


Add.	M	Code	Description
40011	R	CAL	0x0000: Normal condition: operation was successful. 0x0001: Writing to EEPROM failed. 0x0m0n: Calibration <i>n</i> of channel <i>m</i> in progress (response to <i>CmFn</i>). 0xEE1x: Offset overrange gain <i>x</i> . 0xEE2 <i>m</i> : CM overrange on <i>m</i> channel being set. 0xEEEE: A calibration function has been requested that is not available. 0xFFxx: Card is in test mode (<i>xx</i> : countdown); visible via RS232.
40011	W	CAL	0000: Register reset. <i>CmFn</i> : Calibration function <i>n</i> of channel <i>m</i> is activated. FEDF: LEDs on panel are lit for 8 seconds: * If communication is via RS232, card continues to talk. * If communication is via RS485, card locks up in TX (bus lockup!). FEFE: Card's SW reset (reboot). Watchdog test.




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8-INPUT VOLTAGE-CURRENT DATA ACQUISITION MODULE

Z-8AI

GENERAL FEATURES

- Up to 8 inputs independently activatable and configurable to differential or single-ended mode⁽²⁾.
- Monitoring and management of common-mode voltage overrange.
- Sampling time settable for each channel between 10 ms (12 bits) and 75 ms (16 bits).
- Voltage input in ranges $\pm 2.5 V_{DC}$, $\pm 5 V_{DC}$ and $\pm 10 V_{DC}$.
- Current input with external shunt and automatic reading conversion.
- Maximum voltage between measurement terminal and GND (in differential mode): $\pm 20 V$.
- Inputs protected up to $\pm 35 V_{PK}$.
- $1500 V_{AC}$ input isolation from rest of low-voltage circuits.
- In-field recalibration of individual channel without compromising readings on other channels or even having to remove the module from the system.
- Power supply and serial line wiring made easy by means of a bus housed on the DIN rail.
- RS485 serial communication with MODBUS-RTU protocol, maximum 32 nodes.
- Hardware disconnection from communication bus in case of internal failure.
- Added or removed from slot without break in bus communication or power supply.
- Up to 100 samples per second (@ 115200 baud).
- Connection distance up to 1,200 m.
- RS232 connection on front, with automatic communication switching.
- Wide AC/DC power supply range, including operation with 12V batteries.
- Low consumption.

TECHNICAL SPECIFICATIONS

Power supply:	Range 9..45 V _{DC} (free polarity) or 19..28 V _{AC} , 50..400 Hz. Module specifically designed to work with 12 V batteries too					
Consumpt	<500 mW; approx. 35 mA @ 12 V _{DC} .					
COM ports:	RS485 half-duplex serial (2 wires) with settable baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 (rear connector). RS232 full-duplex serial baud rate 2400 (3.5mm jack on front).					
Protocol:	Modicon MODBUS RTU.					
Voltage input:	Bipolar with programmable FS: $\pm 2.5 V_{DC}$, $\pm 5 V_{DC}$ and $\pm 10 V_{DC}$. Input impedance: >3 MW.					
Current input:	Bipolar with $\pm 25 mA_{DC}$ FS, using the 100 W shunts supplied, to be connected to input terminals. Input range selection and measurement conversion are automatic (flags).					
Resolution:	Selectable for each channel between 11, 13, 14 and 15bit + sign.					
Inputs in differential mode:	Maximum voltage with respect to GND Protection tripping					
Accuracy (@16bits)	Initial	Linearity	Zero	CMR	TC	Other ⁽¹⁾
Diff. voltage	0,1% o.r.	0,03% o.s.	0,02% o.s.	>65dB	100ppm/°C	0,02% o.s.
S.e. voltage ⁽²⁾	0,1% o.r.	0,01% o.s.	0,01% o.s.	-	100ppm/°C	0,02% o.s.
Diff. current	0,15% o.r.	0,03% o.s.	0,02% o.s.	>65dB	100ppm/°C	0,02% o.s.
S.e. current ⁽²⁾	0,15% o.r.	0,01% o.s.	0,01% o.s.	-	100ppm/°C	0,02% o.s.
Environmental conditions:	Temperature: range 0..60°C; humidity 30..90% @ 40°C non-condensing.					
Indicator LEDs:	Power ON (green), failure (yellow), hardware RX and TX (red).					
Insulation rating:	IP20					
Weight, dimensions:	140 g., 100 x 112 x 17,5 mm					
Standards:	<p>The instrument meets the following standards: EN50081-2 (electromagnetic emission, industrial environment) EN50082-2 (electromagnetic immunity, industrial environment) EN61010-1 (safety)</p> <p>All circuits must be isolated with dual isolation from circuits with dangerous voltage. The power supply transformer must meet standard EN60742. "Isolation transformers and safety transformers".</p>					



