PILOT ELECTRONIC REFRIGERATION CONTROL SYSTEM

IOM #

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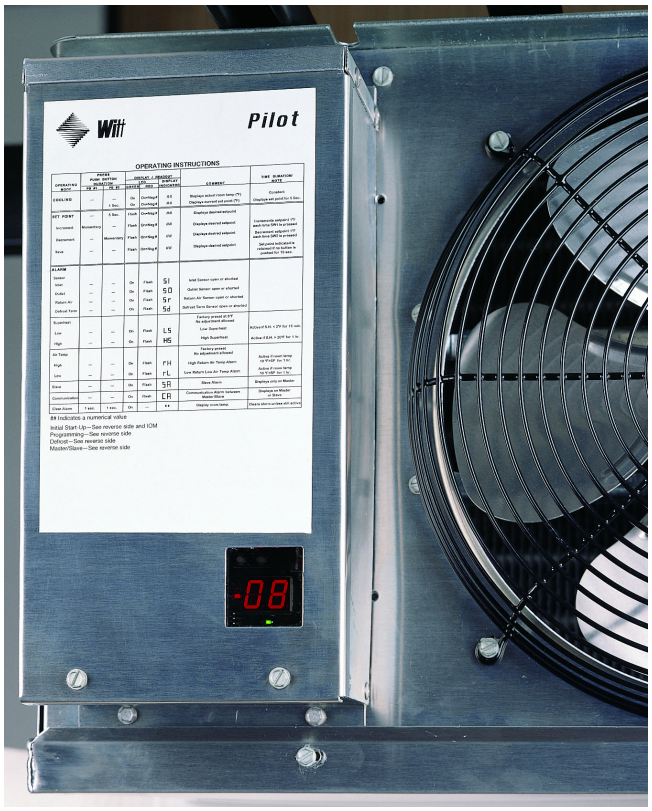

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General Information

Overview
The PILOT system is a state-of-the-art control system for use on refrigeration evaporators (unit coolers) for either freezer or cooler applications. The system utilizes an electronic expansion valve (EEV) and a microprocessor controller to precisely control the freezer or cooler temperature.

The system greatly simplifies installation because all required system components are factory packaged within the unit cooler—several electro-mechanical components which would otherwise be field installed are replaced by the factory-mounted EEV and the controller.

Condensing Unit
Any commercial condensing unit may be used with the PILOT system as long as the condensing unit is equipped with a low pressure control for pumpdown. The condensing unit should be installed in accordance with its installation instructions.

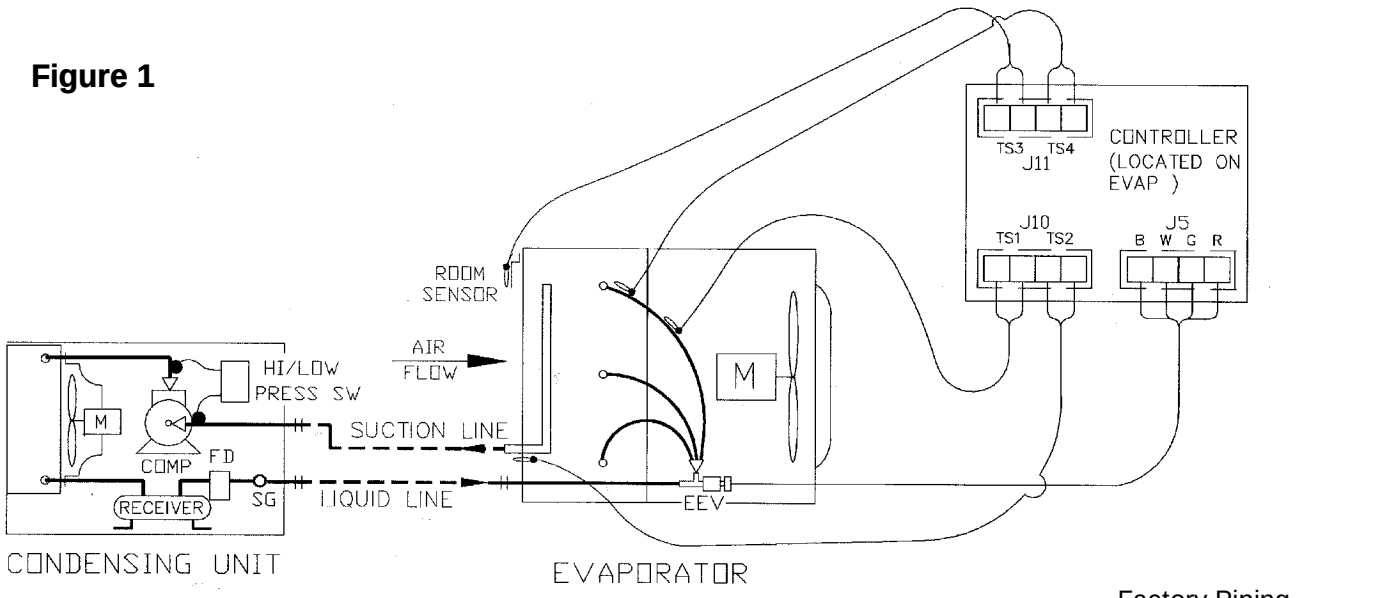
Unit Cooler
The PILOT system is installed on the unit cooler and includes the controller, an electronic expansion valve (EEV), a distributor with orifice, and the necessary sensors. The sensors provide temperature input to the controller from the air temperature entering the coil, refrigerant temperatures entering and leaving the coil and the defrost termination temperature.

Installation

System Piping
Field piping is required and consists of liquid and suction lines. Use acceptable industry piping practices in sizing lines for appropriate refrigerant velocities to assure oil return consistent with acceptable pressure drop. Refer to ASHRAE sizing guides and piping practices (e.g. correct trapping). All piping should consist of Type L refrigerant-duty (ACR) copper tube. Use AWS BCUP 3 - 5 % (minimum) silver alloy solder on all braze joints. Refer to Piping Diagram—Figure 1.

CAUTION— The electronic expansion valve and the suction temperature sensor are extremely sensitive to high temperatures encountered during brazing. Extreme heat can destroy internal components. Heat absorption compounds or wet rags must be used when brazing to avoid damage.

Figure 1



PIPING DIAGRAM

EEV = Electronic Expansion Valve
FD = Filter Drier
M = Motor
SG = Sight Glass

Notes:
1. *Refer to piping instructions for line sizes and specific trap requirements.*
2. *Refer to wiring diagrams for wire connections.*

Factory Wiring

Up to 4 temperature sensors may be attached to the controller: All sensors are 10K-ohm thermisters. The wiring is not polarity sensitive. Refer to wiring Figures 2 thru 5 for details.

Evaporator Coil Inlet Sensor—The sensor to measure the refrigerant temperature entering the coil is clamped to either a return bend or a distributor feed tube and is factory-wired to TS1 of the controller.

Evaporator Coil Outlet Sensor—The sensor to measure the refrigerant temperature leaving the coil is factory-wired to TS2 of the controller. *It must be clamped to the suction line only after suction line brazing is complete to avoid sensor damage*.

Room Air Temperature Sensor—The sensor to measure the entering air temperature of the evaporator is factory-wired to TS3 of the controller. It is located on the entering-air side of the evaporator coil.

Defrost Termination Temperature Sensor—The sensor to measure the defrost termination temperature is factory-wired to TS4 of the controller. This sensor is clamped to a return bend in the coil. On air defrost units this sensor is replaced with a 10K ohm, 1/4 watt, 5 % carbon-film resistor factory-wired across TS4 to avoid a defrost termination sensor alarm.

