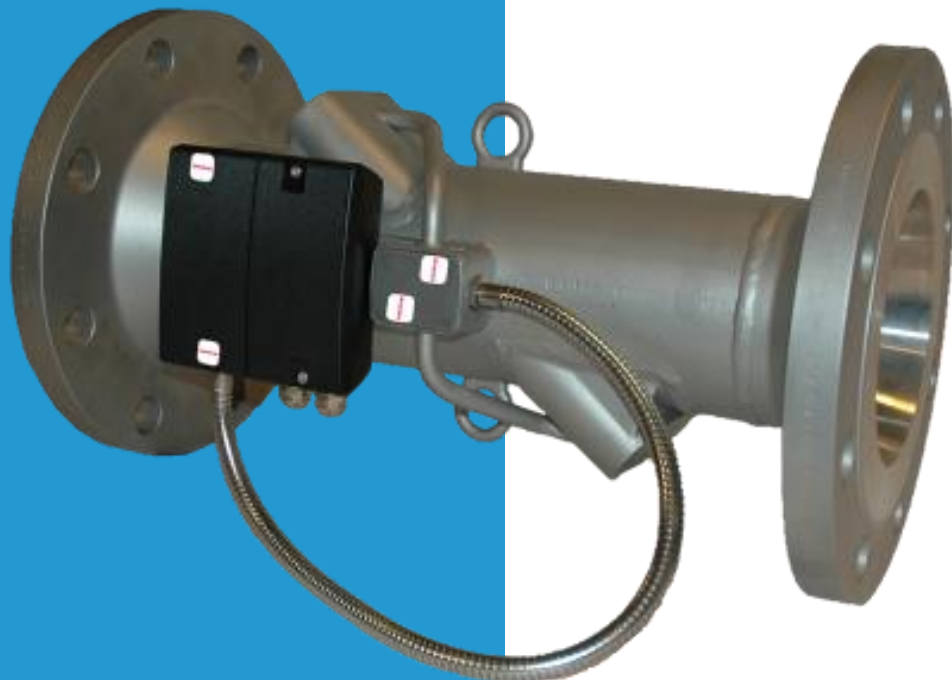


Technical Description

• _____

ULTRAFLOW® 54 DN150-300



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1 General description

ULTRAFLOW® 54 DN150-300 is a static flow sensor based on the ultrasonic measuring principle. It is primarily used as a volume flow sensor for thermal energy meters such as MULTICAL®. ULTRAFLOW® 54 DN150-300 has been designed for use in heating and cooling installations where water is the heat-bearing medium.

ULTRAFLOW® 54 employs ultrasonic measuring techniques and microprocessor technology. All calculating and flow measuring circuits are collected on one single board, thus providing a compact and rational design and, in addition, exceptionally high measuring accuracy and reliability is obtained.

The volume is measured using bidirectional ultrasonic technique based on the transit time method, with proven long-term stability and accuracy. Four ultrasonic transducers are used to send sound signals both against and with the flow. The ultrasonic signal travelling with the flow reaches the opposite transducer first. The time difference between the two signals can be converted into flow velocity and thereby also volume.

A three-wire signal cable is used to connect ULTRAFLOW® 54 to the Kamstrup MULTICAL® calculator. The cable supplies the flow sensor and also transfers the signal from sensor to calculator. A signal corresponding to the flow – or more correctly, a number of pulses proportional to the water volume flowing through – is transmitted.

ULTRAFLOW® 54 DN150-300 is available with internal supply, e.g. if the distance between MULTICAL® and ULTRAFLOW® exceeds 10 metres. When there is a need to extend the cable between ULTRAFLOW® and MULTICAL®, a Cable Extender Box can be used, which is mounted between ULTRAFLOW® and MULTICAL® to extend the cable up to 30 m. Note that ULTRAFLOW® and MULTICAL® in these cases are not galvanically separated.

If ULTRAFLOW® 54 DN150-300 is used for other equipment (e.g. other brands of calculators), the sensor must be fitted with a galvanically separated output module and a supply of its own. In addition, ULTRAFLOW® 54 DN150-300 features a wide range of programmable meter factor and pulse length settings.

2 Data

ULTRAFLOW® 54 DN150-300

2.1 Electrical data

Supply voltage	3.6 VDC ± 0.1 VDC
Supply, galvanically coupled output module (Y=1)	Powered by MULTICAL®
Supply, galvanically separated output module (Y=2) ¹⁾	
Mains supply	230 VAC +15/-30 %, 50 Hz 24 VAC ±50 %, 50 Hz
Power consumption	< 1 W
Backup	Integral SuperCap eliminates interruptions due to short-term power failures
Supply, galvanically separated output module (Y=3)	
Battery	3.65 VDC, D-cell lithium
Replacement interval	6-years @ t _{BAT} < 30 °C
Mains supply	230 VAC +15/-30 %, 50 Hz 24 VAC ±50 %, 50 Hz
Power consumption	< 1 W
Backup	Integral SuperCap eliminates interruptions due to short-term power failures
Signal cable length, from flow sensor electronics box with galvanically coupled output module (Y=1)	Max. 10 m (powered by MULTICAL®)
Signal cable length, from flow sensor electronics box with galvanically separated output module (Y=2 and 3)	Depending on calculator (use of own supply in ULTRAFLOW®). Max. 100 m when connected to MULTICAL® (Y = 2). See <i>paragraph 7.6.2</i> for applications with MULTICAL®
Signal cable length, Cable Extender Box	Max 30 m when connected to MULTICAL® 603 or 803
EMC data	Fulfils EN 1434:2015 class C, MID E1 and E2

2.2 Mechanical data

Metrological class	2 or 3
Environmental class	Fulfils EN 1434 class C
Mechanical environment	MID M1 and M2
Ambient temperature	5...55 °C, non-condensing, closed location (indoor installation)
Protection class	IP67 When installed properly. See <i>paragraph 7.3</i>
Humidity	< 93 % RH, non-condensing
Medium in flow sensor	Water - recommended water quality as in CEN TR 16911 and AGFW FW510
Temperature of medium	2...150 °C (Heat & heat/cooling meters) 2...130 °C (Heat/cooling meters) 2...50 °C (Cooling meters) At medium temperatures above 90 °C or below ambient temperature, the electronics box must be wall mounted or mounted via the enclosed distance piece.
Storage temperature (empty sensor)	-25...60 °C
Pressure stage	PN25, PS25 and PN16, PS16

¹⁾ It is possible to use battery supply in combination with output module (Y=2), e.g. for temporary supply of flow sensors installed at construction sites.

2.3 Flow data

Nom. flow q_p [m ³ /h]	Nom. diameter [mm]	Meter factor ¹⁾ [p/l]	Dynamic range $q_p:q_i$	$q_s:q_p$	Flow@125 Hz ²⁾ [m ³ /h]	$\Delta p@q_p$ [bar]	Min. cut off [l/h]
150	DN150	1	100:1	2:1	450	0.02	300
250	DN150	0.6	100:1	2:1	750	0.055	500
400	DN150	0.4	100:1	2:1	1125	0.04	800
400	DN200	0.4	100:1	2:1	1125	0.01	800
400	DN250	0.4	100:1	2:1	1125	0.01	800
600	DN200	0.25	100:1	2:1	1800	0.022	1200
600	DN250	0.25	100:1	2:1	1800	0.022	1200
1000	DN250	0.15	100:1	2:1	3000	0.015	2000
1000	DN300	0.15	100:1	2:1	3000	0.015	2000

¹⁾ Standard meter factor. Appears from ULTRAFLOW® label. For other meter factors see paragraph 4.

²⁾ Saturation flow 125 Hz. Max. pulse frequency is maintained at higher flow.

Table 1. Flow data.

2.4 Materials

Wetted parts

Housing	Stainless steel, W.no. 1.4307
Transducer holder	Stainless steel, W.no. 1.4308
Transducer	Titanium
Gaskets	Fibre

Electronics box

Base, cover	Thermoplastic, PC 10 % GF
Fitting hardware, distance piece for electronics box	Thermoplastic, PPS 40 % GF

Signal cable (optional for separate ULTRAFLOW® 54)

Silicone cable (3 x 0.5 mm²)

Power supply cable 24/230 VAC (optional when selecting supply module)

Cable with PVC-mantle (2 x 0.75 mm²)

Housing, Cable Extender Box

Base, cover	Thermoplastic, ABS
-------------	--------------------

3 Type overview

Nom. flow q_p [m ³ /h]	Installation dimensions		
	150	DN150x500 mm	
250	DN150x500 mm		
400	DN150x500 mm	DN200x500 mm	DN250x600 mm
600	DN200x500 mm	DN250x600 mm	
1000	DN250x600 mm	DN300x500 mm	

Flange facing type B, raised face according to EN 1092-1

Table 2. Type overview

4 Ordering details

4.1 Type numbers of ULTRAFLOW® 54 for MULTICAL®

The table below shows a list of type numbers for ULTRAFLOW® 54 ordered with MULTICAL®

Type number	q _p [m ³ /h]	q _i [m ³ /h]	q _s [m ³ /h]	Dynamic range q _p :q _i	Connection [mm]	PN [bar]	Length [mm]	Meter factor [p/l]	Material (flow sensor housing)
65-5- FCCN -XXX	150	1.5	300	100:1	DN150	25	500	1	Stainless steel
65-5- FDCN -XXX	250	2.5	500	100:1	DN150	25	500	0.6	Stainless steel
65-5- FECN -XXX	400	4	800	100:1	DN150	25	500	0.4	Stainless steel
65-5- FECP -XXX	400	4	800	100:1	DN200	25	500	0.4	Stainless steel
65-5- FECR -XXX	400	4	800	100:1	DN250	25	600	0.4	Stainless steel
65-5- FFCP -XXX	600	6	1200	100:1	DN200	25	500	0.25	Stainless steel
65-5- FFCE -XXX	600	6	1200	100:1	DN250	25	600	0.25	Stainless steel
65-5- FGCR -XXX	1000	10	2000	100:1	DN250	25	600	0.15	Stainless steel
65-5- FGDS -XXX	1000	10	2000	100:1	DN300	16	500	0.15	Stainless steel

XXX - code for final assembly, approvals etc. - determined by Kamstrup.

Table 3. Type numbers of ULTRAFLOW® 54 for MULTICAL®.

4.2 Type numbers of separate ULTRAFLOW® 54

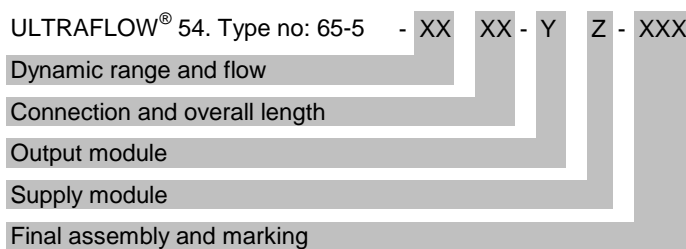
Type number	q _p [m ³ /h]	q _i [m ³ /h]	q _s [m ³ /h]	Dynamic range q _p :q _i	Connection [mm]	PN [bar]	Length [mm]	Material (flow sensor housing)
65-5- FCCN -YZ -XXX	150	1.5	300	100:1	DN150	25	500	Stainless steel
65-5- FDCN -YZ -XXX	250	2.5	500	100:1	DN150	25	500	Stainless steel
65-5- FECN -YZ -XXX	400	4	800	100:1	DN150	25	500	Stainless steel
65-5- FECP -YZ -XXX	400	4	800	100:1	DN200	25	500	Stainless steel
65-5- FECR -YZ -XXX	400	4	800	100:1	DN250	25	600	Stainless steel
65-5- FFCP -YZ -XXX	600	6	1200	100:1	DN200	25	500	Stainless steel
65-5- FFCE -YZ -XXX	600	6	1200	100:1	DN250	25	600	Stainless steel
65-5- FGCR -YZ -XXX	1000	10	2000	100:1	DN250	25	600	Stainless steel
65-5- FGDS -YZ -XXX	1000	10	2000	100:1	DN300	16	500	Stainless steel

XXX - code for final assembly, approvals etc. - determined by Kamstrup.

Table 4. Type numbers of separate ULTRAFLOW® 54. The meter factor can be programmed according to the application.

4.2.1 Ordering details of separate ULTRAFLOW® 54

Type number composition of separate ULTRAFLOW® 54



In addition to the basic variants listed in *Table 4*, you must select output module (Y), supply module (Z) as well as meter factor programming (CC) and pulse duration (E).

4.2.2 Type numbers of output and supply modules

Type number overview of output modules (Y) and supply modules (Z) for separate ULTRAFLOW® 54.

Y	Output module	Corresponding supply module
1	Galvanically coupled module	0 (powered by MULTICAL®)
2	Galvanically separated module	0, 7, 8
3	Galvanically separated module, low power	0, 2, 7, 8

Z	Supply module	Corresponding output module
0	No supply	1, 2, 3
2	Battery, D-cell	3
7	230 VAC supply module	2, 3
8	24 VAC supply module	2, 3

Table 5. Output modules (Y) and supply modules (Z).

The variant with galvanically coupled output module (Y=1) is solely for use together with MULTICAL®.

The variant with galvanically separated output module (Y=2 or 3) is used in the following situations:

- 1) More than 10 metres cable length between MULTICAL® and ULTRAFLOW® is required.
- 2) For flow sensor no. 2 in connection with MULTICAL®. If two flow sensors are used together with MULTICAL®, one must include a galvanically separated output module (Y=2 or 3).
For further details see *paragraph 7.8.2 Calculator with two flow sensors*.
- 3) ULTRAFLOW® is connected to other equipment/foreign calculators.

For more information on electrical connection, please see *paragraph 7.6 Electrical connections to MULTICAL®*.

Please note: Flow info cannot be read if output module with galvanic separation is used.

