THERMOSTAT
WITH BUILT-IN RELAY

902010/32

TECHNICAL MANUAL
ZIGBEE HOME-AUTOMATION 1.2

February 2016

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DS 902010-019A
LBT 90374

1) GENERAL CHARACTERISTICS

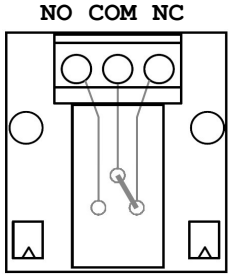
902010/32 is a ZigBee Home Automation compliant Thermostat.
It is a battery-powered device where thermostat function, temperature measuring function and user interface function are all performed by the same device. The device is equipped with a bistable relay.

2) ELECTRICAL CHARACTERISTICS

POWER SUPPLY	2x1,5V AA Size Battery
BATTERY LIFE TIME	>2 years (at normal conditions)
WIRELESS CHARACTERISTICS	2405 MHz ÷ 2480 MHz DSSS Modulation Nominal transmission Power +8dBm Internal PCB Antenna Chipset Ember/SiliconLabs EM357 Stack EmberZNet5.3.1 IEEE 802.15.4 compliant
ZIGBEE PROFILE	Home Automation Profile (HA1.2) Profile ID: 0x0104 End-Point: 1 (=1) Device ID: 0x0301 (Thermostat) In-Cluster List: 0x0000, 0x0001, 0x0003, 0x000A, 0x0020, 0x0201, 0x0204, 0x0B05 Binding Table Size: 10 Reporting Table Size: 10
MEASURES	NTC Sensor Type 103AT (10K at 25°C; beta=3435K) Measurement range -50°C ÷ +100°C Reading resolution 0,1°C Reading accuracy ±0,5°C
RELAY	Bistable Relay Contacts Rated Current 5A (resistive load) Expected life: 100.000 cycles with resistive load
OPERATING CONDITIONS	-10 ÷ +55°C
PROTECTION CLASS	IP20

3) DEVICE VIEW

Relay Connections:

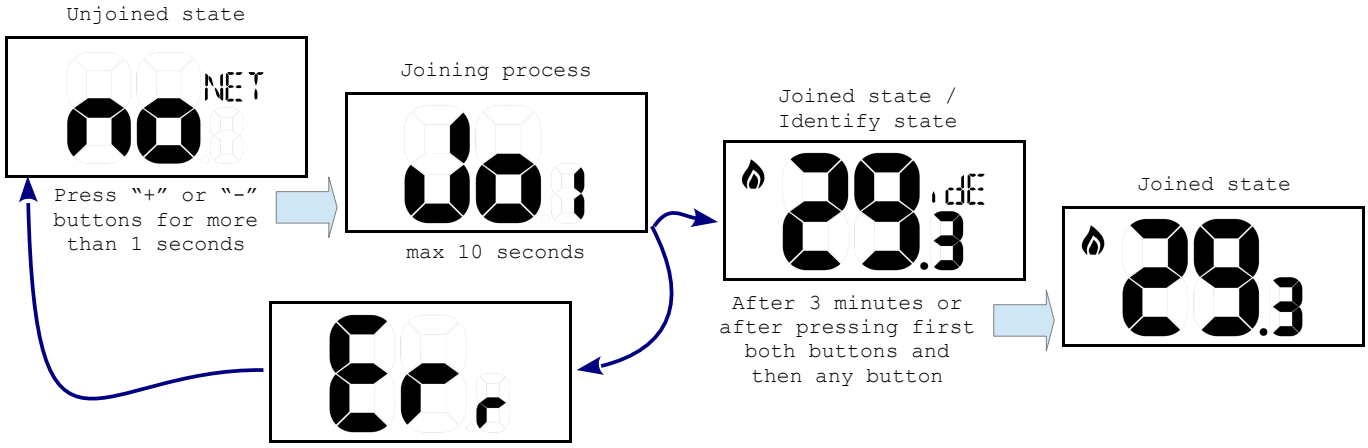


4) JOIN NETWORK

If the device is not part of a ZigBee Network (device not joined), press any of the buttons for at least 1 second to start the join process (Network Steering).

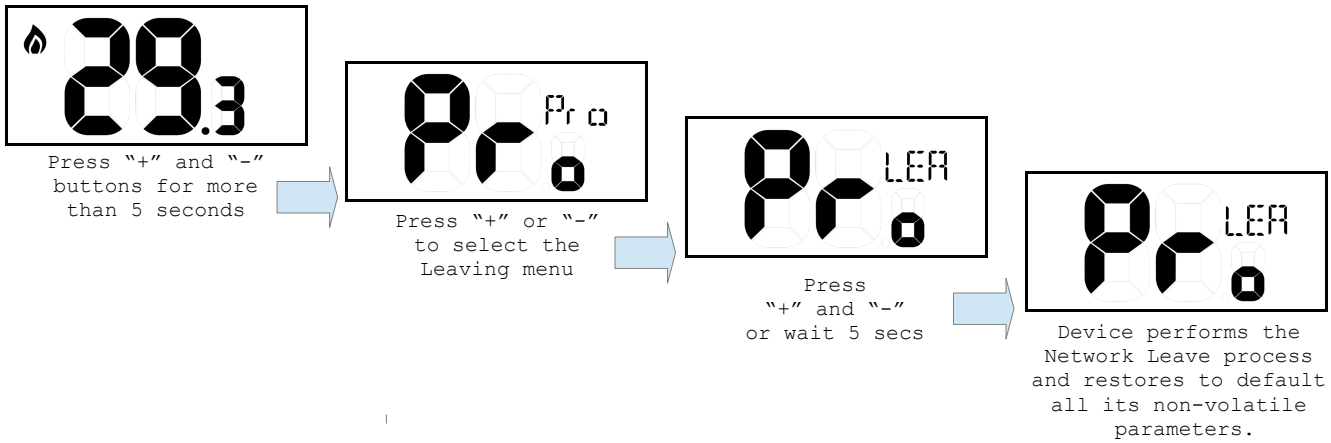
During the Join process, the device will look search all available and try to join ZigBee networks for a duration of 10 seconds. If no open ZigBee HA network is found, the termostat will return to the unjoined state ("no NET" message on the LCD), until a further pairing attempt will be started.

