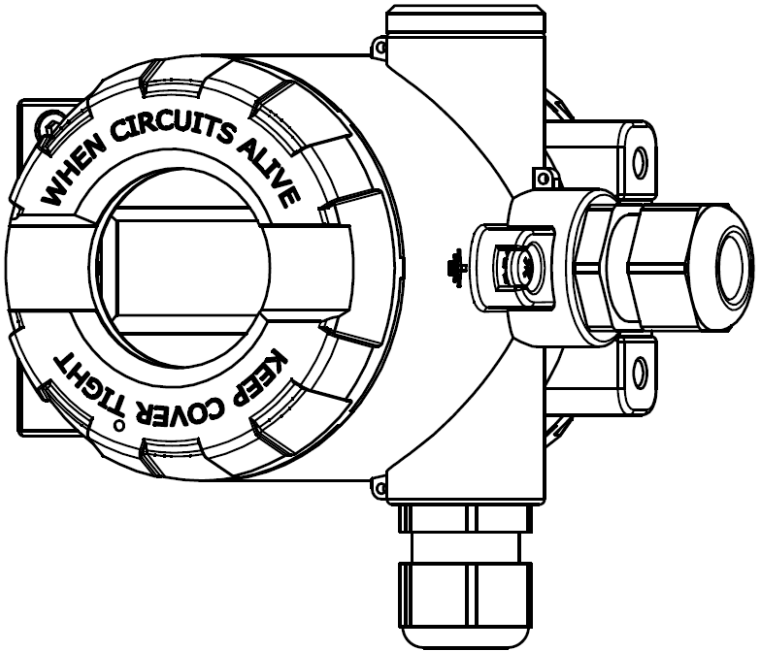
USER'S MANUAL

SMART TEMPERATURE TRANSMITTER

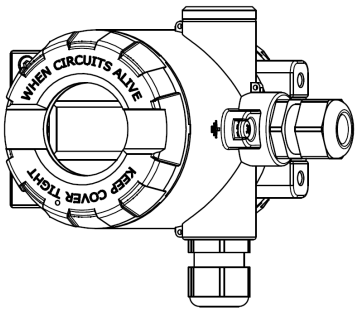
LI-24ALW



APLISENS S.A., 03-192 Warsaw, Morelowa 7 St,
tel. +48 22 814 07 77; fax +48 22 814 07 78
www.aplisens.com, e-mail: export@aplisens.com

PRODUCT CODE – see ➔ 5.2. Transmitter identification.
The QR code or ID number identifies the transmitter and provides quick access to the following documentation on the manufacturer's website: user's manual, explosion-proof device user manual, declarations of conformity and copies of certificates.

LI-24ALW
ID:0028 0004 0002 0000 0000 0000 0001 07
https://www.aplisens.pl/ID/00280004000200000000000000107



Symbols used

Symbol	Description
	Warning to proceed strictly in accordance with the information contained in the documentation in order to ensure the safety and full functionality of the device.
	Information particularly useful during installation and operation of the device.
	Information on disposal of used equipment.

BASIC REQUIREMENTS AND SAFE USE

The manufacturer will not be liable for damage resulting from incorrect installation, failure to maintain a suitable technical condition of the device or use of the device other than for its intended purpose.

Installation should be carried out by qualified staff having the required authorizations to install electrical and I&C equipment. The installer is responsible for performing the installation in accordance with manual as well as with the electromagnetic compatibility and safety regulations and standards applicable to the type of installation.

All safety and protection requirements must be observed during installation, operation and inspections.

If a malfunction occurs, the device should be disconnected and handed over to the manufacturer for repair.

In order to minimize the risk of malfunction and associated risks to staff, the device is not to be installed or used in particularly unfavourable conditions, where the following hazards occur:

- possible mechanical impacts, excessive shocks and vibration;
- excessive temperature fluctuation;
- water vapour condensation, dusting, icing.

Changes made to the manufacturing of products may be introduced before the paper version of the manual is updated. The up-to-date manuals are available on the manufacturer's website: www.aplisens.com.

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1. INTRODUCTION

1.1. Purpose of the document

The subject of manual are smart temperature transmitters **LI-24ALW**, designed to work with a distance or direct sensor. The manual applies to the standard versions.

The manual contains data, tips and general recommendations for safe installation and operation of the transmitters, as well as troubleshooting in case of possible failure.
The manual does not cover explosion protection issues.

1.2. Registered trademarks

HART® is a registered trademark of FieldComm Group.
Windows® is a registered trademark of Microsoft Corporation.
Google Play® is a service registered and managed by Google® Inc.

2. SAFETY

- The installation and start-up of the device and any activities related to operation shall be carried out after thorough examination of the contents of user's manual.
- Installation and maintenance should be carried out by qualified staff having the required authorizations to install electrical and measuring devices.
- The device shall be used according to its intended purpose in line with the permissible parameters specified on the nameplate (➔ 5.2. Transmitter identification).
- The protection elements used by the manufacturer to ensure transmitter safety may be less effective if the device is operated in a manner not consistent with its intended purpose.
- Before installing or disassembling the device, it is absolutely necessary to disconnect it from the power source.
- No repairs or alterations to the transmitter electronic system are permitted. Assessment of damages and possible repair may only be performed by the manufacturer or authorized representative.
- Do not use instruments if damaged. In case of malfunction, the device must be put out of operation.

3. TRANSPORT AND STORAGE

3.1. Delivery check

After receiving the delivery of the equipment, it is necessary to:

- make sure that the packaging and its contents were not damaged during transport;
- check the completeness and correctness of the received order, make sure no parts are missing.

3.2. Transport

Transport of transmitters shall be carried out with the use of covered means of transport, in original packages. The packaging shall be protected against movement and direct impact of atmospheric factors.

3.3. Storage

Transmitters shall be stored in a factory packaging, in an indoor room without vapours and aggressive substances, protected against mechanical impact, at an air temperature and relative humidity not exceeding the permissible ambient parameters in accordance with data sheet.

4. GUARANTEE

General terms and conditions of guarantee are available on the manufacturer's website:
www.aplisens.com/ogolne_warunki_gwarancji

The guarantee shall be repealed if the device is used against its intended use, failure to comply with user's manual or interference with the structure of the device.

5. IDENTIFICATION

5.1. Manufacturer's address

APLISENS S.A.
03-192 Warsaw
Morelowa 7 St
Poland

5.2. Transmitter identification

Depending on the version of the transmitter, the nameplates may differ in the amount of information and parameters.

Table 1. Symbols occurring on the transmitter nameplate

APLISENS S.A.	**Logo and name of manufacturer**
CE	CE mark
CE 1453	CE mark with the number of notified body
	QR code
TYPE:	Transmitter type
ID	Transmitter model ID
	Type of measurement input
U	Supply voltage values
Tamb	Permissible range of ambient temperature
I	Output signal
El. connection:	Type of electrical connection
Ser.- No.	Transmitter serial number
IP	IP range value
//lower part of the nameplate//	Special version
	Note about the read the manual
Aplisens S.A. ul. Morelowa 7, 03-192 Warszawa	Manufacturer address

5.3. CE mark, declaration of conformity

The device has been designed to meet the highest safety requirements, it has been tested and has left the factory in a condition that is safe for operation. The device complies with the applicable standards and regulations listed in the EU Declaration of Conformity and has CE marking on nameplate.

6. CONSTRUCTION

6.1. Construction

The basic transmitter assemblies are the housing and the electronic assembly converting the signal from the measuring sensor into a unified output signal and display parameters on the LCD display.