NOTE (1): Owing to possible electromagnetic interference.
NOTE (2): Single-ended, i.e. measurement with reference to common GND (non-differential).

CHFLAGS detail:

Add.	W	Code	Description
40050.15 40050.08	Y	Reserved	Do not change status of these bits.
40050.07	Y	CHACTIVE	0: Channel is disabled (off): measurement value is 0. 1: Channel is enabled (active).
40050.06	Y	CHDIFF	0: Channel is in single-ended mode; 1: Channel is in differential mode.
40050.05	Y	CHCMFLT	0: In case of CM overrange, reading is frozen to last useful value (with CHCMFLTEN = 1); 1: In case of CM overrange, programmed value in FLTVALUE register is passed (with CHCMFLTEN = 1).
40050.04	Y	CHCMFLTEN	0: CM overrange problem is reported on STATUS only; 1: CM overrange, in addition to being reported on STATUS, also causes the action established in CHCMFLT.
40050.03 40050.02	Y	CHPREC	0b00: Conversion takes place at 12bits, T _{Cmax} = 10ms; 0b01: Conversion takes place at 14bits, T _{Cmax} = 25ms; 0b10: Conversion takes place at 15bits, T _{Cmax} = 40ms; 0b11: Conversion takes place at 16bits, T _{Cmax} = 75ms.
40050.01	Y	CHCM	0: Differential measurement is shown (with CHDIFF = 1); 1: Common-mode measurement (Volt/10) is shown (CHDIFF=1).
40050.00	Y	CHMODE	0: Reading is in voltage; 1: Reading is in current (on 100W shunt).

Note: The autozero procedure is completely transparent to the user, who is not required to set any of its parameters. Nonetheless, it should be borne in mind that an autozero procedure is run whenever channel scanning from 1 to 8 restarts, and that calibration is performed with the maximum accuracy required by the active channels: hence, we need to count an additional time for scanning equivalent to T_{Cmax} (conversion time) of the most accurate channel.
 The table gives the register relating to channel 1 for illustrative purposes only, with the CHFLAGS Address equalling 34 + 16 x n as usual.

40048	Y	FST ±32767	Contains technical full scale (tFS) expressed as an integer in the chosen unit of measurement. ±10000.
40049	Y	FLTVALUE ±32767	Value copied into the output register in the event a common-mode voltage overrange occurs. ±32767.
40050	Y	CHFLAGS 0x0000÷0xFFFF	Channel settings: refer to the CHFLAGS details table.
40051	N	CALCOUNT 0x0000÷0xFFFF	Gives the number of calibrations carried out on the channel.

INSTALLATION INSTRUCTIONS

The module has been designed to be mounted on a DIN 46277 rail fitted with a power supply and communication bus Z-PC-DINx. To help the module's proper ventilation, it is best to mount it upright, taking care not to position raceways or other equipment so that they cover the vents.

Do not place the module on top of equipment generating heat. It is best to locate it in the lower part of the board or containment compartment.

Note: The registers of channel 1 are illustrated for reference purposes, i.e. with start address 40045. The start addresses of the other channels have already been listed and can nonetheless be found with Starting Address = 40029 + 16 x n, where as usual n =1..8 indicates the number of the channel in question. Writing to the registers listed is done directly in EEPROM and is effective immediately.

