Service Training Manual

temperzone climate innovations

Issue 08 - January 2023

Air Cooled Package
Split Ducted
Water Cooled Package
Chilled Water Air Handling

Temperzone

Welcome to the 8th edition temperzone Service Training Manual. The contents of this manual represent the very latest information to aid in the installation, commissioning, servicing and maintenance of the current range of temperzone products.

Described in this latest edition is the introduction of temperzone's R32 refrigerant, inverter compressor operated equipment. This award winning product line provides increased energy efficiency, decreased GWP and a reduction in overall refrigerant charge and physical dimensions which will future proof any installation.

For information on temperzone products, please refer to our website: **www.temperzone.com**

econex
nex gen R32 inverter

aquanex
nex gen R32 inverter

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65 Years On and Counting

From our headquarters in New Zealand, we've applied our expertise and knowledge to the coolest climates, the harshest conditions in Australia and the high humidity of Southeast Asia.

If you're after sales and tech support of the highest order, then you've got it. We have a network of experienced professionals who are always on hand to give all the help you need.

We offer unmatched:

- Selection advice
- Engineered solutions
- Service training seminars
- Product demonstrations.

What about quality? Well, every Temperzone unit is covered by a comprehensive part and labour warranty. And if you ever need spare parts, no problem. We have a network of spare parts warehouses right around the region.

As a local manufacturer we understand local climates and conditions, so we design our products to excel in these conditions. Temperzone designs, develops and manufactures most of our products from some of the world's most modern factory complexes in the world.

"Innovation is at our core to produce ever more relevant technology, pushing the bounds of currently available solutions. Temperzone has embarked on our own decarbonising and sustainability journey, reducing our impact on the environment in the way we operate at all levels and transitioning into a more sustainable and efficient organization. Our products and services can assist others to make the transition and act as enabling technology to transition to zero carbon, pushing the bounds of currently available solutions and technologies that are safe and sustainable from the manufacture, installation, maintenance through to whole of life considerations in the circular economy.

Les Kendall
Governing Director and Chief Executive Officer

Econex = Efficiency, Control and Sustainability

In a world where global warming is driving ever increasing demands on air conditioning, long term sustainability and efficiency have become key elements of new equipment design.

Econex is the embodiment of Temperzone's determination to become Australasia's first producer of a complete range of commercial R32 products, a goal well on the way to being achieved since the launch of locally manufactured R32 split ducted products in Australia and New Zealand. Offering R32 refrigerant across all Temperzone commercial systems will provide a 75% to 80% reduction in GWP per kW of cooling or heating and assist in pathing the way for a zero-carbon future.

Temperzone's Research and Development into the utilisation of low GWP R32 refrigerant for commercial HVAC products was initiated in 2016. Developing commercial R32 product required close R&D efforts with major component suppliers as we were amongst the first worldwide to explore these alternative refrigerants for commercial systems. Through developing these Next Generation low GWP refrigerant platforms and providing cost effective and energy efficient HVAC solutions to the industry, Temperzone is making a significant contribution to the reduction in GHG emissions of the Building Services Sector.

For over 10 years, Temperzone has embarked on a journey of product development, first delivering the ECO range, followed by the ECO Ultra range which culminated in the Multi-Award Winning Temperzone OPA2100 Eco Ultra.

Econex is the next step in our product evolution, a move to R32 Inverter systems designed for local conditions with exceptional part load efficiency and control flexibility. Where possible, this is accompanied by a move towards smaller footprints, reduced weights, and improved service access. **Econex** is the next generation of the ECO range, and as such, continues to offer the ECO range's higher specifications of EC scroll or EC plug fans, variable speed condenser fans, electronic expansion valves, wide capacity range allowing close control, dry mode operation, coil guards and more.

econex

nex gen R32 inverter

Over the next 12 months Temperzone will be releasing new products in the Econex range. First released in mid-2020 were Econex commercial split ducted systems (15 to 35kW) which have proven hugely successful with installers, contractors, consultants and corporate property owners who are seeking commercial HVAC solutions that help to meet businesses carbon reduction targets.

The first Econex OPA range of rooftop package units will be released in the near future. This first range of R32 inverter air cooled packaged units will come in nominal capacities from 25kW ~ 55kW. A nominal 30kW split ducted system will also be added to the Econex range, as well as a range of reverse cycle chiller and water cooled units.

If you are looking for increased efficiency, reduced operational costs and a lower total cost of ownership,
a superior capacity range for delivering increased comfort and a more sustainable refrigerant, then Econex should be your choice.

When you think about it, Econex just makes great business sense!

Resources

What are you looking for when you call a Technical Support Centre?

The answer's pretty obvious – and it's one of the reasons why Temperzone's reputation in the industry is so strong.

When it comes to technical questions about air conditioning systems, the Temperzone team has a great depth of knowledge. And they use it to great effect to answer all sorts of questions and solve problems.

Pinpointing problems

The Temperzone Technical Support team can usually pinpoint service problems very quickly. Problems generally fall into one of two areas – refrigeration or control/electricals – and the team members understand both. With just a few simple questions, they can guide callers through the issues to identify the key problems and help them rectify it.

Different services for different customers

In a typical day, the tech support team members have to be able to think on their feet, because the level of technical knowledge required and the types of questions asked varies greatly from phone call to phone call. The Temperzone team has the ability to answer very different questions depending on who we're talking to – from consumers to installers, service technicians and specialist consultants. At one end of the spectrum, end users may simply be having difficulty using an unfamiliar product. This is often the case when a householder moves into a home with an existing Temperzone air conditioning unit for which the owner's manual has long been lost. Issues like this pose no problems for an engineer who was probably around when the unit was first installed. Installers and service technicians approach the team with different kinds of problems. The Temperzone team appreciate that while the answer to questions such as 'How much refrigerant should I use? Can probably be found in the service manual or published data, an installer or technician working on-site is dealing with time pressures and needs a quick answer. The Temperzone team understand that and do their very best to help. Our consultants build personal relationships based on trust. They will often call to confirm that a particular product is suitable for a specific application. They feel that as technical experts the Temperzone team is at arm's length from the sales process, and they're comfortable with that.

A solution for every problem

Most of the issues the technical support team deal with is fairly straight forward. Yet sometimes they come across a 'curly' one that really tests them. But there has never been a problem with a Temperzone product they haven't been able to solve.

Hitachi support

The Temperzone team delivers the same level of support to Hitachi customers. With the Hitachi product range now part of Temperzone's product offering, Hitachi product specialists have joined the team. This will ensure that Temperzone levels of technical support are available to Hitachi customers now and in the future.

After sales

Temperzone has a complete and comprehensive range of spare parts no matter whether your Temperzone machine is 5 years old or 25 years old. Most components are available at your doorstep in 24 hours, just another example of Temperzone exceeding your after sales expectations.

Nomenclature

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1. Temperzone Air Conditioning Nomenclature

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MODEL

- A – Air Cool
- B – Chiller
- C – Closet
- D – Ducted
- E
- F – Floor
- G
- H – Hideaway
- I – Indoor
- J – Fan Coil Belt Drive
- K – Cassette
- L – Low Profile
- M – Fan Coil Direct Drive
- N
- O – Outdoor
- P – Package
- Q
- R
- S – Split
- T
- U – Under-ceiling
- V – Vertical Unit
- W – Water Heat Exchanger
- X – Suck Through
- Y – Hi-Wall
- Z

KILOWATT

Nominal kilowatt performance rating. Divide the above figure by 10. (This is a rounded estimate.)

TYPE

- A – Tandem Compressor System
- B – Two Compressor Unit
- C – Cooling (DX) Only
- D – Integrated Thermostat
- E – Electric Heating (Std)
- F – Inverter Units
- G – Digital Units
- H – Horizontal Air Flow Discharge
- I – (leave alone)
- J
- K – R410A
- L – R32
- M – Multi (3 or more compressors)
- N – HWP Protection Board
- O – (leave alone)
- P – Plug fan
- Q – EC Condenser Fans
- R – Reverse Cycle
- S – Single Phase
- T – Three Phase
- U – Downward Air Flow Discharge
- V – Vertical Up Airflow Discharge
- W – Chilled Water
- X – IUC Controller
- Y – EC-DC Evaporator Motor
- Z – Hot Water Coil
- # – No. of variable compressors

OPTIONS

- A – Supply Plenum
- B – Return Plenum
- C – Fresh Air Supply
- D – T/Stat Package
- E – Electric Heat (Option)
- F – Filters/Filter Box With Filters
- G – Condensate Pump Kit
- H – Spring Mounting Kit
- I – Hot Gas Bypass
- J – Soft Starter Kit
- K
- L – Zone Plug N Play Kit
- M – Made To Order Special
- N – Safety Drain Tray
- O
- P – Plug Fan
- Q – Differential Pressure Switch
- R
- S – High Static Condenser Fans
- T
- U
- V
- W – Water Hoses
- X
- Y – Outdoor Coil Protection Guards
- Z – Economiser Air Supply
- # – No. Of Water Coil Rows
- /# – No. Of Secondary Water Coil Rows If Fitted

SERIES

Series number starting at 1. (Units released 2019 or later)

EXAMPLE

O S A ☐ | 1 5 0 ☐ | R K S V ☐ — N S ☐☐☐ — S 1 ☐

Model:

- O – Outdoor
- S – Split
- A – Air Cool

NB: O or I to go in the first block, S or P in the second block, followed by any others.

Kilowatt: Approximately 15kW

Type:

- R – Reverse Cycle
- K – R410A
- S – Single Phase
- V – Vertical Air Flow Discharge

NB: C or R to go in the first block. Refrigerant type (where used) in the second block. Phase in the third block, followed by any others. Air flow discharge must always be in the last block. (refer to sheet 3 for OPA airflow options)

Options:

- N – Safety Drain Tray
- S – High Static Condenser Fans

Series:

- S – Series
- 1 – Series No.

2. Aquanex Water System Nomenclature

MW□ — □□□ — □□□□ — □□□□□ — S□□

MODEL (MW□)

- C – Chiller
- D – Dual Water Heat Exchanger (Air Cooled)
- H – In-line Hybrid-pass Heating
- M – Multi-pass Heating
- P – Pool/Spa Heating
- R – Reverse Cycle In-line System
- S – Single-pass Potable Hot Water
- U – Under-floor Heating

KILOWATT (□□□)

Nominal kilowatt performance rating. Divide the above figure by 10. (This is a rounded estimate.)

TYPE (□□□□)

- E – EC Condenser Fans
- K – R410A
- L – R32
- M – Multiple Compressor/ Refrigeration Systems (2 or more)
- P – Paired Tandem Compressor/ Refrigeration System
- S – Single Phase
- T – Three Phase

OPTIONS (□□□□□)

- C – PLC Controller Fitted
- E – EC Condenser Fans
- F – Flow Meter
- L – Liquid Injection
- P – Pump Fitted
- V – Vapour Injection (EVI)

SERIES (S□□)

Series number starting at 1.

EXAMPLES

MWU 150 KS — □□□□□ — S1

- MW – Magnus Water System
- U – Underfloor Heating

Approximately 15kW

- K – R410A
- S – Single Phase

- S – Series
- 1 – Series No.

MWP 400 KT — □□□□□ — S1

- MW – Magnus Water System
- P – Pool Heating

Approximately 40kW

- K – R410A
- T – Three Phase

- S – Series
- 1 – Series No.

MWH 740 LTM — CFV — S1

- MW – Magnus Water System
- H – In-line Hybrid Pass Heating

Approximately 74kW

- L – R32
- T – Three Phase
- M – Twin Compressor

- C – PLC Controller Fitted
- F – Flow Meter
- V – Vapour Injection(EVI)

- S – Series
- 1 – Series No.

MWS 500 LTP — LP — S1

- MW – Magnus Water System
- S – Single-pass Potable Hot Water

Approximately 50kW

- L – R32
- T – Three Phase
- P – Tandem Compressor

- L – Liquid Injection
- P – Pump Fitted

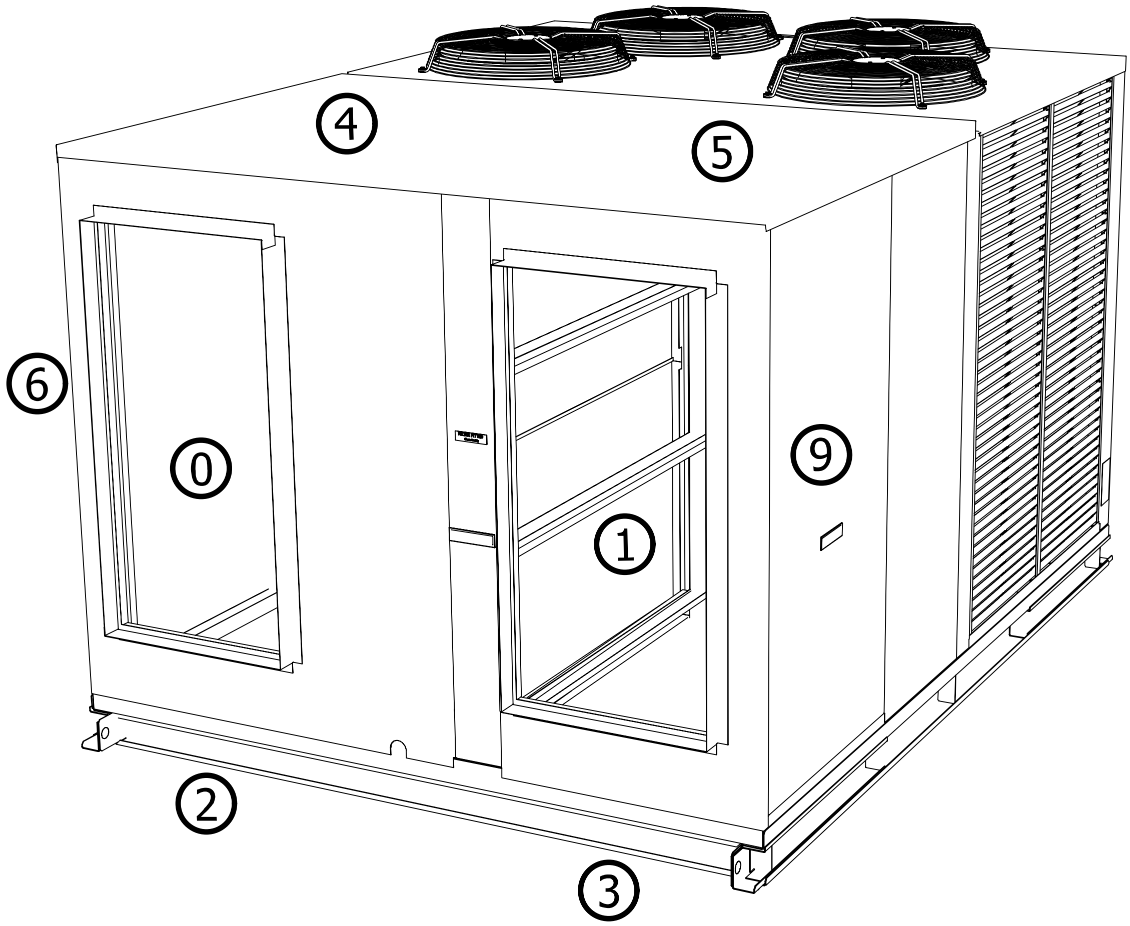
- S – Series
- 1 – Series No.

NB: Refrigerant type to go in the first block, Phase in the second block, followed by any others.

3. Air Flow Handing Nomenclature

What are you looking for when you call a Technical Support Centre?

When choosing supply and return options, the diagram below describes the numbering system used to identify the position of the incoming and outgoing air.



Looking at the unit with the evaporator (indoor) side facing you; use the numbers to represent the position, starting with the supply air followed by the return air.

EXAMPLES

In the example above the supply is on the left and the return is on the right, therefore the numbers would be 01. If the supply was on the top right of the unit and the return was on the return on the left side, this would be 56.

Positions 9 are used for larger units when side options can be positioned either at the front of the unit or towards the middle.

R32 Safety / Data Handling Sheet

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Table 1 Minimum Floor Area p. 21

Symbols

Explanation of symbols displayed on the indoor unit or outdoor unit air conditioner.

	WARNING	This symbol shows that this equipment uses a flammable refrigerant. If the refrigerant is leaked, together with an external ignition source, there is a possibility of ignition.
	CAUTION	This symbol shows that the Operation Manual should be read carefully.
	CAUTION	This symbol shows that a service person should be handling this equipment with reference to the Installation Manual.
	CAUTION	This symbol shows that there is information included in the Operation Manual and/or Installation Manual.

WARNINGS

- Do not use any means to accelerate the defrosting process or to clean a unit, other than those recommended by the manufacturer.
- Prior to installation the outdoor unit, which contains refrigerant, shall be stored in a room without continuously operating ignition sources (for example: open flames, an operating gas appliance or an operating electric heater).
- The outdoor unit shall be stored so as to prevent mechanical damage from occurring.
- Do not pierce or burn.
- Be aware that the R32 refrigerant does not contain an odour.
- Do not disconnect the pipe connection after checking for leaks otherwise it may cause refrigerant leakage.

1. Installation (Space)

- The installation of pipework shall be kept to a minimum.
- Pipework shall be protected from physical damage and shall not be installed in an unventilated space.
- Compliance with national gas regulations shall be observed.
- Mechanical connections shall be accessible for maintenance purposes.
- In cases that require mechanical ventilation, ventilation openings shall be kept clear of obstruction.
- The minimum floor area [m2] is determined based on the installation height of a ceiling mounted unit and is specified in Table 1, page 21.
- An unventilated area where the system is installed shall be so constructed that should any refrigerant leak, it will not stagnate to create a fire or explosion hazard
    - The system shall be stored/installed in a well-ventilated area where the room size corresponds to the room area as specified for operation.
    - The system shall be stored/installed in a room without continuously operating open flames (for example an operating gas appliance) and ignition sources (for example an operating electric heater; other potential continuously operating sources known to cause ignition of the R32 refrigerant.
- Indoor unit serving one or more rooms shall be directly ducted to the space/s. Open areas such as false ceilings shall not be used as a return air duct.
- Ducts connected to the indoor unit shall not contain auxiliary devices which may be a potential ignition source (e.g., hot surfaces with temperatures over 700°C and electrical switching devices).

2. Servicing

2.1 Service Personnel

- Any person who is involved with working on or breaking into a refrigerant circuit should hold a current valid certificate from an industry-accredited assessment authority, which authorizes their competence to handle refrigerants safely in accordance with an industry recognised assessment specification.
- Servicing shall only be performed as recommended by the equipment manufacturer.
- Maintenance and repair requiring the assistance of other skilled personnel shall be carried out under the supervision of a person competent in the use of flammable refrigerants.

2.2 Checks to the Area

- Prior to beginning work on systems containing flammable refrigerants, safety checks are necessary to ensure that the risk of ignition is minimised. For repair to the refrigerating system, the precautions in 2-3 to 2-9 shall be complied with prior to conducting work on the system.

2.3 Work Procedure

- Work shall be undertaken under a controlled procedure so as to minimise the risk of a flammable gas or vapour being present while the work is being performed.

2.4 General Work Area

- All maintenance staff and others working in the local area shall be instructed on the nature of work being carried out. Work in confined spaces shall be avoided. The area around the workspace shall be sectioned off. Ensure that the conditions within the area have been made safe by control of flammable material.

2.5 Checking for Presence of Refrigerant

- The area shall be checked with an appropriate refrigerant detector prior to and during work, to ensure the technician is aware of potentially flammable atmospheres.
- Ensure that the leak detection equipment being used is suitable for use with flammable refrigerants, i.e., non-sparking, adequately sealed or intrinsically safe.

2.6 Presence of Fire Extinguisher

- If any hot work is to be conducted on the refrigeration equipment or any associated parts, appropriate fire extinguishing equipment shall be available to hand.
- Have a dry powder or CO2 fire extinguisher adjacent to the charging area.

2.7 No Ignition Sources

- No person carrying out work in relation to a refrigeration system which involves exposing any pipe work that contains or has contained flammable refrigerant shall use any sources of ignition in such a manner that it may lead to the risk of fire or explosion.
- All possible ignition sources, including cigarette smoking, should be kept sufficiently far away from the site of installation, repairing, removing and disposal, during which flammable refrigerant can possibly be released to the surrounding space.
- Prior to work taking place, the area around the equipment is to be surveyed to make sure that there are no flammable hazards or ignition risks. ‘No Smoking’ signs shall be displayed.

2.8 Ventilated Area

- Ensure that the area is in the open or that it is adequately ventilated before breaking into the system or conducting any hot work.
- A degree of ventilation shall continue during the period that the work is carried out.
- The ventilation should safely disperse any released refrigerant and preferably expel it externally into the atmosphere.

2.9 Checks to the Refrigeration Equipment

- Where electrical components are being changed, they shall be fit for the purpose and to the correct specification.
- At all times the manufacturer's maintenance and service guidelines shall be followed.
- If in doubt consult the manufacturer's technical department for assistance.
- The following checks shall be applied to installations using flammable refrigerants:
    - The charge size is in accordance with the room size within which the refrigerant containing parts are installed.
    - The ventilation machinery and outlets are operating adequately and are not obstructed.
    - If an indirect refrigerating circuit is being used, the secondary circuit shall be checked for the presence of refrigerant.
    - Marking to the equipment continues to be visible and legible. Markings and signs that are illegible shall be corrected.
    - Refrigeration pipe or components are installed in a position where they are unlikely to be exposed to any substance which may corrode refrigerant containing components, unless the components are constructed of materials which are inherently resistant to being corroded or are suitably protected against being so corroded.

3. Checks to Electrical Devices

- Repair and maintenance to electrical components shall include initial safety checks and component inspection procedures.
- If a fault exists that could compromise safety, then no electrical supply shall be connected to the circuit until it is satisfactorily dealt with.
- If the fault cannot be corrected immediately but it is necessary to continue operation, an adequate temporary solution shall be used.
- This shall be reported to the owner of the equipment, so all parties are advised.
- Initial safety checks shall include:
    - That capacitors are discharged: this shall be done in a safe manner to avoid possibility of sparking.
    - That there no live electrical components and wiring are exposed while charging, recovering, or purging the system.
    - That there is continuity of earth bonding.

4. Repairs to Sealed Components

- During repairs to sealed components, all electrical supplies shall be disconnected from the equipment being worked upon prior to any removal of sealed covers, etc.
- If it is necessary to have an electrical supply to equipment during servicing, then a permanently operating form of leak detection shall be located at the most critical point to warn of a potentially hazardous situation.
- Particular attention shall be paid to the following to ensure that by working on electrical components, the casing is not altered in such a way that the level of protection is affected.
- This shall include damage to cables, excessive number of connections, terminals not made to original specification, damage to seals, incorrect fitting of glands, etc.
- Ensure that apparatus is mounted securely.
- Ensure that seals or sealing materials have not degraded such that they no longer serve the purpose of preventing the ingress of flammable atmospheres.
- Replacement parts shall be in accordance with the manufacturer's specifications.

NOTE: The use of silicon sealant may inhibit the effectiveness of some types of leak detection equipment. Intrinsically safe components do not have to be isolated prior to working on them.

5. Repair to Intrinsically Safe Components

- Do not apply any permanent inductive or capacitance loads to the circuit without ensuring that this will not exceed the permissible voltage and current permitted for the equipment in use.
- Intrinsically safe components are the only types that can be worked on while live in the presence of a flammable atmosphere.
- The test apparatus shall be at the correct rating.
- Replace components only with parts specified by the manufacturer.
- Other parts may result in the ignition of refrigerant in the atmosphere from a leak.

6. Cabling

- Check that electrical cabling will not be subject to wear, corrosion, excessive pressure, vibration, sharp edges, or any other adverse environmental effects.
- The check shall also take into account the effects of aging or continual vibration from sources such as compressors or fans.

7. Detection of Flammable Refrigerants

- Under no circumstances shall potential sources of ignition be used in the searching for or detection of refrigerant leaks.
- A halide torch (or any other detector using a naked flame) shall not be used.
- The following leak detection methods are deemed acceptable: bubble method, fluorescent method agents.
- Electronic leak detectors shall be used to detect flammable refrigerants, but the sensitivity may not be adequate, or may need re-calibration. (Detection equipment shall be calibrated in a refrigerant-free area.)

7. Detection of Flammable Refrigerants (continued)

- Ensure that the detector is not a potential source of ignition and is suitable for the refrigerant used.
- Leak detection equipment shall be set at a percentage of the LFL of the refrigerant and shall be calibrated to the refrigerant employed and the appropriate percentage of gas (25% maximum) is confirmed.
- Leak detection fluids are suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine may react with the refrigerant and corrode the copper pipework.
- If a leak is suspected, all naked flames shall be removed/ extinguished.
- If a leakage of refrigerant is found which requires brazing, all of the refrigerant shall be recovered from the system, or isolated (by means of shut-off valves) in a part of the system remote from the leak. Oxygen free nitrogen (OFN) shall then be purged through the system both before and during the brazing process.

8. Removal and Evacuation

- When breaking into the refrigerant circuit to make repairs, or for any other purpose, conventional procedures shall be used. However, it is important that best practice is followed since flammability is a consideration.
- The following procedure shall be adhered to:
    - remove refrigerant
    - purge the circuit with inert gas
    - evacuate
    - purge again with inert gas
    - open the circuit by cutting or brazing.
    - The refrigerant charge shall be recovered into the correct recovery cylinders and returned to an industry recognised reclaim facility.
    - The system shall be 'flushed' with OFN to render the unit safe.
    - This process may need to be repeated several times.
    - Compressed air or oxygen shall not be used for this task.
    - Flushing shall be achieved by breaking the vacuum in the system with OFN and continuing to fill until the working pressure is achieved, then venting to atmosphere, and finally pulling down to a vacuum.
    - This process shall be repeated until no refrigerant is within the system.
    - When the final OFN charge is used, the system shall be vented down to atmospheric pressure to enable work to take place.
    - This operation is absolutely vital if brazing operations on the pipe work are to take place.
    - Ensure that the outlet for the vacuum pump is not close to any potential ignition sources and there is ventilation available.

9. Charging Procedures

- In addition to conventional charging procedures, the following requirements shall be followed:
    - Ensure that contamination of different refrigerants does not occur when using charging equipment.
    - Hoses or lines shall be as short as possible to minimize the amount of refrigerant contained in them.
    - Cylinders shall be kept upright.
    - Ensure that the refrigeration system is earthed prior to charging the system with refrigerant.
    - Label the system when charging is complete (if not already).
    - Extreme care shall be taken not to overfill the refrigeration system.
- Prior to recharging the system, it shall be pressure tested with OFN.
- The system shall be leak tested on completion of charging but prior to commissioning.
- A follow up leak test shall be carried out prior to leaving the site.

10. Decommissioning

- Follow national regulations when disposing of a product.
- Before carrying out decommissioning procedures, it is essential that the technician is completely familiar with the equipment and all its details.
- It is recommended good practice that all refrigerants are recovered safely.
- Prior to the task being carried out, an oil and refrigerant sample shall be taken in case analysis is required prior to re-use of reclaimed refrigerant.
- It is essential that electrical power is available before the task is commenced.
- Become familiar with the equipment and its operation.
- Isolate system electrically.
- Before attempting the procedure ensure that:
    - mechanical handling equipment is available, if required, for handling refrigerant cylinders.
    - all personal protective equipment is available and being used correctly.
    - the recovery process is supervised at all times by a competent person.
    - recovery equipment and cylinders conform to the appropriate standards.
- Pump down refrigerant system, if possible.
- If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.
- Make sure that cylinder is situated on the scales before recovery takes place.
- Start the recovery machine and operate in accordance with manufacturer's instructions.
- Do not overfill cylinders. (No more than 80 % volume liquid charge).
- Do not exceed the maximum working pressure of the cylinder, even temporarily.
- When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.
- Recovered refrigerant shall not be charged into another refrigeration system unless it has been cleaned and checked.

11. Labeling (Following Decommissioning)

- Equipment shall be labelled stating that it has been decommissioned and emptied of refrigerant.
- The label shall be dated and signed.
- Ensure that there are labels on the equipment stating the equipment contains flammable refrigerant.

12. Recovery

- When removing refrigerant from a system, either for servicing or decommissioning, it is recommended good practice that all refrigerants are removed safely.
- When transferring refrigerant into cylinders, ensure that only appropriate refrigerant recovery cylinders are employed.
- Ensure that the correct number of cylinders for holding the total system charge are available.
- All cylinders to be used are designated for the recovered refrigerant and labelled for that refrigerant (i.e. special cylinders for the recovery of refrigerant).
- Cylinders shall be complete with pressure relief valve and associated shut-off valves in good working order.
- Empty recovery cylinders are evacuated and, if possible, cooled before recovery occurs.
- The recovery equipment shall be in good working order with a set of instructions concerning the equipment that is at hand and shall be suitable for the recovery of flammable refrigerants.
- In addition, a set of calibrated weighing scales shall be available and in good working order.
- Hoses shall be complete with leak-free disconnect couplings and in good condition.
- Before using the recovery machine, check that it is in satisfactory working order, has been properly maintained and that any associated electrical components are sealed to prevent ignition in the event of a refrigerant release. Consult manufacturer if in doubt.
- The recovered refrigerant shall be returned to the refrigerant supplier in the correct recovery cylinder, and the relevant Waste Transfer Note arranged.
- Do not mix refrigerants in recovery units and especially not in cylinders.
- If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that flammable refrigerant does not remain within the lubricant.
- The evacuation process shall be carried out prior to returning the compressor to the suppliers.
- Only electric heating to the compressor body shall be employed to accelerate this process.
- When oil is drained from a system, it shall be carried out safely.

Table 1 Minimum Floor Area

Extended line lengths increase the charge requirement and consequently the minimum floor area being served. Refer Specification sheets for charge limitations for your Split system.

R32 Charge (kg)	Min. Floor Area (m^2) ceiling diffuser*	Min. Floor Area (m^2) floor diffuser**
3.5	6.5	104.3
4.0	8.5	136.2
4.5	10.8	172.3
5.0	13.3	212.8
5.5	16.1	257.5
6.0	19.1	306.4
6.5	22.5	359.6
7.0	26.1	417.0
7.5	29.9	478.7
8.0	34.0	544.7
8.5	38.4	614.9
9.0	45.0	689.4
9.5	57.1	768.1
10.0	53.2	851.1
10.5	58.6	938.3
11.0	64.4	1029.8
11.5	70.3	1125.6

R32 Charge (kg)	Min. Floor Area (m^2) ceiling diffuser*	Min. Floor Area (m^2) floor diffuser
12.0	76.6	1225.6
12.5	83.1	1329.8
13.0	89.9	1438.3
13.5	96.9	1551.1
14.0	104.3	1668.1
14.5	111.8	1789.4
15.0	119.7	1914.9
15.5	127.8	2044.7
16.0	136.2	2178.8
16.5	144.8	2317.1
17.0	153.7	2459.6
17.5	162.9	2606.4
18.0	172.3	2757.5
18.5	182.1	2912.8
19.0	192.0	3072.4
19.5	202.3	3236.2
20.0	212.8	3404.3

* Based on a minimum release height of 2.4m. Greater heights reduce required floor area.

** Based on a minimum release height of 0.6m.


GUN 1
R32

Recommended Test & Repair Procedures

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Safety

It is important that all works conducted to refrigeration and air-conditioning systems are conducted by licenced and trained individuals accredited by local and or national governing bodies. All works should be conducted according to current legislation and industry codes of practice.

Temperzone recommends that you familiarise yourself with information available such as the R32 refrigerant handling guide, the split system piping guide, unit specifications, unit installation manual and unit general information manual.

1. Piping

The hierarchy of piping connections tiered from most recommended to least:

1. Brazed with oxygen and acetylene
2. Brazed with induced oxygen (e.g., turbo torch and MAPP Gas)
3. Crimp connections (e.g., Zoom lock crimping tools)
4. Threaded connections

Brazing (oxygen / acetylene and induced oxygen)

WARNING! – Brazing is to be carried out by experienced persons operating under workplace health and safety guidelines.

- Joints for brazing should be prepared by cleaning surfaces with a nylon scouring pad for prevention of particles from material such as sandpaper entering pipework.
- Flux should be used on all joints and brazing rod for the deepest penetration of the joint.
- When un-sweating components or pipework from an R32 system, purge the system with nitrogen while using heat to eliminate the chance of flashover upon breaking of system.
- Purge system pipework with nitrogen when brazing to prevent carbonisation of internal pipework.

Recommended Brazing Agent				
Material	**Copper**	**Brass**	**Steel**	**Stainless Steel**
Copper	15% Silver < (brown tip)	40% Silver < (blue tip)	40% Silver < (blue tip) or brass rod	56% Silver < (orange tip)
Brass	40% Silver < (blue tip)	40% Silver < (blue tip)	40% Silver < (blue tip) or brass rod	56% Silver < (orange tip)
Steel	40% Silver < (blue tip) or brass rod	40% Silver < (blue tip) or brass rod	40% Silver < (blue tip) or brass rod	56% Silver < (orange tip)
Stainless Steel	56% Silver < (orange tip)	56% Silver < (orange tip)	56% Silver < (orange tip)	56% Silver < (orange tip)

Crimp Connections

Install crimp connections in accordance with all the manufacturer's instructions. Temperzone do not recommend this type of connection due to possible limitations of future access for repair, leaks caused by future impacts to pipework, and the possibility of deterioration to mechanical seals over time.

Threaded connections

Only use threaded connections where every other option is eliminated. This may occur in workplaces requiring complete intrinsic safety; however, it is of the recommendation from temperzone to avoid threaded connections whenever possible.

2. Reclaiming refrigerant

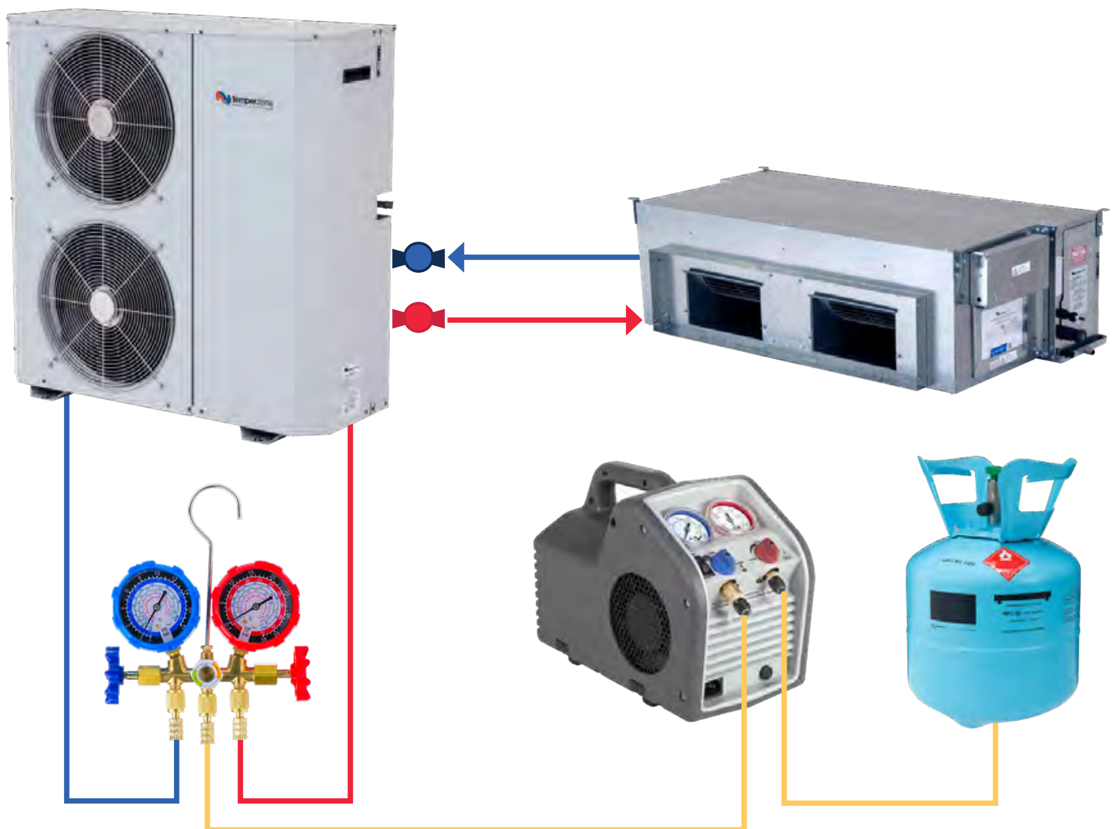
2.1. Pumping the system down

Do not pump down using the system compressor. The compressor should always operate within its operating envelope. Operation outside of the envelope by pumping the system down may cause permanent irreversible damage to compressor components.

2.2. Reclaiming to the indoor or outdoor unit

When conducting repair work to a split system it is possible to close the valves on interconnecting pipework and use a reclaim unit to pump the systems refrigerant from the outdoor unit to the indoor unit or vice versa. This is acceptable, however, for safety reasons, it is suggested that a large volume clean cylinder is added to the circuit to increase system volume in the event of liquid refrigerant expansion. This is especially important on systems with long pipe runs and systems with an unknown quantity of refrigerant. See the image below detailing description when pumping refrigerant to the indoor unit.

Note: Never manually or electrically close the electronic expansion valve for use as an isolation point when conducting works.



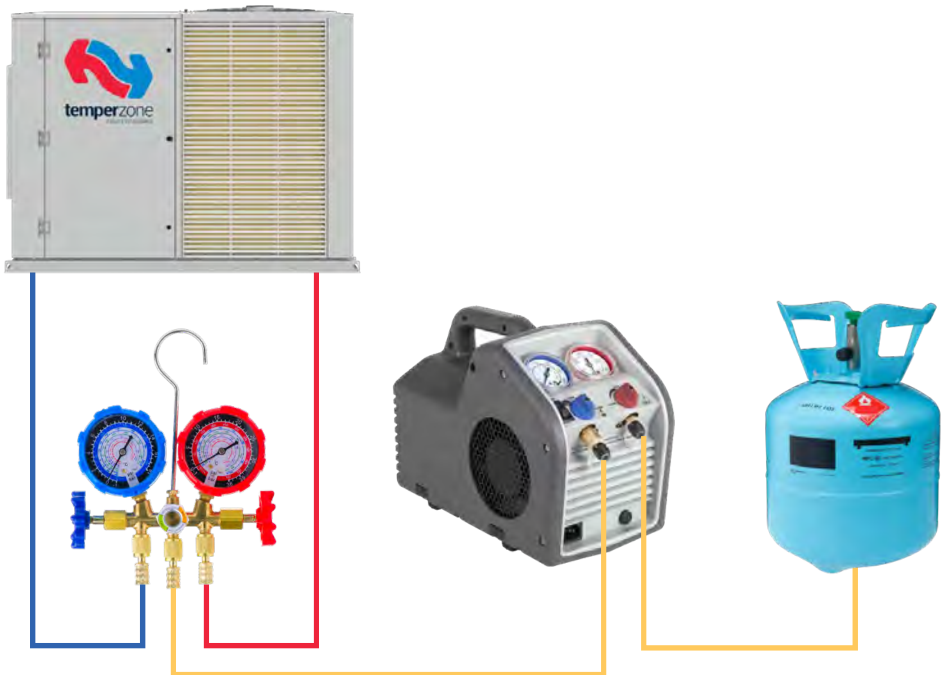
2.3. Vapour / liquid recovery

Vapour / liquid recovery is a valid recovery for temperzone equipment and should be utilised on packaged equipment or split ducted equipment that requires the entire charge removed and is not storing the refrigerant to one half of the circuit as mentioned in section 2.2. This method involves connection from the high and low side ports, through the gauges to the recovery unit suction port. The recovery unit then discharges into the vapour port of the recovery bottle.

An increased recovery speed can be achieved by lowering the head pressure of the recovery unit by cooling the pump down bottle with running water, or an ice bath. Alternatively, a 6mm copper coil can be made (sub-cooler) and connected between the recovery unit discharge and pump down bottle. This coil can then be dunked in a water bath to reduce head pressure and increase refrigerant flow.

Note: Only fill recovery or pump down bottles up to 80% of liquid refrigerant capacity.

Below left is a diagram of the vapour / liquid recovery method. Below right is an example of a handmade and commercially available sub-cooler used to increase recovery speed.



2.4. Push / pull recovery

Three specific system requirements must be fulfilled to conduct a successful push / pull recovery.

1. The system must contain more than 5 Kg of refrigerant
2. The system cannot have a reversing valve
3. The system cannot have an accumulator or between liquid recovery ports or pipework that does not allow the formation of a solid column of liquid.

Although the push pull method is the fastest of all recovery methods it is the inability to meet all the three requirements above that make using the push / pull recovery method on temperzone equipment impractical.

3. Pressure testing

WARNING! Do not pressure test with any gas other than dry nitrogen. Testing with other gasses such as oxygen can be volatile and explosive leading to injury and death!

3.1. Pressure testing with nitrogen

Pressure testing is conducted with dry nitrogen for the following reasons:

- Nitrogen is inert and poses no ignition risk
- Nitrogen is low on the periodic table making it inherently stable in pressure versus temperature relationship
- Nitrogen makes up 70% of the air we breathe making easy to source and environmentally neutral to vent to atmosphere
- Dry nitrogen has all moisture removed, making it a gaseous sponge to absorb moisture within a contaminated refrigeration system.

When pressure testing on a temperzone system, it is recommended to achieve a minimum test pressure above 3000 kPa (435 psi) for leak detection of minor leaks. Test pressure should not exceed 4700 kPa (680 psi) as this is the maximum tolerance allowable for correct calibration of the suction transducer.

Time periods for acceptable pressure testing are up to individual discretion as variables such as the size of the system and the size of the leak can make detection differ in times. The table below gives an indicative guide for the service technician to make a detection time choice for a standing pressure test.

Standing Pressure Test Time Guide		
System size vs leak size	**System with +5 kg refrigerant capacity**	**System with – 5kg refrigerant capacity**
Major Leak	30 minutes	15 minutes
Minor Leak	1 hour	30 minutes
Very Minor Leak	24 hours	12 hours

Note: Systems previously containing refrigerant can hold impregnated refrigerant within oil. This can vary system pressure (especially on small capacity systems) if ambient conditions change. This affect can be helped to overcome if:

- System is purged with nitrogen before standing test is conducted, as this will help remove any traces of air, moisture and refrigerant that may affect readings
- The ambient conditions are as close to possible as the ambient conditions when nitrogen was added when reading results of standing pressure test
- Vacuum pump can be used to help encourage refrigerant boil off before adding nitrogen.
- The sump heater can be energised to encourage refrigerant boil off.

3.2. Leak detection methods

Soapy Bubbles

Soapy solutions are a cheap and effective way of identifying leaks from very large to very small.

Trace gas

Trace gas is a mixture of 95% nitrogen and 5% hydrogen. This combination is non-flammable and can be used in conjunction with an appropriate electronic leak detector to identify leak locations. After leak location is identified, it is recommended to use the soapy bubble method to pinpoint. The trace gas method can be hampered when using in windy areas.

Vacuum Test

A vacuum test works in the same category as a standing pressure test. Vacuum tests should be employed as a secondary test (to double check) after nitrogen pressure testing has deemed the system to be leak free. A vacuum test should never be considered a primary test to conclusively identify a system as leak free.

This can be done after the system has been placed under vacuum and achieved the desired vacuum reading. Before adding refrigerant close the gauges with the vacuum-stat connected on the system. Let the system sit for 15 minutes and watch for a rise on the vacuum-stat. A rise in micron reading indicates there is still a leak in the system.

Note: Embedded refrigerant within the oil can affect standing vacuum readings when boiling off. Running the compressor sump heater while the vacuum pump is operating can help reduce this affect.

4. Placing the system under vacuum

Selection of the correct vacuum method for the correct scenario can save several hours of time to achieve the desired micron reading. The right method can also help to maximise the lifespan of repaired equipment.

Deep vacuum is best used for:

- New pipe
- Small systems
- After leak repairs where the equipment still contained a positive pressure of refrigerant

Triple vacuum is best used for:

- Older systems
- Systems with a history of refrigeration repairs
- Large systems
- Systems suspected to contain moisture
- Systems that have lost their gas charge entirely

4.1. Deep vacuum

The deep vacuum method involves achieving a maximum vacuum of 500 microns in one use of the vacuum pump. It is recommended to conduct a 15-minute standing vacuum test after achieving 500 microns (see section 3.2.).

4.2. Triple vacuum

Triple vacuum method involves three vacuum pump uses to achieve a 1000-micron target.
The steps are as follows:

1. Vacuum pump system down to 5000 microns
2. Break system to a positive pressure with dry nitrogen (no more than 50 kPa system pressure)
3. Vacuum pump system down to 5000 microns a second time
4. Break system to a positive pressure with dry nitrogen (no more than 50 kPa system pressure)
5. Vacuum pump system to 1000 microns (or lower) for the third and final time
6. Perform a standing vacuum test (see section 3.2.)

The vacuum only achieves 5000 microns in the first 2 vacuums as this is the freezing point of water, therefore any moisture in the system will not be removed in vacuums lower than this reading. When the system is broken with dry nitrogen, the dry nitrogen absorbs any moisture that is rapidly evaporating under vacuum. The 'wet' nitrogen is then expelled under the next vacuum. Confidence in knowing all moisture has been removed from the system after this is breaking with nitrogen twice.

Although it is easy to assume the triple vacuum method appears to be longer and more laborious, it is considered by far the superior method of vacuum. Moisture evaporating from a system is what makes achieving a deep vacuum very slow, the high moisture removal capabilities of triple vacuum method can often make it the fastest method.

5. Using hygroscopic oils

Oils by nature have the tendency to draw in moisture from the air. This process is known as hygroscopicity. Synthetic oil used in the refrigeration industry such as P.O.E (polyol ester) and P.V.E (polyvinyl ether) oils used in temperzone equipment are especially hygroscopic. If excessive moisture is absorbed, the oil can become acidic causing de-lamination of motor windings, copper plating of components, ice crystals can form that reduce performance of the evaporator and cause blockages in the expansion devices, and oil viscosity (runniness) is compromised which can lead to blockages, poor oil return and failure of moving parts. For these reasons it is imperative that proper handling of oils is always observed.

5.1. Adding additional oil

It is recommended that when purchasing oil, it is purchased in quantities that are close to the required volume for a job. This is to limit the chance of hygroscopic contamination during long periods of storage.

Oil can be added to a system by two methods, a hand pump or by negative vacuum pressure to draw oil in. In any case oil is best added to the suction line.

Regardless of which method chosen when adding oil care should be taken when the open can is exposed to the atmosphere. Use a rag to make a seal over a gauge line at the can opening. Connect the other end to a nitrogen regulator and bleed a small positive pressure of dry nitrogen into the can while it is open to atmosphere (much like when nitrogen is bled into copper pipe when welding). Keep the can with positive nitrogen pressure until desired oil has been added, then close the can immediately

For information regarding required oil type and volume refer to unit installation manuals and specification sheets.

6. Compressor burnout / seizure recommendations

6.1. Testing of oil and compressor

Temperzone recommend testing the oil of any failed compressor. Professional oil testing can identify if abrasives are present such as metallic shards, if the oil has turned acidic and if there is a presence of moisture. Understanding the condition of the oil within a system that has suffered a compressor failure can help determine the action needed to prevent early failure of the replacement compressor.

Further investigation may be warranted if the system has had repeated compressor failures or failure of a compressor with low running hours. In addition to oil testing a breakdown report can be ascertained from third party compressor engineering companies. A breakdown report can identify oil levels, the presence of liquid flood back, the type of burn out, electrical malfunctions and power supply issues.

6.2. System flush

Should a compressor suffer an electrical burn out, it is not uncommon if the oil within the system is now acidic (this can be proven with oil testing). If the oil is acidic or contains abrasives a system flush should be conducted to clean the internal refrigeration circuit and protect the replacement compressor from premature failure. With the compressor removed from the system, flush pipework with a flushing agent such as Shellite. If permissible disconnect the condenser and evaporator from the piping circuit and flush these components separately. If the circuit has an accumulator remove it and perform the flush separately ensuring inversion of the accumulator. Separate pipework in as many sections as practical and try to flush the piping 'downhill' to harness the assistance of gravity.

6.3. Use of filter dryers

If a system flush is conducted with success, there is no need to add a filter dryer for system clean up. If the system is vacuumed to standard there is no need to add a filter dryer for moisture absorption.

If there is concern about particulates and abrasives in the pipework it is acceptable to install a bi-flow filter dryer in the liquid line to protect the expansion device and prevent particulates returning to the compressor sump. Best practice would be to use a soldered product not flared. If using flared frost-free flare nuts are necessary to prevent fracture in heating mode. It is strongly suggested to install service ports prior and post filter dryer to conduct regular checks for pressure drop, as a blockage can cause loss in capacity and compressor operation out of envelope.

If there is concern about acidic oil remaining in the system due to an ineffective system flush, a burnout filter dryer can be added to the liquid line. Be aware that liquid line burnout filter dryers are not bi-directional. Should one be added to a system it should installed in the direction of most common operation i.e., heating or cooling. In addition, a bypass line with check valve will need to be installed for system operation opposing the direction of the most common mode of operation. A second burnout dryer can be added to the bypass line in reverse direction should it be desired to operate in both directions of flow. Like standard bi-flow liquid line dryers regular checks for pressure drop will be required.

Note: when installing liquid line filter dryers on split ducted system be sure to ascertain the location of the 'true' liquid line as the electronic expansion valve can be at the outdoor unit, indoor unit, or both, dependent on model.

It is **not** recommended to install a suction line burnout filter dryer. The reason for this is due to the reason that any pressure drop across the filter dryer can create inaccurate suction transducer and suction temperature readings depending on location of these components in relation to the filter dryer installation. Consequently, this in turn can cause incorrect modulation of the electronic expansion valve that at best will cause nuisance tripping and at worst, liquid flood back that leads to premature failure of the replacement compressor.

7. Refrigerant charging

Blend refrigerants are made up of two or more single component refrigerants. Azeotropic blend refrigerants are made of refrigerants that have the same boiling points, therefore they behave like a single component refrigerant. Zeotropic blends are made of multiple refrigerants that have different boiling points. These refrigerants require liquid charging as vapour charging will separate the different refrigerants in order by boiling point, hence the zeotropic blend mixture contained within the system will be incorrect. An easy way to recognise a zeotropic blend is in the refrigerants name; any refrigerant name starting with the number four is a zeotropic blend and requires liquid charging e.g., R410a.

Refrigerant Charging Method			
Refrigerant	**Refrigerant Property**	**Liquid Charge**	**Vapour Charge**
R22	Single	Yes	Yes
R407c	Blend	Yes	No
R410a	Blend	Yes	No
R32	Single	Yes	Yes

Pressure Temperature Chart

°C	R32		R410a				R407c				R22		°C
			Bubble		Dew		Bubble		Dew				
	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	
-20	304	44	299	43	298	43	179	26	113	16	144	21	-20
-18	336	49	330	48	329	48	201	29	132	19	163	24	-18
-16	369	54	363	52	362	52	224	33	352	22	184	27	-16
-14	405	59	398	58	396	57	249	36	173	25	206	30	-14
-12	442	64	435	63	433	63	276	40	195	28	229	33	-12
-10	481	70	473	69	471	68	303	44	218	32	253	37	-10
-8	523	76	514	75	512	74	333	48	244	35	279	40	-8
-6	567	82	557	81	555	80	364	53	270	39	306	44	-6
-4	613	89	602	87	600	87	396	57	298	43	335	49	-4
-2	661	96	650	94	647	94	431	62	328	48	365	53	-2
0	712	103	699	101	697	101	467	68	359	52	397	58	0
2	765	111	752	109	749	109	504	73	393	57	430	62	2
4	821	119	806	117	804	117	544	79	427	62	465	67	4
6	880	128	864	125	861	125	586	85	464	67	501	73	6
8	941	137	924	134	921	134	629	91	503	73	540	78	8
10	1006	146	987	143	983	143	675	98	544	79	580	84	10
12	1073	156	1053	153	1049	152	723	105	586	85	622	90	12
14	1143	166	1122	163	1118	162	773	112	631	92	665	97	14
16	1217	176	1193	173	1189	172	825	120	678	98	711	103	16
18	1293	188	1268	184	1264	183	879	128	727	106	759	110	18
20	1373	199	1346	195	1342	195	936	136	779	113	809	117	20
22	1457	211	1628	207	1423	206	996	144	833	121	861	125	22
24	1544	224	1512	219	1507	219	1057	153	890	129	915	133	24
26	1634	237	1601	232	1595	231	1121	163	949	138	971	141	26
28	1728	251	1692	245	1687	245	1188	172	1010	147	1030	149	28
30	1826	265	1788	259	1782	258	1258	182	1075	156	1091	158	30
32	1928	280	1887	274	1881	274	1330	193	1142	166	1154	167	32
34	2034	295	1990	289	1984	288	1405	204	1212	176	1220	177	34
36	2144	311	2098	304	2091	303	1483	215	1285	186	1288	187	36
38	2258	328	2206	320	2202	319	1564	227	1361	197	1359	197	38
40	2377	345	2324	337	2317	336	1648	239	1440	209	1432	208	40
42	2500	363	2444	354	2437	353	1735	252	1522	221	1508	219	42
44	2628	381	2569	373	2561	371	1825	265	1608	233	1587	230	44
46	2760	400	2698	391	2690	390	1918	278	1697	246	1669	242	46
48	2898	420	2831	411	2823	409	2015	292	1790	260	1754	254	48
50	3040	441	2970	431	2962	430	2115	307	1886	274	1841	267	50
52	3187	462	3113	451	3105	450	2218	322	1987	288	1932	280	52
54	3340	484	3263	473	3254	472	2325	337	2091	303	2026	294	54
56	3498	507	3416	495	3408	494	2436	353	2199	319	2123	308	56
58	3662	531	3576	519	3568	517	2550	370	2311	335	2223	322	58
60	3832	556	3741	543	3734	541	2668	387	2427	352	2326	337	60
62	4008	581	3913	567	3905	566	2790	405	2548	390	2433	353	62
64	4190	608	4090	593	4083	592	2916	423	2674	388	2543	369	64
66	4378	635	4274	620	4268	619	3046	442	2805	407	2657	385	66
68	4573	663	4465	648	4461	647	3180	461	2940	426	2775	402	68
70	4776	693	4663	676	4660	676	3318	481	3081	447	2896	420	70

Use dew pressure for superheat calculations and bubble pressure for sub cooling calculations.

Split Systems Installation Guide

(R32 Models)

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Table 1 Split System Piping Requirements p. 38

1. General

All refrigeration pipe brazing, evacuation and charging shall be performed by a technician with a current Refrigerant Handling License.

IMPORTANT.

Read the additional 'R32 Refrigerant Handling' and 'Installation & Maintenance' instructions accompanying each product. Hot Work Permits should be acquired where necessary before work commences. Follow the Refrigerant Handling Code of Practice guidelines.

WARNING.

R32 refrigerant (Class A2L) is mildly flammable.

The system shall be installed, operated and stored in a well-ventilated space.

If the refrigerant gas comes into contact with fire, a toxic gas may occur. Be aware that R32 does not contain an odour.

The appliance shall be stored in a room:

- without continuously operating open flames (for example an operating gas appliance) and ignition sources (for example an operating electric heater).
- away from other potential continuously operating sources known to cause ignition of R32 refrigerant.

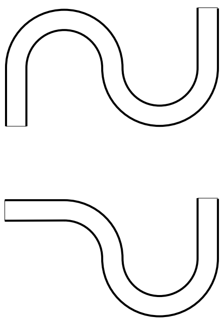
2. Piping

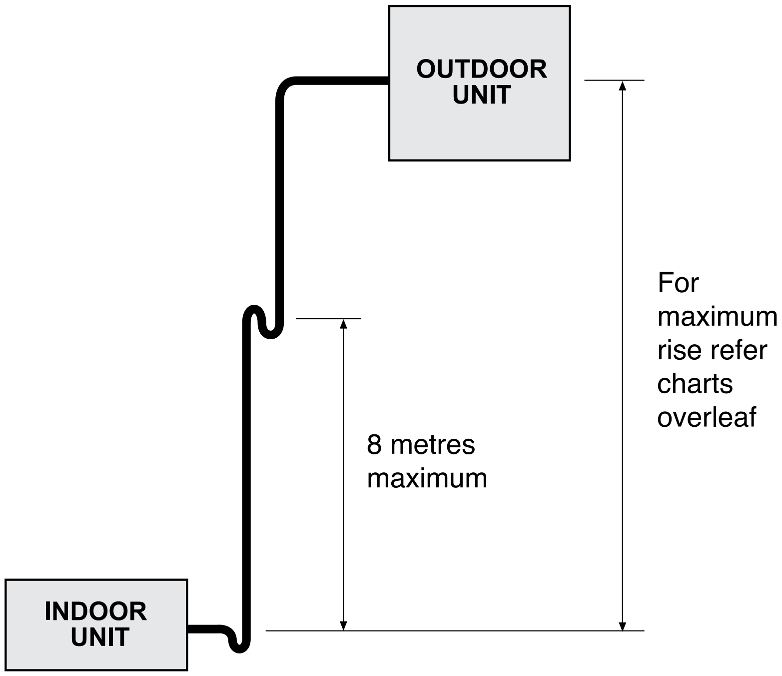
1. Use clean sealed refrigeration grade piping.
2. Pipe to be cut ONLY with a pipe cutter.
3. Use long radius bends (2 x pipe dia.)
4. Insulate both the gas and liquid line on all units and seal all insulation joints.
5. Include a process point on the interconnecting pipework.
6. Ensure all open pipe ends are sealed until the final connection is made.
7. Purge pipes using Nitrogen during brazing.
8. Immediately before removing any brazed seals on pipe stub connections of outdoor units, release any residual pressure using Schraeder valves provided on the pipework after the shut-off valves.
   Warning: Failure to do so may cause injury.
9. Existing R410A pipework can be re-used when replacing older R410A units with new R32 units provided the interconnecting pipe size is not smaller than that recommended for the new system.

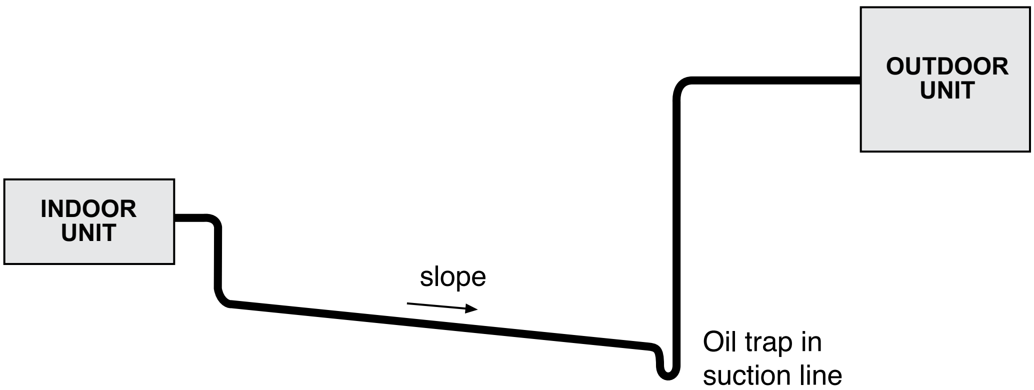
3. Oil Traps

Oil traps must be fitted to vertical suction risers where outdoor unit is above indoor unit. Fit a trap at the bottom of the vertical rise and then at 8 m (maximum) intervals.

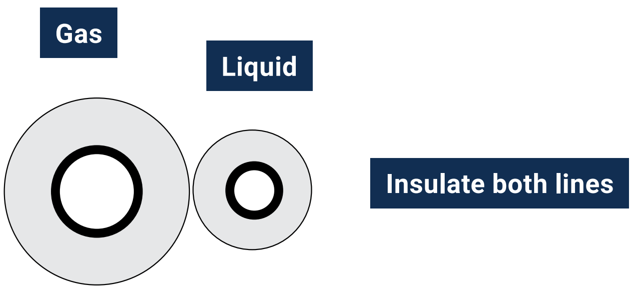
Design







4. Piping Insulation



5. Evacuation Procedure

(Pre-Charged Outdoor Units)

Evacuate the Indoor Unit plus interconnecting pipework to achieve a vacuum of 500 microns which is to be held for 15 mins. The use of an electronic vacuum gauge is essential for this exercise.

6. Pre-Charged Units

Pre-charged Outdoor units include charge sufficient for the line length shown in Table 1 (page 38) and stated in the unit's installation instructions.

Calculate additional refrigerant to suit your line length; note:

- Do not exceed the maximum refrigerant charge specified
- Ensure minimum floor area is not breached (refer 'R32 Refrigerant Handling' document).
- For line lengths less than 5m, deduct excess refrigerant, or coil excess pipe out of sight.

7. Refrigerant Charging

Refrigerant charge to be introduced as liquid only and by weight or volume (not by system pressure or sight glass). Sight glasses are not recommended because of flash gas in liquid line.

Temperzone recommends accurate charging/adding of refrigerant using digital refrigeration scales (spring balance is not acceptable).

For units supplied pre-charged, the actual line length and the final charge is crucial to correct operation. If you fear some charge has been lost, recover all the existing charge and re-charge accurately.

8. Refrigerant Pipe Sizes

Liquid line sizes given in the following tables are interconnecting pipe sizes and are not necessarily the same size as the pipe stub connections exiting the Indoor or Outdoor unit.

On any unit with variable capacity compressors, do not oversize the interconnecting piping as this will reduce the refrigerant velocities significantly with the associated danger of not returning the oil to the compressor.

9. Oil

Oil should be added on extended line lengths (refer tables overleaf).

Strictly adhere to recommended quantities.

Inverter compressors designed for R32 use polyester oil (POE) or polyvinylether oil (PVE) – whichever is specified. POE oil can be used as an alternative to PVE oil.

Polyolester oils (POE) are type NXG5020. Do not use mineral oil.

Polyvinylether oils (PVE) are type FW68S.

Please refer to Table 1 (page 38) or the unit Specification data sheet to ensure the use of the correct oil.

10. Crankcase Heaters

Crankcase heaters are fitted to all compressors. Disconnect the crankcase heater if the total line length is less than 8 m.

11. Pipe Length Capacity Loss

Maximum line lengths given represent **actual** measured line length between Indoor and Outdoor units. The **equivalent** line length is significantly more than actual line length because it includes an allowance for bends and vertical piping. Use the equivalent line length when calculating pressure losses or performance losses.

12. Commissioning

Each outdoor unit is supplied with a Commissioning Sheet to assist installers completing the Start Up Procedure outlined in the Installation & Maintenance pamphlet. We recommend you complete the form, send a copy to temperzone, and keep the original yourself for possible future reference.

13. Manufacturer's Note

The manufacturer reserves the right to make changes at any time without notice or obligation. Should any instruction in this guide conflict with any Installation & Maintenance pamphlet supplied with a unit, then the most recently dated publication should be considered correct.

Table 1. Split System Piping Requirements

Model	Scroll Compressor	Standard Unit Limitations			Maximum Vertical Separation		Refrigerant Charging		Oil Charging		Oil Type
		Gas	Liquid	Max. Line Length m	Outdoor Unit above Indoor Unit m	Indoor Unit above Outdoor Unit m	Precharge for 15m Line Length (R32) kg	Additional Charge for Pipe Line Length g/m (R32)	Add Oil Beyond m	Additional Oil ml/m	
OSA 171RLSF	YPV030LT-3X9-LBK	19	9.5	60	20	20	4.1	60	40	10 ml/m	POE-46 (NXG5020 or equivalent*)
OSA 171RLTF	YPV030LT-4X9-LBK	19	9.5	60	20	20	4.1	60	40	10 ml/m	POE-46 (NXG5020 or equivalent*)
OSA 211RLTF	YPV038LT-4X9-LBK	19	9.5	60	20	20	5.2	60	40	10 ml/m	POE-46 (NXG5020 or equivalent*)
OSA 251RLTF	YPW050ST-4X9-LBK	22	13	60	20	20	8.25	105	40	20 ml/m	POE-46 (NXG5020 or equivalent*)
OSA 351RLTF	AVB66FT2MT	28	13	90	20	20	(10m) 9.05	115	40	20 ml/m	PVE (FW68S or equivalent*) or POE-46

Note: As charge amount increases so to does the minimum floor area required to disperse refrigerant in the unlikely event of a leak.

Refer 'R32 Refrigerant Handling' document supplied with units.

* Oil Type Equivalents

POE Oils:

- Emkarate RL32-3MAF
- Emkarate RL68H
- Chemplas POE

PVE Oils:

- Idemitsu PVE-FVC32D
- Danfoss 320HV

Estimating Effective Line Length for Performance Loss

When calculating performance losses for long line lengths allowances must be made for bends in the pipework.

The tabled data (right) is based on Long Radius 90° bends (2 x pipe dia.).

Add this allowance for every bend to the total line length to calculate an 'effective' line length for performance loss.

Suction Line Bend	Equivalent Pipe Length
16 mm	0.30 m
19 mm	0.42 m
22 mm	0.50 m
28 mm	0.61 m
35 mm	0.76 m

No allowance has been included for any effect from vertical lift.

Standard Unit Limitations allow the unit to be installed without any extra protection other than adjustment of the refrigeration gas and/or oil charge.

Scan QR code for
Duct Work Design
Video Tutorial

Flexible Ducting Installation Guide

(Small to Mid-Range Ducted Units)

Contents

1. Introduction p. 40
2. General Rules p. 40

1. Introduction

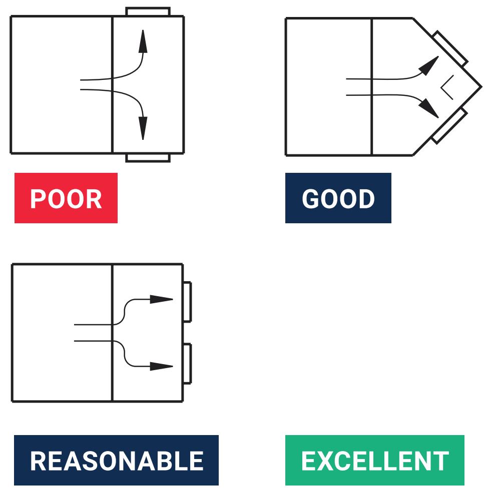
The purpose of this guide is to provide information that assists installers to achieve the desired air flow from temperzone Split System Indoor units and Chilled Water Fan Coil units. It is also useful for investigating systems performing poorly.

Note: Many of these units are designed specifically for low static pressure drops therefore duct losses can be significant.

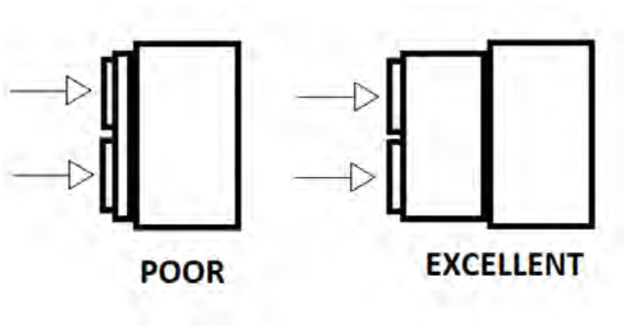
For simplicity, information is based on tests conducted using 250 mm diameter flexible duct. Smaller flexible duct diameters have worse characteristics than larger diameters.

2. General Rules

1. If a unit is supplied with specific size duct spigots, then DO NOT use ducting of a smaller size. If the duct run is more than 3 metres, stepping up to the next size is recommended.
2. If wanting to change the existing number of outlets on ISDL or IMDL low profile units, then the cross-sectional area of the proposed new outlets must be EQUAL TO OR GREATER than that of the original outlets — IT MUST NOT BE LESS.
3. DO NOT blank off an outlet at the spigot plate.
4. AVOID short supply air plenums with side outlets close to the unit, especially with negative pressure units such as IMD and ISD models. This type of plenum generates high pressure losses, turbulence, and noise. Longer plenums with side outlets away from the unit or short plenums with front outlets are preferred. As a rule of thumb, the plenum length should be 7 x fan barrel width, or 4 x duct width long before the first spigot to avoid turbulence.



5. AVOID short return air plenums with inlets close to the unit. Unequal static pressure due to turbulence in short return air plenums encourage uneven air flow and high air speed across the indoor coil resulting in poor performance and water carry over. As a rule of thumb, the return air plenum should be as deep as the flexible connection is wide, i.e., if 400mm return air flexible duct is used the return air plenum should be 400mm deep (multiple flexible return air ducts do not need to be added together).

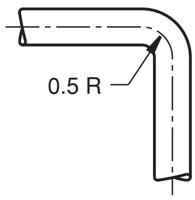


6. Flexible duct can deliver limited volumes of air which will increase with cross sectional size. Design flexible ducting so that the duct selected can SUPPLY THE NOMINAL AIR-FLOW of the unit. Nominal air flow can be identified on the unit specifications. The return air flexible duct MUST also be capable of returning nominal air flow. Special attention needs to be considered when zone dampers are installed to assure that minimum air flow conditions are met regardless of zone operation. Minimum air speed across the indoor coil SHOULD NOT SUBCEED 1.3m/s.

FLEXIBLE DUCT RECOMMENDED AIR QUANTITY	
Cross Section Diameter	**Air Quantity**
150 mm	0-55 L/s
200 mm	56-120 L/s
250 mm	121-195 L/s
300 mm	196-250 L/s
350 mm	251-355 L/s
400 mm	356-500 L/s
450 mm	501-600 L/s

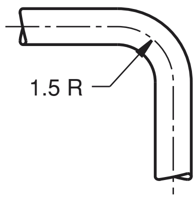
7. Use radii of at least 1.5 times the duct diameter for bends. Tight radii bends can double the pressure loss.

POOR



18 Pa @ 4.5 m/s

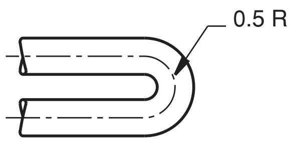
GOOD



10 Pa @ 4.5 m/s

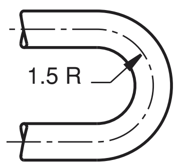
8. 180° ‘U’ bends surprisingly do not generate double the pressure loss of a 90° bend but something much less than double.

POOR



28 Pa @ 4.5 m/s

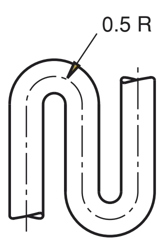
GOOD



12 Pa @ 4.5 m/s

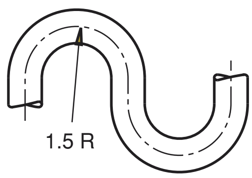
9. Avoid ‘S’ bends as these generate more than double the pressure loss of a 180° bend in fact about 2.5 times the pressure loss

POOR



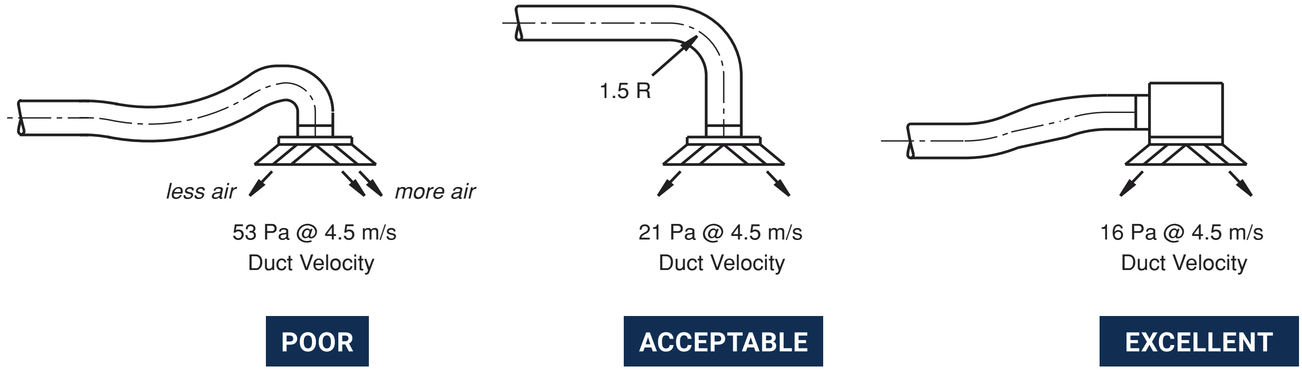
65 Pa @ 4.5 m/s

ACCEPTABLE

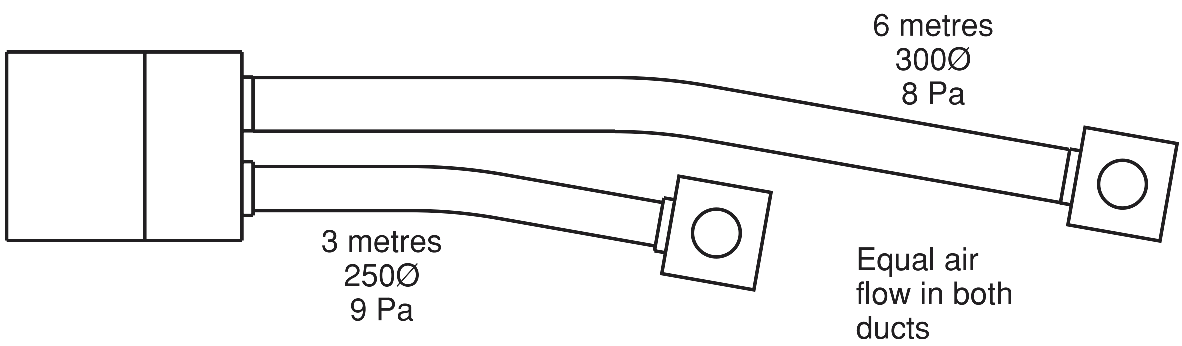


30 Pa @ 4.5 m/s

10. Side entry diffuser boxes generally have a much lower pressure loss than a top entry diffuser; top is satisfactory if the flexible duct is supported and makes a gentle radius entry (1.5 x duct diameter). However, if flexible duct is left unsupported then it will kink when connected to the diffuser adding dramatically to the pressure loss. Side entry cushion head boxes are recommended as they improve equal air distribution, reduce noise, and reduce draft.



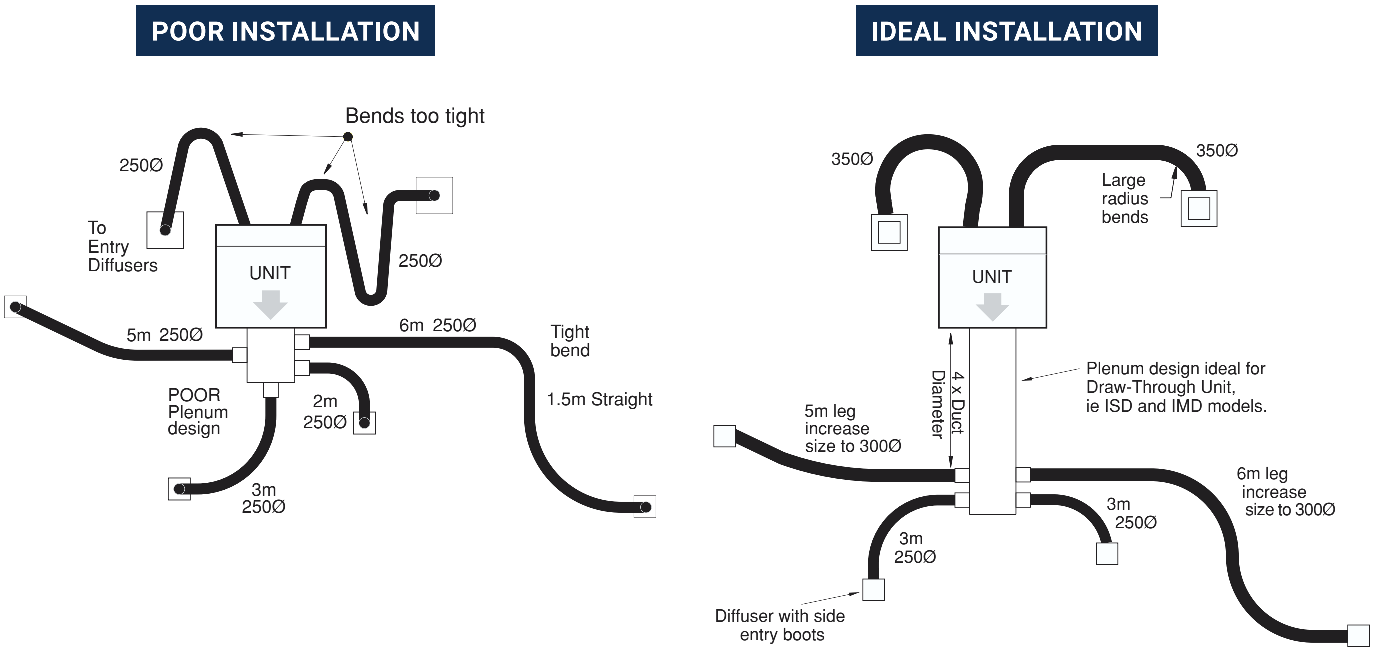
11. Oversize the flexible duct for long runs. It is not recommended to install flexible duct longer than 6 meters. Should longer than 6 meters be required it is suggested to incorporate some rigid straight circular duct.



