Operating Instructions

Portable
Ultrasonic Flowmeter
KATflow 230

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Operating Instructions KATflow 230
Version V09E1108

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Operating Instructions

Table of Content

1 Safety instructions, legal requirements, warranty, return policy

1.1 Symbols used in these operating instructions

Danger
This symbol represents an immediate hazardous situation which could result in a **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 damage or destroy the equipment. Follow the 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 advise if necessary.

Note
This symbol indicates a note or detailed set-up tip.

● This symbol represents enumeration.

<**BRK**> Operator keys are printed in bold typeface and placed in pointed brackets.

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 save them for future reference.
- Observe all warnings, notes and instructions as marked on the packaging, on the equipment and those detailed in the operating instructions.
- Do not use the instrument with removed or opened battery cover under wet conditions.
- Consider the unpacking, storage and preservation instructions to avoid damage to the equipment.
- Install the equipment and cabling securely and safely according to the respective regulations in place.
- If the product does not operate normally, please refer to the service and trouble shooting 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 it has been used for the purpose for which it has been designed for 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 be faulty, it can be returned to KATRONIC for repair using the Customer Returns Note (CRN) attached to the Appendix of this manual. KATRONIC regret that we cannot accept the return of the equipment unless accompanied by the completed CRN for Health & Safety reasons.

1.5 Legislative requirements

CE marking

The flowmeter is designed to meet the safety requirements in accordance with sound engineering practise. It has been tested and 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 comply with applicable regulations and standards for electrical safety EN 61010 and electro-magnetic compatibility EN 61326. A CE Declaration of Conformity is 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) aims to minimise the impact of electrical and electronic goods on the environment, by increasing re-use and recycling and 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 the return to KATRONIC.

RoHS Directive

The European Union's RoHS ("Restriction of the use of certain Hazardous Substances") Directive (2002/95/EC) goes into effect on July 1, 2006. All of the instrumentation manufactured by KATRONIC falls under Category 9, Measurement and Control Equipment. Currently this category is exempt from RoHS compliance until at least 2010, when it and other exemptions will be reviewed. Regardless of this, all products manufactured by KATRONIC are compliant with the RoHS Directive.

2 Introduction

Clamp-on transit-time flowmeter

The KATflow 230 is a portable, battery operated ultrasonic flowmeter utilising clamp-on sensors for the measurement of liquids in full closed pipes. Flow measurements can be undertaken without interrupting of the process or interfering with the integrity of the pipeline. The clamp-on sensors are simply attached to the outside of pipes. The KATflow 230 uses ultrasonic signals for the measurement of the flow, employing the so-called transit-time method.

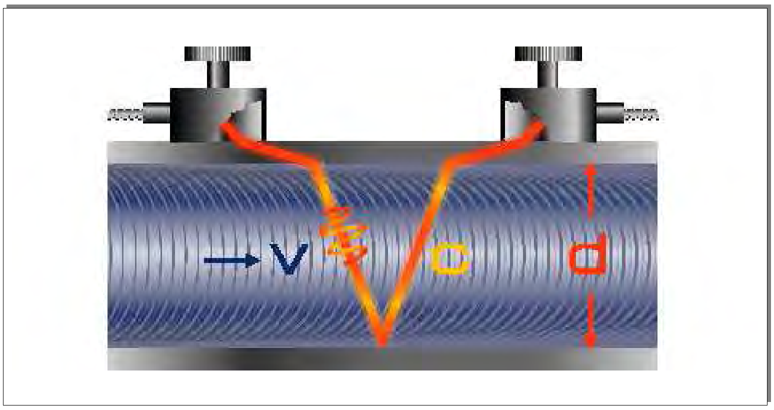


Illustration 1: Clamp-on ultrasonic flowmeter configuration

Measuring principle

Ultrasonic signals are emitted by a first transducer installed on one side of a pipe, reflected on the opposite side and received by a second transducer. These signals are emitted alternatively in the direction of flow and against it. Because the medium in which the signals propagate 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.

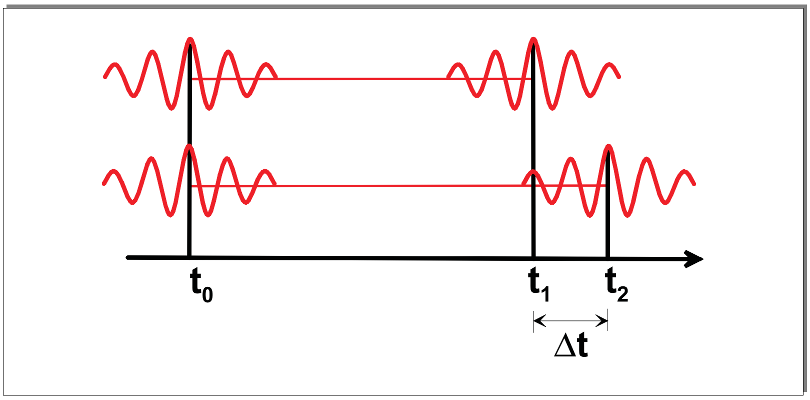


Illustration 2: Transit-time measuring principle

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 parcel 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 for completeness 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 re-cycled or disposed of in a suitable way.

3.1.2 Storage and preservation

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

- in a secure location,
- away from water and harsh environmental conditions,
- in 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 of your scope of supply):

- KATflow 230 portable flowmeter
- Clamp-on sensors (usually one or two pairs depending on pipe sizes to be measured)
- Sensor extension cable(s) (optional)
- Sensor mounting accessories
- Coupling component
- Measuring tape
- Operating instructions
- Calibration certificate(s) (optional)

3.2 Clamp-on sensor installation

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

The correct positioning of the transducers is an essential condition for error-free measurements. It guarantees 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,
- and the presence of gas bubbles and solid particles in the medium.

Check that the temperature at the selected location is within the operating temperature range of the transducers (see technical specification in the Appendix).

Acoustic propagation Acoustic propagation is given 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 do heavily contribute to signal attenuation.

Straight pipe lengths Sufficient straight lengths of pipe on the inlet and outlet of the measuring location guarantee an axi-symmetrical flow profile in the pipe for good measurement accuracy. If no sufficient straight lengths of pipe are available for your application, measurements are still obtainable but the uncertainty of the measurement can be compromised.

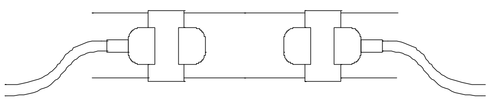
3.3 Installation location

Select an installation location as per recommendations in Table 1 and try to avoid measuring

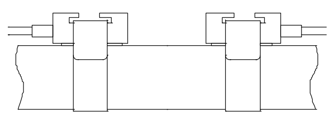
- in the vicinity of deformations and defects of the pipe,
- near welding seams,
- where deposits could be building up in the pipe.

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. Thus, 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.

Correct

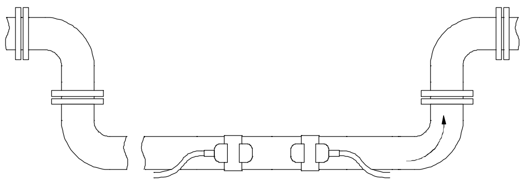


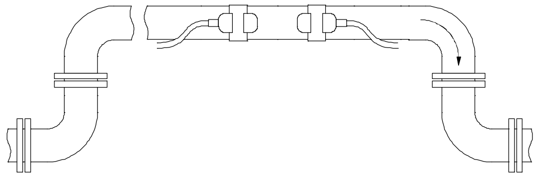
Incorrect



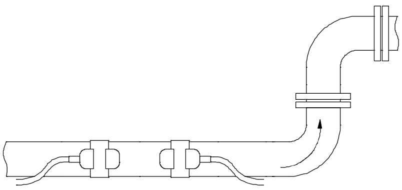
For a free inlet or outlet pipe section:
Select the measuring point at a location where the pipe cannot run empty.

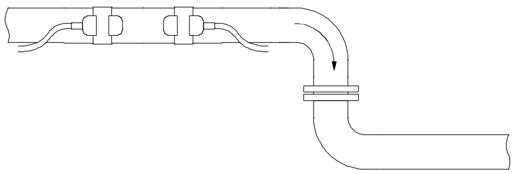
Correct ***Disadvantageous***





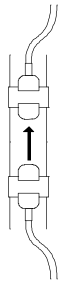
Correct	*Disadvantageous*





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

Correct	*Incorrect*



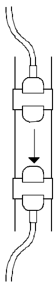
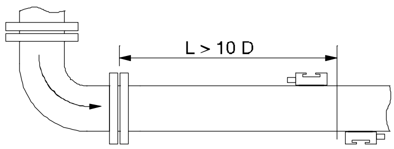


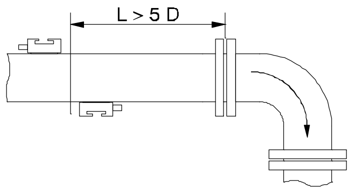
Table 1: Recommendations for sensor mounting location

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 to disturbance sources.