4.2.3 Programming options of meter factor and pulse durations

Overview of programming options as to meter factors (CC) and pulse durations (E) for separate ULTRAFLOW®

q _p [m³/h]	Meter factor			Pulse duration				
	[p/l]	[l/p]	CC	[ms] (E=1)	[ms] (E=4)	[ms] (E=5)	[ms] (E=6)	
150	1		33	3.9	-	-	-	Default
150		10	34	-	20	-	-	
150		25	64	-	20	-	-	
150		100	35	-	20	50	100	
150		250	65	-	20	50	100	
150		1000	36	-	20	50	100	
150		2500	66	-	20	50	100	
250	0.6		43	3.9	-	-	-	Default
250		10	34	-	20	-	-	
250		25	64	-	20	-	-	
250		100	35	-	20	50	100	
250		250	65	-	20	50	100	
250		1000	36	-	20	50	100	
250		2500	66	-	20	50	100	
400	0.4		63	3.9	-	-	-	Default
400		100	35	-	20	50	-	
400		250	65	-	20	50	100	
400		1000	36	-	20	50	100	
400		2500	66	-	20	50	100	
600	0.25		14	3.9	-	-	-	Default
600		100	35	-	20	50	-	
600		250	65	-	20	50	-	
600		1000	36	-	20	50	100	
600		2500	66	-	20	50	100	
1000	0.15		24	3.9	-	-	-	Default
1000	(0.25)	4	14	3.9	-	-	-	*)
1000		100	35	-	20	50	-	
1000		250	65	-	20	50	-	
1000		1000	36	-	20	50	100	
1000		2500	66	-	20	50	100	

*) Spare part for ULTRAFLOW® type 65-S/R/T. Configured 65-5-FGCR. No flow info.

Table 6. Programming options as to meter factor (CC) and pulse durations (E) for ULTRAFLOW® 54 DN150-300.

Based on a q_p value a meter factor in Table 6 is chosen. The valid possible pulse durations are listed on the same line as the chosen meter factor.

Example: For ULTRAFLOW® 54 q_p 400 m³/h a meter factor of 100 liter/pulse (CC=35) is required. Based on this meter factor one of the pulse durations, 20 milliseconds (E4) or 50 milliseconds (E5), is selected.

Default values in Table 6 are programming values for ULTRAFLOW® 54 when connected to a Kamstrup MULTICAL® calculator.

4.3 Accessories

Please note that not all article numbers can be directly ordered. Some articles must be ordered via Kamstrup service department.

Article number	Description	Note (when ordering ULTRAFLOW®)
65-000-000-2000	D-cell lithium battery with two-pole connector	
3026-477 ¹⁾	Fitting for D-cell battery	Enclosed if battery supply or "No supply" is selected
1650-157 ¹⁾	Plug for cable connection	Enclosed if battery supply or "No supply" is selected

¹⁾ Obligatory when changing from mains supply module to battery supply.

Article number	Description	Note (when ordering ULTRAFLOW®)
65-000-000-7000 ¹⁾	230 VAC supply module	
65-000-000-8000 ¹⁾	24 VAC supply module	
5000-290	Cable between supply module and output module	Enclosed if supply module is selected
5000-286	24/230 VAC power cable	Optional

¹⁾ Including 5000-290.

Article number	Description	Note (when ordering ULTRAFLOW®)
66-99-011	Output module (Y=1), galvanically coupled	
66-99-012	Output module (Y=2), galvanically separated	
66-99-013	Output module (Y=3), galvanically separated, "Low power"	

Article number	Description	Note (when ordering ULTRAFLOW®)
5000-333	2.5 m silicone cable (3-wire)	Default for ULTRAFLOW® when ordered with MULTICAL® Optional for separate ULTRAFLOW®
5000-259	5 m silicone cable (3-wire)	Optional
5000-270	10 m silicone cable (3-wire)	Optional
3026-207	Mounting fitting for electronics box	Enclosed (mounted)
6561-332	Short distance piece	
3026-507	Long distance piece	Enclosed
1051-006	Collar band for long distance piece	Enclosed
1150-140	Gasket, DN150 PN25 (1 pc)	Enclosed (2 pcs.)
1150-139	Gasket, DN200 PN25 (1 pc)	Enclosed (2 pcs.)
1150-141	Gasket, DN250 PN25 (1 pc)	Enclosed (2 pcs.)
1150-164	Gasket, DN300 PN16 (1 pc)	Enclosed (2 pcs.)

4.3.1 Cables

ULTRAFLOW® 54 DN150-300, when ordered with MULTICAL®, is supplied with 2.5 metres signal cable, optionally 5 or 10 metres. The cable is mounted in the ULTRAFLOW® 54 electronics box and in MULTICAL® 6xx. When ULTRAFLOW® 54 is ordered with MULTICAL® 8xx, the calculator is supplied separately. Hence the cable is only mounted in the ULTRAFLOW® 54 electronics box.

ULTRAFLOW® 54 DN150-300, when ordered as a separate flow sensor, is optionally available with signal cable in lengths of 2.5, 5 or 10 metres. The cable is mounted in the flow sensor's electronics box.

If 24/230 VAC supply module is selected, the sensor is optionally available with power supply cable. The cable is mounted in the flow sensor's electronics box from the factory.

4.3.2 Cable Extender Box

Cable Extender Box (Type 6699-036) enables a signal cable length of up to 30 m between ULTRAFLOW® and MULTICAL®. The equipment supports flow-info, but not galvanic separation (for more information see *paragraph 4.2.2*). Cable Extender Box (Type 6699-036) must be ordered separately.

Kamstrup offers signal cables in lengths of 2.5 m (Type 5000-333), 5 m (Type 5000-259) and 10 m (Type 5000-270), which can be ordered separately. In combination with the signal cables, which are typically delivered with ULTRAFLOW®, different total lengths of up to 20 m between ULTRAFLOW® and MULTICAL® can be realized. With signal cables of varying lengths but of the same quality as Kamstrup's signal cables, it is possible to find individual solutions for cable extension up to 30 m between ULTRAFLOW® and MULTICAL®. For electrical connections, see *paragraph 7.6.4 Electrical connection of Cable Extender Box*.

5 Dimensional sketches

5.1 ULTRAFLOW® 54 DN150-300

All measurements are in mm, unless otherwise stated.

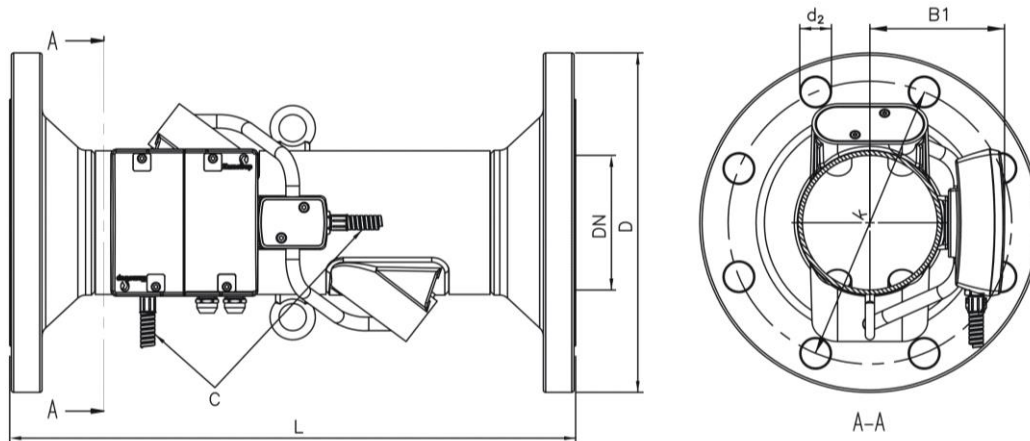


Figure 1

Nom. diameter	PN [bar]	Nom. flow q_p [m ³ /h]	L	D	k	Bolts			B1	E	Steel tube length C	Approx. weight [kg]
						Quantity	Thread	d ₂				
DN150	25	150 & 250	500	300	250	8	M24	26	119	282	650	37
DN150	25	400	500	300	250	8	M24	26	140	303	625	36
DN200	25	400 & 600	500	360	310	12	M24	26	166	329	570	49
DN250	25	400 & 600	600	425	370	12	M27	30	166	329	570	79
DN250	25	1000	600	425	370	12	M27	30	194	357	500	75
DN300	16	1000	500	460	410	12	M24	26	194	357	500	76

Flange facing type B, raised face according to EN 1092-1

Table 7

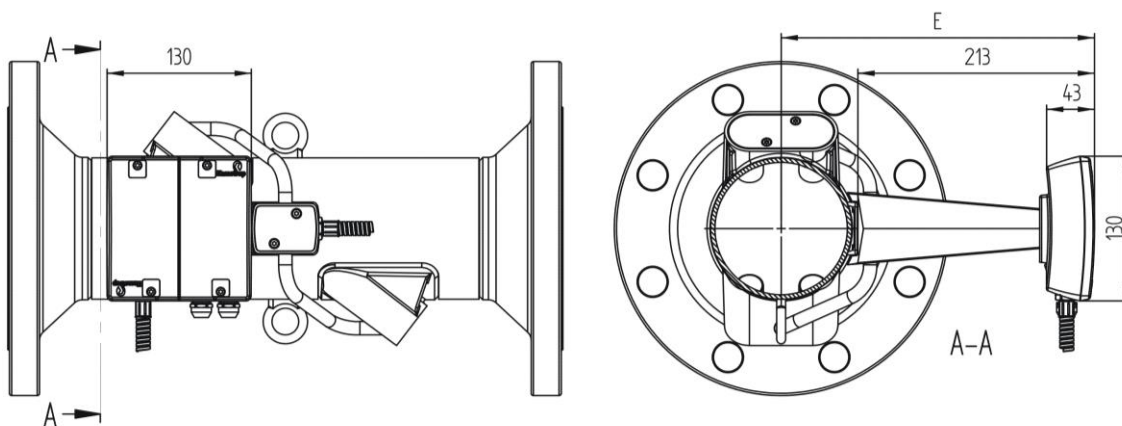


Figure 2

5.2 Cable Extender Box

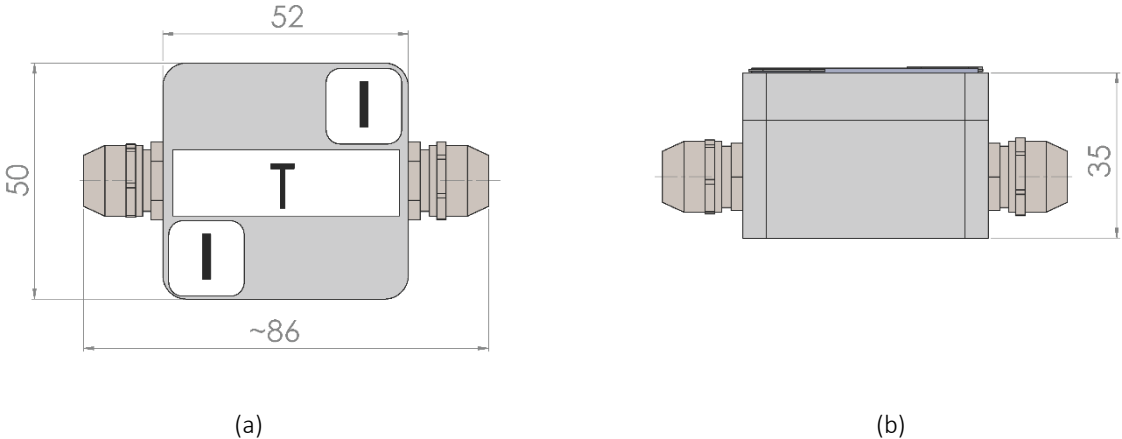


Figure 3. Cable Extender Box seen from the front (a) and from the side (b).

6 Pressure loss

Pressure loss in a flow sensor is stated as max. pressure loss at q_p .

According to EN 1434 max. pressure loss must not exceed 0.25 bar unless the energy meter includes a flow controller or functions as pressure reducing equipment.

The pressure loss in a meter increases with the square of the flow and can be stated as:

$$Q = kv \times \sqrt{\Delta p}$$

where:

Q = volume flow rate [m³/h]

kv = volume flow rate at 1 bar pressure loss

Δp = pressure loss [bar]

Graph	Nom. flow q_p [m ³ /h]	Type number ¹⁾	Nom. diameter [mm]	Length [mm]	$\Delta p@q_p$ [bar]	kv	Q@0,25 bar [m ³ /h]
A	150	65-5- FCCN -XXX	DN150	500	0.02	1060	530
	250	65-5- FDCN -XXX	DN150	500	0.055		
B	400	65-5- FECN -XXX	DN150	500	0.04	2000	1000
C	400	65-5- FECP -XXX	DN200	500	0.01	4040	2020
		65-5- FECR -XXX	DN250	600			
	600	65-5- FFCP -XXX	DN200	500	0.022		
		65-5- FFCR -XXX	DN250	600			
D	1000	65-5- FGCR -XXX	DN250	600	0.015	8160	4080
		65-5- FGDS -XXX	DN300	500			

¹⁾ XXX - code for final assembly, approvals etc. - determined by Kamstrup. A few variants may not be available in national approvals.

Table 8. Pressure loss table.

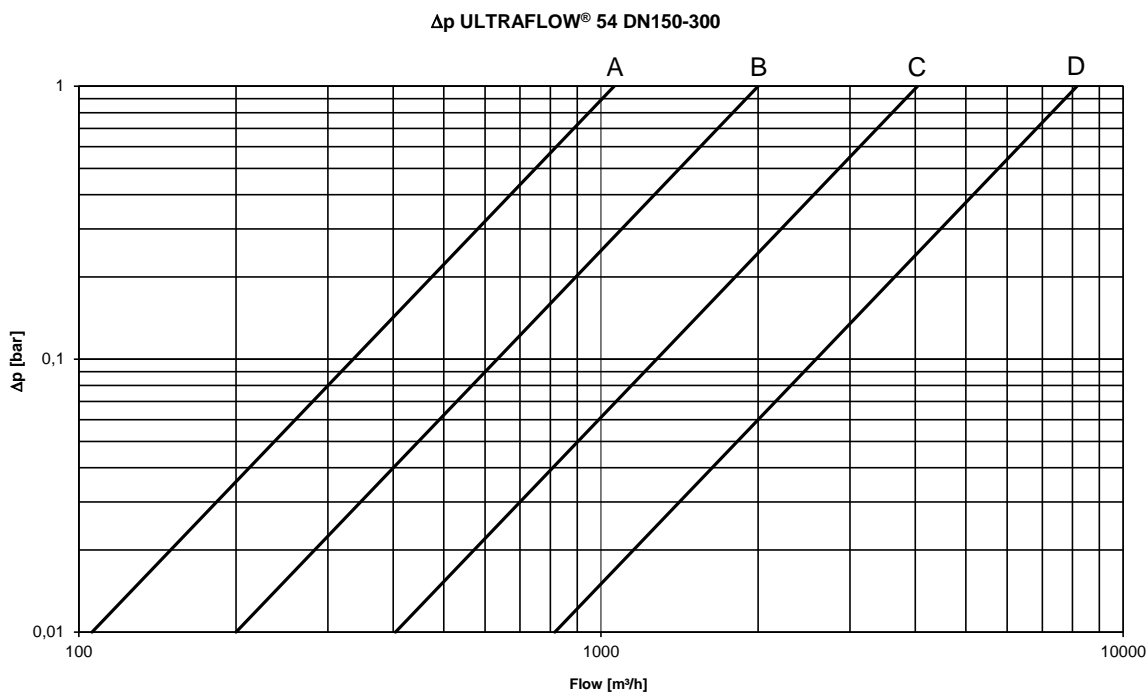


Figure 4. Pressure loss graphs.