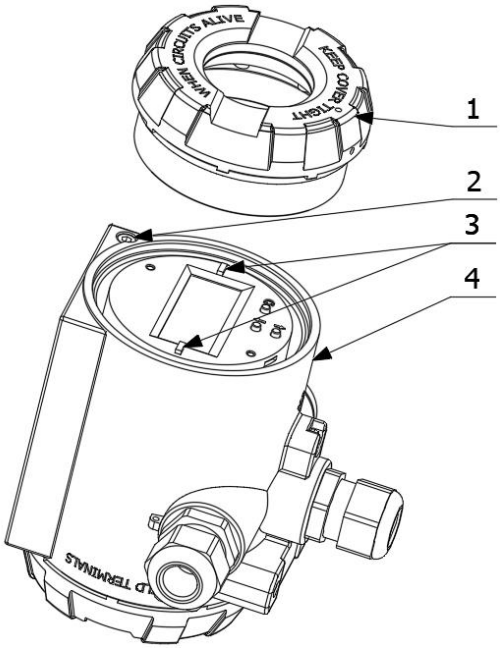
6.2. Measurement principle

The transmitter measures the analogue signal from the sensor and converts it into an internal digital value. The microcontroller of the main board, based on the measured values and using built-in algorithms, calculates the exact temperature value. The resulting value is displayed on the integrated LCD display which can be configured according to the user's needs. The digital value of the measured temperature is converted to analogue 4 … 20 [mA] signal. The built-in HART modem and the implemented HART communication stack rev. 7 enable communication with the transmitter via converter connected to a PC with appropriate software or via communicator.
The electric connection of the transmitter is provided with an output interference filter and overvoltage protection components. LI-24ALW transmitter the operation of their hardware and software resources, and in the event of a fault, display an error symbol on the LCD screen and generate an alarm current in the current loop.
The sensor's measuring signal is galvanically isolated from the current line. As a result, the measurement is less susceptible to interference, and the safety of operation in intrinsically safe applications is increased.

7. INSTALLATION

7.1. General recommendations

Temperature transmitter LI-24ALW can be mounted in any position.
The housing of the transmitter should be protected against hot air streams by appropriate location of the transmitter or by installing thermal shields, so that the transmitter does not heat up to a temperature higher than the permissible one.
The transmitter housing allows for wall and pipe mounting. For this purpose, use the AL handle manufactured by Aplisens S.A.
The transmitter allows adjustment of the display position. To do this, tighten the locking screw (item 2), unscrew the front cover (item 1), and then rotate the display using the extensions (item 3). The display can be rotated by an angle of 345° with a step of 15°.



1. Front cover.
2. Locking screw.
3. Extensions for display rotation.
4. Housing.

Figure 1. Change of display position

8. ELECTRICAL CONNECTION

All connection and installation operations must be performed with disconnected supply voltage and other external voltages, if used.

Failure to provide proper connection of the transmitter may result in danger. Risk of electric shock and/or ignition in potentially explosive atmospheres.

8.1. Cable connection to transmitter terminals

In order to perform correct connection of the cables, the following steps shall be performed:

- disconnect power supply;
- unscrew the rear cover of the transmitter body in order to gain access to the terminals of power supply and measurement and the internal ground terminal;
- pull the cable through the cable gland;
- power supply and signal cables of the 4 … 20 mA current loop should be properly connected to the "+", "-" terminals;
- connect the transmitter in accordance with figures below and section ➔ 8.1.1. Options for connecting sensors, potentiometers and voltage sources to the transmitter, paying attention to the correct tightening of the screws fixing the conductor core to the terminal;
- depending on the type of installation grounding adopted, connect the shield of the cable to the earth screw terminal of the body;
- tighten the rear cover of the transmitter body;
- leaving a slight slack in the cable inside the body, tighten the glands nut so that the gland seal tightens on the cable.

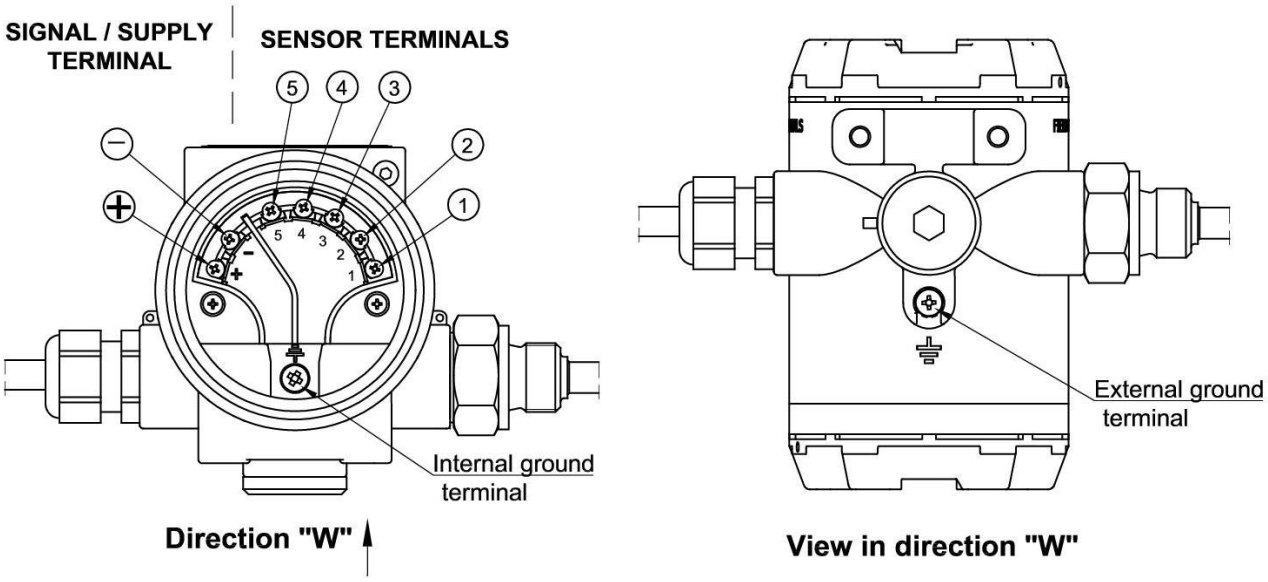


Figure 2. Marking of the LI-24ALW terminals

8.1.1. Options for connecting sensors, potentiometers and voltage sources to the transmitter

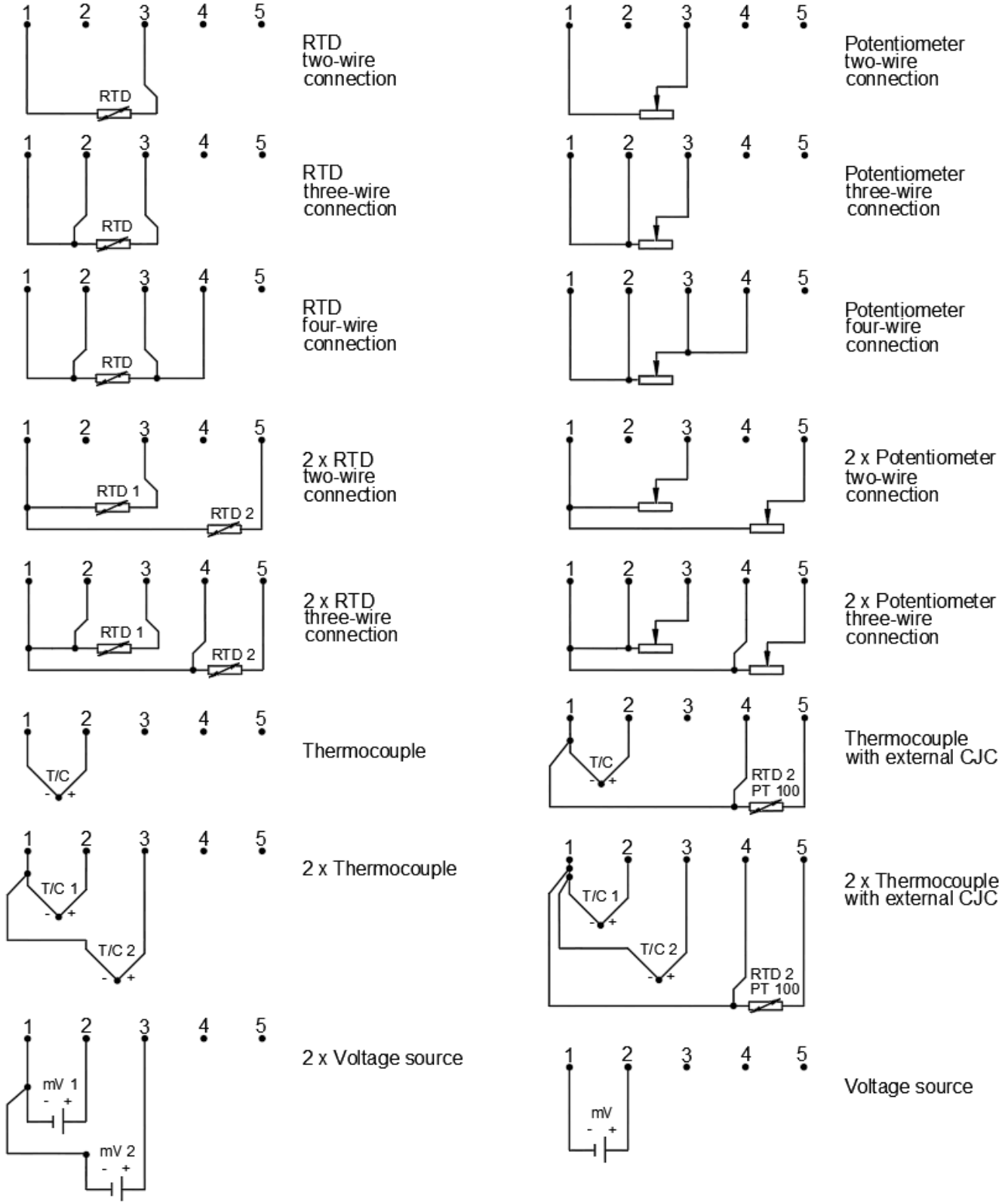


Figure 3. Methods of connecting sensors, potentiometers and voltage sources

8.1.2. Connection of transmitters with the option of using HART communication

The method of connecting a modem to transmitter for HART communication is shown in the figures below.

