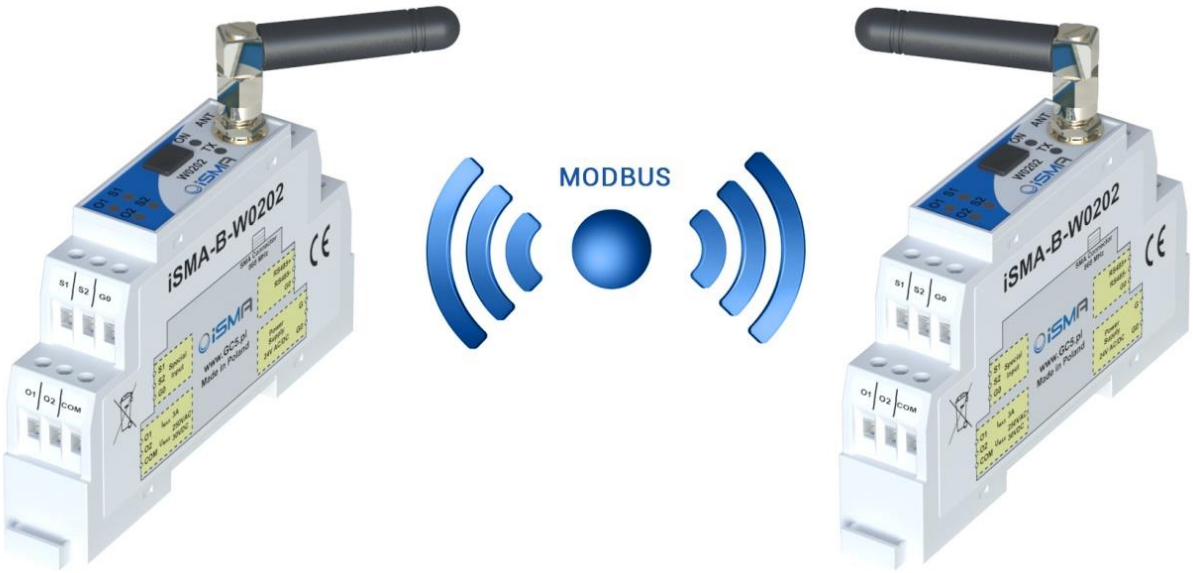
iSMA-B-W0202

User Manual

Modbus



Global Control 5 Sp. z o.o.
Warsaw, Poland
www.gc5.pl

1 Introduction

iSMA-B-W0202 has been built to allow the extension of RS485 bus by using wireless technology wherever use of network cable is impossible or unprofitable. Using two iSMA–B–W0202 modules allow to build the wireless 'bridge' for the RS485 by building wireless remote island (one or more) for devices which communicate via Modbus RTU/ASCII - e.g. iSMA–B–MIX18 or iSMA–B–MIX38.

iSMA-B-W0202 (in addition to the RS485 port and wireless port) is equipped with 2SI (Special Inputs) and 2DO (Digital Outputs max. 230 VAC/30 VDC 3 A). It allows to use the device as an I/O module or light controller communicating on Modbus RTU/ASCII. Algorithm implemented in the processor allows the user to choose one of the three different modes:

Modbus Bridge

Modbus Bridge and I/O module (Digital Outputs work independent to the Special Inputs states)

Modbus Bridge and light controller (Digital Output states depends on assigned Special Inputs states). There are different Operating Modes available (see Special Application modes)

iSMA-B-W0202 is also equipped with a micro USB port which allows to configure the device without the use of an external power supply (the device is powered through the USB port). This solution gives the user an easy way, using 2 laptops, carry out the tests within the existing facility.

1.1 Revision history

Rev	Date	Description
1.0	2015.04.28	First edition
1.1	2016.12.29	The reason for the creation of new version of the document: New functions: • *New HVAC functions Heating and Cooling based on output thermostatic control with a setpoint and differential value setting;* • *Added new input mode Time Relay NC [ms], Time Relay NO and NC in seconds, Input Forwarding;* • *Added new input mode: Ordinary IO, Monostable Relay, Bistable Relay, Time Relay NO and NC [ms], Time Relay NO and NC in seconds, Input Forwarding, Heating, Cooling with corresponding Modbus registers;* • *Added reset output to default after input mode change* Improvements: • *Added power Led flashing after IO watchdog triggered;* • *Changed IO watchdog reset after read/write registers through USB;* • *Added immediately detecting sensors short circuit and disconnection regardless of filter settings on universal inputs;*
1.2	2018.12.17	• *Added watchdog functionality for the Radio, if the radio does not receive the correct packet for 180 seconds, the radio module will restart.*

Table 1 Revision history

1.2 Safety rules

- **Note:** Incorrect wiring of this product can damage it and lead to other hazards. Make sure the product has been correctly wired before turning the power ON.
- Before wiring, or removing/mounting the product, be sure to turn the power OFF. Failure to do so might cause electric shock.
- Do not touch electrically charged parts such as the power terminals. Doing so might cause electric shock.
- Do not disassemble the product. Doing so might cause electric shock or faulty operation.
- Use the product within the operating ranges recommended in the specification (temperature, humidity, voltage, shock, mounting direction, atmosphere etc.). Failure to do so might cause fire or faulty operation
- Firmly tighten the wires to the terminal. Insufficient tightening of the wires to the terminal might cause fire.

1.3 Technical specifications

Power supply	Voltage	24 V AC/DC ± 20%
	Power consumption	2 W @ 24 VDC; 4.5 VA @ 24 VAC
Special Inputs	No. of inputs	2
	Temperature input	Measurement with attached RTDs accuracy ±0.1˚C at 25˚C
	Voltage input	Voltage measurement from 0 to 10 V Input impedance 100 kΩ measurement accuracy ±50 mV
	Resistive input	Measurement of resistance from 0 to 1000 kΩ
	Resistance measurement method	The voltage divider
	Dry contact input	Output current ~1 mA
	Measurement resolution	12-bits
	Fast counters	50 Hz/100 Hz
Digital Outputs (relays)	No. of outputs	2
	Resistive load	3 A @ 230 VAC or 3 A @ 30 VDC
	Inductive load	75 VA @ 230 VAC or 30 W @ 30 VDC
Interface	Mini USB	For power up and configuration
	RS485	Up to 128 devices
	Communication protocol	Modbus RTU, Modbus ASCII
	Baud rate	From 1200 to 115200 bits/s
	Address	0 to 127
Radio	Frequency	868 MHz
	Max output power	+20 dBm (100 mW)
	Sensitivity	-120 dBm
	Radio Channels	1 ÷ 8
	Encryption	AES-128
	Baud Rate	From 1200 to 200000 bits/s
	External antenna	SMA socket
Ingress protection	IP	IP40
Temperature	Storage	– 40˚C to +85˚C
	Operating	– 10˚C to +50˚C
Humidity	Relative	5 to 95%
Connectors	Type	Rising Clamp
	Maximum cable size	2.5 mm^2
Dimension	Width	17 mm
	Length	56 mm
	Height	90 mm

