switch 2 (reset select) should be in the ON position (see Tables 7 and 8).

Under normal operation, the chiller will maintain a constant leaving water temperature approximately equal to the chilled water set point. As the cooler load varies, the entering cooler water will change in proportion to the load as shown in Fig. 16. Usually the chiller size and leaving-water temperature set point are selected based on a full-load condition. At part load, the water temperature set point may be colder than required. If the leaving water temperature was allowed to increase at part load, the efficiency of the machine would increase.

Return temperature reset allows for the leaving temperature set point to be reset upward as a function of the return water temperature or, in effect, the building load.

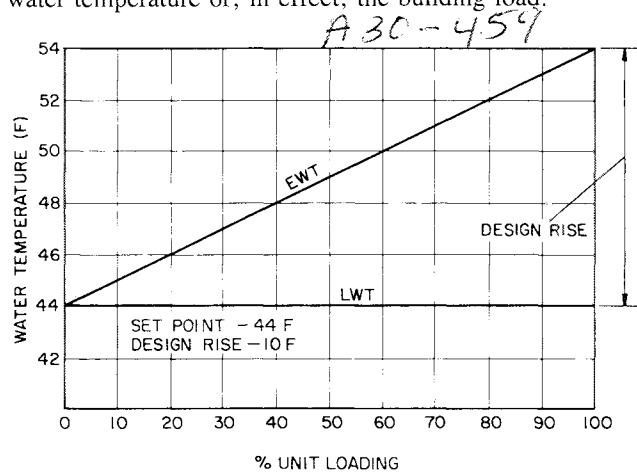


Fig. 16 — Standard Chilled Water Temperature Control — No Reset

Three set point potentiometers are used for this purpose. They are listed below.

CODE	DESCRIPTION	LOCATION	RANGE
P1	Chilled Water Set Point	Display Board	15 to 70 F (-9.4 to 21 C)
P3	Reset Limit Set Point	Accessory Board	0° to 80 F (0° to 44.4 C)
P5	Reset Ratio Set Point	Accessory Board	0 to 100%

The basic rules for setting the potentiometers are as follows:

P1, CHILLED WATER SET POINT POTENTIOMETER — This should always be set at the desired LWT (leaving water temperature) at the zero load condition.

P3, RESET LIMIT POTENTIOMETER — This should be set at the maximum desired amount of leaving water reset. Reset is always zero at zero load and the leaving water temperature is decreased up to the reset limit as the load increases (for return temperature reset).

P5, RESET RATIO POTENTIOMETER — This potentiometer is used to set the rate at which the leaving water temperature is reset. To determine the setting for the reset potentiometer use the following equation:

Reset Ratio

$$= \frac{(0\% \text{ Load LWT}) - (100\% \text{ Load LWT})}{\text{Design Full Load Cooling Range}} \times 100$$

The 100% load LWT point should be determined as if the LWT was not being limited by the reset limit potentiometer.

NOTE: A brine chiller is defined as a chiller with the LWT set point below 40 F (4 C). See Table 7 for proper DIP switch setting. Other factory modifications may also be necessary. The brine chiller LWT range of 15 F to 70 F (-9 C to 21 C) allows for dual set point operation.

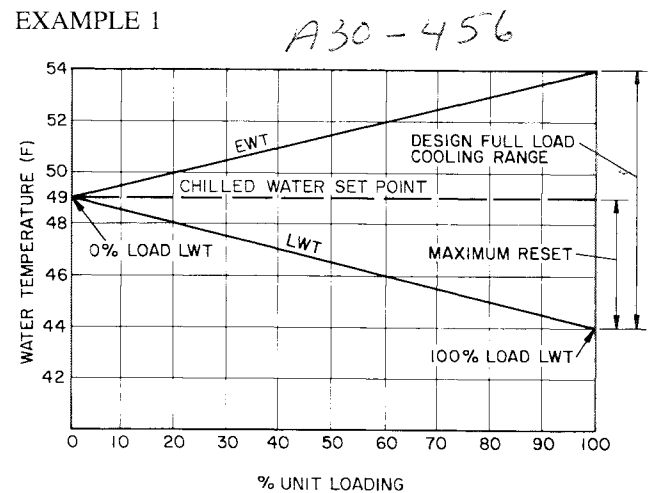
NOTE: The chilled water set point (P1) and the adjusted set point (modified by reset) cannot exceed the following limits:

Water Chillers — 40 F to 70 F (4 C to 21 C)

Brine Chillers — 15 F to 70 F (-9 C to 21 C)

The following examples will explain several reset profiles:

EXAMPLE 1



- The Chilled Water Set Point Potentiometer (P1) = 0% Load LWT = 49 F
- The Reset Limit Potentiometer (P3) = Maximum Reset = 5 F
- Reset Ratio Potentiometer (P5) = X%

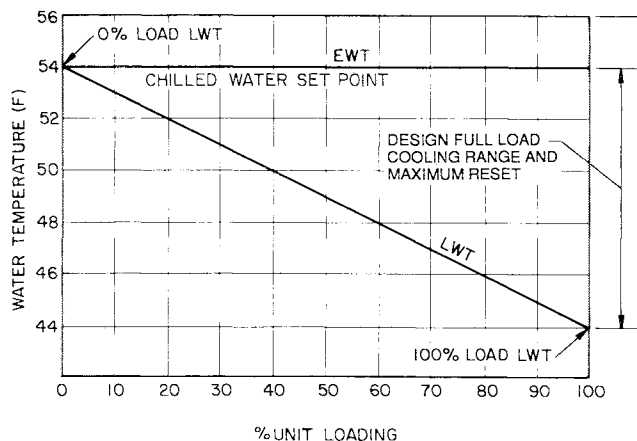
Reset Ratio

$$= \frac{(0\% \text{ Load LWT}) - (100\% \text{ Load LWT})}{\text{Design Full Load Cooling Range}} \times 100$$

$$= \frac{49 \text{ F} - 44 \text{ F}}{54 \text{ F} - 44 \text{ F}} \times 100 = 50\%$$

EXAMPLE 2

A30-457



- The Chilled Water Set Point Potentiometer (P1) = 0% LWT = 54 F
- The Reset Limit Potentiometer (P3) = Maximum Reset = 10 F
- Reset Ratio Potentiometer (P5) = X%

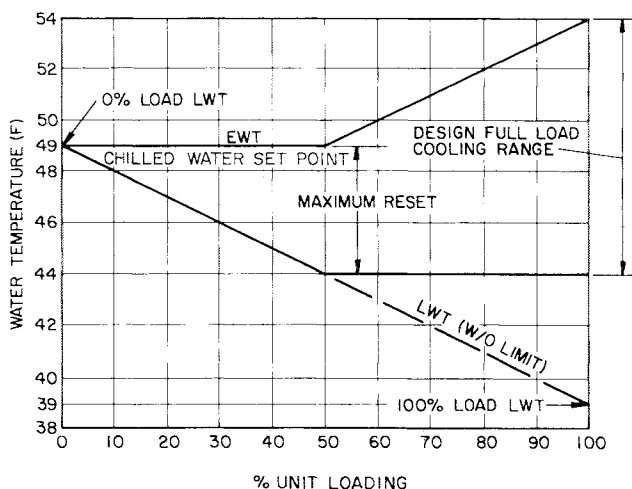
Reset Ratio

$$= \frac{(0\% \text{ Load LWT}) - (100\% \text{ Load LWT})}{\text{Design Full Load Cooling Range}} \times 100$$

$$= \frac{54 \text{ F} - 44 \text{ F}}{54 \text{ F} - 44 \text{ F}} \times 100 = 100\%$$

EXAMPLE 3

A30-458



- The Chilled Water Set Point Potentiometer (P1) = 0% Load LWT = 49 F
- The Reset Limit Potentiometer (P3) = Maximum Reset = 5 F
- Reset Ratio Potentiometer (P5) = X%

Reset Ratio

$$= \frac{(0\% \text{ Load LWT}) - (100\% \text{ Load LWT})}{\text{Design Full Load Cooling Range}} \times 100$$

$$= \frac{49 \text{ F} - 39 \text{ F}}{54 \text{ F} - 44 \text{ F}} \times 100 = 100\%$$

Space and Outdoor-Air Temperature Reset

— Space temperature reset and outdoor-air temperature reset allows for the reset of the leaving water temperature based on an external temperature sensor.

The accessory reset board and an external temperature sensor must be installed to use this option. Also, DIP switch 1 (reset mode select) should be in the OFF position and DIP switch 2 (reset select) should be in the ON position (see Table 7).

Under normal operation the chiller will maintain a constant leaving water temperature approximately equal to the leaving chilled water temperature set point potentiometer on the display board. This temperature is usually selected based on full-load conditions. At part-load conditions, it may be desirable to reset the leaving water set point up to improve the efficiency of the chiller. The control is capable of resetting the chilled water set point up in response to an external temperature. This external temperature can be outdoor air or an internal building temperature.

The external temperature is sensed through the accessory reset sensor.

Space and outdoor air reset requires the use of the following potentiometer inputs:

CODE	DESCRIPTION	LOCATION	RANGE
P1	Chilled Water Set Point	Display Board	15 to 70 F (-9.4 to 21C)
P3	Reset Limit Set Point	Accessory Board	0° to 80 F (0° to 44.4 C)
P5	Reset Ratio Set Point	Accessory Board	0 to 100%
P6	Reset Set Point	Accessory Board	0° to 95 F (-17.8 to 35 C)

The basic rules for setting the potentiometer are:

P1, CHILLED WATER SET POINT POTENTIOMETER — This should be set at full load design leaving water temperature.

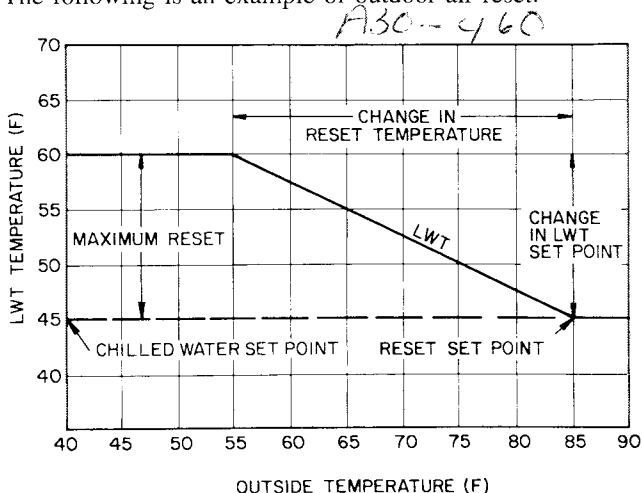
P3, RESET LIMIT POTENTIOMETER — This potentiometer should be set at the maximum desired amount of leaving water reset. As the reset temperature sensor drops in temperature below its set point, the chilled water set point is reset higher until the maximum reset (reset limit) is reached.

P5, RESET RATIO POTENTIOMETER — This potentiometer is used to set the rate at which the leaving water temperature is reset for a change in reset sensor temperature. To determine the setting use the following:

$$\frac{\text{Change in LWT Set Point}}{1^\circ \text{ F Change in Reset Temperature}} \times 20 = \text{Reset Ratio}$$

P6, RESET SET POINT — This potentiometer should be set at the temperature measured by the accessory reset sensor below which temperature reset will occur.

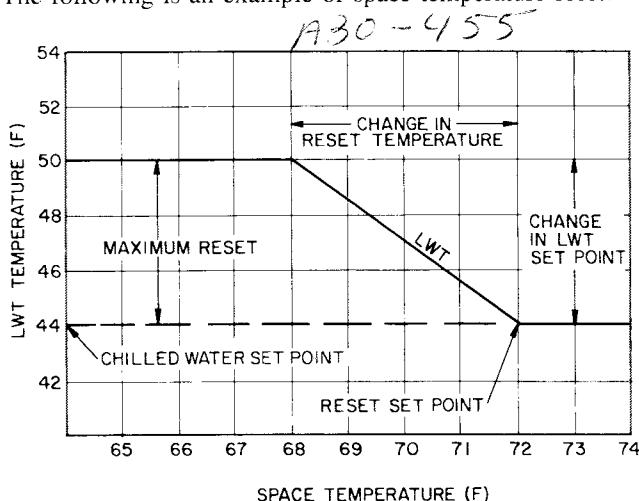
The following is an example of outdoor air reset:



- Reset Set Point Potentiometer (P6) = 85 F
- Chilled Water Set Point Potentiometer (P1) = Full Load LWT = 45 F
- Reset Limit Potentiometer (P3) = Maximum Reset = 15 F
- Reset Ratio Potentiometer (P5)

$$= \frac{60 - 45}{85 - 55} \times 20 = 10\%$$

The following is an example of space temperature reset:



- Reset Set Point (P6) = 72 F
- Chilled Water Set Point Potentiometer (P1) = Full Load LWT = 44 F
- Reset Limit Potentiometer (P3) = 50 - 44 = 6 F
- Reset Ratio (P5)

$$= \frac{50 - 44}{72 - 68} \times 20 = 30\%$$

Demand Limiting — The control has been designed to accept demand limit signals.

The accessory demand limit control module (DLCM) provides 2 demand limit steps. Two adjustable potentiometers are used to set the 2 demand limit set points, one in the range of 100% to 50% of capacity, the second in the range of 49% to 0% of capacity. The capacity steps are controlled by an external, field-supplied switch. For additional information, refer to Accessories and Optional Controls Installation. When demand limit is in effect, the display shows a Code **22** when display button is pushed.

