masibus®

User's Manual

THERMOCOUPLE CALIBRATOR

TC-12

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Contents

1. Introduction 4

Foreword 4

Notice 4

Trademarks 4

Safety 5

General warnings 5

Electrical warnings 5

Cautions 6

2. TC-12 Hardware Parts & Accessories 7

2.1 Unpacking & Inspection 7

2.2 Operational Sections and Connections 7

2.2.1 The Terminal Connections 8

2.2.2 The KeyPad 11

2.2.3 The Display 12

2.2.4 The USB Connection 12

2.2.5 Stand for Table Top Use 12

2.3 Power Options 13

2.4 Battery 13

2.4.1 Charge times 14

2.4.2 Operating Time 14

3. Start Up & Basic Operations 15

3.1 Power ON or OFF 15

3.2 The User Interface 15

3.2.1 The Status Bar 16

3.2.2 The Function key Bar 17

3.2.3 Display Mode 17

3.2.4 Display Operations 20

4. Menu Layout 24

4.1 MENU page 24

4.2 MEASURE Page 24
4.2 SOURCE Page 26
4.2.1 STEP Page 27
4.2.2 RAMP Page 29
4.3 DISPLAY Page 31
4.3.1 EM Display Settings 31
4.3.2TC Display Settings 32
4.4 DATA LOGGING Page 34
4.5 CJC Setting Page 36
4.6 SETTING Page 37
4.6.1 HART Settings 38
4.6.2 Display Settings 38
4.6.3 Date/Time Settings 38
4.6.4 Calibration 39
4.6.5 Battery Info. 45
4.6.6 Set Password 45
4.6.7 Factory Reset 45
4.6.8 About Calibrator 45

5. Maintenance & Troubleshooting 46
5.1 Common Problems 46
5.2 Replacing the Battery 46

6. General Specifications 47
6.1 General Specifications 47
6.2 Electrical Measurement Parameters and Accuracy 48
6.3 Thermocouple/mV Parameter and Accuracy 48
6.5 Enclosure Dimensions 49

1. Introduction

Foreword

Thank you for purchasing ***Thermocouple Calibrator TC-12***.
The TC-12 calibrator is compact hand-held calibrator with an easy to use graphical user interface.

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 as a result 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, however, please inform MASIBUS Sales office or sales representative. Under no circumstances may the contents of this manual, in part or in whole, be transcribed or copied without our permission.

Trademarks

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Adobe, Acrobat, and Postscript are either registered trademarks or trademarks of Adobe Systems Incorporated. All other product names mentioned in this user's manual are trademarks or registered trademarks of their respective companies.

Safety

Before you use the instrument, make sure that you read and understand all the related data. This includes: the applicable local safety procedures, this publication, and the instructions for the accessories/options/equipment you are using it with.

General warnings

WARNING

It is dangerous to ignore the specified limits for the instrument or its related accessories.
Do not use the instrument or accessory if it is not in its normal condition.
Use the applicable protection and obey all safety precautions.
Do not use the instrument in locations with explosive gas, vapor or dust. There is a risk of an explosion

Electrical warnings

To prevent electrical shocks or damage to the instrument, do not connect more than 30V between the terminals, or between the terminals and the ground.

This instrument uses a Lithium-Ion battery pack. To prevent an explosion or fire, do not short circuit, do not disassemble, and keep it safe from damage. For operating conditions, see section 6.1 on Page-47

To prevent battery leakage or heat generation, only use the battery charger in the temperature range 0 to 45°C (32 to 113°F). For operating conditions, see section 6.1 on Page-47.

To make sure the display shows the correct data, disconnect the test leads before you set the power to on or change to another measure or source function.

Cautions

To prevent damage to the display, do not use sharp objects on the screen.

Before you start an operation or procedure in this publication, make sure that you have the necessary skills (if necessary, with qualifications from an approved training establishment). Follow good engineering practice at all times

Summary of functions

This table gives a summary of the available functions with the TC-12 calibrator.

Function
Easy to read liquid crystal display (LCD) in color
Rechargeable lithium Ion battery with enhanced power control for prolonged battery life.
* Measure Thermocouple (E,J,K,T,B,R,S,N), mV(-10 to 250mV), mA, mV(24V)
* SimulateThermocouple (E,J,K,T,B,R,S,N), mV(-10 to 250mV)
Step/Ramp functions: Automatic/Manual
Universal Serial Bus (USB) communications ports: For computer Communications, Battery Charging& Firmware Upgrade
Data Logging.
Other functions: Maximum / Minimum / Average, filter, tare, adjustable backlight, alarm indication (on the display and buzzer), automatic Display off.

** Refer to the Specification Sheet on Page: 47*

2. TC-12 Hardware Parts & Accessories

2.1 Unpacking & Inspection

At the factory each new TC12 passes a careful inspection. It should be free of scrapes and scratches and in proper operation order upon receipt. The receiver should, however, inspect the unit for any damage that may have occurred during transit. If there are signs of obvious mechanical damage, package contents are incomplete, or the instrument does not operate according to specifications, contact the purchasing sales office as soon as possible.

The standard accessories are as follows:

- ✓ Calibration Certificate
- ✓ User Guide
- ✓ 1Test leads (2mm to 2mm)
- ✓ 1 Test lead Cu-Cu(Miniature TC Plug Cu type to 2mm Test lead)
- ✓ 2 Sets of 2mm Crocodile clips.
- ✓ 2 Sets of connecting plug 4mm to 2mm
- ✓ USB A Male to USB mini B Male cable for PC communication and charging.
- ✓ 5 VDC Charging Adaptor
- ✓ Carrying Bag
- ✓ TC-12 Configuration & Logging Software CD-mCAL.

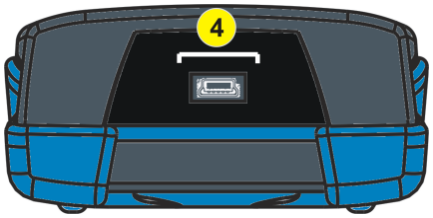
If you have to return the instrument to the factory for any reason, use the original packing whenever possible. Include a detailed description of the reason for the return.

2.2 Operational Sections and Connections

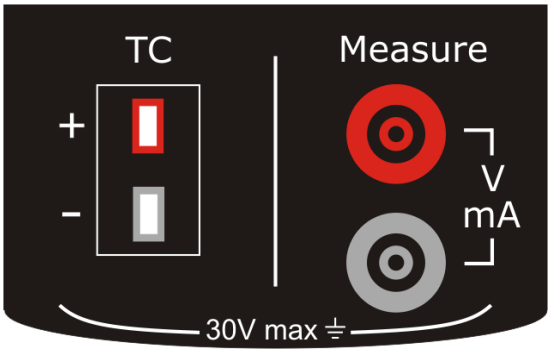
All sections and connections are presented in detail on the next pages.

Note: Keep in mind that the next picture (as well as all pictures ofTC-12 in this manual) has an example configuration of modules. The configuration of your TC-12 may vary significantly from the one in the picture.

1	Terminal Connection For TC Measure & Source and EM Measure
2	Keypad Section
3	Color Display
4	USB Connection Slot for PC Communication & Charging



2.2.1 The Terminal Connections



➢ **EM Measure Terminals**

Input Terminal for measuring voltage, current and supplying loop power.

EM Measure Terminals	
mA	Range: 0.000 – 24.000 mA Resolution: 0.001 mA
mA(24V)	Range: 0.000 – 24.000 mA Resolution: 0.001 mA
V	Range: 0.000 – 30.000 V Resolution: 0.001 V

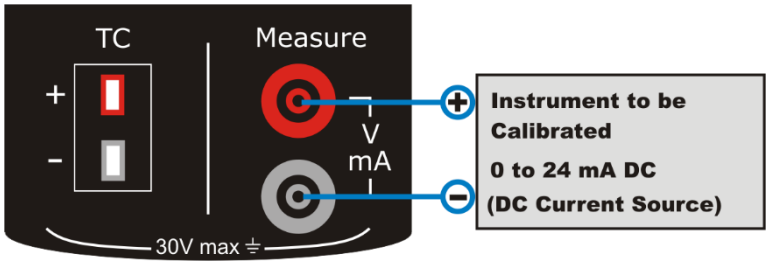
- **Current Measurement**

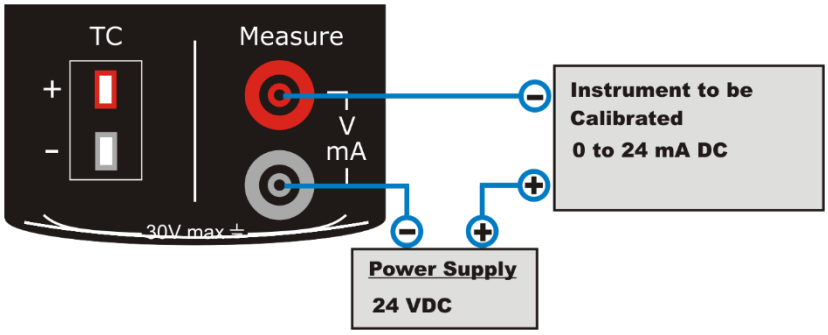
  TC-12 supports current measurement using either TC-12 as the loop power supply while at the same time measuring the current or simply measuring the current while an external power supply is used.

  The following picture displays the connection for Current Measurement for different mode. And also different ways of providing the supply power to the loop.

  - mA Current Measurement

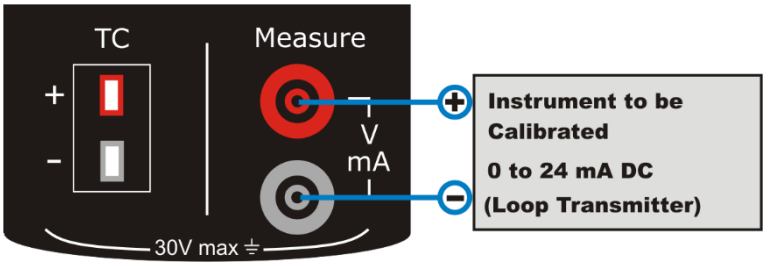
    In this mode TC-12 not providing any supply voltage. For proper measurement the external device should capable of providing the voltage supply. If the external device should not capable, an external Power Supply should be connected in series.





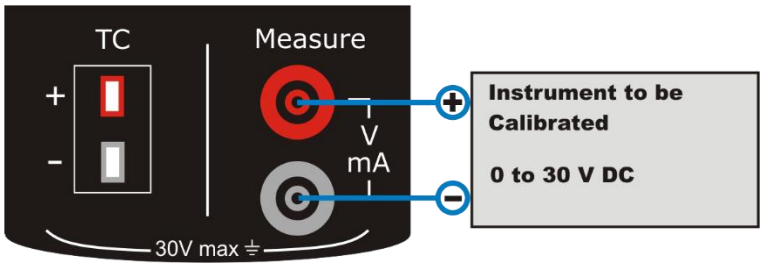
  - mA Read Power Current Measurement

    In this modeTC-12 works as Loop Power Supply while at the same time measuring the current.



Voltage Measurement

TC-12is capable of voltage Measurement with two voltage measurement ranges.
The following picture displays the connection for Voltage Measurement for different mode.

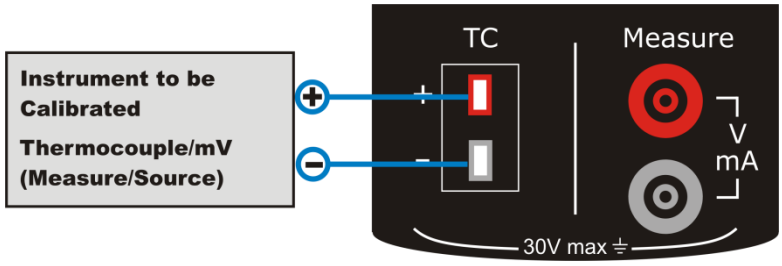


- **TC Terminals**

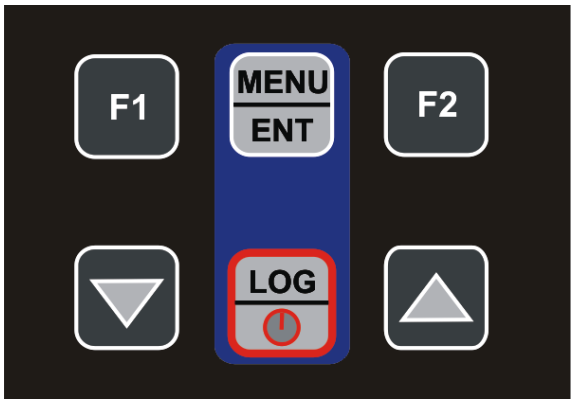
  Terminal for measuring & simulating thermocouples and mV. This terminal accepts a miniature polarized thermocouple plug with flat, in-line blades spaced 7.9 mm (0.312 in) center to center.

TC Terminal (Measure and Source)			
TC Type	**Range**	**Display Resolution**	**Accuracy**
E	-200.0 to 1000.0 °C	0.1 °C	± 0.3 °C
J	-200.0 to 1200.0 °C	0.1 °C	± 0.3 °C
K	-200.0 to 1372.0 °C	0.1 °C	± 0.3 °C
T	-200.0 to 400.0 °C	0.1 °C	± 0.3 °C
B	450.0 to 1800.0 °C	0.1 °C	± 0.5 °C
R	0.0 to 1750.0 °C	0.1 °C	± 0.5 °C
S	0 to 1750.0 °C	0.1 °C	± 0.5 °C
N	-200.0 to 1300.0°C	0.1 °C	± 0.3 °C
mV	-10 to 80 mV	0.001 mV	±0.02% of reading ± 2uV
	-10 to 250 mV	0.01mV	±0.02% of reading ± 0.02mV

TC-12 supports measurement and simulation of Thermocouple and mV.



