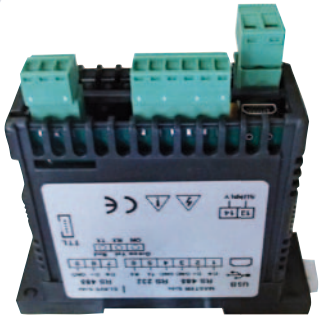
Y39/Z31/Z31Y

Modbus
Communication protocol for
Y39 - Z31 - Z31Y



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PREFACE

The purpose of this document is to describe the communication capabilities of Y39, Z31 and Z31Y instruments which use the Modbus protocol and is dedicated to technicians, system integrators and software designers.

Ascon Tecnologic and its legal representatives do not assume any responsibility for any damage to people, things or animals deriving from violation, wrong or improper use or in any case not in compliance with the instrument's features.

Whenever a failure or a malfunction of the device may cause dangerous situations for persons, things or animals, please remember that the plant has to be equipped with additional devices which will guarantee safety.

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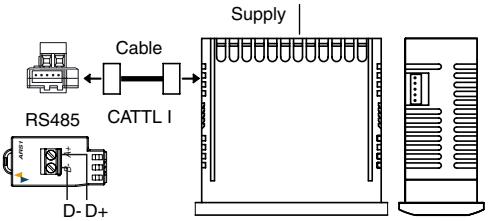
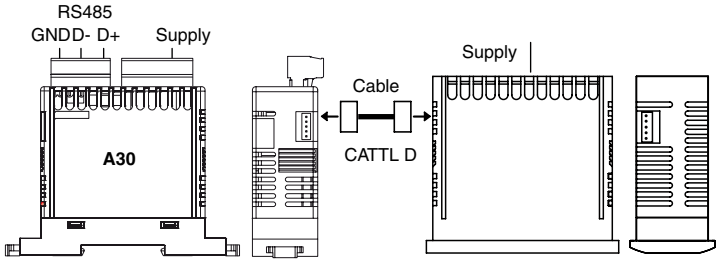
1 CONNECTION

1.1 Interface

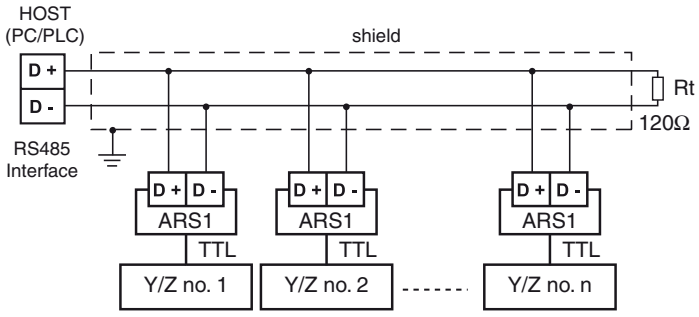
Y39, **Z31** and **Z31Y** instruments are equipped with a **TTL communications port** through a 5-pole connector on the side of the instrument.
Through the **TTL/RS485 interface** offered by the **ARS1** or **A30** devices and the appropriate cables (CATTL I for ARS1 and CATTL D for A30) it is possible to connect the instruments to an **RS485 type serial communications network**. To the network are normally linked other instruments (like controllers or PLC) and a personal computer used as system supervisor.
The ARS1 device is powered directly by the instrument while the A30 device must be powered separately.



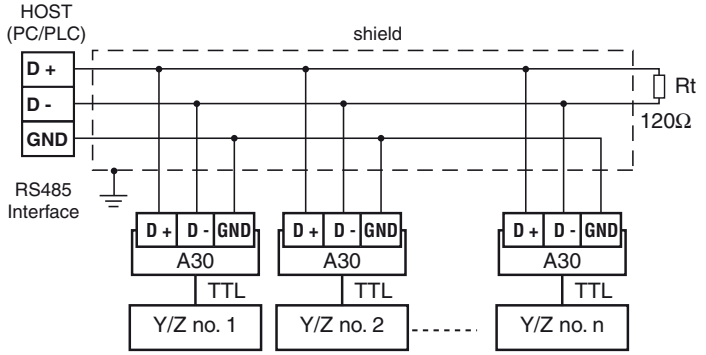


1.2 RS485 LINE

The converters are equipped with two terminals (**D+** and **D-**) which must be connected to all the homonymous terminals of the network. A telephone-type twisted pair is therefore sufficient for wiring the line.