In order to communicate using connected HART modem to the "+" and "-" of transmitter terminals, make sure that the R_{Lmax} resistance viewed from the side of transmitter terminals towards power source is in the range of 240 Ω ≤ R_{Lmax} ≤ 1100 Ω.

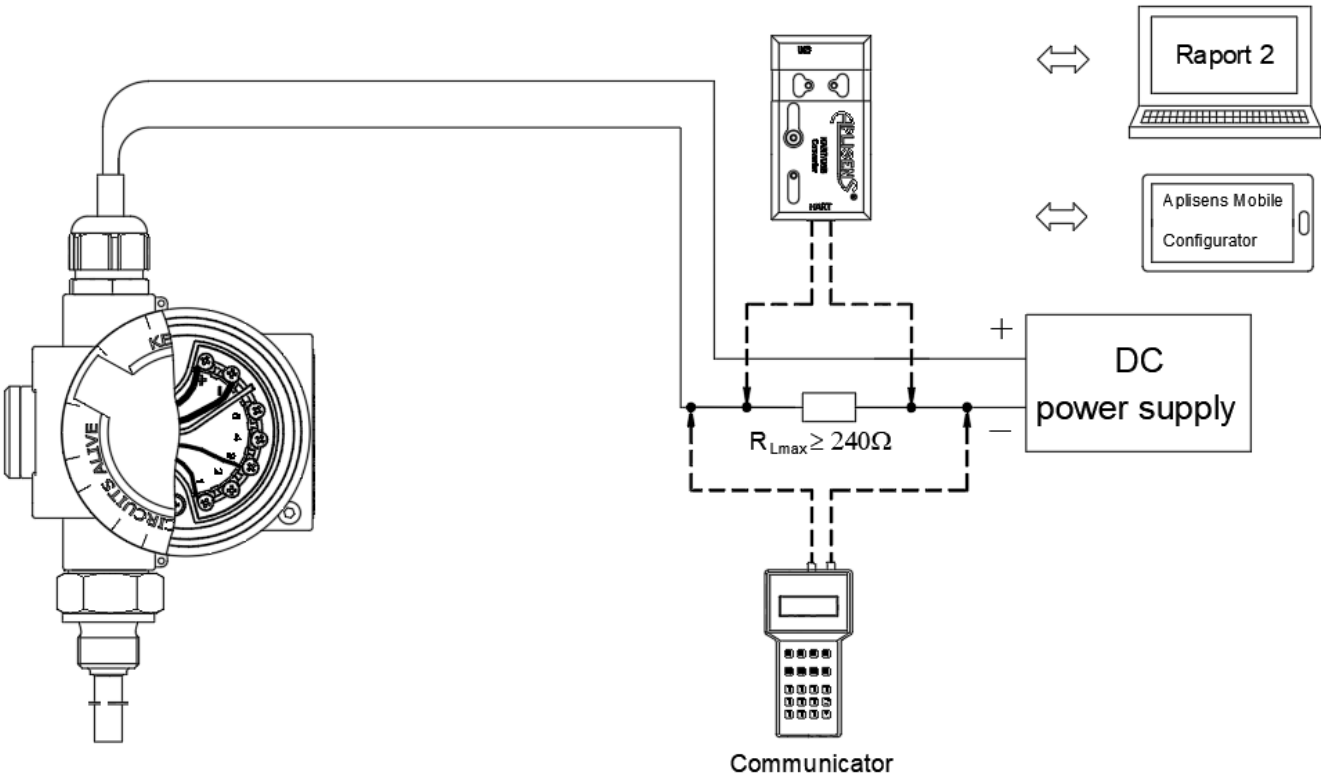


Figure 4. Electrical connection 4 … 20 mA of HART to transmitters in standard version

The HART/USB converter by Aplisens S.A. may also be operated using **Aplisens Mobile Configurator** installed on smartphones with Android system and connected using wireless communication. The software is available on Google Play®:
https://play.google.com/store/apps/details?id=com.aplisens.mobile.amc.

8.2. Transmitter power supply

8.2.1. Transmitter supply voltage

Power cables may be live.
In case of incorrect connection there is a risk of electric shock and/or explosion.

Table 2. Permissible transmitter supply voltages

Version	Minimum supply voltage	Maximum supply voltage
Standard	**11 V DC**	**36 V DC**

8.2.2. Specifications of electrical switching terminals

The internal electrical terminals accept wires with a cross section of 0,5 to 1,75 mm^2. Internal and external electrical terminal of the body ground accepts wires with a cross-section from 0,5 to 4 mm^2.

Possible cables to be used:

- unshielded when using the analogue signal only;
- shielded, approved for the HART communication;
- shielded on the sensor(s) side for a cable length greater than 30 m or over-normative radio interference.

8.2.3. Resistance load in power supply line

The power line resistance, power source resistance and other additional serial resistances increase the voltage drops between the power source and the transmitter terminals. The maximum transmitter current under normal operation conditions is defined as I_max = 21,600 mA (the maximum possible current value issued by the user is 22,000 mA).
The maximum resistance value in the power circuit (along with the power cables resistances) is defined by the formula:

$$R_{Lmax} \leq \frac{(U_{sup} - U_{min})[V]}{0{,}022[A]}$$

where:
R_{Lmax} – maximum power line resistance [Ω],
U_{sup} – voltage at the supply terminals of 4 … 20 mA current loop [V],
U_{min} – minimum supply voltage [V] (➔ Table 2. Permissible transmitter supply voltages).

8.2.4. Shielding, equipotential bonding

Optimal protection against interference is provided by the earthing of the screen on both sides. In case of electrical potential difference between earthing points of devices which may result in the flow of equipotential currents, the screen shall be earthed on one side.

8.3. Final inspection of cabling

After completing the electrical installation of the transmitter, it is necessary to check the following:

- Does the supply voltage measured at the transmitter terminals at maximum set current match the range of supply voltage specified on the transmitter nameplate?
- Is the transmitter connected according to the information given in section ➔ 8.1. Cable connection to transmitter terminals?
- Are all the screws tightened?
- Are the transmitter covers tightened?
- Is the cable gland tightened?

9. START-UP

Upon request the customer receives a transmitter configured according to the setpoints specified in the order. The current base range and the basic unit of the transmitter can be read out from the device via the HART communication.

9.1. Alarms

The alarms signal hardware faults, calculation errors or exceeding the permissible operating ranges of the transmitter. Internal hardware faults include e.g. RAM and FLASH memory failures, damage to the internal oscillator, isolation interface, ADC measurement converter, internal HART modem. External malfunctions are related to damage or improper connection of measurement sensors to the transmitter. Exceeding the permissible operating ranges is related to transmitter operating temperature ranges. The errors are manifested by the transmitter issuing an alarm current in the line and signalling an error code on the display. The alarm current values can be set using the buttons on the display or using the Raport 2 configuration program. It is also possible to order a transmitter with the required alarm configuration directly from the manufacturer.

Temperature transmitters LI-24ALW manufactured by Aplisens S.A. meet the alarm requirements Namur NE 89 and Namur NE 43.

