# 30GT040-420
# Flotronic™ Reciprocating Liquid Chillers
# 50/60 Hz

COMMERCIAL UNITARY SYSTEMS

# Controls and Troubleshooting

## CONTENTS



## GENERAL

Unit sizes 230-420 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 230B-315B, 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).

NOTE: TXVs are not available on modular units.

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.




Book 2 Tab 5c | PC 903 | Catalog No. 563-080 | Printed in U.S.A. | Form 30GT-3T | Pg 1 | 8-95 | Replaces: 30GT-2T

**⚠ 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 30GT | SECTION B UNIT 30GT |
|---|---|---|---|
| 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 | — | — |
| 230 | 220 | 150 | 080 |
| 245 | 230 | 150 | 090 |
| 255 | 240 | 150 | 100 |
| 270 | 260 | 170 | 100 |
| 290 | 280 | 190 | 110 |
| 315 | 300 | 210 | 110 |
| 330 | 325 | 170 | 170 |
| 360 | 350 | 190 | 190/170* |
| 390 | 380 | 210 | 190 |
| 420 | 400 | 210 | 210 |

*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 (factory-installed option) units.

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

- processor board
- relay board
- display board
- thermistors
- EXV or FIOP thermostatic expansion valve (040-110)
- liquid line solenoid valve (FIOP 040-110 TXV units only)
- compressor protection control system (CPCS) (standard on size 070, 50 Hz, and on 080-110 and associated modular sizes)
- ground fault protection system (130-210 and associated modular sizes)
- accessory board (field installed)
- demand limit board (field installed)

The Flotronic control system monitors and controls the following:

- cooler leaving-fluid temperature control (compressor capacity control)
- EXVs
- 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 - 3, is the chiller system's main control center. It contains the microprocessor, microprocessor memory, power supplies, analog-to-digital converters, 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-4C 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.

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

From one to 5 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.

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 EXVs are controlled by the microprocessor. See Fig. 4A-4C for wiring schematic of microprocessor inputs and outputs.

**Table 2 — System Thermistors**

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

LEGEND

**EXV** — Electronic Expansion Valve

## Table 3 — Status Switches

| STATUS SWITCH | J2 PIN CONNECTOR | 040-060 (50 Hz) 040-070 (60 Hz) | 070 (50 Hz) 080, 230B | 090-110, 245B-315B | 130 (60 Hz) | 130 (50 Hz) 150, 230A-255A | 170,190, 270A,290A,330A/B, 360A/B, 390B | 210, 315A, 390A, 420A/B |
|---|---|---|---|---|---|---|---|---|
| Oil Pressure, Ckt B | 1, 2 | Not Used | OPSB | OPSB | OPSB | OPSB | OPSB | OPSB |
| Oil Pressure, Ckt A | 3, 4 | Not Used | OPSA | OPSA | OPSA | OPSA | OPSA | OPSA |
| Loss of Charge, Ckt B | 7, 8 | LCSB | LCSB | LCSB | LCSB | LCSB | LCSB | LCSB |
| Loss of Charge, Ckt A | 9, 10 | LCSA | LCSA | LCSA | LCSA | LCSA | LCSA | LCSA |
| Remote On/Off | 13, 14 | Jumper | Jumper | Jumper | Jumper | Jumper | Jumper | Jumper |
| Compressor Fault Signal, B4 | 15, 17 | Not Used | Not Used | Not Used | Not Used | Not Used | Not Used | Not Used |
| Compressor Fault Signal, B3 | 15, 18 | Not Used | Not Used | Not Used | Not Used | Not Used | CR-B3 | CR-B3 |
| Compressor Fault Signal, B2 | 15, 19 | Not Used | Not Used | CPCS-B2 | CR-B2 | CR-B2 | CR-B2 | CR-B2 |
| Compressor Fault Signal, B1 | 15, 20 | CPCS-B1 | CPCS-B1 | CPCS-B1 | CR-B1 | CR-B1 | CR-B1 | CR-B1 |
| Compressor Fault Signal, A4 | 15, 21 | Not Used | Not Used | Not Used | Not Used | Not Used | Not Used | CR-A4 |
| Compressor Fault Signal, A3 | 15, 22 | Not Used | Not Used | Not Used | Not Used | CR-A3 | CR-A3 | CR-A3 |
| Compressor Fault Signal, A2 | 15, 23 | Not Used | CPCS-A2 | CPCS-A2 | CR-A2 | CR-A2 | CR-A2 | CR-A2 |
| Compressor Fault Signal, A1 | 15, 24 | CPCS-A1 | CPCS-A1 | CPCS-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

| POTENTIOMETER | DESCRIPTION | LOCATION | VALID RANGE | DEFAULT VALUE |
|---|---|---|---|---|
| P1 | Cooler Leaving Fluid Set Point | Display Board | Water:<br>40 to 70 F<br>(4.4 to 21 C)<br>Brine:<br>15 to 70 F<br>(−9.4 to 21 C) | <br>70 F<br>(21 C)<br><br>42 F<br>(5.6 C) |
| P3* | Reset Limit Set Point | Accessory Reset Board | 0° to 80 F<br>(0° to 44.4 C) | 0° F<br>(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° to 95 F<br>(−17.8 to 35 C) | 0° F<br>(−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 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 (dual in-line package) 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.

To allow for field-selectable options, a second configuration method is used. A small DIP 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.

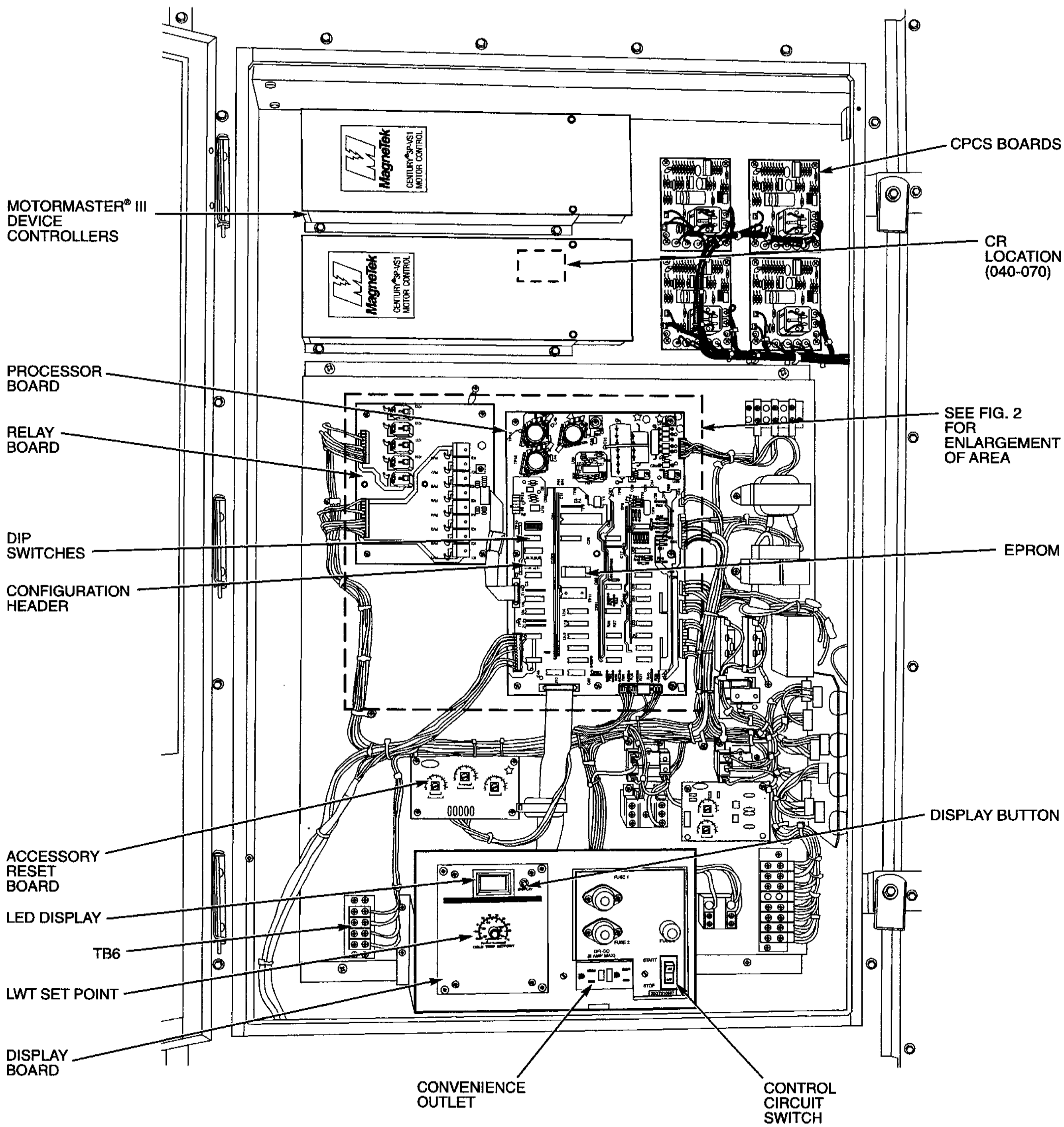
All units are shipped from factory with DIP switches in the following positions. Control circuit must be off before changing a DIP switch setting. See Table 8.

## Table 5 — Configuration Header

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

LEGEND

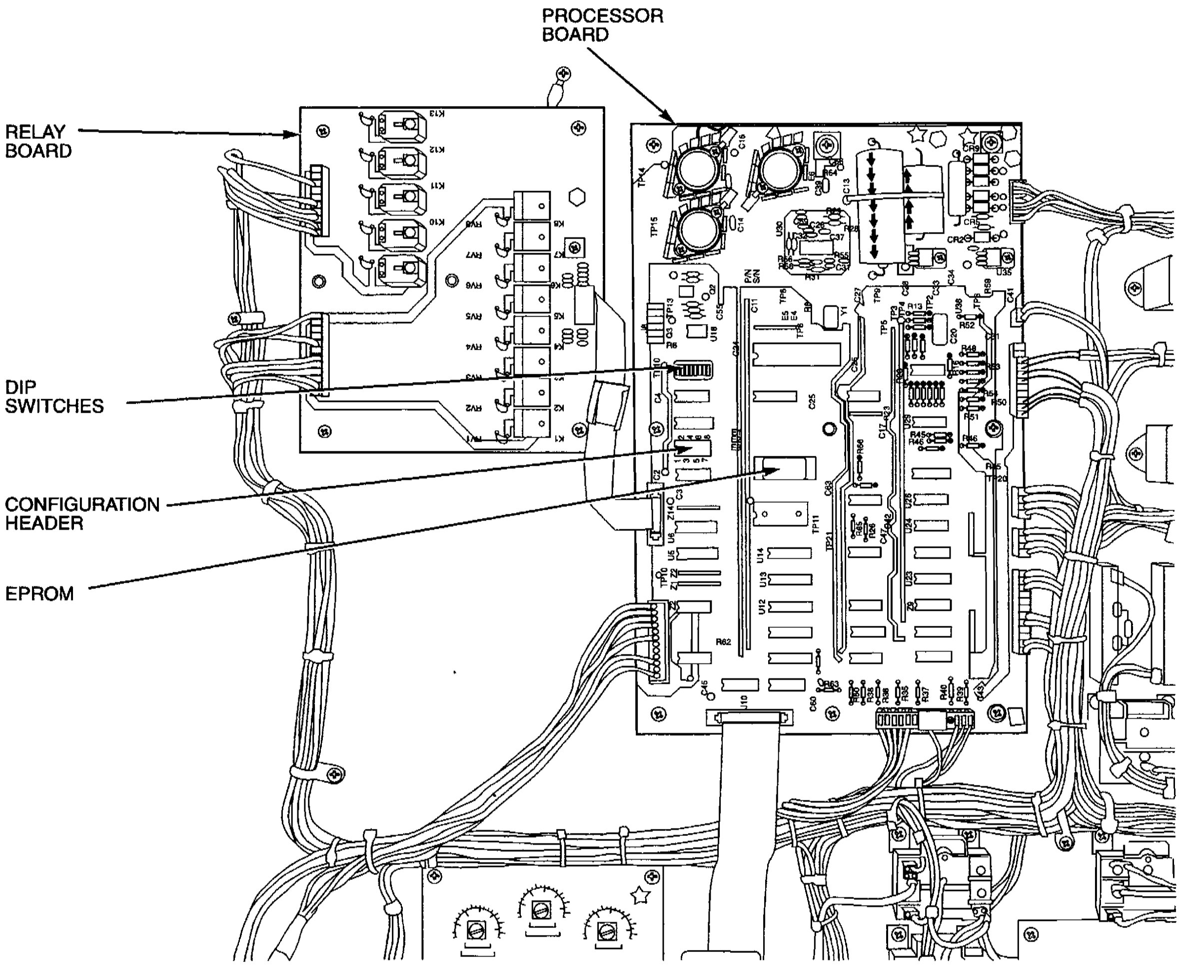
**EXV** — Electronic Expansion Valve
**TXV** — Thermostatic Expansion Valve
□ — Broken Jumper (Open Circuit)
■ — Unbroken Jumper (Closed Circuit)




LEGEND

**CPCS** — Compressor Protection Control System
**CR** — Control Relay
**DIP** — Dual In-Line Package
**EPROM** — Erasable, Programmable Read-Only Memory
**LED** — Light-Emitting Diode
**LWT** — Leaving-Water (Fluid) Temperature

**Fig. 1 — Typical Control Box (080-110 and Associated Modular Units Shown)**




LEGEND

**DIP** — Dual In-Line Package

**Fig. 2 — Photo Inset Enlargement for Fig. 1**

## Table 6 — Configuration Header Settings

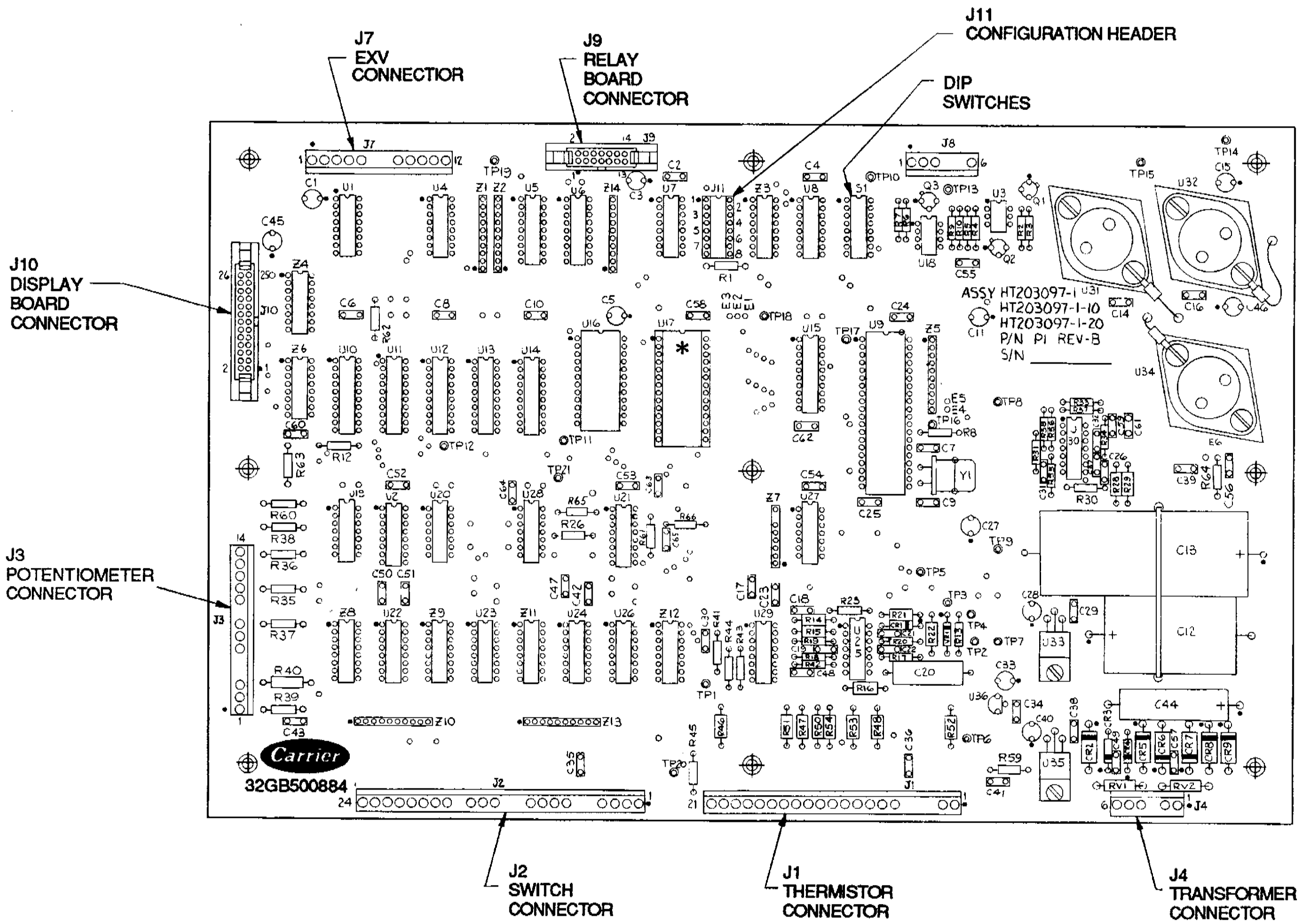
| UNIT SIZE | CONFIGURATION HEADER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 040,045,050,060 — 60 Hz (EXV) | □ | □ | ■ | □ | □ | ■ | □ | ■ |
| 040,045,050,060 — 50 Hz (EXV) | □ | □ | ■ | □ | □ | ■ | ■ | ■ |
| 040,045,050,060 — 60 Hz (TXV) | □ | □ | ■ | □ | □ | □ | □ | ■ |
| 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) | □ | □ | ■ | ■ | □ | ■ | ■ | ■ |
| 090-110 — 60 Hz (TXV) | □ | □ | ■ | ■ | □ | □ | □ | ■ |
| 090-110 — 50 Hz (TXV) | □ | □ | ■ | ■ | □ | □ | ■ | ■ |

| UNIT SIZE | CONFIGURATION HEADER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 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) | □ | □ | □ | ■ | ■ | ■ | □ | ■ |

LEGEND

**EXV** — Electronic Expansion Valve
**TXV** — Thermostatic Expansion Valve
□ — Broken Jumper (Open Circuit)
■ — Unbroken Jumper (Closed Circuit)

*And associated modular units (see Table 1).




