

AQUAIR

MARINE AIR CONDITIONING SYSTEMS

Sapphire TSV & TWS Series
Digital Thermostat
for
Direct Expansion Split Systems
and Self Contained Units



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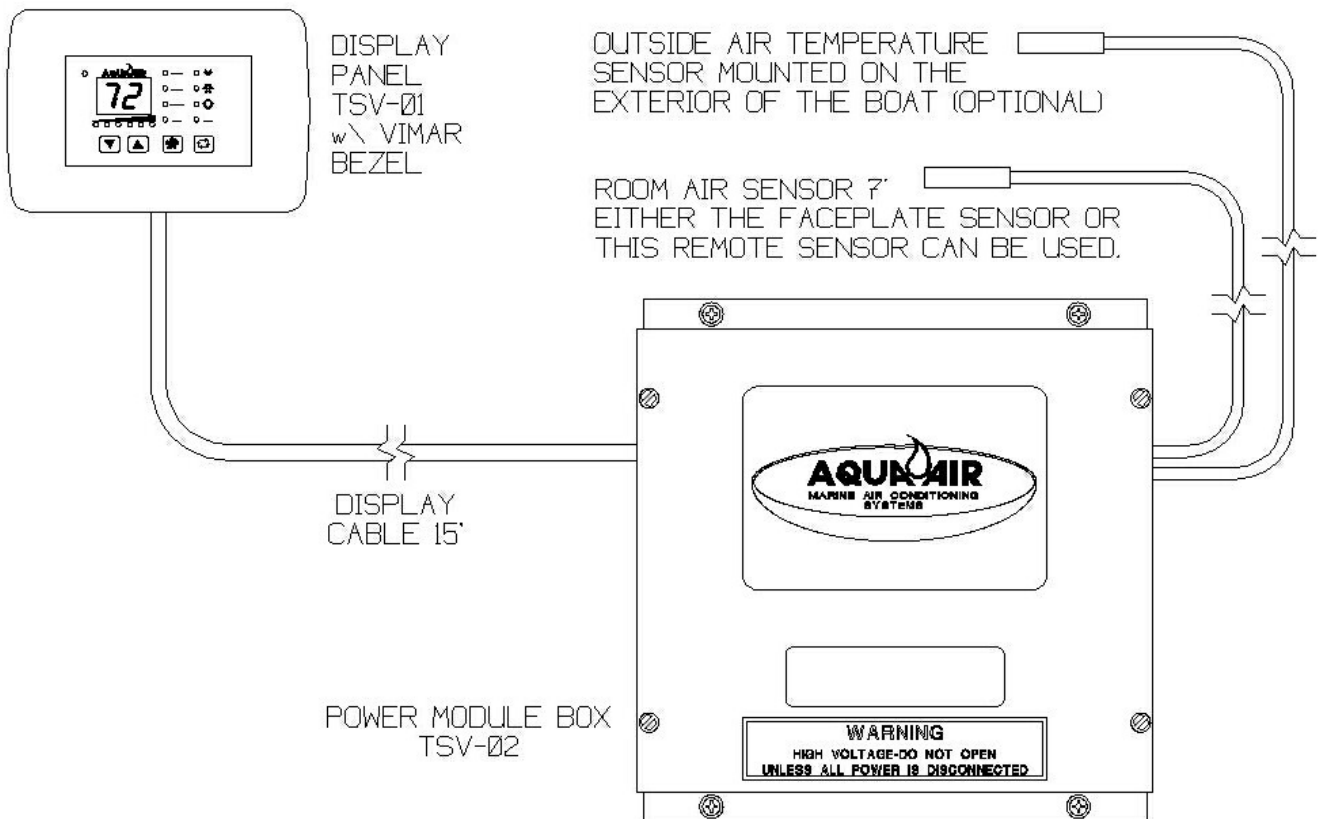
1. Introduction

The Aqua-Air Sapphire TSV and TWS Series Direct Expansion (D/X) Thermostats have been designed specifically to operate either split systems or self contained units. These systems will usually have a compressor, reversing valve, seawater pump and fan motor(s) . All of these components can be regulated by these thermostats.

The only difference between the TSV and the TWS models is the display head appearance. The TSV has a Vimar® brand bezel surrounding the display and button portion of the display head. The TWS was designed as a retrofit for the older Aqua-Air TW-2000 digital thermostat. The TWS display head is exactly the same size as the older TW-2000. Both controls operate in exactly the same way.

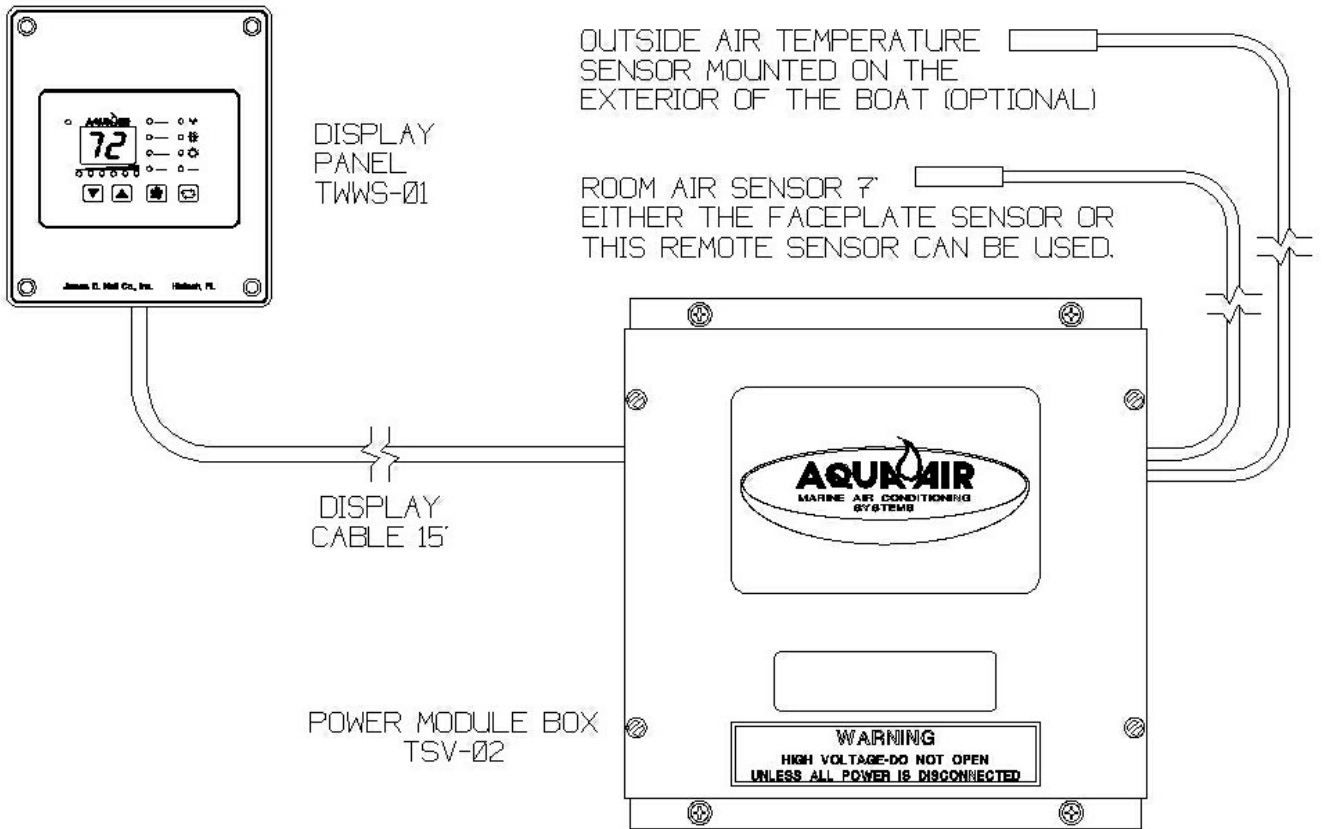
The TSV Thermostat is comprised of the following main components:

1. Display Panel (TSV-01)
2. Display Cable (TSWDC-15)
3. Power Module Box (TSV-02)
4. Room Air Sensor (TW2-SENSOR-07)
5. Outside Air Temperature Sensor (TW2-SENSOR-XX) (optional)



The TWS Thermostat is comprised of the following main components:

1. Display Panel (TWWS-01)
2. Display Cable (TSWDC-15)
3. Power Module Box (TSV-02)
4. Room Air Sensor (TW2-SENSOR-07)
5. Outside Air Temperature Sensor (TW2-SENSOR-XX) (optional)



2. Display Panel

The TSV-01 and TWWS-01 Display Panel is the user interface with the TSV Thermostat. It allows the user to make all necessary changes to operating modes, temperature settings and fan speed settings. It also allows the user to make changes to a set of Programming Parameters that controls many of the features of the thermostat.

The Display Panel has been designed to use the Vimar Idea Series metal bezels giving you an almost unlimited number of color options to match any decor. The bezel snaps on and off easily and it hides all of the mounting screws for the display panel

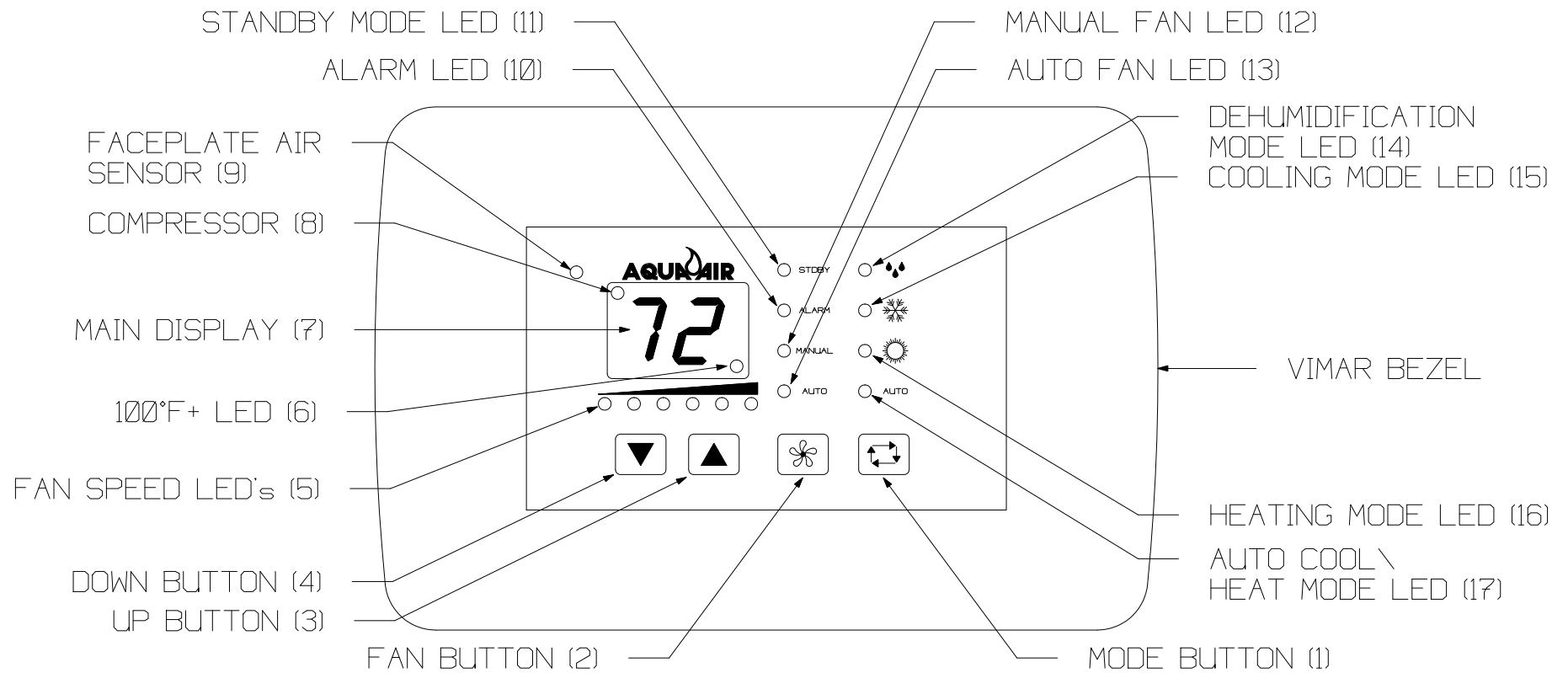
On the following page is a diagram showing all of the features of the Display Panels. The features are applicable for both TSV-01 & TWWS-01 display heads. Each feature has a number associated with it.

