

PERFORMANCE
MADE
SMARTER

Safety manual

9116

Universal converter



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

Version No. V4R0

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, Android and Windows.



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.

SAFETY MANUAL

UNIVERSAL CONVERTER 9116

This safety manual is valid for the following product versions:

9116-003
9116-002
9116-001

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1. Observed standards

Standard	Description
IEC 61508	Functional Safety of electrical / electronic / programmable electronic safety-related systems
IEC 61508-2:2000	Part 2: Requirements for electrical / electronic / programmable electronic safety-related systems
IEC 61508-3:1998	Part 3: Software requirements
IEC 61326-3-1:2008	Immunity requirements for safety-related systems

2. Acronyms and abbreviations

Acronym / Abbreviation	Designation	Description
Element		Term defined by IEC 61508 as "part of a subsystem comprising a single component or any group of components that performs one or more element safety functions"
PFD	Probability of Failure on Demand	This is the likelihood of dangerous safety function failures occurring on demand.
PFH	Probability of dangerous Failure per Hour	The term "Probability" is misleading, as IEC 61508 defines a Rate.
SFF	Safe Failure Fraction	Safe Failure Fraction summarizes the fraction of failures which lead to a safe state and the fraction of failures which will be detected by diagnostic measures and lead to a defined safety action.
SIF	Safety Integrity Function	Function that provides fault detection (to ensure the necessary safety integrity for the safety functions)
SIL	Safety Integrity Level	The international standard IEC 61508 specifies four discrete safety integrity levels (SIL 1 to SIL 4). Each level corresponds to a specific probability range regarding the failure of a safety function.

3. Purpose of the product

Conversion and scaling of temperature (Pt, Ni and TC), voltage, potentiometer, linear resistance and current signals from hazardous area.

The device can be mounted in the safe area and in zone 2 / div. 2 and receive signals from zone 0, 1, 2, 20, 21 and 22 / Class I/II/III, Div. 1, Gr. A-G.

Error events, including cable faults, are monitored and signalled via the individual status relay and/or a collective electronic signal via the power rail.

The 9116 has been designed, developed and certified for use in SIL 2 applications according to the requirements of IEC 61508.

4. Assumptions and restrictions for use of the product

4.1 Basic safety specifications

Operational temperature range	-20...+60°C
Storage temperature range.	-20...+85°C
Power supply type, min.	Double or reinforced
Supply voltage	19.2...31.2 VDC
Relay output pulse length, min.	70 ms
Loop supply	>16.5 V @ 20 mA
External loop supply voltage.	5...26 VDC + external drop
(Passive output)	
Mounting area	Zone 2 / Division 2 or safe area
Mounting environment	Pollution degree 2 or better

4.2 Safety accuracy

The analog output and relay output corresponds to the applied input within the safety accuracy.

Safety accuracy ±2%

4.2.1 Minimum span

For temperature measurements, the selected range (OUT.HI - OUT.LO), and for linear resistance measurements the selected range (R 100% - R 0%), shall be larger or equal to the values below:

Input type	Minimum span for safety accuracy
Pt100, Pt200, Pt1000	28°C
Pt500, Ni100, Ni120, Ni1000	43°C
Pt50, Pt400, Ni50	57°C
Pt250, Pt300	85°C
Pt20	142°C
Pt10	283°C
TC: E, J, K, L, N, T, U	91°C
TC: B, R, S, W3, W5, LR	153°C
Linear resistance, R 100% ≤ 800 Ω	53 Ω
Linear resistance, R 100% > 800 Ω	667 Ω

4.2.2 Range limitations

TC type B shall not be used below +400°C

4.3 Associated equipment

4.3.1 RTD or linear resistance sensor wiring

If a 2-wire or a 3-wire connection for RTD or linear resistance is selected, the end user must ensure that the applied sensor wiring does not introduce failures exceeding the requirements for the safety application.

4.3.2 Sensor errors

If the loop supply is used to supply a current input signal, the sensor error indication shall be enabled on the safety output(s).

If sensor error detection is disabled, or if any of the configurations below are used, the user must ensure that the applied sensor, including wiring, has a failure rate that qualifies it for the safety application without sensor error detection enabled:

- Input is current, 0-20 mA
- Input is voltage
- Input is linear resistance and R_0% < 18 Ω (no short circuit detection)
- Input is Pt10, Pt20 or Pt50 (no short circuit detection)
- Input is potentiometer (no short circuit detection on arm)

4.3.3 Process calibration

If a process calibration is taken into SIL-mode operation, it is mandatory that the accuracy of the device (and sensor, if applicable) are tested by the end user after SIL-mode is entered, in addition to the normal functional test. Refer to section 14 - Safe parameterization - user responsibility.

4.3.4 Analog output

The connected safety PLC shall be able to detect and handle the fault indications on the analog output of the 9116 converter by having a NAMUR NE43-compliant current input.

4.3.5 Relay output

The relay output shall only be connected to equipment which has a current limiting function of 2 A.

4.4 Failure rates

The basic failure rates from the Siemens standard SN 29500 are used as the failure rate database.

Failure rates are constant, wear-out mechanisms are not included.

External power supply failure rates are not included.

4.5 Safe parameterization

The user is responsible for verifying the correctness of the configuration parameters. (See section 14 Safe parameterization - user responsibility).

Manual override may not be used for safety applications.

4.6 Installation in hazardous areas

The IECEx Installation drawing, ATEX Installation drawing and FM Installation drawing shall be followed if the products are installed in hazardous areas.

5. Functional specification of the safety function

Conversion of current signals (0...20 mA or 4...20 mA), voltage signals, potentiometer, linear resistance, RTD sensor signals or thermocouple sensor signals from hazardous areas to a 4...20 mA current output signal, and/or an output relay, within specified accuracy.

For RTD and linear resistance input sensors, cable resistances of up to 50 Ω per wire can be compensated if 3- or 4-wire connection is configured.