LEGEND

**DIP** — Dual In-Line Package
**EPROM** — Erasable, Programmable Read-Only Memory
**EXV** — Electronic Expansion Valve

*EPROM HT207101-1-XX where "XX" is the current revision number.

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

**⚠ WARNING**

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

**Fig. 3 — Processor Board**

## Table 7 — DIP Switches

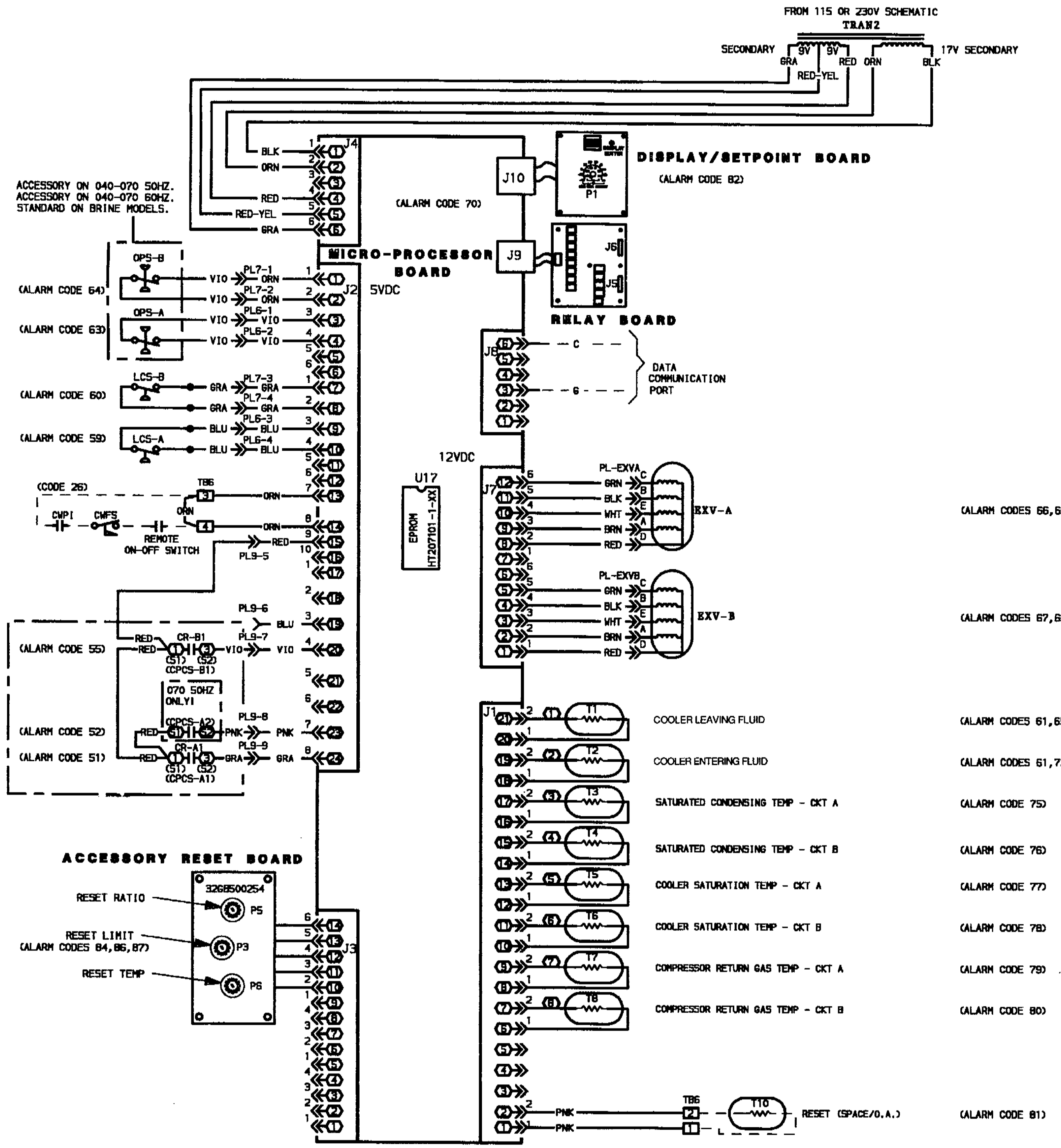
| SWITCH NO. | FUNCTION | SWITCH SETTING* | PURPOSE |
|---|---|---|---|
| 1 | Reset Mode | On<br>Off | Return Reset<br>Space or Outdoor Air Reset |
| 2 | Reset Select | On<br>Off | Enable Reset<br>Disable Reset |
| 3 | Pulldown Select | On<br>Off | Enable Pulldown<br>Disable Pulldown |
| 4 | Not Used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

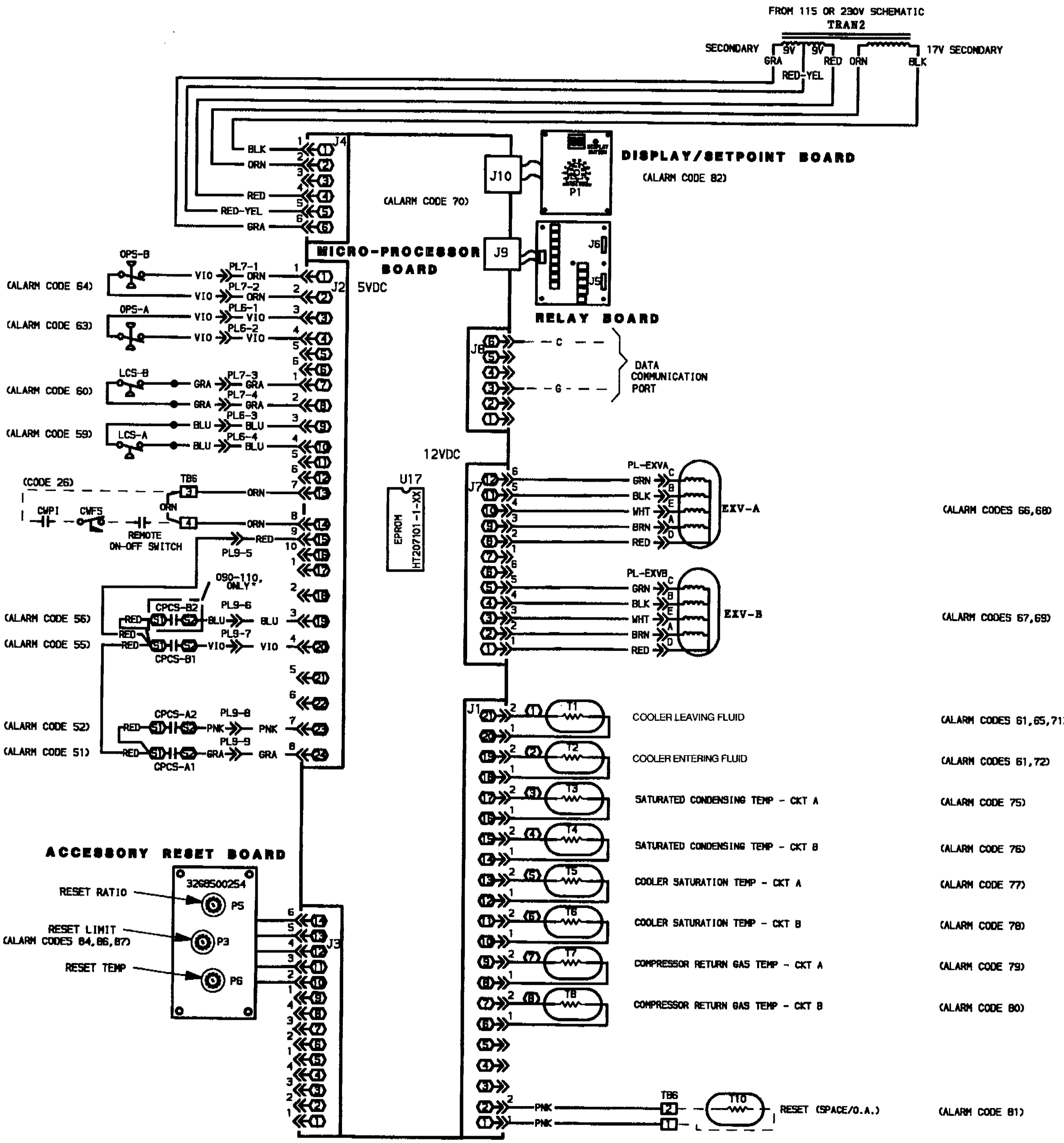
*And associated modular units (see Table 1).




LEGEND

**CPCS** — Compressor Protection Control System
**CWFS** — Chilled Water (Fluid) Flow Switch
**CWPI** — Chilled Water (Fluid) Pump Interlock
**EPROM** — Erasable, Programmable Read-Only Memory
**EXV** — Electronic Expansion Valve
**GND** — Ground
**LCS** — Loss-of-Charge Switch
**OPS** — Oil Pressure Switch
**PL** — Plug
**TB** — Terminal Board
**TRAN** — Transformer

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



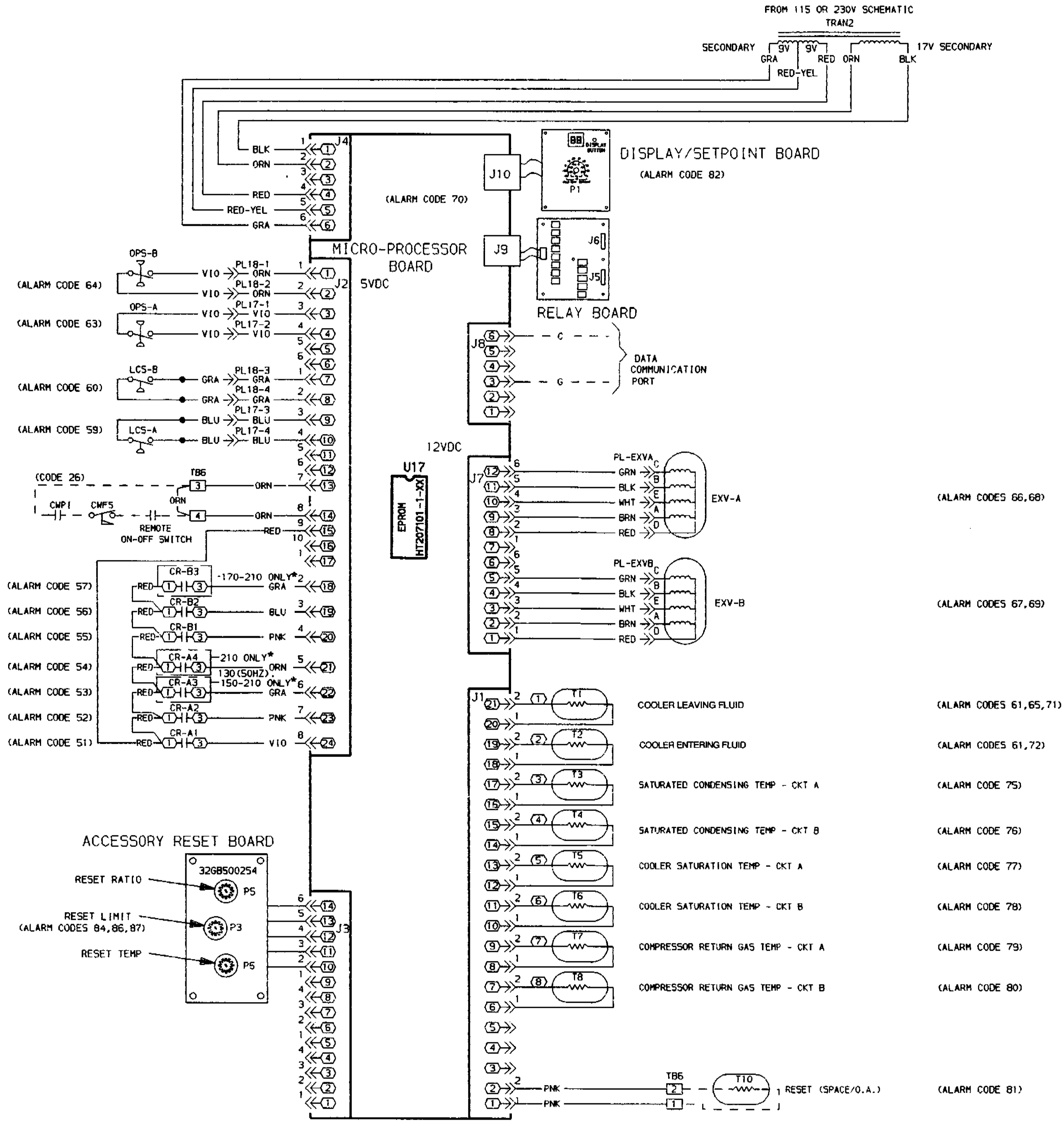

LEGEND

**CPCS** — Compressor Protection Control System
**CWFS** — Chilled Water (Fluid) Flow Switch
**CWPI** — Chilled Water (Fluid) Pump Interlock
**EPROM** — Erasable, Programmable Read-Only Memory
**EXV** — Electronic Expansion Valve
**GND** — Ground
**LCS** — Loss-of-Charge Switch
**OPS** — Oil Pressure Switch
**PL** — Plug
**TB** — Terminal Board
**TRAN** — Transformer

*And associated modular units.

NOTE: See Table 1 for unit sizes and modular combinations.

**Fig. 4B — Processor Input/Output (080-110 and Associated Modular Units)**



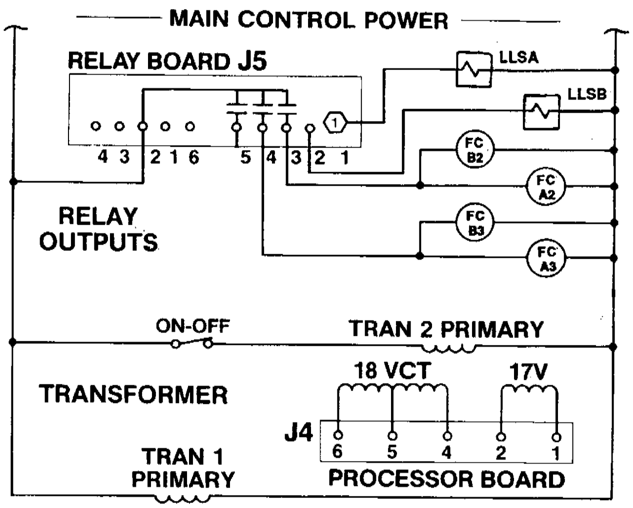

LEGEND

**CPCS** — Compressor Protection Control System
**CWFS** — Chilled Water (Fluid) Flow Switch
**CWPI** — Chilled Water (Fluid) Pump Interlock
**EPROM** — Erasable, Programmable Read-Only Memory
**EXV** — Electronic Expansion Valve
**GND** — Ground
**LCS** — Loss-of-Charge Switch
**OPS** — Oil Pressure Switch
**PL** — Plug
**TB** — Terminal Board
**TRAN** — Transformer

*And associated modular units.

NOTE: See Table 1 for unit sizes and modular combinations.

**Fig. 4C — Processor Input/Output (130-210 and Associated Modular Units)**




LEGEND

FC — Fan Contactor
LLS — Liquid Line Solenoid (FIOP units only)
VCT — Voltage Center Tap

**Fig. 5 — Printed-Circuit Board Connectors**

**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.

**Thermistors —** The electronic control uses 4 to 9 thermistors to sense temperatures for controlling chiller operation. These sensors are outlined below. 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 40 for temperature-resistance-voltage drop characteristics.

