kamstrup

Technical Description

MULTICAL® 302

Kamstrup A/S · Industrivej 28, Stilling · DK-8660 Skanderborg · T: +45 89 93 10 00 · info@kamstrup.com · kamstrup.com

Contents

1 General description

MULTICAL® 302 is a static heat meter, cooling meter or combined heat/cooling meter based on the ultrasonic principle. The meter is intended for energy measurement in almost all types of thermal installations where water is used as the energy-conveying medium.

According to EN 1434 MULTICAL® 302 can be designated a "hybrid instrument", also called a compact meter. During production and initial verification in our factory the meter is treated as three separate units or "sub-assemblies" (flow sensor, calculator and temperature sensor pair) but after delivery the units must not be separated unless by an accredited laboratory.

If flow sensor, calculator or sensor pair have been separated and the seals broken, the meter is no longer valid for billing purposes. Furthermore, the factory guarantee no longer applies.

MULTICAL® 302 employs ultrasonic measuring technique, ASIC and microprocessor technology. A single board construction comprises all calculating and flow measuring circuits, which provides a compact and rational design and, in addition, exceptionally high measuring accuracy and reliability is obtained.

Volume is measured using bidirectional ultrasonic technique based on the transit time method, proven a long-term stable and accurate measuring principle. Two ultrasonic transducers are used to send sound signals with as well as against 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.

The temperature sensor type is Pt500 according to DS/EN 60751. Accurately matched Pt500 sensors measure the temperatures in inlet and outlet pipes. MULTICAL® 302 is supplied with a ø5,2 mm Pt500 sensor pair. One temperature sensor is mounted in the flow sensor from the factory and the other sensor is typically mounted as short direct sensor in e.g. a ball valve.

The accumulated heat energy and/or cooling energy can be displayed in kWh, MWh or GJ, all in the form of seven significant digits and measuring unit. The display has been specially designed to obtain long lifetime and sharp contrast in a wide temperature range.

Other reading options are: accumulated water consumption, operating hour counter, current temperature measurements, current flow and power readings. Furthermore, MULTICAL® 302 can display loggings, target day data, error hour counter, max. flow, max. power, information code and current date/time.

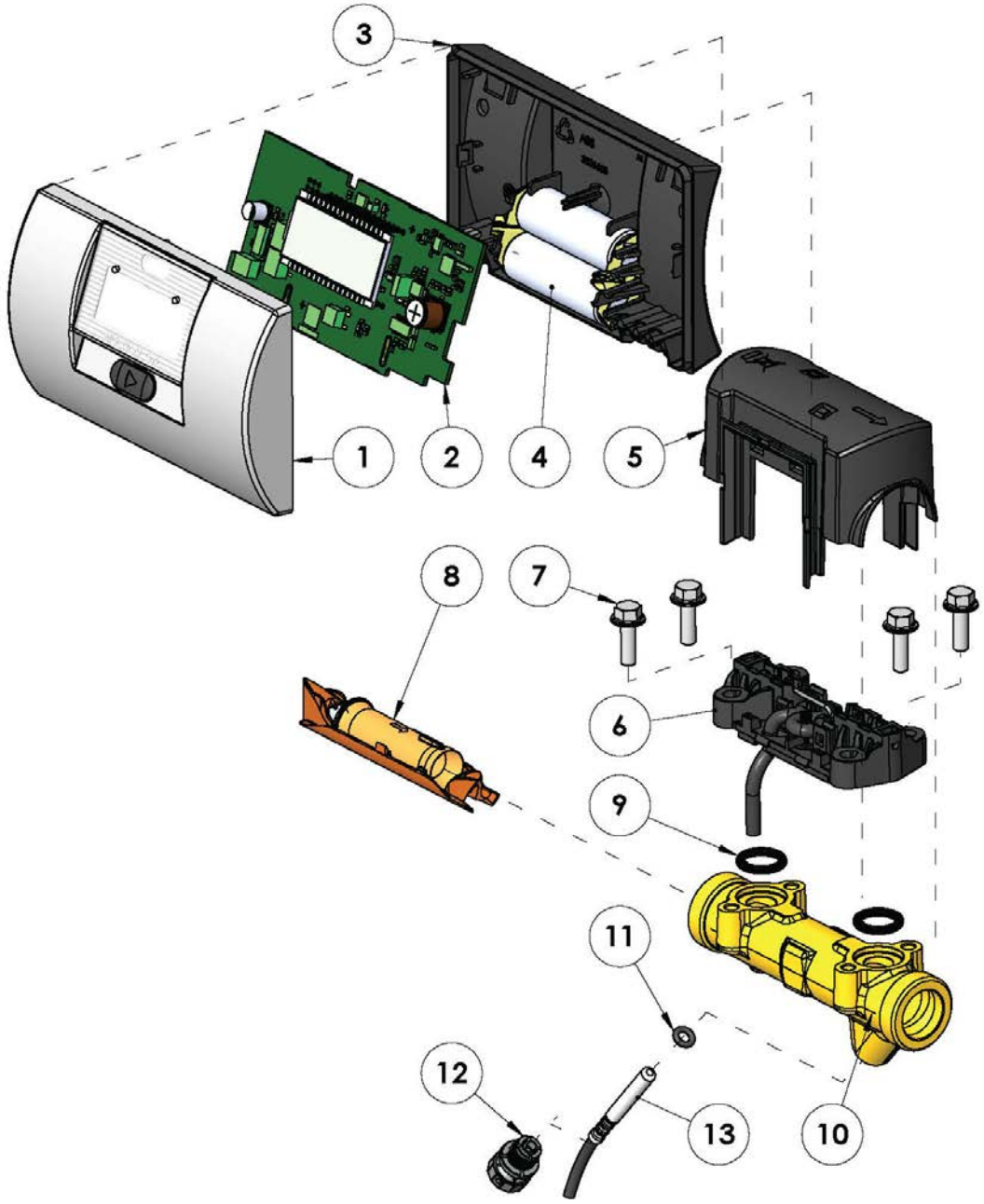
MULTICAL® 302 is powered by an internal A-cell lithium battery with 6-8 years' lifetime or by two A-cells with 12-16 years' lifetime.

MULTICAL® 302 is available with communication for either wired M-Bus and/or Wireless M-Bus.

In designing MULTICAL® 302 great importance has been attached to user comfort and compact external measurements, which makes it suitable for a wide range of applications.

This technical description has been written with a view to enabling operations managers, meter installers, consulting engineers and distributors to utilize all functions comprised in MULTICAL® 302. Furthermore, the description is targeted at laboratories performing tests and verification.

1.1 Mechanical construction



No.	Description
1	Front cover
2	Meter electronics
3	Calculator base
4	A-cell battery
5	Sealing cover for flow sensor
6	Transducer assembly with cable
7	Screws for top beam

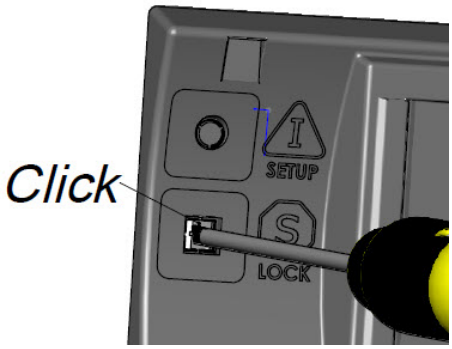
No.	Description
8	Meter tube assembly
9	O-rings
10	Hot brass casing
11	O-ring for temperature sensor
12	Coupling for temperature sensor
13	Temperature sensor ø5,2 mm

1.2 Seals

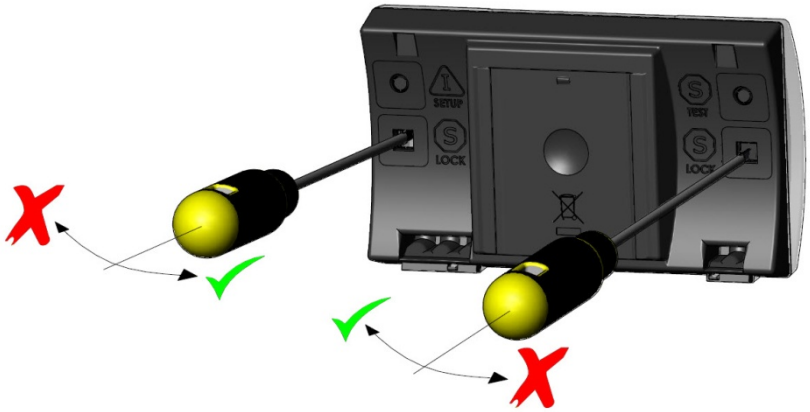
1.2.1 LOCK

The meter's front cover and base are assembled by means of a ”locking system” and the case cannot be separated without breaking the two seals marked Ⓢ LOCK.

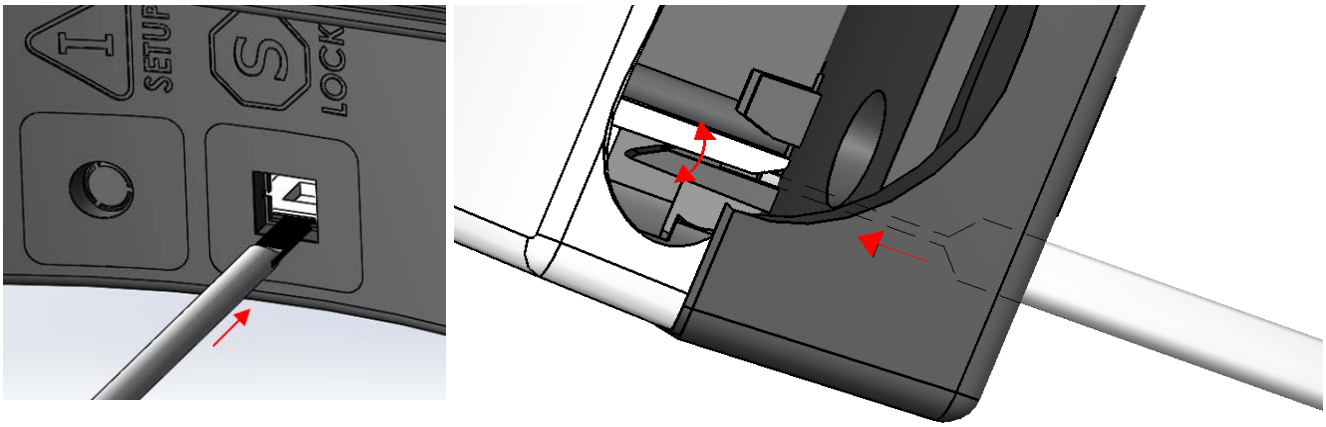
IMPORTANT: If the Ⓢ seals have been broken, the meter may no longer be used for billing. Therefore, the case may only be opened by an accredited laboratory with authorisation to reseal the meter after reverification.



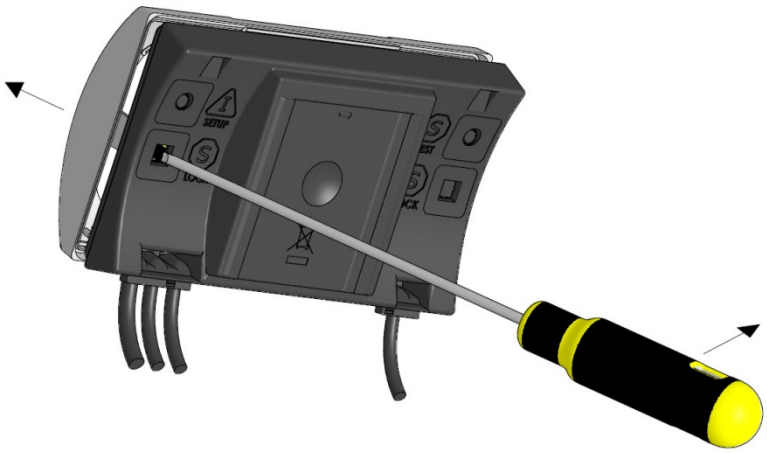
The seals are gently broken using a screwdriver.



The mechanical locks are released by carefully moving the screwdriver towards the centre of the meter.



Close-up illustration of locking function being released.



When the two mechanical locks have been released, remove the top cover from the base.

Reassembling the meter the seals must be re-established using 15 x 15 mm void labels. Note: If the meter is used for billing, this is a legal seal.

2 Technical data

2.1 Approved meter data

Approvals	DK-0200-MI004-031 and TS 27.02 001
Standards	EN 1434:2015
	EU directives Measuring Instruments Directive, Low Voltage Directive, Electro-magnetic Compatibility Directive, Pressurised equipment Directive, RoHS Directive

Heat meter approval, DK-0200-MI004-031

Temperature range	θ: 2 °C…150 °C	The stated minimum temperatures are only related to the type approval. The meter has no cut-off for low temperature and thus measures down to 0.01°C and 0.01 K.
Differential range	ΔΘ: 3 K…130 K	

Cooling meter approval, TS 27.02 001

Temperature range	θ: 2 °C…150 °C
Differential range	ΔΘ: 3 K…85 K

Alternative temperature ranges	θ: 2 °C…130 °C / ΔΘ: 3 K…110 K θ: 2 °C…50 °C / ΔΘ: 3 K…30 K
Accuracy	According to EN 1434
Temperature sensors	Pt500 – EN 60 751, 2-wire, hard-wired connection
EN 1434 designation	Accuracy class 2 and 3 / Environmental class A
MID designation	Mechanical environment: Class M2 Electromagnetic environment: Class E1
	Closed location (indoors), 5…55 °C

	Nom. flow	Max. flow	Min. flow		Min. cut-off	Saturation flow	Pressure loss Δp @ qp	Threaded connection on meter	Length
			100:1	250:1					
Type number	qp [m³/h]	qs [m³/h]	qi [l/h]	qi [l/h]	[l/h]	[m³/h]	[bar]		[mm]
302Txxxxx**10**xxx	0,6	1,2	6	-	3	3,0	0,03	G¾B	110
302Txxxxx**11**xxx	0,6	1,2	6	-	3	3,0	0,03	G¾B	130*
302Txxxxx**12**xxx	0,6	1,2	6	-	3	3,0	0,03	G¾B	165*
302Txxxxx**40**xxx	1,5	3,0	15	6	3	5,0	0,09	G¾B	110
302Txxxxx**41**xxx	1,5	3,0	15	6	3	5,0	0,09	G¾B	130*
302Txxxxx**42**xxx	1,5	3,0	15	6	3	5,0	0,09	G¾B	165*
302Txxxxx**70**xxx	1,5	3,0	15	6	3	5,0	0,09	G1B	130
302Txxxxx**71**xxx	1,5	3,0	15	6	3	5,0	0,09	G1B	190*
302Txxxxx**72**xxx	1,5	3,0	15	6	3	5,0	0,09	G1B	220*
302Txxxxx**A0**xxx	2,5	5,0	25	10	5	7,0	0,09	G1B	130
302Txxxxx**A1**xxx	2,5	5,0	25	10	5	7,0	0,09	G1B	190*
302Txxxxx**A2**xxx	2,5	5,0	25	10	5	7,0	0,09	G1B	220*

Table 1

*With extension piece

2.2 Electrical data

Calculator data	
Typical accuracy	Calculator: E_C ± (0,15 + 2/ΔΘ) % Sensor pair: E_T ± (0,4 + 4/ΔΘ) %
Display	LCD – 7 (8) digits with digit height 6 mm
Resolution	9999,999 – 99999,99 – 999999,9 – 9999999
Energy units	MWh – kWh – GJ
Data logger (Eeprom)	960 hours, 460 days, 24 months, 15 years, 50 Info-events, 25 config. logs
Clock/calendar	Clock, calendar, leap year compensation, target date
Data communication	KMP protocol with CRC16 used for optical communication
Wired M-Bus	Protocol according to EN 13757-3:2013, 300 and 2400 Baud communication speed with automatic baud rate detection. Current consumption 1 unit load (1.5 mA). 1.5 m fixed 2-wire cable. Polarity independent.
wM-Bus	Mode C1 protocol according to EN 13757-4:2013. Individual 128 bit AES encryption. Transmission interval 16 s Mode T1 OMS protocol according to EN13757-4:2013 and OMS Specification Volume 2 issue 3.0.1. Individual 128 bit AES encryption. Transmission interval 15 min.
Power of temperature sensors	< 0,5 µW RMS
Supply voltage	3,6 VDC ± 0,1 VDC
EMC data	Fulfils EN 1434 class A (MID class E1)

Temperature measurement				
2-Wire Pt500	T1 Inlet temperature	T2 Outlet temperature	ΔΘ (T1-T2) Heat metering	ΔΘ (T2-T1) Cooling metering
Measuring range	0,00…155,00 °C	0,00…155,00 °C	0,01…155,00 K	0,01…155,00 K

Battery	3,65 VDC, 1 x A-cell lithium	3,65 VDC, 2 x A-cell lithium
Battery lifetime		
t_{BAT} < 30 °C	8 years	16 years
t_{BAT} < 45 °C	6 years	12 years
	Data modules, frequent data communication and high ambient temperature reduce the battery lifetime	
	NB: With Mode T1 BSI, the above battery lifetime is halved, e.g. to 8 years with 2 x A cell lithium (t_{BAT} < 30 °C)	
Lithium content	0,96 g	2 x 0,96 g
Transport class	Not subject to dangerous goods regulations	
Outside the USA	Non-restricted to transport/Non-assigned to Class 9	
Within the USA	Belonging to the category of ”small primary lithium cells”	

Important: Change of battery on MC302 may only be performed by a Kamstrup service centre.

2.3 Mechanical data

Environmental class: Fulfils EN 1434 class A (MID class E1) and class M2

	Protection class	Ambient temperature	Environmental class	
Calculator	IP65	5…55 °C	Non-condensing	Indoors (closed position)
Flow sensor and sensor pair	IP68		Condensing	

Medium temperatures

Heat meters 302-T	2…130 °C	At medium temperatures below the ambient temperature the calculator must be wall mounted in order to prevent condensation.
Cooling meters 302-T	2…130 °C	
Heat/cooling meters 302-T	2…130 °C	At medium temperatures above 90 °C in the flow sensor the calculator must be wall mounted in order to prevent too high temperature, especially in relation to display and battery lifetime.
Cooling meters 302-C	2…50 °C	

Medium in flow sensor	Water
Storage temperature	-25…60 °C (drained flow sensor)
Pressure stage (with thread)	PN16 and PN25
Weight	From 0,7 to 1,1 kg depending on flow meter size and extension piece
Flow sensor cable	1,2 m (undemountable cable)
Temperature sensor cables	1,5 m (undemountable cables)

2.4 Material

Wetted parts	Flow sensor case	Hot dezincification proof brass (CW 602N)
	Diaphragms	Stainless steel, W.no. 1.4404
	O-rings	EPDM
	Measuring tube	Thermoplastic, PES 30% GF
	Reflectors	Thermoplastic, PES 30% GF and stainless steel, W.no. 1.4306
Flow sensor cover Wall bracket	Thermoplastic, PC 20% GF	
Calculator case	Top	Thermoplastic, PC 10% GF
	Base	Thermoplastic, ABS with TPE gaskets (thermoplastic elastomer)
Cables	Flow sensor Temperature M-Bus	Silicone cable with inner Teflon insulation

2.5 Accuracy

Heat meter components	MPE according to EN 1434-1	MULTICAL® 302, typical accuracy
Flow sensor	Ef= ± (2 + 0,02 qp/q) %	Ef= ± (1 + 0,01 qp/q) %
Calculator	Ec= ± (0,5 + $\Delta\Theta_{min}/\Delta\Theta$) %	Ec= ± (0,15 + 2/$\Delta\Theta$) %
Sensor pair	Et= ± (0,5 + 3 $\Delta\Theta_{min}/\Delta\Theta$) %	Et= ± (0,4 + 4/$\Delta\Theta$) %

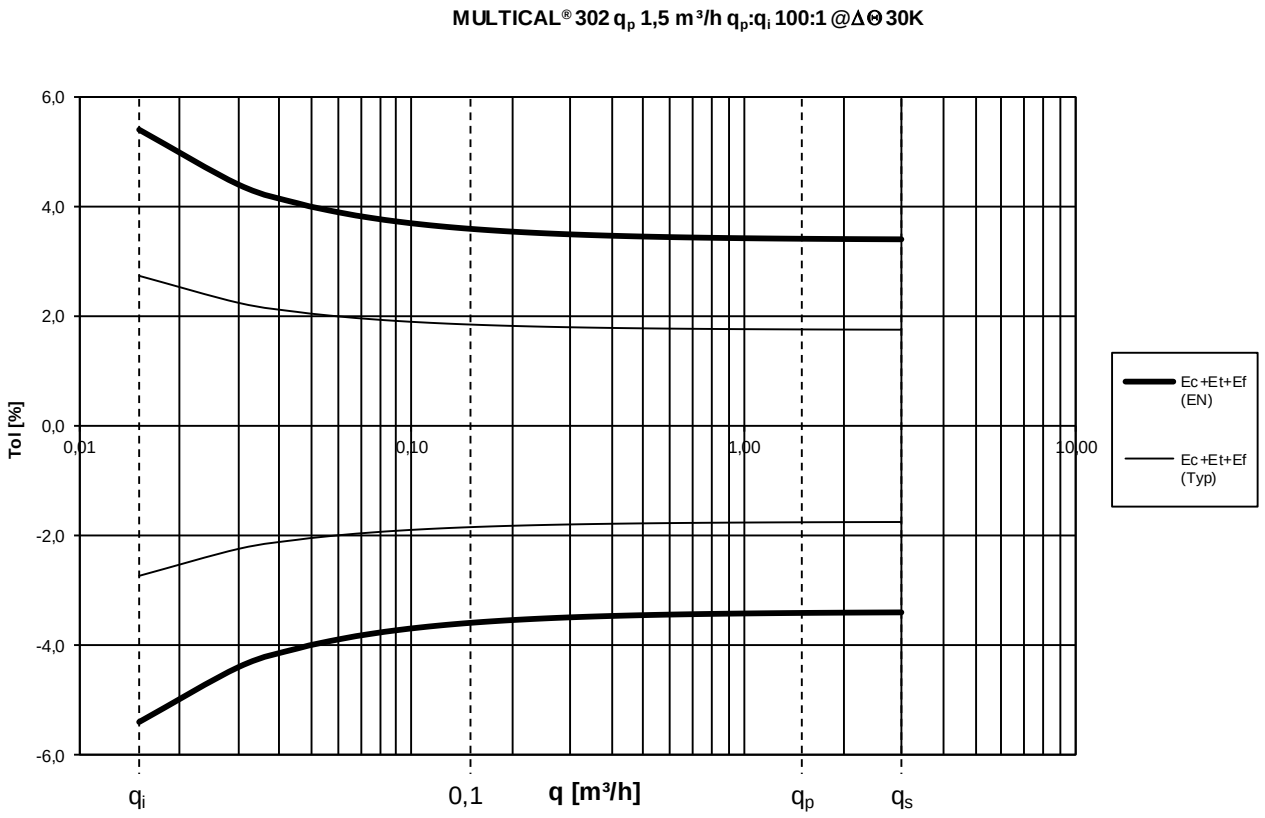


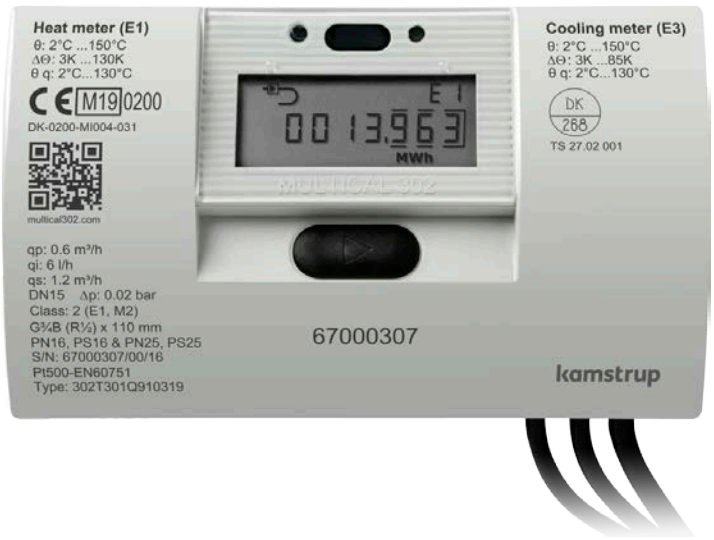
Diagram 1: Total typical accuracy of MULTICAL® 302 compared to EN 1434-1.