STATUS detail:

Add.	W	Code	Description
40002.15	Y	ERRLAMP	0: Normal condition: yellow pilot light off; 1: There is an internal HW error: yellow pilot light on; W: Pilot light test.
40002.14 40002.08	N	Reserved	Do not change status of these bits.
40002.07	Y	CH8CMERR	Channel 8 has exceeded CM range (register with memory)
40002.06	Y	CH7CMERR	Channel 7 has exceeded CM range (register with memory)
40002.05	Y	CH6CMERR	Channel 6 has exceeded CM range (register with memory)
40002.04	Y	CH5CMERR	Channel 5 has exceeded CM range (register with memory)
40002.03	Y	CH4CMERR	Channel 4 has exceeded CM range (register with memory)
40002.02	Y	CH3CMERR	Channel 3 has exceeded CM range (register with memory)
40002.01	Y	CH2CMERR	Channel 2 has exceeded CM range (register with memory)
40002.00	Y	CH1CMERR	Channel 1 has exceeded CM range (register with memory)

WIRING

POWER SUPPLY and COMMUNICATION

Power supply and communication connections are made with the terminals of the bus housed on the DIN rail: hence you should consult the explanatory sheet attached. The figure below gives the layout of the connections of the module's rear connector, which should be connected to the bus (IDC10).

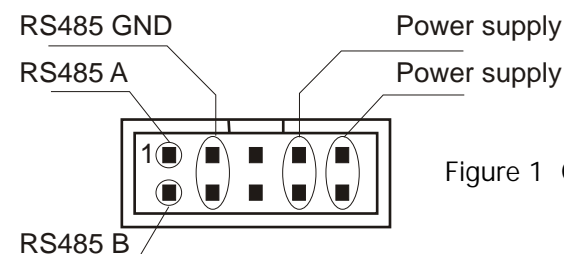


Figure 1 Connections layout (IDC10).

When using a connection or source not protected against short-circuiting, a fuse must be fitted on the power supply line: the maximum admissible value is 2.5 AT.

Whatever the case, supply voltage must not be allowed to exceed the peak value of 50 V or the overvoltage protectors inside the card will trip.

Power supply is galvanically isolated from the module's other circuits: guaranteed isolation 1500 V.

The communication line is galvanically isolated from the module's other circuits: guaranteed isolation 1500 V.

INPUTS

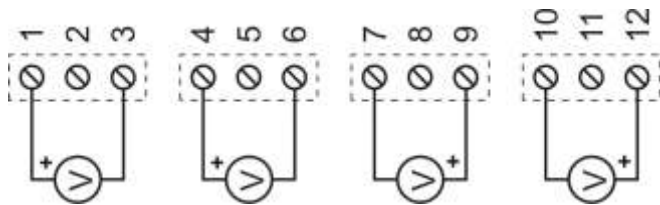


Figure 2A Terminal connections: differential measurements.

NOTE: The symmetrical layout of polarity means the 3-way removable screw terminals can be swapped over without having to rewire the cable. The middle terminals (2, 5, 8, 11) are connected together internally and should be used for the signal acquisition cable shield, where used, and nonetheless represent the "GND" the common mode should be referred to.

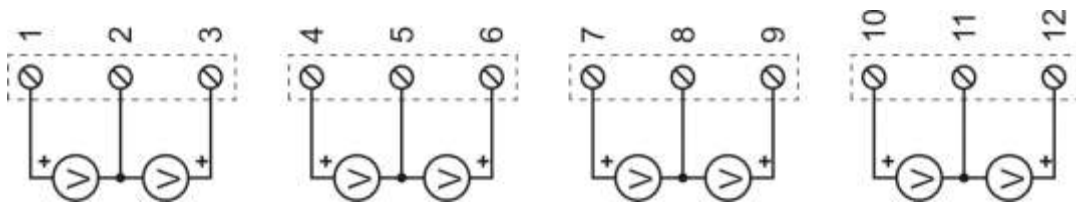
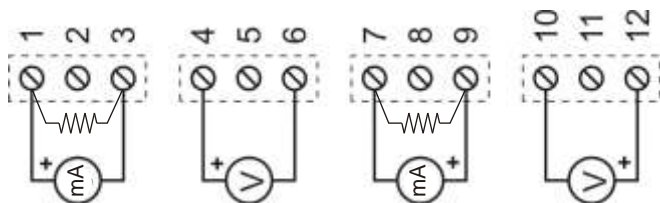


Figure 2B Terminal connections: single-ended.

