PICOCAL

Technical Description

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1. General Description

PICOCAL is a compact heat meter, employing micro-processor technology. The meter features an integral 6-digit liquid crystal display and electronic pick-up of a vane wheel flow meter.

Energy consumption can be displayed in GJ, kWh or MWh. Furthermore, the display indicates water consumption, No. of operating hours, temperature, power and flow measurement.

In addition to the microprocessor, PICOCAL features a permanent memory, EEPROM, which stores data pertinent to the heat meter type. Hourly data for accumulated energy, water consumption and number of operating hours are also stored in the EEPROM.

If the battery should fail, the last hourly readings, which are stored in the EEPROM, will be retrieved when the voltage supply is reestablished.

Data for accumulated energy, accumulated water consumption and information codes are also stored at monthly intervals (730 operating hours).

In all 12 monthly readings can be stored in the EEPROM. The stored monthly data can be used for analytical purposes, e.g. if the amount of water and heat consumed does not tally. Monthly data can be accessed via METERTOOL and Verification equipment or via a test unit (see manual No. 5510-640) using an adapter cable.

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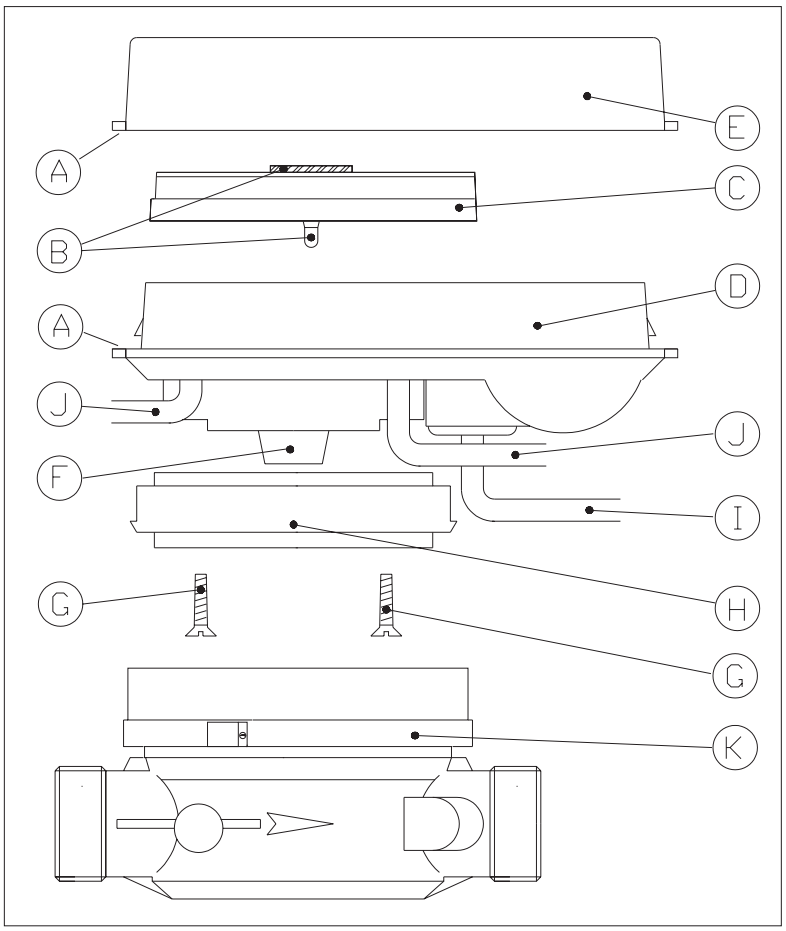
1.1 Mechanical Design



A Sealing Tabs
Used when sealing the meter after installation.

B Snap Lock for verification Cover
This snap lock is placed in the middle of the verification cover and can be released by means of a screwdriver. Releasing the lock means breaking the void label.

C Verification Cover
The cover prevents unauthorized persons from tampering with the electronics and thereby changing the legal measuring data. Once PICOCAL has been verified, the cover is sealed by means of a void label.

The cover gives access to screw terminals for temperature sensors, data/pulse output and test plug.

D PICOCAL Integrator
The microprocessor, display, battery etc., are housed in this unit. “D” indicates where the label showing type, code and instrument number is located. The label can be seen through the protection cover.

E Protection cover
The cover and integrator are joined by means of a snap lock on each side. The snap locks can be released using a screwdriver.

F Pick-up
The magnet-sensitive water meter pick-up is located here. The pick-up is based on a magnet-sensitive Hall-element which does not affect the vanewheel. The start flow of the water meter is, therefore, as low as possible.