For thermocouple sensors, cold junction temperature errors can be compensated, either by an internally mounted temperature sensor, or by an accessory connector with a built-in temperature sensor. The selection of CJC measurement must be done and verified by the end user.

6. Functional specification of the non-safety functions

The status relay (terminal 33 and 34), error signal on power rail (terminal 91) and LED outputs are not suitable for use in any Safety Instrumented Function.

7. Safety parameters

RTD, TC, LinR and Potentiometer input, Current output	
Probability of dangerous Failure per Hour (PFH)	4.30E-08
	Note ¹
Probability of failure on demand (PFD) - 1 year proof test interval	2.82E-04
Proof test interval (10% of loop PFD)	4 years
Safe Failure Fraction	93%
RTD, TC, LinR and Potentiometer input, Relay output	
Probability of dangerous Failure per Hour (PFH)	6.20E-08
	Note ¹
Probability of failure on demand (PFD) - 1 year proof test interval	4.03E-04
Proof test interval (10% of loop PFD)	3 years
Safe Failure Fraction	90%
Voltage input, Current output	
Probability of dangerous Failure per Hour (PFH)	5.60E-08
	Note ¹
Probability of failure on demand (PFD) - 1 year proof test interval	3.66E-04
Proof test interval (10% of loop PFD)	3 years
Safe Failure Fraction	93%
Voltage input, Relay output	
Probability of dangerous Failure per Hour (PFH)	7.60E-08
	Note ¹
Probability of failure on demand (PFD) - 1 year proof test interval	4.89E-04
Proof test interval (10% of loop PFD)	2 years
Safe Failure Fraction	91%

Current input, Current output	
Probability of dangerous Failure per Hour (PFH)	4.20E-08
	Note ¹
Probability of failure on demand (PFD) - 1 year proof test interval	2.77E-04
Proof test interval (10% of loop PFD)	5 years
Safe Failure Fraction	95%
Current input, Relay output	
Probability of dangerous Failure per Hour (PFH)	6.20E-08
	Note ¹
Probability of failure on demand (PFD) - 1 year proof test interval	4.00E-04
Proof test interval (10% of loop PFD)	3 years
Safe Failure Fraction	93%
Common Safety Parameters	
Demand response time	Signal input: < 0.5 seconds Potentiometer and linear resistance input < 0.65 seconds Temperature input: < 1.1 seconds
Demand mode	High
Demand rate	3000 seconds
Mean Time To Repair (MTTR)	24 hours
Diagnostic test interval	30 seconds
Hardware Fault Tolerance (HFT)	0
Component Type	B
SIL capability	SIL 2
Description of the "Safe State", analog output	Output \leq 3.6 mA or Output \geq 21 mA
Description of the "Safe State", relay output	Contact open (relay de-energized)
Relay lifetime (Note ²)	100 000 times

Note¹: The 9116 contains no lifetime limiting components, therefore the PFH figures are valid for up to 12 years, according to IEC 61508.

Note²: The user must calculate the product lifetime with regard to the relay lifetime.

8. Hardware and software configuration

All configurations of software and hardware versions are fixed from factory, and cannot be changed by end-user or reseller. This manual only covers products labelled with the product version (or range of versions) specified on the front page.

9. Failure category

Failure rates (1/h) for RTD, TC, LinR and Potentiometer input, Current output	
Fail Safe Detected	0.000E-0
Fail Safe Undetected	2.78E-07
Fail Dangerous Detected	3.52E-07
Fail Dangerous Undetected	4.30E-08
Failure rates (1/h) for RTD, TC, LinR and Potentiometer input, Relay output	
Fail Safe Detected	0.000E-0
Fail Safe Undetected	3.59E-07
Fail Dangerous Detected	2.30E-07
Fail Dangerous Undetected	6.20E-08
Failure rates (1/h) for Voltage input, Current output	
Fail Safe Detected	0.000E-0
Fail Safe Undetected	3.95E-07
Fail Dangerous Detected	4.79E-07
Fail Dangerous Undetected	5.60E-08
Failure rates (1/h) for Voltage input, Relay output	
Fail Safe Detected	0.000E-0
Fail Safe Undetected	4.80E-07
Fail Dangerous Detected	3.53E-07
Fail Dangerous Undetected	7.60E-08
Failure rates (1/h) for Current input, Current output	
Fail Safe Detected	0.000E-0
Fail Safe Undetected	4.44E-07
Fail Dangerous Detected	5.54E-07
Fail Dangerous Undetected	4.20E-08
Failure rates (1/h) for Current input, Relay output	
Fail Safe Detected	0.000E-0
Fail Safe Undetected	6.36E-07
Fail Dangerous Detected	3.20E-07
Fail Dangerous Undetected	6.20E-08

10. Periodic proof test procedure

Step	Action
1	Bypass the safety PLC or take other appropriate action to avoid a false trip
2	Connect a simulator identical to the input setup
3	Apply input value corresponding to 0/100% output range
4	Observe whether the outputs acts as expected
5	Restore the input terminals to full operation
6	Remove the bypass from the safety PLC or otherwise restore normal operation

This test will detect approximately 95% of possible "du" (dangerous undetected) failures in the pulse isolator. The proof test is equivalent to the functional test.

11. Procedures to repair or replace the product

Any failures that are detected and that compromise functional safety should be reported to the sales department at PR electronics A/S.

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

12. Maintenance

No maintenance required.

13. Documentation for routing diagram

The routing diagram is shown in section 16.2.

13.1 In general

When configuring the 9116, you will be guided through all parameters and you can choose the settings which fit the application. For each menu there is a scrolling help text which is automatically shown in line 3 on the display.

Configuration is carried out by use of the 3 function keys:

- ⏪ will increase the numerical value or choose the next parameter
- ⏩ will decrease the numerical value or choose the previous parameter
- ⏹ will accept the chosen value and proceed to the next menu

When configuration is completed, the display will return to the default state 1.0.