3 Type overview

MULTICAL® 302 can be ordered in various combinations as required by the customer. First select the required hardware from the type overview. Then select ”Config” and ”Data” to suit the application in question.

The meter is configured and ready for use from the factory. It can, however, be reconfigured before installation (see paragraph 8.4 Setup loop for further information).

3.1 Type and configuration overview



Type number

302-x-xx-x-xx-xx-xxx

Type number and serial number (factory set unique serial no.) are written on the meter and cannot be changed after production.

CONFIG ›AB‹

Inlet/outlet - Measuring unit - Resolution

- Can be changed via the pushbutton while the meter is still in transport state.
- Later, the seal ”I (SETUP)” must be broken and the switch activated in order to change the configuration.

CONFIG ›DDD‹

Display

Change only possible via METERTOOL provided that the seal ”I (SETUP)” is broken and the switch activated.

CONFIG ›EFGHHMMM‹

Other configurations (see paragraph 3.6)

Change only possible via METERTOOL provided that the seal ”I (SETUP)” is broken and the switch activated.

CONFIG ”ABDDD-EFGHHMMM” is not written on the meter, it can be read from the display.

DATA

- Can be changed via the pushbutton while the meter is still in transport state.
- Later, data can only be changed via METERTOOL provided that the seal ”I (SETUP)” is broken and the switch activated.
- Customer No.
- Target date
- Average peak time (Max. flow and power)
- θ_{hc} (only active for meter type 6)
- Date/time
- M-Bus primary address

3.2 Type number composition

Type 302-	□	□□	□	□□	□□	□	□□
Basic version							
Pt500 Heat meter and Heat/cooling meter	**T**						
Pt500 Cooling meter	**C**						
Communication							
No communication		**00**					
M-Bus (comes with 1,5 m factory mounted cable)		**20**					
Wireless M-Bus, 868,95 MHz EU MHz (configurable mode C1 or T1)		**30**					
Wireless M-Bus, 868,30 MHz Alt. freq.		**31**					
Supply							
6-8 year battery, Normal Response meter			**1**				
12-16 year battery, Normal Response meter			**2**				
6-8 year battery, Fast Response meter			**3**				
Temperature sensors							
Pt500, ø5,2 mm temperature sensors with cable length 1,5 m and composite union				**Q9**			
Pt500, ø5,2 mm temperature sensors with cable length 1,5 m and brass union				**QF**			

Flow sensor qp [m³/h]	Connection	Length [mm]				
0,6	G¾B (R½)	110			**10**	
	DN15		With extension to 130 mm		**11**	
			With extension to 165 mm		**12**	
1,5	G¾B (R½)	110			**40**	
	DN15		With extension to 130 mm		**41**	
			With extension to 165 mm		**42**	
1,5	G1B (R¾)	130			**70**	
	DN20		With extension to 190 mm		**71**	
			With extension to 220 mm		**72**	
2,5	G1B (R¾)	130			**A0**	
	DN20		With extension to 190 mm		**A1**	
			With extension to 220 mm		**A2**	

Meter type			
Heat meter (MID module B+D)	θ_{hc} = OFF	**2**	
Heat/cooling meter (MID module B+D & TS27.02+DK268)	θ_{hc} = OFF	**3**	
Heat meter (National approval)	θ_{hc} = OFF	**4**	
Cooling meter (TS27.02+DK268)	θ_{hc} = OFF	**5**	
Heat/cooling meter	θ_{hc} = ON	**6**	
Country code (language on label etc.)			**XX**

The flow sensors are type approved for dynamic ranges q_p:q_i = 250:1 and 100:1, but basically 100:1 is supplied.

Extension pieces, if any, are separately enclosed in the packing.

3.2.1 Integration time

Depending on selected type number MULTICAL® 302 is from the factory configured for integration (energy calculation) every 32 seconds or every 8 seconds.

Supply	
6 year battery, Normal Response meter	**1**
12 year battery, Normal Response meter	**2**
6 year battery, Fast Response meter	**3**

Among other things the meter's current consumption depends on the integration frequency of the meter. A Fast Response meter integrates every 8 seconds and uses almost twice as much current as a Normal Response meter. This means that the battery life is halved.
Normal Response cannot be changed to Fast Response and vice versa after delivery.

3.2.2 Configuration during setup of country code

The last two characters of the type number are called the country code. The code is used for setting up language of text on label e.g. class 2 or 3, dynamic range, pressure stage PN16 or PN25, and indicates approval and verification marks.

Please contact Kamstrup for further details on available country codes. Currently available country codes appear from internal document 5514-863 on Kamstrup's Intranet.

3.2.3 Accessories

3026-1034	Plastic seal, black, for ø 5,2 mm sensors w/union
1150-161	O-ring ø4,3 x 2,4 for temperature sensor
4000-008	Mounting tool for temperature sensor incl. O-ring
3026-655.A	Wall fitting (LEXAN 3412R black), with screws and plugs
3026-655	Wall fitting (LEXAN 3412R black)
3026-909	Holder for optical reading head
6699-042	Metal plate for optical readout head (20 pcs.)
3130-362	Blind plug for temperature sensor in flow part (copper alloy brass, CW614N)
4000-010	Union nut set for temperature sensors (copper-alloyed brass, CW617N)
6556-546	R½ x M10 nipple (copper alloyed brass, CW614N)
6556-547	R¾ x M10 nipple (copper alloyed brass, CW614N)
6557-302	G½ sensor pocket 35 mm (copper alloy brass, CW614N)
6699-099	Infra-red optical reading head w/USB plug
6699-304	Infra-red optical reading head for NOWA
6699-016	Kamstrup NOWA KAS software
6699-724	METERTOOL HCW
6699-725	LogView HCW

Note: Ball valves with M10x1 socket (type: 6556-474, -475 and -476) are not suitable for sensors with O-ring seal as they are intended for flat gaskets.

3.2.3.1 Couplings (PN16):

Article number	Size	Nipple	Coupling
6561-323	DN15	R½	G¾
6561-324	DN20	R¾	G1

Material: Copper alloy brass, CW617N (Coupling). Copper alloy brass, CW602N (Nipple)

3.2.3.2 Gaskets for couplings:

Article number	Size (coupling)
3130-126	G¾
3130-127	G1

3.2.3.3 Extension pieces:

Article number	Description	Length [mm]	Total length [mm]
6556-505	Extension piece G¾B	20	130
6556-506	Extension piece G¾B	55	165
6556-507	Extension piece G1B	60	190
6556-508	Extension piece G1B	90	220

Material: Copper alloy brass (CW614N)

3.3 Config. ›A-B‹

The legal parameters of the meter are determined by Config., which can only be changed before installation when the meter is still in transport state, or after breaking the seal "I (SETUP)" and activating the switch.

The **code A** indicates installation of the flow sensor in inlet or outlet pipe. As the density and specific heat capacity of water varies with temperature, the calculator must compensate for the installation type in question. Wrong configuration or installation will result in a measuring error. Further details on installation of flow sensor in inlet and outlet as far as heat and cooling meters are concerned appear from section 6.6.

The **code B** indicates the measuring unit used for energy registration, GJ, kWh or MWh, as well as the display resolution.

		A	- B
Flow sensor position			
Inlet		**3**	
Outlet		**4**	
Measuring unit and resolution			
00000,01 GJ	00000,01 m³		**2**
0000,001 GJ	0000,001 m³		**6**
0000001 kWh	00000,01 m³		**3**
000000,1 kWh	0000,001 m³		**7**
0000,001 MWh	00000,01 m³		**4**

3.3.1 Dependency between measuring unit and resolution

	Number of decimals in display						
qp [m³/h]	**kWh**	**MWh**	**GJ**	**m³**	**l/h**	**m³/h**	**kW**
0,6	0	3	2	2	0	-	1
1,5	0	3	2	2	0	-	1
2,5	0	3	2	2	0	-	1
0,6	1	-	3	3	0	-	1
1,5	1	-	3	3	0	-	1
2,5	1	-	3	3	0	-	1

3.4 Config. ›DDD‹, Display coding

Display code ”DDD” indicates the active readings of each meter type in "User Loop". ”1” is the first indication. The display automatically returns to reading ”1” after 4 minutes. During normal operation the display readings of the selected DDD-code, which are connected to User loop, are shown. See examples of DDD-codes below.

User loop (Loop_1)		Heat meter DDD=217	Heat/cooling DDD=310	Heat meter DDD=410	Cooling meter DDD=510	Heat/cooling DDD=610
1.0	**Heat energy (E1)**	**1**	**1 *)**	**1**		**1 *)**
2.0	**Cooling energy (E3)**		**2 *)**		**1**	**2 *)**
3.0	**Volume**	**2**	**3**	**2**	**2**	**3**
4.0	**Hour counter**	**3**	**4**	**3**	**3**	**4**
5.0	**T1 (Inlet)**	**4**	**5**	**4**	**4**	**5**
6.0	**T2 (Outlet)**	**5**	**6**	**5**	**5**	**6**
7.0	**T1-T2 (Δt)** (Cooling shown by -)	**6**	**7**	**6**	**6**	**7**
8.0	**Flow**	**9**	**8**	**7**	**7**	**8**
9.0	**Power**	**10**	**9**	**8**	**8**	**9**
10.0	**Info Code**	**11**	**10**	**9**	**9**	**10**
11.0	**Customer number (N° 1)**	**12**	**11**	**10**	**10**	**11**
12.0	**Customer number (N° 2)**	**13**	**12**	**11**	**11**	**12**
13.0	**E8 (m^3 x T1)**	**7**				
14.0	**E9 (m^3 x T2)**	**8**				

*) The display order of DDD=3xx and 6xx can either start with ”E1-E3” or ”E3-E1”.

DDD=210/310/410/510/610 are ”standard codes” used by default. A complete overview of all created DDD-codes appears from Kamstrup document 5512-1256.

The different loops are described in paragraph 8.

3.5 Energy overview

The above-mentioned energy types E1, E3, E8 and E9 are calculated as follows:

Formula	Example of application	Condition (country code 6xx only)	
E1=V1(T1-T2)	Heat energy (V1 in inlet or outlet) T1 > T2	T1 > θ_{hc} (Inlet temperature must be higher than the limit value)	Legal Display/Data/Log
E3=V1(T2-T1)	Cooling energy (V1 in inlet or outlet) T2 > T1	T1 < θ_{hc} (Inlet temperature must be lower than the limit value)	Legal Display/Data/Log
E8=m^3 x T1	Used for calculation of average temperature of inlet pipe	None	Display/Data/Log
E9=m^3 x T2	Used for calculation of average temperature of outlet pipe	None	Display/Data/Log

θ_{hc} is the temperature, at which the meter shifts between heat and cooling measurement. The typical value is 25 °C, but other values can be supplied as required.
If θ_{hc} is set at 180 °C the function is disconnected, e.g. to be used for ”purchase/sale” of heat. See paragraph 7.4 for further information on heat/cooling meters.

3.6 CONFIG ›EFGHHMMM‹

The configuration can only be changed via METERTOOL HCW provided that the seal is broken and the switch activated.

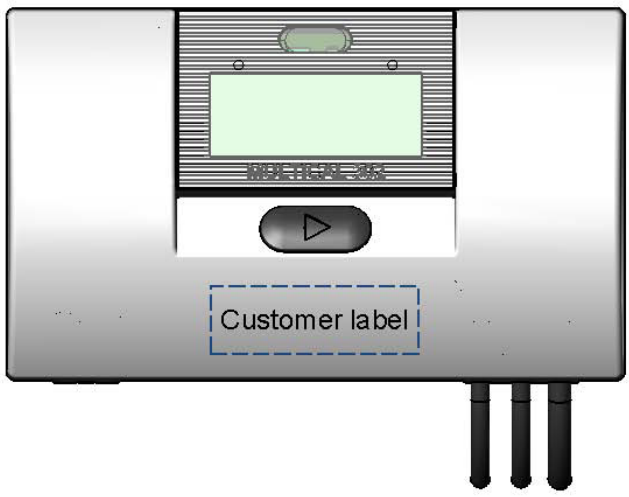
	E	F	G	HH	MMM
Info codes					
Dynamic (Info codes are automatically deleted when the error has been remedied)	1				
Static (Info codes can only be deleted by means of METERTOOL HCW)	2				
Wired M-Bus protocol					
Standard frame format *)		3			
wM-Bus Encryption					
Encryption with common (customer) key			2		
Encryption with individual key			3		
wM-Bus protocol					
Mode C1 according to EN 13757 (16 s interval), yearly target data				01	
Mode C1 according to EN 13757 (16 s interval), monthly target data				02	
Mode C1 according to EN 13757 (16 s interval), yearly target data incl. E8 and E9				11	
Mode C1 according to EN 13757 (16 s interval), monthly target data incl. E8 and E9				12	
Mode T1 OMS (900 s interval), yearly target data				03	
Mode T1 OMS (900 s interval), monthly target data				04	
Customer label 2012-MMM					000

*) Monthly data is transmitted by default. Change to yearly data possible by means of an M-Bus command. For further details we refer to the Technical description of M-Bus for MULTICAL® 302.

Note: Green marking indicates standard.

3.6.1 Customer label

In lower middle part of the meter an area of 15 x 38 mm is reserved for customer labels, e.g. utility logo, bar code, serial number or similar according to customer requirements. Unless otherwise specified in the order, MULTICAL® 302 will be supplied with customer label no. 2012-000, which comprises the meter's customer number.



Please contact Kamstrup for creation of new customer labels.

3.6.2 Configuration data

In addition to Config. ›EFGHHMMM‹ values must be entered in the below-mentioned fields during production of MULTICAL® 302. Unless otherwise specified in the order, MULTICAL® 302 will be supplied with "Automatic" and "Default" data as listed below.

	Automatic	**To be stated in order**	**Default**
Serial number (S/N) * and year (year, however, only on the front)	67.000.000/2013	-	-
Customer No. Display No. 1 = 8 digits MSD Display No. 2 = 8 digits LSD	-	Up to 16 digits In the order system limited to 11 digits due to PcBase compatibility	Customer number = S/N
Target date	-	MM=1-12 and DD=1-28	Dep. on country code setup
Average time of max. P and Q	-	1…1440 min.	60 min.
θ_{hc} Heat/cooling shift Only active with meter type 6 See paragraph 7.4 for functionality	-	0,01…150,00 °C. θ_{hc} = 180,00 °C switches off the function so that the meter can be used for "purchase/sale" of heat	25,00 °C
Date/time	YYYY.MM.DD/hh.mm.ss GMT+offset acc.to del. code	GMT ± 12,0 hours (30 min. in leaps)	-
M-Bus primary addr.		Address 0-250	Deduced from the last 2-3 digits of the customer number
M-Bus ID-No. (used for secondary address)			Customer No.
wM-Bus ID-No.			Serial number

** S/N 67.000.000 to 68.499.999 have been reserved for MC302*

3.6.3 Other functions

Creating an order in BOS you can choose "fixed M-Bus addr" which means that all meters included in the order in question will be configured with the same M-Bus address.

3.6.4 Internal configuration overview

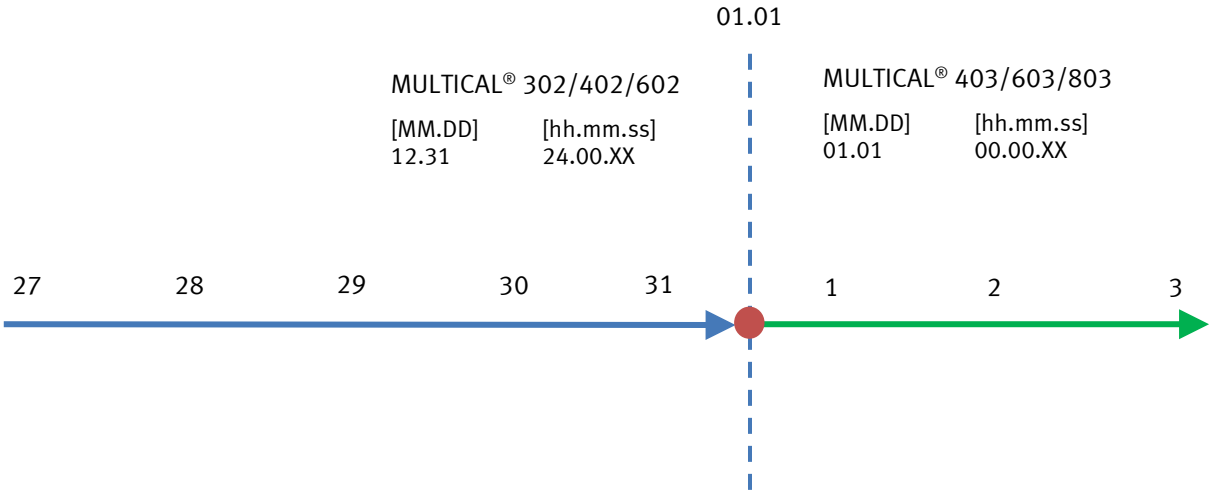
See instructions no. 5508-825 concerning update of configuration.

3.6.5 Target date

MULTICAL® 302 can be configured with up to two monthly target dates. These dates determine on which date data is to be logged (saved) in the meter's interval logger. Unlike new meters, a time stamp is not included in MULTICAL® 302, which simply stamps data with a date. This difference also means that the date stamps of MULTICAL® 302 and new meters vary in spite of the fact that the meters are configured with the same target date, e.g. 01.01 [MM.DD]. Note that although the date stamps of the meters differ, the meters will in practice log (save) data at the same time. This is illustrated by the following example:

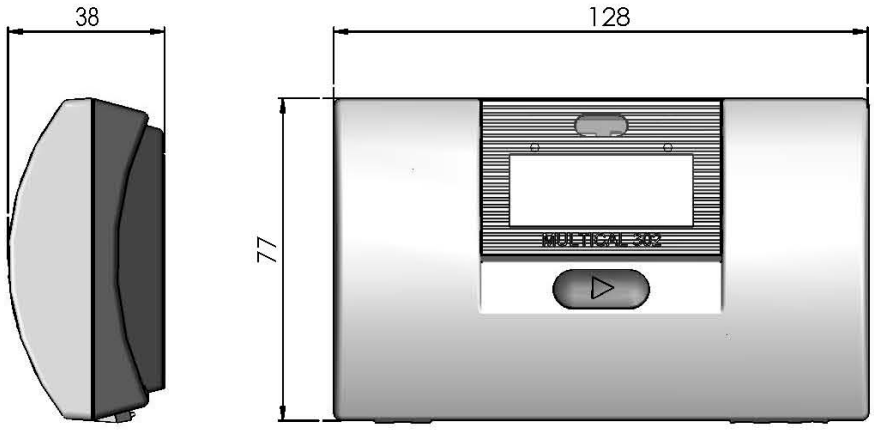
	MULTICAL® 302/402/602	***MULTICAL® 403/603/803***
Yearly target date [MM.DD]	01.01	01.01
Monthly target date [DD]	01	01
Date/time [20YY.MM.DD/ hh.mm.ss]	2018.12.31 / 24.00.XX [1]	2019.01.01 / 00.00.XX

[1] *Note that it is not possible to read out this time stamp from the meter.*

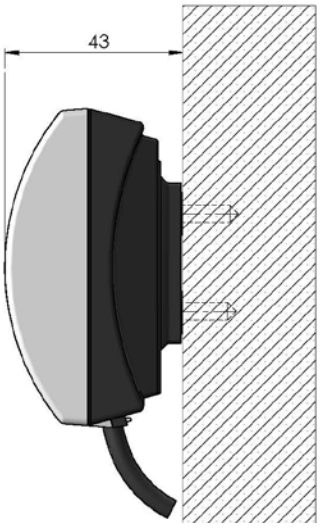


4 Dimensioned sketches

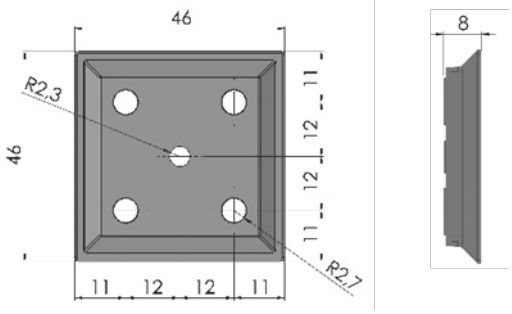
Calculator



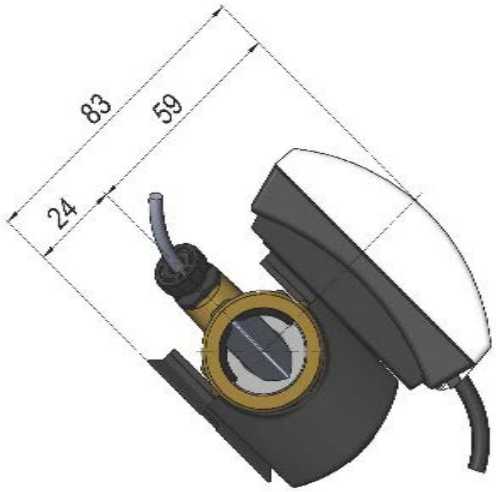
Wall-mounted calculator



Wall fitting for calculator

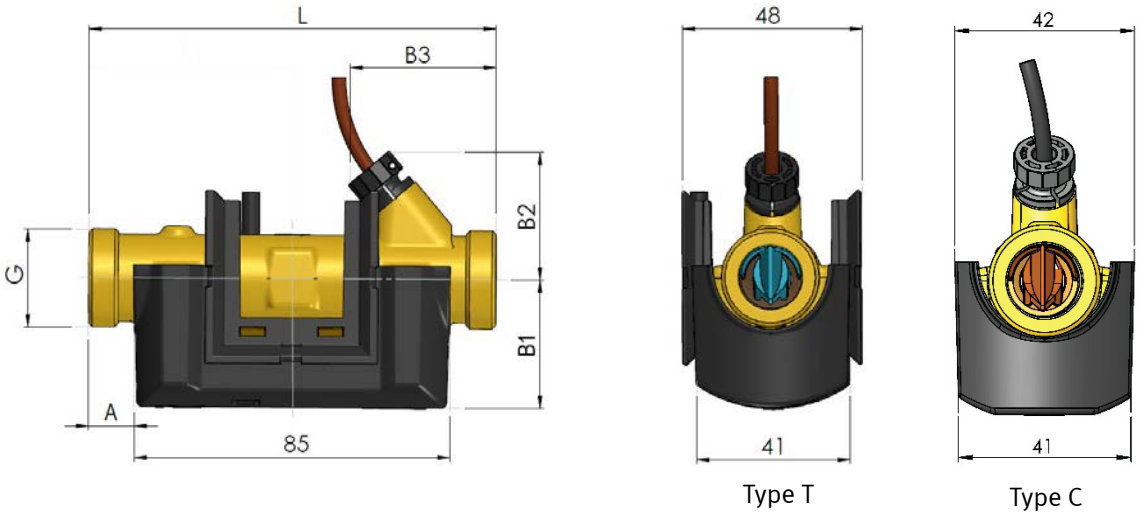


MULTICAL® 302 mounted on flow sensor

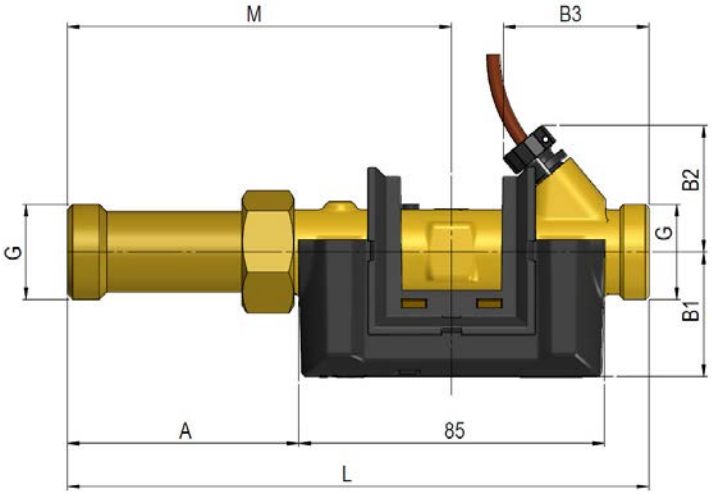


All measurements in [mm]

Flow sensor



Thread	L	A	B1	B2	B3	Approx. weight [kg] *)
G¾B (R½)	110	12	35	35	40	0,7
G1B (R¾)	130	22	38	38	50	0,8



Thread	L	M	A	B1	B2	B3	Approx. weight [kg] *)
G¾B (R½)	130	73	30	35	35	40	0,8
G¾B (R½)	165	109	66	35	35	40	0,8
G1B (R¾)	190	124	81	38	38	50	1,0
G1B (R¾)	220	154	111	38	38	50	1,1

All measurements in [mm]

*) The weight indication comprises the whole meter incl. flow sensor, calculator, sensor pair and 2 x A batteries. Enclosed accessories such as couplings, nipples and sensor pockets, if any, as well as packing are not included in the weight indication.