However, in particular when the network is very long or noisy and in the presence of potential differences between the various GND terminals, it is advisable to use a braided and shielded 3-pole cable connected as shown in the figure.



As illustrated, the line shield must be connected to ground at only one side.

This type of interface allows to connect up to 32 instruments on the same line. The total length of the line can reach a maximum of 1000 m. To maintain the line in resting conditions, the use of a 120 Ω termination resistance (RT) is required at the end of the line.

Once the network has been mounted it is necessary to program, using the LAS parameter, the address of each instrument on the network. Each instrument must have its own unique number from 1 to 255. In order to avoid communication conflicts, turn ON and program 1 instrument at a time.

The baud rate of the serial port is fixed at 9600 baud.

2 MODBUS PROTOCOL

The protocol adopted these controllers is a sub-group of the widely used MODBUS RTU protocol. This choice guarantees easiness of connections to many PLCs and to all the commercial supervision programs.

The functions of the MODBUS RTU protocol used the controllers are:

– **Function 3**: Reading of n words;

– **Function 6**: Writing of a word.

These functions allow the supervision programs to read and change any data from the instrument. The communication is based on messages sent by the master station to a slave station (each controller) and vice versa. The slave station that recognises its own address in the message, analyses the content and, if it finds it to be semantically and formally correct, it then creates a reply message directed back to the master.

The communication process involves five types of message:

From master to slave	From slave to master
Function 3: request for reading of **n** words	Function 3: reply containing **n** words read
Function 6: request for writing of **1 word**	Function 6: confirmation of writing of **1 word**
	Exceptional reply (in reply to both functions in the event of an irregularity)

Each message contains four fields:

– **Slave address**: All values between 1 and 255 are valid; the address 0 (zero) is reserved by MODBUS RTU for the broadcasting messages but is not used fro these controllers due to the implicit reliability of this type of communication;

– **Function code**: This field contains the number **3** or **6** depending on the required function;

– **Information field**: This field contains the addresses or the value of the words, as requested by the function in use;

– **Control word**: This field contains a cyclic redundancy check (CRC) calculated according to the rules provided for the CRC16.

The characteristics of the asynchronous communication are:

– 8 bit;

– No parity;

– One stop bit.

2.1 Function 3 - Reading of n words

The number of words that are to be read must be less or equal to four.

The request has the following structure:

slave #	3	Address of 1st word		Number of words		CRC	
		MSB	LSB	MSB	LSB	LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4	byte 6	byte 6	byte 7

A normal reply (unlike an exception in case of errors) has the following structure:

slave #	3	NB # bytes read	Value of the 1st word		Later words	CRC	
			MSB	LSB	LSB	LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4	byte 6	byte NB +2	byte NB +3

2.2 Function 6 - Writing a word

The write request has the following structure:

slave #	6	Address of 1st word		Vakue to be written		CRC	
		MSB	LSB	MSB	LSB	LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4	byte 6	byte 6	byte 7

The normal reply (unlike the exception reply) is purely an echo of the request message:

slave #	6	Address of 1st word		Vakue to be written		CRC	
		MSB	LSB	MSB	LSB	LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4	byte 6	byte 6	byte 7

2.3 The Exception Reply

These instruments provide an exception reply after having received a formally correct request that cannot be satisfied. The exception reply contains a code that indicates the cause of lack of the regular reply.

The reply structure is as:

