MULTICAL® III
&
ULTRAFLOW II

Technical Description

English

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PREFACE

During recent years, work on developing new energy meters has been intensified. Previously an energy meter would be used only for accumulating energy and water consumption. Today's energy meters are also able to register a wide scope of information.

MULTICAL® III is no exception, particularly with regards to technical finesse. With this Technical Description, Kamstrup A/S describes in detail all technical aspects of MULTICAL® III and ULTRAFLOW II for heating engineers, plumbers, technicians, dealers and other interested parties.

This manual will also be useful to laboratories commissioning or verifying MULTICAL® III.

This manual is, however, not intended to be distributed to private persons or consumers using MULTICAL® III, who need only be acquainted with data acquisition procedures.

To facilitate the changeover from MULTICAL II to MULTICAL® III, special care has been taken in the writing of "MULTICAL® III and ULTRAFLOW II Technical Description" to highlight the functional differences between these two meters.

As a natural element in Kamstrup's ISO 9001 Quality Management Programme, this manual is registered and periodically revised. If you are in any doubt as to the validity of this edition, please contact Kamstrup A/S.

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A.1 MULTICAL® III

A.1.1 HOW DOES THE METER FUNCTION?

MULTICAL® III is designed for use in measuring and accounting systems to determine individual household consumption of thermal energy in district and central heating systems, with flow temperatures up to 160°C and flow sizes of up to 3000 m^3/h. Furthermore, electricity and water consumption can be accumulated, making it possible to use just one meter to measure consumption of electricity, water and heat. All data can be transferred for accounting purposes.

The integrator can be connected to either mechanical or static flow meters, and functions via a universal bracket as both a compact and wall-mounted energy meter. Using Kamstrup's 144 x 192 mm panel bracket, it is also possible to fit MULTICAL® III in panels and control panels.

MULTICAL® III receives volume pulses from the flow meter. Once a certain number of pulses has been received, an integration is performed. The energy calculation encompasses measuring the temperature in the flow and return pipes together with correction for density and heat content using Dr. Stuck's thermal coefficient tables.

MULTICAL® III can be supplied either by means of an integral, 6 year, 3.65 V battery, an integral 24 V AC/DC module, or an integral 230 V AC module. Data acquisition and input of tariff and operating parameters is swift and accurate using the optical head on the front panel.

A.1.2 DISPLAY FEATURES

MULTICAL® III is equipped with a clear, liquid crystal display with 8 digits and 3 alphanumerical characters. During normal operation, the accumulated values for thermal energy and water consumption are shown with 7 digits. The relevant unit of measurement (MWh, m^3 etc.) is displayed in the field with three alphanumerical characters. The first digit in the far left of the display is used to indicate an Error, “E”. This letter is activated if a fault occurs in the energy meter. If a customer ID number is required, all 11 digits in the display can be used.

The display constantly shows the accumulated thermal energy in MWh, kWh or GJ, depending on the meter program. If the right or left keys are pressed, the following information will be displayed:

Right key ⇒		
Accumulated thermal energy		kWh, MWh or GJ
Accumulated water flow		m^3
Hour counter		HRS
Flow temperature		°C
Return temperature		°C
Differential temperature		°C
Actual thermal power		kW or MW
Peak thermal power *)		kWP or MWP
Actual water flow		l/h or m^3/h
Peak water flow *)		l/h P or m^3 P
Information code		info

Left key ⇓		
Tariff register 2		TA2
Tariff limit 2		TL2
Tariff register 3		TA3
Tariff limit 3		TL3
Accumulated water consumption		m^3a
Accumulated water/electricity consumption		m^3b/Elb
Program No.		PGM
Customer ID No.		-
Current date		dat
Segment test		-

Only criteria specified in the meter program will be displayed. The display will automatically revert to accumulated thermal energy approx. 2½ minutes after the key has been activated.

*) Either peak power or peak flow is displayed, depending on the configuration.

The display can also show the following values:

Test Mode, used to read Quick figure	T--M
Programming Mode, displayed when the meter is being programmed	P--M
Call is displayed when the meter rings up using modem	Call

A.1.3 STATUS DIGIT

The digit to the far left of the display is primarily used to display "E", which indicates an information code > 0. This digit is also used when an 11-digit customer ID No. is displayed. The control digit, employed by MULTICAL II during automatic read-out is not a feature of MULTICAL® III.

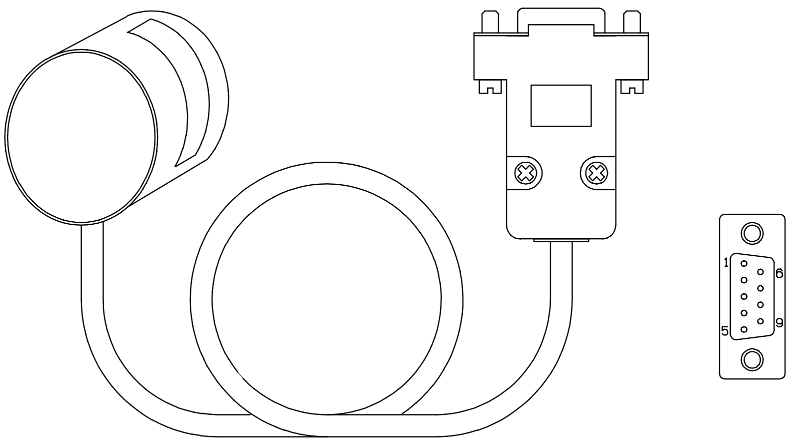
A.1.4 INFORMATION CODES

During normal operation the information code will be equal to 0. Should one or more faults occur, the relevant information code numbers will be added together and the letter "E" will appear in the display. The initial information code is stored in the EE-PROM, together with the date on which the fault occurred. This data can be deleted by "Resetting information codes" or "Total Reset", as described in section A12.

+1	Information code for incorrect reset or power cut does not exist in MULTICAL® III. However, the date for the most recent reset can be read.
+2	Information code for water meter fault is activated when MULTICAL® III does not receive integrator pulses for a period of 48 hours, whilst the differential temp. has been more than 20°C.
+4	The return probe has been below 0°C or higher than 165°C for more than one hour, indicating a shorted or disconnected probe.
+8	The flow probe has been below 0°C or higher than 165°C for more than one hour, indicating a shorted or disconnected probe.
+128	The battery should be replaced. This code appears 8 years after the hour counter has been reset. This information code is disabled when the meter is supplied over a net.
+256	The meter has registered an excessive number of water pulses, corresponding to more than 1 integration per second.
+512	The information code for system fault does not exist in MULTICAL® III. This code has been replaced by three fields situated in the top left corner of the display. During normal operation these will light up from left to right at 1 second intervals. If a fault occurs in the integrator, one or more of the fields will light constantly.

A.2 OPTICAL DATA ACQUISITION VIA THE FRONT PANEL

An optical, infrared transmitter/receiver is situated in the bottom left corner of the front panel, in accordance with the EN 61107 standard. The data format complies with IEC 870 in start mode and can be subsequently changed to a format specified by the manufacturer. A standard optical head with a permanent magnet is used to read data and configure tariff limits.



2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready
5	SG	Signal Ground

The pulse figure, flow meter installation and choice of measuring unit for accumulated energy can be programmed via the optical data acquisition head. Changing this data, however, requires that a link be soldered prior to programming, as this data is legal measuring data.

Kamstrup's data acquisition head, type 66-99-102, can be connected to both Kamstrup's hand-held terminal, MULTITERM III, and a standard IBM-compatible computer with Windows 3.1 or a more recent edition.

For further information on the hand-held terminal or PC-software, please refer to the following documents.

MULTITERM III	type 66-99-100
PC-software	type 66-99-200

A.2.1 DESIGN

When the data acquisition unit, MULTITERM III or a computer, sends a recognisable request string, MULTICAL® III answers with a data string 1-2 seconds after the request string is received. The optical data acquisition head on MULTICAL® III uses the following communication set-up.

300/1200 Baud	1 Startbit	7 Databits	Equal parity	1 Stopbit

The following data string can be read using the optical data head:

A.2.2 DATA STRING FOR A 61107 REQUEST

a) EN61107 DATA READ-OUT

-> / ? ! CR LF [300 BAUD]

<- / K A M 0 M C CR LF [300 BAUD]

-> ACK 0 0 0 CR LF [300 BAUD]

<- STX 0 . 0 (D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1) [300 BAUD]

<- 6.8 (D7 D6 D5 D4 D3 D2 D1 * UNIT1) [300 BAUD]

<- 6.26 (D7 D6 D5 D4 D3 D2 D1 * UNIT2) [300 BAUD]

<- 6.31(D7 D6 D5 D4 D3 D2 D1 * h) ! CR LF ETX BCC [300 BAUD]
Kommaplacering i data: Sendes som "." (decimal punkt)

Key	
UNIT1	kWh , MWh , GJ or none
UNIT2	m^3 or none
STX	Start of Text
ETX	End of Text
BCC	Block Check Character
LF	Line Feed
CR	Carriage Return
Dn	ASCII characters
*	Separates values and units
->	Data string to MULTICAL® III
<-	Data string from MULTICAL® III

A.2.3 DATA STRING

b) NORMAL DATA 1:

-> / # 1 [300 BAUD]

<- Energy, Water, Hour counter, t_F, t_R, Δt, Power, Flow, Peak power/flow, Info, [1200 BAUD]

c) NORMAL DATA 2:

-> / # 2 [300 BAUD]

<- Customer ID no., TA2, TL2, TA3, TL3, Input-a, Input-b, Prog. No., Config. No., Date, [1200 BAUD]

d) DATA READ-OUT OF TARGET DATA:

-> / # 3 [300 BAUD]

<- Customer ID No., Read-out date, Energy, Water, TA2, TA3, Input-a, Input-b, Peak power/flow [1200 BAUD]

e) DATA READ-OUT OF COMMISSIONING DATA:

-> / # 4 [300 BAUD]

<- Energy, Quick sum, Δt x k-factor, Water, Water remainder 1, Water remainder 2, t_F ,t_R , Prog.no., [1200 BAUD]

f) DATA READ-OUT OF MONTHLY DATA :

-> / # 5 [300 BAUD]

<- Customer ID No., Read-out date, Energy, Water, TA2, TA3, Input-a, Input-b, Peak power/flow -- Hourly data, [1200 BAUD]

<- Read-out date, Energy, Water, TA2, TA3, Input-a, Input-b, Peak power/flow -- last month

.

.

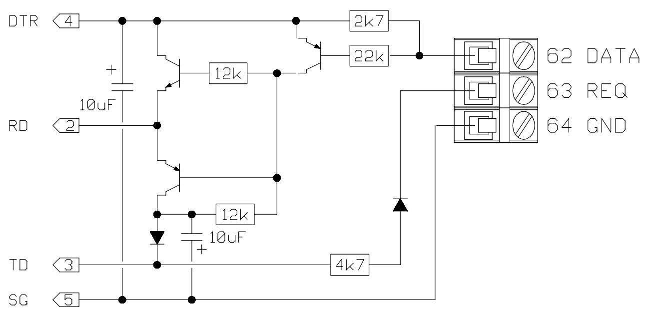
<- Read-out date, Energy, Water, TA2, TA3, Input-a, Input-b, Peak power/flow -- last 30 months

<- Read-out date, Energy, Water, TA2, TA3, Input-a, Input-b, Peak power/flow -- last 31 months

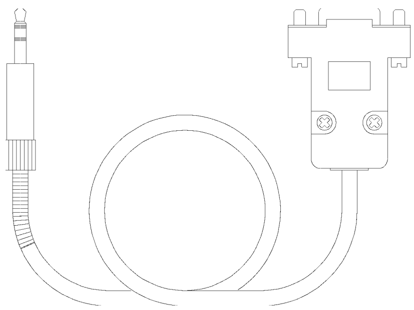
A.3 DATA ACQUISITION VIA CONNECTING UNIT

A “Data and pulse input module” or a “Data and pulse output module” can be fitted in the connecting unit of the MULTICAL® III. The data section is identical in both module types and is furthermore galvanically separated by means of opto-couplers. These modules can be used to establish a permanent thread connection to an external plug for data acquisition (please refer to data sheet No. E40 999), either via a computer or other RS 232 interface. The data modules can manage request signals based on EN 61107, as described in the previous section, and request signals based on MULTITERM II.

As the data port on MULTICAL® III is passively isolated, a circuit directly connected to the PC must be made. The following diagram suggests a possible circuit layout:

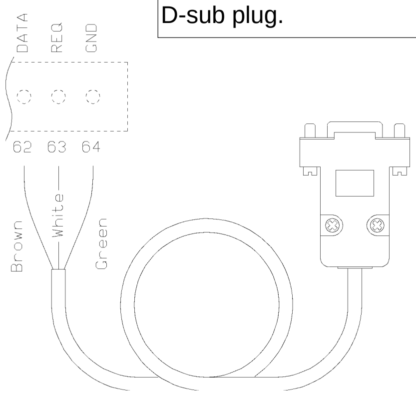


Connection between the computer’s serial COM-port and MULTICAL® III.
The pins stated refer to a COM-port with a standard 9-pole D-sub plug.



Type number 66-99-105

Data cable with built-in RS-232 adapter in D-Sub housing, supplied with 3-pole mini jack plug



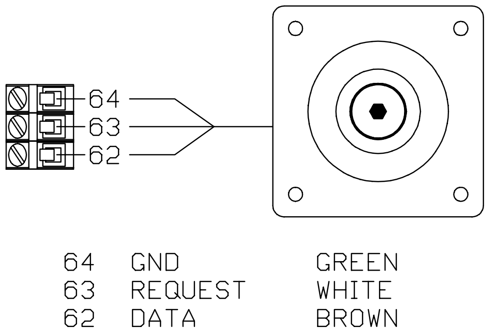
Type number 66-99-106

Data cable with built-in RS-232 adapter in D-Sub housing, supplied with uninsulated connections.

