2011

WaterFurnace FX10 Application Guide

Envision Series

Introduction

This manual provides information about the FX10 Water Source Heat Pump (WSHP) controller as it relates to single compressor water to air heat pumps (3/4 to 6 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. PROFXENV-00). Each software program uses pre-determined factory set points, 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 system's (BAS) network, only the set points and network defined variables may be manipulated using a computer over the BAS network.

Standard features of the FX10 WSHP controller include:

- Heating and cooling control from a remotely located zone sensor or command module
- Monitoring of all equipment protection controls
- Sequencing and timing of fan and compressor operation
- Status of all unit fault and lockout functions
    - High pressure refrigerant
    - Low pressure refrigerant
    - Condensate overflow
    - Water freeze protection
- 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
- Display Link Interface (DLI) board used in conjunction with Medium User Interface (MUI) local control display
- Input / Output expansion board (***requires custom programming by the factory***)

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 zone sensor input is examined to determine whether set point mode or thermostatic operation is chosen. If the zone sensor is detected and is confirmed to be reliable by the FX10, the set point mode is initialized and the thermostatic inputs located on the low voltage terminal strip for Y1, Y2, O, and G input signals are ignored.

Initialization

The microprocessor then determines the Occupancy status of the WSHP by examining the signal at the Occupancy input (DI-1) and the network command at *nviOccManCmd*. If the Occupancy status is determined to be Occupied, the fan will begin operation immediately and will remain in operation as long as the Occupancy status remains Occupied. If the Occupancy status is determined to be Unoccupied, the fan will be operated in a cycled fashion such that it will be off unless the zone temperature is above the Unoccupied Cooling set point or below the Unoccupied Heating set point.

Temperature Control

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 last page of this document. The network variables *nvoClgSetpt* and *nvoHtgSetpt* will show the cooling and heating set points as determined by the occupancy status of the WSHP over the network. Zone temperature sensors which incorporate a warm/cool adjustment feature control the actual cooling and heating functions of the WSHP and display the network variables *nvoEffClgSetpt* and *nvoEffHtgSetpt* as the locally overridden set point values. The warm/cool adjustment may be controlled over the network to limit the temperature set point adjustment available to the occupants (nciRemoteSetptSpan). In the event that the warm/cool adjustment is set to zero, the Temperature Set Points and the Effective Temperature Set Points will register the same value. The warm/cool adjustment is only active when the occupancy status is set to Occupied.

Occupant Override

Zone temperature sensors which incorporate an occupancy override button will temporarily override the network established Unoccupied status for a period of 2 hours (default time period) and is identified Effective Occupancy on the network. Depressing the momentary contact occupancy override button a second time during the override period will re-start the 120 minute occupancy timer of the unit. The temporary occupancy override is only active when the occupancy status is set to Unoccupied.

Reversing Valve

The position of the reversing valve is determined by the zone temperature's relationship to the Effective Temperature Set Points. If the reversing valve is energized (cooling mode), it will remain in this position until the zone temperature drops below the Effective Heating Set Point. If the reversing valve is de-energized (heating mode), it will remain in this position until the zone temperature rises above the Effective Cooling Set Point. All applicable compressor timed delays are enforced to allow refrigeration pressures to equalize prior to changing the reversing valve position.

Compressor

If the zone temperature falls outside of the bounds of the Effective Heating and Cooling Set Points, 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. The compressor is energized when the actual zone temperature exceeds the controlling Effective Set Point plus the value of the parameter '*nciPropBand*' (default setting is 1.0˚F). Compressor operation will continue until the zone temperature crosses back inside the Effective Temperature Set Points band.

Fan

ECM Blower

The FX10 provides direct digital control over the ECM 2.3 blower motor using a Pulse Width Modulating (PWM) signal. The ECM 2.3 blower motor will operate at three differing speed settings which correspond to thermostatic control inputs of Fan-Only (G - Low), Compressor (Y1 - Medium), High Compressor (Y2 - High). These values are chosen by the sequential selection of three out of twelve speed parameters which are factory set and field adjustable. During the Occupied mode (assumes continuous fan operation is selected - default selection) when the compressor is not energized, the blower operates at the Low CFM setting. When the compressor is first energized, the fan will operate at the Medium CFM setting. If the compressor call remains active over a sufficient time period (indicating that the zone temperature is still outside the boundaries of the Effective Temperature Set Point) and the temperature differential is sufficiently large enough, the FX10 will initiate a High Compressor call thereby operating the blower at the High CFM setting. Any changes in blower CFM operation will occur over a period of approximately 30 seconds in order to minimize mechanical stress to the motor and changes in sound transmission. During the Unoccupied mode, the blower motor is cycled with the compressor in response to a space temperature conditioning command.