Pressing and holding ⏹ will return to the previous menu or return to the default state (1.0) without saving the changed values or parameters.

If no key is activated for 1 minute, the display will return to the default state (1.0) without saving the changed values or parameters.

13.2 Further explanations

13.2.1 Password protection

Password protection: Programming access can be blocked by assigning a password. The password is saved in the device in order to ensure a high degree of protection against unauthorized modifications to the configuration. If the configured password is not known, please contact PR electronics support - www.prelectronics.com/contact.

Password protection is mandatory in SIL applications.

13.2.2 Sensor/cable fault information via display front 45xx

When the function is enabled and supported by selected input type, sensor or cable faults are displayed as SE.BR (sensor break) or SE.SH (cable short-circuited).

In case of sensor or cable fault the backlight flashes. This can be reset by pressing the ⏹ key. When the sensor or cable fault has been remedied, the device will return to normal operation.

13.3 Advanced functions (ADV.SET)

The device gives access to a number of advanced functions which can be reached by answering "Yes" to the point "ADV.SET".

13.3.1 Memory (MEM)

In the memory menu a non-SIL configuration can be either saved or loaded from the local memory of the 45xx display unit. Choose SAVE to store the current configuration in the 45xx memory. Press LOAD to read a previously stored configuration in the 45xx memory and store it in the device. It is only possible to load a configuration stored from the same type of device and from the same version, or earlier.

13.3.2 Display setup (DISP)

The brightness contrast and the backlight can be adjusted.

Tag number with 5 alphanumerics can be entered.

Functional readout in line 3 of the display can be selected: choose between readout of output current or tag no. When selecting "ALT" the readout alternates between output current and tag no.

13.3.3 Password (PASS)

Here you can choose a password between 0000 and 9999 in order to protect the device against unauthorized modifications to the configuration. The device is delivered default without password.

13.3.4 Language (LANG)

In this menu you can choose between 7 different language versions of help texts that will appear in the menu. You can choose between UK, DE, FR, IT, ES, SE and DK.


13.3.5 Process calibration (CAL)

A process calibration can be made by the end user. A known process signal must be applied for both low and high end of the input measurement range. The known input of the applied low end signal must be entered in the CAL.LO menu and confirmed by pressing OK before removing or changing the applied signal to the high end signal. The known input of the applied high end signal must be entered in the CAL.HI menu and confirmed by pressing OK before removing. It is possible to enable or disable the use of the latest process calibration.

13.3.6 Power rail (RAIL)

In this menu it can be chosen if sensor errors are transmitted to the central surveillance in the PR 9410 power control device.

13.3.7 Simulation (SIM)

It is possible to override the actual measured input signal by a simulated value. In the REL.SIM menu it is possible to simulate the relay state with out affecting the analog output, by pressing . Leaving the simulation menus, or disconnecting the 45xx device, will disable the simulation mode and bring the output back to correspond to the actual measured value. Simulation is not possible in SIL-mode.

13.3.8 Safety integrity level (SIL)

See section 14 - Safe parameterization - user responsibility

14. Safe parameterization - user responsibility**14.1 Safety-related configuration parameters****14.1.1 Common parameters**

Name	Function
IN.TYPE	Selected input type: TEMP = Temperature CURR = Current VOLT = Voltage LIN.R = Linear resistance POTM = Potentiometer
I.RANGE	Selected fixed input range for current measurements (for IN.TYPE = CURR): 0_20 = 0...20 mA (no sensor error detection!) 4_20 = 4...20 mA
V.RANGE	Selected fixed input range for voltage measurements (for IN.TYPE = VOLT)
SENSOR	Selected temperature sensor type (for IN.TYPE = TEMP): TC = Thermocouple Ni = Ni RTD sensor Pt = Pt RTD sensor

Pt.TYPE	Pt sensor type (for SENSOR = Pt): 10 = Pt10 20 = Pt20 50 = Pt50 100 = Pt100 200 = Pt200 250 = Pt250 300 = Pt300 400 = Pt400 500 = Pt500 1000 = Pt1000 } (No short circuit detection!)
Ni.TYPE	Ni sensor type (for SENSOR = Ni): 50 = Ni50 100 = Ni100 120 = Ni120 1000 = Ni1000
TC.TYPE	Thermocouple type (for SENSOR = TC): TC.B = Thermocouple type B TC.E = Thermocouple type E TC.J = Thermocouple type J TC.K = Thermocouple type K TC.L = Thermocouple type L TC.N = Thermocouple type N TC.R = Thermocouple type R TC.S = Thermocouple type S TC.T = Thermocouple type T TC.U = Thermocouple type U TC.W3 = Thermocouple type W3 TC.W5 = Thermocouple type W5 TC.Lr = Thermocouple type Lr
CJC	CJC type for SENSOR = TC: INT = Internal CJC sensor measurement CONN = CJC connector measurement (accessory)
CONNEC	Selected sensor connection type for RTD or linear resistance measurements (for SENSOR = Ni or Pt or IN.TYPE = LIN.R): 2W = 2-wire 3W = 3-wire 4W = 4-wire If 2W or 3W is selected, the end user must ensure that the applied sensor wiring does not introduce failures exceeding the requirements for the safety application.
R 0%	0% input range for linear resistance measurements (for IN.TYPE = LIN.R). This value must be < (R 100% - minimum span), refer to 4.2.1
R 100%	100% input range for linear resistance measurements (for IN.TYPE = LIN.R) This value must be > (R 0% + minimum span), refer to 4.2.1
UNIT	Selected temperature unit for IN.TYPE = TEMP °C = degrees Celsius °F = degrees Fahrenheit For IN.TYPE ≠ TEMP selectable units refer to routing diagram
DISP.LO	0% display value on 45xx. Can be used as base for relay setpoints (for IN.TYPE ≠ TEMP)
DISP.HI	100% display value on 45xx. Can be used as base for relay setpoints (for IN.TYPE ≠ TEMP)
NEW.PAS	Password for protection of the device configuration from unauthorized access. Range from 0 to 9999.