12. Try to achieve roughly equal pressure losses through each leg.

13. DO NOT coil up surplus flexible duct for short runs, CUT to suit.

14. The return air filter MUST equal the same surface area of the indoor coil face at a MINIMUM. It is recommended to select return air filters that have a surface area larger than that of the return air coil. This can be achieved with corrugated filters or multiple grill filters.



SAT-3 Controller
(Installation and Set-up Guide)

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   - 1.1 General p. 44
     - 1.1.1 Installation Settings p. 44
     - 1.1.2 Clock Settings p. 44
   - 1.2 Fan Setup p. 44
   - 1.3 Air Conditioner Commissioning p. 44
2. Detailed SAT-3 Configuration p. 45
   - 2.1 Installation Settings p. 45
   - 2.2 Fan Settings p. 47
   - 2.3 Commissioning Mode p. 48
3. SAT-3 Fault Indications p. 48

1. Quick Start Guide

1.1 General

Refer to the User's operating instruction booklet for everyday operation of the SAT-3.

The system may include only one SAT-3.

In the following instructions, to navigate the settings of the SAT-3 thermostat press:

To adjust a setting press:

1.1.1 Installation Settings

Apply power to the system.

The SAT-3 is configured by default to operate with standard Temperzone air-conditioners and in most cases no adjustment is necessary. If required, refer to section 2.1 on pages 45-46 for details of the installation settings and how they may be adjusted.

1.1.2 Clock Settings

Hold down the or key (not both keys) for 3 seconds to start adjusting the clock.

The clock symbol will start to flash as well as the presently selected day of the week. Set the day of the week and time using the keys detailed in section 1.1. When the day and time are set correctly, leave the SAT-3 for 15 seconds to return to normal operation.

1.2 Fan Setup

Activate fan setup mode by holding down mode and 4 together for 3 seconds.

When fan setup mode is active the symbol on the display flashes on and off.

1. Adjust the low fan control voltage to a suitable low level while monitoring the airflow.
2. Adjust the high fan control voltage to a suitable high level while monitoring the airflow.

When adjustment is complete press to exit fan setup mode.

Setting	Display	Range	Notes
Low Level Fan Control Voltage	SET Lo	2.0 – 8.0 Default 5.0	Steps of 0.33
High Level Fan Control Voltage	SET Hi	4.0 – 10.0 Default 8.0	Steps of 0.33

1.3 Air Conditioner Commissioning

Activate commissioning mode by holding down mode and 3 together for 3 seconds.

Test the cooling cycle and (if installed) heating cycle operation of the air-conditioner.

Refer to section 2.3 on page 48 for full details of Commissioning mode.

2. Detailed SAT-3 Configuration

2.1 Installation Settings

To activate installer mode hold mode and 6 together for 3 seconds. When the unit is in installer mode the symbol **i** will be shown.

To confirm and save the new setting(s) press mode. The thermostat will return to normal operation and the new settings will apply.

To cancel changes to the settings at any time press ⏻. Any changes made will be discarded and the thermostat will return to normal operation using the old settings.

Setting	Display	Range	Notes
Minimum Setpoint Temperature	**i SET Ct**	5.0°C - Ht	Steps of 0.5°C
Maximum Setpoint Temperature	**i SET Ht**	Ct - 50.0°C	Steps of 0.5°C
Temperature Differential	**i td**	0.5 – 1.5°C	Steps of 0.5°C
Indoor Fan Type	**i Ft**	1 or 3 Speed	Default 3 Speed
Enable / Disable Heating Mode	**i** ☼	On / Off	Default On
Enable / Disable Cooling Mode	**i** ❄	On / Off	Default On
Enable / Disable Cool/ Heat (auto)	**i** ❄ ☼	On / Off	Default On (See Note 1)
Enable / Disable Fan Only	**i**	On / Off	Default On
Enable / Disable Dry Mode	**i**	On / Off	Default On (See Note 2)
Enable / Disable Quiet Mode	**i** Q QUIET	On / Off	Default On
Enable / Disable Sleep Mode	**i** zzZ SLEEP	On / Off	Default On
Enable / Disable Economy Mode	**i** ECO	On / Off	Default On
12 or 24 Hour Clock	**i tC**	12 or 24 hours	Default 24 Hours
Number of Stages	**i St**	1 or 2	Default 1
Room Temp Sensor	**i rt**	1,2,3, or 4	Default 1 (Internal, See Note 3)
Zone 1 Temp Sensor Calibration	**i** ① **OF**	-4.0 – 4.0°C	Steps of 0.1°C, Default 0 (See Note 4)
Zone 2 Temp Sensor Calibration	**i** ② **OF**	-4.0 – 4.0°C	N/A See Note 6
Zone 3 Temp Sensor Calibration	**i** ③ **OF**	-4.0 – 4.0°C	N/A See Note 6

2.1 Installation Settings (continued)

Setting	Display			Range	Notes
Zone 4 Temp Sensor Calibration	i	④	OF	-4.0 – 4.0°C	Steps of 0.5°C
Zone 5 Temp Sensor Calibration	i	⑤	OF	-4.0 – 4.0°C	Steps of 0.5°C
Zone 6 Temp Sensor Calibration	i	⑥	OF	-4.0 – 4.0°C	Steps of 0.5°C
Enable / Disable Zone Control	i	ZONE	En	On / Off	Default 3 Speed
Max Difference of Zone Setpoint from Zone 1 Setpoint	i	ZONE	SP	2.0 - 10°C	Default On
Minimum Number of Zones On	i	ZONE	nn	0,1, or 2	Default On
Zone 1 Size	i	①		1 – 5	Default On (See Note 1)
Zone 2 Size	i	②		0 – 5	Default On (See Note 2)
Zone 3 Size	i	③		0 – 5	Default On
Zone 4 Size	i	④		0 – 5	Default 24 Hours
Zone 5 Size	i	⑤		0 – 5	Default 1 (Internal, See Note 3)
Zone 6 Size	i	⑥		0 – 5	N/A See Note 6
Programmable Timer Function	i		tF	1 or 2	Default 1 (Standard, See Note 5)
Set Display Backlight Duration	i		bd	0 – 59 Sec	Default 30 Sec
Set Display Backlight Intensity	i		bL	0 - 10	Default 10
Set Modbus Device Address	i		Ad	1 - 99	Default 8 Other Settings Will Not Function Correctly
Set RS485 Baud Rate	i		br	1 - 4	1: 4800, 2: 9600 3: 1440, 4: 19200 (Default)
Zone Controlled Auto Mode Dead Band	i		Ab	0 - 10°C	N/A See Note 6

Notes:

1. Auto cool/heat mode can only be enabled if both cooling and heating mode are also enabled.
2. Dry mode (de-humidification) can only be enabled if cooling mode is also enabled.
3. Room temperature sensor: 1 = internal, 2 = external, 3 = average of internal and external, 4=zone 1 temperature (from modbus – do not use with un-zoned systems).
4. Zone 1 temperature calibration is applied to the room temperature from the selected source described above in note 3.
5. Programmable timer function: 1 = standard, 2 = advanced.
6. Not applicable to systems without zone controller.

2.2 Fan Settings

To activate fan setup mode, hold down mode and 4 together for 3 seconds.

When Fan Setup Mode is active the symbol on the display flashes on and off.

In Fan Setup Mode are as follows:

Setting	Display	Range	Notes
Low Level Fan Control Voltage	**SET Lo**	2.0 – 8.0 Default 5.0	Steps of 0.33
High Level Fan Control Voltage	**SET Hi**	4.0 – 1.0 Default 8.0	
Additional Zone Voltage Increase	**SET Ad**	0 – 950 Default 300	Not Applicable to Systems Without Zone Controller
Zone 1 Balance	① **bL**	10 – 100% Default 100%	
Zone 2 Balance	② **bL**	10 – 100% Default 100%	
Zone 3 Balance	③ **bL**	10 – 100% Default 100%	
Zone 4 Balance	④ **bL**	10 – 100% Default 100%	
Zone 5 Balance	⑤ **bL**	10 – 100% Default 100%	
Zone 6 Balance	⑥ **bL**	10 – 100% Default 100%	

As the settings are adjusted the unit controller adjusts its operation to allow the settings to be evaluated:

Setting	Unit Controller Operation
Low Level Control Voltage	The indoor fan operates at the low voltage level selected
High Level Control Voltage	The indoor fan operates at the high voltage level selected

If the mode key is pressed or if no key is pressed for 15 minutes the SAT-3 will return to normal operation using the updated settings.

If the ⏻ button is pressed the SAT-3 will discard the updated settings and resume normal operation with the previous settings.

2.3 Commissioning Mode

To activate or de-activate commissioning mode hold down mode and 3 together for 3 seconds.

When commissioning mode is active the symbol i on the display flashes on and off.

Commissioning mode automatically ends after 30 minutes and the thermostat returns to normal operation.

Commissioning mode also can be terminated by again pressing mode and 3 together for 3 seconds or by removing and then re-applying power to the thermostat.

Operation in commissioning mode is identical to that in normal mode except that safety timer durations are made shorter as follows:

Delay	Normal	Commissioning
Minimum Compressor On Time	90 Seconds	10 Seconds
Minimum Compressor Off Time	90 Seconds	20 Seconds
Minimum Time From Compressor On to Next Compressor On	6 Minutes	30 Seconds
Minimum Cooling to Heating Change Over Time	10 Minutes	1 Minute
Minimum Heating to Cooling Change Over Time	10 Minutes	1 Minute
Power On Delay Prior to Starting Compressor	2 Minutes	2 Minutes

3. SAT-3 Fault Indications

The SAT-3 indicates some faults that may be useful during installation. Faults are indicated in the bottom right area of the display. Wiring changes should only be made with the power disconnected.

Delay	Normal	Commissioning
t1	SAT-3 Internal Temperature Sensor Error	The Internal Temperature Sensor on the SAT-3 Is Damaged, Replace SAT-3
t2	SAT-3 External Temperature Sensor Error	Check External Temperature Sensor Connected to the SAT-3
t3	No Communications Between SAT-3 and Unit Controller	Check the Wiring Between the Unit Controller and the SAT-3.

TZT-100 Thermostat

Contents

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    - 1.1 Mounting the TZT Thermostat p. 50
    - 1.2 Setting the Hardware Switches p. 51
2. TT Terminal Function p. 52
3. Typical Drawings p. 54
4. Attaching the Thermostat p. 55
5. Advanced Installer Settings p. 55
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    - 7.1 Test Fan Operation p. 61
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    - 9.4 Setting Up the Heat and Cool Off Function p. 64
    - 9.5 Adaptive Recovery p. 64
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1. Installation

As with any project undertaken, careful installation is the key to a successful outcome. Time taken during this installation process will be rewarded with a happy customer and fewer call-backs.

The steps required to install the TZT-100 thermostat are -

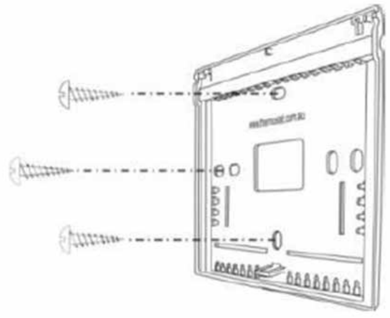
1. Read and understand this manual and the User manual.
2. Mount the TZT-100 back plate in a suitable location.
3. Set the 8 DIP switches to match the need of the project / user.
4. Wire the optional remote temperature sensor(s) or switches if required.
5. Power up the air conditioning system.
6. Set the installer software options (if required).
7. Program and set up the TZT-100 thermostat. (The User Manual will assist with this).
8. Test the heating, cooling, and other functions – Commissioning.

For convenience the layout of this manual is in the same order as the steps listed above.

1.1 Mounting The TZT Thermostat

The TZT-100 can only be as accurate as the on-board temperature sensor, or its optional remote temperature sensor(s) permit. It is therefore essential that the TZT-100 be installed in a location that is typical of the ambient room temperature. Do not install the thermostat in a draft, near a floor, behind doors or on a non-insulated external wall. Also avoid placing the thermostat in areas where the air movement is limited, affected by direct sunlight or other areas not "typical" of the temperature of the room.

Further, when mounting the TZT-100 be aware that drafts may travel down the inside of cavity walls, (especially if mounted on external walls) and enter the back of the thermostat or sensor enclosure through the cable entry holes in the wall. It is important to fully seal these holes to prevent any drafts affecting the internally mounted temperature sensor. It is recommended to mount the TZT-100 or remote sensors between 1.5 & 1.7 metres from the floor where possible.



Move the control wires through the large opening in the thermostat base plate then place the thermostat base on the wall and using appropriate screws, firmly attach the thermostat base to the wall. Block any holes where cables enter the back of the thermostat to prevent drafts entering through these holes affecting the sensor.

1.2 Setting The Hardware Switches

Switch	Off	On
Sw1 – Fan Speeds	1 Speed Fan	3 Speed Fan
Sw2 – Equipment Type	Heat / Cool (Electric Heat)	Heat Pump (Reverse Cycle) (O/B Terminals)
Sw3 – Stages	1 Stage	2 Stages
Sw4 – Reversing Valve (Sw2 'On', Heat Pump)	Energise in Cool (O)	Energise in Heat (B)
Sw4 – Fan Mode (Sw2 'Off', Heat / Cool)	Fan Control by Heater (HG)	Fan Control by Thermostat (HE)
Sw5 – Anti Rapid Cycle Timer	Off	4 Minutes
Sw6 – Operation	Manual Thermostat	Programmable Thermostat
Sw7 – Minimum Run Time	2 Minutes	6 Minutes
Sw8 – Program Type (Sw6 'On', Programmable)	Commercial Program	Residential Program
Sw8 – Set Points (Sw6 'Off', Manual)	Single Set Point	Two Set Points

Typical drawings have been provided on page 55 of this manual that will assist with the selection of the correct positions for these function switches.

Switch 1 – Relay Assignment

The TZT-100 is fitted with 5 relays capable of switching up to 24VAC @ 1Amp each. Switch 1 sets the function of these relays as either 3 fan speeds with 1 heat and 1 cool operation or single fan speed with 2 heat and 2 cool, in either HP (heat pump / reverse cycle) or HC (heat with add on cool) mode.

Switch 2 – Equipment Type.

Both heat with add on cool, or heat pump types of systems can be controlled by the TZT-100 thermostat.

Heat Cool System uses the "W" terminal(s) only for heating and the "Y" terminal(s) only for cooling.

Heat Pump systems use the "Y" terminal(s) for BOTH heating and cooling (the compressor). The "W1" terminal controls the reversing valve which determines the heating or cooling mode.

Switch 3 – Equipment Stages

When it is necessary to control a single stage A/C system fitted with auxiliary heating elements, turn Sw3 OFF thereby selecting single stage mode. Heating elements controlled by the W2 output are now assigned as stage 2 heat.

Switch 4 – Reversing Valve or Fan mode

Regardless of the other switch positions, this switch should normally be left in the factory default ON position for all temperzone units.

Switch 5 – Anti-Rapid Cycle Timer

temperzone recommends that this switch be left in the ON position. This means that the thermostat's Anti-Rapid Cycle Timer is in use. The TZT-100 timer will work in parallel with the Anti-Rapid Cycle Timer in the Heat Pump's internal controls. Leaving "Switch 5" ON will provide the user with feedback as to the equipment status.

Note: When power is first applied to the TZT-100, it "assumes" that the compressor has just stopped and applies this Anti-Rapid Cycle delay time before starting. This may hold off the indoor fan also.

Switch 6 – Thermostat Operation

To suit the varying requirements of the user, the TZT-100 can be set as a "Programmable" thermostat using the time clock to automatically control the building temperature to a programmed temperature profile or to the very simple to operate, "Manual" mode where the user turns the thermostat on or off and adjusts the temperature set point manually.

Switch 7 – Minimum Run Time

To conserve energy and protect the A/C system, it is recommended that each time the compressor starts it runs for a minimum period of time. This ensures oil return for lubrication purposes. "Switch 7" enables you to select a minimum run time of 2 or 6 minutes. Once heat or cool cycle has started it must continue for this minimum period. The LCD will flash the word "Heating" or "Cooling" whenever this timer is holding Heating or Cooling on past set point, or when the user has changed mode etc.

Switch 8 – Thermostat Control Logic

This switch has two functions based on the position of "Switch 6". When the TZT-100 is set as a programmable thermostat, "Switch 8" determines whether a commercial or residential program is selected. When "Switch 6" has the TZT-100 set as a non-programmable thermostat, "Switch 8" then selects between single set point mode (imitating a simple mechanical thermostats operation), or separate heating and cooling set points. "Two set point" mode also permits the user to select a separate day and night set point if desired

2. TT Terminal Functions

The TZT-100 is fitted with a set of terminals marked "TT". Details of the "TT" terminals functionality is provided below. See the advanced installer setting menu on page 59 of this manual for setting the function of this set of terminals. The wiring used in the following examples are not polarity dependent and do not normally require screened cable for short runs (less than 10 metres). With longer cable runs, or where there is electrical noise present, can benefit from the use of screened cable, earthed at one.

Please Note - The TZT-100 can use multiple sensors if required. Drawings showing these various configurations are shown on pages 53-54 of this manual.

Outside Air Sensor Wiring

Set "TT= OA" in the advanced installer menu.

The TZT-100 can display the outside air temperature if desired. Some advanced control functions such as high and low balance points rely on this sensor to be fitted for correct operation. Using a single pair of wires connect the "TT" terminals in the TZT-100 to the two terminals in the outside air temperature sensor. (See Figure 1). If the outside air sensor fails two dashes will be shown on the LCD where the outside air temperature would normally be displayed to alert you of the problem.

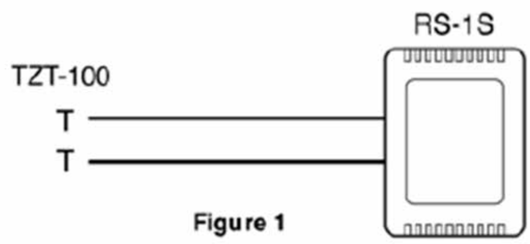


Figure 1

2. TT Terminal Functions (Continued)

Remote Room Temperature Sensor Wiring

Set "TT= RS" in the advanced installer menu. (Default)
When you wish to measure the temperature from a location distant from the TZT-100, simply connect a remote temperature sensor to the "TT" terminals in the TZT-100 controller. This will automatically disable the air temperature sensor fitted inside the TZT-100 and use the remote temperature sensor(s) to control the room temperature (See Figure 1 above). Should you wish, you can easily switch the remote temperature sensor on and off, thereby switching temperature sensing locations between the remote sensor and the TZT-100 internal temperature sensor. Simply fit an in-line switch in the sensor wiring. (See Figure 2.)

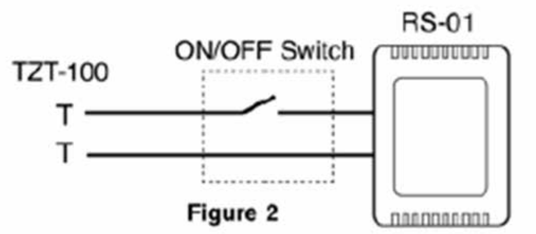


Figure 2

Averaging Temperature Sensors

Set "TT= AV" in the advanced installer menu.
If required, the TZT-100 can average the sensed temperature, between the remote temperature sensor(s) and the one fitted to the TZT-100. (See Figure 1 on the previous page for details on wiring the sensor.) The TZT-100 will auto-detect this sensor and automatically average the two sensor values to control the room temperature.

Remote ON / OFF Function

Set "TT= OF" in the advanced installer menu.
The TZT-100 can be connected to an external dry contact. When this contact is closed the TZT-100 will turn OFF. (See Figure 3.) When the TZT-100 has been switched OFF via the "TT" terminals the word "OFF" will flash in the LCD to indicate that this has been the shutdown method. The TZT-100 will return to the user settings when this switch is open.

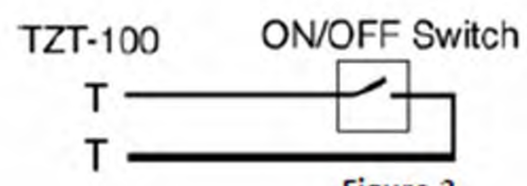


Figure 3

Using the "Occupancy Mode"

Set "TT= OC" in the advanced installer menu.
The TZT-100 can alternate between the user preferred set points and an installer pre- programmed set point when required. Simply wire a remote switch to the TZT-100 "TT" terminals (See Figure 3). When the switch is open the user settings will control the room temperature. When the switch is closed the Installer "Oc" (Occupied Cooling value) & "Oh" (Occupied Heating value) settings will be used to control the room temperature.

Supply Air Temperature Monitoring

Set "TT= DA" in the advanced installer menu.
In this mode, the TZT-100 will ONLY broadcast this sensor temperature value via its ModBus communication. This value is not used by the TZT-100 nor is it displayed on the LCD. It is expected that this information is used for supervisory functions or equipment control feedback.

The TT input pair, is an analogue input designed to read a temperature dependant resistor, otherwise known as a thermistor. If a switched resistor network is connected to the TT inputs, a supervisory system can read the varying analog signal present at the TT terminals as a result of the switching of resistors. This would enable the supervisory system (BMS), to decode a number of digital states.

3. Typical Drawings

Simplified wiring schematics showing different air conditioning system configurations appear on the following pages. The TZT-100 dip switch combinations are the same for each model. First identify which internal controller is used by your system, ie UC6, UC7 or UC8 or IUC.

Figure 4

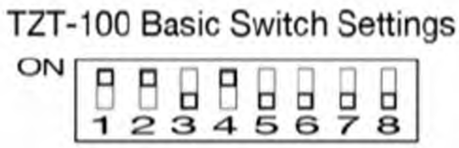


Figure 5

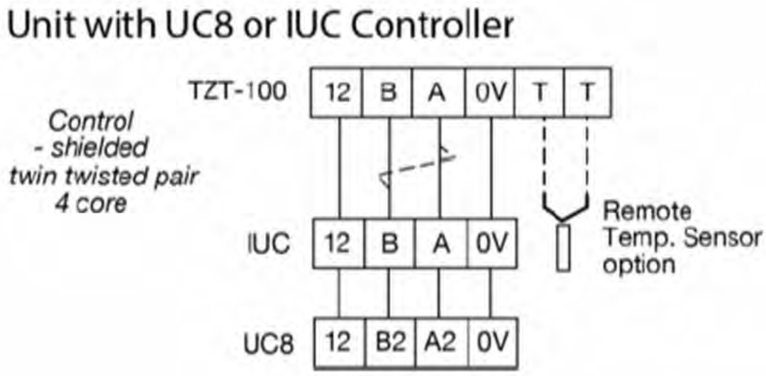


Figure 6

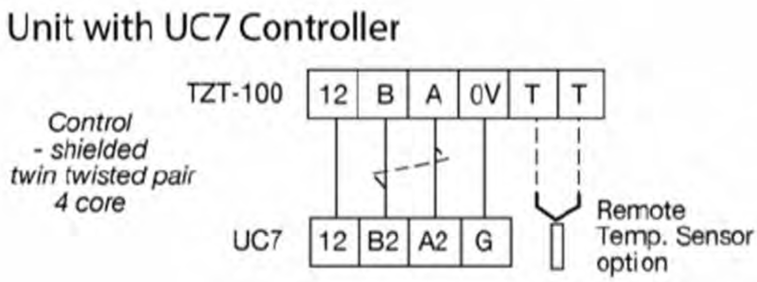
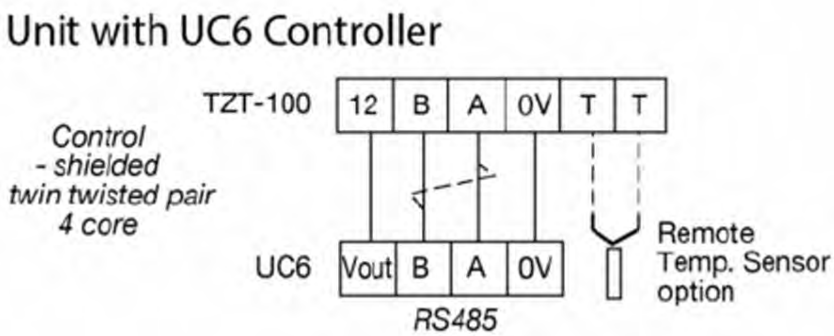


Figure 7



4. Attaching The Thermostat

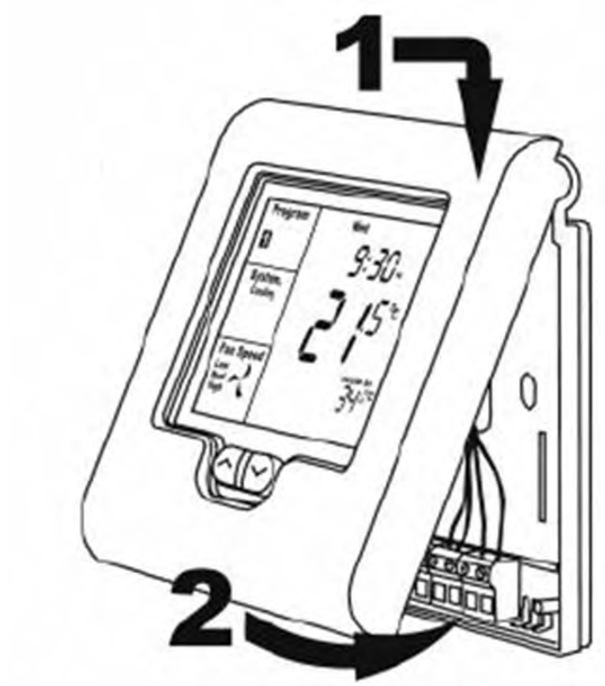


Figure 12

Check that the position of the 8 DIP switches matches the requirements of the equipment being controlled and the specific requirements of the user. Detailed information on the 8 DIP switches can be found on pages 52-53 of this manual.

Check the wiring matches that of the equipment the TZT-100 is to control and that all wiring is tight and not likely to short between adjacent wires. Equipment wiring information can be found commencing on page 55 of this manual.

When using the ModBus communication capability of the TZT-100, ensure the “**A**”, “**B**” & “**T**” data wires are in the correct position as an error here may affect the communication of the entire network. See page 64 for detailed wiring of the communications port of the TZT-100.

Using masking tape or similar, block the hole in the wall where the wiring enters the back of the thermostat to prevent drafts that may travel down the inside of the wall cavity affecting the accuracy of the internally fitted temperature sensor.

Remove and discard the plastic tab on the internally fitted backup battery so that the battery is now in circuit and operating. Be careful not to pull the battery out or damage the battery holder when doing this.

When attaching the thermostat to the base, avoid twisting the case as this may stress the LCD and cause it to crack. Avoid running wiring near the internally fitted sensor.

Take care not to damage or crush the temperature sensor between the two halves of the case when you close the TZT-100 case. Check this sensor location.

5. Advanced Installer Settings

The TZT-100 is a versatile temperature controller fitted with many advanced functions that must be fine-tuned by the installer to match the requirements of the end user.

Normally these functions will not need to be altered from the factory default position however, there may be times when you wish to alter a setting or control capability so that the TZT-100 performance will perfectly match a particular application. On the next few pages there is detailed explanation of these functions and their range of control.

While in the advanced installer menu, all TZT-100 equipment control functions will be suspended. Normal equipment operation will continue when you have exited this menu (after any Anti-Rapid Cycle delays or safety delays have terminated).

5.1 Using The Installer Menu

To move forward through the Installer menu items, tap the “**O/RIDE**” button. To move backwards through the Installer menu items, tap the “PROG” button. To adjust a value, tap the ▲(Up) or ▼(Down) buttons.

To exit the installer menu, tap the “**Mode**” button, the “**Fan**” button or wait 60 seconds.

5.2 Entering The Installer Menu

To enter the Installer menu, press and hold the O/RIDE button for 15 seconds. After 15 seconds the LCD will show "88:15" (eight eight one five).

Adjust this value to "88:21" – (eight eight two one) the factory default PIN (or your previously selected value) by using the ▲(Up) or ▼(Down) button. Tap the O/RIDE button again to enter the menu.

If you have entered the correct PIN you will be given the first menu option, if you have entered an incorrect PIN you will be exited from this menu. You may retry.

The Default Values are shown in bold text in heading line of the explanation for each parameter shown on the following pages:

PN = 21 Keyboard Lock PIN
This is the required PIN for future entry into the Installer menu.
Range 00 to 99 in 01 steps. To prevent accidental PIN changes, you must press and hold the ▲or ▼ buttons for longer than 1 second to change the PIN value.
(Caution, if you change this value and forget your new PIN, you may need to return the TZT-100 to temperzone for unlocking, there may be a fee for this service)

LC = 0 Keyboard Lock level
Programmable Mode (SW6=ON)
LC = 00 - Key board Lock OFF.
LC = 01 - All buttons are locked except the Temperature +/- buttons*.
LC = 02 - All buttons are locked except the O/Ride button & Temp +/- buttons*.
LC = 03 - Fan and Program buttons are locked*.
LC = 04 - Fan, Program and Override buttons are locked *.
LC = 05 - All buttons locked except O/Ride.
LC = 06 - All Buttons locked.
Manual Mode (SW6=Off)
LC = 00 - Key board Lock OFF.
LC = 01 - All buttons are locked except the Mode button.
LC = 02 - All buttons are locked except the Mode and temperature +/- button*.
LC = 03 - Fan & O/ride buttons are locked*.
Mode button can only select Auto (Heat & Cool) and off.
LC = 04 - O/Ride Button is locked*.
Mode button can only select Auto (Heat & Cool) and off.
*(*Note the temp +/- buttons range can be limited in the HL & CL menu)*

HL = 35 (95F) Heating Limit (or High Limit
The highest Heating value permitted to be set by the user.
Adjustable between 5~49°C (41~120°F).

CL = 16 (41F) Cooling Limit (or Low Limit
The lowest Cooling value permitted to be set by the user.
Adjustable between 6 ~50°C. (43~122°F).

CF = C Temperature display Format
Deg C or deg F display type. (effects all user and installer menu items)

C1 = 0.0 Fitted Sensor Calibration
Calibration Offset for the internal sensor. Adjustable range +/- 4.5°C (+/-9°F). in 0.1 steps

tC = 12 Time Clock
tC = 12 - 12 Hour Time Clock. tC = 24 - 24 Hour Time Clock.
tC = 0 - No time clock shown (Manual mode only –SW6=off)

5.2 Entering The Installer Menu (Continued)

td = 0 Temperature Display **td = 00** - The TZT-100 will display both the Room & Set Temperature. **td = 01** - The TZT-100 will display set temperature only.
AH = 2 After Hours Override Timer **Start / Stop Mode** - Commercial Thermostat Mode (Sw6=on, Sw8=off) After hour run time period - Adjustable range 0 (off) to 12 hours in 0.5 hour steps. **Setback (1, 2, 3, 4) mode** – Residential programmable Mode (Sw6=on, Sw8=on) Temporarily program override period. Off= Override till next program change or 0.5 to 12 hours (fixed time override)
St = oFf Start Program temperature (Commercial Mode) Start/stop mode Only. (Sw6=on, Sw8=off). This sets the default temperature that will be used each time the "Start" program begins regardless of any adjustments the user may have made previously. Adjustable between OFF, 15~35°C. (59~95°F). If set to off, the user set point will not be automatically reset to a default value each day.
SC = oFf Stop Cooling temperature (Commercial Mode) Start/stop mode Only. (Sw6=on, Sw8=off). Cooling temperature that will be maintained when running the "STOP" program. (Night Setback) Adjustable between 6 ~50°C. (43~122°F) + OFF.
SH = oFf Stop Heating temperature (Commercial Mode) Start/stop mode Only. (Sw6=on, Sw8=off). Heating temperature that will be maintained when running the "STOP" program. (Night Setback) Adjustable between 5 ~49°C. (41~120°F) + OFF.
db = 0.5 °C/1 °F Single Set Point Dead band *(See page 61 for more information)* Dead band between Heat and Cool cycle when in single set point mode (sw8 off). Adjustable between 0 and 5 °C (or 0 and 10 °F) in 0.5 °C (1 °F) steps.
Fo = 0 Fan Options - Advanced Fan Functions This function is only enabled when the selected fan mode is **Fan On**. "FAN ON" will be displayed in the LCD to confirm this mode. **Fo = 0** - (Default for Residential mode – Sw6 On Sw 8 ON). The fan will run continuously, 24 hours a day 7 days a week when ever "Fan On" mode is selected. **Fo = 1** - The fan will continue to run after the cooling stops to ensure the maximum fresh air ventilation and to aid in cooling. The fan will stop when the heating stops. (This is done to prevent cold drafts that may occur on cold days when the A/C system is heating). **Fo = 2** - (Default in Start Stop Mode). Available only if in Programmable Mode (Sw6=on). The Fan will Run continuously from program # 1 (or Start) Program to program #4 (or stop) program. It will then run in AUTO mode overnight to maintain the night time set points. **Fo = 3** - Available only if in Programmable Mode (Sw6=on). This mode is the combination of option 1 and option 2 given above.
FP = 1 Fan Purge Time Period (Fan run on) If fan mode is "Auto Fan", the indoor fan will run for FP=X minutes after heating or cooling has stopped to extract any residual energy in the indoor coil(s). (Necessary when controlling electric element heating). Adjustable between 0 to 5 minutes in 1 minute intervals.

5.2 Entering The Installer Menu (Continued)

Fn = A Function - Available Equipment Modes
FN = A - Select if controlling a Heating & Cooling system.
FN = C - Select if controlling a Cooling only system. (Disables heating menus)
FN = H - Select if controlling a Heating only system. (Disables cooling menus)
FN= — — (Double Dash) - This mode will set TZT-100 to Heat only, Cool only or OFF. (Emergency heat will also be selectable if enabled)

H3 = oF W2 relay Function
Only operates in single fan speed HP mode. (Sw1=off & Sw2=on).
H3 = oF - W2 relay is used as 2nd (or 3rd) stage Auxiliary heat.
H3 = EH - W2 relay is used to control an Emergency Heating system.
H3 = AH - W2 relay is used to control a Add On Heat system.
H3 = AL - Permits both Aux heat & E. Heating mode (both use W2 relay)
H3 = FF - TZT-100 set up in "Fossil Fuel" Mode (Comp stops with Aux heat)

tt=RS TT terminal Function (See pages 53-54 for more detail on this function)
tt = oA - Connect the outside air temperature sensor to the TT terminals to display the outside Air Temperature. (Required for all outside air control functions to operate.)
tt = RS - Connect the remote room temperature sensor to the TT terminals to measure the temperature at a remote location away from the TZT-100.
(Note: This completely disables the temperature sensor fitted to the TZT-100)
tt = AV - The TT terminals will average the temperature measured by the TZT-100 internal sensor and remote room temperature sensor(s).
tt = oF - A closed contact on the TT terminals will switch the TZT-100 On or OFF. (More detail on this function provided on page 54 of this manual.)
tt = oC - A closed contact on the TT terminals will switch the TZT-100 to Occupied Mode, where the oC & oH temperatures will replace the user set temperatures. *(See page 54 of this manual for more detail on this function.)*
tt = dA - The TZT-100 will broadcast the measured temperature from the remote temperature sensor via Mod-Bus. It will not display this value on the LCD, nor is it used for any control option.
This mode is intended to provide system feedback to the ModBus master only.
tt = 2P – Do not select this option – this is not required for temperzone units.

AF = 0 Anti-Freeze Function AF = 0 - Antifreeze function off.
AF = 1 - Room temperature will not be permitted to fall below 5°C (41°F) even if the TZT-100 mode is OFF.

oH = oFf Occupied Mode Heat Set *(See page 54 for more information)*
Only operates if TT=OC.
This is the heating temperature that will be used in "Occupied mode" and will temporarily replace the user heat set point while the TT terminals are shorted together.
Adjustable range 0-35c (32 – 95f)

oC = oFf Occupied Mode Cool Set *(See page 54 for more information)*
Only operates if TT=OC.
This is the cooling temperature that will be used in "Occupied mode" and will temporarily replace the user cool set point while the TT terminals are shorted together.
Adjustable range 5-37c (41 – 98f)

SP = 2 Stage 1 Span *(See page 61 for an overview of this control function)*
Hysteresis for Stage 1.
(Difference between the heating and cooling turning on and off)
Sp = 1 0.5c
SP = 2 1.0c
Sp = 3 1.5c

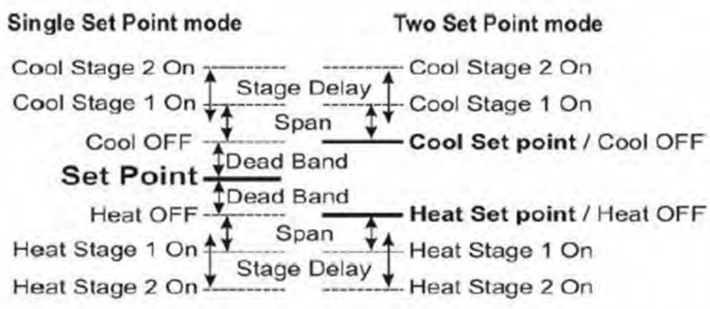
5.2 Entering The Installer Menu (Continued)

Sd = 2 Stage 2 Span *(See page 61 for an overview of this control function)* Hysteresis for Stage 2. (Difference between the 2nd stage heating and cooling turning on and off) **Sd = 1 0.5c** **Sd = 2 1.0c** **Sd = 3 1.5c**
dt = 30 Upstage delay time Time in minutes before next stage of heating or cooling is to be called. Delay only operates if stage trip temperature has not yet been reached. Adjustable between 10 ~ 90 Minutes in 5 minute steps.
oS = 0 Optimised Start/stop. (Adaptive Recovery) oS = 0 - Optimised start/stop function Off. **oS = 1** - Optimised start/stop function activated. *(See page 65 for more information on this function)*
C2 = 0.0 Calibration Remote Sensor Calibration Offset for the TT terminal temperature sensor. Adjustable range +/- 4.5 °C (+/-9 °F).
Co = 5 (41F) Cooling OFF temperature *(See page 65 for more detail.)* Only operates if tt=OA and outside temperature sensor is fitted. Outside air temperature below this value will force the cooling function OFF. Adjustable between 0 ~37°C. (32~98°F).
Ho = 35 (95F) Heating OFF temperature *(See page 65 for more detail.)* Only operates if tt=OA and outside temperature sensor is fitted. Outside air temperature above this value will force the heating function OFF. Adjustable between 0 ~37°C (32~98°F).
HB = 37 (98F) High Balance Point *(See page 65 for more detail.)* tt=OA, the outside temperature sensor must be fitted and Sw 1=off. 2nd (or 3rd) stage heating is locked out when the outside air is above this temperature. Adjustable between 0 ~37°C. (32~98°F).
LB = 9.5 (15F) Low Balance point *(See page 65 for more detail.)* tt = OA, (the outside temperature sensor fitted), H3=EH, Sw 1=off and Sw2=on. Outside temperatures below this value will automatically select the Emergency Heat mode. Adjustable between -9.5 ~25°C (15~77°F).
Ft = oFf Filter warning time Return air filter cleaning warning time. Adjustable between off and 900 hours.
Ad = 07 ModBus Address *(See page 63 for more information.)* ModBus communications address
bd = 9.6 ModBus Baud Rate Bd = 4.8 - ModBus baud rate is 4,800 Baud. Bd = 9.6 - ModBus baud rate is 9,600 Baud. Bd = 19.2 - ModBus baud rate is 19,200 Baud.
Cd = 0 Commissioning Mode *(See page 65 for more detail.)* Cd = 0 - Commissioning mode is OFF. Cd = 1 - All time delays are off or reduced to a very small value.
SS = 0 Start Stop Mode Override *(Typically used by ModBus Master)* SS = 0 - User Start Stop program in use SS = 1 - Thermostat held in “Start” program typically via call from ModBus master. SS = 2 - Thermostat held in “Stop” program typically via call from ModBus master.

OF Override Function *(Typically used by ModBus Master)* OF=0 – The TZT-100 will control its own relays (Default) OF=1 – The 5 TZT-100 relays are being controlled via a ModBus master only. No buttons will function, and all programming and control information is suppressed. The word “Override” will flash on the LCD during this mode. The TZT-100 will automatically exit this mode if no valid ModBus signals have been received for 5 mins.
rS = 40 Thermostat sensor response time to room temperature changes. Adjustable from RS=10 (very fast) to RS=90 (very slow) Default is RS=40
tS = 0 Factory test mode *(See page 64 for more detail.)* **TS = 0** - Factory test Mode OFF. **TS = 1** - Display configuration code.* **TS = 2** - Step cycle all relays in sequence, 1 2 3 4 5 etc. **TS = 3** - Reset software to factory default. Press Fan button to initiate. *(* this table is available from the download section at www.thermostat.com.au)*

6. Control Logic

This simple diagram (right) provides a general insight into the control logic of the TZT-100 thermostat. It attempts to describe the action of the DB=XX, the SP=XX and SD=XX advanced installer control capabilities in both two set point and single set point mode. By adjusting these three values to suit the needs of the user or equipment extremely tight temperature control can be achieved, or a more energy efficient temperature control profile can be set.



In single set point mode (sw8=off) the individual heating and cooling set points are replaced by a “Dead Band” where the heating and cooling differential is controlled by a installer set value. This is the simplest method of temperature control.

Further, you are able to adjust how quickly the TZT-100 thermostat responds to room temperature changes by adjusting the RS=XX value in the installer menu. The lower this setting the faster the thermostat will respond to room temperature fluctuations, the larger this number the slower the thermostat will respond to changes in room temperature.

7. Commissioning

As with any thermostat, commissioning ensures that the thermostat and the equipment connected to it are operating correctly and as expected. Although the TZT-100 is a multifunctional thermostat, commissioning is quite a simple process. Follow the steps detailed below and use the troubleshooting guide on pages 67-68 if you encounter a problem.

When the thermostat is fitted to the base plate and when 12-24VAC power is first applied, the LCD should briefly show all available segments (a LCD function test) then display the thermostat firmware version before showing the time and operating mode etc.

7. Commissioning (Continued)

The TZT-100 is fitted with a number of safety and energy saving time delays. If desired, these can be disabled for commissioning purposes by entering the installer mode and setting the CD=00 value to read CD=01. After exiting the installer menu you will note a "Spanner" icon flashing on the LCD to remind you that commissioning mode is Active. After commissioning has been completed it is important to disable commissioning mode by entering the installer menu once again and setting the CD=01 value back to CD=00.

Note - When in "Commissioning Mode" ALL time delays are either OFF or reduced to an extremely low value, it is therefore normal to potentially call for 3rd stage heating almost instantly 0.5°C below the heating set point.

If you choose not to use commissioning mode, you may see various words and Icons flashing in the LCD whenever a time delay is in use. For example, the word "HEAT" may flash to indicate heating is required but being held off by the 4 minutes Anti-Rapid Cycle Timer. Or the word "HEATING" may be flashing to indicate set point has been achieved however heating is being held ON by the minimum run timer.

The golden rule with the TZT-100 is anything that flashes is a timer over-riding what would normally be expected to occur. Either a function is being held on or off momentarily. Please be patient.

7.1 Test fan operation

With the thermostat OFF (tap the mode button to show OFF in the LCD). Simply tap the fan button to cycle through the available fan speeds. As the LCD changes to show the fan speed or fan mode you should here faint "clicks" as the TZT-100 internal relays change, the equipment fan speed should change accordingly.

7.2 Test heating and cooling (if both fitted)

Turn the TZT-100 to Auto season change mode by tapping the mode button until the words "Heat" and "Cool" are shown on the LCD.

Using the temp▲ or temp ▼ button set the desired temperature a few degrees above the ambient temperature. After a few moments you will hear a click and the word "Heat" will change to "Heating".

Verify that the heating system is on and operating correctly. If stage 2 heat is being called the full stop "." on the end of the word "MODE" will be seen to indicate 2nd stage heat. Stage 3 of heat is indicated by the full stop flashing.

Using the temp **+** or Temp **–** button set the desired temperature a few degrees below the ambient temperature. After a few moments you will hear a click and the word "Cool" will change to "Cooling". Verify that the cooling system is on and operating correctly. When stage 2 cool is being called, the full stop "." on the end of word "MODE" mode will be seen to indicate 2nd stage cool has been called.

Tap the mode button turn the TZT-100 OFF. After any necessary timers have expired all heating, cooling and fan functions should stop. Verify that the system has shut down.

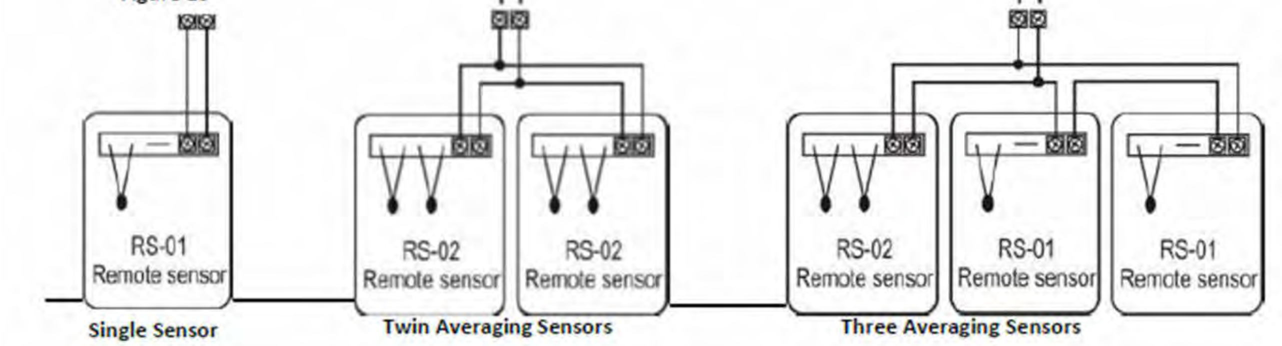
Please Note - In HP mode (SW2=ON) it is normal for the reversing valve to remain energised after the compressor has stopped. This is done to prevent de-compression "HISS" and to limit the wear on the reversing valve. The reversing valve will de-energise 120 minutes after the last heating call to conserve power.

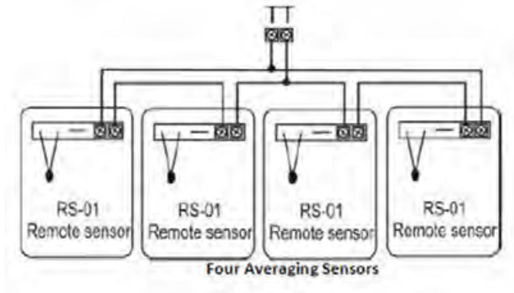
If commissioning mode has been used it is important that this function be turned OFF before handover to the user.

Using the User Manual as a guide set the real time clock and the preferred user program (if applicable). Explain equipment & thermostat operation to the user. Commissioning is complete.

8. Using Remote Temperature Sensors

Figure 13





Single or multiple room air temperature sensors can be connected to the TZT-100 “TT” terminals if temperature averaging over a larger area is desired. 4 examples of commonly used sensor configurations are shown. **Note** - Either TT=RS (remote sensor) or TT=Av (Averaging sensors) value must be set in the advanced installer menu for these sensors to be used.

Please note the configuration of RS-01 & RS-02 sensors in the examples provided above. Other sensor configurations are also available.

A typical maximum of 10 metres is permitted for sensor runs with unshielded cable. If longer distances are required a larger diameter (0.3mm) shielded cable should be used.

When used in Start / Stop commercial programmable mode (SW6=on SW8=off), the after-hours run timer can be toggled on or off as required with a momentary press button on the remote sensor. See figure 17.

As the TZT-100 “Auto detects” sensors connected to the “TT” terminals, temperature sensors can also be switched on and off as required by placing a switch in the sensor wiring to open circuit the sensor loop. See figure 16.

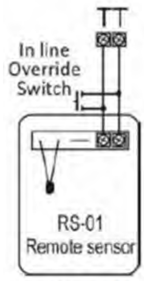


Figure 14

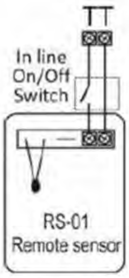


Figure 15

9. Advanced Functions

9.1 ModBus Communications

The TZT-100 has integrated ModBus communications capabilities. Using a remote PC or a Direct Digital Control (DDC) system, many of the TZT-100 functions can be viewed or adjusted remotely.

It is not the scope of this manual to provide detail on the communication capability of the TZT-100. ModBus communication detail will be available for download from www.temperzone.com. This information will be updated as changes are made.

The communications port of the TZT-100 has 3 terminals used for communication. “A”, “B” & “T”. Terminals “A+” & “B-” are used for data communication, the terminal “T” (a shared terminal from the thermostat T T input) is used as a Vss (screen ground to protect the integrity of the communication signal).

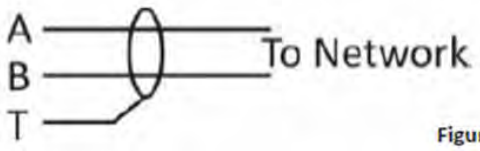


Figure 16

A maximum of 32 TZT-100s can be connected to any single hub. Each TZT-100 on the hub must have a unique network address (factory default is 7). These settings are adjustable from the advanced installer menu. See page 60 for more detail on setting the communications address.

9.1 ModBus Communications (Continued)

A typical ModBus wiring example is given below. If using a common power supply to power all thermostats on a network, it is highly recommended that all thermostats power is wired in phase, i.e., "R" to "R" and "C" to "C" and NOT crossed.

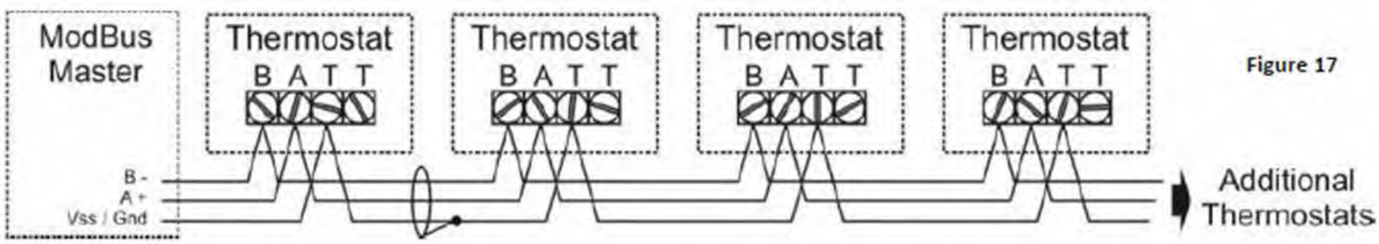


Figure 17

In many cases where multiple thermostats are used in a single network or on a long network run, the two DIP switches located between the "R" & "R/Com" terminals on the **last thermostat on the node** should be switched on to improve network reliability.

It is essential that the network be wired as a daisy chain as shown in fig. 18.

Figures 19 & 20 show examples of how **NOT** to wire a ModBus network.

Short communication runs, 1mm (18 gauge) twisted pair unshielded wire can be used, however for longer runs or where electrical noise may be present twisted pair with shield should be used.

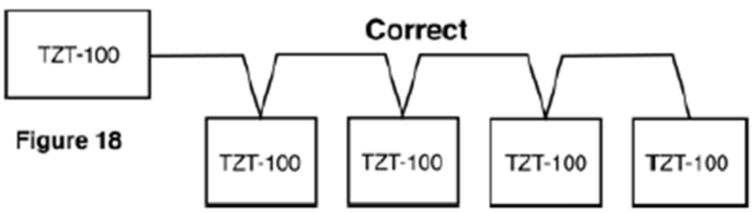


Figure 18

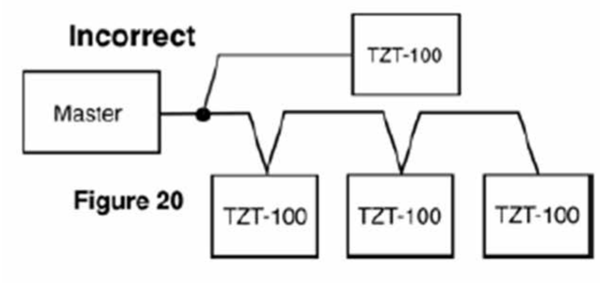


Figure 20

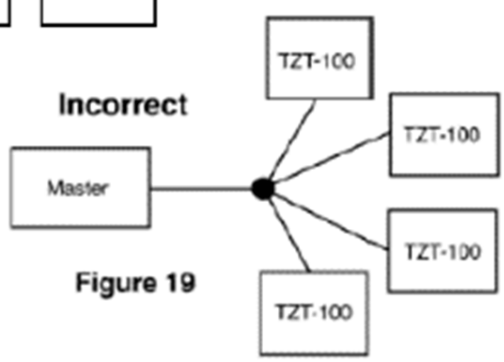


Figure 19

9.2 Factory Test Mode

The TZT-100 is fitted with a simple factory Test Mode where you can confirm that all relays' outputs functions and the current configuration of the thermostat.

Ts = 0 Factory Test Function is OFF.

Ts = 1 Display DIP switch configuration code.

Ts = 2 Relay test mode. All relays cycle on then off in an endless loop.
Ts = 3 Factory Software reset – Press Fan button to confirm.

9.3 High and Low Balance Points

The TZT-100 is fitted with both High and Low Balance Point control capability.

For these functions to operate the Installer setting must be TT=OA (outside air temperature sensor fitted), the outside air sensor must be installed and SW1 must be OFF (Single fan speed mode).

High Balance Point

Set the installer menu value "HB=XX".

When the outside air temperature is above this value, second or third stages of heating are held off regardless of the room and set temperature. Set this function is designed to prevent the excessive consumption of energy for heating when the outside air temperature is warm.

Low Balance Point

SW2=on, H3 =EH (Emergency Heat Mode) Set the installer menu value "LB=XX".

When the outside air temperature is below this value the TZT-100 will automatically switch to emergency heat mode when heating is required. If the outside temperature is above this LB=XX value the emergency heat mode can be selected manually at any time with the "MODE" button.

9.4 Setting Up the Heat and Cool Off Function

To conserve energy, the TZT-100 can suspend the heating or cooling functions if the outside air temperature is within a prescribed installer set range.

If the outside air temperature is above the HO=XX (heating OFF) value, heating will not be called regardless of the room and set temperature. If the outside air temperature is below the CO=XX value, cooling will not be called regardless of the room and set temperature. "Heat" or "Cool" and the word "Locked" will flash on the LCD to show that these modes have been restricted.

9.5 Adaptive Recovery

Only available in programmable mode (sw6=on).

The adaptive recovery function of the TZT-100 permits the user to program a time that a desired set temperature is required, letting the thermostat calculate the most energy efficient time to turn on to achieve the desired temperature at the selected time.

If the user typically returns home at 5:00pm at the end of the work day, setting program #3 (if used in residential programmable mode) to 5:00pm the TZT-100 will calculate the most energy efficient time based on the set and room temperatures as well as a history of temperature change to bring on the equipment prior to 5:00pm to meet the desired set temperature by 5:00pm. For example, when heating is required the heating may start at 4.32pm so that the set temperature is reached at 5:00pm

Adaptive recovery may also prevent the TZT-100 from running for a few moments just prior to a program change occurring.

"RECO" is shown in the LCD whenever Adaptive recovery is being used.

10. Specifications

Input Voltage	24VAC 50/60 Hz +/- 15%
Relay rating	24VAC @ 1Amp maximum per relay
Operating Temperature	0-50°C (32 to 122°F)
Operating RH	0-95% (non-condensing)
Storage Temperature	0-65°C (32 to 150°F)
Size	113 x 103 x 23mm
Display Size	74 x 55mm
Temperature Sensor(s)	10K NTC type 3
Accuracy	+/- 0.3°C @ 25°C. (77°F)
Stage Delays	Minimum temperature change over time method
Timed upstage Delay	5~90 minutes
Anti-Rapid Cycle Delay	Either “Off” or “4-minutes”
Maximum hourly cycles	Unlimited, 30, 10 or 6. (Installer set)
Display resolution	0.1° C (0.2°F)
Control Range	Off to 38°C (100°F)
Outside Air temp display range	-8 ~ +60°C (17 ~ 140°F)
Back light	Blue EL
Backlight life	3,000 hours to half brightness
Adaptive recovery method	Time to Start versus Temp Differential method - updating
Communications Protocol	ModBus – contact Smart Temp or Temperzone for objects list
Fan speeds	Based on difference between room and set temp
Approvals	FCC (Part 15) (pending), C-tick

Sensor Resistance vs Temperature Table

KΩ	24.3	22.0	20.0	18.1	16.2	14.3	13.7	12.5	11.4	10.4	**10.0**	9.57	8.75	8.05
°C	6	8	10	12	14	16	18	20	22	24	**25**	26	28	30
°F	42.8	46.4	50	53.6	57.2	60.8	64.4	68	71.6	75.2	**77**	78.8	82.4	86

11. Trouble Shooting

Symptom	Suspected Fault	Suggested remedy
Temperature display seems inaccurate	Air from the wall cavity may be leaking into the rear of the thermostat / sensor enclosure. A remote sensor rather than the fitted sensor is in use. The internally fitted temperature sensor is folded back inside the enclosure and not being exposed to the room air temperature. External heat or cool source such as lamps, televisions or drafts from open doors affecting the accuracy of sensor. Sensor calibration may setting are incorrect	Plug holes in wall with tape to prevent leaks Check the temperature at the remote sensor location for accuracy. Calibrate if necessary if long cable runs are used. Carefully move the room temperature sensor bead so that it is correctly placed in the sensor cavity in the plastic case. Move lamps, vents or other sources of abnormal temperature away from sensors Adjust C1=XX value in installer mode to correct perceived sensor inaccuracy. Page 57
"Locked" appears on LCD and heating or cooling will not operate.	This is not a fault. Outside air temp. too high to require heating Outside air temp. too low to require cooling.	The Ho=XX &/or Co=XX value is inhibiting heating or cooling calls. Change these values in the installer menu, details on Page 60.
Heating runs in dead band.	TZT-100 incorrectly set to HP mode. (TZT-100 keeps reversing valve energised after heating / cooling has stopped to limit decompression noise from AC system.)	Set SW2=OFF and retest heating and cooling operation.
	Minimum run period has not yet expired. Words "Heating" or "Cooling flash in the LCD	Sw7 sets minimum run period from 2 or 6 minutes.
	Compressor and reversing valve wiring crossed in HP mode (sw2=on)	Check W1 & Y1, Y2 for correct connections.
TZT-100 has no display	Power failure or faulty TZT-100	Check for 12-24V on 12/24V and 0V/COM terminals
Reversing valve remains energised after heating or cooling has stopped.	This is not a fault	The reversing valve remains energised after the heating/cooling has stopped to limit de-compression hiss. Reversing valve will de-energise within 2 hours of the last call.
Spanner Symbol flashes on LCD	This is not a fault Commissioning mode enabled.	Exit commissioning mode before handover to user. See page 60
The word OFF is flashing in the LCD. Mode button has no effect.	This is not a fault	TT=Of in advanced installer menu. The thermostat is being held OFF by a remote device.

11. Trouble Shooting (Continued)

Symptom	Suspected Fault	Suggested remedy
Some buttons do not appear to operate. Padlock is show on LCD.	Key board lock is on.	LC=XX value in advanced installer mode set the lock values, see page 57.
Cannot enter heat or cool modes	TZT-100 thermostat set for Heating or cooling only modes	Heating or cooling mode not available on your air conditioning system
Cannot set heating and cooling to desired value. Padlock symbol flashes	This is not a fault.	HL=XX (heating set point limit) and CL=XX (cooling set point limit) restrict control range. See page 57 for more detail.
Outside Air Temp display is showing dashes	Outside air temperature air sensor has failed.	Check wiring and outside air sensor. Replace outside air sensor
	No outside air sensor fitted.	Change TT=AO to TT=RS in advanced installer menu.
"Heat" or "Cool" is flashing in the LCD. Heating or cooling has not started	This is not a fault. Heating or cooling will start shortly.	Anti-cycle delay in progress. This can be disabled if required for commissioning. See page 60.
The Fan runs on for some time after the heating or cooling stops, even when I turn the TZT-100 OFF.	This is not a fault.	The fan purge mode is set. FP=XX value
TZT-100 displays wrong mode (C or F).	The TZT-100 can operate in both Deg C and Deg F mode as set in installer menu.	See page 57 for changing the CF=XX value
Cannot select multiple fan speeds	SMT-700 set for single fan speed Sw=OFF	Turn SW1 to ON. NOTE, 3 fan speed mode can only be used on single stage systems.
E.Heat or E.Heating is shown on LCD without manually selecting it.	This is not a fault.	LBP reached, outside air too cold for reliable HP operation. Set LBP with the LB=XX value in the installer menu.

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).

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Unit Controller (UC8)

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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	0 - 4500 kPa	0.5 - 4.5 V
LPT	Compressor Suction Gas Pressure	0 - 3450 kPa	0.5 - 4.5 V

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 chapter 0: 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. Relay Outputs LOW, MED and HIGH (OPA)

These relays can be used for control of up to two single-phase outdoor fans or for up to two single- phase indoor fans. The fans can have a single-speed or a three-speed induction motor. Optionally and for some fan configurations, relay HIGH can be used to control a contactor for the indoor fan and relay MED for a contactor for the outdoor fan.

All supported fan combinations are:

Outdoor fan	Indoor fan	Relay HIGH	Relay MED	Relay LOW
1-speed induction motor	**1-speed induction motor**	Indoor fan on/off	Outdoor fan on/off	–
1-speed induction motor	**0-10V EC**	Indoor fan contactor (optional)	Outdoor fan on/off	–
3-speed induction motor	**0-10V EC**	Outdoor fan high-speed tap	Outdoor fan medium-speed tap	Outdoor fan low-speed tap
0-10V EC / TFC	**1-speed induction motor**	Indoor fan on/off	Outdoor fan contactor (optional)	–
0-10V EC / TFC	**3-speed induction motor**	Indoor fan high-speed tap	Indoor fan medium-speed tap	Indoor fan low-speed tap
0-10V EC / TFC	**0-10V EC**	Indoor fan contactor (optional)	Outdoor fan contactor (optional)	–

Note: Relay outputs LOW, MED and HIGH are reserved on OSA (split ducted) models.

1.11. Solid state relay output SSR#1

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

1.12. Relay outputs CMC, SSR#2

Reserved.

1.13. On-status output AUX

Output AUX operates the unit status relay SRB. The SRB relay contacts provide an “On-status” signal. The output is 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 dead band, or the compressor may be held off by an internal safety timer, or by a protection function.

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. Inputs D1, D2, D3

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

1.17 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.

1.18. 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.

1.19. 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.

1.20. 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.

2. DIP Switch Settings

<table>
<tr><th colspan="2">Switch</th><th colspan="3">Function</th></tr>
<tr><td colspan="2">1</td><td colspan="3">Indoor Fan Behaviour</td></tr>
<tr><td colspan="2">On</td><td colspan="3">Indoor Fan Speed May Vary from Thermostat Request</td></tr>
<tr><td colspan="2">Off</td><td colspan="3">Indoor Fan Speed Follows the Thermostat Request
Note: Thermostat fan settings and protection functions can override the selections above.</td></tr>
<tr><td colspan="2">2</td><td colspan="3">De-ice sensors</td></tr>
<tr><td colspan="2">Off</td><td colspan="3">OSA (split ducted) - Reserved Do Not Select Any Other Setting</td></tr>
<tr><td colspan="2">Off</td><td colspan="3">OPA (package) – No second Deice sensor</td></tr>
<tr><td colspan="2">On</td><td colspan="3">OPA (package) – A second de-ice sensor is connected to UC8 input IC</td></tr>
<tr><td>3</td><td>4</td><td colspan="3">Outdoor Fan Type</td></tr>
<tr><td>Off</td><td>On</td><td colspan="3">Outdoor fan 0-10V control signal on output V1.</td></tr>
<tr><td>On</td><td>On</td><td colspan="3">Three-phase fan controlled with a star-delta board connected to UC8 output V1.</td></tr>
<tr><td>Off</td><td>Off</td><td colspan="3">Three-speed fan with single-phase induction motor, UC8 relays HIGH, MED, LOW.</td></tr>
<tr><td>On</td><td>Off</td><td colspan="3">Single-speed fan with single-phase induction motor, UC8 relay MED.</td></tr>
<tr><td>5</td><td>6</td><td colspan="3">Reserved</td></tr>
<tr><td>Off</td><td>On</td><td colspan="3">Do Not Select Any Other Setting</td></tr>
<tr><td>7</td><td>8</td><td colspan="3">Expansion valve arrangement</td></tr>
<tr><td>On</td><td>Off</td><td colspan="3">Single- or parallel- EEV. Refer to expansion valve funtions</td></tr>
<tr><td>9</td><td>10</td><td colspan="2">Electronic expansion valve type</td><td>How to recognise the valve type</td></tr>
<tr><td>Off</td><td>Off</td><td colspan="2">Dunan DPF series</td><td>removable black coil</td></tr>
<tr><td>On</td><td>Off</td><td colspan="2">Zhe Jiang Sanhua DPF series</td><td>non-removable metal coil</td></tr>
<tr><td>Off</td><td>On</td><td colspan="2">Carel E2V series</td><td>removable red coil</td></tr>
<tr><td>On</td><td>On</td><td colspan="3">Reserved, do not select</td></tr>
<tr><td>11
Off
On
Off
On</td><td>12
Off
Off
On
On</td><td colspan="3">Master / Slave Selection</td></tr>
<tr><td></td><td></td><td colspan="3">Master UC8</td></tr>
<tr><td></td><td></td><td colspan="3">Slave system (Nr. 2)</td></tr>
<tr><td></td><td></td><td colspan="3">Slave system (Nr. 3)</td></tr>
<tr><td></td><td></td><td colspan="3">Slave system (Nr. 4)</td></tr>
<tr><td>12
Off</td><td>14
Off</td><td>15
Off</td><td>16
Off</td><td>Models OSA / OPA</td></tr>
</table>

3. Digitally communicating thermostats: SAT-3 and TZT-100

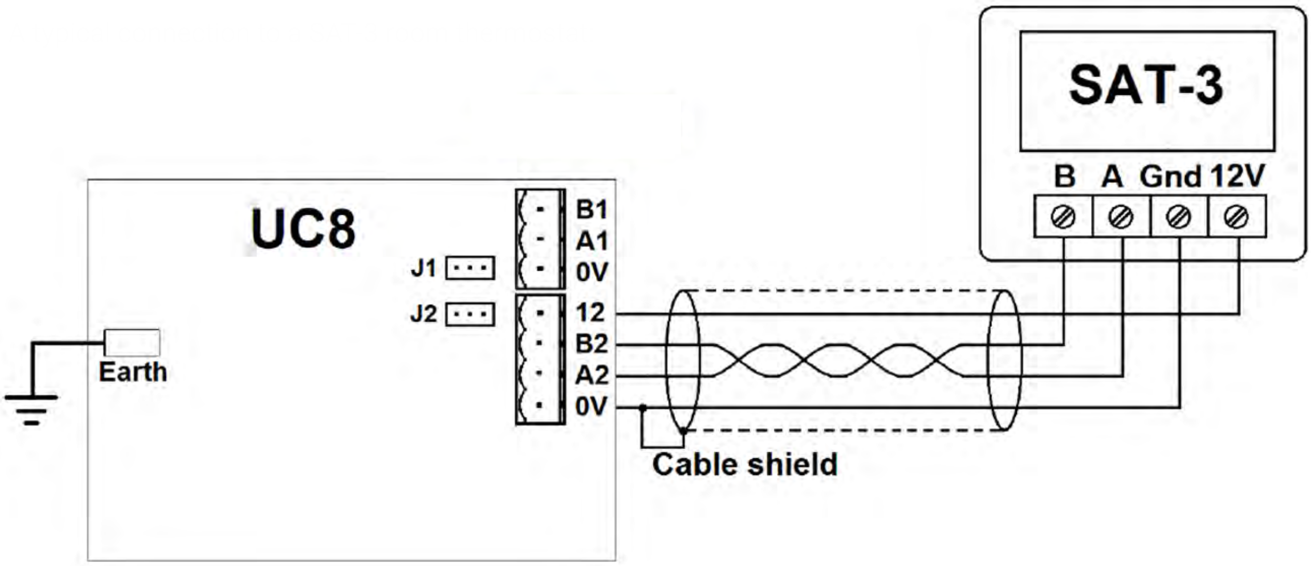
The unit can connect to one SAT-3 or to one TZT-100 room thermostat.

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.

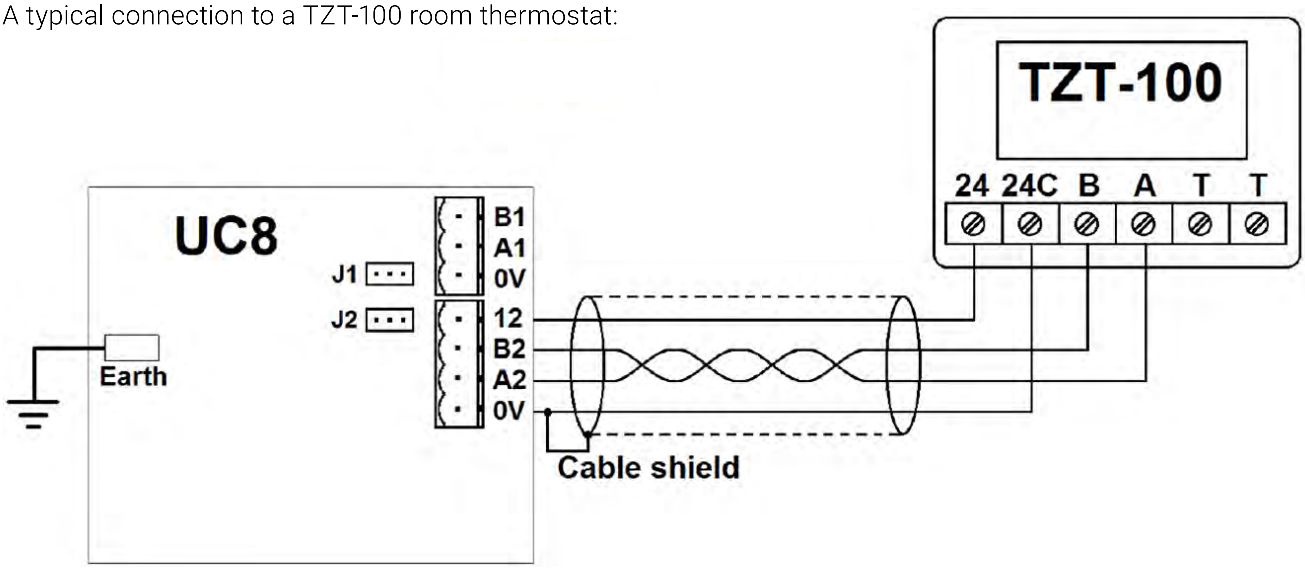
It is recommended to keep the thermostat cable separate from other cables as much as is practical. When the UC8 and room thermostat are communicating a small "satellite dish antenna"  symbol is visible on the thermostat display:

3.1 Temperzone SAT-3 room thermostat

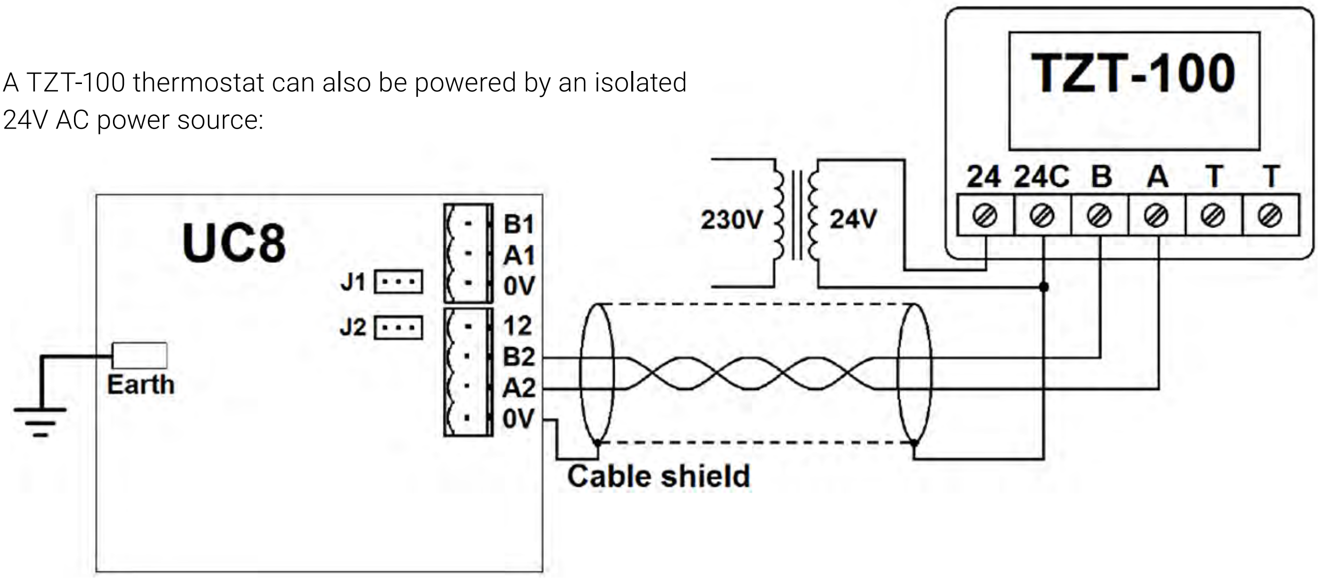


3.2 A typical connection to a TZT-100 room thermostat

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:

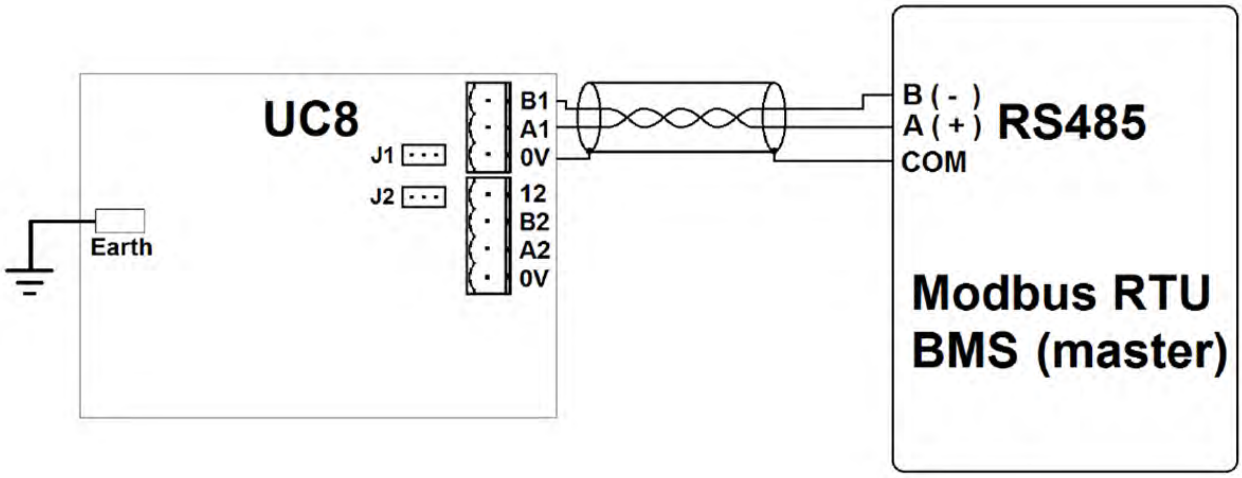
- Baud rate 19200
- 8 Data bits
- Even parity bit
- 1 Stop bit
- TZT-100 modbus device address 7
- SAT-3 modbus device address 8
- The thermostat should be configured for 1-stage operation

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 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 (OSA only)

During the first 30 seconds 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 half minute. The outdoor unit will **not** continue attempting to contact the indoor unit if no reply is received from the indoor unit within those first 30 seconds.

