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EP5000-M air quality probe Modbus protocol

Ver	Date	Update
V1	25/05/2018	Initial version
V2	26/05/2018	Remove ASCII traces
V3	06/06/2018	CRC in detail
V4	09/06/2018	Details
V5	27/06/2018	Status code extended
V6	22/11/2018	PM added + registration for POE
V7	29/01/2019	New sensors data (Pressure, Sound) and sensors presence
V8	24/08/2019	Updates
V9	29/10/2019	Lux and light color T° sensor data added
V10	07/11/2019	Flickering, absolute humidity, FRU and physio added + reorganization
V11	08/02/2020	LEDs dimming & management added
V12	15/04/2020	Bus speed updated to 19200 bauds
V13	07/05/2020	Atmospheric pressure unit in mbar
V14	19/05/2020	FRU update
V15	05/06/2020	Remote LEDs control
V16	07/07/2020	Change in remote LED control, Move dimming register. Add command register
V17	17/09/2020	Extend command register for flushing opportunity for better ABC
V18	15/10/2020	Add outdoor air quality probe data + risk of virus diffusion index
V19	23/11/2020	Add reserved for growth potential
V19.2	01/12/2020	CO2; VOC, absolute humidity, atmospheric pressure ranges & resolutions updated
V19.3	08/03/2020	Add external flash and power goods status in BIT
V19-4	08/04/2020	Add failures criteria's and change AAQ RH resolution
V19-5	05/05/2021	dBA to dB
V19-6	14/05/2021	Set points Range and Defaults values & Numbering
V20	14/05/2021	Additional physio and set points
V21	28/05/2021	Cooling set point in offset + typing mistake in register 80 + LED positions indication for outdoor
V22	10/06/2021	Heating and cooling registers modification (On/off and linear commands in the same register)
V23	09/09/2021	Typing mistake on registration writing
V24	19/10/2021	Serial number added + calibration extended to VOC + AAQ name
V25	0./10/2021	VOC type added, Sulphurous odors added
V26	20/01/2021	Adding description of Modbus function 6
V27	02/02/2022	Adding VOC type, Free cooling, Default LED acknowledgment. Timings details
V28	25/03/2022	Ventilation Modes similar to KNX added
V29	14/10/2022	NOx & O3 sensor presence added
V30	14/11/2022	Thermal Mode added
V31	30/05/2023	Irritation index renamed absence of irritation

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1. Modbus Protocol

The Modbus protocol allows a master unit to access up to 255 slave units connected on a single bus. Each slave is assigned an address that distinguishes it from other slaves connected to the bus.
By default, the bus address is 1 and shall be changed via NFC. The baud rate is by default 19200 Bauds and can also be changed by NFC.

Transactions can only be initiated by the master and are of two types:
- Question / answer One slave is addressed
- Broadcast / no answer All slaves are addressed, but they shall not reply

Characteristics used for communication with Modbus protocol:

Characteristics	RTU (8 bits)
Coding System	Binary
Number of bits par character	10
Start bits	1
data bits (least significant first)	8
Parity (optional)	No parity
Stop bits	1
Error Checking	CRC16
Default baud rate (settable via NFC)	19200
Possible speeds	1200 Bauds 2400 Bauds 4800 Bauds 9600 Bauds 19200 Bauds 38400 Bauds 56700 Bauds

1.1. RTU communication

RTU mode transmission is in binary. Termination of the frame is determined by a time of silence of about 30ms whatever the speed is.

MASTER

ADDRESS	FUNCTION	DATA	ERROR CHECK CRC 16
8-BITS	8BITS	N X 16-BITS	BITS

SLAVE

ADDRESS	FUNCTION	NUMBER OF DATA BYTES	DATA	ERROR CHECK CRC 16
8-BITS	8BITS	8BITS	N X 16-BITS	16 BITS

1.2. Function Field "Function"

The function code tells the recipient slave which function to address.

CODE	MEANING	ACTION	IMPLEMENTED
01	READ COIL STATUS	Obtains current status, (ON/OFF), of a group of logic coils.	No
02	READ INPUT STATUS	Obtains current status, (ON/OFF), of a group of discrete inputs.	No
03	READ HOLDING REGISTER	Obtains current binary value in one or more holding registers.	No
04	READ INPUT REGISTER	Obtains current binary value in one or more input registers.	Yes
05	FORCE SINGLE	Force logic coil to a state of ON or OFF.	No

	COIL		
06	PRESET SINGLE REGISTER	Place a specific binary value into a holding register.	Yes
15	WRITE MULTIPLE COILS	Force a group of logic coils to a defined state.	No
16	PRESET MULTIPLE REGISTERS	Place specific binary values into a group of holding registers.	No

1.3.Number of data Field

This field contains a number indicating the number of bytes in the Data fields.

1.4.Data Field

Data field contains information necessary for the slave to process the command sent by the master, or contains information that is sent in response by the slave to the master.