Note: The WSHP may be configured with a single or dual capacity compressor. The ECM blower operates in the same manner in either configuration.

PSC Blower

The FX10 controls the blower motor contactor as determined by the occupancy mode of the WSHP over the network. During the Occupied mode (assumes continuous fan operation is selected - default selection) the blower motor is energized. During the Unoccupied mode, the blower motor is cycled with the compressor in response to a space temperature conditioning command.

Dehumidification

Non –reheat With ECM

If the WSHP is in the active cooling mode of operation and the humidity input sensor to the FX10 shows a humidity value higher than the dehumidification set point, or if ECM speed switch 12 is ON and the dehumidistat input (DI-4) is activated, the blower volume (CFM) will be reduced by 15% in order to decrease the dry bulb temperature of the discharge air thereby reducing the dew point temperature of the discharge air.

Hot gas Reheat

If the WSHP is in the active cooling mode of operation and the humidity input sensor to the FX10 shows a humidity value higher than the dehumidification set point, or if ECM speed switch 12 is ON and the dehumidistat input is activated, the blower volume will be reduced by 15 % in order to decrease the dry bulb temperature of the discharge air thereby reducing the dew point temperature of the discharge air. If there is no active call for cooling or heating and if there exists a dehumidification call as previously described above, the WSHP will enter the High Cooling Compressor mode of operation and will energize the hot gas reheat valve, this will allow the discharge air to have a neutral effect on the space dry bulb temperature. This essentially converts the operation of the WSHP into a dehumidifier and prevents the

zone from becoming overcooled. If a cooling call is initiated during the dehumidification cycle (Indicating that the zone temperature is now outside the boundaries of the Effective Cooling Set Point), the FX10 controller de-energizes the reheat valve and returns the WSHP to normal cooling mode of operation. If a heating call is initiated during the dehumidification cycle (Indicating that the zone temperature is now outside the boundaries of the Effective Heating Set Point), The FX10 controller will discontinue the operation of the WSHP in the dehumidification mode and will re-initialize the unit for operation in the heating mode.

Humidity Sensor Input AI-2

Humidity input to the FX10 is monitored on AI-2 (FX10 terminal 33) and is configured as a *Ratio Metric* input, which is a linear DC input with a valid reading range from 0.5 VDC to 4.5 VDC. At 0.5 VDC, the reported value is 20% RH and at 4.5 VDC the reported value is 80 % RH. The 5 VDC output on terminal 34 (Yellow/Red wire #53) should NOT be used to power the humidity sensor or any other external loads as the FX10's internal 5VDC supply is not sufficiently robust to support external loads.

Dehumidistat Input DI-4

When the actual humidity value is not required and a more simple hot gas reheat control is requested, then a dehumidistat may be installed in place of a humidity sensor. The low voltage terminal board terminals "LC1" and "LC2" are factory wired to DI-4 of the FX-10 controller in order to accept the field connection to a dehumidistat. When the normally open and voltage free contact is closed on the dehumidistat, the hot gas re-heat mode of operation will be activated.

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 – stop). Only a high pressure fault, emergency stop command, or condensate detection are intended to 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 – start). This is intended to allow time for the gas pressures to equalize and minimize the starting load on the compressor as well as giving time for the windings to cool prior to heat up experienced during a start-up high current condition.

High Pressure

If the high pressure switch opens at any time, the compressor is immediately disabled. Three high pressure events in any 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 in any 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 coaxial heat exchanger, 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 in any 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).

Condensate detection
Two electrodes are positioned in the condensate pan so that if the pan does not drain properly, the presence of excessive water will trigger a detected condensate condition. If the condition exists for 30 continuous seconds, compressor operation is halted. Three condensate events in any 60 minute period will result in a manual reset Lock-out. An alarm is generated for this condition.

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.