5 Pressure loss

Pressure loss in a flow sensor is stated as max. pressure loss at q_p. According to EN 1434 maximum pressure must not exceed 0.25 bar.

The pressure loss in a sensor 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 [m³/h]

Δp = pressure loss [bar]

Graph	q_p [m³/h]	Housing	Nom. diameter [mm]	$\Delta p@q_p$ [bar]	kv	Q@0.25 bar [m³/h]
A	0,6	G3/4B x 110 mm	DN15	0,02	4,89	2,4
A	1,5	G3/4B x 110 mm	DN15	0,09	4,89	2,4
B	1,5	G1B x 130 mm	DN20	0,07	5,71	2,9
C	2,5	G1B x 130 mm	DN20	0,09	8,15	4,1

Table 2: Approximated pressure loss table

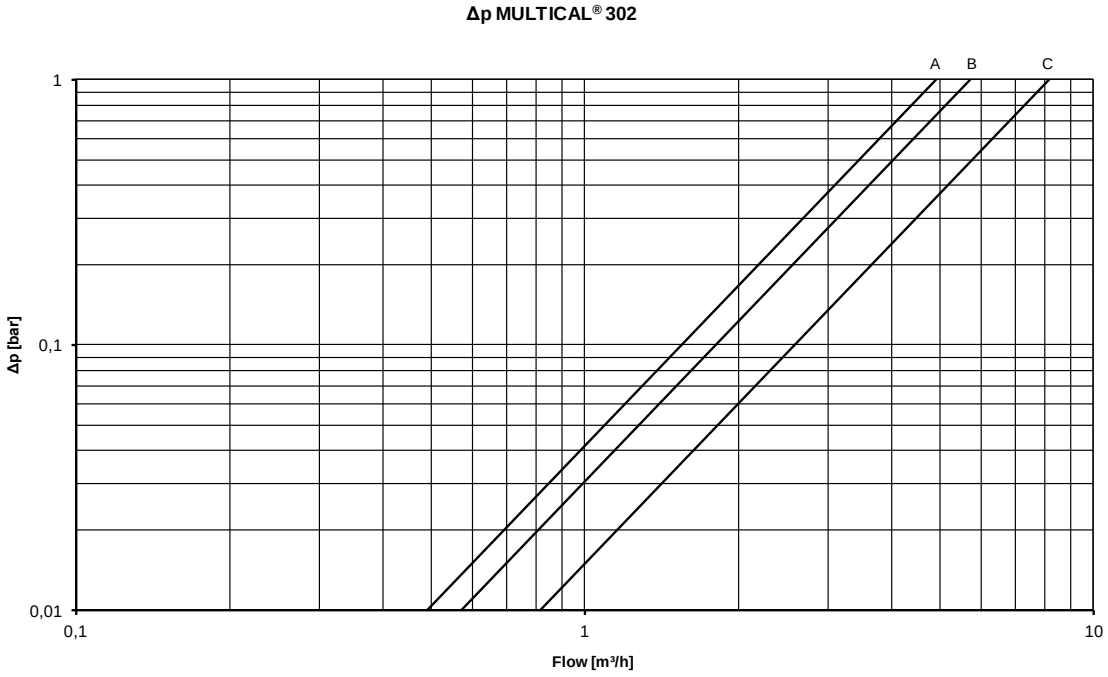


Diagram 2: Pressure loss graphs

5.1 Calculation of pressure loss

The pressure loss at a given water flow can be calculated as: $\Delta p=(Q/kv)^2$.

Example: a qp 1,5 meter with a current flow of 0,5 m³/h: $\Delta p=(0,5/5)^2 = 0,01$ bar

6 Installation

6.1 Installation requirements

Prior to installation of MULTICAL® 302 the heating system should be flushed while a fitting piece replaces the meter. Remove the adhesive wafers from the meter's inlet and outlet and mount the flow sensor with couplings. New fibre gaskets in original quality must be used. The flow sensor must be mounted with the arrow pointing in the flow direction.

If other couplings than the original ones from Kamstrup A/S are used you must make sure that the threaded lengths of the couplings do not prevent proper tightening of the sealing surface.

Correct mounting of flow sensor in inlet or outlet appears from the display.

Example of display reading if the meter is configured for "flow sensor in inlet pipe"

Example of display reading if the meter is configured for "flow sensor in outlet pipe"

In order to prevent cavitation the operating pressure at the flow sensor must be min. 1 bar at qp and min. 2 bar at qs. This applies to temperatures up to approx. 80 °C. See paragraph 6.5 for further information on operating pressure.

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

The flow sensor must not be exposed to lower pressure than the ambient pressure (vacuum).

Permissible operating conditions

Ambient temperature:	5…55 °C (indoors). Max. 30 °C for optimum battery lifetime.
Temperature of medium:	2…130 °C with calculator mounted on a wall 15…90 °C with calculator mounted on flow sensor
System pressure:	1…16 bar or 1…25 bar depending on the meter's marking

Service

When the meter has been mounted in the heating system neither welding nor freezing is allowed. Dismount the meter from the heating system before starting such work.

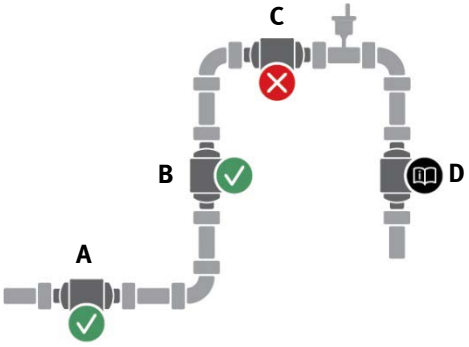
In order to facilitate replacement of the meter, closing valves should be mounted on both sides of the meter.

Under normal operating conditions no pipe strainer is required in front of the meter.

6.2 Inlet prerequisites

Kamstrup's flow sensors require neither straight inlet nor straight outlet to meet the Measuring Instruments Directive (MID) 2014/32/EU, OIML R75:2002 and EN 1434:2015. A straight inlet section will only be necessary in case of heavy flow disturbances before the meter. It is recommended to follow the guidelines in *CEN CR 13582, Heat meter installation. Instructions in selection, installation and use of heat meters*.

Optimal position can be obtained, if you take the below installation recommendations into consideration.



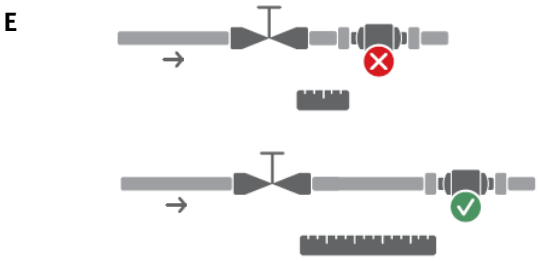
A Recommended flow sensor position.

B Recommended flow sensor position.

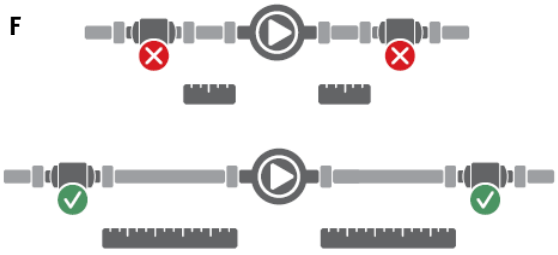
C Unacceptable position due to risk of air build-up.

D Acceptable position in closed systems.
Unacceptable position in open systems due to risk of air build-up in the system.

E A flow sensor ought not to be placed immediately after a valve, with the exception of shut-off valves (full bore ball valve type), which must be fully open when not used for shutting off.



F A flow sensor ought not to be placed immediately before (on the inlet side) or immediately after (on the pressure side) a pump.



G A flow sensor ought not to be placed immediately after a double bend in two planes.

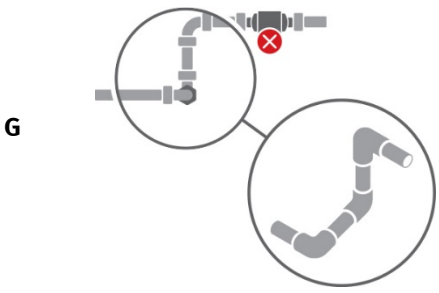
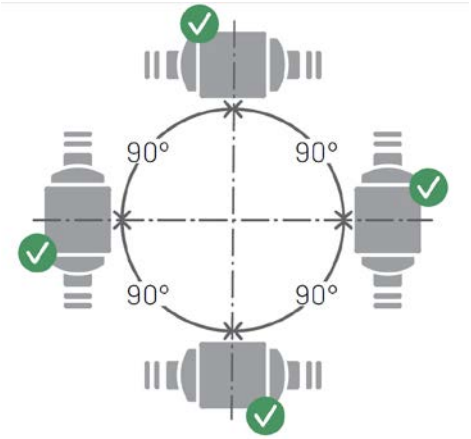


Figure 1 General installation recommendations for flow sensors.

6.3 Orientation of Kamstrup´s flow sensors

The recommended orientation of the flow sensor in an installation takes into account the metrological sensitivity of the flow sensor to orientation, for example because of orientation-dependent flow profiles; poor water quality of district heating water, e.g. dirt, which can accumulate in the flow sensor; air in the system and finally because of environmental requirements, for example in case of condensation. The recommendations may vary for each of the types because of their diversity in the design

6.3.1 General recommendations



Kamstrup's flow sensors can be mounted vertically, horizontally or at an angle.

If Kamstrup flow sensors are vertically mounted, they can be turned ±360° around the pipe axis.

Important!

The plastic box should be placed on the side (at horizontal mounting). See below for additional details.

Figure 2 Separate mounting of Kamstrup flow sensors. Vertically, horizontally or at an angle

At horizontal mounting, Kamstrup's flow sensors can be turned around the pipe axis. Acceptable angles of rotation for the various types of Kamstrup flow sensors can be seen next page.

At medium temperatures above 90 °C and below ambient temperature, i.e. for cooling applications, calculator and Pulse Transmitter/Pulse Divider must not be mounted on the flow sensor. Instead wall-mounting is recommended. The orientation of the flow sensor in a cooling application does therefore not need to take the readability of the calculators display into account and can thereby be limited to the optimum orientation of the flow sensor only.

6.3.2 Recommendations for heat applications

Heat applications

Threaded meter housing with $q_p \leq 2.5\ m^3/h$

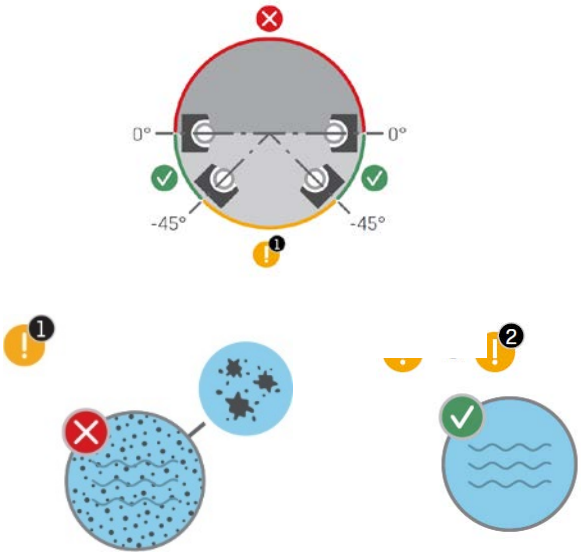


Figure 3. Acceptable orientation of Kamstrup flow sensors around the pipe axis for heating applications at horizontal mounting. Threaded meter housings with $q_p \leq 2.5\ m^3/h$.

Note: The orientations marked with **"!"** are conditionally accepted, when the assumptions below are fulfilled.

(1) District heating/cooling water must be clean and must not contain any kind of dirt. Dirt can otherwise be deposited on the transducers of the flow sensor, which affects their ability to detect and transmit the ultrasound signal.

6.3.3 Recommendations for cooling and combined heat/cooling applications

Threaded meter housing with $q_p \leq 2.5\ m^3/h$

(a)

Figure 4. Recommended orientation of Kamstrup flow sensors around the pipe axis at horizontal mounting for cooling and combined heat/cooling applications. (a) Threaded meter housings with $q_p \leq 2.5\ m^3/h$.

Note: District heating and cooling water must be free of air. Air bubbles will interfere severely with the ultrasound signal. If there is risk of air, mount all flow sensors like in position (a) with the transducers to the side.

6.3.4 Recommendations for directly mounted temperature sensors

When mounting a temperature sensor directly in the outlet of the flow sensor, acceptable orientations for the temperature sensor must be taken into account. For heating applications (*Figure 5 (a)*), the orientation of a temperature sensor is not important as long as a homogeneous temperature distribution can be assumed, i.e. all orientations can be accepted. For cooling applications (*Figure 5 (b)*), water penetration into the sensor element must be avoided. Therefore, a temperature sensor is mounted ideally from the bottom pointing with its tip upwards and can be rotated up to a horizontal position.

(a) (b)

Figure 5. Acceptable orientation of a temperature sensor in (a) a heating and (b) a cooling application.

These recommendations for temperature sensor installation comply with the recommendations for flow sensor installation illustrated in *Figure 3* and *Figure 4*. However, while a temperature sensor can well be directly installed in a flow sensor for cooling application mounted in an ascending pipe, it must not be mounted in a flow sensor for cooling application mounted in a descending pipe.

Installation examples:

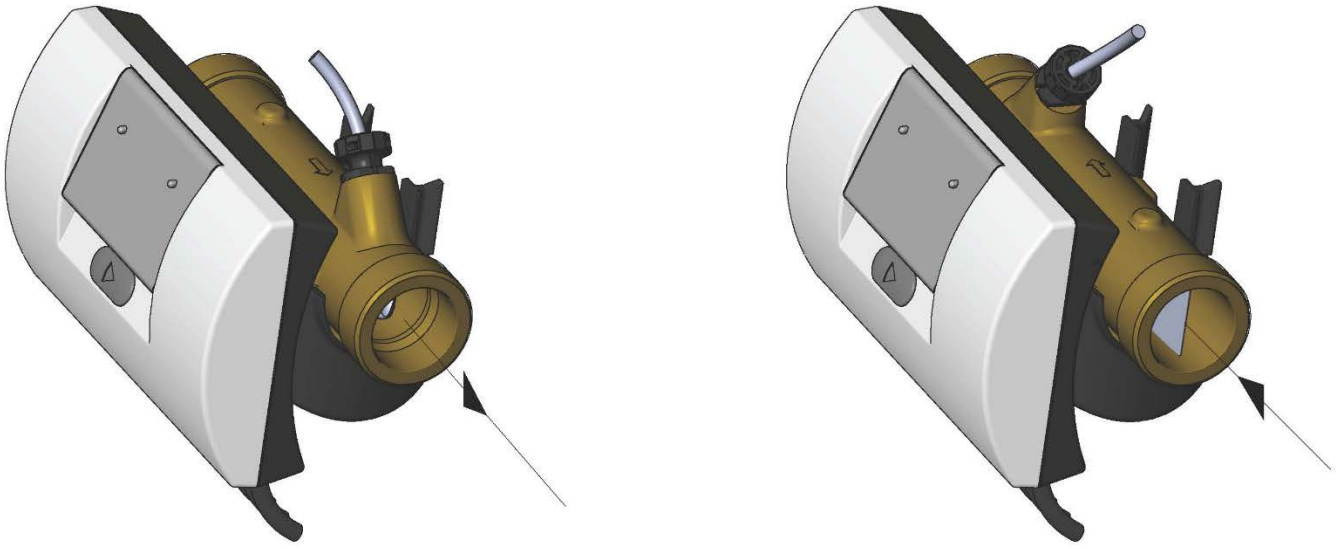
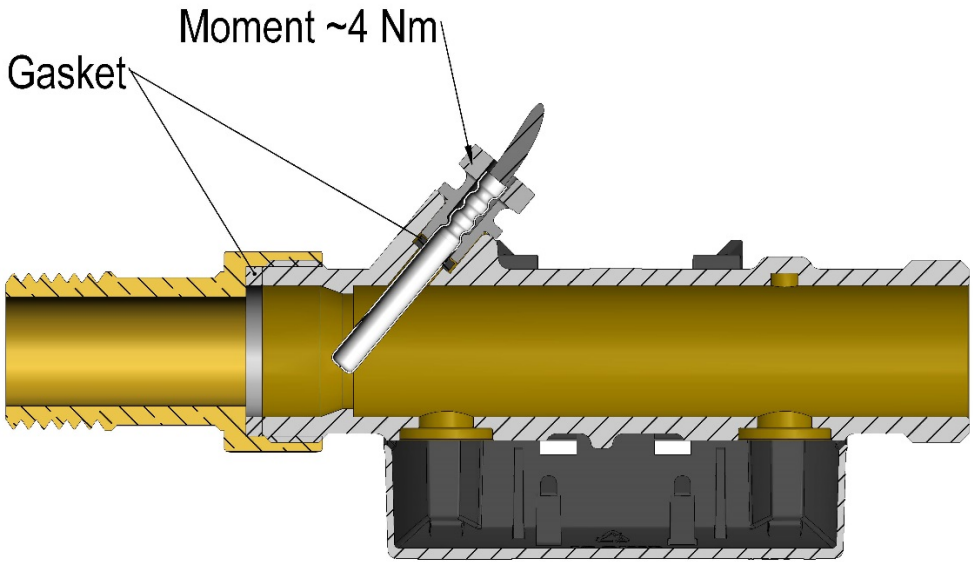


Figure 6: Threaded meter



Mounting of couplings as well as temperature sensor mounted in MULTICAL® 302 flow sensor.

Flow and temperature sensor can be installed in both PN16 and PN25 installations. Enclosed couplings, if any, are only intended for PN16. Suitable PN25 couplings must be used for PN25 installations.

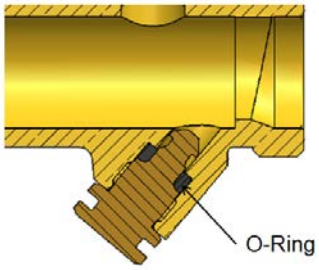
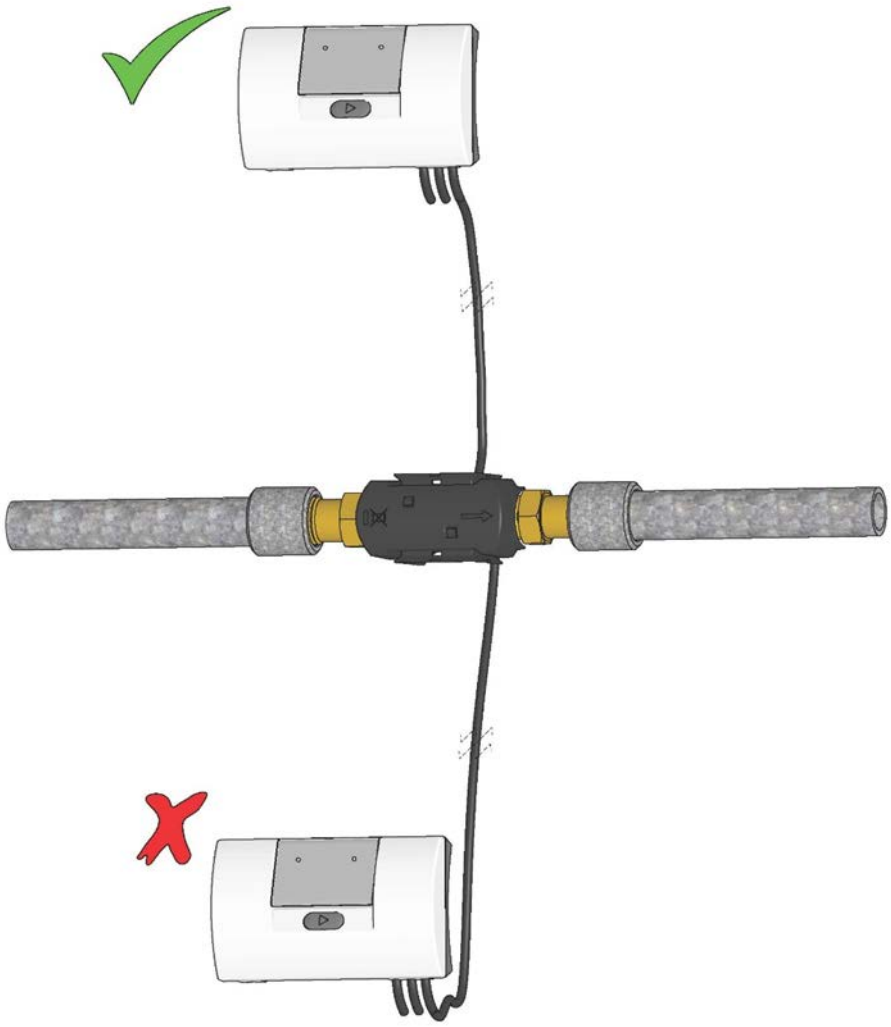


Figure 7

A blind plug, which can be used if the temperature sensor is removed from the flow sensor and e.g. installed in a sensor pocket, is available.

6.4 Position of calculator

If the flow sensor is mounted in a humid or condensing environment, the calculator must be placed in a higher position than the flow sensor.



6.5 Operating pressure of MULTICAL® 302

In connection with installations it has proved practical to work with minimum the pressure mentioned below:

Nominal flow q_p [m³/h]	Recommended back pressure [bar]	Max. flow q_s [m³/h]	Recommended back pressure [bar]
0,6	1	1,2	2
1,5	1	3	2
2,5	1	5	2

Table 3

The purpose of recommended back pressure is to avoid measuring errors as a result of cavitation or air in the water.

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 dissolved air. 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 falling pressure, e.g. caused by a velocity rise in a contraction above the sensor.

The risk of these factors affecting accuracy is reduced by maintaining a fair pressure in the system.

In relation to above table, the steam pressure at the current temperature must also be taken into consideration. Table 3 applies to temperatures up to approx. 80 °C. Furthermore, it must be taken into account that the above-mentioned pressure is the back pressure at the sensor, and that the pressure is lower in a contraction than before one (cones among other things). This means that pressure measured elsewhere in the system may be different from the pressure at the sensor.

This can be explained by combining the continuity equation and Bernoulli's equation. The total energy from the flow will be the same at any cross section. It can be reduced to: $P + \frac{1}{2}\rho v^2 = \text{constant}$.

When dimensioning a flow sensor you must take this into account, especially if the sensor is used within the scope of EN 1434 between q_p and q_s, and in case of heavy contractions of the pipe.

