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WaterFurnace FX10 Application Guide

Reversible Chiller

Introduction

This manual provides information about the FX10 Water Source Heat Pump (WSHP) controller as it relates to dual compressor water to water heat pumps (8 to 50 tons nominal capacity). The manual describes the controller's components, input/output configurations and service procedures. While many WSHP's look and function in a similar manner, there may be significant internal differences that are defined by the model nomenclature. It is imperative that the specific model of the WSHP be properly identified prior to wiring, commissioning or servicing the unit controls. Failure to do so may cause damage to the unit.

The FX10 WSHP controller contains a factory programmed microprocessor which has been tested for safe and reliable unit operation. The actual software programs will vary depending upon factory installed options or engineering specials in order to meet specific customer requirements. The software code is identified on each FX10 controller by a label (i.e. PRODCWWE-06). Each software program uses pre-determined factory fixed control parameters as well as network defined variables to maintain proper unit control. While nearly all of these are available to view over the building automation systems (BAS) network, only the network defined variables may be manipulated using a computer over the BAS network. There are NO INTERNAL SETPOINTS in the controller.

Standard features of the FX10 WSHP controller include:

- Heating and cooling control input from external control system (Aquastat or BAS network)
- Monitoring of all equipment protection controls
- Sequencing and timing of compressor operation
- Status of all unit fault and lockout functions
    - High pressure refrigerant
    - Low pressure refrigerant
    - Water freeze protection
- Display Link Interface (DLI) board used in conjunction with the unit mounted Medium User Interface (MUI) local control display
- Input / Output expansion board (factory predefined I/O)
- Optional control inputs/outputs (predefined or network configurable)

Optional features of the FX10 WSHP controller include:

- Open N2 (Metasys) communication board
- LON network communication board
- BACnet (MSTP – 19,200 baud rate) communication board

Sequence of Operation

When power is applied to the FX10, the processor executes a power-on start-up sequence that includes the generation of a random length program start delay which varies between 1 and 120 seconds. Upon the termination of the start delay timer, the thermostatic inputs of Y1, Y2 and O are examined to determine the specific mode of operation that is required.

Temperature Monitoring
The FX10 WSHP controller uses a Positive Temperature Coefficient (PTC) thermistor for temperature sensing. A thermistor chart, which provides voltage to temperature and resistance to temperature conversion data, is included on the last page of this manual. The network variables *nvoEntSource, nvoLevSource, nvoEntLoad* and *nvoLevLoad* will show the measured temperatures at the water connections of the WSHP over the network.

Reversing Valve
The position of the reversing valve is determined by a 24VAC external control input to the FX10 on the units low voltage terminal strip. If the reversing valve is de-energized (cooling mode), it will remain in this position until the O terminal of the low voltage terminal strip is energized with 24VAC indicating a need for heating. All applicable compressor timed delays are enforced to allow refrigeration pressures to equalize prior to a change in reversing valve position. Using the BAS the reversing valve can be commanded by writing to the REV VALVE CMD (Multistate Output 14.3) 1=cooling and 2=heating.

Compressor
Upon energizing the Y1 or Y2 terminals on the units low voltage terminal strip with 24VAC, the first indication of an eventual compressor operation is that the X1 (Accessory 1) output will be energized with 24 VAC. After a 90 second delay, the compressor will be energized if the internal safeties permit. Compressor operation will continue until the 24VAC control input is removed from the Y1 or Y2 terminals.

Unit / Compressor Protection
There are several conditions that will prevent or interrupt unit/compressor operation. There are also minimum operation times which are strictly enforced by the FX10 controller and are not adjustable or accessible.

Minimum Run
Once compressor operation is initiated, a fixed 120 second run time is enforced (start to stop). Only a high pressure fault, compressor start fault or an emergency stop command can halt the compressor during this period. This period is essential to ensuring proper oil return to the compressor.