7 Installation

Please read this chapter carefully before installing the meter.

In case of incorrect mounting, Kamstrup's guarantee obligations no longer apply.

By connecting to 230 V supply, there is a risk of electric shock.

When working on the flow sensor in the installation, there is a risk of outflow of (hot) water under pressure.

At a media temperature higher than 60 °C, the flow sensor should be shielded from unintended contact.

Prior to installation of the flow sensor, the system should be flushed.

The flow sensor must be suitable for the foreseeable operating conditions in the installation.

New fibre gaskets in original quality must be used.

Correct flow sensor position (inlet or outlet) appears from the front label or the display of MULTICAL®. The flow direction is indicated by an arrow on the flow sensor. See *Figure 7* and *Figure 8*.

Please note: ULTRAFLOW® 54 may be lifted in the lifting rings only.

Pressure stage of ULTRAFLOW® 54: PN25, PS25/PN16, PS16. See marking on label.

Temperature of medium, ULTRAFLOW® 54: 2...150 °C/2...130 °C/2...50 °C. See marking on label.

Mechanical environment: M1 and M2 (fixed installation with minimum vibration and fixed installation with considerable or high vibration level respectively). See marking on label.

Electromagnetic environment: E1 and E2 (housing/light industry and industry respectively). See marking on label.

The meter's signal cables must be drawn at min. 25 cm distance to other installations.

Climatic environment: Must be installed in environments with non-condensing humidity as well as in closed locations (indoor installation).

The ambient temperature must be within 5...55 °C.

Maintenance and repair: The flow sensor is verified separately and can, therefore, be separated from the calculator. It is permitted to replace the supply and change the supply type. For battery supply a lithium battery with connector from Kamstrup A/S must be used. Lithium batteries must be correctly handled and disposed of (see Kamstrup document 5510-408, "Lithium batteries - Handling and disposal"). Other repairs require subsequent re-verification in an accredited laboratory.

If ULTRAFLOW® 54 is connected via a galvanically coupled output module, the flow sensor may be connected to a Kamstrup MULTICAL® calculator only.

If other calculator types are connected, ULTRAFLOW® 54 must be fitted with a galvanically separated output module and a power supply of its own.

Note: Please make sure that the meter factor is identical on flow sensor and calculator.

The steel tube between flow sensor housing and electronics box may not be disassembled.

At medium temperatures above 90 °C or below ambient temperature the flow sensor's electronics box must be mounted via the enclosed distance piece. Alternatively, the electronics box can be wall mounted at a distance of minimum 170 mm from the sensor.

If ULTRAFLOW® is insulated, the electronics box must be kept out of the insulation.

In order to prevent cavitation, the static pressure at the flow sensor outlet must be min. 1.5 bar at q_p and min. 2.5 bar at q_s . This applies to temperatures up to approx. 80 °C.

When the installation has been completed, water flow can be turned on. The valve on the inlet side must be opened first.

7.1 Guidelines for dimensioning ULTRAFLOW® 54

In connection with installations, it has proved practical to work with a static pressure at the flow sensor outlet according to *Table 9*. This minimises the risk of measuring errors as a result of cavitation or air in the water.

Nominal flow q_p [m ³ /h]	Recommended min. static pressure [bar]	Max. flow q_s [m ³ /h]	Recommended min. static pressure [bar]
150	1	300	2
250	1.5	500	2.5
400 (DN150)	1.5	800	2.5
400	1	800	2
600	1.5	1200	2.5
1000	1.5	2000	2.5

Table 9. Recommended minimum static pressure at flow sensor outlet.

It is not necessarily cavitation in the sensor itself, but also bubbles from cavitating pumps and regulating valves mounted before the sensor. It can take some time until such bubbles have been dissolved in the water. Furthermore, water can include air which is dissolved in the water. The amount of air which can be dissolved in water depends on pressure and temperature. This means that air bubbles can be formed due to a decrease in pressure, e.g. caused by a velocity rise in a pipe contraction or in the sensor. The risk of these factors affecting accuracy is reduced by maintaining a suitable pressure in the system.

In relation to the recommended static pressure, the steam pressure at the current temperature must also be considered. The recommended static pressure applies to temperatures up to approx. 80 °C.

The steam pressure is the pressure where steam and liquid are in equilibrium at the current temperature (boiling point at a given pressure). At low temperature and high pressure, water is in the liquid phase. At high temperature and low pressure, water is in the steam phase. The blue curve (the steam pressure curve) in *Figure 5* thus characterizes the equilibrium of the liquid and steam phases. This means that the static pressure in water must be increased at a given temperature to avoid the steam phase that is shown in the lower right corner of the graph in *Figure 5*.

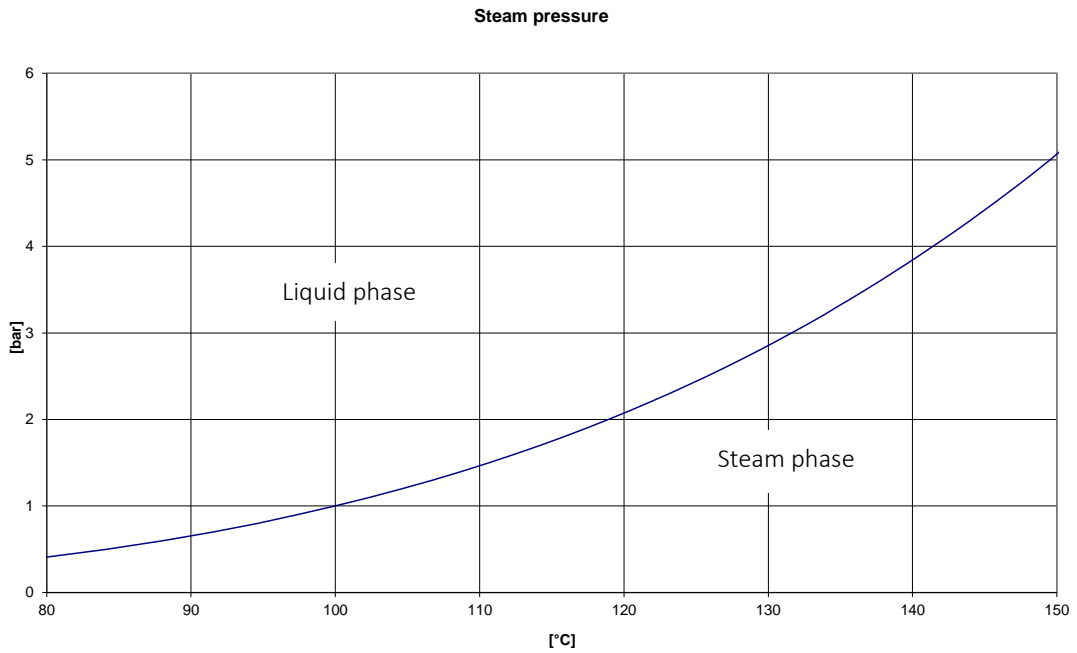


Figure 5. Steam pressure of water. At low temperature and high pressure, water is in the liquid phase. At high temperature and low pressure, water is in the steam phase. The blue curve characterizes the equilibrium of the liquid and steam phases.

Furthermore, it must be taken into account that the above static pressure is lower after a contraction than before (e.g. at cones). This means that the static pressure – when measured elsewhere in the installation– might be different from the pressure at the flow sensor outlet.

7.2 Orientation of ULTRAFLOW® 54

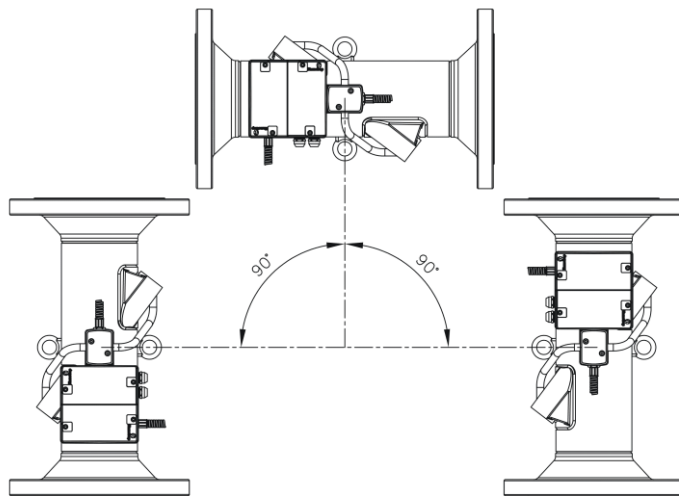


Figure 6

ULTRAFLOW® can be installed horizontally, vertically, or at an angle.

ULTRAFLOW® 54 is normally installed horizontally, with the lifting rings oriented vertically. The ultrasound paths in the flow sensor tube will thus be vertical, which is optimal in connection with possible stratification of the medium.

7.2.1 Mounting ULTRAFLOW® 54 in lifting ring

ULTRAFLOW® 54 can be mounted hanging from one of the two lifting rings depending on required flow direction. The enclosed distance piece can be used to secure optimal position of the electronics box. (See *paragraph 7.3*)



← Flow

Figure 7



Flow →

Figure 8

7.3 Mounting of ULTRAFLOW® 54 electronics box

At **medium temperature below 90 °C and at medium temperature above ambient temperature** the electronics box can be mounted directly on the flow sensor housing via the factory mounted fitting.

If the flow sensor is vertically mounted, the cable connections of the electronics box will be horizontally oriented. This is permitted. If the cable connections should preferably point downwards, the electronics box can be mounted via the enclosed distance piece, which moves the box approx. 170 mm away from the flow sensor housing. Alternatively, a shorter distance piece, which only moves the box approx. 45 mm away from the flow sensor housing, can be used. The short distance piece must be ordered separately (6561-332).



Figure 9

At **medium temperature above 90 °C** the temperature is too high for the electronics box to be mounted directly on the flow sensor housing.

Therefore, the electronics box must be mounted via the enclosed distance piece. The cable connections must always point downwards. (See *paragraph 7.3.1*)

Alternatively, the electronics box can be wall mounted as long as the distance to flow sensor housing and pipe installation is minimum 170 mm.



Figure 10

It can also be an advantage to use the enclosed distance piece if the flow sensor housing is insulated and the electronics box must be removed from the insulation.

If the required position of the electronics box differs from standard position, the distance piece can be mounted with the enclosed collar band around the flow sensor housing. However, please note that the cable connections must always point downwards. (See *paragraph 7.3.1*)

At **medium temperature below ambient temperature** (typically in cooling installations) it is important to take action to avoid condensation in the electronics box.

Therefore, the electronics box must be mounted via the enclosed distance piece.

The cable connections must always point downwards. (See *paragraph 7.3.1*)

If ULTRAFLOW® is insulated, the electronics box must be kept out of the insulation.

Alternatively, the electronics box can be wall mounted as long as the distance to flow sensor housing and pipe installation is minimum 170 mm.

Furthermore, when mounting the electronics box please make sure that the cable connections on the box are at a higher level than the cable connection on the flow sensor housing.

By vertical mounting of ULTRAFLOW® 54 in a riser this can be secured by mounting the distance piece by means of the collar band as shown in *Figure 11*.



Figure 11

If ULTRAFLOW® 54 is mounted horizontally, the electronics box can be mounted on the distance piece by means of the collar band. The distance piece can then be turned upwards until the cable connections on the electronics box are in a higher position than the cable connection on the flow sensor housing. See *Figure 12*.

Alternatively, the electronics box can be wall mounted at a suitable distance to the installation (minimum 170 mm).

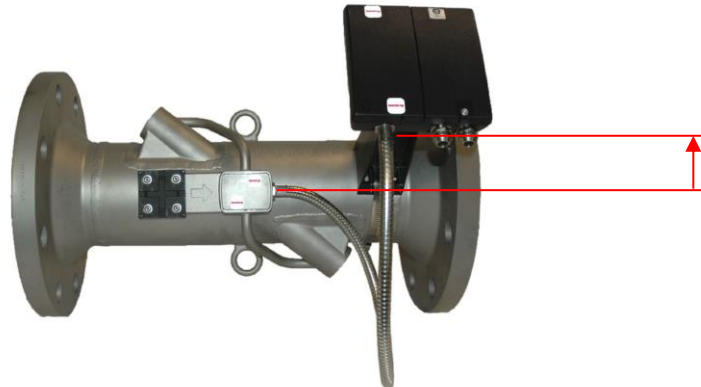


Figure 12

7.3.1 Orientation of flow sensor electronics box

Mounting the electronics box, the cable connections must always be horizontally or downwards oriented in order to avoid the risk of water and condensation being led into the electronics box via the cables.

This is especially important in humid environments, when ULTRAFLOW® 54 is used as cooling sensor or if the medium temperature can become lower than the ambient temperature.

Furthermore, steel tube and wires must in general hang freely downwards after the cable connections to form a drip nose for drainage of water and condensation.

