USER MANUAL

Z-4RTD2-SI

CONVERTER FOR THERMISTORS WITH 4 CHANNELS AND 24BIT ADC

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Document revisions

DATE	REVISION	NOTES	AUTHOR
22/06/2022	0	First revision	MM
10/10/2022	1	Added sampling rate changes for fw 1010 revision. Added info on float swapped registers Corrected errors in the Modbus register list	MM
05/05/2023	2	Added information on USB port Added information on Hardware revisions Added firmware update mode for HW revisions different from A one	MM
19/02/2025	3	Command 40048 register fix Various fix on modbus registers Removed preliminary warnings	MM / AZ

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1. DESCRIPTION

1.1. DESCRIPTION

Z-4RTD2-SI is a converter for thermistors with four independent and isolated measurement channels equipped with an analog-digital converter with a 24-bit resolution.
The insulation relates to both the power supply and the RS485 communication port.

The device measures the value of the thermistors and makes them available through the RS485 port using the Modbus RTU protocol.

1.2. COMMUNICATION PORT SPECIFICATIONS

RS485 COMMUNICATION PORTS	
Number	1
Baudrate	From 2400 to 115200 bit/s configurable
Parity, Data bit, Stop bit	Configurable
Protocol	Modbus RTU Slave

USB COMMUNICATION PORT	
Number	1
Protocol	Modbus RTU Slave
Use	For configuration with Easy-setup software and firmware update

2. TYPE OF SUPPORTED SENSORS

The supported sensors are:

SENSOR	*STANDARD*	*MEASURING RANGE*
PT100	EN 60751/A2 (ITS-90)	-200 ÷ +650°C
PT500	EN 60751/A2 (ITS-90)	-200 ÷ +750°C
PT1000	EN 60751/A2 (ITS-90)	-200 ÷ +210°C
NI100	DIN 43760	-60 ÷ +250°C
CU50	GOST 6651-2009	-180 ÷ +200°C
CU100	GOST 6651-2009	-180 ÷ +200°C
Ni120	DIN 43760	-60 ÷ +250°C
NI1000	DIN 43760	-60 ÷ +250°C

Each channel is independent, therefore it is also possible to use different sensors in the 4 channels.

3. RESPONSE MEASURES AND TIMES

3.1. SAMPLING TIMES AND MEASUREMENT UPDATE TIME

The sampling time is configurable from 25ms to 400ms per channel.

SAMPLING TIME PER CHANNEL
25ms
50ms
100ms
200ms
400ms

for example:

By activating 4 channels and setting a sampling time of 100ms on all, you get a measurement update every: 100*4 = 400 ms.

By activating 2 channels at 25 ms and 2 channels at 100 ms you get a measurement update every: 25*2 + 100*2 = 250 ms.

ATTENTION!

In order not to lose the settings, NEVER update the firmware with a version older than the one installed on the device.

3.2. FILTER

To each channel it is possible to insert a low pass filter to stabilize the measurement, it is a 10-sample moving average filter.

3.3. MODBUS RESPONSE TIME

Modbus Response Time: 5 ms (typical)

4. DEVICE CONFIGURATION

The device can be configured using the Easy Setup or Easy Setup 2 software, configurations are as follows:

SENSOR TYPE: allows you to select the type of sensor connected to the channel, it is also possible to disconnect the channel if it is not used.
UNIT OF MEASUREMENT: allows you to set whether the measurement must be in °C or in Ohm
3-WIRE MEASUREMENT: Allows you to set whether the sensor measurement will be carried out with 3 or 4 wires (for the 2-wire connection, refer to the 4-wire connection)
CHANNEL SPEED: Allows you to set the channel sampling time
IF CHARGE FAILURE: Allows you to replace (or not) the measured value with a temperature/resistance safety value set by the user in the event of a fault. The failure can be caused by:

1) Sensor beyond measurement values
2) Sensor breakage

ACTIVATE FILTER: Allows you to activate the filter on the selected channel, filtering allows you to obtain a slower but stable measurement.

INTERPRETATION OF FLOATING POINTS: Allows you to set whether the single precision (32 bit) Floating Point registers are to be interpreted with the most significant value on the high word or on the low word.