Disturbance source: 90°-elbow

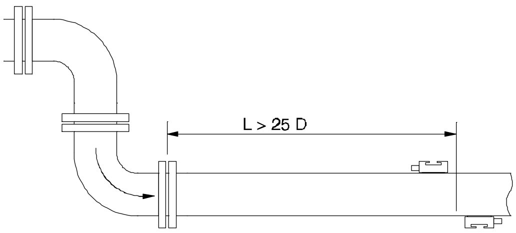
Inlet	Outlet
L ≥ 10 D	L ≥ 5 D

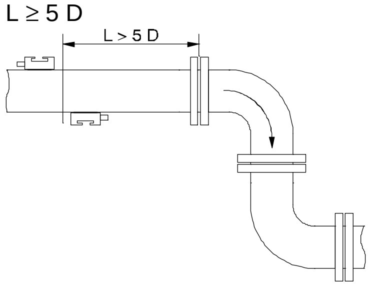




Disturbance source: 2 x 90°-elbows in one plane

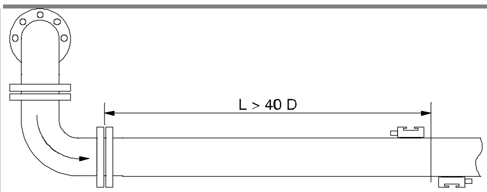
Inlet	Outlet
L ≥ 25 D	L ≥ 5 D

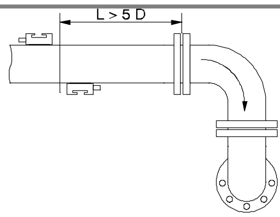




Disturbance source: 2 x 90°-elbows in different pla nes

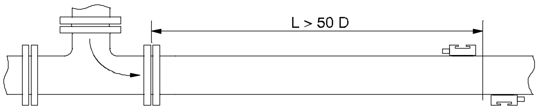
Inlet	Outlet
L ≥ 40 D	L ≥ 5 D



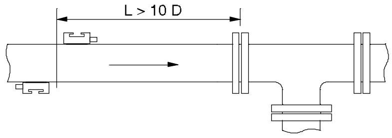


Disturbance source: T-section

Inlet
L ≥ 50 D

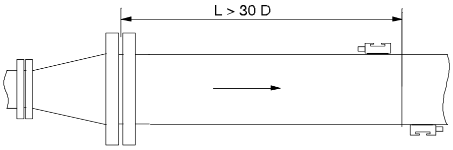


Outlet
L ≥ 10 D

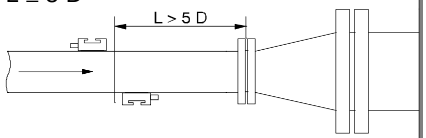


Disturbance source: diffuser

Inlet
L ≥ 30 D

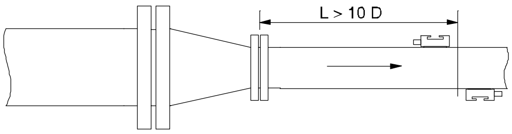


Outlet
L ≥ 5 D

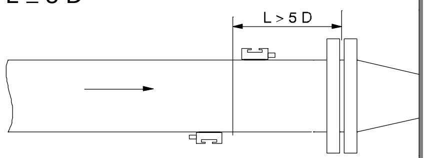


Disturbance source: reducer

Inlet
L ≥ 10 D

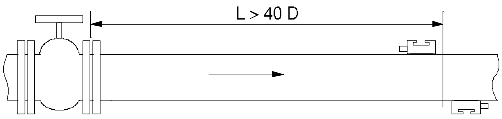


Outlet
L ≥ 5 D

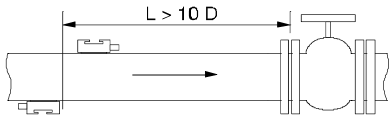


Disturbance source: valve

Inlet
L ≥ 40 D



Outlet
L ≥ 10 D



Disturbance source: pump

Inlet
L ≥ 50 D

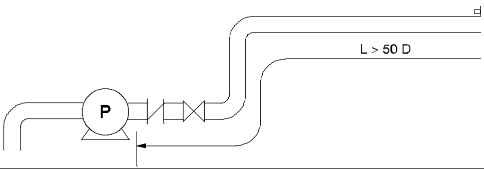


Table 2: Recommended distances from disturbance sources

3.4 Pipe preparation

- Clean the pipework from dirt and dust around the area where the sensors shall be placed.
- Remove loose paint and rust with a wire brush or file.

Firmly bonded paint does not necessarily need to be removed down to bare metal provided the flowmeter diagnostics indicate sufficient signal level strength.

3.5 Clamp-on sensor mounting configurations and separation distance

Reflection Mode

The most common clamp-on sensor mounting configuration is the Reflection Mode, also known as V-Mode (see Illustration 3, sketch (1). Here the ultrasonic signal pass twice through the medium (2 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 perfectly aligned. This method should be used whenever possible.

Diagonal Mode

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

Further variation of the Reflection and the Diagonal Mode are possible by altering the number of passes through the pipe. Any even number of passes would require to mount the sensors on the same side of the pipe, whereas with any 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 4 passes (W-mode) or 3 passes (N-mode) are used (Illustration 3, sketch (2)).

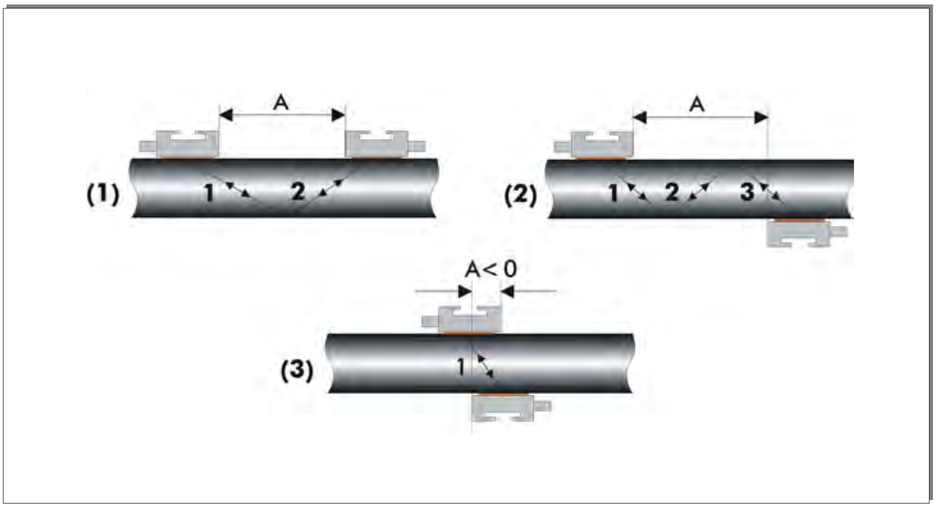


Illustration 3: Clamp-on sensor mounting configurations and separation distances

Transducer separation distance

The transducer separation distance A is measured from the edges of the sensor heads facing each other as shown in illustration 3. 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.

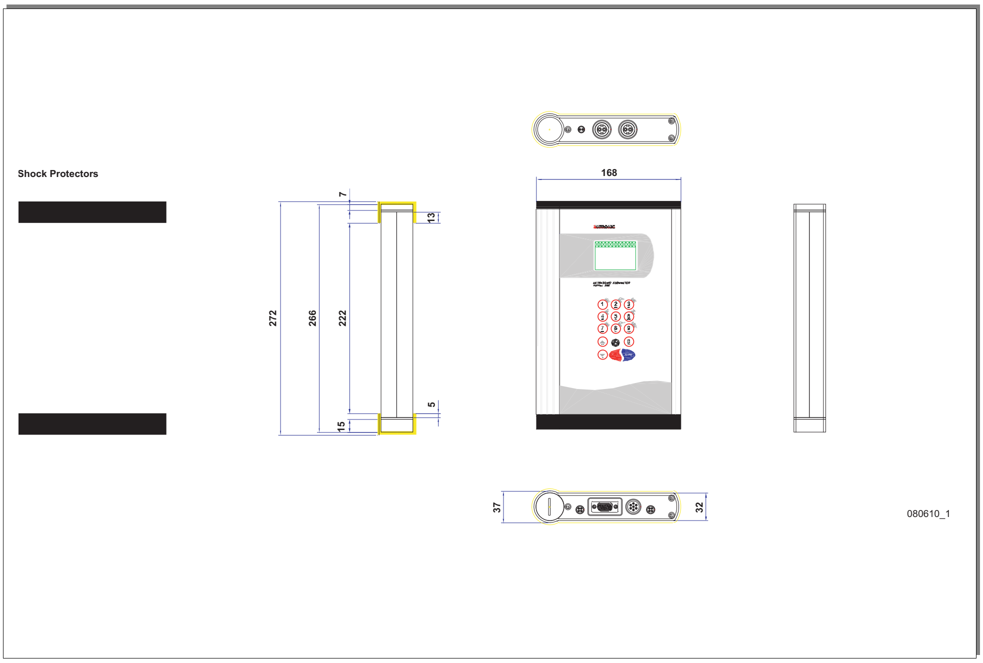
☞ A negative separation distance A < 0 can occur for mounting configurations on small pipes where diagonal mode operation has been selected (see Illustration 3, sketch (3).

3.6 Flowmeter installation

3.6.1 Outline dimensions

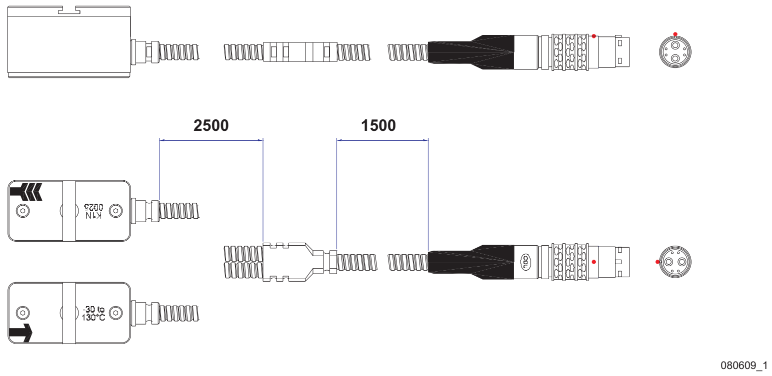
The KATflow 230 is a portable, battery operated device with the following outline dimensions.

