Microwave Measurement

HK2

Operating Manual

Version 2.1

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1. User interface

The instrument is operated by menus. These menus can be accessed and operated by push buttons at the front panel of the instrument. Dependent on the actual menu, the soft keys <SK1>, <SK2> and <SK3> have different functions. <SK1>, <SK2> and <SK3> are located beneath the display. They are counted from the left to the right.

1.1 Keyboard

<SK1>		- Branch to sub-menus
	<SCROLL>	- Entering numbers - Choosing options at certain entries
<SK2>		- Branch to sub-menus - Movement of cursor while entering numbers - Branch back to main menu
<SK3>	<NEXT>	- Next option in dialogue
	<MAIN>	- Back to main menu
	<BACK>	- Return to beginning of the actual sub-menu
<Enter>		- Confirmation of inputs - Deletion of error messages - In input fields with 2 parameters, selection of the second parameter
<Clear>		- Clearance of new input and return to last known value
<Run>		- Start and stop of the measurement

1.2 Dialogue structure

The dialogue is made up of a main menu with different sub-menus. By pushing the soft key beneath the main menu item the user has access to the sub-menus.

Main menu items:

<MEASURE>	<MEAS.PAR.>	<NEXT>	after pushing <NEXT> it appears:
<CALIBR.>	<GENERAL>	<NEXT>	after pushing <NEXT> it appears:
<SYSTEM>	<TEMP.>	<NEXT>	after pushing <NEXT> the first item appears again.

Pushing the soft key beneath the menu item, the user has direct access to the sub-menus.

1.2.1 Measurement „MEASURE“; sub items

P-VALUE:	Actual process value averaged with the time constant. Measuring unit: %, %H_2O, %TS, Bx, g/cm^3, g/l or mg/l
M=	Actual process value
A=	Actual measured attenuation
T=	Actual measured temperature, if a temperature sensor is installed.

1.2.2 Measurement parameters “MEAS.PAR.”; sub items

MEASURING TIME:	Time constant for process value averaging Range: 0 to 999s
IOUT1 [0/4 mA]:	Process value that sets the first current output to 0/4 mA Range: 0 to 10000 (Standard output)
IOUT1 [20 mA]:	Process value that sets the first current output to 20 mA Range: 0 to 10000 (Standard output)

IOUT2 [0/4 mA]: Process value that sets the second current output to 0/4 mA
Range: 0 to 10000 (Second span, see chapter 3.7.3)
IOUT2 [20 mA]: Process value that sets the second current output to 20 mA
Range: 0 to 10000 (Second span, see chapter 3.7.3)

When the relay function to detect minimum or maximum threshold is selected, the submenu additionally displays:

THRESHOLD: Process value at which the relay switches.
Range: 0 – 10000 (see chapter 3.2)
HYSTERESIS: Hysteresis used for MIN/MAX relay.
Range: 0 – 100 (see chapter 3.2)

1.2.3 Calibration „CALIBR." sub items

This menu includes the submenu "COEFF.".

1.2.3.1 Coefficients "COEFF."

This menu is used to define the calibration coefficients A0 and A1. A0 and A1 are offset and slope of a linear regression that describes the relation between microwave signal and laboratory value.

Range: A0: ± 100000 A1: ± 100000

1.2.4 General „GENERAL", sub items

LOCK KEYBOARD: Entering of a password to lock the keyboard.
Range: 0 to 999999
UNLOCK KEYBOARD: Entering of the password to unlock the keyboard.
Range: 0 to 999999
LANGUAGE: Selection of the dialogue language: German/ English/ French/ Czech
RELAY FNCT: Definition of the relay functions: ERROR, MIN-THRESHOLD, MAX-THRESHOLD or FREQENCY OUTPUT.
DIMENSION: Selection of measurement unit: %, %H_2O, %TS, Bx, g/cm^3, g/l, mg/l.

1.2.5 System „SYSTEM", sub items

This menu includes the sub-menus: "USER", "CURRENT", "LIMITS", "REFERENCE", "FACTORY" and "PROTECTED"

1.2.5.1 User "USER"

COM2 BAUDRATE: Baudrate for bidirectional RS 232 communication port:
Baudrate: 4800, 115k, 57600, 38400, 19200, 9600, 2400 Baud
When using the remote control box, the baudrate has to be set to 4800 Bd. COM1 is available in HK1 instruments only.
DATA FORMAT: Defines the format of the COM2 output string: "EXCEL" or "NORMAL"
PRINT EACH: Print cycle for data transfer through COM 2:
Options: OFF / 10sec. / 30sec. / 60seconds

When the relay function, FREQUENCY OUTPUT, is selected, the submenu additionally displays:

FREQ: Option to generate with the relay output a timing signal for various applications. T1 defines the time the relay is OFF, T2 the time the relay is ON. Range: T1 = 1 to 9999s and T2 =1 to 9999s (see chapter 3.6)
T3: Option to define a delay time for the measurement when using the frequency signal (see chapter 3.6).

1.2.5.2 Current „CURRENT“

CURRENT OUTPUT: Selection if current output should be 0-20 mA or 4-20 mA.
TEST CURRENT: Test value for current output 1 and 2, Range 0-21 (see 3.1).

1.2.5.3 Limits “LIMITS”

ATT-L: -50.0 ATT-H: 100.0 Option to enter a min. and max. attenuation at which the current output holds the last valid value or is clamped to 0/4 mA or 20mA.

I-OUT AT ATT-L: If the attenuation falls below the defined min. attenuation, ATT-L value, the current output is set to the last valid value (hold), 0/4 mA or 20 mA.

I-OUT AT ATT-H: If the attenuation exceeds the defined max. attenuation, ATT-H value, the current output is set to the last valid value (hold), 0/4 mA or 20 mA.