5. USB CONNECTION AND CONFIGURATION RESET

The front USB port allows a simple connection to configure the device via the configuration software.
If it is necessary to restore the instrument's initial configuration, use the configuration software.

ATTENTION!

When a cable is connected in the USB port the RS485 port is disabled, to re-enable the RS485 port disconnect the USB cable.

6. FIRMWARE UPDATE

Through the USB port it is possible to update the firmware.

6.1. HARDWARE REVISION

It is possible to know the hardware revision of a device via the paper label printed on the side of the device. The label is:

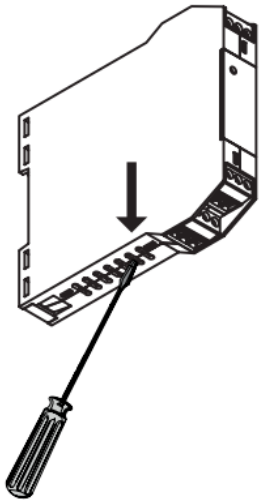
The hardware revision can be found in the top right (in the example this is product Z-4RTD2-SI hardware revision 'B')

6.2. Z-4RTD2-SI HARDWARE REVISION "A" MODEL

In this hardware revision, the firmware update is done by pressing a hidden button.

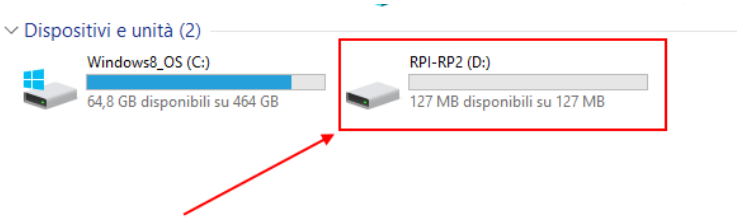
To update the firmware:

1) Disconnect the device from the power supply;
2) Holding down the firmware update button (positioned as shown in the figure), reconnect the device to the power supply

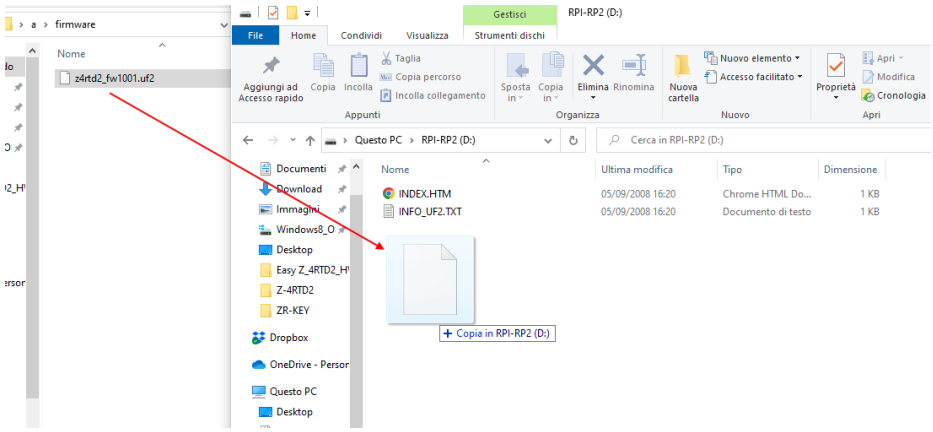


3) Now the instrument is in update mode, stop pressing the update key and connect the USB cable to the PC

4) The device will be displayed in the PC as an “RP1-RP2” external unit



5) Copy the new firmware (uf2 extension) to the root of the “RP1-RP2” unit



6) Once the firmware file has been copied, the device will automatically reboot and be ready for use.