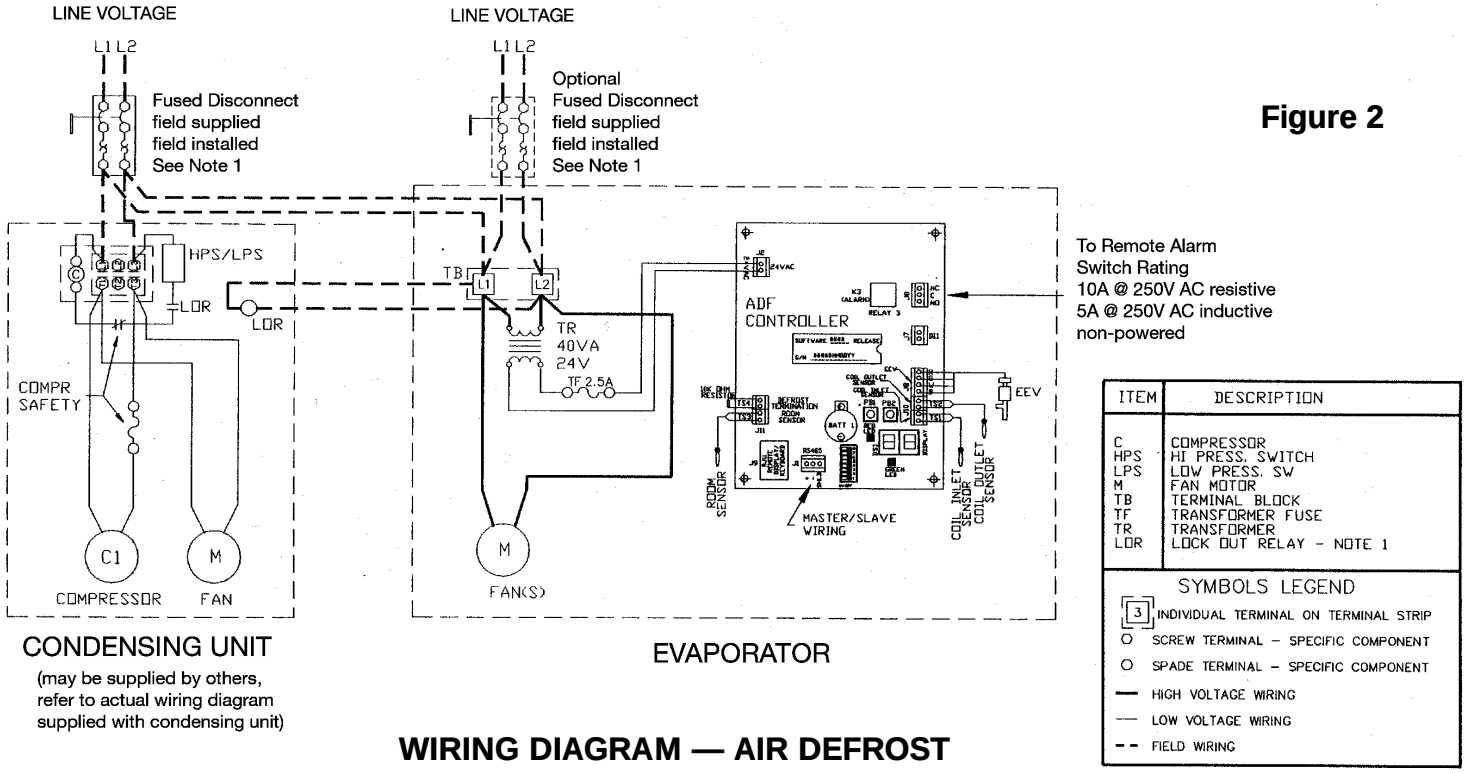
Electronic Expansion Valve—The four color-coded leads from the expansion valve are factory-wired to terminal strip J5 in the controller as follows:

Black lead-connected to the J5 terminal labeled 'B'
White lead-connected to the J5 terminal labeled 'W'
Green lead-connected to the J5 terminal labeled 'G'
Red lead-connected to the J5 terminal labeled 'R'

Defrost Heaters—Relay K1 is connected to L2 (power) to control the defrost heaters. Heater loads greater than 20 amps and 3 phase heaters require the use of a contactor. The contactor coil is controlled by relay K1 and the heaters are energized through the contactor's line voltage contacts. Refer to Diagram in Unit Cooler.

Evaporator Fans—Relay K2 is connected to L2 (power) to control the evaporator fan(s). Fan motor electrical loads greater than 20 amps and 3 phase motors require the use of a contactor. The contactor coil is controlled by relay K2 and the motors are energized through the contactors line voltage contact - refer to the diagram in unit cooler.

Controller Power Supply—24-VAC class II power is applied to controller at terminal J2.



ITEM	DESCRIPTION
C	COMPRESSOR
HPS	HI PRESS. SWITCH
LPS	LOW PRESS. SW
M	FAN MOTOR
TB	TERMINAL BLOCK
TF	TRANSFORMER FUSE
TR	TRANSFORMER
LOR	LOCK OUT RELAY - NOTE 1

SYMBOLS LEGEND

- 3 — INDIVIDUAL TERMINAL ON TERMINAL STRIP
- O — SCREW TERMINAL – SPECIFIC COMPONENT
- O — SPADE TERMINAL – SPECIFIC COMPONENT
- ——— HIGH VOLTAGE WIRING
- ——— LOW VOLTAGE WIRING
- - - - FIELD WIRING

Figure 2

WIRING DIAGRAM — AIR DEFROST

Note:

1. *Line Voltage may be supplied from condensing unit or an additional circuit. If an additional circuit is used, a fused disconnect must be supplied and a lockout relay should be installed to shutdown the condensing unit when power is interrupted at evaporator..*
2. *If multiple fans are used, they are wired in parallel.*

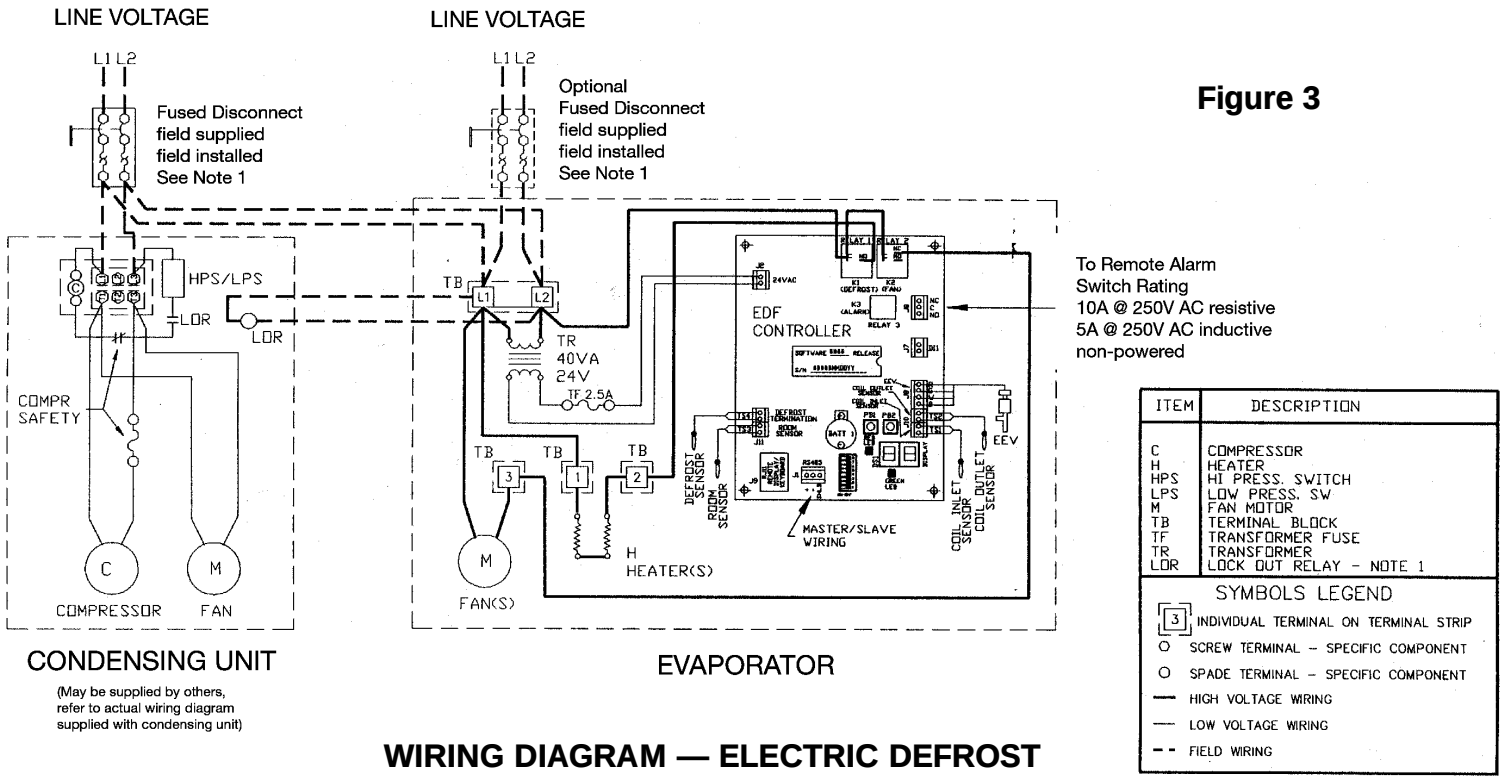


Figure 3

ITEM	DESCRIPTION
C	COMPRESSOR
H	HEATER
HPS	HI PRESS. SWITCH
LPS	LOW PRESS. SW
M	FAN MOTOR
TB	TERMINAL BLOCK
TF	TRANSFORMER FUSE
TR	TRANSFORMER
LOR	LOCK OUT RELAY - NOTE 1

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WIRING DIAGRAM — ELECTRIC DEFROST

Note:

1. *Line voltage may be supplied from condensing unit or an additional circuit. If an additional circuit is used, a fused disconnect must be supplied and a lockout relay should be installed to shutdown the condensing unit when power is interrupted at evaporator.*
2. *If multiple fans are used, they are wired in parallel*
3. *If multiple heaters are used, they are wired in parallel.*

Field Wiring

All wiring is completed at the factory as described above except the high voltage power feed wiring, remote alarm notification, remote defrost initiation, master/slave wiring, and remote panel display keypad wiring. Refer to Air Defrost (Figure 2) or Electric Defrost (Figure 3) wiring diagrams for the specific controller type.

