UFM

OPERATING INSTRUCTIONS

KATflow 150

Advanced Clamp-On Ultrasonic Flowmeter

KATflow 150
Operating Instructions

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 | Software version: 6.06 | Issue: OI_KF150_V50EN_2404

TABLE OF CONTENTS

1 SAFETY INSTRUCTIONS, LEGAL REQUIREMENTS, WARRANTY, RETURN POLICY

1.1 Symbols

 Danger	This symbol represents an immediate hazardous situation which could result in serious injury, death or damage to the equipment. Where this symbol is shown, do not use the equipment further unless you have fully understood the nature of the hazard and have taken the required precautions.
 Attention	This symbol indicates important instructions which should be respected in order to avoid damaging or destroying the equipment. Follow the precautions given in these instructions to avoid the hazard. Call our service team if necessary.
 Call service	Where this symbol is shown call our service team for advice if necessary.
 Note	This symbol indicates a note or detailed setup tip.
ESC Operator key	Operator keys are printed in bold typeface.

1.2 Safety instructions

- Do not install, operate or maintain this flowmeter without reading, understanding and following these operating instructions, otherwise injury or damage may result.
- Study these operating instructions carefully before the installation of the equipment and keep them for future reference.
- Observe all warnings, notes and instructions as marked on the packaging, on the equipment, and detailed in the operating instructions.
- Follow the unpacking, storage and preservation instructions to avoid damage to the equipment.
- Install the equipment and cabling securely and safely according to the relevant regulations.
- If the product does not operate normally, please refer to the service and troubleshooting instructions, or contact Katronic for help.

1.3 Warranty

- Any product purchased from Katronic is warranted in accordance with the relevant product documentation and as specified in the sales contract provided. This is subject to the condition that it has been used for the purpose for which it has been designed and operated as outlined in these operating instructions. Misuse of the equipment will immediately revoke any warranty given or implied.
- Responsibility for suitability and intended use of this ultrasonic flowmeter rests solely with the user. Improper installation and operation of the flowmeter may lead to a loss of warranty.
- Please note that there are no operator-serviceable parts inside the equipment. Any unauthorised interference with the product will invalidate the warranty.

1.4 Return policy

If the flowmeter has been diagnosed to have a problem, it can be returned to Katronic for repair using the Customer Return Note (CRN) attached to the Appendix of this manual. Katronic regret that for health and safety reasons we cannot accept the return of the equipment unless accompanied by the completed CRN.

1.5 Legislative requirements

CE Marking

The flowmeter is designed to meet the safety requirements in accordance with sound engineering practice. It has been tested and has left the factory in a condition in which it is safe to operate. The equipment is in conformity with the statutory requirements of the EC directive and complies with applicable regulations and standards for electrical safety EN 61010 and electromagnetic compatibility EN 61326. A CE Declaration of Conformity has been issued in that respect, a copy of which can be found in the Appendix of these operating instructions.

WEEE Directive

The Waste Electrical and Electronic Equipment Directive (WEEE Directive 2012/19/EU) aims to minimise the impact of electrical and electronic goods on the environment by increasing re-use and recycling and by reducing the amount of WEEE going to landfill. It seeks to achieve this by making producers responsible for financing the collection, treatment, and recovery of waste electrical equipment, and by obliging distributors to allow consumers to return their waste equipment free of charge. Katronic offers its customers the possibility of returning unused and obsolete equipment for correct disposal and recycling. The dustbin symbol indicates that when the last user wishes to discard this product, it must be sent to appropriate facilities for recovery and recycling. By not discarding this product along with other household-type waste, the volume of waste sent to incinerators or landfills will be reduced and natural resources will be conserved. Please use the Customer Return Note (CRN) in the Appendix for return to Katronic.

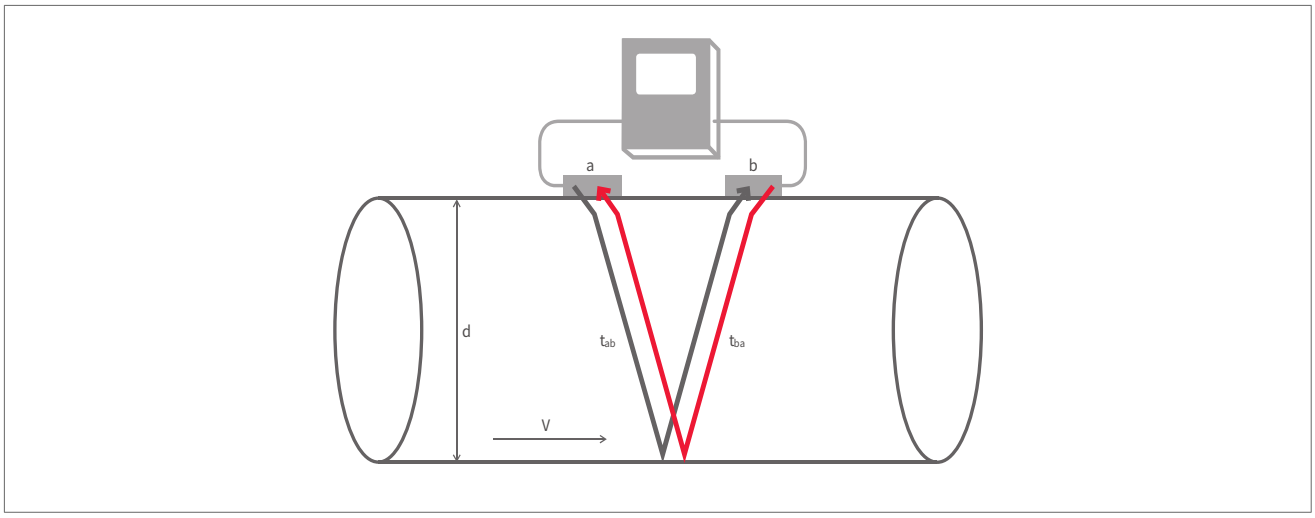
RoHS Directive

All products manufactured by Katronic are compliant with the relevant aspects of the RoHS Directive.

2 INTRODUCTION

2.1 Clamp-on transit-time flowmeter

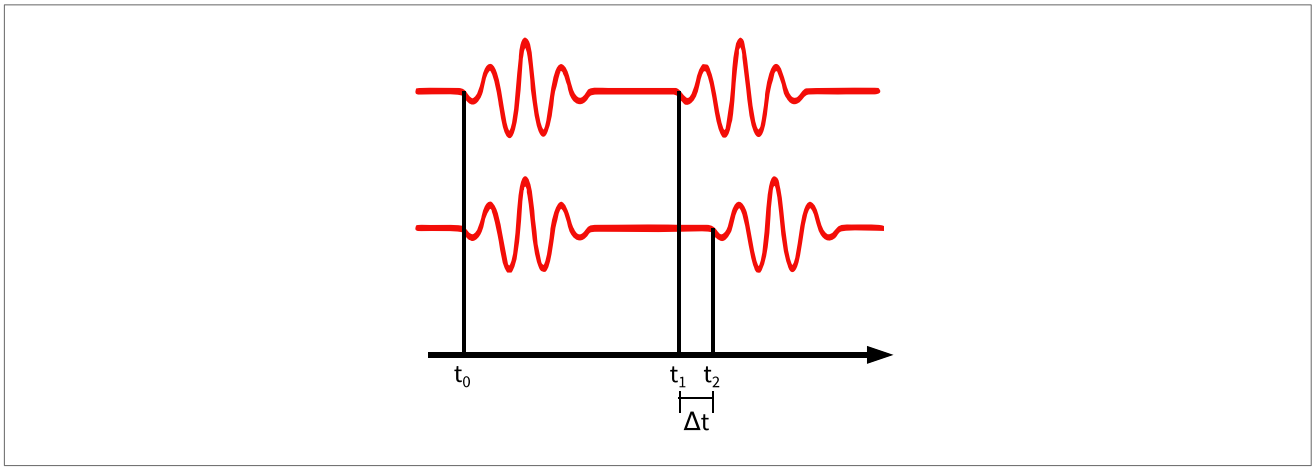
The KATflow 150 is an ultrasonic flowmeter employing clamp-on sensors for the measurement of liquids in full, enclosed pipes. Flow measurements can be undertaken without interruption of the process or interference with the integrity of the pipeline. The clamp-on sensors are attached to the outside of the pipes. The KATflow 150 uses ultrasonic signals for measurement of the flow, employing the transit-time method.



Picture 1: Clamp-on ultrasonic flowmeter configuration

2.2 Measuring principle

Ultrasonic signals are emitted by a transducer installed on a pipe and received by a second transducer. These signals are emitted alternately in the direction of flow and against it. Because the medium is flowing, the transit time of the sound signals propagating in the direction of flow is shorter than the transit time of the signal propagating against the direction of flow. The transit-time difference Δt is measured and allows the determination of the average flow velocity along the path of acoustic propagation. A profile correction is then performed to obtain the average flow velocity over the cross-sectional area of the pipe, which is proportional to the volumetric flow rate.



Picture 2: Transit-time measuring principle

3 INSTALLATION

3.1 Unpacking and storage

3.1.1 Unpacking

Care should be taken when opening the box containing the flowmeter, any markings or warnings shown on the packaging should be observed prior to opening. The following steps should then be taken:

- Unpack the flowmeter in a dry area.
- The flowmeter should be handled with care and not left in an area where it could be subject to physical shocks.
- If using a knife to remove packaging care should be taken not to damage the flowmeter or cables.
- The flowmeter package and contents should be checked against the delivery note supplied and any missing items reported immediately.
- The flowmeter package and contents should be checked for signs of damage during transport and any problems reported immediately.
- The vendor accepts no responsibility for damage or injury caused during the unpacking of the instrumentation supplied.
- Excess packing materials should be either recycled or disposed of in a suitable way.

3.1.2 Storage

If storage is necessary, the flowmeter and sensors should be stored:

- in a secure location,
- away from water and harsh environmental conditions,
- in such a way as to avoid damage,
- small items should be kept together in the bags and small plastic boxes provided to avoid loss.

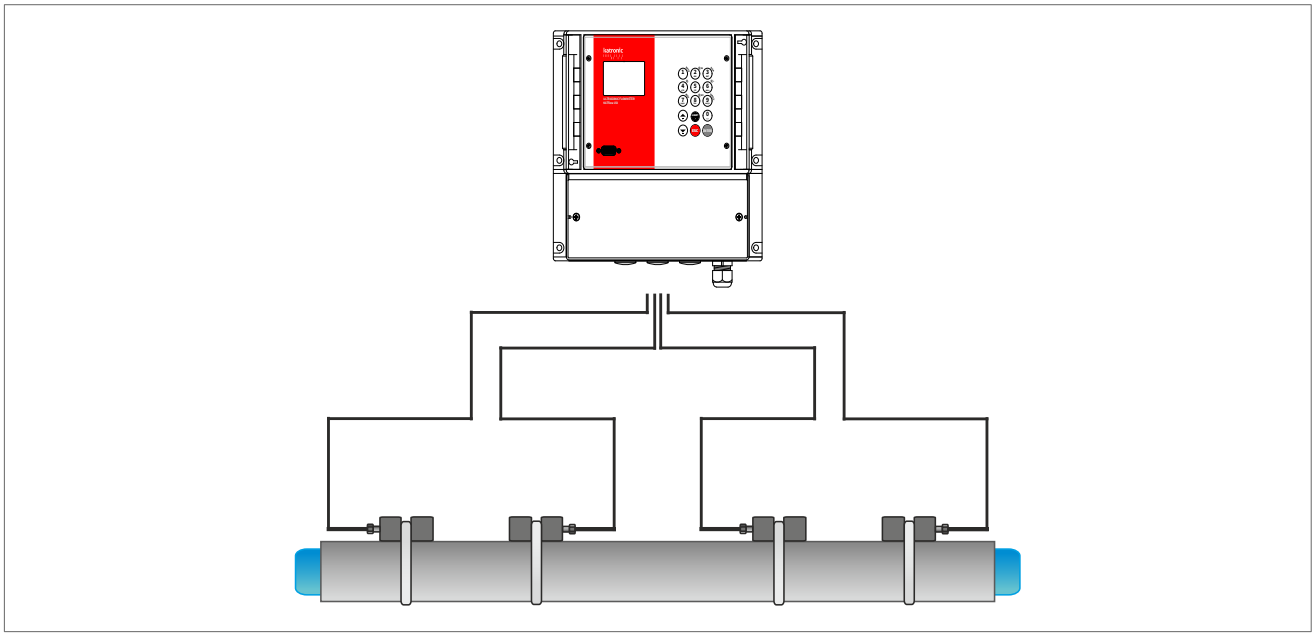
3.1.3 Identification of components

The following items are typically supplied (please refer to your delivery note for a detailed description):

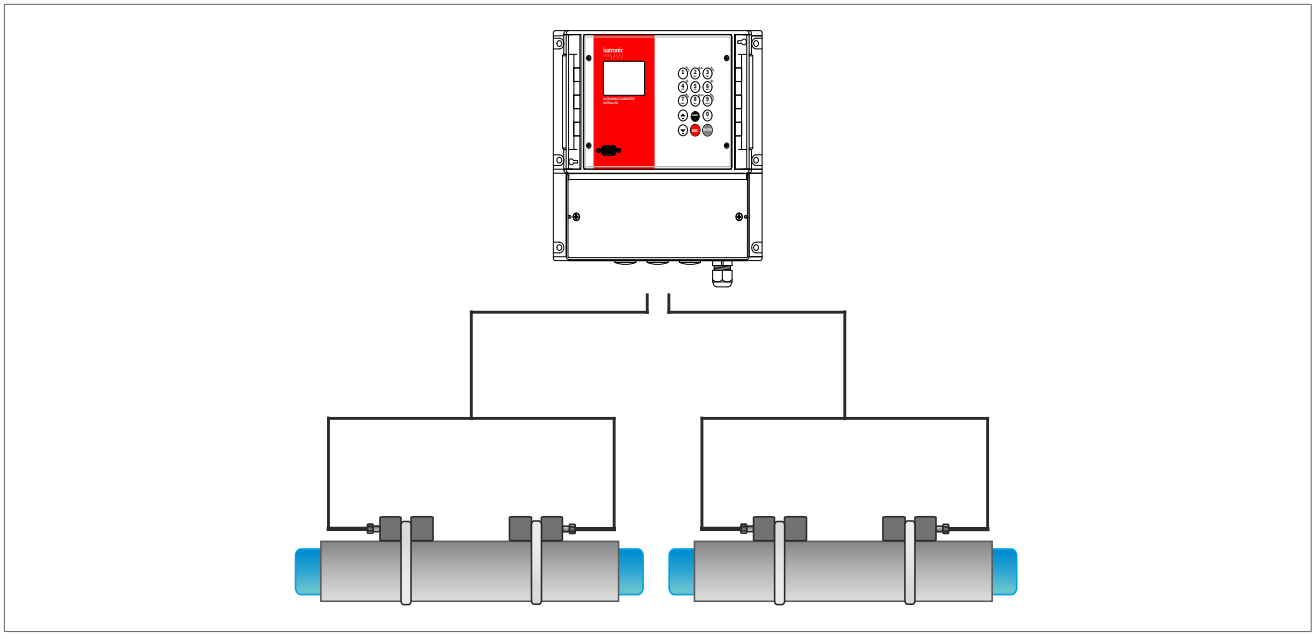
- KATflow 150 ultrasonic flowmeter,
- Clamp-on sensors (one pair for single-channel operation, two pairs for dual-channel operation),
- Sensor connection cable(s) if not direct sensor connection,
- Sensor mounting accessories,
- Coupling component,
- Measuring tape,
- Operating instructions,
- Calibration certificate(s) (optional),
- Temperature measurement probe(s) (optional).

3.2 System configuration

A maximum of two sensor pairs can be installed. If two pairs are installed these can be configured either in a one-pipe dual-path (Picture 3) or a two-pipe single-path (Picture 4) configuration.



Picture 3: KATflow 150 with direct sensor connection in a 1-pipe 2-path configuration



Picture 4: KATflow 150 in a 2-pipe 1-path configuration

3.3 Clamp-on sensor installation

The correct selection of the sensor location is crucial for achieving reliable measurements and high accuracy. Measurement must take place on a pipe in which sound can propagate (see Section 3.3.1 Acoustic propagation) and in which a rotationally symmetrical flow profile is fully developed (see Section 3.3.2 Straight pipe lengths).

The correct positioning of the transducers is an essential condition for error-free measurements. It ensures that the sound signal will be received under optimal conditions and evaluated correctly. Because of the variety of applications and the different factors influencing the measurement, there can be no standard solution for the positioning of the transducers.