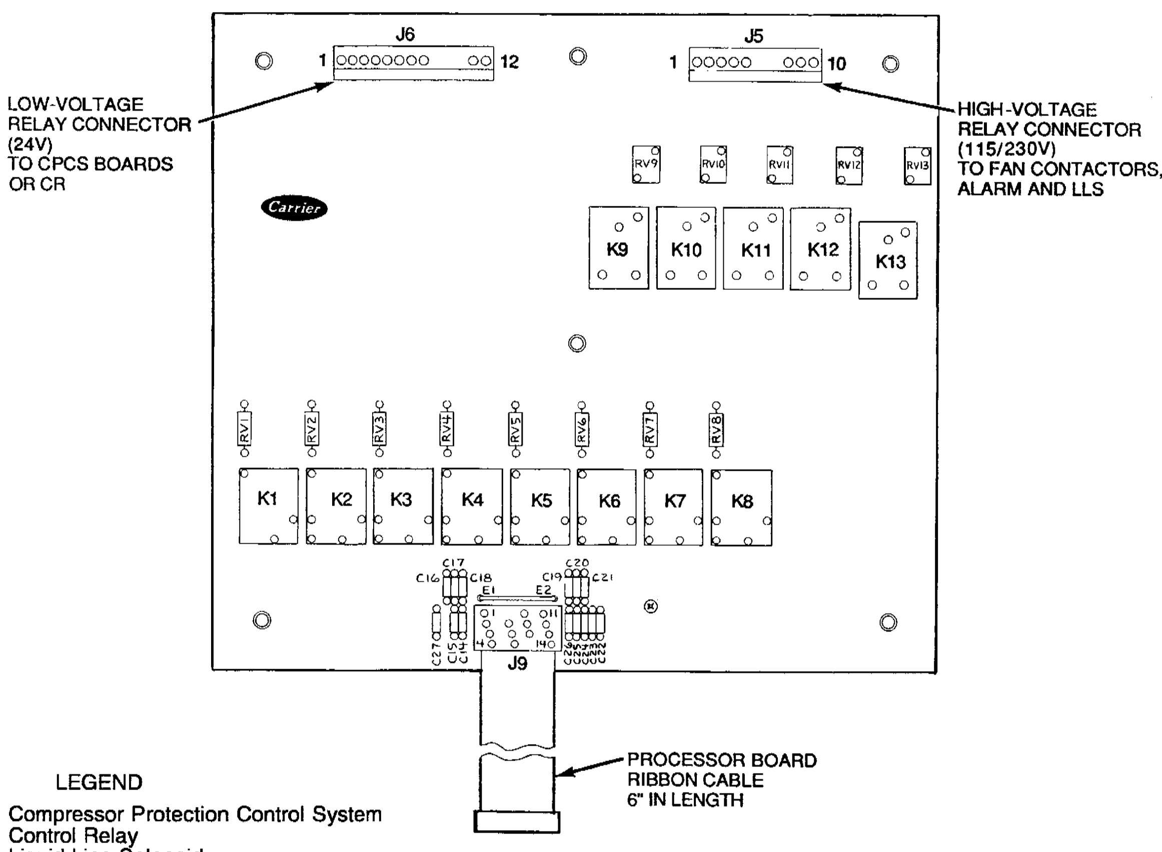
T1 — COOLER LEAVING FLUID SENSOR — This thermistor is located in the leaving fluid nozzle. The thermistor probe is inserted into a friction-fit well. The sensor well is located directly in the refrigerant path.

T2 — COOLER ENTERING FLUID 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, and are inserted into a friction-fit well. The sensor well is located directly in the refrigerant path. 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. These thermistors are inserted into friction-fit wells. The sensor wells are located directly in the refrigerant path. These thermistors are not used on units with TXVs.




LEGEND

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

**Fig. 6 — Relay Board**

**Table 9 — Output Relay**

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

LEGEND

**OFM** — Outdoor-Fan Motor

*And associated modular units (see Table 1).

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.

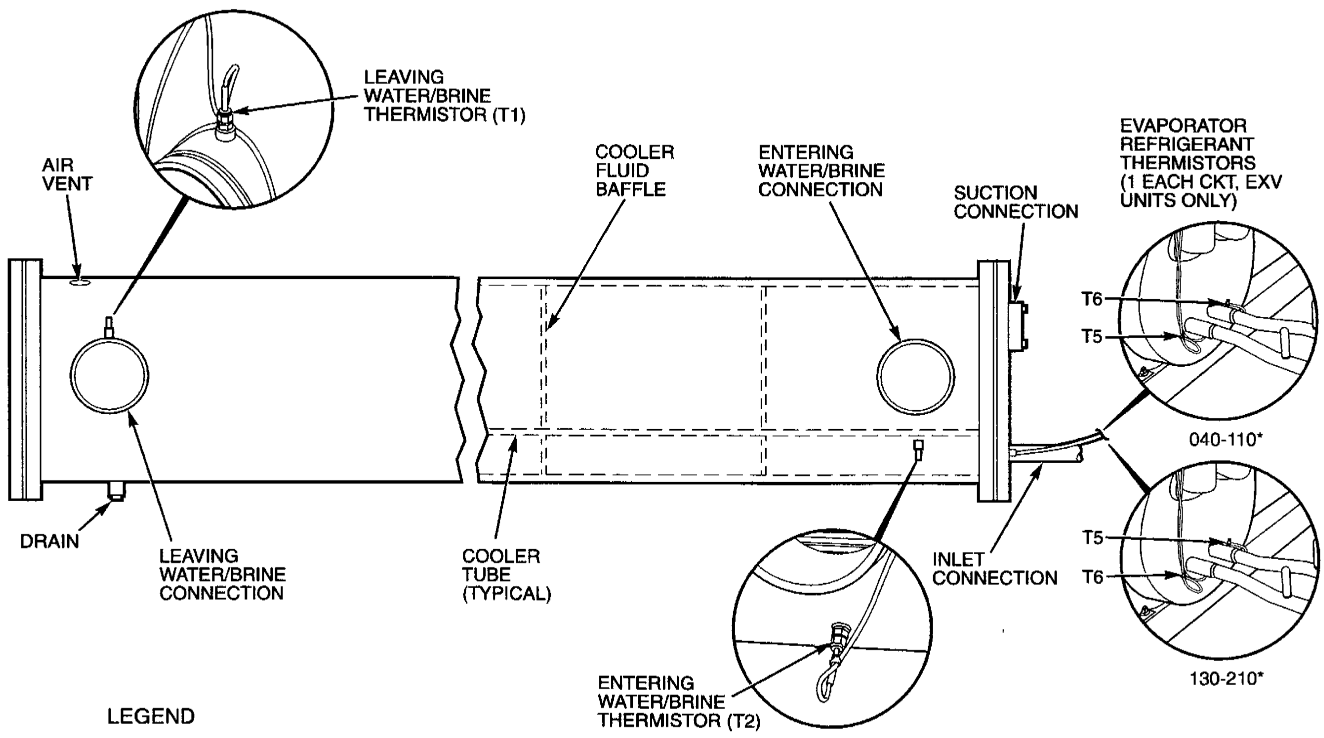
**Electronic Expansion Valves (EXV)** — See description of EXV in Electronic Expansion Valve section on page 20.

**Thermostatic Expansion Valves (TXV)** — Model 30GT040-110 units are available from the factory with conventional TXVs 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.

NOTE: This option is not available for modular units.

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 fluid temperatures without overloading the compressor.

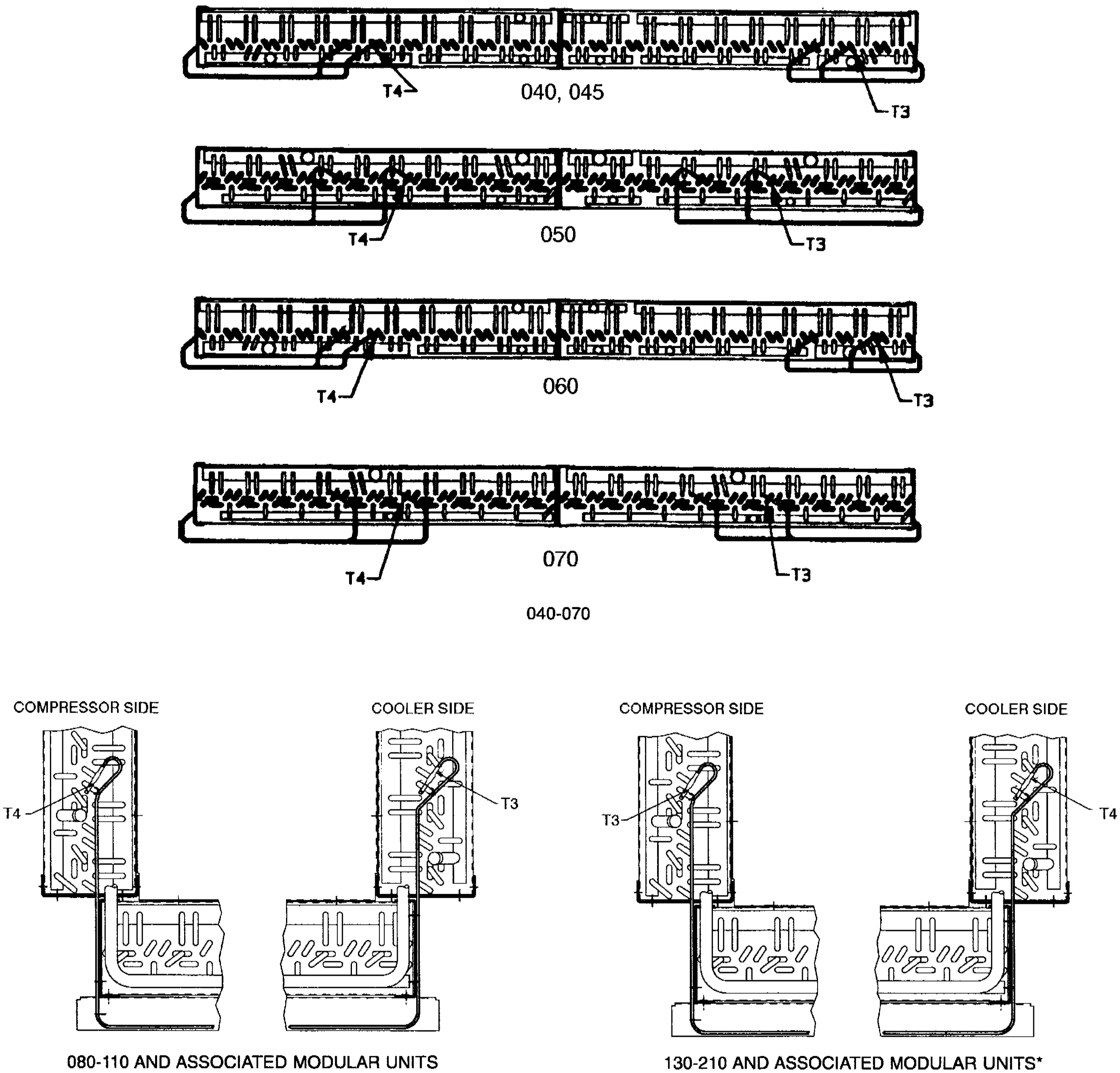



LEGEND

**EXV** — Electronic Expansion Valve

*And associated modular units.

**Fig. 7 — Cooler Thermistor Locations**




*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**

**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 shuts down the compressor.

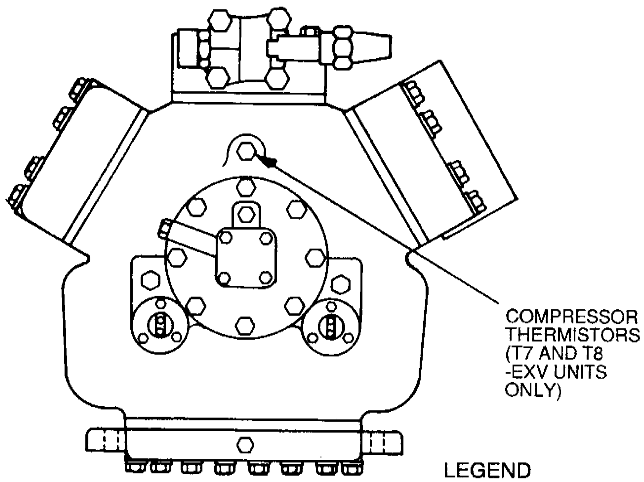



**Fig. 9 — Compressor Thermistor Locations (T7 and T8)**

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 operates the same as the CPCS, except the ground current refrigerant circuit protection is not provided.

**Compressor Ground Current Protection Board (CGF) and Control Relay (CR)** — The 30GT 130-210, and associated modular units (see Table 1) contain one compressor ground current protection board (CGF) for each refrigeration circuit. The CGF 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 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.

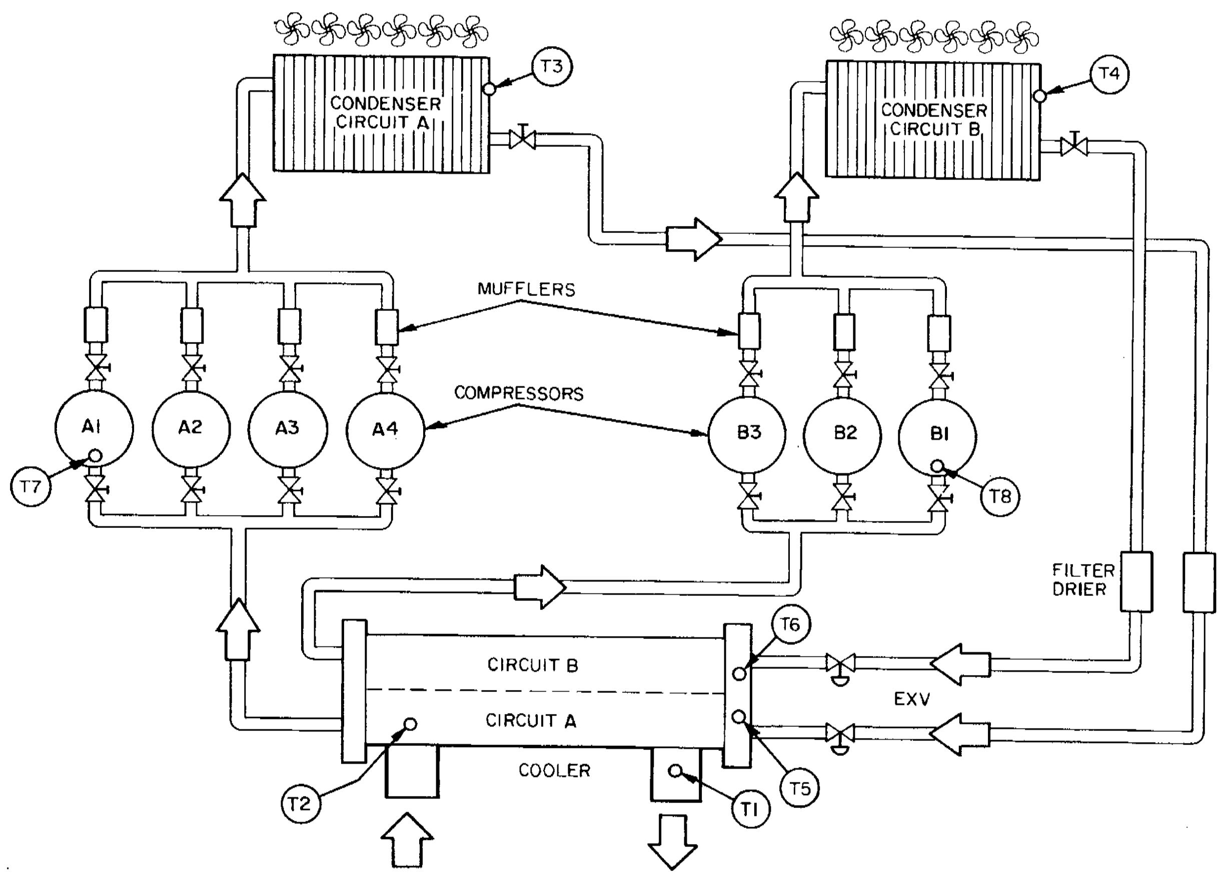



**Fig. 10 — Typical Thermistor Location (30GT210, 315A, 390A, 420A/B Shown)**

**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 fluid 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 section below and Fig. 13. See separate accessory Demand Limit Control Module Installation Instructions.

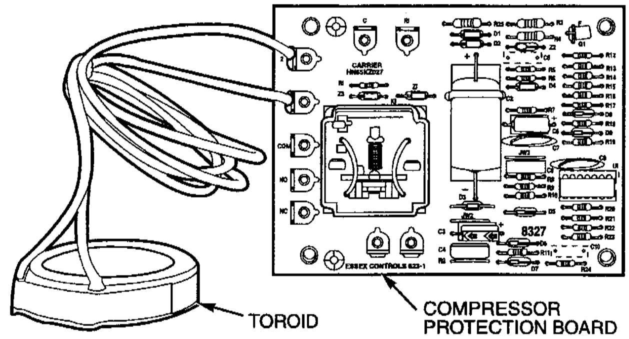
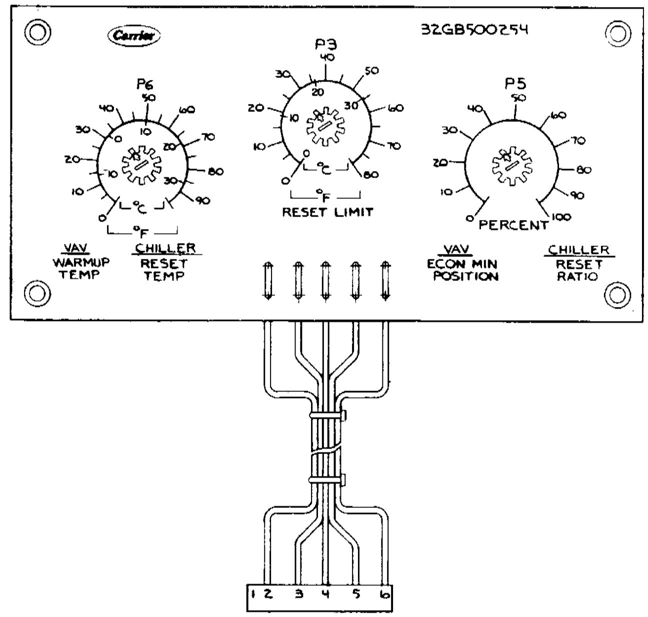


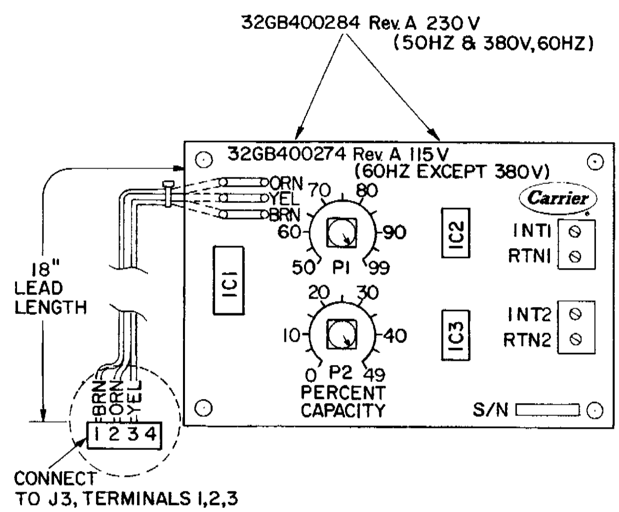

**Fig. 11 — Compressor Protection Control System Module**




LEGEND

P — Potentiometer
VAV — Variable Air Volume

**Fig. 12 — Accessory Reset Board**




LEGEND

INT — Input
P — Potentiometer
RTN — Return
S/N — Serial Number

**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 EXV is closed and initialized. The fluid 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 15 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 30 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 20 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 fluid 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 (Fluid) Flow Switch
**CWPI** — Chilled Water (Fluid) 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 fluid temperature may not equal the cooler leaving-fluid temperature set point potentiometer setting. The set point can be adjusted based on 3 different temperatures; return fluid, 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 fluid temperature, nor load to its full capacity.