All wiring must meet or exceed requirements found in national or local codes.

Power Wiring

A qualified electrician must complete all power wiring. Use copper conductors only. Size wire to meet load requirements of equipment. See wiring diagram for connections. A fused disconnect switch is required and must be sized to meet the load requirements of the connected equipment. All power wiring must be run in a separate conduit from the control circuit wiring. Power may originate from the condensing unit or from a separate power feed. See Note 1 on appropriate wiring diagram.

Optional Feature Wiring

Four remote features can be activated by wiring-in the appropriate remote equipment: Defrost Initiation, Alarm Notification, Master/Slave feature and Display/ Keyboard Panel. Wiring connections are made as follows:

Defrost Initiation—Wire a non-powered switch (by others) across terminals DI1 (on J7). Defrost is initiated when the switch is closed, shorting out the connection.

Caution:
Do not apply power to this connection control panel damage can result.

Alarm Notification—Wire the alarm signal device to alarm relay K3. Relay contacts are rated at 250 VAC—10 amps resistive; 5 amps inductive. This relay allows for remote alarm annunciation, connection to a telephone system auto dialer or a paging network for emergency notification or alarm.

Master/Slave Communication—Wiring is made to the RS-485 connector (on J1). Refer to Master/ Slave section of this manual for connection diagram and logic. Wire must be a minimum of 22 GA AWG twisted shielded pair with a ground wire—Beldan No. 8761 or equivalent.

Display/Keyboard Panel (Optional)—Connect wiring to the telephone jack (on J9). Refer to Display Keypad IOM. Use a 26 GA AWG 4-conductor flat telephone cord with a RJ-11 connector.

Pilot Features with Theory of Operations

LED Lights, Push Buttons, and Display Indicator
The majority of functions involved with the PILOT system are controlled or displayed by the push buttons, LED lights, or display indicator. Refer to Figure 4 (Air Defrost) or Figure 5 (Electric Defrost) for board layout.

Red LED—The red LED, located at the left of the temperature display (DS1), indicates a negative temperature (e.g. minus 20° F.) when it is steadily illuminated (or a positive temperature—e.g. plus 20—when it is off). It indicates an alarm has occurred if it begins flashing. The two-digit read-out will display the alarm code identifying the nature of the problem. (See ALARMS Section in this manual)

Green LED—The GREEN LED, located below the temperature display (DS1), will be steadily illuminated when the control is in the automatic operating mode. The green LED will be flashing when the controller is in programming mode, set point mode, clock set mode, or manual override mode.

Push Buttons—The board is provided with two push buttons, PB1 and PB2, which are used for control programming and manual override of certain modes. Refer to 'Programming & Manual Adjustments' Section for the push-button operating sequence.

Alphanumeric Display—The board is provided with two seven-segment LED's which function as an alphanumeric display to indicate room temperature, temperature set point, defrost mode, coil drain mode, fan delay mode, clock mode, clock time, manual valve position, and specific alarms.

The controller is in either the COOL or OFF mode when the display shows the room air temperature. The controller is in DEFROST mode when the display shows 'dF', the green LED is on and the red LED is off. The controller is in COIL DRAIN mode when the display shows 'Cd', the green LED is on and the red LED is off. The controller is in Fan Delay Mode when the display shows 'Fd', the Green LED is on and the Red LED is off.

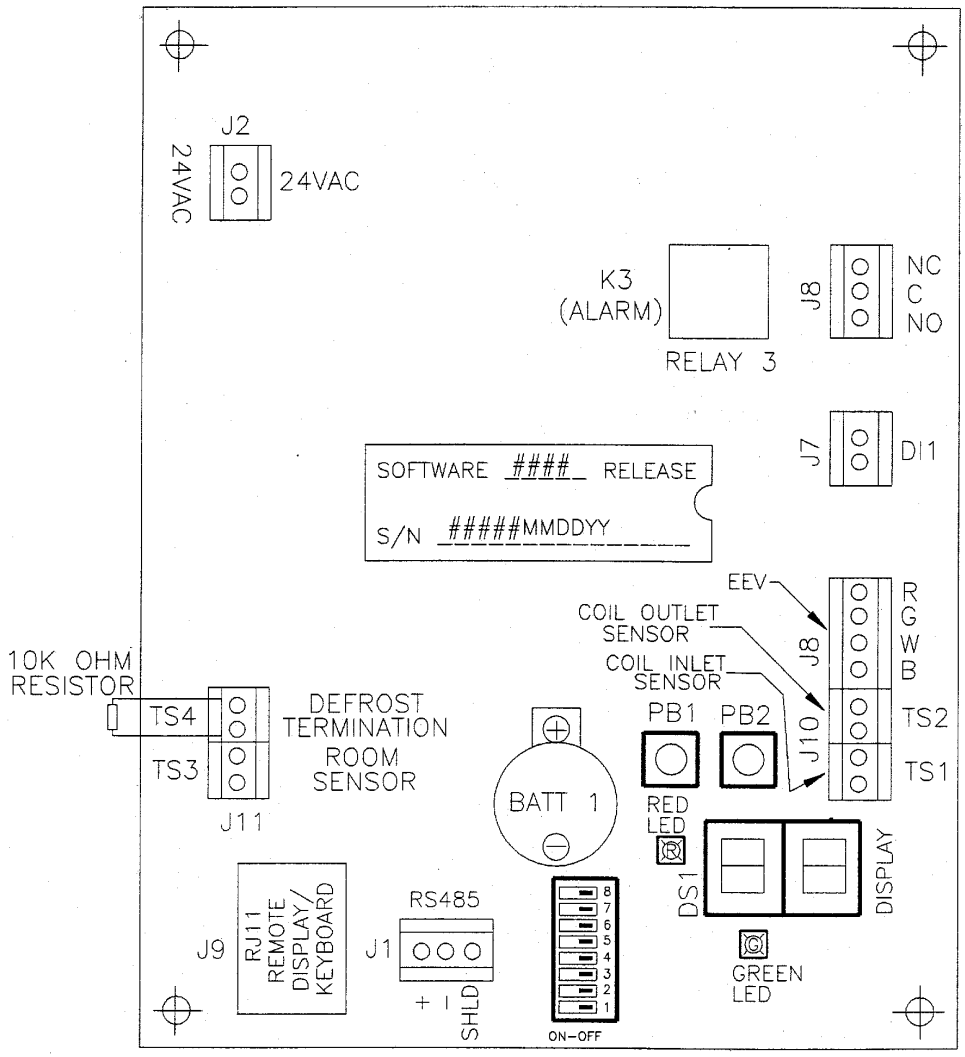
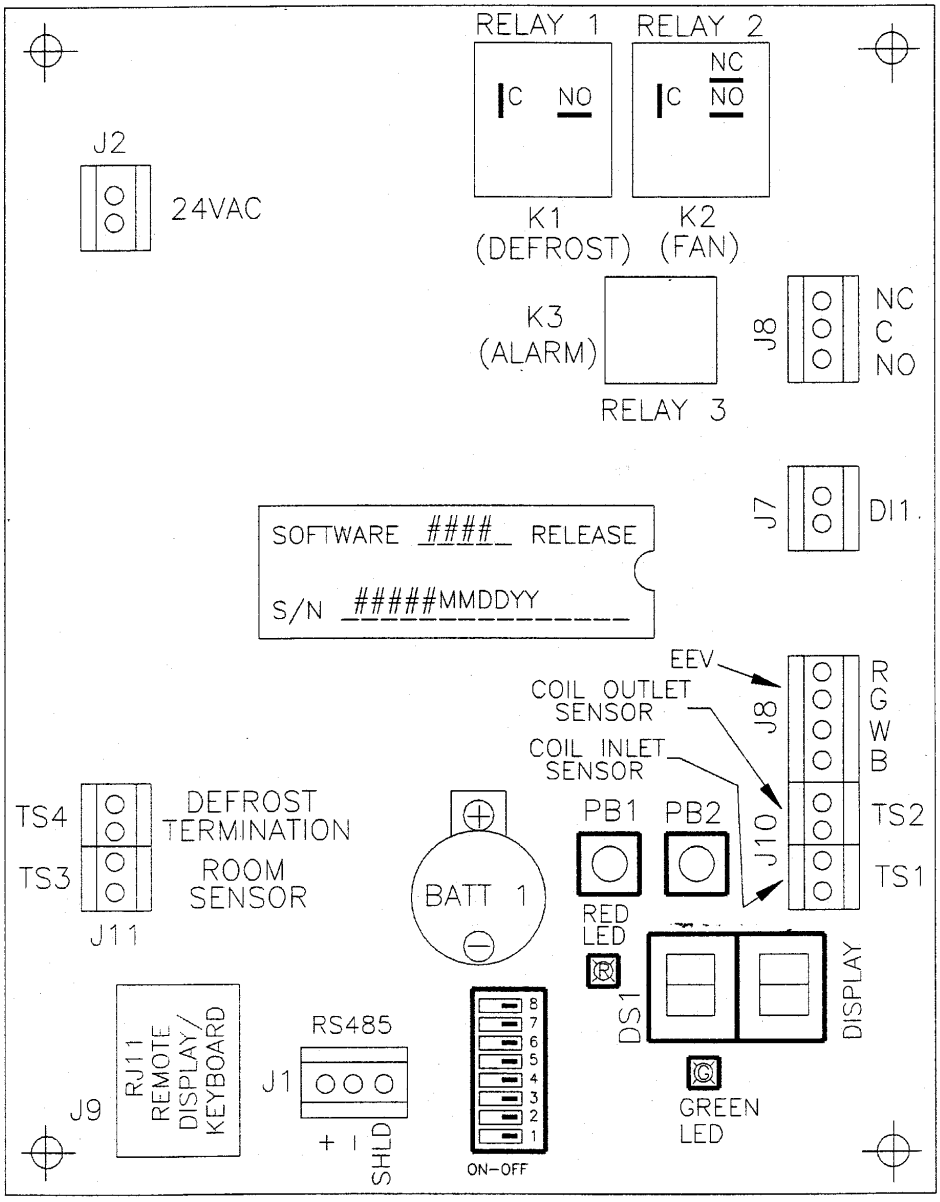