The correct position of the transducers will be influenced by the following factors:

- diameter, material, lining, wall thickness and general condition of the pipe,
- the medium flowing in the pipe,
- the presence of gas bubbles and solid particles in the medium.

After the sensor location has been selected, make sure that the supplied cable is long enough to reach the flowmeter mounting location.

Check that the temperature at the selected location is within the operating temperature range of the transducers (see Chapter 9).

3.3.1 Acoustic propagation

Acoustic propagation is achieved when the flowmeter is able to receive sufficient signal from the transmitted ultrasonic pulses. The signals are attenuated in the pipe material, the medium and at each of the interfaces and reflections. External and internal pipe corrosion, solid particles and gas content in the medium contribute heavily to signal attenuation.

3.3.2 Straight pipe lengths

Sufficient straight lengths of pipe on the inlet and outlet of the measuring location ensure an axi-symmetrical flow profile in the pipe, which is required for good measurement accuracy. If insufficient straight lengths of pipe are available for your application measurements are still obtainable, but the certainty of the measurement can be reduced.

3.4 Installation location

Select an installation location following the recommendations in Table 1 and try to avoid measuring:

- in the vicinity of deformations and defects of the pipe,
- near welding seams,
- where deposits could be building up in the pipe.

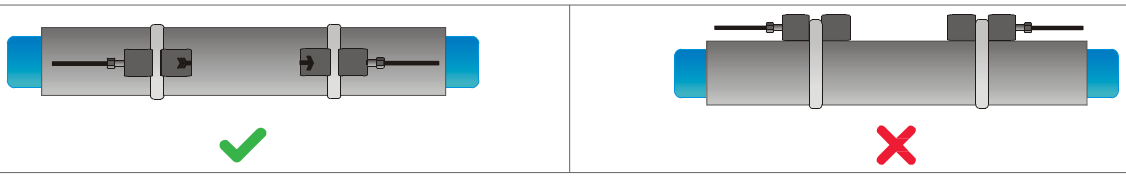
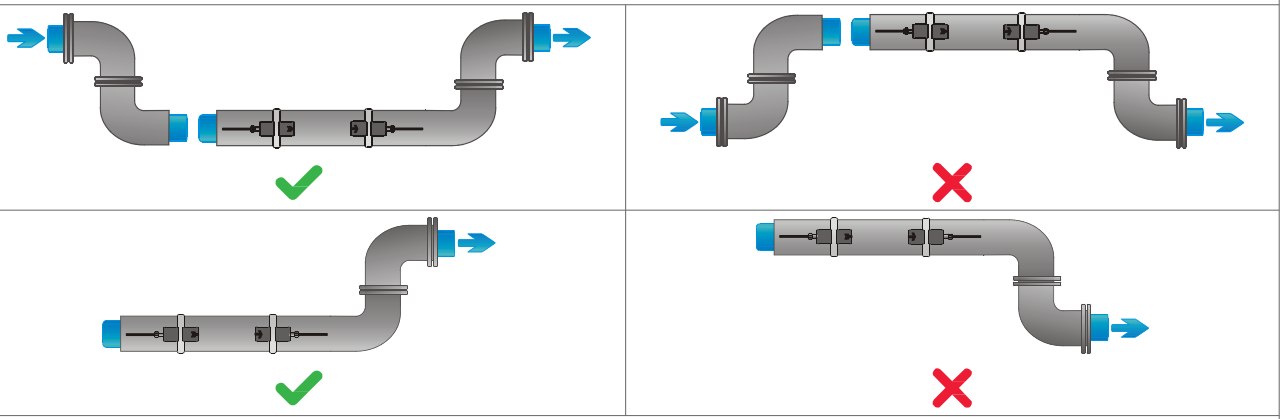
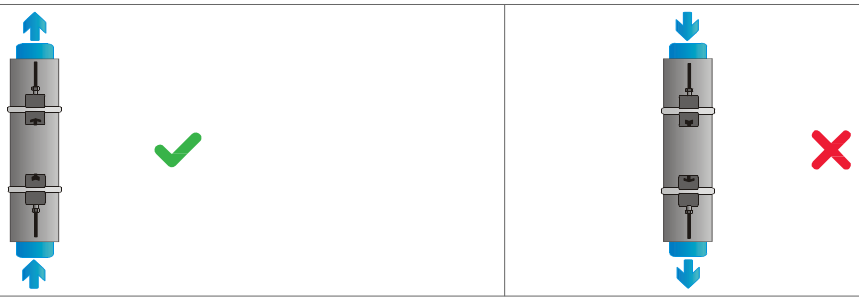
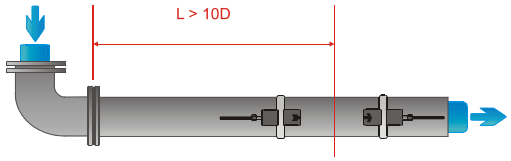
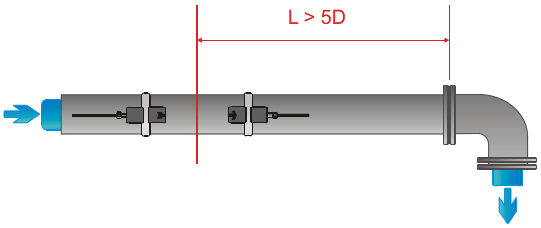
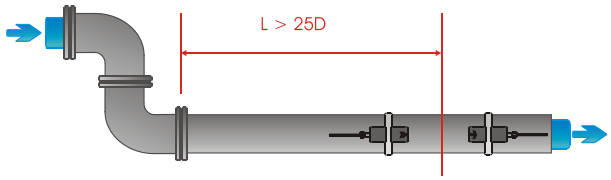
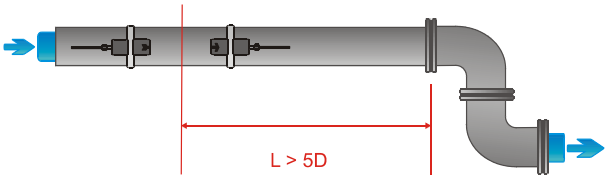
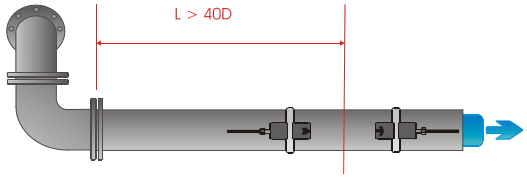
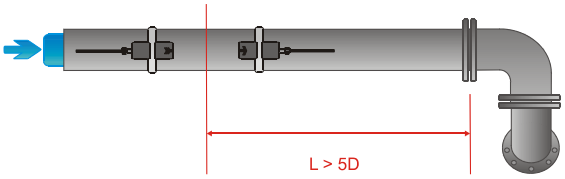
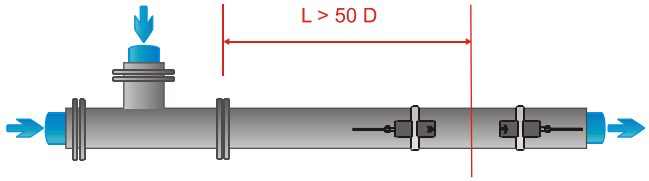
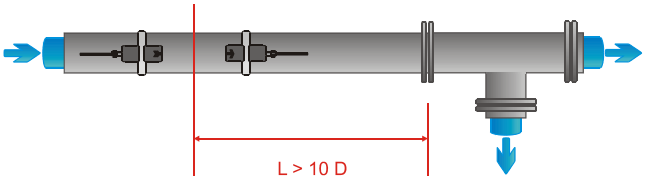
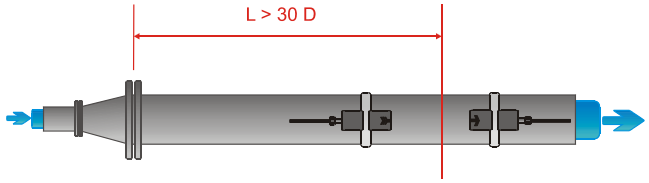
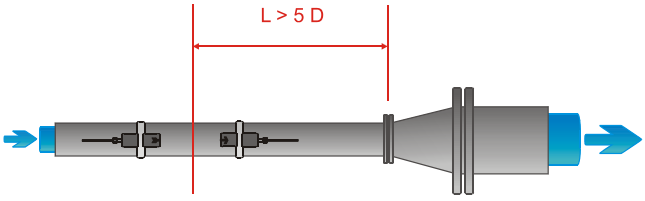
For a horizontal pipe: Select a location where the transducers can be mounted on the side of the pipe, so that the sound waves emitted by the transducers propagate horizontally in the pipe. In this way, the solid particles deposited on the bottom of the pipe and the gas pockets developing at the top will not influence the propagation of the signal.

For a free inlet or outlet pipe section: Select the measuring point at a location where the pipe cannot run empty.

For a vertical pipe: Select the measuring point at a location where the liquid flows upward to ensure that the pipe is completely filled.


Table 1: Recommendations for sensor mounting location

Look for a sensor installation location with sufficient straight pipe to obtain accurate measurements. Please refer to Table 2 as a guideline for recommended distances from disturbance sources.

Disturbance source: 90°-elbow Inlet L ≥ 10D	Outlet L ≥ 5D
	
Disturbance source: 2 x 90°-elbow in one plane Inlet L ≥ 25D	Outlet L ≥ 5D
	
Disturbance source: 2 x 90°-elbow in different planes Inlet L ≥ 40D	Outlet L ≥ 5D
	
Disturbance source: T-section Inlet L ≥ 50D	Outlet L ≥ 10D
	
Disturbance source: diffuser Inlet L ≥ 30D	Outlet L ≥ 5D
	

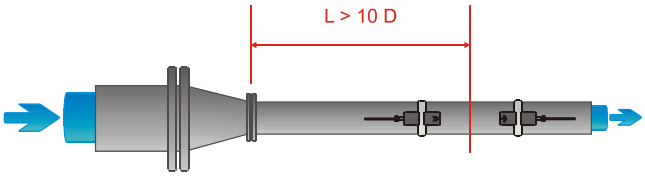
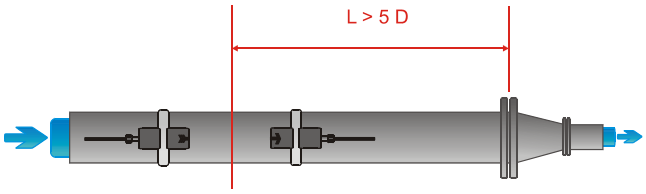
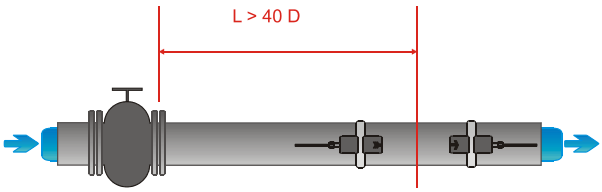
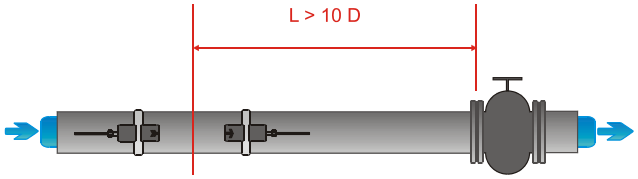
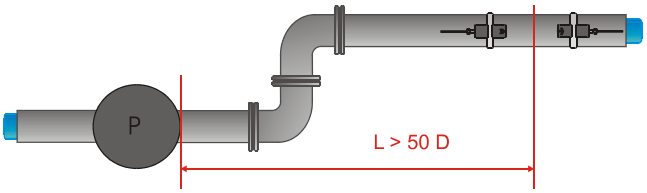
Disturbance source: reducer Inlet L ≥ 10D	Outlet L ≥ 5D
	
Disturbance source: valve Inlet L ≥ 40D	Outlet L ≥ 10D
	
Disturbance source: pump Inlet L ≥ 50D	
	

Table 2: Recommended distances from disturbance sources

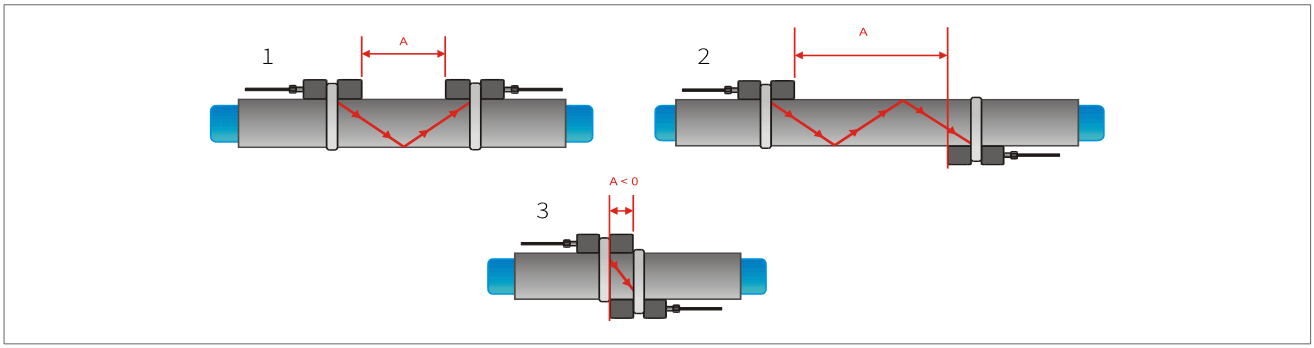
3.5 Pipe preparation

- Clean dirt and dust from around the area of the pipework where the sensors are to be placed.
- Remove loose paint and rust with a wire brush or file.
- Firmly bonded paint does not necessarily need to be removed provided the flowmeter diagnostics indicate sufficient signal strength.

3.6 Sensor mounting configurations and separation distance

3.6.1 Reflection Mode

The most common clamp-on sensor mounting configuration is the Reflection Mode, sometimes known as V-Mode (see Picture 5, sketch 1). Here, the ultrasonic signal passes twice through the medium (two signal passes). The Reflection Mode is the most convenient mounting method as the transducer separation distance can be measured easily and the sensors can be accurately aligned. This method should be used whenever possible.



Picture 5: Clamp-on sensor mounting configurations and sensor spacing

3.6.2 Diagonal Mode

An alternative mounting configuration (see Picture 5, sketch 3) is the Diagonal Mode (Z-Mode). The signals travel only once through the pipe. This method is often used for larger pipes where greater signal attenuation might occur.

Further variation of the Reflection and the Diagonal Modes are possible by altering the number of passes through the pipe. Any even number of passes will require mounting the sensors on the same side of the pipe, while with an odd number of passes, the sensors must be mounted on opposite sides of the pipe. Commonly, for very small pipes, sensor mounting configurations such as four passes (W-Mode) or three passes (N-Mode) are used (see Picture 5, sketch 2).