If the Join process was successful, the device will store the configuration and remain connected to the new ZB network.



5) LEAVING NETWORK

If the device is part of a ZigBee Network (device joined), within one minute from the device reset, enter the "Program"/"Leaving" menu to quit the network.

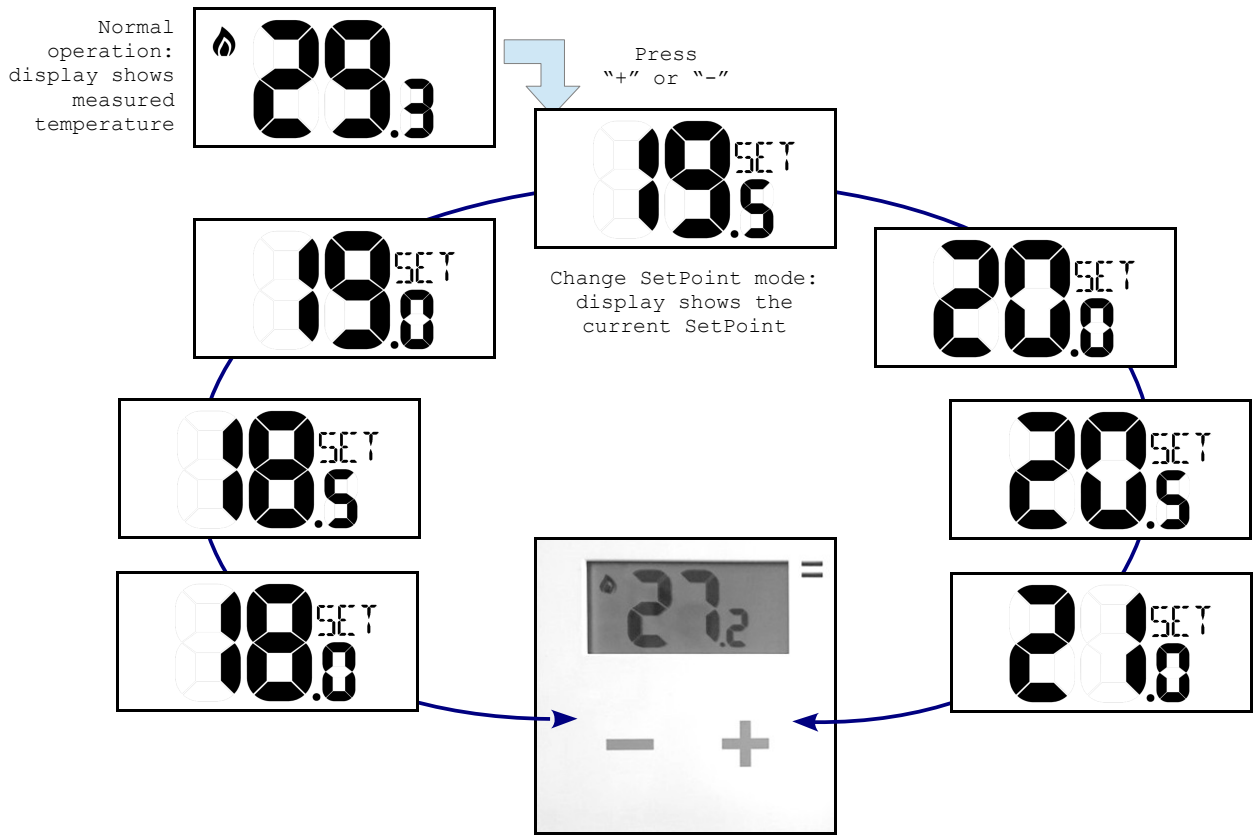


6) COMMISSIONING

If the device is part of a ZigBee Network, enter the "Program"/"Identify" menu to activate the EZ-Mode Target Finding and Binding commissioning process. The process is also activated at the end of the Joining process, if a suitable network is found. During this process, the device activates its own identify state and opens the network.
This process lasts maximum 3 minutes during which the device shows "Iden" message.
The process ends earlier if a button is pressed.

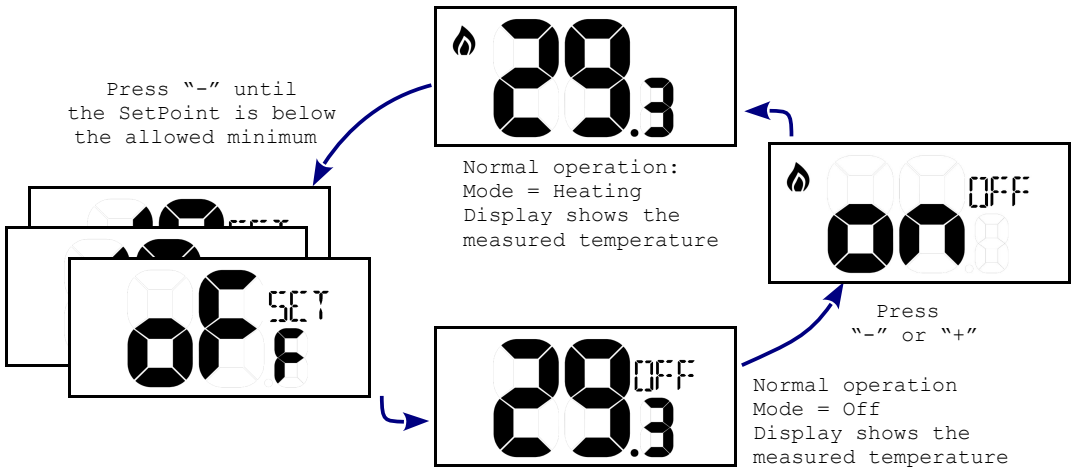
7) CHANGING SETPOINT

By pressing the "+" or "-" button you will enter in the SetPoint change menu.
The activation of this menu is highlighted by the blinking message "SET"and the current value of the SetPoint will be shown.
Use the buttons to change the SetPoint temperature at intervals of 0,5° within the range of the minimum and maximum values configured. The new Set-Point will be confirmed after 5 seconds of inactivity of the keyboard.