Additional Features

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 thereby disabling unit function. The unit will operate normally when a normally open circuit is detected by the controller.

Thermostatic Control
In the absence of a sensor connection to the heat pump control box terminal board terminals ‘RS’ and ‘AIC’ (Analog Input 1) and with no value written to the space temperature override variable, the heatpump control operates in a standard heat pump thermostatic control mode. On the heat pumps

low voltage terminal strip, terminals R, G, O, Y1, Y2, and C are used in the industry-standard fashion for basic control of the heat pump. Terminals LC1 and LC2 are utilized to operate units with hot gas reheat using a dehumidistat rather than a humidity sensor.

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.

Fresh Air Damper
Located on the WSHP low voltage terminal board, X2 (Accessory 2) is wired to DO- 8 of the FX10 controller which is cycled with the operation of the blower motor. The X2 terminal is energized (24VAC) when the blower motor is operating in order to actuate a fresh air damper, power exhaust fan, energy recovery ventilator or another similar system component that requires interlinked operation with the WSHP's blower motor. The relay operation is not field adjustable.

Auxiliary Heat
DO- 5 of the FX10 controller has been predefined as a network variable used to control emergency auxiliary heat (electric duct heater, hydronic heat valve, etc.) external to the WSHP. This output relay is interlocked with the WSHP's blower motor as a safety precaution. The standard FX10 control application does not control auxiliary heat in order to provide supplementary heating operation in conjunction with the WSHP.

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 values are as follows:
0=no alarms
1=condensate alarm
2=Compressor Hi Discharge Pressure alarm
3=Compressor low Suction Pressure alarm
4=Freeze protection alarm
8=Faulty Freeze Sensor alarm
9=Loss of Charge

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.

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 goes out of tolerance 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.

Commissioning

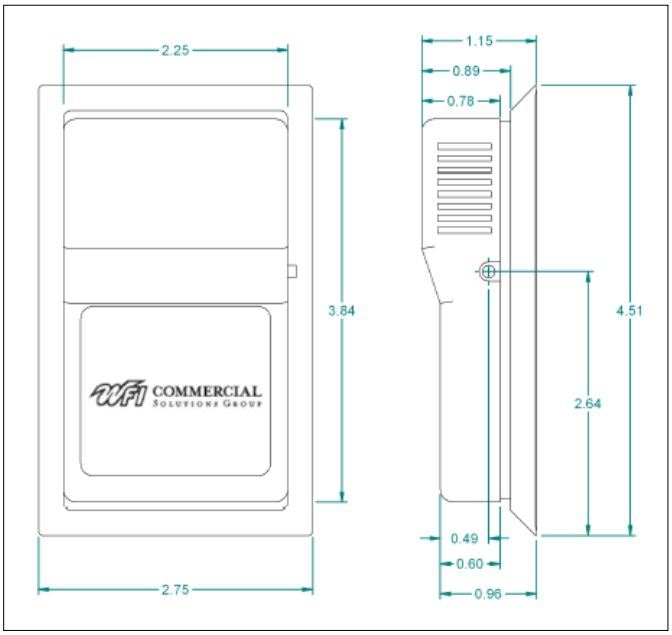
The following commissioning procedures pertain to Water Source Heat Pumps (WSHP) with the factory applied FX10 unitary controller. These procedures must be performed in addition to the mechanical, electrical and plumbing procedures outlined in the installation and operations manuals of each specific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

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

Communication

We offer three different communication protocols, LONworks, N2 Open, BACnet. If you are using a BAS to operate this unit and need the points list please send an E-mail with the model and serial number of the units to shane.mccoart@waterfurnace.com or tim.beachy@waterfurnace.com .

