# UNIT CONTROLLER 8 (UC8)
# Operation Manual

# Split air-conditioning models: OSA-RLF

**Date**:    28 January 2021

**Issue**:   2

**Note**:   Information in this document applies to UC8 controllers with software version 6.1.2-64 and installed in models OSA-RLF

To find the UC8 software version:
Turn on mains power to the UC8 controller and observe the seven-segment display. The display will show the characters "UC8", followed by the software version, build number and software identification code (SHA).

**Contents**

## 1. UC8 circuit board input and output signals

### 1.1. Mains power

| Terminal | |
|----------|---|
| L | Mains live 230V AC |
| N | Mains neutral |
| EARTH | Protective earth |

**NOTE!** The **EARTH** terminal on the UC8 controller board **MUST** always be directly connected to the unit earth stud.

### 1.2. Low voltage signals

| | |
|---|---|
| HI, ME, LO, CP and HT: | Control signal inputs, 24V AC or 12V to 24V DC |
| DL, SL, AMB, DEI, OC, IC: | Inputs for Temperzone standard temperature sensors |
| HPT, LPT: | Inputs for Temperzone standard pressure transducers |
| IN#1, IN#2, D1, D2, D3, On: | Control signal inputs for voltage free relay contacts |
| VC, VF: | Control signal inputs, 0-10V analogue |
| A1, B1, A2, B2: | Communication ports, RS485 Modbus RTU |
| HIGH, MED, LOW, C3, C4: | Relay contact outputs |
| CMC, R/V: | Relay contact outputs |
| SSR#1, SSR#2: | Solid state relay contact outputs |
| V1 and V2: | Control signal outputs, 0-10V analogue |
| EXV1, EXV2: | Outputs for 12V DC uni-polar electronic expansion valves |
| AUX, FLT, EXV2: | Outputs for 12V DC relay coils |

**Notes**: The UC8 controller **cannot** accept 230V AC signals on any of the low voltage inputs!
Terminals marked "0V" and "SC" are electrically directly connected to the EARTH terminal.

### 1.3. Temperature sensor inputs

| Connector | Function | Sensor wire colour |
|-----------|----------|--------------------|
| DL | Compressor discharge gas temperature sensor | Grey |
| SL | Compressor suction gas temperature sensor | White |
| AMB | Outdoor ambient temperature sensor | Black |
| DEI | Outdoor coil de-icing sensor | Blue |

### 1.4. Pressure transducer inputs

| Connector | Function | Pressure range | Output voltage |
|-----------|----------|----------------|----------------|
| HPT | Compressor discharge gas pressure (HP) | 0 to 4500kPa | 0.5 to 4.5V |
| LPT | Compressor suction gas pressure (LP) | 0 to 3450kPa | 0.5 to 4.5V |

## 1.5. Inputs HI, ME, LO, CAP and HT

These inputs are electrically isolated from all other circuits. The inputs can accept 24V AC or 12V DC signals. A thermostat or other controller can be connected as follows:

| | |
|---|---|
| CP | Compressor on/off |
| HT | Cooling / heating |
| HI – ME – LO | Indoor fan speed high / medium / low / off |
| C1 | Common for inputs HI, ME and LO |
| C2 | Common for inputs CP and HT |

## 1.6. Remote On/Off input

A remote on/off signal can be connected to the "On" and "0V" terminals (input for a voltage-free switch or relay contact). To turn the unit on the remote on/off input must be closed-circuit. When the unit is off by the remote on/off signal the display will show a slowly flashing **–** symbol. The remote on/off input cannot override the compressor minimum run-time of 90 seconds.

If no remote On/Off function is needed then the terminals must be connected (shorted).

When the remote on/off input is used in combination with a SAT-3 or TZT-100 thermostat then refer to Thermostat auto–on/off options.

## 1.7. Variable speed indoor fan control input VF (0-10V)

Analogue input VF (0-10V) provides an optional input for control of the indoor fan speed.
Notes:
* 0-10V input VF is referenced to unit earth, it is not electrically isolated.
* Terminal 0V is the reference (return) connection.

For more information about the indoor fan refer to chapter 8.

## 1.8. Variable capacity control input VC (0-10V)

New OSA models are equipped with a variable speed compressor (inverter) and thus can provide variable capacity (duty). If the unit is controlled using the 24V AC / 12V DC inputs then capacity can be controlled by applying a 0-10V analogue signal to input VC.

**Notes**:
* 0-10V input VC is referenced to unit earth, it is not electrically isolated.
* Terminal "0V" is the reference (return) connection.
* The compressor does not switch off when the voltage on input VC is at 0V. Switching the compressor on and off is under the control of input CP.

## 1.9. Reverse cycle valve output R/V

Terminals R/V control the reverse cycle valve. The refrigeration circuit is designed with reverse cycle valve OFF for cooling mode, ON for heating mode.

## 1.10. Solid state relay output SSR#1

Output SSR#1 is for control of a compressor crank case heater.

## 1.11. Relay outputs CMC, LOW, MED and HIGH, SSR#2

Reserved.

## 1.12.        On-status output AUX

Output AUX can operate a unit status relay (SRB). This is an optional small circuit board with a relay that provides one set of voltage-free relay contacts (NO and NC). The SRB relay contacts provide an "On-status" signal. The output is made active when one or more of the following conditions apply:

- The compressor is on.
- The indoor fan is on.
- The compressor and indoor fan are currently off but the thermostat is on, e.g. the unit is off in deadband, or the compressor may be held off by an internal safety timer, or by a protection function.

## 1.13.        Fault-status output FLT

Output FLT can operate a fault relay (FRB). This is an optional small circuit board with a relay that provides one set of voltage-free relay contacts (NO and NC). The FRB relay contacts provide an "Fault-status" signal. The output is made active when the controller has detected a problem within the system.

## 1.14.        Input IN#1

Reserved, leave open circuit.

## 1.15.        Input IN#2

Input for an overload switch signal. If no overload signal is used the terminals must be shorted.

## 1.16.        Modbus RTU serial communication port 1

Terminals A1 and B1 provide a serial communications port for a building management system (BMS) or other type of monitoring and/or controlling device. The communications protocol is Modbus RTU and the signals follow the RS485 standard. On this port the UC8 always acts as a Modbus slave device. The RS485 signal reference is terminal 0V, which is directly connected to unit earth.

## 1.17.        Modbus RTU serial communication port 2

Terminals A2 and B2 provide a serial communications port for a room thermostat and for the compressor driver in a unit with inverter compressor. The communications protocol is Modbus RTU and the signals follow the RS485 standard. On this port the UC8 always acts as a Modbus master device. Refer to chapter 4.
The RS485 signal reference is terminal 0V, which is directly connected to unit earth.
Terminals "0V" (-) and "12" (+) provide 12V DC power that can be used to power the room thermostat.

## 1.18.        Electronic expansion valves

The UC8 controls an electronic expansion valve via output EXV1. Output EXV2 is normally not used but can be used to control a second EEV. The signals on output EXV2 are a duplicate of the signals on output EXV1.

## 1.19.        Inputs D1, D2 and D3

Reserved, leave open circuit (not connected). Terminal SC is internally directly connected to terminals labelled '0V' and the EARTH terminal.