8) CHANGING MODE

The Thermostat Mode selectable depends by "Control Sequence of Operation" attribute (Attribute-ID=0x001B, Cluster-ID=0x0201).
By default it is possible to switch from "Heating Mode" to "Off Mode" and vice versa.
To switch-off the thermostat press "-" button until the Setpoint is below the minimum allowed (default 7°C); to switch-on the thermostat simply press "-" or "+" button.



9) TEMPERATURE ACQUISITION AND THERMO-REGULATION LOOP

902010/32 measures the ambient temperature every 30 seconds using the on-board NTC sensor. This time is fixed at firmware level.
After the temperature measurement the thermo-regulation cycle will be executed in which the measured temperature value is compared with with the SetPoint value. The relay will be switched accordingly.

System Mode (Regulation Mode):
The behaviour of the thermo-regulation cycle is managed by the "System Mode" Attribute (AttributeID=0x001C, Cluster-ID=0x0201) which control the thermostat's Off/Cool/Heat state.

System Mode	Temperature In-equation	Relay State
Off (0x00)	//	Off
Cool (0x03)	Temperature >= (Cooling SetPoint + High_Hysteresis)	On
	Temperature <= (Cooling SetPoint - Low_Hysteresis)	Off
Heat (0x04)	Temperature >= (Heating SetPoint + High_Hysteresis)	Off
	Temperature <= (Heating SetPoint - Low_Hysteresis)	On

10) THERMOSTAT SCHEDULER

902010/32 supports the weekly schedule extension described in the ZigBee HA specification. It allows to configure 10 schedules for 8 days (Sunday to Saturday plus vacation day). The whole structure is duplicate for heating and cooling mode allowing separate schedules for both functions.
Each schedule describes a Transitions Time expressed in minutes from midnight and a SetPoint value.
If scheduling is active, 902010/32 compares its local time with all the schedule-slots of the current day. Once a schedule point is reach, temperature will be set to SetPoint.

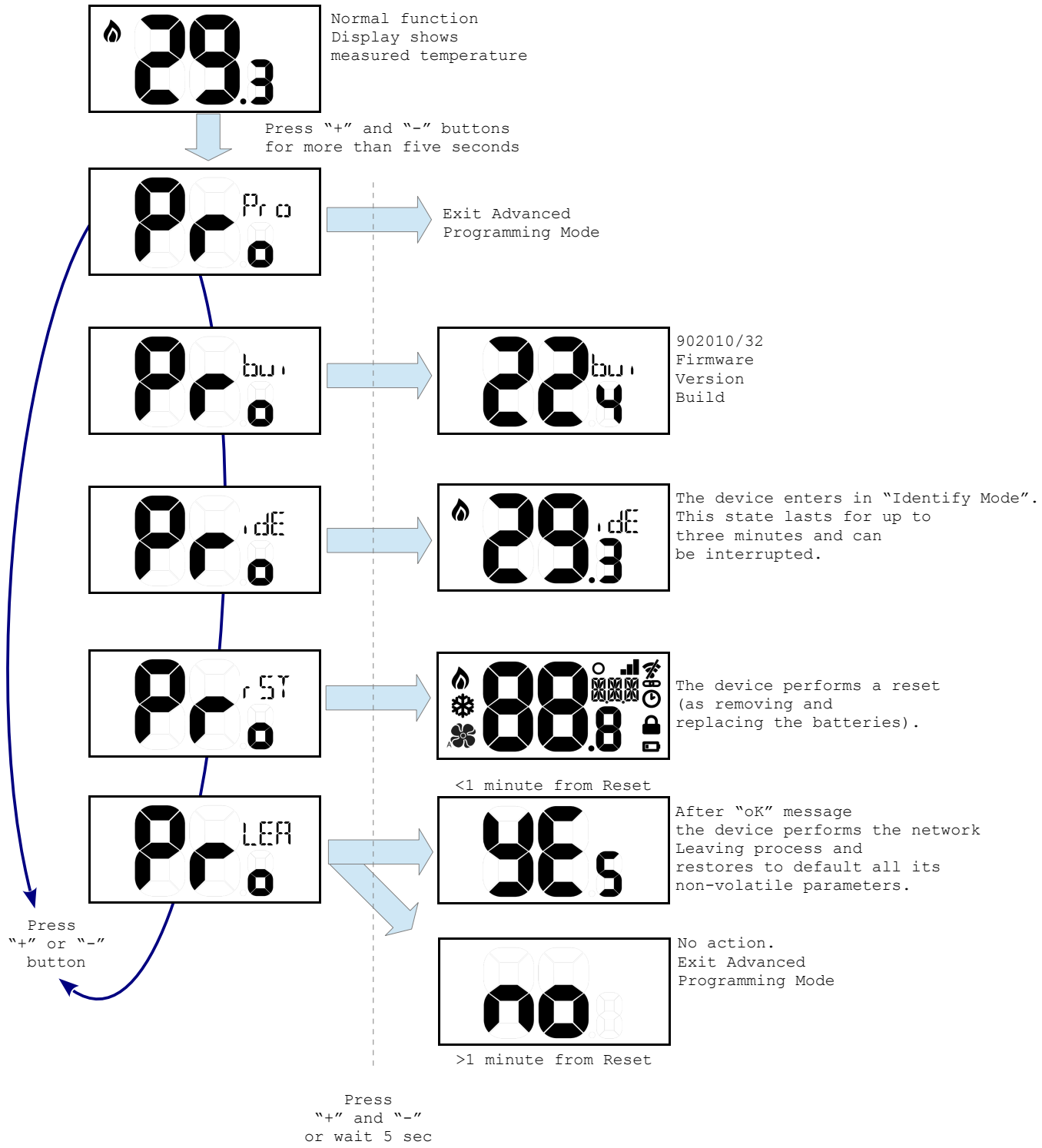
Enable Thermostat Scheduler:
The activation/deactivation of the Thermostat Scheduler is managed by bit#0 of "Thermostat-Programming-Operation-Mode" Attribute (Attribute-ID=0x0025, Cluster-ID=0x0201).

