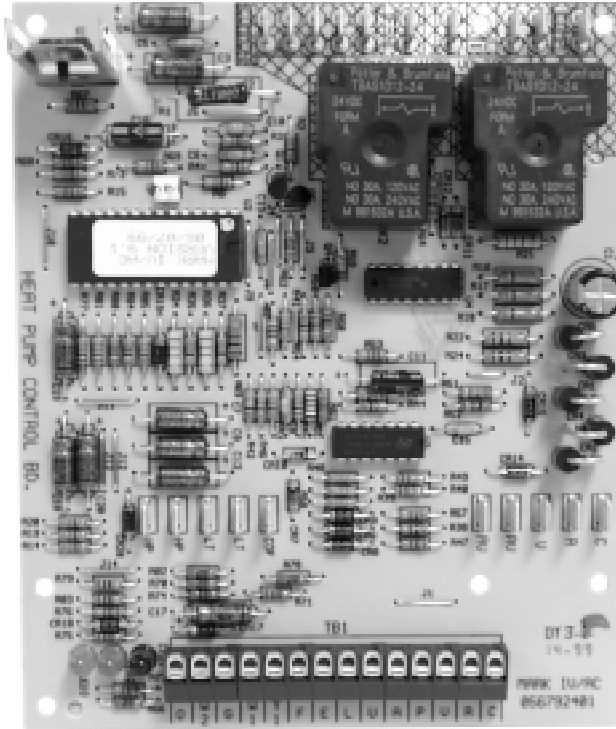


Mark IV/AC Controller For Water Source Heat Pump Units



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Features of the Mark IV/AC Controller

The Mark IV/AC controller incorporates features which improve the operation and safety of AAF-McQuay heat pumps. These features include:

1. Compressor short cycle protection
2. Brownout protection with time delays for the fan and compressor to prevent damage due to low voltage conditions
3. Condensate overflow protection
4. Refrigerant high / low pressure protection
5. Low temperature protection with automatic condenser defrost cycle
6. Random start delay compressor to prevent high building electrical demands when multiple units are simultaneously switched on during power-up, return from brownouts, return from load shed, etc.
7. LED's to indicate operational status and fault indication
8. Controlled delay of the reversing valve to reduce annoying "swish" noise
9. High speed test jumper (TP) used to reduce compressor short cycle and reversing valve delay times to speed system check out and repair.
10. Load shed control input for energy management systems
11. Remote shutdown control input for remote shutdown of unit*
12. Unoccupied control input for night setback control
13. Inputs for both standard (W1) and night setback (W2) thermostats
14. Fault output for remote fault indication
15. Operation of the fan during most faults and load shed to increase comfort
16. Tenant override input to manually switch from unoccupied mode (U) to occupied mode (O)
17. Control board inputs U, L, E, Y1, W1, G, W2, and O have been designed to operate by connecting to the units 24vac, 24vdc, or chassis ground

*The remote shutdown input (E) should not be the sole means of ensuring equipment status when used as a part of a life-safety control system as the unit fan may operate during some fault conditions.

CAUTION

The Mark IV/AC circuit board incorporates static sensitive devices. A static charge from touching the device can damage the electronic components. To prevent damage during service, AAF-McQuay Incorporated recommends the use of static discharge wrist straps which are grounded to the heat pump chassis through a one mega ohm resistor.

For replacement of a Mark IV/AC circuit board:

1. Connect wrist strap to unit.
2. Remove faulty board and place on static protected surface.
3. Remove replacement board from static protected bag.
Do not touch circuit board; hold by edges.
4. Holding board in grounded hand, install board in unit.
5. Insert faulty board in empty static bag for return.