NOTE: The connections for voltage inputs are shown in figures 2A and 2B. For current inputs, the connections remain the same but the 100 Ohm precision resistor (supplied with the instrument) must be connected in parallel with the input terminals.

The instrument cannot power the loop, which must therefore incorporate an external power supply.

In the following example inputs 1 and 3 are connected to accept Current signals.



SYSEPROM detail:

Add.	W	Code Permissible value	Description
40013.15 40013.08	Y	ADDRESS 0x01÷0xFF	Module's MODBUS address. ≠0x01
40013.07 40013.00	Y	PARITY 0x00÷0x02	≠0x00: NO parity (NONE). 0x01: EVEN parity (EVEN). 0x02: ODD parity (ODD).
40014.15 40014.08	Y	BAUDRATE 0x00÷0x07	0x00: 4800Baud; 0x01: 9600Baud; 0x02: 19200Baud; ≠0x03: 38400Baud; 0x04: 57600Baud; 0x05: 115200Baud; 0x06: 1200Baud; 0x07: 2400Baud.
40014.07 40014.00	Y	ANSWERDELAY 0x00÷0xFF	Answer delay: the number of pauses - 6 characters each - to be inserted between the end of the RX message and start of TX. ≠0x00

Note: Changes to communication parameters are made directly in EEPROM but only become effective when the card is rebooted (which can also be done via software through the CAL register) or when switching from RS232 to RS485. Communication switching to RS232 is automatic with the first character sent, which is unfortunately lost. The timeout returning communication to RS485 is approx. 3 s. Communication parameters are fixed: Baud: **2400**; Parity: **No**; Bits: **8**; Stop bits: **1**; Address: **001**; Delay: **0**.

CHxPARAM detail:

Add.	W	Code Permissible value	Description
40045	Y	ISM ±32767	Contains measurement zero scale (mZS) expressed in mV or mA. ≠-10000mV.
40046	Y	FSM ±32767	Contains measurement full scale (mFS) expressed in mV or mA. ≠+10000mV.
40047	Y	IST ±32767	Contains technical zero scale (tZS) expressed as an integer in the chosen unit of measurement. ≠-10000.

40008	N	CH6NM 0x8000÷0x7FFF	Measurement of channel 6 with ±32767 range, normalized according to parameters starting from address 40125 - refer to details table.
40009	N	CH7NM 0x8000÷0x7FFF	Measurement of channel 7 with ±32767 range, normalized according to parameters starting from address 40141 - refer to details table.
40010	N	CH8NM 0x8000÷0x7FFF	Measurement of channel 8 with ±32767 range, normalized according to parameters starting from address 40157 - refer to details table.
40011	Y	CAL 0xCmFn	Register of status and setting of analogue section: $m = 1..8$ and $n = 0..2$. Refer to details table and calibration procedure.
40013 40014	Y	SYSEEPROM	Communication parameters - refer to details table for individual parameters.
40045 40051	Y	CH1PARAM	Channel 1 parameters. Refer to details table.
40061 40067	Y	CH2PARAM	Channel 2 parameters. Refer to details table.
40077 40083	Y	CH3PARAM	Channel 3 parameters. Refer to details table.
40093 40099	Y	CH4PARAM	Channel 4 parameters. Refer to details table.
40109 40115	Y	CH5PARAM	Channel 5 parameters. Refer to details table.
40125 40131	Y	CH6PARAM	Channel 6 parameters. Refer to details table.
40141 40147	Y	CH7PARAM	Channel 7 parameters. Refer to details table.
40157 40163	Y	CH8PARAM	Channel 8 parameters. Refer to details table.