Pulldown Control — Pulldown control is used to reduce the peak kW that occurs at start-up, when the cooler water temperature is very warm, but the load is small. Without pulldown, the chiller will load rapidly and chill the water temperature down quickly. During this time, high kW will be used, which could result in a peak kW charge. To prevent this, the control will limit the rate of leaving-water temperature drop to 1° F (0.6° C) per minute if the demand limit DIP switch 3 is on. If the capacity is being limited by pulldown, the control will display **24** when the display button is pressed.

Dual Set Point Requirement — For installations requiring dual set point capability, the demand limit control module (DLCM) and the accessory reset board are required.

To operate the chiller with a dual set point, the fluid should be properly chosen for temperature application. The chilled water set point is achieved by field installation of a single-pole double-throw relay of the appropriate control voltage, with a single-pole single-throw switch and resistors wired to TB6-1 and -2 as shown in Fig. 17.

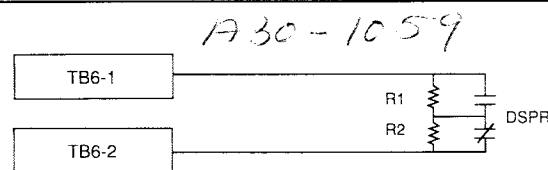
On the processor board, remove the cover to the DIP (dual in-line package) switches. Set DIP switch no. 2 to ON to enable reset. ON-OFF switch must be OFF before changing the setting of the DIP switch.

The chilled liquid set point must be set to the lower of the 2 temperatures selected.

ACCESSORY RESET BOARD — Chiller reset temperature potentiometer should be set between 90 and 95 F (32 and 35 C). If a fault code of **87** is displayed on the LED (light-emitting diode), reduce the value slightly to eliminate the fault code. The reset limit potentiometer must be set to the difference between the low and high set point temperature. The chiller reset ratio potentiometer should be set at 100%. If a fault code of **86** is displayed on the LED, reduce the value slightly to eliminate the fault code.

OPERATION — The chiller will supply water at the higher set point when no power is supplied to the dual set point relay (DSPR). When power is applied to the DSPR, the chiller will supply water (fluid) at the lower temperature. For example: For a dual set point requirement of 44 F (6.7 C) and 26 F (-3.3 C) water, the chiller will supply fluid at 26 F (-3.3 C) when the relay DSPR is energized, and 44 F (6.7 C) when it is not — with the necessary accessories installed and the following control devices set at these values:

	F	C
Chilled Liquid Set Point:	26	-3.3
Chiller Reset Temperature:	95	35
Reset Limit Potentiometer:	18°	10°
Reset Ratio:	100%	



- DSPR** — Dual Set Point Relay **R1** — Resistor 1, 13k ohm (40 F/4.5 C)
SW — Switch **R2** — Resistor 2, 2.7k ohm (105 F/40.5 C)
TB — Terminal Block

Fig. 17 — Dual Set Point Wiring

ACCESSORIES AND OPTIONAL CONTROLS INSTALLATION

Pulldown Control — Pulldown control requires no additional hardware. The pulldown control feature can be accomplished by using DIP switch 3 (see Table 7).

⚠ WARNING

Care should be used when changing the switch position. Use a small screwdriver or similar tool.

To change the switch setting, be sure that all electrical disconnects are open and tagged before any work begins. Then:

1. Open the left side control box door and remove inner panel.
2. Remove cover over the processor board, *being careful not to allow cover to hang by the heater wires.*
3. Locate the DIP switch assembly, and remove protective plastic cover.
4. Change position of DIP switch setting to desired position.
5. Replace the protective cover over DIP switch assembly.
6. Replace cover over the processor board.
7. Secure inner panel of control box.
8. Restore power to unit.
9. Check setting of DIP switch by performing the Quick Test.
10. Start unit and check that it is operating properly.

Return Temperature Reset

ACCESSORY CONTENTS	
Reset Board	32GB-500---254--
Sensor, For Outside or Space Temperature Reset Only	30GB-660---002--
FIELD-SUPPLIED MATERIAL	
4 Screws	8B-18 x 3/4" long

The processor is programmed to perform 3 types of temperature reset: Return Water Reset, Outdoor-Air Temperature Reset, or Space Temperature Reset. The accessory reset board is required to use temperature reset. The accessory reset board has the following potentiometers:

- P3 — Reset Limit Set Point
- P5 — Reset Ratio Set Point
- P6 — Reset Set Point

INSTALLATION — Be sure all electrical disconnects are opened and tagged before any work begins. Inspect package for any damage during shipping, and file a claim with shipper if damage has occurred.

1. Open the left side control box door.
2. Remove the sheet metal access cover over the microprocessor, then remove cover over the processor board. Do not allow processor cover to hang by the heater strip wires.
3. Remove plastic cover over the DIP switches.
4. Set DIP switches 1 and 2 to ON for return water temperature reset. For space or outdoor-air temperature reset, set DIP switch 1 to OFF and switch 2 to ON.
5. Mount Reset Board in lower left side of control panel assembly. See Fig. 1.

6. Fasten accessory reset board to panel with field-supplied 8B-18 screws. Accessory board is not designed for remote mounting.
7. Attach connector at end of accessory reset board plug to microprocessor J3, pins 9 through 14 plug receptacle. See Fig. 18.
8. Replace processor cover.

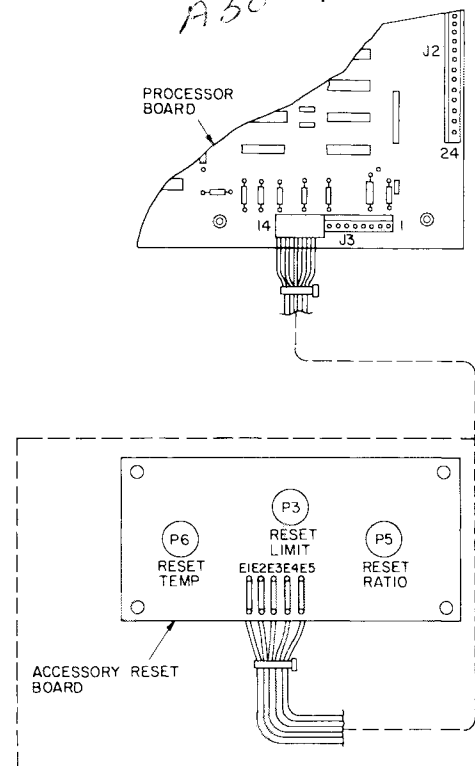
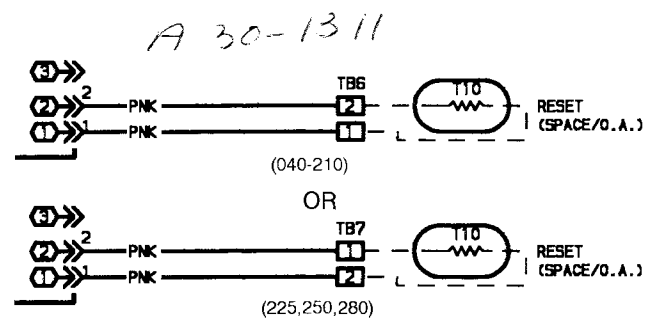


Fig. 18 — Accessory Reset Board Wiring

NOTE: For space or outdoor temperature reset, the additional sensor (30GB660002) must be installed. The thermistor is provided from factory with 30 ft (9.1 m) of 22 gage twisted pair cable. The thermistor must be connected to TB6-1 and TB6-2 for 30GT040-210 units or to TB7-1 and TB7-2 for 225, 250, and 280 units. See Fig. 19.



OA — Outdoor-Air

Fig. 19 — Space/Outdoor Thermistor Wiring

To avoid electrical interference, do not run the thermistor wire near line voltage, electrical machinery, large contactors, or other similar devices. If outdoor temperature reset is used, mount thermistor in an area that is shielded from direct sunlight. When using space temperature reset, the sensor should be located where it will sense freely circulating air.

Determine the settings of the potentiometers for the desired temperature reset. Refer to Table 13.

Table 13 — Temperature Reset Potentiometer Settings

POTENTIOMETER	DESCRIPTION	LOCATION	RANGE
P1	Chilled Water Set Point	Display Board	Water: 40 to 70 F (4.4 to 21 C) Brine: 15 to 70 F (-9.4 to 21 C)
P3	Reset Limit Set Point	Accessory Board	0° to 80 F (0° to 44.4 C)
P5	Reset Ratio Set Point	Accessory Board	0 to 100%
P6 (Required for Space or Outdoor Air Reset)	Reset Set Point	Accessory Board	0° to 95 F (-17.8 to 35 C)

RETURN WATER RESET — Set potentiometers as shown on page 29.

OUTDOOR OR SPACE TEMPERATURE RESET — Set potentiometers as shown on page 30.

Replace inner control panel cover and secure panel. Restore power to unit. Verify that DIP switches, potentiometers, and additional sensor are working and are properly set, using the Quick Test procedure. See Table 11. Confirm that unit functions properly. Close and secure control box door.

OPERATION — When reset begins, Code **21** will appear on display screen. The chilled water temperature may not be the same as the set point of P1.

SERVICE — There are several diagnostic display codes that can appear if reset package fails. See Controls Troubleshooting and Servicing, page 33.

Demand Limit Control Module — See separate installation instructions for demand limit control module packaged with the accessory.

Remote ON-OFF Control — If remote ON-OFF unit control is required, a field-supplied relay must be installed in unit control box and wired as shown in Fig. 20.

Terminals TB6-3 and TB6-4 (040-210) or TB7-9 and TB7-10 (225,250,280) are provided as the circuit for Remote ON-OFF switch wiring. To use this feature, remove the factory-installed jumper and install the device in series.

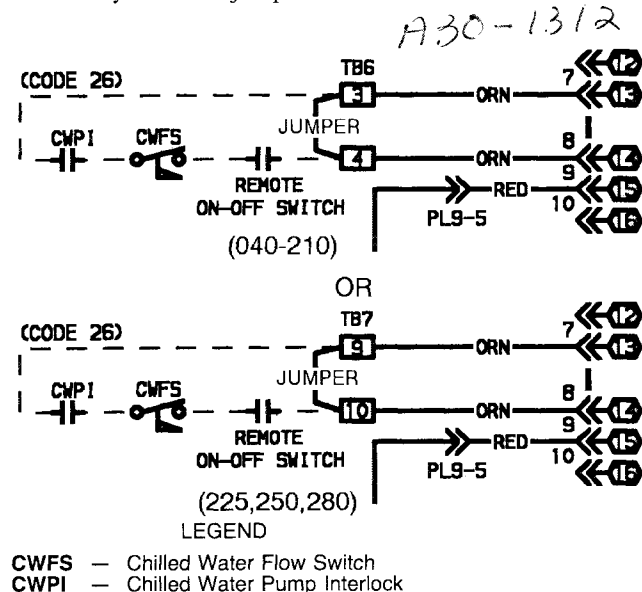


Fig. 20 — Interlock Circuit

External Interlocks — The unit is equipped with provisions for external interlock devices such as pump starters. See Fig. 20 for wiring instructions.

Remove the jumper between TB6-3 and TB6-4 (040-210) or TB7-9 and TB7-10 (225,250,280) and install the remote interlock contacts across pins or terminals. Several devices can be connected in series.

Contacts must be rated for dry circuit application capable of handling a 5 vdc 1 mA to 20 mA load.

⚠ WARNING

Do not use the pump starter as a remote ON-OFF switch.

Remote Alarm — The unit is equipped with a master alarm circuit that is energized any time that a diagnostic code of **51** to **87** is displayed. It is also energized during the Quick Test. The alarm circuit is powered by a 115- or 230-v relay on the relay board. This relay is determined by control circuit voltage. The 208/230-, 460- and 575-v units use 115-v relay. The 380-, 346- and 400-v units use 230-v relay. This same relay energizes the alarm light.

To install a remote alarm light or similar device, it can be connected to TB5-1 and TB5-2. See Fig. 21. A resistor is installed across these terminals to provide a minimum current draw through the contacts of the relay board. When an external alarm is installed, remove this resistor. The maximum load that the relay can handle is 75 va sealed, 360 va inrush for both 115 and 230 v.

If a load with a greater va is to be used, an interface pilot duty relay must be used.

If a remote audible alarm is used, it is recommended that a remote alarm-off switch be installed.

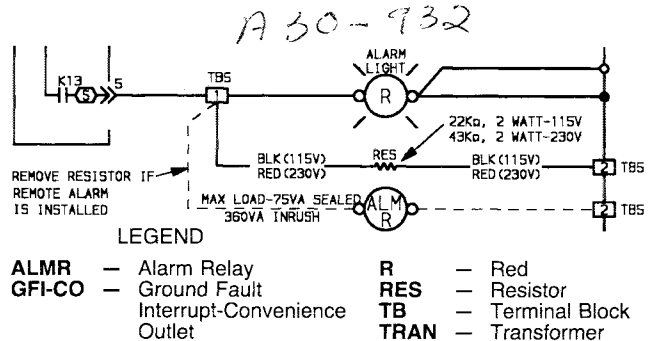


Fig. 21 — Remote Alarm Wiring

CONTROLS TROUBLESHOOTING AND SERVICING

General — The electronic controls used in this unit contain extensive diagnostic capabilities. The 2-digit LED display on the display board (see Fig. 1) will display useful diagnostic codes that can be used to help troubleshoot the system. Refer to Table 11 and diagnostic codes for details.

The control has also been preprogrammed with a Quick Test Procedure that allows for the checkout of all inputs and outputs to and from the microprocessor.

Troubleshooting charts are also contained in this book to help in the troubleshooting of this control.

If a problem is suspected, always check the display for diagnostic information. When a diagnostic code is tripped, the alarm light is energized.

IMPORTANT: The microprocessor memory and the display will be cleared if the power is turned off.