1.4 Dimension

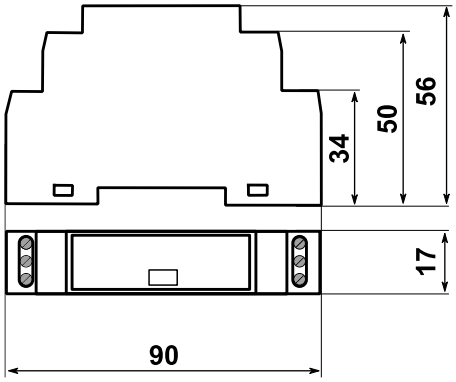


Figure 2 Dimension

1.5 Power supply connection

1.5.1 DC power connection

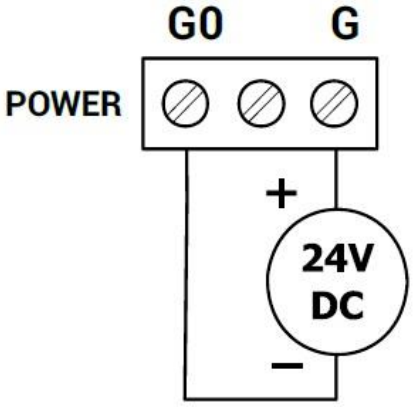


Figure 2 DC power supply connection

1.5.2 AC power connection

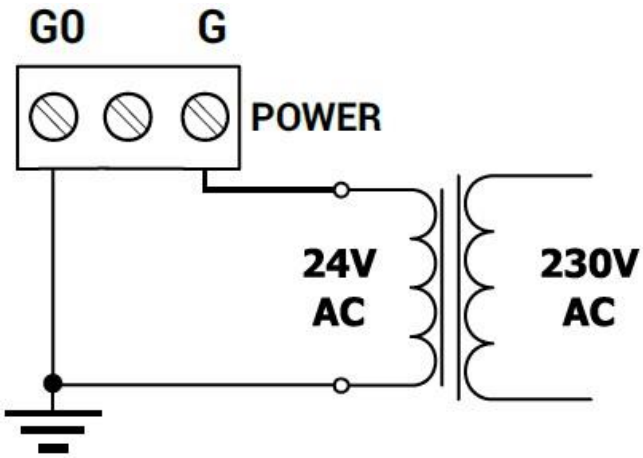


Figure 3 AC power supply connection

1.6 Connecting the communication bus

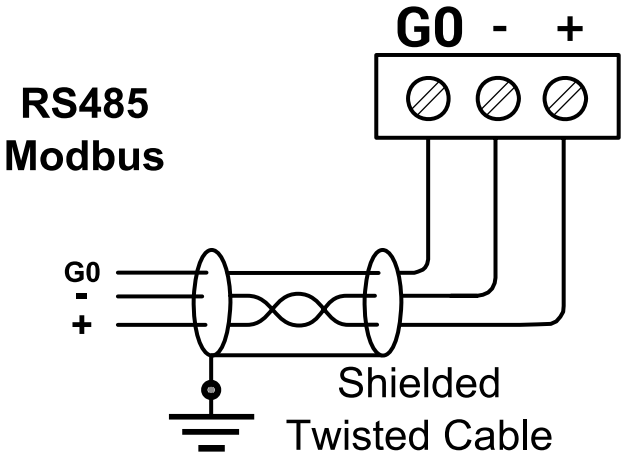


Figure 4 RS485 connection

1.7 LED Indication

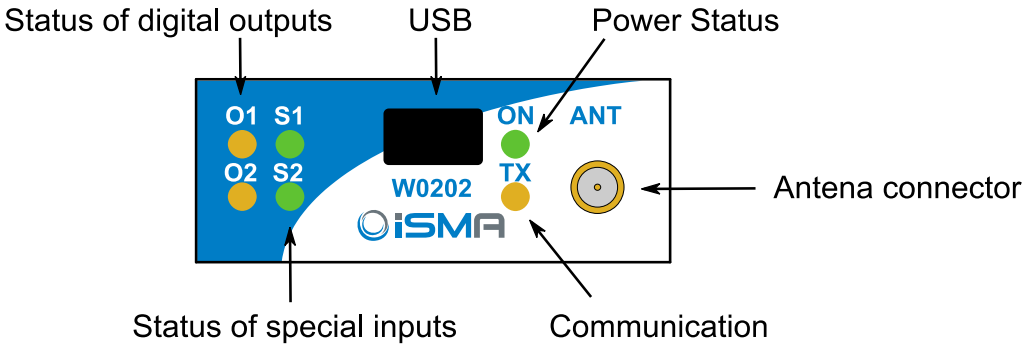


Figure 5 Top panel W0202

- The power LED is ON (green) when the module is running/runs properly.
- Communication LED is ON (orange) for 20 ms after sending each message. If the module receives/sends a lot of messages LED can be lit continuously.
- LEDs indicate the status of the Special Inputs are lit when resistance connected to the input is less than 1 kΩ (Dry Contact input is active).
- **WARNING!** The LED also lights up when voltage connected to the input has a very low potential.
- LEDs indicate the status of the Digital Outputs are lit when output is enabled.

1.8 Grounding and shielding

In most cases, IO modules will be installed in an enclosure along with other devices which generate electromagnetic radiation. Relays, contactors, transformers, motor invertors etc. are the examples of these devices. This electromagnetic radiation can induce electrical noise into both power and signal lines, as well as direct radiation into the module causing negative effects on the system. Appropriate grounding, shielding and other protective steps should be taken at the installation stage to prevent these effects. These protective steps include control cabinet grounding, cable shield grounding, protective elements for electromagnetic switching devices, correct wiring as well as consideration of cable types and their cross sections.

1.9 RS485 Network Termination

The transmission line effects often present problem on data communication networks. These problems include reflections and signal attenuation.

To eliminate the presence of reflections from the end of the cable, the cable must be terminated at both ends with a resistor across the line equal to its characteristic impedance. The both ends must be terminated since the direction of propagation is bidirectional. In the case of an RS485 twisted pair cable. This termination is typically for 120 Ω.

1.10 Module configuration

W0202 can be configured by RS485 Modbus registers or directly by USB connection and iSMA-Configurator software. The iSMA-Configurator can be downloaded from www.support.gc5.pl. When the module is connected, it appears in the hierarchy tree window (left part of the screen). The next step is to read module configuration using the “Read Module” button or to read configuration from a file using the “Load From File” button.

If you want to save changes in the module, you need to use the “Write Module” button. This command writes all parameters down to the module.

WARNING! Radio settings only takes effect after the module restarting.

1.11 Communication

The screen below shows configuration options for RS485 bus.

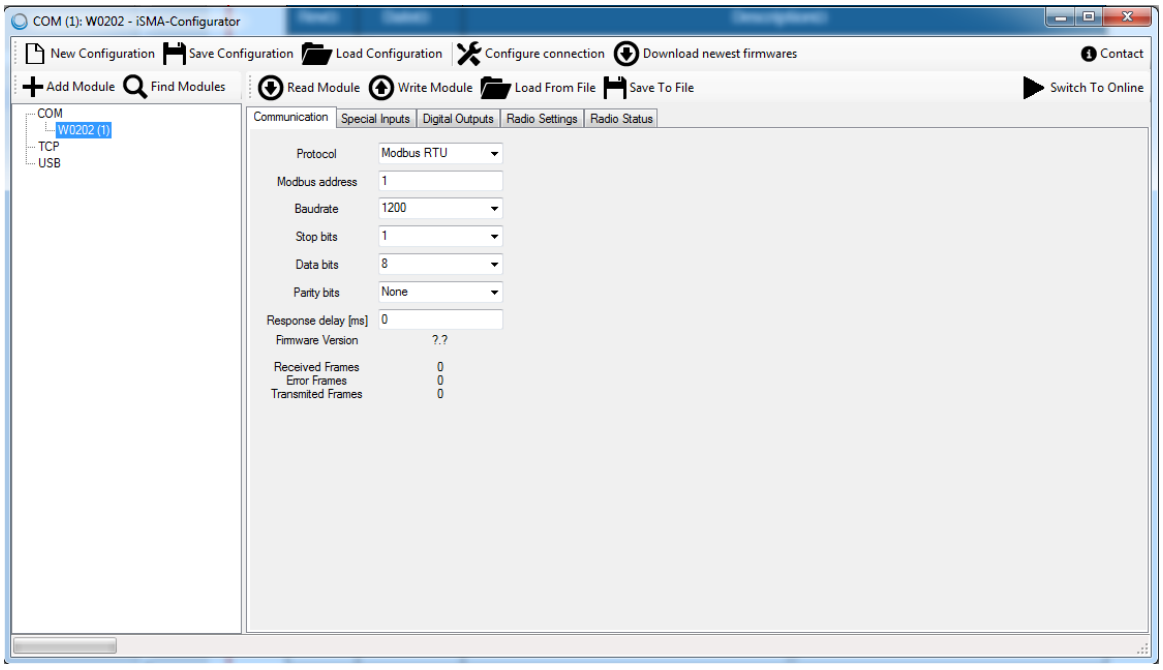


Figure 6 Communication options

1.12 Special Inputs

The screen below shows configuration options for Special Inputs.

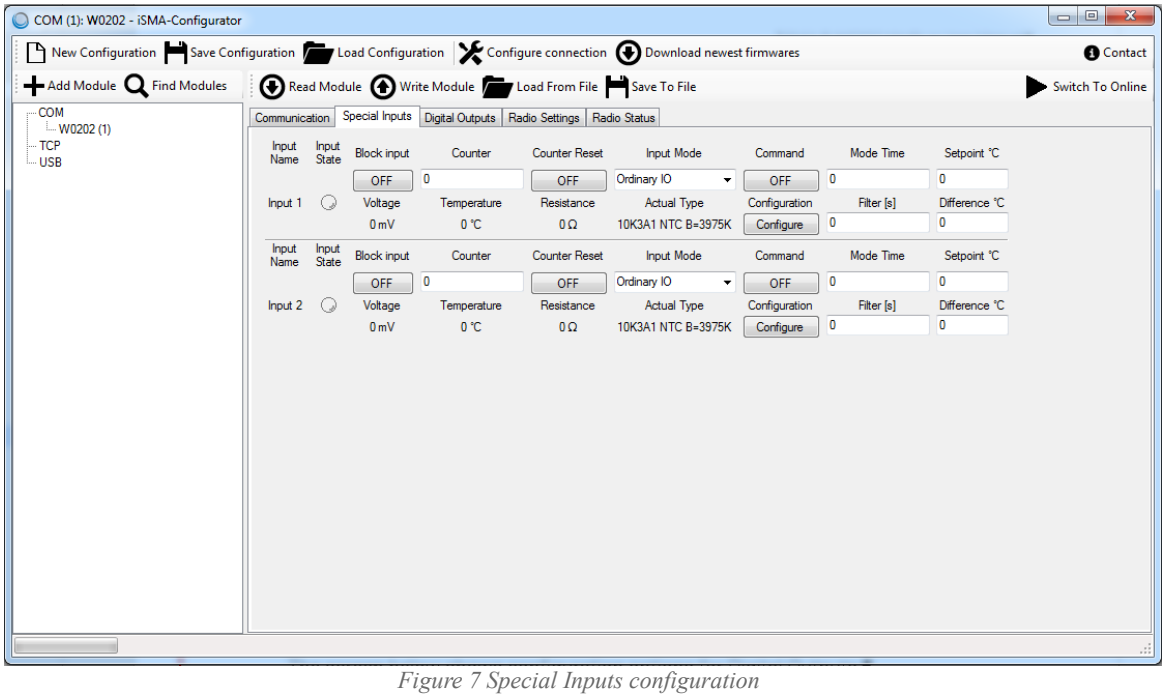


Figure 7 Special Inputs configuration

1.13 Digital Outputs

The screen below shows configuration options for Digital Outputs.