Table 3. Type and level of alarms

Type of alarm	Value of the alarm current	
	Saturation	
	NORMAL 3,9 mA / 20,5 mA	**NAMUR** 3,8 mA / 20,5 mA
NORMAL LOW	3,75 mA	-
NORMAL HIGH	21,6 mA	-
NAMUR LOW	3,6 mA	3,6 mA
NAMUR HIGH	21,0 mA	21,0 mA
SAFETY	3,44 mA	
USER HIGH*	from 20,6 to 22,0 mA	
USER LOW*	from 3,28 to 3,8 mA	from 3,28 to 3,7 mA
*Alarm current value defined by the user		

9.2. Configuration of the operating mode

Before starting the work with the transmitter, the following parameters can be configured:

- Basic unit of the transmitter process variable.
- Measurement input type (voltage/resistance).
- Processing characteristics of measurement sensor (selection of sensor linearization characteristics).
- Type of sensor connections, number of terminals, CJC configuration (internal, external or none) (see ➔ Figure 3. Methods of connecting sensors, potentiometers and voltage sources). The sensor configuration via the local MENU is presented in ➔ Figure 5. Diagram of sensor configuration via the local MENU.
- Type of the mathematical function processing the signal from two sensors (2x RTD 2-wire connection, 2x RTD 3-wire connection, 2x thermocouple, 2x thermocouple with external CJC):
  - Difference of measurements from channels: Ch1-Ch2 or Ch2-Ch1.
  - Measurement average: 0,5 · (Ch1+Ch2).
  - Measurement average with redundancy: 0,5 · (Ch1+Ch2) or Ch2 or Ch1, when one of the sensors is faulty (it is recommended to disable, since the device can continue to operate with a single sensor – otherwise, the alarm may provide conflicting information). Redundancy corresponds to the following variants of the sensors connection: 2x RTD 2-wire connection, 2x RTD 3-wire connection, 2x thermocouple, 2x thermocouple with external CJC.
  - Minimum value of the two measurements: min (Ch1, Ch2).
  - Maximum value of the two measurements: max (Ch1, Ch2).

In case of using the configuration with linearization, a short-circuit between two resistive sensors will trigger an alarm. This is due to the measurement going beyond the linearization table. In non-linearization configurations with resistance sensors, short circuits are undetectable.

- Additional parameters such as offset of measuring channels or external compensation of sensor lead resistance.
- Start point of the set range (LRV) in the set unit.
- End point of the set range (URV) in the set unit.
- Damping time constant.
- Analogue output processing characteristic mode.
- Transmitter tag (TAG).
- Setting the password for changing settings.
- Setting the write lock after performing the configuration actions.

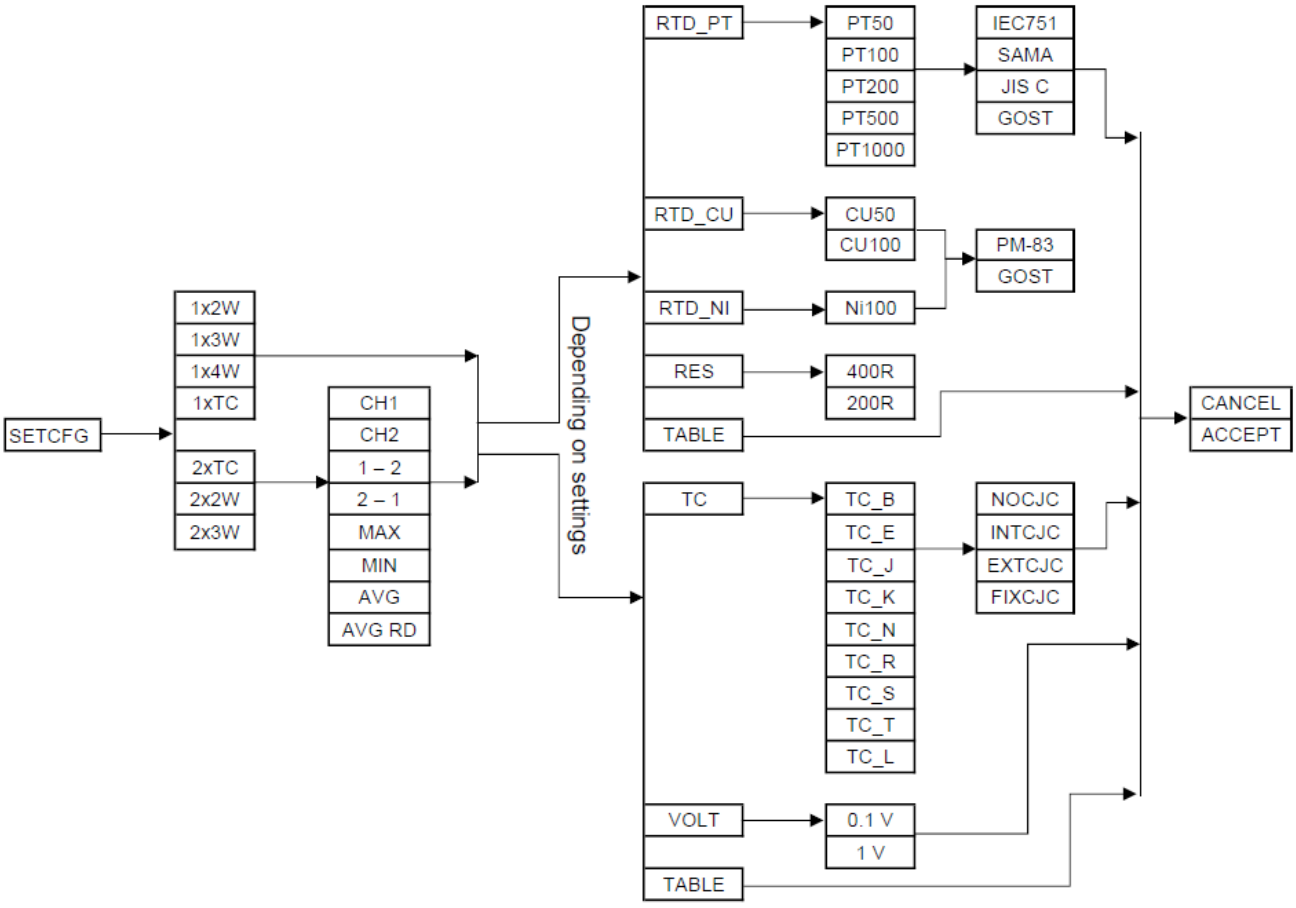


Figure 5. Diagram of sensor configuration via the local MENU

The user can configure the transmitter using software that supports DDL and DTM libraries, such as Raport 2 by Aplisens S.A., or by using the keypad via the local MENU, the structure of which is shown in ➔ Table 5. Structure of the local setpoints MENU.

9.3. Metrological parameters, types of sensors, measuring ranges and errors

- User's processing characteristics: linear function, square root function cube root function, fifth root function, square function, user function (user-defined table-based function), discrete (switch), manufacturer specific function 1, manufacturer specific function 2.
- Input impedance, thermocouple or voltage input: > 10 MΩ.
- Additional error due to supply voltage changes: ±0,002 %/V.
- Temperature impact compensation: polynomial at operating temperature range, segmental with linear approximation between points.
- Output updates time (calculation cycle): approx. 0,5 ÷ 1,4 s.
- Additional electronic damping: 0 ÷ 60 s.

- Maximum wires resistance: 40 Ω for resistive sensors, 500 Ω for thermocouples (wires + thermocouple).
- Sensor current: ~250 µA.

