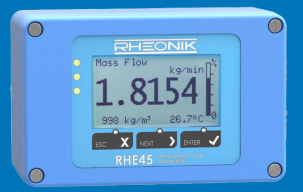
RHEONIK

RHE20 & RHE40 Transmitter Series HMI Tutorial

Installation, Operation and Basic Settings, Special Functions, Diagnosis Features and Troubleshooting



Version 1.1 March 2024

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This tutorial describes the functions of the RHE firmware versions 2.45 and higher. Functions may also be available in previous versions.

1. Installation

The installation and wiring of the RHM sensor and the RHE transmitter are described in the corresponding user manuals and wiring diagrams, which are available for download on the Rheonik website at the corresponding products, e.g. for RHE21:

https://www.rheonik.com/products/transmitter/rhe-21/downloads/?redirected=true

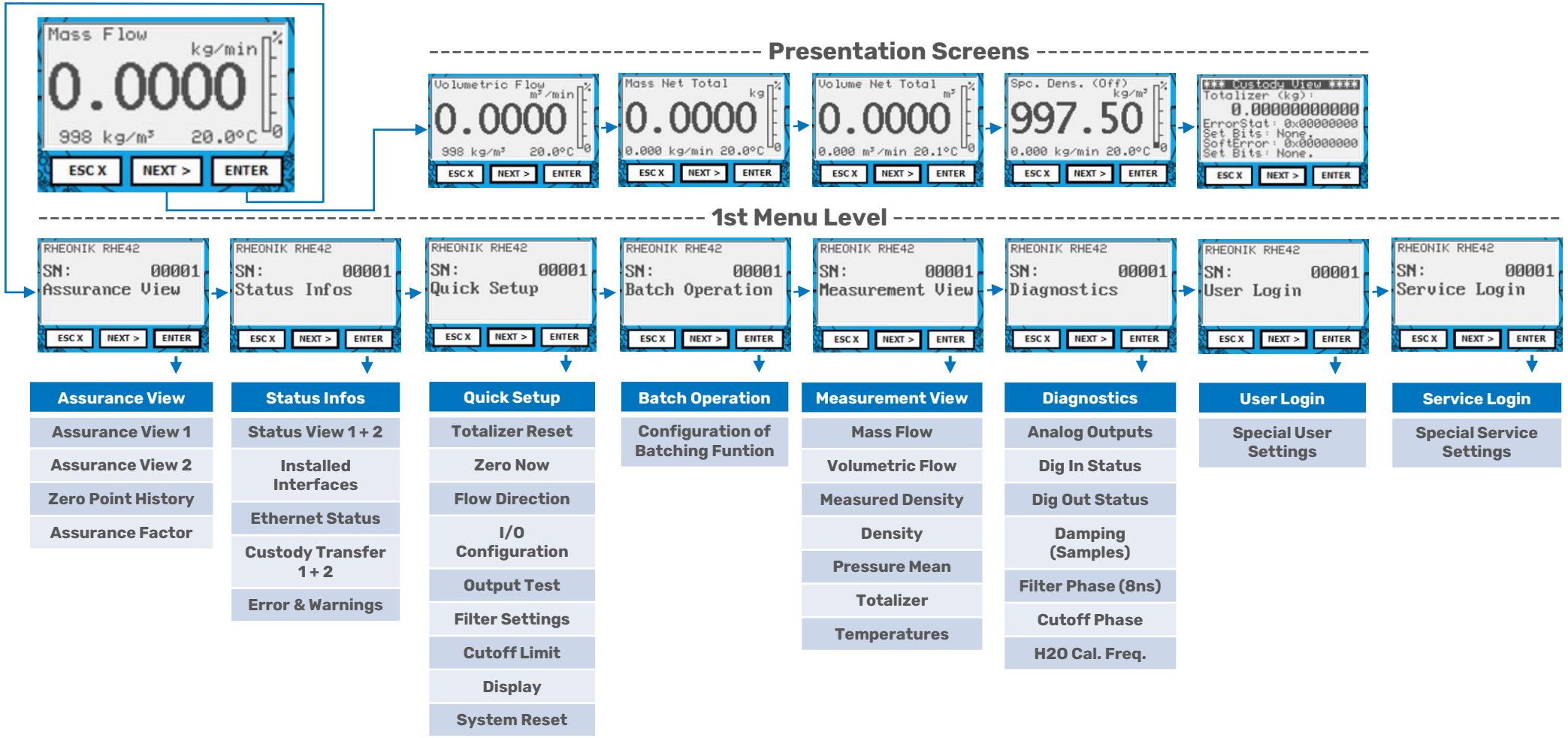
or by means of the QR code on the RHM Sensor terminal box and RHE housing:

https://youtu.be/ITpV9hLP9Fw

2. Operation and Basic Settings

2.1 HMI Menu Structure

Home Screen / Default Display



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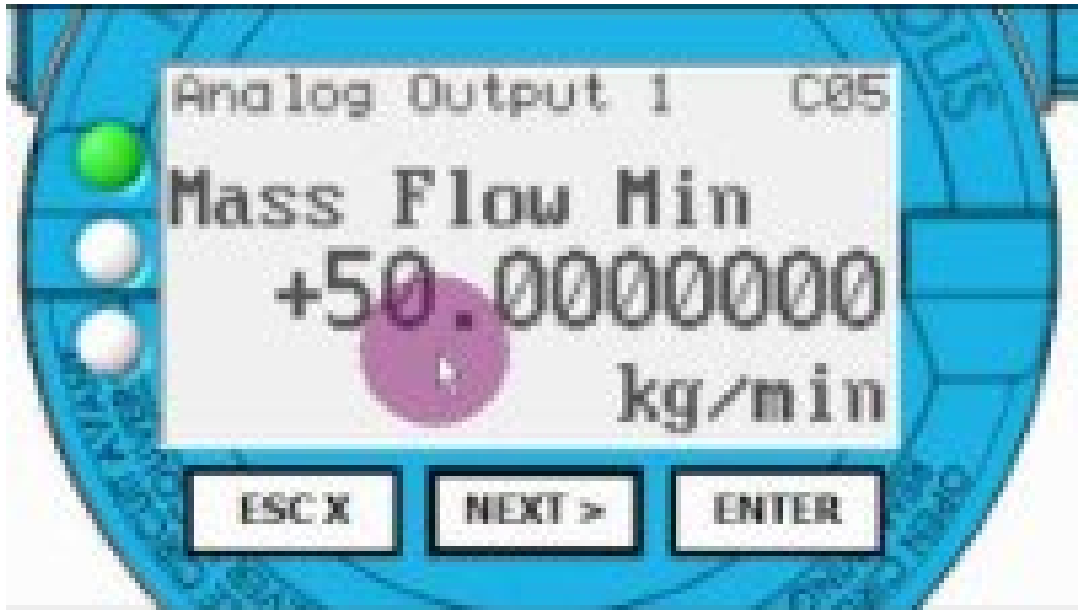
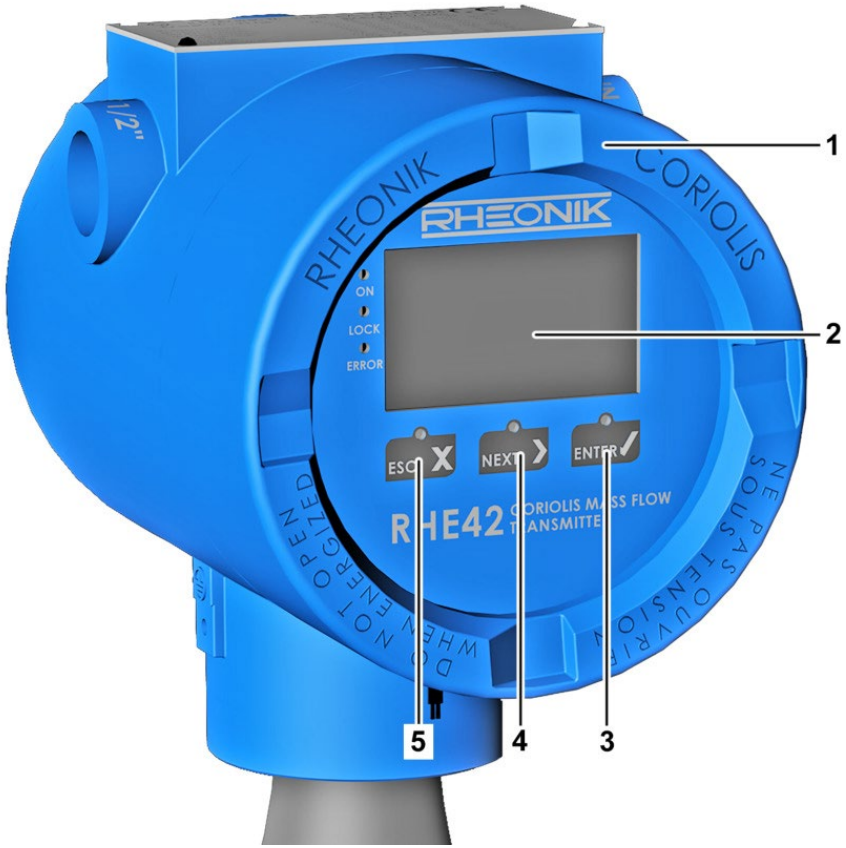
2.2 Function of the keys on the RHE20 & RHE40 Coriolis transmitters

There are three keys for operating the RHE20 & RHE40 Coriolis transmitter, which are identified with “ESC” , “NEXT” and “ENTER”. The functions that these keys control depend on what is currently being displayed.