## 2. DIP switch settings

| Switch | | | | Function | |
|---|---|---|---|---|---|
| **1** | | | | **Indoor fan behaviour** | |
| **OFF** | | | | Indoor fan speed may vary from the thermostat request. | |
| **ON** | | | | Indoor fan speed follows the thermostat request. | |
| | | | | Note: Thermostat fan settings and protection functions can override the selections above. | |
| **2** | | | | **Reserved** | |
| **OFF** | | | | Do not select any other setting. | |
| **3** | **4** | | | **Outdoor fan type** | |
| **OFF** | **ON** | | | Outdoor fan 0-10V control signal on output V1. | |
| **5** | **6** | | | **Reserved** | |
| **OFF** | **ON** | | | Do not select any other setting. | |
| **7** | **8** | | | **Expansion valve arrangement** | |
| **ON** | **OFF** | | | Single- or parallel- EEV. | |
| **9** | **10** | | | **Electronic expansion valve type** | **How to recognise the valve type** |
| **OFF** | **OFF** | | | Dunan DPF series | removable black coil |
| **ON** | **OFF** | | | Zhe Jiang Sanhua DPF series | non-removable metal coil |
| **OFF** | **ON** | | | Carel E2V series | removable red coil |
| **ON** | **ON** | | | Reserved, **do not select** | - |
| **11** | **12** | | | **Master / slave selection** | |
| **OFF** | **OFF** | | | Stand-alone unit or master system (Nr. 1) | |
| **ON** | **OFF** | | | Slave system (Nr. 2) | |
| **OFF** | **ON** | | | Slave system (Nr. 3) | |
| **ON** | **ON** | | | Slave system (Nr. 4) | |
| **13** | **14** | **15** | **16** | | |
| **OFF** | **ON** | **OFF** | **OFF** | Models OSA-RLF and OPA-RLF. | |

## 3. Connecting digitally communicating thermostats: SAT-3 and TZT-100

The unit can connect to one SAT-3 or to one TZT-100 room thermostat.

It is strongly recommended to use a shielded cable with twisted pair wires. Signals from UC8 terminals **A2** and **B2** must form one twisted wire pair. The cable shield should connect to terminal "0V" at the UC8.

12V DC power is available on terminals "0V" (-) and "12" (+) and can be used to power the thermostat. If the cable length between the UC8 and thermostat is greater than about 20m and communications do not work or are intermittent then place UC8 jumper "J2" on the centre and left pins, otherwise place jumper "J2" on the centre and right pins.

It is recommended to keep the thermostat cable separate from other cables as much as is practical. When the UC8 and room thermostat are communicating a small "satellite dish antenna" symbol is visible on the thermostat display:

### 3.1. Temperzone SAT-3 room thermostat

A typical connection to a SAT-3 room thermostat:
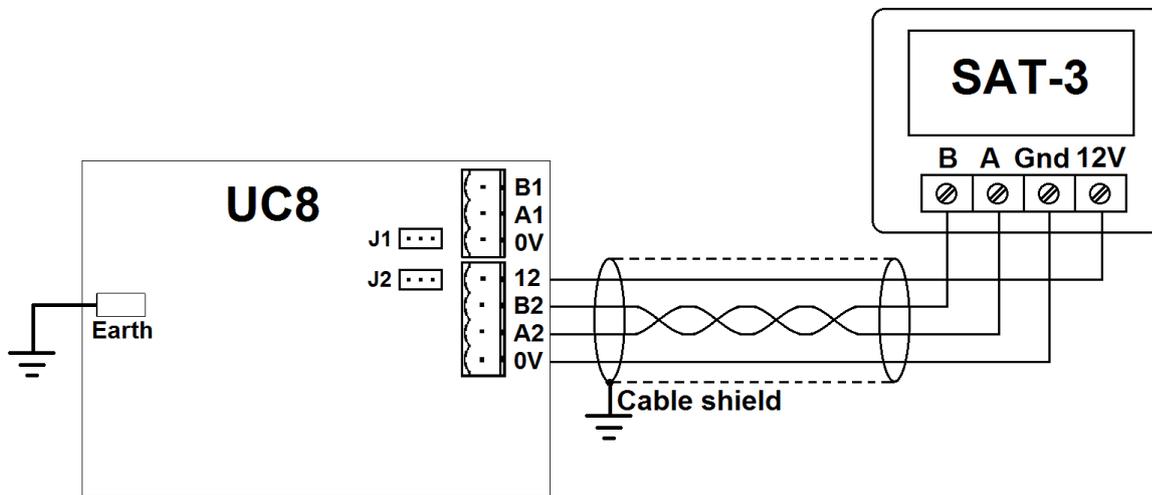
### 3.2. Temperzone TZT-100 room thermostat

A typical connection to a TZT-100 room thermostat:
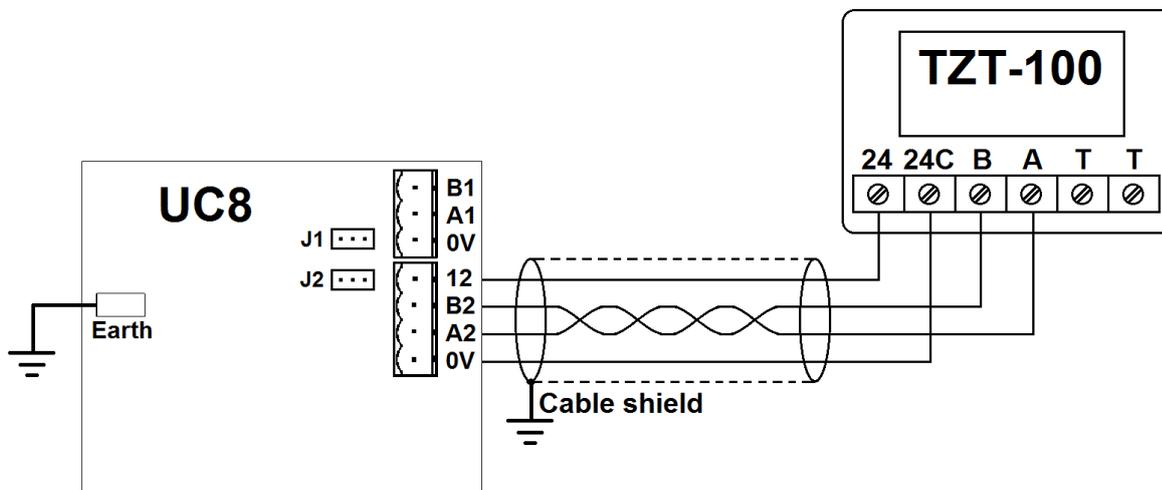
A TZT-100 thermostat can also be powered by an **isolated** 24V AC power source:
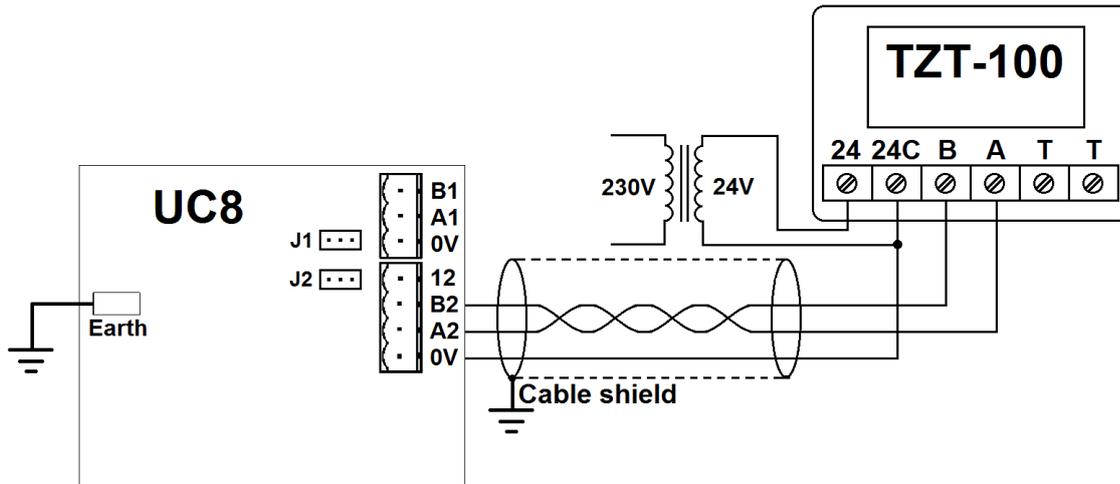


