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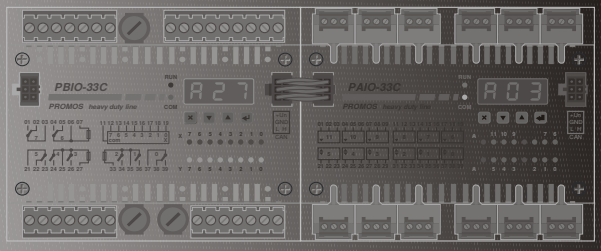

PROMOS Line Heavy Duty Kit

PAIO-33C

Unit of 12 universal analog positions with connection to CAN bus

Technical manual

10. 02. 2016

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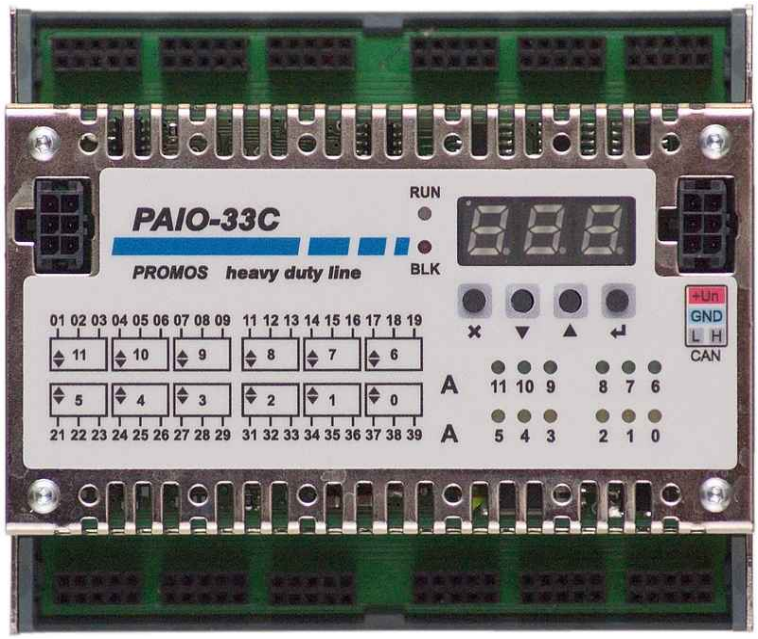
1 PAIO-33C – UNIT OF 12 UNIVERSAL I/O

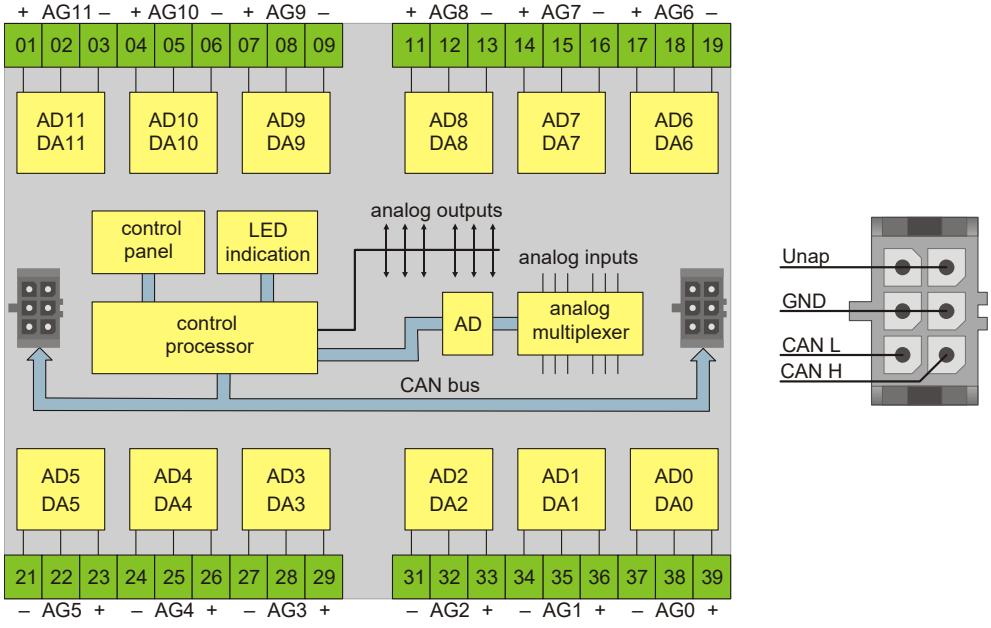
1.1 Basic characteristics

PAIO-33C is peripheral unit with connection to CANopen bus with 12 positions for both analog and digital inputs and outputs. View of the PAIO-33C unit is in the Pic. 1, block schema of the unit is in the Pic. 2.



Pic. 1: PAIO-33C unit

Control of the unit and bus communication is managed by built-in microcomputer. Mainboard contains analog multiplexor and A/D converter with resolution of 16 bits. Analog modules can be placed to universal positions of the mainboard according to the needs, these modules are exchangeable without the need to dismount the unit. ***Power supply of the unit must be switched off when changing the modules!*** Exchangeable moduls are, as well as PAIO-33C unit, made in two different ranges of operating temperatures – standard (-10 ÷ +60 °C) and extended (-40 ÷ +85 °C).



Pic. 2: Block schema of PAIO-33C unit

Analog input modules can be placed at any position. They contain operational amplifier with resistive feedback network and according to the modification they enable measurement of voltage, current, resistance or direct connection of resistance temperature sensors (Pt and Ni) and semiconductor temperature sensors (KTY). It's not necessary to take care of unused positions. For voltage and current measurement it is possible to also use modules with input

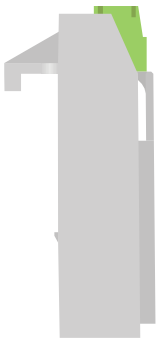
circuits galvanically isolated from other parts of PAIO-33C unit. These modules are marked as EGIU-xx, respectively EGII-xx.
Modules for analog output EPO-xx can be placed at any position. These contain filter and output amplifier. Outputs of microcomputer with Pulse Width Modulation are used. Resolution is 12 bits. Output analog modules EDOx-xx contain D/A converter with 16 bits resolution and it is possible to place it in any position.
To universal positions is possible to place also binary inputs modules EBI-xx or binary outputs modules EBO-xx. Input modules EBI-xx contain two logical inputs in one housing with nominal input voltage 5/12/24 V AC or DC. EBO-xx modules have one SSR switch.
On the front panel is located three-digit seven-segment display with a group of four buttons for movement in the menu and for setting up basic parameters of the unit. Bus is connected to the unit using connecting bridges InCo with crimp connectors. Besides communication line connectors they contain also contacts for connecting power supply. Indicator LED displays state of inputs, set state of outputs and module behavior. Unit itself is constructed and arranged in compact metallic housing which is mounted on DIN rail.

1.2 Technical specifications

Communication protocol		CAN2.0A/CANopen
Communication speed	*type*	500 kb/s
Number of inputs	*max.*	12
Resolution[1)]		16 bits
Max. gain of input amplifier		100
Measuring range [2)]	*voltage (bi-/unipolar)*	50 mV ÷ 10 V
	current (bi-/ unipolar)	1 ÷ 40 mA
	resistance (direct measure)	5 ÷ 100 kΩ
	resistive transmitters	105, 130, 600, 1000 Ω
	temperature sensors	Pt.., Ni.., KTY..
Number of outputs	*max.*	12 / 12
Output type		PWM / DA
Resolution		12 bits / 16 bits
Output range [2)]	*voltage*	1 / 2 / 5 / 10 V
	current	1 / 2 / 5 / 10 / 20 mA
Power voltage		10÷30 V
Power consumption		max. 4 W
Dimensions	w × h × d	110 × 91 × 55 mm *(including DIN holder and connectors)*
Operating temperatures range	*standard*	-10 ÷ 60 °C
	extended	-40 ÷ 85 °C
Overvoltage category		II
Degree of pollution		2

1) Measurement errors are discussed in chapter 1.4 on the page 12.
2) Mentioned are only limits of ranges, specific range of each input is determined according to placed exchangeable configuration module.

