

Technical description

MULTICAL[®] 601



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1 General description

MULTICAL® 601 is a thermal energy meter with many applications. In addition to being a precise and reliable heat meter for battery or mains operation, MULTICAL® 601 is also used for:

- Cooling measurement in water-based systems
- Bifunctional heat/cooling measurements in separate registers
- Leak surveillance of hot and cold-water installations
- Power and flow limiter with valve control
- Data logger
- Data communication
- Energy measurement in open systems

In designing the MULTICAL® 601 we have attached great importance to flexibility via programmable functions and plug-in modules (see chapter 10) in both the calculator top as well as in the base unit to ensure optimal use in a large number of applications. In addition, the construction ensures that already installed MULTICAL® 601 meters can be updated via the PC program METERTOOL.

This technical description is prepared to give managers, meter electricians, consulting engineers and distributors the possibility of utilizing all functions available in the MULTICAL® 601. Furthermore, the description is made for laboratories for the testing and verification process.

During the preparation of this technical description we have drawn attention to the functional differences in changing from MULTICAL® type 66-CDE into MULTICAL® 601 to secure a safe product conversion for existing users.

At each relevant paragraph that refers to this product conversion there will be comments marked as follows:

66-CDE ⇒ MC 601

2 Technical Data

2.1 Approved meter data

Approval	DK-0200-MI004-004, PTB 22.52/05.04, PTB 22.55/05.01, TS 27.01/155	
Standard	EN 1434:2004 and OIML R75:2002	
EU directives	Measuring Instrument Directive, Low Voltage Directive, Electromagnetic Compatibility Directive	
Temperature range	θ : 2°C...180°C	
Differential range	$\Delta\theta$: 3 K...170 K	
Accuracy	$E_c \pm (0.5 + \Delta\theta_{\min}/\Delta\theta) \%$	
Temperature sensors	-Type 67-A Pt100 – EN 60 751, 2-wire connection -Type 67-B and 67-D Pt500 – EN 60 751, 4-wire connection -Type 67-C Pt500 – EN 60 751, 2-wire connection	
Compatible flow sensor types	-ULTRAFLOW® -Electronic meters with an active 24 V pulse output -Mechanical meters with an electronic pick-up unit -Mechanical meters with a Reed switch	
Flow sensor sizes	[kWh]	qp 0.6 m³/h...15 m³/h
	[MWh]	qp 0.6 m³/h...1500 m³/h
	[GJ]	qp 0.6 m³/h...3000 m³/h
EN 1434 designation	Environmental class A and C	
MID designation	Mechanical environment: Class M1	
	Electro-magnetic environment: Class E1 and E2	
	5...55°C, non condensing, closed location (indoor installation)	

2.2 Electrical data

Calculator data

Typical accuracy	Calculator: $E_c \pm (0.15 + 2/\Delta\Theta) \%$ Sensor set: $E_T \pm (0.4 + 4/\Delta\Theta) \%$
Display	LCD – 7 (8) digits with a digit height of 7.6 mm
Resolution	9999.999 – 99999.99 – 999999.9 – 9999999
Energy units	MWh – kWh – GJ – Gcal
Data logger (EEPROM)	Standard: 460 days, 36 months, 15 years, 50 info codes Option: Data loggers with larger depth and hour interval
Clock/calendar	Standard: Clock, calendar, compensation for leap years, target date Option: Real time clock with battery back-up
Data communication	Standard: KMP protocol with CRC16 used for optical communication and for top and base modules. Option: MULTICAL® 66-CDE compatible data for base modules
Power in temperature sensors	< 10 μ W RMS

Supply voltage 3.6 VDC \pm 5%

Battery 3.65 VDC, D-cell lithium

Stand-by current < 35 μ A excluding flow sensor

Replacement interval

- Mounted on the wall 10 years @ $t_{BAT} < 30^\circ\text{C}$

- Mounted on the flow sensor 8 years @ $t_{BAT} < 40^\circ\text{C}$

The replacement interval is reduced when using data modules, frequent data communication and high ambient temperature

Mains supply 230 VAC \pm 15/-30%, 50/60 Hz
24 VAC \pm 50%, 50/60 Hz

Insulation voltage 4 kV

Power supply < 1W

Back-up supply Integral super-cap eliminates operational disturbances due to short-term power cuts

EMC data Meets EN 1434 class C (MID class E2)

Temperature measurement

		T1	T2	T3	T4
67-A 2-W Pt100	Measuring range	0.00...185.00°C	0.00...185.00°C	0.00...185.00°C	N/A
	Preset range	0.01...180.00°C	0.01...180.00°C	0.01...180.00°C	0.01...180.00°C
67-B/D 4-W Pt500	Measuring range	0.00...185.00°C	0.00...185.00°C	N/A	N/A
	Preset range	0.01...180.00°C	0.01...180.00°C	N/A	0.01...180.00°C
67-C 2-W Pt500	Measuring range	0.00...185.00°C	0.00...185.00°C	0.00...185.00°C	N/A
	Preset range	0.01...180.00°C	0.01...180.00°C	0.01...180.00°C	0.01...180.00°C

Max. cable lengths	Pt100, 2-wire	Pt500, 2-wire	Pt500, 4-wire
	2 x 0.25 mm ² : 2.5 m	2 x 0.25 mm ² : 10 m	4 x 0.25 mm ² : 100 m
	2 x 0.50 mm ² : 5 m	2 x 0.50 mm ² : 20 m	-

Flow measuring V1 and V2	ULTRAFLOW®	Reed switches	24 V active pulses
	V1: 9-10-11 and V2: 9-69-11	V1: 10-11 and V2: 69-11	V1: 10B-11B and V2: 69B-79B
EN 1434 pulse class	IC	IB	(IA)
Pulse input	680 kΩ pull-up for 3.6 V	680 kΩ pull-up for 3.6 V	12 mA at 24 V
Pulse ON	< 0.4 V in > 0.5 msec.	< 0.4 V in > 50 msec.	< 4 V in > 0.5 msec.
Pulse OFF	> 2.5 V in > 10 msec.	> 2.5 V in > 50 msec.	> 12 V in > 10 msec.
Pulse frequency	< 128 Hz	< 1 Hz	< 128 Hz
Integration frequency	< 1 Hz	< 1 Hz	< 1 Hz
Electrical isolation	No	No	2 kV
Max. cable length	10 m	25 m	100 m

Pulse inputs VA and VB	Water meter connection	Electricity meter connection
VA: 65-66 and VB: 67-68	FF(VA) and GG(VB) = 01...40	FF(VA) and GG(VB) = 50...60
Pulse input	680 kΩ pull-up for 3.6 V	680 kΩ pull-up for 3.6 V
Pulse ON	< 0.4 V in > 0.1 sec.	< 0.4 V in > 0.1 sec.
Pulse OFF	> 2.5 V in > 0.1 sec.	> 2.5 V in > 0.1 sec.
Pulse frequency	< 1 Hz	< 3 Hz
Electrical isolation	No	No
Max. cable length	25 m	25 m
Requirements to external contact	Leakage current at function open < 1 mA	

Pulse outputs CE and CV

- via top module

Type	Open collector (OB)
Pulse length	Optional 32 msec. or 100 msec. for top module 67-04 (32 msec. for 67-06)
External voltage	5...30 VDC
Voltage	1...10 mA
Residual voltage	$U_{CE} \approx 1 \text{ V}$ at 10 mA
Electrical isolation	2 kV
Max. cable length	25 m

2.3 Mechanical data

Environmental class	Meets EN 1434 class A and C
Ambient temperature	5...55°C non condensing, closed location (indoor installation)
Protection class	IP54
Storage temperature	-20...60°C (drained meter)
Weight	0.4 kg excluding sensors and flow sensor
Connection cables	ø3.5...6 mm
Supply cable	ø5...10 mm

2.4 Materials

Top cover	PC
Base unit	PP with TPE packings (thermoplastic elastomer)
Print box	ABS
Wall brackets	PC + 30% glass

2.5 Accuracy

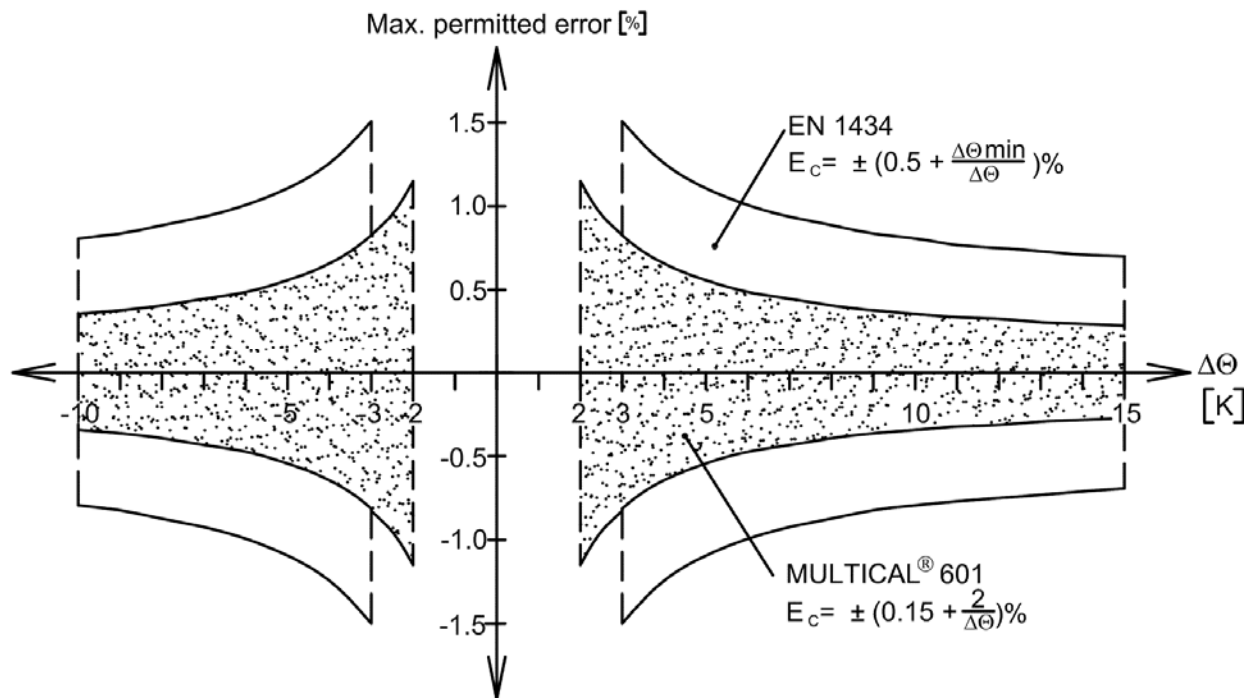


Figure 1 MULTICAL® 601 typical accuracy compared with EN 1434.

3 Type overview

MULTICAL® 601 can be ordered in a countless number of combinations as required by the customer. First the required hardware is selected in the type overview. Then “Prog”, “Config” and “Data” are selected to suit the application in question.

The meter is delivered completely configured and ready for use from the factory but it can also be retrofitted/reconfigured after installation.

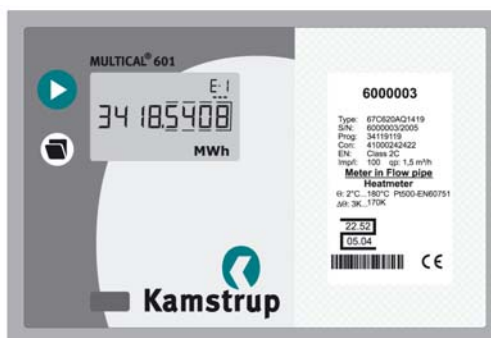
Please note that the items marked “Totalprog” can only be changed when the verification seal is broken. This requires that the change must be made at an accredited meter laboratory.

New functions and modules for MULTICAL® 601 are constantly being developed. Please contact Kamstrup A/S, if the described variants do not meet your requirements.

Type and programming overview

Type number 67-x-x-xx-xxx-xxx
Select calculator, modules,
sensor set and flow sensor

Total prog



Prog: A-B-CCC-CCC

Config: DDD-EE-FF-GG-M-N

Data:

Total prog

Partial prog

Partial prog

3.2 Type number combination

MULTICAL® 601		Type 67-								
Sensor connection										
Pt100	2-wire (T1-T2)	A								
Pt500	4-wire (T1-T2)	B								
Pt500	2-wire (T1-T2-T3)	C								
Pt500	4-wire (T1-T2) w/24 V pulse inputs	D								
Top module										
No module			0							
RTC (Real Time Clock)			1							
RTC + ΔEnergy calculation + hourly data logger ²⁾			2							
RTC + PQ or Δt-limiter + hourly data logger			3							
RTC + data output + hourly data logger			5							
RTC + 66-C compatibility + pulse outputs (CE and CV)			6							
RTC + M-Bus			7							
RTC + 2 pulse outputs for CE and CV + hourly data logger			8							
RTC + ΔVolume + hourly data logger ²⁾			9							
RTC + 2 pulse outputs for CE and CV + hourly data logger + scheduler		A								
RTC + 2 pulse outputs for CE and CV + prog. data logger		B								
Base module										
No module				00						
Data + pulse inputs				10						
M-Bus + pulse inputs ¹⁾				20						
Radio Router + pulse inputs				21						
Prog. data logger + RTC + 4...20 mA inputs + pulse inputs				22						
0/4...20 mA outputs				23						
LonWorks, FTT-10A + pulse inputs				24						
Radio + pulse inputs (internal antenna)				25						
Radio + pulse inputs (external antenna connection)				26						
Telephone modem + pulse inputs + data				03						
M-Bus + pulse inputs ¹⁾				04						
M-Bus + pulse inputs ¹⁾				08						
Radio + pulse inputs (internal antenna)				0A						
Radio + pulse inputs (external antenna connection)				0B						
Supply										
No supply				0						
Battery, D-cell				2						
230 VAC supply module w/transformer				7						
24 VAC supply module w/transformer				8						
Pt500 sensor set										
No sensor set							0			
Pocket sensor set w/1.5 m cable							A			
Pocket sensor set w/3.0 m cable							B			
Pocket sensor set w/5 m cable							C			
Pocket sensor set w/10 m cable							D			
Short direct sensor set w/1.5 m cable							F			
Short direct sensor set w/3.0 m cable							G			
3 Pocket sensors in sets w/1.5 m cable (Different lengths, please see page 61)							L			
3 Short direct sensors in sets w/1.5 m cable							Q3			
Flow sensor/pick-up unit										
Supplied w/1 pcs. ULTRAFLOW® (Please specify type)							1			
Supplied w/2 pcs. (identical) ULTRAFLOW® (Please specify type)							2			
Supplied with Kamstrup pick-up unit set							F			
Prepared for 1 pcs. ULTRAFLOW® (Please specify type)							7			
Prepared for 2 pcs. (identical) ULTRAFLOW® (Please specify type)							8			
Prepared for meters w/electronic pulse output							K			
Prepared for meters w/Reed switch output (both V1 and V2)							L			
Prepared for meters w/24 V active pulses							M			
Meter type										
Heat meter, closed systems (MID marking)								2		
Heat meter, closed systems								4		
Cooling meter								5		
Heat/cooling meter								6		
Volume meter, hot water								7		
Volume meter, cooling water								8		
Energy meter, open systems								9		
Country code (language on label etc.)										XX

When placing orders please state ULTRAFLOW® type numbers separately.

¹⁾ See paragraph 10.2 for further details.

²⁾ Requires two identical flow sensors.

3.2.1 Accessories

66-00-200-100	D-cell battery
66-99-608/-609/-610	Pulse transmitter/divider for 67-A and 67-C
66-99-614	4-wire connection PCB with pulse inputs for 24 V active pulses (for 67-D)
66-99-098	Data cable w/USB plug
66-99-99	Infrared optical reading head w/USB plug
66-99-144	Infrared optical reading head for Kamstrup/EVL w/USB plug
66-99-102	Infrared optical reading head w/D-sub 9F
66-99-106	Data cable RS 232, D-sub 9F
66-99-397/-398/-399	Verification unit (used with METERTOOL)
59-20-147	USB to serial converter
65-56-4x-xxx	Temperature sensor set with connection head (2/4-wire)
66-99-704	METER TOOL for MULTICAL® 601
66-99-705	METER TOOL LogView for MULTICAL® 601

Please contact Kamstrup A/S for questions concerning further accessories.

3.3 PROG, A-B-CCC-CCC

The legal parameters of the meter are determined by Prog, which can only be changed when the verification seal is broken. The change must then be made at an accredited meter laboratory.

The A-code indicates whether the flow sensor (V1) is installed in flow or return pipe. As water has a larger volume at higher temperatures, the calculator must be adjusted for the current installation type. Wrong programming or installation results in measuring errors. For further details on placing the flow and return pipe of the flow sensor in connection with heat and cooling meters, see paragraph 5.1.

The B-code indicates the measuring unit used for the energy register. GJ, kWh or MWh are used most frequently, whereas Gcal is only used in some countries outside the EEA.

The CCC code indicates the calculator's adaptation to a concrete flow sensor type, i.e. the calculation speed and display resolution are optimised to the selected flow sensor type and at the same time the type approval regulations concerning min. resolution and max. register overflow are met. The CCC codes are divided into several tables to give a better survey.

CCC(V1) indicates the CCC code of the flow sensor and is connected to flow sensor input V1 on terminal 9-10-11 (or 10B-11B), which in most applications is the flow sensor used for calculating energy.

CCC(V2) indicates the CCC code of an extra flow sensor, if any, to be connected to terminal 9-69-11 (or 69B-79B). If V2 is not used, CCC(V2) = CCC(V1). In connection with leakage surveillance CCC(V2) = CCC(V1).

Prog. number	A	-	B	-	CCC (V1)	-	CCC (V2)
	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Flow sensor placing:							
k-factor	- Flow pipe (at T1)		3				
table	- Return pipe (at T2)		4				
Measuring unit, energy							
- GJ			2				
- kWh			3				
- MWh			4				
- Gcal			5				
Flow sensor coding (CCC-table)					CCC		CCC

3.3.1 CCC-TABLE FOR MULTICAL® 601

The CCC tables are divided into slow codes e.g. for Reed switches (CCC=0XX) and into fast codes (CCC=1XX) for electronic meters such as ULTRAFLOW®.

CCC= 0XX Mechanical meters emitting slow pulses with bounce (flow part type “L”)

Max. pulse frequency: 1 Hz

Max. integration frequency 1 Hz

CCC= 1XX Electronic meters with fast and bounce-free pulses

Max. pulse frequency: 128 Hz

Max. integration frequency: 1 Hz

Max. integration frequency is 1 Hz for all types. The CCC codes are arranged in a way that $q_{s+20\%}$ (or $Q_{max+20\%}$) does not exceed the 1 Hz in the integration frequency.

Example: CCC=107 (applies for a q_p 1.5 m³/h meter) : 1 Hz in the integration frequency is obtained at $q = 3.6$ m³/h.

EN 1434 makes demands on the resolution and registre size of the energy reading. MULTICAL® 601 meets these demands when connected to below flow sensor sizes:

[kWh]	q_p 0.6 m ³ /h...15 m ³ /h
[MWh]	q_p 0.6 m ³ /h...1500 m ³ /h
[GJ]	q_p 0.6 m ³ /h...3000 m ³ /h

3.3.2 CCC codes for mechanical flow sensors with Reed switch

CCC no.	Pre-counter	Flow factor	Number of decimals on the display								l/pulses	Pulses/l	Qmax [m ³ /h]	Flow sensor
			kWh	MWh Gcal	GJ	m ³ ton	m ³ /h	l/h	kW	MW				
010	1	921600	1	-	3	3	-	0	1	-	1	1	≤ 3,0	L
011	1	921600	-	3	2	2	2		0	-	10	0.1	1...30	L
012	1	921600	-	2	1	1	1		-	2	100	0.01	10...300	L
013	1	921600	-	1	0	0	0		-	1	1000	0.001	100...3000	L
020	4	230400	0	3	2	2	2		0	-	2.5	0.4	≤ 6	L
021	4	230400	-	2	1	1	1		-	2	25	0.04	3...60	L
022	4	230400	-	1	0	0	0		-	1	250	0.004	30...600	L

Current flow (l/h or m³/h) reading is calculated on the basis of the measured period between 2 volume pulses (see paragraph 6.3)

When one of above CCC codes has been selected both CCC (V1) and CCC (V2) must be selected from this table.

3.3.3 CCC codes for ULTRAFLOW® II, type 65 54 XXX

CCC no.	Pre-counter	Flow factor	Number of decimals on the display								Pulses/l	qp [m³/h]	Type no.	Flow sensor
			kWh	MWh Gcal	GJ	m³ ton	l/h	m³/h	kW	MW				
116	3000	78642	0	3	2	2	0		1		300	0.6	65 54 A8X 65 54 AAX	1-2-7-8
119	1000	235926	0	3	2	2	0		1		100	1,5	65 54 A6X 65 54 A7X 65 54 A1X 65 54 A2X 65 54 A3X	1-2-7-8
136	500	471852	0	3	2	2	0		1		50.0	2.5	65 54 A4X 65 54 ADX	1-2-7-8
151	5000	471852		2	1	1	0		1		50.0	3.5	65 54 B1X 65 54 B7X	1-2-7-8
137	2500	943704		2	1	1	0		1		25.0	6.0 6.0 10 10	65 54 B2X 65 54 B5X 65 54 BGX 65 54 BHX	1-2-7-8
120	1000	2359260		2	1	1	0		1		10.0	15 25	65 54 B4X 65 54 B8X	1-2-7-8
158	5000	471852		1	0	0		2	0		5.0	40	65 54 B9X	1-2-7-8
170	2500	943704		1	0	0		2		3	2.5	60	65 54 BAX	1-2-7-8
147	1000	2359260		1	0	0		2		3	1.0	150	65 54 BBX	1-2-7-8
194	400	5898150		1	0	0		2		3	0.4	400	65 54 BCX	1-2-7-8
195	250	9437040		1	0	0		2		3	0.25	1000	65 54 BKX	1-2-7-8

Current flow reading (l/h or m³/h) is calculated on the basis of volume pulses/10 sec. (see paragraph 6.3)

3.3.4 CCC codes for ULTRAFLOW® type 65-R/S/T

CCC no.	Pre-counter	Flow-factor	Number of decimals on the display								Pulses/l	qp [m³/h]	Type no.	Flow part
			kWh	MWh Gcal	GJ	m³ ton	l/h	m³/h	kW	MW				
116	3000	78642	0	3	2	2	0		1		300	0.6	65-X-CAAA-XXX 65-X-CAAD-XXX	1-2-7-8
119	1000	235926	0	3	2	2	0		1		100	1.5	65-X-CDAC-XXX 65-X-CDAD-XXX 65-X-CDAE-XXX 65-X-CDAF-XXX 65-X-CDAA-XXX	1-2-7-8-M
136	500	471852	0	3	2	2	0		1		50.0	3.0	65-X-CFAF-XXX 65-X-CFBA-XXX	1-2-7-8-M
151	5000	471852		2	1	1	0		1		50.0	3,5	65-X-CGAG-XXX 65-X-CGBB-XXX	1-2-7-8-M
137	2500	943704		2	1	1	0		1		25.0	6 6 10 10	65-X-CHAG-XXX 65-X-CHBB-XXX 65-X-C1AJ-XXX 65-X-C1BD-XXX	1-2-7-8-M
178	1500	1572840		2	1	1	0		1		15.0	10	65-X-CJAJ-XXX 65-X-CJBD-XXX	1-2-7-8
120	1000	2359260		2	1	1	0		1		10.0	15	65-X-CKBE-XXX	1-2-7-8-M
179	600	3932100		2	1	1	0		1		6.0	25	65-X-CLBG-XXX	1-2-7-8
120	1000	2359260		2	1	1	0		1		10.0	25	65-X-C2BG-XXX	1-2-7-8-M
158	5000	471852		1	0	0		2	0		5.0	40	65-X-CMBH-XXX	1-2-7-8-M
170	2500	943704		1	0	0		2		3	2.5	60	65-X-FABL-XXX 65-X-FACL-XXX	1-2-7-8-M
180	1500	1572840		1	0	0		2		3	1.5	100	65-X-FBCL-XXX	1-2-7-8
147	1000	2359260		1	0	0		2		3	1.0	150	65-X-FCBN-XXX 65-X-FCCN-XXX	1-2-7-8-M
181	600	3932100		1	0	0		2		3	0.6	250	65-X-FDCN-XXX	1-2-7-8
191	400	589815		1	0	0		1		2	0.4	400	65-X-FEBN-XXX 65-X-FEBR-XXX 65-X-FECN-XXX 65-X-FECP-XXX 65-X-FECR-XXX	1-2-7-8-M
192	250	943704		1	0	0		1		2	0.25	600 600 1000 1000	65-X-FFCP-XXX 65-X-FFCR-XXX 65-X-F1BR-XXX 65-X-F1CR-XXX	1-2-7-8-M
193	150	1572840		1	0	0		1		2	0.15	1000	65-X-FGBR-XXX	1-2-7-8

Current flow reading (l/h or m³/h) is calculated on the basis of volume pulses/10 sec. (see paragraph 6.3)

66-CDE ⇒ MC 601

CCC=171, 172, 182 are not included in MULTICAL® 601. Use CCC= 191, 192, 193 instead.