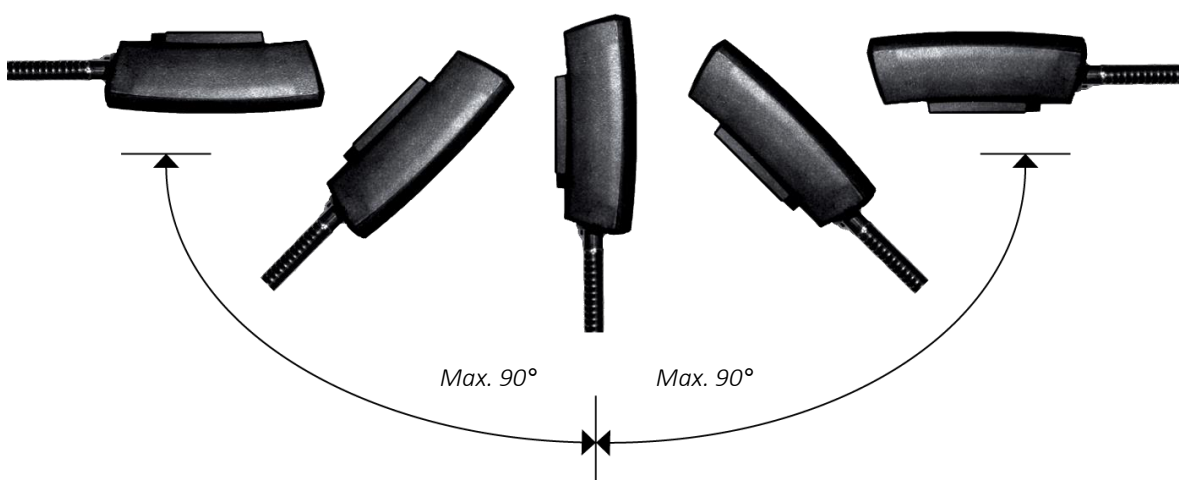
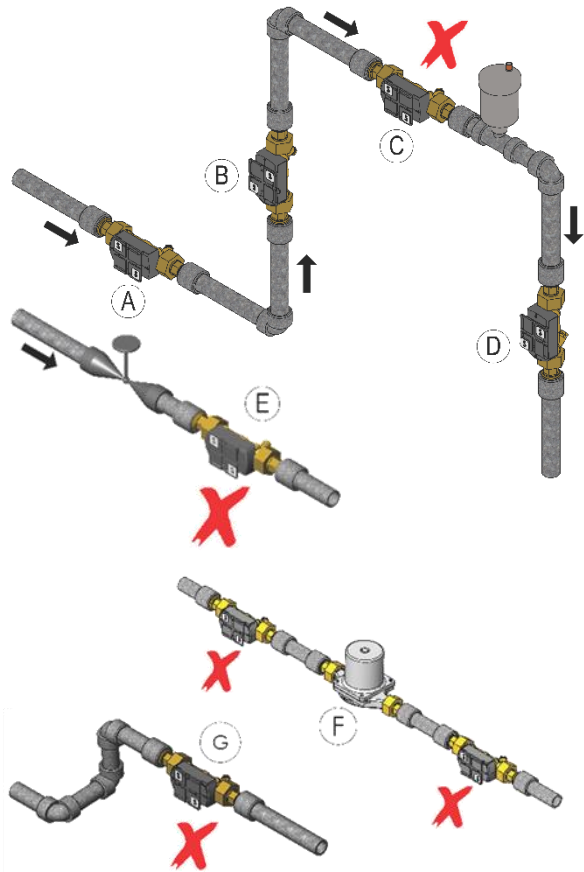


Figure 13

7.4 Straight inlet

ULTRAFLOW® 54 requires neither straight inlet nor outlet in order to fulfil the Measuring Instruments Directive (MID) 2014/32/EU and EN 1434:2015. Only in case of heavy flow disturbances before the meter will a straight inlet section be necessary. We recommend following the guidelines in CEN CR 13582.

Optimal position can be obtained by taking the below-mentioned installation methods into consideration:



- A Recommended flow sensor position.
- B Recommended flow sensor position.
- C Unacceptable position due to risk of air build-up.
- D Acceptable in closed systems. Unacceptable position in open systems due to risk of air build-up.
- E A flow sensor ought not be placed immediately after a valve, with the exception of block valves (full bore ball valve type), which must be fully open when not used for blocking.
- F A flow sensor ought not be placed immediately before (on the suction side) or immediately after a pump (on the pressure side).
- G A flow sensor ought not be placed immediately after a double bend in two planes.

Figure 14

For general information concerning installation see CEN report *CEN CR 13582, Heat meter installation. Instructions in selection, installation and use of heat meters.*

7.5 Operating pressure

In order to prevent cavitation, the static pressure at the flow sensor outlet must be min. 1.5 bar at q_p and min. 2.5 bar at q_s . This applies to temperatures up to approx. 80 °C.

For further information on operating pressure see *paragraph 7.1 Guidelines for dimensioning ULTRAFLOW® 54*

7.6 Electrical connections to MULTICAL®

7.6.1 ULTRAFLOW® 54 and MULTICAL®, galvanically coupled

If ULTRAFLOW® 54 and MULTICAL® are connected via output module (Y=1), ULTRAFLOW® is galvanically coupled with the MULTICAL® calculator and is powered by this via the three-wire signal cable (cable length up to 10 m).

Battery life time in e.g. MULTICAL® 603 is approximately 16 years depending on communication modules in the calculator.

See *paragraph 8.6.1* for electrical data on output module (Y=1).

Note: It is not permitted to mount a supply module or battery in ULTRAFLOW® 54 with output module (Y=1).


ULTRAFLOW® 54	→	MULTICAL®		
11	→	11	GND	(Blue)
9	→	9	+3,6 V	(Red)
10	→	10		(Yellow)

Table 10

7.6.2 ULTRAFLOW® 54 and MULTICAL®, galvanically separated

If ULTRAFLOW® 54 and MULTICAL® are connected via output module (Y=2 or 3) ULTRAFLOW® 54 is galvanically separated from MULTICAL®.

See *paragraph 8.6.2* for electrical data on output module (Y=2 and 3).

Note: Flow info cannot be read.

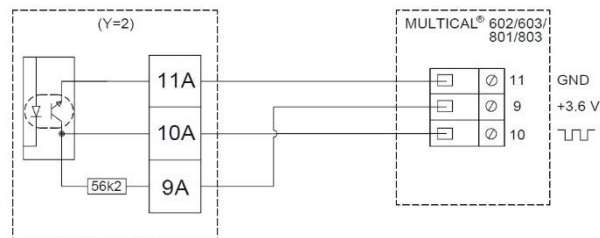


Figure 15. Three-wire connection, MULTICAL® 602/603/801/803 via output module (Y=2).

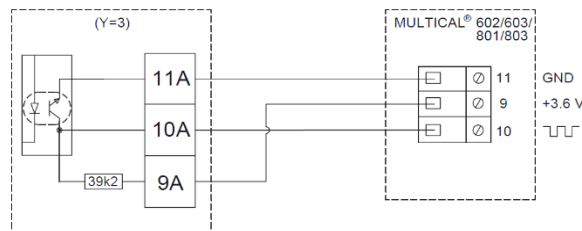


Figure 16. Three-wire connection, MULTICAL® 602/603/801/803 via output module (Y=3).

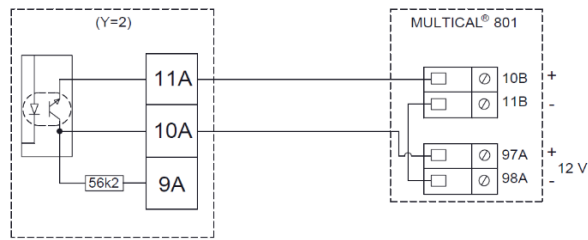


Figure 17. Two-wire connection, MULTICAL® 801 via output module (Y=2). Note the 12 VDC auxiliary supply in MULTICAL® 801.

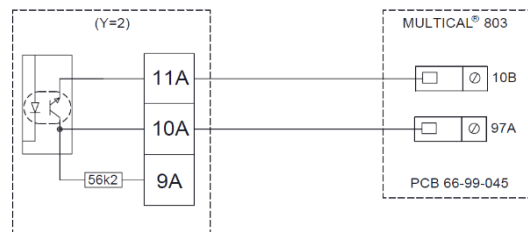


Figure 18. Two-wire connection, MULTICAL® 803 via output module (Y=2). Note the auxiliary supply in MULTICAL® 803 via PCB 66-99-045.

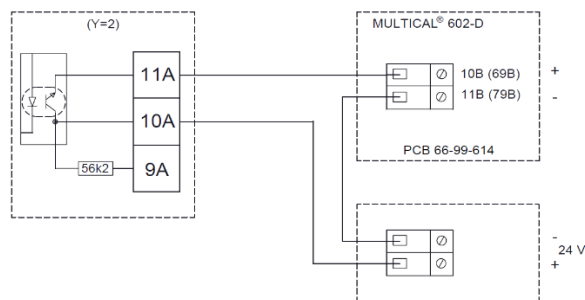


Figure 19. Two-wire connection, MULTICAL® 602-D via output module (Y=2) and external 24 VDC supply.

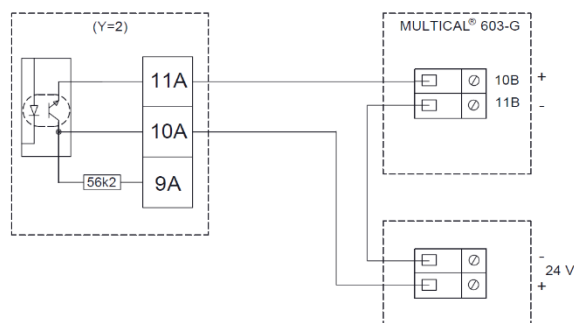


Figure 20. Two-wire connection, MULTICAL® 603-G via output module (Y=2) and external 24 VDC supply.

7.6.3 Cable length

ULTRAFLOW® 54 DN150-300 output module	MULTICAL® 602/603/801/803	
	2-wire connection	3-wire connection
Y=1	N/A	< 10 m
Y=2	< 100 m *)	< 10 m
Y=3	N/A	< 10 m

*) MULTICAL® 602 must have sensor connection type D and external 24 VDC supply.
 MULTICAL® 603 must have sensor connection type G and external 24 VDC supply.
 MULTICAL® 801 features 12 VDC auxiliary supply.
 MULTICAL® 803 features auxiliary supply via PCB 66-99-045.

Table 11. Maximum allowable cable length depends on the output module in ULTRAFLOW® 54 DN150-300 and how the MULTICAL® calculator is connected.

If long signal cables are used, installation requires careful consideration. Due to EMC there must be a distance of min. 25 cm between signal cables and all other cables. Recommended cable cross section for the signal cable is 2 x 0.5 mm².

7.6.4 Electrical connection of Cable Extender Box

The Cable Extender Box includes transient transorb diodes, making it possible to extend the cable between ULTRAFLOW® and MULTICAL® with up to 30 m in total, while the cable length without the Cable Extender Box can be maximum up to 10 m.

Mount Cable Extender Box to the wall or the like close to ULTRAFLOW®. Connect the 3 wires in the cable from ULTRAFLOW® to one of the two terminals in Cable Extender Box. You can select any of the terminals. Use a 3-wire extension cable with a length of up to 27.5 m with the same wire diameter and of the same quality as the cable from ULTRAFLOW®, and connect the 3 wires to the other terminal in Cable Extender Box. Connect the opposite end of the extension cable to the terminal (V1 or V2) in MULTICAL®. Connect the cables according to the following combination: 10: Yellow, 9: Red and 11: Blue. This colour combination applies to both Cable Extender Box and MULTICAL®. Perform a function check, and complete by sealing Cable Extender Box with the included void labels or the seal labels of the utility.

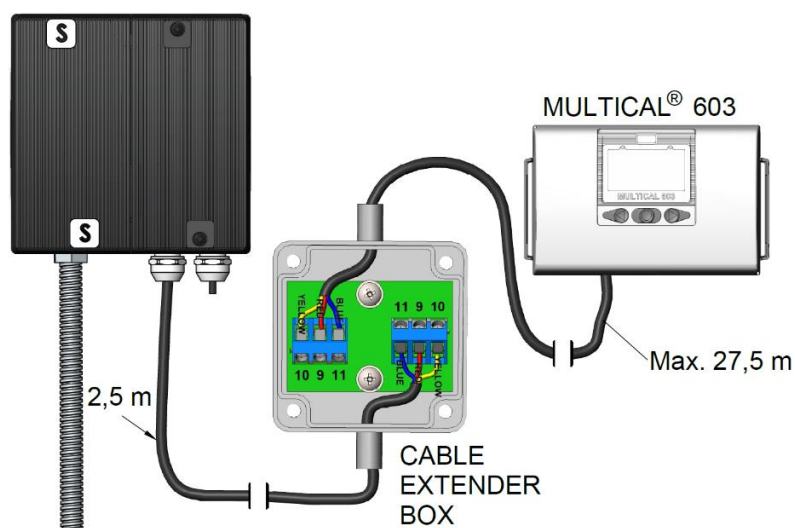


Figure 21. Electrical connection of ULTRAFLOW® 54 DN150-300 with output module Y=1 galvanically coupled to MULTICAL® via Cable Extender Box.

The example illustrates a default 2.5 m cable from ULTRAFLOW® to Cable Extender Box. In this case, the cable length between Cable Extender Box and MULTICAL® can be up to max 27.5 m

7.7 Connection of power supply

If ULTRAFLOW® 54 is mounted with a galvanically coupled output module and connected to MULTICAL®, the flow sensor is supplied by the calculator. Therefore, the flow sensor must not be fitted with a supply of its own.

ULTRAFLOW® 54 may be connected to other calculators via the galvanically separated output module only, and the flow sensor must, therefore, be fitted with a supply module or battery.

Supply module and battery are connected to the two-pole connector on the output module.

7.7.1 Battery supply

ULTRAFLOW® 54 is fitted with a D-cell lithium battery with connector. The battery plug is connected to the output module.

Optimal battery lifetime is obtained by keeping the battery temperature below 30 °C, e.g. by wall mounting the electronics box.

The voltage of a lithium battery is almost constant throughout the lifetime of the battery (approx. 3.65 V). Therefore, it is not possible to determine the remaining capacity of the battery by measuring the voltage.

The battery cannot and must not be charged and must not be short-circuited.

The battery supply may only be replaced by a corresponding lithium battery with connector from Kamstrup A/S. Used batteries must be handed in for approved destruction, e.g. at Kamstrup A/S. (See Kamstrup document 5510-408, "Lithium batteries - Handling and disposal").

7.7.2 Mains supply modules

The mains supply modules are protection class II and are connected to the output module via a small two-wire cable with plugs. The modules are powered via a two-wire mains supply cable (without earth connection) through the cable connector of the electronics box. Use supply cable with an outer diameter of 4.5-10 mm and ensure correct stripping of insulation as well as correct tightening of cable connection (see *paragraph 7.7.4*).