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.**

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.

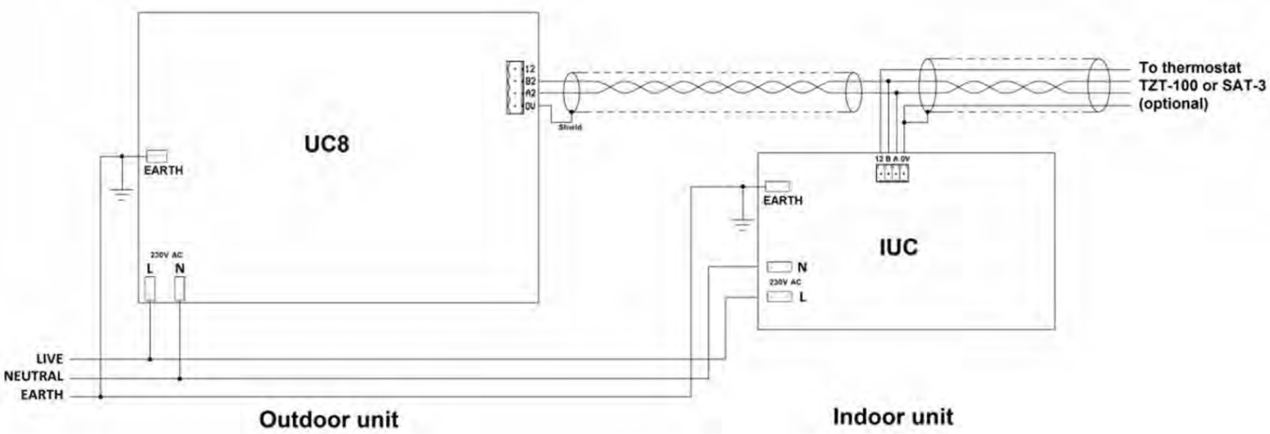
Using a shielded twisted pair cable helps to reduce electrical interference from other nearby cabling:

- 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 **direct and solid earth connection between the outdoor- and the indoor- units.**

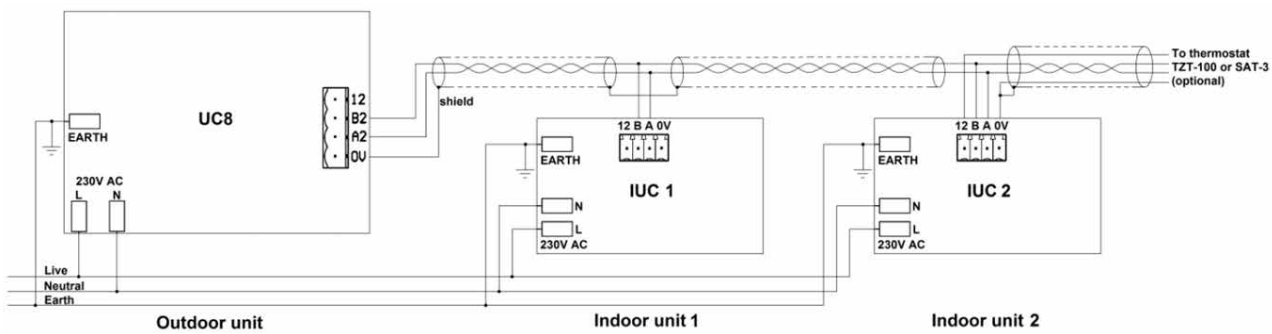
5.2. Connecting 1 outdoor unit to 1 indoor unit

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 and OPA units incorporate 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 3 minutes after starting the capacity is fixed to 33% 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 VC	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

For information how to enable supply air temperature control refer to chapter 10.4.

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 in order 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 to deliver the capacity necessary to keep the room temperature constant. For example, it may happen that 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	**0 = Stop** 100 = Low Speed 550 = Medium Speed 1000 = High Speed
109	Capacity	0 – 20 = Minimum 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 capacity request of 0% provides minimum capacity.

6.5. Oil recovery (oil flush) cycles

Refer to section 13.

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 (Dehumidification)	Variable
Advanced Dry Mode	Fixed

7. Dry mode (de-humidification) (Continued)

- **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.
- **Advanced dry mode (de-humidification):**Advanced dry mode is available only on models with the indoor split into two halves, each with one electronic expansion valve. DIP switches 7 and 8 must be set to ON. When this option is used then UC8 output EXV2 cannot be used for liquid injection nor for inverter cooling. Advanced dry more can provide de-humidification whilst the indoor fan speed can remain constant and over a range of unit capacity.

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

7.2. Dry mode and the TZT-100 thermostat (Continued)

- 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 by serial communications is used, 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 hard-wired to run at a constant fixed speed.

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 hard-wired 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.

8.1. Indoor fan speed adjustment (Continued)

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.

OPA units can alter indoor fan speed via the SW3 push button. In split ducted 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 (split ducted only, disregard DIP switch 5 when adjusting package unit indoor fan speed). After that the fan speed settings can be adjusted as follows:

To adjust the fan high speed setting:

1. Hold down UC8 push-button SW3 until the display shows "**0**", then release the button.
2. The display will now show "**1**" (flashing on and off, this is menu number 1).
3. Hold down the button until the flashing stops.
4. The display will now show "**t**" (flashing on and off).
5. Do a few short button presses until the display shows the letter "**H**".
6. Hold down the button until the flashing stops.
7. The UC8 enters "**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.
8. Use the push-button to change the voltage. It can be set from 3.0 to 10.0V in steps of 0.5V.
9. When the desired fan high speed has been set then hold down the button. The controller will save selected setting and exit from the setting mode.

To adjust the fan low speed setting:

The procedure is the same as for the high-speed setting, but in step 5 select the letter "**L**".

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 in turn may cause supply air to feel relatively cool, or even water freeze protection trips, avoid very high fan speed settings.

8.2. Translation from 0-10V fan control input signal VF to 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. Outdoor fan operation

Cooling mode

When a unit starts cooling the outdoor fan does not start until the condensing temperature in the outdoor coil reaches 30°C. At that temperature the fan starts at the lowest speed. Thereafter the fan will not stop again until cooling ends, or the condensing temperature falls below 10°C.

During normal cooling the outdoor fan speed is automatically adjusted to achieve a condensing temperature of 38°C, the fan speed control voltage will vary between 2.2V and a voltage named VnomC (typically 6V to 10V).

When the condensing temperature rises above 52°C the fan speed control voltage is allowed to rise above VnomC, up to a maximum of 10V.

Heating mode

When a unit starts heating the outdoor fan does not start until the evaporating temperature in the outdoor coil falls to 10°C. At that temperature the fan starts at the lowest speed. Thereafter the fan will not stop again until heating ends, or the evaporating temperature rises above 25°C.

During normal heating the outdoor fan speed is automatically adjusted to achieve an evaporating temperature of 2°C, the fan speed control voltage will vary between 2.2V and a voltage named VnomH (typically 6V to 10V).

When the evaporating temperature falls below -18°C the fan speed control voltage is allowed to rise above VnomH, up to a maximum of 10V.

When the evaporating temperature falls below -18°C the fan speed control voltage is allowed to rise above VnomH, up to a maximum of 10V.

10. De-icing the outdoor coil

A unit will only switch to de-icing of the outdoor coil during normal heating.

Criteria to be met for de-icing to start are:

- The unit has been heating for longer than 3 minutes.
- The de-ice hold-off period (the time passed since the last de-ice cycle) has elapsed. By default, this time is 35 minutes.
- The evaporating temperature (in the outdoor coil) is below -8°C AND (at the same time) the temperature of the refrigerant gas in the suction line is below -4°C (both for longer than 30 s) OR
- the evaporating temperature (in the outdoor coil) is below -12°C for longer than 30 seconds

During de-icing:

When a de-ice cycle commences the compressor speed ramps down to minimum. The outdoor fan continues to run during these 40 seconds. Then the reverse cycle valve changes over to the cooling position, the outdoor fan stops, and the compressor speed can increase again.

The indoor fan may or may not run during de-icing, this depends on whether the thermostat is set to fan-on or fan-auto mode. If the unit has no thermostat connected this depends on the setting of UC8 DIP switch 1. Allowing the indoor fan to continue running typically results in shorter de-ice cycles than with the fan off but comes with the disadvantage that the unit supplies very cold air during de-icing.

During de-icing the compressor speed is varied to achieve a condensing temperature of +11°C.
Should the evaporating temperature (in the indoor coil) fall below -20°C this overrules control of the condensing temperature.

De-icing ends when:

- the de-ice sensor records a temperature above +5°C for longer than 10 seconds
- or the unit has operated in de-icing mode for 10 minutes
- or the unit has stopped due to a trip

When de-icing ends the compressor speed returns to minimum and the outdoor fan starts at high speed. After a short delay the reverse cycle valve returns to the heating position and normal heating resumes.\

De-ice sensor location

The de-ice sensor must be fitted to the copper pipe where liquid refrigerant leaves the outdoor coil during de-icing. (The sensor must not be fitted in the fins of the outdoor coil.) If the outdoor coil consists of two equal halves, mounted in the unit at right angles, then the unit should have two de-ice sensors, fitted to the liquid pipes at the exits of the outdoor coil halves. The second de-ice sensor must connect to UC8 input IC and UC8 DIP switch 2 must be set to ON.

Modbus registers associated with de-icing

Register number	Information
4	Refrigerant suction gas temperature (input SL, 0.01°C)
6	De-ice sensor temperature (input DEI, 0.01°C)
7	Evaporating temperature (0.01°C)
218	De-ice timer (seconds)
660	De-ice hold-off time (seconds)
661	De-ice cycle maximum duration (seconds)
662	De-ice drying duration (seconds)
663	De-ice end duration (seconds)
664	De-ice start evaporating temperature threshold #2 (0.01°C)
665	De-ice end sensor threshold (0.01°C)
802	De-ice start evaporating temperature threshold #1 (0.01°C)
803	De-ice start suction gas temperature threshold #1 (0.01°C)

11. Inverter cooling with refrigerant

Two methods are available to configure UC8 output EXV2 to operate an electronic expansion valve for cooling of the inverter.

Method 1: Using the UC8 display and push-button.

- DIP switches 7 and 8 must be ON
- Hold down UC8 push-button SW3 until the display shows "**0**", then release the button.
- The display will now show "**1**" (flashing on and off, this is menu number 1).
- Press a few times until the display shows "**4**".
- Hold down the button until the flashing stops.
- The display will now show "**E**" (flashing on and off).
- Press a few times until the display shows a small letter "**n**".
- Hold down the button until the flashing stops.
- The UC8 enters "expansion valve setup mode". The display will show the current setting, e.g. "**3**".
- - Press a few times until the display shows "**9**".
- - Hold down the button until the controller saves the selected value and restarts.

Method 2: Using Modbus RTU serial communications.

- First send value 8821 to Modbus register 1401. This step instructs the UC8 controller to accept a new value for programmable registers. If this step is omitted the UC8 will reject any new value.
- Then program Modbus register 614 to value 9.
- After writing a new value the controller must be reset before the change becomes effective.

Caution.

The inverter cooling function for output EXV2 is incompatible with the liquid injection function and incompatible with advanced dry mode.

12. Compressor oil management

The UC8 has two algorithms for compressor oil management.

Oil management

An oil recovery cycle (also called an oil flush cycle) starts when the compressor has continuously operated on a capacity below 40% of nominal for longer than 1 hour and 40 minutes.

Oil recovery cycles last only 1 minute. During the oil recovery cycle the compressor speed increases to 60% of nominal and the EEV is opened proportionally to the increase of compressor speed.

13. Display messages

The following messages can be seen on the LED display.

Display	Meaning	Notes
UC8	Controller name	Shown only after power-on
6.1.8-2	Controller software version and build number	
H7E3B3B8	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	
tZt100	The controller has successfully started communications with the TZT-100 thermostat	Shown only after power-on Note 3 (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 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.

13.1 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	Notes
_. or . or c	Normal Mode (default)	
SLP	Compressor suction line pressure	kPa
Et	Saturated evaporating temperature	°C
SLt	Compressor suction line temperature	°C
SSH	Compressor suction superheat	K
dLP	Compressor discharge line pressure	kPa
Ct	Saturated condensing temperature	°C
dLt	Compressor discharge line temperature	°C
dSH	Compressor discharge super heat	K
ICEt	Outdoor coil de-icing temperature	°C
CAP	Unit capacity	%
EE1	Electronic expansion valve 1 opening	%
EE2	Electronic expansion valve 2 opening	%
Add	UC8 Modbus RTU slave address	
_. or . or c	Back to button press 0	

Pressures are shown in kPa. Divide by 6.895 (roughly 7) 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 (-).

14. Special modes

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

- The compressor must be off.
- There must be no request to start.

When the controller is in settings mode:

- Use short button presses to cycle through the available options (round-robin).
- A long button press confirms the selection made.

To enter settings mode:

1. Apply power to the unit and wait until the power-on sequence is completed. The display should show a blinking dash and decimal point, or just a blinking dash.
2. Press and hold down push-button SW3. After two seconds the display changes to show "**0**.".
3. Release the button. The display will change to show "**1**.".
4. From here short button presses can be used to select the desired menu level, from 1. to 4. or return to normal operation (character **r**). Use a long button press to confirm the selection.
5. Retrospective versions UC8 software may use a different SW3 pushbutton sequence. For this information refer to the UC8 SW3 operation manual.

Possible settings:

Level 0.	Description
1.	Select menu level 1
2.	Select menu level 2
3.	Select menu level 3
4.	Select menu level 4
↖	Back to normal mode.

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
↖	Back to level 0.	

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)
↖	Back to level 0.	

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)
↖	Back to level 0.	

Level 4.	Description
E	Select the compressor model
n	Select the expansion valve functions
u	Select the maximum compressor speed.
↖	Back to level 0.

14.1. 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.

14.2. 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 push-button and select option 'c'. When commissioning mode ends the controller returns to normal mode.

14.3 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. (Refer to IUC manual)

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.

Note: For more information on indoor fan speed adjustment via the UC8 refer to section 8.1

Scan QR code for UC8 Compressor Programming Video Tutorial

14.4. Compressor selection mode: E

IMPORTANT: Always ensure the correct compressor model is selected!

If an incorrect selection is made it is likely to cause the unit to malfunction and could lead to permanent damage to the compressor.

The compressor model can be set with the push-button and display, or the corresponding compressor model number can be written to Modbus register 774.

Compressor model	Display	Compressor UC8 instance number
Three-phase inverter compressors for R32 refrigerant, Carel PSD1 inverter		
Copeland YPV030LT-4X9	P3-Y030L	17
Copeland YPV038LT-4X9	P3-Y038L	18
Copeland YPV050ST-4X9	P3-Y050S	19
Copeland YPV0662-4X9	P3-Y0662	20
Copeland YPV0802-4X9	P3-Y0803E	21
Copeland YPV0962-4X9	P3-Y0962E	22
SCI AVB52	P3-AUb52	23
SCI AVB66	P3-AUb66	24
SCI AVB78	P3-AUb78	25
SCI AVB87	P3-AUb87	26
Single-phase inverter compressors for R32 refrigerant, Carel PSD1 inverter		
Panasonic 9RD138XDA21-230V	P1-9rd138	27
Panasonic 9KD240XDA21-230V	P1-9kd240	28
Copeland YPV030LE-3X9	P1-Y030L	29
Copeland YPV038LE-3X9	P1-Y038L	30
SCI SVB130FBBMT	P1-SUb130	32
SCI TVB306FPGMT	P1-tUb306	33
Single-phase inverter compressors for R32 refrigerant, Ruking ED3 inverter		
Copeland YPV030LE-3X9	E1-Y030L	31
Three-phase inverter compressors for R32 refrigerant, Carel PSD2 inverter		
SCI AVB78	P32AUb78F	34
SCI AVB100	P32AUb100	35
SCI BVB110	P32bUb110	36
Copeland YPV096-4X9	P32Y0962E	37
Single-phase inverter compressors for R32 refrigerant, Carel PSD2 inverter		
SCI SVB092	P12SUb092	38

14.5. Supply-air temperature control option: Y

OSA + ISD installations as well as OPA 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

- Target supply air temperature = setpoint - differential – offset, where:
- Differential is 12°C (a fixed value)
- 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:
- Not be set lower than 10°C
- Not be set higher than 25°C

An example:

- Room temperature 25°C, setpoint 22°C
- Target supply air temperature is 22 - 12 - (25 - 22) = 7°C but this is limited to 10°C
- 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

- Target supply air temperature = setpoint + differential + offset, where:
- Differential is 10°C (a fixed value)
- 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:
- Not be set lower than 30°C
- Not be set higher than 42°C

An example:

- Room temperature 18°C, setpoint 22°C
- 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

- Target supply air temperature is set to 12°C
- 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.

14.5. Supply-air temperature control option: Y (Continued)

Heating mode

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

14.6. 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).

14.7 Expansion valve functions

EEV mode number	EXV1	EXV2	Notes
1	Evaporator superheat	Evaporator superheat	EXV2 duplicates EXV1
2	Evaporator superheat when cooling	Evaporator superheat when heating	The “inactive” EEV is fully open.
3	Evaporator superheat	Dry mode	When dry mode is disabled then EXV2 duplicates EXV1. When dry mode is enabled then the opening of EXV2 can become different to that of EXV1. Refer to Dry mode (de-humidification).
9	Evaporator superheat	Inverter cooling	EXV2 controls refrigerant cooling of the inverter. Refer to Inverter cooling with refrigerant

The EEV mode is selected by a combination of the settings of DIP switches 7 and 8, and Modbus register number 614. The value in register 614 can be set with Modbus RTU serial communications, or with the UC8 push-button and display. Selection is as follows:

DIP switch 7	DIP switch 8	Value of Modbus register 614	EEV mode number
ON	OFF	Any	1
OFF	ON	Any	2
ON	ON	3	3
ON	ON	9	9

15. 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 push-button.

15.1. Fault codes

Display	Meaning	Possible Causes
LP	Low pressure protection is active	Low refrigerant charge (gas leak) Pressure transducer fault EEV malfunction or disconnected Indoor fan or controller malfunction
HP	High pressure protection is active	No water flow (cooling mode) Pressure transducer fault EEV malfunction or disconnected 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) Indoor fan malfunction
HI-t	High temperature protection is active	Insufficient airflow (e.g. a blocked air filter) Indoor fan malfunction
HI-SL	High suction line temperature protection is active	Water temperature too high (heating mode) Short on refrigerant
Lo-dSH	Low discharge superheat protection active	System is flooding back EEV malfunction or disconnected Incorrect EEV operating mode selected
Hi-dSH	High discharge superheat protection active	Low refrigerant charge (gas leak) EEV malfunction or disconnected
CRL	Low compression ratio protection	Internal bypass of refrigerant Water temperature too low or too high
CRH	High compression ratio protection	Pressure transducer fault EEV malfunction or disconnected Indoor fan or controller malfunction
diFF-P	The pressure differential is too high for the inverter compressor to start	Incorrect DIP switch settings Pressure transducer fault
F12	Low pressure transducer fault	Transducer cable disconnected Faulty transducer Loss of refrigerant (gas leak)
F13	High pressure transducer fault	Transducer cable disconnected Faulty transducer 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	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) Faulty transducer EEV malfunctioning or disconnected
F34	Pressures not equalising	Pressure transducer connections swapped Incorrect pressure transducer fitted 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 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) EEV malfunctioning or disconnected
F43	Condensing temperature too low	Supply water temperature too low (cooling mode) EEV malfunctioning or disconnected
F44	Invalid EEV mode selection	Check special mode ‘n’

15.2. 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 Communications cable disconnected Incorrect interconnecting cable termination Driver incorrect DIP switch settings
F101	Motor over-current	Incorrect compressor model selected Insufficient airflow Fan malfunction High Discharge Pressure Corroded Compressor terminals
F102	Motor overload	High discharge pressure Corroded compressor terminals Faulty Compressor
F103	Over-voltage	Mains supply voltage too high
F104	Under-voltage	Mains supply voltage too low

15.2. Inverter fault codes (Continued)

Display	Meaning	Possible Causes
F105	Drive too hot	Insufficient cooling of the drive
F106	Drive too cold	
F107	Drive over-current	Incorrect compressor model selected Insufficient airflow Fan malfunction High discharge pressure Corroded compressor terminals
F108	Motor too hot	Short of refrigerant Compressor inefficient
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	Lack of compression
F120	Power factor correction circuit overload	Liquid in compressor sump
F121	Mains input voltage too high	
F122	Mains input voltage too low	Mains supply voltage too high
F123	Drive internal fault	Mains supply voltage too low
F124	Reserved	
F125	High earth current fault	
F126	Drive processor overload	Motor down to earth
F127	Drive memory loss	
F128	Drive overload protection	
F197	Drive reports incorrect compressor speed	Lack of compression Liquid in compressor sump
F198	Drive and compressor mismatch	Incorrect compressor model selected
F199	Drive configuration fault	Remove mains power, then re-apply

15.3 Carel Power + 2 (PSD2) Fault Codes

In the Carel PSD2 there are two microprocessors:

The first for motor control (defined as Class A)

The second dedicated to safety (class B).

The safety microprocessor is designed for alarm control only and can intervene (after configuration) as a safety device to protect the compressor against Locked rotor or overload events (with motor protection action). The safety microprocessor exposes 25 more alarms than the PSD generation. These alarms, defined as "class B", can be redundant when compared to the alarms "Class A" available in the motor microprocessor.

Code	Fault	Possible Cause
F130	U, V, W currents measurement fault	Current measurement chain damaged (sensors, op amps, shunts, ..)
F131	Unbalanced U, V, W currents	-Indicates a small earth fault on the motor -The current measurement chain (sensors, op amps, shunts, ..) is damaged - Excessive DC bus current -Short circuit between 2 motor phases - Internal driver fault check the condition of the compressor power supply cables - Damage to the insulation of the compressor windings
F132	Over current or ground fault	- Excessive DC bus current -Short circuit between 2 motor phases - Internal driver fault check the condition of the compressor power supply cables - Damage to the insulation of the compressor windings
F133	STO input (Safe Torque Off) open	- Check driver control wiring bridges for loose connection
F134	Internal STO circuit fault	- irreparable damage to the internal "redundancy" circuit of the STO function - permanent damage
F135	Power supply loss	- Mains power quality - Check external protection devices (three-phase) - Check/monitor inverter power supply quality (Including cables)
F136	Motor driver error	- Driver electronics damaged - Permanent damage
F138	Data communica-tion fault	- Incorrect interconnecting or thermostat wiring - damaged Modbus communication wiring (Refer to Communication resistance testing manual) -Incorrect driver DIP switch address set - Driver failure
F139	Motor stall	- Liquid refrigerant in compressor start-up - High compression ratio - High head pressure - Incorrect compressor selection - Electrical 'hot joint' - Internal bypassing of reversing valve - Compressor deterioration

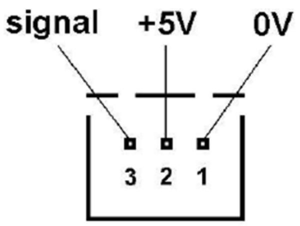
Code	Fault	Possible Cause
F140	DCbus over current	- Excessive current drawn by DCbus (internal load (motor), or by external/auxiliary device (e.g. fans connected to the auxiliary DCbus socket, if present) - Check current drawn by the connected loads
F141	DCbus current Measurement error	- DCbus current measurement chain damaged (sensors, op amps, ..) - Permanent damage
F142	DCbus voltage	- High over voltage peaks on the power supply - excessive deceleration - High head pressure - power supply voltage too low - three-phase case only: driver fault (damaged diode bridge). - Check the current on the three phases to exclude damage to the inverter's diode bridge
F143	DCbus voltage measurement error	- High over voltage peaks on the power supply - excessive deceleration - High head pressure - power supply voltage too low - three-phase case only: driver fault (damaged diode bridge). - Check the current on the three phases to exclude damage to the inverter's diode bridge
F144	Power supply under-voltage	- Mains power quality - Check external protection devices (three-phase) - Check/monitor inverter power supply quality (Including cables)
F145	Power supply voltage measurement error	- Input voltage measurement chain damaged (sensors, op amps, voltage dividers, ..) - Permanent damage
F146	DCbus overload	- Excessive external load (e.g., fans) connected to the DCbus - Check external loads connected to the DCbus terminal: especially when the external load starts
F147	DCbus load measurement error	- Excessive external load (e.g., fans) connected to the DCbus - Check external loads connected to the DCbus terminal: especially when the external load starts
F148	Drive Over temperature	- Blockage in the air-cooling system (debris) - Cooling fans for air cooled driver not operating - EEV for cooling plate not operating correctly. (See UC8 user manual).
F149	Drive Under temperature	- Environment unsuitable - Check ambient temperature
F150	Internal temperature sensor fault	Irreparable damage to the internal circuit
F151	CPU synchronisation error	- Driver electronics damaged
F152	Invalid safety data	- Check UC8 compressor selection special mode 'E' (refer to UC8 user manual)
F154	HW control circuit error	- Driver electronics damaged

16. 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.**

<table>
<tr><td>Controller environmental conditions
Storage temperature range
Operating temperature range
Relative humidity</td><td colspan="3">-20 to +75°C
-10 to +65°C
20 to 95% non-condensing</td></tr>
<tr><td>Mains input
L and N</td><td>230V AC 50Hz nominal</td><td>190V AC minimum</td><td>250V AC maximum</td></tr>
<tr><td>Output relays
Applies to:
HIGH, MED, LOW, CMC and R/V outputs</td><td colspan="3">250V AC, 5A maximum, resistive load
250V AC, 2.5A maximum, inductive load</td></tr>
<tr><td>Solid state output relays
Applies to:
SSR1 and SSR2 outputs</td><td colspan="3">12V AC minimum, 250V AC maximum (AC only!)
0.25A maximum (continuous)
2.5A maximum (peak, 0.5s)</td></tr>
<tr><td>AUX and FLT outputs
Designed to operate a relay with 12V DC coil.</td><td colspan="3">Open collector and +12VDC output
OFF state: leakage current 0.5mA maximum
ON state: 12V DC, 100mA maximum</td></tr>
<tr><td>EXV1 output
For control of a uni-polar electronic expansion valve (5-wire or 6-wire type)</td><td colspan="3">Open collector and +12VDC output
OFF state: leakage current 0.5mA maximum
ON state: 12V DC, 275mA maximum per winding/coil</td></tr>
<tr><td>EXV2 output
For control of 12V DC relay coils.</td><td colspan="3">Open collector and +12VDC output
OFF state: leakage current 0.5mA maximum
ON state: 12V DC, 275mA maximum per winding/coil</td></tr>
<tr><td rowspan="2">Isolated inputs
Applies to:
HI, ME, LO, CP and HT inputs
Common terminals are:
C1 for HI, ME and LO
C2 for CP and HT</td><td colspan="3">When used with 24V AC input signals:
Maximum input voltage OFF state: 2V RMS AC
Minimum input voltage ON state: 18V RMS AC
Absolute maximum input voltage: 35V RMS AC
Input impedance: 2.5kΩ</td></tr>
<tr><td colspan="3">When used with 12V DC input signals:
Maximum input voltage OFF state: 2V DC
Minimum input voltage ON state: 11V DC
Absolute maximum input voltage: 35V DC
Input impedance: 2.5kΩ</td></tr>
</table>

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

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).

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Unit Controller (UC8)

R32 water-sourced air-conditioning

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1. UC8 circuit board input and output signals

1.1 Mains power

Terminal	Indoor Fan Speed
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

Terminal	Function
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	Grey
SL	Compressor suction gas temperature	White
AMB	Electric heating safety sensor	Black
DEI	-	-
OC	Leaving water temperature	Yellow

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. Water flow verification switch input IN#1

A water flow verification switch is recommended. The signal from a flow switch must be voltage-free. Connect the switch directly to the IN#1 terminals. The switch contacts must close when water flow is adequate. If no flow verification switch is used, then the terminals of input IN#1 must be shorted.

1.6. Input IN#2

Reserved, the terminals must be shorted.

1.7. 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:

Terminal	Function
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

1.8. 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.

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

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.

When the remote on/off input is used in combination with a SAT-3 or TZT-100 thermostat then refer to chapter 10.6: Thermostat auto–on/off options.

1.9. Sump condensate float switch input D1

Input D1 can accept a signal from a sump condensate float switch. The float switch must provide a voltage-free contact and connect directly to terminals D1 and SC. The contact must be normally closed when the sump is dry. If no float switch is used, then short circuit terminals D1 and SC.

Terminal SC is internally directly connected to terminals labelled '0V' and the unit EARTH terminal.

1.10. Inputs D2 and D3

Reserved.

1.11. 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 on operation of the indoor fan refer to chapter 7.

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

CWP and HWP units 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. Operation is as follows:

- 0 to 3.0V - Minimum capacity.
- 3.0V to 10V - Capacity varies linearly from minimum at 3.0V to nominal at 10V.

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.

1.13. Relay output CMC

Reserved.

1.14. 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.

1.15. Water pump control output LOW

Terminal LOW provides a switched 230V AC signal that can be used to control a water flow pump.

1.16. Water valve control output MED

Terminal MED switches a 230V AC signal for control of the water flow valve.

1.17. Water valve control output HIGH

Terminal HIGH provides a switched 230V AC signal that can be used to control sump condensate pump.

1.18. Electric heater outputs SSR#1 and SSR#2

Solid state relay outputs SSR1 and SSR#2 are used for control of the electric heating elements.

1.19. On-status output AUX

Output AUX operates the unit status relay SRB. The SRB relay contacts provide an "On-status" signal. The output is 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 dead band, | or the compressor may be held off by an internal safety timer, or by a protection function.

1.20. 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.

1.21. Modbus RTU serial communication port 2

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.

1.22. Electronic expansion valves

The UC8 controls two electronic expansion valves via outputs EXV1 and EXV2. The two expansion valves serve two separate functions:

- EXV1 is for control of superheat
- EXV2 is for control of inverter cooling

Important: The two expansion valves must connect to the correct UC8 socket!

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, 3, 4, 5	**Reserved.**
OFF	Do not select any other setting.
6, 7, 8	**Reserved.**
ON	Do not select any other setting.

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 (& E3V series with uni-polar coil).	removable red coil
ON	**ON**	Reserved, **do not select.**	-

Switch	Function
11, 12	**Reserved**
OFF	Do not select any other setting.

13	14	15	16	
ON	**ON**	**OFF**	**ON**	Model CWPi-RE. All other combinations for DIP switches 13 to 16 are reserved.

3. Digitally communicating thermostats: SAT-3 and TZT-100

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

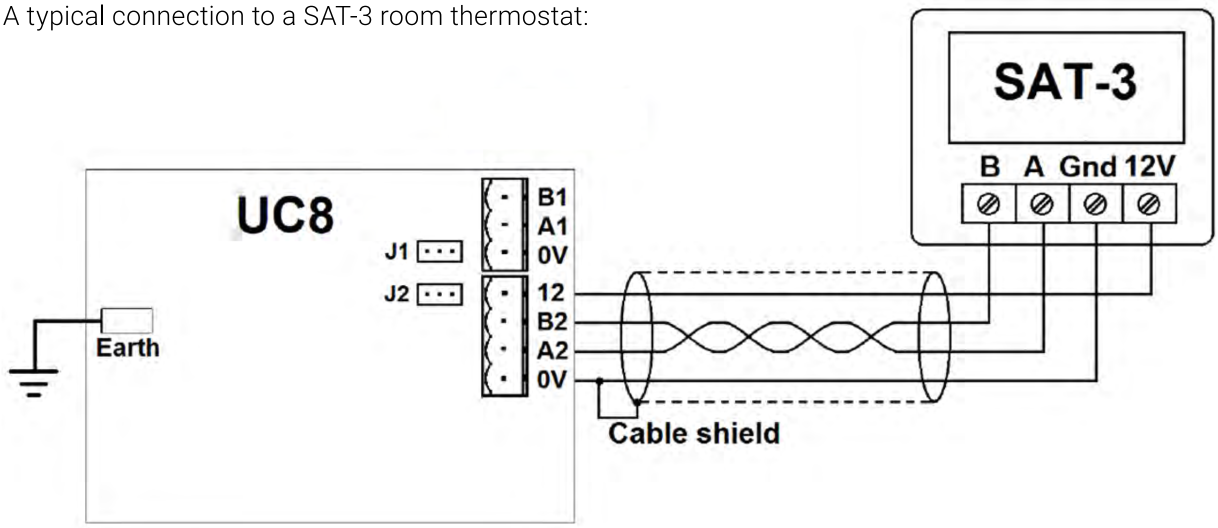
It is strongly recommended to use a shielded cable with twisted pair wires. Signals from UC8 terminals **A2** and **B2** must form one twisted wire pair. The cable shield should connect to terminal "**0V**" at the UC8.

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.

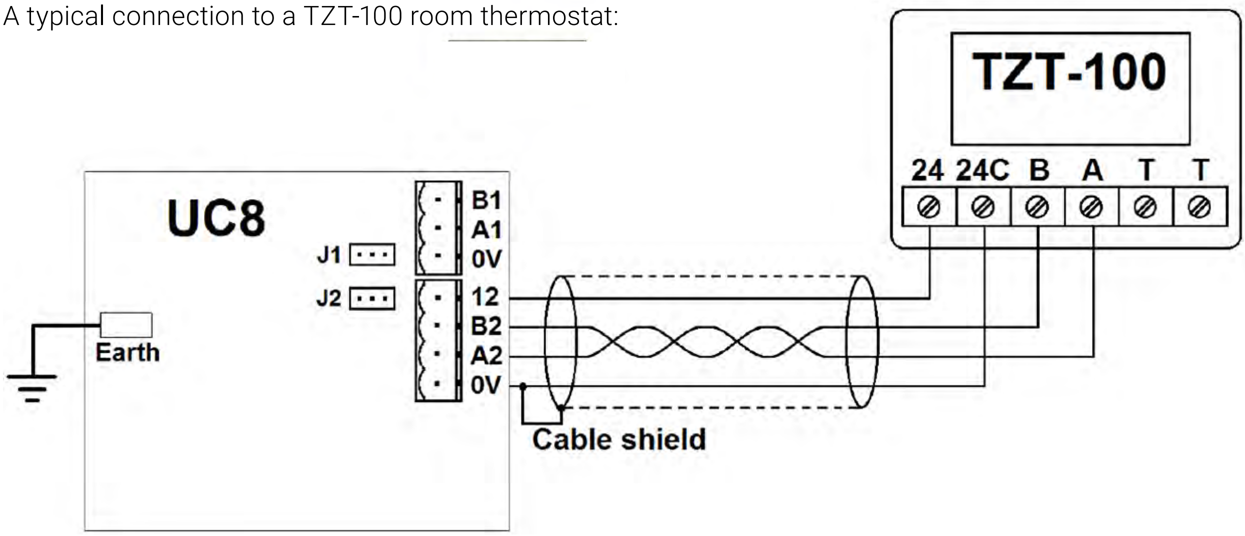
3.1. Temperzone SAT-3 room thermostat

A typical connection to a SAT-3 room thermostat:

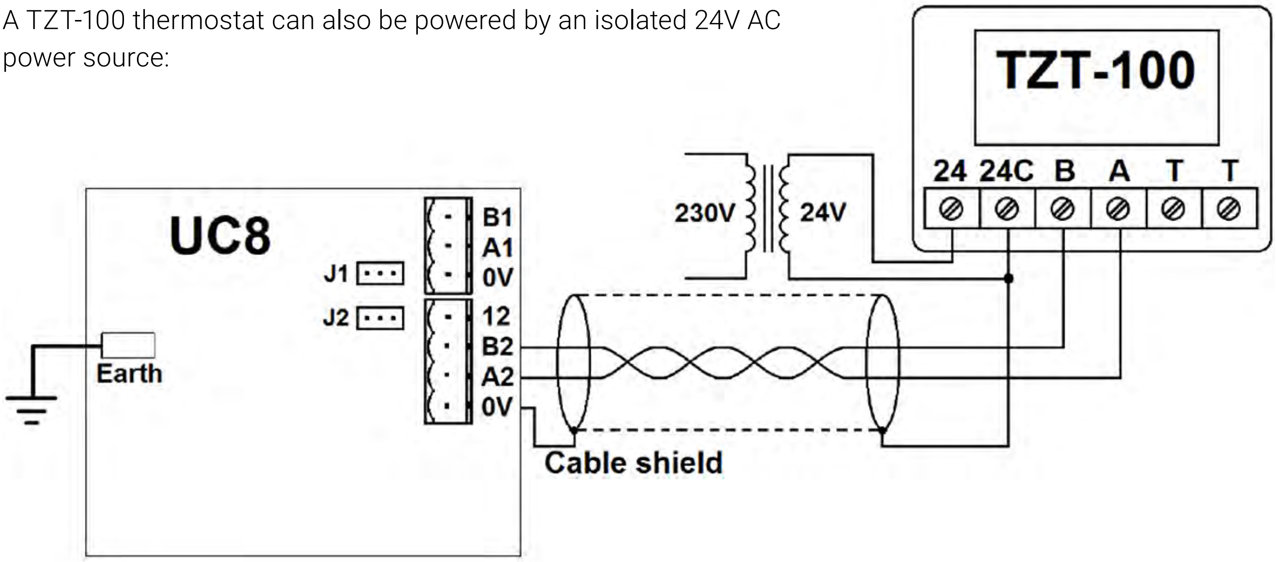


3.2. A typical connection to a TZT-100 room thermostat

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:

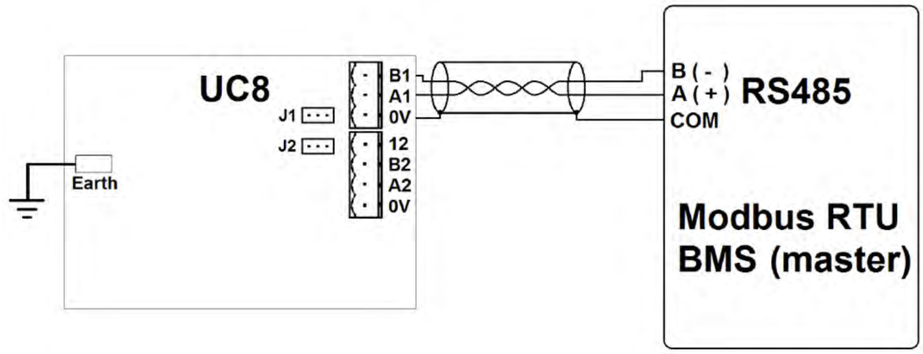
- Baud rate 19200
- 8 Data bits
- Even parity bit
- 1 Stop bit
- TZT-100 Modbus device address 7
- SAT-3 Modbus device address 8
- The thermostat should be configured for 1-stage operation

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 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. Capacity control

CWP and HWP units incorporate 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 fixed to 33% 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:

- Automatic with a SAT-3 or a TZT-100 room thermostat.
- 0-10V analogue voltage on input VC.
- Modbus RTU serial communications.
- Automatic based on evaporating temperature (cooling) or condensing temperature (heating).

5.1. Automatic control with SAT-3 or TZT-100 thermostat

A CWP or HWP unit connected to a SAT-3 or TZT-100 room thermostat automatically varies capacity in order 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 to deliver the capacity necessary to keep the room temperature constant. For example, on warm summer afternoons and with the room temperature equal to setpoint the unit may need to continuously deliver more than 50% 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.

5.2. 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.

5.3. 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	**0 = Stop** 100 = Low Speed 550 = Medium Speed 1000 = High Speed	
109	Capacity	0 – 20 = Minimum 50 = 50% 100 = 100%	

5.3. Modbus RTU control (Continued)

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 capacity request of 0% provides minimum capacity.

5.4. Evaporating / condensing temperature control

For information how to enable evaporating / condensing temperature control refer to chapter 10.5.

5.5. 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 temperzone customer service.

6. Dry mode (de-humidification)

The CWP and HWP model provides 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.

6.1. 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”.

6.2. 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. Indoor fan control

Temperzone CWP and HWP units are equipped with a continuously variable speed fan (EC fan). The following inputs are provided for control of the indoor fan:

- Inputs LO-ME-HI (24V AC or 12V to 24V DC signals, note 1)
- Input VF (0-10V, note 1)
- SAT-3 or TZT-100 room thermostat (note 2)
- Modbus RTU serial communications using RS485 wiring (note 3)

7. Indoor fan control (Continued)

Notes:

1. If the unit is not controlled by serial communications or SAT-3 or TZT-100 then the UC8 automatically selects the input that requests the highest indoor fan speed (LO-ME-HI or VF).
2. If control is by SAT-3 or TZT-100 thermostat then signals on inputs LO-ME-HI and VF have no effect.
3. If control by serial communications is used 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 hard-wired 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.

7.1. Indoor fan speed adjustment

The UC8 controls a variable speed indoor fan using a 0-10V signal from output V2. Factory default settings for the output voltage provided on output V2 are:

CWP90

- Off 0V
- Low 2V
- Medium 3.5V
- High 5V

All Other Models

- 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 the fan speed adjustment procedure is as follows:

To adjust the fan high speed setting:

1. Hold down UC8 push-button SW3 until the display shows "0", then release the button.
2. The display will now show "1" (flashing on and off, this is menu number 1).
3. Hold down the button until the flashing stops.
4. The display will now show "t" (flashing on and off).
5. Do a few short button presses until the display shows the letter "H".
6. Hold down the button until the flashing stops.
7. The UC8 enters "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.
8. Use the push-button to change the voltage. It can be set from 3.0 to 10.0V in steps of 0.5V.
9. When the desired fan high speed has been set then hold down the button. The controller will save selected setting and exit from the setting mode.

To adjust the fan low speed setting:

The procedure is the same as for the high speed setting, but in step 5 select the letter "**L**".

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 in turn may cause supply air to feel relatively cool, or even water freeze protection trips, avoid very high fan speed settings.

7.2. 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 2V for low speed to 5V for high speed.

Input VF	Output V2	Fan
0.0V to 0.99V	0V	Off
1.0V to 1.49V	0 or 2V	Off or Low speed, whichever is currently the case
1.5V to 9.50V	2V to 5V	Low speed to High speed
9.5V to 10.0V	5V	High speed

Input VF Output V2 Fan

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.

8. Circulating water control signals and protection

8.1. Water pump

Relay output LOW provides a signal that can be used for control of a circulating water pump. Conditions that activate the water pump output are:

1. When the UC8 receives a request to start the compressor.
2. When the compressor is running.

The signal is activated about 20 seconds prior to the start of the compressor.

If the installation does not require a pump control signal the output can be left unconnected.

8.2. Water flow control valve

The UC8 provides two output signals that can be used for control of a water flow control valve: 0-10V output V2 and relay output MED. If the water flow control valve requires an open/close signal, then use the relay output MED. If the water flow control valve requires a 0-10V control signal, then use UC8 0-10V output V1.

Control is as follows:

1. When the unit is off the output signal is 0V, the flow valve should close.
2. When the UC8 receives a request to start the compressor the output signal is set to 10V 40 seconds before the compressor is started. This allows even relatively slow-acting valves to open and an adequate flow of water to be present when the compressor is started.
3. When the unit is running in cooling mode UC8 varies the flow valve control signal between 3V and 10V to obtain a condensing temperature of about 40°C.
4. When the unit is heating the signal is set to 10V.

Control of an open/close valve is essentially the same as for a 0-10V flow control valve except the valve cannot actively control the condensing temperature when the unit is cooling.

8.3. Water flow verification switch

UC8 input IN#1 can accept a signal from a circulating water flow verification switch. The switch contacts must be closed-circuit when the water flow is adequate. The UC8 starts checking the signal as soon as it requests the circulating water pump to start via output SSR#1. The switch must activate within 15 seconds or else fault code "no-flow" is reported.

If no flow verification switch is used the input terminals must be connected together (looped).

8.4. Protection against freezing of the circulating water

A CWP or HWP unit operating in heating mode takes energy from the supplied water. To safeguard the installation from freezing the water in the heat-exchanger ensure the following:

1. The water flow rate must remain adequate. The use of a water flow verification switch is recommended.
2. The temperature of the supplied water should be kept above 15°C.

The controller continuously monitors conditions inside the unit. If a situation is detected that potentially could lead to freezing of the water the compressor is turned off and the unit switches over to electric heating. The unit will not return to reverse cycle heating until first the request for heating has been removed.

9. Display messages

The following messages can be seen on the LED display.

Display	Meaning	Notes
UC8	Controller name	Shown only after power-on
6.1.8-2	Controller software version and build number	
H7E3B3B8	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	
tZt100	The controller has successfully started communications with the TZT-100 thermostat	Shown only after power-on Note 3 (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 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	Notes
_. or . or c	Normal Mode (default)	
SLP	Compressor suction line pressure	kPa
Et	Saturated evaporating temperature	°C
SLt	Compressor suction line temperature	°C
SSH	Compressor suction superheat	K
dLP	Compressor discharge line pressure	kPa
Ct	Saturated condensing temperature	°C
dLt	Compressor discharge line temperature	°C
dSH	Compressor discharge super heat	K
ICEt	Outdoor coil de-icing temperature	°C
CAP	Unit capacity	%
EE1	Electronic expansion valve 1 opening	%
EE2	Electronic expansion valve 2 opening	%
Add	UC8 Modbus RTU slave address	
_. or . or c	Back to button press 0	

Pressures are shown in kPa. Divide by 6.895 (roughly 7) 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 push-button are used to make the modifications. To access the available options:

- The compressor must be off.
- There must be no request to start.

When the controller is in settings mode:

- Use short button presses to cycle through the available options (round-robin).
- A long button press confirms the selection made.

To enter settings mode:

1. Apply power to the unit and wait until the power-on sequence is completed. The display should show a blinking dash and decimal point, or just a blinking dash.
2. Press and hold down push-button SW3. After two seconds the display changes to show "**0**.".
3. Release the button. The display will change to show "**1**.".
4. From here short button presses can be used to select the desired menu level, from 1. to 4. or return to normal operation (character **r**). Use a long button press to confirm the selection.
5. Retrospective versions UC8 software may use a different SW3 pushbutton sequence. For this information refer to the UC8 SW3 operation manual.

Possible settings:

Level 0.	Description
1.	Select menu level 1
2.	Select menu level 2
3.	Select menu level 3
4.	Select menu level 4
↖	Back to normal mode.

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
↖	Back to level 0.	

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)
↖	Back to level 0.	

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)
↖	Back to level 0.	

Level 4.	Description
E	Select the compressor model
n	Select the expansion valve functions
u	Select the maximum compressor speed.
↖	Back to level 0.

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 push-button 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. (Refer to IUC manual)

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.

Note: For more information on indoor fan speed adjustment via the UC8 refer to section 8.1

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10.4. Compressor selection mode: E

IMPORTANT: Always ensure the correct compressor model is selected!

If an incorrect selection is made it is likely to cause the unit to malfunction and could lead to permanent damage to the compressor.

The compressor model can be set with the push-button and display, or the corresponding compressor model number can be written to Modbus register 774.

Compressor model	Display	Compressor UC8 instance number
Three-phase inverter compressors for R32 refrigerant, Carel PSD1 inverter		
Copeland YPV030LT-4X9	P3-Y030L	17
Copeland YPV038LT-4X9	P3-Y038L	18
Copeland YPV050ST-4X9	P3-Y050S	19
Copeland YPV0662-4X9	P3-Y0662	20
Copeland YPV0802-4X9	P3-Y0803E	21
Copeland YPV0962-4X9	P3-Y0962E	22
SCI AVB52	P3-AUb52	23
SCI AVB66	P3-AUb66	24
SCI AVB78	P3-AUb78	25
SCI AVB87	P3-AUb87	26
Single-phase inverter compressors for R32 refrigerant, Carel PSD1 inverter		
Panasonic 9RD138XDA21-230V	P1-9rd138	27
Panasonic 9KD240XDA21-230V	P1-9kd240	28
Copeland YPV030LE-3X9	P1-Y030L	29
Copeland YPV038LE-3X9	P1-Y038L	30
SCI SVB130FBBMT	P1-SUb130	32
SCI TVB306FPGMT	P1-tUb306	33
Single-phase inverter compressors for R32 refrigerant, Ruking ED3 inverter		
Copeland YPV030LE-3X9	E1-Y030L	31
Three-phase inverter compressors for R32 refrigerant, Carel PSD2 inverter		
SCI AVB78	P32AUb78F	34
SCI AVB100	P32AUb100	35
SCI BVB110	P32bUb110	36
Copeland YPV096-4X9	P32Y0962E	37
Single-phase inverter compressors for R32 refrigerant, Carel PSD2 inverter		
SCI SVB092	P12SUb092	38

10.5. Supply-air temperature control option: Y

OSA + ISD installations as well as OPA 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

- Target supply air temperature = setpoint - differential – offset, where:
- Differential is 12°C (a fixed value)
- 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:
- Not be set lower than 10°C
- Not be set higher than 25°C

An example:

- Room temperature 25°C, setpoint 22°C
- Target supply air temperature is 22 - 12 - (25 - 22) = 7°C but this is limited to 10°C
- 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

- Target supply air temperature = setpoint + differential + offset, where:
- Differential is 10°C (a fixed value)
- 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:
- Not be set lower than 30°C
- Not be set higher than 42°C

An example:

- Room temperature 18°C, setpoint 22°C
- 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

- Target supply air temperature is set to 12°C
- 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

- Target supply air temperature is set to 36°C
- 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: 0

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).

10.7 Expansion valve functions

IMPORTANT: The EEV operating mode MUST be set to value 9. Do not select any other value.

EEV operating mode 9 uses output EXV1 for control of superheat and output EXV2 for control of the inverter plate cooling.

10.7 Expansion valve functions (Continued)

EEV mode number	EXV1	EXV2	Notes
9	Evaporator superheat	Inverter cooling	EXV2 controls refrigerant cooling of the inverter. Refer to Inverter cooling with refrigerant

The EEV mode is selected by a combination of the settings of DIP switches 7 and 8, and Modbus register number 614. The value in register 614 can be set with Modbus RTU serial communications, or with the UC8 push-button and display. Selection is as follows:

DIP switch 7	DIP switch 8	Value of Modbus register 614	EEV mode number
ON	ON	9	9

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 push-button.

11.1. Fault codes

Display	Meaning	Possible Causes
LP	Low pressure protection is active	Low refrigerant charge (gas leak) Pressure transducer fault EEV malfunction or disconnected Indoor fan or controller malfunction
HP	High pressure protection is active	No water flow (cooling mode) Pressure transducer fault EEV malfunction or disconnected 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) Indoor fan malfunction
HI-t	High temperature protection is active	Insufficient airflow (e.g. a blocked air filter) Indoor fan malfunction
HI-SL	High suction line temperature protection is active	Water temperature too high (heating mode) Short on refrigerant
Lo-dSH	Low discharge superheat protection active	System is flooding back EEV malfunction or disconnected Incorrect EEV operating mode selected
Hi-dSH	High discharge superheat protection active	Low refrigerant charge (gas leak) EEV malfunction or disconnected
CRL	Low compression ratio protection	Internal bypass of refrigerant Water temperature too low or too high
CRH	High compression ratio protection	Pressure transducer fault EEV malfunction or disconnected Indoor fan or controller malfunction
diFF-P	The pressure differential is too high for the inverter compressor to start	Incorrect DIP switch settings Pressure transducer fault
F12	Low pressure transducer fault	Transducer cable disconnected Faulty transducer Loss of refrigerant (gas leak)
F13	High pressure transducer fault	Transducer cable disconnected Faulty transducer 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	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) Faulty transducer EEV malfunctioning or disconnected
F34	Pressures not equalising	Pressure transducer connections swapped Incorrect pressure transducer fitted 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 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) EEV malfunctioning or disconnected
F43	Condensing temperature too low	Supply water temperature too low (cooling mode) EEV malfunctioning or disconnected
F44	Invalid EEV mode selection	Check special mode 'n'

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 Communications cable disconnected Incorrect interconnecting cable termination Driver incorrect DIP switch settings
F101	Motor over-current	Incorrect compressor model selected Insufficient airflow Fan malfunction High Discharge Pressure Corroded Compressor terminals
F102	Motor overload	High discharge pressure Corroded compressor terminals Faulty Compressor
F103	Over-voltage	Mains supply voltage too high
F104	Under-voltage	Mains supply voltage too low

11.2. Inverter fault codes (Continued)

Display	Meaning	Possible Causes
F105	Drive too hot	Insufficient cooling of the drive
F106	Drive too cold	
F107	Drive over-current	Incorrect compressor model selected Insufficient airflow Fan malfunction High discharge pressure Corroded compressor terminals
F108	Motor too hot	Short of refrigerant Compressor inefficient
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	Lack of compression
F120	Power factor correction circuit overload	Liquid in compressor sump
F121	Mains input voltage too high	
F122	Mains input voltage too low	Mains supply voltage too high
F123	Drive internal fault	Mains supply voltage too low
F124	Reserved	
F125	High earth current fault	
F126	Drive processor overload	Motor down to earth
F127	Drive memory loss	
F128	Drive overload protection	
F197	Drive reports incorrect compressor speed	Lack of compression Liquid in compressor sump
F198	Drive and compressor mismatch	Incorrect compressor model selected
F199	Drive configuration fault	Remove mains power, then re-apply

11.3 Carel Power + 2 (PSD2) Fault Codes

In the Carel PSD2 there are two microprocessors:

The first for motor control (defined as Class A)

The second dedicated to safety (class B).

The safety microprocessor is designed for alarm control only and can intervene (after configuration) as a safety device to protect the compressor against Locked rotor or overload events (with motor protection action). The safety microprocessor exposes 25 more alarms than the PSD generation. These alarms, defined as "class B", can be redundant when compared to the alarms "Class A" available in the motor microprocessor.

Code	Fault	Possible Cause
F130	U, V, W currents measurement fault	Current measurement chain damaged (sensors, op amps, shunts, ..)
F131	Unbalanced U, V, W currents	-Indicates a small earth fault on the motor -The current measurement chain (sensors, op amps, shunts, ..) is damaged - Excessive DC bus current -Short circuit between 2 motor phases - Internal driver fault check the condition of the compressor power supply cables - Damage to the insulation of the compressor windings
F132	Over current or ground fault	- Excessive DC bus current -Short circuit between 2 motor phases - Internal driver fault check the condition of the compressor power supply cables - Damage to the insulation of the compressor windings
F133	STO input (Safe Torque Off) open	- Check driver control wiring bridges for loose connection
F134	Internal STO circuit fault	- irreparable damage to the internal "redundancy" circuit of the STO function - permanent damage
F135	Power supply loss	- Mains power quality - Check external protection devices (three-phase) - Check/monitor inverter power supply quality (Including cables)
F136	Motor driver error	- Driver electronics damaged - Permanent damage
F138	Data communica-tion fault	- Incorrect interconnecting or thermostat wiring - damaged Modbus communication wiring (Refer to Communication resistance testing manual) -Incorrect driver DIP switch address set - Driver failure
F139	Motor stall	- Liquid refrigerant in compressor start-up - High compression ratio - High head pressure - Incorrect compressor selection - Electrical 'hot joint' - Internal bypassing of reversing valve - Compressor deterioration

Code	Fault	Possible Cause
F140	DCbus over current	- Excessive current drawn by DCbus (internal load (motor), or by external/auxiliary device (e.g. fans connected to the auxiliary DCbus socket, if present) - Check current drawn by the connected loads
F141	DCbus current Measurement error	- DCbus current measurement chain damaged (sensors, op amps, ..) - Permanent damage
F142	DCbus voltage	- High over voltage peaks on the power supply - excessive deceleration - High head pressure - power supply voltage too low - three-phase case only: driver fault (damaged diode bridge). - Check the current on the three phases to exclude damage to the inverter's diode bridge
F143	DCbus voltage measurement error	- High over voltage peaks on the power supply - excessive deceleration - High head pressure - power supply voltage too low - three-phase case only: driver fault (damaged diode bridge). - Check the current on the three phases to exclude damage to the inverter's diode bridge
F144	Power supply under-voltage	- Mains power quality - Check external protection devices (three-phase) - Check/monitor inverter power supply quality (Including cables)
F145	Power supply voltage measurement error	- Input voltage measurement chain damaged (sensors, op amps, voltage dividers, ..) - Permanent damage
F146	DCbus overload	- Excessive external load (e.g., fans) connected to the DCbus - Check external loads connected to the DCbus terminal: especially when the external load starts
F147	DCbus load measurement error	- Excessive external load (e.g., fans) connected to the DCbus - Check external loads connected to the DCbus terminal: especially when the external load starts
F148	Drive Over temperature	- Blockage in the air-cooling system (debris) - Cooling fans for air cooled driver not operating - EEV for cooling plate not operating correctly. (See UC8 user manual).
F149	Drive Under temperature	- Environment unsuitable - Check ambient temperature
F150	Internal temperature sensor fault	Irreparable damage to the internal circuit
F151	CPU synchronisation error	- Driver electronics damaged
F152	Invalid safety data	- Check UC8 compressor selection special mode 'E' (refer to UC8 user manual)
F154	HW control circuit error	- Driver electronics damaged

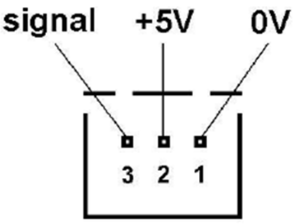
12. UC8 controller circuit board specifications

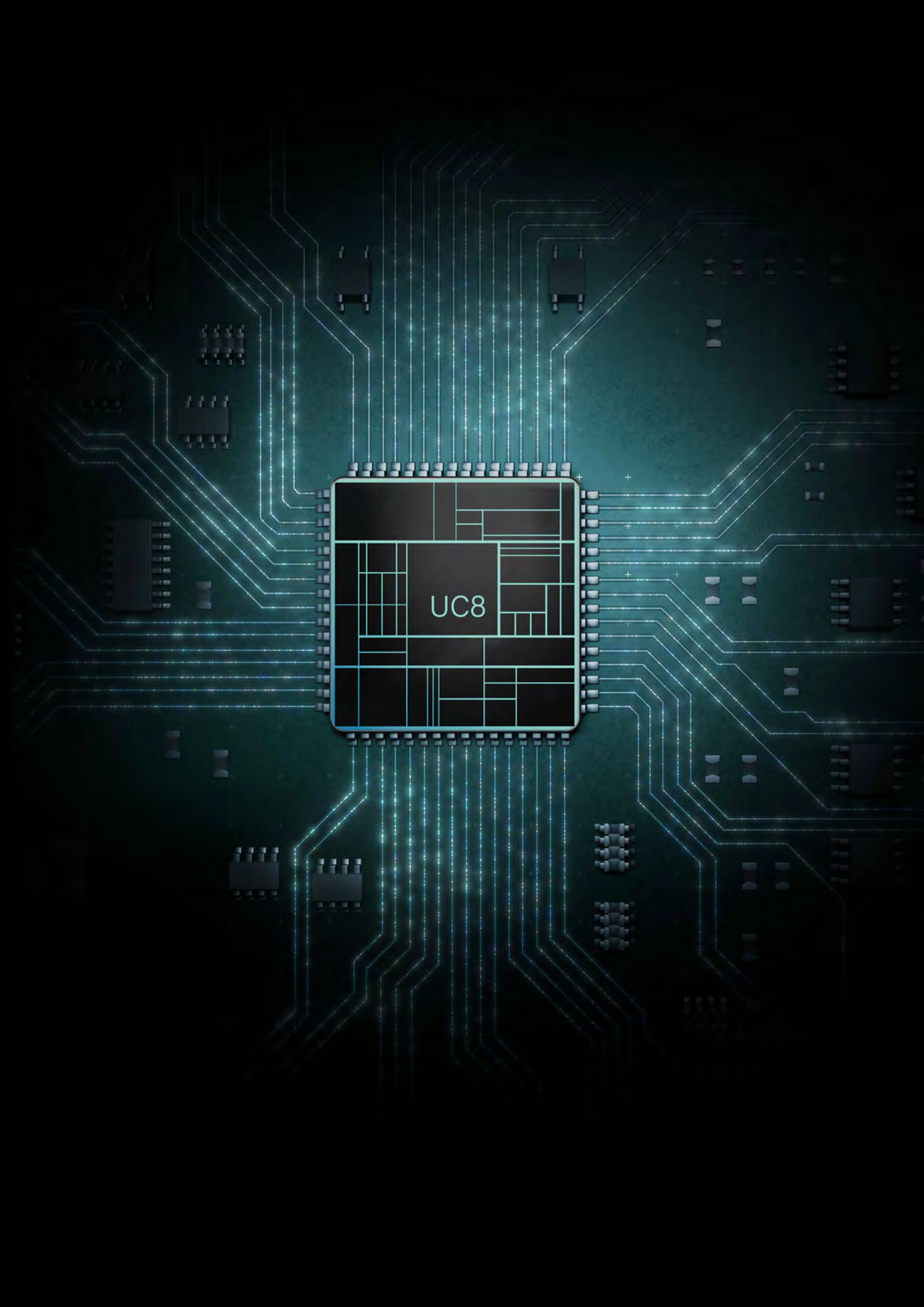
Notes:

- 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 Storage temperature range Operating temperature range Relative humidity	-20 to +75°C -10 to +65°C 20 to 95% non-condensing		
Mains input L and N	230V AC 50Hz nominal	190V AC minimum	250V AC maximum
Output relays Applies to: HIGH, MED, LOW, CMC and R/V outputs	250V AC, 5A maximum, resistive load 250V AC, 2.5A maximum, inductive load		
Solid state output relays Applies to: SSR1 and SSR2 outputs	12V AC minimum, 250V AC maximum **(AC only!)** 0.25A maximum (continuous) 2.5A maximum (peak, 0.5s)		
AUX and FLT outputs Designed to operate a relay with 12V DC coil.	Open collector and +12VDC output OFF state: leakage current 0.5mA maximum ON state: 12V DC, 100mA maximum		
EXV1 output For control of a uni-polar electronic expansion valve (5-wire or 6-wire type)	Open collector and +12VDC output OFF state: leakage current 0.5mA maximum ON state: 12V DC, 275mA maximum per winding/coil		
EXV2 output For control of 12V DC relay coils.	Open collector and +12VDC output OFF state: leakage current 0.5mA maximum ON state: 12V DC, 275mA maximum per winding/coil		
Isolated inputs Applies to: HI, ME, LO, CP and HT inputs Common terminals are: C1 for HI, ME and LO C2 for CP and HT	**When used with 24V AC input signals:** Maximum input voltage OFF state: 2V RMS AC Minimum input voltage ON state: 18V RMS AC Absolute maximum input voltage: 35V RMS AC Input impedance: 2.5kΩ		
	When used with 12V DC input signals: Maximum input voltage OFF state: 2V DC Minimum input voltage ON state: 11V DC Absolute maximum input voltage: 35V DC Input impedance: 2.5kΩ		

12. UC8 controller circuit board specifications (Continued)

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


UC8

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UC8 SW3 Operation

Push Button Operation for Different Software Versions

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1.0 Version 1.0.0. to 4.9.9

1.1. Identifying the software version

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).

The following messages can be seen on the LED display after initial power up.

Display	Meaning	Notes
UC8	Controller name	Shown only after power-on
4.1.3.	Software version and build number	
H7E3B3B8	Controller software identification code	
dELAY	Start-up random delay time	
•	Ready, normal operation	
–	Unit is OFF by Remote On/Off signal	
HOLd	The compressor is held-on or held-off by a timer	
diFF-P	The pressure differential is too high for the inverter compressor to start	

1.2. Viewing pressures temperatures and other variables

The display can be used to monitor pressures and temperatures while the unit is in normal mode or in commissioning mode. This is available regardless of whether the compressor is on or off. Repeatedly press the push-button to cycle the display through the options (in a round robin fashion). After 2 minutes the display will automatically return to a flashing dot (or 'c').

Display	Meaning	Notes
. or c	Normal Mode (default)	
SLP	Compressor suction line pressure	kPa
Et	Saturated evaporating temperature	°C
SLt	Compressor suction line temperature	°C
SSH	Compressor suction superheat	K
dLP	Compressor discharge line pressure	kPa
Ct	Saturated condensing temperature	°C
dLt	Compressor discharge line temperature	°C
dSH	Compressor discharge super heat	K
ICEt	Outdoor coil de-icing temperature	°C
CAP	Unit capacity	%
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	

1.2. Viewing pressures temperatures and other variables (Continued)

Pressures are shown in kPa. Divide by 6.895 (roughly 7) 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. If the unit has one or two pressure transducers, then the condensing and/or evaporating temperatures shown are converted from pressure readings. If a reading is not available, then the display shows a dash symbol (-).

1.3. Special Modes

The UC8 offers a number of modes that allow the factory, installer and service technician to make some changes to the operation of the UC8.

UC8 special modes are selected as follows:

1. Apply power to the unit and wait until the power-on sequence is completed.
2. The compressor must be off and there must be no request to start (CP signal or thermostat must be OFF, no Modbus RTU or BACnet/IP run request).
3. Hold down push-button SW3 until the display shows the specific letter for the required configuration mode, then release the button.
4. The selected mode starts immediately after the button is released. During the configuration mode use the display and push button to make changes to the settings of the UC8.
5. The configuration mode automatically ends when the push button has not been pressed for 30 seconds. Exceptions are commissioning mode which lasts up to 30 minutes, and forced de-ice mode which lasts until ice has been successfully removed from the outdoor coil (maximum 10 minutes).
6. When a setting has been changed during a configuration mode, then the controller saves the change in memory which is kept even when power is switched off. Thus, changes need to be made only once.

UC8 special modes are:

Special Mode	Displayed Symbol
Test	T
Commissioning	C
EC indoor fan high speed adjustment	H
EC indoor fan low speed adjustment	L
Modbus Address	A
Compressor model selection	E
Force an outdoor coil de-ice cycle	d
Supply-air temperature control selection	Y
Shared outdoor fan chamber section	J
Modbus baud rate selection	b
Thermostat auto-on / off selection	o
Expansion device configuration selection	n
Capacity boost mode limiting selection	u

Note: Refer to Unit Controller 8 (UC8) Operation Air-to-air Units.

2. Version 6.0.0 to 6.1.3

2.1. Identifying the software version

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).

The following messages can be seen on the LED display after initial power up.

Display	Meaning	Notes
UC8	Controller name	Shown only after power-on
6.1.2-53	Software version and build number	
HDE5A61E	Software identification code	
dELAY	Start-up random delay time	
•	Ready, normal operation	
–	Unit is OFF by Remote On/Off signal	
HOLd	The compressor is held-on or held-off by a timer	
diFF-P	The pressure differential is too high for the inverter compressor to start	

2.2. 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	Notes
. or c	Normal Mode (default)	
SLP	Compressor suction line pressure	kPa
Et	Saturated evaporating temperature	°C
SLt	Compressor suction line temperature	°C
SSH	Compressor suction superheat	K
dLP	Compressor discharge line pressure	kPa
Ct	Saturated condensing temperature	°C
dLt	Compressor discharge line temperature	°C
dSH	Compressor discharge super heat	K
ICEt	Outdoor coil de-icing temperature	°C
CAP	Unit capacity	%
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 (roughly 7) 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 (-).

2.3. Special Modes

The UC8 offers several options for making modifications to the operation of the unit.

Operating the push-button in level 1:

- Apply power to the unit and wait until the power-on sequence is completed.
- The compressor must be off and there must be no request to start.
- Hold down push-button SW3. After two seconds the display will show the letter t. Continue pressing the push-button until the display shows the character of the desired mode, then release the button.

Operating the push-button in levels 2, 3 and 4:

- In levels 2, 3 and 4 use short button presses to move between options.
- Short presses must be given before the display has shown the same character four times or else the option shown is selected.
- Therefore, to select an option do not press the button. The display will show the character four times, then the controller enters the selected mode.

Level 1.	Option	Factory default
t	Start factory test mode	Off
c	Start or end commissioning mode	Off
H	Adjust the indoor fan high speed voltage	2.0V
L	Adjust the indoor fan low speed voltage	5.0V
2.	Advance to level 2.	
.	Return to normal mode	
Level 2.		
A	Change the UC8 Modbus RTU slave address	44
J	Adjust the water valve delay time	40 seconds
r	Indoor fan fixed speed	Off
o	Turn the thermostat on/off with the remote on/off signal	Off
Y	Enable evaporating / condensing temperature control	Off
3.	Advance to level 3.	
.	Return to normal mode	
Level 3.		
B	Adjust the serial communications baud rate	19200
P	Adjust the serial communications parity & stop bit setting	Even parity, 1 stop bit
4.	Advance to level 4.	
.	Return to normal mode	
Level 4.	**Description**	
E	Select the compressor model	
n	Select the expansion valve operating mode	9
.	Return to normal mode	

3. Version 6.1.4 to current

3.1. Identifying the software version

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).

The following messages can be seen on the LED display after initial power up.

Display	Meaning	Notes
UC8	Controller name	Shown only after power-on
6.1.8-2	Controller software version and build number	
H7E3B3B8	Controller software identification code	
dELAY	Start-up random delay time	
r32	The unit is configured for R32 refrigerant	Shown only after power-on
R410A	The unit is configured for R410a refrigerant	
Air to Air	The type of unit	Shown only after power-on
Nr1	System 1: Master controller	
Nr2	System 2: First slave controller	
Nr3	System 3: Second slave controller	
Nr4	System 4: Third slave controller	
tZt100	The controller has successfully started communications with the TZT-100 thermostat	Shown only after power-on
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	

3.2. 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	Notes
_. or . or c	Normal Mode (default)	
SLP	Compressor suction line pressure	kPa
Et	Saturated evaporating temperature	°C
SLt	Compressor suction line temperature	°C
SSH	Compressor suction superheat	K
dLP	Compressor discharge line pressure	kPa
Ct	Saturated condensing temperature	°C
dLt	Compressor discharge line temperature	°C
dSH	Compressor discharge super heat	K
ICEt	Outdoor coil de-icing temperature	°C
CAP	Unit capacity	%
EE1	Electronic expansion valve 1 opening	%
EE2	Electronic expansion valve 2 opening	%
Add	UC8 Modbus RTU slave address	
_. or . or c	Back to button press 0	

Pressures are shown in kPa. Divide by 6.895 (roughly 7) 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 (-).

3.3. Special modes

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

- The compressor must be off.
- There must be no request to start.

When the controller is in settings mode:

- Use short button presses to cycle through the available options (round-robin).
- A long button press confirms the selection made.

3.3 Special modes (Continued)

To enter settings mode:

1. Apply power to the unit and wait until the power-on sequence is completed. The display should show a blinking dash and decimal point, or just a blinking dash.
2. Press and hold down push button SW3. After two seconds the display changes to show "**0**.".
3. Release the button. The display will change to show "**1**.".
4. From here short button presses can be used to select the desired menu level, from 1. to 4. or return to normal operation (character **r**). Use a long button press to confirm the selection.

Level 0.	Description
1.	Select menu level 1
2.	Select menu level 2
3.	Select menu level 3
4.	Select menu level 4
↖	Back to normal mode.

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
↖	Back to level 0.	

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)
↖	Back to level 0.	

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)
↖	Back to level 0.	

Level 4.	Description
E	Select the compressor model
n	Select the expansion valve functions
u	Select the maximum compressor speed.
↖	Back to level 0.

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UC8 Fault Codes

1. UC8 Fault Routes

UC8 FAULT CODES			
Fault	**Description**	**Version 4 Fault Route**	**Version 6 Fault Route**
LP	Low pressure	< 114 kPa (16.5 psi) on start up or < 228 kPa (33 psi) after 3 minutes	**Case 1:** If a low-pressure (LP) sensor is present, and the sensor signal is invalid, then there's an LP trip **Case 2:** If an LP sensor is present, the compressor is on, the 3 min start-up timer has expired, the LP is above -100kPa and the LP is less than half the LP threshold (which is refrigerant dependent) **Case 3:** If the 3 min start-up timer has expired, the LP is less than the LP threshold (refrigerant dependent), and if the discharge superheat (DSH) is >0 or the DSH is unknown **Case 4:** During the 3 min timer, if LP is less than half the LP threshold (refrigerant dependent) **Case 5:** If the LP is below the envelope minimum, and the compressor speed has been reduced to the minimum allowable speed, the fault is thrown
HP	High Pressure	> 4238 kPa (615 psi) cut out. **Note** Can also be triggered at 0 kPa system pressure	**Case 1:** If the unit is hydronic, and in heating mode, without a low-pressure sensor plugged in, and there's a fault with the indoor coil sensor OR the indoor coil temperature is> 60°C **Case 2:** If HP is above the envelope maximum, and the compressor speed has been reduced to the minimum allowable speed **Case 3:** If the unit is configured for a high-pressure sensor, if there's a fault of the high-pressure sensor, or if the discharge line pressure exceeds the HP threshold (refrigerant dependent)
OL	Overload	Terminals IN#2 are open circuit (auto reset)	Terminals IN#2 are open circuit (auto reset)
FROSt	Frost protection	Evaporator temperature < -8 degrees > 6 minutes	**Case 1:** If the unit is in cooling mode, the code checks if the evaporating temperature is below the frost-protect threshold #1, -8°C **Case 2:** If the UC8 can't measure the evaporating temperature, and if an IUC reports a valid value from the IUC suction line temperature (SLT), this is used, otherwise, the SLT on the UC8 is used. If the SLT is less than the frost-protect threshold #2, -4°C

UC8 FAULT CODES (continued)

Fault	Description	Version 4 Fault Route	Version 6 Fault Route
Lo-T	Freeze Protection	**All cases are relevant for Hydronic Units only** **Case 1:** If the unit is in reverse cycle heating mode, and if the 60-sec average of the suction line temperature is below the freeze threshold (-2°C) **Case 2:** The evaporating temperature is <= -12°C, and the suction line temperature is < -2°C	**All cases are relevant for Hydronic Units only** **Case 1:** If the unit is in reverse cycle heating mode, and if the 60-sec average of the suction line temperature is below the freeze threshold (-2°C) **Case 2:** The evaporating temperature is <= -12°C, and the suction line temperature is < -2°C
HI-t	High discharge line temperature	Discharge temperature > 120 degrees > 2 seconds, or >110 degrees > 30 minutes	**Case 1:** If the discharge line temperature exceeds the slow and fast threshold, 115°C and 125°C respectively – subsequently slow and fast delay timers count down, from 15 mins and 30 secs respectively **Case 2:** If the electric heater temp sensor exceeds the electric cut-out threshold or the ambient sensor is faulty or out of range
HI-SL	High suction line temperature	Suction line temp > 30 degrees, or evaporator temperature > 27.5 (1700 kPa) > 15 min @ 100% capacity	NA
Flood	Flood protection	If the float switch is on (UC8 circuit between SC and D1), the fault timer starts which moves to the fault state (the pump is still on in this state)	If the float switch is on (UC8 circuit between SC and D1), the fault timer starts which moves to the fault state (the pump is still on in this state)
No-Flo	No water flow	IN#1 open circuit (Hydronic)	IN#1 open circuit (Hydronic)
Hi-dSH	High discharge superheat	Discharge superheat > 45 K > 30 min @ 100 % capacity	This fault is set when DSH is too high. The default value is 60K.
Lo-dSH	Low Discharge Superheat	Discharge superheat < 10 K >15 min @ 100% capacity, or 0 K at 40 % capacity	Discharge superheat < 10 K >15 min @ 100% capacity, or 0 K at 40 % capacity
CRL	Compression ratio low	Compression ratio < 1.2 for > 3 minutes	Compression ratio is below the min envelope compression ratio for three minutes
CRH	Compression ratio high	Trips when compression ratio is above 7	Compression ratio is above the envelope for three minutes (More of a cumulative effect than a direct counter).