For all installations DIP switch **4** inside the TZT-100 must be **ON**: Reverse cycle valve On when heating.

### 3.3. Thermostat communication settings

The communications format must be set in accordance with Modbus RTU standard settings:
- Baud rate 19200
- 8 Data bits
- Even parity bit
- 1 Stop bit
- TZT-100 modbus device address 7
- SAT-3 modbus device address 8
- The thermostat should be configured for 1-stage operation

Refer to the thermostat installer manual for procedures to check and adjust the settings in a SAT-3 or TZT-100 thermostat.

## 4. Connecting to external devices using Modbus RTU over RS485

The UC8 provides a serial communications port (terminals A1 & B1) for RS485 type signals and wiring. Full monitoring and control are available through this port. The communications protocol used is Modbus RTU.

For more information refer to document "Temperzone UC8 – Modbus RTU serial communications".
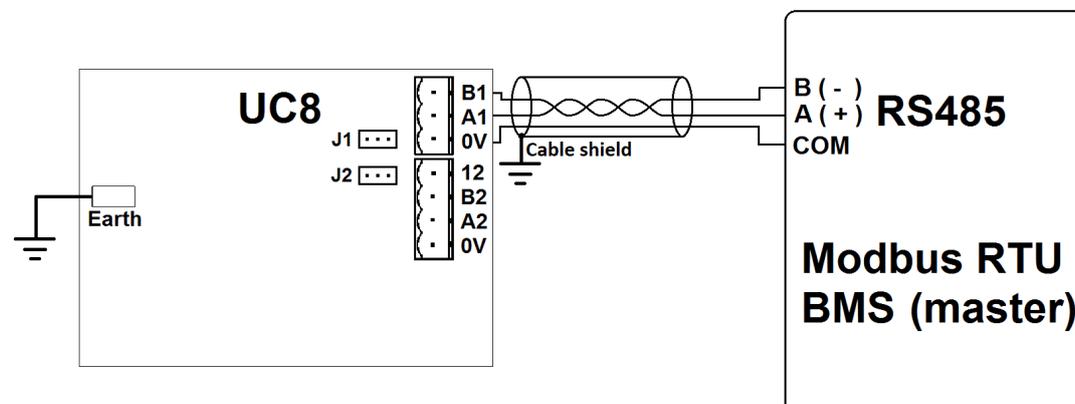
# 5. Connecting the indoor unit

During the first minute after mains power to the outdoor unit is switched on the UC8 controller searches for a connection to an indoor unit. The indoor unit must send a reply to the outdoor unit within that first minute. The outdoor unit will not continue attempting to contact the indoor unit if no reply is received from the indoor unit within that first minute, the system will then not function correctly.

To ensure the indoor unit is ready to reply to the outdoor unit it is important that **power to the indoor unit must be applied either at the same time, or before, the outdoor unit**.

Communications between the outdoor- and the indoor- units must be reliable. For this it is important that the indoor unit receives its mains power directly from the outdoor unit and, most importantly, that there is a **solid mains earth connection between the indoor- and outdoor- units**.

## 5.1. Making a reliable connection between the outdoor- and indoor- unit

In most split air-conditioning installations the UC8 controller in the outdoor unit communicates with an IUC (indoor unit controller) in the indoor unit. For reliable operation the connection should be made using a shielded twisted pair cable. The twisted pair wires must be used for signals A and B. The cable shield can be connected to the 0V terminal at the UC8 only.

Using a shielded twisted pair cable helps to reduce electrical interference from other nearby cabling:

- the cable shield reduces interference from electric fields generated by mains voltages
- using a twisted pair of wires reduces interference from magnetic fields that surround any cables that carry electrical currents

**IMPORTANT**: The communications ports on the UC8 and on the IUC use the unit earth as reference; the ports are not electrically isolated. For that reason it is important that there is a <u>direct and solid earth connection between the outdoor- and the indoor- units</u>.

## 5.2. Connecting 1 outdoor unit to 1 indoor unit

The diagram below shows standard connections between outdoor- and indoor- units.
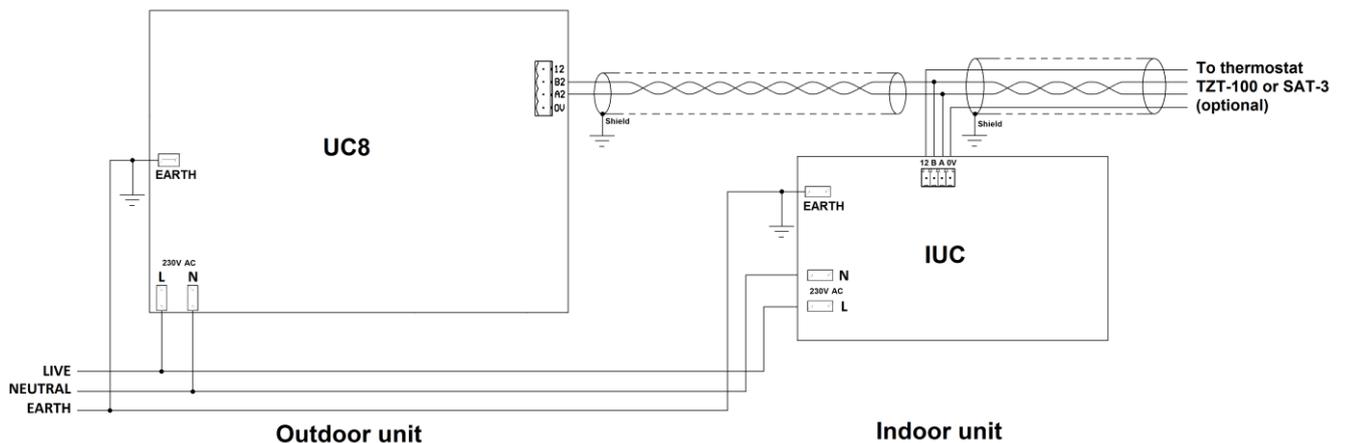
### 5.3. Connecting 1 outdoor unit to 2 indoor units