3.3.5 CCC codes with high resolution for ULTRAFLOW® (for cooling meters etc.)

CCC no.	Pre-counter	Flow factor	Number of decimals on the display								Pulses/l	qp [m³/h]	Type no.	Flow sensor
			kWh	MWh Gcal	GJ	m³ ton	l/h	m³/h	kW	MW				
184	300	78642	1		3	3	0		1		300	0.6		1-2-7-8
107	100	235926	1		3	3	0		1		100	1.5		1-2-7-8-M
136	500	471852	0	3	2	2	0		1		50.0	3.5		1-2-7-8-M
138	250	943704	0	3	2	2	0		1		25.0	6.0		1-2-7-8-M
183	150	1572840	0	3	2	2	0		1		15.0	10		1-2-7-8
185	100	2359260	0	3	2	2	0		1		10.0	15		1-2-7-8-M
186	500	471852		2	1	1		2	0		5.0	40		1-2-7-8-M
187	250	943704		2	1	1		2		3	2.5	60		1-2-7-8-M
188	150	1572840		2	1	1		2		3	1.5	100		1-2-7-8
189	100	2359260		2	1	1		2		3	1.0	150		1-2-7-8-M
191	400	589815		1	0	0		1		2	0.4	400		1-2-7-8-M
192	250	943704		1	0	0		1		2	0.25	600		1-2-7-8-M
193	150	1572840		1	0	0		1		2	0.15	1000		1-2-7-8

Current flow reading (l/h or m³/h) is calculated on the basis of volume pulses/10 sec. (see paragraph 6.3)

3.3.6 CCC codes for other electronic meters with a passive output

			Number of decimals on the display										
CCC no.	Pre-counter	Flow factor	MWh Gcal	GJ	m³ ton	m³/h	kW	MW	l/pulse	Pulses/l	Qmax [m³/h]	Type	Flow sensor
147	1000	2359260	1	0	0	2		3	1	-	18...75	SC-18	K-M
148	400	5898150	1	0	0	2		3	2.5	-	120...300	SC-120	K-M
149	100	2359260	1	0	0	1	-	2		10	-	450...1200	SC-450
150	20	11796300	1	0	0	1	-	2	50	-	1800...3000	SC-1800	K-M
175	7500	314568	1	0	0	2		3	-	7.5	15...30	DF-15	K-M
176	4500	524280	1	0	0	2		3	-	4.5	25...50	DF-25	K-M
177	2500	943704	1	0	0	2		3	-	2.5	40...80	DF-40	K-M

			Number of decimals on the display										
CCC no.	Pre-counter	Flow factor	MWh Gcal	GJ	m³ ton	m³/h	MW	l/pulse	Pulse/l	Qp range (m³/h)	Qs (m³/h)	Type	Flow sensor
201	100	235926	2	1	1	1	2	1	1	10...100	75	FUS380 DN50-65	K-M
202	40	589815	2	1	1	1	2	2.5	0.4	40...200	240	FUS380 DN80-100	K-M
203	400	589815	1	0	0	1	2	2.5	0.4	100...400	500	FUS380 DN125	K-M
204	100	235926	1	0	0	0	1	10	0.1	150...1200	1600	FUS380 DN150-250	K-M
205	20	1179630	1	0	0	0	1	50	0.02	500...3000	3600	FUS380 DN300-400	K-M

Current flow reading (l/h or m³/h) is calculated on the basis of volume pulses/10 pcs. (see paragraph 6.3)

3.3.7 CCC codes for other electronic meters with an active output

Flow sensor with active 24 V pulse output, see paragraph 7.2

3.3.8 CCC codes for vane wheel meters with an electronic pick-up unit

CCC no.	Pre-counter	Flow factor	Number of decimals on the display								Pulses/l	qp [m³/h]	Type	Flow sensor
			kWh	MWh Gcal	GJ	m³ ton	l/h	m³/h	kW	MW				
108	1403	168158	0	3	2	2	0		1		140.3	0.6	GWF	F-D-K
109	957	246527	0	3	2	2	0		1		95.7	1.0	GWF	F-D-K
110	646	365211	0	3	2	2	0		1		64.6	1.5	GWF	F-D-K
111	404	583975	0	3	2	2	0		1		40.4	1.5 (2.5)	HM (GWF)	F-D-K
112	502	469972	0	3	2	2	0		1		50.2	1.5 – 2.5*	GWF	F-D-K
113	2350	1003940		2	1	1	0		1		23.5	3.5 - 6*	GWF	F-D-K
114	712	331357		2	1	1	0		1		7.12	10 - 15*	GWF	F-D-K
115	757	311659	0	3	2	2	0		1		75.7	1.0*	GWF	F-D-K
116	3000	78642	0	3	2	2	0		1		300.0	0.6*	GWF	F-D-K
117	269	877048	0	3	2	2	0		1		26.9	1.5	Brunata	F-D-K
118	665	354776	0	3	2	2	0		1		66.5	1.5	Aquastar	F-D-K
119	1000	235926	0	3	2	2	0		1		100.0	0.6	HM	F-D-K
121	294	802469	0	3	2	2	0		1		29.4	1.5 – 2.5		F-D-K
122	1668	141442	0	3	2	2	0		1		166.8	0.6	HM	F-D-K
123	864	273063	0	3	2	2	0		1		86.4	0.75 - 1*	HM	F-D-K
124	522	451966	0	3	2	2	0		1		52.2	2.5 (1.5*)	CG (HM)	F-D-K
125	607	388675	0	3	2	2	0		1		60.7	1.5 - 1* 1.5*	HM	F-D-K
126	420	561729	0	3	2	2	0		1		42.0	1.0 (2.5*)	CG (HM)	F-D-K
127	2982	791167		2	1	1	0		1		29.82	2.5 3.5*	HM	F-D-K
128	2424	973292		2	1	1	0		1		24.24	3.5*	HM	F-D-K
129	1854	1272524		2	1	1	0		1		18.54	6*	HM	F-D-K
130	770	3063974		2	1	1	0		1		7.7	10*	HM	F-D-K
131	700	3370371		2	1	1	0		1		7.0	15*	HM	F-D-K
132	365	645665	0	3	2	2	0		1		36.54	2.5	Wehrle	F-D-K
133	604	390154	0	3	2	2	0		1		60.47	1.5	Wehrle	F-D-K
134	1230	191732	0	3	2	2	0		1		123.05	0.6	Wehrle	F-D-K
135	1600	1474538		2	1	1	0		1		16.0	10*	HM	F-D-K
139	256	921586	0	3	2	2	0		1		25.6	1.5 – 2.5	GWF	F-D-K
140	1280	1843172		2	1	1	0		1		12.8	3.5 – 5.0	GWF	F-D-K
141	1140	2069526		2	1	1	0		1		11.4	6	GWF	F-D-K
142	400	589815		2	1	1		2		3	4	10	GWF	F-D-K
143	320	737269		2	1	1		2		3	3.2	10 - 15	GWF	F-D-K
144	1280	1843172		1	0	0		2		3	1.28	25 - 40	GWF	F-D-K
145	640	3686344		1	0	0		2		3	0.64	60	GWF	F-D-K
146	128	18431719		1	0	0		2		3	0.128	125	GWF	F-D-K
152	1194	1975930		2	1	1	0		1		11.94	10	GWF	F-D-K
153	1014	2326686		2	1	1	0		1		10.14	15	GWF	F-D-K
156	594	397182	0	3	2	2	0		1		59.4	1.5	Metron	F-D-K
157	3764	626796		2	1	1	0		1		37.64	2.5	Metron	F-D-K
163	1224	192750	0	3	2	2	0		1		122.4	0.6 – 1.0	GWF/U2	F-D-K
164	852	280064	0	3	2	2	0		1		85.24	1.5	GWF/U2	F-D-K
165	599	393735	0	3	2	2	0		1		59.92	2.5	GWF/U2	F-D-K
168	449	5259161		2	1	1	0		1		4.486	15/25	HM/WS	F-D-K
169	1386	1702208		1	0	0		2	0		1.386	40	HM/WS	F-D-K
173	500	471852		1	0	0		1		2	0.5	80	Westland	F-D-K

Current flow reading (l/h or m³/h) is calculated on the basis of volume pulses/10 sec. (see paragraph 6.3)



3.3.9 ULTRAFLOW® X4 CCC-codes with high resolution



CCC no.	Pre-counter	Flow factor	Number of decimals on the display								Pulses/l	qp [m³/h]	Type	Flow sensor
			kWh	MWhGal	GJ	m³ ton	l/h	m³/h	kW	MW				
416	3000	78642	0	3	2	2	0	-	1	-	300	0.6	65-X-CAAA-XXX	1-2-7-8
													65-X-CAAD-XXX	
													65-X-CAAF-XXX	
484	300	78642	1	-	3	3	0	-	1	-	300	0.6		1-2-7-8
419	1000	235926	0	3	2	2	0	-	1	-	100	1.5	65-X-CDA1-XXX	1-2-7-8
													65-X-CDAA-XXX	
													65-X-CDAC-XXX	
													65-X-CDAD-XXX	
													65-X-CDAE-XXX	
													65-X-CDAF-XXX	
													65-X-CDBA-XXX	
407	100	235926	1	-	3	3	0	-	1	-	100	1.5		1-2-7-8
498	600	393210	0	3	2	2	0	-	1	-	60	2.5	65-X-CEAF-XXX	1-2-7-8
													65-X-CEB/CA-XXX	
451	5000	471852	-	2	1	1	0	-	1	-	50	3.5	65-X-CGAG-XXX	1-2-7-8
													65-X-CGB/CB-XXX	
436	500	471852	0	3	2	2	0	-	1	-	50	3.5		1-2-7-8
437	2500	943704		2	1	1	0		1		25	6	65-X-CHAF-XXX	1-2-7-8
													65-X-CHAG-XXX	
													65-X-CHAH-XXX	
													65-X-CHB/CB-XXX	
438	250	943704	0	3	2	2	0	-	1	-	25	6		1-2-7-8
478	1500	1572840	-	2	1	1	0	-	1	-	15	10	65-X-CJAJ-XXX	1-2-7-8
													65-X-CJB/C2-XXX	
													65-X-CJB/CD-XXX	
483	150	1572840	0	3	2	2	0	-	1	-	15	10		1-2-7-8
420	1000	2359260	-	2	1	1	0	-	1	-	10	15	65-X-CKB/C4-XXX	1-2-7-8
													65-X-CKB/CE-XXX	
485	100	2359260	0	3	2	2	0	-	1	-	10	15		1-2-7-8
479	600	3932100	-	2	1	1	0	-	1	-	6	25	65-X-CLBG-XXX	1-2-7-8
458	5000	471852	-	1	0	0	-	2	0	-	5	40	65-X-CMBH-XXX	1-2-7-8
													65-X-CMBJ-XXX	
486	500	471852	-	2	1	1	-	2	0	-	5	40		1-2-7-8
470	2500	943704	-	1	0	0	-	2	-	3	2,5	60	65-X-FACL-XXX	1-2-7-8
487	250	943704	-	2	1	1	-	2	-	3	2,5	60		1-2-7-8
480	1500	1572840	-	1	0	0	-	2	-	3	1,5	100	65-X-FBCL-XXX	1-2-7-8
488	150	1572840	-	2	1	1	-	2	-	3	1,5	100		1-2-7-8

ULTRAFLOW® CCC-koder med høj opløsning

3.4 Display coding

The display code "DDD" indicates the active readings for the individual meter type. "1" is the first primary reading whereas e.g. "1A" is the first secondary reading. The display automatically returns to reading "1" after 4 minutes.

				Date stamp	Heat meter DDD=410	Cooling meter DDD=510	Heat/cooling DDD=610	Heat volume DDD=710	Cooling Volume DDD=810	Heat meter DDD=910
1.0	Heat energy (E1)				1		1			1
		1.1	Yearly data	•	1A		1A			
		1.2	Monthly data	•	1B		1B			1A
2.0	Cooling energy (E3)					1	2			
		2.1	Yearly data	•		1A	2A			
		2.2	Monthly data	•		1B	2B			
3.X		3.1	E2							
		3.2	E4							2
		3.3	E5							2A
		3.4	E6							2B
		3.5	E7							2C
		3.6	E8 (m3*tf)		2					
		3.7	E9 (m3*tr)		2A					
4.0	Volume V1				3	2	3	1	1	3
		4.1	Yearly data	•	3A	2A	3A	1A	1A	
		4.2	Monthly data	•	3B	2B	3B	1B	1B	3A
		4.3	Mass 1							3B
		4.4	P1							3C
5.0	Volume V2									4
		5.1	Yearly data	•						
		5.2	Monthly data	•						4A
		5.3	Mass 2							4B
		5.4	P2							4C
6.0	Hour counter				4	3	4	2	2	5
7.0	T1 (Flow)				5	4	5			6
		7.1	Year-to-date average		5A	4A	5A			
		7.2	Month-to date average		5B	4B	5B			
8.0	T2 (Return flow)				6	5	6			7
		8.1	Year-to-date average		6A	5A	6A			
		8.2	Month-to-date average		6B	5B	6B			
9.0	T1-T2 (Δt) - = cooling				7	6	7			8
10.0	T3									9
11.0	T4 (prog.)									10
12.0	Flow (V1)				8	7	8	3	3	11
		12.1	Max this year	•	8A	7A	8A	3A	3A	
		12.2	Max. yearly data	•						
		12.3	Min. this year	•						
		12.4	Min. yearly data	•						
		12.5	Max. this month	•						
		12.6	Max. monthly data	•	8B	7B	8B	3B	3B	11A
		12.7	Min. this month	•						
		12.8	Min. monthly data	•	8C	7C	8C	3C	3C	11B
13.0	Flow (V2)				9			4	4	12
14.0	Power (V1)				10	8	9			13
		14.1	Max. this year	•	10A	8A	9A			
		14.2	Max. yearly data	•						
		14.3	Min. this year	•						
		14.4	Min. yearly data	•						
		14.5	Max. this month	•						
		14.6	Max. monthly data	•	10B	8B	9B			
		14.7	Min. this month	•						
		14.8	Min. monthly data	•	10C	8C	9C			

					Date stamp	Heat meter DDD=410	Cooling meter DDD=510	Heat/cooling DDD=610	Heat volume DDD=710	Cold volume DDD=810	Heat meter DDD=910
											
15.0	VA (Input A)					11	9	10	5	5	14
		15.1	Meter no. VA			11A	9A	10A	5A	5A	14A
		15.2	Yearly data	•		11B	9B	10B	5B	5B	14B
		15.3	Monthly data	•		11C	9C	10C	5C	5C	14C
16.0	VB (Input B)					12	10	11	6	6	15
		16.1	Meter no. VB			12A	10A	11A	6A	6A	15A
		16.2	Yearly data	•		12B	10B	11B	6B	6B	15B
		16.3	Monthly data	•		12C	10C	11C	6C	6C	15C
17.0	TA2					13		12			
		17.1	TL2			13A					
18.0	TA3					14		13			
		18.1	TL3			13A					
19.0	Info code					15	11	14	7	7	16
		19.1	Info event counter			15A	11A	14A	7A	7A	16A
		19.2	Info logger (last 36 events)	•		15B	11B	14B	7B	7B	16B
20.0	Customer number (N° 1+2)					16	12	15	8	8	17
		20.1	Date			16A	12A	15A	8A	8A	17A
		20.2	Time			16B	12B	15B	8B	8B	17B
		20.3	Target date			16C	12C	15C	8C	8C	17C
		20.4	Serial no. (N° 3)			16D	12D	15D	8D	8D	17D
		20.5	Prog. (A-B-CCC-CCC) (N° 4)			16E	12E	15E	8E	8E	17E
		20.6	Config 1 (DDD-EE) (N° 5)			16F	12F	15F	8F	8F	17F
		20.7	Config 2 (FF-GG-M-N) (N° 6)			16G	12G	15G	8G	8G	17G
		20.8	Software edition (N° 10)			16H	12H	15H	8H	8H	17H
		20.9	Software check-sum (N° 11)			16I	12I	15I	8I	8I	17I
		20.10	Segment test			16J	12J	15J	8J	8J	17J
		20.11	Top module type (N° 20)			16K	12K	15K	8K	8K	17K
		20.12	Base module type (N° 30)			16L	12L	15L	8L	8L	17L
Number of yearly data shown in the display (1... 15)						2	2	2	2	2	2
Number of monthly data shown in the display (1... 36)						12	12	12	12	12	12

DDD=410 is the "standard code" for heat meters with meter type 67xxxxxx4xx. Please contact Kamstrup for other combinations. Max. number of readings on a DDD code is 103. Of these, reading of data logger counts for 4 readings.

A complete survey of existing display codes (DDD) appears from a separate document. Please contact Kamstrup for further details.

Note: Data reading can retrieve up to 36 monthly data and up to 15 yearly data. Number of yearly and monthly data to be shown in the display is determined by the DDD code in each case.

3.4.1 Energy overview

Above energy types E1 to E9 are calculated as follows:

Formula	Example of an application	
E1=V1(T1-T2)	Heat energy (V1 in flow or return flow)	Legal Display/Data/Log
E2=V2(T1-T2)	Heat energy (V2 in return flow)	Display/Data/Log
E3=V1(T2-T1)	Cooling energy (V1 in flow or return flow)	Legal Display/Data/Log
E4=V1(T1-T3)	Flow energy	Display/Data/Log
E5=V2(T2-T3)	Return energy or tap from return flow	Display/Data/Log
E6=V2(T3-T4)	Tap water energy, separate	Display/Data/Log
E7=V2(T1-T3)	Return energy or tap from flow	Display/Data/Log
E8=m3*T1	(Flow pipe)	Display/Data/Log
E9=m3*T2	(Return pipe)	Display/Data/Log

3.5 >EE< Configuration of MULTITARIFF

MULTICAL® 601 has 2 extra registers, TA2 and TA3, that accumulates energy E1 (E=20 accumulates volume) in parallel with the main register based on the limits programmed to tariff limits TL2 and TL3.

Example: E=11 (power tariff)

TA2 shows the energy consumed ...

... over the power limit TL2



E=	TARIFF TYPE	FUNCTION	Country code 2xx	Country code 4xx	Country code 5xx	Country code 6xx	Country code 7xx	Country code 8xx	Country code 9xx
00	No tariff active	No function							
11	Power tariff	Energy is accumulated in TA2 and TA3 based on the power limits in TL2 and TL3.	•	•	•				
12	Flow tariff	Energy is accumulated in TA2 and TA3 based on the flow limits in TL2 and TL3.	•	•	•				
13	Cooling tariff	Energy is accumulated in TA2 and TA3 based on the Δt limits in TL2 and TL3.	•	•	•				
14	Flow temperature tariff	Energy is accumulated in TA2 and TA3 based on the tF-limits in TL2 and TL3.	•	•	•				
15	Return flow temperature tariff	Energy is accumulated in TA2 and TA3 based on the tR-limits in TL2 and TL3.	•	•	•				
19	Time-controlled tariff	TL2=Starting time for TA2 TL3=Starting time for TA3	•	•	•				
20	Heat/cooling volume tariff (TL2 and TL3 are not used)	Volume (V1) is split up into TA2 for heat (T1>T2) and TA3 for cooling (T1<T2) (Recommended on Heating/Cooling applications)				•	•	•	
21	PQ tariff	Energy at P>TL2 is stored in TA2 and energy at Q>TL3 is stored in TA3	•	•	•				

See paragraph 6.9 for further details on the tariff registers.

66-CDE ⇒ MC 601

The tariff types E=6 and E=7 from 66-CDE (average temperature per month and per year) are included in MC 601 as secondary readings for T1 and T2. The average calculations are based on the energy types E8 (m³ x T1) and E9 (m³ x T2).

				Heat meter DDD=410	Cooling meter DDD=510	Heat/cooling DDD=610
7.0	T1 (Flow)			5	4	5
		7.1	Year-to-date average	5A	4A	5A
		7.2	Month-to-date average	5B	4B	5B
8.0	T2 (Return flow)			6	5	6
		8.1	Year-to-date average	6A	5A	6A
		8.2	Month-to-date average	6B	5B	6B

3.6 >FF< Input A (VA), pulse divider >GG< Input B (VB), pulse divider

MULTICAL® 601 has 2 extra pulse inputs, VA and VB, that are placed on the base modules (see paragraph 7.3 for further information). The inputs are configured via the FF and the GG codes as shown in below diagram.

By default the inputs are configured to FF = 24 and GG = 24, unless otherwise informed by the customer.

Input A Terminal 65-66		Input B Terminal 67-68						
FF	Max. input f ≤ 1 Hz	GG	Max. input f ≤ 1 Hz	Pre-counter	Wh/pulses	l/pulse	Measuring unit and decimal point	
01	100 m³/h	01	100 m³/h	1	-	100	vol A/vol b (m³)	000000.0
02	50 m³/h	02	50 m³/h	2	-	50	vol A/vol b (m³)	000000.0
03	25 m³/h	03	25 m³/h	4	-	25	vol A/vol b (m³)	000000.0
04	10 m³/h	04	10 m³/h	10	-	10	vol A/vol b (m³)	000000.0
05	5 m³/h	05	5 m³/h	20	-	5.0	vol A/vol b (m³)	000000.0
06	2.5 m³/h	06	2.5 m³/h	40	-	2.5	vol A/vol b (m³)	000000.0
07	1 m³/h	07	1 m³/h	100	-	1.0	vol A/vol b (m³)	000000.0
24	10 m³/h	24	10 m³/h	1	-	10	vol A/vol b (m³)	00000.00
25	5 m³/h	25	5 m³/h	2	-	5.0	vol A/vol b (m³)	00000.00
26	2.5 m³/h	26	2.5 m³/h	4	-	2.5	vol A/vol b (m³)	00000.00
27	1 m³/h	27	1 m³/h	10	-	1.0	vol A/vol b (m³)	00000.00
40	1000 m³/h	40	1000 m³/h	1	-	1000	vol A/vol b (m³)	0000000
FF	Max. input f ≤ 3 Hz	GG	Max. input f ≤ 3 Hz	Pre-counter	Wh/pulses	l/pulses	Measuring unit and decimal point	
50	2500 kW	50	2500 kW	1	1000	-	EL A/EL b (kWh)	0000000
51	150 kW	51	150 kW	60	16.67	-	EL A/EL b (kWh)	0000000
52	120 kW	52	120 kW	75	13.33	-	EL A/EL b (kWh)	0000000
53	75 kW	53	75 kW	120	8.333	-	EL A/EL b (kWh)	0000000
54	30 kW	54	30 kW	240	4.167	-	EL A/EL b (kWh)	0000000
55	25 kW	55	25 kW	340	2.941	-	EL A/EL b (kWh)	0000000
56	20 kW	56	20 kW	480	2.083	-	EL A/EL b (kWh)	0000000
57	15 kW	57	15 kW	600	1.667	-	EL A/EL b (kWh)	0000000
58	7,5 kW	58	7.5 kW	1000	1.000	-	EL A/EL b (kWh)	0000000
59	750 kW	59	750 kW	10	100	-	EL A/EL b (kWh)	0000000
60	1250 kW	60	1250 kW	2	500	-	EL A/EL b (kWh)	0000000
70	25000 kW	70	25000 kW	1	10000	-	EL A/EL b (MWh)	00000.00

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MULTICAL® 601 does not have pulse outputs via the base modules but via the top modules only (see the next paragraph).

FF and GG are only used for configuration of inputs.

3.7 Configuration of pulse outputs in the top module

See paragraph 10.1

3.8 >MN< Configuration of leak limits

When MULTICAL® 601 is used for leakage surveillance, the sensitivity is "M-N" in connection with configuration.

District heat leakage search (V1-V2)		Cold-water leakage search (VA)	
Sensitivity in leakage search		Constant leakage at no consumption (pulse resolution 10 l/pulses)	
M=		N=	
0	OFF	0	OFF
1	1.0% qp + 20% q	1	20 l/h 3x10 min. (½ hour without pulses)
2	1.0% qp + 10% q	2	10 l/h 6x10 min. (1 hour without pulses)
3	0.5% qp + 20% q	3	5 l/h 12x10 min. (2 hours without pulses)
4	0.5% qp + 10% q		

NB: M=2 and N=2 are default values when leakage surveillance is used. Higher degree of sensitivity, e.g. M=4 can only be obtained by means of METERTOOL.

Info codes for leakage/bursting are only active when M > 0 or N > 0.

3.9 Data for configuration

	Automatic	To be stated when ordering	Default
Serial no. (S/N) and year	E.g. 6000000/2006	-	-
Customer number	-	Up to 16 digits.	Customer number = S/N
Display No. 1 = 8 digits MSD		Limited to 11 digits regarding PcBase compatibility	
Display No. 2 = 8 digits LSD			
Target date	-	MM=1-12 and DD=1-28	Depending on country code
TL2	-	5 digits	0
TL3	-	5 digits	0
Max./min. average peak time	-	1...1440 min.	60 min.
Max. T1 for cooling metering	-	0.01...180°C	25°C at DDD=5xx and 6xx
T2 prog.		0.01...180°C	-
T3 prog.		0.01...180°C	5°C
T4 prog.		0.01...180°C	0°C
Date/time	YYYY.MM.DD/hh.mm.ss GMT+offset according to country code	GMT ± 12.0 hours (0.5 hour in jumps)	-

Data registers for configuration of top/base modules

qp [l/h]	from CCC table	-	-
Valve traction time	-	20...500 sec.	300 sec.
hysteresis	-	0.5...5 sec.	0.5 sec.
Telephone number #1	-	Max. 16 (0-9+P)	-
Telephone number #2	-	Max. 15 (0-9+P)	-
Telephone number #3	-	Max. 15 (0-9+P)	-
Primary Data Address			
Secondary Data Address			
Baud-rate			
Reserved			
Reserved			
Reserved			
.....			
Reserved			

Reserved: These registers are prepared for later extensions of the functionality of the modules and therefore, they have not yet any concrete designations.

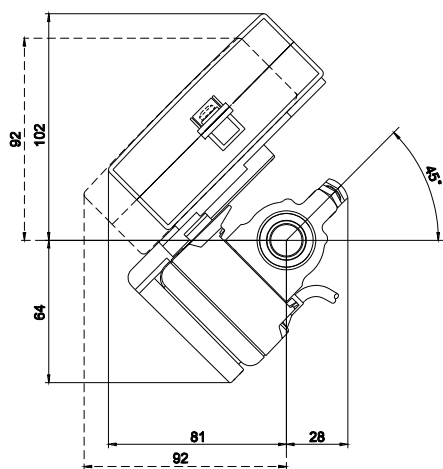
- COUNTRY CODES

For information on country codes see 55 11-988.

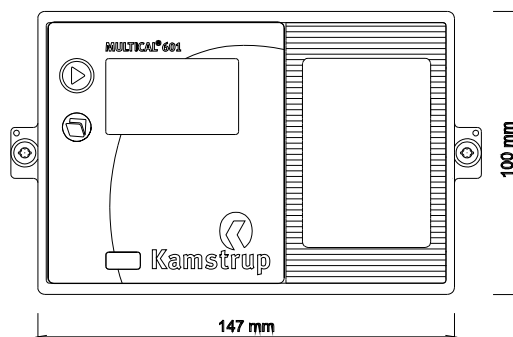
- MAINTENANCE

See instruction no. 55 08-619 concerning updating of programming, configuration and country codes.

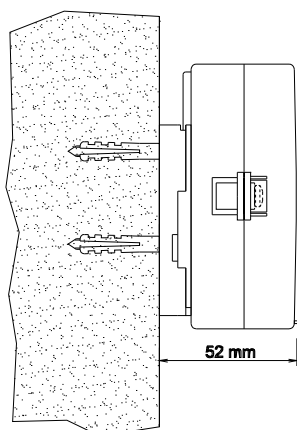
4 Dimentional sketches



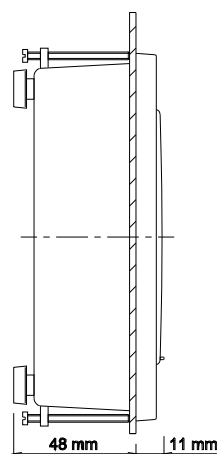
MULTICAL® 601 mounted on ULTRAFLOW®



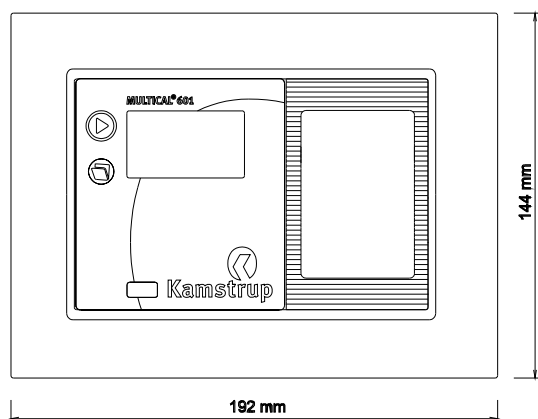
MULTICAL® 601's front dimensions



Wall-mounted MULTICAL® 601 seen from the side



Panel-mounted MULTICAL® 601 seen from the side



Panel-mounted MULTICAL® 601 seen from the front

5 Installation

5.1 Flow pipe and return pipe placing

Prog. number

A
□

Flow sensor placing:

k-factor table	- Flow pipe (at T1)	3
	- Return pipe (at T2)	4

MULTICAL® 601 is programmed for flow sensor placing in either flow or return pipe. Below diagram shows the installation conditions for:

- ◆ Heat meters
- ◆ Cooling meters
- ◆ Heat/cooling meters

Formula:	k-factor	Prog.:	Hot pipe	Cold pipe	Installation:
Heat meter $E1 = V1(T1 - T2)k$	k-factor with T1 in Inlet table	A=3 (Flow sensor in Flow pipe)	V1 and T1	T2	
	k-factor with T2 in Outlet table	A=4 (Flow sensor in Return pipe)	T1	V1 and T2	
Cooling meter $E3 = V1(T2 - T1)k$	k-factor with T1 in Outlet table	A=3 (Flow sensor in Flow pipe)	T2	V1 and T1	
	k-factor with T2 in Inlet table	A=4 (Flow sensor in Return pipe)	V1 and T2	T1	

5.2 EMC conditions

MULTICAL® 601 is designed and CE marked in accordance with EN 1434 Class A and Class C (corresponding to Electromagnetic environment: Class E1 and E2 in the Measuring Instruments Directive) and can therefore be installed in domestic and industrial environments.

All control cables must be installed separately and not in parallel with e.g. power cables or other cables with the risk of induction of electromagnetic interferences. Control cables are laid at a min. distance of 25 cm from other installations.

5.3 Climatic conditions

MULTICAL® 601 is designed for indoor installation in noncondensing environments with ambient temperatures from 5...55°C, however, max. 30°C for optimal battery lifetime.

Protection class IP54 allows periodic splashes of water, but the apparatus cannot stand constant moisture and flooding.

5.4 Electric installations

See paragraph 9.

6 Calculator functions

Energy calculation

MULTICAL® 601 calculates energy based on the formula in EN 1434-1:2004 in which the international temperature scale from 1990 (ITS-90) and the pressure definition of 16 bar is used.

The energy calculation can in a simplified way be expressed as: $\text{Energy} = V \times \Delta\Theta \times k$.

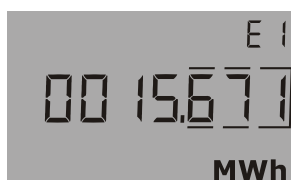
The calculator always calculates energy in [Wh], and then it is converted into the selected measuring unit.

E [Wh] =	$V \times \Delta\Theta \times k \times 1000$
E [kWh] =	$E [\text{Wh}] / 1,000$
E [MWh] =	$E [\text{Wh}] / 1,000,000$
E [GJ] =	$E [\text{Wh}] / 277,780$
E [Gcal] =	$E [\text{Wh}] / 1163,100$

V is the supplied (or simulated) water volume in m³. E.g. if a CCC code = 119 is used, the calculator will be programmed to receive 100 pulses/liter. E.g. if 10,000 pulses are added this corresponds to 10,000/100 = 100 liters or 0.1 m³.