Scheduled Set-Point Overriding:
A manual or remote change to the SetPoint remains unchanged until the next scheduling.

Behaviour at Start-Up:
At the re-ignition of the 902010/32 after a power failure (or after a reset), the device searches for the first schedule-slot preceding the current time and loads the corresponding SetPoint, this unless the last change of the SetPoint has been remote, in which case the SetPoint will remain until the next scheduling.

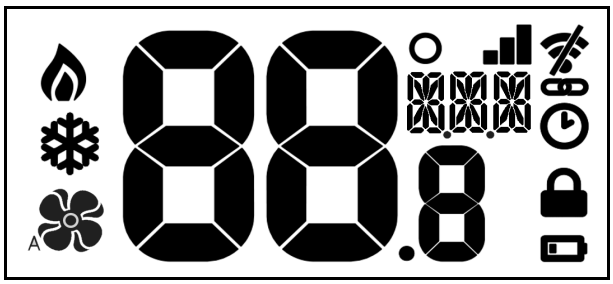
11) ADVANCED PROGRAMMING MODE

By pressing the "+" and the "-" buttons together for more than five seconds you will enter in the "Advanced Programming Mode".



12) LCD

This is the display of the device with all segments enabled:



Meaning of the icons:

Icon	Meaning
	Not Used
	Device not joined with any radio-parent (router or coordinator)
	Thermostat Scheduler is enable (see note 1)
	Thermostat Heating Mode – Relay On
	Thermostat Cooling Mode – Relay On
	Gateway Link Icon (see note 2)
	Low Battery Warning (see note 3)
	Keyboard Locked
	Fan – Not used icon

Note 1:
The clock icon is bound to Thermostat Programming Operation Mode attribute (Attribute-ID =0x0025, Cluster-ID =0x0201) and with the presence of a correct time reference.
If the less significant bit of this attribute is set (scheduler active) and the time reference is present then the icon is lighted.

Note 2:
The "GATEWAY" icon is bound to Gateway Link Timer (Attribute-ID=0x0202, Cluster-ID=0x0201) custom attribute. The icon is lighted if this attribute is different by zero. This attribute is decremented to zero each second by 902010/32.

Note 3:
The "BATTERY" icons is bound to Battery Alarm State (Attribute-ID=0x003E, Cluster-ID=0x0001). This icon is lighted if the Battery Voltage drops below 2,5V (changeable threshold.

12) ZIGBEE DATA AND REFERENCES

The following sections describes some ZigBee characteristics of the device.
More detailed information can be found in the ZigBee Alliance documents quoted in the references.

REFERENCES:

[R1] ZigBee Document 075123r04ZB - ZigBee Cluster Library
[R2] ZigBee Document 05-3520-29 - ZigBee Home Automation Public Application Profile
[R3] ZigBee Document 075356r16ZB - ZigBee Smart Energy Profile Specification

HA.1) END-POINT

Device Name	ZigBee Node Type	End-Point	Device ID	Main Function
902010/32	Sleepy-end-device	1	0x0301	HA Thermostat

HA.2) CLUSTER LIST

Cluster Name	End-Point	Cluster-ID	Client/Server
Basic	1	0x0000	Server
Power Configuration	1	0x0001	Server
Identify	1	0x0003	Client/Server
Time	1	0x000A	Server
Over the Air Bootloading	1	0x0019	Client
Poll Control	1	0x0020	Server
Thermostat	1	0x0201	Server
Thermostat User Interface Configuration	1	0x0204	Server
Diagnostic	1	0x0B05	Server

HA.3) BINDING TABLE SIZE

The Device's Binding Table (non-volatile) has room for 10 entries

HA.4) REPORTING TABLE SIZE

The Device's Reporting Table (non-volatile) has room for 10 entries

HA.5) EZ-MODE COMMISSIONING

The Device acts as an EZ-Mode Target.
When the EZ-Mode is invoked (by entering in the specific user-menu) it activates its identifying state for up to 3 minutes.

HA.6) POLLING RATE

902010/32 is a Sleepy-End-Device, therefore it can receives radio messages only after it has sent to its parent (router) a Polling message (Data Request).
The parent device has the task to keep messages for their children until the receiving of the polling message, this up to a limit of 7,68 seconds (as requested by standard ZigBee HA).
During normal functioning, 902010/32 sends a poll message each 7 seconds.
After the pressure of any button, 902010/32 enters in a state of "fast polling" for the duration of 20 seconds, in this state it sends one polling per half second.
902010/32 implements the Poll Control Cluster (Cluster-ID 0x0020), therefore it is possible to change the long poll interval and the fast poll interval, moreover it is possible to manage the "Check-in" server-side command in order to simplify the communication management in devices which wish to communicate with 902010/32. Note that the poll parameters strongly influence the battery lifetime.

