OPERATING MANUAL

HK – 1M & 1C
MICROWAVE INSTRUMENT SYSTEM

for

Measuring

% Total Solids

of a

Sludge in a Pipe

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APPENDIX

I. INTRODUCTION

A. There are several parameters to check and one (1) measurement to make when setting up the HK Microwave System.

B. A Single Point Calibration will be used for the initial Setup. Multiple Samples will be used to establish the final Calibration Line.

C. The front panel of the HK System looks like Figure 1. There are three (3) Hardware Keys and three (3) Soft Keys. You will use the six (6) buttons to program and operate the Microwave System. In the manual, I will only show the display when showing an example.

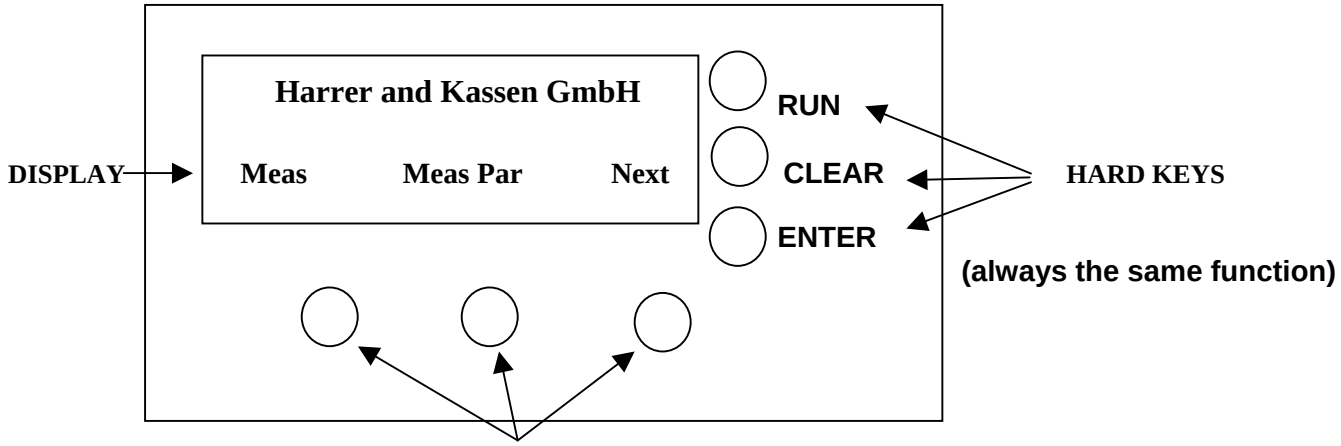


Figure 1 Front Panel of the HK

II. Quick Set UP

A. Installing a Microwave System

1) When installing a Modular Unit HK with Sensor Pins
   a. Install the Transmitter as close as possible to the Insertion Sensor Pins
   b. Install on a vertical pipe and at a 45 degree angle to the flow.
   c. Do not over tighten the coaxial connectors. Tighten with hand and snug with a wrench.
   d. Take care that no water or dirt gets in to the coaxial connections.
   e. Do not bend the coaxial cables directly at the connector.
   f. Use tie raps to secure the cables to something fixed.
   g. Protect the cables from being cut or moved after calibration.

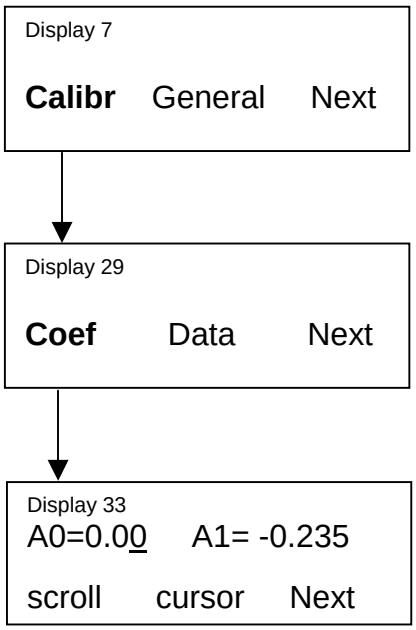
2) When Installing the Single Piece Unit with Sensor Pins
   a. Install the unit on a vertical pipe at a 45 degree angle to the flow.
   b. Avoid areas of high vibration.

3) When Installing Non Insertion Antenae
   c. Install the Transmitter as close as possible to the Antennae
   d. Install on a vertical pipe.
   e. Do not over tighten the coaxial connectors. Tighten with hand and snug with a wrench.
   f. Take care that no water or dirt gets in to the coaxial connections.

g. Do not bend the coaxial cables directly at the connector.
h. Use tie raps to secure the cables to something fixed.
i. Protect the cables from being cut or moved after calibration.

IV. Calibration – Procedures for the Initial Single Point Calibration

Step 1: Check Slope (A1) and Offset (A0)
Step 2: Input Linear Temperature Coefficient (Tk1)
Step 3: Input Reference Temperature (Tref)
Step 4: Input Reference Conductivity
Step 5: Input Conductivity Coefficient
Step 6: Set Current Outputs
Step 7: Perform the REFERENCE MEASUREMENT
Step 8: Input Value of Lab Sample
Step 9: Compute Measurement Range

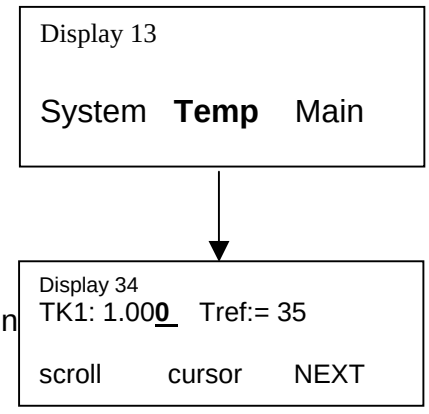


A. Checking and Setting Slope (A1) and Offset (A0) values

1. Select the Calibr. Menu from Display 7.
2. Select the Coef Sub Menu from display 29.
   Set the Offset (A0) = 0.00 for operation (Display 33).
3. Set the Slope (A1). Default of -0.235 is good starting point for Insertion Sensors(Display 33). You must calculate the value for Non Insertion Sensors using the equation in the Appendix.
4. To learn how to use the Software and Hardware Keys; See section VI Page 9 on Entering Numbers.

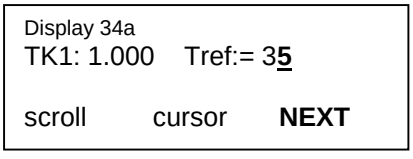
B. Input Temperature Coefficient Tk1.

Step 1: Select Temp Menu form Screen 13.
Step 2: Use Next Button to scroll through screens until the Tk1 parameter is displayed (screen 34).
Step 3: Enter Tk1 of 1.0 for standard 65 mm spacing. **There is sometimes a need to refine this value with data**. For Non Insertion Sensors you need to look at the table in the Appendix.
Note: When you press the ENTER button (Display 34), the Cursor will move to the Tref value (34a). This allows you to Enter the Reference Temperature

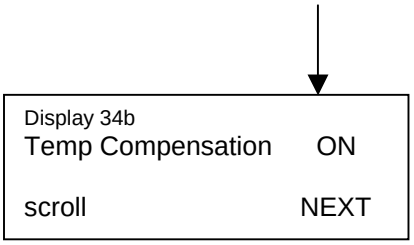


C. Inputting the Reference Temperature

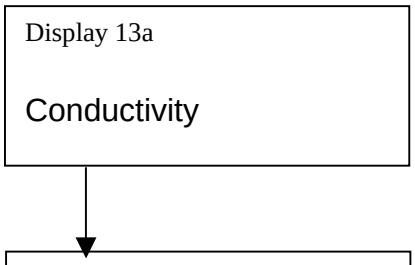
- You will need to enter a Reference Temperature that is within the range of normal operating conditions. Example: Your process operates between 30 and 40 C. It typically operates at 35 C. You should input 35 C as your Reference Temperature.



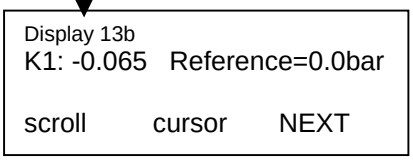
Step 1: Use Scroll and Cursor buttons to set Reference Temperature
Step 2: Press ENTER Button.
Step 3: Turn on Temperature Compensation (Display 34b).



B. Input Conductivity Coefficient.

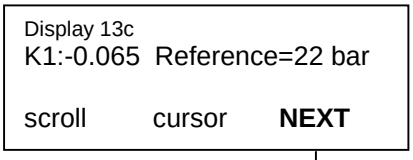


Step 1: Select Conductivity Menu form Screen 13a.
Step 2: Use Next Button to scroll through screens until the Tk1 parameter is displayed (screen 13b).
Step 3: Enter K1 of -0.13 (2 meter coax cable) and -0.065 for 1 meter coaxial cable.



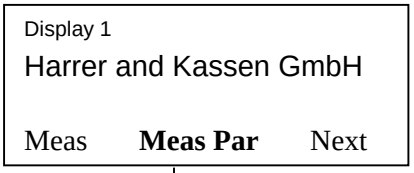
Note: When you press the ENTER button (Display 34), the Cursor will move to the Tref value (13c). This allows you to Enter the Reference Temperature

C. Inputting the Reference Conductivity - You will need to enter the Reference Conductivity of the process at the time you perform the Single Point Calibration.



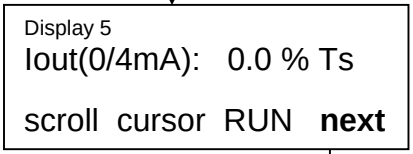
Step 1: Use Scroll and Cursor buttons to set Reference Conductivity
Step 2: Press ENTER Button.

D. Setting the Current Outputs



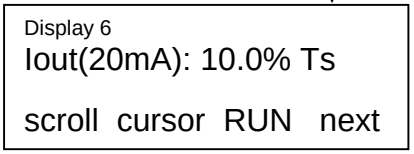
1. It is necessary to setup the Microwave System 4-20 mA Current Output so it outputs usable numbers. Our example, will span the output from 0 – 10 %Ts.

2. Setting the output of the 4 mA and 20 mA signals.



Step 1: Select Meas. Par menu from display1.
Step 2: Select next until display 5 is shown. Use scroll and cursor keys to input 0.0 % for the 4 mA
When you see a 0.0% in display 5, Press Enter Key

Step 3. Enter the value of 10.0 into the display 6



to set the 20 mA output. Press Enter.

E. PERFORMING THE REFERENCE MEASUREMENT:

NOTE: SYSTEM WILL NOT WORK UNTIL YOU PERFORM REFERENCE MEASUREMENT

1. The Reference measurement requires the following condition:

a. Stable, flowing material in the pipe or vessel.
b. At least 15 PSI and well mixed.
c. Operating Temperature stable and typical.

Step 1: Select the System Menu from Display 13
Step 2: Select Next from Display 14.

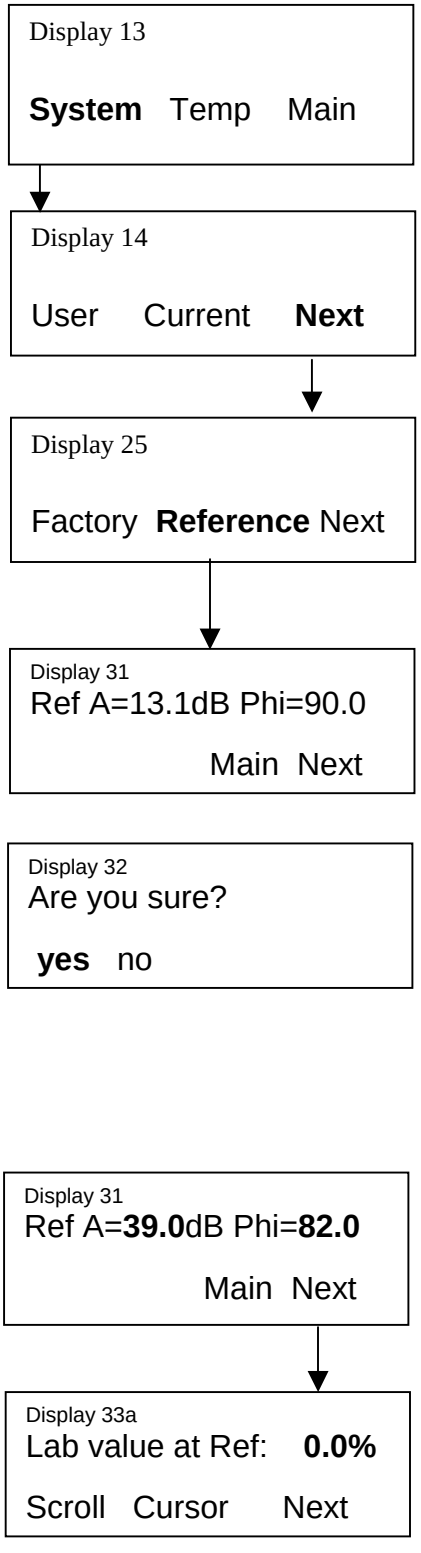
Step3: Select Reference Sub Menu from Display 25

Step 4: When in Display 31 press the **Run** button until you see Display 32.
Step 5: Answer yes from Display 32.
Step 6: Repeat Reference Measurement at least twice. Make sure The readings are stable, +/- 0.5 dB and +/- 20.0 Phi. If the readings are not stable, you must wait until they are to do the Reference Measurement.