Pulldown Control — Code **24** indicates this option is being used, the cooler fluid temperature is warm, and unit is limiting the capacity staging so that the fluid 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 [fluid] flow switch) or CWPI (chilled water [fluid] pump interlock) is detected.

51-87 DIAGNOSTIC DISPLAY CODES — The control contains extensive diagnostic capabilities. If something is not functioning properly, the control 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 on page 30.

**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) 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. 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 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 to OFF position for a few seconds, then to ON position 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, a **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/or 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<br>0 — Switches 6 and 7 off<br>1 — Switch 6 on; Switch 7 off<br>2 — Switch 6 off; Switch 7 on | DIP Switches 6 and 7 |
| 4. | 0 or 1 | 0 — Standard Chiller (Switch off)<br>1 — Brine Chiller* (Switch on) | DIP Switch 8 |
| 5. | 1 or 0 | 1 — EXV<br>0 — TXV | Configuration Header |
| 6. | 50 or 60 | 50 — 50-Hz Power<br>60 — 60-Hz Power | Configuration Header |
| 7. | 0 or 1 | 0 — External Reset (Switch off)<br>1 — Return Fluid Reset (Switch on) | DIP Switch 1 |
| 8. | 0 or 1 | 0 — No Reset (Switch off)<br>1 — Reset Used (Switch on) | DIP Switch 2 |
| 9. | 0 or 1 | 0 — Pulldown Not Used (Switch off)<br>1 — Pulldown Used (Switch on) | DIP Switch 3 |
| 1.0. | 0 or 1 | 0 — Demand Limit Not Used (Switch off)<br>1 — Demand Limit Used (Switch on) | DIP Switch 5 |
| 1.1. † | 0 or 1 | 0 — Remote On/Off (Switch open or jumper not in place)<br>1 — Remote On/Off (Switch closed, or jumper in place) | TB6-3 and TB6-4 |
| 1.2. | 1 | 1 — Loss-of-Charge Switch Closed<br>0 — Loss-of-Charge Switch Open | Circuit A Loss-of-Charge Switch |
| 1.3. | 1 | 1 — Loss-of-Charge Switch Closed<br>0 — Loss-of-Charge Switch Open | Circuit B Loss-of-Charge Switch |
| 1.4. | 0 ** | 1 — Low Oil Pressure Switch Closed<br>0 — Low Oil Pressure Switch Open | Circuit A Low Oil Pressure Switch |
| 1.5. | 0 ** | 1 — Low Oil Pressure Switch Closed<br>0 — Low Oil Pressure Switch Open | Circuit B Low Oil Pressure Switch |

(See Legend and Notes on page 18.)

## Table 11 — Quick Test 8.8 (cont)
### SECTION B. — Thermistor and Potentiometer Checkout

| QUICK TEST STEP NO. | NORMAL DISPLAY | STEP DESCRIPTION | THERMISTOR OR POTENTIOMETER |
|---|---|---|---|
| 1.6. | 1 | 1 — Thermistor OK<br>0 — Thermistor Faulty | T1 — Cooler Leaving Fluid Thermistor |
| 1.7. | 1 | 1 — Thermistor OK<br>0 — Thermistor Faulty | T2 — Cooler Entering Fluid Thermistor |
| 1.8. | 1 | 1 — Thermistor OK<br>0 — Thermistor Faulty | T3 — Saturated Condensing Thermistor, Circuit A |
| 1.9. | 1 | 1 — Thermistor OK<br>0 — Thermistor Faulty | T4 — Saturated Condensing Thermistor, Circuit B |
| 2.0. | 1 or 0 †† | 1 — Thermistor OK<br>0 — Thermistor Faulty or Not Used | T5 — Cooler Thermistor, Circuit A (EXV Units) |
| 2. 1. | 1 or 0 †† | 1 — Thermistor OK<br>0 — Thermistor Faulty or Not Used | T6 — Cooler Thermistor, Circuit B (EXV Units) |
| 2.2. | 1 or 0 †† | 1 — Thermistor OK<br>0 — Thermistor Faulty or Not Used | T7 — Compressor Thermistor, Circuit B ( EXV Units) |
| 2.3. | 1 or 0 †† | 1 — Thermistor OK<br>0 — Thermistor Faulty or Not Used | T8 — Compressor Thermistor, Circuit B (EXV Units) |
| 2.4. | 1 or 0 †† | 1 — Thermistor OK<br>0 — Thermistor Faulty or Not Used | T10 — Accessory Remote Thermistor |
| 2.5. | 1 | 1 — Potentiometer OK<br>0 — Potentiometer Faulty | P1 — Leaving Fluid Set Point Potentiometer |
| 2.6. | 0 | No Significance | — |
| 2.7. | 1 or 0 | 1 — Potentiometer OK<br>0 — Potentiometer Faulty or Option Not Used | P3 — Accessory Reset Limit Potentiometer |
| 2.8. | 1 or 0 | 1 — Potentiometer(s) OK<br>0 — Potentiometer(s) Faulty or Option Not Used | P4 — Accessory Demand Limit Potentiometer(s) |
| 2.9. | 1 or 0 | 1 — Potentiometer OK<br>0 — Potentiometer Faulty or Option Not Used | P5 — Accessory Reset Ratio Potentiometer |
| 3.0. | 1 or 0 | 1 — Potentiometer OK<br>0 — Potentiometer Faulty or Option Not Used | P6 — Accessory Reset Set Point Potentiometer |

(See Legend and Notes on page 18.)

## Table 11 — Quick Test 8 8 (cont)

## SECTION C. — Output Relay

| QUICK TEST STEP NO. | NORMAL DISPLAY | STEP DESCRIPTION | CONTROL SWITCH |
|---|---|---|---|
| 3. 1. | 1 | Energize First Stage of Condenser Fans<br>040-050 — OFM3<br>060-110‖ — OFM3, OFM4<br>130-210‖ — OFM3, OFM4, OFM9, OFM10 | K11 |
| 3.2. | 1 | Energize Second Stage of Condenser Fans<br>040-050 — OFM4<br>060-090‖ — OFM5, OFM6<br>100,110‖ — OFM5, OFM6, OFM7, OFM8<br>130-170‖ — OFM1, OFM2<br>190-210‖ — OFM1, OFM2, OFM11, OFM12 | K12 |
| 3.3. | 1 | Energize Liquid Line Solenoid Valve (040-110 TXV only) Circuit A | K9 |
| 3.4. | 1 | Energize Liquid Line Solenoid Valve (040-110 TXV only) Circuit B | K10 |
| 3.5. | 0 → 1 → 0 ¶ | Energize Compressor A1 and OFM1 (040-110‖)<br>Energize Compressor A1, OFM5, and OFM7 (130-210‖) | K1 |
| 3.6. | 0 → 1 → 0 ¶ | No Action (040-060 [50 Hz], 040-070 [60 Hz]) | K2 |
| | | Energize Compressor A2 (All Others) | |
| 3. 7. | 0 | No action (040-110‖, 130 [60 Hz]) | K3 |
| | 0 → 1 → 0 ¶ | Energize Compressor A3 (130 [50 Hz], 150-210‖) | |
| 3.8. | 0 | Energize Unloader A1 (040-170‖) | K4 |
| | 0 → 1 → 0 ¶ | Energize Compressor A4 (210‖) | |
| 3.9. | 0 → 1 → 0 ¶ | Energize Compressor B1, OFM2 (040-110‖)<br>Energize Compressor B1, OFM6, and OFM8 (130-210‖) | K5 |
| 4.0. | 0 → 1 → 0 ¶ | No action (040-080‖)<br>Energize Compressor B2 (090-210‖) | K6 |
| 4. 1. | 0 | No action (040-150‖) | K7 |
| | 0 → 1 → 0 ¶ | Energize Compressor B3 (170-210‖) | |
| 4.2. | 0 | Energize Unloader B1 (040-170‖)<br>No action (190-210‖) | K8 |

LEGEND

**CPCS** — Compressor Protection Control System
**CR** — Control Relay
**DIP** — Dual In-Line Package
**EPROM** — Erasable, Programmable Read-Only Memory
**EXV** — Electronic Expansion Valve
**FIOP** — Factory-Installed Option
**OFM** — Outdoor (Condenser) Fan Motor
**OPS** — Oil Pressure Switch
**TB** — Terminal Block
**TXV** — Thermostatic 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 on the processor board whenever an EPROM HT207101-1-10 or higher is installed on the processor board.

> 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 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.

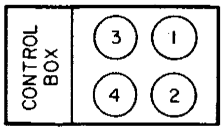
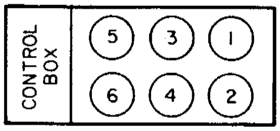
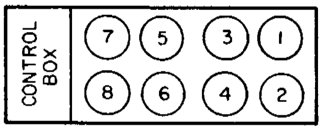
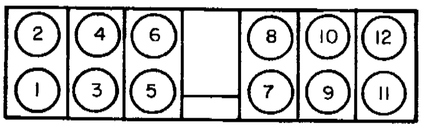
**Will always display 1 for 30GT040-060 unless accessory OPS is installed.

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

Display is 0 for 040-110 Flotronic FIOP units.

‖And associated modular units. See Table 1 for unit sizes and modular combinations.

¶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** | 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, 230B, 245B** | 1 | 3.5. | Compressor No. A1 |
|   | 2 | 3.9. | Compressor No. B1 |
| | 3, 4 | 3.1. | First Stage of Condenser Fans |
| | 5, 6 | 3.2. | Second Stage of Condenser Fans |
| **30GT100,110, 255B-315B** | 1 | 3.5. | Compressor No. A1 |
|   | 2 | 3.9. | Compressor No. B1 |
| | 3, 4 | 3.1. | First Stage of Condenser Fans |
| | 5, 6, 7, 8 | 3.2. | Second Stage of Condenser Fans |
| **30GT130-210, 230A-315A, 330A/B-420A/B†** **POWER** | 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 |
| | 1, 2, 11, 12 | 3.2. | Second Stage of Condenser Fans |

*Quick Test display numbers.
†Fan numbers 11 and 12 do not apply to 30GT130-170 and associated modular units (see Table 1).
**Control box.

**Fig. 14 — Condenser Fan Sequence**

**Capacity Control — Operating Sequence —** 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 microprocessor 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 fluid temperatures to determine the steady-state temperature of the fluid. 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 fluid 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 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 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 EXV will begin to meter the refrigerant, or the liquid line solenoid will open allowing the TXV to meter the refrigerant to the cooler. If the off-time is less than 15 minutes, the EXV or liquid line solenoid will be opened as soon as the compressor starts.

The EXVs 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 2 minutes 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 EXV or close the liquid line solenoid valve.

<u>For units with TXVs,</u> 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.

<u>For units with EXVs,</u> 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 600 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.

**Electronic Expansion Valve (EXV) (See Fig. 15)** — Standard units are equipped with a bottom seal EXV. This device eliminates the use of the liquid line solenoid pump-down at unit shutdown. An O-ring has been added to bottom of orifice assembly to complete a seal in the valve on shut-down. 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 the 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 1500 discrete steps with this combination. The valve orifice begins to be exposed at 320 steps. Since there is not a tight seal with the orifice and the sleeve, the minimum position for operation is 120 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.

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.

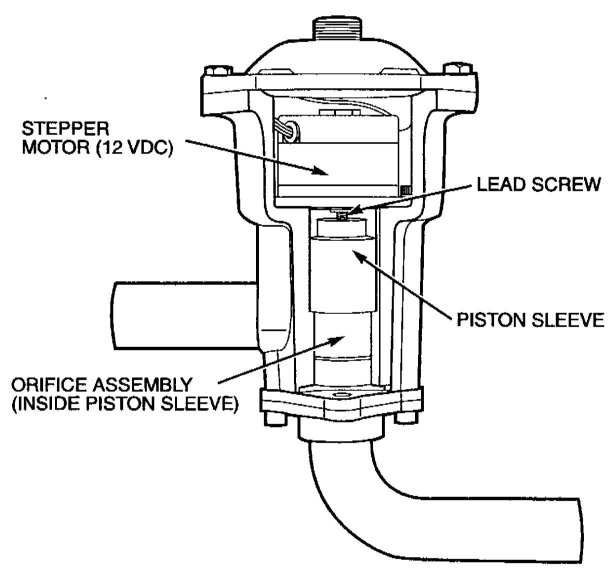



**Fig. 15 — Electronic Expansion Valve (EXV)**

## Table 12A — Capacity Control Steps — 040-070

| UNIT SIZE | CONTROL STEPS | LOADING SEQUENCE A % Displacement (Approx) | LOADING SEQUENCE A Compressors | LOADING SEQUENCE B % Displacement (Approx) | LOADING SEQUENCE B 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*, B1* | 50 | A1*, B1* |
| | 3 | 75 | A1*, B1 | 75 | A1, B1* |
| | 4 | 100 | A1, B1 | 100 | A1, B1 |
| 040 (50 Hz) 045 (60 Hz) A1† | 1 | 22 | A1* | 22 | A1* |
| | 2 | 44 | A1 | 44 | A1 |
| | 3 | 78 | A1*, B1 | 78 | 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 | 31 | A1* | 31 | A1* |
| | 2 | 46 | A1 | 46 | A1 |
| | 3 | 85 | A1*, B1 | 85 | 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 | 85 | A1*, B1 | 85 | 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 | 67 | A1*, B1* | 67 | A1*, 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 | 91 | A1*, A2, B1 | 91 | A1*, A2, B1 |
| | 6 | 100 | A1, A2, B1 | 100 | A1, A2, B1 |

*Compressor unloaded.
†Compressor unloader, standard.
**Compressor unloader, accessory.

NOTES:
1. 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.
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 *fluid loop volume* to ensure adequate run time (see Application Data section in Product Data literature).
   c. Consider adding accessory hot gas bypass package.

## Table 12B — Capacity Control Steps — 080-420

| UNIT SIZE | CONTROL STEPS | LOADING SEQUENCE A % Displacement (Approx) | LOADING SEQUENCE A Compressors | LOADING SEQUENCE B % Displacement (Approx) | LOADING SEQUENCE B Compressors |
|---|---|---|---|---|---|
| **080, 230B (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, 230B (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, 245B (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, 245B (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, 255B, 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, 255B, 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, 290B, 315B (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, 290B, 315B (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.

NOTES:
1. 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.
2. The staging of modular units (30GT230-420) will be random due to variables within the system. The loading sequence of each individual module will be as listed.
3. 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 *fluid loop volume* to ensure adequate run time (see Application Data section in Product Data literature).
   c. Consider adding accessory hot gas bypass package.

## Table 12B — Capacity Control Steps — 080-420 (cont)

| UNIT SIZE | CONTROL STEPS | LOADING SEQUENCE A % Displacement (Approx) | LOADING SEQUENCE A Compressors | LOADING SEQUENCE B % Displacement (Approx) | LOADING SEQUENCE B 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, 230A-255A (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, 230A-255A (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, 270A, 330A/B (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, 270A, 330A/B, 360B (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.

NOTES:
1. 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.
2. The staging of modular units (30GT230-420) will be random due to variables within the system. The loading sequence of each individual module will be as listed.
3. 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 *fluid loop volume* to ensure adequate run time (see Application Data section in Product Data literature).
   c. Consider adding accessory hot gas bypass package.

## Table 12B — Capacity Control Steps — 080-420 (cont)

| UNIT SIZE | CONTROL STEPS | LOADING SEQUENCE A % Displacement (Approx) | LOADING SEQUENCE A Compressors | LOADING SEQUENCE B % Displacement (Approx) | LOADING SEQUENCE B Compressors |
|---|---|---|---|---|---|
| 190, 290A, 360A/B, 390B (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, 290A, 360A/B, 390B (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, 290A, 360A/B, 390B (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, 290A, 360A, 390B (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, 290A, 360A, 390B (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, 290A, 360A, 390B (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, 315A, 390A, 420A/B (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,AB2 | 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, 315A, 390A, 420A/B (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 23.

## Head Pressure Control

FLOTRONIC™ 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 ½ 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.