Figure 4

AIR DEFROST BOARD

Figure 5

ELECTRIC DEFROST BOARD



Dip Switch Instructions

The PILOT system uses a series of dip switches to adjust the master/slave relationships and the number of defrosts in a given day. Switches numbered 1, 5, 6, 7 and 8 control the unit cooler's master/slave settings. The remaining switches, 2,3 and 4 operate the defrost controls. The following charts further explain the correct dip-switch settings to achieve the desired results.

Master-Slave Settings

Control Relationship	*Dip Switch Number*					*Notes*
	1	*5*	*6*	*7*	*8*	
Stand Alone	Off	Off	Off	Off	Off	One system
Master + 1 Slave	On	On	On	Off	Off	**Important**: Switches must be set for actual
Master + 2 Slaves	On	On	Off	On	Off	number of slaves in use. If not set correctly,
Master + 3 Slaves	On	On	Off	Off	On	a communication alarm (CA) will appear.
Slave # 1	Off	Off	On	Off	Off	**Important**: Switches must be set for each
Slave # 2	Off	Off	Off	On	Off	slave unit present for proper communication
Slave # 3	Off	Off	Off	Off	On	with master control.

Defrost Switch Settings

No. Of Defrosts Per Day	*Dip Switch No.*			*Notes*
	2	*3*	*4*	
0	Off	Off	Off	Defrost periods occur based on 24 hrs.
1	On	Off	Off	divided by the number of defrosts per day.
2	Off	On	Off	(e.g.. 4 defrosts per day = 24 / 4 = 6 hr. intervals)
3	On	On	Off	
4	Off	Off	On	
5	On	Off	On	
6	Off	On	On	
7	On	On	On	

Start-Up

Set the controller clock to the correct time after initial power application—refer to the clock-mode instructions on Page 10. Refer to Condensing Unit IOM for system charging instructions. To charge system, it may be necessary to force EEV to an open position-see EEV Override, Page 10.

Automatic Operating Modes

The controller will close the electronic expansion valve when power is applied to the board. This will take 17.5 seconds. The controller then checks the DIP switches for number of defrosts per day, the time-of-day and the Master/Slave relationship. If it is time for the controller to be in defrost, the controller will start-up in the DEFROST mode. If it is not time to be in defrost, the controller will start in OFF mode.

OFF Mode - In OFF mode the fans will operate and the EEV will close causing the condensing unit to pumpdown.

Cool Mode - The controller will initiate cooling if the room temperature is above the set point. The controller starts the COOL mode by opening the expansion valve to 25% of full capacity. The controller keeps the valve at this position until the inlet refrigerant temperature sensor is within 10° F of the room air-temperature set point or 5 minutes has elapsed. This ensures that the inlet sensor is measuring saturated refrigerant temperature.

The controller will then begin to adjust the superheat (outlet refrigerant temperature minus inlet refrigerant temperature) by modulating the valve to achieve the pre-programmed superheat set point of 8° F. The controller will maintain the superheat at this set point for a minimum compressor run time of 5 minutes. To prevent compressor short-cycling a 2 minute minimum OFF time exist.

The controller monitors room air temperature while maintaining superheat at the set point. It closes the expansion valve (assuring pumpdown) and switches the system back to the OFF mode when the actual room temperature is 1° F. below the room temperature set point. The controller monitors the number of defrosts per day and the time-of-day whenever it is in the COOL mode. It will initiate a defrost at each appropriate time-of-day.

Low Superheat Conditions—The two-character readout will display 'LS' and the expansion valve will begin a programmed procedure to confirm the low superheat condition and to identify the cause and severity of the problem. This procedure is described further in the section entitled 'Low Superheat Alarm' In the Alarm Section.

Defrost Mode — Code dF

The time-of-day calculator monitors elapsed time starting at 12:00 midnight (equals zero minutes). After 11:59 PM the timer resets 12:00 midnight to 00:00 hours.

The first defrost start-time begins at an elapsed time of 00:00 (12:00 midnight) until specified otherwise. The controller sets the other defrost start-times by adding the elapsed time between each defrost to the previous start-time. To determine time between defrosts the controller divides 24 hours per day by the number of defrosts per day as set up on the DIP switches; i.e. for 4 defrost per day: 24 ÷ 4 = 6 hr. intervals 00:00, 0600, 1200, 1800.

To adjust defrost times for specific times in a given day, a clock offset may be required. For example: 4 defrost periods are required at 0300, 0900, 1500, 2100. The current time at start-up is 12:00 noon. Set Clock to 0900 (see Clock Mode). System should defrost at this point and every 6 hour from the offset time of 0900.

A power failure does not disrupt the defrost time or logic—The batteries allow the timer to continue tracking the time-of-day even during a power outage.

When power is restored, defrost will be initiated, at that time, if the time-of-day is within any one of its defrost duration periods. Cooling will commence (upon demand) if time-of-day does not require defrost.

Air Defrost—The controller first closes the expansion valve and the system performs a pump-down cycle. The unit cooler fans continue to run, using the room air (+35° minimum) to melt the frost. The controller terminates defrost and returns the system to Cool Mode when the defrost duration time has expired. Factory set to 45 minutes.

Electric Defrost— The controller first closes the expansion valve and the system performs a pump-down cycle. It then energizes the Defrost (K1) Relay and energizes the Fan (K2) relay turning on the defrost heaters and turning off the evaporator fans.

The controller will terminate defrost when the defrost termination sensor reads 55° F. or when the 'Fail-Safe' defrost duration reaches 45 minutes. The controller de-energizes the heater relay at this time and goes into the Coil Drain Mode.

Coil Drain Mode — Cd

The controller automatically goes into the Coil Drain Mode for 3 minutes whenever a defrost is terminated. Fans remain off during this period.

Fan Delay Mode — Code Fd

The controller opens the EEV 25% starting the compressor and the fans remain off until either the Defrost Termination Sensor reaches a Fan Delay Setpoint of 35°F or the 3 minute time delay is reached. The controller returns the system to the Cool Mode after the fan delay by de-energizing the fan relay (starting the unit cooler fans) and modulates the expansion valve to maintain superheat.

Alarms

The controller is programmed to detect up to ten different fault conditions.

The Controller energizes relay #3 when it detects a fault. Each alarm has its own code which is displayed on the 2-character readout on the controller when relay #3 switches.

The green LED will be on and the red LED will blink as an added warning. Multiple alarms can exist, so there is a priority to control which alarm will be displayed in preference to another.

