UNIT CONTROLLER 8 (UC8)
Modbus RTU communications

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Contents

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.
- Enable and disable economy operating mode.
- Enable and disable commissioning mode.
- Request an oil recovery cycle (‘oil flush’).
- Monitor and control de-icing of the outdoor coil.
- 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 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 2.0.9 and 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 15: Write multiple coils
- 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 functions 05 and 15 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: Most 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 access these coils / bits. However using Modbus functions 05 (write one coil) and 15 (write multiple coils) is recommended.

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 pushbutton 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	Modbus port 1 Baud rate	0 = 4800 baud 1 = 9600 baud ***2 = 19200 baud*** 3 = 38400 baud 4 = 57600 baud
718	Modbus port 2 Baud rate	0 = 4800 baud 1 = 9600 baud ***2 = 19200 baud*** 3 = 38400 baud 4 = 57600 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 Modbus 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).

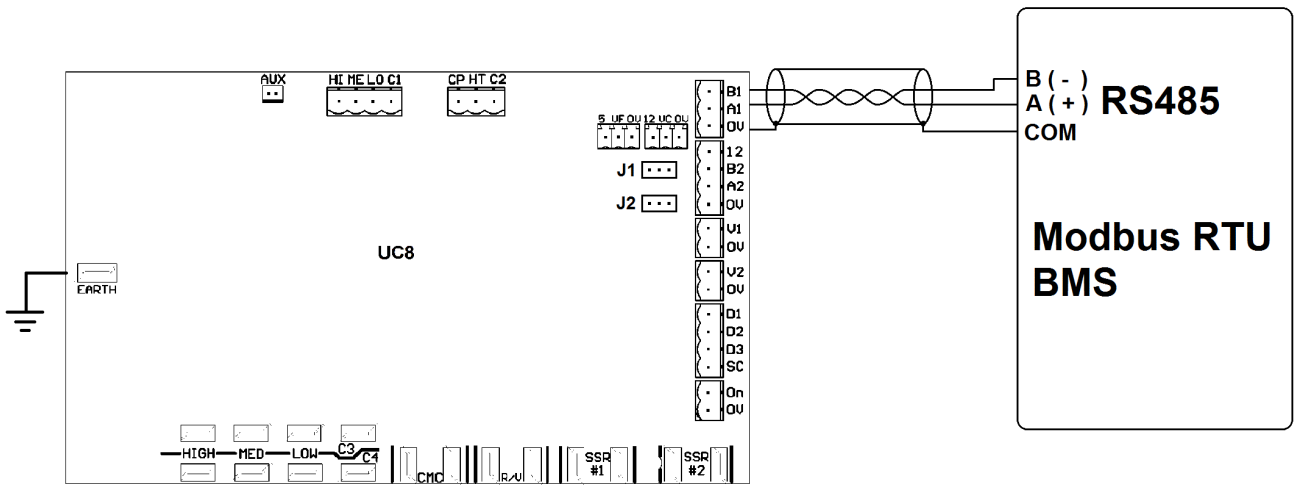
For RS485 Modbus port 1 only:
A method is provided via register 1402 which allows reconfiguration of Modbus port 1 without having to reset the controller. The correct procedure is (in this order):

- Write value 8821 to register 1401 (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, 0.2 to 0.8mm^2).

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 63 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 20m), 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 20m or less, place jumper J1 on the right two pins.

Maximum cable length is 250m.

It is recommended to use an isolated RS485 interface. An isolated interface can improve 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:

- Turn mains power on.
- Ensure the thermostat and the compressor are off.
- Hold down the pushbutton on the controller board, release the button as soon as until the display shows the letter "**A**". The controller is now in "modbus address selection" mode.
- The display will show the current modbus device address. Subsequent button presses will increase the address. After address 63 the address will cycle back to 1 in round-robin fashion.
- When the button has not been pressed for more than 30 seconds the controller will leave setup mode and return to normal mode.

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.

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 can read negative. Negative numbers are represented in standard binary two's-complement 16-bit word format.

Register	Function	Units	Type
1	Outdoor coil temperature (note 2)	0.01°C	Read only
2	Indoor coil temperature (note 2)		
3	Outdoor ambient temperature		
4	Suction line temperature		
5	Discharge line temperature		
6	De-ice sensor temperature		
7	Evaporating temperature (note 3)		
8	Condensing temperature (note 3)		
9	Controller temperature		
10	Suction side superheat	0.01 Kelvin	
11	Discharge side superheat		

Note 1: *Many models do not have all temperature sensors fitted. A read of a holding register 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)].

Register	Function	Units	Type
13	Compressor suction line pressure	kPa	Read only
14	Compressor discharge line pressure		

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 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 not have electronic expansion valves then these registers 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 registers

Modbus holding registers with register address 1xx (101 to 112, 115, 118, 119) can be used to control a unit using the Modbus RTU communications protocol. **Bold** letters indicate factory default values.

Register	Function	Notes	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: Outdoor coil de-icing control Bit 9: Quiet mode Bit 10: Dry mode (de-humidification) Bits 11, 12: Reserved, do not use Bit 13: Economy mode Bits 14, 15: Reserved, do not use	**0 = BMS control disabled** 1 = BMS control enabled	Read / Write
102	Compressor on/off (Comp)	**0 = off** 1 = on [(note 8)]	
103	Cooling/Heating (Heat)	**0 = cooling** 1 = heating	
104	Remote on/off	0 = off **1 = on**	

Continued on the next page.