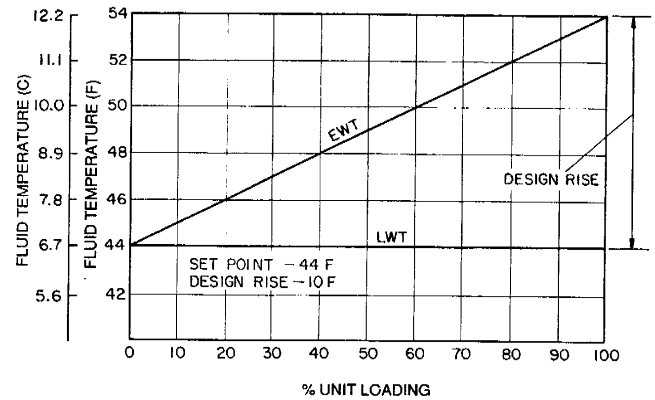
During unit start-up, microprocessor-controlled fans are turned on to prevent excessive discharge pressure during pull-down. If outdoor ambient is between 50 and 70 F (10 and 21 C) as sensed by T3 or T4, first-stage fans are turned on. If ambient is above 70 F (21 C), second-stage fans also are turned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

**Return Temperature Reset —** The control system is capable of handling leaving-fluid temperature reset based on return cooler fluid 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 28. 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 fluid temperature approximately equal to the chilled fluid set point. As the cooler load varies, the entering cooler fluid will change in proportion to the load as shown in Fig. 16. Usually the chiller size and leaving-fluid temperature set point are selected based on a full-load condition. At part load, the fluid temperature set point may be colder than required. If the leaving fluid 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 fluid temperature or, in effect, the building load.




LEGEND

**EWT** — Entering Water (Fluid) Temperature
**LWT** — Leaving Water (Fluid) Temperature

**Fig. 16 — Standard Chilled Fluid Temperature Control — No Reset**

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

| CODE | DESCRIPTION | LOCATION | RANGE |
|---|---|---|---|
| P1 | Chilled Fluid 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 FLUID SET POINT POTENTIOMETER — This should always be set at the desired LWT (leaving water [fluid] temperature) *at the zero load condition.*

P3, RESET LIMIT POTENTIOMETER — This should be set at the maximum desired amount of leaving fluid reset. Reset is always zero at zero load and the leaving fluid 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 fluid temperature is reset. To determine the setting for the reset potentiometer use the following equation:

Reset Ratio

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

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

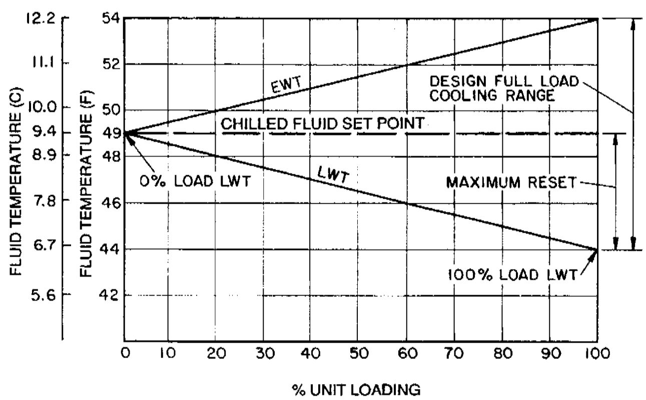
NOTE: A brine chiller is defined as a chiller with the LWT set point below 40 F (4 C). See Table 7 for proper DIP switch setting. Other factory modifications may also be necessary. The brine chiller LWT range of 15 F to 70 F (–9 C to 21 C) allows for dual set point operation.

NOTE: The chilled fluid 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




LEGEND

**EWT** — Entering Water (Fluid) Temperature
**LWT** — Leaving Water (Fluid) Temperature

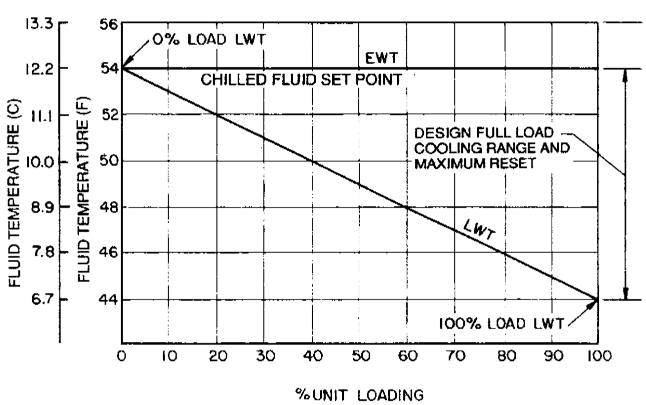
- The Chilled Water Set Point Potentiometer (P1) = 0% Load LWT = 49 F
- The Reset Limit Potentiometer (P3) = Maximum Reset = 5 F
- Reset Ratio Potentiometer (P5) = X%

Reset Ratio

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

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

EXAMPLE 2




LEGEND

**EWT** — Entering Water (Fluid) Temperature
**LWT** — Leaving Water (Fluid) Temperature

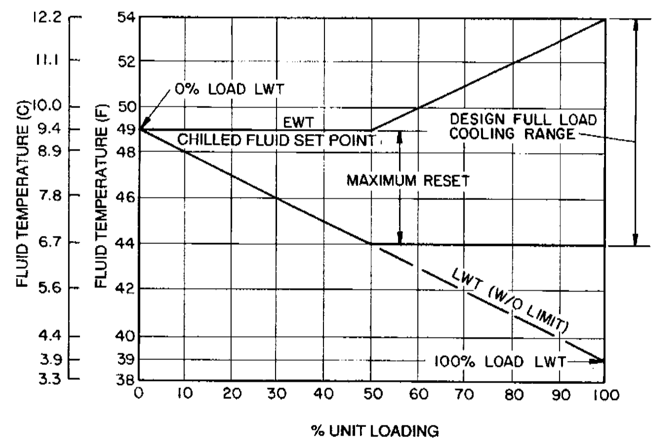
- The Chilled Fluid Set Point Potentiometer (P1) = 0% LWT = 54 F
- The Reset Limit Potentiometer (P3) = Maximum Reset = 10 F
- Reset Ratio Potentiometer (P5) = X%

Reset Ratio

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

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

EXAMPLE 3




LEGEND

**EWT** — Entering Water (Fluid) Temperature
**LWT** — Leaving Water (Fluid) Temperature

- The Chilled Fluid 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

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

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

**Space and Outdoor-Air Temperature Reset** — Space temperature reset and outdoor-air temperature reset allows for the reset of the leaving fluid 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 fluid temperature approximately equal to the leaving chilled fluid 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 fluid set point up to improve the efficiency of the chiller. The control is capable of resetting the chilled fluid 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 Fluid 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 FLUID SET POINT POTENTIOMETER — This should be set *at full load design leaving fluid temperature.*

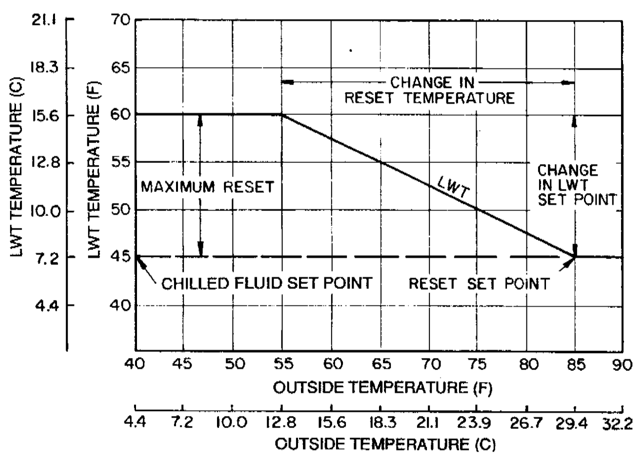
P3, RESET LIMIT POTENTIOMETER — This potentiometer should be set at the maximum desired amount of leaving fluid reset. As the reset temperature sensor drops in temperature below its set point, the chilled fluid set point is reset higher until the maximum reset (reset limit) is reached.

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

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

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:



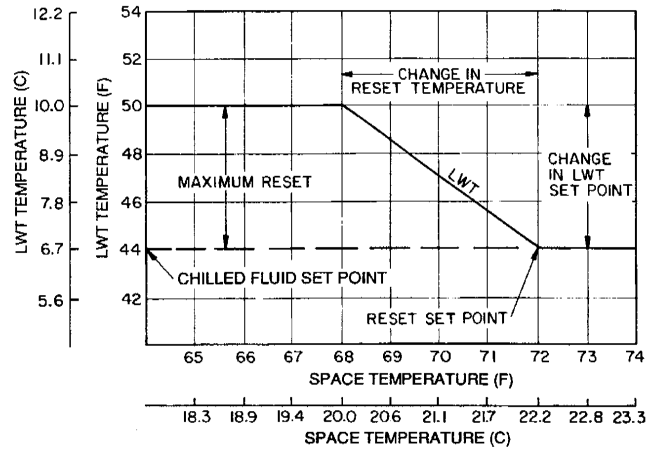

LEGEND

**LWT** — Leaving Water (Fluid) Temperature

- Reset Set Point Potentiometer (P6) = 85 F
- Chilled Fluid Set Point Potentiometer (P1) = Full Load LWT = 45 F
- Reset Limit Potentiometer (P3) = Maximum Reset = 15 F
- Outdoor Air Temperature at which Maximum Reset Occurs = 55 F
- Reset Ratio Potentiometer (P5)

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

The following is an example of space temperature reset:




LEGEND

**LWT** — Leaving Water (Fluid) Temperature

- Reset Set Point (P6) = 72 F
- Chilled Fluid Set Point Potentiometer (P1) = Full Load LWT = 44 F
- Reset Limit Potentiometer (P3) = 50 − 44 = 6 F
- Space Temperature at which Maximum Reset Occurs = 68 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 section on page 28. 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 fluid temperature is very warm, but the load is small. Without pulldown, the chiller will load rapidly and chill the fluid 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-fluid 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 accessory reset board is required.

To operate the chiller with a dual set point, the fluid should be properly chosen for temperature application. The chilled fluid 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.

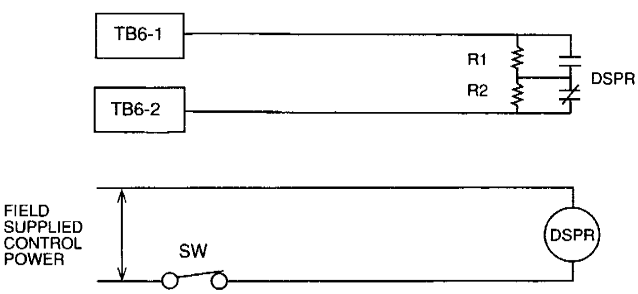
On the processor board, remove the cover to the DIP switches. Set DIP switch no. 2 to ON position to enable reset. The ON-OFF switch must be in OFF position before changing the setting of the DIP switch.

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 fluid 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 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) fluid, 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 Fluid Set Point:** | 26 | –3.3 |
| **Chiller Reset Temperature:** | 95 | 35 |
| **Reset Limit Potentiometer:** | 18° | 10° |
| **Reset Ratio:** | 100% | |




LEGEND

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

**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**

Be careful 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 Outdoor-Air 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 fluid 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 position for return fluid temperature reset. For space or outdoor-air temperature reset, set DIP switch 1 to OFF position and switch 2 to ON position.
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.

NOTE: For space or outdoor temperature reset, an additional thermistor (part no. 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. See Fig. 19.

To avoid electrical interference, do not run the thermistor wire near line voltage, electrical machinery, large contactors, or other similar devices. If outdoor-air 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 circulating air.

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

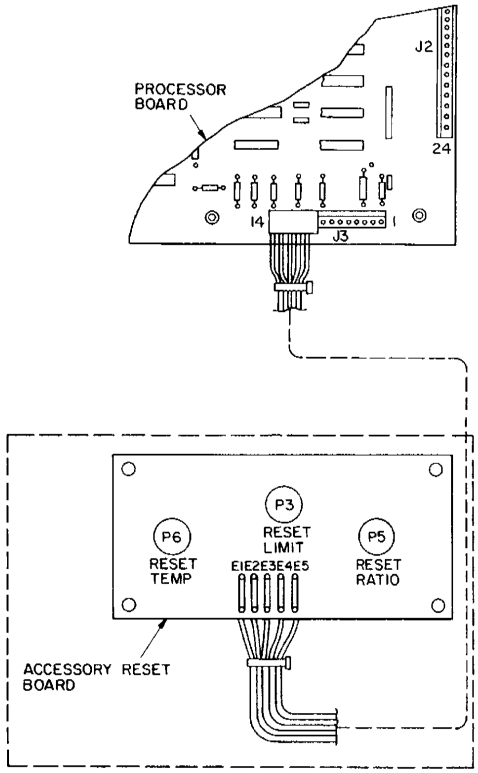
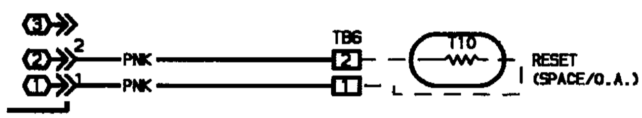



**Fig. 18 — Accessory Reset Board Wiring**




LEGEND

**OA** — Outdoor-Air
**TB** — Terminal Block

**Fig. 19 — Space/Outdoor Thermistor Wiring**

**Table 13 — Temperature Reset Potentiometer Settings**

| POTENTI-OMETER | DESCRIP-TION | LOCATION | RANGE |
|---|---|---|---|
| **P1** | Chilled Fluid Set Point | Display Board | Water: 40 to 70 F (4.4 to 21 C)<br>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 FLUID RESET — Set potentiometers as shown on page 25.

OUTDOOR-AIR OR SPACE TEMPERATURE RESET — Set potentiometers as shown in Space and Outdoor-Air Temperature Reset section on page 26.

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.

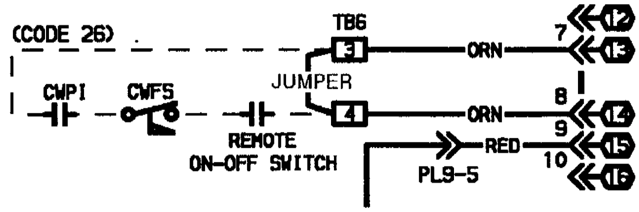
OPERATION — When reset begins, Code **21** will appear on display screen. The chilled fluid temperature may not be the same as the set point of P1.

SERVICE — There are several diagnostic display codes that can appear if reset package fails. See Controls Troubleshooting and Servicing section on page 30.

**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 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.




LEGEND

**CWFS** — Chilled Water (Fluid) Flow Switch
**CWPI** — Chilled Water (Fluid) Pump Interlock
**PL** — Plug
**TB** — Terminal Block

**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, 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**

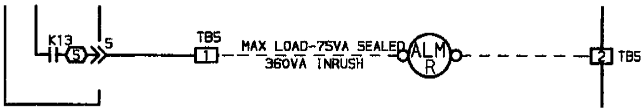
Do not use the pump starter as a remote on-off switch.

**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.

To install a remote alarm light or similar device, connect it to TB5-1 and TB5-2. See Fig. 21. 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, install a remote alarm-off switch.




LEGEND

**ALMR** — Alarm Relay
**TB** — Terminal Block

**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.

In addition, troubleshooting charts are contained in this book to help troubleshoot this control.

If a problem is suspected, always check the display for diagnostic information.

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 51-57 — 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,** and **57,** the processor will shut down only the compressor involved on 040-110 and associated modular units. For 130-210 and associated modular units, the CGF board will shut off all compressors in the circuit for codes **52** through **57.** 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 position.

NOTE: It takes 10 seconds for the control to generate the alarm code and lockout compressor(s).

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 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.

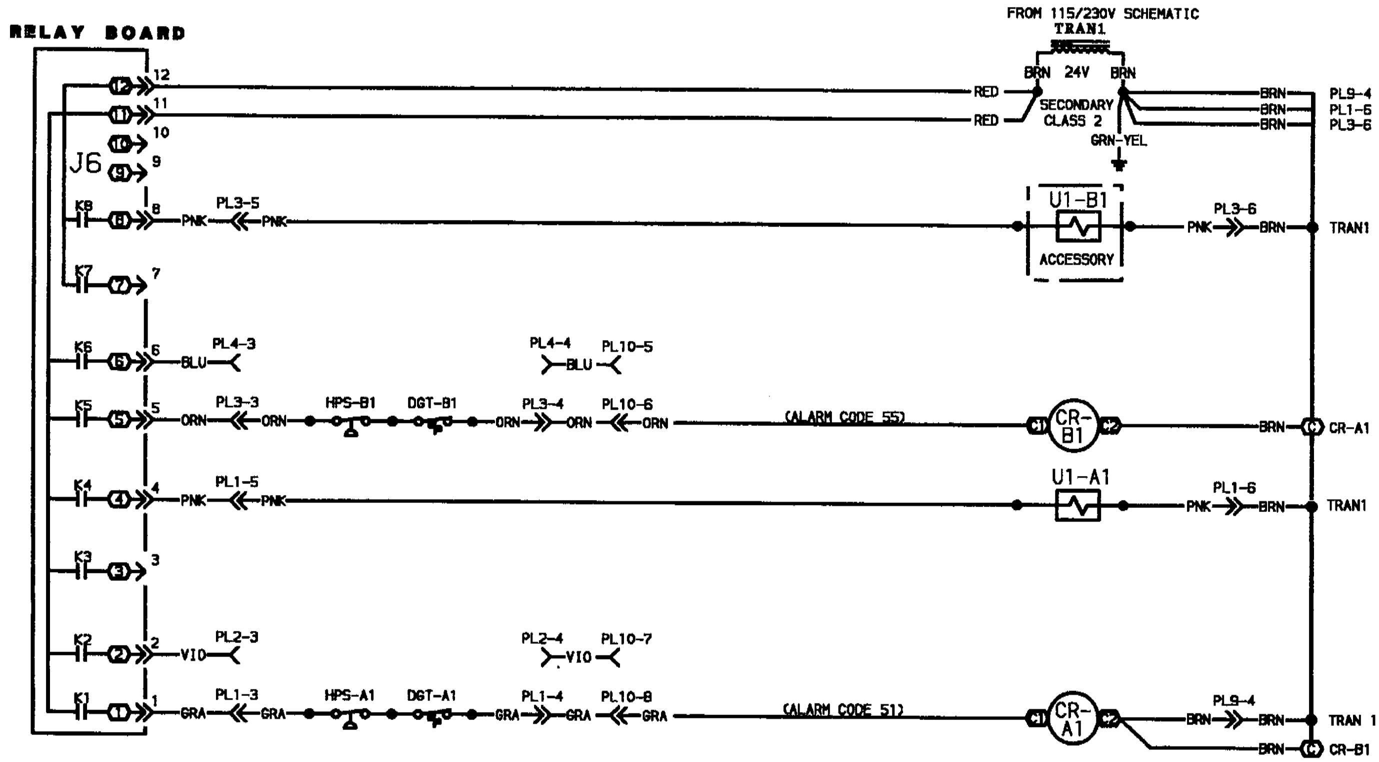
Processor Failure — If the hardware fails to energize the proper relay, an alarm condition may be signaled.