Features of the TSV-01 and TWWS-01 Display Panels are:

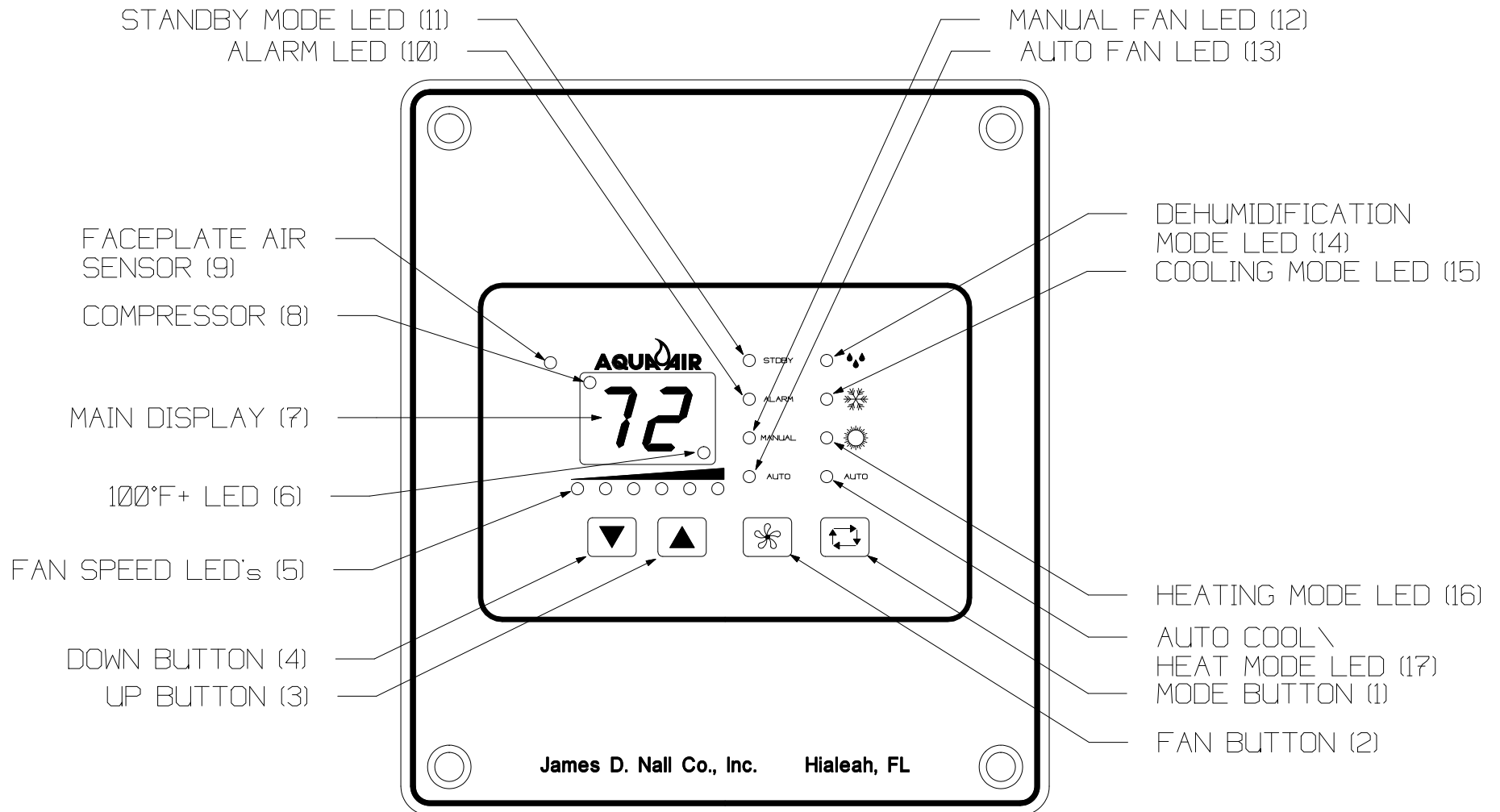
1. **MODE BUTTON** - The Mode Button is used to select one of the four operating modes and standby (off) mode. Pressing and releasing the Mode Button will advance you to the next mode. Continue to do this until you have reached the desired mode. The available modes are as follows:

STANDBY	Thermostat is OFF, no Cooling or Heating functions are available. The fan can be operated in the Manual mode. Indicated by LED 11.
DEHUMIDIFICATION	Thermostat is in the Dehumidification Mode indicated by LED 14.
COOLING	Thermostat is in the Cooling Mode only, indicated by LED 15.
HEATING	Thermostat is in the Heating Mode only, indicated by LED 16.
AUTO	Thermostat is in the Auto Mode where it will automatically choose between Cooling and Heating as the room temperature dictates. This mode is indicated by LED 17.
2. **FAN BUTTON** - The Fan Button is used to select between AUTO and MANUAL Fan Speed Control as indicated by LED's 12 and 13 respectively. To go from AUTO to MANUAL Mode press the Fan Button once. To change Fan Speeds while in MANUAL Mode press the Fan Button once and then the Up or Down Button to increase or decrease, respectively, the Fan Speed. To switch from MANUAL to AUTO Mode press the Fan Button twice

TSV SAPPHIRE SERIES DIGITAL DISPLAY PANEL



TWS SAPPHIRE SERIES DIGITAL DISPLAY PANEL



3. UP BUTTON - The Up Button is used to increase values for set points, fan speeds and programmable parameters. During normal operation, momentarily pressing the Up Button will display the Set Point. Continued pressing of the Up Button will increase the Set Point
4. DOWN BUTTON - The Down Button is used to decrease values for set points, fan speeds and programmable parameters. During normal operation, momentarily pressing the Down Button will display the Set Point. Continued pressing of the Down Button will decrease the Set Point.

To view the Outside Air Temperature (OAT) sensed by the optional OAT Sensor:

1. Press and HOLD the Down Button (4)
 2. Press and RELEASE the Up Button (3)
5. FAN SPEED LED's - These six LED's indicate the current Fan Speed 1-6. Low Speed (#1) is the left most LED and High Speed (#6) is indicated by the LED on the far right.
 6. 100°F+ LED - Indicates that the actual temperature displayed is in excess of 100° F. Add the value displayed to 100 to get the actual temperature. If the 100°F LED is lit and the display shows 10 then the actual temperature would be 110°F.
 7. MAIN DISPLAY - This is a 2 digit, 7 segment LED display. Normally the current room temperature is displayed. It can also display the Set Point, Water Temperature, Programmable Parameters and Alarm codes.
 8. COMPRESSOR LED - This LED indicates if the Compressor output has been turned on (in either the Cooling or Heating mode).
 9. FACEPLATE AIR SENSOR - The TSV can use either this Faceplate Air Sensor to sense the room temperature or the Air Sensor that is plugged into the Power Module PC Board. This is selected by Programmable Parameter B1. If the Faceplate Sensor is used it is not necessary to have the Air Sensor plugged into the PC Board.
 10. ALARM LED - Indicates that the control is in a fault condition.
 11. STANDBY MODE LED - Indicates that the control is in the Standby Mode. All Cooling and Heating functions are turned off. If the fan is in the Auto Mode then it will be turned off. If the Fan is in the Manual Mode then the Fan will still operate at the last fan speed selected.
 12. MANUAL FAN LED - Indicates the Fan Speed is in the Manual Speed Selection Mode
 13. AUTO FAN LED - Indicates the Fan Speed is in the Automatic Speed Selection Mode
 14. DEHUMIDIFICATION MODE LED - Indicates that the control is in the Dehumidification Mode
 15. COOLING MODE LED - Indicates the control is in the Cooling Mode

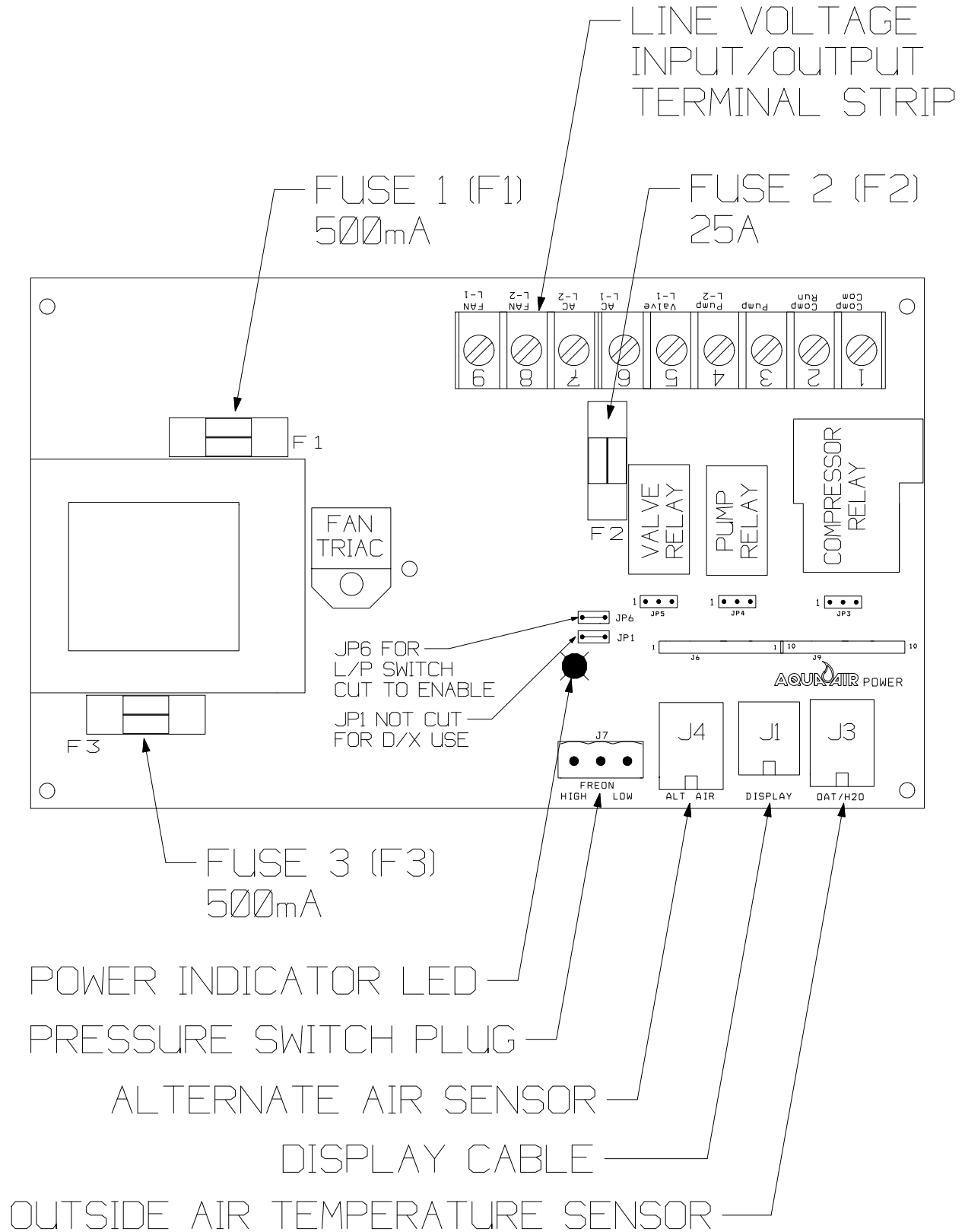
- 16. HEATING MODE LED - Indicates the control is in the Heating Mode
- 17. AUTO COOL/HEAT MODE LED - Indicates the control is in the Automatic Cooling or Heating Mode. In this mode the control will automatically select, based on the room temperature and the set point, whether the control is operating in the Cooling or Heating Mode.

3. Power Module Box

The Power Module Box is comprised of the Main Power PC Board enclosed inside of an aluminum enclosure. The PC Board's main features are shown on the following page.

POWER MODULE PC BOARD JUMPERS				
Jumper	Description	Type	Specification	Notes
JP1	Chillwater / Direct Expansion Selection	Wire	C/W: Jumper Cut D/X: Jumper Not Cut	Do not cut with power applied to board.
JP3	Compressor Relay Test	3 pos. pin	Install jumper in positions 1 & 2 to energize the compressor	
JP4	Pump Relay Test	3 pos. pin	Install jumper in positions 1 & 2 to energize the pump	
JP5	Reversing Valve Relay Test	3 pos. pin	Install jumper in positions 1 & 2 to energize the reversing valve	
JP6	Low Pressure Switch	Wire	LPS connected to J7, positions 2 & 3: Cut No LPS connected: Not Cut	