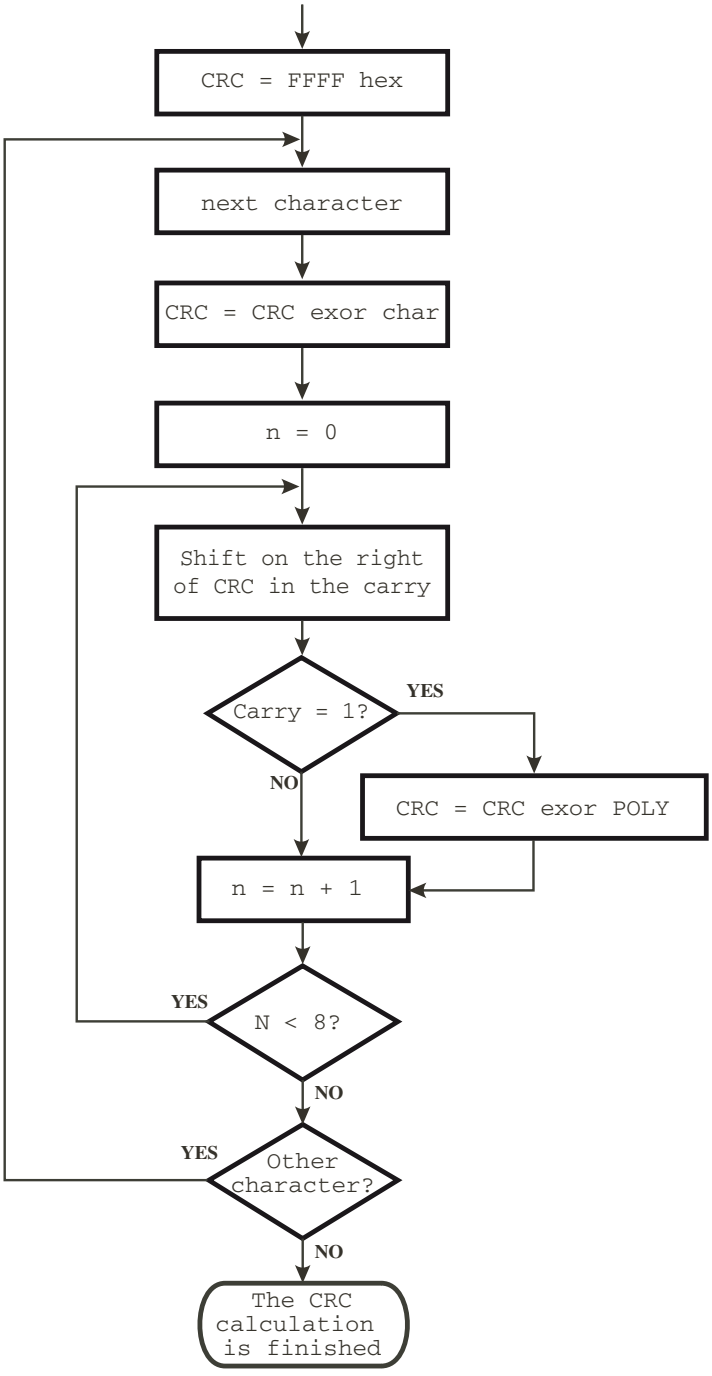
slave #	Function code with MSB at 1	Exception code	CRC	
			LSB	MSB
byte 0	byte 1	byte 2	byte 3	byte 4

The controllers of these series adopt a sub-group of exception codes of the MODBUS RTU

Unknown function code	1
Invalid memory address	2
Invalid value in data field	3
Data not ready	6

2.4 Cyclic Redundancy Ceck (CRC)

CRC is a check word that permits to verify the integrity of a message. Each message, sent or received, contains the CRC word as the last two characters of the message.
After receiving a request, the controller checks the validity of the message received, comparing the CRC contained in the message with the one calculated during reception.
While in transmission, the controller calculates the CRC and places the two characters at the end of the message.
The calculation of the CRC is carried out on each character of the message except for the last two.
As these instruments are compatible with the MODBUS RTU (JBUS) protocol, they use the same algorithm for calculating the CRC. The CRC algorithm is sketched in following diagram:



2.5 Data exchange

All the data exchanged are made up of 16 bit words.
There are two types of data: numerical (N) and symbolic (S) (or non numerical).
The numerical data represent the value of phisycal dimension (**e.g.**: the measured variable, etc.)
The symbolic data represent a particular value within a range of choices (**e.g.** the temperature engineering unit can be “°C” or “°F”).
Both types are encoded with integer numbers: integer numbers with a sign are adopted for numerical data (N)and integer numbers without a sign for symbolic data(S).
Numerical data must be associated with the appropriate number of decimal figures, so that it represents a size with the same engineering unit adopted in controller.
Numerical data are represented in fixed point according to the number of decimal digits shown in the tables of the chapter “**Memory Area**”.

2.6 Performance

After receiving a valid request, the instrument prepares the reply and sends it to the master station, according to the modes specified below:

– A time equal to three characters is guaranteed before the reply to allow the line switching;
– The answer is ready to be transmitted within a time that is less than 20 ms, with the exception made for function 3;

A 20 ms of silence time on the line is necessary to recover all irregular conditions or error messages: this means that the time that runs between two consecutive characters in the same message must be less than 20 ms.
It is possible to write one word at a time only.