Register	Function	Notes	Type
105	Indoor fan mode Bit 0: Fan auto/fixed speed Bit 1: Fan off/on in deadband Bit 2: Fan off/on during de-icing Bit 3: Fan off/on during heating start Bit 4: Fan run-on after cooling end	Refer to chapter 9: Indoor fan control 0 = auto **1 = fixed** 0 = off **1 = on** 0 = off **1 = on** 0 = off **1 = on** **0 = off** 1 = on	Read / Write
106	EXV mode (note 9)	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 9: Indoor fan control	
109	Capacity	0% to 100%, **default 50%** Refer to chapter 10: Capacity control	
110	Outdoor coil de-ice control Bit 0: De-icing permission Bit 4: Force de-ice control All other bits are reserved and must not be written to.	**0 = de-ice not allowed** 1 = de-ice allowed **0 = run normally** 1 = De-ice now Refer to chapter 15: Outdoor coil de-icing	
111	Quiet mode (note 10)	**0 = off** 1 = on Refer to chapter 12: Quiet mode	
112	Dry mode (note 11) (de-humidification)	**0 = off** 1 = on Refer to chapter 13: Dry mode	
115	Economy mode	**0 = off** 1 = on Refer to chapter 14: Economy mode	
118	Supply air temperature target Cooling mode	**1200 = 12.00°C**, allowed range 10°C to 25°C Refer to chapter 11: Supply air control	
119	Supply air temperature target Heating mode	**3600 = 36.00°C**, allowed range 30°C to 42°C Refer to chapter 11: Supply air control	
120	Threshold capacity for oil recovery cycles	Allowed range 0 to 1000 (0 to 100%) **600 = 60%** of Nom. (digital scroll comp.) **450 = 60%** of Nom. (variable speed comp.) Refer to chapter 10.3: Oil recovery	
121	Request an oil recovery cycle	**0 = off** 1 = on Refer to chapter 10.3: Oil recovery	

Notes:

5: *When a BMS requires control over a particular signal, the BMS must 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(s) that may be available to the controller no longer has control over that signal. One can also use modbus functions 1 (read N coils), 5 (write single coil) and 15 (write multiple coils) to read and control individual bits in register 101 (recommended).*

6: *Read and write operations to all control registers 101 to 112, 118 and 119 are allowed at any time but have effect only when the corresponding enable-bit in register 101 is set to value 1.*

Notes, continued:

7: *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.*

8: *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 (bit 3)	Slave 2 (bit 2)	Slave 1 (bit 1)	Master (bit 0)	
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

9: *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.*

10: *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.*

11: *The UC8 offers a number of options for dry mode (de-humidification). The options that are available depend on the unit model.*

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)	
215	Cooling hold-off time (minimum time between heating --> cooling)	
216	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 12, 13)		
404	Expansion valve 2 position	0 (closed) to 480, 960 or 4000 (open) (notes 12, 13)		
405	Unit capacity	0 to 1000		
406	Digital output signals (relays and function status)			
	Bit 0:	CMC relay	0 = off 1 = on	
	Bit 1:	R/V relay	0 = cooling 1 = heating	
	Bit 2:	SSR1 relay	0 = off 1 = on	
	Bit 3:	SSR2 relay	0 = off 1 = on	
	Bit 4:	AUX output	0 = off 1 = on	
	Bit 5:	DRED status	0 = compressor may be on 1 = compressor will be off	
	Bit 6:	High relay	0 = off 1 = on	
	Bit 7:	Medium relay	0 = off 1 = on	
	Bit 8:	Low relay	0 = off 1 = on	
	Bits 9 and 10:	Reserved, do not use		
	Bit 11:	De-ice request	0 = no de-icing needed 1 = controller requests permission to de-ice the outdoor coil	
	Bit 12:	De-ice status	0 = no de-icing in progress 1 = unit is de-icing the outdoor coil	
	Bit 13:	Reserved, do not use		
	Bit 14:	Oil recovery status	0 = no oil recovery in progress 1 = unit is recovering (flushing) oil	
	Bit 15:	Reserved, do not use		

Continued on the next page.

Register	Function	Type
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.	

Notes:

***12**: Position numbers reported for the expansion valves depend on the type of valve fitted to the unit. Numbers for fully-open positions are: Dunan DPF series = 480, Carel E2V and E3V series = 960, Sanhua DPF series = 4000.*

***13**: Expansion valve openings are also reported as percentages (0-100%) in modbus registers 26 and 26. Refer to paragraph 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 14)**). Divide by 100 to obtain temperature in degrees Celsius (16 bit signed numbers).

Address	Function	Units	Type
511	Set point temperature	0.01°C	Read only
512	Room temperature		
1201	Indoor unit coil temperature, circuit 1		
1202	Indoor unit suction line temperature, circuit 1 **(note 15)**		
1203	Indoor unit coil temperature, circuit 2		
1204	Indoor unit suction line temperature, circuit 2 **(note 15)**		
1205	Supply air temperature		
1206	Return air temperature		

***Note 14**: If no communicating thermostat and/or indoor unit is connected then a read of these registers will return value -100.00°C (-10000).*

***Note 15**: This sensor reports suction line temperature when the unit is cooling. When the unit is heating this sensor reports the warm liquid line temperature.*

6.8. UC8 controller information registers

Register 601 can be used to identify the Temperzone UC8 controller.
Register 602 provides the controller software version.

Address	Function	Type
601	UC8 controller ID code Value 210	Read only
602	UC8 software version Example: 209 = version 2.0.9	

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
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

Continued on the next page.

Fault status, continued.

Address	Function	Type
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	
905	Fault number The fault number follows the order of fault bits in registers 901 to 903. Examples: 1 = HP, 2 = LP, 3 = Overload, 4 = Frost, etc. If more than one fault is present this number represents only the fault with the lowest number.	