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.

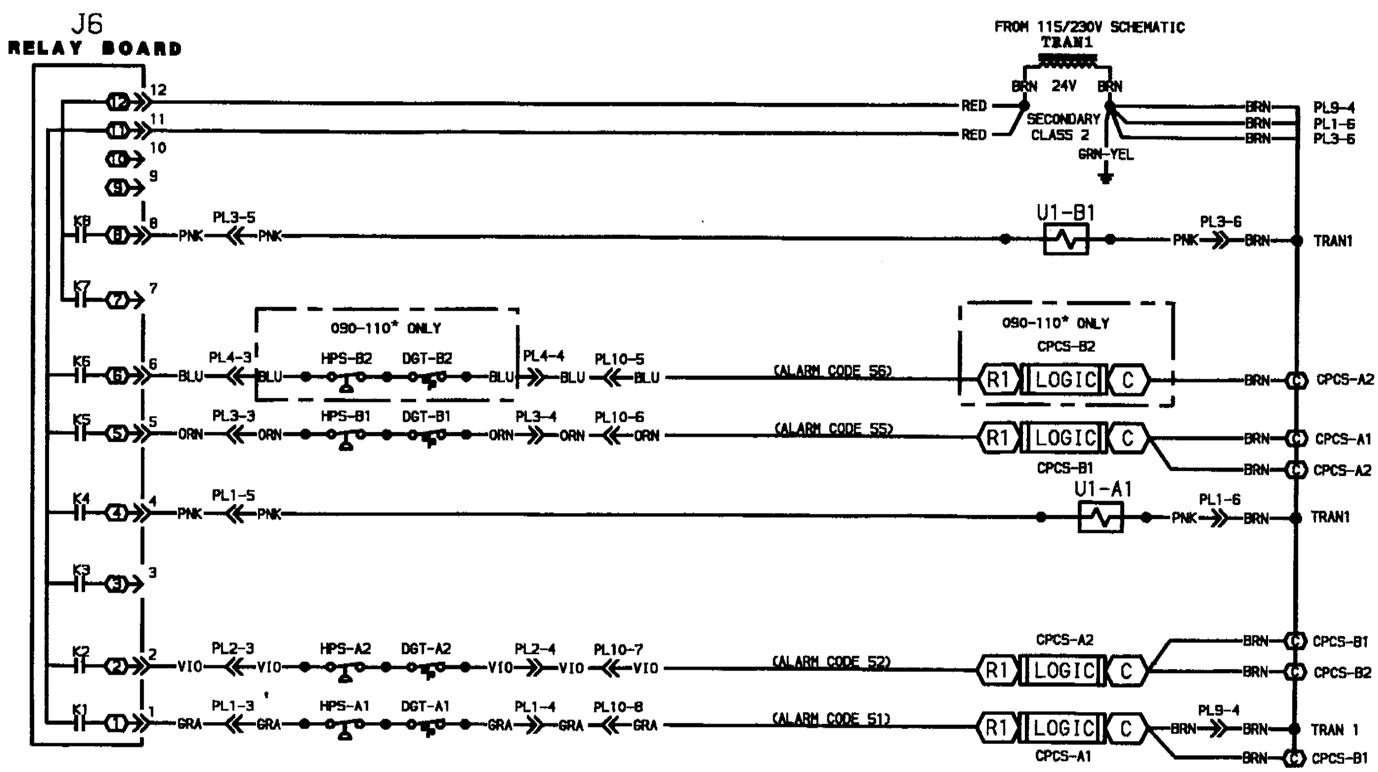
Code **60** indicates a failure of Circuit B and, as a result, that circuit will be shut down. These codes will be displayed only when the display button is pressed. To reset the circuit, the ON-OFF switch must first be turned to OFF, then to ON position.

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 fluid thermistors are used for this purpose. The leaving fluid thermistor is located in the leaving fluid nozzle. The entering fluid 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 fluid thermistor and a rapid drop in the entering fluid temperature when the compressors are on. When the entering fluid temperature drops to 5 F (2.8 C) below the leaving fluid 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 position, when cooler fluid flow returns. This error occurs for low or no cooler flow, or if cooler fluid flow is in the wrong direction. The cooler heaters, if installed, may have enough heat to raise the leaving fluid temperature above the entering fluid 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 ± 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 to 22 psig (110 to 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 position.




070 (60 Hz); 040-060



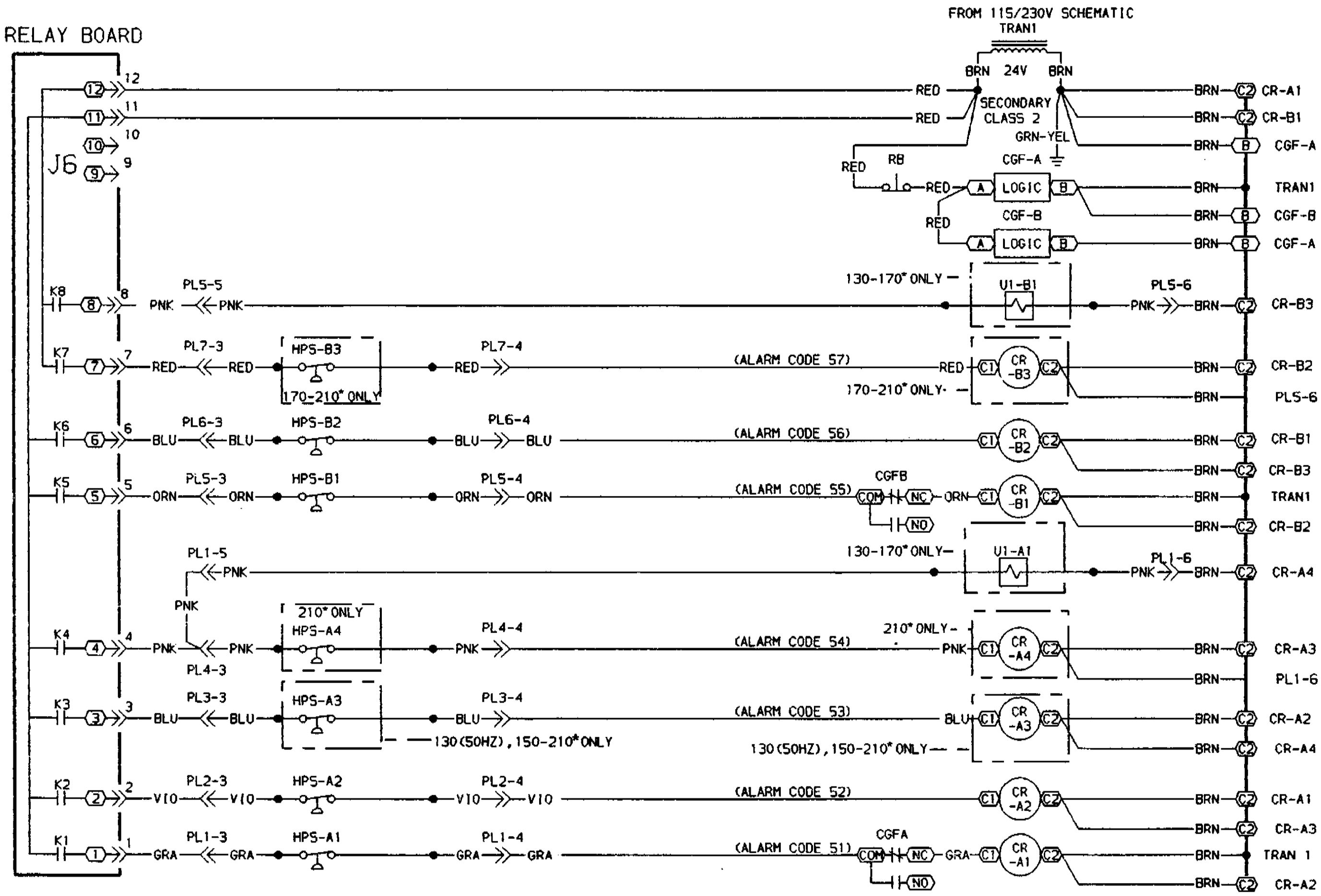

070 (50 Hz); 080-110, 230B-315B

LEGEND

**CGF** — Compressor Ground Fault
**CPCS** — Compressor Protection Control System
**CR** — Control Relay
**DGT** — Discharge Gas Thermostat
**HPS** — High-Pressure Switch
**NC** — Normally Closed
**NO** — Normally Open
**PL** — Plug
**TRAN** — Transformer
**U** — Unloader

*And associated modular units (see Table 1).

**Fig. 22 — Low Voltage Control Circuit**



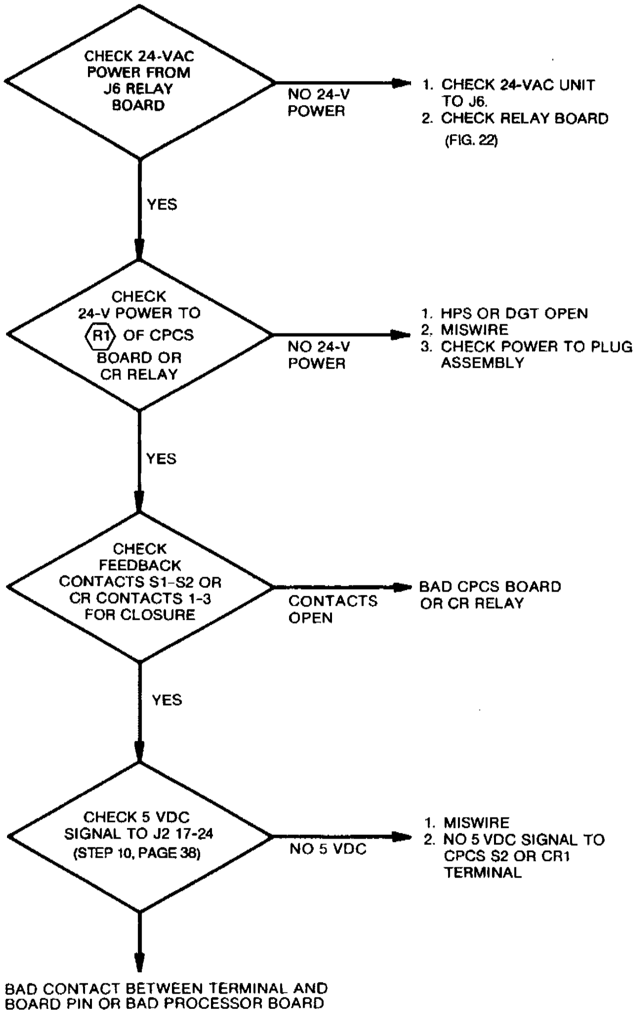

130-210, 230A-315A, 330A/B-420A/B

LEGEND

| | | | |
|---|---|---|---|
| **CGF** | — Compressor Ground Fault | **NC** | — Normally Closed |
| **CPCS** | — Compressor Protection Control System | **NO** | — Normally Open |
| **CR** | — Control Relay | **PL** | — Plug |
| **DGT** | — Discharge Gas Thermostat | **TRAN** | — Transformer |
| **HPS** | — High-Pressure Switch | **U** | — Unloader |

*And associated modular units (see Table 1).

**Fig. 22 — Low Voltage Control Circuit (cont)**




LEGEND

**CPCS** — Compressor Protection Control System
**CR** — Control Relay
**DGT** — Discharge Gas Thermostat
**HPS** — High-Pressure Switch

**Fig. 23 — Error Code 51-57 Troubleshooting Chart**

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 fluid 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 position.

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.

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.

CODES 68 AND 69 — LOW SUCTION SUPERHEAT (EXV Units Only) — If suction superheat is equal to 0° F or °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 to OFF, then ON position.

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 fluid 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 Fluid Thermistor (T1)
Code **72** Entering Fluid 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 in ON position and DIP switch 2 must be in OFF position. 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-FLUID SET POINT POTENTIOMETER FAILURE — If this potentiometer fails, the processor uses the default supply fluid 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 40 to 70 F (4.4 to 21.1 C). 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 and the EPROM is HT207101-1-10 or earlier. 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 the 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 in ON position. Two-step demand limit is a 2-potentiometer system. For both potentiometers, the control recognizes only 10 to 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. Exercise caution 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 ± 0.1 v
Terminal 2 to 3 — 5.0 vdc ± 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 ± 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 ± 0.1 v

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

Terminal 1 to 2 — 2.5 vdc ± 0.1 v
Terminal 2 to 3 — 5.0 vdc ± 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 in ON position 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 in ON position, and DIP switch 1 must be in OFF position. 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* | | | | |
| 51 | Compr | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | Failure | Circuit A shut off | Manual | 040-110*: High-pressure switch trip. 130-210*: Ground fault relay or high-pressure switch trip. In addition (if CPCS is installed), compressor ground current > 2.5 amps, compressor board relay on when it is not supposed to be on, or wiring error between electronic control and compressor protection module.† |
| 52 | Compr | — | — | A2 | A2 | A2 | A2 | A2 | A2 | Failure | Compressor shut off | | |
| 53 | Compr | — | — | — | — | — | A3 | A3 | A3 | Failure | Compressor shut off | | |
| 54 | Compr | — | — | — | — | — | — | — | A4 | Failure | Compressor shut off | | |
| 55 | Compr | B1 | B1 | B1 | B1 | B1 | B1 | B1 | B1 | Failure | Circuit B shut off | | |
| 56 | Compr | — | — | — | B2 | B2 | B2 | B2 | B2 | Failure | Compressor shut off | | |
| 57 | Compr | — | — | — | — | — | — | B3 | B3 | Failure | Compressor shut off | | |
| 59 | Loss of charge circuit A | | | | | | | | | | Circuit A shut off | Manual | Low refrigerant charge, or low-pressure switch failure |
| 60 | Loss of charge circuit B | | | | | | | | | | Circuit B shut off | | |
| 61 | Low cooler flow | | | | | | | | | | Unit shut off | Manual | No cooler flow or reversed cooler flow |
| 63 | Low oil pressure circuit A | | | | | | | | | | Circuit A 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. |
| 64 | Low oil pressure circuit B | | | | | | | | | | Circuit B shut off | | |
| 65 | Freeze protection | | | | | | | | | | Unit shut off | Auto. | Low cooler flow |
| 66 | High suction superheat circuit A | | | | | | | | | | Circuit A shut off | Manual | Low charge, or plugged filter drier, or EXV failure, or bad thermistor. Check the liquid line service valve. |
| 67 | High suction superheat circuit B | | | | | | | | | | Circuit B shut off | | |
| 68 | Low suction superheat circuit A | | | | | | | | | | Circuit A shut off | Manual | EXV failure or bad thermistor |
| 69 | Low suction superheat circuit B | | | | | | | | | | Circuit B shut off | | |
| 70 | Illegal unit configuration | | | | | | | | | | Unit will not start | Manual | Configuration error (See Note 2.) |
| 71 | Leaving fluid thermistor failure | | | | | | | | | | Unit shut off | Auto. | Thermistor failure, wiring error, or thermistor not connected to processor board. |
| 72 | Entering fluid thermistor failure | | | | | | | | | | Use default value | | |
| 75 | Saturated condensing thermistor failure circuit A | | | | | | | | | | Circuit shut off | | |
| 76 | Saturated condensing thermistor failure circuit B | | | | | | | | | | Circuit shut off | | |
| 77 | Evaporator refrigerant thermistor failure circuit A | | | | | | | | | | Circuit shut off | | |
| 78 | Evaporator refrigerant thermistor failure circuit B | | | | | | | | | | Circuit shut off | | |
| 79 | Compressor thermistor failure circuit A | | | | | | | | | | Circuit shut off | | |
| 80 | Compressor thermistor failure circuit B | | | | | | | | | | Circuit shut off | | |
| 81 | Remote temperature failure | | | | | | | | | | Stop reset | Auto. | Potentiometer improperly connected, potentiometer setting out of range, potentiometer failure, or wiring error. |
| 82 | Leaving fluid set point potentiometer failure | | | | | | | | | | Use default value | | |
| 84 | Reset limit potentiometer failure | | | | | | | | | | Stop reset | | |
| 85 | Demand limit potentiometer failure | | | | | | | | | | Stop demand limit | | |
| 86 | Reset ratio potentiometer failure | | | | | | | | | | Stop reset | | |
| 87 | Reset set point potentiometer failure | | | | | | | | | | Stop reset | | |
| 83 | None | | | | | | | | | | Unit Operates Normally | — | Wrong EPROM |

LEGEND

**CB** — Circuit Breaker
**CPCS** — Compressor Protection Control System Board
**EPROM** — Erasable, Programmable Read-Only Memory
**EXV** — Electronic Expansion Valve
**LLS** — Liquid Line Solenoid Valve

*And associated modular units (see Table 1).
†See Fig. 23 Compressor Troubleshooting Chart (Error Code 51-57)

NOTES:
1. Freeze protection trips at 35 F (1.7 C) for water and 6° F (3.3° C) below set point for brine units. Protection resets at 6° F (3.3° C) above set point.
2. Illegal unit configuration caused by missing programmable header or both unloader DIP switches on.
3. All auto. reset failures that cause the unit to stop will restart the unit when the error has been corrected.
4. All manual reset errors must be reset by turning the control circuit breaker to OFF and then to ON position.
5. Valid resistance range for thermistors is 363,000 to 216 ohms.
6. Codes 58, 62, 73, and 74 are not used on these units.