The diagram below shows how to connect one outdoor unit to two indoor units. Refer to the IUC manual for the required IUC DIP switch settings.
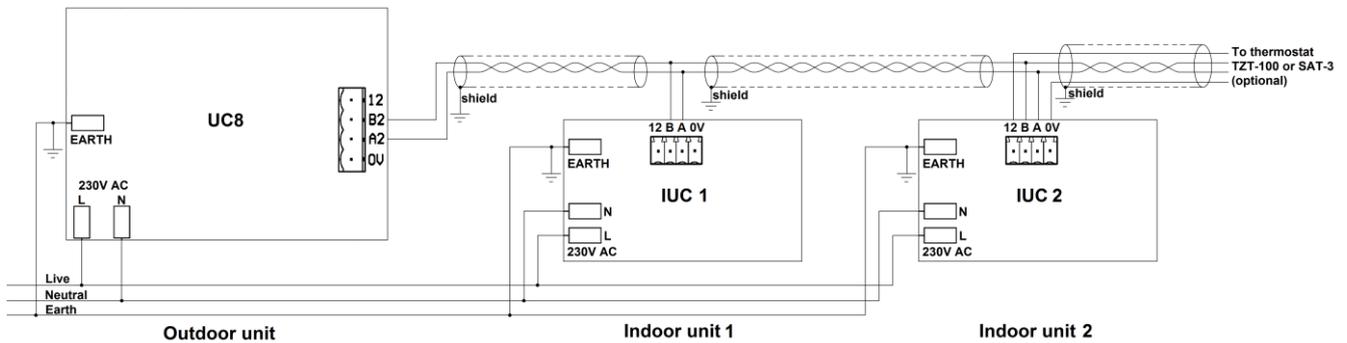


Operation of the two indoor units is always identical, they cannot be controlled individually.

## 6. Capacity control

OSA units are fitted with an inverter compressor that provides variable capacity. The following paragraphs provide details on the available capacity control options.

**Capacity at start-up**

During the first 2 minutes after starting the capacity is restricted to 33% or 50% of unit rated capacity. After this initial period normal capacity control commences.

**Capacity control options**

The following options are available for control of unit capacity:
- 0-10V analogue voltage on input VC.
- Automatic with a SAT-3 or a TZT-100 room thermostat.
- Modbus RTU serial communications.
- Automatic based on supply air temperature.

### 6.1. 0-10V control

Capacity can be controlled with a 0-10V analogue control voltage from an external control device. The unit must not connect to a SAT-3 nor to a TZT-100 room thermostat, must not be controlled with Modbus RTU serial communications, and must not be configured for automatic control of the evaporating / condensing temperatures.

| Control voltage VF | Capacity |
|---|---|
| 0V to 2V | Minimum |
| 2V to 10V | Capacity varies approximately linearly as a function of the control voltage |
| 10V | Maximum |

**Note**: Switching off and on of the compressor is not controlled by the capacity signal.

### 6.2. Supply air temperature control

Refer to "Supply-air temperature control option" for more information on supply air temperature control.

### 6.3. Automatic control with SAT-3 or TZT-100 thermostat

An OSA unit connected to a SAT-3 or TZT-100 room thermostat automatically varies capacity to make the room temperature equal to the selected setpoint temperature and then keep the room temperature constant.

This means that, when the room temperature is equal to the selected setpoint, the unit does not necessarily turn off but instead often continues operating and deliver the capacity necessary to keep the room temperature constant. For example, on a warm summer afternoon, with the room temperature equal to setpoint, the unit may still need to continuously deliver cooling capacity to match the heat load. Should the room temperature move to more than 0.3°C past setpoint then the thermostat will stop the compressor.

The automatic capacity control function operates with conservative reaction speeds. This is necessary to enable the function to work effectively over a wide range of applications. However, the function may be too reactive in applications where there is a large mismatch between the unit capacity and the room load. Typically this can occur in situations where a unit can deliver much more capacity than is needed for the space. At the other end of the spectrum the response of the unit may sometimes seem slow and sluggish.

### 6.4. Modbus RTU control

For detailed information on Modbus RTU serial communications refer to document "Unit controller 8 (UC8) Modbus RTU communications".

An example for control of the compressor on/off, cooling/heating, indoor fan speed and unit capacity (default values in **bold** letters):

| Modbus register | Function | Values | |
|---|---|---|---|
| 101 | Control-enable register | 195 | |
| 102 | Compressor off / on | ***0 = Off*** | 1 = On |
| 103 | Cooling / Heating | ***0 = Cooling*** | 1 = Heating |
| 108 | Indoor fan speed | **Stop** | **0** |
| | | Low speed | 100 |
| | | Medium speed | 550 |
| | | High speed | 1000 |
| 109 | Capacity | Minimum | 0 to 20 |
| | | **50%** | **50** |
| | | 100% | 100 |

**Notes**:

1. Before switching the compressor on always first write to register 103 to select cooling or heating. If this sequence is not adhered to then the unit may already have started when the desired mode is changed. The result would be that the compressor would first continue to operate for the minimum run time of 2 minutes (in the undesirable mode), followed by a 10-minute-long mode change-over delay, and then finally re-start in the desired mode.

2. Switching the compressor on and off is controlled with register 102 and not by the capacity in register 109. When the compressor is running then a request for 0% provides minimum capacity.

### 6.5. Oil recovery (oil flush) cycles

If the unit operates on low capacity for longer than 1 hour and 40 minutes the controller will perform an oil recovery cycle. Oil recovery cycles are necessary to ensure sufficient lubricating oil returns to the compressor. An oil recovery cycles takes 1 minute. During this one-minute the compressor speed is increased and the EEV is directed to open.

It is possible to change the interval between oil recovery cycles (normally 1 hour and 40 minutes). It is also possible to disable oil recovery cycles. If this is required contact R&D.

## 7. Dry mode (de-humidification)

OSA models provide three options for cooling mode:

| Mode | Indoor fan speed |
|---|---|
| Standard cooling | Fixed |
| High-efficiency cooling | Variable |
| Dry cooling (de-humidification) | Variable |

- **Standard cooling mode:**

This is the default mode. In this mode the controller does not actively control the indoor coil temperature. De-humidification occurs only when the indoor coil temperature (= the refrigerant evaporating temperature) is below the dew point. Under normal operating conditions the indoor fan speed is kept equal to the speed requested by the thermostat.
Standard cooling mode is suitable for installations where indoor airflow must remain constant and/or when de-humidification is not required.

- **High efficiency cooling mode:**

The UC8 controller must be allowed to vary the indoor fan speed to obtain an indoor coil temperature for optimum unit duty and efficiency. Note that in this mode the indoor fan speed can differ from the speed requested by the thermostat. De-humidification occurs only when the indoor coil temperature is below the dew point.
High efficiency cooling mode may be unsuitable for installations where indoor airflow must remain constant.

- **Dry cooling mode (de-humidification):**

The UC8 controller must be allowed to vary the indoor fan speed to obtain an indoor coil temperature to that is below the dew point. The indoor fan speed can differ from the speed as requested by the thermostat.
Dry cooling mode may be unsuitable for installations where indoor airflow must remain constant.

### 7.1. Dry mode and the SAT-3 thermostat

Refer to the SAT-3 installer and user manuals for configuring the SAT-3 thermostat.

To operate a unit in dry mode: Select cool + dry or auto cool / heat + dry, start the unit in cooling mode. Select fan auto-speed (the word AUTO shows on the fan display).