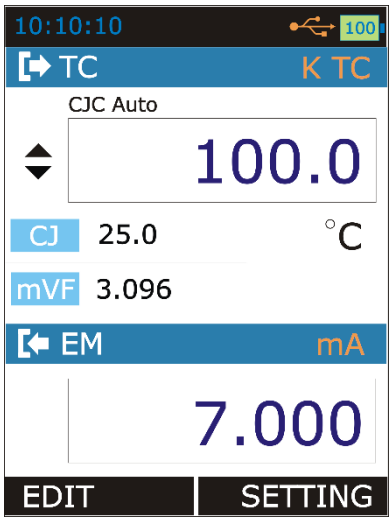
2.2.2 The KeyPad



TC-12 has six different keys. The key description is given below.

F1	This key has different functionalities in different menu. And that is shown on Bottom Left Part of Display.
F2	This key has different functionalities in different menu. And that is shown on Bottom Right Part of Display.
▽	This key is use to scroll down to the next parameter. And also for decrementing the value of digit in Editbox.
△	This key is use to scroll up to the previous parameter. And also for incrementing the value of digit in Editbox.
MENU ENT	This Key is use for Entering into the MENU Page from Run Page. And Also for Saving Edited Parameter to the memory.
LOG	This key is use to log current reading in memory if device is on Run Page& Log Mode is Manual. (In other Page than Run Mode, this key is use to come directly to Run Page. Long presses (Approx. 2 Sec) on this key will ON-OFF the Unit.

2.2.3 The Display



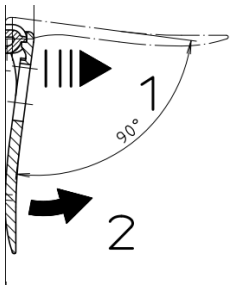
- This is a LCD with a 2.4” color display.
- The display has resolution of 240x320 pixels supporting 262K Colors.
- Refer Section 3.2.3 on Page-17for more details on Different Display Mode and Icon Details.

2.2.4 The USB Connection

- The USB Connection Connector is given at Top of the TC-12. It’s a USB mini B-Type Female Connector.
- It is common for PC Communication & Charging the device.
- The USB cable given with the device is USB A-type Male to USB B-type male. It’s common for connecting Charger & PC.

2.2.5 Stand for Table Top Use

- This Stand would offer the best support for table top use which gives good viewing angle when UC12 is placed table top
- Procedure to Open Stand
  - is being engraved on the top of the stand. You should pull a bit first.
  - is being engraved on the bottom of the stand. Now during first pull of above you can release this lower part easily so that you can maneuver the stand as you like.



2.3 Power Options

There are three power options:

- **Lithium-Ion battery:** All the instrument functions are available with a charged battery.
- **5 V DC Charging Adaptor:** It supplies power to the instrument and charges the battery at the same time. It charges the battery when the instrument is on or off.
- **USB mini Type B connection:** This charges the battery when the instrument is off and increases the battery life when the instrument is on.

2.4 Battery

The Device uses 2300mAh Lithium-Ion Battery.

WARNING

- **To prevent an explosion or fire, do not short circuit, do not disassemble, and keep it safe from damage.** For operating conditions, **see section 6.1 on Page-47.**
- **To prevent an explosion or fire, use only the Masibus specified battery, battery charger & USB Cable.**
- **To prevent battery leakage or heat generation, only use the battery charger in the temperature range 0 to 45°C (32 to 113°F).** For operating conditions, **see section 6.1 on Page-47.**

When you set the power on, the battery symbol at the top of the display shows the charge Status. To get more information on Battery go to Battery Info Page in Setting Menu.

2.4.1 Charge times

Charge Method	Charge Time (to Full Capacity)
External Charging Adaptor	≈ 5 hours

Note:
USB mini Type B connector charges the battery when the instrument is off and increases the battery life when the instrument is on.

2.4.2 Operating Time

Operation	Battery Duration
Continuous operation (measure or source)	>18 hours
Continuous operation (12mA(24V) measure)	> 8 hours

These are typical operating times for a new, fully charged Li-Ion battery pack with these settings:

- *Backlight Intensity* set to 5% (Default: 100%)
- *Backlight Timeout* set to 0 (0=Infinite) (Default: 0)

Power save options: To get the best battery duration, set a low value for the *Backlight Intensity* (40%) and a short *Timeout*.

The maximum operating time without recharging varies depending on the usage and brightness setting of the display light. Also the generated output and the usage of the 24V transmitter supply affect the maximum operating time.

Notes:

- *TC-12's memory and the internal clock/calendar use a small amount of power although the calibrator is switched off. Remember to check the capacity of the batteries from time to time although TC-12 is not in use.*
- *Do not leave TC-12 without a Battery Pack or an Empty Battery for a long time. TC-12 may lose its settings if it is left without a support voltage for an extended period.*

3. Start Up & Basic Operations

3.1 Power ON or OFF

To set the instrument power ON, press and release this button down until the display comes on. During the power on sequence, the instrument shows a Startup Message and then shows the applicable data.

To set the instrument power off, press and hold (≈ 2 seconds) this button again. When the power is off, the last set of configuration options stays in memory.

3.2 The User Interface

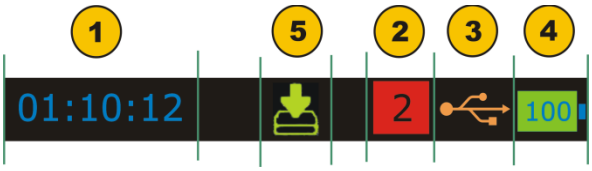
Every time TC-12 is switched on, the startup message ends in RUN Page.

There are3 Display Mode available in RUN Page.

1. TC Measure/Source Mode
2. EM Measure Mode
3. TC Measure/Source + EM Measure Mode

This Display Mode can be selected from MENU→DISPLAY Page.
In case of Dual Mode Display Screen is divided into two parts. Due to that only few additional info will appear on RUN Page. But Which Information to be shows can be selectable in Display Mode Menu. Refer Section 3.2.3 on Page-17for more info.

3.2.1 The Status Bar



The Status Bar at the top of the display is visible only in RUN Page. It is divided into four main sections.

1	Time in HH:MM:SS Format Available in Two Format 1. 24 Hour (default) 2. 12 Hour *This setting is available in Date/Time in Settings Menu*
2	Error Code Indicator This Icon is visible if any On-Board Peripherals like RTC, ADC, DAC, etc. not working Properly. Refer Section 5.1 on Page 46 for Troubleshooting these Errors. The List of Error Code available in this device is given below.

Error Code	Description
0	Memory Corrupted or Device Unable to Read/Write it.
1	RTC Not working Properly
2	Device unable to Read battery Information.
3	Measure Mode Not Working
4	Device unable to get Source Feedback Reading.
5	Data Log Memory Corrupt
6	Source Mode Not Working
9	More than one Errors from above list is occurring.

3	USB Connection Status Icon Icon is visible if USB Charger Adaptor or USB Data Cable is connected to the Device. Icon is different for both indication & this stated below.

	USB Data Cable is connected & Communication with PC is available.
	USB Charger Adaptor is connected. Battery starts Charging.

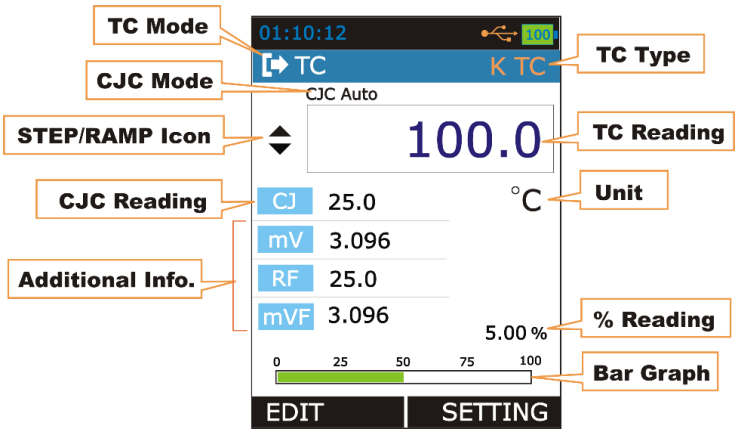
4	Battery Charge Percentage Indicator. Always visible in Run page. Battery % is shown in the center of the icon. And the icon background is filled with Green, Yellow & Red color if Battery % is >= 50%, >= 20 &<20 respectively.
5	Data Logging Enable Status Indicator. Icon is visible if Data Logging is enabled and also it will blink when a Datalog is stored to memory.

3.2.2 The Function key Bar

The Function Key Bar at the bottom of the display is visible all the time. There are 2 Function Key Available. The meaning of the Function Keys varies depending on the situation. A Blank Function key text means that the function is disabled at the moment.

3.2.3 Display Mode

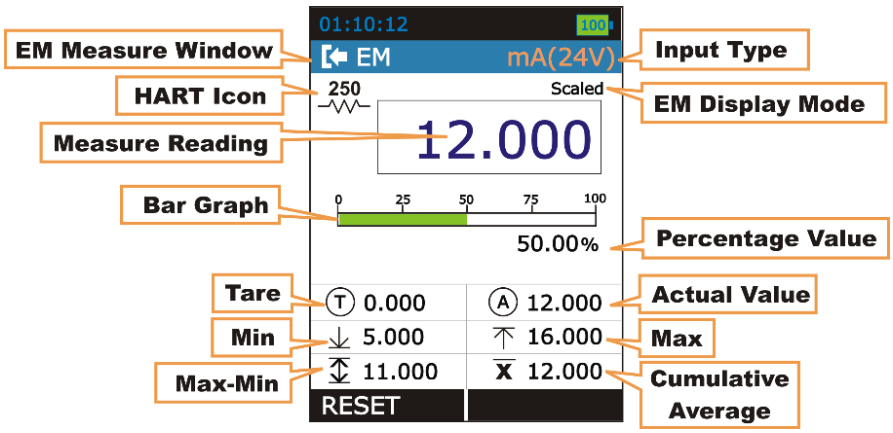
1. TC Mode



TC Display Mode	
TC Mode	Shows the Current Thermocouple Mode TC Measure Mode TC Source Mode
TCType	Shows the current Thermocouple/mV Type.
CJC Mode	Shows the CJC Mode CJC Auto: CJC Auto Mode CJC Manual: CJC Manual Mode
TC Reading	Shows the Thermocouple/mV Measure/Source reading according to display mode & TC Type.
Unit	Shows the Unit of the TC Reading, CJC. °C: Shows If TC Display mode is *Actual* and TC Unit is *Celsius*. °F: Shows If TC Display mode is *Actual* and TC Unit is *Fahrenheit*. K: Shows If TC Display mode is *Actual* and TC Unit is

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>Kelvin.</td></tr>
<tr><td>mV</td><td>Shows If TC Display mode is Actual. And TC Type is -10 to 80 or -10 to 250mV.</td></tr>
<tr><td>%</td><td>Shows If TC Display mode is Percentage.</td></tr>
</table>
</td></tr>
<tr><td>STEP/RAMP Icon</td><td>Shows the Icon indicating STEP/RAMP mode. Only applicable if TC mode is SOURCE.
<table>
<tr><td></td><td>Manual Step</td></tr>
<tr><td></td><td>Step UP</td></tr>
<tr><td></td><td>Step DOWN</td></tr>
</table>
<table>
<tr><td></td><td>Rising Ramp</td></tr>
<tr><td></td><td>Falling Ramp</td></tr>
<tr><td></td><td>Ramp Hold @ 0%</td></tr>
<tr><td></td><td>Ramp Hold @ 100%</td></tr>
</table>
</td></tr>
<tr><td>CJC Reading</td><td>Shows the Temperature of the Cold Junction if CJC mode is selected as AUTO and shows the user entered CJC Temperature value if CJC mode is MANUAL.
The Reading unit is same as TC Unit.</td></tr>
<tr><td>Additional Info.</td><td>Shows the Addition Information according to TC Mode & Additional Info selected in MENU →DISPLAY→TC terminal.</td></tr>
<tr><td>Bar Graph</td><td>Horizontal Bar graph according to TC Percentage Value (0.00% - 100.00%). The value scales according to TC reading and Input 0% & 100% value as set in MENU →DISPLAY→TC terminal Menu.</td></tr>
<tr><td>Percentage Value</td><td>The Percentage Value in according to TC Reading.</td></tr>
</table>

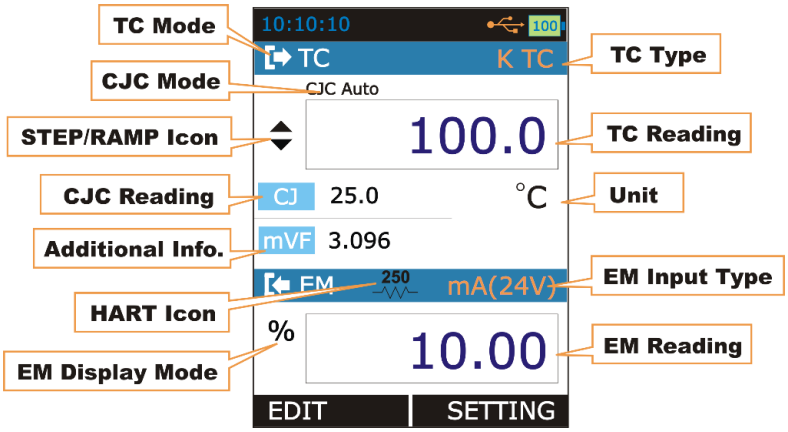
2. EM Measure Mode



<table>
<tr><th colspan="2">Measure Window</th></tr>
<tr><td>Input Type</td><td>The Input Type.
<table>
<tr><td>mA</td><td>mA Current Input</td></tr>
<tr><td>mA(24V)</td><td>mA Current (Read Power-24V) Input</td></tr>
<tr><td>V</td><td>V Voltage Input</td></tr>
</table>
</td></tr>
<tr><td>EM Display Mode</td><td>The Measure Reading Display Mode.
<table>
<tr><td>Actual</td><td>Displays the Raw Input Value without any scaling</td></tr>
<tr><td>Percentage</td><td>Displays the Percentage Value.</td></tr>
<tr><td>Scaled</td><td>Displays the Scaled Value</td></tr>
</table>
</td></tr>
</table>

Measure Reading	The Reading as per the Measure Display Mode
HART Icon	HART Enable Status Icon. This icon will appear if HART is enabled from *MENU →SETTING →HART* page. (This icon is visible for mA(24V) Input Type only. For other Input Types this will invisible regardless of HART settings)
Bar Graph	Horizontal Bar graph according to Input Percentage Value (0.00% - 100.00%).
Percentage Value	The Percentage Value in Percentage according to Input Value.
Tare	The Tare Value Set from *MENU→DISPLAY→EM Terminal-Tare* page
Actual Value	The Raw Input Value without any scaling This will appear only if **Main Display** in *MENU→DISPLAY→EM Terminal is* set to **PERCENTAGE/SCALED.**
Min	Displays the minimum value found after a measurement was started or minimum was reset.
Max	Displays the maximum value found after a measurement was started or maximum was reset.
Max-Min	Displays the Maximum-Minimum value found after a measurement was started or Maximum-Minimum was reset.
Cumulative Average	Displays the Cumulative Average value found after a measurement was started or Cumulative Average was reset.

3. TC + EM Mode



TC + EM Mode	
TC Mode **TC Type** **CJC Mode** **TC Reading** **STEP/RAMP Icon** **CJC Reading** **Additional Info.** **Unit**	Refer TC Display Mode on Page 17.
EM Input Type **EM Reading** **HART Icon**	Refer EM Display Mode on Page 18

EM Display Mode	The Measure Reading Display Mode. " " (Blank) — Displays the Raw Input Value without any scaling % — Displays the Percentage Value. S — Displays the Scaled Value

3.2.4 Display Operations

There are mainly four types of widgets available in the Device Menu Style.

i. ListBox
ii. EditBox
iii. CheckBox
iv. RadioButtonBox

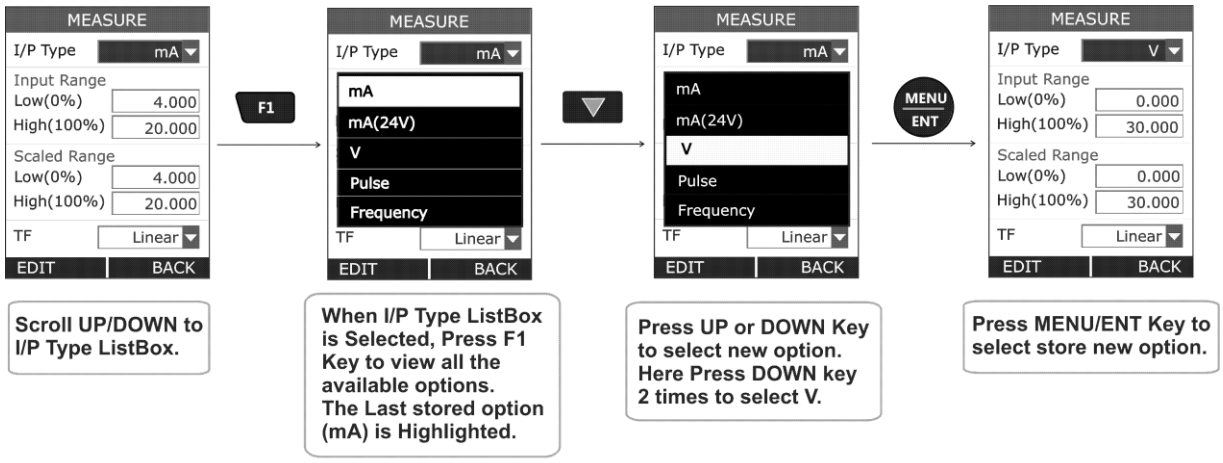
The below section will show how to change the value of different widgets.

- **ListBox**

  ListBox are used when there is a limited amount of preset values. You have to select one of the available options. The list of available options is displayed in the Centre part.

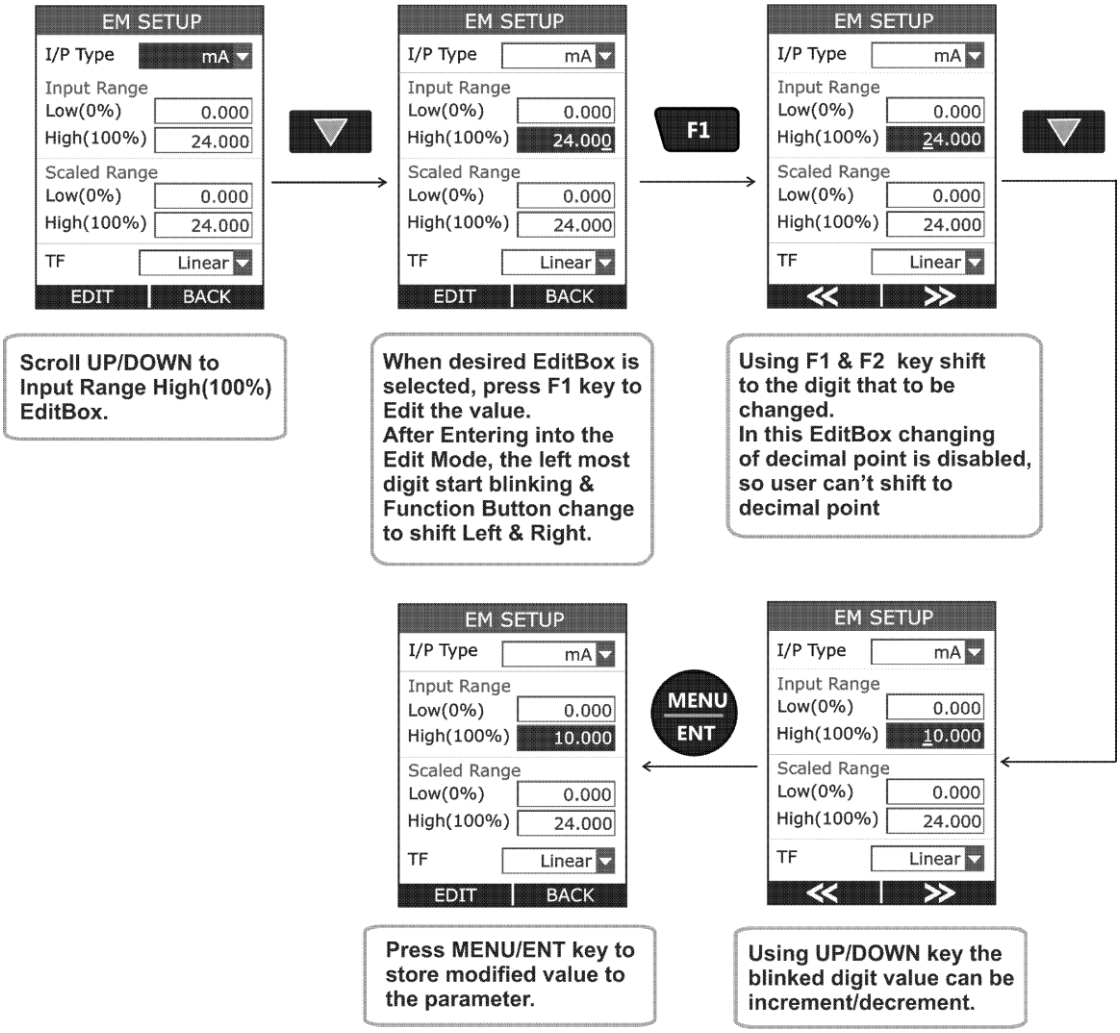
  A ListBoxList opens when you press the **F1**key. Use **UP/DOWN** key to scroll through the available options. Select one of the options with the **ENTER** key.

  Example: How to change of Input Type (I/P Type) from mA to V.
  This Option is available in *MENU→EM SETUP* Page.



- **EditBox**

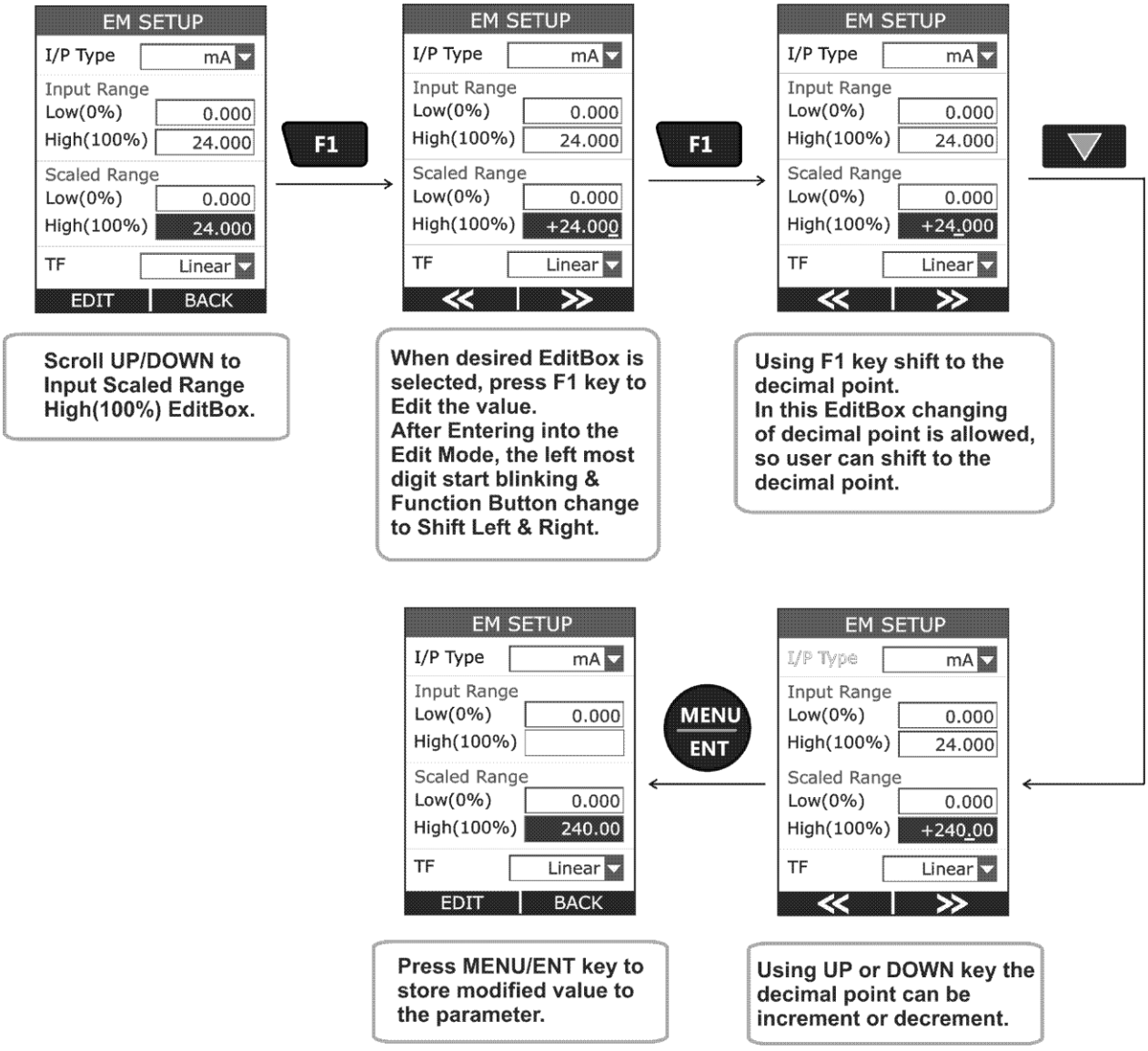
  EditBox is used where a large range of value can be possible for a parameter.
  To edit the value of an EditBox press **F1** key. After that EditBox enters into the Edit mode where **F1**&**F2** keys are works as shifter. User can shift to desired digit and using **UP** or **DOWN** key digit value can be incremented or decremented. The modified value can be saved using **MENU/ENT** key.



The above figure shows the example how to change Input High(100%)Range from 24.000 to 10.000 mA.

There are mainly 2 types of EditBox in this device. In most of the EditBox changing of decimal point & changing of sign is not allowed. But there are few EditBox, where these are allowed. Examples Scaled Low(0%) & High(100%) etc.

The below figure shown the example how to change decimal point of the Input Scaled High(100%) Range.

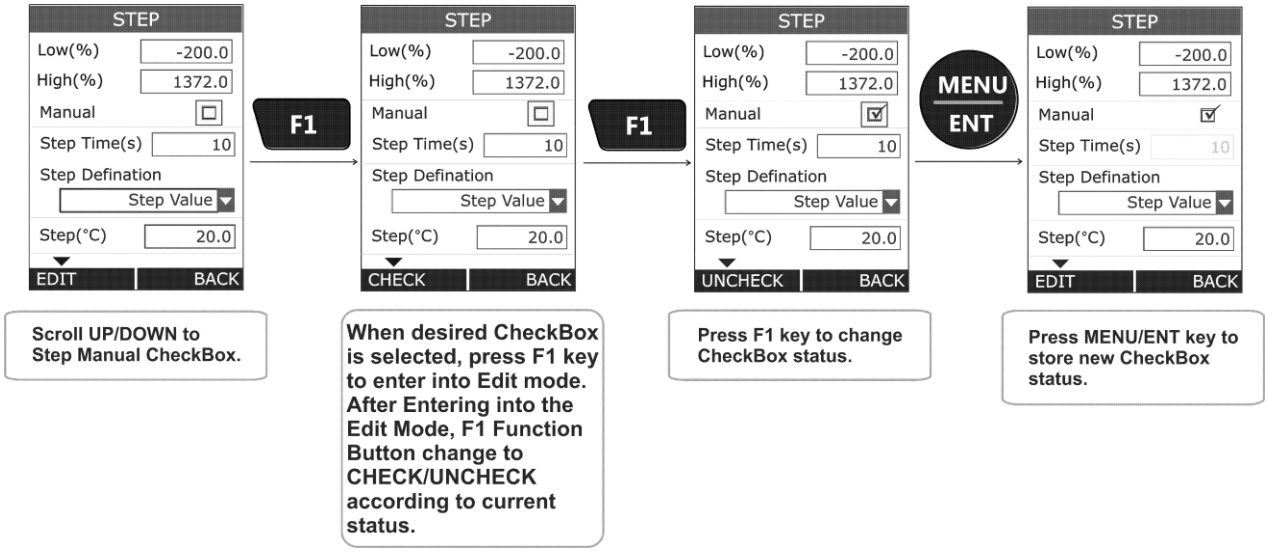


To change the sign of the value, shift to the sign digit and pressing UP or DOWN key will toggle the sign.

- **<u>CheckBox</u>**

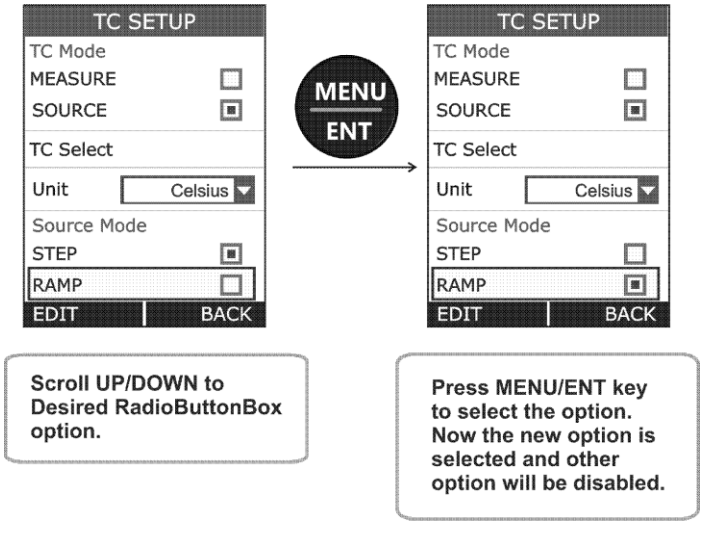
  CheckBox is used where Binary Value (1/0, True/False) is available for any parameter.

  To change the Check Box status press **F1** key. This will enter into the edit mode. In this mode status can be toggled by pressing **F1** key. Press **MENU/ENT** key to store new status.



- **<u>RadioButtonBox</u>**

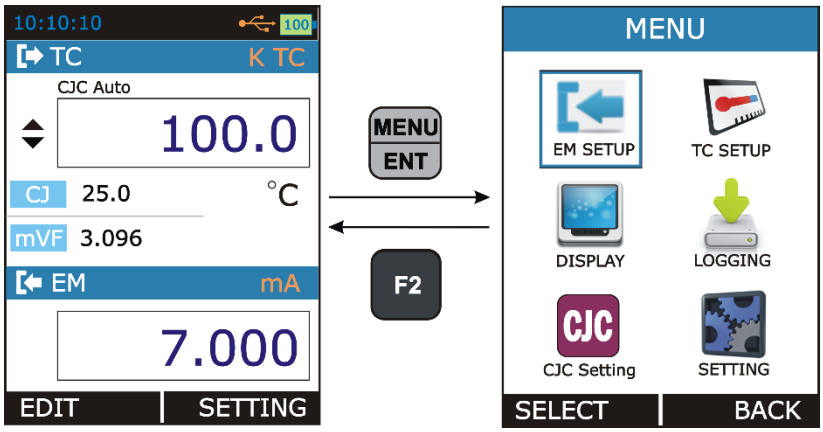
  Radio Button Box is used where very few values can be possible and all the available values need to be visible.
  In this device, two types of Radio Button Box are available. One with 1 value can be selectable & the other where 1 or 2 values can be selectable at a time.
  In Radio Button Box the other option can be selected by pressing MENU/ENT key on that option. When pressing this key the new option will be selected and the other option will be disabled.
  Below an example is given, How to change TC Source Mode from STEP to RAMP.



4. Menu Layout

4.1 MENU page

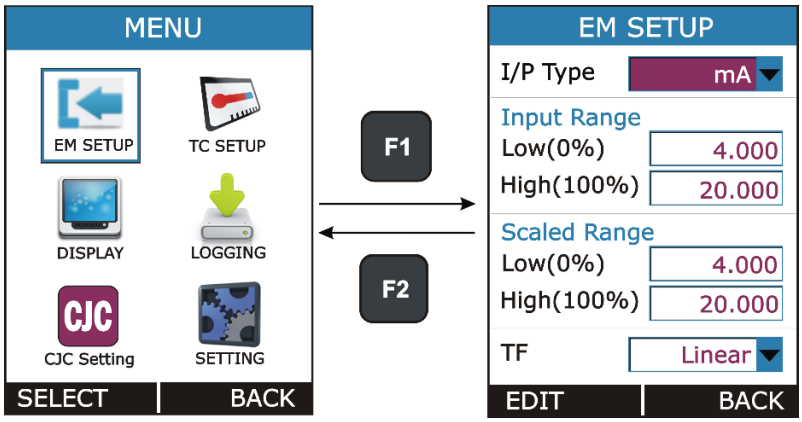
There are mainly six Menus in this device.
To enter into the MENU page press **MENU/ENT** key & press **F2** key to come out from Menu page.



EM SETUP	Contains Parameters related to EM Measure Mode like Input Type, Range etc.
TC SETUP	Contains Parameters related to Thermocouple like TC Mode, TC Type etc.
DISPLAY	Contains Parameters related to different display mode for RUN page
LOGGING	Contains Parameters related to Data Logging.
CJC Setting	Contains Parameters related to Alarm & Alarm Set-Points.
SETTINGS	Contains Parameters related to General Settings of the device like display, Date/Time, Calibration, Reset, etc.

4.2 MEASURE Page

This Page is appears in *RUN →MENU →EM SETUP.*

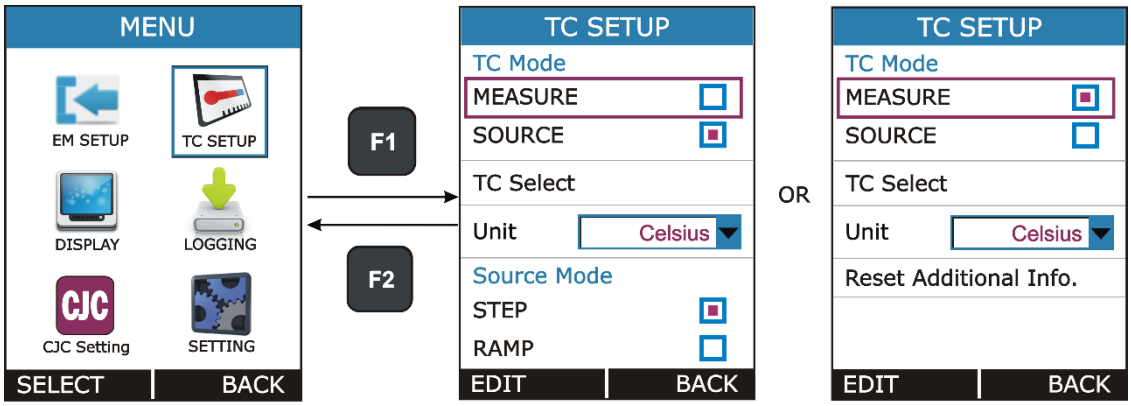


This page contains parameters related to EM Measure like Input Type, Input Range, Scaling and Transfer Function. The Description of the Parameters appear on this page is given below.

Parameter Name	Description / Options
I/P Type (Input Type)	Measure Input Type Available Options: mA : 0.000 to 24.000 mA DC mA(24V) : 0.000 to 24.000 mA DC V : 0.000 to 30.000 V DC
Input Range **Low (0%)**	Low Range for Measure Input. Range: Default Input Low to **Input Range High(100%)** This parameter is enabled, if **Main Display** in *MENU →DISPLAY →EM SETUP* is set to **Percentage**or **Scaled.**
Input Range **High (100%)**	High Range for Measure Input. Range: **Input Range Low(0%)**to Default Input High This parameter is enabled, if **Main Display** in *MENU →DISPLAY →EM SETUP* is set to **Percentage**or **Scaled.**
Scaled Input Range **Low(0%)**	Scaling Low Range for Measure Input. Range: -99999 to **Scaled Input Range High(100%)** Decimal Point for this Edit Box can be changeable. This parameter is enabled, if **Main Display** in *MENU →DISPLAY →EM SETUP* is set to **Scaled.**
Scaled Input Range **High(100%)**	Scaling High Range for Measure Input. Range: **Scaled Input Range Low(0%)**to 99999 Decimal Point for this EditBox can be changeable. This parameter is enabled, if **Main Display** in *MENU →DISPLAY →EM SETUP* is set to **Scaled.**
TF (Transfer Function)	Transfer Function for Scaling Available Options: Linear x^2 (x^2) x^(1/2) (√x) This parameter is enabled, if **Main Display** in *MENU →DISPLAY →EM SETUP* is set to **Scaled.**

4.2 SOURCE Page

This Page is appears in *RUN →MENU →TC SETUP.*



TC SOURCE Page TC MEASURE Page

This page contains parameters related to Thermocouple like TC Mode Type, TC Type, Unit, TC Source Mode etc. The Description of the Parameters appear on this page is given below.

Parameter Name	Description / Options
TC Mode	Thermocouple Mode Available Options: MEASURE SOURCE
TC Select	Select the Thermocouple/mV Type for Measurement / Simulation Available Options:

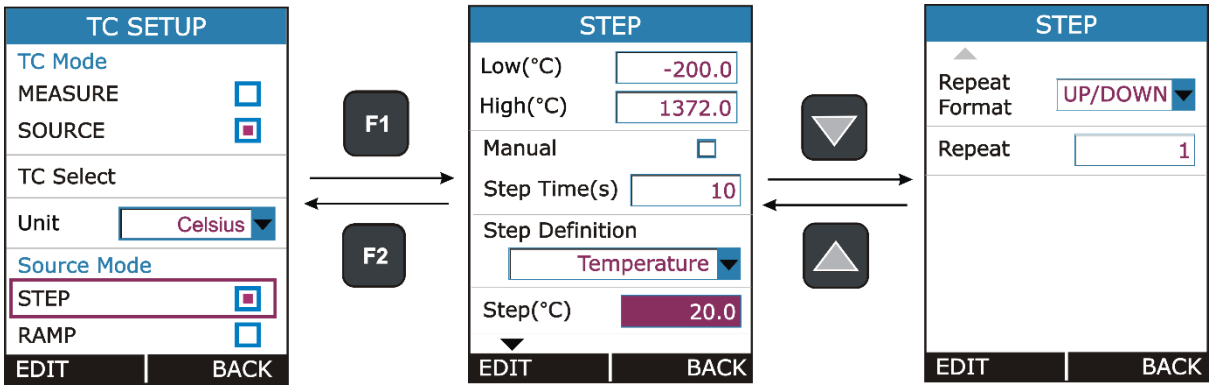
TC Type	Range	Resolution
E TC	-200.0 to 1000.0 °C	0.1 °C
J TC	-200.0 to 1200.0 °C	
K TC	-200.0 to 1372.0 °C	
T TC	-200.0 to 400.0 °C	
B TC	450.0 to 1800.0 °C	
R TC	0.0 to 1750.0 °C	
S TC	0.0 to 1750.0 °C	
N TC	-200.0 to 1300.0 °C	
-10 to 80 mV	-10.000 to 80.000 mV	0.001 mV
-10 to 250 mV	-10.00 to 250.00 mV	0.01 mV

Refer section 6 on page 47 for more details on TC type and its available range.

TC Unit **Unit**	Measure/Source Reading Unit Available Options: Celsius Fahrenheit Kelvin
Source Mode	TC Source Output Format

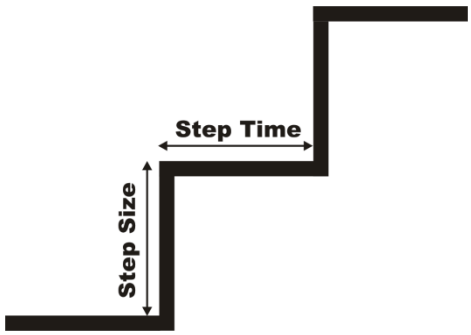
	This option appear only if TC Mode is *SOURCE*. Available Options: STEP RAMP At a time one can be selectable. Press F1 key on the one of the option for more settings.
Reset Additional Info.	Reset the Additional Information of Measure mode like Minimum & Maximum This option appear only if TC Mode is *MEASURE*.

4.2.1 STEP Page



Parameter Name	Description / Options
Low	Starting Value of Step. Enter value according to TC Display Mode. If display mode is actual enter value in temperature/mV and if display mode is % enter value in %.
High	Ending Value of Step. Enter value according to TC Display Mode. If display mode is actual enter value in temperature/mV and if display mode is % enter value in %.
Manual (Output Type)	Step Manual Mode Selection CheckBox. Ticking this checkbox will enable Step Manual Mode. And Un-ticking will enable Auto Step Mode.
Step Time (s)	Enter the time for a single step in seconds, Range: 1 to 9999 This parameter is enabled only for Auto Step Mode (Manual CheckBox is Un-Checked)
Step Definition	Step Definition for the Step function. Available Options: Temperature (Appear only if TC Display mode is Actual) Percentage (Appear only if TC Display mode is Percentage) User Defined

Step	Step Value in Temperature/mV/% according to TC Display Mode and TC unit. Only appear if Step Definition is Temperature or Percentage.
Define Steps	User Defined Step value for Manual and Auto Step Mode. This option appear only if Step Definition is User Defined. Maximum 10 step value can be configured. First enter the no of step and then define step value in serial order.
Repeat Format	How the stepping should be done. <u>Available Options:</u> UP DOWN UP/DOWN DOWN/UP This parameter is enabled only for Auto Step Mode (Manual CheckBox is Un-Checked)
Repeat Repeat Counts	Defines how many times the steps are repeated <u>Range:</u> 1 to 9999 This parameter is enabled only for Auto Step Mode (Manual CheckBox is Un-Checked)



- **<u>Manual Stepping</u>**

  To Enable Manual Stepping, select Source Type as STEP & Check the Manual CheckBox.

  If this mode is enabled, ▲▼ icon will appear in Source Display Window in RUN Page.

  Pressing UP or DOWN key in RUN Page will Increment or Decrement Source Value by Step specified in STEP Page.

  In RUN Page, Source Value can directly change by Pressing **F1** key (EDIT) and modifying value like in EditBox. And STEP Setting can be accessed directly by **F2** key (SETTING).

Auto Stepping

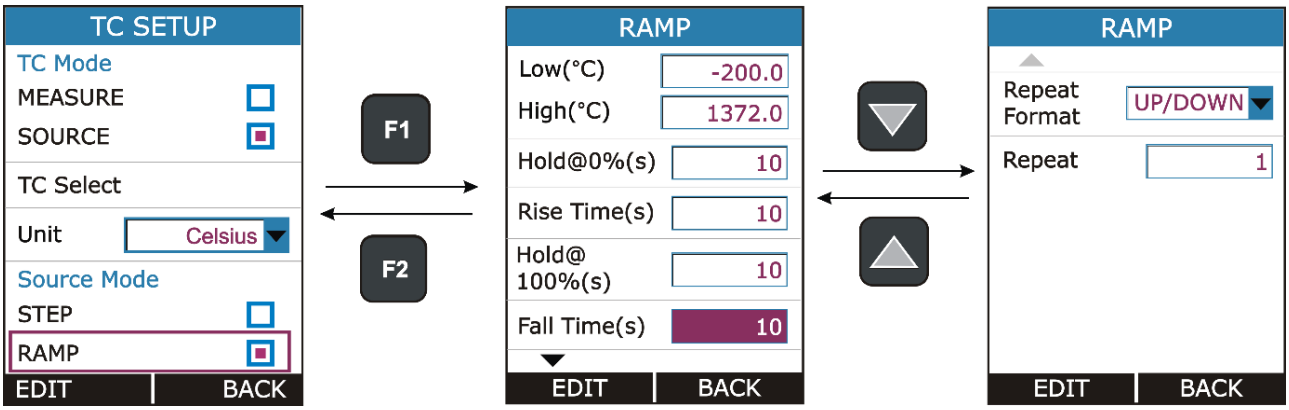
To Enable Auto Stepping, select Source Type as STEP & Un-Check the Manual Check Box.
If this mode is enabled, (Step UP) or (Step Down) icon will appear in Source Display Window in RUN Page and F1 & F2 Button change to **START**&**SETTING** respectively.

Automated Step can be started by Pressing **F1** key (START). After that F1 & F2 key will change to **PAUSE**&**STOP** respectively. So by pressing F1 & F2 key running STEP can be PAUSE or STOP at any time in RUN Page.

STEP Setting can be accessed directly by **F2** key (SETTING).

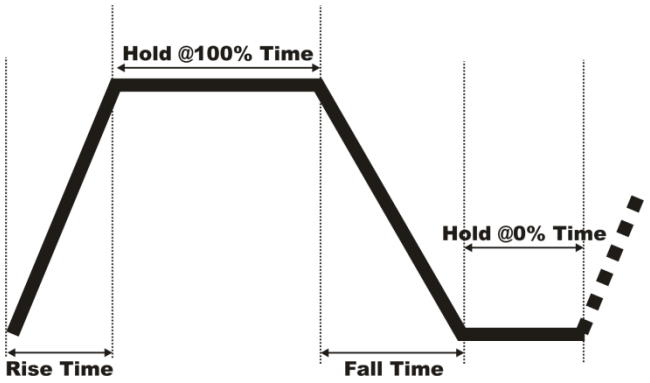
NOTE: While STEP is running STEP settings can't be accessible and Source Page Parameter settings can't be change.Stop STEP before changing any settings.

4.2.2 RAMP Page



Parameter Name	Description / Options
Low	Starting Value of Ramp. Enter value according to TC Display Mode. If display mode is actual enter value in temperature/mV and if display mode is % enter value in %.
High	Ending Value of Ramp. Enter value according to TC Display Mode. If display mode is actual enter value in temperature/mV and if display mode is % enter value in %.
Hold@0%(s)	Time to wait at Low(0%) level in second. This parameter is use for **Repeat Format UP/DOWN** or **DOWN/UP**.

	Range: 0 to 9999
Rise Time (s)	Time to Increase from Low to High Level. Range: 1 to 9999
Hold@100%(s)	Time to wait at High(100%) level in second. This parameter is use for **Repeat Format UP/DOWN** or **DOWN/UP**. Range: 0 to 9999
Fall Time (s)	Time to decrease from High to Low Level. Range: 1 to 9999
Repeat Format	How the Ramp should be done. Available Options: UP DOWN UP/DOWN DOWN/UP
Repeat Repeat Counts	Defines how many times the steps are repeated Range: 1 to 9999



- **Starting the RAMP**

  To Enable Ramp, select Source Type as RAMP.

  If this mode is enabled, ⎍ (Rising Ramp) or ⎏ (Falling Ramp) or ⎍⎏ (Ramp Hold @ 100%) or ⎏⎍ (Ramp Hold @ 0%) icon will appear in Source Display Window according to current RAMP mode in RUN Page and F1 & F2 Button change to **START**&**SETTING** respectively.

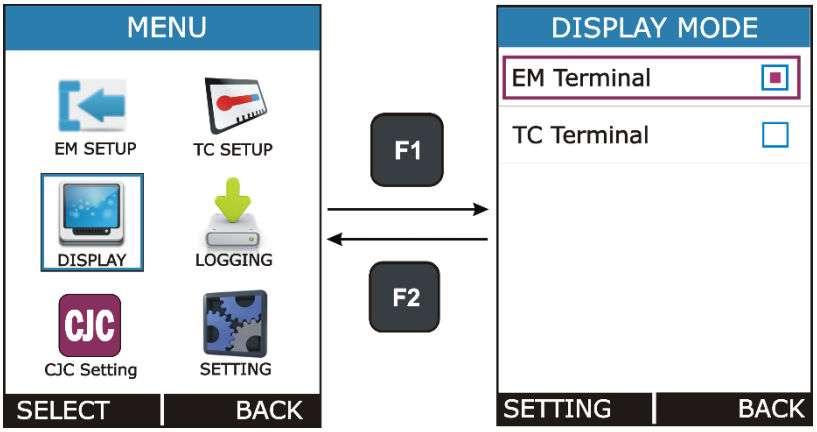
  RAMP can be started by Pressing **F1** key (START). After that F1 & F2 key will change to **PAUSE**&**STOP**respectively. So by pressing

F1 & F2 key running RAMP can be PAUSE or STOP at any time in RUN Page.

NOTE: While RAMP is running RAMP settings can't be accessible and Source Page Parameter settings can't be change. Stop RAMP before changing any settings.

4.3 DISPLAY Page

This Page is appears in *RUN →MENU →DISPLAY.*



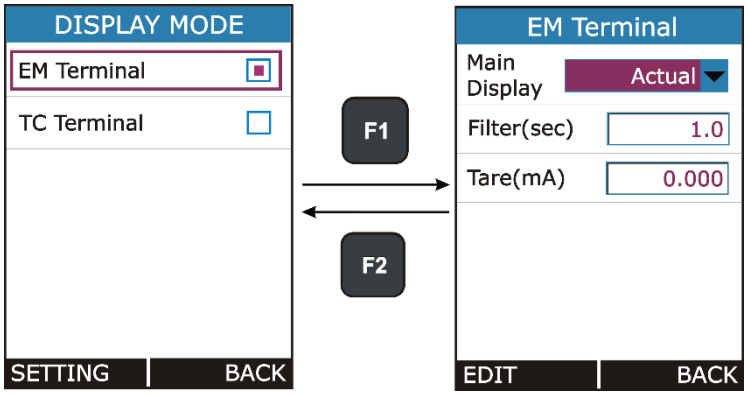
There is mainly Four RUN Display Mode possible in this device. And this mode can be selected from the above Page. What information to be shown in each RUN Display Mode can be defined by this page.

In this page there is one RadioButtonBox. At a time one or two option can be selected. The possible combinations are given below.

1	EM(Electrical Measurement) Only
2	TC(Thermocouple) Only
3	EM + TC

4.3.1 EM Display Settings

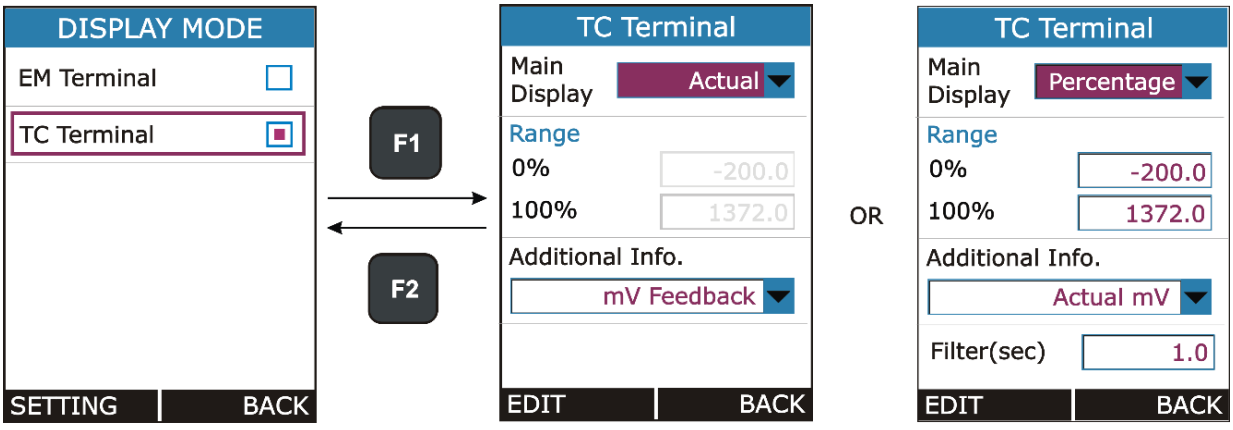
This Page is appears in *RUN →MENU →DISPLAY →EM Terminal.*



Parameter Name	Description / Options
Main Display	Select which Reading to be display as a Main Reading (Reading Displays in Box in RUN Page). Available Options: Actual — Display the Actual Input Value Percentage — Display the Percentage Value of the Input. The Value depends on Input Range. These settings are available from *MENU →EM SETUP.* Scaled — Display the Scaled Value of the Input. The Scale Value depends on Input Range, Input Scaled Range & Transfer Function. These settings are available from *MENU →EM SETUP.*
Filter(sec)	1st Order IIR Low Pass Filter for Input Reading. Filter is useful when a measurement signal contains unwanted noise. Range: 0.0 to 60.0 sec
Tare(unit)	The Tare value is subtracted from the reading of the measured value. Here unit is changed according to current Input Type and Measure Display Mode. Range: In accordance with Input Range & Measure Display Mode. **Note: Beware of the problems that may result in not seeing the true measurement value**.

4.3.2TC Display Settings

This Page is appears in *RUN →MENU →DISPLAY →TC Terminal.*



TC SOURCE Mode

TC MEASURE Mode

Parameter Name	Description / Options
Main Display	Select which Reading to be display as a Main Reading (Reading Displays in Box in RUN Page). Available Options:

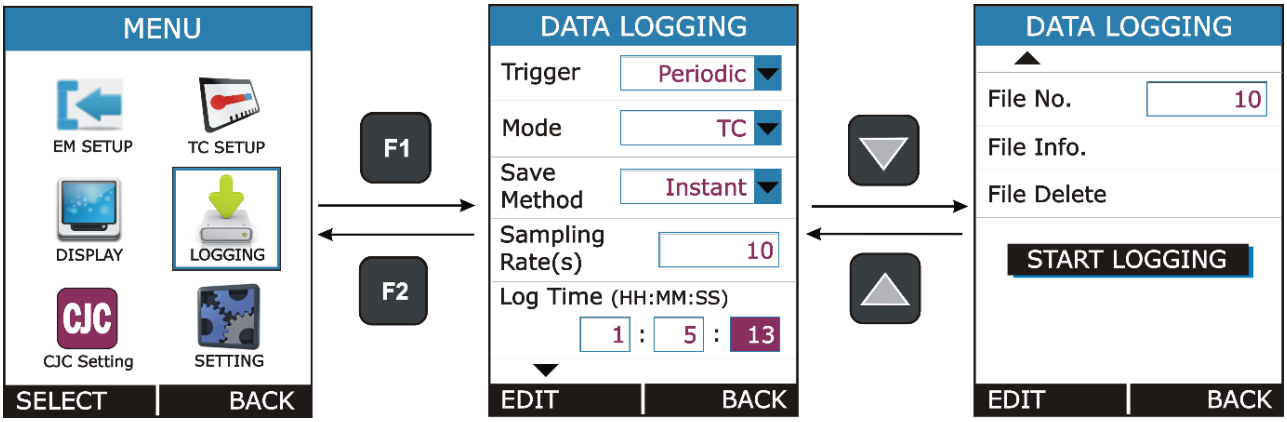
<table>
<tr><td></td><td>
<table>
<tr><td>Actual</td><td>Display the Actual Thermocouple/mV Value</td></tr>
<tr><td>Percentage</td><td>Display the Percentage Value of Thermocouple/mV according to value set in 0% & 100%.</td></tr>
</table>
</td></tr>
<tr><td>0%</td><td>Low Value in Temperature/mV for (0-100%) scaling.</td></tr>
<tr><td>100%</td><td>High Value in Temperature/mV for (0-100%) scaling.</td></tr>
<tr><td>Additional Info.1</td><td>Choose which information to be shown as TC Mode Additional Information on RUN Page.
<u>Available Options for TC Measure Mode:</u>
<table>
<tr><th>Options</th><th>Icon</th><th>Description</th></tr>
<tr><td>None</td><td>-</td><td>No info is visible.</td></tr>
<tr><td>Actual Value</td><td>AV</td><td>Shows the Actual Thermocouple Temperature/mV value without any scaling. This option is available only if TC Display Mode is Percentage.</td></tr>
<tr><td>mV</td><td>mV</td><td>Shows the Thermovoltagewhich is measured through TC terminals.</td></tr>
<tr><td>mV w/o CJC</td><td>mV₀</td><td>Shows the Thermovoltageaccording to TC Temperature with adding CJ Temperature mV.</td></tr>
<tr><td>Maximum</td><td>⤒</td><td>Shows the Maximum measured reading from the time when info last reset.</td></tr>
<tr><td>Minimum</td><td>⤓</td><td>Shows the Minimum measured reading from the time when info last reset.</td></tr>
<tr><td>Min & Max</td><td>-</td><td>Shows the Minimum (in place of mV_0) and Maximum value both together. This option available only for only TC Display mode.</td></tr>
</table>
<u>Available Options for TC Source Mode:</u>
<table>
<tr><th>Options</th><th>Icon</th><th>Description</th></tr>
<tr><td>None</td><td>-</td><td>No info is visible.</td></tr>
<tr><td>Actual Value</td><td>AV</td><td>Shows the Actual Thermocouple Temperature/mV value without any scaling. This option is available only if TC Display Mode is Percentage.</td></tr>
<tr><td>mV</td><td>mV</td><td>Shows the Thermovoltageaccording to Temperature including CJ temperature mV. The mV which is sourced through TC Terminal.</td></tr>
<tr><td>Reading Feedback</td><td>RF</td><td>Shows the Feedback Temperature/mV Reading.
When TC-12 generate mV, it uses its own measurement function to control the generated value. This feedback measurement is shows if this option is selected.</td></tr>
<tr><td>%Error</td><td>%E</td><td>Shows the error in % between the Desired Source Value and Feedback value.</td></tr>
<tr><td>mV Feedback</td><td>mVF</td><td>Shows the Feedback mV Reading.</td></tr>
<tr><td>mV w/o CJC</td><td>mV₀</td><td>Shows the Thermovoltage according to Temperature (for CJ Temperature = 0 °C)</td></tr>
</table>
</td></tr>
</table>

Filter(sec)	1st Order IIR Low Pass Filter for TC Measure Reading. This option is available only for TC mode is Measure. Filter is useful when a measurement signal contains unwanted noise. Range: 0.0 to 60.0 sec

4.4 DATA LOGGING Page

This section gives examples of how to log Readings with time and date over a set time period or on a key press. Logged data is stored in a user defined file in internal memory.

This Page is appears in *RUN →MENU →LOGGING.*



Parameter Name	Description / Options
Trigger	Data Logging Trigger ModeSelection. Available Options: Key Press — Log Data on pressing LOG from RUN key Page. Periodic — Log Data periodically at every Sampling Rate for total time specified by Logging Time.
Mode	Data Mode Selection for Logging Available Options: EM — Log only EM Measure Readings. TC — Log only TC Terminal Readings. EM+TC — Log EM Measure andTC Terminal both Readings. This parameter is enabled only for Periodic Trigger.
Save Method	Reading Type selection for Logging Available Options: Instant Min Max Average All

	This parameter is enabled only for Periodic Trigger.
Sampling Rate(s)	Sampling Rate for Periodic Data Logging in seconds. Range: 1 to 9999 This parameter is enabled only for Periodic Trigger.
Logging Time (HH:MM:SS)	Total Logging Time in HH:MM:SS Format for Periodic Logging. This parameter is enabled only for Periodic Trigger.
File No.	File Number. Range: 1 to 25 This parameter is enabled only for Periodic Trigger.
File Info.	Shows the information of stored files. This information contains Logging Start Time & Date and No of Samples stored in the file.
File Delete	Delete stored file.
START LOGGING	Press F1 key while selecting this button to start the Logging.

NOTES:

- Maximum No of Reading that can be stored in,

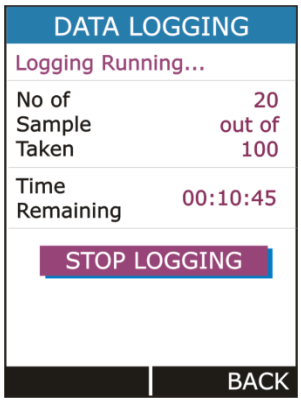
Logging Mode	Max. Reading
Periodic	150000
Key Press	484

- In Periodic mode, changing of any Measure or Source parameter is not allowed. So While Periodic Logging is Running, User can't enter into *MEASURE*, *SOURCE* and *DISPLAY* menu. But in Key Press Logging mode, there is no restriction.

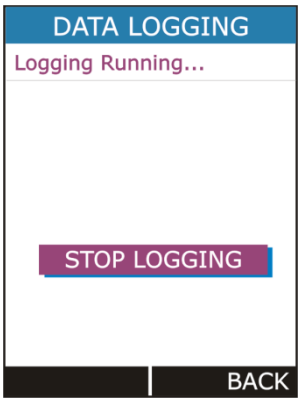
- In Periodic Mode, if error message like "*Not Sufficient Memory*" comes while starting the Logging. Try to Reduce Logging Time or Increase Sampling Period or try deleting some existing files.

- In Key Press Mode, If No of Samples reach its maximum limit that is 484, the next sample will start from the first overwriting the memory.
- While Logging is running, entering into the *LOGGING* menu shows below page.

for Periodic Mode



for Key Press Mode



For Periodic Mode, this page contains information of Number of Samples Taken and

Time Remaining for Logging in HH:MM:SS.

- Both Periodic and Key Press logging can be stop manually by pressing F1 key on STOP LOGGING Button. For Periodic Mode, Logging will automatically stopped when defined log time ends and a message "*LOGGING DONE*" pop ups.

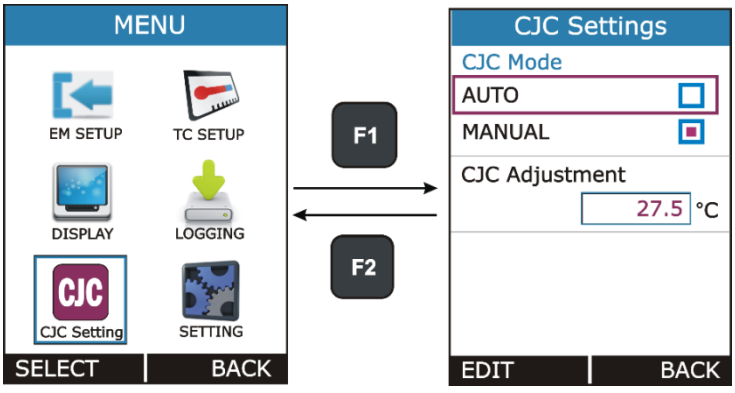
Transferring the Results to a Personal Computer:

A 32-bit Windows® software called **mCAL+.exe**is shipped together with TC-12 if you bought the Data Logging option. Start this software just as any other Windows® software.

All communication between the PC and TC-12 is initiated from**mCAL+.exe**.
More information of the software in mL12lm201_00.pdf document available in software CD.

4.5 CJC Setting Page

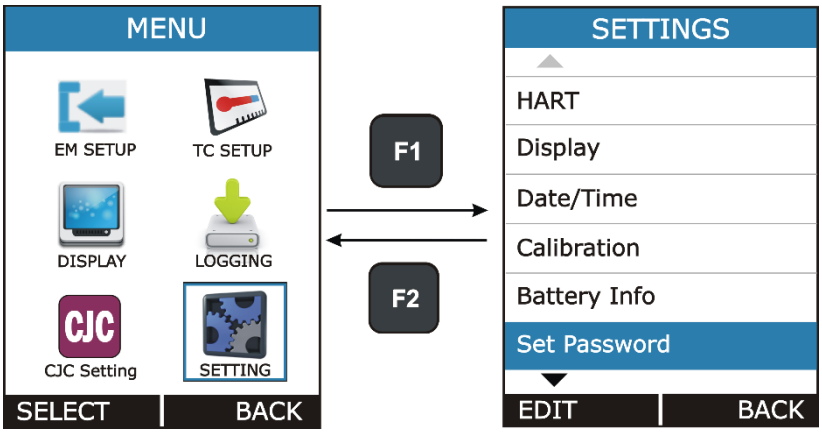
This Page is appears in *RUN →MENU →CJC Settings.*



<table>
<tr><th>Parameter Name</th><th>Description / Options</th></tr>
<tr><td>CJC Mode</td><td>CJ (Cold Junction) Temperature Mode
<u>Available Options:</u><table><tr><td>AUTO</td><td>CJ Temperature is TC Terminal’s temperature.</td></tr><tr><td>MANUAL</td><td>CJ Temperature is user selectable irrespective of TC Terminal temperature.</td></tr></table></td></tr>
<tr><td>CJC Adjustment</td><td>CJ Temperature adjustment for Manual CJC Temperature.</td></tr>
</table>

4.6 SETTING Page

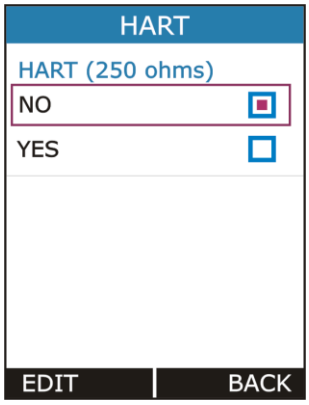
This Page is appears in *RUN →MENU →SETTING.*



All the available Settings Options are given below.

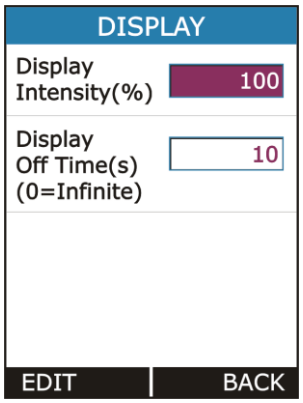
i. HART
ii. Display
iii. Date/Time
iv. Calibration
v. Battery Info.
vi. Set Password
vii. Factory Reset
viii. About Us

Press F1 key to Enter into the settings of any option.
Description of all settings given below.



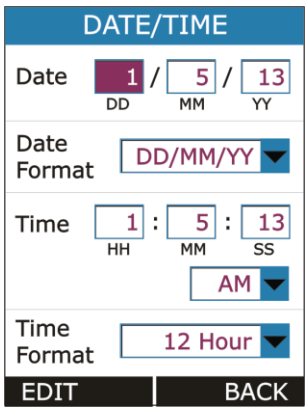
4.6.1 HART Settings

Select YES to add a Series resistor (250Ω) into the mA circuit.
You can then use this instrument together with a HART® communicator to set up and calibrate HART® devices.
This option is applicable for mA(24V) Read Power Input Type Only.



4.6.2 Display Settings

Display Intensity	Display Brightness Settings. Range: 5 to 100
Display Off Time	Standby Time in second after which display will turn Off. To turn the display off press any key. Range: 0 to 9999 sec Setting 0 will disable this feature. That means display will never turn off automatically.



4.6.3 Date/Time Settings

To set the Time + Date of the device.

There are 2 Date Format supported in this device **DD/MM/YY**&**MM/DD/YY**. This is useful only in Data Logging, to decide in which format Date to be stored.

There are 2 Time format supported in this device **24 Hour**&**12 Hour**. This is to select in which format the time should be displayed on Run page & time to be stored in Data Logging.

AM/PM selection is enabled only for 12 Hour Time Format.