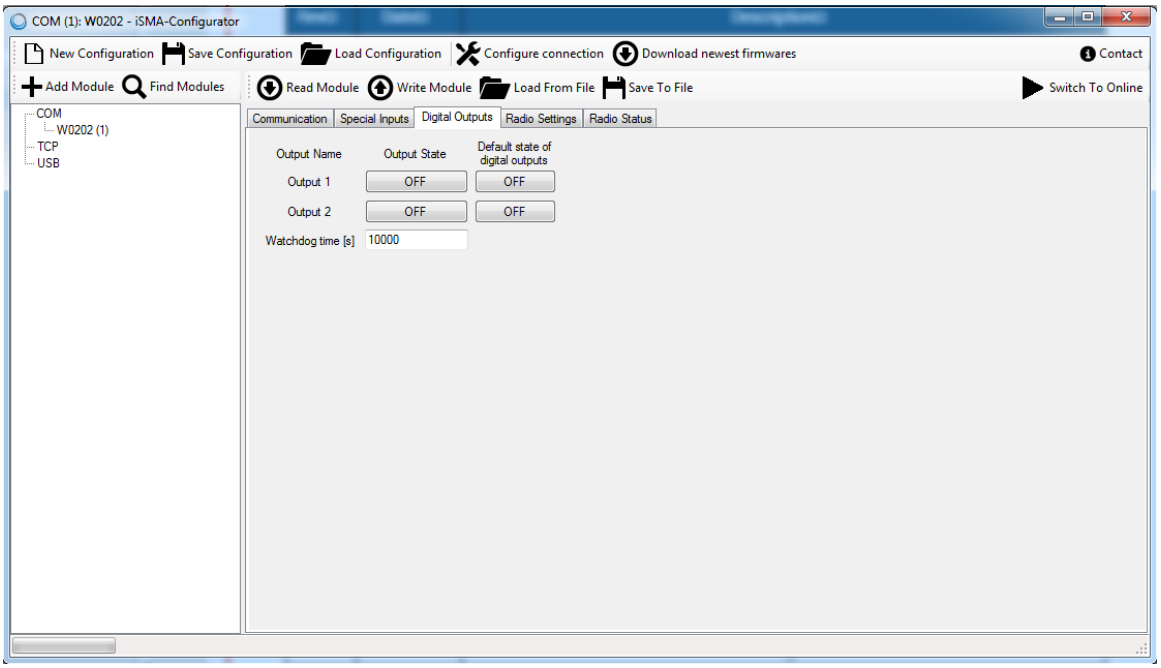


Figure 8 Digital Outputs configuration

1.14 Radio Settings

The screen below shows configuration options for Radio.

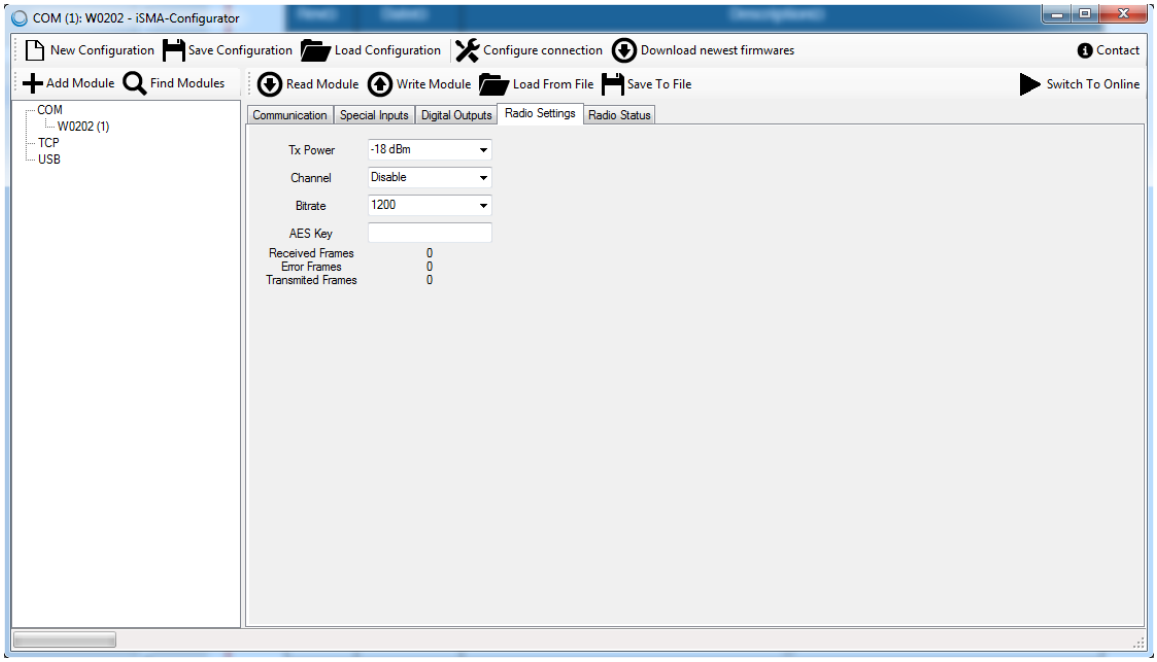


Figure 9 Radio Settings

1.15 Radio Status

The screen below shows radio status for all devices working in the same group.

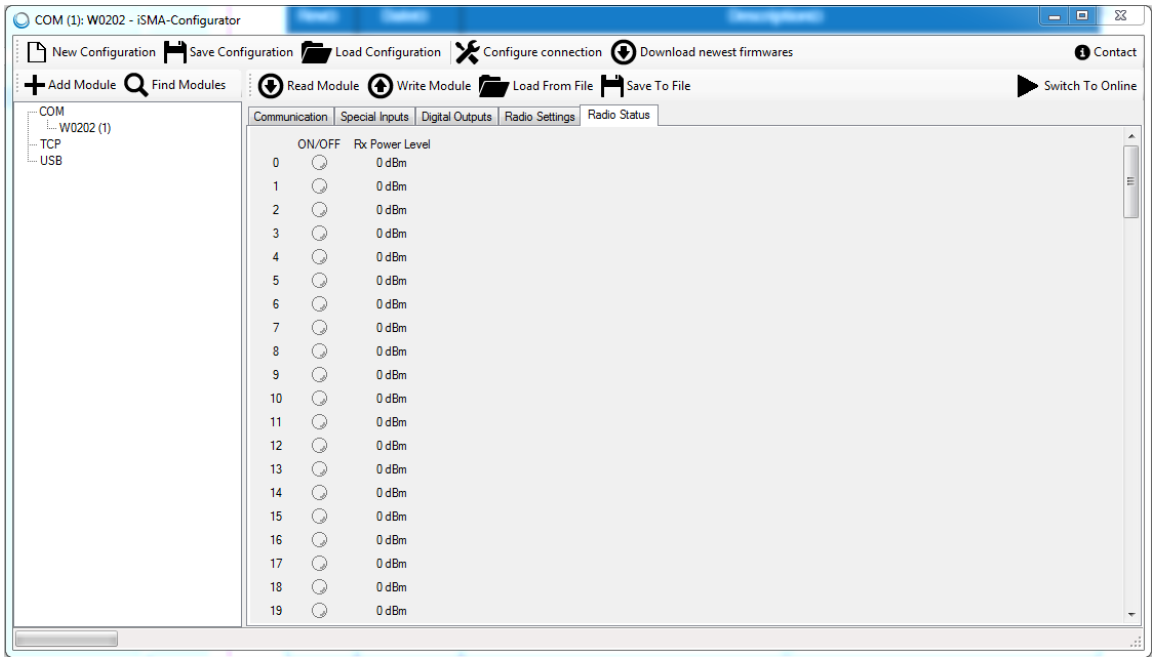


Figure 10 Radio Status

2 Configuration registers

WARNING! Changing the parameters concerning the transmission configuration will only take effect after restarting the module or reload settings –register (40001).

2.1 Firmware version and module type (30001)

In this register are encoded type and firmware version of module.

Low byte contains information about the type of module in accordance with the table below:

Value	Type
80_{10} ($0x50_{16}$)	iSMA-B-W0202

Table 3 Firmware version and module type

High byte contains the module firmware version multiplied by 10.

The example:

In register 30001 is number 20490_{10} = $0x500A_{16}$. It means that it is a module iSMA-B-W0202 (0x50) with firmware in version 1.0 ($0x0A_{16} = 10_{10}$)

2.2 Counter of received messages (30004)

32-bit register with the number of valid Modbus messages received by the module from the last powered up. The value is reset after power cycle or after changing transmission parameters (baud rate, stop bits, parity, etc.).

2.3 Counter of error messages (30006)

32-bit register with the number of error Modbus messages received by the module from last powered up. The value is reset after power cycle or after changing transmission parameters (baud rate, stop bits, parity, etc.).