Flowmeter outline dimensions

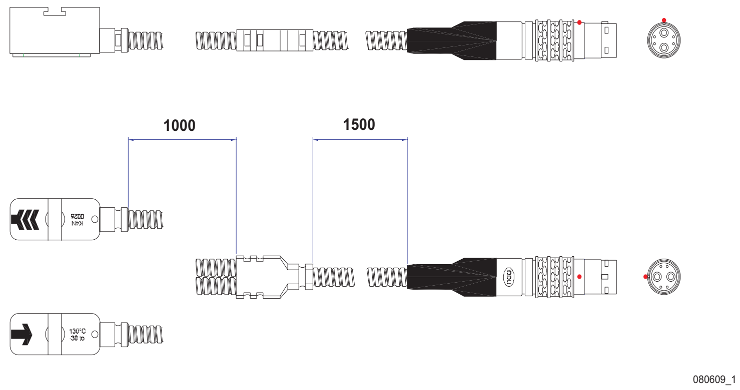


Drawing 1: Outline dimensions KATflow 230

K1 type transducer

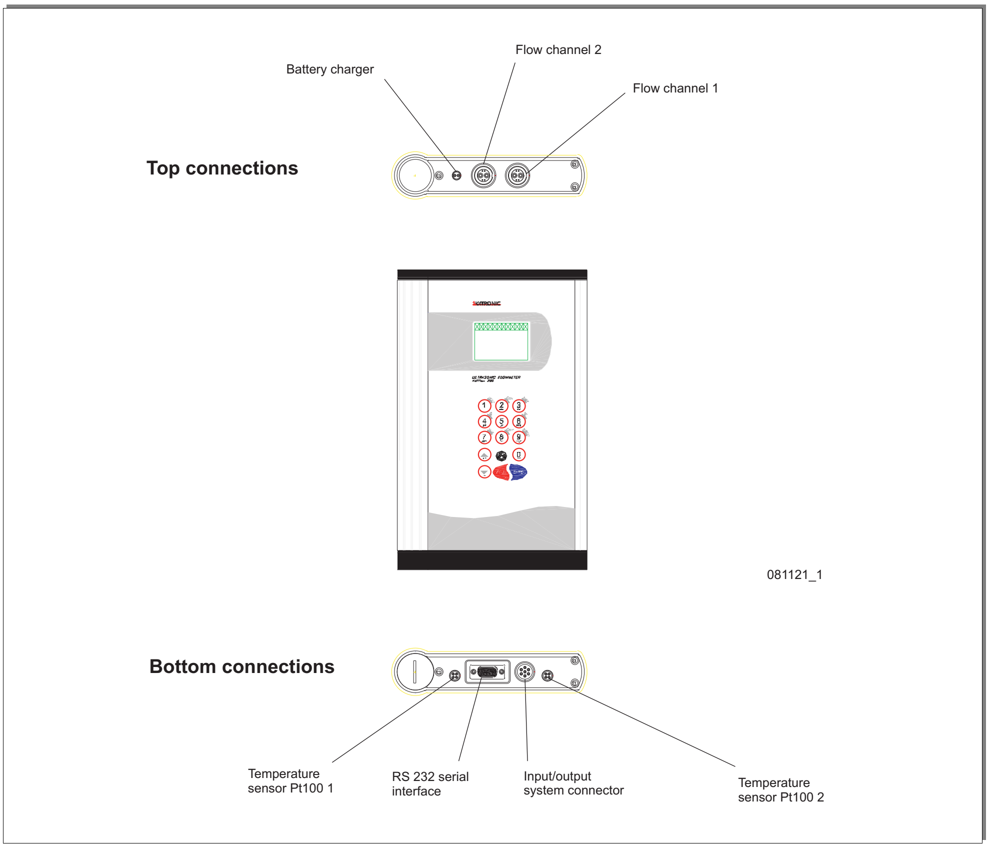


K4 type transducer



Drawing 2: Transducers

3.6.2 Electrical interconnections



Drawing 3: Electrical interconnections overview KATflow 230

3.7 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 batteries must be sufficiently charged,
- the sensors must be connected to the transmitter.

Depending on which sensor mounting method is being used (V or Z-mode), 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).

3.7.1 Sensor pipe mounting configurations

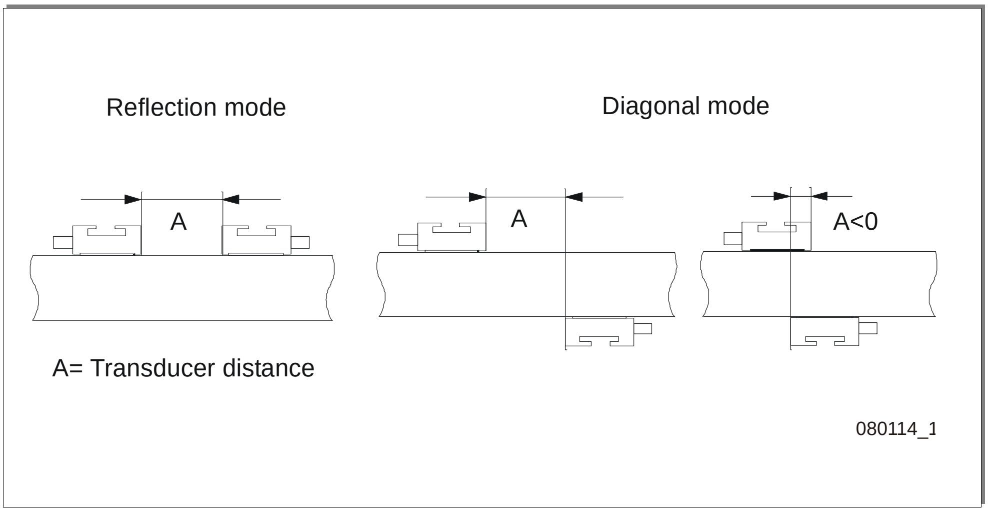


Illustration 4: Sensor pipe mounting configurations

3.7.2 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.

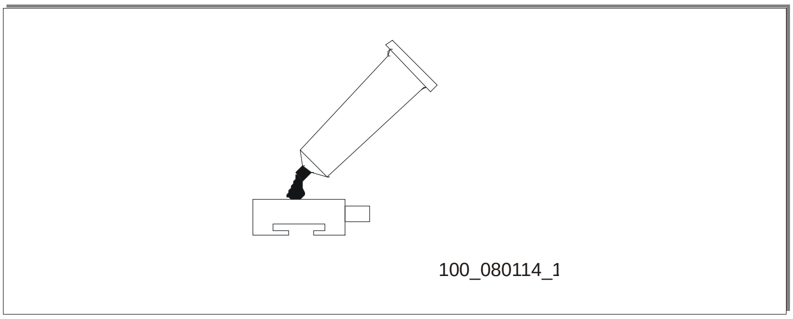


Illustration 5: Application of acoustic coupling gel

3.7.3 Correct positioning of the sensors

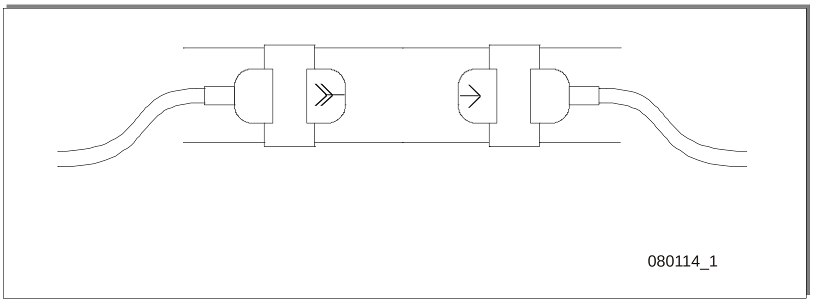


Illustration 6: Correct positioning of the sensors

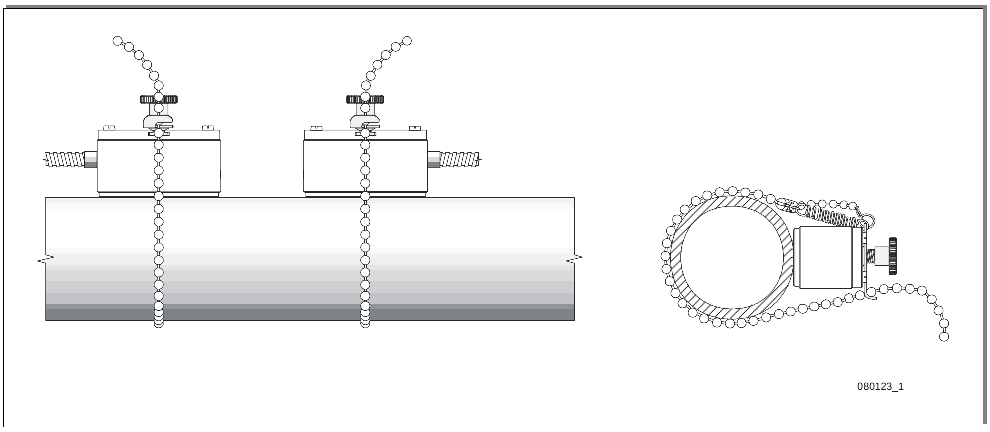
Always mount the transducer pair such that the free front edges of the sensors face each other.

There is a different engraving on the top of each transducer. The transducers are mounted correctly if the engravings on the two transducers are forming an arrow together. The transducer cables should then show in opposite directions.

Later, the arrow, in conjunction with the indicated measured value, will help to determine the direction of flow.

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.

3.7.4 Sensor mounting with fixtures and chains



Drawing 4: Sensors mounted with fixtures and chains

- Insert the retaining clip into the groove on the top of the transducer and secure it using the screw knob.
- Apply some acoustic coupling component to the contact surface of the transducer.
- Place the transducer to the side of the pipe or alternatively 45 degrees from the pipe axis.

This is necessary to establish the best acoustic contact since on top of the pipe air pockets could develop and deposits could accumulate at the bottom of the pipe.

- Take the spring end of the chain in one hand and insert the last ball element in the vertical slot of the retaining clip. Mount the chain around the pipe.
- Pull the chain firmly around the pipe and fasten it in the lateral slot of the retaining clip. There should be no air pockets between the transducer surface and the pipe wall.
- Mount the second transducer the same way.
- Using a measuring tape, adjust the sensor separation distance as suggested by the flowmeter.

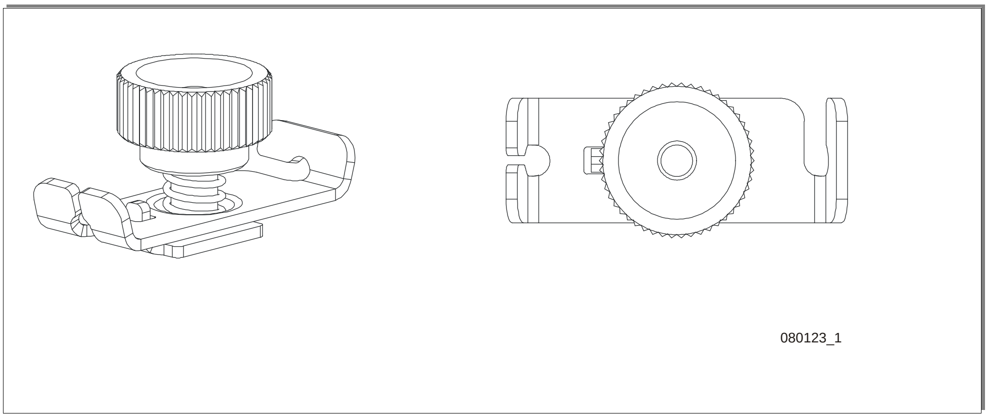


Illustration 7: Sensor mounting with fixtures and chains (retaining clip)

4 Operation

4.1 Switching On/Off

The flowmeter is switched on by the **<ON>** key for more than 2 seconds continuously. Equally it can be switched off by pressing the **<OFF>** key for more than 2 seconds.

4.2 Battery charging

The internal batteries can be recharged with the supplied external battery charger. Simply connect the battery charger to the charging socket of the flowmeter and to the mains supply 100 ... 240 V AC, 50/60 Hz. The battery charger mains plug is supplied country specific as per order code.

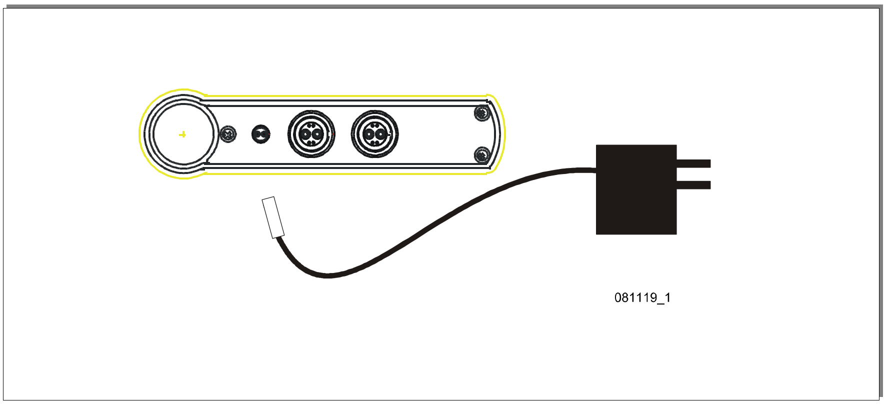


Illustration 8: Battery charging

During the charging process, the battery icon is blinking. For a fully charged battery all segments of the battery icon are filled.

4.3 Keypad and display

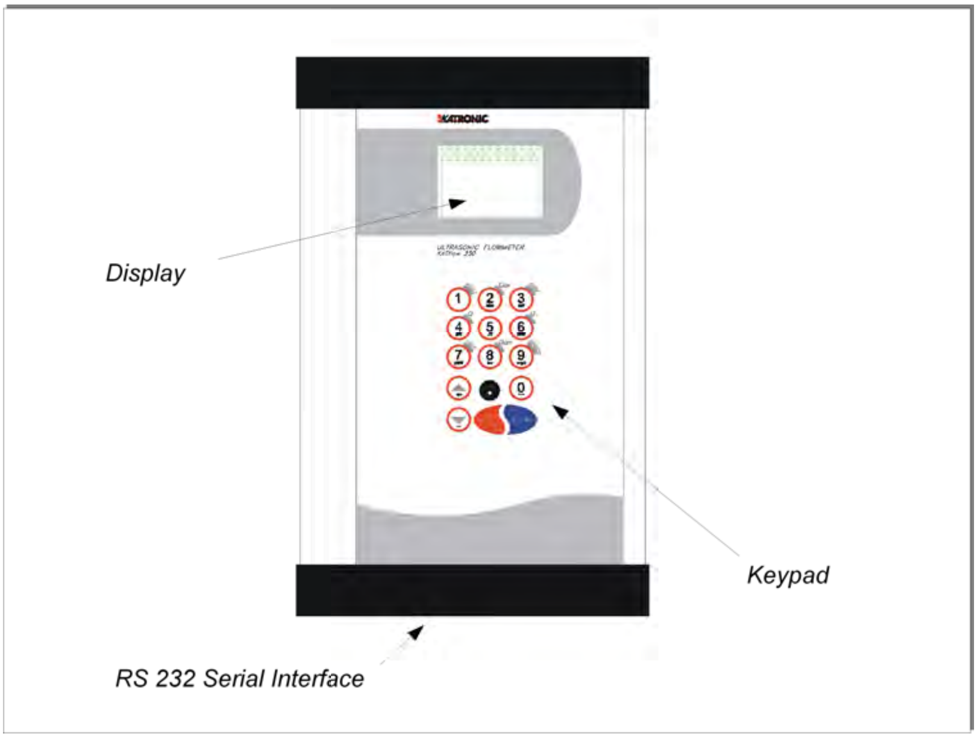
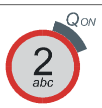


Illustration 9: Keypad and display overview

4.3.1 Keypad key functions

Key	Main function	Secondary function
	Alphanumerical entry: **1** (1 short key stroke) **,** (2 short key strokes) **.** (3 short key strokes) _ (4 short key strokes)	Show **NEXT** available item
	Alphanumerical entry: **A** **B** **C** **2** **/**	**Q_{ON}** = Start totaliser function
	Alphanumerical entry: **D** **E** **F** **3** **?**	Show next **DISP**lay
	Alphanumerical entry: **G** **H** **I** **4**	**Q_-** = Show negative total value

	<	
	Alphanumerical entry: **J** **K** **L** **5** **>**	
	Alphanumerical entry: **M** **N** **O** **6** **$**	**Q_+** = Show positive total value
	Alphanumerical entry: **P** **Q** **R** **S** **7**	Toggle **MU**ltiple**X**er (for multi-channel functionalities)
	Alphanumerical entry: **T** **U** **V** **8** *****	**Q_{OFF}** = Stop totaliser function
	Alphanumerical entry: **W** **X** **Y** **Z** **9**	**DIRECT** menu access
	Move menu/list selection item **UP**	Alphanumerical entry: Character backspace clear
	Numerical entry only: **.** (decimal point)	Switch LCD backlight on/off
	Alphanumerical entry: **0** **Space character** **+** **=** **#**	
	Move menu/list selection item **DOWN**	Numerical entry only: **-** (minus sign)
	**ESC**ape menu item	Abort entry without saving Switches the instrument **OFF** if pressed for more than 2 s
	**ENTER** menu item	Confirm entry with saving Switches the instrument **ON** if pressed for more than 2 s

4.3.2 Display functions

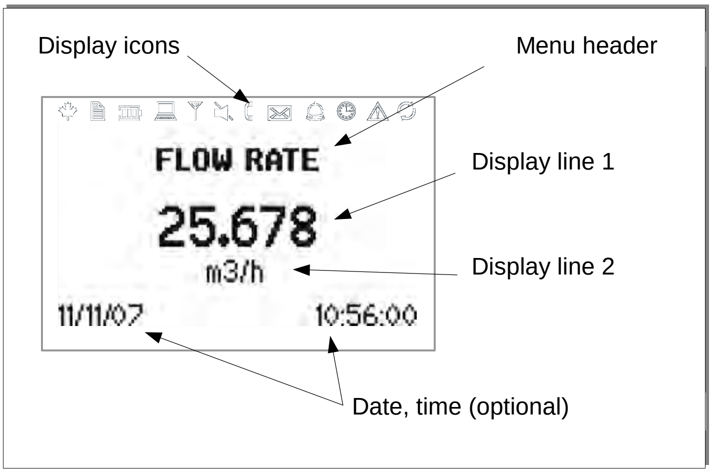
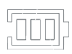
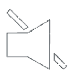
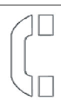


Illustration 10: Main display functions

Display icon	Function
	**On** Icon not used **Off**
	**On** Datalogger recording **Off** Datalogger switched off
	**On** 1 segment = 33% battery power available 2 segments = 66% battery power available 3 segments = 100% battery power available **Off** < 5% battery power available **Outline blinking** Battery charging
	**On** LCD backlight switched on **Off** LCD backlight switched off
	**On** Signal strength sufficient for measurement **Off** Signal strength insufficient for measurement
	**On** Without strike-through: Speaker on **Off** With strike-through: Speaker off
	**On** Poor sensor coupling, low SNR **Off** Sensor coupling OK
	**On** Icon not used **Off**
	**On** Icon not used **Off**

	**On** **Off**	RTC operating RTC failure
	**On** **Off**	Error recorded in error log No error detected
	**On** **Off**	Serial output RS 232 switched on Serial output RS 232 switched off

4.4 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:

Display screen	Operation
MAIN MENU Quick start System Installation Diagnostics Output Datalogger Input Serial Comm	Upon first power on and the boot-up sequence, the main menu is displayed. Use <**UP**> and <**DOWN**> cursor keys to select **Quick start**. Confirm by pressing <**ENTER**>.
QUICK START MENU Setup Wizard Single Setup Wizard Dual Start Measurement	Use cursor keys to select **Setup Wizard**. Confirm by pressing <**ENTER**>.
PIPE MATERIAL Stainless Steel Stainless Steel Stainless Steel	Choose pipe material using cursor keys and pressing <**ENTER**>.
OUTSIDE DIAMETER 76.1 mm	Enter outside pipe diameter using alphanumerical keys and confirm by pressing <**ENTER**>. Use key <**UP**> as character backspace clear to correct for data entry errors.
WALL THICKNESS 3.4 mm	Enter pipe wall thickness using alphanumerical keys and confirm by pressing <**ENTER**>. Use key <**UP**> as character backspace clear to correct for data entry errors.

