OPERATING MANUAL

HK – 2 MICROWAVE INSTRUMENT SYSTEM

for

Measuring

Brix, % Total Solids or % Concentration

of a

Liquid Product in a Vessel or a Pipe

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Using the HK-2 Microwave Insertion System to measure % Total Solids, °Brix, grams/cc or % Concentration, of a liquid in a Pipe or Vessel.

I. INTRODUCTION

A. This manual will explain the setup for using the HK-2 with a liquid in a Pipe or Vessel.

B. There are several parameters to check and one (1) measurement to make when setting up the HK-2 Microwave System.

C. SINGLE POINT and MULTI POINT Calibrations are possible.

D. The only unit of measure that will be referenced from here on, will be % Total Solids. It will represent all units of measure available

E. The front panel of the HK-2 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.

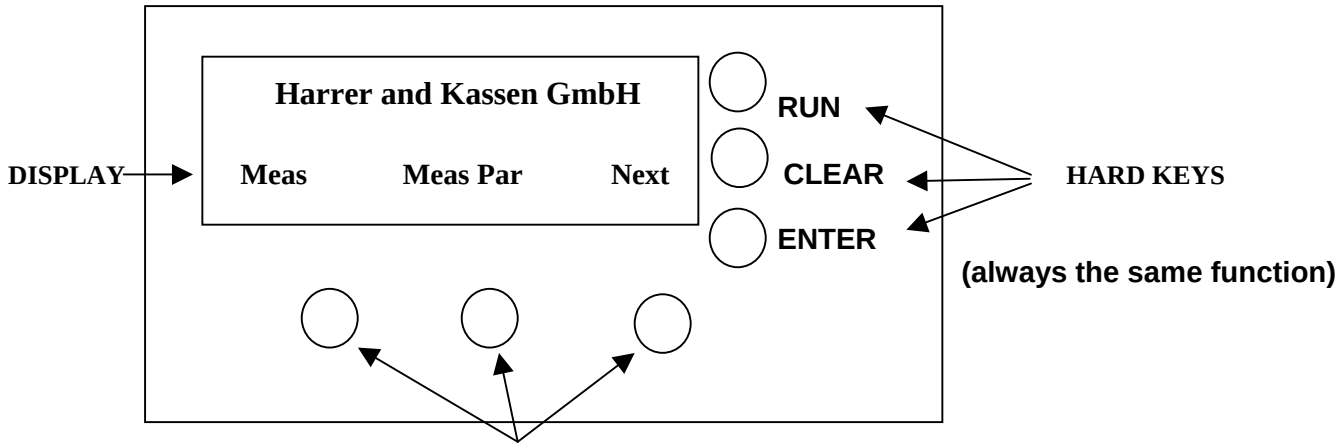


Figure 1 Front Panel of the HK-2

II. Quick Set UP

A. Installing a Microwave System

1. Bracket Dimensions for mounting the Microwave Transmitter can be found in Appendix.
2. Dimensions for installing the Compact Unit can be found in Appendix.

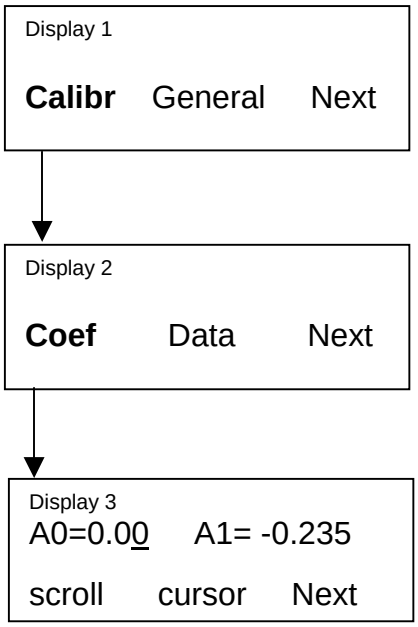
1) When installing a Modular Unit HK-2M
   a. Install the Transmitter as close as possible to the Insertion Sensor Pins.
   b. Do not over tighten the coaxial connectors. Tighten with hand and snug with a wrench.
   c. Take care that no water or dirt gets in to the coaxial connections.
   d. Do not bend the coaxial cables directly at the connector.
   e. Use tie raps to secure the cables to something fixed.

f. Protect the cables from being cut or moved after calibration.

2) When Installing the HK-2 Compact Unit
   a. The Compact Unit must be installed on Pipelines or Vessels that do not have high vibration. Typical vibration levels found in most applications do not present a problem.
   b. Make sure the mounting neck is as short as possible so the Sensor Pins are properly positioned in the liquid stream.
   c. The standard flange for mounting is 2-1/2" ANSI.

B. Calibration – Procedures for a Single Point Calibration

Step 1: Check Slope (A1) and Offset (A0)
Step 2: Perform the REFERENCE MEASUREMENT
Step 3: Input Value of Lab Sample
Step 4: Input Measurement Range



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

1. Select the Calibr. Menu from Display 1.
2. Select the Coef Sub Menu from display 2.
   Set the Offset (A0) = 0.00 for operation (Display 3).
3. Set the Slope (A1) with a value determined by manufacturer.
   Default is around -0.235 (Display 3).
4. To learn how to use the Software and Hardware Keys;
   See section VI Page 12 on Entering Numbers.

D. PERFORMING THE REFERENCE MEASUREMENT:

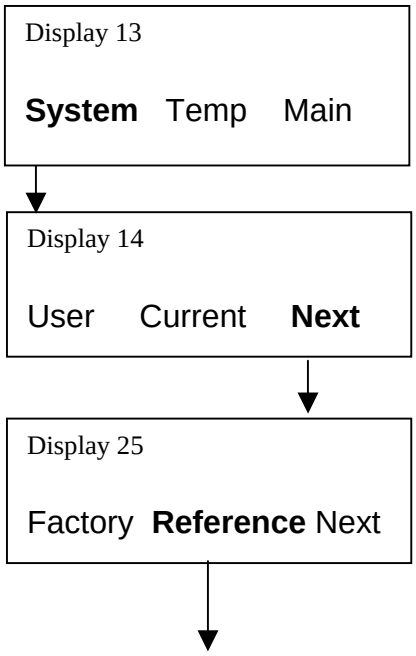
NOTE: SYSTEM WILL NOT WORK UNTIL YOU PERFORM REFERENCE MEASUREMENT

1. The Reference measurement requires the following condition:

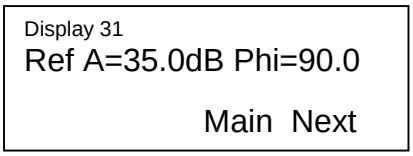
   a. Stable, material in the pipe or vessel.
   b. Operating Temperature stable and typical.

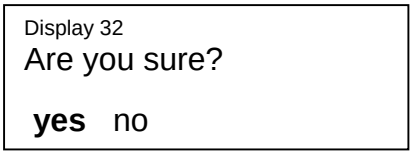
Step 1: Select the System Menu from Display 13
Step 2: Select Next from Display 14.

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.

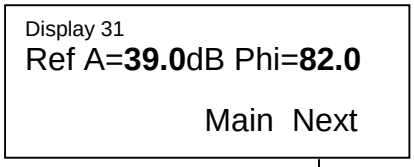


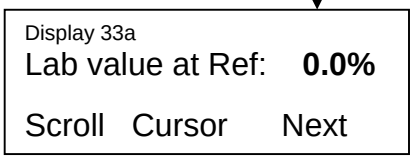


Step 7: Record new numbers which appear Display 31 for A= 39.0, And PHI=82.0.

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.

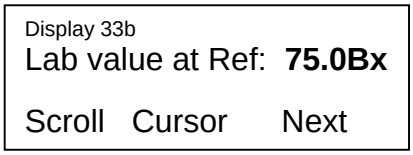
Max allowed 55 dB
Min allowed 5 dB





E. Inputting Lab Value for Initial Single Point Calibration

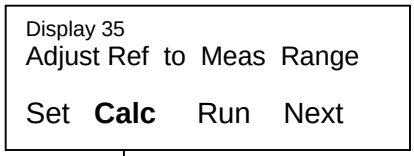
Step 1: A sample of the Sugar Solution must be collected at the same time The Reference Measurement is Performed.
Step 2: Take sample to the lab for analysis of the Bx.
Step 3: Press Next Display 31.
Step 4: Input lab value, (example 75.0Bx) into Display 33a. Press Enter Display 33b.

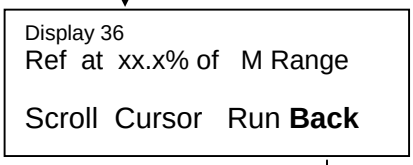


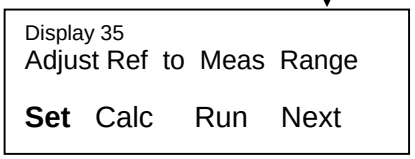
F. Computing the measuring Range.

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

Step 1: After you enter 75.0 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.







G. Set the P-Min and P-Max to disregard bad readings (see Page 13). Set P-Min to 60 Bx and the P-Max = 100 for Vacuum Pans.

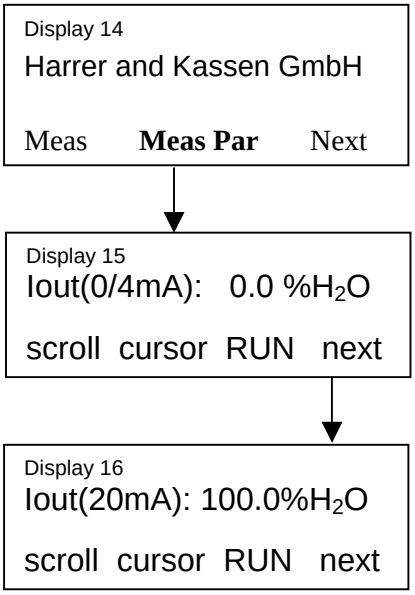
III. Setting the Current Outputs

A. 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 – 100%.

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

Step 1: Select Meas. Par menu from display14.
Step 2: Select next until display 15 is shown. Use scroll and cursor keys to input 0.0 % for the 4 mA
When you see a 0.0% in display 15, Press Enter Key

E. Enter the value of 100.0 into the display 16 to set the 20 mA output.



IV. Setting Min and Max P-values

A. Go to the LIMITS Sub Menu Page 15, for instructions about setting the P-value Min and Max.

YOU ARE NOW READY TO RUN.