1.5.Request from the master:

INPUT MODE: Function = 4

FIRST REGISTER	NUMBER OF REGISTERS TO READ
16-BIT	16-BIT

WRITE SINGLE REGISTER: Function = 6

REGISTER'S ADDRESS	VALUE TO WRITE
16-BIT	16-BIT

RITE MULTIPLE REGISTERS: Function = 16

REGISTER'S ADDRESS	NUMBER OF REGISTERS TO WRITE	BYTE COUNT	VALUE(S) TO WRITE
16-BIT	16-BIT	8-BIT	16-BIT

The address of the first register is 0

1.6.Registers:

Read access: Function = 4 (0x04) and Write access: Function = 16 (0x10)

Register number	Register address	Size in bits	Name	Read	Write
1	@0	16	PRODUCT CODE	✓	
2	@1	16	FIRMWARE VERSION	✓	
3	@2	16	SENSORS PRESENCE	✓	
4	@3	16	BIT STATUS	✓	
5	@4	16	BUILT IN TEST EQUIPMENT / FRU	✓	
6	@5	16	CO2 CONCENTRATION	✓	
7	@6	16	VOC CONCENTRATION	✓	
8	@7	16	TEMPERATURE	✓	
9	@8	16	RELATIVE HUMIDITY	✓	
10	@9	16	ABSOLUTE HUMIDITY	✓	
11	@10	16	ATMOSPHERIC. PRESSURE	✓	
12	@11	16	PM10	✓	
13	@12	16	PM2.5	✓	
14	@13	16	PM1	✓	
15	@14	16	AVERAGE NOISE LEVEL	✓	
16	@15	16	PEAK NOISE LEVEL	✓	

Register number	Register address	Size in bits	Name	Read	Write
17	@16	16	LUX	✓	
18	@17	16	LIGHT COLOR T°	✓	
19	@18	16	LIGHT FLICKERING	✓	
20	@19	16	SULPHUROUS ODORS	✓	
21	@20	16	NOX	✓	
22	@21	16	O3	✓	
23	@22	16	RESERVED	✓	
24	@23	16	RESERVED	✓	
25	@24	16	ON OFF VENTILATION COMMAND	✓	
26	@25	16	LINEAR VENTILATION COMMAND	✓	
27	@26	16	ON OFF RECYCLING COMMAND	✓	
28	@27	16	LINEAR RECYCLING COMMAND	✓	
29	@28	16	HEATER COMMAND IN %	✓	
30	@29	16	COOLING COMMAND IN %	✓	
31	@30	16	COGNITIVITY INDEX	✓	
32	@31	16	QUALITY OF SLEEP INDEX	✓	
33	@32	16	LONG TERM HEALTH INDEX	✓	
34	@33	16	SHORT TERM HEALTH INDEX	✓	
35	@34	16	BUILDING HEALTH INDEX	✓	
36	@35	16	RESPIRATORY TRACT IRRITATION INDEX	✓	
37	@36	16	OLFACTORY COMFORT INDEX	✓	
38	@37	16	RISK OF VIRUS SPREADING INDEX	✓	
39	@38	16	IAQ PROBE FLOOR	✓	✓
40	@39	16	ACTION CODE	✓	✓
41	@40	16	OUTDOOR FAÇADE 1 T°	✓	✓
42	@41	16	OUTDOOR FAÇADE 1 RH	✓	✓
43	@42	16	OUTDOOR FAÇADE 1 PM10	✓	✓
44	@43	16	OUTDOOR FAÇADE 1 PM2.5	✓	✓
45	@44	16	OUTDOOR FAÇADE 1 PM1	✓	✓
46	@45	16	OUTDOOR FAÇADE 1 NO2	✓	✓
47	@46	16	OUTDOOR FAÇADE 1 O3	✓	✓
48	@47	16	OUTDOOR FAÇADE 1 AVERAGE NOISE	✓	✓
49	@48	16	OUTDOOR FAÇADE 1 PEAK NOISE	✓	✓
50	@49	16	OUTDOOR FAÇADE 1 RESERVED	✓	✓
51	@50	16	OUTDOOR FAÇADE 1 RESERVED	✓	✓
52	@51	16	OUTDOOR FAÇADE 2 T	✓	✓
53	@52	16	OUTDOOR FAÇADE 2 RH	✓	✓
54	@53	16	OUTDOOR FAÇADE 2 PM10	✓	✓
55	@54	16	OUTDOOR FAÇADE 2 PM2.5	✓	✓
56	@55	16	OUTDOOR FAÇADE 2 PM1	✓	✓
57	@56	16	OUTDOOR FAÇADE 2 NO2	✓	✓
58	@57	16	OUTDOOR FAÇADE 2 O3	✓	✓
59	@58	16	OUTDOOR FAÇADE 2 AVERAGE NOISE	✓	✓
60	@59	16	OUTDOOR FAÇADE 2 PEAK NOISE	✓	✓
61	@60	16	OUTDOOR FAÇADE 2 RESERVED	✓	✓
62	@61	16	OUTDOOR FAÇADE 2 RESERVED	✓	✓
63	@62	16	REMOTE LEDs	✓	✓
64	@63	16	LEDs DIMMING	✓	✓
65	@64	16	REMEDIATION ON VALUE OR PHYSILOGICAL EFFECTS	✓	✓
66	@65	16	CO2 SET POINT	✓	✓
67	@66	16	VOC SET POINT	✓	✓
68	@67	16	RH SET POINT HIGH	✓	✓
69	@68	16	PM2.5 SET POINT	✓	✓
70	@69	16	RESERVED SET POINT	✓	✓
71	@70	16	PRODUCTIVITY SETPOINT	✓	✓