ΔΘ is the temperature difference measured, e.g. ΔΘ = flow temperature – return flow temperature. Please note, that various temperatures are used to calculate ΔΘ as MULTICAL® 601 calculates various different energy types. Both in the display and during data reading each energy type is uniquely defined, e.g.:

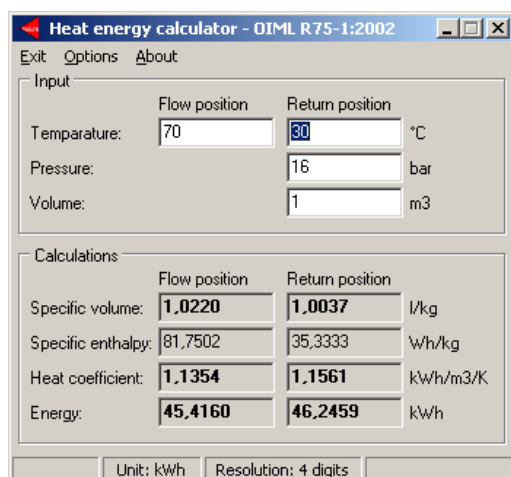
Heat energy: $E1 = V1(T1-T2)k$



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



k is the thermal coefficient of water which is calculated on the basis of formula in EN 1434-1:2004 (identical with the energy formula in OIML R75-1:2002). For control calculations Kamstrup can supply an energy calculator:

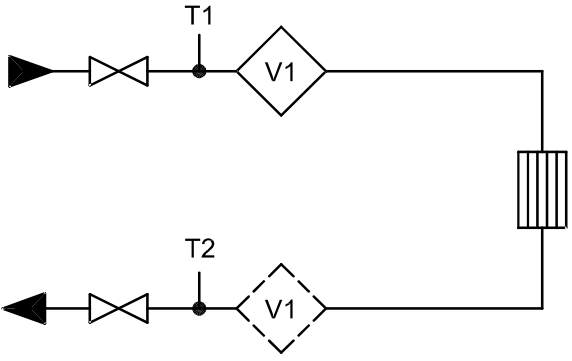
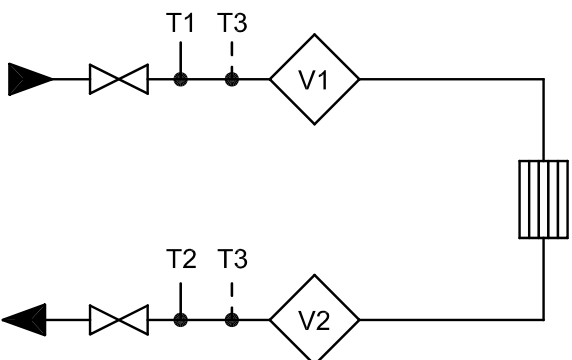


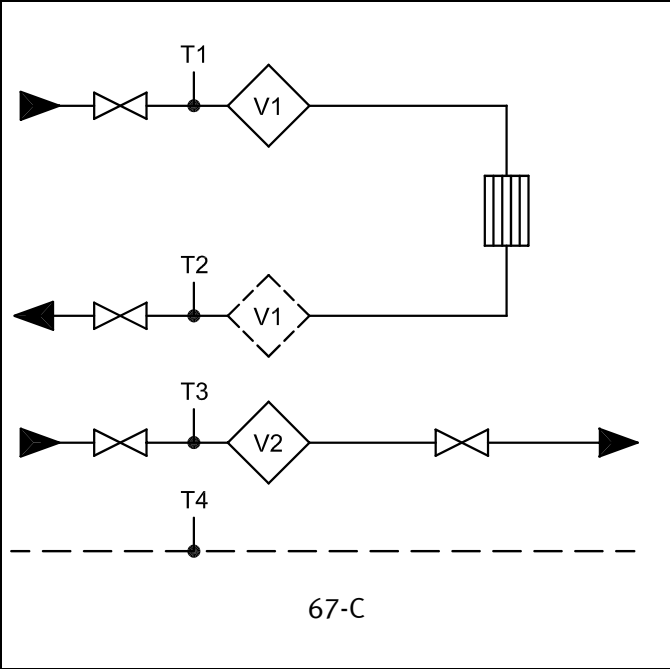
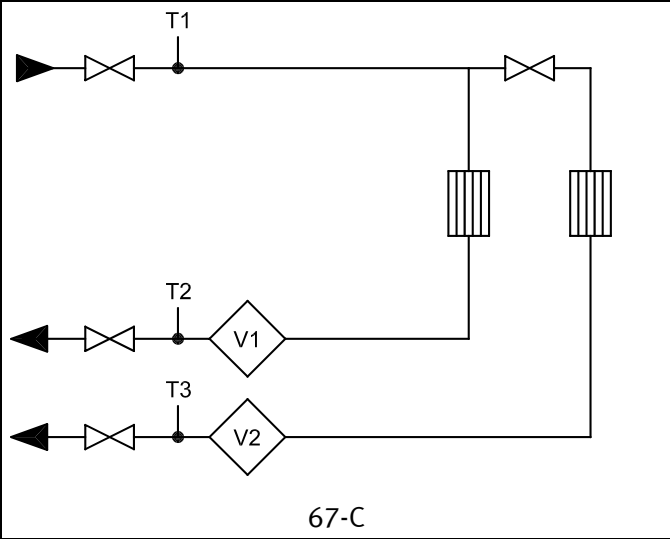
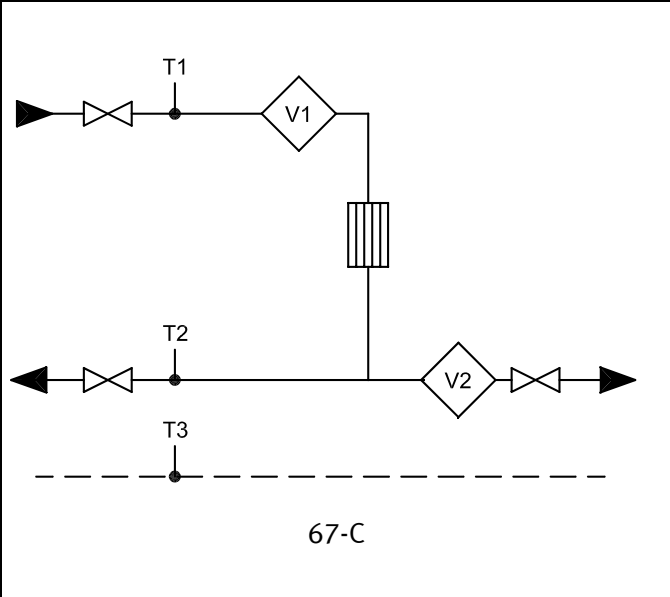
6.2 Application types

MULTICAL® 601 operates with 9 different energy formulas, E1...E9, that are all calculated in parallel with each integration no matter how the meter is configured.

6.2.1 E1...E7

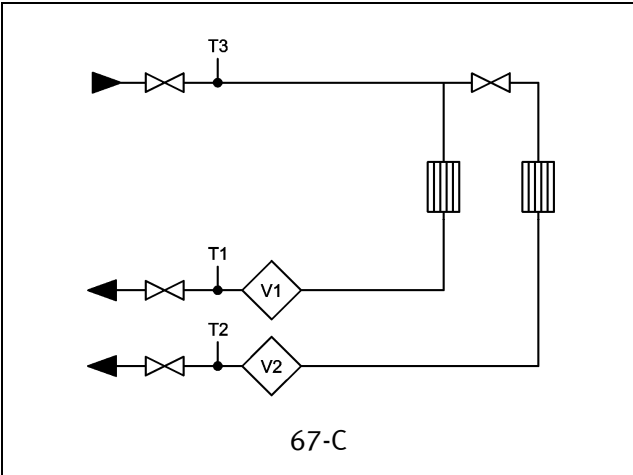
The energy types E1...E7 are described with application examples below.

 <p style="text-align: center;">67-A/B/C/D</p>	<p>Application no. 1</p> <p>Closed thermal system with 1 flow sensor</p> <p>Heat energy: $E1 = V1(T1-T2)k_{T1:Flow \text{ or } T2:Return}$</p> <p>Cooling energy: $E3 = V1 (T2-T1)k_{T2:Flow \text{ or } T1:Return}$</p> <p>Flow sensor V1 is placed in flow or return pipe as chosen under PROG options.</p> <p>Mass: $M1 = V1 (K_{mass} t1)$ or Mass: $M1 = V1 (K_{mass} t2)$ depending on the Flow/Return programming</p>
 <p style="text-align: center;">67-C</p>	<p>Application no. 2</p> <p>Closed thermal system with 2 identical flow sensors</p> <p>Billing energy: $E1 = V1(T1-T2)k_{T1:Flow}$</p> <p>Control energy: $E2 = V2 (T1-T2)k_{T2:Return}$</p> <p>T3 can be used for control measurement of either the flow or return temperature, but T3 is not included in calculations.</p> <p>Mass: $M1 = V1 (K_{mass} t1)$ Mass: $M2 = V2 (K_{mass} t2)$</p>

 <p>67-C</p>	<p>Application no. 3</p> <p>2 string system with 2 flow sensors</p> <p>Heat energy: $E1 = V1(T1-T2)k_{T1:Flow \text{ or } T2:Return}$</p> <p>Tap water energy: $E6 = V2(T3-T4)k_{T3:Flow}$</p> <p>T3 is measured or programmed T4 is programmed</p> <p>Flow sensor V1 is placed in flow or return pipe as chosen under PROG options.</p> <p>Mass: $M1 = V1(Kmass \ t1)$ or Mass: $M1 = V1(Kmass \ t2)$ depending on the Flow/Return programming Mass: $M2 = V2(Kmass \ t3)^*$</p>
 <p>67-C</p>	<p>Application no. 4</p> <p>2 heat circuits with joint flow</p> <p>Heat energy #1: $E1 = V1(T1-T2)k_{T2:Return}$</p> <p>Heat energy #2: $E7 = V2(T1-T3)k_{T3:Return}$</p> <p>T3 is measured or programmed Mass: $M1 = V1(Kmass \ t2)$ Mass: $M2 = V2(Kmass \ t3)^*$</p>
 <p>67-C</p>	<p>Application no. 5</p> <p>Open system with tap from return flow</p> <p>Heat energy: $E1 = V1(T1-T2)k_{T1:Flow}$</p> <p>Tap water energy: $E5 = V2(T2-T3)k_{T2:Flow}$</p> <p>T3 is measured or programmed.</p> <p>Mass: $M1 = V1(Kmass \ t1)$ Mass: $M2 = V2(Kmass \ t2)$</p>

<p style="text-align: center;">67-C</p>	<p>Application no. 6</p> <p>Open system with separate flow sensor for tap water</p> <p>Heat energy: $E1 = V1(T1-T2)k_{T2:Return}$</p> <p>Tap water energy: $E6 = V2 (T3-T4)k_{T3:Flow}$</p> <p>T3 is measured or programmed T4 is programmed</p> <p>Mass: $M1 = V1 (K_{mass} t2)$ Mass: $M2 = V2 (K_{mass} t3)^*$</p>
<p style="text-align: center;">67-C</p>	<p>Application no. 7</p> <p>Open system with 2 flow sensors</p> <p>Flow energy: $E4 = V1 (T1-T3)k_{T1:Flow}$</p> <p>Return energy: $E5 = V2 (T2-T3)k_{T2:Flow}$</p> <p>($\Delta E = E4-E5$ can be calculated by the topmodule, but only if the 2 flow sensors are identical)</p> <p>Heat energy: $E2 = V2 (T1-T2)k_{T2:Return}$</p> <p>T3 is measured or programmed.</p> <p>Mass: $M1 = V1 (K_{mass} t1)$ Mass: $M2 = V2 (K_{mass} t2)$</p>
<p style="text-align: center;">67-C</p>	<p>Application no. 8</p> <p>Hot-water boiler with circulation</p> <p>Total consumption: $E1 = V1 (T1-T2)k_{T2:Return}$</p> <p>Circulated consumption: $E7 = V2 (T1-T3)k_{T3:Return}$</p>

* $M2 = V2 (K_{mass} t3)^*$ only on selected country codes (930...939)!

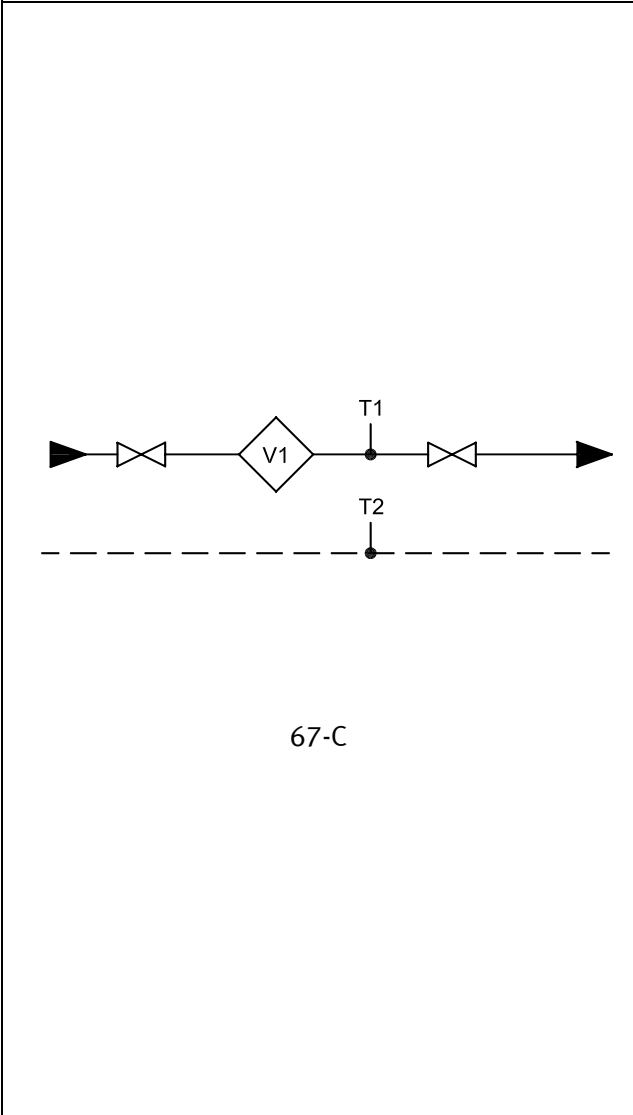


Application no. 9

2 cooling circuits with joint flow

Cooling energy #1: $E_4 = V_1(T_1 - T_3)k_{T_1:Flow}$

Cooling energy #2: $E_5 = V_2(T_2 - T_3)k_{T_2:Flow}$



Application no. 10

Hot tap water energy: $E_1 = V_1 (T_1 - T_2)K_{T_1:Flow}$

T1 is measured with a 2-wire sensor (67-C) or with a 4-wire sensor (67-B/D)

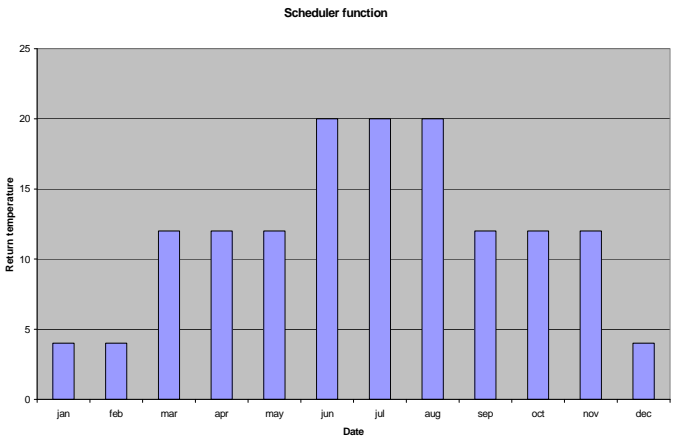
T2 is either measured with a 2-wire sensor (67-C) or with a 4-wire sensor (67-B/D)

Or

T2 is programmed with a fixed temperature value

Or

T2 is programmed via the scheduler and hourly datalogger top module, type 67-0A. The temperature T2 will then follow a schedule where T2 changes up to 12 times per year.



6.2.2 E8 and E9

E8 and E9 are used as calculation basis for calculating volume based average temperatures in flow and return pipe, respectively. For each integration (every 0.01 m³ for qp 1.5 m³/h) the registers are accumulated with the product of m³ × °C, for such purposes E8 and E9 is a suitable basis for calculating volume based average temperatures.

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

E8 = m³ × tF E8 is accumulated with the product of m³ × tF



E9 = m³ × tR E9 is accumulated with the product of m³ × tR



Resolution on E8 and E9

E8 and E9 are depending on the volume resolution (m³)

Volume resolution	E8 and E9 resolution
0000.001 m ³	m ³ × °C × 10
00000.01 m ³	m ³ × °C
000000.1 m ³	m ³ × °C × 0.1
0000001 m ³	m ³ × °C × 0.01

Example 1: After 1 year a heat installation has consumed 250.00 m³ of district heating water and the average temperatures have been 95°C in flow and 45°C in return pipe.
E8 = 23750 and E9 = 11250.

Example 2: It is required that the average temperatures are measured at the same time as the yearly reading, and therefore E8 and E9 are included in the yearly reading.

Reading date	Volume	E8	Average flow	E9	Average return flow
2003.06.01	534.26 m ³	48236		18654	
2002.06.01	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 1

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E8 and E9 have the same function as "m³ × tF" and "m³ × tR" in 66-CDE

6.3 Flow measurement, V1 and V2

MULTICAL® 601 calculates current water flow according to two different principles depending on the connected flow sensor type:

• Fast volume pulses (CCC > 100)

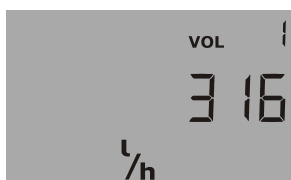
The current water flow for fast volume pulses is calculated, without average determination, as the number of volume pulses per 10 sec. multiplied by a scaling factor.

$$q = (\text{pulses}/10 \text{ sec.} \times \text{flow factor})/65535 \text{ [l/h] or [m}^3\text{/h]}$$

Example:

- ULTRAFLOW qp 1.5 m³/h with 100 pulses/l (CCC=119), flow factor = 235926
- Current water flow = 317 l/h corresponding to 88 pulses/10 sec.

$$q = (88 \times 235926)/65535 = 316.8 \text{ which is shown in the display as 316 [l/h]}$$



Current water flow in V1

• Slow volume pulses (CCC = 0XX)

The current water flow for slow volume pulses (typically from flow sensors with a Reed switch) is calculated without average determination as a scaling factor divided by the period of time between two volume pulses.

$$q = \text{flow factor}/(256 \times \text{period in sec.}) \text{ [l/h] or [m}^3\text{/h]}$$

Example:

- Mechanical flow sensor Qn 15 qp m³/h with 25 l/pulse (CCC=021), flow factor = 230400
- Current water flow = 2.5 m³/h corresponding to 36 sec. in the period of time between 2 pulses

$$q = 230400/(256 \times 36) = 25, \text{ which is shown in the display as 2.5 [m}^3\text{/h]}$$

V1 and V2 must be the same type (either quick (CCC > 100) or slow (CCC=0XX)) but can have different qp-codings (CCC).

Using top modules 67-02 or 67-09, V1 and V2 must have identical qp-codings (CCC).

6.4 Power measurement, V1

MULTICAL® 601 calculates the current power based on the current water flow and the temperature difference measured at the last integration based on following formula:

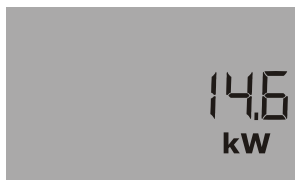
$$P = q (T1 - T2) \times k \text{ [kW] or [MW]}$$

where "k" is the water's heat coefficient that is constantly calculated by MULTICAL® 601 according to EN 1434:2004.

Example:

- Current water flow, $q = 316 \text{ l/h}$ and flow sensor is placed in return pipe
- $T1 = 70.00^\circ\text{C}$ and $T2 = 30.00^\circ\text{C}$, k-factor is calculated for $1.156 \text{ kWh/m}^3/\text{K}$

$$P = 0.316 (70-30) \times 1.156 = 14.6 \text{ [kW]}$$



Current power in V1

Both heat power and cooling power are shown numerically

6.5 Min. and max. flow and power, V1

MULTICAL[®] 601 registers both minimum and maximum flow and power both on a monthly and on a yearly basis. These values can be read in full via data communication. In addition, a small number of monthly and yearly registers can be read on the display depending on the selected DDD code.

Min. and Max. registration comprises following flow and power values including date.

Registration type:	Max. data	Min. data	Yearly data	Monthly data
<i>Max. this year (since last target date)</i>	•		•	
<i>Max. yearly data, up to 15 years back</i>	•		•	
<i>Min. this year (since last target date)</i>		•	•	
<i>Min. yearly data, up to 15 years back</i>		•	•	
<i>Max. this month (since last target date)</i>	•			•
<i>Max. monthly data, up to 36 months back</i>	•			•
<i>Min. this month (since last target date)</i>		•		•
<i>Min. monthly data, up to 36 months back</i>		•		•

All max. and min. values are calculated as largest and smallest average of a number of current flow or power measurements. The average period used for all calculations are selected in the interval 1...1440 min. in jumps in 1 min. (1440 min. = 1 full day).

The average period and target date are stated in connection with orders or re-configured by means of METERTOOL. Where nothing has been stated when the order was placed the average period is set at 60 min. and the target date is set at the standard applying for the country code used.

In connection with commencement of a new year or month the max. and min. values are stored in the data logger and the current max. and min. registers are "reset" according to the selected target date and the internal clock and calendar of the meter.

"Reset" is made by putting the max. value at zero and min. value at 10000.0 kW at e.g. CCC=119.

If the max. or min. registration is used for billing purposes, we recommend to supplement MULTICAL[®] 601 with a top module containing real time clock and battery back-up.

Date for year-to-date max.



Value for year-to-date max.



Date for min. in the current month



Value for min. in the current month



6.6 Temperature measurement

MULTICAL® 601 has a high resolution analog/digital converter that measures the temperatures T1, T2 and T3 with a resolution of 0.01°C (T3 is not available on meters with 4-wire sensor inputs). The same measuring circuit is used for all 3 temperature inputs to obtain the lowest possible measuring error on the temperature difference. Prior to each temperature measurement an automatic adjustment of the internal measuring circuit is made on the basis of integral reference resistances at 0°C and 100°C, respectively. This ensures a very good accuracy and a very stable long-term operation.



Current T1

Temperature measurements are made in connection with each integration (energy calculation) and every 10 sec. when the display shows temperature. The measuring circuit has a temperature range of 0.00°C...185.00°C. In case of a disconnected temperature sensor the display shows 200.00°C and in connection with a short-circuited temperature sensor it shows 0.00°C. In both cases the info code for sensor error will appear.

To reduce the influence from the mains frequency which can e.g. be inducted to long sensor cables, double measurements are made with a delay of 1/2 period , and the average of the 2 measurements make up the temperature measurement used for calculation and display. Suppressing of the mains frequency is optimised to either 50 Hz or 60 Hz depending on the selected country code.

6.6.1 Measuring current and power

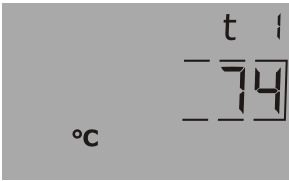
Measuring current is only sent through the temperature sensors in the short period of time it takes to measure the temperature. However, the effective power that is consumed in the sensor elements is minimal and the influence on the self-heating of the temperature sensors is typically less than 1/1000 K.

	Pt100	Pt500
Testing current	< 3 mA	< 0.5 mA
Peak power	< 1.5 mW	< 0.2 mW
RMS power	< 10 µW	< 1 µW

6.6.2 Average temperatures

MULTICAL® 601 constantly calculates the average temperatures for flow and return (T1 and T2) in the entire °C range and the background calculations E8 and E9 (m³ x T1 and m³ x T2) are made for each energy calculation (e.g. for each 0.01 m³ for qp 1.5 meter size), whereas the display value is updated every day. Thereby the average calculations are weighted according to volume and can therefore be used for control purposes.

Registration type:	Average	Yearly data	Monthly data
Year-to-date average (since last target date)	•	•	
Month-to-date average (since last target date)	•		•



Year-to-date average for T1.

(Current date with "comma lines" under year or month is shown just BEFORE this reading)

6.6.3 Programmed temperatures

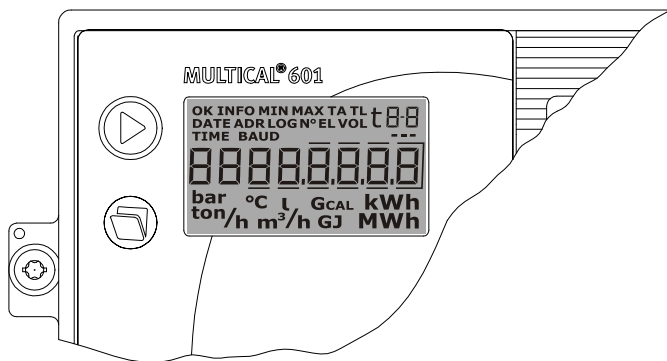
The temperatures T3 and T4 can be programmed in the memory of the calculator, and these temperatures can be used for calculating energy with fixed temperature reference, as used in connection with the calculations of the energy types E4, E5, E6 and E7 (see the application drawings in paragraph 6.2)

The temperatures can be programmed when placing orders or by means of METERTOOL in the range 0.01...180°C, once the meter is installed.

6.7 Display functions

MULTICAL® 601 is equipped with a clear LC display including 8 digits, units of measurement and information panel. In connection with energy and volume readings 7 digits and the corresponding units of measurement are used, whereas 8 digits are used when e.g. a meter number is shown.

As a starting point the display shows the accumulated energy. When the push buttons are activated the display reacts immediately by showing other readings. The display automatically returns to energy reading 4 minutes after last activation of the push buttons.

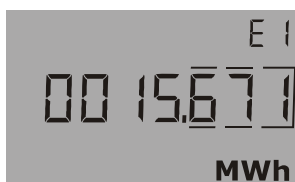


6.7.1 Primary and secondary readings

The upper button is used to switch between the primary readings of which the consumers typically use the first primary readings in connection with self-reading for billing purposes.

The lower push button is used to show secondary information on the primary reading that has been selected.

Example: When the primary reading selected is "Heat energy" the secondary readings will be yearly data and monthly data for heat energy.



Heat energy E1 in MWh



Yearly data, date for LOG 1 (last yearly reading)



Yearly data, value for LOG 1 (last yearly reading)



Monthly data, date for LOG 1 (last monthly reading)

6.7.2 Display structure

Below diagram shows the display structure with up to 20 primary readings and a number of secondary readings under most primary readings. The number of secondary readings for yearly data and monthly data has been laid down under the DDD code. If nothing is informed in connection with placing the order, the reading is set at 2 yearly data and 12 monthly data. The target date is set at the standard valid for the country code used.

As the display is configured according to the needs of the customer (by selecting DDD code), the display will usually contain fewer readings than shown below.