14.1.2 Parameters related to Relay Output

REL.UNI	Relay Units (for IN.TYPE \neq TEMP): PERC = Relay setpoint in percent of input range. DISP = Relay setpoints and hysteresis values relates to DISP.LO and DISP.HI (display units)
REL.FUN	Relay Function: OFF (Note ³) = Relay is always OFF POW (Note ³) = Relay is always ON if power is applied ERR = Relay is activated when sensor error is present WIND = Relay is activated when input signal is between SETP.LO and SETP.HI values SETP = Relay is activated when input signal reaches SETP value
CONTAC.	Relay contact function: N.C. = Normally Closed relay contact (for REL.FUN = SETP) N.O. = Normally Open relay contact (for REL.FUN = SETP) O.I.W = Relay contact Open Inside Window (for REL.FUN = WIND) C.I.W = Relay contact Closed Inside Window (for REL.FUN = WIND)
SETP.	Relay setpoint value in REL.UNI units for IN.TYPE \neq TEMP or in UNIT for IN.TYPE = TEMP. (for REL.FUN = SETP)
SETP.LO	Relay setpoint low value in REL.UNI units for IN.TYPE \neq TEMP or in UNIT for IN.TYPE = TEMP. (for REL.FUN = WIND)
SETP.HI	Relay setpoint high value in REL.UNI units for IN.TYPE \neq TEMP or in UNIT for IN.TYPE = TEMP. (for REL.FUN = WIND)
ACT.DIR	Relay action for increasing or decreasing input signal (for REL.FUN = SETP): DECR = Relay activates when input signal \leq SETP. INCR = Relay activates when input signal \geq SETP.
HYST	Hysteresis value in REL.UNI units for IN.TYPE \neq TEMP or in UNIT for IN.TYPE = TEMP. (for REL.FUN = SETP or WIND)
ERR.ACT	Relay sensor error action (for REL.FUN = SETP, WIND or ERR): Only relevant if IN.TYPE = TEMP, CURR and I.RANGE = 4-20, POTM or LIN.R and R 0% is \geq 18. NONE (Note ³) = Sensor error detection NOT enabled (Note ⁴), relay state at sensor error is undefined. (NOT for REL.FUN = ERR) OPEN = Relay contact is open at sensor error CLOS = Relay contact is closed at sensor error HOLD (Note ³) = Relay contact holds the state as before sensor error occurred. (NOT for REL.FUN = ERR)
ON.DEL	Relay ON delay from SETP or SETP.LO/HI is crossed in units of seconds (for REL.FUN = SETP or WIND)
OFF.DEL	Relay OFF delay from SETP +/- HYST or SETP.LO/HI +/- HYST is crossed in units of seconds (for REL.FUN = SETP or WIND)

Note³: Value not allowed if the relay is used in a safety application (EN.SIL = YES) and IN.TYPE = CUR and loop supply is used to supply a current input signal.

Note⁴: Error detection is enabled if OUT.ERR \neq none, but relay state at sensor error is undefined.

14.1.3 Parameters related to analogue output

Name	Function
O.RANGE	Fixed output range for current output: 0-20 = 0...20 mA Value not allowed when EN.SIL = YES (Safety applications) 4-20 = 4...20 mA 20-0 = 20...0 mA Value not allowed when EN.SIL = YES (Safety applications) 20-4 = 20...4 mA
OUT.ERR	Fixed output value on detected sensor error: NONE (Note ⁵) = Sensor error detection NOT enabled (Note ⁶), output at sensor error is undefined. The end user must ensure that the applied sensor including wiring has a failure rate qualifying it for the safety application without the detection enabled. 0 mA = Output is 0 mA at sensor error 3.5 mA = Output is 3.5 mA at sensor error (NE43 downscale) 23 mA = Output is 23 mA at sensor error (NE4 upscale)
OUT.LO	Selected temperature value for 0% output for IN.TYPE = TEMP in units defined by the UNIT parameter (°C or °F) Range is defined by the selected temperature sensor (SENSOR and TC.TYPE, Ni.TYPE or Pt.TYPE), but value must be less than OUT.HI - minimum span.
OUT.HI	Selected temperature value for 100% output for IN.TYPE = TEMP in units defined by the UNIT parameter (°C or °F). Range is defined by the selected temperature sensor (SENSOR and TC.TYPE, Ni.TYPE or Pt.TYPE), but must be larger than OUT.LO + minimum span.
RESP	Analog output response time in seconds. Range is 0.0 to 60.0 seconds.
USE.CAL	Use the applied process calibration values: NO = The last performed process calibration is not used. The channel operates with accuracy as specified. YES = The last performed process calibration is in operation. The required accuracy must be verified by user. End user must verify by test that the applied process calibration does not introduce failures exceeding the requirements for the safety application.

Note⁵: Value not allowed if analog output is used in a safety application (EN.SIL = YES) and IN.TYPE = CURR and loop supply is used to supply a current input signal.

Note⁶: Error detection is enabled if ERR.ACT ≠ NONE, but analog output value is undefined.

14.2 Verification procedure

The verification is done using the display / programming front PR 45xx and following the procedure described below.

14.2.1 If no password is set

	Action	Display shows
1	Press OK	ADV.SET
2	Set (ADV.SET) to Yes and press OK	SETUP
3	Set SETUP to SIL and press OK	EN.SIL
4	Set EN.SIL to YES and press OK	NEW.PAS
5	Set password to a number between 0 and 9999 and press OK (At this time the device starts operating in SIL mode with the entered configuration parameters!)	CONFIG Verify OPEN->LOCK (Note ⁷)
6	Press OK to confirm verification of the OPEN->LOCK in the display	IN.TYPE
7	Verify input type and press OK	I.RANGE

Note⁷: Open is shown briefly in the display.