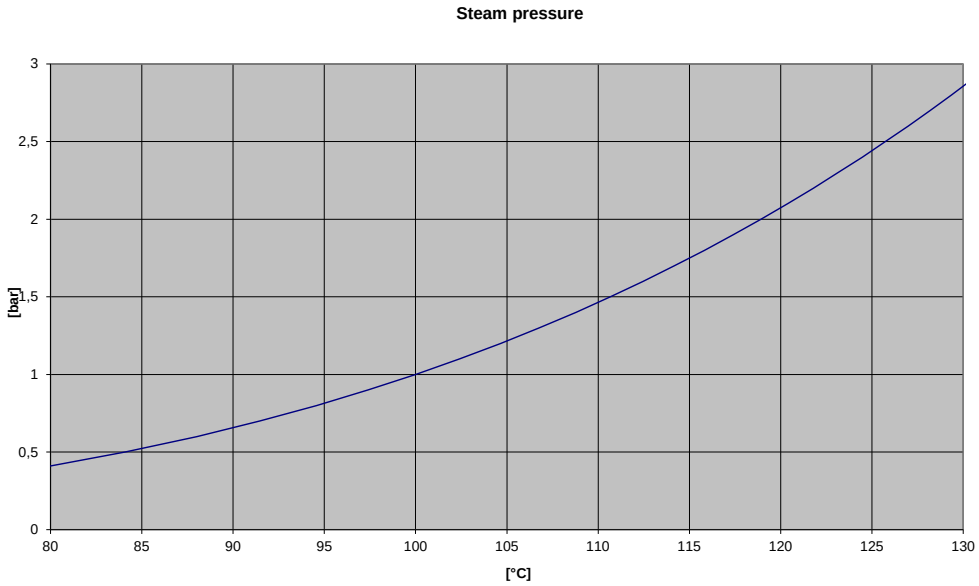
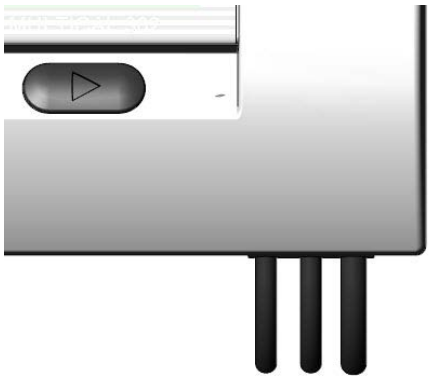
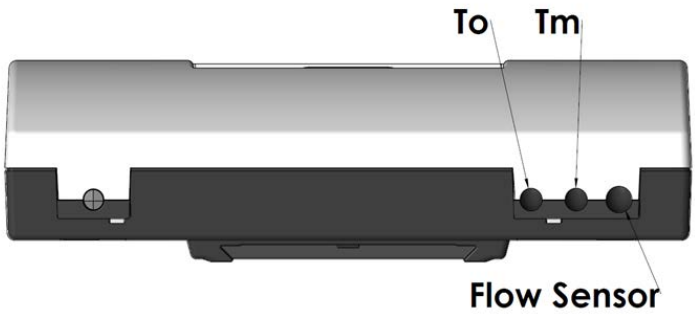


Diagram 3

6.6 Mounting in inlet or outlet pipe



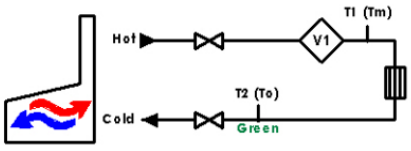
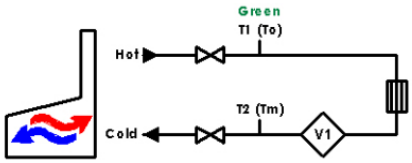


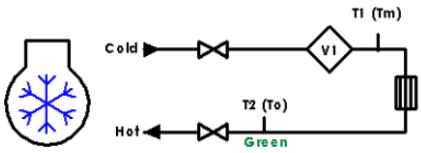
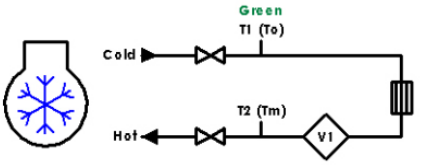
In one side of the meter three cables appear. One cable is connected to the flow sensor. The other two cables are temperature sensors, connected to the meter. If one temperature sensor is mounted in the flow sensor, this sensor is called Tm and the other sensor is called To. See examples below:

Config. number		**A**
		☐
Flow sensor position:		
k-factor	- Inlet	3
	- Outlet	4

MULTICAL® 302 is configured for flow sensor mounted in either inlet or outlet pipe. The table below indicates installation conditions of:

- Heat meters
- Cooling meters
- Heat/cooling meters

Formula	**k-factor**	**Config.**	**Hot pipe**	**Cold pipe**	**Installation**
Heat meter E1=V1(T1-T2)k	k-factor for T1 in inlet	A=3 (Flow sensor in inlet pipe)	V1 and T1(T_M)	T2(T_O)	
	k-factor for T2 in outlet	A=4 (Flow sensor in outlet pipe)	T1(T_O)	V1 and T2(T_M)	

Cooling meter E3=V1(T2-T1)k	k-factor for T1 in outlet	A=3 (Flow sensor in inlet pipe)		T2(T_0)	V1 and T1(T_M)	
	k-factor for T2 in inlet	A=4 (Flow sensor in outlet pipe)		V1 and T2(T_M)	T1(T_0)	

6.7 EMC conditions

MULTICAL® 302 has been designed and CE-marked according to EN 1434 Class A (corresponding to Electromagnetic environment: Class E1 of the Measuring Instruments Directive) and can thus be installed in both domestic and industrial environments.

All control cables must be drawn separately and not parallel to e.g. power cables or other cables with the risk of inducing electromagnetic interference. There must be a distance of min. 25 cm between signal cables and other installations.

6.8 Climatic conditions

MULTICAL® 302 is designed for indoor installation in non-condensing environments with ambient temperatures from 5…55 °C, but max. 30 °C for optimum battery lifetime. However, the flow sensor is specially protected against humidity and tolerates condensing environment.

Protection class IP65 for the calculator allows splashes of water, but the calculator does not withstand permanent water/humidity impact or submergence.

Protection class IP68 for the flow sensor allows permanent condensation and submergence.

7 Calculator functions

7.1 Measuring sequences

MULTICAL® 302 uses time-based integration, which means that calculations of accumulated volume and energy are carried out at fixed time intervals independent of current water flow. In normal mode the integration interval of MULTICAL® 302 is 32 s, whereas the interval is 8 s in ”fast mode”.

”Transport state”

In ”Transport state” MULTICAL® 302 runs through an integration sequence of 96 s, which minimizes the power consumption during transport.

”Normal mode”

In "normal mode" MULTICAL® 302 passes through an integration sequence of 32 s During this sequence water flow is measured at 4-second intervals. Inlet and outlet temperatures are measured in the middle of the sequence and at the end of the sequence energy and volume are calculated. All display readings are updated at 32-second intervals.

”Fast mode”

In "fast mode" MULTICAL® 302 passes through an 8-second integration sequence. During this sequence water flow is measured at 2-second intervals. Inlet and outlet temperatures are measured in the middle of the sequence and at the end of the sequence energy and volume are calculated. All display readings are updated at 8-second intervals.

”Test mode”

In "test mode" MULTICAL® 302 passes through a 4-second integration sequence. During this sequence water flow is measured at half-second intervals. Inlet and outlet temperatures are measured in the middle of the sequence and at the end of the sequence energy and volume are calculated. All display readings are updated at 4-second intervals.

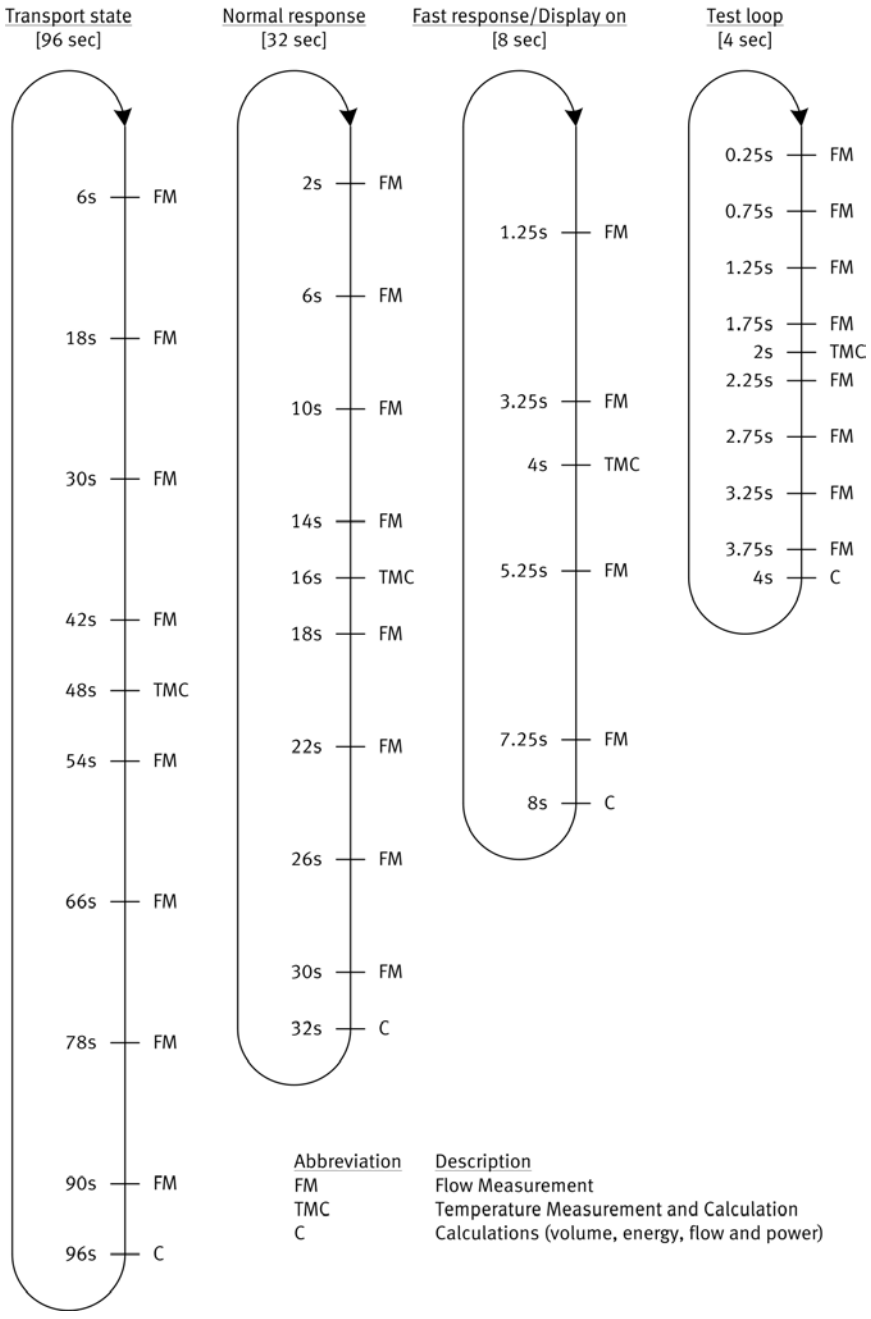
If you press the front button for 5 seconds the display reverts to energy reading. Alternatively, the display reverts to energy reading after 9 hours in test mode.

”Display on”

Press the front button to switch on the display. If you leave the display at other readings than energy, it automatically reverts to the primary energy indication after 4 minutes, and after 4 more minutes without touching the button the display switches off.

Tolerance of time indications

The timing of the measuring sequences can vary approx. ± 3 % in order to secure correct synchronisation with data communication.



Display loop	**Mode**	**Measuring sequence**
Display off	Normal mode (Type number 302-x-xx-1 and -2)	32 s
	Fast mode (Type number 302-x-xx-3)	8 s
USER loop	Fast mode	8 s
TECH loop		
SETUP loop		
TEST loop	Test mode	4 s

7.2 Energy calculation

MULTICAL® 302 calculates energy on the basis of the formula stated in EN 1434-1:2015, which uses the international temperature scale issued in 1990 (ITS-90) and the pressure definition of 16 bar.

In a simplified form the energy calculation can be expressed as: Energy = V x ΔΘ x k. The calculator always calculates energy in [Wh], and then converts the value to the selected measuring unit.

E [Wh] =	V x ΔΘ x k x 1.000
E [kWh] =	E [Wh] / 1.000
E [MWh] =	E [Wh] / 1.000.000
E [GJ] =	E [Wh] / 277.780

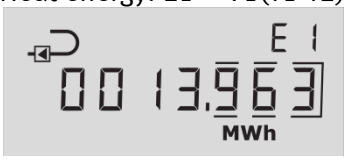
V is the added (or simulated) water volume in m^3

ΔΘ is the measured temperature difference

Heat energy (E1):
ΔΘ = inlet temperature – outlet temperature
Cooling energy (E3):
ΔΘ = outlet temperature – inlet temperature

Both in the display and during data reading each energy type is uniquely defined, e.g.

Heat energy: E1 = V1(T1-T2)k

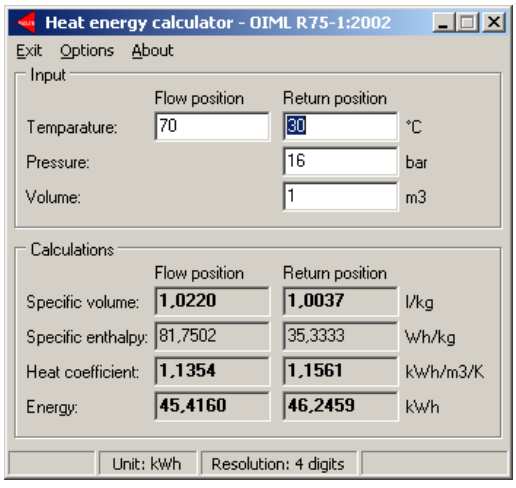


Cooling energy: E3 = V1 (T2-T1)k

k is the heat coefficient of water, which is calculated according to the formula of EN 1434-1:2015 (identical with the energy formula of OIML R75-1:2002)

Note: In case of temperature sensor error ΔΘ is set at 0,00 K, which causes the meter's energy calculation to stop. A sensor error also stops volume accumulation. Energy calculation and volume accumulation continue as soon as the error has been remedied. Please note that the error will remain visible in the info-event-counter if static info codes have been selected (until the error has been deleted via METERTOOL HCW), although the error has been corrected and the meter counts again.

Kamstrup can supply an energy calculator for check measurement:

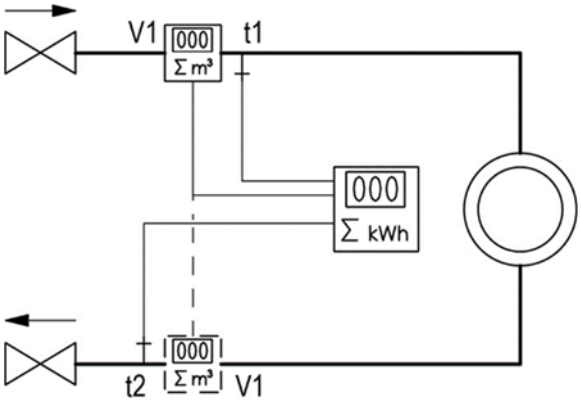


7.3 Application types

MULTICAL® 302 operates with 4 different energy formulas, E1, E3, E8 and E9, which are all calculated parallel with each integration no matter how the meter is configured. E8 and E9 are used as basis for calculation of average temperatures in inlet and outlet pipes only, whereas E1 and E3 are used for heat and cooling measurement respectively.

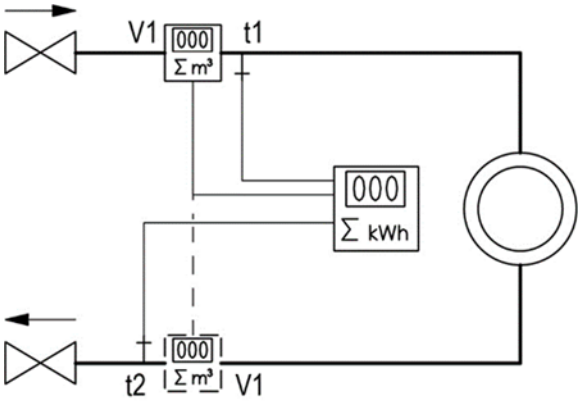
7.3.1 E1 and E3

Energy types E1 and E3 are described by application examples below.

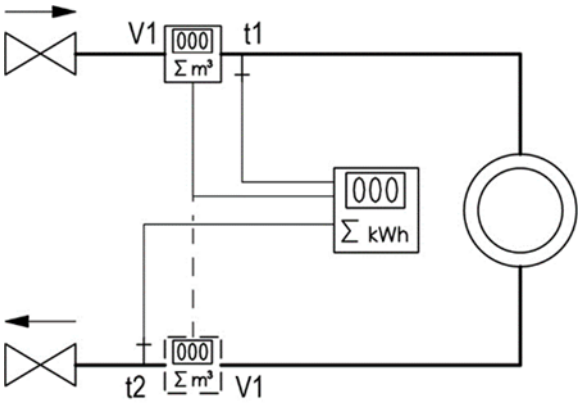
<table>
<tr>
<td> 

302-Txxxxxx2xx</td>
<td><u>Application A</u>

Closed heating system with one flow sensor
Heat energy: E1 = V1(T1-T2)k T1:Inlet or T2:Outlet

Flow sensor V1 is placed in inlet or outlet as selected during Config.</td>
</tr>
<tr>
<td> 

302-Txxxxxx5xx</td>
<td><u>Application B</u>
Closed cooling system with one flow sensor
Cooling energy: E3 = V1 (T2-T1)k T2:Inlet or T1:Outlet

Flow sensor V1 is placed in inlet or outlet as selected during Config.</td>
</tr>
<tr>
<td> 

302-Txxxxxx3xx
302-Txxxxxx6xx</td>
<td><u>Application C</u>
Closed heat/cooling system with one flow sensor
Heat energy: E1 = V1(T1-T2)k T1:Inlet or T2:Outlet

Cooling energy: E3 = V1(T2-T1)k T2:Inlet or T1:Outlet

Flow sensor V1 is placed in inlet or outlet as selected during Config.</td>
</tr>
</table>

7.3.2 E8 and E9

E8 and E9 are used as a basis for calculation of volume-based average temperatures in inlet and outlet pipes respectively. With every volume increase (every 0,01 m^3 or 0,001 m^3) the registers are increased by the product of m^3 x °C, which makes E8 and E9 suitable for calculation of volume-based average temperature.

E8 and E9 can be used for average calculation during any period of time as long as the volume register is read at the same time as E8 and E9.

E8= m^3 x tF
E8 is increased by the product of m^3 x T1

E9 = m^3 x tR
E9 is increased by the product of m^3 x T2

Resolution of E8 and E9

E8 and E9 depend on the resolution of volume (m^3)

Volume resolution	Resolution of E8 and E9
0000,001 m^3	m^3 x °C x 10
00000,01 m^3	m^3 x °C

Example 1: Within a year a heating installation has used 250,00 m^3 district heating water and the average temperatures have been 95 °C in inlet and 45 °C in outlet.
E8 = 23750 and E9 = 11250.

Example 2: The average temperatures are to be measured together with the yearly reading. Therefore, E8 and E9 are included in the yearly reading.

Date of reading	Volume	E8	Average of inlet pipe	E9	Average of outlet pipe
2012.06.01	534,26 m^3	48236		18654	
2011.06.01	236,87 m^3	20123		7651	
Yearly consumption	297,39 m^3	28113	28113/297,39 **= 94,53 °C**	11003	11003/297,39 **= 36,99 °C**

Table 4

7.4 Bifunctional heat/cooling metering

MULTICAL® 302 is available as heat meter (meter type 2xx or 4xx), cooling meter (meter type 5xx) or bifunctional heat/cooling meter (meter type 3xx or 6xx).

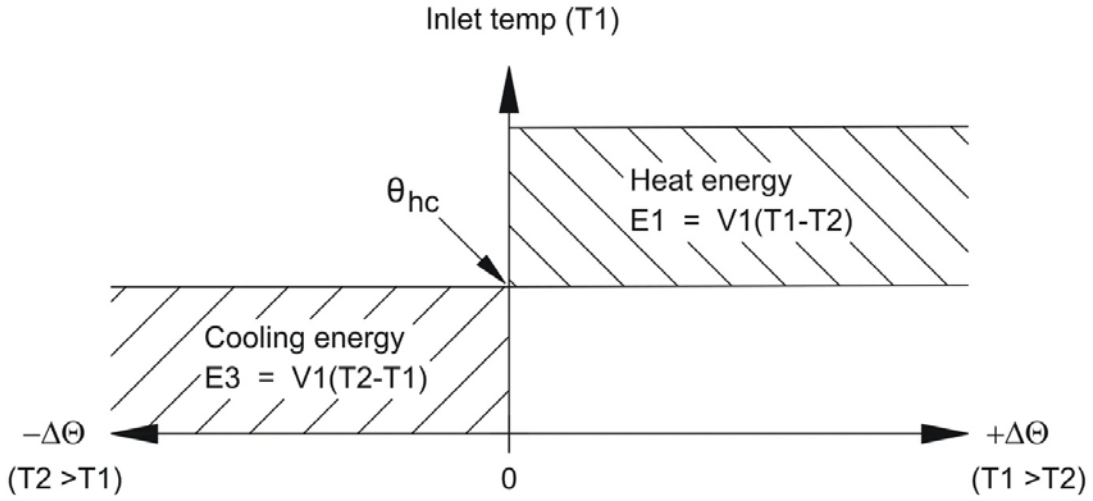
Meter type		
Heat meter (MID module B+D)	θ_{hc} = OFF	**2**
Heat/cooling meter (MID module B+D & TS27.02+DK268)	θ_{hc} = OFF	**3**
Heat meter (National approval)	θ_{hc} = OFF	**4**
Cooling meter (TS27.02+DK268)	θ_{hc} = OFF	**5**
Heat/cooling meter	θ_{hc} = ON	**6**
Country code (language on label etc.)		**xx**

If MULTICAL® 302 has been supplied as a heat/cooling meter (meter type 3xx or 6xx), it measures heat energy (E1) at a positive temperature difference (T1 > T2), whereas it measures cooling energy (E3) at a negative temperature difference (T2 > T1).

7.4.1 Heat/cooling cutoff function

Meter type 6 has a cutoff function, which ensures that heat energy is only measured if the inlet temperature exceeds a preprogrammed temperature (θ_{hc}) and correspondingly that cooling energy is only measured if the inlet temperature is lower than the preprogrammed temperature.

θ_{hc} is the temperature point used to shift between heat and cooling measurement. θ_{hc} is configurable within temperature range 0,01…150,00 °C.



If current T1 exceeds or equals θ_{hc}, only heat energy can be measured. If current T1 is lower than or equals θ_{hc}, only cooling energy can be measured.

In combined heat/cooling meters θ_{hc} should correspond to the highest occurring inlet temperature in connection with cooling, e.g. 25 °C. If the meter is to be used for "purchase and sale of heat", θ_{hc} will be a legal value and this will be shown on the display.

If you want to switch the θ_{hc} function on or off compared to current condition, it is necessary to perform a total programming of the meter by means of METERTOOL HCW.

The change between heat and cooling measurement involves no hysteresis ($\Delta\theta_{hc}$ = 0,00 K).

θ_{hc} is configured by means of METERTOOL HCW, see paragraph 15 for further information.

7.5 Max. flow and max. power

MULTICAL® 302 registers maximum flow values and maximum power values on a yearly as well as a monthly basis. The registration can be read via data communication or via the display in "TECH mode".

Max. registration includes the following flow and power values with indication of date:

Type of registration:
Max. this year (since latest target date MM.DD)
Max. yearly data, up to latest 15 years
Max. this month (since latest target date DD)
Max. monthly data, up to latest 24 months

All max. values are calculated as the highest average of a number of current flow or power measurements. The average period used for all calculations can be selected in the interval 1...1440 min. in one minute leaps. (1,440 min. = 24 hours).

