AC-116

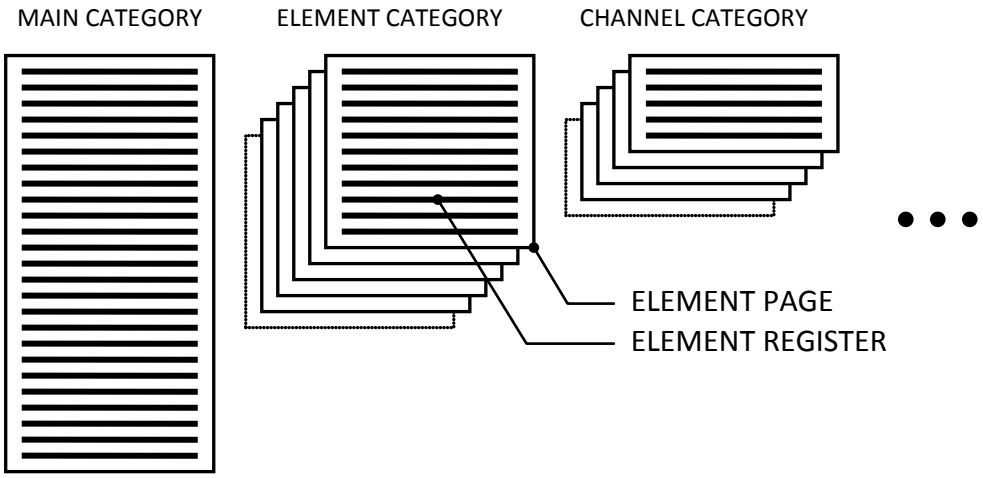
Modbus Register Map

1. Registers

All internal parameters, controls and statuses are stored in Registers. Registers are 16 bits wide and store either unsigned value from 0 to 65536 decimal, or signed value from -32768 to 32767 decimal. For better organization and structural access the Registers are separated to Categories. Each register Category contains one or more register Pages depending on the category and each page contains several Registers as shown on Picture 1.1.

Not all register locations or bits are fully implemented. Unimplemented bits are shown as ‘ - ‘ and should not be written to. When reading unimplemented bit, the value is undefined.

There are also “don’t care” bits marked as ‘X’. Writing to don’t care bits is allowed but does not have any effect. It is also not guaranteed that a don’t care bit can be actually modified. For future compatibility reasons, always write 0 to don’t care bits.



Picture 1.1

1.1 Register Category Overview

List of all Register Categories is shown in Table 1.1 with their number of register Pages and number of Registers per Page.

Category Name	Pages per Category	Registers per Page
MAIN (0x00)	1	31
ELEMENTS (0x01)	48	13
PACKED DATA (0x02)	17	17
CHANNELS (0x03)	17	4
RELAYS (0x04)	2	7
CLOCK (0x05)	1	7
SCHEDULES (0x06)	17	22
INFO (0x07)	1	5

Table 1.1

1.2 Main Category

Main Category contains global settings and status of the whole system and has only one Page.

1.2.1 Main Registers Overview

Index	Register name	Sheet
00	ELEMENT CHANGE FLAGS 0	
01	ELEMENT CHANGE FLAGS 1	
02	ELEMENT CHANGE FLAGS 2	
03	ELEMENT CHANGE FLAGS 3	
04	CHANNEL CHANGE FLAGS L	
05	CHANNEL CHANGE FLAGS H	
06	PACKED DATA CHANGE FLAGS L	
07	PACKED DATA CHANGE FLAGS H	
08	STATUS L	
09	STATUS H	
0A	LEARN MASK L	
0B	LEARN MASK H	
0C	LEARN CHANNEL	
0D	LAST LEARNED ELEMENT INDEX	
0E	DHW SENSOR	
0F	INLET SENSOR	
10	TOTAL CURRENT L	
11	TOTAL CURRENT H	
12	CPU TEMPERATURE	
13	INPUT VOLTAGE	
14	DHW TEMPERATURE COMFORT	
15	DHW TEMPERATURE ECO	
16	DHW TEMPERATURE CLEANING	
17	DHW TEMPERATURE STANDBY	
18	DHW CLEANING SCHEDULE	
19	HIGH TEMP CUT OFF TEMPERATURE	
1A	AUTO KICK IN TEMPERATURE	
1B	HIGH TEMP CUT OFF DELAY	
1C	ACTUATOR ACTIVATION INTERVAL	
1D	ACTUATOR ACTIVATION DURATION	
1E	ACTUATOR POLARITY	

1.2.2 Element Change Flags 0

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x00	EL16 CF	EL15 CF	EL14 CF	EL13 CF	EL12 CF	EL11 CF	EL10 CF	EL9 CF	EL8 CF	EL7 CF	EL6 CF	EL5 CF	EL4 CF	EL3 CF	EL2 CF	EL1 CF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

1.2.3 Element Change Flags 1

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x01	EL32 CF	EL31 CF	EL30 CF	EL29 CF	EL28 CF	EL27 CF	EL26 CF	EL25 CF	EL24 CF	EL23 CF	EL22 CF	EL21 CF	EL20 CF	EL19 CF	EL18 CF	EL17 CF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

1.2.4 Element Change Flags 2

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x02	EL48 CF	EL47 CF	EL46 CF	EL45 CF	EL44 CF	EL43 CF	EL42 CF	EL41 CF	EL40 CF	EL39 CF	EL38 CF	EL37 CF	EL36 CF	EL35 CF	EL34 CF	EL33 CF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

EL*n* CF — Element *n* Change Flag. Bit is set when any Element Register of the element at index *n* is changed. Bits in one register are cleared automatically after reading the register.

1.2.5 Element Change Flags 3

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x03	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

Register is reserved for future use.

1.2.6 Channel Change Flags L

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x04	CH16 CF	CH15 CF	CH14 CF	CH13 CF	CH12 CF	CH11 CF	CH10 CF	CH9 CF	CH8 CF	CH7 CF	CH6 CF	CH5 CF	CH4 CF	CH3 CF	CH2 CF	CH1 CF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

1.2.7 Channel Change Flags H

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x05	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	CH17 CF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

CH*n* CF — Channel *n* Change Flag. Bit is set when any Channel Register of the channel at index *n* is changed. Bits in one register are cleared automatically after reading the register.