HA.7) REJOIN MECHANISM

The Rejoin process is the process by which a sleepy-end-device already part of a network tries to find another parent (due to the fact that the old parent was deemed as not working).
The rejoin process is very expensive in energy terms, so to preserve the battery life, has been chosen this rejoin strategy:

- At beginning of the orphaning state rejoin each 2 minutes
- After one hours, rejoin each 30 minutes

As a consequence of this, if all the routers in the closeness of 902010/32 are turned off for more than one hour, when they return to function the 902010/32 returns to work up to 30 minutes after.

CL.1) SERVER SIDE CLUSTER DESCRIPTION – BASIC CLUSTER (CLUSTER-ID=0x0000)

Implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default Value
0x0000	ZCL Version	0x20 (int8u)	0x00÷0xFF	R-	1
0x0001	Application Version	0x20 (int8u)	0x00÷0xFF	R-	1
0x0002	Stack Version	0x20 (int8u)	0x00÷0xFF	R-	2 (ZigBee Pro)
0x0003	HW Version	0x20 (int8u)	0x00÷0xFF	R-	2
0x0004	Manufacturer Name	0x42 (String)	0÷32 bytes	R-	"Bitron Home"
0x0005	Model Identifier	0x42 (String)	0÷32 bytes	R-	"902010/32"
0x0006	Date Code	0x42 (String)	0÷16 bytes	R-	Serial number
0x0007	Power Source	0x30 (enum8)	0x00÷0xFF	R-	0x03 (Battery)
0x4000	SW Build ID	0x42 (String)	0÷32 bytes	R-	Firmware build like: "V1b225-20151013"

Commands Received (Client to Server):

Command-ID	Name
0x00	Reset to Factory Defaults

CL.2) SERVER SIDE CLUSTER DESCRIPTION – POWER CONFIGURATION CLUSTER (CLUSTER-ID=0x0001)

Implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default Value
0x0020	Battery Voltage	0x20 (int8u)	0x00÷0xFF	R-	--
0x0035	Battery Alarm Mask	0x18 (bit8)	0x00÷0xFF	RW	1
0x0036	Battery Voltage min Threshold	0x20 (int8u)	0x00÷0xFF	RW	25 (2,5 V)
0x003E	Battery Alarm State	0x1B (bit32)	0÷ 2^{32}-1	R-	--

Note about Attribute Battery Voltage (Attribute-ID 0x0020)
This attribute is expressed in tenths of volts (0x1E = 30 → 3,0V) and represents the battery voltage measured by the device each 30 seconds.

Note about Attribute Battery Alarm Mask (Attribute-ID 0x0035)
This attribute is an enabling mask configuration.
The less significant bit of this attribute enables the management of the Battery Alarm flag (default value).

Note about Attribute Battery Voltage Min Threshold (Attribute-ID 0x0036)
This attribute is expressed in tenths of volts.
If the battery value drops below this threshold and the Battery Alarm Mask is enabled then the corresponding bit in Battery Alarm State attribute is set.

Note about Attribute Battery Alarm State (Attribute-ID 0x003E)
If the bit#0=1 (LSB) of this attribute is set it means that the Battery Voltage is below the alarm threshold.
The Battery Alarm Icon is associated to the less significant bit of this attribute.

See specification [R1]

CL.3) SERVER SIDE CLUSTER DESCRIPTION – IDENTIFY CLUSTER (CLUSTER-ID=0x0003)

Implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default Value
0x0000	Identify Time	0x21 (int16u)	0x0000÷ 0xFFFF	RW	0

Commands Received (Client to Server):

Command-ID	Name
0x00	Identify
0x01	Identify Query

Commands Generated (Server to Client):

Command-ID	Name
0x00	Identify Query Response

See specification [R1]

CL.4) SERVER SIDE CLUSTER DESCRIPTION – TIME CLUSTER (CLUSTER-ID=0x000A)

Implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default Value
0x0000	Time	0xE2 (UTC Time)	0÷ 2^{32}-1	RW	0
0x0001	Time Status	0x18 (bit8)	0000xxxx	RW	0
0x0002	Time Zone	0x2B (int32s)	-86400 ÷ +86400	RW	0
0x0003	Daylight Saving Time Start	0x23 (int32u)	0÷ 2^{32}-1	RW	0
0x0004	Daylight Saving Time End	0x23 (int32u)	0÷ 2^{32}-1	RW	0
0x0005	Daylight Saving Time Shift	0x2B (int32s)	-86400 ÷ +86400	RW	0
0x0006	Standard Time	0x23 (int32u)	0÷ 2^{32}-1	R-	0

0x0007	Local Time	0x23 (int32u)	0÷ 2^{32}-1	R-	0
0x0008	Last Set Time	0xE2 (UTC Time)	0÷ 2^{32}-1	R-	0xFFFFFFFF
0x0009	Valid Until Time	0xE2 (UTC Time)	0÷ 2^{32}-1	RW	0xFFFFFFFF

Note about Attribute Time Status (Attribute-ID 0x0001)
902010/32 allows only setting/resetting of bit#1 (Synchronized) of this Attribute.

Note about Attribute Valid Until Time (Attribute-ID 0x0009)
902010/32 sets this attribute with the value of UTC Time immediately after a setting of the time.

Time Reference
The time reference is required for the properly operation of the Thermostat Scheduler.
902010/32 is not provided with a backup-battery Real Time Clock (RTC) therefore it does not retain a precise time reference through the absence of power supply (battery-replacement).
The internal crystal oscillator used has an error of about ±100ppm, therefore the expected time reference error is about ±5 minutes per month.

Gateway Requirements
The customer's Gateway has the responsibility of maintenance a more precise time reference, the setting of the correct TimeZone and the setting of the annual beginning/end of summer time (DST).