Minimum Off
When compressor operation is terminated, a fixed minimum off time of 5 minutes is enforced (stop to start). This minimum off time is intended to allow time for the gas pressures to equalize and to minimize the starting load on the compressor as well as giving the compressor windings time to cool down from the heat experienced during start of a compressor and its high current draw.

High Pressure
If the high pressure switch opens at any time, the compressor is immediately disabled. Three high pressure events within a 60 minute period will result in a manual reset lock-out. An alarm is generated for this condition.

Low Pressure
If the low pressure switch is open prior to compressor start, it is deemed a loss of charge condition and the compressor will not start. An alarm is generated for this condition. Once the compressor is started, the low pressure switch is ignored for the first 2 minutes. Thereafter, if the low pressure switch is open for 30 continuous seconds, compressor operation is halted. Three low pressure events within a 60 minute
period will result in a manual reset Lock-out. An alarm is generated for this condition.

Low Temperature
To prevent freeze damage to the brazed plate heat exchangers, the refrigerant temperature is monitored after the minimum run time has expired. If the refrigerant temperature is below the low limit for 30 seconds continuously, compressor operation is halted. Three low temperature events within a 60 minute period will result in a manual reset Lock-out. An alarm is generated for this condition. The temperature sensor is located on the low pressure refrigerant line in close proximity to the leaving water outlet of the heat exchanger. The FX10 automatically converts the refrigerant temperature to a corresponding leaving water temperature for comparison to the freeze protection set point. The refrigerant temperature is utilized as it responds more quickly to changes in temperature and is less susceptible to errors caused by changes in water flow or sensor installation. Laboratory testing has proven that the error rate in the temperature between the refrigerant and water while in the heating mode is less than 1˚F (less than 2˚ F in cooling mode).

Reversing Valve change
If the compressor is operating and the minimum run timer has expired, a commanded change in the reversing valve position will halt the compressor. The compressor will not be started until the minimum off timer has expired and all safeties have been satisfied.

Internal Compressor Control Module
Reads a thermister chain within the compressor to protect against excessive motor and discharge temperature. A problem in either area will cause the module to interrupt the control circuit.

Phase Guard Control Module
The phase guard module monitors the supply voltage to the unit. If any of the points it monitors are outside of the range the phase guard will remove power to the control board until the condition is corrected. The points it monitors are under/over voltage, phase imbalance, phase loss, and phase reversal.

Additional Features

Advanced Freeze Protection
Freeze protection uses the leaving water temperature and the refrigerant temperature to determine if a freeze condition is possible, and will disable the compressor associated with the freeze condition. If both

compressors are running at the time of this, only the compressor associated with the freeze condition will be shut down. If there is only one compressor running it will shut down this compressor and not allow the other compressor to start until the temperature is above a value that is determined by the freeze setpoint. It takes three failures within a 60 minute period to create a lockout condition, which will generate a manual reset alarm.

Alarm Reset

In the event of a manual reset lockout, the condition may be reset by turning off primary power for a minimum of 20 seconds. The lockout can also be reset over the BAS network by commanding the variable *nviAlarmReset* from an uncommanded or Off value to a Low_ST_On value. In the event that the network is not available, but a Medium User Interface (MUI) is connected; simultaneously pressing of the Return and ESC keys on the display will also reset the alarm.

Emergency Shutdown

DI-2 on the FX10 controller has been predefined as the emergency shutdown input. In the event that it is necessary to disable operation of the WSHP unit, DI-2 recognizes a voltage free contact closure as a command to cease unit operation. The compressor and blower contactors are interlock with DI-2 internally and will drop out 24VAC to the contactors and thereby disabling unit function. The unit will operate normally when a normally open circuit is detected by the controller. Compressor delay timers are restarted at this time.