DIFFERENTIAL MEASUREMENT

Differential voltage measurement is useful when you have to measure a potential difference (PD) between two terminals without either being referred to the instrument's reference, or "GND". This technique offers various advantages, essentially attributable to the removal of errors owing to disturbance components (oscillatory and/or static) referred to GND. Equally, this technique is necessary when you want to use the same instrument (which has a single GND) to measure voltages referred to each other and that, for obvious reasons, cannot be subject to additional reference to a common reference terminal.

Nonetheless, there are practical limits to the application of this idea, basically owing to the fact that the instrument's GND exists and that the input terminal must therefore be able to withstand the "absolute" value (i.e. with respect to the reference) of the applied voltage.

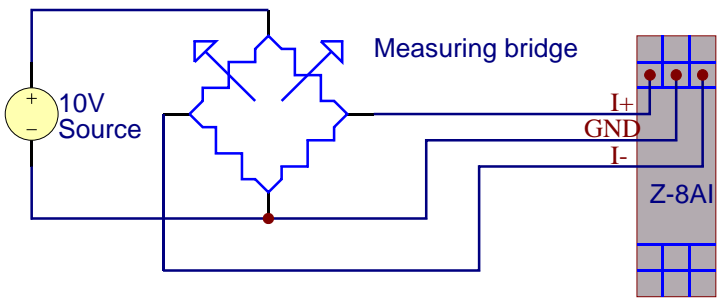
Hence, there is an GND even in the differential connection, with respect to which measurement voltages must not exceed a certain value: if the source is left entirely "floating" with respect to said terminal, we run the risk of the measurement inputs exceeding the maximum admissible values, even just as the result of disturbance picked up by the connection line. Hence, according to the application, you must assure a known and appropriate route between the source reference and measuring instrument reference.

Accepted practice is to consider a differential measurement parameter that expresses the average of the input voltages V_{I+} and V_{I-} referred to the instrument's GND: this PD is known as "Common Mode" (CM), hence the voltages determined are differential voltage V_{Diff} and common-mode voltage V_{CM} :

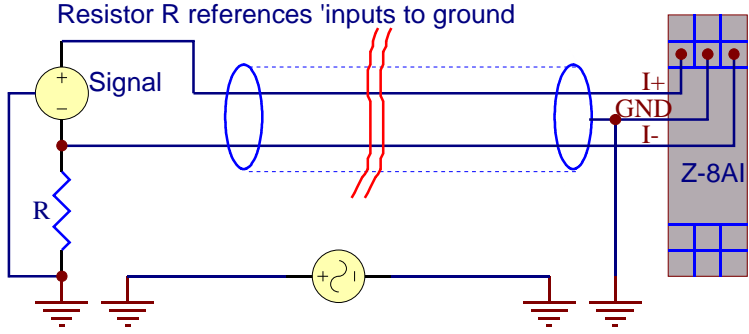
$$V_{Diff} = V_{I+} - V_{I-} \quad \text{and} \quad V_{CM} = \frac{V_{I+} + V_{I-}}{2} \quad \{1\}$$

The absolute value now allowed for V_{I+} and V_{I-} in the Z-8AI module is 20 V, whilst for V_{Diff} it is 2.5, 5 or 10 V. It follows, therefore, that the V_{CM} module below which any differential voltage value is possible, is 18.75, 17.5 or 15 V respectively. The card handles V_{CM} (or CM) overranges depending on how the CHCMFLTEN and CHCMFLT flags are set, reporting an error when V_{CM} exceeds the maximum value permissible for the range selected. Nonetheless, when we are certain that V_{I+} and V_{I-} are confined within the ±20 V range, it is best to disable CHCMFLTEN and hence be able to use Z-8AI to the limit of its input acceptability, for instance with a $V_{Diff}=1$ V and $V_{CM}=19.5$ V with a $FS_{Diff}=10$ V. A typical case is when the positive terminal is referred to a known positive voltage (for instance 20 V with respect to GND), whilst the negative one goes to a potential that remains lower than the positive rail so that V_{CM} decreases when V_{Diff} increases. Since two differential channels are connected on the same terminals, one can be configured to get the V_{CM} value (CHCM, tenths of a Volt) and get V_{I+} and V_{I-} through the inverses of {1} so that it is the supervisor system that handles the overranges. However, note that this procedure uses the average V_{CM} values, whilst the card has more or less instantaneous values for detecting the overrange: V_{CM} is actually acquired with a speed up to 40 times greater than V_{Diff} .