3.6.3 Transducer separation distance

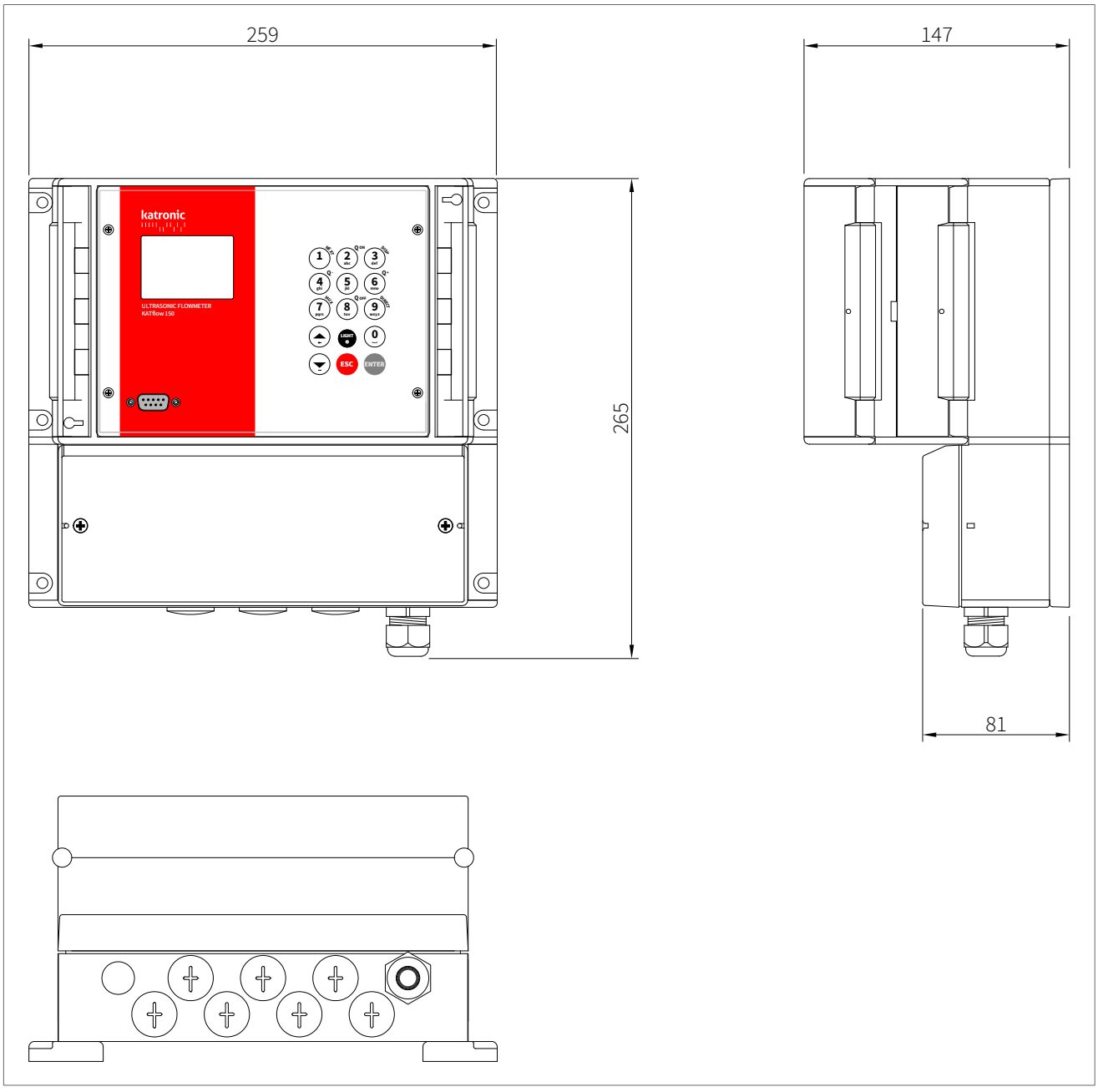
The transducer separation distance A is measured from the inside edges of the sensor heads as shown (see Picture 5). It is automatically calculated by the flowmeter based on the parameter entries for pipe outside diameter, wall thickness, lining material and thickness, medium, process temperature, the sensor type and the selected number of signal passes.

A negative separation distance A < 0 can occur for mounting configurations on small pipes where Diagonal Mode operation has been selected (see Picture 5, sketch 3). Negative separation distances may be suggested for Reflection Mode installations, but are not possible. In these cases, use Diagonal Mode or a larger number of passes.

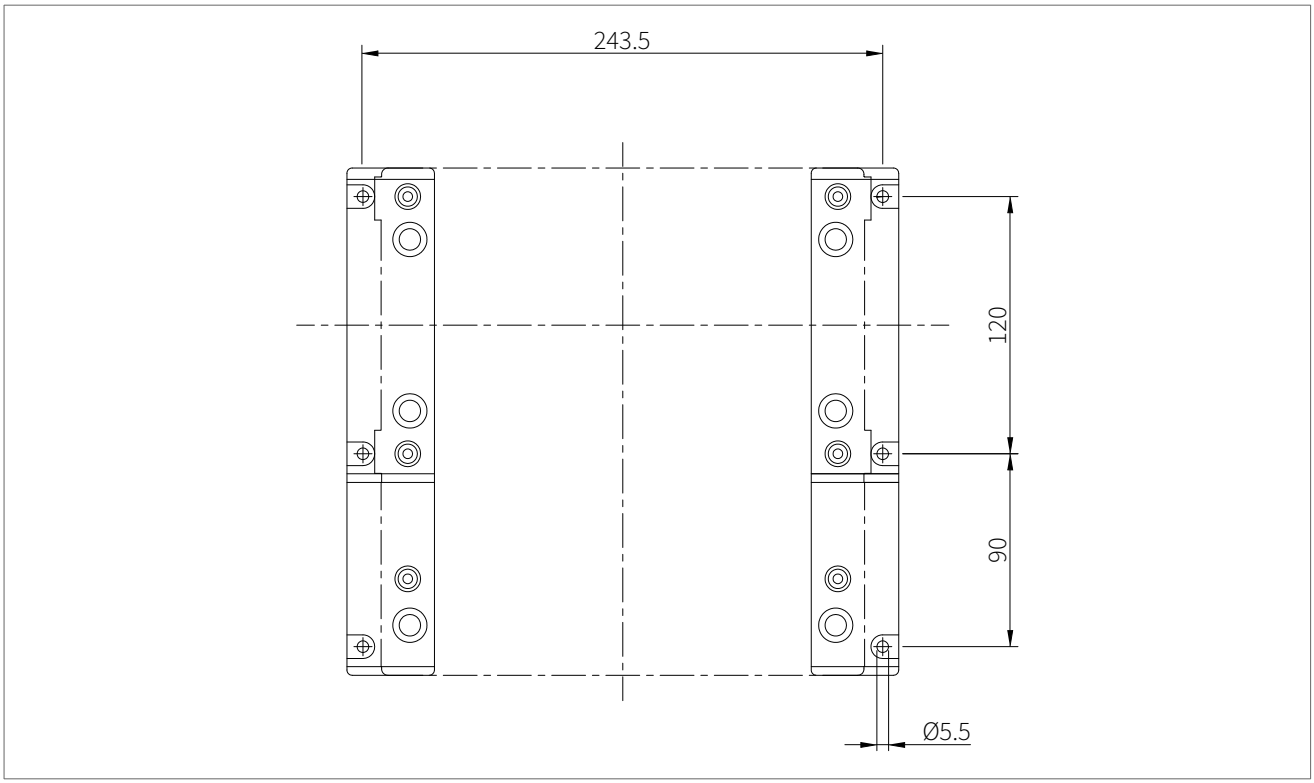
3.7 Flowmeter installation

3.7.1 Outline dimensions

The KATflow 150 is a wall mounted device and can be installed using suitable screws and wall plugs according to the following drawings (Picture 6 and 7).



Picture 6: Outline dimensions KATflow 150



Picture 7: Drilling aid for wall mounting KATflow 150

Make sure that the ambient temperature is within the -10 ... +60 °C operating temperature range specified for the flowmeter unit (see Section 9.2).

3.7.2 Electrical connections

Please note that in order to supply the unit with mains power, the equipment must be protected by suitably sized switches and circuit breakers.

100 ... 240 V AC, 50/60 Hz	10 VA
9 ... 36 V DC	10 W

Power supply

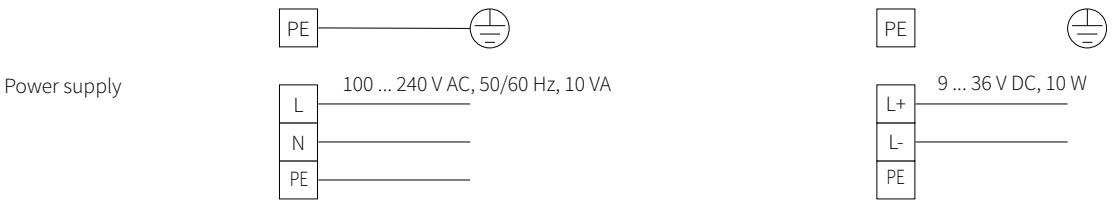


Table 3: Electrical diagram power supply for the KATflow 150 flowmeter

Sensor connections

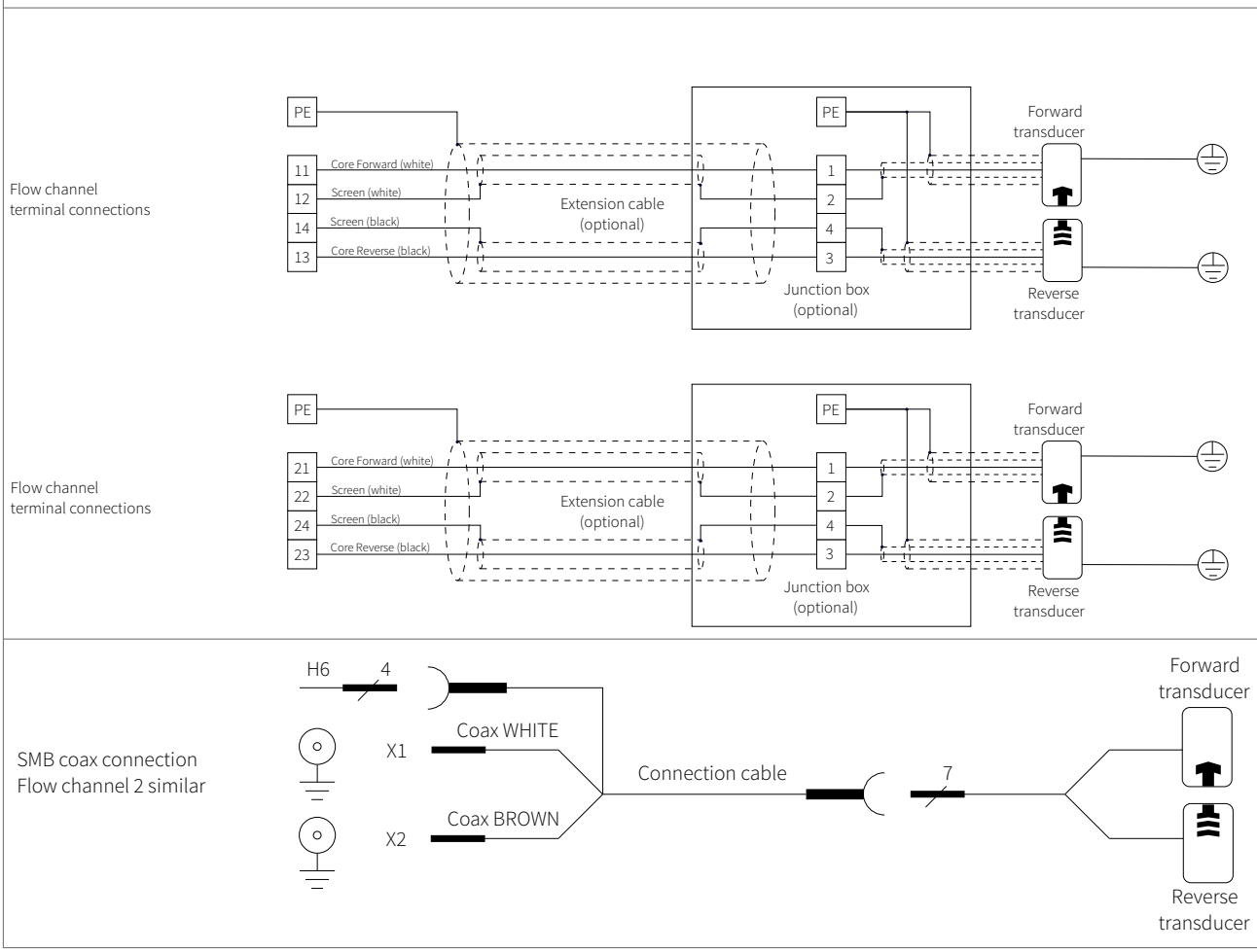


Table 4: Electrical diagram sensor connections for the KATflow 150 flowmeter (direct wired sensor CH1/CH2 and Amphenol connection)

The KATflow 150 has 10 Input/Output slot positions which can be configured with up to 10 individual I/O modules. The assignment of slots is detected by the flowmeter, and will be as shown in the “Inputs/Outputs” menu.

All 10 slots (marked SLOT 1 to 10) and occupy 4-wire terminals each (marked 1 to 4).

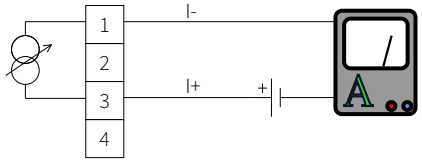
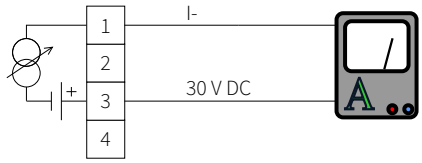
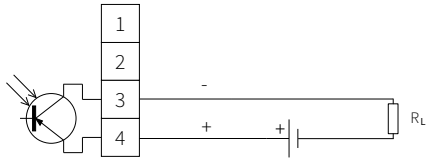
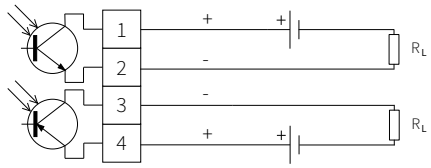
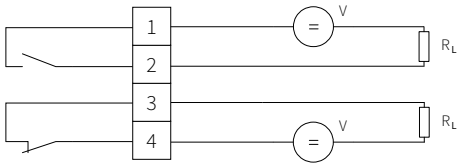
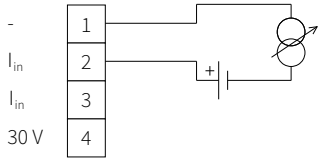
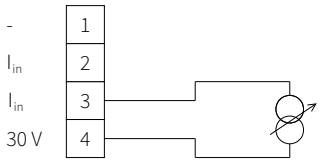
Process outputs		
Passive current output (optional)		4 ... 20 mA, load < 500 Ω
Active current output (optional)		0/4 ... 20 mA, load < 500 Ω
Frequency (analogue output) (optional)		2 ... 10 000 Hz
Digital output "Open-Collector" (optional)		Configurable Error, Limit, Total Pulse
Digital relay output (optional)		Configurable Error, Limit, Total Pulse

Table 5: Electrical diagram process outputs for the KATflow 150 flowmeter

Process inputs		
Passive analogue input (optional)		4 ... 20 mA, passive input
Active analogue input (optional)		0/4 ... 20 mA, active input

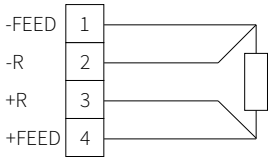
Temperature input Pt 100 4-wire (optional)		Pt 100 temperature sensor

Table 6: Electrical diagram process inputs for the KATflow 150 flowmeter

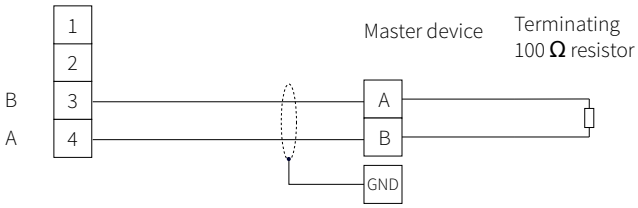
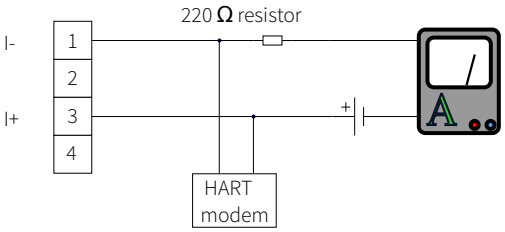
Communication		
RS 232 9-pin D-type serial interface	Tx 1 Rx 2 GND 5	For on- and offline data transfer, diagnostics, firmware updates
Modbus RTU slave		
HART® compatible output (optional)		

Table 7: Electrical diagram communication options for the KATflow 150 flowmeter

3.8 Clamp-on-sensor mounting

Before the sensors can be mounted

- the installation location should have been determined,
- a sensor mounting method should be chosen,
- the flowmeter must be mechanically and electrically installed,
- the sensors must be connected to the flowmeter.

Depending on which sensor mounting method is being used, the clamp-on sensors are either mounted on the same side of the pipe (Reflection Mode) or on opposite sides of the pipe (Diagonal Mode). The sensor spacing is calculated by the flowmeter from the pipe parameters entered (see Section 3.6).

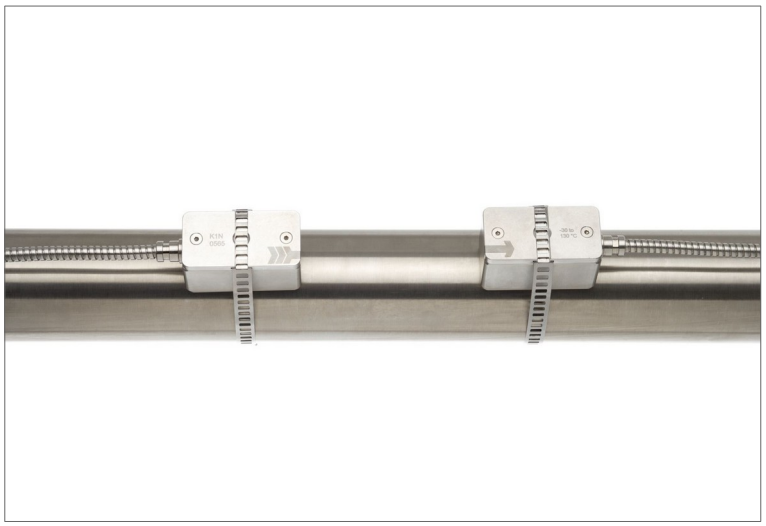
3.8.1 Acoustic coupling gel

In order to obtain acoustical contact between the pipe and the sensors, apply a bead of acoustic coupling gel lengthwise down the centre of the contact area of the sensors.