1.3 Universal positions



Pic. 3: Exchangeable module

PAIO-33C unit contains twelve universal positions for inputs/outputs (labelled 0 to 11). Type of each position (input or output) and its range is defined by placed exchangeable configuration module ExIx-xx for input and ExOx-xx for output. Each analog position is equipped with a detection of exchangeable module type. Besides the type (input or output) is also detected its type designation, range and linearization constants. Its type is indicated on LED diods 0 to 11 in right part of the unit. Description of indication is discussed in chapter 1.6.3.

1.3.1 Exchangeable modules

Exchangeable modules (housings) are inserted to the universal analog positions and are used to determine analog position type and range. The view of the module is in Pic. 3. Inputs can be used to measure voltage, current and resistance (resistive transmitters, resistor temperature sensors Pt../Ni.. and semiconductor temperature sensors KTY..). Output modules are designed either with voltage or current output. Types of exchangeable modules and their ranges are stated in the tables below. Each module contains identification memory EEPROM in which there are saved information about module type, range and its linearization constants. It is possible to create custom-made exchangeable module with different range.

1.3.2 Analog inputs

For usage of universal positions as analog inputs, modules EAIx-xx are used. These can be mounted to each of twelve universal positions. Each module has differential input and contains operational amplifier with configuration resistance ladder. According to its type it allows measurement of voltage, current, resistance, eventually direct connecti-

on of resistance temperature sensors Pt100, Ni1000 etc. A/D Input converter ensures resolution of 16bits. Indicator LED diods 0 to 11 in the right part of the unit indicate the limitation of input values of input modules.

The inputs can be connected only to sensors with output corresponding to the type of exchangeable module. For example it means, that the input which is designed for measurement of resistance or current **MUST NOT** be connected to power supply. Further, between input source terminals „+“ and „–“ **MUST NOT** be connected voltage lower than –15 V and greater than +15 V (power supply voltage of operational amplifier). It does not apply for xAIU and xAIV modules – for them the maximal voltage equals their range.

Analog inputs and binary inputs X1 of EBI-xx housings (left terminal) are captured with a period of 13ms. Each input contains software low-pass filter of 1st degree. Its time constant can be within the range of 0÷65536 ms. To make the filter effective, its time constant should be at least doubled compared to its sampling period, that means at least 26ms. By default the time constant of the filter is set to 1024ms.

For each input it is possible to put linearization polynomial of 3rd degree

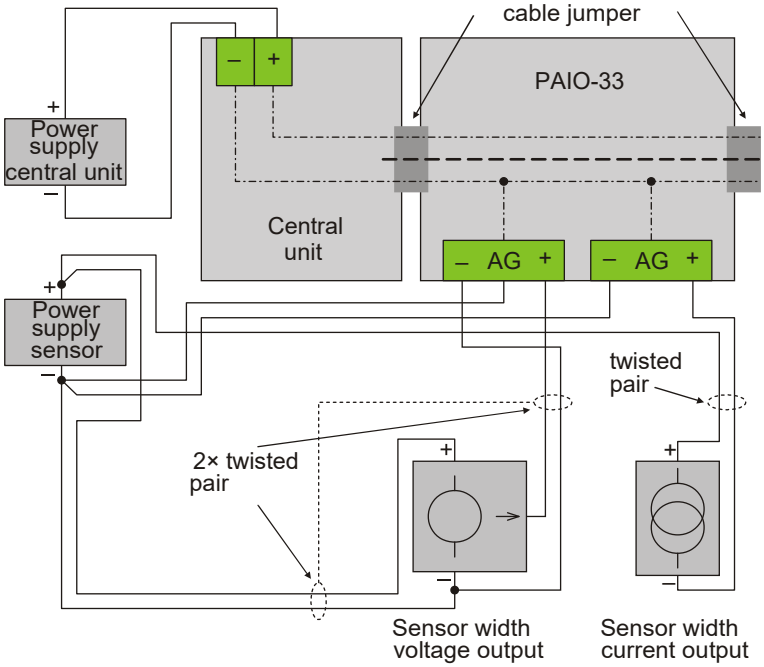
$$ax^3+bx^2+cx+d\ ,\ x=k\cdot AD\ ,$$

where *a, b, c, d* are the constants of polynomial for each input separately,

AD is the value of input on the output of converter.

Default settings of polynomial constants is a=b=d=0, c=k=1 and it is possible to overwrite them by loading from the housing EEPROM. Linearization has a meaning only for resistance-measurement modules – modules EAIB, EAIN, EAIP a EAIS, When converting resistance to voltage there is non-linearity transfered. Depending on the exchangeable module type, ranges withing approx 0,5% to almost 7% (EAIN). Besides that linearization also compensates for its own sensor non-linearity. After A/D conversion and passing through the linearization polynomial it ranges withing maximum rank of 0,01 %, the greatest is 0,13 % in EAIS modules.

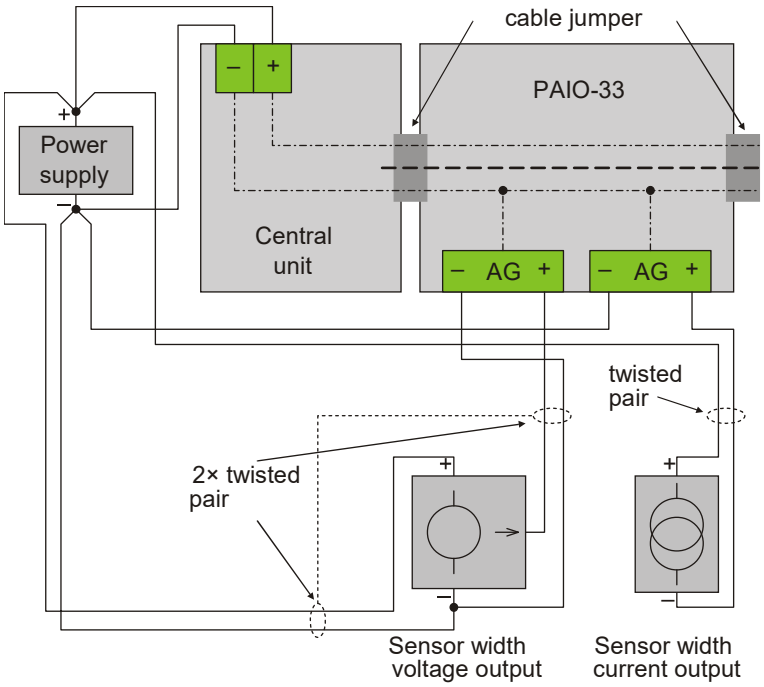
Connecting of active sensors



Pic. 4: Sensors powered by independent supply

While using active sensors requiring power supply (for example thermometer with temperature/voltage or temperature/current converter) is appropriate to supply these sensors from independent power supply, whose common terminal is connected to AG terminal of exchangeable module only in one place – do not interconnect AG of all units. Connection of active sensors with voltage and current output to PAIO-33C is in the Pic. 4.