Register number	Register address	Size in bits	Name	Read	Write
72	@71	16	QUALITY OF SLEEP SETPOINT	✓	✓
73	@72	16	LONG TERM HEALTH SETPOINT	✓	✓
74	@73	16	SHORT TERM HEALTH SETPOINT	✓	✓
75	@74	16	BUILDING HEALTH SETPOINT	✓	✓
76	@75	16	RESPIRATORY TRACT IRRITATION SET POINT	✓	✓
77	@76	16	OLFACTORY SET POINT	✓	✓
78	@77	16	HEATING SETPOINT	✓	✓
79	@78	16	COOLING SETPOINT OFFSET	✓	✓
80	@79	16	RESERVED to POE : IP NETWORK REGISTRATION	✓	✓
81	@80	16	VOC TYPE	✓	
82	@81	16	FREE COOLING MODE	✓	✓
83	@82	16	VENTILATION MODES (similar to KNX)	✓	✓
84	@83	16	THERMAL MODE	✓	✓
85	@84	16	RESERVED	✓	
86	@85	16	RESERVED	✓	
87	@86	16	RESERVED	✓	
88	@87	16	RESERVED	✓	
89	@88	16	RESERVED	✓	
90	@89	16	Serial number Part 1	✓	
91	@90	16	Serial number Part 2	✓	
92	@91	16	Serial number Part 3	✓	
93	@92	16	Serial number Part 4	✓	

1.7.Description of Read records:

1.7.1.PRODUCT CODE: Register #1 (address 0)

2-CHAR (16-BITS):

01 E5000
02 P5000
03 EP5000
04 AAQ

1.7.2.FIRMWARE VERSION: Register #2 (address 1)

16-BITS

1.7.3.SENSOR PRESENCE: Register #3 (address 2)

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

BIT 0: 0 ➔ CO2 sensor not present
1 ➔ CO2 sensor present

BIT 1: 0 ➔ VOCT sensor not present
1 ➔ VOCT sensor present

BIT 2: 0 ➔ Temperature sensor not present
1 ➔ Temperature sensor present

BIT 3: 0 ➔ Humidity sensor not present
1 ➔ Humidity sensor present

BIT 4: 0 ➔ Particles PM1 sensor not present
1 ➔ Particles PM1 sensor present

BIT 5: 0 ➔ Particles PM2.5 sensor not present
1 ➔ Particles PM2.5 sensor present

BIT 6: 0 ➔ Particles PM10 sensor not present
1 ➔ Particles PM10 sensor present

BIT 7: 0 ➔ Pressure sensor not present
1 ➔ Pressure sensor present

BIT 8: 0 ➔ Sound sensor not present
1 ➔ Sound sensor present

BIT 9: 0 ➔ Lux sensor not present
1 ➔ Lux sensor present

BIT 10: 0 ➔ Light Color T° sensor not present
1 ➔ Light color T° sensor present

BIT 11: 0 ➔ Flickering sensor not present
1 ➔ Flickering sensor present

BIT 12: 0 ➔ NOx & Ozone sensor not present
1 ➔ NOx & Ozone sensor present

BIT 13: Reserved
BIT 14: Reserved
BIT 15: Reserved

1.7.4.BIT STATUS: Register #4 (address 3)

Each failure is allocated to a specific bit so combination of failures can be indicated

	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
CO2 sensor failure																X
VOC & NOx- O3 sensor module failure															X	
T° & RH Sensor Failure														X		
Particles sensor Failure													X			
Pressure sensor Failure												X				
Sound sensor Failure											X					
Light sensor failure										X						
NFC EEPROM default									X							
Power sup. failure								X								
MCU overheat							X									
T° too high						X										
T° too low					X											
Sensors life span overpassed				X												
Modbus integrity failure			X													
LED driver failure		X														
External flash failure	X															

Failures Criteria

CO2 sensor failure	No response, service life exceeded
VOC sensor failure	No response, service life exceeded
T ° & RH sensor failure	No response
Particle sensor failure	No response
Pressure sensor failure	No response, value <500 millibar
Sensor failure Sound	No response, value > 200
Light sensor failure	No response
NFC EEPROM failure	No response, bad reference
5V or 3.3V not OK	According to voltage regulator self-test (<90% Vout, 2% hysteresis)
MCU overheat	Over 70°C
T ° too high (> 50 °C)	Probe temperature measurement
T ° too low (< 0 °C)	Probe temperature measurement
Sensor lifetime exceeded	CO2 or VOC or PM sensor lifetime exceeded (see BITE status in NFC)
Modbus integrity fault	CRC error
LED driver failure	No response or a LED not detected
External Flash Error	No response, bad reference, repeated CRC errors

1.7.5.BUILT IN TEST FRU: REGISTER #5 (address 4)

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

BIT 0: 0 ➔ Front PCB FRU to be replaced
1 ➔ Front PCB FRU OK

BIT 1: 0 ➔ Single band CO2 sensor module to be replaced
1 ➔ Single band CO2 sensor module OK

BIT 2: 0 ➔ Dual band CO2 sensor module to be replaced
1 ➔ Dual band CO2 sensor module OK

BIT 3: 0 ➔ VOC sensor module to be replaced
1 ➔ VOC sensor module OK

BIT 4: 0 ➔ Main board PCB to be replaced
1 ➔ Main board PCB OK

BIT 5: 0 ➔ Inter board PCB to be replaced
1 ➔ Inter board PCB OK

BIT 6: 0 ➔ Particles sensor to be replaced
1 ➔ Particles sensor OK

BIT 7: 0 ➔ Power supply PCB to be replaced
1 ➔ Power supply PCB OK

BIT 8: 0 ➔ Multiple boards default
1 ➔No multiple default

BIT 9: 0 ➔ End of life of replaceable sensor
1 ➔ No end of life of replaceable sensor