6.10. Unit history

Address	Function	Type
1001	UC8 modbus address	Read only
1002	Reserved	
1003	Total hours cooling mode	
1004	Total minutes cooling mode	
1005	Total hours heating mode	
1006	Total minutes heating mode	
1007	Total hours de-ice mode	
1008	Total minutes de-ice mode	
1009	Total cooling cycles made	
1010	Total heating cycles made	
1011	Total de-ice cycles made	
1012	HP trip events	
1013	LP trip events	
1014	Frost protection events	
1015	Freeze protection events (hydronic models only)	
1016	High temperature protection events	
1017	High suction line temperature protection events	
1018	Overload protection events	
1019	Low discharge superheat protection events	
1020	High discharge superheat protection events	
1021	Number of power-on reset events	
1022	Reserved	
1023	Reserved	
1024	Reserved	
1025	Indoor coil temperature sensor faults	
1026	Outdoor coil temperature sensor faults	
1027	Outdoor ambient temperature sensor faults	
1028	Discharge line temperature sensor faults	
1029	Suction line temperature sensor faults	
1030	De-ice temperature sensor faults	
1031	High pressure transducer faults	
1032	Low pressure transducer faults	
1033	High board temperature faults	
1034	Reverse cycle valve faults	
1035	IUC communications faults	
1036	IUC faults	
1037	Inverter faults	
1038	Compressor out-of-envelope faults	

7. List of coils

A UC8 programmed with software version 2.0.9 or later supports Modbus coil functions:

- 1 read multiple coils
- 5 write one coil
- 15 write multiple coils

Any coil can be read at any time. Coils 1 to 26 also have write-access. Coil 27 has write access only when the compressor is off and only via Modbus function 5 (write one coil).

The tables in paragraphs 7.1 and 7.2 describe the function of each coil. Note that most coils also exist as individual bits in holding registers. The tables indicate the corresponding holding registers and bit positions of each coil.

Where possible it is recommended to use Modbus functions 5 (write one coil) and/or 15 (write multiple coils) rather than use Modbus function 6 (write one register), although one is free to choose either function for writing to these coils / bits.

7.1. Coils with read and write access

Bold letters indicate default values (every time power is applied to the controller).

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 de-icing of the outdoor coil**	Enable control over de-icing of the outdoor coil	101	8
10	**Disable control over quiet mode**	Enable control over quiet mode	101	9
11	**Disable control over dry mode**	Enable control over dry mode	101	10
12	**Disable control over economy mode**	Enable control over economy mode	101	13
13	**Compressor off**	Compressor on	102	0

Continued on the next page.

Coils with read and write access, continued.

Coil	Function		Holding register	Bit position (0..15)
	0	1		
14	**Cool**	Heat	103	0
15	Remote off	**Remote on**	104	0
16	Auto indoor fan speed	**Fixed indoor fan speed**	105	0
17	Auto fan mode	**Fan on mode**	105	1
18	Indoor fan off when de-icing the outdoor coil	**Indoor fan on when de-icing the outdoor coil**	105	2
19	Indoor fan allowed off when heating starts (avoid cold drafts)	**Indoor fan continues to run when heating starts**	105	3
20	**Indoor fan does not run-on after cooling**	Indoor fan run-on after cooling ends (remove moisture from the indoor coil)	105	4
21	**Quiet mode off**	Quiet mode on	111	0
22	**Dry mode off**	Dry mode on	112	0
23	**Economy mode off**	Economy mode on	115	0
24	**Unit is not allowed to de-ice the outdoor coil**	Unit is allowed to de-ice the outdoor coil	110	0
25	**Allow normal heating mode**	Unit must de-ice the outdoor coil now	110	4
26	**Normal operation**	Request an oil recovery cycle	121	0
27	**Commissioning mode off**	Commissioning mode on (note 16)	-	-

***Note 16**: Coil 27 can be used to start and end commissioning mode, but write access to this coil is granted only when the compressor is off and only function 5 (write one coil) can be used. An attempt to write to this coil while the compressor is on has no effect on the unit operation and the controller will return a Modbus exception code.*

7.2. Coils with read-only access

Signals that are inputs to the UC8 circuit board.

Coil	Function	Holding register	Bit position (0..15)
28	Input CP	22	0
29	Input HT	22	1
30	Input IN#1	22	2
31	Input IN#2	22	3
32	Input ON (remote on/off)	22	4
33	Input LO	22	7
34	Input ME	22	8
35	Input HI	22	9

Signals that are outputs from the UC8 circuit board.

Coil	Function	Holding register	Bit position (0..15)
36	Output relay CMC	406	0
37	Output relay R/V	406	1
38	Output relay SSR1	406	2
39	Output relay SSR2	406	3
40	Output relay AUX	406	4
41	Output relay HIGH	406	6
42	Output relay MED	406	7
43	Output relay LOW	406	8
44	Outdoor coil de-icing not required / required	406	11
45	Outdoor coil de-ice cycle inactive / active	406	12
46	Oil recovery (oil flush) cycle inactive / active	406	14
47	DRED function inactive/active	406	5

Fault status coils.

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

Coil	Function	Holding register	Bit position (0..15)	Fault code
48	HP	901	0	HP
49	LP	901	1	LP
50	Overload	901	2	OL
51	Indoor coil frost	901	3	Frost
52	Hydronic unit water freeze	901	4	Freeze
53	Compressor discharge line high temperature	901	5	Hi-t
54	Compressor suction line high temperature or high evaporating pressure / temperature	901	6	Hi-SL
55	Hydronic unit condensate tray (sump) flooding	901	7	Flood
56	Hydronic or chiller unit water circulation verification switch open	901	8	No-Flo

Continued on the next page.

Fault status coils, continued.