UC8 FAULT CODES (continued)			
Fault	**Description**	**Version 4 Fault Route**	**Version 6 Fault Route**
ctrL	Loss of control communication	Slave Unit Waiting Master Communication	Slave Unit Waiting Master Communication
diFF-P F34	High pressure differential	HPT/LPT Ratio Must be Between 0.75 and 2.25	HPT / LPT pressures are not approximately equal - when we have both pressure transducers and EEV, and if the ratio (compression ratio) is not close to 1
F10	Incorrect outdoor fan	Incorrect outdoor fan selection	NA
F11	Incorrect indoor fan	Incorrect indoor fan selection	NA
F12	Low pressure transducer fault	UC8 cannot identify suction pressure	UC8 cannot identify suction pressure
F13	High pressure transducer fault	UC8 cannot identify a discharge pressure	UC8 cannot identify a discharge pressure
F14	Suction line sensor fault (SL)	Suction sensor open circuit	Suction sensor open circuit
F15	Discharge line sensor fault (DL)	Discharge sensor open circuit	Discharge sensor open circuit
F16	De-ice sensor fault (DEI)	De-ice sensor open circuit	De-ice sensor open circuit
F17	Outdoor coil sensor fault (OC)	Outdoor coil sensor open circuit	Outdoor coil sensor open circuit
F18	Indoor coil sensor fault (IC)	Indoor coil sensor open circuit	Indoor coil sensor open circuit
F19	Ambient sensor fault (AMB)	Ambient sensor open circuit	Ambient sensor open circuit
F20	Superheat unknown	Cannot calculate superheat	When there aren't enough sensors to measure discharge or superheat
F21	Thermostat fault	**Case 1:** The ID code of the thermostat is read, if the ID code is invalid and ten or more attempts have been made to read the ID, the thermostat fault is signalled. This is true for the SAT 3, the zone board, and the HL-2028. **Case 2:** Another case is if the reply is invalid or there's no reply from the thermostat (which means we can't be in start-up mode). Then, if there are ten or more attempts to get a reply	**Case 1:** The ID code of the thermostat is read, if the ID code is invalid and ten or more attempts have been made to read the ID, the thermostat fault is signalled. This is true for the SAT 3, the zone board, and the HL-2028. **Case 2:** Another case is if the reply is invalid or there's no reply from the thermostat (which means we can't be in start-up mode). Then, if there are ten or more attempts to get a reply

UC8 FAULT CODES (continued)			
Fault	**Description**	**Version 4 Fault Route**	**Version 6 Fault Route**
F22	Comms Master	The BMS or a master UC8 is the Modbus master here. If the timer is at zero this means that contact with the Modbus master (Master UC8/BMS)	The BMS or a master UC8 is the Modbus master here. If the timer is at zero this means that contact with the Modbus master (Master UC8/BMS)
F23	Comms Slave 1	HPT/LPT Ratio Must be Between 0.75 and 2.25	If the slave UC8 should have replied to the master UC8, and there have been ten or more communication attempts made, the slave is reported missing
F24	Comms Slave 2	If the slave UC8 should have replied to the master UC8, and there have been ten or more communication attempts made, the slave is reported missing	If the slave UC8 should have replied to the master UC8, and there have been ten or more communication attempts made, the slave is reported missing
F25	Comms Slave 3	If the slave UC8 should have replied to the master UC8, and there have been ten or more communication attempts made, the slave is reported missing	If the slave UC8 should have replied to the master UC8, and there have been ten or more communication attempts made, the slave is reported missing
F26	Invalid DIP switch selection	This fault is thrown provided that DIP switch 13 is on and 14, 15, and 16 are not set to a valid configuration (illegal configuration). If 13 is not on, 14, 15, and 16 are not set correctly.	This fault is thrown provided that DIP switch 13 is on and 14, 15, and 16 are not set to a valid configuration (illegal configuration). If 13 is not on, 14, 15, and 16 are not set correctly.
F27	Fan selection	**Case 1:** If a 0-10V variable speed compressor is selected (this is illegal). **Case 2:** If indoor or outdoor fans are configured as three-speed (set to be driven by relays) **Case 3:** If the outdoor fan is configured to a configuration other than those available/specified. Illegal configuration.	**Case 1:** If a 0-10V variable speed compressor is selected (this is illegal). **Case 2:** If indoor or outdoor fans are configured as three-speed (set to be driven by relays) **Case 3:** If the outdoor fan is configured to a configuration other than those available/ specified. Illegal configuration.
F28	Reserved	Reserved	Reserved
F29	Micro controller hot	If the board temperature is greater than or equal to 105°C	If the board temperature is greater than or equal to 105°C
F30	Supply voltage out of bounds	Trips <2.7vdc Auto Reset After 30 sec, no Lockout. Mains is Below 190VAC.	Trips <2.7vdc Auto Reset After 30 sec, no Lockout. Mains is Below 190VAC.
F31	Slave fault	Slave UC8 reports a fault	**Case 1:** If the ID code is invalid, the slave is reported missing **Case 2:** If the slave should have replied and if ten or more communication attempts were made, report the slave is missing

UC8 FAULT CODES (continued)			
Fault	**Description**	**Version 4 Fault Route**	**Version 6 Fault Route**
F32	0-10V input fault	Incorrect voltage on 0-10v input	The I2C fault is set if the I2C slave did not acknowledge when it should have, or the SDA line is low when it shouldn't be. Additionally, if the error count > 10 the fault will be set. The following scenarios result in an error report, this, in turn, sets the fault for I2C: **Case 1 :** If SDA and/or SCL is low cannot generate start and an error is reported. If SDA is low **Case 2:** If SDA is left high (no ack coming in) and if we're expecting a slave receiver acknowledge bit, the error is flagged. **Case 3:** If SDA is low when it should be high **Case 4:** If SDA and/or SCL level is not correct **Case 5:** If one or both lines are still high
F33	High discharge superheat	Discharge Superheat >45K > 30min @ 100% Capacity.	This fault is set when DSH is too high. The default value is 60K.
F34	Pressure not equalising	HPT/LPT Ratio Must be Between 0.75 and 2.25	HPT / LPT pressures are not approximately equal - when we have both pressure transducers and EEV, and if the ratio (compression ratio) is not close to 1
F35	Reversing valve fault	Heating: IC Must be Closer to the CondT Than to the EvapT >3min.	N/A
F36	Invalid DIP switches TZT-100	Invalid DSW Setting on TZT-100 Thermostat	Invalid DSW Setting on TZT-100 Thermostat
F37	No communication IUC	The IUC comms fault is set when the number of attempts to establish communication with the IUC is >= 10, and in the event that the fault flag is not yet set.	The IUC comms fault is set when the number of attempts to establish communication with the IUC is >= 10, and in the event that the fault flag is not yet set.
F38	IUC fault	Fault present on IUC	Fault present on IUC
F39	Inverter fault	Inverter fault present	Inverter fault present
F40	High compression ratio	Trips When Compression Ratio is Above 7x	Compression ratio is above the envelope for three minutes (More of a cumulative effect than a direct counter).

UC8 FAULT CODES (continued)			
Fault	**Description**	**Version 4 Fault Route**	**Version 6 Fault Route**
F41	Low compression ratio	Compression Ratio < 1.2 + 3 minutes	Compression ratio is below the min envelope compression ratio for three minutes
F42	High evaporator temperature	Suction Line Temp >30° or EvapT>27.5 (1700kPa) >15min @100% Capacity	The evaporating temperature remains above the max envelope evaporating temperature for 3 minutes
F43	Low condensing temperature	Condensing Temperature <5 deg + 3 minutes	This fault is set when the condensing temperature is low, and when in cooling or heating mode (and not just started, and not de-icing) where resultantly a 3 min timeout is applied.
F44	Invalid EEV selection	Incorrect EEV Selection	**Case 1:** If the compressor is of type variable speed, the fault is set. **Case 2:** If the output EXV2 is used to operate extra relays (hydronic unit with fixed or digital comp), the fault is set.
F45	Reserved	Reserved	Reserved
F46	Invalid thermostat	Invalid thermostat connected	NA
F100<	Carel power + inverter fault	F100 and higher fault routes determined by Carel Power + inverter. Refer to Carel Power + User manual or UC8 user manual for further detail.	F100 and higher fault routes determined by Carel Power + inverter. Refer to Carel Power + User manual or UC8 user manual for further detail.

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Modbus RTU Communications

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1. Introduction

Temperzone air conditioning units equipped with a UC8 controller board provide a facility to communicate with external devices, such as a Building Management System (BMS) or a data logging device. Communications follow standard Modbus RTU format.

A Modbus master connected to RS485 port 1 on the UC8 controller is able to do the following:

- Turn the compressor on and off.
- Read and control the indoor fan speed.
- Read and control cooling, heating or fan only.
- Read and control the capacity.
- Enable and disable de-humidification mode.
- Enable and disable quiet operating mode.
- Monitor temperatures, pressures, states of other input signals.
- Observe unit safety timers.
- Observe the state of the outputs such as CMC relay, R/V relay etc.
- Observe information on reported faults.
- Restart a locked-out unit.
- If the unit has a master system plus one or more slave systems then all of the above information is also available for all slave systems.

Regardless of whether the unit is controlled by a simple thermostat or a full-fledged BMS, safety features built into the unit will always be applied. For example: A compressor may be held off until a minimum off-time has expired, and this delay will always be applied independent of the request of a thermostat and/or a BMS.

2. Available Modbus functions

A UC8 programmed with software version 1.5.2 or later accepts the following modbus function codes:

- Function code 01: Read coils
- Function code 03: Read holding registers
- Function code 05: Write single coil
- Function code 06: Write single register
- Function code 16: Write multiple registers

Read access through function 03 is limited to a maximum of 25 registers per function call.

Write access through function 05 is allowed to a restricted set of coils.

Write access through functions 06 and 16 is allowed to a restricted set of holding registers.

Note: Coils also exist as bits in holding registers. One is free to choose whether to use Modbus coil functions or Modbus holding register functions to read or write these coils / bits.

3. Communications rate and format

The Modbus mode is RTU half-duplex using serial communications over RS485. Factory default settings are:

Baud rate	Data bits	Parity	Stop bits
19200	8	Even	1

It is possible to change the baud rate, parity, and the number of stop bits using the UC8 push-button and display and also via the Modbus RTU serial connection on port 1. The following modbus holding registers are provided for this.

Bold letters indicate factory default values.

Register number	Register name	Register values
717	Port 1 Baud rate	0 = 4800 baud 1 = 9600 baud **2 = 19200 baud** 3 = 38400 baud 4 = 57600 baud 5V= 115200 baud
718	Port 2 Baud rate	0 = 4800 baud 1 = 9600 baud **2 = 19200 baud** 3 = 38400 baud 4 = 57600 baud 5 = 115200 baud
719	Port 1 Parity and Stop bits	0 = No parity 2 stop bits 1 = Odd parity 1 stop bit **2 = Even parity 1 stop bit**
720	Port 2 Parity and Stop bits	0 = No parity 2 stop bits 1 = Odd parity 1 stop bit **2 = Even parity 1 stop bit**
1401	Write enable	**0 = Write disabled** 8821 = Write enabled
1402	Reset port 1	**0 = No action** 1 = Reconfigure port 1

Note: Before the UC8 controller accepts any changes to registers 717 to 720 first the user must write value 8821 (hexadecimal 0x2275) to register 1401. Modbus function 6 must be used.

If the value of any of registers 717 to 719 is modified the changes become effective after the controller has been reset by cycling mains power to the controller off and on again. Modbus function 6 must be used, the controller will not accept Modbus function 16 for these registers.

For RS485 port 1 only:

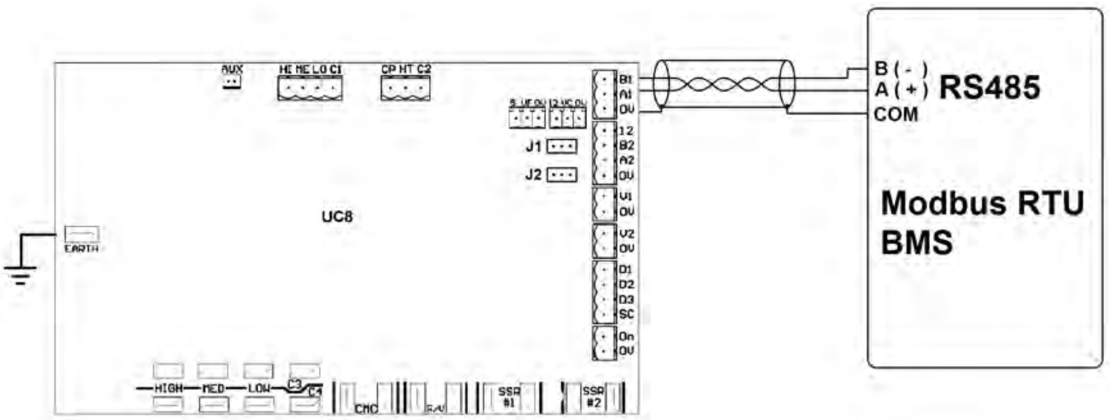
A method is provided via register 1402 which allows reconfiguration of port 1 only without having to reset the controller. The correct procedure is (in this order):

- Write value 8821 to register 1401 (to enable write access)
- Write value 0 to 5 (as required) to register 717 (select the required baud rate)
- Write value 0 to 2 (as required) to register 719 (select the required parity and stop bits)
- Write value 1 to register 1402 (reset RS485 port 1)
- **Note:** The UC8 Modbus reply to the last write command (value 1 to register 1402) will immediately use THE NEW SETTINGS!

4. BMS to UC8 connection

Modbus communications with the UC8 are handled via RS485. It is recommended to use a shielded twisted pair cable. Recommended wire gauges are 24AWG to 18 AWG (0.5 to 1.0mm wire diameter).

The external device must be a Modbus master and should connect to terminals A1 (+) and B1 (-), as shown below. The shield wire should connect to terminal G.



Up to a maximum of 99 units can be connected on a common RS485 bus in daisy-chain fashion.

When the RS485 cable ends at the unit and the length of the RS485 cable is relatively long (more than about 10m), then place jumper J1 on the left two pins. When the unit is not at the end of the RS485 cable, or where the cable length is 10m or less, place jumper J1 on the right two pins. **Maximum cable length is 1000m.**

It is recommended to use an isolated RS485 interface. An isolated interface ensures maximum safety and reliability, especially when the RS485 cable length is long.

5. Changing the Modbus device address

The default Modbus device address of the Temperzone UC8 controller is **44**. The controller offers a facility to view and change the Modbus device address. The procedure is as follows:

- The compressor must be off.
- There must be no request to start.

When the controller is in settings mode:

- Use short button presses to cycle through the available options (round-robin).
- A long button press confirms the selection made.

To change Modbus address in special mode:

1. Apply power to the unit and wait until the power-on sequence is completed. The display should show a blinking dash and decimal point, or just a blinking dash.
2. Press and hold down push-button SW3. After two seconds the display changes to show “0.”.
3. Release the button. The display will change to show “1.”.
4. Tap once to select menu ‘2’ and long press to enter.
5. When the display says ‘A’ long press SW3 to enter.
6. The UC8 default address will display ‘44’. Use short presses to select desired Modbus address.
7. When the desired Modbus address is selected long press SW3 to confirm selection.

If the address was changed during address selection mode, then the controller will save the new address in non-volatile memory. The new Modbus device address will be retained even after mains power has been switched off.

It is also possible to change the UC8 controller Modbus address via the Modbus connection itself. For more information on this method contact temperzone.8. UC8 will now return to default display screen.

6. List of holding registers

6.1. Temperatures

The following registers represent temperatures (note 1). Divide by 100 to obtain temperature in °C. Temperatures are signed numbers and may read negative. Negative numbers are represented in standard binary two's-complement 16-bit word format.

<table>
<tr><th>Register</th><th>Function</th><th>Units</th><th>Type</th></tr>
<tr><td>1</td><td>Outdoor coil temperature (note 2)</td><td rowspan="9">0.01°C</td><td rowspan="11">Read Only</td></tr>
<tr><td>2</td><td>Indoor coil temperature (note 2)</td></tr>
<tr><td>3</td><td>Outdoor ambient temperature</td></tr>
<tr><td>4</td><td>Suction line temperature</td></tr>
<tr><td>5</td><td>Discharge line temperature</td></tr>
<tr><td>6</td><td>De-ice sensor temperature</td></tr>
<tr><td>7</td><td>Evaporating temperature (note 3)</td></tr>
<tr><td>8</td><td>Condensing temperature (note 3)</td></tr>
<tr><td>9</td><td>Controller temperature</td></tr>
<tr><td>10</td><td>Suction side superheat</td><td rowspan="2">0.01 Kelvin</td></tr>
<tr><td>11</td><td>Discharge side superheat</td></tr>
</table>

Note 1: Many models do not have all temperature sensors fitted. A read of a holding registers where the associated sensor is absent will return value -10000 (that is: -100.00°C).

Note 2: If a unit is fitted with pressure transducers on the compressor discharge- and suction- lines then usually no temperature sensor are fitted to the indoor- and outdoor- coils.

Note 3: If a unit is fitted with pressure transducers on the compressor discharge- and suction- lines then evaporating and condensing temperatures are calculated from these pressure readings. If no pressure transducers are fitted, then the evaporating- and condensing- temperatures are copies of the associated coil temperature sensors. If the unit also lacks coil temperature sensors, then the evaporating and condensing temperatures are unknown.

6.2. Pressures

The following two registers represent pressures in kPa (note 4).

<table>
<tr><th>Register</th><th>Function</th><th>Units</th><th>Type</th></tr>
<tr><td>13</td><td>Compressor suction line pressure</td><td rowspan="2">kPa</td><td rowspan="2">Read Only</td></tr>
<tr><td>14</td><td>Compressor discharge line pressure</td></tr>
</table>

Note 4: Not all models are fitted with pressure transducers. If no pressure transducer is present, then value -200 kPa is returned.

6.3. Electronic expansion valve positions

The following two registers can indicate the current position of up to two electronic expansion valves, expressed as a percentage (0% is fully closed, 100% is fully open). If a unit does have electronic expansion valves, then a read of these two registers will return value 0%.

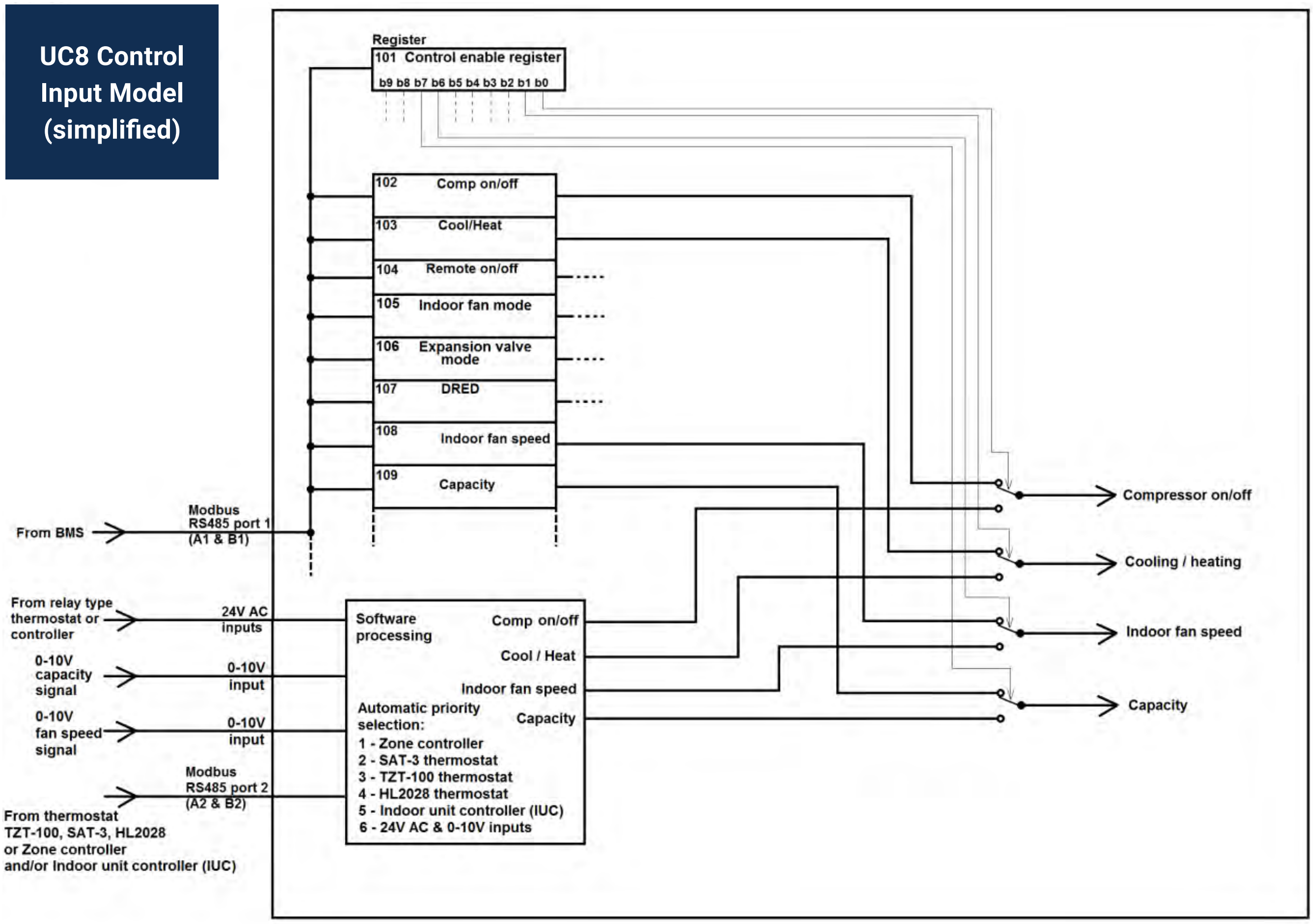
Register	Function	Units	Type
26	Electronic expansion valve EXV1 opening	%	Read Only
27	Electronic expansion valve EXV2 opening		

6.4. Unit control

Modbus holding registers with register address 1xx (101 to 112) are provided for control of a unit by a communicating BMS. Many of the individual bits in these registers can also be addressed as coils numbered coil 1 through to coil 19. These unit control registers / coils can be read from and written to by the BMS at any time. However, before a value written to any one of the unit control registers or coils has any effect on unit operation first a value '1' must be written to the corresponding bit in "control-enable" register 101 or alternatively to coils 1 through to 10. The default state of all bits/coils in control-enable register 101 is 0. That is: All controls via this set of registers and coils are disabled.

Below is a diagram that illustrates the control logic implemented by the UC8. For simplicity only four control signals are fully shown.

UC8 Control Input Model (simplified)



When a BMS has written **any** of the control-enable bits/coils to value 1, then the BMS must control and/or request information from the unit at least once every 5 minutes. Any read from -or write to- any register/coil is considered sufficient to maintain contact.

If 5 minutes expire without the BMS making contact then the controller takes the following actions:

- The fault relay is activated and a fault code is shown on the display (F22).
- If the BMS controls the compressor the unit will stop.
- If the BMS does NOT control the compressor the unit continues operating using the last known parameters.
- The indoor fan continues running at the most recent requested speed.

Bold letters indicate factory default values.

Register	Function	Units	Type
101	**Control-enable bits (notes 5, 6)** Bit 0: Compressor on/off Bit 1: Heating/cooling Bit 2: Remote on/off Bit 3: Indoor fan mode Bit 4: EXV mode (note 8) Bit 5: DRED Bit 6: Indoor fan speed Bit 7: Capacity Bit 8: Reserved, do not use Bit 9: Quiet mode Bit 10: Dry mode (de-humidification) Bit 11 to 15: Reserved, do not use	**All bits: default value: 0** 0 = BMS control disabled 1 = BMS control enabled	Read / Write

6.4. Unit control (Continued)

Bold letters indicate factory default values.

Register	Function	Units	Type
102	Compressor on/off (Comp)	**0 = off** 1 = on (note 7)	Read / write
103	Cooling/Heating (Heat)	**0 = cooling** 1 = heating	
104	Remote on/off	0 = off **1 = on**	
105	Indoor fan mode Bit 0: Fan auto/fixed speed Bit 1: Fan off/on in dead band Bit 2: Fan off/on during de-icing Bit 3: Fan off/on during heating start	Refer to chapter 0: Indoor fan control 0 = auto **1 = fixed** 0 = off **1 = on** 0 = off **1 = on** 0 = off **1 = on**	
106	EXV mode (note 8)	0 = accurators (no electronic expansion valve) 1 = single or parallel expansion valve(s) 2 = series expansion valves 3 = dual expansion valves and split indoor coil	
107	DRED	**0** to 3 (as per DRED standard)	
108	Indoor fan speed	**0** (stop) to 1000 (high speed) Refer to chapter 0: Indoor fan control	
109	Capacity	0% to 100%, **default 50%** Refer to chapter 0: Capacity control	
110	Reserved	Do not use	
111	Quiet mode (note 9)	**0 = off** 1 = on Refer to chapter 10: Quiet mode	
112	Dry mode (note 10) (de-humidification)	**0 = off** 1 = on Refer to chapter 11: Dry mode	

Notes:

Note 5: When a BMS requires control over a particular signal, the BMS needs to write the corresponding bit for that signal in register 101 to 1 (enabled). As soon as a BMS has written a bit in this register to 1, any other input signal that may be available to the controller no longer has control over that signal. One can also use Modbus functions 1 (read N coils) and 5 (write single coil) to read and control individual bits in register 101. Refer to chapter7.1.

Example: If a BMS writes value 1 to bits 0 and 1, or switches 'on' coils 1 and 2, then the BMS has assumed control over the signals Comp and Heat. Control over these signals is then via registers 102 and 103 or alternatively through coils 11 and 12. The unit will no longer respond to a thermostat (if one is connected). In situations where both a thermostat and a BMS are connected to the unit, the above actions could be confusing to a user if the thermostat displays conflicting information. We recommend that, where possible, the installer disables functions on the thermostat that are controlled by a BMS.

Note 6: When mains power is removed from the unit all bits in register 101 will always be reset to the default value 0. To re-gain control over a unit after mains power has been interrupted, a BMS must again write to control-enable register 101. Read and write operations to all control registers 101 to 112 are allowed at any time.

Note 7: If a unit has multiple compressors and multiple UC8 controllers that are connected in master-save fashion, then the value written to register 102 (COMP) can allow individual control over all of the compressors in the unit. The value of COMP is then used as follows:

Bit 0 = Master compressor on/off

Bit 1 = Slave 1 compressor on/off

Bit 2 = Slave 2 compressor on/off

Bit 3 = Slave 3 compressor on/off

Examples:

COMP value	Slave 3	Units	Type	Type	
0	**0**	0	0	0	All compressors off
1	0	0	0	1	Only the master compressor on
3	0	0	1	1	Master and slave 1 compressors on
15	1	1	1	1	All compressors on

Note 8: Only selected Temperzone unit models are equipped with dual electronic expansion valves and a split indoor coil. A unit that does not offer that option will accept write operations to EXV Mode control register 106 but will disallow setting of bit 4 in control-enable register 101. The default EXV mode is factory-set by UC8 DIP switches 7 and 8.

Note 9: Quiet mode can slow down the outdoor fan if operating conditions allow. Quiet mode has no effect on the indoor fan or on the compressor.

Note 10: The UC8 offers a number of options for dry mode (de-humidification). Which options are available depends on the unit model.

A control example

A communicating BMS is to control a reverse cycle unit with a single compressor. The compressor is a digital scroll type (capable of variable duty); the indoor fan is a three speed type. The application requires that the indoor fan must continue running at fixed medium speed setting even when the unit has just started in heating mode (and the indoor coil may still be relatively cool) and when the unit is de-icing the outdoor coil. The unit is to operate in cooling mode at 70% of maximum capacity.

This example illustrates control using access to holding registers. Where possible one may choose to control using access to coils instead, or even use a combination of coils and holding registers.

A suitable set of control commands would be as follows (in a suggested logical order):

Register		Value to write	Result
105	Indoor fan mode	Value 1 to bits 0, 1, 2 and 3. In decimal number format: 1+2+4+8 = 15 In hexadecimal format: 0x000F	Fixed fan speed (bit 0 = 1) Fan On in dead band (bit 1 = 1) Fan On during outdoor coil de-icing (bit 2 = 1) Fan On during heating start (bit 3 = 1) Note: At any time the UC8 controller can intervene if required to protect the unit from damage.

Register		Value to write	Result
108	Indoor fan speed	Value 550 In hexadecimal format: 0x0226	Request medium speed for the indoor fan
109	Capacity	Value 70 In hexadecimal format: 0x0046	Request unit capacity 70%
103	Cooling / Heating	Value 0	Request Cooling mode
102	Compressor on/off	Value 1	Request to start the compressor
101	Control enable	Value 1 to bits 0, 1, 3, 6 and 7. All other bits are to remain at value 0. In decimal number format: 1+2+8+64+128 = 203 In hexadecimal format: 0x00CB	The BMS gains control over: Compressor on/off (bit 0 = 1) Heating or cooling (bit 1 = 1) Indoor fan mode (bit 3 = 1) Indoor fan speed (bit 6 = 1) Unit capacity (bit 7 = 1)

Use of Modbus function 6 (write one holding register) is recommended but Modbus function 16 (write N holding registers) can also be used. When using Modbus function 16 one must make sure that values written to registers that are not used for unit control (i.e. the corresponding control enable bit values are 0) are still written with values that are valid for each particular register.

Using the example above: A single write command using Modbus function 16 for registers 101 to 109 could specify all values in the table above, but that command would then necessarily include registers 104, 106 and 107 which are not required in this example and the corresponding control enable bits are left clear. Suitable (recommended) values for these three “unused” registers are:

104, Remote on/off: 1 (unit on)

106, EXV Mode: 0 to 3, as appropriate for the unit

107, DRED: 0 (no restrictions on unit energy consumption)

6.5. Safety timers

The following registers are safety timers in seconds.

These timers, when not zero, can hold the compressor on or off.

Register	Function	Type
201	Minimum On-Off time (minimum run time)	Read only
202	Minimum Off-On time (minimum off time)	
203	Minimum On-On time (minimum time between compressor starts)	
216	Cooling hold-off time (minimum time between heating --> cooling)	
217	Heating hold-off time (minimum time between cooling --> heating)	

6.6. Controller board output signals

Register	Function	Type
401	Outdoor fan speed 0 (stop) to 1000 (high speed)	Read only
402	Indoor fan speed 0 (stop) to 1000 (high speed)	
403	Expansion valve 1 position 0 (closed) to 480, 960 or 4000 (open) (notes 11, 12)	
404	Expansion valve 2 position 0 (closed) to 480, 960 or 4000 (open) (notes 11, 12)	
405	Unit capacity 0 to 1000	
406	Digital output signals (relay outputs and DRED function output) Bit 0: CMC 0 = off 1 = on Bit 1: R/V 0 = cooling 1 = heating Bit 2: SSR1 0 = off 1 = on Bit 3: SSR2 0 = off 1 = on Bit 4: AUX 0 = off 1 = on Bit 5: DRED 0 = compressor may be on 1 = compressor will be off Bit 6: High 0 = off 1 = on Bit 7: Medium 0 = off 1 = on Bit 8: Low 0 = off 1 = on All other bits are reserved and should be ignored.	
407	Unit mode 0 = Start-up 1 = Off 2 = Cooling start 3 = Cooling run 4 = Cooling end 5 = Heating start 6 = Heating run 7 = Heating end 8 = De-ice start 9 = De-ice run 10 = De-ice dry 11 = De-ice end 12 = Lock-out All other codes are reserved.	

Note 11: Position numbers reported for the expansion valves depend on the type of valve fitted to the unit: Dunan DPF = 480, Carel E2V or E3V = 960, Sanhua DPF = 4000.

Note 12: Expansion valve openings are also reported as percentages (0-100%) in Modbus registers 26 and 26. Refer to chapter 6.3: Electronic expansion valve positions.

6.7. Thermostat and indoor unit signals

The following registers represent temperatures as reported by a communicating thermostat and an indoor unit (if connected (note 13)). Divide by 100 to obtain temperature in degrees Celsius (16 bit signed numbers).

Address	Function	Units	Type
511	Set point temperature		
512	Room temperature		
1201	Indoor unit coil temperature, circuit 1		
1202	Indoor unit suction line temperature, circuit 1	0.01°C	Read Only
1203	Indoor unit coil temperature, circuit 2		
1204	Indoor unit suction line temperature, circuit 2		
1205	Supply air temperature		
1206	Return air temperature		

Note 13: If no communicating thermostat and/or indoor unit is connected then a read of these registers will return value -100.00°C (-10000).

6.8. UC8 controller information registers

Register 601 can be used to identify the Temperzone UC8 controller.

Register 603 provides the controller software version.

Address	Function	Type
601	UC8 controller ID code Value 210	Read only
602	UC8 software version Example: 152 = version 1.5.2	

6.9. Fault status

Address	Function	Type
901	**Faults 0 = no fault, 1 = fault** Bit 0: HP Bit 1: LP Bit 2: Overload Bit 3: Frost protection Bit 4: Freeze protection (water sourced units only) Bit 5: High temperature protection Bit 6: High suction line temperature/pressure protection Bit 7: Flood protection (hydronic models only) Bit 8: Water flow protection (water sourced units only) Bit 9: Low discharge superheat protection Bit 10: No communications with outdoor fan speed controller Bit 11: No communications with indoor fan speed controller Bit 12: Low pressure transducer fault Bit 13: High pressure transducer fault Bit 14: Suction line temperature sensor fault Bit 15: Discharge line temperature sensor fault	Read only

6.9. Fault status (Continued)

Address	Function	Type
902	**Faults** **0 = no fault, 1 = fault** Bit 0: De-ice temperature sensor fault Bit 1: Outdoor coil temperature sensor fault Bit 2: Indoor coil temperature sensor fault Bit 3: Outdoor ambient temperature sensor fault Bit 4: Superheat is unknown Bit 5: No communications with the thermostat Bit 6: No communications with UC8 master board Bit 7: No communications with UC8 slave 1 board Bit 8: No communications with UC8 slave 2 board Bit 9: No communications with UC8 slave 3 board Bit 10: Problem with reading the DIP switches Bit 11: Illegal combination of indoor- & outdoor- fan selection Bit 12: Unit requires an outdoor coil de-ice temperature sensor Bit 13: UC8 controller board temperature is too high Bit 14: UC8 controller supply voltage fault Bit 15: A slave system reports a fault	Read only
903	**Faults** **0 = no fault, 1 = fault** Bit 0: 0-10V Analogue input fault Bit 1: High discharge superheat protection Bit 2: Problem with readings from the pressure transducers Bit 3: Reverse cycle valve fault Bit 4: Invalid DIP switch settings on TZT-100 thermostat Bit 5: No communications with the indoor unit controller (IUC) Bit 6: The indoor unit controller (IUC) reports a fault Bit 7: The variable speed compressor driver reports a fault Bit 8: Compression ratio too high Bit 9: Compression ratio too low Bit 10: Evaporating temperature too high Bit 11: Condensing temperature too low Bits 12 to 15: Reserved	

6.10. Changing operation of the fault relay output (FLT)

Register 721 can be used to change operation of the fault relay output 'FLT'. Three options are available. The default setting is indicated with **bold letters**.

Address	Function	Type
721	0. The fault relay output becomes active only when the unit is locked out. 1. The fault relay output becomes active only for those faults that cause the compressor to stop. **2. The fault relay output becomes active for all faults.**	Read / write

Note:
Before the UC8 controller accepts a new value for register 721 it is necessary to first issue a write-enable command to the controller. The write enable register is 1401 and must be written with value 8821 (hexadecimal 0x2275). Modbus function 6 (write one holding register) must be used.

6.11. Compressor selection mode: E

IMPORTANT: Always ensure the correct compressor model is selected!

If an incorrect selection is made it is likely to cause the unit to malfunction and could lead to permanent damage to the compressor.

The compressor model can be set with the push-button and display, or the corresponding compressor model number can be written to **Modbus register 774.**

Compressor model	Display	Compressor UC8 instance number
Three-phase inverter compressors for R32 refrigerant, Carel PSD1 inverter		
Copeland YPV030LT-4X9	P3-Y030L	17
Copeland YPV038LT-4X9	P3-Y038L	18
Copeland YPV050ST-4X9	P3-Y050S	19
Copeland YPV0662-4X9	P3-Y0662	20
Copeland YPV0802-4X9	P3-Y0803E	21
Copeland YPV0962-4X9	P3-Y0962E	22
SCI AVB52	P3-AUb52	23
SCI AVB66	P3-AUb66	24
SCI AVB78	P3-AUb78	25
SCI AVB87	P3-AUb87	26
Single-phase inverter compressors for R32 refrigerant, Carel PSD1 inverter		
Panasonic 9RD138XDA21-230V	P1-9rd138	27
Panasonic 9KD240XDA21-230V	P1-9kd240	28
Copeland YPV030LE-3X9	P1-Y030L	29
Copeland YPV038LE-3X9	P1-Y038L	30
SCI SVB130FBBMT	P1-SUb130	32
SCI TVB306FPGMT	P1-tUb306	33
Single-phase inverter compressors for R32 refrigerant, Ruking ED3 inverter		
Copeland YPV030LE-3X9	E1-Y030L	31
Three-phase inverter compressors for R32 refrigerant, Carel PSD2 inverter		
SCI AVB78	P32AUb78F	34
SCI AVB100	P32AUb100	35
SCI BVB110	P32bUb110	36
Copeland YPV096-4X9	P32Y0962E	37
Single-phase inverter compressors for R32 refrigerant, Carel PSD2 inverter		
SCI SVB092	P12SUb092	38

6.12. Unit history

Address	Function	Type
1001	UC8 Modbus address	Read only
1002	Reserved	
1003	Total running hours	
1004	Total running minutes	
1005	Total cooling cycles	
1006	Total heating cycles	
1007	Total de-ice cycles	
1008	HP trip events	
1009	LP trip events	
1010	Frost protection events	
1011	Freeze protection events (hydronic models only)	
1012	High temperature protection events	
1013	High suction line temperature protection events	
1014	Overload protection events	
1015	Low discharge superheat protection events	
1016	High discharge superheat protection events	
1017	Number of power-on reset events	
1018	Reserved	
1019	Reserved	
1020	Reserved	
1021	Indoor coil temperature sensor faults	
1022	Outdoor coil temperature sensor faults	
1023	Outdoor ambient temperature sensor faults	
1024	Discharge line temperature sensor faults	
1025	Suction line temperature sensor faults	
1026	De-ice temperature sensor faults	
1027	High pressure transducer faults	
1028	Low pressure transducer faults	
1029	High board temperature faults	
1030	Reverse cycle valve faults	
1031	IUC communications faults	
1032	IUC faults	
1033	Inverter faults	
1034	Compressor out-of-envelope faults	

7. List of coils

A UC8 programmed with software version 1.5.2 or later supports Modbus functions 1 (read N coils) and 5 (write single coil). All coils can be read at any time, but not all coils have write-access.

Note: All coils also exist as individual bits in holding registers. One is free to choose whether to use Modbus coil functions or Modbus holding register functions for reading and/or writing to these coils / bits. The tables below indicate the corresponding holding register address and bit position for each coil.

7.1. Coils with read/write access

Bold letters indicates factory default values.

Coil	Function		Holding Register	Bit Position (0..15)
	0	1		
1	**Disable control over comp on/off**	Enable control over comp on/off	101	0
2	**Disable control over cool/heat**	Enable control over cool/heat	101	1
3	**Disable control over remote on/off**	Enable control over remote on/off	101	2
4	**Disable control over fan mode**	Enable control over fan mode	101	3
5	**Disable control over EXV mode**	Enable control over EXV mode	101	4
6	**Disable control over DRED**	Enable control over DRED	101	5
7	**Disable control over fan speed**	Enable control over fan speed	101	6
8	**Disable control over capacity**	Enable control over capacity	101	7
9	**Disable control over quiet mode**	Enable control over quiet mode	101	9
10	**Disable control over dry mode**	Enable control over dry mode	101	10
11	**Compressor off**	Compressor on	102	0
12	**Cooling**	Heating	103	0
13	Remote off	**Remote on**	104	0
14	Auto fan speed	**Fixed fan speed**	105	0
15	Auto fan mode (off in dead band)	**Fan on mode (on in dead band)**	105	1
16	Fan off when de-icing the outdoor coil	**Fan on**	105	2
17	Fan off when heating starts (avoid cold drafts)	**Fan on even when heating starts**	105	3
18	**Quiet mode off**	Quiet mode on	111	0
19	**Dry mode off**	Dry mode on	112	0
20	**Commissioning mode off (note 14)**	Commissioning mode on (note 14)	-	-

Note 14: Coil 20 is available only with software versions 1.5.3 and later.

7.2. Coils with read-only access

Signals that are inputs to the UC8 circuit board.

Coil	Function	Holding Register	Bit Position (0..15)
21	Input CP	22	0
22	Input HT	22	1
23	Input IN#1	22	2
24	Input IN#2	22	3
25	Input ON (remote on/off)	22	4
26	Input LO	22	7
27	Input ME	22	8
28	Input HI	22	9
29	Reserved, always returns 0	-	-
30	Reserved, always returns 0	-	-

Signals that are outputs from the UC8 circuit board.

Coil	Function	Holding Register	Bit Position (0..15)
31	Output relay CMC	106	0
32	Output relay R/V	106	1
33	Output relay SSR1	106	2
34	Output relay SSR2	106	3
35	Output relay AUX	106	4
36	Output relay HIGH	106	6
37	Output relay MED	106	7
38	Output relay LOW	106	8
39	Outdoor coil de-ice cycle inactive/active	106	12
40	Oil recovery (oil flush) cycle inactive/active	106	14
41	DRED function inactive/active	106	5

Fault status signals.

For information on troubleshooting refer to the temperzone UC8 Troubleshooting Guide.

Coil	Function	Holding register	Bit position (0..15)	Fault code
42	HP	901	0	HP
43	LP	901	1	LP
44	Overload	901	2	OL
45	Indoor coil frost	901	3	Frost
46	Hydronic unit water freeze	901	4	Freeze
47	Compressor discharge line high temperature	901	5	Hi-t
48	Compressor suction line high temperature or high evaporating pressure / temperature	901	6	Hi-SL
49	Hydronic unit condensate tray (sump) flooding	901	7	Flood
50	Hydronic or chiller unit water circulation verification switch open	901	8	No-Flo
51	Low discharge superheat	901	9	Lo-DSH
52	Outdoor fan problem	901	10	F10
53	Indoor fan problem	901	11	F11
54	Low pressure transducer problem (LPT)	901	12	F12
55	High pressure transducer problem (HPT)	901	13	F13
56	Compressor suction line temperature sensor problem (SL)	901	14	F14
57	Compressor discharge line temperature sensor problem (DL)	901	15	F15
58	Outdoor coil de-ice temperature sensor problem (DEI)	902	0	F16
59	Outdoor coil temperature sensor problem (OC)	902	1	F17
60	Indoor coil temperature sensor problem (IC)	902	2	F18
61	Outdoor ambient temperature sensor problem (AMB)	902	3	F19
62	Superheat unknown, cannot control EXV	902	4	F20
63	Lost communications with the thermostat	902	5	F21
64	Lost communications with UC8 master	902	6	F22
65	Lost communications with UC8 slave 1	902	7	F23
66	Lost communications with UC8 slave 2	902	8	F24
67	Lost communications with UC8 slave 3	902	9	F25
68	Problem reading UC8 DIP switches	902	10	F26
69	Illegal fan selection (illegal UC8 DIP switch selections)	902	11	F27
70	Outdoor coil de-ice sensor (DEI) is required	902	12	F28
71	UC8 control board is too hot	902	13	F29
72	Problem with UC8 supply voltage	902	14	F30
73	One or more UC8 slave boards reports a problem	902	15	F31
74	0-10V input fault	903	0	F32

Fault status signals (continued).

Coil	Function	Holding register	Bit position (0..15)	Fault code
75	High discharge superheat	903	1	Hi-DSH
76	Pressures are not equalising	903	2	F34
77	Reverse cycle valve problem	903	3	F35
78	Invalid DIP switch selection on TZT-100 thermostat	903	4	F36
79	Lost communications with indoor unit controller (IUC)	903	5	F37
80	Indoor unit controller (IUC) reports a problem	903	6	F38
81	Variable speed compressor driver reports a problem	903	7	F39
82	Compression ratio too high (out of compressor operating envelope)	903	8	F40
83	Compression ratio too low (out of compressor operating envelope)	903	9	F41
84	Evaporating pressure / temperature too high (out of compressor operating envelope)	903	10	F42
85	Condensing pressure / temperature too low (out of compressor operating envelope)	903	11	F43

8. Indoor fan control

Primary Modbus control registers for the indoor fan are registers 101 (control enable), 105 (indoor fan mode) and 108 (indoor fan speed). Control details are given in the following sections.

Note 15: In all cases, if certain temperatures and/or pressures are outside safe operating values, the controller may protect the system and/or the components by changing the indoor fan speed to a value different from that written to the fan speed register (108).

If the application must never allow the indoor fan speed to change regardless of compressor operating conditions, then the controlling BMS may directly connect to the indoor fan, bypassing the UC8 controller. In such applications it is the responsibility of the system designer, installer, and end- user to ensure unit reliability. In this case it must be noted that, should the controller detect sustained running outside safe operating conditions, additional safety protection mechanisms may operate and, if the protection mechanisms need to operate repeatedly, the unit may eventually be locked out.

8.1. Indoor fan operating mode

Modbus register 105 controls the following aspects of the indoor fan.

Bold letters indicate factory default values.

Bit	Value	
	0	1
0	auto-speed	**fixed-speed**
1	fan-auto mode	**fan-on mode**
2	fan is off during de-ice cycles	**fan continues running during de-ice cycles**
3	fan may be kept off briefly when heating starts (warm start)	**fan runs when heating starts (no warm-start)**

Explanation of terms:

Auto-speed: The controller is allowed to change the indoor fan speed to a value different from the value given in the fan speed register (108) in order to obtain an optimum evaporating- or condensing- temperature.

Fixed speed: The indoor fan speed remains equal to the value set in the fan speed register (108).

Fan-auto mode: The controller may protect the unit by fully stopping the fan if temperatures and/or pressures are well outside safe operating values

Fan-on mode: The controller may protect the unit by changing the fan speed but never slower than minimum if temperatures and/or pressures are well outside compressor safe operating values.

Warm start: If commands are sent to the controller to switch the reverse cycle valve to the heating position and to start the indoor fan, but the compressor is still off and/or the indoor coil temperature / condensing temperature is below 26°C, then the indoor fan will be kept off. The fan will only start when the compressor is on, and the indoor coil / condensing temperature is 26°C or warmer. This feature can be used to prevent cold drafts when the controller requires heating mode.

8.2. Control of single speed fans

Modbus register 108 controls the indoor fan. Valid values that can be written to the register are 0 to 1000. If the unit has a single speed indoor fan, then control is as follows:

- If the single speed fan is off, then any value from 50 to 1000 starts the fan. For values from 0 to 49 the fan remains off.
- To stop a running single speed fan, use value 0; any other value leaves the fan on.

Thus: Value 0 stops a single speed indoor fan; any value from 50 to 1000 starts the fan.

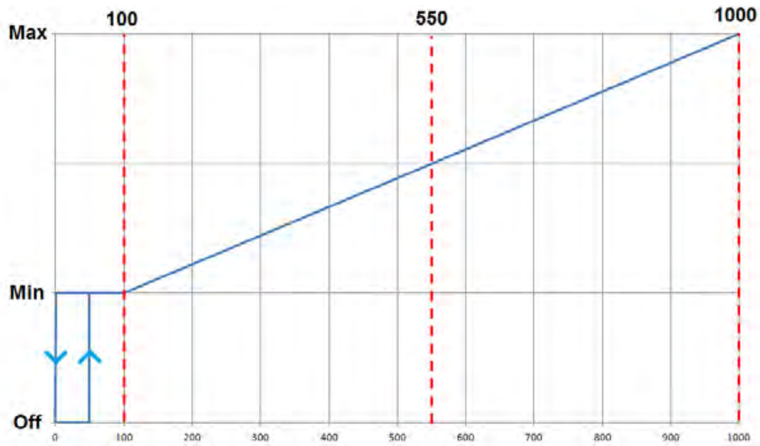
8.3. Control of variable speed fans

Modbus register 108 controls the indoor fan speed. Valid values that can be written to the register are 0 to 1000. If the unit has a continuously variable speed indoor fan (e.g., EC fan) then control is as follows:

- The value 0 will stop the fan. However, if the compressor is still on then the controller will overrule the stop command and the fan will continue running on minimum speed.
- If the fan is off, then a value of 50 or higher starts the fan. For values from 0 to 49 the fan remains off.
- For values from 50 to 100 the indoor fan runs on minimum speed.
- For values from 100 to 1000 the indoor fan speed linearly varies from minimum to maximum.

The minimum and maximum fan speeds can be adjusted using the button and display on the UC8 controller or by using indoor fan speed setup mode on a SAT-3 thermostat. If the system is a split unit with an IUC fitted in the indoor unit then indoor fan speed can also be set by DIP switches on the IUC. For more information on fan speed adjustment refer to document "Temperzone UC8 Operation and Installation - Air-to-Air units".

To the right is a graphical representation of the conversion from 0-1000 to Off-Minimum-Maximum.



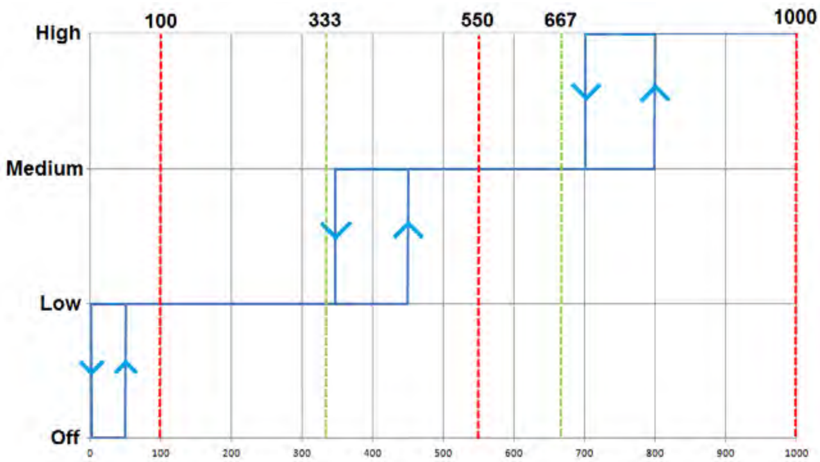
8.4. Control of three speed fans

Modbus register 108 controls the indoor fan speed. Valid values that can be written to the register are 0 to 1000. When the unit has a 3-speed indoor fan then control is as follows:

- The value 0 will stop the fan. However, if the compressor is still on then the controller will overrule the stop command and the fan will continue running on low speed.
- If the fan is off, then a value of 50 and higher starts the fan. For values from 0 to 49 the fan remains off.
- If fan speed is low, then a value of 0 stops the fan, a value of 450 and higher switches fan speed up. For values from 1 to 449 the fan speed remains low.
- If fan speed is medium, then a value of 349 or lower reduces fan speed, a value of 800 or higher increases fan speed to high. For values from 350 to 799 the fan speed remains medium.
- If fan speed is high, then a value of 699 or lower reduces fan speed. For values from 700 to 1000 the fan speed remains high.

Thus: Value 0 stops the indoor fan, 100 runs the fan on low speed, 550 runs the fan on medium speed and 1000 runs the fan on high speed. The controller also remains compatible with values 0 (stop), 333 (low), 667 (medium) and 1000 (high) that were used with the UC7 controller.

To the right is a graphical representation of the conversion from 0-1000 to Off-Low-Medium-High.



9. Capacity control

Modbus register 109 can be used to control unit capacity (duty). Valid values that can be written to the register are 0 to 100. Capacity control only has meaning on units with a digital scroll compressor or a variable speed compressor. The way the value written to capacity is interpreted depends on the unit type as follows:

Single fixed capacity compressor	Capacity is ignored.
Multiple fixed capacity compressors	Capacity is ignored.
Single variable capacity compressor	The compressor operates at the required capacity. The compressor can be switched on or off via register 102 (Comp).
One variable capacity compressor and one or more fixed capacity compressors	The variable capacity compressor operates at the required capacity. Compressors can be switched on or off individually via register 102 (Comp).
More than one variable capacity compressor	All compressors operate at the required capacity. Compressors can be switched on or off individually via register 102 (Comp).

9.1. Minimum and maximum capacity

The UC8 controller can impose a minimum capacity. If the compressor is running, then the unit capacity will normally be equal to that as dictated by the BMS unless the BMS requests a capacity less than the allowed minimum. The installer can choose between two levels of minimum capacity:

- UC8 DIP switch 14 OFF: 40% (default, suitable for most applications, provides best unit efficiency)
- UC8 DIP switch 14 ON: 16% (suitable for close control applications)

Note 16: Minimum capacity of a unit with a variable speed compressor may be different from 16%. The exact value depends on the compressor model.

Maximum capacity of a unit normally is 100%. Maximum capacity can be limited to less than 100% but this is normally only the case when the unit is experiencing difficulties or during adverse operating conditions.

Operating a unit with a variable speed compressor is best limited to 75% for most applications and conditions. Operation above 75% is possible and permitted but should be of limited duration. When a unit with a variable speed compressor is operating at a capacity higher than 75% increased noise may be apparent and unit efficiency may be less than optimum.

9.2. Start-up capacity

During the first two minutes following a start of the compressor the capacity may differ from the value dictated by the BMS or 0-10V capacity input. This is done to ensure adequate return to the compressor of the compressor lubricating oil that may have settled elsewhere in the system. Following these first two minutes the minimum and maximum capacity reverts to the values mentioned in paragraph 9.1.

When a **digital scroll** compressor is started then for the first two minutes following the start the **minimum** operating capacity is 75%.

When a **variable speed** compressor is started then for the first two minutes following the start the unit will operate at a **fixed** capacity of 50%. This is to ensure adequate return to the compressor of the compressor lubricating oil that may have settled elsewhere in the system.

9.3. Oil recovery capacity

To ensure adequate return to the compressor of the compressor lubricating oil that may have settled elsewhere in the system the controller can impose oil recovery cycles. During an oil recovery cycle, the unit capacity will differ from the value as dictated by the BMS. By default, oil recovery cycles can occur once every 1 hour 40 minutes and last for 1 minute. These and other values are adjustable via Modbus RTU, contact Temperzone if an application requires different settings.

10. Quiet mode

Quiet mode can reduce the amount of air-handling-noise from the outdoor fan(s). Quiet mode neither has any effect on the indoor fan nor on the unit capacity. The method used to obtain a quieter outdoor fan is by setting a different target for condensing or evaporating temperatures (when cooling or heating, respectively).

To gain control over quiet mode on/off:

- Write value 1 to bit 9 of write-enable register (101) or write value 1 to coil 9.
- Once the BMS has assumed control over quiet mode:
- Write value 0 to quiet mode register (111) to disable quiet mode, value 1 to enable, or write to coil 18.

Enabling quiet mode can be effective when a unit is cooling, and the outdoor ambient temperature is below about 35°C. Higher outdoor ambient temperatures reduce the effectiveness; quiet mode is not effective when cooling and the outdoor ambient temperature is above about 40°C.

Similarly, enabling quiet mode can be effective when a unit is heating, and the outdoor ambient temperature is above about 15°C. Lower outdoor ambient temperatures reduce the effectiveness; when heating while the outdoor ambient temperature is below about 10°C then enabling quiet mode will have no effect.

If a unit is equipped with a variable speed- or a digital scroll- compressor, then reducing the unit capacity can also aid in achieving quieter outdoor fans.

11. Dry mode (de-humidification)

De-humidification mode can increase the amount of moisture that is removed by the unit from the supply air, and so provide more cooling comfort.

The UC8 controller offers a number of methods by which de-humidification is achieved. Which method is used depends on the user requirements and preferences and the unit capabilities. An explanation of the various de-humidification methods and how to enable and disable follows here.

Conventional de-humidification mode

Available on all models. This method slowly varies the indoor fan speed in order to achieve a low indoor coil evaporating temperature and so reduce the moisture content of the supply air. It shall be clear that this method is not suitable for applications where the volume of supply air must remain constant.

To select conventional de-humidification mode:

- Write value 1 to bits 3 and 10 of the control-enable register (101) to gain control over the indoor fan mode register (105) and dry mode register (112).
- Write value 0 to bit 0 of indoor fan mode register (105) to allow variable indoor fan speed.
- Write value 0 or 1 to dry mode register (112) to switch dry mode off or on, as required.

Note 16: Selected unit models are fitted with dual expansion valves and a split indoor coil. To operate in conventional de-humidification mode these models should have value 1 written to register 106 (EXV mode), otherwise the unit may operate in super de-humidification mode.

11. Dry mode (de-humidification) (Continued)

Advanced de-humidification mode

Available only on selected models with dual expansion valves and a split indoor coil. Suitable for applications where the volume of supply air must remain constant.

To select advanced de-humidification mode:

- Write value 1 to bits 3 and 10 of control-enable register (101) to gain control over indoor fan mode register (105) and dry mode register (112).
- Write value 1 to bit 0 of indoor fan mode register (105) to select fixed indoor fan speed.
- Ensure the EXV mode register (106) is set to value 3: dual expansion valves. If not, then write value 3 to this register after first writing value 1 to bit 4 of the control-enable register (101).
- Write value 0 or 1 to dry mode register (112) to switch dry mode off or on, as required.

Super de-humidification mode

Available only on selected models with dual expansion valves and a split indoor coil. This mode is uses combination of advanced- and conventional- de-humidification modes as described above. The controller will first attempt to control the indoor coil evaporating temperature by means of the electronic expansion valves alone whilst the indoor fan speed is kept constant. Only when the desired evaporating temperature cannot be achieved with the use of the electronic expansion valves then the controller will also slowly vary the indoor fan speed. Therefore, this mode may not suitable be for applications where the volume of supply air must remain constant.

To select super de-humidification mode:

- Write value 1 to bits 3 and 10 of register 101 (write-enable) to gain control over registers 105 (indoor fan mode) and 112 (de-humidification mode).
- Write value 0 to bit 0 of register 105 (indoor fan mode) to allow variable indoor fan speed.
- Ensure register 106 (EXV mode) contains value 3 (dual expansion valves). If not, then write value 3 to this register after first gaining write access (write value 1 to bit 4 of register 101).
- Write value 0 or 1 to register 112 to disable/enable de-humidification.

12. Lockout and system reset

12.1. Lockout

Lockout can occur when a certain fault condition repeats three times within a sliding 12 hour window. When a unit is locked out it will not run the compressor or the indoor- and outdoor- fans. Faults that have occurred longer than 12 hours ago are removed from the count. Fault counts are reset to zero every time the unit switches off normally, either by the thermostat or BMS or by mains power off.

For example: If a unit operates under marginal running conditions that occasionally cause the indoor coil frost protection to operate once when the unit starts, this will not lead to a lockout situation since the frost protection counter is reset to zero every time the thermostat switches the unit off.

Lockout condition can be identified via Modbus by reading the value of register 407 (unit mode). The value indicating lockout condition is 12.

There are three methods to restart a locked-out unit:

1. Switch mains power to the controller off, wait for a few seconds and then switch power back on.
2. Use Modbus function 6 (write one holding register) to write value 21930 (hexadecimal 0x55aa) to register 1901, followed by value 3855 (hexadecimal 0x0f0f) to this same register. The second write must be made within 10 seconds following the first write.
3. By issuing a system reset command, refer to chapter 12.2.

Note 18: When mains power is applied to a controller that was locked out the display will show the cause of the previous lockup for 20 seconds. This message will stop appearing after the unit has completed at least one full normal cooling or heating cycle.

12.2. System reset

A unit can be reset via Modbus at any time by using the following procedure, in this order:

1. Write value 8821 (0x2275) to register 1401.
2. Write value 4460 (0x1234) to register 1901.

This enforces a full system restart, identical to a start made when mains power is removed then re-applied to the unit.

13. Multiple compressor units

If a unit has multiple compressors each of which is controlled by a separate UC8 controller and the controllers are connected in a master-slave arrangement, then a BMS or data logging system can access all of the information as described in the previous pages for each of the systems.

Information on each of the slave systems can be obtained via the RS485 connection to the master. No separate connections are necessary. All that is required to read information from a slave unit is to add a fixed offset to the Modbus holding register address. The register address offset values are:

System	Offset
Master	0
Slave 1	2000
Slave 2	4000
Slave 3	6000

Some examples:

To obtain the evaporating temperature for the master system read register 7.

To obtain the evaporating temperature for slave 1 system read register 7 + 2000 = 2007.

To obtain the evaporating temperature for slave 2 system read register 7 + 4000 = 4007.

Notes

- Only Modbus function 03 (read N registers) can be used.
- When information from a slave system is requested the master controller needs to relay the message to the correct slave system, receive the reply from the slave and then forward the reply to the BMS or data logger. Because of the extra message handling the reply can be delayed by up to 1 second. This delay is not present when requesting information from the master system.
- If the application does not strictly require the controller master-slave arrangement, then Temperzone recommends operating each controller independently (i.e. each controller is its own master) and connect the BMS to each controller via the RS485 Modbus RTU wiring. This latter arrangement can provide better system reliability, easier control and avoids communication delays.

14. Notes

Beside the holding registers listed in this document, many other registers exist in the UC8 controller that can be read via the Modbus connection.

In the interest of unit reliability and safety, registers that are not described in this document are read-only. Functions of undocumented registers may change without notice when new software versions are released.

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1.Introduction

Temperzone air conditioning units with UC8 controller board(s) can be connected to a standard BACnet control and monitoring network by a Modbus to BACnet converter. Temperzone provides a suitable converter called “Babel Buster”. One Babel Buster can control up to four UC8 controllers. Communications follow the BACnet/IP protocol over a standard Ethernet computer network connection.

A BACnet controller / management system communicating with the UC8(s) via the Babel Buster is able to do the following:

- Turn compressor on and off.
- Monitor and control the indoor fan speed.
- Monitor and control cooling, heating, or fan only.
- Monitor and control unit capacity.
- Monitor and control de-icing of the outdoor coil.
- Monitor temperatures and pressures.
- Enable and disable de-humidification mode.
- Enable and disable quiet operating mode.
- Enable and disable economy operating mode.
- Enable and disable commissioning mode.
- Enable and disable supply air temperature control operating mode.
- Observe unit safety timers.
- Observe the state of inputs and outputs such as CMC relay, R/V relay etc.
- Observe information on reported faults.
- Restart a locked-out unit.

2.Connections

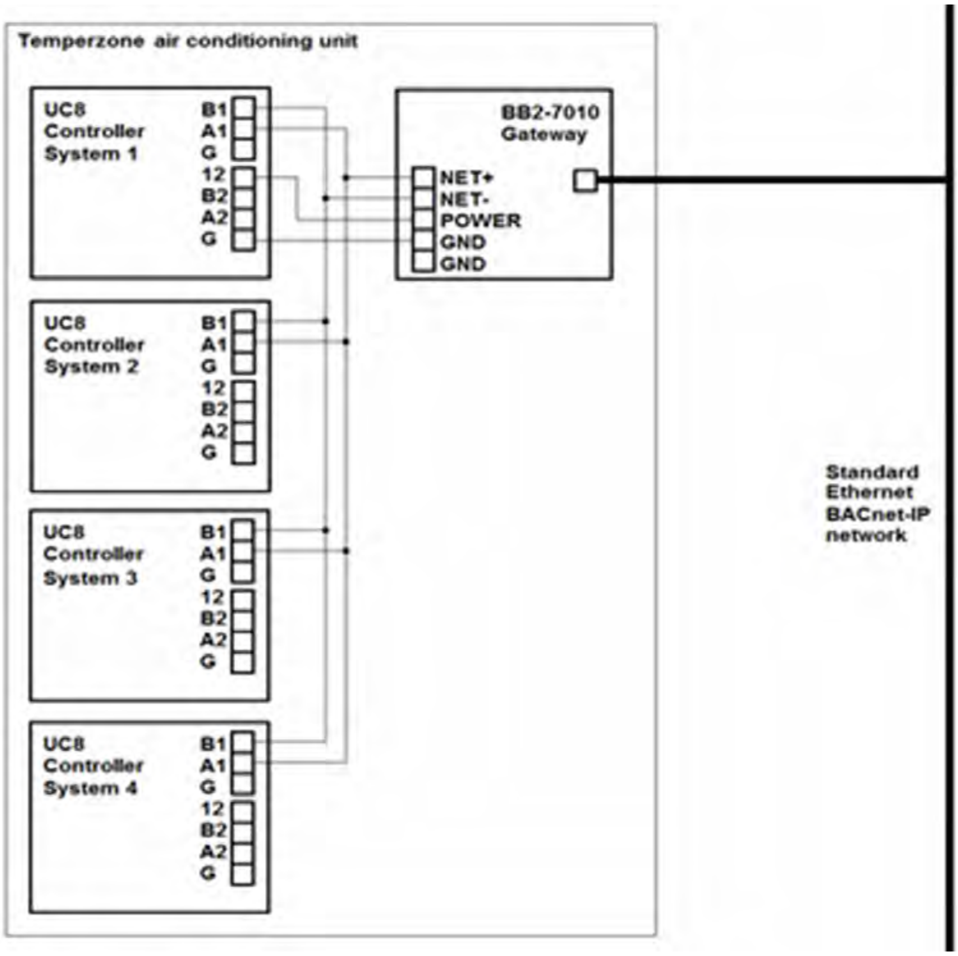
Step 1:

Use a shielded twisted pair cable to connect the Babel Buster to the UC8 controller(s):

- Connect “**12**” from RS485 port 2 on any UC8 board to “**POWER**” on the Babel Buster
- Connect “**G**” from RS485 port 2 on the same UC8 to “**GND**” on the Babel Buster
- Connect “**A1**” from RS485 port 1 on the same UC8 to “**NET+**” on the Babel Buster
- Connect “**B1**” from RS485 port 1 on the same UC8 to “**NET-** “on the Babel Buster
- Connect in a parallel circuit all “**A1**” “**B1**” ports all UC8 boards for intended control.

Step 2:

Connect a standard Ethernet patch cable between the Babel Buster and an Ethernet network switch or hub. Alternatively connect directly to the Ethernet port on a computer using an Ethernet cross-over type cable.



Step 3:

Configure UC8 DIP switches to master control. Each UC8 in the looped circuit will need to be configured as a "**Master**" board. This can be done by setting dip switches 11 and 12 to "**OFF**".

Switch		Function
11	**12**	**Master / Slave Selection**
Off	Off	Master UC8
On	Off	Slave system (Nr. 2)
Off	On	Slave system (Nr. 3)
On	On	Slave system (Nr. 4)

Step 4:

Use the push-button on the second, third and fourth UC8 controllers to adjust the Modbus devices address from 44 to: 45 (second controller), 46 (third controller), 47 (fourth controller) (display option letter "**A**", default value "**44**" = first UC8 controller)

2. Connections (Continued)

UC8 Addressing Procedure

The default Modbus device address of the Temperzone UC8 controller is 44.

The controller offers a facility to view and change the Modbus device address. The procedure is as follows:

- The compressor must be off.
- There must be no request to start.

When the controller is in settings mode:

- Use short button presses to cycle through the available options (round-robin).
- A long button press confirms the selection made.

To change Modbus address in special mode:

1. Apply power to the unit and wait until the power-on sequence is completed. The display should show a blinking dash and decimal point, or just a blinking dash.
2. Press and hold down push-button SW3. After two seconds the display changes to show "0.".
3. Release the button. The display will change to show "**1**.".
4. Tap once to select menu '**2**' and long press to enter.
5. When the display says '**A**' long press SW3 to enter.
6. The UC8 default address will display '**44**'. Use short presses to select desired Modbus address.
7. When the desired Modbus address is selected long press SW3 to confirm selection.
8. If the address was changed during address selection mode, then the controller will save new address in non-volatile memory. The new Modbus device address will be retained even after mains power has been switched off.

Step 5:

Depending on which Babel Buster software is installed, single dual or quad; baud rate of the UC8's may require adjustment.

There are 4 types of Babel Buster's with the following baud rates required.

Single: One UC8 Board - baud rate 19200 (UC8 Default).

Dual: Two UC8 Board - baud rate 19200 (UC8 Default).

Triple: Three UC8 Board - baud rate 38400.

Quad: Four UC8 Board - baud rate 38400.

Adjustment of baud rate is accessed via the special mode on the UC8. It is represented by the letter **"b"**.

Baud Rate Selection Procedure

The default baud rate of temperzone UC8 controller is 19200.

The controller offers a facility to view and change the baud rate. The procedure is as follows:

- The compressor must be off.
- There must be no request to start.

When the controller is in settings mode:

- Use short button presses to cycle through the available options (round-robin).
- A long button press confirms the selection made.

To change baud rate in special mode:

1. Apply power to the unit and wait until the power-on sequence is completed. The display should show a blinking dash and decimal point, or just a blinking dash.
2. Press and hold down push-button SW3. After two seconds the display changes to show "**0**".
3. Release the button. The display will change to show "**1**".
4. Tap twice to select menu '**3**' and long press to enter.
5. Tap once until the display says '**b**' long press SW3 to enter.

6. The UC8 default baud rate (19200) will display as a "**2**". Use short presses to select desired baud rate.

Modbus Baud Rate Special Mode Selection		
Special Mode	**Selection Options**	**Baud Rate**
b	0	4800
	1	9600
	2	19200
	3	38400
	4	57600

7. When the desired Modbus address is selected long press SW3 to confirm selection.
   If the address was changed during address selection mode, then the controller will save new address in non-volatile memory. The new Modbus device address will be retained even after mains power has been switched off.

Step 6:

Use a BACnet explorer to discover the Babel Buster on the network. The Babel Buster will be visible as an object with instance number 1.

Step 7:

Read the device object list.

Step 8:

The system is ready to monitor and control the unit.

2.1. Babel Buster Specifications

- Read/Write any standard Modbus register via BACnet objects
- 300 Non-commandable objects OR
- 135 Commandable objects OR
- Between 135 and 300 objects of mixed types.
- Object allocations are user configurable
- AI, AO, AV, BI, BO, BV, MSI, MSO, MSV objects
- COV, COVP subscription support
- BACnet slave is Modbus RTU master or vice versa
- Bidirectional communication between BACnet and Modbus
- Supports Modbus "coils", input registers, holding registers
- Single or double Modbus registers, signed, unsigned, IEEE 754
- Modbus register mapping configured via object properties
- Modbus registers may be scaled (x10, x100, x0.1, x0.01, etc.)
- Modbus (master) polling interval configurable per point
- Commandable BACnet objects implement priority array
- Fully configurable via BACnet object properties
- USB to MS/TP adapter available
- Configuration software included for use with USB adapter
- Hardened EIA-485 transceiver for serial ports
- MS/TP baud rates: 9600, 19200, 38400, 76800
- Modbus RTU baud rates: 4800, 9600, 19200, 38400
- Powered by 12-24V DC/AC 50/60 Hz
- Power Consumption: 0.1A @ 24VDC
- DIN rail mounting, 100mm H x 70mm W x 60mm D
- Pluggable screw terminal blocks
- Operating temperature -40°C to +85°C
- Humidity 5% to 90% non-condensing
- FCC, CE Mark, BTL Listed
- Listed to UL 916 and (Canadian) C22.2 No. 205-M1983

3. Object lists

The Babel Buster can connect to one, two, three or four UC8 controllers. Make sure to correctly specify the number of controllers when placing an order for the Babel Buster.

When the system connects to more than 1 UC8 controller identical sets of data are available for each individual controller. The table below provides the object ranges for each controller.

Object Type	Object Numbers							
	Unit 1		Unit 2		Unit 3		Unit 4	
	First	Last	First	Last	First	Last	First	Last
Analog input	1	100	101	200	201	300	301	400
Analog output	1	10	11	20	21	30	31	40
Analog value	1	30	31	60	61	90	91	120
Binary input	1	30	31	60	61	90	91	120
Binary output	Not used							
Binary value	1	30	31	60	61	90	91	120
Multistate input	1	10	11	20	21	30	31	40
MultiLstate output	Not used							
MultiLstate value								

Notes:

- The following paragraphs list the object number, name and function for "unit 1". If the Babel Buster connects to more than one unit all objects are repeated for each unit with the object numbers offset as indicated in the table above. Examples:

Unit 1 condensing temperature	analog input object 10	U1_T_CO
Unit 2 condensing temperature	analog input object 110	U2_T_CO
Unit 3 condensing temperature	analog input object 210	U3_T_CO
Unit 4 condensing temperature	analog input object 310	U4_T_CO

- Not all objects have an assigned function. Such unused objects can be read from, written to or both in accordance with the object type, but doing so provides no information about the unit nor has any influence on operation of the unit.

3.1. Analogue input objects

These objects can be used to collect information about the system.

Note:
Many units do not have all temperature sensors or pressure transducers fitted. For example, units with pressure transducers normally do not have temperature sensors fitted to the indoor and outdoor coils. Reading data from an object where the associated sensor is absent returns an out-of-range value, such as K100°C for a temperature sensor or K200 kPa for a pressure transducer.