Initial Power Up

When power is first applied to the unit, the following events occur:

1. The board executes a reset routine which sets up the microcontroller for normal operation. During this routine the following occurs:
 - a. The reversing valve may click on and off.
 - b. The A output goes low for a fraction of a second.
 - c. The GREEN LED will flash at 1/2 second intervals for approximately 1 1/2 seconds.
 - d. A new random start delay time between 0 and 32 seconds is generated. A new short-cycle timer is also generated by adding 180 to the new start delay time for a total time delay between 180 and 212 seconds. Once these numbers are generated, the same time delays will be used until the next power cycle.
2. The microcontroller then checks for the following conditions in the following order:
 - a. High pressure fault
 - b. Low temperature fault
 - c. Load shed signal on
 - d. Brownout or remote shutdown condition
 - e. Condensate fault
 - f. Unoccupied signal onIf any of these conditions are true, the microcontroller executes the appropriate routine. For example, if the high pressure switch is open upon power up, the compressor will not start and the RED LED will flash.
3. If none of the above signals or faults are detected during start up, the unit will go into normal operation.

General Use and Information

The Mark IV/AC control board is provided with three drive terminals, R (24vac), F (24vdc), and C (0vac) that can be used by the end user to drive the thermostat inputs (G, Y1, W1, and W2) and control inputs (U, L, E, and O). Any combination of or single board drive terminal (R, F, or C) may be used to operate the Mark IV/AC boards control or thermostat inputs. However, only one drive terminal (R, F, or C) can be connected to any individual input terminal or damage will occur. Some of the control inputs are used within the Water Source Heat Pump and not accessible to the end user. For example HP, LT, and COF are not available for use by the end user.

Typically the Mark IV/AC board's R (24vac) terminal is used to drive the board's thermostat inputs and control inputs by connecting it to the R terminal of an industry standard thermostat. The control outputs of the standard thermostat are then connected to the Mark IV/AC board thermostat inputs and control inputs as needed. Any remaining board input(s) may be operated by additional thermostat outputs or remote relays (dry contacts only).

All Mark IV/AC board inputs must be operated by dry contacts powered by the control board's power terminals. No solid state devices (Triacs) may be used to operate Mark IV/AC board inputs. No outside power sources may be used to operate Mark IV/AC board inputs.

Occupied Operation

Board LED Status		
Yellow	Green	Red
Off	On	Off

The board will be in occupied mode if the unoccupied terminal (U) is de-energized.

Thermostat Inputs (G, Y1, W1, and W2)

Thermostat inputs used during occupied operation are G, Y1, and W1, which when energized will activate the Fan Only, Cooling Mode, and Heating Mode respectively. Input W2, unoccupied Heating Mode has no effect during occupied mode.

The Mark IV/AC board is configured so that when either the Y1 or W1 input is energized the unit fan will also be activated with Cooling or Heating Modes. In other words, energizing Y1 and G together will have the same effect as energizing just Y1.

The W1 input has priority over the Y1 input. In situations when both inputs W1 and Y1 become energized (unlikely) in any order the unit will go into the Heating Mode as described below:

- For example, if the unit is in Cooling Mode, Y1 energized, and W1 becomes energized and remains energized, the following will occur:
 - The compressor will be de-energized
 - The reversing valve will energize 1 minute later (Heating Mode position)
 - The compressor will restart between 180 and 212 seconds (short-cycle timer)
- If the unit is in Cooling Mode, Y1 energized, and W1 becomes energized momentarily the controller will de-energize the compressor for 180 to 212 seconds (short-cycle timer) and then return to the cooling mode.
- However, if the unit is in Heating Mode, W1 energized, and Y1 becomes energized the unit will remain in Heating Mode.

Control Inputs (HP, LT, COF, U, L, E, O)

The control inputs are High / Low Pressure (HP), Low Temperature (LT), Condensate Overflow (COF), Unoccupied (U), Load Shed (L), and Remote Shutdown (E). The control inputs will all be in their normal states during occupied mode. The state of each control in occupied mode during normal operation is as follows:

- High / Low Pressure (HP): energized, switch is closed (no fault)
- Low Temperature (LT): energized, switch is closed (no fault)
- Condensate Overflow (COF): sensing no condensate water (no fault)
- Unoccupied (U): de-energized (no signal)
- Load Shed (L): de-energized (no signal)
- Remote Shutdown (E): de-energized (no signal)
- Tenant Override (O): has no effect in occupied mode

Control Outputs (A and P)

The control outputs are Alarm Fault (A) and Pump Request (P). The operation of the control outputs during occupied mode is as follows:

- Alarm Fault (A): energized (no fault)
- Pump Request (P): energized when the compressor is off, and de-energized when the compressor is on.