### 7.2. Dry mode and the TZT-100 thermostat

To configure the TZT-100 thermostat for dry mode:
- Press-and-hold the O/RIDE button for 15 seconds until the PIN code is shown (88:15).
- Use the Up/Down buttons to select the correct PIN code (default is 88:21), then press O/RIDE again. The thermostat is now in installer mode.
- Press O/RIDE a number of times until the screen shows Fn.
- Press the Up/Down buttons to select the correct option. The options are:
    - -- manually select heating / cooling
    - H heating only
    - C cooling only
    - A heating / cooling / auto
    - **d-** manually select heating / cooling / cooling with **dry mode**
    - **dC** cooling / cooling with **dry mode**
    - **dA** heating only / cooling only / cooling with **dry mode** / auto with **dry mode**
- After selecting the desired option press MODE to exit from installer mode.

To operate a unit in dry mode: Select cool + dry or auto cool / heat + dry, start the unit in cooling mode. Select fan setting "Low-Med-High".

## 8. Indoor fan control

Temperzone OSA units normally connect to a matching indoor unit, models ISD. For convenience any of the following inputs can be used to control the fan in the indoor unit:

- IUC inputs Hi-Me-Lo (inputs for voltage-free contacts, note 1)
- UC8 inputs HI-ME-LO (24V AC or 12V to 24V DC signals, note 1)
- UC8 input VF (0-10V, note 1)
- SAT-3 or TZT-100 room thermostat (note 2)
- Modbus RTU serial communications using RS485 wiring (note 3)

Notes:
1. If the unit is not controlled by Modbus RTU serial communications or SAT-3 or TZT-100 then the UC8 automatically selects the input that requests the highest indoor fan speed.
2. If control is by SAT-3 or TZT-100 thermostat then signals on IUC inputs Hi-Me-Lo and on UC8 inputs HI-ME-LO and VF have no effect.
3. If control is by serial communications then all other control options are disabled. For more information refer to document "Temperzone UC8 Modbus communications".

Some installations do not permit indoor fan speed to vary from the requested speed at any time. For such installations the indoor fan can be controlled directly by an external controller or the fan may be hardwired to run at a constant fixed speed.

*If the UC8 is not used to control the indoor fan then it is the responsibility of the system- designer and -installer to ensure proper and safe operation of the indoor fan, and the system as a whole, under all operating conditions.*

## 8.1. Indoor fan speed adjustment

The IUC inside the indoor unit controls a variable speed indoor fan using a 0-10V signal from output V1. Factory default settings for the output voltage provided on output V2 are:

- Off        0V
- Low        5V
- Medium    6.5V
- High        8V

It is possible to adjust these voltages. If the unit is controlled by a SAT-3 thermostat then placing the SAT-3 in fan speed setup mode will allow adjustment via the keypad on the SAT-3 thermostat. For more information on this refer to the SAT-3 installer manual.

If the unit is not controlled by a SAT-3 thermostat then by default the fan speed settings are determined by DIP switch settings on the IUC. For more information refer to the manual for the IUC.

In installations where access to the indoor unit is restricted it could be more convenient to adjust the indoor fan speed settings from the UC8 in the outdoor unit. If this is the case then turn on UC8 DIP switch 5, remove power and then re-apply power to the unit. After that the fan speed settings can be adjusted as follows:

**To adjust the fan high speed setting:**
> Hold down UC8 pushbutton SW3 until the display shows the letter "**H**", then release the button. The UC8 will enter "fan high speed setup mode". The display will show the current high-speed voltage setting, e.g. "8.0" and the indoor fan will run accordingly.
> Use the pushbutton to change the voltage from 3.0 to 10.0V in steps of 0.5V.
> When the desired fan high speed has been set then wait 30 seconds, the controller will save selected setting.

**To adjust the fan low speed setting:**
> Hold down UC8 pushbutton SW3 until the display shows the letter "**L**", then release the button. The UC8 will enter "fan low speed setup mode". The display will show the current low speed voltage setting, e.g. "5.0" and the indoor fan will run accordingly.
> Use the pushbutton to change the voltage from 1.0 to 8.0V in steps of 0.5V.
> When the desired fan low speed has been set then wait 30 seconds, the controller will save selected setting.

**Notes**:

1. It is allowed to select a low speed voltage equal to the high speed voltage. In effect the fan then operates as a fixed-speed fan at the selected control voltage.
2. Fan medium speed voltage is always halfway between the low and high control voltages.
3. Fan off voltage is always 0V.

In most installations the factory settings provide an adequate range of indoor airflow whilst avoiding risk of indoor coil frost, water carry-over and excessive noise. Care must be taken when changing the indoor fan speed control voltages:

- To ensure the indoor fan always starts it is recommended to avoid 'low speed voltage' settings below 2V.
- To avoid increased risk of frost protection trips and unit lock-out do not set the fan low speed so low that the evaporating temperature can fall below 0°C.
- To avoid risk of water leaking from the supply air vents and corrosion of ducting do not set the fan high speed so high that moisture that may have condensed on the fins of the indoor coil is blown off the coil and into the supply air duct.
- Reducing the high fan speed settings may help when there's significant noise from supply air vents.
- To reduce risk of 'over-condensing' during heating mode, which would cause supply air to feel relatively cool and can lead to additional de-icing cycles (of the outdoor coil), avoid very high fan speed settings.

## 8.2. Translation from 0-10V fan control input signal VF to a fan output signal

Input VF on the UC8 can be used for a 0-10V control signal for the indoor fan.

If the indoor fan speed is controlled using a control voltage applied to input VF then that input voltage is **translated** to a corresponding output voltage. The translation ensures that the UC8 programmed fan speed settings are obeyed.

Translation from 0-10V input VF to a voltage on output V2 is as follows, assuming the default settings of 5V for low speed to 8V for high speed.

| Input VF | Output V2 | Fan |
|---|---|---|
| 0.0V to 0.99V | 0V | Off |
| 1.0V to 1.49V | 0 or 5V | Off or Low speed, whichever is currently the case |
| 1.5V to 9.50V | 5V to 8V | Low speed to High speed |
| 9.5V to 10.0V | 8V | High speed |

If above translation is undesirable then one could follow the procedure described above to change the minimum and maximum voltage settings, or one could bypass the UC8 and apply the external control voltage directly to the indoor fan.

## 9. Display messages

| Display | Meaning | Notes |
|---|---|---|
| UC8 | Controller name | Shown only after power-on |
| 6.1.2-64 | Controller software version and build number | |
| H935413C | Controller software identification code | |
| dELAY | Start-up random delay time | |
| r32 | The unit is configured for R32 refrigerant | Shown only after power-on Note 1 (below) |
| R410A | The unit is configured for R410a refrigerant | |
| Air to Air | The type of unit | Shown only after power-on Note 2 (below) |
| Nr1 | System 1: Master controller | |
| Nr2 | System 2: First slave controller | |
| Nr3 | System 3: Second slave controller | |
| Nr4 | System 4: Third slave controller | |
| IUC | The controller has successfully started communications with the indoor unit | Shown only after power-on Note 3 (below) |
| tZt100 | The controller has successfully started communications with the TZT-100 thermostat | Shown only after power-on Note 4 (below) |
| SAt3 | The controller has successfully started communications with the SAT-3 thermostat | |
| ● or _● | Normal operation | Blinking on and off |
| C | Normal operation, commissioning mode enabled | |
| _ | Unit is OFF by Remote On/Off signal | Slowly blinking on and off |
| HOLd | The compressor is held-on or held-off by a timer | |

Notes
1. The refrigerant type is automatically set in accordance with the selected compressor model.
2. The type of unit and the system number are set with DIP switches 13…16 and 11…12 respectively.
3. If the display does not show the message 'IUC' during the first minute after start-up, then the indoor unit is not detected. The controller will then incorrectly assume that it is fitted in a packaged unit and the system will not operate correctly. For example, the indoor fan cannot be started. The cause must be found and corrected before running the compressor.
4. If the system includes a TZT-100 or a SAT-3 thermostat but the display does not show the message 'tZt100' or 'Sat3' during the first minute after start-up, then the thermostat is not detected. The controller will then incorrectly assume that no thermostat is connected, and the system will not react to the controls on thermostat. The cause must be found and corrected before the system can function correctly.