YOU ARE NOW READY TO RUN WITH AN INITIAL SINGLE POINT CALIBRATION.

Notes:

1) **To get a good response from the Start of the Batch to the end of the batch, you must collect 1 or 2 samples at the start of the range and 1 or 2 samples higher in the range. The samples should be at least 10 Bx apart. You can use this data to Fine Tune the Calibration Curve. See Section XI; Final Adjustments to the Calibration Curve, Regression Analysis on Pages 16-18. If you have difficulty with this procedure, call 412 653 7717.**

IV. Basic Operating Principles of the HK Microwave Instrument System

The HK-1 and HK-2 Instrument Systems use a microwave signal to determine the water content of solutions and slurries. Microwaves are electromagnetic waves similar to radio waves. Just like radio waves, microwaves are capable of traveling from a transmitter to a receiver in either a vacuum or through a space filled with a material.

When the microwave signal travels in a vacuum; its speed, frequency, and energy are constant. When the space is filled with a material containing a varying amount of water; the speed, frequency and energy of the wave will change as the water content varies. By measuring the changes in the properties of the microwave signal, it is possible to determine the amount of water in the material.

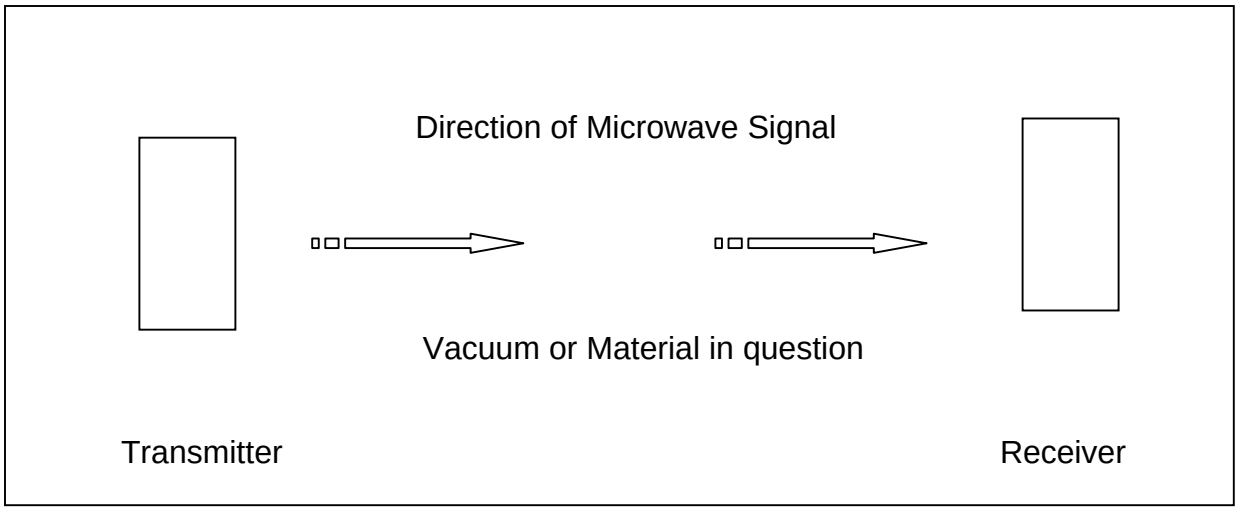


Figure 1

The water molecules found in the material have the greatest effect on the microwave signal. The higher the water content, the higher the Phase Shift.

A. Basic System Configurations

- The **HK 2-M** Microwave Instrument System is configured as a 3 piece modular system. The 3 sub-systems are:

1) Microwave Transmitter (Figure 2).
2) Coaxial Cables (Maximum length 2 meters (6.6 feet)). The shorter the better.
3) Microwave Insertion Sensors (pair) (see Page 26). The Insertion Sensors can be installed in the following configurations:
   a) Insertion Sensors mounted on a 2-1/2" Flange (Figure 3).
   b) Insertion Sensors mounted in a pipe or vessel with threaded dowels.
   c) Insertion Sensors mounted in a Spool Piece.

- The **HK-2 Compact System** is a one-piece unit mounted on a 2-1/2" ANSI flange (Figure 4).

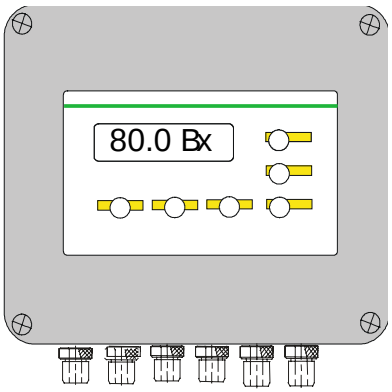
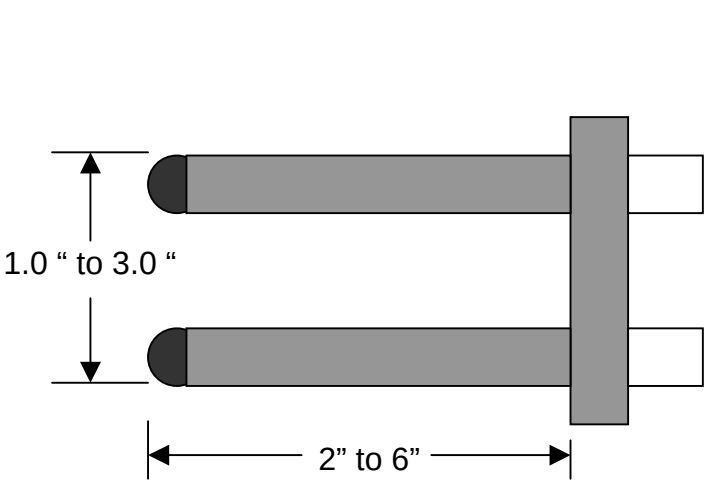
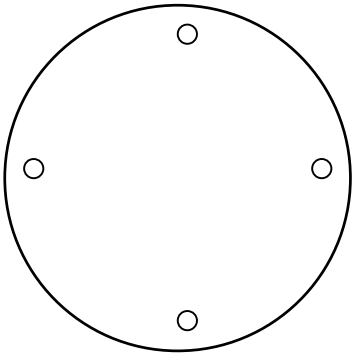


Figure 2 The Microwave Transmitter



2-1/2 inch flange



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

Figure 3 Insertion Sensor on 2-1/2” Flange

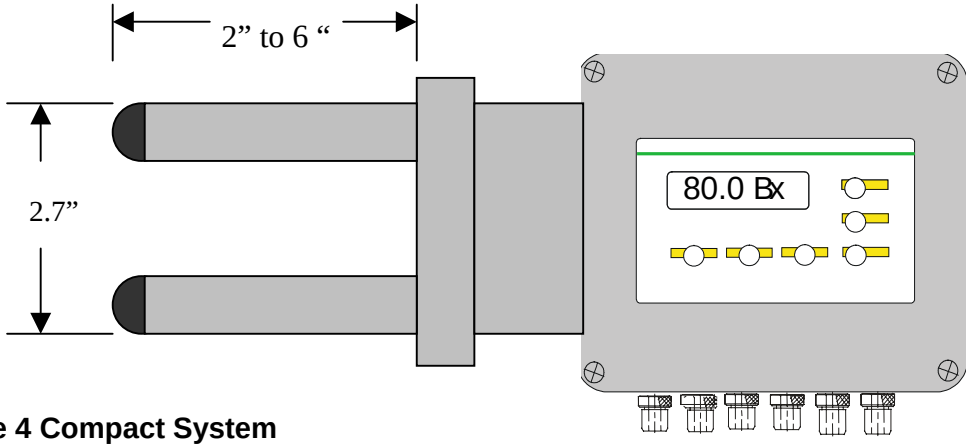


Figure 4 Compact System

V. Principles of Signal Generation

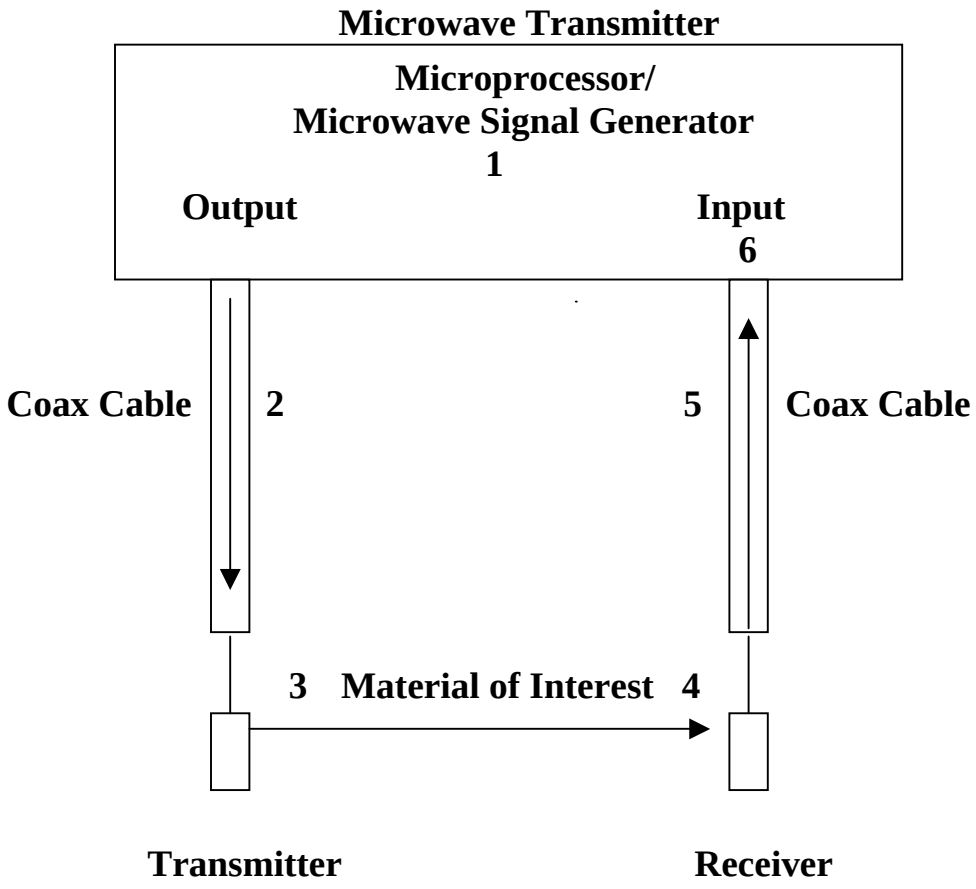


Figure 5

A) The HK Microwave System performs the following steps during its measurement cycle:

1) A microwave signal is produced in the Microwave Transmitter
2) The signal is transmitted from the Microwave Transmitter to an Insertion Sensor over a coax cable.
3) One Insertion Sensor acts as a transmitting antenna, and one acts as a receiving antenna.
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 Microwave Transmitter
6) The Microwave Transmitter receives the signal and measures its properties

VI. User Interface

A. Basic Principles

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 Microwave Transmitter (Figure 6). There are six (6) buttons, which allow the user to interface with the menu driven software that run the HK systems.

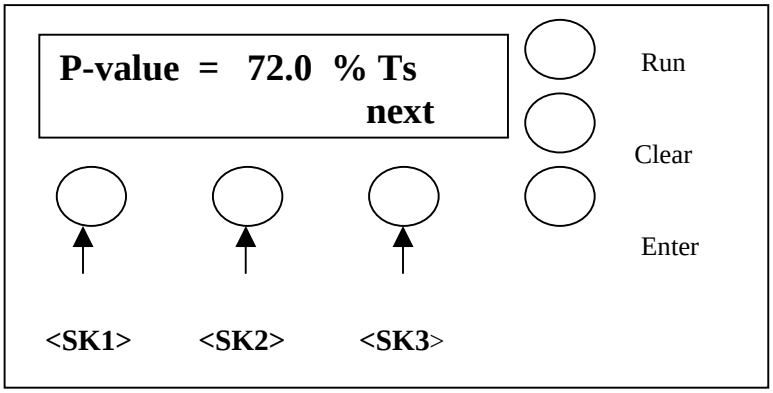


Figure 6

1. Keypad

A. SOFT KEYS (SK1, SK2, and SK3) – Variable Functions controlled by software

<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

B. HARD KEYS – Fixed Functions controlled by Hardware

<Enter>
- This button is pressed to confirm an input or change
  Deletion of error messages

<Clear>
- Press to clear display and return to last known value

<Run>
- Starts and stops the measurement

VII. Menus

A. System Software uses the following menus and sub-menus for configuration:

MENU	SUB-MENU
Main	
	Measure
	Meas. Par.
General	
Calibr.	
	Coeff.
	Data
Temp.	
System	
	User
	Current
	Limits
	Reference
	Factory
	Protected

B. Menu Name and Menu Description

1. Main The Main Menu has the following sub-menus

a. Measure Display of Live Readings in the following **ENGINEERING UNITS: Bx, %H_2O, %Ts, %, and g/cc**
Attenuation and Temperature are also available in this sub menu

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

1) Time constant for signal averaging. Range 0-999 sec
2) Current output values – Set range for 4mA= and 20mA=

2. General General parameters are located in this menu:

a) Locking and unlocking the keypad
b) Selection of language
c) Set Relay Function Control (Optional – need to have had relay installed)
d) Units of measure

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

a. Coeff. Set the offset (A0), and slope (A1) of Calibration Line

b. Data Calibration data points are located here (Call Factory)

4. System There are 6 sub-menus accessed through this menu;

a. User

1) Baud rate for serial output
2) Data format for serial port

b. Current

1) Select Current output for 0-20 mA (Euro) or 4-20 mA (US) Output Range
2) Test current set here

c. Limits

1) Set Upper and Lower Attenuation Limits
2) Set Upper and Lower Limits for Measured Signal
3) Set max Brix rate (sugar only)

d. Reference

1) Perform Reference Measurement in this Menu.
2) Set Lab Value for **Single Point Calibration**
3) Set range of measurement

e. Factory menu requires password and is normally not accessible

f. Protected menu requires password

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

VIII. Entering Numbers

A. DEFINITIONS

1) SOFTKEY – When you press a SOFTKEY you tell the computer to perform the task which is written above it.
2) SCROLL – Causes the value of the number above the blinking cursor to increase.
3) CURSOR – Moves the cursor across the display.
4) ENTER button is a HARDWARE button which confirms changes made by the SCROLL and CURSOR SOFTKEYS.

Display 16a
Iout (20 mA): **2**0.0 Bx

scroll cursor next

Display 16b
Iout (20 mA): 100.0 Bx

scroll cursor next

B. Changing a number in the Display.

1. Current value = 20.0 Bx (Display 16a)
2. New value = 100.0 Bx (Display 16b)

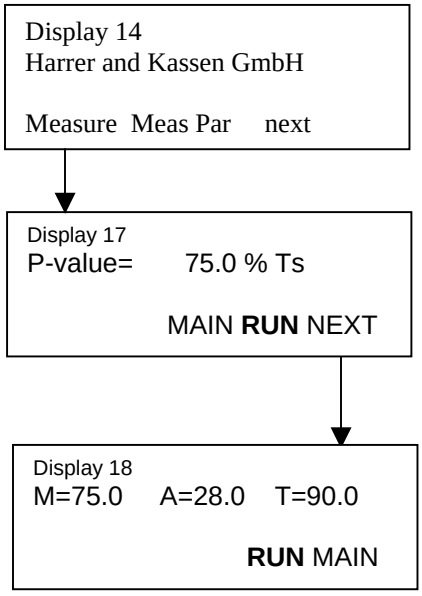
Display 16b
Iout (20 mA): 100.0 Bx

scroll cursor next

Step 1. Move cursor by pressing the cursor Button in display 16a.
The cursor should now be under the 2, display 16a.
Step 2. Press scroll and cursor keys to change the 20 to a 100, Display 16b.
Step 3. When you have changed the 20 to a 100 (display 16b).
Press Enter.

IX. Using System Software

A. MAIN MENU - Display 14
B .Measure Sub Menu



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

Step 1. Select the Measure Menu.
Step 2. Display 17 should be shown, live readings should be in display.
Step 3. Press Run Button to place system in measurement mode. The word **RUN in CAPITAL LETTERS** must be in Display 17

2. Getting the live reading of the Temperature and Attenuation in the display.

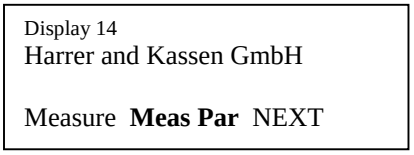
Step 1. Select the Measure Menu from MAIN Menu (Display 14).
Step 2. Press Next button to see Display 18. These are live readings of the following parameters:

M = Measured Value, Identical to the displayed value.
A = Attenuation, not time averaged
T = Temperature, Degrees Celsius

Note: Two (2) wire SENSOR is required for temperature measurement with Modular Units. The Compact Unit has a built in RTD.

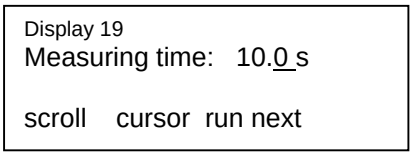
C. Meas. Par. Sub Menu

1. Setting the system time constant.



a. The value of the time constant will depend on the following factors:

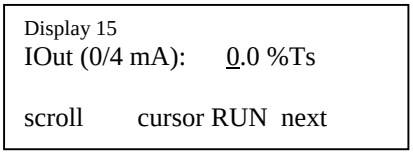
- The consistency of the material being measured.
- The rate at which the material may change.
- The requirements of the control loop.



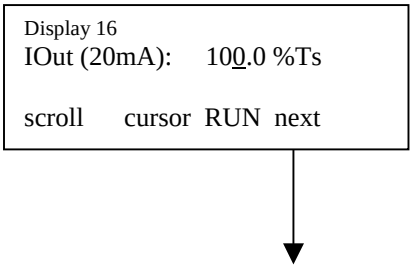
A good starting value for an insertion or in-line measurement would be 10.0 sec. This can be reduced or increased depending on the performance of the instrument. Too low is not good (1 sec) and too high is not good (100 sec).

Step 1: Select Meas Par Sub Menu Display 14
Step 2. Display 19 should be shown.
Step 3. Press scroll button to change the number above the Cursor.
Step 4. Press cursor button to re-position the Cursor.
Step 5. Press Enter button when the display shows the time constant you wish to use.

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



Step 1. Select the Meas. Par. Sub Menu
Step 2. Display 19 should be shown.
Step 3. Press next button until display 15 is shown.
Step 4. Press scroll button to change the number over the Cursor.
Step 5. Press cursor 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 %Ts.

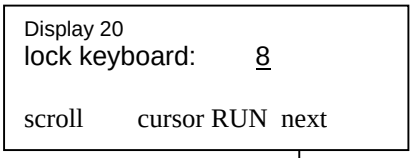


3. Setting the 20 mA of the system current output.

Step 1. Press Next Display 15.
Step 2. Use scroll and cursor keys to enter 100.0%
Step 3. Press Enter button when the desired 20 mA value is in the display. In this case the value representing 20 mA is 100.0 %Ts.

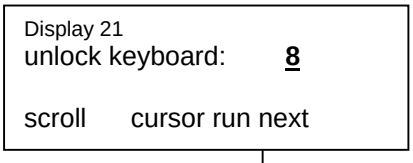
D) General Menu

1. Locking the keypad – when it is necessary to protect the data in your Microwave Transmitter from unauthorized access, it is possible to enter a pass number to lock out keypad access.

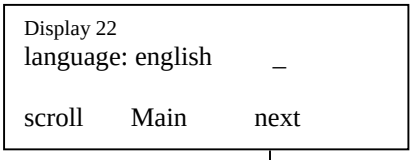


Note: Make sure the system is in the RUN mode before locking the keypad.
Step 1. Select General Menu, Display 1.
Step 2. Use Scroll and Cursor Keys to enter 8 over cursor, Display 20.
Step 4. Press the Enter button. This number has become your password. The keypad is now locked and you must re-enter this passnumber to unlock it.

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 next button until display 21 is shown.
Step 3. Press scroll button to place the number 8 over the Cursor.
Step 4. Press the Enter button to unlock keypad.



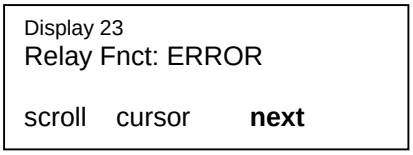
3. Changing the language of your Microwave Transmitter

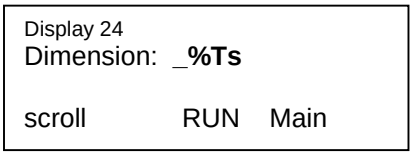
Step 1. Select the General Menu.
Step 2. Display 1 should be in the display.
Step 3. Press next button until display 22 is shown.
Step 4. Press scroll button until language of choice is shown.
Step 5. Press the Enter button to select language in display.

4. Relay Function (display 23)

Three settings are:

ERROR
Min Thresh
Max Thresh.



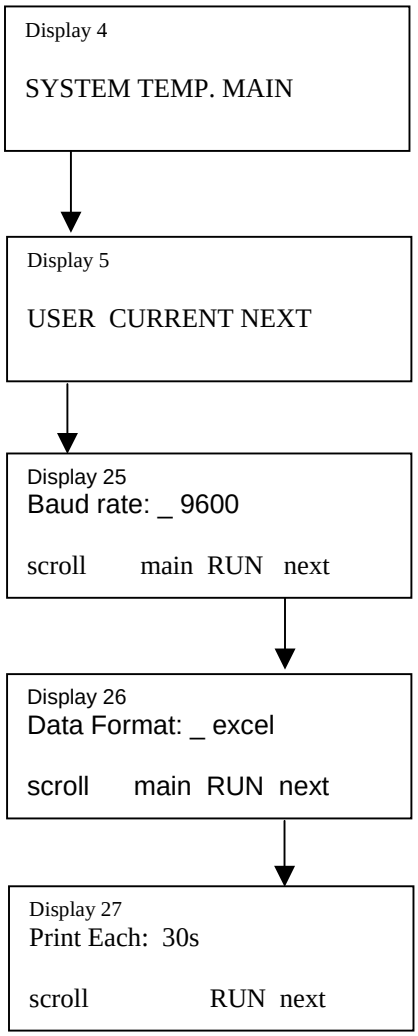


Most US units do not have relays. If your unit does, the above will select its function.

5. Selecting the units of measure.

Available Units of Measure:
Bx, g/cm3, %, g/l, %H_2O, %Ts

Step 1. Select the General Menu.
Step 3. Press next button until display 24 is shown.
Step 4. Press scroll button until the desired units are in Display, %Ts.
Step 5. Press Enter button to select units.



E) System Menu

1. USER SUB-MENU

A. Selecting the baudrate for the serial output.

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 25 should be shown.
Step 3. Press scroll button to change the baudrate.
Step 4. Press Enter button when desired value is in display

Available rates 4800 and 9600 baud.

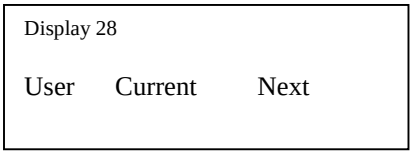
B Selecting the output format for serial data.

Step 1. Select the System Menu and then the User Sub-Menu.
Step 2. Display 25 should be shown.
Step 3. Press next button display 26 is shown.
Step 4. Press scroll button to change the format, Excel or Normal.
Step 5. Press Enter button when desired format is in display

C. Select the timing for the output of the serial data
OFF, 10s, 30s, and 60s

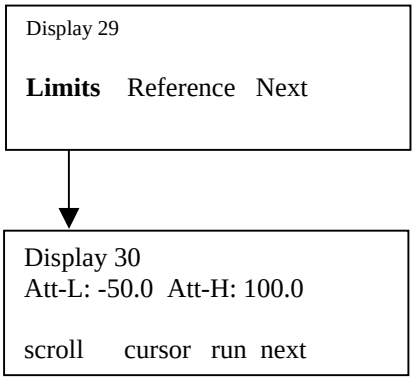
Step 1. Select the System Menu and then the User Sub-Menu.
Step 3. Press next button until display 27 is shown.
Step 4. Press scroll button to change the timing of output.
Step 5. Press Enter button when desired value is in display

2. LIMITS SUB MENU



A. Setting Minimum (Att-L) and Maximum (Att-H) allowed Attenuation.

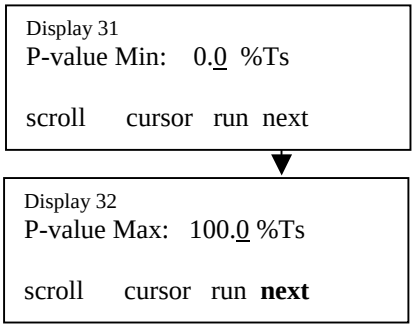
NOTE: Unless this is a special application, leave default values of -50.0 and 100 alone. The system will run good.



Step 1. Select the System Menu and then the **Limits** Sub-Menu
Step 2. Display 30 should be shown.
Step 3. Use scroll and cursor keys to first set the Min Attenuation.
Step 4: Press Enter button to accept Att-L value and move cursor To Att-H.
Step5. Use scroll and cursor keys to change Att-H value.
Step 6: Press Enter to accept Att-H value.

B. Setting minimum and maximum acceptable P-values.

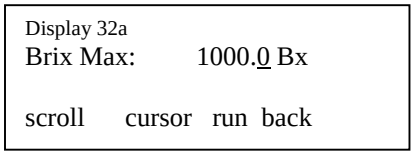
Note: Erroneous readings are sometimes possible with Microwave Instrument Systems. To assure that these readings are discarded as no good, we input a value for the Minimum acceptable reading, P-value Min (Display 31), and the Maximum acceptable reading, P-value Max (Display 32).



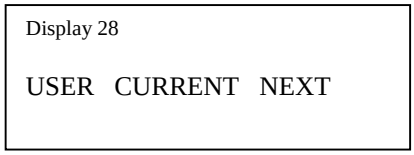
1. Setting Minimum Value, (P-value Min)

Step 1. Press next key until you see display 31.
Step 2. Use cursor button to move cursor and scroll button to change the value P-value Min.
Step 3. Enter new value with Enter button.
Step 4. Minimum value should be set at 2 to 5 Brix below lowest expected reading. EX: Lowest expected Reading = 70 Brix, P-value Min = 68 Brix

2. Setting Maximum Value, (P-value Max)



Step 1. Press next key until you see display 32.
Step 2. Use cursor button to move cursor and scroll button to change the value P-value Max.
Step 3. Enter new value with Enter button.
Step 4. Maximum value should be set at 2 to 5 Brix above highest expected reading. EX: Highest expected Reading = 90 Brix, P-value Max = 92 Brix



E. Selecting the current output range: 0-20 or 4-20 mA

Step 1. Select the System Menu and then the Current Sub-Menu, Display 28.
Step 2. Display 23c should be shown.
Step 3. Press scroll button to change range from either 0-20 mA (European) 4-20 mA (USA)
Step 4. Press Enter button when desired value is in display.

F. Entering a test current (must not be in Run mode)

Step 1. Select System Menu and then the Current Sub-Menu.
Step 2. Press scroll key until display 33 is shown.
Step 5. Press scroll button to select the value of the test current. The system will output 4 mA when it looks like Display 33, with 5 mA entered.
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.

Display 33
Current Output: 4-20mA

scroll main RUN next

Display 33
test current: **5** mA

scroll cursor back

NOTE: YOU MUST ENTER A VALUE THAT IS 1 NUMBER HIGER THAN THE CURRENT OUTPUT YOU WANT TO MEASURE.

G. Selecting the Measurement Type. Phase Shift, Attenuation, or Phase/Attenuation

NOTE: PHASE IS ALWAYS USED.

Step 1. Select the System Menu and then the Reference Sub-Menu
Step 2. Press scroll button to select the Phase, or Attenuation.
Step 3. Press Enter button when desired value is in display

Display 6

Factory **Reference** Next

Display 4

System **Temp.** Main

H. TEMPERATURE MENU, (TEMP.)

1. Activate temperature measurement

Step 1. Select the TEMP. Menu, display 4
Step 2. Press next button, display 34 should be in display.
Step 3. Press scroll button to activate temperature.
Step 4. Press Enter button when desired value is in display.

Display 34
Temp.Measurement:_ON

scroll main NEXT

Display 35
T-Offset= 0.0 C

scroll cursor NEXT

2. Entering a linear temperature offset.

Step 1. Select the Temp. Menu
Step 2. Press <SK3> button, till 38 is in the display.
Step 3. Press <SK1> button to change the number over the Cursor.
Step 4. Press <SK2> to re-position the Cursor.
Step 5. Press Enter button when desired value is in display.