Analog input objects for Unit1			
Nr.	**Name**	**Function**	**Units**
1	U1_ID	Controller: ID code (210 = UC8)	L
2	U1_SW	Controller: Software version (e.g. 205 = V2.0.5)	
3	U1_T_OC	Temperature: Outdoor coil	°C
4	U1_T_IC	Temperature: Indoor coil	
5	U1_ T_OA	Temperature: Outdoor ambient	
6	U1_ T_SL	Temperature: Compressor suction line	
7	U1_ T_DL	Temperature: Compressor discharge line	
8	U1_ T_DEI	Temperature: Outdoor coil de-ice sensor	
9	U1_ T_EV	Temperature: Evaporating	
10	U1_ T_CO	Temperature: Condensing	
11	U1_ T_UC	Temperature: Controller board	
12	U1_SH_S	Superheat: Suction side	K
13	U1_SH_D	Superheat: Discharge side	
14	U1_SH_C	Superheat: Calculated	
15	U1_P_SL	Pressure: Compressor suction line (evaporating)	kPa
16	U1_P_DL	Pressure: Compressor discharge line (condensing)	
17	U1_ T_SA	Temperature: Supply air	°C
18	U1_ T_RA	Temperature: Return air	
19	U1_ T_SP	Temperature: Thermostat setpoint	
20	U1_ T_RT	Temperature: Room	%
21	U1_EEV1	Expansion valve 1 opening	
22	U1_EEV2	Expansion valve 2 opening	
23	U1_FAN_OD_SPEED	Fan speed: Outdoor fan	
24	U1_FAN_ID_SPEED	Fan speed: Indoor fan	
25	U1_COMP_CAPACITY	Compressor: Capacity	
26	U1_COMP_FREQ	Compressor: Frequency (variable speed compressor only)	Hz
27	U1_COMP_CURRENT	Compressor: Current (variable speed compressor only)	A
28	U1_COMP_POWER	Compressor: Power (variable speed compressor only)	W
29	U1_COMP_VOLTAGE	Compressor: Voltage (variable speed compressor only)	V
30	U1_T_INVERTER	Temperature: Inverter (variable speed compressor only)	°C

Analog input objects for Unit1 (Continued)			
Nr.	**Name**	**Function**	**Units**
31	U1_Timer_RUN	Timer: Minimum on-to-off ('run' timer)	s
32	U1_ Timer_OFF	Timer: Minimum off-to-on ('off' timer)	
33	U1_ Timer_CYCLE	Timer: Minimum on-to-on ('cycle' timer)	
34	U1_ Timer_COOL_HOLD	Timer: Cooling mode hold-off	s
35	U1_ Timer_HEAT_HOLD	Timer: Heating mode hold-off	
36	U1_Timer_DE_ICE	Timer: Outdoor coil de-icing	
37	U1_ STAT_COOL_HOURS	Running hours, cooling	Hours
38	U1_ STAT_COOL_MINUTES	Running minutes, cooling	Minutes
39	U1_ STAT_HEAT_HOURS	Running hours, heating	Hours
40	U1_ STAT_HEAT_MINUTES	Running minutes, heating	Minutes
41	U1_ STAT_DEICE_HOURS	Running hours, de-icing	Hours
42	U1_ STAT_DEICE_MINUTES	Running minutes, de-icing	Minutes
43	U1_ STAT_CYC_COOL	Number of completed cooling cycles	L
44	U1_ STAT_CYC_HEAT	Number of completed heating cycles	
45	U1_ STAT_CYC_DEICE	Number of completed outdoor coil de-icing cycles	
46	U1_ STAT_HP_TRIPS	Number of HP trips	
47	U1_ STAT_LP_TRIPS	Number of LP trips	
48	U1_ STAT_FROST_TRIPS	Number of indoor coil frost trips	
49	U1_ STAT_FREEZE_TRIPS	Number of water freeze protection trips	
50	U1_ STAT_Hi_DL_TRIPS	Number of compressor discharge side high temperature trips	
51	U1_ STAT_Hi_EVAP_TRIPS	Number of compressor suction side high temperature trips	
52	U1_ STAT_OL_TRIPS	Number of overload trips	
53	U1_ STAT_Lo_DSH_TRIPS	Number of low discharge superheat trips	
54	U1_ STAT_Hi_DSH_TRIPS	Number of high discharge superheat trips	
55	U1_ STAT_IC_FAULTS	Number of indoor coil temperature sensor faults	
56	U1_ STAT_OC_FAULTS	Number of outdoor coil temperature sensor faults	
57	U1_ STAT_AMB_FAULTS	Number of outdoor ambient temperature sensor faults	
58	U1_ STAT_DL_FAULTS	Number of compressor discharge line temperature sensor faults	
59	U1_ STAT_SL_FAULTS	Number of compressor suction line temperature sensor faults	

<table>
<tr><th colspan="4">Analog input objects for Unit1 (Continued)</th></tr>
<tr><th>Nr.</th><th>Name</th><th>Function</th><th>Units</th></tr>
<tr><td>60</td><td>U1_ STAT_DEI_FAULTS</td><td>Number of outdoor coil de-icing temperature sensor faults</td><td rowspan="11">L</td></tr>
<tr><td>61</td><td>U1_ STAT_HPT_FAULTS</td><td>Number of high pressure transducer faults</td></tr>
<tr><td>62</td><td>U1_ STAT_LPT_FAULTS</td><td>Number of low pressure transducer faults</td></tr>
<tr><td>63</td><td>U1_ STAT_RV_FAULTS</td><td>Number of reverse cycle valve faults</td></tr>
<tr><td>64</td><td>U1_ STAT_IUC1_FAULTS</td><td>Number of faults reported by indoor unit controller 1</td></tr>
<tr><td>65</td><td>U1_ STAT_IUC2_FAULTS</td><td>Number of faults reported by indoor unit controller 2</td></tr>
<tr><td>66</td><td>U1_ STAT_VSD_FAULTS</td><td>Number of faults reported by compressor inverter</td></tr>
<tr><td>67</td><td>U1_ STAT_ENV_TRIPS</td><td>Number of out-of-compressor-operating-envelope trips</td></tr>
<tr><td>68</td><td>-</td><td></td></tr>
<tr><td>69</td><td>-</td><td></td></tr>
<tr><td>70</td><td>U1_FAULT_CODE</td><td>Current fault code</td></tr>
</table>

3.2. Analog output objects

This object can be used to unlock the controller.

Analog input objects for Unit1			
Nr.	**Name**	**Function**	**Refer to section**
1	U1_CNTRL_REG_RESET	Controller unlock and reset control	5.8 and 5.9

3.3. Analog value objects

These objects can be used to collect information about and to control some features of the system.

<table>
<tr><th colspan="6">Analog input objects for Unit1</th></tr>
<tr><th>Nr.</th><th>Name</th><th>Function</th><th>Units</th><th>Range</th><th>Refer to section</th></tr>
<tr><td>1</td><td>U1_REQ_DRED</td><td>Demand reduction (DRED)</td><td>L</td><td>0 to 3</td><td>K</td></tr>
<tr><td>2</td><td>U1_REQ_FAN</td><td>Indoor fan speed</td><td rowspan="2">%</td><td rowspan="2">0 to 100</td><td>5.2</td></tr>
<tr><td>3</td><td>U1_REQ_CAPACITY</td><td>Unit capacity</td><td>5.3</td></tr>
<tr><td>4</td><td>U1_PRM_SECURITY</td><td>Security code</td><td>L</td><td>K</td><td></td></tr>
<tr><td>5</td><td>U1_PRM_CAP_PROP</td><td>Variable capacity proportional gain constant (P)</td><td>L</td><td>0 to 50</td><td rowspan="2">5.3.4</td></tr>
<tr><td>6</td><td>U1_PRM_CAP_INT</td><td>Variable capacity integration time</td><td>s</td><td>1 to 300</td></tr>
<tr><td>7</td><td>U1_PRM_OILFLUSH_CAP</td><td>Oil flush cycle capacity threshold</td><td>%</td><td>0 to 80</td><td>5.3.1</td></tr>
<tr><td>8</td><td>U1_MODE_EEV</td><td>Expansion valve operating mode</td><td>L</td><td>0 to 3</td><td>5.4</td></tr>
</table>

3.4. Binary input objects

These objects can be used to view the current status of various binary (on/off) signals that are input to and output from the UC8 controller.

Binary input objects for Unit1		
Number	**Name**	**Shows status of:**
1	U1_IN_CP	CP input
2	U1_IN_HT	HT input
3	U1_IN_IN#1	IN#1 input
4	U1_IN_IN#2	IN#2 input
5	U1_IN_ROO	Remote on/off input
6	U1_IN_LO	LO input
7	U1_IN_ME	ME input
8	U1_IN_HI	HI input
9	U1_RLY_CMC	CMC output relay
10	U1_RLY_RV	RV output relay
11	U1_RLY_SSR1	SSR1 output relay
12	U1_RLY_SSR2	SSR2 output relay
13	U1_RLY_AUX	AUX output
14	U1_RLY_HIGH	HIGH output relay
15	U1_RLY_MED	MED output relay
16	U1_RLY_LOW	LOW output relay
17	U1_FN_DEICE_REQUEST	Set when the outdoor coil needs to be de-iced
18	U1_FN_DEICE_ACTIVE	Set when the controller is de-icing the outdoor coil
19	U1_FN_OILFLUSH	Set when the controller has activated oil flush mode
20	U1_FN_DRED	Set when the controller has switched the compressor off to meet DRED requirements

3.5. Binary output objects

No binary output objects are available.

3.6. Binary value objects

These objects can be used to control some features of the system.

The default values (active after every power-on and system reset) are indicated in with **bold letters.**

Binary value objects for Unit1		
Number	**Name**	**Shows status of:**
1	U1_EN_COMP	Enable (1) / **disable (0)** control over compressor
2	U1_EN_HEAT	Enable (1) / **disable (0)** control over cooling / heating
3	U1_EN_SPEED_FAN	Enable (1) / **disable (0)** control over indoor fan speed
4	U1_EN_CAPACITY	Enable (1) /**disable (0)** control over unit capacity
5	U1_EN_DEHUM	Enable (1) / **disable (0)** control over dehumidification
6	U1_EN_QUIET	Enable (1) / **disable (0)** control over quiet mode
7	U1_EN_ECONOMY	Enable (1) / **disable (0)** control over economy mode
8	U1_EN_REMONOFF	Enable (1) / **disable (0)** control over remote off / on
9	U1_EN_MODE_FAN	Enable (1) / **disable (0)** control over indoor fan mode
10	U1_EN_MODE_EEV	Enable (1) / **disable (0)** control over expansion valve mode
11	U1_EN_DRED	Enable (1) / **disable (0)** control over DRED input
12	U1_EN_DEICE	Enable (1) / **disable (0)** control over de-icing of the outdoor coil
13	U1_REQ_COMP	Request compressor **off (0)** or on (1)
14	U1_REQ_HEAT	Request **cooling (0)** or heating (1)
15	U1_REQ_DEHUM	Request dehumidification when cooling **off (0)** or on (1)
16	U1_REQ_QUIET	Request quiet mode **off (0)** or on (1)
17	U1_REQ_ECONOMY	Request economy mode **off (0)** or on (1)
18	U1_REQ_REMONOFF	Request remote off (0) or **on (1)**
19	U1_REQ_FAN_FIXED	Request indoor fan auto-speed (0) or **fixed speed (1)**
20	U1_REQ_FAN_ONMODE	Request indoor fan-auto mode (0) or **fan-on mode (1)**
21	U1_REQ_FAN_DEICEON	Request indoor fan off during de-ice (0) or **on during de-ice (1)**
22	U1_REQ_FAN_COOL	Request indoor fan heating warm start (0) or **cool start (1)**
23	U1_REQ_COMMISSIONING	Request commissioning mode **off (0)** or on (1)
24	U1_DEICE_PERMIT	**Allow (1)** or disallow (0) de-icing of the outdoor coil when the controller determines this is necessary
25	U1_DEICE_FORCE	When set forces the controller to start de-icing of the outdoor coil

3.7. Multi-state input objects

This object can be used to collect information about the system.

Multi-state input objects for Unit1			
Nr.	**Name**	**Function**	**Refer to section**
1	U1_MODE	Unit1 operating mode	**4**

3.8. Multi-state output objects

No multi-state output objects are available.

3.9. Multi-state value objects

No multi-state value objects are available

4. Unit status

The following objects provide basic information about current unit status.

4.1. Operating mode and fault code

Object	Name	Function	Values
Multi-state input object 1	U1_MODE	Current state of the unit	1. Off 2. Cooling Start 3. Cooling Run 4. Cooling End 5. Heating Start 6. Heating Run 7. Heating End 8. De-ice Start 9. De-ice Run 10. De-ice Dry 11. De-ice End 12. Lock Out

4.1. Operating mode and fault code (Continued)

Object	Name	Function	Values
Analog input object 70	U1_FAULT_CODE	Current fault code	0 No faults 1. HP trip 2. LP trip 3. Overload 4. Indoor coil frost protection 5. Water freeze protection 6. High discharge temperature 7. High evaporation / suction temperature 8. Sump condensate flooding 9. No circulating water flow 10. Low discharge superheat 11. Outdoor fan fault 12. Indoor fan fault 13. Low pressure transducer fault 14. High pressure transducer fault 15. Suction line temperature sensor fault 16. Discharge line temperature sensor fault 17. Outdoor coil de-ice temp. sensor fault 18. Outdoor coil temperature sensor fault 19. Indoor coil temperature sensor fault 20. Outdoor ambient temperature sensor fault 21. Cannot calculate superheat 22. Thermostat communications lost 23. Master UC8 communications lost 24. Slave 1 UC8 communications lost 25. Slave 2 UC8 communications lost 26. Slave 3 UC8 communications lost 27. Cannot read UC8 DIP switches 28. Invalid fan selection 29. Outdoor coil de-ice sensor missing 30. Controller temperature too high 31. Controller supply voltage problem 32. Slave controller reports a problem 33. UC8 controller internal problem 34. High discharge superheat 35. Pressures not equalising 36. Reverse cycle valve problem 37. TZTK100 thermostat invalid DIP switch settings 38. Indoor unit (IUC) communications lost 39. Indoor unit (IUC) reports a problem 40. Compressor inverter (VSD) reports a problem 41. High compression ratio 42. Low compression ratio 43. High evaporating temperature 44. Low condensing temperature 45. - 46. - 47. - 48. -

4.2. Compressor, reverse cycle valve, indoor and outdoor fan status and capacity

Object	Name	Function	Values
Binary input object 9	U1_RLY_CMC	Current state of the compressor	0 = off 1 = on
Binary input object 10	U1_RLY_RV	Current position of the reverse cycle valve	0 = cooling position 1 = heating position
Analog input object 23	U1_FAN_OD_SPEED	Current state of the outdoor fan	0 = off 10 = low speed 55 = medium speed 100 = high speed
Analog input object 24	U1_FAN_ID_SPEED	Current state of the indoor fan	0 = off 10 = low speed 55 = medium speed 100 = high speed
Analog input object 25	U1_COMP_ CAPACITY	Current operating capacity (duty)	0 = off 16 = minimum 100 = maximum

5. Unit control

This chapter gives details on control of the compressor, reverse cycle valve, indoor fan, capacity (duty), dry and quiet modes and how to unlock or reset the controller.

5.1. Compressor and reverse cycle valve

5.1.1. Objects related to the compressor and reverse cycle valve

Default values present after power-up and controller reset are indicated with bold letters.

Object	Name	Function		
Binary value object 1	U1_EN_COMP	Control over compressor	**0 = disabled**	1 = enabled
Binary value object 2	U1_EN_HEAT	Control over cooling/heating	**0 = disabled**	1 = enabled
Binary value object 13	U1_REQ_COMP	Request compressor	**0 = OFF**	1 = ON
Binary value object 14	U1_REQ_HEAT	Request cooling or heating	**0 = cooling**	1 = heating
Binary value object 23	U1_REQ_ COM-MISSIONING	Request commissioning	**0 = OFF**	1 = ON
Binary input object 9	U1_RLY_CMC	CMC output relay:	0 = OFF	1 = ON
Binary input object 10	U1_RLY_RV	R/V output relay:	0 = OFF	1 = ON
Multi-state input object 1	U1_MODE	Current state of the unit (refer section 4)		

5.2. Indoor fan

5.2.1. Objects related to the indoor fan

Default values present after power-up and controller reset are indicated with bold letters.

Object	Name	Function
Binary value object 3	U1_EN_SPEED_FAN	BMS control over the speed of the indoor fan: 0 Disabled: Indoor fan speed is controlled from terminals on the UC8 (or IUC) or by a communicating thermostat. 1 Enabled: Indoor fan speed is controlled by BMS via BACnet.
Binary value object 9	U1_EN_MODE_FAN	BMS control over the behaviour of the indoor fan: 0 Disabled: Indoor fan behaviour is controlled by DIP switches on the UC8 and/or a communicating thermo-stat. 1 Enabled: Indoor fan behaviour is controlled by BMS via BACnet.

5.2.1. Objects related to the indoor fan (Continued)

Object	Name	Function	
Binary value object 19	U1_REQ_FAN_FIXED	0	The UC8 is allowed to automatically vary indoor fan speed to control the evaporating or condensing temperature.
		1	**The UC8 will not automatically vary indoor fan speed (unless required to protect the compressor).**
Binary value object 16	U1_REQ_FAN_ONMODE	0	The UC8 is allowed to stop the indoor fan when evaporating and/or condensing temperature are outside recommended values.
		1	**The UC8 is not allowed to stop the indoor fan (even when pressure(s) and or temperature(s) are outside recommended values).**
Binary value object 17	U1_REQ_FAN_DEICEON	0	The indoor fan stops when the unit is de-icing the outdoor coil.
		1	**The indoor fan continues to run when the unit is de-icing the outdoor coil.**
Binary value object 18	U1_REQ_FAN_COOL	0	The indoor fan may stop when the unit starts in heating mode, but the indoor coil has not yet warmed up.
		1	**The indoor fan continues to run when the unit starts in heating mode.**
Analog value object 2	U1_REQ_FAN	**0**	**Request indoor fan to stop.**
		10	Request indoor fan run at minimum speed.
		55	Request indoor fan run at medium speed.
		100	Request indoor fan run at maximum speed.
Analog input object 24	U1_FAN_ID_SPEED	0	Indoor fan is stopped.
		10	Indoor fan is running at minimum speed.
		55	Indoor fan is running at medium speed.
		100	Indoor fan is running at maximum speed.

Notes:

- If certain temperatures and/or pressures are outside values required for reliable operation the controller may protect the system by changing the indoor fan speed to a value different from that written to the indoor fan speed control object.
- If an application requires that indoor fan speed must never change regardless of operating conditions, then the controlling BMS may bypass the UC8 controller and directly connect to the indoor fan. In such applications it is the responsibility of the system designer, installer and end- user to ensure unit reliability. As always: Should the controller detect sustained running outside safe operating conditions, safety protection mechanisms may operate and, if the protection mechanisms need to operate repeatedly, the unit may eventually be locked out.
- If the compressor is running but there is no request for the indoor fan to run then the UC8 controller automatically runs the indoor fan at minimum speed.

5.2.2. Single speed fans

To gain control over the indoor fan write value 1 to binary value object 3 (U1_EN_SPEED_FAN). Thereafter write to analog value object 2 (U1_REQ_FAN) to control the indoor fan.
Valid values that can be written to U1_REQ_FAN range from 0 to 100. Single speed indoor fan control is as follows:

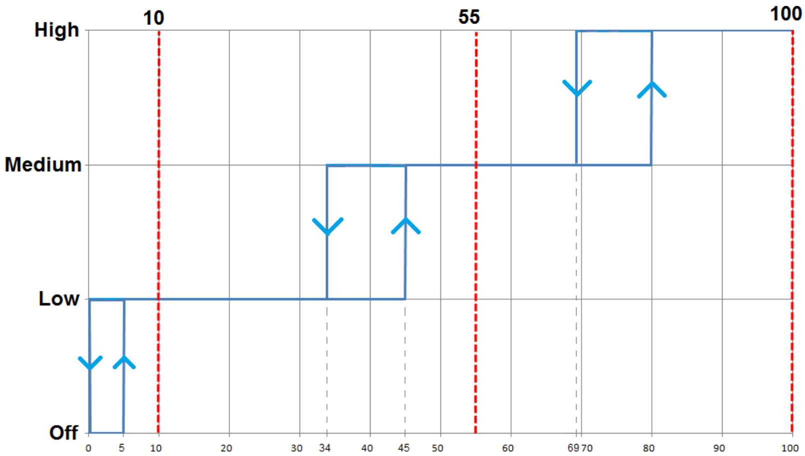
- If the fan is off, then any value from 5 to 100 starts the fan. For values from 0 to 4 the fan remains off.
- To stop a running fan use value 0; any other value leaves the fan on. Suggested control values for single-speed indoor fans are:
  - Write value 0 to stop the indoor fan
  - Write value 100 to start the indoor fan

5.2.3. Three speed fans

To gain control over the indoor fan write value 1 to binary value object 3 (U1_EN_SPEED_FAN). Thereafter write to analog value object 2 (U1_REQ_FAN) to control the indoor fan speed.

- Valid values that can be written to U1_REQ_FAN range from 0 to 100. Three-speed indoor fan control is as follows:
- Value 0 stops the fan. However, if the compressor is still on then the controller will overrule the command and continue to run the fan on low speed.
- If the fan is off, then a value of 5 and higher starts the fan. For values from 0 to 4 the fan remains off.
- If fan speed is low, then a value of 0 stops the fan, a value of 45 and higher switches fan speed up. For values from 1 to 44 the fan speed remains low.
- If fan speed is medium, then a value of 34 or lower reduces fan speed, a value of 80 or higher increases fan speed to high. For values from 35 to 79 the fan speed remains medium.
- If fan speed is high, then a value of 69 or lower reduces fan speed. For values from 70 to 100 the fan speed remains high.

Beside is a graphical representation of the conversion from 0K100 to Off-Low-Medium-High.



Suggested control values for three-speed indoor fans are:

- Write value 0 to stop the indoor fan
- Write value 10 to run the indoor fan on low speed
- Write value 55 to run the indoor fan on medium speed
- Write value 100 to run the indoor fan on high speed

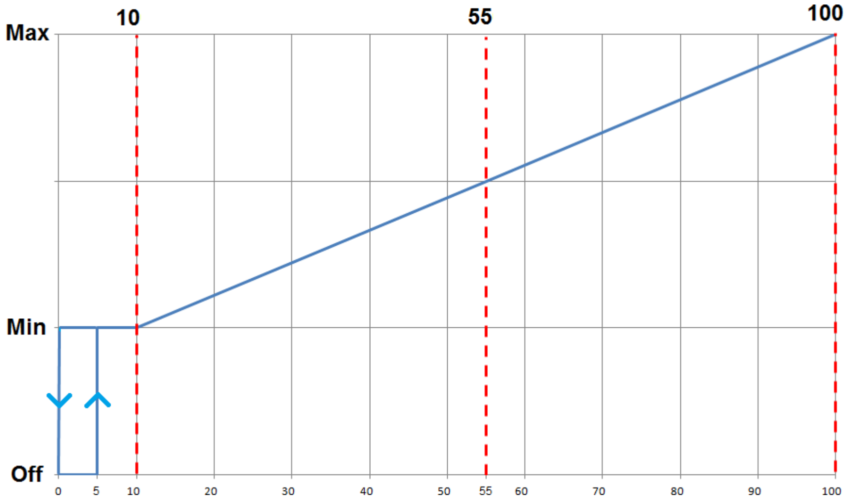
5.2.4. Variable speed fans

To gain control over the indoor fan write value 1 to binary value object 3 (U1_EN_SPEED_FAN). Thereafter write to analog value object 2 (U1_REQ_FAN) to control the indoor fan speed. Valid values that can be written to U1_REQ_FAN range from 0 to 100. Continuously variable speed indoor fan (EC fan) control is as follows:

- Value 0 will stop the fan. However, if the compressor is still on then the controller will overrule the stop command and the fan will continue running on minimum speed.
- If the fan is off, then a value of 5 or higher starts the fan. For values from 0 to 4 the fan remains off.
- For values from 5 to 10 the indoor fan runs on minimum speed.
- For values from 10 to 100 the indoor fan speed linearly varies from minimum to maximum.

Actual minimum and maximum fan speeds can be adjusted by using the button and display on the UC8 controller or by using indoor fan speed setup mode on a SAT-3 thermostat. If the system is a split unit with an IUC fitted in the indoor unit then indoor fan speed can also be set by DIP switches on the IUC. For more information on fan speed adjustment refer to document "Temperzone UC8 Operation and Installation – Air Cooled Units".

Beside is a graphical representation of the conversion from 0K100 to off & minimum to maximum.



5.3. Capacity

If a unit is equipped with a variable speed compressor or a digital scroll compressor, then it is possible to vary capacity (duty) of the unit. Capacity control is not possible for a unit with a fixed duty compressor. The following sections give details of objects for control and status of unit capacity.

5.3.1. Objects related to capacity

Objects related to unit capacity are:

Object	Name	Function
Analog input object 25	U1_COMP_CAPACITY	Current unit capacity (0 to 100%)
Analog value object 3	U1_REQ_CAPACITY	Requested unit capacity (0 to 100%, **default 50%**)
Binary input object 19	U1_FN_OILFLUSH	Set when the controller has activated oil flush mode
Binary value object 4	U1_EN_CAPACITY	Enable (1) / **disable (0)** control over unit capacity

5.3.2. Minimum and maximum capacity

The following table gives a list of capacities available:

Compressor Type	Minimum Capacity		Nominal Capacity	Boost Mode Capacity
	Close Control	Standard Control		
Fixed Duty	100%			
Digital Scroll	16%	40%	100%	
Variable Speed	15%	40%	75%	100%

Notes:

- UC8 DIP switch 14 selects minimum capacity: OFF = Standard control, ON = Close control.
- The UC8 controller enforces a minimum capacity. If the compressor is running, then the unit capacity will normally be equal to that as dictated by the BMS unless the BMS requests a capacity less than the allowed minimum.
- The UC8 controller may automatically alter capacity from the requested value in order to avoid undesirable operating conditions and trips. However, capacity will never be reduced to less than standard control minimum nor will capacity be automatically increased above nominal (values as per the table above). Example:
- When a unit is cooling then capacity may automatically be reduced, to a minimum of 40%, to avoid frost (ice) forming on the indoor coil.
- Operating a unit with a variable speed compressor at higher than nominal capacity ("boost mode") is possible and permitted but we recommend this to be for limited duration only. When a unit is operated in boost mode then unit efficiency may be less than optimum and increased noise may be apparent.

5.3.3. Start-up capacity

During the first two minutes following a start of the compressor the capacity may differ from the value dictated by the BMS or 0K10V capacity input. This is done to return to the compressor any lubricating oil that may have settled elsewhere in the system. Following these first two minutes the minimum and maximum capacities revert to the values listed in paragraph 5.3.2.

Compressor type	Start-up capacity	
	Minimum	Maximum
Fixed duty	100%	
Digital scroll	75%	100%
Variable speed	50%	

5.3.4. Autonomous capacity

There are three installations where the UC8 controller can autonomously control capacity. These are:

1. The unit is controlled by a SAT-3, or a TZT-100 wall thermostat.
2. The unit is controlled by a Temperzone ZONE controller.
3. The unit is configured to autonomously control the supply air temperature.

The following applies only to installations with the unit controlled by a SAT-3 or TZT-100 wall thermostat. (Installations 2 and 3 are not discussed in this document.)

5.3.4. Autonomous capacity (Continued)

The UC8 interrogates the wall thermostat to obtain the current values for the room temperature and the setpoint. This information is then used in a closed loop control function with proportional and integrating control (PI). The PI function controls unit capacity attempting to make the room temperature equal to the setpoint and hold it there steadily. Depending on the load at the time and the size of the unit doing so may take any capacity from 0 to 100%, the PI function will make the unit deliver the required capacity.

The “reactiveness” of the PI function can be controlled with the following objects:

Object	Name	Function	Units	Range
Analog value object 5	U1_PRM_CAP_PROP	Variable capacity proportional gain constant (P)	L	**0 to** 50 (**default 45**)
Analog value object 6	U1_PRM_CAP_INT	Variable capacity integration time constant (I)	s	**1 to 300 (default 40s)**

It is possible that for some installations the PI function varies capacity too fast. This can lead to the unit capacity endlessly varying up and down while the room temperature swings above and below the desired setpoint. In such a case control may be improved by reducing the proportional gain and/or increasing the integration time constant.

If the opposite is the case and capacity varies very slowly despite a large differential between the room temperature and the setpoint then one can increase the proportional gain and/or reduce the integration time constant.

Note: It is necessary to first write value 8821 (hexadecimal 0x2275) to analog value object 4 (U1_PRM_SECURITY) before the UC8 controller will accept new values for U1_PRM_CAP_PROP and U1_PRM_CAP_INT.

5.3.5. Oil flush capacity

To return to the compressor any lubricating oil that may have settled elsewhere in the system the controller can impose oil flush cycles. Oil flush cycles are activated only when the compressor has remained on with capacity continuously remaining relatively low for an extended period of time. By default, this period of time is 1 hour and 40 minutes. Oil flush cycles last only for 1 minute. During an oil flush cycle, the unit capacity will differ from the value as dictated by BMS or 0K10V input.

5.4. Dry mode (dehumidification)

Dehumidification mode can provide increased cooling comfort by removing moisture from the supply air. Dehumidification relies on methods that bring the indoor coil evaporating temperature below the dew point. This causes moisture to condense on the indoor coil and so be removed from the supply air. The UC8 controller offers a number of methods by which dehumidification can be achieved.

Which method is used depends on the user requirements and preferences and the unit capabilities.

- Normal cooling mode is available on all unit models. Moisture will be removed from the supply air only if the temperature of the indoor coil is below the dew point. If it is desirable to expressly not remove moisture from the air but cooling is still required (the room is warm and relative humidity is normal or low) then operate the unit in normal cooling mode. Selecting a high indoor fan speed can also help to retain moisture in the supply air.
- Conventional dehumidification mode relies on automatic control over the indoor fan speed. Conventional dehumidification is available on all models except units with a fixed speed indoor fan. This method is unsuitable for applications where the volume of supply air must remain constant. In this mode the UC8 controller takes control over the speed of the indoor fan. There is no need to control objects related to the indoor fan other than the objects listed above.
- Advanced dehumidification mode is available only on models with dual expansion valves and split indoor coil.

Indoor fan speed can remain constant making this method suitable for applications where the volume of supply air must remain constant. It is also suitable for units with single-speed indoor fan.

- Super dehumidification mode is available only on models with dual expansion valves and split indoor coil. This method combines advanced and conventional dehumidification modes as described above. Super dehumidification is not suitable be for applications where the volume of supply air must remain constant. It is also unsuitable

The table below lists the BACnet objects associated with control over dehumidification and the values to write to the objects to select the desired mode.

Mode	Binary value object 5 U1_EN_DEHUM	Binary value object 9 U1_EN_MODE_FAN	Binary value object 19 U1_REQ_FAN_FIXED	Binary value object 10 U1_EN_MODE_EEV	Analog value object 8 U1_ MODE_EEV	Binary value object 15 U1_REQ_DEHUM
Normal Cooling	0 or 1	0 or 1	0 or 1	0	0 or 1	0
Conventional Dehumidification	1	1	0	0	0 or 1	1
Advanced Dehumidification	1	1	1	1	3	1
Super Dehumidification	1	1	0	1	3	1

The objects listed in the table need to be written to only once after each power-on or reset of the UC8 controller. Once the objects are set to the values indicated one can start and stop the unit in cooling mode as normal. It is allowed to write to binary value object 15 (U1_REQ_DEHUM) while a unit is cooling to switch between normal cooling (value 0) or cooling with dehumidification (value 1).

Writing a value to analog value object 8 (U1_ MODE_EEV) is successful only when UC8 DIP switches 7 and 8 are both set to ON and only values 1 and 3 will be accepted; all other values are rejected. If DIP switch 7 and/or 8 is/are OFF, then any write action to this object has no effect.

When a unit is cooling with conventional dehumidification enabled there is no need to control the indoor fan, since the UC8 will automatically control the indoor fan speed. When operating in any other one should control the indoor fan as normal (refer to chapter 5.2).

5.5. Quiet mode

Quiet mode can reduce the amount of noise produced by the outdoor fan(s). The method used to obtain a quieter outdoor fan is by setting a different target for the condensing temperature (when cooling) or evaporating temperature (when heating). Quiet mode has no effect on the indoor fan nor on unit capacity (duty).

Enabling quiet mode can be effective when a unit is cooling, and the outdoor ambient temperature is below about 35°C. Higher outdoor ambient temperatures reduce the effectiveness; quiet mode is not effective when cooling and the outdoor ambient temperature is above 40°C.

Similarly, enabling quiet mode can be effective when a unit is heating, and the outdoor ambient temperature is above about 15°C. Lower outdoor ambient temperatures reduce the effectiveness; when heating while the outdoor ambient temperature is below 10°C then enabling quiet mode will have no effect.

If a unit is equipped with a variable speed or a digital scroll compressor, then reducing capacity can also aid in achieving quieter unit operation.

5.5.1. Objects are associated with control over quiet mode

Binary value object 6	U1_EN_QUIET	Enable (1) / **disable (0)** control over quiet mode
Binary value object 16	U1_REQ_QUIET	Request quiet mode **off** (**0**) or on (1)

5.6 De-icing the outdoor coil

5.6.1. Objects associated with de-icing the outdoor coil

Analog input 5	U1_T_AMB	Outdoor ambient temperature	°C
Analog input 8	U1_T_DEI	Outdoor coil de-ice sensor temperature	
Analog input 9	U1_T_EV	Evaporating temperature	
Analog input 36	U1_Timer_DEICE	Outdoor coil de-icing timer	seconds
Binary input 17	U1_FN_DEICE_REQUEST	Set when the controller has determined that the outdoor coil requires to be de-iced	
Binary input 18	U1_FN_DEICE_ACTIVE	Set when the controller is de-icing the outdoor coil	
Binary value 12	U1_EN_DEICE	BMS control over de-icing: **0 = Disabled** (UC8 autonomous control) 1 = Enabled	
Binary value 9	U1_EN_MODE_FAN	BMS control over indoor fan operating mode: **0 = Disabled**. 1 = Enabled	
Binary value 21	U1_REQ_FAN_DEICEON	Indoor fan operation during de-icing: 0 = Off **1 = On**	
Binary value 24	U1_DEICE_PERMIT	**Allow (1)** or disallow (0) de-icing of the outdoor coil when the controller determines this is necessary	
Binary value 25	U1_DEICE_FORCE	When set forces the controller to start de-icing of the outdoor coil	

5.6.2. Indoor fan operation during de-icing of the outdoor coil

- During de-icing of the outdoor coil, it is possible to either leave the indoor fan running or to stop the indoor fan. In general:
- Stopping the indoor fan during a de-ice cycle avoids cold air being blown into the room. However, usually it causes the de-icing operation to take longer than when the indoor fan is allowed to continue running. Use this option when the application has no requirements for delivery of a minimum air volume and delivery of cold air into the room is not acceptable.
- Leaving the indoor fan running during a de-ice cycle will cause cold air to be blown into the room. However, usually it helps to shorten the duration of the de-ice cycles. Use this option when the application requires delivery of a minimum air volume.

The UC8 provides the following options for control of the indoor fan during de-ice cycles:

Binary value 9 (U1_EN_MODE_FAN) = 0:

Operation of the indoor fan during outdoor coil de-ice cycles is determined either by a SATR3 or TZTR 100 wall thermostat (if present) or, if no wall thermostat is connected, by UC8 DIP switch 1.

- Wall thermostat: Fan-Auto mode allows the indoor fan to stop.
  Fan-On mode requires the indoor fan to continue running.
- UC8 DIP switch 1: OFF allows the indoor fan to stop.
  ON requires the indoor fan to continue running.

Binary value 9 (U1_EN_MODE_FAN) = 1:

The BMS controls operation of the indoor fan when the unit is de-icing the outdoor coil. BMS control is then possible via binary value 21:

- U1_REQ_FAN_DEICEON = 0: Allow the indoor fan to stop.
- U1_REQ_FAN_DEICEON = 1: Require the indoor fan to continue running.

5.6.3. BMS control of outdoor coil de-ice cycles

BMS control over de-ice cycles is especially useful for installations with more than one compressor. In such installations the BMS can monitor operating conditions, then allow and disallow units to de-ice in order to optimise user comfort and unit performance. For example, in an installation with four compressors the BMS could be programmed to allow only one or perhaps two systems to de-ice at any time while using the other two systems to continue heating.

The following objects can be monitored by the BMS to obtain de-icing status information:

Object	Name	Function
Binary input object 17	U1_FN_DEICE_REQUEST	Set when the controller has determined that the outdoor coil requires de-icing
Binary input object 18	U1_FN_DEICE_ACTIVE	Set when the controller is de-icing the outdoor coil
Multi state input object 1	U1_MODE	Reflects the current mode of the unit (off, cooling, heating, de-icing, …)

The UC8 provides the following objects for control of outdoor coil de-ice cycles.

Object			Operation
Binary value 12 U1_EN_DEICE	Binary value 24 U1_DEICE_PERMIT	Binary value 25 U1_DEICE_FORCE	
0	Any (defaults to 1)	Any	UC8 autonomous control
1	0	0	De-icing is not allowed.
1	1	0	The UC8 is allowed to de-ice when necessary.
1	Any	1	Immediately start a de-ice cycle.

- **Notes:**
  Using binary value 25 (U1_DEICE_FORCE) to force the unit to start a de-ice cycle is effective only when the unit is heating and has done so for more than 2 minutes.
- When using forced de-ice cycles via binary value 25 (U1_DEICE_FORCE) the object value is automatically reset to 0 as soon as the de-ice cycle has commenced. However, the object update rate is once a minute which can cause up to one minute delay before this is reported in the object value.

Should one wish to forcibly end a de-ice cycle the recommended method is to remove the request for heating, preferably by writing value 0 to binary value object 13 (U1_REQ_COMP). Doing so will make the UC8 immediately advance to the "de-ice dry" and "de-ice end" modes, followed by "off".

Completing this sequence takes about 1 minute; thereafter the unit can be restarted heating if desired.

Caution:
When the BMS controls de-icing of the outdoor coil care must be exercised that de-icing occurs regularly enough not to impair unit operation. Too infrequent de-icing can cause severe blocking of the outdoor coil and lead to LP trips and unit lock-out.

5.7. Dynamic demand reduction (DRED)

Dynamic demand reduction (DRED) allows an external device to reduce the energy consumption of the air conditioning system. There are four levels of demand reduction:

0 Normal operation: Up to 100% of rated energy consumption.

1 Minimum energy consumption. The compressor will be held off, but the indoor fan is allowed to continue running.

2 Up to 50% of rated energy consumption.

3 Up to 75% of rated energy consumption.

Levels 2 and 3 are achieved by switching the compressor off for part of half-hour intervals.

The following objects are associated with control over demand reduction (default values in bold):

Object	Name	Function
Binary value object 11	U1_EN_DRED	Enable (1) / **disable (0)** control over DRED
Analog value object 1	U1_REQ_DRED	Level **0** to 3

5.8. Resetting the controller

The controller can be reset using one of the following methods.

Warning!

Use caution when using BACnet to reset the controller! After receiving the correct command sequence the unit immediately performs a full system reset, regardless of the current unit operation! The controller restarts in the same way as when mains power to the unit is switched on. Normal operation can resume after about 30 seconds to 1 minute.

Method 1. Switch mains power to the controller off, wait for at least 5 seconds, then switch mains power back on again.

Method 2 Use BACnet communications to send the following two commands to the controller.

Commands must be given in the order listed here:

- Write value 8821 (hexadecimal 0x2275) to analog value object 4: U1_PRM_SEC.
- Write value 4660 (hexadecimal 0x1234) to analog output object 1: U1_CNTRL_RESET.
- No specific timing requirements exist for the above two commands.

5.9. Unlocking a unit

A unit is locked out when a serious fault occurs three times within a 12-hour period and the request for compressor-on has remained continuous. Faults that have occurred longer than 12 hours ago are removed from the count. Fault counts are reset to zero every time the unit switches off normally, either by the thermostat, by BMS or by mains power off.

When a unit is locked out it will not run the compressor or the indoor and outdoor fans. A locked-out unit reports value 12 (Lock Out) in multi-state input object 1 (U1_MODE).

When mains power is applied to a controller that was locked out, or the controller is reset, the display shows the cause of the previous lock-out for 20 seconds. This message will stop appearing after the unit has completed at least one full normal cooling or heating cycle.

A unit that is locked-out can be un-locked using one of the following methods:

Method 1. Switch mains power to the controller off, wait for at least 5 seconds, then switch mains power back on again.

Method 2. Use BACnet communications to send the following two commands to the controller.

Commands must be given in the order listed here:

- Write value 21930 (hexadecimal 0x55AA) to analog output object 1: U1_CNTRL_RESET.
- Write value 3855 (hexadecimal 0x0F0F) to analog output object 1: U1_CNTRL_RESET.
- The second command must be sent within 10 seconds following the first command.

After receiving the above two commands in the correct order and with the correct timing the unit mode returns from “Lock Out” to “Off” (to monitor unit mode read multi-state input object 1 U1_MODE). The unit is then immediately ready to restart normal operation. If the commands are sent to the unit when the unit was not locked out, or more than 10 seconds elapse between the two commands, or the commands are sent in an incorrect order then the commands have no effect.

Method 3. Reset the controller. Refer to section 5.8.

5.10. Control example

The following example shows how BACnet communications can be used to control an air-cooled reverse cycle unit (unit 1) with a variable speed indoor fan and variable capacity. The procedure is the same for other units, if present, adjusting the object numbers according to the unit number.

The following write-actions are required once only after every power-on and system reset (repeated writes are allowed):

Object	Name	Action	Purpose
Binary value object 1	U1_EN_COMP	Write value 1	Gain control over compressor off and on
Binary value object 2	U1_EN_HEAT	Write value 1	Gain control over cooling or heating
Binary value object 7	U1_EN_SPEED_FAN	Write value 1	Gain control over the indoor fan speed
Binary value object 8	U1_EN_CAPACITY	Write value 1	Gain control over unit capacity

The following write-actions are required when changing an aspect of unit operation:

Object	Name	Action	Purpose
Binary value object 13	U1_REQ_COMP	Write value 0 = off 1 = on	Switch the compressor off or on
Binary value object 14	U1_REQ_HEAT	Write value 0 = cooling 1 = heating	Select cooling or heating
Analog value object 2	U1_REQ_FAN	Write value 0 to 100	Set the indoor fan speed (refer to chapter 5.2)
Analog value object 3	U1_REQ_CAP	Write value 0 to 100	Set the unit capacity (refer to chapter 5.3)

Notes

- Regardless of how a unit is controlled, safety features built into the unit are always applied. For example: A compressor can be held off until the minimum off-time has expired, and this delay will always be applied independent of the request received via BACnet.
- When mains power is removed from the unit and then re-applied all control objects always are reset to their default values. To re-gain control over a unit after mains power has been interrupted, or after the controller has been reset, a BMS must again write to the appropriate control-enable objects (binary value objects 1 to 12, U1_EN_xxx).
- Objects associated directly with unit control and active state monitoring are updated once every 5 seconds. However, many other objects, for example objects that provide status information with values that normally remain static or infrequently change value have much slower update rates, such as once a minute or once every 10 minutes.
- When a Babel Buster is used to control more than one UC8 controller then often there will be some delay between a command being issued and the response of the targeted controller. This is normal and not a malfunction.

6. Notes

Additional information is available from Temperzone customer services and on the Temperzone internet web site: http://www.temperzone.com/

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Modbus Resistance
Testing
Video Tutorial

Modbus Communications Line Resistance Testing

(Testing Communications Errors)

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2. Performing communication resistance tests p. 205
    2.1 Cabling requirements p. 205
    2.2 Testing circuit resistance p. 205

1. Introduction

Temperzone products utilise Modbus communication methods for the transfer of information and actions between common components including:

- UC8 (Unit controller 8)
- IUC (Indoor unit controller)
- Carel Power + Inverter
- TZT-100 Thermostat
- SAT-3 Thermostat

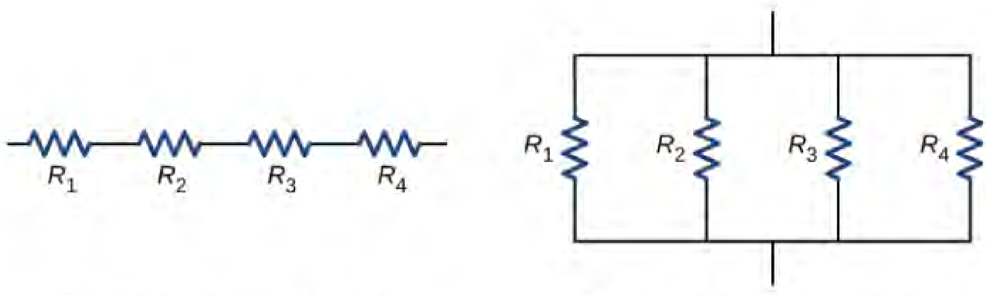
Modbus communication is transferred through ‘daisy chained’ communication cabling. This ‘daisy chain is completed by the installer via the A and B connections when connecting a Temperzone thermostat or interconnecting cabling on OSA (split ducted) models.

Each component in the circuit has an embedded internal resistance when testing between the two communication wiring input terminals (A and B, or TxRx+ and TxRx-). Component resistances are listed below:

Component	Terminal ID	Resistance (K Ohms)
UC8	A2 / B2	430
IUC	A / B	37
Carel Power + Inverter	TxRx+ / TxRx-	29.6
TZT-100 Thermostat	A / B	19.8
SAT-3 Thermostat	A / B	57.9

1.1. Theory behind the testing

Resistors connected in series will increase a circuits resistance. Resistors connected in parallel, like the temperzone Modbus communication daisy chain, will reduce a circuits resistance.



(a) Resistors connected in series

INCREASED RESISTANCE

(b) Resistors connected in parallel

REDUCED RESISTANCE

The total resistance (Rt) of a parallel circuit is calculated by the formula here:

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$

2. Performing communication resistance tests

2.1. Cabling requirements

Cable issues are the main cause of communication fault. Before conducting resistance tests check:

Requirements of field installed cable and pre-test checks:

- Ensure that any communications cable installed in the field is a twisted, screened and shielded RS485 or equivalent
- Should multiple cables be used in the communication link ensure that the A and B communication share the same cable
- Do not exceed maximum recommended communication cable maximum lengths
- Avoid unnecessary joins in cable
- Avoid running cable through or over sharp surfaces
- Avoid running cable with, over or near (500mm) to high voltage cables, high frequency areas (data rooms) or other equipment that can cause interference such as lift motors, satellites etc.
- Ensure that screen is grounded on 1 end only
- Terminations must be tight without exposed conducting cable protruding from terminal
- Ensure that cable does not cross, and A terminals connect to A and B connect to B

2.2. Testing circuit resistance

WARNING: Isolate Power Before Testing!

Using a multimeter capable of testing on a 10 M Ohm range, test the total resistance of the communication circuit (A-B). If circuit resistance is incorrect disconnect one component at a time until the correct resistance is achieved. By doing this the component incorrectly communicating will be identified through elimination.

Below is a chart of possible component combinations and total circuit resistances. Individual component resistance is identified in brackets beneath the component. Blue cells indicate the component included in the circuit:

Component				Resistance (Kilo Ohms)
TZT-100 19.8K	UC8 430K	IUC 37K	Carel Power+ 29.6K	
				8.80K
				8.99K
				11.56K
				12.53K
				15.85K
				12.91K
				18.96K
				34.07K
				27.73K
				16.46K

By process of elimination the communication error can now be identified to one of two components. Check the identified components resistance without communication cables connected.

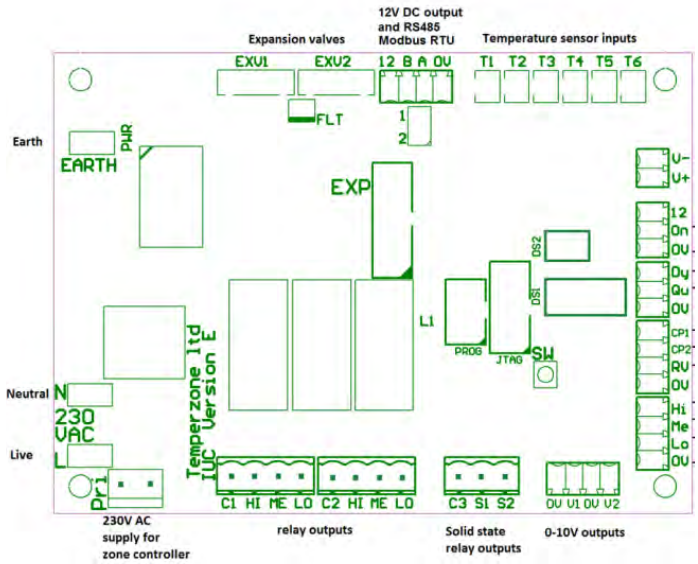
- If the resistance of the component is correct the cause of the communication error is in the cable. Check for cable damage and correct polarity.
- If the resistance of the component is incorrect (+ or – 10% due to variations in temperature) the component is the cause of the communication failure.

The UC8 or IUC is the cause of the communication error

From time to time you may encounter a Modbus communications issue with either the UC8, IUC or both. This could be caused by a higher than 12V voltage applied to the A2-B2 terminals on the UC8 or the A-B terminals on the IUC.

Below are the resistances you should read when testing across terminals. Remove communication cabling from component prior to performing tests. Cells shaded blue indicate tested terminals:

UC8 Controller			
Terminal			Resistance
A2	B2	0V	
			4-5 M Ohm
			4-5 M Ohm
			400-460 K Ohm

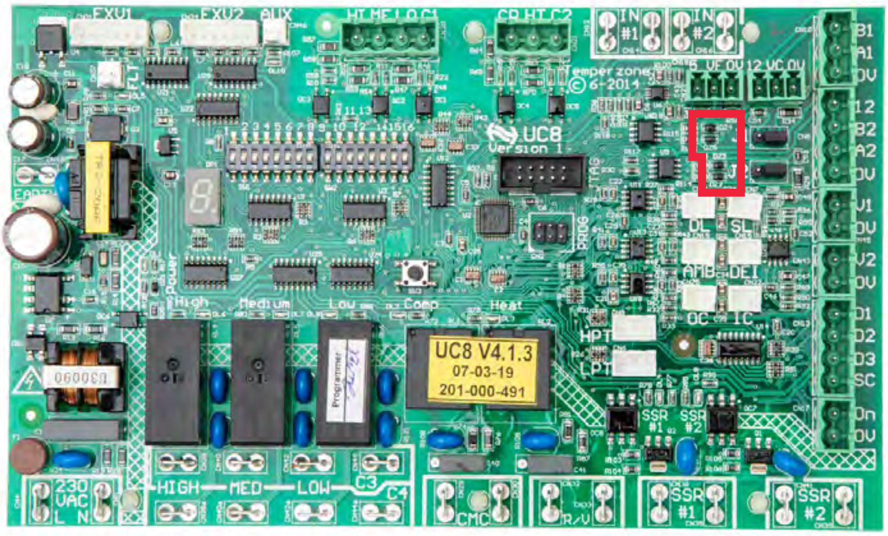


IUC Controller			
Terminal			Resistance
A	B	0V	
			18-18.5 K Ohm
			18-18.5 K Ohm
			36.5 - 37 K Ohm

If the resistance readings are lower than the above, the removal of the transils may bring the UC8 back to a working condition. A transil or transil diode (Transient Voltage Suppressor, TVS) – is a type of protecting semiconductor diode with method of operation similar to varistor, which is designed to protect sensitive electronic components from electrical surges.

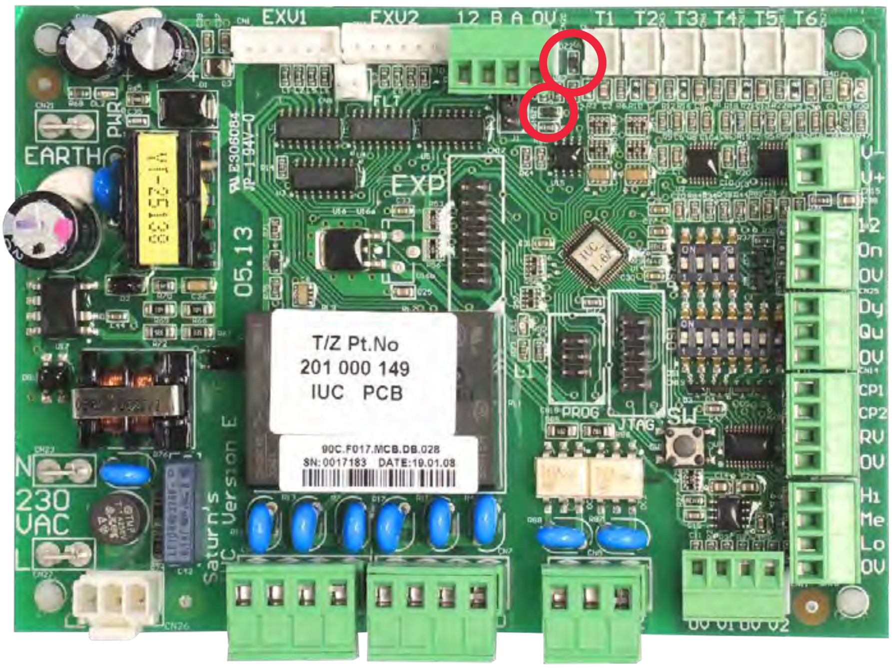
Below shows the locations of the UC8 and IUC transils:

UC8:



With a small flat blade screwdriver, scrape off DZ2, DZ3, DZ4 and DZ5 transils.

IUC:



With a small flat blade screwdriver, scrape off DZ1 and DZ2.

After scraping off the transils, perform resistance checks again. If the resistances remain incorrect and the communication error persists the component has an internal failure and requires replacement.

Scan QR code for IUC (Indoor Unit Controller) Video Tutorial

Indoor Unit Controller (IUC)

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1. Introduction

The temperzone Indoor Unit Controller (IUC) is used in temperzone Ducted Split Systems. Indoor units with an IUC are identified by the 'X' at the end of the product model, e.g., ISD 351 LYX.

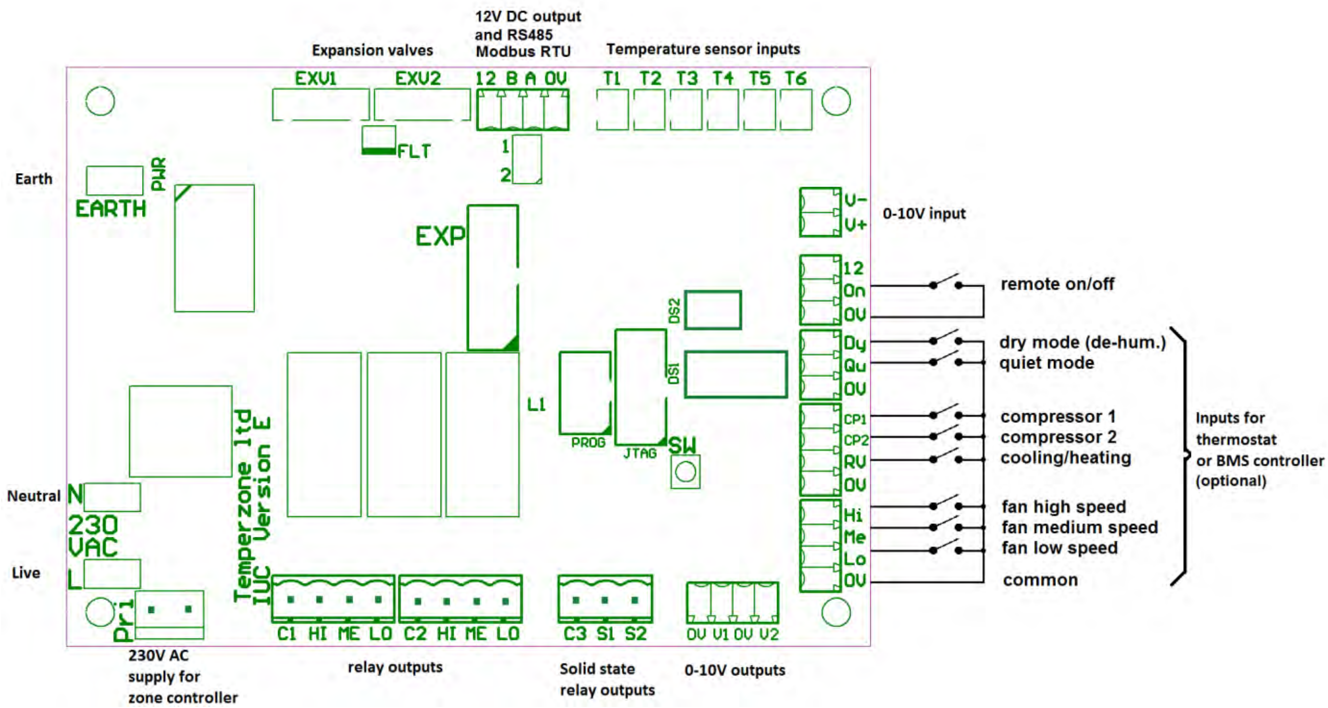
The IUC is an integral part of the air conditioning system. Factory installed in the Indoor unit, the IUC communicates with the UC8 Controller located in the Outdoor unit. The IUC measures temperatures in the indoor unit, controls the indoor fans as directed by the outdoor unit and offers conveniently located connections for thermostats or building management controls. The IUC also can allow adjustment of the indoor fan speed settings.

A wall mounted room temperature thermostat, for example the temperzone SAT-3, can be connected to the same wiring that connects the IUC to the outdoor unit. The interconnecting cable between the indoor and the outdoor unit is a screened twisted pair cable suitable for RS485 serial communications and is available from temperzone.

IUC Features:

- Measures indoor coil-, supply air-, return air- and suction line temperatures (on cooling cycle).
- Allows connection of SAT-3, TZT-100, Climate Touch and other thermostats.
- Ability to connect one or two electronic expansion valves.
- Remote on/off switch terminals.
- Low/Medium/High fan speed control.
- 0 to 10V control of EC Motor/Fan with DIP switch selection of maximum speed and range between highest and lowest speeds.
- Status/Fault LED.

2. Inputs and outputs



2.1. Temperature sensor inputs T1 to T6

The IUC can be used to report up to six temperatures using standard temperzone temperature sensors. Most indoor units do not need all six sensors, a typical small indoor unit usually has only four sensors: T1, T2, T5 and T6.

T1 **Indoor coil 1 temperature**

T2 **Suction line 1 temperature (cooling mode)**

T3 **Indoor coil 2 temperature**

T4 **Suction line 2 temperature (cooling mode)**

T5 **Supply air temperature**

T6 **Return air temperature**

Inputs that are not used should be left open circuit.

2.2. Thermostat inputs

The following set of inputs allows control of the unit with a thermostat or other type of controller that provides voltage-free dry relay contacts. Terminal '0V' is the common for all inputs.

The inputs are directly referenced to unit earth, they are not electrically isolated.

Dy **Dry mode (de-humidification)**

Qu **Quiet mode**

CP1 **Compressor 1**

CP2 **Compressor 2**

RV **Cooling / heating**

Hi **Indoor fan High speed**

Me **Indoor fan Medium speed**

Lo **Indoor fan Low speed**

Inputs that are not used should be left open circuit.

Note:
If the IUC is connected to an outdoor unit with UC8 controller, then inputs CP, RV, Hi, Me and Lo work in parallel with corresponding inputs on the UC8. In other words: One is free to choose whether to control the unit from the indoor- or the outdoor- unit.

2.3. Remote on/off input 'On'

The remote on/off input ('On') can be used to switch the entire unit off, e.g., by means of a time clock.

The input should be connected to a voltage-free dry relay contact. Terminal '0V' is the common terminal. The input is directly referenced to unit earth, it is not electrically isolated.

In order to turn the unit ON the input must connect to 0V. If this input is not used it should be shorted (looped).

Note:
If the IUC is connected to an outdoor unit with UC8 controller, then the unit can be turned off using either remote control input. For the unit to be enabled (On) both the remote on/off input on the IUC and the remote on/off input on the UC8 must be "on" (looped). One is free to choose whether to control the remote on/off signal at the indoor- or the outdoor- unit; the 'unused' input should remain shorted.

2.4. 0-10V capacity control input V+/V-

Duty of a variable capacity unit (e.g., with digital scroll or variable speed compressor) can be controlled by an appropriate 0-10V analogue control signal connected to inputs V+ and V- on the IUC.

Terminal V- is the reference signal (usually 0V), terminal V+ should receive the 0-10V control signal.

Notes:
The 0-10V input is not electrically isolated.

If the IUC is connected to an outdoor unit with UC8 controller, then unit capacity can be controlled using either inputs V+/V- on the IUC or input VC on the UC8. The input that is to remain unused should be left open circuit.

2.5. Modbus RTU serial communications port

Terminals A and B should connect to the corresponding Modbus port on the outdoor unit. For the UC8 that is terminals A2 and B2.

The cable between the indoor and outdoor units should be a shielded twisted pair wire suitable for computer serial communications. The cable shield should connect to terminal 0V at the UC8 only and **NOT** connect at the IUC (to avoid creating an earth loop).

2.6. Relay outputs HI, ME, LO, C1, C2

The IUC provides two double pole relays. The relay contacts are brought out on terminals HI, ME, LO, C1 and C2. Terminal C1 is the common for the left set of terminals, C2 is common for the right set of terminals. These terminals are electrically isolated from all other circuits, and thus can be used to switch low or high voltages as required.

Typically, outputs HI, ME and LO are used for control of one or two single-phase three-speed or single-speed induction motors for the indoor fan(s). For a three-speed single-phase fan one should connect terminal C1 to 230V AC mains live while terminals HI, ME and LO connect to the appropriate speed-tapping's of the fan. The fan neutral wire should connect directly to mains neutral. A second three-speed fan can be connected in the same way to the other set of terminals.

The IUC can also be configured with the relays available for general purpose use. For more information on this contact Temperzone.

2.7. 0-10V analogue outputs V1 and V2

The IUC provides two 0-10V outputs on terminals V1 and V2. Terminals '0V' are the reference for these outputs. The outputs are directly referenced to unit earth, they are not electrically isolated. Typical uses for these outputs are control of variable speed fans and/or proportional damper position.

2.8. Expansion valve control outputs EXV1 and EXV2

Up to two electronic expansion valves can be connected using connectors EXV1 and EXV2.

The expansion valves must be 6-wire 12V DC uni-polar types. Suitable valves are Sanhua DPF series and Carel E2V series.

2.9. Fault relay output FLT

A standard temperzone fault relay board (FRB) can be connected to connector FLT. The output is normally off and becomes active when the IUC software detects a fault, such as a missing temperature sensor, lack of communications or other problem. For more information on fault status refer to chapter 4.

3. DIP switches DS1 and DS2

The IUC circuit board has two sets of DIP switches: DS1 has 8 switches, DS2 has four switches. The DIP switches must be set correctly for the unit to operate correctly. The following sections provide information how to set the DIP switches.

3.1. DIP switches DS1-1 to DS1-5: Output voltage ranges of V1 and V2

DS1 switches 1 to 5 can control the output voltage range of analogue outputs V1 and V2.

DS1 switches 1, 2 and 3 set the HIGH-level output voltage.

DS1 switches 4 and 5 set the output voltage RANGE. (RANGE is the voltage difference between HIGH- and LOW-level).

Shaded cells represent DIP switches turned **ON**:

<table>
<tr><th colspan="3">DIP Switch</th><th rowspan="2">Output Voltage HIGH V (high)</th></tr>
<tr><th>1-1</th><th>1-2</th><th>1-3</th></tr>
<tr><td></td><td></td><td></td><td>6.5 V</td></tr>
<tr><td style="background:#d3e3e3"></td><td></td><td></td><td>7.0 V</td></tr>
<tr><td></td><td style="background:#d3e3e3"></td><td></td><td>7.5 V</td></tr>
<tr><td style="background:#d3e3e3"></td><td style="background:#d3e3e3"></td><td></td><td>8.0 V</td></tr>
<tr><td></td><td></td><td style="background:#d3e3e3"></td><td>8.5 V</td></tr>
<tr><td style="background:#d3e3e3"></td><td></td><td style="background:#d3e3e3"></td><td>9.0 V</td></tr>
<tr><td></td><td style="background:#d3e3e3"></td><td style="background:#d3e3e3"></td><td>9.5 V</td></tr>
<tr><td style="background:#d3e3e3"></td><td style="background:#d3e3e3"></td><td style="background:#d3e3e3"></td><td>10.0 V</td></tr>
</table>

<table>
<tr><th colspan="2">DIP Switch</th><th rowspan="2">Output Voltage RANGE V(high) - V(low)</th></tr>
<tr><th>1-4</th><th>1-5</th></tr>
<tr><td></td><td></td><td>2 V</td></tr>
<tr><td style="background:#d3e3e3"></td><td></td><td>3 V</td></tr>
<tr><td></td><td style="background:#d3e3e3"></td><td>4.5 V</td></tr>
<tr><td style="background:#d3e3e3"></td><td style="background:#d3e3e3"></td><td>6 V</td></tr>
</table>

If an output is configured not to use the range function, then the setting of switches DS1-1 to DS1-5 has no effect on the output voltage. Refer to section 3.4: DIP switches DS2-1 to DS2-4.

Note:
When a combination of DIP switch settings would give a LOW output voltage of less than 2.3V then the IUC automatically limits the LOW output voltage to 2.3V. (This may be required to prevent a fan controller from stopping a fan when low speed is requested.)

Example:
DIP switches 1, 2 and3 are set for HIGH voltage 7.0V (ON, OFF and OFF).

DIP switches 4 and 5 are set for output voltage RANGE 6V (ON and ON).

The LOW voltage would be 7V - 6V = 1.0V but such a low level is not allowed, the IUC will provide 2.3V instead. The MEDIUM output voltage is unaffected and will be (7.0+1.0)/2=4.0V.

Note: STOP is always 0V.

3.2. DIP switches DS1-6 and DS1-7: Relay functions

DS1 switches 6 and 7 select the functionality of the HI-ME-LO relays:

DIP Switch		Function
1-6	1-7	
		Modbus control via Hi-Me-Lo transfer function. Intended for three-speed fan control.
		Modbus direct control. This option gives full control over each individual relay via one Modbus register **Error! Reference source not found.**. **Must NOT be used for three-speed induction motor fan control! The fan motor may be damaged!**
		The three relays are controlled directly by the signals present at inputs Hi-Me-Lo, but only one relay will ever be on at any time (even if more than input is made active). Intended for three speed fan control.
		The three relays are controlled directly by the signals present at inputs Hi-Me-Lo. If more than one input is made active, then also more than one relay will be on. Intended for general relay control. **Must NOT be used for three-speed induction motor fan control! The fan motor may be damaged!**

The two direct individual control options for the relays are intended for the control of single speed fans, contactors, electric heaters, open/close dampers, etcetera.

3.3. DIP switch DS1-8

DIP switch DS1 switch 8 selects the electronic expansion valve (EXV) model:

DIP Switch DS1-8	EXV1 and EXV2 model
	Sanhua DPF series, 12V DC uni-polar coil, 2000 steps
	Carel E2V series, 12V DC uni-polar coil, 480 steps

3.4. DIP switches DS2-1 to DS2-4

DS2 switches 1, 2, 3 and 4 select configurations for 0-10V analogue voltage outputs V1 and V2. The table below shows all possible options. The meanings are as follows:

MB direct
The output is directly controlled by the corresponding Modbus register. In this case the register value directly sets the output voltage in a linear fashion: 0.01V per count, 0 = 0V, 1000 = 10V.

Intended for control of 0-10V dampers or valves and for continuously variable speed fans in some specific applications, such as when the unit is controlled by the temperzone six-zone controller.

MB scaled
The output is controlled by the corresponding Modbus register, but scaling is applied according to the settings of DIP switches DS1-1 to DS1-5. Refer to section 3.1 for more information about the scaling function.

Intended for control of continuously variable speed fans.

MB stepped
The output is controlled by the corresponding Modbus register, but stepping is applied. The stepping function can be used in applications where it is of advantage to avoid certain fan speeds that otherwise could lead to unwanted mechanical (audible) resonances.

MB scaled and stepped
The output is controlled by the corresponding Modbus register, scaling and stepping is applied, refer to chapter 3.1.

HML inputs scaled
The output is controlled by the High-Medium-Low inputs on the IUC circuit board. The scaling function is applied.

DIP Switch				V1 Configuration	V2 Configuration	Notes
2-1	2-2	2-3	2-4			
				MB direct	MB direct	
■				MB scaled	MB direct	
	■			MB stepped	MB direct	
■	■			MB scaled and stepped	MB direct	
		■		HML inputs scaled	MB direct	
■		■		MB scaled	MB scaled	
	■	■		MB stepped	MB scaled	
■	■	■		MB scaled and stepped	MB scaled	
			■	HML inputs scaled	MB scaled	
■			■	MB stepped	MB stepped	
	■		■	MB scaled and stepped	MB stepped	
■	■		■	HML inputs scaled	MB stepped	
		■	■	MB scaled and stepped	MB scaled and stepped	
■		■	■	HML inputs scaled	MB scaled and stepped	
	■	■	■	HML inputs scaled	HML inputs scaled	
■	■	■	■	MB direct	MB direct	DS1-1 to DS1-5 select the IUC Modbus device address.

3.5. Re-definition of the DS1 DIP switches 1 to 5

With DS2-1, -2, -3 and -4 all set to the ON position the output voltage range function is not used. In this case the function of DIP switches DS1-1 to DS1-4 is changed to allow selection of the IUC Modbus device address. This enables the use of the IUC in installations with multiple indoor units.

Default device address is 60.

DIP Switch				IUC Modbus device address
1-1	1-2	1-3	1-4	
				60
■				61
	■			62
■	■			63
		■		64
■		■		65
	■	■		66
■	■	■		67
			■	68
■			■	69
	■		■	70
■	■		■	71
		■	■	72
■		■	■	73
	■	■	■	74
■	■	■	■	75

4. LED status indication

The LED on the IUC circuit board is used to indicate status of the IUC. Use the following table to determine the status. A dot (.) represents a short flash, a dash (-) represents a long flash.

LED Blinking Pattern		IUC Status
- -	Slowly flashing on and off	No faults
.	Single short flashes	Sensor T1 fault
. .	Double short flashes	Sensor T2 fault
. . .	Triple short flashes	Sensor T3 fault
- .	One long flash followed by one short flash	Sensor T4 fault
- . .	One long flash followed by two short flashes	Sensor T5 fault
- . . .	One long flash followed by three short flashes	Sensor T6 fault
- - .	Two long flashes followed by one short flash	The circuit board is too hot
- - . .	Two long flashes followed by two short flashes	Problem with the supply voltage
- - . . .	Two long flashes followed by three short flashes	No Modbus communications
Any other pattern		Internal problem

ALC 0-10V Level Controller

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   - 1.1. Application p. 218
   - 1.2. Function p. 218
   - 1.3. Inputs p. 218
   - 1.4. Outputs p. 218
   - 1.5. Run On p. 219
   - 1.6. DIP Switch Settings p. 219
   - 1.7. Terminals p. 219

1. 0-10V Level Controller

(Referred to as “LC” – Level Controller, in temperzone Wiring Schematics)

1.1. Application

To control the speed of 0-10V dc input fan controllers where speed range selection is not available.

e.g.:

- ECC-1260 - 600W / 900W / 1250W
- ECC-240 – 230W
- Others with appropriate specification checks

1.2. Function

8 maximum output voltage levels between 6.7 and 10 V selectable with 3 dip switches.

4 ranges of between 2 and 6V selectable with 2 dip switches.

Fan run-on time is selectable between 40 or 120 seconds. Run on occurs at the listed “L” Voltage level.

1.3. Inputs

Supply voltage 10 to 15V DC, 10mA.

0-10V dc level or voltage free H, M and L contacts.

Where a 0-10Vdc control is used; the Input voltages shown in the table to the right, correspond to the 3 selectable speed levels.

Input Voltage (V)	Level
10	High
6	Medium
2	Low

1.4. Outputs

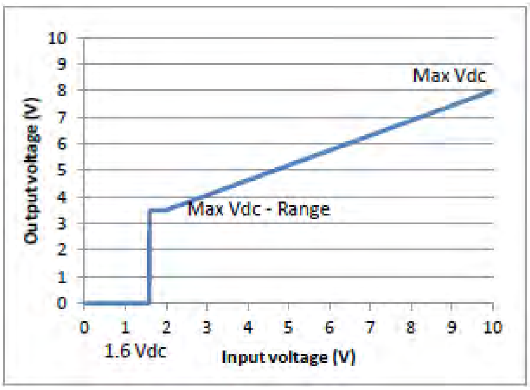
Output voltage is controlled by selecting a Maximum output voltage and a Range. The Minimum output voltage is determined by:

Minimum output voltage = Maximum output voltage – Range

Input voltages below 1.6V produce 0V output voltage.

Input voltages between 1.6V and 2.0V produce minimum output voltage.

If the Minimum output voltage is below 2.2V the output voltage level is limited to a minimum of 2.2V.



The example to the right shows 8V Maximum output voltage, Range 4.5V.

1.5. Run On

Run on can be selected as 40 seconds (standard) and 120 seconds for electric heat applications.

1.6. Dip Switch settings

Output voltage “Maximum” and “Range” and Fan Run on settings. Shaded cells represent DIP switches turned ‘ON’.