## 9.1. Viewing pressures, temperatures and other variables

**Short button presses** can be used to view pressures and temperatures and other information on the display. This is available irrespective of whether the compressor is on or off.

Use **short button presses** to cycle through the options. When the button is not pressed for longer than 2 minutes the display automatically returns to a flashing dot (or 'c').

| Display | Meaning | Units |
|---------|---------|-------|
| ● or c | Normal mode (default) | - |
| SLP | Compressor suction line pressure | kPa |
| Et | Evaporating temperature | °C |
| SLt | Compressor suction line temperature | °C |
| SSH | Compressor suction side superheat | K |
| dLP | Compressor discharge line pressure | kPa |
| Ct | Condensing temperature | °C |
| dLt | Compressor discharge line temperature | °C |
| dSH | Compressor discharge side superheat | K |
| ICEt | Outdoor coil de-icing sensor temperature | °C |
| CAP | Unit capacity (duty) | % |
| EE1 | Electronic expansion valve 1 opening | % |
| EE2 | Electronic expansion valve 2 opening | % |
| Add | UC8 Modbus RTU slave address | - |
| ● or c | Back to button press 0 | - |

Pressures are shown in kPa. Divide by 6.895 to convert to PSI.

Temperatures are shown in whole degrees Celsius. If the indicated temperature is below 0°C then a minus sign is shown before the value. The condensing- and the evaporating-temperature are converted from the pressure readings.

If a measurement is not available then the display shows a dash symbol (-).

## 10. Special modes

The UC8 offers several options to modify operation of the unit. The display and pushbutton are used to make the modifications. To access the available options:

- There must be no request to start.
- And the compressor must be off.

**To start the process: Entering level 1**

1. Apply power to the unit and wait until the power-on sequence is completed. The display should show a blinking decimal point or a blinking dash.
2. Press and hold down pushbutton SW3. After two seconds the display changes. <u>Continue pressing the pushbutton.</u> The following set of options will be shown in sequence, one after the other. Release the button when the display shows the character of the desired option.

| Level 1. | Description | Factory default |
|----------|-------------|-----------------|
| t | Start factory test mode | Off |
| c | Start or end commissioning mode | Off |
| H | Adjust the indoor fan high speed voltage | 5.0V |
| L | Adjust the indoor fan low speed voltage | 8.0V |
| 2. | Advance to level 2. | |
| . | Return to normal mode | |

**Selecting options in levels 2, 3 and 4**

**Please note!** Using the pushbutton in levels 2, 3 and 4 is **different** from level 1.

- In levels 2, 3 and 4 **short button presses** must be used to move between options.
- If the button is not pressed after the display has shown the same character **four times** then that option is selected. Therefore:
  - To move to another option: Make sure to briefly press the button <u>before</u> the same character has been shown 4 times.
  - To select an option: Simply do not press the button. The display will show the character four times, and then the controller enters the selected mode.
- Options available in levels 2, 3, and 4 are:

| Level 2. | Description | Factory default |
|----------|-------------|-----------------|
| A | Change the UC8 Modbus RTU slave address | 44 |
| r | Indoor fan fixed speed | Off (0) |
| o | Turn the thermostat on/off with the remote on/off signal | Off (0) |
| Y | Enable evaporating / condensing temperature control | Off (0) |
| 3. | Advance to level 3. | |
| . | Return to normal mode | |
| **Level 3.** | **Description** | **Factory default** |
| J | Outdoor fan common chamber | No (0) |
| B | Adjust the serial communications baud rate | 19200 (2) |
| P | Adjust the serial communications parity & stop bit setting | Even parity, 1 stop bit (2) |
| 4. | Advance to level 4. | |
| . | Return to normal mode | |
| **Level 4.** | **Description** | **Factory default** |
| E | Select the compressor model | |
| n | Select the expansion valve operating mode | |
| . | Return to normal mode | |

## 10.1.  Factory test mode: t

In factory test mode the controller activates the various control board output signals one by one, with a pause between each step. When the test sequence is complete the controller automatically returns to normal mode.

## 10.2.  Commissioning mode: c

During commissioning mode delay times are reduced:
- Minimum On-Off time ('Run'-time)      90 seconds
- Minimum Off-On time ('Off'-time)      20 seconds
- Minimum On-On time ('Cycle'-time)      1 minute
- Cooling to heating change-over time      1 minute
- Heating to cooling change-over time      1 minute

Commissioning mode ends automatically after 30 minutes. It is also possible to manually end commissioning mode either by cycling mains power off and on again, or by again using the pushbutton and select option 'c'. When commissioning mode ends the controller returns to normal mode.

## 10.3.  Indoor fan speed settings: H and L

The indoor fan speed settings are normally selected with the DIP switches in the indoor unit. The settings under options H and L on the UC8 then have no effect.

Alternatively, if the system makes use of the SAT-3 thermostat then the indoor fan speed settings can be changed using the fan speed setting modes available on the SAT-3.

If the system does not include a SAT-3 thermostat and access to the outdoor unit is easier than access to the indoor unit, then one can set UC8 DIP switch 5 to ON and reset the controller. This will allow indoor fan speed settings to be set using the display options H and L.

For more information refer to Indoor fan speed adjustment.

## 10.4.  Compressor selection mode: E

**IMPORTANT**: Always ensure the correct compressor model is selected! An incorrect selection is likely to cause the unit to malfunction and could lead to permanent damage to the compressor.

| Unit model | Compressor model | Display |
|---|---|---|
| OSA 171 RLS | YPV030LT-3X9 Copeland | P1-Y030L |
| OSA 171 RLT | YPV030LT-4X9 Copeland | P3-Y030Lt |
| OSA 211 RLT | YPV038LT-4X9 Copeland | P3-Y038L |
| OSA 251 RLT | YPV050ST-4X9 Copeland | P3-Y050S |
| OSA 351 RLT | AVB66FT2MT SCI | P3-AUb66 |

## 10.5.    Supply-air temperature control option: Y

OSA + ISD installations can provide automatic control of the supply air temperature. Available selections are:

- **0**: Disable supply air temperature control (default value)
- **1**: Enable supply air temperature control

If the system includes a TZT-100 or a SAT-3 thermostat then the setpoint (SP) and room temperature (RT) are known. The logic for supply air temperature control then is as follows:

**Cooling mode**
- o   Target supply air temperature = setpoint - differential – offset, where:
- o   Differential is 12°C (a fixed value)
- o   Offset is the distance between RT and SP (RT - SP), but not less than 0°C and not more than 5°C

The target supply air temperature shall:
- o   Not be set lower than 10°C
- o   Not be set higher than 25°C

An example:
- o   Room temperature 25°C, setpoint 22°C
- o   Target supply air temperature is 22 - 12 - (25 - 22) = 7°C but this is limited to 10°C
- o   The inverter speed will be varied to deliver air with a temperature of 10°C.