Coil	Function	Holding register	Bit position (0..15)	Fault code
57	Low discharge superheat	901	9	Lo-DSH
58	Outdoor fan problem	901	10	F10
59	Indoor fan problem	901	11	F11
60	Low pressure transducer problem (LPT)	901	12	F12
61	High pressure transducer problem (HPT)	901	13	F13
62	Compressor suction line temperature sensor problem (SL)	901	14	F14
63	Compressor discharge line temperature sensor problem (DL)	901	15	F15
64	Outdoor coil de-ice temperature sensor problem (DEI)	902	0	F16
65	Outdoor coil temperature sensor problem (OC)	902	1	F17
66	Indoor coil temperature sensor problem (IC)	902	2	F18
67	Outdoor ambient temperature sensor problem (AMB)	902	3	F19
68	Superheat unknown, cannot control EXV	902	4	F20
69	Lost communications with the thermostat	902	5	F21
70	Lost communications with UC8 master	902	6	F22
71	Lost communications with UC8 slave 1	902	7	F23
72	Lost communications with UC8 slave 2	902	8	F24
73	Lost communications with UC8 slave 3	902	9	F25
74	Problem reading UC8 DIP switches	902	10	F26
75	Illegal fan selection (illegal UC8 DIP switch selections)	902	11	F27
76	Outdoor coil de-ice sensor (DEI) is required	902	12	F28
77	UC8 control board is too hot	902	13	F29
78	Problem with UC8 supply voltage	902	14	F30
79	One or more UC8 slave boards reports a problem	902	15	F31
80	0-10V input fault	903	0	F32
81	High discharge superheat	903	1	Hi-DSH
82	Pressures are not equalising	903	2	F34
83	Reverse cycle valve problem	903	3	F35
84	Invalid DIP switch selection on TZT-100 thermostat	903	4	F36
85	Lost communications with indoor unit controller (IUC)	903	5	F37
86	Indoor unit controller (IUC) reports a problem	903	6	F38
87	Variable speed compressor driver reports a problem	903	7	F39
88	Compression ratio too high (outside compressor operating envelope)	903	8	F40
89	Compression ratio too low (outside compressor operating envelope)	903	9	F41
90	Evaporating pressure / temperature too high (outside compressor operating envelope)	903	10	F42
91	Condensing pressure / temperature too low (outside compressor operating envelope)	903	11	F43
92 to 95	Reserved	-	-	-

8. Unit control via Modbus RTU

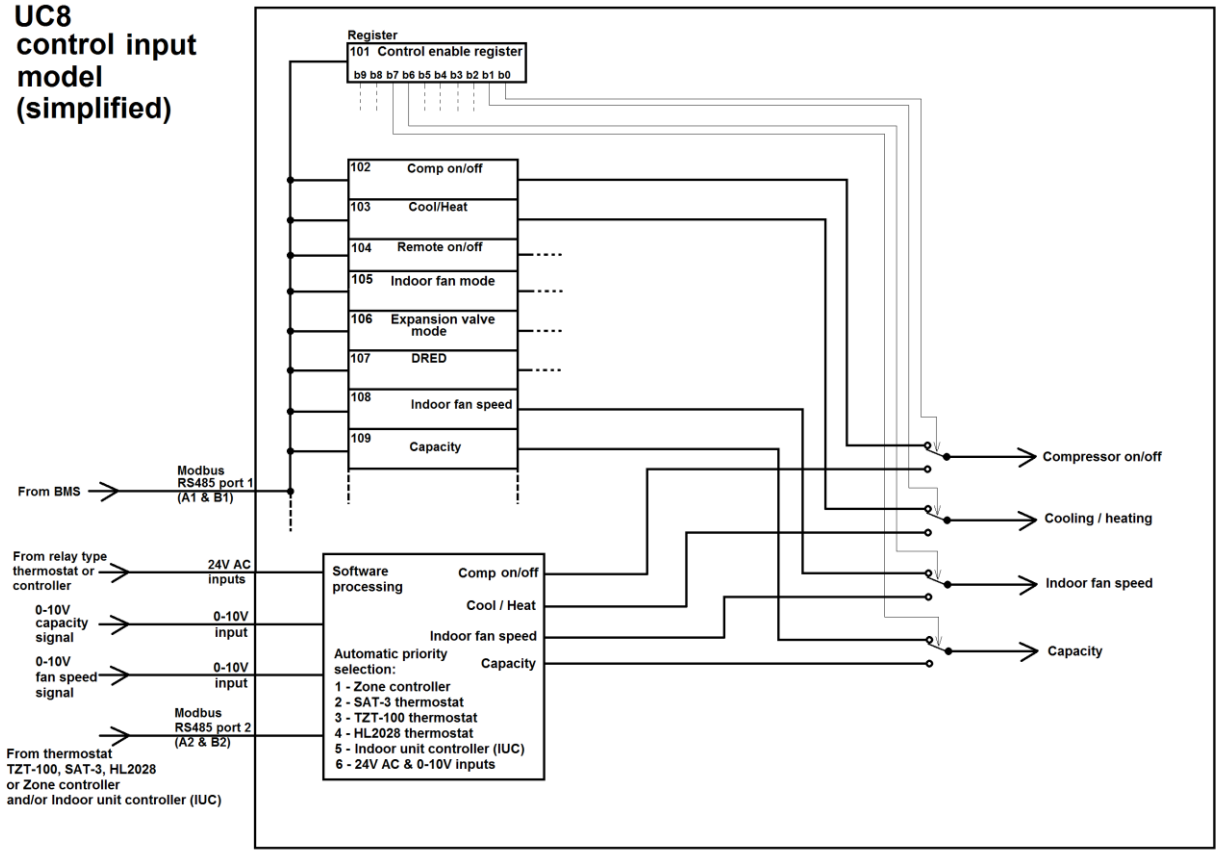
Temperzone units with UC8 controller can be fully monitored and controlled via Modbus RTU serial communications. One is free to control a unit using write-operations only to holding registers or (recommended) by using a combination of registers and coils.

Unit control registers and coils can be read from and written to by the BMS at any time. However, before a value written to any one of unit control registers 102 to 119 has any effect on unit operation first a value '1' must be written to the corresponding bit in "control-enable" register 101 (or to coils 1 to 12). The default state of all bits/coils in control-enable register 101 is 0. That is: Control via modbus registers (and coils) is disabled.