BIT 10: Reserved
BIT 11: Reserved
BIT 12: Reserved
BIT 13: Reserved
BIT 14: Reserved
BIT 15: Reserved

1.7.6.CO2 CONCENTRATION: Register #6 (address 5)

16-BITS:
Bit 0 to 15: Unsigned integer value
Unit: ppm
Valid Range: 0/5000
Range of measurement 0 to 5000ppm
Resolution: 1 ppm/LSB

1.7.7.VOC CONCENTRATION: Register #7 (address 6)

16-BITS:
Bit 0 to 15: Unsigned integer value
Unit: µg/m^3
Valid Range: 0/65 535
Range of measurement: 65 535 µg/m^3
Resolution: 1 µg/m^3/LSB

1.7.8. TEMPERATURE: Register # 8 (address 7)

16-BITS
16 bits = Signed integer Temperature value
Unit: °C
Valid range: 0-500
Range of measurement 0 to +50°C

Examples
0°C = 0
12,9°C (value sent: 129) = 129 (decimal)

Resolution: 0,1°C/LSB

1.7.9. RELATIVE HUMIDITY: Register # 9 (address 8)

2-CHAR (16-BITS):
16 bits = Unsigned integer humidity value
Unit: %RH
Valid range: 0/100
Range of measurement: 0 to 100%RH
Resolution: 1%/LSB

1.7.10. ABSOLUTE HUMIDITY: Register # 10 (address 9)

2-CHAR (16-BITS):
16 bits = Unsigned integer absolute humidity value
Unit: g/m^3
Range: NA, calculated from RH & T°
Resolution: $0.01g/m^3$/LSB

1.7.11. PRESSURE: Register # 11 (address 10)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: mbar
Valid Range: 0/16 384
Range of measurement: 0 to 1 638.4 mbar
Resolution: 0.1 mbar/LSB

1.7.12. PM10: Register # 12 (address 11)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: $\mu g/m^3$
Valid range: 0/1000
Range of measurement 0 to 1000 $\mu g/m^3$
Resolution: 1 $\mu g/m^3$/LSB

1.7.13. PM2.5: Register # 13 (address 12)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: $\mu g/m^3$
Valid range: 0/1000
Range of measurement 0 to 1000 $\mu g/m^3$
Resolution: 1 $\mu g/m^3$/LSB

1.7.14. PM1: Register # 14 (address 13)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: $\mu g/m^3$
Valid range: 0/1000 LSB
Range of measurement 0 to 1000 $\mu g/m^3$
Resolution: 1 $\mu g/m^3$/LSB

1.7.15. AVERAGE SOUND LEVEL: Register # 15 (address 14)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Period of measurement: 30 seconds
Unit: dB or dBA according to setting
Valid Range: 0/122
Range of measurement: 0 to 120 dB or dBA according to setting
Resolution: 1 dB/LSB

1.7.16. PEAK SOUND LEVEL: Register # 16 (address 15)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Period of measurement: 30 seconds
Unit: dB or dBA according to setting
Valid Range: 0/122
Range of measurement: 0 to 120 dB or dBA according to setting
Resolution: 1 dB/LSB

1.7.17. LUX: Register # 17 (address 16)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: Lux
Valid Range: 0/30 000
Range of measurement 0 to 30 000 Lux
Resolution: 1 lux/LSB

1.7.18. LIGHT COLOR T°: Register # 18 (address 17)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: Degree Kelvin
Valid Range: 0/65 535
Range of measurement 600°K to 10 000°K
Resolution: 1°K/LSB

1.7.19. LIGHT FLICKERING: Register # 19 (address 18)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: %
Valid Range: 0-100
Range of measurement 0 to 100%
Resolution: 1%/LSB

1.7.20. SULPHUROUS ODORS: Register # 20 (address 19)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: No
Valid Range: 1 to 10
Resolution: 0.1/LSB

1.7.21. NOX: Register # 21 (address 20)

Growth potential
2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: ppb
Valid Range: 20 to 500ppb
Resolution: 1ppb/LSB

1.7.22. OZONE (O3): Register # 22 (address 21)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: ppb
Valid Range: 20 to 500ppb
Resolution: 1ppb/LSB

1.7.23. 2 SPEEDS VENTILATION ON OFF COMMAND: Register # 25 (address 24)

2-CHAR (16-BITS):
Character 1: Fan Speed 1
Character 2: Fan Speed 2

00: Ventilation Off
FF: Ventilation ON

Example:

- Fan 1 ON
- Fan 2 OFF

REGISTER #20 : ON OFF 2 FAN SPEEDS COMMAND			
Character 1		Character 2	
F	F	0	0
4-CHAR = 16-BITS			

1.7.24. LINEAR VENTILATION COMMAND: Register # 26 (address 25)

2-CHAR (16-bit)
Value between 0 and 100%. This value can be used to control ventilation in continues. To be noted that to keep the building health a minimum of 10% is applied.
For Automatic Baseline Calibration of CO2 and VOC sensors, the ventilation will be activated at 100% during 30 minutes once every 15 days.

1.7.25. 2 SPEEDS RECYCLING ON OFF COMMAND: Register # 27 (address 26)

Growth potential

1.7.26. LINEAR RECYCLING COMMAND: Register # 28 (address 27)

Growth potential

1.7.27. HEATING COMMANDS: Register # 29 (address 28)

2-CHAR (16-bit)

On/Off command:

- 00: Off
- FF: On

Linear command value between 0 and 100%. This value can be used to control heating in continues.

