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User's Manual

FIELD MOUNTED HART TEMPERATURE TRANSMITTER TT7S10E-XP

HART COMMUNICATION PROTOCOL

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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 MASIBUS 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.

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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.
Masibus is 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.
Masibus 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

- Masibus Model 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 PV Input

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

Table-1

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

Table-2

Input Type	Range	Min SPAN	A/D Accuracy	D/A Accuracy
E	-200 to 1000ºC	50	0.6 ºC	0.04% of Span
J	-200 to 1200ºC	50	0.6 ºC	
K	-200 to 1370ºC	50	0.6 ºC	
T	-200 to 400ºC	50	0.6 ºC	
B	450 to 1800ºC	100	1.5 ºC	
R	0 to 1750ºC	100	1.5 ºC	
S	0 to 1750ºC	100	1.5 ºC	
N	-200 to 1300 ºC	50	0.6 ºC	
PT100	-200 to 850 ºC	100	0.5 ºC	
Resistance 0 to 2500 Ω	-1999 to 9999	2500	1.5 Ω	
0 to 75 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

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

3.3 Output

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

3.4 Power Supply

Standard	12.5 – 36 VDC - 2 wire
Reverse Polarity Protection	Yes

3.5 Environmental

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

3.6 Physical

Dual Compartment

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

Single Compartment

Mounting	Wall (Std) or 2" Pipe mount (optional)
Dimensions in mm	140(H) x 145(W) x 80(D)
Weight (without mounting clamps)	~1 Kg
Enclosure Material	Aluminium Alloy LM-6
Ingress Protection	IP65
Area Classification	Zone 1 & 2, Gas Group: IIA & IIB
Cable entry size	2 nos. of M20 double compression cable glands

3.7 Communication

Interface	TTL (3 Wire)
Protocol	Modbus-RTU
Slave ID	1
Baud rate	9600 bps

3.8 HART Functionality

HART Protocol Versions	HART 7
HART Physical layer	FSK 1200
Baud rate	1200 bps
NAMUR compliance	Output limit and failure current acc. To NAMUR NE 43
Available Command	Device information, Range, Unit, Damping value, Polling address, Output trimming, Tag, Message, Descriptor, Date
Identification command	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 Massage
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

3.9 Ordering Code

Model	Input Type		Mounting & Compartment Type	
TT7S10E-XP	x		x	
	1	E	SW	Single compartment Wall Mount
	2	J	SP	Single compartment Pipe Mount
	3	K	DW	Dual compartment Wall Mount
	4	T	DP	Dual compartment Pipe Mount
	5	B		
	6	R		
	7	S		
	8	N		
	9	PT100		
	C	4-20mA		
	D	0-20mA		
	U	0-75 mV		
	H	0-500 mV		
	I	0-2500 Ω		

4. PHYSICAL SPECIFICATIONS & MOUNTING DETAILS

- **Dual Compartment**

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

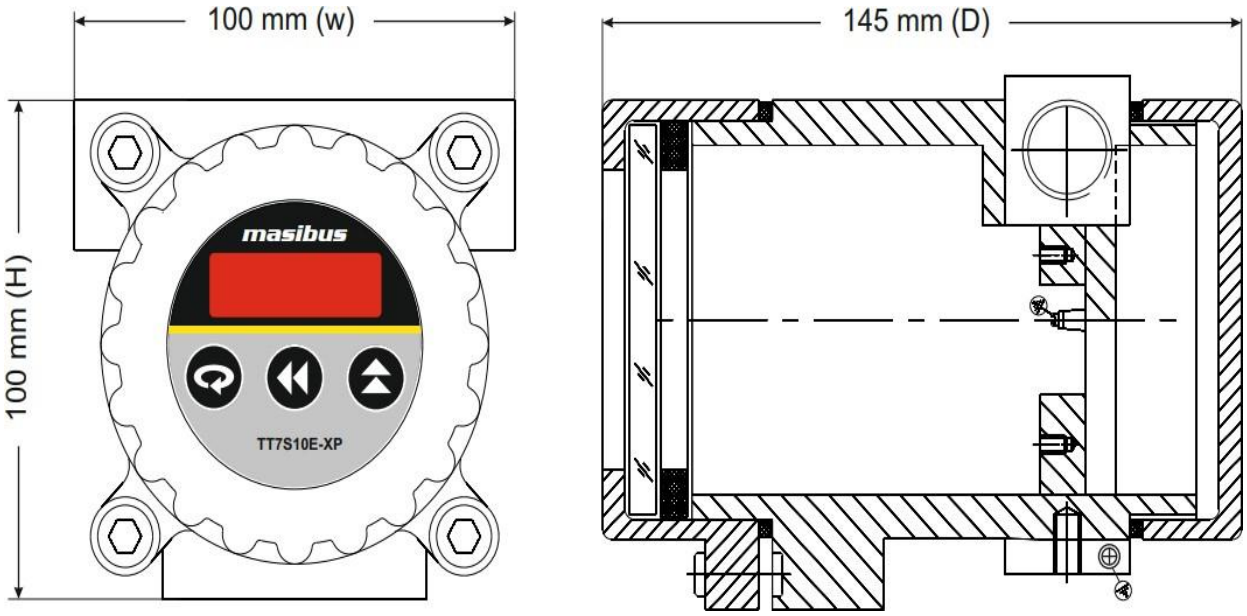


Fig 4.1: Physical Details

4.1 Mounting Positions

There are two types of mounting available in the device.