If the actual supply air temperature is not known to the controller then the function substitutes the evaporating temperature with an offset of +5°C.

**Heating mode**
- o   Target supply air temperature = setpoint + differential + offset, where:
- o   Differential is 10°C (a fixed value)
- o   Offset is the distance between RT and SP (SP - RT), but not less than 0°C and not more than 5°C

The target supply air temperature shall:
- o   Not be set lower than 30°C
- o   Not be set higher than 42°C

An example:
- o   Room temperature 18°C, setpoint 22°C
- o   Target supply air temperature is 22 + 10 + (22 - 18) = 36°C

If the supply air temperature is not known to the controller then the function substitutes the condensing temperature with an offset of -5°C.


If the system does not include a thermostat then the room temperature and the setpoint are not known to the controller. In those systems:

**Cooling mode**
- o   Target supply air temperature is set to 12°C
- o   If the actual supply air temperature also is not known to the controller then the function substitutes evaporating temperature with an offset of +5°C.

**Heating mode**
- o   Target supply air temperature is set to 36°C
- o   If the supply air temperature also is not known to the controller then the function substitutes condensing temperature with an offset of -5°C.

## 10.6.　　　Thermostat auto-on/off options: o

The UC8 can be configured to automatically switch the SAT-3 or TZT-100 thermostat on and off synchronous with the remote on/off input terminal of the UC8 circuit board. Available selections are:

- **0**: Thermostat automatic on/off is disabled (default).
- **1**: Thermostat automatic on/off is enabled.
- **2**: Thermostat automatic on/off is enabled, the unit automatically starts in cooling mode every time the UC8 remote on/off signal changes from off to on.

**Option 0 (default):**
The auto-on/off feature is disabled. This means that a SAT-3 or TZT-100 thermostat that is switched on can show that a unit is active (cooling, heating or fan-only) even when the unit is actually off because the UC8 remote on/off terminal is made inactive (open-circuit).

**Option 1 [note 1] :**
The thermostat shows the actual state of the unit. In this case when a thermostat is on and the UC8 remote on/off signal becomes inactive (open circuit) the thermostat is automatically switched off. While the UC8 remote on/off signal remains inactive the thermostat is held off, pressing the thermostat on/off button is overruled by the UC8 off-command. When the UC8 remote on/off signal becomes active again then the thermostat resumes operation with the same settings that were valid when last active.

**Option 2:**
This mode is intended for use only on **cooling-only** installations; it is unsuitable for installations that also require operation in heating mode. The thermostat is forced to remain off when the UC8 remote-on/off input is inactive. When the UC8 remote on/off signal becomes active the thermostat is automatically switched on in cooling mode.


**Note 1**: If power is removed from the unit while the unit is switched off by the remote on/off signal, then the thermostat will power up in the OFF-state. *The unit will NOT resume operation in the last active mode!* If it is essential that the unit must always come back on after a power-cut then the unit must be configured for option 0 (feature disabled) or option 2 (cooling starts automatically).

## 11. Troubleshooting

When the UC8 controller detects a problem within the system the fault relay output (FLT) is activated. Fault light FLT will illuminate, and a fault code is shown on the LED display.

Some faults will stop the compressor and the fan. Other faults may stop the compressor but allow the fan to continue running. Yet other faults will be signalled but do not stop the unit from operating.

If a serious fault repeatedly stops the unit it may be locked-out. A locked unit will not run the compressor and the fan. To unlock the unit cycle mains power to the unit off and on again, alternatively a unit can be unlocked via Modbus RTU serial communications.

If a unit locks out three times successively without completing a successful cooling or heating cycle, then the unit will be locked out and can only be unlocked by pressing the UC8 pushbutton.

### 11.1. Fault codes

| Display | Meaning | Possible causes |
|---|---|---|
| LP | Low pressure protection is active | Low refrigerant charge (gas leak) <br> Pressure transducer fault <br> EEV malfunction or disconnected <br> Indoor fan or controller malfunction |
| HP | High pressure protection is active | No water flow (cooling mode) <br> Pressure transducer fault <br> EEV malfunction or disconnected <br> Indoor fan or controller malfunction |
| OL | Overload protection (input IN#2 is open circuit) | Check overload switches (if used) |
| FROSt | Indoor coil frost protection is active | Insufficient airflow (e.g. a blocked air filter) <br> Indoor fan malfunction |
| HI-t | High temperature protection is active | Insufficient airflow (e.g. a blocked air filter) <br> Indoor fan malfunction |
| HI-SL | High suction line temperature protection is active | Water temperature too high (heating mode) |
| Lo-dSH | Low discharge superheat protection active | EEV malfunction or disconnected <br> Incorrect EEV operating mode selected |
| Hi-dSH | High discharge superheat protection active | Low refrigerant charge (gas leak) <br> EEV malfunction or disconnected |
| CRL | Low compression ratio protection | Water temperature too low or too high |
| CRH | High compression ratio protection | Pressure transducer fault <br> EEV malfunction or disconnected <br> Indoor fan or controller malfunction |
| diFF-P | The pressure differential is too high for the inverter compressor to start | Incorrect DIP switch settings <br> Pressure transducer fault <br> EEV malfunction or disconnected |

| Display | Meaning | Possible causes |
|---------|---------|-----------------|
| F12 | Low pressure transducer fault | Transducer cable disconnected<br>Faulty transducer<br>Loss of refrigerant (gas leak) |
| F13 | High pressure transducer fault | Transducer cable disconnected<br>Faulty transducer<br>Loss of refrigerant (gas leak) |
| F14 | Suction line temperature sensor fault | Sensor cable disconnected |
| F15 | Discharge line temperature sensor fault | Sensor cable disconnected |
| F18 | Indoor coil temperature sensor fault | Sensor cable disconnected |
| F19 | Heating element temperature sensor fault | Sensor cable disconnected |
| F20 | Superheat is unknown | Missing sensor |
| F21 | Thermostat fault | Loss of serial communications |
| F22 | BMS fault | Loss of serial communications |
| F26 | Invalid DIP switches setting | |
| F29 | Microcontroller too hot | Inadequate electrical box ventilation |
| F30 | Supply voltage out of bounds | Electrical short circuit / overload |
| F33 | High discharge superheat protection | Loss of refrigerant (gas leak)<br>Faulty transducer<br>EEV malfunctioning or disconnected |
| F34 | Pressures not equalising | Pressure transducer connections swapped<br>Incorrect pressure transducer fitted<br>EEV malfunctioning or disconnected |
| F35 | Reverse cycle valve fault | Reverse cycle valve disconnected |
| F36 | Invalid DIP switch setting on TZT-100 thermostat | Set TZT-100 DIP switch 2 ON<br>and TZT-100 DIP switch 4 OFF |
| F39 | Variable speed compressor driver reports a fault | Check inverter driver |
| F42 | Evaporating temperature too high | Supply water temperature too high (heating mode)<br>EEV malfunctioning or disconnected |
| F43 | Condensing temperature too low | Supply water temperature too low (cooling mode)<br>EEV malfunctioning or disconnected |
| F44 | Invalid EEV mode selection | |
| | | |

### 11.2. Inverter fault codes

The following set of fault codes relate to the Power+ compressor driver.