1.2.8 Packed Data Change Flags L

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x06	PD16 CF	PD15 CF	PD14 CF	PD13 CF	PD12 CF	PD11 CF	PD10 CF	PD9 CF	PD8 CF	PD7 CF	PD6 CF	PD5 CF	PD4 CF	PD3 CF	PD2 CF	PD1 CF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

1.2.9 Packed Data Change Flags H

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x07	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	PD17 CF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

PD*n* CF — Packed Data *n* Change Flag. Bit is set when any Packed Data Register of the channel at index *n* is changed. Bits in one register are cleared automatically after reading the register.

1.2.10 Status L

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x08	GLOB STBY	-	DHW ENA	HTC ENA	INLET SENS	DHW SENS	-	-	-	-	-	-	-	-	RTC UPD	RTC VALID
	R	R	R/W	R/W	R	R	R	R	R	R	R	R	R	R	R/W	R/W

GLOB STBY — Global Standby. Bit is set when external global standby input is active and the system is put into a standby mode.

DHW ENA — DHW Enable. Domestic Hot Water function is enabled when this bit is set. Channel 16 of the control unit becomes dedicated for DHW. This bit should not be set when channel 16 is not empty.

HTC ENA — High Temp Cut-off Enable. High inlet temperature safety cut-off function is enabled when this bit is set.

INLET SENS — Inlet Sensor Present. Bit is set when a temperature sensor is present at the Inlet sensor terminal.

DHW SENS — DHW Sensor Present. Bit is set when a temperature sensor is present at the DHW sensor terminal.

RTC UPD — RTC Updated Flag. Indicates that clock has been changed by a thermostat.

RTC VALID — RTC Valid Flag. Indicates that clock has a valid time and date.

1.2.11 Status H

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Register is reserved for future use.

1.2.12 Learn Mask L

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x0A	CH16 LM	CH15 LM	CH14 LM	CH13 LM	CH12 LM	CH11 LM	CH10 LM	CH9 LM	CH8 LM	CH7 LM	CH6 LM	CH5 LM	CH4 LM	CH3 LM	CH2 LM	CH1 LM
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

CHn LM — Channel n Learn Selection Mask. Set bits to 1 to enable Learning Mode at the corresponding channels. More bits can be set to 1 at a time. Learn Channel register also needs to be set. Please refer to 1.2.14.

Warning: Rules apply to setting multiple bits to 1. Learning elements to incorrect set of channels may lead to system malfunction! Selection must either contain any number of empty channels or a whole room (group of channels joined previously by learning the same element into empty channels). Be careful not to mix these sets.

1.2.13 Learn Mask H

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x0B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	CH17 LM
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

CH17 LM — Channel 17 Learn Enable. Set the bit to enable Learning Mode at channel 17. Learn Channel register also needs to be set. Please refer to 1.2.14. **Note:** Channel 17 is separated from other channels and it cannot be a part of a room. Don't set any other CHn LM bit together with CH17 LM.

1.2.14 Learn Channel

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x0C	0	0	0	0	0	0	0	0	0	0	0	LCHAN[4:0]				
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

LCHAN[4:0] — Specifies a channel used as a primary channel during the learning process. It should be always set to the index of the lowest channel selected by Learn Mask register.

1.2.15 Last Learned Element Index

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x0D	0	0	0	0	0	0	0	0	0	0	0	LLEIDX[4:0]				
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

LLEIDX[4:0] — It is set to the newly learned element index+1 after finishing the learning process. It must be cleared to 0 by user.

1.2.16 DHW Sensor Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x0E	DHW[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

DHW[15:0] — DHW Sensor Temperature in 0.1 °C units. For example 45.5 °C is stored as 455 decimal (0x01C7).

1.2.17 Inlet Sensor Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x0F	INLET[15:0]															

R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

INLET[15:0] Inlet Sensor Temperature in 0.1 °C units. For example 45.5 °C is stored as 455 decimal (0x01C7).

1.2.18 Total Current L

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x10	TCURR[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

1.2.19 Total Current H

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x11	TCURR[31:16]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

TCURR[31:0] Total current consumption of all actuators in 0.54 mA units. Power consumption is P_{TOT} = 24 * TCURR / 0.54 [mW].

1.2.20 Reserved

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x12	RESERVED[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

RESERVED[15:0]

1.2.21 Reserved

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x13	RESERVED[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

RESERVED[15:0]

1.2.22 DHW Comfort Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x14	DHWCOMF[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

DHWCOMF[15:0] DHW Comfort temperature in 0.1 °C units. For example 45.5 °C is stored as 455 decimal (0x01C7).

1.2.23 DHW Eco Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Index 0x15	DHWECO[15:0]

R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W

DHWECO[15:0] DHW Eco temperature in 0.1 °C units. For example 45.5 °C is stored as 455 decimal (0x01C7).

1.2.24 DHW Cleaning Temperature

Bit: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Index 0x16	DHWCLEAN[15:0]

R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W

DHWCLEAN[15:0] DHW Cleaning temperature in 0.1 °C units. For example 45.5 °C is stored as 455 decimal (0x01C7).

1.2.25 DHW Standby Temperature

Bit: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Index 0x17	DHWSTBY[15:0]

R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W

DHWSTBY[15:0] DHW Standby temperature in 0.1 °C units. For example 45.5 °C is stored as 455 decimal (0x01C7).

1.2.26 DHW Cleaning Schedule

Bit: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Index 0x18	DAYOFWEEK[4:0]	HOUR[4:0]	MINUTE[5:0]

R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W

DAYOFWEEK[4:0] Specifies a day of week when the DHW cleaning is due. 0 = Monday, 1 = Tuesday, 6 = Sunday.

HOUR[4:0] Specifies an hour when the DHW cleaning is due. Range is 0 to 23.

MINUTE[5:0] Specifies a minute when the DHW cleaning is due. Range is 0 to 59.

1.2.27 High Temp Cut-off Temperature

Bit: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Index 0x19	CUTOFF[15:0]

R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W

CUTOFF[15:0] High Temperature safety cutoff temperature in 0.1 °C units. For example 45.5 °C is stored as 455 decimal (0x01C7).

1.2.28 Auto Kick-in Temperature

Bit: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Index 0x1A	KICKIN[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

KICKIN[15:0] High Temperature safety cutoff automatic recovery temperature in 0.1 °C units. For example 45.5 °C is stored as 455 decimal (0x01C7).