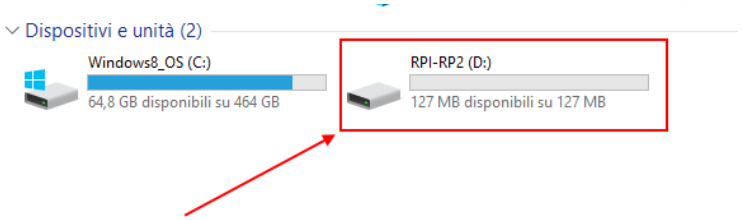
7) Verify that the fw update was successful by connecting the device to the Easy Setup software, the firmware revision (in this case 1002) is shown in the bottom left:

6.3. *Z-4RTD2-SI HW REVISION “B” MODEL REVISION “B” MODEL AND FOLLOWING*

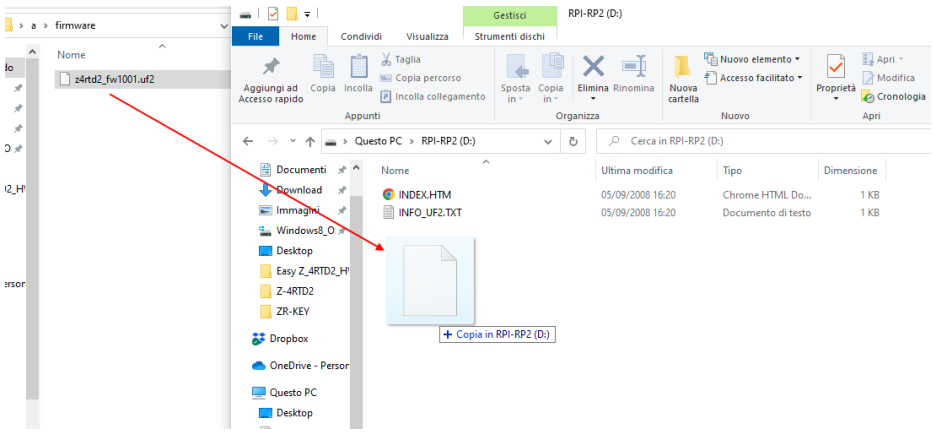
In this hardware revision, the firmware update is done by moving dip switch 9 to the ‘ON’ position:

To update the firmware:

1) Disconnect the device from the power supply;
2) Turn dip switch 9 to ON.
3) Now the device is in "firmware update" mode (the TX led stays on), connect the USB cable to the PC
4) Power up the device
5) The device will be displayed in the PC as an “RP1-RP2” external unit



6) Copy the new firmware (uf2 extension) to the root of the “RP1-RP2” unit



Once the firmware file has been copied, the device will automatically reboot

7) Remove power from the device
8) Turn dip switch 9 to OFF, the device is now in “normal operation” mode.
9) Power up the device
10) Verify that the fw update was successful by connecting the device to the Easy Setup software, the firmware revision (in this case 1002) is shown in the bottom left:

7. MODBUS COMMUNICATION PROTOCOL

The supported communication protocol is:

- Modbus RTU Slave (from both the RS485 and USB ports)

For more information on these protocols, see the website:
http://www.modbus.org/specs.php.

7.1. SUPPORTED MODBUS FUNCTION CODES

The following Modbus functions are supported:

- Read Holding Register (function 3)
- Write Single Register (function 6)
- Write Multiple registers (function 16)

ATTENTION!

All 32-bit values are contained in 2 consecutive registers

ATTENTION!

All 64-bit values are contained in 4 consecutive registers

ATTENTION!

Any registers with RW* (in flash memory) can be written up to about 10000 times
The programmer must make sure the PLC/Master Modbus does not exceed this limit

8. MODBUS REGISTER TABLE

The following abbreviations are used in the register tables:

MS	Most Significant
LS	Least Significant
MSBIT	Most Significant Bit
LSBIT	Least Significant Bit
MMSW	“Most” Most Significant Word (16bit)
MSW	Most Significant Word (16bit)
LSW	Least Significant Word (16bit)
LLSW	“Least” Least Significant Word (16bit)
RO	Read Only
RW*	Read-Write: REGISTERS CONTAINED IN FLASH MEMORY: WRITABLE ABOUT 10,000 TIMES MAXIMUM
RW**	Read-Write: REGISTERS THAT CAN BE WRITTEN ONLY AFTER WRITING THE COMMAND "ENABLE WRITE CUSTOM ENERGIES = 49616"
UNSIGNED 16 BIT	Unsigned integer register that can assume values from 0 to 65535
SIGNED 16 BIT	Signed integer register that can take values from -32768 to +32767
UNSIGNED 32 BIT	Unsigned integer register that can assume values from 0 to 4294967296
SIGNED 32 BIT	Signed integer register that can take values from -2147483648 to 2147483647
UNSIGNED 64 BIT	Unsigned integer register that can assume values from 0 to 18446744073709551615
SIGNED 64 BIT	Signed integer register that can assume values from -2^63 to 2^63-1
FLOAT 32 BIT	32-bit, single-precision floating-point register (IEEE 754) https://en.wikipedia.org/wiki/IEEE_754
BIT	Boolean register, which can take the values 0 (false) or 1 (true)

