

HWP Protection Board

Features and Operation

This board provides the “system protection” features necessary to keep our HWP (Water Sourced Heat Pump) units safe in the instances when they are NOT fitted with a sophisticated electronic thermostat that would provide equivalent protection. An example of such a thermostat is our “SAT-2” or its successors.

When an HWP unit has one of these Protection Boards fitted, a simple thermostat or a Building Management system can be used to request Cooling or Heating. The Protection Board will act independently of the external control system, to prevent potentially damaging situations occurring, such as rapid cycling of the compressor or running when the condensate drain tray is full of water etc.

The HWP Protection Board does not control the Indoor fan. Therefore it cannot provide Fan Run-On if an Electric Heat Element has been fitted. A Fan Run-On timer must also be fitted when installing an Electric Heat Element.

Unlike the SAT-2 thermostat, the HWP Protection Board cannot specifically identify most faults it detects, because it has no display and no ability to communicate with an external display device. It does however have three LEDs on its Printed Circuit Board (PCB). These LEDs help with fault diagnosis and serve the following functions:

Green	Indicates the Board is “Powered Up”
Amber or Yellow	Condensate / Drain Tray Float switch tripped
Red	There is a fault which has stopped the compressor

As can be seen from the above table, the Yellow LED is specific to just one fault; the Drain Tray Float Switch (if fitted). The Red LED however does not specify which fault caused the compressor to stop. It simply indicates the existence of a fault.

It is up to the Service Person to investigate the possible causes, which are:

High Discharge temperature (DT)	Measured by the Red sensor connected to the plug labelled “DT” on the HWP Protection Board. This safety feature works in both cycles to protect against high discharge temperatures caused by partial loss of refrigerant.
Low Indoor Coil temperature (ID)	Measured by the Yellow sensor connected to the plug labelled “ID” on the HWP Protection Board. This fault only applies in Cooling cycle. The sensor has no function in Heating cycle.
Low Suction temperature (LST)	Measured by the Blue sensor connected to the terminal labelled “LST” on the HWP Protection Board. Protects against excessively low Suction temperature in Heat cycle. This could result in the circulating water freezing and damaging the Tube-in-Tube heat exchanger.

(Table continued on next page)

High Pressure switch trip (HP)	If the 200–250VAC signal applied to the “HP” terminal disappears for more than 0.5 sec, the compressor will stop for at least 3 minutes. This safety feature works in both cycles. Repeated HP trips (≥ 3 times within 2 hours) will result in lockout.
Condensate (Water) Float switch trip (WF)	If the 200–250VAC signal applied to the “WF” terminal disappears for more than 0.5 sec, the compressor will stop for at least 3 minutes. This safety feature works in both cycles. Repeated trips (≥ 3 times within 2 hours) will result in lockout.
Water Circulation Verification trip (CIR PUMP)	If the 200–250VAC signal applied to the “CIR PUMP” spade terminal disappears for more than 0.5 sec, the compressor will immediately lockout.

Notes in relation to these “safety” related inputs described above:

- Each must be in the “safe” state BEFORE the compressor can start. All inputs require a stable period without on/off fluctuations before they are considered “valid”. In the case of the Water Circulation Verification input, it must be closed and remain that way for 30 seconds before the compressor is allowed to start. This ensures that no air pockets are circulating around the water system.
- The term “lock-out”, means the compressor will not start again until either the power is removed and reinstated, OR the thermostat’s Compressor request signal (connected to the “COMP ON” spade terminal) is removed and reapplied.
- References in this document to 200-250VAC “Control” and “Fault” input signals require the voltage to be measured relative to the “N3” input terminal. “N3” is NOT internally connected to Neutral on the HWP Protection Board. Ensure “N3” is connected to Neutral when wiring the board to a unit.
- A sensor “fault” is a possibility. This is distinct from it measuring an out of range temperature. A sensor needs to be continuously “faulty” (either open or short circuit) for 3 minutes before it is recognized as faulty.

