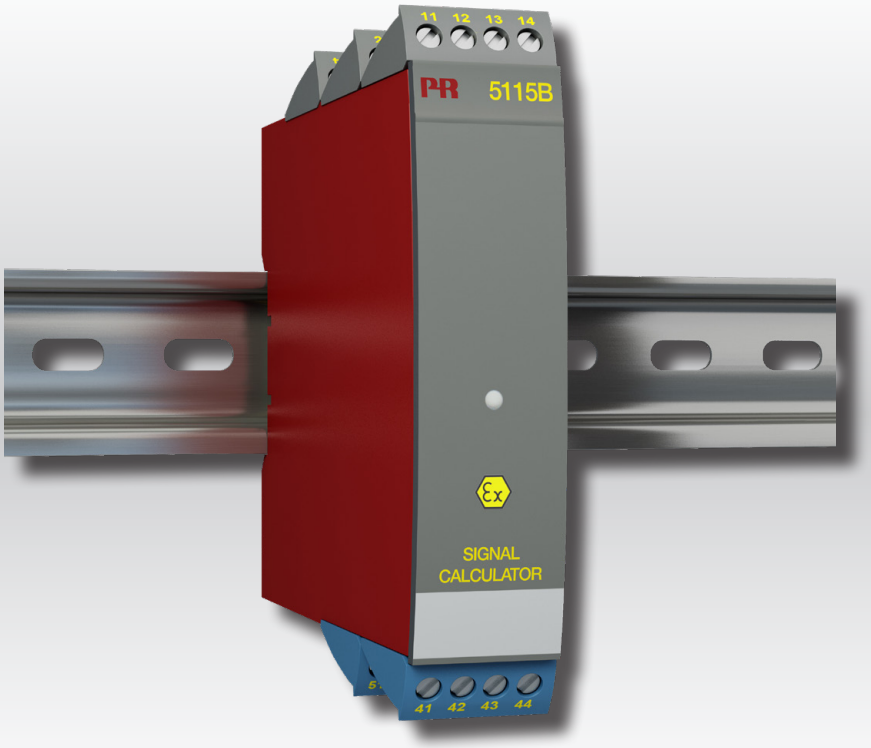
PERFORMANCE
MADE
SMARTER

Product manual
5115
Signal calculator



TEMPERATURE | I.S. INTERFACES | COMMUNICATION INTERFACES | MULTIFUNCTIONAL | ISOLATION | DISPLAY

No. 5115V105-UK
From serial no. 191129001

PR electronics

6 Product Pillars
to meet your every need

Individually outstanding, unrivalled in combination

With our innovative, patented technologies, we make signal conditioning smarter and simpler. Our portfolio is composed of six product areas, where we offer a wide range of analog and digital devices covering over a thousand applications in industrial and factory automation. All our products comply with or surpass the highest industry standards, ensuring reliability in even the harshest of environments and have a 5-year warranty for greater peace of mind.

Temperature

Our range of temperature transmitters and sensors provides the highest level of signal integrity from the measurement point to your control system. You can convert industrial process temperature signals to analog, bus or digital communications using a highly reliable point-to-point solution with a fast response time, automatic self-calibration, sensor error detection, low drift, and top EMC performance in any environment.

I.S. Interface

We deliver the safest signals by validating our products against the toughest safety standards. Through our commitment to innovation, we have made pioneering achievements in developing I.S. interfaces with SIL 2 Full Assessment that are both efficient and cost-effective. Our comprehensive range of analog and digital intrinsically safe isolation barriers offers multifunctional inputs and outputs, making PR an easy-to-implement site standard. Our backplanes further simplify large installations and provide seamless integration to standard DCS systems.

Communication

We provide inexpensive, easy-to-use, future-ready communication interfaces that can access your PR installed base of products. All the interfaces are detachable, have a built-in display for readout of process values and diagnostics, and can be configured via push-buttons. Product specific functionality includes communication via Modbus and Bluetooth and remote access using our PR Process Supervisor (PPS) application, available for iOS and Android.

Multifunction

Our unique range of single devices covering multiple applications is easily deployable as your site standard. Having one variant that applies to a broad range of applications can reduce your installation time and training, and greatly simplify spare parts management at your facilities. Our devices are designed for long-term signal accuracy, low power consumption, immunity to electrical noise and simple programming.

Isolation

Our compact, fast, high-quality 6 mm isolators are based on microprocessor technology to provide exceptional performance and EMC-immunity for dedicated applications at a very low total cost of ownership. They can be stacked both vertically and horizontally with no air gap separation between units required.

Display

Our display range is characterized by its flexibility and stability. The devices meet nearly every demand for display readout of process signals and have universal input and power supply capabilities. They provide a real-time measurement of your process value no matter the industry and are engineered to provide a user-friendly and reliable relay of information, even in demanding environments.

Signal calculator

5115

Table of contents

Warning

GENERAL

This device is designed for connection to hazardous electric voltages.
Ignoring this warning can result in severe personal injury or mechanical damage.
To avoid the risk of electric shock and fire, the safety instructions of this manual must be observed and the guidelines followed.
The specifications must not be exceeded, and the device must only be applied as described in the following.
Prior to the commissioning of the device, this manual must be examined carefully.
Only qualified personnel (technicians) should install this device.
If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Warning

HAZARD-OUS VOLTAGE

Until the device is fixed, do not connect hazardous voltages to the device.
The following operations should only be carried out on a disconnected device and under ESD-safe conditions:

- Dismantlement of the device for setting of DIP-switches and jumpers.
- General mounting, wire connection and disconnection.
- Troubleshooting the device.