P-VALUE MIN: Option to define a minimum threshold for valid measuring values. Range: -999 to 10000.

P-VALUE MAX: Option to define a maximum threshold for valid measuring values. Range: -999 to 10000.

Brix-Max: If measuring Brix, a maximum threshold can be defined at which the current output is set to 0/4 mA. Range: 0 - 1000

1.2.5.4 Reference „REFERENCE“

REF:A= XXXdB PHI = XXXX : Option to perform a reference measurement, the measured attenuation, A, and the measured phase shift, PHI, are displayed.

LAB.VALUE AT REF: Manual entry of the laboratory value at reference.

ADJUST REF.TO MEAS.RANGE: Selection, if the adjustment of the reference measurement to the desired measuring range should be done by manual entry, SET, or should be calculated, CALC, by the instrument. Choice: SET or CALC

SET: Manual adaption of measuring range and reference. Range: 0% to 100%

CALC: Automatic adaption of measuring range and reference. Range: 0% to 100%

RANGE FROM: XXX TO: XXX : Definition of the measuring range. The maximum permitted range is A1*147 (A1 see chapter 1.2.3.1).

1.2.5.5 Factory “FACTORY“

The factory menu is not accessible.

1.2.5.6 Protected “PROTECTED”

PASSWORD: In order to protect the settings done in this menu an additional password is required to get access. Password: 911

HF-MODE: Sets the microwave operation mode of the instrument. Choice: STANDARD (vacuum pan); MODE1 (pipes)

EVALUATION: Selection of the raw value the calculation of the measured value is based on. Choice: PHASE, ATTENUATION, PHASE/ATT (phase divided by attenuation)

IOUT2: Defines the function of the second current output, 0/4 – 20 mA. Choice: 2 ND SPAN (second output for process value), TEMPERATURE

HF-BOARD VERSION: Informs about the version of the used HF board inside the instrument. Notification: ->A07 or A08->

DEVICE SERIAL NUM: Notification of the instrument`s serial number.

1.2.6 Temperature „TEMP“

See appendix 1, temperature compensation.

1.3 Entering Numbers

The instrument has no decimal keyboard to enter numbers. The numerical entry is done by soft keys. When numbers can be entered the following is displayed:

SCROLL CURSOR NEXT

With the following functions:
SROLL: increment digit
CURSOR: move cursor
NEXT: next menu entry

The cursor (underscore) indicates the digit, which can be changed. With SCROLL the right value for the selected digit can be entered. After this, the next digit can be selected by pressing CURSOR. This is repeated until the total number is entered. To make data entering easier the actual, by the cursor marked, digit is blinking. Confirmation of the complete number is done by pressing <Enter> .

1.4 Error messages

If the instrument discovers an error, it displays an error message and additionally the relay, if defined as error output, switches. To delete an error message press <Enter>. The following error messages could appear:

ILLEGAL PASSWORD! PLEASE CORRECT!	Illegal password
VALUE OUT OF RANGE!	Entered value out of range
ILLEGAL INPUT!	Illegal input (e.g. 2 decimal points entered)
PARAMTER ERROR! CHECK IOUTL, IOUTH AND REF.!	One of the indicated parameters is missing, the one point calibration is impossible.
CALIBRATION IMPOSSIBLE! MEASURING RANGE=0!	One point calibration impossible. Measuring Range=0 (defined by IOUT(0/4mA) and IOUT(20mA))

1.5 Lock keyboard

After setting the instrument into operation, the keyboard can be locked to avoid unauthorized use. A locked keyboard is indicated by the word “LOCKED” visible in the display. Scrolling through the menu and reading parameters is possible, but changing the settings of the instrument is impossible.

Example: Lock keyboard by entering the password: 268

Display: LOCK KEYBOARD: _
SCROLL CURSOR NEXT

The cursor points to the last digit. With SCROLL the number 8 is entered and after this, the next digit is selected by pressing CURSOR.

Display: LOCK KEYBOARD: _8
SCROLL CURSOR NEXT

Now use SCROLL to enter 6 and after this use CURSOR to move the cursor one position to the left.

Display: LOCK KEYBOARD: _68
SCROLL CURSOR NEXT

Use SCROLL to enter 2.

Display: LOCK KEYBOARD: _268
SCROLL CURSOR NEXT

Now the total number is entered. To confirm, press <Enter>. The display stops blinking, use NEXT to move to the next menu entry.

1.6 Unlock keyboard

Entering the wrong password in order to unlock the keyboard causes the error message “ILLEGAL PASSWORD! PLEASE CORRECT!”. After confirming with the <ENTER> button, the password can be re-entered again. In case the password has been forgotten, please ask your vendor for a superior password.

Example: Unlock keyboard by entering the password: 268
Choose the menu “GENERAL” and switch to the sub item “UNLOCK KEYBOARD”.

Display: UNLOCK KEYBOARD: _
SCROLL CURSOR NEXT

The cursor points to the last digit. With SCROLL the number 8 is entered and after this, the next digit is selected by pressing CURSOR.

Display: UNLOCK KEYBOARD: _8
SCROLL CURSOR NEXT

Now use SCROLL to enter 6 and after this use CURSOR to move the cursor one position to the left.

Display: UNLOCK KEYBOARD: _68
SCROLL CURSOR NEXT

Use SCROLL to enter 2.

Display: UNLOCK KEYBOARD: _268
SCROLL CURSOR NEXT

Now the total number is entered. In order to confirm, press the <Enter> button. The display stops blinking, use NEXT to move to the next menu entry. The word “LOCKED” in the display disappears.

2. System installation

The following installation steps are recommended:

- Set instrument configuration
- Enter measurement parameters
- Calibration
- Start measurement

2.1 Selection of system configuration

- Select language
- Choice of the measuring unit
- Definition of the current output

2.1.1 Language

Select the menu “GENERAL” in the main menu. Use NEXT to move the dialogue until the display for the language selection appears.

