English

User Manual

PCE-TDS 75 Ultrasonic Flow Meter

User manuals in various languages (français, italiano, español, português, nederlands, türk, polski, русский, 中文) can be found by using our product search on: www.pce-instruments.com

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Contents

1 Safety notes

Please read this manual carefully and completely before you use the device for the first time. The device may only be used by qualified personnel and repaired by PCE Instruments personnel. Damage or injuries caused by non-observance of the manual are excluded from our liability and not covered by our warranty.

- The device must only be used as described in this instruction manual. If used otherwise, this can cause dangerous situations for the user and damage to the meter.
- The instrument may only be used if the environmental conditions (temperature, relative humidity, …) are within the ranges stated in the technical specifications. Do not expose the device to extreme temperatures, direct sunlight, extreme humidity or moisture.
- Do not expose the device to shocks or strong vibrations.
- The case should only be opened by qualified PCE Instruments personnel.
- Never use the instrument when your hands are wet.
- You must not make any technical changes to the device.
- The appliance should only be cleaned with a damp cloth. Use only pH-neutral cleaner, no abrasives or solvents.
- The device must only be used with accessories from PCE Instruments or equivalent.
- Before each use, inspect the case for visible damage. If any damage is visible, do not use the device.
- Do not use the instrument in explosive atmospheres.
- The measurement range as stated in the specifications must not be exceeded under any circumstances.
- Non-observance of the safety notes can cause damage to the device and injuries to the user.

We do not assume liability for printing errors or any other mistakes in this manual.

We expressly point to our general guarantee terms which can be found in our general terms of business.

If you have any questions please contact PCE Instruments. The contact details can be found at the end of this manual.

2 Specifications

2.1 Technical specifications

Model	PCE-TDS 75
Measurement range	±0.03 ... ±5 m/s (±0.09 ... ±16 ft/s)
Measurement accuracy	±1 % of measured value
Repeatability	0.2 %
Pipe diameter	25 ... 1200 mm (1 ... 48 ")
Analogue output	0/4 ... 20 mA (maximum load 750 Ω)
Pulse output	0 ... 9999 Hz OCT
	(frequency limits are adjustable)
Relay output	1 A at 125 VAC, 2 A at 30 VDC
	maximum frequency 1 Hz
Communication interface	RS232 & RS485
Power supply	10 ... 36 VDC
Power consumption	1 A
Display	LCD, 256 x 128 pixels, with backlight
Ambient conditions base	-40 ... 60 °C (-40 ... 140 °F), 0 ... 99 % RH, non-condensing
Ambient conditions sensor	-40 ... 80 °C (-40 ... 176 °F), 0 ... 99 % RH, non-condensing
Housing material base	PC/ABS
Protection class base	IP 65
Protection class sensor	IP 68
Cable length	9 m, 30 ft
Dimensions	16 x 23 x 28 cm / 6.3 x 9.1 x 11"
Weight	3.2 kg / 7.1 lbs

2.2 Delivery scope

1 x ultrasonic flow meter PCE-TDS 75
2 x flow sensor (9 m cable length)
2 x pipe clamp
1 x ultrasound contact gel
1 x mounting plate
1 x user manual
1 x factory calibration certificate

3 System description

3.1 Device

Front

Bottom

1 Display
2 Membrane keypad
3 Sensor
4 Wiring channels / sensor port

4 Preparation

4.1 Wiring

Open the device by loosening the four screws on the front to gain access to the ports for the power supply, for the sensors, etc. First, lead the cables for the power supply through the cable gland provided for this purpose and establish the power supply via the DC+ and DC- connections. Ensure correct polarity. Then connect the inlet sensor and the outlet sensor to the corresponding ports. For more information on the connection labels, refer to the following chart. When connecting, make absolutely sure that there is no voltage.

Character	Description
DC+	Direct current DC 10 … 36 V+
DC-	Direct current DC 10 … 36 V
	Grounding
RL OUT+	Relay output
RL OUT-	
OCT OUT+	OCT output
OCT OUT	
GND	Inlet sensor ground (black)
UP+	Inlet sensor + (brown)
UP-	Inlet sensor - (blue)
GND	Outlet sensor ground (black)
DN+	Outlet sensor + (brown)
DN-	Outlet sensor - (blue)
I OUT+	4 … 20 mA output
I OUT-	
TX	RS232 output
RX	
GND	
A	RS485 output
B	

Attention!

Only wire the PCE-TDS 75 when it is switched off. The unit must be reliably grounded before installation and use. Use either AC or DC power. Do not connect both at the same time.

4.2 Switchon

As soon as the PCE-TDS 75 is connected to a power source, it starts automatically and the system runs automatically according to the parameters last entered. After *R is displayed in the upper right corner, the instrument will automatically start measuring.
If this is the first use or installation at a new location, you must enter the parameters of the new installation location. All parameters set by the user are permanently saved until changed. The flow meter will continue to measure continuously regardless of the menu that is open.

4.3 Functions of membrane keypad

.	Comma
⮌	Back key / return to previous menu
▼	Open the next menu / decrease a number
▲	Return to previous menu / increase a number
☰	Open menu
ENTER ↵	Confirm / edit

5 Quick start

5.1 Basic settings

This example assumes a 4 mm thick PVC pipe without coating with a diameter of 200 mm. The medium flowing through the pipe is water.
These parameters should be adopted as follows:

Step 1 Pipe dimensions
Open M10 (menu 10) by pressing the menu key and then entering the number 10. Now enter the diameter and thickness of the pipe and confirm with the ENTER key.

M10	Pipe settings	*R
Size	M.	
OD	200.0	mm
thk	4.0	mm

Step 2. Pipe material
Press the "↓" key to select the pipe material. Select PVC and confirm your entry with the ENTER key.

M10	Pipe settings	*R
Size	M.	
M.	0.PVC	
Other	3200	m/s

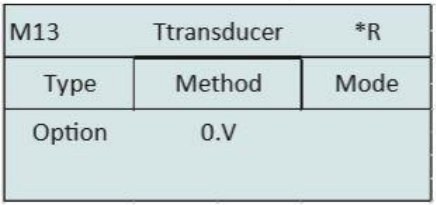
Step 3 Water temperature
Open M12 and enter the water temperature. The temperature should be within the range of 0 ... 80 °C.
Press ENTER to confirm your entry.

M12	Medium	*R
WTMP	20	(° C)

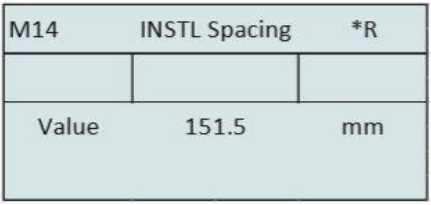
Step 4 Sensor type
Open M13 and select the sensor type. Here, you can select the first sensor type, i. e. Clamp-On-D. Confirm your entry with ENTER.

M13	Ttransducer	*R
Type	Method	Mode
Option	0.Clamp-On	

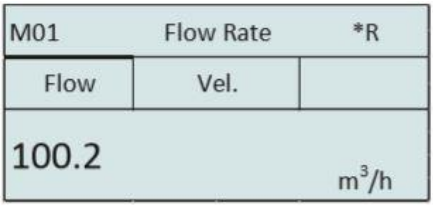
Step 5. Mounting method
Press "↓" to switch to the next submenu. Here, you select 0.V, for example. Press ENTER to confirm your selection.



Step 6. Sensor spacing
Open M14 and mount the sensors according to the indicated distance and the selected method.



Step 7 Display measured value
Open menu 01 to display the flow rate in m³/h.



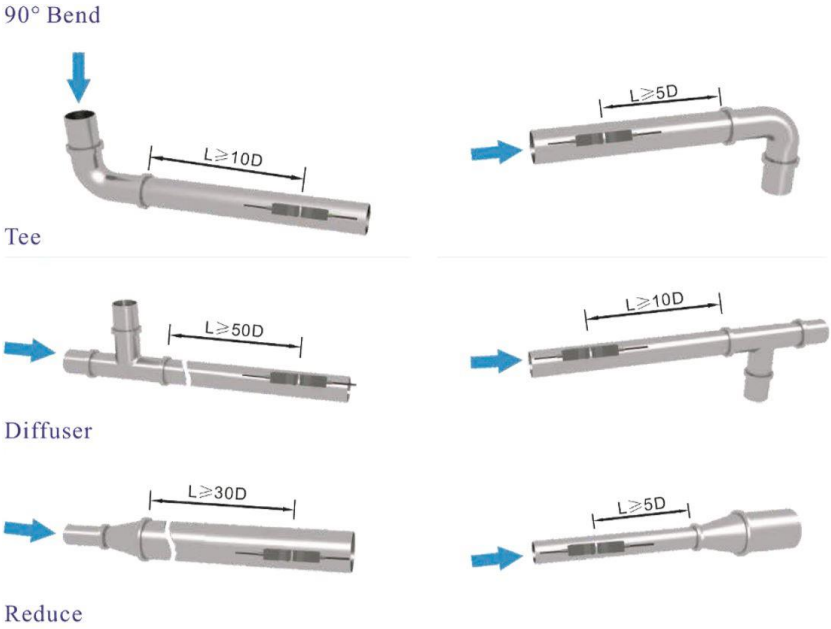
Attention!
Always press the ENTER key first if you want to change a parameter. If "Change" is still not possible after pressing the ENTER key, this means that the system is locked by a password. To unlock, select "Unlock" in window M54 and enter the password you have previously specified.