A.3.1 EXTERNAL DATA ACQUISITION PLUG

Kamstrup's data acquisition plug for external use can be connected to MULTICAL® III in the following manner:

This type of connection is used together with MULTITERM II, and renders the data acquisition features of MULTICAL® III compatible with MULTICAL II integrators already installed, type 65-C, 65-D, 65-E and 65-M.



A.3.2 DESIGN

Once the data acquisition unit has beenconnected, e.g. to a PC, and sends a recognisable request string, MULTICAL® III answers with a data string 1-2 seconds after the request string has been received. MULTICAL® III's data acquisition employs the following communication set-up :

300/1200 Baud	1 Start bit	7 Data bits	Equal parity	1 Stop bit

The following data string, in addition to the data strings described under the section pertaining to optical data acquisition, can be read via the data module in the connecting unit.

A.3.3 DATA STRING

a)...f) As described in section A2.3

g) DATA READ-OUT OF ADDRESSABLE DATA:

-> / # A ADR [300 BAUD] (ADR: 1-127 BINARY, always transmitted on address=0)

<- Customer ID No., Energy, Water, Hours, Input-a, Input-b, TA2, TA3, Info, Address - [1200 BAUD]

A.3.4 DATA STRING IN MULTICAL II FORMAT

h) DATA READ-OUT OF NORMAL DATA (MULTITERM II REQUEST):

Data string, “Format suitable for MULTITERM II . 6 digits“

Energy, Water and Customer ID No.: Transmits the six least important digits.

-> Long request pulse (t > 40 ms)

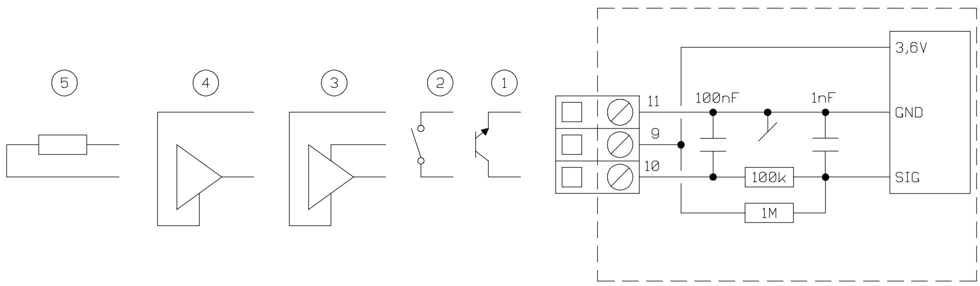
<- Energy, Water, t_F, t_R, Δt, Flow, Info, Hour counter, Customer ID No. [1200 BAUD]

NB.: MULTICAL® III transmits all temperature registers t_F, t_R and Δt with a resolution of 0,01°C., compared with MULTICAL II, which transmits t_F and t_R with a resolution of 0,1°C and Δt with 0,05°C.

NB.: Data format h) is only used when data acquisition for MULTICAL® III is to be compatible with standard versions of MULTICAL II type 65-C, 65-D, 65-E and 65-M. The data format from other versions of MULTICAL II and MULTICAL SA are not supported by MULTICAL® III.

A.4 PULSE INPUT FOR FLOW METERS

The pulse input for the energy meter’s flow meter can, depending on the type of flow meter, be coded for quick pulses (CCC > 100) or slow pulses (CCC < 100). In either instance, a built-in low pass filter is used to dampen bouncing that might occur.



1 **Flow meter with transistor output**

The signal transmitter is typically an opto-coupler with a transistor output which is connected to MULTICAL® III’s clamps 10 and 11, as above. The transistor’s leak current must not exceed 1 µA when OFF. U_{CE} when ON must not exceed 0.8 V DC.

2 **Flow meter with relay or reed switch output**

The signal transmitter is a reed-switch, typically fitted with vane wheel/Woltmann meters or relay output from MID-meters etc.

This type of signal transmitter is usually used together with slow coding (CCC < 100), the interval between signals must be at least 110 msec.

3 **Flow meters with active output supplied by MULTICAL® III**

This connection is used for Kamstrup's ULTRAFLOW II and Kamstrup's pick-ups for vane-wheel meters. The power consumption in these units is exceedingly low and perfectly suited to the lifetime expectancy of battery-driven MULTICAL® III.

Connection	9: Red	10: Yellow	11: Blue

4 **Self-supplying flow meter with active output**

Flow meters with active signal output are connected as shown above. The signal level must be between 3.5 and 5 V. Higher signal levels can be connected via a passable current distributor, e.g. 47 kΩ/10 kΩ at 24 V signal level.

5 **External Pull-up resistor**

If the flow meter signal has an interval of less than 110 msec, it may be necessary to fit an external pull-up resistor of 100 kΩ. The external pull-up resistor must not be fitted on meters with a battery, as the lifetime expectancy of the battery will be reduced.

Pulses from the flow meter are initially lead through a programmable precounter, the separations of which are specified in the CCC-table . When the precounter passes the separation, integration is activated. The integration frequency must not exceed 1 Hz. The flow and return temperatures are measured at each integration and the energy increase is calculated.

Quick pulses (CCC > 100)

Passive output from flow meter	Active output from flow meter
Precounter ε [2 ; 32000] . t_{LOW} > 0.5 ms and t_{HIGH} > 110 ms f< 9 Hz when precounter ≥ 9 .	Precounter ε [2 ; 32000] t_{LOW} > 0.5 ms and t_{HIGH} > 0.5 ms f < 100 Hz, when precounter ≥ 100 *) f < 50 Hz, when precounter ≥ 50 *) *) Max. frequency stated, depends on the active output being able to unload the input capacity.

Slow pulses (CCC < 100)

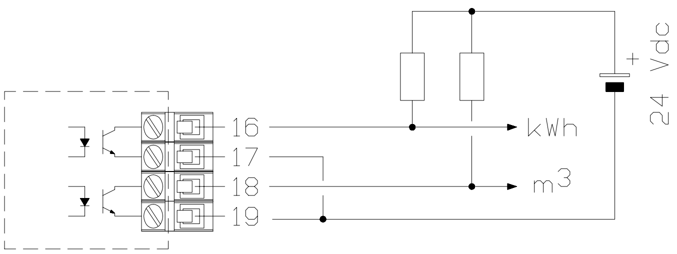
Passive output from flow meter	**Active output from flow meter**
Precounter ε [1 ; 65535] . t_{LOW} > 0.5 ms and t_{HIGH} > 110 ms f < 1 Hz	Precounter ε [1 ; 65535] t_{LOW} > 0.5 ms and t_{HIGH} > 110 ms f < 1 Hz

NB.: With CCC-codes of 003, 005 and 007, an extra 4-separator is coupled to the flow meter input. The accumulated water quantity on the display is, therefore, only updated for every fourth integration.

A.5 PULSE OUTPUTS AND INPUTS

A.5.1 PULSE OUTPUTS FOR ENERGY AND WATER

MULTICAL® III can emit energy and volume pulses to i.a. CTS plants and similar methods of remote counting. Pulse outputs are ideal for connecting electrical counter inputs. However, electro-mechanical counters usually require greater amperage and pulse duration than the pulse output permits. The pulse outputs are connected to the Data/Pulse Output module located in the connection unit.



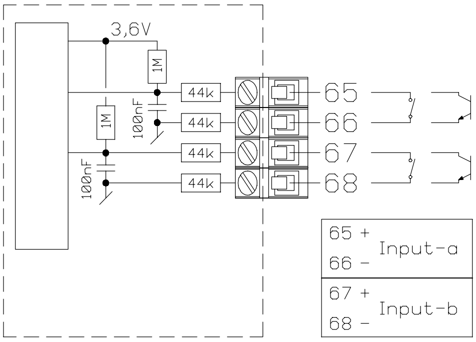
Pulse duration	> 30 msec
Load	< 10 mA
Pull-up	> 2.7 kΩ

An pulse is emitted for each update in the least significant digit in both energy and water consumption read-out. Example (CCC=119): 1 kWh/imp and 0.01 m^3/imp.

NB.: The pulse outputs are only active when both FF and GG are "00". See ch. 7.6

A.5.2 PULSE INPUTS FOR ELECTRICITY AND WATER

2 extra pulse transmitters can be connected to MULTICAL® III for use with i.a. electricity meters or water meters. Meters with switch and transistor outputs can be connected, provided that the earth current in the output is lower 1µA. Please refer to section A7.6 for programming of the pulse inputs.



A.6 TYPE NUMBER

The type number of MULTICAL® III reflects the components the meter is composed of. The various components available can be seen in the following table.

The type number is of particular importance when ordering and with regards to accessories, programming and labelling.

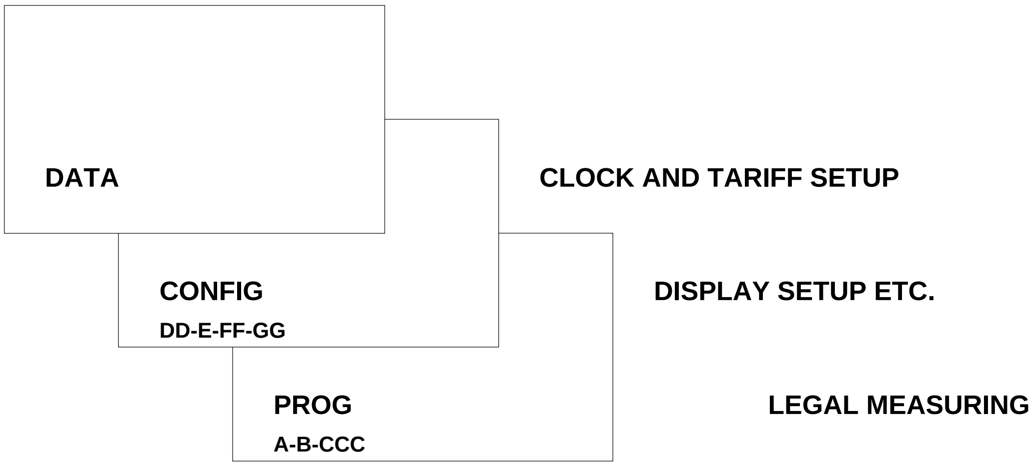
Type number	**66 - B -** ❑	- ❑	- ❑	- ❑	- ❑❑❑
Plug-in Modules					
None	0				
Data/pulse input	1				
Data/pulse output	2				
Telephone modem	3				
M-Bus, pr EN 1434	4				
Echelon, XF-78	6				
Supply Module					
None		0			
D-cell, Lithium battery		1			
230 V AC		3			
24 V AC/DC		4			
Pt 500 Temperature Sensors					
None			0		
Pocket sensor set with 1.5 m cable			1		
Pocket sensor set with 3.0 m cable			2		
Direct sensor set with 1.5 m cable			3		
Direct sensor set with 3.0 m cable			4		
Short direct sensor set with 1.5 m cable			5		
Short direct sensor set with 3.0 m cable			6		
Pocket sensor set with 5 m cable			7		
Pocket sensor set with 10 m cable			8		
Pick-up/Flow Meter					
Flow meter with integral pick-up				0	
GWF/Unico pick-up with 0.2 m cable				A	
GWF/Unico pick-up with 2.5 m cable				B	
GWF/MTW pick-up with 0.2 m cable				C	
GWF/MTW pick-up with 2.5 m cable				D	
Kamstrup pick-up with 0.2 m cable				E	
Kamstrup pick-up with 2.5 m cable				F	
Compact meter with ULTRAFLOW II *)				9	
Delivery code (Country code)					XXX

*) ULTRAFLOW II type must be stated separately (please refer to data sheet No. E20 499)

A.7 PROGRAMMING MULTICAL® III

-Prog, Config and Data

The many functions in MULTICAL® III are determined via programming - done by either Kamstrup, your local distributor or the Board/Works. Programming is divided into three groups: PROG, CONFIG and DATA.