It is as follows:

PRIORITY	*ALARM*	*DISPLAY*	*CAUSE*
1	Inlet Sensor TS1	Si	Inlet sensor open or shorted
2	Outlet Sensor TS2	So	Outlet Sensor open or shorted
3	Room Sensor TS3	SA	Room Sensor open or shorted
4	High Superheat	HS	Superheat > 20° F for 60 min.
5	Low Superheat	LS	Superheat < 2° F for 5 min.
6	High Room Temp	rH	Room temp. 5° over setpoint temp. for 5 min.
7	Low Room Temp	rL	Room temp 5° below setpoint temp. for 5 min.
8	Slave Alarm	SL	An alarm exists at a Slave Unit
9	Defrost Term. Sensor	Sd	Defrost Term. Sensor open or shorted
10	Communication Alarm	CA	Communication Failure between Master and Slave units

- The four temperature sensors are checked continuously for opens or shorts.
- A sensor must read between -50° F. and +113.4° F. or it will report an alarm.
- A sensor must be connected to each temperature sensor terminal on the controller (TS1 thru 4) or an alarm will be generated.
- TS4 is the defrost termination connection terminal. Air defrost controllers do not use a defrost termination sensor, so a 10 k-ohm resistor is factory-wired in its place (across TS4) to simulate the sensor, thereby avoiding a false alarm.

Inlet And Outlet Sensor Alarms—Codes Si & So

The controller will initiate a recovery routine if an alarm occurs at either TS1 (refrigerant inlet sensor) or TS2 (refrigerant outlet sensor) and the system is in the COOL mode. It will close the expansion valve for 3 minutes, then open it to 25% for 90 seconds. The controller will repeat this cycle until the alarm is corrected. The OFF, DEFROST, COIL DRAIN, and FAN DELAY modes are unaffected by inlet or outlet sensor alarms.

Room Sensor Alarm—Code SA

The controller will run in the COOL mode for 5 minutes then in the OFF mode for 2 minutes if the room temperature sensor at TS3 fails. It will repeat this cycle until the alarm is corrected.

High Superheat Alarm—Code HS

The High Superheat Alarm occurs if the superheat remains at 22° F. (i.e. 14° above the preset 8° superheat) or above for 60 minutes or more. The alarm will clear when the superheat decreases to 22° or below. There is no automatic corrective procedure for this alarm.

Low Superheat Alarm—Code LS

This alarm occurs if the superheat remains below 2° F. for 5 minutes.

The Two-Temperature method of superheat measurement is used in the Pilot system. Its accuracy depends upon saturated refrigerant being present at TS1, the Coil Inlet Sensor. If saturated refrigerant ***is not present at TS1****, the temperature at TS1 will rise along with the temperature at the outlet sensor (TS2) as the cooling load is imposed upon the unit cooler.* ***This condition will simulate a reasonable superheat, preventing the controller from recognizing the starved condition of the coil.***

The controller therefore initiates a routine to determine whether the superheat is really too low or the coil is actually starved of refrigerant. The controller will close the expansion valve for 15 minutes, assuring pumpdown. It will then open the valve 25 % for 2 minutes.

A low superheat condition is proven if the inlet refrigerant temperature does not drop at least 2.5° F. within that 2-minute period. The controller will repeat the cycle as described above until the Low Superheat Alarm is cleared.

A starved condition is proven if the inlet refrigerant temperature drops 2.5° F. or more, within that 2-minute period. The Low Superheat Alarm will then be cleared and the High Superheat Alarm set. The controller will operate as previously described in High Superheat Alarm.

High Room Temperature Alarm—Code rH

The High Room Temperature Alarm occurs when the room temperature is 5° F. or more above its set point for 5 minutes. This alarm is inhibited during defrost and for 1 hour thereafter; and is delayed for 1 hour after a power-up. The alarm is cleared when the room temperature is within 5° F of its set point.

Low Room Temperature Alarm—Code rL

The Low Room Temperature Alarm occurs when the room temperature is 5° F or more below its set point. for 5 minutes. The alarm is cleared when the room temperature is within 5° F of its set point.

Slave Alarm— Code SL

The Master controller will report a Slave Alarm when any of its Slave controllers report an alarm.

Defrost Termination Sensor Alarm—Code Sd

The Defrost Termination Sensor Alarm will occur if the defrost termination temperature sensor at TS4 fails. The controller will terminate defrost after 45 minutes.

Communication Alarm—Code CA

A Communication Alarm can only occur if controllers are set up as Master and Slave(s).

Communication must be exchanged between Master and each Slave controllers at least once every minute or the Communication Alarm is activated.

The Master controller will act as a stand-alone controller until the alarm is cleared, but will continue to send out commands for the current operating mode. The alarm will clear when all of the Slave controllers resume regular communication. For more details, see the MASTER/SLAVE Section.

A Slave controller will act as a stand-alone controller until the alarm is cleared.

Alarm Clearing

Hold both push buttons down for 1/2 to 5 seconds to clear an alarm. This also resets the alarm timer. Reset multiple alarms by depressing both push buttons for each alarm. They will be reset in descending order of priority.

NOTE
An alarm will remain on the display until reset. The alarm will return after reset, if the fault causing the alarm is still active.

Programming and Manual Adjustments

Set-Point Modes

Room Temperature Mode

Hold push button #2 (PB2) down for 1/2 to 5 seconds to display the room-air temperature set-point. The red LED will be off if the set point is above 0° F. (i.e. a positive number) or on if the set-point below 0° F. The green LED will blink for 10 seconds, then stop.

Activate the Set-Point Mode by holding push button #2 (PB2) down for 5 seconds. The green LED will start blinking and the set point will be displayed. The red LED will indicate a positive or negative number as before. Push button #1 (PB1) increases the set point; push button #2 (PB2) decreases the set point. Press-and-release the appropriate button to change the set point by 1° F. Continue as required to reach the desired set point.

Room Temperature Save

The new set point will automatically be saved if neither button is pushed for ten seconds. The last displayed set point becomes the new set point, and the controller will return to normal operation.

Clock Mode

Clock Reset Mode

Hold push button #1 (PB1) down for 1/2 to 5 seconds to reset the clock to 0 minutes (12:00 midnight). The display will show CL the red LED will be off; and the green LED will blink for 10 seconds.

Clock Hour Setting

Press-and-hold push button PB1 for more than 5 seconds while the green LED is blinking—push PB1, the elapsed-time counter will advance by 1 hour. The display will be '01' for 1:00 AM and the green LED will blink for another 10 seconds. Continue as required to reach the desired time. Pressing PB1 when the display reads 23 will return the counter to 0 and the display to CL.

Clock Time Based Defrost Periods.

Clock time can be set by pressing PB1 for greater than 5 seconds, and using PB1 to increment time between 00:00 and 23:00. Prior to saving by waiting ten seconds, press PB2 while still in clock mode (green LED flashing) will initiate an actual time of day based defrost routine. This will allow one to set defrosts to occur when they want instead of trying to calculate a time offset. Sequence as follows:

Set actual clock time to nearest hour using PB1 function. Prior to 10-second time out, press PB2. Pressing PB2 automatically saves current time (00:00 to 23:00) and now allows one to set the time of day when the first defrost will occur by pressing PB2 incrementally and waiting 10 seconds for the memory to be saved. The program then refers to the DIP switches to determine the defrost incremental time and will defrost accordingly. Example - You want 4-defrosts a day to occur at 0200, 0800, 1400, 2000. So you set DIP switches accordingly. Set clock time to nearest hour with PB1 and then set first defrost period to 02 with PB2. The processor then adds 6-hours for each desired defrost time.

Clock Time Save

The new clock time will automatically be saved if neither button is pushed for ten seconds, at which time the green LED will stop blinking. The last displayed clock time becomes the new clock time, and the controller will return to normal operation.

Manual Control Modes

Defrost Initiation

Hold push button PB1 down for 5 seconds when the controller is in the OFF or COOL mode to switch the controller to the DEFROST mode as described on Page 7. Code dF displayed.

Coil Drain Initiation

Hold push button PB1 down for 5 seconds when the controller is in the DEFROST mode to switch the controller to the COIL DRAIN mode as described on Page 8. Code Cd displayed.

Fan Delay Initiation

Hold push button PB1 down for 5 seconds when the controller is in the COIL DRAIN MODE to switch the controller to the FAN DELAY mode as described on Page 8. Code Fd displayed.

Cool Initiation

Hold push button PB1 down for 5 seconds when the controller is in the FAN DELAY mode to switch the controller to the COOL mode as described on Page 7. Room temperature displayed.

EEV Override

Hold both push buttons down simultaneously for 5 seconds to switch the controller into Manual Valve positioning. The controller will close the expansion valve; the red LED will be off; and the green LED will blink.

The display indicates the percentage of full stroke that the valve is open (at this time 00 will be displayed). Push button PB1 opens the expansion valve; PB2 closes it. Press-and-release the appropriate push button to change the valve position by 1% of full stroke. The display will also increment by 1%. Continue as required to reach the desired valve position, 00 to 99 percent.