The “ERROUT” connector:

Roughly in the middle of the HWP Protection Board is a small, white coloured, 2-pin connector labelled “ERROUT”. On temperzone unit wiring diagrams it is called the “FAULT OUTPUT”. A temperzone “Fault Relay” (our part number 201 000 105) can be attached to this connector and wired into an end-user provided fault circuit. This enables indication of a fault without necessarily looking at the LEDs.

DIP switch functions:

In the bottom right hand corner of the HWP Protection Board is a bank of small switches (called DIP switches). Only the first 3 of these switches perform a function.

Switch	Switch ON function	Switch OFF function
1	Enables Reverse-Cycle operation	Selects Cool-only operation.
2	The “Fault Output” (ERROUT) is activated each time a fault occurs.	The “Fault Output” (ERROUT) is activated only when lockout occurs.
3	An LST sensor trip occurs at a temperature of approx. -1°C on “REV0C”, and -2°C on “REV0D” HWP boards	An LST sensor trip occurs at a temperature of approx. -2°C on “REV0C”, and -3°C on “REV0D” HWP boards

Control Inputs:

There are only two “control” inputs. These are activated by a mains voltage signal in the range of 200-250VAC on to the relevant spade terminal. As was the case with the “safety” inputs (namely HP, WF and CIR PUMP), the voltage applied to the control inputs is relative to the “N3” neutral connection.

The “Control” input spade terminals are as follows:

HEAT IN	If 200–250VAC is applied to this terminal it signifies to the HWP Protection Board that when the compressor next starts, it is to run in Heat cycle.
COMP ON	If 200–250VAC is applied to this terminal it is a request for the compressor to start (or to “Load”). On temperzone unit wiring diagrams this terminal is labelled “COMP LOAD”

Mains voltage measured on the “COMP ON” terminal does not necessarily mean the compressor should be running. The compressor may be locked out due to a fault or waiting until the Anti-Rapid Cycle Timer has expired.

Commissioning Mode:

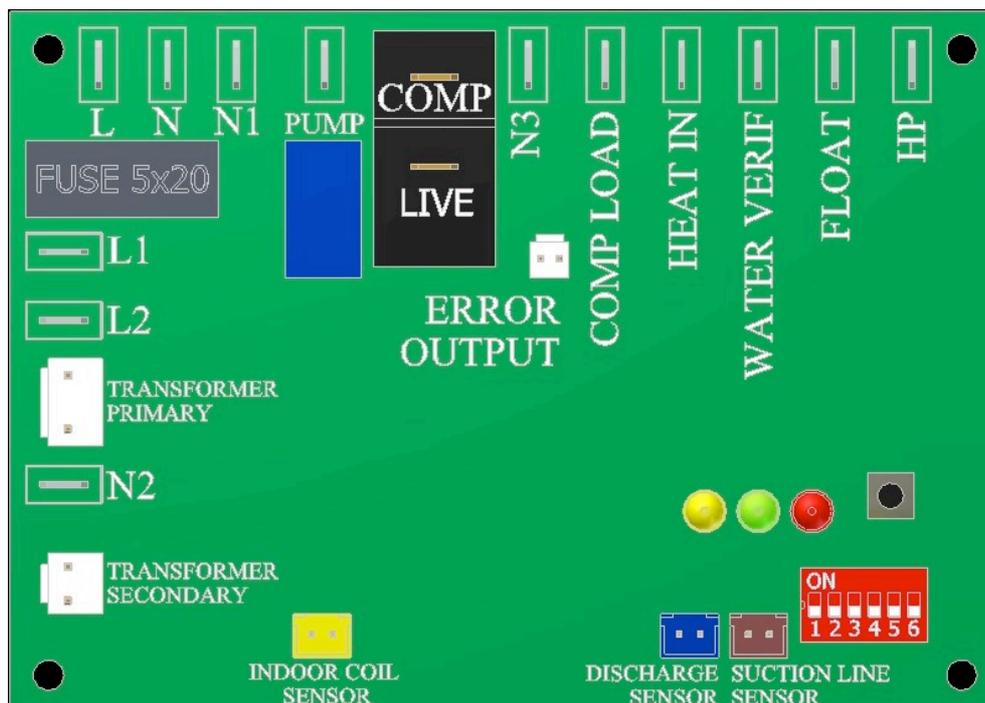
As with some other temperzone controls, a limited duration “Commissioning mode” is incorporated. When activated, delay times are dramatically shortened, saving time during commissioning or diagnostic tests. This mode will only last for about 25 minutes before normal operation is resumed.