1.2.29 High Temp Cut-off Delay

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x1B	HTCDELAY[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

HTCDELAY[15:0] Specifies High Temperature safety cutoff delay time in seconds.

1.2.30 Actuator Activation Interval

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x1C	AAINTERVAL[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

AAINTERVAL[15:0] Specifies time interval between periodic Actuator Activations in seconds.

1.2.31 Actuator Activation Duration

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x1D	AADURATION[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

AADURATION[15:0] Specifies duration of Actuator Activation process in seconds.

1.2.32 Actuator Polarity

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Index 0x1E	AC16 POL	AC15 POL	AC14 POL	AC13 POL	AC12 POL	AC11 POL	AC10 POL	AC9 POL	AC8 POL	AC7 POL	AC6 POL	AC5 POL	AC4 POL	AC3 POL	AC2 POL	AC1 POL
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

ACn POL Sets actuator polarity for each channel. 0 = Normally Closed, 1 = Normally Open. Please note the actuator polarity is a complement to the channel polarity.

1.3 Elements Category

Contains parameters which are unique to the element. Not all Element pages have to be populated. Empty page has both ADDRESS_L and ADDRESS_H registers equal zero.

1.3.1 Element Registers Overview

Index	Register name	Sheet

00	ADDRESS L	
01	ADDRESS H	
02	ASSIGNMENT MAP L	
03	ASSIGNMENT MAP H	
04	AIR TEMPERATURE	
05	FLOOR TEMPERATURE	
06	DEW POINT TEMPERATURE	
07	RELATIVE HUMIDITY	
08	STATUS	
09	RSSI	
0A	BATTERY STATUS	
0B	SYNC GROUP	
0C	LIVE TIMER	

1.3.2 Address L

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ADDRESS[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

1.3.3 Address H

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ADDRESS[31:16]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

ADDRESS[31:0] Unique physical address of the element. Address equal to zero means that the element page is not used. By setting these registers to zero the element can be deleted from the system. **Please note**: To delete the Primary element also the Primary Element register in Channel Category needs to be updated (see 1.4.4 for details).

1.3.4 Assignment Map L

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	CH15 AF	CH14 AF	CH13 AF	CH12 AF	CH11 AF	CH10 AF	CH9 AF	CH8 AF	CH7 AF	CH6 AF	CH5 AF	CH4 AF	CH3 AF	CH2 AF	CH1 AF	CH0 AF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

1.3.5 Assignment Map H

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	CH17 AF
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

CHn AF — Channel n Assignment Flags. For each element it specifies in which channel the element is present. **Please note**: At least one element from the group (called Room) should be marked as Primary (see 1.4.4 for details). Channel 17 is separated from other channels and it cannot be a part of the room. Don't set any other CHn AF bit together with CH17 AF and also don't set CH17 AF when any other CHn AF bit is set.

1.3.6 Air Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	AIRTEMP[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

AIRTEMP[15:0] — Reads the current air temperature measured by a room thermostat. If the temperature is not known it shows 0x7FFF.

1.3.7 Floor Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	FLOORTEMP[15:0}															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

FLOORTEMP[15:0] — Reads the current floor temperature measured by a room thermostat. If the temperature is not known it shows 0x7FFF.

1.3.8 Dew Point Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	DEWPOINT[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

DEWPOINT[15:0] — Reads the current dew point temperature measured by a room thermostat. If the temperature is not known it shows 0x7FFF.

1.3.9 Relative Humidity

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	HUMIDITY[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

HUMIDITY[15:0] — Reads the current relative air humidity in percentage measured by a room thermostat. If the humidity is not known it shows 0x7FFF.

1.3.10 Status

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

ALIVE	-	-	-	LOST	LOW BATT	NAT ELEM	TP	TP ACT	ACTIVE	-	RFSH	-	-	-	-
R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

ALIVE — Reflects the online status of the element. The bit goes to 0 when valid packet not received for approximately 25 minutes.

LOST — Goes to 1 when the element is not alive.

LOW BATT — Indicates the simple battery status of the element. Goes to 1 when the element battery is running low.

NAT ELEM — Signals that the element is a Magnetic contact.

TP — Signals that the element is a Thermostat.

TP ACT — Signals that status of the Thermostat output is active.

ACTIVE — Signals that status of the Magnetic contact output is active.

RFSH — Set if valid packet received from periphery.

1.3.11 RSSI

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	RSSIEL[7:0]								RSSICU[7:0]							
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

RSSIEL[7:0] — Received Signal Strength Indication at the element side. A signed value of zero means -74 dBm and one step is 0.5 dBm. Example: 0x00 = -74 dBm, 0x01 = -73.5 dBm, 0x08 = -70 dBm, 0xFF = -74.5 dBm.

RSSICU[7:0] — Received Signal Strength Indication at the control unit side. A signed value of zero means -74 dBm and one step is 0.5 dBm. Example: 0x00 = -74 dBm, 0x01 = -73.5 dBm, 0x08 = -70 dBm, 0xFF = -74.5 dBm.

1.3.12 Battery Status

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	0	0	0	BATT[3:0]			
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

BATT[3:0] — Battery status in 10% units. 0 means battery discharged, 10 means battery fully charged.

1.3.13 Sync Group

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-	-	-	-	-	-	-	-	SYNCG[7:0]							
	R	R	R	R	R	R	R	R	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

SYNCG[7:0] — Element's primary channel number (0..15 or 16). When the element is learned into only one channel, this should be the channel number. When the element is learned

into more than one channel, this should point to the lowest channel number in a group.

1.3.14 Live Timer

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	LTIMER[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

LTIMER[15:0] Register is reserved for internal use only and should not be used.

1.4 Channels Category

Contains parameters which are unique to the channel. All channel pages are populated.

1.4.1 Channel Registers Overview

Index	Register name	Sheet
00	TIMER EVENT	
01	CURRENT CONSUMPTION	
02	PRIMARY ELEMENT	
03	TIMER	

1.4.2 Timer Event

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	OVER CURR	FROST ALARM	ACT ENAB	BLKD	LOST	-	-	-	-	-	-	OUTP ON	TEVENT[3:0]			
	R	R	R/W	R/W	R	R	R	R	R	R	R	R	R/W	R/W	R/W	R/W

OVER CURR Overcurrent alarm flag. Set to 1 when excessive current is drawn from actuator output.