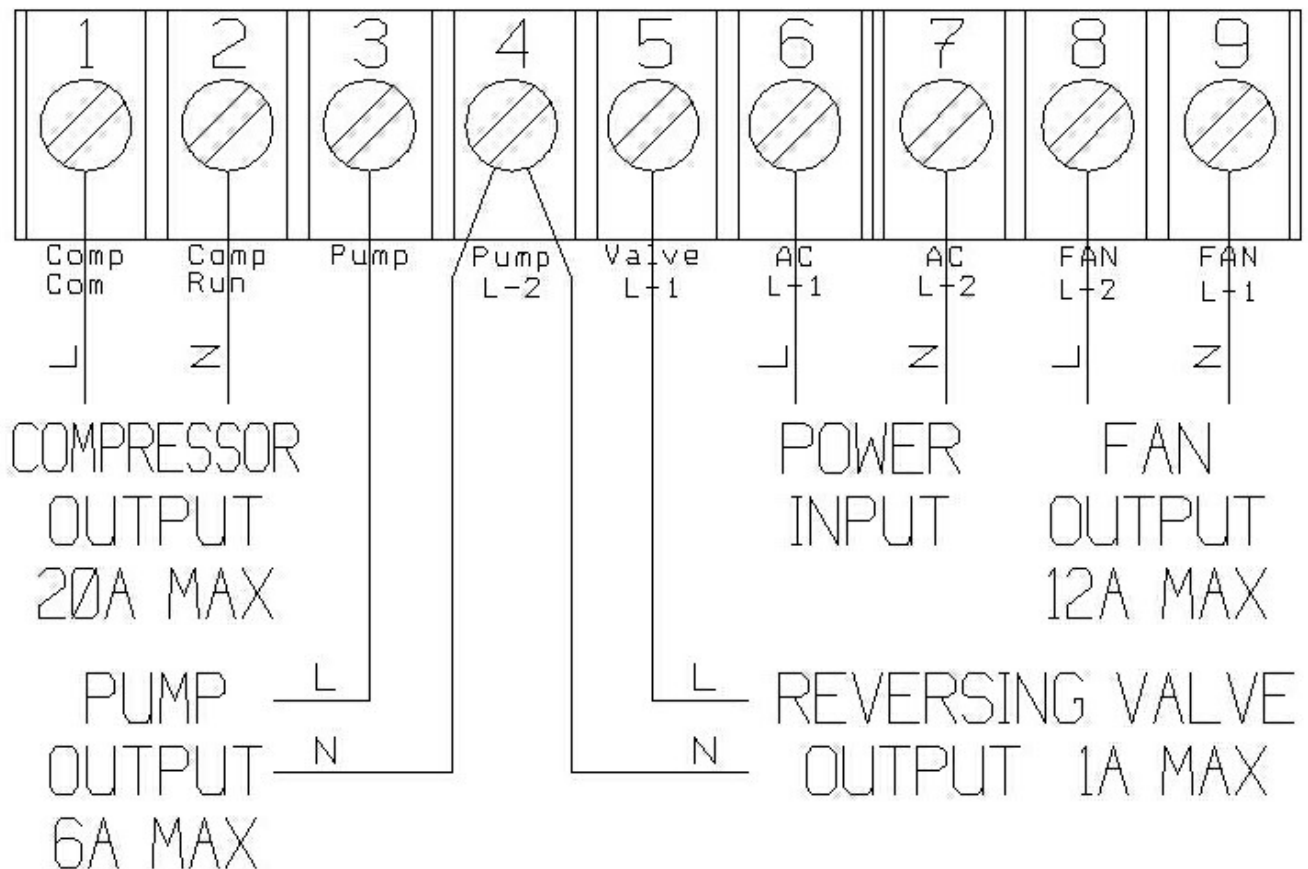
TSV POWER MODULE P.C. BOARD TWS-PCBOARD



POWER MODULE PC BOARD FUSES			
Fuse	Description	Fuse Amperage Rating	Fuse Size Part Number
F1	Protects against a line voltage short circuit on the primary side of the transformer TX	500 mA (1/2 A)	5mm x 20mm TWS-PCBFUSE1
F2	Protects against a short circuit on the Compressor, Reversing Valve or Seawater Pump circuits.	20 A	5mm x 20mm TWS-PCBFUSE1
F3	Protects against a control circuit short circuit on the secondary side of the transformer TX	500 mA (1/2 A)	5mm x 20mm TWS-PCBFUSE1

**Basic External Wiring Connections to the
TSV and TWS PC Board Located in the Power Module Box**

PC BOARD TERMINAL STRIP



"L" AND "N" REPRESENT "LINE" AND "NEUTRAL" FOR A 115V SYSTEM
"L" AND "N" WOULD BE "L1" AND "L2" FOR A 230V SYSTEM

4. Operation

Below are the steps necessary for the basic operation of the control.

Entering the Cooling Mode

Press and release the Mode Button (1) until the Cooling Mode LED (15) is lit.

Entering the Heating Mode

Press and release the Mode Button (1) until the Heating Mode LED (16) is lit.

Automatic (Auto) Cool / Heat Mode

Press and release the Mode Button (1) until the Auto LED (17) is lit

Entering the Dehumidification Mode

Press and release the Mode Button (1) until the Dehumidification Mode LED (14) is lit.

Turn the Control OFF (Standby Mode)

Press and release the Mode Button (1) until the Standby Mode LED (11) is lit.

View the Set Point Temperature

Press and release either the Up Button (3) or the Down Button (4).

Increasing the Set Point Temperature

Press and release the Up Button (3) until you reach the desired temperature

Decreasing the Set Point Temperature

Press and release the Down Button (4) until you reach the desired temperature

Putting the Fan Mode into Manual

Press and release the Fan Button (2) until the Manual Fan LED (12) is lit

Increasing the Fan Speed in the Manual Fan Mode

Press and release the Fan Button (2) and then press and release the Up Button (3) until you reach the desired speed as indicated by the Fan Speed LED's (5).

Decreasing the Fan Speed in the Manual Fan Mode

Press and release the Fan Button (2) and then press and release the Down Button (4) until you reach the desired speed as indicated by the Fan Speed LED's (5).

Putting the Fan Mode into Auto

Press and release the Fan Button (2) twice

Displaying the Outside Air Temperature

Press and hold the Down Button (4) then press and release the Up Button (3)

Changing the Fan Speeds in the Standby Mode

Press and release the Up Button (3) or the Down Button (4) until the desired speed is reached. To turn the fan off in the Standby Mode press the Down Button (4) until all of the Fan Speed LED's are off.

5. Entering the Programming Mode

There are currently 17 different programmable parameters in the TSV and TWS Thermostats. All of these parameters can be changed from the Display Panel with some simple keystrokes.



The Program Mode can ONLY be entered while the control is in the Standby Mode

To Program the TSV Control:

1. Press the Mode Button until the control is in the Standby Mode which is indicated by the Standby Mode LED (11)
2. Press the Up Button and the Down Button at the SAME time. The first Programmable Parameter code "P1" will appear in the window for 2 seconds and then the P1 setting that is currently stored in the control will appear.
3. To change the parameter setting press and release the Up or Down Buttons.
4. The Fan Button advances you to the next parameter. Advancing to the next parameter SAVES the previous parameter setting. If you do not advance to the next parameter the setting WILL NOT BE SAVED unless you press the Mode Button to exit the Programming Mode (see 5 below).
5. Pressing the Mode Button exits the Programming Mode. Any changes made to any of the parameter settings will be saved.
6. If you do not press any buttons for 30 seconds the control will automatically exit from the Program Mode. The last parameter change will NOT BE SAVED.

Programmable Parameters				
Parameter Number	Description		Default	Range
P1*	High Fan Speed Limit (% of input voltage)		100 "00."	56 - 100 (100 = 00.)
P2* **	Low Fan Speed Limit (% of input voltage)		50	30 - 55
P3	Compressor Staging Time Delay		15 secs	5-135 secs
P4	Temperature Sensor Calibration		0	-10° to +10° F
P5	Failsafe Mode		3	Off 1=Continuous, No Display 2=Continuous w/ Display 3=Failure, Reset Required
P6	Low A/C Voltage Cutoff	115 VAC	85VAC	Off - 75 to 100
		230 VAC	185 VAC	Off - 175 to 200
P7	De-Icing Cycle		0	0=Off 1-3 minutes
P8	Auto Dim		no	no 4-13 (Brightness)
P9	Display LED Brightness Control		13	4 = min 13 = max
A1	Displays °F or °C		°F	°F / °C
A2	Cycle Pump with Compressor or Continuous Pump Operation		Off	OFF=Cycle w/ Compressor ON=Continuous Running
A3	Reverse Fan Speed in Heating Mode		rE	No = Normal rE = Reverse
A4	Continuous Fan Operation or Cycling on Demand		Co	CY = Cycle Co = Continuous
A5**	Reverse Cycle Heat or Electric Element Heat		nor	nor = Reverse Cycle Heat EL = Electric Heat
A6	Fan Motor Type, Shaded Pole or Split Capacitor		SP	SP = Shaded Pole SC = Split Capacitor
A7	Reset Memorized Programming Defaults		nO	nO = Normal Rs = Reset Default
A8	Unused - reserved		N/A	N/A
A9	Unused - reserved		N/A	N/A

CONTINUED ON THE NEXT PAGE

Programmable Parameters (cont)			
Parameter Number	Description	Default	Range
b1	Air Temperature Sensed from the Display Panel or the Air Sensor connected to the PC Board	on	on = PC Board of = Display Panel
b2	Delay Before Fan Turns Off	30s	30 - 199 seconds

- * P1 and P2 values are expressed as a percentage of the input voltage. If the setting for P1 is 90 then the maximum voltage output at high fan speed (speed 6) will be approximately 90% of the input voltage. As you are changing the settings in P1 and P2 the fan will operate and change according to the settings you are entering.
- ** If Electric Heat is selected (A5 = EL) then P2 must NOT be set lower than 50 and parameter b2 must be set to a minimum of 60 seconds.
- *** Auto Dim - After 2 minutes without any buttons being pressed display will turn OFF all LEDs and the seven segment display except for the alarm LED and one of the mode LEDs which will dim to the desired brightness.

FAULT CODES	
Code	Description
AA	Air Sensor Failure or Disconnected. If you get this error code and you intend to use the air sensor on the Display Panel change Parameter b1 to "of".
E1	Display cable damaged. Check to see if the cable has been cut or otherwise damaged.
HP	High Refrigerant Pressure. The seawater flow to the condensing unit has been interrupted
LA	Low Voltage Input to Power Module Box. Check your incoming voltage to the Power Module Box and verify that it is within +/-10% of the rated voltage
LP	Low Refrigerant Pressure. This fault can be due to restricted air flow through the evaporator coil or a refrigerant leak.

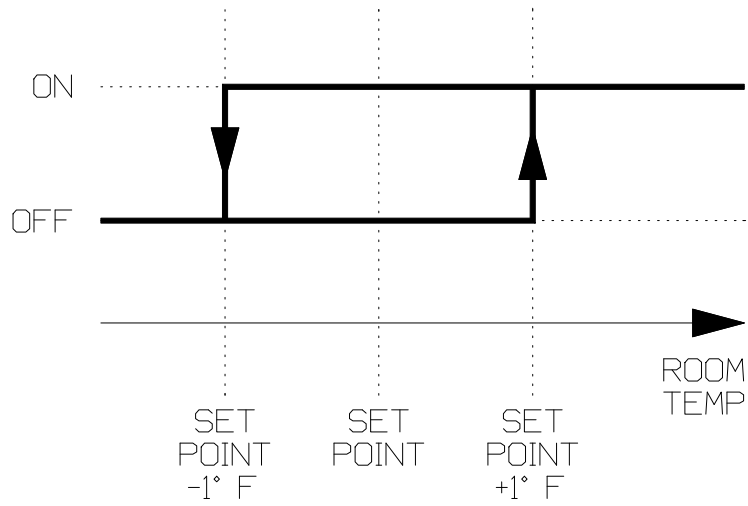
6. Control Operation Flow Charts and Diagrams

On the following pages are flow charts and graphic representations of how the control operates the compressor, fan, reversing valve and pump in each of the 4 operating modes. Some of the abbreviations used are as follows:

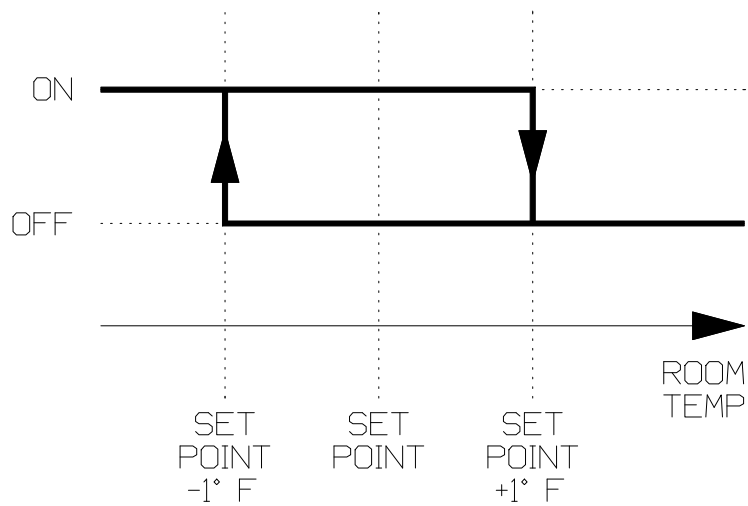
TERM	Definition
Abs	Absolute Value. The Absolute Value of 5 is 5. The Absolute Value of (-3) is 3. The Absolute Value of an equation that returns a negative number is always a positive number. Therefore $Abs(3-8) = 5$
DELTA	Difference between two values. As used in this manual it is the difference between two temperatures
Hysteresis	The lag between making a change, such as increasing or decreasing temperature, and the response or effect of that change. It typically refers to turn-on and turn-off points. For example, if a thermostat set for 70 degrees turns on when the temperature reaches 68 and turns off at 72, the hysteresis is the range from 68 to 72.
LED	Light Emitting Diode. These are all of the lights on the display panel. The two 7 segment numerical displays are each made up of 7 individual diodes.
OAT	Outside Air Temperature
Tair	Air Temperature as sensed by either the Display Panel or Room Air Sensor
Tset	Set Temperature of the thermostat