Repair of the device and replacement of circuit breakers must be done by PR electronics A/S only.

Warning

INSTAL-LATION

SYSTEM 5000 must be mounted on a DIN rail according to DIN 60715.
The communication connector of SYSTEM 5000 is connected to the input terminals on which dangerous voltages can occur, and it must only be connected to the programming unit Loop Link by way of the enclosed cable.

Symbol identification

Triangle with an exclamation mark: Read the manual before installation and commissioning of the device in order to avoid incidents that could lead to personal injury or mechanical damage. Warning / demand. Potentially lethal situations.

The CE mark proves the compliance of the device with the essential requirements of the EU-directives.

The double insulation symbol shows that the device is protected by double or reinforced insulation.

Ex devices have been approved acc. to the ATEX directive for use in connection with installations in explosive areas.

Safety instructions

Definitions

Hazardous voltages have been defined as the ranges: 75 to 1500 Volt DC, and 50 to 1000 Volt AC.
Technicians are qualified persons educated or trained to mount, operate, and also trouble-shoot technically correct and in accordance with safety regulations.
Operators, being familiar with the contents of this manual, adjust and operate the knobs or potentiometers during normal operation.

Receipt and unpacking

Unpack the device without damaging it and check whether the device type corresponds to the one ordered. The packing should always follow the device until this has been permanently mounted.

Environment

Avoid direct sun light, dust, high temperatures, mechanical vibrations and shock, and rain and heavy moisture. If necessary, heating in excess of the stated limits for ambient temperatures should be avoided by way of ventilation.
The device must be installed in pollution degree 2 or better.
The device is designed to be safe at least under an altitude up to 2 000 m.
The device is designed for indoor use.

Mounting

Only technicians, who are familiar with the technical terms, warnings, and instructions in the manual and who are able to follow these, should connect the device. Should there be any doubt as to the correct handling of the device, please contact your local distributor or, alternatively,

PR electronics A/S
www.prelectronics.com

Mounting and connection of the device should comply with national legislation for mounting of electric materials, i.e. wire cross section, protective fuse, and location.

Stranded wire should be installed with an insulation stripping length of 5 mm or via a suitable insulated terminal such as a bootlace ferrule.

Descriptions of input / output and supply connections are shown in the block diagram and side label.

The following apply to fixed hazardous voltages-connected devices:

The max. size of the protective fuse is 10 A and, together with a power switch, it should be easily accessible and close to the device. The power switch should be marked with a label telling it will switch off the voltage to the device.

Year of manufacture can be taken from the first two digits in the serial number.

Calibration and adjustment

During calibration and adjustment, the measuring and connection of external voltages must be carried out according to the specifications of this manual. The technician must use tools and instruments that are safe to use.

Normal operation

Operators are only allowed to adjust and operate devices that are safely fixed in panels, etc., thus avoiding the danger of personal injury and damage. This means there is no electrical shock hazard, and the device is easily accessible.

Cleaning

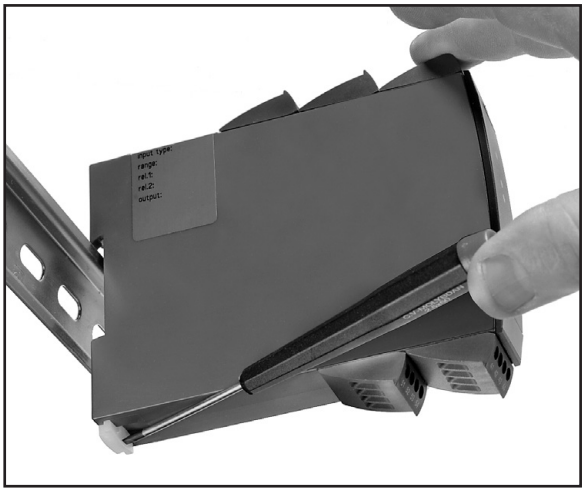
When disconnected, the device may be cleaned with a cloth moistened with distilled water.

Liability

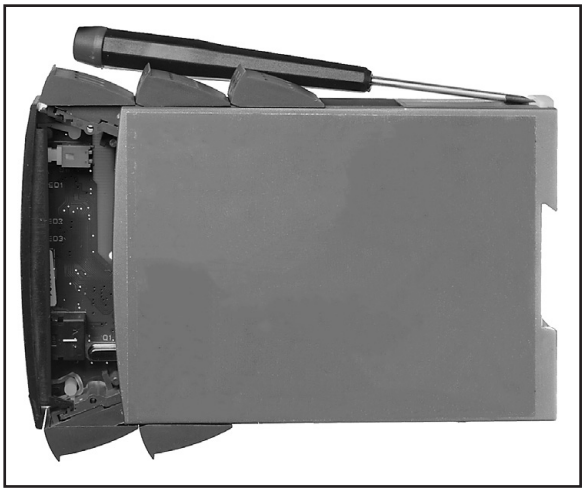
To the extent the instructions in this manual are not strictly observed, the customer cannot advance a demand against PR electronics A/S that would otherwise exist according to the concluded sales agreement.