To activate, press and hold (for 10 seconds,) the small push-button labelled “K1”, located just above the DIP switches in the bottom right hand corner of the board.

Models of HWP Protection Board:

To date temperzone has used two versions of the HWP Protection board, both very similar. The identifying code is written on the PC Board, just below the DIP Switches.

A simplified layout of the “HWP Protection Board – REV0C” is shown below:



Summary of features provided by “REV0C” and “REV0D” boards:

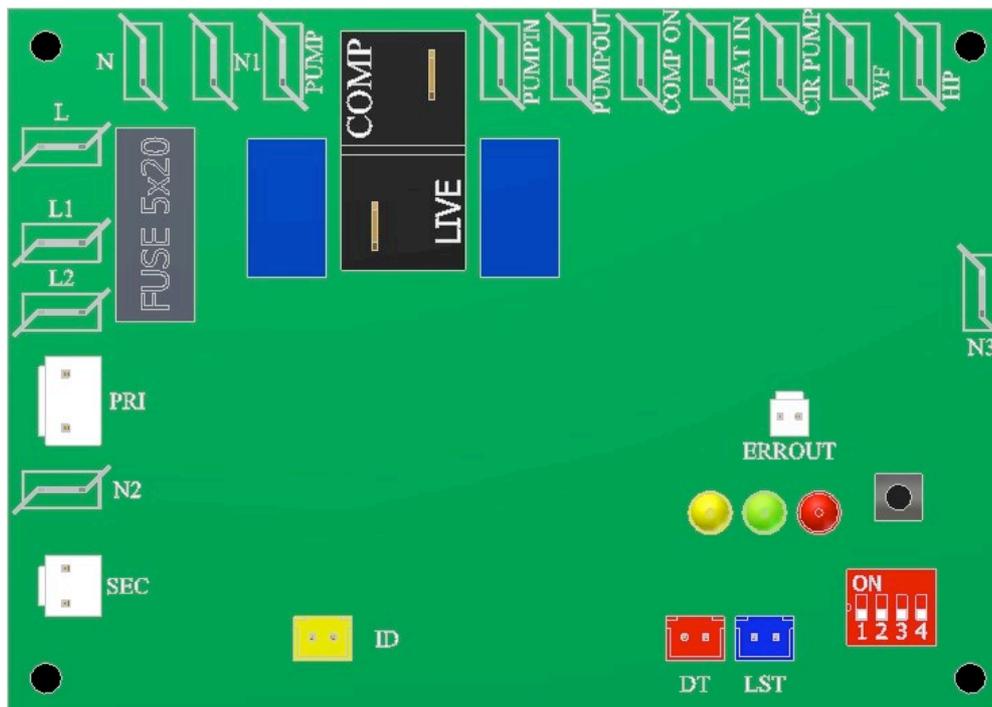
- a) 3 minute Anti-Rapid Cycle control - Avoids short cycling the compressor
- b) Indoor Coil Freeze Protection - Stops Cooling if Indoor Coil $< -1^{\circ}\text{C}$ for 30 sec.
- c) Loss of Refrigerant Protection - Stops Compressor if Discharge temp $\geq 120^{\circ}\text{C}$
- d) High (Head) Pressure protection - Monitors HP switch (Mains voltage) input
- e) Low Suction temperature protection - Stops Heating if LST sensor $< -1^{\circ}$ or -2°
- f) Condensate overflow protection - Monitors the WF (Water Float) input
- g) No Compressor if Pump not running - Monitors Circulation Pump “Verification” input
- h) Starts/Stops Condensate Pump - Starts with Compressor. Stops 5 mins after Comp.
- i) Controls separate Fault Relay - Enables external indication of a fault