3 MEMORY AREA

For the functions adopted, all the data that can be read and written appear as 16 bit words allocated in the instrument's memory.

The map of the memory has three areas:

– Variables,

– Parameters,

– Identification code of the instrument.

The following sections illustrate the characteristics of each of these areas.

3.1 Variables Memory Area

In this area are stored the instrument main variables (inputs, control mode, outputs etc.) those that are frequently calculated and updated are grouped together. These are the data available:

Variable	Hex Addr.	Description	Data type	Dec. digits	Range
Pr1	200	Measurement input Pr1	N	1	-99.9 ÷ 999.0
Pr2	201	Measurement input Pr2	N	1	-99.9 ÷ 999.0
dP	202	Temperature decimal point position	S		1
Pr3	203	Measurement input Pr3	N	1	-99.9 ÷ 999.0
Lt	204	Min. measured Temperature (min. peak)	N	1	-99.9 ÷ 999.0
Ht	205	Max. measured Temperature (max. peak)	N	1	-99.9 ÷ 999.0
	206	Controller status	N		0 oFF 1 Control 2 Defrost
	207	Alarm condition (each alarm is associated to a bit of the word)	N		b0 Not used b1 1 = Overrange Pr1 (E1) b2 1 = Underrange Pr1 (-E1) b3 1 = Overrange Pr2 (E2) b4 1 = Underrange Pr2 (-E2) b5 1 = Overrange Pr3 (E3) b6 1 = Underrange Pr3 (-E3) b7 1 = Power On delay (od) b8 1 = High Alarm (Hi) b9 1 = Low Alarm (Lo) b10 1 = Door Open (oP) b11 1 = Input Alarm (AL)
	20E	Digital Input status	S		0 Open 1 Closed
ot	210	Temperature control output	S		0 oFF 1 on
dF	211	Defrost Output	S		0 oFF 1 on
Fn	212	Evaporator fans output	S		0 oFF 1 on
Au	213	Auxiliary output	S		0 oFF 1 on
At	214	Acnowledgeable alarm output	S		0 oFF 1 on
AL	215	Not acnowledgeable alarm output	S		0 oFF 1 on
	216	Continuous cycle	S		0 oFF 1 on
	217	Temperature control request (with no inhibitions)	S		0 oFF 1 on
	218	Fans ouput request (with no inhibitions)	S		0 oFF 1 on
	219	Continuous cycle request	S		0 oFF 1 on
	21A	Defrost request	S		0 oFF 1 on
	21B	End defrost request	S		0 oFF 1 on
	21C	Auxiliary output activation request	S		0 oFF 1 on

Variable	Hex Addr.	Description	Data type	Dec. digits	Range
	21D	Fans output inhibtion due to the open door	S		0 oFF 1 on
	21E	Control output inhibtion due to the open door	S		0 oFF 1 on
	21F	Open door	S		0 oFF 1 on
	220				
	221	Display lock during defrost	S		0 oFF 1 on
	222	Outputs inhibition for external alarm from digital input	S		0 oFF 1 on

Irregular conditions of the process variables are shown as special values of the measurement:

Irregular condition	Returned value	Instrument error
Short circuit on measurement input	-10000	-E
Opern circuit on measurement input	10000	E
Overflow (A/D converter)	10001	
Variable not available	10003	- - - -

3.2 Command memory area

The instrument controls include the commands that can be made from the instrument keyboard in order to perform particular actions or functions.
The data is write only.

Hex Addr.	Description	Data type	Range
280	Continuous cycle	S	1 = Start/Stop continuous cycle
281	Defrost start	S	1 = Start defrost
282	Defrost end	S	1 = End defrost
283	Auxiliary output activation	S	1 = Activate/Deactivate Auxiliary output
284	Stand-by	S	1 = Instrument Stand-by
285	ON	S	1 = Instrument ON
286	Minimum peak (Lt) reset	S	1 = Reset Lt
287	Maximum peak (Ht) reset	S	1 = Reset Ht
288	Alarms acknowedge	S	1 = Alarm Acknowledgement

3.3 Configuration and functional parameters area

The operating and configuration parameters can be read and written through serial communication.
If one tries to read or write a parameter not available for a certain instrument configuration, an error message is displayed: **data not available. (6)**.
After have written into the parameters zone, it is necessary to start the CHECKSUM calculation, writing any value at address **HEX 0500**.