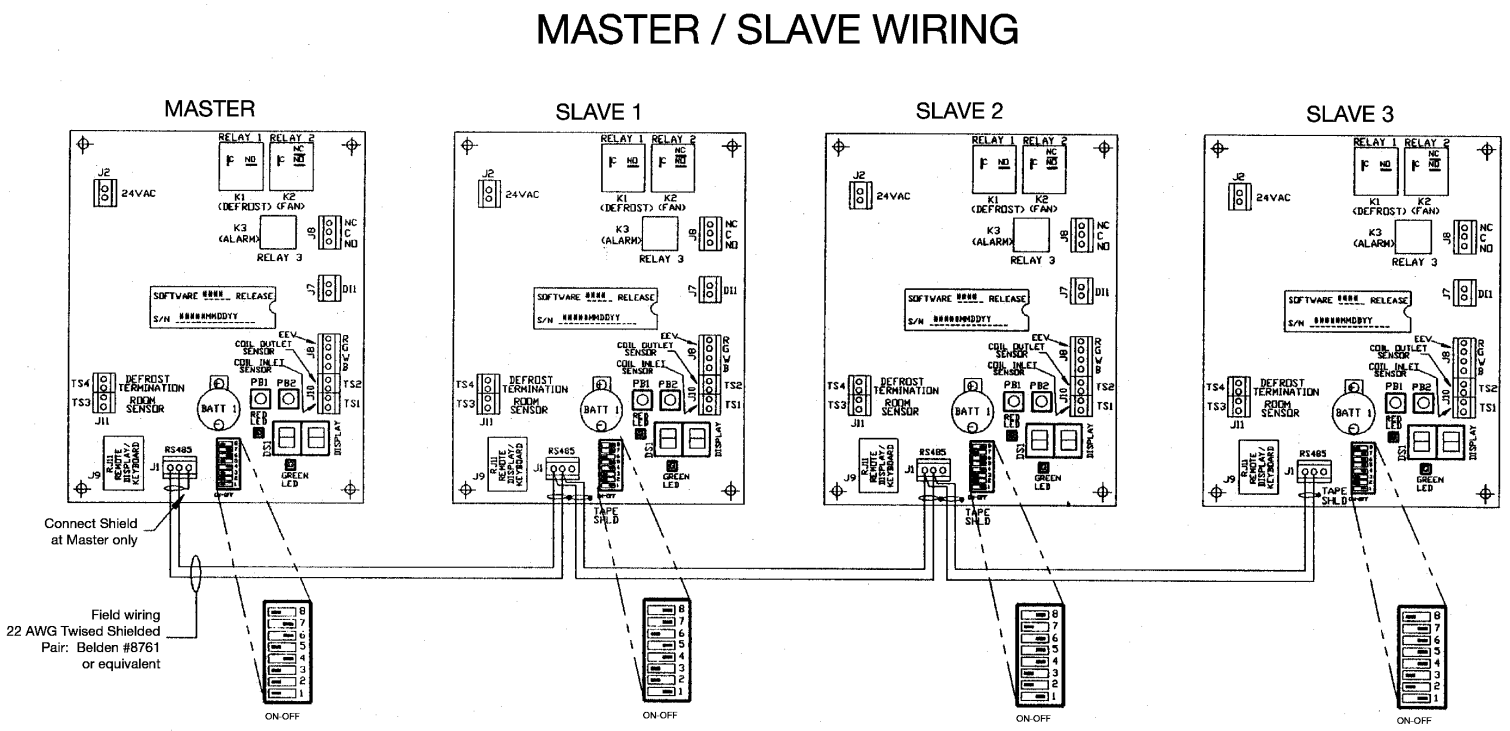
Hold both push buttons down simultaneously for 5 seconds to switch the controller back into normal operation. The controller will return to normal operation if neither push button is pressed for 1 hour.

NOTE:

1. *This feature may be used to manually pump down the system for service. System power should be turned off, in this case, to keep valve closed past its one-hour reset period.*
2. *This feature may be used to open the EEV while initially charging the system.*

Master / Slave Connection

The PILOT control system allows one unit cooler, the Master, to control up to three other unit coolers or Slaves. Refer to Figure 6 for wiring connections. The number of defrosts and all desired set points must be identical whenever using a Master/Slave configuration. The master will control all the functions of the slaves.
Refer to Dip Switch Settings on Page 6.



Note:

1. *Line Voltage wiring is not shown for clarity. Each unit must have Line Voltage Wiring installed. Refer to appropriate diagram.*
2. *Electric Defrost Board is shown. Master/Slave Wiring for Air Defrost is identical.*
3. *Dip Switch Settings shown refer to a Master with 3 Slaves, all set to 3 defrosts per day. See Page 6 and 7 of IOM for other settings.*

Figure 6

Master/Slave Sequence

The Master controller will initialize itself by fully closing the expansion valve when power is turned on. A Slave controller will put itself in the OFF mode and wait for a command from the Master. Failure to receive a command within one minute will activate the Communication Alarm. It will then run as a stand-alone controller except that it can only time-terminate a DEFROST. The Communication Alarm clears when it receives any command from the Master.

There are three commands that a Slave controller can receive from the Master controller:

1. Go to the OFF mode
2. Go to the COOL mode
3. Initiate DEFROST

All commands are addressed to a specific Slave (e.g. Slave #1, Slave #2). The addressed Slave will respond to all OFF and COOL commands with one of two responses.

1. Ready to go to OFF mode
2. Ready to go to COOL mode

Slave #1 will respond immediately; #2 will respond after 1 second; #3 will respond after 2 seconds of receiving the command.

The Slave gives the OFF mode response whenever the Air Temperature is below the OFF TEMPERATURE set point or if the Slave received the OFF mode command from the Master controller and the Air Temperature is below the COOL TEMPERATURE set point. The Slave gives the COOL mode response whenever the Air Temperature is above the COOL TEMPERATURE set point or if the Slave received the COOL mode command from the Master controller and the Air Temperature is above the OFF TEMPERATURE set point.

The Slave will initiate DEFROST if it receives the DEFROST mode command from the Master. The Slave does not respond to the DEFROST command from the Master until the DEFROST TERMINATION TEMPERATURE has reached its set point. The Slave will then respond that it is 'Ready to go to COOL mode'.

The Slave will stay in the DEFROST mode as long as it is receiving the DEFROST command from the Master. The Slave will terminate DEFROST when it receives either the OFF command or the COOL command from the Master.

The Slave will immediately go into COIL DRAIN mode and use the COIL DRAIN TIME programmed in its memory. After the COIL DRAIN TIME is complete, it will go into COOL mode or OFF mode, depending upon the last command received from the Master.

The Master controller, after power-up, will go either into the OFF mode or DEFROST mode if a defrost is due. The Master will send the OFF mode command or the DEFROST mode command to the Slave(s), depending upon the Master's mode.

The Master and Slave(s) must stay in the OFF mode for the MINIMUM OFF TIME before they can re-enter the COOL mode. The Master will go to the COOL mode and command the Slave(s) to the COOL mode when there is a demand for cooling and when all the Slaves respond that they are 'Ready to go to COOL mode'.

The Master and Slave(s) must stay in the COOL mode for the MINIMUM RUN TIME before they can re-enter the OFF mode. The Master will go to the OFF mode and command the Slave(s) to the OFF mode when the demand for cooling is over and when all the Slaves respond that they are 'Ready to go to OFF mode'.

The Master will start sending the DEFROST command when it calculates that it is time to initiate a DEFROST. The Slaves that receive the DEFROST command will initiate a DEFROST. None of the Slaves will respond with a further command until the DEFROST TERMINATION TEMPERATURE of that Slave has reached its SET POINT. That Slave will start responding with the COOL response. When all Slaves respond that they are 'Ready to go to COOL mode' and the Master's DEFROST TERMINATION TEMPERATURE has reached its SET POINT, the Master will start sending the COOL command. All controllers will go to COIL DRAIN mode for the programmed time and will then go to COOL mode and continue as above. The Master will also terminate DEFROST if its DEFROST DURATION TIME has timed out.

The Master will give a Communication Alarm if any one of the Slaves does not respond to an OFF command or COOL command within a 1 minute time period. The Master will act as a Stand-alone controller with the exceptions that it will keep transmitting the commands for the mode that it is in and it will terminate DEFROST on time only. The Master clears the Communication Alarm when all Slaves resume responding to the Master.

Battery Information

Two Lithium-Ion coin-type batteries are located in BATT 1 holder. Refer to Figure 4 or 5 for location. The controller is powered with a battery backup to retain program parameters during a power outage.

The board is shipped with a deactivation spacer between the battery and the positive post. Remove the spacer prior to unit operation.