Display 36

T-Product= 100 C
NEXT

3. Activating temperature compensation

Step 1. Select the Temp. Menu
Step 2. Press next button, till 37 is in the display.
Step 3. Press scroll button to activate temperature compensation.
Step 4. Press Enter button when desired value is in display.

4. Entering Linear temperature coefficient

Step 1. Select the Temp. Menu
Step 2. Press next button, till 38 is in the display.
Step 3. Press scroll and cursor buttons to enter a Linear Temp coefficient TK1. and the normal operating temperature Tref
Step 4. Press Enter button when desired value is in display. After entering TK1, the cursor will move under the Tref.

Display 38
TK1: 0.000 Tref:= 0

scroll cursor NEXT

Display 39
TK2: 0.000 E-3

scroll cursor MAIN

5. Entering Square temperature coefficient

Step 1. Select the Temp. Menu
Step 2. Press <SK3> button, till 50f is in the display.
Step 3. Press <SK1> and <SK2>buttons to enter a Square Temp coefficient TK2.
Step 4. Press Enter button when desired value is in display. After entering TK1, the cursor will move under the Tref.

X. Calibration Muti Point

NOTE: If the Single Point Calibration is not accurate enough, perform a Multi-Point Calibration.

Step 1. Perform the Single Point Calibration.
Step 2. Perform a dynamic calibration by collecting product samples for lab analysis while recording the HK-2 Reading.
Step 3: Enter lab values and instrument values into a Regression Program to determine a new slope and offset.

Display 40
A0=70.0 A1=-0.235

scroll cursor next

XI. 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.

A) Collecting data – you should run the system long enough to see the %Total Solids change a minimum of 1.5 to 3.0 % Ts. During that time period, you should write down the Microwave value and the value of the sample. You will get a table of numbers like table 1.

Sample Number	Lab	Microwave	Sample Number	Lab	Microwave
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

B) Analyzing the data – you should enter the Lab and Microwave values into any simple statistical program capable of simple Regression Analysis. There will be a Regression line computed by the statistics program

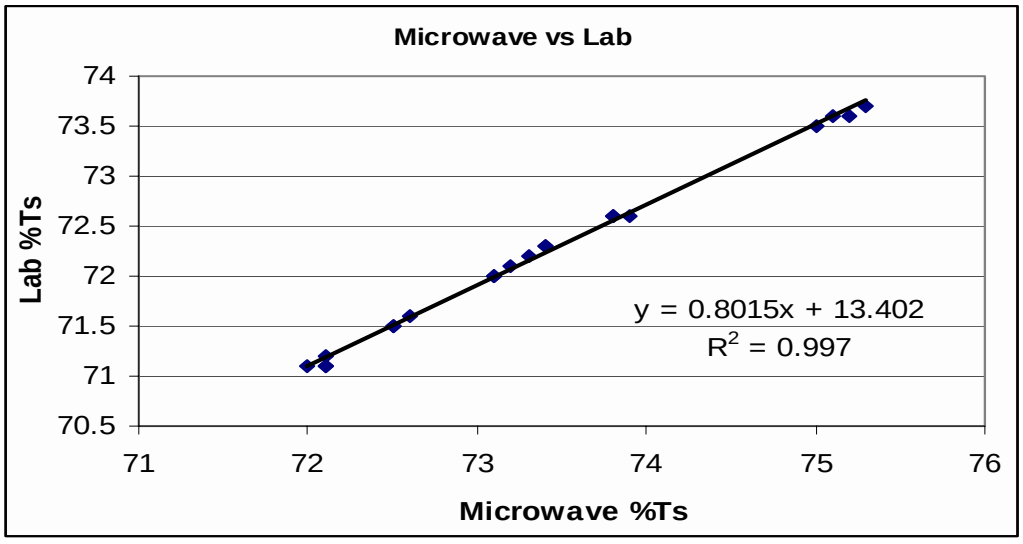


Figure 9 Regression plot for Calibration

Correcting Regression Line: Lab = **13.4** + **0.8015** (HK-2/Microwave)

C. 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 41

Old Slope Value (A1 Old) =-0.23500
Old Offset Value (A0 Old) = 70.0

Display 41
A0=70.0 A1=-0.235

scroll cursor next

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

New Slope Value (A1 New) =

(A1 Old) x Correcting slope of Regression line (m)

New Offset Value (A0 New) =

(A0 Old) x Correcting slope of Regression line (m) + Correcting offset of Regression line.

A1 New = -0.235 x 0.8015 = -0.1883

A0 New = 70.0 x 0.8015 + 13.4 = 69.5

Display 42
A0=69.5 A1=-0.1883

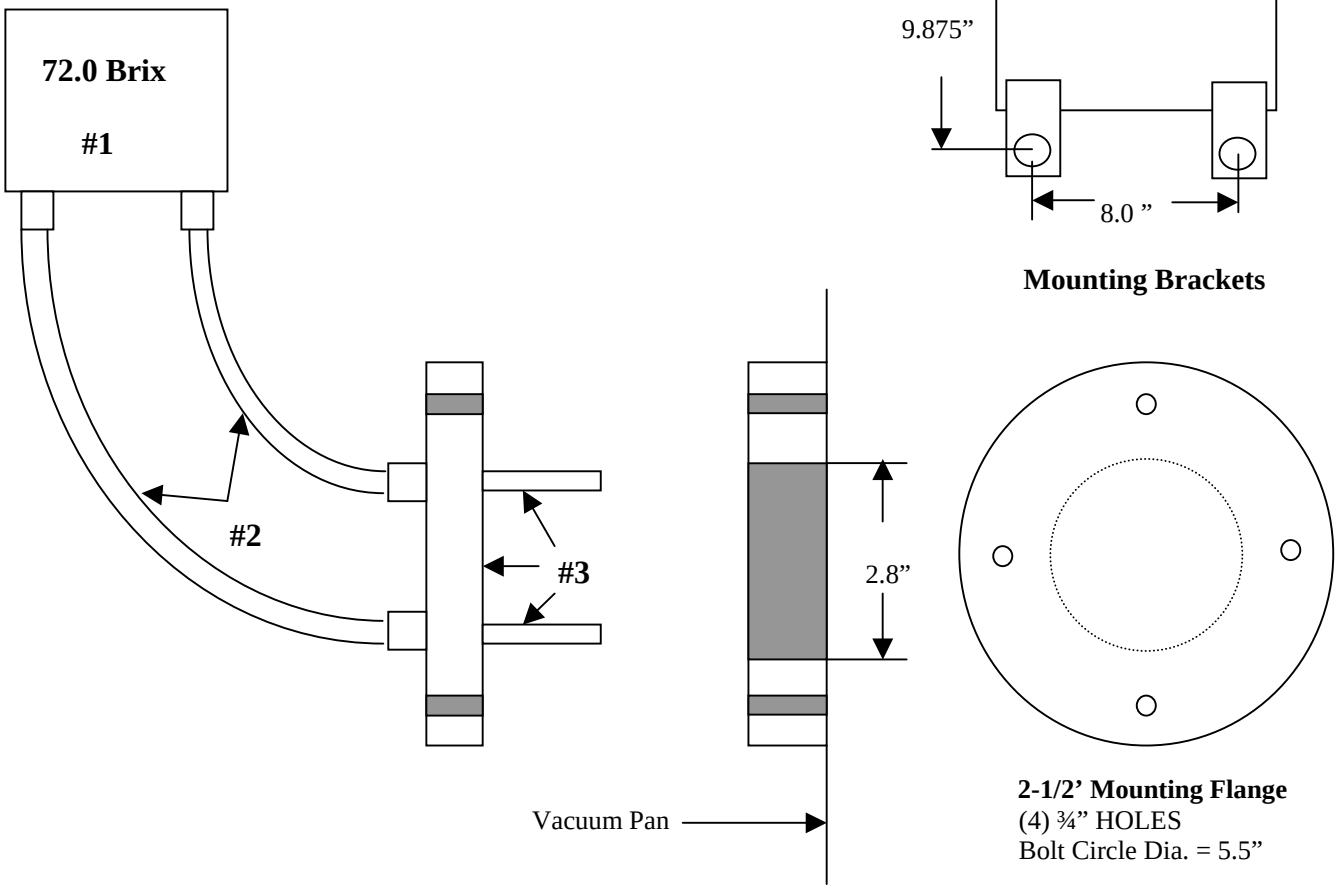
scroll cursor next

Enter the A1 New and A0 New into display, see display 42.

APPENDIX

II Installing the HK2-M Microwave System on a Vacuum Crystallization Pan

Three (3) System Components:
1. Microwave Transmitter
2. Coaxial Cables (2 meters max.)
3. Sensor Pins and Flange



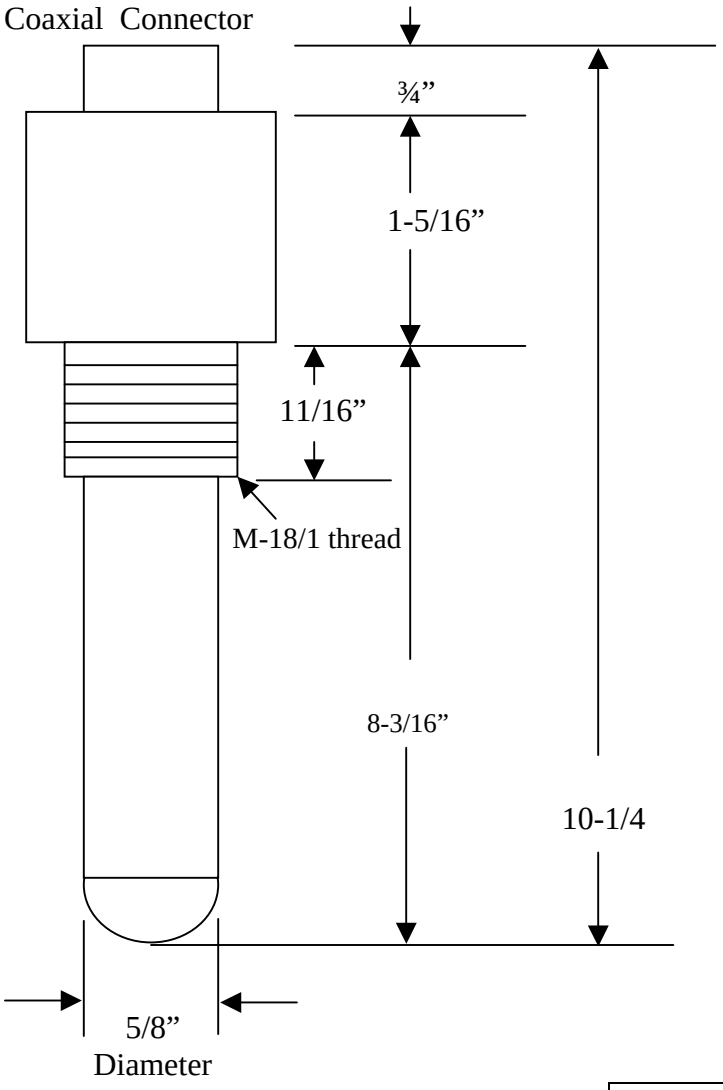
Mounting Brackets

2-1/2’ Mounting Flange
(4) ¾” HOLES
Bolt Circle Dia. = 5.5”

Installation Instructions:

1) The Microwave Transmitter has (4) Mounting Brackets on the back. Use (4) ¼” Bolts to support Transmitter.
2) Coaxial Cables are 2 meters long MAX. It must be installed as close as possible to the Sensor Pins.
    a) DO NOT OVERTIGHTEN Coaxial Connectors. Hand tighten and then snug with a Creasant Wrench.
    b) KEEP CONNECTORS DRY. Moisture of any kind in the coaxial connector is bad.
    c) DO NOT OVERBEND THE COAXIAL CABLE.
3) Sensor Pins are screwed into a 2-1/2” Stainless Steel Blind Flange. See Mounting Flange Dimensions above.
4) Where on the Vessel should you install the Sensor Pins?
    a) Above the Calandria – The Pins can be installed above the Calandria if they will be covered by at least 4 inches of juice after the initial charge.
    b) Below the Calandria but above the Pan Floor – If it is not possible to install above the Calandria, than the next best place is below the Calandria but above the pan floor.
    c) Below Calandria and below the Pan Floor. This is the least favorable place for the Microwave Transmitter because in this location it is hard to work on. Temperature is not a problem. The unit is designed for very high operating temperatures.

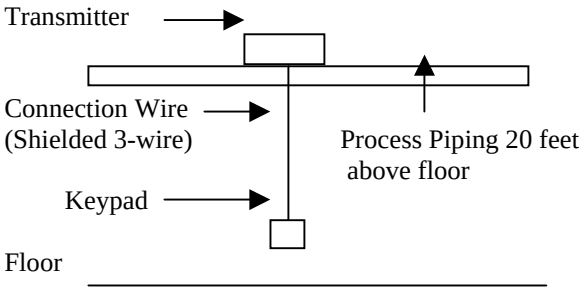
III. DRAWING OF INSERTION SENSOR PIN

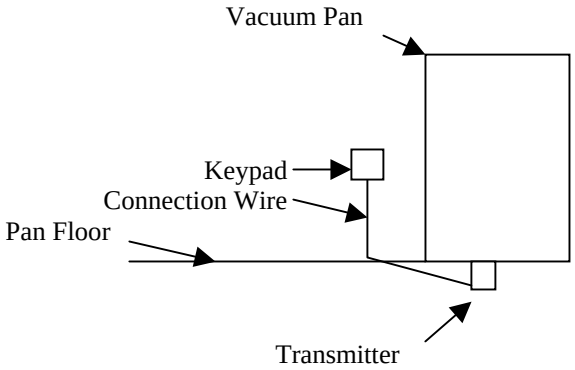


HK Instrument Systems		
Title: **Microwave Insertion Pin**		
Date: **Aug. 25, 2003**	Dwg #: PIN-002	System: HK1/2
Scale: Not to scale	Drawn By: CAF	Checked By:

IV. Remote Keypad Option

The HK 1 and HK 2 Instrument Systems can be ordered with a Remote Keypad. This option allows the Instrument Keypad to be located up to 10 Meters (30 feet) from the Transmitter. If the Transmitter is High in the air, or under a hot Vacuum Pan, the Keypad can be located on the floor where it is Easy to Reach, and the Ambient Temperature is not very high.





V. Technical data control unit

System:	1 Microprocessor with Non Volatile memory
Housing:	Aluminum IP 65, NEMA 4
Dimension:	HxBxD = 7.0” x 7.0” x 4.0”
Weight:	10 lbs.
Voltage:	230 / 115 V ± 15%, 47-65 Hz
Power consumption:	230 / 115 V 50 VA
Signal output 1:	0/4 - 20 mA; isolated; product %Consistency, max. load 500 ohms.
Signal input:	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:	4800, 9600 Bd
Display:	2 x 24 characters LCD, dialogue with push buttons and alphanumeric display.
Microwave frequency:	ISM - Band; Multi or 2.45 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

VI. Listing of Displays

Display 1
Harrer and Kassen GmbH

Measure Meas Par NEXT

Display 2
P-value= 3.0 % Ts

MAIN RUN NEXT

Display 3

M=3.0 A=28.0 T=90.0
RUN MAIN

Display 4
Measuring time: 10.0 s

scroll cursor run next

Display 5
IOut (0/4 mA): 0.0 %Ts

scroll cursor RUN next

Display 6
IOut (20mA): 10.0 %Ts

scroll cursor RUN next

Display 6a
Iout (20 mA): 10.0 %Ts

scroll cursor next

Display 7

Calibr General Next

Display 8
lock keyboard: 8

scroll cursor RUN next

Display 9
unlock keyboard: **8**

scroll cursor run next

Display 10
language: english

scroll Main next

Display 11
Relay Fnct: ERROR

scroll cursor next

Display 12
Dimension: _%Ts

scroll RUN Main

Display 13

System Temp Main

Display 14

User Current Next

Display 15
Baud rate: _ 9600

scroll main RUN next

Display 16
Data Format: _ excel

scroll main RUN next

Display 17
Print Each: 30s
scroll RUN next

Display 18

Limits Reference Next

Display 19
Att-L: -50.0 Att-H: 100.0

scroll cursor run next

Display 20
P-value Min: 0.0 %Ts

scroll cursor run next

Display 21
P-value Max: 10.0 %Ts

scroll cursor run **next**

Display 22
Brix Max: 1000.0 Bx

scroll cursor run back

Display 23
Current Output: 4-20mA

scroll main RUN next

Display 24
test current: **5** mA

scroll cursor back

Display 26
Temp.Measurement:ON

scroll main NEXT

Display 25

Factory Reference Next

Display 27
T-Offset= 0.0 C

scroll cursor NEXT

Display 28

T-Product= 100 C
NEXT

Display 29

Coef Data Next

Display 30
TK2: 0.00**0** E-3

scroll cursor MAIN

Display 32
Are you sure?
yes no

Display 32g
MP 01 W: 3.0 P: 12.7

Scroll Cursor Run Next

Display 32h
Cal ? (Enter)

Run Back

Display 33
A0=0.00 A1= -0.12

scroll cursor Next

Display 33a
Lab value at Ref: **0.0%**

Scroll Cursor Next

Display 33b
Lab value at Ref: **5.0%**

Scroll Cursor Next

Display 34
TK1: 0.00**0** Tref:= 0

scroll cursor NEXT

Display 35
Adjust Ref to Meas Range

Set **Calc** Run Next

Display 41
A0=3.0 A1=-.011

scroll cursor next

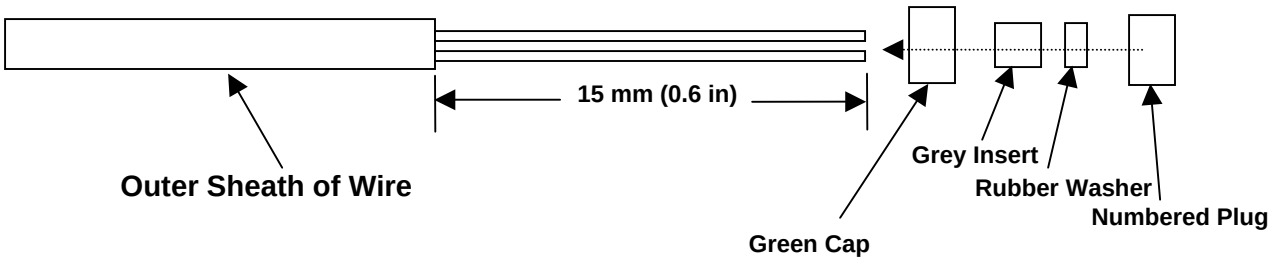
Display 41a
A0=3.26 A1=-0.1208

scroll cursor next

Phoenix Connectors

The following Information can be used to identify the wires needed to wire up to the HK Instrument Systems Microwave

Connector Type	Number of Conductors	AWG	Diameter of Outer Sheath of Conductor	Diameter of Wire including Insulation
AC Power	3	16-18	0.22 inch - 0.35 inch	< or = 2.5mm < or = 0.1 inch
Current outputs	4	18-22	0.16 inch - 0.3 inch	< or = 2.5mm < or = 0.1 inch
Temperature Inputs	2	16-18	0.16 inch - 0.3 inch	< or = 3.0 mm < or = 0.12 inch
Temperature Inputs	3	18-22	0.16 inch - 0.24 inch	< or = 2.5mm < or = 0.1 inch
Relay Inputs	2	16-18	0.16 inch - 0.3 inch	< or = 2.5mm < or = 0.1 inch



1) Strip 15 mm of the outer sheath off. Do not strip inner sheath off of the wires
2) Put Green Cap, Grey Insert, and Rubber Washer over outer sheath.
3) Insert wires into numbered plug. Trim off wire ends that stick out.
4) Press assembly into the green connector on your transmitter and screw in the green cap.