COMPRESSOR OPERATION

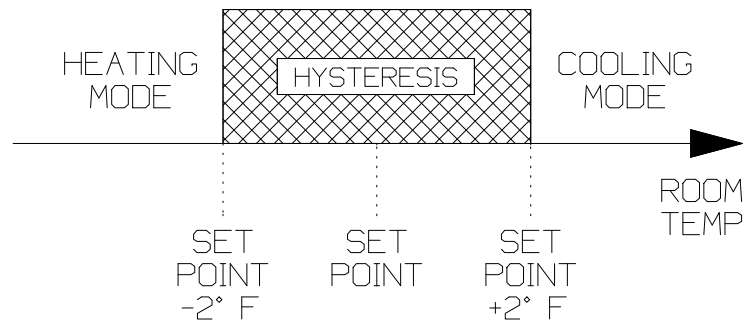
COOLING MODE



HEATING MODE

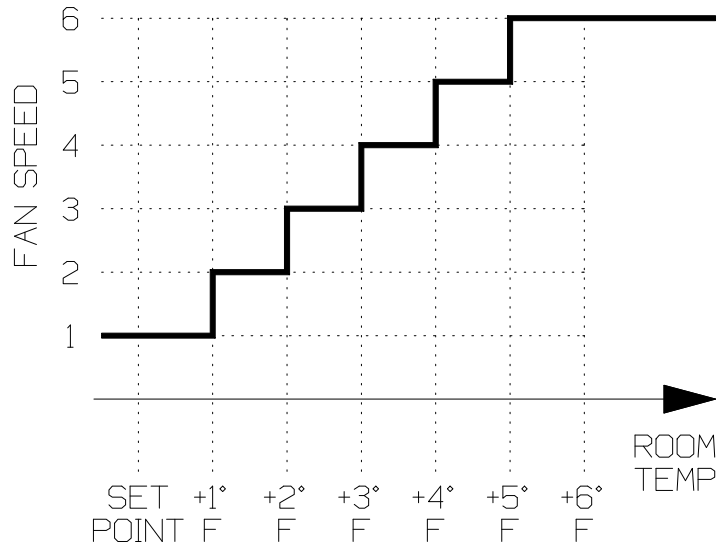


AUTOMATIC FUNCTION MODE CHANGEOVER



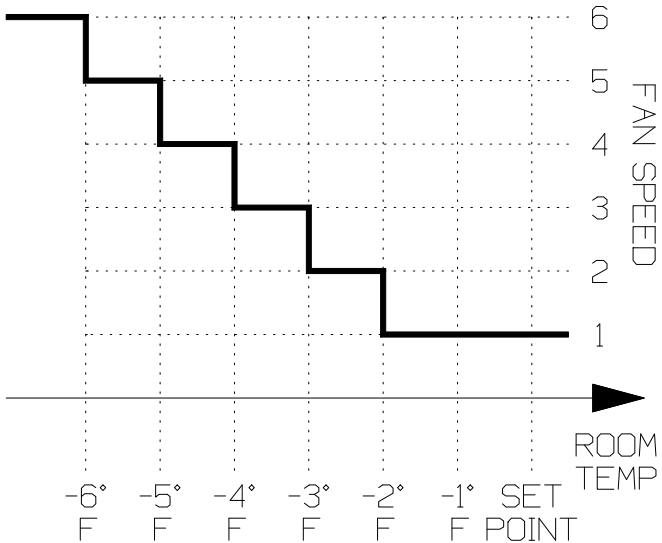
AUTO FAN SPEED OPERATION

COOLING MODE



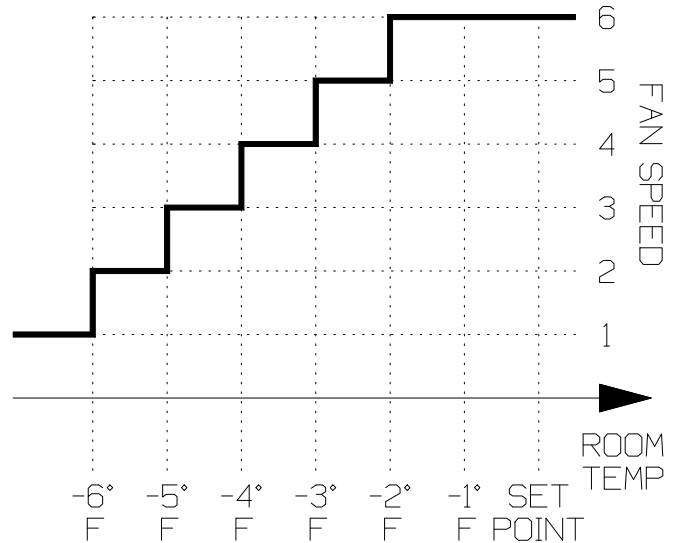
HEATING MODE

PARAMETER A3 = NORMAL (No)

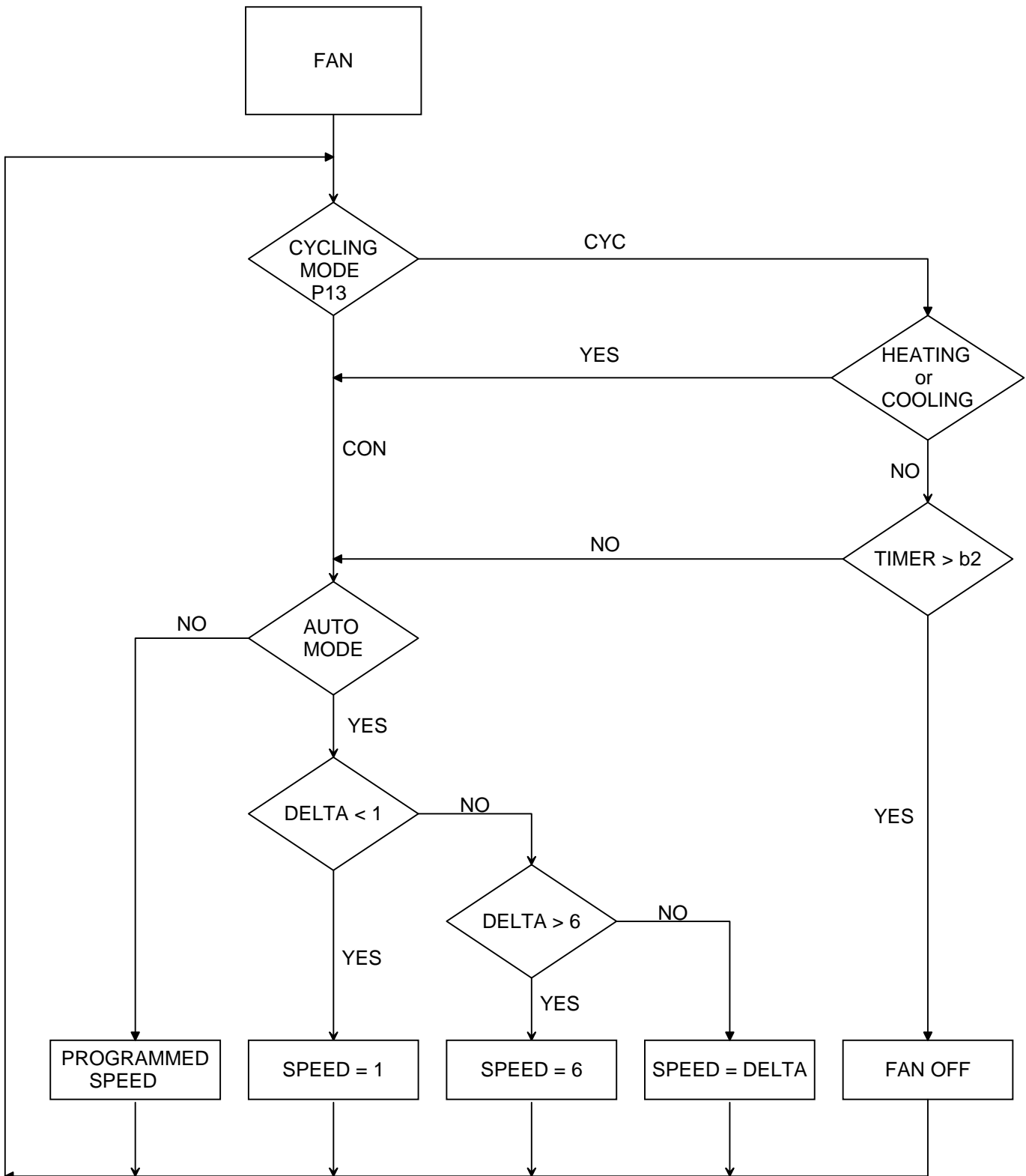


HEATING MODE

PARAMETER A3 = REVERSE (rE)



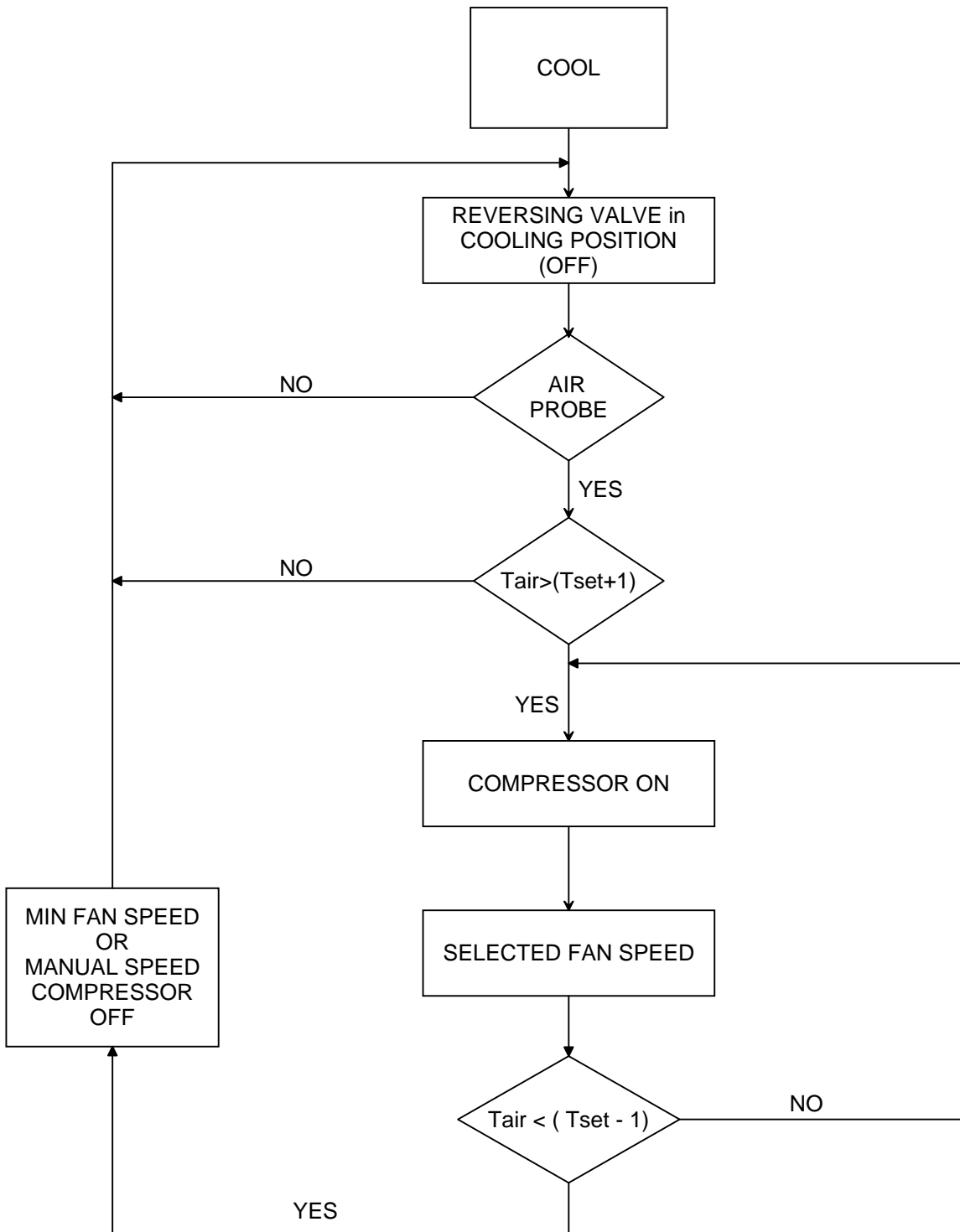
FAN OPERATION & SPEED SELECTION



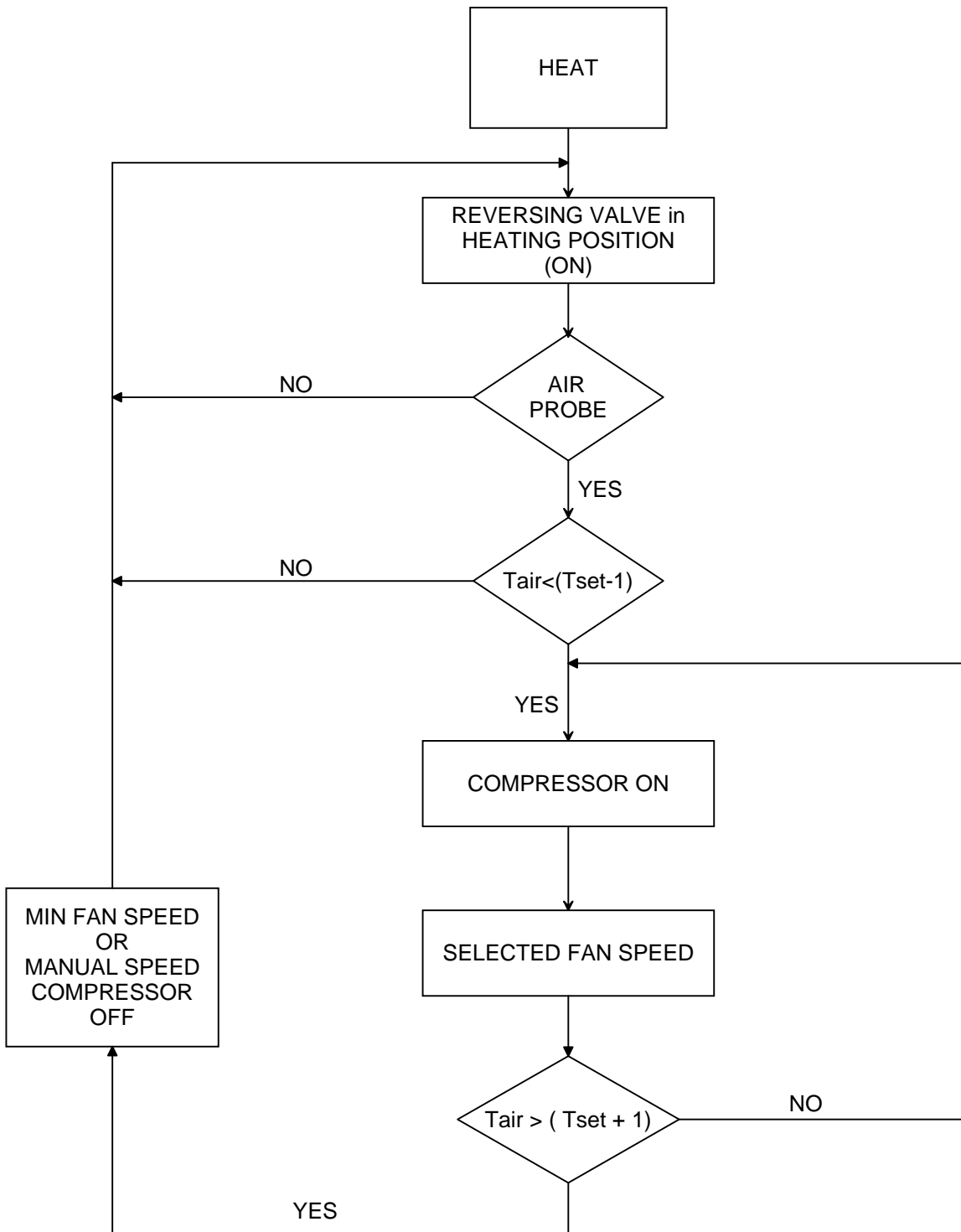
Normal Fan Operation
 $\text{DELTA} = \text{Abs}(T_{\text{air}} - T_{\text{set}})$