These two screws fix the adapter ring to the integrator. The screws should be removed, if the adapter ring is to be used with a water meter of a different make.

H Adapter Ring
The water meter is fitted to the integrator by means of an adapter ring. PICOCAL can be supplied with several different adapter rings, which means that the one integrator can be used together with water meters from different manufacturers.

I Cable Gland for Data or Pulse Output
Three cable glands are supplied with PICOCAL, one for each of the two temperature sensors, and one for either data or pulse output connection (output cable not supplied).

J Cable for Temperature Sensor
The temperature sensors supplied have either a 5 mm diameter (2 x 0.5 mm^2 cross-section) or a 3.5 mm diameter (2 x 0.25 mm^2 cross-section) silicone cable. The cabling in PICOCAL is designed so that a snug fit is achieved with both cable dimensions.

K Water Meter
Using various adapter rings, PICOCAL can be used with water meters from four different manufacturers – all based on magnetic pick-up.

The type of water meter supplied with PICOCAL as a compact meter should be fitted to the integrator by means of the snap lock. Water meters from other manufacturers must be secured with a fitting ring, supplied with the water meter.

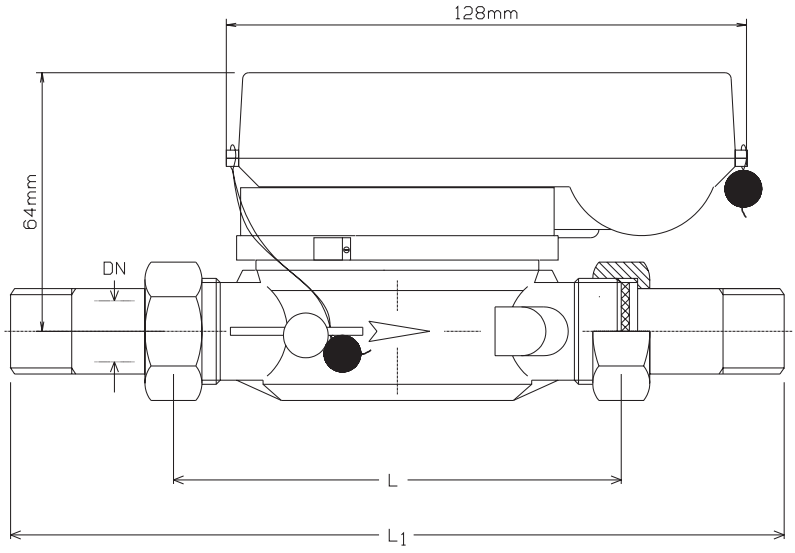
1.2 Dimensional Drawing

When PICOCAL is supplied with a flow meter, the physical dimensions are as follows.

These measurements will, of course, vary if PICOCAL is ordered as an independent calculator for use with your own water meter.

$Q_s(Q_n)$	L [mm]	L1 [mm]
0.6 m^3/h	110	190
1.5 m^3/h	110	190
2.5 m^3/h	130	228

The measurements stated apply to a single jet Hydrometer flow meter.



2. Integrator Unit

2.1 Design

The heart of the PICOCAL integrator is a micro-processor which controls all primary functions.

Flow pulses are routed through a debouncer into a divider. The divider steps the pulses down to the integration pulses. For example, if PICOCAL is coded to receive 166.8 pulses per litre and integrate for every 10 litres, 1668 water pulses are required before an integration pulse is emitted. In this technical description, the divider is referred to as a "pre-counter".

Temperatures are measured subsequent to each integration pulse. To avoid "old" temperature measurements from being displayed when the water flow has been interrupted, the temperature is measured automatically at 10 minute intervals – regardless of whether there is water flow. Each time the temperature is measured, the zero point and measuring range are automatically adjusted. When adjusting, the micro-processor, via the analogue/digital converter, changes the settings to 0°C and 100°C – based on internal reference resistances used solely for this purpose. This means that it is not necessary to adjust PICOCAL.

Δt is calculated on the basis of the temperatures measured, and the calculator calculates the solution, $\Delta t \times m^3 \times k$. The value of k is stipulated in a table stored in the micro-processor. The k-value corrects the water density at the temperature where the flow is measured (return and flow pipe) together with the heat content of the water. A precounter for calculating the energy steps the heat quantity down to GJ, kWh or MWh, depending on the PICOCAL coding.