This video shows how to operate the transmitter using the user interface:



https://youtu.be/Tn24fxt0p8c



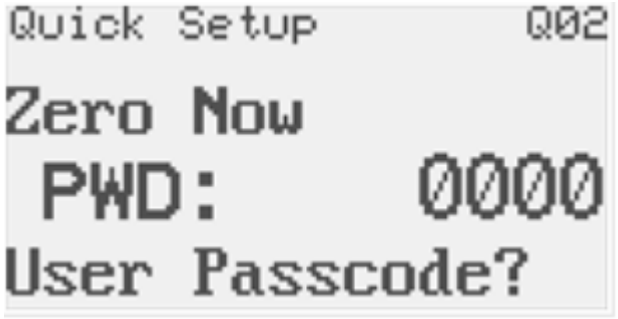
1 *Coriolis Transmitter*
2 *Display*
3 *ENTER Key*
4 *NEXT Key*
5 *ESC Key*

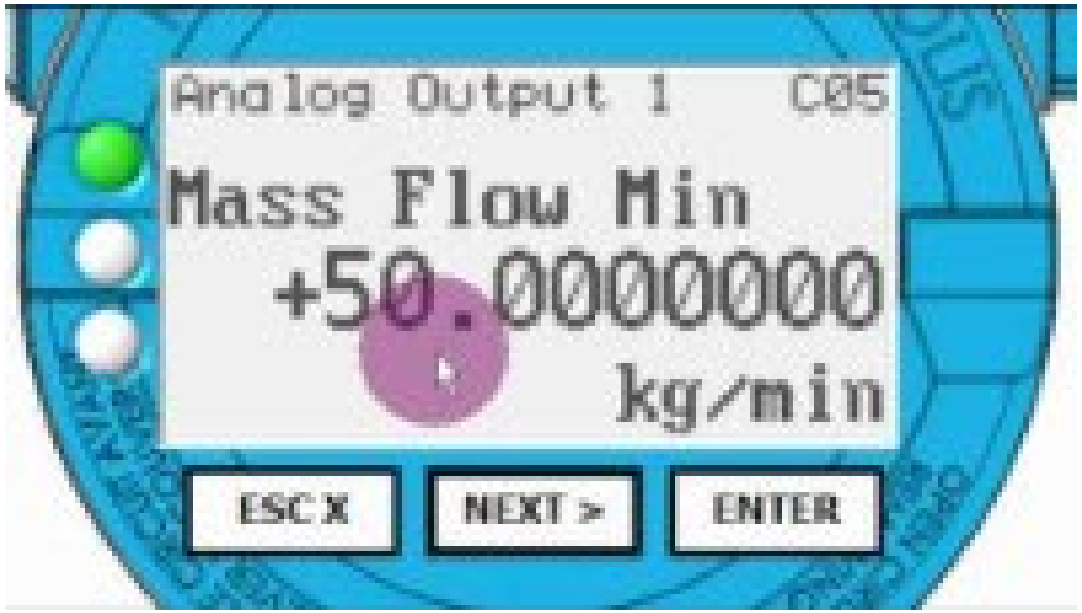
2.3 Passcode Input

You will need to enter a password before being able to configure and execute certain features of the RHE20 and RHE40 Coriolis transmitter. The password protects the configuration and prevents it being changed accidentally.

There are two access levels with different passwords:

- User Login: 1111
- Service Login: 5678





https://youtu.be/Tn24fxt0p8c

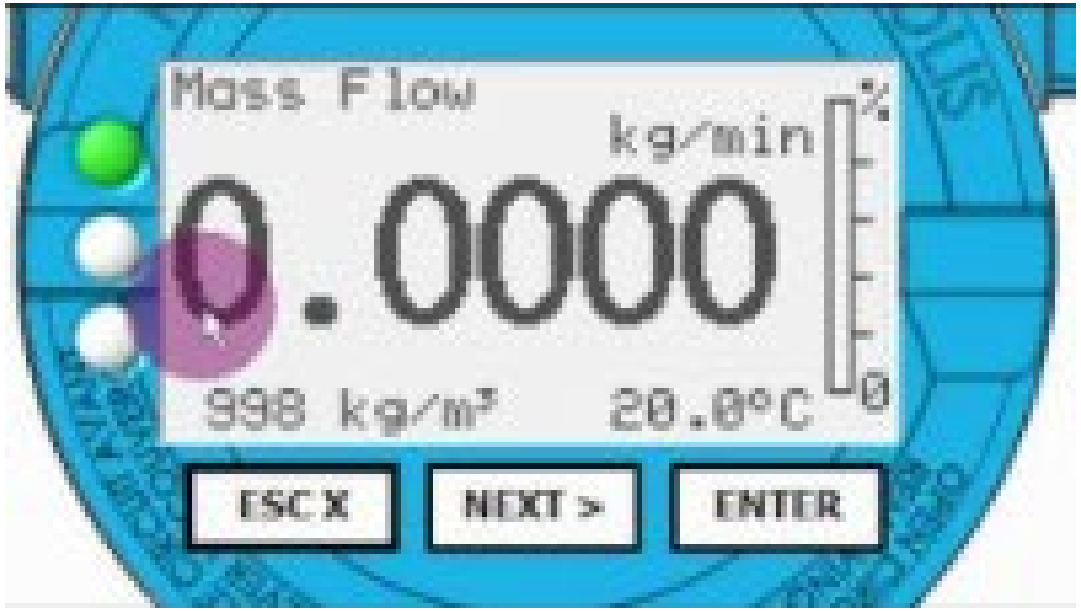
2.4 Zero Point Calibration / Zeroing

The zero point calibration is an important operation to ensure accurate flow measurement, it can be compared with the taring of a scale. It should be carried out:

- When an RHM flow sensor and/or RHE transmitter has been newly installed.
- Before field or laboratory calibration of the meter.
- During routine maintenance of the meter.

For the best measurement performance, the meter should be zeroed under full operating pressure and temperature. A shut off valve should be installed downstream of the meter to facilitate zeroing. It is highly recommended to install a valve upstream of the meter as well to prevent convection flow that might affect the zeroing procedure. Only tight-closing, high-quality valves should be used. In the majority of cases, relying upon simply switching off a pump will not be sufficient.

A zero point calibration can take a few seconds up to a maximum of 30 seconds.



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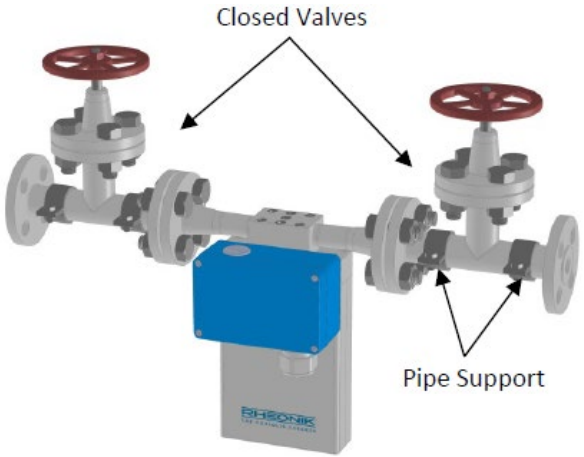

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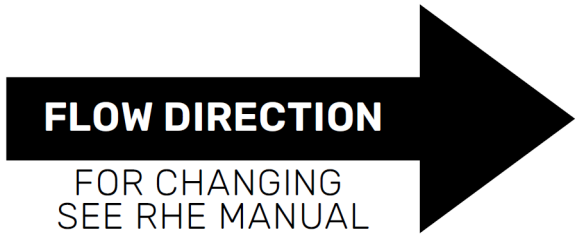
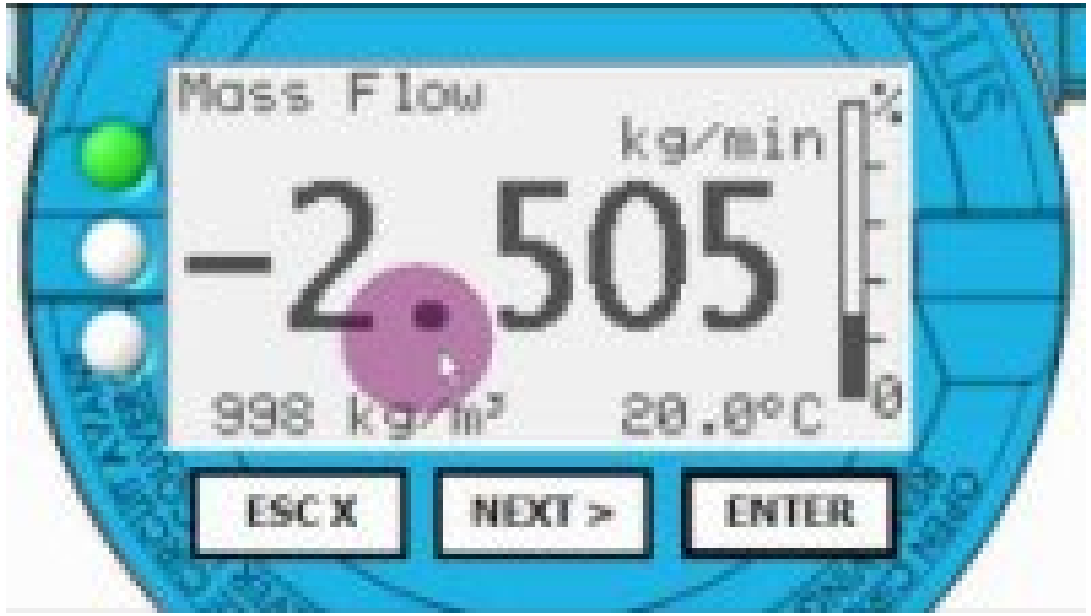
2.5 Change of positive Flow Direction

Rheonik mass flow meters are bi-directional and can operate with flow passing through them in any direction. In some cases, after installation, the transmitter may read negatively because of orientation. In this case, the flow direction indication can be reversed within the transmitter.





https://youtu.be/_G3mjcfwfjM

2.6 Setting the Units of Measurement

The RHE transmitter offers the possibility to present measurement results in a wide variety of standardized metric and imperial units.

https://youtu.be/eW-BE082EiM

Mass Flow	Mass	Density	Volume Flow	Volume	Temperature	Pressure
kg/min (default)	kg (default)	kg/m³ (default)	m³/min (default)	m³ (default)	°C (default)	HPa (default)
kg/s	g	kg/dm³	(S,N)m³/s	dm³	°F	bar
kg/h	mg	kg/l (SG)	(S,N)m³/h	cm³	°K	psi
kg/d	mt (metric ton)	kg/Nm³	(S,N)m³/d	mm³	°R	Pa
g/s	oz	g/cm³	l/s	l		kPa
g/min	lb	g/ml	l/min	cl		mbar
g/h	ST (short ton)	mt/cm³	l/h	ml		Torr
g/d		lb/in³	l/d	hl		
mt/s		lb/ft³	(S)CFS	in³		
mt/min		lb/gal	(S)CFM	CF, ft³		
mt/h		lb/SCF	(S)CFH	us gal		
mt/d		oz/in³	(S)CFD	bbl		
lb/s		°BéH	us gal/s	SCF		
lb/min		°BéL	us gal/min	Nm³		
lb/h		°API	us gal/h	Sm³		
lb/d		°Bx	us gal/d			
ST/s			(k)bbl/s			
ST/min			(k)bbl/min			
ST/h			(k)bbl/h			
ST/d			(k)bbl/d			
oz/s			ml/s			
oz/min			ml/min			
oz/h			ml/h			
			ml/d			
			in³/s			
			in³/min			
			in³/h			