Display: LANGUAGE: _ENGLISH
SCROLL MAIN NEXT

Use SCROLL to select the desired language (German, English, French, and Czechoslovak) and confirm by pressing <Enter>.

2.1.2 Measuring unit

Select the menu “GENERAL” in the main menu. Use NEXT to move the dialogue until the display for the measuring unit selection appears.

Display: DIMENSION: _%H2O
SCROLL MAIN

Use SCROLL to select the measuring dimension (%H2O, %Ts, Bx, %, g/cm3, g/l, mg/l) and confirm by pressing <Enter>. MAIN leads back to the main menu.

2.1.3 Current output

Select the menu “SYSTEM” in the main menu. In this menu select the sub-menu “CURRENT”. The first entry in this sub-menu is the display for the current output selection.

Display: CURRENT OUTPUT: _0-20mA
SCROLL MAIN NEXT

Use SCROLL to select 0-20 mA or 4-20 mA and confirm by pressing <Enter>.

2.2 Measurement parameters

- Definition of the time constant for averaging the measured value
- Definition of the current output range
- Setting the threshold output

2.2.1 Time constant

The instrument determines a measurement value each 250 ms. In order to minimize short-term variations, it is possible to use a linear filter. The averaged measurement value is displayed and is available as a current output signal. The time constant is entered in seconds.

Example: Select the menu “MEAS.PAR” and set the MEASURING TIME with “SCROLL” and “CURSOR” to the required value.

Display: MEASURING TIME: 5s
SCROLL CURSOR NEXT

2.2.2 Current Output (Standard Output)

The current output signal is defined by two values: one for lower limit (0/4 mA) and one for the upper limit (20 mA). The imits can be defined freely depending on the range of interest of the measuring value.

Example:

IOUT(0/4mA)= 5%Ts
IOUT(20mA) = 15%Ts

This means that a current output of 0/4 mA is equal to 5%Ts and an output of 20 mA is equal to 15%Ts. If the measurement exceeds 15%Ts the current output retains at 20mA and if the measurement falls below 5%Ts the current output stays at 0/4 mA.
Select the “MEAS.PAR” menu and scroll through the menu with the “NEXT” button.
Choose the item IOUT(0/4mA) and enter the required value by using the “CURSOR” and the “SCROLL” button. Use “ENTER” for confirmation and switch with the “NEXT” button to IOUT(20mA). Defining the upper end of the current output is done similar to the previously explained procedure.
If the instrument is equipped with the second current output, it is possible to define a second span for the process value. E.g. the standard output is used for a global view of the total measuring range and the second output is used to show a special region of interest with a higher resolution.

2.2.3 Threshold output

Depending on the selected relay function (see chapter 3.2) it is possible to configure a minimum or a maximum threshold output, which for example could be used as an alarm. When this threshold is crossed, the relay switches. To avoid continuous switching of the relay a hysteresis can be defined.

Example:

MIN-THRESH= 20%H2O or MAX-THRESH= 40%H2O
HYSTERESIS= 1%H2O

Selecting the maximum threshold, the relay switches when a measurement exceeds 40% H2O and it switches back when the measurement drops below 39% H2O. When the minimum threshold is used, the relay switches when the measurement falls below 20%H2O and it switches back when the measurement exceeds again 21%H2O.

If the chosen relay function in the “GENERAL” menu is “MIN THRESH.” or “MAX THRESH.”, the menu “MEAS.PAR.” has to be used to define the threshold and the hysteresis.
Select the “MEAS.PAR” menu and scroll through the menu with the “NEXT” button. Define the “THRESHOLD” by the use of the CURSOR and SCROLL button. Press “ENTER” for confirmation and define the “HYSTERESIS” in the following menu.

2.3 Start measurement

The measurement is started by pressing the <Run> button. When the instrument is started, the display automatically switches to the menu 'MEASURE' and shows the actual measured process value, “P-VALUE”. The message RUN, shown in the display, indicates that the measurement is running.

2.3.1 Error messages

During measurement “RUN” is displayed to indicate a proper measurement. If the instrument detects any error or if any threshold, entered by the user, is crossed, the instrument displays RNx instead of RUN. The various meanings are:

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 threshold and the current output is clamped to the chosen status (see chapter 3.3).
RN3:	The measured Brix value has crossed the Brix-Max threshold and the output is clamped to 0/4mA (see chapter 3.5).
RN4:	Evaluation of the raw phase is unstable. If this occurs, the actual measured 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 measured 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 measured value is rejected and the output holds the last valid value (see chapter 3.4).
RN7:	The measured value has crossed the max. threshold of the valid measuring range. The actual measured value is rejected and the output holds the last valid value (see chapter 3.4).
RN8:	T3 active (relay is used for timing functions, see chapter 3.6)
RNB:	Frequency of the microwave synthesizer is not stable. Measured values might be wrong.

2.4 Reference Measurement

In order to adapt the instrument to the environment of the installation it is necessary to execute a reference measurement. It is recommended, that the measuring device is filled up with product when the reference measurement is performed.
Select the menu “SYSTEM” in the main menu and switch to the sub-menu “REFERENCE”. The first entry in this sub-menu is the display for the reference parameters:

Display: REF: A= XX.X dB PHI= XXX.X
MAIN NEXT

To execute the reference measurement press “Run”. The instrument asks:

ARE YOU SURE?
YES NO

If you want to do the reference confirm with YES. If not, abort with NO. After the reference measurement is done the instrument shows the new reference phase and the new reference attenuation. All further measurements of phase and attenuation are related to these values.

2.5 Calibration

The instrument calculates the process value with a linear function:

Process value = A0 + A1*x

With

A0:	intercept
A1:	slope
x:	raw value measured by the instrument (phase, attenuation or phase/attenuation)

2.5.1 One Point Calibration

The instrument is delivered with A1 = -0,235 and A0 = 0 as default values.
The proposed calibration coefficient A1=-0,235 is valid for an antenna spacing of 50mm and is confirmed by many instrument calibrations. Using this slope provides the opportunity to perform a one-point calibration, because only the coefficient A0 of the linear function is unknown.
Before executing the one-point calibration, take care that:
a) the current output, 0/4mA to 20mA, is defined
b) and that it is possible to take a sample of the product for analysing.
The instrument asks for the laboratory value in order to calculate the offset A0 and to adjust the measuring range dependent on the reference measurement, automatically.

Select “SYSTEM” and scroll to “REFERENCE”.
Perform the reference measurement and take a sample for analysing. After pressing the NEXT button the instrument asks for the laboratory value.

Display: LAB. VALUE AT REF: XX.X
SCROLL CURSOR NEXT

Use SCROLL and CURSOR to enter the laboratory value of the previously taken sample and confirm with ENTER.

Use NEXT to step to the next display:

Display: ADJUST REF. TO MEAS.RANGE
SET CALC BACK

Press CALC.

Display: RANGE FROM: XXX TO: XXX
SCROLL CURSOR NEXT

Use SCROLL and CURSOR to define the measuring range of the instrument. This definition may differ from the previously defined current output, but the defined range has to be smaller than A1 * 147. Using the proposed slope A1 = -0,235, the range must be smaller than 34.5 %.

Using NEXT, the instrument skips to the following question:

Display: START CALCULATION?
YES NO

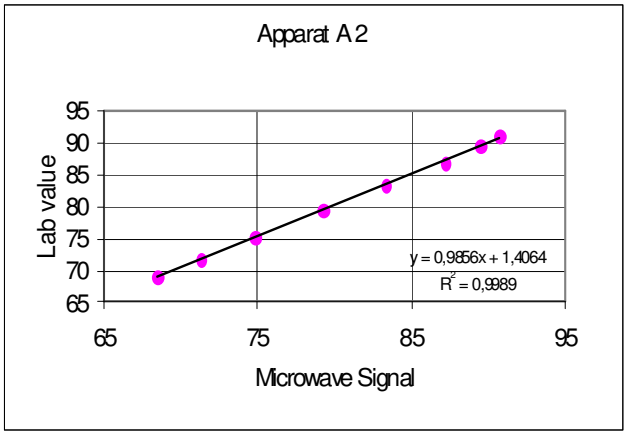
Press YES and the instrument adjusts the measuring range dependent on the reference measurement. Afterwards the instrument displays the following information:

Display: REF. AT XX.X% OF M.RANGE
SCROLL CURSOR BACK

This means, that the reference was taken at XX.X% of the defined measuring range.
The one point calibration is finished now and the calibration coefficient A0 is stored in the calibration menu.
The manual input of the calculated value, REF. AT XX.X% OF M.RANGE, is also possible.

2.5.2 External Calibration

If more than 10 samples are available, spread sheet software, like EXCEL or LOTUS, can be used for calculating the calibration coefficients. Furthermore an external calibration via PC provides the possibility to improve the correlation between laboratory value and process value. Changing the calibration coefficients is possible at any time.
In order to calculate new coefficients it is necessary to have a list of laboratory values and corresponding microwave values. A diagram that shows microwave values versus laboratory values makes it possible to calculate a linear regression. The resulting regression coefficients, a = slope and b = offset, can be used to correct the old instrument's calibration coefficients, A0(old) and A1(old).



Calibration:		Apparat A2
Date: 28.01.2014		Time: 17:30
A0(old) = 205,6	A1(old) = -0,302	

Microwave		Laboratory
68,5		69,0
71,3		71,6
74,8		75,2
79,2		79,6
83,3		83,4
87,2		86,8
89,5		89,7
90,7		91,2

The new calibration coefficients are calculated as follows:

A0(new) = a * A0(old) + b	A1(new) = a * A1(old)

A0(new) = 0,9856 * 205,6 + 1,4064 = 204,05 A1(new) = 0,9856 * -0,302 = -0,298

In order to change the coefficients please enter the menu "CALIBR."
Switch to "COEFF." and use SCROLL and CURSOR to enter the new values.
The <Enter> button is used to confirm the new values. Return to the menu "MEASURE" and start the measurement with <Run>.

3. Miscellaneous

3.1 Test current

In order to test the function of the current output loop it is possible to set a constant current. Choosing the values listed below sets the current output to:

Input value: 0 = test current off
1 = current output 0 mA
2 = current output 1 mA
3 to 20 = current output 2 mA to 19 mA
21 = current output 20 mA

Use <NEXT> and switch to "SYSTEM" .
Select the sub menu "CURRENT".
Scroll through the menu with <NEXT> until „TEST CURRENT" is displayed.
Use <SCROLL> and <CURSOR> to enter the input value that corresponds to the desired output current.

Remark: 1. To operate the test current function, the measurement must be switched off.
2. Set the input value to zero before leaving the test function.
3. Push the <Run> button to start the measurement again.

3.2 Relay function:

The relay can be assigned to four different tasks. The choice of the relay function is done in the menu “GENERAL“.

ERROR:	If an error occurs, the relay switches (error messages 2.3.1).
MIN THRESH.:	The relay switches when the minimum threshold is reached. The definition of the threshold value is done in the menu "MEAS.PAR.".
MAX THRESH.:	The relay switches when the maximum threshold is reached. The definition of the threshold value is done in the menu "MEAS.PAR.".
FREQ. OUTPUT:	The relay generates a square wave signal that can be used as a timing signal, for example to control a valve for sensor cleaning. The definition of the timing signal is done in the menu "USER". (see also chapter 3.6)

3.3 Current output clamping:

The menu “LIMITS” provides the possibility to use the measured attenuation to detect different working conditions of the measurement, for example an empty pipe or conveyor belt. Does the measured attenuation cross one of the free selectable thresholds, ATT-L or ATT-H, the current output signal is set to 0/4 mA or 20 mA or it is clamped on the last valid process value.

Choose the menu "SYSTEM" and select "LIMITS".

Display: ATT-L: -50.0 ATT-H: 100
SCROLL CURSOR NEXT

Use <SCROLL> and <CURSOR> to set the threshold values. Both values, ATT-L and ATT-H, have to be changed to activate the function. Confirm the settings with “ENTER”.
Use “NEXT” to define the current output value for the lower limit:

Display: I-OUT AT ATT-L: 0/4 mA
SCROLL MAIN NEXT

Choose between 0/4 mA, 20 mA or HOLD by pressing the “SCROLL” button. Confirm with “ENTER” and use “NEXT” to define the current output value for the upper limit:

Display: I-OUT AT ATT-H: 0/4 mA
SCROLL MAIN NEXT

If the measured attenuation crosses one of the defined thresholds, the display shows "RN2" instead of "RUN".

3.4 Setting valid process value

Within the “LIMITS” menu it is possible to define the range of valid process values. Is one of the measured values out of range, it is rejected and not used for calculating the averaged process value. This function is a useful option on belt applications.

Select the “LIMITS” menu and press “NEXT” until “P-VALUE MIN:” is displayed.

Display: P-VALUE MIN: -999.0 %
SCROLL CURSOR NEXT

Use <SCROLL> and <CURSOR> to set the lowest valid process value and confirm with “ENTER”. Switch to the next display and set the upper limit of the process value

Display: P-VALUE MAX: 9999.0 %
SCROLL CURSOR NEXT

The rejection of measuring values that are out of range is indicated by displaying "RN6" or "RN7" instead of “RUN”.

3.5 Setting Brix-Max

If the measuring unit BRIX is chosen, it is possible to define a maximum threshold for the Brix value.
Select “LIMITS” from the system menu and scroll with “NEXT” through the menu until “BRIX-MAX: is displayed.

Display: BRIX-MAX: 1000.0
SCROLL CURSOR BACK

Use <SCROLL> and <CURSOR> to set the threshold for the Brix value and confirm with “ENTER”.
If the threshold is crossed, the current output switches to 0/4 mA and the display shows “RN3” instead of “RUN”.

3.6 Relay as frequency generator

It is possible to operate the relay output with a periodic timing function that can be used for simple switching operations.

Go to the menu “GENERAL” and select “RELAY FNCT: FREQ.OUTPUT”.

After this is done go to the system menu “‘USER” and scroll through the menu until “FREQ:” appears:

Display: FREQ: T1= 1800s T2= 5s
SCROLL CURSOR NEXT

With entering T1 and T2 it is possible to generate a square wave, available on the relay output. Use “SCROLL” and “CURSOR” to enter the switching times of the relay.

T1 defines the time in seconds the relay is switched off.
T2 defines the time in seconds the relay is switched on.
Use the “NEXT” button and switch to T3.

Display: T3= 0s
SCROLL CURSOR NEXT

With T3 it is possible to hold the measurement (display and current output signal) during T3 on the last value before T2 has started. The hold time T3 starts simultaneously with T2.

EXAMPLE:
The sensor of the instrument is installed on a continuous sugar cooking pan, and it is necessary to clean the sensor periodically with water. Therefore it is necessary to control a valve, which supplies the cleaning device periodically with water. If we want to clean the sensor every 30 minutes for a period of 5 seconds, we have to enter T1=1800s (30minutes * 60s) and T2=5s. 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, cleaning with water in process)

As long as the water used for cleaning the sensor is inside the measuring path of the microwave signal, it affects the process value. This leads to an unstable output signal of the instrument, which disturbs the control loop of the cooking pan. To avoid this, T3 is used. Let us assume it takes 60s to remove the water from the measuring path, so we have to choose a hold time of the output signal of 60s for T3. The complete timing function of the relay is:

During T1 the relay is off (no water). During T2 the relay is on (cleaning with water in process). T3 starts simultaneously with T2. Until T3 is elapsed, the output signal is hold on the last measured value before T2 (and T3) has started. When T3 is elapsed the measurement continues as normal.

While T3 is active RN8 is displayed to indicate active T3.

3.7 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. Therefore 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.

3.7.1 HF-mode

The microwave part of the instrument can operate in two different operating modes. The “STANDARD” mode, which covers almost all applications, is set as the default mode. If during calibration or operation of the instrument the error messages RN4 or RN5 appear, it is necessary to switch to “MODE1”. When the instrument is installed on a pipe generally the operation mode “MODE1” has to be chosen. 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.

3.7.2 Evaluation mode

The instrument measures phase shift and attenuation of the microwave signal (called the raw values) caused by the dielectric properties of the product. As both values are moisture dependent, it is either possible to perform a calibration based on the phase shift or the attenuation. At delivery the instrument is preset to use the phase as raw value. Only for measuring special products, like for example an acid, the attenuation achieves a higher resolution than the phase shift and then it is useful to choose the evaluation mode attenuation.

3.7.3 Second 0/4-20mA output

If the instrument is equipped with the second 0/4-20mA output it is possible to define the output as temperature output or as second span output for the process value.
The second current output is enabled in the menu “PROTECTED”. Depending on the function selected, “TEMPERATURE” or “2 ND SPAN”, the definition of the 0/4-20mA output is done in the menu “TEMPERATURE” or “MEAS.PAR”.

3.7.4 HF-board version and Serial number

Displays the instrument`s serial number and the version of the inserted HF-board.

3.8 RS232-Interface COM 2

3.8.1 Baudrate

The speed of the RS232 communication port COM2 can be selected in the “USER” menu. It is possible to choose a baudrate of 2400 Bd, 4800 Bd, 9600 Bd, 19200 Bd, 38400 Bd, 57600 Bd or 115k Bd. If the instrument should operate with the remote control box it is required that the bi-directional communication port, COM2, is set to 4800 Bd.

Display: COM2 BAUDRATE: 4800 Bd
SCROLL MAIN NEXT

Use the <SCROLL> button to select the desired baudrate and confirm with <ENTER>. Take care that receiver and transmitter operate with the same baudrate. The maximum distance between receiver and transmitter, depending on the chosen baudrate, that can be obtained is listed below.

Baudrate	Cable length
19200	15 meter
9600	152 meter
4800	300 meter
2400	900 meter

It is required to use a cable with low capacity, like UTP CAT-5.

3.8.2 Data format

The choice “NORMAL” or “EXCEL” changes the delimiter of the output data string in order to import the data directly into spread sheet software. When “EXCEL” is chosen a semicolon is used, when “NORMAL” is chosen a blank.

3.8.3 Print interval

When using the RS232-interface, COM2, for data transmission it is necessary to define the print interval. Choice: OFF / 10sec / 30sec / 60sec.

Switch to "SYSTEM" and enter the “USER” menu.
Select “DATA FORMAT” and use “SCROLL” to select the desired format.
Confirm with “ENTER” and use “NEXT” to switch to “PRINT EACH”.
Define the print interval with the “SCROLL” button and confirm with “ENTER”.

4. Technical data

System:	Microprocessor with NV-memory
Housing:	Aluminium, IP65 LxWxH = 180x180x100mm
Weight:	about 5kg
Voltage:	100-240 VAC +/- 10% 47 - 65Hz
Power consumption:	50VA
Current output 1:	0/4 - 20mA active output, isolated, max. load 500 Ohm
Temperature input:	NTC (10 kOhm) input
COM2 bi-directional:	RS232, 2400, 4800, 9600, 19200, 38400, 57600, 115k Baud, 8 data bit, 1 stop bit, no paritity
Display:	2x24 characters LCD, LED-backlight
Microwave frequency:	2,45GHz ISM-Band
Maximum power:	0 dBm, 1mW
Sensitivity:	-80 dBm, 1nW
Operating temperature:	-20 - 85 °C
Storage temperature:	-30 - 95 °C
Radiation:	EN55011 Teil B
Noice immunity:	EN50082/1
Safety:	IEC1010-1

Options

Current output 2:	0/4 - 20mA active output, isolated, temperature or 2'nd output for process value, max. load 500 Ohm
Relay:	AC 250VA, DC 30V 1A
Temperature sensor:	installed in flange or as a clamp
Line Voltage:	any AC or DC voltage on request
Temperature input:	PT100 input instead of NTC input

Sensor

Standard:	2 sensor pins installed in flange DN65 PN6 (other flanges as option) operating temperature -30 - 170 °C (250°C on request)
Others:	any other sensors are application depending options

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5. COM 2 output string definition

RS232 Protocol HK2		
Byte number	**Character**	**Description**
0	L	Start code
1		delimiter if transmission format = EXCEL: delimiter = semicolon ($3B)
2	D	2 byte day
3	D	
4	.	$2E
5	M	2 byte month
6	M	
7	.	$2E
8	J	2byte year
9	J	
10		delimiter
11	H	2 byte hour
12	H	
13	:	$3A
14	M	2 byte minute
15	M	
16		delimiter if transmission format= NORMAL delimiter = blank ($20)
17	X	6 byte process value
18	X	
19	X	
20	.	
21	X	
22	X	
23		delimiter
24	X	8 byte phase shift (°/GHz)
25	X	
26	X	
27	X	
28	X	
29	.	
30	X	
31	X	
32		delimiterà
33	X	6 byte attenuation (dB)
34	X	
35	X	
36	.	
37	X	
38	X	
39		delimiter
40	X	5 byte prod. Temperature (°C)
41	X	
42	X	
43	.	
44	X	
45		delimiter
46	X	6 byte 2'd comensation input
47	X	
48	X	
49	.	
50	X	
51	X	
52		delimiter
53	X	7 byte square failure PHI rest
54	X	
55	X	
56	X	
57	.	
58	X	
59	X	
60		delimiter

61	X	6 byte square failure
62	X	
63	X	
64	X	
65	.	
66	X	
67		delimiter
68	E	1 byte error number
69	CR	1 byte carriage return $D
70	LF	1 byte line feed $A
Data string has 71 byte		
transmission format: 8 data bit, no parity, 1 stop bit, no handshake		

Appendix 1 Temperature compensation

A1.1 Temperature acquisition

The instrument is equipped with a temperature input in order to determine the product temperature. It is required to use a 10 kOhm NTC as temperature sensor (PT100 as option). The temperature sensor is directly mounted into the sensor flange or sometimes it is clamped to the outside of a pipe or vessel. The measured temperature is displayed both in the menu “MEASURE” and “TEMP.”. The menu “TEMP.” offers the possibility to switch the temperature measurement on and off.

Display: TEMP.MEASUREMENT:_ON
SCROLL MAIN NEXT

Use the “SCROLL” button to switch the measurement ON and OFF.
Confirm with “ENTER”.

A1.2 Temperature compensation

The temperature measurement must be switched on to get access to the sub-menu that enables the temperature compensation. Choosing the option temperature measurement off disables the compensation, too.
The temperature compensation helps to increase the accuracy of the measurement when the product temperature is changing. A linear or a square function can be used for compensation:

$W = A1 * Mc + A0$ $Mc = M + (T-TRef) * TK1 + (T-TRef)^2 * TK2$

W:	process value
A1, A0:	coefficients, linear regression
Mc	microwave signal, temperature compensated
M	microwave signal, uncompensated (phase or attenuation)
T	measured product temperature
TRef	reference temperature in°C
TK1	linear temperature coefficient
TK2	quadratic temperature coefficient

A1.3 Use of the temperature compensation

T-OFFSET:	Correction of the displayed temperature. Range: ± 100°C.
T-PRODUCT:	Display of the actual measured product temperature.
TEMP. COMPENSATION:	Enabling and disabling of the compensation. Choice: ON / OFF.
TK1: XXX TRef= XXX :	Input of the linear temperature coefficient and the reference temperature. Range TK1: +/- 100 Range Tref: -50°C to +255°C
TK 2:	Input of the quadratic temperature coefficient. Range: ± 999 * 10^-3

Choose the menu "TEMP." and switch the temperature measurement on.

Display: TEMP.MEASUREMENT:_ON
SCROLL MAIN NEXT

Use the “SCROLL” button to choose between ON and OFF and confirm with “ENTER”.
Press the “NEXT” button and “T-OFFSET” is displayed.

Display: T-OFFSET= XXX°C
SCROLL CURSOR NEXT

Use “SCROLL” and “CURSOR” to correct the offset between measured and actual product temperature. The next display informs about the actual product temperature.

Display: T-PRODUCT= °C
MAIN NEXT

Switch with “NEXT” to “TEMP-COMPENSATION:” and use the “SCROLL” button to enable the compensation. Confirm with “ENTER”.
The next step is setting the coefficients TK1 and TRef.

Display: TK1: XXXX TREF= XXXX
SCROLL CURSOR NEXT

Use “SCROLL” and “CURSOR” to enter the requested values and confirm with “ENTER”. It is expected, that the value of TK1 is around one. The reference temperature is the measured temperature at that time, the reference measurement was performed. If the compensation was enabled prior the reference measurement was performed, the reference temperature is stored automatically.
If it is necessary, the quadratic coefficient, TK2, could be used. This value has to be multiplied by 1000, because the preset exponent is 10^-3.

Precautions for pipe installations

As a standard, it is recommended to install the sensor in a vertical pipe. The sensor pins should be positioned 90° to the pipe, so that the product flows between the sensor pins. Especially avoid installing the sensor in a horizontal position under following conditions:

Air-bubbles or captured air remains in the pipe
The solids concentration is not even distributed, because solids stay either at the bottom or at the top of the pipe due to slow product speed or other reasons
The pipe diameter enlarges right after the sensor installation.

Always install the sensor at a place, where it is sure, that the pipe is always filled with product and that there are no air-bubbles or captured air. If the pipe is not completely filled, or if the product contains air, the measurement value varies or is inaccurate.

Avoid installing the sensor at places, where sediments are collected.

Install the sensor always so, that the sensor pins are in the middle of the pipe (possible up to a pipe diameter of 300mm / 12inch). On bigger pipes install the sensor pins as far as possible into the pipe.

If there is any danger of sticking product at the sensor, caused by long fibres or other reasons install the sensor in an angle of about 45° into flow direction. This avoids sticking, because the sensor is cleaned by the product flow.

Always install the sensor at the outlet of a pump. Never install the sensor at the suction side of a pump.

Install the sensor at a measuring site, where maximum water pressure is applied. That means to install the sensor as far away as possible from the pipe outlet opened to ambient atmosphere. This avoids air to be trapped into the product or sticking at the sensor by product expansion.

If there is a danger of heavy pieces to be carried through the pipe (like stones or pieces of metal) which could harm the sensor pins install the sensor in an angle of about 45° into flow direction.

If the sensor is equipped with a Pt100 adjust the insertion length of the Pt100 so, that it only rises a little into the pipe. This avoids breaking the Pt100 due to the impact of heavy pieces, carried by the product.

If there is not always a product flow, the measuring value could be inaccurate because of dissolving of the product. If this disturbs the process control loop, it is possible to synchronize the instrument with the pump operation by an external digital signal.

Always place the sampling valve close to the sensor.

Special Precaution for the compact instrument

Don’t install the instrument at a place where vibrations, from a pump or from other vibration sources, are transmitted through the pipe to the instrument.

Declaration of Conformity

Herewith we declare, that the microwave gauge

HK2-xx

is in conformity with the requirements 2014/30/EU and 2014/35/EU.

The instrument is developed and manufactured by applying the following harmonised standards:

- EN 61000-6-2	Generic Immunity Standard Part 6-2 for Industrial Environment
- EN 61000-6-4	Generic Emission Standard Part 6-4 for Industrial Environment
- EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

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10.07.2017

Dr. Horst Harrer, Managing Director

Quick Start-up

Preparations

1. Look whether the electrical cabling is done correctly and whether the screw connections are fastened.
2. The high frequency cables for connecting instrument and sensor may not be folded. Make sure that the coaxial connectors are absolutely dry. Male and female connector must align with the inner conductor. The torque for the coaxial connectors is 1.1 Nm.
3. Enter the menu „SYSTEM“ and choose the sub-menu „CURRENT”, in order to select whether the current output should be 0-20mA or 4-20mA.
4. Switch to „MEAS.PAR.“ and define the range of the current output: IOUTL (0/4mA) = XXX % ; IOUTH(20mA) = XXX %.
5. Enter the menu „PROTECTED“ (password 911) and set the „HF-MODE“ dependent on the application: MODE1 - pipe installations; STANDARD - vessels.