To do that the Gateway must:
1) implements the Server-Side Time Cluster (Cluster-ID 0x000A).
2) keeps its UTC Time Attribute (Attribute-ID 0x0000) as precise as possible.
3) sets the correct value to its TimeZone Attribute (Attribute-ID 0x0002).
4) sets the correct value to its (annually changing) Dst Start, Dst End, Dst Shift Attributes (Attribute-ID 0x0003, 0x0004, 0x0005).
5) sets bit#0 (Master) and/or bit#3 (Superseding) and sets bit #2 (Master Zone Dst) on the Time Status Attribute (Attribute-ID 0x0001)

Time Reference Synchronization
902010/32 synchronizes its time reference following the rules described in ZigBee Cluster Library Specification.
After a time between 2 and 10 minutes from the reset (chosen randomly), and every 24 hours post, 902010/32 looks for the best time server presents on its radio network.
If it finds a suitable time server then it collects the relevant time attributes.

Note on Time Attributes

The Utc Time Attribute (Attribute-ID 0x0000) is expressed in seconds from 1/1/2000.

Standard Time Attribute (Attribute-ID 0x0006) is calculated as:
Standard Time = Utc Time + TimeZone

Local Time Attribute (Attribute-ID 0x0007) is calculated as:
Local Time = Standard Time (if Utc Time is not between Dst Start and End)
Local Time = Standard Time + Dst Shift (if Utc Time is between Dst Start and End)

Thermostat Scheduler uses the Local Time Attribute.

All the time attributes except Utc Time, Standard Time and Local Time, are saved in non-volatile memory.

CL.5) SERVER SIDE CLUSTER DESCRIPTION – POLL CLUSTER (CLUSTER-ID=0x0020)

Implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default Value
0x0000	Check-in Interval	0x23 (int32u)	0 ÷ 0x6E0000	RW	57600 (4 hours)
0x0001	Long Poll Interval	0x23 (int32u)	0 ÷ 0x6E0000	R-	28 (7 sec)
0x0002	Short Poll Interval	0x21 (int16u)	0x0001 ÷ 0xFFFF	R-	2 (0,5 sec)
0x0003	Fast Poll Time Out	0x21 (int16u)	0x0001 ÷ 0xFFFF	RW	240 (60 sec)
0x0004	Check-in Interval Min	0x23 (int32u)	-	R-	180 (45 sec)
0x0005	Long Poll Interval Min	0x23 (int32u)	-	R-	20 (5 sec)
0x0006	Fast Poll Time Out Max	0x23 (int32u)	-	R-	480 (120 sec)

Commands Received (Client to Server):

Command-ID	Name
0x00	Check-in Response
0x01	Fast Poll Stop
0x02	Set Long Poll Interval
0x03	Set Short Poll Interval

Commands Generated (Server to Client):

Command-ID	Name
0x00	Check-in

Note about Check-in server to client command:
This command is sent to all devices which are bound with 902010/32 through the cluster Poll Control.
This command is sent at the frequency controlled by the Check-in Interval attribute.
This command expects a Check-in Response command sent back from the Poll Control Client.
If 902010/32 does not receive a Check-in Response it returns to the normal polling rate, according to the Long Poll Interval Attribute.

Note that the poll parameters strongly influence the 902010/32 battery lifetime.

See specification [R2]

CL.6) SERVER SIDE CLUSTER DESCRIPTION – THERMOSTAT CLUSTER (CLUSTER-ID=0x0201)

Implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default
0x0000	Local Temperature	0x29 (int16s)	0x954D ÷ 0x7FFF	R-	--
0x0001	Outdoor Temperature	0x29 (int16s)	0x954D ÷ 0x7FFF	R-	--
0x0002	Occupancy	0x18 (bit8)	0000000x	R-	1
0x0003	Abs Min Heat Setpoint Limit	0x29 (int16s)	0x954D ÷ 0x7FFF	R-	700 (7°C)
0x0004	Abs Max Heat Setpoint Limit	0x29 (int16s)	0x954D ÷ 0x7FFF	R-	300 (30°C)
0x0005	Abs Min Cool Setpoint Limit	0x29 (int16s)	0x954D ÷ 0x7FFF	R-	1600 (16°C)
0x0006	Abs Max Cool Setpoint Limit	0x29 (int16s)	0x954D ÷ 0x7FFF	R-	3200 (32°C)
0x0010	Local Temperature Calibration	0x28 (int8s)	0xE7 ÷ 0x19	RW	0 (0°C)
0x0011	Occupied Cooling Setpoint	0x29 (int16s)	Min ÷ Max Cool SetPoint Limit	RW	2600 (26°C)
0x0012	Occupied Heating Setpoint	0x29 (int16s)	Min ÷ Max Heat SetPoint Limit	RW	2000 (20°C)
0x0013	Unoccupied Cooling Setpoint	0x29 (int16s)	Min ÷ Max Cool SetPoint Limit	RW	2600 (26°C)
0x0014	Unoccupied Heating Setpoint	0x29 (int16s)	Min ÷ Max Heat SetPoint Limit	RW	2000 (20°C)
0x0015	Min Heat Setpoint Limit	0x29 (int16s)	0x954D ÷ 0x7FFF	RW	700 (7°C)
0x0016	Max Heat Setpoint Limit	0x29 (int16s)	0x954D ÷ 0x7FFF	RW	3000 (30°C)
0x0017	Min Cool Setpoint Limit	0x29 (int16s)	0x954D ÷ 0x7FFF	RW	1600 (16°C)
0x0018	Max Cool Setpoint Limit	0x29 (int16s)	0x954D ÷ 0x7FFF	RW	3200 (32°C)
0x001B	Control Sequence Of Operation	0x30 (enum8)	0 ÷ 5	R-	2 (Heating)
0x001C	System Mode	0x30 (enum8)	0 ÷ 5	RW	4 (Heat)
0x0020	Start Of Week	0x30 (enum8)	0 ÷ 6	R-	0
0x0021	Number Of Weekly Transitions	0x20 (int8u)	0 ÷ 0xFF	R-	70
0x0022	Number Of Daily Transitions	0x20 (int8u)	0 ÷ 0xFF	R-	10
0x0025	Thermostat Programming Operation Mode	0x18 (bit8)	00xxxxxx	RW	0