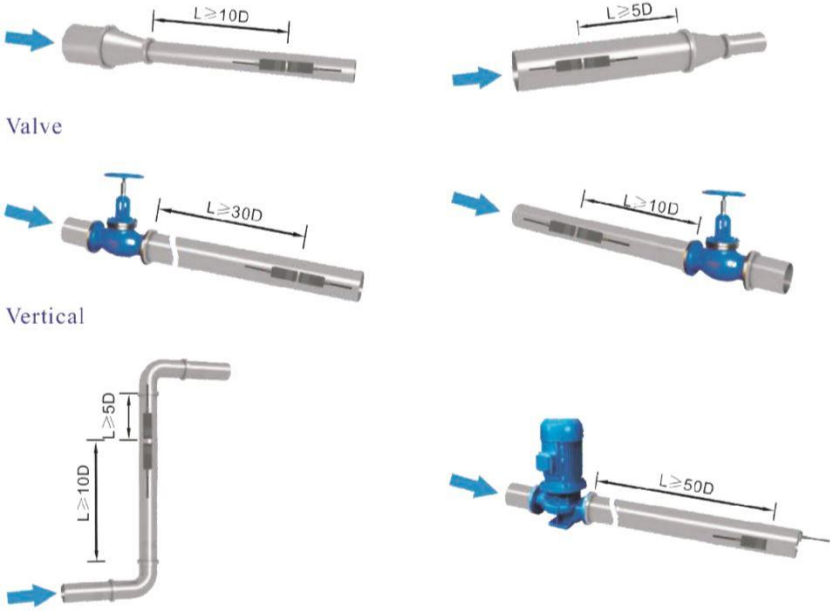
6 Sensor installation

6.1 Selection of the measuring location

The installation of the PCE-TDS 75 is very simple. You only need a suitable measuring location, then attach the sensors to the pipe and start the measurement. The following must be observed when selecting a suitable installation location:

- Select a pipe section that is always filled with liquid, e. g. a vertical pipe with flow upwards or a full horizontal pipe.
- Ensure a sufficiently straight pipe length for the installation of the upstream and downstream sensors.
- In the case of a horizontal pipe, the sensors should be mounted on the side to prevent air bubbles at the top or deposits at the bottom from falsifying the measurement result.
- Make sure that the temperature of the measuring location is below the temperature limits of the sensors.
- The inside of the pipe should also be in good condition. If possible, choose a section of pipe where the interior is free from corrosion.
- The section must be sound-conducting.





6.2 Mounting the sensors

Make sure that the pipe surface where the sensors are to be mounted is clean and smooth. There should also be no rust or loose paint on it. Select a suitable section and do not forget to apply the coupling gel. Apply the coupling gel to the centre of each sensor's front surface and to the pipe surface. Ensure that there are no air bubbles between the sensors and the pipe wall, then attach the sensors to the pipe using the pipe clamps provided and tighten them securely.

Note:
The two sensors should be mounted laterally and centrally on horizontal pipes. Make sure that the mounting direction of the sensors is parallel to the flow. If the sensors cannot be mounted horizontally symmetrically due to limited local installation conditions, it may be necessary to mount the sensors at a location where the pipe is always filled with liquid.

6.2.1 Sensor spacing

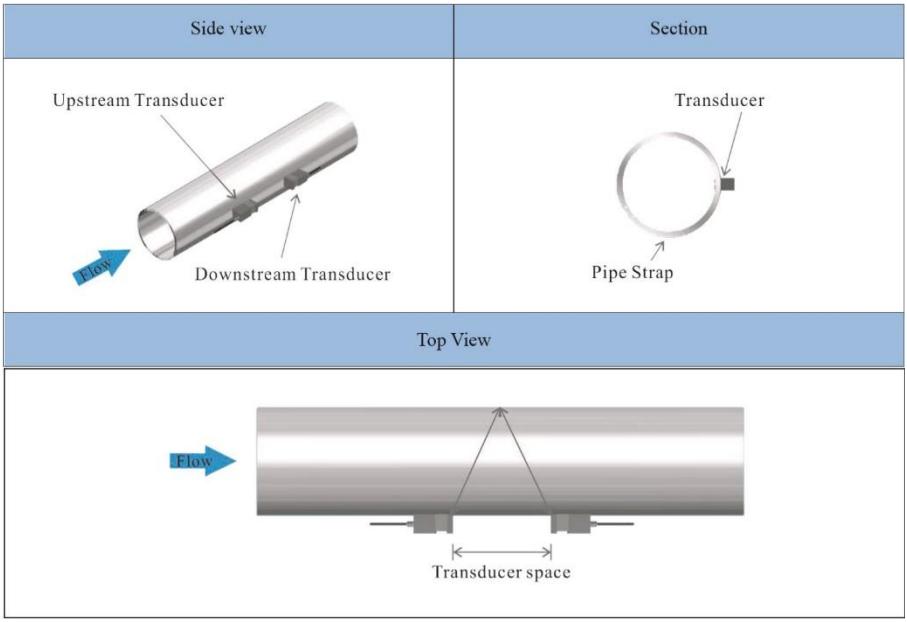
The distance between the ends of the two sensors can be looked up in M14 (menu 14). After entering the required parameters, check the data displayed in window M14 and adjust the spacing between the sensors according to the data.

6.2.2 Selection of the measuring method

There are two mounting methods you can use depending on the measurement environment: the V method (reflect method) and the Z method (direct method). The V method is easy to install and suitable for most ultrasonic environments, the Z method has a stronger signal and works better in complicated measurement environments.

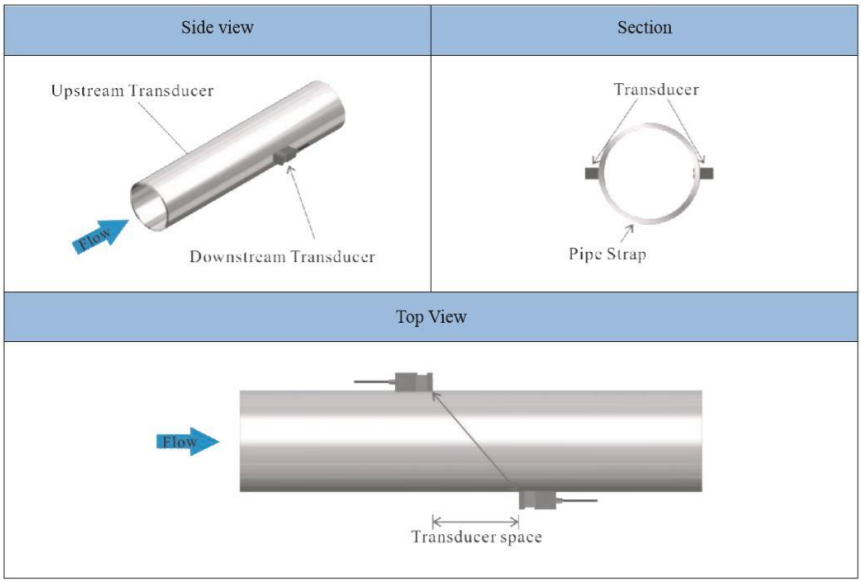
V method

The V method is considered the standard method. It is practical to use. Nevertheless, it must be ensured that the pipe is mounted correctly (see 6.2 ff.).



Z method

If the pipe diameter is too large or the lining is too thick, it is recommended to use the Z method. The signal transmitted after a Z-method installation has less attenuation than a signal transmitted using the V method. This is because the Z method uses a directly transmitted (rather than reflected) signal that passes through the medium only once. With the Z method, you can measure on pipe diameters ranging from 100 to 5000 mm (4 ... 200 in.). Therefore, we recommend the Z method for pipe diameters over 300 mm (12 in.).



6.2.3 Inspection

Verify that the sensors are properly installed and that there is an accurate and strong ultrasonic signal that ensures proper operation and high reliability of the sensors. This can be confirmed by checking the detected signal strength, the total transit time, the delta time as well as the transit time ratio. The following inspections must be made to ensure high reliability of the measurement and long-term operation of the device.

Signal strength

The signal strength can be checked in window M04. Here, you can see the strength of the signal of both sensors. The signal strength is indicated by numbers from 00.0 to 99.9. 00.0 stands for no detected signal, while 99.9 stands for the maximum signal strength. The stronger the detected signal strength, the longer the device works reliably and the more stable the obtained measured value will be. Position the sensors optimally and check whether sufficient coupling gel was applied during installation to obtain the maximum signal strength. The system requires a signal strength of more than 75.0 for both sensors. If the determined signal strength is too low, the position of the sensors and the spacing should be re-adjusted and the pipe re-inspected. You can also change the mounting method to rectify this problem.

