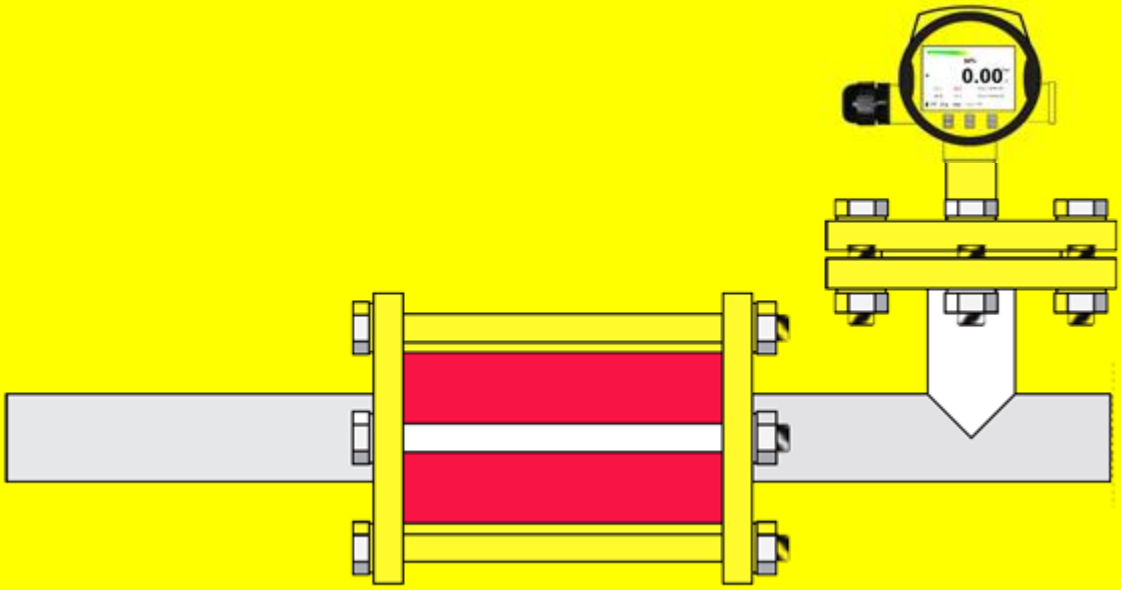
Smart Temperature Transmitter
MODEL: SB-TT

SMART BIENE.



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Document ID: SB-TT (0102)

Measuring principle

SB-TT Smart Temperature transmitter measures process temperature using thermocouples or RTD sensors in 2, 3 or 4 wire configuration:

- **SB-TT** measures microvolt changes by thermocouples and as result calculates temperature using **ITS-90** standard Equations.
- **SB-TT** measures resistance changes in RTD and as a result calculates temperature using **ITS-90** standard Equations.

Figure 1. SB-TT Smart Temperature transmitter

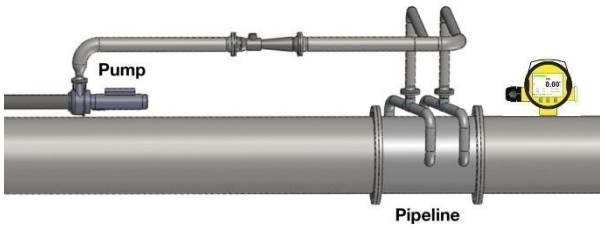


Figure 2. SB-TT as a pipeline temperature measurement

All Sensor Types

- **SB-TT** smart temperature transmitter measures temperature by 8 types of thermocouples **(B, E, J, K, N, R, S, T)** selectable by user. **SB-TT** uses a high precision sensor (±0.4 ˚C) for Cold Junction temperature measurement.
- you can measure any millivolt source (any type of sensor transducer with volt output) by **SB-TT** and Define a Linear equation between measured signal and display or output values.
- **SB-TT** smart temperature transmitter measures temperature by 7 types of RTD (PT50, PT100, PT200, PT500, PT1000, CU10, NI 120) selectable by user.
- You can also measure any resistor (any type of sensor transducer with resistance output like potentiometer) by **SB-TT** and Define a Linear equation between measured signal and display or output values.

Sensor Type	Measuring Range ˚C	Precision ˚C
B	250 to 1820	±1
E	-200 to 1000	±0.5
J	-210 to 1200	±0.5
K	-200 to 1372	±0.5
N	-200 to 1300	±0.5
R	-50 to 1768	±1
S	-50 to 1768	±1
T	-200 to 400	±0.5

Sensor Type	Measuring Range ˚C	Precision ˚C
PT-50	-200 to 850	±0.5
PT-100 (α=0.00385)	-200 to 850	±0.5
PT-200	-200 to 500	±0.5
PT-500	-100 to 455	±0.5
PT-1000	-100 to 200	±0.5
CU-10	-100 to 150	±1
Ni-120	-80 to 260	±0.5

Sensor Type	Measuring Range Ω	Precision Ω
Resistor (Potentiometer)	0 to 5000	±0.05

Sensor Type	Measuring Range mv	Precision FS
Millivolt Input	-187.5 to 187.5	0.01%

MEASURING SPECIFICATIONS

Reference Condition: 25 ˚C (77 ˚F):

- Stability: < ±0.2% of span for 12 months.
- Response Time: 2 sample / sec.
- Output Resolution: 0.05% FS (URL)
- LCD Accuracy:±0.05% FS (URL) + last digit

*URL: Accuracy includes the effects of linearity, Hysteresis, and repeatability.

ELECTRICAL SPECIFICATIONS

- Display: 2.8 inch full-color TFT LCD with LED Backlight.
- Power Supply: 24VDC.
- Current Output: 0-10 , 0-20 , 4-20 mA , MAX Load: 500Ω
- Relay Output: 2 or 4 Relays, 0.5A-220VAC or 4A-30VDC.
- 2 Wire Modbus-RTU communication protocol.
- All In/Out Ports: 30VDC Circuit Protected.

MECHANICAL SPECIFICATIONS

- Robust NEMA 4X (IP66) aluminum Die cast housing for panel.
- Mounting torque: 15...20 nm.
- Mounting Accessories: U-Bolt
- Weight: ~ 1900 gr.

ENVIRONMENTAL CONDITIONS

- Operating temperature: -10 ...+70°c
- Humidity: max. 95%
- Relative vibration: 2g (10...2000 Hz)
- Shock: 5g/ 8 ms.