4.6.4 Calibration

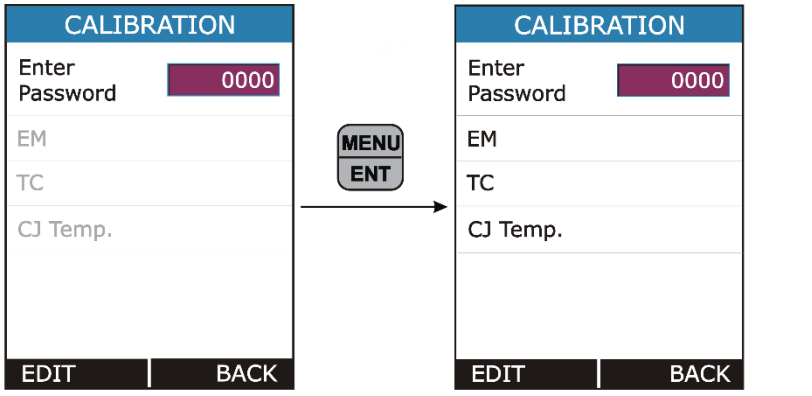
The instrument is factory calibrated for the specified range, but due to long term drift of components, re-calibration may be necessary in some cases. For calibrating the instrument a reliable source & reliable measurement device is required. This source should be at least ten times accurate compared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

Note: Masibus can provide a calibration service that is traceable to international standards.

We recommend that you return the instrument to the manufacturer or an approved service agent forcalibration.If you use an alternative calibration facility, make sure thatit uses these standards.

The unit can be calibrated without opening it and without trim pots. To enter in calibration mode follow the steps below.

First press the MENU/ENT key in RUN mode to enter in Menu page. In Menu page select the Settings option and press F1 key to enter into the Setting mode. In setting mode select the Calibration option and press F1 key to enter into the calibration mode.



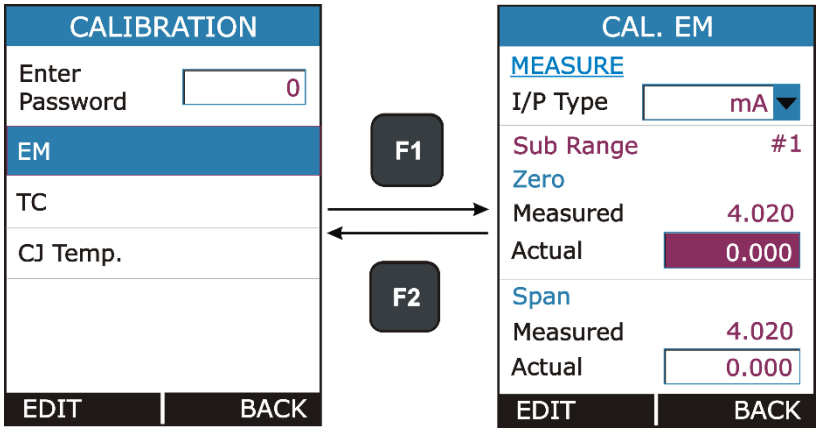
Press F1 Key to Enter Into the Password Edit Mode. Press UP or DOWN key to change to the Right Password value.

Press Enter key to verify the Password. If the password is correct Measure & Source calibration options will be enabled.

To calibrate the instrument first enter the correct password. If the entered password is correct Measure & Source Calibration option will be enabled.

- **<u>Procedure for calibration of EM Measure Mode</u>**

  First select the Input Type which to be calibrated.



For Better Calibration Input Range is divided into two sub ranges. So For each input type, Calibration of both sub ranges need to done. The Sub Ranges of each input type is given in the below table.

Input Type	Sub Ranges	Recommended Calibration Points
mA (0.000 to 24.000 mA)	1. 0.000 to 12.000 mA	ZERO: 1.000 mA SPAN: 11.000 mA
	2. 12.000 to 24.000 mA	ZERO: 13.000 mA SPAN: 23.000 mA
mA(24V) (0.000 to 24.000 mA)	1. 0.000 to 12.000 mA	ZERO: 1.000 mA SPAN: 11.000 mA
	2. 12.000 to 24.000 mA	ZERO: 13.000 mA SPAN: 23.000 mA
V (0.000 to 30.000 V)	1. 0.000 to 15.000 V	ZERO: 1.000 V SPAN: 14.000 V
	2. 15.000 to 30.000 V	ZERO: 16.000V SPAN: 29.000V

Note: It is not compulsory to calibrate at recommended points. User can calibrate at any points within specified Sub Range. The Sub Range is shown on the screen. But make sure to calibrate Zero & Span in the same sub range.

Example: - Calibrating mA Input

To calibrate **ZERO for Sub Range #1,**

- Apply mA Input value near to Recommended Zero Value for Sub Range 1 (for mA sub range 1 it is 1.000mA) from reliable source device.
- For example, If apply 1.000mA from the external source. **Measured** value shows the value that has been measured by the TC-12. If this value is 1.020 enter 1.000 value in **ZERO Actual Value** Edit Box & Press **MENU/ENT** key to calibrate the ZERO.

Similarly, for **SPAN for Sub Range #1** calibration,

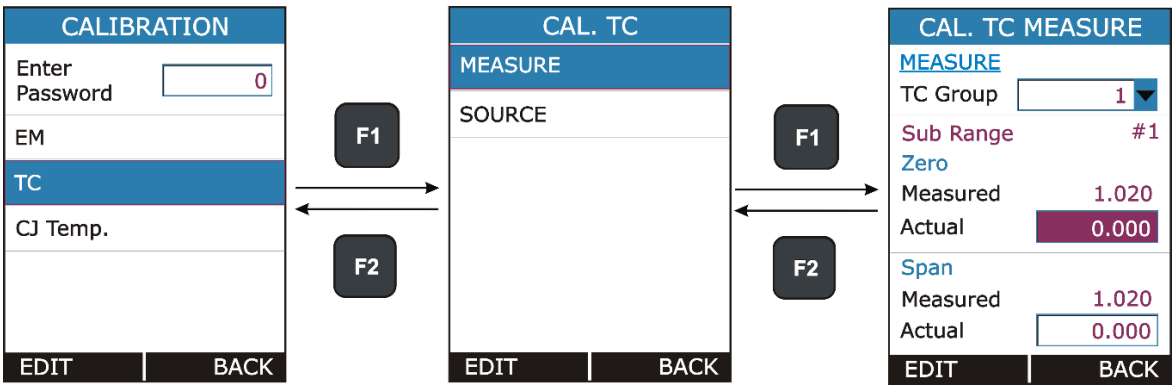
- Apply mA Input value near to Recommended Span Value for Sub Range 1 (for mA sub range 1 it is 11.000mA) from reliable source device.
- For example, If apply 11.000mA from the external source. If the **Measured** value shows 10.995 enter 11.000 value in **SPAN Actual Value** Edit Box & Press **MENU/ENT** key to calibrate the SPAN.

- Follow the same procedure to calibrate for the Sub Range 2.
- The same procedure is applicable for other Input Type.
- To calibrate input use other source in series or parallel to device according to the input type which is ten times accurate compared to the range of the instrument.

Note: Calibration of mA Input will also calibrate mA(24V) input. No need to separately
calibrate mA(24V) Input.

- **Procedure for calibration of TC Measure**

To enter into the TC Measure Calibration, Select the **TC** option in Calibration page and MEASURE option in CAL. TC page.



All Thermocouple and mV input are divided into 5 groups.
For Better Calibration Accuracy group 1 & 5 are divided into two sub ranges. So for those groups, Calibration of both sub ranges need to done. The Sub Ranges of each input type is given in the below table.

TC MEASURE Group		Sub Range	Recommended Zero	Recommended Span
1	E-TC, J-TC, -10 to 80 mV	1	-5.000 mV	35.000 mV
		2	45.000 mV	75.000 mV
2	K-TC, N-TC	1	0.000 mV	50.000 mV
3	T-TC, R-TC, S-TC	1	0.000 mV	15.000 mV
4	B-TC	1	2.000 mV	10.000 mV
5	-10 to 250 mV	1	0.00 mV	110 mV
		2	140.00 mV	235.00 mV

Note: It is not compulsory to calibrate at recommended points. User can calibrate at any points within specified Sub Range. The Sub Range is shown on the screen. But make sure to calibrate Zero & Span in the same sub range.

Example: - Calibrating Group-1

Select Group 1 in TC Group ListBox.

To calibrate **ZERO for Sub Range #1,**

- Apply mV Input value near to Recommended Zero Value for Sub Range 1 (for Group 1 sub range 1 it is -5.000mV) from reliable source device.
- For example, If apply -5.000mV from the external source. **Measured** value shows the value that has been measured by the TC-12. If this value is -5.020 enter -5.000 value in **ZERO Actual Value** Edit Box & Press **MENU/ENT** key to calibrate the ZERO.

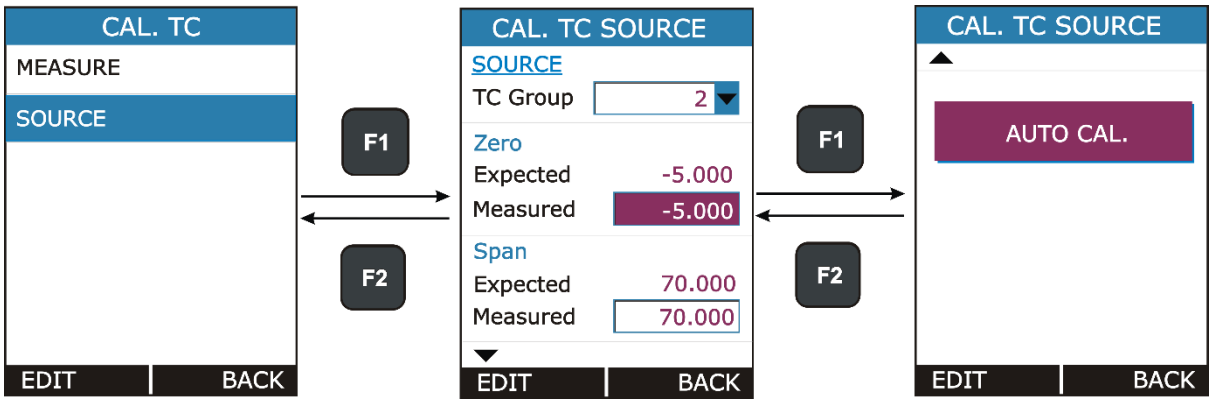
Similarly, for **SPAN for Sub Range #1** calibration,

- Apply mV Input value near to Recommended Span Value for Sub Range 1 (for Group 1 sub range 1 it is 35.000mV) from reliable source device.
- For example, If apply 35.000mV from the external source. If the **Measured** value shows 34.995 enter 35.000 value in **SPAN Actual Value** Edit Box & Press **MENU/ENT** key to calibrate the SPAN.

- Follow the same procedure to calibrate for the Sub Range 2.
- The same procedure is applicable for other TC Measure Group.
- To calibrate input use other source according to the input type which is ten times accurate compared to the range of the instrument.

- **Procedure for calibration of TC Source**

To enter into the TC Source Calibration, Select the **TC** option in Calibration page and SOURCE option in CAL. TC page.



All Thermocouple and mV Source are divided into 2 groups.

TC SOURCE Group		Zero	Span
1	-10 to 250 mV	0.00 mV	230.00 mV
2	-10 to 80 mV and all TC types	-5.000 mV	70.000 mV

Example: - Calibrating Group-2

To calibrate **ZERO,**

- Select **ZERO Measured** Edit Box, when this Edit Box is selected TC-12 will source value that is seen in **ZERO Expected** Value (here TC-12 will source -5.000mV).
- Now Measure the source value in Reliable Measure Unit. For Example the external measure unit is measuring -4.998mV. Then enter -4.998 value in **ZERO Measured** Edit Box & Press **MENU/ENT** key to calibrate the ZERO.

To calibrate **SPAN,**

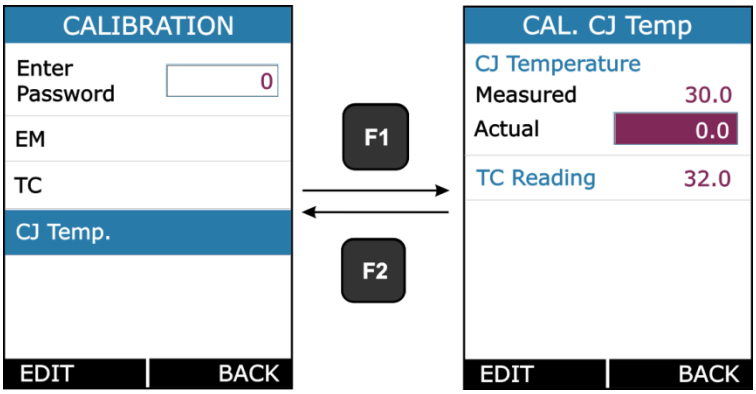
- Select **SPAN Measured** Edit Box, when this Edit Box is selected TC-12 will source value that is seen in **SPAN Expected** Value (here TC-12 will source 70.000mV).
- Now Measure the source value in Reliable Measure Unit. For Example the external measure unit is measuring70.010mV. Then enter 70.010value in **SPAN Measured** Edit Box & Press **MENU/ENT** key to calibrate the SPAN.

- Follow the same procedure to calibrate the other TC Source Group.