Step 7: Record new numbers which appear Display 31 for A= 39.0, And PHI=82.0.

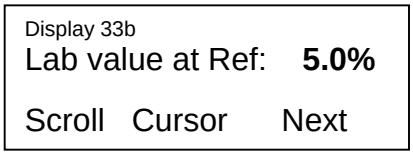
NOTE: The values listed here in the manual, 39.0 dB and a Phi =82.0, are only examples and will be different for each application. However, there are MAXIMUM and MINIMUM allowed values for the A value.

Max allowed 55 dB
Min allowed 5 dB



F. Inputting Lab Value for Initial Single Point Calibration

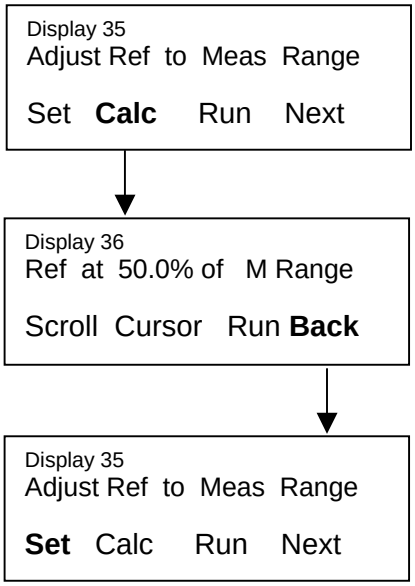
Step 1: A sample of the Process Stream must be collected at the same time The Reference Measurement is Performed.
Step 2: Take sample to the lab for analysis of % Total Solids.
Step 3: Press Next Display 31.
Step 4: Input lab value, (example 5.0%) into Display 33a. Press Enter Display 33b.



G. Computing the measuring Range.

1. You must tell the Software to calculate what the measuring range is. This is very important.

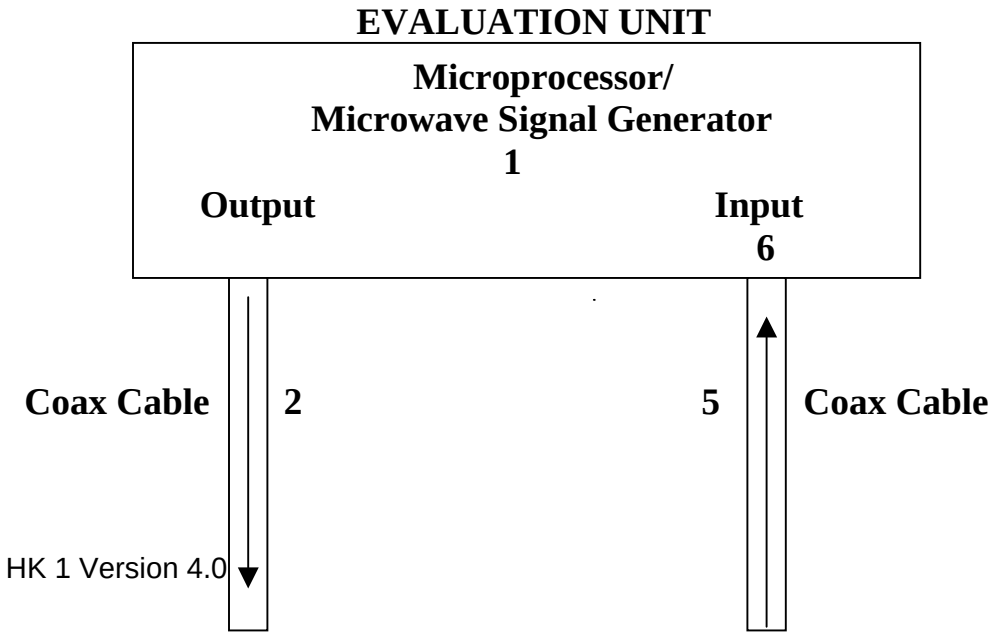
Step 1: After you enter 5.0 in Display 33b, you will go to Display 35.
Step 2: Press Soft button under Calc. See Display 36.
Step 3: Press Back. See Display 35.
Step 4: Press Soft button under Set.



Non Intrusive Sensor

Minimum Temperatures for 100% Water

2. Basic Hardware and Signal Generation



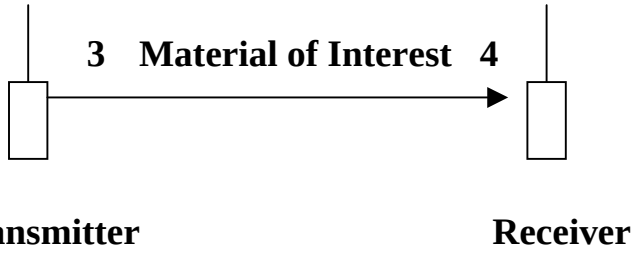


Figure 7

The pMt 581and 581L perform the following steps during their measurement cycle:

1) A microwave signal is produced in the Evaluation Unit
2) The signal is transmitted from the Evaluation Unit to an antenna over a coax cable
3) The transmitting antenna emits a microwave signal in the material in question
4) The microwave signal transmits through the material from the transmitting antenna to the receiving antenna
5) From the receiving antenna the signal is transmitted back to the Evaluation Unit
6) The Evaluation Unit receives the signal and measures its properties

3. User Interface

The parameters that set up the microwave system and allow the user to perform the required operations are accessed through the keypad located on the front panel of the Evaluation Unit (Figure 8). There are six (6) buttons, which allow the user to interface with the menu driven software that runs the pMt 581 and 581L.

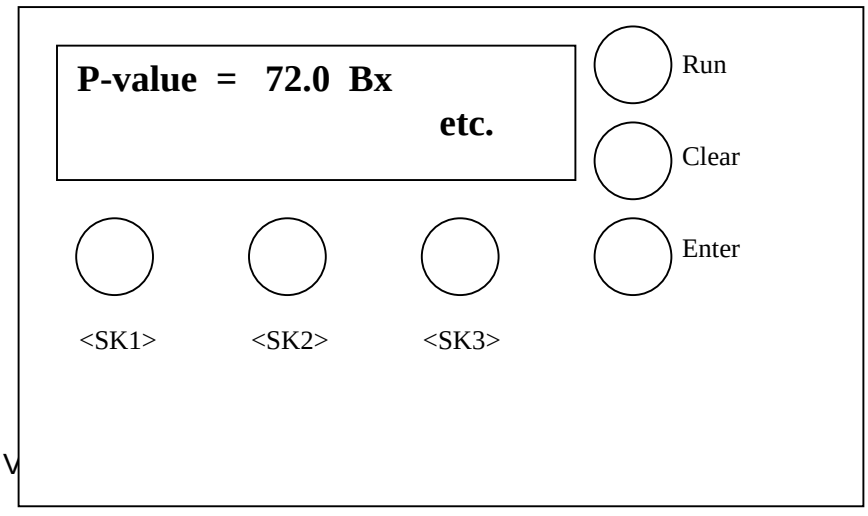


Figure 8

3.1 Keypad

3.1.a) Description of keypad buttons

<SK1>	♦ Selection of menus and sub-menus ♦ Entering of numbers, when necessary ♦ Viewing of options within a sub-menu
<SK2>	♦ Selection of menus and sub-menus Moving of cursor when entering numbers
<SK3.>	♦ Use this button to move from one menu position to the next
<Enter>	♦ This button is pressed to confirm an input or change
<Clear>	♦ Press to clear display and return to last known value
<Run>	♦ Starts and stops the measurement

3.2 Menus

The pMt 581 uses the following menus to configure the system:

- General
- Meas. par
- Operate
- Calibr.
- T-comp.
- System

Menu Name	**Menu Description**
General	General system parameters are located in this menu: 1) Locking and unlocking the keypad 2) Selection of language 3) Program version 4) Date 5) Units of measure

Meas. Par. Specific system parameters are located in this menu:

1) Time constant for signal averaging
2) Current output values

Operate Measured values are displayed in this menu. No inputs allowed:

1) Live display of measurement, °Bx, %H2O, %Ts (total solids), g/cc
2) Live display of product temperature (optional)

Calibr. There are 2 sub-menus accessed through this menu:

Coeff. Slope (A1) and offset (A0) of calibration curve found in this sub-menu.
Data Calibration data points are located here (Optional)

System There are 2 sub-menus accessed through this menu; User and Factory (not accessible to user)

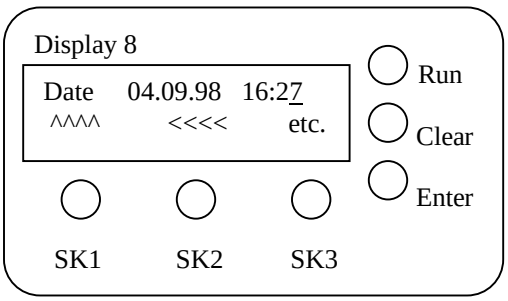
User Calibration and other system parameters found here:

1) Zero measurement 'B-Ref' performed here
2) Starting point of measurement entered here
3) Calibration line, i.e.: Linear, ln-function, e-function
4) Load compensation turned on and off here
5) Current output selection of 0-20 mA or 4-20 mA
6) Current input selection of 0-20 mA or 4-20 mA
7) Value of current output when system is in hold status
8) Test current output selected here
9) Temp. input type – PT100 or current input
10) Calibration of PT100 performed here
11) Live Temp of Product and Evaluation unit displayed here
12) Baudrate for serial output
13) Data format for serial port

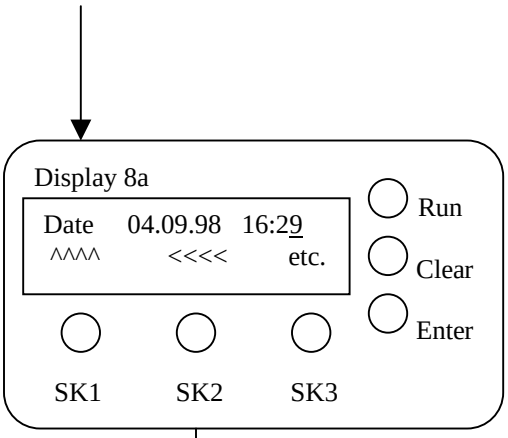
T-comp In this menu, it is possible to switch on or off the temperature compensation and to adjust the necessary parameters.

3.3 Entering Numbers

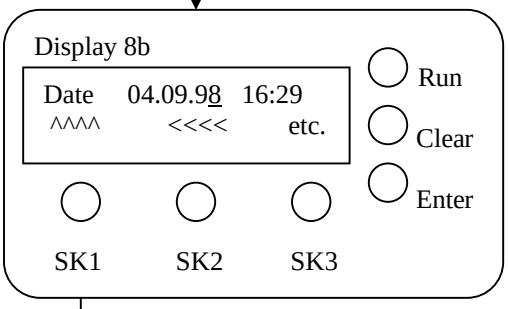
Entering numbers is quite easy. Three buttons are used to enter numbers - <SK1>, <SK2>, and Enter.
<SK1> is used to increase the number directly over the Cursor.
<SK2> moves the Cursor to the left.
Enter button confirms entry.
Let's enter a new number in the display for date and time.
Current value = 04.09.98 16:27
New value = 04.09.99 16:29:



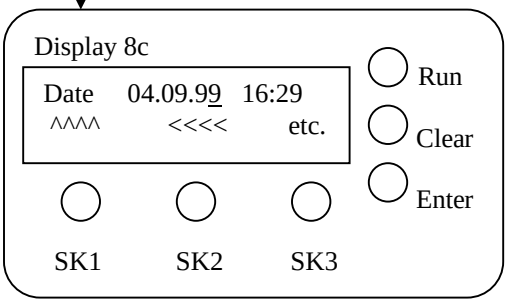
Step 1. Looking at display 8, increase the number over the Cursor to the number 9. It is now 7.
Press the <SK1> button until the number 9 is seen over the Cursor (display 8a). Press Enter.