ESD CAUTION

ESD (electrostatic discharge) sensitive device: Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

CAUTION

- **Some liquid mixtures are dangerous. This includes mixtures that occur because of contamination. Make sure that the device is safe to use with the necessary media.**
- **It is dangerous to ignore the specified limits for the device or to use the device when it is not in its normal condition. Use the applicable protection and obey all safety precautions.**
- **Keep LCD away from direct sunlight.**
- **Before you start an operation or procedure, make sure that you have the necessary skills (if necessary, with qualifications from an approved training establishment).**

TERMINAL WIRING

01. Current Output (+)
02. Current Output (-)
03. Sensor connection (+24VDC)
04. Sensor connection (GND)
05. RS-485 (Modbus-RTU): A
06. RS-485 (Modbus-RTU): B
07. Temperature Sensor connection
08. Temperature Sensor connection
09. Temperature Sensor connection
10. Temperature Sensor connection
11. Relay-1: COM
12. Relay-1: NC
13. Relay-1: NO
14. Relay-2: COM
15. Relay-2: NC
16. Relay-2: NO
17. Relay-3: COM
18. Relay-3: NC
19. Relay-3: NO
20. Relay-4: COM
21. Relay-4: NC
22. Relay-4: NO

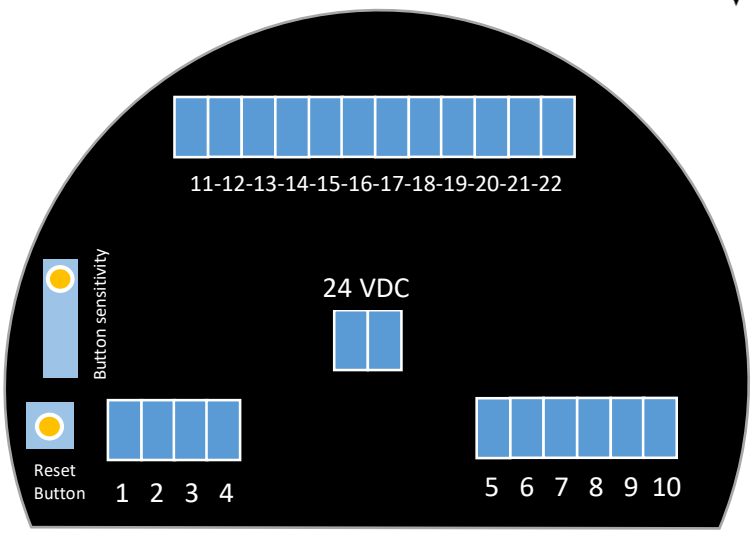


Figure 3. Panel Terminal Wiring

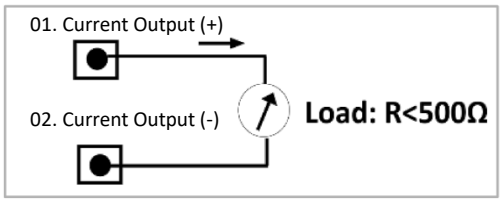


Figure 4. Current Output Wiring

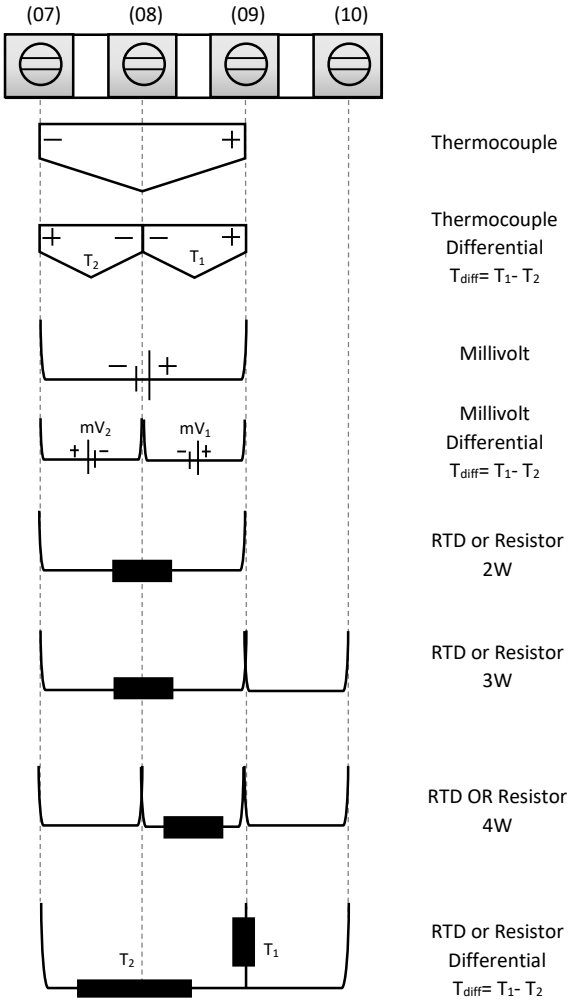


Figure 5. All types of sensors Wiring

Connection Cable

For Current Output If electromagnetic interference is expected which is above the test values of EN 61326-1 for industrial areas, **screened cable should be used**.

If screened cable is required, we recommend connecting the cable screen on both ends to ground potential. In the sensor, the screen should be connected directly to the internal ground terminal. The ground terminal on the outside of the housing must be connected to the ground potential (with low impedance).

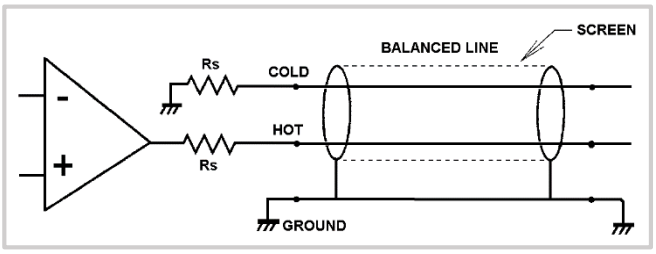


Figure 6. screened cable wiring

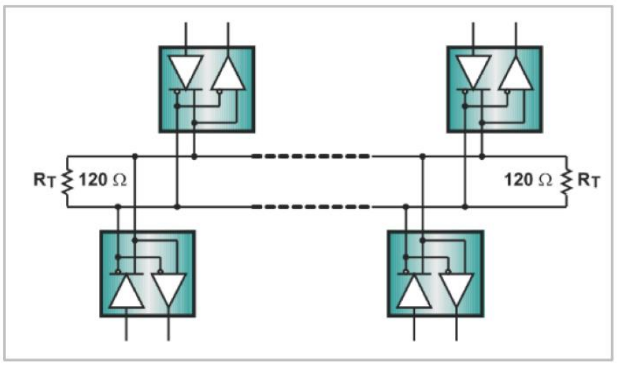


Figure 7. RS-485 network topology

RS-485 Network Topology.