Additional feature provided by “REV0D” boards:

- j) Water Circulation Pump control - A “dry-contact” relay to activate pump

Our “REV0D” HWP Protection Board has one additional relay-switched output, absent on “REV0C” boards. This extra output activates and deactivates the Circulation Pump.

A simplified layout of the “HWP Protection Board – REV0D” is shown below:



The “PUMP IN” and “PUMP OUT” spade terminals shown above are respectively the “Pole” and the “Normally Open” contact of the Circulation Pump relay. When multiple, individually controlled HWP units are installed on a site, the Circulation Pump relays from each of the Protection boards can be wired in parallel to the coil of the Circulation Pump contactor, so that any of the HWP units can start the pump. Then, only when none of the units are running will the circulation pump stop.

N.B. In particularly cold environments, it may not be safe to stop the circulation pump at all for fear of the water freezing, in which case there should be an additional temperature controlled over-ride to keep the pump running even if no units were on.

Terminal labelling and function:

Power terminals:

L	The main “Phase” AC feed in to the HWP board. Current from this terminal flows first through the 3.15A / 250V (5 x 20mm) fuse located under the grey plastic cover.
L1	This terminal is powered from the “load” side of the fuse. This terminal should be connected to the White input wire of the EMI filter (temperzone Part No. 201 000 037). N.B. The “input” side of the EMI filter has the Green/Yellow Earth wire exiting from it.
L2	This is the “Phase” AC returning to the EMI filter. The White wire from the “output” side of the EMI filter should be connected to this terminal.
PRI	A 2-pin connector provided for the “Primary” side of the mains transformer (temperzone Part No. 201 000 032)
N2	This is the “Neutral” return for the transformer primary. The Black wire from the “output” side of the EMI filter should be connected to this terminal.
SEC	A 2-pin connector to receive the low voltage (nom. 10V AC) from the “Secondary” side of the mains transformer. This secondary voltage is what powers the “Green” LED.
N	The main “Neutral” AC feed in to the HWP board. A wire from this terminal should be connected directly to the incoming Neutral supply to the unit.
N1	An additional “Neutral” terminal provided for convenience. (Internally connected to the “N” terminal.) The Black neutral wire from the “input” side of the EMI filter could be connected to this terminal.
LIVE	A spade terminal on top of the large black (compressor) relay. A phase supply must be provided to this terminal of a voltage suitable for the compressor or its contactor.
PUMP IN	Only applicable to HWP-REV0D Protection Boards. The voltage applied to this terminal is switched out to the PUMP OUT terminal to activate the water Circulation Pump.

Output terminals:

PUMP	The same voltage that is present on the “L1” is switched out of this terminal via a relay on the HWP board, to power the Condensate Pump. This is activated when the compressor is running and continues for 5 mins after compressor stops. This occurs on both cycles – Cool AND Heat.
COMP	A spade terminal on top of the large black relay. It can power small compressors directly or the Compressor contactor.
PUMP OUT	Only applicable to HWP-REV0D Protection Boards. This is used to activate the water Circulation Pump.

Operation Overview:

The following description assumes there are no faults present to start with and that mains power is applied to the unit. Therefore ONLY the Green LED should be lit.

N.B. Unless in “Commissioning Mode”, the HWP Protection Board will not start the compressor for about 2½ minutes after the mains power is applied to the board, regardless of control signal requests. This is a precaution against brief power outages rapid cycling the compressor, and placing high loads on the electricity supply network.