Fan Operation

The G terminal controls Fan Only operation. The fan will start when the G terminal is energized. De-energizing the G terminal will cause the fan to stop unless the W1 or Y1 terminals are energized.

Cooling Mode

The Y1 terminal controls Cooling Mode operation. When the Y1 terminal is energized, the following will occur:

- The fan will be energized immediately
- The compressor will be energized after 0 to 32 seconds (start delay timer)

- The P control output is de-energized when the compressor is energized

When the Y1 terminal is then de-energized, the following will occur:

- The compressor is de-energized immediately
- The fan is de-energized immediately, unless the G terminal is energized
- The P control output is energized when the compressor is de-energized

Compressor time delays may be longer than indicated above as the short-cycle timer (180 to 212 seconds) will be used as needed to prevent adverse compressor cycling.

Heating Mode

The W1 terminal controls occupied Heating Mode operation. When the W1 terminal is energized the following will occur:

- The reversing valve will be energized immediately
- The fan will be energized immediately
- The compressor will be energized after 0 to 32 seconds (start delay timer)
- The P control output is de-energized when the compressor is energized

When the W1 terminal is then de-energized the following will occur:

- The compressor will be de-energized immediately
- The fan will be de-energized immediately, unless the G terminal is energized
- The reversing valve de-energizes after 1-minute
- The P control output is energized when the compressor is de-energized

Compressor time delays may be longer than indicated above as the short-cycle timer (180 to 212 seconds) will be used as needed to prevent adverse compressor cycling.

Unoccupied Operation

Board LED Status		
Yellow	Green	Red
On	On	Off

The board will be in unoccupied mode if the unoccupied terminal (U) is energized.

Thermostat Inputs (G, Y1, W1, and W2)

The only thermostat input used during unoccupied operation is W2, which when energized will activate Heating Mode. Inputs G, Y1, and W1 have no effect during unoccupied mode.

Control Inputs (HP, LT, COF, U, L, E, O)

The control inputs are High / Low Pressure (HP), Low Temperature (LT), Condensate Overflow (COF), Unoccupied (U), Load Shed (L), and Remote Shutdown (E). The state of each control input during unoccupied mode during normal operation is as follows:

- High / Low Pressure (HP): energized, switch is closed (no fault)
- Low Temperature (LT): energized, switch is closed (no fault)
- Condensate Overflow (COF): sensing no condensate water (no fault)
- Unoccupied (U): energized (signal provided)
- Load Shed (L): de-energized (no signal)
- Remote Shutdown (E): de-energized (no signal)
- Tenant Override (O): see section "Tenant Override Mode"

Control Outputs (A and P)

The control outputs provided by the Mark IV/AC board are Alarm Fault (A) and Pump Request (P). The operation of the control outputs during unoccupied mode is the same as in occupied mode. See occupied operation.

Fan Operation

The G terminal has no effect during unoccupied mode. Operation of the fan is controlled by the W2 input.

Cooling Mode

Cooling operation is not provided during unoccupied mode.

Heating Mode

The W2 terminal controls unoccupied Heating Mode operation. When the W2 terminal is energized the following occurs:

1. The reversing valve is energized immediately
2. The fan is energized immediately
3. The compressor will start after 0 to 32 seconds (start delay timer)
4. The P control output is de-energized when the compressor is energized

When the W2 terminal is then de-energized the following occurs:

1. The compressor is de-energized immediately
2. The reversing valve de-energizes after 1-minute
3. The P control output is energized when the compressor is de-energized

Compressor time delays may be longer than indicated above as the short-cycle timer (180 to 212 seconds) will be used as needed to prevent adverse compressor cycling.