Step 2. Change the year to 99. Press <SK2>
until the Cursor is positioned under the 8 (display 8b).



Step 3. Press the <SK1> button until the number 9 is seen over the Cursor (display 8c).



Step 4. Press Enter button and change the date from 04.09.98 16:27 to 04.09.99 16:29.

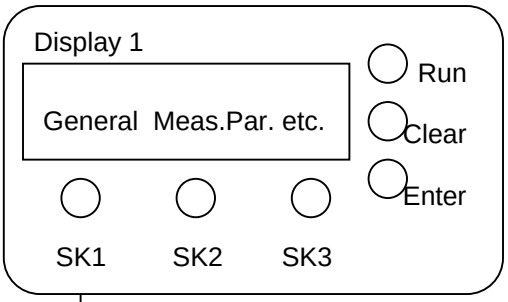
4. How to make it work, Using System software

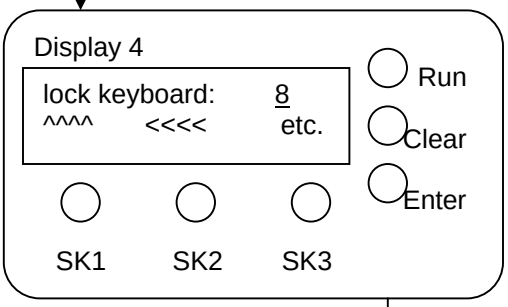
4.A General Menu

4.A.1 Locking the keypad – when it is necessary to protect the data in your evaluation unit from unauthorized
access, it is possible to enter a passnumber to lock out keypad access.

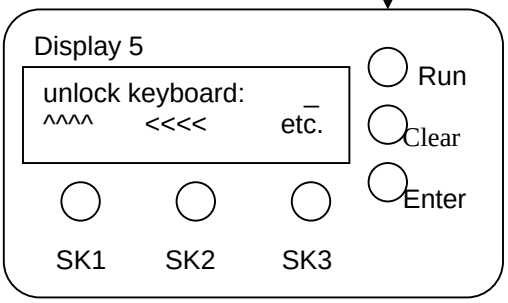
Note: Make sure the system is in the RUN mode before locking the keypad.

Step 1. Press the <SK3> button until you see the word General displayed.
Step 2. Press the <SK> button, which selects the General Menu. The first display in the General menu is display 4.





Step 3. Press <SK1> to place a number over the Cursor. 8 will be entered here.
Step 4. Press <SK2> to move the Cursor. Repeat Step 3.
Step 5. After you have placed your passnumber in the display press the Enter button. This number has become your password. The keypad is now locked and you must re-enter this passnumber to unlock it.

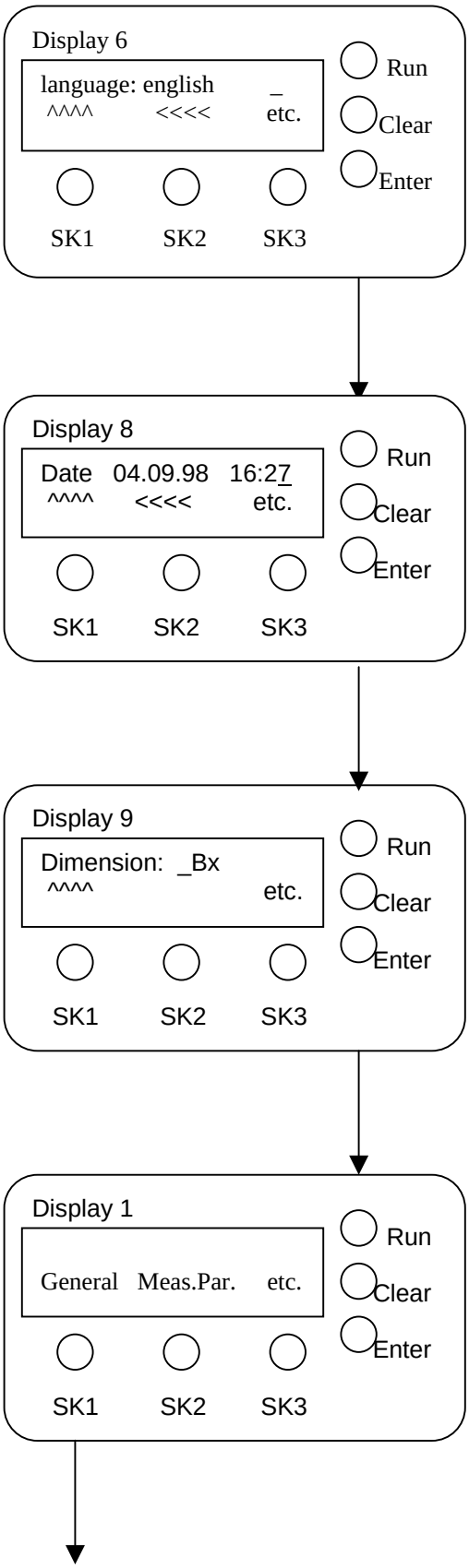


4.A.2 Unlocking the keypad – if you have entered a number to lock the keypad, you must re-enter that number according to the following steps to unlock the keypad and gain access:

Step 1. Select the General Menu.
Step 2. Press <SK3> button until display 5 is shown.
Step 3. Press <SK1> button to place a number over the Cursor.
Step 4. Press <SK2> to re-position the Cursor.
Step 5. Repeat until you see your passnumber in the display.
Step 6. Press the Enter button to unlock keypad.

4.A.3 Changing the language of your Evaluation Unit

Step 1. Select the General Menu.
Step 2. Display 4 should be in the display (see page 8).
Step 3. Press <SK3> button until display 6 is shown.
Step 4. Press <SK1> button until language of choice is shown.
Step 5. Press the Enter button to select language in display.



4.A.4 Changing the time and date in the Evaluation Unit.

Format is European - day:month:year hour:minute

Step 1. Select the General Menu.
Step 2. Display 4 should be in display (see page 8).
Step 3. Press <SK3> button until display 8 is shown.
Step 4. Press <SK1> button to change the value of the number directly over the Cursor.
Step 5. Press <SK2> to re-position the Cursor.
Step 6. When the time and date in the display is correct, press the Enter button for the Evaluation Unit to accept value.

4.A.5 Selecting the units of measure

Step 1. Select the General Menu.
Step 2. Display 4 should be shown (see page 8).
Step 3. Press <SK3> button until display 9 is shown.
Step 4. Press <SK1> button until the desired units are in display.
Step 5. Press Enter button to select units.

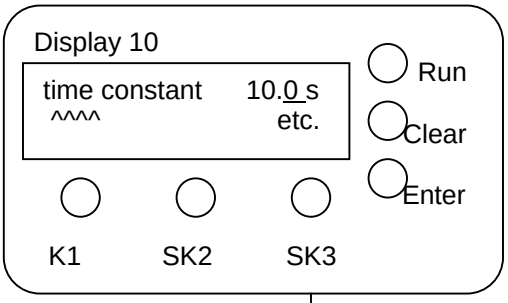
4.B Meas. Par. Menu

4.B.1 Setting the system time constant.

The value of the time constant will depend on the following factors:
1) The consistency of the material being measured.
2) The rate at which the material may change.
3) The requirements of the control loop.

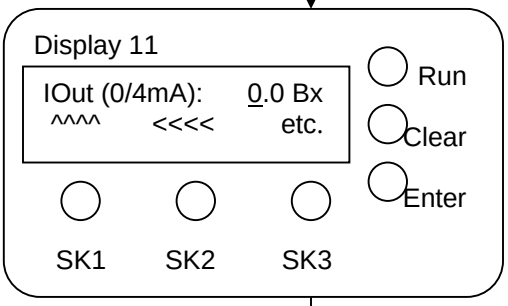
A good starting value for an insertion or in-line measurement would be 10.0 sec. This can be reduced or increased depending on the performance of the instrument. Too low is not good (1 sec) and too high is not good (100 sec).

Step 1. Select the Meas.Par. Menu, Press <SK2> display 1 (see page 9).
Step 2. Display 10 should be shown.
Step 3. Press <SK1> button to change the number above the Cursor.
Step 4. Press <SK2> button to re-position the Cursor.
Step 5. Press Enter button when the display shows the time constant you wish to use.



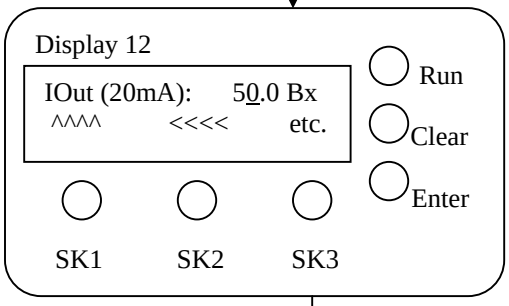
4.B.2 Setting the 4 mA of the system current output.

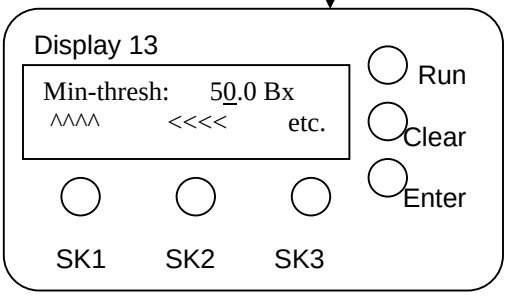
Step 1. Select the Meas. Par. Menu (see page 9).
Step 2. Display 10 should be shown.
Step 3. Press <SK3> button until display 11 is shown.
Step 4. Press <SK1> button to change the number over the Cursor.
Step 5. Press <SK2> button to move the Cursor.
Step 6. Press Enter button when the desired 4-mA value is in the display. In this case, the value representing 4 mA will be 0.0 Bx.



4.B.3 Setting the 20 mA of the system current output.

Step 1. Select Meas.Par. Menu (see page 9).
Step 2. Display 10 should be shown.
Step 3. Press <SK3> button until display 12 is shown.
Step 4. Press <SK1> button to increase the number over the Cursor.
Step 5. Press <SK2> button to move the Cursor.
Step 6. Press Enter button when the desired 20 mA value is in the display. In this case the value representing 20 mA is 50.0 Bx.

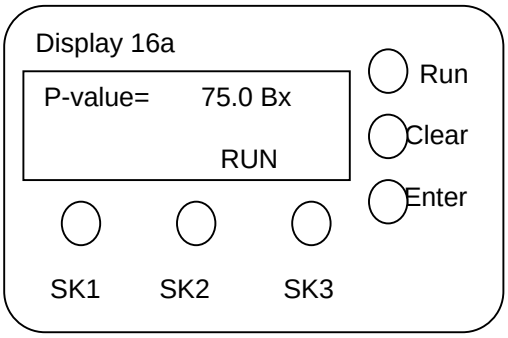


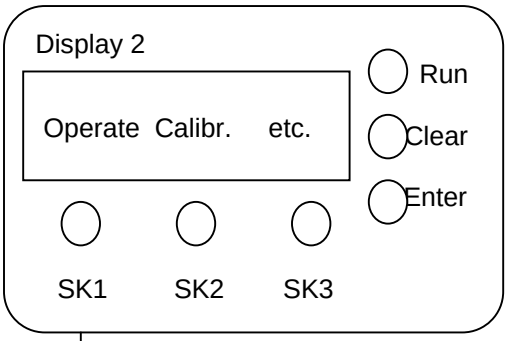


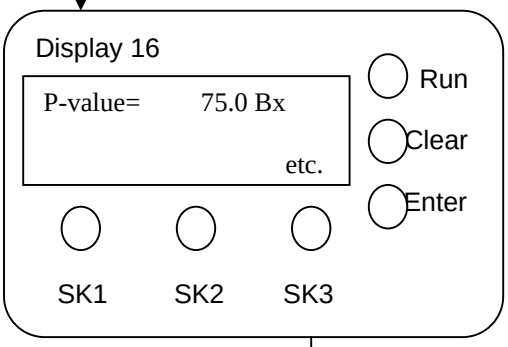
4.C Operate Menu

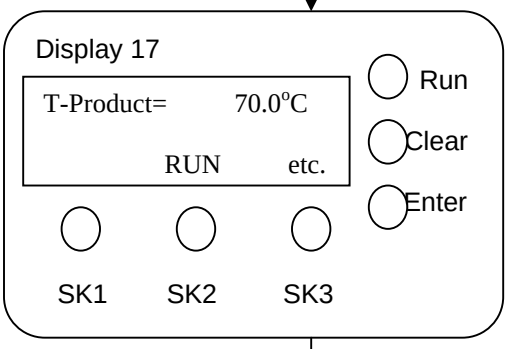
4.C.1 Getting the live reading of the units of measure in the display.

Step 1. Select the Operate Menu.
Step 2. Display 16a should be shown, live readings should be in display. Display 16 is not in the Run mode.
Step 3. Press Run Button to place system in measurement mode.









4.C.2 Getting the live reading of the Temperature in the display.

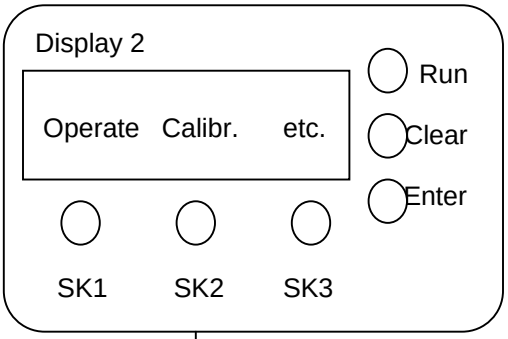
Step 1. Select the Operate Menu.
Step 2. Live readings should be in display, Display 16a.
Step 3. Press <SK3> button, display 17 should be shown.
Step 4. Press <SK3> button until you see the word Operate. Press <SK> button under Operate.

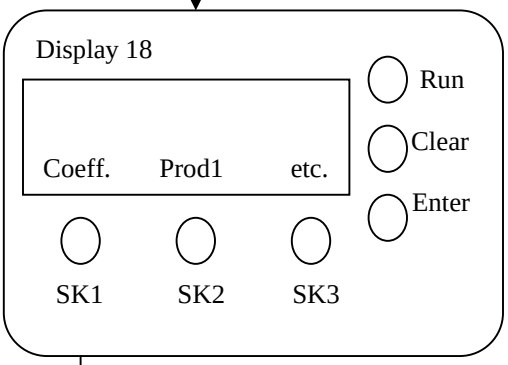
4.D Calibr. Menu

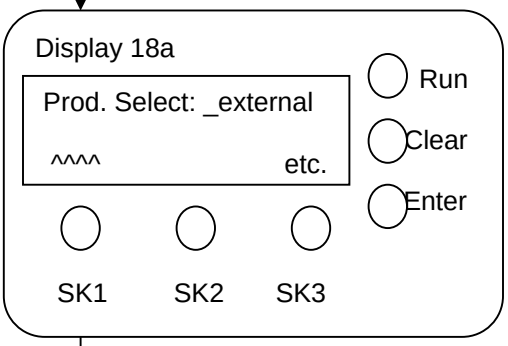
4.D.1 Selecting Internal or External switching of Calibration Sets Selecting Calibration Curves for Products 1 or 2

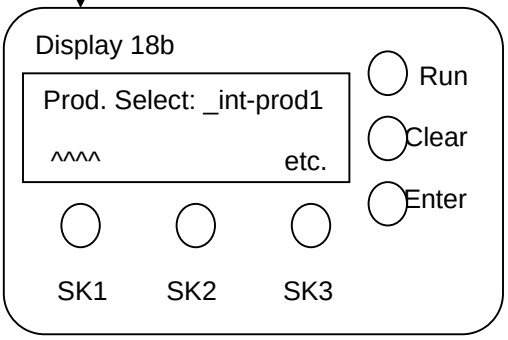
Step 1. Select Calibr. Menu, Press <SK2> Display 2
Step 2. Select Coeff. Menu, Press <SK1> Display 18
Step 3. Select external (Display 18a) or int-prod1 (Display 18b) or int-prod2 (Display 18c)

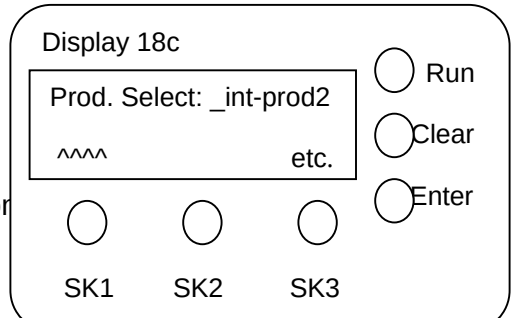
Note: This unit has the ability to use 1 of 2 Calibration Sets. They can be selected at the Keypad or by Remote Contacts. By selecting Display 18a you will get external switching. By selecting 18 b or c, you get internal selecting of Calibration set for Product 1 (Display 18b) or Calibration Set for Product 2 (Display 18c).





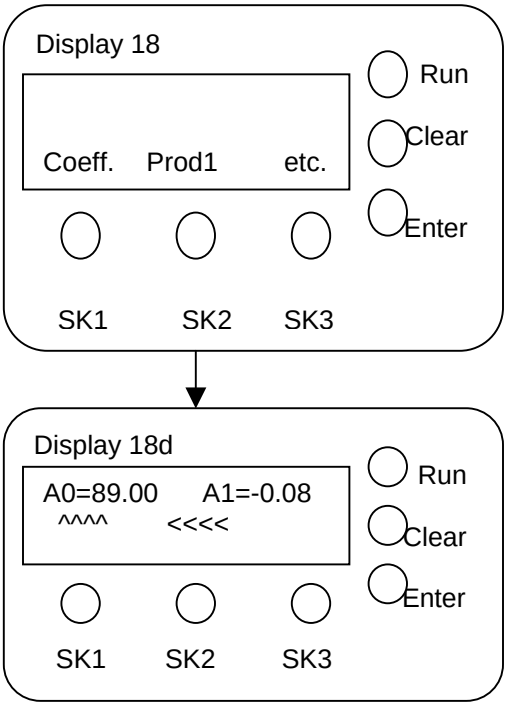






HK 1 Version

4.D.2 Entering the slope and offset for Product 1 or Product 2

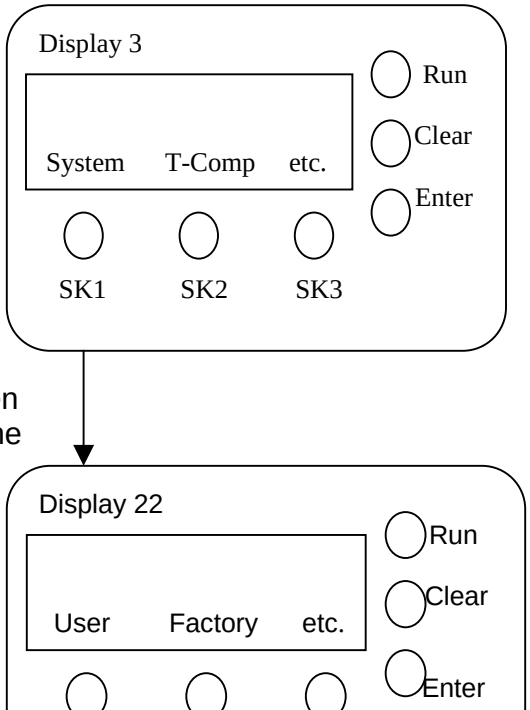


Step 1. Select Calibr. Menu, Press <SK2> display 2
Step 2. Display 18 should be shown.
Step 3. Select the SK button under Product 1 or Product 2 depending on which Calibration You want to use.

Step 3. Enter a value for the offset A0, press enter, then enter A value for the slope A1. Use SK2 to move the cursor And SK1 to change the value of the number above the cursor.

A1 (the slope) can vary from +/- 0.05 to +/- 0.25

NOTE: For certain displays there are 2 distinct values to enter, display 18d is 1 of those displays. After you press the Enter button the first time, the Cursor will move to the second entry.



4.E System Menu

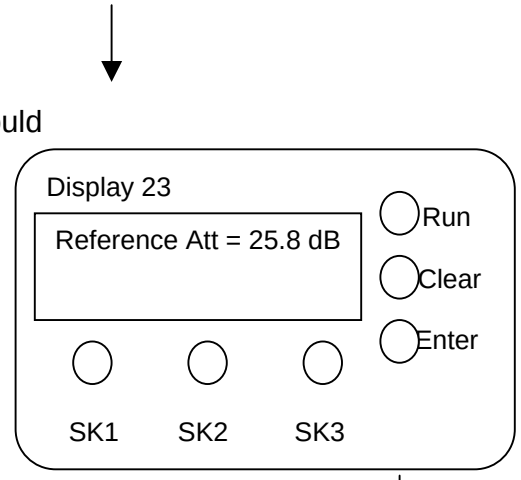
4.E.1 Performing system Reference Measurement.

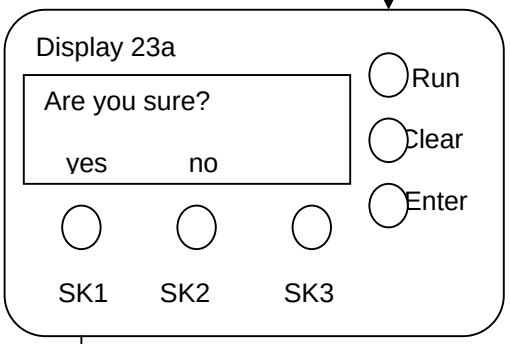
Introduction – The system reference measurement should be performed when the system is operating in a stable fashion. The easiest place to perform the ref, is when the process material is at or around mid – point. If the operating range is 75 – 95 Brix, then perform the Ref Measurement when the process material is

at 85 Brix. The ref can be performed at any point in the range. If the Ref. is performed at mid point, here are no changes required in the starting point value which has a defaultalue of 50.0%.

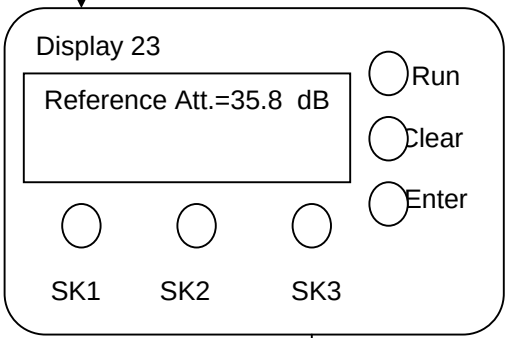
Step 1. Select the System Menu, press <SK1> in display 3.
Step 2. Display 22 should be shown.
Step 3. Press <SK1> button, for User Sub Menu, display 23 should be in display. Note that the word RUN is not displayed. The System Reference Measurement is done with the system out Of the RUN mode.

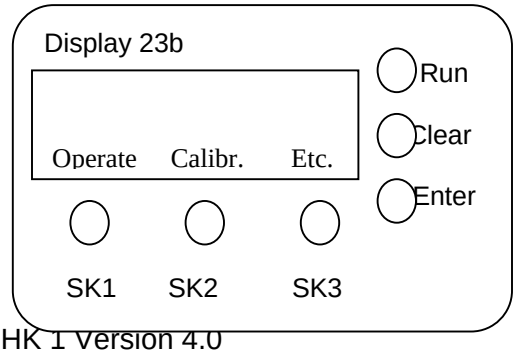
Step 4. Press Run button. Display 23a should appear.





Step 6. If you want this Ref press <SK1>. If not press <SK2>.



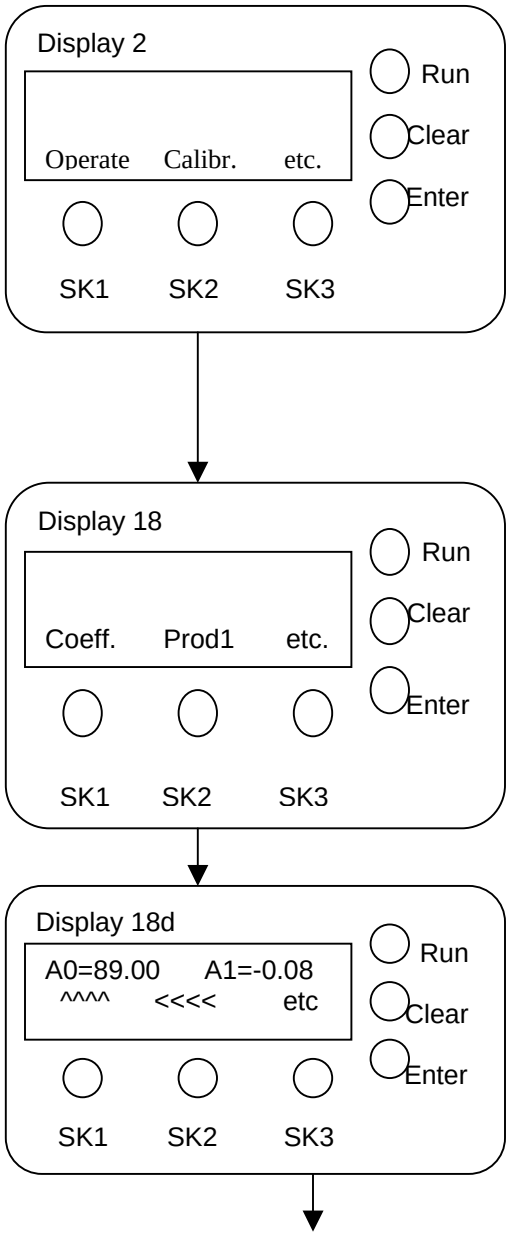


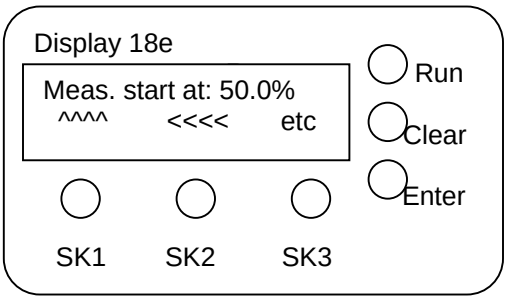
Step 7. To start the system measuring when at display 23, press <SK3> until you get display 23b. Press <SK1> and then press the Run button and the system will begin measuring again. You will see RUN in the display.

4.E.2 Selecting the point to begin measurement.

Introduction – The default value for the Meas. Start at is 50.0%. If this value needs to be changed see the appendix write up of the procedure.

Step 1. Select Calibr. Menu, Display 18 should be shown.
Step 2. Select <SK2> for Prod1, Display 18d is shown.
Step 3. Press <SK3> button until display 18e is shown.
Step 4. Press <SK1> button to increase the number over the Cursor.
Step 5. Press <SK2> button to move the Cursor.
Step 6. Press Enter button when desired value is in display.





4.E.3 Selecting the type of calibration line

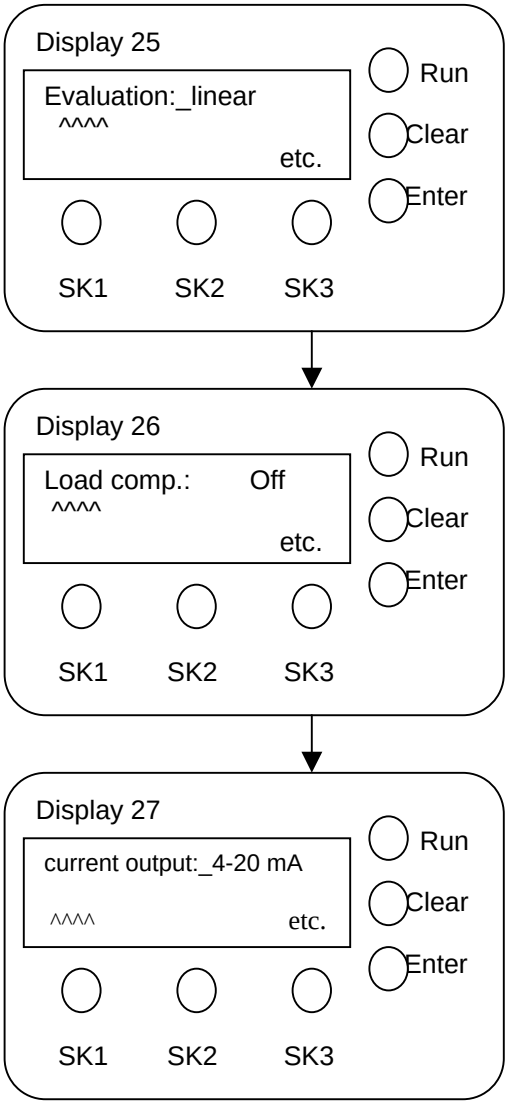
Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 25 is shown.
Step 4. Press <SK1> button to change the calibration type
Linear, ln-function, or e-function.
Step 5. Press Enter button when desired value is in display.

4.E.4 Turning load compensation on and off.

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown
Step 4. Press <SK3> button until display 26 is shown.
Step 5. Press <SK1> button to turn compensation on or off.
Step 6. Press Enter button when desired value is in display.

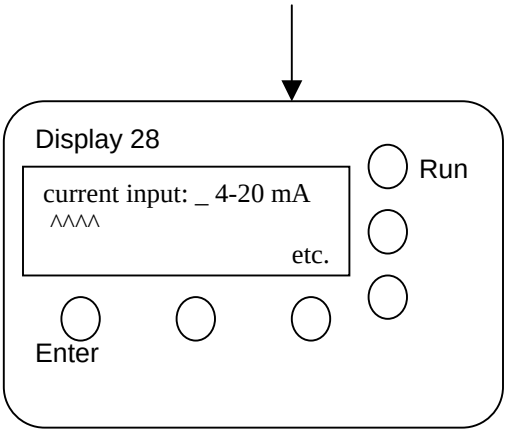
4.E.5 Selecting a 0-20 mA scale or a 4-20 mA scale for output

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 27 is shown.
Step 4. Press <SK1> button to select 0-20 or 4-20 mA.
Step 5. Press Enter button when desired value is in display.



4.E.6 Selecting a 0-20 mA scale or a 4-20 mA scale for input

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 28 is shown.
Step 4. Press <SK1> button to select 0-20 or 4-20 mA.
Step 5. Press Enter button when desired value is in display.



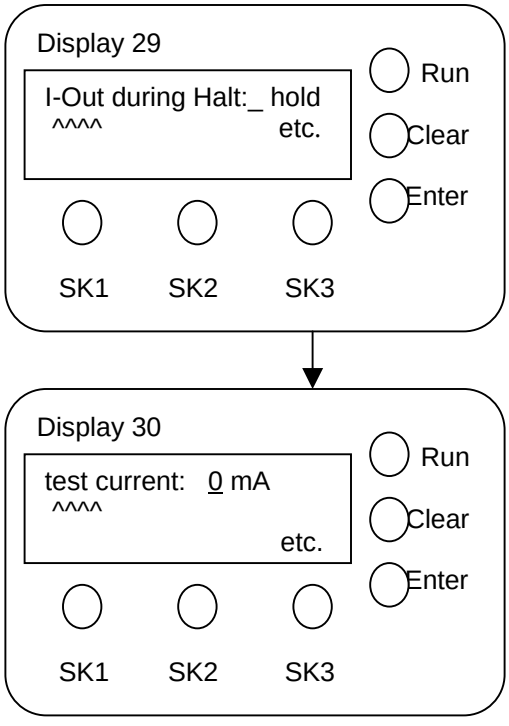
4.E.7 Selecting the value of the current output during a hold condition

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 4. Press <SK3> button until display 29 is shown.
Step 5. Press <SK1> button to select the value of the current loop during a hold condition. The value can be, hold last reading, hold 0 mA, hold 4 mA, or hold 20 mA.
Step 6. Press Enter button when desired value is in display.

4.E.8 Entering a test current <u>(must not be in Run mode)</u>

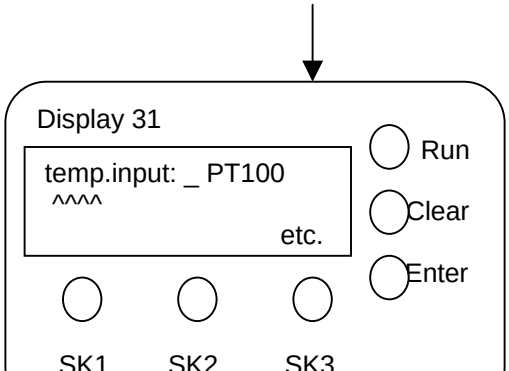
Step 1. Select System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 4. Press <SK3> button until display 30 is shown.
Step 5. Press <SK1> button to select the value of the test current.
Input: 0 = test current off
1 = current output of 0 mA
2 = current output of 1 mA
21 = current output of 20 mA

Step 6. Press Enter button when desired value is in display.

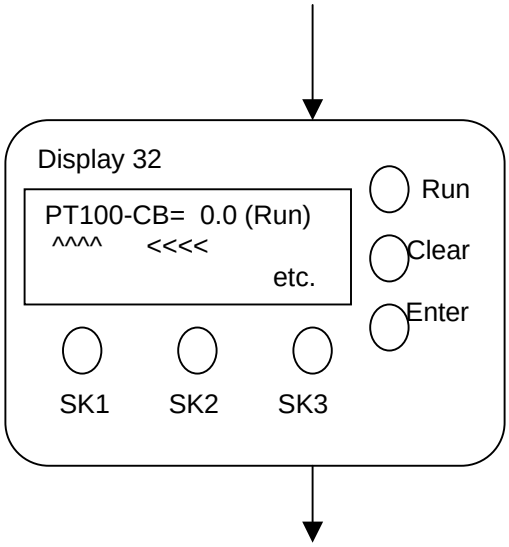


4.E.9 Selecting the type of temperature input.

Step 1. Select the System Menu and then the User Sub-Menu



Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 31 is shown.
Step 5. Press <SK1> button to select the PT100 or
current loop input
Step 6. Press Enter button when desired value is in display

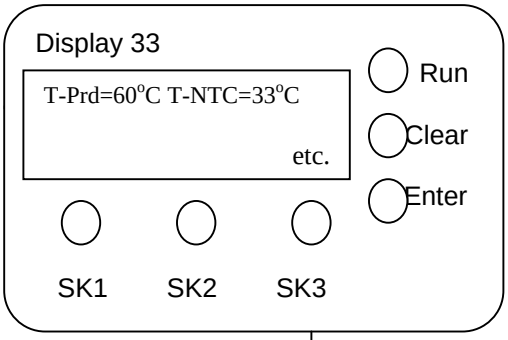


4.E.10 Calibrating the temperature input

Step 1. Connect a precision 100-Ohm resistor across terminals 20 and 21 (see Connection diagram in Appendix).
Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 32 is shown.
Step 4. Press Run button to measure the resistor and calibrate the circuit.
Step 5. Press Enter button when desired value is in display

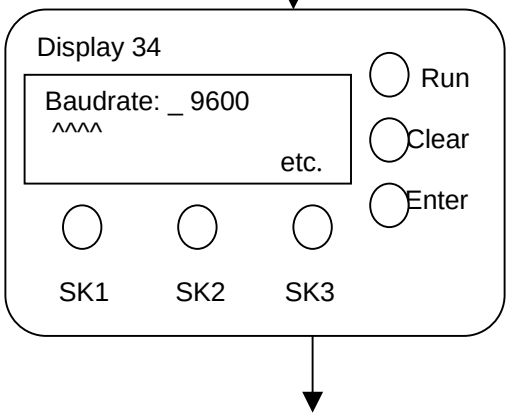
4.E.11 Viewing the Live Readings of both the Product and Evaluation Unit Temperature on one screen.

Step 1. Select the System Menu and then the User Sub-Menu
Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 33 is shown.



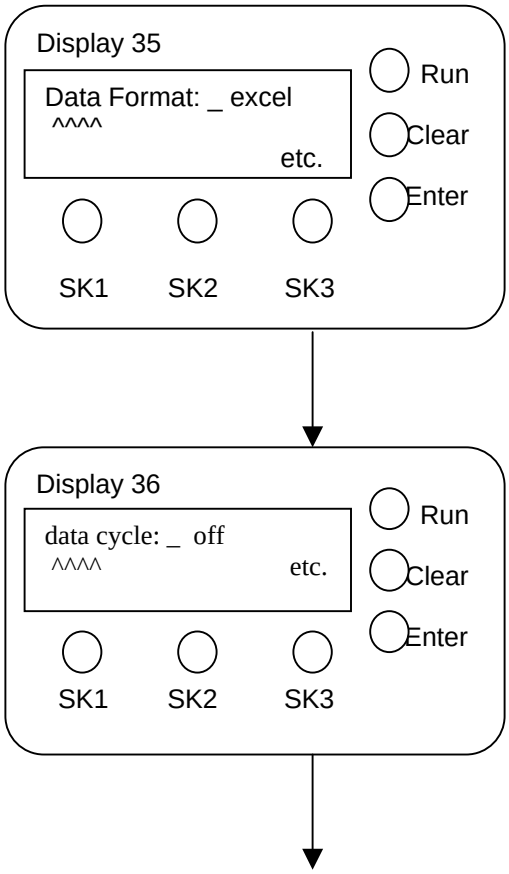
4.E.12 Selecting the baudrate for the serial output.

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 34 is shown.
Step 5. Press <SK1> button to change the baudrate.
Step 6. Press Enter button when desired value is in display



4.E.13 Selecting the output format for serial data.

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 35 is shown.
Step 4. Press <SK1> button to change the format.
Step 5. Press Enter button when desired format is in display



4.E.14 Select the timing for the output of the serial data

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 23 should be shown.
Step 3. Press <SK3> button until display 36 is shown.
Step 4. Press <SK1> button to change the timing of output.
Step 5. Press Enter button when desired value is in display

Temperature compensation / temperature acquisition

Background:

The temperature of the AMBIENT Environment can change.
The temperature of the PRODUCT can change.

1. Ambient Temperatures

   a. The standard System compensates for the effects of changes in Ambient Temperature on the electronics in the Microwave Transmitter. This is accomplished with a feedback loop in the solid state electronics.
   b. The standard System does not compensate for the effects of Ambient Temperature changes to the Coaxial Cables. The performance of the cables is effected by their temperature. There are two (2) possible solutions to overcome the effects of Ambient Temeprature changes on the Coaxial cables.

      1) Since the Compact System does not have Coaxial Cables it is not effected by Ambient temperature changes as the Modular System which has Coaxial Cables. The effect on the cables is length dependent, the longer the cables the greater the effect on the measured signal.

It is not always possible to use the Compact System, because it has a maximum possible sensor spacing.

2) There is an option which can be included with the Modular System to comp[ensate for Ambient Changes. This is presently not a rugged device and is only applicable where it can be protected from water and vibration.

2. Product Temperatures

a. Every System has the cabibility to compensate for the effects of changes in the temperature of the product. Several steps must be taken to configure each system.

1) Compact System. All Compact Systems come with a temperature sensor built in. A temperature measurement for temperature compensation is always available.
2) Modular System.

a) All Modular Systems come with the ability to input a 2-wire RTD (Resistance Temperature Device), but it is not built in.
b) The RTD must be installed and connected to the system to have a measurement of product temperature available to use for compensation.
c) It can either be supplied by the user or the equipment supplier, but it must be installed and wired to the System to be available.

3. When is Temperature Compensation Required

a) There are three (3) parameters which determine if Temperature Compensation is required:

1) ACCURACY – What are the actual requirements?
2) TEMPERATURE CHANGES – What are the Ambient and Product temperature changes which are likely?
3) RESOLUTION OF MEASUREMENT – What is the resolution of the measuremet?

b) Accuracy requirements. Each application will have different requirements for accuracy. Here are two (2) examples:

1) Sand and Water – the required accuracy for this measurement can be +/- 1.5 %Total Solids.
2) Wood Fiber and Water – the required accuracy for this measurement cab be +/- 0.15 %Total Solids.

The first application is unlikey to require Temperature Compensation. The second application will probably require temperature compensation.

c) Changes in Temperature. Variations in process temperature during a production process is usually quite small. Some applications will have changes in process temperature which require temperature compensation.

NOTE: If the change in temperature is due to System Upset Conditions, or Start Up Conditions, it will be very difficult to compensate for the changes in temperature. Temperature compensation and comparative sampling are only good under normal conditions. Under normal conditions, changes are

slow to happen, and are usually small.

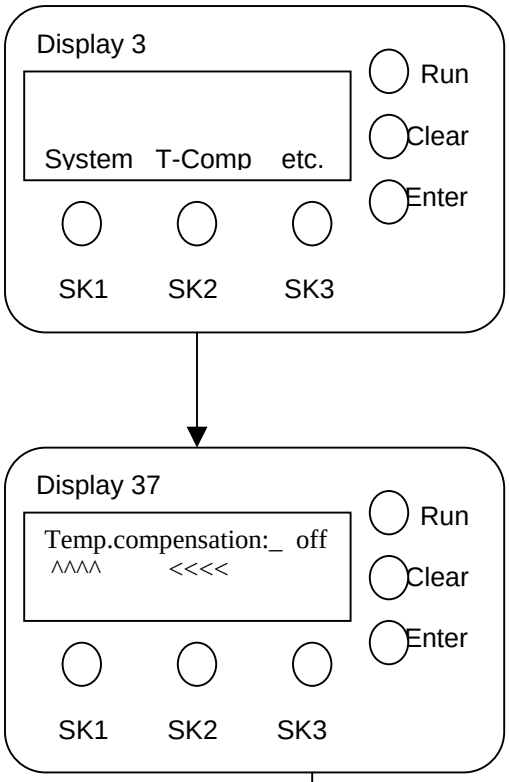
d) Resolution of the measurement. The resolution of each application is different. The higher the resolution of the measurement, the less likely it will be to need compensation.

T-Comp Menu (Temperature Compensation)

The equation used for temperature compensation of the signal:

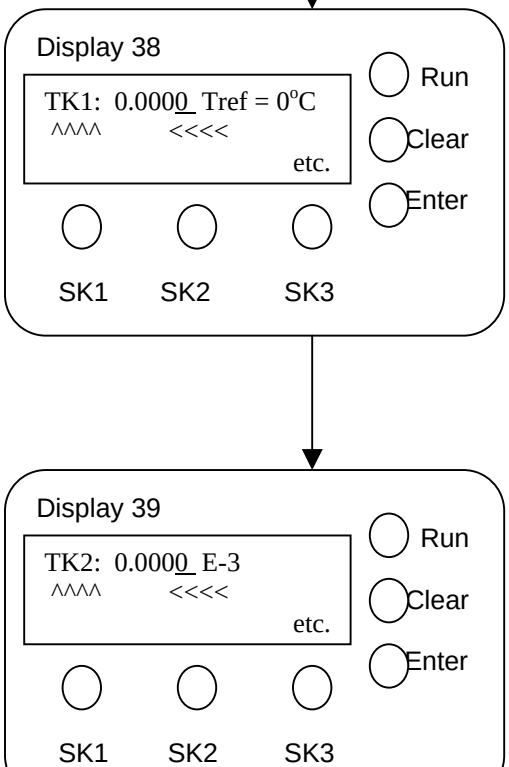
W=A1*Ts+A0; Ts=X+(T-Tref)*Tk1+(T-Tref)^2*Tk2
A1/A0 = Calibration line slope and offset
Ts = Temperature compensated signal
X = Uncompensated signal
T = actual product temperature
Tref = reference temperature

Tk1 = Linear Temperature coefficient
Tk2 = Square Temperature coefficient



4.F.1 Activate temperature compensation

Step 1. Select the T-Comp Menu, press <SK2> display 3
Step 2. Press <SK2> button, display 37 should be in display.
Step 3. Press <SK1> button to activate temperature comp.
Step 4. Press Enter button when desired value is in display.



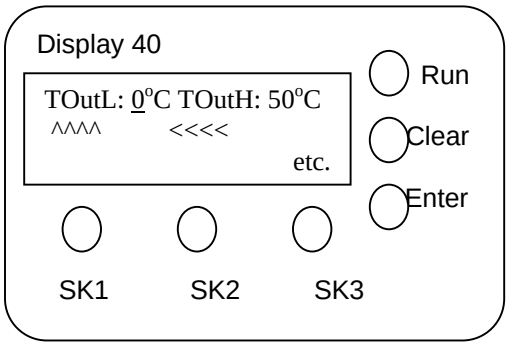
4.F.2 Entering a linear temperature coefficient and a reference temperature.

Step 1. Select the T-Comp Menu
Step 2. Display 37 should be in display.
Step 3. Press <SK3> button, display 38 should be in the display.
Step 4. Press <SK1> button to change the number over the Cursor.
Step 5. Press <SK2> to re-position the Cursor.
Step 6. Press Enter button when desired value is in display. The Cursor will now move to the Tref position.
Step 7. Press <SK1> to change the number over the Cursor for the T-ref (Reference temperature)
Step 8. Press Enter button when desired value is in display.

4.F.3 Entering the square temperature coefficient.

Step 1. Select the T-Comp Menu.
Step 2. Display 37 should be shown.
Step 3. Press <SK3> button until display 39 is shown.
Step 4. Press <SK1> button to change the number over the Cursor.
Step 5. Press <SK2> to move the Cursor.
Step 6. Press Enter button when desired value is in display.

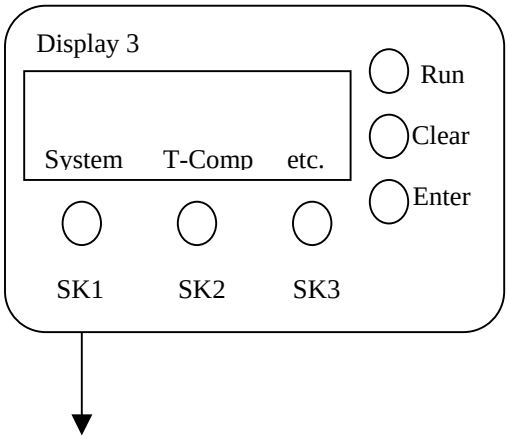
4.F.4 Entering the values of the 4-20 mA current output that represent the temperature.



Step 1. Select T-Comp Menu.
Step 2. Display 37 should be shown.
Step 3. Press <SK3> button until display 40 is shown.
Step 4. Press <SK1> button to change the number over the Cursor.
Step 5. Press <SK2> to re-position the Cursor.
Step 6. Press Enter button when desired value is in display.
Step 7. Press <SK1> button to change the number over the cursor.
Step 8. Press <SK2> button to move the cursor.
Step 9. Press Enter button when desired value is in display.