Reverse Fan Operation
 $\text{DELTA} = \text{Abs}[\text{Abs}(T_{\text{air}} - T_{\text{set}}) - 6]$

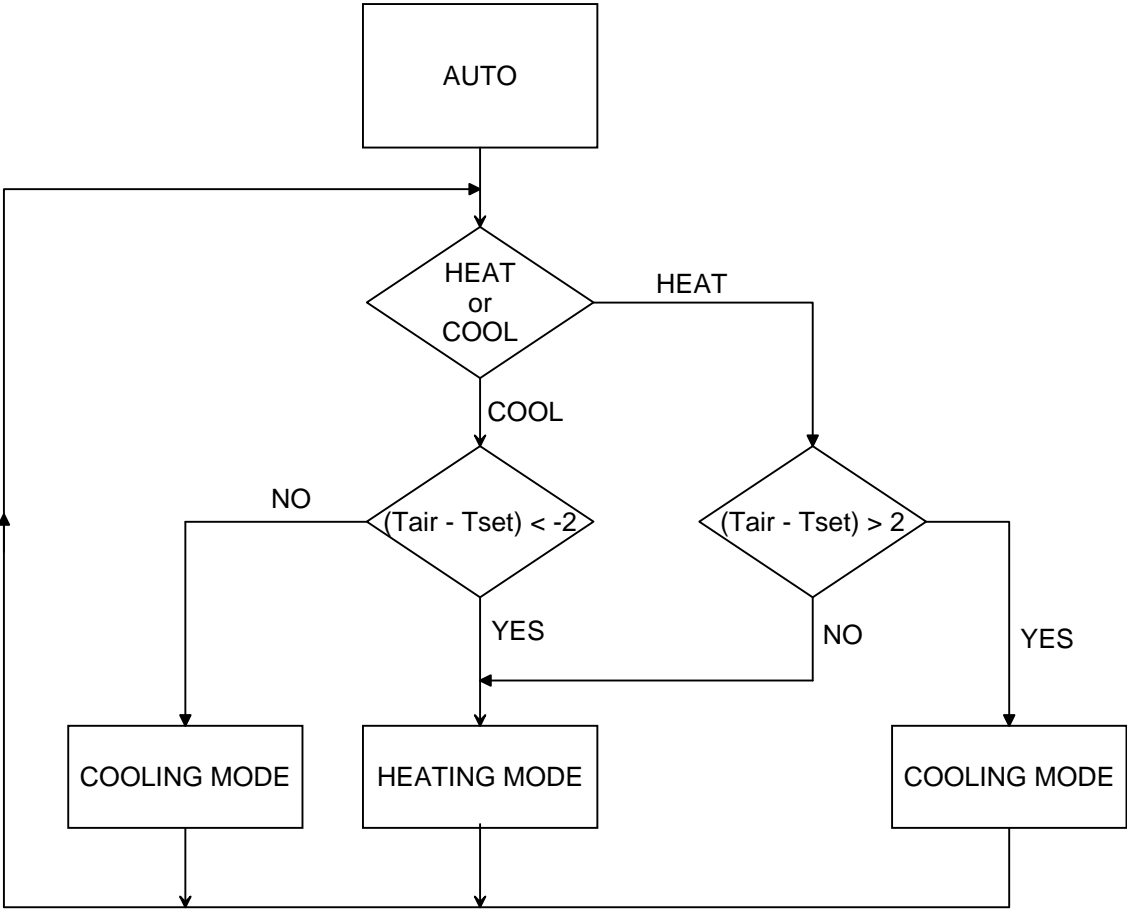
COOLING MODE



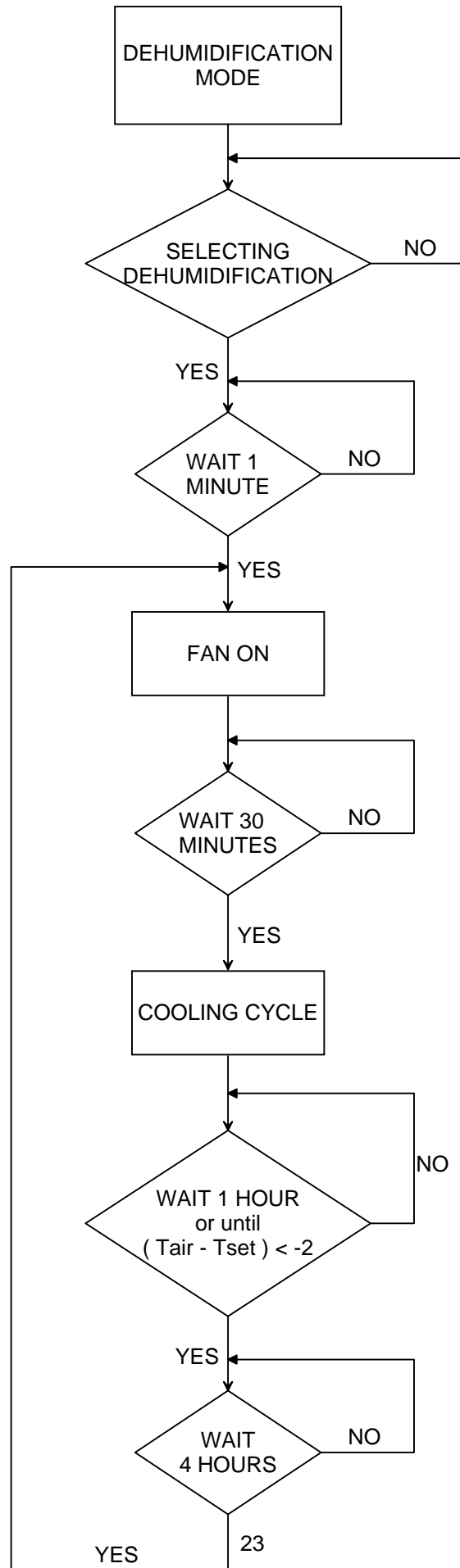
HEATING MODE



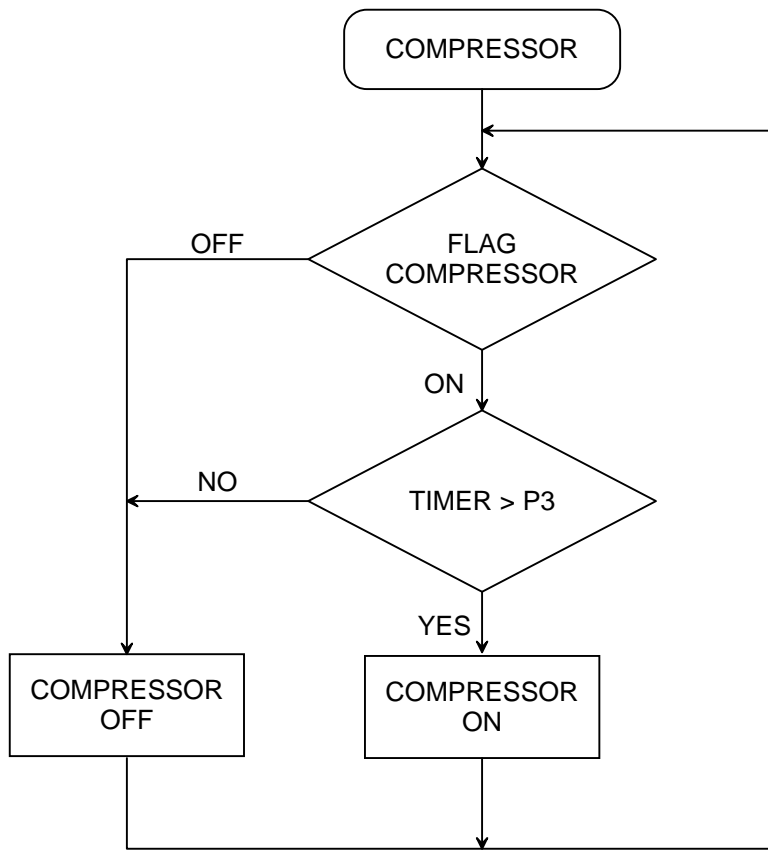
AUTO MODE



DEHUMIDIFICATION MODE

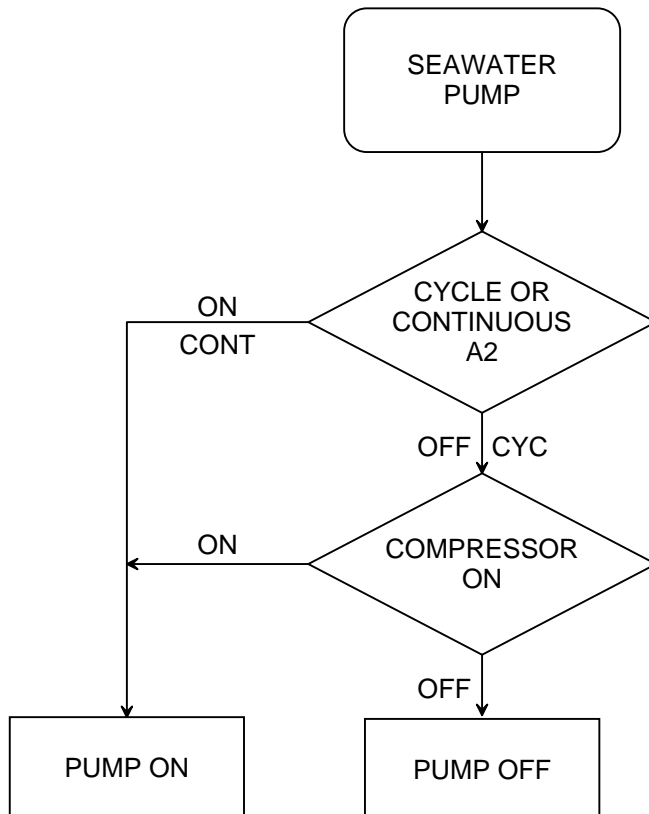


COMPRESSOR



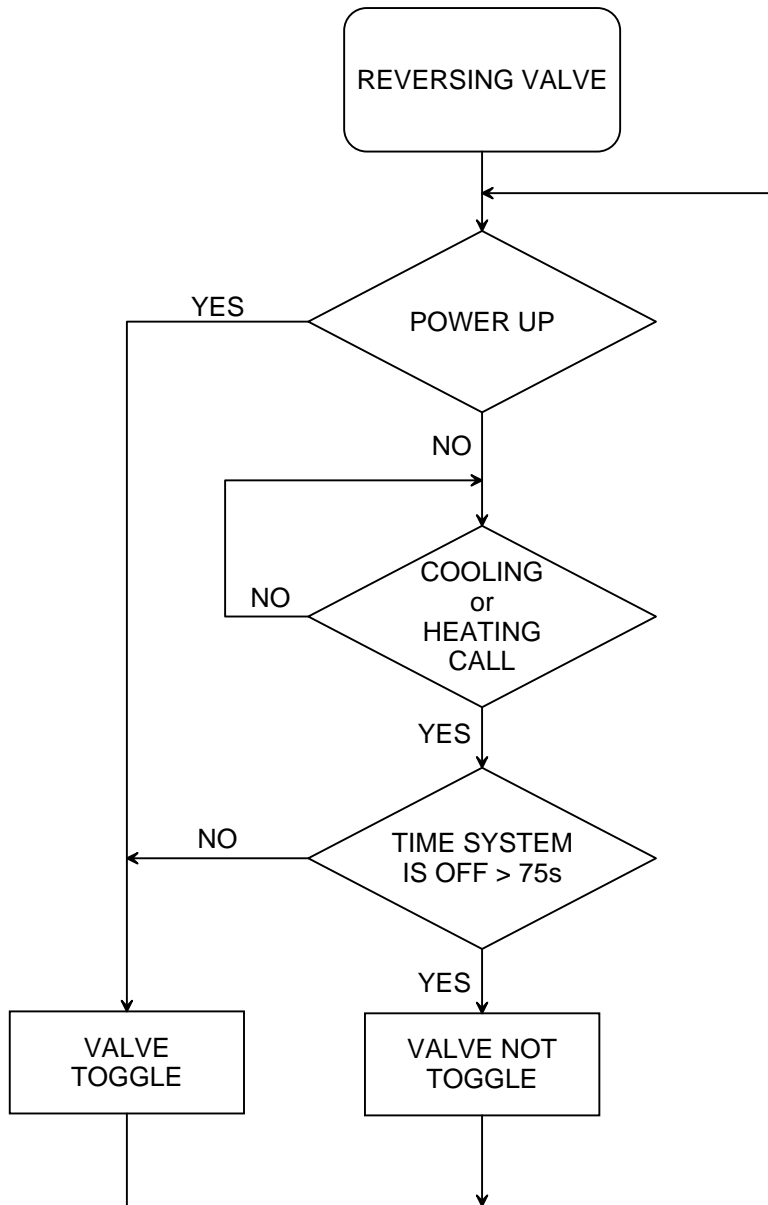
P3 REFERS TO