Additional Operating Modes

Load Shed

Board LED Status		
Yellow	Green	Red
Off	Off	On

The Mark IV/AC board will be in load shed mode when the L terminal is energized unless overridden by a higher priority mode

or fault. Load shed is provided so that when properly connected to a building automation system, remote switch, etc., the L terminal can be used to deactivate the compressor. The load shed input may also be used as part of a boiler-less system kit, which will disable the compressor by energizing the L terminal when loop water temperature drops. The fan will operate normally during load shed mode.

Some faults and modes have higher priority than load shed mode. See the section "Priority of Faults and Modes".

When the L terminal is energized the following occurs:

1. The compressor is immediately de-energized
2. The reversing valve will be de-energized after 1-minute

When the L terminal is then de-energized, the controller will automatically return to normal operation.

Brownout

Board LED Status		
Yellow	Green	Red
Off	Flash	Off

The Mark IV/AC board is designed to monitor the 24vac supply to the board. If the line voltage supplied to the water

source heat pump drops, the 24vac supply to the control board will also drop. When the line voltage supplied to the unit drops below approximately 80% of the unit nameplate rated value the controller will go into brownout mode. The controller will then remain in brownout mode until line voltage returns to approximately 90% of the unit nameplate value. Brownout mode is provided to protect the water source heat pump's motors from low voltage conditions.

When in brownout mode all thermostat and control inputs have no effect on unit operation. No faults or modes have higher

priority than brownout mode. Remote shutdown and brownout modes have the same level of priority. See the section "Priority of Faults and Modes".

When the unit is in brownout mode the following occurs:

1. The compressor is immediately de-energized
2. The reversing valve is immediately de-energized
3. The fan is immediately de-energized
4. Fault terminal (A) is de-energized (fault)

When the line voltage supplied to the unit returns to acceptable levels (~90% of nameplate) the controller will return to the current mode.

Remote Shutdown

Board LED Status		
Yellow	Green	Red
Flash	Off	Off

The Mark IV/AC board will be in remote shutdown when the E terminal is energized. Remote shutdown is provided so that when properly connected to a building automation system, remote switch, etc., the E terminal can be used to shut down the water source heat pump.

When in remote shutdown (E terminal energized) no other thermostat or control inputs will have effect on unit operation. No faults or modes have higher priority than remote shutdown. Remote shutdown and brownout modes have the same level of priority. See the section "Priority of Faults and Modes".

When the unit is in remote shutdown mode the following occurs:

1. The compressor is immediately de-energized
2. The reversing valve is immediately de-energized
3. The fan is immediately de-energized
4. Fault terminal (A) is de-energized (fault)

When the E terminal is de-energized the unit will automatically return to normal operation.

*The remote shutdown input (E) should not be the sole means of ensuring equipment status when used as a part of a life-safety control system as the unit fan may operate during some fault conditions.

High / Low Pressure Faults

Board LED Status		
Yellow	Green	Red
Off	Off	Flash

Normally closed high and low refrigerant pressure switches are used as needed within the water source heat pump to help protect from excessively high or low refrigerant pressures. The Mark IV/AC board will monitor these switches connected in series through the HP control input terminals on the board. When the HP circuit is open the controller will go into the pressure fault mode. The fan will operate normally during the pressure fault mode.

Only brownout and remote shutdown modes have higher priority than the pressure fault mode. See the section "Priority of Faults and Modes".

When the unit is in pressure fault mode the following occurs:

1. The compressor is immediately de-energized
2. The reversing valve is immediately de-energized
3. The fault terminal (A) is de-energized (fault)

After the HP circuit is then closed the unit will not return to normal operation until the control board is reset. The unit is locked out in this manner after a high / low pressure fault to help insure that a service technician inspects it to verify no problems exist. The control board is reset by a short interruption of unit power.