How to demount system 5000

First, remember to demount the connectors with hazardous voltages.

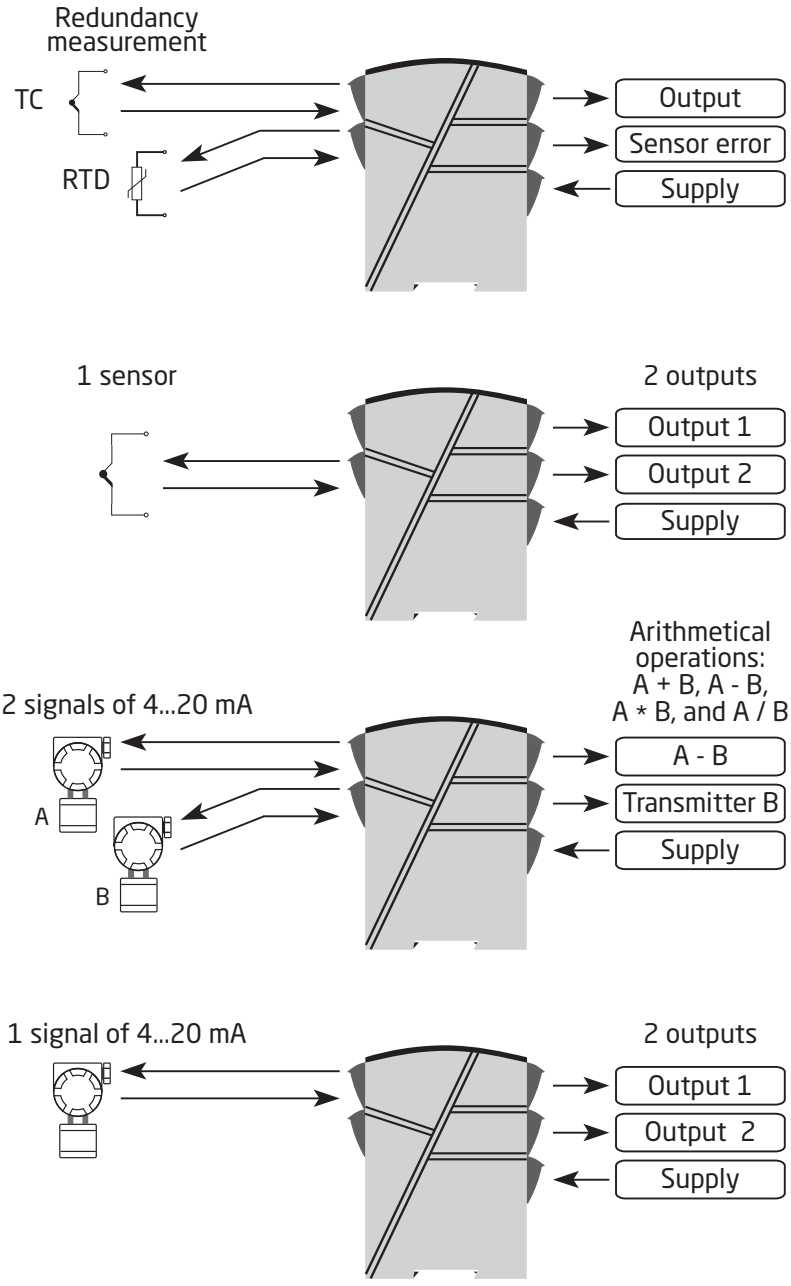


Picture 1:
By lifting the bottom lock, the device is detached from the DIN rail.



Picture 2:
By lifting the upper lock and pulling the front plate simultaneously the PCB can be removed Switches and jumpers can now be adjusted.

Applications



Signal calculator
5115

- Redundancy measurement with 2 input signals
- Signal calculator with four arithmetical operations
- Duplication of the input signal
- Input for RTD, Ohm, TC, mV, mA, and V
- Universal AC or DC supply

Application

- Redundancy measurement of temperature by means of two sensors, where the secondary sensor takes over the measurement when a sensor error occurs on the primary sensor.
- Duplication of the input signal, e.g. from a temperature sensor or an analogue process signal to two separate analog outputs.
- Signal calculator with the four arithmetical operations: addition, subtraction, multiplication and division.
- Example: Differential measurement: (Input 1 * K1) - (Input 2 * K2) + K4
- Example: Average measurement: (Input 1 * 0.5) + (Input 2 * 0.5) + K4
- Example: Different functions on the outputs: Output 1 = input 1 - input 2, and Output 2 = input 1 + input 2

Technical characteristics

- Within a few seconds the user can program PR5115 to a selected application using the configuration program PReset.
- A green front LED that indicates normal operation, sensor error on each sensor, and functional error.
- Continuous check of vital stored data for safety reasons.
- 5-port 3.75 kVAC galvanic isolation.

Mounting / installation

- Mounted vertically or horizontally on a DIN rail. As the devices can be mounted without any distance between neighbouring units, up to 42 devices can be mounted per metre.

Order

Type	Version		Input	
5115	Standard	: A	RTD / TC / mV / R / mA / V	: _
	ATEX Ex	: B	RTD / TC / mV / R	: 1
			mA / V / mV	: 2
			Input 1, RTD / TC / mV / R Input 2, mA / V / mV	: 3

Example: 5115B3

NB! Please remember to order CJC connectors type 5910Ex (input 1) and 5913Ex (input 2) for TC inputs with an internal CJC.