A.7.1 PROG, A-B-CCC

Program number	**A**	-	**B**	-	**C C C**
	❑		❑		❑❑❑
Flow meter installation					
- Flow	1				
- Return	2				
- Flow (disabled total reset)	3				
- Return (disabled total reset)	4				
Measuring unit					
- GJ			2		
- kWh			3		
- MWh			4		
Flow meter code					XXX

A.7.2 CCC-TABLE FOR MULTICAL® III

			Number of decimals displayed											
CCC No.	Pre-counter	Flow-factor	kWh	MWh	GJ	m³	l/h	m³/h	kW	MW	l/pulses	pulses/l	Q_n	Type
000	10	3072		3	2	2		2		3	1	1	1-3,5	
001	4	7680		3	2	2		2		3	2,5	0,4	1,5-6	
002	1	3072		3	2	2		1		2	10	0,1	2,5-30	
003	1	7680		2	2	1		1		2	25	0,04	6-60	
004	10	3072		2	1	1		1		2	10	0,1	2,5-30	
005	10	7680		1	1	0		1		2	25	0,04	60-600	
006	1	3072		2	1	1		0		1	100	0,01	25-300	
007	1	7680		1	1	0		0		1	250	0,004	60-600	
008	1	30720		1	0	0		0		1	1000	0,001	250-3000	
009	28	1097	0	3	2	2		2		3	0,357	2,8000	1,5	Brunata
108	1403	219	0	3	2	2	0		1		0,007128	140,3	0,6	GWF/Un
109	957	321	0	3	2	2	0		1		0,010449	95,7	1,0	GWF/Un
110	646	476	0	3	2	2	0		1		0,015479	64,6	1,5	GWF
111	404	760	0	3	2	2	0		1		0,024752	40,4	1,5 2,5	HM GWF/Un
112	502	612	0	3	2	2	0		1		0,01992	50,2	1,5 2,5*	GWF/ MTW
113	2350	1307		2	1	1	0		1		0,042553	23,5	3,5 6*	GWF/ MTW
114	712	4315		2	1	1	0		1		0,14044	7,12	10 15*	GWF/ MTW
115	757	406	0	3	2	2	0		1		0,01321	75,7	1,0*	GWF
116	3000	102	0	3	2	2	0		1		0,00333	300,0	0,6*	GWF
117	269	1142	0	3	2	2	0		1		0,037174	26,9	1,5	Brunata
118	665	462	0	3	2	2	0		1		0,015037	66,5	1,5	Aquastar
119	1000	307	0	3	2	2	0		1		0,01	100,0	0,6 1,5	HM UF I/UFII
120	1000	3072		2	1	1	0		1		0,1	10,0	15 25	UF II UF II
121	294	1045	0	3	2	2	0		1		0,034013	29,4		
122	1668	184	0	3	2	2	0		1		0,005995	166,8	0,6	HM
123	864	356	0	3	2	2	0		1		0,011574	86,4	0,75 1*	HM
124	522	589	0	3	2	2	0		1		0,019157	52,2	2,5 1,5*	CG HM
125	607	506	0	3	2	2	0		1		0,016475	60,7	1,5 1* 1,5*	HM
126	420	731	0	3	2	2	0		1		0,023809	42,0	1,0 2,5*	CG HM
127	2982	1030		2	1	1	0		1		0,033534	29,82	2,5 3,5*	HM
128	2424	1267		2	1	1	0		1		0,041254	24,24	3,5*	HM

*)=Multi jet

0XX	Slow pulses
1XX	Rapid pulses

A.7.3 CCC-TABLE FOR MULTICAL® III

CCC No.	Pre-counter	Flow-factor	Number of decimals displayed: kWh	MWh	GJ	m³	l/h	m³/h	kW	MW	l/pulses	pulses/l	Qn	Type
129	1854	1657		2	1	1	0		1		0,053937	18,54	6*	HM
130	770	3990		2	1	1	0		1		0,12987	7,7	10*	HM
131	700	4389		2	1	1	0		1		0,14285	7,0	15*	HM
132	365	841	0	3	2	2	0		1		0,027322	36,54	2,5	Wehrle
133	604	508	0	3	2	2	0		1		0,016537	60,47	1,5	Wehrle
134	1230	250	0	3	2	2	0		1		0,008126	123,05	0,6	Wehrle
135	1600	1920		2	1	1	0		1		0,0625	16,0	10*	HM
136	500	614	0	3	2	2	0		1		0,02	50	2,5 3	UFII UF I
137	2500	1229		2	1	1	0		1		0,04	25	6 10	UF I/II UF II
139	256	1200	0	3	2	2	0		1		0,03906	25,6	1,5 2,5	GWF/IVG
140	1280	2400		2	1	1	0		1		0,078125	12,8	3,5 5,0	GWF/IVG
141	1140	2695		2	1	1	0		1		0,087719	11,4	6	GWF/IVG
142	400	768		2	1	1		2		3	0,25	4	10	GWF/IVG
143	320	960		2	1	1		2		3	0,3125	3,2	10 15	GWF/IVG
144	1280	2400		1	0	0		2		3	0,78125	1,28	25 40	GWF/IVG
145	640	4800		1	0	0		2		3	1,5625	0,64	60	GWF/IVG
146	128	24000		1	0	0		2		3	7,8125	0,128	125	GWF/IVG
147	1000	3072		1	0	0		2		3	1	1	18 30 45 75	Sonocal
148	400	7680		1	0	0		2		3	2,5	0,4	120 220 300	Sonocal
151	5000	614		2	1	1	0		1		0,02	50	3 3,5	UF II
152	1194	2573		2	1	1	0		1		0,083752	11,94	10	GWF/H2
153	1014	3030		2	1	1	0		1		0,098619	10,14	15	GWF/H2
156	594	517		3	2	2	0		1		0,016835	59,4	1,5	Metron
157	3764	816		2	1	1	0		1		0,0265675	37,64	2,5	Metron
158	5000	614		1	0	0		2	0		0,2	5	40	UF II
163	1224	251	0	3	2	2	0		1		0,00817	122,4	0,6/1,0	GWF/U2
164	852	360	0	3	2	2	0		1		0,01173	85,24	1,5	GWF/U2
165	599	513	0	3	2	2	0		1		0,01669	59,92	2,5	GWF/U2
166	1000	3072		0	X10	X10		1		2	10	0,1	450-1200	Sonocal"149"
167	200	15360		0	X10	X10		1		2	50	0,02	1800-3000	Sonocal"150"
168	449	6848		2	1	1	0		1		0,2229	4,486	15/25	HM/WS
169	1386	2216		1	0	0		2	0		0,7215	1,386	40	HM/WS

159-162 (not used) *)=Multi jet

0XX	Slow pulses
1XX	Rapid pulses

A.7.4 CONFIG, DD-E-FF-GG

7.4.1 >DD< Configuration of elements to be displayed

DD		12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Energy		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1
Water		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2
Hour counter		3	3	3	3	3	3	3	3	3	3	3	3	3		3	3		3	3	3	3	3	3
T_{FLOW}		4	4			4	4	4	4	4	4	4	4	4		4	4		4	4	4	4	4	4
T_{RETURN}		5	5			5	5	5	5	5	5	5	5	5		5	5		5	5	5	5	5	5
Δt		6	6			6	6	6	6	6	6	6	6	6		6	6		6	6	6	6	6	6
Power	⇒	7	7			7	7	7	7	7	7	7	7	7		7	7		7	7	7	7	7	7
Peak Power		8	8	•	•	8	8	8	8	8		8	8		•	•	•		8	•		8	8	8
Flow		9	9			9	9	9	9	9	8	9	9	8		8	8	1	9	8	8	9	9	9
Peak Flow											9			9				2			9			
All Info [1)]										10	10													
Info (-2) [1)]		10		4		10		10					10	10	•	9		•		9	10			
Info (-2 & -128) [2)]			10		4		10		10															
Info (-128) [2)]												10					9		10			10	10	10
TA 2						A	A			A	•	A		A			A		A	A	A			A
TL 2						B	B			B		B					B		B	B	B			B
TA 3						C	C			C	A	C		B			C		C	C	C			C
TL 3						D	D			D		D					D		D	D	D			D
Input a	⇓							A	A	E									E				A	E
Input b								B	B	F									F				B	F
Prog No										G	B					A			G					
Customer ID		A	A	A	A	E	E	C	C	H	C	E	A	C		B	E	A	H	E	E	A	C	G
Date										I	D		B			C			I					
Segment test		B	B	B	B	F	F	D	D	J	E	F	C	D	A	D	F	B	J	F	F	B	D	H

Number/letter:	*Display selection*
	• = Hidden selection
	1=First primary display
	A=First secondary display
NB:	*Infocode 1 does not exist in MULTICAL® III*
	1) Meters supplied by battery
	2) Meters supplied by 230 VAC or 24 VAC

A.7.5 MULTI-TARIFF CONFIGURATION

E=	TARIFF TYPE
0	No active tariff
1	Tariff controlled by power
2	Tariff controlled by flow
3	Cooling tariff
4	
5	Return temperature tariff
6	Average temperature tariff
7	Bonus figure
8	Remote controlled tariff

For further information regarding MULTICAL® III's tariff types, please see section "A7. Tariff functions".

A.7.6 CONFIGURING EXTRA COUNTER INPUTS

When MULTICAL® III is equipped with a Data/pulse input module, up to two extra counters (e.g. for water or electricity meters) can be connected.

7.6.1 >FF< Input a, Pulse divider ($f \le 0.5$ Hz). Pulse and interval duration > 1 sec.

FF	Precounter	Max. input flow/power	Wh/pulses	l/pulses	Unit and decimal point placement	
00	Input a = OFF					
01	1	50 m^3/h	-	100	m^3a	000000,0
02	2	25 m^3/h	-	50	m^3a	000000,0
03	4	12 m^3/h	-	25	m^3a	000000,0
04	10	5 m^3/h	-	10	m^3a	000000,0
05	20	2.5 m^3/h	-	5.0	m^3a	000000,0
06	40	1 m^3/h	-	2.5	m^3a	000000,0
07	100	0.5 m^3/h	-	1.0	m^3a	000000,0
08	1	500 m^3/h	-	1000	m^3a	0000000
50	1	500 kW	1000	-	Ela	0000000
51	60	8 kW	16.67	-	Ela	0000000
52	75	6 kW	13.33	-	Ela	0000000
53	120	4 kW	8.333	-	Ela	0000000
54	240	2 kW	4.167	-	Ela	0000000
55	340	1 kW	2.941	-	Ela	0000000
56	480	1 kW	2.083	-	Ela	0000000
57	600	1 kW	1.667	-	Ela	0000000
58	1000	0.5 kW	1.000	-	Ela	0000000

7.6.2 >GG< Input b, Pulse divider ($f \leq 3$ Hz). Pulse and interval duration > 0.15 sec.

GG	Precounter	Max. input flow/power	Wh/pulses	l/pulses	Unit and decimal point placement	
00	Input b = OFF					
01	1	250 m^3/h	-	100	m^3b	000000.0
02	2	125 m^3/h	-	50	m^3b	000000.0
03	4	60 m^3/h	-	25	m^3b	000000.0
04	10	25 m^3/h	-	10	m^3b	000000.0
05	20	12 m^3/h	-	5.0	m^3b	000000.0
06	40	6 m^3/h	-	2.5	m^3b	000000.0
07	100	2.5 m^3/h	-	1.0	m^3b	000000.0
08	1	2500 m^3/h	-	1000	m^3b	0000000
50	1	2500 kW	1000	-	Elb	0000000
51	60	50 kW	16.67	-	Elb	0000000
52	75	40 kW	13.33	-	Elb	0000000
53	120	25 kW	8.333	-	Elb	0000000
54	240	10 kW	4.167	-	Elb	0000000
55	340	8 kW	2.941	-	Elb	0000000
56	480	6 kW	2.083	-	Elb	0000000
57	600	5 kW	1.667	-	Elb	0000000
58	1000	2.5 kW	1.000	-	Elb	0000000

A.7.7 DATA SET UP

a) ADDRESS 1...126

Used with addressable meters with an RS 232 interface. If the meter is not to be addressable, select address “0”.

b) CURRENT DATA YY.MM.DD

The current date - as specified in the computers internal clock - is noted during programming. 10 March 1995 is written as 95.03.10. The date can be changed using a hand-held terminal.

c) READ-OUT DATA MM.DD

The 1st June (06.01) is set as the default during programming. This date can be changed using a hand-held terminal. The read-out data determines on which date monthly data is read.

Input limits: MM: 1...12
DD: 1...28

Data is read at midnight (12.00 p.m.) on the pre-programmed date. If the read-out is to include a date later than the 29th e.g. 31st March (03.31), the pre-programmed read-out date should be set at 1st April (04.01).

d) CUSTOMER ID NO. VARIABLE

The customer Identification No. can consist of max. 11 digits.

e) **AVERAGE TIME**

The average time for calculating peak power or peak flow can vary from 1..120 min (EEPROM).

f) **TARIFF LIMITS** **TL2/TL3**

Tariff No. E	Tariff type	TL2/TL3 limits *)
1	Power P>x	10 - 499,000
2	Flow Q>x	10 - 2,999,999
3	Cooling $\Delta t<x$	3.00 - 150.00
4	-	-
5	$t_{RETUR N}$ $t_R>x$	3.00 - 150.00
6	t_F/t_R avr/month	-
7	Bonus figure	-
8	Remote controlled	-

**) Power and flow must be stated with the same format as the meter's programming, but without a decimal point.*

E.g. Temperature Δt limit 30°C must be entered as 3000!

Please refer to section A8 for more information on tariff limits.

A.8 TARIFF FUNCTIONS

MULTICAL® III has 2 extra energy registers TA2 and TA3. Based on a pre-programmed tariff condition, these registers can accumulate energy, independent of the accumulation made in the main register. The measuring unit of TA2 and TA3 is always the same as the one used in the main register (kWh, MWh or GJ), but the unit field only indicates TA2 and TA3.

The main register always accumulates as it is considered a legal accounting register no matter which tariff function you choose. The tariff conditions TL2 and TL3 are monitored after each integration as far as temperature controlled tariffs are concerned, and every 30 sec. as far as power and flow controlled tariffs are concerned.

The tariff conditions having been fulfilled, the heat energy consumed will be counted in either TA2 or TA3, independent of the counting in the main register.

Two tariff conditions, TL2 and TL3, which are always used in the same tariff type, are connected to each tariff function. I.e. it is not possible to “mix” two tariff types.

A.8.1 TARIFF TYPES

E=0) NO TARIFF ACTIVE

Should you not want to use the tariff function, choose the set-up E=0.

E=1) POWER CONTROLLED TARIFF

If the actual heat flow rate (P), in kW or MW, exceeds TL2, but is lower than TL3, heat energy will be counted in both TA2 and in the main register. Should the actual flow rate exceed TL3, heat energy is counted in both TA3 and in the main register.

P < TL2	Accumulation in main register only
TL3 > P > TL2	Accumulation in TA2 and main register
P > TL3	Accumulation in TA3 and main register

During data set-up TL3 must, naturally, exceed TL2.

The power controlled tariff is e.g. used as a basis for the connection fee of the individual heat consumer. Furthermore, this form of tariff can provide the heating station with valuable data with a view to evaluating new construction activities.

E=2) FLOW CONTROLLED TARIFF

When the actual water flow (Q), in l/h or m^3/h, exceeds TL2, but is lower than TL3, heat energy is counted in both TA2 and in the main register. Should the actual water flow exceed TL3, heat energy is counted in both TA3 and in the main register.