Table 4. Types of measurements, linearization and mathematical operations

Thermocouples	
Input impedance: > 10 MΩ Maximum wires resistance: 500 Ω (wires + thermocouple) Cold junctions compensation: internal sensor Pt100, external sensor Pt100, temperature constant of the cold junctions Voltage measurement range: -10 … 100 mV or -100 … 1000 mV Minimum range span 50°C	
Linearization type / base range	Sensor type and CJC configurations
Linear / -10 … 100 mV or -100 … 1000 mV	1 x TC (voltage measurement) 2 x TC (voltage measurements) 1 x TC (without CJC) 1 x TC (internal CJC – PT100) 1 x TC (external CJC – PT100, 3-wire) 1 x TC (entered CJC value) 2 x TC (without CJC) 2 x TC (internal CJC – PT100) 2 x TC (external CJC – PT100, 3-wire) 2 x TC (entered CJC value)
Customised multi-section linear, 21 points / -10 … 100 mV or -100 … 1000 mV	
Type B (IEC 584) / 500 … 1820°C	
Type E (IEC 584) / -150 … 1000°C	
Type J (IEC 584) / -210 … 1200°C	
Type K (IEC 584) / -150 … 1372°C	
Type N (IEC 584) / -150 … 1300°C	
Type R (IEC 584) / 50… 1768°C	
Type S (IEC 584) / 50 … 1768°C	
Type T (IEC 584) / -150 … 400°C	
Type L (GOST P 8.585-2001) / -200 … 800°C	
RTD type sensors	
Thermal resistance sensors: 2, 3 or 4 wires connection Sensor current: ~250 µA Maximum wires resistance: 40 Ω Resistance measurement range: 0 … 400 Ω or 0 … 2000 Ω Minimum range span 10°C	
Linearization type/base range	Sensor type configurations
Linear / 0 … 400 Ω or 0 … 2000 Ω	1 x RTD 2 x Wire 1 x RTD 3 x Wire 1 x RTD 4 x Wire 2 x RTD 2 x Wire 2 x RTD 3 x Wire
Custom multi-section linear, 21 points / 0 … 400 Ω or 0 … 2000 Ω	
Calibrated RTD	
PT50 α=0,003850 (IEC 751) / -200 … 850°C	
PT100 α=0,003850 (IEC 751) / -200 … 850°C	
PT200 α=0,003850 (IEC 751) / -200 … 850°C	
PT500 α=0,003850 (IEC 751) / -200 … 850°C	
PT1000 α=0,003850 (IEC 751) / -200 … 266°C	
PT50 α=0,003916 (JIS C 1604-81) / -200 … 630°C	
PT100 α=0,003916 (JIS C 1604-81) / -200 … 630°C	
PT200 α=0,003916 (JIS C 1604-81) / -200 … 630°C	
PT500 α=0,003916 (JIS C 1604-81) / -200 … 630°C	
PT1000 α=0,003916 (JIS C 1604-81) / -200 … 261°C	
PT50 α=0,003923(SAMA RC-4-1966) / -200 … 650°C	
PT100 α=0,003923 (SAMA RC-4-1966) / -200 … 650°C	
PT200 α=0,003923 (SAMA RC-4-1966) / -200 … 650°C	
PT500 α=0,003923(SAMA RC-4-1966) / -200 … 650°C	
PT1000 α=0,003923(SAMA RC-4-1966) / -200 … 271°C	
PT50 W100=1,3910 (GOST 6651-94) / -200 … 1100°C	
PT100 W100=1,3910 (GOST 6651-94) / -200 … 1100°C	
PT200 W100=1,3910 (GOST 6651-94) / -200 … 1100°C	
PT500 W100=1,3910 (GOST 6651-94) / -200 … 900°C	
PT1000 W100=1,3910 (GOST 6651-94) / -200 … 266°C	
CU50 W100=1,426 (GOST 6651-94) / -50 … 200°C	
CU100 W100=1,426 (GOST 6651-94) / -50 … 200°C	
CU50 W100=1,428 (GOST 6651-94) / -185 … 200°C	
CU100 W100=1,428 (GOST 6651-94) / -185 … 200°C	
NI100 W100=1,617 (GOST 6651-94) / -60 … 180°C	
NI100 W100=1,617 (PN-83/M-53952) / -60 … 180°C	
CU100 W100=1,426 (PN-83/M-53952) / -50 … 180°C	
CU50 W100=1,426 (PN-83/M-53952) / -50 … 180°C	

9.4. Process Variables

In the LI-24ALW transmitter, in accordance with the HART specification, nine Device Variables (DV) have been implemented:

- **DV0** – Mathematical variable – A variable calculated based on the values of DV1 and DV2, which represent the temperatures measured by the first (CH1) and second (CH2) measurement channels. If a configuration without linearization is selected, DV0 is calculated based on DV5 (CH1) and DV6 (CH2) in resistance measurement mode, or DV7 (CH1) and DV8 (CH2) in voltage measurement mode. This variable is assigned to the temperature category, enabling its use within the temperature profile.
- **DV1** – Sensor 1 temperature – Represents the temperature calculated during the linearization process of DV5 or DV7. Depending on the configuration, either of these variables is active. They represent, respectively, the resistance of a resistive temperature sensor (RTD) or the voltage of a voltage-type sensor (thermocouple, TC) connected to the first measurement channel. If a configuration without linearization is selected, this variable is inactive.
- **DV2** – Sensor 2 temperature – Represents the temperature calculated during the linearization process of DV6 or DV8. Depending on the configuration, one of these variables is active. They represent, respectively, the resistance of a resistive temperature sensor (RTD) or the voltage of a voltage-type sensor (thermocouple, TC) connected to the second measurement channel. If a configuration without linearization is selected, this variable is inactive.
- **DV3** – Cold junction compensation temperature (CJC) – Represents the cold junction temperature of a thermocouple (voltage sensor). Depending on the configuration, the value is measured based on the resistance of a Pt100 sensor located inside or outside the device, or defined as a fixed value by the user. If a configuration other than a voltage-type sensor (TC) with cold junction compensation is selected, this variable is inactive.
- **DV4** – CPU temperature – Represents the temperature of the microcontroller.
- **DV5** – Sensor 1 resistance – Represents the resistance of a resistive sensor (RTD, resistor, or potentiometer) connected to the first channel. If a voltage sensor configuration is selected, this variable is inactive.
- **DV6** – Sensor 2 resistance – Represents the resistance of a resistive sensor (RTD, resistor, or potentiometer) connected to the second channel. This variable is inactive when a voltage sensor configuration is selected, or when the resistive sensor configuration uses only one sensor (on channel 1).
- **DV7** – Sensor 1 voltage – Represents the voltage of a voltage sensor (thermocouple or voltage source) connected to the first channel. If a resistive sensor configuration is selected, this variable is inactive.
- **DV8** – Sensor 2 voltage – Represents the voltage of a voltage-type sensor (thermocouple or voltage source) connected to the second channel. This variable is inactive when a resistive sensor configuration is selected, or when the voltage sensor configuration uses only one sensor (on channel 1).

Each of the above Device Variables (DV) can be assigned (mapped) to one of the four Dynamic Variables:

- **PV** (Primary Variable) – the main dynamic process variable (default: DV0), responsible for controlling the current loop output.
- **SV** (Secondary Variable) – second dynamic process variable (default: DV1).
- **TV** (Tertiary Variable) – third dynamic process variable (default: DV2).
- **QV** (Quaternary Variable) – fourth dynamic process variable (default: DV4).

Mathematical operations to be set for CH1 and CH2 channels:

- CH1
- CH1-CH2
- (CH1+CH2)/2
- CH2
- CH2-CH1
- (CH1+CH2)/2 or CH1 – if CH2 fails or CH2 – if CH1 fails
- max(CH1,CH2)
- min(CH1,CH2)

10. OPERATION

The programmable display is designed to show the values measured during the measurement process also allows for transmitter configuration changes. It can show process values such as current in the current loop, percentage of the measuring range, or a process variable that can be assigned to one of the nine Device Variables (DV) listed in section ➔ 9.4. Process Variables.

10.1. View of local LCD display

Display options can be changed in local MENU using buttons. The display is shown in the figure below.

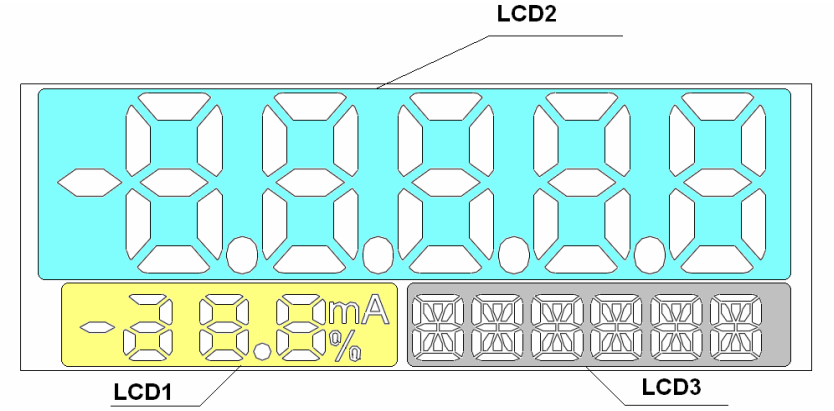


Figure 6. Display information fields

There are three basic fields on the display:
LCD1 field:

Displays the current value or the percentage of the configured output range. Depending on the configuration, this field may show the current value in the 4 … 20 mA loop with a resolution of 0.1 mA, or the percentage of the configured control range with a display resolution from 0.1% to 9.9% and from 10% to 100%.