⚠ WARNING

Do not attempt to bypass, short or modify the control circuit or electronic boards in any way to correct a problem. This could result in component failures or a hazardous operating condition.

Diagnostic Display Codes — Following is a detailed description of each diagnostic error and the possible cause. See Table 14.

CODE 51-58 — COMPRESSOR FAILURE (See Fig. 22 and 23) — If the control relay should open before or during operation, an alarm code and light will be indicated. Codes **51** and **55** will shut off all compressors of that circuit. For Codes **52, 53, 54, 56, 57**, and **58**, the processor will shut down only the compressor involved. These display codes will only be shown when the display button is pressed. To reset the circuit, the ON-OFF switch must be turned to OFF, then to ON.

Code **51** indicates an operational failure of compressor A1. If compressor A2, the second compressor of circuit A, has an operational failure, a code **52** will be displayed. If compressor A3, the third compressor of circuit A, has an operational failure, a code **53** will be displayed. If compressor A4, the fourth compressor of circuit A, has an operational failure, a code **54** will be displayed. A code **55** indicates an operational failure of compressor B1. If compressor B2, the second compressor of circuit B has an operational failure, a code **56** will be displayed. If compressor B3, the third compressor of circuit B has an operational failure, a code **57** will be displayed. If compressor B4, the fourth compressor of circuit B has an operational failure, a code **58** will be displayed.

If a failure occurs, there are several possible causes in addition to the normal service problems for a compressor, circuit breaker, or contactor.

High-Pressure Switch Open — The high-pressure switch is wired in series with the CPCS relay coils or control relay (CR). If the switch fails or opens, this will be detected by the processor through the feedback contacts. Refer to Fig. 22 wiring schematics.

Ground Current Failure — The CPCS modules have the ability to detect currents-to-ground. If this current is > 2.5 amps as detected by the current toroids, an alarm condition will be signaled when the CPCS module stops the compressor or the ground fault relay trips.

CPCS Module or CR Failure — If the CPCS module or CR fails and indicates operation of a compressor that actually is off, an alarm condition will be signaled. The affected compressor will be locked off.

Possible causes for this alarm:

Wiring Problem — A wiring error or a loose wire may cause the feedback circuit to be broken.

Relay Board Failure — If a relay on the relay board fails, the processor will detect the failure through the feedback circuit.

Processor Failure — If the hardware fails to energize the proper relay, an alarm condition may be signaled.

CODES 59 AND 60 — LOSS-OF-CHARGE SWITCH — The processor monitors the loss-of-charge switch. If the switch opens either by low refrigerant charge or failure, a wiring error or a switch or processor board failure, the circuit is locked off. Code **59** indicates a failure of Circuit A and, as a result, that circuit will be shut down.

Code **60** indicates a failure of Circuit B and, as a result, that circuit will be shut down. These codes will be displayed only when the display button is pressed. To reset the circuit, the ON-OFF switch must first be turned to OFF, then to ON.

CODE 61 — NO COOLER FLOW — The processor monitors the temperature in the cooler barrel. Logic internal to the board protects the cooler against loss of cooler flow. The entering and leaving water thermistors are used for this purpose. The leaving water thermistor is located in the leaving water nozzle. The entering water is in the first baffle spacing close to the cooler tube bundle. No cooler flow will be detected by no temperature change between the leaving water thermistor and a rapid drop in the entering water temperature when the compressors are on. When the entering water temperature drops to 5 F (2.8 C) below the leaving water temperature, all compressors stop and Code **61** is displayed. To reset this error, the ON-OFF switch must be turned to OFF, then to ON, when cooler water flow returns. This error occurs for low, or no cooler flow, or if cooler water flow is in the wrong direction. The cooler heaters, if installed, may have enough heat to raise the leaving water temperature above the entering water temperature, thereby satisfying the above conditions. In these instances, check for a faulty cooler heater thermostat or contactor.

CODES 63 AND 64 — OIL PRESSURE SWITCH — If the oil pressure switch opens, either by low oil pressure ($< 5 \pm 1$ psig [34.5 ± 6.8 kPa]), low oil level, switch failure, compressor circuit breaker trip, processor board failure or wiring error, the circuit is locked off. Normal oil pressure for an 06E compressor is 16-22 psig (110-152 kPa) above the suction pressure. Code **63** indicates a failure of Circuit A and results in circuit shutdown. Code **64** indicates a failure of Circuit B and results in circuit shutdown. These codes are displayed only when the display button is pressed. To reset the circuit, the ON-OFF switch must be turned to OFF, then to ON.

NOTE: If these codes appear on a unit without an oil pressure switch, check the jumper between terminals J2-1 and J2-2 (code **63**) or the jumper between terminals J2-3 and J2-4 (code **64**).

CODE 65 — FREEZE PROTECTION — If leaving water temperature is below 35 F (1.7 C) for a water chiller, or 6 F (3.3 C) below set point for brine applications, all compressors stop. This safety automatically resets when the temperature is 6 F (3.3 C) above set point.

The causes for this failure are usually due to low cooler flow or rapid changes in building load.

CODES 66 AND 67 — HIGH SUCTION SUPERHEAT (EXV Units Only) — The microprocessor has the following logic: If all of the conditions occur, all compressors in that circuit stop. Code **66** indicates a failure of Circuit A, and Code **67** indicates a failure of Circuit B.

Conditions are: If suction superheat is greater than 75 F (41.7 C), saturated cooler suction temperature is less than 55 F (12.8 C), and these 2 conditions have existed for more than 5 minutes. To reset this alarm, turn ON-OFF switch to OFF, then to ON.

Possible causes for this alarm:

Low Refrigerant Charge — A low refrigerant charge will not allow the correct amount of refrigerant to be fed to the evaporator, resulting in high suction superheat.

Plugged Filter Drier — If liquid line filter drier becomes plugged, it can result in not enough refrigerant being fed to the evaporator, resulting in high superheat. Check the liquid line service valve (040-210) or the LLS (225,250,280).

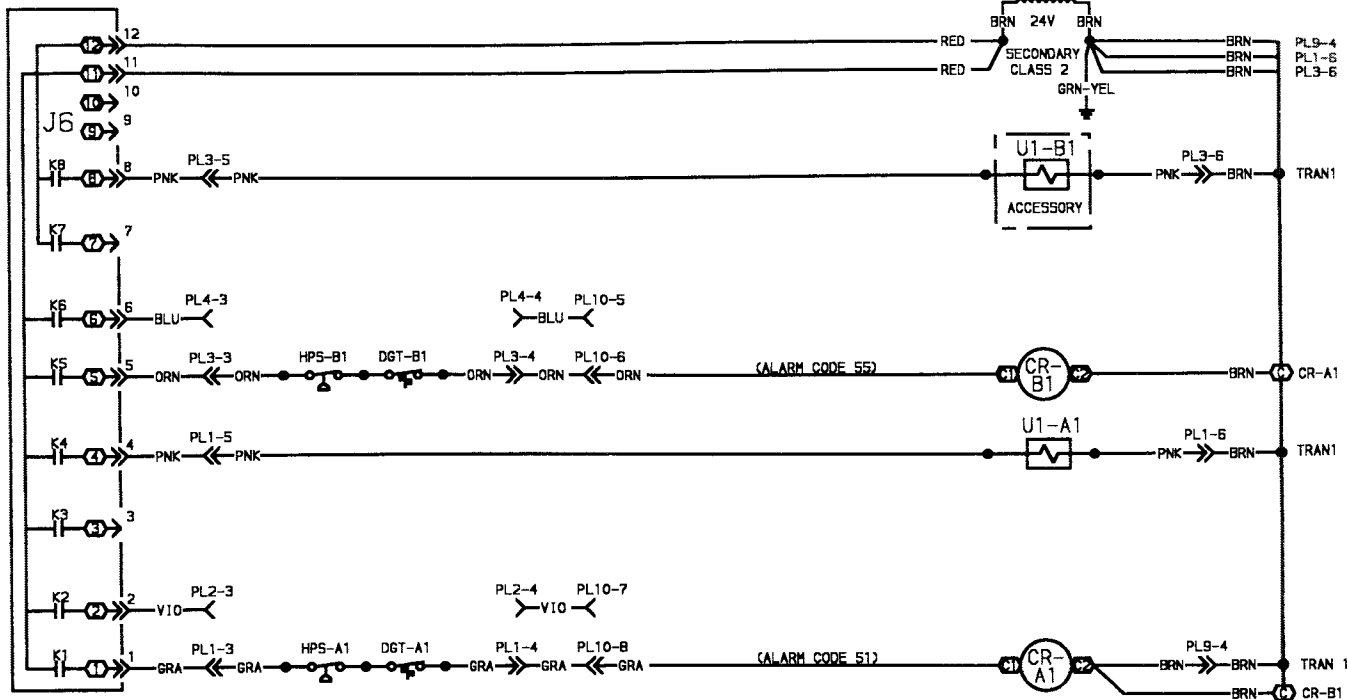
EXV Failure — EXV fails to open properly, it may not be able to feed enough refrigerant.

Processor Board Failure — If processor board fails, the valve will not move.

Bad Thermistor — Thermistor is mislocated or out of calibration.