Low Temperature Faults

Board LED Status		
Yellow	Green	Red
Flash	Off	Off

A normally closed low temperature switch is used as needed within the water source heat pump to help protect from excessively low water out temperatures. The Mark IV/AC board will monitor this switch connected to the LT control input terminals on the board. When the LT circuit is open the controller will go into the low temperature fault mode. The controller is programmed for different responses if a low temperature fault is detected during heating or cooling modes. The control board LED status shown below only occurs when a low temperature fault is detected during heating mode. No LED status changes occur if the fault is detected while in cooling mode. The fan will operate normally during the low temperature fault mode.

Brownout, remote shutdown, and pressure fault modes have higher priority than the low temperature fault mode. See the section "Priority of Faults and Modes".

When the unit senses a low temperature fault while in heating mode the following occurs:

1. The reversing valve will be immediately de-energized
2. The compressor will run in cooling mode for 1-minute (heating the unit's water coil) and then be de-energized
3. The fault terminal (A) is de-energized (fault)

When the LT circuit is then closed after a fault during heating mode the unit will not return to normal operation until the control board is reset. The unit is locked out in this manner after a low temperature fault to help insure that a service technician inspects it to verify no problems exist. The unit is reset by a short interruption of unit power.

When the unit senses a low temperature fault while in the cooling mode the following occurs:

1. The compressor is immediately de-energized
2. The fault terminal (A) remains energized (no fault)

When the LT circuit is then closed after a fault during cooling mode the unit will automatically return to normal operation.

Condensate Overflow

Board LED Status		
Yellow	Green	Red
On	Dim	Off

The Mark IV/AC board is designed to sense when condensate water levels in the drain pan become excessively high. When high condensate water levels are detected during cooling mode the controller will go into condensate fault mode. No condensate overflow fault will occur during heating modes, therefore the unit will be allowed to heat with high condensate water levels. The fan will operate normally during the condensate overflow fault mode.

Some faults and modes have higher priority than condensate overflow mode. See the section "Priority of Faults and Modes".

When the unit senses a condensate overflow fault while in cooling mode the following occurs:

1. The compressor is immediately de-energized
2. The fault terminal (A) is de-energized (fault)

When condensate levels return to normal, the controller will automatically return to normal operation.

Tenant Override

Prior to reviewing this section, read "Occupied Operation" and "Unoccupied Operation" sections. The Mark IV/AC board will be in tenant override mode when the O terminal is momentarily energized during a period when the water source heat pump is in unoccupied mode (U terminal energized). Tenant override is

provided so that when the controller is placed into unoccupied mode by a building automation system, timer, remote switch, etc., a tenant returning to the controlled space during the unoccupied period can activate the tenant override input (O) forcing the unit into occupied mode. A tenant override option is provided for this purpose on some AAF-McQuay thermostats. Any remote button or switch with momentary dry contacts can be used for this purpose. During the 2-hour tenant override period the W2 input will be ignored and the G, Y1, and W1 inputs will be used (see Occupied Operation) for unit operation. If after the 2-hour time limit the U terminal is still energized the unit will return to unoccupied mode. If after the 2-hours the U terminal is de-energized the unit will remain in occupied mode.

Operation of the Fan during most Modes, Faults, and Shutdowns

To increase the level of comfort the Mark IV/AC controller is configured to allow fan operation during most modes, faults, and shutdowns. However, the fan will not operate during brownout mode. During most modes, faults, or shutdowns the fan will operate under the following conditions:

1. In occupied modes, whenever the thermostat inputs G, Y1, or W1 are energized
2. In unoccupied modes, whenever the thermostat input W2 is energized

Operation with the High Speed Jumper

The Mark IV/AC board is provided with a high-speed jumper terminal labeled TP to speed system check out and troubleshooting. This jumper is intended for AAF-McQuay factory unit testing and should only be used by trained service technicians as several timing functions are reduced to speed system check out. When a jumper is placed on the TP terminal, operation of the unit is normal except the following timing values are used:

1. Reversing valve delay time = 2 seconds
2. Compressor delay time = 6 seconds

Note: It is required that power be disconnected to the unit when installing or removing the high-speed jumper.