Example: - Auto Calibration for TC Source

- For Fast calibration of TC Source Auto Calibration option is available.
- Auto Calibration can be started by pressing "***AUTO CAL.***" Button. This procedure will do calibration of Zero followed by the calibration of span automatically for 5 no of times.
- Auto Calibration is done for the selected group only.
- **Please note that in Auto Calibration is taken place with reference with reference of Feedback ADC reading not the external measurement device. So it may happen that feedback ADC reading may be differing from the actual source value. For successful auto calibration please make sure TC Measure calibration is completed for all the group. And also check the calibration with respect to external measurement device after Auto Calibration.**

- **Procedure for calibration of CJ Temperature**
  - To enter into the CJ Temperature Calibration, Select the **CJ Temp.** option in Calibration page.

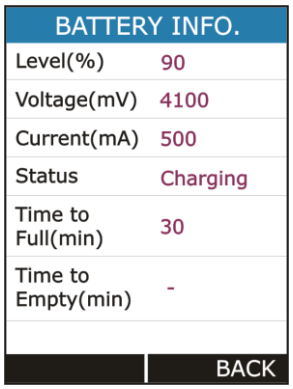


Example: - Calibrating CJ Temperature

CJ measured value shows the current measured temperature of the TC Terminals in the Display Unit selected in TC Setup Page. For example if it shows 30.0 °C and the real temperature of the TC terminal is 30.5 °C then enter 30.5 in Actual Editbox to calibrate CJ Temperature.

Note:

- Usually, TC-12 calibrates using the above steps in one/two time only. But if the Input / Output are very out from the desired value repeat the Calibration steps until the device calibrated properly.



4.6.5 Battery Info.

This page shows the basic battery Information.

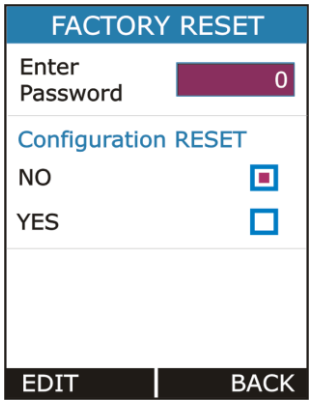
- Battery Level (Percentage)
- Battery Voltage (in mV)
- Current (in mA)
- Battery Status
- Time to Full (in min)
- Time to Empty (in min)

4.6.6 Set Password

Change Device Password.

This password has to be entered before Calibrating & Resetting Configuration Parameters.

To change password Enter Current Password. If the entered password is correct then New Password EditBox will be enabled. Then enter the New Password and press **MENU/ENT** key to store it.



4.6.7 Factory Reset

To Reset TC-12 Parameters to its Default Value.

To Reset Enter Current Password. If the entered password is correct then New Password EditBox will be enabled. Then enter the New Password and press **MENU/ENT** key to store it.

4.6.8 About Calibrator

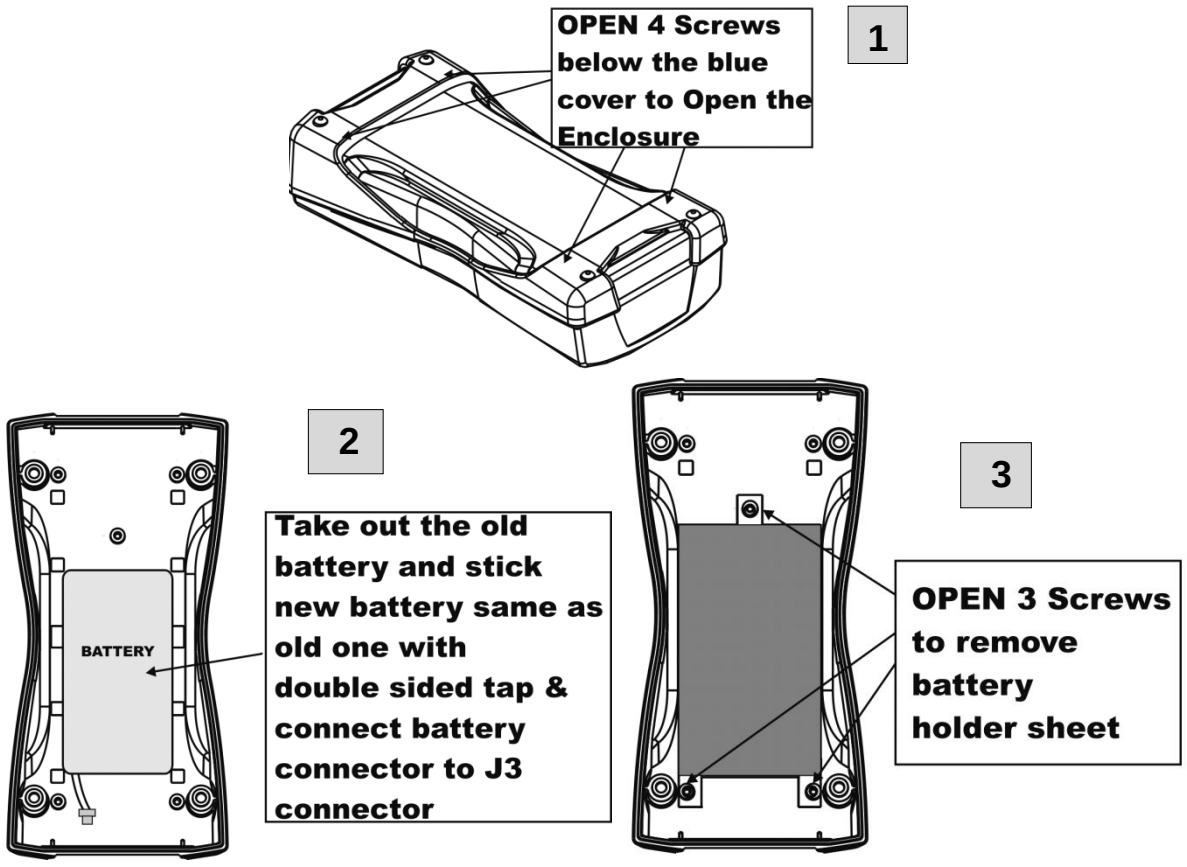
This Page illustrates the Connection diagrams for valid connections to this device.

5. Maintenance & Troubleshooting

5.1 Common Problems

Problem	Possible Causes
Device Not Starting Up	• Battery Discharged • Battery Connection Loose
Reading Fluctuation/ Reading OPEN	• Wrong / Loose Connections
Error Code on status bar	• One of the peripheral not working properly. (Solution: Restart the Device if still error code showing contact factory)
Calibration Out	• Distortion in due to external noise connection (Solution: Check connection. If still out contact factory or Recalibrate Device in authorized cal-lab.)
Battery Not Charging	• Battery Connection Loose • Battery Dead

5.2 Replacing the Battery



6. General Specifications

6.1 General Specifications

- **General Specifications**

Display Mode	mA/V Measure + TC/mV(Source or measure), mA/V Measure Only, TC/mV(Source or measure) only
Supported units for TC type	°C/°F/°K
CJC error	≤± 0.5 °C
Max. input voltage	30 V DC
Temperature Coefficient	≤30 ppm
Input Impedance Measure	TC/mV/V >1MΩ mA =10 Ω
Response time	Input <100ms Output <100ms
Load impedance	>4.7KΩ for TC/mV O/P
Display update rate	10 readings / sec
Isolation	250VDC between mA/V Measure and TC/mV(Source or measure),
Data logging	Logged data is stored in a user defined file in internal memory Periodic logging: 150000 readings max
Communication Interface	USB 2.0

- **Display & Keys**

Display	2.4" TFT LCD, 262K Color, Graphical, 42.72 mm x 60.26 mm, 240x320 pixels, White LED Backlight
Keys	6 Membrane Keys

- **Special Features**

Loop power output	24V DC, ±10% (24mA maximum)
HART mA Loop Resistor	250 Ω ± 20%
Special Function	Step/Ramp functions: Automatic/Manual. $\sqrt{x}$, x^2 : for mA/V measure

- **Power Supply**

Battery Type	Rechargeable Li-ion battery pack, 2300mAh 3.7V
Charging Time	<5 hours max
Charger supply	100-240 VAC, 50/60 Hz; Output 5V DC@1A
Battery Life on full charge	>18 hours for ET measure or TC measure with minimum backlight brightness. > 8 hours for 12mA(24V) measure mode with minimum backlight brightness
Battery Status Indication	Battery symbol displayed with % power remaining

- **Physical**

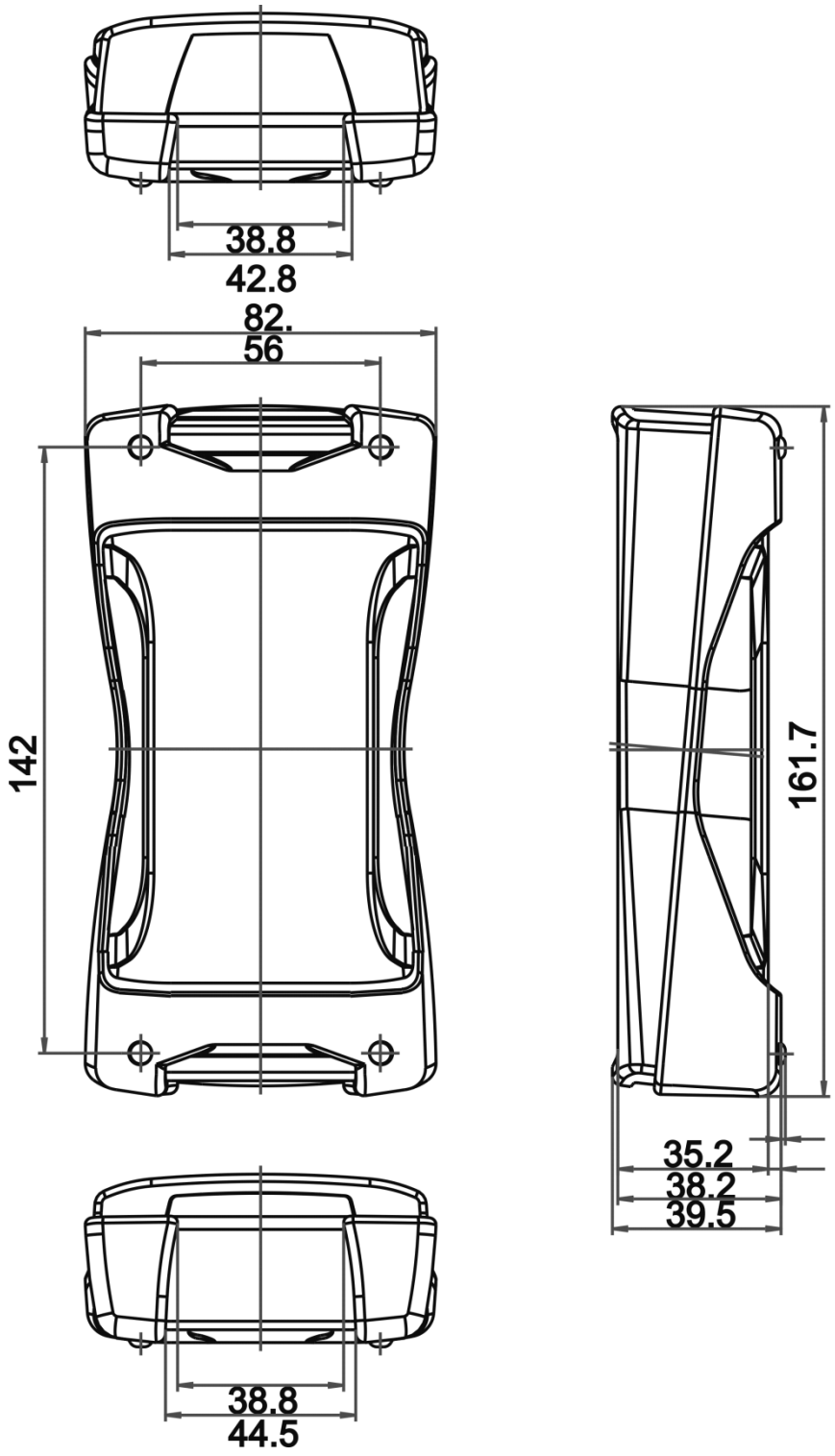
Dimensions	161.7 mm (L) x 82.1 mm (W) x 39.5 mm (H)
Housing Material	ABS Plastic
Electrical Terminals	Two nos. , 2 mm safety sockets
Thermocouple Terminal	Thermocouple minijack socket(cu type)
Weight	<300 grams
Protection	IP40

6.2 Electrical Measurement Parameters and Accuracy

Parameter	Range	Resolution	Accuracy
V	0-30.00 VDC	0.001 V	±0.02% of reading ± 2 mV
mA	0-24.00 mA	0.001 mA	±0.02% of reading ± 2 uA

6.3 Thermocouple/mV Parameter and Accuracy

TC Terminal (Measure and Source)			
TC Type	**Range**	**Display Resolution**	**Accuracy**
E	-200.0 to 1000.0 °C	0.1 °C	± 0.3 °C
J	-200.0 to 1200.0 °C	0.1 °C	± 0.3 °C
K	-200.0 to 1372.0 °C	0.1 °C	± 0.3 °C
T	-200.0 to 400.0 °C	0.1 °C	±0.3 °C
B	450.0 to 1800.0 °C	0.1 °C	± 0.5 °C
R	0.0 to 1750.0 °C	0.1 °C	± 0.5 °C
S	0 to 1750.0 °C	0.1 °C	± 0.5 °C
N	-200.0 to 1300.0°C	0.1 °C	± 0.3 °C
mV	-10 to 80 mV	0.001 mV	±0.02% of reading ± 2uV
	-10 to 250 mV	0.01mV	±0.02% of reading ± 0.02mV

Note: temperature standard ITS-90

6.5 Enclosure Dimensions