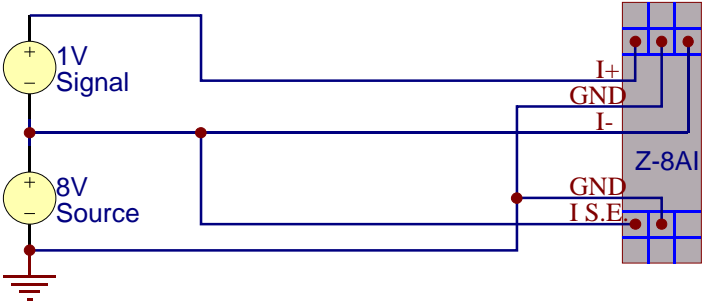
Figure 3 Sample uses of differential measurement.



A - Differential measure on a resistive bridge



B - 'Ground Noise' problems due to ground PD



C - Chain of sources

MODBUS REGISTERS

MODBUS COMMANDS

Code	Function	Description
03	Read Holding Register	Lists contents of RAM or EEPROM registers up to a maximum of 16 at a time.
06	Preset Single Register	Writes a RAM or EEPROM register: any attempt to write in a read-only register generates an <i>exception error</i> .
16	Preset Multiple Register	Writes multiple registers in a single data exchange.

REGISTERS

W (Y/N): means: **Y** 'writable'; **N** 'not writable'.
α: indicates **default** value.

The table below lists and describes the Holding Registers to be found in the module.

Add.	W	Code Permissible value	Description
40001	N	MTYPE, VERS 0x0Exx	Contains the ID code of instrument MTYPE (α14) in MSB and version of instrument VERS xx in LSB.
40002	Y	STATUS 0x0000÷0xFFFF	Register of status of instrument HW and CM overrange alarms - refer to details table.
40003	N	CH1NM 0x8000÷0x7FFF	Measurement of channel 1 with ±32767 range, normalized according to parameters starting from address 40045 - refer to details table.
40004	N	CH2NM 0x8000÷0x7FFF	Measurement of channel 2 with ±32767 range, normalized according to parameters starting from address 40061 - refer to details table.
40005	N	CH3NM 0x8000÷0x7FFF	Measurement of channel 3 with ±32767 range, normalized according to parameters starting from address 40077 - refer to details table.
40006	N	CH4NM 0x8000÷0x7FFF	Measurement of channel 5 with ±32767 range, normalized according to parameters starting from address 40109 - refer to details table.
40007	N	CH5NM 0x8000÷0x7FFF	Misura del canale 5 con range ±32767, normalizzata secondo i parametri a partire dall'indirizzo 40109; si rimanda alla tabella di dettaglio.

NOTE (1): Default settings are as follows: Baud: **38400**; Parity: No; Bits: **8**; Stop bits: **1**. Address: **001**.

For the resetting of communication parameters to be effective, you must move **SW1.1** and **reboot the module** (you can also do this with a soft reset): dip switch settings are only read during booting.

NOTE (2): Remember that RS485 line termination must be performed **at line ends only**.