Signal quality

The signal quality or Q value is displayed in window M04. It indicates the level of the detected signal. The Q value is indicated by numbers from 00 to 99. 00 represents the weakest detected signal whereas 99 represents the maximum. The position of the sensors should be adjusted until the detected signal quality is as strong as possible.

Total time and delta time

The total transit time and the total transit time difference, which are displayed in window M04, are further factors for the measurement accuracy. The measurement calculations in the flow meter are based on these two parameters. Therefore, if the total transit time difference varies greatly, it means that the detected signal quality is too poor. This may be the result of poor pipe installation conditions, inadequate sensor installation or incorrect parameter entry. In general, the variation of the total transit time difference should be less than ±20 %. Only if the pipe diameter is too small or the velocity too low, the variation can be larger.

Transit time ratio

The transit time ratio indicates whether the mounting distance of the sensors is accurate. The normal transit time ratio should be 100 ±3 % when properly installed. Check this in window M04. If the transit time ratio exceeds 100 ±3 %, a check is required:

- whether the parameters (pipe outside diameter, wall thickness, pipe material, lining, etc.) have been entered correctly,
- whether the mounting distance of the sensors corresponds to the display in window M14,
- whether the sensors are correctly positioned on the pipe,
- whether the shape of the pipe is distorted or deformed.

6.2.4 Warnings

The pipe parameters must be entered accurately or the flow meter will not work properly.

- During installation, apply enough coupling gel to mount the sensors to the pipe wall. While checking the signal strength and Q value, slowly move the sensors across the mounting location until the strongest signal and maximum Q value are reached. Note that the larger the pipe diameter, the more the sensors need to be moved.
- Check that the mounting distance matches the indication in window M14 and that the sensors are mounted centrally on the pipe on the same pipe size.
- Pay special attention to pipes with seams as such pipes are usually uneven. If the signal strength is always displayed as 0.00, this means that no signal is detected. Therefore, it is necessary to check whether the parameters (including all pipe parameters) have been entered correctly. Check that the sensor mounting method is correct, the pipe is not worn and the lining is not too thick. Make sure that there is actually fluid in the pipe or that the sensors are not too close to a valve or manifold and that there are not too many air bubbles in the fluid, etc. If still no signal is detected, the measuring location must be changed.

- Make sure that the PCE-TDS 75 can operate properly and with high reliability. The stronger the signal strength displayed, the higher the achieved Q value. The longer the flow meter runs accurately, the higher the reliability of the displayed flow rates. If there is interference from electromagnetic waves in the environment or the detected signal is too weak, the displayed flow rate value is not reliable; consequently, reliable operation is not guaranteed under these circumstances.

7 Operation

7.1 Normal operation

When the letter "*R" appears on the display, this indicates that the system is operating normally. When the letter "D" is displayed, this indicates that the system is adjusting the signal gain before measurement. This also means that the system is operating normally. The letter "E" indicates that no signal is detected. Check that the wiring connections of the sensors are correct, firmly installed, etc. For more information, refer to "Troubleshooting".

7.2 Limit value for lowest flow rate

The value in M21 is the minimum value for the flow rate. If the flow falls below this value, the flow display will be set to zero. This feature can prevent the flow meter from displaying the flow as "0" after a pump has been turned off but when there is still fluid movement in the pipe, resulting in a cumulative error. In general, it is recommended to enter 0.03 m/s as the minimum value for the lowest flow. The limit value is not related to the measurement results once the velocity increases above the limit value.

7.3 Zero setting

As soon as a zero flow occurs, a zero point is displayed on the flow meter but the displayed measured value is not equal to "0", this value only indicates "zero". To any measuring instrument, it applies that the smaller the zero point is, the better the quality will be. If the zero point is too high, this means that the quality of the instrument is poor. If the zero set value is not at the true zero flow, a measurement difference may occur. The smaller the physical measurement capacity, the greater the measurement difference from the zero point. It is necessary to perform a zero calibration to improve measurement accuracy at low flow. This can be done via the M22 menu. Go to the "Cutoff" submenu and select "Yes". The instrument will now start the zero calibration. The device will indicate when zero calibration is complete.

7.4 Scaling factor

The scaling factor describes the relationship between the "actual value" and the "read value". For example, if the reading is 2.00 and is indicated as 1.98 on the device, the scaling factor is 2/1.98. This means that the best scaling factor is a constant 1. However, it is difficult to keep the scaling factor "1" on the instrument, especially for serial measurements. During operation, there are still possible differences in pipe parameters, etc. The "scaling factor" may be required when the PCE-TDS 75 is used for different pipes. Therefore, the scaling factor calibration is specifically designed to calibrate the differences resulting from the application on different pipes. The scaling factor entered must be the one resulting from the actual flow calibration. The scale factor can be entered in window M26.

7.5 System lock

The system lock is intended to prevent operating errors due to tampering by unauthorized personnel. M54 is the system lock menu which you can only unlock with the password you set. When "Lock" is displayed, enter the correct password. Remember the password or keep it in a safe place, otherwise the device can no longer be used.

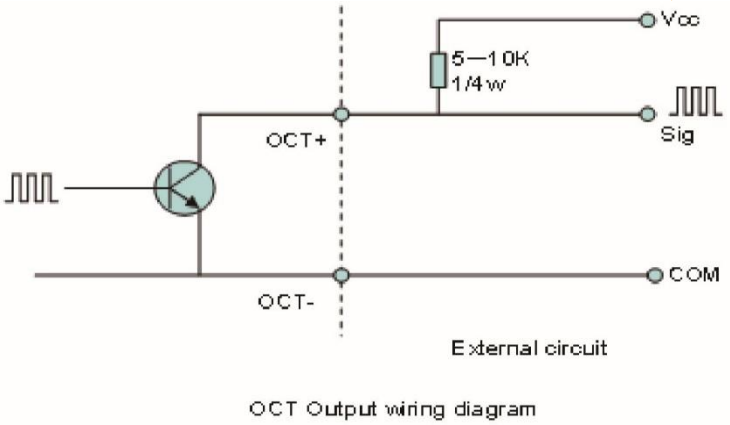
7.6 Current loop output

With a current loop output, the flow meter is programmable and configurable with outputs such as 4 – 20 mA or 0 – 20 mA. This can be selected in menu 32. For example, if the flow range is 0 ... 1000 m^3/h, enter 0 for "Range" and "LowerL" and 1000 for "UpperL". For "Mode", set 4-20 mA. If the flow is within the range -1000 … 2000 m^3/h, select the 20 - 4 - 20 mA output for "Mode". Enter 1000 for "Range" and "LowerL" and 2000 for "UpperL". If the flow direction is relevant, the 0 - 4 - 20 mA output is available. When the flow direction is indicated as negative, the current output is within the range of 0 … 4 mA, whereas the 4 … 20 mA is for the positive direction. The options for the output mode are displayed in the M32 window under "Mode". Calibration and testing of the current loop are performed in the M32 window under "Check". Perform the steps as follows: "check 4mA", "check 8mA", "check 16mA", "check 20mA". Connect an ammeter to test the current loop output and calculate the difference. Calibration of the 4-20 mA output is possible in menu M62.

7.7 Frequency output

The PCE-TDS 75 flow meter is equipped with a transmission function with frequency output. The displayed high or low frequency output indicates the high or low flow rate reading. The user can set both the frequency output and the flow rate according to their requirements. E. g., if a pipe flow range is 0 ... 5000 m^3/h, the required relative frequency output is 100 ... 1000 Hz. The configuration is as follows:

- In window M33 "LowerL" (lower limit value of the output flow frequency), select "0";
- Select "5000" for "UpperL" (upper limit of output flow frequency);
- Select "Mode-Frange" and enter "100" and "1000";
- Select "Mode Option" and enter "a. Flow Rate";



OCT Output wiring diagram

7.8 Totalizer pulse output

Each time the flow meter reaches a consistent flow, it can generate a totalizer pulse. The totalizer pulse can be transmitted to a remote counter via OCT (Open Collector Transistor) or a relay. Therefore, it is necessary to configure the OCT and relay accordingly (see windows M33 and M34). For example, if it is necessary to transmit the positive totalizer pulse via a relay and each pulse represents a flow of 10 m^3, configure as follows:

- Open M41 and select the totalizer flow unit "m ³";
- go to M41-MULT and select the scaling factor "e. x10";
- in M34-Option, select "g. POS Total".

Attention!
Make sure to select a suitable totalizer pulse. If the totalizer pulse is too high, the output cycle will be too long; if the totalizer pulse is too low, the relay will operate too fast. You can shorten the life of the relay and skip some pulses. It is recommended that the totalizer transmits within the range of 1 ... 3 pulses per second.

7.9 Alarm programming

The on-off alarm is generated by the OCT or by transmission to an external circuit by opening or closing a relay. The on-off output signal is activated under the following conditions:

- Signal not detected.
- Bad signal detected.
- The flow meter is not ready for normal measurement.
- The flow is in reverse direction (backflow).
- The analogue outputs exceed the measuring span by 120 %.
- The frequency output exceeds the span by 120 %.
- The flow rate exceeds the configured ranges. Configure the flow ranges using the software alarm system. There are two software alarms: alarm no. 1 and alarm no. 2. Example 1: If the flow rate exceeds 300 ... 1000 m^3/h, follow these steps to program the relay output alarm:

(1) In menu 35, set Alarm1 LowL to 300.
(2) In menu 35, set Alarm1 Upper to 1000.
(3) Select d. Alarm1 under Option in Menu 34.

7.10 4-20 mA analogue output calibration

Attention!
Each flow meter has been calibrated before leaving the factory. It is not necessary to perform this step unless the current value (determined during current loop calibration) displayed in the M32 window is not identical to the actual output current value.

The hardware detection window must be activated before calibrating the analogue output. To do this, you must proceed as follows:

Open M62 for 4-20 mA calibration. Use "↑" and "↓" to toggle. Calibrate the 4 mA output of the current loop. Use an ammeter to measure the current loop output current while adjusting the numerical values until the ammeter reads 4.00. The 4 mA output value has now been calibrated. Use "↑" and "↓" to toggle and calibrate the 20 mA output of the current loop. The method is the same as for the 4 mA calibration. The results are automatically saved to the EEPROM and are not lost even when the power is turned off.

7.11 ESN

We equip the flow meter with a unique electronic serial number to identify each flow meter for the benefit of the manufacturer and customers. The ESN, device types and versions can be viewed in window M50.

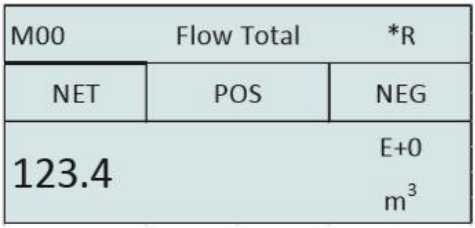
8 Explanation of the menu windows

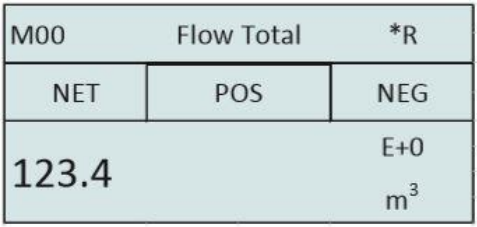
8.1 Display overview

	Short explanation	Menu window
M0X	Display values and conditions	M00 Totalizer for flow values
		M01 Flow rate
		M04 Status
M1X	Installation settings	M10 Pipe settings
		M11 Pipe lining parameters
		M12 Medium parameters
		M13 Sensor settings
		M14 Sensor spacing indicator
M2X	Calibration settings	M20 Damping
		M21 Minimum flow cutoff value
		M22 Zero setting
		M23 Counter
		M25 Power-off compensation switch
		M26 K factor
		M27 Correction
		M28 Statistical analysis
M3X	Input and output settings	M30 Interface parameters
		M31 Analogue input settings
		M32 Current loop mode settings
		M33 OCT settings
		M34 Relay settings
		M35 Alarm value setting
M4X	Flow unit	M40 Switch unit system
		M41 Flow unit
M5X	System settings	M50 Serial number
		M51 Date and time
		M52 Key tone
		M53 Language settings
		M54 System lock
		M55 System reset
M6X	Others	M60 Date and time setting
		M61 Timer
		M62 Calibration adjustment
		M64 Analogue input adjustment

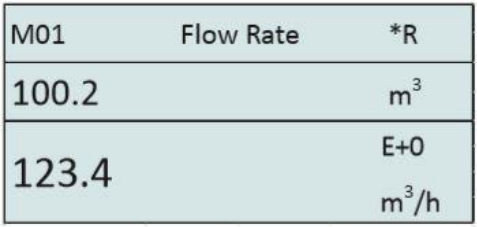
8.2 Menu window explanation

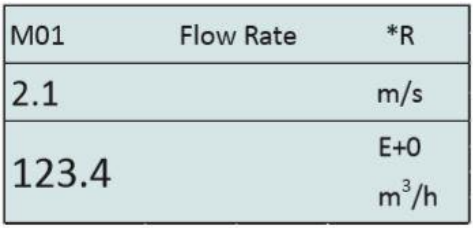
M00
Totalizer for flow values
Display net volume
Display positive value
Display negative value
Use "↑"and "↓" to switch between the submenus.





M01
Flow rate
Displays the flow rate and the absolute flow.
Displays the velocity.
Flow rate and velocity change every 6 seconds.
Press ENTER to pause the change.





M04
Status
The inlet direction signal strength and the outlet direction signal strength are displayed. The signal quality Q is indicated as 00 ... 99. 00 represents the worst signal while 99 represents the best signal. Normally, the signal quality Q value should be above 60.

M04	Status	*R
Signal	Sound	Time
Up	Dn	Q
80.0	80.1	85

Display of the measured liquid sound velocity. Normally, this value should be approximately equal to the value entered in window M12. If the difference is too large, this is probably due to an incorrect value entered in window M12 or improper installation of the sensors.

M04	Status	*R
Signal	Sound	Time
Vel.	1482	E+0
Ratio	100%	m^3

Displays the measured and the calculated transmission time. The difference should be as small as possible. The ratio should be a maximum of 100 ±3 %. If the difference is too large, check that the parameters have been entered correctly, especially the sound velocity of the liquid.

Displays the measured ultrasonic averaging time (unit: µs) and the delta time of the upstream and downstream time (unit: ns). The velocity calculation in the flow meter is based on the two measured values. The delta time is the best indication of whether the device is running stably. Normally, the variation of the delta time should be less than 20 %. If this is not the case, check whether the sensors are installed correctly or whether the parameters have been entered correctly.

M04	Status	*R
Signal	Sound	Time
Total	185.0	us
Delta	30.5	ns

M10
Tube settings
Here you can enter the outer pipe diameter. The outer pipe diameter must be within the range of 10 … 1200 mm.
Notice:
Enter either the outer pipe diameter or the pipe outer perimeter. Enter the pipe wall thickness. The pipe wall thickness is required.
Enter the pipe material.
The following options are available:
0. PVC
1. CS (carbon steel)
2. SSP (stainless steel pipe)
3. CIP (cast iron pipe)
4. DIP (ductile cast iron pipe)
5. Copper
6. Alu. (Aluminum)
7. ACP (asbestos cement pipe)
8. FGP (fiberglass pipe)
9. Other
It is possible to enter other materials not included in the previous eight items. Once item 9 is selected, the relevant pipe sound velocity must be entered.

M10	Pipe settings	*R
Size	M.	
OD	108.0	mm
thk	4.0	mm

M10	Pipe settings	*R
Size	M.	
M.	0.PVC	
Other	3200	m/s

M11
Coating
Enter the thickness of the liner.

M11	Lining	*R
Size	M.	
thk	3.0	mm

Select the liner material.

The following options are available:
0. No liner
1. Tar epoxy
2. Rubber
3. Mortar
4. PP polypropylene
5. Polystyrol
6. PS polystyrene
7. Polyester
8. PE polyethylene
9. Ebonite
10. Teflon
11. Other

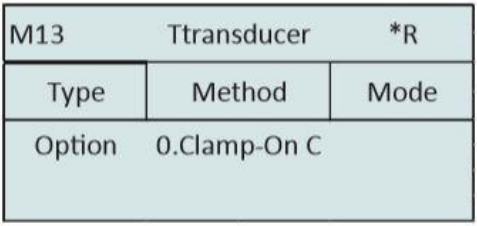
M11	Lining	*R
Size	M.	
M.	0.No Liner	
Other	2400	m/s

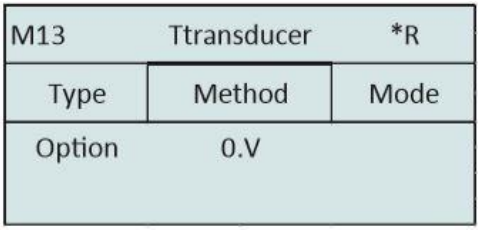
Item 11 "Other" is available to enter other materials not included in the previous ten items. Once "Other" is selected, the appropriate sound velocity of the liner must be entered.

M12
Medium
Select the water temperature. The temperatures should be 0 ... 80 °C. Press ENTER to confirm.

M13
Sensors
Here you can select the sensor type. The following options are available:
0. Clamp-on C
1. Clamp-on D
2. Clamp-on X
3. Plus-in
4. Plus-in X

Here you can select the sensor mounting method.
Two mounting methods are available:
0. V (Reflect) method
1. Z (Direct) method





M14
Installation spacing
This value is calculated by the PCE-TDS 75. The user must mount the sensors according to the displayed sensor spacing (make sure that the sensor spacing is measured accurately during installation). The system will automatically display the data after the pipe parameter is entered.