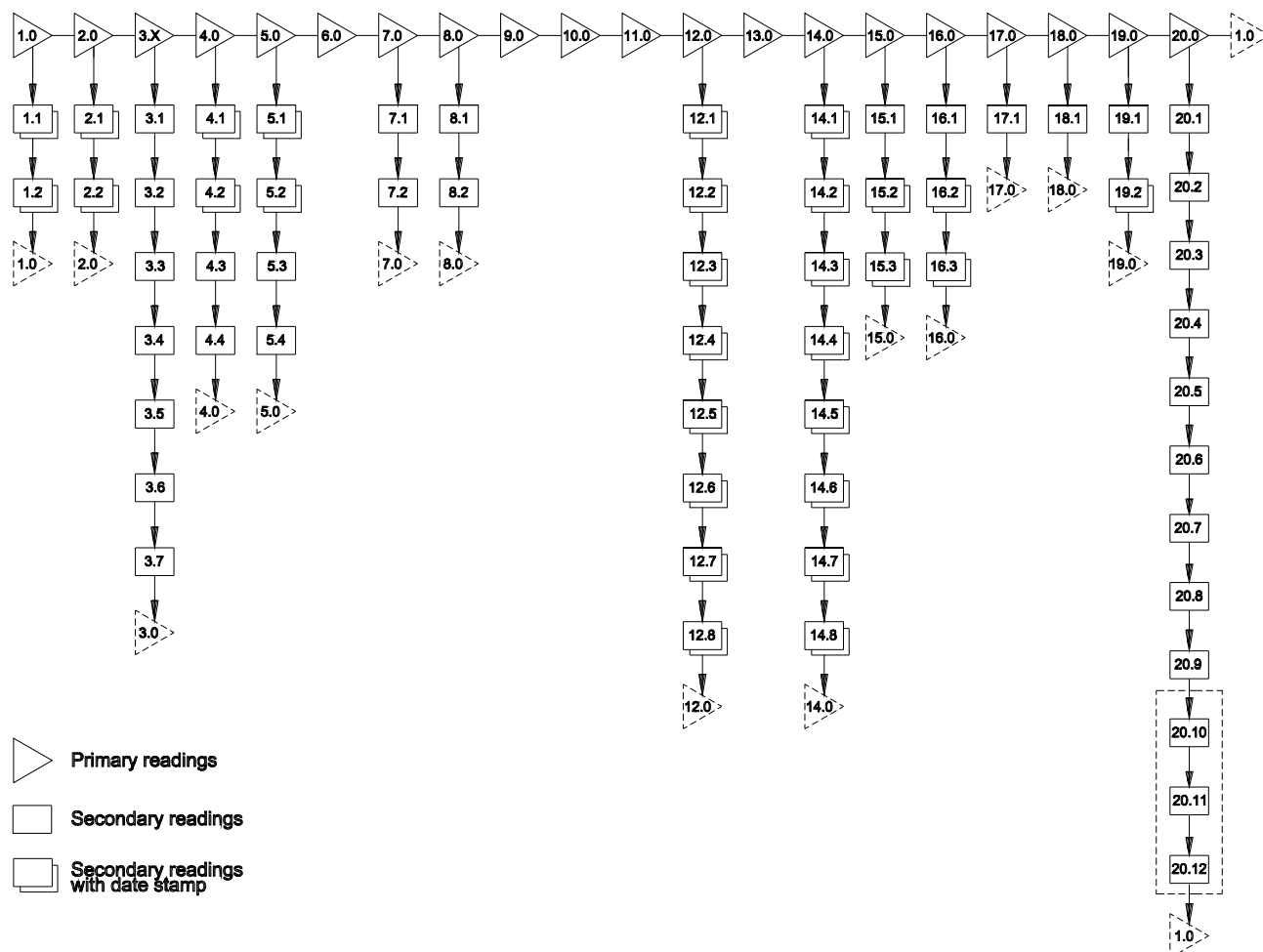




Figure 2

6.7.3 Display grouping

MULTICAL® 601 can be configured for a number of various applications, which creates the need for various display groupings. In the overview below the possible readings [●] will appear for heat meter, cooling meter etc., which readings are supported by date stamps, and which reading is automatically shown 4 min. after last activation of the push buttons [1●]. (This chapter applies to design of DDD-codes only).

				Date stamp	Heat meter DDD=4xx	Cooling meter DDD=5xx	Heat/cooling DDD=6xx	Heat volume DDD=7xx	Cold volume DDD=8xx	Heat meter DDD=9xx
1.0	Heat energy (E1)				1●		1●			●
		1.1	Yearly data	●	●		●			●
		1.2	Monthly data	●	●		●			●
2.0	Cooling energy (E3)					1●	●			●
		2.1	Yearly data	●		●	●			●
		2.2	Monthly data	●		●	●			●
										●
3.X	Other energy types	3.1	E2							●
		3.2	E4							●
		3.3	E5							●
		3.4	E6							●
		3.5	E7							●
		3.6	E8 (m3*tf)		●					●
		3.7	E9 (m3*tr)		●					●
4.0	Volume V1				●	●	●	1●	1●	●
		4.1	Yearly data	●	●	●	●	●	●	●
		4.2	Monthly data	●	●	●	●	●	●	●
		4.3	Mass 1		●	●	●	●	●	●
		4.4	P1		●	●	●	●	●	●
5.0	Volume V2							●	●	●
		5.1	Yearly data	●				●	●	●
		5.2	Monthly data	●				●	●	●
		5.3	Mass 2					●	●	●
		5.4	P2					●	●	●
6.0	Hour counter				●	●	●	●	●	●
7.0	T1 (Flow)				●	●	●			●
		7.1	Year-to-date average		●	●	●			●
		7.2	Month-to-date average		●	●	●			●
8.0	T2 (Return flow)				●	●	●			●
		8.1	Year-to-date average		●	●	●			●
		8.2	Month-to-date average		●	●	●			●
9.0	T1-T2 (Δt) - = cooling				●	●	●			●
10.0	T3				●	●	●			●
11.0	T4 (programmed)									●
12.0	Flow (V1)				●	●	●	●	●	●
		12.1	Max. this year	●	●	●	●	●	●	●
		12.2	Max. yearly data	●	●	●	●	●	●	●
		12.3	Min. this year	●	●	●	●	●	●	●
		12.4	Min. yearly data	●	●	●	●	●	●	●
		12.5	Max. this month	●	●	●	●	●	●	●
		12.6	Max. monthly data	●	●	●	●	●	●	●
		12.7	Min. this month	●	●	●	●	●	●	●
		12.8	Min. monthly data	●	●	●	●	●	●	●
13.0	Flow (V2)				●			●	●	●
14.0	Power (V1)				●	●	●			●
		14.1	Max. this year	●	●	●	●			●
		14.2	Max. yearly data	●	●	●	●			●
		14.3	Min. this year	●	●	●	●			●
		14.4	Min. yearly data	●	●	●	●			●
		14.5	Max. this month	●	●	●	●			●
		14.6	Max. monthly data	●	●	●	●			●
		14.7	Min. this month	●	●	●	●			●
		14.8	Min. monthly data	●	●	●	●			●

				Date stamp	Heat meter DDD=4xx	Cooling meter DDD=5xx	Heat/cooling DDD=6xx	Heat volume DDD=7xx	Cold volume DDD=8xx	Heat meter DDD=9xx
15.0	VA (Input A)				•	•	•	•	•	•
		15.1	Meter no. VA		•	•	•	•	•	•
		15.2	Yearly data	•	•	•	•	•	•	•
		15.3	Monthly data	•	•	•	•	•	•	•
16.0	VB (Input B)				•	•	•	•	•	•
		16.1	Meter no. VB		•	•	•	•	•	•
		16.2	Yearly data	•	•	•	•	•	•	•
		16.3	Monthly data	•	•	•	•	•	•	•
17.0	TA2				•	•	•			
		17.1	TL2		•	•				
18.0	TA3				•	•	•			
		18.1	TL3		•	•				
19.0	Info code				•	•	•	•	•	•
		19.1	Info event counter		•	•	•	•	•	•
		19.2	Info logger (last 36 events)	•	•	•	•	•	•	•
20.0	Customer number (N° 1+2)				•	•	•	•	•	•
		20.1	Date		•	•	•	•	•	•
		20.2	Time		•	•	•	•	•	•
		20.3	Target date		•	•	•	•	•	•
		20.4	Serial no. (N° 3)		•	•	•	•	•	•
		20.5	Prog. (A-B-CCC-CCC) (N° 4)		•	•	•	•	•	•
		20.6	Config 1 (DDD-EE) (N° 5)		•	•	•	•	•	•
		20.7	Config 2 (FF-GG-M-N) (N° 6)		•	•	•	•	•	•
		20.8	Software edition (N° 10)		•	•	•	•	•	•
		20.9	Software check-sum (N° 11)		•	•	•	•	•	•
		20.10	Segment test		•	•	•	•	•	•
		20.11	Top module type (N° 20)		•	•	•	•	•	•
		20.12	Base module type (N° 30)		•	•	•	•	•	•



Display example showing the PROG number.

A complete survey of existing display codes (DDD) appears from a separate document. Please contact Kamstrup for further details.

6.8 Info codes

MULTICAL® 601 constantly surveys a number of important functions. Where serious errors have occurred in the measuring system or in the installation, a flashing "info" will appear in the display while the error exists. The "Info" panel will flash for as long as the error exists no matter which reading is selected. The "Info" panel will automatically turn off, when the source of error has been corrected.

6.8.1 Examples of info codes on the display

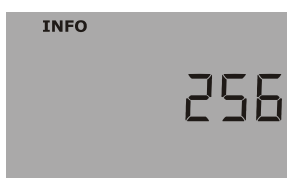
Ex. 1



Flashing "info"

If the info code exceeds 000 a flashing "info" will appear in the information panel.

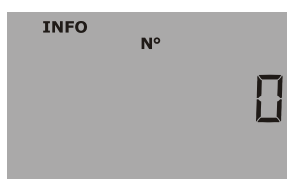
Ex. 2



Current info code

When the upper (primary) push button is activated several times the current info code can be shown on the display.

Ex. 3



Info event counter

- indicates how many times the info code has been changed.

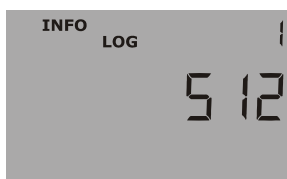
Ex. 4



Info logger

By pressing one more time on the lower push button data logger for the info code is displayed.

First, the date of the first change is displayed ...



...then the info code appearing on that particular date is displayed. In this case there has been a "bursting alarm" on the 4th January 2006.

The data logger stores the last 50 changes, of which the last 36 are shown in the display.

In addition, the info code is stored in the hourly logger (if top module with hourly logger is mounted), the daily logger, the monthly logger and the yearly logger for diagnosis purposes.

6.8.2 Types of info codes

Info code	Description	Response time
0	No irregularities	-
1	Supply voltage has been cut off	-
8	Temperature sensor T1 outside measuring range	1...10 min.
4	Temperature sensor T2 outside measuring range	1...10 min.
32	Temperature sensor T3 outside measuring range	1...10 min.
64	Leak in the cold-water system	1 day
256	Leak in the heating system	1 day
512	Burst in the heating system	120 sec.
ULTRAFLOW® X4 info (if activated CCC=4XX)		
16	Flow sensor V1, Datacomm error, signal too low or wrong flow direction	After reset and 1 day (00:00)
1024	Flow sensor V2, Datacomm error, signal too low or wrong flow direction	After reset and 1 day (00:00)
2048	Flow sensor V1, Wrong meter factor	After reset and 1 day (00:00)
128	Flow sensor V2, Wrong meter factor	After reset and 1 day (00:00)
4096	Flow sensor V1, Signal too low (Air)	After reset and 1 day (00:00)
8192	Flow sensor V2, Signal too low (Air)	After reset and 1 day (00:00)
16384	Flow sensor V1, Wrong flow direction	After reset and 1 day (00:00)
32768	Flow sensor V2, Wrong flow direction	After reset and 1 day (00:00)

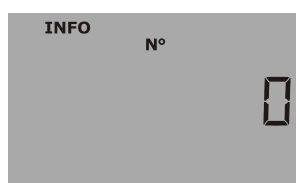
If several info codes appear at the same time the sum of the info codes is shown. E.g. if both temperature sensors are outside measuring range, info code 00012 will appear.

During configuration at the factory the individual info - active or passive - are set and in this way a standard heat meter not using T3, cannot display info code 00032.

6.8.3 Transport mode

When the meter leaves the factory it is in transport mode, and the info codes are only active on the display and not in the data logger. This prevents both "info event" to increment and the storage of non relevant data in the info logger. When the meter has summed up the volume register for the first time after installation the info code is automatically set at active.

6.8.4 Info event counter



Info event counter

Counting takes place every time the info code is changed.

The info event counter will be 0 on receipt, as "transport mode" prevents counting during transport

Info code	"Info" on display	Registration in the info, daily, monthly or yearly logger	Counting of info events
00001	No	Yes	At each "Power-On-Reset"
00004, 00008, 00032	Yes	Yes	When info 4, 8, 32 are set or removed. Max. 1 per measurement of temperature
00064, 00256	Yes	Yes	When info is set and when info is deleted. Max. 1 time/day
00512	Yes	Yes	When info is set and when info is deleted. Max. 1 time/120 sec.

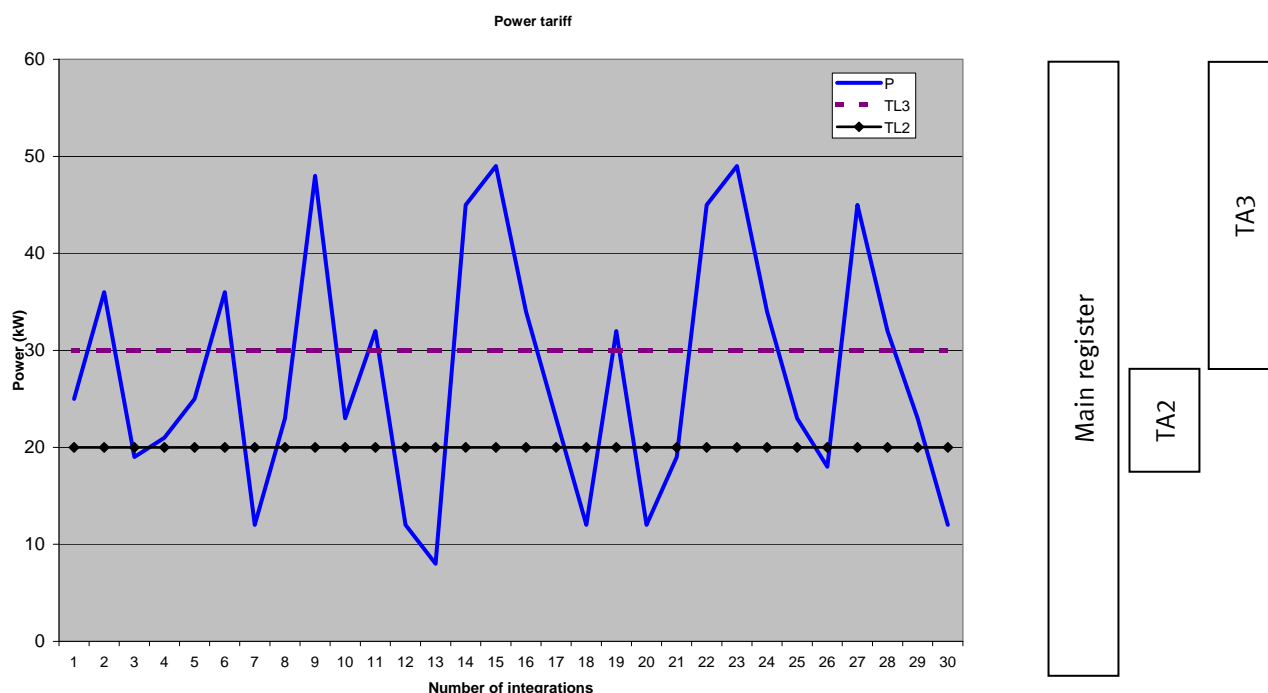
66-CDE ⇒ MC 601

The info event counter replaces the error hour counter.

6.9 Tariff functions

MULTICAL® 601 has 2 extra registers TA2 and TA3 to accumulate heat energy (E=20 accumulates volume) in parallel to the main register based on a programmed tariff condition. No matter which tariff form is selected the tariff registers are indicated as TA2 and TA3 in the display. The tariff function is only applicable for heat energy (E1).

The main register is always accumulated as it is considered a legal billing register, irrespective of the selected tariff function. The tariff conditions TL2 and TL3 are monitored before each integration. When the tariff conditions are fulfilled the consumed heat energy is counted in either TA2 or TA3, in parallel to the main register.



To each tariff function two tariff conditions, TL 2 and TL3 are connected, which are always used in the same tariff type. Therefore, it is not possible to "mix" two tariff types.

Example: E=11 (Power tariff)

TA2 shows the consumed energy...

...over the power limit TL2 (but under TL3)



6.9.1 Tariff types

Below table indicates which tariff types MULTICAL® 601 can be configured to:

E=	TARIFF TYPE	FUNCTION
00	No tariff active	No function
11	Power tariff	Energy will be accumulated in TA2 and TA3 based on the power limits in TL2 and TL3
12	Flow tariff	Energy will be accumulated in TA2 and TA3 based on the flow limits in TL2 and TL3
13	T1-T2 tariff	Energy will be accumulated in TA2 and TA3 based on the Δt -limits in TL2 and TL3
14	Flow temperature tariff	Energy will be accumulated in TA2 and TA3 based on the t_F -limits in TL2 and TL3
15	Return temperature tariff	Energy will be accumulated in TA2 and TA3 based on the t_R -limits in TL2 and TL3.
19	Time-controlled tariff	TL2=Starting time for TA2 TL3=Starting time for TA3
20	Heat/cooling volume tariff (TL2 and TL3 are not used)	Volume (V1) is divided into TA2 for heat ($T_1 > T_2$) and TA3 for cooling ($T_1 < T_2$), where T_1 is less than T_1 limit.
21	PQ-tariff	Energy at $P > TL2$ is stored in TA2 and energy at $Q > TL3$ is stored in TA3

E=00 No tariff active

If the tariff function should not be used, select the set-up for E=00.

However, the tariff function can be made active at a later date by a reconfiguring the function by means of METERTOOL for MULTICAL® 601. See paragraph 13 METERTOOL.

E=11 Power controlled tariff

When the current power is higher than TL2, but lower than/equal to TL3, the heat energy in TA2 is counted in parallel to the main register. If the current power exceeds TL3, the heat energy in TA3 is counted in parallel to the main register.

$P < TL2$	Counting in main register only	TL3 > TL2
$TL3 \geq P > TL2$	Counting in TA2 and the main register	
$P > TL3$	Counting in TA3 and the main register	

When setting up data TL3 must always be higher than TL2. Among other things the power controlled tariff is used as a basis for calculating the individual heat consumer's connection costs. Furthermore, this tariff form can provide valuable statistical data when the utility evaluates new installation activities.

E=12 Flow controlled tariff

When the current water flow is higher than TL2 but lower than/equal to TL3, the heat energy in TA2 is counted in parallel to the main register. If the current water flow becomes higher than TL3, the heat energy in TA3 is counted in parallel to the main register. When setting up data, TL3 must always be higher than TL2.

$q < TL2$	Counting in main register only	TL3 > TL2
$TL3 \geq q > TL2$	Counting in TA2 and the main register	
$q > TL3$	Counting in TA3 and the main register	

Among other things the flow controlled tariff is used as a basis for calculating the individual heat consumer's connection costs. Furthermore, this tariff form provides valuable statistical data when the utility evaluates new installation activities.

When the power or flow tariff is used it is possible to get a total overview of the total consumption compared to the part of the consumption, that is used above the tariff limits.

E=13 Differential temperature tariff (Δt)

When the current T1-T2 (Δt) is lower than TL2, but higher than TL3, the heat energy in TA2 is counted in parallel to the main register. If the current cooling drops to less than/equal to TL3, the heat energy in TA3 is counted in parallel to the main register.

$\Delta t > TL2$	Counting in main register only	TL3 < TL2
$TL3 < \Delta t < TL2$	Counting in TA2 and the main register	
$\Delta t \leq TL3$	Counting in TA3 and the main register	

When setting up tariff limits TL3 must always be lower than TL2.

The T1-T2 tariff can be used to form the basis for a weighted user payment. Low Δt (small difference between flow and return flow temperatures) is uneconomical for the heat supplier.

E=14 Flow temperature tariff

When the current flow temperature (T1) is higher than TL2, but lower than/equal to TL3, the heat energy in TA2 is counted in parallel to the main register. If the current flow temperature becomes higher than TL3, the heat energy in TA3 is counted in parallel to the main register.

$T1 < TL2$	Counting in main register only	TL3 > TL2
$TL3 \geq T1 > TL2$	Counting in TA2 and the main register	
$T1 > TL3$	Counting in TA3 and the main register	

When setting up data TL3 must always be higher than TL2.

The flow temperature tariff can form the basis of billing of those customers who are guaranteed a given flow temperature. When the “guaranteed” minimum temperature set at TL3, the calculated consumption is accumulated in TA3.

E=15 Return temperature tariff

When the current return temperature (T2) is higher than TL2 but lower than/equal to TL3, the heat energy in TA2 is counted in parallel to the main register. If the current return temperature becomes higher than TL3, the heat energy in TA3 is counted in parallel to the main register.

$T2 < TL2$	Counting in main register only	TL3 > TL2
$TL3 \geq T2 > TL2$	Counting in TA2 and the main register	
$T2 > TL3$	Counting in TA3 and the main register	

When setting up data TL3 must always be higher than TL2.

The return temperature tariff can form the basis of a weighted user payment. A high return flow temperature indicates insufficient heat utilization which is uneconomical for the heat supplier.

E=19 Time-controlled tariff

The time-controlled tariff is used for time division of the heat consumption. If TL2 = 08:00 and TL3 = 16:00 the consumption of the entire day from 08:00 till 16:00 will be accumulated in TA2, whereas the consumption of the evening and the night from 16:01 till 07:59 will be accumulated in TA3.

TL2 must have a lower number of hours than TL3.

$TL\ 3 \geq \text{Clock} \geq TL2$	Counting in TA2 and the main register	TL3 > TL2
$TL\ 2 > \text{Clock} > TL3$	Counting in TA3 and the main register	

The time tariff is suitable for billing in housing sectors close to industrial sectors with a large consumption of district heating and for billing industrial customers.

A top module with real time clock should be used to ensure correct hour as basis for the time tariff.

E=20 Heat/cooling volume tariff

The heat/cooling volume tariff is used for dividing volume into heat and cooling consumption. TA2 accumulates the volume consumed together with E1 (heat energy) and TA3 accumulates the volume consumed together with E3 (cooling energy).

$T1 \geq T2$	Volume is accumulated in TA2 and V1	TL2 and TL3 are not used
$T2 > T1$ og $T1 < T1\ \text{limit}$	Volume is accumulated in TA3 and V1	
$T2 > T1$ og $T1 > T1\ \text{limit}$	Volume is accumulated in TA2 and V1	

In connection with combined heat/cooling measurement the total volume in the V1 register is accumulated, whereas the heat energy is accumulated in E1 and the cooling energy in E3. The heat/cooling tariff divides the consumed volume into heating and cooling volume.

E=20 should always be selected together with heat/cooling meters, type 67-xxxxxxx-6xx.

E=21 PQ tariff

The PQ tariff is a combined power and flow tariff. TA2 functions as a power tariff and TA3 as a flow tariff.

$P \leq TL2$ and $q \leq TL3$	Counting in the main register only	TL2 = power limit (P) TL3 = flow limit (q)
$P > TL2$	Counting in TA2 and the main register	
$q > TL3$	Counting in TA3 and the main register	
$P > TL2$ and $q > TL3$	Counting in TA2, TA3 and the main register	

Among other things the PQ tariff is used for customer paying a fixed duty based on max. power and max. flow.

6.10 Data loggers

MULTICAL® 601 contains a permanent memory (EEPROM), where the results of a number of various data loggers are stored. The meter contains following data loggers:

Data logging interval	Data logging depth	Logged value
Yearly logger	15 years	Counter registers •
Monthly logger	36 months	Counter registers •
Daily logger	460 days	Consumption (increase)/day ♦
Hourly logger (Top module)	1392 hours	Consumption (increase)/hour ♦
Info logger	50 events (36 events can be displayed)	Info code and date

The loggers are static and therefore the register types cannot be changed, furthermore, the logging intervals are fixed. When the last record has been written in the EEPROM the oldest one is overwritten.

6.10.1 Yearly, monthly, daily and hourly loggers

Following registers are logged every year and every month on target date as counter values. In addition, the increases of the day and the hour are logged at midnight.

Register type	Description	Yearly logger	Monthly logger	Daily logger	Hourly logger
Date (YY.MM.DD)	Year, month and day for logging times	•	•	♦	♦
E1	E1=V1(T1-T2) Heat energy	•	•	♦	♦
E2	E2=V2(T1-T2) Heat energy	•	•	♦	♦
E3	E3=V1(T2-T1) Cooling energy	•	•	♦	♦
E4	E4=V1(T1-T3) Flow energy	•	•	♦	♦
E5	E5=V2(T2-T3) Return flow energy or tap from return flow	•	•	♦	♦
E6	E6=V2(T3-T4) Tap water energy, separate	•	•	♦	♦
E7	E7=V2(T1-T3) Tap water energy from flow	•	•	♦	♦
E8	E8=m3*T1 (flow)	•	•	♦	-
E9	E9=m3*T2 (return flow)	•	•	♦	-
TA2	Tariff register 2	•	•	-	-
TA3	Tariff register 3	•	•	-	-
V1	Volume register for Volume 1	•	•	♦	♦
V2	Volume register for Volume 2	•	•	♦	♦
VA	Extra water or electricity meter connected to Input A	•	•	♦	♦
VB	Extra water or electricity meter connected to Input B	•	•	♦	♦
M1	Mass corrected V1	-	-	♦	♦
M2	Mass corrected V2	-	-	♦	♦
INFO	Information code	•	•	♦	♦
DATE FOR MAX. FLOW V1	Date stamp for max. flow in the period	•	•	-	-
MAX. FLOW V1	Value for max. flow in the period	•	•	-	-
DATE FOR MIN. FLOW V1	Date stamp for min. flow in the period	•	•	-	-
MIN. FLOW V1	Value for min. flow in the period	•	•	-	-
DATE FOR MAX. POWER V1	Date stamp for max. power in the period	•	•	-	-
MAX. POWER V1	Value for max. power in the period	•	•	-	-
DATE FOR MIN. POWER V1	Date stamp for min. power in the period	•	•	-	-
MIN. POWER V1	Value for min. power in the period	•	•	-	-
T1avg	Time based average for T1	-	-	♦	♦
T2avg	Time based average for T2	-	-	♦	♦
T3avg	Time based average for T3	-	-	♦	♦
P1avg	Time based average for P1	-	-	♦	♦
P2avg	Time based average for P2	-	-	-	♦
dE (dV)	Differential energy (differential volume)	-	-	-	♦
cE (eV)	Check energy (check volume)	-	-	-	♦

6.10.2 Info logger

Every time the information code is changed, date and info code are logged. Thereby, it is possible to data read the last 50 changes in the information code and the date of the change.

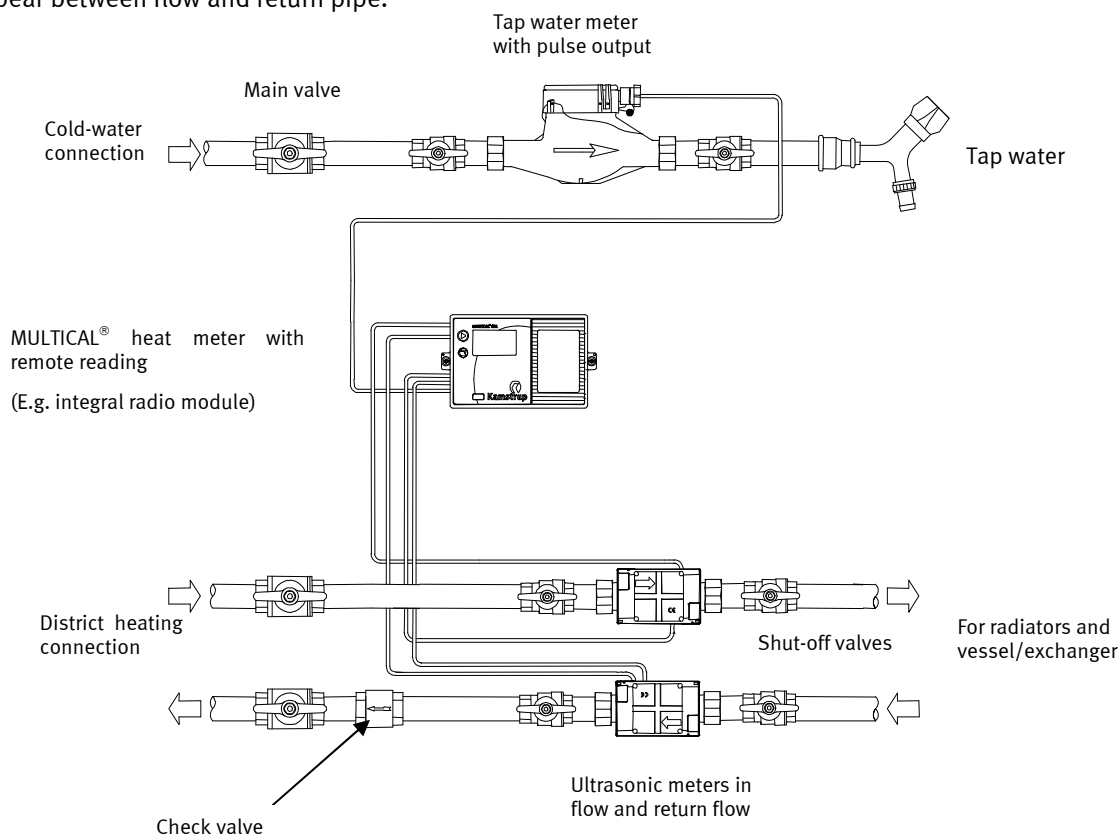
Register type	Description
Date (YY.MM.DD)	Year, month and day for the logging time
Info	Information code on above date

When the info logger is read on the display the last 36 changes including dates can be read.