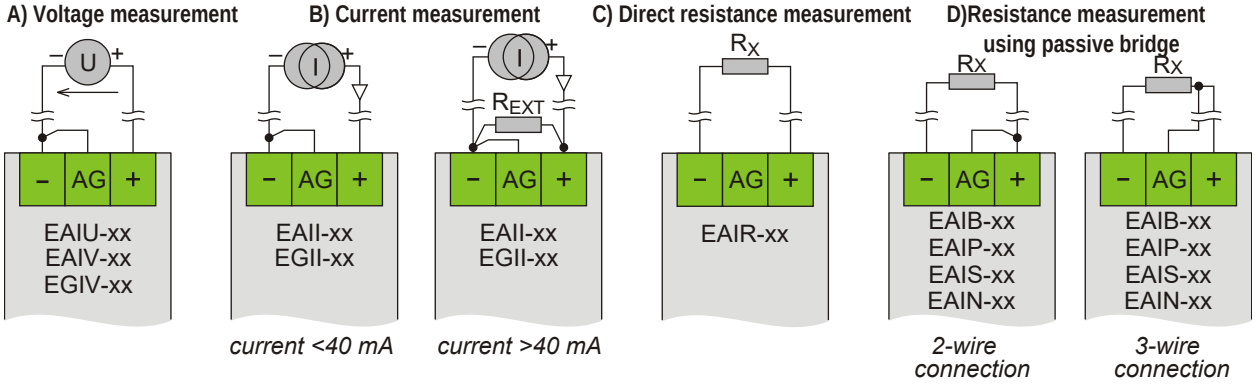
It is also possible to supply these sensors from the power supply of control system. Connection of sensors is displayed in the Pic. 5. Using this connection is not allowed to connect common terminal of power supply to the AG terminal (There is already connection inside of the unit). For connection of sensors with current output is appropriate using twisted-pair wire, sensors with voltage output using two twisted pair wire – one for power supply and second for output voltage (due to interference induced to the conduction – it will be suppressed by differential amplifier on the input of exchangeable module).



Pic. 5: Sensors powered by control system power supply

Connecting of passive sensors

Connecting of passive sensors differes according to the type of measured quantity and the type of its measuring. Everything is clearly displayed in the Pic. 6.



Pic. 6: Connecting of passive sensors to the exchangeable modules

Voltage measurement

Input amplifier is connected as differential voltage amplifier with both inputs carried out to input terminals. Modules are manufactured in two versions which differs in maximum voltage of any input against analog ground (AG). Connecting of signal to the module input is clearly displayed in the Pic. 6a).

The data of standard EAIU-xx modules are mentioned in Tab. 1, the data of EAIV-xx modules with extended level of input signal against common analog ground are mentioned in Tab 2.

EGIV-12 module for voltage measurement has galvanically separated input circuits from other parts of PAIO-33C unit. They contain input amplifier, 16bits A/D converter and galvanic separation. Detailed data are in the Tab. 3.

Tab. 1: Modules for voltage measurement - standard

Module type	Range [V]	Lower limit [V]	Upper limit [V]	U_{MAX}*) [V]	Input resistance [kΩ]			Resolution [mV]
					R_{DIF}	R_{IN+}	R_{IN-}	
EAIU-02	20 V	0,0 V	20,0 V	±40 V	1440	900	720	305
EAIU-12	10 V	0,0 V	10,0 V	±25 V	720	540	360	153
EAIU-22	5 V	0,0 V	5,00 V	±15 V	360	360	180	76
EAIU-32	2 V	0,0 V	2,00 V	±10 V	144	252	72	30,5
EAIU-42	1 V	0,0 V	1,00 V	±40 V	72	216	36	15,3
EAIU-52	500 mV	0,0 V	0,50 V	±40 V	36	198	18	7,6
EAIU-62	200 mV	0,0 V	0,20 V	±40 V	14,4	187	7,2	3,05
EAIU-72	100 mV	0,0 V	0,10 V	±40 V	7,2	184	3,6	1,53
EAIU-9..	custom design							

*) *maximum allowed voltage between any input and input analog ground*
R_{DIF} *resistance between inputs „+“ and „–“*
R_{IN+} *resistance between input „+“ and analog ground AG*
$R_{IN–}$ *resistance between input „–“ and analog ground AG*
*prefered types are marked by **bold font**, others comes with surcharge*

Tab. 2: Modules for voltage measurement with extended durability

Module type	Range [V]	Lower limit [V]	Upper limit [V]	U_{MAX}*) [V]	Input resistance [kΩ]			Resolution [mV]
					R_{DIF}	R_{IN+}	$R_{IN–}$	
EAIV-02	20 V	0,0 V	20,0 V	±100 V	1440	739	720	305
EAIV-12	10 V	0,0 V	10,0 V	±150 V	360	379	360	153
EAIV-22	5 V	0,0 V	5,00 V	±80 V	180	199	180	76
EAIV-9..	custom design							
EAIV-92	35 V	0,0 V	35,0 V	±200 V	—	—	—	534

*) *maximum allowed voltage between any input and input analog ground*
R_{DIF} *resistance between inputs „+“ and „–“*
R_{IN+} *resistance between input „+“ and analog ground AG*
$R_{IN–}$ *resistance between input „–“ and analog ground AG*
*prefered types are marked by **bold font**, others comes with surcharge*

Tab. 3: Modules for galvanically separated voltage measurement

Module type	Range [V]	Lower limit [V]	Upper limit [V]	U_{MAX}*) [V]
EGIV-12	±10 V	-10,0	+10,0	±12 V

*) *maximum allowed voltage between any input and input analog ground*

Current measurement

It is done indirectly by measuring of voltage drop on the sensing resistor, which is connected between input terminals „+“ and „–“. Module types and their parameters are displayed in the Tab. 4, connecting signal to module input is clear from the left part of Pic. 6b).

Tab. 4: Modules for current measurement

Module type	Range [mA]	Lower limit [mA]	Upper limit [mA]	Sensing resistance
EAII-02	40	0,0	40,0	125 Ω
EAII-12	20	0,0	20,0	125 Ω
EAII-22	10	0,0	10,0	100 Ω
EAII-32	5	0,0	5,0	200 Ω
EAII-9..	custom design			

*prefered types are marked by **bold font**, others comes with surcharge*

Standard modules allows to measure current up to 40mA, for measuring of greater current is necessary to use external sensing resistor. For a value of external resistor R_{EXT} the following applies:

$$R_{EXT} = \frac{R_B \cdot I_M}{I - I_M}$$

where: R_{EXT} is counted external resistor value
R_B is sensing resistor of the module (according to the Tab. 4)
I_M is current range of the module (according to the Tab. 4)
I required current range

To keep accuracy of measurement is absolutely necessary for counted value of external resistor to keep up with tolerance ±0,1 %. Connecting external resistor R_{EXT} is displayed in the right part of Pic. 6b).

Modules EGII-12 for current measuring have input circuits galvanically separated from other parts of PAIO-33C unit. They contain input amplifier, 16bits A/D converter and galvanical separation. Detailed data can be found in the Tab. 5.

Tab. 5: Modules for galvanically separated current measurement

Module type	Range [mA]	Lower limit [mA]	Upper limit [mA]	I_{MAX}*) [mA]
EGII-12	±20	-20,0	+20,0	±25,0

*) *maximum allowed current between + and –*

Direct resistance measurement

Is done using inverting amplifier where the measured resistance is connected in feedback. Module contain only RA resistor which determines the range of measurement. Connecting signal to the module input is clear from Pic. 6c), modules types and parameters are displayed in the Tab. 6.