A30-943

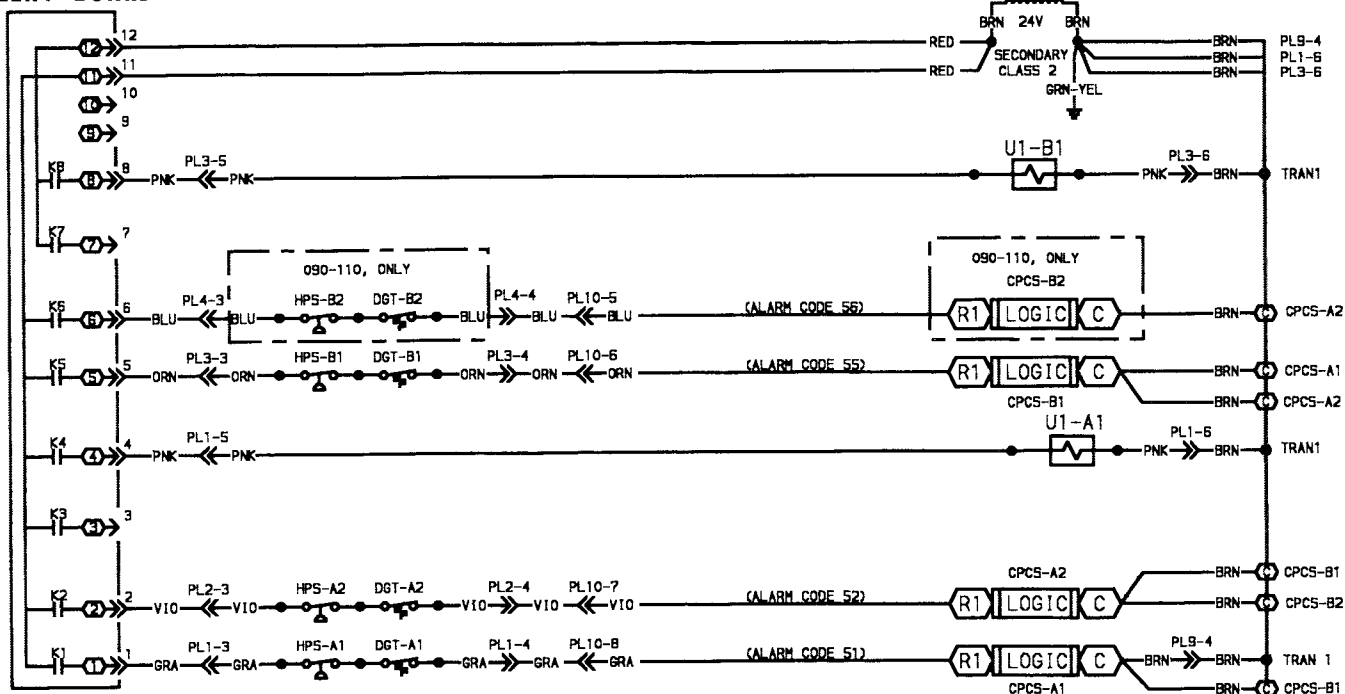
RELAY BOARD



070 (60 Hz); 040-060

J6 RELAY BOARD

A30-933



070 (50 Hz); 080-110

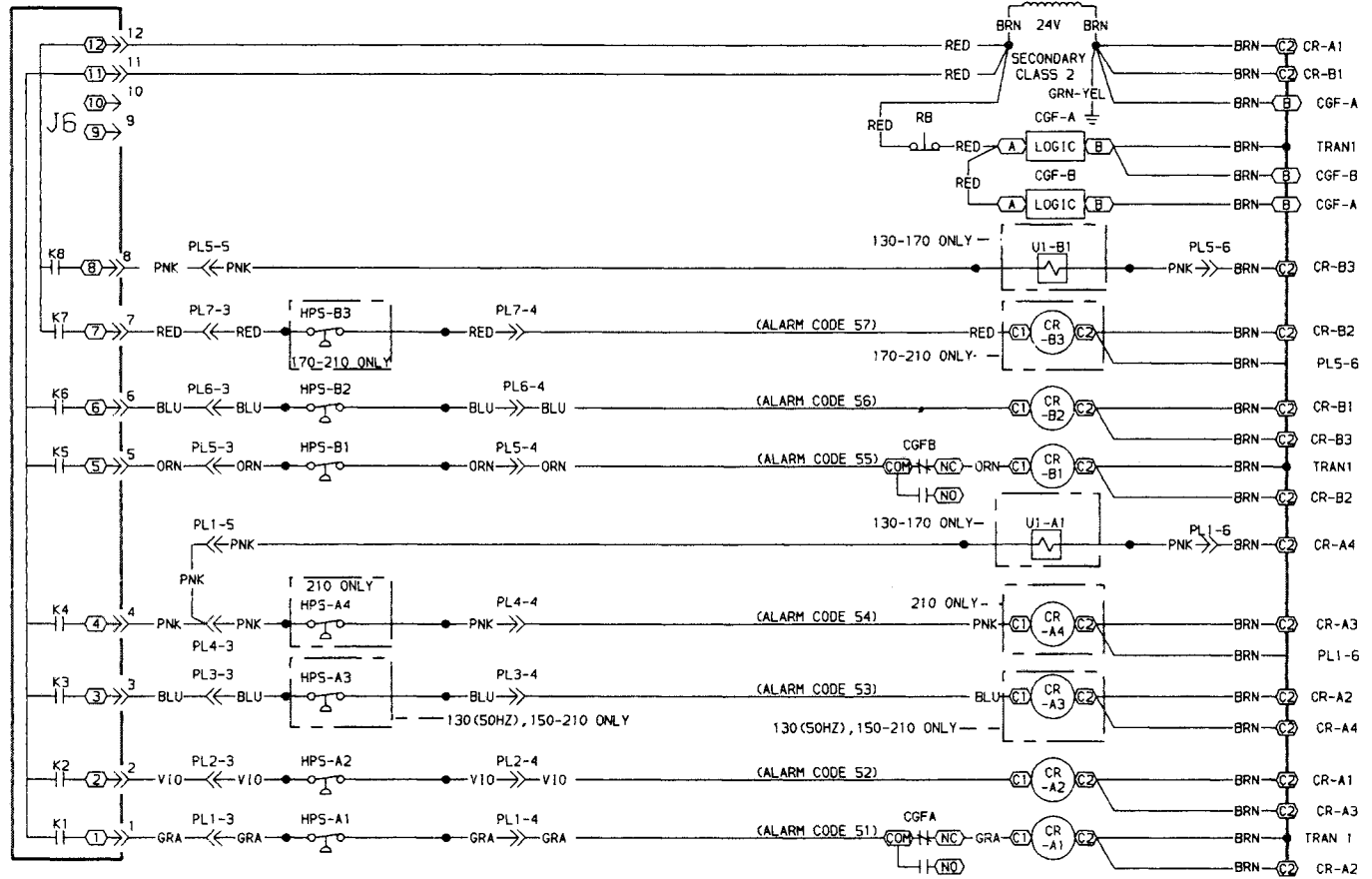
LEGEND

- CGF — Compressor Ground Fault
- CPCS — Compressor Protection Control System
- CR — Control Relay
- DGT — Discharge Gas Thermostat
- HPS — High-Pressure Switch
- PL — Plug
- TRAN — Transformer

Fig. 22 — Low Voltage Control Circuit

A30-1313

RELAY BOARD



130-210

Fig. 22 — Low Voltage Control Circuit (cont)

A30-1314

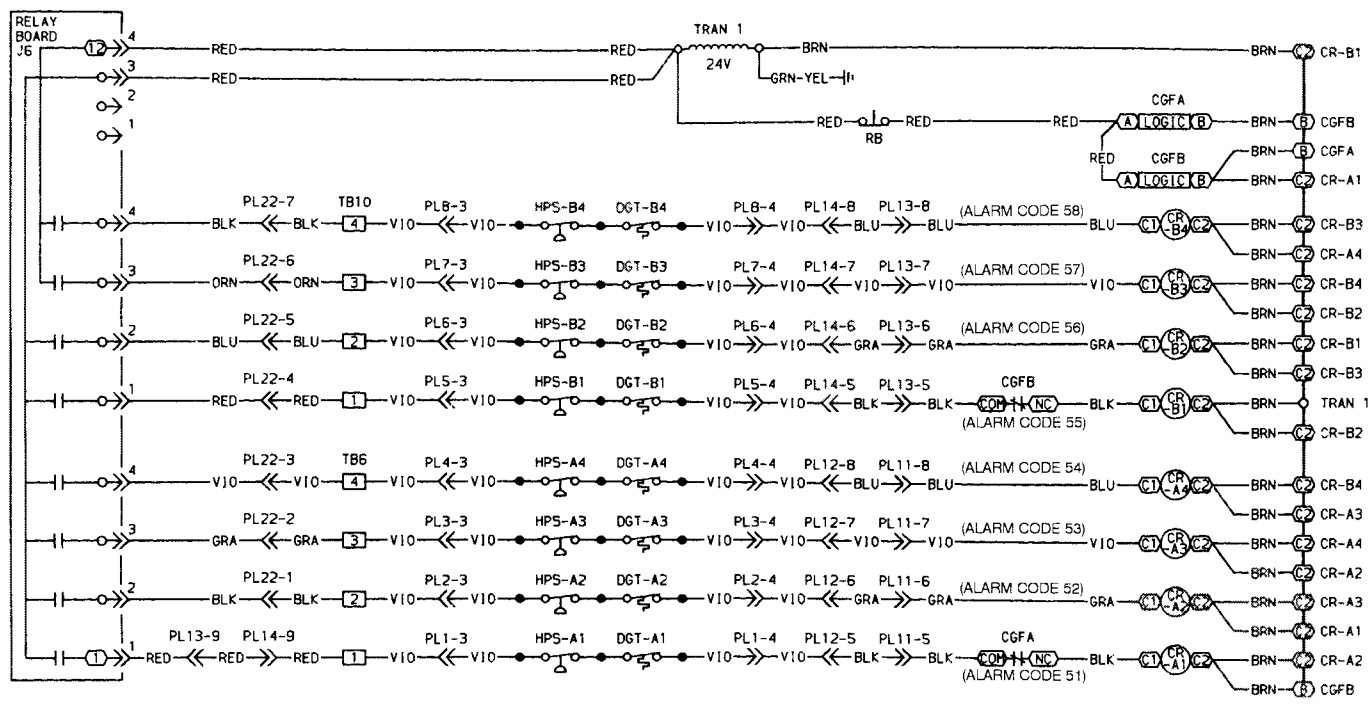


Fig. 22 — Low Voltage Control Circuit (cont)

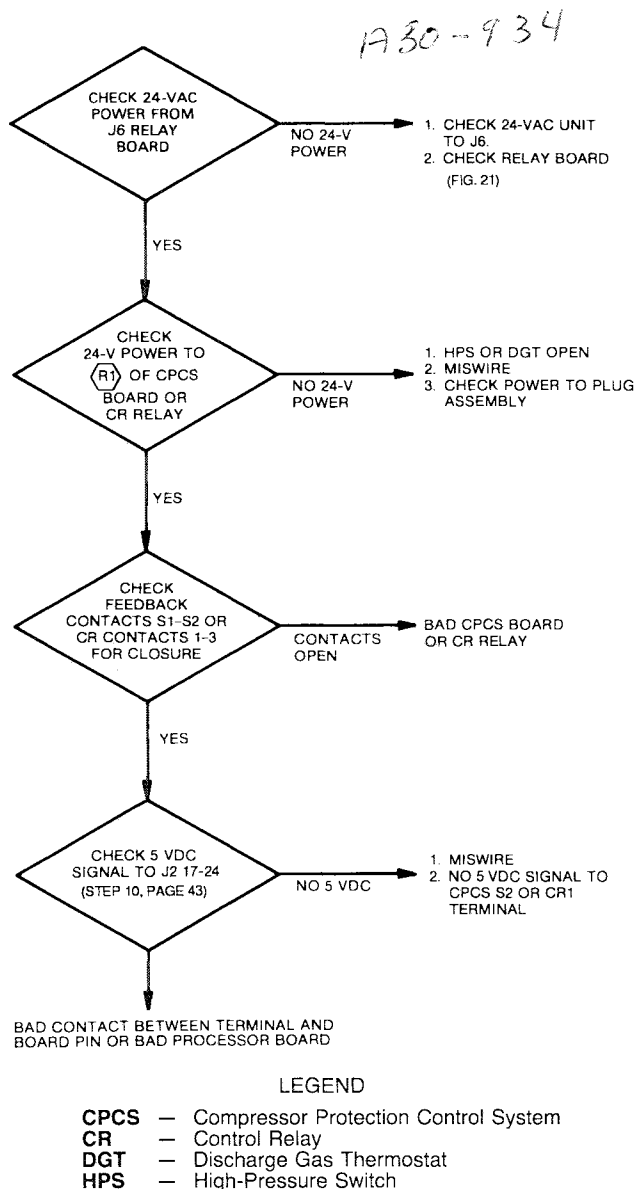


Fig. 23 — Error Code 51-58 Troubleshooting Chart

CODES 68 AND 69 — LOW SUCTION SUPERHEAT (EXV Units Only) — If suction superheat is equal to 0° F (0° C), or saturated suction temperature is greater than 58 F (14.4 C), and either condition is true for more than 5 minutes, then all compressors in the circuit stop.

Code **68** indicates a failure of Circuit A, Code **69**, indicates a failure of Circuit B. To reset this alarm, turn ON-OFF switch off, then on.

Possible causes for this alarm:

EXV Failure — EXV fails to close properly, or is stuck.

Processor Board Failure — If processor board fails, valve does not move.

Bad Thermistor — Thermistor is mislocated or out of calibration.

CODE 70 — ILLEGAL UNIT CONFIGURATION — If unit configuration header is improperly installed, improperly configured, or DIP switch settings are not properly set,

alarm Code **70** is displayed when display button is pushed. Unit does not start. Check settings of configuration header and DIP switches.

CODES 71-81 — THERMISTOR FAILURE — If measured resistance of a thermistor is outside the valid range, (363,000 to 216 ohms), the appropriate sensor alarm code is energized when display button is pushed. All codes reset automatically when problem is corrected. There are several possible causes. All the codes result in unit shut-down, except entering water thermistor failure, in which case the processor uses the default value.

Possible causes for this alarm:

Thermistor Failure — A shorted or open thermistor.

Wiring Problem — Circuit is open.

Processor Board Failure — Processor board hardware fails.

The failure codes and corresponding sensor names are as follows:

Code **71** Leaving Water/Brine Thermistor (T1)

Code **72** Entering Water/Brine Thermistor (T2)

Code **75** Circuit A Saturated Condensing Thermistor (T3)

Code **76** Circuit B Saturated Condensing Thermistor (T4)

Code **77** Circuit A Evaporator Refrigerant Thermistor (T5)

Code **78** Circuit B Evaporator Refrigerant Thermistor (T6)

Code **79** Circuit A Compressor Return Gas Thermistor (T7)

Code **80** Circuit B Compressor Return Gas Thermistor (T8)

Code **81** Remote Temperature Thermistor (T10)

The remote thermistor is an optional thermistor and is only used with outdoor or space temperature reset. DIP switch 1 must be on and DIP switch 2 must be off. If thermistor T10 failure should occur, diagnostic Code **81** appears on display screen when display button is depressed, and reset will be terminated. This is an automatic reset failure when the situation is corrected. The thermistor can also be checked during the Quick Test routine.

CODE 82 — LEAVING-WATER SET POINT POTENTIOMETER FAILURE — If this potentiometer fails, the processor uses the default supply water set point value of 70 F (21 C) for water, or 42 F (5.6 C) for brine units to operate the machine. This potentiometer is located on the display board. If a failure of this potentiometer is detected, the processor displays Code **82** when the display button is pushed. If the potentiometer is outside the valid range of -22 to 70 F (-30 to 21 C), an alarm condition is signaled.

The full scale resistance of this potentiometer is 10 K ohms. The operational set point range is 45 to 70 F. If the potentiometer is outside the operational set point range, but within the valid range, the control uses the default value without energizing an alarm code.

Possible causes for this alarm:

Incorrect Potentiometer Setting — Potentiometer is turned fully clockwise, or fully counterclockwise, outside the valid range.

Wiring Problem — Wiring between potentiometer and processor is incorrect.

Potentiometer Failure — Potentiometer is shorted or open.

CODE 83 (NO FAILURE) — This failure code is displayed if a jumper is installed between terminals TB6-3 and TB6-4 (040-210) or between terminals TB7-9 and TB7-10 (225,250,280) and the EPROM is HT207101-1-10 or earlier (040-210) or HT204247-1-11 or earlier (225,250,280). Unit runs normally. Remove jumper or update EPROM to remove the fault code. See Table 11 footnotes (†).

CODE 84 — RESET LIMIT POTENTIOMETER FAILURE — This code is applicable if reset is being used. If a failure occurs, alarm Code **84** is displayed when display button is pressed. P3 has a full-scale resistance of 10 K ohms, but when installed in parallel with other 2 potentiometers on accessory reset board, its measured resistance is 3.3 K ohms. This potentiometer has a valid range of 0° to 80 F (0° to 44.4 C). Failure automatically resets when problem is corrected.

Possible causes for this alarm:

DIP Switch 2 — Switch is on and accessory board is missing from unit.

Incorrect Potentiometer Setting — Potentiometer is turned fully clockwise, or fully counterclockwise, outside the valid range.

Wiring Problem — Wiring between potentiometer and processor is incorrect.

Potentiometer Failure — Potentiometer is shorted or open.

CODE 85 — DEMAND LIMIT POTENTIOMETER FAILURE — This code is applicable only if demand limit is being used. DIP Switch 5 must be on. Two-step demand limit is a 2-potentiometer system. For both potentiometers, the control recognizes only 10-90% of the potentiometer's full range of resistance. If resistance value is outside this range, the processor energizes alarm light and displays alarm Code **85** when display button is pressed. Failure automatically resets when problem is corrected.

Possible causes for this alarm:

DIP Switch 5 — Switch is on and demand limit option potentiometers are not used.

Incorrect Potentiometer Setting — Potentiometer is turned fully clockwise, or fully counterclockwise, outside the valid range.