Q < TL2	Accumulation in main register only
TL3 > Q > TL2	Accumulation in TA2 and main register
Q > TL3	Accumulation in TA3 and main register

During data set-up TL3 must, naturally, always exceed TL2.

The flow controlled tariff is e.g. used as a basis for the connection fee of the individual consumer. Furthermore, this form of tariff can provide the heating station with valuable statistical data with a view to evaluating new construction activities.

E=3) COOLING TARIFF (ΔT)

If the actual cooling (Δt), in °C, is lower than TL2, but exceeds TL3, heat energy is counted in both TA2 and in the main register. Should the actual cooling become lower than TL3, heat energy is counted in both TA3 and in the main register.

Δt > TL2	Accumulation in main register only
TL3 < Δt < TL2	Accumulation in TA2 and main register
Δt < TL3	Accumulation in TA3 and main register

During data set-up TL3 must, naturally, always be lower than TL2.

The cooling tariff can be used as a basis for weighted consumer payment. Low cooling (small difference between flow and return temperatures) means bad economy to the heat supplier.

E=5) RETURN TEMPERATURE TARIFF

If the actual return temperature (t_R), in °C, exceeds TL2, but is smaller than TL3, heat energy is counted in both TA2 and in the main register. Should the actual return temperature exceed TL3, heat energy is counted in both TA3 and in the main register.

t_R < TL2	Accumulation in main register only
TL3 > t_R > TL2	Accumulation in TA2 and main register
t_R > TL3	accumulation in TA3 and main register

During data set-up TL3 must, naturally always be bigger than TL2.

The return temperature tariff can be used as a basis for weighted consumer payment. A high return temperature indicates insufficient utilisation of the heat and thereby means bad economy to the heat supplier.

E=6) AVERAGE TEMPERATURE

This type of tariff does not use TL2 and TL3. After each temperature measurement (integration) the flow temperature (t_F) and the return temperature (t_R) are entered in an average calculation. Average calculations are made over one month at a time. The results are stored in monthly data, which are available for te preceeding 32 months.

The display shows the average temperatures of the current month for t_F and t_R respectively as TA2 and TA3.

Average t_F	$\sum t_F/n$	TA2
Average t_R	$\sum t_R/n$	TA3

E=7) BONUS FIGURE

This type of tariff does not use TL2 and TL3. The bonus figure is calculated as the total of each measurement of flow and return temperatures divided by 100, a figure with two decimals on the scale of 1.00. Heating plants with economical operation provide low bonus figures, whereas uneconomical operation results in high bonus figures.

The actual bonus figure, which is calculated after each integration, is displayed as TA2. The monthly bonus figure calculated as the average since the latest storage of monthly data is displayed as TA3.

Actual bonus figure	$(t_F + t_R)/100$	TA2
Bonus figure current month	$(\sum t_F + \sum t_R)/n \times 100$	TA3

E=8) EXTERNALLY CONTROLLED TARIFF

The above-mentioned types of tariffs can all be calculated as internal tariffs as they are controlled by the integrating unit. The tariff registers of MULTICAL® III, TA2 and TA3, however, can also be externally controlled via data communication. By sending three different data commands (TAR0, TAR2 or TAR3), the tariff registers can be controlled from e.g. the computer at the heating station.

TAR0	Accumulation in main register only
TAR2	Accumulation in TA2 and main register
TAR3	accumulation in TA3 and main register

This type of tariff is e.g. used for time zone controlled rate fixing.

A.9 ENTERING TARIFF LIMITS

MULTICAL ® III's tariff limits must be entered as whole digits and decimals - although the decimal points must not be used. The temperature tariffs (E=3 and E=5) must be entered in °C with two decimals. Power and flow tariffs (E=1 and E=2) however, can have different units and number of decimals depending on the flow meter code (CCC no.).

NB:

TL3 must be *larger* than TL2 when the code is E=1, 2 and 5
TL3 must be *less* than TL2 when the code is E=3 (Δt tariff).

E.g. 1: Δt tariff (E=3)	***E.g. 2: Power tariff (E=1)***
With TL2 = 30.00°C and TL3 = 20.00°C enter: ***TL2 = 3000 and TL3 = 2000***	With TL2 = 10.0 kW and TL3 = 15.0 kW enter: ***TL2 = 100 and TL3 = 150***

CCC No.	E=1 Power (TL3 > TL2)	Input limits E=1	E=2 Flow (TL3 > TL2)	Input limits E=2
000	0.001…1.200 MW	1…1200	0.01…7.00 m^3/h	1…700
001	0.001…2.000 MW	1…2000	0.01…12.00 m^3/h	1…1200
002	0.01…9.00 MW	1…900	0.1…60.0 m^3/h	1…600
003	0.01…20.00 MW	1…2000	0.1…120.0 m^3/h	1…1200
004	0.01…10.00 MW	1…1000	0.1…60.0 m^3/h	1…600
005	0.01…20.00 MW	1…2000	0.1…120.0 m^3/h	1…1200
006	0.1…90.0 MW	1…900	1…600 m^3/h	1…600
007	0.1…200.0 MW	1…2000	1…1200 m^3/h	1…1200
008	0.1…900.0 MW	1…9000	1…6000 m^3/h	1…6000
009	0.001…0.500 MW	1…500	0.01…3.00 m^3/h	1…300

108	0.1…180.0 kW	1…1800	1…1200 l/h	1…1200
109	0.1…300.0 kW	1…3000	1…2000 l/h	1…2000
110	0.1…450.0 kW	1…4500	1…3000 l/h	1…3000
111	0.1…750.0 kW	1…7500	1…5000 l/h	1…5000
112	0.1…750.0 kW	1…7500	1…5000 l/h	1…5000
113	0.1…1800.0 kW	1…18000	1…12000 l/h	1…12000
114	0.1…4500.0 kW	1…45000	1…30000 l/h	1…30000
115	0.1…300.0 kW	1…3000	1…2000 l/h	1…2000
116	0.1…180.0 kW	1…1800	1…1200 l/h	1…1200
117	0.1…450.0 kW	1…4500	1…3000 l/h	1…3000
118	0.1…450.0 kW	1…4500	1…3000 l/h	1…3000
119	0.1…450.0 kW	1…4500	1…3000 l/h	1…3000
120	0.1…4500.0 kW	1…45000	1…30000 l/h	1…30000
121	0.1…1000.0 kW	1…10000	1…7000 l/h	1…7000
122	0.1…180.0 kW	1…1800	1…1200 l/h	1…1200
123	0.1…300.0 kW	1…3000	1…2000 l/h	1…2000
124	0.1…750.0 kW	1…7500	1…5000 l/h	1…5000
125	0.1…450.0 kW	1…4500	1…3000 l/h	1…3000
126	0.1…750.0 kW	1…7500	1…5000 l/h	1…5000
127	0.1…1000.0 kW	1…10000	1…7000 l/h	1…7000
128	0.1…1000.0 kW	1…10000	1…7000 l/h	1…7000

CCC No.	E=1 Power (TL3 > TL2)	Input limits E=1	E=2 Flow (TL3 > TL2)	Input limits E=2
129	0.1...1800.0 kW	1...18000	1...12000 l/h	1...12000
130	0.1...3000.0 kW	1...30000	1...20000 l/h	1...20000
131	0.1...4500.0 kW	1...45000	1...30000 l/h	1...30000
132	0.1...750.0 kW	1...7500	1...5000 l/h	1...5000
133	0.1...450.0 kW	1...4500	1...3000 l/h	1...3000
134	0.1...180.0 kW	1...1800	1...1200 l/h	1...1200
135	0.1...3000.0 kW	1...30000	1...20000 l/h	1...20000
136	0.1...900.0 kW	1...9000	1...6000 l/h	1...6000
137	0.1...3000.0 kW	1...30000	1...20000 l/h	1...20000
139	0.1...750.0 kW	1...7500	1...5000 l/h	1...5000
140	0.1...1500.0 kW	1...15000	1...10000 l/h	1...10000
141	0.1...1800.0 kW	1...18000	1...12000 l/h	1...12000
142	0.001...3.000 MW	1...3000	0.01...20.00 m^3/h	1...2000
143	0.001...5.000 MW	1...5000	0.01...30.00 m^3/h	1...3000
144	0.001...12.000 MW	1...12000	0.01...80.00 m^3/h	1...8000
145	0.001...30.000 MW	1...30000	0.01...120.00 m^3/h	1...12000
146	0.001...40.000 MW	1...40000	0.01...250.00 m^3/h	1...25000
147	0.001...30.000 MW	1...30000	0.01...150.00 m^3/h	1...15000
148	0.001...90.000 MW	1...90000	0.01...600.00 m^3/h	1...60000
151	0.1…1000.0 kW	1…10000	1…7000 l/h	1…7000
152	0.1…3000.0 kW	1…30000	1…20000 l/h	1…20000
153	0.1…4500.0 kW	1…45000	1…30000 l/h	1…30000
156	0.1…450.0 kW	1…4500	1…3000 l/h	1…3000
157	0.1…750.0 kW	1…7500	1…5000 l/h	1…5000
158	1…12000 kW	1…12000	0.01…80.00 m^3/h	1…800
163	0.1…300.0 kW	1…3000	1…2000 l/h	1…2000
164	0.1…500.0 kW	1…5000	1…3000 l/h	1…3000
165	0.1…750.0 kW	1…7500	1…5000 l/h	1…5000
166	0.01…360.00 MW	1…36000	0.1…2400.0 m^3/h	1…24000
167	0.01…900.00 MW	1…90000	0.1…6000.0 m^3/h	1…60000
168	0.1…7500.0 kW	1…75000	1…50000 l/h	1…50000
169	0.001…12.000 MW	1…12000	0.01…80.00 m^3/h	1…8000

CCC No.	E=3 Δt (TL3 < TL2)	Input limits E=3	E=5 Return (TL3 > TL2)	Input limits E=5
All	3.00...150.00 °C	300...15000	3.00...150.00 °C	300...15000

A.10 ENERGY CALCULATION AND k-FACTOR

MULTICAL® III uses Dr. Stuck's heat coefficient tables as a k-factor basis for the energy measurement. Based on the original tables, a total of 8 tables have been composed, which cover the complete temperature range of MULTICAL® III without interpolation.

The measuring unit of the k-factors included is [MJ/m^3 x °C]

k-factor for flow meter in return pipe

Temperature in return pipe [°C]			Δt = 0-41 °C, P = 1 bar	Δt = 42-82 °C, P = 1 bar	Δt = 83-123 °C, P = 16 bar	Δt = 124-163 °C, P = 16 bar
t_R			k - MJ	k - MJ	k - MJ	k - MJ
0	-	3.1	4.1918	4.1838	4.1887	4.2063
3.2	-	6.3	4.1880	4.1830	4.1898	4.2085
6.4	-	9.5	4.1843	4.1822	4.1902	4.2103
9.6	-	12.7	4.1811	4.1810	4.1903	4.2118
12.8	-	15.9	4.1781	4.1797	4.1902	4.2131
16	-	19.1	4.1751	4.1782	4.1898	4.2141
19.2	-	22.3	4.1710	4.1764	4.1890	4.2113
22.4	-	25.5	4.1679	4.1737	4.1881	4.2099
25.6	-	28.7	4.1646	4.1715	4.1871	4.2075
28.8	-	31.9	4.1613	4.1691	4.1858	4.2049
32	-	35.1	4.1577	4.1665	4.1845	4.2028
35.2	-	38.3	4.1541	4.1624	4.1824	4.1976
38.4	-	41.5	4.1490	4.1593	4.1808	
41.6	-	44.7	4.1449	4.1562	4.1790	
44.8	-	47.9	4.1407	4.1530	4.1772	
48	-	51.1	4.1350	4.1481	4.1753	
51.2	-	54.3	4.1305	4.1452	4.1733	
54.4	-	57.5	4.1258	4.1417	4.1706	
57.6	-	60.7	4.1195	4.1381	4.1686	
60.8	-	63.9	4.1163	4.1345	4.1636	
64	-	67.1	4.1114	4.1315	4.1584	
67.2	-	70.3	4.1064	4.1278	4.1531	
70.4	-	73.5	4.0997	4.1222	4.1476	
73.6	-	76.7	4.0946	4.1185	4.1400	
76.8	-	79.9	4.0895	4.1148		
80	-	83.1	4.0846	4.1112		
83.2	-	86.3	4.0772	4.1075		
86.4	-	89.5	4.0721	4.1027		
89.6	-	92.7	4.0670	4.0992		
92.8	-	95.9	4.0619	4.0957		
96	-	99.1	4.0569	4.0922		
99.2	-	102.3	4.0519	4.0855		
102.4	-	105.5	4.0453	4.0787		
105.6	-	108.7	4.0404	4.0695		
108.8	-	111.9	4.0355	4.0624		
112	-	115.1	4.0307	4.0553		
115.2	-	118.3	4.0235	4.0480		
118.4	-	121.5	4.0198	4.0407		
121.6	-	124.7	4.0152	4.0308		
124.8	-	127.9	4.0107			
128	-	131.1	4.0048			
131.2	-	134.3	4.0019			
134.4	-	137.5	3.9989			
137.6	-	140.7	3.9895			
140.8	-	143.9	3.9841			
144	-	147.1	3.9760			
147.2	-	150.3	3.9651			
150.4	-	153.5	3.9568			
153.6	-	156.7	3.9484			
156.8	-	159.9	3.9399			
160	-	163.1	3.9399			

k-factor for flow meter in flow pipe

Temperature in flow pipe [°C]			Δt = 0-41 °C, P = 1 bar	Δt = 42-82 °C, P = 1 bar	Δt = 83-123 °C, P = 16 bar	Δt = 124-163 °C, P = 16 bar
t_F			k - MJ	k - MJ	k - MJ	k - MJ
0	-	3.1	4.2117			
3.2	-	6.3	4.2077			
6.4	-	9.5	4.2036			
9.6	-	12.7	4.1994			
12.8	-	15.9	4.1952			
16	-	19.1	4.1909			
19.2	-	22.3	4.1866			
22.4	-	25.5	4.1779			
25.6	-	28.7	4.1713			
28.8	-	31.9	4.1652			
32	-	35.1	4.1580			
35.2	-	38.3	4.1522			
38.4	-	41.5	4.1468			
41.6	-	44.7	4.1415	4.1477		
44.8	-	47.9	4.1362	4.1421		
48	-	51.1	4.1292	4.1343		
51.2	-	54.3	4.1237	4.1283		
54.4	-	57.5	4.1183	4.1221		
57.6	-	60.7	4.1127	4.1158		
60.8	-	63.9	4.1071	4.1092		
64	-	67.1	4.1013	4.1012		
67.2	-	70.3	4.0935	4.0937		
70.4	-	73.5	4.0875	4.0841		
73.6	-	76.7	4.0815	4.0769		
76.8	-	79.9	4.0754	4.0696		
80	-	83.1	4.0692	4.0601	4.0635	
83.2	-	86.3	4.0629	4.0529	4.0534	
86.4	-	89.5	4.0546	4.0457	4.0456	
89.6	-	92.7	4.0482	4.0384	4.0378	
92.8	-	95.9	4.0419	4.0312	4.0298	
96	-	99.1	4.0355	4.0239	4.0217	
99.2	-	102.3	4.0269	4.0140	4.0107	
102.4	-	105.5	4.0206	4.0067	4.0019	
105.6	-	108.7	4.0143	3.9994	3.9933	
108.8	-	111.9	4.0080	3.9920	3.9847	
112	-	115.1	4.0017	3.9847	3.9763	
115.2	-	118.3	3.9934	3.9749	3.9651	
118.4	-	121.5	3.9873	3.9675	3.9567	
121.6	-	124.7	3.9811	3.9601	3.9484	3.9467
124.8	-	127.9	3.9751	3.9528	3.9401	3.9376
128	-	131.1	3.9670	3.9459	3.9317	3.9283
131.2	-	134.3	3.9611	3.9381	3.9234	3.9159
134.4	-	137.5	3.9552	3.9284	3.9124	3.9064
137.6	-	140.7	3.9474	3.9217	3.9013	3.8968
140.8	-	143.9	3.9435	3.9139	3.8957	3.8872
144	-	147.1	3.9359	3.9038	3.8847	3.8743
147.2	-	150.3	3.9303	3.8972	3.8764	3.8648
150.4	-	153.5	3.9247	3.8932	3.8676	3.8554
153.6	-	156.7	3.9192	3.8831	3.8598	3.8460
156.8	-	159.9	3.9137	3.8761	3.8515	3.8366
160	-	163.1	3.9084	3.8691	3.8432	3.8273

A.11 CALCULATION

A.11.1 FLOW CALCULATION

MULTICAL® III calculates the flow value by multiplying the number of pulses from the flow meter - over a period of 30 seconds - by a flow factor. The flow factor is stated in the CCC code (see section A6.2 and A6.3) and is unique for each individual meter code

$$\text{Flow} = \frac{\text{flow pulses / 30 sec} \times \text{flow factor}}{256} \; [\text{l / h}]$$

Example:

- *ULTRAFLOW II - 1.5 m³/h*
- *100 pulses/litre*
- *Flow factor = 307*

$$\text{Flow} = \frac{1250 \times 307}{256} = 1499 \; [\text{l / h}]$$

With MULTICAL® III it is also possible to incorporate a filter function in the flow calculation which stabilises the flow value. The filter function is especially valuable when MULTICAL® III is connected to a Woltmann meter - or similar - with relatively few volume pulses.

If the CCC code is less than 100, a flow filter is automatically in the meter.

$$\text{Flow}_{\text{FILTER}} = \frac{\text{Flow}_{\text{NEW}} + (3 \times \text{Flow})_{\text{OLD}}}{4} \; [\text{m}^3 / \text{h}]$$

t+0 sec.	10 m³/h
t+30 sec.	32 m³/h
t+60 sec.	49 m³/h
t+90 sec.	61 m³/h
t+120 sec.	70 m³/h
t+150 sec.	77 m³/h
t+180 sec.	82 m³/h
t+210 sec.	86 m³/h
t+240 sec.	89 m³/h
...	...

A theoretical flow change (jump function) of e.g. 10 m³/h to 100 m³/h shows, when the filter function is connected on CCC code=006.

Furthermore, MULTICAL® III can determinate and display peak flow. The peak flow is calculated as the average of 30 instantaneous flow calculations, corresponding to the average over the last 15 minutes. If the new calculation gives a flow that exceeds previous results, this flow is stored as the new peak flow. The average time can be configured from 1 - 120 minutes using a hand terminal or a computer.

A.11.2 POWER CALCULATION

The instantaneous power calculation of MULTICAL® III is based on a k-factor, the flow calculation and the prevailing differential temperature. The display shows the actual power calculation every 30 seconds.

The peak power is calculated as the average of 120 instantaneous power calculations, that means the average of the last 60 minutes. If the new calculation gives a power that exceeds previous results, it is stored as the new peak power.

The average time can be configured from 1 - 120 minutes using a hand terminal or a computer, an average time of 60 minutes is recommended.

Once a month the peak power is stored in the EEPROM and a new calculation for the next month begins.

When reading monthly data, the stored monthly peak power values can be used as statistic overview for the heat supplier.

NB: MULTICAL III can be programmed to display and store <u>either</u> peak flow <u>or</u> peak power.

A.12 RESET FUNCTIONS

MULTICAL® III is supplied with a "Power On reset" circuit, that is activated when power supply is connected by means of placing the top of the integrator on the battery supplied connection bracket or, when power supply is connected to a bracket with net supply.

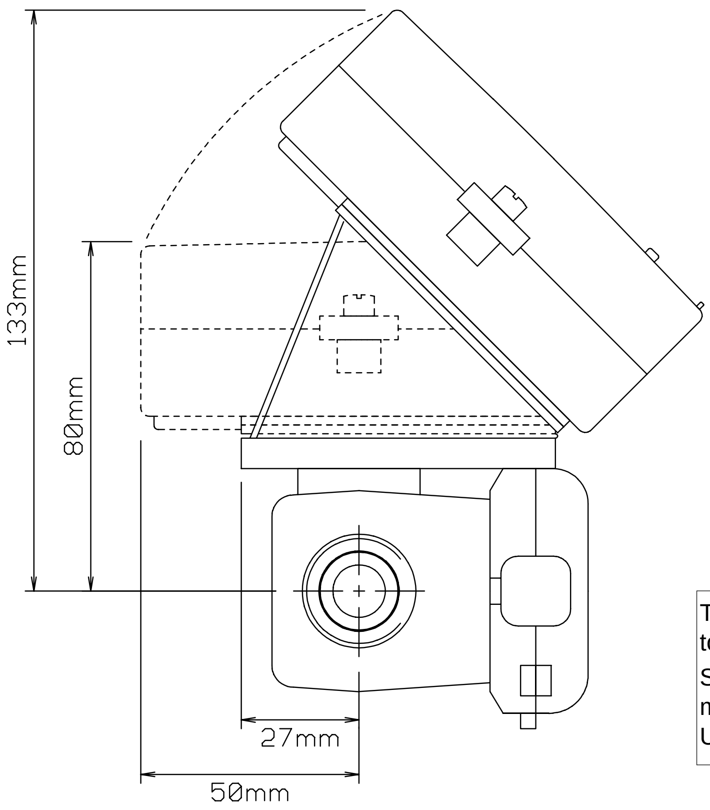
Through the combination of the reset function and pressing of both front plate keys the following reset functions can be activated:

Reset Quickfigure	Reset without pressing front plate keys
Reset hour counter	Reset + left front plate key
Reset information codes	Reset + right front plate key
Total reset	Reset + both front plate keys

Total reset is disabled, when A-B-CCC = 3-x-xxx or 4-x-xxx

See chapter A7.1

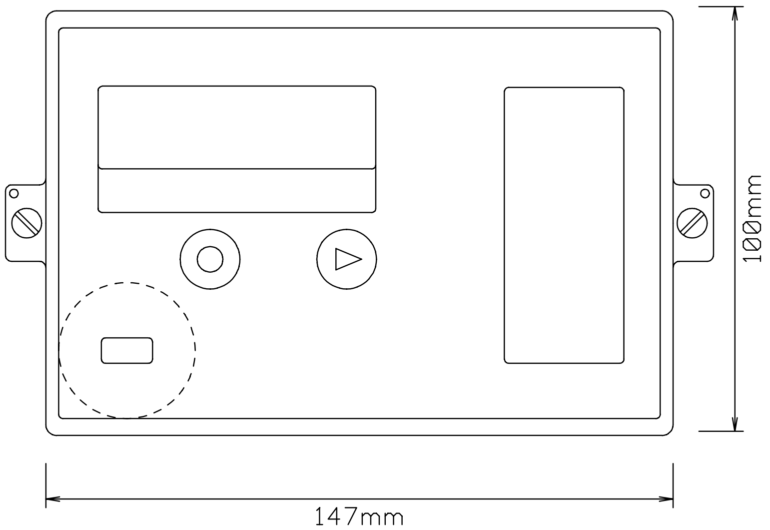
A.13 DIMENSIONAL DRAWINGS



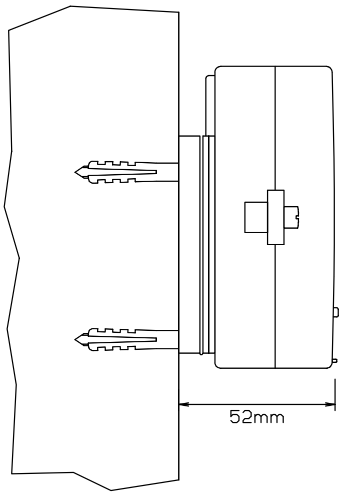
The measurements stated apply to ULTRAFLOW II 1.5 m^3/h

See section C3 for measurements for the larger meters in the ULTRAFLOW II series.

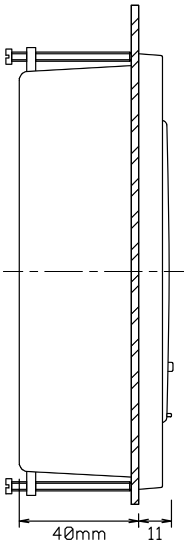
Compact mounted MULTICAL® III with ULTRAFLOW II



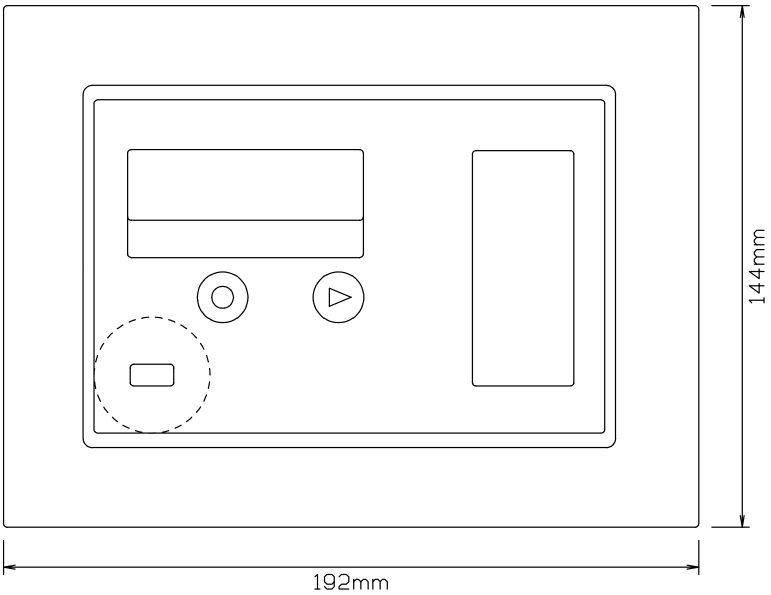
MULTICAL® III front measurements



Wall-mounted MULTICAL® III
from the side



Panel-mounted MULTICAL® III,
from the side



Panel-mounted MULTICAL® III, front view

A.14 COMMISSIONING MULTICAL® III

A.14.1 QUICK FIGURE

The Quick figure is **only** used whilst commissioning MULTICAL® III. The meters highest resolution is defined as the Quick figure.

Quick figure can be read in 3 different ways:

1) EXTERNAL PULSE COUNTER

The current Quick figure can be accessed as pulses on the MULTICAL® III connection print, pin 12 and 13. Pulses can be measured by means of a battery-driven frequency counter connected between Quick-output (pin 13) and the battery plus pole (pin 12). If a frequency counter with a high impedance (Zin > 100 kΩ) is used, it may be necessary to fit a pull-up resistor (100 kΩ) from pin 12 to 13.

The Quick figure is given for each energy integration as a pulse burst with a frequency of approx. 40 kHz.

2) MULTICAL® III DISPLAY

A simpler method is to fit a resistor of 100 kΩ between pin 12 and 13 on the connection print. The display will change from normal to Quick and stay in the Quick-mode until the resistor is removed.

Furthermore, the Quick figure can be read short term by pressing both front plate keys.

3) DATA OUTPUT

Both the optical read-out of MULTICAL® III and the data acquisition output on the connection bracket can be used to read the Quick figure. See section A.2.3 Commissioning data.

RESET OF QUICK FIGURE

The Quick figure is reset when the integrator and connection bracket are disconnected, as the power supply is interupted.

QUICK SUM

While commissioning e.g. an ULTRAFLOW II, Qn 1.5 m^3/h, 10,000 pulses would be sent, which indicates 10 energy integrations or 100 litres. This means the accumulated Quick figure is most important for commissioning.