**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 is acceptable.

> **⚠ WARNING**
>
> You will be working with solid-state electronic components. Do not short devices. Use extreme care while working with the board. Follow the procedure exactly as listed.

STEP 1 — CHECK TRANSFORMER INPUT TO PROCESSOR BOARD — Connector J4 (see Fig. 24) 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:

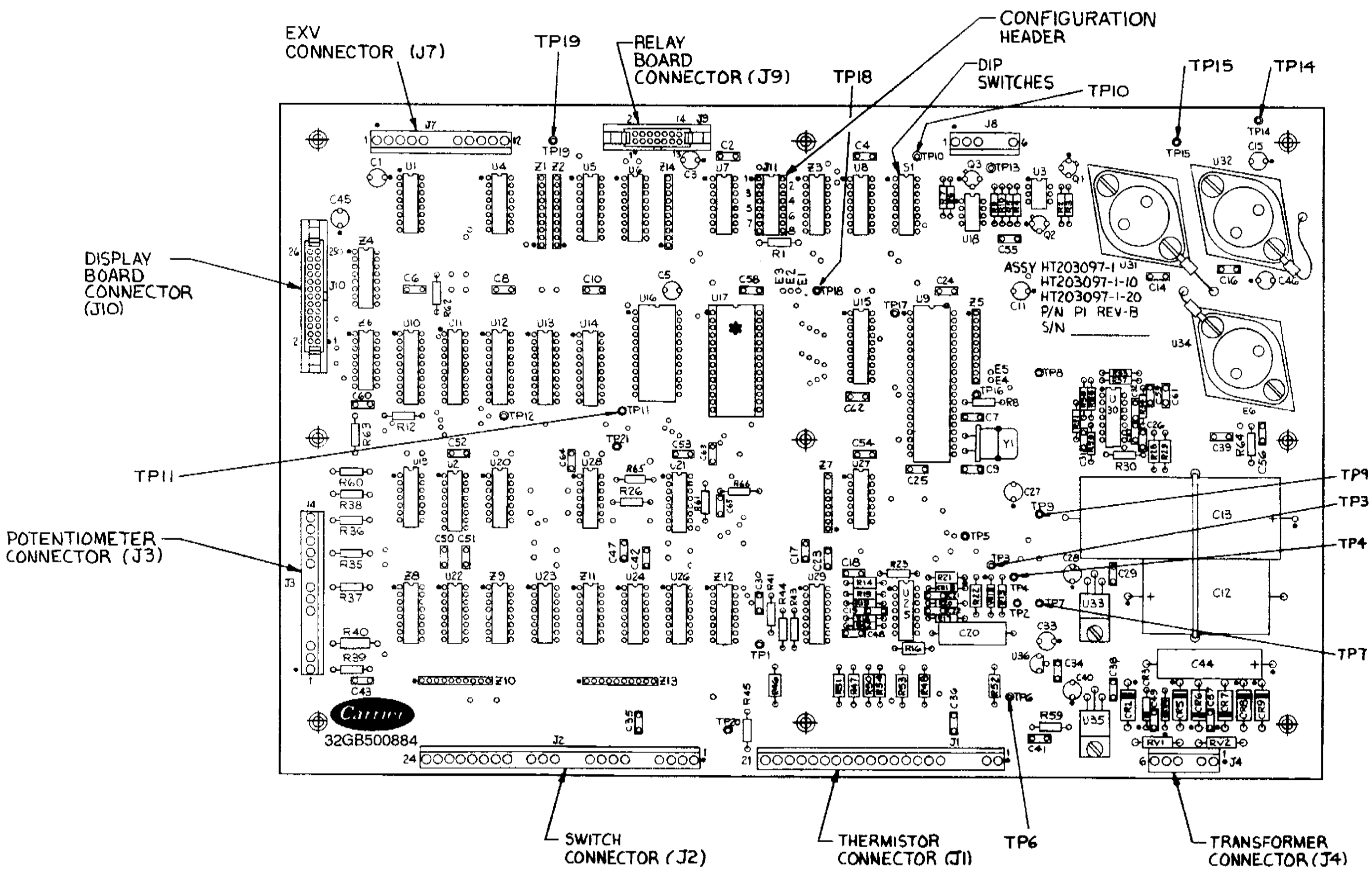
| TERMINAL PINS (J4) | VOLTAGE (VAC) |
|---|---|
| 1 to 2 | 15.0 — 20.6 |
| 4 to 6 | 16.0 — 21.8 |
| 5 to 6 | 8.0 — 10.9 |
| 5 to 4 | 8.0 — 10.9 |

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 on page 37, replace the processor board.




LEGEND

**EPROM** — Erasable, Programmable, Read-Only Memory
**TP** — Test Pin

*EPROM HT207101-1-XX where "XX" is the current revision number.

> **⚠ WARNING**
>
> DO NOT remove label covering EPROM or program will be erased.

**Fig. 24 — Processor Board Test Pins and Connectors**

| 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 1 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 in Table 15.

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

### Table 15 — Quick Test Voltages

| 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: 0 v — zero to 4 v
12 v — 11 to 13 v

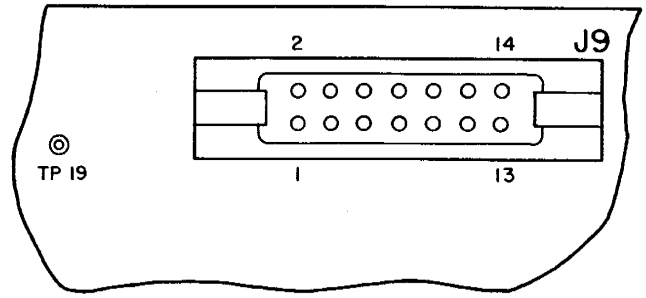



**Fig. 25 — Relay Board Connector**

STEP 6 — EXV OUTPUTS

Processor Board Outputs— Turn unit 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 unit power on, but do not enter 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 0 v, replace the processor board. If the outputs are correct, then check the EXV.

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 unit power off and *disconnect ribbon cable.* Connect the negative test lead to TP18 on the processor board. Turn unit power on. You should get the following voltages at connector J10 (see Fig. 26):

| TERMINAL PINS (J10) | VOLTAGE (vdc ± 0.5 v) |
|---|---|
| 17 | 5 |
| 18 | 5 |
| 20* | 2 to 5 |
| 22* | 2 to 5 |
| 24 | 5 |

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

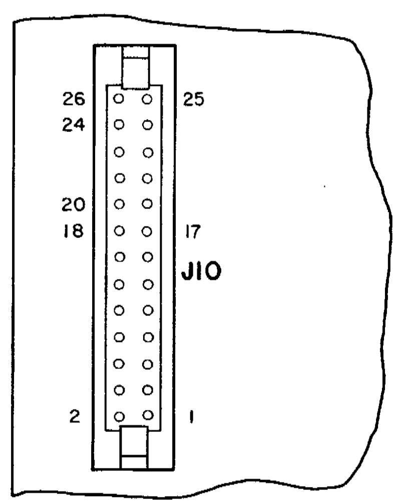



**Fig. 26 — Display Board Connector**

STEP 8 — POTENTIOMETER CONNECTION CHECK-OUT — Turn unit power off and disconnect plugs from J3. Connect negative test lead to terminal TP18 on the processor board. Turn unit 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 ± 0.5 v) |
|---|---|
| 1* | 2 to 5 |
| 3 | 5 |
| 6 | 5 |
| 8* | 2 to 5 |
| 10* | 2 to 5 |
| 12 | 5 |
| 13* | 2 to 5 |
| 14* | 2 to 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 unit power off and remove thermistor connections from J1 (identify for replacing). Connect negative test lead to TP18. Turn unit power on and enter quick test. Check for the following voltages at connector J1 (see Fig. 24):

| TERMINAL PINS (J1) | VOLTAGE (vdc ± 0.25 v) | TERMINAL PINS (J1) | VOLTAGE (vdc ± 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 unit power off and disconnect all plugs from J2. Connect negative test lead to test pin TP18. Turn unit power on and enter quick test. Check for the following voltages at connector J2 (see Fig. 24):

| TERMINAL PINS (J2) | VOLTAGE (vdc ± 0.25 v) | TERMINAL PINS (J2) | VOLTAGE (vdc ± 0.5 ) |
|---|---|---|---|
| 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 this procedure is completed successfully, but the unit will not function properly, replace the processor board.

**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.

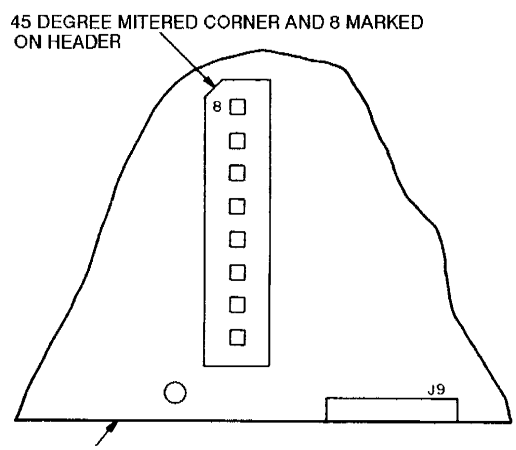



**Fig. 27 — Configuration Header**

**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 the control ON-OFF switch to OFF position 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 36).

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

| QUICK TEST STEP NUMBER | VOLTAGE (vdc ± 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 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 quick test steps noted below, resistance should be zero ohms; at all others ∞ (infinity).

| QUICK TEST STEP NUMBER | VOLTAGE (vdc ± 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 pressed and open when the switch is pressed.

**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 these results are not obtained, 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 a **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 14 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, 230A-315A, and 330A/B-420A/B) —** 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 16 or 17 (°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.

NOTE: The range potential of the thermistor is –60 to 240 F (–51 to 116 C), but the feasible operating range of –25 to 225 F (–32 to 107 C) is shown in Tables 16 and 17.

> 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 base unit Installation, Start-Up and Service Instructions.

**EXV Troubleshooting —** If it appears that the EXV 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). This procedure is described in Step 6 of Processor Board Checkout Procedure (see page 36).

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

1. Check color coding and wire connections. Make sure that wires 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-4C.
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 ± 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, and 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 16 or 17.
3. Make sure that thermistor leads are connected to the proper pin terminals at the J1 terminal strip on processor board and that thermistor probes are located in proper position in the refrigerant circuit.

When these checks have been completed, the actual operation of the EXV can be checked by using the procedures outlined in Step 5 – Check Operation of the EXV section below. During quick test steps 3.5. and 3.9., each EXV is opened approximately 500 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 EXVs.

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 (1500 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 ¼ in. to ¾ 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 100 seconds of the initialization mode, each valve is driven to the fully closed position (1500 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 EXV 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. 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, be careful 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. Be careful not to twist or pull on wires from EXV motor to valve cover pin connections. Check EXV operation in quick step steps.

## Table 16 — Sensor Temperature (F) vs Resistance/Voltage Drop; Flotronic™ Units

| TEMPERATURE (F) | VOLTAGE DROP (V) | RESISTANCE (OHMS) |
|---|---|---|
| -25 | 4.684 | 98,010 |
| -24 | 4.673 | 94,707 |
| -23 | 4.662 | 91,522 |
| -22 | 4.651 | 88,449 |
| -21 | 4.640 | 85,485 |
| -20 | 4.628 | 82,627 |
| -19 | 4.616 | 79,871 |
| -18 | 4.604 | 77,212 |
| -17 | 4.591 | 74,648 |
| -16 | 4.578 | 72,175 |
| -15 | 4.565 | 69,790 |
| -14 | 4.551 | 67,490 |
| -13 | 4.537 | 65,272 |
| -12 | 4.523 | 63,133 |
| -11 | 4.509 | 61,070 |
| -10 | 4.494 | 59,081 |
| -9 | 4.479 | 57,162 |
| -8 | 4.463 | 55,311 |
| -7 | 4.448 | 53,526 |
| -6 | 4.431 | 51,804 |
| -5 | 4.415 | 50,143 |
| -4 | 4.398 | 48,541 |
| -3 | 4.381 | 46,996 |
| -2 | 4.363 | 45,505 |
| -1 | 4.345 | 44,066 |
| 0 | 4.327 | 42,678 |
| 1 | 4.308 | 41,339 |
| 2 | 4.289 | 40,047 |
| 3 | 4.270 | 38,800 |
| 4 | 4.250 | 37,596 |
| 5 | 4.230 | 36,435 |
| 6 | 4.209 | 35,313 |
| 7 | 4.188 | 34,231 |
| 8 | 4.167 | 33,185 |
| 9 | 4.145 | 32,176 |
| 10 | 4.123 | 31,201 |
| 11 | 4.101 | 30,260 |
| 12 | 4.078 | 29,351 |
| 13 | 4.055 | 28,472 |
| 14 | 4.032 | 27,624 |
| 15 | 4.008 | 26,804 |
| 16 | 3.984 | 26,011 |
| 17 | 3.959 | 25,245 |
| 18 | 3.934 | 24,505 |
| 19 | 3.909 | 23,789 |
| 20 | 3.883 | 23,096 |
| 21 | 3.858 | 22,427 |
| 22 | 3.831 | 21,779 |
| 23 | 3.805 | 21,153 |
| 24 | 3.778 | 20,547 |
| 25 | 3.751 | 19,960 |
| 26 | 3.723 | 19,392 |
| 27 | 3.696 | 18,843 |
| 28 | 3.668 | 18,311 |
| 29 | 3.639 | 17,796 |
| 30 | 3.611 | 17,297 |
| 31 | 3.582 | 16,814 |
| 32 | 3.553 | 16,346 |
| 33 | 3.523 | 15,892 |
| 34 | 3.494 | 15,453 |
| 35 | 3.464 | 15,027 |
| 36 | 3.434 | 14,614 |
| 37 | 3.404 | 14,214 |
| 38 | 3.373 | 13,826 |
| 39 | 3.343 | 13,449 |
| 40 | 3.312 | 13,084 |
| 41 | 3.281 | 12,730 |
| 42 | 3.250 | 12,387 |
| 43 | 3.219 | 12,053 |
| 44 | 3.187 | 11,730 |
| 45 | 3.156 | 11,416 |
| 46 | 3.124 | 11,111 |
| 47 | 3.093 | 10,816 |
| 48 | 3.061 | 10,529 |
| 49 | 3.029 | 10,250 |
| 50 | 2.997 | 9,979 |
| 51 | 2.965 | 9,717 |
| 52 | 2.933 | 9,461 |
| 53 | 2.901 | 9,213 |
| 54 | 2.869 | 8,973 |
| 55 | 2.837 | 8,739 |
| 56 | 2.805 | 8,511 |
| 57 | 2.772 | 8,291 |
| 58 | 2.740 | 8,076 |
| 59 | 2.708 | 7,868 |
| 60 | 2.676 | 7,665 |
| 61 | 2.644 | 7,468 |
| 62 | 2.612 | 7,277 |
| 63 | 2.581 | 7,091 |
| 64 | 2.549 | 6,911 |
| 65 | 2.517 | 6,735 |
| 66 | 2.486 | 6,564 |
| 67 | 2.454 | 6,399 |
| 68 | 2.423 | 6,237 |
| 69 | 2.391 | 6,081 |
| 70 | 2.360 | 5,929 |
| 71 | 2.239 | 5,781 |
| 72 | 2.299 | 5,637 |
| 73 | 2.268 | 5,497 |
| 74 | 2.237 | 5,361 |
| 75 | 2.207 | 5,229 |
| 76 | 2.177 | 5,101 |
| 77 | 2.147 | 4,976 |
| 78 | 2.117 | 4,855 |
| 79 | 2.088 | 4,737 |
| 80 | 2.058 | 4,622 |
| 81 | 2.029 | 4,511 |
| 82 | 2.000 | 4,403 |
| 83 | 1.972 | 4,298 |
| 84 | 1.943 | 4,195 |
| 85 | 1.915 | 4,096 |
| 86 | 1.887 | 4,000 |
| 87 | 1.859 | 3,906 |
| 88 | 1.832 | 3,814 |
| 89 | 1.805 | 3,726 |
| 90 | 1.778 | 3,640 |
| 91 | 1.751 | 3,556 |
| 92 | 1.725 | 3,474 |
| 93 | 1.699 | 3,395 |
| 94 | 1.673 | 3,318 |
| 95 | 1.647 | 3,243 |
| 96 | 1.622 | 3,170 |
| 97 | 1.597 | 3,099 |
| 98 | 1.572 | 3,031 |
| 99 | 1.548 | 2,964 |
| 100 | 1.523 | 2,898 |
| 101 | 1.500 | 2,835 |
| 102 | 1.476 | 2,773 |
| 103 | 1.453 | 2,713 |
| 104 | 1.430 | 2,655 |
| 105 | 1.407 | 2,598 |
| 106 | 1.385 | 2,542 |
| 107 | 1.362 | 2,488 |
| 108 | 1.341 | 2,436 |
| 109 | 1.319 | 2,385 |
| 110 | 1.298 | 2,335 |
| 111 | 1.277 | 2,286 |
| 112 | 1.256 | 2,238 |
| 113 | 1.236 | 2,192 |
| 114 | 1.216 | 2,147 |
| 115 | 1.196 | 2,103 |
| 116 | 1.176 | 2,060 |
| 117 | 1.157 | 2,018 |
| 118 | 1.138 | 1,977 |
| 119 | 1.120 | 1,937 |
| 120 | 1.101 | 1,898 |
| 121 | 1.083 | 1,860 |
| 122 | 1.065 | 1,822 |
| 123 | 1.048 | 1,786 |
| 124 | 1.030 | 1,750 |
| 125 | 1.013 | 1,715 |
| 126 | 0.997 | 1,680 |
| 127 | 0.980 | 1,647 |
| 128 | 0.964 | 1,614 |
| 129 | 0.948 | 1,582 |
| 130 | 0.932 | 1,550 |
| 131 | 0.917 | 1,519 |
| 132 | 0.902 | 1,489 |
| 133 | 0.887 | 1,459 |
| 134 | 0.872 | 1,430 |
| 135 | 0.857 | 1,401 |
| 136 | 0.843 | 1,373 |
| 137 | 0.829 | 1,345 |
| 138 | 0.815 | 1,318 |
| 139 | 0.802 | 1,291 |
| 140 | 0.788 | 1,265 |
| 141 | 0.775 | 1,239 |
| 142 | 0.762 | 1,214 |
| 143 | 0.750 | 1,189 |
| 144 | 0.737 | 1,165 |
| 145 | 0.725 | 1,141 |
| 146 | 0.713 | 1,118 |
| 147 | 0.701 | 1,095 |
| 148 | 0.689 | 1,072 |
| 149 | 0.678 | 1,050 |
| 150 | 0.666 | 1,028 |
| 151 | 0.655 | 1,007 |
| 152 | 0.644 | 986 |
| 153 | 0.634 | 965 |
| 154 | 0.623 | 945 |
| 155 | 0.613 | 925 |
| 156 | 0.602 | 906 |
| 157 | 0.592 | 887 |
| 158 | 0.582 | 868 |
| 159 | 0.573 | 850 |
| 160 | 0.563 | 832 |
| 161 | 0.554 | 815 |
| 162 | 0.545 | 798 |
| 163 | 0.536 | 782 |
| 164 | 0.527 | 765 |
| 165 | 0.518 | 749 |
| 166 | 0.509 | 734 |
| 167 | 0.501 | 719 |
| 168 | 0.493 | 705 |
| 169 | 0.484 | 690 |
| 170 | 0.476 | 677 |
| 171 | 0.468 | 663 |
| 172 | 0.461 | 650 |
| 173 | 0.453 | 638 |
| 174 | 0.446 | 626 |
| 175 | 0.438 | 614 |
| 176 | 0.431 | 602 |
| 177 | 0.424 | 591 |
| 178 | 0.417 | 581 |
| 179 | 0.410 | 570 |
| 180 | 0.403 | 560 |
| 181 | 0.397 | 551 |
| 182 | 0.390 | 542 |
| 183 | 0.384 | 533 |
| 184 | 0.378 | 524 |
| 185 | 0.371 | 516 |
| 186 | 0.365 | 508 |
| 187 | 0.360 | 501 |
| 188 | 0.354 | 494 |
| 189 | 0.348 | 487 |
| 190 | 0.342 | 480 |
| 191 | 0.337 | 473 |
| 192 | 0.332 | 467 |
| 193 | 0.326 | 461 |
| 194 | 0.321 | 456 |
| 195 | 0.316 | 450 |
| 196 | 0.311 | 444 |
| 197 | 0.306 | 439 |
| 198 | 0.301 | 434 |
| 199 | 0.297 | 429 |
| 200 | 0.292 | 424 |
| 201 | 0.288 | 419 |
| 202 | 0.283 | 415 |
| 203 | 0.279 | 410 |
| 204 | 0.274 | 405 |
| 205 | 0.270 | 401 |
| 206 | 0.266 | 396 |
| 207 | 0.262 | 391 |
| 208 | 0.258 | 386 |
| 209 | 0.254 | 382 |
| 210 | 0.250 | 377 |
| 211 | 0.247 | 372 |
| 212 | 0.243 | 366 |
| 213 | 0.239 | 361 |
| 214 | 0.236 | 356 |
| 215 | 0.232 | 350 |
| 216 | 0.229 | 344 |
| 217 | 0.225 | 338 |
| 218 | 0.222 | 332 |
| 219 | 0.219 | 325 |
| 220 | 0.215 | 318 |
| 221 | 0.212 | 311 |
| 222 | 0.209 | 304 |
| 223 | 0.206 | 297 |
| 224 | 0.203 | 289 |
| 225 | 0.200 | 282 |