Electrical specifications

Environmental conditions

Operating temperature . . . . . -20°C to +60°C
Calibration temperature . . . . . 20...28°C
Relative humidity . . . . . < 95% RH (non-cond.)
Protection degree IP20

Mechanical specifications

Dimensions (HxWxD) . . . . . 109 x 23.5 x 130 mm
Weight approx. . . . . 225 g
DIN rail type . . . . . DIN EN 60715 - 35 mm
Wire size (min....max.) . . . . . 0.13...2.08 mm^2 AWG 26...14 stranded wire
Screw terminal torque . . . . . 0.5 Nm
Vibration . . . . . IEC 60068-2-6
2...13.2 Hz . . . . . ±1 mm
13.2...100 Hz . . . . . ±0.7 g

Common electrical specifications

Supply voltage . . . . . 21.6...253 VAC, 50...60 Hz
or 19.2...300 VDCC
Fuse . . . . . 400 mA SB / 250 VAC
Max. required power, 1 / 2 channels . . . . . 2.1 W / 2.8 W
Max. power dissipation . . . . . 2.0 W
Max. required power is the maximum power needed at terminals 31 and 33.
Max. power dissipation is the maximum power dissipated by the device.

Isolation voltage, test / operation . . . . . 3.75 kVAC / 250 VAC
PELV/SELV . . . . . IEC 61140
Communications interface . . . . . Loop Link
Signal / noise ratio . . . . . Min. 60 dB (0...100 kHz)
Redundancy switch-over time . . . . . ≤ 400 ms
Updating time:
Temperature input . . . . . 115 ms
mA / V / mV input . . . . . 75 ms
Response time (0...90%, 100...10%), programmable:
Temperature input . . . . . 400 ms to 60 s
mA / V / mV input . . . . . 250 ms to 60 s
Signal dynamics, input . . . . . 22 bit
Signal dynamics, output . . . . . 16 bit

Accuracy, the greater of the general and basic values:

General values		
Input type	Absolute accuracy	Temperature coefficient
All	≤ ±0.05% of span	≤ ±0.01% of span / °C

Basic values		
Input type	Basic accuracy	Temperature coefficient
mA	≤ ±4 µA	≤ ±0.4 µA / °C
Volt	≤ ±10 µV	≤ ±1 µV / °C
RTD	≤ ±0.2°C	≤ ±0.01°C / °C
Lin. R	≤ ±0.1°Ω	≤ ±10 mΩ / °C
TC type: E, J, K, L, N, T, U	≤ ±1°C	≤ ±0.05°C / °C
TC type: B, R, S, W3, W5, Kr, Lr	≤ ±2°C	≤ ±0.2°C / °C

EMC - immunity influence. . . . . < ±0.5% of span
Extended EMC immunity:
NAMUR NE 21, A criterion, burst . . . . . < ±1% of span

Auxiliary supplies:
Reference voltage . . . . . 2.5 VDC ±0.5% / 15 mA
2-wire supply (pin 44...42 and 54...52). . . . . 28...17.1 VDC / 0...20 mA

Electrical specifications - input
Max. offset . . . . . 50% of selected max. value

TC input

Type	Min. value	Max. value	Min. span	Standard
B	+400°C	+1820°C	200°C	IEC 60584-1
E	-100°C	+1000°C	50°C	IEC 60584-1
J	-100°C	+1200°C	50°C	IEC 60584-1
K	-180°C	+1372°C	50°C	IEC 60584-1
L	-100°C	+900°C	50°C	DIN 43710
N	-180°C	+1300°C	100°C	IEC 60584-1
R	-50°C	+1760°C	200°C	IEC 60584-1
S	-50°C	+1760°C	200°C	IEC 60584-1
T	-200°C	+400°C	50°C	IEC 60584-1
U	-200°C	+600°C	75°C	DIN 43710
W3	0°C	+2300°C	200°C	ASTM E988-90
W5	0°C	+2300°C	200°C	ASTM E988-90
Kr	0°C	+400°C	50°C	GOST 68
Lr	-200°C	+800°C	50°C	GOST 3044-84

Sensor error current . . . . . Nom. 30 µA
CJC . . . . . < ±1°C

RTD and linear resistance input

Input type	Min. value	Max. value	Min. span	Standard
Pt46	0°C	+400°C	25°C	GOST 6651-59
Pt100	-200°C	+850°C	25°C	IEC 60751
Ni100	-60°C	+250°C	25°C	DIN 43760
Cu53	0°C	+400°C	100°C	GOST 6651-59
Linear resist.	0 Ω	5000 Ω	30 Ω	-

Max. cable resistance per wire . . . . . 10 Ω
Sensor current . . . . . Nom. 0.2 mA
Effect of sensor cable resistance (3- / 4-wire) . . . . . < 0.002 Ω / Ω
Sensor error detection . . . . . Yes

mV input
Measurement range . . . . . -150...+150 mV
Min. measurement range (span) . . . . . 5 mV
Input resistance . . . . . Nom. 10 MΩ