4.1.1 Wall Mount connection

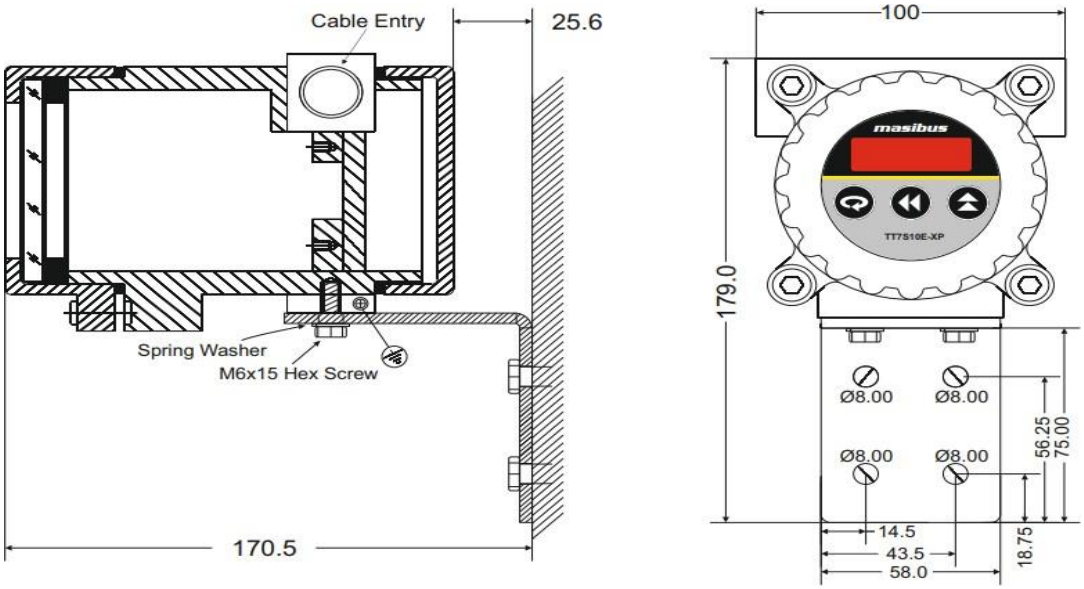


Fig. 3.2 Wall Mount

4.1.2 Pipe Mount Connection

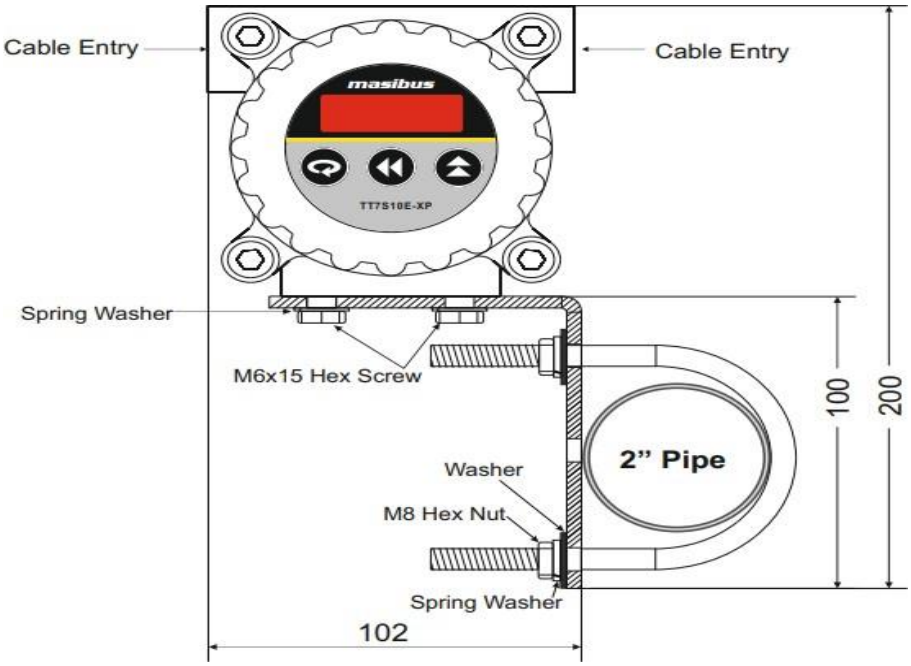


Fig. 3.3 Pipe Mount

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

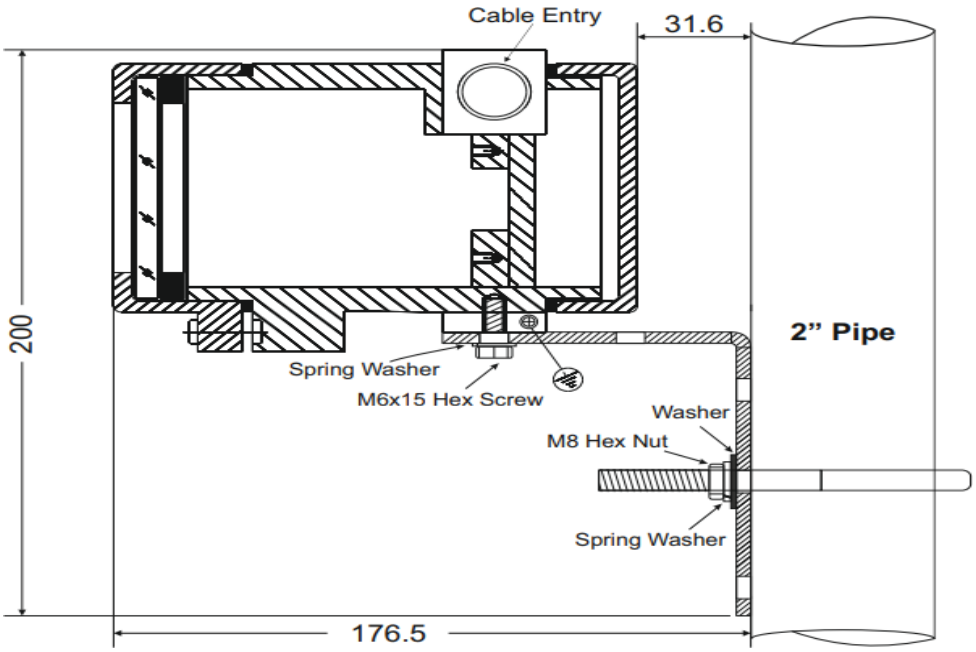


Fig. 3.4 Vertical Pipe Mount

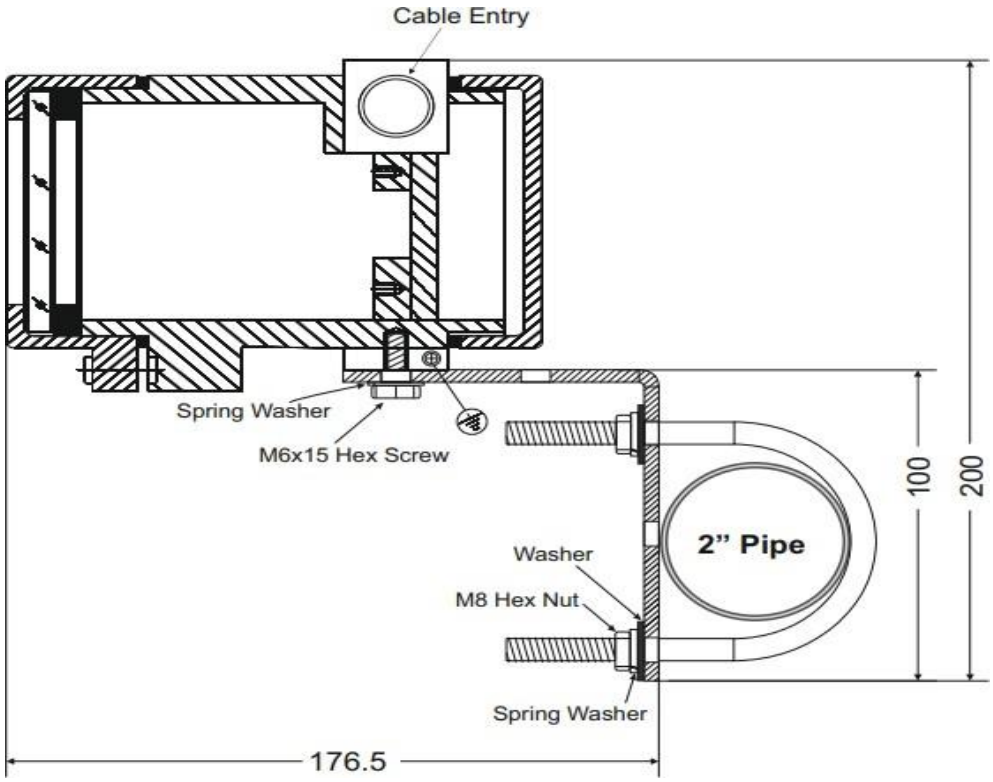
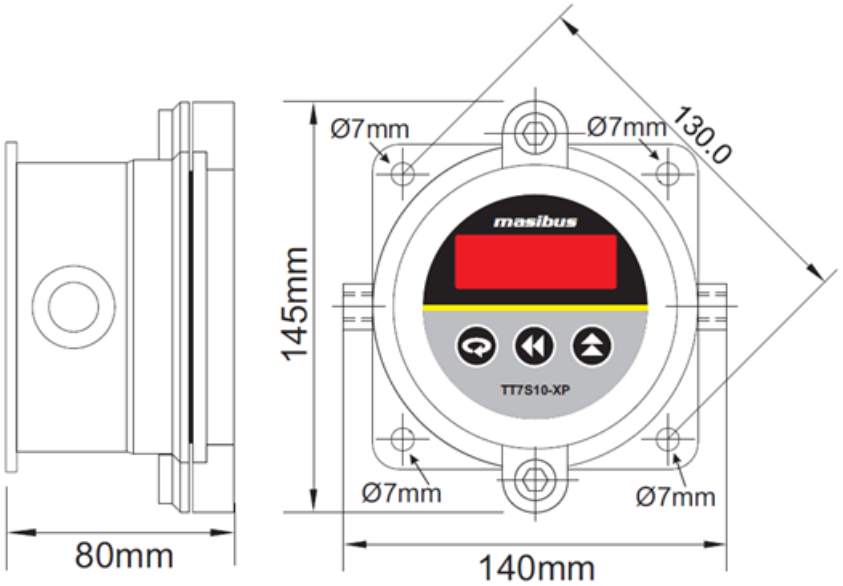


Fig. 3.5 Horizontal Pipe Mount

- **Single Compartment**

Mounting	Wall (Std) or 2" Pipe mount (optional)
Dimensions in mm	140(H) x 145(W) x 80(D)
Weight (without mounting clamps)	~1 Kg
Enclosure Material	Aluminium Alloy LM-6
Ingress Protection	IP65
Area Classification	Zone 1 & 2, Gas Group: IIA & IIB
Cable entry size	2 nos. of M20 double compression cable glands



5. TERMINAL CONNECTIONS

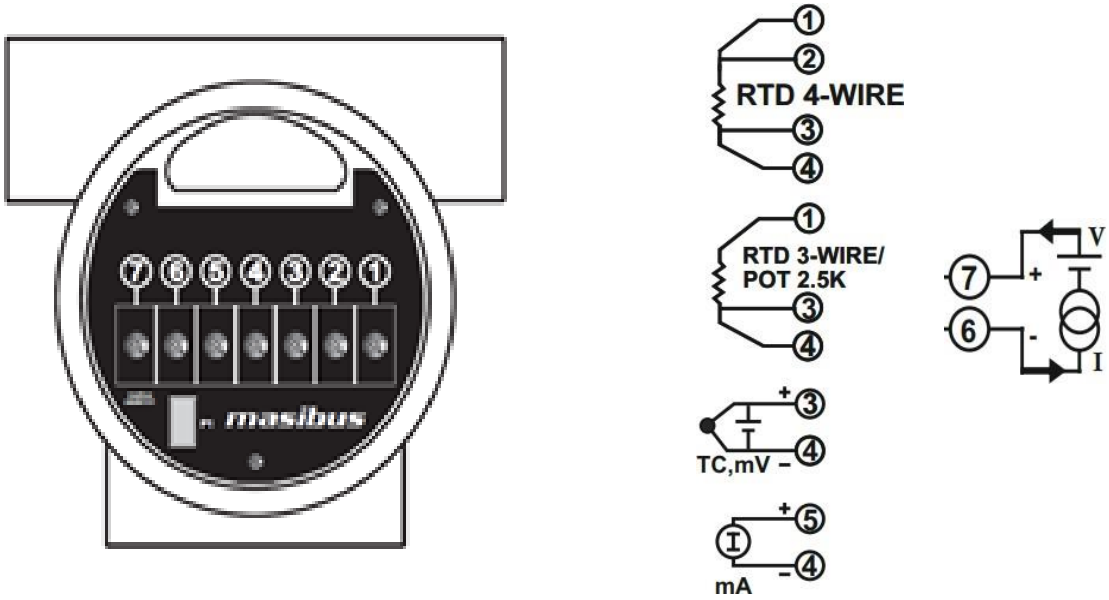


Fig 4.1: Terminal Connection Detail

5.1 How to connect wires.

Before carrying out wiring, turn off the power to the controller and check that the cablesto 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 andregulations. 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.

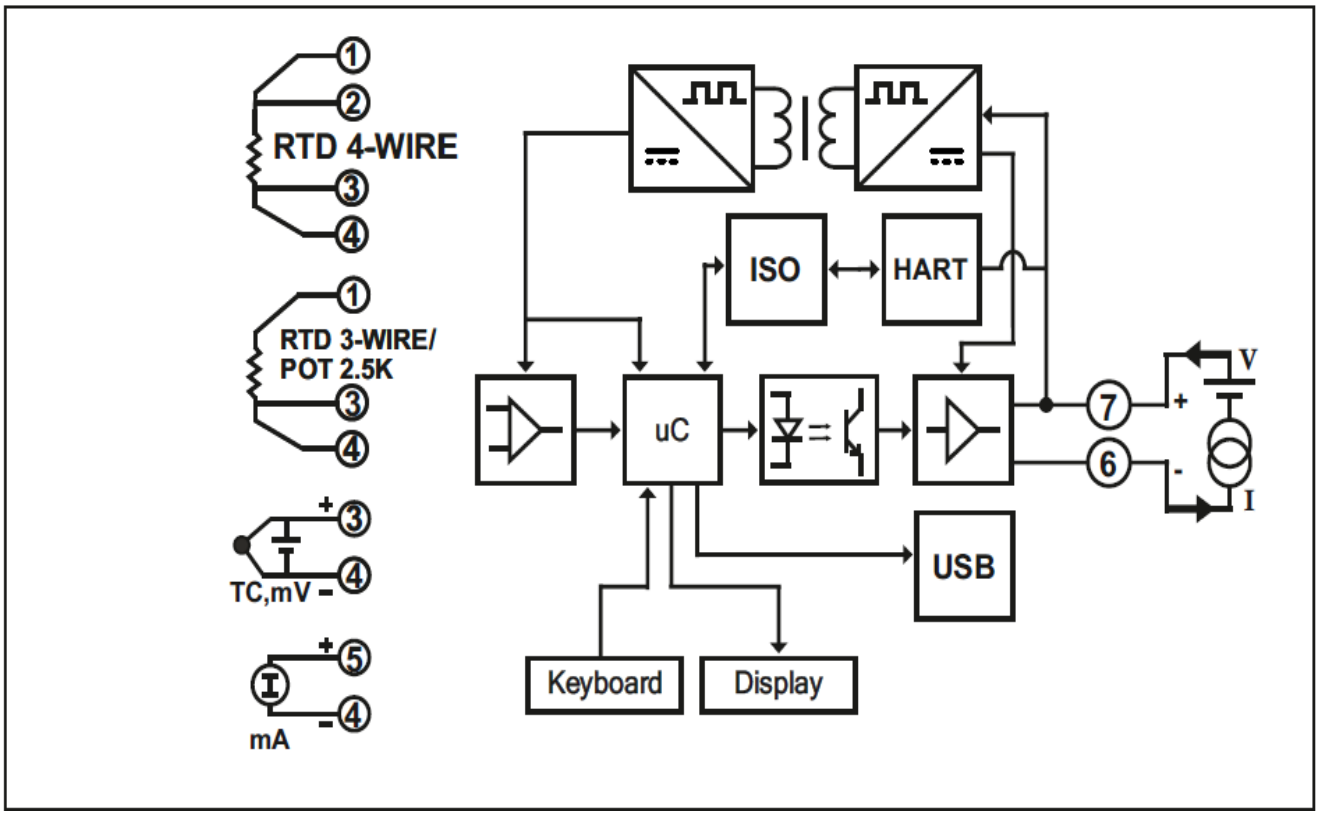
6. FRONT PANEL DETAILS

Dual Compartment **Single Compartment**

6.1 Front Panel Description

Name of Part	Symbol	Function
Increment Key		• Increment the Value of any Parameter. • Shows ambient value for T/C Input in RUN mode.
Escape Key		• Used as a back key in menu, calibration and configuration mode. • Used as slide button to move from one digit to another while writing specific parameter value.
Enter Key		• In Menu it can be used to get to the next Parameter. • 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.
Process Value Display	PV	• 4-digit 0.4-inch LED Display • Display process value. • Display parameter name when user set parameter. • Display error message (dErr) when a memory corruption occurs.

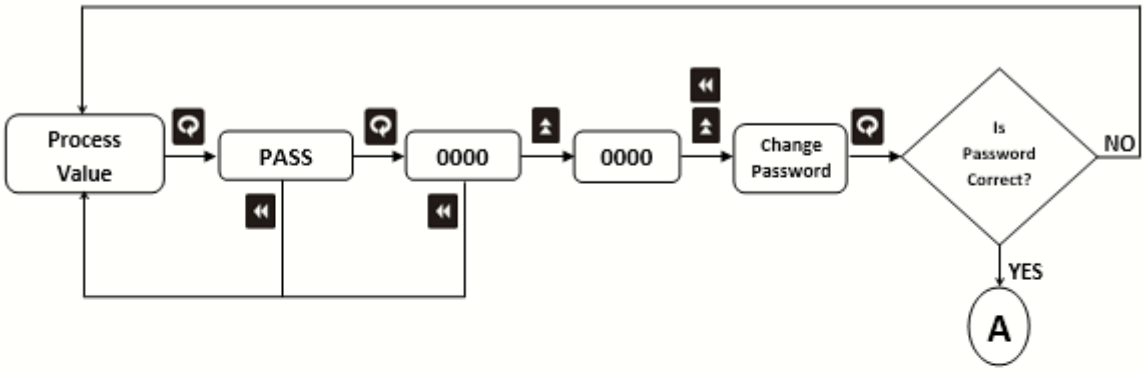
7. BLOCK DIAGRAM

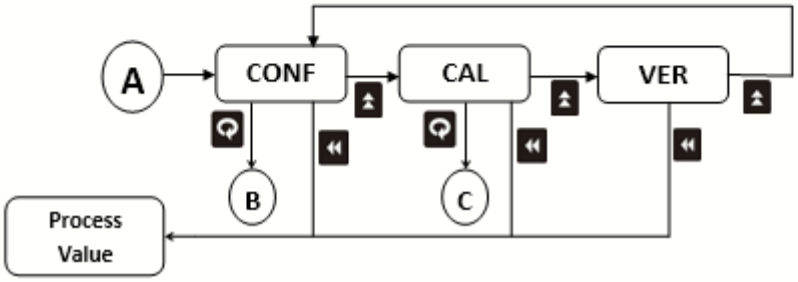


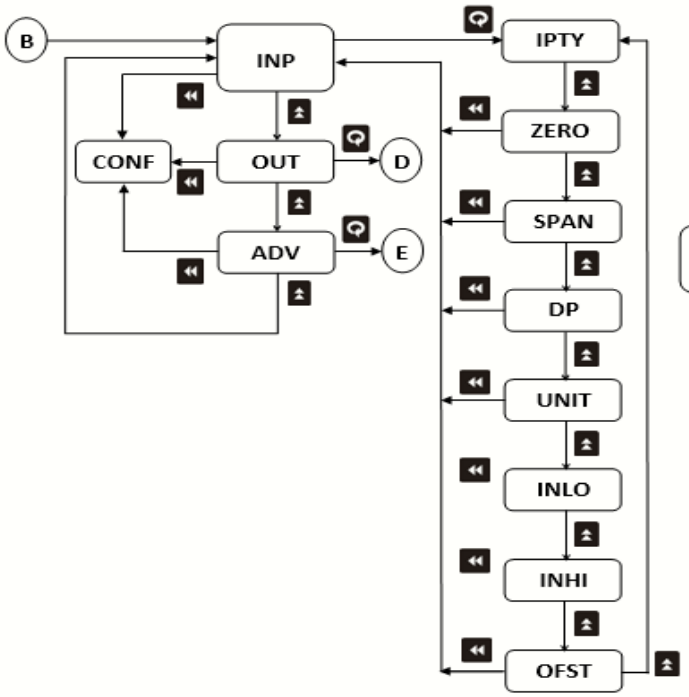
8. MENU LAYOUT

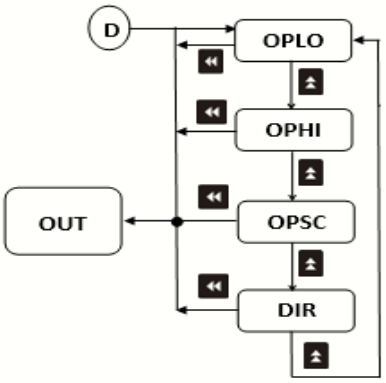
8.1 Menu Layout

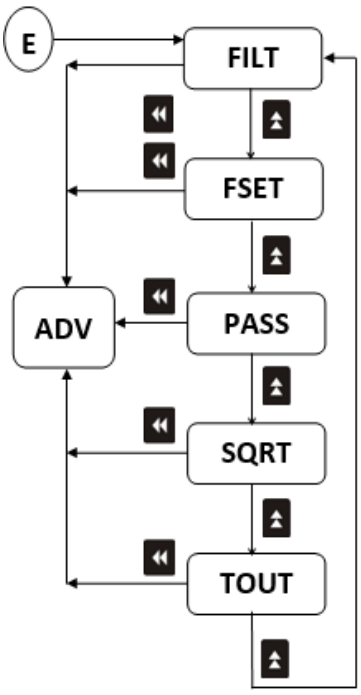
Menu can be access by using the keypad in a device. The flow of the menu is described as below.

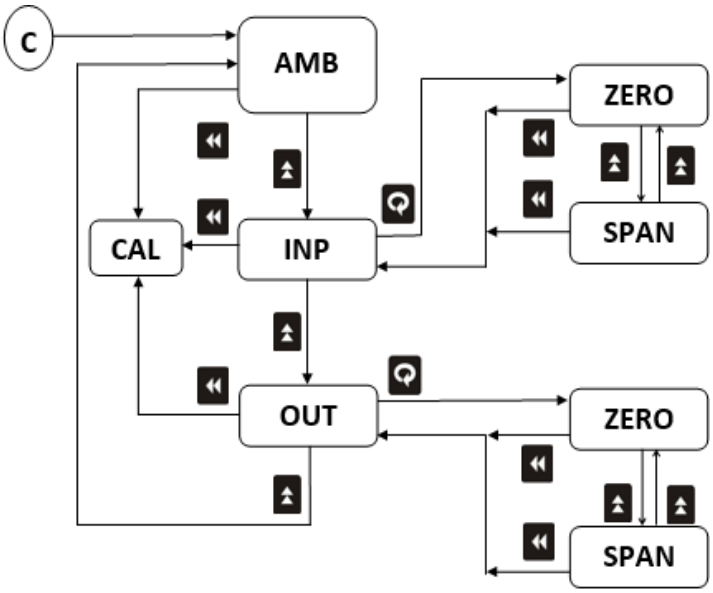





B
INP
IPTY
ZERO
SPAN
DP
UNIT
INLO
INHI
OFST
CONF
OUT
D
ADV
E


D
OPLO
OPHI
OPSC
DIR
OUT


E
FILT
FSET
PASS
SQRT
TOUT
ADV


C
AMB
ZERO
SPAN
CAL
INP
OUT
ZERO
SPAN

8.2 Menu Parameter Description

8.2.1 LEVEL 1 Input Configuration Mode

<table>
<tr><th colspan="2">PARAMETER</th><th rowspan="2">Setting Name & Description</th><th rowspan="2">Default Value</th><th rowspan="2">Show if only</th></tr>
<tr><th>Symbol</th><th>Name</th></tr>
<tr><td>PASS
(PASS)</td><td>PASSWORD</td><td>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.</td><td>0000</td><td></td></tr>
<tr><td>CONF
(Conf)</td><td>Configuration Mode</td><td>To Enter into Configuration Mode to Configure the parameters of Instrument.</td><td></td><td></td></tr>
<tr><td>INPT
(inPt)</td><td>Input</td><td>For Input Parameters. In Conf mode, user can set input Configuration.</td><td></td><td></td></tr>
<tr><td>IPTY
(iPtY)</td><td>Input Type</td><td>To set input type.
E-tC/J-tC/K-tC/t-tC/b-tC/r-tC/S-tC/n-tC/rtd3/500/0-75/P2 .5P/rtd4/4-20/ 0-20
<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 ℃</td></tr>
<tr><td>2</td><td>J-tC</td><td>J-TC</td><td>-2000 to 12000 ℃</td></tr>
<tr><td>3</td><td>K-tC</td><td>K-TC</td><td>-2000 to 13700 ℃</td></tr>
<tr><td>4</td><td>t-tC</td><td>T-TC</td><td>-2000 to 4000 ℃</td></tr>
<tr><td>5</td><td>b-tC</td><td>B-TC</td><td>4500 to 18000 ℃</td></tr>
<tr><td>6</td><td>r-tC</td><td>R-TC</td><td>0 to 17500 ℃</td></tr>
<tr><td>7</td><td>S-tC</td><td>S-TC</td><td>0 to 17500 ℃</td></tr>
<tr><td>8</td><td>n-tC</td><td>N-TC</td><td>-2000 to 13000 ℃</td></tr>
<tr><td>9</td><td>rtd3</td><td>RTD3</td><td>-2000 to 8500 ℃</td></tr>
<tr><td>10</td><td>500</td><td>0-500 mV</td><td>-1999 to 9999 ℃</td></tr>
<tr><td>11</td><td>0-75</td><td>0-75 mV</td><td>-1999 to 9999 ℃</td></tr>
<tr><td>12</td><td>P2 .5P</td><td>Pot 2.5 K</td><td>-1999 to 9999 ℃</td></tr>
<tr><td>16</td><td>rtd4</td><td>RTD4</td><td>-2000 to 8500 ℃</td></tr>
<tr><td>26</td><td>4-20</td><td>4-20mA</td><td>-1999 to 9999 ℃</td></tr>
<tr><td>27</td><td>0-20</td><td>0-20mA</td><td>-1999 to 9999 ℃</td></tr>
</table></td><td>K-tC</td><td></td></tr>
<tr><td>ZERO
(Zero)</td><td>Zero</td><td>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.</td><td>-200</td><td></td></tr>
<tr><td>SPAN
(SPAn)</td><td>Span</td><td>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.</td><td>1370</td><td></td></tr>
<tr><td>UNIT
(UNit)</td><td>Unit</td><td>Configure the Engineering Unit for Process Input Value only for TC/RTD (°C, °F, °K).
dEGC/dEGF/dEGK
1:dEGC: °C
2:dEGF: °F
3:dEGK: °K</td><td>dEGC</td><td>If input type is TC or RTD.</td></tr>
<tr><td>INLO
(inLo)</td><td>Input Low</td><td rowspan="2">Used for Input Low and Hi Value Select.
INHI – INLO >10. Applicable for Linear/POT Input Type.</td><td>0000
(for 0-500mV input)</td><td rowspan="2">If input type is linear or pot.</td></tr>
<tr><td>INHI
(inHi)</td><td>Input High</td><td>0500
(for 0-500mV input)</td></tr>
</table>

DP (dP)	Decimal Point	To Set position of Decimal Point on Process Value. Applicable for Linear/POT Input Type.	0001	If input type is liner or pot.
OFFSET (oFSt)	PV offset	It is a PV bias used for PV correction	0000	
ACJC (AcJc)	Auto CJC	Auto Cold junction Compensation YES/NO 1:(YES) 0:(No)	YES	Input Sensor is TC type TC
FCJC (FcJc)	Fix cold junction Compensation	0 to 80.0 Degree	0 .0	If ACJC no

8.2.2 *LEVEL 2 Output Configuration Mode*

PARAMETER		Setting Name & Description	Default Value	Show if only
Symbol	**Name**			
OPT (oPt)	Output	For Output Parameters. In Conf mode, user can set Output Configuration.		
OPLO (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.	0000	If input type is linear or pot.
OPHI (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.	0100	
OPSC (oPSC)	OPEN Sensor Indication	To set O/P to either Upscale or Downscale when Input is OPEN. (Not applicable for 0-20mA) UPSc/dnSc **1:UPSc:** upscale(21mA) **2:dnSc:** downscale(3.6mA)	dnSc	
DIR (dir)	Output Direction	To set Retransmission O/P Direction to either Direct or Reverse. dirt/rEvr **1:dirt**: Direct(4-20mA) **2:rEvr**: Reverse(20-4mA)	dirt	

8.2.3 *LEVEL 3 Advance Configuration Mode*

PARAMETER		Setting Name & Description	Default Value	Show if only
Symbol	**Name**			
ADV (Adv)	Advance	To configure advanced parameters.		
FILT (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.	0002	
FSET (FSEt)	Factory Reset	To retrieve the factory setting. Refer appendix to understand how to do manual reset.	0000	

PASS (PASS)	Change Password	To change the Password of device to Enter in Configuration/Calibration Mode.	0000	
SQRT (SQrt)	Square Root	Applicable for Linear/POT Input with Options of YES or NO. Refer appendix for the calculation of square root. YES/no 1:no: no 2:YES: yes	no	If input type is linear or pot
TOUT (tout)	Timeout	Time Setting to Return in RUN mode while no key operation. Timeout Range is between 10 to 300 seconds.	00 10	

8.2.4 *LEVEL 4 Calibration Mode*

PARAMETER		Setting Name & Description	Default Value	Show if only
Symbol	**Name**			
CALI (CAL i)	Calibration Mode	To Enter in Calibration Mode to Calibrate the Instrument.		
AMB (Amb)	Ambient Calibration	To Calibrate the Ambient Temperature. Applicable only if TC input Type is selected.	0000	If input type is TC.
INPT (inPt)	Input	To calibrate the input range. 2Ero/SPAn 2Ero: to calibrate input zero.	**PV VALUE**	
		SPAn: to calibrate input span.		
OPT (oPt)	Output	To calibrate the output range. 2Ero/SPAn 2Ero: to calibrate output zero.	04 .00	
		SPAn: to calibrate output span.	20 .00	
VER (uEr)	Version	Shows the Version of the Current Firmware.	3 .00	

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 baud rate 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

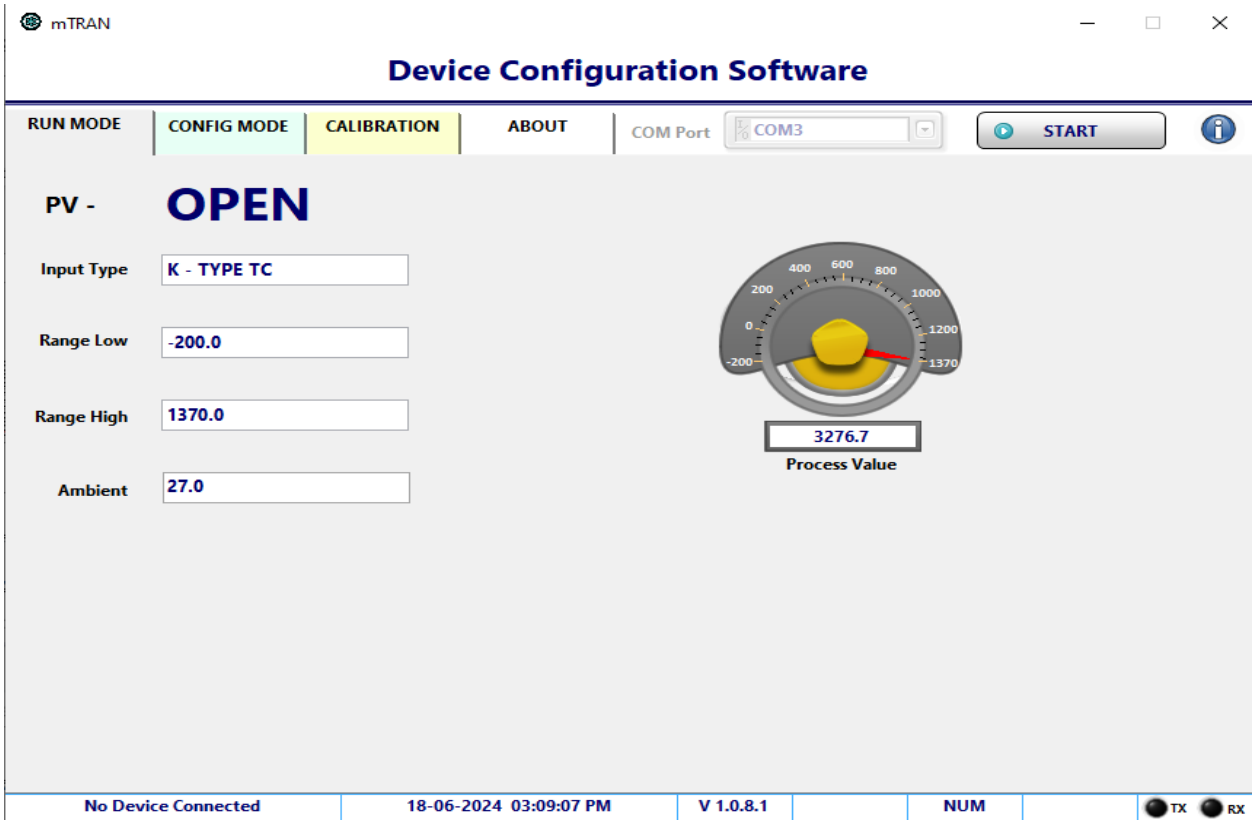
CODE	MEANING
01	Function code Invalid. It must be 01, 05, 03 or 06. The function codereceived in the query is not allowable action for the slave.
02	Illegal address value. The data address received in the query is not anallowable address for the salve.
03	Illegal data value. A value contained in the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

10.3 mTran Software Modes

- mTran is a software developed by masibus to configure and calibrate device based on modbus protocol.
- **Note :** Only device that is developed by masibus can be calibrate using mtran software.
- mTran software has three modes.

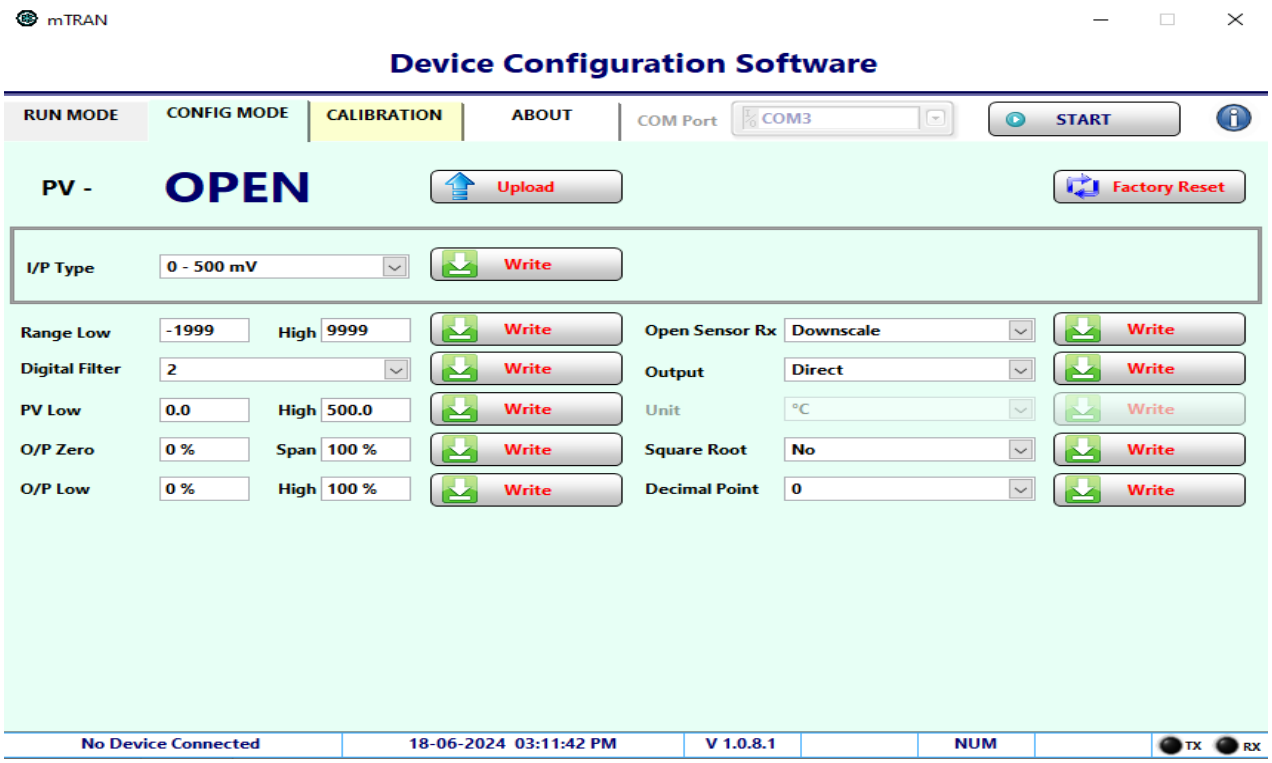
1. RUN Mode:

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



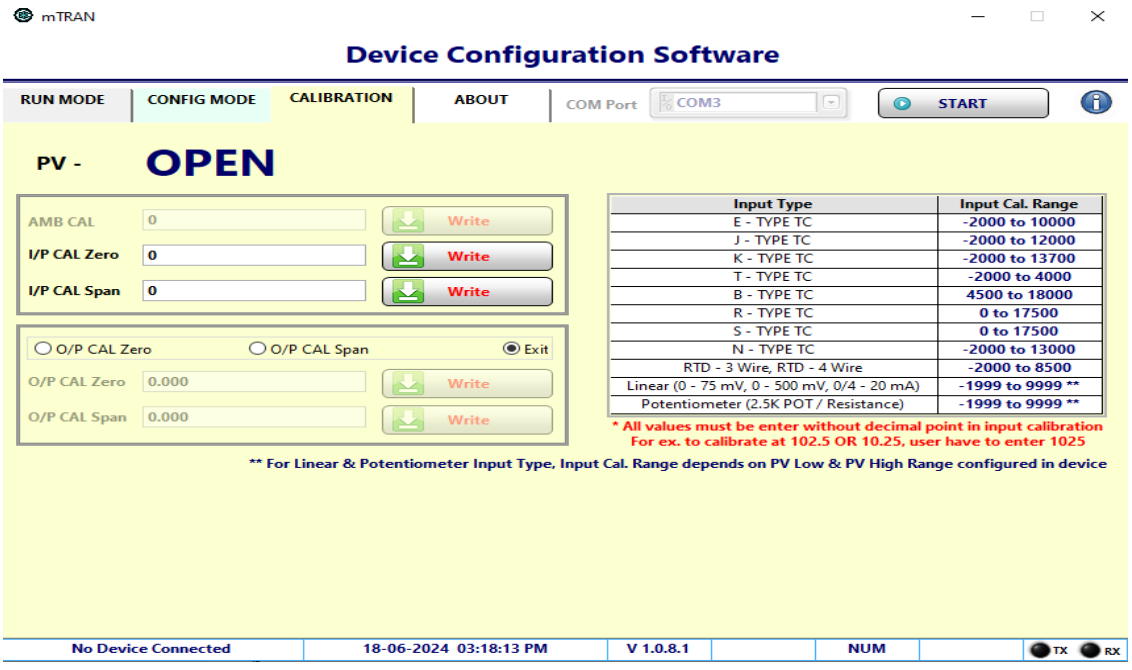
2. CONFIG Mode:

- 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.



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.



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 filed 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.

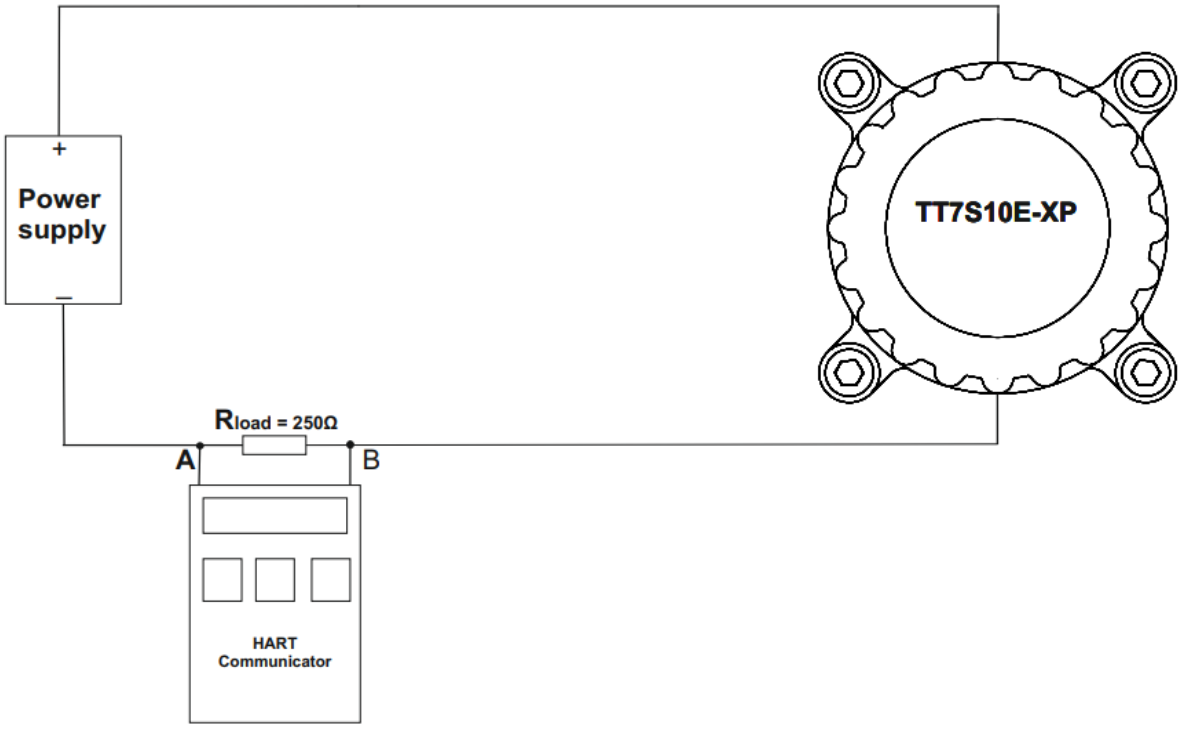
11. COMMUNICATION PROTOCOL–HART

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 Configurationtool

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.

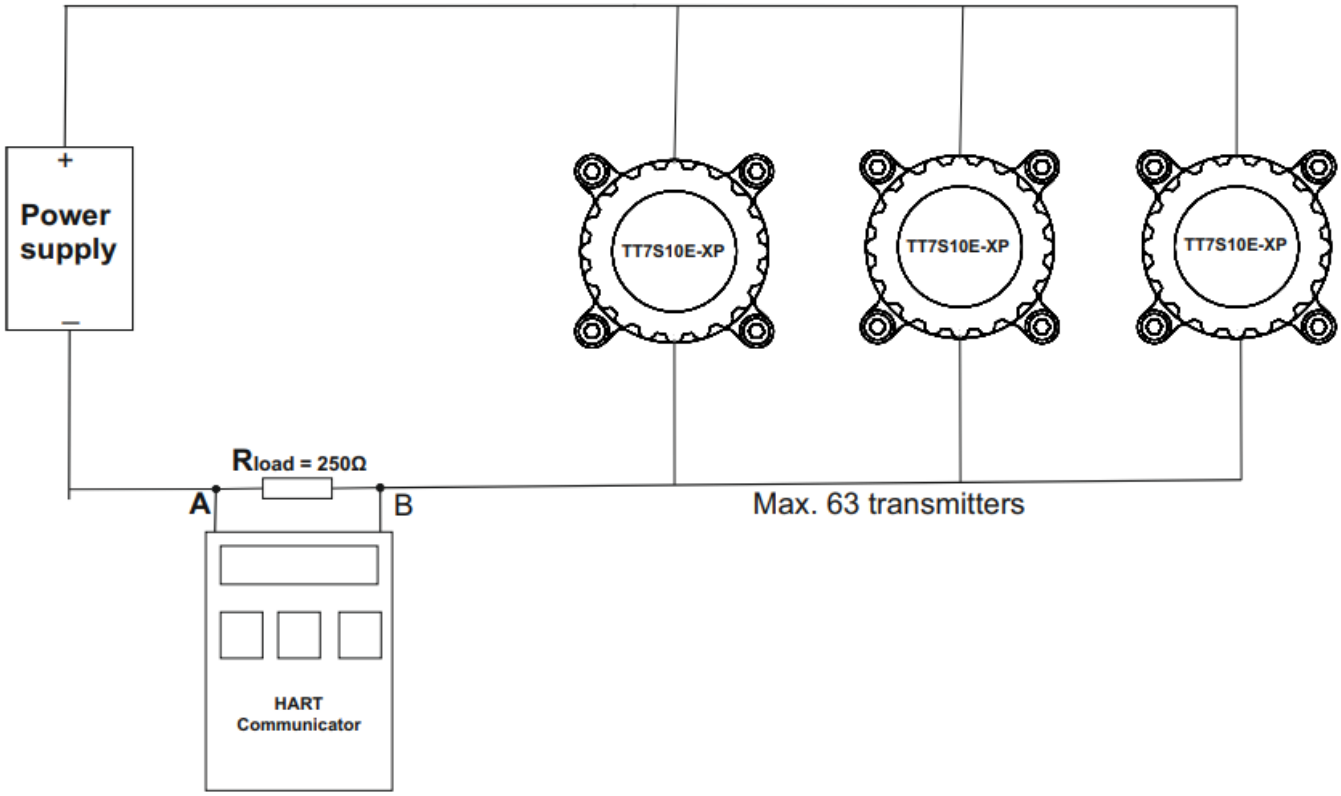


The HART communicator or HART modem will be connected across AB.

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 Table-11.1 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 caseof sensor break or PV out of limit refer Table-12.1.	-
	Current percentage	Value of current after converting it into percentage.	-
	Input Type	Sensor Input Type. Refer Table-1 for input types.	K-TC
	Unit	PV unit. Can Configure the EngineeringUnit for Process Input Value only for TC/RTD (°C, °F, °K).	℃
	Upper Range Value	PV upper range value. Refer Table-1 for value based on input type	1370
	Lower Range Value	PV lower range value. Refer Table-1 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 Table-1 for value based on input type	1370
	Lower Sensor limitValue	PV Minimum Lower range value that can be set. Refer Table-1 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
Memory	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 identifierassociated 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 bewritten 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-digitsensor number must be written in a device.	000000
Testing & calibration	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
0	Read: Unique Identifier	Read
1	Read: Primary Variable	Read
2	Read: Current Loop, Percent of Range	Read
3	Read: Dynamic Variable, Loop Current	Read
6	Write: Polling address	Write
7	Read: loop configuration	Read
8	Read: Dynamic variable classification	Read
9	Read: Device variables with status	Read
11	Read: unique Identifier Associated with Tag	Read
12	Read: Message	Read
13	Read: TAG, DESCRIPTOR, DATE	Read
14	Read: Primary variable sensor information	Read
15	Read Device Information	Read
16	Read Assembly number	Read
17	Write: Message	Write
18	Write: TAG, DESCRIPTOR, DATE	Write
19	Write: Assembly number	Write
20	Read: long tag	Read
21	Read: unique Identifier Associated with Long Tag	Read
22	Write: Long Tag	Write
38	Reset Configuration change flag	Write
33	Read: Transmitter Variables	Read
34	Write: Primary Variable Damping Value	Write
35	Write: Primary Variable Range Value	Write
40	Enter/Exit Fixed Primary Variable Current Mode	
42	Perform Master Reset	
44	Write: Primary Variable Units	Write
45	Trim Primary Variable Current DAC Zero	Write
46	Trim Primary variable Current DAC Gain	Write
47	Write: Primary variable transfer function	Write
49	Write: Primary Variable Sensor Serial Number	Write
59	Write: Response Preamble	Write
130	Read: Input Type selection	Read
131	Write: Read Input Type selection	Write
132	Read: open sensor and output current direction value	Read
133	Write: open sensor and output current direction value	Write
144	Write: Amb calibration value	Write
145	Write: PV Zero calibration value	Write
146	Write: PV span calibration value	Write
147	Write: Decimal point	Write
148	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 (iPtY)	K-TC (H-tc)
Sensor upper range value(SPAn)	1370 (1370)
Sensor lower range value (2Ero)	-200 (-200)
Unit (Un it)	℃ (dEGC)
Filter **(F iLt)**	2 (0002)
Open sensor value (oPSc)	Downscale (dnSc)
Output direction (d ir)	Direct(d irt)
Decimal point(dP)	1(000 1)

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 "ouEr" 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.