Note: 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 assumes that contact is lost and takes the following actions:

- The fault relay output (FLT) is activated.
- Fault code F22 is shown on the display.
- 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.

The diagram below illustrates the control logic implemented by the UC8. For simplicity only four control signals are fully shown.



8.1. Unit control example using Modbus holding registers

Modbus holding registers with register address 1xx (101 to 112, 115, 118, 119) are provided for control of a unit by a BMS using the Modbus RTU protocol.

The example below illustrates control using read and write access to holding registers only.

Example:

A communicating BMS is to control a reverse cycle unit with a single compressor. The compressor is capable of variable duty (a digital scroll- or variable speed-compressor); the indoor fan is a three speed type. The application requires that the indoor fan must continue running even when the unit has just started in heating mode (while the indoor coil is still cool) and also when the unit is de-icing the outdoor coil. The unit is to operate in cooling mode at 65% capacity.

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

Initial unit set-up:
Initial unit set-up needs to be done only once after every power-on, but repeating the commands is allowed.

Register		Value to write	Result
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)
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 deadband (bit 1 = 1) Fan On during outdoor coil de-icing (bit 2 = 1) Fan On during heating start (bit 3 = 1) No run-on after cooling (bit 4 = 0) **Note**: At any time the UC8 controller can intervene if required to protect the compressor.

Operating the unit:

Register		Value to write	Result
103	Cool / Heat	Value 0	Request Cooling mode
108	Indoor fan speed	Value 550 In hexadecimal format: 0x0226	Request medium speed for the indoor fan.
109	Capacity	Value 65 In hexadecimal format: 0x0041	Request unit capacity 65%
102	Compressor on/off	Value 1	Request to start the compressor

Use of Modbus function 6 (write one holding register) is recommended even though Modbus function 16 (write N holding registers) can be used. When using Modbus function 16 ensure that values written to registers that are not used (i.e. the corresponding control enable bit values in register 101 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 two tables above, but that command then includes registers 104, 106 and 107 which are not required in this control example. The control enable bits for these three registers should be left clear (0) and recommended values for the three "unused" registers would be:

- 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)

8.2. Unit control example using Modbus coils and registers

This example performs the same control as the example in paragraph 0 but makes use of Modbus function 5 'write one coil' or, alternatively, function 15 'write multiple coils'. Some controls still require use of Modbus functions to write to holding registers, in particular: control of the indoor fan speed and unit capacity.

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

Initial unit set-up:

Initial unit set-up needs to be done only once after every power-on, but repeating the commands is allowed. Use either function 5 'write one coil' for each coil (in this example there are 9 coils to do, as shown below), or use function 15 'write multiple coils'.

If function 15 'write multiple coils' is used then any "unused" coil(s) that may be included within the command must be set to appropriate value(s).

Coil	Value to write	Result
1	1	The BMS gains control over Compressor on/off.
2	1	The BMS gains control over Heating or cooling.
4	1	The BMS gains control over Indoor fan mode.
7	1	The BMS gains control over Indoor fan speed.
8	1	The BMS gains control over Unit capacity.
16	1	Indoor fan fixed speed.
17	1	Indoor fan On in deadband.
18	1	Indoor fan On during outdoor coil de-icing.
19	1	Indoor fan On during heating start.

Operating the unit:

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 65 In hexadecimal format: 0x0041	Request unit capacity 65%
Coil		**Value to write**	**Result**
14	Cooling/heating	0	Cooling mode.
13	Compressor on/off	1	Start the compressor.

9. Indoor fan control

Modbus control registers for the indoor fan are:

- 101 control enable
- 105 indoor fan mode
- 108 indoor fan speed

Associated Modbus coils (representing bits in registers 101 and 105) are:

- 4 fan mode control enable
- 7 fan speed control enable
- 16 fan auto-speed or fixed-speed
- 17 fan-auto mode or fan-on mode
- 18 fan off or on during de-icing of the outdoor coil
- 19 fan off or on at the start of a heating cycle
- 20 fan off or runs on after cooling

Control details are given in the following sections.

***Note**:*

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 it is permitted for external controls to directly connect to the indoor fan, bypassing the UC8 controller.

However, in those applications it becomes the responsibility of the system designer, installer and end-user to ensure unit reliability. Should the UC8 controller detect sustained running outside safe operating conditions then safety protection mechanisms may operate and, if these protection mechanisms operate repeatedly, the unit may eventually be locked out.

9.1. Indoor fan operating mode

Modbus register 105 controls the following aspects of the indoor fan. Alternatively use Modbus coils 16 to 20 for the same set of functions.
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)**
4	**Fan obeys thermostat / BMS speed request after cooling has ended**	Fan continues to run for 5 minutes after cooling has ended (on low speed or faster if so directed by the thermostat / BMS)

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). (Note fan speed is always subject to the compressor safe operating envelope.)

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 speed** 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 minimise cold drafts when the controller requires heating mode.

Fan run-on: **I**ndoor fan run-on after cooling can be used to unobtrusively remove moisture (condensate) from the indoor coil after the units has stopped cooling. In some cases this may be of advantage such as reduced potential of smells and avoiding warm damp air when the unit is run in heating mode not long after cooling (e.g. thermostat is set to auto cool / heat mode).

9.2. 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. Values from 0 to 49 leave the fan off.
- If the single speed fan is on, then value 0 stops the fan; 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.