REGISTER #29 : HEATING COMMAND	
Character 1 (On/Off command)	Character 2 (Linear command)
4-CHAR = 16-BITS	

1.7.28. COOLING COMMANDS: Register # 30 (address 29)

2-CHAR (16-bit)

On/Off command:

- 00: Off
- FF: On

Value between 0 and 100%. This value can be used to control air conditioning in continues.

REGISTER #30 : HEATING COMMAND	
Character 1 (On/Off command)	Character 2 (Linear command)
4-CHAR = 16-BITS	

1.7.29. COGNITIVITY INDEX: Register # 31 (address 30)

2-CHAR (16-bit)
Cognitivity / productivity
Value between 0 and 100%
Resolution 1

1.7.30. QUALITY OF SLEEP INDEX: Register # 32 (address 31)

2-CHAR (16-bit)
Quality of sleep
Value between 0 and 100%
Resolution 1

1.7.31. LONG TERM HEALTH INDEX: Register # 33 (address 32)

2-CHAR (16-bit)
Value between 0 and 100%
Resolution 1

1.7.32. SHORT TERM HEALTH INDEX: Register # 34 (address 33)

2-CHAR (16-bit)
Value between 0 and 100%
Resolution 1

1.7.33. BUILDING HEALTH INDEX: Register # 35 (address 34)

2-CHAR (16-bit)
Value between 0 and 100%
Resolution 1

1.7.34. ABSENCE OF IRRITATION INDEX: Register # 36 (address 35)

2-CHAR (16-bit)
Value between 0 and 100%
Resolution 1

1.7.35. OLFACTORY COMFORT INDEX: Register # 37 (address 36)

2-CHAR (16-bit)
Value between 0 and 100%
Resolution 1

1.7.36. RISK OF VIRUS SPREADING INDEX: Register # 38 (address 37)

2-CHAR (16-bit)
Value between 0 and 100%
Resolution 1

1.7.37. IAQ PROBE FLOOR: Register # 39 (address 38)

2-CHAR (16-bit)
Used to adjust outdoor air quality measured at 2-3m to the window altitude (based on 3m par floor)
Resolution 1

1.7.38. ACTION CODE: Register # 40 (address 39)

Launch an action via Modbus and read the status:

- Calibrate CO2 (and VOC sensors for probe delivered after November 2021):

- 0xCA00 : A calibration has been requested
- 0xCA01 : A calibration is underway (the 20 minutes' calibration count down has been launched)
- 0xCA02 : The calibration has been performed successfully
- 0xCA03 : The calibration has failed

- Air flushing opportunity for ABC:
  - 0xF701 : A flushing opportunity has occurred (once an hour to 4 time per day)
  - 0xF700 : The flushing opportunity has been interrupted (occupancy detected)

- Acknowledgment
  - o 0xA00 Default acknowledgment (LEDs return to normal state)
  - o 0xA01 Acknowledgment executed successfully

1.7.39. OUTDOOR FAÇADE 1 T°: Register # 41 (address 40)

2-CHAR (16-bit)
Outdoor temperature on indicated façade by LED position.
16 bits = temperature value (signed)

Examples
0°C = 0
12,9°C (value sent: 129) = 129 (decimal)
-5°C (value sent: -50) = -32718 (decimal) (complement at 2 on 16 bits: 1 bit for sign + 15 bits for value)

Range of measurement -20 to +50°C
Resolution: 0,1°C/LSB

1.7.40. OUTDOOR FAÇADE 1 RELATIVE HUMIDITY: Register # 42 (address 41)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: %RH
Valid range: 0/100
Range of measurement: 0 to 100%RH
Resolution: 1%/LSB

1.7.41. OUTDOOR FAÇADE 1 PM10: Register # 43 (address 42)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Valid range: 0/1000
Range of measurement 0 to 1000 µg/m^3
Resolution: 1 µg/m^3/LSB

1.7.42. OUTDOOR FAÇADE 1 PM2.5: Register # 44 (address 43)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Valid range: 0/1000
Range of measurement 0 to 1000 µg/m^3
Resolution: 1 µg/m^3/LSB

1.7.43. OUTDOOR FAÇADE 1 PM1: Register # 45 (address 44)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Valid range: 0/1000
Range of measurement 0 to 1000 µg/m^3
Resolution: 1 µg/m^3/LSB

1.7.44. OUTDOOR FAÇADE 1 NO2: Register # 46 (address 45)

2-CHAR (16-BITS):

16 bits = Unsigned integer value
Valid range 200 µg/m^3
Resolution: 0.2 µg/m^3/LSB

1.7.45. OUTDOOR FAÇADE 1 O3: Register # 47 (address 46)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Valid range 200 µg/m^3
Resolution: 0.2 µg/m^3/LSB

1.7.46. OUTDOOR FAÇADE 1 AVERAGE SOUND LEVEL: Register # 48 (address 47)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Period of measurement: 30 seconds
Unit: dB
Valid Range: 0/122
Resolution: 1 dB/LSB

1.7.47. OUTDOOR FAÇADE 1 PEAK SOUND LEVEL: Register # 49 (address 48)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Period of measurement: 30 seconds
Unit: dB
Valid Range: 0/122
Resolution: 1 dB/LSB

1.7.48. OUTDOOR FAÇADE 2 T°: Register # 52 (address 51)

2-CHAR (16-bit)
Outdoor temperature on indicated façade by LED position.
16 bits = Unsigned integer value