8.1. NUMBERING OF "0-BASED" OR "1-BASED" MODBUS ADDRESSES

According to the Modbus standard the Holding Registers are addressable from 0 to 65535, there are 2 different conventions for numbering the addresses: "0-BASED" and "1-BASED".
For greater clarity, Seneca shows its register tables in both conventions.

ATTENTION!

CAREFULLY READ THE DOCUMENTATION OF THE MODBUS MASTER DEVICE IN ORDER TO UNDERSTAND WHICH OF THE TWO CONVENTIONS THE MANUFACTURER HAS DECIDED TO USE

8.2. NUMBERING OF MODBUS ADDRESSES WITH "0-BASED" CONVENTION

The numbering is:

HOLDING REGISTER MODBUS ADDRESS (OFFSET)	*MEANING*
0	FIRST REGISTER
1	SECOND REGISTER
2	THIRD REGISTER
3	FOURTH REGISTER
4	FIFTH REGISTER

Therefore, the first register is at address 0.
In the following tables, this convention is indicated with ***"ADDRESS OFFSET".***

8.3. NUMBERING OF MODBUS ADDRESSES WITH "1 BASED" CONVENTION (STANDARD)

The numbering is that established by the Modbus consortium and is of the type:

HOLDING REGISTER MODBUS ADDRESS 4x	*MEANING*
40001	FIRST REGISTER
40002	SECOND REGISTER
40003	THIRD REGISTER
40004	FOURTH REGISTER
40005	FIFTH REGISTER

In the following tables this convention is indicated with ***"ADDRESS 4x"*** since a 4 is added to the address so that the first Modbus register is 40001.

A further convention is also possible where the number 4 is omitted in front of the register address:

HOLDING MODBUS ADDRESS WITHOUT 4x	*MEANING*
1	FIRST REGISTER
2	SECOND REGISTER
3	THIRD REGISTER
4	FOURTH REGISTER
5	FIFTH REGISTER

8.4. *BIT CONVENTION WITHIN A MODBUS HOLDING REGISTER*

A Modbus Holding Register consists of 16 bits with the following convention:

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

For instance, if the value of the register in decimal is
12300
the value 12300 in hexadecimal is:
0x300C

the hexadecimal 0x300C in binary value is:
11 0000 0000 1100

So, using the above convention, we get:

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

8.5. *MSB and LSB BYTE CONVENTION WITHIN A MODBUS HOLDING REGISTER*

A Modbus Holding Register consists of 16 bits with the following convention:

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

LSB Byte (Least Significant Byte) defines the 8 bits ranging from Bit 0 to Bit 7 included, we define MSB Byte (Most Significant Byte) the 8 bits ranging from Bit 8 to Bit 15 inclusive:

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
BYTE MSB								BYTE LSB							

8.6. *REPRESENTATION OF A 32-BIT VALUE IN TWO CONSECUTIVE MODBUS HOLDING REGISTERS*

The representation of a 32-bit value in the Modbus Holding Registers is made using 2 consecutive Holding Registers (a Holding Register is a 16-bit register). To obtain the 32-bit value it is therefore necessary to read two consecutive registers:
For example, if register 40064 contains the 16 most significant bits (MSW) while register 40065 contains the least significant 16 bits (LSW), the 32-bit value is obtained by composing the 2 registers:

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
40064 MOST SIGNIFICANT WORD															

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
40065 LEAST SIGNIFICANT WORD															