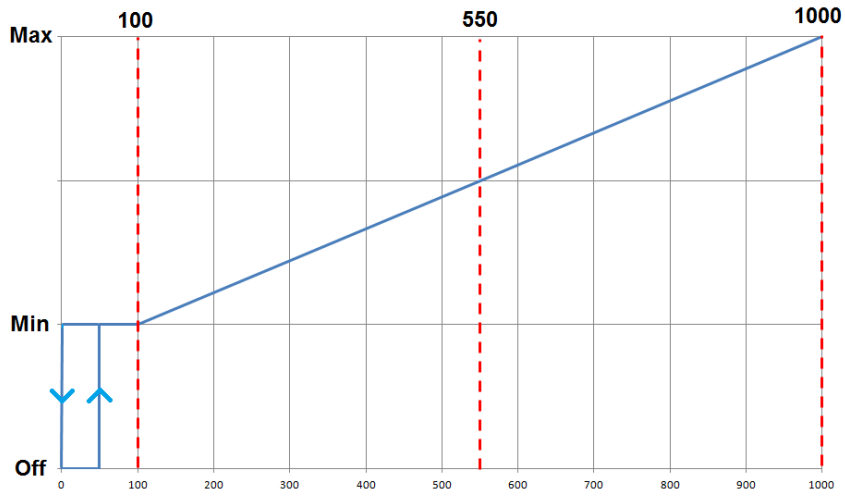
9.3. Control of variable speed fans

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:

- Value 0 stops the fan. However if the compressor is still on then the controller overrules the command and the fan continues 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”.

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



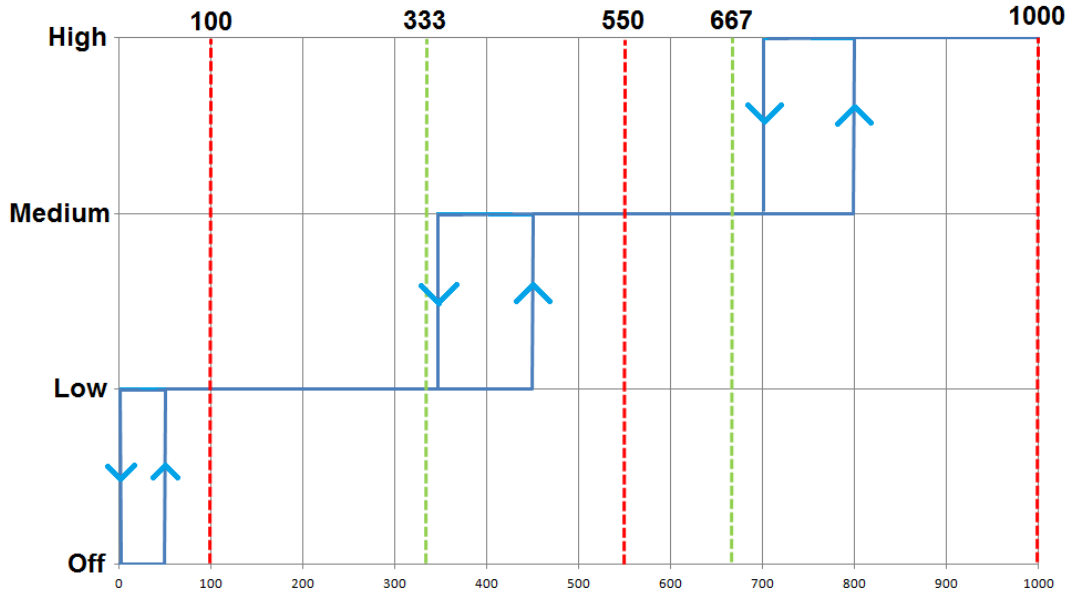
9.4. Control of three speed fans

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:

- Value 0 stops the fan. However if the compressor is still on then the controller overrules the command and the fan continues 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.

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



10. 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- or a variable speed- compressor. The interpretation of the value written to capacity 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	Compressors that are running operate at the required capacity. Compressors can be switched on or off individually via register 102 (Comp).

10.1. Minimum, nominal and maximum capacity

Temperzone units employ three types of compressors: fixed duty, digital scroll and variable speed. A unit with a digital scroll- or variable speed compressor is capable of variable duty. Some differences exist between available capacities, capacity rating point and capacity control values.

The table below explains the differences. Each cell has three entries:

- Top entry: Unit capacity as a percentage of nominal (rated) capacity.
- Middle entry: 0-10V control voltage to operate the unit at that capacity (UC8 input VC).
- Bottom entry: Modbus RTU value to write to holding register 109 to operate the unit at that capacity.

Compressor type	**Capacity**				
	Minimum, close control	**Minimum, zoned system**	**Minimum, standard ctrl.**	**Nominal (rating)**	**Boost**
Fixed duty			**100%** - -		
Digital scroll	**16%** 1.6V 16	**30%** 3.0V 30	**40%** 4.0V 40	**100%** 10.0V 100	Not available - -
Variable speed	**21%** 1.6V 16	**30%** 2.25V 22	**40%** 3.0V 30	**100%** 7.5V 75	**≈120%** 10.0V 100

Notes:

Recommended operating capacity range for all units is between standard control minimum (40%) and nominal (100%). Operation outside this range is permitted but unit efficiency may be less than optimum.

To protect the unit from a fault trip or damage to the compressor the UC8 controller may automatically modify operating capacity at any time.

10.2. Start-up

During the first 1.5 minutes following a start of the compressor the capacity may differ from the value dictated by the BMS or 0-10V capacity input VC. This is done to ensure adequate return to the compressor of the lubricating oil that may have settled elsewhere in the system. Following these first 1.5 minutes the minimum and maximum capacity reverts to the values given in chapter 10.1.

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 1.5 minutes following the start the unit will operate at a **fixed** capacity of 50%.

10.3. Oil recovery

When a compressor runs for an extended period at significantly less than nominal capacity the compressor lubricating oil may slowly migrate out of the compressor and settle elsewhere in the system. The UC8 controller automatically implements oil recovery cycles to ensure adequate return of the lubricating oil to the compressor. During an oil recovery cycle the unit capacity will differ from the value as dictated by a BMS or 0-10V control signal.

Factory default settings for oil recovery cycles are:

- Threshold is 60% of unit nominal capacity, which equates to:
  60% of 100% = 60% for a digital scroll compressor
- 60% of 75% = 45% of maximum rated speed for a variable speed compressor
- Frequency: Once every 1 hour 40 minutes.
- Duration: 1 minute.