Picture 8: Application of acoustic coupling gel

3.8.2 Correct positioning of the sensors

Always mount the transducer pair so that the free front edges of the sensors face each other. There is a different engraving on the top of each transducer. The transducers are mounted correctly if the engravings on the two transducers form an arrow. The transducer cables should point in opposite directions. Later, the arrow, in conjunction with the indicated measured value, will help to determine the direction of flow (see Section 3.4).
The sensor separation distance is automatically calculated by the flowmeter based on the parameter entries for pipe outside diameter, wall thickness, lining material and thickness, medium, process temperature, the sensor type and the selected number of signal passes. The sensor positioning screen (see Section 4.3) allows fine adjustment of the sensor location.



Picture 9: Correct positioning of the sensors

3.8.3 Sensor mounting with tension straps

- Cut the tension straps to the appropriate length.
- Pull at least 2 cm of the tension strap through the slot in the clamp and bend the strap back to secure the clamp to the tension strap.
- Guide the other end of the tension strap through the groove on top of the sensor.
- Place the sensor onto the prepared pipe section.
- Hold the transducer with one hand and guide the tension strap around the pipe.
- Pull the tension strap and guide the free end through the clamp so that the clamp hooks engage. Slightly tighten the screw on the clamp.
- Mount the second sensor in the same way.
- Press the sensors firmly onto the pipe. There should be no air pockets between the transducer surface and the pipe wall.
- Using a measuring tape, adjust the sensor separation distance as suggested by the flowmeter. When the sensor positioning screen (see Section 4.3) is displayed, the middle bar allows fine adjustment of the sensor location.
- Ensure that the narrower side of the clip is above and inside the wider side and that the two sides of the clip do not come into contact while tightening, as this will prevent the strap from being correctly tensioned.

Picture 10: Sensor mounting with tension straps

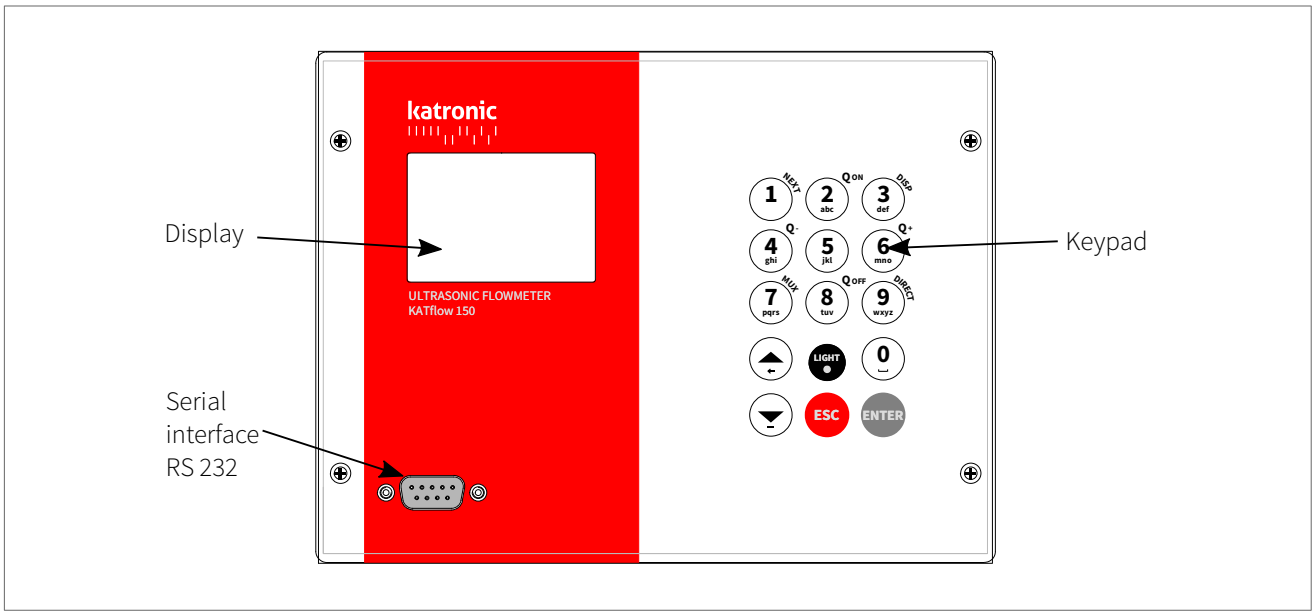
Picture 11: Metallic mounting straps

4 OPERATION

4.1 Switching On/Off

The flowmeter is switched on by connecting the power supply to the instrument. Disconnecting the external supply switches the flowmeter off.

4.2 Keypad and display



Picture 12: Keypad and display KATflow 150

Customer-specific settings for data to be displayed can be achieved by using the appropriate menu items.

4.2.1 Keypad key functions

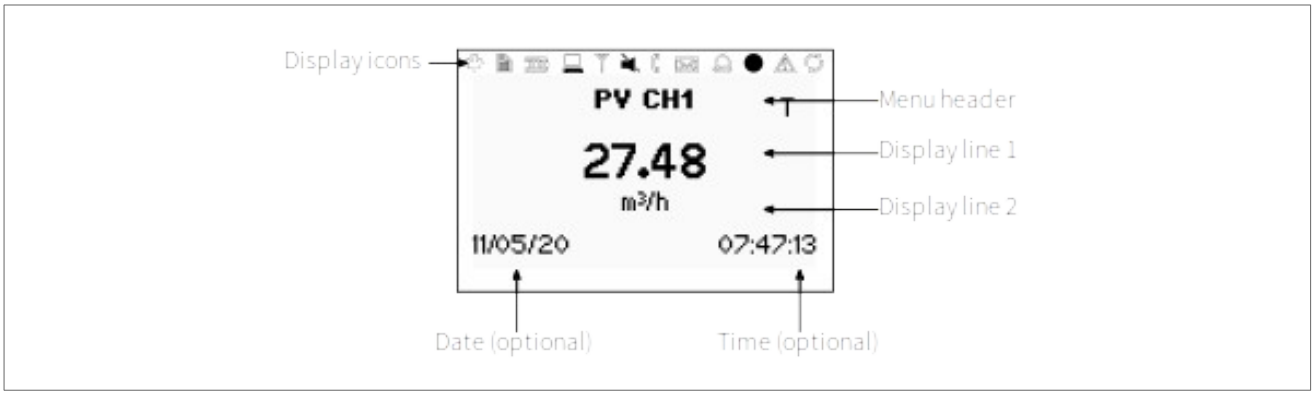
Used keys	Main function	Secondary function
1 NEXT	1 (1 short key stroke) , (2 short key strokes) . (3 short key strokes) _ (4 short key strokes)	In measurement mode: Show **NEXT** available item Direct Access: Keypad sound off/on
2 abc Q_{ON}	A B C 2 /	In measurement mode: Q_{ON} = Start totaliser function In menus: Increase brightness/contrast (long key stroke) Direct Access: Language selection

Used keys	Main function	Secondary function
	D E F 3 ?	In measurement mode: **DISP** = Change between measurement display and diagnostic displays
	G H I 4 <	In measurement mode: **Q**- = Reset negative total value
	J K L 5 >	In measurement mode: Activate auto sequence in process value display Direct Access: Start scope function
	M N O 6 $	In measurement mode: **Q**+ = Reset positive total value
	P O R S 7	In measurement mode: Toggle **MU**ltiple**X**er (where multi-channel function is provided)
	T U V 8 *	In measurement mode: **Q**OFF = Stop totaliser function In menus: Reduce brightness/contrast (long key stroke)
	W X Y Z 9	In menus: **DIRECT** = Quick access to device functions A code can be used to switch directly to important device functions. Codes: 1: Keypad sound off/on 2: Language selection 5: Scope function In sensor positioning screen: **9** = Start scope function (Note: This applies to ultrasonic board version 5.0 or higher) In measurement mode: **9** = Activation of key lock

Used keys	Main function	Secondary function
	0 ␣ (Space character) + = #	–
	Move menu/list selection item **UP**	Character entry: ← (backspace) clear
	Move menu/list selection item **DOWN**	Character entry: - (minus sign)
	. (decimal point)	Switch LCD backlight on/off
	**ESC**ape menu item	Abort entry without saving
	**ENTER** menu item	Confirm entry with saving

Table 8: Keypad key functions

4.2.2 Display icons and functions



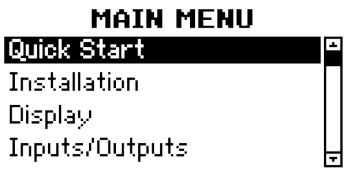
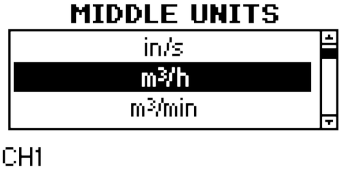
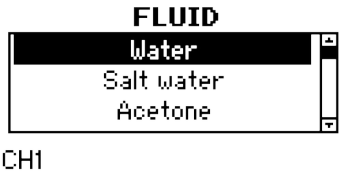
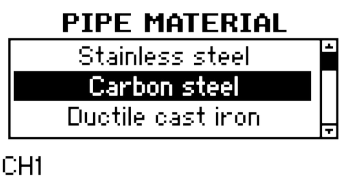
Picture 13: Display overview

Display icon	Function	
	On Off Flashing	Display of the transmission voltage: 75 V 10 V 150 V
	On Off Flashing	Data logger recording Data logger switched off Data logger full
		Function not used on KATflow 150
	On Off	LCD backlight switched on LCD backlight switched off
	On Off	I/O processor error (internal display only) I/O processor works without errors
	On Off	Without strike-through: Speaker on With strike-through: Speaker off
	On Off	Sensor coupling error, low SNR Sensors operating correctly
		Function not used on KATflow 150
	On Off	Key lock activated Key lock deactivated
	On Off	Time/date set Clock error
	On Off	Error recorded in error log No error detected
	On Off	Serial output (RS 232 and/or RS 485) switched on Serial output switched off
L, T or LT		Displays whether flow is **L**aminar, **T**urbulent or **L**aminar-**T**urbulent
Q	On Off	Totaliser for the active channel switched on Totaliser for the active channel switched off

Table 9: Display icon functions

4.3 Quick Setup Wizard

The Quick Setup Wizard allows for a speedy setup of the most important parameters in order to achieve successful measurements in the shortest possible time:

Used keys	Display screen	Operation
		At first power on and the boot sequence, the "Main Menu" is displayed. Use the **UP** ▲ and **DOWN** ▼ cursor keys to select "Quick Start" and confirm by pressing **ENTER**.
		Use cursor keys to select "Setup Wizard". Confirm by pressing **ENTER**. If the sensors are recognised, the serial number will be shown. If not, the type can be selected.
		Select the main measurement unit using the cursor keys and confirm with **ENTER**. This unit will be displayed in the middle of the measurement screen. Selecting **OFF** deactivates the measurement channel.
		Select the fluid using cursor keys. Confirm by pressing **ENTER**.
		Enter the fluid temperature using the keypad. Confirm by pressing **ENTER**. Use **UP** ▲ key as a backspace to correct for entry errors.
		Select pipe material using the cursor keys and confirm with **ENTER**.
		Enter the outer pipe diameter using the alphanumeric keys and confirm with **ENTER**. Use **UP** ▲ key as backspace to correct for entry errors. If 0 is entered and confirmed, an additional screen appears that allows entry of the circumference.
		Enter the circumference using the alphanumeric keys. Press **ENTER** to confirm.

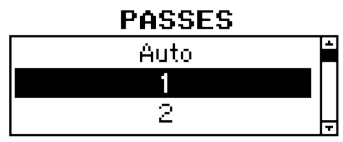
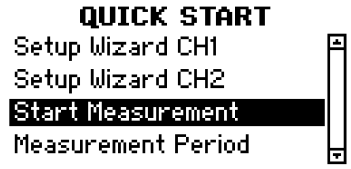
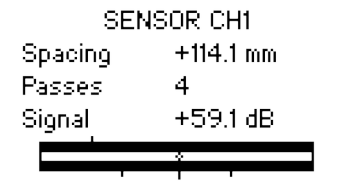
Used keys	Display screen	Operation
		Enter pipe wall thickness using the alphanumeric keys and confirm with **ENTER**. Use **UP** ▲ key as a backspace to correct for entry errors.
		Select pipe liner material using cursor keys and confirm by pressing **ENTER**. If a liner material is chosen, an additional screen appears that allows entry of liner thickness.
		Select number of sound passes (sound paths) using cursor keys. Auto: Automatically 1: 1 pass (Diagonal Mode) 2: 2 passes (Reflection Mode) 3: 3 passes (Diagonal Mode) 4: 4 passes (Reflection Mode) etc. Confirm with **ENTER**.
		Select “Start Measurement” and confirm with **ENTER** to start the sensor positioning procedure.
		Sensor positioning screen: Mount transducers with suggested spacing and use middle bar for fine adjustment of position (central position is desired). Observe signal-to-noise (upper bar) and quality (lower bar). These should be of identical length. Note: **NEXT** switches between different signal diagnostic data. With **9** the scope function can be selected for further diagnosis. Confirm by pressing **ENTER** to obtain measurements. Note: Numbers shown are for indication only.
		Success!

Table 10: Quick Setup Wizard

4.4 Measurement

4.4.1 Main process value display

Measurement is started using “Start Measurement” in the Quick Start Wizard. If all parameters have been entered, the next time the flowmeter is switched on the main process value (PV) is immediately shown on the display and/or made available as an output signal (if installed and operating).

The main process value (PV) is the primary measurement data and is usually displayed as the middle unit. User-specific settings for the main process value display can be made using the corresponding options in the menu. The process value can be selected from a list of available values.

Used keys	Display screen	Operation
		The main process value can be changed in the “Quick Start” or “Display” menus. MUX switches between channel 1 and channel 2 in a dual-channel flowmeter. Press ESC at any time to return to the “Main Menu”. Change to other displays by pressing NEXT. Change to the diagnostic displays by pressing DISP. 5 = Switches on and off the display sequence which automatically cycles through the various process value or diagnostic displays. Can only be activated if a value not equal to 0 has been set in the display menu for display sequence. 9 = Activate/deactivate the key lock. Enter the password defined in the user menu (max. 4 numbers) and confirm with ENTER. Note: A message appears when the display sequence or key lock is activated or the password is entered.

Table 11: Main process value display

The sequence of the process value displays is: Main process value display, three-line display, totaliser display, dual-channel display, “Math” display.

4.4.2 Three-line display

Used keys	Display screen	Operation
	PV CH1 T 1.23 m/s **38.19 m³/h** 35.40 dB Signal 04/06/20 17:01:46	The three-line display screen is configurable to show flow, totalisers and diagnostic functions. Change to diagnostic displays by pressing DISP. Cycle through display screens (measurement or diagnostics) using NEXT. Cycle through available flow channels using MUX if two channels are activated.

Table 12: Main process value display in three-line display format

4.4.3 Totaliser

The totaliser displays will only be shown when the totalisers are activated and a volume flow, mass flow or heat flow is selected as process value (middle line).

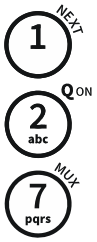
Used keys	Display screen	Operation
	Q PV CH1 T Q+ 8.09 m³ **38.47 m³/h** Q− 0.00 m³ 04/06/20 16:57:51	The flow totaliser can be started by pressing Q_{ON} when a volume or totalised measurement is selected as process variable PV. The totaliser screen is viewed by pressing NEXT sequentially until the desired screen is shown. The middle line shows the selected process variable, the other lines show the positive and negative totals. Pressing NEXT again will indicate first the current daily (D), monthly (M) and yearly (Y) totals and then on the next screen the last D, M and Y history values. Pressing NEXT will cycle through all measurement screens. If two channels are activated using MUX will change between flow channels CH1 and CH2.
		Pressing Q_+ resets the total accumulated flow in the positive flow direction. Pressing Q_- resets the total accumulated flow in the negative flow direction.
		The totalisers can be stopped by pressing Q_{OFF}.
		Change to other displays or revert to the totaliser screen by pressing DISP or NEXT.