RS-485 suggests its nodes to be networked in a daisy-chain, or bus topology.

In this topology, the participating drivers, receivers, and transceivers connect to a main cable trunk via short network stubs. The interface bus can be designed for half-duplex transmission.

R_t=120Ω

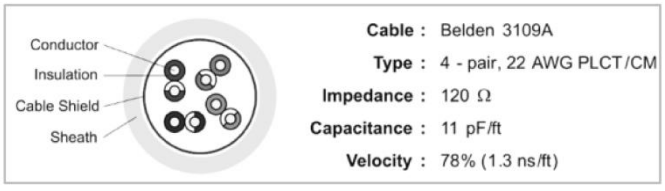


Figure 8. RS-485 Cable

MODEL SELECTION

S	B	-	T	T	-	-	-	-	-	0	0	4	-	-	G	-	-	-	-	-	-	-	-	U	L	-	-

Device Type:

TT: Smart Temperature transmitter.

Output:

1: Current Output (0-20/4-20 mA) **0:** NO Current Output

1: Modbus-RTU Output **0:** NO Modbus-RTU Output

2: Two-Relay Output **4:** Four-Relay Output

Connection Type:

G: G 1/2" - female

Options:

UL: USB Connection & Data Logger.

T: External Trimming Potentiometer.

S	B	-	T	W	-	50	/	100	/	L	-	PT100	--	3	-	3	-	

Device Type:

TW: Temperature Thermo-well.

Neck Length: (Extension) mm

Specified by customer: 50 to 200

Insertion Length: (Immersion) mm

Specified by customer: 50 to 1000

Material:

S: SS-316

L: SS-316L

Sensor Type:

B - E - J - K - N - R - S - T - PT50 - PT100 - PT200 - PT500 - PT1000 - CU10 - Ni120

Wire: (For RTD Sensors only)

2: 2 wire RTD 3: 3wire RTD 4: 4wire RTD

Process Connection:

1: ANSI 1/2" – 150 Flange

2: ANSI 3/4" – 150 Flange

3: ANSI 1" – 150 Flange

4: ANSI 1-1/2" – 150 Flange

5: Thread NPT 1/2" - M

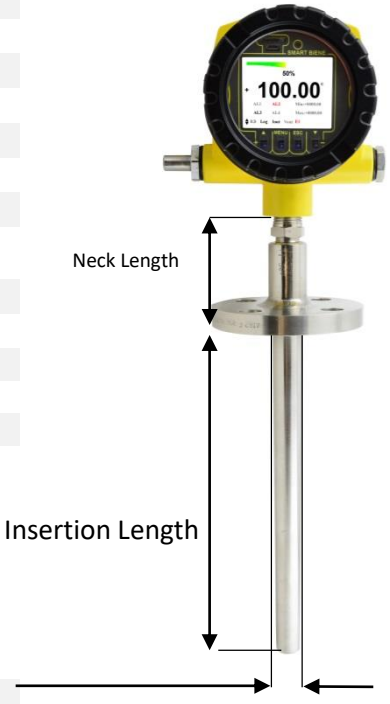
6: Thread NPT 3/4" - M

7: Thread NPT 1" - M

8: Other size Specified by customer

Insertion Maximum Diameter: (Immersion) mm

Specified by customer: from 1cm over



EXTERNAL TRIMPOT

External trimming potentiometer can be used for external configuration of alarm value:

- No need to Enter in Menu
- You can see alarm value in main page 1.
- User friendly for machine operators.

OPERATION

Touch Buttons:

Three infrared touch buttons are designed for device configuration. Under extremely rare case, the infra-red switches may respond unexpectedly in such conditions as sticking ball of water or extraneous substances on the surface of display panel glass according to the principle of infra-red switch operation.
It is probability rises in such cases as sticking rain water by storm or other similar situation and washing up work near panel installation place. Either to illuminate or stop illuminating the infra-red switches by the flashlight may cause the miss-reaction. During data entry the device remains on-line, the Outputs continue to indicate the actual operating values. The individual key functions are described below:

Up Button: (▲)

This key is one of the two arrow keys. It's Used for increasing digits, going up in Menu subpages, changing main pages, etc.

Menu / Enter Button: (►)

It's used for entering in menu (hold it 3SEC), Entering in submenus, Selecting digits, etc.

Back Button: (◄)

It's used for returning to main Pages from menu, return from submenus In menu, etc.

RESET FACTORY

- If it is necessary to restore all settings to the original factory configuration, touch and hold menu and back buttons (►◄ 3SEC) until the display asks for reset factory and then select YES.
  Notice: In reset factory mode all settings return to its default factory configuration and when you reset panel by power **off** & **on,** or by reset push-button in back end of panel all settings will not change.