6.11 Leak surveillance

6.11.1 District heating installations

The leak surveillance system is primarily intended for directly connected district heating installations, i.e. installations without heat exchanger between the district heating network and the heating system of the housing. The surveillance system consists of two water meters based on the ultrasonic principle placed in both flow and return pipe, and of temperature sensors in both pipes. In addition, the electronic unit MULTICAL® 601, which in addition to calculating the heat energy also surveys the mass difference (temperature compensated volume) that may appear between flow and return pipe.



If a difference of more than 20% of the measuring range (corresponding to 300 l/h in a single-family house) is registered, an alarm will be sent within 120 sec. via remote communication.

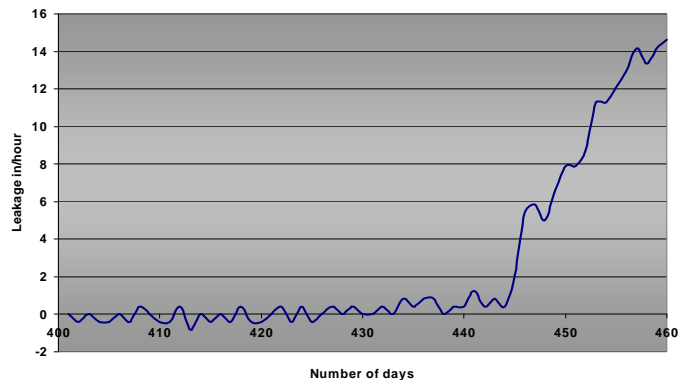
Small leaks from 15 kg/h and upwards for q_p 1.5 m³/h are under surveillance on the basis of a 24-hour average to rule out incorrect alarms as a consequence of air pockets and fast flow changes e.g. from hot-water exchangers.

District heating leak surveillance (V1-V2)	
M=	Sensitivity in leak surveillance
0	OFF
1	1.0% q_p + 20% q
2	1.0% q_p + 10% q
3	0.5% q_p + 20% q
4	0.5% q_p + 10% q

NB: M=2 is a default value when leak surveillance is used. Higher degrees of sensitivity, e.g. M=4 is only possible by means of METERTOOL.

Info codes for leak/bursting are only active when $M > 0$ or $N > 0$, respectively.

Example: The curve below illustrates the difference between Mass V1 and Mass V2 in an extract of 60 days before the leak in a floor heating pipe was the reason for a leak alarm. As will appear from below, there is a fluctuation of approx. ± 1 kg/hour in the first 43 days which is a normal fluctuation for installations without leaks.



6.11.2 District heating bursting

Every 30 sec. the current flow in the flow pipe is compared with that in the return flow pipe. If the difference at 4 measurements in a row (120 sec.) is larger than 20% of the nominal flow info = 00512 and a "bursting alarm" will be sent via remote communication.

6.11.3 Cold-water systems

In addition to above functions MULTICAL® 601 can be connected to the pulse signal from the cold-water meter of the house. In this way it can survey the cold-water consumption. A flushing toilet cistern, leaky heating coils in the water tanks or other leaks will cause that impulses from the cold-water meter are received 24 hours a day.

If MULTICAL® 601 does not register e.g. at least one continuous hour/day without pulses from the water meter, this is a sign of a leak in the water system and an alarm will be sent via remote communication.

Cold-water leak search (VA)	
N=	Constant leak at no consumption (pulse resolution 10 l/pulse)
0	OFF
1	20 l/h (1/2 hour without pulses)
2	10 l/h (1 hour without pulses)
3	5 l/h (2 hours without pulses)

NB: N=2 is a default value in connection with leak surveillance. Higher degree of sensitivity, e.g. N=3 is only possible if using METERTOOL. Infocodes for leak/bursting are only active when M > 0 or N > 0, respectively.

6.11.4 Receiving alarm messages

When the meter has registered a leak or bursting it will send an alarm message to a receiving station, where incoming alarms are handled on the basis of an encoded action pattern that is laid down for each individual customer, e.g. starting with an SMS message to the customer's mobile phone. At the same time the utility on duty receives the message. Regular data readings from MULTICAL® 601 to the receiving station/monitoring center ensure that defective remote readings, if any, are detected.

6.11.5 Surveillance, but no automatic blocking

The leak surveillance system is based on installation at a large number of private district heating customers'. Usually, the individual utility installs and maintains the leak surveillance, integrated with the compulsory heat metering at all district heating customers in their area. In this way, the individual private district heating customers neither maintain the system nor perform other technical tasks in connection with the installed leak surveillance system, and the surveillance system must not imply an increased risk of faulty blocking that may lead to frost bursts. As a consequence of this the entire system must have a reliability that ensures operation for 12 years without maintenance. As neither thermally nor electrically activated shut-off valves can be expected to have such a long lifetime it will not be possible to use automatic blocking.

6.11.6 First day after reset

The first day after installation (when the meter has had no supply voltage) no infocodes will be set and no alarms will be sent in case of calculated district heating or cold-water leak.

This limitation has been introduced to avoid wrong alarms as a result of the installation and the shortened metering period.

The alarm function can be tested via remote communication by pressing both push buttons simultaneously, until a "Call" appears in the display.



6.12 Reset functions

6.12.1 Resetting the hour counter

The operational hour counter can be reset e.g. when the battery is changed.

As the hour counter usually is used to control that the meter has been in operation in the entire billing period (e.g. 1 year = 8760 hours) the district heating supplier must always be informed which meters have had their hour counter reset.



Resetting of the operational hour counter is made firstly by breaking the utility seals, lifting the calculator top off the base unit and waiting for the display to turn off.

Then the calculator top is put back on the base unit. The upper push button is activated for at least 10 sec., until the display shows e.g. energy.



The operational hour counter is now reset.

6.12.2 Resetting data loggers

Separate reset of data loggers, info loggers, max. & min. loggers (without resetting the legal registers) are only possible by means of METERTOOL. See paragraph 13 for further details.

6.12.3 Resetting all registers

Resetting all legal and non-legal registers including all data loggers, info loggers, max. & min. loggers can only be made by using METERTOOL or via NOWA, if the verification seal is broken and the internal "Total programming lock" is short-circuited. As the verification seal is broken, this can only be made at an accredited laboratory.

Following registers are reset:

All legal and non-legal registers including all data loggers, info loggers, max. & min. loggers (max. values are set at zero, whereas min. values are set at 100000).

After reset "Date" is set at 2000.01.01 and is then changed to current date/time of the PC used for the task. Remember to check correct date/time (technical standard time = "winter-time") on the PC before the reset function is initiated.

7 Flow sensor connection

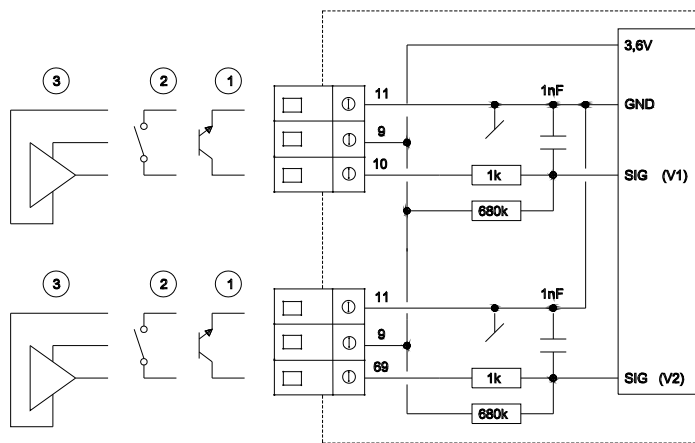
MULTICAL® 601 can be used with up to 4 pulse inputs, of which V1 and V2 are used for energy calculation and leak surveillance, whereas VA and VB are used to accumulate pulses e.g. from tap-water meters and electricity meters.

V1 and V2 can either be used for fast pulses ($CCC > 100$) or for slow pulses ($CCC = OXX$). Fast and slow pulses cannot be used simultaneously.

7.1 Volume inputs V1 and V2

MULTICAL® 601 can be connected to one or two flow sensors depending on the required application. Typical heat installations with one flow sensor are always connected to V1 irrespective if this flow sensor is installed in flow pipe or return pipe.

Almost all available flow sensor types with pulse output can be connected as the standard connection PCB receives pulses from both electronic and mechanical meters. In addition, a connection PCB that receives 24 V active pulses is also available.



7.1.1 Flow sensor with transistor- or FET output ①

Typically, the signaller is an optocoupler with a transistor or a FET output. V1 is connected to terminal 10(+) and 11(-), V2 is connected to terminals 69(+) and 11(-). Terminal 9 is not used in this application.

The leak current in the transistor or FET output must not exceed $1\mu A$ in OFF state and there must be max. 0.4 V in ON state.

A suitable CCC code must be selected with the same number of pulses/liter as the flow part, and for this flow sensor type the CCC code must be $CCC > 100$.

Example: $CCC=147$ fits an electronic meter with 1 pulse/liter and qp of $150 m^3/h$.

7.1.2 Flow sensor with Reed switch output ②

The signaller is a Reed switch typically mounted on vane wheel or Woltmann meters, or a relay output from e.g. a magnetic inductive flow sensor. V1 is connected to the terminals 10(+) and 11(-), V2 is connected to the terminals 69(+) and 11(-). Terminal 9 is not used in this application.

The leak current must not exceed $1\mu A$ in OFF state and there must be max. $10 k\Omega$ in ON state.

A suitable CCC code must be selected with the same number of pulses/liter as the flow part, and for this flow sensor type the CCC code must be in the range $010 \leq CCC \leq 022$.

Example: $CCC=012$ fits a mechanical flow sensor with 100 liter/pulse. Flow sensors with Q_{max} in the range $10...300 m^3/h$ can use this CCC code.

7.1.3 Flow sensor with active output supplied from MULTICAL® ③

This connection is used both together with Kamstrup's ULTRAFLOW® and Kamstrup's electronic pick-up units for vane wheel meters. The power consumption in these units is very low and is adapted to MULTICAL®'s battery lifetime.

A suitable CCC code must be selected with the same number of pulses/liter as the flow part, and for this flow sensor type the CCC code must be $CCC > 100$.

Example: CCC=119 fits an electronic meter with 100 pulses/liter and typical qp is 1.5 m³/h.

V1 and V2 are connected as shown in below diagram.

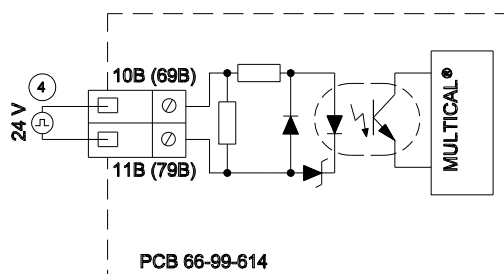
	V1	V2
Red (3.6 V)	9	9
Yellow (Signal)	10	69
Blue (GND)	11	11

Table 2

7.2 Flow sensor with active 24 V pulse output ④

When MULTICAL® is connected to "industrial" flow sensors with a 24 V active pulse output, the connection board type 66-99-614 must be used in MULTICAL® 601 type 67-B or 67-D, with a 4 wire temperature sensor connection.

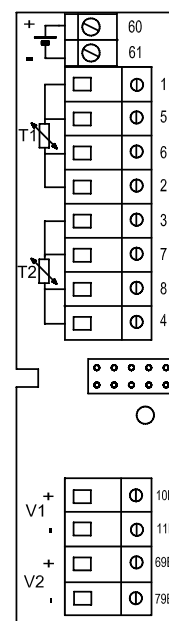
67-D is mounted with 66-99-614 from the factory.



Technical data

Pulse input voltage	12...32 V
Pulse current	Max. 12 mA at 24 V
Pulse frequency	Max. 128 Hz
Pulse duration	Min. 3 msec.
Cable length V1 and V2	Max. 100 m (including min. 25 cm distance to other cables)
Galvanic insulation	The inputs V1 and V2 are both individually insulated and insulated from MULTICAL®
Insulation voltage	2 kV
Net supply to MULTICAL®	24 VAC or 230 VAC
Battery life time for MULTICAL®	When using V1: 6 years When using both V1 and V2: 4 years

If in addition, a data communication modules is used in MULTICAL® the battery lifetime will be reduced further. Please contact Kamstrup A/S for further details.



7.2.1 Connection examples

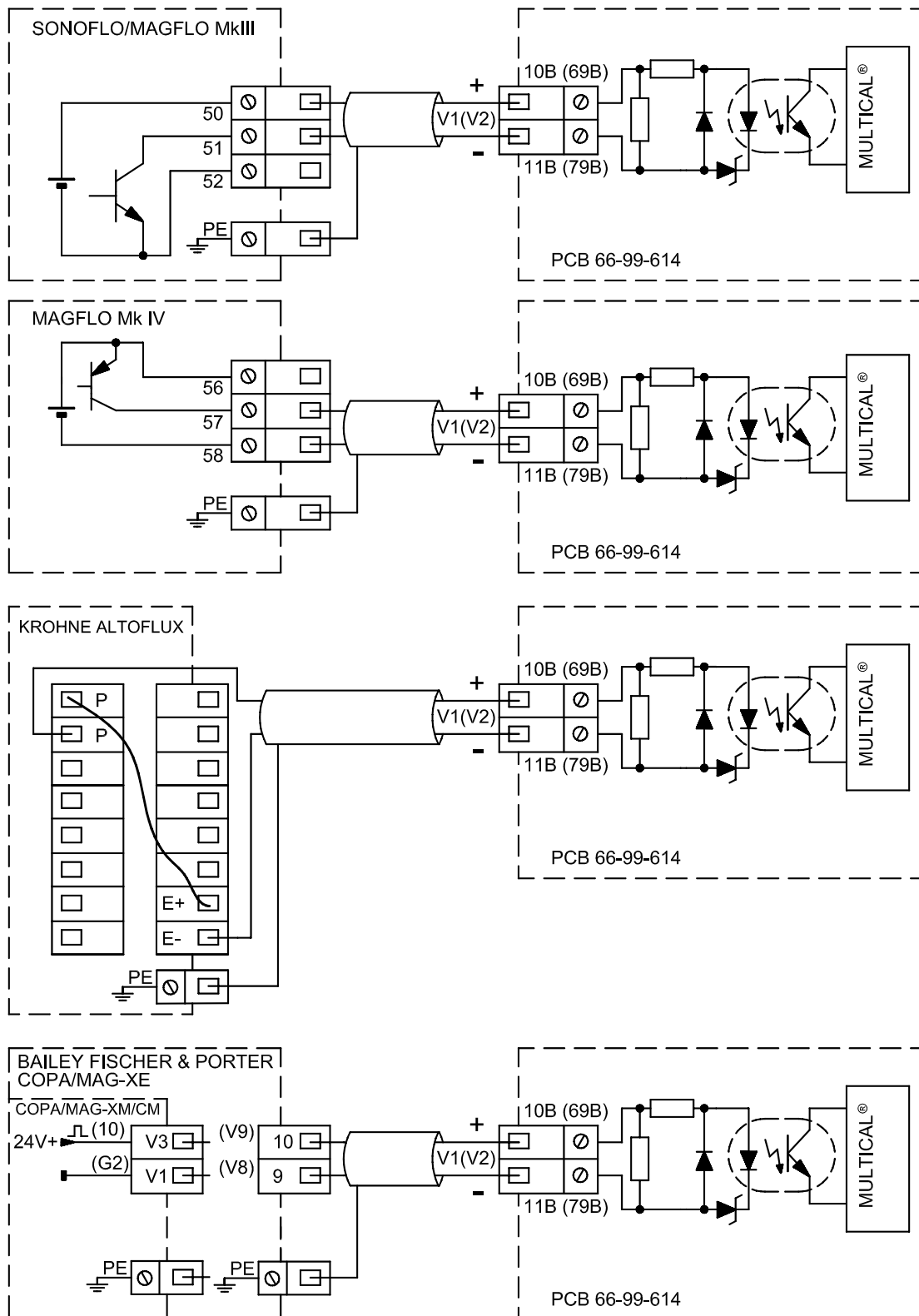


Figure 3

7.2.2 Flow sensor coding

In connection with installation it is important that both the flow sensor and the MULTICAL® are programmed correctly. Below table states the possibilities:

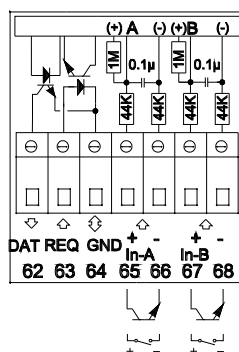
CCC no.	Pre-counter	Flow factor	Number of decimals on the display					l/pulse	Pulse/l	Qp range (m³/h)	Qs (m³/h)	Type	Flow sensor
			MWh Gcal	GJ	m³ ton	m³/h	MW						
201	100	235926	2	1	1	1	2	1	1	10...100	75	FUS380 DN50-65	K-M
202	40	589815	2	1	1	1	2	2.5	0.4	40...200	240	FUS380 DN80-100	K-M
203	400	589815	1	0	0	1	2	2.5	0.4	100...400	500	FUS380 DN125	K-M
204	100	235926	1	0	0	0	1	10	0.1	150...1200	1600	FUS380 DN150-250	K-M
205	20	1179630	1	0	0	0	1	50	0.02	500...3000	3600	FUS380 DN300-400	K-M

Table 3

7.3 Pulse inputs VA and VB

In additions to the pulse inputs V1 and V2 MULTICAL® 601 has two extra pulse inputs, VA and VB, to collect and accumulate pulses remotely, e.g from cold-water meters and electricity meters. The pulse inputs are physically placed on the "base modules" as for instance on the "data/pulse input module" that can be placed in the connection base, however, accumulation and data logging of values are made by the calculator.

The pulse inputs VA and VB function independantly of the other inputs/outputs and thereby they are not included in any energy calculations.



Both pulse inputs are constructed identically and can individually be set up to receive pulses from water meters with max. 1 Hz or pulses from electricity meters with max. 3 Hz.

Configuration to correct pulse value is made at the factory on the basis of order information or are configured by means of METERTOOL. See paragraph 3.6 concerning configuration of VA (FF codes) and VB (GG codes).

MULTICAL® 601 registers the accumulated consumption for the meters connected to VA and VB and stores the registers every month and every year on the target date. To facilitate the identification during data reading it is also possible to store the meter numbers for the two meters that are connected to VA and VB. Programming is made by means of METERTOOL.

The registers that can both be read on the display (by selecting a suitable DDD code) and via data communication contains the following information as well as date of yearly and monthly data:

Registration type:	Count	Identification	Yearly data	Monthly data
VA (accumulated register)	•			
Meter number VA		•		
Yearly data, up to 15 years back			•	
Monthly data, up to 36 months back				•
VB (accumulated register)	•			
Meter number VB		•		
Yearly data, up to 15 years back			•	
Monthly data, up to 36 months back				•

By using METERTOOL the registers VA and VB can be preset to the value of the connected meters at the time of installation.

7.3.1 Display example, VA

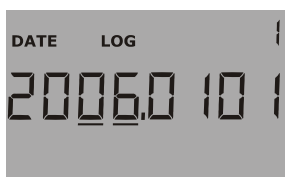
In the example below VA is configured to FF=24, which corresponds to 10 liters/pulse and a max. flow of 10 m³/h. The meter that is connected to VA has meter number 75420145 which is stored in MULTICAL® 601's internal memory by means of METERTOOL .



Accumulated register for VA (Input A)



Meter number for VA (max. 8 digits)



Yearly data, date for LOG 1 (last target date)



Yearly data, value for LOG 1 (last yearly reading)

This is the accumulated volume registered on VA on the 1st January 2006.

8 Temperature sensors

For MULTICAL® 601 either Pt100 or Pt500 temperature sensors are used according to EN 60751 (DIN/IEC 751). A Pt100 or Pt500 temperature sensor is a platinum sensor with a nominal ohmic resistance of 100.000 Ω and 500.000 Ω , respectively, at 0.00°C and 138.506 Ω and 692.528 Ω at 100.00°C, respectively. All values for the ohmic resistance are laid down in the international standard IEC 751 valid for Pt100 temperature sensors. The values for the ohmic resistances in Pt500 sensors are 5 times higher. In below tables the resistance values in [Ω] are stated for every whole degree celcius for both Pt100 and for Pt500 sensors:

Pt100										
°C	0	1	2	3	4	5	6	7	8	9
0	100.000	100.391	100.781	101.172	101.562	101.953	102.343	102.733	103.123	103.513
10	103.903	104.292	104.682	105.071	150.460	105.849	106.238	106.627	107.016	107.405
20	107.794	108.182	108.570	108.959	109.347	109.735	110.123	110.510	110.898	111.286
30	111.673	112.060	112.447	112.835	113.221	113.608	113.995	114.382	114.768	115.155
40	115.541	115.927	116.313	116.699	117.085	117.470	117.856	118.241	118.627	119.012
50	119.397	119.782	120.167	120.552	120.936	121.321	121.705	122.090	122.474	122.858
60	123.242	123.626	124.009	124.393	124.777	125.160	125.543	125.926	126.309	126.692
70	127.075	127.458	127.840	128.223	128.605	128.987	129.370	129.752	130.133	130.515
80	130.897	131.278	131.660	132.041	132.422	132.803	133.184	133.565	133.946	134.326
90	134.707	135.087	135.468	135.848	136.228	136.608	136.987	137.367	137.747	138.126
100	138.506	138.885	139.264	139.643	140.022	140.400	140.779	141.158	141.536	141.914
110	142.293	142.671	143.049	143.426	143.804	144.182	144.559	144.937	145.314	145.691
120	146.068	146.445	146.822	147.198	147.575	147.951	148.328	148.704	149.080	149.456
130	149.832	150.208	150.583	150.959	151.334	151.710	152.085	152.460	152.835	153.210
140	153.584	153.959	154.333	154.708	155.082	155.456	155.830	156.204	156.578	156.952
150	157.325	157.699	158.072	158.445	158.818	159.191	159.564	159.937	160.309	160.682
160	161.054	161.427	161.799	162.171	162.543	162.915	163.286	163.658	164.030	164.401
170	164.772	165.143	165.514	165.885	166.256	166.627	166.997	167.368	167.738	168.108

Pt100, IEC 751 Amendment 2-1995-07

Table 4

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
170	823.861	825.716	827.571	829.426	831.280	833.133	834.986	836.838	838.690	840.541

Pt500, IEC 751 Amendment 2-1995-07

Table 5

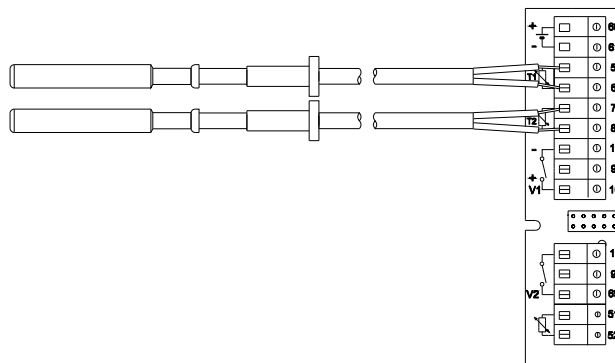
8.1 Sensor types

MULTICAL® 601	Type 67-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pt500 sensor set						
No sensor set						0
Pocket sensor set w/1.5 m cable						A
Pocket sensor set w/3.0 m cable						B
Pocket sensor set w/5 m cable						C
Pocket sensor set w/10 m cable						D
Short direct sensor set w/1.5 m cable						F
Short direct sensor set w/3.0 m cable						G
3 Pocket sensors in sets w/1.5 m cable						L
3 Pocket sensors in sets w/3.0 m cable						M
3 Pocket sensors in sets w/5 m cable						N
3 Pocket sensors in sets w/10 m cable						P
3 Short direct sensors in sets w/1.5 m cable						Q3

8.2 Cable influence and compensation

8.2.1 2 wire sensor set

Small and medium-sized heat meters only need a relatively short temperature sensor length, and the 2 wire sensor set can be used with the advantage of easy installation.



The cable length and the cross sectional area must always be identical for the 2 sensors used as a temperature sensor pair for a heat meter. The length of the cable sensors must neither be shortened nor extended.

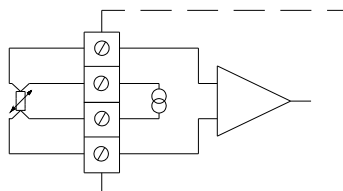
The limitations attached to using the 2 wire sensor set according to EN 1434-2:2004 are stated in below table.

Cable cross section [mm²]	Pt100 sensors		Pt500 sensors	
	Max. cable length [m]	Temperature increase [K/m] <i>Copper @ 20 °C</i>	Max. cable length [m]	Temperature increase [K/m] <i>Copper @ 20 °C</i>
	0.22	2.5	0.450	12.5
0.50	5.0	0.200	25.0	0.040
0.75	7.5	0.133	37.5	0.027
1.50	15.0	0.067	75.0	0.013

Table 6

8.2.2 4 wire sensor set

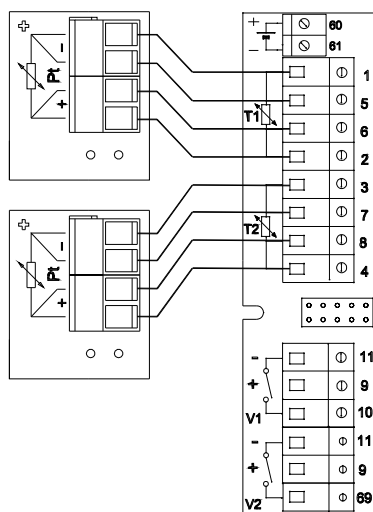
For installations requiring longer cable lengths than stated in above table, we recommend a 4 wire sensor set and a MULTICAL® 601 type 67-B with 4 wire connection.



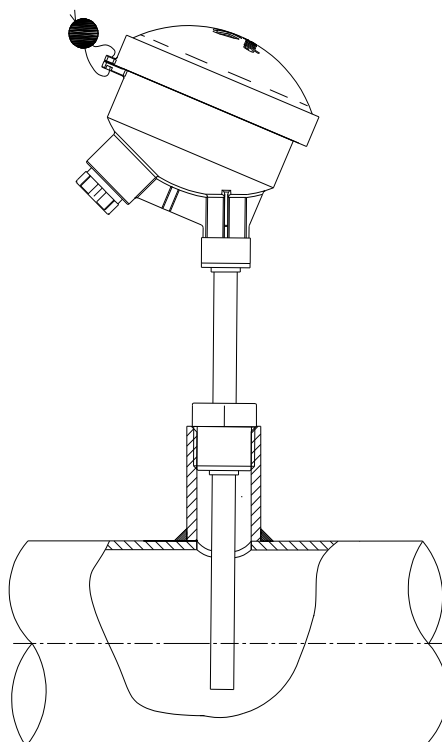
The 4 wire construction uses two conductors for testing current and the two other conductors for measuring signal. In this way, the construction will in theory not be affected by long sensor cables. However, in practice cables longer than 100 m should not be used. We recommend to use 4 x 0.25 mm².

The connection cable should have an outside diameter of 5-6 mm to obtain optimal tightening in both

MULTICAL® 601 and in the cable gland on the 4 wire sensor. The insulation material/cover of the cable should be selected based on the max. temperature in the installation. PVC cables are typically used up to 80°C and in connection with higher temperatures silicone cables are often used.



4 wire sensor set from Kamstrup has an interchangeable sensor pocket and is available in the lengths 90, 140 and 180 mm.



8.3 Pocket sensors

The Pt500 cable sensor is constructed with a 2 wire silicone cable and closed with a shrunk-on stainless steel tube with a diameter of $\varnothing 5.8$ mm that protects the sensor element.

The steel tube is fitted in a sensor pocket (pocket) which has an inside diameter of $\varnothing 6$ and an outside diameter of $\varnothing 8$ mm. The sensor pockets are supplied with an $R\frac{1}{2}$ (conical $\frac{1}{2}$ "") connection in stainless steel with a length of 65, 90 or 140 mm. The sensor construction with separate pocket allows replacement of sensors without turning off the water flow. The large selection of pocket lengths also ensures that the sensors can be fitted in all pipe sizes.

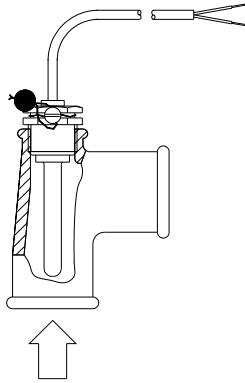


Figure 4

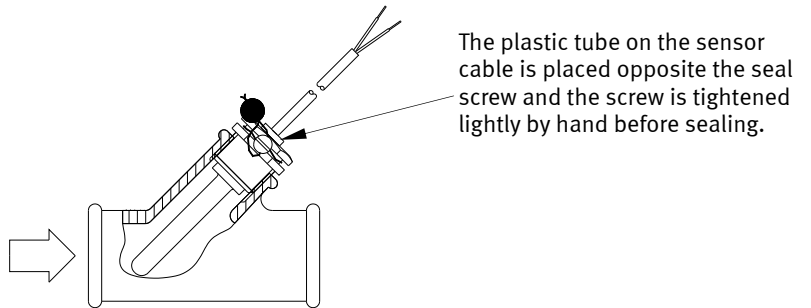


Figure 5

The stainless steel pockets is used in PN25 installations!