FROST ALARM Freezing alarm flag. Set to 1 when air temperature drops below low alarm temperature.

ACT ENAB Set to 1 to enable periodic activation cycle

BLKD Goes to 1 when output is blocked by Magnetic contact.

LOST Goes to 1 when the any element in channel is not alive.

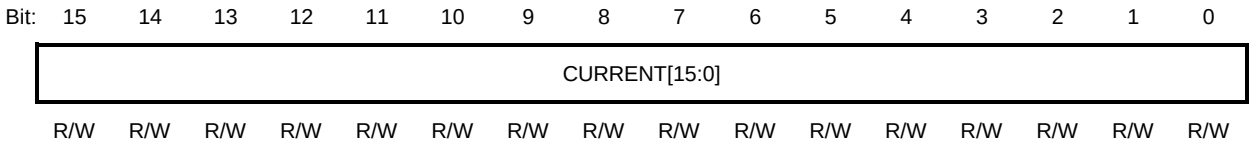
OUTP ON Channel output status flag. Set to 1 when channel output is active.

TEVENT[3:0] Current timer event.

Value	Timer event name
00	NO_EVENT
01	IDLE_TIMER
02	CUT_OFF
03	CONTROL_BYPASS
04	START_DELAY_TIMER

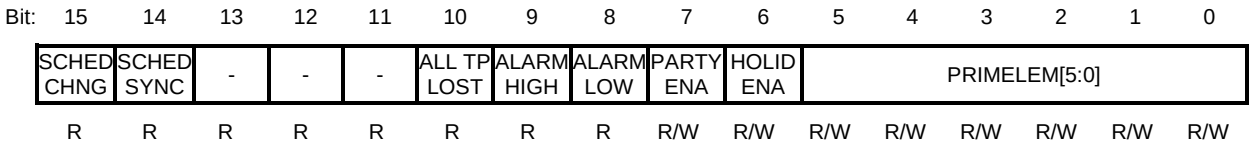
05	OUTPUT_OVERCURRENT
06	OVERRIDE_OUTPUT_OFF
07	OUTPUT_ON
08	FREEZING
09	DHW_OUTPUT_ON
0A	STOP_DELAY_TIMER
0B	DHW_CLEANING_TIMER
0C	OVERRIDE_OUTPUT_ON
0D	PERIODIC_CYCLE_TIMER

1.4.3 Current Consumption



CURRENT[15:0] Current consumption of an actuator connected to the channel in 0.54 mA units. Power consumption is P_{CH} = 24 * CURRENT / 0.54 [mW].

1.4.4 Primary Element Index



SCHED CHNG Indicates that channel schedule has been changed by room thermostat or other element. Bit is cleared automatically after reading the register.

SCHED SYNC Indicates that unit will synchronize parameters in the next communication frame.

ALL TP LOST Indicates that all Thermostats in the channel are lost.

ALARM HIGH Indicates that any Thermostat in the channel reached ALARM HIGH temperature.

ALARM LOW Indicates that any Thermostat in the channel reached ALARM LOW temperature.

PARTY ENA Specifies whether the channel has a Party mode allowed. This bit has no real effect on hardware, it's only a single bit non-volatile storage used to save the user's preference. The party mode itself has to be activated/deactivated separately and independently for each channel according to this bit's value.

HOLID ENA Specifies whether the channel has a Holiday mode allowed. This bit has no real effect on hardware, it's only a single bit non-volatile storage used to save the user's preference. The Holiday mode itself has to be activated/deactivated separately and independently for each channel according to this bit's value.

PRIMELEM[5:0] Channel primary element. This is the index+1 of the first element learned into the channel. When more channels are joined to form a room, this should point to the same element in all joined channels. When the channel is not used it is set to 0.

1.4.5 Timer

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	TIMER[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

TIMER[15:0] Register is reserved for internal use only and should not be used.

1.5 Relays Category

Contains relays-specific settings. All pages are populated.

1.5.1 Relay Registers Overview

Index	Register name	Sheet
00	TIMER EVENT	
01	ASSIGNMENT MAP	
02	START DELAY	
03	STOP DELAY	
04	ACTIVATION INTERVAL	
05	ACTIVATION DURATION	
06	TIMER	

1.5.2 Timer Event

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-	-	-	-	-	-	-	-	-	-	-	-	TEVENT[3:0]			
	R	R	R	R	R	R	R	R	R	R	R	R	R/W	R/W	R/W	R/W

TEVENT[3:0] Current timer event.

Value	Timer event name
00	NO_EVENT
01	IDLE_TIMER
02	CUT_OFF
03	CONTROL_BYPASS
04	START_DELAY_TIMER
05	OUTPUT_OVERCURRENT
06	OVERRIDE_OUTPUT_OFF
07	OUTPUT_ON
08	FREEZING
09	DHW_OUTPUT_ON
0A	STOP_DELAY_TIMER
0B	DHW_CLEANING_TIMER
0C	OVERRIDE_OUTPUT_ON

0D	PERIODIC_CYCLE_TIMER

1.5.3 Assignment Map

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	CH16 ENA	CH15 ENA	CH14 ENA	CH13 ENA	CH12 ENA	CH11 ENA	CH10 ENA	CH9 ENA	CH8 ENA	CH7 ENA	CH6 ENA	CH5 ENA	CH4 ENA	CH3 ENA	CH2 ENA	CH1 ENA
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

CHn ENA — Relay enable bits for each channel. Relay is turned on when any of the selected channel's actuator is active.

1.5.4 Start Delay

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	STARTDLY[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

STARTDLY[15:0] — Relay start delay in seconds. The relay actually turns on after a specified time when the condition from 1.5.3 becomes true.

1.5.5 Stop Delay

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	STOPDLY[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

STOPDLY[15:0] — Relay stop delay in seconds. The relay actually turns off after a specified time when the condition from 1.5.3 becomes false.

1.5.6 Activation Interval

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ACTINTERVAL[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

ACTINTERVAL[15:0] — Pump activation interval in seconds.

1.5.7 Activation Duration

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ACTDURATION[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

ACTDURATION[15:0] — Pump activation duration in seconds.

1.5.8 Timer

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	TIMER[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

TIMER[15:0] Register is reserved for internal use only and should not be used.

1.6 Packed Data Category

Contains parameters common to all elements learned into one channel. Not all pages have to be populated.