Average period and target date must be stated in the order or reconfigured by means of METERTOOL HCW. Unless otherwise stated in the order, average period will be set at 60 min. and the target date applying to the selected delivery code will be used, normally the first day of each month or first January every year.

At the end of a year or a month max. values are saved in the data logger, and the current max. registers are "reset" according to selected target date and the meter's internal clock and calendar.

Date of this month's max. power

Value of this month's max. power

Lines above and below the month indication show that monthly data are displayed.

Example of max. power on a monthly basis

Date of this year's max. flow

Value of this year's max. flow

Lines above and below the year indication show that yearly data are displayed.

Example of max. flow on a yearly basis

7.6 Temperature measurement

Inlet and outlet temperatures are measured by means of an accurately matched Pt500 sensor pair. During each temperature measurement MULTICAL® 302 sends measuring current through each sensor. For Pt500 the current is approx. 0,5 mA. Two measurements are carried out in order to suppress mains voltage picked up via sensor cables (50 Hz or 60 Hz, depending on country code). Furthermore, current measurements are made by internal reference resistors in order to secure optimum measuring stability.

The display presents inlet and outlet temperatures as well as temperature difference in the range 0,00 °C to 155,00 °C.

Inlet or outlet temperatures below 0 °C are displayed as 0,00 °C and temperatures above 155 °C are displayed as 155,00 °C. When the temperature sensors are outside measuring range, Info=8 (inlet) or Info=4 (outlet) is set.

At negative temperature difference (inlet < outlet) the temperature difference is displayed with a negative sign and cooling energy is calculated (provided that the meter has been configured for cooling metering).

Note: When Info = 4 or 8, the meter's energy calculation and volume accumulation stop.

7.6.1 Measuring current and power

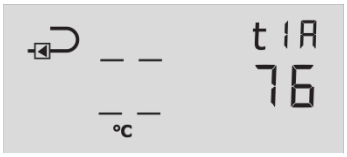
Measuring current is only sent through the temperature sensors during the short duration of the temperature measurement. The effective power that is deposited in the sensor elements is thus very small, and its influence on self-heating of the temperature sensors is less than 1/1000 K.

	Pt500
Measuring current	< 0,5 mA
Measuring period	< 12 ms
Peak power	< 200 µW
RMS influence ("fast mode")	< 0,5 µW
RMS influence ("normal mode")	< 0,08 µW

7.6.2 Average temperatures

MULTICAL® 302 currently calculates the average temperatures of inlet and outlet (T1 and T2) in °C without decimals. The background calculations E8 and E9 (m^3 x T1 and m^3 x T2) are carried out with every volume increase (every 0,01 m^3 or 0,001 m^3 determined by the meter's configuration). The display is updated every day at midnight. The average temperatures are thus volume weighted and can be used directly for checking purposes.

Type of registration:	***Average***	***Yearly data***	***Monthly data***
Year-to-date average (since latest target date MM.DD)	•	•	
Month-to-date average (since latest target date DD)	•		•



Year-to-date average of T1.

(Current date with a stipulated line under year or month is displayed immediately BEFORE this reading)

7.7 Info codes

MULTICAL® 302 constantly monitors a number of important functions. If a serious error occurs in measuring system or installation, a flashing “info” will appear in the display. The ”Info” field keeps flashing as long as the error exists no matter which reading you choose. The ”Info” field automatically disappears when the reason for the error has been removed.

However, configuration for ”Manual reset of info codes” (static info codes) is possible. If ”Manual reset of info codes” has been selected, info codes will remain in the display until they have been manually reset).

7.7.1 Info code types

Info code	Description	Response time
0	No irregularities	-
1	Supply voltage has been interrupted	-
4	Temperature sensor T2 outside measuring range	< 32 s
8	Temperature sensor T1 outside measuring range	< 32 s
32	Temperature difference has wrong polarity	< 32 s and 0,05 m^3
128	Supply voltage too low	< 10 s
16	Flow sensor with weak signal or air	< 32 s
2	Flow sensor with wrong flow direction	< 32 s

If more than one info code appear at a time, the sum of info codes is displayed. If e.g. both temperature sensors are outside measuring range, info code 12 (info codes 4+8) is displayed.

Info codes 4 and 8 are set when the temperature falls below 0,00 °C or exceeds 155,00 °C. Info codes 4 and 8 are also set for short-circuited and disconnected sensors.

Note: If Info = 4 or 8, the meter's energy calculation and volume accumulation stop.

7.7.2 Examples of displayed info codes

Example 1

Flashing ”INFO”

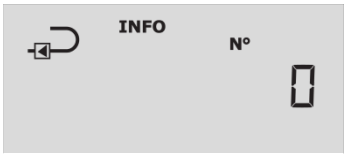
If the information code exceeds 0, a flashing “INFO” will appear in the information field.

Example 2

Current information code

Activating the push-button, the current information code is displayed.

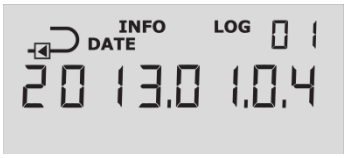
Example 3

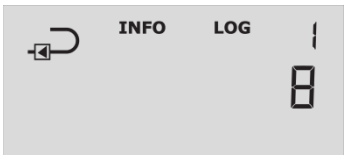


Info-event-counter

- shows how many times the information code has been changed (only available in TECH loop).

Example 4





Info logger

If you press the push-button once more, data logger for information code is displayed (only visible in TECH loop).

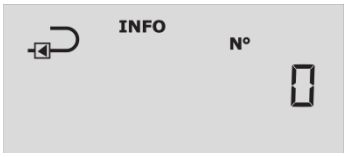
First the date of the latest change is shown…

…next the information code set on this date is displayed. In this case there has been a sensor error in temperature sensor T1 on 04 January 2013.

The data logger saves the latest 50 changes. The latest 36 changes can be displayed, and the rest can be read by means of METERTOOL HCW.

Furthermore, the info code is saved in hourly, daily, monthly and yearly logger for diagnostic purposes.

7.7.3 Info-event-counter



Enumeration takes place every time the info code is changed (the info code is added to the info-event counter and data logged when it has remained present for minimum an hour).

The info-event counter of a new meter will be 0 as "transport state" prevents counting during transportation.

Info code	"info" in display	Registration in info, hourly, daily, monthly and yearly logger	Enumeration of Info-event
1	No	Yes	Upon each "Power-On-Reset"
4, 8	Yes	Yes	When Info 4 or 8 is set or removed
16, 2	Yes	Yes	When Info is set and when Info is deleted
32	Yes	Yes	At wrong temperature difference
128	Yes	Yes	Battery voltage below 3,0 VDC

7.7.4 Transport state

The meter leaves the factory in transport state, i.e. the info codes are active in the display, but not in the data logger. This prevents "info-event" from counting during transportation and non-relevant data from appearing in the info logger. The first time the meter enumerates the volume register after installation, the info code automatically becomes active in the data logger (after one hour).

If the meter has built-in wM-Bus communication, the radio transmitter will be switched off when the meter is in transport state.

7.8 Data loggers

MULTICAL® 302 has a permanent memory (EEPROM), in which the results from various data loggers are saved. The meter includes the following data loggers:

Data logging interval	Data logging depth	Logged value
Yearly logger	15 years	Counter register
Monthly logger	24 months	Counter register
Daily logger	460 days	Counter register
Hourly logger	960 hours	Counter register
Info logger	50 Events (36 events can be displayed)	Info code and date
Config. logger	25 config. changes	New config. and date

Loggers are static ones. Therefore, register types and logging intervals cannot be changed. When the last record has been written into the EEPROM the oldest one will be overwritten.

The meter only permits 25 reconfigurations, which means that the config. logger cannot be overwritten (unless the seal is broken).

7.8.1 Yearly, monthly, daily and hourly loggers

The following registers are logged every year and every month on target date. Furthermore, the daily registers are logged at midnight and the hourly registers are logged every hour.

All the below registers are logged as counter registers.

Register type	Description	Yearly logger	Monthly logger	Daily logger	Hourly logger
Date (YY.MM.DD.hh)	Logging time: year, month, day and hour	•	•	•	•
E1	Heat energy	•	•	•	•
E3	Cooling energy	•	•	•	•
E8	E8=m^3 x T1 (inlet)	•	•	-	-
E9	E9=m^3 x T2 (outlet)	•	•	-	-
V	Volume register	•	•	•	•
INFO	Information code	•	•	•	•
h	Hour counter	•	•	-	-
h-INFO	Error hour counter	•	•	-	-
DATE FOR MAX. FLOW	Date stamp for max. flow during period	•	•	-	-
MAX. FLOW	Value of max. flow during period	•	•	-	-
DATE FOR MAX. POWER	Date stamp for max. power during period	•	•	-	-
MAX. POWER	Value of max. power during period	•	•	-	-

7.8.2 Info logger

Every time the information code has remained changed for minimum one hour, date and info code are logged. Thus, it is possible to data read the latest 50 changes of the information code as well as the date the change was made.

Register type	Description
Date (YY.MM.DD)	Logging time: year, month and day
Info	Information code on above date
E1	Heat energy
E3	Cooling energy
Clock (hh.mm.ss)	Time

If the info logger is read from the display, the latest 36 changes including dates can be read too. All of the 50 changes can be read by means of the PC program LogView HCW.

7.8.3 Configuration logger

Every time configuration is changed, date, energy and the new config. are logged. Thus, it is possible to data read the latest 25 configuration changes as well as the date the change was made. The meter only permits 25 config. changes, unless the legal seal is broken.

Register type	Description
Date (YY.MM.DD)	Year, month and day of config. change
E1 and E3	Counter values just before reconfiguration
Config. ABDDDEFGHHMMM	The new config. number

7.9 MULTICAL® 302 – Radio communication

With software revision J1 or newer, two new options for turning the radio communication On and Off is available with MULTICAL® 302. The new software enables the meter to automatically turn On the radio communication after a pre-defined time[1]. The timer starts when the meter is produced from factory. Furthermore, the radio communication can now be permanently turned Off.

In TECH loop viewing 2-11-08 the software part number and revision is shown, e.g. rev. J1 is shown as 2402**1001**, where the last 4 digits indicate the software revision.

Radio Stop

When MULTICAL® 302 is delivered from factory the radio will always be Off, due to transport restrictions[2]. If it is required that the radio should be permanently Off, the meter can after delivery via SETUP loop or METERTOOL HCW be configured to Radio Stop.

Radio On and Radio Pause

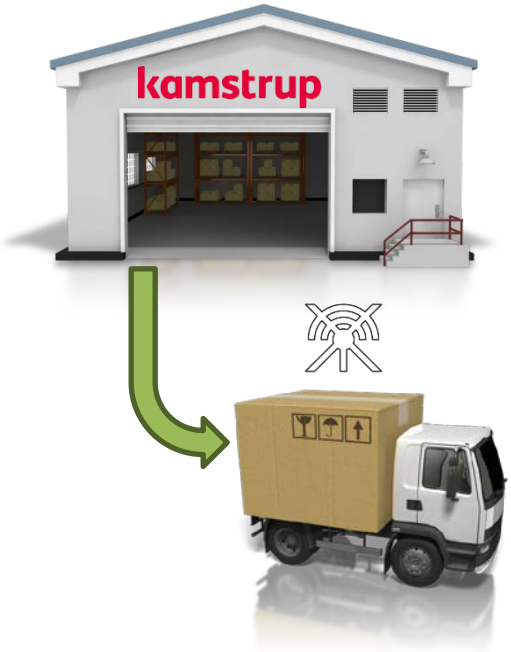
There are three ways for the meters radio to activate and start transmitting data.

1. Consumption: Consumption (water flow) is registered by the meter and it activates the radio.

2. Automatically via timer: The hour counter reaches the pre-defined time and the meter activates the radio.

3. SETUP loop: In SETUP loop (or via METERTOOL HCW) the technician manually activates the radio.

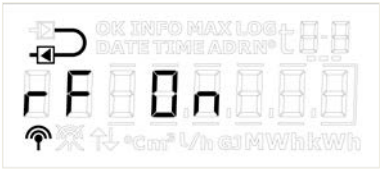
When installed MULTICAL® 302 can be in one of the three following settings: RF stop, RF pause and RF On. All three settings are described and shown below.



Radio permanently disabled

Radio is paused until manually activated, timer activated, or consumption is registered

Radio is active



IMPORTANT

- If the meter is in TEST mode, the radio will not be activated with the timer or registered consumption.
- A total reset of the meter will reset the meter back to Radio pause, which is setting all meters are delivered in.
- Installation request cannot be used, when the meters radio is permanently turned Off (Radio stop).

[1] If this function is selected on the country code

[2] All meters delivered from factory is delivered as Radio Pause.

8 Display functions

MULTICAL® 302 is fitted with an easily readable LC-display comprising 8 digits, measuring units and an information field. Energy and volume readings use 7 digits and corresponding measuring units, whereas 8 digits are used to display e.g. the meter number.

If the push-button has not been activated for 4 minutes, the display switches off. When the display is off, three lines will appear in the right side of the display every 32 seconds in "normal mode" or every 8 seconds in "fast mode". In order to activate the display you press the push-button.

Basically accumulated energy is displayed. Activating the push-button, the display immediately switches to other readings. The display automatically returns to energy reading four minutes after the latest activation of the push-button, and after four more minutes without activation of the push-button the display switches off in order to save current.

The accumulated energy registers, E1 and E3, are both always displayed as positive values. Differential temperature and power are either displayed as positive (heat) or negative (cooling) when reading the values on MULTICAL® 302, 303, 403, 603 and 803.

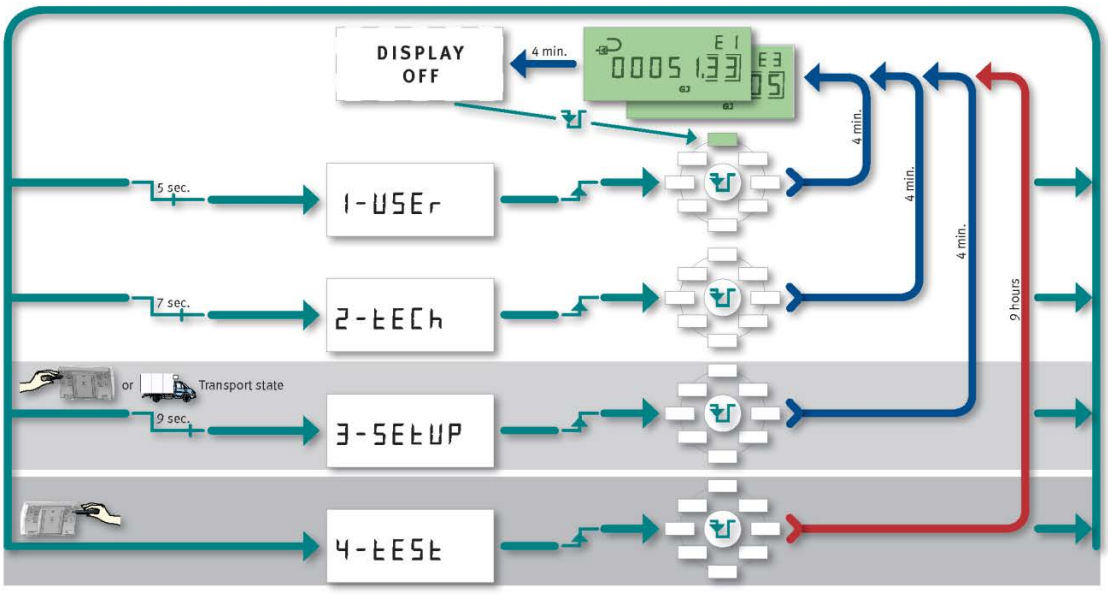
The meter uses four different loops for four different user situations: User loop, Tech loop, Setup loop and Test loop. It is only possible to display one loop at a time.

8.1 Select display loop

By means of the push-button on the front of the meter you can choose between four display loops. No matter which display you have selected you can change to USER loop by pressing the push-button for 5 s until "1-User" is displayed and then releasing the button. If the button is pressed for 7 s instead, "2-Tech" is displayed, and if you release the push-button now, you have access to Tech loop.

When you receive the meter it is in "Transport State", from which you access Setup loop (depending on country code) by pressing the push-button for 9 seconds and then releasing the button. When the meter has registered its first volume accumulation, either 0,01 m^3 (10 L) or 0,001 m^3 (1 L) – determined by selected resolution, the meter changes from "Transport State" to "Normal State", from which Setup loop cannot be accessed unless the seal at the back of the meter is broken and the installation switch activated.

There is only access to Test loop if the Test seal is broken and the Test switch activated.



Front key:

9 sec. = Press and hold the specified number of seconds

= Activated on release

= Activated on click

From the three top loops the meter automatically reverts to energy (heat energy or cooling energy, depending on the meter's configuration) 4 min. after the last activation of the push-button.

The individual display loops are described below.

8.2 USER loop

User loop is the primary loop, which is accessible when the meter has been installed and is in normal operation. The loop includes legal and most used readings. User loop is primarily intended for the user of the meter. See paragraph 3.4 for more details.

8.3 TECH loop

Tech loop is primarily for technicians and other persons who are interested in viewing further data. Tech loop displays all legal registers, other important registers as well as logged data (see paragraph 7.8 for data loggers).

Tech loop comprises everything that the meter can display. Tech loop is displayed when the front key has been pressed continuously for 7 s The content of Tech loop is not configurable. After a brief activation in Tech loop the display moves to the next main reading, whereas two seconds' activation in Tech loop makes the meter switch to sub-reading. After a brief activation in sub-reading the display changes to the next sub-reading. Two seconds' activation in sub-reading makes the meter revert to main reading.

After five seconds' activation in Tech loop the display reverts to User loop.

Tech loop Main		*Tech loop Sub*		Index number in display	
				Start number	Record number
1.0	**Heat energy (E1)**			**2-01**	
		1.1	*Yearly date*	2-01-01	Log 01-02
		1.2	*Yearly data*	2-01-02	
		1.3	*Monthly date*	2-01-03	Log 01-24
		1.4	*Monthly data*	2-01-04	
2.0	**Cooling energy (E3)**			**2-02**	
		2.1	*Yearly date*	2-02-01	Log 01-02
		2.2	*Yearly data*	2-02-02	
		2.3	*Monthly date*	2-02-03	Log 01-24
		2.4	*Monthly data*	2-02-04	
3.0	**Volume**			**2-03**	
		3.1	*Yearly date*	2-03-01	Log 01-02
		3.2	*Yearly data*	2-03-02	
		3.3	*Monthly date*	2-03-03	Log 01-24
		3.4	*Monthly data*	2-03-04	
4.0	**Hour counter**			**2-04**	
		4.1	*Error hour counter*	2-04-01	
5.0	**T1 (Inlet)**			**2-05**	
		5.1	*Year-to-date average*	2-05-01	
		5.2	*Month-to-date average*	2-05-02	
6.0	**T2 (Outlet)**			**2-06**	
		6.1	*Year-to-date average*	2-06-01	
		6.2	*Month-to-date average*	2-06-02	
7.0	**T1-T2 (Δt)** (Cooling shown by -)			**2-07**	
		7.1	*E8 (m3*T1)*	2-07-01	
		7.2	*E9 (m3*T2)*	2-07-02	
8.0	**Flow**			**2-08**	
		8.1	*Date of max. yearly data*	2-08-01	
		8.2	*Max. yearly data*	2-08-02	
		8.3	*Date of max. monthly data*	2-08-03	
		8.4	*Max. monthly data*	2-08-04	
9.0	**Power**			**2-09**	
		9.1	*Date of max. yearly data*	2-09-01	
		9.2	*Max. yearly data*	2-09-02	
		9.3	*Date of max. monthly data*	2-09-03	
		9.4	*Max. monthly data*	2-09-04	
10.0	**Info Code**			**2-10**	
		10.1	*Info event counter*	2-10-01	
		10.2	*Info logger date*	2-10-02	Log 01-36
		10.3	*Info logger data*	2-10-03	
11.0	**Customer No.**			**2-11**	Nº 1
		11.1	*Customer No.*	2-11-01	Nº 2
		11.2	*Date*	2-11-02	
		11.3	*Hour*	2-11-03	
		11.4	*Target date*	2-11-04	
		11.5	*Serial number*	2-11-05	Nº 3
		11.6	*Config. 1 (ABDDD)*	2-11-06	Nº 5
		11.7	*Config. 2 (EFGHHMMM)*	2-11-07	Nº 6
		11.8	*Software edition*	2-11-08	Nº 10
		11.9	*Software checksum*	2-11-09	Nº 11
		11.10	Average time of max. P and Q	2-11-10	
		11.11	θ_{hc}	2-11-11	
		11.12	*Segment test*	2-11-12	
		11.13	M-Bus primary address	2-11-13	Nº 31
		11.14	M-Bus secondary address	2-11-14	Nº 32

After 4 minutes without activation of the button the meter reverts to energy reading in "User loop".

8.4 SETUP loop

Setup loop comprises everything that can be changed in the meter. Setup loop is no longer available, when the meter has registered its first volume accumulation or if you exit via the ”EndSetup” function.

SETUP loop can be enabled again by breaking the seal and activating the switch. In that case Setup is locked by ”EndSetup” or automatically 4 min. after the last activation of the button.

In SETUP loop selected configurations of the meter can be changed:

-Customer number

-Date

-Time

-Target date

-Flow sensor position (inlet/outlet)

-Energy unit

-Primary M-Bus address

-Average peak time max./min.

-Heat/cooling switching

-Radio (on/off)

Setup

When delivered the meter is in transport state, which means that display loop ”Setup” is available.

Setup loop is selected by activating the button continuously for 9 s until ”SETUP” is displayed.

The meter remains in Setup loop until the front button is pressed for 5 s however, a time-out secures that the meter reverts from Setup loop to User loop after 4 minutes.

Transport state ends when the meter has registered its first volume accumulation, either 0.01 m^3 (10 L) or 0,001 m^3 (1 L) – determined by the selected resolution.

When the meter has left transport state, SETUP loop is no longer available, unless the SETUP seal is broken and the contact points behind the seal short-circuited with short-circuit pen type 66-99-278.

The seal must be re-established with a void label size 15 x 15 mm . The seal is important with a view to the meter's approval and to maintaining its protection class.

Note: The option Setup has been deselected on certain country codes.

The readings of Setup loop are listed below including index numbers:

Setup loop		Index number in display
1.0	**Customer number (N° 1)**	3-01
2.0	**Customer number (N° 2)**	3-02
3.0	**Date**	3-03
4.0	**Hour**	3-04
5.0	**Target date (MM.DD)**	3-05
6.0	**Flow sensor in: Inlet or Outlet (code A)**	3-06
7.0	**Measuring unit and resolution (code B)**	3-07
8.0	**M-Bus primary address (N° 31)**	3-08
9.0	**Average time of max. P and Q**	3-09
10.0	θ_{hc} (Can only be changed with meter type 6. Other country codes show 180°C without changing option)	3-10
11.0	**Radio "on" or "off"**	3-11
12.0	**End setup**	3-12

After 4 minutes without activation of the button the meter reverts to energy reading in "User loop".

8.4.1 Changing the installation position

The setup of the meter's installation position can be changed from inlet meter to outlet meter (and vice versa):

Setup loop

When the meter is in operation Setup loop can be selected by breaking the seal and using the short-circuit pen to make a brief short-circuit, which makes the reading shown to the left appear.

Do not forget to seal with a void label.

Installation position, reading 3-06

Subsequently reading 3-06 is found by means of the button below the display.

Inlet

If the meter is set to be a inlet meter, the text "inlet" is displayed. In order to change the setting, press the button for two seconds. ”Setup” is briefly displayed and then ”Inlet” flashes. Press the button once and "Outlet" is displayed. If you want to save the setting, press the button for two seconds until ”OK” appears in the display.

Outlet

If the meter is set to be a outlet meter, the text "Outlet" is displayed. In order to change the setting, press the button for two seconds. ”Setup” is briefly displayed and then ”Outlet” flashes. Press the button once and "Inlet" is displayed. If you want to save the setting, press the button for two seconds until ”OK” appears in the display.

8.4.2 Changing the energy unit

If you change the energy unit setting in Setup loop you must be aware that the change can influence the most significant digits of the display. If for instance you change from GJ with 2 decimals to GJ with 3 decimals, the most significant digit will disappear. The same applies if you change from kWh without decimals to kWh with 1 decimal. And conversely the least significant digit disappears if e.g. you change from kWh with 1 decimal to kWh without decimals. See examples below:

Example 1

GJ with 2 decimals (B=2)

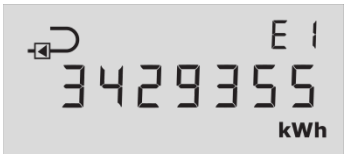
This is an example of how the energy reading E1 can appear – counted in GJ.

Example 2

GJ with 3 decimals (B=6)

Here the most significant digit has disappeared compared to example 1. In outlet you receive a higher resolution.

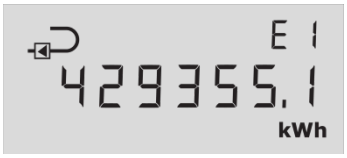
Example 3



kWh without decimals (B=3)

This is an example of how energy reading E1 can appear – counted in kWh.

Example 4



kWh with 1 decimal (B=7)

Here the most significant digit has disappeared compared to example 3. In outlet you receive a higher resolution.

Example 5

MWh with 3 decimals (B=4)

In principle this is the same resolution as in example 3, but energy is now counted in MWh.

8.5 TEST loop

Test loop is intended for laboratories and others who are to verify the meter (see paragraph 14 for further details on Test).

9 Flow sensor

9.1 Ultrasound combined with piezo ceramics

For more than 20 years ultrasonic measurement has proved the most long-term stable measuring principle for heat measurement. Experience with ultrasonic meters in operation as well as repeated reliability tests carried out in Kamstrup's accredited long-term test equipment and at AGFW in Germany have documented the long-term stability of ultrasonic meters.

9.2 Principles

The thickness of a piezoceramic element changes when exposed to an electric field (voltage). If the element is influenced mechanically, it generates a corresponding electric charge. Therefore, the piezoceramic element can function as both transmitter and receiver.

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 very similar to the effect you experience when a car drives by. The sound (the frequency) decreases as the car passes by.

9.3 Transient time method

The transient time method used in MULTICAL® 302 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.

The transient time difference of 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.

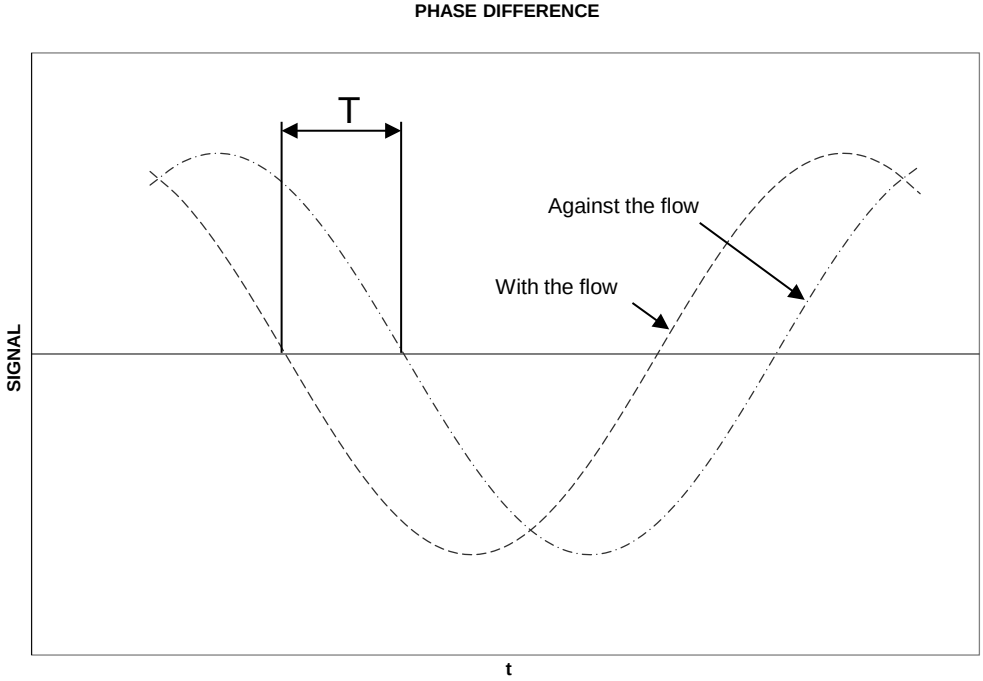


Diagram 4

In principle, the flow is determined by measuring the flow velocity and multiplying it by the area of the measuring pipe:

$$Q = F \times A$$

where:

Q is the flow

F is the flow velocity

A Is the area of the measuring pipe

The area and the length, which the signal travels in the sensor, are well-known factors. The length which the signal travels can be expressed by $L = T \times V$, which can also be written as:

$$T = \frac{L}{V}$$

where:

L is the measuring distance

V is the sound propagation velocity

T is the time

$$\Delta T = L \times \left(\frac{1}{V_1} - \frac{1}{V_2} \right)$$

In connection with ultrasonic flow sensors the velocities V_1 and V_2 can be stated as:

$V_1 = C - F$ and $V_2 = C + F$ respectively

where: C is the velocity of sound in water

Using the above formula you get:

$$\Delta T = L \times \frac{1}{C - F} - \frac{1}{C + F}$$

which can also be written as:

$$\Delta T = L \times \frac{(C + F) - (C - F)}{(C - F) \times (C + F)}$$

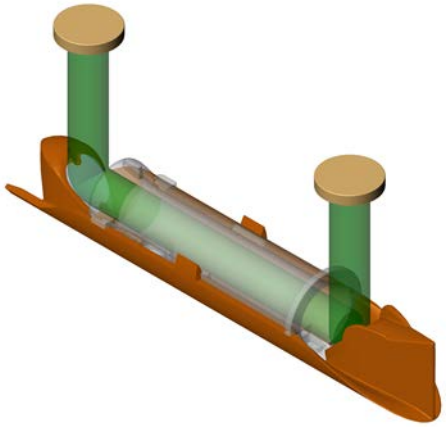
$$\Downarrow$$

$$\Delta T = L \times \frac{2F}{C^2 - F^2}$$

As $C \rangle\rangle F$ - F^2 can be omitted and the formula reduced as follows:

$$F = \frac{\Delta T \times C^2}{L \times 2}$$

9.4 Signal paths



q_p 0,6 - 1,5 - 2,5 m³/h

Parallel measurement

The sound path is parallel to the measuring pipe and the sound signal is sent from the transducers via reflectors.

9.5 Flow limits

In the meter's working range from min. flow cutoff and far beyond qs there is a linear connection between the flow rate and the measured water flow.

In practice the highest possible water flow through the meter will be limited by the pressure in the system or possible cavitation due to too low back pressure.

If the flow is lower than min. cutoff or negative, MULTICAL® 302 does not measure any flow.

According to EN 1434 the upper flow limit qs is the highest flow at which the flow sensor may operate for short periods of time (<1h/day, <200h/year) without exceeding max. permissible errors. MULTICAL® 302 has no functional limitations during the period, when the meter operates above qp. Please note, however, that high flow velocities may cause cavitation, especially at low static pressure. See paragraph 6.5 for further details on operating pressure.

10 Temperature sensors

MULTICAL® 302 comes with fixed (soldered) Pt500 temperature sensors according to EN 60751 (DIN/IEC 751). A Pt500 temperature sensor is a platinum sensor that has a nominal ohmic resistance of 500,000 Ω at 0,00 °C and 692,528 Ω at 100,00 °C. All ohmicn resistance values are laid down in the international standard IEC 751 applying to Pt100 temperature sensors. The ohmic resistance values of Pt500 sensors are five times higher. The table below shows resistance values of Pt500 sensors in [Ω] for each degree Celsius:

Pt500										
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	500,000	501,954	503,907	505,860	507,812	509,764	511,715	513,665	515,615	517,564
10	519,513	521,461	523,408	525,355	527,302	529,247	531,192	533,137	535,081	537,025
20	538,968	540,910	542,852	544,793	546,733	548,673	550,613	552,552	554,490	556,428
30	558,365	560,301	562,237	564,173	566,107	568,042	569,975	571,908	573,841	575,773
40	577,704	579,635	581,565	583,495	585,424	587,352	589,280	591,207	593,134	595,060
50	596,986	598,911	600,835	602,759	604,682	606,605	608,527	610,448	612,369	614,290
60	616,210	618,129	620,047	621,965	623,883	625,800	627,716	629,632	631,547	633,462
70	635,376	637,289	639,202	641,114	643,026	644,937	646,848	648,758	650,667	652,576
80	654,484	656,392	658,299	660,205	662,111	664,017	665,921	667,826	669,729	671,632
90	673,535	675,437	677,338	679,239	681,139	683,038	684,937	686,836	688,734	690,631
100	692,528	694,424	696,319	698,214	700,108	702,002	703,896	705,788	707,680	709,572
110	711,463	713,353	715,243	717,132	719,021	720,909	722,796	724,683	726,569	728,455
120	730,340	732,225	734,109	735,992	737,875	739,757	741,639	743,520	745,400	747,280
130	749,160	751,038	752,917	754,794	756,671	758,548	760,424	762,299	764,174	766,048
140	767,922	769,795	771,667	773,539	775,410	777,281	779,151	781,020	782,889	784,758
150	786,626	788,493	790,360	792,226	794,091	795,956	797,820	799,684	801,547	803,410
160	805,272	807,133	808,994	810,855	812,714	814,574	816,432	818,290	820,148	822,004

Pt500, EN 60 751:2008

Table 5

10.1 Sensor types

MULTICAL® 302 comes with a ø5,2 mm Pt500 temperature sensor pair fitted with composite couplings and 1,5 m silicone cable, see *Figure 6*. The composite coupling is made of PPS and withstands a maximum continuous temperature of 150 °C and may be used together with both PN16 and PN25. By means of the fitted composite couplings and associated O-rings, the temperature sensor pair is used as direct temperature sensors.

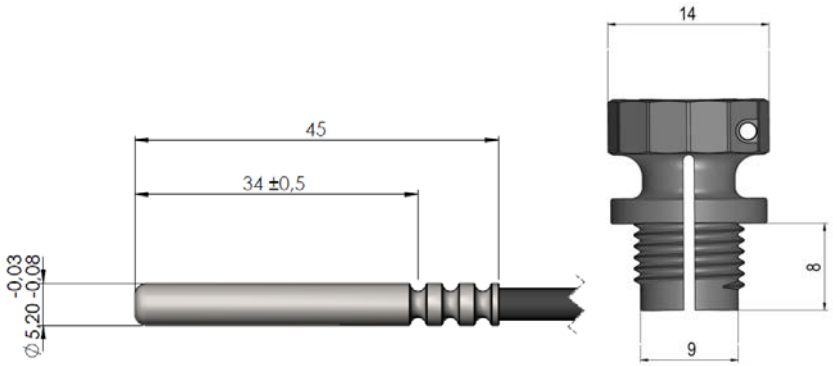


Figure 8

At delivery, one of the temperature sensors is always mounted in the flow sensor and the other temperature sensor must thus be mounted as a direct temperature sensor in, for example, a ball valve or a nipple. No matter where the direct sensor is installed, it is very important that you observe the tolerances stated in *Figure 7*. If not, the O-ring may not provide correct sealing. If one of the temperature sensors is not to be mounted in the flow sensor, this sensor must instead be mounted as close to the outlet of the flow sensor as possible so that the distance between the flow sensor and the temperature sensor is max 12 cm.

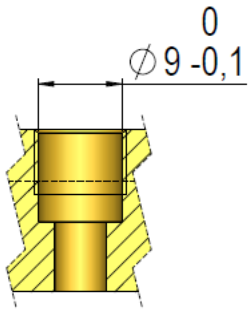


Figure 9

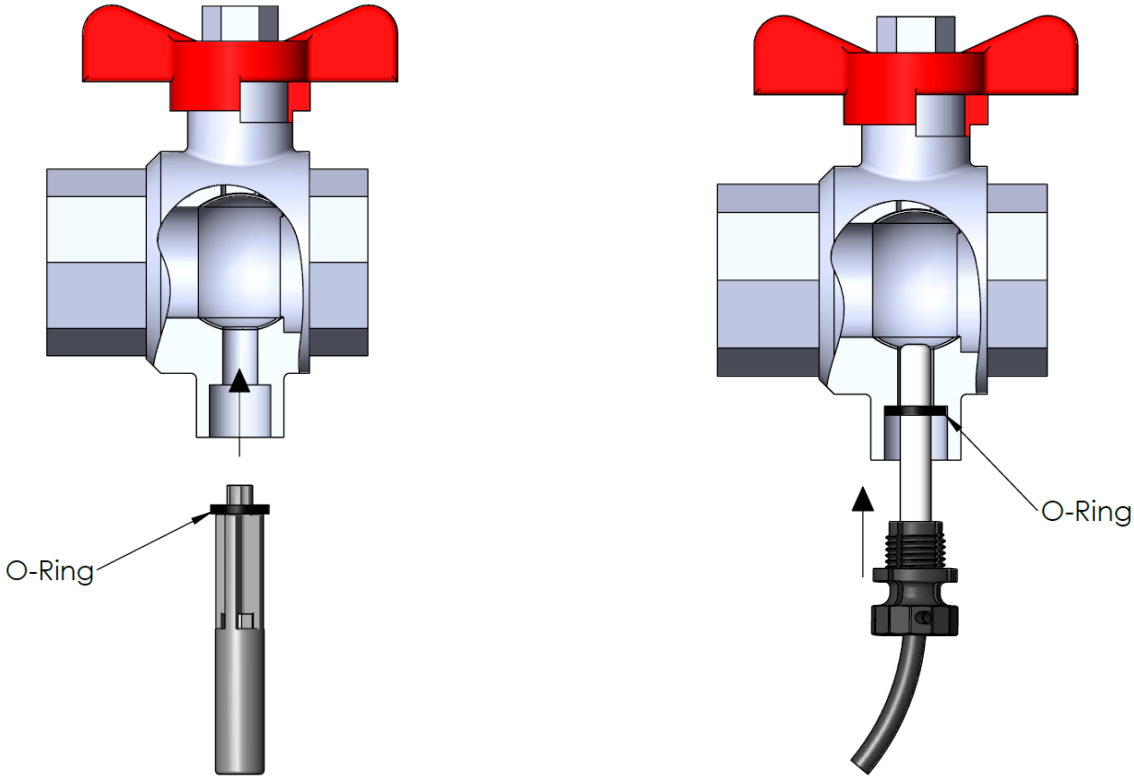
The fitted composite coupling can be removed, and the sensor can then be used in a sensor pocket. If this is the case, both sensors must be mounted in sensor pockets as symmetrical sensor installation gives the best measuring result.

Asymmetrical sensor installation (one direct sensor and one pocket sensor) is only advisable where national regulations allow this and never in systems with low differential temperature and/or low water flow.

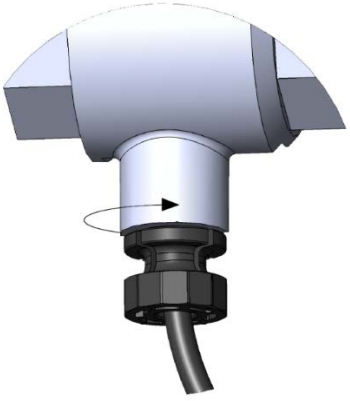
The temperature sensor which is mounted in the flow sensor from the factory has no marking on the sensor cable. The other sensor, which is marked with a green plastic ring, must be mounted in the “opposite” pipe compared to the flow sensor. According to *Figure 8*, the display shows that the flow sensor must be mounted in outlet and the temperature sensor with the green plastic ring must thus be mounted in inlet. See the table in paragraph 6.5 for further information.

Figure 10

10.2 Coupling for direct sensor



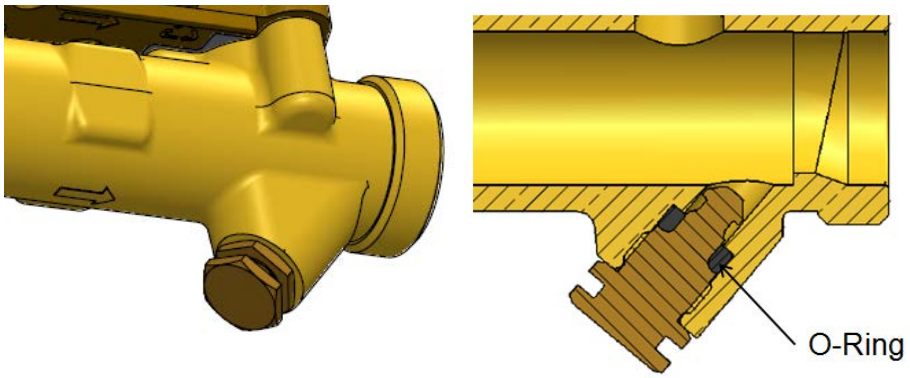
The guide of the O-ring is used for sliding the O-ring into place after which the sensor can be pushed as far as it will go.



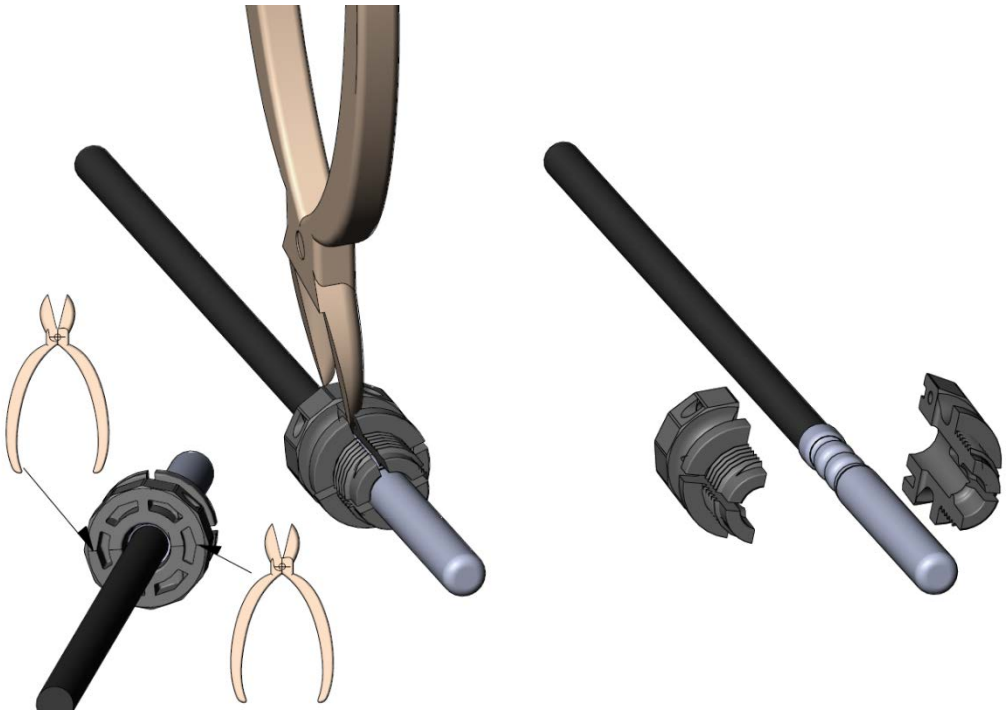
Fasten the plastic coupling manually. The use of tools is not permitted.

10.3 Using temperature sensors as pocket sensors

If the temperature sensors are to be used as pocket sensors, the temperature sensor mounted in the sensor socket of the flow sensor is first removed. Note that the O-ring of the temperature sensor is also removed. As shown in the figure below, a blind plug is then inserted in the sensor socket.



The composite fittings are then removed using a diagonal cutter. As shown in the figures below, a composite fitting can be relatively easily removed by marking the upper part of the composite fitting twice.



11 Power supply

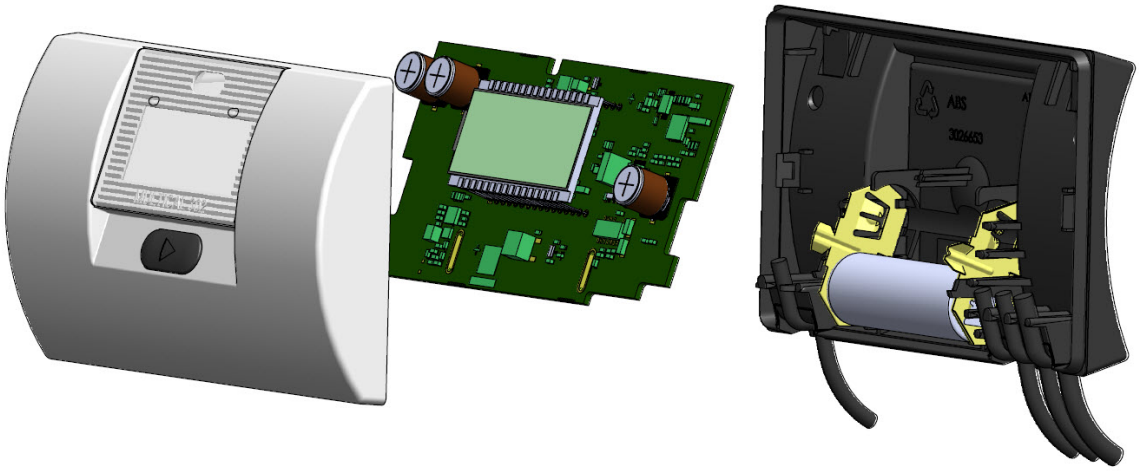
MULTICAL® 302 is powered by 3.6 VDC from 1 or 2 built-in batteries, according to the type ordered.

Type 302-	□
Supply	
6-8 year battery, Normal Response meter	1
12-16 year battery, Normal Response meter	2
6-8 year battery, Fast Response meter	3

Important: It is not possible to change the battery on MC302

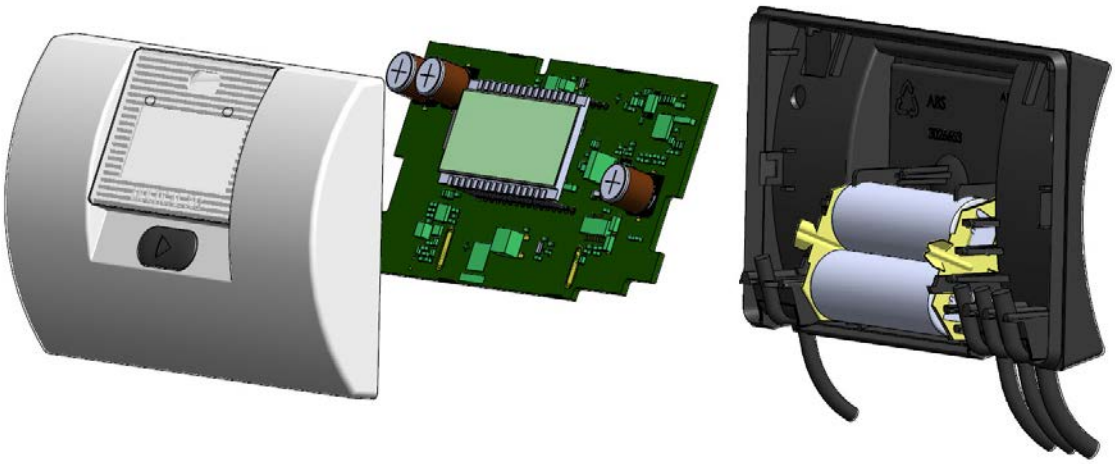
11.1 Built-in A-cell lithium battery

The A-cell lithium battery is sufficient to power MULTICAL® 302 for a 6-year period of operation. A-cell lithium batteries include 0.96 g lithium each and are thus not subject to transport restrictions.