Manufacturer: Panasonic
Manufacturer P/N: CR223
Operating life: 7 years powered
(3 years unpowered)

When replacing batteries, make sure that both batteries are installed with the positive (+) position facing out toward the installer. See Figure 7.

When replacing batteries, replace both batteries.
Do not replace only one.

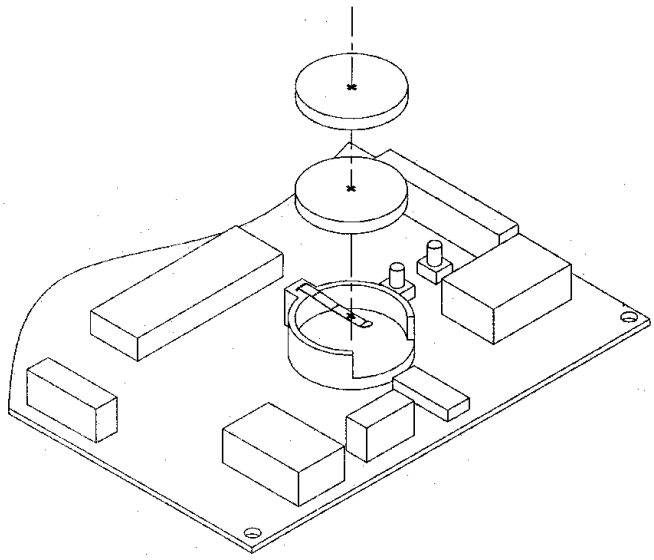


Figure 7

OPERATING INSTRUCTIONS

OPERATING MODE	PRESS PUSH BUTTON DURATION PB #1	PRESS PUSH BUTTON DURATION PB #2	DISPLAY / READOUT LED GREEN	DISPLAY / READOUT LED RED	DISPLAY / READOUT DISPLAY INDICATOR	COMMENT	TIME DURATION/ NOTE
COOLING	—	—	On	On=Neg #	##	Displays actual room temp (°F)	Constant
		1 Sec.	On	On=Neg #	##	Displays current set point	Displays set point for 5 Sec.
SET POINT	—	5 Sec.	Flash	On=Neg #	##	Displays desired setpoint	
Increment	Momentary	—	Flash	On=Neg #	##	Displays desired setpoint	Increments setpoint 1°F each time SW1 is
Decrement	—	Momentary	Flash	On=Neg #	##	Displays desired setpoint	Decrement setpoint 1°F each time SW2 is
Save	—	—	Flash	On=Neg #	##	Displays desired setpoint	Set point indicated is retained if no button is pushed for 10 sec.
ALARM							
Sensor							
Inlet	—	—	On	Flash	S1	Inlet Sensor open or shorted	
Outlet	—	—	On	Flash	S0	Outlet Sensor open or shorted	
Return Air	—	—	On	Flash	Sr	Return Air Sensor open or shorted	
Defrost Term	—	—	On	Flash	Sd	Defrost Term Sensor open or shorted	
Superheat						Factory preset at 8°F No adjustment allowed	
Low	—	—	On	Flash	LS	Low Superheat	Active if S.H. < 2°F for 15 min.
High	—	—	On	Flash	HS	High Superheat	Active if S.H. > 20°F for 1 hr.
Air Temp						Factory preset No adjustment allowed	
High	—	—	On	Flash	rH	High Return Air Temp Alarm	Active if room temp 10 °F>SP for 1 hr.
Low	—	—	On	Flash	rL	Low Return Low Air Temp Alarm	Active if room temp 10 °F<SP for 1 hr.
Slave	—	—	On	Flash	SA	Slave Alarm	Displays only on Master
Communication	—	—	On	Flash	CA	Communication Alarm between Master/Slave	Displays on Master or Slave
Clear Alarm	1 sec.	1 sec.	On	—	##	Display room temp.	Clears alarm unless still active

Indicates a numerical value

Initial Start-Up—See reverse side and IOM
Programming—See reverse side
Defrost—See reverse side
Master/Slave—See reverse side

PROGRAMMING / OPERATING INSTRUCTIONS

OPERATING MODE	PRESS PUSH BUTTON DURATION PB #1	PB #2	DISPLAY / READOUT LED GREEN	RED	DISPLAY INDICATOR	COMMENT	TIME DURATION/ NOTE
CL0CK	1 TO 5 sec	—	On	—	CL	Reset clock to 00:00 and activates defrost	See Defrost Mode and Dip SW Setting
Hour Set	Increment	Decrement	Flash	—	0-23	Set clock time to nearest whole hour	Military 24 hr. time
Save Time	—	—	Flash	—	##	Displays hour	Retains after 10 sec
DEFROST		—	On	—		Activate manual defrost	Terminates on Temp 55°F or 45 min. See Coil Drain below
Manual	5 sec.	—	On	—	dF		
COIL DRAIN		—	On	—		If in Defrost Mode forces Coil Drain and terminates defrost	3 min. (fixed). See Fan Delay below
Manual	5 sec.	—	On	—	cd		
FAN DELAY		—	On	—		Forces Fan Delay	3 min. (fixed). See Cool Mode Below
Manual	5 sec.	—	On	—	Fd		
COOL MODE	5 sec.	—	On	On=Neg #	##	Activates Cool Mode if in Fan Delay Mode	
EEV						Allows manual EEV override	
Manual	5 sec.	5 sec.	Flash	—	00	Valve closes	Causes Pump Down. Control automatically releases manual valve override 1 hr. after last adjustment See EEV Release
Increment	Momentary	—	Flash	—	01-99	% valve open	Increments valve position 1% each time SW1 is
Decrement	—	Momentary	Flash	—	00-99	% valve closed	Decrements valve position 1% each time SW2 is
EEV RELEASE	5 sec.	5 sec.	On	—	##	Display actual room temp.	Releases EEV Manual Control to normal operation mode

indicates a numerical value

CONTROLLER DIP SWITCH SETTINGS

Defrost Control (See note 1)				Stand Alone / Master / Slave (See note 2, 3)					
No. of Defrosts Per Day	Switch Number 2	3	4	Control Action	Switch Number 1	5	6	7	8
0	Off	Off	Off	Stand Alone Control	Off	Off	Off	Off	Off
1	On	Off	Off	Master w/one Slave	On	On	On	Off	Off
2	Off	On	Off	Master w/two Slaves	On	On	Off	On	Off
3	On	On	Off	Master w/three Slaves	On	On	Off	Off	On
4	Off	Off	On	Slave #1	Off	Off	On	Off	Off
5	On	Off	On	Slave #2	Off	Off	Off	On	Off
6	Off	On	On	Slave #3	Off	Off	Off	Off	On
7	On	On	On						

NOTE: 1. Defrost periods occur based on 24 hrs. divided by No. of defrosts per day. i.e. 4 defrosts per day = 24 ÷ 4 = 6 hour intervals. For time of day defrost, set clock to nearest whole hour where a required defrost period must occur.
2. Master and Slave(s) must have the same defrost per day setting. Slave unit(s) must have individual switch settings for proper communication.
3. Refer to IOMfor master slave logic.

Initial Start-Up

1. Refer to IOM for Evap mounting, piping, wiring.
2. Set control Dip Switches to desired settings.
3. Turn power on.

Refer to installation instructions

EEV SERVICE AND TROUBLE-SHOOTING

OPERATION

The EEV is a step motor operated electric expansion valve. Step motors are designed to provide discrete segments of angular motion, or rotation, in response to an electronically generated signal. The advantages of step motors in valve applications are high resolution, repeatability and reliability with low hysteresis. Feedback loops are not required, simplifying controller design and circuitry.

The step motor used in the EEV valve is a 12 volt DC, two phase, bi-polar, permanent magnet rotor type. Each step creates a 3.6° rotation of the rotor. This rotation is increased in torque and reduced in speed by a 12.25:1 gear train. Final rotation is converted to linear motion by the use of a lead screw and threaded drive coupling. Forward motion of the motor extends the drive coupling and pin modulating the valve closed. Backward rotation of the motor retracts the drive coupling and pin modulating the valve open. Full forward or backward travel, while the valve is assembled, is limited by the valve seat in the closed position or an upper stop in the open direction. A slight racheting sound may be heard at either of these two positions and does no harm to the valve or drive mechanism.

The valve will operate only when connected to its controller and the controller has power. If the valve is in an open position and control power is disrupted, the valve will remain in that specific open position. The fans are wired to normally closed contact on relay K2 and will operate if control power is removed and line voltage is still present. This will help eliminate potential floodback. The controller must supply the necessary square wave step signal at 12 volts DC and 200 PPS for the valve to control properly. The PILOT control algorithm for the valve includes an initialization sequence that will first over-drive the valve to a fully closed position. This assures that the valve is completely shut and establishes a "zero" open position. The controller then keeps track of valve's position for normal operation. During this initialization phase, a light racheting sound may be heard and will serve as proof of valve operation and closure.