Table 13: Totaliser display

4.4.4 Diagnostic display

Used keys	Display screen	Operation
	**DIAGNOSTICS** 28.9 dB Gain **35.4 dB Signal (U)** −22.3 dB Noise 04/06/20 17:05:52	Line 1 shows the amplifier gain. Line 2 displays the signal strength. Line 3 indicates the noise. Change to more diagnostic displays by pressing **NEXT**. Press **DISP** to switch to the process value displays. Cycle through available flow channels using **MUX** if two channels are activated. **ENTER** changes between signal strength in flow direction (D) and against flow direction (U) (Note: This applies to ultrasonic board version 5.0 or higher). Refer to Customer Support for the meanings of each diagnostic screen.

Table 14: Diagnostic display

Diagnostic displays can be viewed directly during measurement. Other diagnostic functions are available in the menu structure.

4.4.5 Dual-channel measurement screen

Used keys	Display screen	Operation
	**DUAL CH1** T CH1 38.80 m³/h **m³/h** CH2 38.79 m³/h 04/06/20 16:56:20	Line 1 shows the PV on the selected channel. Line 2 shows the selected units. Note: If a “Math” function has been activated, the result of the calculation is displayed in the middle line. Line 3 shows the PV on the other channel (in its selected units). Change to diagnostic displays by pressing **DISP** and to totaliser and main PV screens by pressing **NEXT**. Cycle through available flow channels using **MUX** if two channels are activated.

Table 15: Dual-channel measurement screen

The dual-channel measurement screen is skipped if the flowmeter is not configured as a dual-channel device or if one of the channels is disabled.

4.4.6 “Math” display

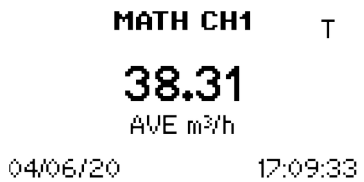
Used keys	Display screen	Operation
		Displays the “Math” function (when enabled on multi-channel meters). “Sum”, “Difference”, “Average” and “Maximum” can be selected in the “Calculation” menu. “Average” shown in illustration. Change to diagnostic displays by pressing **DISP** and to totaliser, dual and main PV screens by pressing **NEXT**. Cycle through available flow channels using **MUX** if two channels are activated.

Table 16: “Math” display

The same units must be set for the function selection “Sum”, “Difference” or “Average”. Otherwise the error message “!?!” will be displayed instead of the unit. If “Maximum” is selected as math function, the units of the channel which delivers the highest measured value is displayed (related to the set units, not m/s basic process measured value).

4.4.7 Data logger

- The data logger is enabled from the “Main Menu” and operates when a non-zero value is entered for the interval.
- Items to be logged are selected from the “Selection” screen. **ENTER** selects items, **0** deselects.
- Up to ten items may be selected.
- When “dB Signal” and “dB SNR” are selected, two variables are stored, since one measurement is carried out with the flow direction (D – downstream) and one against the flow direction (U – upstream) (Note: This applies to ultrasonic board version 5.0 or higher).
- If no items are selected the logger will record blank space.
- Send logger by serial port to a terminal program by selecting “Log Download”.
- Clear the logger by selecting “Log Erase”.
- Remaining logger space can be seen in the diagnostic displays.
- Logged data can be downloaded, viewed and exported using the KATdata+ software.
- “Wrap Mode” saves as a single measurement session which deletes earlier data once the logger is full. When resuming a measurement, it must be confirmed that the data memory will be deleted in this case. If a restart occurs that is not user initiated (for example power failure), the previous measurement session will be continued. Note that the KATdata+ software cannot be used with this mode.

5 COMMISSIONING

5.1 Menu structure

Main menu	Menu level 1	Menu level 2	Description/settings
Quick Start			
	Setup Wizard CH1 or CH2		Select channel 1, channel 2
		Default Sensor	Indication of sensor type and serial number if automatically detected, otherwise select from list ↑↓ • K1L, K1N, K1E, K1Ex, K1P • K4L, K4N, K4E, K4Ex • K0L, K0N, M, Q, Special (see “Start Measurement” below)
		Middle Units (main displayed)	Select from list where available ↑↓ • Off (disable channel) • m/s, ft/s, in/s (flow velocity) • m/s, ft/s, in/s, m^3/h, m^3/min, m^3/s, l/h, l/min, l/s USgal/h, USgal/min, USgal/s, bbl/d, bl/h, bbl/min (volume flow) • g/s, t/h, kg/h, kg/min (mass flow) • m^3, l, USgal, bbl (volume, totaliser volume flow) • g, t, kg (mass, totaliser mass flow) • W, kW, MW (heat flow, HQM) • J, kJ, MJ (heat, totaliser heat flow) Diagnostic data: • dB Signal (signal), dB Noise (noise), db SNR (signal-to-noise ratio) • m/s c (speed of sound), CU (housing temperature) • K (correction factor), Re (Reynolds number) • V (battery voltage) • SOS (calculated speed of sound), Density, Kin. Vis. (kinematic viscosity), Dyn. Vis. (dynamic viscosity), SHC (specific heat capacity from inputs/calculation) • TEMP (specified or measured fluid temperature) • Press. (specified or measured fluid pressure) • T in, T out (inlet and outlet temperature) • Other (assignable input or calculated value) • V Sensor (sensor voltage) • Math (calculated value – see below)
		Fluid	Select from list ↑↓ • Water, Salt water, Acetone, Alcohol, Ammonia, Carbon Tet (carbon tetrachloride), Ethanol, Ethyl alcohol, Ethyl ether, Ethylene glycol, Glycol/water 50 %, Kerosene, Methanol, Methyl alcohol, Milk, Naphtha, Car oil, Refrigerant R134a, Refrigerant R22, Hydrochloric acid, Sour cream, Sulphuric acid, Toluene, Vinyl chloride • User (kinematic viscosity, density, medium sound speed)
		Kinematic Viscosity	(Only if user fluid selected) 0.001 ... 30 000 mm^2/s
		Density	(Only if user fluid selected) 100 ... 2 000 kg/m^3
		Medium Sound Speed	(Only if user fluid selected) 100 ... 3 500 m/s

Main menu	Menu level 1	Menu level 2	Description/settings
		Temperature	-30 ... +300 °C
		Pipe Material	Select from list ↑↓ • Stainless steel, Carbon steel, Ductile cast iron, Grey cast iron, Copper, Lead, PVC, PP, PE, ABS, Glass, Cement • User (pipe sound speed)
		Pipe Sound Speed	(Only if user pipe material selected) 600 ... 6 553.5 m/s
		Outside Diameter	6 ... 6 500 mm
		Circumference	(Only if 0.0 is selected for outer diameter) 18.8 ... 20 420.4 mm
		Wall Thickness	0,5 ... 80 mm
		Liner Material	Select from list ↑↓ • None • Epoxy, Rubber, PVDF, PP, Glass, Cement • User (liner sound speed)
		Liner Thickness	(Only if lining material selected) 1.0 ... 99.0 mm
		Liner Sound Speed	(Only if lining material selected) 500 ... 5 000 m/s
		Passes	Select from list ↑↓ Auto, 1 ... 16
	Start Measurement		
		Sensor Type	Indication of sensor type and serial number if automatically detected, otherwise select from list ↑↓
		SP1 – Sensor Frequency	Only for special, unrecognised sensors
		SP2 – Wedge Angle	Only for special, unrecognised sensors
		SP3 – Wedge Sound Speed 1	Only for special, unrecognised sensors
		SP4 – Wedge Sound Speed 2	Only for special, unrecognised sensors
		SP5 – Crystal Offset	Only for special, unrecognised sensors
		SP6 – Spacing Offset	Only for special, unrecognised sensors
		SP7 – Zero Flow Offset	Only for special, unrecognised sensors
		SP8 – Upstream Offset	Only for special, unrecognised sensors
		Sensor K-Factor	Only for special, unrecognised sensors
		Sensor Placement	Adjust sensor position (see sensor positioning screen, Section 4.3)

Main menu	Menu level 1	Menu level 2	Description/settings
	Measurement Period		Selection of the waiting time between two measurements: 1 ... 3 600 s Note: If the Saver Mode is activated, the measurement period changes automatically from seconds to minutes.
Installation			Select channel 1, channel 2
	Pipe		
		Material	Select from pipe material list ↑↓
		Outside Diameter	6 ... 6 500 mm (outside diameter)
		Wall Thickness	0.5 ... 80 mm (wall thickness)
		Transv. Sound Velocity	(Transverse sound velocity) 600 ... 6 553,5 m/s
		Long. Sound Velocity	(Longitudinal sound velocity) 600 ... 8 000 m/s
		Circumference	18.8 ... 20 420 mm (pipe circumference)
		Roughness	0 ... 10 mm
	Medium		
		Fluid	Select from fluid list ↑↓
		Kinematic Viscosity	0.001 ... 30 000 mm^2/s
		Dynamic Viscosity	0 ... 30 000 g/ms
		Density	100 ... 2 000 kg/m^3
		Transv. Sound Velocity	(Transverse sound velocity) 100 ... 3 500 m/s
		Temperature	-30 ... +300 °C
	Lining		
		Material	Select from material list ↑↓
		Thickness	0.1 ... 99.9 mm
		Transv. Sound Velocity	(Transverse sound velocity) 600 ... 6 553 m/s
	Passes		Select from list ↑↓
Display			Select channel 1, channel 2
		Top Line	Select unit from list ↑↓
		Middle Line	Select unit from list ↑↓
		Bottom Line	Select unit from list ↑↓
		Damping	Reduces fluctuations in the display output 1 ... 255 s
		Metric/Imperial	Use metric or imperial units for entered data
		Auto Seq. Timer	Set automatic change of display 0 ... 60 measurements (0 deactivates automatic change of display

Main menu	Menu level 1	Menu level 2	Description/settings
Inputs/ Outputs			Lists available input/output slots Possible configurable settings below [where specified]
	I Out		Analogue current output (active or passive)
		Source	Select from list ↑↓ Off, Channel 1, (if dual-channel device: Channel 2, Math 1, Math 2), Test
		Units	Select from list ↑↓
		Min. Value	Min. process variable (PV) value that corresponds to 0 mA (only active) or 4 mA -10 000 ... 10 000
		Max. Value	Max. process variable (PV) value that corresponds to 20 mA
		Damping	Additional smoothing of the current output, the higher the damping factor: 1 ... 255 measurements
		Span	(Only active current output) 0 ... 20 mA or 4 ... 20 mA
		Error	Defines output behaviour in the event of error Select from list ↑↓ • Hold (hold last value, select hold time) • 3.8 mA • 21.0 mA
	Voltage Out		Analogue voltage output
		Source	Select from list ↑↓ Off, Channel 1, (if dual-channel device: Channel 2, Math 1, Math 2), Test
		Units	Select from list ↑↓
		Min. Value	Min. process variable (PV) value that corresponds to 0 V -10 000 ... 10 000
		Max. Value	Max. process variable (PV) value that corresponds to 10 V -10 000 ... 30 000
		Damping	Additional smoothing of the current output, the higher the damping factor: 1 ... 255 measurements
		Error	Defines output behaviour in the event of error Select from list ↑↓
	Frequency Out		Analogue frequency output
		Source	Select from list ↑↓ Off, Channel 1, (if dual-channel device: Channel 2, Math 1, Math 2), Test
		Units	Select from list ↑↓
		Min. Value	Min. process variable (PV) value that corresponds to minimum frequency: -10 000 ... 10 000
		Max. Value	Max. process variable (PV) value that corresponds to maximum frequency: -10 000 ... 30 000

Main menu	Menu level 1	Menu level 2	Description/settings
		Damping	Additional smoothing of the current output, the higher the damping factor: 1 ... 255 measurements
	Pulse Out		Digital open-collector output
		Source	Select from list ↑↓ Off, Channel 1, (if dual-channel device: Channel 2, Math 1, Math 2), Test
		Units	Select from list ↑↓
		Mode	Select from list ↑↓ Alarm: PV alarm switch • On Point – Value of the process variable (PV) at which the relay switches to alarm mode: -10 000 ... 10 000 • Off Point – Value of the process variable (PV) at which the relay interrupts the alarm mode again: -10 000 ... 10 000 Pulse: Sum value of the selected process variable (PV) for which a pulse signal is generated, e. g. PV [m^3], pulse value = 10, a pulse is generated every 10 m^3 • Amount of the selected unit: 0.00 ... 1 000 000 (total of the selected unit) • Width: Duration of the pulse 10 ... 999 ms • Source (Grand, Positive, Negative) Linear: Calculated maximum number of pulses per second, i. e. the maximum pulse rate in Hz • Min. Value: -10 000 ... 10 000 • Max. Value: -10 000 ... 30 000 • Damping: 1 ... 255 measurements
	Relay Out		Digital relay output
		Source	Select from list ↑↓ Off, Channel 1, (if dual-channel device: Channel 2, Math 1, Math 2), Test
		Units	Select from list ↑↓
		Mode	Select from list ↑↓ Alarm: • On Point – Value of the process variable (PV) at which the relay switches to alarm mode: -10 000 ... 10 000 • Off Point – Value of the process variable (PV) at which the relay interrupts the alarm mode again: : -10 000 ... 10 000 Pulse: • Amount of the selected unit: 0.00 ... 1 000 000 (total of the selected unit) • Width (in ms): 10 ... 999 ms Linear: • Min. Value: -10 000 ... 10 000 • Max. Value: -10 000 ... 30 000 • Damping: 1 ... 255 measurements
	Pt 100 4 Wire		Temperature input
		Source	Select from list ↑↓ Off, Channel 1, (if dual-channel device: Channel 2, Math 1, Math 2), Test

Main menu	Menu level 1	Menu level 2	Description/settings
		Type	Select from list ↑↓ • User – Input of a temperature value defined by the user within the range -200 ... +600 °C • Pt 100 – Temperature (in °C) determined and read in by a probe (Pt 100)
		In-Out	Select from list ↑↓ • Inlet – Inlet temperature for HQM measurement • Outlet – Outlet temperature for HQM measurement • Compensation – Temperature for temperature compensated measurements
		Value	(Only if user selected) Input of a temperature value defined by the user within the range -200 ... +600 °C
		Offset	Input of a user-defined offset within the range -100 ... +100 °C
	Current In		Analogue current input (passive or active)
		Source (Channel)	Select from list ↑↓ Off, Channel 1, (if dual-channel device: Channel 2, Math 1, Math 2), Test
		Source (Value)	Select from list ↑↓ Density, Kin. Viscosity, Dyn. Viscosity, Temperature, Pressure, Other
		Min. Value	Minimum value of the variable input parameters: -10 000 ... 10 000
		Max. Value	Maximum value of the variable input parameters: -10 000 ... 30 000
		Span	(Only passive current input) 0 ... 20 mA or 4 ... 20 mA
	RS 485		Please consult customer support.
	Modbus RTU		Please refer to dedicated instructions (Modbus RTU).
	Modbus TCP		Please refer to dedicated instructions (Modbus TCP/IP).
	HART		(HART® compatible output, where specified, only for HART® software version 3.0.0 or higher) HART® is a registered trademark of the HART® Communication Foundation
		Source	Select from list ↑↓ Off, Channel 1, (if dual-channel device: Channel 2), Test
		Units	Select and assign units (**ENTER** selects, **0** cancels selection, **ESC** exits menu) ↑↓ • P – Primary Value PV • S – Secondary Value SV (optional) • T – Third Value TV (optional) • F – Fourth Value FV or QV (optional)
		Min. Value	Minimum value of the primary process variable (PV) corresponding to a current of 4 mA: -10 000 ... 10 000

Main menu	Menu level 1	Menu level 2	Description/settings
		Max. Value	Maximum value of the primary process variable (PV) corresponding to a current of 20 mA: -10 000 ... 30 000
	M-Bus		
		Address	Primary address input is immediately after selecting “WIRES M-BUS” in the inputs/outputs menu Enter the primary address of the encoder: 1 ... 250
		Baud Rate	Selection of the baud rate ↑↓ 300, 600, 1 200, 2 400, 4 800, 9 600, 19 200, 38 400 baud
	Other In/Out types		Refer to Technical Support
System			
	Instrument Info		
		Model Code	KATflow 150
		Serial No.	(Serial number) Example: 15002013
		HW Revision	Example: 3.00, 1.70
		SW Revision	Example: 6.06.00.0, 5.0 KAT
	Calculation		
		Select Channel	Select channel 1, channel 2
		Low Flow Cut-Off	± Low flow velocity cut-off: 0 ... 1 m/s
		High Flow Cut-Off	± Maximum flow velocity cut-off: 0 ... 30 m/s
		Corrected	Apply flow velocity profile correction: Yes/No
		PV Offset	Calibration process variable zero offset: -30 ... +30 m/s
		PV Scaling	Calibration process variable gradient scaling: -10.0 ... +10.0 m/s
		Zero Calibration	Zero calibration settings Adjust: • Zero (Yes/No): Sets current flow as zero (Perform auto zero calibration) • Track (Yes/No): Zero follows output variations • Delta time: Zero flow offset in ns (Zero flow delta time offset in ns, read from sensor PROM or entered directly for special sensors) • Time Up: Transit time offset in µs, for delays in special sensors, thermal buffers and cable extensions
		Math Function	Select from list ↑↓ None, Sum, Difference, Average (mean), Maximum, Ratio
		Heat Capacity	Specify heat capacity of the medium: 0 ... 10 J/gK