Current input
Measurement range . . . . . 0...100 mA
Min. measurement range (span) . . . . . 4 mA
Input resistance:
Supplied unit . . . . . Nom. 10 Ω + PTC 10 Ω
Non-supplied unit . . . . . RSHUNT = ∞, VDROP < 6 V

Voltage input
Measurement range . . . . . 0...250 VDC
Min. measurement range (span) . . . . . 5 mVDC
Input resistance ≤ 2.5 VDC . . . . . Nom. 10 MΩ
> 2.5 VDC . . . . . Nom. 5 MΩ

Electrical specifications - output

Current output
Signal range. . . . . 0...23 mA
Min. signal range (span). . . . . 10 mA
Load (max.) . . . . . ≤ 600 Ω
Load stability . . . . . ≤ 0.01% of span / 100 Ω
Current limit. . . . . ≤ 28 mA

Voltage output
Signal range. . . . . 0...10 VDC
Min. signal range (span). . . . . 500 mV
Load (min.) . . . . . 500 kΩ

2-wire 4...20 mA output
Signal range. . . . . 4...20 mA
Load stability . . . . . ≤ 0.01% of span / 100 Ω
Load resistance. . . . . ≤ (Vsupply-3.5) / 0.023 A [Ω]
Max. external 2-wire supply . . . . . 29 VDC
Effect of external 2-wire supply voltage variation . . . . . < 0.005% of span / V

Sensor error detection
Programmable . . . . . 0...23 mA
NAMUR NE43 Upscale . . . . . 3 mA
NAMUR NE43 Downscale. . . . . 3.5 mA

Of span = of the currently selected measurement range

I.S. / Ex data for 5115B, all types

Terminal 31, 32 and 33

Um	250 V

I.S. / Ex data for 5115 B1 (input 1 for 5115B3)

Terminal 41, 42, 44 to 43 (51, 52, 54 to 53)

Uo	7.5 VDC
Io	6.0 mADC
Po	11.25 mW
Lo	200 mH
Co	6.0 µF

I.S. / Ex data for 5115 B2 (input 2 for 5115B3)

Terminal 44 to 41 (54 to 51)

Uo	28 VDC
Io	87 mADC
Po	0.62 W
Lo	4.2 mH
Co	0.08 µF

Terminal 42, 43 to 41 (52, 53 to 51)

Uo	7.5 VDC
Io	6.0 mADC
Po	11.25 mW
Lo	200 mH
Co	6.0 µFA

Observed authority requirements

EMC	2014/30/EU
LVD	2014/35/EU
ATEX	2014/34/EU
RoHS	2011/65/EU

Approvals

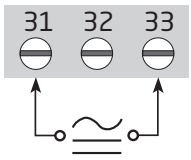
Det Norske Veritas, Ships & Offshore	TAA0000101
EAC	TR-CU 020/2011

I.S. / Ex approvals

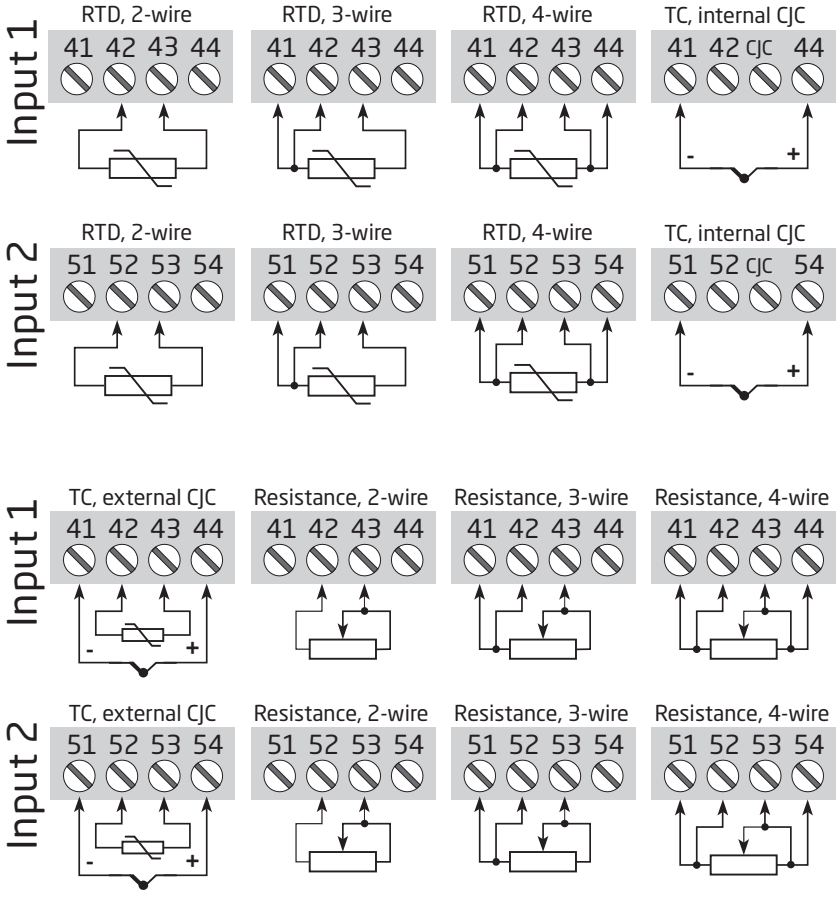
ATEX	DEMKO 00ATEX128567
EAC Ex TR-CU 012/2011	RU C-DK.HA65.B.00355/19