2.4 Counter of sent messages (30008)

32-bit register with the number of Modbus messages sent by the module from last powered up. The value is reset after power cycle or after changing transmission parameters (baud rate, stop bits, parity, etc.).

2.5 Up time (30012)

This 32-bits register contains module working time in seconds from last power up or module reset.

2.6 Device actions (40001)

Setting register 40001 according to the table below will enable 1 of 3 available actions: reset module, reload settings and set to default.

Value	Type of action
0x01FF	Reset of device
0x02FF	Reload settings (RS485, Radio)
0x03FF	Set device to default

Table 4 Device actions

2.7 Modbus protocol type (40134)

This register contains parameters which define Modbus protocol type (RTU or ASCII).

Value	Protocol Type
0 (default)	Modbus RTU
1	Modbus ASCII

Table 5 Modbus type selection

2.8 Modbus address (40135)

This register contains information about the address of the Modbus module. The default address is 1.

2.9 Baud rate (40136)

This register contains information about the baud rate.

Particular register value determined by? baud rate in accordance with the table below.

Value	Baud rate
0	1200
1	2400
2	4800
3	9600
4	19200
5	38400
6	57600
7	115200(default)

Table 6 Baud rate

2.10 Stop bits (40137)

The number of stop bits is determined on the basis of this register in accordance with the following table:

Value	No of stop bits
1 (default)	1
2	2

Table 7 Stop bits

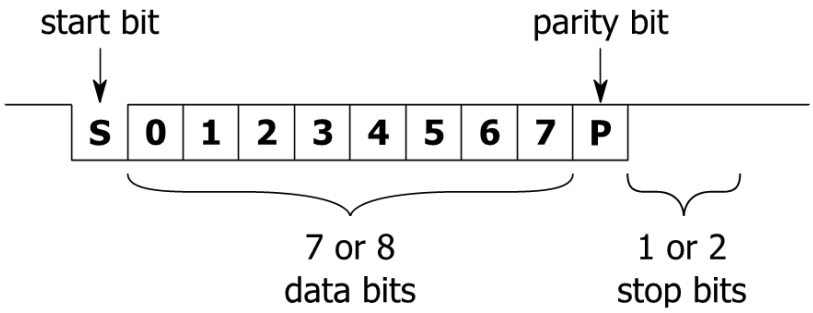


Figure 11 Modbus message frame

2.11 Data bits (40138)

The number of data bits transmitted in a single byte is determined according to the following table:

Value	No of data bits
7	7
8 (default)	8

Table 8 Data bits

2.12 Parity bit (40139)

Each byte of data being transferred may have additional protection as a parity bit added before stop bit (bits).

The method of calculating parity bit determines the table below:

Register value	Type of parity bit
0 (default)	none
1	Odd (number of all ones in a byte is odd)
2	Even (number of all ones in a byte is even)
3	Always 1
4	Always 0

Table 9 Parity bit

2.13 Response delay time (40140)

The value of this register determines the number of milliseconds to wait before the unit answers

the question. This time is used to extend the interval between question and answer. The default value of 0 means no delay (the answer is sent once during the 3.5 character required by the protocol Modbus RTU).

2.14 Watchdog time (40141)

This register specifies the time in seconds to watchdog reset. If module does not receive any valid message within that time, Digital Outputs will be set to default state, which is determined by value in 40142 register.

This feature is useful if for some reason there is an interruption in data transmission and for security reasons output state must be set to the appropriate state endanger the safety of persons or property.

Setting of 0 value will disable the watchdog. The default value is 15 seconds.

2.15 Watchdog for Radio

If the radio does not receive the correct data packet for 180 seconds, the radio module will restart. Time 180 seconds is a constant value.

3 Radio configuration registers

WARNING! Changing the parameters concerning the transmission configuration will only take effect after restarting the module or reload settings –register (40001).

3.1 Radio TX Power (40242)

This register contains radio transmission signal power. The signal strength depends on the distance between devices and the environment conditions.

Value	Radio TX Power [dBm]	Radio TX Power [mW]
0	-18	0,0158
1	0	1
2	7	5
3	10	10
4	14	25
5	17	50
6	20	100

Table 10 Radio TX Power register

3.2 Radio Channel (40243)

This register contains information about a radio channel. All modules which work in the same group require the same channel number. More than one wireless network can be used but each of them has to work on different channel. Each channel has to have no influence on each other (see chapter Radio Baud Rate).

Value	Channel	Frequency
0	DISABLE	-
1	Channel 1	869,415 MHz
2	Channel 2	869,445 MHz

3	Channel 3	869,475 MHz
4	Channel 4	869,505 MHz
5	Channel 5	869,535 MHz
6	Channel 6	869,565 MHz
7	Channel 7	869,595 MHz
8	Channel 8	869,625 MHz

Table 11 Radio channel register

3.3 Radio Baud Rate (40244)

The register contains baud rate used in Radio protocol. All devices which work in the same group (the same channel) have to have the same baud rate value. Different baud rate values can be used for RS485 bus and for Radio protocol.

Value	Baud rate
0	1200
1	2400
2	4800
3	9600
4	19200
5	38400
6	57600
7	115200
8	200000

Table 12 Radio baud rate selection

Higher baud rate value requires more bandwidth which can occur on adjacent channels.

The table below shows the dependencies between these parameters.

Baud rate	No of channels	Channels
1200	1	1-8
2400	1	1-8
4800	1	1-8
9600	1	1-8
19200	1	1-8
38400	2	2-7
57600	3	3-6
115200	4	4
200000	4	4

Table 13 Relation between Baud rate and no of the channels

3.4 Radio AESKEY (40249 – 40256)

Each package transmitted by Radio protocol is encrypted by AES-128 algorithm. It protects the network against unauthorized access. The encryption uses 128-bits key stored in 8 registers (8 x 16 bits). Each device works in the same group has to have the same encryption key.

Register	Device
40249	Radio AESKEY D1-D0
40250	Radio AESKEY D3-D2
40251	Radio AESKEY D5-D4
40252	Radio AESKEY D7-D6
40253	Radio AESKEY D9-D8
40254	Radio AESKEY D11-D10
40255	Radio AESKEY D13-D12
40256	Radio AESKEY D15-D14

Table 14 Radio AESKEY registers

3.5 Radio Received Frames Counter (40257)

32-bit register with the number of valid messages received by the module via Radio protocol from last powered up. The register value is reset after power cycle or after changing transmission parameters (baud rate, stop bits, parity, etc.).

3.6 Radio ERROR Frames Counter (40259)

32-bit register with the number of error messages received by the module via Radio from last powered up. The value is reset after power cycle or after changing transmission parameters (baud rate, stop bits, parity, etc.).

3.7 Radio Transmitted Frames Counter (40261)

32-bit register with the number of transmitted messages by the module via Radio from last powered up. The value is reset after power cycle or after changing transmission parameters (baud rate, stop bits, parity, etc.).

3.8 Wireless Device Status (40263 – 40390)

The register contains information about the signal strength of the other W0202 modules operating on the same channel. Each device has its own register for status indication

The device number equals the Modbus address of this device.

Register	Device
40263	WIRELESS DEVICE STATUS 1
40264	WIRELESS DEVICE STATUS 2
40265	WIRELESS DEVICE STATUS 3
40266	WIRELESS DEVICE STATUS 4
....	.....
40389	WIRELESS DEVICE STATUS 127
40390	WIRELESS DEVICE STATUS 128

Table 15 Wireless Device Status registers

The particular register contains information about the signal strength in dBm and remotes device status.

No of bit in register	Function
0 ÷ 7	RX POWER [dBm]
8	0-> DOWN; 1-> OK

Table 16 Wireless Device Status register structure

4 Special inputs connections

4.1 Connection of Special Input to measure voltage 0 – 10 V

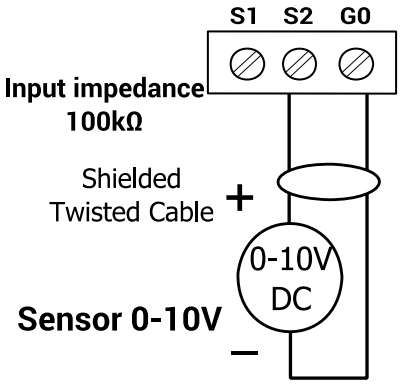


Figure 12 Connection of Special Input to measure voltage 0-10 V

4.2 Connection of Special Input to measure temperature

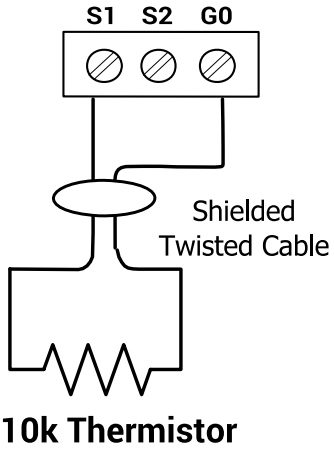


Figure 13 Connection of Special Input to measure temperature

4.3 Connection of Special Input as a Digital Input (Dry Contact)

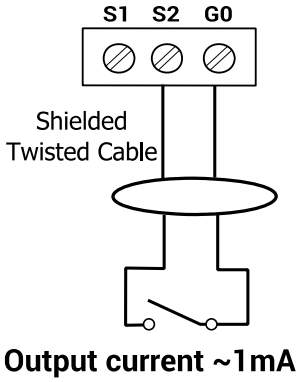


Figure 14 Connection of Special Input as a Digital Input

5 Special inputs MODBUS registers

5.1 Status of Special Inputs working as Digital Inputs (30017)

This register contains information about the status of Special Inputs (dry contact). Shortcut the input to the ground sets the corresponding bit of the register in accordance with the following table:

No of input	No of register bit
1	0
2	1

Table 17 Special Inputs Status

5.2 Special Input measure voltage 1 – 2 (30071, 30073)

The registers contain the results of the voltage measuring for each Special Input.