Main menu	Menu level 1	Menu level 2	Description/settings
		Missed Measure-ments	• Setting for the behaviour of the output values when too many unsuccessful measurements occur: • Hold Value: Output value of the last successful measurement • Go to Zero: Output value becomes 0 • User Value: User-specific error value: -1 ... 300 000 m/s
	User		
		Identifier	Example: Pump P3A (9 character string possible)
		Tag No.	(Tag number) Example: 1FT-3011 (9 character string possible)
		Password	Set 4 character password (default 1111) When the device is restarted, the password is reset to the default setting
	Test		
		Installation	Control system simulation 60 second ramping up of flow velocity in m/s from 0 to programmed High Flow Cut-Off and subsequent 60 second ramping down All configured outputs will exhibit their programmed behaviour Test Mode: Yes/No
		Display	Display screen test routine
		Keypad	Keypad test routine
		Memory	Memory test routine Memory erase: Yes/No
		Peripherals	Unit temperature, time, date, clock
		Ultrasonics	Tests ultrasonic board and sensors
		Calibration Pt 100	Tests measured temperature and resistance
		Reset Pt 100s	Resets temperature inputs
	Settings		
		Date	Example: 16/03/2024
		Time	Example: 09:27:00
		Date Format	Select from list ↑↓ • dd/mm/yy • mm/dd/yy • yy/mm/dd
		Language	Select from list (as available) ↑↓ English, German, French, Spanish, Russian
		Keypad	Keypad sound: Yes/No
	Timer Mode		Device starts measurement for the set measuring period • Activate Timer Mode: Yes/No • Input: Start Time • Input: End Time Note: Measurement does not start automatically The programmed measurement must be activated once via “Start Measurement” Device confirms the set time interval
	Load Defaults		Load default settings (except date and time): Yes/No

Main menu	Menu level 1	Menu level 2	Description/settings
	Key Lock		Activate key lock: Yes/No Locks the keypad until password is entered (4 number keys followed by **ENTER**); See also “Password” above
	Measurement Mode		Selection of the measuring method: • Normal: Standard measuring mode • Doppler: Doppler measurement mode • Auto: Automatic selection of standard or Doppler measurement mode • Fast: Fast mode (Measuring mode with the smallest possible measuring cycle time. No indication of the measured value on the display. Output via serial interface and/or by storing the measured values in the internal data logger)
Diagnostics			
			Shows internal error messages (error flags), measured temperature, available logger memory Acknowledge error message with **ENTER** or quit the error display with **ESC** Further displays of temperature, data memory, etc.
Data Logger			
		Interval	Enter logging interval in seconds: 0 ... 3 600 s
		Selection	Select from list ↑↓ **ENTER** selects, **0** deselects Up to ten variables may be logged Note: When “dB Signal” and “dB SNR” are selected, two variables are stored in each case, since one measurement is performed with the flow direction (D – downstream) and one against the flow direction (U – upstream) (This applies to ultrasonic board version 5.0 or higher).
		Low Memory	Warning output 4 ... 100 %
		Log Wrap	Yes/No Output of selected values as continuous data streams with header Note: Only one measurement session can be recorded in this mode
		Log Download	Sends all logger data using serial port
		Log Erase	Clears the logger content
Serial Com-munication			
		Mode	Select from list ↑↓ • None • Printer (serial interface online output of selected logging values) • Diagnostic • Download (send logger content using serial port) • Calibration Test (laboratory calibration, not recommended for field or customer use)

Main menu	Menu level 1	Menu level 2	Description/settings
		Baud	Select from list ↑↓ • 9 600 (default) • 19 200 • 38 400 • 57 600 • 115 200 • 230 400
		Parity	Select from list ↑↓ • None • Even (default) • Odd
		Type	Select from list ↑↓ RS 232, RS 485 etc. (as installed)
Scope			Scope function can be accessed in the sensor positioning screen by pressing button **9** or in Direct Access (DIRECT) by pressing button **5**.
			Shows the received acoustic pulse and further data to evaluate the signal quality as a scope function on channel 1 and channel 2 (upstream and downstream) (see Section 5.8) • Exit screen: **ESC** • Sampling window +6 µs: **UP** • Sampling window -6 µs: **DOWN** • Switching the display flow direction: **ENTER**

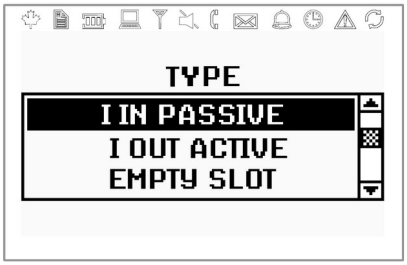
Table 17: Menu structure KATflow 150

5.2 Output configuration

The KATflow 150 has 10 Input/Output slot positions which can be configured with up to 10 individual I/O modules. The assignment of slots is detected by the flowmeter, and will be as shown in the “Inputs/Outputs” menu.

All 10 slots (marked SLOT 1 to 10) and occupy 4-wire terminals each (marked 1 to 4).

The following picture shows an example assignment with a passive current input on slot 1 (line 1) and an active current output on slot 2 (line 2).



Picture 14: Display example passive current input slot 1, active current output slot 2

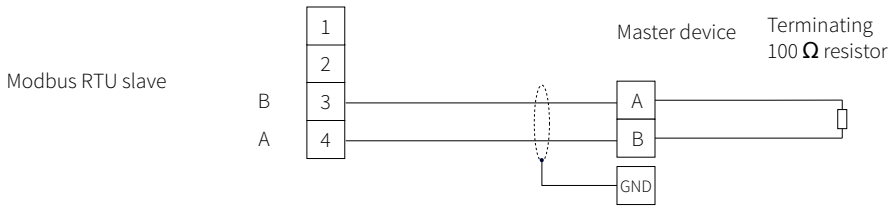
5.2.1 Serial interface

The RS 232 serial interface can be used to transmit data online, to download the integral data logger content or to communicate with peripheral equipment. The settings can be found in the “Serial Communication” submenu.

In addition, the ASCII printer output can also directed through the RS 485 interface (where installed) instead of the RS 232 to increase the transmission distance.

5.2.2 Modbus RTU

The interface is used for networking up to 32 flowmeters to a centralised computer system. Each flowmeter is given an unique address to be able to communicate effectively. The communication protocol used conforms to the conventions of the Modbus RTU protocol, a description of which is given in a separate document. Please refer to Customer Support for further information.



	Setup	Please refer to Customer Support.
	Operation	Please refer to Customer Support.

Table 18: Wiring Modbus RTU

5.2.3 HART® compatible output

The KATflow 150 can also be configured with an optional module which responds to output commands conforming to the HART® protocol. Please refer to Customer Support for further information.

HART® is a registered trademark of the HART Communication Foundation.

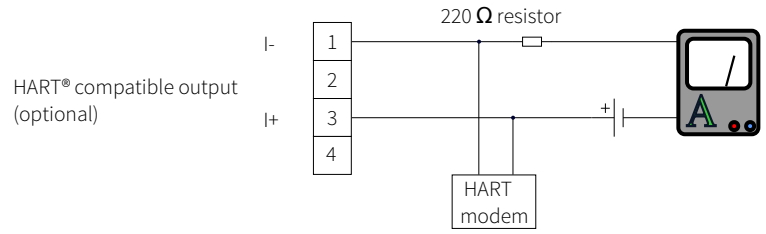
<table>
<tr><td colspan="3"> 
</td></tr>
<tr><td>Electrical characteristics</td><td colspan="2">• Galvanically isolated from main electronics and from other inputs and outputs
• 4 process variables selectable (PV, SV, TV and FV)
• Analogue: 4 ... 20 mA passive, R_{Load} = 220 Ω, U = 24 V, accuracy: 0.1 % of measured value</td></tr>
<tr><td rowspan="2"></td><td>Setup</td><td>Please refer to Customer Support.</td></tr>
<tr><td>Operation</td><td>Please refer to Customer Support.</td></tr>
</table>

Table 19: Wiring HART® compatible output

5.2.4 Analogue current output 0/4 ... 20 mA

The analogue current outputs operate in a 4 ... 20 mA (active or passive) or 0 ... 20 mA (active) span.

Current outputs may be assigned to process values in the “Mode” section of the output menu. The outputs can be programmed and scaled within the menu structure.

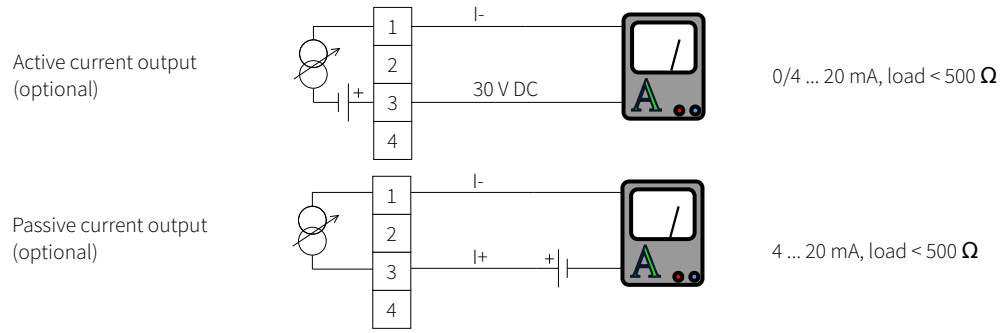
<table>
<tr><td colspan="3"> 
</td></tr>
<tr><td>Electrical characteristics</td><td colspan="2">• 0/4 ... 20 mA active and 4 ... 20 mA passive options
• Galvanically isolated from main electronics and from other inputs and outputs
• Active: U = 30 V, R_{Load} < 500 Ω, 16 bit resolution, accuracy: 0.1 % of measured value
• Passive: U = 9 ... 30 V, R_{Load} < 500 Ω, 16 bit resolution, accuracy: 0.1 % of measured value</td></tr>
</table>

Table 20: Wiring analogue current output 0/4 ... 20 mA

5.2.5 Analogue voltage output 0 ... 10 V

Voltage outputs may be assigned to process values in the “Mode” section of the output menu. The outputs can be programmed and scaled within the menu structure.

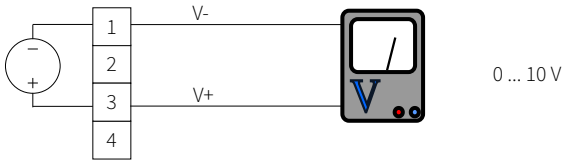
Voltage output (optional)  0 ... 10 V	
Electrical characteristics	• Galvanically isolated from main electronics and from other inputs and outputs • Range: 0 ... 10 V • R_{Load} = 1 kΩ, C_{Load} = 200 pF • Resolution: 16 bit, accuracy: 0.1 % of measured value

Table 21: Wiring analogue voltage output 0 ... 10 V

5.2.6 Analogue frequency output (passive)

Frequency outputs may be assigned to process values in the “Mode” section of the output menu. The outputs can be programmed and scaled within the menu structure.

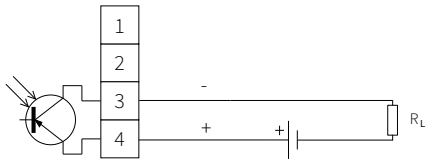
Frequency (analogue output) (optional)  2 ... 10 000 Hz	
Electrical characteristics	• Galvanically isolated from main electronics and from other inputs and outputs • 2 Hz ... 10 kHz • U = 24 V, I_{max} = 4 mA

Table 22: Wiring analogue frequency output (passive)

5.2.7 Digital open-collector output

Open-collector outputs may be assigned to process values in the “Mode” section of the output menu. The outputs are configured using the menu structure.

The totaliser function is enabled and controlled using the menu structure.

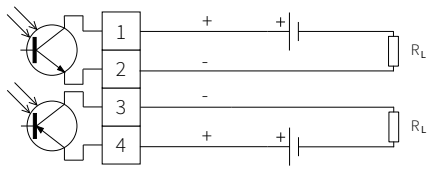
Digital output "Open-Collector" (optional)  Configurable Error, Limit, Total Pulse	
Electrical characteristics	• Galvanically isolated from main electronics and from other inputs and outputs • Function: Alarm or Totaliser • Totaliser value: 0.01 ... 1 000/unit • Width: 1 ... 990 ms • U = 24 V, I_{max} = 4 mA • NO and NC contacts

Table 23: Wiring digital open-collector output

5.2.8 Digital relay output

Relay outputs may be assigned to process values in the “Mode” section of the output menu. The relay outputs are configured using the menu structure.

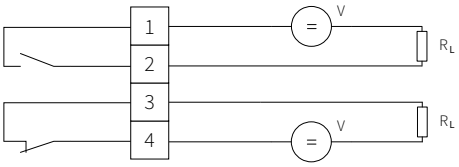
Digital relay output (optional)		Configurable Error, Limit, Total Pulse
Electrical characteristics	• Galvanically isolated from main electronics and from other inputs and outputs • Function: Alarm or Totaliser • Totaliser value: 0.01 ... 1 000/unit • Width: 1 ... 990 ms • U = 48 V, I_{max} = 250 mA • NO and NC contacts	

Table 24: Wiring digital relay output

5.3 Input configuration

5.3.1 Pt 100 inputs

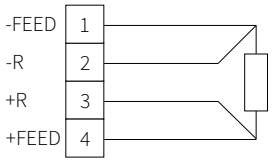
Temperature input Pt 100 4-wire (optional)		Pt 100 temperature sensor
Electrical characteristics	• Pt 100 options: three- or four-wire circuit, Pt 1000 on request • Galvanically isolated from main electronics and from other inputs and outputs • Measurement range: -50 ... +400 °C (-58 ... +752 °F) • Resolution: 0.01 K, accuracy: ±0.02 K	

Table 25: Wiring Pt 100 inputs

5.3.2 Analogue current input 0/4 ... 20 mA

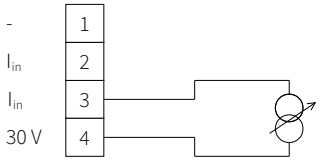
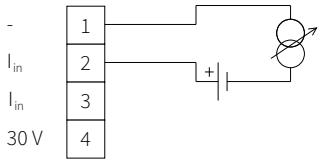
Active analogue input (optional)		0/4 ... 20 mA, active input
Passive analogue input (optional)		4 ... 20 mA, passive input
Electrical characteristics	• 0/4 ... 20 mA active or 4 ... 20 mA passive • U = 30 V, R_i = 50 Ω, accuracy: 0.1 % of measured value	

Table 26: Wiring analogue current input 0/4 ... 20 mA

5.4 Temperature compensation

With temperature compensation enabled the temperature dependency of the medium in relation to speed of sound, viscosity and density calculations will be compensated. The “Inputs/Outputs” menu will then allow the user to select the temperature input source, either Pt 100 temperature sensors or via a 0/4 … 20 mA input channel.

5.5 Heat quantity measurement

Where equipped, heat quantity (energy) and heat flow (energy flow) can be measured. If a heat quantity unit is specified for the process value, the KATflow 150 will ask the user for the specific heat capacity of the medium in J/g/K (for example 4.186 J/g/K for water).

The output options menu for the Pt 100 will allow the user to select the temperature input source; either Pt 100 temperature sensors or a fixed value for measurement against a known inlet or outlet temperature. Where Pt 100 sensors are selected, the Wizard will prompt the user for a temperature offset, which may be useful where the temperature of the medium differs from the temperature of the pipe wall (for example with unlagged pipes). If a fixed value is selected, the user will be asked to specify this value.

When heat quantity units are selected, these behave as any other process value and may be totalised, logged, or applied to a process output.