## Table 17 — Sensor Temperature (C) vs Resistance/Voltage Drop; Flotronic™ Units

| TEMPERATURE (C) | VOLTAGE DROP (V) | RESISTANCE (OHMS) |
|---|---|---|
| **-32.0** | 4.690 | 100 049 |
| **-31.5** | 4.680 | 97 006 |
| **-31.0** | 4.671 | 94 061 |
| **-30.5** | 4.661 | 91 209 |
| **-30.0** | 4.651 | 88 449 |
| **-29.5** | 4.641 | 85 777 |
| **-29.0** | 4.630 | 83 191 |
| **-28.5** | 4.620 | 80 687 |
| **-28.0** | 4.609 | 78 264 |
| **-27.5** | 4.597 | 75 918 |
| **-27.0** | 4.586 | 73 648 |
| **-26.5** | 4.574 | 71 451 |
| **-26.0** | 4.562 | 69 324 |
| **-25.5** | 4.550 | 67 265 |
| **-25.0** | 4.537 | 65 272 |
| **-24.5** | 4.525 | 63 344 |
| **-24.0** | 4.512 | 61 477 |
| **-23.5** | 4.499 | 59 670 |
| **-23.0** | 4.485 | 57 921 |
| **-22.5** | 4.471 | 56 228 |
| **-22.0** | 4.457 | 54 589 |
| **-21.5** | 4.443 | 53 003 |
| **-21.0** | 4.428 | 51 467 |
| **-20.5** | 4.413 | 49 980 |
| **-20.0** | 4.398 | 48 541 |
| **-19.5** | 4.383 | 47 148 |
| **-19.0** | 4.367 | 45 799 |
| **-18.5** | 4.351 | 44 492 |
| **-18.0** | 4.334 | 43 228 |
| **-17.5** | 4.318 | 42 003 |
| **-17.0** | 4.301 | 40 817 |
| **-16.5** | 4.283 | 39 668 |
| **-16.0** | 4.266 | 38 556 |
| **-15.5** | 4.248 | 37 478 |
| **-15.0** | 4.230 | 36 435 |
| **-14.5** | 4.211 | 35 424 |
| **-14.0** | 4.193 | 34 444 |
| **-13.5** | 4.174 | 33 495 |
| **-13.0** | 4.154 | 32 576 |
| **-12.5** | 4.135 | 31 685 |
| **-12.0** | 4.115 | 30 821 |
| **-11.5** | 4.094 | 29 984 |
| **-11.0** | 4.074 | 29 173 |
| **-10.5** | 4.053 | 28 386 |
| **-10.0** | 4.032 | 27 624 |
| **- 9.5** | 4.010 | 26 884 |
| **- 9.0** | 3.989 | 26 168 |
| **- 8.5** | 3.967 | 25 472 |
| **- 8.0** | 3.944 | 24 798 |
| **- 7.5** | 3.922 | 24 144 |
| **- 7.0** | 3.899 | 23 509 |
| **- 6.5** | 3.876 | 22 893 |
| **- 6.0** | 3.852 | 22 296 |
| **- 5.5** | 3.829 | 21 716 |
| **- 5.0** | 3.805 | 21 153 |
| **- 4.5** | 3.781 | 20 606 |
| **- 4.0** | 3.756 | 20 076 |
| **- 3.5** | 3.732 | 19 561 |
| **- 3.0** | 3.707 | 19 061 |
| **- 2.5** | 3.682 | 18 575 |
| **- 2.0** | 3.656 | 18 103 |
| **- 1.5** | 3.631 | 17 645 |
| **- 1.0** | 3.605 | 17 199 |
| **- 0.5** | 3.579 | 16 766 |
| **0.0** | 3.553 | 16 346 |
| **0.5** | 3.526 | 15 937 |
| **1.0** | 3.500 | 15 539 |
| **1.5** | 3.473 | 15 153 |
| **2.0** | 3.446 | 14 777 |
| **2.5** | 3.419 | 14 412 |
| **3.0** | 3.392 | 14 057 |
| **3.5** | 3.364 | 13 711 |
| **4.0** | 3.337 | 13 375 |
| **4.5** | 3.309 | 13 048 |
| **5.0** | 3.281 | 12 730 |
| **5.5** | 3.253 | 12 420 |
| **6.0** | 3.225 | 12 119 |
| **6.5** | 3.197 | 11 826 |
| **7.0** | 3.169 | 11 541 |
| **7.5** | 3.140 | 11 263 |
| **8.0** | 3.112 | 10 992 |
| **8.5** | 3.083 | 10 729 |
| **9.0** | 3.054 | 10 472 |
| **9.5** | 3.026 | 10 223 |
| **10.0** | 2.997 | 9 979 |
| **10.5** | 2.968 | 9 742 |
| **11.0** | 2.939 | 9 512 |
| **11.5** | 2.911 | 9 287 |
| **12.0** | 2.882 | 9 068 |
| **12.5** | 2.853 | 8 855 |
| **13.0** | 2.824 | 8 647 |
| **13.5** | 2.795 | 8 444 |
| **14.0** | 2.766 | 8 247 |
| **14.5** | 2.737 | 8 055 |
| **14.5** | 2.737 | 8 055 |
| **15.0** | 2.708 | 7 868 |
| **15.5** | 2.680 | 7 685 |
| **16.0** | 2.651 | 7507 |
| **16.5** | 2.622 | 7334 |
| **17.0** | 2.593 | 7165 |
| **17.5** | 2.565 | 7000 |
| **18.0** | 2.536 | 6840 |
| **18.5** | 2.508 | 6683 |
| **19.0** | 2.479 | 6531 |
| **19.5** | 2.451 | 6382 |
| **20.0** | 2.423 | 6237 |
| **20.5** | 2.395 | 6096 |
| **21.0** | 2.367 | 5959 |
| **21.5** | 2.339 | 5825 |
| **22.0** | 2.311 | 5694 |
| **22.5** | 2.283 | 5566 |
| **23.0** | 2.256 | 5442 |
| **23.5** | 2.228 | 5321 |
| **24.0** | 2.201 | 5203 |
| **24.5** | 2.174 | 5088 |
| **25.0** | 2.147 | 4976 |
| **25.5** | 2.120 | 4867 |
| **26.0** | 2.094 | 4760 |
| **26.5** | 2.067 | 4656 |
| **27.0** | 2.041 | 4555 |
| **27.5** | 2.015 | 4457 |
| **28.0** | 1.989 | 4360 |
| **28.5** | 1.963 | 4267 |
| **29.0** | 1.938 | 4175 |
| **29.5** | 1.912 | 4086 |
| **30.0** | 1.887 | 4000 |
| **30.5** | 1.862 | 3915 |
| **31.0** | 1.837 | 3832 |
| **31.5** | 1.813 | 3752 |
| **32.0** | 1.789 | 3674 |
| **32.5** | 1.764 | 3597 |
| **33.0** | 1.741 | 3523 |
| **33.5** | 1.717 | 3450 |
| **34.0** | 1.693 | 3379 |
| **34.5** | 1.670 | 3310 |
| **35.0** | 1.647 | 3243 |
| **35.5** | 1.624 | 3177 |
| **36.0** | 1.602 | 3113 |
| **36.5** | 1.579 | 3051 |
| **37.0** | 1.557 | 2990 |
| **37.5** | 1.536 | 2931 |
| **38.0** | 1.514 | 2873 |
| **38.5** | 1.492 | 2816 |
| **39.0** | 1.471 | 2761 |
| **39.5** | 1.450 | 2707 |
| **40.0** | 1.430 | 2655 |
| **40.5** | 1.409 | 2603 |
| **41.0** | 1.389 | 2553 |
| **41.5** | 1.369 | 2504 |
| **42.0** | 1.349 | 2457 |
| **42.5** | 1.330 | 2410 |
| **43.0** | 1.311 | 2364 |
| **43.5** | 1.292 | 2320 |
| **44.0** | 1.273 | 2276 |
| **44.5** | 1.254 | 2234 |
| **45.0** | 1.236 | 2192 |
| **45.5** | 1.218 | 2152 |
| **46.0** | 1.200 | 2112 |
| **46.5** | 1.182 | 2073 |
| **47.0** | 1.165 | 2035 |
| **47.5** | 1.148 | 1997 |
| **48.0** | 1.131 | 1961 |
| **48.5** | 1.114 | 1925 |
| **49.0** | 1.098 | 1890 |
| **49.5** | 1.081 | 1856 |
| **50.0** | 1.065 | 1822 |
| **50.5** | 1.049 | 1789 |
| **51.0** | 1.034 | 1757 |
| **51.5** | 1.019 | 1725 |
| **52.0** | 1.003 | 1694 |
| **52.5** | 0.988 | 1663 |
| **53.0** | 0.974 | 1634 |
| **53.5** | 0.959 | 1604 |
| **54.0** | 0.945 | 1575 |
| **54.5** | 0.931 | 1547 |
| **55.0** | 0.917 | 1519 |
| **55.5** | 0.903 | 1492 |
| **56.0** | 0.890 | 1465 |
| **56.5** | 0.876 | 1438 |
| **57.0** | 0.863 | 1412 |
| **57.5** | 0.850 | 1387 |
| **58.0** | 0.837 | 1362 |
| **58.5** | 0.825 | 1337 |
| **59.0** | 0.812 | 1313 |
| **59.5** | 0.800 | 1289 |
| **60.0** | 0.788 | 1265 |
| **60.5** | 0.776 | 1242 |
| **61.0** | 0.765 | 1219 |
| **61.5** | 0.753 | 1197 |
| **62.0** | 0.742 | 1175 |
| **62.5** | 0.731 | 1153 |
| **63.0** | 0.720 | 1132 |
| **63.5** | 0.709 | 1111 |
| **64.0** | 0.698 | 1090 |
| **64.5** | 0.688 | 1070 |
| **65.0** | 0.678 | 1050 |
| **65.5** | 0.667 | 1030 |
| **66.0** | 0.657 | 1011 |
| **66.5** | 0.648 | 992 |
| **67.0** | 0.638 | 973 |
| **67.5** | 0.628 | 955 |
| **68.0** | 0.619 | 937 |
| **68.5** | 0.609 | 919 |
| **69.0** | 0.600 | 902 |
| **69.5** | 0.591 | 885 |
| **70.0** | 0.582 | 868 |
| **70.5** | 0.574 | 852 |
| **71.0** | 0.565 | 836 |
| **71.5** | 0.557 | 820 |
| **72.0** | 0.548 | 805 |
| **72.5** | 0.540 | 790 |
| **73.0** | 0.532 | 775 |
| **73.5** | 0.524 | 761 |
| **74.0** | 0.516 | 746 |
| **74.5** | 0.508 | 733 |
| **75.0** | 0.501 | 719 |
| **75.5** | 0.493 | 706 |
| **76.0** | 0.486 | 693 |
| **76.5** | 0.479 | 681 |
| **77.0** | 0.472 | 669 |
| **77.5** | 0.465 | 657 |
| **78.0** | 0.458 | 645 |
| **78.5** | 0.451 | 634 |
| **79.0** | 0.444 | 623 |
| **79.5** | 0.437 | 613 |
| **80.0** | 0.431 | 602 |
| **80.5** | 0.425 | 592 |
| **81.0** | 0.418 | 583 |
| **81.5** | 0.412 | 573 |
| **82.0** | 0.406 | 564 |
| **82.5** | 0.400 | 556 |
| **83.0** | 0.394 | 547 |
| **83.5** | 0.388 | 539 |
| **84.0** | 0.383 | 531 |
| **84.5** | 0.377 | 524 |
| **85.0** | 0.371 | 516 |
| **85.5** | 0.366 | 509 |
| **86.0** | 0.361 | 502 |
| **86.5** | 0.355 | 496 |
| **87.0** | 0.350 | 489 |
| **87.5** | 0.345 | 483 |
| **88.0** | 0.340 | 477 |
| **88.5** | 0.335 | 472 |
| **89.0** | 0.331 | 466 |
| **89.5** | 0.326 | 461 |
| **90.0** | 0.321 | 456 |
| **90.5** | 0.317 | 451 |
| **91.0** | 0.312 | 446 |
| **91.5** | 0.308 | 441 |
| **92.0** | 0.303 | 436 |
| **92.5** | 0.299 | 432 |
| **93.0** | 0.295 | 427 |
| **93.5** | 0.291 | 423 |
| **94.0** | 0.287 | 419 |
| **94.5** | 0.283 | 415 |
| **95.0** | 0.279 | 410 |
| **95.5** | 0.275 | 406 |
| **96.0** | 0.271 | 402 |
| **96.5** | 0.267 | 398 |
| **97.0** | 0.264 | 393 |
| **97.5** | 0.260 | 389 |
| **98.0** | 0.257 | 385 |
| **98.5** | 0.253 | 380 |
| **99.0** | 0.250 | 376 |
| **99.5** | 0.246 | 371 |
| **100.0** | 0.243 | 367 |
| **100.5** | 0.240 | 362 |
| **101.0** | 0.236 | 357 |
| **101.5** | 0.233 | 352 |
| **102.0** | 0.230 | 346 |
| **102.5** | 0.227 | 341 |
| **103.0** | 0.224 | 335 |
| **103.5** | 0.221 | 330 |
| **104.0** | 0.218 | 324 |
| **104.5** | 0.215 | 318 |
| **105.0** | 0.212 | 312 |
| **105.5** | 0.209 | 305 |
| **106.0** | 0.206 | 299 |
| **106.5** | 0.204 | 292 |
| **107.0** | 0.201 | 285 |