Examples
0°C = 0
12,9°C (value sent: 129) = 129 (decimal)
-5°C (value sent: -50) = -32718 (decimal) (complement at 2 on 16 bits: 1 bit for sign + 15 bits for value)

Range of measurement -20 to +50°C
Resolution: 0,1°C/LSB

1.7.49. OUTDOOR FAÇADE 2 RELATIVE HUMIDITY: Register # 53 (address 52)

2-CHAR (16-BITS):
16 bits = humidity value (not signed)
Unit: %RH
Valid range: 0/100 LSB
Range of measurement: 0 to 100%RH
Resolution: 1%/LSB

1.7.50. OUTDOOR FAÇADE 2 PM10: Register # 54 (address 53)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Valid range: 0/1000 LSB
Unit: µg/m^3
Range of measurement 0 to 1000 µg/m^3
Resolution: 1 µg/m^3/LSB

1.7.51. OUTDOOR FAÇADE 2 PM2.5: Register # 55 (address 54)

2-CHAR (16-BITS):
16 bits = Unsigned integer value

Unit: µg/m^3
Valid range: 0/1000 LSB
Range of measurement 0 to 1000 µg/m^3
Resolution: 1 µg/m^3/LSB

1.7.52. OUTDOOR FAÇADE 2 PM1: Register # 56 (address 55)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: µg/m^3
Valid range: 0/1000 LSB
Range of measurement 0 to 1000 µg/m^3
Resolution: 1 µg/m^3/LSB

1.7.53. OUTDOOR FAÇADE 2 NO2: Register # 57 (address 56)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Unit: µg/m^3
Valid range 200 µg/m^3
Resolution: 0.1 µg/m^3/LSB

1.7.54. OUTDOOR FAÇADE 2 O3: Register # 58 (address 57)

2-CHAR (16-BITS):
Unit: µg/m^3
Valid range 200 µg/m^3
Resolution: 0.1 µg/m^3/LSB

1.7.55. OUTDOOR FAÇADE 2 AVERAGE SOUND LEVEL: Register # 59 (address 58)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Period of measurement: 30 seconds
Unit: dB
Valid Range: 0/122 LSB
Resolution: 1 dB/LSB

1.7.56. OUTDOOR FAÇADE 2 PEAK SOUND LEVEL: Register # 60 (address 59)

2-CHAR (16-BITS):
16 bits = Unsigned integer value
Period of measurement: 30 seconds
Unit: dB
Valid Range: 0/122 LSB
Resolution: 1 dB/LSB

1.7.57. REMOTE LEDs: Register # 63 (address 62)

2-CHAR (16-bit)

BIT 0 : 0 ➔ LED Flag Remote Off
1 ➔ LED Flag Remote ON

BIT 1 & 2: Blue and yellow LEDs driving mode
0 0 ➔ ON / OFF mode
0 1 ➔ Slow breathing mode
1 0 ➔ Fast breathing mode
1 0 ➔ Reserved (assumed ON / OFF)

BIT 3 : 0 ➔ Blue LED Off
1 ➔ Blue LED active

BIT 4 : 0 ➔ Yellow LED Off

1 ➔ Yellow LED active

BIT 5: 0 ➔ Window Green left LED Off
1 ➔ Window Green left LED On

BIT 6: 0 ➔ Window Red left LED Off
1 ➔ Window Red left LED On

BIT 7: 0 ➔ Window Green right LED Off
1 ➔ Window Green right LED On

BIT 8: 0 ➔ Window Red right LED Off
1 ➔ Window Red right LED On

There is no red maintenance LED remote control as it is reserved to failures detected by the probe itself and will override the remote led driving.

1.7.58. LEDs DIMMING: Register # 64 (address 63)

REGISTER #29 : LEDs DIMMING	
Byte 1	Byte 0
LED Dimming (%)	LEDs Rules
16-BITS	

2-CHAR (16-bit)
Byte 0: LEDs Rules
Byte 1: LEDs Dimming in %

LEDS dimming
Value between 0 and 100%

BIT 0: 0 ➔ Dimming on physiological effects
1 ➔ Dimming on thresholds

BIT 1: 0 ➔ Off at night
1 ➔ On at night

BIT 2: 0 ➔ 100% of dimming set point at night (if Bit 1 at 1)
1 ➔ 10% of dimming set point at night (if Bit 1 at 1)

1.7.59. REMEDIATION ON THRESHOLDS OR PHYSIO EFFECTS: Register # 65 (address 64)

2-CHAR (16-BITS):

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

BIT 0: 0 ➔ Thresholds on concentration setpoints with OR
1 ➔ Physiological effects

1.7.60. CO2 SET POINT: Register 66 (address 65)

2-CHAR (16-bit)
Resolution: Same as measure
Default value: 1000ppm
Range: 500 to 2250ppm

1.7.61. VOC SET POINT: Register # 67 (address 66)

2-CHAR (16-bit)
Resolution: Same as measure
Default value: 300µg/m^3

Range: 0 to 25500µg/m^3

1.7.62. RH HIGH SET POINT: Register # 68 (address 67)

2-CHAR (16-bit)
Default value: 75%
Range: 0 to 100%

1.7.63. PM2.5 SET POINT: Register # 69 (address 68)

2-CHAR (16-bit)
Resolution: Same as measure
Default value: 20µg/m^3
Range: 10 to 255µg/m^3