STEP Number	FUNCTION OR ACTION REV0C Boards only	FUNCTION OR ACTION REV0D Boards only
1	For Cool cycle do not apply power to the “HEAT IN” terminal. For Heating mains power should be applied. N.B. A signal to this terminal does not start the compressor, it only “indicates” which cycle is wanted.	For Cool cycle do not apply power to the “HEAT IN” terminal. For Heating mains power should be applied. N.B. A signal to this terminal does not start the compressor, it only “indicates” which cycle is wanted.
2	Apply Mains power to “COMP ON”. N.B. It is this signal which requests that the compressor start or stop (for both Heat and Cool cycles)	Apply Mains power to “COMP ON”. N.B. It is this signal which requests that the compressor start or stop (for both Heat and Cool cycles)
3	N.B. The Circulation Pump must already be running AND the “CIR PUMP” (Water Verification) input should have a signal back from the flow switch confirming water flow. In which case the “COMP” output would be activated at this point.	Assuming the compressor has been OFF for at least 15 mins. The “PUMP OUT” relay is closed (to start the water circulation pump)
4		The Protection Board waits for a stable signal on the “CIR PUMP” (Water Verification) input. If stable for 30 seconds the “COMP” output is activated. If the “CIR PUMP” signal is not returned and stable within 3 minutes a “fault” is counted. Three periods of CIR PUMP failure within 2 hours will result in “Lock-Out”.
5	Compressor operation continues until the “COMP ON” signal disappears or a fault occurs, in which case the compressor stops.	Compressor operation continues until the “COMP ON” signal disappears or a fault occurs, in which case the compressor stops.
6	The 3-minute Anti-Rapid Cycle Timer is started, preventing the compressor from restarting in less than 3 minutes.	The 3-minute Anti-Rapid Cycle Timer is started preventing the compressor from restarting in less than 3 minutes.
7		“PUMP OUT” remains active for 15 minutes after the compressor stops.
8	Cycle again with each COMP ON signal	Cycle again with each COMP ON signal

Protection features during operation:

The function of each protection input is described at the bottom of the first, and the top of the second page of this brochure. A summary of the software controlled protection features also appears on page 4.

The combination of the temperature sensors and the switched safety inputs being interpreted by the Microcontroller, at the heart of the HWP Protection Board, provides a high level of risk reduction, acting against problems that may occur causing damage to the compressor and refrigeration system of an HWP unit.

When faults recur 3 times within 2 hours the HWP Protection Board “locks out” the unit so that it will not run again until either the COMP ON signal, or the Mains Power is removed and then reapplied. Such “lock-outs” should not be treated as “nuisances”. They will have been caused by a problem that needs further investigation to determine the exact cause as the Protection Board cannot identify each individual fault.

Some of these potential problems are not immediately obvious and as previously pointed out the HWP Protection Board has only 2 “Fault” LEDs. One has a specific function (Drain Tray Float Switch), the other indicates a number of possibilities when it is illuminated so a methodical approach is required when investigating faults.

Troubleshooting:

Some guidelines for fault diagnosis follow. This list does not represent all the possible problems. Hopefully it provides a starting point for the Service Person. In presenting this list we are presuming that the Air Conditioner is not running (although the fan may be blowing air) and that it has been in this state for some time (i.e. It has “locked-out”).