The fault code shown on the controller is F100 plus the alarm code as reported by the Power+ driver.

For detailed information about the Power+ alarm codes refer to the **Carel Power+ speed drive user manual**, **chapter 8.3: Alarms table**. A brief summary follows here:

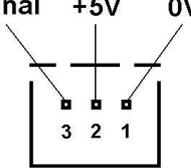| Display | Meaning | Possible causes |
|---|---|---|
| F100 | No communications between Power+ driver and UC8 | No power to the driver<br>Communications cable disconnected<br>Driver incorrect DIP switch settings |
| F101 | Motor over-current | Incorrect compressor model selected<br>Insufficient airflow<br>Fan malfunction |
| F102 | Motor overload | |
| F103 | Over-voltage | Mains supply voltage too high |
| F104 | Under-voltage | Mains supply voltage too low |
| F105 | Drive too hot | Insufficient cooling of the drive |
| F106 | Drive too cold | |
| F107 | Drive over-current | Incorrect compressor model selected<br>Insufficient airflow<br>Fan malfunction |
| F108 | Motor too hot | |
| F109 | Reserved | |
| F110 | Drive internal error | |
| F111 | Incorrect parameter | Incorrect compressor model selected |
| F112 | Excessive drive DC bus ripple | Unbalanced mains phase voltages |
| F113 | Communication fault | Communications cable disconnected |
| F114 | Internal fault | |
| F115 | Auto-tuning fault | |
| F116 | Driver is disabled (input STO is open circuit) | Wire links to the drive disconnected |
| F117 | Motor phase fault | Loose compressor motor wire |
| F118 | Internal fan fault | Faulty fan in the driver |
| F119 | Speed fault | |
| F120 | Power factor correction circuit overload | |
| F121 | Mains input voltage too high | Mains supply voltage too high |
| F122 | Mains input voltage too low | Mains supply voltage too low |
| F123 | Drive internal fault | |
| F124 | Reserved | |
| F125 | High earth current fault | |
| F126 | Drive processor overload | |
| F127 | Drive memory loss | |
| F128 | Drive overload protection | |
| F129 | Safety intervention fault | |
| F197 | Drive reports incorrect compressor speed | |
| F198 | Drive and compressor mismatch | Incorrect compressor model selected |
| F199 | Drive configuration fault | Remove mains power, then re-apply |

## 12. UC8 controller circuit board specifications

*Notes:*

- *Relay outputs HIGH, MED, LOW, C3, C4, CMC, R/V, SSR#1 and SSR#2 are isolated from all other circuits. It is permitted to connect these relay outputs to mains live circuits.*
- *Inputs HI, ME, LO, C1, CP, HT and C2 are isolated from all other circuits. These inputs accept 24V AC or 12V DC control signals.*
- *All other input and output signals from/to the UC8 are referenced to unit EARTH.*
- *It is recommended that any input signal that is referenced to EARTH and that needs to connect to a circuit external to the temperzone unit to be isolated by a suitable means, for example a relay. Typical examples of this are the remote On/Off input and the DRED inputs.*
- ***For safety and to ensure correct operation of the unit the EARTH terminal must directly connect to a unit earth stud located close to the controller board.***

| **Controller environmental conditions**<br>Storage temperature range<br>Operating temperature range<br>Relative humidity | -20 to +75°C<br>-10 to +65°C<br>20 to 95% non-condensing | | |
|---|---|---|---|
| **Mains input**<br>L and N | 230V AC 50Hz<br>nominal | 190V AC<br>minimum | 250V AC<br>maximum |
| **Output relays**<br>Applies to:<br>HIGH, MED, LOW, CMC and R/V outputs | 250V AC, 5A maximum, resistive load<br>250V AC, 2.5A maximum, inductive load | | |
| **Solid state output relays**<br>Applies to:<br>SSR1 and SSR2 outputs | 12V AC minimum, 250V AC maximum (**AC only!**)<br>0.25A maximum (continuous)<br>2.5A maximum (peak, 0.5s) | | |
| **AUX and FLT outputs**<br>Designed to operate a relay with 12V DC coil. | Open collector and +12VDC output<br>OFF state: leakage current 0.5mA maximum<br>ON state: 12V DC, 100mA maximum | | |
| **EXV1 output**<br>For control of auni-polar electronic expansion valve (5-wire or 6-wire type) | Open collector and +12VDC output<br>OFF state: leakage current 0.5mA maximum<br>ON state: 12V DC, 275mA maximum per winding/coil | | |
| **EXV2 output**<br>For control of 12V DC relay coils. | Open collector and +12VDC output<br>OFF state: leakage current 0.5mA maximum<br>ON state: 12V DC, 275mA maximum per winding/coil | | |

| | |
|---|---|
| **Isolated inputs**<br>Applies to:<br>HI, ME, LO, CP and HT inputs<br>Common terminals are:<br>C1 for HI, ME and LO<br>C2 for CP and HT | **When used with 24V AC input signals:**<br>Maximum input voltage OFF state:  2V RMS AC<br>Minimum input voltage ON state:  18V RMS AC<br>Absolute maximum input voltage:  35V RMS AC<br>Input impedance:  2.5kΩ |
| | **When used with 12V DC input signals:**<br>Maximum input voltage OFF state:  2V DC<br>Minimum input voltage ON state:  11V DC<br>Absolute maximum input voltage:  35V DC<br>Input impedance:  2.5kΩ |
| **VC and VF 0-10V analogue inputs**<br>Referenced to terminal 0V | Absolute maximum input voltage:  -2 to +15V DC<br>Nominal input voltage:   0 to +10V DC<br>Input impedance:  13.9kΩ |
| **IN#1 and IN#2**<br>**DRED inputs D1, D2, D3**<br>**Remote On/Off input**<br>Referenced to terminals 0V and SC | Designed to be operated by isolated voltage free contacts.<br>Open circuit voltage:  3.3V DC typical<br>Closed circuit current:  3.3mA DC typical |
| **V1 and V2 0-10V analogue outputs**<br>Referenced to terminal 0V | Maximum load:  6.5kΩ<br>Maximum short circuit output current:  30mA |
| **Temperature sensor inputs**<br>DL:  red<br>SL:  white<br>AMB:  black (electric heating models only)<br>IC:  yellow<br>OC, DEI:  not used on hydronic units | Designed to connect to standard Temperzone thermistor temperature sensors. |
| **Pressure transducer inputs**<br> | Power:  5.0±0.2V DC, maximum current draw 50mA<br>Signal:  0.5V at the lowest pressure<br>    4.5V at the highest pressure<br>Pressure ranges:<br>LPT, all units:  0 to 3450 kPa (0-34.5 bar, 0-500 PSI)<br>HPT, all units:  0 to 4500 kPa (0-45.0 bar, 0-653 PSI) |
| **Modbus RS485 serial communications format** | Baud rate  19200<br>Data bits  8<br>Parity  even<br>Stop bits  1 |

Disclaimer: