

## **User's Manual**

# **FIELD MOUNTED HART TEMPERATURE TRANSMITTER TT7S10E-XP**



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# **1. INTRODUCTION**

## ***Foreword***

Thank you for purchasing TT7S10E-XP Field mounted HART Temperature transmitter. This manual describes the basic functions and operation methods. Please read through this user's manual carefully before using the product.

## ***Notice***

The contents of this manual are subject to change without notice because of continuous improvements to the instrument's performance and functions. Every effort has been made to ensure accuracy in the preparation of this manual. Should any errors or omissions come to your attention, please inform our sales office or sales representative. Under no circumstances may the contents of this manual, in part or entirely, be transcribed or copied without our permission.

## ***Checking the Contents of the Package***

Unpack the box and check the contents before using the product. If the product is different from which you have ordered, if any parts or accessories are missing, or if the product appears to be damaged, contact your sales representative.

## ***List of Accessories***

The product is provided with the following accessories according to the model and suffix codes (see the table below). Check that none of them are missing or damaged.

| No | Item name                | Part number | Qty. | Remarks |
|----|--------------------------|-------------|------|---------|
| 1  | Mounting Clamps          | -           | 2    |         |
| 2  | 250Ω resistor (for HART) | -           | 1    |         |

## **Safety Precautions**

The product and the instruction manual describe important information to prevent possible harm to users and damage to property and to use the product safely. Understand the following description (signs and symbols), read the text and Observe Descriptions.

To ensure that the device can be operated safely, and all functions can be used, please read these instructions carefully.

Installation and Start-up must be carried out by qualified personnel only. The relevant country-specific regulations must also be observed.

Before start-up it is particularly important to ensure:

- Terminal wiring: check that all cables are correctly connected according to the connection diagram.
- All wiring must confirm to appropriate standards of good practice and local codes and regulations. Wiring must be suitable for voltage, current and temperature rating of the system.
- Unused control terminals should not be used as jumper points as they may be internally connected, which may cause damage to the unit.

## **Warranty**

The warranty does not apply to defects resulting from action of the user such as misuse, improper wiring, operation outside of specification, improper maintenance or repair, or unauthorized modification.

We are not liable for special, indirect or consequential damage or for loss of profit or for expenses sustained as a result of a device malfunction, incorrect application or adjustment.

Our total liability is limited to repair or replacement of the product. The warranty set forth above is inclusive and no other warranty, whether written or oral, is expressed or implied.

## **2. GENERAL DISCRIPTION**

- TT7S10E-XP is a 2-Wire Loop Powered & fully programmable Universal field mounted HART Temperature Transmitter with Display, designed for Isolated and accurate temperature measurements and signal conditioning applications.
- Model TT7S10E-XP is an Ex-proof transmitter available in Wall or 2" Pipe mount option. TT7S10E-XP is programmable for Thermocouples, Pt-100 RTD, mV and Resistance/Potentiometer. Output signal is standard 4-20mA in 2-wire mode. A built-in 4-digit LED display facilitates the user to monitor process value and helps in instantaneous configuration and calibration. Transmitters have Process Temperature value display setting for °C, °F & K.
- Model TT7S10E-XP also supports HART protocol version 7 functionality with HART 5 compatibility for seamless communication, enabling easy configuration and monitoring.
- Programming of the Transmitter is done either by touch keys or HART modem or user friendly mTRAN windows-based configuration software.
- TT7S10E-XP Transmitter is built using the latest technology to deliver high performance in accuracy, resolution, stability and isolation. Transmitter is equipped with Zero/Span adjustments, sensor break detection, Downscale/Upscale output and Reverse Loop Polarity protection.
- Software techniques like polynomial linearization and digital filtering gives linearized and stable output in harsh industrial conditions, high level of isolation between input and output prevents ground loop errors and protects costly measurement and control systems under fault conditions.
- Configuration access of device is protected by assigning a Password in order to ensure a high degree of protection against unauthorized modification to configuration and calibration.

**Features:**

- **Universal input**
  - ✓ **RTD (3W / 4W)**
  - ✓ **Thermocouple**
  - ✓ **Resistance**
  - ✓ **mV**
- **User friendly configuration and calibration using**
  - ✓ **Touch keys**
  - ✓ **Windows based mTran software**
  - ✓ **HART COMMUNICATOR**
- **Easy to read - 0.4", 4-digit LED display for efficient monitoring**
- **HART 7 functionality with HART 5 compatibility**
- **1.5 KV RMS Isolation between Input & Output**
- **Linearized Output**
- **PV bias for input correction**
- **Digital Filter**
- **Built in Reverse polarity protection**
- **Selectable Direct / Reverse output**
- **Sensor breaks detection as per NAMUR NE43**
- **Ex-proof Transmitter with Wall mount and Pipe mount**

### 3. SPECIFICATIONS

#### *3.1 Input*

|                                                        |                                                                     |
|--------------------------------------------------------|---------------------------------------------------------------------|
| <b>Input Type</b>                                      |                                                                     |
| <b>RTD</b>                                             | PT100 3/4-WIRE                                                      |
| <b>Resistance/Potentiometer</b>                        | 0 to 2500Ω                                                          |
| <b>T/C</b>                                             | E, J, K, T, B, R, S, N with internal CJC (ANSI standard)            |
| <b>LINEAR</b>                                          | 0 to 75mv/500mVDC, 0/4-20 mA                                        |
| <b>RTD/Resistance/Potentiometer excitation Current</b> | ~0.2 mA                                                             |
| <b>Input Impedance for mV Input</b>                    | ≥ 1M ohms                                                           |
| <b>Input Impedance for mA Input</b>                    | ≤ 10 ohms                                                           |
| <b>Sensor Break current</b>                            | <1 μA                                                               |
| <b>Input Range</b>                                     | <b>Refer <a href="#">Table-1</a>.</b>                               |
| <b>Zero &amp; Span Adjust</b>                          | Adjustable either from Touch Keys, mTRAN Software or HART Modem     |
| <b>Accuracy</b>                                        | <b>Refer <a href="#">Table-2</a></b>                                |
| <b>CJC Error</b>                                       | ±2 °C                                                               |
| <b>ADC Resolution</b>                                  | 17bit                                                               |
| <b>Stability</b>                                       | ±0.1% per year                                                      |
| <b>Response time</b>                                   | ≤ 250ms                                                             |
| <b>Digital Filter</b>                                  | 0-20 User Programmable                                              |
| <b>Sensor open Detection</b>                           | Available (Not Applicable on 0-20mA)                                |
| <b>Allowable wiring resistance for RTD</b>             | Maximum 15 ohms/wire (Resistance between all wires should be equal) |
| <b>CMRR</b>                                            | >120 dB                                                             |
| <b>NMRR</b>                                            | ~40 dB                                                              |
| <b>Temp-co</b>                                         | < 100ppm                                                            |

**Table-1**

| Input                                | Input Type                   | Range           |
|--------------------------------------|------------------------------|-----------------|
| <b>Thermocouple</b>                  | E                            | -200 to 1000°C  |
|                                      | J                            | -200 to 1200°C  |
|                                      | K                            | -200 to 1370°C  |
|                                      | T                            | -200 to 400°C   |
|                                      | B                            | 450 to 1800°C   |
|                                      | R                            | 0 to 1750°C     |
|                                      | S                            | 0 to 1750°C     |
|                                      | N                            | -200 to 1300 °C |
| <b>RTD</b>                           | PT100 3/4 Wire               | -200 to 850 °C  |
| <b>Linear V</b>                      | 0 to 75mV /<br>0 to 500mV DC | -1999 to 9999   |
| <b>Linear mA</b>                     | 0 to 20mA /<br>4 to 20mA     | -1999 to 9999   |
| <b>Resistance/<br/>Potentiometer</b> | 0 to 2500Ω                   | -1999 to 9999   |

**Table-2**

| Input Type                | Range           | Min SPAN | A/D Accuracy | D/A Accuracy  |
|---------------------------|-----------------|----------|--------------|---------------|
| E                         | -200 to 1000°C  | 50       | 0.6 °C       | 0.04% of Span |
| J                         | -200 to 1200°C  | 50       | 0.6 °C       |               |
| K                         | -200 to 1370°C  | 50       | 0.6 °C       |               |
| T                         | -200 to 400°C   | 50       | 0.6 °C       |               |
| B                         | 450 to 1800°C   | 100      | 1.5 °C       |               |
| R                         | 0 to 1750°C     | 100      | 1.5 °C       |               |
| S                         | 0 to 1750°C     | 100      | 1.5 °C       |               |
| N                         | -200 to 1300 °C | 50       | 0.6 °C       |               |
| PT100                     | -200 to 850 °C  | 100      | 0.5 °C       |               |
| Resistance<br>0 to 2500 Ω | -1999 to 9999   | 2500     | 1.5 Ω        |               |
| 0 to 75<br>mv             | -1999 to 9999   | 100      | 0.020 mV     |               |
| 0 to 500 mv               | -1999 to 9999   | 100      | 0.400 mV     |               |
| 0 to 20 mA                | -1999 to 9999   | 20       | 0.008 mA     |               |
| 4 to 20 mA                | -1999 to 9999   | 20       | 0.008 mA     |               |

**Note 1: Total Accuracy** = (A/D Accuracy / Span + D/A Accuracy).

Example: when selecting Pt100 with measurement range of 0 to 800 °C

0.5°C / 800°C×100% of span +0.04% of span = 0.1% of span

### 3.2 Display & Keys

|                     |                                                                           |
|---------------------|---------------------------------------------------------------------------|
| <b>Display Type</b> | 0.4" 4 Digit 7 Segment Red LED                                            |
| <b>Keys</b>         | 3 Touch keys (ENT, ESC, INC) for configuration, calibration and Operation |

### 3.3 Output

|                                |                                      |
|--------------------------------|--------------------------------------|
| <b>Current Output (2-Wire)</b> | 4-20mA or 20-4mA (User programmable) |
| <b>Output Accuracy</b>         | ± 0.04% of Full Span                 |
| <b>Sensor Break Output</b>     | ≤ 3.6 or ≥21.0mA programmable.       |
| <b>Output load</b>             | R load = (V supply - 12.5)/0.021 Ohm |

### 3.4 Power Supply

|                                    |                        |
|------------------------------------|------------------------|
| <b>Standard</b>                    | 12.5 – 36 VDC - 2 wire |
| <b>Reverse Polarity Protection</b> | Yes                    |

### 3.5 Environmental

|                              |                               |
|------------------------------|-------------------------------|
| <b>Operating temperature</b> | 0 to 80°C                     |
| <b>Storage temperature</b>   | -20 to 85 °C                  |
| <b>Humidity</b>              | 30% to 95% RH(Non-condensing) |

### 3.6 Physical Dual Compartment

|                                         |                                              |
|-----------------------------------------|----------------------------------------------|
| <b>Mounting</b>                         | Wall (Std) or 2" Pipe mount (optional)       |
| <b>Dimensions in mm</b>                 | 100(H) x 200(W) x 145(D)                     |
| <b>Weight (without mounting clamps)</b> | ~1.65 Kg                                     |
| <b>Enclosure Material</b>               | Aluminium Alloy LM-6                         |
| <b>Ingress Protection</b>               | IP66                                         |
| <b>Area Classification</b>              | Zone 1 & 2, Gas Group: IIA & IIB             |
| <b>Cable entry size</b>                 | 2 nos. of M20 double compression cable gland |

### *Single Compartment*

|                                         |                                               |
|-----------------------------------------|-----------------------------------------------|
| <b>Mounting</b>                         | Wall (Std) or 2" Pipe mount (optional)        |
| <b>Dimensions in mm</b>                 | 145(H) x 240(W) x 80(D)                       |
| <b>Weight (without mounting clamps)</b> | ~1 Kg                                         |
| <b>Enclosure Material</b>               | Aluminium Alloy LM-6                          |
| <b>Ingress Protection</b>               | IP65                                          |
| <b>Area Classification</b>              | Zone 1 & 2, Gas Group: IIA & IIB              |
| <b>Cable entry size</b>                 | 2 nos. of M20 double compression cable glands |

### *3.7 Communication*

|                  |              |
|------------------|--------------|
| <b>Interface</b> | TTL (3 Wire) |
| <b>Protocol</b>  | Modbus-RTU   |
| <b>Slave ID</b>  | 1            |
| <b>Baud rate</b> | 9600 bps     |

### *3.8 HART Functionality*

|                               |                                                                                                                  |
|-------------------------------|------------------------------------------------------------------------------------------------------------------|
| <b>HART Protocol Versions</b> | HART 7                                                                                                           |
| <b>HART Physical layer</b>    | FSK 1200                                                                                                         |
| <b>Baud rate</b>              | 1200 bps                                                                                                         |
| <b>NAMUR compliance</b>       | Output limit and failure current acc. To NAMUR NE 43                                                             |
| <b>Available Command</b>      | Device information, Range, Unit, Damping value, Polling address, Output trimming, Tag, Message, Descriptor, Date |
| <b>Identification command</b> | Generic mode: 0, 1, 3, 6, 12, 13, 14, 17, 18, 34, 35, 40, 42, 44, 45, 46.                                        |

| Generic Command | Description                                 |
|-----------------|---------------------------------------------|
| 0               | Device Information                          |
| 1               | Read PV                                     |
| 3               | Read PV, Ambient Temperature & Loop Current |
| 6               | Write Polling Address                       |
| 12              | Read Message                                |
| 13              | Read TAG, DESCRIPTOR, DATE                  |
| 14              | Read Primary variable sensor information    |

|    |                                                |
|----|------------------------------------------------|
| 17 | Write Message                                  |
| 18 | Write TAG, DESCRIPTOR, DATE                    |
| 34 | Write Primary Variable Damping Value           |
| 35 | Write Primary Variable Range Value             |
| 40 | Enter/Exit Fixed Primary Variable Current Mode |
| 42 | Perform Master Reset                           |
| 44 | Write Primary Variable Units                   |
| 45 | Trim Primary Variable Current DAC Zero         |
| 46 | Trim Primary variable Current DAC Gain         |

## 4. PHYSICAL SPECIFICATIONS & MOUNTING DETAILS

- Dual Compartment

|                                         |                                               |
|-----------------------------------------|-----------------------------------------------|
| <b>Mounting</b>                         | Wall (Std) or 2" Pipe mount (optional)        |
| <b>Dimensions in mm</b>                 | 100(H) x 200(W) x 145(D)                      |
| <b>Weight (without mounting clamps)</b> | ~1.65 Kg                                      |
| <b>Enclosure Material</b>               | Aluminium Alloy LM-6                          |
| <b>Ingress Protection</b>               | IP66                                          |
| <b>Area Classification</b>              | Zone 1 & 2, Gas Group: IIA & IIB              |
| <b>Cable entry size</b>                 | 2 nos. of M20 double compression cable glands |

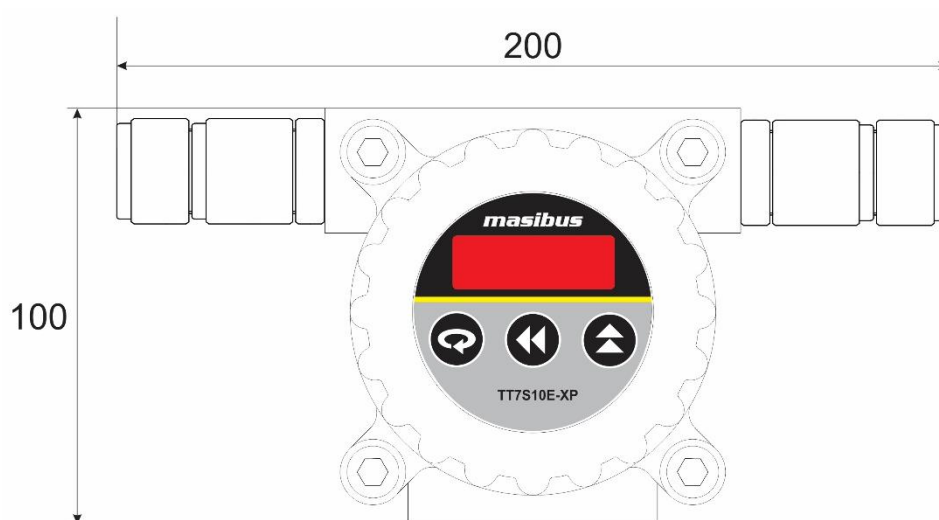
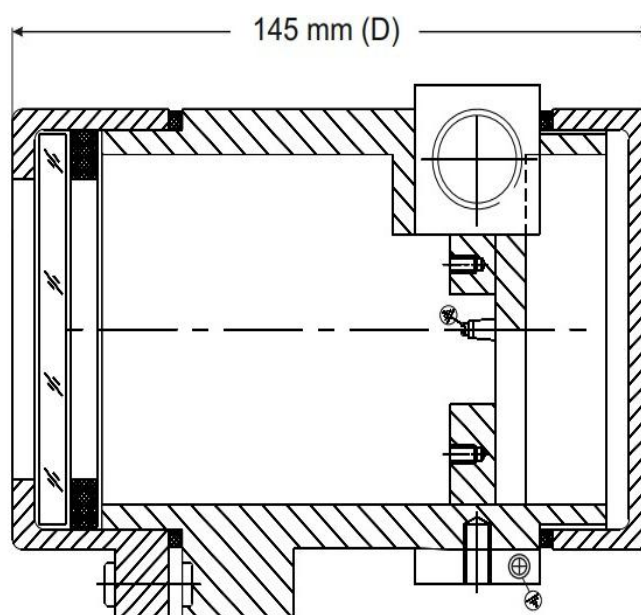


**Fig 4.1: Physical Details**

## 4.1 Mounting Positions

There are two types of mounting available in the device.

### 4.1.1 Wall Mount connection

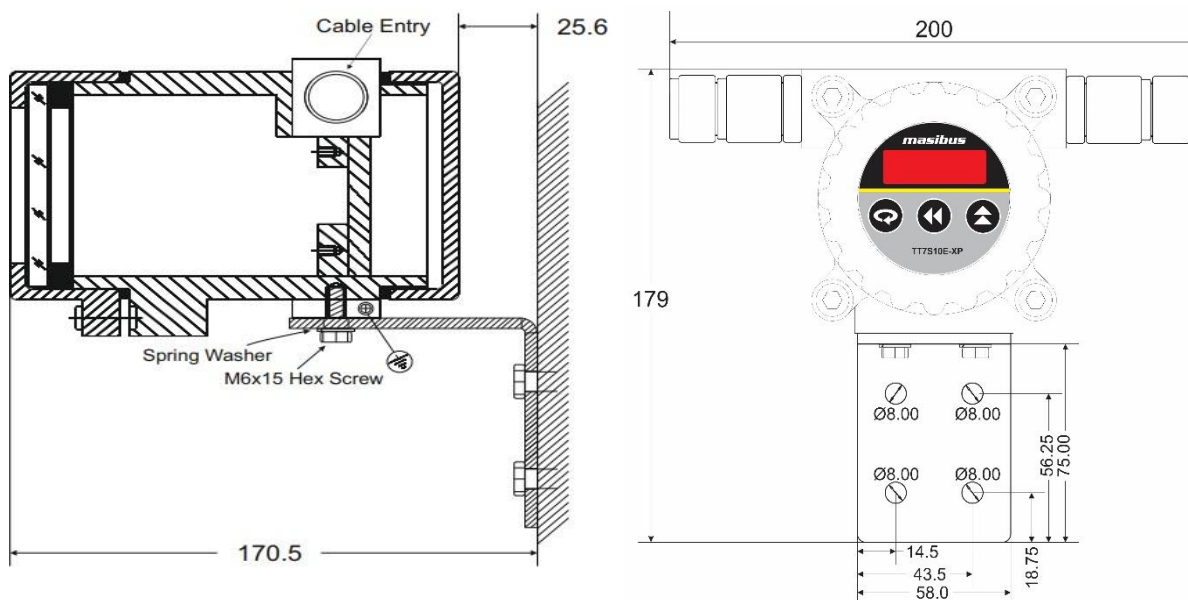


**Fig. 4.1.1 Wall Mount**

### 4.1.2 Pipe Mount Connection

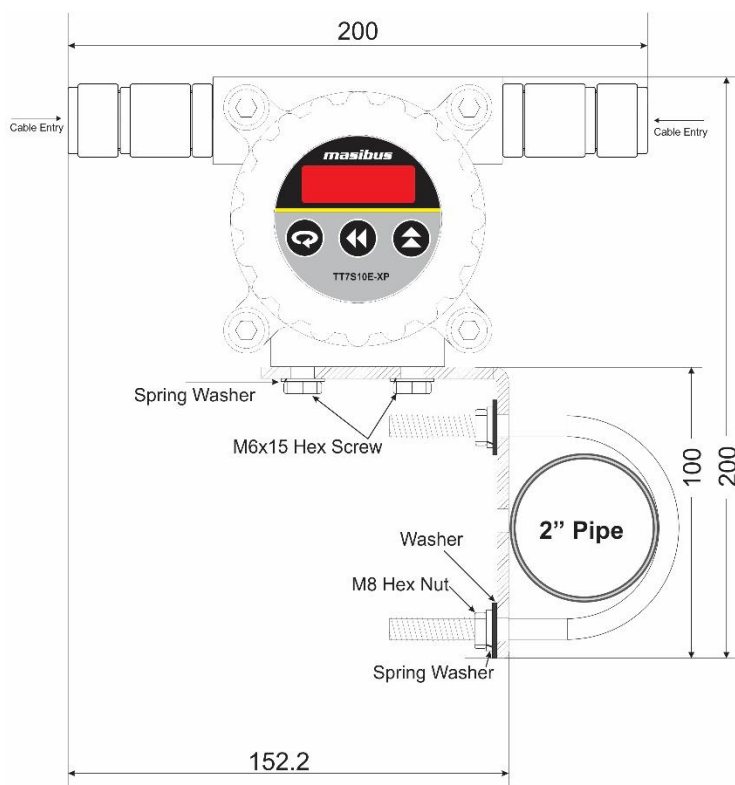


**Fig. 4.1.2 Pipe Mount**

- There are two ways to connect devices in pipe mount. Note that only 2" pipe can be used in pipe mounting.

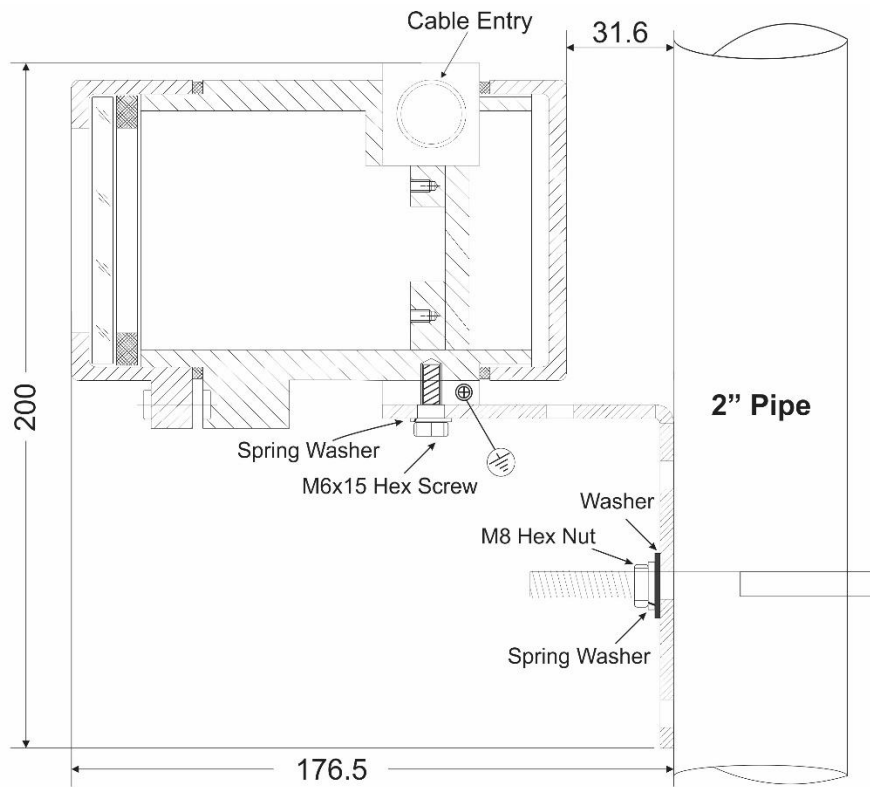


**Fig. 4.1.3 Vertical Pipe Mount**

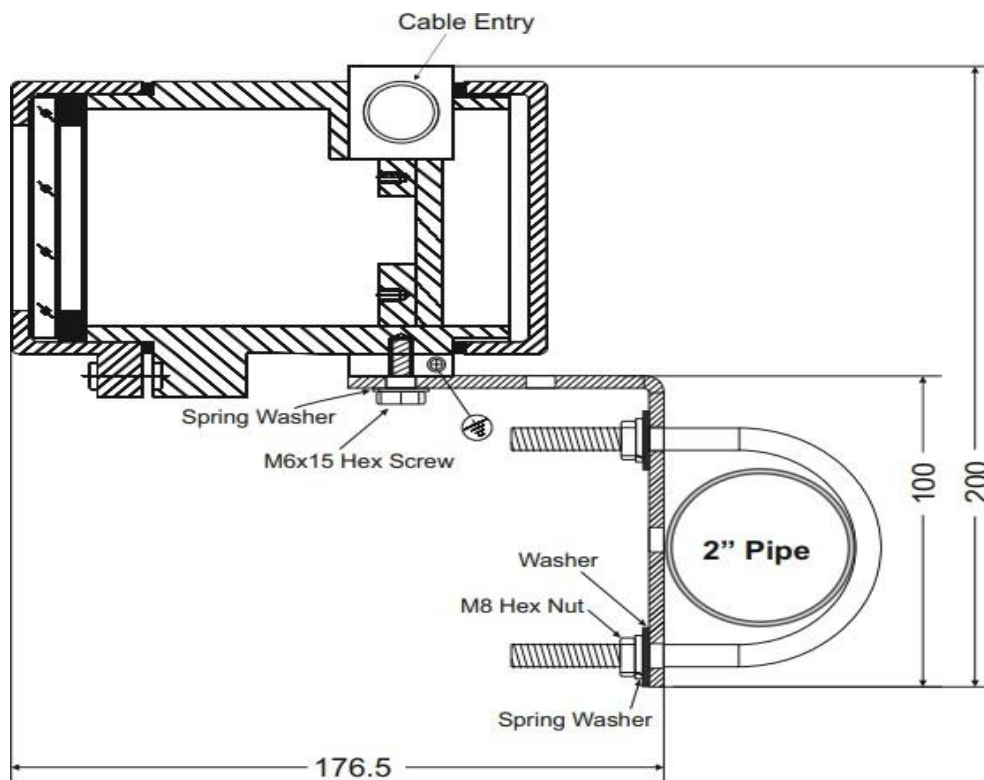
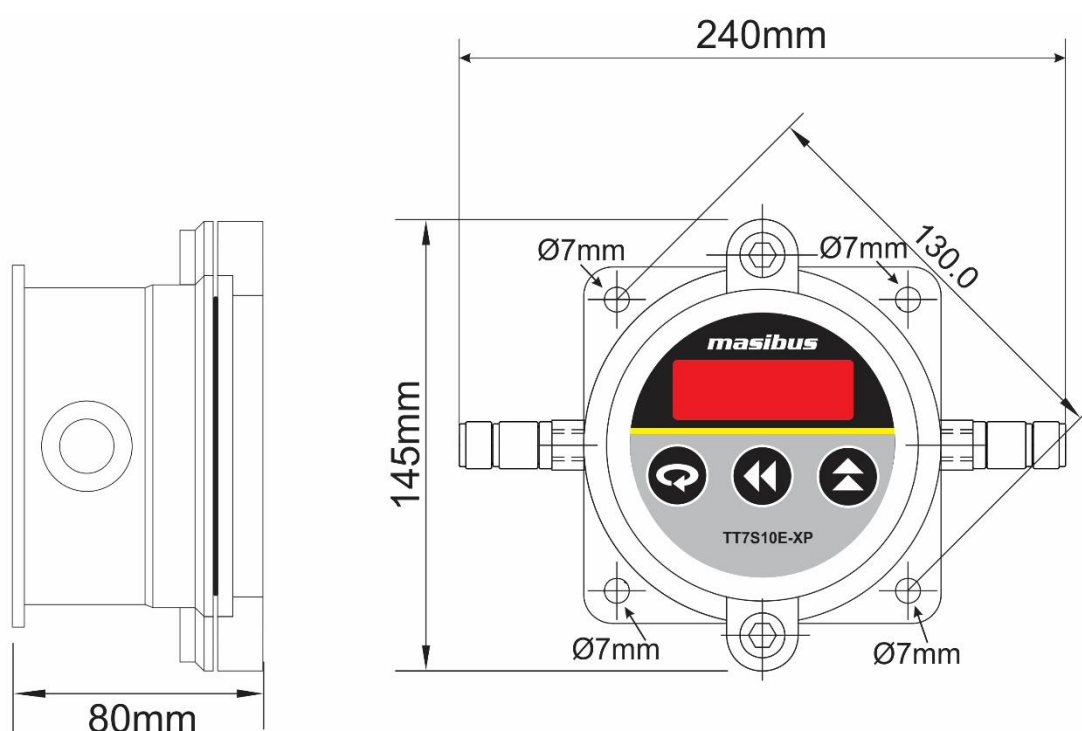


**Fig. 4.1.4 Horizontal Pipe Mount**

- **Single Compartment**

|                                         |                                               |
|-----------------------------------------|-----------------------------------------------|
| <b>Mounting</b>                         | Wall (Std) or 2" Pipe mount (optional)        |
| <b>Dimensions in mm</b>                 | 145(H) x 240(W) x 80(D)                       |
| <b>Weight (without mounting clamps)</b> | ~1 Kg                                         |
| <b>Enclosure Material</b>               | Aluminium Alloy LM-6                          |
| <b>Ingress Protection</b>               | IP65                                          |
| <b>Area Classification</b>              | Zone 1 & 2, Gas Group: IIA & IIB              |
| <b>Cable entry size</b>                 | 2 nos. of M20 double compression cable glands |



## 5. TERMINAL CONNECTIONS

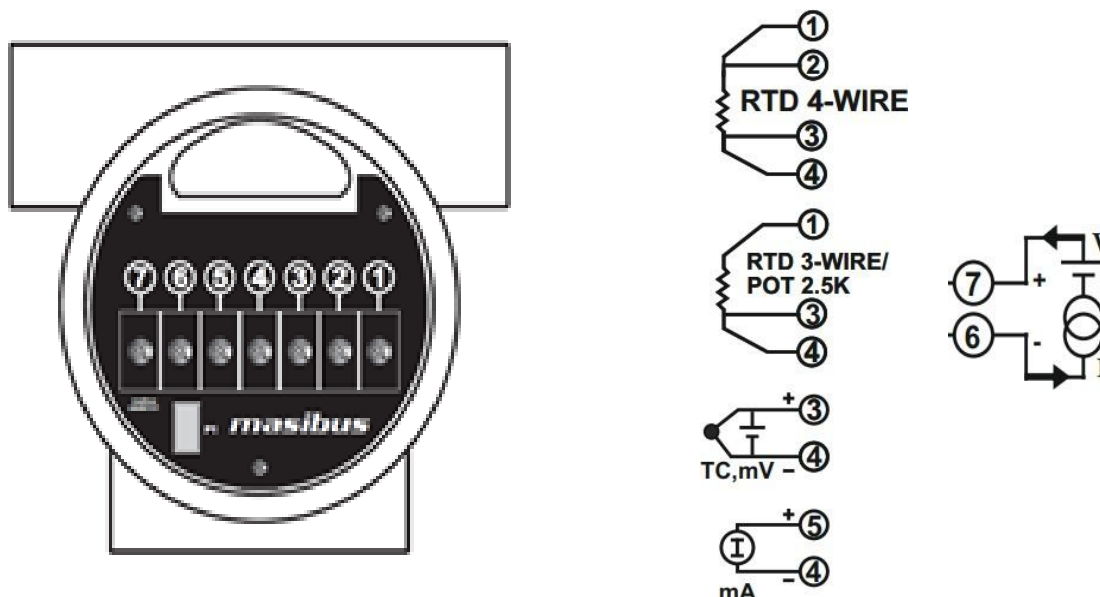


*Fig 4.1: Terminal Connection Detail*

### 5.1 How to connect wires.

Before carrying out wiring, turn off the power to the controller and check that the cables to be connected are not alive because there is a possibility of electric shock.

#### **NOTE:**

- ✓ All wiring must confirm appropriate standards of good practice and local codes and regulations. Wiring must be suitable for Voltage, Current and temperature rating of the system.
- ✓ Provide power from a 24VDC power supply.
- ✓ For thermocouple input, use shielded compensating lead wires for wiring. For RTD input, use shielded wires that have low conductor resistance and cause no significant differences in resistance between the three wires.
- ✓ Unused terminals should not be used as jumper points as they may be internally connected, which may cause damage to the unit.
- ✓ Supply voltage must be below maximum voltage rating specified on the label.

## 6. FRONT PANEL DETAILS



Dual Compartment

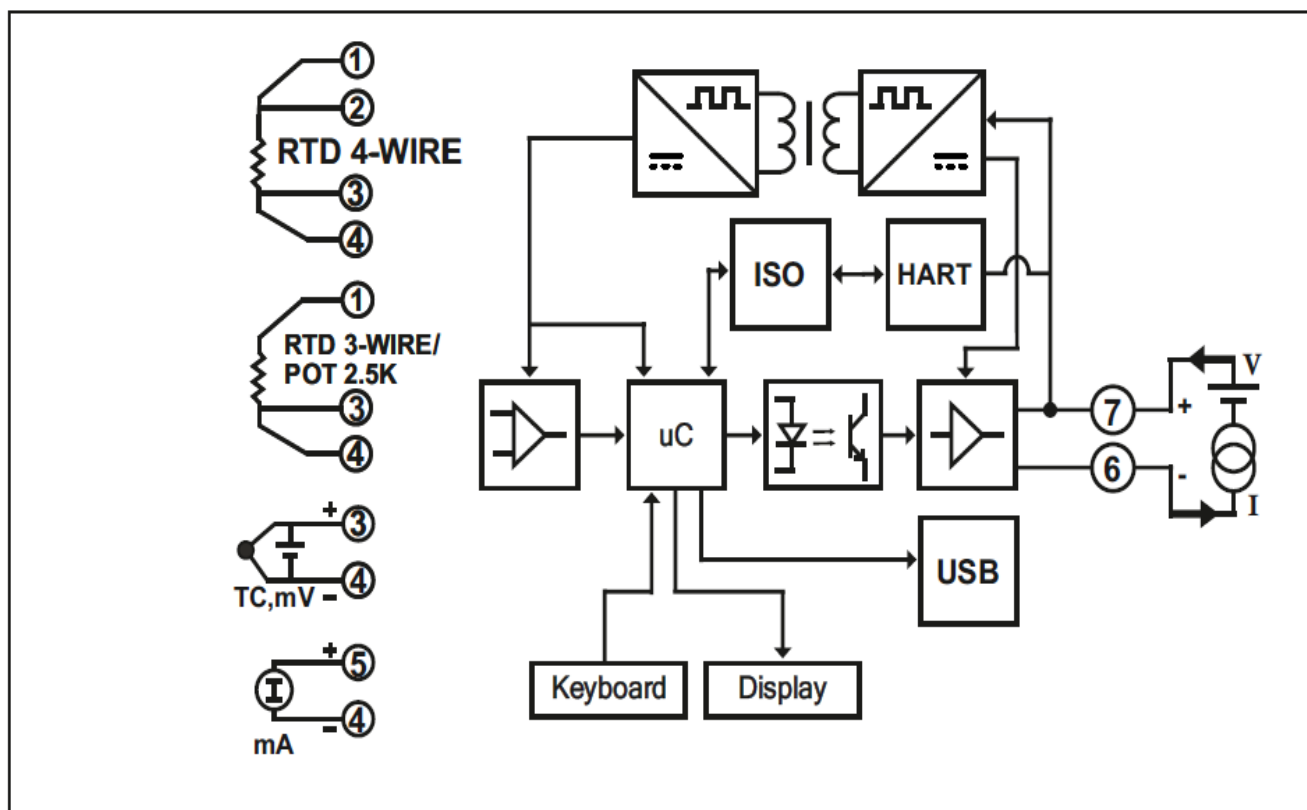


Single Compartment

### 6.1 Front Panel Description

| Name of Part          | Symbol                                                                              | Function                                                                                                                                                                                                                                                                   |
|-----------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Increment Key         |  | <ul style="list-style-type: none"> <li>Increment the Value of any Parameter.</li> <li>Shows ambient value for T/C Input in RUN mode.</li> </ul>                                                                                                                            |
| Escape Key            |  | <ul style="list-style-type: none"> <li>Used as a back key in menu, calibration and configuration mode.</li> <li>Used as slide button to move from one digit to another while writing specific parameter value.</li> </ul>                                                  |
| Enter Key             |  | <ul style="list-style-type: none"> <li>In Menu it can be used to get to the next Parameter.</li> <li>It is also used to save the parameters to non-volatile memory, when user setting a proper data by Increment and decrement key for parameter configuration.</li> </ul> |
| Process Value Display | PV                                                                                  | <ul style="list-style-type: none"> <li>4-digit 0.4-inch LED Display</li> <li>Display process value.</li> <li>Display parameter name when user set parameter.</li> <li>Display error message (dErr) when a memory corruption occurs.</li> </ul>                             |

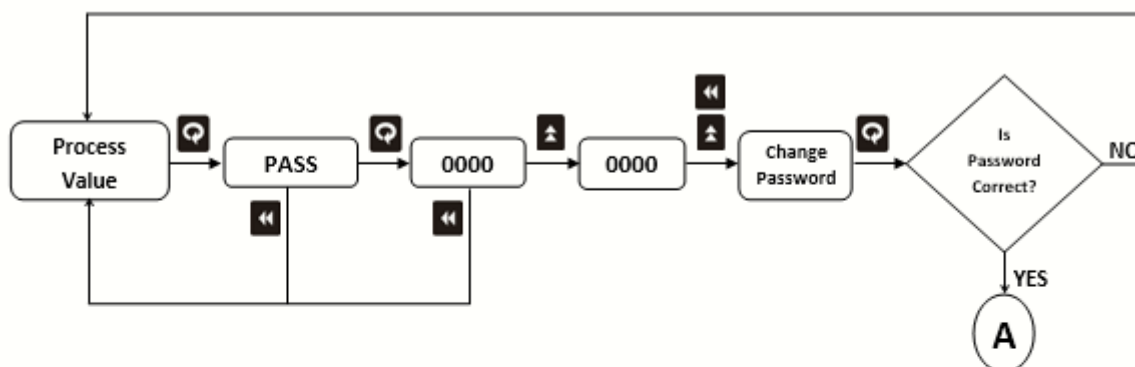
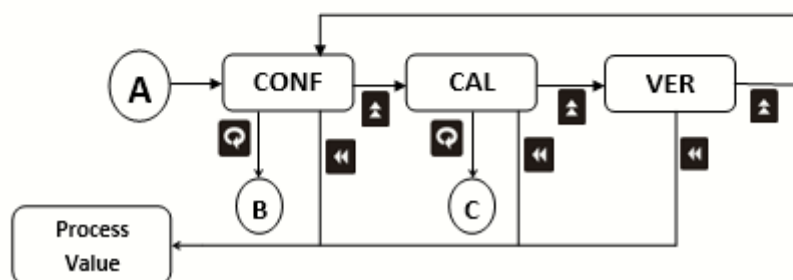
## 7. BLOCK DIAGRAM

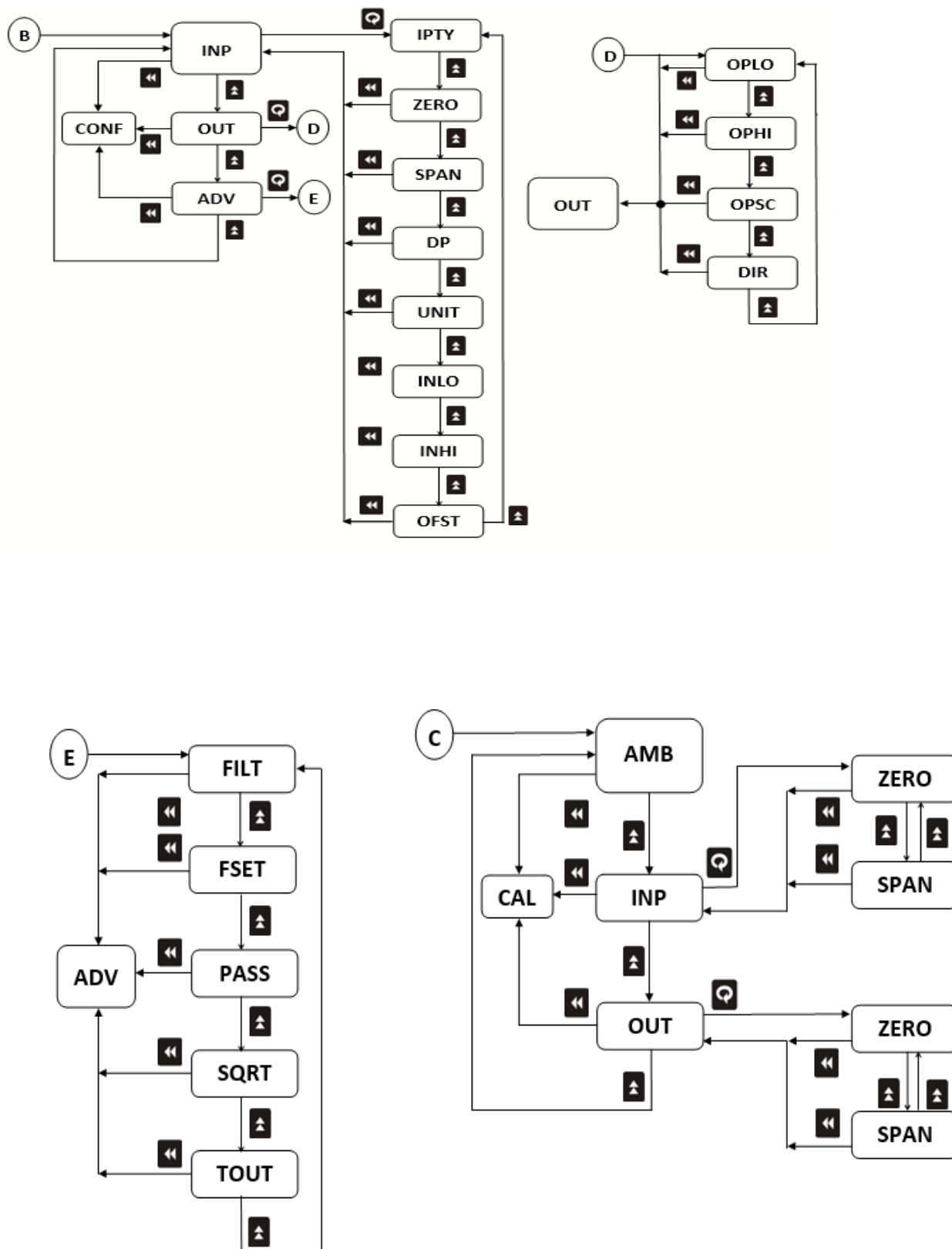


## 8. MENU LAYOUT

### 8.1 Menu Layout

Menu can be access by using the keypad in a device. The flow of the menu is described as below.





## 8.2 Menu Parameter Description

### 8.2.1 LEVEL 1 Input Configuration Mode

| PARAMETER             |                    | Setting Name & Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Default Value               | Show if only                    |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|-----------------------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|---------------------------------|--------|-----------|-------------------|-------|---|------|------|-------------------|---|------|------|-------------------|---|------|------|-------------------|---|------|------|------------------|---|------|------|------------------|---|------|------|---------------|---|------|------|---------------|---|------|------|-------------------|---|------|------|------------------|----|-----|----------|------------------|----|------|---------|------------------|----|-------|-----------|------------------|----|------|------|------------------|----|------|--------|------------------|----|------|--------|------------------|
| Symbol                | Name               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                             |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>PASS</b><br>(PASS) | PASSWORD           | If a user enters the correct password, the user can configure or calibrate the device. If a wrong password is entered, the device goes to run mode again and shows PV Value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0000                        |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>CONF</b><br>(ConF) | Configuration Mode | To Enter into Configuration Mode to Configure the parameters of Instrument.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>INPT</b><br>(inPt) | Input              | For Input Parameters. In Conf mode, user can set input Configuration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                             |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>IPTY</b><br>(iPty) | Input Type         | To set input type.<br>E-tC/J-tC/k-tC/t-tC/b-tC/r-tC/S-tC/n-tC/rtd3/500/0-75/P2.5k/rtd4/4-20/ 0-20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | k-tC                        |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | <table><tr><th>value</th><th>Symbol</th><th>Name</th><th>Range</th></tr><tr><td>1</td><td>E-tC</td><td>E-TC</td><td>-2000 to 10000 °C</td></tr><tr><td>2</td><td>J-tC</td><td>J-TC</td><td>-2000 to 12000 °C</td></tr><tr><td>3</td><td>k-tC</td><td>K-TC</td><td>-2000 to 13700 °C</td></tr><tr><td>4</td><td>t-tC</td><td>T-TC</td><td>-2000 to 4000 °C</td></tr><tr><td>5</td><td>b-tC</td><td>B-TC</td><td>4500 to 18000 °C</td></tr><tr><td>6</td><td>r-tC</td><td>R-TC</td><td>0 to 17500 °C</td></tr><tr><td>7</td><td>S-tC</td><td>S-TC</td><td>0 to 17500 °C</td></tr><tr><td>8</td><td>n-tC</td><td>N-TC</td><td>-2000 to 13000 °C</td></tr><tr><td>9</td><td>rtd3</td><td>RTD3</td><td>-2000 to 8500 °C</td></tr><tr><td>10</td><td>500</td><td>0-500 mV</td><td>-1999 to 9999 °C</td></tr><tr><td>11</td><td>0-75</td><td>0-75 mV</td><td>-1999 to 9999 °C</td></tr><tr><td>12</td><td>P2.5k</td><td>Pot 2.5 K</td><td>-1999 to 9999 °C</td></tr><tr><td>16</td><td>rtd4</td><td>RTD4</td><td>-2000 to 8500 °C</td></tr><tr><td>26</td><td>4-20</td><td>4-20mA</td><td>-1999 to 9999 °C</td></tr><tr><td>27</td><td>0-20</td><td>0-20mA</td><td>-1999 to 9999 °C</td></tr></table> |                             |                                 | value  | Symbol    | Name              | Range | 1 | E-tC | E-TC | -2000 to 10000 °C | 2 | J-tC | J-TC | -2000 to 12000 °C | 3 | k-tC | K-TC | -2000 to 13700 °C | 4 | t-tC | T-TC | -2000 to 4000 °C | 5 | b-tC | B-TC | 4500 to 18000 °C | 6 | r-tC | R-TC | 0 to 17500 °C | 7 | S-tC | S-TC | 0 to 17500 °C | 8 | n-tC | N-TC | -2000 to 13000 °C | 9 | rtd3 | RTD3 | -2000 to 8500 °C | 10 | 500 | 0-500 mV | -1999 to 9999 °C | 11 | 0-75 | 0-75 mV | -1999 to 9999 °C | 12 | P2.5k | Pot 2.5 K | -1999 to 9999 °C | 16 | rtd4 | RTD4 | -2000 to 8500 °C | 26 | 4-20 | 4-20mA | -1999 to 9999 °C | 27 | 0-20 | 0-20mA | -1999 to 9999 °C |
|                       |                    | value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                             |                                 | Symbol | Name      | Range             |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | E-tC   | E-TC      | -2000 to 10000 °C |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | J-tC   | J-TC      | -2000 to 12000 °C |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | k-tC   | K-TC      | -2000 to 13700 °C |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | t-tC   | T-TC      | -2000 to 4000 °C  |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | b-tC   | B-TC      | 4500 to 18000 °C  |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | r-tC   | R-TC      | 0 to 17500 °C     |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | S-tC   | S-TC      | 0 to 17500 °C     |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | n-tC   | N-TC      | -2000 to 13000 °C |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |                                 | rtd3   | RTD3      | -2000 to 8500 °C  |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |                                 | 500    | 0-500 mV  | -1999 to 9999 °C  |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |                                 | 0-75   | 0-75 mV   | -1999 to 9999 °C  |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |                                 | P2.5k  | Pot 2.5 K | -1999 to 9999 °C  |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
|                       |                    | 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |                                 | rtd4   | RTD4      | -2000 to 8500 °C  |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| 26                    | 4-20               | 4-20mA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -1999 to 9999 °C            |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| 27                    | 0-20               | 0-20mA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -1999 to 9999 °C            |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>ZERO</b><br>(zero) | Zero               | Can be set to any value within the Input Range & less than SPAN Value. Value of Zero must be less than Span Value by 10.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | -200                        |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>SPAN</b><br>(span) | Span               | Can be set to any value within the Input Range & greater the ZERO Value. Value of Span must be greater than Zero Value by 10.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1370                        |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>UNIT</b><br>(uNiT) | Unit               | Configure the Engineering Unit for Process Input Value only for TC/RTD (°C, °F, °K).<br>DegC/degf/degk<br>1:DegC: °C<br>2:Degf: °F<br>3:Degk: °K                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | DegC                        | If input type is TC or RTD.     |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>INLO</b><br>(inLo) | Input Low          | Used for Input Low and Hi Value Select.<br>INHI – INLO >10. Applicable for Linear/POT Input Type.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0000<br>(for 0-500mV input) | If input type is linear or pot. |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |
| <b>INHI</b><br>(inHi) | Input High         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 0500<br>(for 0-500mV)       |                                 |        |           |                   |       |   |      |      |                   |   |      |      |                   |   |      |      |                   |   |      |      |                  |   |      |      |                  |   |      |      |               |   |      |      |               |   |      |      |                   |   |      |      |                  |    |     |          |                  |    |      |         |                  |    |       |           |                  |    |      |      |                  |    |      |        |                  |    |      |        |                  |

|                         |                                |                                                                                          | input)      |                                |
|-------------------------|--------------------------------|------------------------------------------------------------------------------------------|-------------|--------------------------------|
| <b>DP</b><br>(dp)       | Decimal Point                  | To Set position of Decimal Point on Process Value. Applicable for Linear/POT Input Type. | <b>0001</b> | If input type is liner or pot. |
| <b>OFFSET</b><br>(ofst) | PV offset                      | It is a PV bias used for PV correction                                                   | <b>0000</b> |                                |
| <b>ACJC</b><br>(acjc))  | Auto CJC                       | Auto Cold junction Compensation<br>YES/NO<br>1:(YES)<br>0:(No)                           | <b>yes</b>  | Input Sensor is TC type TC     |
| <b>FCJC</b><br>(fcjc)   | Fix cold junction Compensation | 0 to 80.0 Degree                                                                         | <b>0.0</b>  | If ACJC no                     |

### 8.2.2 LEVEL 2 Output Configuration Mode

| PARAMETER             |                        | Setting Name & Description                                                                                                                                                       | Default Value | Show if only                    |
|-----------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------------------|
| Symbol                | Name                   |                                                                                                                                                                                  |               |                                 |
| <b>OPT</b><br>(oPt)   | Output                 | For Output Parameters. In Conf mode, user can set Output Configuration.                                                                                                          |               |                                 |
| <b>OPLO</b><br>(opLo) | Output Low             | O/P Low value limit will be limited between 0-25% of O/P Span value. Output will not be scaled but will be limited to configured % of output.                                    | <b>0000</b>   | If input type is linear or pot. |
| <b>OPHI</b><br>(opHi) | Output High            | O/P Hi value limit will be limited between 75-100 % of O/P Span value. Output will not be scaled but will be limited to configured % of output.                                  | <b>0100</b>   |                                 |
| <b>OPSC</b><br>(opSC) | OPEN Sensor Indication | To set O/P to either Upscale or Downscale when Input is OPEN. (Not applicable for 0-20mA)<br><b>UpSC/dnSC</b><br><b>1:UpSC:</b> upscale(21mA)<br><b>2:DnSC:</b> downscale(3.6mA) | <b>DnSC</b>   |                                 |
| <b>DIR</b><br>(dir)   | Output Direction       | To set Retransmission O/P Direction to either Direct or Reverse.<br><b>dirt/revr</b><br><b>1:dirt:</b> Direct(4-20mA)<br><b>2:revr:</b> Reverse(20-4mA)                          | <b>dirt</b>   |                                 |

### 8.2.3 LEVEL 3 Advance Configuration Mode

| PARAMETER             |         | Setting Name & Description                                                                                                                                                                                                                                                                                                          | Default Value | Show if only |
|-----------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------|
| Symbol                | Name    |                                                                                                                                                                                                                                                                                                                                     |               |              |
| <b>ADV</b><br>(Adv)   | Advance | To configure advanced parameters.                                                                                                                                                                                                                                                                                                   |               |              |
| <b>FILT</b><br>(fILt) | Filter  | To set Digital filter for PV Value (0 to 20). The value of Filter will determine the ability of filtering noise. When a large value is set, the measurement of input is stabilized but the response speed is slow. When the device is under examination at laboratory, "FILT" should be set to 0 or 1 to shorten the response time. | <b>0002</b>   |              |

|                       |                 |                                                                                                                                                                                            |             |                                |
|-----------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------------------|
| <b>FSET</b><br>(fSet) | Factory Reset   | To retrieve the factory setting. Refer <a href="#">appendix</a> to understand how to do manual reset.                                                                                      | <b>0000</b> |                                |
| <b>PASS</b><br>(PASS) | Change Password | To change the Password of device to Enter in Configuration/Calibration Mode.                                                                                                               | <b>0000</b> |                                |
| <b>SQRT</b><br>(Sqrt) | Square Root     | Applicable for Linear/POT Input with Options of YES or NO. Refer <a href="#">appendix</a> for the calculation of square root.<br><b>yes/no</b><br>1: <b>no</b> : no<br>2: <b>yes</b> : yes | <b>no</b>   | If input type is linear or pot |
| <b>TOUT</b><br>(toUt) | Timeout         | Time Setting to Return in RUN mode while no key operation. Timeout Range is between 10 to 300 seconds.                                                                                     | <b>0010</b> |                                |

### 8.2.4 LEVEL 4 Calibration Mode

| PARAMETER             |                     | Setting Name & Description                                                                   | Default Value             | Show if only         |
|-----------------------|---------------------|----------------------------------------------------------------------------------------------|---------------------------|----------------------|
| Symbol                | Name                |                                                                                              |                           |                      |
| <b>CALI</b><br>(CALi) | Calibration Mode    | To Enter in Calibration Mode to Calibrate the Instrument.                                    |                           |                      |
| <b>AMB</b><br>(Amb)   | Ambient Calibration | To Calibrate the Ambient Temperature. Applicable only if TC input Type is selected.          | <b>0000</b>               | If input type is TC. |
| <b>INPT</b><br>(inPt) | Input               | To calibrate the input range.<br><b>Zero/span</b><br><b>Zero:</b> to calibrate input zero.   | <b>PV</b><br><b>VALUE</b> |                      |
|                       |                     | <b>Span:</b> to calibrate input span.                                                        |                           |                      |
| <b>OPT</b><br>(oPt)   | Output              | To calibrate the output range.<br><b>Zero/span</b><br><b>Zero:</b> to calibrate output zero. | <b>04.00</b>              |                      |
|                       |                     | <b>Span:</b> to calibrate output span.                                                       | <b>20.00</b>              |                      |
| <b>VER</b><br>(vEr)   | Version             | Shows the Version of the Current Firmware.                                                   | <b>3.00</b>               |                      |

## **9. CALIBRATION PROCEDURE**

### ***9.1 Procedure for CAL-zero and CAL-span***

The instrument is factory calibrated for the specified range, but due to long term drift of components, re-calibration may be necessary in some cases. For calibrating the instrument, a reliable source is required. This source should be at least ten times accurate compared to the range of the instrument.

The unit can be calibrated without opening it and without trim pots. For Entering into the Calibration Mode, please refer [Menu Layout](#).

After applying appropriate Input from the calibrator source, press 'INCREMENT' OR 'ESCAPE KEY' to bring the actual process value on display.

#### **Example: -**

At zero calibration reading expected on the display is 100 and it shows 107, adjust the process value to 100 by using 'INCREMENT KEY'. Now press 'ENTER KEY' to store the calibration parameter in non-volatile memory. Similarly, one can calibrate Ambient, SPAN and retransmission parameters.

For calibrating i/p, both zero and span are calibrated. Here **one-shot calibration** technique is used, i.e. the zero and span are calibrated once. Individual zero or span can also be calibrated; first calibrate zero and then span. While calibrating thermocouple type input, first calibrate the ambient (if required) and then continue with the zero & span calibration of the same.

### ***9.2 Procedure for RET-zero and RET-span***

For calibrating the retransmission output, both retransmission zero and retransmission span must be calibrated. No need to feed input while calibrating retransmission o/p. It is like calibrating using a digital trim pot. Only look at the output, display value has no significance with output generated.

#### **Example: -**

At retransmission zero calibration, expected output is 4.00mA and it gives 4.153mA. Then adjust the output value to 4.153 by using 'INCREMENT KEY'. Now press 'ENTER KEY' to store the calibration parameter in non-volatile memory. Similarly, one can calibrate retransmission span.

## 10. COMMUNICATION PROTOCOL-MODBUS RTU

### 10.1 Introduction

The unit can be connected in TTL communication data link. Only one unit can be connected at a time. The slave Id for every unit is 1. Before starting any communication, choose a baudrate compatible to the host computer. The serial protocol used is MODBUS RTU.

### Function Code for Modbus

| CODE | NAME                   | Function                                    |
|------|------------------------|---------------------------------------------|
| 01   | Read coil status       | Use to read Relay and Digital output status |
| 03   | Read Holding registers | Use to read programmable registers          |
| 04   | Read input registers   | Use to read PV, Control op etc.             |
| 06   | Preset Single register | Use to write programmable register          |

The error checking field contains a 16-bit value implemented as two eight-bit bytes. The error check value is the result of a Cyclical Redundancy Check (CRC) calculation performed on the message contents.

### 10.2 Parameter Address Details

| Sr. No. | Parameters    | Absolute Address | Type | Access Type |
|---------|---------------|------------------|------|-------------|
| 1       | AMBIENT       | 30001            | Int  | Read Only   |
| 2       | PROCESS VALUE | 30002            | Int  | Read Only   |

#### **NOTE:** Process Value (PV) Error Conditions Value

OPEN :32767

UNDER:32765

OVER:32766

| Sr. No. | Parameters                                 | Absolute Address | Type | Access Type |
|---------|--------------------------------------------|------------------|------|-------------|
| 1       | Input type. Refer                          | 40001            | Int  | R + W       |
| 2       | AMB calibration value                      | 40002            | Int  | R + W       |
| 3       | Zero calibration of Input Value            | 40003            | Int  | R + W       |
| 4       | Span calibration of Input Value            | 40004            | Int  | R + W       |
| 5       | Zero calibration of retransmission (4 mA)  | 40005            | Int  | R + W       |
| 6       | Span calibration of retransmission (20 mA) | 40006            | Int  | R + W       |
| 7       | I/P Zero                                   | 40007            | Int  | R + W       |

|    |                                            |       |     |       |
|----|--------------------------------------------|-------|-----|-------|
| 8  | I/P Span                                   | 40008 | Int | R + W |
| 9  | Direction for RTR OP                       | 40009 | Int | R + W |
| 10 | Open sensor for RTR OP                     | 40010 | Int | R + W |
| 11 | PV offset                                  | 40011 | Int | R + W |
| 12 | Digital filter                             | 40012 | Int | R + W |
| 13 | Output Calibration Mode Entering           | 40013 | Int | R + W |
| 14 | Engineering Units                          | 40014 | Int | R + W |
| 15 | Factory Reset                              | 40015 | Int | R + W |
| 16 | O/P Lo (% of O/P Zero range) for O/P1      | 40016 | Int | R + W |
| 17 | O/P High (% of O/P Span range) for O/P1    | 40017 | Int | R + W |
| 18 | O/P Z (% of O/P Zero) of O/P 1 for scaling | 40018 | Int | R + W |
| 19 | O/P S (% of O/P Span) of O/P 1 for scaling | 40019 | Int | R + W |
| 20 | I/P Lo                                     | 40020 | Int | R + W |
| 21 | I/P Hi                                     | 40021 | Int | R + W |
| 22 | Square root                                | 40022 | Int | R + W |
| 23 | Decimal Point                              | 40023 | Int | R + W |
| 24 | Auto CJC                                   | 40024 | Int | R + W |
| 25 | Fix CJC                                    | 40025 | Int | R + W |

## Exception Response

Table -10.1

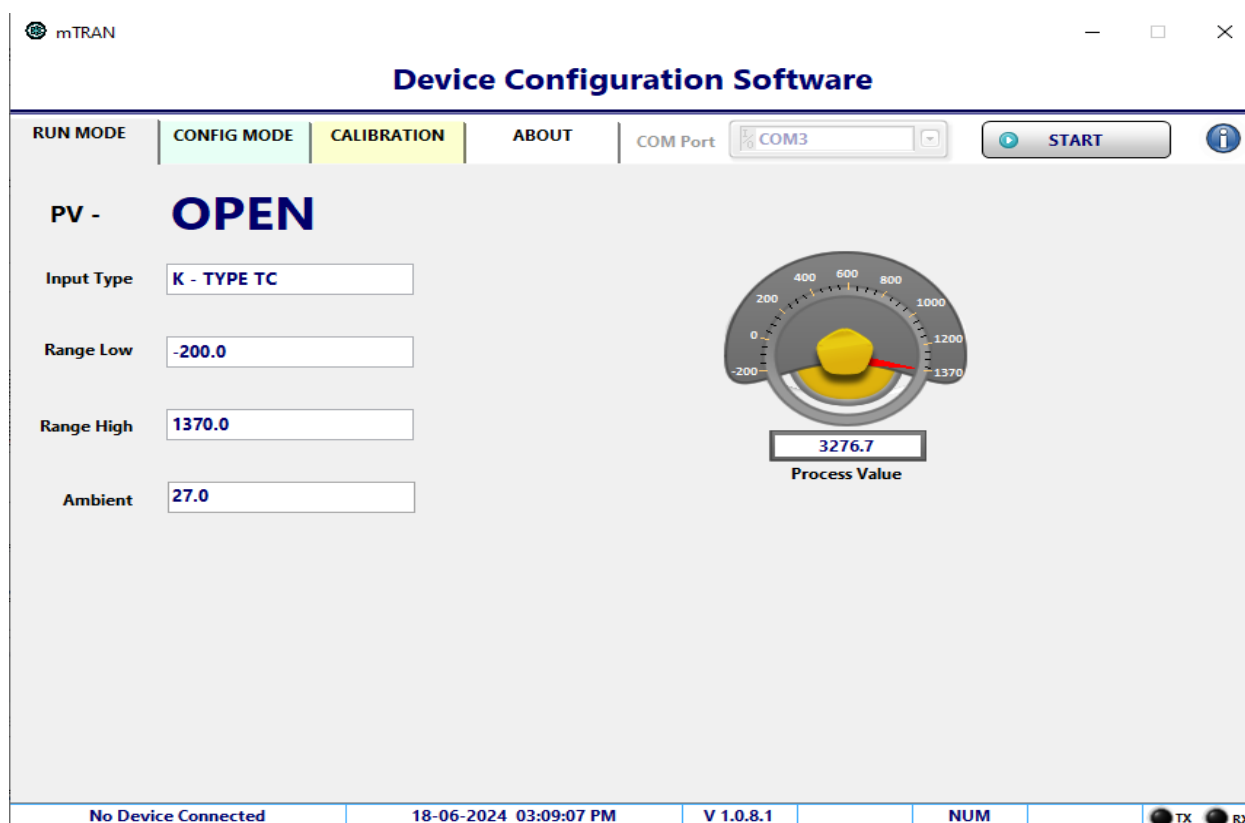
| CODE      | MEANING                                                                                                                                    |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <b>01</b> | Function code Invalid. It must be 01, 05, 03 or 06. The function code received in the query is not allowable action for the slave.         |
| <b>02</b> | Illegal address value. The data address received in the query is not allowable address for the slave.                                      |
| <b>03</b> | Illegal data value. A value contained in the query data field is not allowable value for the slave.                                        |
| <b>06</b> | When Master device write some parameters to Slave device, If slave device busy then it will send 06 code to indicate slave device is busy. |

### 10.3 mTran Software Modes

- mTran is a software used to configure and calibrate device based on modbus protocol.
- mTran software has three modes.

#### 1. RUN Mode:

- Run Mode displays process values, Input Types, Range High, Range Low, AmbientTemperature.
- Start communication button is available in the screen. So, User Can Start/StopCommunication and select the COM Port from any window.



#### 2. CONFIG Mode:

- In configuration mode user can set I/P type, Range low, Range high, PV Low, PV High, O/P Low, O/P High, O/P Zero, O/P Span, Digital filter, Open sensor O/P (Upscale/Downscale), Output type (Direct/Reverse), Unit (Deg C, Deg F, Deg K), Square root (Square root PV on/off).
- User can see updated process values in all screens.
- After successfully write/download, the status message displays in status box.

mTRAN

## Device Configuration Software

RUN MODE

CONFIG MODE

CALIBRATION

ABOUT

COM Port COM3

START

PV -

OPEN

Upload

Factory Reset

I/P Type 0 - 500 mV

Write

Range Low -1999 High 9999

Write

Open Sensor Rx Downscale

Write

Digital Filter 2

Write

Output Direct

Write

PV Low 0.0 High 500.0

Write

Unit °C

Write

O/P Zero 0 % Span 100 %

Write

Square Root No

Write

O/P Low 0 % High 100 %

Write

Decimal Point 0

Write

No Device Connected

18-06-2024 03:11:42 PM

V 1.0.8.1

NUM

TX RX

### 3. CALIBRATION Mode:

- In calibration mode user can write CAL-Zero, CAL-Span, Ambient Calibration, output-Zero Calibration, and output-Span Calibration.
- After successfully write/download, the status message displays in status box.

mTRAN

Device Configuration Software

RUN MODE

CONFIG MODE

CALIBRATION

ABOUT

COM Port COM3

START

PV -

OPEN

AMB CAL 0

Write

I/P CAL Zero 0

Write

I/P CAL Span 0

Write

☐ O/P CAL Zero
 ☐ O/P CAL Span
 ☒ Exit

O/P CAL Zero 0.000

Write

O/P CAL Span 0.000

Write

| Input Type                                  | Input Cal. Range |
|---------------------------------------------|------------------|
| E - TYPE TC                                 | -2000 to 10000   |
| J - TYPE TC                                 | -2000 to 12000   |
| K - TYPE TC                                 | -2000 to 13700   |
| T - TYPE TC                                 | -2000 to 4000    |
| B - TYPE TC                                 | 4500 to 18000    |
| R - TYPE TC                                 | 0 to 17500       |
| S - TYPE TC                                 | 0 to 17500       |
| N - TYPE TC                                 | -2000 to 13000   |
| RTD - 3 Wire, RTD - 4 Wire                  | -2000 to 8500    |
| Linear (0 - 75 mV, 0 - 500 mV, 0/4 - 20 mA) | -1999 to 9999 ** |
| Potentiometer (2.5K POT / Resistance)       | -1999 to 9999 ** |

\* All values must be enter without decimal point in input calibration  
For ex. to calibrate at 102.5 OR 10.25, user have to enter 1025

\*\* For Linear & Potentiometer Input Type, Input Cal. Range depends on PV Low & PV High Range configured in device

No Device Connected

18-06-2024 03:18:13 PM

V 1.0.8.1

NUM

TX RX

**Note:** refer [appendix](#) to see the value of error condition on pv using mTran software.

### ***10.3.1 Procedure for I/P CAL zero and I/P CAL span***

In mTran Software, All Values must be entered without decimal point in input calibration field. i.e. To Calibrate at 102.5 or 10.25, User must enter 1025 in input calibration field.

For Linear, mA and Potentiometer input type, Input cal. Range depends on Zero and Span Range Configured in Device.

#### **Example: -**

Suppose the input value is 100 and PV on mTran is 105. Enter 1000 in appropriate input calibration field and then click on write. Similarly, one can calibrate Ambient, SPAN and retransmission parameters.

For calibrating i/p, both zero and span are calibrated. Here **one-shot calibration** technique is used, i.e. the zero and span are calibrated once. first calibrate zero and then span. While calibrating thermocouple type input, first calibrate the ambient (if required) and then continue with the span calibration of the same

### ***10.3.2 Procedure for O/P CAL zero and O/P CAL span***

For calibrating the retransmission output, both retransmission zero and retransmission span must be calibrated. No need to feed input while calibrating retransmission o/p. it is like calibrating using digital trim pot. Only look at the output, display value has no significance with output generated.

#### **Example: -**

At retransmission zero calibration, expected output is 4.00mA and it gives 4.153mA. write 4.153 value on the zero calibration and then press write. Similarly, one can calibrate retransmission span.

**Note:** In retransmission calibration user write the value with decimal point.

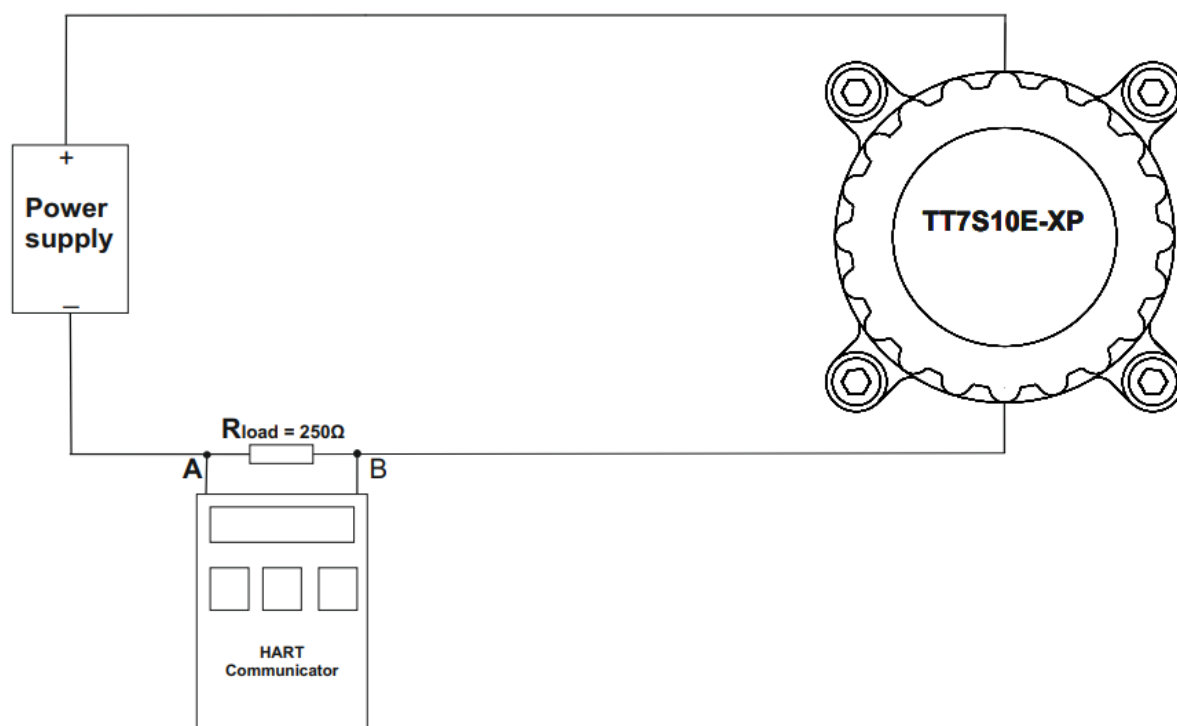
## **11. COMMUNICATION PROTOCOL-HART**

### ***11.1 Introduction***

The Highway Addressable Remote Transducer (HART) protocol is a widely used communication standard in industrial automation. It enables digital communication between smart field devices and control systems, allowing for real-time monitoring and control over process variables. HART combines analog and digital communication, providing enhanced functionality and diagnostics for improved efficiency and maintenance.

### ***11.2 Interconnection between TT7S10E-XP AND HART Configuration tool***

The HART configuration tool can interface with the transmitter from the control room, the transmitter site, or any other wiring termination point in the loop. To communicate, the tool must be connected to the signal line in parallel with the transmitter; the connections are non-polarized. The HART digital signal is superimposed on the analog signal. Below Figure illustrates the wiring connections for direct interface at the transmitter site. The HART configuration tool can be used for remote access from any terminal strip as well.

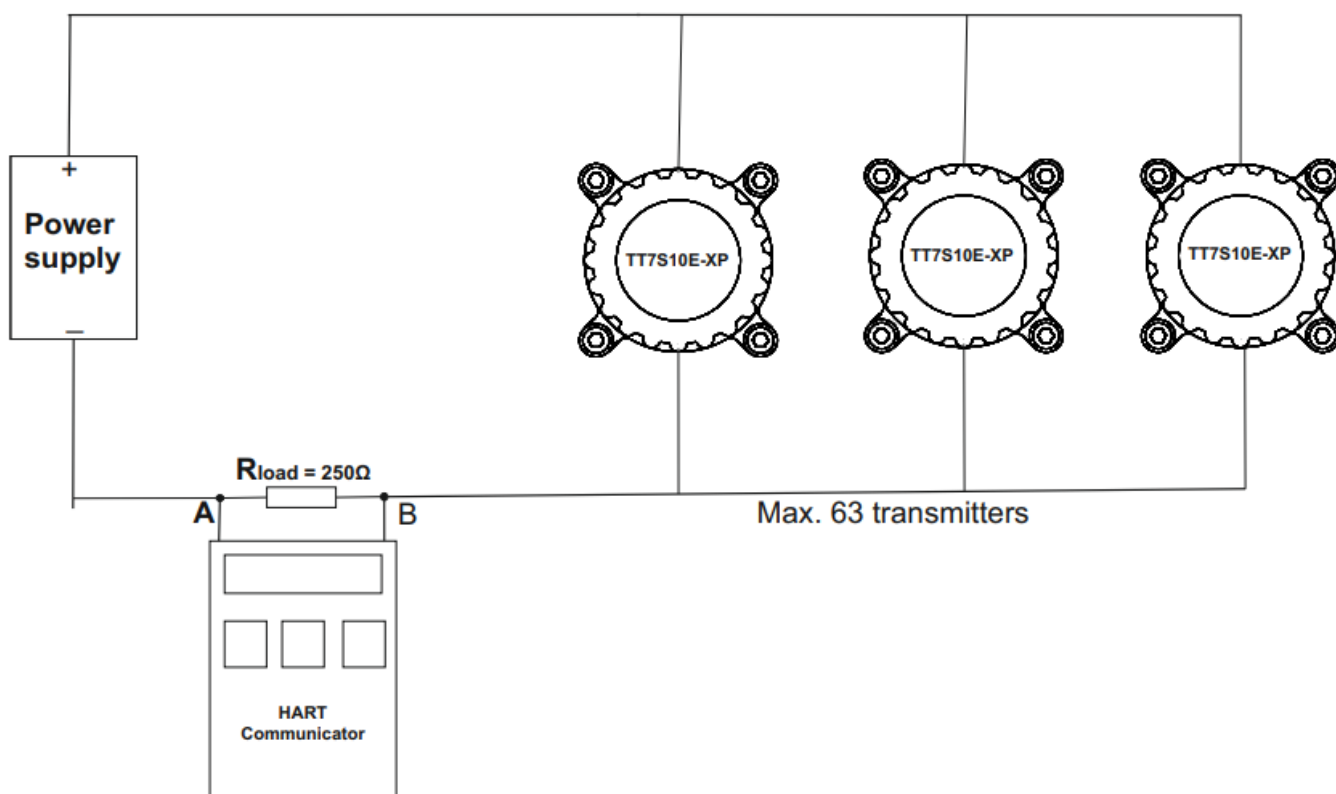


The HART communicator or HART modem will be connected across AB.

### **11.2.1 Connection of TT7S10E-XP in multidrop mode**

The outputs of maximum 63 transmitters can be connected in parallel for a digital HART 7 communication on 2-wires. Before they are connected, each transmitter must be configured

with a unique polling address ranging from one to 63. If two transmitters are configured with the same address, both will be excluded. The transmitter must be configured for multidrop mode with a fixed output signal of 4 mA. The maximum current in the loop is therefore 252 mA. Communication is done by either a HART communicator or a HART modem.



The HART communicator or HART modem will be connected across AB.

### 11.3 Basic Parameter Description

| Item       | Parameter               | Description                                                                                                                                                                                | Default Value |
|------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Unit info. | Polling Address         | Device Identifier in multidrop mode. 0 – 63 values can be set. Besides 0 for all the other polling address loop currentvalue will be fixed to 4 mA.                                        | 0             |
|            | Manufacturer Id.        | Manufacturer Identification                                                                                                                                                                |               |
|            | Device Id.              | Unique Id, For a device. Once set it cannot be changed for that device.                                                                                                                    | 000000        |
|            | Universal Version       | HART Version                                                                                                                                                                               | 7             |
|            | Software Version        | Software revision No.                                                                                                                                                                      | 1             |
|            | Hardware version        | Hardware revision No. with physical Signaling Code                                                                                                                                         | 8             |
|            | Preamble                | First field in a response message. Can be set from 5-20.                                                                                                                                   | 5             |
|            | Field Device Status     | Indicate the status information related to field device. Refer <a href="#">Table-11.1</a> for error message and correction                                                                 | 0x00          |
| PV         | PV (Primary Variable)   | Temperature                                                                                                                                                                                | -             |
|            | SV (Secondary Variable) | Ambient                                                                                                                                                                                    | -             |
|            | Current                 | Value of retransmission current in a device. The current is always between 4-20 mA in normal operation mode. In case of sensor break or PV out of limit refer <a href="#">Table-12.1</a> . | -             |
|            | Current percentage      | Value of current after converting it into percentage.                                                                                                                                      | -             |
|            | Input Type              | Sensor Input Type. Refer <a href="#">Table-1</a> for input types.                                                                                                                          | K-TC          |
|            | Unit                    | PV unit. Can Configure the Engineering Unit for Process Input Value only for TC/RTD (°C, °F, °K).                                                                                          | °C            |
|            | Upper Range Value       | PV upper range value. Refer <a href="#">Table-1</a> for value based on input type                                                                                                          | 1370          |
|            | Lower Range Value       | PV lower range value. Refer <a href="#">Table-1</a> for value based on input type                                                                                                          | -200          |
|            | Minimum Span            | Minimum Range that can be set in a device                                                                                                                                                  | 10            |
|            | Upper sensor limitValue | PV Maximum Upper range value that can be set. Refer <a href="#">Table-1</a> for value based on input type                                                                                  | 1370          |
|            | Lower Sensor limitValue | PV Minimum Lower range value that can be set. Refer <a href="#">Table-1</a> for value based on input type                                                                                  | -200          |

|                                  |                    |                                                                                                                                                                                  |            |
|----------------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
|                                  | Decimal Point      | Position of Decimal Point on Process Value. Applicable for Linear/POT Input Type. Can be set from 0-3.                                                                           | 1          |
|                                  | Damping Value      | Digital filter for PV Value. Can be set from 0-20.                                                                                                                               | 2          |
|                                  | Transfer Function  | Mathematical relationship that describes how input signals are transformed into output signals by a device. Applicable only for linear/pot. Can be set to linear or square root. | Linear     |
| <b>Memory</b>                    | Tag                | Unique identifier associated with each device. Up to 8-character can be written.                                                                                                 | TAG        |
|                                  | Descriptor         | specific piece of information associated with a device. Up to 16-character descriptor can be written in a device.                                                                | DESCRIPTOR |
|                                  | Date               | To set date indication for a device. (Ex. Date of installation, date of last change etc.)                                                                                        | 1996/08/06 |
|                                  | Message            | Specific piece of long data that can be written in a device. Up to 32-character tag can be write in a device.                                                                    | MESSAGE    |
|                                  | Long Tag           | Extended Version of a unique identifier associated with each device. Up to 32-character long tag can be written in a device.                                                     | LONG TAG   |
|                                  | Serial No.         | Unique identifier assigned to a device sensor. 6-digit sensor number must be written in a device. Once set it cannot be changed for that device.                                 | 000000     |
|                                  | Final Assembly No. | Unique identifier assigned to a device during its manufacturing process. 6-digit sensor number must be written in a device.                                                      | 000000     |
| <b>Testing &amp; calibration</b> | Loop test          | To fix the value of Rx output. Used to test the loop current                                                                                                                     | -          |
|                                  | Loop current Trim  | To Calibrate the Rx output Current                                                                                                                                               | -          |

**Table - 11.1**

| Bit | Error message          | Error Description                                            | Status value |
|-----|------------------------|--------------------------------------------------------------|--------------|
| 0   | PV Out of Limit        | set when PV is out of limit                                  | 0x01         |
| 2   | Loop current Saturated | set when loop current is out of limit                        | 0x04         |
| 3   | Loop current Fixed     | Set when either Transmitter in Multi-Drop mode or loop test. | 0x08         |
| 5   | Cold Start             | set when a power failure or device reset occur               | 0x20         |
| 6   | Config Changed         | set when any parameter is hart changed                       | 0x40         |

## 11.4 List of Commands

| Commands   | Command Description                                   | Access Type |
|------------|-------------------------------------------------------|-------------|
| <b>0</b>   | Read: Unique Identifier                               | Read        |
| <b>1</b>   | Read: Primary Variable                                | Read        |
| <b>2</b>   | Read: Current Loop, Percent of Range                  | Read        |
| <b>3</b>   | Read: Dynamic Variable, Loop Current                  | Read        |
| <b>6</b>   | Write: Polling address                                | Write       |
| <b>7</b>   | Read: loop configuration                              | Read        |
| <b>8</b>   | Read: Dynamic variable classification                 | Read        |
| <b>9</b>   | Read: Device variables with status                    | Read        |
| <b>11</b>  | Read: unique Identifier Associated with Tag           | Read        |
| <b>12</b>  | Read: Message                                         | Read        |
| <b>13</b>  | Read: TAG, DESCRIPTOR, DATE                           | Read        |
| <b>14</b>  | Read: Primary variable sensor information             | Read        |
| <b>15</b>  | Read Device Information                               | Read        |
| <b>16</b>  | Read Assembly number                                  | Read        |
| <b>17</b>  | Write: Message                                        | Write       |
| <b>18</b>  | Write: TAG, DESCRIPTOR, DATE                          | Write       |
| <b>19</b>  | Write: Assembly number                                | Write       |
| <b>20</b>  | Read: long tag                                        | Read        |
| <b>21</b>  | Read: unique Identifier Associated with Long Tag      | Read        |
| <b>22</b>  | Write: Long Tag                                       | Write       |
| <b>38</b>  | Reset Configuration change flag                       | Write       |
| <b>33</b>  | Read: Transmitter Variables                           | Read        |
| <b>34</b>  | Write: Primary Variable Damping Value                 | Write       |
| <b>35</b>  | Write: Primary Variable Range Value                   | Write       |
| <b>40</b>  | Enter/Exit Fixed Primary Variable Current Mode        |             |
| <b>42</b>  | Perform Master Reset                                  |             |
| <b>44</b>  | Write: Primary Variable Units                         | Write       |
| <b>45</b>  | Trim Primary Variable Current DAC Zero                | Write       |
| <b>46</b>  | Trim Primary variable Current DAC Gain                | Write       |
| <b>47</b>  | Write: Primary variable transfer function             | Write       |
| <b>49</b>  | Write: Primary Variable Sensor Serial Number          | Write       |
| <b>59</b>  | Write: Response Preamble                              | Write       |
| <b>130</b> | Read: Input Type selection                            | Read        |
| <b>131</b> | Write: Read Input Type selection                      | Write       |
| <b>132</b> | Read: open sensor and output current direction value  | Read        |
| <b>133</b> | Write: open sensor and output current direction value | Write       |
| <b>144</b> | Write: Amb calibration value                          | Write       |
| <b>145</b> | Write: PV Zero calibration value                      | Write       |
| <b>146</b> | Write: PV span calibration value                      | Write       |
| <b>147</b> | Write: Decimal point                                  | Write       |
| <b>148</b> | Read: Decimal point                                   | Read        |

## 12. APPENDIX

### 12.1 Retransmission Output Table for OPEN /OVER /UNDER Condition

Table-12.1

| RETRASMISSION | VARIABLE | SCALE | ACTION | OPEN | OVER | UNDER |
|---------------|----------|-------|--------|------|------|-------|
| 4-20mA        | PV       | UP    | DIR    | 21   | 21   | 3.6   |
|               | PV       | DOWN  | REV    | 3.6  | 3.6  | 21    |
|               | PV       | UP    | REV    | 21   | 3.6  | 21    |
|               | PV       | DOWN  | DIR    | 3.6  | 21   | 3.6   |

**NOTE: -**

1. OPEN/UNDER/OVER conditions are applicable to all input types except 0-20mA.

### 12.2 Factory reset

Users can perform factory reset using mTran software or using display menu.

**To perform factory reset using mTran follow the below step:**

1. Connect the device to the mTran software using TTL connector and open the configuration mode.
2. Click on the factory reset written on the upper right corner.
3. After clicking on that there is window pop-up asking for a password.
4. To reset the device, enter the password **"1975"**.
5. After writing the password click enter and the device will be reset. After resetting all the parameter set to factory setting

All the parameters value after factory reset is given below table.

TABLE -12.2

| Factory setting for configuration |                  |
|-----------------------------------|------------------|
| Parameter                         | Factory Setting  |
| Input Type (ipity)                | K-TC (k-tc)      |
| Sensor upper range value(span)    | 1370 (1370)      |
| Sensor lower range value (Zero)   | -200 (-200)      |
| Unit (unit)                       | °C (degC)        |
| Filter (fiLT)                     | 2 (0002)         |
| Open sensor value (opsc)          | Downscale (dnsc) |
| Output direction (Dir)            | Direct(dirt)     |
| Decimal point(dp)                 | 1(0001)          |

**To perform manual reset using keypad follow below step:**

1. Go to **adv**(advance) parameter shown in '[section E](#)'.
2. Go into the **fset**(factory reset) and set the password "**1975**".
3. Press "Enter key" and the device will be reset to factory setting.

Refer above [Table-12.2](#) to see value of parameter in factory setting.

### **12.3 Square root Calculation**

By using Square Root, Output will be displayed as per equation

"PV = SQRT [ {(input reading – config. IP Zero) / (config. IP Span – config. IP Zero)} \* Config. OP Span] + Config. OP Zero."

**Note:** Square root is only used for linear(0-500mV, 0-75mv, 0-20mA, 4-20mA) and Pot 2.5K input type.

### **12.4 Error conditions**

- Process Value of device will show "**over**" when process value is higher than 5% of individual span. At that time Device will send '32766' by Modbus to PC.
- Same way when process value is lower than 1 % of individual zero, Device will show "**undr**" on its display, but it will send '32765' by Modbus to PC.
- If process value is out of limit for particular I/P type, then device will show "**Open**" on display, but it will send '32767' by Modbus to PC.