FLUID Water Water Water	Select fluid using cursor keys. Confirm by pressing <**ENTER**>.
TEMPERATURE 20.0 C	Enter process temperature using alphanumerical keys and confirm by pressing <**ENTER**>. Use key <**UP**> as character backspace clear to correct for data entry errors.
LINER MATERIAL Rubber Rubber Rubber	Select pipe lining material using cursor keys. Confirm by pressing <**ENTER**>.
PASSES Auto Auto Auto	Select transducer configuration (number of passes) using cursor keys. **Auto** Automatically **Z** Z-mode (1 pass), diagonal mode **V** V-mode (2 passes), reflection mode **N** N-mode (3 passes), diagonal mode **W** W-mode (4 passes), reflection mode **5** 5 passes, diagonal mode **6** 6 passes, reflection mode Confirm by pressing <**ENTER**>.
CHNL1 SENSOR Spacing 110.5 mm Reflection 6 Mode Signal 26 dB	Sensor placement screen: Mount transducers with suggested spacing. Observe signal strength. Confirm by pressing <**ENTER**> to obtain measurements.
FLOW RATE 25.678 m3/h 11/11/07 10:56:00	**Success!**

4.5 Measurements

4.5.1 Main process value (PV) display

The measurements are started either through the Quick Setup Wizard or the menu structure by selecting **Start Measurement** upon first power on. Once all the parameters are programmed, any subsequent power-on sequences will bring up the main PV display immediately.

Display screen	Operation
FLOW RATE **25.678** m3/h 11/11/07 10:56:00	The main process value can be changed by accessing the menu structure. Press **<ESC>** at any time to access the main menu. Change to the 3-line display by pressing **<DISP>**.

4.5.2 3-line display

Display screen	Operation
FLOW Pump P3A **25.678 m3/h** 1.370 m/s 11/11/07 10:56:00	Line 1 shows the Tag ID but is universally configurable through the installation menu. Line 2 displays the main PV. Line 3 displays the flow velocity. Change to diagnostic displays by pressing **<DISP>**.

4.5.3 Diagnostic displays

Display screen	Operation
DIAGNOSTIC 1 55.2 Gain **20.5 Sig %** 5780.0 Correlation 11/11/07 10:56:00	Line 1 shows the amplifier gain. Line 2 displays the signal strength. Line 3 indicates the correlation value. Change to more diagnostic displays by pressing **<NEXT>**.

4.5.4 Totalisers

The totaliser displays will only be shown when the totalisers are activated.

Display screen	Operation
TOTAL+ 2580.0 m3 11/11/07 10:56:00	The flow totaliser can be started by pressing **<Q_{ON}>**. Pressing **<Q_{+}>** shows the total accumulated flow in positive flow direction. Pressing **<Q->** shows the total accumulated flow in negative flow direction. The totalisers can be stopped by activating **<Q_{OFF}>**. Change to other measurement displays by pressing **<NEXT>**.

5 Commissioning

5.1 Menu structure

Main menu	Menu level 1	Menu level 2	Description/settings
Quick Start			
	Setup Wizard Single		
		Units	*Select from list ↑↓* m/s f/s in/s m3/h m3/min m3/s l/h l/min l/s USgall/h USgall/min USgall/s bbl/d bbl/h bbl/min g/s t/h kg/h kg/min
		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 c-speed)
		Pipe c-speed	*Only if user pipe material selected* 600 ... 6553.5 m/s
		Outside dia-meter	6 ... 6500 mm
		Wall thickness	0.5 ... 75 mm
		Fluid	*Select from list ↑↓* Water Salt water Acetone Alcohol Ammonia Carbon Tet Ethanol Ethyl alcohol Ethyl ether Ethylene glycol Glycol/water 50% Kerosene Methanol Methyl alcohol Milk Naphtha Car oil Freon R134a Freon R22

			Hydrochloric acid Sour cream Sulphuric acid Toluene Vinyl chloride User (kinematic viscosity, density, medium c-speed)
		Kinematic vis-cosity	*Only if user fluid selected* 0.001 ... 30000 mm²/s
		Density	*Only if user fluid selected* 100 ... 2000 kg/m³
		Medium c-speed	*Only if user fluid selected* 800 ... 3500 m/s
		Temperature	-30 ... 300 °C
		Liner Material	*Select from list* ↑↓ None Epoxy Rubber PVDF PP Glass User (liner c-speed)
		Liner c-speed	*Only if lining material selected* 600 ... 6553.0 m/s
		Liner thickness	*Only if lining material selected* 1.0 ... 99.0 mm
		Passes	*Select from list* ↑↓ Auto 1 2 3 4 5 6 etc.
		Sensor type	*Indication of sensor type and serial number if automatically detected, otherwise select from list* ↑↓ K1 K4 M Q Special
		Sensor fre-quency	*SP1, only for special, unrecognised sensors*
		Wedge angle	*SP2, only for special, unrecognised sensors*
		Wedge c-speed 1	*SP3, only for special, unrecognised sensors*
		Wedge c-speed 2	*SP4, only for special, unrecognised sensors*
		Crystal offset	*SP5, only for special, unrecognised sensors*
		Spacing offset	*SP6, only for special, unrecognised sensors*
		Zero flow offset	*SP7, only for special, unrecognised sensors*
		Upstream off-set	*SP8, only for special, unrecognised sensors*
		Sensor place-ment	
	Setup Wizard Dual		
			As per setup wizard single for channel 1
			Repeat for channel 2
	Start Measure-		

	ment		
		Sensor type	*Indication of sensor type and serial number if automatically detected, otherwise select from list ↑↓* K1 K4 M Q Special
		SP 1 ... SP 8	*Only for special, unrecognised sensors*
		Sensor placement	
Installation			
	Pipe		
		Material	*Select from pipe material list ↑↓*
		Outside diameter	6 ... 6500 mm
		Wall thickness	0.5 ... 75 mm
		Pipe c-speed	600 ... 6553.5 m/s
		Pipe circumference	18.8 ... 20420.4 mm
		Roughness	0.0 ... 10 mm
	Medium		
		Fluid	*Select from fluid list ↑↓*
		Kinematic viscosity	0.001 ... 30000 mm^2/s
		Density	100 ... 2000 kg/m^3
		C-speed	800 ... 3500 m/s
		Temperature	-30 ... 300 ℃
	Lining		
		Material	*Select from material list ↑↓*
		Thickness	1 ... 99 mm
		C-speed	600 ... 6553.0 m/s
	Passes		
		Passes	*Select from list ↑↓*
Output			
	Display		
		Units	*Select from unit list ↑↓*
		Damping	*Smooths the display output, the higher the damping factor* 1 ... 255 s
	Current		
		Mode	Yes – *Current output on* No – *Current output off*
		Min Value	*Min. process variable (PV) value that corresponds to 0/4 mA*
		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 s*
	Open Collector		
		Mode	Yes – *Pulse output on*

			No – *Pulse output off*
		Pulse Value	*Totaliser value of selected PV at which a pulse is generated, e.g. PV = [m3/h], Pulse Value = 10, a pulse is output every 10 m3* 0.01 ... 1000
		Pulse Width	*Width of the pulse* 30 ... 999 ms
		Calc. Max	*This is the calculated max. number of pulses per second., i.e. the max. pulse rate in Hz*
	Relay		
		Mode	Off – *Permanently off* On – *Permanently energised* Alarm – *PV alarm switch* Fault – *Allocated to system failures, see error report list*
		On Point	*Value of PV at which the relay energises when in alarm m ode*
		Off Point	*Value of PV at which the relay de-energises when in alarm m ode*
Input			
	Temperature		
		Source	Fixed – *A fixed temperature can be entered under value* PT100 – *Value read from PT100 temperature sensor in ºC*
		Value	*Enter fixed user defined value* 0 ... 250 ºC
System			
	Instrument info		
		Model Code	230
		Serial No.	*Example:* 23000003
		HW Revision	*Example:* 1.0, 1.0
		SW Revision	*Example:* 1.0, 1.0
	Calculation		
		Low F Cut	± *Low flow velocity cut off* 0 ... 0.25 m/s
		Max F Cut	± *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 units
		PV Scaling	*Calibration process variable gradient scaling* 0 ... 10000 units
	Zero Cal		*Zero calibration settings*
		Zero	*Perform auto zero calibration* Yes No
		Track	*Track zero offset* Yes No
		Delta	*Zero flow delta time offset in ns, read from sensor PROM or entered directly for special sensors*
		Timeup	*Upstream transit-time offset in µs, allows for fixed delays in special sensors, buffer rods and extension leads*