PROGRAMMABLE
PARAMETER P3

SEAWATER PUMP

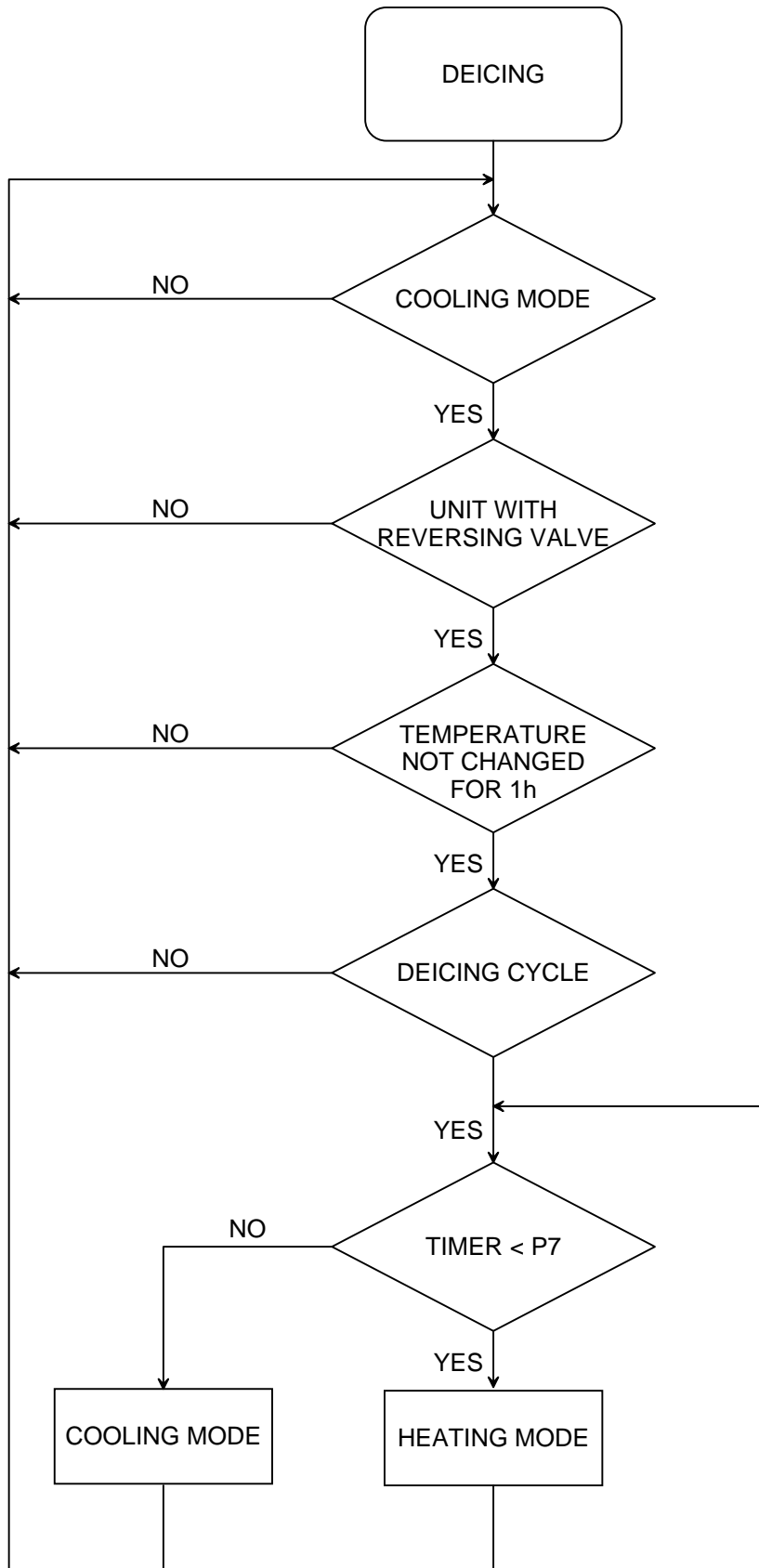


A2 REFERS TO
PROGRAMMABLE
PARAMETER A2

REVERSING VALVE



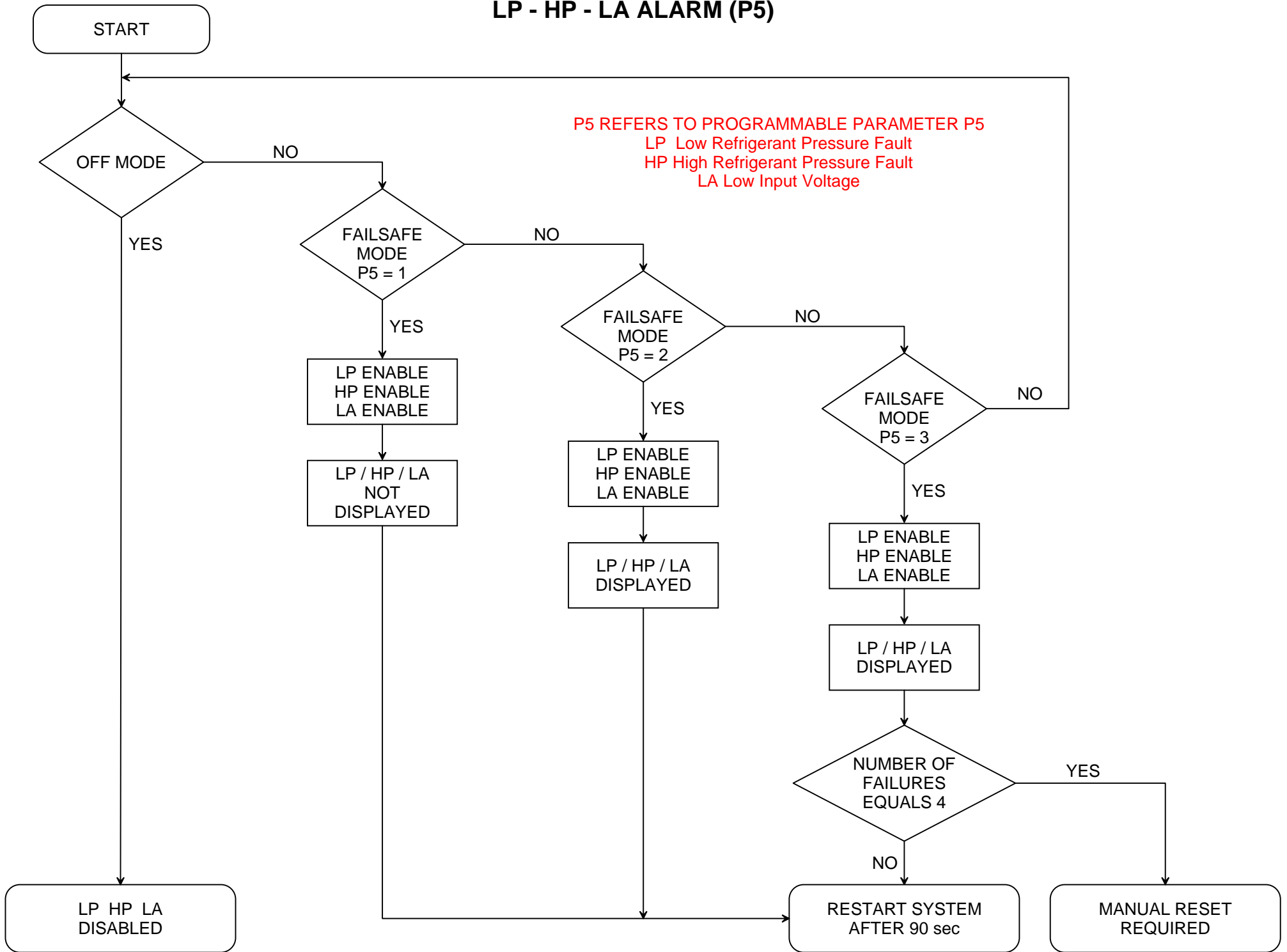
DEICING MODE



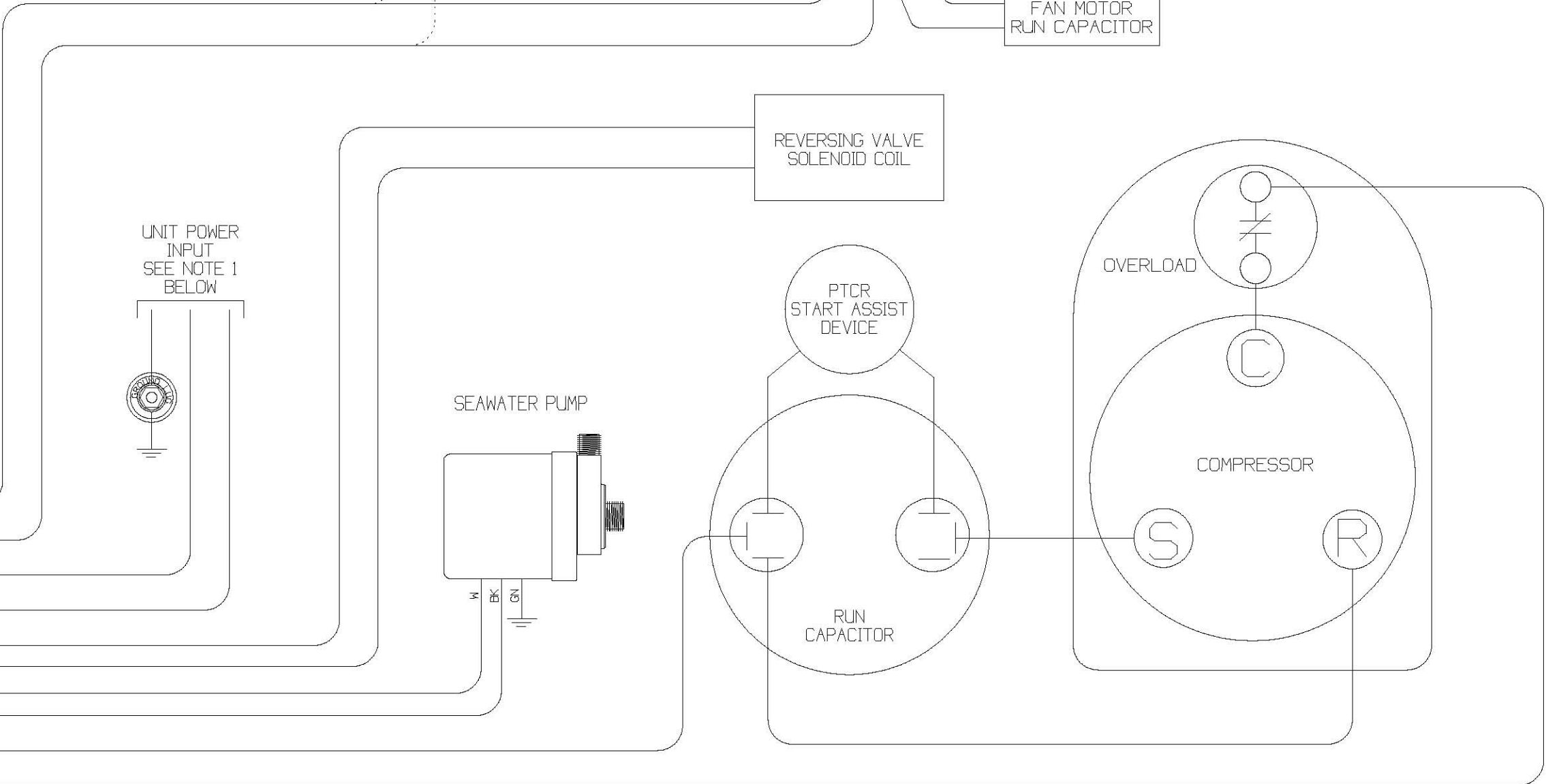
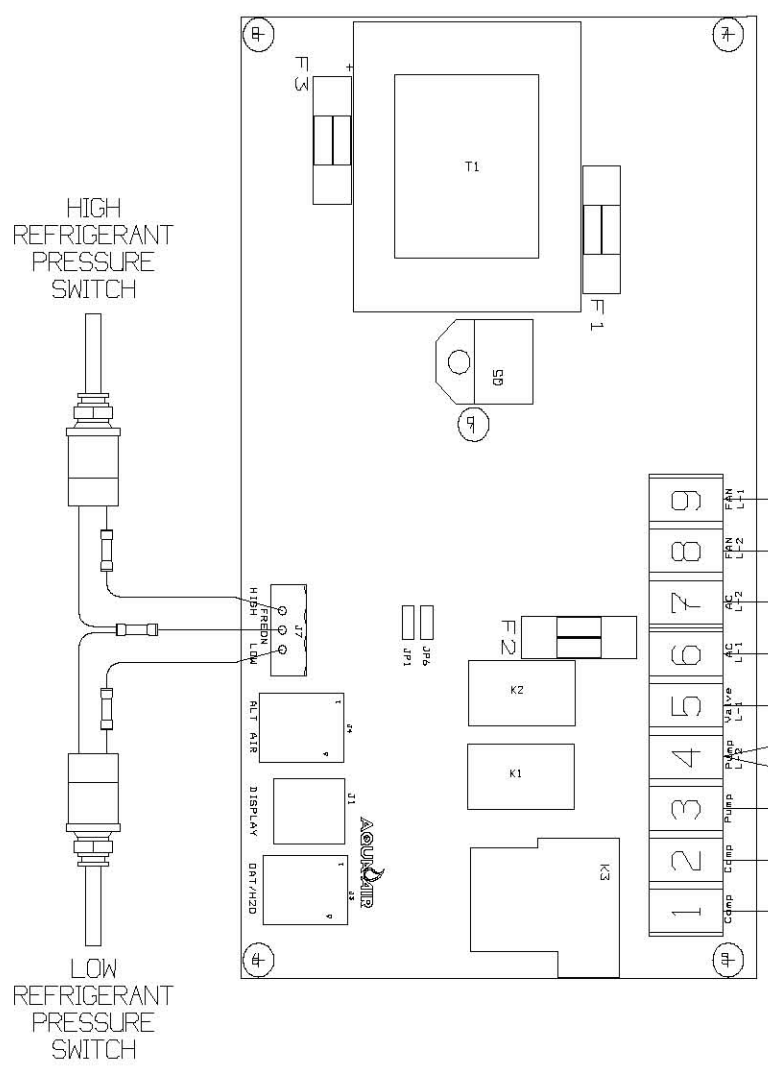
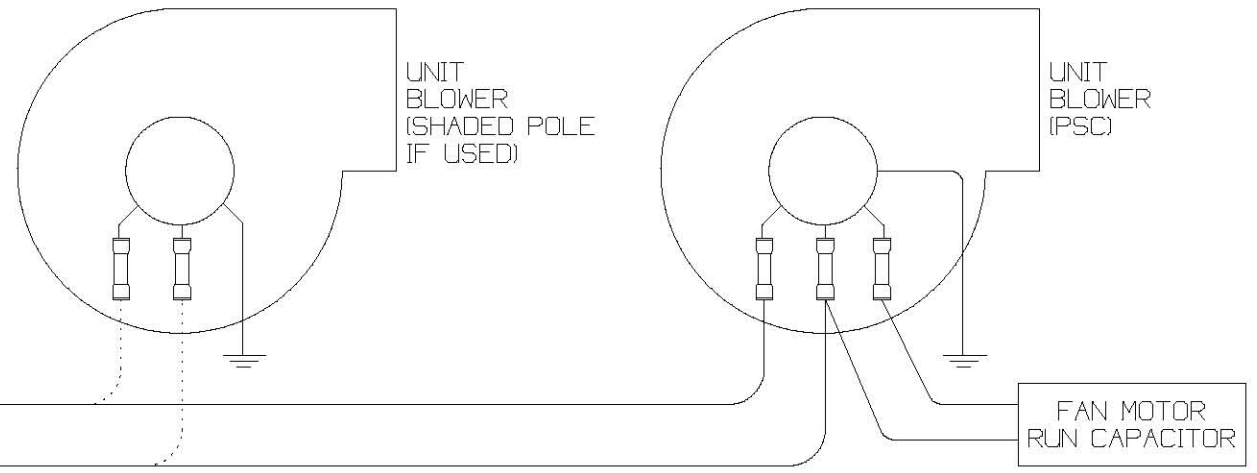
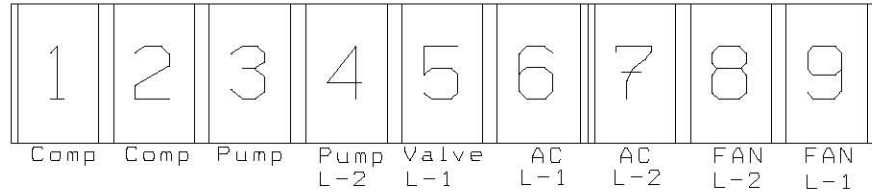
P7 REFERS TO PROGRAMMABLE PARAMETER P7

LP - HP - LA ALARM (P5)

P5 REFERS TO PROGRAMMABLE PARAMETER P5
LP Low Refrigerant Pressure Fault
HP High Refrigerant Pressure Fault
LA Low Input Voltage



TERMINAL BLOCK - ENLARGED VIEW



NOTE 1 POWER INPUT

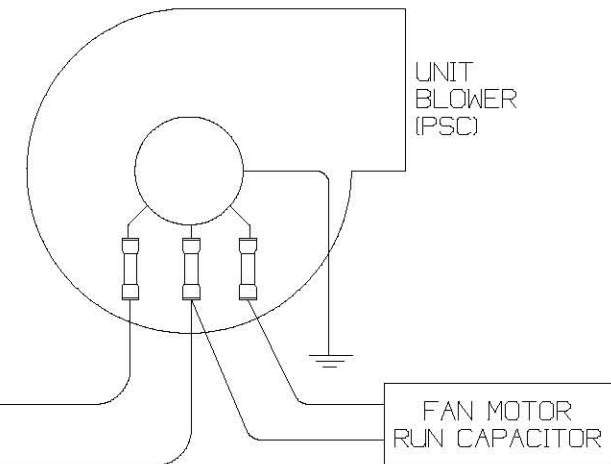
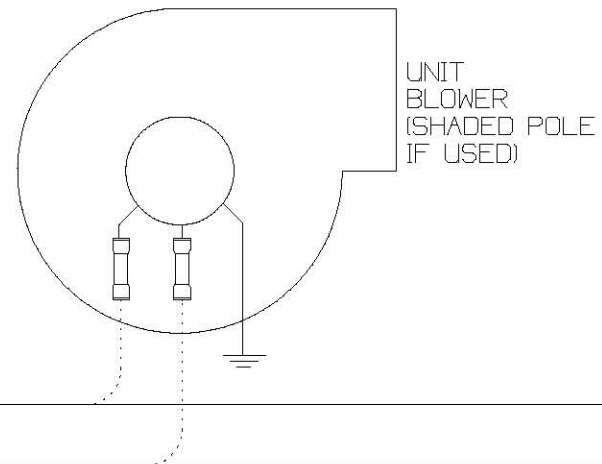
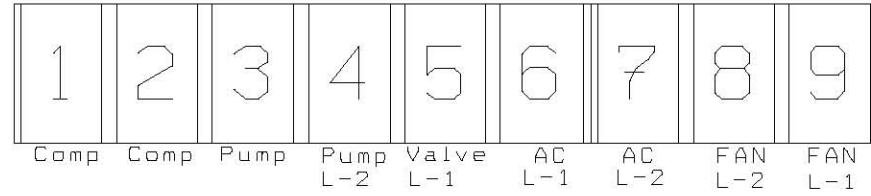
VOLTAGE	TERMINAL		GRND
	6	7	LUG
115	L	N	G \perp
230	L1	L2	G \perp

AQUA-AIR MARINE AIR CONDITIONING SYSTEMS

SELF CONTAINED UNIT WIRING WITH SAPPHIRE DIGITAL THERMOSTAT (w/HIGH & LOW PRESSURE SWITCH)

DRAWING NUMBER	4010-03J	DRAWN BY	SB	DATE	08-11-08
SCALE	NONE	APPROVED BY	DN	REVISION DATE	

TERMINAL BLOCK - ENLARGED VIEW



FAN MOTOR RUN CAPACITOR

HIGH REFRIGERANT PRESSURE SWITCH

REVERSING VALVE SOLENOID COIL

UNIT POWER INPUT
SEE NOTE 1 BELOW

SEAWATER PUMP

PTCR START ASSIST DEVICE

RUN CAPACITOR

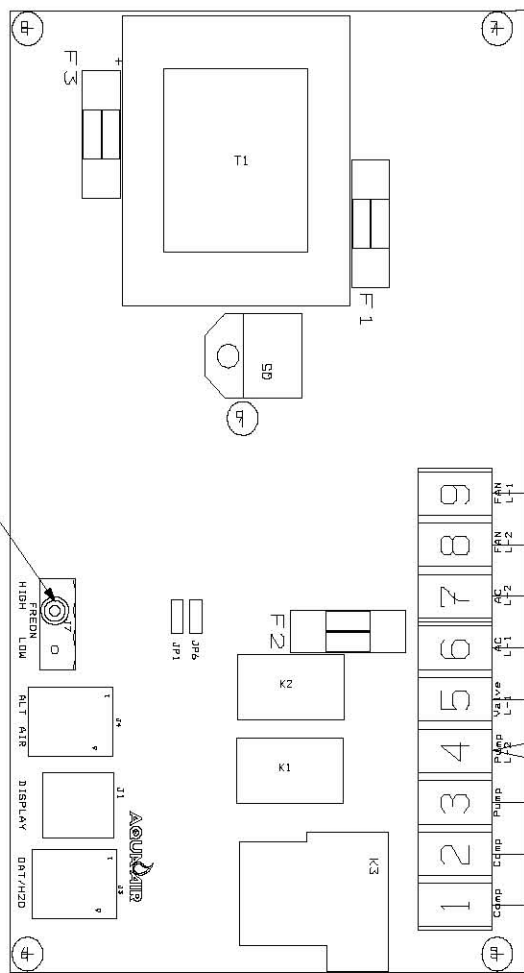
OVERLOAD

COMPRESSOR

S

R

HIGH PRESSURE JUMPER



NOTE 1 POWER INPUT

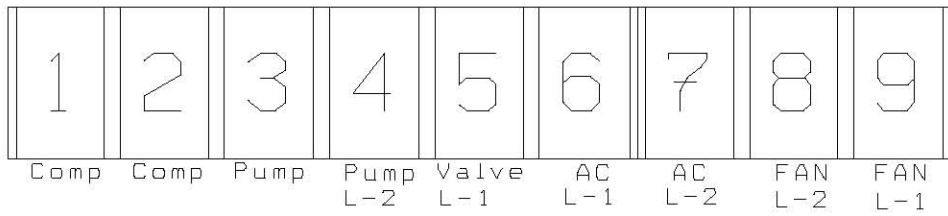
VOLTAGE	TERMINAL		GRND
	6	7	LUG
115	L	N	G \perp
230	L1	L2	G \perp

AQUA-AIR MARINE AIR CONDITIONING SYSTEMS

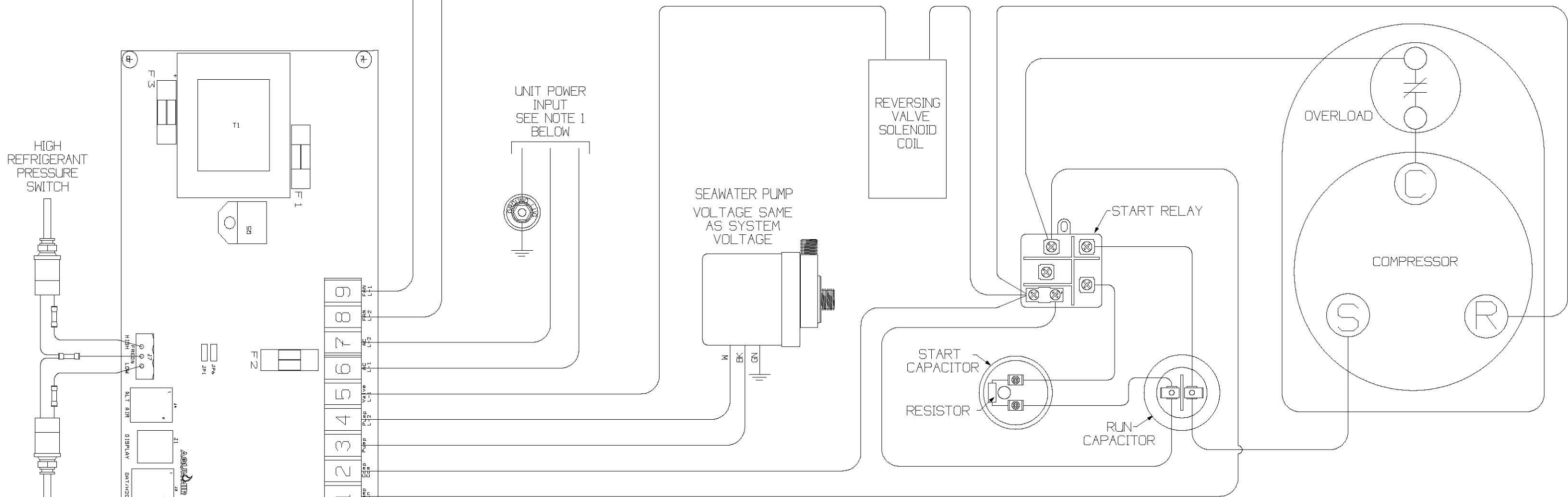
SELF CONTAINED UNIT WIRING WITH SAPPHIRE DIGITAL THERMOSTAT (w/HIGH PRESSURE JUMPER)