11.2 Built-in 2 x A-cell lithium battery

2 x A-cell lithium battery must be selected for MULTICAL® 302 if a battery lifetime of 12-16 years is required. The 2 x A-cell lithium batteries contain 2 x 0,96 g lithium each and are thus not subject to transport restrictions.



Note: *MULTICAL® 302 cannot be mains supplied.*

12 Communication

MULTICAL® 302 offers two different forms of communication, namely wired M-Bus or Wireless M-Bus.

12.1 Wired M-Bus

If the meter is supplied with built-in wired M-Bus, M-Bus protocol according to EN 13757-3:2013 is used. Connection to the M-Bus master is established via the fixed 1,5 m 2-wire cable. Connection is independent of polarity and the M-Bus interface is galvanically separated from the rest of the meter.
The communication speed with automatic baud rate detection is 300 or 2400 Baud. Both primary and secondary addressing is supported. Current consumption is 1 unit load (1,5 mA).

Reading intervals down to one hour do not influence the specified battery lifetime, whereas reading intervals down to 5 minutes halves the battery lifetime.

We recommend a communication speed of 2400 Baud as the current consumption is higher at a communication speed of 300 Baud.

The following data can be read via M-Bus:

M-Bus data header	Current data	Target data*	Meter data
M-Bus ID Producer ID Version Device type Access counter Status Configuration	Heat energy E1 Cooling energy E3 Energy m^3xT1= E8 Energy m^3xT2 = E9 Volume V1 Hour counter Error hour counter T1 T2 T1-T2 Current power Max. power current month* Current flow Max. flow current month* Info code Date/time	Heat energy E1 Cooling energy E3 Energy m^3xT1 = E8 Energy m^3xT2 = E9 Volume V1 Max. power Max. flow Target date	Serial number Customer number 1 Customer number 2 Config. number 1 Config. number 2 Meter type SW-revision

* Monthly data is transmitted by default. Change to yearly data possible by means of an M-Bus command. For further details we refer to Technical description on M-Bus for MULTICAL® 302, see documentation 5512-1329_GB.

12.2 Wireless M-Bus

If the meter has built-in wireless M-Bus, you can choose between Mode C1 or Mode T1 OMS.
Mode C1 is used in connection with Kamstrup's reading systems and for drive-by meter reading in general.
Mode T1 OMS is used in connection with OMS-based stationary networks. The meter has an internal antenna.

12.2.1 Mode C1

Protocol according to EN 13757-4:2013. Transmission interval of 16 s Individual 128 bit AES encryption.

Data packets Mode C1

Heat meter HH = 01 or 02	**Heat meter HH = 11 or 12**	**Cooling meter**	**Heat/cooling meter**
Header Manufacturer Id Serial number Version Device type Hour counter	**Header** Manufacturer Id Serial number Version Device type Hour counter	**Header** Manufacturer Id Serial number Version Device type Hour counter	**Header** Manufacturer Id Serial number Version Device type Hour counter
Current data Heat energy E1 Volume V1 Power Info code	**Current data** Heat energy E1 Info code	**Current data** Cooling energy E3 Volume V1 Power Info code	**Current data** Heat energy E1 Cooling energy E3 Power Info code
Target data Date Heat energy E1 Last month or last year*	**Target data** Date Heat energy E1 Volume V1 Energy m^3xT1 = E8 Energy m^3xT2 = E9 Last month or last year*	**Target data** Date Cooling energy E3 Last month or last year*	**Target data** Date Heat energy E1 Cooling energy E3 Last month or last year*

* Monthly or yearly data depends on the HH configuration. See paragraph 3.6 Config ›EFGHHMMM‹.

12.2.2 Mode T1 OMS

Protocol according to EN13757-4:2013 and OMS Specification Volume 2 issue 3.0.1. Transmission interval of 900 s Individual 128 bit AES encryption.

Data packets Mode T1 OMS

Heat meter	Cooling meter	Heat/cooling meter
Header Device type Producer Id Serial number Version Status	**Header** Device type Producer Id Serial number Version Status	**Header** Device type Producer Id Serial number Version Status
Current data Heat energy E1 Volume V1 Power Flow T1 T2 Hour counter Date Info code	**Current data** Cooling energy E3 Volume V1 Power Flow T1 T2 Hour counter Date Info code	**Current data** Heat energy E1 Cooling energy E3 Volume V1 Power Flow T1 T2 Hour counter Date Info code
Target data* Heat energy E1 last month Volume V1 last month or Heat energy E1 last year Volume V1 last year Target date	**Target data*** Cooling energy E3 last month Volume V1 last month or Cooling energy E3 last year Volume V1 last year Target date	**Target data*** Heat energy E1 last month Cooling energy E3 last month Volume V1 last month or Heat energy E1 last year Cooling energy E3 last year Volume V1 last year Target date

* Monthly or yearly data depends on the HH configuration. See paragraph 3.6 Config ›EFGHHMMM‹.

13 Data communication

13.1 MULTICAL® 302 Data Protocol

Internal data communication in MULTICAL® 302 is based on the Kamstrup Meter Protocol (KMP) which provides a fast and flexible reading structure and also fulfils future requirements to data reliability.

The KMP protocol is used in all Kamstrup consumption meters launched from 2006 onwards. The protocol is used for the optical eye.

The KMP protocol has been designed to handle point to point communication in a master/slave system (e.g. a bus system) and is used for data reading of Kamstrup energy meters.

Software and parameter protection
The meter's software is implemented in a Flash and cannot be changed, neither deliberately nor by mistake.
Legal parameters cannot be changed via data communication.

Software conformity
Software check sum, based on CRC16, is available via data communication and in the display.

Integrity and authenticity of data
All data parameters include type, measuring unit, scaling factor and CRC16 check sum.
Every produced meter includes a unique identification number.

Two different formats are used for communication between master and slave. Either a data frame format or an application acknowledgement.

- A request from master to slave is always sent in a data frame
- The response from the slave can either be sent in a data frame or as an application acknowledgement

The data frame is based on the OSI model using the physical layer, the data link layer and the application layer.

Bytes in each field	1	1	1	0-?	2	1
Field designation	Start byte	Destination address	CID	Data	CRC	Stop byte
OSI – layer			Application layer			
		Data link layer				
	Physical layer					

The protocol is based on half duplex serial asynchronous communication with the setup: 8 data bits, no parity and 2 stop bits. The data bit rate is 1200 or 2400 baud. CRC16 is used in both request and response.

Data is transferred byte for byte in a binary data format, in which the 8 data bits represent one byte of data.

Byte Stuffing is used to extend the value range.

13.1.1 MULTICAL® 302 Register Ids

ID	Register	Description
1003	Date	Current date (YYMMDD)
1002	Clock	Current hour (hhmmss)
99	InfoCode	Info code register, current
113	InfoEventCounter	InfoEvent counter
1004	HourCounter	Operating hour counter
60	Energy1	Energy register 1: Heat energy
63	Energy3	Energy register 3: Cooling energy
97	Energy8	Energy register 8: [m^3 x T1]
110	Energy9	Energy register 9: [m^3 x T2]
68	Volume1	Volume register V1
86	Temp1	Current inlet temperature
87	Temp2	Current outlet temperature
89	Temp1-Temp2	Current differential temperature
74	Flow1	Current water flow
80	Power1	Current power
239	V1HighRes	High-resolution volume register for test purposes
266	E1HighRes	High-resolution heat energy register for test purposes
267	E3HighRes	High-resolution cooling energy register for test purposes
98	LogDaySetUp	Target date (reading date)
146	AvrTemp1(y)	Year-to-date average of T1
147	AvrTemp2(y)	Year-to-date average of T2
149	AvrTemp1(m)	Month-to-date average of T1
150	AvrTemp2(m)	Month-to-date average of T2
229	AutoIntT1Average	T1 average of latest autointegration
230	AutoIntT2Average	T2 average of latest autointegration
123	MaxFlow1Date(y)	Date of this year's max.
124	MaxFlow1(y)	This year's max. value
127	MaxPower1Date(y)	Date of this year's max.
128	MaxPower1(y)	This year's max. value
138	MaxFlow1Date(m)	Date of this month's max.
139	MaxFlow1(m)	This month's max. value
142	MaxPower1Date(m)	Date of this month's max.
143	MaxPower1(m)	This month's max. value
98	Xday	Target date
153	ConfNo1	Config no. ABDDD
168	ConfNo2	Config. no. EFGHHMMM
1001	SerialNumber	Serial no. (unique number of each meter)
112	MeterNo(high)	Customer number (8 most significant digits)
1010	MeterNumber(low)	Customer number (8 least significant digits)
1005	MeterType	Meter type
184	MBusBotDispPriAddr	Primary M-Bus address
185	MBusBotDispSecAddr	Secondary M-Bus address
154	CheckSum	Software checksum
175	Infohour	Error hour counter

13.1.2 Data protocol

Utilities and other relevant companies who want to develop their own communication driver for the KMP protocol can order a demonstration program in C# (.net based) as well as a detailed protocol description (in English language).

13.2 Optical eye

The optical eye can be used for data communication via the optical interface. The optical eye is placed on the front of the integrator just above the display as shown in the picture below. Please note that the optical eye includes a very strong magnet, which should be covered by a protection plate when not in use.

MULTICAL® 302 does not include a metal plate, which can retain the reading head's magnet. Therefore, the optical reading head must be held in place manually during brief data readings.

In connection with prolonged data readings, reading of data loggers, or if you want the optical reading head to be retained on the meter for other reasons, you can use a transparent holder, which is clicked onto the meter.

Different variants of the optical eye (with USB-plug and 9-pole D-Sub plug) appear from the list of accessories (see paragraph 3.2.3).

13.2.1 Power-saving in connection with the optical eye

In order to limit the power consumption of the circuit around the optical eye, the circuit is not permanently switched on. It is activated by pressing the key. The circuit will remain on 4 minutes after the last activation of the button.

14 Test

MULTICAL® 302 can be tested as a complete energy meter or as a hybrid meter determined by the available equipment.

The test as a complete energy meter can be carried out without disassembling the meter, except from the fact that the ”TEST” seal must be broken (see paragraph 14.1.1). The high-resolution test registers can be read from the display, via serial data reading, or via high-resolution pulses.

Before test as a hybrid meter MULTICAL® 302 must be disassembled and the sensor pair must be soldered off. Subsequently, the calculator is tested separately by means of precision resistors and the meter's built-in "Auto-integration". Flow sensor and temperature sensors are tested separately too. During test of the flow sensor it is important that the temperature sensor, to be mounted in the flow sensor, is installed.

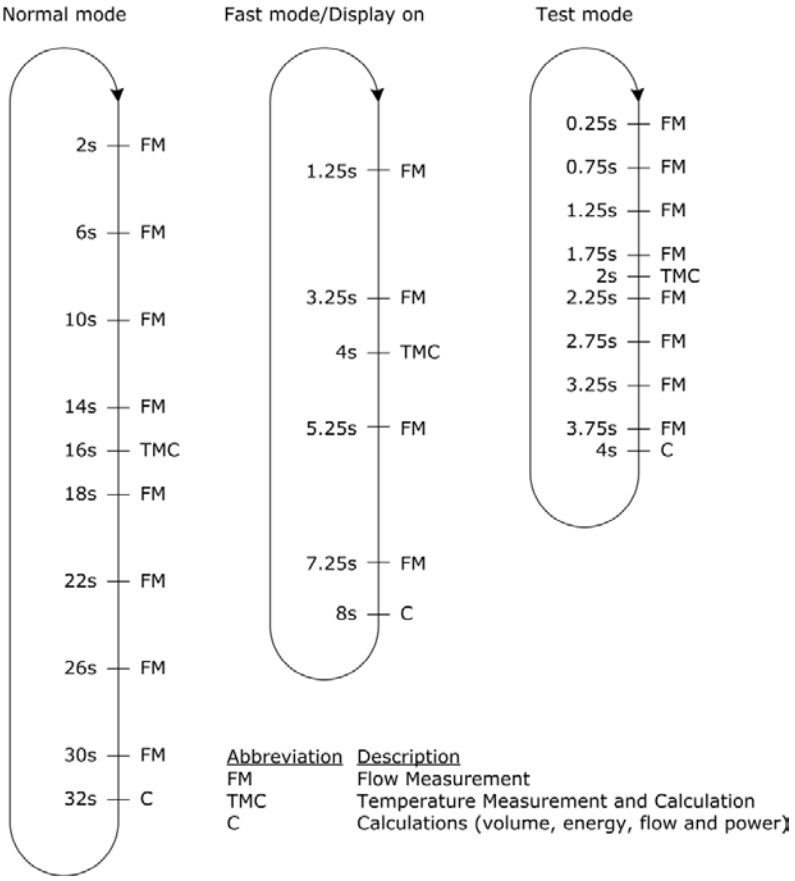
If ”energy verification” with separate temperature baths is used, it is important that the medium in the flow sensor and the temperature bath, in which the temperature sensor mounted in the flow sensor is placed, have the same temperature.

In order to obtain quick test/verification of MULTICAL® 302, the meter has a test mode which repeats the measuring sequence every four seconds, i.e. eight times faster than in normal mode or twice as fast as in fast mode. In test mode heat energy, cooling energy and volume are displayed with a resolution which is higher than normal in order to enable a shorter test duration.

MULTICAL® 302 uses more current in test mode, but under normal circumstances where the meter is in test mode a few times during its lifetime, this is without importance for the meter's battery lifetime.

14.1 Meter modes

The meter can operate in three different modes: "Normal", ”Fast” and "Test" mode, as shown below. The choice between normal and fast mode must be made when ordering the meter and this choice cannot be changed subsequently. No matter whether the meter is supplied with normal mode or fast mode, test mode (see paragraph 14.1.1) can be selected.



14.1.1 Test mode

In order to access test mode the "TEST" seal Ⓢ on the back of the meter must be carefully broken with a screwdriver and the contact points behind the seal short-circuited with short-circuit pen type 66-99-278.

Subsequently, test is displayed.

The meter remains in test mode until the front button is activated for 5 s, however, a time-out secures that the meter returns from test mode to normal mode after 9 hours.

When tests are finished the seal must be re-established using a void label size 15 x 15 mm . The seal is important with a view to the meter's approval and to maintain its protection class.

14.1.2 Test loop

Test loop includes six different main readings and three different sub-readings:

Test loop **Main**		*Test loop* *Sub*		**Index number in display**
1.0	**High-resolution heat energy ***			**4-01**
		1.1	Heat energy (E1)	4-01-01
2.0	**High-resolution cooling energy ***			**4-02**
		2.1	Cooling energy (E3)	4-02-01
3.0	**High-resolution volume ***			**4-03**
		3.1	Volume	4-03-01
4.0	**T1 (Inlet)**			**4-04**
5.0	**T2 (Outlet)**			**4-05**
6.0	**Flow**			**4-06**

After 9 hours the meter reverts to energy reading in "User loop".

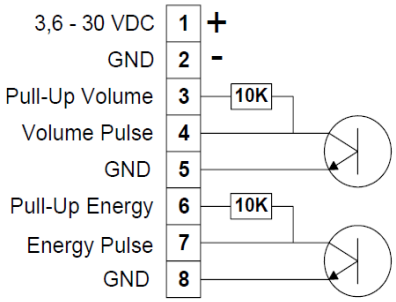
* Register/resolution of the high-resolution registers are as follows: **"0000001 Wh"** and **"00000.01 l"**

TEST loop can only be displayed if the verification seal is broken and the switch activated.
The high-resolution registers can only be reset in connection with a total reset. See paragraph 15 for further information about METERTOOL HCW.

14.2 Test connection

During test either optical reading head with USB plug (66-99-099) for serial reading of high-resolution energy and volume registers, or Pulse Interface (66-99-143) with optical reading head and connection unit for high-resolution pulse outputs is used. Do not forget that the meter must be in Test mode.

14.2.1 Verification pulses



When Pulse Interface type 66-99-143 is connected to power supply or battery, the unit is placed on the meter, and the meter is in test mode, the following pulses are transmitted:

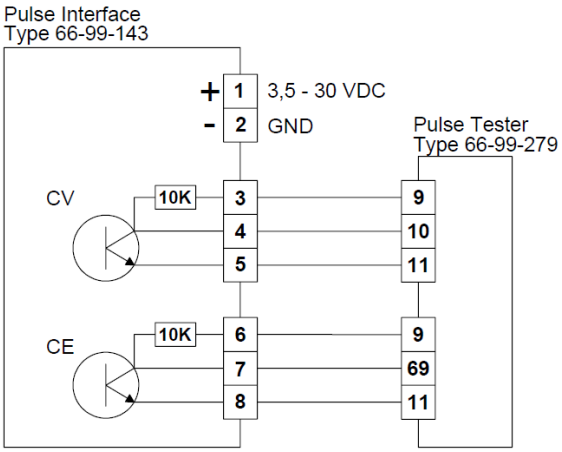
- High-resolution energy pulses (1 Wh/pulse) on terminals 7 and 8
- High-resolution volume pulses (10 ml/pulse) on terminals 4 and 5

Pulse Interface 66-99-143, technical data

Supply voltage	3,6 – 30 VDC
Current consumption	< 15 mA
Pulse outputs	< 30 VDC < 15 mA
Pulse duration	3,9 ms.
Energy pulse	1 Wh/pulse (1000 pulses/kWh)
Volume pulse	10 ml/pulse (100 pulses/litre)

14.2.2 Use of high-resolution pulses

High-resolution energy and volume pulses can be connected to the test stand used for calibration of the meter, or to Kamstrup's Pulse Tester, type 66-99-279, as shown in the drawing below.



14.2.3 Auto-integration

The purpose of auto-integration is to test the calculator's accuracy. During auto-integration the water flow through the meter must be cut off to make it possible to read the volume and energy counted during auto-integration without the meter continuing normal counting in the registers afterwards.

At the beginning of an auto-integration the meter receives a serial data command with test volume and number of integrations over which the meter is to distribute the volume.

In MULTICAL® 302 the high-resolution test registers cannot be separately reset, so the test must be based on the increase in the high-resolution registers during test.

After auto-integration all volume and energy registers – incl. the high-resolution test registers – have been enumerated by the given volume and the calculated energies. Furthermore, the average of the temperatures measured during auto-integration has been saved in two registers, "T1 average inlet temperature" and "T2 average outlet temperature".

For calculation of accuracy and precision the below-mentioned registers can be read after auto-integration:

Verification registers		**RID**
Heat energy	E1HighRes	266
Cooling energy	E3HighRes	267
Volume	V1HighRes	239
T1 average inlet temperature	T1average_AutoInt	229
T2 average outlet temperature	T2average_AutoInt	230

14.3 Handling different test methods

14.3.1 Standing start/stop

Standing start/stop is a method used for testing the flow sensor's accuracy. During the test the meter must be mounted in a flow test stand. The flow through the sensor is cut off. Subsequently, water flow is added for a certain period, during which the water passing through the sensor is collected. Having switched off the flow the volume of the collected water is compared to the volume counted by the meter. In general, standing start/stop requires bigger test volume than flying start/stop.

14.3.1.1 Standing start/stop via display reading

Condition: MULTICAL® 302 must be in test mode (see paragraph 14.1.1).

The high-resolution display readings are updated at 4-second intervals.

14.3.1.2 Standing start/stop using pulse outputs

Condition: MULTICAL® 302 must be in test mode (see paragraph 14.1.1).

Verification pulses are connected as described in paragraph 14.2.1 above.

14.3.1.3 Flying start/stop

Condition: MULTICAL® 302 must be in test mode (see paragraph 14.1.1).

Verification pulses are connected as described in paragraph 14.2.1 above.

"Flying start/stop" is the most frequently used method for testing the accuracy of flow sensors. During the test the meter must be mounted in a flow test stand and there is constant water flow through the sensor.

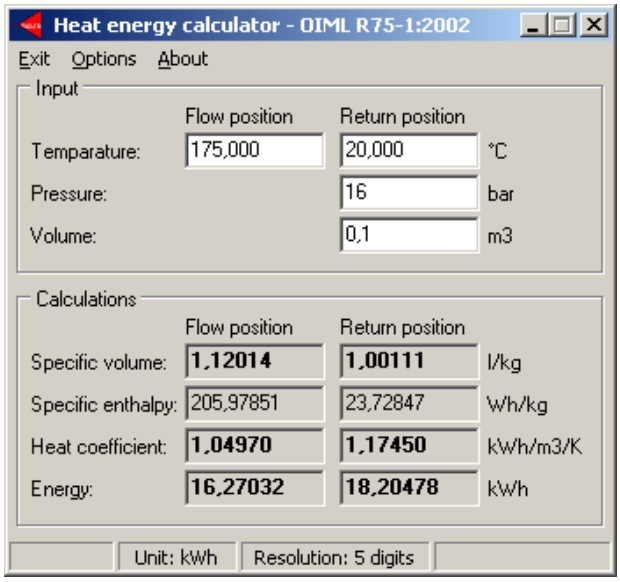
Verification pulses, as described in paragraph 14.2.1, can be directly used for the test stand if it is designed to control the start/stop synchronisation. Alternatively, Pulse Tester, type 66-99-279, can be used as external start/stop pulse counter.

As the meter calculates volume and energy every four seconds in test mode (see paragraph 14.1.1), the verification pulses will also be updated every four seconds as described in paragraph 14.2.1. It is important to allow for this time interval, which means that the test duration from start to stop must be so long that the update time does not influence the measuring uncertainty to any very considerable extent.

14.4 True energy calculation

During test and verification the heat meter's energy calculation is compared to the "true energy", which is calculated according to the formula of EN 1434-1:2007 or OIML R75:2002.

For control calculations Kamstrup can supply an energy calculator:



The true energy at the most frequently used verification points is indicated in the table below.

T1 [°C]	T2 [°C]	ΔΘ [K]
42	40	2
43	40	3
53	50	3
50	40	10
70	50	20
80	60	20
160	40	120
160	20	140

Flow [Wh/0.1 m³]	Outlet [Wh/0.1 m³]
230.11	230.29
345.02	345.43
343.62	344.11
1146.70	1151.55
2272.03	2295.86
2261.08	2287.57
12793.12	13988.44
14900.00	16390.83

15 METERTOOL HCW

15.1 Introduction

The Kamstrup Software product "METERTOOL HCW" (66-99-724) is used for configuration of MULTICAL® 302 as well as configuration of other Kamstrup heat, cooling and water meters.

15.1.1 System requirements

As a minimum METERTOOL HCW requires Windows XP SP3, Windows 7 Home Premium SP1 or newer, as well as Windows 10 and Windows Internet Explorer 5.01 or newer.

Minimum:	1 GB RAM	**Recommended:**	4 GB RAM
	10 GB free HD space		20 GB free HD space
	Display resolution 1280 x 720		1920 x 1080
	USB		
	Printer installed		

Administrator rights to the PC are needed in order to install and use the programs. They must be installed under the user login of the person, who is to use the programs.

15.1.2 Interface

The following interfaces can be used:

Optical eye USB	type	6699-099
Optical eye COM port	type	6699-102
Blue Tooth optical eye	type	6699-005

15.1.3 Installation

Check that system requirements are fulfilled.

Close other open programs before starting the installation.

Download the METERTOOL HCW software from Kamstrup's FTP-server and follow the program's directions through the installation.

During installation of the METERTOOL HCW program the USB-driver for the optical readout head is automatically installed if not already existing.

When the installation is completed, the icon "METERTOOL HCW" will appear in the 'All Programs' menu under 'Kamstrup METERTOOL HCW' (or from the menu "start" for Windows XP) and as a link on the desktop. Double-click on link or icon in order to start the program.