Tab. 6: Modules for direct resistance measurement

Module type	Range [kΩ]	Resolution [Ω]	Measuring current
EAIR-01	5	0,305	1 mA

Module type	Range [kΩ]	Resolution [Ω]	Measuring current
EAIR-11	10	0,61	0,5 mA
EAIR-21	20	1,22	0,25 mA
EAIR-31	50	3,05	0,1 mA
EAIR-41	100	6,1	0,05 mA
EAIR-9..	custom design		

*prefered types are marked by **bold font**, others comes with surcharge*

Resistance measurement using passive bridge

This measurement is used when measuring resistance of low-resistance sensors of non-electrical quantities (e.g. temperature, pressure) for which there is usually just small change of resistance. Sensor is connected to the bridge using 3-wire connection which partially allows elimination of line resistance. Connecting signal to the module input is clearly displayed in Pic. 6d), modules types shows Tab. 7.

Tab. 7: Modules for resistance measurement using passive bridge

Module type	Range [Ω]	Lower limit [Ω]	Upper limit [Ω]
EAIB-00	0÷105	0,0	111,7
EAIB-01	0÷130	0,0	134,5
EAIB-02	0÷600	0,0	605,0
EAIB-03	0÷1000	0,0	1012

*prefered types are marked by **bold font**, others comes with surcharge*

Connecting of temperature sensors Pt100, Pt500 a Pt1000

For connecting of temperature sensors Pt100, Pt500 a Pt1000 are used modules EAIP-xx. Connecting signal to modul input is clearly displayed in the Pic. 6d). Modules types and precise ranges are shown in Tab. 8.

Tab. 8: Modules for connecting of temperature sensors Pt...

Module type	Sensor type	Range [°C]	Lower limit [°C]	Upper limit [°C]
EAIP-600	Pt100	-200÷50	-206,7	51,31
EAIP-610		-50÷150	-62,97	164,35
EAIP-620		0÷300	0,08	309,48
EAIP-630		0÷600	0,08	621,15
EAIP-601	Pt500	-200÷50	-201,47	51,81
EAIP-611		-50÷150	-55,47	166,71
EAIP-621		0÷300	-15,17	329,78
EAIP-631		0÷600	-15,17	601,15
EAIP-602	Pt1000	-200÷50	-201,94	54,05
EAIP-612		-50÷150	-62,97	156,89
EAIP-622		0÷300	0,08	317,3
EAIP-632		0÷600	0,08	638,48
EAIP-901	Pt100	-100÷200	-110,02	225,44
EAIP-9..	custom design			

*prefered types are marked by **bold font**, others comes with surcharge*

Connecting of KTY temperature sensors

For connecting of semiconductor temperature sensors KTY are used modules EAIS-xx. Connecting signal to modul input is clearly displayed in the Pic. 6d). Modules types and precise ranges for KTY sensors are shown in Tab. 9.

Tab. 9: Modules KTY temperature sensors

Module type	Range [°C]	Lower limit [°C]	Upper limit [°C]
for KTY6-10 sensor			
EAIS-01	-50÷50	-53,8 °C	57,1 °C
EAIS-02	-50÷100	-53,8 °C	109,8 °C
EAIS-03	0÷100	-3,4 °C	107,2 °C
for KTY81-110 sensor			
EAIS-11	-50÷50	-51,0 °C	50,3 °C
EAIS-12	-50÷100	-51,0 °C	107,7 °C
EAIS-13	0÷100	-9,6 °C	107,4 °C
for KTY81-210 sensor			
EAIS-21	-50÷50	-53,0 °C	55,0 °C
EAIS-22	-50÷100	-53,0 °C	103,4 °C
EAIS-23	0÷100	-2,1 °C	101,0 °C

*prefered types are marked by **bold font**, others comes with surcharge*

Connecting of temperature sensors Ni...

For connecting sensors Ni1000 (5000 ppm and 6180 ppm) and Ni891 (6371 ppm) are used modules EAIN-xx. Connecting signal to modul input is clearly displayed in the Pic. 6d). Modules types and precise ranges for KTY sensors are shown in Tab. 10.

Tab. 10: Modules for connecting temperature sensors Ni...

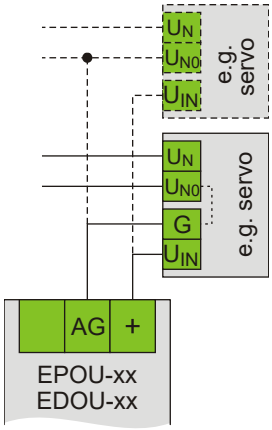
Module type	Sensor type	Range [°C]	Lower limit [°C]	Upper limit [°C]
EAIN-610	Ni1000/5000 ppm	-50÷150	-60,46	162,64
EAIN-611	Ni1000/6180 ppm	-50÷150	-48,45	151,16
EAIN-612	Ni891/6371 ppm	-50÷150	-57,82	149,95
EAIN-9..	custom design			

*prefered types are marked by **bold font**, others comes with surcharge*

1.3.3 Analog outputs PWM

For using universal positions as analog outputs are used modules EPOx-xx, which can be mounted to any position. Each module contain operational amplifier with configuration resistor ladder and a filter. According to the type allows voltage or current output. Microcomputer outputs are used with Pulse-width modulation (PWM). Resolution is 12bits.

Voltage output



Pic. 7: Connectiong of voltage output

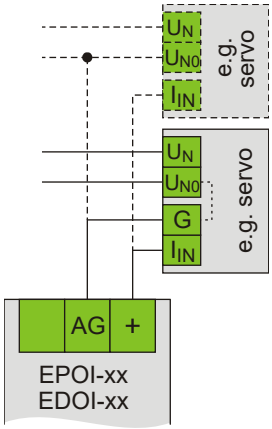
For voltage outputs of PAIO-33C unit are used EPOU-xx modules, which process signal with pulse-width modulation. Connecting output to the module is displayed in Pic. 7, module types for voltage output is shown by Tab. 11.

Tab. 11: Modules for voltage output with PWM

Module type	Range [V]	Resolution [mV]	I_{OMAX} [mA]
EPOU-00	0 ÷ 10	2,44	10
EPOU-10	0 ÷ 5	1,22	
EPOU-20	0 ÷ 2	0,49	
EPOU-30	0 ÷ 1	0,24	
EPOU-9..	custom design		

*prefered types are marked by **bold font**, others comes with surcharge*

Current output



Pic. 8: Connecting of current output

For current outputs with PWM of PAIO-33C unit are used Modules EPOI-xx, which process signal with pulse-width modulation. Output circuit operates as power supply. Its typical output voltage is 12 V, minimal is 10 V. Connecting output to module is displayed in the Pic. 8, module types for current output is shown by Tab. 12.

Tab. 12: Modules for current output with PWM

Module type	Range [mA]	Resolution [mA]	R_{ZMAX} [Ω]
EPOI-00	0 ÷ 20	4,88	600
EPOI-10	0 ÷ 10	2,44	1200
EPOI-20	0 ÷ 5	1,22	2400
EPOI-30	0 ÷ 2	0,49	6 k
EPOI-40	0 ÷ 1	0,24	12 k
EPOI-9..	custom design		

*prefered types are marked by **bold font**, others comes with surcharge*

1.3.4 Analog outputs with DA

PAIO-33C unit allows to mount EDOx-xx modules, which can be mounted to any position. Each module contains D/A converter with resolution of 16 bits, operational amplifier with configuration resistor ladder and filter, and protection against connecting of external voltage on output terminals of the module. According to the type the module allows voltage or current output.