M20
Damping
The damping factor ranges from 1 to 999 seconds. 1 means no damping; 999 means maximum damping. The damping function stabilizes the flow display. Typically, a damping factor of 3 to 10 is recommended for applications.

M20	Damping	*R
Value	6	

M21
Low Vel. Cutoff
The low flow cutoff is used to make the system display 0 at minimum flow. For example, if the minimum value is set to 0.03, the system will regard all measured flow rate values from -0.03 to + 0.03 as "0". In general, a value of 0.03 is recommended for most applications.

M21	Low Vel. Cutoff	*R
Value	0.03	m/s

M22
Zero Settings
When the fluid is in a static state, the displayed value is called zero point. If the zero point in the flow meter is not zero, the difference is added to the actual flow values and measurement differences occur in the flow meter.

The zero point must be set after the sensors are installed and the flow in the pipe is in absolute static condition (no fluid movement in the pipe). In this way, the zero point resulting from different pipe mounting locations and parameters can be eliminated. This increases the measurement accuracy at low flow and eliminates the flow offset.
Select "Yes"; reset the zero point set by the user.

M22	Zero Settings	*R
Cutoff	Reset	Offset
Option	0.No	

M22	Zero Settings	*R
Cutoff	Reset	Offset
Option	0.No	

This method is not frequently used. The zero point should only be adjusted when all other methods do not lead to a solution. Manually enter the value you wish to add to the measured value to obtain the actual value.
For example
Actual measured value ＝240 m^3/h
Value deviation ＝250 m^3/h
Flow meter display ＝250 m^3/h
Normally, the value is set to "0". Use "↑" and "↓" to toggle.

M22	Zero Settings	*R
Cutoff	Reset	Offset
Value	0.0	m^3/h

M23
Counter
Select the counter type
0. POS (positive counter)
1. NEG (negative counter)
2. NET

M23	Totalizer	*R
Switch	Reset	
Flow	0.POS	0.ON

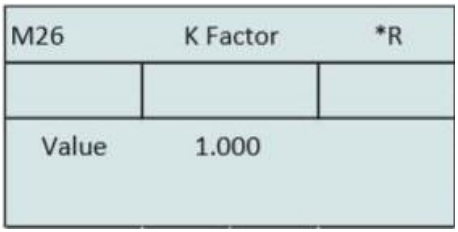
Select the value of the flow totalizer that you want to reset to 0.
0. POS positive counter
1. NEG negative counter
2. NET
3. All

M23	Totalizer	*R
Switch	Reset	
Flow	0.POS	

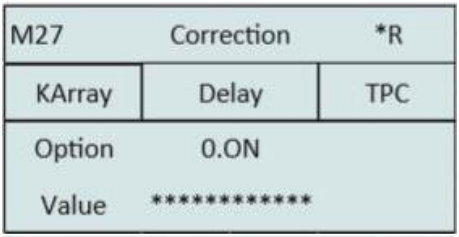
M25
Power-off-compensation
The automatic power-off compensation switch feature allows the flow rate lost in an offline session to be estimated and automatically adjusted. The estimate is based on the average of the flow rate before the offline session and the measured flow rate after the next online session, multiplied by the time the meter was offline. Select "ON" to use this feature; select "OFF" to not use this feature.

M25	PowerDown COMP	*R
Option	0.ON	

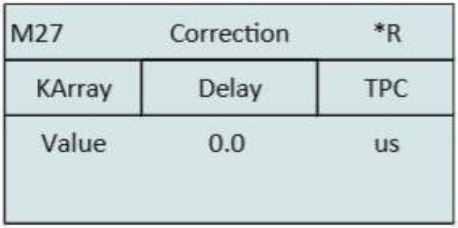
M26
K Factor
The calibration factor is used to modify the measurement results. The user can enter a numerical value (except "1") according to the actual calibration results.



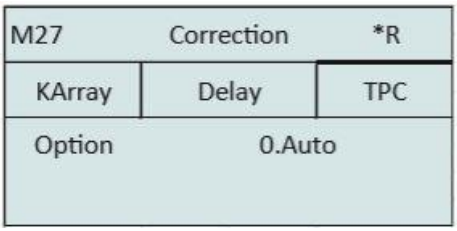
M27
Correction
KArray
Sectional correction
ON: opening the sectional correction
OFF: closing the sectional correction



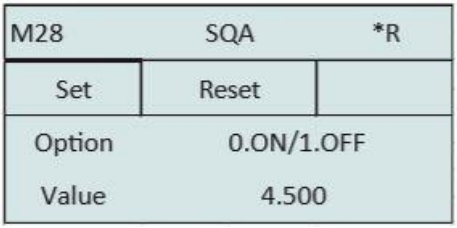
For the "Delay" submenu, you should use the factory settings.



TPC
Transducer power control
Use the factory setting.
0. Auto
1. Low
2. High



M28
SQA
Statistical analysis



M28	SQA	*R
Set	Reset	
Option	0.Auto	
Value	4.500	

M30
RS232/RS485
Setting the serial interfaces
. 2400 None
. 4800 None
. 9600 None
. 19200 None
. 38400 None
. 56000 None

M30	RS232/RS485	*R
Set	Order	
Option	0.2400 None	
Adr	55	

You can set the order as follows:
a. 1-0 : 3-2
b. 0-1 : 2-3
c. 3-2 : 1-0
d. 2-3 : 0-1

M30	RS232/RS485	*R
Set	Order	
Option	a. 1-0:3-2	

M31
AI Settings
Display analogue value of analogue input AI1.

M31	AI Settings	*R
AI1	AI2	
LowerL	1.0	
UpperL	1000.0	

Display analogue value of analogue input AI2.

M31	AI Settings	*R
AI1	AI2	
LowerL	1.0	
UpperL	1000.0	

M32
CL Settings
Current loop mode options

M32	CL Settings	*R
Mode	Range	Check
Option	a.4-20mA	

Select the CL range value

Set the CL output value according to the flow value at 4 mA or 0 mA.

Set the CL output value according to the flow value at 20 mA.

M32	CL Settings	*R
Mode	Range	Check
LowerL	0.0	m^3/h
UpperL	1000.0	m^3/h

4-20 mA check options
a. Check 4 mA
b. Check 8 mA
c. Check 12 mA
d. Check 20 mA

M32	CL Settings	*R
Mode	Range	Check
Option	a.Check 4mA	

M33
OCT Settings
The following signal options are available:

a. Flow Rate
b. POS Total
c. NEG Total
d. NET Total
e. Energy Rate
f. Heat Total
g. Cool Total
h. Rationing
i. Uart CTRL

M33	OCT Settings	*R
Mode	Range	Check
Option	a.Flow Rate	
Frange	0-5000 Hz	

Select the value for the OCT range.

M33	OCT Settings	*R
Mode	Range	Check
LowerL	0.0	m^3/h
UpperL	1000.0	m^3/h

OCT check options :

a. Check 500
b. Check 1000
c. Check 3000
d. Check 5000

M33	OCT Settings	*R
Mode	Range	Check
Option	a.Check 500	

M34
Relay Settings
The following signal options are available:
a. No Signal
b. *E
c. Reverse
d. Alarm1
e. Alarm2
f. Ration
g. POS Total
h. NEG Total
i. NET Total
j. Not using

M34	Relay Settings	*R
Option	a.No Signal	

M35
Alarm setting
Enter the lower alarm value;
Any measured flow lower than the lower value will activate the alarm in the OCT or relay output.

M35	Alarm Settings	*R
Alarm1	Alarm2	
LowerL	0.0	m^3/h
UpperL	1000.0	m^3/h

Enter the upper limit alarm value; any measured flow higher than the upper value will activate the alarm in the OCT or relay output.

M35	Alarm Settings	*R
Alarm1	Alarm2	
LowerL	0.0	m^3/h
UpperL	1000.0	m^3/h

M40
Toggle Unit
Select the measuring unit as follows:
a. Metric
b. British

M40	Toggle Unit	*R
Option	a.Metric	

M41
Flow Unit
The following flow rate units are available:
0. Cubic Meters (m ^{3})
1. Liters (l)
2. USA Gallons (GAL)
3. Imperial Gallons (Imp gal)
4. Million Gallons (mg)
5. Cubic Feet (cf)
6. USA Barrels (US bbl)
7. Imperial Barrels (Imp bbl)
8. Oil Barrels (Oil bbl)

The following time units are available:
/Day /Hour
/Min /Sec

M41	Flow Unit	*R
Unit	MULT.	
Rate	m3/h	
Total	m3	

The factory setting is cubic meters/hour. You can set a different time factor using the following chart:

a. x 0.001 (E-3)	b. x 0.01 (E-2)
c. x 0.1 (E-1)	d. x 1 (E+0)
e. x 10 (E+1)	f. x 100 (E+2)
g. x 1000 (E+3)	h. x10000 (E+4)

M41	Flow Unit	*R
Unit	MULT.	
Option	d. *1	

M42
Energy Unit

The following energy units can be selected

M42	Energy Unit	*R
Unit	MULT.	
Rate	GJ/h	
Total	GJ	

0. Giga Joule (GJ)	1. Kilocalorie (Kc)
2. MBtu	3. KJ
4. Btu	5. KWh
6. MWh	7. TH

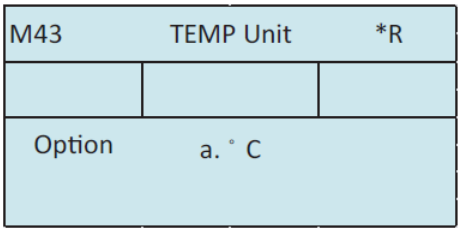
a. x 0.001 (E-3)	b. x 0.01 (E-2)
c. x 0.1 (E-1)	d. x 1 (E+0)
e. x 10 (E+1)	f. x 100 (E+2)
g. x 1000 (E+3)	h. x10000 (E+4)

M42	Energy Unit	*R
Unit	MULT.	
Option	d. *1	

M43
Temperature Unit

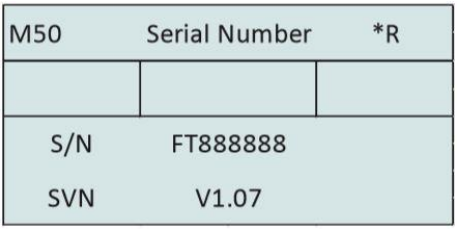
a. °C
b. °F

Use "↑"and "↓" to change the unit.



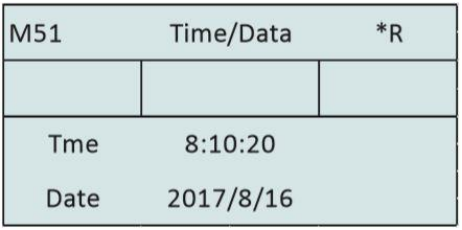
M50
Serial Number

The serial number (S/N) of the device is displayed here. The S/N is unique.



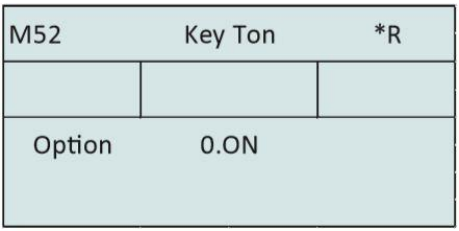
M51
Time and date

Date and time changes are made in this menu.

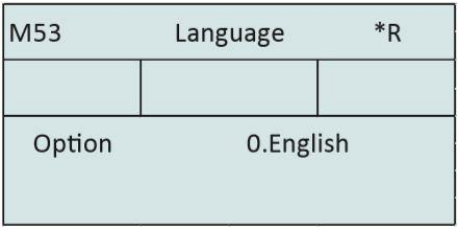


M52
Key Tone

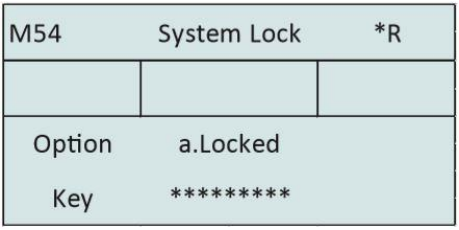
Use this menu to switch the key tone on or off ("ON" / "OFF").



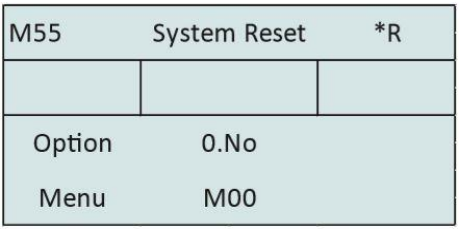
M53
Language setting
Here you can set the language.



M54
System Lock
Here, you have the possibility to lock the flow meter by a password. Once the system is locked, any change to the system is blocked, the parameter remains readable. The correct entry of the set password is the only way to unlock the system. The password consists of 6 digits.



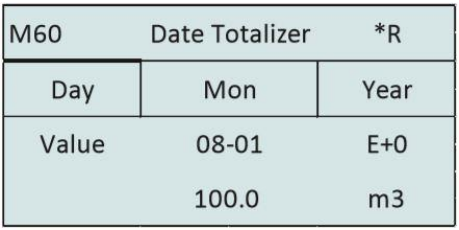
M55
System reset
Select 1. Reset to reset the device to factory settings.
Select the boot screen menu.



M60
Data Totalizer
The following options are available:

0. Day
1. Month
2. Year

In this window, it is possible to review the historical flow data net totalizer of each day for the last 31 days, each month for the last 12 months and each year for the last 6 years.



M61
Running Time
With this function it is possible to display the total number of operating days since the flow meter left the factory.

M61	Running Time	*R
Value	5	Day

M62
CL Adjustment
This menu is for the 4-20 mA calibration. Enter the password to adjust.

M62	CL Adjust	*R
4mA	Enter to go	
20mA	Enter to go	

M63
RTD Adjustment
This menu is used for the RTD calibration. Enter the password to adjust.

M63	RTD Adjust	*R
0 ° C	Enter to go	
180° C	Enter to go	

M64
AI Adjustment
This menu is for calibration of the analogue input. Enter the password to adjust.

M64	AI adjust	*R
AI1	AI2	
4mA	Enter to go	
20mA	Enter to go	

M64	AI adjust	*R
AI1	AI2	
4mA	Enter to go	
20mA	Enter to go	

9 Troubleshooting

The PCE-TDS 75 has advanced self-diagnostic functions and displays any errors in the upper right corner of the LCD screen via unique codes in date/time order. Errors caused by improper operation, incorrect settings and unsuitable measurement conditions can be displayed accordingly during operation. This function helps the user to detect errors and find the causes quickly. Thus, problems can be solved promptly according to the following chart. If a problem cannot be solved, contact PCE Instruments.

9.1 Error codes during operation

Codes	Causes	Solutions
*R	The system is running normally.	
*E	- Signal not detected.	- Attach the sensors to the pipe and tighten them firmly with the clamps. Apply a generous amount of coupling gel to the sensors and the pipe wall.
	- The distance between the sensors is not correct or not enough coupling gel has been applied to the sensors.	- Remove rust or loose paint from the pipe surface. Clean it thoroughly.
	- The sensors are not installed correctly.	- Check the entered parameter settings.
	- The wall is too thick.	- Select a new pipe section. The instrument may be run properly in a new location.
	- The thickness of the pipe liner was incorrectly specified.	- Wait after setting the parameters again. Normally, the device should function normally afterwards.
*D	Adjusting gain for normal measurement	

9.2 Frequently asked questions

Question:
New pipe and all installation requirements are met: Why is still no signal detected?

Help:
Check the pipe parameter settings, installation method and wiring connections. Make sure that sufficient coupling gel has been applied, the pipe is filled with fluid, the distance between the sensors matches the value displayed in M14 and the sensors are installed in the correct direction.

Question:
Old pipe with contamination inside, no or bad signal detected: How to solve the problem?

Help:
Check that the pipe is filled with fluid. Try the Z method for installing the sensors. Carefully select a good section of pipe and clean it completely, apply enough coupling gel to each sensor face and install the sensors properly. Slowly and carefully move each sensor against each other around the installation point until maximum signal is achieved. Make sure that the new installation point inside the pipe is not contaminated and that the pipe is concentric (not distorted) so that the sound waves are not reflected outside the intended area.

Question:
Why is the CL output (current loop mode) abnormal?

Help:
Check whether the output mode is set correctly in window M32 under "Mode". Check whether the maximum and minimum current values are set correctly in window M32 under "Range". Recalibrate the current loop and check this in window M32 under "Check".

Question:
Why is the flow rate still displayed as zero even though there is obviously fluid in the pipe and the "R" symbol is displayed on the screen?

Help:
Check whether the "zero setting" was performed when the flow was not zero (see window M22). If this is the case, restore the factory setting in window M22-Reset.

10 Appendix - Use and communication protocol of serial interface network

10.1 Overview

The flow meter has a communication protocol. It can be connected to a RS-485 Modbus. Two basic schemes can be selected for networking, i. e. the analogue current output method with the flow meter only or the RS232 communication method via the serial port directly from the flow meter.

When the serial port communication method is used directly to implement a monitoring network system, the address identification code of the flow meter is used as a network address code. An extended command set with [W] is used as the communication protocol.

RS-232 (cable length 0 ... 15 m) or RS-485 (cable length 0 ... 1000 m) can be used directly for data transmission links for a short distance. Current loop can be used for medium or long-distance transmission.