8.4 Pt500 short direct sensor set

The Pt500 short direct sensor is constructed according to the European standard for thermal heat meters EN 1434-2. The sensor is constructed for fitting directly in the measuring medium, i.e. without sensor pocket. In this way an extremely fast response time on temperature changes from e.g. domestic water exchangers is obtained.

The sensor is based on a 2 wire silicone cable. The sensor tube is made of stainless steel and has a diameter of $\varnothing 4$ mm at the tip where the sensor element is placed. Fitting can also be made directly in many flow sensor types, which reduces the installation costs.

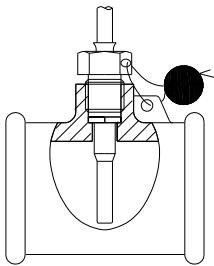


Figure 6

The sensor is fitted in special T-sections, that is available for $\frac{1}{2}$ ", $\frac{3}{4}$ " and 1" pipe installations.

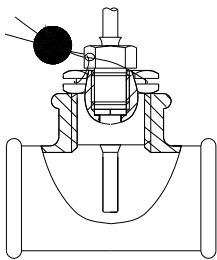


Figure 7

In addition, the short direct sensor is fitted by means of a $R\frac{1}{2}$ or $R\frac{3}{4}$ for M10 nipple in a standard 90° tee.

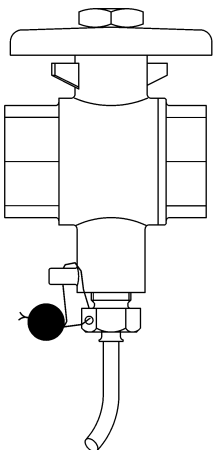


Figure 8

To obtain the best serviceability during meter replacements, the short direct sensor can be placed in a ball valve with a sensor connecting piece.

Ball valves with a sensor connecting piece are available in $G\frac{1}{2}$, $G\frac{3}{4}$ and G1.

No.	6556-474	6556-475	6556-476
	$G\frac{1}{2}$	$G\frac{3}{4}$	G1

Max. 130°C and PN16

9 Voltage supply

MULTICAL® 601 must always be supplied internally with 3.6 VDC ($\pm 5\%$) on terminals 60(+) and 61(-). This is obtained by one of the following supply modules:

Supply	MULTICAL 601®	Type 67-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Battery, D-cell										
230 VAC supply module with trafo										
24 VAC supply module with trafo										

The 3 above supply modules are all included in the extensive type test made on MULTICAL® 601. Within the frameworks of the type approval, the CE declaration and the factory guarantee, no other types of supply modules must be used than those mentioned above.

66-CDE \Rightarrow MC 601 MULTICAL® 601 cannot be supplied from 24 VDC.

Integral D-cell lithium battery

A lithium D-cell battery (Kamstrup type 66-00-200-100) must be used for the meter. The battery is placed at the right in the base unit and can easily be replaced just by using a screwdriver.



The battery lifetime partly depends on the temperature to which the battery is exposed and partly of the selected meter application.

Application (temperature)	Battery lifetime	
	With 1 ULTRAFLOW®	With 2 ULTRAFLOW®
MULTICAL® 601 mounted on the wall (battery temperature $< 30^{\circ}\text{C}$)	10 years	6 years
MULTICAL® 601 mounted on the flow part (battery temperature $< 45^{\circ}\text{C}$)	8 years	5 years

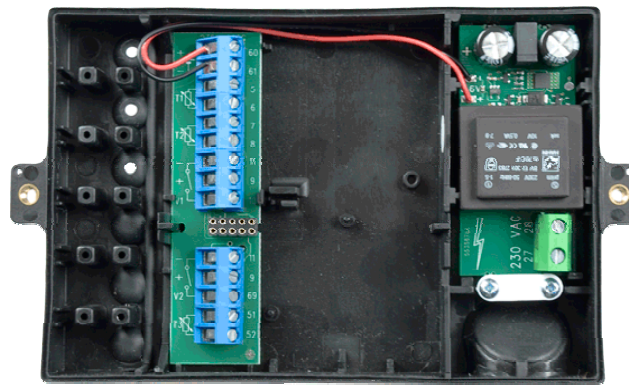
Above battery lifetimes apply for standard installations. Following may reduce the battery lifetime:

- Warm ambient temperatures
- Connection of data modules
- Frequent data communication

Please contact Kamstrup for further details.

9.2 Supply module 230 VAC

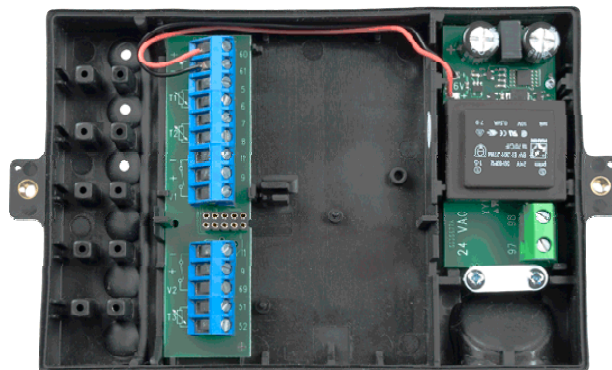
This PCB module is galvanically separated from the mains supply and is suited for direct 230 V mains installation. The module contains a double chamber safety transformer that meets the demands for double insulation when the calculator top has been mounted. The power consumption is less than 1 VA/1 W.



National electricity installation requirements must be met. The 230 VAC module must be connected/disconnected by the utility staff, whereas the fixed 230 V installation for the switch cabinet must only be made by an authorised electrician.

9.3 Supply module 24 VAC

This PCB module is galvanically separated from the 24 VAC mains supply and is suited for industrial installations with joint 24 VAC supply and individual installations supplied from a separate 230/24 V safety transformer in the switch cabinet. The module contains a double chamber safety transformer that meets the demands for double insulation when the calculator top has been mounted. The power consumption is less than 1 VA/1 W.



National electricity installation requirements must be met. The 24 VAC module must be connected/disconnected by the utility staff, whereas installation of 230/24 V in the switch cabinet must only be made by an authorised electrician.

The module is especially suited for installation together with a 230/24 V safety transformer, e.g. type 66-99-403, that can be installed in the switch cabinet before the safety relay. When the transformer is used the power consumption will be less than 1.7 W for the entire meter including the 230/24 V transformer.



9.4 Exchanging the supply unit

The power supply unit for MULTICAL® 601 can be exchanged from mains supply to battery or vice versa as the needs at the utility change. In this way, mains supplied meters can be exchanged for battery meters with advantage in connection with buildings in the course of construction, as the mains supply may be unstable or lack periodically.

Exchange from battery to mains supply does not require reprogramming, as MULTICAL® 601 does not contain an information code for worn out batteries.

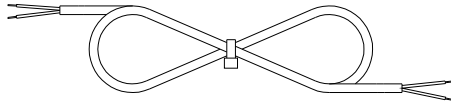
However, exchange from mains supply to battery must not be made on MULTICAL® 601 with following base modules:

	MULTICAL 601®	Type 67-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Base module										
Radio Router/pulse inputs					21					
Prog. data logger + RTC + 4...20 mA inputs + pulse inputs					22					
0/4...20 mA outputs					23					
LonWorks, FTT-10A/pulse inputs					24					

See paragraph 10.1.5 re supply options for top and base modules.

9.5 Mains supply cables

MULTICAL® 601 is available with 1.5 m supply cable, type "H05 VV-F" for either 24 VAC or for 230 VAC. Supply cables with copper conductors and a cable cross section of $2 \times 0.75 \text{ mm}^2$ must be connected via a fuse of max. 6 Amp.



Supply cable, type 5000-286 ($2 \times 0.75 \text{ mm}^2$)

"H05 VV-F" is the designation for a heavy PVC cable, that stands max. 70°C . The supply cable must therefore be installed with a sufficient distance to hot pipes and the like.

9.6 Danish regulations for connection of electric mains operated meters

Installation to electric mains operated equipment for consumption registration (text from The Danish Safety Technology Authority , 2004-12-06)

Registration of the energy and resource consumption (electricity, heat, gas and water) at the individual consumer's is to a greater extent made by means of electronic meters, and often equipment for remote reading and remote control of both electronic and non-electronic meters is used.

To prevent the consumer intentionally or unintentionally from disconnecting the supply to electronic meters or the remote reading and remote controlling equipment, the Electricity Council earlier allowed that installations could be made according to instructions given in ELRÅD-MEDDELELSE "Installationer nr. 5/98" (information given by the Electricity Council).

As a consequence of the introduction of new regulations in paragraph 6 of the heavy current instructions, the Electricity Council is no longer of the opinion that there is a need for special permissions in connection with installation of such equipment.

The ordinary regulations for carrying out installations must therefore be fulfilled. However, it is allowed to utilize following exemptions:

If meters or equipment for remote reading or remote control are double insulated it is not necessary to carry through a protective conductor to the point of connection. This also applies when the point of connection is a socket outlet provided that it is placed in a canning that is sealable or that can only be opened by means of a key or tool.

If meters or equipment for remote reading or remote control are used that are connected to a safety transformer placed in the switch cabinet or connected directly on the consumer supply line, there are no demands on switch or separate overcurrent protection neither in the primary nor in the secondary circuit, provided that following conditions are fulfilled:

- The safety transformer must either be inherently short-circuit proof or fail-safe.
- The cable in the primary circuit must either be short-circuit protected by the overcurrent protection of the consumer supply line or stored in a short-circuit proof way.
- The cable in the secondary circuit must have a conductor cross section of min. 0.5 mm^2 and a current value larger than the current supplied by the transformer.
- It must be possible to separate the secondary circuit either by means of isolators or it must be stated in the installation guide that the secondary circuit can be disconnected in the transformer terminals.

General information

Work with fixed installations, including any intervention in the group board, must only be made by an authorized circuit installer.

It is not required that service work on equipment comprised by this ELRÅDS-meddelelse, as well as connection and disconnection of the equipment outside the board is made by an authorized circuit installer. These works can also be performed by persons or companies that commercially produce, repair or maintain the equipment when the person performing the work has the necessary knowledge.

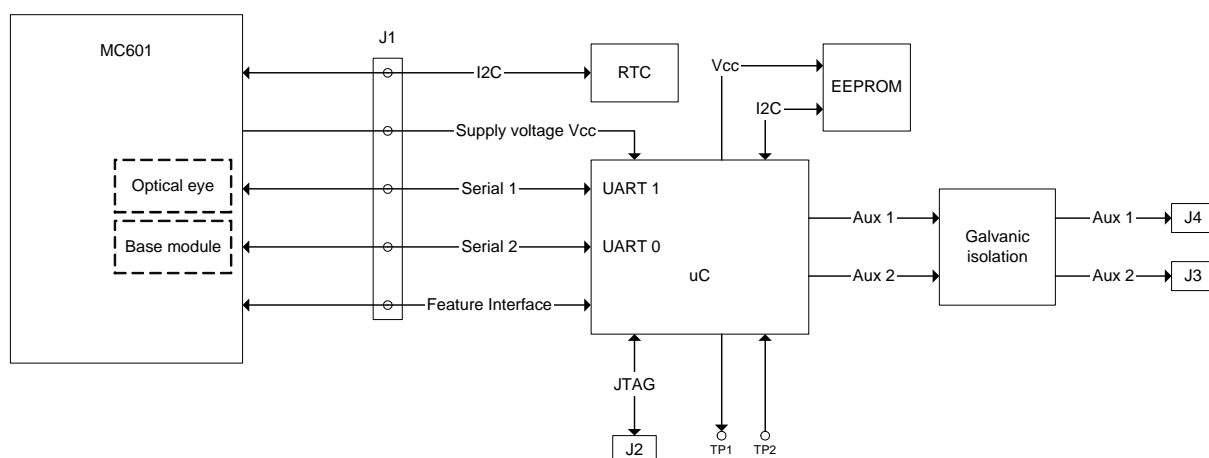
10 Plug-in modules

Plug-in modules can be added to MULTICAL® 601 both in the calculator top (top modules) and in the base unit (base modules), in this way the meter adapts to a number of various applications.

All plug-in modules are included in the extensive type test which MULTICAL® 601 has gone through. Within the framework of the type approval, the CE declaration and the factory guarantee other types of plug-in modules than those mentioned below cannot be used:

10.1 Top modules

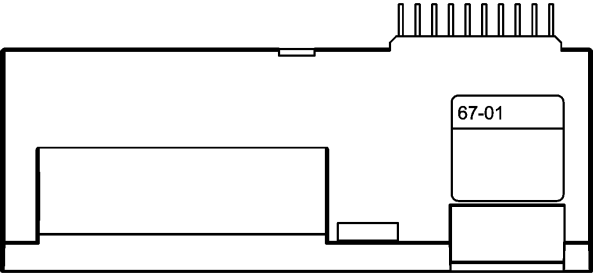
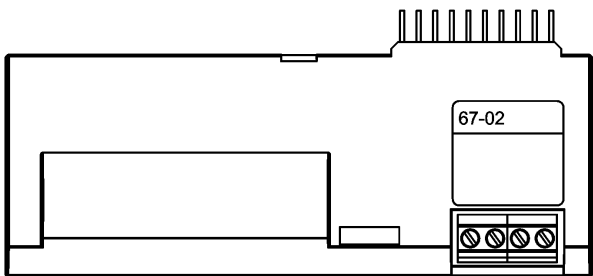
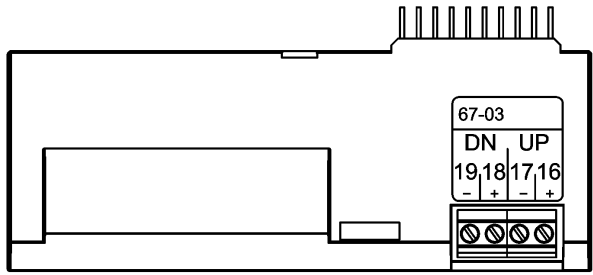
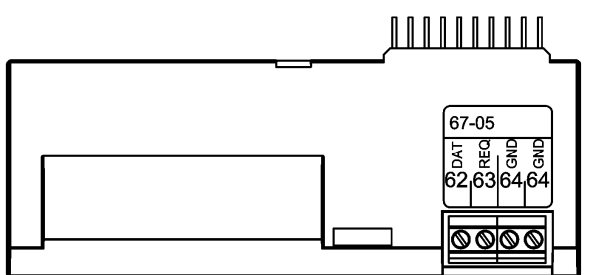
	MULTICAL 601®	Type 67-								
Top module										
RTC (Real Time Clock)			1							
RTC + Δ Energy calculation + hourly data logger			2							
RTC + PQ or Δt -limiter + hourly data logger			3							
RTC + data output + hourly data logger			5							
RTC + 66-C compatibility + pulse outputs (CE and CV)			6							
RTC + M-Bus			7							
RTC + 2 pulse outputs for energy/volume + hourly data logger			8							
RTC + Δ Volume + hourly data logger			9							
RTC + 2 pulse outputs CE and CV + hourly data logger + scheduler			A							
RTC + 2 pulse outputs CE and CV + prog. data logger			B							

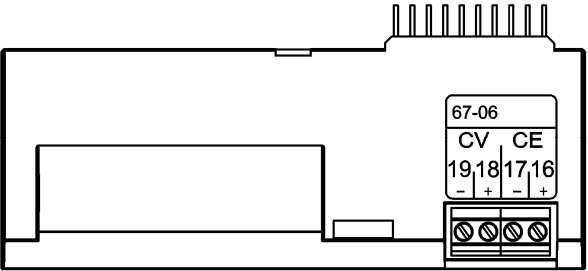
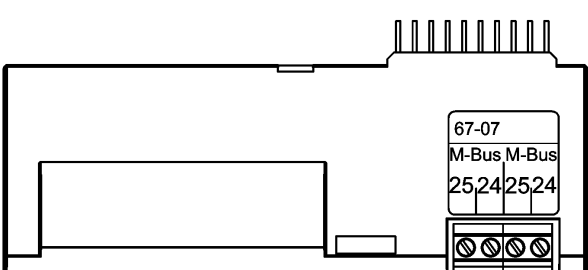
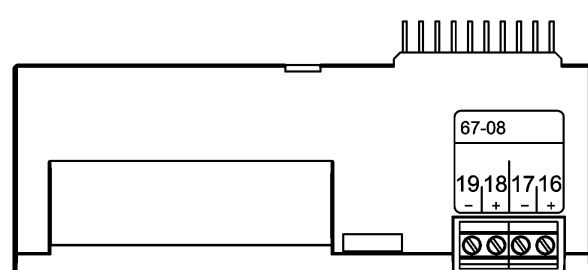
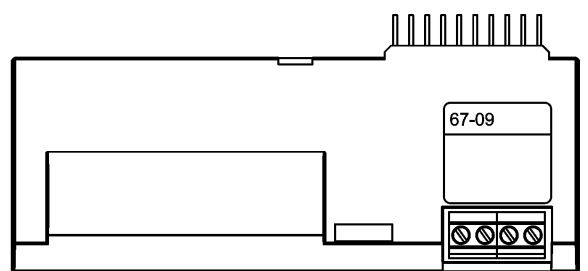


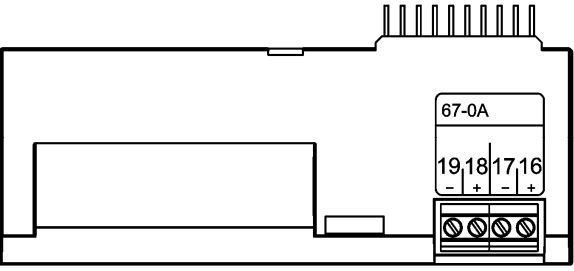
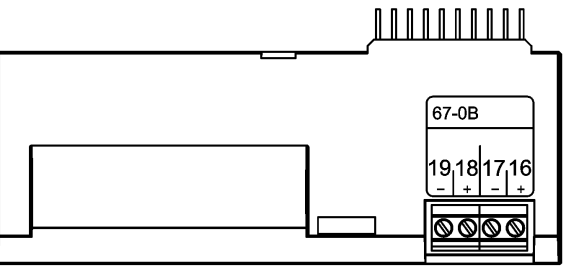
Topmodule functional block diagram

The top modules are build up on the above joint hardware platform. The application program in the micro controller and the component location vary according to the task.

10.1.1 Top module overview

	<p>Type 67-01: RTC, Real Time Clock</p> <p>The top module consists of real time clock and battery backup. When the MULTICAL® 601 calculator top is placed in the connecting bracket and is powered, current date and time are transferred from top module to calculator.</p> <p>The top module is recommended for applications where correct date/time in data loggers as well as time-controlled tariffs are important.</p> <p>Real time clock and battery backup are standard features in all other top modules.</p> <p><i>Terminal screws are not used in this module.</i></p>
	<p>Type 67-02: RTC + Δ energy calculation and hourly data logger</p> <p>This top module calculates the difference between forward and return energy, whereby an expression of the tapped energy in open systems is obtained.</p> <p>Differential energy $dE=E_4-E_5$.</p> <p>The module also comprises an hourly data logger. Besides the differential energy dE, the logger includes registers such as daily logger (see paragraph 6.10 Data loggers).</p> <p><i>Terminal screws are not used in this module.</i></p>
	<p>Type 67-03: RTC + PQ-limiter + hourly data logger</p> <p>The module has two pulse outputs which can be used for UP/DOWN control of a low-speed three-point motor-operated valve via an external solid-state relay, type S75-90-006 and a 230/24 V trafo, type 66-99-403.</p> <p>The required power and flow limits are entered into MULTICAL® 601 via the PC-program METERTOOL.</p> <p>Also see instructions: 5512-498</p> <p>The module also includes an hourly data logger.</p>
	<p>Type 67-05: RTC + data output + hourly data logger</p> <p>The module has a galvanically separated data port which functions together with the KMP-protocol. The data output can be used for e.g. connection of external communication units or other hardwired data communication which it is not expedient to carry out via the optical communication on the meter's front.</p> <p>62: DATA (Brown) – 63: REQ (White) – 64: GND (Green). Use data cable type 66-99-106 with 9-pole D-sub or type 66-99-098 with USB connector.</p> <p>The module also includes an hourly data logger.</p> <p>Only current and accumulated data can be read. Data loggers for time/days/months/years cannot be read through the data port of top module 67-05.</p>

 <p>67-06 CV CE 19 18 17 16 - + - +</p>	<p>Type 67-06: RTC + 66-C compatibility + pulse outputs</p> <p>The top module makes MULTICAL® 601 data compatible with MULTICAL® 66-C making it possible to use many of the previous base modules for MULTICAL® 66-C in MULTICAL® 601 too. Furthermore the top module has two pulse outputs for energy (CE) and volume (CV) respectively. The pulse resolution follows the display (fixed in CCC-code). E.g. CCC=119 (qp 1.5): 1 pulse/kWh and 1 pulse/0.01 m³. The pulse width is 32 ms. The pulse outputs are optoinsulated and can be charged with 30 VDC and 10 mA.</p>
 <p>67-07 M-Bus M-Bus 25 24 25 24</p>	<p>Type 67-07: RTC + M-Bus</p> <p>M-Bus can be connected in star, ring and bus topology. Depending on M-Bus master and cable length/cross section, up to 250 meters can be connected with primary addressing, and even more using secondary addressing.</p> <p>Cable resistance in network: < 29 Ohm</p> <p>Cable capacity in network: < 180 nF</p> <p>The connection polarity of terminals 24-25 is unimportant. Unless otherwise stated in the order, the primary address consists of the last three digits of the customer number, but it can be changed via the PC program METERTOOL.</p>
 <p>67-08 19 18 17 16 - + - +</p>	<p>Type 67-08: RTC + 2 pulse outputs for CE and CV + hourly data logger</p> <p>This top module has two configurable pulse outputs, which are suitable for volume and energy pulses for heat meters, cooling meters and combined heat/cooling meters.</p> <p>The pulse resolution follows the display (fixed in the CCC-code). E.g. CCC=119 (qp 1.5): 1 pulse/kWh and 1 pulse/0.01 m³.</p> <p>The pulse outputs are optoinsulated and can be charged with 30 VDC and 10 mA.</p> <p>Normally, energy (CE) is connected to 16-17 and volume (CV) to 18-19, but other combinations can be selected via the PC program METERTOOL, also used to select pulse width 32 or 100 ms.</p> <p>The module also comprises an hourly data logger, including registers such as daily logger (see paragraph 6.10 Data loggers).</p>
 <p>67-09</p>	<p>Type 67-09: RTC + ΔVolume calculation and hourly data logger</p> <p>This top module calculates the difference between forward and return volume, whereby an expression of the tapped energy in open systems is obtained.</p> <p>Differential volume $dV = V1 - V2$.</p> <p>The module also comprises an hourly data logger. Besides the differential volume, the logger includes registers such as daily logger (see paragraph 6.10 Data loggers).</p> <p>Requires CCC1=CCC2 and a suitable DDD-code.</p> <p><i>Terminal screws are not used in this module.</i></p>

	<p>Type 67-0A: RTC + 2 pulse outputs for CE and CV + hourly data logger + scheduler</p> <p>See Application no. 10 on page 32, Hot water meter</p> <p>The top module has the same functions as the 67-08 top module and furthermore the module is able to simulate a cold water temperature according to a programmed scheduler, where the programmed temperature for T2, T3 or T4 can be programmed with up to 12 individual dates/temperatures per year.</p>
	<p>Type 67-0B: RTC + 2 pulse outputs for CE and CV + prog. data logger</p> <p>The RTC and pulse output functions of this top module are identical with the functions described under top module 67-08.</p> <p>The top module is prepared for use in a Kamstrup radio network together with the Radio Router base module 6700210003xx, read data being transferred to the system software via network unit RF Concentrator.</p>

10.1.2 Top module 67-06 pulse outputs

This module has two pulse outputs with fixed functions and pulse widths:

Meter function	Output C (16-17)	Output D (18-19)	Pulse duration
Heat meter	CE+ Heat energy	CV+ Heat Volume	32 msec.

Pulse resolution follows the display (fixed in CCC-code). E.g. CCC=119: 1 pulse/kWh and 1 pulse/0.01m³

66-CDE ⇒ MC 601

Modems, M-Bus and radio modules for MULTICAL® 66-C can be used in MULTICAL® 601 if top module 67-06 is mounted.

The top module supports following data strings: /#1, /#2, /#3, /#5, /#B, /#C, /#E, /#K, /#N as well as manual calls and alarms.

10.1.3 Top module 67-08 pulse outputs

This top module has two configurable pulse outputs, which are suitable for combined heating/cooling applications among other things:

Meter function	Output C (16-17)	Output D (18-19)	Pulse duration
Heat meter	CE+ Heat energy (E1)	CV+ Volume (V1)	32 msec. or 100 msec.
Volume meter	CV+ Volume (V1)	CV+ Volume (V1)	
Cooling meter	CE- Cooling energy (E3)	CV+ Volume (V1)	
Heat/cooling meter	CE+ Heat energy (E1)	CE- Cooling energy (E3)	

Pulse resolution follows the display (fixed in CCC-code). E.g. CCC=119: 1 pulse/kWh and 1 puls/0.01m³

The module includes the configuration data, which will also follow the module in case of replacement.

CV- (TA3) is only used in connection with tariff EE=20.

10.1.4 Fitting and removing the top module

The top module is released by pressing downwards in the middle of the plastic piece on the left, and at the same time pushing the top module towards the left.



Figure 9

10.1.5 Supply options for top and base modules

Top ⇒ Base ↓	67-01 RTC	67-02+67-09 RTC + ΔE + H- Log	67-03 RTC + PQ + H-Log	67-05 RTC + Data + H- Log	67-06 RTC + 66-C +CE-CV	67-07 RTC + M-Bus	67-08+67-0A RTC+H-Log+ 2 pulse out	67-09 RTC + ΔV + H-Log	67-0B RTC+2 pulse out+prog.data log
67-00-10 Data+p/i	Battery or mains	Battery or mains	Mains only	Battery or mains	Battery or mains	Mains only	Battery or mains	Battery or mains	Battery or mains
67-00-20 M-Bus+p/i	Battery or mains	Battery or mains	Mains only	Battery or mains	N/A	Mains only	Battery or mains	Battery or mains	Battery or mains
67-00-21 Radio Router +pulse inp.	Mains only	Mains only	Mains only	Mains only	N/A	Mains only	Mains only	Mains only	Mains only
67-00-22 4-20 inp.	Mains only	Mains only	Mains only	Mains only	N/A	Mains only	Mains only	Mains only	Mains only
67-00-23 0/4-20 out	Mains only	Mains only	Mains only	Mains only	N/A	Mains only	Mains only	Mains only	Mains only
67-00-24 LONWorks +pulse inp.	Mains only	Mains only	Mains only	Mains only	N/A	Mains only	Mains only	Mains only	Mains only
67-00-25 RF+p/i	Battery or mains	Battery or mains	Mains only	Battery or mains	N/A	Mains only	Battery or mains	Battery or mains	Battery or mains
67-00-26 RF+p/i	Battery or mains	Battery or mains	Mains only	Battery or mains	N/A	Mains only	Battery or mains	Battery or mains	Battery or mains
67-00-03 Modem +pulse inp.	N/A	N/A	N/A	N/A	Battery or mains	N/A	N/A	N/A	N/A
67-00-04 M-Bus+p/i	N/A	N/A	N/A	N/A	Battery or mains	N/A	N/A	N/A	N/A
67-00-08 M-Bus+p/i	N/A	N/A	N/A	N/A	Battery or mains	N/A	N/A	N/A	N/A
67-00-0A RF+p/i	N/A	N/A	N/A	N/A	Battery or mains	N/A	N/A	N/A	N/A
67-00-0B RF+p/i	N/A	N/A	N/A	N/A	Battery or mains	N/A	N/A	N/A	N/A

10.1.6 Module survey for Top module 67-05 with external communication box











Top ⇒ Ext. box ↓	67-05 RTC + Data + H-Log	Comments/restrictions in use
67-00-10	N/A	
67-00-20	N/A	
67-00-21 Radio Router +pulse inp.	Mains only	The module type in the external communication box is not displayed in MC601. Only accumulated and actual data. No hourly/daily/monthly/yearly data loggers can be read through the data port on the 67-05 top module. Radio Router always requires mains supply.
67-00-23	N/A	
67-00-24 LONWorks +pulse inp.	Mains only	The module type in the external communication box is not displayed in MC601. Only accumulated and actual data. No hourly/daily/monthly/yearly data loggers can be read through the data port on the 67-05 top module. LONWorks always requires mains supply.
67-00-25 RF+p/i	Battery or mains	The module type in the external communication box is not displayed in MC601. Only accumulated and actual data. No hourly/daily/monthly/yearly data loggers can be read through the data port on the 67-05 top module.
67-00-26 RF+p/i	Battery or mains	The module type in the external communication box is not displayed in MC601. Only accumulated and actual data. No hourly/daily/monthly/yearly data loggers can be read through the data port on the 67-05 top module.
67-00-03	N/A	
67-00-04	N/A	
67-00-08	N/A	
67-00-0A	N/A	
67-00-0B	N/A	

Note: Pulse inputs for VA and VB (terminals 65-66-67-68) are not connected when a module is installed in an external connection box.

10.2 Base modules

The base modules for MULTICAL® 601 can be divided into 3 groups:

67-00-2X	Modules specifically developed for MULTICAL® 601 and the KMP protocol. The top module type 67-06 should not be used.
67-00-1X	Modules with simple functions and without a microprocessor. Can be used in both MULTICAL® 601 and CDE.
67-00-0X	Modules from MULTICAL® 66-CDE that can be used in MULTICAL® 601, if a top module type 67-06 is connected at the same time.

MULTICAL 601®		Type 67-			 					 
Base module										
Data + pulse inputs					10					
M-Bus + pulse inputs					20					
Radio Router + pulse inputs					21					
Prog. data logger + RTC + 4...20 mA inputs + pulse inputs					22					
0/4...20 mA outputs					23					
LonWorks, FTT-10A + pulse inputs					24					
Radio + pulse inputs (internal antenna)					25					
Radio + pulse inputs (external antenna connection)					26					
Telephone modem + pulse inputs + data					03					
M-Bus + pulse inputs					04					
M-Bus + pulse inputs					08					
Radio + pulse inputs (internal antenna)					0A					
Radio + pulse inputs (external antenna connection)					0B					

10.2.1 Data + pulse inputs (67-00-10)

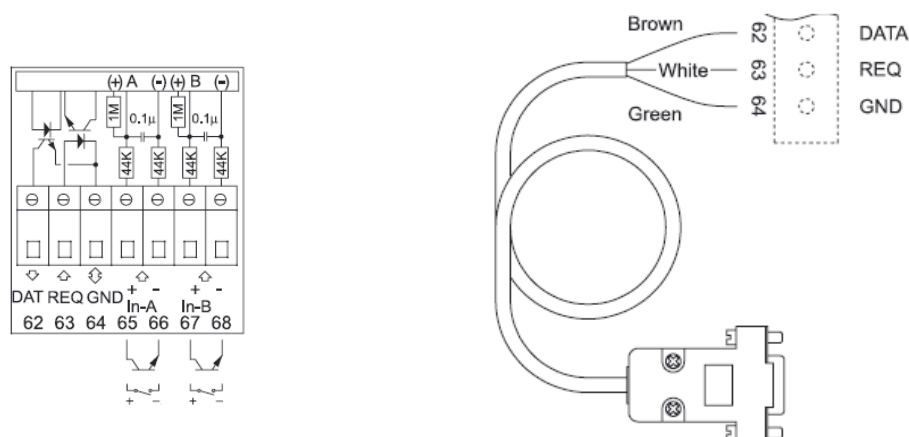
The module has a galvanically separated data port that functions with the KMP protocol. The data output can be used for connection of external communication units or another wired data communication which is not suitable to perform via optical communication on the front of the meter.

See paragraph 7.3 Pulse inputs VA and VB concerning functioning of the pulse inputs.

66-CDE ⇒ MC 601	When top module type 67-06 is used the data port will be compatible with the basic functions of MULTICAL® 66-C, such as /#1, /#2, /#3, /#5, /#B, /#C, /#E, /#K, /#N
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The module comprises data connection, which can be used for external data plug, designed for use with the hand-held terminal from Kamstrup, or as a semi-permanent PC connection.

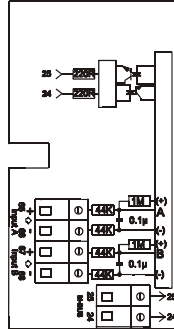
The data connection is galvanically isolated from the optocouplers which makes it necessary to use data cable type 66-99-105 or 66-99-106 in order to adjust the signal to RS-232 level, which is used by PC and with the handheld terminal from Kamstrup. See section 11. *Data communication* for information on data strings and protocols. If the computer does not have a COM port, a data cable with USB connection, type 66-99-098, can be used.



10.2.2 M-Bus + pulse inputs (67-00-20)

The M-Bus module is supplied via the M-Bus network and is independent of the meter's own supply. M-Bus and the energy meters communicate two-way via opto couplers which gives galvanically separation between M-Bus and the meter. The module supports primary, secondary and enhanced secondary addressing.

The M-Bus module has 2 extra inputs. See paragraph 7.3 Pulse inputs VA and VB concerning functioning of the pulse inputs.

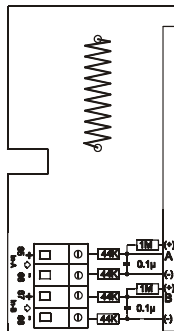


10.2.3 Radio Router + pulse inputs (67-00-21)

The radio module is supplied as standard to operate in a licence-free frequency band but can also be supplied to other frequencies requiring licence.

The radio module is prepared to form part of a Kamstrup radio network, where the data are automatically transferred to system software via the network components RF Router and RF Concentrator.

The radio module has 2 extra inputs. See paragraph 7.3 Pulse inputs VA and VB regarding functioning of the pulse inputs.

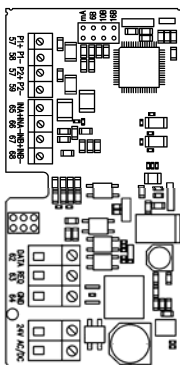


10.2.4 Prog. data logger + RTC + 4...20 mA inputs + pulse inputs (67-00-22)

The module has connection possibility for two pressure transmitters on terminals 57, 58 and 59 and can be adjusted for current reading or pressure ranges of 6, 10 or 16 bar.

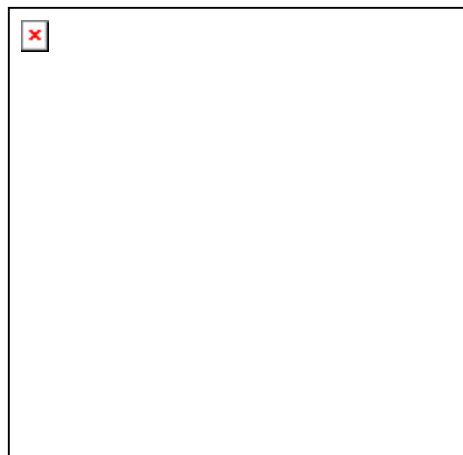
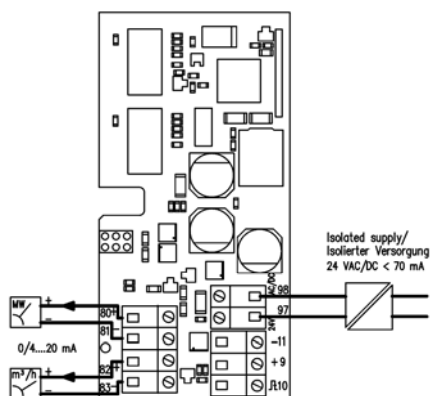
The module is prepared for remote reading, data from meter/module being transferred to the system software via the connected external GSM/GPRS modem on terminals 62, 63 and 64.

Furthermore, the module has two extra pulse inputs, see section 7.3: Pulse inputs VA and VB as to function. The module must always be powered by 24 VAC.



10.2.5 0/4...20 mA outputs (67-00-23)

The module is furnished with two active analogue outputs, which can both be configured for 0...20 mA or for 4...20 mA. In addition, the outputs can be configured to any measuring value (power, flow, or temperature) and to any range scaling.



The module must be mounted in MULTICAL® 601. It cannot be used separately together with flow meters. The configuration is carried out via the menu "Bottom module" in METERTOOL.

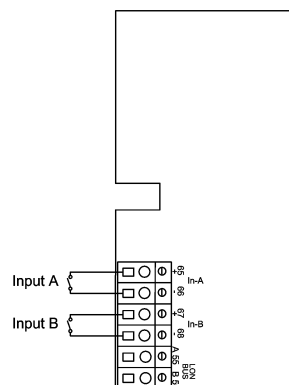
10.2.6 LonWorks, FTT-10A + pulse inputs (67-00-24)

The LonWorks module is used for data transfer from MULTICAL 601® either for data reading/registration for adjusting purposes via the Lon-bus.

See section 7.3 Pulse inputs VA and VB for details on the functioning of the pulse inputs. The module must be provided with 24 VAC voltage supply.

For a list of network variables (SNVT) and further information on the LonWoks module please see data sheet 5810-510. GB version 5810-511, DE version 5810-512.

For installation please refer to Installation Guide 5512-396.

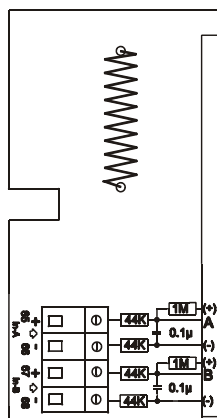


10.2.7 Radio + pulse inputs (67-00-25/26)

The radio module is supplied as standard to operate in a licence-free frequency band but can also be supplied to other frequencies requiring licence.

The radio module is prepared to form part of a Kamstrup radio network, where read data automatically is transferred to system software via the network components RF Router and RF Concentrator.

The radio module has 2 extra inputs. See paragraph 7.3 Pulse inputs VA and VB regarding functioning of the pulse inputs.

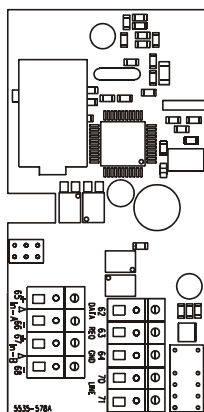


67-00-25: Internal antenna

67-00-26: External antenna connection

10.2.8 Telephone modem + pulse inputs + data (67-00-03)

The modem module is used for remote reading of heat meters via a DTMF telephone line. The modem module has 2 extra inputs. See paragraph 7.3 Pulse inputs VA and VB regarding functioning of the pulse inputs.



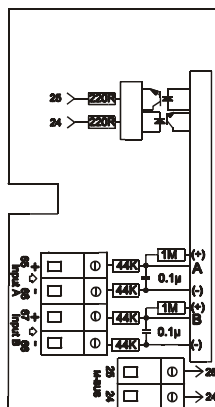
Note! The modem module is not recommended for new projects, but should only be used as spare part for existing installations.

Note! Requires top module Typ 67-06

10.2.9 M-Bus/pulse inputs (67-00-04/08)

The M-Bus module is supplied via the M-Bus network and is independent of the meter's own supply. M-Bus and the energy meter communicate two-way via opto couplers which gives galvanically separation between M-Bus and the meter.

The M-Bus module has 2 extra inputs. See paragraph 7.3 Pulse inputs VA and VB regarding functioning of the pulse inputs.



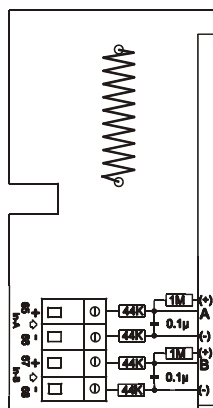
Note! Requires top module
Typ 67-06

10.2.10 Radio + pulse inputs (67-00-0A/0B)

The radio module is supplied as standard to operate in a licence-free frequency band but can also be supplied to other frequencies requiring licence.

The radio module is prepared to form part of a Kamstrup radio network, where read data automatically is transferred to system software via the network components RF Router and RF Concentrator.

The radio module has 2 extra inputs. See paragraph 7.3 Pulse inputs VA and VB regarding functioning of the pulse inputs.



67-00-0A: Internal antenna
67-00-0B: External antenna connection

Note! Requires top module
Typ 67-06

10.3 Retrofitting modules

Top as well as base modules for MULTICAL® 601 can be supplied separately for retrofitting. The modules are configured from the factory and ready to be mounted. Some of the modules, however, need individual configuration after installation, which can be carried out by means of METERTOOL.

Top module

Top module		Possible configuration after installation
RTC (Real Time Clock)	1	Adjustment of clock
RTC + Δ Energy calculation + Hourly data logger	2	Adjustment of clock
RTC + PQ or Δt -limiter + hourly data logger	3	Adjustment of clock Magnification, hysteresis and possible flow cutoff must be adjusted during commissioning. All parameters and limits can be changed via METERTOOL
RTC + data output + hourly data logger	5	Adjustment of clock
RTC + 66-C compatibility + pulse outputs (CE and CV)	6	Adjustment of clock Telephone numbers for DTMF-modems are set up via METERTOOL
RTC + M-Bus	7	Adjustment of clock Primary and secondary M-Bus addresses can be changed via METERTOOL or M-Bus. Furthermore, monthly logger data can be selected instead of yearly logger data by means of M-Bus
RTC + 2 pulse outputs for CE and CV + hourly data logger	8	Adjustment of clock. Configuration of pulse outputs. (Configured from the factory according to customer requirements)
RTC + Δ Volume + hourly data logger	9	Adjustment of clock
RTC + 2 pulse outputs for CE and CV + hourly data logger + scheduler	A	Adjustment of clock Configuration of pulse outputs.
RTC + 2 pulse outputs for CE and CV + prog. data logger	B	Adjustment of clock Configuration of pulse outputs.

Base module

Data/pulse inputs	10	Pulse values of VA and VB are changed via METERTOOL
M-Bus/pulse inputs	20	Pulse values of VA and VB are changed via METERTOOL Primary and secondary M-Bus addresses can be changed via METERTOOL or M-Bus. Furthermore, monthly logger data can be selected instead of yearly logger data via M-Bus
Radio Router/pulse inputs	21	Pulse values of VA and VB are changed via METERTOOL
Prog. data logger + RTC + 4...20 mA inputs + pulse inputs	22	Adjustment of clock Pulse values of VA and VB are changed via METERTOOL
0/4...20 mA outputs	23	Config data must be programmed into the calculator by means of METERTOOL in case of retrofitting. Furthermore, all parameters can be changed via METERTOOL
LonWorks, FTT-10A/pulse inputs	24	Pulse values of VA and VB are changed via METERTOOL. All other configurations via LonWorks
Radio + pulse inputs (internal antenna)	25	Pulse values of VA and VB are changed via METERTOOL
Radio + pulse inputs (external antenna)	26	Pulse values of VA and VB are changed via METERTOOL

11 Data communication

11.1 MULTICAL® 601 data protocol

Internally in MULTICAL® 601 the data communication is built up with a Kamstrup Meter Protocol (KMP) that both gives a fast and flexible reading structure, and fulfils future demands on data reliability.

The KMP protocol is common for all Kamstrup consumption meters introduced in 2006 and later. The protocol is used on the optical eye and via pins to the base module. Base modules with e.g. M-Bus interface uses the KMP protocol internally and the M-Bus protocol externally.

The KMP protocol is constructed to handle point-to-point communication in a master/slave system (bus system, if required) and is used for data reading of Kamstrup energy meters.

Software and parameter protection

The meter's software is implemented into ROM and can after that not be changed neither deliberately nor non-deliberately. The legal parameters cannot be changed via data communication without breaking the legal seal and short-circuiting the "total programming lock".

Software conformity

The check sum of the software, based on CRC16, is available via data communication and on the display.

Integrity and authenticity of data

All data parameters contain type, measuring unit, scaling factor and CRC16 check sum.

Each meter produced contains a unique identification number.

In the communication between master and slave two different formats are used. Either a data frame format or an application knowledge.

- Request from master to slave always takes place with a data frame.
- Response from the slave either takes place with a data frame or an application knowledge.

The data frame is based on the OSI model, in which the physical layer, data link layer and the application layer are used.

Number of bytes in each field	1	1	1	0-?	2	1
Field description	Start byte	Destination address	CID	Data	CRC	Stop byte
OSI – lag			Application layer			
		Data link layer				
	Physical layer					

The protocol is based on half duplex serial asynchronous communication with the setup: 8 databits, no parity and 2 stopbits. 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 where the 8 databits thereby represent a byte data.

"Byte Stuffing" is used to extend the data domain.

11.1.1 MULTICAL® 601 Register ID's

ID	Register	Description
1003	DATE	Current date (YYMMDD)
60	E1	Energy register 1: Heat energy
94	E2	Energy register 2: Control energy
63	E3	Energy register 3: Cooling energy
61	E4	Energy register 4: Flow energy
62	E5	Energy register 5: Return flow energy
95	E6	Energy register 6: Tap water energy
96	E7	Energy register 7: Heat energy Y
97	E8	Energy register 8: [m ³ • T1]
110	E9	Energy register 9: [m ³ • T2]
64	TA2	Tariff register 2
65	TA3	Tariff register 3
68	V1	Volume register V1
69	V2	Volume register V2
84	VA	Input register VA
85	VB	Input register VB
72	M1	Mass register V1
73	M2	Mass register V2
1004	HR	Operational hour counter
113	INFOEVENT	Info-event counter
1002	CLOCK	Current time (hhmmss)
99	INFO	Infocode register, current
86	T1	Current flow temperature
87	T2	Current return flow temperature
88	T3	Current temperature T3
122	T4	Current temperature T4
89	T1-T2	Current temperature difference
91	P1	Pressure in flow
92	P2	Pressure in return flow
74	FLOW1	Current flow in flow
75	FLOW2	Current flow in return flow
80	EFFEKT1	Current power calculated on the basis of V1-T1-T2
123	MAX FLOW1DATE/ÅR	Date for max. this year
124	MAX FLOW1/ÅR	Max. value this year
125	MIN FLOW1DATE/ÅR	Date for min. this year
126	MIN FLOW1/ÅR	Min. value this year
127	MAX EFFEKT1DATE/ÅR	Date for max. this year
128	MAX EFFEKT1/ÅR	Max. value this year
129	MIN EFFEKT1DATE/ÅR	Date for min. this myear
130	MIN EFFEKT1/ÅR	Min. value this year
138	MAX FLOW1DATE/MÅNED	Date for max. this year
139	MAX FLOW1/MÅNED	Max. value this year
140	MIN FLOW1DATE/MÅNED	Date for min. this month
141	MIN FLOW1/MÅNED	Min. value this month
142	MAX EFFEKT1DATE/MÅNED	Date for max. this month
143	MAX EFFEKT1/MÅNED	Max. value this month
144	MIN EFFEKT1DATE/MÅNED	Date for min. this month
145	MIN EFFEKT1/MÅNED	Min. value this month
146	AVR T1/ÅR	Year-to-date average for T1
147	AVR T2/ÅR	Year-to-date average for T2
149	AVR T1/MÅNED	Month-to-date average for T1
150	AVR T2/MÅNED	Month-to-date average for T2
66	TL2	Tariff limit 2
67	TL3	Tariff limit 3
98	XDAY	Target date (reading date)
152	PROG NO	Program no. ABCCCCC
153	CONFIG NO 1	Config no. DDDEE
168	CONFIG NO 2	Config. no. FFGGMN
1001	SERIE NO	Serial no. (unique number for each meter)
112	METER NO 2	Customer number (8 most important digits)
1010	METER NO 1	Customer number (8 less important digits)
114	METER NO VA	Meter no. for VA
104	METER NO VB	Meter no. for VB
1005	METER TYPE	Software edition
154	CHECK SUM 1	Software check sum
155	HIGH RES	High-resolution energy register for testing purposes
157	TOPMODUL ID	ID number for top module
158	BOTMODUL ID	ID number for base module

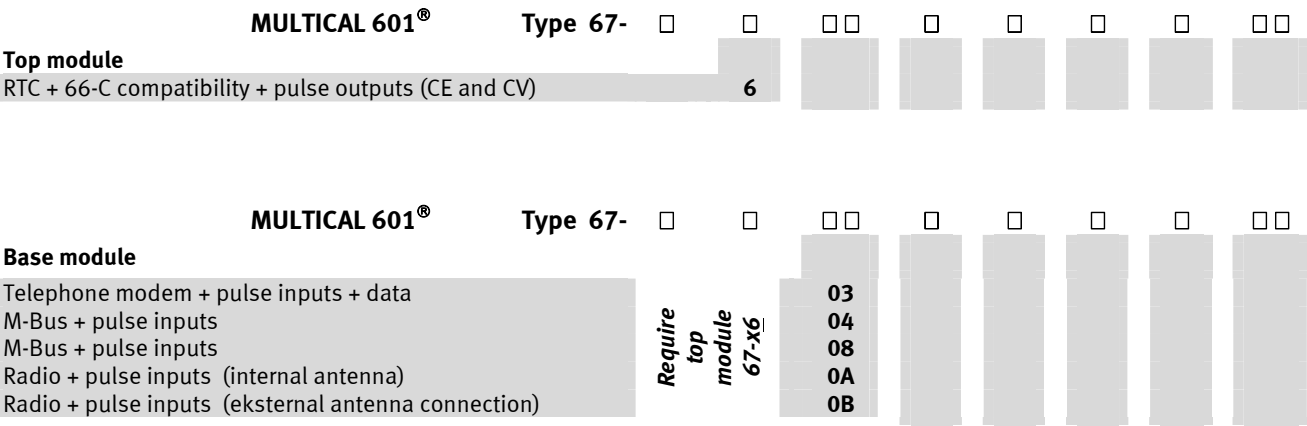
11.1.2 Open data protocol

Companies who want to develop their own communication driver for the KMP protocol can order a demonstration program with "open source code" in C# (.net based) as well as a detailed protocol description (in English language).

11.2 MULTICAL® 66-CDE compatible data

As described above MULTICAL® 601 uses a data protocol that is very different from the data strings read from MULTICAL® 66-CDE.

When top module type 67-06 is placed in MULTICAL® 601 it will, however, be possible to use a number of the modules used so far from MULTICAL® 66-CDE as shown below.



Top module type 67-06 placed in MULTICAL® 601 makes following data strings possible via the base unit:

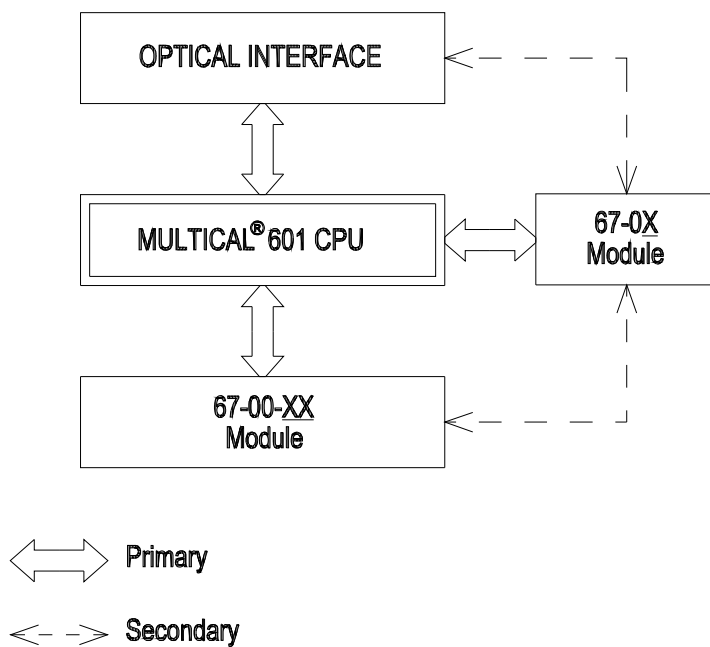
/#1, /#2, /#3, /#5, /#B, /#C, /#E, /#K, /#N

However, in data strings /#2 enter 0000000 in instead of DDEFFGG, as the configuration number is not unique between MULTICAL® 601 and MULTICAL® 66-CDE.

66-CDE ⇒ MC 601	Optical data reading according to EN 61107/IEC 1107 is not supported by MULTICAL® 601
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11.3 MC 601 communication paths

Physically, it is possible to communicate directly as shown below. Via destination addresses data communication can be routed internally between modules and calculator.

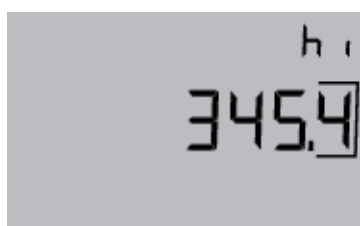


12 Calibration and verification

12.1 High-resolution energy reading

If a need for high resolution of the energy reading arises during testing and verification it can be initialised as follows:

- Lift up the calculator top from the base unit and wait for the display to turn off
- Press both push buttons simultaneously while the calculator top is placed in the base unit again and keep pressing both push buttons until the display becomes active
- The display now shows energy with a 0.1 [Wh] resolution until one of the push buttons are activated



The display example shows 345.4 [Wh] which corresponds to the energy accumulated at flow = 43.00°C and return flow = 40.00°C and a return volume of 0.1 m³.

The high-resolution energy reading is displayed in Wh at a volume resolution of 0.01 m³ (qp 1.5 m³/h). In connection with large meters the energy shown must be multiplied by 10 or 100.

m ³	Wh
0.001	x 0.1
0.01	x 1
0.1	x 10
1	x 100

The high-resolution energy can be used for both heat energy (E1) and for cooling energy (E3).

NB! Hour counter and info event counter are always reset when HighRes is activated by pressing both buttons in connection with reset.

12.1.1 Data reading of high-resolution energy

Data reading of the register "HighRes" is possible with ID = 155.

The read value will show correct measuring unit and value irrespective of the meter size.

12.2 Pulse interface

During test and verification of MULTICAL® 601, where high resolution energy pulses are needed, the verification adapter, type 66-99-275, can be used in the module area of the connection bracket.

The pulse interface gets serial data from MULTICAL® 601 every 7. sec. and converts these to high resolution energy pulses with the same resolution as the high resolution display mode. (see chapter 12.1)

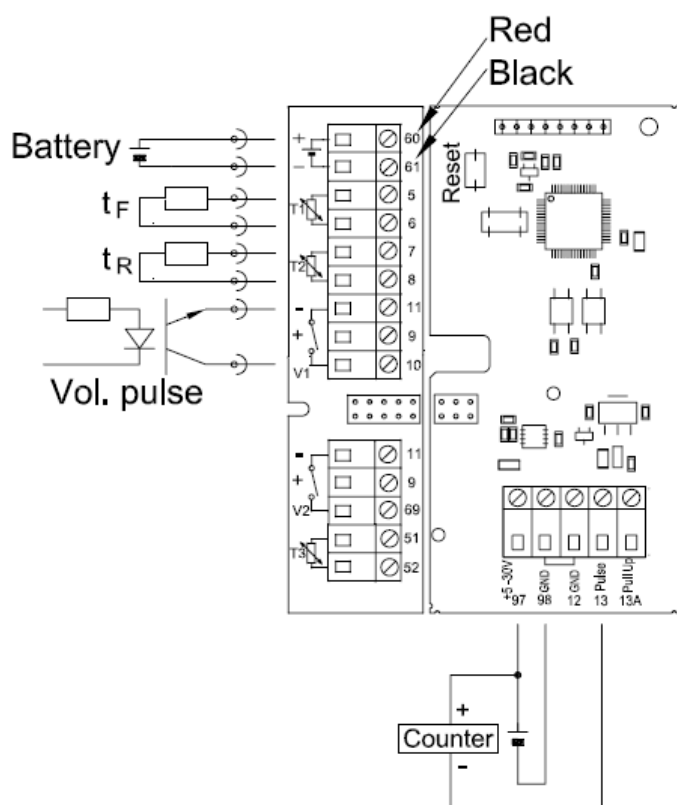
The pulse interface must be power supplied on terminal 97-98 from an external 5...30 VDC. The current consumption is max. 5 mA.

The high resolution energy pulses is a open collector signal on terminal 13-12. An additional pull-up resistor on 10 kOhm can be connected via terminal 13A.

12.2.1 Meter types

Pulse interface type 5550-888 can be used for verification of the below 4 variants of MULTICAL® 601, if the correct connection PCB and the correct temperature sensors/simulators and flow simulator is used.

Meter type	67-A	67-B	67-C	67-D
Connection PCB	5550-492	5550-568	5550-492	5550-732
Sensor type	Pt100, 2-Wire	Pt500, 4- Wire	Pt500, 2- Wire	Pt500, 4- Wire
Volume input	ULTRAFLOW® (11-9-10) or Reed-contact (11-10)			24 V pulses (10B-11B)



Pulsinterface 5550-888 (to the right) with connection PCB 5550-492 (to the left)

12.2.2 Technical data

Power supply (97-98):	5...30 VDC
Current consumption:	Max. 5 mA
Volume simulation:	Max. 128 Hz for CCC=1xx (ULTRAFLOW®) Max. 1 Hz for CCC=0xx (Reed-contact)
HF-energy output (13-12):	Open collector, 5...30 VDC max. 15 mA
Pulse frequency (13-12):	Max. 32 kHz as burst per integration
Data interval:	Ca. 7 sec.
Time-out with no data:	Ca. 35 sec.

12.3 True energy calculation

During test and verification the energy calculation of the heat meter is compared with the "true energy" calculated according to the formular stated in EN 1434-1:2004 or OIML R75:2002.

The PC program METERTOOL from Kamstrup contains an energy calculator suitable for the purpose:

The conventional true energy at the most frequent verification points is stated in below table.

T1 [°C]	T2 [°C]	$\Delta\Theta$ [K]	Flow [Wh/0.1 m³]	Return flow [Wh/0.1 m³]
42	40	2	230.11	230.29
43	40	3	345.02	345.43
53	50	3	343.62	344.11
50	40	10	1146.70	1151.55
70	50	20	2272.03	2295.86
80	60	20	2261.08	2287.57
160	40	120	12793.12	13988.44
160	20	140	14900.00	16390.83
175	20	155	16270.32	18204.78

13 METERTOOL for MULTICAL® 601

13.1 Introduction

METER TOOL for MULTICAL® 601 consists of two separate programs:

"METER TOOL MULTICAL® 601" is configuration and verification software for reconfiguration and test/verification of MULTICAL® 601 (ordering no. 66-99-704).

"LogView MULTICAL® 601" for log data readout as well as interval logging. The read 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 direct to "Windows Office Excell" (ordering no. 66-99-705).

13.1.1 System requirements

METER TOOL/LogView requires minimum Windows 2000 SP3 or Windows XP SP2 or higher as well as Explorer 5.01.

Minimum:	Pentium III or equivalent	Recommended:	Pentium 4 or equivalent
	256 MB RAM		512 MB RAM
	1 GB HD		10 GB HD
	Display resolution 1024 X 768		
	USB and CD-ROM drive		
	Printer installed		

Administrator rights to the PC are needed in order to install and use the programs. Must be installed under the logon of the person, who is to use the programs.

13.1.2 Interface

The following interfaces can be used:

Verification equipment	type	66-99-399	Verification of 67-C (2-W/Pt500) and total/partial reconfiguration
Verification equipment	type	66-99-398	Verification of 67-B/D(4-W/Pt500) and total/partial reconfiguration
Verification equipment	type	66-99-397	Verification of 67-A (2-W/Pt100) and total/partial reconfiguration
Programming base	type	S-7590-014	Total/partial reconfiguration
Optical eye USB	type	66-99-099	Partial reconfiguration
Optical eye Comport	type	66-99-102	Partial reconfiguration
USB 3-wire	type	66-99-098	Partial reconfiguration via module

Using equipment with Kamstrup USB, the USB driver must be installed before connection.

13.1.3 Installation

Check that system requirements are fulfilled.

Close other open programs before starting the installation.

Insert the CD in the drive and follow the program's directions through the installation.

When the installation is completed, the icon "METER TOOL MULTICAL® 601" and/or "LogView MULTICAL® 601" will appear from the menu "start" and as a link on the desktop. Doubleclick on link or icon in order to start the required program.

13.2 METERTOOL MULTICAL® 601

13.2.1 General information

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

There are two programming options "Partial programming" and "Total programming".

"Partial programming" does not allow change of coding which is important to energy calculation, e.g. Type number and Program number.

"Total programming" makes it possible also to change the rest of the values, programming is only possible if the internal programming lock is closed (short circuit pen 66-99-278).

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

"V2(CCC)", "T1", "T2" and "Max T1 for cooling" can be disabled, depending on the meter type in question.

Partial/Total programming



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.

13.2.2 File

The menu "File" includes printer setup as well as printout possibility of new meter label or test certificate.

Exit Close METERTOOL

Certificate Initiates printout of test certificate

Print Label Initiates printout of meter label

Select Label Printer Printer setup

13.2.3 Utility

The menu "Utility" includes the following configuration and test points:

Configuration Overall view which is used during reading and programming (see example at top of page)

Preset VA/VB Presets the register values of the two extra pulse inputs for water and electricity meters

Time/Date Transfer of date and time to MULTICAL® 601 calculator and top module

Reset Normal reset, i.e. reset of data logger and total reset

Meter Type Reads meter type, software revision and CRC checksum

Verification See separate paragraph, **13.3** Verification

13.2.4 Settings

Comport Setup of comport for interface of calculator /equipment.

Verification unit settings Input and maintenance of verification data of connected verification equipment.
See separate paragraph, **13.3 Verification with METERTOOL MULTICAL® 601.**

Verification unit calibration Used for changing between temperature set points during calibration.

13.2.5 Top modules

The menu "Top modules" includes identification as well as configuration of top module mounted in MULTICAL®.

Top modules and possible configurations are described in paragraph **10. Top modules.**

Note! Top module no. 67-01 cannot be identified, as this module does not include identification which can be read by MULTICAL® 601.

13.2.6 Base modules

The menu "Bottom modules" is used for the configuration of base module data. See section 10.2 Base modules.

13.2.7 Backup

Used for exporting/importing a backup file of saved verification data.

13.2.8 Windows

The function makes it possible to change between open dialog boxes of the program.

13.2.9 Help

Output Opens the communication log, which is used in connection with troubleshooting in the program.

Contact Mail address for registration of METERTOOL users, and questions on subjects related to METERTOOL.

About Includes program numbers and revisions of the various components of the installed version. In connection with error reports on METERTOOL software we ask you to e-mail us a screen dump of "About".

13.2.10 Application

Doubleclick on link or icon in order to start the program.

Activate "Configuration" under "Utility" in order to start meter configuration.

Enter the present configuration by activating "Read meter".

Make the required coding changes and activate "Program" in order to carry out the changes in the meter.

Note! Please remember setup of comport the first time the program is used.

13.3 Verification with METERTOOL MULTICAL® 601

13.3.1 General information

Verification of MULTICAL® 601 requires verification equipment, and verification data must be entered into the METERTOOL program.

13.3.2 Verification equipment

Verification equipment, e.g. type 66-99-399, is used for verification of the calculator MULTICAL® 601. Verification includes energy verification of "E1" and "E3", test of volume inputs "V1", "V2", "VA" and "VB" as well as test of temperature input "T3".

Different temperatures are simulated for the two sensor inputs, "T1" and "T2", which form the basis of the verification of the energy calculation together with the volume simulation.

The equipment was primarily constructed for use in laboratories, which test and verify heat meters, but can also be used for performance testing the meter.

The computer program "METERTOOL MULTICAL® 601" type 66-99-704 is used for configuration, test and verification.

Verification equipment for MULTICAL® 601 includes USB interface (type 66-99-098) as well as corresponding driver software. During installation this interface creates a "Virtual comport" which figures in the computer as an optional comport of the METERTOOL MULTICAL® 601 software. As this "Virtual comport" only exists when the equipment is connected, the verification equipment *must* always be connected to the computer before the program "METERTOOL MULTICAL® 601" is started.

Furthermore, the verification equipment requires mains supply via the included mains adapter.

Verification does not apply to temperature sensors and flow part(s).



The verification equipment is available in three different types, depending on the MULTICAL® 601 type used and the temperature points to be tested.

66-99-397 Standard (EN1434/MID) Type 67-A (2-wire Pt100)	T1 [°C] 160 80 43	T2 [°C] 20 60 40	T3 [°C] 5
66-99-398 Standard (EN1434/MID) Type 67-B/D (4-wire Pt500)	T1 [°C] 160 80 43	T2 [°C] 20 60 40	T3 [°C] -
66-99-399 Standard (EN1434/MID) Type 67-C (2-wire Pt500)	T1 [°C] 160 80 43	T2 [°C] 20 60 40	T3 [°C] 5

For other equipment variants (types or temperature points), please contact Kamstrup A/S.

13.3.3 Function

Verification equipment, e.g. type 66-99-399, which is mounted in a standard MULTICAL® base, includes battery, verification PCB with connection terminals, microprocessor, control relays and precision resistors.

The calculator can simply be mounted on this base instead of the calculator base.

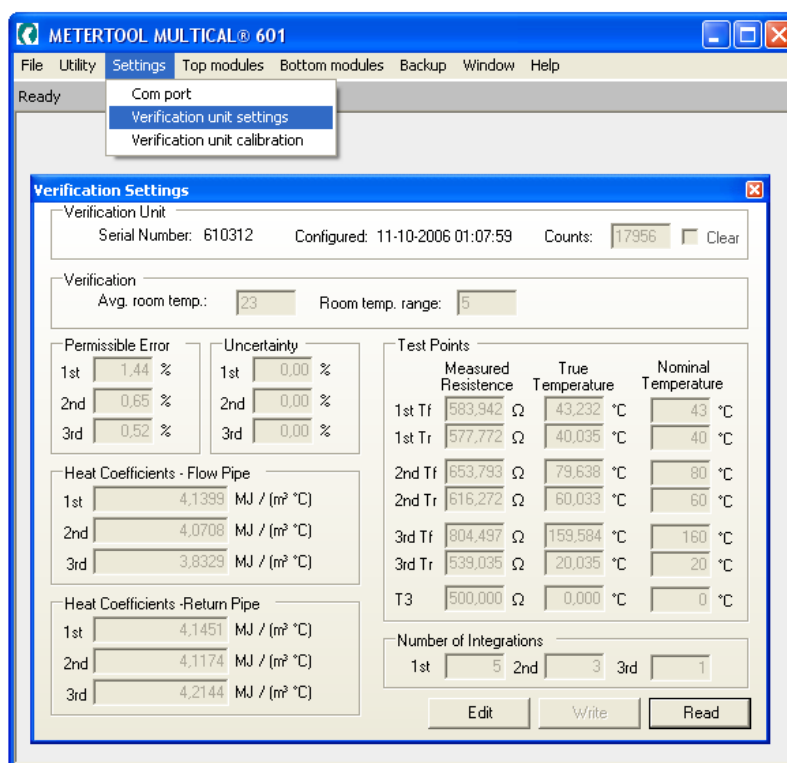
During test the calculator is supplied by the battery. The verification PCB is powered with 12 VDC by the enclosed external mains adapter. The microprocessor simulates volume based on pulse frequency and the number of pulses per test point selected in the computer program. The temperature simulation is obtained by means of fixed precision resistors, which are automatically changed via relays controlled by the microprocessor.

After test the computer reads all registers of the calculator and compares these values with the calculated values.

The calibration result in percentage of each test point can be stored in the computer under the series number of the tested MULTICAL® 601 to be printed out later on a test certificate.

13.3.4 Verification data

The first time METERTOOL and the verification equipment is used a number of calibration data must be entered into the menu "Verification" under "Settings" in the program METERTOOL. Calibration data is electronically included in the verification equipment (also enclosed with the verification equipment as a certificate on paper). In order to transfer calibration data from the equipment to the program select "Verification" from the menu "Settings" and activate "Read". Calibration data is now transferred to and saved in the program METERTOOL.



The calibration data of the equipment and the program verification data are compared every time the verification equipment is connected in order to secure that verification data is updated if the calibration data of the equipment have been changed. For instance this can be due to recalibration of verification equipment. Calibration data of the verification equipment can be maintained by changing the verification data in the program METERTOOL and clicking on "Write" this new data into the equipment. In order to avoid unintentional change of calibration data "write" is protected by a password, which can be obtained from Kamstrup A/S.

Calibration data include test points, permissible error, uncertainty, ambient temperature (fixed value) and number of Integrations per test.

Having entered verification data the program automatically calculates the true k-factor in accordance with the formula of EN 1434 and OIML R75:2002.

13.3.5 Verification

The verification program menu is opened by activating "Verification" in the menu "Utility".

Verification

Test Date: 14. april 2008

Manufacturer:

Operator:

Calib. procedure:

Order No.:

Comments:

Equipment Serial Number: 610312

Meter Serial No.: 6094407
Customer No.: 000000006094407
Type No.: 67800000L243
Program No.: 44012012
Config No.: 21200242400

☒ Energy & volume (Test result can be saved)
☐ Volume only (No saving of test results)

True volume	True T1	True Tr	True Energy	Measured Energy	Error
500,00001	43,232 °C	40,035 °C	1,8404 kWh	1,8370 kWh	-0,1846 %
300,00000	79,638 °C	60,033 °C	6,7270 kWh	6,7310 kWh	0,0600 %
100,00000	159,584 °C	20,035 °C	16,3366 kWh	16,3420 kWh	0,0329 %

Volume (V1)	Volume (V2)	Volume (VA)	Volume (VB)
Test start: 12156,5 m3	12265,1 m3	123,80 m3	543,57 m3
Test stop: 12156,6 m3	12265,2 m3	123,81 m3	543,58 m3

Energy	Volume (V1)
Test start: 296,41 MWh	12155,6 m3
Test stop: 296,45 MWh	12156,6 m3

Temperatures: True T3: 0,00 Measured T3: 0,00

Buttons: Save, Start verification

Klick on "Start verification" in order to start test/verification.

When the test has been completed the result will be displayed. If the result can be approved click on "Save". The result is now saved in the database under the series number of the calculator. You can save several results under one series number without overwriting earlier results.

13.3.6 Certificate

If you want to print out a certificate with saved results, select "Certificate" in the menu "File". You can now find the test/verification result according to series number, and the certificate can be printed out.

Create Certificate

Search criteria:
Serial No from: 0
Serial No to: 0
Calibrated from: 14-04-2008
Calibrated to: 14-04-2008
Search:

Customer:
Name:
Address 1:
Address 2:
Address 3:
Address 4:
Signature:
Report type: English

Selected	Serial No	Created
<input checked="" type="checkbox"/>	6094407	2008-04-14 10:07:27

Print:

13.4 LogView MULTICAL® 601

13.4.1 Introduction and installation

Regarding "Introduction", "Interface" and "Installation" see paragraph **13.1 Introduction METERTOOL**.

13.4.2 General information

"LogView MULTICAL® 601" is used for read-out of logging data from MULTICAL® 601 calculator and top modules (e.g. hourly data) as well as interval logging. 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" (ordering no. 66-99-705).

For available logging data see paragraph **6.10 Data loggers**.

13.4.3 "File"

Settings Setup of comport for interface of calculator/equipment.

Note! Please remember that the USB interface must be connected before starting the LogView program.

Exit Exit LogView

13.4.4 "Log"

Select the required data function.

Interval Data allows interval reading of current MULTICAL® 601 counts at optional intervals between 1 and 1440 minutes as well as an optional number of repetitions of the reading between 1 and 9999 times.

For read-out of "current" counts, enter interval: 1 and repetition: 1. Thereby you obtain one "instantaneous" reading.

Daily Data, Monthly Data and Yearly Data allow read-out of data logged by MULTICAL® 601, with optional data period and values.

Info Data allows read-out of the latest 50 info events from MULTICAL® 601, reading includes date and info code of the info event.

13.4.5 "Top Module Log"

This function makes it possible to read out logging data, which have been logged by and stored in a top module. This will mainly be read-out of e.g. "Hourly Logging Data", for other possibilities see paragraph 10.1.1 Top modules

13.4.6 "Bottom Module Log"

Is used for reading of logger data collected in base modules.

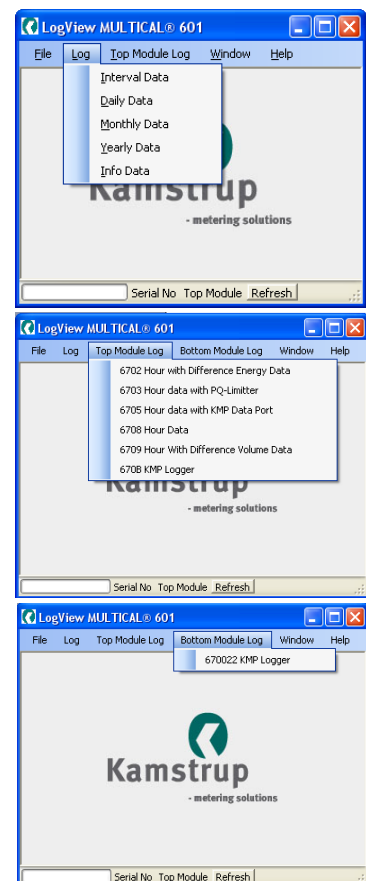
13.4.7 "Window"

The function makes it possible to change between open dialog boxes in the program.

13.4.8 "Help"

Contact Mail address for registration as LogView user as well as for requests on LogView related subjects.

About Includes program numbers and revisions of the different components of the installed version. In connection with error reports on LogView software we ask you to mail us a screen dump of "About".

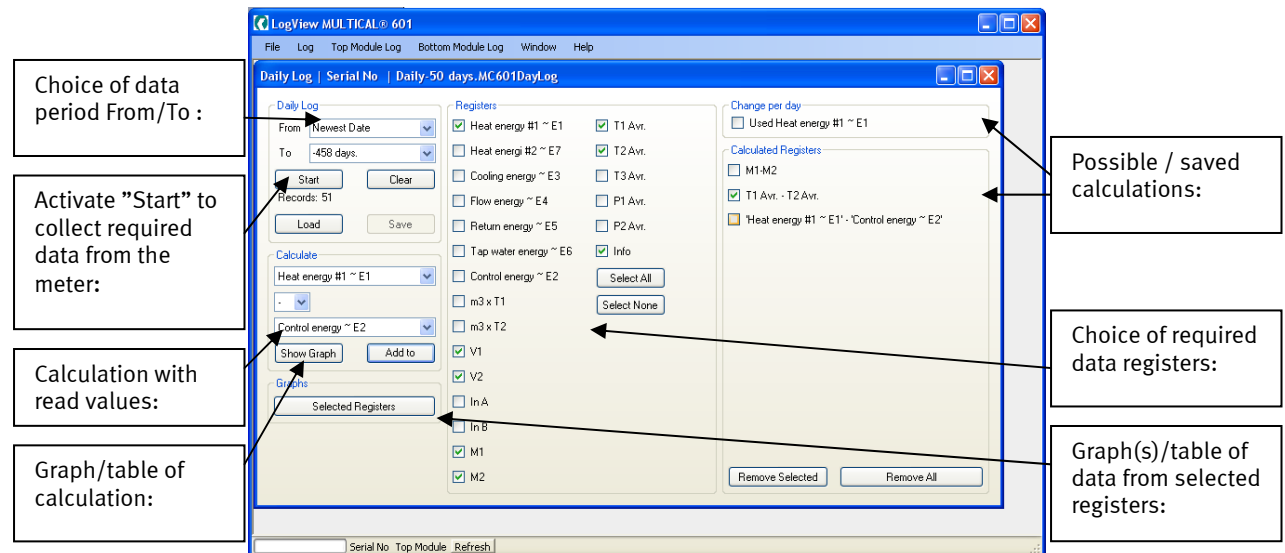


13.4.9 Application

Doubleclick on link or icon for "LogView MULTICAL® 601" in order to start the program, and select the required data function.

Note! Remember to set up the comport the first time the program is used.

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



After read-out nonselected data registers are toned grey and cannot be used during further processing/analysis. To read out all data, activate "Select All" to select all values.

When read-out has been completed the program automatically asks whether the data should be saved. We recommend you to save the read-outs, securing that data can be reopened later for further analysis or documentation.

Additional functions can now be selected for the read data. By means of "**Calculation**" individual calculations can be carried out, and graphs/tables with the values appear by activating "Show Graph". If you want to save calculation forms for reuse, select "Add to" and the function is added to "Calculated Registers".

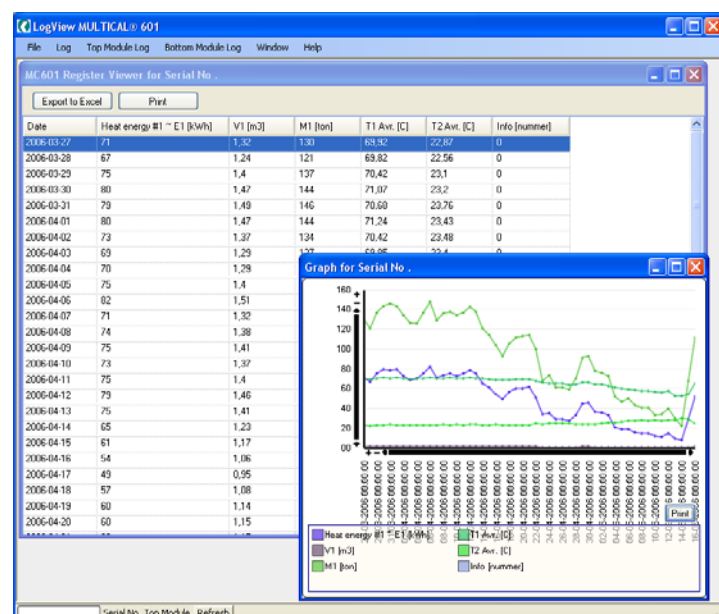
In order to carry out a new data read-out, click on "Clear", and select new period and new data registers.

Choosing "Selected Registers" under "Graphs" graph(s)/table with the marked registers are displayed.

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

To zoom in activate (+), to zoom out activate (-) on the axes.

The arrows (↑↓→←) on the axes are used for manoeuvring in the graph area.



14 Approvals

14.1 Type approvals

MULTICAL® 601 is type approved in Denmark on the basis of prEN 1434-4:2004 and OIML R75:2002.

The testing report, project A530123, is made by DELTA and forms the basis of type approvals in a number of countries including Denmark and Germany.

For further details on type approvals and verification please contact Kamstrup A/S.

TS 27.01
155
EN 1434 - OIML R75:2002

PTB

22.52
05.04

PTB

22.55
05.01

14.2 CE marking

MULTICAL® 601 is CE marked in accordance with following directives:

EMC directive 89/336/EEC

LV directive 73/23/EEC

14.3 Measuring instrument directive

MULTICAL® 601 is available with marking according to MID (2004/22/EC). The certificates have the following numbers:

B-Module: DK-0200-MI004-004

D-Module: DK-0200-MIQA-001



Declaration of Conformity

Overensstemmelseserklæring
Déclaration de conformité
Konformitätserklärung
Deklaracja Zgodności
Declaración de conformidad

We
Vi
Nous
Wir
My
Nosotros

Kamstrup A/S
Industrivej 28, Stilling
DK-8660 Skanderborg
Denmark
Tel: +45 89 93 10 00

declare under our sole responsibility that the product(s):

erklærer under eneansvar, at produkt(erne):
déclarons sous notre responsabilité que le/les produit(s):
erklären in alleiniger Verantwortung, dass/die Produkt(e):
deklarujemy z pełną odpowiedzialnością o produkt(y):
Declaramos, bajo responsabilidad propia que el/los producto

Instrument	Type	Type No.:	Classes	Type Approval Ref.:
Heat Meter	MULTICAL® 401	66-V and 66-W	Cl 2/3, M1, E1	DK-0200-MI004-001
Temperature Sensors	PL and DS	65-00-0A/B/C/D 66-00-0F/G 65-00-0L/M/N/P 66-00-0Q3/4 65-56-4	M1	DK-0200-MI004-002
Flow Sensor	ULTRAFLOW® qp 0.6...400 m³/h	65-S/R/T	Cl 3, M1, E1	DK-0200-MI004-003
Flow Sensor	ULTRAFLOW® qp 0.6...40 m³/h	65-S/R/T	Cl 2/3, M1, E1	DK-0200-MI004-003
Calculator	MULTICAL® 601	67-A/B/C/D	M1, E1/E2	DK-0200-MI004-004
Flow Sensor	ULTRAFLOW® 54	65-5	Cl 2/3, M1 E1/E2	DK-0200-MI004-008
Water Meter	MULTICAL® 41	66-Z	Cl 2, M1, E1	DK-0200-MI001-003

is/are in conformity with the requirements of the following directive(s):

er i overensstemmelse med kravene i følgende direktiv(er):
est/sont conforme(s) aux exigences de la/des directive(s):
mit den Anforderungen der Richtlinie(n) konform ist/sind:
jest/s zgodne z wymaganiami następujących dyrektyw:
es/son conforme(s) con los requerimientos de la(s) siguiente(s) directiva(s):

Measuring Instrument Directive
EMC Directive
LVD Directive
PE-Directive (Pressure)
R&TTE

2004/22/EC
89/336/EEC
2006/95/EEC
97/23/EC
1999/5/EC

Date: 2008-10-07

Sign.:

Kurt Stochholm
Quality Assurance Manager

15 Trouble-shooting

MULTICAL® 601 is constructed with a view to fast and simple mounting as well as long-term, reliable operation at the heat consumer's.

Should you, however, experience an operating problem with the meter, the error detection table below may help you clarify the possible reason.

In connection with repair, if necessary, we recommend to replace only battery and temperature sensors and communication modules. Alternatively, the entire meter must be replaced.

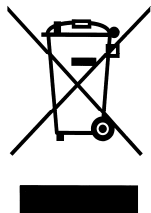
Major repairs must be made in our factory.

Before sending in the meter for repair, you must go through below error detection table to help clarify the possible cause of the problem.

Symptom	Possible cause	Suggested corrections
No display function (blank display)	No power supply.	Replace the battery or check the mains supply. Is there 3.6 VDC on terminal 60(+) and 61(-) ?
No accumulation of energy (e.g. MWh) and volume (m ³)	Read "info" on the display.	Check the error indicated by the info code (see section 6.8)
	If "info" = 000 ⇒	Check that the flow direction corresponds with the arrow on the flow sensor
	If "info" = 004, 008 or 012 ⇒	Check the temperature sensors. If defects are detected, replace the sensor set.
Accumulation of volume (m ³), but not of energy (e.g. MWh)	Flow and return sensors have been reversed, either during installation or connection.	Mount the sensors correctly
No accumulation of volume (m ³)	No volume pulses	Check that the flow direction corresponds with the arrow on the flow sensor. Check the flow sensor connection
Incorrect accumulation of volume (m ³)	Incorrect programming	Check if the pulse figure on the flow sensor corresponds with the calculator
Incorrect temperature indication	Defective temperature sensor Insufficient installation	Replace the sensor set. Check the installation
Temperature display is too low or accumulated energy is too little (e.g. MWh)	Poor thermal sensor contact Heat dissipation Sensor pockets too short	Place the sensors in the bottom of the sensor pockets. Insulate the sensor pockets. Replace sensor pockets with longer ones.

16 Disposal

Kamstrup A/S is environmentally certified according to ISO 14001, and as far as possible and as part of our environmental policy we use materials that can be recycled in an environmentally correct way.



As of August 2005 heat meters from Kamstrup are marked according to the EU directive 2002/96/EEA and the standard EN 50419.

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

• Disposal

Kamstrup is willing to dispose of worn out MULTICAL[®] 601 in an environmentally safe manner according to a previous arrangement. The disposal arrangement is free of charge to the customer, who only pays for transportation to Kamstrup A/S or the nearest approved disposal arrangement.

The meters must be separated into below parts. The separated parts should be sent for approved destruction. Batteries must not be exposed to mechanical impact and the lead-in wires of the battery must not short-circuit during transport.

Subject	Material	Recommended destruction
Lithium cells in MULTICAL [®] 601	Lithium and Thionylchlorid >UN 3090< D-cell: 4.9 g lithium	Approved destruction of lithium cells
PC boards in MULTICAL [®] 601 (LC-display must be removed)	Copper epoxide laminate with soldered componenets	Print board scrap for concentration of noble metals
LC-display	Glass and liquid crystals	Approved processing of LC displays
Cables for flow sensor and sensors	Copper with silicone mantle	Cable recycling
Transparent top cover	PC	Plastic recycling
Print box and base unit	Noryl and ABS with TPE gaskets	Plastic recycling
Other plastic parts, cast	PC + 20% glass	Plastic recycling
Meter case, ULTRAFLOW [®]	> 84% alpha brass/redbrass < 15% standard steel (St 37) < 1% stainless steel	Metal recycling
Packing	Environmental cardboard	Cardboard recycling (Resy)
Packing	Polystyrene	EPS recycling

Please direct any questions you may have concerning environmental matters to:

Kamstrup A/S

FAO: Environmental and quality assurance department
Fax.: +45 89 93 10 01
info@kamstrup.com

17 Documents

	Danish	English	German	Russian
Technical description	5512-300	5512-301	5512-387	5512-338
Data sheet	5810-489	5810-490	5810-491	5810-514
Installation and user guide	5512-298	5512-299	5512-302	5512-345