VIII. TROUBLESHOOTING

A. ERROR MESSAGES:

1. 1. The Way that the system displays the RUN in the Display can be used to diagnose a problem.
2. The following shows what is displayed and what it means -

RUN: everything o.k.
RN1: ADC-overflow. This means the sensor is not covered with product and the measured results are not valid. (For example an empty pipe)
RN2: The measured attenuation is outside of the set range for min and max attenuation and the current output is clamped to 4mA. Look in Limits Menu for settings, and change them.
RN3: The measured Brix value has crossed the Brix-Max threshold and the output is clamped to 4mA. Look in Limits Menu for setting and change it.
RN4: Evaluation of the raw phase is unstable. If this occurs the actual measuring value is rejected and the output is kept on the last valid value.
RN5: Evaluation of the raw phase is unstable. If this occurs the actual measuring value is rejected and the output is kept on the last valid value.
RN6: The measured value exceeds the P-value min setting. The actual measuring value is rejected and the output holds the last valid value.
RN7: The measured value exceeds the P-value max setting. The actual measuring value is rejected and the output holds the last valid value.

B. The ATTENUATION Measurement as an indicator of Trouble

1. Think of the Microwave Measurement as an electrical circuit. The Total Attenuation of the Circuit is indicated when you Perform The Reference Measurement.
2. Think of the Process Liquid as a Variable Resistor and the rest of the Measurement Circuit as a relatively constant resistance.
3. When you Perform the Reference Measurement, you measure the Total Attenuation of the Electrical Circuit. The Attenuation can be read in Display 31. The A= value is the Attenuation of the Measuring Circuit. In this example, the Attenuation is 39.1. The Attenuation should not be higher than 55dB or lower than 5 dB. Consistency Measurements range between 30 and 50 dB.

Display 31	Display 3
Ref A=39.1dB Phi=90.0	M=3.0 A=1.0 T=90.0
Main Next	RUN MAIN

4. WHAT DOES THIS MEAN:

   a. The Live Attenuation can be seen in Display 3, (A=1.0). The actual Measured Attenuation when in the RUN Mode is calculated by adding the Attenuation Measured in Display 31 plus the Attenuation in Display 3, (39.1 + 1.0 = 40.1).
   b. The Variation of the Measured Attenuation should be relatively constant. When the system is functioning well, the Live Attenuation will not change more than a few dB. The live reading should always be close to 0.0. If it varies more than -3 to +3 dB the circuit and its components should all be checked.
   c. It is a very good idea to record the variations which you see in the Live Display 3, when the system is operating well. If this variation increases more than a couple of dB, there is probably a problem with the Circuit.
   d. Problems with Circuit Can be Caused by:

1) Loose or bad Coaxial Connectors. Moisture inside the connector will cause problems.
2) Damaged Sensors or Cables. Moisture inside the Sensor Pins will cause trouble.
3) A big change in the Attenuation of the Process Stream. This can be caused from an addition of Salt or a change in PH.

5. The first thing to check when you are having troubles is the Attenuation Measurement in Display 3. This measurement is a good indicator of the quality of the complete Electrical Circuit and can help identify a problem.

C. Changes in the Salinity or Conductivity of the Process Fluid

1. Since the Microwave Measurement is electrical in nature, the Salinity and Conductivity of the Process Fluid will have an affect on the accuracy of the measurement.
2. For most Process Streams, these changes cause minimal and mostly negligible errors.
3. When the changes are large enough to cause large errors, we can measure the Conductivity and compensate for it.
4. The Maximum Conductivity is 20,000 micro Siemens.

D. Software Reset -**ONLY TO BE USED IN AN EMERGENCY**

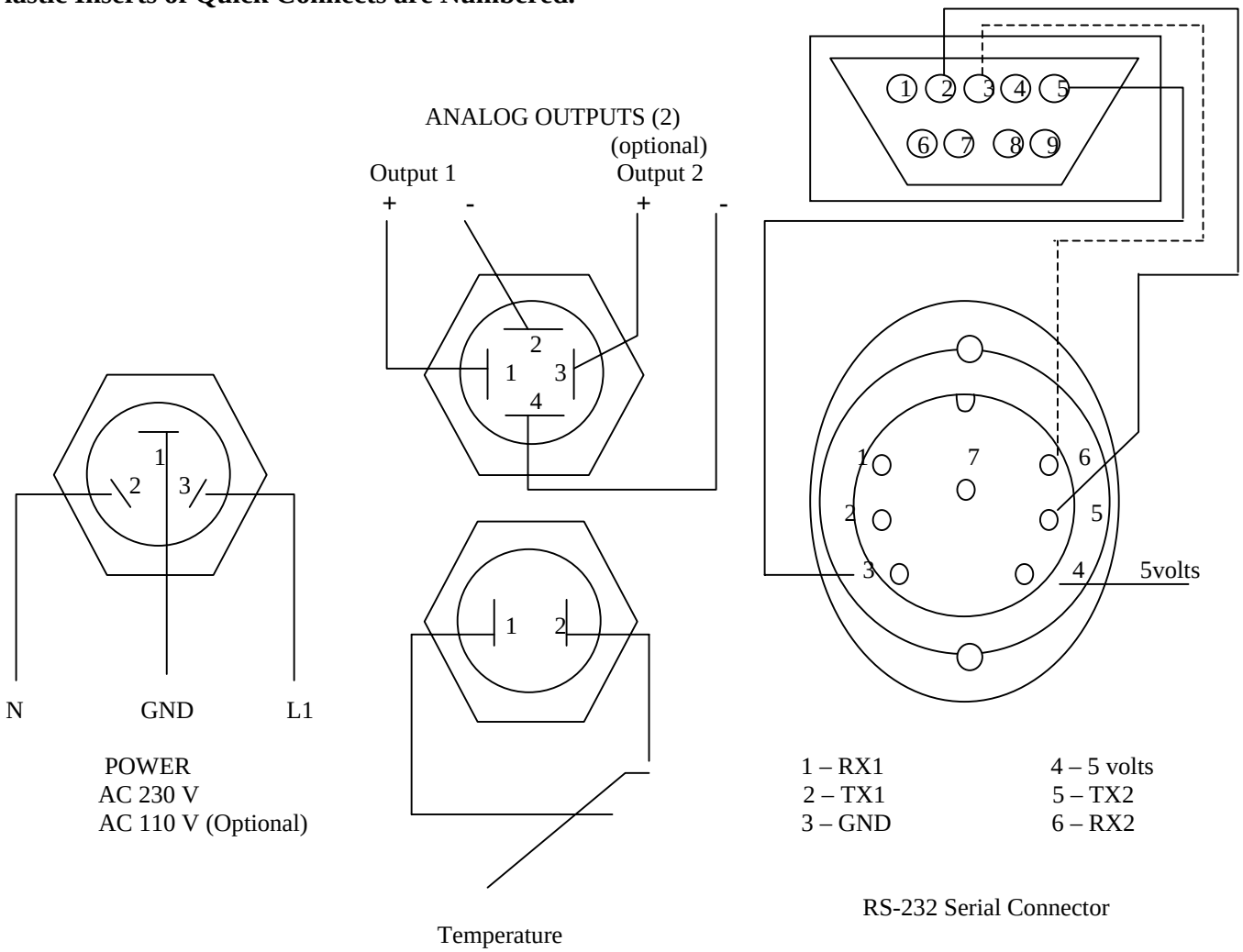
1. It is possible to reset System Software.
2. The System Reset, should only be done when the Keypad is locked. A Locked up keypad is when there is not any response to any button, or when the system is in RUN Mode but is not making a measurement, (flat line).
3. To reset System Software:

    a. Power down the unit.
    b. Press the Enter and Clear buttons at the same time, and hold them down while powering the unit up.
    c. This should initialise a re loading of default values.

NOTE: AS OF THIS SOFTWARE VERSION, ONE FEATURE WILL NOT WORK AFTER A SYSTEM RESET, THE RTD TEMPERATURE MEASUREMENT. IN ORDER TO FIX THE RTD MEASUREMENT YOU MUST ENTER THE FACTORY MENU. THIS CAN ONLY BE DONE WITH THE HELP OF THE FACTORY. SO IF YOU ARE GOING TO PERFORM A SYSTEM RESET, CALL THE FACTORY FIRST.

V. WIRING DIAGRAM

Plastic Inserts of Quick Connects are Numbered.



Title: Wiring Diagram HK-2 Compact System	**By: Charlie Ferrin**
Date: August 20, 2001	**Signed:**
Dwg no: HK2WIRING1	**Company: HK Instrument Systems**

VI. TROUBLESHOOTING

A. The Way that the system displays the RUN in the Display can be used to diagnose a problem. The following shows what is displayed and what it means -

RUN: everything o.k.
RN1: ADC-overflow. This means the sensor is not covered with product and the measured results are not valid. (For example an empty pipe)
RN2: The measured attenuation has crossed the entered thresholds and the current output is clamped to 0/4mA (see chapter 3.5)
RN3: The measured Brix value has crossed the Brix-Max threshold and the output is clamped to 0/4mA see chapter 3.7).
RN4: Evaluation of the raw phase is unstable. If this occurs the actual measuring value is rejected and the output is kept on the last valid value.
RN5: Evaluation of the raw phase is unstable. If this occurs the actual measuring value is rejected and the output is kept on the last valid value.
RN6: The measured value has crossed the min. threshold of the valid measuring range. the actual measuring value is rejected and the output is hold on the last valid value (see chapter 3.6).
RN7: The measured value has crossed the max. threshold of the valid measuring range. the actual measuring value is rejected and the output is hold on the last valid value (see chapter 3.6).

VII. Setting Brix-Max (Sugar Only)

When measuring Brix it is possible to define a max. threshold for the Brix value.

Select 'LIMITS' from the system menu and press NEXT until the following displays appear.