Max. permitted fuse: 6 A

230 VAC

This PCB module is galvanically separated from the mains supply and is suitable for direct 230 VAC mains installation. The module includes a double-chamber safety transformer, which fulfils double-isolation requirements when the cover is mounted on the electronics box. Power consumption is less than 1 VA or 1 W.

National regulations for electric installations must be observed. The 230 VAC module can be connected/disconnected by the district heating station's personnel, whereas the fixed 230 VAC installation to the main electrical panel must be carried out by an authorized electrician.

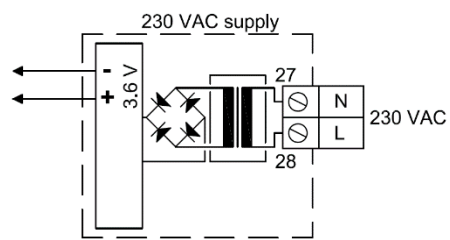


Figure 22. 230 VAC supply module.

24 VAC

This PCB module is galvanically separated from the 24 VAC mains supply and is both suitable for industrial installations with joint 24 VAC supply and individual installations, which are supplied by a separate 230/24 VAC safety transformer in the main electrical panel. The module includes a double-chamber safety transformer, which fulfils double-isolation requirements when the cover is mounted on the electronics box. Power consumption is less than 1 VA or 1 W.

National regulations for electric installations must be observed. The 24 VAC module can be connected/disconnected by the district heating station's

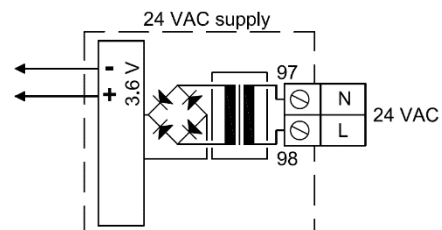


Figure 23. 24 VAC supply module.

personnel, whereas the fixed 230/24 VAC installation in the main electrical panel must only be carried out by an authorized electrician.

Note: This module cannot be supplied by 24 VDC (direct current).

230/24 VAC safety transformer

The 24 VAC module is especially suited for installation together with a 230/24 VAC safety transformer, e.g. type 66-99-403, which can be installed in the main electrical panel before the safety relay. When the transformer is used, the total power consumption of the meter incl. the 230/24 VAC transformer will not exceed 1.7 W.



Figure 24. 230/24 VAC safety transformer.

7.7.3 Mains supply cable

ULTRAFLOW® 54 is available with mains supply cable H05 VV-F for either 24 V or 230 V (l=1.5 m):

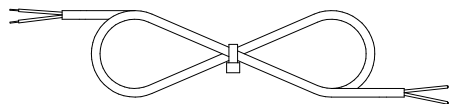


Figure 25. Mains cable (2x0.75 mm²), max. 6 A fuse.

"H05 VV-F" is the designation of a strong PVC mantle, which withstands max. 70 °C. Therefore, the mains cable must be installed with sufficient distance to hot pipes etc.

7.7.4 Cable connections

Cable dimension in connections: 4.5...10 mm.

Tightening torque: Maximum 4 Nm (cable strain relief minimum 40 N according to EN 61558)

Please note: If ULTRAFLOW® 54 is mounted with a galvanically coupled output module, or if a galvanically separated output module is used in combination with battery supply the unused cable connection must be sealed off as shown in *Figure 26*.

7.7.5 Change of supply unit

The supply unit of ULTRAFLOW® 54 can be changed from mains supply to battery or vice versa as the needs of the supply company change. Thus, it can be an advantage to temporarily change mains supplied meters to battery supplied meters e.g. in case of buildings under construction where the mains supply can be unstable or periodically missing.

Please note that the supply type of some ULTRAFLOW® sensors appears from the label. If the original supply type is changed, it will no longer be in accordance with the label.

7.8 Installation examples (electrical)

7.8.1 Example of connection of ULTRAFLOW® 54 and MULTICAL®

ULTRAFLOW® 54 with galvanically coupled output module (Y=1), powered by MULTICAL® via a three-wire connection.

See paragraph 7.6.1 for electrical wiring.

Note: Installed plug in the unused rightmost connector of the electronics box.

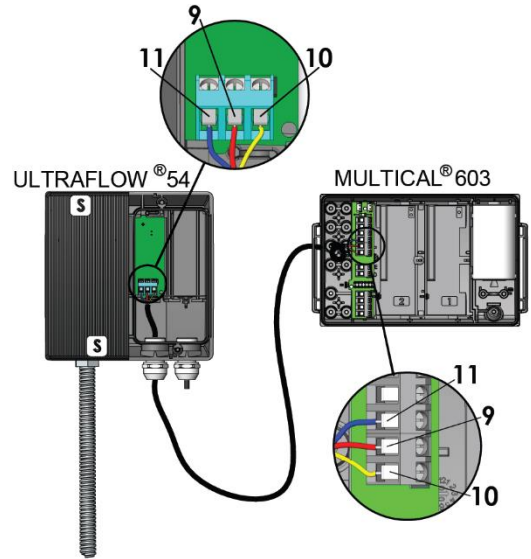


Figure 26. ULTRAFLOW® 54 connected to MULTICAL® 603 via a three-wire connection.

ULTRAFLOW® 54 with galvanically separated output module (Y=2) and 230 VAC supply of its own is connected to MULTICAL® via a two-wire connection.

See paragraph 7.6.2 for electrical wiring.

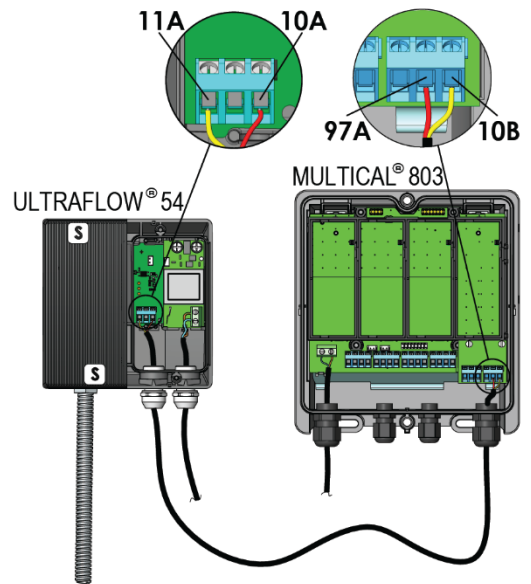


Figure 27. ULTRAFLOW® connected to MULTICAL® 803 via a two-wire connection.

7.8.2 Calculator with two flow sensors

MULTICAL® 602/603/801/803 can be used in various applications with two flow sensors, e.g. leak surveillance or open systems. When two ULTRAFLOW® are direct connected to one MULTICAL®, a close electric coupling between the two pipes ought to be carried out as a main rule. If the two pipes are installed in a heat exchanger, close to the flow sensors, however, the heat exchanger will provide the necessary electric coupling.

- Inlet and outlet pipes are closely electrically coupled
- No welded joints occur

In installations where the electric coupling cannot be carried out, or where welding in the pipe system can occur, one ULTRAFLOW® must be mounted with a galvanically separated output module and also a supply of its own.

- Inlet and outlet pipes are not necessarily closely coupled
- Electric welding *) can occur

*) Electric welding must always be carried out with the earth pole closest to the welding point. Damage to meters due to welding is **not** comprised by Kamstrup's factory guarantee.

7.9 Operational check

Carry out an operational check when the complete meter (flow sensor, temperature sensors and calculator) has been installed and connected. Open thermostats and valves so that water is flowing in the system and check that there are credible values for temperatures and water flow in the calculator display.

8 Functional description

Within the heat, cooling and water meter industry, producers have been working on alternative techniques for the replacement of flow sensors based on the mechanical principle. Research and development at Kamstrup have proven that ultrasonic measuring is the most viable solution. Combined with microprocessor technology and piezo ceramics, ultrasonic measuring is not only accurate but also reliable.

8.1 Flow measurement with ultrasound

Within ultrasonic flow measuring, there are two main principles: the transit time method and the Doppler method. The Doppler method is based on the frequency change which occurs when sound is reflected by a moving particle. This is the effect you experience when a car drives by. The sound (the frequency) decreases when the car passes by. The transit time method used in ULTRAFLOW® utilizes the fact that it takes an ultrasonic signal, sent in the opposite direction of the flow, longer to travel from transmitter to receiver than a signal sent in the same direction as the flow.

A piezo-ceramic element is used for transmitting and receiving ultrasound. The thickness of the element changes when exposed to an electric field (voltage) and thereby it functions as a transmitter of ultrasound. When the element is mechanically influenced, it generates a corresponding electric voltage and thus functions as a receiver of ultrasound.

8.2 Signal path, flow calculation and flow profiles

As proven by the calculations below, the average flow velocity is directly proportional to the transit time difference of ultrasound signals which are sent with or against the flow. *Figure 28* shows as example the essential elements of the signal path in ULTRAFLOW® 54 (type 65-5-XXHX-XXX, q_p 0.6...2.5 m³/h): Piezo-electric elements transmit and receive the ultrasound signal, which is reflected into and through the measuring tube to the receiver via reflectors. Due to superposition of velocities of water and sound signal, ultrasound propagates faster with the flow than against the flow.

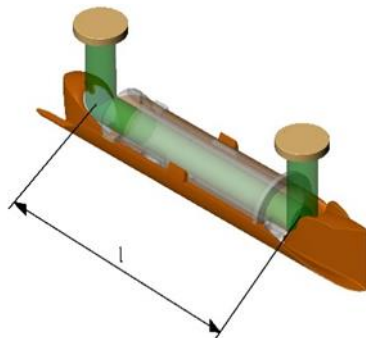


Figure 28. Signal path in ULTRAFLOW® 54 (type 65-5-XXHX-XXX, q_p 0.6...2.5 m³/h). Sound signals are transmitted by the transducers via 2 reflectors. The signal's transit times with and against the flow vary for the significant sound path distance (parallel with the measuring tube). In this case, the flow is flowing from right to left.

For the calculation of the transit time difference, the signal path along the flow is crucial, and the transit time to the measuring distance is calculated as:

$$t = \frac{l}{c \pm v}$$

where:

t is the transit time from sender to receiver of the sound signal along the measuring distance l . [s]

l is the measuring distance. [m]

c is the sound propagation velocity in stagnant water. [m/s]

v is the average flow velocity of water. [m/s]

The transit time difference can be expressed as the difference between the absolute time of the signal sent against the flow (-) and the signal sent with the flow (+).

$$\Delta t = \frac{l}{c - v} - \frac{l}{c + v}$$

which can also be written as:

$$\Delta t = l \frac{(c + v) - (c - v)}{(c - v) \cdot (c + v)} \Rightarrow \Delta t = l \frac{2v}{c^2 - v^2}$$

As $c^2 \gg v^2$, v^2 can be omitted and the formula reduced as follows:

$$v = \frac{\Delta t \cdot c^2}{2l}$$

Thus, we know the basic connection between the average flow velocity and the transit time difference.

The transit time difference in a flow sensor is very small (nanoseconds). Therefore, the time difference is measured as a phase difference between the two 1 MHz sound signals in order to obtain the necessary accuracy.

Furthermore, the influence of the temperature of the sound velocity of water must be taken into account. In ULTRAFLOW®, the velocity of ultrasound c is measured by means of a number of absolute time measurements between the two transducers. As the geometry of the flow sensor is known, the measured speed of the ultrasound is thus a scale for the water temperature, which is further used in the built-in ASIC in connection with the flow calculations.

The flow (volume flow rate) is then determined by measuring the transit time difference, calculate the average flow velocity and multiply it by the area of the measuring tube:

$$q = v \cdot A$$

where:

q is the flow (volume flow rate). $\left[\frac{m^3}{h}\right]$

A is the area of the measuring pipe. $[m^2]$

The volume V passing through is finally calculated as a time integration over the flow (multiplication of (cross section constant) flow by time).

The calculation above is simplified since it does not take into account the flow profiles. In general, flow profiles influence the measurement, which in our case is the transit time difference. Flow sensors are thus adjusted properly according to the different Reynolds numbers that characterize the flow, i.e. in practice for different flows (volume flow) and temperatures. To cover the various flow profiles in the best possible way with the ultrasound signal, Kamstrup uses a triangle sound path, as illustrated in *Figure 29* from two perspectives, for large ULTRAFLOW® 54 flow sensor (q_p 3.5...100 m^3/h) and ULTRAFLOW® 34 (q_p 2.5...100 m^3/h).

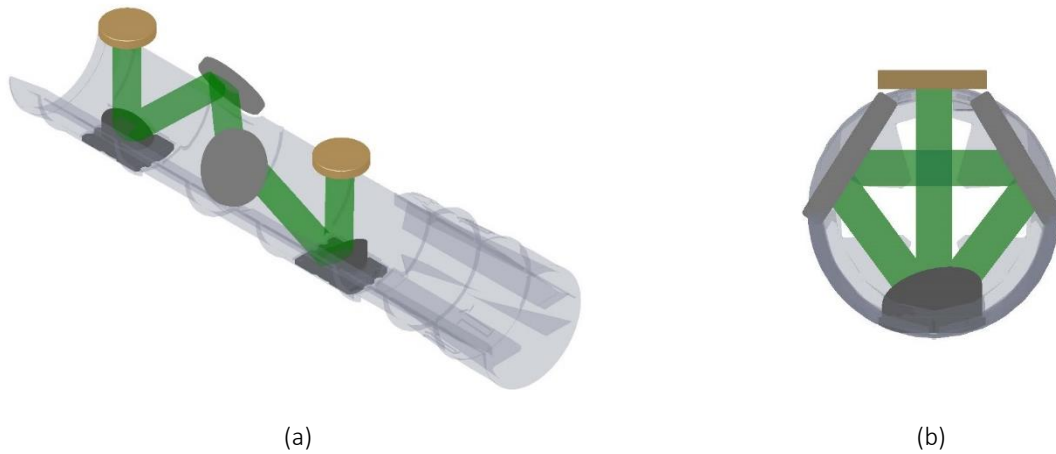


Figure 29. Signal path in ULTRAFLOW® 54 (q_p 3.5...100 m³/h) and ULTRAFLOW® 34 (q_p 2.5...100 m³/h) shown from the side (a) and looking into the measuring tube (b). Sound signals are transmitted by the transducers via 4 reflectors. When you look into the measuring tube (b), the signal is reflected along a triangular path.