CONVENTIONS

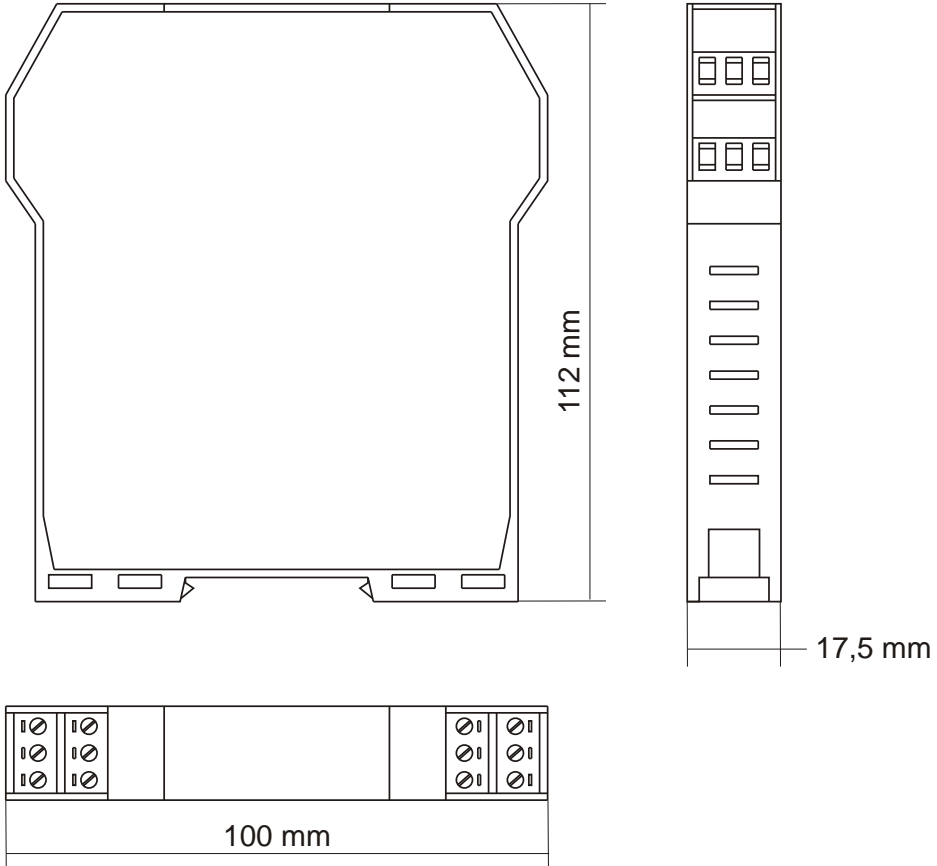
The module has been designed to be mounted on a DIN 46277 rail fitted with a power supply and communication bus Z-PC-DINx. To help the module's proper ventilation, it is best to mount it upright, taking care not to position raceways or other equipment so that they cover the vents.

Do not place the module on top of equipment generating heat. It is best to locate it in the lower part of the board or containment compartment.

DESCRIPTION AND OPERATING MODES

The module has eight MODBUS Holding Registers, which are updated at regular intervals with the voltage (or current) value of the corresponding input. Correspondence between the register and input terminals is predetermined and given in the table below:

OVERALL DIMENSIONS



Channel	MODBUS Register	First configuration register	Differential mode			Single-ended mode	
			I+	Terminal GND	I-	I+	I-
1	40003	40045	1	2 (common)	3	1	2 (common)
2	40004	40061	1	2 (common)	3	3	2 (common)
3	40005	40077	4	5 (common)	6	4	5 (common)
4	40006	40093	4	5 (common)	6	6	5 (common)
5	40007	40109	9	8 (common)	7	9	8 (common)
6	40008	40125	9	8 (common)	7	7	8 (common)
7	40009	40141	12	11 (common)	10	12	11 (common)
8	40010	40157	12	11 (common)	10	10	11 (common)

Terminals 2, 5, 8 and 11 are connected together internally and represent the reference zero potential: in differential mode, they are used to establish the signal common mode and to connect its shield, whilst in single-ended mode, they also represent the actual reference (-) for the signals. In this case, a single terminal is shared by two channels. Channels can be activated and configured independently: this means a channel not being used can be switched off, thus saving on the corresponding measuring time (max. 75ms). Each channel can also be set as differential or single-ended. Hence we can set up the module to meet specific needs, for instance implementing two differential channels and four single-ended ones. Of course, given the terminals available, the maximum number of differential voltages that can be measured is four, whilst eight single-ended voltages can be measured. The same terminal can be used for both kinds of measurement at the same time, for instance to determine the common-mode voltage. The latter can also be acquired by activating two differential channels on the same terminals and setting a specific flag on the second channel. Another option is to alter reading accuracy individually and hence acquisition time.