1.6.1 Packed Data Registers Overview

Index	Register name	Page
00	MANUAL TEMPERATURE	
01	COMFORT TEMPERATURE	
02	ECO TEMPERATURE	
03	HOLIDAY TEMPERATURE	
04	STANDBY TEMPERATURE	
05	PARTY TEMPERATURE	
06	MODE LENGTH	
07	CONFIGURATION	
08	MINIMUM TEMPERATURE	
09	MAXIMUM TEMPERATURE	
0A	FLOOR MINIMUM TEMPERATURE	
0B	FLOOR MAXU\IMUM TEMPERATURE	
0C	ALARM MINIMUM TEMPERATURE	
0D	ALARM MAXIMUM TEMPERATURE	
0E	HYSTERESIS	
0F	TEMPERATURE OFFSET	
10	DESIRED TEMPERATURE	

1.6.2 Manual Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	MANTEMP[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

MANTEMP[15:0] Set temperature for Manual mode. One LSB equals 0.1 °C.

1.6.3 Comfort Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

COMFTEMP[15:0]
R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W

COMFTEMP[15:0] Comfort temperature in 0.1 °C units.

1.6.4 Eco Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ECOTEMP[15:0]																
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

ECOTEMP[15:0] Economic temperature. One LSB equals 0.1 °C.

1.6.5 Holiday Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
HOLIDAYTEMP[15:0]																
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

HOLIDAYTEMP[15:0] Override temperature in Holiday mode. One LSB equals 0.1 °C.

1.6.6 Standby Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
STBYTEMP[15:0]																
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

STBYTEMP[15:0] Override temperature in Standby mode in. One LSB equals 0.1 °C.

1.6.7 Party Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
PARTYTEMP[15:0]																
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

PARTYTEMP[15:0] Temperature increment for Party mode. One LSB equals 0.1 °C.

1.6.8 Mode Length

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MDLENGTH[15:0]																
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

MDLENGHT[15:0] Override mode duration. One LSB equals 2 minutes.

1.6.9 Configuration

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

FLOOR SENS	FLOOR ENA	COOL MODE	ADAPT MODE	INT LOCK	CTRL LOCK	HOTEL MODE	-	-	-	-	-	SCHED ENA	MODE[2:0]		
R	R/W	R/W	R/W	R/W	R/W	R/W	R	R	R	R	R	R/W	R/W	R/W	R/W

FLOOR SENS — Indicates whether the channel has at least one thermostat with the floor sensor.

FLOOR ENA — Enables/disables floor temperature sensing. When there's no thermostats with the floor sensor present this bit has no effect.

COOL MODE — Enables cooling mode instead of heating.

ADAPT MODE — Enables adaptive mode for the room thermostats.

INT LOCK — When set, user is prevented to enter the service menu of the room thermostats.

CTRL LOCK — When set, a user is prevented to make any changes on the room thermostats. **Note:** When both INT LOCK and CTRL LOCK are set, a user is prevented to enter the room thermostat menu completely.

HOTEL MODE — When set, the room thermostats are switched to the Hotel mode.

SCHED ENA — Week scheduler of the room thermostats is enabled when the bit is set. It should be set together with MODE[2:0] bits.

MODE[2:0] — Sets the mode of the channel.

SCHED ENA	MODE	Mode name
0	00	MANUAL
0	01	PERMANENT STANDBY
0	02	PERMANENT ECO
0	03	PERMANENT COMFORT
0	04	PARTY ON MANUAL MODE
0	05	HOLIDAY ON MANUAL MODE
1	00	WEEK SCHEDULE
1	01	TEMPORARY STANDBY (do not use)
1	02	TEMPORARY ECO
1	03	TEMPORARY COMFORT
1	04	PARTY WITH WEEK SCHEDULE
1	05	HOLIDAY WITH WEEK SCHEDULE

1.6.10 Minimum Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	MINTEMP[15:0]															
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

MINTEMP[15:0] — Minimum temperature the user can set on a room thermostat. One LSB equals 0.1 °C.

1.6.11 Maximum Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

MAXTEMP[15:0]
R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W

MAXTEMP[15:0] Maximum temperature the user can set on a room thermostat. One LSB equals 0.1 °C.

1.6.12 Floor Minimum Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FLMINTEMP[15:0]																
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

FLMINTEMP[15:0] Minimum floor temperature. One LSB equals 0.1 °C. When the floor temperature drops below this point, the channel will demand heating regardless of the air temperature.

1.6.13 Floor Maximum Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FLMAXTEMP[15:0]																
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

FLMAXTEMP[15:0] Maximum floor temperature. One LSB equals 0.1 °C. When the floor temperature rises above this point, the channel will stop heating regardless of the air temperature.

1.6.14 Alarm Low Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ALARMLOTEMP[15:0]																
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

ALARMLOTEMP[15:0] Minimum allowed air temperature. One LSB equals 0.1 °C. When the air temperature drops below this point, an alarm is set off.

1.6.15 Alarm High Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ALARMHITEMP[15:0]																
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

ALARMHITEMP[15:0] Maximum allowed air temperature. One LSB equals 0.1 °C. When the air temperature rises above this point, an alarm is set off.

1.6.16 Hysteresis

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
HYST[15:0]																

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

HYST[15:0] Temperature control loop hysteresis. One LSB equals 0.1 °C.

1.6.17 Temperature Offset (removed)

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Register has been removed and should not be used.

1.6.18 Desired Temperature

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	DESTEMP[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

DESTEMP[15:0] Reflects the desired temperature to which the channel is currently heating to. One LSB equals 0.1 °C.

1.7 Clock Category

Real time clock registers.

Please note: Clock register page should always be read or written at once to prevent unwanted clock changes between writes/reads.

1.7.1 Clock Registers Overview

Index	Register name	Page
00	YEAR	
01	MONTH	
02	DAY	
03	DAY OF WEEK	
04	HOUR	
05	MINUTE	
06	SECOND	

1.7.2 Year

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	YEAR[11:0]											
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

YEAR[11:0] Year register. Correct values are 2001 to 2099.

1.7.3 Month

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	0	0	0	MONTH[3:0]			
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

MONTH[3:0] Month register. Correct values are 1 to 12.

1.7.4 Day

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	0	0	DAY[4:0]				
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

DAY[4:0] Day register. Correct values are 1 to 31 (depending on current month).