The oil recovery threshold capacity is adjustable via Modbus RTU by writing to register 120. If value 0 is written to register 120 then oil recovery cycles are disabled (use with care!).

A BMS can also request an oil recovery cycle by writing value 1 to register 121 or by writing to coil number 26. An oil recovery cycle request is effective only if the unit has a digital scroll- or variable speed- compressor and is operating in normal cooling or heating mode.

If a BMS writes value 1 to register 121 or to coil 26 to initiate an oil recovery cycle the controller automatically clears the register- and coil- value back to 0 as soon as the request is granted.

Register	Function	Notes	Type
120	Threshold capacity for oil recovery cycles	**600 = 60%** of Nom. (digital scroll compressor) **450 = 60%** of Nom. (variable speed compressor) Allowed range 0 to 1000 (0 to 100%)	Read / Write
121	Oil recovery cycle request	**0 = off** 1 = on	

Coil	Function		Holding register	Bit position (0..15)
	0	1		
26	**Normal operation**	Request an oil recovery cycle	121	0

For more information about oil recovery cycles refer to document “Temperzone UC8 Operation and Installation - Air-to-Air units”.

11. Supply air temperature control

Units with UC8 controller and a digital scroll- or variable speed- compressor can be configured to provide a constant supply air temperature. The following sections give details how to configure and operate the UC8 for supply air temperature control.

11.1. Configuring the controller for supply air temperature control

The procedure detailed below can be only be followed when the unit has a digital scroll compressor (UC8 DIP switch 2 set to ON) or has a variable speed compressor and inverter. If the unit has a fixed duty compressor then the configuration procedure is not available.

1. Turn power on to the UC8 controller.
2. Do not request the compressor to start.
3. Wait until the display shows a flashing decimal point.
4. Hold down pushbutton SW3 on the circuit board, release the button as soon as the display shows the letter **Y**.
5. The display will show 0 or 1.
6. Use the pushbutton to select the required operating mode:
    - 0 = supply air temperature control disabled (default value)
    - 1 = supply air temperature control enabled
7. Wait 30 seconds. The controller will save the selected value and re-start.

Note:

A UC8 controller that is configured for supply air control and is controlled via:

- 24V AC inputs on the UC8 controller circuit board
- or by relay contact inputs on the indoor unit controller (IUC)
- or by Modbus communicating BMS system
- but **without** TZT-100 thermostat, SAT-3 thermostat or ZONE controller

automatically implements a 5 minute run-on time of the indoor fan after the unit has stopped cooling. During the 5minute period the indoor fan will run at low speed, or faster if requested via the appropriate control signal. If the 5 minute fan run-on is undesirable then a BMS can use Modbus function 05 (write one coil) to clear coil 20.

11.2. Operating the unit with supply air temperature control

The following two Modbus registers are used to set the target supply air temperature.

Register	Function	Notes	Type
118	Supply air temperature target, Cooling mode	**Default value 1200 = 12.00°C** Allowed range 400 to 2000 (4°C to 20°C)	Read / Write
119	Supply air temperature target, Heating mode	**Default value 3600 = 36.00°C** Allowed range 2000 to 4500 (20°C to 45°C)	Read / Write

A split system where the indoor unit has an indoor unit control board (IUC) measures the supply air temperature and this measurement is used directly for control.
A packaged system (where there is no IUC) does not directly measure and control the supply air temperature. In its place the UC8 controller estimates the supply air temperature as follows:

- Cooling mode: Supply air temperature = Evaporating temperature + 5°C
- Heating mode: Supply air temperature = Condensing temperature - 5°C

Accuracy of the estimated supply air temperature depends on additional factors such as the indoor fan speed, the indoor coil air-on temperature and relative humidity.

12. Quiet mode

Quiet mode can reduce the amount of air-handling-noise from the outdoor fan(s). Quiet mode does not have any effect on the indoor fan neither does it influence unit operating 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).

Quiet mode can be controlled via Modbus registers as follows:

- Write value 1 to bit 9 of register 101 (enable quiet mode control).
- Write value 1 to register 111 to enable quiet mode, write value 0 to disable.

Quiet mode can also be controlled via Modbus coils as follows:

- Switch on coil 9 (enable quiet mode control).
- Switch on coil 20 to enable quiet mode, switch off coil 20 to disable.

Quiet mode can reduce noise from the outdoor fan when a unit is cooling and the outdoor ambient temperature is below about 30°C. Outdoor ambient temperatures above 30°C reduce the effectiveness. Quiet mode is not effective when cooling and the outdoor ambient temperature is above about 40°C.

Similarly, quiet mode can reduce noise from the outdoor fan when a unit is heating and the outdoor ambient temperature is above 15°C. Lower outdoor ambient temperatures reduce the effectiveness. Quiet mode is not effective when heating and the outdoor ambient temperature is below about 10°C.

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

13. 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 and help to avoid dampness.

The UC8 controller offers a number of methods by which de-humidification can be achieved. Which method is used depends on the user requirement, user preference and unit capability. An explanation of the various de-humidification methods and how to enable and disable follows here.

Conventional de-humidification mode

Available on all models where the indoor fan can vary speed. This method 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. This method is not suitable for applications where the volume of supply air must remain constant.

To select conventional de-humidification mode using Modbus register commands:

- 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.

To select conventional de-humidification mode using Modbus coil commands:

- Switch on coil 4 (enable fan mode control) to gain control over coils 16 to 20 (indoor fan modes).
- Switch on coil 11 (enable dry mode control) to gain control over coil 22 (dry mode on/off).
- Switch off coil 16 to select variable indoor fan speed.
- Switch on or off coil 22 to switch dry mode off or on, as required.