Voltage output

For voltage outputs of PAIO-33C unit are used EDOU-xx modules. Connecting output to the module is displayed in the Pic. 7, module types are shown in the Tab. 13.

Tab. 13: Modules for voltage output DA

Module type	Range [V]	Resolution [mV]	I_{OMAX} [mA]
EDOU-00	0 ÷ 10	152,6	10
EDOU-10	0 ÷ 5	76,3	
EDOU-20	0 ÷ 2	30,5	
EDOU-30	0 ÷ 1	15,26	
EDOU-9..	custom design		

*prefered types are marked by **bold font**, others comes with surcharge*

Current output

For current outputs of PAIO-33C unit are used EDOI-xx modules. Output circuit operates as power supply. Its typical voltage output is 12 V, minimal is 10 V. Connecting output to the module is displayed in the Pic. 8, module types are shown in the Tab. 14.

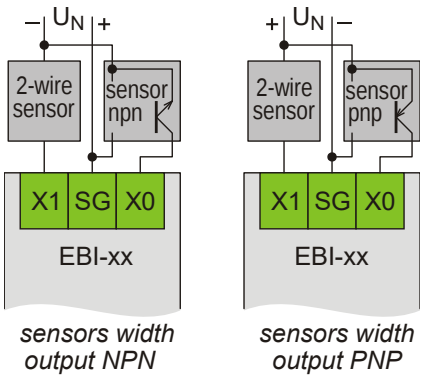
Tab. 14: Modules for current output with DA

Module type	Range [mA]	Resolution [nA]	R_{ZMAX} [Ω]
EDOI-00	0 ÷ 20	305	600
EDOI-10	0 ÷ 10	152,6	1200
EDOI-20	0 ÷ 5	76,3	2400
EDOI-30	0 ÷ 2	30,5	6 k
EDOI-40	0 ÷ 1	15,26	12 k
EDOI-9..	custom design		

*prefered types are marked by **bold font**, others comes with surcharge*

1.3.5 Binary inputs

For connecting binary sensors (contacts, two- and three-wires semiconductor sensors) serve EBI-xx modules, which contain two binary inputs.



sensors width output NPN *sensors width output PNP*

Pic. 9: Connecting of binary inputs

Input type for all module types is 1 according to ČSN EN 61131-2. If there is a need of input type 2, it is possible to aquire that by connecting external resistor 2,2 kΩ (only to EBI-12) between input X0 (resp. X1) and SG. Connecting sensors to the module is displayed in the Pic. 9, module types are shown in the Tab. 15. Two-wires sensor can be either semiconductor-based or contact.

Tab. 15: Modules for binary inputs

Module type	U_{INH} [V] *min / typ / max*	U_{INMAX} [V] *max, 1s*	U_{INL} [V] *max*	I_{IN} [mA] *typ*
EBI-10	4,5 / 5 / 6,5	8 V	1,5	8
EBI-11	5,6 / 12 / 15	26 V	2,4	10
EBI-12	11 / 24 / 30	40	5	8

*prefered types are marked by **bold font**, others comes with surcharge*

1.3.6 Binary outputs

PAIO-33C unit allows to mount output module with switching transistor on every positions. Available are two modules for maximus switching current 250 mA a 2 A.

EBO-10

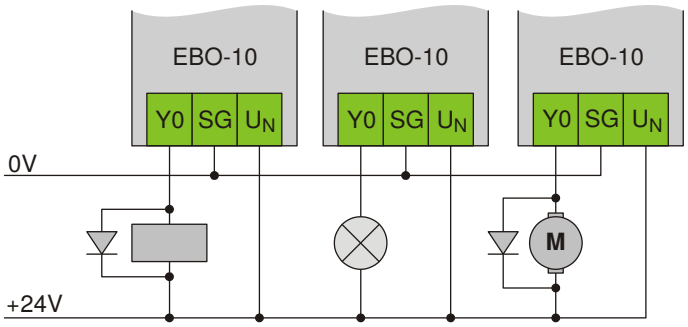
This is a transistor output module for peripheral PAIO-33C units for switching DC load up to 2 A. For being fully functional it is necessary to connect auxiliary power supply to the terminal U_N.

Technical parameters

Max. switching voltage	40 V DC
Max. switching current	2 A
Max. auxiliary voltage	35 V
Min. Auxiliary voltage	12 V
Protection	fuse F2 A
Insulation voltage GO	500 V AC / 1 min.

Connection of output

Connecting the load to the EBO-10 module is displayed in the Pic. 10. When switching appliances with induction caracter supplied by DC voltage, the diode is connected in the closing direction in paralel with the appliance to treat transient response (connection is displayed in the Pic. 10).



Pic. 10: Way of connecting the load to EBO-10

Module contains protection of switching element using a fuse. The fuse is accessible after plastic lid removal – for sliding the printed circuit board out is needed to bend protective element under connecting terminals.

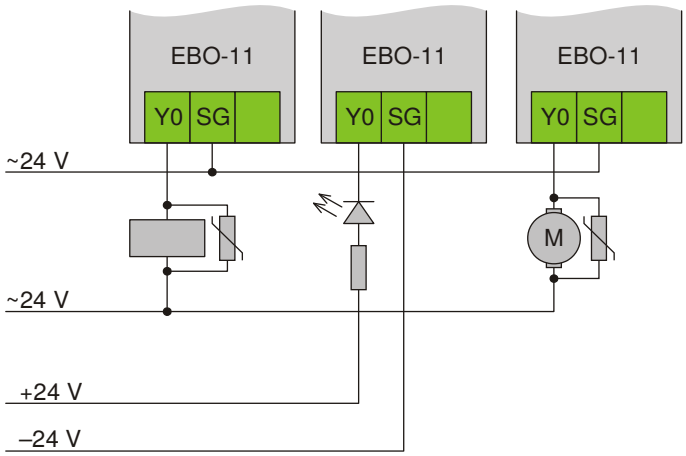
EBO-11

Transistor output module for peripheral PAIO-33C units for switching DC and AC load up to 250 mA.

Technical parameters

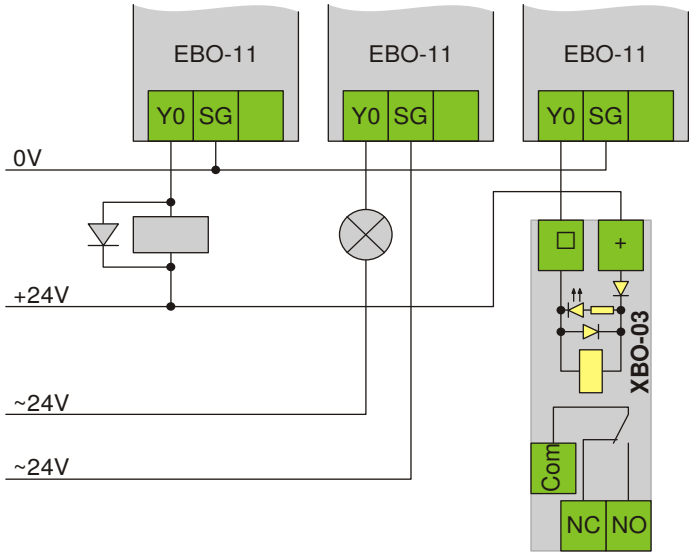
Max. switching voltage	50 V DC / 30 V AC
Max. switching current	250 mA
Protection	fuse F250 mA
Insulation voltage GO	500 V AC / 1 min.