1.7.5 Day of Week

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	DOW[3:0]		
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

DOW[3:0] Day of Week register. Correct values are 0 to 6 (0 = Monday, 6 = Sunday).

1.7.6 Hour

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	0	0	HOUR[4:0]				
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

HOUR[4:0] Hour register. Correct values are 0 to 23.

1.7.7 Minute

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	0	MINUTE[5:0]					
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

MINUTE[5:0] Minute register. Correct values are 0 to 59.

1.7.8 Second

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	0	SECOND[5:0]					
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

SECOND[5:0] Seconds register. Correct values are 0 to 59.

1.8 Schedules Category

Channel week schedules.

Please note: To write to the schedule page, a whole page must be written at once. Not doing so may lead to system malfunction.

1.8.1 Schedule Registers Overview

Index	Register name	Page
00	HEADER	
01	WORD 0	
02	WORD 1	
03	WORD 2	
04	WORD 3	
05	WORD 4	
06	WORD 5	
07	WORD 6	
08	WORD 7	
09	WORD 8	
0A	WORD 9	
0B	WORD 10	
0C	WORD 11	
0D	WORD 12	
0E	WORD 13	
0F	WORD 14	
10	WORD 15	
11	WORD 16	
12	WORD 17	
13	WORD 18	
14	WORD 19	
15	WORD 20	

1.8.2 Header

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	X	X	X	X	X	X	X	X	KIND[7:0]							
	RW	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

KIND[7:0] Schedule kind. It has no real effect on hardware, it is used only to store the schedule identifier together with the schedule bitmap to differentiate between several (possibly) identical schedules.

1.8.3 Word 0 – Word 20

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	MON[15:0]															

Word 1	MON[31:16]
Word 2	MON[47:32]
Word 3	TUE[15:0]
Word 4	TUE[31:16]
Word 5	TUE[47:32]
Word 6	WED[15:0]
Word 7	WED[31:16]
Word 8	WED[47:32]
Word 9	THU[15:0]
Word 10	THU[31:16]
Word 11	THU[47:32]
Word 12	FRI[15:0]
Word 13	FRI[31:16]
Word 14	FRI[47:32]
Word 15	SAT[15:0]
Word 16	SAT[31:16]
Word 17	SAT[47:32]
Word 18	SUN[15:0]
Word 19	SUN[31:16]
Word 20	SUN[47:32]

R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W R/W

xxx[47:0] Schedule bitmap for day xxx. Each one of the 48 bits represents a 30 minutes long time frame of the day. Bit 0 represents the time frame from 00:00 to 00:30, bit 47 the time frame from 23:30 to 24:00. When the bit is set, the relevant time frame is programmed to the Comfort temperature. When it's cleared, it's the Eco temperature.

In a Hotel mode, the behavior is different. All bits of the day should be set to 1 except of one bit set to 0. When the bit is set, there's no action during the time frame. When the bit is cleared, a Hotel mode set temperature is restored to the default temperature (Eco) at the beginning of the time frame.

1.9 Info Category

1.9.1 Info Registers Overview

Index	Register name	Page
00	CONTROL UNIT ADDRESS L	
01	CONTROL UNIT ADDRESS H	

02	HW VERSION	
03	SW VERSION	
04	DEVICE NAME	

1.9.2 Control Unit Address L

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ADDRESS[15:0]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

1.9.3 Control Unit Address H

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	ADDRESS[31:16]															
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

ADDRESS[31:0] Control unit physical address.

1.9.4 HW Version

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	HWVERS[6:0]						
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

HWVERS[6:0] Hardware version number suffix. The complete version number is MC110xx, where xx is the contents of the HWVERS register in decimal. For example HWVERS = 12 (0x000C) means the version MC11012.

1.9.5 SW Version

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	SWVERS[7:0]								BETA[3:0]			
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

SWVERS[7:0] Software version number suffix. The complete version number is MC610xx, where xx is the contents of SWVERS in BCD. For example SWVERS = 20 (0x0014) means the software version MC61014.

BETA[3:0] Identifies a software beta version. When BETA is not zero, "**b**nn" suffix should be added to the software version, where nn is BETA contents in decimal. For example BETA = 11 (0x000B) means software version MC61014b11 from the previous example.

1.9.6 Device Name

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	DEVNAME[15:0]															

R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

DEVNAME[15:0] Device name suffix. The full device name is AC-xxx, where xxx is DEVNAME contents in decimal. For example DEVNAME = 116 (0x0074) means device name AC-116.

2. Addressing the units

Each control unit has a unique 32bit factory preset physical address and a logical 8bit address according to the Modbus protocol specifications. Only the logical address is used in standard Modbus communications. How to assign logical addresses please refer to the chapter 3. Control unit enumeration. Every control unit responds at address 0x01 regardless of its assigned logical address for compatibility reasons. Besides that, a unit can be assigned to a specific logical address to which the unit responds as well, so that the assigned logical address should be always higher than 0x01.

3. Control unit enumeration

3.1 Introduction

Control units have no manual control over their logical addresses therefore a building management system is responsible to assign them. After power-up, default logical address of each control unit is 0x00. When only one unit is installed in the system, no enumeration is needed and BMS can communicate with the unit using the address 0x01 (see 2. Addressing the units). When two or more units are chained together, enumeration needs to be done before they can be accessed.
Since Modbus protocol has no native support for address enumeration, the communication protocol has been extended by three commands. Behavior and responses to these commands are different to the official Modbus specification. All enumeration commands must be issued to the destination logical address 0x01 even when some of the units already have the logical address assigned.

3.2 Enumeration Process

1. Reset logical addresses of all units.
2. Try to directly assign logical addresses to all previously known units.
3. Start enumeration of the rest (units assigned at 2. will not respond).
4. Assign new logical addresses to physical addresses found by enumeration.
5. Repeat enumeration at 3. until there’s no response or all addresses have been assigned.

3.3 Enumeration Commands

3.3.1 Reset Logical Addresses of All Units

Command resets the logical addresses of all connected control units to default (0x01). Units with non-zero logical addresses do not respond to Start of Enumeration command so this can be used to restart the enumeration process from the beginning. Units do not respond to this command.