Connections

Supply:

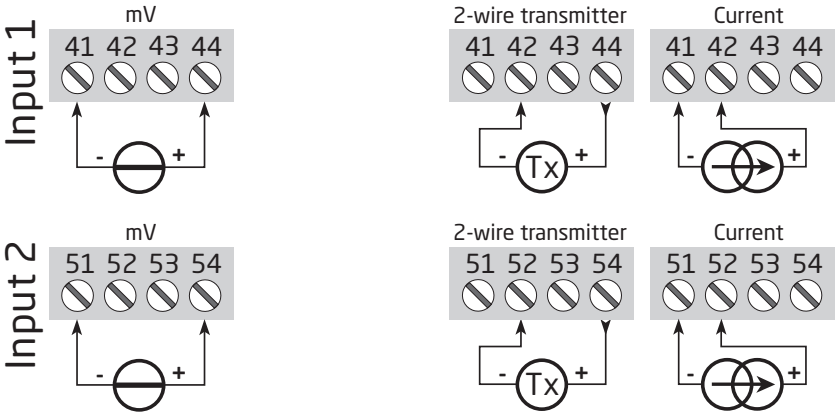


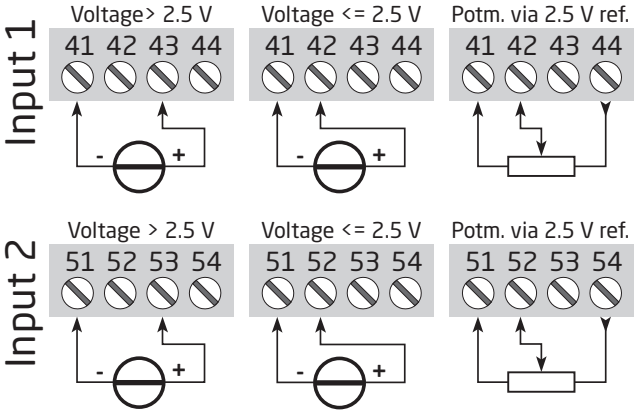
Inputs:



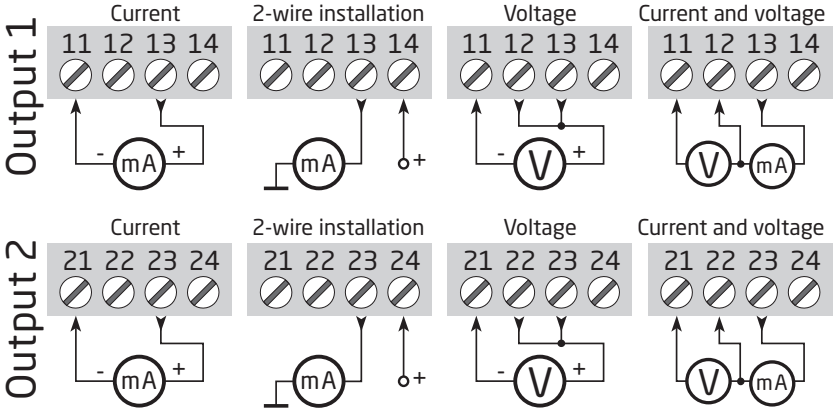
Connections

Inputs:

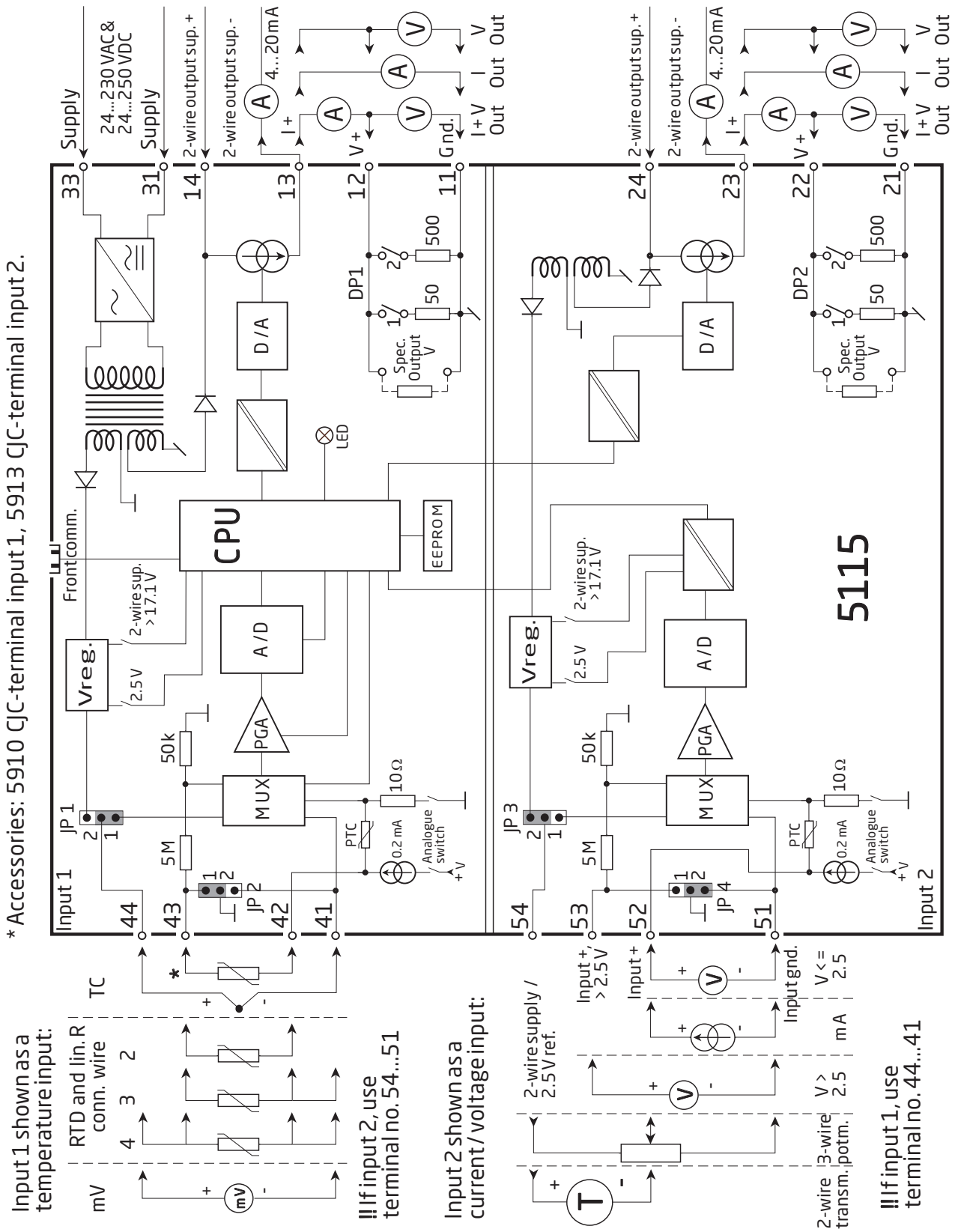




Outputs:



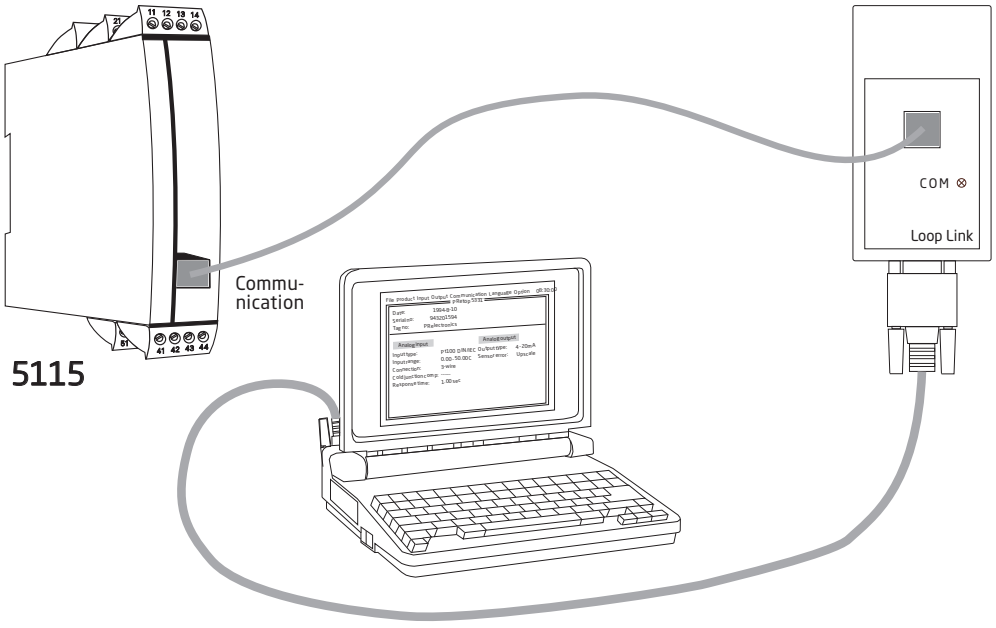
Block diagram



Selection of input type (5115A)

Input	JP 1	JP 2	JP 3	JP 4
Temperature input 1	1	1	-	-
Temperature input 2	-	-	1	1
Current / voltage input 1	2	2	-	-
Current / voltage input 2	-	-	2	2

5115 connection to Loop Link



Function description

In general

Output 1 and output 2 can be configured for standard current / voltage signals in the ranges 0/4...20 mA and 0...10 VDC. When selecting the arithmetical functions, up to 4 constants, K1, K2, K3, and K4, must also be defined.
The functions can be selected individually for both outputs. Duplication of the signal from e.g. input 1 is obtained by selecting the function Input 1 for both output 1 and output 2.

Selection of functions for the outputs (to be selected in the configuration program PReset)

Input 1

Input 1 is transmitted directly to the selected output.

Input 2

Input 2 is transmitted directly to the selected output.

Addition: (Input 1 * K1 + Input 2 * K2 + K4)

After calculation, the result of the addition is transmitted to the selected output.

Example 1

When adding 2 identically scaled input signals of e.g. 4...20 mA, the output would be 8...40 mA at the same scaling. But as the output follows standard current signals of 0/4...20 mA, the scaling on the output is double of the scaling on the inputs. This means that each input must be scaled by only half the scale of the output. This is done by setting K1 and K2 at 0.5. The offset constant K4 will typically be 0.