One Point Calibration

1. Switch to the menu „CALIBR.“ and enter the sub-menu “COEFF.”. The proposed calibration coefficient A1=-0,235 is valid for an antenna spacing of 50mm and is confirmed by many instrument calibrations. A0 is the offset of the regression used for calibration. When performing the reference measurement with a known laboratory value, A0 is calculated and inserted automatically. If necessary it is possible to change the calibration coefficients at any time.
2. Enable the temperature compensation if necessary.
3. Perform a reference measurement.

Enable temperature compensation

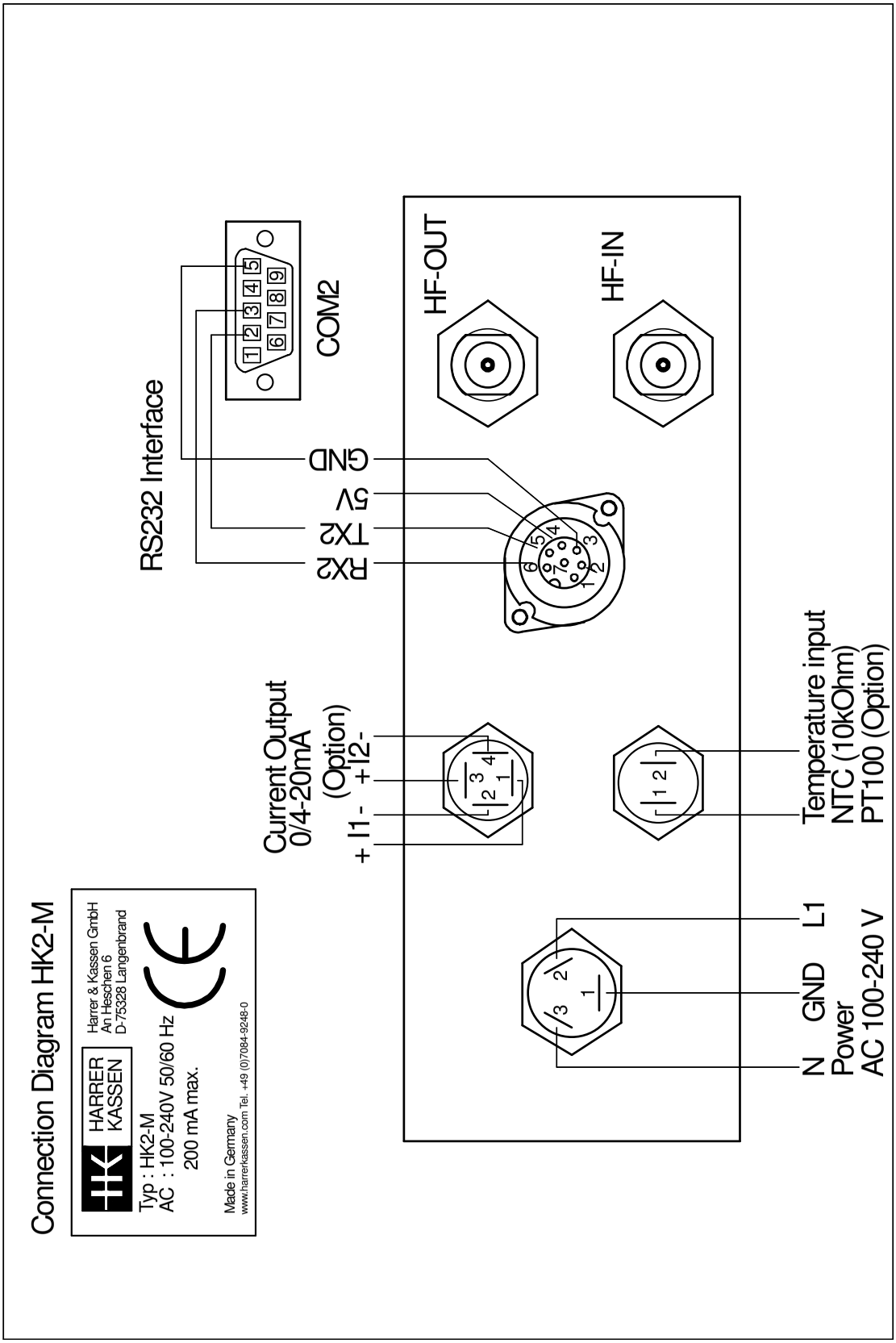
1. Enter the menu „TEMP.“ and switch the temperature compensation on.
2. Use “NEXT” and enter the temperature coefficient TK1. It is expected that the TK1 is around one. The reference temperature is the measured temperature at that time the reference measurement was performed. If the compensation was enabled prior the reference measurement was performed, the reference temperature is stored automatically.

Reference measurement

1. Switch to the menu „SYSTEM“ and select „REFERENCE“. The display shows the actual stored values, the attenuation and the phase shift, used as reference.
2. Press the “RUN” button and answer the question „ARE YOU SURE“ with „YES“. The display now shows the new values, attenuation and phase shift that are stored and used as reference.
3. Take a sample and give it to the laboratory for analysing.
4. Press “NEXT” and enter the laboratory value, „LAB.VALUE AT REF: XXX“. Confirm with “ENTER”.
5. The next menu item is the adjustment of the reference dependent on the measuring range. Choose the option “CALC”.
6. Define the measuring range of the product. This definition may differ from the previously defined current output, but the range has to be smaller than A1 * 147. Using the proposed slope A1 = -0,235, the range must be less than 34.5 %. Start the calculation. The instrument displays „REF. AT XX.X% OF M.RANGE“.
   The reference measurement is completed.
7. Use the “BACK” button and return to the measuring menu. Start the measurement with “RUN”.

It is recommended to take samples periodically in order to prove and to improve the correlation between measurement and laboratory. Changing the calibration parameters A0, A1 and TK1 is possible at any time.

Connection Diagram HK2-M



Connection Diagram HK2-M (Relay)