Connecting output



Pic. 11: Way of connecting AC load to EBO-11

When switching appliances with induction caracter supplied by AC voltage is necessary to externaly take care of transient response using varistor (24 V~). Example of connection is displayed in the Pic. 11. Varistor is necessary to connect as close to the appliance as possible.



Pic. 12: Way of connection DC load to EBO-11

When switching appliances with induction caracter supplied by DC voltage, for treatment of transient response there is used diode connected in reverse direction in paralel to the appliance (connection is shown in the Pic. 12).

1.4 Errors of measuring chain

For assessment of total accuracy of a circuit is necessary to consider parameters of individual elements of this measuring chain.

1.4.1 Resistors of exchangeable modules

For individual resistors of exchangeable modules are used resistors with tolerance of 0,1%. In places, where is important ratio or resistors matching, individual resistors are chosen to respect either this tolerance and also the ratio or resistors matching. Temperature dependence of the resistors is maximum 25 ppm/°C.

1.4.2 Operational amplifiers

Used operational amplifiers OP07 have following parameters:

	type	max	unit
Drift voltage at 25°C	60	150	mV
Drift temperature dependence	0,5	1,8	mV/°C
Drift voltage of temp. range 0÷70°C	85	250	mV
Input current at 25°C	1,8	7	nA
Temperature dependence of input current	18	50	pA/°C
Input current at temperature range 0÷70°C	2,2	7	nA
Input current non-symetry	0,8	6	nA
Common Mode Rejection coef.	120		dB

Influence of these variables on accuracy of measurement depends on specific connection of input circuit, especially on amplifying and size of resistors connected to the inputs of the amplifier. When the gain is around 1 with resistors sizes up to 100 kΩ, the influence of drift voltage and input currents is completely negligible. When the gain is around 50, by non-reset amplifier (standard setup of the unit) the error can reach values in range 0 to 0,3 % of the range.

1.4.3 A/D converter

A/D converter used in the PAIO-33C unit has following parameters:

	type	max	unit
Integral non-linearity		±6	LSB
Offset error	±3	±1,5	mV
Range error	±6	±24	mV
Range temperature dependence	±0,3		ppm/°C
Noise	20		uV RMS

1.4.4 Reference voltage

Reference voltage is set to value 2,5 V with accuracy ±0,2 %. Influence of external amplifier of reference voltage is due to the gain 1 and minimal impedances in input circuits completely negligible. Temperature coefficient of reference voltage is typically 20 ppm/°C, maximum 100 ppm/°C. Influence of reference voltage applies only when measuring voltage or current. When resistance measuring is this influence compensated by using same power supply voltage to supply either measuring bridge and supporting voltage supply for approximation converter.

1.4.5 D/A converter

In PAIO-33C unit is D/A converter realized on the principle of pulse-width modulation. There are used twelve PWM channels of microcomputer which controls the unit. Each channel has following parameters:

Output type	PWM	
Resolution	12	bit
Zero output offset, type	1	LSB
Accuracy of conversion	2	%
Linearity	0,3	%
Temperature dependence	80	ppm/°C

Resulting error of conversion is influenced, beside converter parameters, also parameters of operational amplifier and resistors used in output module. Due to the use of same type of components as for input modules, applies what is written in chapters 1.4.1 a .1.4.2

1.5 Communication parameters

PAIO-33C unit, connected to CAN bus, processes objects from Object Dictionary written in independent manual "Communication protocols of PL2 and PLHD units".

1.6 Unit configuration

In the front panel of PAIO-33C (Pic. 13) there are located all connecting, setting and indication elements. On the sides there are two connectors for connecting unit to CAN bus. This bus is pass-through - it makes it easy to put multiple units in the row. For connecting these units there are special connection bridges InCo with cripming connectors used.

1.6.1 Setting parameters of the unit

After switching the unit on there is current address of the unit shown on the display. Using ▼ or ▲ buttons is possible to browse individual menu items (browsing is going on in both directions, after last menu item the first appears), × is used to get back by one level (resp. default item) and ↵ is used for changing to deeper level (resp. it allows changing the value of this item). Items are sorted in the menu consecutively, same as description below.

Setting up the address

Current address is shown on the display after switching the unit on (E.g. A02). In peripheral system the address must be in given segment always unique. Change of the address can be done by pressing ↵ (Two-cipher number representing the address starts to blink), pressing ▼ or ▲ is used to set required address and after that is this new address saved by repeated pressing ↵. Newly set address takes effect in communication after proceeding with item "Saving parameters". Address can be set in range 0÷99 (address 0 is not allowed with some protocols). By pressing × is possible to leave address setting in any moment and to return to original address.

Setting up communication speed

Units with letter „C“ in the end of the name (with CANOpen protocol) allows to set following communication speeds:

- 10 kbps – indicated by displaying b10,
- 20 kbps – indicated by displaying b20,
- 50 kbps – indicated by displaying b50,
- 100 kbps – indicated by displaying b01,
- 250 kbps – indicated by displaying b02,
- 500 kbps – indicated by displaying b05,
- 1 Mbps – indicated by displaying b08.

Setting up communication speed is done by pressing ↵ (text starts to blink), pressing ▼ or ▲ sets the required communication speed and saves by pressing ↵. Newly set speed is taking effect in communication after proceeding with item "Saving parameters". By pressing × is possible to leave this setting in any moment of setting up communication speed and to get back to original speed.

Saving up parameters

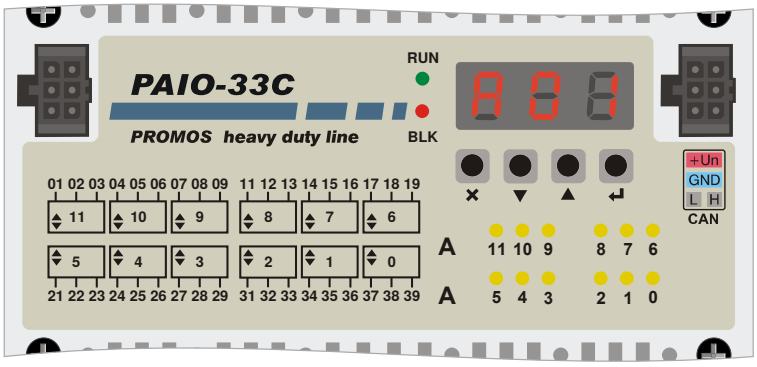
Changed parameters are saved by item SAV, first press ↵ (item starts to blink) and after that again pressing ↵. Flashing of changed datas is in proces and displays turns black for a moment (Reset of the unit is done).

Factory reset

Factory reset is done by item RES, in the first by pressing ↵ (item starts to blink) and after that again by pressing ↵.

Firmware version

It's not possible to set anything in this item, there is only text shown, e.g. F01 (firmware version 01).



Pic. 13: Front panel of PAIO-33C unit

Displaying plug-in modules values

Displaying of current values on inputs (resp. outputs) of plug-in modules is possible after pressing button ↵ on the menu item labeled U A I. In this regime the meaning of LEDs of analog positions is changed. Value shown on the display belongs always to the plug-in module on which the LED is on (lighting). Switching between positions is done using buttons ▼ or ▲. By pressing × is possible to return back to the base menu.