Note: It is required that the high speed jumper only be used for short periods of time and only to aid the testing of the unit's operation by a trained service technician. The jumper must be removed for normal unit operation. If the jumper is left on after system check out, the unit will be damaged.

Priority of Faults and Modes

The Mark IV/AC control board is configured with mode and fault priorities. The higher level priorities, lower numbers in the table below, override lower level modes and faults under most conditions. There are some exceptions to this priority list. For example, tenant override has no effect on occupied modes.

Priority Level	Mode or Fault
1	Emergency Shutdown Mode + Brownout Fault
2	High / Low Pressure Fault
3	Low Temperature Fault*
4	Load Shed Mode
5	Tenant Override Mode
6	Unoccupied Heating Mode
7	Occupied Heating Mode
8	Condensate Overflow Fault
9	Occupied Cooling Mode

* in heating mode only

LED Status and Fault Output Status

Mode	Board Status LED's			Fault Output
	Yellow	Green	Red	Terminal A
Occupied	Off	On	Off	Energized
Unoccupied	On	On	Off	Energized
Load Shed	Off	Off	On	Energized
Condensate Overflow	On	Dim	Off	De-energized
High / Low Pressure Fault	Off	Off	Flash	De-energized
Low Temperature Fault*	Flash	Off	Off	De-energized
Brownout	Off	Flash	Off	De-energized
Emergency Shutdown	Off	Flash	Off	De-energized

* in heating mode only

Note: The fault output is energized when no faults exist. The fault output is de-energized during faults and when unit power is off.

14-Position Terminal Strip

Pin	Designation	Description
1	C	Transformer ground (0vac)
2	R	Transformer supply (24vac)
3	V	-DC power connection
4	P	Pump request output
5	A	Alarm fault output
6	U	Unoccupied input
7	L	Load shed input
8	E	Remote shutdown input
9	F	+DC power connection
10	Y1	Occupied cooling mode input
11	W1	Occupied heating mode input
12	G	Fan only input
13	W2	Unoccupied heating mode input
14	O	Tenant override input

Trouble Shooting the Mark IV/AC Control Board

Note: Only trained and experienced service technicians may perform the trouble-shooting techniques described below.

- How can I prove the water source heat pump is operating properly?

Test the water source heat pump's fan, cooling, and heating operation. To do this first switch off unit power, remove and safely secure all wires connected to the board's 14-position terminal strip, and then switch on unit power. Make sure no faults exist. If no faults exist the green LED should be on solid with the red and yellow LED's off. If another LED pattern appears try resetting the controller by temporarily interrupting unit power. All faults must be eliminated prior to performing this test. If the board is functioning properly the only possible fault conditions with all wires removed from the board's 14-position terminal strip are high / low pressure, low temperature, condensate overflow, or brownout. Remember that while performing this test the compressor may take more than 3-minutes to start due to the short cycle timer. Return all wiring to original positions when testing is complete.

To test fan operation: connect a jumper from the R terminal to the G terminal. The fan will start if the board and unit are operating properly; disconnect the jumper when complete.

To test cooling operation: connect a jumper from the R terminal to the Y1 terminal. The unit will go into cooling mode if

the board and unit are operating properly; disconnect the jumper when complete.

To test heating operation: connect a jumper from the R terminal to the W1 terminal. The unit will go into heating mode if the board and unit are operating properly; disconnect the jumper when complete.

- How can I prove the Mark IV/AC board is receiving 24vac and that its DC power supply is operating correctly?

The Mark IV/AC board is provided 24vac by the water source heat pump's 24vac transformer. The board has a built-in DC power supply that converts a portion of the 24vac into 24vdc. A voltage meter set to read AC voltage can be used to verify the 24vac supply to the board by placing the meter's leads onto board terminals C and R. You should read approximately 24vac if it is operating correctly. A voltage meter set to read DC voltage can be used to verify the board's DC voltage supply by connecting the meter's leads to board terminals F (+) and V (-). You should read approximately between +28 to +33vdc if the board is operating correctly.

- What voltages will I measure at the thermostat and control inputs on the Mark IV/AC board when they are energized or de-energized?