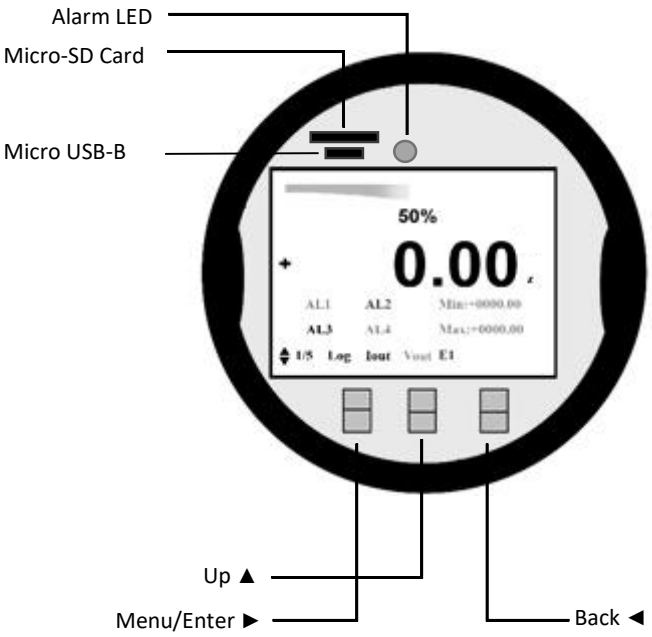


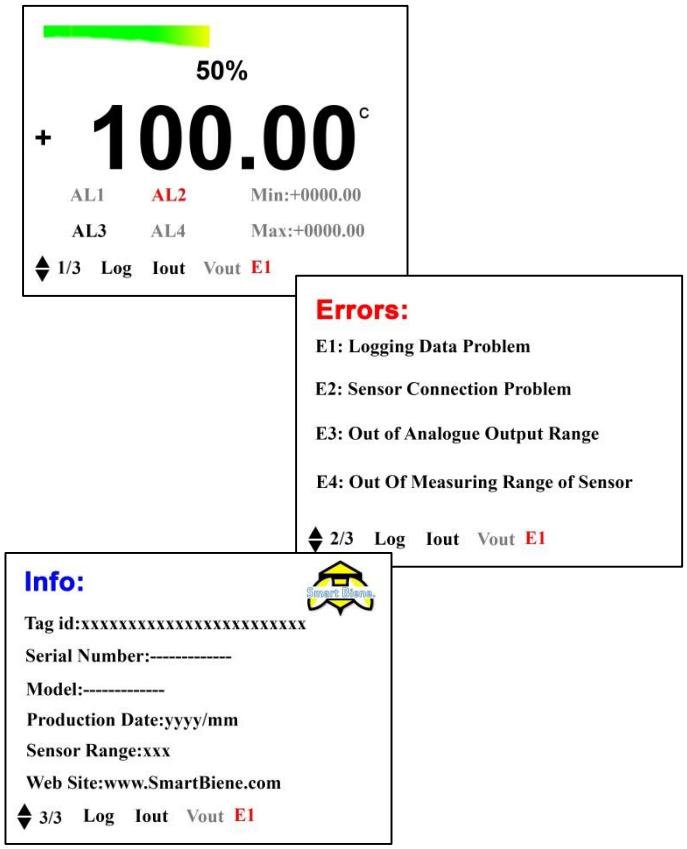
Figure 9. Panel front View

NOTICE

- To improve sensitivity of touch buttons set the screw in terminal panel, which is mentioned on page 3. In electrical diagram section. **Reset device and use touch buttons setting.**
- Don't open the device front panel cover (keep clean inside surface of glass - that's **vital**)
- Operate the display unit under the condition where direct sunlight, etc... do not shine to the setting switches directly when the parameter setting operation is carried out.
- **Use switches with panel glass cover.**
- If dirt, dust or other substances surfaces on the display panel glass, wipe them clean with a soft dry cloth.
- The operation with dirty gloves may cause a switch response error.
- If dirt, dust or other substances surfaces on the display panel glass, wipe them clean with a soft dry cloth.

MAIN PAGES

- 6 Main Pages are Designed for measuring parameters, output status …., you can move between main pages by up button(▲):
  - MAIN PAGES 1/3: measuring values and parameters, output status …
  - ERRORS PAGE 2/3: Describes errors which are shown in MAIN PAGES.
  - INFO PAGE 3/3: Describes some features and specifications of device such as serial number, model code, measuring range…



MAIN PAGES (1/3)

- Measured Values: the main 6 digits show measured value temperature, millivolt or resistance of connected sensor.
- Alarms status: Bold when enabled, and red when excited.
- MIN & MAX values: Bold when Enabled.
- Current Output (Iout) status: Bold when Enabled.
- Data Logger (Log) status: Bold when Enabled.
- Percent of Measuring Range (refer to info page) Graph: 50% as show in figures.
- Errors status: E1, (Refer to error page.)
- Measuring Unit: meter as shown in figures.

INFO PAGE (3/3)

- Tag ID: you can change Tag ID **only** by PC Software of device and Modbus protocol.
- Serial Number, Model code, sensor range and production date are factory registered information.
- NOTICE: percentage value in main page 1 is based on sensor range. Min-Max of range is equal to 0-100%.

ERROR PAGE (2/3)

- E1: this error appears when data logging is impossible such as the absence of SD-Card, full memory, or any other Hardware based problems.
- E2: this error appears when sensor connection to device has problem such as disconnecting, short circuit or any damage to sensor cables.
- E3: this error appears when measured value exceeds the measuring range of sensor. This error can result in damage of device.
- E4: this error appears when measuring value is out of measuring outputs. For example if 20 mA configured equal to 20 m and measured value is more than 20 m, this error appears.

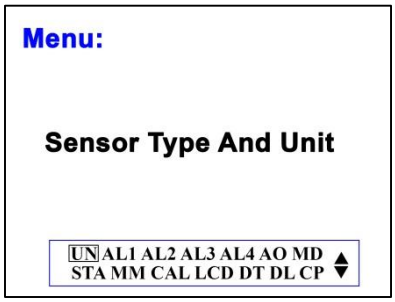
MENU QUICK GUIDE

RESET FACTORY - RESET PASSWORD

- If it is necessary to restore all menu settings to the original factory configuration, touch and hold menu and back buttons (►◄ 3SEC) until the display ask for reset factory and then select YES.
- **If you have forgotten Password, so you can use Reset factory configuration, it changes password to 000.**

HOW TO ENTER MENU

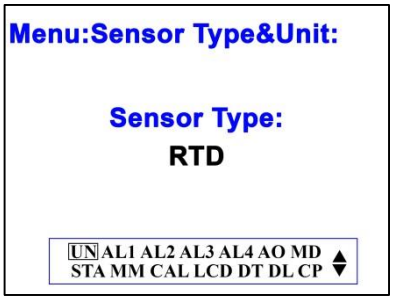
- Touch and hold menu button for 3sec and enter password. (► 3SEC)
- Use menu button to move between digits. (►)
- Use button to increase and decrease digits. (▲)
- Touch and hold menu button for 3sec to enter menu (if password is correct). (► 3SEC)
- If you have forgotten password , touch and hold menu and back buttons to (►◄ 3SEC)