Motorized Solenoid Valve

Located on the WSHP low voltage terminal board, X1 (Accessory 1) is wired to DO-7 of the FX10 controller, which is cycled with the operation of the compressor. The X1 terminal is energized (24VAC) when the compressor is operating (factory default selection), and is field adjustable to accommodate alternative valve actuation.

General Fault

When an alarm condition is actively preventing compressor operation, the 'L' terminal located on the low voltage terminal board and wired to DO-6 of the FX10 controller will be energized (24VAC).

Network Alarm Variable

The network variable *nvoAlarms* has a numeric output that shows the alarm condition of the WSHP. The Alarm values for the NXW are as follows:

0=No alarms
1=Load Flow Switch
2=Compressor 1 Low Suction Pressure
3=Source Low Temp alarm Compressor 1
4=Source Predictive Freeze alarm Compressor 1
5=Source Flow Switch
6=Hi Pressure Compressor 1
7=Bad Source Sensor Compressor 1
8=Bad Load Sensor Compressor 1
9=Compressor 2 Low Suction Pressure
10=Source Low Temp alarm Compressor 2
11=Bad Sensor Source Compressor 2
12= Source Predictive Freeze alarm Compressor2
13=Bad Sensor Load Compressor 2
14=Hi Pressure Compressor 2
15= Compressor 1 Start Fail alarm
16=Low temp cutoff Comp 1
17= Low temp cutoff Comp 2
18=Compressor 2 Start Failure alarm
19=Load Low Temp alarm Compressor 1
20=Load Predictive Freeze alarm Compressor 1
21=Load Low Temp alarm compressor 2
22=Load predictive Freeze alarm compressor 2
23=Compressor 1 charge loss
24=compressor 2 charge loss

Brownout Protection

The FX10 has been designed to protect the compressor contactors from low voltage or "brownout" conditions. If the supply voltage to the WSHP is below 85% of the nameplate rating, the FX10 de-energizes the compressor and blower contactors. When proper power has been restored the WSHP resumes normal operation.

Lead-Lag

When the unit receives a Y1 or Y2 call, the processor will determine which of the two compressors was last to run and then it will enable the other compressor, the unit does not care which Y1 or Y2 signal it receives, lead lag is determined by using a the theory of the first on is the first off and the last off is the last on.

Commissioning

The following commissioning procedures pertain to Water Source Heat Pumps (WSHP) with the factory applied FX10 unitary controller. These procedures must be performed in addition to the mechanical, electrical and plumbing procedures outlined in the installation and operations manuals of each specific WSHP.

Before a unit has power applied to it, a technician must visually inspect the control box to verify that all wire connections are tight, and that all Molex plugs are properly and fully seated on the control board. After this step is complete the technician can apply power to the unit and begin to fill out the startup sheet. Once the unit is up and operational, the technician will need to record all the readings and verify that they are within the unit specifications.

Communication

WaterFurnace offers three different communication protocols, LONworks, N2 Open, BACnet. Points list are available for download from the Commercial page of the Waterfurnace website.

A99 Sensor Chart

Voltage to Temperature to Resistance

Voltage DC	Temperature °C	Temperature °F	Resistance Ω
	-40	-40	613
	-35	-31	640
1.170	-30	-22	668
1.207	-25	-13	697
1.245	-20	-4	727
1.284	-15	5	758
1.323	-10	14	789
1.362	-5	23	822
1.402	0	32	855
1.443	5	41	889
1.483	10	50	924
1.522	15	59	960
1.562	20	68	997
1.603	25	77	1035
1.642	30	86	1074
1.682	35	95	1113
1.722	40	104	1153
1.760	45	113	1194
1.792	50	122	1236
1.840	55	131	1279
1.878	60	140	1323
1.917	65	149	1368
1.955	70	158	1413
1.993	75	167	1459
2.031	80	176	1506
2.069	85	185	1554
2.106	90	194	1602
2.142	95	203	1652
	100	212	1702
	105	221	1753

A99 sensors are only used in Units that have the FX10 Controller.