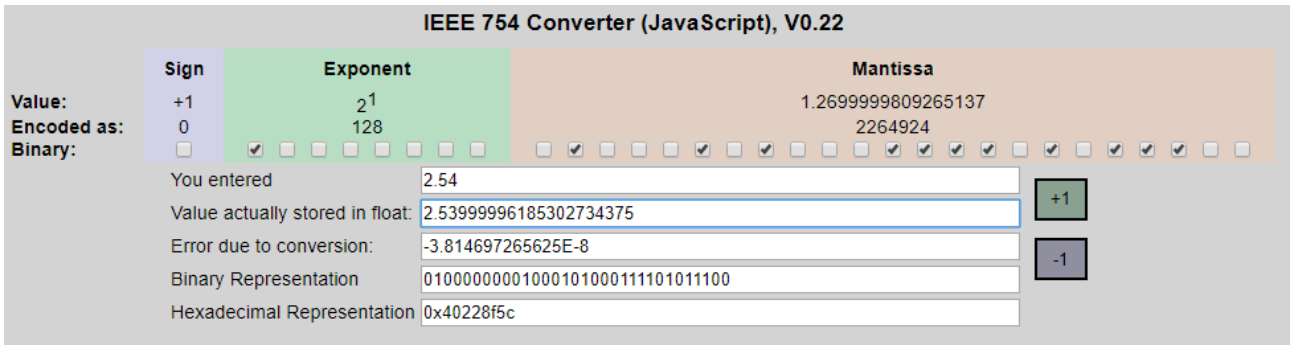
$$Value_{32bit} = Register_{LSW} + (Register_{MSW} * 65536)$$

In the reading registers it is possible to swap the most significant word with the least significant word, therefore it is possible to obtain 40064 as LSW and 40065 as MSW.

8.7. *TYPE OF 32-BIT FLOATING POINT DATA (IEEE 754)*

The IEEE 754 standard (https://en.wikipedia.org/wiki/IEEE_754) defines the format for representing floating point numbers.
As already mentioned, since it is a 32-bit data type, its representation occupies two 16-bit holding registers.
To obtain a binary/hexadecimal conversion of a floating point value it is possible to refer to an online converter at this address:

http://www.h-schmidt.net/FloatConverter/IEEE754.html



Using the last representation the value 2.54 is represented at 32 bits as:

0x40228F5C

Since we have 16-bit registers available, the value must be divided into MSW and LSW:

0x4022 (16418 decimal) are the 16 most significant bits (MSW) while 0x8F5C (36700 decimal) are the 16 least significant bits (LSW).

8.8. Z-4RTD2-SI: MODBUS 4X HOLDING REGISTER TABLE (FUNCTION CODE 3)

ADDRESS (4x)	OFFSET	REGISTER	ORDER	CHANNEL	DESCRIPTION	R/W	TYPE
40001	0	MACHINE IDENTIFICATION	-	-	Identification code	RO	UNSIGNED 16 BIT
40002	1	ERRORS	-	-	Bit[15] 1 = IN1 MEASURE OUT OF RANGE 0 = IN1 MEASURE OK Bit[14] 1 = IN2 MEASURE OUT OF RANGE 0 = IN2 MEASURE OK Bit[13] 1 = IN3 MEASURE OUT OF RANGE 0 = IN3 MEASURE OK Bit[12] 1 = IN4 MEASURE OUT OF RANGE 0 = IN4 MEASURE OK Bit[11] 1 = IN1 BURNOUT 0 = IN1 OK Bit[10] 1 = IN2 BURNOUT 0 = IN2 OK Bit[9] 1 = IN3 BURNOUT 0 = IN3 OK Bit[8] 1 = IN4 BURNOUT 0 = IN4 OK Bit[7..0] NOT USED	RO	UNSIGNED 16 BIT
40003	2	16 bit MEASURE	-	1	If Measure Type = "°C" unit measure is [°C/10] For example 2000 -> 200.0° C If Measure Type = "Ohm" unit measure is: for PT100/NI100/NI120/ CU50/CU100 [Ohm/100] (example	RO	SIGNED 16 BIT