5. Calibration

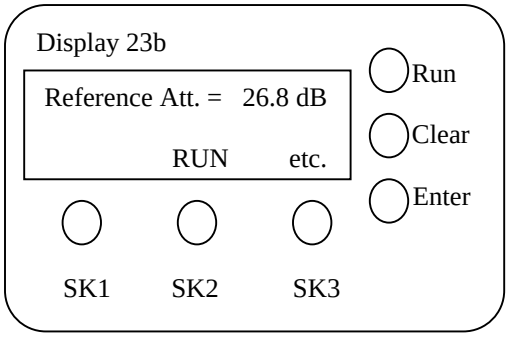
5.A Performing the Reference Measurement



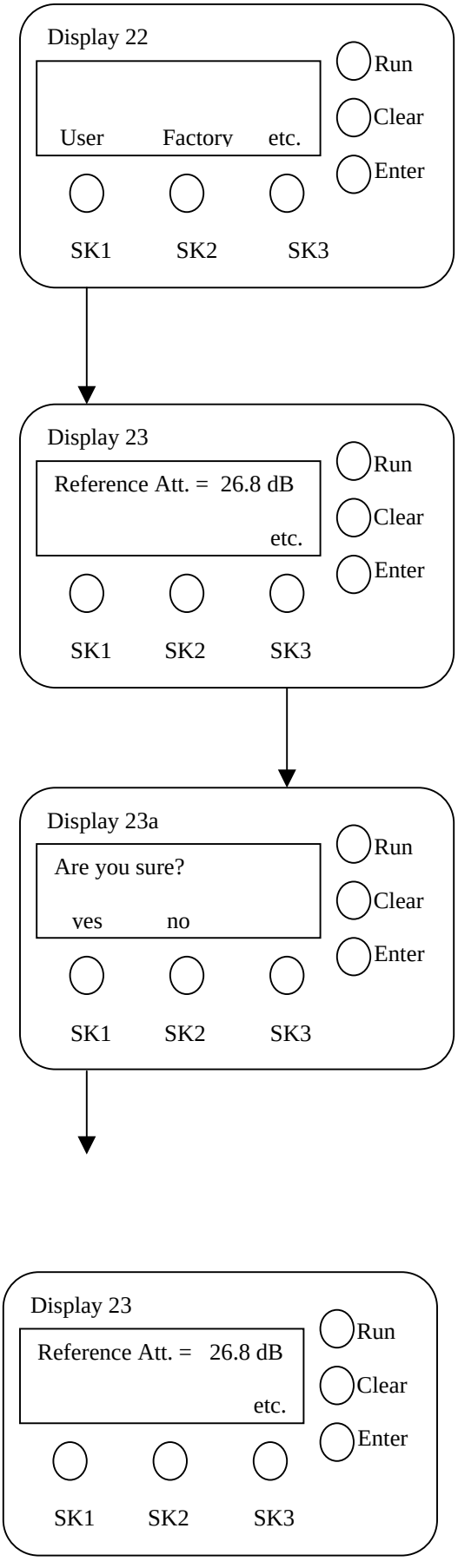
1. The calibration process is carried out in 3 steps:
   a) Reference or 'B-ref' measurement
   b) Initial adjustment of offset
   c) Final adjustment of calibration curve slope and offset

2. The Reference measurement requires the following conditions:
   a) Stable material in the vessel, pipe, or chute.
   b) No air in the material.
   c) Material must be in the range of operation.

3. Performing the Reference measurement:
   a) Select the System Menu, press <SK1> display 3.
   b) Select the User Sub-Menu, press <SK1> display 22.
   c) Before you start the Ref measurement, the display should look like display 23 and not like 23b.
   d) Push the Run button and the system will perform the Ref. After the Ref is completed the display will change to display 23a



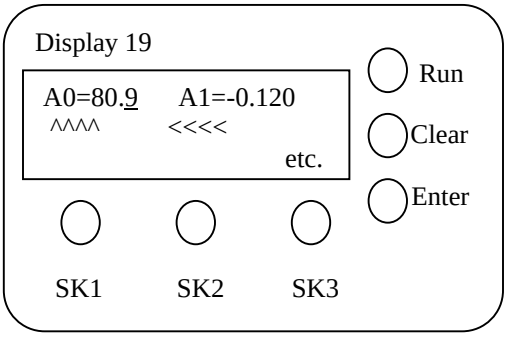
   e) If you have performed a good Ref, then you should press <SK1> button to accept Ref. If you feel you did not get a good ref, press the <SK2> or reject the Ref. If you reject it, you need to repeat Step 3.



Note: You should write down the new Reference Att.
The maximum Att allowed, is 40 dB. Anything above 40 dB would be suspect.

5.B Initial Adjustment of the slope and offset

5.B.1 Call up display 19.



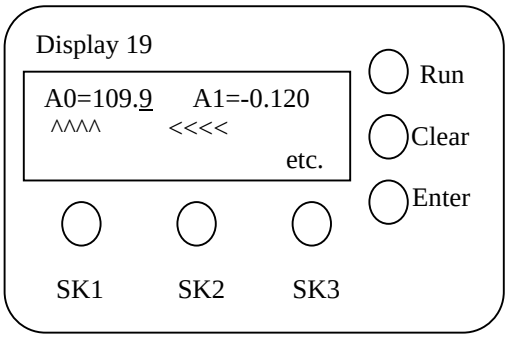
Step 1. Select the Calibr. Menu .
Step 2. Select the Prod1 or Prod2 Sub-Menu, display 19 should be seen.
Step 3. The initial slope, A1, will be installed at the factory and should Be between -.05 and -0.25.

If you are not sure of the slope, please find typical values in Section 7.

Step 4. Adjust the offset, A0, in the following manner:

a. Install the system, enter starting slope A1, perform Reference Measurement. Put in Run mode.
b. With material stable take a sample of material and analyze. Adjust the offset so the live readings are as close as possible to the sample value. The initial slope and offset adjustments are completed.

The initial offset is determined by comparing an initial sample against the initial reading.



Example: initial slope = -0.12
initial offset = 80.9
initial pMt 581 reading = 56.0
initial Lab reading = 76.0

76.0 – 56.0 = 20.0

20.0 + 80.9 = 109.9

adjusted offset = 109.9
adjusted pMt 581 reading = 76.0

5.C Making Final Adjustments to the Calibration Line.

The secret to getting a good final adjustment is in sampling. If you get representative samples you will get a good calibration.

5.C.1 Collecting data – you should run the system long enough to see the °Brix change a minimum of 1.5 to 2.0 °Brix. During that time period, you should write down the pMt 581 value and the value of the sample. You will get a table of numbers like table 1.

Sample Number	Lab	pMt 581	Sample Number	Lab	pMt 581
1	72.1	73.2	11	73.6	75.1
2	73.5	75.0	12	71.5	72.5
3	72.3	73.4	13	73.7	75.3
4	71.1	72.0	14	71.2	72.1
5	71.1	72.1	15	73.6	75.2
6	72.3	73.4	16	71.6	72.6
7	71.5	72.5	17	72.2	73.3
8	72.6	73.8	18	72.0	73.1
9	72.6	73.9	19	71.1	72.1
10	72.0	73.1	20	72.6	73.8

5.C.2 Analyzing the data – you should enter the Lab and pMt 581 values into any simple statistical program capable of simple Regression Analysis. There will be a Regression line computed by the statistics program

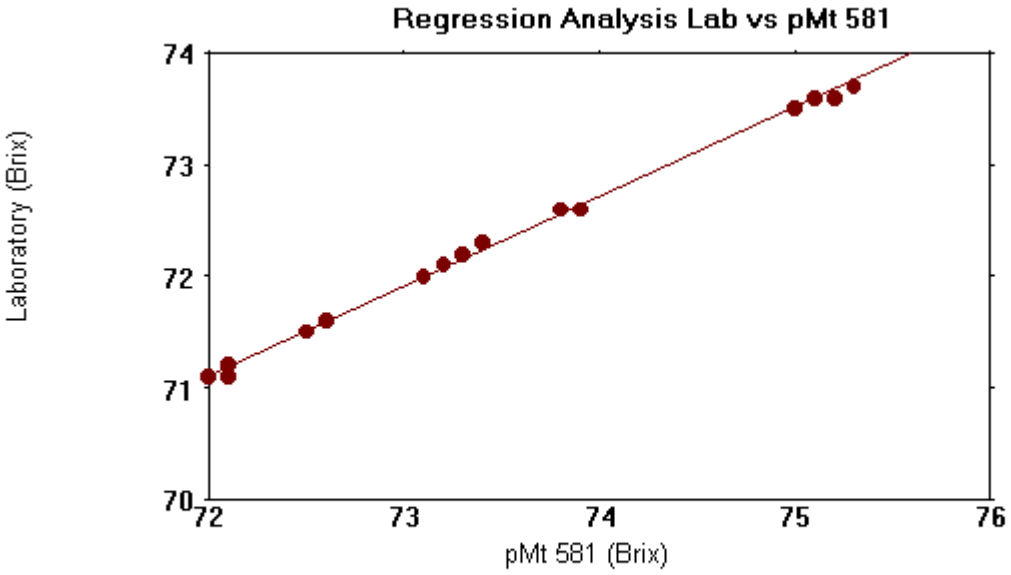
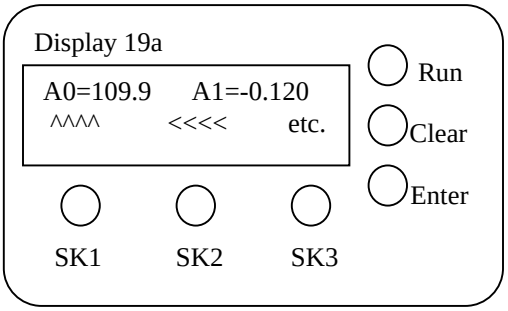


Figure 9 Regression plot for Calibration

Correcting Regression Line: Lab = **13.4** + **0.8015** (pMt 581)

5.C.3 Correcting the slope and offset – you will use the Regression line to correct the slope and offset by the following method:



The Old Values are found in Display 19a

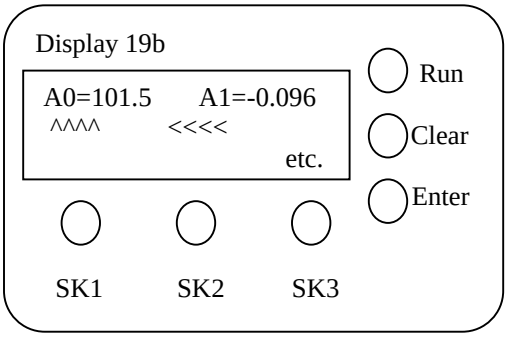
Old Slope Value (A1 Old) =-0.1200
Old Offset Value (A0 Old) = 109.9

Correcting Slope of Regression Line = 0.8015
Correcting Offset of Regression Line = 13.4

New Slope Value (A1 New) = Old Slope Value (A1 Old) x Correcting slope of Regression line (m)
New Offset Value (A0 New) = Old Offset Value (A0 Old) x Correcting slope of Regression line (m) + Correcting offset of Regression line.

A1 New = -0.120 x 0.8015 = -0.096
A0 New = 109.9 x 0.8015 + 13.4 = 101.5

Enter the A1 New and A0 New into display, see display 19b.



5. D Selecting a Calibration Line Type

Under most circumstances, a linear type line is chosen. If the linear function is chosen as the moisture evaluation function the measurement value is calculated with a linear function of the following form:

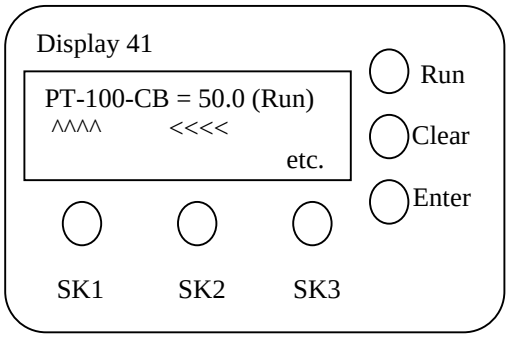
5.D.1 Moisture content = A1 * x + A0 ; x = microwave signal (linear)

There are 2 calibration line types other than the linear – ln and exp.

1) Moisture content = A1 * ln(x); x = microwave signal (log natural)
2) Moisture content = A0 * exp (A1*x); x = microwave signal (exponential)

NOTE: Coefficients for the exponential and log natural calibration curves must be calculated after collecting at least 30 points.

6. Calibrating the PT100 Input Circuit



The PT100 input can be calibrated using a 100-ohm precision resistor. In a new installation or new instrument this calibration will have been done at the factory. If re-calibration is necessary the following procedure can be followed:

Step 1. Connect to the PT100 input a 100 ohms precision resistor.
Step 2. Select System Menu and then the User Sub-Menu, display 41 Should be shown.
Step 3. Press Run button and wait until the measurement has stabilized.
Step 4. Press Run Button to stop calibration and to restore the value.

7. Installation

7.A Configuration possibilities

7.A.1 There are presently two (2) types of **Insertion Probes**, one (1) In-line sensor, and one (1) type of Bulk Material Moisture Sensor available for use with the pMt 581 Microwave System:

1) **pMt 581 is used in Vacuum Pans (Figures 10 and 11).**

2) pMt 581 is used in Pipeline and Vessel applications – Thick Juice, Milk-of lime, and Cement and Gypsum Slurries (Figures 12,13 and 14).

3) pMt 581 In-line Gage is used with Tuchenhagen In-line pipes. Available for pipelines from 2 – 6 " in diameter (Figure 15).

4) pMt 581 Moisture Sensors for measuring the moisture of Bulk Materials on belts, in chutes, and in pipelines (Figures 16 and 17).

7.A.2 The pMt 581L – used in Vacuum Pans. A general sketch of this probe is shown in Figure 10.

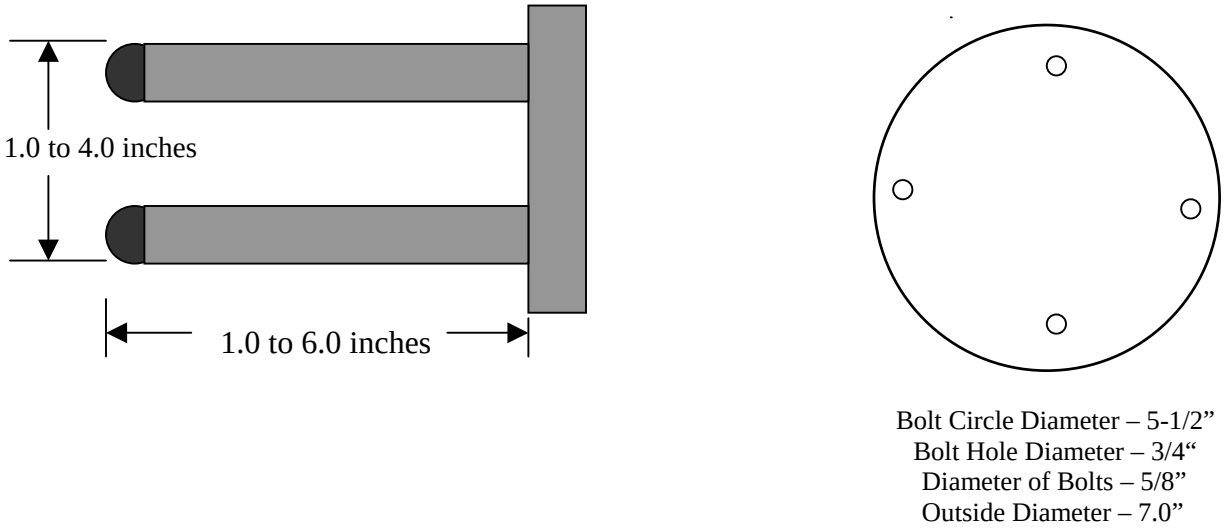


Figure 10

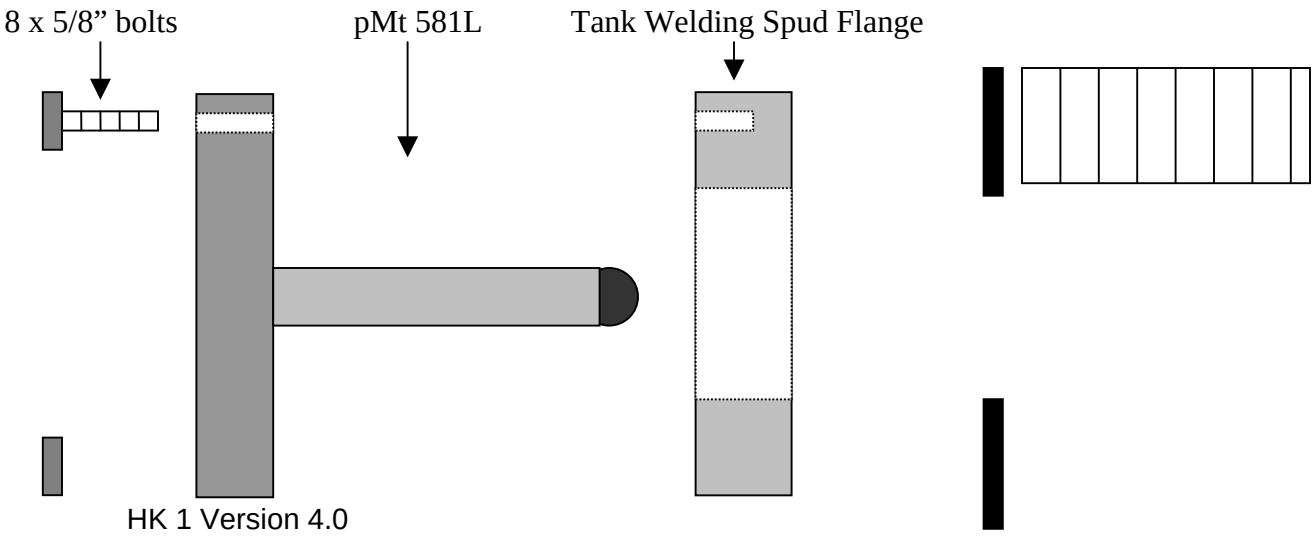
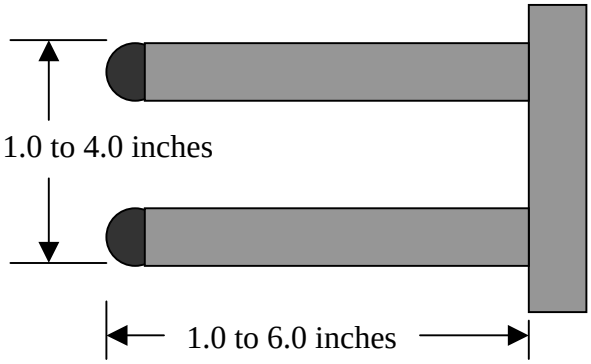
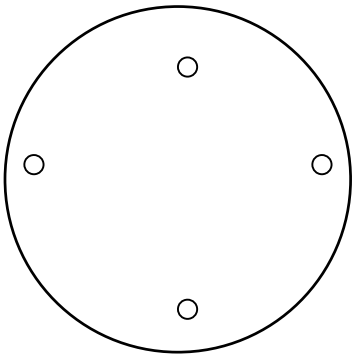


Figure 11 Exploded view of Vacuum Pan Installation

1) **The pMt 581L mounts to the Vacuum Pan using a standard 2-1/2 inch ASA flange (see Figure 11).**
2) **The best mounting flange to use with this installation is seen in Figure 11.**
3) **The best positions for the installation are directly under or over the Callandria so that there is a continuous flow of representative material past the probe. Above the Calandria is the easiest location to install the sensor. If the position above the Calandria is completely covered after charging the vessel, install here. If the position above the Calandria is not completely covered it is best to install the system below the Calandria**.
4) When inserting the pMt 581L, the antenna should be mounted so they lie in a horizontal plane.



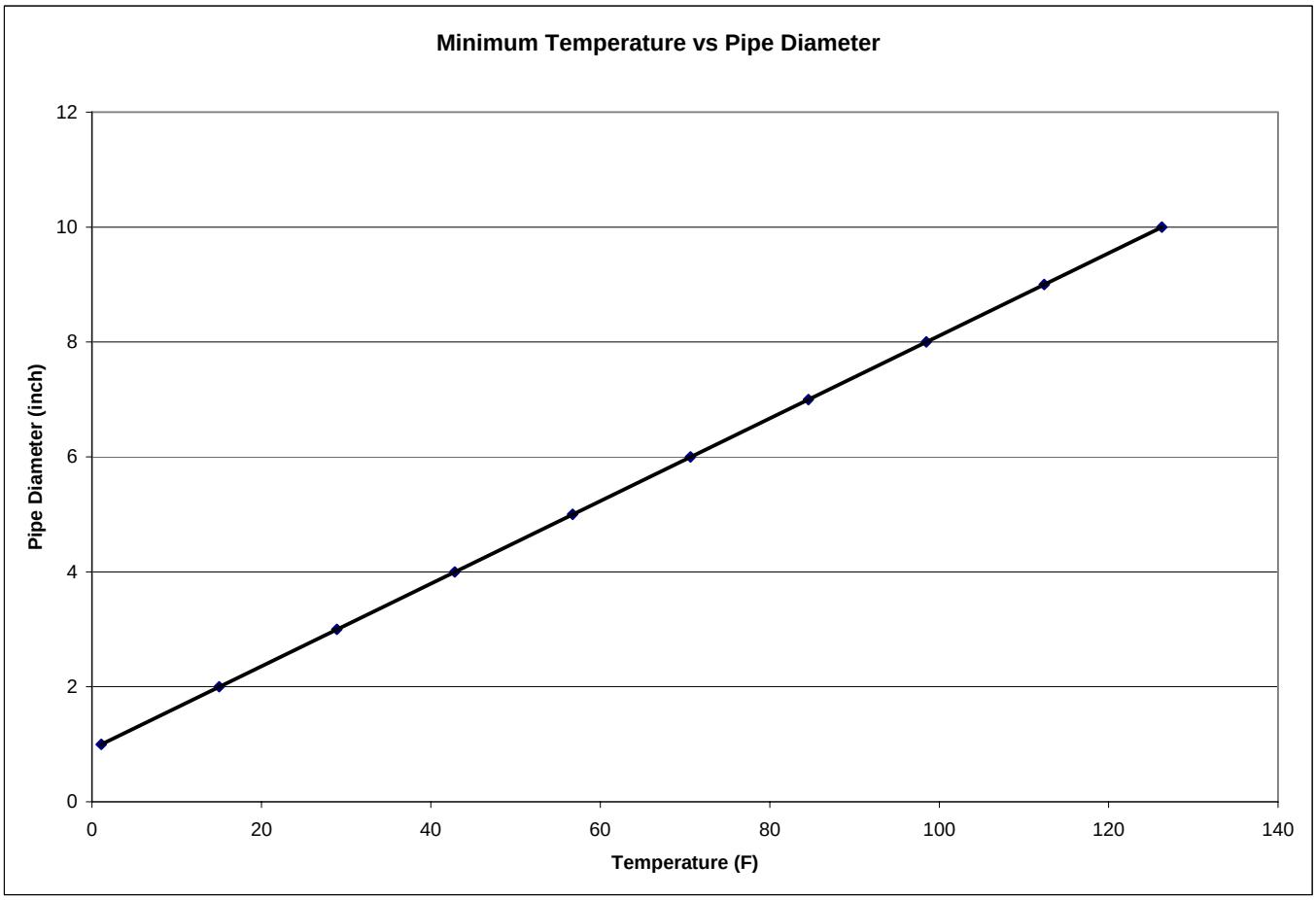


Bolt Circle Diameter – 5-1/2”
Bolt Hole Diameter – 3/4“
Diameter of Bolts – 5/8”
Outside Diameter – 7.0”

8. Technical data control unit

System:	1 Microprocessor with EPROM memory
Housing:	IP 65
Dimension:	HxBxD = 230 x 200 x 110 mm (9.1” x 7.9” x 4.3”)
Weight:	4.5 kg (10 lbs)
Voltage:	230 / 115 V $\pm$ 15%, 47-65 Hz
Power consumption:	230 / 115 V 50 VA
Signal output 1:	0/4 - 20 mA; isolated; product temperature, max. load resistance 500 ohms.
Signal input:	0/4 - 20 mA; not isolated; temperature; range - 50^{O}C and 200^{O}C or PT100 (2

	wire connection and max. cable length 50 m.)
HF-connection:	N-connection for microwave probe; max. cable length 2 meters with N-connectors.
RS 232 port:	2400, 4800, 9600 Bd
Display:	2 x 24 characters LCD, dialogue with push buttons and alphanumeric display.
Microwave frequency:	ISM - Band; 5.8 Ghz
Maximum power:	0dBm, 1mW
Sensitivity:	-80 dBm, 10 nW
Instrument outputs:	4 x PG11, 2 x Hf outputs with N-connectors at the bottom of the system.
Operating temperature:	0 ^{o}C to 50 ^{o}C
Storage temperature:	-40 ^{o}C to 85 ^{o}C
Standard BZT	ZZF no. requested
CE-mark	
Noise immunity:;	IEC 801, part 1-5
Radiation:	VDE 0871 Klasse B
Instrument safety:	IEC 1010-1



Minimum Temperature (F)	Pipe Diameter (Inch)
15.0	2
28.0	3
43.0	4
56.0	5
70.0	6
84.0	7
98.0	8
112.0	9
126.0	10

The above Table shows the Minimum Temperatures which are required for the Non-Contacting Sensor. Examples:

1. If you want to install the Non-Contacting Sensor on a 6 inch Pipe, your Process Fluid needs to remain equal to or above 70.0 Degrees F.
2. If you want to install the Non-Contacting Sensor on a 8 inch Pipe, your Process Fluid needs to remain equal to or above 98.0 Degrees F.