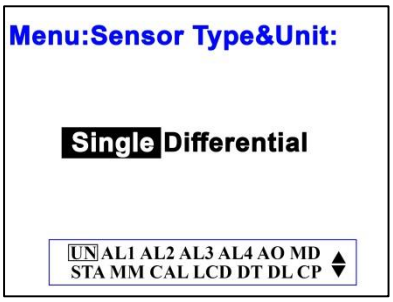


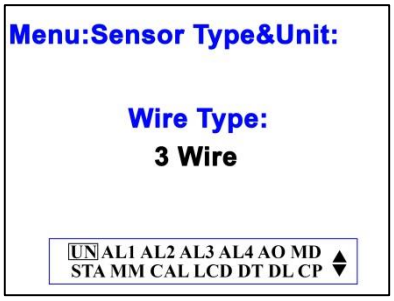
SENSOR TYPE & UNIT SELECTION

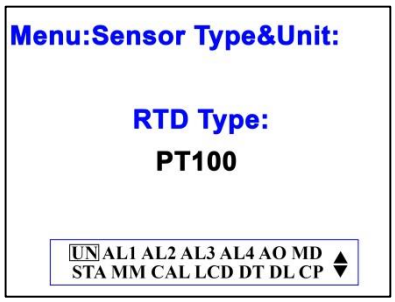
After enter in menu, first setting is measuring unit:

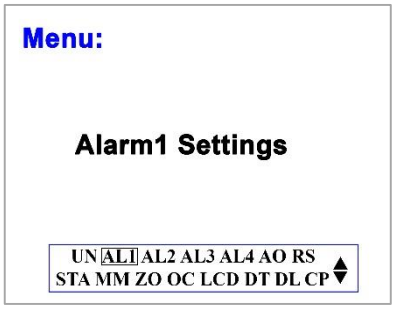
- Touch menu to enter units (►)
- Use up button to move between 10 sensor types and units. (▲)
- Touch menu again to select the unit. (►)
- Touch back button to exit from unit setting. (◄)

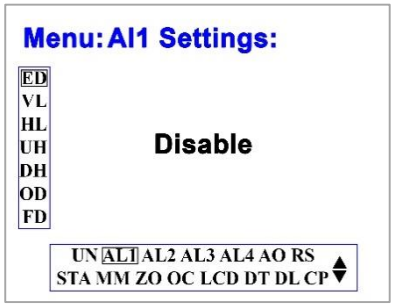


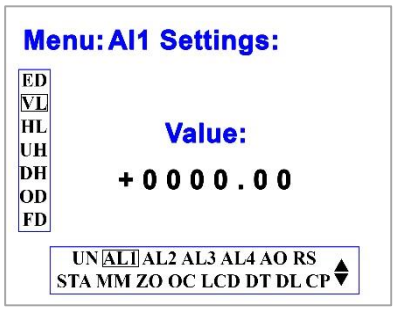


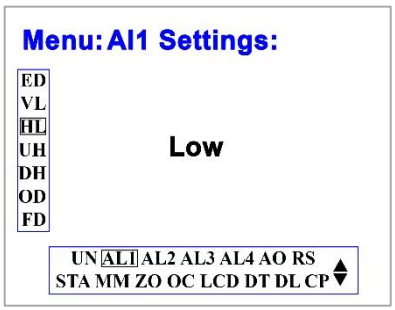










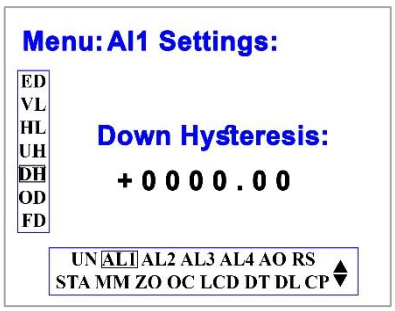


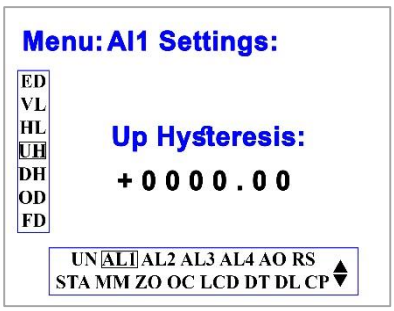
ALARM SETTINGS

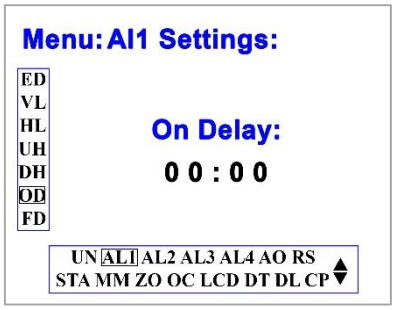
Based on relay selection you can configure two or four relays setting in menu:

Alarm x setting:

- Touch up to select Alarm x settings. (▲)
- Touch menu. (►)
- **Enable or disable:** you can disable or enable alarm (relay). Use up to move and finally use menu button to select disable or enable. (▲►)
- **Value:** Touch up button and then menu to change alarm value, use menu to move between digits and up change values. (▲►)
- **High or low:** Touch up button and then menu button to select High or Low setting for alarm:
    - **High:** when measured value exceeds alarm value, then relay excites.
    - **Low:** when measured value lessens than alarm value, then relay excites.
- **Hysteresis:** you can define up and down hysteresis values for alarm value: Touch up button and then menu button to change hysteresis values, use menu to move between digits and up to change values. (▲►)
    - **Up hysteresis:** when alarm is in low mode, and relay is excited; when measured value exceeds alarm value + up hysteresis, relay returns to its normal status.
    - **Down hysteresis:** when alarm is in high mode, and relay is excited; when measured value lessens alarm value - down hysteresis, relay returns to its normally situation.
- **Delay:** you can define on and off delay for alarms, you can define up and down hysteresis values for alarm value: Touch up button and then menu to change hysteresis values, use menu to move between digits and up to change values. (▲►)
    - **Delay on:** delay for relay excitation.
    - **Delay off:** delay for relay to return to its normal status.
- Touch back button to return to the main menu



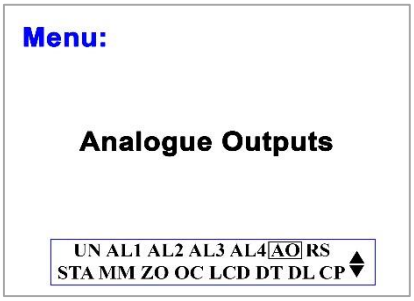


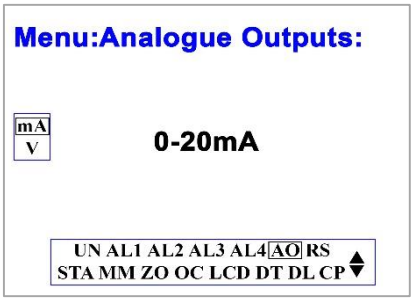


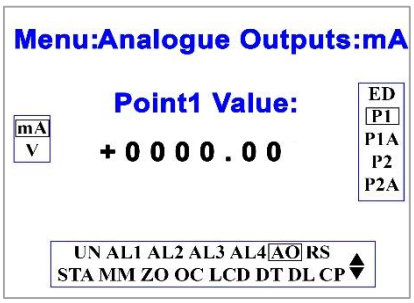
ANALOGUE OUTPUT

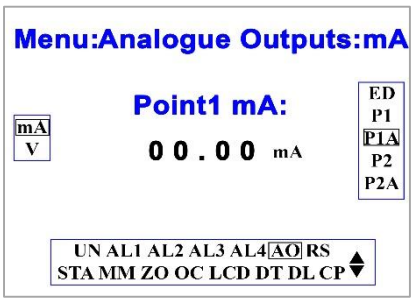
There is one analogue output for device:

- Touch up and menu to enter in analogue output setting: (▲►)
- Touch up and menu to select 0-20mA settings: (▲►)
- **0-20mA:**
    - You can disable or enable 0-20mA output. Use up to move and finally use menu button to select disable or enable. (▲►)
    - **point Value & point mA:**
      For this output type you can define a linear relation between measured value (between measuring range) and current output (between 0 to 20mA) by means of two points. Thus we have:
      Point 1 value ↔ point1 mA
      Point 2 value ↔ point2 mA
      Thus you can have 4-20mA or 0-20mA … current outputs for your measurement range!
      Touch up button and then menu to change alarm value, use menu to move between digits and up to change values. (▲►)





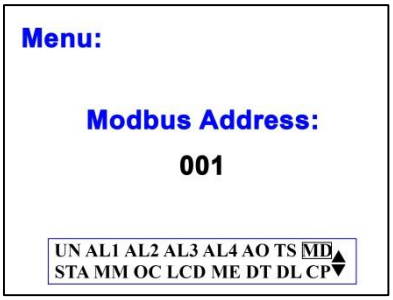




RS-485 (Modbus-RTU)

Based on model order Modbus-RTU communication protocol is possible for device, Touch up button and then menu to change address value. (▲►)

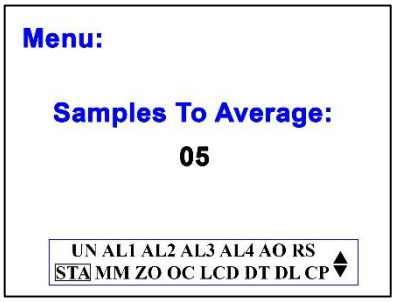
- Refer to **Modbus-RTU map Register manual** for transmitter.
- In menu you can define device as a slave with address 001 to 247.



SAMPLES TO AVERAGE

You can define number of samples to average for measuring algorithms:

- Increasing samples to average, damp noise of measured value and increase response time of device.



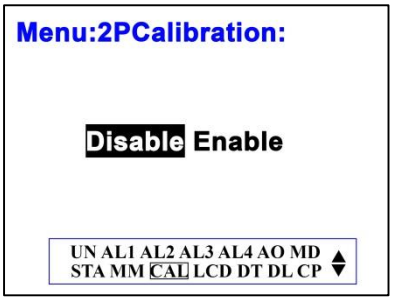
MAX & MIN

- you can record and display max and min of measured value in main page 1:
  - **Enable or disable:** in Min & Max menu, Use up to move and finally use menu button to select disable or enable. (▲►)
  - **Erase:** in Min & MAX menu, Use up to move and finally use menu button to select Erase and then select yes to erase and reset Max & Min values displayed in main page 1. (▲►)

TWO POINT CALIBRATION
(Millivolt & Resistor Input)

You can use this setting for field calibration of **device when TC or RTD** is selected:

- You can measure any millivolt or potentiometer source (any type of sensor transducer with volt or resistance output) and Define a Linear equation between measured signal and display or output values. Definition of linear equation is possible by two-point calibration of signal:
    - apply first reference by sensor(for example apply 20Ω by potentiometer) as point 1
    - enter corresponding value for point1
    - Then press menu to calibrate and receive "point1 calibrated" command.
    - Do this for second point
    - Thus you have linear relation between displayed or output value and input signal As show in fig.10.



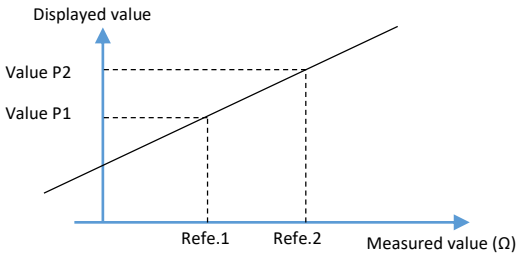
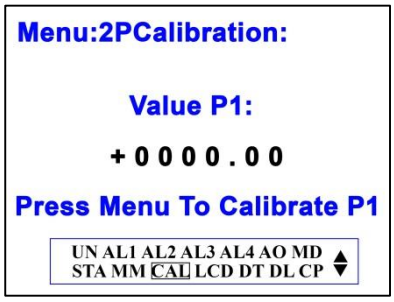
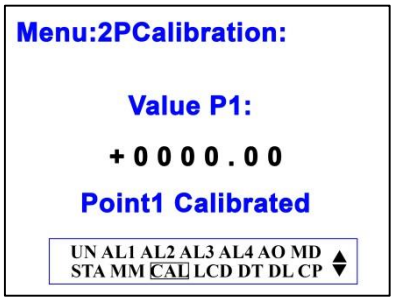


Figure 10. point calibration (for millivolt and resistor only)





OFFSET CALIBRATION (TC & RTD)

You can use this setting for field calibration of **device when TC or RTD** is selected:

- Put sensor in reference Temperature.
- Insert reference value in offset calibration value and then touch menu to calibrate it.
- In this calibration method a constant value (reference value - measured value) will be added to measured value to achieve correct measurement.

LCD POWER OFF TIME

You can define a power off time for LCD Backlight:

- Values form 1 to 60 minutes.
- Also you can select disable for continuously LCD Backlight ON. Not Recommended!

DATE & TIME

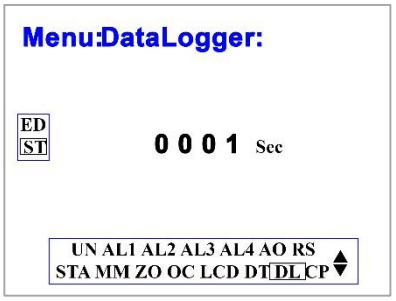
For Data Logger option, you can set date and time, use menu to move between digits and up to change values. (▲►)

- Use CR2032- 3V battery on electrical board behind LCD.
- For normal operation, life of battery is 2 years.
- If don't use battery, date and time will reset by device power off.