ADDRESS (4x)	OFFSET	REGISTER	ORDER	CHANNEL	DESCRIPTION	R/W	TYPE
					20000 -> 200.00 Ohm) for PT1000/PT500/NI1000 [Ohm/10] (example 2000 -> 200.0 Ohm)		
40004	3	16 bit MEASURE	-	2	If Measure Type = "°C" unit measure is [°C/10] For example 2000 -> 200.0° C If Measure Type = "Ohm" unit measure is: for PT100/NI100/NI120/CU50/CU100 [Ohm/100] (example 20000 -> 200.00 Ohm) for PT1000/PT500/NI1000 [Ohm/10] (example 2000 -> 200.0 Ohm)	RO	SIGNED 16 BIT
40005	4	16 bit MEASURE	-	3	If Measure Type = "°C" unit measure is [°C/10] For example 2000 -> 200.0° C If Measure Type = "Ohm" unit measure is: for PT100/NI100/NI120/CU50/CU100 [Ohm/100] (example 20000 -> 200.00 Ohm) for PT1000/PT500/NI1000 [Ohm/10] (example 2000 -> 200.0 Ohm)	RO	SIGNED 16 BIT

ADDRESS (4x)	OFFSET	REGISTER	ORDER	CHANNEL	DESCRIPTION	R/W	TYPE
40006	5	16 bit MEASURE	-	4	If Measure Type = "°C" unit measure is [°C/10] For example 2000 -> 200.0° C If Measure Type = "Ohm" unit measure is: for PT100/NI100/NI120/ CU50/CU100 [Ohm/100] (example 20000 -> 200.00 Ohm) for PT1000/PT500/NI100 0 [Ohm/10] (example 2000 -> 200.0 Ohm)	RO	SIGNED 16 BIT
40007	6	FLOAT MEASURE	MSW	1	Measure [°C] or [Ohm]	RO	FLOAT 32
40008	7		LSW				
40009	8	FLOAT MEASURE	MSW	2	Measure [°C] or [Ohm]	RO	FLOAT 32
40010	9		LSW				
40011	10	FLOAT MEASURE	MSW	3	Measure [°C] or [Ohm]	RO	FLOAT 32
40012	11		LSW				
40013	12	FLOAT MEASURE	MSW	4	Measure [°C] or [Ohm]	RO	FLOAT 32
40014	13		LSW				
40015	14	REVISION FIRMWARE	-	-	Firmware Revision	RO	UNSIGNED 16 BIT
40035	34	RS485 ADDRESS_PARITY	-	-	Bit[15:8] RS485 Modbus Station Address [1..255] Bit[7:0] RS485 Parity : 0=no, 1=even, 2=odd	RW*	UNSIGNED 16 BIT
40036	35	RS485 BAUDRATE	-	-	Bit[15:8] Baudrate: 0=4800 1=9600 2=19200 3=38400 4=57600 5=115200 6=1200 7=2400	RW*	UNSIGNED 16 BIT

ADDRESS (4x)	OFFSET	REGISTER	ORDER	CHANNEL	DESCRIPTION	R/W	TYPE
40037	36	INPUT CONFIGURATION	-	1	Bit[15..12] Not Used Bit[11:9] Filter: 0=not active 1=active Bit[8:6] RTD TYPE 0= PT100 1= NI100 2= PT500 3= PT1000 4= CU50 5= CU100 6= NI120 7= NI1000. Bit[5]: Measure Type 0= Temperature, 1= Resistance Bit[4]: RTD Measure 0= RTD 2/4 wires 1= RTD 3 wires Bit[2:0] Channel Speed 0= disabled, 1= 25ms, 2= 50ms, 3= 100ms, 4= 200ms, 5= 400ms	RW*	UNSIGNED 16 BIT
40038	37	INPUT CONFIGURATION	-	2	Bit[15..12] Not Used Bit[11:9] Filter: 0=not active 1=active Bit[8:6] RTD TYPE 0= PT100 1= NI100 2= PT500 3= PT1000 4= CU50 5= CU100 6= NI120 7= NI1000. Bit[5]: Measure Type 0= Temperature, 1= Resistance Bit[4]: RTD Measure 0= RTD 2/4 wires 1= RTD 3 wires Bit[2:0] Channel Speed 0= disabled, 1= 25ms, 2= 50ms, 3= 100ms, 4= 200ms, 5= 400ms	RW*	UNSIGNED 16 BIT