***Note**: Selected unit models are fitted with dual expansion valves and a split indoor coil. To use conventional de-humidification mode such models should have value **1** written to register 106 (EXV mode), otherwise the unit may operate in super de-humidification mode. This is best done automatically by setting UC8 DIP switch 7 ON and switch 8 OFF.*

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.

EXV mode register (106) must be set to value 3: dual expansion valves. This is automatically done when UC8 DIP switches 7 and 8 are both set to ON.

To select advanced de-humidification mode using Modbus register commands:

- 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.
- Write value 0 or 1 to dry mode register (112) to switch dry mode off or on, as required.

To select advanced de-humidification mode using Modbus coil commands:

- Switch on coil 4 (enable fan mode control) to gain control over coils 16 to 20 (indoor fan modes).
- Switch on coil 11 (enable dry mode control) to gain control over coil 22 (dry mode on/off).
- Switch on coil 16 to select fixed indoor fan speed.
- Switch on or off coil 22 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 indoor fan speed is kept constant. Only when the desired evaporating temperature cannot be achieved with the use of the electronic expansion valves alone then the controller will also vary the indoor fan speed. This mode is not suitable for applications where the volume of supply air must remain constant.

EXV mode register 106 must be set to value 3 (dual expansion valves). This is automatically done when UC8 DIP switches 7 and 8 are both set to ON.

To select super de-humidification mode using Modbus register commands:

- 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.
- Write value 0 or 1 to register 112 to disable/enable de-humidification.

To select super de-humidification mode using Modbus coil commands:

- Switch on coil 4 (enable fan mode control) to gain control over coils 16 to 20 (indoor fan modes).
- Switch on coil 11 (enable dry mode control) to gain control over coil 22 (dry mode on/off).
- Switch off coil 16 to select variable indoor fan speed.
- Switch on or off coil 22 to enable/disable dry mode.

14. Economy mode

Economy mode, when enabled, operates as follows:

- **A unit with a variable speed compressor:** Capacity is limited to not higher than nominal. In other words: Boost mode operation is disabled.
- **A unit with a digital scroll compressor:** Capacity is limited to not less than 60% (systems with a zone controller excluded).
- **A unit operating with supply air control:** Indoor fan speed may be automatically increased when supply air temperature varies too far from the supply-air setpoint.

To select economy mode using Modbus register commands:

- Write value 1 to bit 13 of register 101 (write-enable) to gain control over register 115 (economy mode).
- Write value 0 or 1 to register 115 to disable/enable economy mode.

To select economy mode using Modbus coil commands:

- Switch on coil 12 (enable economy mode control) to gain control over coil 23 (economy mode on/off).
- Switch on or off coil 23 to enable/disable economy mode.

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

Register 721 can be used to change operation of the fault relay output 'FLT' (note 16). Three options are available. The default setting is indicated with **bold** letters.

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

***Notes**:*

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.

A value written to register 721 is retained even when power to the controller is switched off and back on again; the register needs to be written to only once, then never again.

16. Outdoor coil de-icing

The UC8 controller offers the option to monitor and control outdoor coil de-icing cycles. The following coils / register bits are provided for this purpose. Default values are in **bold** letters.

Coil	Function		Holding register	Bit position (0..15)
	0	1		
9	**Disable control over de-icing of the outdoor coil**	Enable control over de-icing of the outdoor coil	101	8
24	Unit is not allowed to de-ice the outdoor coil	**Unit is allowed to de-ice the outdoor coil**	110	0
25	**Allow normal heating mode**	Unit must de-ice the outdoor coil now	110	4
44	**Outdoor coil de-icing not required**	Outdoor coil de-icing required	406	11
45	**Outdoor coil de-ice cycle inactive**	Outdoor coil de-ice cycle active	406	12

Register	Function	Values	Type
101	Bit 8: Enable outdoor coil de-icing control	**0 = BMS control disabled** 1 = BMS control enabled	Read / write
110	Bit 0: De-icing permission Bit 4: Force de-ice control All other bits are reserved and must not be written to.	**0 = de-ice not allowed** 1 = De-ice allowed **0 = run normally** 1 = De-ice now	
406	Bit 11: De-ice request Bit 12: De-ice status	**0 = no de-icing is needed** 1 = UC8 controller requests permission to de-ice the outdoor coil **0 = no de-icing in progress** 1 = unit is de-icing the outdoor coil	Read only

Important:

A control strategy for de-icing the outdoor coil must be designed with care.

Very frequent de-icing cycles can lead to a loss in duty and can place unnecessary stress on the compressor. On the other hand, a unit that is not allowed to de-ice often enough can cause the outdoor coil to become blocked by ice and lead to a trip on LP and lock out. It is recommended to make use of the UC8 controller indication available in bit 11 of register 406 or coil 44 (de-ice request) to aid in deciding when to start a de-ice cycle.

When a BMS controls outdoor coil de-icing we recommend to make use of Modbus coil write function 5 rather than use register write function 6.

When the BMS has not assumed control over outdoor coil de-icing (value 0 in bit 8 of register 101, coil 9 off) then the UC8 controller will automatically de-ice the outdoor coil when necessary.

17. Lockout and system reset

17.1. 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.

The UC8 provides three methods to un-lock unit:

1. Switch mains power to the controller off, wait 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 section 17.2.

Notes: *When mains power is applied to a controller that was locked out the UC8 display shows 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.*

The purpose of lock-out is to protect the refrigeration components from damage. We recommend to first investigate and correct the cause of a lock-out before unlocking the unit.

17.2. 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 4660 (0x1234) to register 1901.

Above set of commands enforce a full system restart, identical to a start made when mains power is removed then re-applied to the unit. It is recommended make careful considerations before using this option.

18. 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 a few seconds. 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 it is recommended to operate 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.*

19. Notes

Beside the registers and coils 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.

Additional information is available from Temperzone customer services and on the Temperzone internet web site: http://www.temperzone.biz/