Param.	Hex. Address	Description	Data type	Dec. digits	Range	Note
S.LS	**2800**	Minimum Set Point	N	1	-99.9 ÷ HS	
S.HS	**2801**	Maximum Set Point	N	1	LS ÷ 999.0	
S.SA	**2802**	Active Set Point	N	0	1 ÷ 2	
SP	**2803**	Set Point (1)	N	1	S.LS ÷ S.HS	
SP2	**2804**	Set Point 2	N	1	S.LS ÷ S.HS	
i.SE	**2805**	Probes Type	S		Pt PTC nt NTC	
i.uP	**2806**	Temperature Engineering unit and resolution (decimal point)	S		0 C0 °C resolution 1° 1 F0 °F resolution 1° 2 C1 °C resolution 0.1° 3 F1 °F resolution 0.1°	
i.Ft	**2807**	Measurement filter	N	1	0 oF 0.1 ÷ 20.0 s	
i.C1	**2808**	Pr1 Probe Calibration	N	1	-30.0 ÷ 30.0°C/°F	
i.C2	**2809**	Pr2 Probe Calibration	N	1	-30.0 ÷ 30.0°C/°F	
i.C3	**280A**	Pr3 Probe Calibration	N	1	-30.0 ÷ 30.0°C/°F	
i.CU	**280B**	Measure offset on the display	S		-30.0 ÷ 30.0°C/°F	
i.P2	**280C**	Pr2 input function	S		0 oF Not active 1 EP Evaporator probe 2 Au Auxiliary probe 3 dG Digital input	
i.P3	**280D**	Pr3 input function	S			
i.Fi	**280E**	Function and logic function of digital input	N	0	0 No function 1 Start defrost 2 End defrost 3 Continuous cycle 4 External alarm 5 Door open with fan stop 6 Door open with fan and compressor stop 7 Auxiliary output command 8 Selection of active Set Point 9 External alarm with deactivation of control outputs 10 Switch on/Switch off (Stand-by) 11 Selection of active Set Point and control action (SP-H, SP2-C)	
i.ti	**280F**	Delay in acquiring digital input	N	2	0 oF 0.01 ÷ 99.5 (min.s)	
i.dS	**2810**	Variable normally shown on display	S		0 P1 Pr1 probe measurement 1 P2 Pr2 probe measurement 2 P3 Pr3 probe measurement 3 SP Active Setpoint 4 oF Display OFF	
r.d	**2811**	Differential (Hysteresis)	N	1	0 ÷ 30°C/°F	
r.t1	**2812**	Output (ot) activation time for probe (Pr1) error	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
r.t2	**2813**	Output (ot) deactivation time for probe (Pr1) error	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
r.HC	**2814**	Output (ot) operating mode	S		0 H Heating 1 C Cooling	
r.tC	**2815**	Continuous cycle Time	N	2	0 oF 0.01 ÷ 99.5 (h.min)	
d.dt	**2816**	Defrost Type	S		0 EL Electrical heating/Compressor stop 1 In Hot gas/Reverse cycle 2 No Without compressor output condictioning 3 Et Electrical heating with evaporator temperature control	
d.di	**2817**	Defrost interval	N	2	0 oF 0.01 ÷ 99.59 (h.min)	