2.7 Resetting the Mass and Volume Totalizers

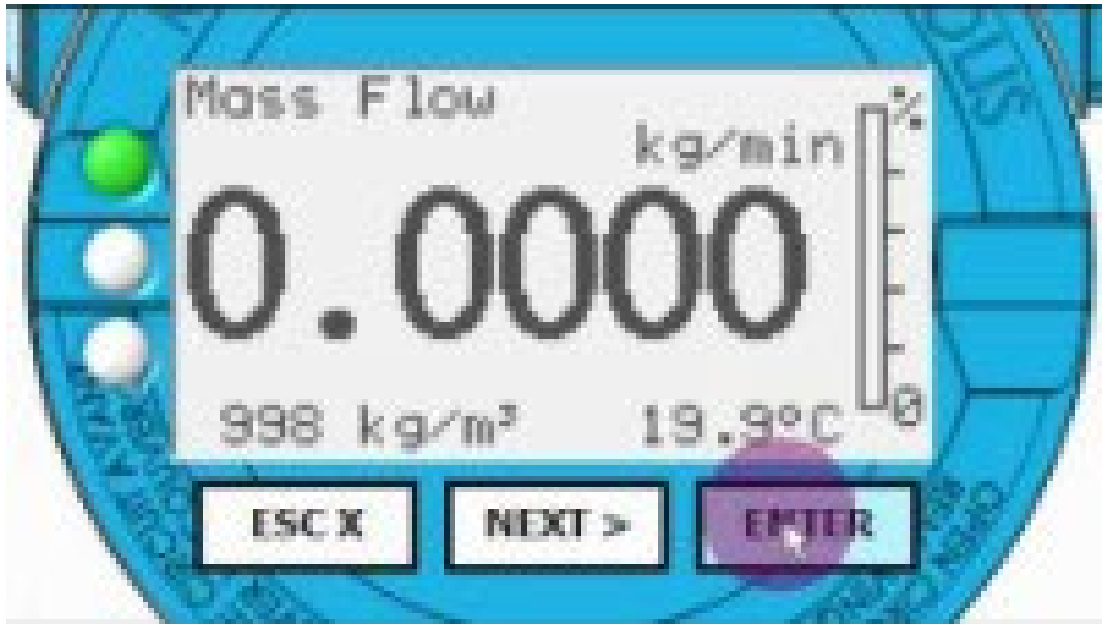
The totalizers of the RHE transmitter is used to accumulate the mass flow and volumetric flow rates. RHE20 and RHE40 Coriolis transmitter offer 14 different totalizers:

- Mass forward, reverse and net (32 and 64 bit precision)
- Volume forward, reverse and net (32 and 64 bit precision)*
- Mass net (64 bit, not resettable)
- Volume net (64 bit, not resettable)*

The net totalizer adds all flows in the positive direction, any flow in the negative direction is subtracted from it.

The forward totalizer adds up only forward flows and the backward totalizer adds up only the backward flows.

* The volume flow and any totalized volume are only correct if the density measurement is active and calibrated or a correct fixed density value is entered in the RHE transmitter.

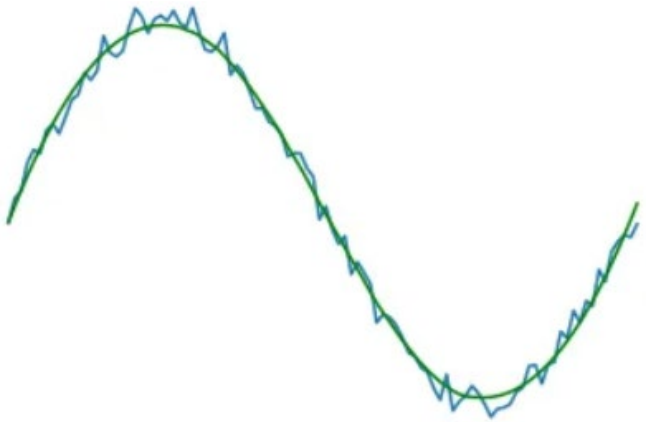


https://youtu.be/3aTpDpFpvNM

2.8 Setting the filter/damping values

The Filter Settings menu enables you to set the stability of the measured values and the response time of the measuring device. Whilst increasing the filter values will result in more stable and smoothed measured values, it will also extend the measuring device's response time.

To ensure high measurement accuracy for short measurement periods, use the lowest possible filter values. In contrast, higher filter values can be used for long-term measurements in order to optimally stabilize the measured values.



https://youtu.be/0gacqeS1AXY

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2.9 Display Settings

Default Screen

The measured value that is permanently displayed on the RHE transmitter can be selected. The following options are available:

- Mass Flow (default)
- Volume Flow
- Total Mass
- Total Volume
- Density
- Custody Transfer View
- Toggle all Values every 20s
- Batch Mode Screen

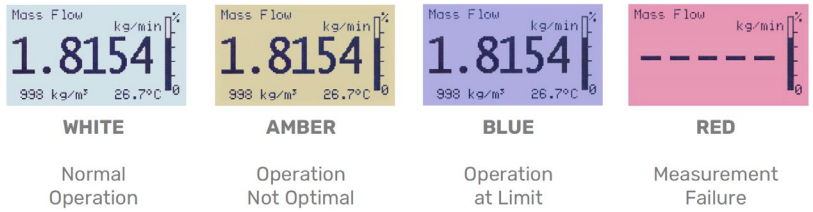
https://youtu.be/ErDzJc3m-cY

Lighting Configuration

- Set on-time (illumination period after the user operates the device)
- Permanent on (permanently illuminated)
- On at Flow (illuminated when the device is recording a flow)

Background Color

- Namur Colors (white, yellow=Warning, red=Error, blue=wrong configuration)
- White only
- Assurance Level >



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3. Configuration and Test of Outputs, Inputs and Interfaces

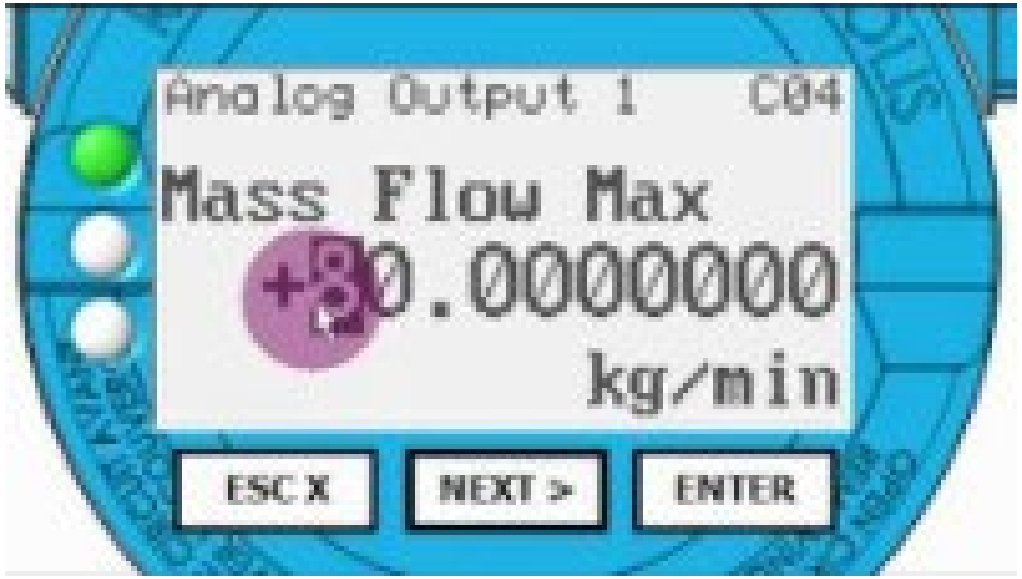
The product code and wiring diagrams provide information about the available outputs, inputs and interfaces.

3.1 Configuration of Analog Outputs

RHE20 and RHE40 transmitters are equipped with up to two analog 4-20mA outputs.

These outputs can be configured to output the following measured variables:

- Mass Flow
- Volume Flow
- Density
- Tube Temperature (Fluid Temperature)
- Torsion Bar Temperature
- Sensor Drive Power
- Assurance Factor
- Percent Main Substance: Proportion of Oil (Net Oil Function) / Solids



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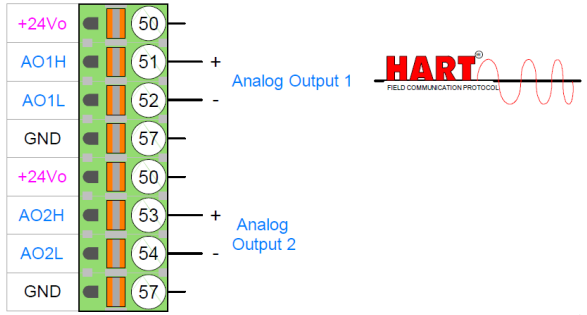

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3.2 Configuration of Digital Outputs 1 and 2 as Pulse/Frequency Outputs

RHE20 and RHE40 transmitters are equipped with up to two digital outputs which are able to act as pulse/frequency outputs.

The outputs can be configured to output the following measured variables:

- Mass Flow (via Frequency)
- Volume Flow (via Frequency)*
- Total Mass (via Pulses)
- Total Volume (via Pulses)*

The standard settings allow pulse modes with 25-10000 Hz (pulses/s) or 0-50 Hz (pulses/s).
The frequency mode works from 25-10000 Hz.
If one of these ranges is not sufficient, you will find other pulse/frequency modes in the "Special settings" chapter.

* The volume flow and any total volume are only correct if the density measurement is active and calibrated or a correct fixed density value is entered in the RHE transmitter.

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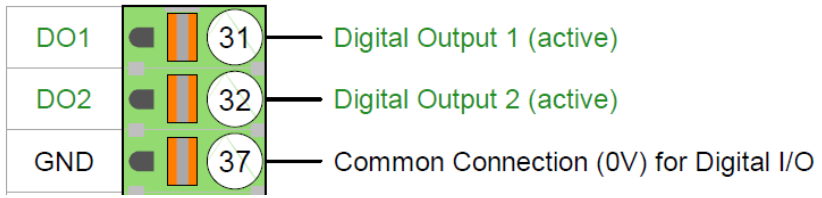

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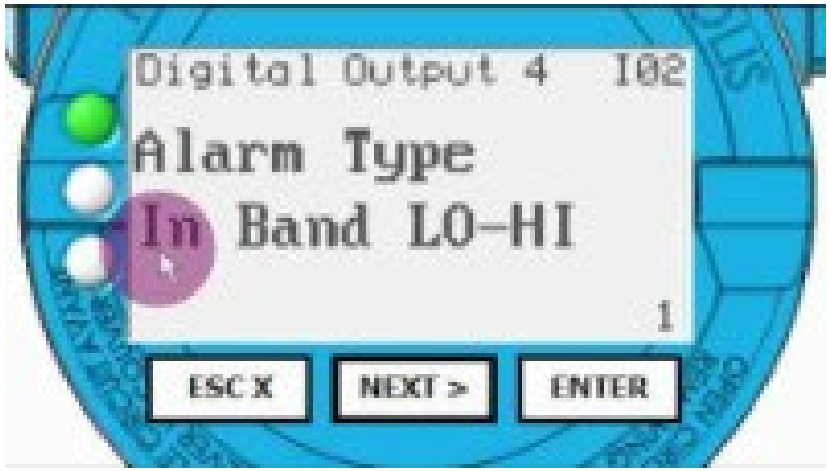
3.3 Configuration of Digital Outputs 1, 2, 3 and 4 as Status Outputs

RHE20 and RHE40 transmitters are equipped with up to four digital outputs which are able to act as status outputs.

The outputs can be configured to output the following status messages:

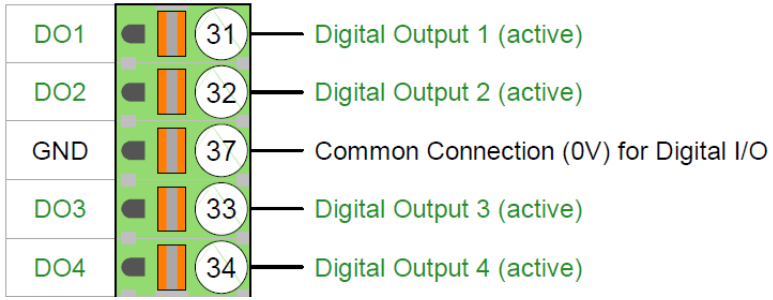
- Mass Flow or Total Mass Alarm
- Volume Flow or Total Volume Alarm
- Density Alarm
- Tube Temperature (Fluid Temperature) Alarm
- Torsion Bar Temperature Alarm
- Reverse Volume Flow Alarm
- Fatal Error or Zeroing Low (0V) or High (24V)
- Assurance Factor Alarm
- Error Alarm (default; 0V at zero and positive flow, 24V at negative flow; available for outputs 1 and 4 only)
- Flow Direction (default; 0V in case of error, else 24V; available for outputs 2 and 3 only)



https://youtu.be/M3ZVGRDMq38

The following alarm types can be selected for the alarm functions:

- Setpoint Alarm (Set HI/Reset LO): Alarm (24V) is indicated when the measured value is higher than the high alarm value and cleared (0V) when it returns below the low alarm value.
- Inband Alarm (In Band LO-HI): Alarm (24V) is indicated when the measured value is in the range between the low and the high alarm value.
- Outband Alarm (Out Band LO-HI): Alarm (24V) is indicated when the measured value is outside the range between the low and the high alarm value.



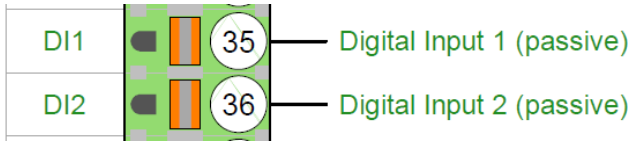
3.4 Configuration of Digital Inputs

RHE20 and RHE40 transmitters are equipped with up to two digital inputs which can be used for following purposes:

- Start Zeroing LO-HI[1]
- Start Zeroing HI-LO[2]
- Reset & Start Totalizers LO-HI
- Reset & Start Totalizers HI-LO
- Stop (LO-HI) and Restart (HI-LO) Totalizers
- Stop (HI-LO) and Restart (LO-HI) Totalizers
- Special Function 1 (reserved)
- Batch Stop LO-HI
- Batch Stop HI-LO
- Batch restart LO-HI
- Batch Restart HI-LO
- Reset & Hold Totalizers LO-HI
- Reset & Hold Totalizers HI-LO

https://youtu.be/aFt3NZT_9PI

[1] LO-HI: Change from 0V to 24V
[2] HI-LO: Change from 24V to 0V



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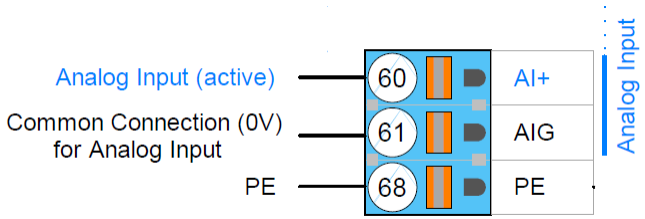
3.5 Configuration of the Analog Input

Special versions of RHE20 transmitters are equipped with one 4-20mA input which can be used for following purposes:

- Absolute Pressure Input
- Relative Pressure Input
- Temperature Input

The pressure or temperature value can then be used for API calculations (please see sections 4.3 and 4.4) or passed on to the process control system.



https://youtu.be/CGuLG27Oc9A

3.6 Configuration of the RS485 Interface

All RHE20 and RHE40 transmitters are equipped with a two-wire isolated RS485 interface with Modbus communication protocol.

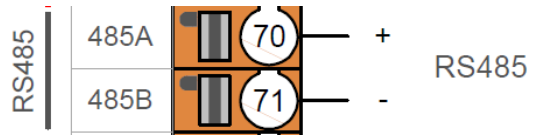
The data rate is configurable from 9.6kBaud to 57.6kBaud.

Multiple devices with unique Modbus addresses can be connected to the RS485 wire pair. The MODBUS address of the RHE transmitter is configurable in the range of 1 to 247.

The communication parameters set in the RHE transmitter and in the process control system must match so that a connection is possible.

The RHE transmitter features an internal 120-ohm termination resistor. It is located on a circuit board within the RHE transmitter. Its exact location and the terminals for the RS485 wire connection are shown in the RHE type specific installation manual. Normally, the termination switch (and the factory default position) should be set to ON. When more than one device is attached to the RS485 line this switch must be set to OFF for all devices on the line except for those devices at each end of the line, where the switch must be set to ON.

Maximum line distance for the RS485 interface is 1200m.



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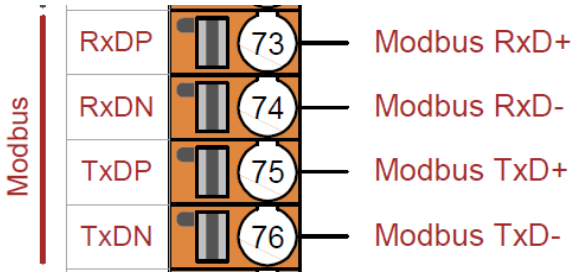
3.7 Connecting the Ethernet Interface

Special versions of RHE40 transmitters are equipped with an Ethernet interface.

Once the RHE transmitter has been connected to a network, it is assigned an IP address. This IP address is required in order to connect the RHE transmitter with a process control system. The IP address can be read on the display of the RHE transmitter.



https://youtu.be/PIYQOFCoKsY

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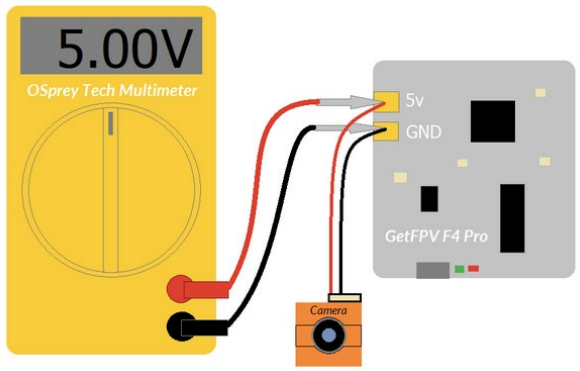
3.8 Output Test Function

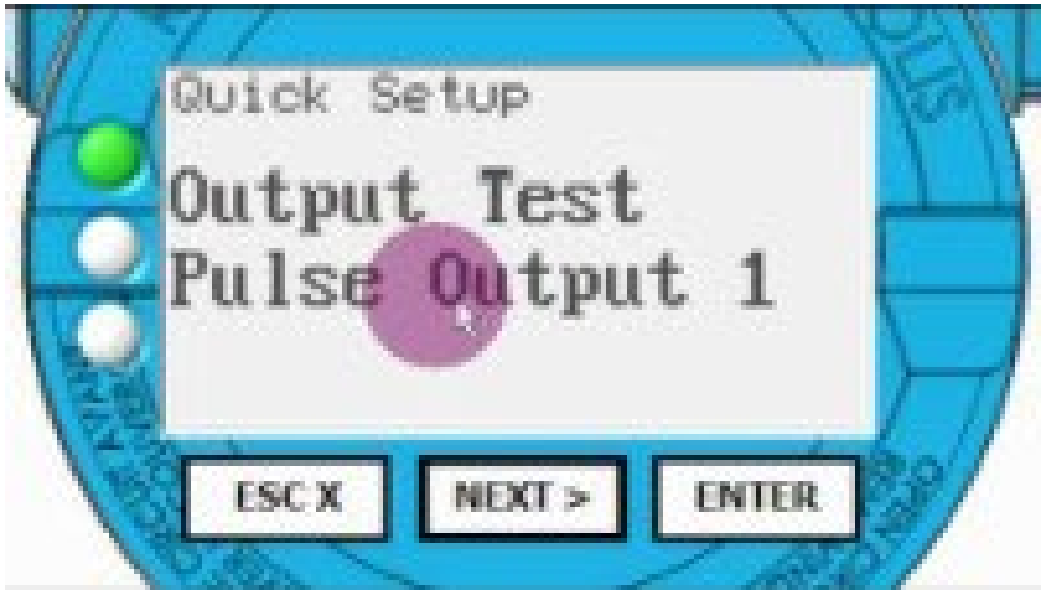
All RHE20 and RHE40 transmitters are equipped with an output test function which allows to test the analog and digital outputs.

The analog outputs can be set to any value, which is then held until the test mode is deactivated.

The digital outputs can be be set to any value depending on the configuration:

- Status: 0 (0V) or 1 (24V)
- Pulse: from 1 (100Hz) to 100 (10000Hz) pulses per 10ms
- Frequency: from 1 to 10000Hz





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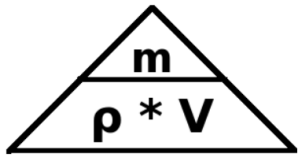
4. Special Functions and Service Settings

4.1 Density and Volume Settings

In addition to the optional density measurement, via which volumetric measured values are available, there are the following other options for outputting volumetric values:



Fixed Density Function

The Fixed Density function allows to enter a fixed density value for volumetric flow calculations.

1. Enable the function by selecting “Constant Base” under *Main Screen > Service Login > xxx Density > Density Config*
2. Enter a density value under *Main Screen > Service Login > xxx Density > Density Base Val*

Calculated Density Function

The Calculated Density function allows density to be generated based upon process temperature. A base/reference density at a known temperature is entered for the fluid being measured along with a coefficient describing the change in density per temperature unit. The firmware in the transmitter calculates flowing density based upon this information to use for volumetric flow calculations.

1. Enable the function by selecting “Calculated Dens.” under *Main Screen > Service Login > xxx Density > Density Config*
2. Enter the reference density value under *Main Screen > Service Login > xxx Density > Density Ref. Val*
3. Enter the reference temperature value under *Main Screen > Service Login > xxx Density > Density Ref. Tmp*
4. Enter the expansion coefficient (in [K^{-1}]) under *Main Screen > Service Login > xxx Density > Expansion Coeff.*

Standardized/Normalized Volume

This function calculates the volume of gas passing through the meter at standard conditions. The density of the gas at standard conditions is entered into the transmitter and the volume is calculated using this in conjunction with the flowing mass.

1. Enable the function by selecting “Constant Base” under *Main Screen > Service Login > xxx Density > Density Config*
2. Enter the standard density value under *Main Screen > Service Login > xxx Density > Density Base Val*

Standardized/Normalized density, volume and volume flow can be displayed in corresponding units, please see section 2.5.

The standardized/normalized volume is a unit of measurement for the mass of fluids commonly used in pneumatics, process engineering and gas engineering. It is used to compare gas volumes present at different pressures and temperatures (operating condition, operating volume). For this purpose, the gas volumes are converted to the same standard state in each case.

$$V_{norm} = \frac{p}{1013.25\,mbar} \cdot \frac{273.15\,K}{T} \cdot V$$

4.2 Batch Controller

All RHE20 and RHE40 transmitters are equipped with an onboard batch controller that, in conjunction with external pumps and/or valves allows the precise delivery of a preset mass or volume of process fluid on demand. Operated from the instrument front panel, remotely via operator switches or through digital communication from a connected supervisory control system, the transmitter can be configured to utilize either a one stage, a two stage or a self-learning delivery strategy in ensuring the right amount of fluid is batched through the meter.

This is how the batch controller is configured and activated using the HMI:

1. Enter the Batch Configuration Menu under *Main Screen > Batch Operation*
2. Batch Variable
   Select whether a certain mass or volume is to be filled and determine the corresponding unit.
3. Batch Mode
   Now you can choose from the following three filling modes
   a. Self-Adjustment: The transmitter learns the optimum time to transmit the signal in order to stop the filling process so that the set target quantity is optimally achieved. Thus, with a target filling mass of e.g. 1 kg, the filled mass is automatically achieved more and more accurately from filling to filling by this mode:

      1st Filling: 0.985 kg
      2nd Filling: 0.993 kg
      3rd Filling: 0.997 kg
      4th Filling: 0.999 kg
      5th Filling: 1.000 kg

b. Single Stage: The transmitter always transmits the signal in order to stop the filling process when the entered target quantity is reached. Depending on the design of the filling line, it may be necessary to enter the target quantity in the transmitter slightly lower than the actual target quantity.

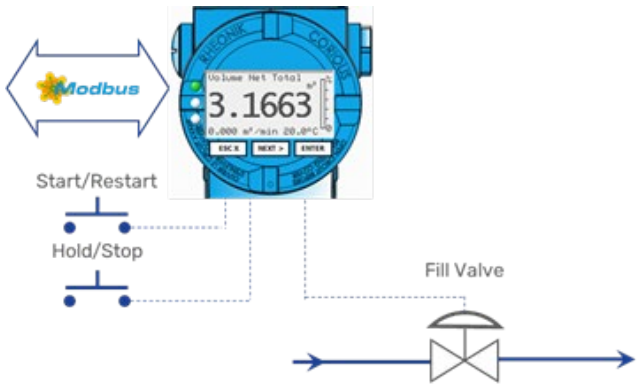
c. Dual Stage: The transmitter transmits two signals in order to stop the filling process. The first signal is output when the coarse target quantity is reached, the second signal when the fine/final target quantity is reached. With this mode it is possible to realize even difficult fillings by means of different inflows in two stages and thus more precisely.

4. Input Devices

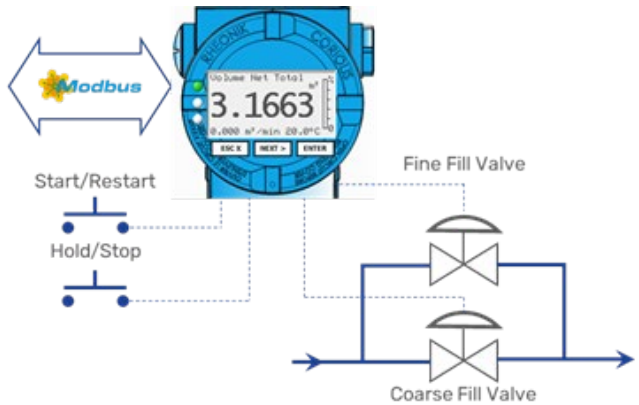
After a filling operation, the totalizer can be reset via the HMI or a digital input. This also resets the transmitter signal to close the valve or stop the pump, which starts the next filling process.
In this menu item you can select whether the start of the next filling process should be via the HMI or a digital input.

Dual stage filling is carried out via coarse filling with a higher flow rate until the coarse target quantity (e.g. 0.95 kg) is reached, then the fine target quantity (e.g. 1 kg) is reached as accurately as possible by means of fine filling with a lower flow rate.

Single Stage Filling



Dual Stage Filling



 |

5. DI Polarity (is only displayed if a digital input was selected under point 4)
   When using a digital input to start the next filling process, the polarity can be selected as follows:
   - Positive (L->H): Change from 0V to 24V at the digital input causes a start of the next filling process
   - Negative (H->L): Change from 24V to 0V at the digital input causes a start of the next filling process

6. Select Valve DO (Fine Valve DO, if the Dual Stage Mode was selected under point 3)
   The digital output for closing the valve or stopping the pump can be selected here. The Self-Adjustment mode can only be used in combination with Digital Output 3.
   If the Dual Stage Mode was selected under point 3: Select the digital output for the fine filling.

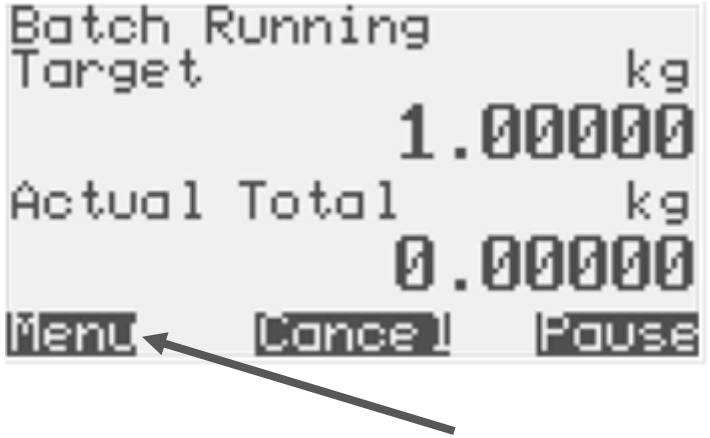
7. DO Polarity
   The polarity of the digital output can be selected as follows:
   - Positive (L->H): The digital output switches from 0V to 24V when the target quantity is reached
   - Negative (H->L): The digital output switches from 24V to 0V when the target quantity is reached

8. (Fine) Target Quantity
   The target filling mass or volume can be entered here with a freely selectable value.
   If the Dual Stage Mode was selected under point 3: Select the fine/final target filling mass or volume.

9. Corse Valve DO (is only displayed if the Dual Stage Mode was selected under point 3)
   Select the digital output for the coarse filling.

10. Coarse Target Mass (is only displayed if the Dual Stage Mode was selected under point 3)
    Select the coarse target filling mass or volume.

When the configuration of the batching function is completed, the transmitter performs a restart and then shows the batching screen:



The batching function and screen can be deactivated by entering the menu and changing the default screen, please see section 2.9.

4.3 API Standard Density/Volume

All RHE20 and RHE40 transmitters with corresponding software function package are able to calculate API standard density and volume at 60°F and the standard atmospheric pressure for different hydrocarbon types in accordance with the API MPMS Standard (Chapter 11, Section1, Addendum 1, September 2007).
All three product groups – crude oil, refined products and lubricants can be metered using this built-in application. These functions can be activated under this path:

Main Screen > User Login > xxx Density > Spec Dens Calc

by setting one of these values:

- 1 API MPMS Density calculation for Crude Oil
- 2 API MPMS Density calculation for Refined Products
- 3 API MPMS Density calculation for Lubricants

Precise calculation requires temperature and pressure inputs. The following values can be used for the temperature and pressure.

Setting under *Main Screen > User Login > Pressure > Configuration*	**Temperature and Pressure Values**
1	Temperature is taken from flow sensor tube temperature, pressure is taken from the parameter under *Main Screen > User Login > Pressure > External Setting*
2	Temperature is taken from flow sensor tube temperature, pressure is taken from an absolute pressure sensor attached to the analog input (please see section 3.5)

Setting under *Main Screen > User Login > Pressure > Configuration*	Temperature and Pressure Values
3	Temperature is taken from flow sensor tube temperature, pressure is taken from a relative pressure sensor attached to the analog input (please see section 3.5)
4	Temperature is taken from a temperature sensor attached to the analog input (please see section 3.5), pressure is taken from the parameter under *Main Screen > User Login > Pressure > External Setting*
5	Temperature is taken from Modbus register 0x662A, pressure is taken from the parameter under *Main Screen > User Login > Pressure > External Setting* ! Configuration can only be activated with the RHEComPro communication software !
6	Temperature is taken from Modbus register 0x662A, pressure is taken from an absolute pressure sensor attached to the analog input (please see section 3.5) ! Configuration can only be activated with the RHEComPro communication software !
7	Temperature is taken from Modbus register 0x662A, pressure is taken from a relative pressure sensor attached to the analog input (please see section 3.5) ! Configuration can only be activated with the RHEComPro communication software !

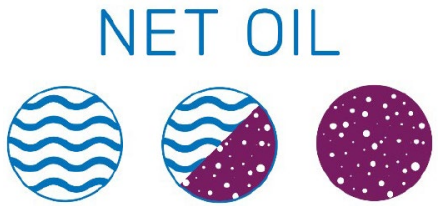
When the API density calculation is active the following features of the RHE transmitter will then be based on the API Standard Density/Volume:

- HMI Volume Flow and Volume Total Presentation Screen
- HMI Density Presentation Screen
- 4-20mA Current Outputs when “Density” or “Volume Flow” is selected as data source
- Frequency Outputs when “Density” or “Volume Flow” is selected as data source
- Modbus registers “StdDensity” (0x480A), “Volumetric Flow Rate” (0x4A00), “TotalVolFwd” (0x4B02) and all other volume totalizers

4.4 API Net Oil

Crude Oil is often mixed with water. When the density of both substances are different enough (>10%) it is possible to calculate the amount of oil in the mixture out of the measured density. This is done using the density values of the crude oil and saline water at 60°F and standard pressure.

In addition to the API standard density/volume function, the RHE20 and RHE40 transmitters also offer a net oil Function. The net oil function can be activated under this path by setting the value 4:



Main Screen > User Login > xxx Density > Spec Dens Calc

The density of the crude oil and saline water at 60° F and standard pressure can be entered here:

- Density crude oil: *Main Screen > User Login > xxx Density > Dens Main Subst.*
- Density salinity water: *Main Screen > User Login > xxx Density > Dens Add Subst.*

Both standard densities are used to calculate density values which correspond to the current environmental conditions (for temperature and pressure input options please see table in chapter 4.3) before the portion of the crude oil in the current substance mix is calculated.

The calculation for the density of the crude oil follows the API MPMS Standard and the calculation for the water density use the formulas found in Deep-sea Research, vol. 28A, no. 6, pp. 625-629. The water density calculation takes the temperature, the pressure, and the salinity contents into account.

When the net oil function is active the following features of the RHE transmitter will then be based on the fraction of crude oil:

- HMI Volume Flow and Volume Total Presentation Screen
- 4-20mA Current Outputs when “Volume Flow” or “Percent Main Sub” is selected as data source
- Frequency Outputs when , “Volume Flow” is selected as data source
- Modbus registers “VolPercentMainSubstance” (0x480C), crude oil volume fraction in %
  “CutMainMass“ (0x480E), crude oil mass fraction in %
  “VolumetricFlowRate ” (0x4A00), volume flow rate
  “TotalVolFwd” (0x4B02) and all other volume totalizers

4.5 Percent Concentration Calculation

Percent concentration of a fluid in a mixture of two fluids (e.g. alcohol in water) or solids in liquid can be determined using the percent concentration function. With this function, the density of both components in the stream must be provided as inputs for the calculation. These values are entered manually through the transmitter's menu and should be updated as temperature conditions change to obtain the best performance.

The percent concentration calculation function can be activated under this path by setting the value **5** or **7**:

Main Screen > User Login > xxx Density > Spec Dens Calc

The density of the main (e.g. water) and add substance (e.g. alcohol) at process conditions can be entered here:

- Density main substance: *Main Screen > User Login > xxx Density > Dens Main Subst.*
- Density add substance: *Main Screen > User Login > xxx Density > Dens Add Subst.*

With percent concentration calculation setting **5** the following features of the RHE transmitter will then be based on the main substance:

- HMI Volume Flow and Volume Total Presentation Screen
- 4-20mA Current Outputs when "Volume Flow" or "Percent Main Sub" is selected as data source
- Frequency Outputs when , "Volume Flow" is selected as data source
- Modbus registers "VolPercentMainSubstance" (0x480C), main substance volume fraction in %
  "CutMainMass" (0x480E), main substance mass fraction in %
  "VolumetricFlowRate " (0x4A00), volume flow rate
  "TotalVolFwd" (0x4B02) and all other volume totalizers

With setting **7**, the volume flow rate and volume totalizer values are related to the total volume flow and not only to the main substance.

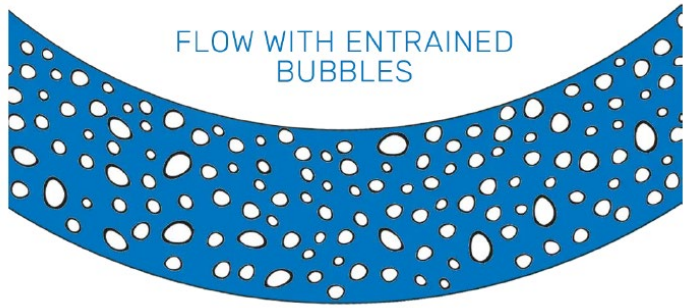
4.6 Partly Filled Pipe Management (PFPM)

Often referred to as multiphase flow, the flow regime in a partially filled pipe can cause large measurement errors and even create a measurement fault condition in a Coriolis Flow Meter.

RHE20 and RHE40 transmitters offer a function to detect a partly filled pipe and “bridging” an interrupted measurement (e.g. caused by big gas bubbles), the Partly Filled Pipe Management (PFPM).

Lite Version (included in software function package DO and higher)

Density measurement is continuously compared to preset limits to determine if the sensor is seeing a liquid/gas mixture running through it. When multiphase flow is detected, it can be signaled, e.g. by a DO, to alert users and allow action to be taken to minimize error.



Full Version (included in software function package AF and higher)

With the full version density measurement and/or sensor pickup voltage levels (raw measurement signal for flow and density) is continuously compared to preset limits to determine if the sensor is seeing a liquid/gas mixture running through it. When multiphase flow is detected, it can be signaled, e.g. by a DO, to alert users and allow action to be taken to minimize error. It is also possible to “bridge” an interrupted measurement for up to 60s with the last valid measurement values for mass flow, density and volume flow.

Both versions can only be activated and configured using the RHEComPro communication software, please see corresponding tutorial.

4.7 PID Flow Control Function

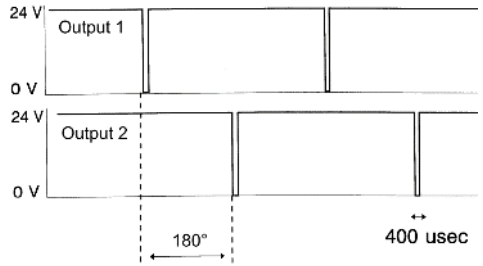
A PID controller is implemented in the RHE20 and RHE40 transmitter to provide direct control to a valve or pump via a 4-20mA output for flow control purposes. The PID controller function features fully tunable PID parameters for either mass or volumetric flow rate.

The PID flow control function can only be activated and configured using the RHEComPro communication software, please see corresponding tutorial.

For a detailed insight into the functionality please refer to this pdf file:

4.8 Special Pulse Modes

Special pulse modes are required for custody transfer applications. At e.g. fuel stations, the measured quantity is often transmitted to the fuel station computer via two pulse outputs, with the two pulse outputs transmitting the pulses out of phase (90 ° or 180 °). This procedure increases the security of data transmission.



The special pulse modes can be set under this path:

Main Screen > User Login > Pulse Output 1/2 > Configuration

by selecting one of these settings:

- 3: Mass Flow 90°
- 4: Volume Flow 90°
- 15: Mass Flow Forward/Positive 180° (RHE40 transmitters only)
- 16: Volume Flow Forward/Positive 180° (RHE40 transmitters only)
- 17: Mass Flow Reverse/Negative 180° (RHE40 transmitters only)
- 18: Volume Flow Forward/Positive 180° (RHE40 transmitters only)

The pulse rate (pulses per quantity) can be set under this path:

Main Screen > User Login > Pulse Output 1/2 > Mass/Volume Pulse Ref

Certain data acquisition systems require inverted pulses for safety reasons, i.e. pulses are signaled with a voltage of 0V, while 24V is transmitted otherwise. By default, pulses are signaled with a voltage of 24V, while otherwise a voltage of 0V is output.
The pulse inversion can be activated by setting the value 1 (Pulse inverted/n) under this path:

Main Screen > User Login > Pulse Output 1/2 > Pulse Inversion

The maximum pulse width can be set under

Main Screen > User Login > Pulse Output 1/2 > Max Pulse Width

in the range from 50 to 4000 µs.

4.9 Calibration / Adjustment of Measured Variables

In exceptional situations, unexpected external influences can lead to deviations in measured variables. If these deviations are systematic, they can be corrected by means of certain parameters in the RHE transmitter.

Mass Flow Measurement Adjustment

A mass flow measurement deviation can be corrected by adapting the mass flow calibration factor under this path

Main Screen > Service Login > Mass Flow > MassFlowKFactor

according to the following equations:

$$KFactor_{new} = KFactor_{old} \cdot \frac{reference\ value\ [kg]}{flowmeter\ value\ [kg]} \quad \textbf{or} \quad KFactor_{new} = KFactor_{old} \cdot \left(\frac{100}{100+deviation\ [\%]^{*}}\right)$$

* deviation flowmeter – reference; please always consider the algebraic sign (+/-) of the deviation

Temperature Measurement Adjustment

A temperature measurement deviation can be corrected by entering the difference between actual and measured value under this path:

Main Screen > Service Login > Temperature Meas > Tube Temp Offs

Density Measurement Adjustment

A density measurement deviation can be corrected using either the calibration factor (recommended) or the offset correction function.

The calibration factor can be used to correct the density readings by any percentage. The calibration factor can be changed under this path

Main Screen > Service Login > Measured Density > Density K-Factor

according to the following equations:

$$KFactor_{new} = KFactor_{old} \cdot \frac{reference\ value\ [kg/m^3]}{flowmeter\ value\ [kg/m^3]} \quad \textbf{or} \quad KFactor_{new} = KFactor_{old} \cdot \left(\frac{100}{100+deviation\ [\%]^*}\right)$$

* deviation flowmeter – reference; please always consider the algebraic sign (+/-) of the deviation

With the offset correction function, the density readings can be corrected by any absolute offset. The offset can be set under this path

Main Screen > Service Login > Measured Density > Density Offset

4.10 Hardware Lock Switch

All RHE20 and RHE40 transmitters offer a hardware lock switch as an option, it is needed for applications such as custody transfer where sealing is required. This switch, when engaged, prevents change of any setting within the transmitter through both the user panel interface and through a digital communications port.
Once the Lock Switch is set, a tamperproof seal can be applied to the transmitter case to indicate if the transmitter has not been opened since sealing.

The hardware lock switch can be configured to allow totalizer reset and/or zero calibration when it is active. This setting can be made under this path:

Main Screen > Service Login > HMI Setup > Custody Lock Pr.

- 0: Hardware lock switch prohibits all inputs
- 1: Zero point calibration / zeroing is allowed while hardware lock switch is active
- 2: Totalizer reset is allowed while hardware lock switch is active
- 3: Zero Point Calibration / Zeroing and Totalizer Reset is allowed while hardware lock switch is active

An active hardware lock switch is indicated by the illuminated yellow LED on the transmitter front.

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5. Diagnosis Features and Troubleshooting

5.1 LED Status Indicator

There are three LEDs on the front of the RHE transmitter. The following table gives an overview of the possible states of these LEDs and their meaning.

LED	State	Meaning
Green	Off	RHE transmitter is not ready. The device is either initializing after a system reset, has no power, or is defective.
	On	RHE transmitter in operation.
	Flashing	A fast flashing green LED indicates that the bootloader of the RHE transmitter is active, usually seen during download/upgrade of instrument firmware.
Yellow	Off	Hardware lock switch (Custody Transfer Lock) inactive.
	On	Hardware lock switch (Custody Transfer Lock) active.
	Flashing	When the orange and the red LEDs flash together the Zeroing Process is in progress.
Red	Off	No errors are present and the instrument is operating as intended.
	On	There is at least one error being reported by the instrument. Details of the exact error(s) can be obtained by reading the error status screens Soft Error Stat and Error Status.
	Flashing	When the yellow and the red LEDs flash together, the Zeroing Process is in progress.

5.2 Input and Output Diagnostics

To check the current output and input values, the status of the inputs and outputs can be displayed in the Diagnostics menu und this path:

Main Screen > Diagnostics

The status of following inputs and outputs can be checked:

- Analog outputs
- Digital inputs
- Digital outputs as status outputs
- Digital outputs as pulse/frequency outputs

The displayed states and values can be compared with the process control system or a measuring instrument to check the inputs and outputs.

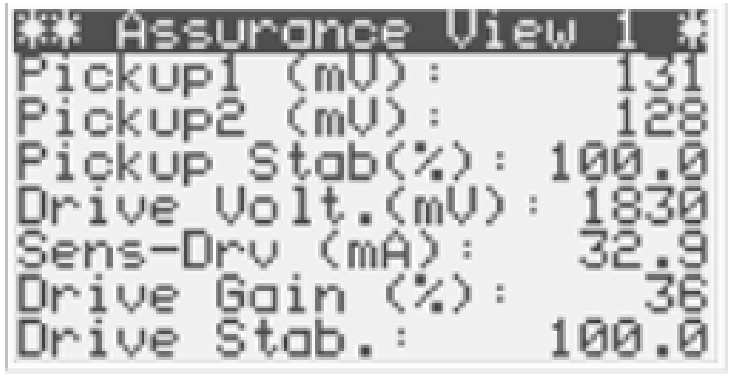
The other parameters in the Diagnostics menu are intended for factory diagnostics.

5.3 Assurance View

The Assurance View menu provides an overview of all important diagnostic parameters and gives information about the status of the measuring device, it can be found under this path:

Main Screen > Assurance View

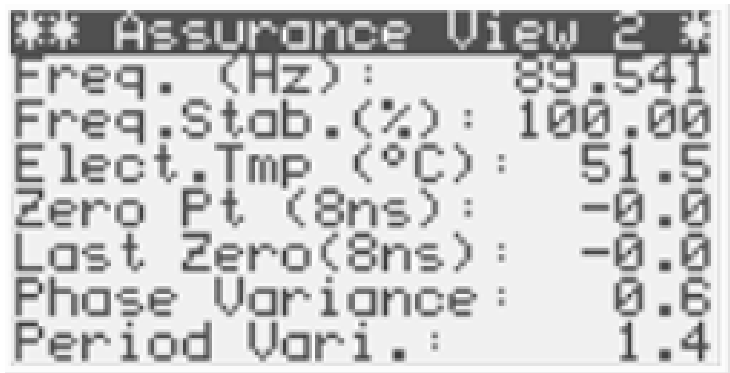
Assurance View 1



Voltage of the 1st sensor pick-up (measurement signal) coil, typ. range 55-135 mV*
Voltage of the 2nd sensor pick-up (measurement signal) coil, typ. range 55-135 mV*
Stability of the pick-up voltages, typical range >95%
Sensor drive voltage, typical range 500-3000 mV
Sensor drive current, typical range 10-100 mA
Required drive power in % of maximum available power, typical range 5-75 %
Stability of the drive power, typical range >95%

* The two pickup voltages must not differ by more than 5 mV

Assurance View 2



Sensor frequency in Hz, depends on sensor size, typical range 70-260 Hz
Stability of the sensor frequency, typical range >95%
Inner temperature of the RHE transmitter, typical range 0-60°C
Current zero point
Last zero point
Variance of zero point during last zero point calibration
Variance of sensor frequency during last zero point calibration

5.4 Assurance Factor

RHE20 and RHE40 transmitters with software function package AF and higher offer the Assurance Factor® under

Main Screen > Assurance View

The Assurance Factor® is a numeric value from 0 to 100% generated by an internal algorithm that in indicates the overall health of the flow meter and measurement. The Assurance Factor® value can be used to trigger changes to the screen color if the background color configuration is set accordingly, providing highly visible wide area condition indication.

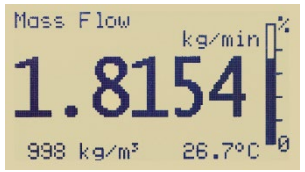
The Assurance Factor® can also be output with an analog output or read out via Modbus.

ASSURANCE
Factor®

WHITE

Normal Operation

No faults present. All parameters within expected limits. Meter fully operational



AMBER

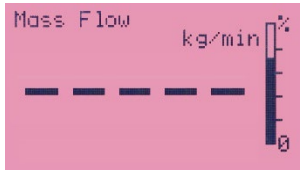
Operation Not Optimal

Sensor subject to noise / changing conditions in pipe. Measurement quality may be compromised

BLUE

Operation at Limit

Sensor experiencing disturbance. Measurement quality compromised



RED

Measurement Failure

Sensor experiencing extreme disturbance / meter in fault. Measurement offline

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5.5 Zero Point History

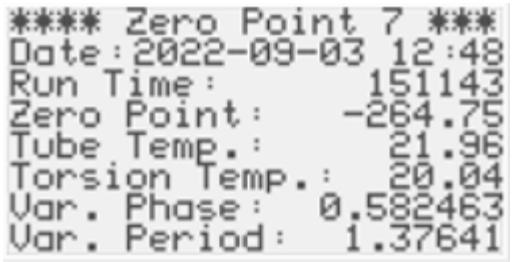
RHE20 and RHE40 transmitters with software function package AF and higher offer the Zero Point History function under

Main Screen > Assurance View

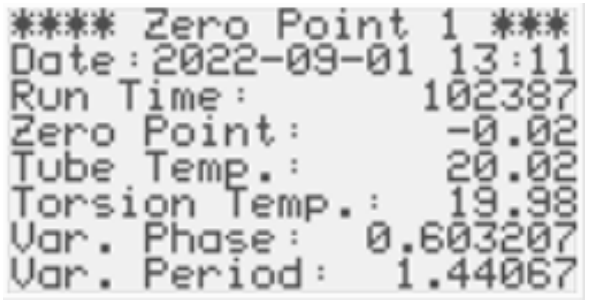
The transmitters logs the last 10 zero points for inspection and troubleshooting. Zero point setting is very dependent upon installation conditions and is therefore specific to each sensor in the field. Comparing zero point history can help identify installation and operation issues that could effect accuracy and performance of the flow meter.

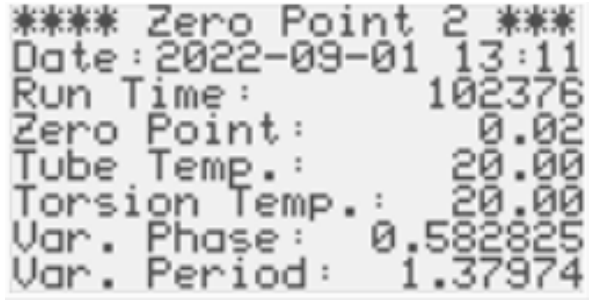
Example:

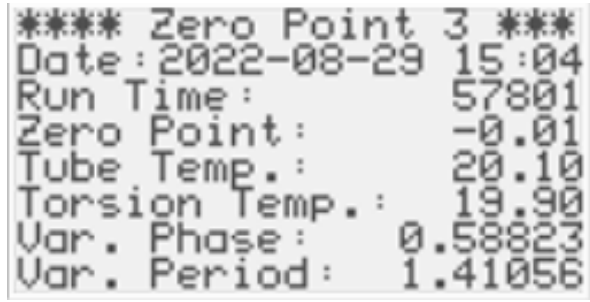
If the following zero point entry is found during an inspection, it can be clearly determined from the deviations to the lateral zero point entries that this zero point was calibrated at flow. From the zero point history, the use of this incorrect zero point can be determined time-wise and the measurement error in this period can be calculated.



In general, zero point values with an amount greater than 100 can be considered conspicuous and most likely false. The same applies to zero point value changes of more than 5 under constant process conditions. In this case, the zero point calibration should be repeated according to section 2.4.
Higher changes can occur with changing process conditions.



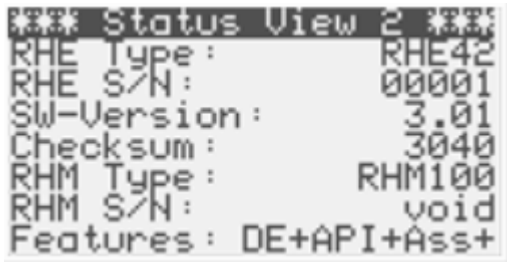




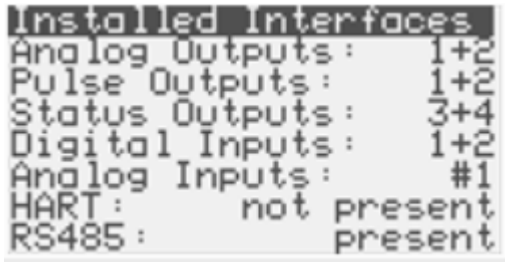
5.6 Status Infos, Errors and Warnings

All RHE20 / RHE40 transmitters are equipped with a Status Infos menu (*Main Screen > Status Infos*), which provides information about

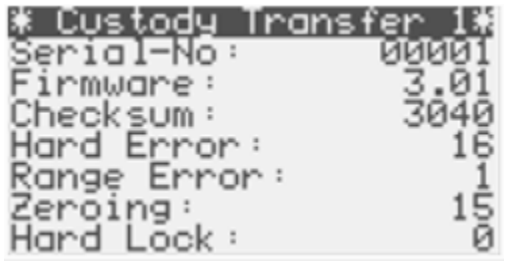
- the device (e.g. types, serial numbers etc.),



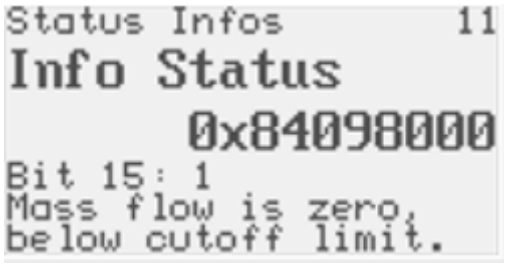
- interfaces and I/Os (available types, configuration),



- custody transfer parameters (e.g. calibration factor, firmware version etc.)



- error, warning and info status



If there is no error or no warning, the corresponding code is 0x00000000. All other values for error and warning codes indicate an error or a warning, e.g.

In this case, the error or warning is described under the error or warning code, in this case “Tube Temperature in error. Wiring?”.

If there is more than one error, the error codes can be scrolled through using the ENTER key.

If the error or warning cannot be corrected using the instructions in the tables in section 5.7, please contact your local partner or Rheonik at service@rheonik.com.

5.7 Troubleshooting

In case of a warning or an error, please read the message in the corresponding menu (see section 5.6) and proceed according to the descriptions in the following tables.