The Mark IV/AC board is designed to be very flexible as to how its thermostat (G, Y1, W1, and W2) and control inputs (U, L, E, and O) are activated. The board inputs are capable of being energized by 24vac, 24vdc, or a connection to ground. Terminals R (24vac), F (24vdc), and C (ground) on the Mark IV/AC board are the drive terminals that must be used to energize the board's thermostat and control inputs. A table of voltages are provided below that will be measured for each of the board's drive terminals. Before measuring any voltage, switch off unit power, remove and safely secure all wires connected to the board's 14-position terminal strip, and then switch on unit power. Use a voltage meter to verify the de-energized input voltages and compare with the table. Then, using jumpers, energize the desired inputs (U, L, E, G, Y1, W1, W2, and O) one at a time with the drive terminal of choice. Use the voltage meter to verify the jumper-connected terminal voltage and compare with table results. This is also a good method to test board function. The voltages given in this table are approximations that will vary slightly based upon unit options, present power consumption, etc. Be sure that when testing is complete you remove any jumpers and reconnect all wires to their proper location with unit power off. The table below may also be used to determine if an input is energized or de-energized with wiring connected to the 14-position thermal strip.

	Using Drive Terminal R (24vac)		Using Drive Terminal F (ground)		Using Drive Terminal C (24vdc)	
	De-energized	Energized	De-energized	Energized	De-energized	Energized
Place the Meters Red (+) Lead on Input to be checked	Place the Meters on Black (-) Lead on C		Place the Meters Black (-) Lead on V		Place the Meters Black (-) Lead on R	
U, L, E, Y1, W1, G, W2, O	10 to 14vac	22 to 26vac	0vdc	30 to 33vdc	10 to 14vac	22 to 26vac

- Do I need to use the same drive terminal for all Mark IV/AC board inputs?

No. You can use one, two, or all three of the drive terminals. For example, you can use terminal R to drive inputs G, Y1, W1, and W2; terminal C to drive inputs U, L, E; and then terminal F to drive input O. The R terminal (24vac) is the terminal most commonly used to drive the control board's thermostat and control inputs. You cannot connect two drive terminals to one board input or board damage will result.

- Can I use 24vac or 24vdc power from the water source heat pump to provide power to my programmable thermostat or some other external devices that I need to power?

No. The water source heat pump is provided with a 24vac transformer that is capable of providing power only to devices supplied with the unit from the factory or to approved add on options typically shipped with the unit or purchased as accessories. The Mark IV/AC board cannot be used to provide 24vdc power to external equipment. If you need to power external devices you will need to provide power from another location.

- How can I test the unit's high / low pressure switch or the low temperature switch?

The Mark IV/AC board uses its DC power supply as a source for these normally closed safety switches. There are two HP and two LT spade terminals located on the Mark IV/AC board for this purpose. You can use a voltage meter to determine if the switch is open or closed. Carefully placing the meter's probes, one on each of the control board's HP terminals, you will measure approximately 30vdc when the switch is open (fault) or 0vdc when the switch is closed (no fault). The same procedure can be applied to the LT terminals. To prove the circuit operates you can pull one HP or LT spade connection off the control board to cause the fault condition. Be sure to replace these connections if removed.

- How can I test the condensate overflow circuit?

The condensate overflow circuit is designed to sense a connection to chassis ground through the drain pan when the drain pan is over full with condensate water. To test this circuit, activate the fault when the unit is in cooling mode by connecting a jumper between the COF spade terminal and the C (ground) spade terminal. Be sure to remove this jumper when testing is complete.

- Can I use a 24vac solenoid on the reversing valve?

No. The Mark IV/AC board is designed to drive a 24vdc reversing valve solenoid. If you switch the 24vdc solenoid provided with the water source heat pump with a 24vac solenoid you will damage the Mark IV/AC control board. This type of damage to the board may not occur immediately and it can cause the fan and or compressor outputs to operate erratically or not operate at all. If the compressor and or the fan do not operate as expected, check the reversing valve solenoid to ensure it is the proper voltage type.