2.2 Display Functions

PICOCAL is very simple to operate – just press the key on the front panel. During normal operation, the display will show the accumulated energy consumption. If the key on the front panel is pressed for approx. 1. sec., the display will change to show the next reading. Each time the key is pressed, the display will change to the next reading. If pressure is sustained on the key, the display will change from one reading to the next every second.

The display will automatically revert to the energy reading after 2½ minutes.

An arrow, or a combination of arrows will appear in the bottom of the display for each reading. The arrows indicate which function is being displayed. The functions will be displayed in the following order:

- Accumulated energy [GJ, kWh or MWh]
- Accumulated water consumption [m^3]
- Number of operating hours
- Flow temperature [°C]
- Return temperature [°C]
- Differential temperature [K]
- Actual water flow [l/h]
- Actual heat load [kW]
- Information Code (see paragraph 2.3)

Display test

2.3 Information Codes

PICOCAL has a built-in register which stores information pertaining to abnormal installation conditions and any operating disturbances which may have occurred. Under normal circumstances the information code register will display "0".

If one or more of the following errors occur, the relevant number will be added to the information register. This register can only be deleted by removing the integrating unit and connecting this to a test unit using an adapter cable.

The information codes can be deciphered as follows:

+1 The heat meter has been reset due to a fault in the reset function. This information code will be registered if PICOCAL has been reset without anyone activating the reset key on the front panel. This code will also be registered if the battery supply fails.

This information code supercedes all other information codes.

"E" will not be displayed.

+2 The water meter may have stopped turning. This information code will be registered if PICOCAL has registered a temperature difference larger than 12 K for a period of 42 hours without performing a calculation. Calculation is described in section 2.1

When PICOCAL is programmed with a standard UU code 11, 16 or 17, this code will not cause "E" to appear in the display. UU codes 21, 26 and 27 will, however, cause the letter "E" to be displayed. (Please refer to paragraph 2.5, UU coding).

Whether or not this code appears is often dependant on the installation conditions. If the flow is interrupted, the flow and return temperatures will begin to fall to ambient temperature. The differential temperature will then be lower than 12 K.

If the temperature sensors are situated close to the main pipe, heat radiation from the pipe – or internal circulation in the service pipe – may affect the temperature, so that the differential temperature remains above 12 K when the water flow is cut-off. Information code 2 will be registered after 42 hours.

+4 The temperature sensor in the return pipe is defective. This information code will be registered if the return pipe temperature exceeds the normal limits (0-135°C) for a period of 1-2 hours. The sensor may be shorted or disconnected.

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If the temperature sensor is defective, both temperature sensors must be replaced with an original Pt500 sensor pair from Kamstrup. Please note that when replacing the sensor set, the heat meter must be taken apart. It may then be necessary to re-verify the meter. Please check with your local supplier.

+8 The temperature sensor in the flow pipe is defective. This information code will be registered if the forward temperature exceeds the normal limits (0-135°C) for a period of 1-2 hours. The sensor may be shorted or disconnected.

(Refer to information code 4 (page 9) for information relating to replacing the sensor).

+128 The meter must be replaced as the battery has expired. This information code will be registered if the battery is 15 years old, or more accurately, when the battery has been in operation for 131,070 hours after reset hour/total reset. Continued meter operation with a new battery is not recommended.

+256 The water meter emits pulses too frequently. This information code will be registered if pulses are emitted so frequently that PICOCAL performs an integration more than once a second. This will occur if the water flow is greater than PICOCAL is designed for.

Information codes are permanent and can only be deleted by using a test unit and an adapter cable. The codes themselves do not influence heat meter operation. However, the cause of the code may well prevent correct accumulation of consumer data.

The information code register adds the value of each code registered and stores the total. To determine which disturbances have been registered, you must subtract one code number from the other.

Example: If the code register indicates 140, the following code numbers have been activated: 128 + 8 + 4.

2.4 Control Digit

PICOCAL can be supplied with a control digit – which can be seen in the far left of the display. The digit pertains to the accumulated energy reading and the accumulated water reading.

The control digit is primarily used to check the correctness of the reading in connection with consumers who read their own meters. The control digit can also indicate operational disturbances.

The factory coding of each PICOCAL determines the function of the control digit.

A control digit can be calculated for each accumulated amount of energy and water. This digit is unambiguous. The control digit calculation is described in a separate document, which can be forwarded on request.

Under normal conditions, the control digit indicates 0-7 (please refer to paragraph 2.5, *The Z-Group* for further information).

2.5 Coding

As stated under General Description, PICOCAL must be coded for the actual application. The code is programmed into PICOCAL's EEPROM using a standard personal computer (PC) (Please refer to chapter 8).