The result is expressed in millivolts.

Special Input	Register number
S1	30071
S2	30073

Table 18 Special Inputs Voltage measurement

5.3 Special Input measure temperature 1 – 2 (30072, 30074)

The registers contain the results of the temperature measuring for each Special Input.

The result is expressed in Celsius degrees multiplied by 10.

Input	Registers
S1	30072
S2	30074

Table 19 Special Inputs Temperature measurement

5.4 Special Input measure resistance 1 – 2 (30103-30104, 30105-30106)

These 32-bit registers contain the results of the temperature measuring for each Special Input.

The result is expressed in Ω (Ohms). The register with lower number contains lower part of the result.

Input	Registers
S1	LO – 30103, HI - 30104
S2	LO – 30105, HI - 30106

Table 20 Special Inputs Resistance measurement

5.5 Fast counter (40023-40024, 40025-40026)

The module has two 32-bit counters for Special Input. The counter's value is stored in non-volatile memory (EEPROM).

Input	Registers
S1	LO – 40023, HI - 40024
S2	LO – 40025, HI - 40026

Table 21 Fast counters registers for Special Inputs

In the case you would like to change the value of the register you can write any value (called preset) for pulse counting registers. In the particular case, you can reset the counter by entering 0.

The counter reset is also possible by switching-on relevant bits in the register 40022.

WARNING! In default fast counters work with 50Hz frequency. To change the frequency to 100 Hz, please refer to registers (40151 – 40152).

5.6 Resetting counters values (40022)

Setting true value for particular bit resets the corresponding counter according to the following table:

No of register bit	Special Input Counter
0	S1
1	S2

Table 22 Resetting counters' values

True value of the bit causes continuous resetting of the counter.

Setting the bit to 0 restores normal operation.

5.7 Special input configuration 1 – 2 (40151 – 40152)

These registers are dedicated for the Special Inputs configuration in accordance with the following table:

Register value	Description
0	Off resistance measurement (only measuring the voltage, dry contact off)
1 (default)	The temperature sensor 10K3A1 NTC B=3975K
2	The temperature sensor 10K4A1 NTC B=3695K
3	The temperature sensor 10K NTC B=3435K Carel
4	The temperature sensor 20K6A1 NTC B=4262K
5	The temperature sensor 2,2K3A1 NTC B=3975K
6	The temperature sensor 3K3A1 NTC B=3975K
7	The temperature sensor 30K6A1 NTC B=4262K
8	The temperature sensor SIE1
9	The temperature sensor TAC1
10	The temperature sensor SAT1
+128 (set 7. bit of register)	Off voltage measurement and **fast counters working on 100Hz**

Table 23 Special Input Configuration register

5.8 Filter time of the Special Input 1 – 2 (40159 – 40160)

The registers contain a time constant of low pass filter value. The value is expressed in seconds. Valid values are between 1 and 60 seconds.

The default filter value is 2 seconds. Setting 0 disables the filter.

6 Digital Outputs (relays) connections

6.1 Connecting a solenoid valve to the Digital Output

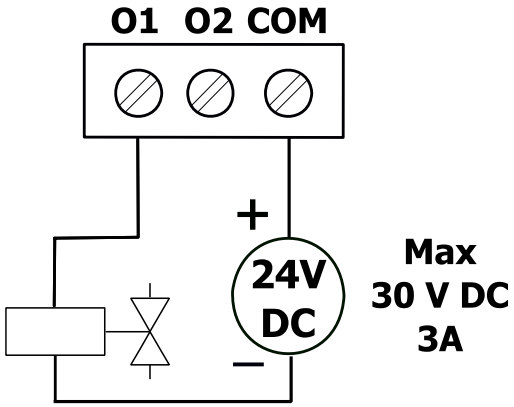


Figure 15 Connection of a solenoid valve to the Digital Output

6.2 Connecting a resistive load to the Digital Output

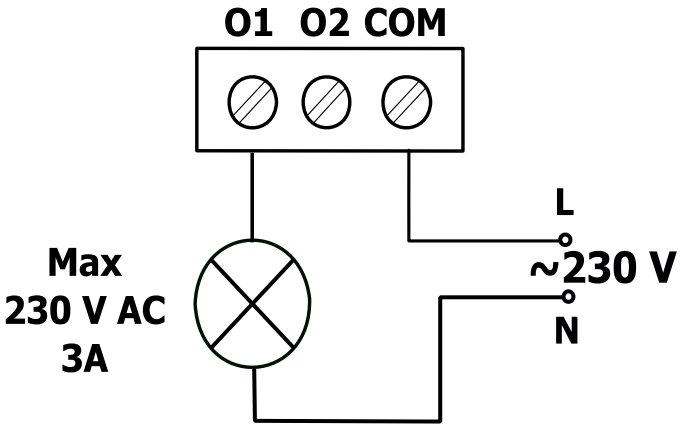


Figure 16 Connection of a resistive load to the Digital Output

7 Digital Outputs (relays) MODBUS registers

7.1 State of Digital Outputs (40018)

The register contains the state of the Digital Outputs. Setting true value of particular bit activates assigned output according to the following table:

No of bit in register	No of digital output
0	1
1	2

Table 24 State of the Digital outputs register structure

7.2 Default state of Digital Outputs (40143)

The register contain the default states of the Digital Outputs after power-up or watchdog reset. Particular bits with assigned Digital Outputs are shown in the table:

No of bit in register	No of digital output
0	1
1	2

Table 25 Default states of Digital Inputs register

8 Special application modes

In W0202 module simple applications have been built which can be used to control building devices. The applications make logic between signal from Special Input and control Digital Output state. Relation between Inputs and Outputs is shown in the table below and it cannot be changed.

Special Input	Digital Output
SI1	DO1
SI2	DO2

Table 26 Built in application relation between input and output

The Special Inputs can be set to work in different modes. There are dedicated registers for operation mode (40176, 40180), time parameters (40177, 40181), setpoints for heating/cooling modes (40178, 40182), and for differential value in heating/cooling modes (40179, 40183).

Register	Description
40176	Input S1 OPERATION MODE
40177	Input S1 TIME VALUE
40178	Input S1 SETPOINT
40179	Input S1 DIFFERENTIAL
40180	Input S2 OPERATION MODE
40181	Input S2 TIME VALUE
40182	Input S2 SETPOINT
40183	Input S2 DIFFERENTIAL

Table 27 List of registers dedicated for special application mode

8.1 Operation Mode registers (40176,40180)

This register contains information about module working mode. Available modes and register values are shown in the table below:

Value	OPERATION MODE Register
0	Ordinary IO(def)
1	Monostabile Relay
2	Bistabile Relay
3	Time Relay NO [ms]
4	Time Relay NC [ms]
5	Time Relay NO [s]
6	Time Relay NC [s]
7	Input Forwarding
8	Heating
9	Cooling

Table 28 Special application modes

Operating mode can be changed by writing right value in the Operation Mode register.

Special modes are initialized after 3 seconds from power-up or restart of the modul (the time value needed to stabilize the analog transmitter working).

Each Input mode change sets assigned Output to default state and reset the timer (used in Time-based modes). When the new selected operating mode is running output is controlled according to the new mode functioning.

8.1.1 Ordinary IO

In this mode, the module works as a standard IO, inputs and outputs are not related which each other.

8.1.2 Monostable Relay

In this mode both rising and falling edge on Special Input change output state. The action of monostable relay can be executed remotely by changing the state of bit from false to true in COMMAND register (40020). Outputs can be also overwritten by DIGITAL OUTPUT register (40018), which allows remote control from BMS.

8.1.3 Bistable Relay

In this mode only rising edge on Special Input change output state. The action of bistable relay can be executed remotely by changing the state of bit from false to true in COMMAND register (40020). Outputs can be also overwritten by DIGITAL OUTPUT register (40018), which allows remote control from BMS.

8.1.4 Time Relay NO [ms]

In this mode when the output value is false, rising edge on Special Input set output to true value. Every falling edge on Special Input starts the counter from the beginning what means that the output will stay in true value for a time defined in TIME VALUE register (expressed in

milliseconds), counting from the last falling edge of Special Input. The action of time relay can be executed remotely by changing state from false to true in relevant COMMAND register (40020). Outputs can be also overwritten by module DIGITAL OUTPUT register (40018), which allows to remote control from BMS.

8.1.5 Time Relay NC [ms]

In this mode when the output value is false, falling edge on Special Input set output to true value. Every rising edge on Special Input starts the counter from the beginning what means that the output will stay in true value for a time defined in TIME VALUE register (expressed in milliseconds), counting from the last rising edge of Special Input. The action of time relay can be executed remotely by changing state from false to true in relevant COMMAND register (40020). Outputs can be also overwritten by module DIGITAL OUTPUT register (40018), which allows remote control from BMS.