DRAWING NUMBER	4010-03K	DRAWN BY	SB	DATE	08-11-08
SCALE	NONE	APPROVED BY	DN	REVISION DATE	

TERMINAL BLOCK - ENLARGED VIEW



FAN COIL UNIT
VOLTAGE SAME AS SYSTEM
VOLTAGE



UNIT POWER INPUT
SEE NOTE 1 BELOW

SEAWATER PUMP
VOLTAGE SAME AS SYSTEM
VOLTAGE

REVERSING VALVE SOLENOID COIL

START RELAY

OVERLOAD

COMPRESSOR

START CAPACITOR

RESISTOR

RUN CAPACITOR

NOTE 1 POWER INPUT

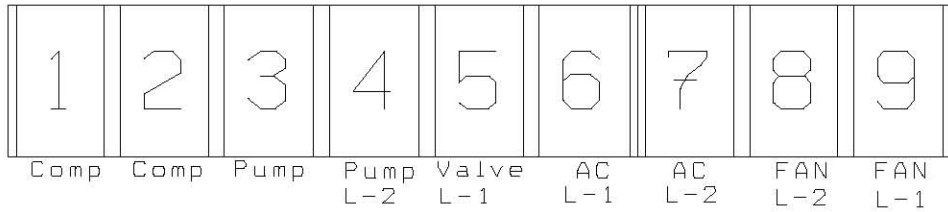
VOLTAGE	TERMINAL		GRND
	6	7	LUG
115	L	N	G \perp
230	L1	L2	G \perp

AQUA-AIR MARINE AIR CONDITIONING SYSTEMS

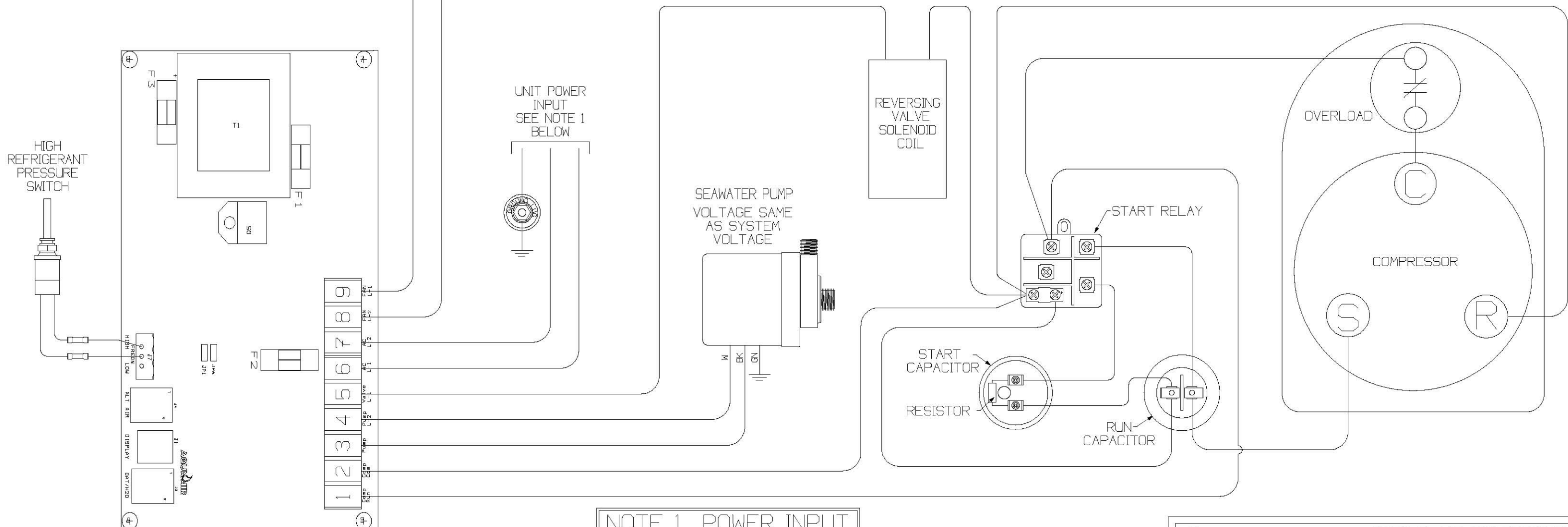
CONDENSING UNIT WIRING WITH SAPPHIRE DIGITAL THERMOSTAT (w/HIGH & LOW PRESSURE SWITCH)

DRAWING NUMBER	4009-47D	DRAWN BY	SB	DATE	08-11-08
SCALE	NONE	APPROVED BY	DN	REVISION DATE	

TERMINAL BLOCK - ENLARGED VIEW



FAN COIL UNIT
VOLTAGE SAME AS SYSTEM
VOLTAGE



UNIT POWER INPUT
SEE NOTE 1 BELOW

SEAWATER PUMP
VOLTAGE SAME AS SYSTEM
VOLTAGE

NOTE 1 POWER INPUT

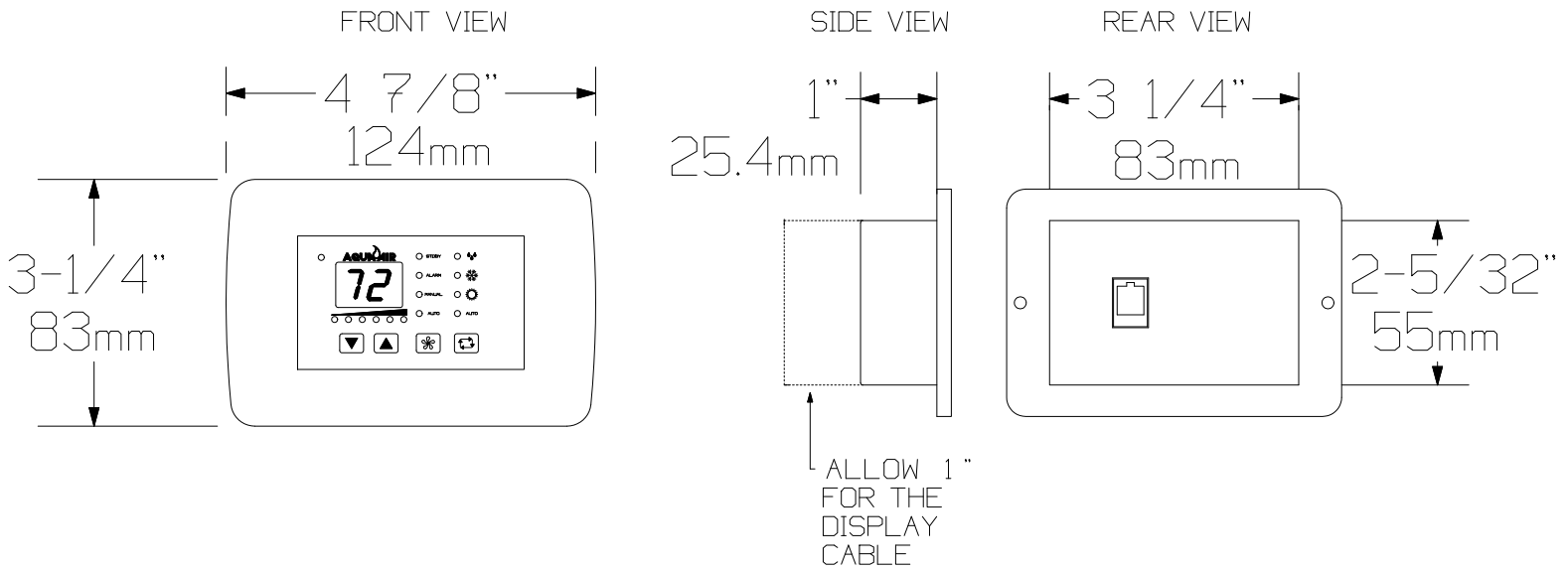
VOLTAGE	TERMINAL		GRND
	6	7	LUG
115	L	N	G \perp
230	L1	L2	G \perp

AQUA-AIR MARINE AIR CONDITIONING SYSTEMS

CONDENSING UNIT WIRING WITH SAPPHIRE DIGITAL THERMOSTAT (w/o LOW PRESSURE SWITCH)

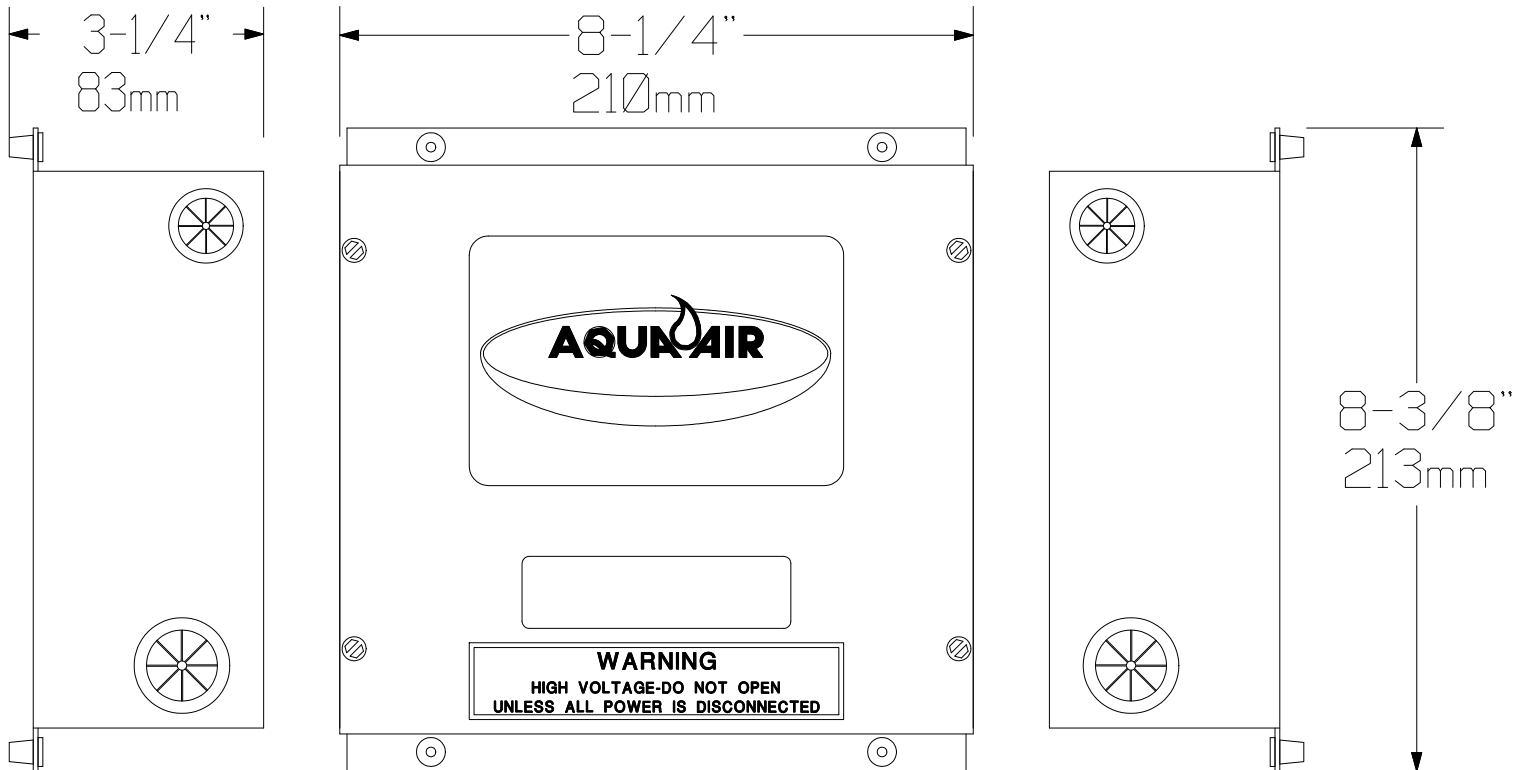
DRAWING NUMBER	4009-47E	DRAWN BY	SB	DATE	08-11-08
SCALE	NONE	APPROVED BY	DN	REVISION DATE	

TSV COMPONENT DIMENSIONS

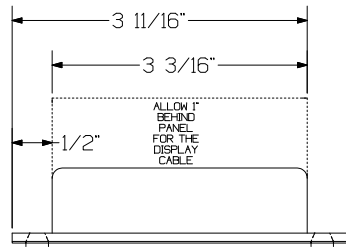


TSV-01 DISPLAY

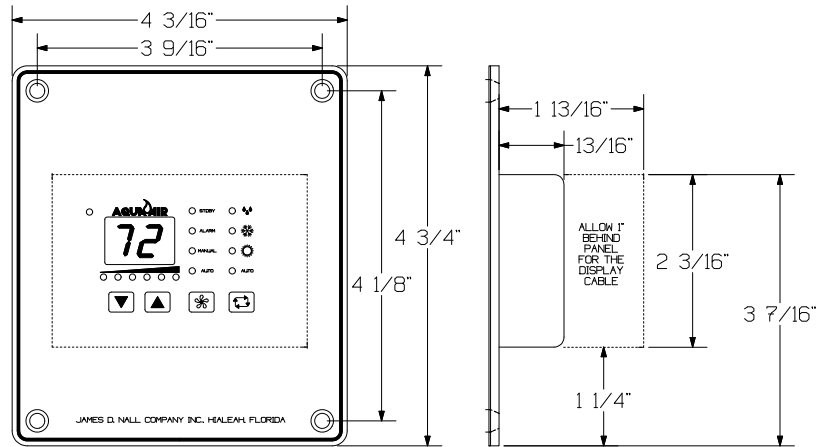
TSV-02 CONTROL MODULE



TWS DIGITAL THERMOSTAT COMPONENT DIMENSIONS



TWWS-01
DISPLAY HEAD



TSV-02 CONTROL MODULE