5.6 Sound velocity measurement

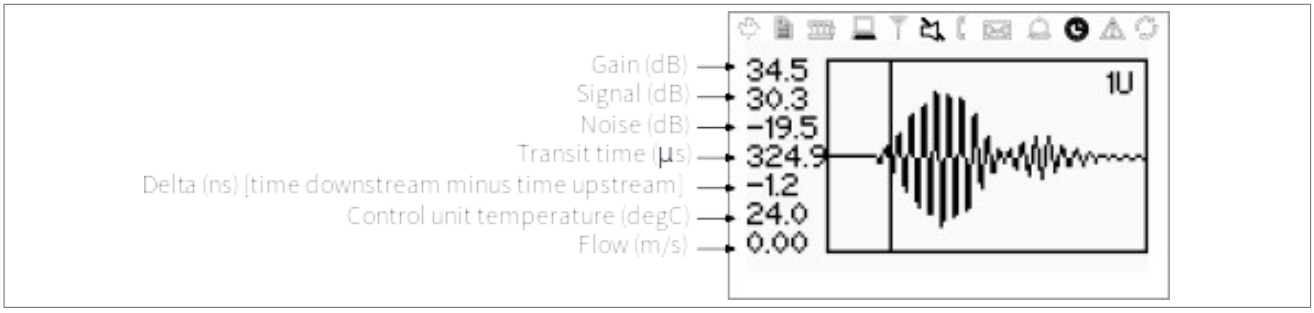
The measured speed of sound (SOS) is available as a diagnostic function during measurement and may be applied to a process output by selecting “c” from the appropriate output menu.

5.7 Dual-channel flow calculations

Where suitably equipped, dual-channel calculations are available from the System - Calculation - Math menu. These allow the user to select the Sum, Difference, Average (mean) or Maximum of the two flow channels. This value may be displayed or applied to a process output by selecting “Math” from the appropriate output menu.

5.8 Scope function

Katronic flowmeters have an additional scope function which shows a representation of the pulse received by the sensors on channel 1 and channel 2. For each active channel the measuring direction (with or against the flow direction) can be selected. The measuring direction can be switched with **ENTER** and is indicated by an abbreviation (e. g. 1U = channel 1, upstream) at the top right of the graph. In addition to displaying the received pulse, this screen lists the data given from top to bottom (Picture 15).



Picture 15: Scope function display

5.9 KATdata+ software

Software can be provided for downloading the contents of the data logger and communication with the flowmeter.

6 MAINTENANCE

KATflow flowmeters are maintenance free concerning the flow measurement functions. Within the scope of periodic inspections, regular inspection for signs of damage or corrosion is recommended for the transducers, the junction box (if installed) and the flowmeter housing.

6.1 Service/Repair

KATflow flowmeters have been carefully manufactured and tested. If installed and operated in accordance with the operating instructions, no problems are usually experienced.

Should you nevertheless need to return a device for inspection or repair, please pay attention to the following points:

- Due to statutory regulations on environmental protection and safeguarding the health and safety of our personnel, the manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.
- This means that the manufacturer can only service this device if it is accompanied by a Customer Return Note (CRN) confirming that the device is safe to handle.

If the device has been operated with toxic, caustic, flammable or water-endangering products, you are kindly requested:

- To check and ensure, if necessary by rinsing or neutralising, that all cavities are free from such dangerous substances,
- to enclose a certificate with the device confirming that is safe to handle and stating the product used.

7 TROUBLESHOOTING

7.1 Measurement difficulties and error messages

Most problems with measurement are due to poor signal strength or quality. Initial checks should include:

- Has sufficient acoustic coupling paste been applied?
- Can the number of sound passes be changed? As a general rule, more passes will improve accuracy, fewer passes will give better signal strength.
- Are there any nearby sources of noise or disturbance?
- Can the signal be improved by moving the sensors around the circumference of the pipe?
- Are the application parameters correct?

Should there be the need to call Customer Service, please let us know the following details:

- Model code,
- Serial number,
- SW, HW revision,
- Error log list.

Possible error messages may include the following:

Error message	Group	Description	Error handling
ULTRASONIC FAIL CYCLE POWER	Hardware	Internal ultrasonic board communication error at power up	Power off/on, otherwise call Customer Support
NO SERIAL NUMBER CYCLE POWER	Hardware	Failed to read from system memory	Power off/on, otherwise call Customer Support
NO VERSION NUMBER CYCLE POWER	Hardware	Failed to read the ultrasonic board's version number	Power off/on, otherwise call Customer Support
PARAMETER XX READ ERROR	Hardware	Failed to read from system memory	Load defaults, otherwise call Customer Support
PARAMETER XX WRITE ERROR	Hardware	Failed to write to system memory	Call Customer Support
MEASUREMENT STOPPED REASON: COM ERRORS RESTARTING	Hardware	Too many internal ultrasonic board communication errors	Call Customer Support
LOADING FAILED	Hardware	Failed to read a stored setup from system memory	Call Customer Support
MENU ERROR	Hardware, Software	Failed to load a Menu	Call Customer Support
PLEASE LOAD KF-TABLES DATA VERSION X.X.X XXX	Software	The external system memory is empty or an incompatible dataset was detected	Power off/on, otherwise call Customer Support

Error message	Group	Description	Error handling
TRANSLATION FAILED	Hardware, Software	Failed to load the chosen language from the system memory	Call Customer Support
BAD SENSOR COUPLING	Application	Weak sensor coupling, low SNR	Recouple sensors, check installation, reduce number of passes, look for other location, then have a cup of tea and call Customer Support!

Table 27: Error list

For all other error messages, please turn off and restart the flowmeter and if messages continue call Customer Support.

7.2 Data download difficulties

If difficulties are encountered downloading the logger data:

- Check that the flowmeter is switched on and not in measurement mode.
- Check that the same number COM port is allocated in the “Device Manager” (or equivalent) as is set in the KATdata+ software.
- Check that the settings (baud, parity, word length, stop bits) are identical.
- Use the supplied connectors – whether connecting to a 9-pin COM port or converting from serial communication to a Universal Serial Bus (USB).

8 TECHNICAL DATA

8.1 Sound speed of selected pipe materials

Material	Sound speed* shear wave (at +25 °C)	
	m/s	ft/s
Steel, 1 % Carbon, hardened	3 150	10 335
Carbon steel	3 230	10 598
Mild steel	3 235	10 614
Steel, 1 % Carbon	3 220	10 565
302 Stainless steel	3 120	10 236
303 Stainless steel	3 120	10 236
304 Stainless steel	3 141	10 306
304L Stainless steel	3 070	10 073
316 Stainless steel	3 272	10 735
347 Stainless steel	3 095	10 512
“Duplex” stainless steel	2 791	9 479
Aluminium	3 100	10 171
Aluminium (rolled)	3 040	9 974
Copper	2 260	7 415
Copper (annealed)	2 325	7 628
Copper (rolled)	2 270	7 448
CuNi (70 % Cu 30 % Ni)	2 540	8 334
CuNi (90 % Cu 10 % Ni)	2 060	6 759
Brass (Naval)	2 120	6 923
Gold (hard-drawn)	1 200	3 937
Inconel	3 020	9 909
Iron (electrolytic)	3 240	10 630
Iron (Armco)	3 240	10 630
Ductile iron	3 000	9 843
Cast iron	2 500	8 203
Monel	2 720	8 924
Nickel	2 960	9 712
Tin (rolled)	1 670	5 479
Titanium	3 125	10 253
Tungsten (annealed)	2 890	9 482
Tungsten (drawn)	2 640	8 661
Tungsten carbide	3 980	13 058
Zinc (rolled)	2 440	8 005
Glass (pyrex)	3 280	10 761
Glass (heavy silicate flint)	2 380	7 808
Glass (light borate crown)	2 840	9 318
Nylon	1 150	3 772
Nylon, 6-6	1 070	3 510
Polyethylene (LD)	540	1 772
PVC, CPVC	1 060	3 477
Acrylic resin	1 430	4 690
PTFE	2 200	7 218

Table 28: Technical data pipe material

*Note these values are to be considered nominal. Solids may be inhomogeneous and anisotropic. Actual values depend on exact composition, temperature, and to a lesser extent, on pressure and stress.

8.2 Technical data of selected fluids

All data given at +25 °C (+77 °F) unless otherwise stated				Sound speed				Change of sound speed per °C		Viscosity (kinematic)			
Substance	Chemical formula	Density $g \cdot cm^{-3}$		$m \cdot s^{-1}$		$ft \cdot s^{-1}$		$m \cdot s^{-1} \cdot °C^{-1}$		$mm^2 \cdot s^{-1}$		$10^{-6} \cdot ft^2 \cdot s^{-1}$	
Acetic acid, anhydride	(CH3CO)2O	1.082	20 °C	1 180.0		3 871.4		2.50		0.769		8.274	
Acetic acid, nitrile	C2H3N	0.783		1 290.0		4 232.3		4.10		0.441		4.745	
Acetic acid, ethyl ester	C4H8O2	0.901		1 085.0		3 559.7		4.40		0.467		5.025	
Acetic acid, methyl ester	C3H6O2	0.934		1 211.0		3 973.1				0.407		4.379	
Acetone	C3H6O	0.791		1 174.0		3 851.7		4.50		0.399		4.293	
Acetylene dichloride	C2H2Cl2	1.260		1 015.0		3 330.1		3.80		0.400		4.304	
Acetylene tetrachloride	C2H2Cl4	1.595		1 147.0		3 763.1		3.80		1.156	15 °C	12.440	15 °C
Alcohol	C2H6O	0.789		1 207.0		3 960.0		4.00		1.396		15.020	
Ammonia	NH3	0.771		1 729.0	-33 °C	5 672.6	-27 °C	6.68		0.292	-33 °C	3.141	-27 °F
Benzene	C6H6	0.879		1 306.0		4 284.8		4.65		0.711		7.650	
Benzol	C6H6	0.879		1 306.0		4 284.8		4.65		0.711		7.650	
Bromine	Br2	2.928		889.0		2 916.7		3.00		0.323		3.475	
n-Butane (2)	C4H10	0.601	0 °C	1 085.0	-5 °C	3 559.7	23 °C	5.80					
2-Butanol	C4H10O	0.810		1 240.0		4 068.2		3.30		3.239		34.851	
sec-Butylalcohol	C4H10O	0.810		1 240.0		4 068.2		3.30		3.239		34.851	
n-Butyl bromide (46)	C4H9Br	1.276	20 °C	1 019.0	20 °C	3 343.2	68 °F			0.490	15 °C	5.272	59 °C
n-Butyl chloride (22,46)	C4H9Cl	0.887		1 140.0		3 740.2		4.57		0.529	15 °C	5.692	59 °F
Carbon tetrachloride	CCl4	1.595	20 °C	926.0		3 038.1		2.48		0.607		6.531	
Carbon tetrafluoride (Freon 14)	CF4	1.750	-150 °C	875.2	-150 °C	2 871.5	-238 °F	6.61					
Chloroform	CHCl3	1.489		979.0		3 211.9		3.40		0.550		5.918	
Dichlorodifluoromethane (Freon 12)	CCl2F2	1.516	40 °C	774.1		2 539.7		4.24					
Ethanol	C2H6O	0.789		1 207.0		3 960.0		4.00		1.390		14.956	
Ethyl acetate	C4H8O2	0.901		1 085.0		3 559.7		4.40		0.489		5.263	
Ethyl alcohol	C2H6O	0.789		1 207.0		3 960.0		4.00		1.396		15.020	
Ethyl benzene	C8H10	0.867	20 °C	1 338.0	20 °C	4 890.8	68 °F			0.797	17 °C	8.575	63 °F
Ether	C4H10O	0.713		985.0		3 389.8		4.87		0.311		3.346	
Ethyl ether	C4H10O	0.713		985.0		3 231.6		4.87		0.311		3.346	
Ethylene bromide	C2H4Br2	2.180		995.0		3 264.4				0.790		8.500	
Ethylene chloride	C2H4Cl2	1.253		1 193.0		3 914.0				0.610		6.563	
Ethylene glycol	C2H6O2	1.113		1 658.0		5 439.6		2.10		17.208	20 °C	185.158	68 °F
Fluorine	F	0.545	-143 °C	403.0	-143 °C	1 322.2	-225 °F	11.31					
Formaldehyde, methyl ester	C2H4O2	0.974		1 127.0		3 697.5		4.02					
Freon R12				774.2		2 540.0		6.61					
Glycol	C2H6O2	1.113		1 658.0		5 439.6		2.10					
50 % Ethylene glycol/ 50 % Water				1 578.0		5 177.0							
Isopropanol	C3H8O	0.785	20 °C	1 170.0	20 °C	3 838.6	68 °F			2.718		29.245	
Isopropyl alcohol (46)	C3H8O	0.785	20 °C	1 170.0	20 °C	3 838.6	68 °F			2.718			

All data given at +25 °C (+77 °F) unless otherwise stated				Sound speed				Change of sound speed per °C		Viscosity (kinematic)			
Substance	Chemical formula	Density $g \cdot cm^{-3}$		$m \cdot s^{-1}$		$ft \cdot s^{-1}$		$m \cdot s^{-1} \cdot °C^{-1}$		$mm^2 \cdot s^{-1}$		$10^{-6} \cdot ft^2 \cdot s^{-1}$	
Kerosene		0.810		1 324.0		4 343.8		3.60					
Methane	CH4	0.162	-89 °C	405.0	-89 °C	1 328.7	-128 °F	17.50					
Methanol	CH4O	0.791	20 °C	1 076.0		3 530.2		292.00		0.695		7.478	
Methyl acetate	C3H6O2	0.934		1 211.0		3 973.1				0.407		4.379	
Methyl alcohol	CH4O	0.791		1 076.0		3 530.2		292.00		0.695		7.478	
Methyl benzene	C7H8	0.867		1 328.0	20 °C	4 357.0	68 °F	4.27		0.644		7.144	
Milk, homogenised				1 548.0		5 080.0							
Naphtha		0.760		1 225.0		4 019.0							
Natural gas		0.316	-103 °C	753.0	-103 °C	2 470.5	-153 °F						
Nitrogen	N2	0.808	-199 °C	962.0	-199 °C	3 156.2	-326 °F			0.217	-199 °C	2.334	-326 °F
Oil, Car (SAE 20a.30)		1.740		870.0		2 854.3				190.000		2 045.093	
Oil, Castor	C11H10O0	0.969		1 477.0		4 845.8		3.60		0.670		7.209	
Oil, Diesel		0.800		1 250.0		4 101.0							
Oil, Fuel AA gravity		0.990		1 485.0		4 872.0		3.70					
Oil (Lubricating X200)				1 530.0		5 019.9							
Oil (Olive)		0.912		1 431.0		4 694.9		2.75		100.000		1 076.365	
Oil (Peanut)		0.936		1 458.0		4 738.5							
Propane (-45 to -130 °C)	C3H8	0.585	-45 °C	1 003.0	-45 °C	3 290.6	-49 °F	5.70					
1-Propanol	C3H8O	0.780	20 °C	1 222.0	20 °C	4 009.2	68 °F						
2-Propanol	C3H8O	0.785	20 °C	1 170.0	20 °C	3 838.6	68 °F			2.718		29.245	
Propene	C3H6	0.563	-13 °C	963.0	13 °C	3 159.4	9 °F	6.32					
n-Propylalcohol	C3H8O	0.780	20 °C	1 222.0	20 °C	4 009.2	68 °F			2.549		27.427	
Propylene	C3H6	0.563	-13 °C	963.0	-13 °C	3 159.4	9 °F	6.32					
Refrigerant 11	CCl3F	1.490		828.3	0 °C	2 717.5	32 °F	3.56				8.500	
Refrigerant 12	CCl2F2	1.516	-40 °C	774.1	-40 °C	2 539.7	-40 °C	4.24					
Refrigerant 14	CF4	1.750	-150 °C	875.2	-150 °C	2 871.6	-268 °F	6.61					
Refrigerant 21	CHCl2F	1.426	0 °C	891.0	0 °C	2 923.2	32 °F	3.97					
Refrigerant 22	CHClF2	1.491	-69 °C	893.9	50 °C	2 923.2	32 °F	4.79					
Refrigerant 113	CCl2F-CClF2	1.563		783.7	0 °C	2 571.2	32 °F	3.44					
Refrigerant 114	CClF2-CClF2	1.455		665.3	-10 °C	2 182.7	14 °F	3.73					
Refrigerant 115	C2ClF5			656.4	-50 °C	2 153.5	-58 °F	4.42					
Refrigerant C318	C4F8	1,620	-20 °C	574.0	-10 °C	1 883.2	14 °F	3.88					
Sodium nitrate	NaNO3	1.884	336 °C	1 763.3	336 °C	5 785.1	637 °F	0.74		1.370	336 °C	14.740	637 °F
Sodium nitrite	NaNO2	1.805	292 °C	1 876.8	292 °C	6 157.5	558 °F						
Sulphur	S			1 177.0	250 °C	3 861.5	482 °F	-1.13					
Sulphuric Acid	H2SO4	1.841		1 257.6		4 126.0		1.43		11.160		120.081	
Tetrachloroethane	C2H2Cl4	1.553	20 °C	1 170.0	20 °C	3 838.6	68 °F			1.190		12.804	
Tetrachloroethene	C2Cl4	1.632		1 036.0		3 399.0							
Tetrachloromethane	CCl4	1.595	20 °C	926.0		3 038.1				0.607		6.531	
Tetrafluoromethane (Freon 14)	CF4	1.750	-150 °C	875.2	-150 °C	2 871.5	-283 °F	6.61					