0x0029	Thermostat Running State hvac relay state)	0x19 (Bit16)	000000xx	R-	0
0x0030	Setpoint Change Source	0x30 (enum8)	0 ÷ 0x02	R-	0
0x0031	Setpoint Change Amount	0x29 (int16s)	0 ÷ 0xFFFF	R-	0x8000
0x0032	Setpoint Change Source Timestamp	0xE2 (UTCTime)	0 ÷ 0xFFFFFFFF	R-	1

Commands Received (Client to Server):

Command-ID	Name
0x00	Setpoint Raise/Lower
0x01	Set Weekly Schedule
0x02	Get Weekly Schedule
0x03	Clear Weekly Schedule

Commands Generated (Server to Client):

Command-ID	Name
0x00	Current Weekly Schedule

Note about Attribute Local Temperature (Attribute-ID 0x0000)
This value represents the local temperature, measured by the built-in probe.
This value is used in the thermo-regulation cycle.

Note about Attribute Outdoor Temperature (Attribute-ID 0x0001)
Same value present on the above attribute.

Note about Attribute Occupancy (Attribute-ID 0x0002)
Currently the Occupancy sensor management is not yet implemented, the value of this attribute is fixed to 1 (space occupied).

Note about Attribute Local Temperature Calibration (Attribute-ID 0x0010)
This attribute is used to correct the temperature of the local thermal measure.

Note about Attribute Control Sequence Of Operation (Attribute-ID 0x001B)
This Attribute is used to permit or not the selection of Cooling and Heating Mode.

Control Sequence of Operation	Description	Possible values of System Mode
0x00	Cooling Only	0x00(Off) / 0x03(Cool)
0x01	Cooling with Reheat	0x00(Off) / 0x03(Cool)
0x02 (Default)	Heating Only	0x00(Off) / 0x04(Heat)
0x03	Heating with Reheat	0x00(Off) / 0x04(Heat)
0x04	Cooling and Heating 4-pipes	0x00(Off) / 0x03(Cool) / 0x04(Heat)
0x05	Cooling and Heating 4-pipes with Reheat	0x00(Off) / 0x03(Cool) / 0x04(Heat)

Note about Attribute System Mode (Attribute-ID 0x001C)
This Attribute is used to chose the thermo-regulation mode.

System Mode	Description
0x00	Off
0x03	Cool
0x04 (Default)	Heat

Other values are not allowed.

Note about Attribute Thermostat Programming Operation Mode (Attribute-ID 0x0025)
Bit#0 of this attribute controls the enabling of the Thermostat Scheduler.

Note about Attribute SetPoint Change Source (Attribute-ID 0x0030)
This Attribute is used to determine the source of the last changing of the SetPoint.

SetPoint Change Source	Description
0x00	Manual, user-initiated SetPoint change via the thermostat
0x01	Schedule/internal programming-initiated SetPoint change
0x02	Externally-initiated SetPoint change

Other values are not allowed.

Note about Thermostat Scheduler Programming (Command-ID 0x01)
The Thermostat Scheduler programming procedure follows the ZigBee HA specifications (see [R2], Paragraph 10.2.3.4.1.1 (Set Weekly Schedule), page 325).

Example:
you want the schedule will be made as follows:

Time 06.30 → SetPoint = 22,5°C
Time 08.30 → SetPoint = 18,0°C
Time 12.00 → SetPoint = 20,0°C

This only for days:
Monday, Tuesday, Thursday, Friday

This only for the Heat mode.

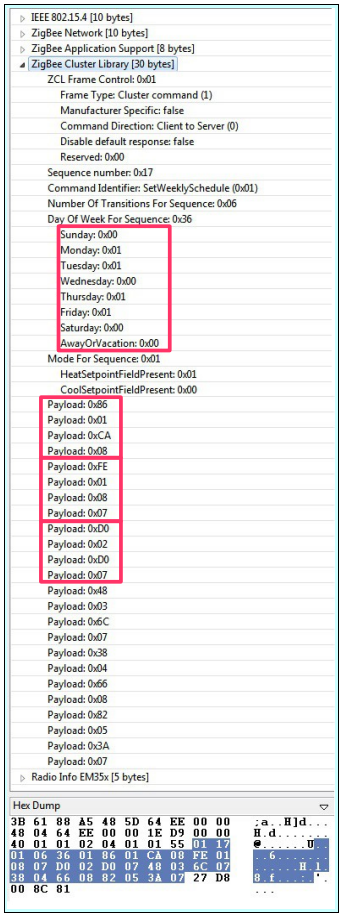
This translates into the programming of 6 schedule-slots.

1° slot:
Time 06.30 = 390 minutes from midnight = 0x0186
Heat SetPoint = 22,5°C = 2250 (cents)°C = 0x08CA

2° slot:
Time 08.30 = 510 minutes from midnight = 0x01FE
Heat SetPoint = 18,0°C = 1800 (cents)°C = 0x0708

3° slot:
Time 12.00 = 720 minutes from midnight = 0x02D0
Heat SetPoint = 20,0°C = 2000 (cents)°C = 0x07D0

To the right the message sent from Gateway to a 902010/32, captured by the Ember radio sniffer.