LCD2 field:
Displays mainly the floating-point value of the process variable, in the unit shown on LCD3. The position of the decimal point can be set in the local MENU or remotely. In some cases, other messages may appear:

- ● ● ● ● or – ● ● ● ●, when the displayed value exceeds the configured display range;
- **E.xxxx**, where *xxxx* is an error code triggered when a condition causing alarm current is detected during operation;
- **U_AL**, when the process variable exceeds the user-defined alarm threshold;
- **Sn_AL**, when the sensor difference limit is exceeded (Status: SensorDiffDetected);
- **NAN**, when the displayed value is not a real number as defined in the IEEE-754 standard;
- **IdXXX**, where XXX is a decimal constant assigned to the currently displayed system parameter;
- **XX.YY.Z**, when the current loop configuration is displayed, where:
  - „XX” – loop saturation level:
    - **no** – Normal,
    - **nA** – Namur;
  - „YY” – alarm type:
    - **no** – Normal,
    - **nA** – Namur,
    - **SA** – Safety,
    - **uS** – User;
  - „Z” – alarm level:
    - **L** – Low,
    - **H** – High;
- **INFO**, when to press the [●] button to get additional information about the parameters;
- **|--** or **---** or **--|**, when you need to scroll up or down using the [↓] or [↑] button to view more information;

- **inAct** or **oFF**, when the selected option is inactive;
- **Act** or **on**, when the selected option is active;
- **ErSEt**, when the selected option has a configuration error;
- **XXYYh** or **YYh**, where "XX" is the most significant byte and "YY" is the least significant byte of the displayed value.

LCD3 field:

- the name of the unit assigned to the process variable;
- **ERROR**, when a system error is detected;
- **X OoL**, when value X exceeds its range (X may be: LRV, URV, damping factor, or dead zone point);
- **WAIT**, when waiting for measurement data (displayed when starting the device or after each change of measurement configuration);
- **DONE**, when the local configuration function has been successfully completed;
- **LOCKED**, when an attempt is made to access the Menu mode while the Menu mode access lock is active;
- **ER_Lxx**, when an error occurs during the execution of a local configuration function, where xx is the error identifier (see ➔ Table 6. Local configuration error and warning codes with descriptions);
- **WG_Lxx**, when the local configuration function is executed correctly, but the modified parameters reach values related to the device's operating limits, where xx is the error identifier (see ➔ Table 6. Local configuration error and warning codes with descriptions);
- **HELP** mode parameters (see ➔ Table 7. HELP mode structure).

10.2. Display configuration

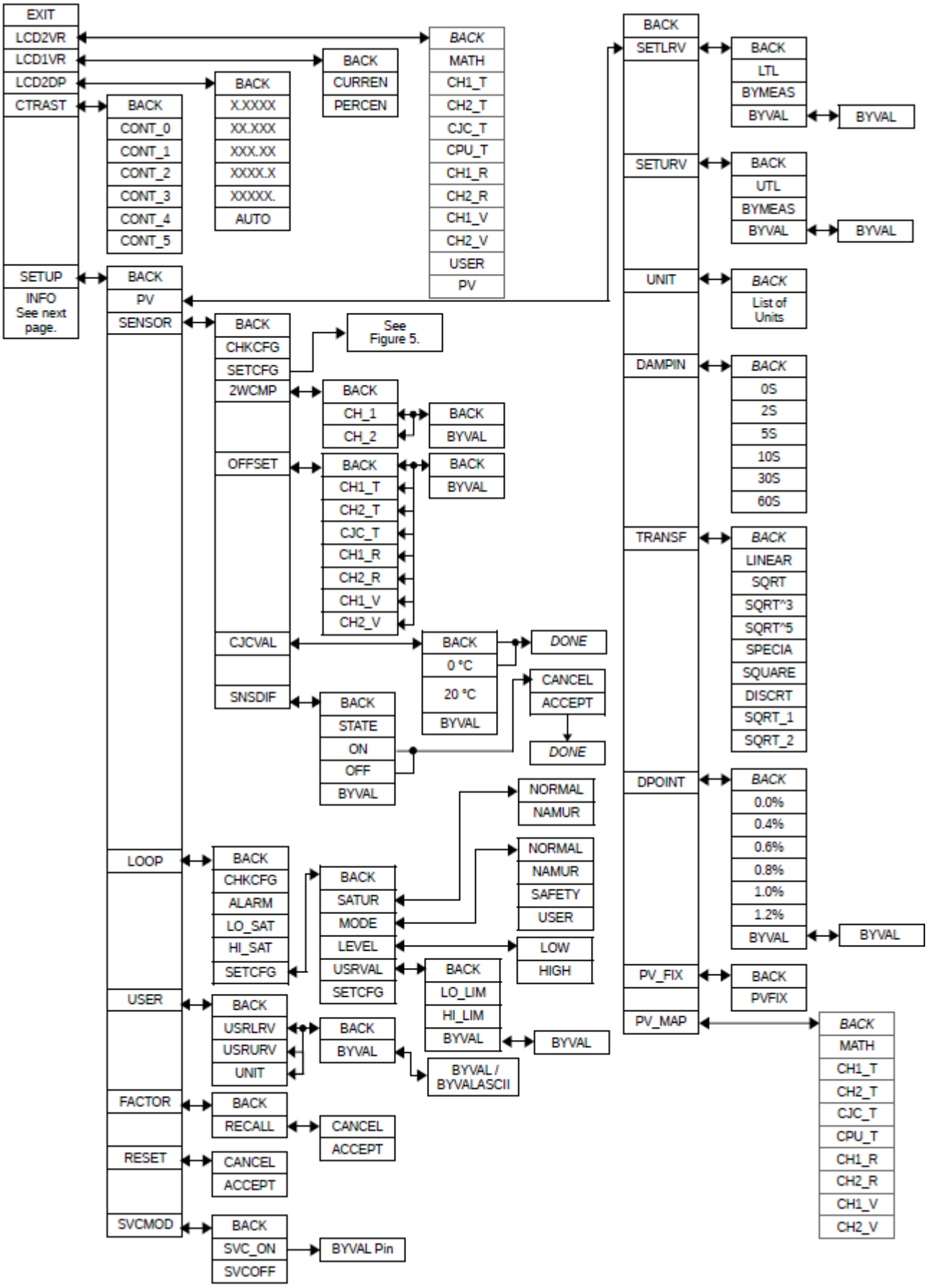
The user can change some transmitter settings, including the display, using the buttons below the display. The buttons can be accessed by unscrewing the display cover. The buttons are marked with symbols: [↓], [↑] and [●].
The buttons [↓], [↑] are used to move up and down the MENU structure, and the button [●] confirms and executes the selected option. Pressing and holding [●] button for about 3 seconds will cause enter to the local setting mode, and the following message “EXIT” appears on the display in the field LCD3. To exit the local MENU, confirm the "EXIT" option by holding the [●] button for about 3 seconds. No activity in the MENU area for longer than 2 minutes automatically exits the local setting mode and return to displaying the process variable. After confirming a selected parameter, the display will confirm the acceptance of the command with a "DONE" message. The "← BACK" option allows to move up a level higher in the MENU structure.
The way of navigating in the MENU structure of the local display is shown in the ➔ Table 5. Structure of the local setpoints MENU.

Table 5. Structure of the local setpoints MENU

EXIT		Exit the local MENU.
LCD2VR		Selection of the process variable displayed on LCD2.
	BACK	Return one level up in the local MENU.
	MATH	Process variable DV0 – Mathematical variable.
	CH1_T	Process variable DV1 – Channel 1 temperature.
	CH2_T	Process variable DV2 – Channel 2 temperature.
	CJC_T	Process variable DV3 – Cold junction compensation temperature.
	CPU_T	Process variable DV4 – CPU temperature.
	CH1_R	Process variable DV5 – Channel 1 resistance.
	CH2_R	Process variable DV6 – Channel 2 resistance.
	CH1_V	Process variable DV7 – Channel 1 voltage.
	CH2_V	Process variable DV8 – Channel 2 voltage.
	USER	User-defined variable.
	PV	Process variable assigned to PV.
LCD1VR		Selection of display mode on LCD1.
	BACK	Return one level up in the local MENU.
	CURREN	Display of loop current.
	PERCEN	Display of percentage of the control range.