STEP	DIAGNOSTIC ACTION	POSSIBLE CAUSE
1	Is the Green LED illuminated?	No - There is no power getting to the board, or the Protection Board is faulty. Test for Mains voltage across L2 and N2. If no voltage present, yet it is present between L and N1, fuse is blown. (5 x 20mm – 250V / 3.15A Glass fuse) Yes - Progress to the next step.
2	Is the Amber (or Yellow) LED lit?	No - Progress to the next step. Yes - The Float switch input “WF” is open circuit. The drain line may be blocked or the condensate pump is not working.
3	Is the Red LED illuminated?	No - The Protection Board has not detected a fault. The thermostat may not be activating the “COMP ON” input. Check voltage at the “COMP ON” terminal. Yes - One (or more) protection feature has been activated. Check terminal “N3” is connected to “Neutral”. If not, turn off the power and make a secure connection between “N3” and a Neutral terminal. If “N3” is connected, go to the next step.

4	Has the unit ever run before, or is the unit being commissioned for the first time in its present location?	<p>No - Check the control signal wiring to the HWP. Of particular interest is the connection of the Water Flow Verification “CIR PUMP” input. It would normally be connected to a flow switch and the water pump interlock. This wiring may be faulty or if this is a REV0D board the PUMPIN and PUMPOUT relay terminals may not have been wired to activate the water circulation pump. The installer, not temperzone, makes all this wiring.</p> <p>Yes - One (or more) of the protection features has been activated. Go to the next step.</p>																																								
5	Is there mains voltage present on the control and safety inputs?	<p>No - Adjust the thermostat so that it is calling for the compressor to run. Ensure power is connected to the thermostat, allowing it to operate. If one of the safety inputs has no mains voltage measurable on it, trace that safety circuit to determine the cause of the problem. E.g. Pressure switch / Water not circulating / Drain Tray full of water.</p> <p>Yes - Go to the next step.</p>																																								
6	<p>There may be a sensor fault.</p> <p>Do you have any of temperzone’s standard sensors (Part numbers – 201 000 101 – Red, 201 000 102 – Yellow, or 201 000 103 – Blue)?</p>	<p>No - Disconnect each temperature sensor from the socket on the HWP Protection Board that it is plugged in to. Using fine probes or fine wire inserted into the connector holes, measure the resistance of each sensor. Typical resistances are as follows:</p> <table border="1" data-bbox="839 1218 1442 1644"> <thead> <tr> <th>Temp °C</th> <th>Resistance Ω</th> <th>Temp °C</th> <th>Resistance Ω</th> </tr> </thead> <tbody> <tr> <td>-10</td> <td>57.7 k</td> <td>35</td> <td>6.4 k</td> </tr> <tr> <td>-5</td> <td>44.0 k</td> <td>40</td> <td>5.2 k</td> </tr> <tr> <td>0</td> <td>33.8 k</td> <td>45</td> <td>4.2 k</td> </tr> <tr> <td>5</td> <td>26.1 k</td> <td>50</td> <td>3.5 k</td> </tr> <tr> <td>10</td> <td>20.4 k</td> <td>55</td> <td>2.8 k</td> </tr> <tr> <td>15</td> <td>16.0 k</td> <td>60</td> <td>2.3 k</td> </tr> <tr> <td>20</td> <td>12.6 k</td> <td>65</td> <td>1.9 k</td> </tr> <tr> <td>25</td> <td>10.0 k</td> <td>70</td> <td>1.6 k</td> </tr> <tr> <td>30</td> <td>8.0 k</td> <td>75</td> <td>1.4 k</td> </tr> </tbody> </table> <p>Yes - Unplug each sensor in turn. Temporarily connect a known good sensor. Wait at least 30 seconds to see if the Red Fault light goes out. When the Red light goes out you have located the faulty sensor.</p>	Temp °C	Resistance Ω	Temp °C	Resistance Ω	-10	57.7 k	35	6.4 k	-5	44.0 k	40	5.2 k	0	33.8 k	45	4.2 k	5	26.1 k	50	3.5 k	10	20.4 k	55	2.8 k	15	16.0 k	60	2.3 k	20	12.6 k	65	1.9 k	25	10.0 k	70	1.6 k	30	8.0 k	75	1.4 k
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For further technical assistance or to order spare parts, contact a temperzone office or your local temperzone agent.

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