DATA LOGGER

With this option you can measure and record data to SD-Card:

- Recording Data on 2GB MICRO SD-Card with date and time tag. Saving data as a TEXT file.
- **Sampling period:** change sampling period from 1sec to 9999 sec. use menu to move between digits and up to change values. (▲►)



CHANGE PASSWORD

You can change Password for entering menu:

- Enter menu: change password
- Enter old password
- Enter new password
- Confirm new password, enter new password again.
- Password changed!

If you have forgotten password, use reset factory option.

Modbus-RTU Map Register

Format of the master message

each message sent by the master obeys the following format:

Device Address	Function code	n byte parameters (optional)	CRC16_L	CRC16_H

Device Address: Address of the device.
Address 0 is reserved for broadcasting.
Addresses 1 to 247 can be used for this device
Function code: Function number
this function code use for read or write data.
Parameters: parameters different based on function
CRC16: 16-bit checksum to verify that data received correctly

Format of the slave message
a message transmitted by the slave obey the following format:

Device Address	Function code	n byte parameters (optional)	CRC16_L	CRC16_H

• Device Address**: Address of the device.**
• Function code**: The function number is same to the function number sent by the master.**
• Data**: Any data requested via the function follow here. If error occurred function code Oared with 0x80 and returned**
• CRC16
Exception errors
If message has been received correctly (no transmission error has occurred), but the transmitted function number and/or the parameters are invalid.
The slave responds an exception error, unless the message has been received in broadcasting mode.
The message transmitted as a response by the slave has the following format:

Device Address	Function code	Exception code	CRC16_L	CRC16_H

Modbus RTU Frame Layout

> 3.5 char Delay time	8 bit address	8 bit Function code	n*(8 bit data)	CRC16	> 3.5 char Delay time

The entire message frame must be transmitted continuously. If an interval of more than 1.5 character times occurs between two characters, the message frame is declared incomplete and discarded by the receiver.

Description of MODBUS functions
F3: Read registers on MODBUS address space
F6: Write single register on MODBUS address space
F8: MODBUS Echo function
F16: Write multiple registers on MODBUS address space

Function 3: MODBUS Read Register
Read single or multiple registers in the MODBUS address space starting with Start Address. Note that the data returned based on "MODBUS Register Map".
Request:

Device Address	0x03	Start addr H	Start addr L	#Reg H	#Reg L	CRC16_L	CRC16_H

Response:

Device Address	0x03	# Bytes	Data H	Data L	…	CRC16_L	CRC16_H

Error:

Device Address	0x83	Error	CRC16_L	CRC16_H

Function 6: MODBUS Write Single Register

This function is similar to F16, but writes only 1 register. Note, that the data will be written based on "MODBUS Register Map".

Request:

Device Address	0x06	Start addr H	Start addr L	Data H	Data L	CRC16_L	CRC16_H

Response:

Device Address	0x06	Start addr H	Start addr L	Data H	Data L	CRC16_L	CRC16_H

Error:

Device Address	0x86	Error	CRC16_L	CRC16_H

Function 8: MODBUS Echo Test

This function used to perform a quick line check. It returns the data that received.

Request:

Device Address	0x08	0	0	Data H	Data L	CRC16_L	CRC16_H

Response:

Device Address	0x08	0	0	Data H	Data L	CRC16_L	CRC16_H

Error:

Device Address	0x88	Error	CRC16_L	CRC16_H

Function 16: MODBUS WRITE Register

Write multiple registers on the MODBUS address space starting with Start Address. Note, that the data will be written based on "MODBUS Register Map".

Request:

Device Address	0x10	Start addr H	Start addr L	# Reg H	# Reg L	# Bytes	Data H	Data L	…	CRC16_L	CRC16_H

Response:

Device Address	0x10	Start addr H	Start addr L	# Reg H	#Reg L	CRC16_L	CRC16_H

Error:

Device Address	0x90	Error	CRC16_L	CRC16_H

RTU character framing

Start bit	1	2	3	4	5	6	7	8	Even parity	Stop bit

Note that this device only support baud rate 9600.

SB-TT Map register

word	name	R/W
0,1(Float IEEE754)	Min measuring range	R
2,3(Float IEEE754)	Max measuring range	R
4,5(Float IEEE754)	Sensor Data	R
6,7(Float IEEE754)	Ambient temp	R
8,9(Float IEEE754)	0 or ambient pressure	R
10(bit)	0-E1 1-E2 2-E3 3-E4 5-Al1On 6-Al2On 7-Al3On 8-Al4On	R
11-16(char)	Model ID	R
17-22(char)	Serial Number	R
23	Sensor type Unit 0-RTD C 1-RTD F 2-resistor milliohm 3-resistor ohm 4-TC C 5-TC F 6-microvolt mv 7-microvolt uv	R
24-35(char)	Tag ID	R/W

SOFTWARE

SB-TT (01) is Portable device software; you can connect your device to computer with USB Cable (USB to Micro-USB) and configure your device or see measured value plots, save data…:

Min System Requirement:

- CPU: 2GHz.
- Memory: 2GB RAM.
- Hard Drive: 80 MB available in the hard disk.
- Windows 8 or superior.
- USB2 Port.

Software consists of three tabs:

- **DATA (Real Time):** Display measured value with a real time graph. Start, pause and erase data logging. Saving text file or a plot image from logged data. Display alarms status, errors, main and max values of measured value.
- **Configuration:** In this tab you can get device configuration or change configuration and set them to device, also you can reset device using reset factory.
- **Info:** In info tab you can change Tag ID of device. You can see device serial number registered by **Smart Biene.**