Interfacing the Mark IV/AC Controller to External Equipment

A 14-position terminal strip is provided on the control board to interface to external equipment.

- The Mark IV/AC board's thermostat input terminals may be directly interfaced with any standard or night setback thermostat that uses mechanical dry contacts. Power cannot be supplied from the water source heat pump for electronic thermostats that require a separate power supply for their internal operation except those provided by AAF-McQuay. Only the programmable and mercury bulb type thermostats offered by AAF-McQuay are proven to operate properly with the Mark IV/AC control board. AAF-McQuay makes no guarantees about any other thermostat or control device interfaced by the end user with the Mark IV/AC board.
- Care must be used to isolate all external power sources from the Mark IV/AC board to prevent ground loops and other unpredictable electrical problems. Only dry mechanical contacts should be used to operate or interface with the

Mark IV/AC board's thermostat and or control inputs. If external equipment with its own power supply is used to interface with or control the Mark IV/AC board's thermostat and or control inputs, you must use mechanical relays to isolate the two power systems. For example, if you have a building automation system, controller, etc., and you wish to use a digital output from the building automation system or controller that is internally powered, then you must use an additional mechanical relay (not supplied by AAF-McQuay) to isolate the Mark IV/AC board.

- If you need to connect multiple water source heat pumps with Mark IV/AC control boards, use a connection to ground (terminal C) to drive the thermostat (G, Y1, W1, and W2) and control inputs (U, L, E, and O). For example, the load shed input of multiple Mark IV/AC controllers may be daisy-chained together through one set of dry contacts to ground (C). This is useful if you need to operate multiple units from one thermostat or if you need to signal multiple units from one location. However, care must be used to ensure that this type of connection has very low resistance to ground for proper operation. To keep resistance low, wire runs should be kept short and wire gauges may need to be increased. AAF-McQuay also offers special control boards and relays for operating two or three water source heat pumps from one thermostat which should be used when multiple unit operation is required.
- Due to the nature of triacs and other solid state devices they cannot be directly used to operate the Mark IV/AC board's thermostat or control inputs. To interface triacs or other solid state switching devices to the Mark IV/AC board inputs, you need to separate them from the board using mechanical relays. To do this, use the triac or solid state device to drive a mechanical relay (not supplied by AAF-McQuay), then use the mechanical relay's dry contacts to drive the desired Mark IV/AC board input.
- Do not connect the coils of standard mechanical relays in series or parallel with the Mark IV/AC board inputs as you may introduce electrical noise causing unexpected water source heat pump operation or board damage. AAF-McQuay offers a special relay for this purpose when additional signaling is needed.
- The Mark IV/AC board's fault terminal (A) is primarily designed to operate a fault LED on the AAF-McQuay wall thermostats. Terminal A is designed to maintain an equivalent DC voltage level with board terminal F (+30vdc) when no faults exist. When a fault exists, the A terminal will be lowered to 0vdc. To use this output to signal external equipment, connect the coil of a 24vdc mechanical relay (not provided by AAF-McQuay) between terminals F and A on the Mark IV/AC board. Then use the dry contacts of this mechanical relay as an alarm or fault signal to external equipment or systems. When using this output to signal external equipment it cannot be used to operate a thermostat fault LED and vice versa.
- The Mark IV/AC board's pump request terminal (P) is designed for use as a signal to external equipment that water flow is required by the heat pump. The P terminal follows compressor operation inversely and will equal approximately 30vdc when the compressor is off and 0vdc when the compressor is on. The P terminal should only be used as a signal to pump controls if the water loop can respond with water flow fast enough (3-5 seconds) to prevent unit shut-down due to high refrigerant pressure from a lack of water flow. If adequate water flow is a concern, and the load shed terminal (L) is not used for other purposes, you may use the L terminal to prevent compressor operation until water flow is established by using a flow control device as a signal to allow compressor operation when flow exists.

Typical Mark IV/AC Unit Wiring Diagram