1.7.64. PRODUCTIVITY SET POINT: Register # 71 (address 70)

2-CHAR (16-bit)
Value between 0 and 100%
Default value: 80%
Range: 0 to 90%

1.7.65. QUALITY OF SLEEP SET POINT: Register # 72 (address 71)

2-CHAR (16-bit)
Value between 0 and 100%
Default value: 80%
Range: 0 to 90%

1.7.66. LONG TERM HEALTH SET POINT: Register # 73 (address 72)

2-CHAR (16-bit)
Value between 0 and 100%
Default value: 80%
Range: 0 to 90%

1.7.67. SHORT TERM HEALTH SET POINT: Register # 74 (address 73)

2-CHAR (16-bit)
Value between 0 and 100%
Default value: 80%
Range: 0 to 90%

1.7.68. BUILDING HEALTH SET POINT: Register # 75 (address 74)

2-CHAR (16-bit)
Value between 0 and 100%
Default value: 80%
Range: 0 to 90%

1.7.69. ABSENCE OF IRRITATION SET POINT: Register # 76 (address 75)

2-CHAR (16-bit)
Value between 0 and 100%
Default value: 80%
Range: 0 to 90%

1.7.70. OLFACTORY COMFORT SET POINT: Register # 77 (address 76)

2-CHAR (16-bit)
Value between 0 and 100%
Default value: 80%
Range: 0 to 90%

1.7.71. HEATING SETPOINT (in 0.1 °C): Register # 78 (address 77)

2-CHAR (16-BITS)
16 bits = temperature value (unsigned)

Examples
20.9°C (value sent: 209) = 209 (decimal)

1.7.72. COOLING SETPOINT OFFSET (in 0.1 °C): Register # 79 (address 78)

2-CHAR (16-BITS)
16 bits = temperature value (unsigned)

Examples
2.9°C (value sent: 29) = 29 (decimal)
Offset of register 78 (cooling set point) register 78-79)

1.7.73. IP NETWORK REGISTRATION: Register # 80 (address 79)

(Specific to POE version with external POE interface)

16-BITS
Byte 1: = 00 and Byte 0: FF: Registration requested
Byte 1: = FF and Byte 0: 00: Registration acknowledge, no request

REGISTER #40 : IP NETWORK REGISTRATION			
Byte 1		Byte 0	
F	F	0	0
16-BITS			

1.7.74. VOC TYPE: Register # 81 (address 80)

16-BITS
Enumeration
0: AMS MEMS sensor (sensitive to occupancy)
1: IDT MEMS sensor (not sensitive to occupancy)

1.7.75. FREE COOLING MODE Register # 82 (address 81)

2-CHAR (16-BITS)
Byte 1: = 00 and Byte 0: FF: Heat exchanger On
Byte 1: = FF and Byte 0: 00: Heat exchanger Off
Byte 1: = 00 and Byte 0: 00: Not used

REGISTER #82 : FREE COOLING MODE			
Byte 1		Byte 0	
F	F	0	0

This mode can be decided from the sensor based on the delta T if an outdoor air quality sensor is used. The delta T is defined via the smartphone App.
The configuration of the free cooling mode (T° regulation and its setpoint or a percentage of the nominal flow (or opening angle of a damper) can also be configured via the smartphone App.
In this case, the information comes from the sensor for the benefit of the HVAC or a double flow ventilation which must disengage its heat exchanger and continue to provide sufficient air flow. If the ventilation is a simple flow, the free cooling information is used to activate the maximum air flow.

This mode can be decided at the HVAC or at the double flow ventilation level when it has an outdoor T° sensor and a free cooling setting (delta T, heat exchanger disengagement, air flow or pressure). In this case, the probe controls dampers or VAV on a thermal criterion according to the configuration via the App. Indeed, at night, in case of unoccupancy, the air flow tends to be reduced but the requirement of free cooling requires on the contrary a maximum air flow. This message makes it possible to overcome this contradiction.

1.7.76. VENTILATION MODE: Register # 83 (address 82)

Modes are similar to those used in KNX
2-CHAR (16-BITS)

Byte #1 Enumeration (Less Significant Byte):

Value	Mode
0	Comfort
1	Eco
2	Night
3	Maintenance (Stop)

Depending on the NFC configuration, the mode can be decided internally (light sensor for Night mode, CO2 sensor for Comfort mode (occupancy) and Eco mode (unoccupancy) or externally (the automat can retrieve information from occupancy and night sensors and sent the Mode to be applied to the sensor). Note that the mode can be override like maintenance to stop the ventilation.

Byte # 2 override (Most Significant Byte):

Exemption byte	Value
0	Auto
1	Override

In case of auto, the mode in byte1 does not apply.
In Auto, modes are based on internal sensors or external sensors received by radio (ZigBee or Enocean for example).

1.7.77. THERMAL MODE: Register # 84 (address 83)

Modes are similar to those used in KNX
2-CHAR (16-BITS)

Byte #1 Enumeration (Less Significant Byte):

Value	Mode
0	Comfort
1	Eco
2	Night
3	Maintenance (Stop)
4	Defrost

Depending on the NFC configuration, the mode can be decided internally (light sensor for Night mode, CO2 sensor for Comfort mode (occupancy) and Eco mode (unoccupancy) or externally (the automat can retrieve information from occupancy and night sensors and sent the Mode to be applied to the sensor). Note that the thermal mode is mainly intended to be overridden by the BMS in order to take into account the thermal inertia of the building and the anticipations linked to the temperature rise time between modes (clock, self-learning of presences, etc.) .
Also note that the frost protection setpoint temperature value is not adjustable and is equal to 6°C.