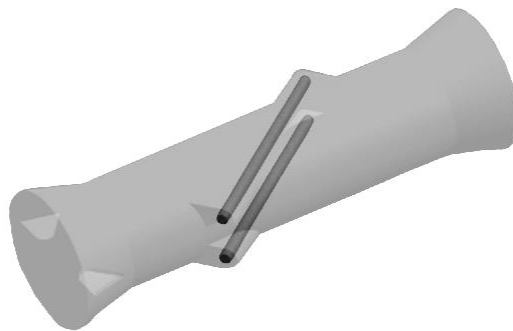


Figure 30. ULTRAFLOW® 54 (q_p 150...1000 m³/h). Two parallel sound paths at a slant in the measuring pipe.

8.3 Function of ULTRAFLOW®

During a flow measurement, ULTRAFLOW® passes through a number of sequences, which are repeated at fixed intervals. Deviations only occur when the flow sensor is in test mode and when the supply is connected during initialization/start-up.

The difference between the main routines in normal mode and fast/test mode is the frequency of the measurements on which pulse emission is based.

In connection with Power Down, it may take up to 16 seconds to start with proper functioning.

In the flow sensor's working range from min. cut off to saturation flow, there is a linear connection between the flow rate and the number of pulses being emitted. The diagram below shows an example of the connection between flow and pulse frequency for ULTRAFLOW® q_p 150 m³/h (Figure 31).

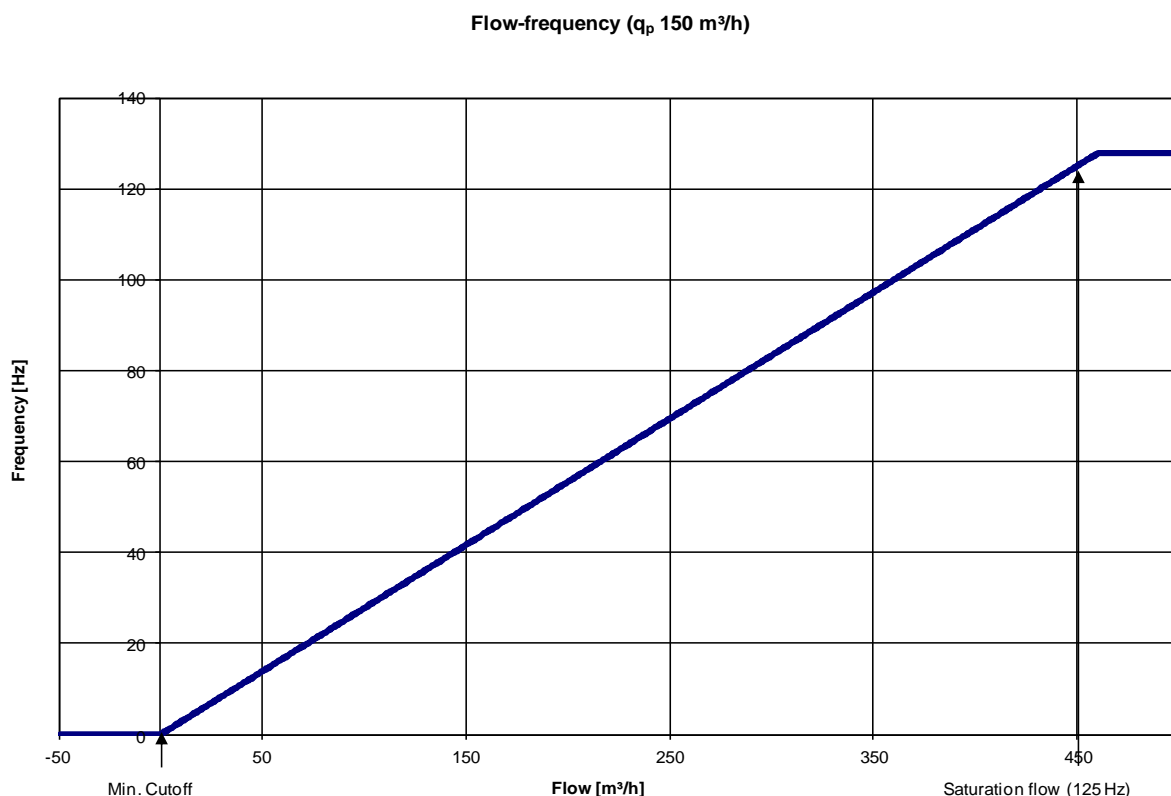


Figure 31. Pulse frequency as a function of flow q_p 150 m³/h

If the flow is lower than min. cut off or negative (backward flow), ULTRAFLOW® does not emit pulses.

At flows exceeding the flow corresponding to pulse emission at max pulse frequency, the max pulse frequency will be maintained.

Table 12 shows the saturation flow at a pulse frequency of 125 Hz for the different flow sizes and meter factors.

q_p [m ³ /h]	Meter factor [pulse/l]	Flow at 125 Hz [m ³ /h]
150	1	450
250	0.6	750
400	0.4	1125
600	0.25	1800
1000	0.15	3000

Table 12. Flow rate at saturation flow (125 Hz).

According to EN 1434 the upper flow limit q_s is the highest flow at which the flow sensor may operate for short periods of time (<1h/day, <200 h/year), without exceeding max. permissible error. ULTRAFLOW® has no functional limitations during the period when the flow sensor operates above q_p .

Please note, however, that high flow velocities may cause cavitation, especially at low static pressure.

8.4 Pulse emission

Pulses are emitted at 1-second intervals. The number of pulses to be emitted is calculated every second. Pulses are emitted in bursts with a pulse duration of 2...5 ms and pauses depending on the current pulse frequency. The duration of the pauses between the individual bursts is approx. 30 ms.

The transmitted pulse signal is the average determination of a series of flow measurements. This means that there will be a transient phenomenon until correct flow signal has been obtained during start-up. Furthermore, this brings about a pulse tail of up to 8 seconds in case of sudden hold.

8.5 Supply and power consumption of ULTRAFLOW®

Normally, ULTRAFLOW® is supplied by the connected MULTICAL® calculator. When ULTRAFLOW® is supplied in any other way, for example via direct connection in a flow bench, the following applies:

Supply voltage of ULTRAFLOW®:

3.6 VDC \pm 0.1 VDC

The current consumption of ULTRAFLOW®:

Max average 50 μ A

Max current 7 mA (max 40 ms)

8.6 Pulse output of ULTRAFLOW®

8.6.1 Galvanically coupled

Galvanically coupled output module (Y=1). ULTRAFLOW® is powered by MULTICAL®.

Note: ULTRAFLOW® must not be mounted with a supply.

Cable length ULTRAFLOW® to MULTICAL® Max. 10 m

Type	Push-Pull
Output impedance	~10 kΩ

Concerning meter factor and pulse durations see *paragraph 4.2.3*

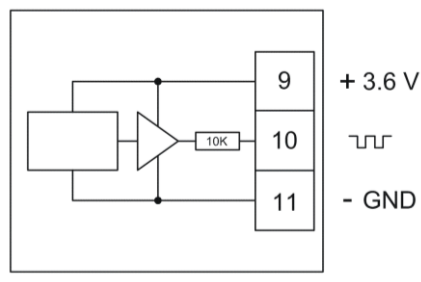


Figure 32. Block diagram of galvanically coupled output module (Y=1) in ULTRAFLOW® 54.

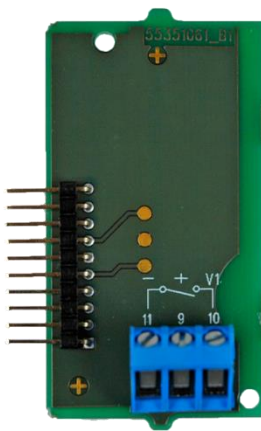


Figure 33. Galvanically coupled output module (Y=1).

8.6.2 Galvanically separated

Galvanically separated output module (Y=2). ULTRAFLOW® is powered by the built-in supply module (Z=7 or 8).

Cable length to ULTRAFLOW® depends on calculator. When connected to MULTICAL® maximum cable length is 100 metres (2-wire connection).

To calculator:

Type: Open collector.

Connection: Can be connected as two-wire or as three-wire via the built-in 56.2 kΩ pull-up.

Module Y=2	OC and OD	(OB) Kam
Max input voltage	6 V	30 V
Max input current	0.1 mA	12 mA
ON condition	$U \leq 0.3 \text{ V @ } 0.1 \text{ mA}$	$U_{CE} \leq 2.5 \text{ V @ } 12 \text{ mA}$
OFF condition	$R \geq 6 \text{ M}\Omega$	$R \geq 6 \text{ M}\Omega$

Table 13

Concerning meter factor and pulse durations, see paragraph 4.2.3

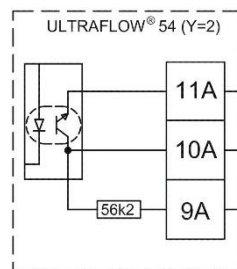


Figure 34. Block diagram of galvanically separated output module (Y=2) in ULTRAFLOW® 54.

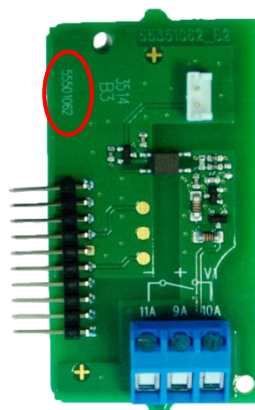


Figure 35. Galvanically separated output module (Y=2). Note the PCB number 5550-1062 in the encircled area.

Galvanically separated output module (Y=3). ULTRAFLOW® is powered by the built-in supply (Z=2, 7 or 8).

Cable length to ULTRAFLOW® depends on calculator. When connected to MULTICAL® maximum cable length is 10 metres.

To calculator:

Type: Open collector.
 Connection: Three-wire via the built-in 39.2 kΩ pull-up.

Module Y=3	OC and OD
Max input voltage	6 V
Max input current	0.1 mA
ON condition	$U \leq 0.3 \text{ V @ } 0.1 \text{ mA}$
OFF condition	$R \geq 6 \text{ M}\Omega$

Table 14

Concerning meter factor and pulse durations, see paragraph 4.2.3

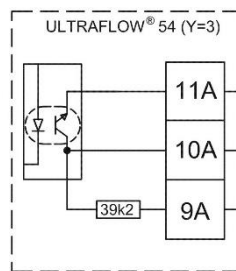


Figure 36. Block diagram of galvanically separated output module (Y=3) in ULTRAFLOW® 54.

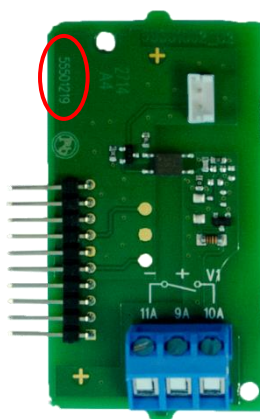


Figure 37. Galvanically separated output module (Y=3). Note the PCB number 5550-1219 in the encircled area.

8.7 Interface connector/serial data

ULTRAFLOW® 54 is fitted with a four-pole connector under the cover. The cover is supplied with a factory seal, and in connection with verified sensors it will be a laboratory seal (legal seal). Thus, it is not possible to access the connector without breaking the seal.

The connector is used for:

- Meter programming, including adjustment of correction curve by means of METERTOOL
- Bringing the sensor into test mode
- Reading accumulated water quantity in connection with calibration
- External control of start/stop in connection with calibration

The interface connector is constructed as shown in *Figure 38*.

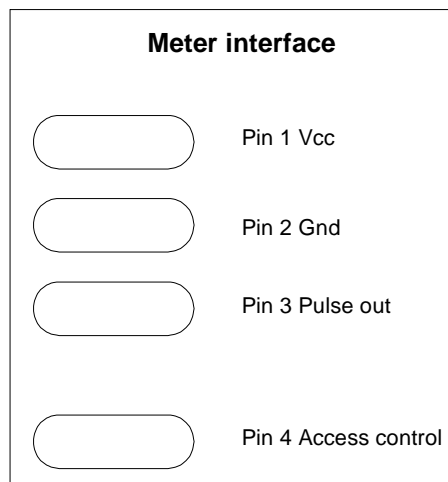


Figure 38. Interface connector.

8.8 Test mode

To minimize the time spent on calibration, ULTRAFLOW® 54 can be switched into test mode. When ULTRAFLOW® is in test mode (verification mode), the measuring routines only take one fourth of the time they take in normal mode.

ULTRAFLOW® is put into test mode by connecting pin 4 (Verification/Adjustment) on the internal connector to ground (GND), which is located at pin 1 or 2, respectively (see *Figure 38*) and subsequently connecting the supply. After approx. 1 second, the sensor goes into test mode and the connection between pin 4 and frame must be disconnected again.

Test mode is ended automatically by disconnecting the supply to the sensor.

Note: ULTRAFLOW® in test mode uses approx. 3 times as much power as in normal mode. However, this does not influence the total battery lifetime of the energy meter as the total duration of ULTRAFLOW® in test mode is negligible compared to the operating time of ULTRAFLOW® outside test mode.

8.9 Externally controlled start/stop

In connection with calibration by means of serial data, e.g. in connection with NOWA, ULTRAFLOW® 54/34 can be monitored by an external signal when it is in verification mode (see *paragraph 8.8 Test mode*). This is done by grounding pin 4 of the internal plug when starting the test and removing it when the test has been completed. The volume of water that has been accumulated during the test can be read serially.

The accumulation is based on the same data as those used for calculating the number of pulses to be emitted.

In addition to accumulating water volume during test, the sensor corrects for the excess quantity in connection with start as well as the quantity lacking in connection with stop. These deviations are due to the fact that the sensor measures flow and calculates volume at fixed intervals as illustrated in *Figure 39*.

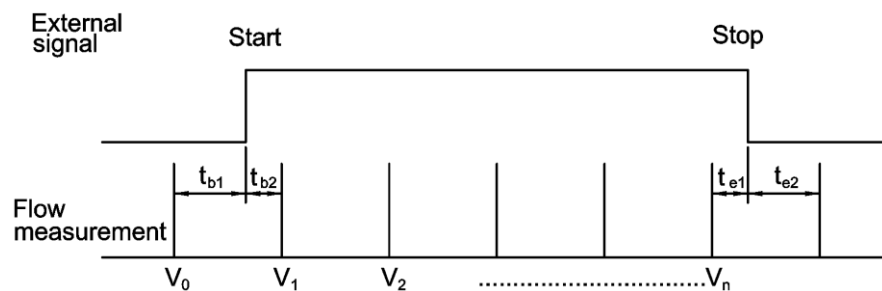


Figure 39

The excess quantity of water in connection with start is the water volume that passes through the sensor during the time t_{b1} before the first accumulation V_1 within the test period. In the same way the lacking quantity is the water volume passing through the sensor during the time t_{e1} from the last accumulation V_n until stop.

The volume accumulated during the test can be stated as:

$$\sum \frac{V_1 \times t_{b2}}{t_{b1} + t_{b2}} + V_2 \dots + V_n + \frac{V_n \times t_{e1}}{t_{e1} + t_{e2}}$$

8.10 Calibration using serial data and externally controlled start/stop

The routine for calibrating ULTRAFLOW® using serial data is outlined below.

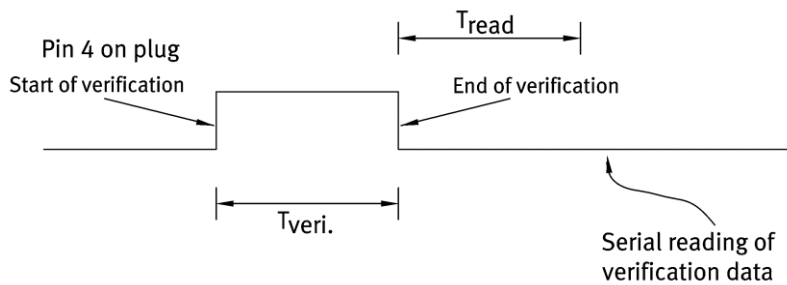


Figure 40

The sensor must be in test mode (see *paragraph 8.8 Test mode*).

Calibration is started by grounding pin 4 of the internal connector (see *Figure 40*) and at the same time starting the test in a flow stand. This might e.g. take place at the same time as the master meter starts accumulating pulses or the diverter of the weight is changed. Then, ULTRAFLOW® accumulates the water volume until pin 4 is disconnected to terminate the test. Subsequently, the volume accumulated during the test can be read in consideration of start and stop. From the test has been completed and until the accumulated quantity of water can be read, minimum 2 seconds must pass (T_{read}). Communication with ULTRAFLOW® during test is not allowed.

Pulse emission stops when pin 4 is disconnected. The read water quantity and the number of emitted pulses may differ as the pulse emission is monitored at intervals of 1 second.

8.11 Accuracy

ULTRAFLOW® 54 has been developed as a volume flow rate sensor for energy meters according to EN 1434. The tolerances permitted for flow sensors according to EN 1434 with a dynamic range of 100:1 ($q_p:q_i$) and q_p 150 m³/h are shown in *Figure 41*. The tolerances are defined for class 2 and class 3 with following formulas:

Class 2: $\pm 2 + 0.02 \times \frac{q_p}{q}$ %, however max. ± 5 %

Class 3: $\pm 3 + 0.05 \times \frac{q_p}{q}$ %, however max. ± 5 %

EN 1434 defines following dynamic ranges ($q_p:q_i$): 10:1, 25:1, 50:1, 100:1 and 250:1.

In connection with accuracies the range from q_p to q_s is defined as max. flow short-term, where tolerances are adhered to. There are no requirements as to the relation between q_p and q_s . See *Table 1* for information on q_s for ULTRAFLOW®.

To render probable that the sensors meet the tolerance requirements, EN 1434-5 specifies calibration requirements in connection with verification of sensors. It is required that flow sensors are tested at following 3 points:

$q_i \dots 1.1 \times q_i$, $0.1 \times q_p \dots 0.11 \times q_p$ and $0.9 \times q_p \dots q_p$

During test the water temperature must be 50 °C \pm 5 °C for ULTRAFLOW® as a heat meter.

For ULTRAFLOW® as a cooling meter the water temperature must be 15 °C \pm 5 °C.

Further requirements are that the tolerance of the equipment used to perform the test must be less than 1/5 MPE (Maximum Permissible Error) to permit the acceptance limit to be equal to MPE. If the equipment does not observe 1/5 MPE, the acceptance limit must be reduced by the tolerance of the equipment.

ULTRAFLOW® will typically do better than half of the permitted tolerance according to EN 1434 class 2.

Note: For further information regarding allowable test conditions such as water temperature and flow of the individual ULTRAFLOW®, see the approval of ULTRAFLOW® (see *paragraph 11 Approvals*).

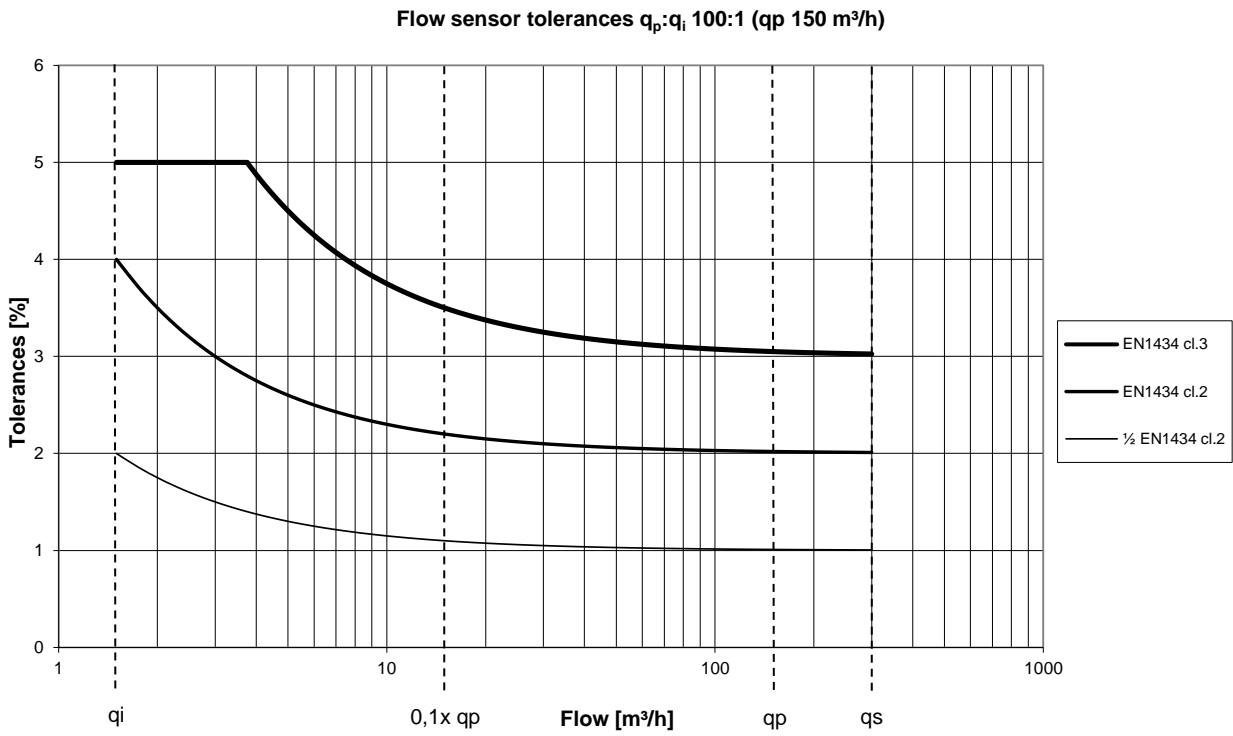


Figure 41. Flow sensor tolerances specified as an example for a flow sensor with q_p 150 m³/h and $q_p:q_i = 100:1$.

9 Calibrating ULTRAFLOW®

Calibration can be based on:

- Pulses in standard mode
- Pulses in test mode
- Pulses using Pulse Tester type 66-99-279
- Serial data with the sensor in test mode

9.1 Technical data for ULTRAFLOW®

ULTRAFLOW® emits flow-proportional pulses depending on programming (see type label and *Table 6*). If ULTRAFLOW® is connected to equipment other than MULTICAL® calculators, for example a flow bench, it is recommended to use galvanic separation.

Supply:	3.6 VDC ±0.1 VDC
Pulse duration:	2...100 ms depending on programming. Appears from type label.
Meter factor:	Depends on programming. Appears from type label.
Start-up:	It takes 16 seconds from start-up until true flow reading has been obtained and calibration can start.

9.2 Electrical connection

Galvanically coupled output module (Y=1).

Type: Push-Pull
 Output impedance: ~ 10 kΩ

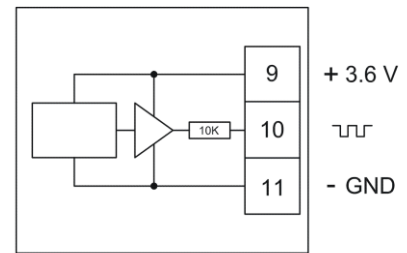


Figure 42

Galvanically separated output module (Y=2).

Open collector. Two-wire or three-wire via the built-in pull-up of 56.2 kΩ

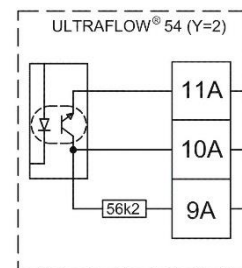


Figure 43

Module Y=2	OC and OD	(OB) Kam
Max input voltage	6 V	30 V
Max input current	0.1 mA	12 mA
ON condition	$U \leq 0.3 \text{ V @ } 0.1 \text{ mA}$	$U_{CE} \leq 2.5 \text{ V @ } 12 \text{ mA}$
OFF condition	$R \geq 6 \text{ M}\Omega$	$R \geq 6 \text{ M}\Omega$

Table 15

Galvanically separated output module (Y=3).

Open collector. Three-wire via the built-in pull-up of 39.2 kΩ

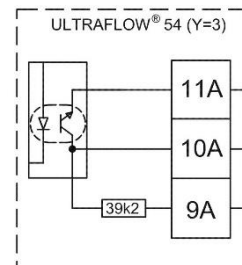


Figure 44

Module Y=3	OC and OD
Max input voltage	6 V
Max input current	0.1 mA
ON condition	$U \leq 0.3 \text{ V @ } 0.1 \text{ mA}$
OFF condition	$R \geq 6 \text{ M}\Omega$

Table 16

9.3 Suggested test points

Nom. flow q_p [m ³ /h]	Meter factor [pulses/l]	Test points			Test duration			Test quantities		
		q_p [m ³ /h]	q_i [m ³ /h]	$0.1 \times q_p$ [m ³ /h]	q_p [min]	q_i [min]	$0.1 \times q_p$ [min]	q_p [kg]	q_i [kg]	$0.1 \times q_p$ [kg]
150	1	150	1.5	15	3	20	6	7500	500	1500
250	0.6	250	2.5	25	3	20	6	12500	833	2500
400	0.4	400	4	40	3	19	6	20000	1250	4000
600	0.25	600	6	60	3	20	6	30000	2000	6000
1000	0.15	1000	10	100	3	20	6	50000	3400	10000

Table 17. Table for ULTRAFLOW® including suggested test points, test durations and test quantities

The suggested test parameters are based on EN 1434-5 and $q_p:q_i$ 100:1.

The test set-ups have been selected on the basis of the following requirements:

- Minimum test duration of 3 minutes
- Water volumes at q_i and $0.1 \times q_p$ of minimum 10 % of the water volume per hour
- Water volume at $0.1 \times q_p$ corresponding to minimum 1000 pulses
- Water volume at q_i corresponding to minimum 500 pulses

These suggested test points can be optimized for the test benches as well as for the test purpose.

9.4 Optimization in connection with calibration

To make a rational test of ULTRAFLOW®, it must be possible to reproduce the test results. This is also very important if the tested sensors are to be adjusted.

Experience shows that ULTRAFLOW® operates with standard deviations of 0.3...0.4 % at q_i and 0.2...0.3 % at q_p . This is standard deviations for 300...500 pulses at q_i , 3000...5000 at q_p , and flying start/stop.

In connection with optimization of calibration, the following subcomponents can be considered:

Pressure: Optimal working pressure is 4...6 bar of static pressure. This minimizes the risk of air and cavitation.

Temperature: Calibration temperature according to EN 1434-5 is 50 °C ±5 °C for heat meters and 15 °C ±5 °C for cooling meters.

Note: For further information regarding allowable test conditions such as water temperature and flow of the individual ULTRAFLOW®, see the approval of ULTRAFLOW® (see *paragraph 11 Approvals*).

Water quality: Recommended water quality as described in CEN TR 16911 and AGFW FW510

Installation (mechanical conditions):

To avoid flow disturbances, the inlet pipes and distance pieces must have the same nominal diameter as the sensors. There should be min. 5 x DN between the sensors. In connection with bends, etc., there should be a minimum distance of 10 x DN. If tests are made at low flow with a bypass at right angles to the pipe, it will be an advantage to mount an absorber of pressure fluctuations due to the perpendicular inlet. This can be a flexible tube on the bypass. In addition, it will be an advantage to mount a flow straightener before the first distance piece. Flow disturbances such as pulsations, e.g. pump fluctuations must be minimized. In connection with calibration, a code of practice for distance pieces has been made on the basis of many years' experience:

The lengths of the distance pieces must be 10 x DN.

Installation (electrical conditions):

To avoid interference from the outside as well as to obtain an electrical interface to MULTICAL®, it is recommended to use a Pulse Tester (see *paragraph 9.5*) or to connect ULTRAFLOW® and the relevant test equipment that counts pulses via a galvanically separated output module.

9.5 Pulse Tester

During a calibration process it is often practical to use Pulse Tester type No. 66-99-279 with the following functions:

- Galvanically separated pulse outputs
- Integral supply for ULTRAFLOW®
- LCD-display with counter
- Externally controlled "Hold" function
- Can be mounted directly in a MULTICAL® base unit (type 66- and 602-)

9.5.1 Technical data of Pulse Tester

Pulse inputs (M1/M2)

Counter inputs	Max. frequency: 128 Hz
Active signal	Amplitude: 2.5 - 5 Vpp
Pulse duration	> 1 ms
Passive signal	Internal pull-up 680 kΩ
Internal supply	3.65 V lithium battery

Please note: Depending on the connecting base used there are one or two pulse inputs/outputs.