Warnings

Warning Bit(s)	Warning Message	Possible Cause	Solution
0,1,2,3,4,8,9,11, 16,17,18,19,20, 24,25	Mass flow / density / volume flow / temperature / totalizer / pressure lower or upper warning limit exceeded	Mass flow / density / volume flow / temperature / totalizer / pressure warning limits configured incorrectly	Check and reconfigure the warning limits (“Lower Warn Lim”, “Upper Warn Lim”) under e.g. *Main Screen > User Login > Mass Flow*
		Specified operating values of the RHM flow sensor are exceeded	- Operate the RHM flow sensor within its specified operating ranges - Use a RHM flow sensor suitable for the process conditions
15,21	Current output 1/2 range exceeded	Current output configuration wrong, operating values outside the configured range	Check and reconfigure the current output configuration, please see section 3.1
		Negative flow rate, flow direction configured incorrectly	Change the flow direction configuration, please see section 2.5

Warning Bit(s)	Warning Message	Possible Cause	Solution
26	Multi-Phase Flow Condition detected	Two phases (gas or liquid) in the RHM flow sensor	Make sure that only one phase (either gas or liquid) passes through the sensor.
29	Software performance problem detected	Hardware failure	Contact your local partner or Rheonik
30,31	Mass flow / density change exceeds set limit	Change of mass flow / density changes faster than the set limit	Increase the change limit under e.g. *Main Screen > Service Login > Mass Flow > MsFlwChange*

Soft Errors

Soft Error Bit(s)	Soft Error Message	Possible Cause	Solution
1	Current output readback failed	Hardware failure	Contact your local partner or Rheonik
2	Pulse output range exceeded	Pulse rate or frequency at operating conditions too high, max. possible output frequency must be <10kHz	Check and reconfigure the pulse/frequency output configuration, please see section 3.2
3,4	Tube or torsion bar measurement error	Wiring incorrectly, damaged wire or contact problem at RHM sensor or RHE transmitter	Connect RHM sensor and RHE transmitter according wiring diagram, check the functionality of the wires and the contacts on the terminal strip(s)
		See next page	See next page

Soft Error Bit(s)	Soft Error Message	Possible Cause	Solution
		Temperature measurement configuration incorrect	Correct the temperature measurement under *Main Screen > Service Login > Temperature Meas > Configuration* to: - 1: for use with RHM sensor which has been delivered with or for RHE01-14 transmitters - 3: for use with RHM sensor which has been delivered with or for RHE16 transmitters - 7: for use with RHM sensor which has been delivered with or for RHE20 / RHE40 transmitters
5	Transmitter electronics temperature reading error	Hardware failure	Contact your local partner or Rheonik
6	ADS1248 failure. Internal hardware error related to the temperature measurement	Hardware failure	Contact your local partner or Rheonik
7,8,9,15,16	Mass flow / density / volume flow / volume limits exceeded	Specified operating values of the RHM flow sensor are exceeded	- Operate the RHM flow sensor within its specified operating ranges - Use a RHM flow sensor suitable for the process conditions

Soft Error Bit(s)	Soft Error Message	Possible Cause	Solution
10	Zero point calibration not successful	Instability during zero point calibration	- Perform another zero point calibration according to section 2.4 - Make sure that the measuring device is not disturbed too much by external vibrations
11	Analog input exceedance	Technical problem with connected external device (e.g. pressure sensor)	Check connected external device
12,13,14,17,22	Sensor signals out of range	Wiring incorrectly, damaged wire or contact problem at RHM sensor or RHE transmitter	Connect RHM sensor and RHE transmitter according wiring diagram, check the functionality of the wires and the contacts on the terminal strip(s)
		RHM sensor or RHE transmitter is damaged	Check voltages and resistances at the RHM flow sensor terminals using a good quality voltmeter/multimeter according to the following tables

To be measured with **connected** RHM sensor and RHE transmitter

Sensor Terminals	Voltage
1 – 2	0.25 – 5 VAC
6 – 7	10 – 150 mVAC
8 – 9	10 – 150 mVAC

To be measured with **disconnected** RHM sensor and RHE transmitter

Sensor Terminals	Resistance
1 – 2	5 – 70 Ω
3 – 4	approx. 108 Ω[1] / 1078 Ω[2]
4 – 5	approx. 108 Ω[1] / 1078 Ω[2]
6 – 7	10 – 160 Ω
8 – 9	10 – 160 Ω
1…9 – Housing	> 10 MΩ – ∞

[1] valid for Pt100 temperature sensor at about 20°C/68°F
[2] valid for Pt1000 temperature sensor at about 20°C/68°F

If one or more of the voltage/resistance values are outside the specified ranges, please contact us and specify the fault.

Soft Error Bit(s)	Soft Error Message	Possible Cause	Solution
18,19	RHE transmitter firmware performance problem / self-test failure	Hardware failure	Contact your local partner or Rheonik
20	CRC error in flash memory used for Zeroing data	Hardware failure	Repeat zero point calibration. Contact your local partner or Rheonik if the problem persists
21	CRC error found in flash memory used for totalizer data	Hardware failure	Repeat totalizer reset. Contact your local partner or Rheonik if the problem persists

Soft Error Bit(s)	Soft Error Message	Possible Cause	Solution
24	Inconsistent calibration information for the analog input interface provided	Calibration incorrect	Analog input calibration has to be repeated. Contact your local partner or Rheonik for assistance
25	Pickup voltage below defined threshold detected. Multi-phase flow assumed	Two phases (gas or liquid) in the RHM flow sensor	Make sure that only one phase (either gas or liquid) passes through the sensor

Errors

Error Bit(s)	Error Message	Possible Cause	Solution
0	Internal EEPROM error.	Hardware failure	Contact your local partner or Rheonik
1,10	Analog output 1/2 configuration is invalid.	Incomplete or incorrect analog output configuration	Check and reconfigure the current output configuration, please see section 3.1
2	Pulse/frequency output configuration is invalid	Incomplete or incorrect pulse/frequency output configuration	Check and reconfigure the pulse/frequency output configuration, please see section 3.2
3	Temperature measurement time out (no response)	Hardware failure	Restart the transmitter. Contact your local partner or Rheonik if the problem persists

Error Bit(s),	Error Message	Possible Cause	Solution
4	Zeroing data lost	Software/hardware failure	Perform a zero point calibration. Contact your local partner or Rheonik if the problem persists
5	Internal totalizer data lost	Software/hardware failure	Perform a totalizer reset. Contact your local partner or Rheonik if the problem persists
6	Sensor signals out of range	Please see Soft Errors troubleshooting table, Soft Error bits 12,13,14,17,22	
7	EEPROM data lost	Software/hardware failure	Restart the transmitter and check all setup data, especially calibration information, if the error is resolved. Contact your local partner or Rheonik if the problem persists
8	Non-volatile memory error	Software/hardware failure	
9	Density configuration error	Incomplete or incorrect density configuration	Check and reconfigure the current output configuration, please see section 4.1
11	Configuration of the analog input invalid	Incomplete or incorrect analog input configuration	Check and reconfigure the current output configuration, please see section 3.5
12	Batch configuration invalid	Incomplete or incorrect batch configuration	Check and reconfigure the batch configuration, please see section 4.2

5.8 Frequently Asked Questions (FAQ)

Installation and Commissioning

Question	Possible Cause	Solution
What do I have to consider when installing the flowmeter with regard to position, flow direction and inlet/outlet distances?	-	Read the corresponding RHM user manual, it provides information on all these points
My RHE transmitter does not have a display. How can I make configurations and/or perform tests?	-	All RHE20/40 transmitters are equipped with an RS485 interface, some transmitters are also equipped with an accessible mini-USB port (RHE26/27/45/46/49). The transmitter can be connected to a PC via the RS485 interface using an RS485-USB converter. Once the transmitter is connected to the PC, various configurations and tests can be performed using the RHEComPro software
Why does the RHE transmitter not start?	Defective or insufficient power supply	Check power supply functionality and specification. The power supply should be able to provide at least a power of 7 W per connected RHE transmitter
	The power supply fuse inside the RHE transmitter is broken	Replace the power supply fuse with a new Littelfuse fuse: - Part# 37305000000 for DC power supply - Part# 37202000001 for AC power supply Contact your local partner or Rheonik for more information
	Defective RHE transmitter	Return the device to Rheonik for repair or replace it

Question	Possible Cause	Solution
Why do I get a negative flow value after installation?	Wrong flow direction configuration	The flow meters are delivered with a predefined, positive flow direction. This can be changed in the transmitter, see section 2.5.

Operation

Question	Possible Cause	Solution
Why does the device output a flow even though the valve in the supply line is closed or the pump is switched off?	Leaking valve	Clean/replace valve
	Natural (due to temperature differences) or forced (e.g. due to a slope in the line) convection.	Install valve to avoid convection
	Zero point calibration was not performed properly	Perform a zero point calibration according to section 2.4
Why does the measured flow value fluctuate strongly?	Strong vibrations at the RHM flow sensor	Try to isolate the RHM flow sensor from external vibration as much as possible: - Use flexible tubing to connect the flow sensor to the process line

Question	Possible Cause	Solution
		- Attach the RHM flow sensor to your system with rubber spacers
	Cavitation of the measured medium due to high flow velocity and insufficient distance to the boiling point	- Reduce flow rate - Increase process pressure - Reduce process temperature - Use bigger RHM flow sensor
	Pulsating flow	Buffer the flow by using rubber tubes or a buffer storage
	Two-phase flow	Make sure that only single-phase flow is measured
	If the response time does not matter, the filter parameters according to section 2.8 can also always be applied to this problem in order to smooth the measured flow value	
Why don't I get volume and density output?	Density Measurement not available/ordered	In most cases, standard density measurement can be activated in the field for a service fee. Contact your local partner or Rheonik
	Density functions deactivated	Activate a density function according to section 4.1
Why does the analog output not change the output value although there is flow?	Configuration of analog output not correct	Check and if needed reconfigure the analo output according to section 3.1
	Negative flow is measured	If the analog output is assigned to a positive flow range, nothing is output when the flow is negative. Change flow direction according to section 2.5 or assign the analog output to a negative flow range according to section 3.1

Question	Possible Cause	Solution
Why does the pulse/frequency output not change the output value although there is flow?	Configuration of pulse/frequency output not correct	Check and if needed reconfigure the pulse/frequency output according to section 3.2
	Negative flow is measured	The pulse/frequency operates only in the positive flow range. Change flow direction according to section 2.5. If the pulse/frequency output is required in the negative flow range, please refer to the RHE20/40 Desktop Reference Manual for special settings.

6. Setting the RHE transmitter to another RHM flow sensor

If you need to set up an RHE20/40 transmitter to an RHM flow sensor that has not been calibrated together with the transmitter, it is always recommended to upload the RHM specific configuration file to the RHE transmitter using the RHEComPro software - **with RHE40 transmitters there is no other possibility**. For information on how to do this, please refer to the corresponding tutorial.

If the setting is not possible via the RHEComPro software, it can alternatively be done for RHE20 transmitters by entering the following parameters via the display.
You can obtain the values for your RHM flow sensor by specifying the serial number via the e-mail address service@rheonik.com.

Parameter	Value	Unit	Menu Path
MassFlowKFactor		kg/s²	Main Screen > Service Login > Mass Flow
MsFlwUpFctSL		kg/min	
MsFlwLwFctSL		kg/min	
s10		-	
s01		-	
Density Corr Fct		m³/t	
Cutoff Limit		kg/min	Main Screen > User Login > Mass Flow
Upper Warning Limit		kg/min	
Lower Warning Limit		kg/min	
Density Config		-	Main Screen > Service Login > xxx Density
u10		-	
u01		-	
Density Low		kg/m³	
Frequency High		Hz	
Density High		kg/m³	
Frequency Low		Hz	
Configuration		-	Main Screen > Service Login > Temperature Meas
Tube Temp Min		°C	
Tube Temp Max		°C	
Torsion Temp Min		°C	
Torsion Temp Max		°C	
Sensor Type		-	Main Screen > Service Login > Generic Setup

If you have any questions about the operation or configuration of our products, please contact us at service@rheonik.com.

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