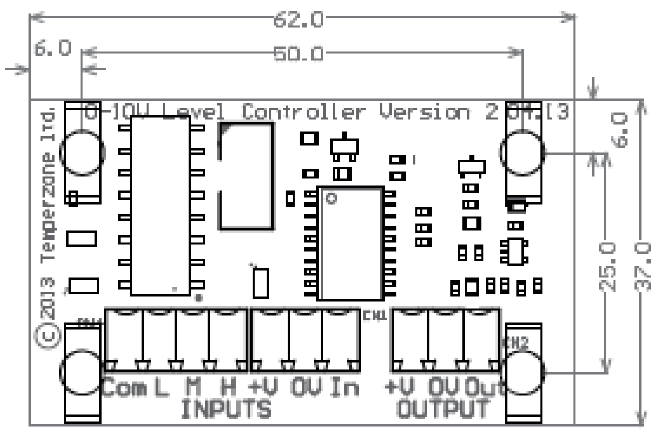
Max Speed Setting			
DIP Switch			Max VDC Output
1	2	3	
			6.7
■			7.3
	■		8
■	■		8.3
		■	8.7
■		■	9
	■	■	9.3
■	■	■	10

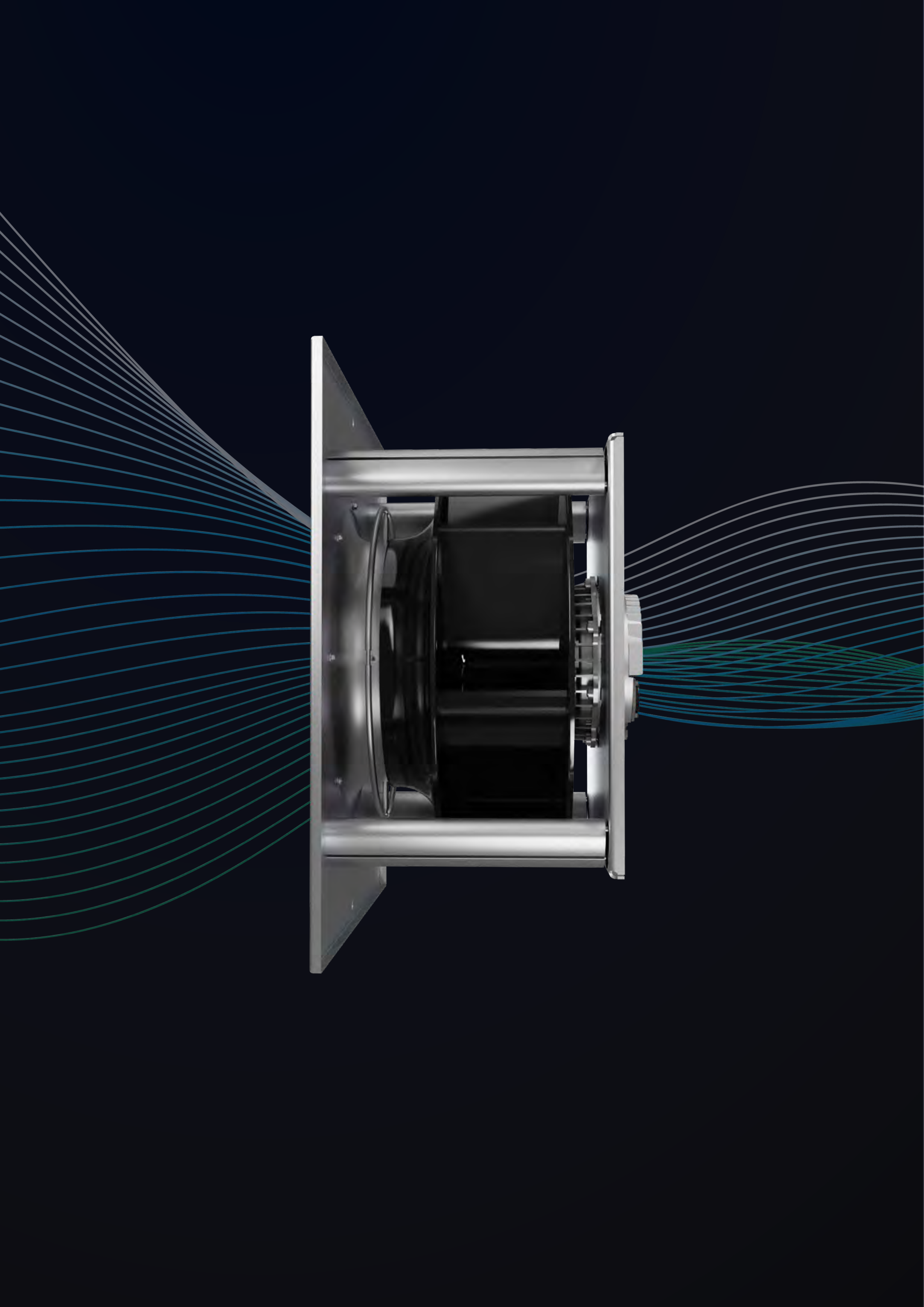
Speed Range		
DIP Switch		VDC
4	5	
		2
■		3
	■	4.5
■	■	6

Fan Run On		
DIP Switch 6	Time (seconds)	Application
	40	Standard
■	120	Elec.Heat

1.7. Terminals

Inputs	
Com	Common for L, M and H voltage free contacts
L	Low input – voltage free contacts
M	Medium input – voltage free contacts
H	High input – voltage free contacts
+V	10 to 15 V 10 mA DC voltage supply
0V	0V reference for DC Voltage supply and “In” terminal
In	0-10V DC input terminal
Outputs	
+V	10 to 15 V 10 mA DC voltage supply
0V	0V reference for DC Voltage supply and “Out” terminal
Out	0-10V DC output terminal





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ECC Fan Controller

Fault Diagnostics

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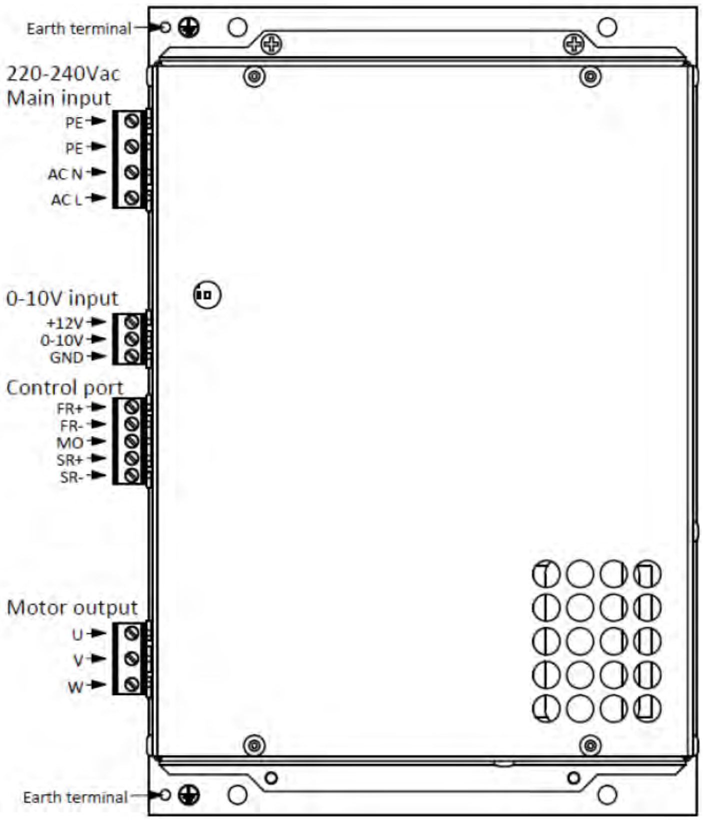
3. Functional Diagram p. 222
4. Fault Identification p. 223

1. Application

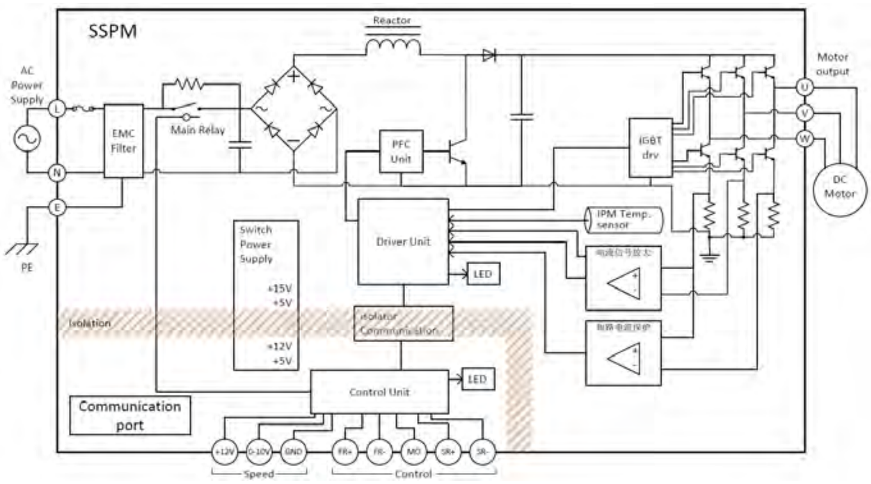
The ECC fan controller is an inverter module used to control indoor fan speed via a 0-10V DC input. The controller translates the 0 – 10V calculation, rectifies the single-phase input into a 3-phase output, and adjusts output frequency to the indoor fan to control speed. This type of fan speed control is commonly found on temperzone equipment with forward curve centrifugal fans ('barrel' fans) such as ISD split ducted indoor units, HWP water cooled package units and more.

2. Terminal Identification

Terminal	Function	Description
PE	AC Power Input	Connected to terminal on heatsink
PE		Main earth
AC N		Neutral
AC L		240 V supply
+12V	0-10V Input	Isolated +12V supply
0-10V		Target speed input
GND		Isolated Ground
FR+	Control Port	Fault out +
FR-		Fault out -
MO		1250W / 900W configuration
SR+		Motor temp sensor input +
SR-		Motor temp sensor input-
U	Motor Output	Motor out U
V		Motor out V
W		Motor out W



3. Functional Diagram

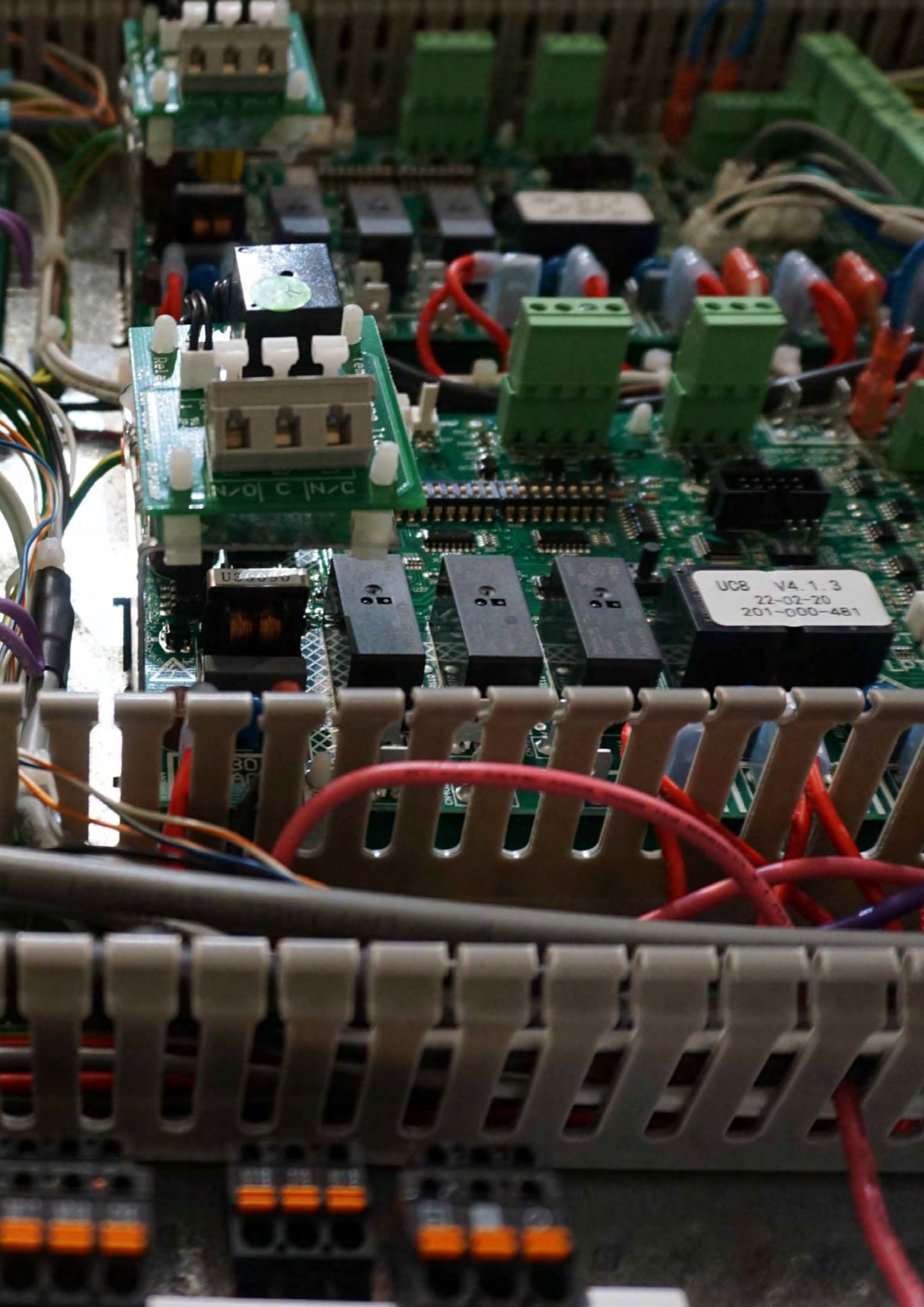


4. Fault Identification

The ECC controller will display a continuous slow flash from and LED light visible through the small display port on the front cover during normal operation. In the event of a fault the ECC fan controller board will display a series of flashes visible through the small display port on the front cover. The pattern of long and short flashes identifies the cause for fault.

In the following fault table long flashes are indicated by a **"–"** and short flashes are indicated by a "**.**"

Flashes	Fault	Cause
-	DC Voltage High	DC Voltage > 430V
. -	DC Voltage Low	DC Voltage < 180V
- -	Phase Imbalance	One or more phases below the voltage of the other(s)
. . - . . .	Loss of Synchronization	Back EMF <15V
- . - . . .	Speed Fault	Motor is running over speed ratings
. - - . . .	Motor Current High	Motor is drawing too much current
- - - . . .	IPM FO failure	IPM is sending an FO signal too narrow
. . . - . .	IPM FO level	IPM is sending an FO signal too wide
- . - - . .	Motor Power High	Motor power draw is above user defined limit (if used)
. - - - . .	AC Input too High	Input current is above user defined limit (if used)
- - - - . .	AD Fault	Motor Temp sensor failed
. - . . - .	Motor Temperature Sensor Fault	Temperature of motor sensor too high
- - . . - .	Motor Overheat	Motor is operating above user defined temperature (if used)
. . - . - .	IPM Temperature High	Reduced operation because IPM temperature is too high
. - - . - .	Communication	Loss of communication
- - - . - .	Parameter Fault	Incorrect parameter settings installed
- . . - - .	WWprom Fault	EEprom Fault
- - . - - .	Resistance of Motor Fault	Motor resistance high
. . - - - .	IPM Overheated	IPM has overheated too far and has been forced to stop fan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TFC Controller
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Triac Fan Controller

1. Introduction

This document describes how to connect, set up and use the Temperzone Triac Fan Controller board (TFC).

The controller is intended for use with single phase, capacitor-run induction motors (PSC) with rated voltage of 230V AC, 50Hz. Continuous maximum rated current is 5A RMS (up to 60°C ambient). The controller does not incorporate overload or over-temperature protection.

The controller can operate in any one of five modes. The operating mode is selected by means of DIP switches 1 and 2 and by Modbus communication protocol.

- 0 to 10 V input
- 10 to 0 V input
- Head Pressure control
- 3-Speed digital control mode (H, M and L)
- Serial Modbus control mode

In addition, the controller can be configured to operate in up to 3 anti-resonance modes. Selection of an anti-resonance mode may help to avoid undesirable mechanical resonances that may exist in a unit.

A soft-start function is implemented to avoid high motor inrush current, reduce mechanical stress and reduce fan start-up noise.

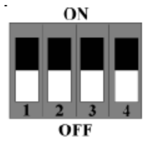
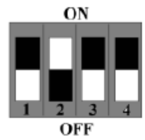
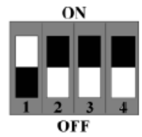
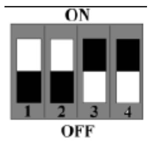
The controller board provides inputs and outputs for:

- One temperature sensor
- One pressure transducer
- One 0-10V analogue input signal
- Three digital inputs (suitable for relay control)
- One RS-485 serial communication channel
- Single phase 230V AC mains input (mains live, mains neutral and earth)
- Fan motor output (fan live, fan neutral and earth)

Operation of the controller is determined by the various input signals, four DIP switch settings and several programmable settings. Programmable settings can be modified by using an RS-485 serial connection to a PC or laptop computer.

2. Operating mode selection

The operating mode is selected by DIP switches 1 and 2 as follows (shaded cells indicate DIP switch 'ON'):

Mode Number	DIP Switch Number		Operating Mode	DIP Switches
	1	2		
0			0-10V Input Control	
1		ON (shaded)	10-0V Input Control	
2	ON (shaded)		3 Speed Digital Control	
3	ON (shaded)	ON (shaded)	Head Pressure Control	

Control via the Modbus interface can be initiated by writing a value between 1 and 100 to the fan duty register 16. Alternately Modbus control can be set by writing a value of 4 to register 18. This setting is volatile and will require to be re-written following every cycling of the TFC input power. Further modes accessible with Modbus commands to register 18 are:

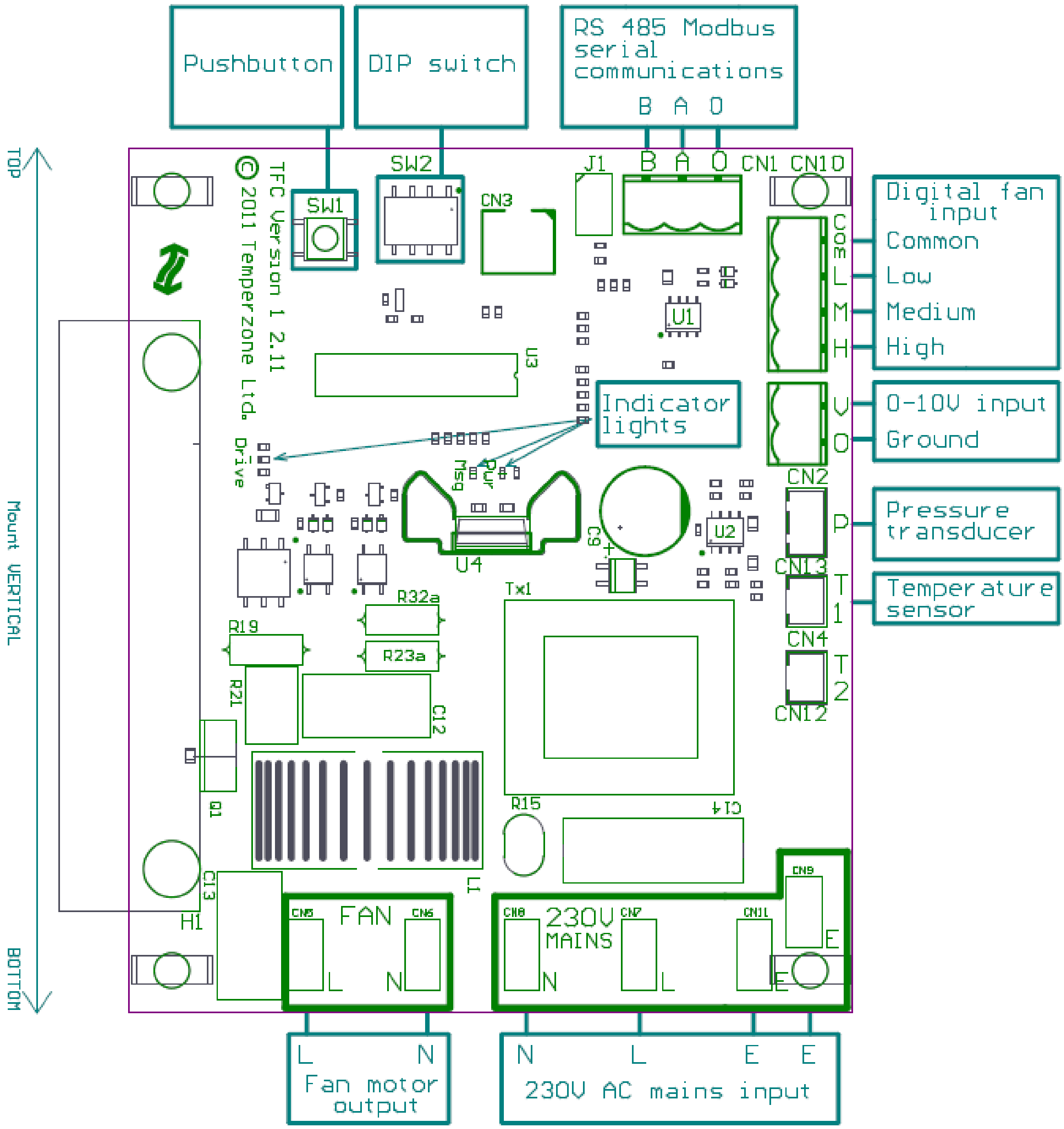
Mode Number	Operating Mode	Description
4	Modbus serial control	Fan motor duty is set using Modbus function 6 to write a speed value (0 to 100 unsigned) to register 16.
5	Soak Test mode	Fan motor duty operates at between 30% and 100%, changing state every 15 minutes.
6	Production Test mode	Fan motor speed oscillates with a 25.5 second cycle, alternating between full and minimum speed.
7	Engineering Test mode	Fan motor duty is set in % by number of button presses x 4.

3. Anti-resonance modes

Anti-resonance modes may help avoid mechanical resonances. Operation of the anti-resonance modes is controlled with DIP switched 3 and 4 as follows (shaded cells represent DIP switch 'ON'):

Mode Number	DIP Switch Number		Anti-resonance Mode
	3	4	
0			Anti-resonance disabled; fan duty controlled in 1% steps
1		ON (shaded)	Fan duty controlled in 12% steps
2	ON (shaded)		Fan duty controlled in 12% steps
3	ON (shaded)	ON (shaded)	Fan duty controlled in 33% steps

4. Connections, controls, and indicator lights



Mode Number	Operating Mode	Required Connections
3a	Head pressure control with temperature sensor	A standard „Temperzone" temperature sensor must be connected to input "T1". The sensor should have yellow or blue wires. Connect a relay contact to the H input that operates as follows: Heating mode - Closed Cooling mode – Open Connect a relay contact to the M input that operates as follows: Compressor Running - Closed Compressor Stopped - Open
3b	Head pressure control with pressure sensor	A 45-bar pressure sensor, sensing the pressure in the outdoor coil, must be connected to input "P". If a temperature sensor is fitted in addition to the pressure sensor input from the temperature sensor is ignored. Connect a relay contact to the H input that operates as follows: Heating mode - Closed Cooling mode – Open Connect a relay contact to the M input that operates as follows: Compressor Running - Closed Compressor Stopped - Open
0, 1	Voltage control	An analogue voltage source (0 to +10.0 volt) must be connected to screw terminal "V". The screw terminal marked "0" is the ground return (reference).
2	3-Speed digital control	Connect three digital control signals to the screw terminals marked "H-M-L". The screw terminal marked "Com" is the return (reference). Note: These inputs are not isolated. These inputs accept low voltage only. The signals must be voltage free relay contacts.
4	Modbus control	An RS-485 compatible serial connection to the screw terminals marked "A" (+) and "B" (-) is required. The "Gnd" screw terminal is the ground (reference).
5, 6, 7	Test modes	No inputs necessary

5. Push-button Control

During the first 15 minutes following power on the button may be used to change the operating mode of the TFC.

Commands are entered with a number of presses of the button. The button must be pressed for between 100ms and 200ms before the press will register. When the press is registered the msg LED turns on. When the button is released the msg LED is turned off. If the button is pressed again within 1 second, the presses is counted. If the button is not pressed within 1 second, the number of presses is used to enter a command as follows:

Number of presses	Operating Mode	Command
1	Production Test Mode	Enter production test mode
2		None
3		None
4		Reserved (press button 4 times again to toggle out of this mode)
5		Increment Modbus address. (Modbus address may be changed between 48 and 51, when incremented beyond 51 it returns to 48.)
6		Reset Modbus address to the default value of 48.
7		Save parameters to flash memory
8		Erase parameters from flash memory
9	Soak Test Mode	Enter soak test mode
10	Engineering Test Mode	Enter engineering test mode (once set the TFC must be powered off to reset)

6. Indicator Lights

Light	Function	On	Off	Blinking
Pwr	Power indication	230V AC power is off.	230V AC power is on.	-
Msg	Controller status (in normal modes)	Does not occur in normal operation	Does not occur in normal operation	Normal operation, 1.6 second period

7. System Variables

#	Variable	Data Type	Function
1	System Time H	Unsigned 32 bit	Total duration of operation in 0.1 second increments
2	System Time L		
3	Half Mains Average	Unsigned 16 bit	Average recorded period between zero crossings in increments of 2.0 us
4	Band-gap conversion	Unsigned 16 bit	Supply voltage = 255*1.21/Band-gap conversion
5	CPU Temperature	Unsigned 16 bit	CPU internal temperature in 0.1°C increments
6	Modbus address	Unsigned 16 bit	Address for modbus commands
7	Thermocouple T1 temperature	Signed 16 bit	Temperature of thermocouple T1 in 0.1°C increments. Default for thermocouple not connected is 20°C.
8	Thermocouple T2 temperature	Signed 16 bit	Temperature of thermocouple T2 in 0.1°C increments. Default for thermocouple not connected is 20°C.
9	0 to 10 Voltage input conversion	Unsigned 16 bit	Input 0 to 10 Voltage, scale 0-1020.
10	Saturated gas temperature	Signed 16 bit	Saturated gas temperature calculated from the pressure sensor input.
11	Pressure	Unsigned 16 bit	Pressure sensor input in kPa.
12	Error Conditions	Unsigned 16 bit	Logged abnormal software conditions.
13	Duty	Unsigned 8 bit	Drive duty for the fan motor output.

8. Operation in head pressure control mode

The controller provides proportional control of the motor speed with a dead band.

Cooling Mode:

Temperature sensor input	Fan speed
<26 °C	Stopped
26 to 37 °C	Variable speed to maintain a measured temperature of 38 °C or equivalent pressure
>44 °C	Full speed

Heating Mode:

Temperature sensor input	Fan speed
> 15 °C	Stopped
15 to 5 °C	Proportional 30% to 100% with 3 degrees dead band before reducing fan speed for coil increasing in temperature
< 5 °C	Full speed

9. Operation in 0 – 10 V voltage control mode

The motor speed is according to the following table:

Analogue input voltage	Action
< 1.0V	0% (stop)
1.0V to 3.0V	30%
3.0V to 9.0V	30% to 90% (Continuously variable in normal mode, in discrete steps in anti-resonance mode)
> 9.0V	100% (full speed)

10. Operation in 10 – 0 V voltage control mode

The motor speed is according to the following table:

Analogue input voltage	Action
< 1.2V	100% (full speed)
1.2V to 7.1V	30% to 90% (Continuously variable in normal mode, in discrete steps in anti-resonance mode)
7.1V to 9.0V	30%
> 9.0V	0% (stop)

11. Operation in three speed digital control mode

The motor speed is according to the following table:

Digital input	Action	Notes
All off	0%	Stop
Low input active	40%	
Medium input active	60%	
High input active	100%	

If at any time more than one input is active, then the highest fan speed takes priority.

12. Operation in Modbus control mode

To set the fan speed, write the desired speed (0 to 100) as an unsigned integer to the Modbus speed setting register 16.

To modify the contents of the Modbus speed register you must use either Modbus function 6 (write one register) or Modbus function 16 (write N registers) with N=1.

The motor speed is according to the following table:

Modbus speed register setting	Action
0 to 9 increasing speed 0 to 5 decreasing speed	0% (stop)
10 to 30 increasing speed 5 to 30 decreasing speed	30%
30 to 90 increasing speed 30 to 85 decreasing speed	30% to 90% continuously variable in normal mode rounded to nearest discrete step value when anti-resonance mode is enabled
90 to 100 increasing speed 85 t0 100 decreasing speed	100% (full speed)

A degree of hysteresis is used between stopped and constant speed modes and full and variable speed modes to prevent obvious, repeated transitions of speed.

Default serial communications parameters are:

Baud Rate	9600
Number of Data Bits	8
Parity	None
Number of Stop Bits	1
Modbus Address	48-51

Inverter Fundamentals

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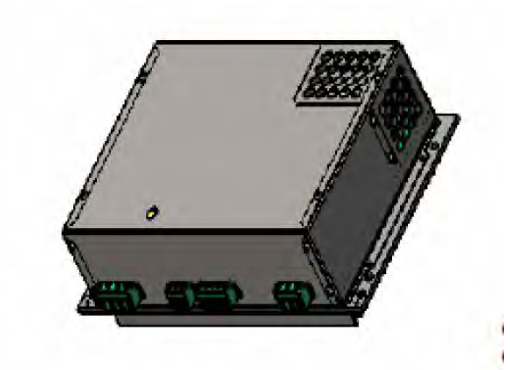
2. Principles and features p. 237
3. Brushless DC motors p. 239

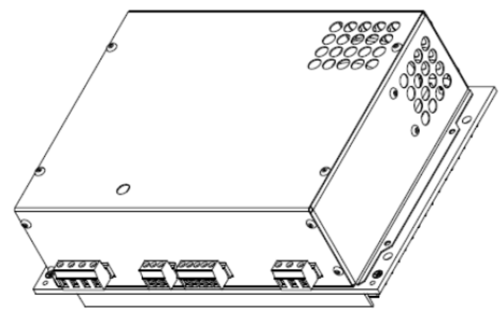
1. What Is an Inverter?

An inverter controls the frequency of power supplied to an AC motor to control the rotation speed of the motor. Sometimes called AC drives, Variable Speed Drive (VSD) or Variable Frequency Drives (VFD). The correct term is frequency converter. They sit between the electrical supply and the motor. Power from the electrical supply goes into the drive. The drive regulates the power which is then fed to the motor.

Without an inverter, a compressor or fan motor would operate at full speed as soon as the power supply was turned ON. Inverter applications allow for speed control of critical equipment in the refrigeration system. Speed control of compressors allows for variable capacity control of an air conditioning system. A fan that is inverter speed controlled can maintain a constant condensing temperature in wide ranges of ambient temperature or maintain static duct pressure on variable air systems. These applications can greatly improve the operating range and therefore power efficiency of HVAC products.

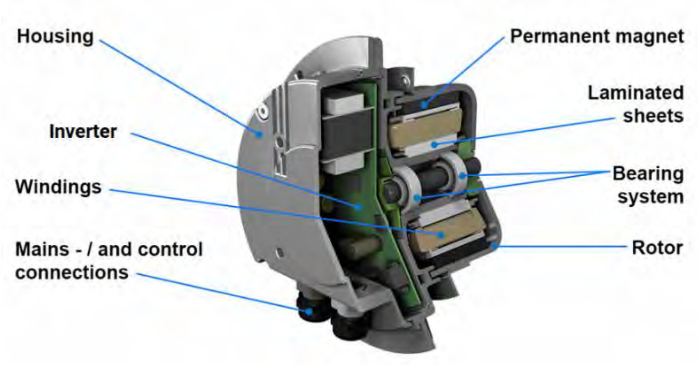
Common inverters used to control temperzone compressors are the Carel Power + :





The common inverter used to control fan speed in temperzone equipment is the ECC driver board:

Plug fans like the axial prop plug fan used on some condensers and backward curve plug fan used on larger evaporators, have inverters built internally to control fan speed. Because of the built in, all as one, inverter, these types of motors are called ‘plug’ motors or ‘plug’ fans due to their ‘plug-and play’ approach.



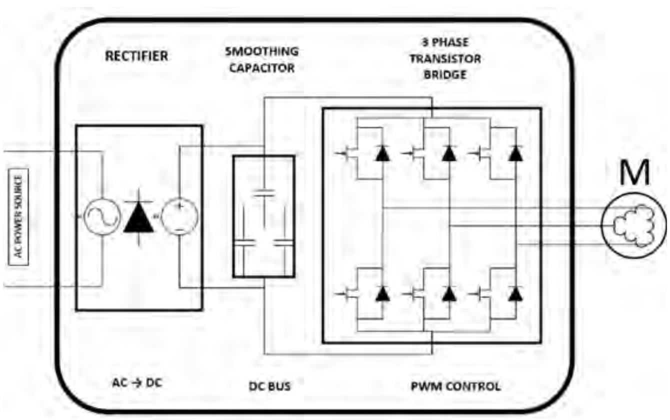
2. Principles and features

Inside the drive, the input power is run through a rectifier that converts the incoming AC power to DC power by interrupting and redirecting the AC wavelength. DC power is then fed to capacitors (DC Bus) inside the drive to smooth out the electrical wave form which provides a clean power supply for the next step. Power then flows from capacitors to a 3 phase transistor bridge (inverter) which changes the DC power to the pseudo-AC output power that goes to the motor. This step allows the drive to adjust the frequency that is supplied to the motor based on the required load.

The primary sections contained within an inverter’s main power circuit are:

1. **A rectifier/converter:**
   The first component when it comes to power flow, the rectifier/converter rectifies incoming AC voltage into DC voltage. The converter section is comprised of diodes, silicon-controlled rectifiers (SCRs), or insulated gate bipolar transistors (IGBTs) connected in a full-wave bridge configuration
2. **DC bus:**
   The second component, which is mostly made up of capacitors that store power rectified by the converter
3. **Inverter:**
   The final primary section of an inverter’s main power circuit. An inverter is made up of IGBTs that create sinusoidal output current using pulsed dc bus voltage, or pulse width modulation (PWM)

   Regardless of whether a power supply is single phase, or three phase Inverters will output a three phase signal and drive a three phase motor.

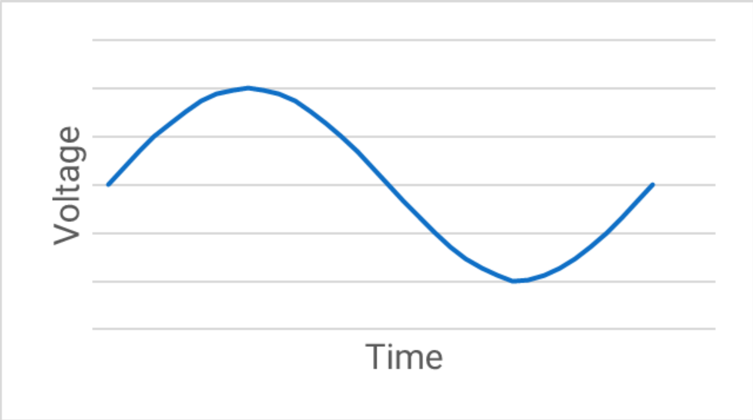


The basic working principle of an inverter is switching the DC on and off so rapidly that the motor receives a pulsating voltage that is similar to AC. The switching rate is controlled to vary the frequency of the simulated AC that is applied to the motor.

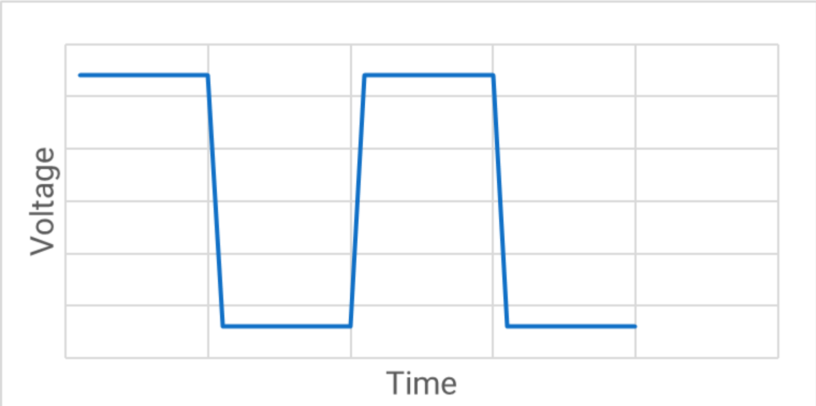
An AC wavelength in Australia or New Zealand peaks and troughs between a nominal +240 Volts and – 240 Volts at a rate of 50 cycles per second (Frequency measured in Hertz, Hz). The wavelength smoothly and evenly travels in between these upper and lower voltage limits in a cycle.

Mains AC Voltage frequency:

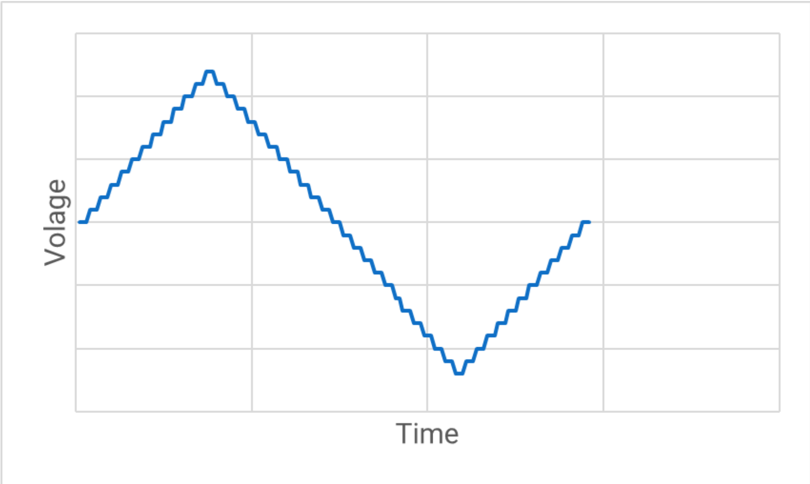
An inverter creates a pseudo-AC wavelength pulsing a DC voltage on and off. The regularity of the on and off DC signal produces the desired frequency. Simple inverted DC voltage frequency can appear very square when graphed. Inverters that utilise pulse width modulation (PWM) are a closer representative of an AC frequency. Although the Power supply consists of DC voltage testing of inverter voltage uses AC power selection on multimeters.



Simple Square Inverted DC Voltage Frequency:



Pulse Width Modulated Inverted DC Voltage Frequency:



3. Brushless DC motors

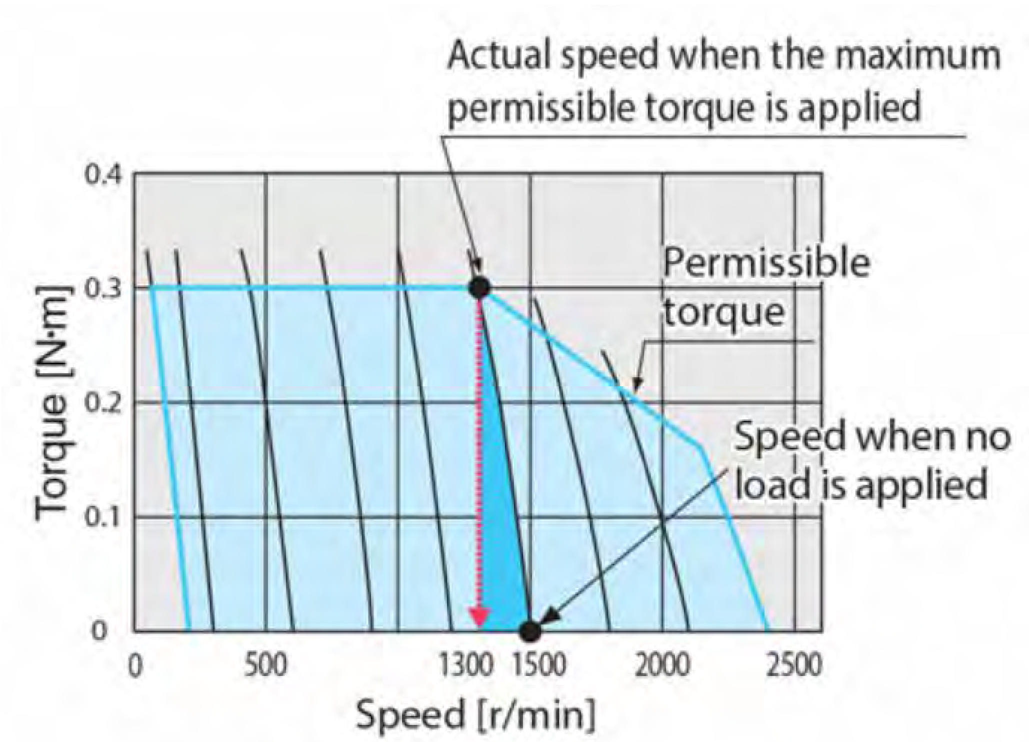
To harness the full capabilities of inverter speed control, temperzone make use of these advantages by pairing inverters with brushless DC motors. A brushless DC electric motor (BLDC motor or BL motor), also known as an electronically commutated motor (ECM or EC motor) or synchronous DC motor, is a synchronous motor using a direct current (DC) electric power supply. The key point of difference between brushless DC motors and traditional induction motors in the rotor. The rotor on an EC motor is constructed of magnetic material typically neodymium. The advantages of a brushless motor over traditional AC brushed motors are high power-to-weight ratio, high speed, nearly instantaneous control of speed (rpm) and torque, high efficiency, and low maintenance. Brushless DC motors have allowed redundancy of rubber belts for direct-drive design.

In a traditional AC induction motor the field of the non-magnetic rotor is induced by the electromagnetic field of the stator (windings). That the rotor is always being ‘drawn or ‘pulled’ trying to catch up. The electromagnetic field produced by the stator using AC power is always going to be a little faster than the rotor’s field. The spin of the rotor creates the torque needed to create mechanical power to compress refrigerant in the compressor or spin a fan to create airflow.

When DC power is sent through the stator (windings) of an EC motor, it creates a temporary electromagnetic field that interacts with the permanent magnetic field of the magnetic rotor. As the polarity of the field is flipping, the rotor keeps rotating. Advantage is taken of the natural poling of magnetic fields between the electromagnet (stator) and the permanent magnet (rotor). As the electromagnet field inverts, the magnetic forces repel the rotor. As the repelling magnetic force weakens, the attracting magnetic force dominates, thus rotation of the rotor continues. This magnetic influence between electromagnet and permanent magnet creates torque at a large variety of speeds due to the magnetic resistance to spin backwards, allowing for greater and more accurate speed control needed to produce mechanical power.

AC Induction motors

Most AC induction motor inverters do not communicate with the motor. The majority of today’s inverters still run open loop. Under the open-loop system, when the load changes, the actual speed does not follow the command. This is why the speed changes slower when more load is added.

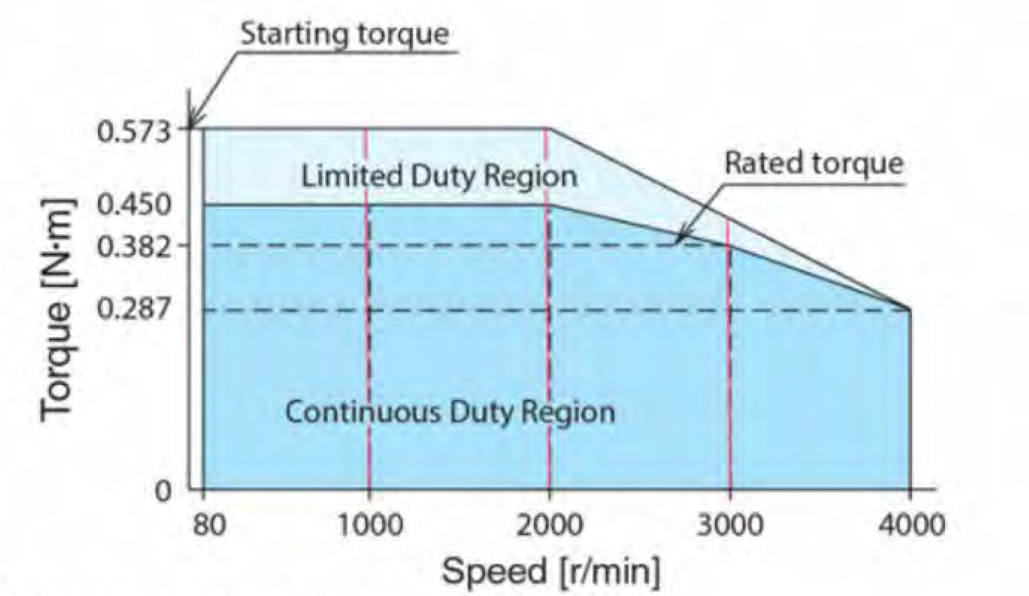


Because torque is lower in an AC motor at high or low speeds from rated speed, which is an inherent torque characteristic of the three-phase motor, it is difficult to obtain both the speed and torque you want at the same time. The inverter is effective when the operation continues at a fixed speed, but it is not ideal for multi-speed operations.

Heat is also a common component to AC induction motors. To combat this a cooling fan is attached to the back of the motor. Due to the AC induction motors design, heat rises when the motor runs slow, and the cooling fan is runs slower. Inversely, when the motor is running at high speed, heat from the windings is also increasing.

Brushless DC motors:

EC the brushless DC motors adopt a PM motor (permanent magnet is used for the rotor) and come standard with closed-loop speed control, where the motors operation status is fed back to the driver. This ensures the motor speed remains constant at the commanded. Additionally, flat torque is produced whether operating at high or low speed. Even if the load changes, at whatever speed is commanded, stable driving speed is ensured. This means that EC motors are highly effective in situations in which the inverter struggles.



Torque is not lost even at low speeds
Even if the load changes, operation speed is kept constant

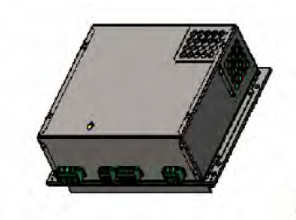
The windings of an electric motor act like a generator as they cut through magnetic field lines. A potential is generated in the windings, measured in Volts, and called an electromotive force (EMF). According to Lenz's law, this EMF gives rise to secondary magnetic field that opposes the original change in magnetic flux driving the motor's rotation. In simpler terms, the EMF resists the motor's natural movement and is referred to as a "back" EMF.

Manufacturers of BLDC motors specify a parameter known as the back EMF constant that can be used to estimate back EMF for a given speed. The potential across a winding can be calculated by subtracting the back EMF value from the supply voltage. Motors are designed such that when they are running at rated speed, the potential difference between the back EMF and supply voltage will cause the motor to draw the rated current and deliver the rated torque.

Because back EMF detracts from the motor's torque, it is sometimes considered a disadvantage, but, in the case of BLDC motors, engineers have turned the phenomenon to their benefit. Internal inverter technology employs EMF calculations to accurately monitor and control speed, frequency, amps voltage and much more without any external sensors!

Inverter and brushless DC motor pairings with either external or internal inverters (plug motors) for accurate speed control can be found throughout the temperzone product line.

Evaporator Fans:



+

Condenser Fans:

Pumps:

Compressors:

+

power+
speed drive
L1 L2 L3
U V W
1 2
3 4 5
6 7 8 9 10
L1 L2 L3

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Carel Power + Inverter

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1. Introduction

The Power+ PSD series inverters are designed and optimised to control compressors in HVAC/R applications driven by sensorless PMIM (Permanent Magnet Interior Mounted) synchronous motors. The Power+ PSD series inverters are not designed for stand-alone operation, but rather connected via **Modbus over RS845 serial line to the UC8 controller.**

The Power+ PSD series drive implements logic capable of identifying refrigerant circuit operating conditions that may be critical or dangerous for the compressor and, consequently, can independently shutdown the compressor, activating an alarm that indicates the reason why the compressor was shut down. The alarm code can be identified on the UC8 LCD 7 segment display. It is important to know that certain alarms indicate thermodynamic conditions that are unfavourable for normal and correct compressor operation. Being able to recognise these is therefore essential in resolving and subsequently prevent such conditions. The aim of this document is not to give information on solving every possible situation, but rather to provide a useful tool for facing the most frequent and easily resolvable problems.

2. Replacement information

When replacing a Carel Power+ in temperzone equipment there are some important steps which need to be observed in order for successful commissioning.

2.1. Addressing

Modbus address must be set via DIP switches within the Carel Power + inverter to allow for communication with the UC8 controller. Remove the cover of the Carel Power + and locate the 4 DIP switches indicated below. All temperzone equipment use the same Modbus address for every Carel Power + inverter. In the table below shaded cells indicate DIP switch position.

DIP Switch	On	Off
1		
2		
3		
4		

2.2. Wiring

Three phase mains supply power is auto corrected in the case of reversal of phases; however, compressor power feed is phase rotation sensitive. Ensure that connections U, V and W are correct.

Ensure that compressor cable screen and communication cable screens are securely grounded.

Check the location and tightness of all cables including the noise filter, if fitted.

! Secure all earth connections and test earth continuity!

2.3. Compressor selection

Under the technical specifications for each compressor there is a chart of "condensing pressure/ temperature - evaporation pressure/temperature"; this represents the area (envelope) in which the compressor can operate, with possible additional limits in discharge temperature and range of compressor speed. The limitations of the compressor envelope are programmed to the Carel Power + when compressor selection is made within special mode 'E' on the UC8 controller. Identify the compressor model of the temperzone equipment and follow the procedure for special mode 'E' in the UC8 user manual.

IMPORTANT: Always ensure the correct compressor model is selected!

If an incorrect selection is made it is likely to cause the unit to malfunction and could lead to permanent damage to the compressor.

The compressor model can be set with the push-button and display, or the corresponding compressor model number can be written to Modbus register 774.

Compressor model	Display	Compressor UC8 instance number
Three-phase inverter compressors for R32 refrigerant, Carel PSD1 inverter		
Copeland YPV030LT-4X9	P3-Y030L	17
Copeland YPV038LT-4X9	P3-Y038L	18
Copeland YPV050ST-4X9	P3-Y050S	19
Copeland YPV0662-4X9	P3-Y0662	20
Copeland YPV0802-4X9	P3-Y0803E	21
Copeland YPV0962-4X9	P3-Y0962E	22
SCI AVB52	P3-AUb52	23
SCI AVB66	P3-AUb66	24
SCI AVB78	P3-AUb78	25
SCI AVB87	P3-AUb87	26
Single-phase inverter compressors for R32 refrigerant, Carel PSD1 inverter		
Panasonic 9RD138XDA21-230V	P1-9rd138	27
Panasonic 9KD240XDA21-230V	P1-9kd240	28
Copeland YPV030LE-3X9	P1-Y030L	29
Copeland YPV038LE-3X9	P1-Y038L	30
SCI SVB130FBBMT	P1-SUb130	32
SCI TVB306FPGMT	P1-tUb306	33
Single-phase inverter compressors for R32 refrigerant, Ruking ED3 inverter		
Copeland YPV030LE-3X9	E1-Y030L	31
Three-phase inverter compressors for R32 refrigerant, Carel PSD2 inverter		
SCI AVB78	P32AUb78F	34
SCI AVB100	P32AUb100	35
SCI BVB110	P32bUb110	36
Copeland YPV096-4X9	P32Y0962E	37
Single-phase inverter compressors for R32 refrigerant, Carel PSD2 inverter		
SCI SVB092	P12SUb092	38

2.4. Inverter cooling

Temperzone equipment utilises one of two methods of inverter cooling to target a 40°C internal inverter temperature.

Air-Cooled

The first method of cooling is by use of aluminium heatsink and cooling fans controlled internally by the Carel Power +.

Refrigerant Cooled

The second method is by use of a cold plate in replacement of the air-cooled heatsink. This method uses liquid refrigerant expanded through an electronic expansion valve to the cool plate acting as an evaporator to cool the inverter.

It is important to identify the method of cooling when replacing the inverter.

If the inverter being replaced is air-cooled no special installation requirements apply

Should the inverter being replaced is cooled using the refrigeration circuit, it is important to liberally apply heat transfer paste to the transfer surface of the inverter and the cool plate. The UC8 controller must also be programmed to operate the electronic expansion valve to the cooling requirements of the inverter. This can be done by selecting operation ‘9’ in special mode ‘n’. Refer to the UC8 operation manual to conduct this operation.

3. Compressor start-up and capacity control

3.1. Start-up

The features of a brushless motor are quite different from those of an asynchronous (On / Off) motor, as the permanent magnet rotor speed corresponds exactly to the power supply frequency delivered by the inverter.

Consequently, during start-up, the inverter must deliver an initial frequency that is near zero and then gradually increased to the required value; the maximum frequency allowed is normally quite higher than would be feasible with standard mains power networks.

The inverter that drives the brushless motor can change the frequency and power delivered to the motor so as to control it according to requirements.

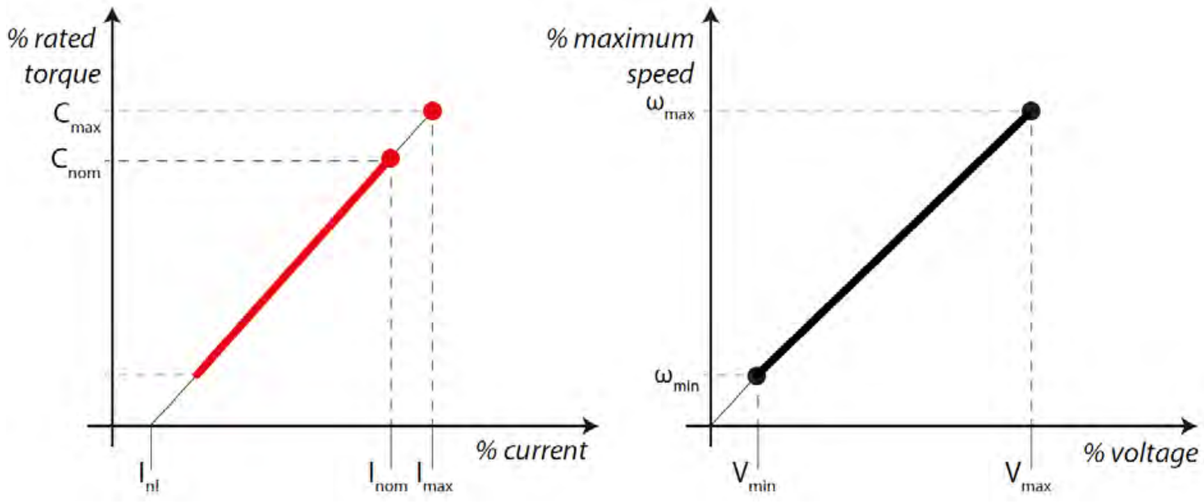
As an initial approximation:

- motor speed is proportional to power supply frequency
- motor torque is proportional to current delivered.

Unlike an asynchronous motor, the current supplied to a brushless motor should never exceed the rated value, to avoid demagnetising the rotor or damaging the semiconductors in the inverter: consequently, the motor torque when starting – proportional to current - will not be able to exceed the rated current, rather it will be slightly lower.

Remembering that at start-up resistance torque is also affected by breakaway friction, the difference between discharge and suction pressure that the motor needs to overcome will be lower than the maximum rated value in steady-state operation.

Typical curves of torque, current, speed and voltage for a brushless motor:



3.2. Capacity control

Capacity at start-up

During the first 3 minutes after starting the capacity is fixed to a predetermined 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. (Load is determined by set point proportional band)
- Modbus RTU serial communications.
- Automatic based on supply air temperature by use of special mode 'y' within the UC8 menu.

4. Fault finding

4.1. Compressor model selection

There may be several causes that prevent a compressor from starting correctly, all of which will display one of multiple faults relayed to the UC8 from the inverter. Before investigating any inverter fault further, identify that the correct compressor program has been selected within the UC8 special menu. Check the compressor model and cross-reference the UC8 display message in the table in section 2.3. This information can also be located in the UC8 user manual. Isolate power to the UC8 controller and watch the display screen upon energizing.
The compressor identification code will be displayed. If it is incorrect follow the process within the UC8 user manual to change compressor model selection in special mode 'E'.

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4.2. Liquid refrigerant on start-up

The presence of liquid refrigerant in the compression chamber that prevents start-up is a much more complex and risky issue. If during start-up the compressor stalls (i.e. fails to start), the CAREL inverter repeats several attempts until, after a certain number of failures, the procedure is interrupted and an error is signalled.

Note that this type of warning does not indicate an inverter malfunction, rather is intended to protect both the compressor and the inverter.

Liquid refrigerant at suction port:

This typically occurs due to migration of refrigerant when the compressor is off, above all when there are significant differences in temperature between the two sides of the circuit. Commonly identified as a F101, F102, F107 and F119 fault.

The following should be checked:

- Sump heater operating correctly.
- Operate sump heater 4 hours prior to commissioning (the sump heating will automatically run for four hours each time the UC8 is powered).
- the expansion valve and its driver are working correctly
- Expansion valve stuck open
- Flooding back to the compressor during transients in more extreme cases

Liquid refrigerant in discharge line

Liquid may cause a sudden increase in pressure in the discharge line if this is narrow and/or partially blocked by valves, or alternatively when the condenser is full of liquefied refrigerant. Common fault codes for this type of malfunction is F101, F102, F107, F119. In cases such as this it is recommended to reset and restart the unit when ambient temperatures are higher.

4.3. Low compression ratio

A lack of compression can cause speed faults in the Carel Power + inverter. This is identified as an F119 fault. This could be caused from a bypassing reversing valve, incorrect wiring between inverter and compressor (phase direction sensitive), or uncommonly a mechanical failure of the compressor.

4.4. High compression ratio

High discharge pressure elevating the compression ratio will trigger a fault on the Carel Power + once the compressor is operating outside of its envelope. F101, F102 and F107 are common faults in this instance. In this instance check:

- Condenser fan operation is correct
- Condenser is clear of debris
- Adequate airflow in heating mode
- Pump down solenoid operating correctly
- EEV stuck closed
- Pipework blockages

4.5. Communication errors

Communication errors triggered by the Carel Power+ are rarely caused by the Power +. In most occasions the cause of the communication faults are caused by incorrect field wiring of the Modbus communication looped daisy chain that the Power + inverter is a part of. Check all cabling and componentry on this circuit as per the control circuit resistance testing guide. Common fault displays for communication errors are F110 and F113.

4.6. Power supply issues

Power supply issues can interrupt the correct operation of the Carel Power +. Loss of phases, drop in voltage, excess voltage and DC BUS ripple are the most frequent of power related issues. Power supply from generators is typically unstable (especially upon generator start) and can cause repetitive faults on inverter equipment. It is not recommended to use generator power supply. Overloaded power grids and new power grids (new housing estates for example) can also be the source of repetitive power related faults. From a local standpoint, all terminations leading to the inverter should be checked for 'hot joints' that may be increasing the resistance to one or more of the incoming phases. Faults that could be expected from power issues include F103, F104, F112, F121, F122, F129.

4.7. Ground fault

If the inverter detects a circuit to earth on the compressor leads, F103 or F125 will be displayed. This does not mean that the compressor is the cause of the detection of an earth current, often the cause is found in deterioration of compressor leads. Check lead condition as well as compressor testing.

4.8. Internal failure of Power +

Internal failures of the electronics inside the Carel Power + are typically:

- Presence of water and / or humidity,
- Induction of electrostatic discharges on components
- High temperature
- Strong vibrations and / or mechanical stress
- over voltages and over currents

In the event of a fault such as F105, or F114, check that the Power + heatsink is free of debris and has clear airflow. If the Power + is refrigerant cooled, check the operation of the EEV used to control refrigerant for the cool plate. Check UC8 user manual for further information.

If the inverter requires replacement check the condition of internal electronics. If signs of corrosion are evident check the level of the compartment containing the Power + (generally the compressor compartment). Ensure that any water that may enter the base drains adequately out of designed drain holes.

5. Power + fault codes

5.1 Class A fault codes

Class A fault codes are considered of highest importance within the two fault tiers (Class A and Class B). Class A faults can be identified on the UC8 7 segment display. Inverter generated Class A faults are identified in the table below:

Code	Fault	Description	Possible Cause	Criticality
F101	Over Current	Measured current to the motor got over the driver design threshold (non-public value). This threshold is managed by UC8 logic on the controller, and it activates usually faster than uSafety alarm 103 (uSafety alarm is an F129 fault) (The parameters of alarm 103 are set for motor protection, according to the UC8 compressor selection). The activation threshold is lower than the threshold for error 7	- Liquid refrigerant in compressor start-up - High compression ratio - High head pressure - Incorrect compressor selection - Electrical 'hot joint' - Compressor deterioration	Resettable
F102	Motor Overload	This alarm is only enabled if the driver is used in "motor control Volt Hertz" mode. The current delivered by the inverter has continuously exceeded 150% of the rated motor current for 1 minute.	- Liquid refrigerant in compressor start-up - High compression ratio - High head pressure - Incorrect compressor selection - Electrical 'hot joint' - Compressor deterioration	Resettable
F103	Over Voltage	Instant DC bus voltage measured over threshold. For single-phase, the thresholds are adjusted automatically based on whether the PFC is on or off.	- High over voltage peaks on the power supply - excessive deceleration - High head pressure	Resettable
F104	Under Voltage	DC bus voltage measured below threshold.	- power supply voltage too low - three-phase case only: driver fault (damaged diode bridge). Check the current on the three phases to exclude damage to the inverter's diode bridge	Resettable

F105	Drive Over Temperature	The value read by at least one of the 3 inverter temperature probes (board, inverter, PFC diode bridge or PFC coil temperature) is instantly above the threshold.	- Blockage in the air-cooling system (debris) - Cooling fans for air cooled driver not operating - EEV for cooling plate not operating correctly. (See UC8 user manual).	Serious
F106	Drive Under Temperature	The value read by at least one of the 3 inverter temperature probes (board, inverter, PFC diode bridge or PFC coil temperature) is instantly below the threshold.	- Environment unsuitable - Check ambient temperature	Resettable
F107	HW Over Current	Designed for virtually instantaneous activation. Measured current to the motor got over the driver design threshold. This threshold is controlled by the UC8 compressor selection. The threshold for this HW alarm is higher than the one of alarm F101 and the response is faster than the one used on uSafety alarm 103 (used as motor protection) (uSafety alarm is an F129 fault)	- Liquid refrigerant in compressor start-up - High compression ratio - High head pressure - Incorrect compressor selection - Electrical 'hot joint' - Compressor deterioration	Serious
F110	CPU Error	Control memory corruption	- Incorrect interconnecting or thermostat wiring - damaged Modbus communication wiring (Refer to Communication resistance testing manual) -Incorrect driver DIP switch address set - Driver failure	Restorable
F111	Default Program	Confirmation that the default parameters have been written	Incorrect UC8 compressor selection. Refer to UC8 user manual	Restorable

F112	DC bus Ripple	DCbus voltage is not constant. The main reasons may be: 1) unbalanced three-phase input voltages (not equal in magnitude and phase). 2) aging of the DC bus capacitors 3) Triggering of oscillations in DCbus voltages	- Loss of one power supply phase, or asymmetrical triad. Check/ monitor the inverter power supply quality (especially power supply asymmetry for three-phase). - Inverter lifetime limit exceeded. - Driver electronics damaged. Check the current of the three phases to exclude damage to the inverter's diode bridge - DC choke inductance saturation due to excessive current draw with consequent increase in ripple. Check presence and size of DC choke	Serious
F113	Data Communication Fault	Communication failure between controller and driver. This alarm can only be generated after a successful communication between the main controller and the driver has been at least once established	- Incorrect interconnecting or thermostat wiring - damaged Modbus communication wiring (Refer to Communication resistance testing manual) -Incorrect driver DIP switch address set - Driver failure	Restorable
F114	Drive Internal Temperature Probe Fault	The value read by at least one of the 3 driver temperature probes (board, inverter, PFC diode bridge or PFC coil temperature) is outside of the range of measurement.	Irreparable damage to the internal circuit	Replace
F117	Motor Phase Fault	Motor cable not connected (at least one of the three phases)	Check compressor motor cabling	Restorable

F119	Speed Fault	The driver cannot properly move the rotor at the required speed. This is probably due to the fact that the rotor is blocked or at very low speed, with the consequent effect that the inverter saturates the torque/ current, thus no longer controlling the speed.	- Liquid refrigerant in compressor start-up - High compression ratio - High head pressure - Incorrect compressor selection - Electrical 'hot joint' - Internal bypassing of reversing valve - Compressor deterioration	Serious
F120	PFC Module Error	The PFC controller has detected a problem. - PFC over current - PFC power module over temperature - DC bus voltage error - PFC controller failure (electronics damaged)	-Check the conditions of the heat dissipation devices (heat sink, fans) to exclude overheating - Blockage in the air-cooling system (debris) - Cooling fans for air cooled driver not operating - EEV for cooling plate not operating correctly. (See UC8 user manual).	Serious
F121	Power Supply Over Voltage	Single-phase only with active PFC, the measured power supply voltage has exceeded the limit threshold	• check/monitor inverter power supply quality (Example: check that any inductive loads on the power line do not generate over voltage)	Resettable
F122	Power Supply Under Voltage	Single-phase only with active PFC, the measured power supply voltage is lower than the limit threshold	Check/monitor inverter power supply quality (Including cables), to exclude excessive voltage drops during operation	Resettable
F125	Ground Fault	Designed for almost instantaneous activation. The measured DCbus high voltage branch current got beyond the inverter design threshold.	- Excessive DC bus current -Short circuit between 2 motor phases - Internal driver fault check the condition of the compressor power supply cables - Damage to the insulation of the compressor windings	Serious
F126	CPU Synchronisation Error 1	Electronics damaged	- Driver electronics damaged	Replace

F127	CPU Synchronisation Error 2	Electronics damaged	- Driver electronics damaged	Replace
F128	Driver Overload	This can only occur if the driver is used in “motor control Volt-Hertz” mode	The current delivered by the inverter has continuously exceeded 150% of the rated motor current for 1 minute. - Liquid refrigerant in compressor start-up - High compression ratio - High head pressure - Incorrect compressor selection - Electrical ‘hot joint’ - Compressor deterioration	Serious
F129	Safety intervention	Activation of a uSafety Alarm	check uSafety alarm table. NOTE: the resetting the class A alarm 29 is dependent on the resetting of the class B alarms	

5.2 Class B fault codes (F129)

In the PSD2 there are two microprocessors:

The first for motor control (defined as Class A)

The second dedicated to safety (class B).

The safety microprocessor is designed for alarm control only and can intervene (after configuration) as a safety device to protect the compressor against Locked rotor or overload events (with motor protection action). The safety microprocessor exposes 25 more alarms than the PSD generation. These alarms, defined as “class B”, can be redundant when compared to the alarms “Class A” available in the motor microprocessor. The alarms class B are managed via a dedicated Modbus address (see table below) and can be viewed by using the WSU (Wi-Fi service utility tool). See WSU user manual for configuration. When a Class B fault is activated the UC8 fault display will be F129.

Code	Fault	Description	Possible Cause	Criticality
101	U, V, W currents measurement fault	Only when the compressor has stopped, the motor current sensor measures values (instantaneous) above the minimum limit (which is indicatively below 10%)	Current measurement chain damaged (sensors, op amps, shunts, ..)	Replace
102	Unbalanced U, V, W currents	Only when the compressor is on, the three motor currents must be equal in terms of RMS, otherwise the alarm is activated.	-Indicates a small earth fault on the motor -The current measurement chain (sensors, op amps, shunts, ..) is damaged - Excessive DC bus current -Short circuit between 2 motor phases - Internal driver fault check the condition of the compressor power supply cables - Damage to the insulation of the compressor windings	Serious

103	Over current or ground fault	The alarm indicates either over current or a ground fault. There are 3 situations in which this alarm is activated: - Class B over current (parameter settings based on the type of compressor if PEC protection is enabled), it does not activate instantaneously as it is based on the thermal inertia of the compressor (equivalent to a thermal cut-out therefore with a motor protection function) - Ground fault. Refer to class A alarm number F125 - HW over current: refer to class A alarm number F107. In terms of response speed, this uSafety alarm 103 is on average faster than the corresponding class A alarms F107 and F125, which means that in the case of situations managed by alarm F107 or F125, the uSafety alarm 103 will be activated first or alone.	- Excessive DC bus current -Short circuit between 2 motor phases - Internal driver fault check the condition of the compressor power supply cables - Damage to the insulation of the compressor windings	Serious
104	STO input (Safe Torque Off) open	Activation of external protectors connected to the STO input.	- Check driver control wiring bridges for loose connection	Restorable
105	Internal STO circuit fault	Fault in the internal STO circuit (different from the external circuit), only used for checking/redundancy of the "STO" function.	- irreparable damage to the internal "redundancy" circuit of the STO function - permanent damage	Replace
106	Power supply loss	If the power supply voltage is too high or low for a certain time the alarm is activated. The thresholds differ for single-phase operation with PFC on or off and three-phase.	- Mains power quality - Check external protection devices (three-phase) - Check/monitor inverter power supply quality (Including cables)	Serious
107	Motor driver error	Alarm indicating breakage of the electronic feedback that confirms when the inverter buffers switch off. Without this feedback, the compressor can no longer be powered	- Driver electronics damaged - Permanent damage	Replace

109	Data communication fault	Refer to class A alarm F113. Redundancy with respect to class A (with different thresholds)	- Incorrect interconnecting or thermostat wiring - damaged Modbus communication wiring (Refer to Communication resistance testing manual) -Incorrect driver DIP switch address set - Driver failure	Restorable
110	Motor stall	Compressor safety alarm (therefore calibrated by the compressor safety parameters that characterise an inverter as a PEC). Indicates that the rotor, despite being powered, is completely blocked. Similar to the corresponding class A alarm (alarm F119)	- Liquid refrigerant in compressor start-up - High compression ratio - High head pressure - Incorrect compressor selection - Electrical ‘hot joint’ - Internal bypassing of reversing valve - Compressor deterioration	Serious
111	DCbus over current	If the maximum DCbus output current threshold is exceeded for a certain time, an alarm is activated	- Excessive current drawn by DCbus (internal load (motor), or by external/auxiliary device (e.g. fans connected to the auxiliary DCbus socket, if present) - Check current drawn by the connected loads	Serious
112	DCbus current Measurement error	Alarm occurs only with the compressor running. If the DCbus output current remains below the minimum threshold for a certain time, an alarm is activated	- DCbus current measurement chain damaged (sensors, op amps, ..) - Permanent damage	Replace
113	DCbus voltage	Refer to class A alarm F103 and F104. It combines class A numbers F103 and F104. Redundancy with respect to class A (With different thresholds). VALID ONLY WITH COMPRESSOR ON.	- High over voltage peaks on the power supply - excessive deceleration - High head pressure - power supply voltage too low - three-phase case only: driver fault (damaged diode bridge). - Check the current on the three phases to exclude damage to the inverter’s diode bridge	Resettable

114	DCbus voltage measurement error	Refer to class A alarm F103 and F104. it combines class A numbers F103 and F104. Redundancy with respect to class A (with different thresholds). VALID ONLY WITH COMPRESSOR OFF.	- High over voltage peaks on the power supply - excessive deceleration - High head pressure - power supply voltage too low - three-phase case only: driver fault (damaged diode bridge). - Check the current on the three phases to exclude damage to the inverter's diode bridge	Serious
115	Power supply under-voltage	If the power supply voltage is too high or low for a certain time the alarm is activated. The thresholds differ for single-phase operation with PFC on or off and three-phase.	- Mains power quality - Check external protection devices (three-phase) - Check/monitor inverter power supply quality (Including cables)	Serious
116	Power supply voltage measurement error	This corresponds to alarm Class B 115, with higher thresholds in terms of power supply. Indicates a large deviation from the standard power supply voltage	- Input voltage measurement chain damaged (sensors, op amps, voltage dividers, ..) - Permanent damage	Replace
201	DCbus overload	The DC bus power (product of DC current and DC voltage) is higher than a threshold for a fixed time (order of seconds)	- Excessive external load (e.g., fans) connected to the DCbus - Check external loads connected to the DCbus terminal: especially when the external load starts	Serious
202	DCbus load measurement error	it is used to compare output power (motor) and input power (DC bus). If the power values diverge, an alarm is activated. This is measured over a fixed monitoring time in the order of seconds	- Excessive external load (e.g., fans) connected to the DCbus - Check external loads connected to the DCbus terminal: especially when the external load starts	Serious
203	Drive Over temperature	The value read by at least one of the 3 driver temperature probes (board, inverter, PFC diode bridge or PFC coil temperature) is instantly above the threshold Redundancy with respect to class A (with different thresholds)	- Blockage in the air-cooling system (debris) - Cooling fans for air cooled driver not operating - EEV for cooling plate not operating correctly. (See UC8 user manual).	Serious

204	Drive Under temperature	The value read by at least one of the 3 driver temperature probes (board, inverter, PFC diode bridge or PFC coil temperature) is instantly below the threshold (confidential). Redundancy with respect to class A (with different thresholds)	- Environment unsuitable - Check ambient temperature	Resettable
205	Internal temperature sensor fault	The value read by at least one of the 3 driver temperature probes (board, inverter, PFC diode bridge or PFC coil temperature) is outside of the range of measurement. Redundancy with respect to class A (with different thresholds)	Irreparable damage to the internal circuit	Replace
206	CPU synchronisation error	Alarm that signals breakage of the ADC (Analogue Digital Converter) in the safety circuit	- Driver electronics damaged	Replace
207	Invalid safety data	uSafety parameters entered with ranges not supported by the inverter. This is symptomatic of an incorrect driver-compressor combination (which sets the uSafety parameters that characterise the inverter as a PEC)	- Check UC8 compressor selection special mode 'E' (refer to UC8 user manual)	Restorable
209	HW control circuit error	Fault detected in the PWM signals (to generate output voltages) or in the reference voltage of the micro-safety controller	- Driver electronics damaged	Replace

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R32

Using RCD’s with Inverter Equipment

+ Residual Current Device Exemption

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2. RCD exemption p. 263

1. Types of RCD protection

Inverter earth leakage can be the cause of nuisance tripping of RCD (residual current device) protected circuits if an inappropriate RCD or RCBO (Residual current operated Circuit Breaker with Over-current protection) is selected for use. Type A and AC devices trip within 30mA of earth leakage, earth leakage from inverters can reach levels up to and exceeding 300mA. It is for this reason and the type of wavelength of the load that correct selection of protection device is necessary.

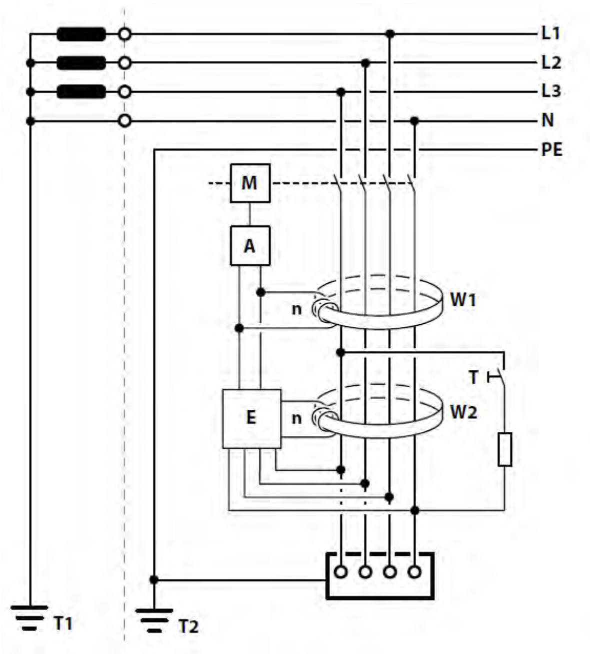
As residual current devices differ in their ability to detect different waveforms, the input circuit of the load must be taken into account when selecting the device. If earth current is not sinusoidal but rather direct, operation of the RCD is altered and therefore it may not trip.

The following types of circuit breakers can be identified based on the waveform they can detect:

- AC: AC current only.
- A: for AC current and/or pulsating DC residual current.
- F: for leakage current with mixed frequencies not detectable by type AC and A devices.
- B, B+: for AC current and/or pulsating DC residual current and DC fault current.

In accordance with current regulations, if the electronic equipment uses any type of inverter, only type B and B+ RCDs can be used, and in some cases type F (only for single-phase). Temperzone recommend selection of type B devices for protection of inverter operated equipment. Type B RCDs are electronic devices equipped with two ferromagnetic cores in series: one is designed for detection of AC and pulsating currents, the other DC currents. All live conductors (phases and neutral) pass through both cores.

The detection circuit on a type B, B+ device is shown in the following figure:



A	Trip relay
M	Protective device mechanisms
E	Trip circuit for DC residual current
T	Test button
n	Secondary winding
W1	Transformer to detect sinusoidal fault current
W2	Transformer to detect DC fault current

The first core operates in electromechanical mode in the same way as a type A or AC RCD: residual current at mains frequency generates a voltage across the secondary winding by electromagnetic induction, which, if reaching a certain threshold, causes a magnetic actuator to trip and activate the contact opening mechanism.

2. RCD exemption

Temperzone's Inverter units use a 3rd-party Variable Speed Drive (VSD) to control the speed and therefore the refrigerant pumping capacity of the compressor.

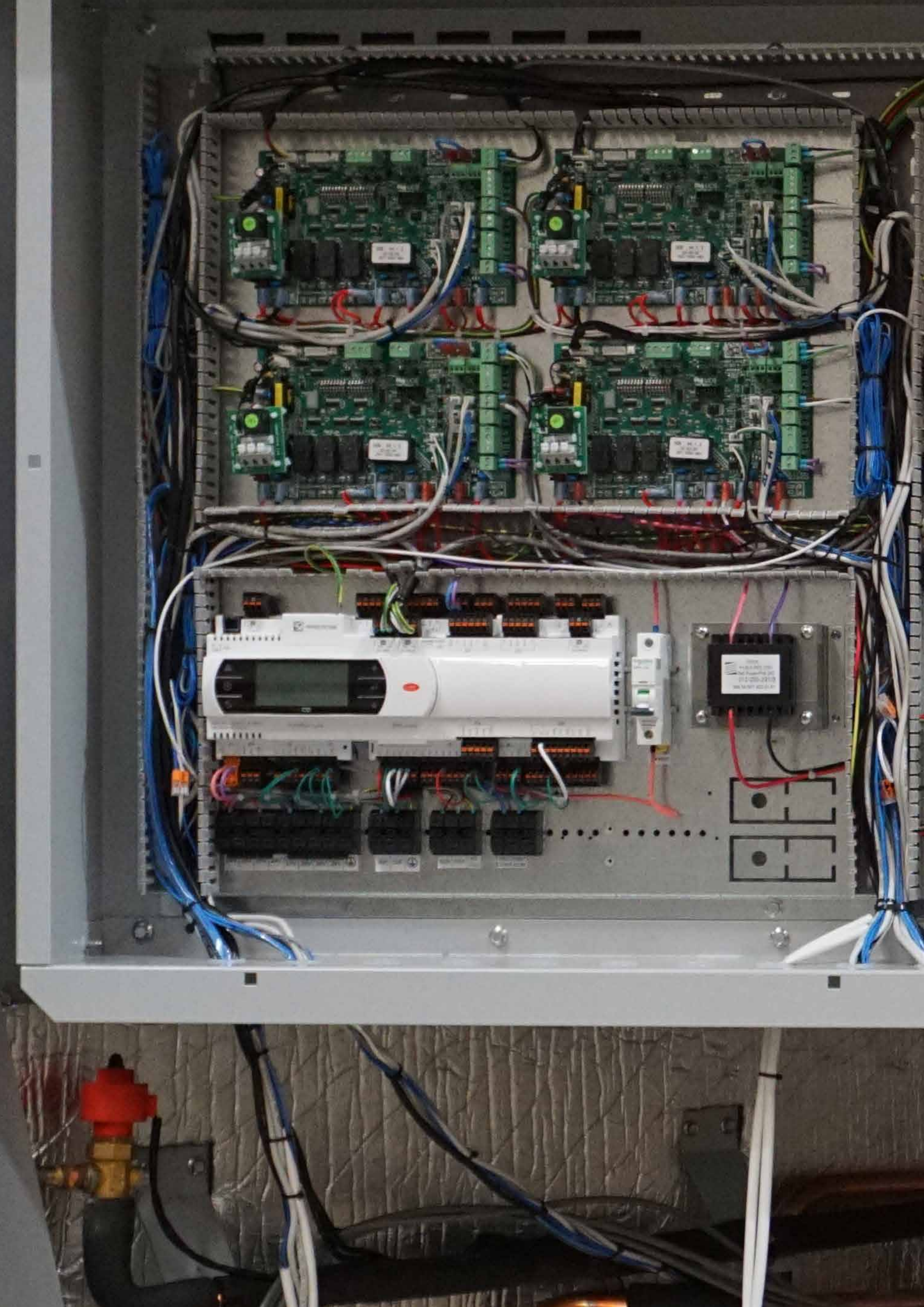
The use of VSDs is recognised as a special case in the Australia / New Zealand Wiring Rules AS/NZS 3000:2018. It is accepted that "in the normal operation of the equipment (e.g. VSDs)", spurious nuisance tripping through high leakage current can occur (up to 300mA in some cases)

(Refer to section 2.6.3.2.3.3 and the "Exceptions" section of it. Exception 3 and specifically point "(ii)" of it refer to this issue.)