8	Verify fixed input current range and press OK (ONLY if IN.TYPE = CURR)	CONNEC
9	Verify sensor connection type and press OK (ONLY if IN.TYPE = TEMP and SENSOR = Ni or Pt or IN.TYPE = LIN.R)	UNIT
10	Verify temperature unit and press OK (ONLY if IN.TYPE = TEMP)	SENSOR
11	Verify temperature sensor type and press OK (ONLY if IN.TYPE = TEMP)	Pt.TYPE
12	Verify Pt sensor type and press OK (ONLY if IN.TYPE = TEMP and SENSOR = Pt)	Ni.TYPE
13	Verify Ni sensor type and press OK (ONLY if IN.TYPE = TEMP and SENSOR = Ni)	TC.TYPE
14	Verify Thermocouple type and press OK (ONLY if IN.TYPE = TEMP and SENSOR = TC)	CJC
15	Verify CJC type and press OK (ONLY if IN.TYPE = TEMP and SENSOR = TC)	V.RANGE
16	Verify fixed input voltage range and press OK (ONLY if IN.TYPE = VOLT)	R 0%
17	Verify input resistance 0% range and press OK (ONLY if IN.TYPE = LIN.R)	R 100%
18	Verify input resistance 100% range and press OK (ONLY if IN.TYPE = LIN.R)	UNIT
19	Verify display units for 45xx and press OK (ONLY if IN.TYPE ≠ TEMP)	DEC.P
20	Verify display decimal point for 45xx and press OK (ONLY if IN.TYPE ≠ TEMP)	DISP.LO
21	Verify display value for 45xx at 0% input and press OK (ONLY if IN.TYPE ≠ TEMP)	DISP.HI
22	Verify display value for 45xx at 100% input and press OK (ONLY if IN.TYPE ≠ TEMP)	REL.UNI
23	Verify relay setpoint units and press OK (ONLY if IN.TYPE ≠ TEMP)	REL.FUN
24	Verify relay function and press OK	CONTAC.
25	Verify relay contact function and press OK (ONLY if REL.FUN ≠ OFF or POW)	SETP.
26	Verify relay setpoint and press OK (ONLY if REL.FUN = SETP)	SETP.LO
27	Verify low setpoint value and press OK (ONLY if REL.FUN = WIND)	SETP.HI
28	Verify high setpoint value and press OK (ONLY if REL.FUN = WIND)	ACT.DIR
29	Verify relay activation direction and press OK (ONLY if REL.FUN = SETP)	HYST
30	Verify relay setpoint hysteresis and press OK (ONLY if REL.FUN = SETP or WIND)	ERR.ACT
31	Verify relay action on sensor error and press OK (ONLY if REL.FUN = SETP, WIND or ERR and the selected input type and range support sensor error detection, refer to section 4.3.2)	ON.DEL
32	Verify relay ON delay and press OK (ONLY if REL.FUN = SETP or WIND)	OFF.DEL
33	Verify relay OFF delay and press OK (ONLY if REL.FUN = SETP or WIND)	O.RANGE

34	Verify fixed output range for current output	OUT.ERR
35	Verify fixed output value on detected sensor error and press OK (ONLY if IN.TYPE \neq VOLT, or IN.TYPE = CURR and I.RANGE \neq 0-20 mA)	OUT.LO
36	Verify temperature for 0% output and press OK (ONLY if IN.TYPE = TEMP)	OUT.HI
37	Verify temperature for 100% output and press OK (ONLY if IN.TYPE = TEMP)	RESP
38	Verify analog output response time and press OK	CH1.CAL
39	Verify the use of applied process calibration values and press OK	PASSW.
40	Verify password and press OK	SIL.OK
41	Verify SIL mode within 1 second	

14.2.2 If password is set

	Action	Display shows
1	Press OK	PASSW
2	Enter password and press OK	ADV.SET
3	Set ADV.SET to Yes and press OK	SETUP
4	Set SETUP to SIL and press OK	EN.SIL
5	Set EN.SIL to YES and press OK (At this time the device starts operating in SIL mode with the entered configuration parameters!)	CONFIG Verify OPEN->LOCK (Note ⁸)
6 to 41	As step 6 to 41 for 14.2.1	As step 6 to 41 for 14.2.1

Note⁸: Open is shown briefly in the display

14.2.3 If any parameter is found to be incorrect during verification

Remove SIL-mode (by entering the password and selecting EN.SIL = NO).

Go through the setup menu and correct the parameter(s).

Repeat step 1 to 41 (with correct parameters).

14.3 Functional test

The user is responsible to make a functional test after verification of the safety parameters. The procedure for periodic proof test described in section 10 shall be used.

In addition, if a process calibration is taken into SIL-mode operation (refer to section 13.3 - Advanced functions), it is mandatory that the accuracy of the device (and sensor, if applicable) are tested.

15. Fault reaction and restart condition

When the 9116 detects a fault the outputs will go to Safe State, in which the outputs will be "de-energized".

If the fault is application-specific (cable error detection) the 9116 will restart when the fault has been corrected.

Power cycle the device for bringing it out of Safe State.