Wiring Problem — Wiring between potentiometer and processor is incorrect.

Potentiometer Failure — Potentiometer is shorted or open.

If a problem is suspected in DLCM (demand limit control module) board, use the following test procedure and a digital volt-ohmmeter. If a digital volt-ohmmeter is unavailable, a good quality analog meter is acceptable.

The board can be checked only when it is connected to processor, and microprocessor is energized so that DLCM is supplied with 5 vdc power. The terminals referenced are those of the DLCM connector. Caution should be exercised to avoid damaging connector or processor board when taking voltage readings. P1 and P2 refer to the potentiometers of the DLCM.

Be careful to avoid damaging connector or processor board when taking voltage readings.

Condition 1: No power to INT1 or INT2.

Terminal 1 to 2 — 4.5 vdc $\pm$ 0.1 v

Terminal 2 to 3 — 5.0 vdc $\pm$ 0.1 v

Condition 2: Power to INT2 or to both INT1 and INT2, and P2 set at 25%.

Terminal 1 to 2 — 1.5 vdc $\pm$ 0.1 v

Voltage should vary between 0.5 vdc and 2.5 vdc as the setting of P2 varies between 0 and 49%.

Terminal 2 to 3 — 5.0 vdc $\pm$ 0.1 v

Condition 3: Power to INT1 only, P1 set at 50%.

Terminal 1 to 2 — 2.5 vdc $\pm$ 0.1 v

Terminal 2 to 3 — 5.0 vdc $\pm$ 0.1 v

Voltage should vary between 2.5 vdc and 4.5 vdc as the setting of P1 varies between 50 and 100%.

If the voltages listed above are not obtained during this check, the board must be replaced.

CODE 86 — RESET RATIO POTENTIOMETER FAILURE — This code is used only if reset is used (DIP switch 2 is on). If this potentiometer (P5) fails, processor energizes alarm light and alarm Code **86** is displayed when display button is pressed. P5 has a full-scale resistance of 10 K ohms, but when installed in parallel with other 2 potentiometers on accessory reset board, its measured resistance is 3.3 K ohms. This potentiometer has a valid range of 0 to 100%. Failure automatically resets when problem is corrected.

Possible causes for this alarm:

DIP Switch 2 — Switch is on and accessory board is missing from unit.

Incorrect Potentiometer Setting — Potentiometer is turned fully clockwise, or fully counterclockwise, outside the valid range.

Wiring Problem — Wiring between potentiometer and processor is incorrect.

Potentiometer Failure — Potentiometer is shorted or open.

CODE 87 — RESET SET POINT POTENTIOMETER FAILURE — This failure code is applicable only if reset is used. DIP switch 2 must be on, and DIP switch 1 off. P6 has a full scale resistance of 10 K ohms, but when installed in parallel with other 2 potentiometers on accessory reset board, its measured resistance is 3.3 K ohms. The potentiometer has a valid range of 0° to 95 F (– 17.8 to 35 C). If failure of this potentiometer is detected, Code **87** is displayed when display button is pushed. If potentiometer is outside the valid range of 0° to 95 F (– 17.8 to 35 C), an alarm is signaled. Full scale resistance of this potentiometer is 10 K ohms.

Possible causes for this alarm:

DIP Switch 2 — Switch is on and accessory board is missing from unit.

Incorrect Potentiometer Setting — Potentiometer is turned fully clockwise, or fully counterclockwise, outside the valid range.

Wiring Problem — Wiring between potentiometer and processor is incorrect.

Potentiometer Failure — Potentiometer is shorted or open.

Table 14 — Diagnostic Display Codes

DISPLAY	DESCRIPTION OF FAILURE										ACTION TAKEN BY CONTROL	RESET METHOD	PROBABLE CAUSE
	Unit Size												
	040-070 60 Hz	040-060 50 Hz	070 50 Hz, 080	090-110	130 (60 Hz)	130 (50 Hz), 150	170, 190	210	225,250, 280	Failure			
51	Compr	A1	A1	A1	A1	A1	A1	A1	A1	Failure	Circuit A Shut Off	Manual	040-110: High-Pressure Switch Trip.
52	Compr	—	A2	A2	A2	A2	A2	A2	A2	Failure	Compressor Shut Off	Manual	130-210,225,250,280: Ground fault
53	Compr	—	—	—	—	A3	A3	A3	A3	Failure	Compressor Shut Off	Manual	relay or High-Pressure Switch Trip.
54	Compr	—	—	—	—	—	—	A4	A4	Failure	Compressor Shut Off	Manual	In addition (if CPCS is installed),
55	Compr	B1	B1	B1	B1	B1	B1	B1	B1	Failure	Circuit B Shut Off	Manual	Compressor Ground Current
56	Compr	—	—	B2	B2	B2	B2	B2	B2	Failure	Compressor Shut Off	Manual	>2.5 amps. Compressor Board
57	Compr	—	—	—	—	—	B3	B3	B3	Failure	Compressor Shut Off	Manual	Relay on when it is not supposed to
58	Compr	—	—	—	—	—	—	—	—	Failure	Compressor Shut Off	Manual	be on, or Wiring Error between
59	Loss of Charge	Circuit A	—	—	—	—	—	—	—	Failure	Circuit A Shut Off	Manual	Electronic Control and Compressor
60	Loss of Charge	Circuit B	—	—	—	—	—	—	—	Failure	Circuit B Shut Off	Manual	Protection Module.*
61	Low Cooler Flow	Low Cooler Flow	—	—	—	—	—	—	—	Failure	Unit Shut Off	Manual	Low Refrigerant Charge, or Low- Pressure Switch Failure
63	Low Oil Pressure Circuit A	—	—	—	—	—	—	—	—	Failure	Circuit A Shut Off	Manual	No Cooler Flow or Reversed Cooler Flow
64	Low Oil Pressure Circuit B	—	—	—	—	—	—	—	—	Failure	Circuit B Shut Off	Manual	Oil Pump Failure or Low Oil Level, or Switch Failure, or Compressor CB Tripped. Check jumper between J2-1 and J2-2 (code 63) or between J2-3 and J2-4 (code 64) if the oil pressure switch is not installed.
65	Freeze Protection	—	—	—	—	—	—	—	—	Failure	Unit Shut Off	Auto.	Low Cooler Flow
66	High Suction Superheat Circuit A	—	—	—	—	—	—	—	—	Failure	Circuit A Shut Off	Manual	Low Charge, or Plugged Filter Drier, or EXV Failure, or Bad Thermistor.
67	High Suction Superheat Circuit B	—	—	—	—	—	—	—	—	Failure	Circuit B Shut Off	Manual	Check the liquid line service valve (040-210) or the LLSV (225,250,280)
68	Low Suction Superheat Circuit A	—	—	—	—	—	—	—	—	Failure	Circuit A Shut Off	Manual	EXV Failure, or Bad Thermistor
69	Low Suction Superheat Circuit B	—	—	—	—	—	—	—	—	Failure	Circuit B Shut Off	Manual	
70	Illegal Unit Configuration	—	—	—	—	—	—	—	—	Failure	Unit Will Not Start	Manual	Configuration Error (See Note 2.)
71	Leaving Water/Brine Thermistor Failure	—	—	—	—	—	—	—	—	Failure	Unit Shut Off	Auto.	
72	Entering Water/Brine Thermistor Failure	—	—	—	—	—	—	—	—	Failure	Use Default Value	Auto.	
75	Saturated Cond. Thermistor Failure Circuit A	—	—	—	—	—	—	—	—	Failure	Unit Shut Off	Auto.	Thermistor Failure, or Wiring Error, or
76	Saturated Cond. Thermistor Failure Circuit B	—	—	—	—	—	—	—	—	Failure	Unit Shut Off	Auto.	Thermistor not connected to Proces- sor Board.
77	Evaporator Refrigerant Thermistor Failure Circuit A	—	—	—	—	—	—	—	—	Failure	Unit Shut Off	Auto.	
78	Evaporator Refrigerant Thermistor Failure Circuit B	—	—	—	—	—	—	—	—	Failure	Unit Shut Off	Auto.	
79	Compressor Thermistor Failure Circuit A	—	—	—	—	—	—	—	—	Failure	Unit Shut Off	Auto.	
80	Compressor Thermistor Failure Circuit B	—	—	—	—	—	—	—	—	Failure	Unit Shut Off	Auto.	
81	Remote Temperature Failure	—	—	—	—	—	—	—	—	Failure	Stop Reset	Auto.	Potentiometer improperly connected,
82	Leaving Water Set Point Potentiometer Failure	—	—	—	—	—	—	—	—	Failure	Use Default Value	Auto.	or Potentiometer setting out of range,
84	Reset Limit Potentiometer Failure	—	—	—	—	—	—	—	—	Failure	Stop Reset	Auto.	or Potentiometer Failure, or Wiring
85	Demand Limit Potentiometer Failure	—	—	—	—	—	—	—	—	Failure	Stop Demand Limit	Auto.	Error.
86	Reset Ratio Potentiometer Failure	—	—	—	—	—	—	—	—	Failure	Stop Reset	Auto.	
87	Reset Set Point Potentiometer Failure	—	—	—	—	—	—	—	—	Failure	Stop Reset	Auto.	
83	None	—	—	—	—	—	—	—	—	Failure	Unit Operates Normally	—	Wrong EPROM

LEGEND

EPROM — Erasable, Programmable Read-Only Memory
EXV — Electronic Expansion Valve
LLS — Liquid Line Solenoid Valve

*See Fig. 22 Compressor Troubleshooting Chart (Error Code 51-58)

NOTES:

- Freeze protection trips at 35 F (1.7 C) for water and 6° F (3.3° C) below set point for brine units. Resets at 6° F (3.3° C) above set point.
- Illegal unit configuration caused by missing programmable header or both unloader DIP switches on.
- All AUTO. reset failures that cause the unit to stop will restart the unit when the error has been corrected.
- All manual reset errors must be reset by turning the control circuit breaker off and on.
- Valid resistance range for thermistors is 363,000 to 216 ohms.

Processor Board Checkout Procedure — Before using this procedure, check the display for diagnostic codes. If a display is present, refer to the diagnostic section of this book for further details.

If there are no diagnostic codes, first check the Quick Test Procedure before using the following test procedure. The following procedure should only be used if the processor board is suspected of being faulty.

A digital volt-ohmmeter is useful in the following procedure, but a good quality analog meter will be acceptable.

⚠ WARNING

You will be working with solid-state electronic components. Do not short devices. Extreme care should be used while working with the board. Follow the procedure exactly as listed.

STEP 1 — CHECK TRANSFORMER INPUT TO PROCESSOR BOARD — Connector J4 (see Fig. 23) is used to connect the control transformer to the microprocessor board. Set your volt-ohmmeter to the ac voltage with a range setting of approximately 30 v. Turn the control ON-OFF switch to the ON position and check the voltages at the connector. They should be as follows:

TERMINAL PINS (J4)	VOLTAGE VAC
1 to 2	15.0 — 20.6
4 to 6	16.0 — 21.8
5 to 6	8.0 — 10.9
5 to 4	8.0 — 10.9

If the voltage is not as listed, the problem is not with the processor board, but could be due to a blown fuse, faulty transformer, or wiring error.

STEP 2 — CHECK PROCESSOR BOARD POWER SUPPLIES — The processor board has 7 separate dc voltage power supplies, all of which are required for the processor to operate properly.

Set meter for approximately 20 vdc.

Connect the negative test lead to test pin TP18, (see Fig. 24). Turn the control switch on and press the display button so that the control enters the Quick Test mode. Check the voltage at each of the test pins listed. If the voltage is not as specified, replace the processor board.

TEST PIN NO.	VOLTAGE (vdc ± 0.5 v)
TP3	+10
TP4	+12
TP6	+5
TP10	+5
TP14	+12
TP15	+12
TP7	-5*

*If you are not using a digital voltmeter, you will have to reverse leads on the meter.

STEP 3 — CHECK VOLTAGE TOLERANCE CIRCUITRY — The board includes hardware to check for low control circuit voltage. First turn the ON-OFF switch to the OFF position and connect the negative test probe to TP18. Turn power to the ON position and enter Quick Test mode. Check the voltage at test pin TP9. If the voltage measured is greater than one v, there is a problem. Recheck transformer input voltage and if still within specifications, replace the processor board.

STEP 4 — CHECK PROCESSOR RESET LINE — First turn control switch to the OFF position. Connect negative test probe to test pin TP18. Turn power to the ON position and enter Quick Test mode. Check the voltage at test pin TP11. If the voltage is greater than + 3 v, there is a problem. Reset the ON-OFF switch and recheck the value. If still greater than + 3 v, replace the processor board.

STEP 5 — CHECK RELAY BOARD OUTPUTS — This step involves checking the output signals to relays K1-13 on the relay board. Disconnect cable from relay board to processor board at J9.

Set meter for approximately 20 vdc. Connect the negative lead to test pin TP19. Turn power on and enter Quick Test mode. Check voltage at terminal 14 on connector J9 (see Fig. 25). If it is not 12 ± 1 vdc, replace the processor board.

Next, turn the power off, and connect the positive test lead to TP15. Turn power on and enter Quick Test mode. Check the voltage at connector J9 pins. Voltages should be as follows:

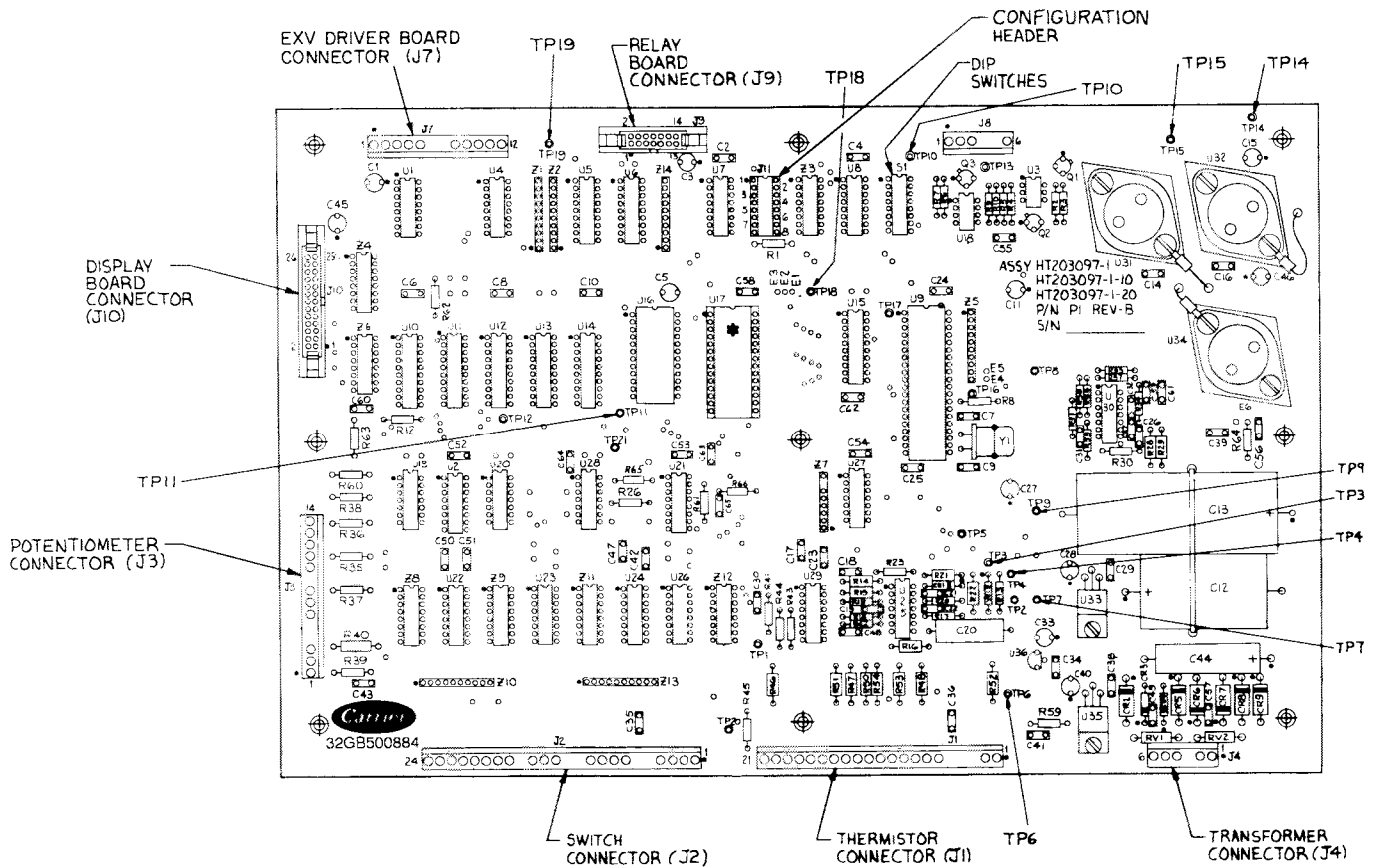
QUICK TEST STEP NUMBER	VOLTAGE (vdc)												
	Terminal Pins (J9)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. TO 3.0.	0	0	0	0	0	0	0	0	0	0	0	0	12
3.1.	0	0	0	0	0	0	0	0	0	0	12	0	12
3.2.	0	0	0	0	0	0	0	0	0	0	0	12	12
3.3.	0	0	0	0	0	0	0	0	12	0	0	0	12
3.4.	0	0	0	0	0	0	0	0	0	12	0	0	12
3.5.	12	0	0	0	0	0	0	0	12	0	0	0	12
3.6.	0	12	0	0	0	0	0	0	12	0	0	0	12
3.7.	0	0	12	0	0	0	0	0	12	0	0	0	12
3.8.	0	0	0	12	0	0	0	0	12	0	0	0	12
3.9.	0	0	0	0	12	0	0	0	0	12	0	0	12
4.0.	0	0	0	0	0	12	0	0	0	12	0	0	12
4.1.	0	0	0	0	0	0	12	0	0	12	0	0	12
4.2.	0	0	0	0	0	0	0	12	0	12	0	0	12

NOTE: Pins shown in **boldface type** will be energized for only 10 seconds. All other pins will be energized continuously while at the proper Quick Test step. The control will stand in the Quick Test mode for only 10 minutes unless the display button is pressed.

Acceptable range for voltage reading:

zero v — zero-4 v
12 v — 11-13 v

If any of the above voltages are not measured, replace the processor board.



*EPROM HT207101-1-XX (040-210) or HT204247-1-XX (225,250,280) where "xx" is the current revision number.

⚠ WARNING

Do not remove label covering EPROM. Removal causes program to be erased.

A30-452

Fig. 24 - Processor Board Test Pins and Connectors

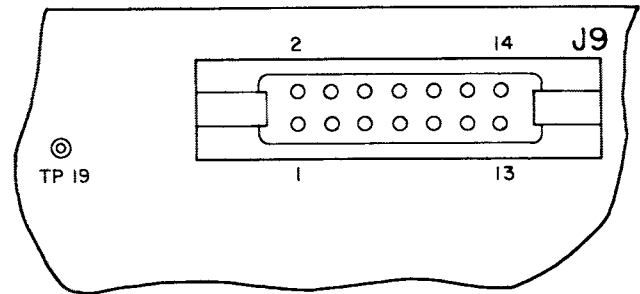


Fig. 25 - Relay Board Connector

STEP 6 - ELECTRONIC EXPANSION VALVE OUTPUTS

Driver Board Outputs— Turn power off. Connect positive test lead of meter to terminal 8 on connector J11 of the driver board. Set meter for approximately 20 vdc. Turn power on, but do not enter the Quick Test mode. For the first 50 seconds the valve windings alternately energize to close the valve in Circuit A. During this time, connect the negative test lead to terminals 9, 10, 11, and 12 in succession. The voltage should fluctuate at each pin. If it remains constant at a voltage or at zero v, remove the connector and recheck. If the outputs are correct, the expansion valve should be checked. If the outputs are not correct, disconnect driver

board plugs P3 and P7 from the processor board and check the processor board EXV outputs. See Processor Board Outputs section below.

To test Circuit B outputs, follow the procedure for Circuit A, except connect the positive lead of the meter to terminal 1, and the negative lead to terminals 2, 3, 4, and 5 in succession. The Circuit B valve energizes for approximately 50 seconds immediately after Circuit A valve.

Processor Board Outputs— Turn power off. Connect the positive lead of the meter to terminal 8 on connector J7 on the processor board. Set meter for approximately 20 vdc. Turn power on, but do not enter the Quick Test mode. For the first 50 seconds the valve windings alternately energize to close the valve in Circuit A. During this time, connect the negative test lead to terminals 9, 10, 11, and 12 in succession. The voltage should fluctuate at each pin. If it remains constant at a voltage or at zero v, replace the processor board. If the outputs are correct, and the driver board outputs are not correct, replace the driver board. If the driver board and processor board outputs are correct, then the expansion valve should be checked.

To test Circuit B outputs, follow the same procedure for Circuit A, except connect the positive lead of the meter to terminal 1, and the negative lead to terminals 2, 3, 4, and 5 in succession. The Circuit B valve energizes for approximately 50 seconds immediately after Circuit A valve.

STEP 7 — DISPLAY BOARD CONNECTION CHECK-OUT — Turn power OFF and *disconnect ribbon cable*. Connect the negative test lead to TP18 on the processor board. Turn power on. You should get the following voltages at connector J10 (see Fig. 26):

TERMINAL PINS (J10)	VOLTAGE (vdc $\pm$ 0.5 v)
17	5
18	5
20*	2-5
22*	2-5
24	5

*Voltage reading is dependent on meter impedance. Reading may vary with different meters.

STEP 8 — POTENTIOMETER CONNECTION CHECK-OUT — Turn power off and disconnect plugs from J3. Connect negative test lead to terminal TP18 on the processor board. Turn power on and enter Quick Test mode. You should get the following voltages at each pin on connector J3 (see Fig. 24):

TERMINAL PINS (J3)	VOLTAGE (vdc $\pm$ 0.5 v)
1*	2-5
3	5
6	5
8*	2-5
10*	2-5
12	5
13*	2-5
14*	2-5

*Voltage reading is dependent on meter impedance. Reading may vary with different meters.

If these voltages are not obtained, replace the processor board.

STEP 9 — THERMISTOR INPUT CONNECTOR CHECK-OUT — Turn power off and remove thermistor connections from J1 (identify for replacing). Connect negative test lead to TP18. Turn power on and enter Quick Test. Check for the following voltages at connector J1 (see Fig. 24):

TERMINAL PINS (J1)	VOLTAGE (vdc $\pm$ 0.25 v)	TERMINAL PINS (J1)	VOLTAGE (vdc $\pm$ 0.5 v)
1	0	13	5
2	5	14	0
6	0	15	5
7	5	16	0
8	0	17	5
9	5	18	0
10	0	19	5
11	5	20	0
12	0	21	5

If anything different is found, replace the processor board.

STEP 10 — SWITCH INPUT CONNECTION CHECK-OUT — Turn power off and disconnect all plugs from J2. Connect negative test lead to test pin TP18. Turn power on and enter Quick Test. Check for the following voltages at connector J2 (see Fig. 24):

TERMINAL PINS (J2)	VOLTAGE (vdc $\pm$ 0.25 v)	TERMINAL PINS (J2)	VOLTAGE (vdc $\pm$ 0.5 v)
1	0	15	0
2	5	17	5
3	0	18	5
4	5	19	5
7	0	20	5
8	5	21	5
9	0	22	5
10	5	23	5
		24	5

If any other voltage is obtained, replace the processor board.

If the above procedure is completed successfully, but the unit will not function properly, replace the processor board.

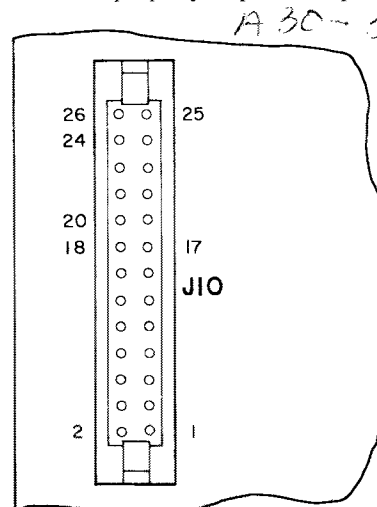


Fig. 26 — Display Board Connector

Processor Board Replacement — If it is necessary to replace the processor board, proceed as follows:

1. Before any work begins, be sure that all disconnects are open and tagged. Open the control box cover and remove the inner panel.
2. Remove the sheet metal cover over the processor board. Be careful not to allow the cover to hang near the heater wires.
3. Disconnect all the electrical connectors from the processor board and label them for replacement.
4. Remove the processor from the unit by removing the screws that hold the processor to the control box panel.
5. Remove the old processor board from the unit.
6. Install new processor in the unit. Use extreme care in installing.
7. Remove the protective shipping material from the board connectors and reconnect all plugs.

IMPORTANT: When installing thermistors, make sure the thermistors are connected to the correct pins on the processor board. The processor is not capable of determining whether the correct thermistor is connected to the correct set of pins on the board.

8. Remove the factory-installed configuration header from the old processor board. Use a small screwdriver to wedge under the configuration header to remove it; then reinstall the header in the new board. The orientation of the header should be as shown in Fig. 27. Use extreme care in handling the header.
9. Adjust the DIP switches on the new board to match those on the old board. Be sure to replace the plastic cover over the DIP switch assembly. Check that all connections are proper and tight.
10. Replace the sheet metal cover over the processor board.
11. Replace inner panel to control box and restore power to unit.

12. Use the Quick Test procedure to check the operation of the unit. When operation is confirmed, close and secure the control box door.
13. Start unit and confirm operation.

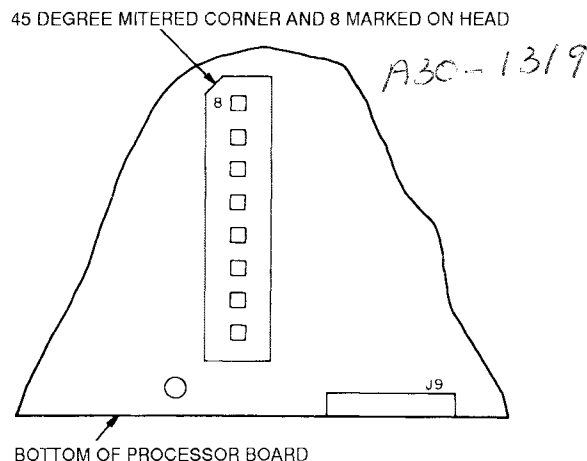


Fig. 27 — Configuration Header

Relay Board Troubleshooting — The relay board contains 13 electro-mechanical relays. The small relays are 24 vac. The large relays are 115 v or 230 v depending on control voltage. The relays are controlled by the processor through the ribbon cable attached to the relay board.

The following procedure can be used to check out the operation of the relays. Turn off the control ON-OFF switch and remove the wiring connectors connected to J5 and J6 (see Fig. 6). Set meter for resistance.

If the contacts do not close at the required Quick Test step, check the relay outputs from the processor board (see Processor Board Checkout procedure section on page 41).