Temperzone Air Conditioner construction leaves no end-user accessible live terminals exposed through ventilated panels. Each one is a closed, "earth-connected" metal box. Accordingly, it "is not likely to present a significant risk of electric shock". (This statement refers to the wording used in the heading for Exception 3.)

Therefore, the preceding requirements in AS/NZS 3000:2018 in respect of using a 30mA RCD to provide "additional protection" to the sub-circuit to which the Air Conditioner is connected, do not have to apply. This gives the Electrician connecting our unit to the Mains LV supply, the right to either:

1. Use a Type B RCD with a higher trip current limit, e.g., 100mA or 300mA.
2. Not use an RCD at all PROVIDING THAT the sub-circuit to the Air Conditioner is labelled (we would suggest both at the Distribution Board AND at the Isolating Switch adjacent to the unit) stating that RCD protection is not provided. (See the last statement in section 2.6.3.2.3.3 Exception 3 of AS/NZS 3000:2018)



EMI Filter Board

Fundamentals

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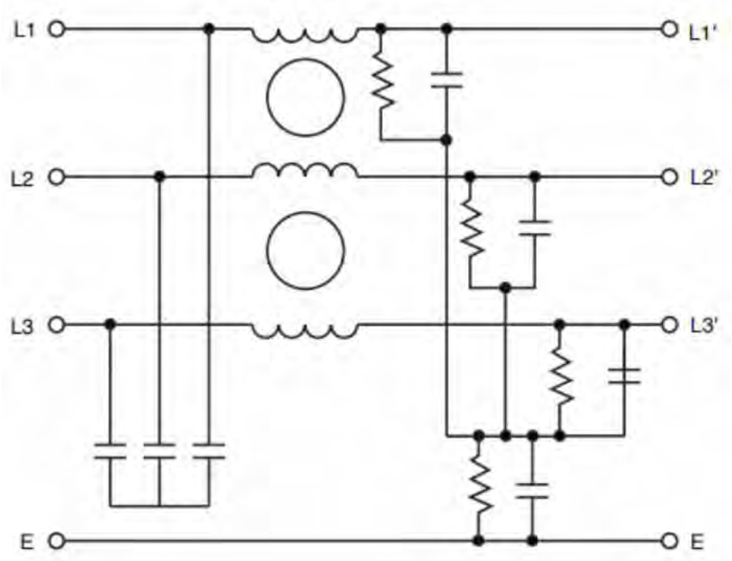
2. Three phase EMI board p. 267
3. RS-485 EMI filter board p. 267
4. Troubleshooting p. 267

1. Introduction

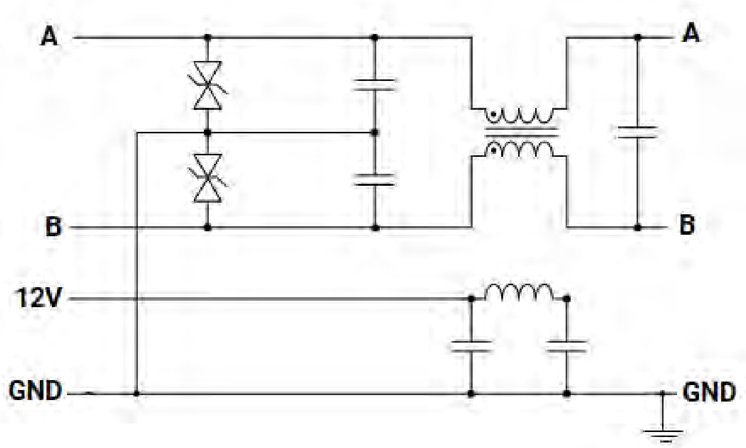
Most electronics contains an EMI filter, either as a separate device, or embedded in circuit boards. Temperzone use two different EMI filters in some models of the R32 product range. Their function is to reduce high frequency electronic noise that may cause interference with other devices. Regulatory standards exist in most countries that limit the amount of noise that can emitted.

EMI, or Electro-Magnetic Interference, is defined as unwanted electrical signals. Componentry that rectifies AC wavelength into DC wavelength are particularly high in EMI. It is for this reason that temperzone use EMI filters where required to reduce noise to incoming power and communications transmissions.

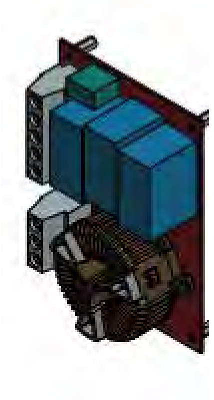
An EMI filter for a power supply normally consists of passive components, including capacitors and inductors. The inductor(s) allow DC or low frequency currents to pass through, while blocking the harmful unwanted high frequency currents. The capacitors provide a low impedance path to divert the high frequency noise away from the input of the filter, either back into the power supply, or into the ground connection.

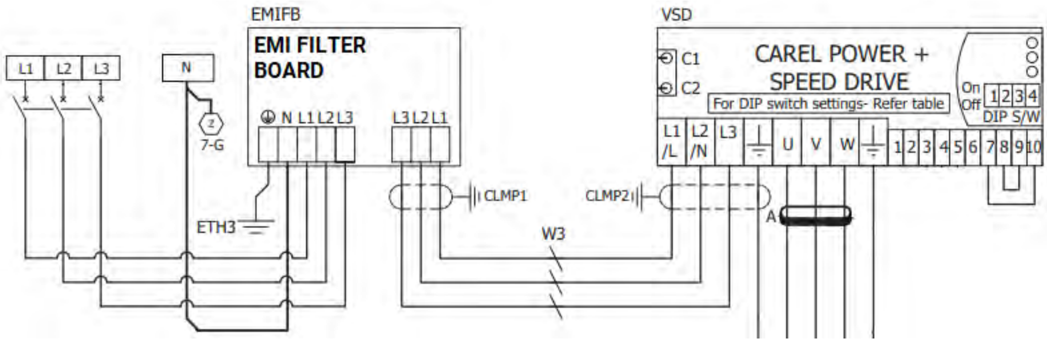


To ensure trouble free communication and correct operation of Modbus communicating components the RS-485 data cable also uses an EMI filter. Much like the three phase filter the RS-485 filter consists of a common motor choke (to impede AC frequencies) and capacitors to help divert high frequencies to ground.

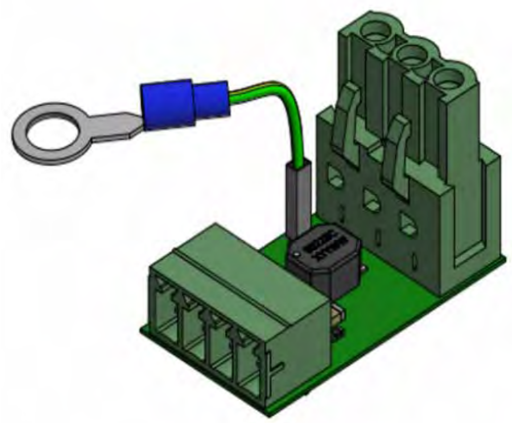


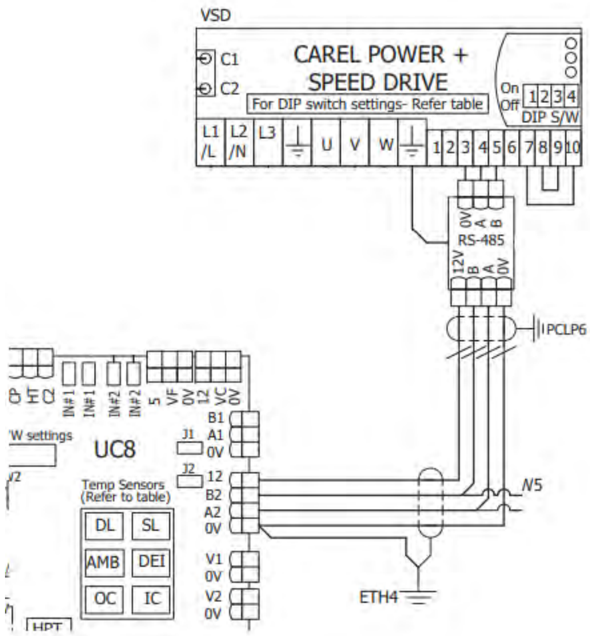
2. Three phase EMI filter board (46Amp)





3. RS-485 EMI filter board





4.Troubleshooting

Each type of filter should offer little in terms of faults, as the components consist of static parts. Testing of the filters should include a continuity test to ensure a complete circuit through the common terminals.


CAREL
E2V
CAREL
E2V

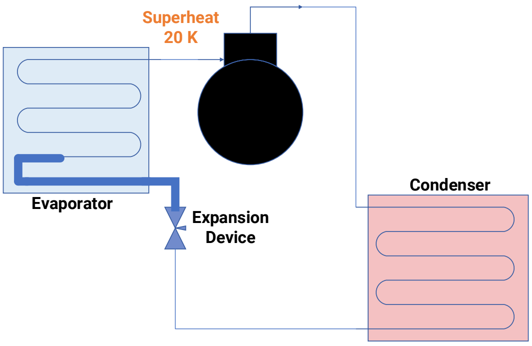
Superheat Management & EEV Control

Contents

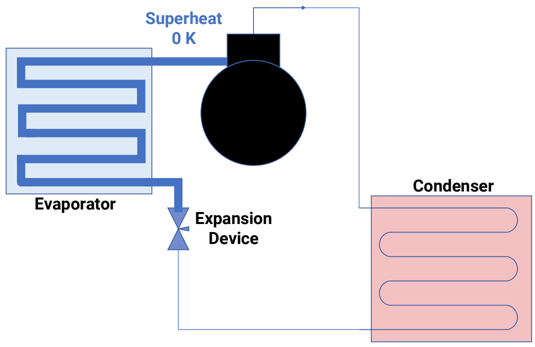
1. Suction superheat p. 270
2. Discharge superheat p. 271
3. UC8 superheat identification p. 272
4. Temperzone superheat control p. 273

1. Suction superheat

The importance of suction superheat is not a new concept to the refrigeration and air-conditioning industry. Suction superheat (temperature difference between the refrigerant gas on the low side and its saturated suction temperature, or evaporating temperature) provides an insight into the efficiency of the evaporator. A system with a large suction superheat indicates that the evaporator is underutilised or 'starving' of refrigerant. A system with a low suction superheat indicates that the evaporator is over utilised or 'flooded' and liquid refrigerant is entering the suction line with the potential to cause damage to the compressor.



Starving Evaporator (High Superheat)



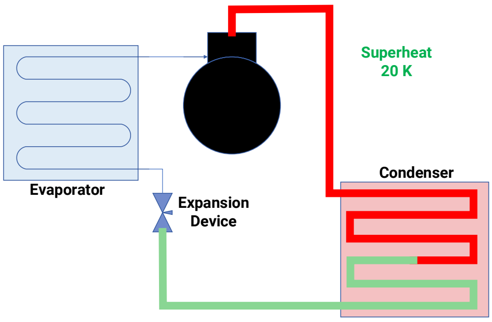
Flooding Evaporator (No Superheat)

Suction superheat not only plays a vital role in establishing the efficiency of the evaporator, but an ideally controlled suction superheat also provides cooling to the compressor motor, as is the case with 'cold shell' compressors such as reciprocating, screw and some scroll compressors. A typical AC induction motor relies on air cooling through the motor frame. As air cooling is not possible on a hermetic compressor motor, cool suction gas is often drawn across windings helping to reduce the size and running amps of the compressor motor. Suction superheat measured at the evaporator is called evaporator superheat, while suction superheat measured at the compressor is referred to as compressor superheat, or total suction superheat.

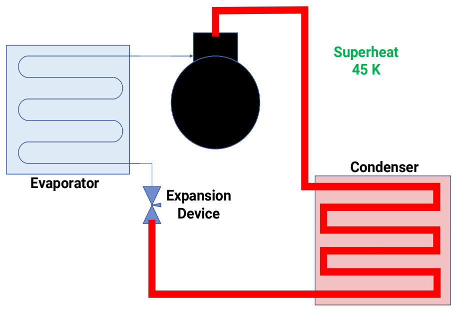
Current ranges of Temperzone equipment offer electronic expansion valves to control the efficiency of the evaporator, older equipment models used piston type accurators and thermostatic (TX) expansion valves. In these instances, suction superheat is to be field set (on split ducted models) either by adjusting gas charge in the case of accurators or adjusting spring pressure in the case of TX valve. To ensure that the compressor remains within safe working parameters on unit models with accurators or TX valves it is recommended a compressor, or total suction superheat of 4K-7K is achieved at set room temperature in the case of accurators and TX valve, built models.

2. Discharge superheat

Commonly overlooked and misunderstood by field technicians is discharge superheat. Measuring the temperature difference between discharge temperature and condensing temperature (saturated discharge temperature) provides the discharge superheat. This value is total heat rejection required to condense discharge gas into liquid refrigerant. Similar in the way that low side superheat describes the efficiency of the evaporator, discharge superheat describes the efficiency of the condenser. A low discharge superheat means that more condenser surface area is available for liquid condensation, enabling condenser fans to operate at lower speeds and providing more surface area to be available in high ambient temperature conditions. A higher discharge superheat means that less surface area is available for liquid condensation which may lead to under condensing.



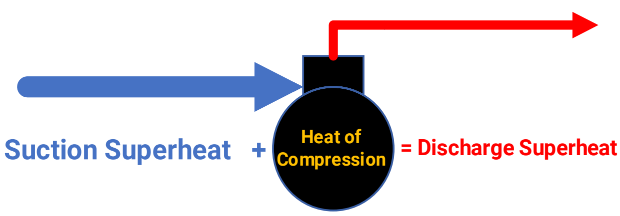
Efficient Condenser
(Acceptable Discharge Superheat)

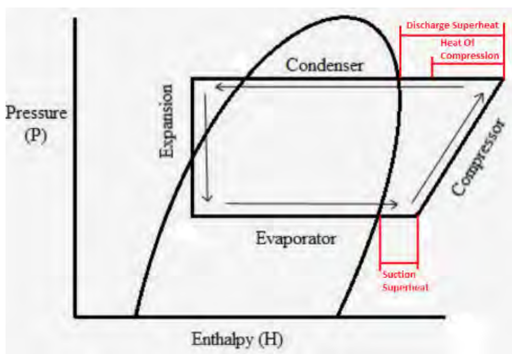


Under condensing
(High Discharge Superheat)

The importance of discharge superheat is because the information contained within is relative to the high side of the system, as well as the low side. Discharge superheat is equal to the total suction superheat + the heat of compression. The heat of compression adds generally anywhere from 15 to 25 degrees depending on an many factors such as type of refrigerant and charge volume, air cooled or water-cooled condenser, condition, and age of heat transfer medium, as well as ambient and operating conditions. Control of discharge superheat (and discharge temperature) is critical in the safe operation of ‘hot shell’ compressors such as rotary compressors and some scroll compressors. The windings in ‘hot shell’ hermetic compressors are located on the discharge side of compression, therefore operating temperatures are critically linked to discharge temperature.

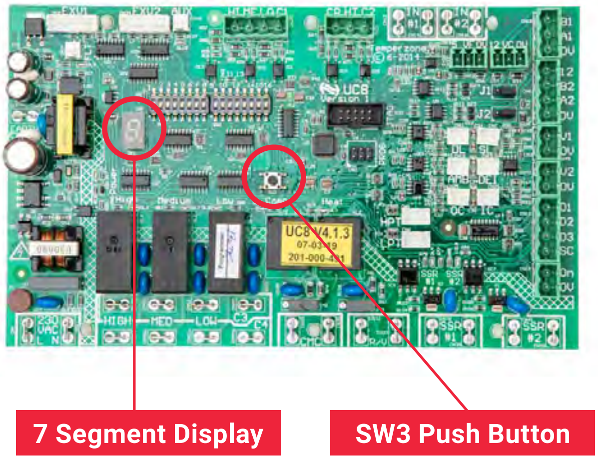
Typical discharge superheat on R410a and R22 Temperzone water cooled equipment is 15K – 20K while R32 is 15K – 25K. Typical discharge superheat on R410a and R22 Temperzone air cooled equipment is 15K – 28K while R32 equipment is 20K – 35K. Discharge superheat below these ranges indicates a system with an over utilised evaporator. In flood back situations the discharge super heat can be as low as zero due to liquid evaporation (latent heat) in the compressor absorbing the heat of compression. Discharge superheats above these common ranges can sometimes indicate a pipework blockage however it will more than likely be cause by a system starved of refrigerant causing an increased suction superheat.





3. UC8 superheat Identification

With the introduction of the UC8 controller, Temperzone has placed the determining factors of superheat identification at the fingertips of every technician. By tapping the SW3 push button, the 7-segment display on the UC8 will display unit data captured by sensors and pressure transducers. Tapping SW3 consecutively will scroll through a list of data described in the table below. The number that proceeds the display code is the value represented for this data point.



Note - Evaporating Temperature and Condensing Temperature are not a sensor measurement, but a low side and high side saturated temperature.

Note – Suction Line Temperature is measured in the compressor compartment. On some split ducted units Suction Superheat is calculated from the suction sensor reading and the indoor coil sensor reading at the indoor unit controller. These sensors are not displayed on the UC8. This may make the Suction Superheat measurement appear to be incorrect if comparing UC8 LCD display against WSU superheat calculations.

Note – EEV 1 and 2 percentages are relative only to EEV's controlled from the UC8 controller
Some larger models of split ducted units' control EEV's from an indoor unit controller.

Display Code	Description	Unit Of Measurement
SLP	Suction Line Pressure	kPa
Et	Evaporating Temperature	Saturated Suction Temperature
SLt	Suction Line Temperature	Degrees
SSH	Suction Superheat	Degrees Kelvin
dLP	Discharge Line Pressure	kPa
Ct	Condensing Temperature	Saturated Discharge Temperature
dLt	Discharge Line Temperature	Degrees C
dSH	Discharge Superheat	Degrees Kelvin
ICEt	Deice Sensor Temperature	Degrees C
CAP	Compressor Capacity	%
EE1	Expansion Valve 1	%
EE2	Expansion Valve 2	%
Add	Modbus Address	0-64 (number)

4. Temperzone superheat control

Traditional theory when using variable flow expansion devices takes advantage of suction superheat parameters to determine evaporator efficiency and compressor safety. With the modern UC8 control providing real time low tolerance data on pressure and temperature along with the advent of electronic expansion valves that allow fast and accurate modulation of refrigerant flow, temperzone has become capable of developing much more scientific method of superheat control that allows for a system to become more versatile as operating conditions inside the space and outside are constantly changing.

Combined superheat control allows the UC8 controller to consider the suction superheat as well as the discharge superheat before opening or closing the electronic expansion valve to operate the system at peak performance. Combined super heat calculation is not as simple as adding suction superheat and discharge superheat together, a complicated engineering formula provides this answer. The combined super heat cannot be read on the UC8 display menu but can be seen on the Wi-Fi Service Utility tool (WSU) seen to the right.

The table below highlights that the optimum combined superheat is 9.0 in a **cooling** on **R410a** equipment. Combined superheat below 9 will encourage the expansion valve to close, combined superheat above 9 will encourage the expansion valve to open. The target combined superheat for **R32** equipment is **13K**.

DSH	SSH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0		0.0	0.5	1.1	1.7	2.3	3.0	3.7	4.5	5.3	6.1	7.0	7.9	8.9	9.9	10.9	12.0
2		0.2	0.8	1.4	2.0	2.7	3.4	4.1	4.9	5.7	6.6	7.5	8.5	9.5	10.5	11.6	12.7
4		0.4	1.0	1.7	2.3	3.0	3.8	4.6	5.4	6.2	7.1	8.1	9.1	10.1	11.2	12.3	13.4
6		0.7	1.3	2.0	2.7	3.4	4.2	5.0	5.9	6.8	7.7	8.7	9.7	10.7	11.8	13.0	14.1
8		1.0	1.6	2.3	3.1	3.8	4.6	5.5	6.4	7.3	8.3	9.3	10.3	11.4	12.5	13.7	14.9
10		1.3	2.0	2.7	3.5	4.3	5.1	6.0	6.9	7.9	8.9	9.9	11.0	12.1	13.3	14.5	15.7
12		1.6	2.3	3.1	3.9	4.7	5.6	6.5	7.5	8.4	9.5	10.6	11.7	12.8	14.0	15.2	16.5
14		2.0	2.7	3.5	4.3	5.2	6.1	7.1	8.0	9.1	10.1	11.2	12.4	13.6	14.8	16.0	17.3
16		2.4	3.1	4.0	4.8	5.7	6.6	7.6	8.6	9.7	10.8	11.9	13.1	14.3	15.6	16.9	18.2
18		2.8	3.6	4.4	5.3	6.2	7.2	8.2	9.3	10.4	11.5	12.7	13.9	15.1	16.4	17.7	19.1
20	CSH	3.2	4.0	4.9	5.8	6.8	7.8	8.8	9.9	11.0	12.2	13.4	14.6	15.9	17.2	18.6	20.0
22		3.7	4.5	5.4	6.4	7.4	8.4	9.5	10.6	11.7	12.9	14.2	15.4	16.8	18.1	19.5	20.9
24		4.1	5.0	6.0	7.0	8.0	9.0	10.2	11.3	12.5	13.7	15.0	16.3	17.6	19.0	20.4	21.9
26		4.6	5.6	6.5	7.6	8.6	9.7	10.8	12.0	13.2	14.5	15.8	17.1	18.5	19.9	21.4	22.9
28		5.2	6.1	7.1	8.2	9.3	10.4	11.6	12.8	14.0	15.3	16.6	18.0	19.4	20.9	22.3	23.9
30		5.7	6.7	7.7	8.8	9.9	11.1	12.3	13.5	14.8	16.1	17.5	18.9	20.3	21.8	23.3	24.9
32		6.3	7.3	8.4	9.5	10.6	11.8	13.1	14.3	15.6	17.0	18.4	19.8	21.3	22.8	24.4	26.0
34		6.9	7.9	9.0	10.2	11.4	12.6	13.9	15.2	16.5	17.9	19.3	20.8	22.3	23.8	25.4	27.0
36		7.5	8.6	9.7	10.9	12.1	13.4	14.7	16.0	17.4	18.8	20.2	21.7	23.3	24.9	26.5	28.1
38		8.1	9.3	10.4	11.6	12.9	14.2	15.5	16.9	18.3	19.7	21.2	22.7	24.3	25.9	27.6	29.3
40		8.8	10.0	11.2	12.4	13.7	15.0	16.4	17.8	19.2	20.7	22.2	23.8	25.4	27.0	28.7	30.4

Status	R410a	R32
Flooding	<1.5K	<1.5K
Normal operation	1.5K - 15K	1.5K -20K
Optimum	9K	13K
Valve static	9K	13K
Starving	15K<	20K<
CSH equal to SSH		

The table below is representative of an **R410a** system in **heating** cycle. The target combined superheat for **R410a** equipment in heating is **10K**. The target combined superheat for **R32** equipment in heating is **13K**

DSH	SSH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0		0.0	0.5	1.1	1.7	2.3	3.0	3.7	4.5	5.3	6.1	7.0	7.9	8.9	9.9	10.9	12.0	13.1	14.3	15.5	16.7	18.0
2		0.3	0.9	1.5	2.1	2.8	3.5	4.3	5.1	5.9	6.8	7.7	8.7	9.7	10.7	11.8	12.9	14.1	15.3	16.5	17.8	19.1
4		0.6	1.2	1.9	2.6	3.3	4.0	4.8	5.7	6.6	7.5	8.4	9.4	10.5	11.6	12.7	13.8	15.0	16.3	17.6	18.9	20.2
6		1.0	1.6	2.3	3.0	3.8	4.6	5.4	6.3	7.2	8.2	9.2	10.2	11.3	12.4	13.6	14.8	16.0	17.3	18.6	20.0	21.4
8		1.4	2.1	2.8	3.6	4.4	5.2	6.1	7.0	8.0	9.0	10.0	11.1	12.2	13.4	14.6	15.8	17.1	18.4	19.8	21.2	22.6
10		1.8	2.5	3.3	4.1	4.9	5.8	6.7	7.7	8.7	9.7	10.8	11.9	13.1	14.3	15.5	16.8	18.1	19.5	20.9	22.3	23.8
12		2.2	3.0	3.8	4.6	5.5	6.4	7.4	8.4	9.4	10.5	11.6	12.8	14.0	15.2	16.5	17.8	19.2	20.6	22.0	23.5	25.0
14		2.7	3.5	4.3	5.2	6.1	7.1	8.1	9.1	10.2	11.3	12.5	13.7	14.9	16.2	17.5	18.9	20.3	21.7	23.2	24.7	26.3
16		3.2	4.0	4.9	5.8	6.8	7.8	8.8	9.9	11.0	12.2	13.4	14.6	15.9	17.2	18.6	20.0	21.4	22.9	24.4	26.0	27.6
18		3.7	4.6	5.5	6.4	7.4	8.5	9.6	10.7	11.8	13.0	14.3	15.6	16.9	18.2	19.6	21.1	22.6	24.1	25.6	27.2	28.9
20	CSH	4.2	5.1	6.1	7.1	8.1	9.2	10.3	11.5	12.7	13.9	15.2	16.5	17.9	19.3	20.7	22.2	23.7	25.3	26.9	28.5	30.2
22		4.8	5.7	6.7	7.8	8.8	10.0	11.1	12.3	13.6	14.8	16.2	17.5	18.9	20.4	21.8	23.4	24.9	26.5	28.2	29.8	31.6
24		5.3	6.3	7.4	8.4	9.6	10.7	11.9	13.2	14.4	15.8	17.1	18.5	20.0	21.4	23.0	24.5	26.1	27.8	29.4	31.2	32.9
26		5.9	7.0	8.0	9.2	10.3	11.5	12.8	14.0	15.4	16.7	18.1	19.6	21.0	22.6	24.1	25.7	27.4	29.0	30.8	32.5	34.3
28		6.6	7.6	8.8	9.9	11.1	12.4	13.6	15.0	16.3	17.7	19.2	20.6	22.2	23.7	25.3	27.0	28.6	30.4	32.1	33.9	35.8
30		7.2	8.3	9.5	10.7	11.9	13.2	14.5	15.9	17.3	18.7	20.2	21.7	23.3	24.9	26.5	28.2	29.9	31.7	33.5	35.3	37.2
32		7.9	9.0	10.2	11.5	12.8	14.1	15.4	16.8	18.3	19.8	21.3	22.8	24.4	26.1	27.8	29.5	31.2	33.0	34.9	36.8	38.7
34		8.6	9.8	11.0	12.3	13.6	15.0	16.4	17.8	19.3	20.8	22.4	24.0	25.6	27.3	29.0	30.8	32.6	34.4	36.3	38.2	40.2
36		9.3	10.5	11.8	13.1	14.5	15.9	17.3	18.8	20.3	21.9	23.5	25.1	26.8	28.5	30.3	32.1	33.9	35.8	37.7	39.7	41.7
38		10.0	11.3	12.6	14.0	15.4	16.8	18.3	19.8	21.4	23.0	24.6	26.3	28.0	29.8	31.6	33.4	35.3	37.2	39.2	41.2	43.2
40		10.8	12.1	13.5	14.9	16.3	17.8	19.3	20.9	22.5	24.1	25.8	27.5	29.3	31.1	32.9	34.8	36.7	38.7	40.7	42.7	44.8

Status	R410a	R32
Flooding	<1.5K	<1.5K
Normal operation	1.5K - 15K	1.5K -20K
Optimum	10K	13K
Valve static	10K	13K
Starving	15K<	20K<
CSH equal to SSH		

The advantage of this type of control method ensures that the evaporator coil is optimised. If evaporator air on condition is unexpectedly high or low, the valve becomes required to open to meet a combined superheat of ~10K (R410a). Increased performance in high ambient conditions is created by lowering of suction temperature and lowering of head pressure by opening the valve position to meet the combined superheat target as discharge superheat increases. The prejudice within the superheat calculation to weight values of extreme suction or discharge superheats less the farther they travel from optimum allows for safe operation even if sensors are incorrectly calibrated. The most modern compressors in Temperzone equipment are designed to accept a small amount of flash gas which can be used to decrease discharge temperature that has elevated to unsafe levels for compressor operation. Combined superheat control is maximising the efficiency of all Temperzone UC8 controlled equipment.

Scan QR code for Electronic Expansion Valve Video Tutorial

Carel Electronic Expansion Valve

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1. Introduction

Carel electronic expansion valves are designed for installation in refrigerant circuits as the refrigerant expansion device, using the combined superheat calculated within the UC8 controller. Carel EEV's can be found on all ranges of temperzone air-cooled and water-cooled air-conditioning products. They can be used as main evaporator expansion devices as well as for expansion devices for cool plates to cool inverters. On package units (water and air) and small to mid-range split ducted units the EEV is electrically connected to the UC8 control board. Larger range split ducted units will have EEV's electrically connected to the UC8 controller and the IUC controller.

Although the Carel EEV's appear similar to a typical solenoid valve, operation of the spindle does not operate in a piston motion like that of a solenoid valve. The Carel EEV will open and close through a screw type of operation in where the electromagnet draw of the motor (coil) will open or close the valve in a winding or unwinding motion. Clockwise to open, anti-clockwise to close.

2. Welding and handling

The E2V-Z valves must be joined to the circuit by braze welding the copper fittings to the condenser outlet (IN) and evaporator inlet (OUT) pipes. Proceed as indicated in Fig. 2:

1. Take the body of the valve from the packaging.
2. Insert the pipes in the female valve fittings, being careful not to go beyond the specific restrictions present in the joints of the valve. Weld by aiming the flame at the ends of the fittings (for better braze welding without affecting the seal of the welded area between the body and the fittings, use alloys with a fusion temperature less than 650 °C or with a silver content above 25%);
3. Take the cartridge.
4. Make sure that the plunger and 'o' ring are present and positioned in their site (Fig. 2-B) (if applicable).
5. Make sure that the metal mesh filter is inserted on the brass bushing (Fig.2-B). Otherwise, position it as shown in the figure and make sure it's properly in place.
6. It is necessary to lubricate with oil (any of those normally used in refrigerant circuits) the outer surface of the cartridge 'o' ring (Fig. 2-B) (if applicable)
7. Insert the cartridge inside the braided body, taking care not to force it during insertion (Fig 2-C).
8. Proceed to manually screw the brass nut until it reaches its limit (Fig. 2-D).
9. Tighten the nut on the valve body with a 24-inch fork wrench with a tightening torque of 45Nm (Fig. 2-E). It is possible to change the valve size only by replacing the existing cartridge with a different size (without changing the valve body).
10. Insert the red stator, not included (see table "Electrical connections"), on the cartridge with the black nut screwed on tightly until deforming the rubber ring on the stator (tightening torque 0.3 Nm) (Fig. 2-E).
11. Connect the motor to the driver via a compatible cable if not already integrated in the motor itself.

CAREL valves are supplied in the fully open position. If the valve is activated before being welded to the circuit, it must be returned to the fully open position to prevent high temperatures from damaging the internal components.

Note:

- Do not twist or strain the valve or the connection pipes.
- Do not strike the valve with hammers or other objects.
- Do not use pliers or other tools that may deform the external structure or damage the internal parts.
- Never point the flame at the valve.
- Never bring the valve near magnets or magnetic fields.
- Do not install or use the valve in the event of: deformation or damage to the external structure; heavy impact, for example due to dropping; damage to the electrical parts (stator, contact carrier, connector,...).
- The presence of dirt particles may cause valve malfunctions.

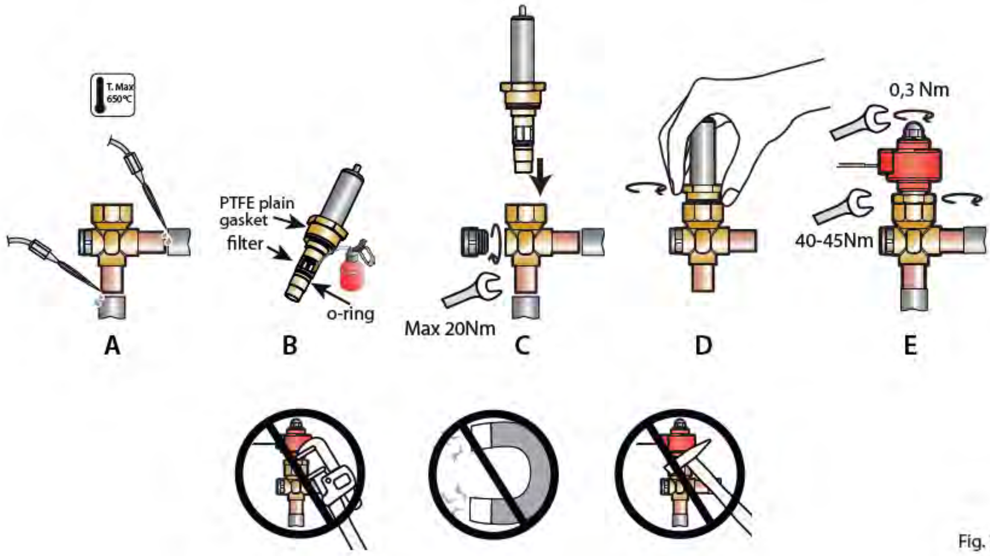
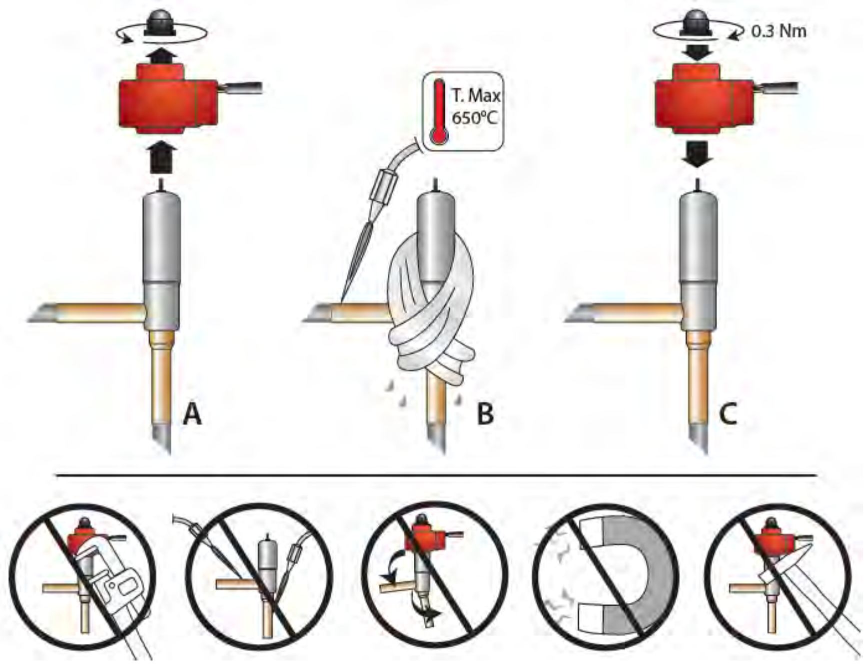


Fig. 2



Electrical connections

Ensure that EEV motor cables are installed firmly and securely into EEV port. Use cable ties to ensure excess cable is not damaged by moving parts. If the temperzone equipment under repair utilizes a 'cool plate' for inverter cooling, it is imperative that the EEV being replaced is plugged into the correct port. EEV1 port is for the main evaporator, EEV2 port is for the cool plate.

3. Troubleshooting

3.1. Testing tools

Equipment recommended for testing of Carel EEV's include:

Multimeter capable of DC voltage measurements with micro test probes.

Carel EEV spindle magnets. These magnets are used to manually open and close the EEV. This is done by placing the correct valve magnet on the spindle and winding clockwise and anti-clockwise. Purchase of these magnets can be done directly through Carel or at a HVAC and refrigeration trade supplier.

3.2. Initial inspections

- Investigate the condition of valve motor. Check for signs of corrosion and swelling of outer casing.
- Check EEV motor leads for damage.
- Check for correct orientation of valves. Pay note to systems using a 'cool plate' to cool inverter as this EEV must be located in the EEV2 socket. Pay note to multi-stage split ducted units ensuring that EEV1 socket powers valve on stage 1 and EEV2 socket powers valve on stage 2
- Make sure plug connections are tight and secure.
- Confirm accuracy of discharge and suction pressure transducer readings
- Confirm accuracy of system temperature sensor readings
- Ensure that all sensors hare secure to pipe work in the appropriate location. Anything less than tight connection to pipe work can create an inaccuracy of several degrees and cause poor EEV operation. Zip tie sensors to pipework and insulate in any uncertainty.
- If system is operating pay attention to valve noise. Valve noise may increase when refrigerant charge is insufficient.

Note:
Most if not nearly all EEV malfunctions are resolved by one of the above methods. Be certain that all the above conditions are deemed satisfactory before deciding on replacement of an EEV body or motor.

3.3. Initial power up

Upon energizing of the UC8 controller the Carel EEV will perform a stroke test to identify the location of the spindle. This involves the spindle winding 100% closed, unwinding 100% open and then winding 30-50% open depending on software programming installed. During this operation fast “clicking” and slow “clicking” can be felt by holding the valve motor while on the valve body.

Note: Do not operate valve motor without valve body inserted. Operation in such a way will lead to overheating and burn out of valve motor in a short period.

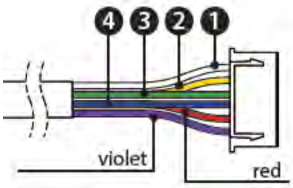
If no “clicking” can be felt further electrical testing will be required.

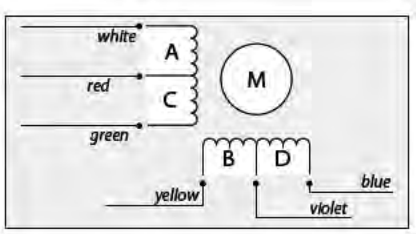
3.4. Magnet testing

After the power up sequence a valve in working condition should be in a position somewhere between 30 and 50%. Isolate power and remove valve motor. Use the correct size Carel magnet to wind the valve open and closed to identify if the unit is stuck in one of the extreme positions. If the valve is stuck. The magnet will be felt poling and clicking as magnetic force is unable to wind the spindle. Discovering this will require valve replacement.

3.5. Electrical testing

Remove the EEV plug and check resistance between motor windings. Micro test probes may be required to measure the resistance on the motor lead.





The below table represents a series of tests to check EEV motor resistances. Resistances can vary between different valve models and temperatures; however, the resistance of motor windings is relative to one another. It is for this reason that the ohms reading result will represent as ‘X’.

Example:
If a test between white and red measures 40 Ohms (X) the reading between white and green should read 80 ohms (2X). Shaded ‘multimeter lead’ cells indicate where to place test leads.

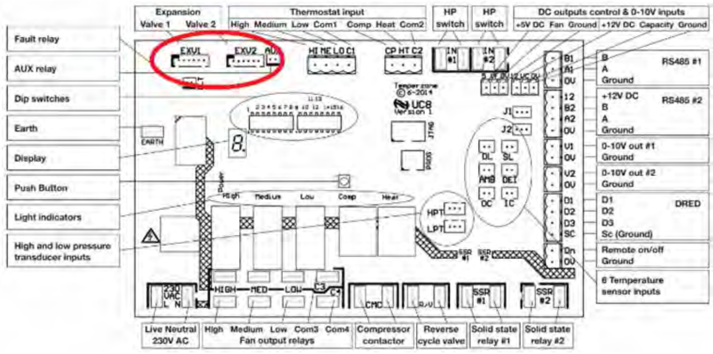
Winding Test	Multimeter Lead 1	Multimeter Lead 2	Result Ohms	Notes
A	Red	White	X	Each of these winding measurements should measure equal. Unequal results indicate failure of winding.
B	Yellow	Violet	X	
C	Red	Green	X	
D	Blue	Violet	X	
A+C	White	Green	2X	Each measurement should measure double of the individual winding test.
B+D	Yellow	Blue	2X	

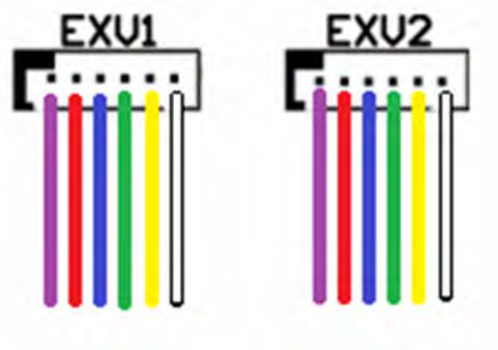
Perform a resistance test between winding A+B and B+D.

Winding A+C	Resistance (Ohms)	Winding B+D
White		Yellow
Red	**OPEN CIRCUIT**	Violet
Green		Blue

Note: If there is a circuit between opposing motor windings, this will indicate the motor has a short circuit.

With the EEV unplugged, voltage output to the motor can be checked on the pins within the plug socket (see figure below). First the EEV intended position (%) must be identified for the intended plug socket. This can be checked via the UC8 push-button under title 'EEV1' or 'EEV2". (Refer to UC8 user manual for information pertaining to push button operation).





Testing for 12V DC signal on the corresponding pin colour will give an indication if the EEV signal is operating in the intended % range of operation.

Wire	Winding	% Of valve operation							
		0-12.5	12.5-25	25-37.5	37.5-50	50-62.5	62.5-75	75-87.5	87.5-100
White	**A**	**12V**	**12V**	Off	Off	Off	Off	Off	**12V**
Yellow	**B**	Off	**12V**	**12V**	**12V**	Off	Off	Off	Off
Green	**C**	Off	Off	Off	**12V**	**12V**	**12V**	Off	Off
Blue	**D**	Off	Off	Off	Off	Off	**12V**	**12V**	**12V**

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Carel Pressure Transducer

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1. Introduction

Temperzone equipment that harnesses the UC6, UC7 and UC8 unit controller for efficient operation use Carel pressure transducers to accurately measure operating suction and discharge pressure. There are three different transducers employed in temperzone products that operate in different pressure ranges depending on the unit controller.

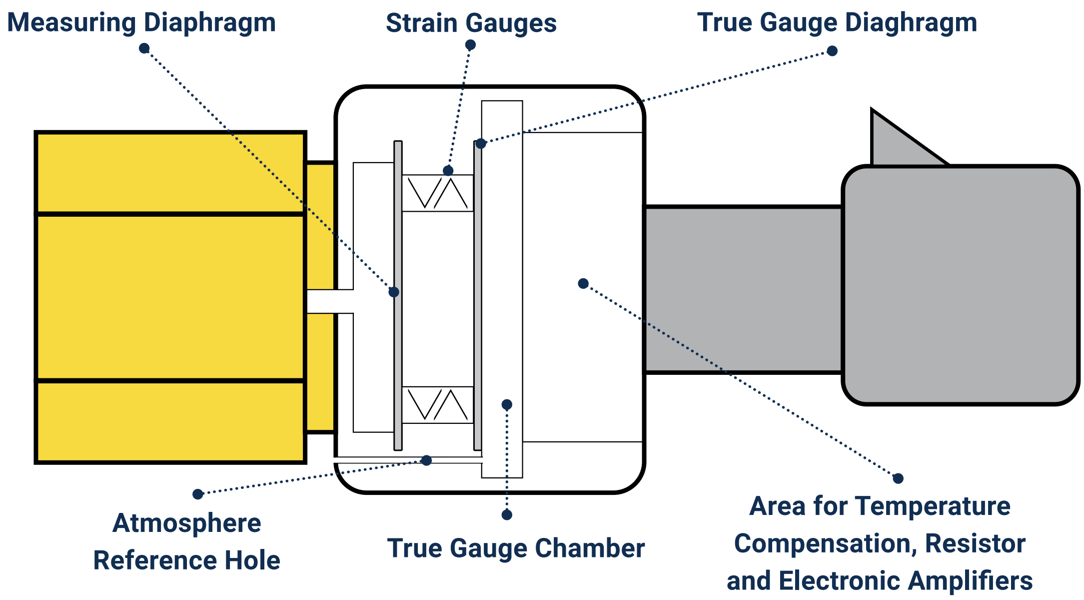
Unit Controller	Low Side Transducer Range	High Side Transducer Range
UC6	0 – 18.5 bar	0 – 45 bar
UC7	0 – 34.5 bar	0 – 45 bar (if used)
UC8	0 – 34.5 bar	0 – 45 bar

2. Principles

A pressure transducer consists of a pressure-sensitive element, such as a diaphragm, with a constant area. Gas pressure causes the diaphragm to deflect. The pressure transducer also consists of a transduction element. This transduction element converts the deflection sensed by the diaphragm into an electrical output signal. This signal will increase or decrease proportionally to the pressure change.

Carel pressure transducers require a 5V DC power supply to produce electrical signals. DC voltage output uses a 3-wire configuration; 5V DC supply, 0-5V DC output and ground.

A pressure transducer should not be confused with a pressure switch. A pressure switch is a device that operates an electrical contact when a preset gas pressure is reached.



3. Removal and fitting

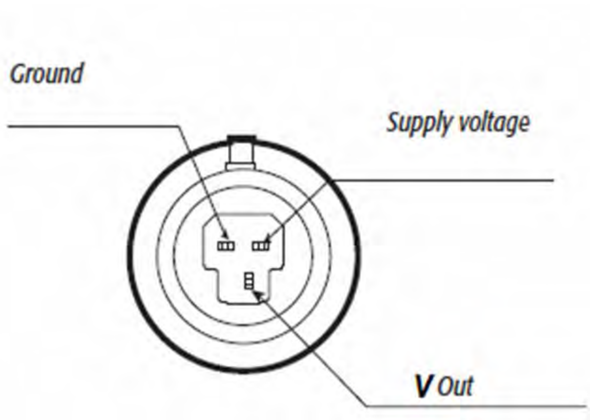
Transducers are fitted to schraeder ports. A schraeder depressor internally manufactured within the female socket of the transducer allows pressure to enter the diaphragm. To remove transducer first unplug transducer cable, use two spanners (one to secure schraeder stem and one to loosen transducer) to briskly undo the schraeder stem (normal thread, not opposing thread). Release of refrigerant will cease as soon as the schraeder has seated.

4. Wiring

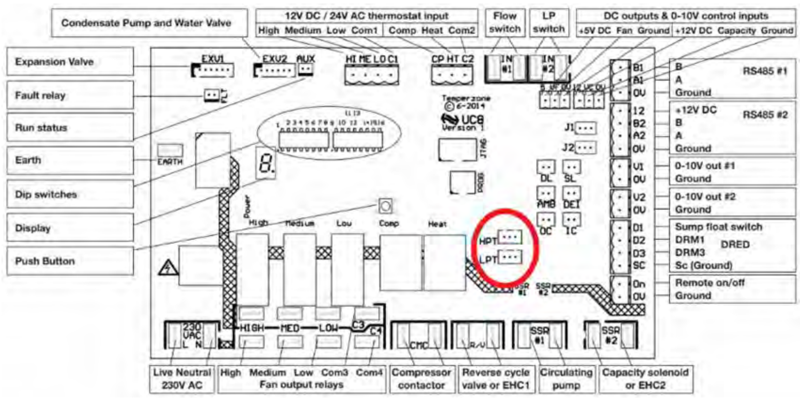
The transducer cable identification is as follows.

Wire	Duty	Voltage DC
White	V Out	0.5 – 5 VDC
Black	Supply	5 VDC
Green	Ground	0 V

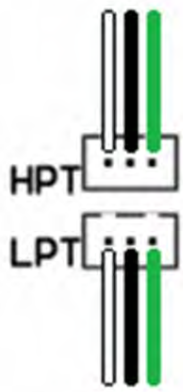
Transducer Lead



Transducer Head



UC8 Controller



Transducer Connection

5. Troubleshooting

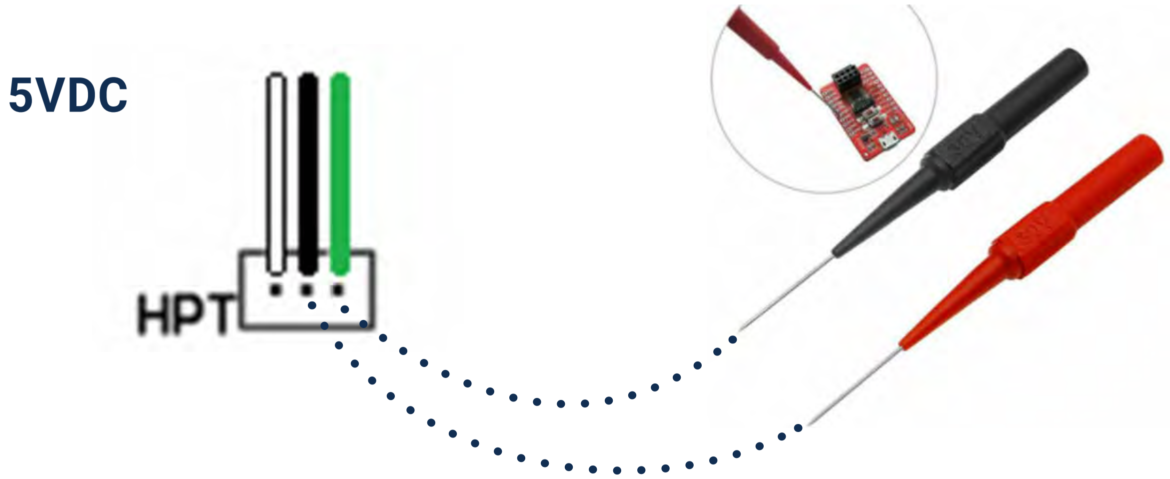
5.1. Initial inspection

- Investigate the condition of transducer. Check for signs of oil inside terminal connections. If discovered, clean with contact cleaner.
- Check transducer leads for damage.
- Check for correct orientation of leads, i.e., HP transducer to HPT socket, LP transducer to LPT socket.
- Make sure plug connections are tight and secure.
- Confirm accuracy of discharge and suction pressure transducer readings by comparing to gauge readings.

5.2 Electrical testing

Test 1

Use micro test leads (below right) to test for the presence of 5V DC supply signal on the black (centre) wire on the transducer lead whilst using the green wire as ground reference. This test should be conducted with the transducer plugged in, or on directly on the UC8 pins with the lead unplugged. If micro test leads are unavailable cut the transducer leads and re-join with a cable connection with a testing point (e.g., a BP connector).



The absence of a 5V DC supply (+ or – 10%) indicates a failure of the UC8 board or short circuit to ground in the transducer or transducer lead.

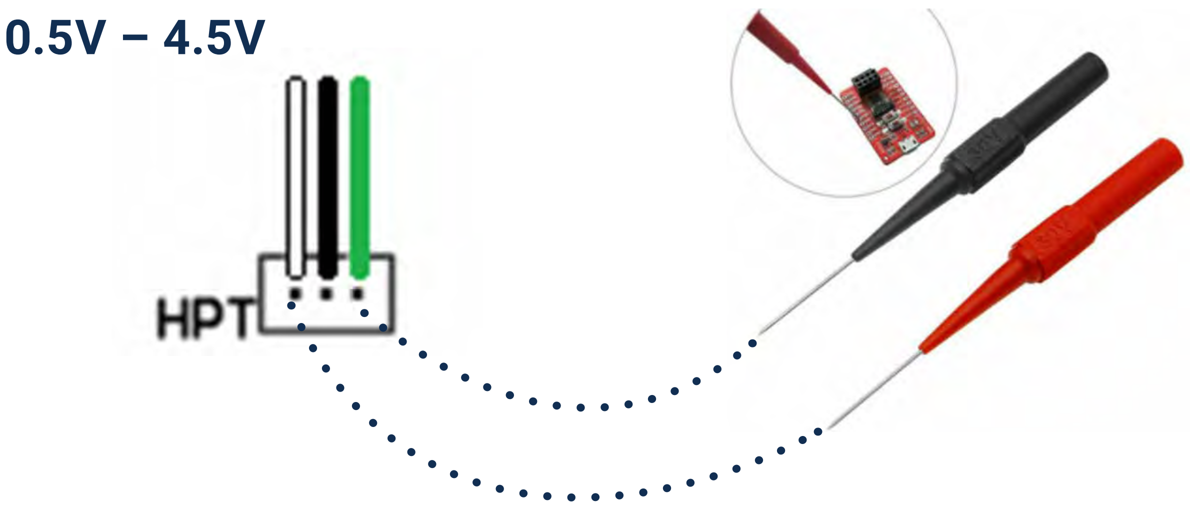
Unplug both transducers and test for 5V DC on the centre pin of the LPT and HPT connections of the UC8 board. If 5V DC is not present replace UC8.

If 5 V DC is present resistance test transducers and transducer leads while they are unplugged. If a short circuit is present between the 5V DC power supply wire or terminal and ground terminal or wire are present replace this component.

Hint: Swap transducer leads if in doubt. This can help include or exclude the leads as part of the fault circuit.

Test 2

Test between V Out (white cable left pin) and ground (green cable right pin) to check the DC output voltage of the transducer. Translate this voltage to pressure by comparison on the table (section 5.3.) for the appropriate transducer range marked on the brass casing of the transducer. Compare the pressure indicated on the chart to gauge pressure, and pressure displayed on the UC8 7 segment display (refer to UC8 user manual for suction and discharge pressure identification using the SW3 push-button.



Test voltage matches gauge reading	Test voltage matches UC8 display	Action
Yes	No	- Check transducer is the correct range for controller (see section 1) - Replace UC8
No	No	- Check transducer is the correct range for controller (see section 1) - Replace transducer

5.3. Voltage conversion table

Transducer Voltage to Pressure Table			
Voltage (DC)	Transducer Range		
	0 - 17.5 bar	0 – 34.5 bar	0 – 45 bar
0.5	0	0	0
0.6	43	86	113
0.7	87	173	225
0.8	130	259	338
0.9	173	345	450
1.0	216	431	563
1.1	260	518	675
1.2	303	604	788
1.3	346	690	900
1.4	389	776	1013
1.5	433	863	1125
1.6	476	949	1238
1.7	519	1035	1350
1.8	562	1121	1463
1.9	606	1208	1575
2.0	649	1294	1688
2.1	692	1380	1800
2.2	735	1466	1913
2.3	779	1553	2025
2.4	822	1639	2138
2.5	865	1725	2250
2.6	908	1811	2363
2.7	952	1898	2475
2.8	995	1984	2588
2.9	1038	2070	2700
3.0	1081	2156	2813
3.1	1125	2243	2925
3.2	1169	2329	3038
3.3	1211	2415	3150
3.4	1254	2501	3263
3.5	1298	2589	3375
3.6	1341	2674	3488
3.7	1384	2760	3600
3.8	1427	2846	3713

Transducer Voltage to Pressure Table (Continued)			
Voltage (DC)	Transducer Range		
	0 - 17.5 bar	0 – 34.5 bar	0 – 45 bar
3.9	1471	2933	3825
4.0	1514	3019	3938
4.1	1557	3105	4050
4.2	1600	3191	4163
4.3	1644	3278	4275
4.4	1687	3364	4388
4.5	1730	3450	4500

Sensor Resistance Table

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Temperature (°C)	Sensor (by colour) Resistance (kOhm)					
	White	Blue	Yellow	Black	Red	Grey
-10	58.00	58.00	58.00	58.00	58.00	NA
-9	55.20	55.20	55.20	55.20	55.20	NA
-8	52.40	52.40	52.40	52.40	52.40	NA
-7	49.60	49.60	49.60	49.60	49.60	NA
-6	46.80	46.80	46.80	46.80	46.80	NA
-5	44.00	44.00	44.00	44.00	44.00	NA
-4	42.00	42.00	42.00	42.00	42.00	NA
-3	40.00	40.00	40.00	40.00	40.00	NA
-2	38.00	38.00	38.00	38.00	38.00	NA
-1	36.00	36.00	36.00	36.00	36.00	NA
0	34.00	34.00	34.00	34.00	34.00	161.64
1	32.60	32.60	32.60	32.60	32.60	153.69
2	31.20	31.20	31.20	31.20	31.20	146.19
3	29.80	29.80	29.80	29.80	29.80	139.09
4	28.40	28.40	28.40	28.40	28.40	132.38
5	27.00	27.00	27.00	27.00	27.00	126.02
6	25.60	25.60	25.60	25.60	25.60	120.01
7	24.20	24.20	24.20	24.20	24.20	114.32
8	22.80	22.80	22.80	22.80	22.80	108.93
9	21.40	21.40	21.40	21.40	21.40	103.83
10	20.00	20.00	20.00	20.00	20.00	98.99
11	19.26	19.26	19.26	19.26	19.26	94.41
12	18.52	18.52	18.52	18.52	18.52	90.06
13	17.78	17.78	17.78	17.78	17.78	85.93
14	17.04	17.04	17.04	17.04	17.04	82.02
15	16.30	16.30	16.30	16.30	16.30	78.31
16	15.56	15.56	15.56	15.56	15.56	74.79
17	14.82	14.82	14.82	14.82	14.82	71.44
18	14.08	14.08	14.08	14.08	14.08	68.26
19	13.34	13.34	13.34	13.34	13.34	65.24
20	12.60	12.60	12.60	12.60	12.60	62.37
21	12.08	12.08	12.08	12.08	12.08	59.64
22	11.56	11.56	11.56	11.56	11.56	57.05
23	11.04	11.04	11.04	11.04	11.04	54.58
24	10.52	10.52	10.52	10.52	10.52	52.23
25	10.00	10.00	10.00	10.00	10.00	50.00
26	9.60	9.60	9.60	9.60	9.60	47.87
27	9.20	9.20	9.20	9.20	9.20	45.85
28	8.80	8.80	8.80	8.80	8.80	43.92
29	8.40	8.40	8.40	8.40	8.40	42.08
30	8.00	8.00	8.00	8.00	8.00	40.33
31	7.72	7.72	7.72	7.72	7.72	38.66
32	7.44	7.44	7.44	7.44	7.44	37.07
33	7.16	7.16	7.16	7.16	7.16	35.55

Temperature (°C)	Sensor (by colour) Resistance (kOhm)					
	White	Blue	Yellow	Black	Red	Grey
34	6.88	6.88	6.88	6.88	6.88	34.11
35	6.60	6.60	6.60	6.60	6.60	32.73
36	6.32	6.32	6.32	6.32	6.32	31.41
37	6.04	6.04	6.04	6.04	6.04	30.15
38	5.76	5.76	5.76	5.76	5.76	28.95
39	5.48	5.48	5.48	5.48	5.48	27.80
40	5.20	5.20	5.20	5.20	5.20	26.71
41	5.03	5.03	5.03	5.03	5.03	25.66
42	4.86	4.86	4.86	4.86	4.86	24.66
43	4.69	4.69	4.69	4.69	4.69	23.70
44	4.52	4.52	4.52	4.52	4.52	22.79
45	4.35	4.35	4.35	4.35	4.35	21.91
46	4.18	4.18	4.18	4.18	4.18	21.08
47	4.01	4.01	4.01	4.01	4.01	20.28
48	3.84	3.84	3.84	3.84	3.84	19.51
49	3.67	3.67	3.67	3.67	3.67	18.78
50	3.50	3.50	3.50	3.50	3.50	20.28
51	3.38	3.38	3.38	3.38	3.38	17.40
52	3.26	3.26	3.26	3.26	3.26	16.76
53	3.14	3.14	3.14	3.14	3.14	16.14
54	3.02	3.02	3.02	3.02	3.02	14.98
55	2.90	2.90	2.90	2.90	2.90	14.98
56	2.78	2.78	2.78	2.78	2.78	14.44
57	2.66	2.66	2.66	2.66	2.66	13.92
58	2.54	2.54	2.54	2.54	2.54	13.42
59	2.42	2.42	2.42	2.42	2.42	12.94
60	2.30	2.30	2.30	2.30	2.30	12.48
61	2.24	2.24	2.24	2.24	2.24	12.04
62	2.19	2.19	2.19	2.19	2.19	11.62
63	2.13	2.13	2.13	2.13	2.13	11.21
64	2.07	2.07	2.07	2.07	2.07	10.82
65	2.01	2.01	2.01	2.01	2.01	10.44
66	1.96	1.96	1.96	1.96	1.96	10.08
67	1.90	1.90	1.90	1.90	1.90	9.74
68	1.84	1.84	1.84	1.84	1.84	9.41
69	1.78	1.78	1.78	1.78	1.78	9.09
70	1.73	1.73	1.73	1.73	1.73	8.78
71	1.67	1.67	1.67	1.67	1.67	8.48
72	1.61	1.61	1.61	1.61	1.61	8.20
73	1.55	1.55	1.55	1.55	1.55	7.93
74	1.50	1.50	1.50	1.50	1.50	7.66
75	1.44	1.44	1.44	1.44	1.44	7.41
76	1.38	1.38	1.38	1.38	1.38	7.17
77	1.32	1.32	1.32	1.32	1.32	6.93

Temperature (°C)	Sensor (by colour) Resistance (kOhm)					
	White	Blue	Yellow	Black	Red	Grey
78	1.27	1.27	1.27	1.27	1.27	6.71
79	1.21	1.21	1.21	1.21	1.21	6.49
80	1.15	1.15	1.15	1.15	1.15	6.28
81	NA	NA	NA	NA	1.13	6.08
82	NA	NA	NA	NA	1.10	5.89
83	NA	NA	NA	NA	1.08	5.70
84	NA	NA	NA	NA	1.05	5.52
85	NA	NA	NA	NA	1.03	5.35
86	NA	NA	NA	NA	1.01	5.18
87	NA	NA	NA	NA	0.98	5.02
88	NA	NA	NA	NA	0.96	4.86
89	NA	NA	NA	NA	0.93	4.71
90	NA	NA	NA	NA	0.91	4.57
91	NA	NA	NA	NA	0.89	4.43
92	NA	NA	NA	NA	0.86	4.29
93	NA	NA	NA	NA	0.84	4.16
94	NA	NA	NA	NA	0.81	4.04
95	NA	NA	NA	NA	0.79	3.92
96	NA	NA	NA	NA	0.77	3.80
97	NA	NA	NA	NA	0.74	3.69
98	NA	NA	NA	NA	0.72	3.58
99	NA	NA	NA	NA	0.69	3.47
100	NA	NA	NA	NA	0.67	3.37
101	NA	NA	NA	NA	0.65	3.27
102	NA	NA	NA	NA	0.64	3.18
103	NA	NA	NA	NA	0.62	3.18
104	NA	NA	NA	NA	0.60	3.18
105	NA	NA	NA	NA	0.59	3.18
105	NA	NA	NA	NA	0.57	3.18
107	NA	NA	NA	NA	0.55	3.18
108	NA	NA	NA	NA	0.53	2.67
109	NA	NA	NA	NA	0.52	2.59
110	NA	NA	NA	NA	0.50	2.52

Scan QR code for
Plug and EC Fan
Video Tutorial

Plug Fan
Fundamentals and Troubleshooting

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1.Introduction

Temperzone harness the superior operating capabilities and energy efficiency benefits of plug fans to perform the duties of the indoor fan and the outdoor fan (on air-cooled package units) on all R32 equipment.

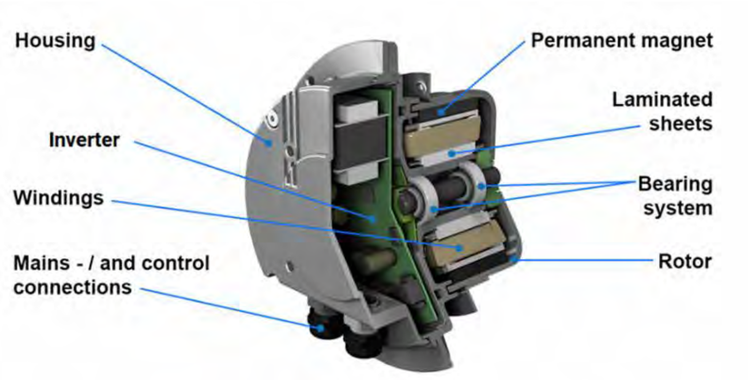
1.1. What is a plug fan?

Plug fans use an inverter in conjunction with brushless DC motors for superior operational range and energy efficiency. This is the reason why these types of motors are called 'plug' motors or 'plug' fans due to their 'plug-and play' approach. They can also be referred to as EC fans (electronically controlled fans). Temperzone plug fans can be separated into two categories internally contained inverter, and external inverter.

Note: For further understanding about brushless DC motors refer to section 3. in the inverter fundamentals manual.

1.2. Internally mounted inverter

Plug fans such as backward curve centrifugal evaporator fans, some forward curve centrifugal evaporator fans, and axial propeller fans used as outdoor fans on package units, contain an internally mounted inverter used to drive the operational speed of the fan motor.



1.3. External inverter

Some forward curve centrifugal evaporator fans on small to mid-capacity units, use an external inverter (called and ECC driver board) to control motor speed (for more information on the EEC driver board refer to the ECC user manual).

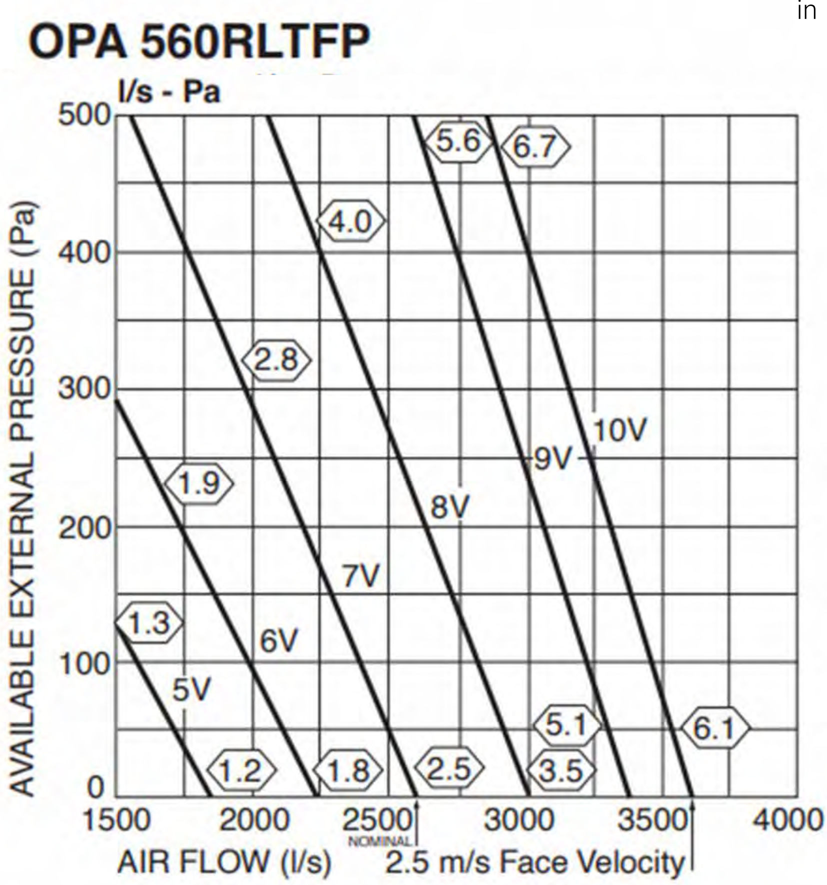
2. Fan curve data

Temperzone provide fan curve data within product technical data manual. Plotting site measured data onto the fan curve can reveal estimated data on static pressure and air volume. All that is required to plot this point is the fan input voltage (measured between V2 and 0V on the UC8) and the fan running amps to achieve an estimated total static pressure and air volume. See example below:

DC Voltage between V2 and OV = **8V DC**

Indoor fan running amps = **3.85 Amps**

By intersecting the amp draw (indicated in the hexagon) upon the input voltage line it can be seen that this system has an estimated 275pa total external static pressure and 2500 L of air flow. Note on the 'x' axis nominal air flow and 2.5m/s face velocity are indicated.



It should be noted that maximum system capacity and optimal running conditions reached when indoor fan volume is as close as possible to nominal unit air flow (temperzone design airflow). Temperzone do not recommend air velocity across indoor coils lower than 1.5 m/s and faster than 2.8 m/s. Speeds outside of this range encourage moisture ingress into critical parts and nuisance tripping.

Minimum allowable volume and maximum allowable total static pressure are dictated by the x and y scale on the fan curve chart.

Hint: Total system static as plotted on the 'y' axis of the fan curve chart is the measurement of return air negative static pressure plus supply air positive static pressure. For example, A system measures -100pa static pressure (compared to atmosphere) on the return air chamber and 175pa static pressure (compared to atmosphere) on the supply air chamber:

Return air static pressure + Supply air static pressure = Total system static pressure

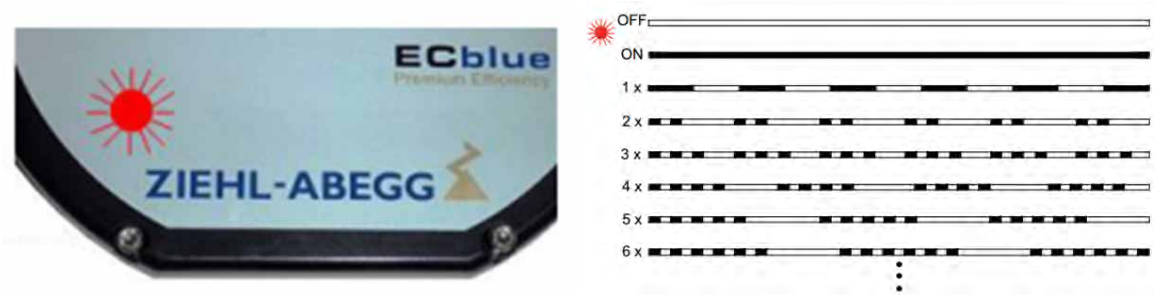
-100pa + 175pa = 275pa

3. Troubleshooting

3.1. Checking motors with internally mounted inverters

Due to the nature of the internal wiring of the internal inverter, typical motor winding tests are not possible. Visual checks should be conducted of lead integrity and termination tightness. For further fault diagnosis the fault LED pattern should be referenced to the motor manufacturers table, or follow the manufactures test schedule:

Ziehl-Abegg
LED Indicator

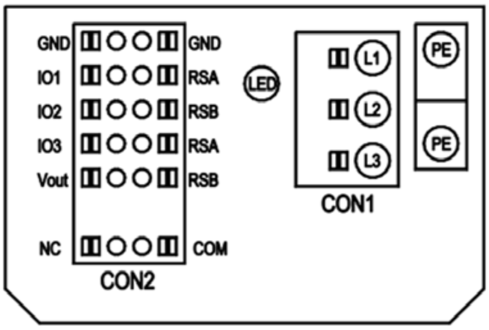


LED Flashes	Cause	Action
Off	No line voltage	Line voltage available? Unit switch OFF and automatically ON when the voltage has been restored
ON	Normal operation without fault	
1	No enable = OFF Terminals “D1” - “24 V” (Digital In 1) not bridged	Switch OFF by external contact (see digital input)
2	Temperature management active The device has an active temperature management to protect it from damage due to too high inside temperatures. In case of a temperature rise above the fixed limits, the modulation is reduced linearly. To prevent the complete system being switched off externally (in this operation permissible for the controller) in case of reduced operation due to too high an internal temperature, no fault message is sent via the relay	With a drop in temperature the modulation rises again linear. Check cooling of the controller
3	HALL-IC Incorrect signal from the Hall-ICs, error in the commutation. Internal plug connection faulty.	EC controller switches off and does not switch on again. Reset by disconnecting the line voltage necessary.
4	Line failure (only for 3 ~ types) The device is provided with a built-in phase monitoring function for the mains supply. In the event of a mains interruption (failure of a fuse or mains phase) the unit switches off after a delay (approx. 200 ms). Only functioning with an adequate load for the controller.	Following a shutoff, a startup attempt is made after approximately 15 seconds, if the voltage supply is high enough. This keeps occurring until all 3 supply phases are available again. Check power supply
5	Motor blocked If after 8 seconds of commutation no speed is measured > 0, the fault “Motor blocked” is released.	EC-Controller switches off, renewed attempt to start after about 2.5 sec. Final shut-off after five unsuccessful start-up attempts. It is then necessary to have a reset by disconnecting the line voltage. Check if motor is freely rotatable
6	IGBT Fault Short circuit to earth or short circuit of the motor winding.	EC-Controller switches off, renewed attempt to start after about 60 sec. see code 9. Final shutoff, if - following a second starting test – a second fault detection is detected within a period of 60 seconds. It is then necessary to have a reset by disconnecting the line voltage.
7	Intermediate under-voltage If the DC-link voltage drops below a specified limit the device will switch off.	If the intermediate circuit voltage again rises above the specified limit, an automatic start-up attempt is run. If the intermediate circuit voltage remains below the specified limit for more than 75 seconds, an error message will appear.