A.14.2 ENERGY CALCULATION

The "true" energy admitted to MULTICAL® III during commissioning must be calculated carefully as this "true" energy forms the basis for calculating the meters commissioning divergence.

E_{MJ} =	$m^3 \times \Delta t \times k_{STUCK}$	[MJ]
E_{GJ} =	$\frac{E_{MJ}}{1000}$	[GJ]
E_{kWh} =	$\frac{E_{MJ}}{3,6}$	[kWh]
E_{MWh} =	$\frac{E_{MJ}}{3600}$	[MWh]

m^3 is the admitted (or simulated) amount of water during commissioning. If MULTICAL® III has a Qn 1.5 m^3/h flow meter and a CCC code of 119, the calculator will be programmed to receive 100.0 volume pulses per litre.
If for example 10000 volume pulses are admitted during commissioning, this corresponds to 10000/100 = 100 litres, or 0.1 m^3.

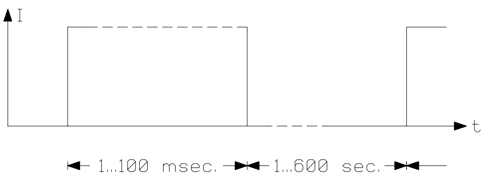
Δt is the difference between the flow and return pipe temperatures (t_F - t_R). Regardless of whether the probes are in a liquid bath or precision resistors are used during commissioning, the temperatures must be entered correctly.

K_{STUCK} is the specific heat of the water which can be found in the table entitled "Tabellen von Wärme-koeffizienten für Wasser als Wärmeträgermedium", published in 1986 by Wirtschaftverlag NW. The following data must be on hand when referring to this table:

- Flow temperature, t_F
- Return temperature, t_R
- Flow meter installation: flow or return pipe
- Plant pressure (1 or 16 bar, or an interpolation between the two)

The k-factor stated in the table is the basis for calculating energy in MJ. It must, therefore, be converted using the above formula when energy is required expressed in a different unit.

NB.: Use only passive precision resistors to test and verify MULTICAL® III. An electronic resistance simulator, e.g. based on a power supply controlled FET, is not suitable, because the measuring power of MULTICAL® III is intermittant (pulsing).



The measuring power (I) is ca. 0,5 mA, and the measuring sequence will be from 1 to 100 ms, depending on the flow and return temperatures. The measurement repeats at a 1 to 600 seconds interval, depending on the actual flow.

A.14.3 Σ QUICK-FIGURE

The sum of the Quick-figure, e.g. determined while commissioning, is called the Σ Quick-figure. The value can be up to 999999 and is accessed through the data output and the HF output, pin 4 on the test plug. The Σ Quick-figure is also shown in MULTICAL® III 's display, as previously described in section A14.1.

The accumulated Quick figure, which MULTICAL® III, under ideal circumstances, should emit during commissioning, can be determined as a calculation of the "true" energy multiplied by the high-resolution Quick-factor:
Quick figure = E_{GJ} x Q_{GJ} or E_{MWh} x Q_{MWh},, where Q_{GJ} and Q_{MWh} (see table below):

CCC-code (see section A7.2 and A7.3)	Q_{GJ}	Q_{MWh}	**Decimals [m^3] displayed**
000, 001, 002, 108, 109, 110, 111, 112, 115, 116, 117, 118, 119, 121, 122, 123, 124, 125, 126, 132, 133, 134, 136, 139, 156, 163, 164, 165	2,388,900	8,600,000	2
003	955,200	3,440,000	1
004, 006, 113, 114, 120, 127, 128, 129, 130, 131, 135, 137, 140, 141, 142, 143, 151, 152, 153, 157, 168	238,890	860,000	1
005, 007	95,520	344,000	0
008, 144, 145, 146, 147, 148, 149, 150, 158, 169	23,889	86,000	0
166, 167	2,389	8,600	X10

Example:

- *MULTICAL® III, programmed for Qn 1.5 m^3/h flow meter (CCC=119)*
- *Placed in flow pipe*
- *10.000 volume pulses are admitted, corresponding to 0.1 m^3*
- *Temperature is simulated as: t_F = 49.00°C and t_R = 40.00°C.*

$$E_{MJ} = m^3 \times \Delta t \times k_{STUCK} = 0.1 \times 9 \times 4.1316 = 3.71844 \text{ [MJ]}$$

$$\text{Quick} = \frac{E_{MJ} \cdot Q_{GJ}}{1000} = \frac{3.71844 \cdot 2{,}388{,}900}{1000} = 8883$$

A.14.4 THE NOMINAL QUICK FIGURE

The nominal Quick Figure while commissioning MULTICAL® III can be determined by specifying "ideal" conditions. These nominal Quick figures can naturally only be used as guidelines or in respect to a function test. Prior to final commissioning, corrections must be made for temperature deviations etc.

Table 1, Nominal Quick figure

- ULTRAFLOW II, Qn 1.5 m^3/h, CCC=119
- Mounted in flow pipe

Qn [m^3/h]	t_F [°C]	t_R [°C]	Δt [°C]	Flow meter	Imp/10 Int.	$Quick_{NOM}$
1.5	43.00	40.00	3.00	Flow	10,000	2,966
1.5	49.00	40.00	9.00	Flow	10,000	8,883
1.5	61.00	40.00	21.00	Flow	10,000	20,602
1.5	80.00	40.00	40.00	Flow	10,000	38,843
1.5	160.00	10.00	150.00	Flow	10,000	137,122

Table 2, Nominal Quick figure

- ULTRAFLOW II, Qn 1.5 m^3/h, CCC=119
- Mounted in return pipe

Qn [m^3/h]	t_F [°C]	t_R [°C]	Δt [°C]	Flow meter	Imp/10 Int.	$Quick_{NOM}$
1.5	43.00	40.00	3.00	Return	10,000	2,970
1.5	49.00	40.00	9.00	Return	10,000	8,912
1.5	61.00	40.00	21.00	Return	10,000	20,803
1.5	80.00	40.00	40.00	Return	10,000	39,667
1.5	160.00	10.00	150.00	Return	10,000	151,117

B.1 TEMPERATURE PROBES

B.1.1 SENSOR ELEMENT

Pt500 temperature probes are used with MULTICAL® III, in accordance with DIN/IEC 751. A Pt500 temperature probe is a resistance sensor, where the nominal resistance is 500 Ω at 0°C and 692.5 Ω at 100°C. All values for the Ohm-resistance are stipulated in the international standard DIN/IEC 751, which applies to Pt100 temperature probes. The Ohm-resistance values for Pt500 probes are five times higher and can be seen in the following table [Ω]:

°C	0	1	2	3	4	5	6	7	8	9
0	500.00	501.95	503.91	505.86	507.81	509.76	511.71	513.66	515.61	517.56
10	519.51	521.46	523.41	525.35	527.30	529.24	531.19	533.13	535.08	537.02
20	538.96	540.91	542.85	544.79	546.73	548.67	550.61	552.55	554.48	556.42
30	558.36	560.30	562.23	564.17	566.10	568.03	569.97	571.90	573.83	575.77
40	577.70	579.63	581.56	583.49	585.41	587.34	589.27	591.20	593.12	595.05
50	596.98	598.90	600.82	602.75	604.67	606.59	608.51	610.44	612.36	614.28
60	616.20	618.12	620.03	621.95	623.87	625.78	627.70	629.62	631.53	633.45
70	635.36	637.27	639.18	641.10	643.01	644.92	646.83	648.74	650.65	652.56
80	654.46	65637	658.28	660.18	662.09	663.99	665.90	667.80	669.71	671.61
90	673.51	675.41	677.31	679.21	681.11	683.01	684.91	686.81	688.71	690.60
100	692.50	694.40	696.29	698.19	700.08	701.97	703.87	705.76	707.65	709.54
110	711.43	713.32	715.21	717.10	718.99	720.87	722.76	724.65	726.53	728.42
120	730.30	732.19	734.07	735.95	737.84	739.72	741.60	743.48	745.36	747.24
130	749.12	751.00	752.87	754.75	756.63	758.50	760.38	762.25	764.13	766.00
140	767.88	769.75	771.62	773.49	775.36	777.23	779.10	780.97	782.84	784.71
150	786.57	788.44	790.31	792.17	794.04	795.90	797.77	799.63	801.49	803.35
160	805.22	807.08	808.94	810.80	812.66	814.51	816.37	818.23	820.09	821.94

There are several advantages when using a resistance sensor with a high Ohm value (Pt500), as opposed to a resistance sensor with a low Ohm value (Pt100):

- Less cable resistance in the probe cable and change-over resistance in the connections.
- Greater Ohm change per degree centigrade gives better accuracy in the calculator's analogue/digital converter.
- The temperature probes can be matched as a pair with greater accuracy.

B.1.2 PAIRING

The differential temperature is a significant factor when calculating the amount of heat. It is, therefore, necessary that this measurement is accurate.

Accuracy tolerances for temperature probes are according to DIN/IEC 751 B ±0.3°C at 0°C and ±0.8°C at 100°C. These tolerances are sufficient to determine flow and return temperatures, as deviations need only be seen in relation to which k-factor is to be used. However, when measuring the differential temperature, the above accuracy tolerances are far from adequate. The two temperature probes, used to measure the difference between the temperatures, must have precisely the same deviation characteristic.

Kamstrup check the deviation of temperature probes by first immersing them in a thermostatically controlled bath at 40°C. They are then split up into 50 groups, determined by the deviation at this temperature. Each group has a tolerance of 0.01°C.
All the probes in a group are tested again in a thermostatically controlled bath at 130°C and again split into groups, this time 32 groups with a ±0.01°C tolerance. The grouping is again determined by the individual probe accuracy at 130°C. The individual sensor sets must then be tested at 85°C taking a specified number of pairs at random or testing all sensor sets, depending on the relevant approval.

The temperature probes that are grouped together both at 40°C and 110°C form matched pairs which should not be split up.

B.1.3 NUMBERING

Temperature probes are fitted with a name plate which shows the catalogue number and the serial number for that particular probe. The probes must be ordered as a pair. The catalogue number for ordering temperature probe sets together with MULTICAL® III is not the same as the number the probes are marked with. The number on the probes pertains to that particular probe set.

Each temperature probe has a serial No., which is indicated on the plastic label. The probe for the return pipe has the same number as the probe for the flow pipe.

B.2 PROBE TYPES

MULTICAL® III can be supplied with three different temperature probe sets - all with 1.5 or 3.0 metre cable. The function of all three temperature probe types is identical. However, they are fitted in different ways. The most important characteristics of the three types are listed in the following section.

Type number **66 - B -** ❑ - ❑ - ❑ - ❑ - ❑❑❑

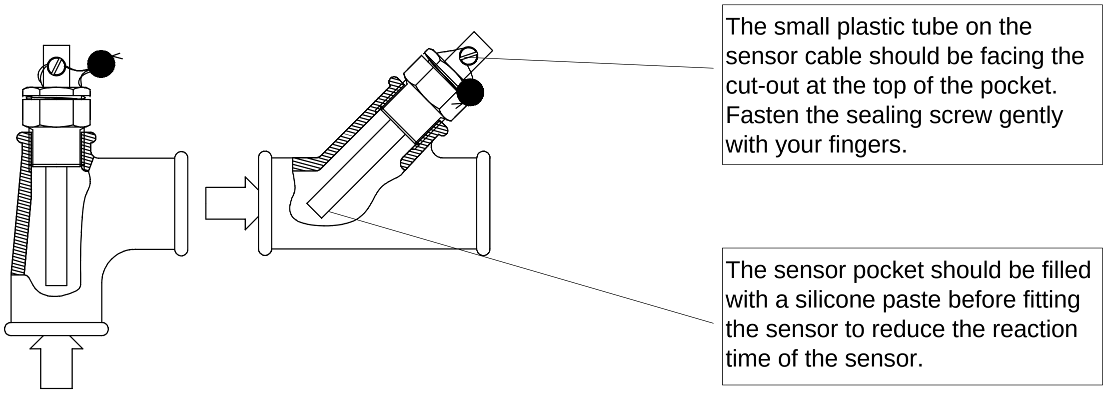
Pt 500 Temperature Sensors	
Pocket sensor set with 1.5 m cable	1
Pocket sensor set with 3.0 m cable	2
Direct sensor set with 1.5 m cable	3
Direct sensor set with 3.0 m cable	4
Short direct sensor set with 1.5 m cable	5
Short direct sensor set with 3.0 m cable	6
Pocket mounted sensor set with 5 m cable	7
Pocket mounted sensor set with 10 m cable	8

B.2.1 PT500 POCKET MOUNTED TEMPERATURE PROBE SET

Pt500 cable probe comprises a 5 mm diameter 2-wire silicone cable. A 5.8 mm brass tube protects the sensor element. This tube is shrunk onto the element.

The brass tube is fitted in a probe pocket which has an internal dimension of 6 mm and an external dimension of 8 mm. The probe pocket is supplied with a ½"BSP connection in both brass and stainless steel in 40, 60, 90 and 140 mm lengths. (Please refer to data sheet No. E90 799 for further information).

The probe design with separate pocket means that the probe can be replaced without shutting the water off. Additionally, the large selection of pocket lengths means that the probes can be fitted in all pipe sizes.

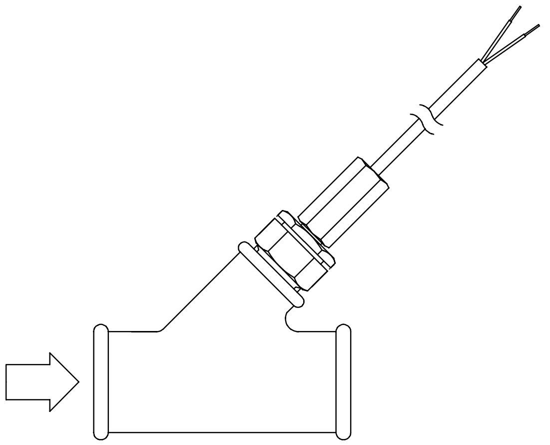


Brass sensor pockets can be used up to a plant pressure of PN16, with a plant pressure of PN25 sensor pockets in stainless steel are recommended.

B.2.2 PT500 DIRECT MOUNTED TEMPERATURE PROBES

Pt500 direct mounted temperature probes measure the temperature in the flow direction of the medium without a sensor pocket. The probe itself comprises a 3.5 mm diameter 2-wire silicone cable with a 75 mm sensor tube (3.5 mm diameter) in stainless steel. The probe is fitted either by means of a ½ BSP - 3/8" UNF nipple or directly in the ball valve designed for this type of temperature probe.

If you prefer to fit the probe using an ½" BSP - 3/8" UNF nipple, relieve the pressure in the plant before changing the probe. If the probe is fitted in the ball valve it can be replaced by simply turning the valve. (Please see data sheet No. E90 799 for further information).

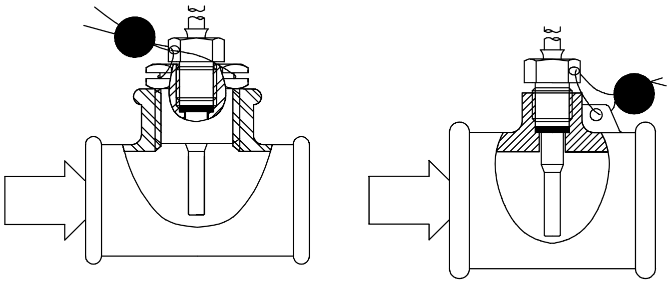


Because of their short response time direct mounted temperature probes are especially recommended for heating plants with flow change.

B.2.3 PT500 DIRECT MOUNTED SHORT TEMPERATURE PROBES

The Pt500 direct mounted short temperature probe is designed in accordance with European standards for thermal energy meters, prEN 1434 (previously CEN TC-176). The probe is designed for fitting directly into the measuring medium.

This probe also comprises a 3.5 mm diameter, 2-wire silicone cable. The sensor tube is made of stainless steel and has a diameter of 4 mm at its end.



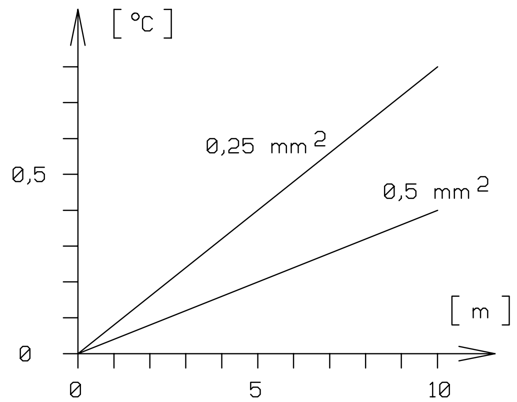
The probe can be fitted in a special T-section, which can be supplied for ½", ¾" and 1" pipe installations. Furthermore, the direct mounted short temperature probe can also be fitted in a standard 90° T using a ½" or ¾" BSP to M10 nipple.

The probe can also be fitted directly into many types of flow meter - this obviously reduces installation costs.

B.3 PROBE CABLE

As mentioned previously, the temperature probe comprises silicone cable. This is both heat resistant and flexible. The cross-sectional area is 0.5 mm^2 for pocket mounted probe sets which corresponds to 0.04°C/metre. The two other probes types have a cross sectional area of 0.25 mm^2, which corresponds to a positive measure deviation of 0.08°C/metre.

The figures stated apply to 2 individual cross sectional areas in a 1 metre length. With all three temperature probe types the cable length for the forward and return probes must be identical. If the lengths are not the same, the cable resistance will affect the measurement of the differential temperature.



We would generally advise customers to use the temperature probes with the cable supplied. If the cable is too long, the excess can be rolled up and secured with cable strips.

If after careful consideration, you decide to shorten the cable, please note that both cables must have exactly the same length.

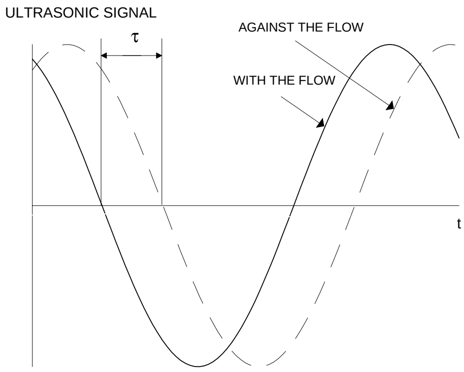
C.1 ULTRAFLOW II

C.1.1 FUNCTION

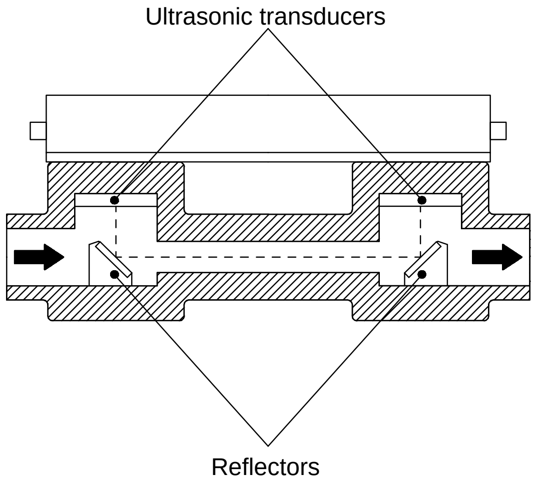
ULTRAFLOW II is a μ-processor controlled static flow meter, especially designed for MULTICAL II and MULTICAL® III heat meters from Kamstrup A/S. ULTRAFLOW II is supplied with 3.6 VDC by the connected MULTICAL, which can be supplied through a battery or mains.

The function is based on the ultrasonic principle and the flow meter is used in heating installations to record the volume of heating water. ULTRAFLOW II has no moving parts, which means there is no wear, no cleaning and continuous high performance and accuracy throughout the meter's lifetime.

ULTRAFLOW II has two ultrasonic transducers which send ultrasonic signals, with the flow and against the flow, through the water flow simultaneously. The function of the transducers alternates from sending to receiving signals and the time difference between the two signals is measured. The ultrasonic signal travelling **with** the flow will reach the opposite transducer first.



The time difference between the two ultrasonic signals depends on several factors:
- flow velocity
- length of the measuring pipe
- diameter of the measuring pipe
- velocity of sound in water



The internal construction of Ultraflow II is simple ensuring reliable operation.

The transducers send signals to each other through the measuring pipe via reflectors.

In addition to the transducers, ULTRAFLOW II has a probe measuring the temperature of the water, as it affects the velocity of sound in water.

The water flow is the multiplication of the time difference between the two ultrasonic signals and the volume of the measuring pipe.

The ULTRAFLOW II micro processor converts the water flow to pulses of a given quantity of water per pulse - depending on what size ULTRAFLOW II is installed.

Qn [m^3/h]	number of [pulses/litre]	CCC-code
0.6	300	116
1.5	100	119
2.0	100	119
2.5	50	136
3.0	50	151
3.5	50	151
6.0	25	137
10	25	137
15	10	120
25	10	120
40	5	158

See also CCC-tables in section A7.2 and A7.3 for further information about how MULTICAL® III organises flow meters, for where to place the comma in m^3 etc.

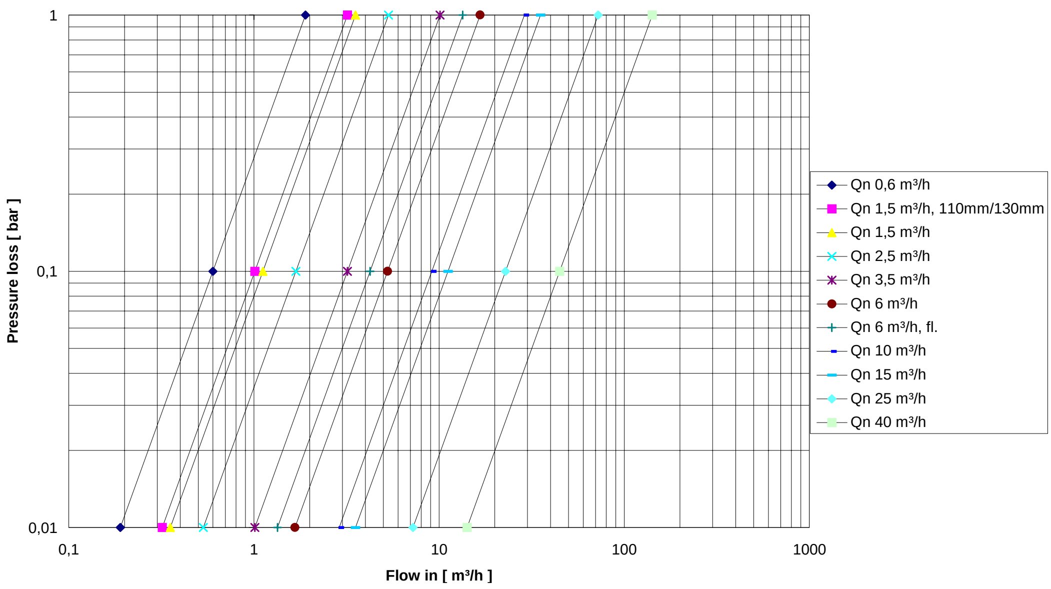
C.1.2 MEASURING SEQUENCY

ULTRAFLOW II measures the relevant factors every second. The measuring sequence comprises 8 measurements described as follows:

Measure-ment no.	**Type of measurement**
1	*Flow measurement*
2	Reference measurement of temperatures by means of a built-in reference resistor to eliminate drift in the temperature circuit.
3	*Flow measurement*
4	Water temperature in ULTRAFLOW II is measured to get the right velocity of sound in the flow calculation and to add the right temperature into the flow meter's temperature curve.
5	*Flow measurement*
6	Reference measurement of maximum water flow. The time difference corresponding to maximum flow is simulated and the result is taken to correct the measurement circuit.
7	*Flow measurement*
8	Reference measurement of minimum water flow The time difference corresponding to minimum flow is simulated and the result is taken to correct the measurement circuit.

C.1.3 PRESSURE LOSS

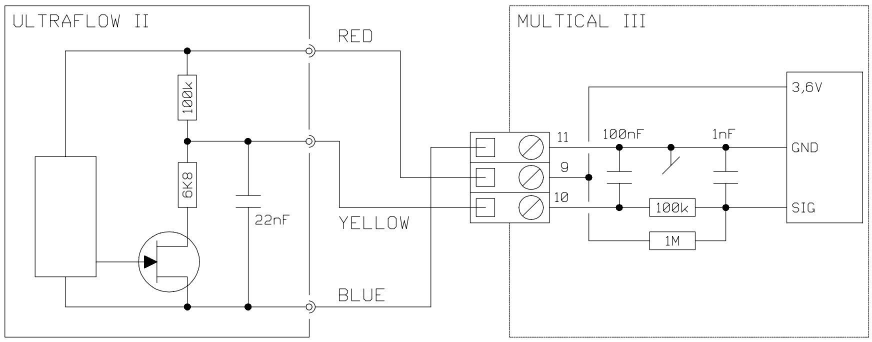
The mechanical construction of ULTRAFLOW II allows the biggest part of the water flow to pass the meter freely and assures a minimal pressure loss. The pressure loss depends on the size of the flow meter and is shown in the diagram below:



C.1.4 OUTPUT CIRCUIT

As mentioned previously, ULTRAFLOW II is especially designed for MULTICAL II and MULTICAL® III heat meters from Kamstrup. As a consequence the output circuit is designed for minimal power consumption and optimal immunity to interference. The output circuit should be able to manage a pulse frequency up to 128 Hz, that however only occurs when the water flow is higher than the meter's nominal size.

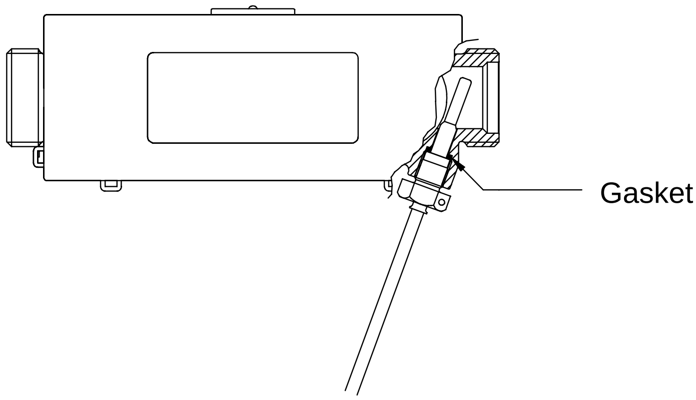
The diagram below shows the connection between the output circuit of ULTRAFLOW II and the input circuit of MULTICAL® III:



C.2 TEMPERATURE PROBE MOUNTING

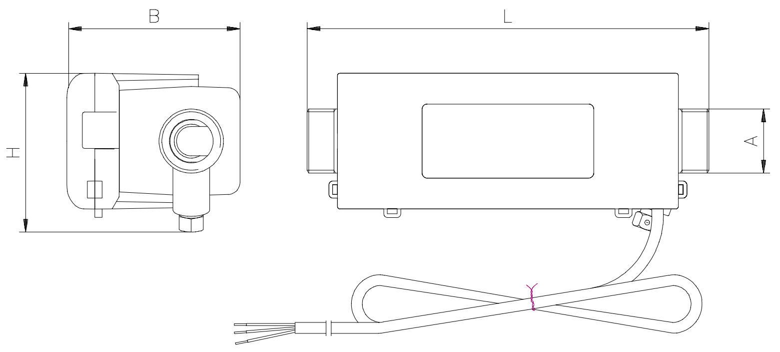
ULTRAFLOW II with flow ranges from 1.5 m^3/h to 2.5 m^3/h (DN15 and DN20) are designed with an integrated temperature probe connection. The probe for the flow- or return pipe of MULTICAL® III can be mounted directly in the flow meter, which makes installation very easy

The probe connection shown is designed for CEN short direct temperature probes, that complies with the mechanical requirements of prEN 1434-2.