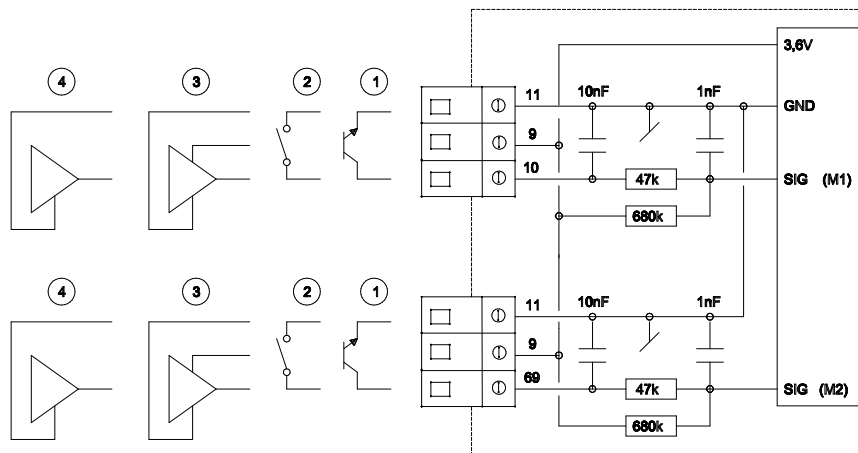


Figure 45

1 Flow sensor with transistor output

The transmitter is normally an optocoupler with FET or transistor output to be connected to terminals 10 and 11 for water meter M1 or terminals 69 and 11 for water meter M2.

The leak current of the transistor must not exceed 1 μA in off-state, and U_{CE} in on-state must not exceed 0.5 VDC.

2 Flow sensor with relay or reed-switch output

The transmitter is a reed-switch, which is normally mounted on vane wheel and Woltmann meters, or the relay output of e.g. MID-meters. This type of transmitter should not be used as the quick pulse input of the Pulse Tester may regard bounce from the transmitter as pulses.

3 **Flow sensor with active pulse output, powered by the Pulse Tester**

This connection is used together with either Kamstrup’s ULTRAFLOW® or Kamstrup’s electronic pick-up for vane wheel meters.

Connection (M1)	9: Red (9A)	10: Yellow (10A)	11: Blue (11A)
Connection (M2)	9: Red (9A)	69: Yellow (10A)	11: Blue (11A)

Table 18

4 **Flow sensor with active output and integral supply**

Flow sensors with active signal output are connected as shown in *Figure 46*. The signal level must be between 3.5 V and 5 V. Higher signal levels can be connected via a passive voltage divider, e.g. of 47 kΩ/10 kΩ at a signal level of 24 V.

Pulse outputs (M1/M2)

Pulse duration > 4 ms
 Duration of pause Depending on the actual pulse frequency

Two-wire connection:

Voltage < 24 V
 Load > 1.5 kΩ

Three wire connection:

Voltage 5...30 V
 Load > 5 kΩ

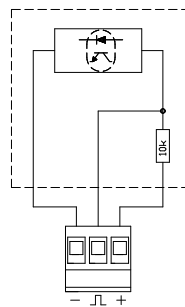


Figure 46

The outputs are galvanically separated and protected against overvoltage and reversed polarity.

Max. counter capacity before overflow is 9,999,999 counts.

9.5.2 Hold-function

When the Hold input is activated (high level applied to input), counting stops at the counted pulse figure.

When the Hold signal is removed (low level applied to input), counting restarts.

The counters can also be reset by pressing the right key on the front panel (Reset).

Hold input	Galvanically separated
Input protection	Against reversed polarity
“Open input”	Count (see <i>Figure 47</i>)

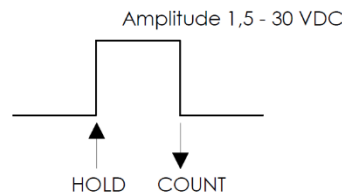


Figure 47

9.5.3 Push-button functions



Figure 48. The left push-button shifts between readings/counts of the two flow sensor inputs. In the display, M1 and M2 respectively indicate the currently displayed flow sensor inputs/counters.

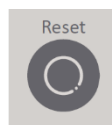


Figure 49. The right push-button resets the two counters (M1 and M2).

9.5.4 Using Pulse Tester

The Pulse Tester can be used as follows:

- Standing start/stop of flow sensor using the integral pulse counters.
- Standing start/stop of flow sensor using the pulse outputs for external test equipment.
- Flying start/stop of flow sensor using the integral counters controlled by external equipment (Sample & Hold).
- Flying start/stop of flow sensor using the pulse outputs controlled by external equipment (Sample & Hold).

9.5.5 Spare parts

Description	Type No.
Battery D-cell	1606-064
Cable retainer (secures the battery)	1650-099
2-pole plug (female)	1643-185
3-pole plug (female)	1643-187
PCB (66-R)	5550-517

Table 19. Spare parts for Pulse Tester.

9.5.6 Battery replacement

If the Pulse Tester is used continuously we recommend that the battery is replaced once a year.

Remove the battery plug from the battery and strip the cable insulation before connecting the battery to the terminals marked "Batt", the red wire to + and the black one to -.

Current consumption:

Current consumption with no sensors connected	400 μ A
Max. current consumption with two ULTRAFLOW® connected	1.5 mA

Note: If the base unit is fitted with battery or externally supplied, the Pulse Tester's integral supply must be disconnected (unplugged).

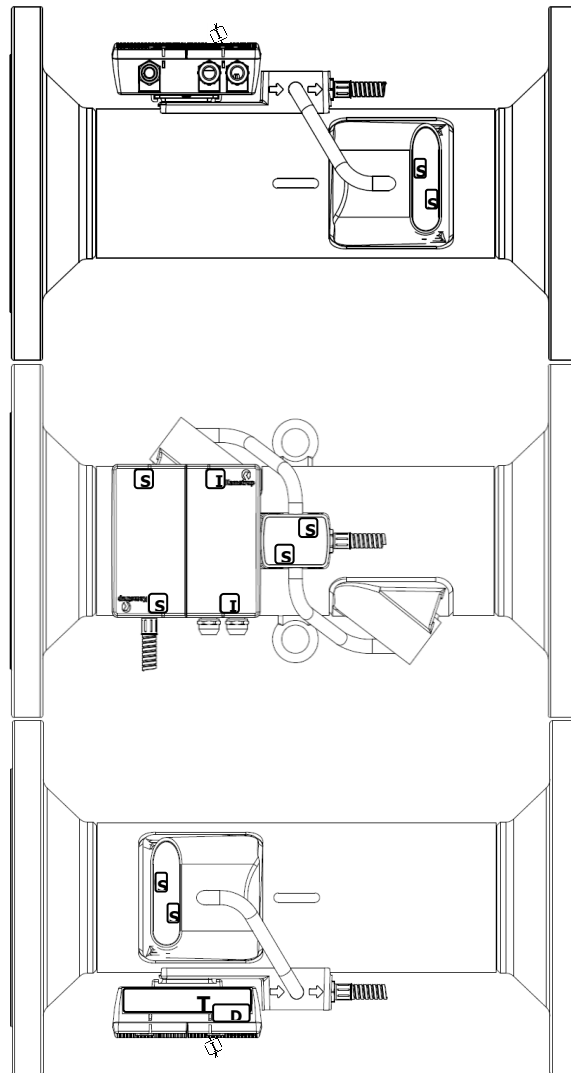
9.6 Sealing

ULTRAFLOW® is factory sealed. Verified sensors will be supplied with security seals (S) and a year mark (D).

If the seal of a verified sensor is broken, the sensor must be verified before being installed in a location demanding verification.

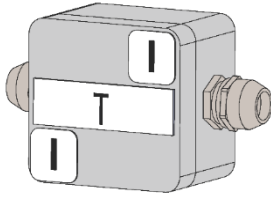
Sealing of ULTRAFLOW® 54 is shown below.

Please note: Sealing requirements may vary due to national regulations.

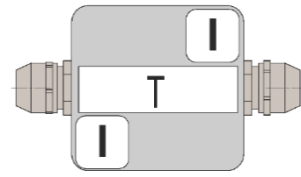


- D** Security seal or module D/F label (Depending on type label)
- S** Security seal. Covering screws
- T** Type label (as void label or with security seal D)
- I** Installation seal (wire and seal or sealing label)

Figure 50. Sealing and marking of ULTRAFLOW® 54 DN150-300.



(a)



(b)

Figure 51. Sealing of Cable Extender Box seen from the front (a) and from the side (b).

10 Software for Kamstrup heat/cooling meters

To adjust ULTRAFLOW® and to programme Pulse Divider, the software METERTOOL HCW 6699-724 is used. For more information, see the Technical description of METERTOOL HCW (5512-2097_GB).

11 Approvals

11.1 MID and DK-BEK 1178 – 06/11/2014

ULTRAFLOW® 54 is available as a flow sensor for heating installations with CE-marking according to MID (2014/32/EU). The certificates have the following numbers:

EC-Type Examination certificate (B-Module): DK-0200-MI004-008

MID-certificate acc. to Module D: DK-0200-MID-D-001

ULTRAFLOW® 54 is approved as a cooling flow sensor in accordance with DK-BEK 1178 – 06/11/2014:

System designation: TS 27.02 002

Verification: DANAK accreditation 268

Please contact Kamstrup A/S for further details on type approval and verification.

Standard: EN 1434:2015

11.2 CE-Marking

In addition, ULTRAFLOW® 54 is marked according to the following directives:

EMC directive 2014/30/EU

LV directive 2014/35/EU (when fitted with 230 VAC supply module)

PE directive 2014/68/EU (DN150...DN300) category II

11.3 EU declaration of conformity

With each ULTRAFLOW® 54 DN150-300 delivered from Kamstrup, an EU declaration of conformity is provided. See Kamstrup documentation No. 5518-309.

12 Troubleshooting

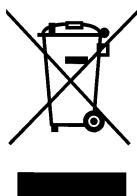
Before sending in the sensor for repair or testing, please use the error detection table below to help you clarify the possible cause of the problem.

Symptom	Possible cause	Proposal for correction
No update of display values	No power supply	Replace battery or check mains supply
No display function (blank display)	No power supply and backup	Replace back-up cell. Replace battery or check mains supply
No accumulation of m ³	No volume pulses Incorrect connection	Check flow sensor connection. (Check with Pulse Tester, if necessary)
	Flow sensor inverted	Check flow sensor direction
	Air in sensor/cavitation	Check installation angle. Check if there is air in the system or cavitation from valves and pumps. If possible, try to increase the static pressure.
	Flow sensor error	Replace flow sensor/send sensor for repair
Erroneous m ³ accumulation	Erroneous programming	Check consistency between meter factor of calculator and flow sensor
	Air in sensor/cavitation	Check installation angle. Check if there is air in the system or cavitation from valves and pumps. Increase the static pressure, if possible
	Flow sensor error	Replace flow sensor/Send sensor for repair

13 Disposal

Kamstrup A/S holds an environmental certification according to ISO 14001, and as part of Kamstrup’s environment policy, materials that can be recovered environmentally correctly are used to the greatest possible extent.

Kamstrup A/S has climate accounts (Carbon footprint) for all meter types.



Kamstrup's heat meters are marked according to EU Directive 2012/19/EU and the standard EN 50419.

The purpose of the marking is to inform our customers that the heat meter cannot be disposed of as ordinary waste.

- **Disposal by Kamstrup A/S**

Kamstrup A/S accepts worn-out meters for environmentally correct disposal according to previous agreement. The disposal is free of charge to our customers, except for the cost of transportation to Kamstrup A/S.

- **The customer sends for disposal**

The meters must not be disassembled prior to dispatch. The complete meter is handed in for approved national/local disposal. Enclose a copy of this page in order to inform the recipient of the contents.

Lithium cells and meters including lithium cells must be forwarded as dangerous goods (see Kamstrup document 5510-408, "Lithium batteries - Handling and disposal").

Meter part	Material	Recommended disposal
Lithium cell (D-cell)	Lithium and thionyl chloride > UN 3091 < D-cell: 4.9 g lithium	Approved deposit of lithium cells
PCB	Coppered epoxy laminate, components soldered on	PCB scrap for concentration of metals
Signal cable for flow sensor	Copper with silicone mantle	Cable recycling
Supply cable	Copper with PVC mantle	Cable recycling
Electronics box, base & cover	Thermoplastic, PC 10% GF	Plastic recycling
Mounting fitting, distance piece for electronics box	Thermoplastic, PPS 40% GF	Plastic recycling
Housing, Cable Extender Box	Thermoplastic, ABS	Plastic recycling
ULTRAFLOW® sensor housing	Stainless steel, W.no. 1.4307	Metal recycling
Transducer holder	Stainless steel, W.no. 1.4308	Metal recycling
Transducer	Titanium	Metal recycling
Packing	Recycled cardboard and EPS	Cardboard and EPS recycling (Resy)

Please send any questions you may have regarding environmental matters to:

Kamstrup A/S
 Att.: Quality and environmental dept.
 Fax: +45 89 93 10 01
 info@kamstrup.com

14 Technical documentation

	Danish	English	German	Russian
Technical description				
ULTRAFLOW® 54/34 DN15-125	5512-2463	5512-2464	5512-2465	5512-2466
ULTRAFLOW® 44 DN15-125	5512-2598	5512-2599	5512-2600	5512-2601
ULTRAFLOW® 54 DN150-300	5512-875	5512-876	5512-877	5512-878
Data sheet				
ULTRAFLOW® 54 DN15-125	5810-1546	5810-1547	5810-1548	5810-1549
ULTRAFLOW® 34 DN15-125	5810-1244	5810-1273	5810-1274	-
ULTRAFLOW® 44 DN15-125	5810-1753	5810-1751	5810-1754	-
ULTRAFLOW® 54 DN150-300	5810-834	5810-835	5810-836	5810-837
Installation guide				
MULTICAL® 603 & ULTRAFLOW®	5512-2231	5512-2231	5512-2231	5512-2231
MULTICAL® 803 & ULTRAFLOW®	5512-2408	5512-2408	5512-2408	5512-2408
ULTRAFLOW® 54 DN150-300	5512-886	5512-887	5512-888	5512-889
Pulse Transmitter/Pulse Divider	5512-1387	5512-1421	5512-1422	-
Cable Extender Box	5512-2008	5512-2008	5512-2008	-

Table 20. Technical documentation for ULTRAFLOW®.

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