LOW-VOLTAGE RELAYS — Connect the negative test lead to terminals 11 and 12 of connector J6. At the following indicated Quick Test steps, the resistance should be zero, and at all others ∞ (infinity). Turn power on and proceed through Quick Test.

QUICK TEST STEP NUMBER	VOLTAGE (vdc $\pm$ 0.5 v)							
	Terminal Pins (J6)							
	1	2	3	4	5	6	7	8
1. to 3.4.	∞	∞	∞	∞	∞	∞	∞	∞
3.5.	0	∞	∞	∞	∞	∞	∞	∞
3.6.	∞	0	∞	∞	∞	∞	∞	∞
3.7.	∞	∞	0	∞	∞	∞	∞	∞
3.8.	∞	∞	∞	0	∞	∞	∞	∞
3.9.	∞	∞	∞	∞	0	∞	∞	∞
4.0.	∞	∞	∞	∞	∞	0	∞	∞
4.1.	∞	∞	∞	∞	∞	∞	0	∞
4.2.	∞	∞	∞	∞	∞	∞	∞	0

0 The resistance will stay at zero ohms for only 10 seconds on each step.

HIGH-VOLTAGE RELAY CHECK — Connect the negative test lead to either terminal 8, 9, or 10 on connector J5. Check resistance between terminals 8 and 5 before entering Quick Test. Resistance should be ∞ (infinity). At the following Quick Test steps noted, resistance should be zero ohms; at all others ∞ (infinity).

QUICK TEST STEP NUMBER	VOLTAGE (vdc $\pm$ 0.5 v)				
	Terminal Pins (J5)				
	1	2	3	4	5
1. to 3.0	∞	∞	∞	∞	0
3.1.	∞	∞	0	∞	0
3.2.	∞	∞	∞	0	0
3.3.	0	∞	∞	∞	0
3.4.	∞	0	∞	∞	0
3.5.	0	∞	∞	∞	0
3.6.	0	∞	∞	∞	0
3.7.	0	∞	∞	∞	0
3.8.	0	∞	∞	∞	0
3.9.	∞	0	∞	∞	0
4.0.	∞	0	∞	∞	0
4.1.	∞	0	∞	∞	0
4.2.	∞	0	∞	∞	0

Display Board Checkout — The display board can be completely checked out using the Quick Test procedure.

The display should first be checked when entering the Quick Test mode. The display should read **88**. If it does not, replace the display board.

The set point potentiometer can be checked using Step 2.5. of the Quick Test.

The display button is a normally closed switch. Failures of the switch will usually result in the switch not clicking. The other method that can be used to check the switch is to connect an ohmmeter to the 2-switch terminals that have leads connected to them. The center terminal is not used. The contacts should be closed when the switch is not depressed and open when the switch is depressed.

Accessory Reset Board Checkout — The accessory reset board (see Fig. 12) is only required when temperature reset is used. It can be completely checked out using the Quick Test procedure, Steps 2.7., 2.9., and 3.0.

The reset board can also be checked using the following procedure:

1. Remove connector from processor board (see Fig. 1) and connect an ohmmeter to terminals 3 and 4 on the connector. Numbers are marked on the connector. Set the meter for 10,000 ohms. You should obtain a resistance of 3,333 ohms. Adjust the potentiometers on the board. Resistance should remain constant at 3,333 ohms.
2. Connect the ohmmeter to terminals 3 and 6. As the reset limit potentiometer is turned clockwise, resistance should increase from 0 ohms to approximately 3,400 ohms.
3. Connect the ohmmeter to terminals 3 and 5. If the reset ratio potentiometer is turned clockwise, resistance should increase from 0 ohms to approximately 3,400 ohms.
4. Connect the ohmmeter to terminals 3 and 2. As the reset set point potentiometer is turned clockwise, resistance should increase from 0 ohms to approximately 3,400 ohms.

If any of the above steps are incorrect, replace the board; it cannot be serviced.

Compressor Protection Control System (CPCS) Board — The compressor protection board controls the compressor and compressor crankcase heater.

The ground current protection is provided by the compressor board.

The large relay located on the board is used to provide a feedback signal to the processor board.

The operation of the compressor board can be checked using the Quick Test procedure. When the Quick Test step (3.5. to 4.2.) that turns on the compressor board is energized, the compressor board will be energized for 10 seconds and will then be turned off. During the 10 seconds, the crankcase heater will be turned off and the compressor contactor will be turned on. The feedback contacts will close, but it will take approximately 3 to 6 seconds for the microprocessor to read the feedback contacts. The status for the feedback switch is displayed by a **0** or **1** in the display. A **0** means open contacts and a **1** means closed contacts.

If the board does not perform properly, use standard wiring troubleshooting procedures to check the wiring for open circuits. Refer to Operating Information section on page 17 for diagnostic codes for possible causes for failure.

If a compressor short-to-ground exists, the compressor board may detect the short before the circuit breaker trips. If this is suspected, check the compressor for short-to-ground failures with an ohmmeter. The ground current is sensed with a current toroid (coil) around all 3 or 6 wires between the main terminal block and the compressor circuit breaker(s).

Compressor Ground Current (CGC) Board (30GT130-210, and 225,250,280) —

One board is used for each circuit of these units. Each board receives input from 4 toroids wired in series, one toroid per compressor. With 24 v supplied at terminals A and B, a current imbalance (compressor ground current) sensed by any toroid causes the NC (normally closed) contacts to open, shutting down the lead compressor in the affected circuit. All other compressors in that circuit shut down as a result. The NC contacts remain open until the circuit is reset by momentarily deenergizing the board using the push-button switch.

If the NC contacts open, it is necessary to remove toroids from the T1-T2 circuit to determine which toroid is causing the trip. The chiller circuit can then be put back on line after the circuit breaker of the faulty compressor is opened. The compressor problem can then be diagnosed by normal troubleshooting procedures.

Thermistor Troubleshooting — The Flotronic™ control system uses thermistors to measure temperatures at various points in the refrigeration circuit as shown in Fig. 7-10.

The resistance vs temperature and electrical characteristics for all thermistors in the system are identical. To obtain an accurate reading, a high-impedance meter (such as a digital meter) must be used.

The thermistors in the Flotronic control system have a 5 vdc signal applied across them any time unit control circuit is energized. The voltage drop across the thermistor is directly proportional to the temperature and resistance of the thermistor.

To determine temperatures at the various thermistor locations, disconnect the thermistor from the processor board, and measure the resistance across the appropriate thermistor using a high quality digital voltmeter. Use resistance reading obtained to determine thermistor temperature from Tables 15 or 16 (°F or °C).

The microprocessor has been programmed to check the operation of the thermistors. If the measured temperature is outside the range of -60 to 240 F (-51 to 116 C) (363,000

ohms to 216 ohms), it will be treated as a sensor failure and a diagnostic code will be displayed. It is also possible to check the operation of the thermistors using the Quick Test procedure.

IMPORTANT: If a thermistor has failed or the wire is damaged, replace the complete thermistor assembly. Do not attempt to splice wires or repair assembly. For thermistor replacement instructions, see separate Installation, Start-Up and Service Instructions.

EXV Troubleshooting — If it appears that the electronic expansion valve is not properly controlling operating suction pressure or superheat, there are a number of checks that can be made using the Quick Test and initialization features built into the Flotronic microprocessor control.

Follow the procedure below to diagnose and correct EXV problems.

STEP 1 — CHECK PROCESSOR EXV OUTPUTS — Check EXV output signals at the J7 terminals of the processor board, and the J11 terminals of the EXV driver board (if provided). This procedure is described in Step 6 of Processor Board Checkout Procedure (see page 42).

STEP 2 — CHECK EXV WIRING — Check wiring to electronic expansion valves from J7 terminal strip on processor board.

1. Check color coding and wire connections. Make sure that they are connected to correct terminals at J7 terminal strip and EXV plug connections. Check for correct wiring at driver board input and output terminals. See Fig. 4A-4D.
2. Check for continuity and tight connection at all pin terminals.
3. Check plug connections at J7 terminal strip and at EXVs. Be sure EXV connections are not crossed.

STEP 3 — CHECK RESISTANCE OF EXV MOTOR WINDINGS — Remove plug at J7 terminal strip and check resistance between common lead (red wire, terminal D) and remaining leads A, B, C, and E. Resistance should be 25 ohms $\pm$ 2 ohms.

STEP 4 — CHECK THERMISTORS THAT CONTROL EXV — Check thermistors that control processor output voltage pulses to the EXVs. Circuit A thermistors are T5 and T7, Circuit B thermistors are T6 and T8. Refer to Fig. 7, 9 and 10 for location.

1. Use Quick Test steps 2.0. through 2.3. to determine if thermistors are shorted or open.
2. Check thermistor calibration at known temperature by measuring actual resistance and comparing value measured with values listed in Tables 15 or 16.
3. Make sure that thermistor leads are connected to the proper pin terminals at the J11 terminal strip on processor board and that thermistor probes are located in proper position in the refrigerant circuit.

When the above checks have been completed, the actual operation of the EXV can be checked by using the procedures outlined in Step 5 on page 46. During Quick Test steps 3.5. and 3.9. each EXV is opened approximately 250 steps by the processor. This Quick Test feature, along with the initialization mode **20** can be used to verify proper valve operation.

STEP 5 — CHECK OPERATION OF THE EXV — Use the following procedure to check the actual operation of the electronic expansion valves.

1. Close the liquid line service valve for the circuit to be checked and run through the appropriate Quick Test step 3.5. or 3.9. to pump down the low side of the system. Repeat the Quick Test step 3 times to ensure all refrigerant has been pumped from the low side and that the EXV has been driven fully open (760 steps).

NOTE: Do not use the control ON-OFF switch to recycle the control during this step, and be sure to allow the compressors to run the full 10 seconds at each step.

2. Turn OFF control circuit switch and compressor circuit breaker(s). Close compressor service valves and remove any remaining refrigerant from the low side of the system.
3. Remove screws holding top cover of EXV. Carefully remove top cover, using caution to avoid damage to the O-ring seal and motor leads. If EXV plug was disconnected during this process, reconnect it after the cover is removed.
4. Note position of lead screw (see Fig. 15). If valve has responded properly to processor signals in Step 5.1 above, the valve should be fully open and the lead screw should protrude approximately $\frac{1}{4}$ in. to $\frac{3}{4}$ in. above the top of the motor.
5. Recycle the control by turning the control circuit switch to the ON position. This puts the control in initialization mode **20**. During the first 10 seconds of the initialization mode, each valve is driven to the fully closed position (760 steps) by the processor. With the cover lifted off the EXV valve body, observe the operation of the valve motor and lead screw. The motor should turn in the counterclockwise (CCW) direction and the lead screw should move down into the motor hub until the valve is fully closed. Lead screw movement should be smooth and uniform from the fully open to the fully closed position.
6. When test has been completed, carefully reassemble expansion valve. Be careful not to damage motor or O-ring when reassembling valve. Open compressor service valves and close compressor circuit breakers. Open liquid line service valve. Turn control circuit switch to ON position, and allow unit to operate. Verify proper operation of unit.

This process of opening and closing the EXV can be repeated by repeating this Quick Test step 3.5. or 3.9. and recycling the control as described in the preceding steps. If the valve does not operate as described when properly connected to the processor and receiving the correct signals, it should be replaced.

If operating problems persist after reassembly, they may be due to out-of-calibration thermistor(s), or intermittent connections between the processor board terminals and the EXV plug. Recheck all wiring connections and voltage signals.

Other possible causes of improper refrigerant flow control could be restrictions in the liquid line. Check for plugged filter drier(s), restricted metering slots in the EXV, or partially closed liquid line service valves. Formation of ice or frost on the lower body of the electronic expansion valve is one symptom of restricted metering slots. Clean or replace the valve if necessary. Wrap a wet cloth around the valve if it is to be replaced to prevent the heat from damaging the internal components of the valve.

NOTE: Frosting of the valve is normal during Quick Test steps 3.5. and 3.9. and at initial start-up. The frost should dissipate after 5 to 10 minutes operation of a system that is operating properly.

NOTE: The EXV orifice is a screw-in type and may be removed for inspection and cleaning (040-225 units). Once the top cover has been removed, the EXV motor may be taken out by removing the 2 cap screws securing motor to valve body. Pull motor, lead screw and the slide assembly up off the orifice assembly. See Fig. 15. A slot has been cut in top of orifice assembly to facilitate removal using a large screwdriver. Turn orifice assembly counterclockwise to remove.

When cleaning or reinstalling orifice assembly, care must be taken not to damage orifice assembly seals. The bottom seal acts as a liquid shut-off, replacing a liquid line solenoid valve.

Reassembly of valve is made easier by screwing the slide and lead screw assembly out of the motor. Align hole in top of slide with the guide pin in orifice assembly and gently push slide and lead screw onto orifice assembly about halfway. Screw motor onto lead screw and secure EXV motor with cap screws. Care must be taken not to twist or pull on wires from EXV motor to valve cover pin connections. Check EXV operation in Quick Step steps.