CL.7) SERVER SIDE CLUSTER DESCRIPTION
THERMOSTAT USER INTERFACE CONFIGURATION CLUSTER (CLUSTER-ID=0x0204)

Implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default
0x0000	Temperature Display Mode	0x30 (enum8)	0 ÷ 1	RW	0
0x0001	Keypad Lockout	0x30 (enum8)	0 ÷ 5	RW	0
0x0002	Schedule Programming Visibility	0x30 (enum8)	0 ÷ 1	RW	0

Note about Attribute Temperature Display Mode (Attribute-ID 0x0000)
- 0 → temperature unit °C
- 1 → temperature unit °F

Note about Attribute Keypad Lockout (Attribute-ID 0x0001)
- 0 → No Lookout
- 1 → Mode Looked
- >=2 → Mode and SetPoint looked

Note about Attribute Schedule Programming Visibility (Attribute-ID 0x0002)
This attribute is not yet used

CL.8) SERVER SIDE CLUSTER DESCRIPTION – DIAGNOSTIC CLUSTER (CLUSTER-ID=0x0805)

Implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access
0x0000	Number of Resets	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0104	Mac Tx Unicast Retry	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0105	Mac Tx Unicast Fail	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0106	APS Rx Broadcast	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0107	APS Tx Broadcast	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0108	APS Rx Unicast	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0109	APS Unicast Success	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x010A	APS Tx Unicast Retries	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x010B	APS Tx Unicast Failures	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x010C	Route Discovery Initiated	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x010D	Neighbour Added	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x010E	Neighbour Removed	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x010F	Neighbour Stale	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0110	Join Indication	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0111	Child Moved	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0112	NWK Frame Control Failure	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0113	APS Frame Control Failure	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0114	APS Unauthorized Key	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0115	NWK Decrypt Failures	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0116	APS Decrypt Failures	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0117	Packet Buffer Allocate Failures	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0118	Relayed Unicast	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x0119	Phy to MAC queue limit reached	0X21 (int16u)	0 ÷ 0xFFFF	R-
0x011A	Packet Validate drop count	0X21 (int16u)	0 ÷ 0xFFFF	R-

CL.9) CLIENT SIDE CLUSTER DESCRIPTION – OVER THE AIR BOOTLOADING (CLUSTER-ID=0x0019)

902010/32 implements the Zigbee Over-the-air Bootload Client Cluster.
The device periodically searches an OTA server in the network, if it finds it, then it periodically queries the server for a new image to download, if it finds a coherent and newer firmware image, it downloads the data and, eventually, uses the downloaded image to update itself.

The OTA server is searched by a "Match Description Request" done through a broadcast message, this is issued some minutes after the device reset and each about 4 hours, until an OTA server is found.

If an OTA server has been found, the device requires for an upgrading image each about 4 hours.

During the OTA downloading, the delay between packets is fixed to 1 second.

Downloading the whole firmware image takes about an hour.

The device does not implement the Image Page Request Command.

Client-Side implemented Attributes:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default
0x0000	OTA Upgrade Server ID	0xF0 (IEEE_ADDRESS)	0÷ 2^{64}-1	R-	0xFFFFFFFFFFFFFFFF
0x0001	Offset into the file	0x23 (int32u)	0÷ 2^{32}-1	R-	0
0x0006	Upgrade Status	0x30 (enum8)	0x00÷0xFF	R-	0

CC.1) PROPRIETARY EXTENSIONS

The device has some manufacturer specific extensions added to the standard ZigBee command set. These functions can be accessed using the manufacturer code 0x1071.

CC.2) PROPRIETARY EXTENSIONS – BASIC CLUSTER (CLUSTER-ID=0x0000)

Vendor Specific Commands Received (Client to Server):

Command-ID	Name	Payload Size	Payload
0xFC	PROPRIETARY COMMAND	2	1° int16u: Command value

List of PROPRIETARY COMMAND values and the respective functions:

Vendor COMMAND value	Command Issued
0x196E	Reload Default Parameters
0x196F	non-volatile memory total initialize
0x1970	Reset
0x1971	Disassociation
0x1972	Disassociation with reload default parameters
0x1973	Disassociation with non-volatile memory total initialize
0x1975	Rejoin
0x2100 -:- 0x21FF	Change Transmission Power (value in the low byte, from -30 to 8)
0x2501	Initialize OTA external eeprom
0x2502	Restart OTA Server searching

CC.3) PROPRIETARY EXTENSIONS – THERMOSTAT CLUSTER (CLUSTER-ID=0x0201)

List of PROPRIETARY ATTRIBUTES:

Attribute-ID	Name	Attribute Type	Range	Access	Attribute Default Value
0x0101	Thermostat High Hysteresis	0x21 (int16u)	0 ÷ 0x03E8	RW	25 (0,25°C)
0x0102	Thermostat Low Hysteresis	0x21 (int16u)	0 ÷ 0x03E8	RW	25 (0,25°C)
0x0201	Setpoint Change Source Network-ID	0x21 (int16u)	0 ÷ 0xFFFF	RW	0xFFFF
0x0201	Gateway Link Timer	0x21 (int16u)	0 ÷ 0xFFFF	RW	0

Note aboute Hysteresis Attributes (Attribute-ID 0x0101, 0x0102):
The two custom attributes control the high value of hysteresis (hysteresis added to the set-point) and the low value of hysteresis (hysteresis subtracted to the set-point).
The default value of both these attributes is 0,25°C.

Note about custom Attribute Setpoint Change Source NetworkId (Attribute-ID 0x0201)
This is the Network-ID of the source of the last radio SetPoint change.

Note about custom Attribute Gateway Link Timer (AttributeID 0x0202)
If this attribute is set to a value different by zero, then it is decremented by 902010/32 by one unit per second. If the value of this attribute is different by zero the "Gateway" icon on the 902010/32 is switched on.