LCD2DP		Decimal point position setting for the displayed variable. **AUTO** mode enables automatic decimal placement.
CTRAST		Contrast adjustment for the display in the range from **CONT_0** to **CONT_5**.
SETUP		Transmitter configuration options.
	BACK	Return one level up in the local MENU.
	PV	Process variable configuration.
		SETLRV — LRV setting. Can be set using option **LTL**, by measurement using **BYMEAS**, or by entering value using **BYVAL**.
		SETURV — URV setting. Can be set using option **UTL**, by measurement using **BYMEAS**, or by entering value using **BYVAL**.
		UNIT — Unit selection. Options: **°C** (degrees Celsius), **°F** (degrees Fahrenheit), **°R** (degrees Rankine), **K** (Kelvin), **OHM** (ohms), **KOHM** (kiloohms), **V** (volts), **mV** (millivolts).
		DAMPIN — Time constant setting for primary variable damping. Available values: **0**, **2**, **5**, **10**, **30**, or **60** seconds.
		TRANSF — Selection of the type of output signal transformation.
		BACK — Return one level up in the local MENU.
		LINEAR — Linear function.
		SQRT — Square root function.
		SQRT^3 — Cube root function.
		SQRT^5 — Fifth root function.
		SPECIA — User function (user-defined table-based function).
		SQUARE — Square function.
		DISCRT — Discrete (switch)
		SQRT_1 — Manufacturer specific function 1.
		SQRT_2 — Manufacturer specific function 2.
		DPOINT — Setting the % dead zone point value for selected characteristics. Available values: **0.0**, **0.4**, **0.6**, **0.8**, **1.0**, **1.2**, **0.0%**, or a user-defined value using the **BYVAL** option.
		PV_FIX — Assignment of default unit, LRV, and URV values to the active PV variable. Must be confirmed by selecting the **PVFIX** option.
		PV_MAP — Assignment of a process variable to the PV variable.
		BACK — Return one level up in the local MENU.
		MATH — Process variable DV0 – Mathematical variable.
		CH1_T — Process variable DV1 – Channel 1 temperature.
		CH2_T — Process variable DV2 – Channel 2 temperature.
		CJC_T — Process variable DV3 – Cold junction compensation temperature.
		CPU_T — Process variable DV4 – CPU temperature.
		CH1_R — Process variable DV5 – Channel 1 resistance.
		CH2_R — Process variable DV6 – Channel 2 resistance.
		CH1_V — Process variable DV7 – Channel 1 voltage.
		CH2_V — Process variable DV8 – Channel 2 voltage.
	SENSOR	Sensor configuration.
		BACK — Return one level up in the local MENU.
		CHKCFG — Display the current sensor configuration.
		SETCFG — Sensor configuration setting (the configuration steps are presented in → *Figure 5. Sensor configuration scheme from the local MENU*).
		2WCMP — Setting wire resistance compensation values for **CH1** (sensor channel 1) and **CH2** (sensor channel 2) by entering values using the **BYVAL** option.
		OFFSET — Selection of offset value for the process variable.
		BACK — Return one level up in the MENU.
		CH1_T — Process variable DV1 – Channel 1 temperature.
		CH2_T — Process variable DV2 – Channel 2 temperature.
		CJC_T — Process variable DV3 – Cold junction compensation temperature.
		CH1_R — Process variable DV5 – Channel 1 resistance.
		CH2_R — Process variable DV6 – Channel 2 resistance.
		CH1_V — Process variable DV7 – Channel 1 voltage.
		CH2_V — Process variable DV8 – Channel 2 voltage.
		CJCVAL — Setting a fixed cold junction compensation value to **0°C**, **20°C**, or entering a custom value using **BYVAL** in units: **°C**, **°F**, or **°R**.
		SNSDIF — Displaying the **STATE** option of the temperature difference status between the two sensors or setting it using **ON** or **OFF**, or entering a value using **BYVAL**.

LOOP			Current loop configuration.
	BACK		Return one level up in the MENU.
	CHKCFG		Display the current configuration of the current loop.
	ALARM		Display the current alarm current value of the current loop.
	LO_SAT		Display the current low saturation value of the current loop.
	HI_SAT		Display the current high saturation value of the current loop.
	SETCFG		Setting the current loop configuration. In order to save changes, they must be confirmed using the **SETCFG** option.
		BACK	Return one level up in the MENU.
		SATUR	Selection of **NORMAL** or **NAMUR** saturation level for the current loop.
		MODE	Selection of alarm current mode: **NORMAL**, **NAMUR**, **SAFETY**, or **USER**.
		LEVEL	Selection of **LOW** or **HIGH** alarm level.
		USRVAL	Selection of displaying the current user-defined alarm limit for the current loop: **LO_LIM** (lower limit) or **HI_LIM** (upper limit), or entering a parameter value using the **BYVAL** option.
		SETCFG	Confirmation of configuration settings. After confirmation, the current configuration will be displayed via the **CHKCFG** option.
	USER		User unit configuration by setting the lower limit value via **USRLRV**, upper limit via **USRURV**, and unit name via the **UNIT** option.
	FACTOR		Restoring factory default settings of the transmitter. Confirmation required using the **RECALL** option.
	RESET		Reset of transmitter operation. Confirmation required using the **ACCEPT** option.
	SVCMOD		Switching transmitter operation mode from normal to service. The **SVC_ON** option enables service mode, and the **SVCOFF** option disables it.
INFO			Display information about transmitter operation.
	BACK		Return one level up in the local MENU.
	PV_IDX		Display the index of the process variable assigned as the primary variable.
	DV_CNT		Number of device variables in the system.
	HW_VER		Hardware configuration version of the transmitter.
	SW_VER		Software version of the transmitter.
	HART		HART communication protocol information.
		BACK	Return one level up in the local MENU.
		HT_REV	Version of the HART communication protocol implemented in the transmitter.
		DEVREV	Device revision version.
		POLL	Device address in multi-drop configuration.
		EDT	Extended Device Type code of the HART communication protocol.
		TAG [8:0]	Packed ASCII string identifying the physical device. Due to the string length, it is divided into three parts. Use the [↓] or [↑] button to read the next part.
		DEV_ID [8:0]	Device identification number. Due to the string length, it is divided into three parts. Use the [↓] or [↑] button to read the next part.
	RUNTIM		Display the transmitter's operating time since the last reset. The value can be shown in: **DAYS**, **HOURS**, **MINS**, or **SECS**.
	STATUS		Transmitter status display
		BACK	Return one level up in the local MENU.
		START	Display transmitter startup statuses.
		SENS	Display input channel statuses of the transmitter.
		SENS 1	Display the status of input channel 1.
		SENS 2	Display the status of input channel 2.
		SENSCJ	Display the status of the cold junction compensation sensor.
		CFG	Display configuration status of the transmitter.
		NVM	Display non-volatile memory status.
		DIAG	Display transmitter diagnostics status.
		OTHER	Display other transmitter statuses.
		CHKSTA	Display **C**heckConfig status of the transmitter.


EXIT
LCD2VR
LCD1VR
LCD2DP
CTRAST
SETUP
INFO
See next page.
BACK
CONT_0
CONT_1
CONT_2
CONT_3
CONT_4
CONT_5
BACK
X.XXXX
XX.XXX
XXX.XX
XXXX.X
XXXXX.
AUTO
BACK
CURREN
PERCEN
BACK
MATH
CH1_T
CH2_T
CJC_T
CPU_T
CH1_R
CH2_R
CH1_V
CH2_V
USER
PV
BACK
PV
SENSOR
BACK
CHKCFG
SETCFG
2WCMP
OFFSET
CJCVAL
SNSDIF
See Figure 5.
BACK
CH_1
CH_2
BACK
BYVAL
BACK
CH1_T
CH2_T
CJC_T
CH1_R
CH2_R
CH1_V
CH2_V
BACK
BYVAL
BACK
0 °C
20 °C
BYVAL
DONE
CANCEL
ACCEPT
DONE
BACK
STATE
ON
OFF
BYVAL
LOOP
BACK
CHKCFG
ALARM
LO_SAT
HI_SAT
SETCFG
BACK
SATUR
MODE
LEVEL
USRVAL
SETCFG
NORMAL
NAMUR
NORMAL
NAMUR
SAFETY
USER
LOW
HIGH
BACK
LO_LIM
HI_LIM
BYVAL
BYVAL
USER
BACK
USRLRV
USRURV
UNIT
BACK
BYVAL
BYVAL / BYVALASCII
FACTOR
BACK
RECALL
CANCEL
ACCEPT
RESET
CANCEL
ACCEPT
SVCMOD
BACK
SVC_ON
SVCOFF
BYVAL Pin
BACK
SETLRV
SETURV
UNIT
DAMPIN
TRANSF
DPOINT
PV_FIX
PV_MAP
BACK
LTL
BYMEAS
BYVAL
BYVAL
BACK
UTL
BYMEAS
BYVAL
BYVAL
BACK
List of Units
BACK
0S
2S
5S
10S
30S
60S
BACK
LINEAR
SQRT
SQRT^3
SQRT^5
SPECIA
SQUARE
DISCRT
SQRT_1
SQRT_2
BACK
0.0%
0.4%
0.6%
0.8%
1.0%
1.2%
BYVAL
BYVAL
BACK
PVFIX
BACK
MATH
CH1_T
CH2_T
CJC_T
CPU_T
CH1_R
CH2_R
CH1_V
CH2_V