BRIX-MAX: 1000.0
SCROLL CURSOR NEXT

Enter the desired thresholds and confirm with enter.

If, during measurement, this threshold is crossed the output signal is set to 0/4mA. To indicate, that this threshold is crossed, instead of 'RUN' 'RN3' is displayed.

VIII. The System menu ‘PROTECTED’

This menu contains data which should only be changed by the advanced users of the instrument. Any change in this menu modifies the operating mode of the instrument, and some changes even require a new calibration of the instrument. This is why the instrument is protected by a password. The password which allows access to this menu is 911 and should only be known by authorized persons.

IX. Operating Modes of Microwave Transmitter

The instrument has three operating modes for the HF-part of the instrument. There are three operating modes available: Standard, Mode1, and Mode2. All instruments are delivered in the standard mode, which covers almost all applications. If, during calibration or operation of the instrument, there are problems. It is possible to go from standard mode to mode1 or mode2. Changing the HF-operating mode

has no effect on the calibration of the instrument. Before changing the HF-mode we recommend to contact us or our local distributor.

A. Evaluation mode

The instrument measures phase and attenuation (called the raw values) caused by the properties of the product. As both values are moisture depending, it is possible to do a measurement/calibration based on phase or attenuation. At delivery the instrument is set up to use phase. For measuring special products attenuation sometimes gives a higher resolution and it is useful to swith to attenuation (for example: measuring acids).

X. Temperature compensation / temperature acquisition

To increase the accuracy of the measurement when the product temperature is changing the instrument offers the option of temperature compensation. The temperature compensation is done with a linear or a cubic function:

W=a1*Xk + a0; mit Xk = X + (T-TREF)*TK1 + (T-TREF)^2*TK2

With W: measuring value
a1,a0: constants (see calibration)
Xk: temperature compensated raw value (phase or attenuation)
X: uncompensated raw value
T: actual product temperature
TREF: reference temperature
TK1: linear temperature coefficient
TK2: cubic temperature coefficient

A. Temperature acquisition basics

The temperature sub-menu is structured as follows:

- Temperature enable :	Enabling /disabling of temperature measurement
- Temperature offset:	Adjustment for temperature display. Range -100°C to 100°C
- Product temperature:	Display of actual product temperature
- Temperature current output:	Define current output span for 0/4mA und 20mA output. Range -50°C to 255°C. **Option**
- Temperature compensation on:	Enabling / disabling of temperature compensation
- Linear TC und T-Ref:	Input for linear temperature coefficient a reference temperature. Range for TK1 -100 to 100. Range for T-Ref -50°C to 255°C
- Cubic TK:	cubic temperature coefficient . Range -999 to 999. (Input *E03)

Default the temperature compensation is disabled. The temperature system first has to be enabled (in the temperature sub-menu). If the temperature system is disabled all temperature related parameters are not displayed. To enable enter the sub-menu 'TEMPR.' and enable the temperature system as follows:
TEMP:MEASUREMENT: _ON
SCROLL MAIN NEXT

Select ON and confirm with <Enter>.

The instrument measures temperature with a sensor directly mounted to the flange or clamped to a pipe-line.

If there is any reason to adjust the temperature display with a constant value, this could be done by entering an offset. It might be, for example, necessary to adjust the instruments temperature reading to a parallel running temperature gauge.

T-OFFSET= 0°C
SCROLL CURSOR NEXT

At delivery this value is zero. If this value is not zero the entered value is added to the measured temperature.

B. Enabling / disabling the temperature compensation

Temperature compensation on/off

To enable the temperature compensation switch to the temperature sub-menu. To enable the temperature compensation set it to ON.

TEMP.COMPENSATION: _ON
SCROLL MAIN NEXT

Entering the linear temperature coefficient and Reference temperature

Go to the temperature sub-menu and select the display for the linear temperature coefficient and enter the required value.

TK1: 0.0000 TREF: 0°
SCROLL CURSOR NEXT

Confirm with <Enter> and the cursor moves to the input field for the reference temperature.
Enter the reference temperature and confirm with <Enter>.

Entering the cubic temperature coefficient

Go to the temperature sub-menu and select the display for the cubic temperature coefficient and enter the required value.

TK2: 0.0000 E-3
SCROLL CURSOR MAIN

Remark: The cubic temperature coefficient has to be entered multiplied by 1000. For example: TK2 required is 0.001 leads to an input value of 0.001*1000=1.

C. CONTINUOUS PAN OPERATION

1. When the Microwave Instrument System is installed on a continuous sugar cooking pan, it is necessary to clean the sensor periodically with high pressure water or thin juice. This is accomplished by installing special self cleaning half couplings and sensor pins and attaching a water/juice line with pressure.

2. The self cleaning half couplings and sensor pins are installed on the vessel, and then water/juice lines are attached with a 3/8 inch NPT fitting.

3. With the self cleaning sensor pins, it is necessary to use a control a valve, which supplies the cleaning device periodically with water or thin juice. **STEAM IS NOT TO BE USED FOR CLEANING.**

4. The Microwave Transmitter has software which allows you to open and close a relay, allowing water/juice to enter the self cleaning half coupling and come out the end where the measuring sensor is. Cleaning will take place every 30 minutes for a period of 5 seconds. The Microwave Transmitter is programmed so that the relay opens and closes in the following sequence. There are three time settings, T1, T2 and T3. We have to enter T1=1800s (30minutes * 60s) and we have to enter T2=5s and T3=30s. After this is done, the relay performs as follows:

- During the period T1 the relay is off (valve switched off, no water)
- During the period T2 the relay is on (valve switched on, water)
- During the period T3 the relay is (no water, and system is holding the last good reading)

5. Programming the Microwave Transmitter:

a) The Microwave Transmitter should be factory programmed to operate the above sequence of Measure, Clean, Stand Idle, and then start over. You should check to make sure the parameters are set correctly using the following instructions.

b) Go to the sub-menu ‘GENERAL’ and select RELAY FNCT: FREQ.OUTPUT

c) After this is done go to the system sub-menu ‘USER’ and move the display until the following display appears:

- FREQ: T1 = 1800s T2 = 5s,
- SCROLL CURSOR **NEXT**
- FREQ: T3= 30s

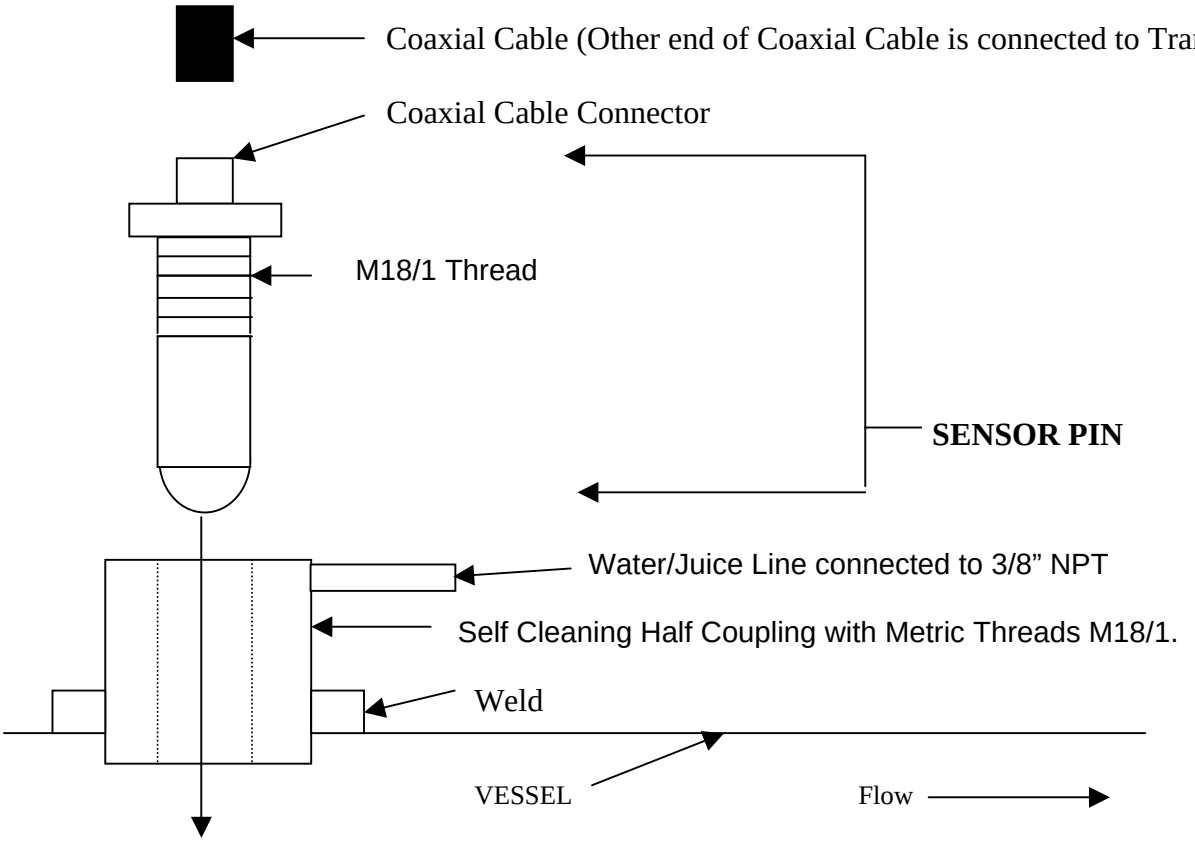
d) With entering T1 and T2 it is possible to generate a square wave, available on the relay output.

- T1 defines the time in seconds where the relay is off
- T2 defines the time in seconds where the relay is on
- T3 defines the time the measurement is unstable after cleaning

YOU ARE READY TO RUN IN SELF CLEANING MODE

6. ASSEMBLING THE SELF CLEANING SYSTEM ON A CONTINUOUS PAN

Unassembled Components



Assembled

Two Microwave Insertion Sensors been installed in a typical Continuous Pan installation.