8.1.6 Time Relay NO [s]

In this mode when the output value is false, rising edge on Special Input set output to true value. Every falling edge on Special Input starts the counter from the beginning what means that the output will stay in true value for a time defined in TIME VALUE register (expressed in seconds), counting from the last falling edge of Special Input. The action of time relay can be executed remotely by changing state from false to true in relevant COMMAND register (40020). Outputs can be also overwritten by module DIGITAL OUTPUT register (40018), which allows remote control from BMS.

8.1.7 Time Relay NC [s]

In this mode when the output value is false, falling edge on Special Input set output to true value. Every rising edge on Special Input starts the counter from the beginning what means that the output will stay in true value for a time defined in TIME VALUE register (expressed in seconds), counting from the last rising edge of Special Input. The action of time relay can be executed remotely by changing state from false to true in relevant COMMAND register (40020). Outputs can be also overwritten by module DIGITAL OUTPUT register (40018), which allows remote control from BMS.

8.1.8 Input Forwarding

In this mode, any signal from the input is transferred directly to the assigned output without any modifications. The input forwarding mode functioning can be stopped by Block Input function (see Blocking register).

8.1.9 Heating mode

In this mode output is controlled as a typical thermostat, based on Setpoint register and Control value (Input value) with differential parameter defined in Differential register. The output signal works in 2 states low and high.

When Control value is lower or equal the difference of Setpoint register and differential register the output is in low state.

When Control value is higher or equal the sum of Setpoint register and differential register the output is in high state.

Output in low state:

Control value >= Setpoint + Differential

Output in high state:

Control value <= Setpoint – Differential

The heating mode algorithm is shown in chart below.

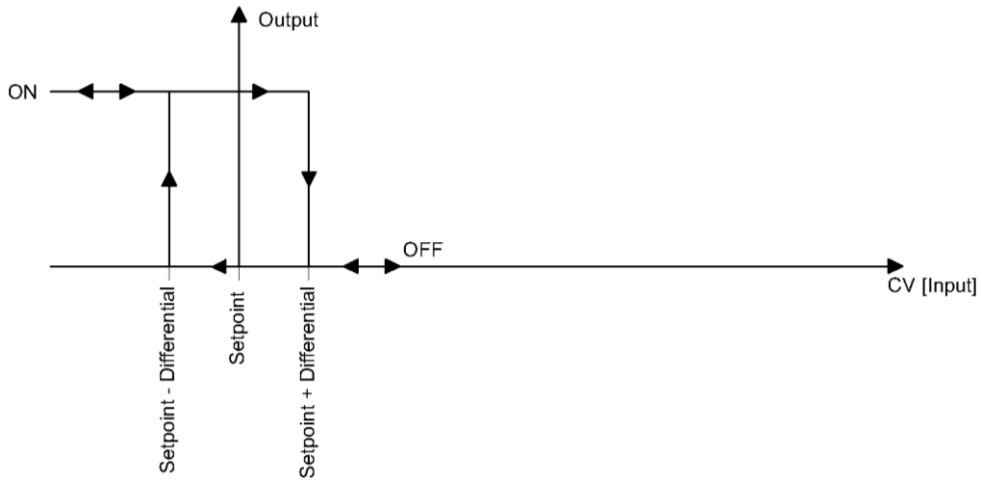


Figure 17 Heating mode algorithm functioning

WARNING! In the case when temperature sensor is failed (disconnected or shortcut) then heating mode does not work and output stays in the false state.

8.1.10 Cooling mode

In this mode output is controlled as a typical thermostat, based on Setpoint register and Control value (Input value) with differential parameter defined in Differential register.

The output signal works in 2 states - low and high.

When Control value is lower or equal the difference of Setpoint register and Differential register the output is in low state.

When Control value is higher or equal the sum of Setpoint register and Differential register the output is in high state.

Output in low state:

Control value <= Setpoint – Differential

Output in high state:

Control value >= Setpoint + Differential

The cooling mode algorithm is shown in chart below.

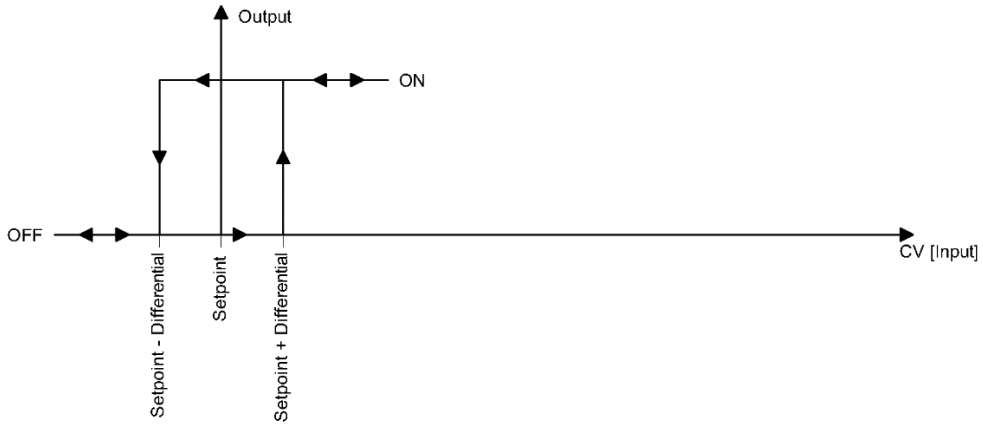


Figure 18 Cooling mode algorithm functioning

WARNING! In the case when temperature sensor is failed (disconnected or shortcut) then heating mode does not work and output stays in the false state.

8.2 Command register (40020)

The module have special register COMMAND (40020). The command register is used to remotely execute action (simulate light switch/PIR). The action is executed by changing state of relevant bit (changing from false to true). All special application modes can be executed except Input Forwarding, Heating and Cooling modes.

No of bit in register (40020)	Command input number
0	*1*
1	*2*
2	*3*
3	*4*

Table 29 Command register

8.3 Block Inputs register (40021)

The Block Inputs register is used to block physical input signals to take action in logic. By setting true value on relevant bit the module Block Input and no action will be executed. Setting false value restores normal operation. The Block Input function does not work when the heating/cooling input mode is set.

No of bit in register (40021)	Block input number
0	*1*
1	*2*
2	*3*
3	*4*

Table 30 Block Inputs register

8.4 Setpoint registers (40178,40182)

The SETPOINT registers contain values which are used in heating/cooling modes as the setpoints for heating/cooling control algorithm

The default Setpoint value is 21. (read more in Heating mode, Cooling mode).

The register stores the setpoint multiplied by 10.

8.5 Differential registers (40179,40183)

The DIFFERENTIAL registers contain values which are used in heating/cooling modes as the differential for heating/cooling control algorithm. Setpoint registers and Differential registers create deadband of the Control values which has no influence on output.

Deadband = (Setpoint – Differential, Setpoint + Differential)

The default Differential value is 1. (read more in Heating mode, Cooling mode).

The register stores the differential multiplied by 10.

9 List of Modbus registers

<table>
<tr><th>Modbus Address</th><th>Dec Address</th><th>Hex Address</th><th>Register name</th><th>Access</th><th>Description</th></tr>
<tr><td>30001</td><td>0</td><td>0x00</td><td>VERSION AND MODULE TYPE</td><td>Read Only</td><td>Firmware version and module type (30001)</td></tr>
<tr><td>30004</td><td>3</td><td>0x03</td><td>RS485 COUNTER OF RECEIVED FRAMES (32–bits)</td><td>Read Only</td><td>Counter of received messages (30004) Default state is 0 Reset at the unit start and change of transmission parameters.</td></tr>
<tr><td>30006</td><td>5</td><td>0x05</td><td>RS485 COUNTER OF FRAMES WITH ERROR (32–bits)</td><td>Read Only</td><td>Counter of error messages (30006) Default state is 0 Reset at the unit start and change of transmission parameters.</td></tr>
<tr><td>30008</td><td>7</td><td>0x07</td><td>RS485 COUNTER OF SENT FRAMES (32–bits)</td><td>Read Only</td><td>Counter of sent messages (30008) Default state is 0 Reset at the unit start and change of transmission parameters.</td></tr>
<tr><td>30017</td><td>15</td><td>0x0F</td><td>STATUS OF SPECIAL INPUTS WORKING AS DIGITAL INPUT</td><td>Read Only</td><td>Status of Special Inputs working as Digital Inputs are represented by bits 0 and 1 in register (30017)</td></tr>
<tr><td>40001</td><td>0</td><td>0x00</td><td>VERSION AND MODULE TYPE PLUS ENABLE OF ACTIONS</td><td>Read & Write</td><td>Firmware version and module type plus enable of actions<table><tr><th>Value</th><th>Type of action</th></tr><tr><td>0x01FF</td><td>Reset of device</td></tr><tr><td>0x02FF</td><td>Reload settings (RS485, Radio)</td></tr><tr><td>0x03FF</td><td>Set device to default</td></tr></table></td></tr>
<tr><td>40018</td><td>17</td><td>0x11</td><td>STATE OF DIGITAL OUTPUTS</td><td>Read & Write</td><td>State of Digital Outputs (40018)</td></tr>
<tr><td>40020</td><td>19</td><td>0x12</td><td>SPECIAL INPUTS COMMAND REGISTER</td><td>Read & Write</td><td>Special Inputs command register (40020)</td></tr>
<tr><td>40021</td><td>20</td><td>0x14</td><td>SPECIAL INPUTS BLOCKING</td><td>Read & Write</td><td>Special Inputs blocking (40021) default set to 0</td></tr>
<tr><td>40022</td><td>21</td><td>0x15</td><td>COUNTER RESET</td><td>Read & Write</td><td>Resetting counters value (40022) Set bit in register to reset corresponding counter.</td></tr>
<tr><td>40023</td><td>22</td><td>0x16</td><td>COUNTER 1 LSB</td><td rowspan="2">Read & Write Memory</td><td rowspan="4">32-bit counters for each Special Input counting pulses.</td></tr>
<tr><td>40024</td><td>23</td><td>0x17</td><td>COUNTER 1 MSB</td></tr>
<tr><td>40025</td><td>24</td><td>0x18</td><td>COUNTER 2 LSB</td><td rowspan="2">Read & Write Memory</td></tr>
<tr><td>40026</td><td>25</td><td>0x19</td><td>COUNTER 2 MSB</td></tr>
<tr><td>30071</td><td>70</td><td>0x46</td><td>SPECIAL INPUT 1 VOLTAGE</td><td>Read Only</td><td rowspan="5">Special Input measure voltage 1 – 2 (30071, 30073) and Special Input measure temperature 1 – 2 (30072, 30074)