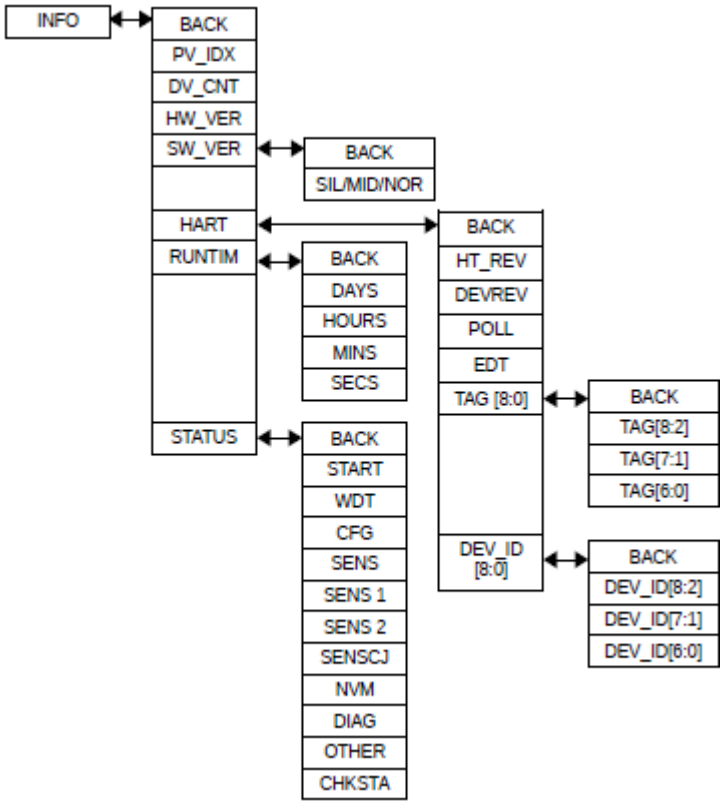


Figure 7. Structure of the local setpoints MENU

10.3. Local MENU, error messages

During the execution of some functions in the local MENU, the error message may be displayed on the LCD2 field. Displaying an error means that the local MENU command was not carried out. Errors in the display or incorrect configuration of the display do not affect the value of the process variable in current loop.

Table 6. Local configuration error and warning codes with descriptions

ER_L06	This message appears when an internal device error occurs, preventing the proper completion of the executed function.
ER_L07	This message appears if a function that writes to non-volatile memory is executed while write protection is active.
ER_L09	This message appears if the new parameter value calculated by the executed function exceeds the upper limit of the allowable parameter range.
ER_L10	This message appears if the new parameter value calculated by the executed function is below the lower limit of the allowable parameter range.
ER_L14	This message appears if the new LRV/URV value calculated by the executed function cannot be accepted because it reduces the configured range below the minimum allowable span.
ER_L18	This message appears when a parameter change is attempted, but the current device configuration does not allow the requested function to execute correctly.
WG_L14	This message appears when the new LRV/URV value calculated by the executed function reduces the width of the previously configured range. Accepting the new LRV will cause the URV value to shift to one of the basic range limits.
WG_L29	This message appears when attempting to access PV configuration options while the process variable assigned to PV is inactive. The new value will be accepted.

10.4. HELP mode structure

In measurement mode of local interface, user can rapidly display the values of selected primary variable parameters or displayed variable assignment. Mentioned parameters can be shown on LCD3 field by pressing [↑], [↓] buttons. By this action, local interface enters the HELP mode (without entering MENU mode).

Table 7. HELP mode structure

LCD2VR-DV_ID	[↑]	Name of process variable currently assigned to displayed variable.
LCD2VR-Unit	-	Default local interface setting in measurement mode, displaying the unit of displayed variable.
PV-Name	[↓]	Name of process variable assigned to primary variable
PV-Zero	[↓]	Zero trim value of primary variable, displayed as „Zxxxxx" in unit of primary variable.
PV-LRV	[↓]	Lower Range Value of primary variable, displayed as „Lxxxxx" in unit of primary variable.
PV-URV	[↓]	Upper Range Value of primary variable, displayed as „Uxxxxx" in unit of primary variable.
PV-Damping	[↓]	Value of time constant damping, displayed as „Dxxxxx" in seconds.
PV-Transf	[↓]	Value of time constant damping, displayed as „Dxxxxx" in seconds.
PV-DPoint	[↓]	Cutoff point value of transfer function, displayed as „%xxxxx". If transfer function does not support a dead band, „%-----" is displayed instead.

10.5. Operating temperature

Standard version
-40 … 80°C (-40 … 176°F)

10.6. Remote configuration of setpoints (HART)

The transmitter allows to read and configure parameters via HART communication using 4 … 20 mA loop as the physical layer for FSK BELL 202 modulation.

10.6.1. Compatible devices

The following devices may be used to communicate with the transmitter:

- HART/USB converter by Aplisens S.A. or other manufacturers;
- PC computers equipped with HART modem (e.g. HART/USB converter by Aplisens S.A.) installed software Raport 2 manufactured by Aplisens S.A.;
- PC computers equipped with HART modem using software from other companies, accepting DDL and DTM libraries;
- smartphones with Android system, using a converter providing wireless communication (e.g. HART/USB converter by Aplisens S.A.) using Aplisens Mobile Configurator software. The software is available on Google Play under the link: https://play.google.com/store/apps/details?id=com.aplisens.mobile.amc.

10.6.2. Compatible configuration software

- Raport 2 manufactured by Aplisens S.A.;
- Aplisens Mobile Configurator under control of the Android system;
- every software from other companies accepting DDL and DTM libraries.

10.6.3. Method of connecting communication devices

The method of connecting communication devices to the transmitter is described in chapter ➔ 8.1.2. Connection of transmitters with the option of using HART communication. When using remote communication, the HART modem must be connected in parallel to the 4 … 20 mA line. A resistance of ≥ 240 Ω is required between the power supply and the modem connection point. Also follow the guidelines for maximum load resistance R_{Lmax} described in section ➔ 8.2.3. Resistance load in power supply line. When using measuring cards with an integrated HART master, the card manufacturer's regulations must be followed.

11. MAINTENANCE

11.1. Periodic inspections

Periodic inspections shall be carried out in accordance with applicable standards. During the inspection, check the condition of electrical terminal connections (reliability of the connections) and the stability of transmitter mounting.

11.2. Non-periodic inspections

If the transmitter at the installation site has been exposed to mechanical damage, overvoltage or incorrect operation of the transmitter is detected, the device shall be inspected.

If there is no signal in the transmission line or its value is improper, check the supply line, connection status on terminal blocks, connectors, etc. Check if the supply voltage and load resistance are correct.

11.3. Spare parts

Parts of the transmitter that may be worn or damaged and thus replaced: cover gasket and cable gland gasket.

11.4. Repair

Faulty or non-operational transmitter shall be provided to the manufacturer.

11.5. Returns

In the following cases, the transmitter should be returned directly to the manufacturer:

- need for repair;
- need for factory calibration;
- replacement of improperly selected/shipped transmitter.

12. SCRAPPING, DISPOSAL

Worn or damaged devices shall be scrapped in accordance with WEEE Directive (2012/19/EU) on waste electrical and electronic equipment or returned to the manufacturer.

13. HISTORY OF REVISIONS

Revision No.	Document revision	Description of changes
-	01_A1_2014-11	First version of the document. Prepared by DKD.
1	01_02.B.003_2018	Documentation update. Prepared by DKD
2	01_02.C.004_2018	New certification, documentation update. Prepared by DKD.
3	01.A.001/2021.05	New version. Prepared by DBFD.
4	02.A.001/2025.04	Documentation update related to the new transmitter version.