	User		
		Identifier	*Example:* Pump P3A *9 alphanumeric character string*
		Tag No.	*Example:* 1FT-3011 *9 alphanumeric character string*
	Test		
		Test Mode	*Control system simulation: 60 second ramping up of flow velocity in m/s from 0 to programmed Max F Cut and subsequent 60 second ramping down, i.e. the process variable would change over complete possible range. All configured outputs will exhibit their programmed behaviour.* Yes No
	Settings		
		Date	*Example:* 03/10/07
		Time	*Example:* 09:27:00
		Date Format	*Select from list* ↑↓ dd/mm/yy mm/dd/yy yy/mm/dd
		Language	*Select from list* ↑↓ English German French Spanish Russian
		Keypad	*Enable keypad sound* Yes No
	Defaults		*Reload factory default settings, except for date and time* Yes No
Diagnostics			
		Temperature	*Shows control unit temperature*
		Log Memory	*Percentage of unused datalogger memory remaining*
Datalogger			
		Interval	*A value of zero turns the datalogger off, a non-zero value turns the datalogger on and defines the logging interval. Going from a value of zero to a non-zero value, clears the log memory.* 0 ... 999 s
		Overwrite	*When the log memory is full, i.e. 0 % remaining, the logger wraps around and starts to overwrite memory.* Yes No
		Low Memory	*Warning output: The amount of memory remaining at which the flowmeter begins to give an audible warning.* 0 ... 100 %
		Log Download	*Sends logger content to selected serial communication port.*
Serial Comm			
		Mode	*Select from list* ↑↓ None Printer Diagnostic Log download
		Baud	*Select from list* ↑↓

			2400 9600 *(Default)* 19200
		Parity	*Select from list* ↑↓ None Even *(Default)* Odd
		Type	*Select from list* ↑↓ None RS232

5.2 Diagnostics

Diagnostic screens can be accessed directly during measurement or through the menu structure.

5.3 Display settings

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

5.3.1 Main PV

The main Process Value (PV) is the primary measurement data.

5.3.2 Line 1

Display line 1 can be programmed by a list of available items.

5.4 Output configurations

There are 2 output connectors at the bottom of the KF230 enclosure. One is for serial communication through a standard 9-pin D-type RS 232 connector, process outputs (analogue and digital outputs) are available using a system I/O connector which must be connected via an I/O interface cable to a breakout terminal junction box.

Illustration 11: Process output breakout box

5.4.1 Serial interface RS 232

Serial interface RS232

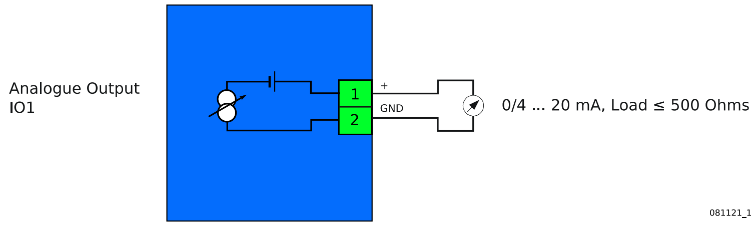
The RS 232 serial interface can be used to transmit data on-line or to download the integral datalogger content. The settings can be found in submenu **Serial Comm**.

Analogue outputs

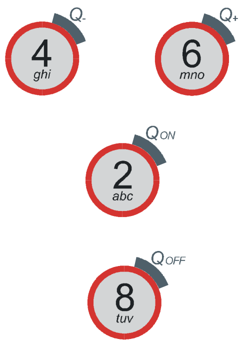
5.4.2 Analogue current output 0/4 ... 20 mA

The analogue current output operate in 4 ... 20 mA mode by default. 0 ... 20 mA operation is possible, please contact customer support.

The current output can be programmed, scaled and assigned to flow channel 1 or 2 within the menu structure.

<table>
<tr><td>Wiring</td><td>
</td></tr>
<tr><td>Electrical characteristics</td><td>Range = 0/4 ... 20 mA
Resolution = 16 bit
U = 30 V
R_{Load} < 500 Ω
Accuracy = 0.1 %
Galvanically isolated from main device and other I/O</td></tr>
</table>

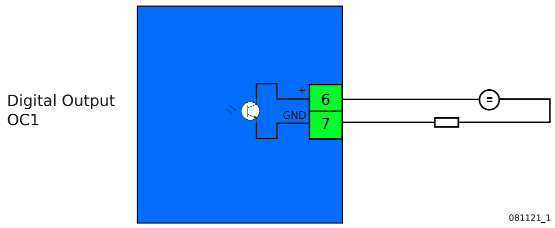
Digital outputs



5.4.3 Digital Open-Collector output

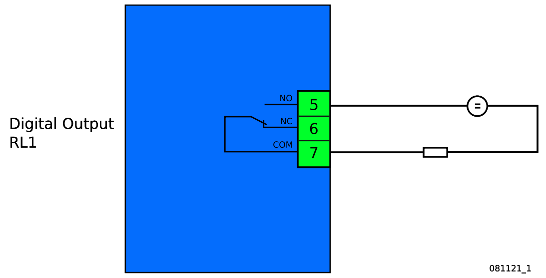
The totaliser function is enabled and controlled using the **<Q_{ON}>**, **<Q_+>**, **<Q->** and **<Q_{OFF}>** keys and from the menu structure where the pulse value and width are selected.

The digital Open-Collector output can be assigned to flow channel 1 or 2.

<table>
<tr><td>Wiring</td><td>
</td></tr>
<tr><td>Electrical characteristics</td><td>U = 24 V
I_{max} = 4 mA
Value = 0.01 ... 1000
Pulse width = 30 ... 999 ms</td></tr>
</table>

5.4.4 Digital relay output

The relay outputs are enabled, controlled and assigned to flow channel 1 or 2 using the menu structure.

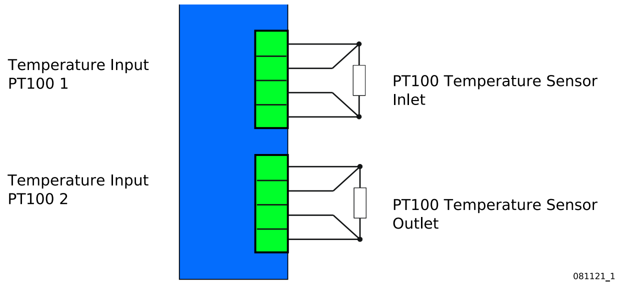
Wiring	
Electrical characteristics	Form C (SPDT-CO) contacts V = 48 V I_{max} = 250 mA

5.5 Input configurations

There are two 4-wire circuit PT100 inputs available at the bottom of the enclosure.

5.5.1 PT100 inputs

Inputs

Wiring	
Electrical characteristics	PT100 4-wire circuit Measuring range = -50 ... 400 °C Resolution = 0.1 K Accuracy = ±0.2 K

5.6 Heat quantity measurement (HQM)

Future implementation.

5.7 Sound velocity measurement (SVM)

Future implementation.

5.8 Dual-channel flow calculations (maths functions)

Future implementation

5.9 KATdata+ software

Please consult customer services for assistance.

5.10 Wall thickness measurement (WTM)

Future implementation.

6 Maintenance

No general maintenance is required for this equipment.

7 Troubleshooting

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 list

Error message	Group	Description	Error handling
USB INIT FAIL	Hardware	Internal board communic-ation error	Power on/off, otherwise call customer support
NO SERIAL NO.	Hardware	Failed to read from FRAM	Call customer support
NO VERSION NO.	Hardware	Failed to read from FRAM	Call customer support
PARA READ FAIL	Hardware	Failed to read from FRAM	Load defaults, other-wise call customer sup-port
PARA WRITE FAIL	Hardware	Failed to write to FRAM	Load defaults, other-wise call customer sup-port
VAR READ FAIL	Hardware	Failed to read from FRAM	Call customer support
VAR WRITE FAIL	Hardware	Failed to write to FRAM	Call customer support
SYSTEM ERROR	Hardware		Call customer support
VISIBILITY ERR	Hardware	Failed to read from FRAM	Call customer support
FRAM LONG WRITE ERR	Hardware	Failed to write to FRAM	Call customer support
FRAM READ ERR	Hardware	Failed to read from FRAM	Call customer support
RTC ERR	Hardware	Real Time Clock failure	Power on/off, otherwise call customer support
EXTMEM ERR	Hardware	Logger memory failure	Power on/off, otherwise call customer support
SPI ERR	Hardware	SPI bus failure	Power on/off, otherwise call customer support
I2C ERR	Hardware	I2C bus failure	Power on/off, otherwise call customer support
MATH ERR	Software	Internal calculation error	Call customer support
STACK ERR	Software	Internal calculation error	Call customer support
ADDR ERR	Software	Internal calculation error	Call customer support
OSC ERR	Software	Internal calculation error	Call customer support
ADC ERR	Software	Internal calculation error	Call customer support
IO ERR	Software	Internal calculation error	Call customer support
TIMING ERR	Software	Internal calculation error	Call customer support
COMM INIT ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM START ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM HS0 ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM HS1 ERR	Hardware	Internal communication	Power on/off, otherwise

		error	call customer support
COMM READ AVE ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM READ RAW ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM READ HISTORY ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM CRC ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
SENSOR COUPLING ERR	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 3: Error messages

8 Technical data

	Sound Speed* Shear Wave (at 25 ºC)	
Material	**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
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 silicante first)	2,380	7,808
Glass (light brate 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	1,430	4,690

* Please 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.