Range of shown values is limited by display on integers from –99 to 999. Values from input modules (EAIx) are displayed in units written on module tag, set-up values of output modules (EPOx, EDOx) are displayed in range 0 ÷ 100% of maximum values written on module tag. In case of input plug-in modules with big range (>1000) the displayed value is 1000× smaller.

Ranges of displayed values for different types of plug-in modules is by follow:

- *EAIx, EGIx* from „**-99**“ to „**999**“,
- *EPOx, EDOx* from „ **0**“ to „**100**“,
- *EBI* „**0-0**“ / „**1-0**“ etc., where right number marks input X0 and left X1,
- *EBO* „ **0**“ or „ **1**“,
- *volná pozice* „**---**“.

Enabling/disabling of outputs

Outputs are enabled/disabled by last item in the menu. Label on the display shows current status. If there is E n A shown, there is value accepted from the bus in the outputs and **BLK** diode is not lighting. If there is d I S shown, there is zero value in the outputs and **BLK** diode is lighting. Change of the settings is done by pressing ↵ (item is blinking), by pressing ▼ or ▲ is possible to set required state and saves by pressing ↵ again. by pressing × it is possible to leave setting up of blocking outputs and return back to original settings. Settings are valid only until restart (resp. switching off) the unit, after that is always set up by E n A.

1.6.2 State indication LED

In the left part next to the display there are two state indication LEDs (bi-colour **RUN** a red **BLK**) indicating current stat and module behaviour.

State of common activity of the unit

- diode **RUN** blinks green, when operational communication is going on („ping“),
- diode **BLK** does not light.

Guard Error State

In this state the unit does not communicate yet (process data) with supervizor system, typically after-switching-on state,

- diode **RUN** lights red,
- diode **RUN** blinks yellow if there is configuration going on after switching on,
- diode **BLK** blinks.

Output Disconnection State

- diode **RUN** does not change behaviour,
- diode **BLK** lights.

When there is both, Guard Error state and activ output disconnection state, Guard Error State is indicated.

In the regime of Guard Error State there is pre-set value on each output, which is factory set to 0 (Outputs disconnected). In case there is another behaviour needed in regime without communication it is necessary to use programmable unit XAIO-33E.

1.6.3 LEDs of analog positions

In the right part of the front panel in the down part there are located two rows of eight yellow LEDs (labeled A 5 to 0 in lower row and A 6 to 11 in upper row). These diods indicates presence of plugged in module, when output module used also indicates the limitation of input value. If plug-in module is plugged and is recognized by the unit, the relevant diode lights.

If there is plugged input module and current input value is out of the module range, diode of relevant position blinks with following meaning:

– *short ligh, long* gap input value is under the lower limit

– *long light, short* gap input value is above the upper limit.

Data for ordering

Type	Ord. No.	Modification
PAIO-33C	EI6543.00	CAN modul 12 universal positions AI, DI, AO, DO, Un=10 ÷ 30 V, -40 ÷ +85 °C
	EI6543.50	CAN modul 12 universal positions AI, DI, AO, DO, Un=10 ÷ 30 V, -10 ÷ +60 °C

Data for exchangeable modules ordering – standard temperature range

Module type	Range	Ord. No.
EAIU-02	0 ÷ 20 V	EI5950.02
EAIU-12	***0 ÷ 10 V***	***EI5950.12***
EAIU-22	0 ÷ 5 V	EI5950.22
EAIU-32	0 ÷ 2 V	EI5950.32
EAIU-42	***0 ÷ 1 V***	***EI5950.42***
EAIU-52	0 ÷ 500 mV	EI5950.52
EAIU-62	0 ÷ 200 mV	EI5950.62
EAIU-72	0 ÷ 100 mV	EI5950.72
EAIU-9..	custom	EI5950.9..
EAIV-02	0 ÷ 20 V	EI5951.02
EAIV-12	***0 ÷ 10 V***	***EI5951.12***
EAIV-22	0 ÷ 5 V	EI5951.22
EAIV-92	0 ÷ 35 V	EI5951.92
EAIV-9..	custom	EI5951.9..
EGIV-12	±10 V	EI5961.12
EAII-02	0 ÷ 40 mA	EI5952.02
EAII-12	***0 ÷ 20 mA***	***EI5952.12***
EAII-22	0 ÷ 10 mA	EI5952.22
EAII-32	0 ÷ 5 mA	EI5952.32
EAII-9..	custom	EI5952.9..
EGII-12	±20 mA	EI5962.12
EAIR-01	0 ÷ 5 kΩ	EI5953.01
EAIR-11	0 ÷ 10 kΩ	EI5953.11
EAIR-21	***0 ÷ 20 kΩ***	***EI5953.21***
EAIR-31	0 ÷ 50 kΩ	EI5953.31
EAIR-41	***0 ÷ 100 kΩ***	***EI5953.41***
EAIR-9..	custom	EI5953.9..
EAIB-00	0 ÷ 105 Ω	EI5954.00
EAIB-01	***0 ÷ 130 Ω***	***EI5954.01***
EAIB-02	0 ÷ 600 Ω	EI5954.02
EAIB-03	***0 ÷ 1000 Ω***	***EI5954.03***
EAIP-600	-200 ÷ 50 °C	EI5957.600
EAIP-610	***-50 ÷ 150 °C***	***EI5957.610***
EAIP-620	***0 ÷ 300 °C***	***EI5957.620***
EAIP-630	0 ÷ 600 °C	EI5957.630
EAIP-601	-200 ÷ 50 °C	EI5957.601
EAIP-611	***-50 ÷ 150 °C***	***EI5957.611***
EAIP-621	***0 ÷ 300 °C***	***EI5957.621***
EAIP-631	0 ÷ 600 °C	EI5957.631
EAIP-602	-200 ÷ 50 °C	EI5957.602
EAIP-612	***-50 ÷ 150 °C***	***EI5957.612***
EAIP-622	***0 ÷ 300 °C***	***EI5957.622***
EAIP-632	0 ÷ 600 °C	EI5957.632

Module type	Range	Ord. No.
EAIP-901	-100 ÷ 200 °C	EI5957.901
EAIP-9..	custom	EI5957.9..
EAIN-610	***-50 ÷ 150 °C***	***EI5956.610***
EAIN-611	***-50 ÷ 150 °C***	***EI5956.611***
EAIN-612	***-50 ÷ 150 °C***	***EI5956.612***
EAIN-9..	custom	EI5956.9..
EAIS-01	-50 ÷ 50 °C	EI5958.01
EAIS-02	***-50 ÷ 100 °C***	***EI5958.02***
EAIS-03	0 ÷ 100 °C	EI5958.03
EAIS-11	-50 ÷ 50 °C	EI5958.11
EAIS-12	***-50 ÷ 100 °C***	***EI5958.12***
EAIS-13	0 ÷ 100 °C	EI5958.13
EAIS-21	-50 ÷ 50 °C	EI5958.21
EAIS-22	***-50 ÷ 100 °C***	***EI5958.22***
EAIS-23	0 ÷ 100 °C	EI5958.23
EPOU-00	***0 ÷ 10 V***	***EI5981.00***
EPOU-10	0 ÷ 5 V	EI5981.10
EPOU-20	0 ÷ 2 V	EI5981.20
EPOU-30	0 ÷ 1 V	EI5981.30
EPOU-9..	custom	EI5981.9..
EPOI-00	***0 ÷ 20 mA***	***EI5983.00***
EPOI-10	0 ÷ 10 mA	EI5983.10
EPOI-20	0 ÷ 5 mA	EI5983.20
EPOI-30	0 ÷ 2 mA	EI5983.30
EPOI-40	0 ÷ 1 mA	EI5983.40
EPOI-9..	custom	EI5983.9..
EDOU-00	***0 ÷ 10 V***	***EI5984.00***
EDOU-10	0 ÷ 5 V	EI5984.10
EDOU-20	0 ÷ 2 V	EI5984.20
EDOU-30	0 ÷ 1 V	EI5984.30
EDOU-9..	custom	EI5984.9..
EDOI-00	***0 ÷ 20 mA***	***EI5985.00***
EDOI-10	0 ÷ 10 mA	EI5985.10
EDOI-20	0 ÷ 5 mA	EI5985.20
EDOI-30	0 ÷ 2 mA	EI5985.30
EDOI-40	0 ÷ 1 mA	EI5985.40
EDOI-9..	custom	EI5985.9..
EBI-10	5 V	EI5971.00
EBI-11	***12 V***	***EI5971.10***
EBI-12	***24 V***	***EI5971.20***
EBO-10	***2 A***	***EI5972.10***
EBO-11	***250 mA***	***EI5972.11***