8	DC link over voltage If the DC-link voltage increases above a specified limit, the motor will switch off. Reason for excessively high input voltage or alternator motor operation.	If the intermediate circuit voltage again drops below the specified limit, an automatic startup attempt is run. If the intermediate circuit voltage remains above the specified limit for more than 75seconds, an error message will appear.
9	IGBT cooling down period	IGBT cooling down period for approx. 60 sec. Final shutoff after 2 cooling-off intervals see code 6.
11	Error motor start If a starting command is given (enable available and Setpoint > 0) and the motor does not start to turn in the correct direction within 5 minutes, then an error message will appear	If it is possible to start the motor in the target direction of rotation after the error message, the error message will disappear. Should a voltage interruption occur in the meantime, the time taken up to the switch off will begin again. Check if motor is freely rotatable. Check if the fan is driven in reverse direction by an air stream (see behavior in rotation by air current in reverse direction)
12	Line voltage too low If the DC-link voltage drops below a specified limit the device will switch off	If the line voltage again rises above the specified limit, an automatic startup attempt is run. If the line voltage remains below the specified limit for more than 75 seconds, an error message will appear
13	Line voltage too high Cause to high input voltage If the line voltage increases above a specified limit, the motor will switch off.	Line voltage too high Cause to high input voltage If the line voltage increases above a specified limit, the motor will switch off.
14	Error peak current If the motor current increases above the specified limit (even in a short timeframe) the device will switch-off.	After a switch off the controller waits for 5 seconds then the controller attempt a start. Arises within 60 sec. in series 5 further disconnections a final switch off with fault indication follows. Should no further switch off be exceeded in 60 sec. the counter will be reset.
17	Temperature alarm Excess of the max. permissible inside temperature.	Controller switches off motor. Automatic restarting after cooling down. Check cooling of the controller

EBM-PAPST

LED Indicator



LED Flashes	Cause	Action
1	Current limitation in action	Check current draw
2	Line impedance too high (DC-link voltage unstable)	Check voltage and connections
3	Power limiter in action	Check bearings and static pressure
4	Output stage temperature high	Check conditions
5	Motor temperature high	Check bearings
6	Temperature inside electronics high	Check conditions
7	DC-link voltage low	Check voltage
8	Braking mode: set in case of external drive in opposite direction at high speed for lengthy period	
9	Calibration of rotor position sensor in progress	
10	Actual speed is lower than run monitoring speed limit	
11	Open circuit at analog input or PWM input for the set value	PWM fail
13	DC-link voltage high	Check voltage
15	Line voltage high	Check voltage
16	Shake-loose function activated	

Test Schedule

SINGLE-PHASE FANS (P5 WIRING INTERFACE)

1. With the mains power off, check whether the impeller can rotate or spin freely. If not, find and remove any material which is blocking the impeller.
2. Check whether there are any water marks or evidence of presence of water before opening the junction box. If yes, document this before removing the terminal box lid.
3. Note and remove all existing control connections to the fan.
4. With mains power on, measure the mains power supply voltage at the fan terminal box. Match the reading with the fan label and specifications.
5. Measure between +10V (red wire) and GND (blue wire). It should yield an output of +10V with tolerance of ± 3%.
6. If +10V is not present, this suggests the electronics of the fan have been damaged.
7. If +10V is present, check the alarm relays. If NC-COM is open, this indicates a fault state within the fan.
8. If the previous checks are OK, remove the mains power supply and bridge 0-10V/PWM (yellow wire) and +10V (red wire). With the mains power supply on, the fan should spin at its maximum speed if the fan is programmed to source of set value analogue Ain1. Necessary precautions must be taken before attempting to run the fan.
9. If the fan still does not run, fault finding via RSA-RSB (white and brown wire respectively) is to be attempted. This requires ebm-papst EC-Control software and an RS485 USB converter (part #: 21490-1-0174).

THREE-PHASE FANS (M3 WIRING INTERFACE)

1. With the mains power off, check whether the impeller can rotate or spin freely. If not, find and remove any material which is blocking the impeller.
2. Check whether there are any water marks or evidence of presence of water before opening the junction box. If yes, document this before removing the terminal box lid.
3. Note and remove all existing control connections to the fan.
4. With mains power on, measure the mains power supply voltage at the fan terminal box. Match the reading with the fan label and specifications.
5. Measure between +10V (pin 5 of KL3) and GND (pin 3 or pin 10 of KL3). It should yield an output of +10V with tolerance of ± 3%.
6. Measure between +20V (pin 12 of KL3) and GND (pin 3 or pin 10 of KL3). It should yield an output of +20V with tolerance of +25%/-10%.
7. If +10V and +20V are not present, this suggests the electronics of the fan have been damaged.
8. If +10V and +20V are present, check the alarm relays. If NO-COM is closed and NC-COM is open, this indicates a fault state within the fan.
9. If the previous checks are OK, remove the mains power supply and bridge Ain1 U (pin 4 of KL3) and +10V (pin 5 of KL3). With the mains power supply on, the fan should spin at its maximum speed if the fan is programmed to source of set value analogue Ain1. Necessary precautions must be taken before attempting to run the fan.
10. If the fan still does not run, fault finding via RSA-RSB (pin 1 and pin 2 of KL3) needs to be done. This requires ebm-papst EC-Control software and an RS485 USB converter (part #: 21490-1-0174).

ROSENBERG

Test Schedule

Fault	Cause	Action
Fan is not rotating or stops after a various time	No supply voltage present or missing of a single phase.	Check the supply voltage directly on the fan. ➔If not all phases are measurable check the fuses and the wiring of the service switch.
	Missing setpoint	Check the setpoint and its correct polarity
	Missing enable signal. (If in wiring diagram present)	Check the 24VDC between “Enable “and GND clamps
	Internal protective feature has tripped. (Failure can be read out with the Software “ECParam” if necessary)	” Under voltage” – Input voltage falls below the tolerance limit of the specified line voltage. Check main supply and fuses. ➔ Failure is automatically reset after the voltage rises above the minimum limit
		“Over voltage “– Input voltage rises above the tolerance limit of the specified line voltage. Check main supply and fuses. ➔ Failure is automatically reset after the voltage fall under the maximum limit.

Fault	Cause	Action
Fan is not rotating or stops after a various time	Internal protective feature has tripped. (Failure can be read out with the Software “ECParam” if necessary)	“Locked rotor “ Check the fan impeller for overload caused by dirt or foreign matters and turn by hand. Check fastenings of motor and nozzle. ➔ Reset failure
		“Over temperature electronic “ Control the airflow temperature and ambient temperature for its limits. ➔ Failure is reset automatically after the temperature is cooled down to a normal level.
		“Over temperature motor “ Control the airflow temperature and ambient temperature for its limits. Check the fan impellers for overload caused by dirt or foreign matters. ➔ Reset failure
		“Failure in power section “– current or voltage rise to a critical level. Check main supply and fuses. ➔ Reset failure
Fan rotates at maximum speed, independent of the set-point.	Fan is in closed loop.	Change parameter with “EC-Param” or contact the Rosenberg support.
Fan does not run at maximum speed	Max. setpoint is not present on analog 1.	Check setpoint according to pin connection and increase
	Setpoint on analog 1 is too high.	Limit setpoint according to pin connection.
	Temperature dependent power derating is activated.	Control the airflow temperature and ambient temperature for its limits (Nameplate data).
Fan turns but there is no or not enough airflow.	Rotation speed of the fan too low.	Please see “fan does not run at maximum speed
	Air flow interrupted.	Check duct system (e.g., suction, filter, sealing caps).
	Calculated pressure does not correspond to the real value.	Check fan selection.
	Unfavorable installation conditions.	Check the installation situation

Fault	Cause	Action
Vibrations / noises in fan	Chafing of impeller.	Check impeller for dirt and clearance. Check mounting of Impeller and inlet cone
	Deformation	Stop fan immediately. Contact Rosenberg support.
	Dirty impeller.	Clean impeller.
	Damaged ball bearings	Stop fan immediately. Contact Rosenberg support.
	Wrong Operating point (Only axial-fans).	Operating point is in the forbidden area of the air curve. Reduce pressure losses.
RCD-Switch or fuse trips.	Ground fault or short circuit.	Check if the cables are damaged or moisture is present.
	Defect of the motor and/or the electronics.	Contact Rosenberg support

3.2. Checking motors with external motors

When inspecting plug fans with external inverters such as the ECC driver board refer to the appropriate manual to identify inverter faults.

Testing of BLDC (brushless DC) motors is typical to that of testing standard three phase motors with the exception of two additional tests to check for demagnetization of the stator or rotor (depending on construction).

Test 1 – Earth Continuity

Check for continuity between earth lead and motor frame. Should be less than 0.5 Ohm

Test 2 – Insulation Resistance

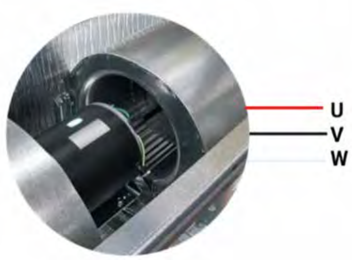
Using a megaohm meter on 500 VDC scale and test earth insulation resistance test. Must be greater than 1 M Ohm

Test 3 – Winding Continuity

Check resistance of motor windings. Each winding should have an equivalent resistance to the other. If not, this indicates a short circuit.

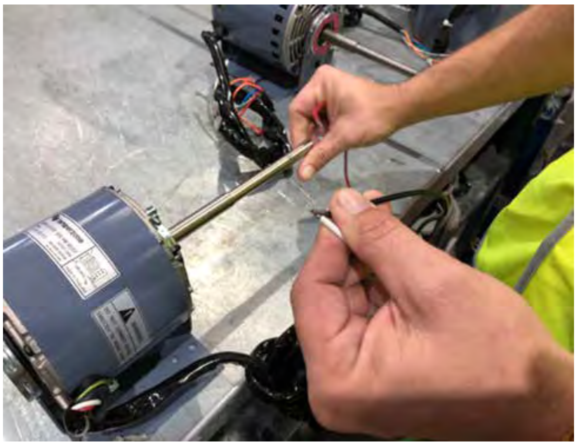
Test 4 – AC generation

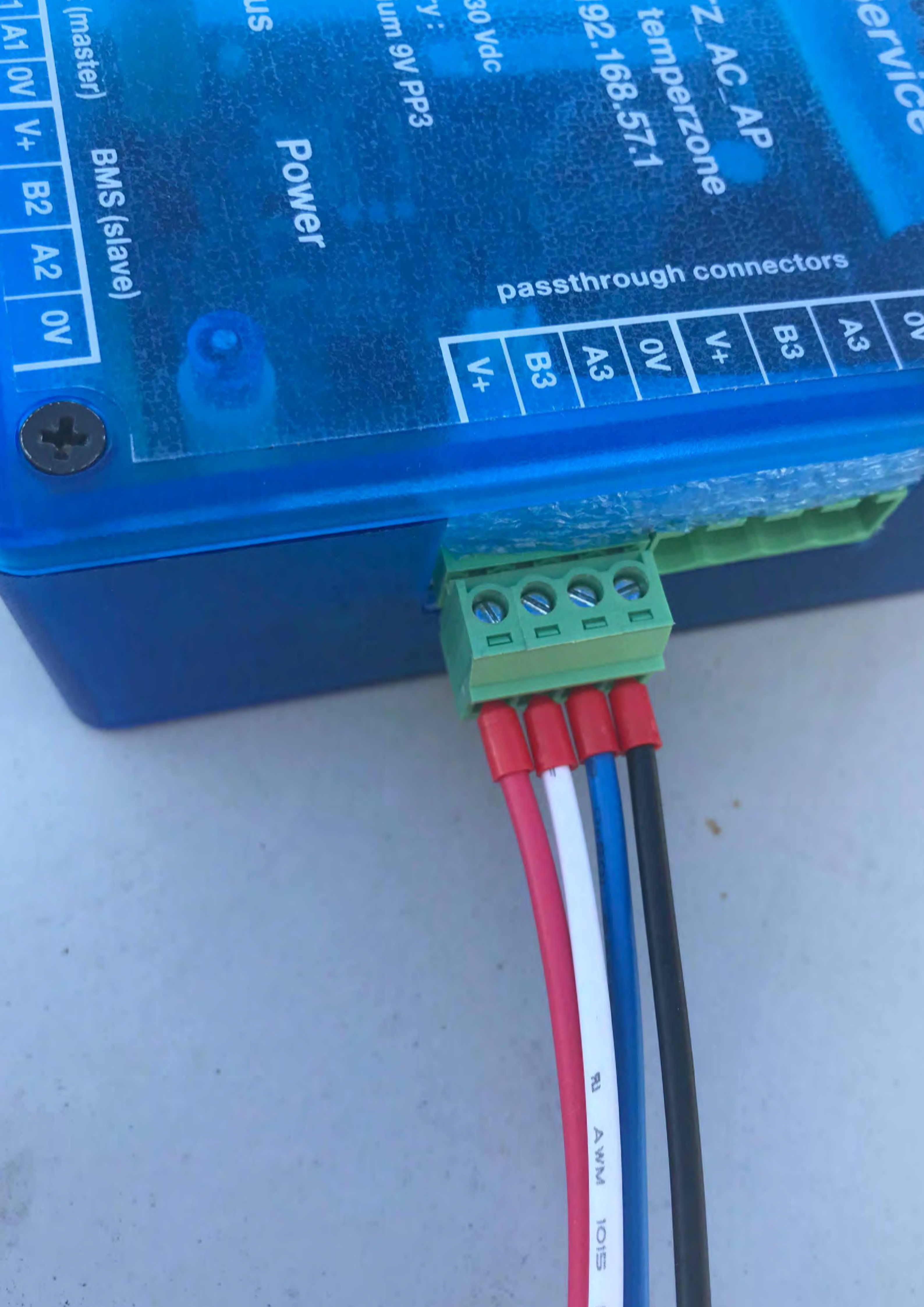
With motor leads unplugged use a multimeter set to AC voltage place test leads across two motor leads. Spin fan blade by hand. Due to the spinning magnetic rotor the multimeter should show a generated AC voltage. Repeat the process for the other 2 motor lead combinations. If no voltage is generated, the motor has demagnetized.



Test 5 – Magnet polling

With motor leads disconnected touch 2 motor lead terminals together. While lead terminals are touching attempt to spin the motor by hand. The motor should feel seized and require are large amount of force to rotate. This indicates that magnet poles are correct. Repeat the process for the other 2 lead combinations to check for the same result. If the motor spins freely the motor has become demagnetized.





A1
0V
V+
B2
A2
0V
(master)
BMS (slave)
Power
9V PP3
30 Vdc
temperzone
passthrough connectors
V+
B3
A3
0V
V+
B3
A3
AWM
1015

Wi-Fi Service Utility

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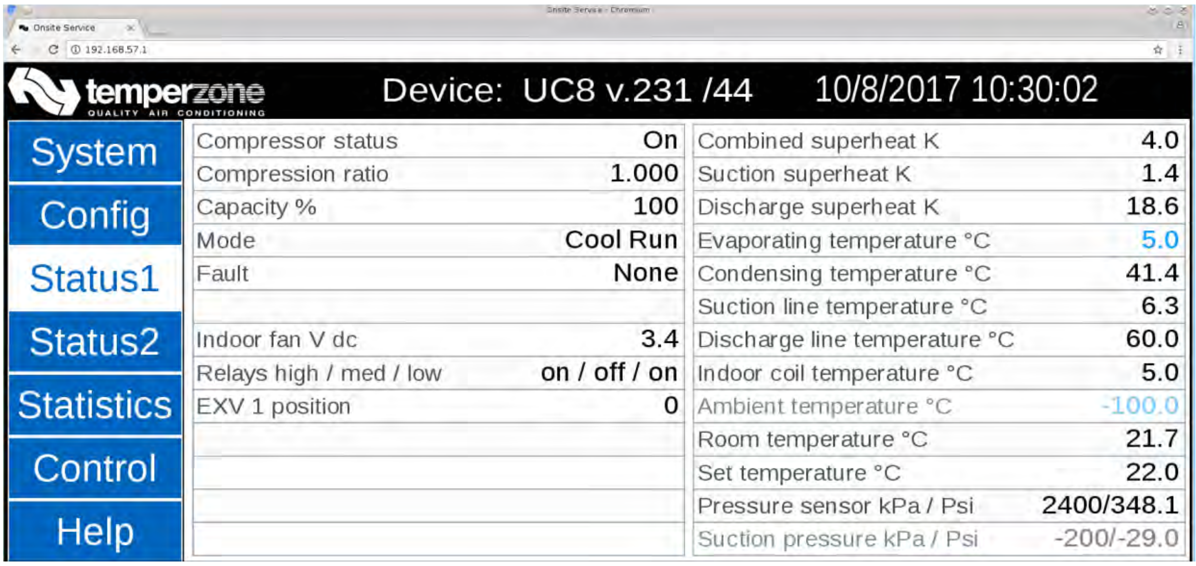
Appendix I WSU target wiring combinations p. 309

1. Overview

The Wi-Fi Service Utility (WSU) allows qualified installers and service technicians to view the operating data of temperzone's Modbus accessible electronic controls using a Wi-Fi connection and a web browser.

The WSU connects to the control's Modbus slave port and reads the available data. The WSU incorporates a Wi-Fi access point. Any device connecting to the WSU's access point may read the controller data and perform a limited amount of control using a web browser such as Chrome, Safari or Firefox.

Status information from an operating UC8 controller



2. Before Use

Fit the internal 9V alkaline battery if it is not already fitted.

Use with no battery or with a flat battery may result in damage to the WSU operating system.

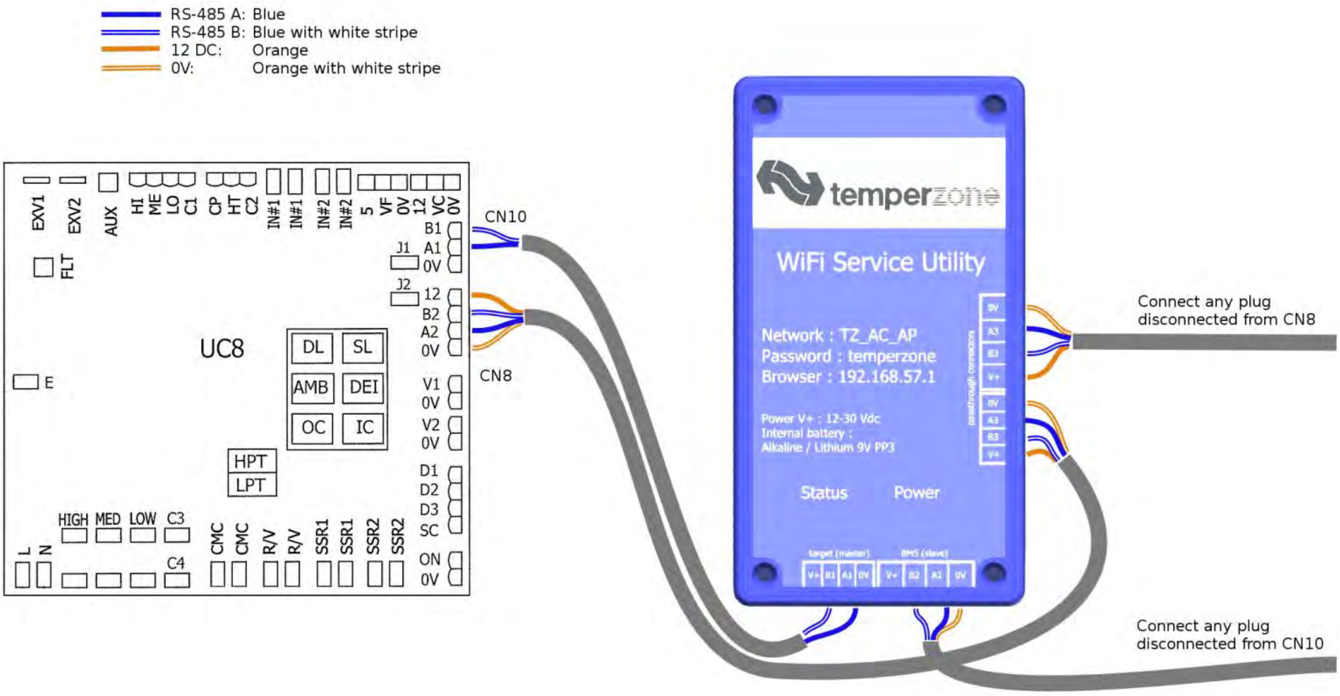
3. Connection

Connect the WSU Target (Modbus master) terminals A1 and B1 to the Modbus slave A and B terminals of the target controller. Any device disconnected from the targets Modbus slave A and B terminals may be re-connected to the WSU BMS A2 and B2 terminals.

The WSU requires a 12 to 30 V dc supply to operate. Connect the voltage supply to any of the WSU 0V and V+ terminals.

For the temperzone UC7/8 controllers, the 12 V supply output is available with the controllers Modbus master output CN8. The WSU provides pass through sockets so that any device un-plugged from the target UC7/8 may be plugged into the WSU and the WSU connected to the UC7/8 target.

WSU connection to UC8 target. See appendix I for connections to other target components



4. Device Setup

Power the system. The Power LED should begin blinking immediately.

Wait approximately 40 seconds for the Status LED to begin blinking rapidly.

With your device (smartphone, tablet computer, laptop etc.), navigate to the Wi-Fi, WLAN or wireless network settings and connect to the access point named “TZ_AC_AP”. The password is “temperzone” without the quotation marks.

Once you have connected your device to the Wi-Fi access point, open your web browser and enter the address “192.168.57.1”. The system screen of the WSU web page should appear.

5. WSU use

5.1 Operation

Following application of power, the WSU system begins to operate with the following stages:

Operation	Approximate Duration	Status LED Indication	Power LED Indication
Preparing for operation	40 seconds	Off	On half a second, off half a second
Searching for controllers	3 minutes	Flashing rapidly	
Normal operation		On briefly every second	
Shutdown	30 Seconds	Off	On briefly every second

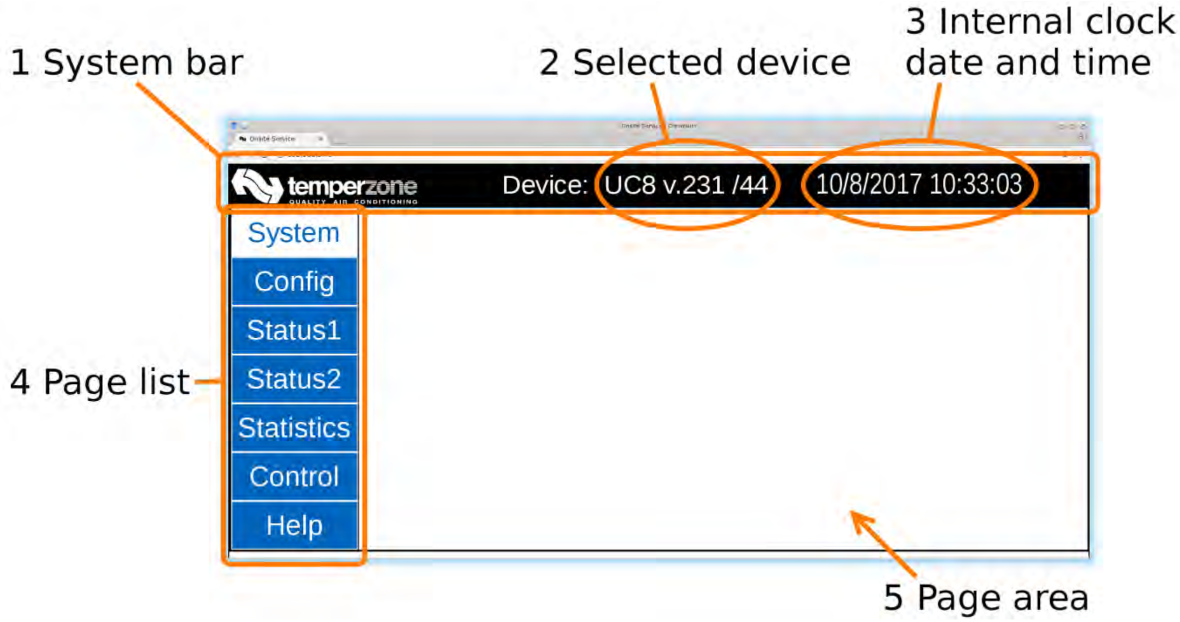
5.1 Operation (Continued)

The controllers found during the search are listed in the system page together with their communication parameters. Controllers connected after the search has begun may not be detected. If no controllers are detected the search re-starts.

During normal operation the Modbus parameters are read periodically from each of the connected target controllers.

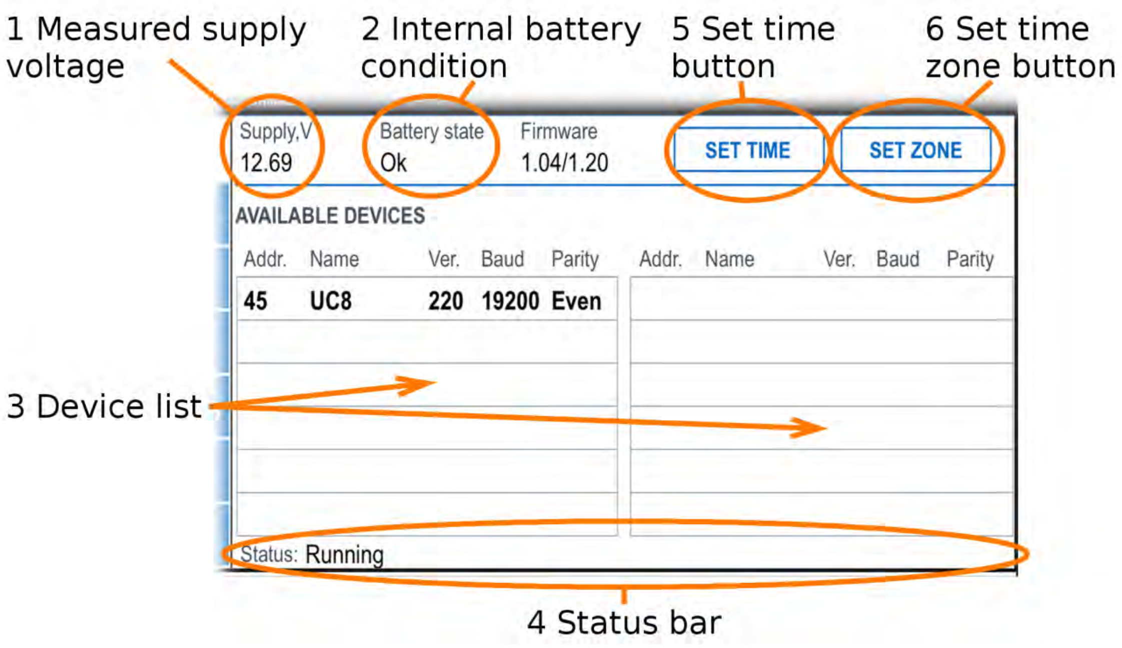
Shutdown starts when power is disconnected.

5.2. Page Overview



1. **System bar**
   The system bar displays system information.
2. **Selected device**
   Information from this device will be displayed in the page area. The selected device can be changed in the system page.
3. **WSU internal clock time and date**
   The progress of the WSU internal clock reading is an indicator of the reliability of the Wi-Fi communication link. If several Wi-Fi communication attempts fail the time and date are replaced by the message, Check Wi-Fi! It may be necessary to move closer to the WSU or check the wireless networks settings of your device.
4. **Page list**
   The page list is set by the device selected on the system page. Selecting the page name shows the corresponding page in the page area.
5. **Page area**
   The page area displays the selected information page.

5.3. System Page



1. **Measured supply voltage**
   Indicates the supply voltage connected to the WSU.
2. **Internal battery condition**
   Displays the state of the WSU's internal battery, refer to the Internal Battery section.
3. **Device list**
   Devices connected to the WSU target connector are listed in the left and right panes with their Modbus address, communications settings, and software version. Select the displayed device to show data from that device.
4. **Status bar**
   The status bar shows the current activity of the WSU.
5. **Set time button**
   Select the Set time button to synchronise the WSU internal time (displayed above) with your devices time.
6. **Set time zone button**
   Select the Set time zone button to choose the time zone for the WSU time display.

5.4. Data Pages

Each data page displays up to 26 data items read from the controller. Where a data item is not available it may be displayed greyed out.

5.5. Control Page

Up to 18 controllable variables are listed on the control page. Depending on the controller there may be an enable box that must be activated before the control can be used. Action buttons are provided to adjust the control value and the current state of the control value is shown.

Following a change to a control value the value's colour changes to pink while it is being modified. After 1 second, without a further button press, the value changes to brown to indicate that it has been transferred to the controller. After a further 2 seconds the value read back from the controller is displayed in the normal colour. If the change was successful the updated value will be shown, if the change was not successful the value will revert to the initial controller value.

5.6. Help Page

This manual and manuals for supported temperzone controllers are accessible through the help page. These manuals may be updated, and the latest versions can be found at www.temperzone.com

5.7. Internal Battery

The WSU uses a PP3 9V Alkaline or Lithium battery. The status of the battery is displayed on the System Page. When the battery state indication is “Low” the battery should be replaced. If the status indication is “Flat” the battery should be replaced immediately, as the WSU’s operating system may be damaged.

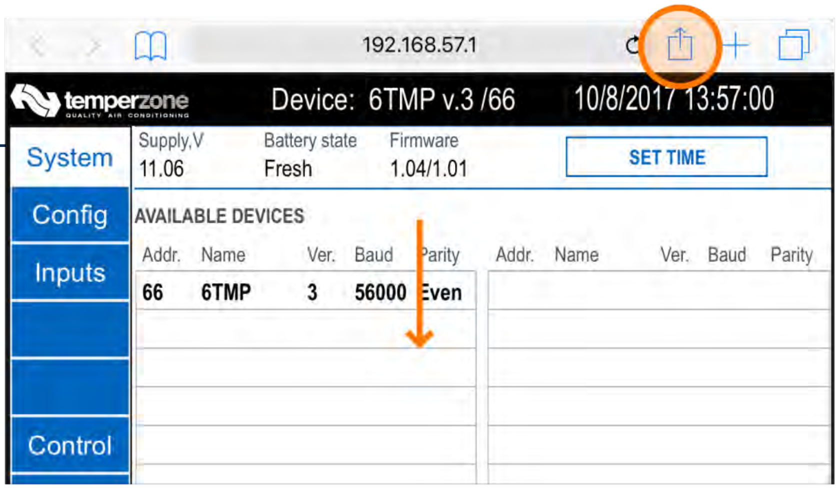
NOTE: The battery state may indicate flat when the WSU is first used and on the first use after the battery has been replaced. After the first use the battery state will indicate correctly.

6. Adding a Shortcut to your Desktop

6.1. iOS desktop.

Step 1

In Safari web browser, while viewing the WSU web pages select the action button at the top of the screen. If the menu is not visible swipe the web page downwards to show it.

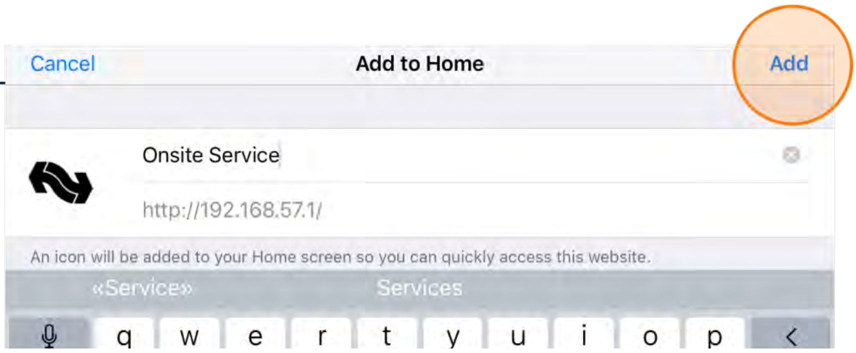


Step 2

Select the + icon.

Step 3

Select Add to add the icon to your desktop.



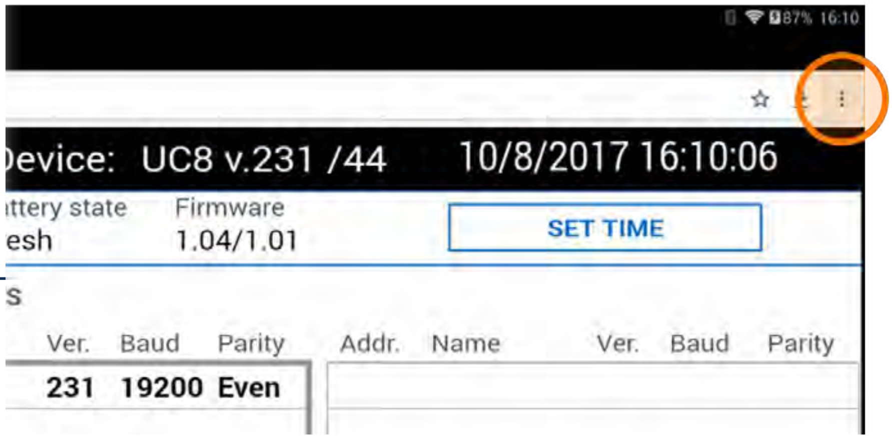
6.2. Android

Follow these instructions to add a shortcut to your Android desktop. Operation may vary between Android devices; the following steps may not exactly match your device.

Chrome Browser

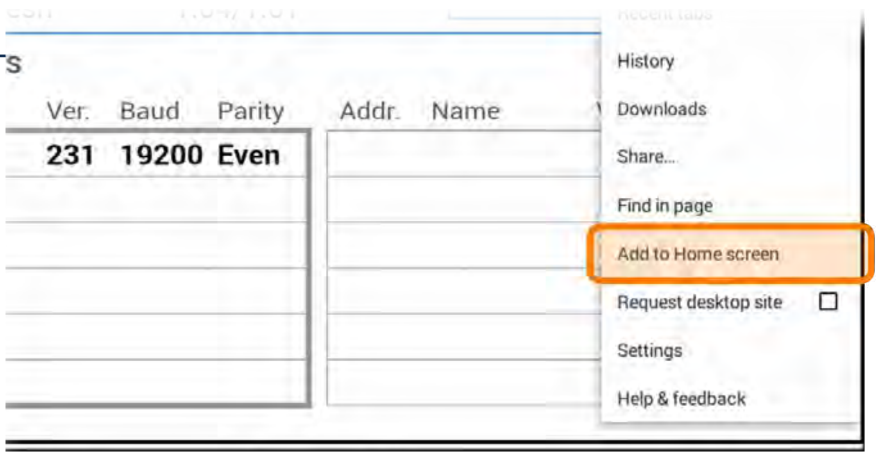
Step 1

Select the menu button.



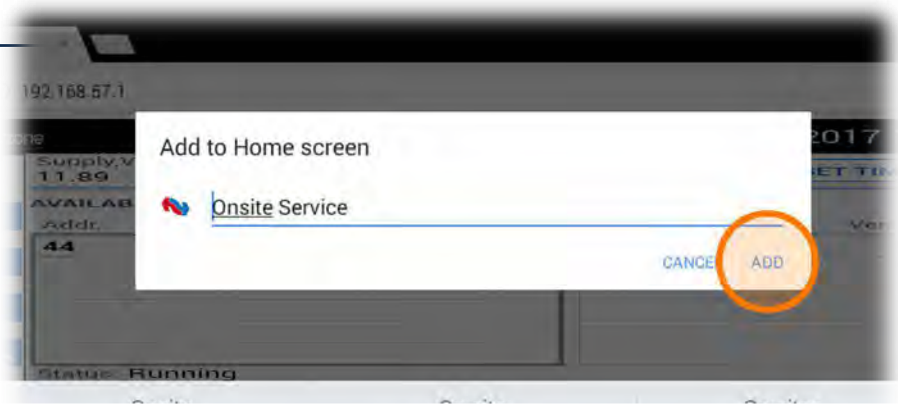
Step 2

Select Add to Home screen from the menu.



Step 3

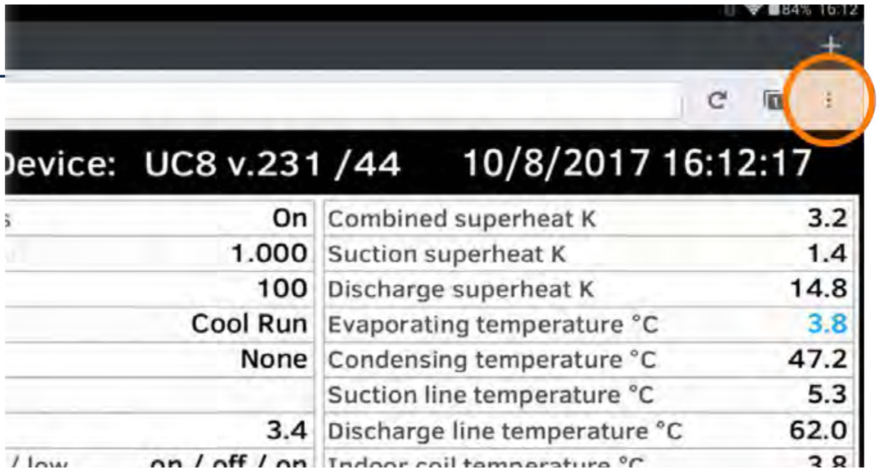
Select Add to add the icon to your desktop.



6.3. Firefox Browser

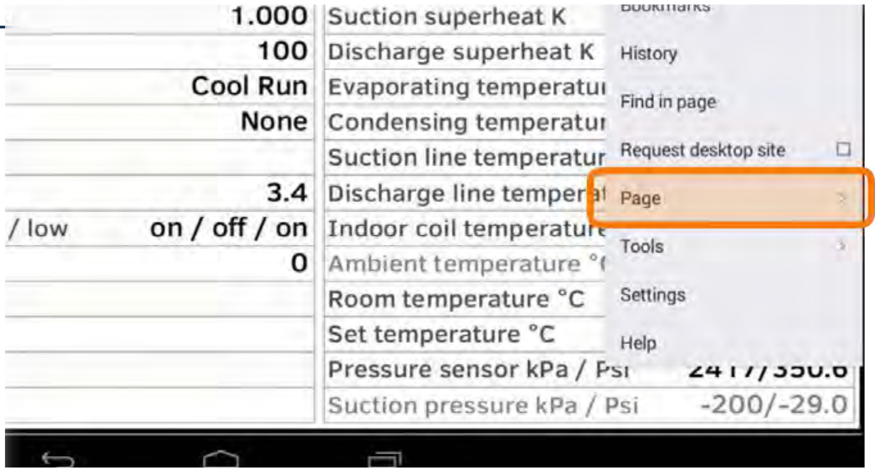
Step 1

Select the menu button.



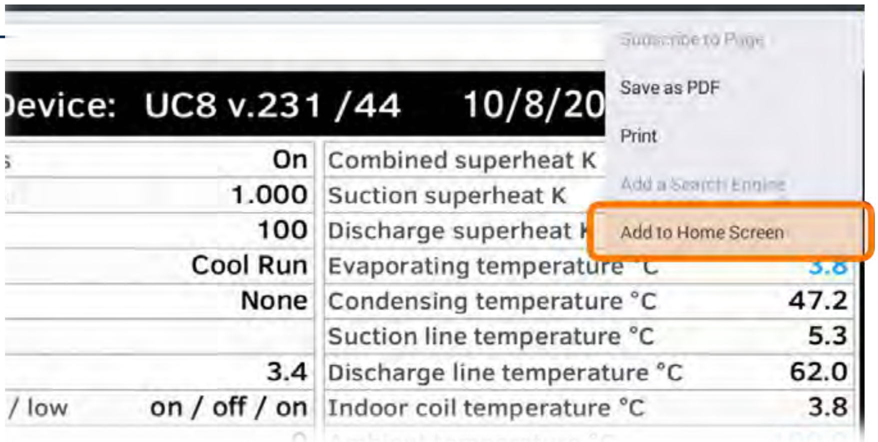
Step 2

Select Page from the menu.



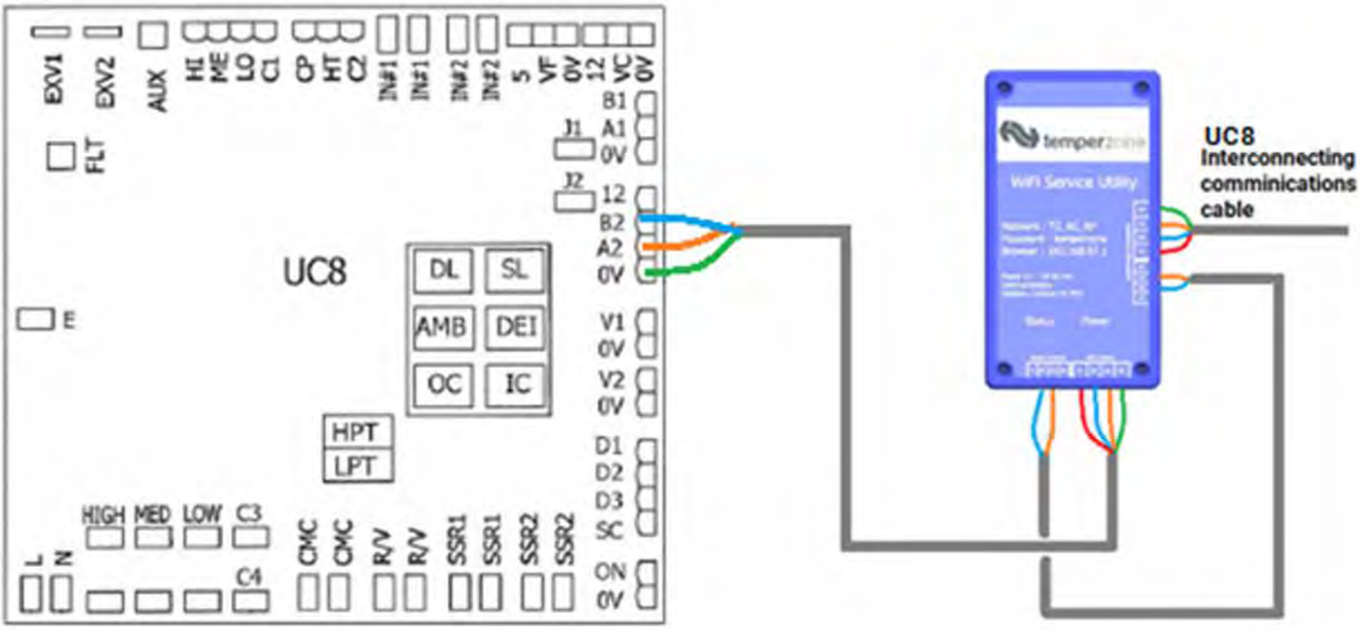
Step 3

Select Add to Home Screen from the menu.

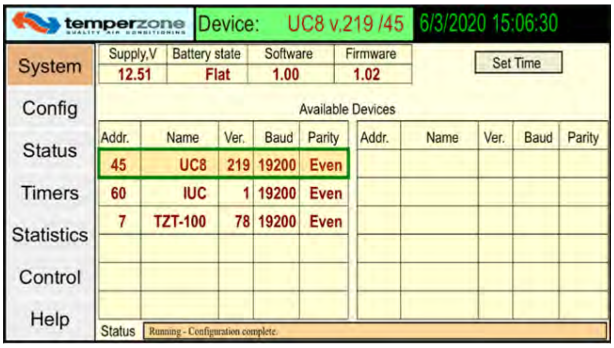


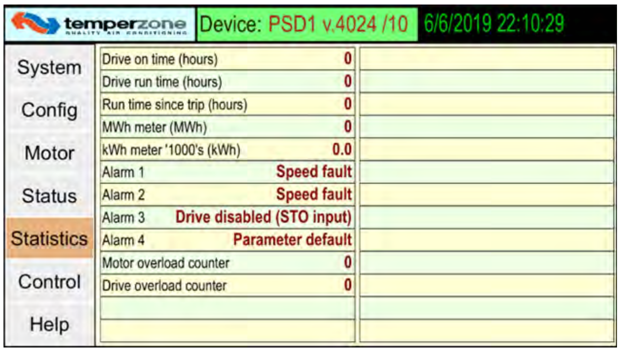
Appendix I – WSU target wiring combinations

IUC – SAT 3 – TZT-100 - Carel PSD Inverter

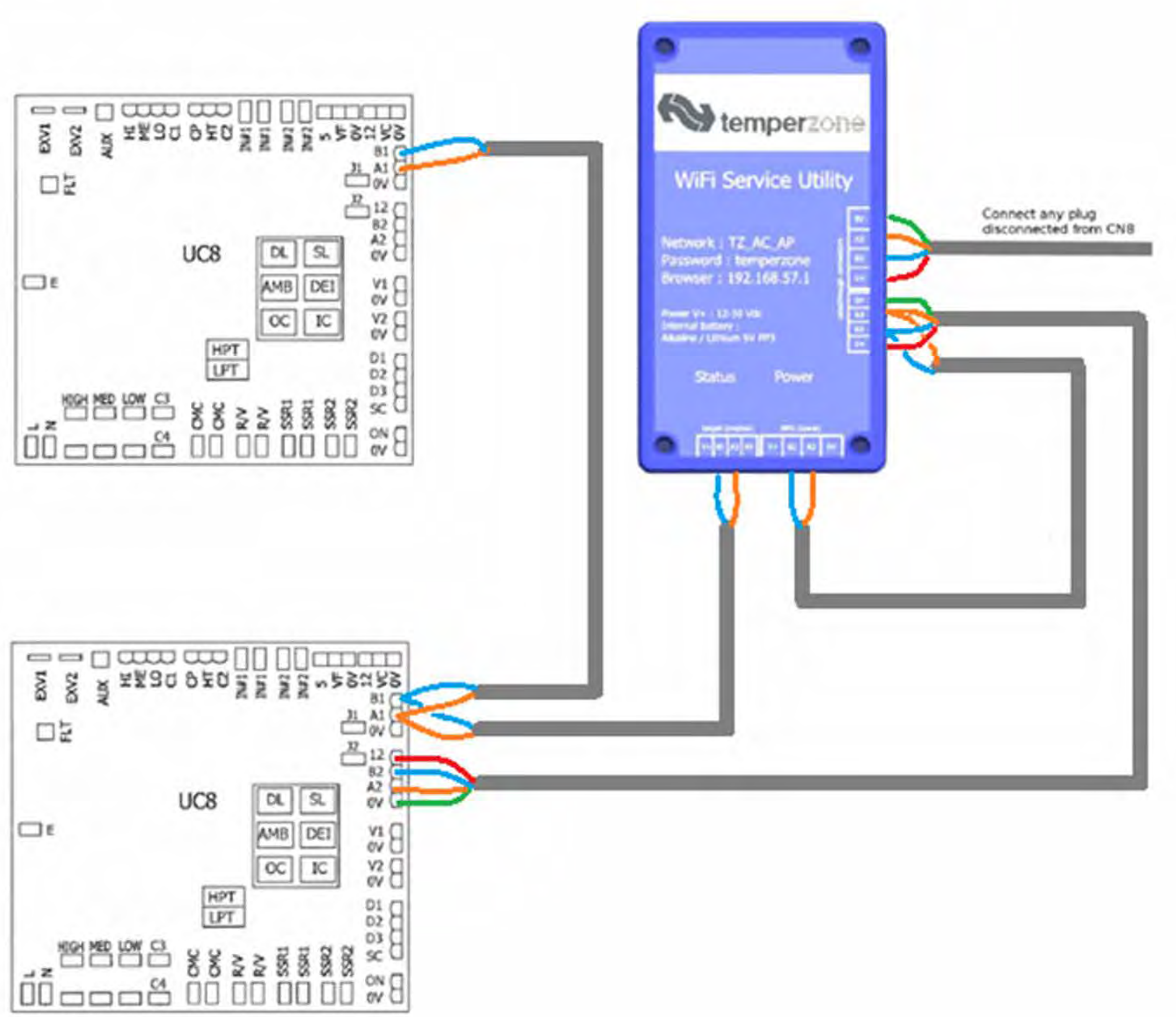


When connected choose the system that you wish to investigate in the systems menu then inspect data.





Master / Slave UC8



Relative Humidity

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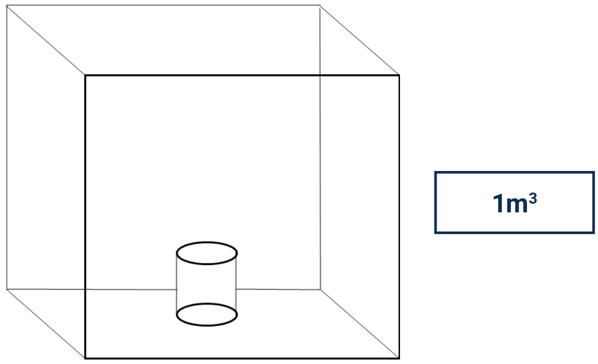
1. Introduction

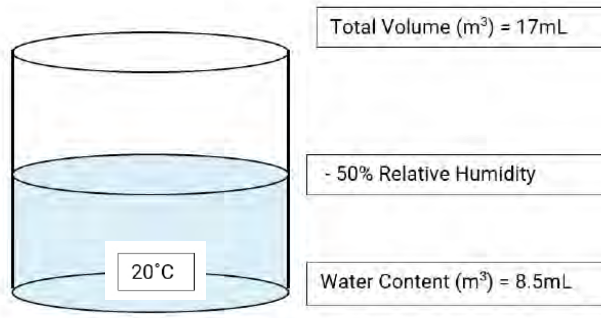
Relative humidity is the most common method of humidity measurements, yet it is also the most perplexing. Relative humidity is expressed as the percentage of water vapour in the air RELATIVE to the total amount of water the air can hold at a given temperature.

When the temperature of air increases the total amount of water vapour that can be contained in the air increases. As the temperature of air decreases the total amount of water vapour that can be contained in the air decreases. Therefore, relative humidity is not the ideal metric for evaluating the water content within air as the ratio of vapour content to total possible vapour content changes with temperature



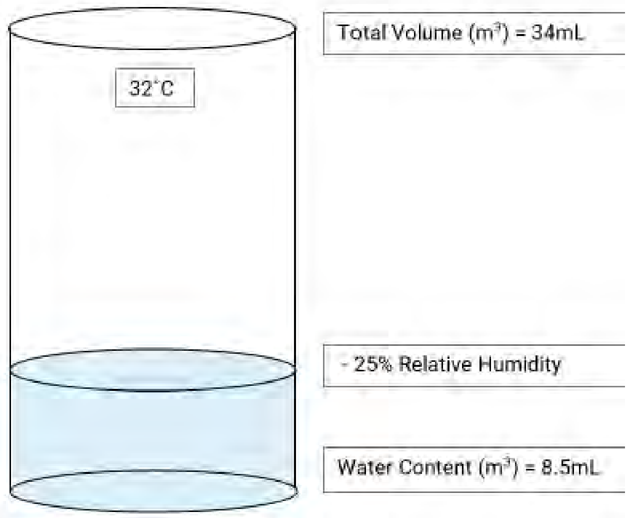
For simplicity to help understanding, consider a scenario in which a jug was to represent the total amount of volume available to absorb moisture within 1m³ of air at a given temperature

If the temperature of the air is 20˚C the total volume of water the jug can hold is 17g (17mL) of water per cubic meter of air. 50% relative humidity would mean that the jug will hold 8.5 g/m³.



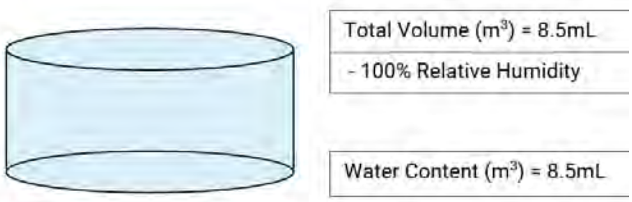
As air increases in temperature the amount of water that it can absorb increases. In other words, the size of the jug grows.

If the temperature of the air rises to 32˚C, the total volume of water it can absorb increases to 34 grams of water per cubic meter. The volume of water in the air remains the same, but the relative humidity has changed.



Conversely if the air were to decrease in temperature the amount of water it can absorb will also decrease. In other words, the size of the jug is reduced.

If the temperature of the air decreases to 8˚C the total volume of water it can absorb is reduced to 8.5 grams of water per cubic meter. The volume of water in the air remains the same but the relative humidity has changed.



When relative humidity reaches 100% the air cannot hold any more water vapour. This is called saturation point. This is the point when clouds can produce rain, windows condense, and cool objects sweat.

As you can see relative humidity can be deceiving when measuring humidity. A more accurate method is to use absolute humidity (the amount of grams of water in a cubic meter of air) or specific humidity (the amount of grams of water in one kilogram of dry air). By using one of these two methods the water content within the air will remain constant regardless of the temperature of the air.

Humans' bio-cooling system is based upon the perspiration and then evaporation of sweat from our pores. It is this cooling system that makes humans particularly susceptible to fluctuations in humidity. If the water content in the surrounding air is high the evaporation of our perspiration is inhibited, making us feel uncomfortable at a given temperature, vice versa if the water content in the surrounding air is particularly low perspiration is free to evaporate effortlessly making us feel more comfortable at a given temperature. Therefore, an understanding of the impacts of humidity on the effectiveness of an air conditioner is important in the initial design, control methodology and system diagnosis is essential.

Under Sized Systems

Undersized systems are ineffective at removing the moisture content from the air. Much of the available capacity is utilized removing moisture rather than reducing supply air temperature. Undersized systems often display symptoms such as:

- High space temperatures
- High space RH% and wet bulb temperatures
- Mould and contaminants within split system casing and supply fan and duct
- High power consumption
- Long cooling hours
- Low air on/off temperature difference

Oversized Systems

Commonly systems can be overdesigned in capacity requirements due to improper heat load estimation. An oversized system will cycle onto cooling mode and the indoor coil will become damp with condensed moisture. The unit will then reach set point temperature and cycle off before the water condensed on the coil has had adequate time to accumulate in droplets and run off the coil and released out of the drain line. In the proceeding off cycle this moisture is evaporated back into the supply air stream along with additional moisture added from the fresh air intake and other fresh air ingress points. Oversized systems often display symptoms of:

- Stuffiness and discomfort within the space at set point. Especially noticeable on low ambient high humidity days (rainy / overcast).
- High RH% and wet bulb temperatures at set point
- Higher moisture content in the space than in ambient conditions

Economy Cycle

Systems using economy cycle controlled of a dry bulb ambient temperature reading can increase the capacity requirements of the air-conditioning system if additional moisture is added to the space. An increase in moisture content will require an increase in cooling capacity required to remove additional latent heat resulting in a decrease in energy efficiency rather than an increase. Economy cycle should only be operated when the total heat energy of the air (sensible heat + latent heat) of the conditioned space is higher than the total heat energy of the ambient conditions. In other words, the wet bulb temperature of the outdoor condition should not be higher than that of the conditioned space wet bulb temperature.

Enthaply

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1. Introduction

Heat is energy; the total amount of heat energy contained in a volume of air is referred to as enthalpy. The combination of parts that make enthalpy are sensible heat and latent heat. Sensible heat is energy that is transferred to change the temperature of a material. Latent heat is the energy that is transferred to change the state of a material.

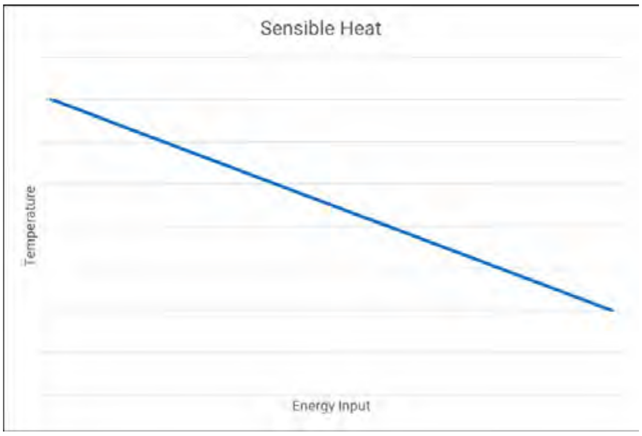
Sensible heat is easily understood and easily observed in the field, as energy into the refrigeration cooling cycle can be witnessed as a supply air dry bulb temperature drop.

The word latent comes from the Latin word 'latens', meaning hidden, latent heat literally translates to hidden energy. This is the energy that is transferred when changing a materials state, such as the condensation of water vapour in the air during a cooling cycle. Latent heat does not change the dry bulb temperature of the supply air, hence the name 'hidden energy'. Although hidden, its effects on the capacity requirements, comfort of occupants and performance related issues are very real.

Understanding the impacts of both of types of heat energy that make up enthalpy will aid and assist design, commissioning, and fault diagnosis of an air conditioning system.

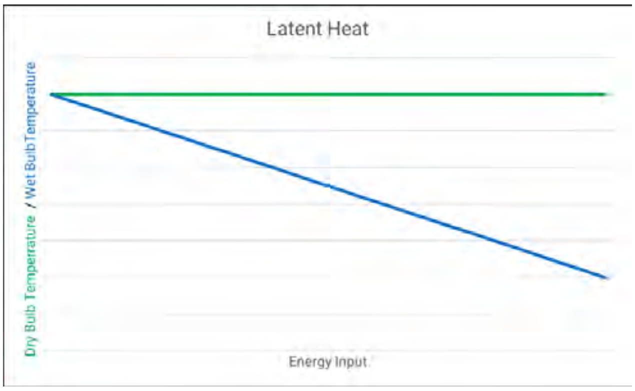
Sensible Heat – is the energy absorbed to change a material's temperature.

The energy input to the refrigeration system in cooling mode has a direct impact on the change of air temperature. As the energy input is increased, supply air temperature will decrease (until dewpoint is reached).

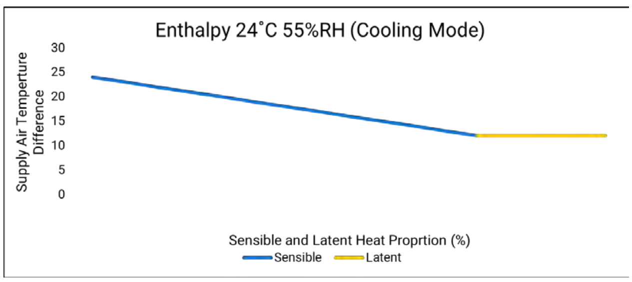


Latent Heat – is the energy absorbed to change a material's state.

The energy input to the refrigeration cooling system has no effect on the change of air temperature in the latent heat removal process. However, as the moisture in the air changes state (condenses from vapour to liquid) the moisture content within the air is reduced, decreasing the wet bulb temperature and dewpoint temperature.



In a typical cooling cycle of a correctly performing air conditioner with room temperature of 24˚C and 55% relative humidity will have the enthalpy profile of the chart below. 75.8% of the energy input is directed to the efficient removal of sensible heat. In other words, 75.8% of the duty is used to lower supply air dry bulb temperature. 24.2% of the energy input is directed to latent heat removal. In other words, 24.2% of duty is used to remove moisture from the air without affecting the supply air temperature.



Practical Enthaply

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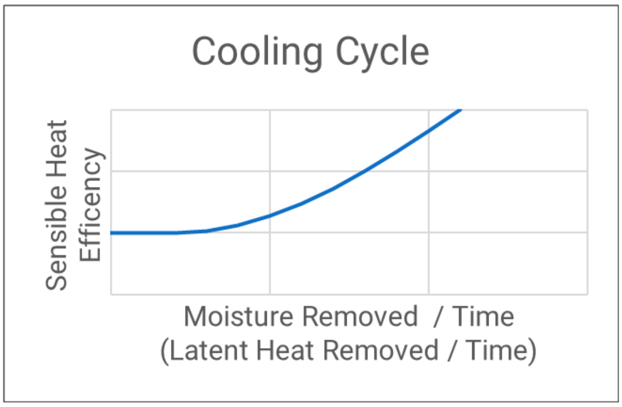
1. Introduction

During a full cooling cycle, the amount of moisture in the air decreases. As this happens the amount of energy required for the latent heat process is reduced. This energy then becomes available for absorption in the sensible cooling process.

As the cooling cycle progresses over time, moisture (or latent heat) is removed from the air. As the air requires less latent heat absorption for moisture removal the availability of capacity for sensible heat absorption increases. As the sensible heat absorption increases, supply air temperature decreases, room conditions improve and energy efficiency increases (see chart to the right).



A real-world scenario that highlights thermodynamic energy distribution is to investigate the latent and sensible heat requirements of an air conditioner at the start of a cooling cycle compared to the end of a cooling cycle.

Model - **OPA 970**

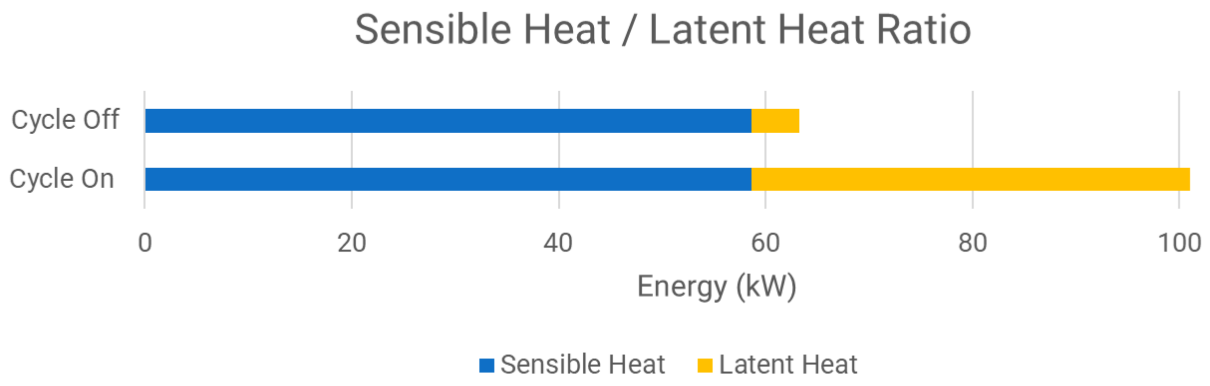
Capacity - **16kW - 102kW**

Air flow - **4700L/s**

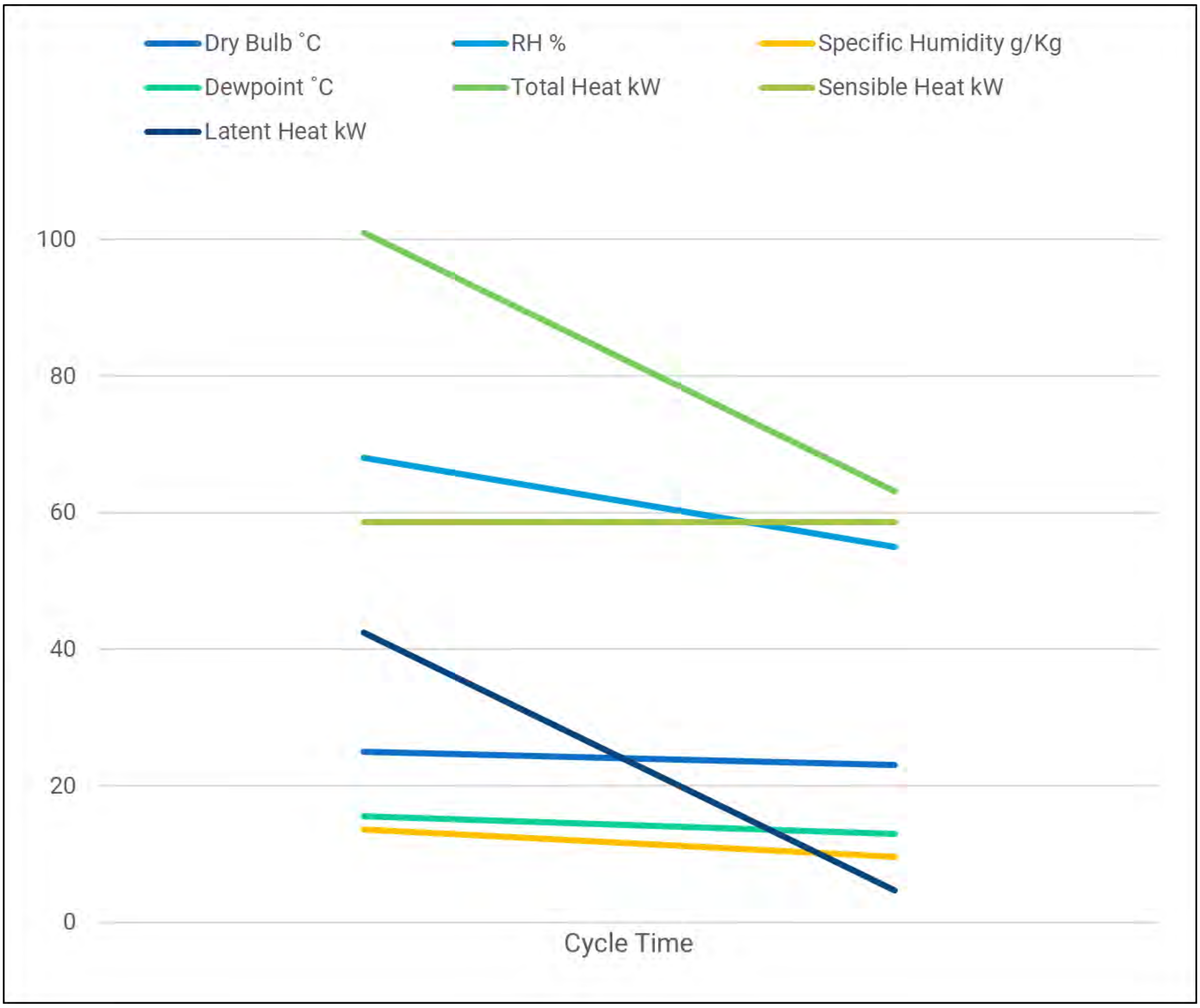
Cycle on - **25°C**

Cycle off - **23°C**

Space Conditions		
Measurement	**Cycle On**	**Cycle Off**
Dry Bulb	25 ˚C	23 ˚C
Relative Humidity	68 %	55 %
Specific Humidity	13.6 g/Kg	9.6 g/Kg
Dewpoint	15.6 ˚C	13.0 ˚C
Target Supply Air Temperature	15.6˚C	13˚C
Target Supply Air Humidity	100%	100%
Total Heat	101 kW	63.2 kW
Sensible Heat	58.6 kW	58.6 kW
Latent Heat	42.4 kW	4.7 kW



The latent heat load of the air decreases as moisture content is removed. This lowers the total heat capacity of the air being conditioned. The result is compressor inverters can lower unit output decreasing the electrical input and increasing efficiency.



What are the repercussions of selecting an air conditioner that is undersized for the enthalpy (total energy) of the air within the space?

If the same cycle on conditions were present but the heat load estimation determined that air-flow requirements of the building increased from 4700 L/s to 7500 L/s, yet the same OPA970 was selected the capacity deficit would look like this.

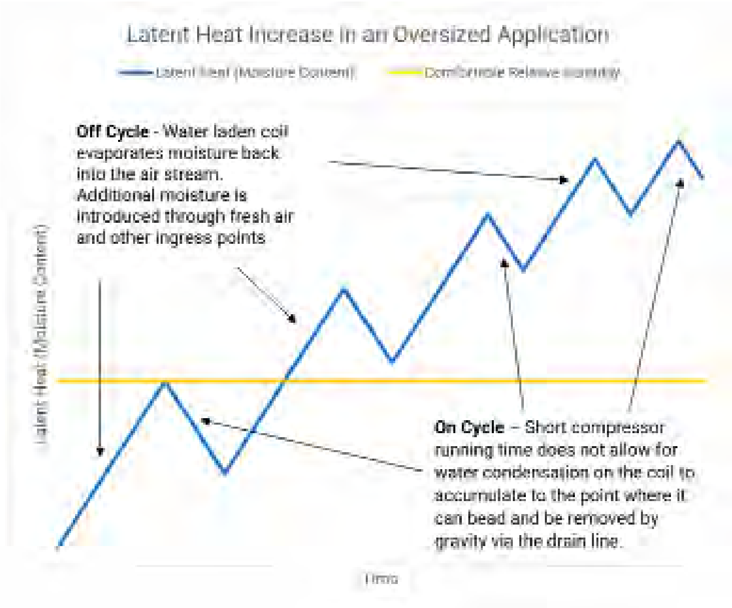
Cycle On Conditions - 25˚C, 68 % Relative Humidity	
Sensible Heat	93.5 kW
Latent Heat	67.6 kW
Total Heat	161.1 kW
OPA970 Maximum Capacity	102 kW
Capacity Deficit	59.1 kW

Due to the deficiency in capacity the OPA970 will struggle to maintain or lower space temperature as well as an inability to effectively reduce the moisture within the air.

What are the effects on latent heat when a system is oversized?

An oversized system will cycle onto cooling mode and the indoor coil will become damp with condensed moisture. The unit will then reach set point temperature and cycle off before the water condensed on the coil has had adequate time to accumulate in droplets and run off the coil and released out of the drain line. In the proceeding off cycle this moisture is evaporated back into the supply air stream along with additional moisture added from the fresh air intake and other fresh air ingress points.

In each off cycle the latent heat (and moisture content) of the conditioned space increases incrementally. Although dry bulb temperature within the space remains within the set point tolerance, the space begins to feel stuffy, and discomfort increases with every off cycle. The latent heat increase is typical of the chart to the right.



Oversizing of an air conditioner can easily be misunderstood as a necessary security measure to deal with a margin of error when designing an installation. In doing so the design risks the increase in discomfort during low load scenarios that will increase the unmanaged latent heat of the space that is to be conditioned. In fact, oversizing an air conditioner may actually lead to the space becoming de-conditioned.

What are the risks of not utilising enthalpy control when enabling economy cycle?

Economy cycle that uses dry bulb temperature control, will open the air stream to induce outside air to perform the task of cooling the space when the outside air dry bulb temperature is lower than the inside space dry bulb temperature. This is often referred to as free cooling as the space can cooled without operating the compressors. What happens if the dry bulb temperature outside is lower than inside, but the wet bulb temperature is higher? This is not an uncommon situation that can be achieved during conditions of rain, fog and heavily overcast days at particular times of year. If economy is used in this scenario the attempted efficiency of free cooling is actually an inefficient burden of latent heat.

Energy Contained in Outside Air Compared to Inside Air at 4700 L/s		
Measurement	**Inside Air**	**Outside Air**
Dry Bulb	23˚C	19˚C
Wet Bulb	16.2˚C	17.9˚C
Relative Humidity	50%	90%
Specific Humidity	8.8 g/kg	12.4 g/kg
Enthalpy	45.5 kJ/kg	50.6 kJ/kg
Sensible Heat	-23.5 kW	
Latent Heat	53.2 kW	
Total Heat Gain	29.7 kW	

Although the outside cooler air lowers sensible heat requirements, the increased in enthalpy means the introduction of latent heat (53.2kW) outweighs the benefits of the sensible heat (-23.5kW). The conditioned space is increasing in thermal energy rather than decreasing the need for mechanical operation of the compressors to condition the space. The added increase in latent heat will increase human discomfort due to the increase in moisture content of the air.

It is for the above reasons that economy cycle should not be used if the wet bulb temperature of outside is higher than inside as it will directly increase the amount of heat energy in the room rather than decrease.

Terminology

Add – Modbus device Address
ALC – Analogue Level Controller
BLDC – BrushLess Direct Current motor
CAP – Unit CAPacity (%)
CT – Condensing Temperature (saturated discharge temperature)
CWP – Cupboard Water-cooled Packaged
DLP – Discharge Line Pressure
DS – Dip Switch
DSH – Discharge SuperHeat
DT – Discharge Temperature
ECC – Electronic Centrifugal fan-speed Controller
EC Motor – Electronically Controlled Motor
Econex – Latest R32 inverter operated air conditioning range from temperzone
EEV – Electronic Expansion Valve
EEV1 – Electronic Expansion Valve 1 (%)
EEV2 – Electronic Expansion Valve 2 (%)
EMI – Electro Magnetic Interference
ET – Evaporator Temperature (saturated suction temperature)
HWP – Hideaway Water-cooled Packaged
ISD – Indoor Split Ducted
IUC – Indoor Unit Controller
OPA – Outdoor Packaged Air-cooled
OSA – Outdoor Split ducted Air-cooled
Plug Fan – Fan motor containing an inbuilt inverter
PSD – Carel Power + Speed Drive
RA – Return Air
RV – Reversing Valve
SA – Supply Air
SLP – Suction Line Pressure
SSH – Suction SuperHeat
ST – Suction Temperature
SW3 – UC8 Push-button
TFC – Triac Fan Controller
UC6 – Unit Controller 6
UC7 – Unit Controller 7
UC8 – Unit Controller 8
WSU - Wi-Fi Service Utility

Rules of Thumb

Air flow

- Supply air plenum should be 7x length of barrel fan diameter before first spigot to avoid turbulence
- Return air plenum should be 2x length of fan barrel diameter before first spigot to avoid turbulence
- Large duct = high volume, low velocity, low static pressure, short throw, low noise
- Small duct = low volume, high velocity, high static pressure, long throw, high noise
- Surface area of return air filter should be no less than the surface area of the indoor coil ideally filter should be no less than 1.8x indoor coil surface area
- Return air flex duct cross sectional area should be the same size as the indoor coil surface area or larger
- Air speed across indoor coil should be no lower than 1.3m/s and no higher than 2.8m/s
- The colder the air the higher the relative humidity (supply air can be close to 100% RH)
- For maximum throw on side blow diffusers angle all blades horizontally except for the bottom blade. Turn the front edge of bottom blade up on a 45° angle
- To overcome stratification on heating increase air velocity
- Decrease noise by changing duct direction 3 times (this can be flex or hard duct)
- Toilet exhausts require 10L/s of exhaust per stall

Electrical

- Running amps of a motor are generally 7x less than locked rotor amps
- Star connection = low speed, high torque
- Delta connection = high speed low torque
- Capacitors connected in series decrease capacitance (C1 x C2 / (C1 + C2))
- Capacitors connected in parallel increase capacitance (C1 + C2)
- Fan amp draw decreases due to a resistance in air flow (e.g., blocked filter) on centrifugal fans (unless speed controlled on air flow)
- Fan amp draw increases due to a resistance in air flow (e.g., blocked condenser coil) on propeller fans.

Piping

- Five changes in direction before between fixing points reduces vibration without the need for vibration eliminators
- Suction lines should tilt downhill towards the compressor 10mm for every horizontal meter of suction pipe
- The longer the suction line and the more bends the bigger the reduction in unit capacity
- Suction line must be trapped at the very first vertical rise after indoor unit regardless of total vertical height.
- Traps should be as short as possible horizontally as to only hold the minimum amount of oil before flushed out (prevention of oil logging)

Water

- Drain trap exit should be half the height of entry.
- Use a deeper drain trap to overcome large negative static on the return air chamber
- Drain lines should slope down a minimum of 10mm per 1m
- Water pressure increases 10pa with every 1m of vertical rise
- Pumps located on ground level are larger and more power consuming than pumps on roof level due to water level (gravity) not increasing the head required to create flow
- Ideal condensing water temperature supplied from cooling towers is 28-32 degrees
- Ideal condensing temperature on water cooled equipment is 32-34 degrees
- Swapping inlet and outlet hoses on water cooled equipment can clear condenser blockages, just remember to swap them back after its cleared!
- Wind thread tape in the opposite direction to thread

Heat Load estimation

- General home sizing is approximately 130 W/m
- 1 computer is approximately 100W
- Heat load of a passive person is 150 -200W
- Sensible load performs the change of air temperature
- Latent load removes humidity and does not change air temperature
- High humidity can make rooms ‘feel’ excessively hot. This is common is oversized air-conditioned spaces during low load
- Glass is an architect’s best friend and the HVAC designer’s enemy. Reduce impacts of sun on glass wherever possible
- Economic lifespan of packages and split ducted units is 10 years full use (10 hrs day 5 days a week)

Conversion Tables

Pressure

	Bar	kPa	Psi
1 Bar	1	100	14.50
1 kPa	0.01	1	6.89
1 Psi	0.069	6.89	1

Temperature

Fahrenheit to Celsius:

°C = 5 / 9 x (°F − 32)

Celsius to Fahrenheit:

°F = (9 / 5 x °C) + 32

Energy

	kW	HP	BTU/hr	Tons
1 kW	1	1.34	3412	0.284
1 HP	0.746	1	2544	0.212
1 BTU/hr	3412	0.000393	1	12000
1 Ton	3.52	4.781	12000	1

Copper tube

Imperial	Metric
1/4	6
3/8	10
1/2	12
5/8	15
3/4	19
7/8	22
1	25
1,1/8	28
1,3/8	35

Length

	Inches	Feet	Yards
1 mm	0.039	0.003	0.001
1 cm	0.393	0.032	0.010
1 m	39.37	3.280	1.093

Weight

	Ounces	Pounds	Stones	US Ton
1 g	0.035	0.002	0.00015	1.1023e-6
1 kg	35.274	2.2046	0.1574	0.0011
1 t	35274	2204.62	157.473	1.1023

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