TAXXA02



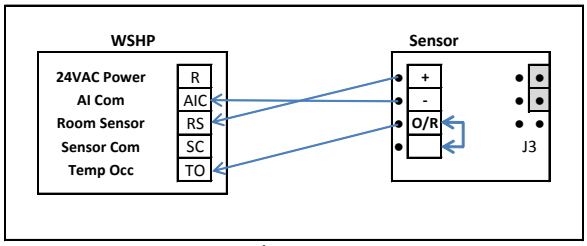
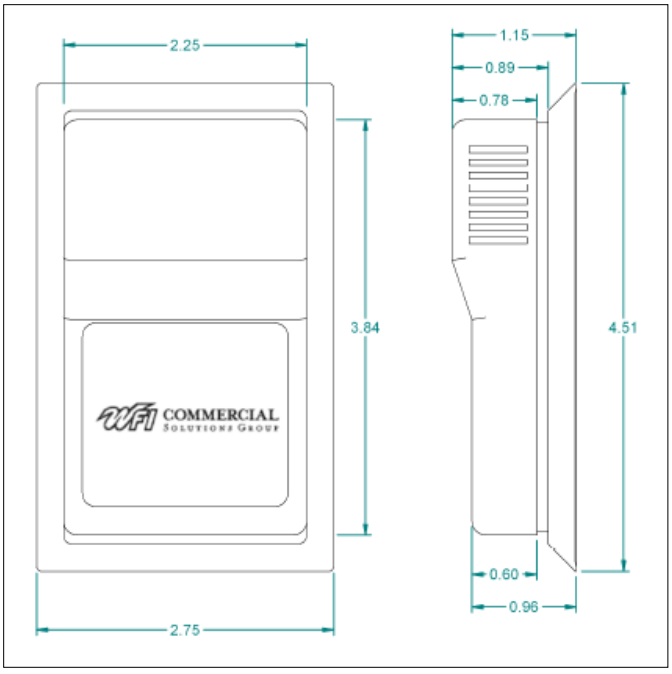


Figure 2: TAXXA02 Zone Sensor w/Occupancy Override

TAXXA03



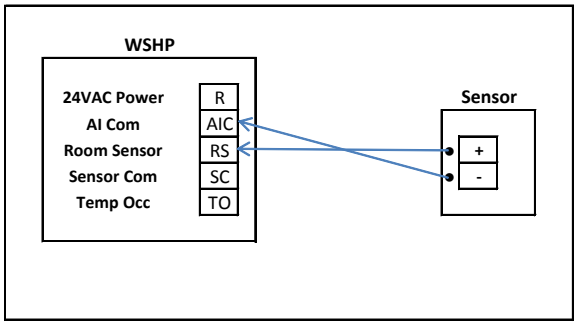
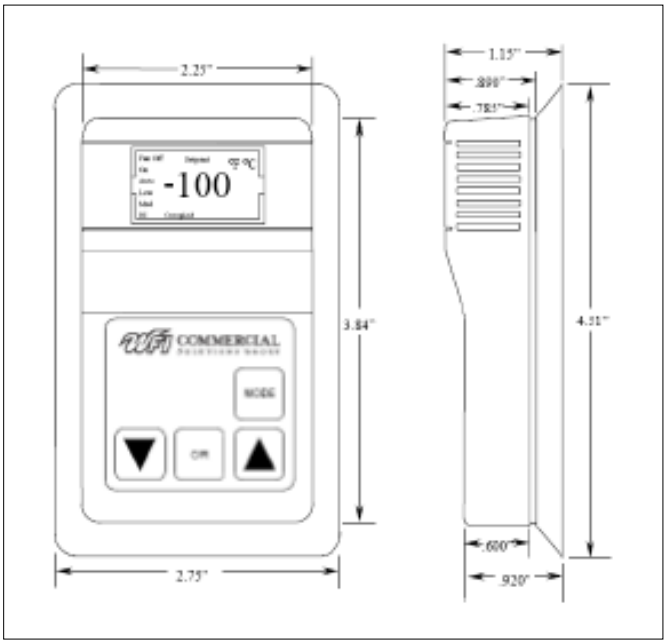


Figure 3: TAXXA03 Zone Sensor

TAXXA04



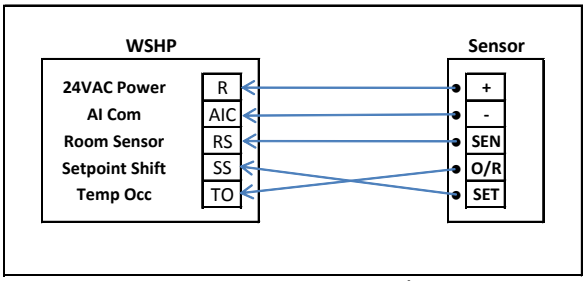


Figure 4: TAXXA04 Room Command Module w/LCD Display

A99 Sensor Chart

Temperature versus 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.