15.2 How to use METERTOOL HCW for MULTICAL® 302

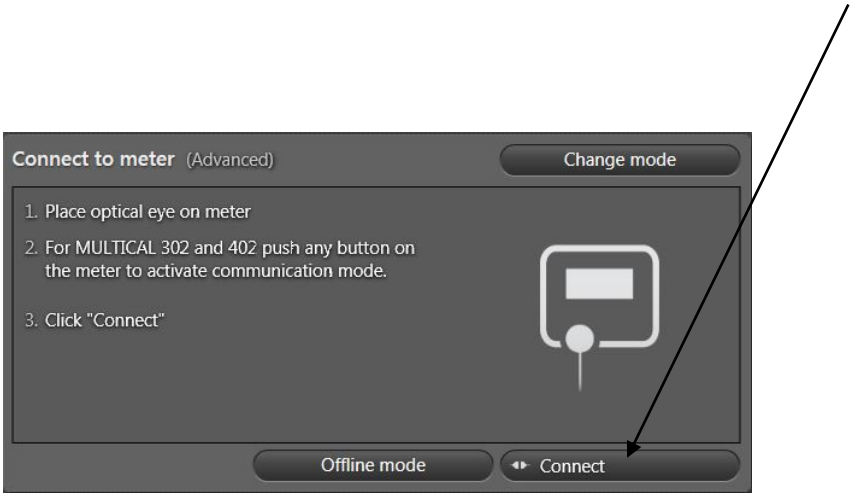
15.2.1 General information

It is important to be familiar with the calculator's functions before starting programming.

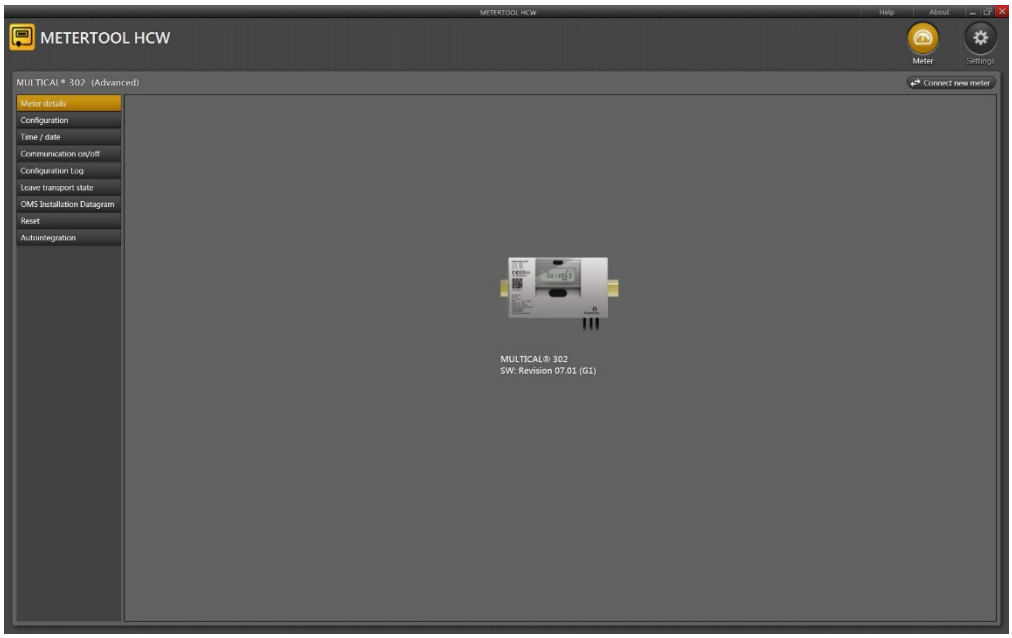
The Kamstrup Software product "METERTOOL HCW" (66-99-724) is used for MULTICAL® 302.

Before running the program, connect your optical readout head to your computer and place the head in the plastic holder on the calculator.

Start up METERTOOL HCW, press the button on the calculator and click "Connect" in METERTOOL HCW.

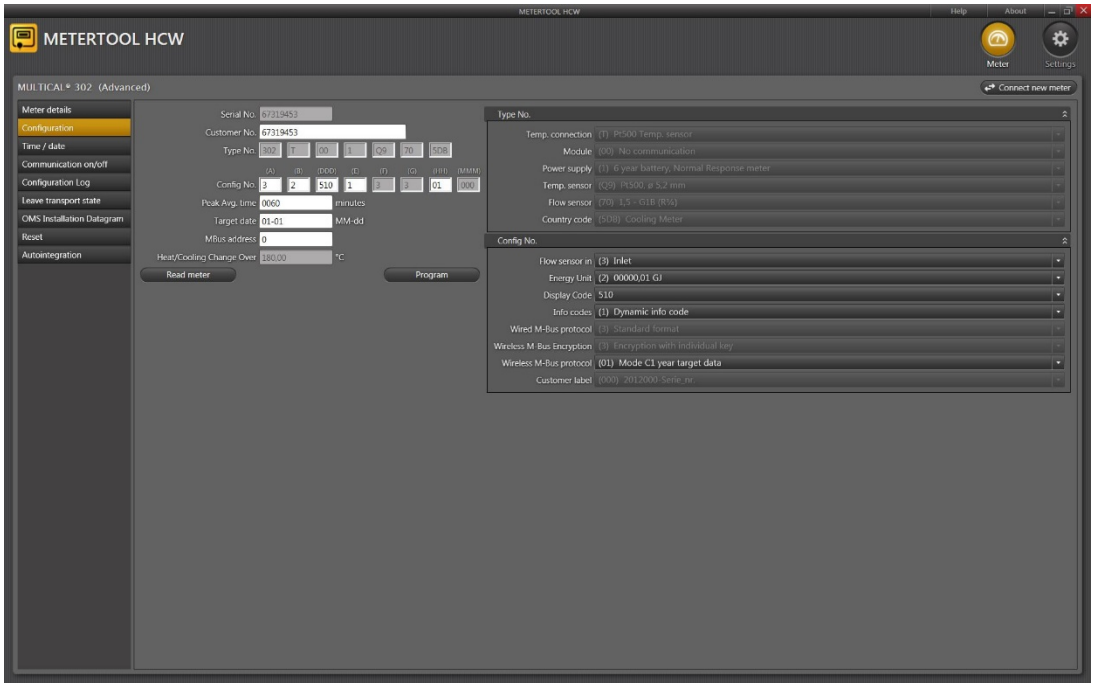


METERTOOL HCW will respond by showing a picture of MULTICAL® 302 with information about S/W revision etc.



From the menu in the left side of the screen a number of different options are available, depending on mode (Basic/Advanced).

15.2.2 Configuration (Basic/Advanced Mode)



The configuration of MULTICAL® 302 can be read without setting the meter to Setup Loop. The program is self-explanatory as to most coding numbers (see text in ”combo-boxes”), further details can be found in the respective paragraphs of the technical description.

15.2.3 Changing the configuration of MULTICAL® 302

To program new values into the meter it must be in Setup Loop. If the MULTICAL® 302 has not yet been used it will be in "Transport State" and the programming can take place without further action. METERTOOL HCW for MULTICAL® 302 will automatically set the meter to Setup Loop.
If the MULTICAL® 302 has been in use prior to the programming, the meter will have to be set to "Setup loop" before the programming can commence. This can be done only by first breaking the ⚠ SETUP seal and short-circuiting the contact points behind the seal with short-circuit pen type 66-99-278. After that, "Setup" is displayed.
Note! This should be done only by an authorized installer, and an approved seal has to be replaced after programming.
After shorting ⚠ SETUP seal, the meter will remain in Setup loop for 4 minutes. To extend this period the front button can be pressed, which will extend the Setup loop time by another 4 minutes. This can be done multiple times.

Figure 11

It is not possible to change the series number, as this is a unique number which is allocated to the meter during production.

15.2.4 Time / date (Basic/Advanced Mode)

In this menu the built-in clock in the meter can be read out and adjusted either manually or by setting the meter to the clock of the PC where METERTOOL HCW is running. It is only possible to write to a meter in "Setup Loop".

15.2.5 Communication on/off (Advanced Mode)

In this menu the M-Bus radio transmitter can be switched on or off. This is useful if the meter is being transported e.g. by air.

15.2.6 Configuration log (Advanced Mode)

Displays how many times the meter configuration has been changed since the first configuration. The maximum number of configuration changes is 25.

15.2.7 Reset (advanced mode)

This menu comprises three different types of reset.

1. **Normal Reset**
   This reset does not zero any registers. The data logger structure implemented in the meter permits logging at intervals: hour, day, month, year. Furthermore, info events and configuration events are logged. In addition to the logs mentioned, which are dedicated to reading, a backup log, which is used in case of voltage failure or reset, is logged. ”Normal Reset” updates the backup log, the meter restarts and restores the configuration parameters. It may be necessary to perform a ”Normal Reset” if the configuration parameters are changed as a ”Normal Reset” restores the configuration parameters, which means that the meter registers the changes.
2. **Data logger reset**
   This reset zeroes the meter's data protocols, including yearly, monthly, daily and hourly logs as well as info code and configuration log.
3. **Static info code reset**
   If the meter has been configured for ”Manual reset of info codes”, the info code remains visible in the meter's display until a ”Static info code reset” has been performed. If the meter has been configured with ”Dynamic info codes”, however, the info code disappears when the error has been corrected. A ”Static info code reset” does not reset the info code logger.

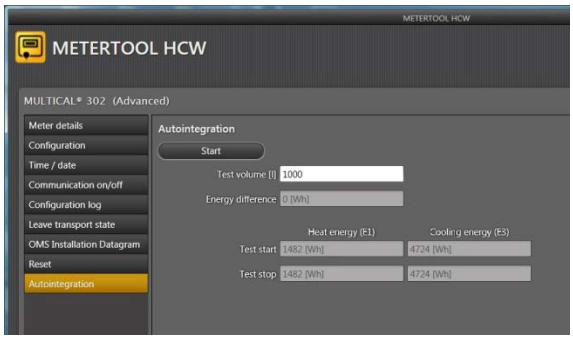
15.2.8 Leave transport state (Advanced Mode)

If the meter has not yet been commissioned and no water has passed through the flow sensor, the meter is still in Transport state. If needed, the meter can be taken out of Transport state by clicking “Yes” to leave “Transport state”.

15.2.9 Autointegration (Advanced Mode)

Using this feature you will have to either connect two known (precision) resistors to the temperature sensor inputs of the meter or use the existing connected temperature sensors and keep them at two known temperatures e.g. boiling water = 100°C and icy water = 0°C.

Thus, you can simulate energy consumption and thereby verify the energy calculation of the meter.



15.2.10 Settings

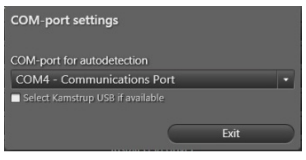
By clicking the “Settings” tab the following can be changed:

Change language

The program language can be changed between 9 different languages: Danish, German, English, French, Polish, Russian, Czech, Swedish and Spanish.

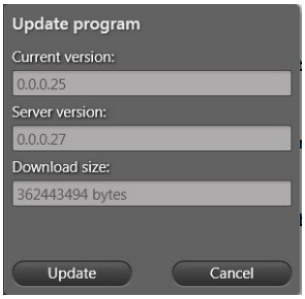
COM port settings

The COM port can be selected manually instead of the default setting which is automatic.



Update program

In this menu the METERTOOL HCW program can be updated if a newer revision is available on Kamstrup’s FTP-server. Also the driver for the USB optical read out head can be installed manually from this menu.



Update database

In this menu the METERTOOL HCW database can be updated if a newer revision is available on Kamstrup's FTP-server.

Backup & Rest. databases This button is not used with MULTICAL® 302.

Install USB driver This button installs the USB driver used or the optical read out head.

15.2.11 Help button

Contact The contact button gives you the links to Kamstrup's Website and mailbox.

Output This function shows the latest functions used in the program.

User manual Links to the user manual for the meter on Kamstrup's website.

15.2.12 About button

About lists the METERTOOL HCW program version and revision numbers as well as all sub-programs, their type numbers and revision numbers for the entire METERTOOL HCW program.

15.3 Flow sensor adjustment

Flow sensor adjustment of MULTICAL® 302 can only be done by an authorized laboratory using LabTool, which is not available for ordinary users.

15.4 LogView HCW

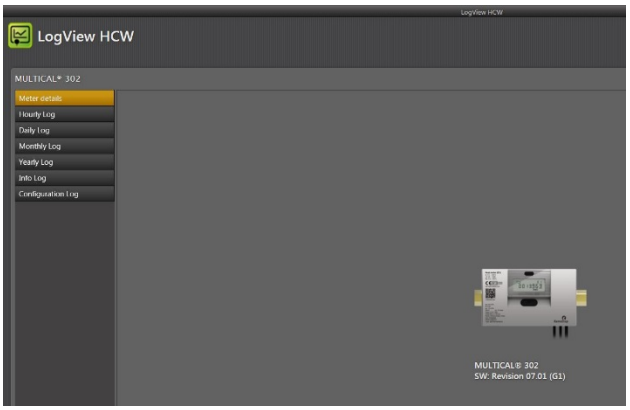
15.4.1 Introduction and installation

Regarding ”Introduction”, ”Interface” and ”Installation” see paragraph **15.1 Introduction METERTOOL HCW** since it is similar for LogView HCW.

15.4.2 General information

”LogView HCW” (ordering no. 6699-725) is used for read-out of logging data from MULTICAL® 302 meter. The read out data can be used for analysis and diagnostic test of the heating installation. Data can be presented as table and graphics, tables can be exported to ”Windows Office Excel”.

For available logging data see paragraph **7.8 Data loggers.**



15.4.3 ”Log”

Select the required data function.

Daily Data, Monthly Data and Yearly Data allow read-out of data logged by MULTICAL® 302 with optional data period and values.

Info Data allows read-out of the latest 50 info events from MULTICAL® 302, reading includes date and info code of the info event.

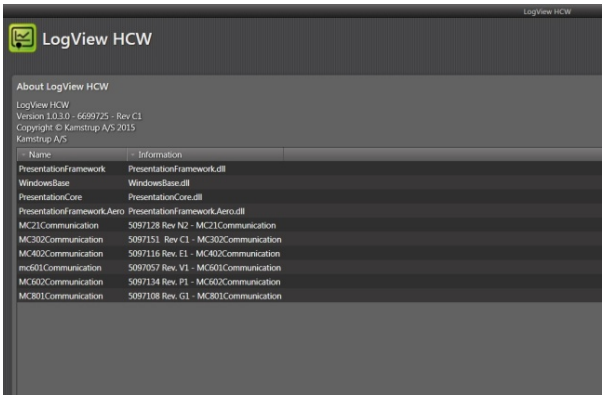
Configuration log allows read out of all configuration changes (max. 25) that have been made to the meter.

15.4.4 Help button

Contact	The contact button gives you the links to Kamstrup’s website and mailbox.
Output	This function shows the latest functions used in the program.
User manual	Links to the user manual for the meter on Kamstrup’s website.

15.4.5 About button

About lists the LogView HCW program version and revision numbers as well as all sub-programs, their type numbers and revision numbers for the entire LogView HCW program.

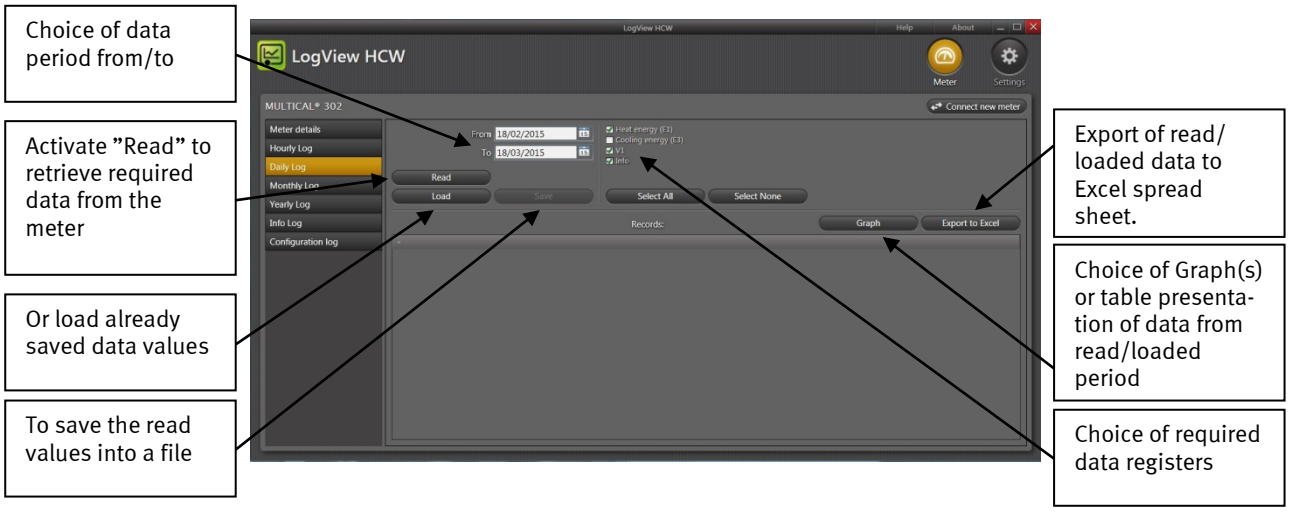


15.4.6 Application

Double-click on link or icon for ”LogView HCW” in order to start the program, and select the required data function.

Meter identification! Click “connect to meter”

”**Daily Data**” is used as an example:

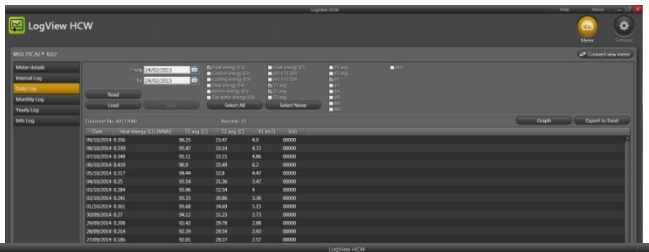


Select the required registers by clicking on the box next to the register name. To read out all data, activate ”Select All” to select all values.

When read-out has been completed the read values can be saved by clicking “Save”. We recommend to save the read-outs, securing that data can be reopened later for further analysis or documentation.

The values appear in graphs or list form by activating ”Graph”/”Table” (toggle function).

In order to carry out a new data read-out, you just select a new period and new data registers. If the formerly read values are not already saved, you will be asked if you want to do so.

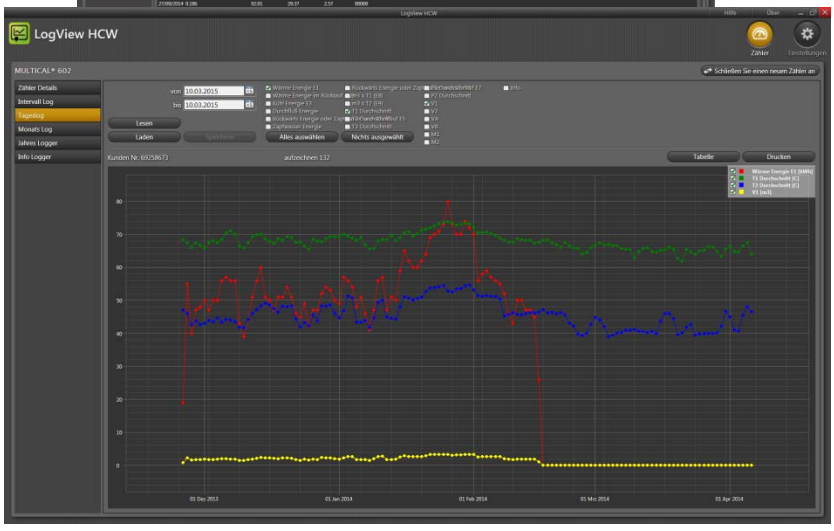


Tables can be exported direct to ”Windows Office Excel” or printed.

To zoom in, activate Zoom and select the area, on which you want to zoom in.

To zoom out, double-click anywhere in the system of coordinates.

In order to read current values from the graphs; remove the marking from Zoom and let the mouse cursor hover above the required point.



16 Approvals

16.1 Type approvals

MULTICAL® 302 is type approved according to MID on the basis of EN 1434-4:2015.

MULTICAL® 302 has a national Danish cooling approval TS 27.02 001.

16.2 The Measuring Instruments Directive

MULTICAL® 302 is available with CE-marking according to MID (2014/32/EU). The certificates have the following numbers:

Module B: DK-0200-MI004-031

Module D: DK-0200-MID-D-001

17 Troubleshooting

MULTICAL® 302 has been constructed with a view to quick and simple installation as well as long and reliable operation at the heat consumer.

Should you, however, experience an operating problem with the meter, the table below can be used for troubleshooting.

The meter may only be opened and/or repaired by an authorized laboratory or at Kamstrup A/S.

Before sending us the meter to be repaired or checked, we recommend that you go through the error options listed below in order to clarify the possible cause of the problem.

Symptom	Possible reason	Proposal for correction
No display function (empty display)	Display is in "sleep mode"	Press the front button in order to activate the display.
No energy accumulation (e.g. MWh) and volume (m^3)	Read "info" in the display	Check the error indicated by the info code (see paragraph 7.8)
	If "info" = 2 ⇒	Check that the flow direction matches the arrow on the flow sensor
	If "info" = 4, 8 or 12 ⇒	Check temperature sensors. If defective, replace the meter.
Accumulation of volume (m^3) but not of energy (e.g. MWh)	Temperature sensors can be defective. Check the temperature sensor cable for visible damage.	Replace the meter
	Heat/cooling cutoff θ_{hc} has been configured too low (only relevant for meter type 6xx)	Reconfigure θ_{hc} at a suitable value, or configure θ_{hc} at 180 °C, thereby disconnecting the cutoff function.
Incorrect temperature reading	Defective temperature sensor Insufficient installation	Check the installation Replace the meter
Temperature indication a little too low, or accumulation of energy (e.g. MWh) slightly too low	Bad thermic sensor contact Heat dissipation Too short sensor pockets	Make sure that the sensors have been pushed to the bottom of the sensor pockets Insulate sensor pockets Replace by longer pockets

18 Disposal

Kamstrup A/S holds an environmental certification according to ISO 14001, and as part of our environment policy we use materials which can be recovered environmentally correct to the greatest possible extent.

Heat meters from Kamstrup are marked according to the 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

Kamstrup accept end-of-life MULTICAL® 302 for environmentally correct disposal according to previous agreement. The disposal arrangement is free of charge to the customer, except for the cost of transportation to Kamstrup A/S or the nearest disposal system.

The meters should be disassembled as described below and the separate parts handed in for approved destruction. The batteries must not be exposed to mechanical impact and the lead-in wires must not be short-circuited during transport.

Item	**Material**	**Recommended disposal**
2 x A Lithium cells	Lithium and thionyl chloride 2 x A-cells: 2 x 0,96 g lithium	Approved deposit of lithium cells
1 x A Lithium battery	Lithium and thionyl chloride 1 x A-cell: 0,96 g lithium	Approved deposit of lithium cells
PCBs in MULTICAL® 302 (remove LC-display)	Coppered epoxy laminate, components soldered on	PCB scrap for metal recovery
LC-display	Glass and liquid crystals	Approved processing of LC-displays
Cables for flow sensor and temperature sensors	Copper with silicone mantle	Cable recovery
Transparent top cover	PC + 10% glass	Plastic recycling or combustion
PCB case and connecting base	ABS with TPE gaskets	Plastic recycling or combustion
Wall bracket	PC + 20% glass	Plastic recycling or combustion
Meter case Transducer/reflector	Hot dezincification proof brass, CW 602N < 1% stainless steel	Metal recovery
Packing	Environmental cardboard	Cardboard recycling (Resy)
Packing	Polystyrene	EPS recovery

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

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

19 Documents

MULTICAL® 302	Danish	English	German	Russian
Technical description	5512-1333	5512-1334	5512-1335	5512-1336
Data sheet	5810-1203	5810-1205	5810-1206	5810-1207
Installation and user's guide	5512-1350	5512-1351	5512-1352	5512-1353

	Danish	English	German	Russian
Technical description M-Bus	-	5512-1329	-	-
Technical description wM-Bus	-	5512-1330	5512-2191	-