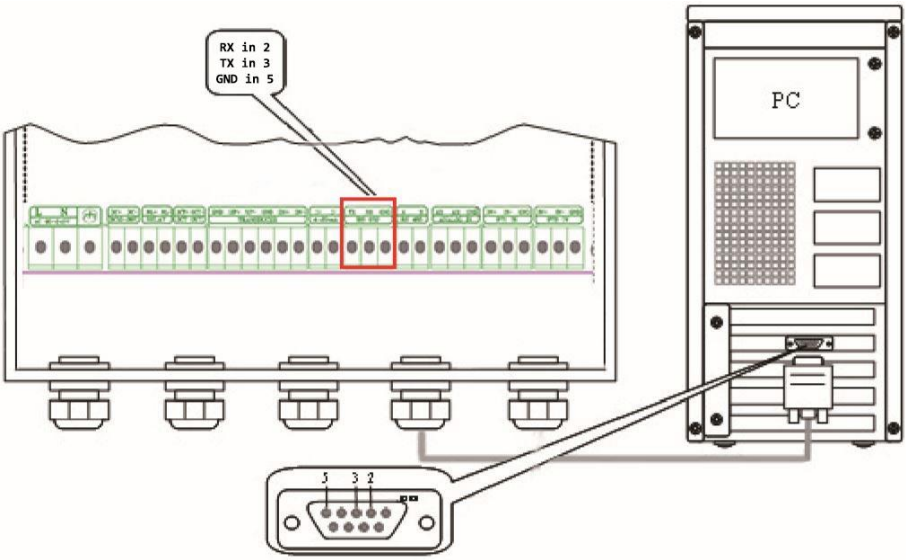
When the flow meter is used in a network environment, various operations can be performed by a host device, except for programming the address identification code, which must be done via the flow meter keypad.
For data transmission, the command answer mode is used, i.e. the host device issues commands and the flow meter responds accordingly.

Attention!
RS232 serial communication and RS485 communication cannot be used simultaneously with the functions available in the communication protocol.

10.2 Definitions of the serial port

Flowmeter - RS232:
TXD send
RXD receive
GND ground
PC:
PIN 1 empty
PIN 2 RXD send
3 TXD send
PIN 4 ground
PIN 5 ground
PIN PIN 6 empty
PIN 7 empty
PIN 8 empty
PIN 9 empty

10.3 Direct connection to the host device via RS232



10.4 Communication protocols and their use

The flow meter supports these three communication protocols: FUJI protocol, MODBUS-C protocol, MODBUS-I protocol.

10.4.1 HL protocol

The host device requests the flow meter to respond by sending a command. The baud rate of asynchronous communication (primary station: computer system; secondary station: ultrasonic flow meter) is generally 9600 BPS. A single byte has the data format (10 bits): one start bit, one stop bit and 8 data bits, check bit: none. A data character string is used to express basic commands and a carriage return (ENTER) is used to express the end of a command. The characteristic is that the data string is flexible. The order applies to both RS232 and RS485. Some frequently used commands are listed in the following chart:

Communication commands:

Commands	Description	Data format
RFR(cr)(lf)	Return instantaneous flow	±d.dddddE±dd(cr) Note1
RVV(cr)(lf)	Return instantaneous velocity	±d.dddddE±dd(cr)
RT+(cr)(lf)	Return positive accumulative flow	±ddddd.dE±d(cr) Note 2
RT-(cr)(lf)	Return negative accumulative flow	±ddddd.d±d(cr)
RTN(cr)(lf)	Return net accumulative flow	±ddddd.d±d(cr)
RTH(cr)(lf)	Return net accumulative energy(hot)	±ddddd.d±d(cr)
RTC(cr)(lf)	Return net accumulative energy(cold)	±ddddd.d±d(cr)
RER(cr)(lf)	Return instantaneous energy value	±d.dddddE±dd(cr)
RA1(cr)(lf)	Return analog input value of AI1 (Temperature, Pressure, etc.)	±d.dddddE±dd(cr)
RA2(cr)(lf)	Return analog input value of AI2 (Temperature, Pressure, etc.)	±d.dddddE±dd(cr)
RID(cr)(lf)	Return Net address of the instrument	ddddd(cr) 5 bits in length
RSS(cr)(lf)	Return signal intensity	UP:dd.d, DN:dd.d, Q=dd(cr).
REC(cr)(lf)	Return current error code	*R/*D/*E Note 3
RRS(cr)(lf)	Return Relay Status	ON/OFF(cr)
RDT(cr)(lf)	Current date and time	yy-mm-dd, hh:mm:ss(cr)
RSN(cr)(lf)	Return serial number	ddddddddt(cr) Note 4
SFQdddd.d(cr)(lf)	OCT setting	dddd.d(cr) Successful setting will go back to "OK".
SCLdd.d(cr)(lf)	Current setting	dd.d(cr) Successful setting will go back to "OK".
SRS(cr)(lf)	Start quantitative control	OK(cr) Successful setting will go back to "OK".
P	Prefix of return command with check	Note 5
W	Networking command prefix of numeric string address	Note 6

Notes:

1. (cr) expresses the carriage return (ENTER). Its ASCII value is 0DH. (lf) expresses the line feed. Its ASCII value is 0AH.

2. d expresses a number from 0 ... 9. The value 0 is expressed as +0.000000E+00.

3. There is no decimal point in the integral part before E.

4. ddddddddt represents the serial number of the instrument, t represents the model of the instrument.

5. The character P can be added before every basic command. It means that the transmitted data has CRC verification. The verification method is to add all data back to the data that is cumulative and binary and the 8-bit binary data is taken.
For example, the return information of the RT (cr) (lf) is : +1234567E+0m3 (cr) (lf), (the relative binary system data is : 2BH, 31H, 32H, 33H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 20H, 20H, 0DH, 0AH).
The sum of all its return data is =2BH+31H+32H+33H+34H+34H+35H+ 36H+37H+45H+2BH+30H+6DH+33H +20H=2F7, the low 8-bit data of its binary is F7. Therefore, the data of the order PRT (cr) (lf) is called + 1234567E + 0m3!F7 (cr) (lf), "!" For delimiters, the preceding character is the character of summation, followed by a check code of 1 byte.

6. Use of prefix W: W + numeric string address code + basic command. The numeric string value range is 0 … 255, except 13 (0DH carriage return), 10 (0AH line feed). If the instantaneous velocity of flow meter no. 123 is to be accessed, the command W123DV (cr) (lf) can be issued. The corresponding binary code is 57H, 31H, 32H, 33H, 44H, 56H, 0DH, 0AH; only the same device with the same address of the Internet address and command will return the data.

7. W and P commands can be used in combination, for example W123PRT +. This means that the device reading the network address is the cumulative value of the device with 123 and its return data has eight accumulations and checksums. "s" expresses ON or OFF or UD. For example, "TR:ON, RL:ON" expresses that the OCT and relay are in an actuated state; "TR:UD, RL:UD" expresses that the OCT and relay are not actuated.

10.4.2 MODBUS-I communication protocol

This MODBUS-I protocol uses RTU transmission mode. The verification code uses CRC-16-IBM (polynomial is X16+X15+X2+1, shield character is 0xA001) gained by cyclic redundancy algorithm method. MODBUS-I-RTU mode uses hexadecimal numbers for data transmission.

1. Function code and format of the MODBUS-I protocol
The flow meter protocol supports the following two MODBUS function codes

Function code	Performance data
0x03	Read register
0x06	Write single register

2. Use of the MODBUS protocol function code 0x03
The host sends out the frame format of the read register information:

Slave address	Operation function code	First address register	Register number	Verify code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01 ~ 0xF7	0x03	0x0000 - 0xFFFF	0x0000 - 0x7D	CRC (Verify)

The slave returns the data frame format:

Slave address	Read operation function code	Number of data bytes	Data bytes	Verify code
1 byte	1 byte	1 byte	N*x2 byte	2 bytes
0x01 - 0xF7	0x03	2xN*	N*x2 (Data)	CRC (Verify)

N*= Data register number

3. Use of the MODBUS protocol function code 0x06
The host sends a command to write a single register information frame format (function code 0x06):

Slave address	Operation function code	Register address	Register data	Verify code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01 - 0xF7	0x06	0x0000 - 0xFFFF	0x0000 - 0xFFFF	CRC (Verify)

The slave returns the data frame format (function code 0x06):

Slave address	Operation function code	Register address	Register data	Verify code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01 - 0xF7	0x06	0x0000 - 0xFFFF	0x0000 - 0xFFFF	CRC (Verify)

The range of flow meter addresses is 1 … 247 (hexadecimal: 0x01 - 0xF7) and can be checked in menu 46. For example, the decimal number "11" displayed in menu 46 means that the flow meter address in the MODBUS protocol is 0x0B.
The CRC verification code adopts CRC-16-IBM (polynomial is X16+X15+X2+1, shield character is 0xA001) gained by the cyclic redundancy algorithm method. The low byte of the verification code is at the beginning, while the high byte is at the end.
For example, to read the address 1 (0x01) in RTU mode if the instantaneous flow rate uses hour as unit (m^3/h), that is, i. e. reads 40005 and 40006 register data, the read command is as follows:

0x01	0x03	0x00 0x04	0x00 0x02	0x85 0xCA
Flowmeter Address	Function Code	First Address Register	Register Numbers	CRC Verify Code

The data returned by the flow meter are (assuming that the actual flow is = 1.234567 m^3/h):

0x01	0x03	0x04	0x06 0x51	0x3F 0x9E0x3B 0x32
Flowmeter Address	Function code	Data Bytes	Data (1.2345678)	CRC Verify Code

The four bytes 3F 9E 06 51 are in IEEE754 format in the single precision floating point form of 1.2345678.
Pay attention to the data storage order of the above example. To explain the data in C language, pointers can be used directly to enter the required data in the corresponding variable address, the low byte is placed at the beginning, as in the above example 1.2345678 m/s, 3F 9E 06 51 Data stored in the order 51 06 9E 3F.
Example: If you want to convert address 1 (0x01) to 2 (0x02), register 44100 must be programmed as 0x02 as follows:

0x01	0x06	0x10 0x03	0x00 0x02	0xFC 0xCB
Flowmeter address	Function Code	Register Address	Register Number	CRF Verify Code

The data returned by the flow meter are:

0x01	0x06	0x10 0x03	0x00 0x02	0xFC 0xCB
Flowmeter address	Function Code	Register Address	Register Number	CRF Verify Code

4. Error check
The flow meter only returns an error code 0x02, which means that the first address of the data is incorrect.
For example, to read address 1 (0x01) of the 40002 flow meter register data in RTU mode, the flow meter considers this data to be invalid and sends the following command:

0x01	0x03	0x00 0x01	0x00 0x01	0xD5 0xCA
Flowmeter Address	Function Code	Register Address	Register Number	CRF Verify Code

The error code returned by the flow meter is:

0x01	0x83	0x02	0xC0 0xF1
Flowmeter Address	error code	Error Extended Code	CRF Verify Code

5. MODBUS register address list

The MODBUS register of the flow meter has a read register and a write register.

a) Read register address list (function code 0x03 is used for reading)

PDU Address	Register	Read	Write	Type	No. Registers*
$0000	40001	Flow/s - low word	32 bits real	2	
$0001	40002	Flow/s - high word			
$0002	40003	Flow/m - low word	32 bits real	2	
$0003	40004	Flow/m - high word			
$0004	40005	Flow/h - low word	32 bits real	2	
$0005	40006	Flow/h - high word			
$0006	40007	Velocity - low word	32 bits real	2	
$0007	40008	Velocity - high word			
$0008	40009	Positive total - low word	32 bits real	2	
$0009	40010	Positive total - high word			
$000A	40011	Positive total - exponent	16 bits int	1	
$000B	40012	Negative total - low word	32 bits real	2	
$000C	40013	Negative total - high word			
$000D	40014	Negative total - exponent	16 bits int	1	
$000E	40015	Net total - low word	32 bits real	2	
$000F	40016	Net total - high word			
$0010	40017	Net total - exponent	16 bits int	1	
$0019	40026	Up signal - low word	32 bits real	2	0 - 99.9
$001A	40027	Up signal - high word			
$001B	40028	Down signal -low word	32 bits real	2	0 - 99.9
$001C	40029	Down signal -high word			
$001D	40030	Quality	16 bits int	1	0 - 99.9
$001E	40031	Error code -char 1	String	1	Refer to "Error Analysis" for detailed codes meanings.
$003B	40060	Flow velocity unit -char 1,2	String	2	Only m/s right now
$003C	40061	Flow velocity unit -char 3,4			
$003D	40062	Flow rate unit -char 1,2	String	2	Note 1
$003E	40063	Flow rate unit -char 3,4			
$003F	40064	Flow totalunit -char 1,2	String	1	
$0040	40065	Energy rateunit -char1,2	String	2	Note 2
$0041	40066	Energy rateunit -char 3,4			
$0042	40067	Energy totalunit -char 1,2	String	1	
$0043	40068	Instrument address-low word	32 bits real	2	
$0044	40069	Instrument address-high word			
$0045	40070	Serial number -char 1,2	String	4	
$0046	40071	Serial number -char 3,4			
$0047	40072	Serial number -char 5,6	String	4	
$0048	40073	Serial number -char 7,8			

$0049	40074	Analog Input AI1 Value-low word	32 bits real	2	Returned temperature value with RTD option
$004a	40075	Analog Input AI1 Value-high word			
$004b	40076	Analog Input AI2 Value-low word	32 bits real	2	
$004c	40077	Analog Input AI2 Value-high word			
$004d	40078	4-20mA Value-low word	32 bits real	2	Unit: mA
$004e	40079	4-20mA Value-high word			

b) Single Write Register Address List (use 0x06 performance code for writing)

PDU Address	Register	Description	Read/W rite	Type	No. registers*
$1003	44100	Flowmeter address (1 -255)	R/W	16 bits int.	1
$1004	44101	Communication Baud Rate 0 =2400, 1 = 4800, 2 = 9600, 3 = 19200, 4 = 38400, 5 = 56000	R/W	16 bits int.	1

Notes:

1. the following flow units are available:
   0. "m3" Cubic Meter
   1. "l" Litres
   2. "ga" Gallons
   3. "ig" -Imperial Gallons
   4. "mg" -Million Gallons
   5. "cf" -Cubic Feet
   6. "ba" -US Barrels
   7. "ib" -Imperial Barrels
   8. "ob" -Oil Barrels

2. the following energy units are available:
   0. "GJ" -Giga Joule
   1. "Kc" Kilocalorie
   2. "MB" -MBtu
   3. "KJ" -Kilojoule
   4. "Bt" -Btu
   5. "Ts" -US Tonnes
   6. "Tn" -US Tons
   7. "kw" -Kwh

3. 16 bits int-short integer, 32 bits int - long integer, 32 bits real-floating point number, string-alphabetic string

11 Flow application data

11.1 Sound velocities for different commonly used materials

Pipe material	Speed (m/s)
Steel	3206
ABS	2286
Aluminum	3048
Glass	3276
Polyethylene	1950
PVC	2540
Liner material	**Speed (m/s)**
Teflon	1225
Titanium	3150
Cement	4190

Brass	2270
Cast iron	2460
Bronze	2270
Fiberglass epoxy	3430
Bitumen	2540
Porcelain enamel	2540
Glass	5970
Plastic	2280
Polyethylene	1600
PTFE	1450
Rubber	1600

11.2 Sound velocity in water (1atm = 1 bar) at different temperatures

T (°C)	v(m/s)	T (°C)	v(m/s)	T (°C)	v(m/s)
0	1402.3	34	1517.7	68	1554.3
1	1407.3	35	1519.7	69	1554.5
2	1412.2	36	1521.7	70	1554.7
3	1416.9	37	1523.5	71	1554.9
4	1421.6	38	1525.3	72	1555.0
5	1426.1	39	1527.1	73	1555.0
6	1430.5	40	1528.8	74	1555.1
7	1434.8	41	1530.4	75	1555.1
8	1439.1	42	1532.0	76	1555.0
9	1443.2	43	1533.5	77	1554.9
10	1447.2	44	1534.9	78	1554.8
11	1451.1	45	1536.3	79	1554.6
12	1454.9	46	1537.7	80	1554.4
13	1458.7	47	1538.9	81	1554.2
14	1462.3	48	1540.2	82	1553.9
15	1465.8	49	1541.3	83	1553.6
16	1469.3	50	1542.5	84	1553.2
17	1472.7	51	1543.5	85	1552.8
18	1476.0	52	1544.6	86	1552.4
19	1479.1	53	1545.5	87	1552.0
20	1482.3	54	1546.4	88	1551.5
21	1485.3	55	1547.3	89	1551.0
22	1488.2	56	1548.1	90	1550.4
23	1491.1	57	1548.9	91	1549.8
24	1493.9	58	1549.6	92	1549.2
25	1496.6	59	1550.3	93	1548.5
26	1499.2	60	1550.9	94	1547.5
27	1501.8	61	1551.5	95	1547.1
28	1504.3	62	1552.0	96	1546.3
29	1506.7	63	1552.5	97	1545.6
30	1509.0	64	1553.0	98	1544.7
31	1511.3	65	1553.4	99	1543.9
32	1513.5	66	1553.7		
33	1515.7	67	1554.0		

12 Warranty

You can read our warranty terms in our General Business Terms which you can find here: https://www.pce-instruments.com/english/terms.

13 Disposal

For the disposal of batteries in the EU, the 2006/66/EC directive of the European Parliament applies. Due to the contained pollutants, batteries must not be disposed of as household waste. They must be given to collection points designed for that purpose.

In order to comply with the EU directive 2012/19/EU we take our devices back. We either re-use them or give them to a recycling company which disposes of the devices in line with law.

For countries outside the EU, batteries and devices should be disposed of in accordance with your local waste regulations.

If you have any questions, please contact PCE Instruments.

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