Example 2

When adding 2 differently scaled input signals, K1 and K2 can be calculated as follows:
Input 1: 4...20 mA corresponding to a flow of 0...100 m3 / h.
Input 2: 4...20 mA corresponding to a flow of 0...150 m3 / h.
The output signal of 4...20 mA must correspond to a flow of 0...250 m3 / h.
Input 1 must be scaled by 100/250 corresponding to a K1 of 0.4.
Input 2 must be scaled by 150/250 corresponding to a K2 of 0.6.
The offset constant K4 will typically be 0.

Subtraction: (Input 1 * K1 - Input 2 * K2 + K4)

After calculation, the result of the subtraction is transmitted to the selected output.
Input 1 must be the highest signal, or the offset constant K4 must be of sufficient value to ensure that the output is not negative.

Example

When subtracting 2 identically scaled signals, the constants K1 and K2 = 1 and the offset constant K4 = 0.
If K1, K2, and K4 = 0.5, the output will be 50% by identical signals on the inputs. If input 1 receives a 100% signal and input 2 receives a 0% signal, the output will be 100%. If input 2 receives a 100% signal and input 1 receives a 0% signal, the output will be 0%.

Subtraction: (Input 2 * K2 - Input 1 * K1 + K4)

Input 2 must be the highest signal. For further details see Subtraction: (Input 1 * K1 - Input 2 * K2 + K4).

Multiplication: ((Input 1 + K1) * (Input 2 + K2) * K3 + K4)

After calculation, the result of the multiplication is transmitted to the selected output.
The offset constants K1 and K2 are used as additions on the inputs. The constant K3 is multiplied on the result and the offset constant K4 is added to the outputs.

Example

By means of a potentiometer via the 2.5 V reference voltage on input 1, the signal on input 2 can be variable by a factor of 0.75...1.25.

Configuration of input 1:

When the potentiometer is at zero, the result of (Input 1 + K1) * K3 must be 0.75 and when the potentiometer is in the top position, the result of (Input 1 + K1) * K3 must be 1.25. By solving the following two equations with 2 unknowns, K1 and K3 can be found:
Equation 1: (0 + K1) * K3 = 0.75
Equation 2: (1 + K1) * K3 = 1.25
Solution: K1 = 1.5 and K3 = 0.5

Configuration of input 2:
As the signal on input 2 must be scaled by its real value, K2 must be 0.

Configuration of K4:

In the above example, there is no offset on the output, K4 is thus set to 0.

Division: $\left(\frac{\text{Input 1 + K2}}{\text{Input 2 + K2}} \text{ x K3 + K4} \right)$

After calculation, the result of the division is transmitted to the selected output.
The constants K1, K2, K3, and K4 are configured in the same way as described under multiplication.

Division: $\left(\frac{\text{Input 1 + K2}}{\text{Input 2 + K2}} \text{ x K3 + K4} \right)$

After calculation, the result of the division is transmitted to the selected output.
The constants K1, K2, K3, and K4 are configured in the same way as described under multiplication.

Redundancy: (Primary input 1 –> Secondary input 2 * K2 + K4)

The redundancy function transmits the primary signal from input 1 to the selected output. By sensor error on input 1, the output automatically changes to the secondary signal from input 2.
If the signals on input 1 and input 2 are identically scaled, K2 = 1 and K4 = 0.
Sensor error detection can be selected acc. to requirement, but if "off" mode is selected, the output is undefined in case of sensor error on both inputs.
Maximum safety is obtained by using output 2 for sensor error detection. This can be done by selecting [Output] as [Fixed] and selecting [Sensor error action] and [Detect] on output 2 acc. to requirement.

Redundancy: (Primary input 2 –> Secondary input 1 * K1 + K4)

See the above description of "redundancy" for further details.

Green LED function

The green front LED indicates the following states:

Normal operation, i.e. no errors:	LED flashes quickly.
Functional error:	LED lights constantly.
Sensor error on input 1:	LED flashes once per second.
Sensor error on input 2:	LED flashes twice per second.
Sensor error both inputs:	LED lights constantly.

Document history

The following list provides notes concerning revisions of this document.

Rev. ID	Date	Notes
105	2208	Options for TC-Kr, Pt46 and Cu53 added.

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Our trusted red boxes are supported wherever you are

All our devices are backed by expert service and a 5-year warranty. With each product you purchase, you receive personal technical support and guidance, day-to-day delivery, repair without charge within the warranty period and easily accessible documentation.

We are headquartered in Denmark, and have offices and authorized partners the world over. We are a local business with a global reach. This means that we are always nearby and know your local markets well. We are committed to your satisfaction and provide PERFORMANCE MADE SMARTER all around the world.

For more information on our warranty program, or to meet with a sales representative in your region, visit prelectronics.com.

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PERFORMANCE MADE SMARTER

PR electronics is the leading technology company specialized in making industrial process control safer, more reliable and more efficient. Since 1974, we have been dedicated to perfecting our core competence of innovating high precision technology with low power consumption. This dedication continues to set new standards for products communicating, monitoring and connecting our customers' process measurement points to their process control systems.

Our innovative, patented technologies are derived from our extensive R&D facilities and from having a great understanding of our customers' needs and processes. We are guided by principles of simplicity, focus, courage and excellence, enabling some of the world's greatest companies to achieve PERFORMANCE MADE SMARTER.