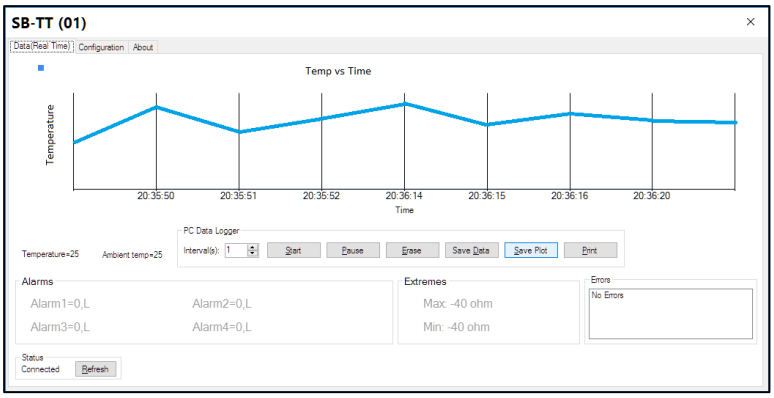


Figure 11. Device software- DATA (Real Time) Tab

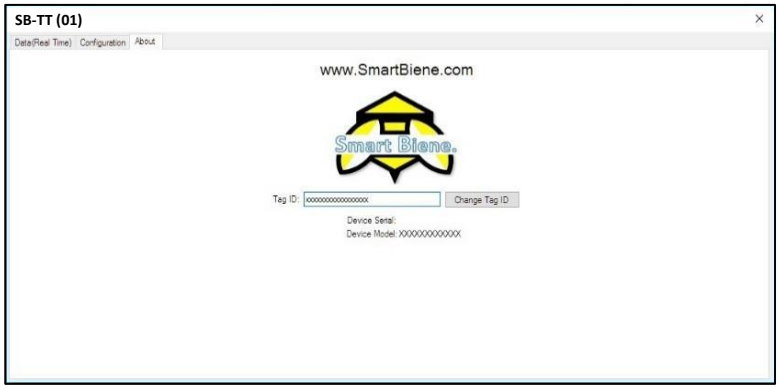


Figure 12. Device software- info Tab

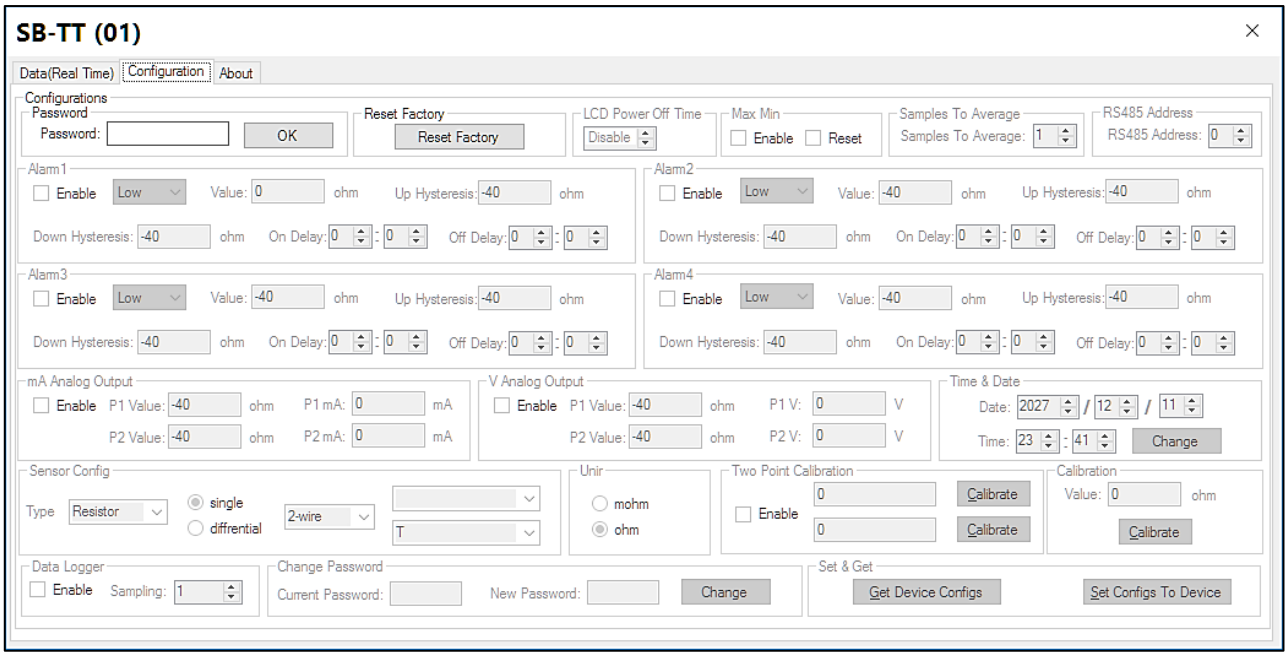


Figure 13. Device software- Configuration Tab

DIMENSIONAL DRAWING & INSTALLATION

(All dimensions in mm.)

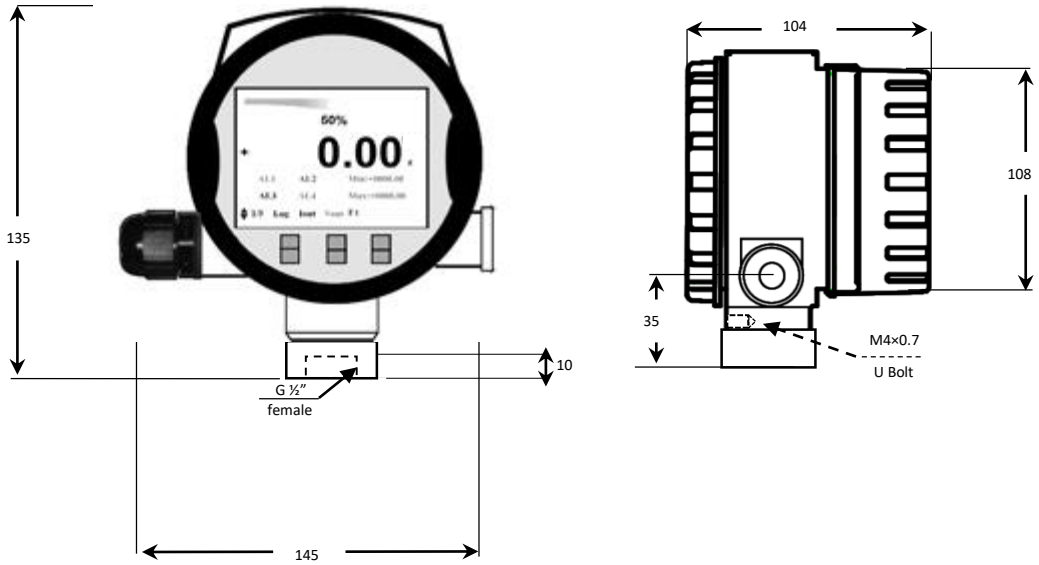


Figure 14. Panel dimensional drawings- all dimensions in mm.

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