*prefered types are marked by **bold font**, others comes with surcharge and has longer delivery time*

Data for exchangeable modules ordering – extended temperature range

Module type	Range	Ord. No.
EAIU-02/HD	0 ÷ 20 V	EI6950.02
EAIU-12/HD	***0 ÷ 10 V***	***EI6950.12***
EAIU-22/HD	0 ÷ 5 V	EI6950.22
EAIU-32/HD	0 ÷ 2 V	EI6950.32
EAIU-42/HD	***0 ÷ 1 V***	***EI6950.42***
EAIU-52/HD	0 ÷ 500 mV	EI6950.52
EAIU-62/HD	0 ÷ 200 mV	EI6950.62
EAIU-72/HD	0 ÷ 100 mV	EI6950.72
EAIU-9../HD	custom	EI6950.9..
EAIV-02/HD	0 ÷ 20 V	EI6951.02
EAIV-12/HD	***0 ÷ 10 V***	***EI6951.12***
EAIV-22/HD	0 ÷ 5 V	EI6951.22
EAIV-92/HD	0 ÷ 35 V	EI6951.92
EAIV-9../HD	custom	EI6951.9..
EGIV-12/HD	±10 V	EI6961.12
EAII-02/HD	0 ÷ 40 mA	EI6952.02
EAII-12/HD	***0 ÷ 20 mA***	***EI6952.12***
EAII-22/HD	0 ÷ 10 mA	EI6952.22
EAII-32/HD	0 ÷ 5 mA	EI6952.32
EAII-9../HD	custom	EI6952.9..
EGII-12/HD	±20 mA	EI6962.12
EAIR-01/HD	0 ÷ 5 kΩ	EI6953.01
EAIR-11/HD	0 ÷ 10 kΩ	EI6953.11
EAIR-21/HD	***0 ÷ 20 kΩ***	***EI6953.21***
EAIR-31/HD	0 ÷ 50 kΩ	EI6953.31
EAIR-41/HD	***0 ÷ 100 kΩ***	***EI6953.41***
EAIR-9../HD	custom	EI6953.9..
EAIB-00/HD	0 ÷ 105 Ω	EI6954.00
EAIB-01/HD	***0 ÷ 130 Ω***	***EI6954.01***
EAIB-02/HD	0 ÷ 600 Ω	EI6954.02
EAIB-03/HD	***0 ÷ 1000 Ω***	***EI6954.03***
EAIP-600/HD	-200 ÷ 50 °C	EI6957.600
EAIP-610/HD	***-50 ÷ 150 °C***	***EI6957.610***
EAIP-620/HD	***0 ÷ 300 °C***	***EI6957.620***
EAIP-630/HD	0 ÷ 600 °C	EI6957.630
EAIP-601/HD	-200 ÷ 50 °C	EI6957.601
EAIP-611/HD	***-50 ÷ 150 °C***	***EI6957.611***
EAIP-621/HD	***0 ÷ 300 °C***	***EI6957.621***
EAIP-631/HD	0 ÷ 600 °C	EI6957.631
EAIP-602/HD	-200 ÷ 50 °C	EI6957.602
EAIP-612/HD	***-50 ÷ 150 °C***	***EI6957.612***
EAIP-622/HD	***0 ÷ 300 °C***	***EI6957.622***
EAIP-632/HD	0 ÷ 600 °C	EI6957.632

Module type	Range	Ord. No.
EAIP-901/HD	-100 ÷ 200 °C	EI6957.901
EAIP-9../HD	custom	EI6957.9..
EAIN-610/HD	***-50 ÷ 150 °C***	***EI6956.610***
EAIN-611/HD	***-50 ÷ 150 °C***	***EI6956.611***
EAIN-612/HD	***-50 ÷ 150 °C***	***EI6956.612***
EAIN-9../HD	custom	EI6956.9..
EAIS-01/HD	-50 ÷ 50 °C	EI6958.01
EAIS-02/HD	***-50 ÷ 100 °C***	***EI6958.02***
EAIS-03/HD	0 ÷ 100 °C	EI6958.03
EAIS-11/HD	-50 ÷ 50 °C	EI6958.11
EAIS-12/HD	***-50 ÷ 100 °C***	***EI6958.12***
EAIS-13/HD	0 ÷ 100 °C	EI6958.13
EAIS-21/HD	-50 ÷ 50 °C	EI6958.21
EAIS-22/HD	***-50 ÷ 100 °C***	***EI6958.22***
EAIS-23/HD	0 ÷ 100 °C	EI6958.23
EPOU-00/HD	***0 ÷ 10 V***	***EI6981.00***
EPOU-10/HD	0 ÷ 5 V	EI6981.10
EPOU-20/HD	0 ÷ 2 V	EI6981.20
EPOU-30/HD	0 ÷ 1 V	EI6981.30
EPOU-9../HD	custom	EI6981.9..
EPOI-00/HD	***0 ÷ 20 mA***	***EI6983.00***
EPOI-10/HD	0 ÷ 10 mA	EI6983.10
EPOI-20/HD	0 ÷ 5 mA	EI6983.20
EPOI-30/HD	0 ÷ 2 mA	EI6983.30
EPOI-40/HD	0 ÷ 1 mA	EI6983.40
EPOI-9../HD	custom	EI6983.9..
EDOU-00/HD	***0 ÷ 10 V***	***EI6984.00***
EDOU-10/HD	0 ÷ 5 V	EI6984.10
EDOU-20/HD	0 ÷ 2 V	EI6984.20
EDOU-30/HD	0 ÷ 1 V	EI6984.30
EDOU-9../HD	custom	EI6984.9..
EDOI-00/HD	***0 ÷ 20 mA***	***EI6985.00***
EDOI-10/HD	0 ÷ 10 mA	EI6985.10
EDOI-20/HD	0 ÷ 5 mA	EI6985.20
EDOI-30/HD	0 ÷ 2 mA	EI6985.30
EDOI-40/HD	0 ÷ 1 mA	EI6985.40
EDOI-9../HD	custom	EI6985.9..
EBI-10/HD	5 V	EI6971.00
EBI-11/HD	***12 V***	***EI6971.10***
EBI-12/HD	***24 V***	***EI6971.20***
EBO-10/HD	***2 A***	***EI6972.10***
EBO-11/HD	***250 mA***	***EI6972.11***

*prefered types are marked by **bold font**, others comes with surcharge and has longer delivery time*