ADDRESS (4x)	OFFSET	REGISTER	ORDER	CHANNEL	DESCRIPTION	R/W	TYPE
40039	38	INPUT CONFIGURATION	-	3	Bit[15..12] Not Used Bit[11:9] Filter: 0=not active 1=active Bit[8:6] RTD TYPE 0= PT100 1= NI100 2= PT500 3= PT1000 4= CU50 5= CU100 6= NI120 7= NI1000. Bit[5]: Measure Type 0= Temperature, 1= Resistance Bit[4]: RTD Measure 0= RTD 2/4 wires 1= RTD 3 wires Bit[2:0] Channel Speed 0= disabled, 1= 25ms, 2= 50ms, 3= 100ms, 4= 200ms, 5= 400ms	RW*	UNSIGNED 16 BIT
40040	39	INPUT CONFIGURATION	-	4	Bit[15..12] Not Used Bit[11:9] Filter: 0=not active 1=active Bit[8:6] RTD TYPE 0= PT100 1= NI100 2= PT500 3= PT1000 4= CU50 5= CU100 6= NI120 7= NI1000. Bit[5]: Measure Type 0= Temperature, 1= Resistance Bit[4]: RTD Measure 0= RTD 2/4 wires 1= RTD 3 wires Bit[2:0] Channel Speed 0= disabled, 1= 25ms, 2= 50ms, 3= 100ms, 4= 200ms, 5= 400ms	RW*	UNSIGNED 16 BIT

ADDRESS (4x)	OFFSET	REGISTER	ORDER	CHANNEL	DESCRIPTION	R/W	TYPE
40041	40	CONFIGURATION2	-	-	Bit[15] Floating Point Representation 0= MSW FIRST 1= LSW FIRST Bit[14..4] NOT USED Bit[3] IN1 FAULT BEHAVIOUR 1 = LOAD FAIL VALUE 0 = KEEP LAST VALUE Bit[2] IN2 FAULT BEHAVIOUR 1 = LOAD FAIL VALUE 0 = KEEP LAST VALUE Bit[1] IN3 FAULT BEHAVIOUR 1 = LOAD FAIL VALUE 0 = KEEP LAST VALUE Bit[0] IN4 FAULT BEHAVIOUR 1 = LOAD FAIL VALUE 0 = KEEP LAST VALUE	RW*	UNSIGNED 16 BIT
40042	41	MEASURE VALUE	-	1	Fault value to load [°C/10] or [Ohm] if Fault Behaviour is configured in "Load fail value"	RW*	SIGNED 16 BIT
40043	42	MEASURE VALUE	-	2	Fault value to load [°C/10] or [Ohm] if Fault Behaviour is configured in "Load fail value"	RW*	SIGNED 16 BIT
40044	43	MEASURE VALUE	-	3	Fault value to load [°C/10] or [Ohm] if Fault Behaviour is configured in "Load fail value"	RW*	SIGNED 16 BIT
40045	44	MEASURE VALUE	-	4	Fault value to load [°C/10] or [Ohm] if Fault Behaviour is configured in "Load fail value"	RW*	SIGNED 16 BIT
40048	47	COMMAND REGISTER	-	-	Register for command execution (decimal): REBOOT=52428	RW	UNSIGNED 16 BIT

ADDRESS (4x)	OFFSET	REGISTER	ORDER	CHANNEL	DESCRIPTION	R/W	TYPE
					SAVE CONFIGURATION = 51792 SAVE AND REBOOT = 49568		
40133	132	OFFSET [°C / Ohm]	MSW	1	Offset for the measure channel [°C/Ohm]	RW*	FLOAT 32
40134	133		LSW				
40135	134	OFFSET [°C / Ohm]	MSW	2	Offset for the measure channel [°C/Ohm]	RW*	FLOAT 32
40136	135		LSW				
40137	136	OFFSET [°C / Ohm]	MSW	3	Offset for the measure channel [°C/Ohm]	RW*	FLOAT 32
40138	137		LSW				
40139	138	OFFSET [°C / Ohm]	MSW	4	Offset for the measure channel [°C/Ohm]	RW*	FLOAT 32
40140	139		LSW				

By adding the offset 1000 to the register it is possible to obtain 32-bit swapped values, for example the floating point current measurement register:

40007	**6**	**FLOAT MEASURE 1**	**MSW**
40008	**7**		**LSW**

The same register is also located at 41007-41008 swapped

41007	**1006**	**FLOAT MEASURE 1 SWAPPED**	**LSW**
41008	**1007**		**MSW**