All data given at 25 ºC (77 ºF) unless otherwise stated

Substance	Chemical Formula	Specific Gravity	Sound Speed m/s	Sound Speed ft/s	Change v/ºC m/s/ºC	Kinematic x10-6 m^2/s	Viscosity ft^2/s
Acetic anhydride	(CH3CO)2O	1.082 (20 ºC)	1,180	3,871.4	2.5	0.769	8.274
Acetic acid, anhydride	(CH3CO)2O	1.082 (20 ºC)	1,180	3,871.4	2.5	0.769	8.274
Acetic acid, nitrile	C2H3N	0.783	1,290	4,232.3	4.1	0.441	4.745
Acetic acid, ethyl ester	C4H802	0.901	1,085	3,559.7	4.4	0.467	5.025
Acetic acid, methyl ester	C3H6O2	0.934	1,211	3,973.1		0.407	4.379
Acetone	C3H6O	0.791	1,174	3,851.7	4.5	0.399	4.293
Acetylene dichloride	C2H2Cl2	1.26	1,015	3,330.1	3.8	0.400	4.304
Alcohol	C2H6O	0.789	1,207	3,960	4.0	1.396	15.02
Ammonia	NH3	0.771	1,729 (-33 ºC)	5,672.6 (-27 ºC)	6.68	0.292 (-33 ºC)	3.141 (-27 ºF)
Benzene	C6H6	0.879	1,306	4,284.8	4.65	0.711	7.65
Benzol	C6H6	0.879	1,306	4284.8	4.65	0.711	7.65
Bromine	Br2	2.928	889	2,916.7	3.0	0.323	3.475
n-Butane(2)	C4H10	0.601 (0ºC)	1,085 (-5º C)	3,559.7 (23 ºC)	5.8		
2-Butanol	C4H10O	0.81	1,240	4,068.2	3.3	3.239	34.851
sec-Butylalcohol	C4H10O	0.81	1,240	4,068.2	3.3	3.239	34.851
n-Butyl bromide (46)	C4H9Br	1.276 (20ºC)	1,019 (20ºC)	3,343.2 (68ºF)		0.49 (15ºC)	5.272 (59ºC)
n-Butyl chloride (22,46)	C4H9Cl	0.887	1,140	3,740.2	4.57	0.529 (15ºC)	5.692 (59ºF)
Carbon tetrachloride	CCl4	1.595 (20ºC)	926	3038.1	2.48	0.607	6.531
Carbon tetrafluoride (Freon 14)	CF4	1.75 (-150 ºC)	875.2 (-150 ºC)	2,871.5 (-238 ºF)	6.61		
Chloroform	CHCl3	1.489	979	3,211.9	3.4	0.55	5.918
Dichlorodifluoromethane (Freon 12)	CCl2F2	1.516 (40 ºC)	774.1	2,539.7	4.24		
Ethanol	C2H6O	0.789	1,207	3,960	4.0	1.39	14.956
Ethyl acetate	C4H8O2	0.901	1,085	3,559.7	4.4	0.489	5.263
Ethyl alcohol	C2H6O	0.789	1,207	3,960	4.0	1.396	15.020
Ethyl benzene	C8H10	0.867 (20 ºC)	1,338 (20 ºC)	4,.89.8 (68 ºF)		0.797 (17 ºC)	8.575 (63 ºF)
Ether	C4H10O	0.713	985	3231.6	4.87	0.311	3.346
Ethyl ether	C4H10O	0.713	985	3231.6	4.87	0.311	3.346
Ethylene bromide	C2H4Br2	2.18	995	3264.4		0.79	8.5
Ethylene chloride	C2H4Cl2	1.253	1,193	3,914		0.61	6.563
Ethylene glycol	C2H6O2	1.113	1,658	5439.6	2.1	17,208 (20ºC)	185.158 (68ºF)
Fluorine	F	0.545 (-143 ºC)	403 (-143 ºC)	1322.2 (-225 ºF)	11.31		
Formaldehyde, methyl ester	C2H4O2	0.974	1,127	3697.5	4.02		
Freon R12			774.2	2540			
Glycol	C2H6O2	1.113	1658	5439.6	2.1		
50% Glycol/50% H2O			1,578	5,177			
Isopropanol	C3H8O	0.785 (20 ºC)	1,170 (20 ºC)	3,838.6 (68 ºF)		2.718	29.245
Isopropyl alcohol (46)	C3H8O	0.785 (20 ºC)	1,170 (20 ºC)	3,838.6 (68 ºF)		2.718	29.245
Kerosene		0.81	1,324	4,343.8	3.6		
Methane	CH4	0.162 (-89 ºC)	405	1,328.7	17.5		

			(-89 ºC)	(-128 ºF)			
Methanol	CH4O	0.791 (20 ºC)	1,076	3,530.2	292	0.695	7.478
Methyl acetate	C3H6O2	0.934	1,211	3,973.1		0.407	4.379
Methyl alcohol	CH4O	0.791	1,076	3,530.2	292	0.695	7.478
Methyl benzene	C7H8	0.867	1,328 (20 ºC)	4,357 (68 ºF)	4.27	0.644	7.144
Milk, homogenized			1,548	5,080			
Naphtha		0.76	1,225	4,019			
Natural Gas		0.316 (-103 ºC)	753 (-103 ºC)	2,470.5 (-153 ºF)			
Nitrogen	N2	0.808 (-199 ºC)	962 (-199 ºC)	3,156.2 (-326 ºF)		0.217 (-199 ºC)	2.334 (-326 ºF)
Oil, Car (SAE 20a.30)		1.74	870	2,854.3		190	2,045.093
Oil, Castor	C11H10O0	0.969	1,477	4,845.8	3.6	0.670	7.209
Oil, Diesel		0.80	1,250	4,101			
Oil, Fuel AA gravity		0.99	1,485	4,872	3.7		
Oil (Lubricating X200)			1,530	5,019.9			
Oil (Olive)		0.912	1,431	4,694.9	2.75	100	1,076.365
Oil (Peanut)		0.936	1,458	4,738.5			
Propane (-45 to -130 ºC)	C3H8	0.585 (-45 ºC)	1,003 (-45 ºC)	3,290.6 (-49 ºF)	5.7		
1-Propanol	C3H8O	0.78 (20 ºC)	1,222 (20 ºC)	4,009.2 (68 ºF)			
2-Propanol	C3H8O	0.785 (20 ºC)	1,170 (20 ºC)	3,838.6 (68 ºF)		2.718	29.245
Propene	C3H6	0.563 (-13ºC)	963 (-13ºC)	3159.4 (9ºF)	6.32		
n-Propyl-alcohol	C3H8O	0.78 (20 ºC)	1,222 (20 ºC)	4,009.2 (68 ºF)		2.549	27.427
Propylene	C3H6	0.563 (-13 ºC)	963 (-13 ºC)	3159.4 (9 ºF)	6.32		
Refrigerant 11	CCl3F	1.49	828.3 (0 ºC)	2,717.5 (32 ºF)	3.56		
Refrigerant 12	CCl2F2	1.516 (-40 ºC)	774.1 (-40 ºC)	2,539.7 (-40 ºC)	4.24		
Refrigerant 14	CF4	1.75 (-150 ºC)	875.24 (-150 ºC)	2,871.6 (-268 ºF)	6.61		
Refrigerant 21	CHCl2F	1.426 (0 ºC)	891 (0 ºC)	2,923.2 (32 ºF)	3.97		
Refrigerant 22	CHClF2	1.491 (-69 ºC)	893.9 (50 ºC)	2,932.7 (122 ºF)	4.79		
Refrigerant 113	CCl2F-CClF2	1.563	783.7 (0 ºC)	2,571.2 (32 ºF)	3.44		
Refrigerant 114	CClF2-CClF2	1.455	665.3 (-10 ºC)	2,182.7 (14 ºF)	3.73		
Refrigerant 115	C2ClF5		656.4 (-50 ºC)	2,153.5 (-58 ºF)	4.42		
Refrigerant C318	C4F8	1.62 (-20 ºC)	574 (-10 ºC)	1,883.2 (14 ºF)	3.88		
Sodium nitrate	NoNO3	1.884 (336 ºC)	1,763.3 (336 ºC)	5,785.1 (637 ºF)	0.74	1.37 (336 ºC)	14.74 (637 ºF)
Sodium nitrite	NoNO2	1.805 (292 ºC)	1876.8 (292 ºC)	6157.5 (558 ºF)			
Sulphur	S		1177 (250 ºC)	3861.5 (482 ºF)	-1.13		
Sulphuric Acid	H2SO4	1.841	1,257.6	4,126	1.43	11.16	120.081
Tetrachloroethane	C2H2Cl4	1553 (20 ºC)	1,170 (20 ºC)	3,838.6 (68 ºF)		1.19	12.804
Tetrachloro-ethene	C2Cl4	1.632	1,036	3,399			

Tetrachloro-Methane	CCl4	1.595 (20 ºC)	926	3,038.1		0.607	6.531
Tetrafluoro-methane (Freon 14)	CF4	1.75 (-150 ºC)	875.24 (-150 ºC)	2,871.5 (-283 ºF)	6.61		
Toluene	C7H8	0.867 (20 ºC)	1,328 (20 ºC)	4,357 (68 ºF)	4.27	0.644	6.929
Toluol	C7H8	0.866	1,308	4,291.3	4.2	0.58	6.24
Trichloro-fluoromethane (Freon 11)	CCl3F	1.49	828.3 (0 ºC)	2,717.5 (32 ºF)	3.56		
Turpentine		0.88	1,255	4,117.5		1.4	15.064
Water, distilled	H2O	0.996	1,498	4,914.7	-2.4	1.00	10.76
Water, heavy	D2O		1,400	4,593			
Water, sea		1.025	1531	5023	-2.4	1.00	10.76