All data given at +25 °C (+77 °F) unless otherwise stated				Sound speed				Change of sound speed per °C		Viscosity (kinematic)			
Substance	Chemical formula	Density $g \cdot cm^{-3}$		$m \cdot s^{-1}$		$ft \cdot s^{-1}$		$m \cdot s^{-1} \cdot °C^{-1}$		$mm^2 \cdot s^{-1}$		$10^{-6} \cdot ft^2 \cdot s^{-1}$	
Toluene	C7H8	0.867	20 °C	1 328.0	20 °C	4 357.0	68 °F	4.27		0.644		6.929	
Toluol	C7H8	0.866		1 308.0		4 291.3		4.20		0.580		6.240	
Trichlorofluoromethane (Freon 11)	CCl3F	1.490		828.3	0 °C	2 717.5	32 °F	3.56					
Turpentine		0.880		1 255.0		4 117.5				1.400		15.064	
Water, distilled	H2O	0.996		1 498.0		4 914.7		-2.40		1.000		10.760	
Water, heavy	D2O			1 400.0		4 593.0							
Water, sea		1.025		1 531.0		5 023.0		-2.40		1.000		10.760	

Table 29: Technical data of fluids

8.3 Dependence between temperature and sound speed in water

Temperature		Sound speed in water	
°C	°F	m/s	ft/s
0	32.0	1 402	4 600
1	33.8	1 407	4 616
2	35.6	1 412	4 633
3	37.4	1 417	4 649
4	39.2	1 421	4 662
5	41.0	1 426	4 679
6	42.8	1 430	4 692
7	44.6	1 434	4 705
8	46.4	1 439	4 721
9	48.2	1 443	4 734
10	50.0	1 447	4 748
11	51.8	1 451	4 761
12	53.6	1 455	4 774
13	55.4	1 458	4 784
14	57.2	1 462	4 797
15	59.0	1 465	4 807
16	60.8	1 469	4 820
17	62.6	1 472	4 830
18	64.4	1 476	4 843
19	66.2	1 479	4 853
20	68.0	1 482	4 862
21	69.8	1 485	4 872
22	71.6	1 488	4 882
23	73.4	1 491	4 892
24	75.2	1 493	4 899
25	77.0	1 496	4 908
26	78.8	1 499	4 918
27	80.6	1 501	4 925
28	82.4	1 504	4 935
29	84.2	1 506	4 941
30	86.0	1 509	4 951
31	87.8	1 511	4 958
32	89.6	1 513	4 964
33	91.4	1 515	4 971
34	93.2	1 517	4 977
35	95.0	1 519	4 984
36	96.8	1 521	4 984
37	98.6	1 523	4 990
38	100.4	1 525	4 997
39	102.2	1 527	5 010
40	104.0	1 528	5 013
41	105.8	1 530	5 020
42	107.6	1 532	5 026
43	109.4	1 534	5 033
44	111.2	1 535	5 036
45	113.0	1 536	5 040
46	114.8	1 538	5 046
47	116.6	1 538	5 049
48	118.4	1 540	5 053
49	120.2	1 541	5 056
50	122.0	1 543	5 063

Temperature		Sound speed in water	
°C	°F	m/s	ft/s
51	123.8	1 543	5 063
52	125.6	1 544	5 066
53	127.4	1 545	5 069
54	129.2	1 546	5 072
55	131.0	1 547	5 076
56	132.8	1 548	5 079
57	134.6	1 548	5 079
58	136.4	1 548	5 079
59	138.2	1 550	5 086
60	140.0	1 550	5 086
61	141.8	1 551	5 089
62	143.6	1 552	5 092
63	145.4	1 552	5 092
64	147.2	1 553	5 092
65	149.0	1 553	5 095
66	150.8	1 553	5 095
67	152.6	1 554	5 099
68	154.4	1 554	5 099
69	156.2	1 554	5 099
70	158.0	1 554	5 099
71	159.8	1 554	5 099
72	161.6	1 555	5 102
73	163.4	1 555	5 102
74	165.2	1 555	5 102
75	167.0	1 555	5 102
76	167.0	1 555	5 102
77	170.6	1 554	5 099
78	172.4	1 554	5 099
79	174.2	1 554	5 099
80	176.0	1 554	5 099
81	177.8	1 554	5 099
82	179.6	1 553	5 095
83	181.4	1 553	5 095
84	183.2	1 553	5 095
85	185.0	1 552	5 092
86	186.8	1 552	5 092
87	188.6	1 552	5 092
88	190.4	1 551	5 089
89	192.2	1 551	5 089
90	194.0	1 550	5 086
91	195.8	1 549	5 082
92	197.6	1 549	5 082
93	199.4	1 548	5 079
94	201.2	1 547	5 076
95	203.0	1 547	5 076
96	204.8	1 546	5 072
97	206.6	1 545	5 069
98	208.4	1 544	5 066
99	210.2	1 543	5 063
100	212.0	1 543	5 063
104	220.0	1 538	5 046
110	230.0	1 532	5 026
116	240.0	1 524	5 000
121	250.0	1 516	5 007

Temperature		Sound speed in water	
°C	°F	m/s	ft/s
127	260.0	1 507	4 944
132	270.0	1 497	4 912
138	280.0	1 487	4 879
143	290.0	1 476	4 843
149	300.0	1 465	4 807
154	310.0	1 453	4 767
160	320.0	1 440	4 725
166	330.0	1 426	4 679
171	340.0	1 412	4 633
177	350.0	1 398	4 587
182	360.0	1 383	4 538
188	370.0	1 368	4 488
193	380.0	1 353	4 439
199	390.0	1 337	4 387
204	400.0	1 320	4 331
210	410.0	1 302	4 272
216	420.0	1 283	4 210
221	430.0	1 264	4 147
227	440.0	1 244	4 082
232	450.0	1 220	4 003
238	460.0	1 200	3 937
243	470.0	1 180	3 872
249	480.0	1 160	3 806
254	490.0	1 140	3 740
260	500.0	1 110	3 642

Table 30: Temperature and sound speed in water

9 SPECIFICATION

9.1 General

Measuring principle	Ultrasonic time difference correlation principle
Flow velocity range	0.01 ... 25 m/s
Resolution	0.25 mm/s
Repeatability	0.15 % of measured value, ± 0.015 m/s
Accuracy	Volume flow: ± 1 ... 3 % of measured value depending on application ± 0.5 % of measured value with process calibration Flow velocity (mean): ± 0.5 % of measured value
Turn down ratio	1/100
Gaseous and solid content of liquid media	< 10 % of volume

9.2 Flowmeter

Enclosure type	Wall mounted housing
Degree of protection	IP66 according EN 60529
Operating temperature	-10 ... +60 °C (+14 ... +140 °F)
Housing material	Polycarbonate
Measurement channels	1 or 2
Power supply	100 ... 240 V AC, 50/60 Hz 9 ... 36 V DC, special versions on request
Display	LCD graphic display, 128 x 64 dots, backlit
Dimensions	237 (h) x 258 (w) x 146 (d) mm (without cable glands)
Weight	Approx. 2.3 kg
Power consumption	< 10 W
Signal damping	0 ... 99 s
Transit time measurement rate	100 Hz (standard)
Output update time	1 s, faster rates on application
Calculation functions	Average/difference/sum/maximum (dual-channel use only)
Operating languages	Czech, Dutch, English, French, German, Italian, Romanian, Russian, Spanish, Turkish (others on request)

9.3 Quantity and units of measurement

Volumetric flow rate	m^3/h, m^3/min, m^3/s, l/h, l/min, l/s USgal/h (US gallons per hour), USgal/min, USgal/s bbl/d (barrels per day), bbl/h, bbl/min, bbl/s
Flow velocity	m/s, ft/s, inch/s
Mass flow rate	g/s, t/h, kg/h, kg/min
Volume	m^3, I, gal (US gallons), bbl
Mass	g, kg, t
Heat flow	W, kW, MW (only with heat quantity measurement option)
Heat quantity	J, kJ, kWh (only with heat quantity measurement option)
Temperature	T in , T out , CU (housing temperature) in °C
Speed of sound	c in m/s
Signal quality	Signal in dB, Noise in dB, SNR (signal-to-noise ratio)

9.4 Internal data logger

Storage capacity	In excess of one million data points (16 MB)
Logging data	All measured and totalised values, parameter sets

9.5 Communication

Serial interface	RS 232 Optional: USB cable, RS 485, Modbus RTU, Modbus TCP/IP, HART* compatible output, Profibus PA, Profibus DP, Profinet, LONworks, M-Bus, BACnet MSTP, BACnet IP
Data	Instantaneous measured value, parameter set and configuration, logged data

9.6 KATdata+ software

Functionality	Download of measured values/parameter sets, graphical presentation, list format, export to third party software, online transfer of measured data
Operating systems	Windows 10, 11, Linux, Apple Mac (optional)

9.7 Process inputs

A maximum of ten input and output slots can be used.
All process outputs are galvanically isolated from the device electronics and from other inputs/outputs.

Temperature	Pt 100, three- or four-wire circuit, Pt 1000 on request Measurement range: -50 ... +400 °C (-58 ... +752 °F) Resolution: 0.01 K, accuracy: ±0.02 K
Current	0/4 ... 20 mA active or 4 ... 20 mA passive, U = 30 V, R_i = 50 Ω, accuracy: 0.1 % of measured value

Further process inputs available on application.

9.8 Process outputs

A maximum of ten input and output slots can be used.
All process outputs are galvanically isolated from the device electronics and from other inputs/outputs.

Current	0/4 ... 20 mA active and 4 ... 20 mA passive options Active: U = 30 V, R_{Load} < 500 Ω, 16 bit resolution, accuracy: 0.1 % of measured value Passive: U = 9 ... 30 V, R_{Load} < 500 Ω, 16 bit resolution, accuracy: 0.1 % of measured value
Voltage	Range: 0 ... 10 V, R_{Load} = 1 kΩ, C_{Load} = 200 pF, resolution: 16 bit, accuracy: 0.1 % of measured value
Digital optical open-collector	Function: Alarm or Totaliser Totaliser value: 0.01 ... 1 000/unit, width: 1 ... 990 ms, U = 24 V, I_{max} = 4 mA, NO and NC contacts
Digital relay	Function: Alarm or Totaliser Totaliser value: 0.01 ... 1 000/unit, width: 1 ... 990 ms, U = 48 V, I_{max} = 250 mA, NO and NC contacts
Analogue frequency (passive)	2 Hz ... 10 kHz, U = 24 V, I_{max} = 4 mA
HART®	HART-compatible output: 4 process variables selectable (PV, SV, TV and FV) Analogue: 4 ... 20 mA passive, R_{Load} = 220 Ω, U = 24 V, accuracy: 0.1 % of measured value

Further process outputs available on application.

9.9 Sensors: K1P, K1L, K1N, K1E, K0L

Sensor type	K1P	K1L/K0L	K1N/E
Pipe diameter range	50 ... 500 mm	50 ... 6 500 mm	50 ... 3 000 mm
Temperature range	-20 ... +60 °C (-4 ... +140 °F)	-30 ... +80 °C (-22 ... +176 °F)	K1N: -30 ... +130 °C (-22 ... +266 °F) K1E: -30 ... +250 °C (-22 ... +482 °F) (for short periods up to +300 °C (+572 °F))
Material of cable conduits	PVC	PVC	Stainless steel
Standard cable lengths	10.0 m	5.0 m, 10.0 m (standard), 30.0 m	4.0 m
Dimensions of sensor heads	40 (l) x 30 (w) x 30 (h) mm	K1L: 60 (l) x 30 (w) x 34 (h) mm K0L: 110 (l) x 42 (w) x 42 (h) mm	60 (l) x 30 (w) x 34 (h) mm
Material of sensor heads	PEEK	K1L: Stainless steel K0L: Stainless steel, PPSU	Stainless steel
Degree of protection	IP66 according to EN 60529 (IP67 and IP68 on request)		

9.10 Sensors: K4L, K4N, K4E

Sensor type	K4L	K4N	K4E
Pipe diameter range	10 ... 250 mm	10 ... 250 mm	10 ... 250 mm
Temperature range	-30 ... +80 °C (-22 ... +176 °F)	-30 ... +130 °C (-22 ... +266 °F)	-30 ... +250 °C (-22 ... +482 °F) (for short periods up to +300 °C (+572 °F))
Material of cable conduits	PVC	Stainless steel	Stainless steel
Standard cable lengths	5.0 m, 10.0 m	2.5 m	2.5 m
Dimensions of sensor heads	43 (h) x 18 (w) x 22 (d) mm	43 (h) x 18 (w) x 22 (d) mm	43 (h) x 18 (w) x 22 (d) mm
Material of sensor heads	Stainless steel	Stainless steel	Stainless steel
Degree of protection	IP66 according to EN 60529 (IP67 and IP68 on request)		

9.11 Sensors: K1Ex, K4Ex

The sensors are suitable for use in hazardous areas classified as Zone 1 and 2. The flowmeter unit must be placed in a safe area or suitable enclosure.

Sensor type	K1Ex	K4Ex
Pipe diameter range	50 ... 3 000 mm	10 ... 250 mm
Manufacturer	Katronic Technologies Ltd. Earls Court 13 Warwick Street Coventry CV5 6ET United Kingdom	
Ex-certification code	Gas groups: IIC 2G Ex mb IIC T4 - T6 X Dust groups: II 2D Ex mbD 21 IP68 T80 °C - T120 °C X	
Ex-certification number	TRAC 09 ATEX 21226X	
Degree of protection	IP68 according to EN 60529	
Ex-protection method	Encapsulation (m), high level of protection (b)	
Temperature range	Temperature class T4: -50 ... +115 °C (-58 ... +239 °F) Temperature class T5: -50 ... +90 °C (-58 ... +194 °F) Temperature class T6: -50 ... +75 °C (-58 ... +167 °F)	
Dimensions of sensor heads	60 (h) x 30 (w) x 34 (d) mm	
Material of sensor heads	Stainless steel	
Material of cable conduits	PTFE	
Standard cable lengths	5.0 m	

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11 APPENDIX A – CERTIFICATE OF CONFORMITY

katronic

Declaration of Conformity

CE

We, Katronic Technologies Ltd., declare under our sole responsibility that the product listed below to which this declaration relates are in conformity with the EU directives and other mentioned standards:

- Directive 2014/30/EU for Electromagnetic Compatibility (EMC)
- Low Voltage Directive 2014/35/EU for Electrical Safety (LVD)
- Directive 2011/65/EU on the Restriction of Hazardous Substances (RoHS)
- ISO 2406:2023 – Measurement of fluid flow in closed conduits - Clamp-on ultrasonic transit-time meters for liquids and gases
- ASME MFC-5.1:2011 – Measurement of Liquid Flow in Closed Conduits Using Transit-Time Ultrasonic Flowmeters

Name of Product	Description
KATflow 100, 150, 200, 210 and 230	Ultrasonic flowmeter with associated KATRONIC transducers

The mentioned products are in conformity with the following European Standards:

Class	Standard	Description
EMC Directive	BS EN 61326-1:2022	Electrical equipment for measurement, control and laboratory use – EMC requirements
Immunity	BS EN 61000-4-2:2009	Electrostatic discharge
	BS EN 61000-4-3:2021	RF field
	BS EN 61000-4-4:2013	Electric fast transient/burst
	BS EN 61000-4-5:2019	Surge
	BS EN 61000-4-6:2014	RF conducted
	BS EN 61000-4-11:2021	AC mains voltage dips and interruption
Emission	BS EN 61326-1:2022	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
	BS EN 55022:2010	Disturbance voltage Class A
Low Voltage Directive	BS EN 61010-1:2020	Safety requirements for electrical equipment for measurement, control and laboratory use

Coventry, 03 April 2024

For and on behalf of Katronic Technologies Ltd.

Yours sincerely,

Andrew Sutton
Managing Director

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Cert. No. 23ISO0338

12 NOTES