Param.	Hex. Address	Description	Data type	Dec. digits	Range	Note
d.Sd	**2818**	1st defrost delay after Power ON	N	2	0 oF 1st defrost at Power ON 0.01 ÷ 99.59 (h.min)	
d.dE	**2819**	Length (max.) of defrost cycle	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
d.tE	**281A**	Stop defrost temperature	N	1	-99.9 ÷ 999.0°C/°F	
d.tS	**281B**	Enable defrost temperature (d.dC = rt or ct) or start (d.dC = St)	N	1	-99.9 ÷ 999.0°C/°F	
d.dC	**281C**	Defrost starting mode	S		0 rt Real time intervals 1 ct Output **ot** ON time intervals 2 cS Defrost at all Output **ot** switching OFF (+ rt intervals) 3 St Defrost when Pr2 < dt5 (+ rt intervals) 4 dd "Dynamic defrost intervals" (+ Pr2 < dt5)	
d.dd	**281D**	Dynamic Defrost Percentage reduction	N	0	0 ÷100%	
d.td	**281E**	Compressor delay after defrost (drainage time)	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
d.dL	**281F**	Display lock during defrost	S		0 OF display free 1 On Lock on temp. Pr1 before defrost 2 Lb Lock on label dEF (during defrosting) and PdF (during post-defrosting)	
F.tn	**2820**	Fan time activation with **ot** output (compressor) OFF	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
F.tF	**2821**	Fan time deactivation with **ot** output (compressor) OFF	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
F.FL	**2822**	High temp. fan deactivation	N	1	-99.9 ÷ 999.0°C/°F	
F.LF	**2823**	Low temp. fan deactivation	N	1	-99.9 ÷ 999.0°C/°F	
F.dF	**2824**	Differential fan control	N	1	0.0 ÷ 30 .0°C/°F	
F.FE	**2825**	Fan during defrost	S		0 oF 1 on	
F.Fd	**2826**	Fan delay after defrost	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
P.P1	**2827**	Control output **ot** delay when switched ON	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
P.P2	**2828**	Control output **ot** delay when switched OFF	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
P.P3	**2829**	Control output **ot** delay between 2 switch ON	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
P.od	**282A**	Outputs delay at Power ON	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
A.Ay	**282B**	Temperature alarm type	N	0	1 Absolute for **Pr1** with label (Hi - Lo) 2 Relative for **Pr1** with label (Hi - Lo) 3 Absolute for **Au** with label (Hi - Lo) 4 Relative for **Au** with label (Hi - Lo) 5 Absolute for **Pr1** no label 6 Relative for **Pr1** no label 7 Absolute for **Au** no label 8 Relative for **Au** no label	
A.HA	**282C**	High temperature Alarm threshold	N	1	-100 oF -99.9 ÷ 999°C/°F	
A.LA	**282D**	Low temperature Alarm threshold	N	1	-100 oF -99.9 ÷ 999°C/°F	
A.Ad	**282E**	Temperature Alarms Differential	N	1	0.0 ÷ 30.0°C/°F	
A.At	**282F**	Temperature Alarms delay	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
A.tA	**2830**	Alarm memory	S	2	0 oF 1 on	
A.PA	**2831**	Temperature Alarms delay at Power ON	N	2	0 oF 0.01 ÷ 99.59 (h.min)	
A.dA	**2832**	Temperature Alarms delay after defrost and continuous cycle, and unlock display delay after defrost	N	2	0 oF 0.01 ÷ 99.59 (h.min)	
A.oA	**2833**	Open door alarm delay	N	2	0 oF 0.01 ÷ 99.59 (min.s)	

Param.	Hex. Address	Description	Data type	Dec. digits	Range	Note
o.o1	**2834**	Output Out1 function	S		0 oF No function 1 ot Temperature control (compressor) 2 dF Defrost 3 Fn Fan 4 Au Auxiliary 5 At Acknowledgeable alarm 6 AL Not acknowledgeable alarm 7 An Stored alarm 8 on ON when instrument switched ON	
o.o2	**2835**	Output Out2 function	S			
o.o3	**2836**	Output Out3 function	S			
o.bu	**2837**	Buzzer function mode	S		0 oF (function disabled) 1 Active for alarms only 2 Active for key pressed only 3 Active for alarms and key pressed	
o.Fo	**2838**	Auxiliary output function mode	N	0	0 oF (No Function) 1 Delayed Control output (**ot**) activation 2 Manual activation by key or digital input 3 Shop window light with economy mode (ON with **SP** and OFF with **SP2**) 4 Internal light (OFF with door closed and ON with door opened)	
o.tu	**2839**	Time relative to auxiliary output	N	2	0 oF 0.01 ÷ 99.59 (min.s)	
t.UF	**283A**	Function mode (U) key	N	0	0 oF (No function) 1Auxiliary output command 2Continuous cycle command 3Active Setpoint selection (+ light OFF-eco mode) 4Switch on/off (Stand-by)	
t.Fb	**283B**	Function mode key Down/Aux (▼)	N	0		
t.Lo	**283C**	Keyboard lock function delay	N	2	0 oF (function disabled) 0.01 ÷ 30.00 (min.s)	
t.PP	**283D**	Password to access parameter functions	N	0	0 oF (function disabled) 1 ÷ 999	
t.AS	**283E**	MODBUS Station address (for serial communication)	N	0	0 ÷ 255	