Table 15 – Sensor Temperature (F) vs Resistance/Voltage Drop; Flotronic™ Units

TEMPERATURE (F)	VOLTAGE DROP (V)	RESISTANCE (OHMS)	TEMPERATURE (F)	VOLTAGE DROP (V)	RESISTANCE (OHMS)	TEMPERATURE (F)	VOLTAGE DROP (V)	RESISTANCE (OHMS)
-25	4.684	98,010	59	2.708	7,868	143	0.750	1,189
-24	4.673	94,707	60	2.676	7,665	144	0.737	1,165
-23	4.662	91,522	61	2.644	7,468	145	0.725	1,141
-22	4.651	88,449	62	2.612	7,277	146	0.713	1,118
-21	4.640	85,485	63	2.581	7,091	147	0.701	1,095
-20	4.628	82,627	64	2.549	6,911	148	0.689	1,072
-19	4.616	79,871	65	2.517	6,735	149	0.678	1,050
-18	4.604	77,212	66	2.486	6,564	150	0.666	1,028
-17	4.591	74,648	67	2.454	6,399	151	0.655	1,007
-16	4.578	72,175	68	2.423	6,237	152	0.644	986
-15	4.565	69,790	69	2.391	6,081	153	0.634	965
-14	4.551	67,490	70	2.360	5,929	154	0.623	945
-13	4.537	65,272	71	2.329	5,781	155	0.613	925
-12	4.523	63,133	72	2.299	5,637	156	0.602	906
-11	4.509	61,070	73	2.268	5,497	157	0.592	887
-10	4.494	59,081	74	2.237	5,361	158	0.582	868
-9	4.479	57,162	75	2.207	5,229	159	0.573	850
-8	4.463	55,311	76	2.177	5,101	160	0.563	832
-7	4.448	53,526	77	2.147	4,976	161	0.554	815
-6	4.431	51,804	78	2.117	4,855	162	0.545	798
-5	4.415	50,143	79	2.088	4,737	163	0.536	782
-4	4.398	48,541	80	2.058	4,622	164	0.527	765
-3	4.381	46,996	81	2.029	4,511	165	0.518	749
-2	4.363	45,505	82	2.000	4,403	166	0.509	734
-1	4.345	44,066	83	1.972	4,298	167	0.501	719
0	4.327	42,678	84	1.943	4,195	168	0.493	705
1	4.308	41,339	85	1.915	4,096	169	0.484	690
2	4.289	40,047	86	1.887	4,000	170	0.476	677
3	4.270	38,800	87	1.859	3,906	171	0.468	663
4	4.250	37,596	88	1.832	3,814	172	0.461	650
5	4.230	36,435	89	1.805	3,726	173	0.453	638
6	4.209	35,313	90	1.778	3,640	174	0.446	626
7	4.188	34,231	91	1.751	3,556	175	0.438	614
8	4.167	33,185	92	1.725	3,474	176	0.431	602
9	4.145	32,176	93	1.699	3,395	177	0.424	591
10	4.123	31,201	94	1.673	3,318	178	0.417	581
11	4.101	30,260	95	1.647	3,243	179	0.410	570
12	4.078	29,351	96	1.622	3,170	180	0.403	560
13	4.055	28,472	97	1.597	3,099	181	0.397	551
14	4.032	27,624	98	1.572	3,031	182	0.390	542
15	4.008	26,804	99	1.548	2,964	183	0.384	533
16	3.984	26,011	100	1.523	2,898	184	0.378	524
17	3.959	25,245	101	1.500	2,835	185	0.371	516
18	3.934	24,505	102	1.476	2,773	186	0.365	508
19	3.909	23,789	103	1.453	2,713	187	0.360	501
20	3.883	23,096	104	1.430	2,655	188	0.354	494
21	3.858	22,427	105	1.407	2,598	189	0.348	487
22	3.831	21,779	106	1.385	2,542	190	0.342	480
23	3.805	21,153	107	1.362	2,488	191	0.337	473
24	3.778	20,547	108	1.341	2,436	192	0.332	467
25	3.751	19,960	109	1.319	2,385	193	0.326	461
26	3.723	19,392	110	1.298	2,335	194	0.321	456
27	3.696	18,843	111	1.277	2,286	195	0.316	450
28	3.668	18,311	112	1.256	2,238	196	0.311	444
29	3.639	17,796	113	1.236	2,192	197	0.306	439
30	3.611	17,297	114	1.216	2,147	198	0.301	434
31	3.582	16,814	115	1.196	2,103	199	0.297	429
32	3.553	16,346	116	1.176	2,060	200	0.292	424
33	3.523	15,892	117	1.157	2,018	201	0.288	419
34	3.494	15,453	118	1.138	1,977	202	0.283	415
35	3.464	15,027	119	1.120	1,937	203	0.279	410
36	3.434	14,614	120	1.101	1,898	204	0.274	405
37	3.404	14,214	121	1.083	1,860	205	0.270	401
38	3.373	13,826	122	1.065	1,822	206	0.266	396
39	3.343	13,449	123	1.048	1,786	207	0.262	391
40	3.312	13,084	124	1.030	1,750	208	0.258	386
41	3.281	12,730	125	1.013	1,715	209	0.254	382
42	3.250	12,387	126	0.997	1,680	210	0.250	377
43	3.219	12,053	127	0.980	1,647	211	0.247	372
44	3.187	11,730	128	0.964	1,614	212	0.243	366
45	3.156	11,416	129	0.948	1,582	213	0.239	361
46	3.124	11,111	130	0.932	1,550	214	0.236	356
47	3.093	10,816	131	0.917	1,519	215	0.232	350
48	3.061	10,529	132	0.902	1,489	216	0.229	344
49	3.029	10,250	133	0.887	1,459	217	0.225	338
50	2.997	9,979	134	0.872	1,430	218	0.222	332
51	2.965	9,717	135	0.857	1,401	219	0.219	325
52	2.933	9,461	136	0.843	1,373	220	0.215	318
53	2.901	9,213	137	0.829	1,345	221	0.212	311
54	2.869	8,973	138	0.815	1,318	222	0.209	304
55	2.837	8,739	139	0.802	1,291	223	0.206	297
56	2.805	8,511	140	0.788	1,265	224	0.203	289
57	2.772	8,291	141	0.775	1,239	225	0.200	282
58	2.740	8,076	142	0.762	1,214			

Table 16 – Sensor Temperature (C) vs Resistance/Voltage Drop; Flotronic™ Units

TEMPERATURE (C)	VOLTAGE DROP (V)	RESISTANCE (OHMS)	TEMPERATURE (C)	VOLTAGE DROP (V)	RESISTANCE (OHMS)	TEMPERATURE (C)	VOLTAGE DROP (V)	RESISTANCE (OHMS)
-32.0	4.690	100 049	14.5	2.737	8055	61.0	0.765	1219
-31.5	4.680	97 006	15.0	2.708	7868	61.5	0.753	1197
-31.0	4.671	94 061	15.5	2.680	7685	62.0	0.742	1175
-30.5	4.661	91 209	16.0	2.651	7507	62.5	0.731	1153
-30.0	4.651	88 449	16.5	2.622	7334	63.0	0.720	1132
-29.5	4.641	85 777	17.0	2.593	7165	63.5	0.709	1111
-29.0	4.630	83 191	17.5	2.565	7000	64.0	0.698	1090
-28.5	4.620	80 687	18.0	2.536	6840	64.5	0.688	1070
-28.0	4.609	78 264	18.5	2.508	6683	65.0	0.678	1050
-27.5	4.597	75 918	19.0	2.479	6531	65.5	0.667	1030
-27.0	4.586	73 648	19.5	2.451	6382	66.0	0.657	1011
-26.5	4.574	71 451	20.0	2.423	6237	66.5	0.648	992
-26.0	4.562	69 324	20.5	2.395	6096	67.0	0.638	973
-25.5	4.550	67 265	21.0	2.367	5959	67.5	0.628	955
-25.0	4.537	65 272	21.5	2.339	5825	68.0	0.619	937
-24.5	4.525	63 344	22.0	2.311	5694	68.5	0.609	919
-24.0	4.512	61 477	22.5	2.283	5566	69.0	0.600	902
-23.5	4.499	59 670	23.0	2.256	5442	69.5	0.591	885
-23.0	4.485	57 921	23.5	2.228	5321	70.0	0.582	868
-22.5	4.471	56 228	24.0	2.201	5203	70.5	0.574	852
-22.0	4.457	54 589	24.5	2.174	5088	71.0	0.565	836
-21.5	4.443	53 003	25.0	2.147	4976	71.5	0.557	820
-21.0	4.428	51 467	25.5	2.120	4867	72.0	0.548	805
-20.5	4.413	49 980	26.0	2.094	4760	72.5	0.540	790
-20.0	4.398	48 541	26.5	2.067	4656	73.0	0.532	775
-19.5	4.383	47 148	27.0	2.041	4555	73.5	0.524	761
-19.0	4.367	45 799	27.5	2.015	4457	74.0	0.516	746
-18.5	4.351	44 492	28.0	1.989	4360	74.5	0.508	733
-18.0	4.334	43 228	28.5	1.963	4267	75.0	0.501	719
-17.5	4.318	42 003	29.0	1.938	4175	75.5	0.493	706
-17.0	4.301	40 817	29.5	1.912	4086	76.0	0.486	693
-16.5	4.283	39 668	30.0	1.887	4000	76.5	0.479	681
-16.0	4.266	38 556	30.5	1.862	3915	77.0	0.472	669
-15.5	4.248	37 478	31.0	1.837	3832	77.5	0.465	657
-15.0	4.230	36 435	31.5	1.813	3752	78.0	0.458	645
-14.5	4.211	35 424	32.0	1.789	3674	78.5	0.451	634
-14.0	4.193	34 444	32.5	1.764	3597	79.0	0.444	623
-13.5	4.174	33 495	33.0	1.741	3523	79.5	0.437	613
-13.0	4.154	32 576	33.5	1.717	3450	80.0	0.431	602
-12.5	4.135	31 685	34.0	1.693	3379	80.5	0.425	592
-12.0	4.115	30 821	34.5	1.670	3310	81.0	0.418	583
-11.5	4.094	29 984	35.0	1.647	3243	81.5	0.412	573
-11.0	4.074	29 173	35.5	1.624	3177	82.0	0.406	564
-10.5	4.053	28 386	36.0	1.602	3113	82.5	0.400	556
-10.0	4.032	27 624	36.5	1.579	3051	83.0	0.394	547
- 9.5	4.010	26 884	37.0	1.557	2990	83.5	0.388	539
- 9.0	3.989	26 168	37.5	1.536	2931	84.0	0.383	531
- 8.5	3.967	25 472	38.0	1.514	2873	84.5	0.377	524
- 8.0	3.944	24 798	38.5	1.492	2816	85.0	0.371	516
- 7.5	3.922	24 144	39.0	1.471	2761	85.5	0.366	509
- 7.0	3.899	23 509	39.5	1.450	2707	86.0	0.361	502
- 6.5	3.876	22 893	40.0	1.430	2655	86.5	0.355	496
- 6.0	3.852	22 296	40.5	1.409	2603	87.0	0.350	489
- 5.5	3.829	21 716	41.0	1.389	2553	87.5	0.345	483
- 5.0	3.805	21 153	41.5	1.369	2504	88.0	0.340	477
- 4.5	3.781	20 606	42.0	1.349	2457	88.5	0.335	472
- 4.0	3.756	20 076	42.5	1.330	2410	89.0	0.331	466
- 3.5	3.732	19 561	43.0	1.311	2364	89.5	0.326	461
- 3.0	3.707	19 061	43.5	1.292	2320	90.0	0.321	456
- 2.5	3.682	18 575	44.0	1.273	2276	90.5	0.317	451
- 2.0	3.656	18 103	44.5	1.254	2234	91.0	0.312	446
- 1.5	3.631	17 645	45.0	1.236	2192	91.5	0.308	441
- 1.0	3.605	17 199	45.5	1.218	2152	92.0	0.303	436
- 0.5	3.579	16 766	46.0	1.200	2112	92.5	0.299	432
0.0	3.553	16 346	46.5	1.182	2073	93.0	0.295	427
0.5	3.526	15 937	47.0	1.165	2035	93.5	0.291	423
1.0	3.500	15 539	47.5	1.148	1997	94.0	0.287	419
1.5	3.473	15 153	48.0	1.131	1961	94.5	0.283	415
2.0	3.446	14 777	48.5	1.114	1925	95.0	0.279	410
2.5	3.419	14 412	49.0	1.098	1890	95.5	0.275	406
3.0	3.392	14 057	49.5	1.081	1856	96.0	0.271	402
3.5	3.364	13 711	50.0	1.065	1822	96.5	0.267	398
4.0	3.337	13 375	50.5	1.049	1789	97.0	0.264	393
4.5	3.309	13 048	51.0	1.034	1757	97.5	0.260	389
5.0	3.281	12 730	51.5	1.019	1725	98.0	0.257	385
5.5	3.253	12 420	52.0	1.003	1694	98.5	0.253	380
6.0	3.225	12 119	52.5	0.988	1663	99.0	0.250	376
6.5	3.197	11 826	53.0	0.974	1634	99.5	0.246	371
7.0	3.169	11 541	53.5	0.959	1604	100.0	0.243	367
7.5	3.140	11 263	54.0	0.945	1575	100.5	0.240	362
8.0	3.112	10 992	54.5	0.931	1547	101.0	0.236	357
8.5	3.083	10 729	55.0	0.917	1519	101.5	0.233	353
9.0	3.054	10 472	55.5	0.903	1492	102.0	0.230	346
9.5	3.026	10 223	56.0	0.890	1465	102.5	0.227	341
10.0	2.997	9 979	56.5	0.876	1438	103.0	0.224	335
10.5	2.968	9 742	57.0	0.863	1412	103.5	0.221	330
11.0	2.939	9 512	57.5	0.850	1387	104.0	0.218	324
11.5	2.911	9 287	58.0	0.837	1362	104.5	0.215	318
12.0	2.882	9 068	58.5	0.825	1337	105.0	0.212	312
12.5	2.853	8 855	59.0	0.812	1313	105.5	0.209	305
13.0	2.824	8 647	59.5	0.800	1289	106.0	0.206	299
13.5	2.795	8 444	60.0	0.788	1265	106.5	0.204	292
14.0	2.766	8 247	60.5	0.776	1242	107.0	0.201	285