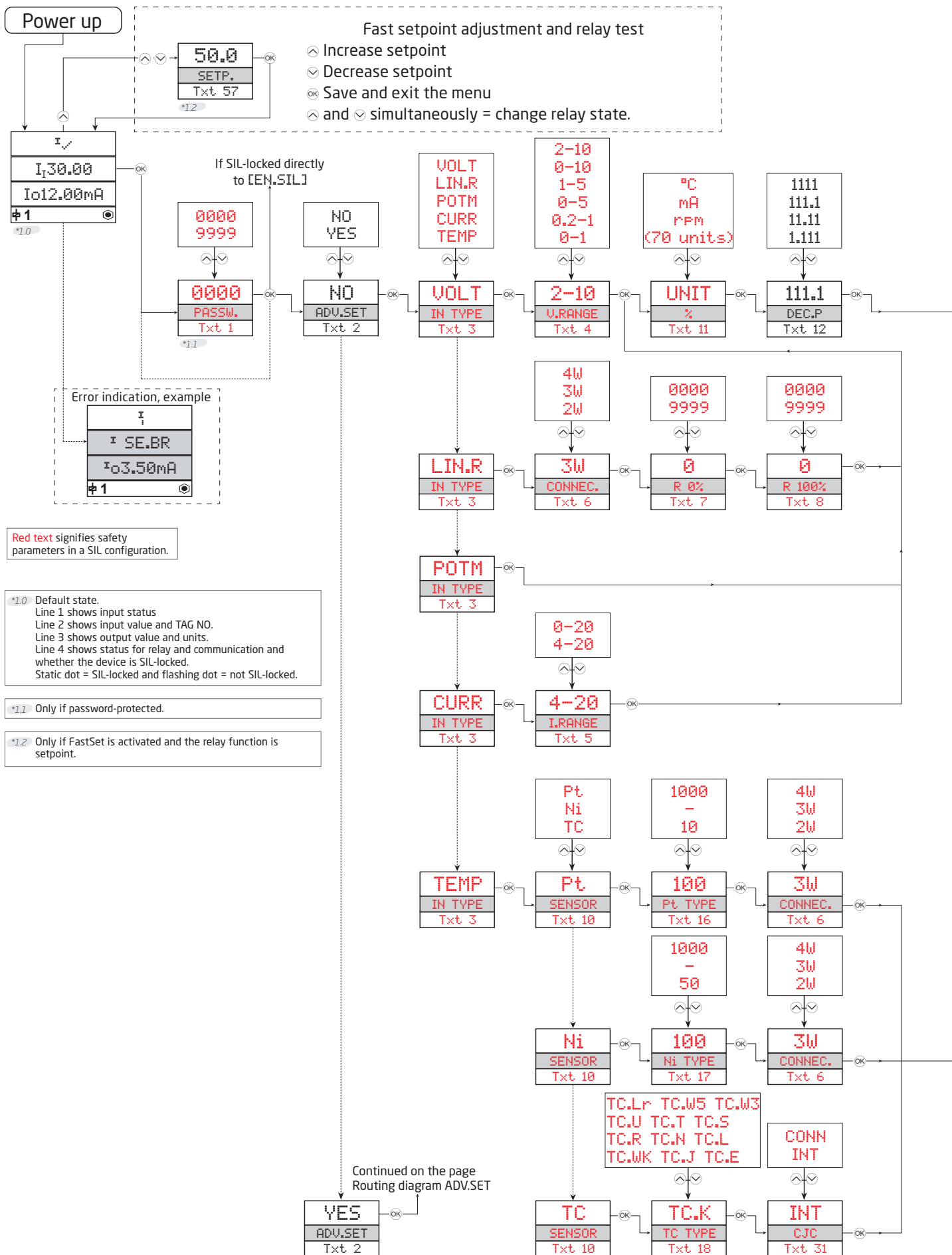
16. User interface

16.1 Scrolling help texts in display line 3

- | | | | |
|------|---|------|--|
| [01] | Set correct password | | Select TC-W5 sensor type |
| [02] | Enter Advanced setup menu? | | Select TC-Lr sensor type |
| [03] | Select Temperature input | [19] | Select OFF function - relay is permanently off |
| | Select Potentiometer input | | Select POWER function - relay indicates power status OK |
| | Select Linear resistance input | | Select ERROR function - relay indicates sensor error only |
| | Select Current input | | Select WINDOW function - relay is controlled by 2 setpoints |
| | Select Voltage input | | Select SETPOINT function - relay is controlled by 1 setpoint |
| [04] | Select 0.0-1 V input range | [20] | Select Normally Closed contact |
| | Select 0.2-1 V input range | | Select Normally Open contact |
| | Select 0-5 V input range | [21] | Select Relay setpoint |
| | Select 1-5 V input range | [22] | Select Action on decreasing signal |
| | Select 0-10 V input range | | Select Action on increasing signal |
| | Select 2-10 V input range | [23] | Select Relay hysteresis |
| [05] | Select 0-20 mA input range | [24] | Select No error action - undefined status at error |
| | Select 4-20 mA input range | | Select Open relay contact at error |
| [06] | Select 2-Wire sensor connection | | Select Close relay contact at error |
| | Select 3-Wire sensor connection | | Select Hold relay status at error |
| | Select 4-Wire sensor connection | [25] | Select Relay ON delay in seconds |
| [07] | Set Resistance value low | [26] | Select Relay OFF delay in seconds |
| [08] | Set Resistance value high | [27] | Select Contact is Closed Inside Window |
| [09] | Select Celsius as temperature unit | | Select Contact is Open Inside Window |
| | Select Fahrenheit as temperature unit | [28] | Select Relay window setpoint low |
| [10] | Select TC sensor type | [29] | Select Relay window setpoint high |
| | Select Ni sensor type | [30] | Select Relay window hysteresis |
| | Select Pt sensor type | [31] | Select Internal temperature sensor |
| [11] | Select Display unit | | Select CJC connector (Accessory) |
| [12] | Select Decimal point position | [34] | Select Open relay contact at error |
| [13] | Set Display range low | | Select Close relay contact at error |
| [14] | Set Display range high | [37] | Select 0-20 mA outout range |
| [15] | Select Relay setpoint in % of input range | | Select 4-20 mA output range |
| | Select Relay setpoint in display units | | Select 20-0 mA output range |
| [16] | Select Pt10 sensor type | | Select 20-4 mA output range |
| | Select Pt20 sensor type | [38] | Select No error action - output undefined at error |
| | Select Pt50 sensor type | | Select Downscale at error |
| | Select Pt100 sensor type | | Select Namur NE43 downscale at error |
| | Select Pt200 sensor type | | Select Namur NE43 upscale at error |
| | Select Pt250 sensor type | [39] | Select Analog output response time in seconds. |
| | Select Pt300 sensor type | [41] | Set Temperature for analog output low |
| | Select Pt400 sensor type | [42] | Set Temperature for analog output high |
| | Select Pt500 sensor type | [43] | Enter SIL setup |
| | Select Pt1000 sensor type | | Enter Simulation mode |
| [17] | Select Ni50 sensor type | | Enter Rail setup |
| | Select Ni100 sensor type | | Perform Process Calibration |
| | Select Ni120 sensor type | | Enter Language setup |
| | Select Ni1000 sensor type | | Enter Password setup |
| [18] | Select TC-B sensor type | | Enter Display setup |
| | Select TC-E sensor type | | Perform Memory operations |
| | Select TC-J sensor type | [44] | Load saved configuration into module |
| | Select TC-K sensor type | | Save configuration in display front |
| | Select TC-L sensor type | [45] | Adjust LCD contrast |
| | Select TC-N sensor type | [46] | Adjust LCD backlight |
| | Select TC-R sensor type | [47] | Write a 5-character channel TAG |
| | Select TC-S sensor type | | |
| | Select TC-T sensor type | | |
| | Select TC-U sensor type | | |
| | Select TC-W3 sensor type | | |