Voltage measurement value is</td></tr>
<tr><td>30072</td><td>71</td><td>0x47</td><td>SPECIAL INPUT 1 TEMPERATURE</td><td>Read Only</td></tr>
<tr><td>30073</td><td>72</td><td>0x48</td><td>SPECIAL INPUT 2 VOLTAGE</td><td>Read Only</td></tr>
<tr><td>30074</td><td>73</td><td>0x49</td><td>SPECIAL INPUT 2 TEMPERATURE</td><td>Read Only</td></tr>
</table>

<table>
<tr><th>Modbus Address</th><th>Dec Address</th><th>Hex Address</th><th>Register name</th><th>Access</th><th>Description</th></tr>
<tr><td>30087</td><td>86</td><td>0x56</td><td>SPECIAL INPUT 1 VOLTAGE</td><td>Read Only</td><td rowspan="4">expressed in mV.
For current measurements, the formula for the current:
$I = \frac{U}{500}$
where: U – register value,
500 – value of attached resistance

Temperature is expressed in Celsius degrees * 10
For a result, divide the registry value by 10:

$T = \frac{registervalue}{10}$

Selection of the type sensor is done using registers from 40151 to 40152 for each input separately</td></tr>
<tr><td>30088</td><td>87</td><td>0x57</td><td>SPECIAL INPUT 2 VOLTAGE</td><td>Read Only</td></tr>
<tr><td>30095</td><td>94</td><td>0x5E</td><td>SPECIAL INPUT TEMPERATURE 1</td><td>Read Only</td></tr>
<tr><td>30096</td><td>95</td><td>0x5F</td><td>SPECIAL INPUT TEMPERATURE 2</td><td>Read Only</td></tr>
<tr><td>30103</td><td>102</td><td>0x66</td><td>RESISTIVE INPUT 1 LSB</td><td>Read Only</td><td rowspan="4">Special Input measure resistance 1 – 2 (30103-30104, 30105-30106)

Resistance measurement result expressed in Ω</td></tr>
<tr><td>30104</td><td>103</td><td>0x67</td><td>RESISTIVE INPUT 1 MSB</td><td>Read Only</td></tr>
<tr><td>30105</td><td>104</td><td>0x68</td><td>RESISTIVE INPUT 2 LSB</td><td>Read Only</td></tr>
<tr><td>30106</td><td>105</td><td>0x69</td><td>RESISTIVE INPUT 2 MSB</td><td>Read Only</td></tr>
<tr><td>40134</td><td>133</td><td>0x85</td><td>MODBUS PROTOCOL TYPE</td><td>Read & Write Memory</td><td>RS485 Modbus protocol type
0 -> RTU, 1->ASCII</td></tr>
<tr><td>40136</td><td>135</td><td>0x87</td><td>RS485 BAUD RATE</td><td>Read & Write Memory</td><td>RS485 baud rate (40136)</td></tr>
<tr><td>40137</td><td>136</td><td>0x88</td><td>RS485 STOP BITS</td><td>Read & Write Memory</td><td>Stop bits (40137)
Supported values are 1 and 2
The default value 1</td></tr>
<tr><td>40138</td><td>137</td><td>0x89</td><td>RS485 DATA BITS</td><td>Read & Write Memory</td><td>Data bits (40138)
Supported values are 7 and 8
The default value 7</td></tr>
<tr><td>40139</td><td>138</td><td>0x8A</td><td>RS485 PARITY BIT</td><td>Read & Write Memory</td><td>Parity bit (40139)
The default value is 0 (no parity)
Allowed values:<table><tr><th>Value</th><th>Description</th></tr><tr><td>0 (default)</td><td>none</td></tr><tr><td>1</td><td>Odd</td></tr><tr><td>2</td><td>Even</td></tr><tr><td>3</td><td>Always 1</td></tr><tr><td>4</td><td>Always 0</td></tr></table></td></tr>
<tr><td>40140</td><td>139</td><td>0x8B</td><td>RESPONSE DELAY</td><td>Read & Write Memory</td><td>Response delay time (40140)
Delay in ms before sending response
The default value is 0.</td></tr>
<tr><td>40141</td><td>140</td><td>0x8C</td><td>WATCHDOG TIME</td><td>Read & Write</td><td>Watchdog time (40141)
Time in second before watchdog reset</td></tr>
</table>

<table>
<tr><th>Modbus Address</th><th>Dec Address</th><th>Hex Address</th><th>Register name</th><th>Access</th><th>Description</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Memory</td><td>in case no transmission.
Setting value of 0 disables Watchdog.
The default value is 15s</td></tr>
<tr><td>40143</td><td>142</td><td>0x8E</td><td>DEFAULT STATE OF DIGITAL OUTPUTS</td><td>Read & Write Memory</td><td>Default state of Digital Outputs (40143)
State of Digital Outputs assigned at the start of the module and watchdog reset.
The default value is 0.</td></tr>
<tr><td>40151</td><td>150</td><td>0x96</td><td>SPECIAL INPUT 1 CONFIGURATION</td><td>Read & Write Memory</td><td rowspan="2">Configuration of Special Input and type of temperature sensor.

The default value is 1.

<table><tr><th>Value</th><th>Description / Sensor</th></tr><tr><td>0</td><td>Resistance measurement off</td></tr><tr><td>1</td><td>10K3A1 NTC</td></tr><tr><td>2</td><td>10K4A1 NTC</td></tr><tr><td>3</td><td>10K NTC Carel</td></tr><tr><td>4</td><td>20K6A1 NTC</td></tr><tr><td>5</td><td>2,2K3A1 NTC B=3975K</td></tr><tr><td>6</td><td>3K3A1 NTC</td></tr><tr><td>7</td><td>30K6A1 NTC</td></tr><tr><td>8</td><td>SIE1</td></tr><tr><td>9</td><td>TAC1</td></tr><tr><td>10</td><td>SAT1</td></tr><tr><td>+128</td><td>Voltage measurement off and fast counters working on 100Hz</td></tr></table></td></tr>
<tr><td>40152</td><td>151</td><td>0x97</td><td>SPECIAL INPUT 2 CONFIGURATION</td><td>Read & Write Memory</td></tr>
<tr><td>40159</td><td>158</td><td>0x9E</td><td>FILTER TIME CONSTANT OF THE SPECIAL INPUT 1</td><td>Read & Write Memory</td><td rowspan="2">Filter time of the Special Input 1 – 2 (40159 – 40160)
Filter time constant, expressed in seconds in the range from 0 to 60 seconds.
The default value is 2s, set to 0s disable the filter.</td></tr>
<tr><td>40160</td><td>159</td><td>0x9F</td><td>FILTER TIME CONSTANT OF THE SPECIAL INPUT 2</td><td>Read & Write Memory</td></tr>
<tr><td>40176</td><td>175</td><td>0xAF</td><td>SPECIAL INPUT 1 CONFIGURATIO MODE</td><td>Read & Write Memory</td><td rowspan="5"><table><tr><th>Value</th><th>Description</th></tr><tr><td>0</td><td>Ordinary IO</td></tr><tr><td>1</td><td>Monostabile Relay</td></tr><tr><td>2</td><td>Bistabile Relay</td></tr><tr><td>3</td><td>Time Relay</td></tr></table>
TIME VALUE [ms]</td></tr>
<tr><td>40177</td><td>176</td><td>0xB0</td><td>SPECIAL INPUT 1 TIME VALUE</td><td>Read & Write Memory</td></tr>
<tr><td>40180</td><td>179</td><td>0xB3</td><td>SPECIAL INPUT 2 CONFIGURATIO MODE</td><td>Read & Write Memory</td></tr>
<tr><td>40181</td><td>180</td><td>0xB4</td><td>SPECIAL INPUT 2 TIME VALUE</td><td>Read & Write Memory</td></tr>
</table>