Request

Function Code	1 Byte	**0x6D**
Physical Address_L	2 Bytes	0x0000
Physical Address_H	2 Bytes	0x0000
Target Logical Address	1 Byte	0x00

Response

- none -

3.3.2 Start of Enumeration

This command makes all units to respond with their physical addresses. Each unit chooses a random time frame in which it sends the response. In ideal case the host receives as many responses as the number of units present. It may also happen that two or more units choose the same time frame, responses collide and the host receives a frame with an incorrect CRC. Maximum delay between the command and the response is 1500 ms and minimum is 62 ms. Units with the logical address assigned to a non-zero value do not respond to this command.

Request

Function Code	1 Byte	**0x6D**
Physical Address_L	2 Bytes	0x0000
Physical Address_H	2 Bytes	0x0000
Logical Address	1 Byte	any non-zero value

Responses

Function Code	1 Byte	**0x6D**
Physical Address_L	2 Bytes	0x0000 to 0xFFFF
Physical Address_H	2 Bytes	0x0000 to 0xFFFF
Logical Address	1 Byte	0x00

Example:

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function Code	**0x6D**	Function Code	**0x6D**
Physical Address_L (Hi)	**0x00**	Physical Address_L (Hi)	**0x34**
Physical Address_L (Lo)	**0x00**	Physical Address_L (Lo)	**0x12**
Physical Address_H (Hi)	**0x00**	Physical Address_H (Hi)	**0x78**
Physical Address_H (Lo)	**0x00**	Physical Address_H (Lo)	**0x56**
Logical Address	**0x01**	Logical Address	**0x00**

One unit responded with its physical address 0x12345678. Logical address at the response is always zero because units with non-zero addresses do not respond.

3.3.3 Assign the Logical Address to a Unit

Command sets the unit at the specified physical address to the specified logical address. As soon as the unit has the logical address assigned, it does not respond to Start of Enumeration commands anymore.

Request

Function Code	1 Byte	**0x6D**
Physical Address_L	2 Bytes	0x0000 to 0xFFFF
Physical Address_H	2 Bytes	0x0000 to 0xFFFF
Logical Address	1 Byte	0x01 to 0xF7

Response

Function Code	1 Byte	**0x6D**
Physical Address_L	2 Bytes	0x0000 to 0xFFFF
Physical Address_H	2 Bytes	0x0000 to 0xFFFF
Logical Address	1 Byte	0x01 to 0x7F

Example:

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function Code	**0x6D**	Function Code	**0x6D**
Physical Address_L (Hi)	**0x34**	Physical Address_L (Hi)	**0x34**
Physical Address_L (Lo)	**0x12**	Physical Address_L (Lo)	**0x12**
Physical Address_H (Hi)	**0x78**	Physical Address_H (Hi)	**0x78**
Physical Address_H (Lo)	**0x56**	Physical Address_H (Lo)	**0x56**
Logical Address	**0x02**	Logical Address	**0x02**

Logical address 0x02 assigned to the unit with address 0x12345678.

4. Modbus Commands

Communication with the device is performed by a set of Modbus commands specifically designed to easily address the desired Register(s). Register addressing can be made either by Category, Page and Register Index or within an Elements Category also by Element Address and Register Index. Register value byte order is always MSB first. However, a 32bit register composed of two 16bit registers has always lower register first (at lower index).

4.1 Read Register from Index

Reads one or more registers addressed by Category/Page/Index. Page and Index value ranges depend on selected Category (see Table 1.1).

Request

Function Code	1 Byte	**0x43**
Register Category	1 Byte	0x00 to 0x07
Register Index	1 Byte	Varies
Register Page	1 Byte	Varies
Quantity of Registers	1 Byte	**N** = 0x01 to 0x16

Response

Function Code	1 Byte	**0x43**
Byte Count	1 Byte	2 * **N**
Register Data	2 * **N** Bytes	

Error

Error Code	1 Byte	**0xC3**
Exception Code	1 Byte	

Example: Reading an address of the Element at Page 3

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function Code	**0x43**	Function Code	**0x43**
Register Category	**0x01**	Byte Count	**0x04**
Register Index	**0x00**	ADDRESS_L (Hi)	**0x34**
Register Page	**0x03**	ADDRESS_L (Lo)	**0x12**
Quantity of Registers	**0x02**	ADDRESS_H (Hi)	**0x78**
		ADDRESS_H (Lo)	**0x56**

Address of the Element at Page 3 was read as 0x12345678.

4.2 Read Register from Address

Reads one or more registers addressed by Element Address/Index. Usage of this command is valid only when addressing registers in Elements Category.

Request

Function Code	1 Byte	**0x41**
Register Category	1 Byte	0x01
Register Index	1 Byte	0x00 to 0x0C
Address_L	2 Bytes	0x0000 to 0xFFFF
Address_H	2 Bytes	0x0000 to 0xFFFF
Padding	1 Byte	0x00
Quantity of Registers	1 Byte	**N** = 0x01 to 0x0D

Response

Function Code	1 Byte	**0x41**
Byte Count	1 Byte	2 * **N**
Register Data	2 * **N** Bytes	

Error

Error Code	1 Byte	**0xC1**
Exception Code	1 Byte	

Example: Reading a status of the Element with address 0x12345678

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function Code	**0x41**	Function Code	**0x41**
Register Category	**0x01**	Byte Count	**0x02**
Register Index	**0x08**	STATUS (Hi)	**0x80**

Address_L (Hi)	**0x34**	STATUS (Lo)	**0x00**
Address_L (Lo)	**0x12**		
Address_H (Hi)	**0x78**		
Address_H (Lo)	**0x56**		
Padding	**0x00**		
Quantity of Registers	**0x01**		

Status of the Element at Address 0x12345678 was read as 0x8000.

4.3 Write Register to Index

Writes one or more registers addressed by Category/Page/Index. Page and Index value ranges depend on selected Category (see Table 1.1).

Request

Function Code	1 Byte	**0x44**
Register Category	1 Byte	0x00 to 0x07
Register Index	1 Byte	Varies
Register Page	1 Byte	Varies
Quantity of Registers	1 Byte	**N** = 0x01 to 0x16
Register Data	2 * **N** Bytes	values

Response

Function Code	1 Byte	**0x44**
Byte Count	1 Byte	2 * **N**
Register Data	2 * **N** Bytes	written data

Error

Error Code	1 Byte	**0xC4**
Exception Code	1 Byte	

Example: Setting a DHW Eco Temperature to 50 °C

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function Code	**0x44**	Function Code	**0x44**
Register Category	**0x00**	Byte Count	**0x02**
Register Index	**0x15**	Temperature (Hi)	**0x01**
Register Page	**0x00**	Temperature (Lo)	**0xF4**
Quantity of Registers	**0x01**		
Temperature (Hi)	**0x01**		
Temperature (Lo)	**0xF4**		

Temperature 0x01F4 (500 decimal) was written to a register at Category 0x00, Page 0x00, Index 0x15.