Byte # 2 override (Most Significant Byte):

Exemption byte	Value
0	Auto
1	Override

In case of auto, the mode in byte1 does not apply.
In Auto, modes are based on internal sensors or external sensors received by radio (ZigBee or Enocean for example).

1.8. Description of Write records

Only indicated registers are writable to allow adjustment of ventilation, heating and cooling set points, LED dimming and registration acknowledgement.

1.9.Response to master when using function 16 (0x10)

Write acknowledge:

FUNCTION CODE (0x10)	REGISTER'S ADDRESS	NUMBER OF REGISTERS TO WRITE
8-BIT	16-BIT	16-BIT

When ending with an error:

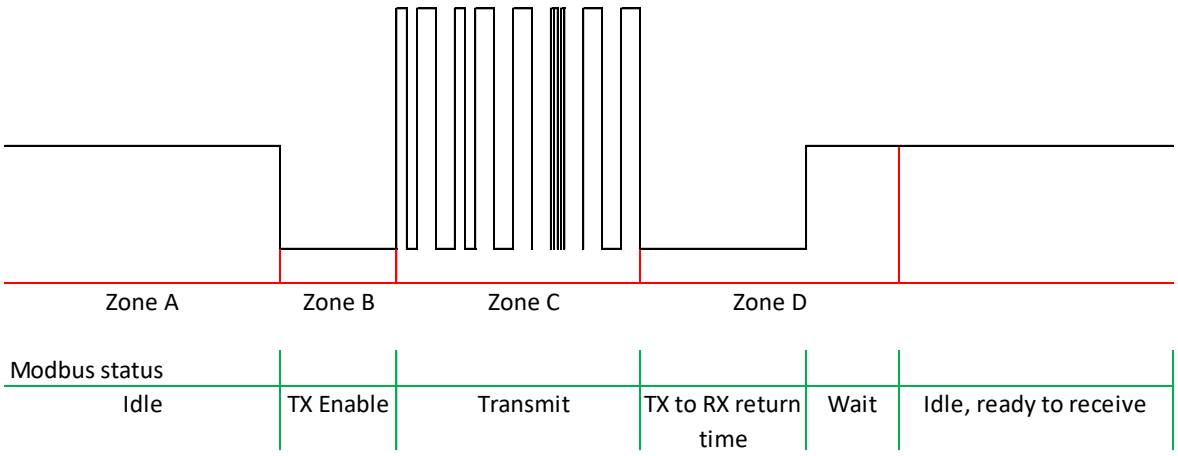
ERROR CODE (0x90)	EXCEPTION CODE
8-BIT	8-BIT

The exception code used by the EP5000 is the exception n° 3 (Illegal data value). This exception means registration is impossible. For example, if the difference of heating set point and cooling set is less than 5°C

1.10. Timings

Transmission of the probe

	Min	Max
Zone A	Firmware under 5.9: 30ms Firmware from 5.9: 5ms from 9600 bad rate	Emission rate dependent
Zone B	10ms	60ms
Zone C	Baud rate an content dependent	Baud rate an content dependent
Zone D	Firmware under 5.9: 600ms Firmware from 5.9: 10ms to 60ms	Firmware under 5.9: 2s (time out) Firmware from 5.9: 200 to 260ms (time out)



Mechanism:

Firmware under 5.9

Silence (end of frame): if after the last byte received, there is a silence of 30ms or above, the probe considers this silence as the end of frame.

Each time a byte is received, the 30ms time out is reloaded.

After the silence the acknowledgement to switch in transmission is as per zone B here above.

Firmware from 5.9

Silence (end of frame): if after the last byte received, there is a silence depending of the baud rate (30ms @ 1200 bauds, proportional above and 5ms from 9600 bauds) or above, the probe considers this silence as the end of frame.
Each time a byte is received, the silence time out is reloaded.
After the silence the acknowledgement to switch in transmission is as per zone B here above.

1.11. CRC16 calculation

```
static const unsigned char auchCRCHi[] = {
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40
} ;

static const unsigned char auchCRCLo[] = {
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4,
0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
0x1D, 0x1C, 0xDC, 0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7,
0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE,
0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2,
0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB,
0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0, 0x50, 0x90, 0x91,
0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88,
0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80,
0x40
} ;


unsigned short crc16(unsigned char *puchMsg , unsigned short usDataLen)
{
  unsigned char uchCRCHi = 0xFF ; /* high byte of CRC initialized */
  unsigned char uchCRCLo = 0xFF ; /* low byte of CRC initialized */
  unsigned uIndex ; /* will index into CRC lookup table */

  unsigned short usVal1;
  unsigned short usVal2;


  while (usDataLen--)/* pass through message buffer */
  {
```



```
    uIndex = uchCRCHi ^ *puchMsg; //++ ; /* calculate the CRC */
    puchMsg++ ;
    uchCRCHi = uchCRCLo ^ auchCRCHi[uIndex];
    uchCRCLo = auchCRCLo[uIndex] ;
   }

  usVal1 = uchCRCHi;
  usVal2 = uchCRCLo;

  usVal1 = usVal1 << 8;
  usVal1 = usVal1 | usVal2;

  return usVal1; //( ((unsigned short)uchCRCHi << 8) | (unsigned short)uchCRCLo) ;
 }
```