- [48] Show Analog output value in display
Show TAG on display
Alternate shown information in display
- [49] Calibrate Input low to process value?
- [50] Calibrate Input high to process value?
- [51] Enable input simulation?
- [52] Set the input simulation value
- [53] Relay simulation - use \odot to toggle relay
- [54] Enable Password protection?
- [55] Set New password
- [56] Enable Fastset functionality?
- [57] Relay setpoint - press \odot to save
- [58] Relay setpoint - Read only
- [59] Select Language
- [60] Use process calibration values?
- [61] Set value for low calibration point
- [62] Set value for high calibration point
- [63] Enable Rail status signal output?
- [64] Enable SIL configuration lock?
0...20 mA is not a valid output range for SIL operation
- [65] is channel using process-compensated calibration data?
- [66] Configuration SIL status (Open / Locked)
- [80] Sensor short circuit
- [81] Sensor wire breakage
- [82] Display underrange
- [83] Display overrange
- [84] Input underrange
- [85] Input overrange
- [86] Input error - check input connections and reset power
- [87] Output error - check connentions and reset power
- [88] Flash memory error - chek configuration
- [89] Invalid configuration type or version
- [90] Hardware error
- [91] CJC sensor error - check device temperature
- [92] CJC error - check CJC connector block
- [93] No communication

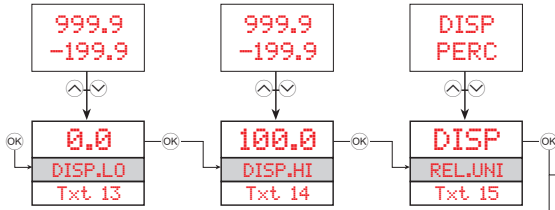
16.2 Routing diagram



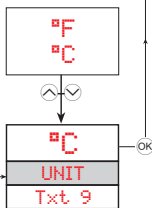
Routing diagram

If no key is activated for 1 minute, the display will return to the default state 1.0 without saving configuration changes.

- ⬆ Increase value / choose next parameter
- ⬇ Decrease value / choose previous parameter
- Ⓞ Save the chosen value and proceed to the next menu
- Hold Ⓞ Back to previous menu / return to menu 1.0 without saving.



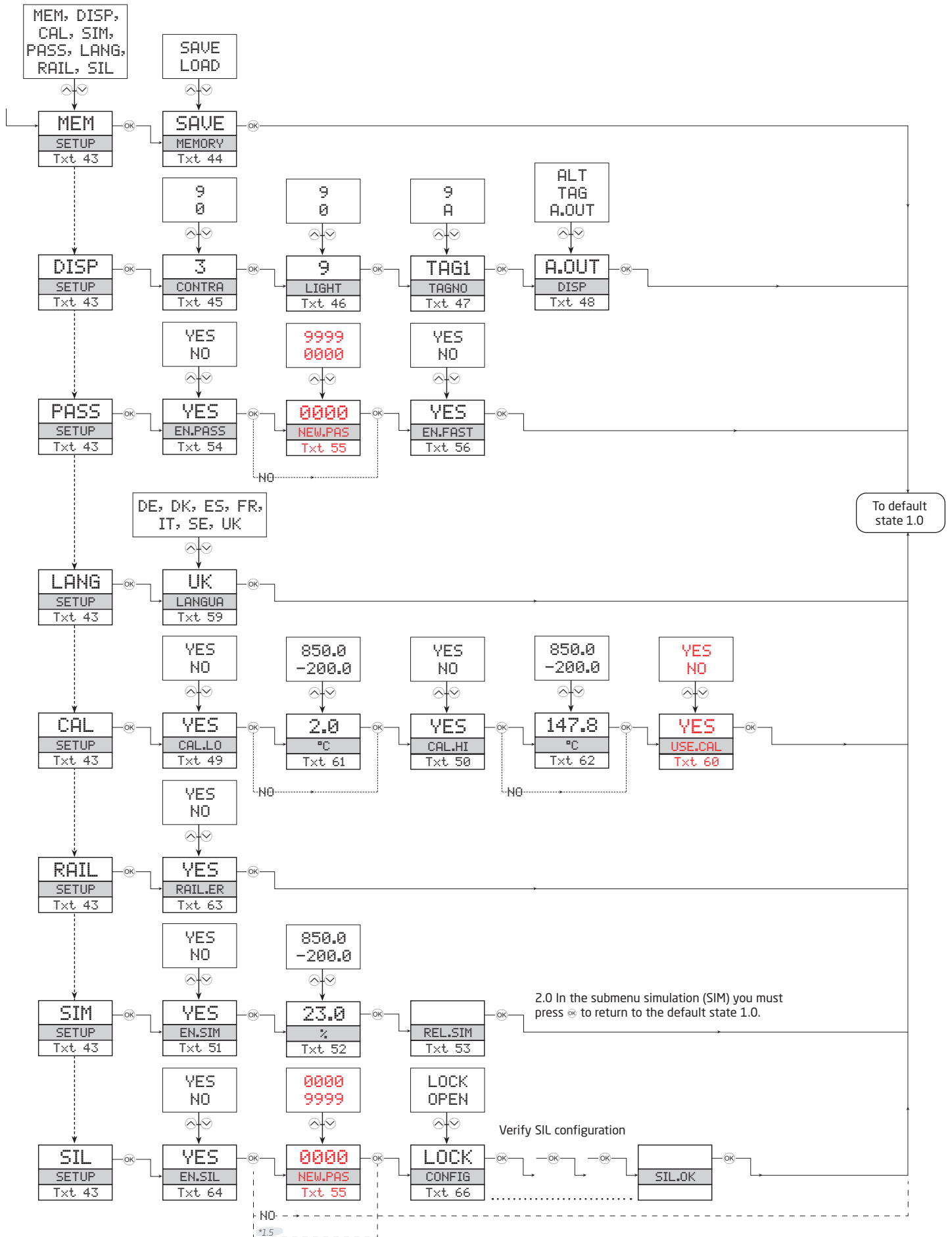
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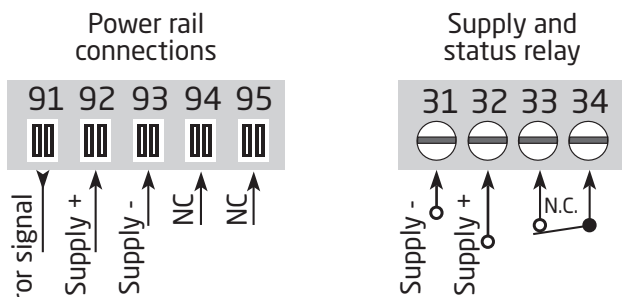
Selectable UNITS:

°C	s	rpm	MUh	ohm
°F	min	Hz	kUh	S
K	m/s	t	U	uS
%	mm/s	kg	GU	m3/min
m	m/min	g	MU	m3/h
cm	m/h	N	kU	l/s
mm	in/s	Pa	hP	l/min
um	ips	MPa	A	l/h
ft	ft/s	kPa	kA	gal/min
in	in/min	hPa	mA	gal/h
mils	ft/min	bar	uA	t/h
yd	in/h	mbar	U	mol
m3	ft/h	kJ	kU	pH
l	m/s2	Uh	mU	[blank]

16.3 Routing diagram, advanced settings (ADV.SET)

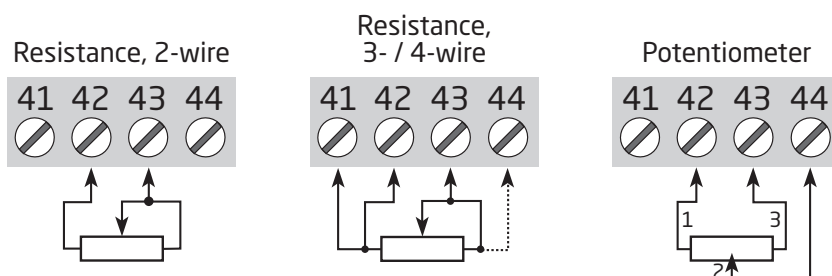
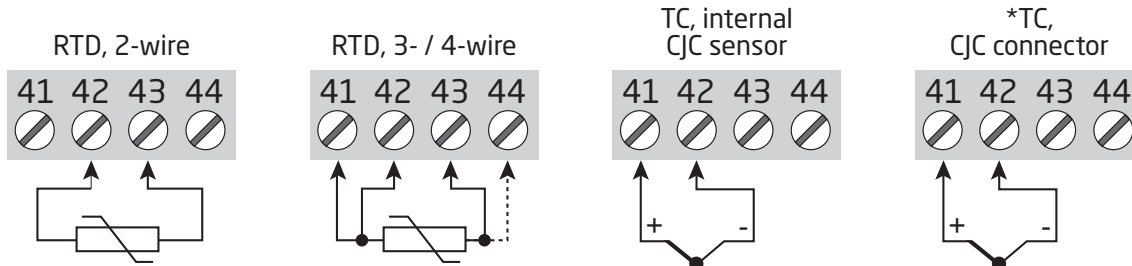


17. Connections diagram

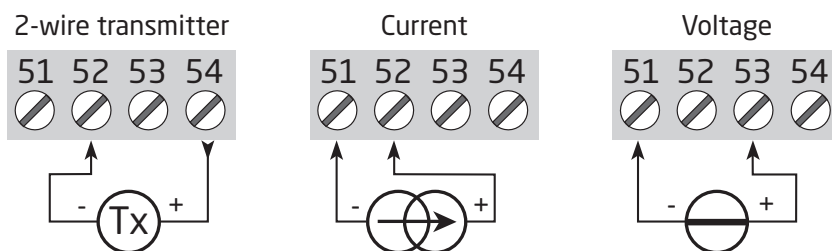


NC = no connection

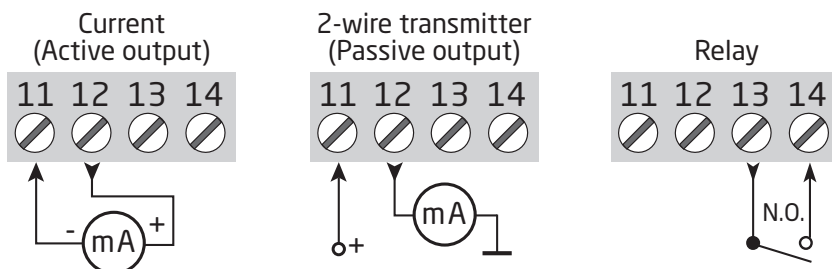
Inputs:



* Order separately:
CJC connector 5910 / 5910Ex



Outputs:



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