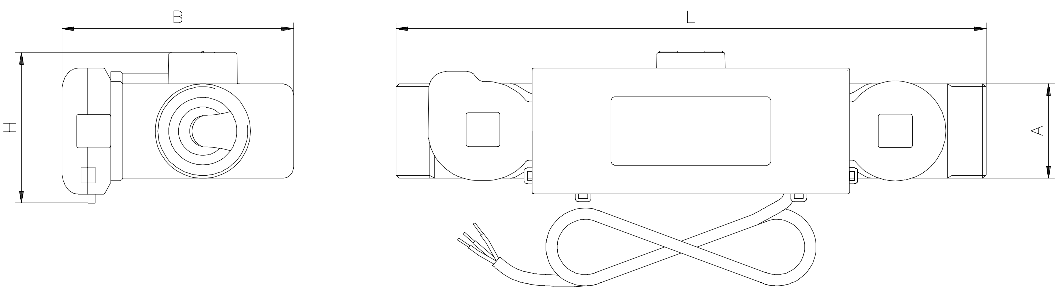


ULTRAFLOW II is supplied with mounted screw-joint and gasket.

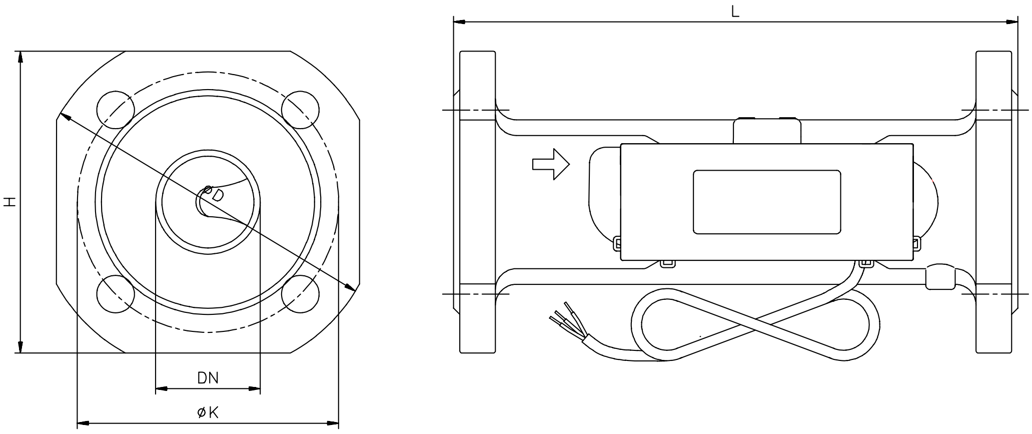
C.3 DIMENSIONAL DRAWINGS



Qn [m^3/h]	1.5	2	1,5 or 2,5
Size	DN15	DN20	DN20
Connection A	G3/4B	G1B	G1B
B [mm]	71	71	71
H [mm]	68.5	68,5	62,5
L [mm]	165	165	165/190



Qn [m^3/h]	3/3.5 or 6	10
Size	DN25	DN40
Connection A	G1 1/4B	G2B
B [mm]	102	106,5
H [mm]	67	67
L [mm]	260	300



Qn [m^3/h]	6	10	15
Size	DN25	DN40	DN50
Bolt ØK [mm]	85	110	125
Diameter ØD [mm]	115	150	165
H [mm]	106	136	145
L [mm]	260	300	270

C.4 COMMISSIONING ULTRAFLOW II

C.4.1 MOUNTING

ULTRAFLOW II with flow ranges from 1,5 m^3/h to 2,5 m^3/h (DN15 and DN20) can be mounted without considering inlet sections. ULTRAFLOW II in other sizes should be mounted with a straight inlet section of 3 to 5 x DN at a minimum. When mounting ULTRAFLOW II the mounting angle must be considered. The limitations appear on the installation instructions for ULTRAFLOW II.

C.4.2 TECHNICAL DATA

• **Output signal**

Qn [m^3/h]	number of [pulses/litre]	CCC-code
0.6	300	116
1.5	100	119
2.0	100	119
2.5	50	136
3.0	50	151
3.5	50	151
6.0	25	137
10	25	137
15	10	120
25	10	120
40	5	158

Type: FET (open drain) with pull-up resistor of 100 kΩ

Output impedance: ≈10 kΩ

Pulse length: 2 - 5 ms

Pause time: Depending on flow/pulse frequency

Frequency: 0 - 90 Hz, depending on flow meter type

• **Connection**

Through 3-wire cable Yellow: Signal
Red: Supply
Blue: Ground

Supply: 3.6 V DC ± 0.1 V

It takes 16 sec. from start-up to true flow indication/starting the commissioning.

• **Flow measurement**

In order to obtain correct flow measurement, commissioning must take at least 2 minutes.

• **Vacuum protection**

ULTRAFLOW II should not be exposed to vacuum.

C.4.3 PULSE TESTING APPARATUS FOR ULTRAFLOW II

As mentioned previously, ULTRAFLOW II is normally supplied by MULTICAL® III. During commissioning a PULSE TESTING APPARATUS, type no. 79-65-270, should be used, which has the following functions:

- Built-in supply for ULTRAFLOW II
- Galvanically separated pulse output
- Light diode for indication of pulses from output
- LC Display with counter
- Sample hold function, externally controlled

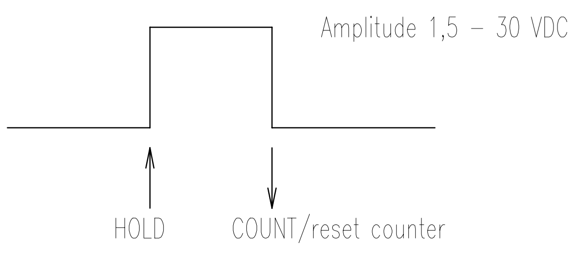
C.4.4 TECHNICAL DATA FOR PULSE TESTING APPARATUS

- **Pulse input**

Counter input	Max. frequency: 100 Hz
Active signal	Amplitude: 2.5 - 30 Vpp
	Pulse duration > 0.1 msec.
Passive signal	Internal pull-up 1MΩ
	Internal supply 3.65 V lithium battery

- **Hold input**

Input	Galvanically isolated input
Input protection	against reverse polarity.
“Open input”	⇒ Count (see sketch below)



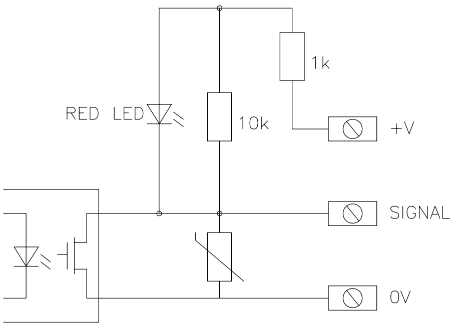
C.4.5 HOLD FUNCTIONS

When the Hold-signal is removed, (High level added to input) the counter display stops at the number of pulses counted.

When the Hold-signal is removed, (Low level added to input) the counter is automatically reset and new counting starts.

The counter can also be reset via the right key on the front panel.

C.4.6 SIGNAL OUTPUT FOR PULSE TESTING APPARATUS



Technical data	
Pulse duration	8.5 ms
Pause duration	1.5 ms with 100 Hz
Output type	OptoFET
Power	12...30 VDC/AC
Current	< 100 mA
Power	< 3W/VA

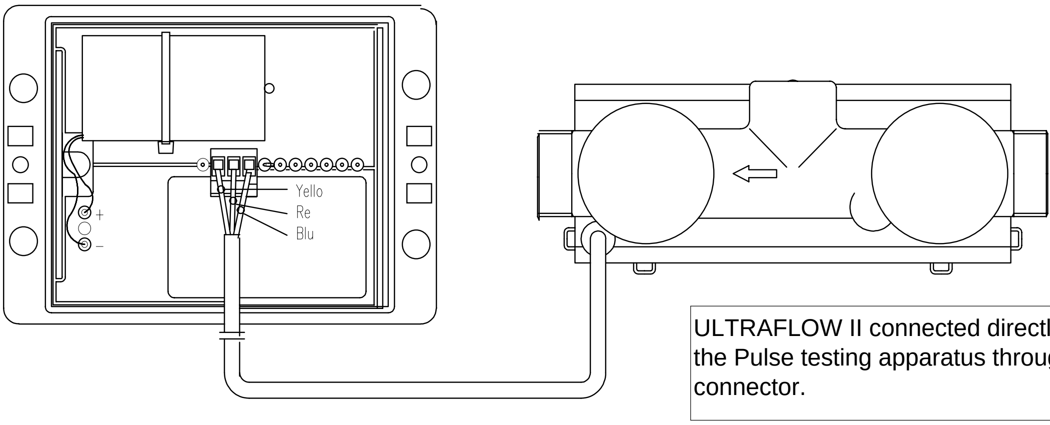
- The output is galvanically isolated with overvoltage protection.
- The red link at the front of the pulse testing apparatus indicates that the optorelay is active (contact closed). The light diode is externally supplied.
- Max. Counter capacity until overflow is 99.999.999 counts

C.4.7 APPLICATION OF PULSE TESTING APPARATUS

The pulse testing apparatus can be used in the following ways:

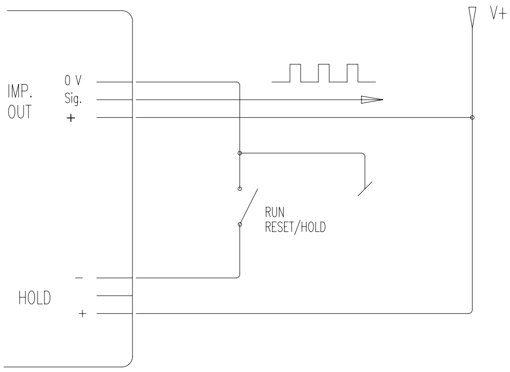
- Standing start-stop of flow meter using the built-in pulse counter.
- Standing start-stop of flow meter using the pulse output of external pulse equipment.
- Flying start-stop of flow meter using the built-in counter controlled from external equipment (Sample hold).
- Flying start-stop of flow meter using the pulse output controlled from external equipment (Sample hold).

C.4.8 CONNECTING THE PULSE TESTING APPARATUS



ULTRAFLOW II connected directly to the Pulse testing apparatus through a connector.

Connection to external equipment



Connection of pulse testing apparatus to external equipment

D.1 TROUBLE SHOOTING

Symptom	Possible reason	Proposal for correction
Display not functioning (blank display)	No power supply	Replace battery, Check net supply
No energy accumulation, (e.g. MWh) and m^3	Read “info” from display If “info” = 000 ⇒ If “info” > 000 ⇒	 Check both flow meter and temperature sensors Check the error indicated by the info code
Accumulation of m^3 but not energy (e.g. MWh)	Forward and return sensors have been inverted either at the installation or at the connection	Mount sensors correctly
No accumulation of m^3	No volume pulses	Check flow meter connection, Check flow meter direction
Faulty accumulation of m^3	Error in flow meter Flow meter inverted Erroneous programming	Send meter for repair Invert flow meter Send MULTICAL® III for control
Faulty temperature indication	Defective temperature sensor	Replace the pair of sensors
Temperature indication or accumulation of energy (e.g. MWh) slightly too low	Bad thermal sensor contact Heat dissipation Sensor pockets too short	Push sensors as far into the sensor pockets as possible Insulate sensor pockets Replace with longer pockets

E.1 DISPOSING OF ENERGY METERS

Kamstrup’s energy meters have been designe and constructed for many years’ reliable operation. But, as you know, all good things must come to an end, and a worn out energy meter must be disposed of with consideration to the environment.

- **DISPOSAL BY THE SUPPLIER**

Kamstrup are willing to dispose of worn.out energy meters (Multical III and Ulftraflow II) in an environmentally safe manner, according to previous agreement.

The disposal arrangement is free of charge to the customer, who only pays for the transportation to Kamstrup A/S.

- **DISPOSAL BY THE CUSTOMER**

The lithium battery <u>must</u> be removed from the meter and sent to separate, approved destruction. It must <u>not</u> be possible to short the lead-in wires of the battery during transportation.

- **small quantities** of energy meters without lithium batteries can be handed in for industrial scrapping or burning with subsequent metal recycling.

- **large quantities** of energy meters: the parts ought to be separated, sorted and handed in for separate destruction and recycling as described in the list below.

Part	**Information on materials**	**Recommended disposal**
Lithium battery in MULTICAL® III	Quantity: 2...5 g lithium >UN 3091<	Approved destruction of lithium cells
PC boards in MULTICAL® III and ULTRAFLOW II	Copper epoxide laminate, components soldered on	PC board scrap for concentration to noble metals among other things
Flow meter cable	Copper with PVC-mantle	Cable recycling
Sensor cables	Copper with silicone mantle	Cable recycling
Plastic parts, cast	Noryle and ABS	Plastic recycling
ULTRAFLOW II meter case	Brass/red brass and stainless steel	Metal recycling
Packing	Recycled cardboard	Cardboard recycling

Please fax any questions you may have concerning environmental matters, to:

KAMSTRUP A/S
FAO.: Quality Control Dept.
Fax.: +45 89 93 10 01