4.4 Write Register to Address

Writes one or more registers addressed by Element Address/Index. Usage of this command is valid only when addressing registers in Elements Category.

Request

Function Code	1 Byte	**0x42**
Register Category	1 Byte	0x01
Register Index	1 Byte	0x00 to 0x0C
Address_L	2 Bytes	0x0000 to 0xFFFF
Address_H	2 Bytes	0x0000 to 0xFFFF
Padding	1 Byte	0x00
Quantity of Registers	1 Byte	**N** = 0x01 to 0x0D
Register Data	2 * **N** Bytes	values

Response

Function Code	1 Byte	**0x42**
Byte Count	1 Byte	2 * **N**
Register Data	2 * **N** Bytes	written data

Error

Error Code	1 Byte	**0xC2**
Exception Code	1 Byte	

Example: Deleting an Element with address 0x12345678

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function Code	**0x42**	Function Code	**0x42**
Register Category	**0x01**	Byte Count	**0x04**
Register Index	**0x00**	New Address_L (Hi)	**0x00**
Address_L (Hi)	**0x34**	New Address_L (Lo)	**0x00**
Address_L (Lo)	**0x12**	New Address_H (Hi)	**0x00**
Address_H (Hi)	**0x78**	New Address_H (Lo)	**0x00**
Address_H (Lo)	**0x56**		
Padding	**0x00**		
Quantity of Registers	**0x02**		
New Address_L (Hi)	**0x00**		
New Address_L (Lo)	**0x00**		
New Address_H (Hi)	**0x00**		
New Address_H (Lo)	**0x00**		

Element was deleted by writing 0x00000000 to a register pair ADDRESS_L and ADDRESS_H at Category 0x01, Address 0x12345678, Index 0x00.

4.5 Write Register Masked to Index

Writes individual bits of one or more registers addressed by Category/Page/Index. Page and Index value ranges depend on selected Category (see Table 1.1). Value written to the register follows this equation:

new_register_content = (current_value AND mask) OR (data AND NOT mask)

In other words – setting a bit in a *mask* to 1 means to keep the corresponding register bit value unchanged regardless of the *data*. Setting the bit to 0 means to set the corresponding register bit to the value specified by *data*.

Request

Function Code	1 Byte	**0x45**
Register Category	1 Byte	0x00 to 0x07
Register Index	1 Byte	Varies
Register Page	1 Byte	Varies
Quantity of Registers	1 Byte	**N** = 0x01 to 0x16
Register Data, Mask	4 * **N** Bytes	2 bytes data, 2 bytes mask

Response

Function Code	1 Byte	**0x45**
Byte Count	1 Byte	2 * **N**
Register Data	2 * **N** Bytes	actually written data

Error

Error Code	1 Byte	**0xC5**
Exception Code	1 Byte	

Example: Enabling a DHW Function

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function Code	**0x45**	Function Code	**0x45**
Register Category	**0x00**	Byte Count	**0x02**
Register Index	**0x08**	STATUS_L (Hi)	**0x3C**
Register Page	**0x00**	STATUS_L (Lo)	**0x03**
Quantity of Registers	**0x01**		
Data (Hi)	**0x20**		
Data (Lo)	**0x00**		
Mask (Hi)	**0xDF**		
Mask (Lo)	**0xFF**		

Bit 13 (DHW ENA) in register STATUS_L was set to 1. STATUS_L register was changed from 0x1C03 to 0x3C03.

4.6 Write Register Masked to Address

Writes individual bits of one or more registers addressed by Element Address/Index. Index value range depends on selected Category (see Table 1.1). Usage of this command is valid only when addressing registers in Elements Category. The principle of register modification by mask is described in 32.5 Write Register Masked to Index.

Request

Function Code	1 Byte	**0x46**
Register Category	1 Byte	0x01
Register Index	1 Byte	0x00 to 0x0C
Address_L	2 Bytes	0x0000 to 0xFFFF
Address_H	2 Bytes	0x0000 to 0xFFFF
Padding	1 Byte	Varies
Quantity of Registers	1 Byte	**N** = 0x01 to 0x0D
Register Data, Mask	4 * **N** Bytes	2 bytes data, 2 bytes mask

Response

Function Code	1 Byte	**0x46**
Byte Count	1 Byte	2 * **N**
Register Data	2 * **N** Bytes	actually written data

Error

Error Code	1 Byte	**0xC6**
Exception Code	1 Byte	

Example: Changing an Assignment Map of the Element with address 0x12345678

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function Code	**0x46**	Function Code	**0x46**
Register Category	**0x01**	Byte Count	**0x04**
Register Index	**0x02**	ASSIGNMENT_MAP_L (Hi)	**0xAA**
Address_L (Hi)	**0x34**	ASSIGNMENT_MAP_L (Lo)	**0xA0**
Address_L (Lo)	**0x12**	ASSIGNMENT_MAP_H (Hi)	**0xFA**
Address_H (Hi)	**0x78**	ASSIGNMENT_MAP_H (Lo)	**0xAA**
Address_H (Lo)	**0x56**		
Padding	**0x00**		
Quantity of Registers	**0x02**		
Data (Hi)	**0x00**		
Data (Lo)	**0x00**		
Mask (Hi)	**0xFF**		
Mask (Lo)	**0xF0**		
Data (Hi)	**0xFF**		
Data (Lo)	**0xFF**		
Mask (Hi)	**0x0F**		
Mask (Lo)	**0xFF**		

Original assignment map 0xAAAAAAAA was changed to 0xFAAAAAA0.

5. Modbus RTU Description

5.1 Modbus Physical Parameters

Device uses Modbus RTU[1] over RS-485 with parameters specified in Table 5.1.

Parameter	Value
Baud rate	38400 bps
Data bits	8
Start bits	1
Stop bits	1
Parity	none

Table 5.1

[1] For Modbus basics please refer to: http://en.wikipedia.org/wiki/Modbus, http://www.modbus.org/specs.php