<table>
<tr><th>Modbus Address</th><th>Dec Address</th><th>Hex Address</th><th>Register name</th><th>Access</th><th>Description</th></tr>
<tr><td>40242</td><td>241</td><td>0xF1</td><td>RADIO TX POWER</td><td>Read & Write Memory</td><td><table><tr><th>Value</th><th>Radio TX Power</th></tr><tr><td>0</td><td>-18 dBm</td></tr><tr><td>1</td><td>0 dBm</td></tr><tr><td>2</td><td>7 dBm</td></tr><tr><td>3</td><td>10 dBm</td></tr><tr><td>4</td><td>14 dBm</td></tr><tr><td>5</td><td>17 dBm</td></tr><tr><td>6</td><td>20 dBm</td></tr></table></td></tr>
<tr><td>40243</td><td>242</td><td>0xF2</td><td>RADIO CHANNEL</td><td>Read & Write Memory</td><td>Radio Channel (40243)</td></tr>
<tr><td>40244</td><td>243</td><td>0xF3</td><td>RADIO BAUD RATE</td><td>Read & Write Memory</td><td>Radio baud rate (20249)</td></tr>
<tr><td>40249</td><td>248</td><td>0xF8</td><td>RADIO AESKEY D1-D0</td><td>Read & Write Memory</td><td rowspan="10">Radio transmission 128bit encryption key
(40249 – 40256)
Default value
1111 2222 3333 4444 5555 6666 7777 8888</td></tr>
<tr><td>40250</td><td>249</td><td>0xF9</td><td>RADIO AESKEY D3-D2</td><td>Read & Write Memory</td></tr>
<tr><td>40251</td><td>250</td><td>0xFA</td><td>RADIO AESKEY D5-D4</td><td>Read & Write Memory</td></tr>
<tr><td>40252</td><td>251</td><td>0xFB</td><td>RADIO AESKEY D7-D6</td><td>Read & Write Memory</td></tr>
<tr><td>40253</td><td>252</td><td>0xFC</td><td>RADIO AESKEY D9-D8</td><td>Read & Write Memory</td></tr>
<tr><td>40254</td><td>253</td><td>0xFD</td><td>RADIO AESKEY D11-D10</td><td>Read & Write Memory</td></tr>
<tr><td>40255</td><td>254</td><td>0xFE</td><td>RADIO AESKEY D13-D12</td><td>Read & Write Memory</td></tr>
<tr><td>40256</td><td>255</td><td>0xFF</td><td>RADIO AESKEY D15-D14</td><td>Read & Write Memory</td></tr>
<tr><td>40257</td><td>256</td><td>0x0100</td><td>RADIO COUNTER OF RECEIVED FRAMES (32 – bits)</td><td>Read & Write Memory</td><td>Counter of received messages (30004) Default state is 0 Reset at the unit start and change of transmission parameters.</td></tr>
<tr><td>40259</td><td>258</td><td>0x0102</td><td>RADIO COUNTER OF ERROT FRAMES (32 – bits)</td><td>Read & Write Memory</td><td>Counter of error messages (30006) Default state is 0 Reset at the unit start and change of transmission parameters.</td></tr>
</table>

Modbus Address	Dec Address	Hex Address	Register name	Access	Description
40261	260	0x0104	RADIO COUNTER OF TRANSMITTED FRAMES (32 – bits)	Read & Write Memory	Counter of sent messages (30008) Default state is 0 Reset at the unit start and change of transmission parameters.
40263 - 40390	262 - 389	0x0106 – 0x0185	WIRELESS DEVICE STATUS 1 ÷ 128	Read Only	Bit 7:0 - Int8 RX POWER [dBm] Bit 8 - 0-> DOWN; 1-> OK

10 List of supported temperature sensors

No	1	No	2
Sensor	10K3A1	Sensor	10K4A1
β coefficient	3975K	β coefficient	3695K
Manufacturers	Aquatrol, Cylon, Honeywell, Johnson,Satchwell, Seachange	Manufacturers	Andover,Delta Controls, Siebe, York
°C	Ω	°C	Ω
–50	667828	–50	441667
-45	491749	-45	330749
–40	335671	–40	239831
-35	241840	-35	181532
–30	176683	–30	135233
-25	131251	-25	105081
–20	96974	–20	78930
–15	72895	–15	61030
–10	55298	–10	47549
–5	42314	–5	37316
0	32650	0	29490
5	25396	5	23462
10	19904	10	18787
15	15714	15	15136
20	12494	20	12268
25	10000	25	10000
30	8056	30	8197
35	6530	35	6754
40	5325	40	5594
45	4367	45	4656
50	3601	50	3893
55	2985	55	3271
60	2487	60	2760
65	2082	65	2339
70	1751	70	1990
75	1480	75	1700
80	1256	80	1458
85	1070	85	1255
90	916	90	1084
95	787	95	939
100	678	100	817
105	587	105	713
110	510	110	624

No	1	No	2
115	444	115	547
120	388	120	482
125	340	125	426

No	3	No	4
Sensor	10K Carel	Sensor	20K6A1
β coefficient	3435K	β coefficient	4262K
–50	329500	Manufacturers	Honeywell
-45	247700	°C	Ω
–40	188500	–40	806800
-35	144100	-35	574400
–30	111300	–30	413400
-25	86430	-25	300400
–20	67770	–20	220600
–15	53410	–15	163480
–10	42470	–10	122260
–5	33900	–5	92220
0	27280	0	70140
5	22050	5	53780
10	17960	10	41540
15	14690	15	32340
20	12090	20	25340
25	10000	25	20000
30	8313	30	15886
35	6940	35	12698
40	5827	40	10212
45	4912	45	8260
50	4161	50	6718
55	3536	55	5494
60	3020	60	4518
65	2588	65	3732
70	2228	70	3098
75	1924	75	2586
80	1668	80	2166
85	1451	85	1823
90	1266	90	1541
95	1108	95	1308
100	973	100	1114
105	857	105	953
110	758	110	818
115	672	115	704
120	597	120	609
125	531	125	528

No	5	No	6
Sensor	2.2K3A1	Sensor	3K3A1
β coefficient	3975K	β coefficient	3975K
Manufacturers	Ambiflex, Johnson	Manufacturers	Alerton
°C	Ω	°C	Ω
–50	329500	–50	200348
-45	247700	-45	150524
–40	188500	–40	100701
-35	144100	-35	76853
–30	111300	–30	53005
-25	86430	-25	41048
–20	67770	–20	29092
–15	53410	–15	21868
–10	42470	–10	16589
–5	33900	–5	12694
0	27280	0	9795
5	22050	5	7619
10	17960	10	5971
15	14690	15	4714
20	12090	20	3748
25	10000	25	3000
30	8313	30	2417
35	6940	35	1959
40	5827	40	1598
45	4912	45	1310
50	4161	50	1080
55	3536	55	896
60	3020	60	746
65	2588	65	625
70	2228	70	526
75	1924	75	444
80	1668	80	377
85	1451	85	321
90	1266	90	275
95	1108	95	236
100	973	100	204
105	857	105	176
110	758	110	153
115	672	115	133
120	597	120	117
125	531	125	102

No	7	No	8
Sensor	30K6A1	Sensor	SIE1
β coefficient	4262K	Manufacturers	Barber Colman, Siebe
Manufacturers	Drayton	°C	Ω
°C	Ω	–50	10732
–30	622911	-45	10624
-25	477393	–40	10517
–20	331876	-35	10344
–15	245785	–30	10172
–10	183697	-25	9913
–5	138502	–20	9654
0	105305	–15	9320
5	60713	–10	8933
10	62347	–5	8496
15	48511	0	8044
20	38019	5	7489
25	30000	10	6938
30	23828	15	6370
35	19046	20	5798
40	15317	25	5238
45	12390	30	4696
50	10079	35	4185
55	8243	40	3707
60	6777	45	3271
65	5600	50	2875
70	4650	55	2521
75	3879	60	2206
80	3251	65	1929
85	2737	70	1685
90	2313	75	1472
95	1963	80	1287
100	1672	85	1127
105	1430	90	986
110	1228	95	866
115	1058	100	760
120	915	105	670
125	793	110	590
		115	522
		120	462
		125	410

No	9	No	10
Sensor	TAC1	Sensor	SAT1
β coefficient	3500K	Manufacturers	Satchwell
Manufacturers	TAC	°C	Ω
°C	Ω	–50	9719
–40	39024	-45	9652
-35	29358	–40	9584
–30	22284	-35	9467
-25	17073	–30	9349
–20	13192	-25	9159
–15	10276	–20	8968
–10	8068	–15	8708
–5	6382	–10	8396
0	5085	–5	8031
5	4078	0	7614
10	3294	5	7150
15	2676	10	6649
20	2188	15	6121
25	1800	20	5580
30	1488	25	5039
35	1237	30	4513
40	1034	35	4012
45	869	40	3545
50	733	45	3117
55	622	50	2730
60	529	55	2386
65	453	60	2082
70	389	65	1816
75	335	70	1585
80	290	75	1385
85	252	80	1213
90	220	85	1064
95	192	90	937
100	169	95	828
105	149	100	734
110	131	105	654
115	116	110	585
120	103	115	525
125	92	120	474
		125	429