The valve has stainless steel to brass seating for tight shutoff and has uniquely characterized pin and port combinations for exceptional control of refrigerant flow. The seats require no service and are not replaceable.

For service, the step motor may be easily removed without removing the valve from the piping. Refer to disassembly.

INSTALLATION

The EEV is an electronically controlled step motor expansion valve and is installed before the evaporator and distributor. The valve must be installed in the proper direction, the inlet is clearly marked. The maximum cable length from controller to EEV is forty feet. The valve may be installed in any position except with the motor housing below the liquid line. Cable routing should avoid any sharp edges or other types of potential physical damage such as defrost heaters. For neatness and protection, the cable may be fastened to the suction or liquid lines with nylon wire ties. The valve has copper connections and a low silver content solder or brazing alloy (BCuP3 - 5%silver) should be used to install the valve. There is no need to disassemble the valve for installation, however, the torch flame should be directed away from the motor housing and cable. Care must be taken to assure that the cable is not damaged either directly from the flame, or indirectly from contact with hot piping. The valve is shipped in the open position to prevent heat being conducted into the motor, but it is strongly suggested that the valve body be wrapped with a wet cloth during the soldering operation. Inlet strainers are supplied separately with the valves , we do not recommend using them. The valve should be completely installed and reassembled, if necessary, before connecting to the controller and applying power. The wiring is color coded and must match the color codes denoted on the control board.

FIELD SERVICING INSTRUCTIONS

THE FOLLOWING STEPS ARE NECESSARY FOR THE PROPER DISASSEMBLING, INSPECTING , CLEANING AND REASSEMBLING OF THE EEV VALVE WHETHER IT HAS BEEN PREVIOUSLY INSTALLED OR IS BEING BENCH TESTED.

VALVE DISASSEMBLY

1. Before disassembling the valve, be sure the refrigerant pressure in the system has been reduced to a safe level (0 PSIG).
2. Disconnect the line voltage to the PILOT valve controller.
3. Using appropriate wrenches or a vice to properly support the valve body, remove the motor assembly from the valve body by loosening the locknut. To prevent permanent damage to the motor, DO NOT attempt to disassemble the motor housing.

EEV SERVICE AND TROUBLE-SHOOTING

CAUTION:
Regardless of whether the valve is in the system or in a vise, care must be taken to prevent distorting the valve parts when tightening.

4. The motor assembly may be removed for inspection and cleaning, however, the valve port is pressed into the valve body and no attempt should be made to remove it.

OPERATIONAL CHECKOUT

1. If the motor fails to operate properly, check the resistance of each motor phase. Disconnect the valve's wiring from controller to check motor resistance. Resistance between the black and white leads or between the red and green leads should be approximately 75 ohms. Differences of more than 10% between phases indicate a defective motor. Resistance between black and red, or any lead and housing should be infinite, any resistance reading will indicate a shorted winding and the valve will need to be replaced.
2. If you have access to a SMA test instrument, operation of the valve may be proven. Connect the motor leads to the proper color coded connector on the SMA. Set the rate to 200 PPS and toggle in the "OPEN" direction. The white polyester driver/pin should retract into the driver guide. After approximately 7.5 seconds the driver should be fully retracted and a light "clicking" or ratcheting sound may be heard, this is normal to the valves and proves operation of the motor. If the SMA is toggled in the "CLOSE" position, after approximately 7.5 seconds the white polyester driver/pin should disengage the lead screw, and can be removed. Inspect the driver/pin for damage. To replace the driver, toggle the SMA to the "OPEN" position and carefully engage the driver to the lead screw.

CAUTION:
Whenever the motor is powered while not in place on the valve, the driver must be fully retracted into the guide before reassembly to the valve. Failure to do this will permanently damage the valve.

3. If the motor responds to step 6 above, the valve body itself should be checked for obstruction. Check for contaminants in the port.
4. If the valve body is clear and the motor operates as in step 6 above, the valve is considered operational and the problem lies in the controller or power supply. Refer to controller trouble shooting guide.

VALVE REPLACEMENT

The entire valve may be replaced if desired. The old valve may be unbrazed or cut out. When installing a new valve, refer to valve installation instructions. The valve need not be disassembled, but the body and motor assembly should be wrapped with a wet rag to prevent damage.

Extra care should be taken to prevent damage to the motor cable, either directly from the torch, or indirectly from contact with a hot surface.

If the valve is disassembled for installation, refer to REASSEMBLY instructions, below.

REASSEMBLY

1. Use the SMA in the "OPEN" mode or PILOT controller to retract the white polyester driver/pin fully into the driver guide. Remove power from the valve or controller.
2. Lightly oil the O-ring with refrigerant oil. Carefully seat the adapter on the valve body.
3. Engage and tighten the locknut to a torque of 25 to 33 ft-lbs. Sealing is accomplished by the O-ring in the body, so excessive tightening force is not necessary achieve a leakproof seal.
4. Pressurize the system and check for leaks.
5. Reapply power to the controller.

TROUBLE SHOOTING
PILOT SYSTEM

PROBLEM	POSSIBLE CAUSE	POSSIBLE CORRECTIVE ACTION
Fans do not operate	1. Fused Disconnect or Circuit Breaker turned off. 2. Blown Fuse or Circuit Breaker tripped. 3. Fan Relay (K-2) miswired. 4. Controller in Defrost Mode 5. Loose Wiring at Terminal Block.	1. Close Disconnect or Breaker. 2. Check for reason and repair. 3. Change position of wire to NC. 4. Denoted by 'dF' on display unit. 5. Check wiring & repair.
Heater does not operate	1. Loose wiring at Terminal Block or Heater. 2. Controller not in Defrost Mode 'dF'. 3. Open or short in Heater.	1. Check wiring and repair. 2. Manually force a defrost period to check out. 3. Check heater with Ohmmeter, replace if required.
Display not illuminated	1. Power not 'ON'. 2. 24 VAC not present at Controller. 3. Defective Controller.	1. Turn on power. 2.1 Transformer miswired or defective—repair. 2.2 Transformer fuse blown-remove and replace. 2.3 24 VAC wire not connected to Term. J2-connect. 3. Replace Controller if 24 VAC power present at J2.
Frost not clearing from Coil	1. Not enough defrost periods. 2. Defrost Termination Temp. too low. 3. Defrost Duration Time too low. 4. Heaters not operating. 5. Coil Drip Time not long enough.	1. Increase number of defrosts-see Dip Switch Settings. 2. Increase Defrost Termination Temperature* 3. Increase Defrost Time Duration* 4. See Heaters above. 5. Increase Coil Drip Time
Ice Build-up on walls or on Evaporator	1. Too many defrost periods. 2. Defrost Time too long. 3. Ambient air leaks (humidity infiltration). 4. Voltage too high (causes heater steaming).	1. Reduce number of defrost periods-See Dip Switch Settings. 2. Decrease Defrost Time Duration * 3. Correct air leaks 4. Check Line Voltage-if greater than 10% design voltage, call power company.
EEV Underfeed	1. Valve too small. 2. Ref. Inlet Sensor TS1 in wrong position on coil 3. Blockage or clogged line. 4. Low refrigerant charge. 5. Motor not modulating.	1. Check sizing charts and replace if necessary. 2. Move TS1 to Dist. Feed or relocate to another feed. 3. Determine cause and correct. 4. Determine if a leak is present, correct and add refrigerant as necessary 5.1 Check valve wiring-color coded. 5.2 Check Underfeed with Manual EEV Override. 5.3 Refer to EEV Service/Troubleshooting.
Alarms		
Sensor Alarm — Si, So, Sa, Sd	Sensor open or shorted	Check wiring and sensor with ohmmeter-replace if required.
High Superheat	Superheat greater than 22°F for 60 min.	Inlet Sensor location move to Distributor Feed or clamp to line.
Low Superheat	Superheat less than 20°F for 5 min.	Check sensor output with lines, clamp.
High Room Temp.	Setpoint too high.	Change Setpoint to a lower temperature.
Low Room Temp.	Setpoint too low.	Change Setpoint to a higher temperature.
Slave Alarm	Alarm exists at a Slave Unit	Look at Slave Units to determine alarm type and repair.
Communication Alarm	Communication failure between motor and a Slave	Check interconnect wiring and repair Check Master/Slave Dip Switch Settings

* Must use PC or remote keypad for changes.

TROUBLESHOOTING MAINTENANCE LOG

DATE	SERVICE BY	PROBLEM	SOLUTION / COMMENTS

TROUBLESHOOTING MAINTENANCE LOG

DATE	SERVICE BY	PROBLEM	SOLUTION / COMMENTS