Temperature		**Sound Speed in Water**	
º C	**º F**	**m/s**	**ft/s**
0	32.0	1402	4600
1	33.8	1407	4616
2	35.6	1412	4633
3	37.4	1417	4649
4	39.2	1421	4662
5	41.0	1426	4679
6	42.8	1430	4692
7	44.6	1434	4705
8	46.4	1439	4721
9	48.2	1443	4734
10	50.0	1447	4748
11	51.8	1451	4761
12	53.6	1455	4774
13	55.4	1458	4784
14	57.2	1462	4797
15	59.0	1465	4807
16	60.8	1469	4820
17	62.6	1475	4830
18	64.4	1476	4843
19	66.2	1479	4853
20	68.0	1482	4862
21	69.8	1485	4872
22	71.6	1488	4882
23	73.4	1491	4892
24	75.2	1493	4899
25	77.0	1496	4908
26	78.8	1499	4918
27	80.6	1501	4925
28	82.4	1504	4935
29	84.2	1506	4941
30	86.0	1509	4951
31	87.8	1511	4958
32	89.6	1513	4964
33	91.4	1515	4971
34	93.2	1517	4977
35	95.0	1519	4984
36	96.8	1521	4984

37	98.6	1523	4990
38	100.4	1525	4997
39	102.2	1527	5010
40	104.0	1528	5013
41	105.8	1530	5020
42	107.6	1532	5026
43	109.4	1534	5033
44	111.2	1535	5036
45	113.0	1536	5040
46	114.8	1538	5046
47	116.6	1538	5049
48	118.4	1540	5053
49	120.2	1541	5056
50	122.0	1543	5063
51	123.8	1543	5063
52	125.6	1544	5066
53	127.4	1545	5069
54	129.2	1546	5072
55	131.0	1547	5076
56	132.8	1548	5079
57	134.6	1548	5079
58	136.4	1548	5079
59	138.2	1550	5086
60	140.0	1550	5086
61	141.8	1551	5089
62	143.6	1552	5092
63	145.4	1552	5092
64	147.2	1553	5092
65	149.0	1553	5095
66	150.8	1553	5095
67	152.6	1554	5099
68	154.4	1554	5099
69	156.2	1554	5099
70	158.0	1554	5099
71	159.8	1554	5099
72	161.6	1555	5102
73	163.4	1555	5102
74	165.2	1555	5102
75	167.0	1555	5102
76	167.0	1555	5102
77	170.6	1554	5099
78	172.4	1554	5099
79	174.2	1554	5099
80	176.0	1554	5099
81	177.8	1554	5099
82	179.6	1553	5095
83	181.4	1553	5095
84	183.2	1553	5095
85	185.0	1552	5092
86	186.8	1552	5092
87	188.6	1552	5092
88	190.4	1551	5089
89	192.2	1551	5089
90	194.0	1550	5086

91	195.8	1549	5082
92	197.6	1549	5082
93	199.4	1548	5079
94	201.2	1547	5076
95	203.0	1547	5076
96	204.8	1546	5072
97	206.6	1545	5069
98	208.4	1544	5066
99	210.2	1543	5063
100	212.0	1543	5063
104	220.0	1538	5046
110	230.0	1532	5026
116	240.0	1524	5000
121	250.0	1526	5007
127	260.0	1507	4944
132	270.0	1497	4912
138	280.0	1487	4879
143	290.0	1476	4843
149	300.0	1465	4807
154	310.0	1453	4767
160	320.0	1440	4725
166	330.0	1426	4679
171	340.0	1412	4633
177	350.0	1398	4587
182	360.0	1383	4538
188	370.0	1368	4488
193	380.0	1353	4439
199	390.0	1337	4387
204	400.0	1320	4331
210	410.0	1302	4272
216	420.0	1283	4210
221	430.0	1264	4147
227	440.0	1244	4082
232	450.0	1220	4003
238	460.0	1200	3937
243	470.0	1180	3872
249	480.0	1160	3806
254	490.0	1140	3740
260	500.0	1110	3642

9 Specification

KATRONIC

Ultrasonic Flowmeter
KATflow 230

- Transit-time correlation measurement
- Dual DSP-technology, coded signals for better measurement accuracy
- Two channel portable unit with graphic display
- Easy to install clamp-on sensors with no process interruption
- Non-invasive flow measurement of liquids or liquified gases
- Optional wall thickness, heat quanity and sound velocity measurement
- Suitable for all commonly used pipe materials with pipe diameters from 10 mm (4/10") to 3 m (118")

Description

The KATflow range of non-invasive flowmeters utilises ultrasonic technology for the accurate flow measurement of liquids and liquified gases in full pipes.

The KATflow 230 is designed for portable use to meet the needs of the Service/Maintenance and Commissioning Engineer wishing to check the flow rate at different locations in the plant. The set-up of the unit is simple through a setup wizard in order to obtain the required flow information in minutes.

The measurement of flow is based on the principle that sound waves are influenced by a flowing medium. Measurements are made by penetrating the pipe with ultrasound and subsequently time differences, frequency variations and phase shifts of the ultrasonic signals are evaluated.

The ultrasonic sensors are clamped onto the outside of the pipe, thus eliminating the need to dismantle the pipework and interrupt the process. The KATflow 230 can be applied to any type of standard pipe carrying clean or dirty liquids and liquified gases.

Advantages

- **Low installation effort and costs**
- **Measurement is independent of fluid conductivity**
- **No pressure loss, no possibility of leakage**
- **Retrospective installation for existing plants possible**
- **No cutting of pipes necessary, no interruption of process, no plant shut down**
- **No additional fittings for maintenance required**
- **Hygienic measurement, no risk of contamination, suitable for ultra clean liquids**
- **No contact with medium, no risk of corrosion when used with aggressive media**
- **Cost advantages when used with large diameter pipes, high pressure systems, etc.**

Specification

General

Measuring principle	:	Ultrasonic time difference correlation principle
Flow velocity range	:	0.01 ... 25 m/s
Resolution	:	0.25 mm/s
Repeatibility	:	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* ±0.5 % of measured value
Turn down ratio	:	1/100
Gaseous and solid content of liquid media	:	< 10 % of volume

Flowmeter

Enclosure	:	Portable
Degree of protection	:	IP 65 according EN 60529
Operating temperature	:	-10 ... 60 °C (14 ... 140 °F)
Housing material	:	Extruded aluminium, Al MG Si 0.5, lids die-cast zinc alloy GD-Zn AL 4 CU 1
Flow channels	:	2
Power supply	:	Internal rechargeable batteries, 8 x NiMH AA 2850 mAh or external power supply 9 V DC
Display	:	LCD graphic display, 128 x 64 dots, backlit
Dimensions	:	H 266 x W 168 x D 37 mm
Weight	:	Approx. 2.0 kg

KATRONIC

Flowmeter (cont.)

Power consumption	:	< 5 W
Signal damping	:	0 ... 99 s
Measurement rate	:	10 ... 1000 s^{-1}
Operating languages	:	English, German, French, Spanish, Russian
Response time	:	1 s, faster rates upon request
Calculation functions	:	Average/difference/sum

Quantity and units of measurement

Volumetric flow rate	:	m3/h, m3/min, m3/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
Flow velocity	:	m/s, ft/s, inch/s
Mass flow rate	:	g/s, t/h, kg/h, kg/min
Volume	:	m^3, l, gal (US gallons), bbl
Mass	:	g, kg, t
Heat flow	:	W, kW, MW (only with heat quantity measurement option)
Heat quantity	:	J, kJ, MJ (only with heat quantity measurement option)

Internal data logger

Storage capacity	:	approx. 30,000 samples (128 kByte), optional > 100,000 samples (512 kByte)
Logging data	:	All measured and totalised values, parameter sets

Communication

Serial interface	:	RS 232
Data	:	Instantaneous measured value, parameter set and configuration, logged data

Software KATdata+

Functionality	:	Downloading of measured values/parameter sets, graphical presentation, list format, export to third party software, on-line transfer of measured data
Operating systems	:	Windows 2000, NT, XP, Linux Mac (optional)

Process inputs	:	Galvanically isolated from main electronics and from other I/O's
Temperature	:	PT 100, four-wire circuit, measuring range -50 ... 400 °C, resolution 0.1 K, accuracy ±0.2 K

Process outputs	:	Galvanically isolated from main electronics and from other I/O's
Current	:	0 ... 20 mA, active (R_{Load} < 500 Ω), 16 bit resolution, U = 30 V, accuracy 0.1 %
Digital (Open-Collector)	:	Totaliser, value 0.01 ... 1000/unit, width 30 ... 999 ms, U = 24 V, I_{max} = 4 mA
Digital (relay)	:	Alarm, fault (programmable) Form C (SPDT-CO) contacts, U = 48 V, I_{max} = 250 mA

Clamp-on sensors

Type K1N, K1E

Diameter range	:	50 ... 3000 mm
Dimensions	:	60 x 30 x 34 mm
Material	:	Stainless steel
Temperature range	:	*Type K1N:* -30 ... 130 °C (-22 ... 266 °F) *Type K1E:* -30 ... 200 °C (-22 ... 392 °F), for short periods up to 300 °C (572 °F)
Degree of protection	:	IP 66 acc. EN 60529, IP 67 and IP 68 optional

Type K4N, K4E

Diameter range	:	10 ... 250 mm
Dimensions	:	43 x 18 x 22 mm
Material	:	Stainless steel
Temperature range	:	*Type K4N:* -30 ... 130 °C (-22 ... 266 °F) *Type K4E:* -30 ... 200 °C (-22 ... 392 °F), for short periods up to 300 °C (572 °F)
Degree of protection	:	IP 66 acc. EN 60529, IP 67 and IP 68 optional