The code number is combined as follows:

WXYYZ-UU-AAA,

where W determines the code for groups UU and AAA.

	W	X	YY	Z	UU	AAA
	□ -	□ -	□□ -	□ -	□□ -	□□□
Standard data output and full display	0					
Addressable data output and full display	1					
Standard data output and limited display	2					
Addressable data output and limited display	3					
Pulse output for energy and full display	4					
Pulse output for energy and limited display	5					
Energy in MWh or kWh *)		0				
Energy in GJ		4				
Pulse counter and decimal point position (see separate table)			YY			
Flow meter in return pipe, without control digit in display				2		
Flow meter in flow pipe, without control digit in display				3		
Flow meter in return pipe, with control digit in display				6		
Flow meter in flow pipe, with control digit in display				7		
Complete user display, no information code 1&2					11	
Limited user display/information code on request					UU	
Address, to be stated if addressable output is selected						001-126

*) Depending on YY-coding

The W-Group
The W code determines whether the data output is to be used for standard data, addressable data or as a pulse output for energy. Furthermore, W determines whether all or just some of the functions featured are to be displayed.

The X-Group
The X code determines whether the reading displayed for accumulated energy is given in GJ, kWh or MWh. Note that the kWh and MWh selections have the same code – whether one or the other is required is stated in the actual order number (see table above).

The YY-Group
Certain standards e.g. OIML R75, require that a heat meter is able to register at least 3000 hours at full thermic load, i.e. at the meter's maximum power without causing the display to roll.

Applied to PICOCAL, this means that the decimal point can only be placed as follows (note that kWh/MWh selections are determined for the individual YY codes).

The Z-Group
The Z code determines whether PICOCAL is to be installed in the flow or return pipe. This code also determines whether the control digit is displayed.

The UU-Group
The UU code determines how many functions will be displayed. The UU code also determines if information codes 1 & 2 are to be displayed.

UU =	11	16	17	21	26	27
Amount of Energy	x	x	x	x	x	x
Water consumption	x	x	x	x	x	x
Hour counter	x	x	x	x	x	x
Flow temp.	x		x	x		x
Return temp..	x		x	x		x
Differential temp.	x		x	x		x
Actual flow	x		x	x		x
Actual heat load	x			x		
Information code	x	x	x	x	x	x
Display test	x	x	x	x	x	x
Info. code 1&2				x	x	x
Info. code 4&8	x	x	x	x	x	x
Info. code 128&256	x	x	x	x	x	x

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Flow meter pulse counter and decimal point placement (YY-code)

Water Meter Data				Decimal Point Placement					
YY	Precounter	Pulses/l	$Q_s(Q_n)$	kWh x=0	MWh x=0	GJ x=4	Water [m³]	Heat [kW]	Flow [l/h]
8	1403	140.3	0.6	0		2	2	1	0
9	957	95.7	1	0		2	2	1	0
10	646	64.6	1.5	0		2	2	1	0
11	404	40.4	1.5/2.5	0		2	2	1	0
12	502	50.2	1.5/2.5	0		2	2	1	0
13	2350	23.5	3.5		2	1	1	0	0
15	757	75.7	1	0		2	2	1	0
16	3000	300	0.6	0		2	2	1	0
17	269	26.9	1.5	0		2	2	1	0
18	665	66.5	1.5	0		2	2	1	0
19	1000	100	0.6	0		2	2	1	0
21	294	29.4		0		2	2	1	0
22	1668	166.8	0.6	0		2	2	1	0
23	864	86.4	0.75/1	0		2	2	1	0
24	522	52.2	2.5/1.5	0		2	2	1	0
25	607	60.7	1.5	0		2	2	1	0
26	420	42	1.0/2.5	0		2	2	1	0
27	2982	29.82	2.5		2	1	1	0	0
27	2982	29.82	3.5		2	1	1	0	0
28	2424	24.24	3.5		2	1	1	0	0
29	1854	18.54	2.5/6		2	1	1	0	0
30	770	7.7	10		2	1	1	0	0
31	700	7.0	15		2	1	1	0	0
32	366	36	2.5	0		2	2	1	0
33	604	60.47	1.5	0		2	2	1	0
34	1230	123.05	0.6	0		2	2	1	0
36	500	50	3	0		2	2	1	0
39	256	25.6	1.5/2.5	0		2	2	1	0
40	1280	12.8	3.5		2	1	1	0	0
54	1668	166.8	0.6		3	2	2	1	0
55	607	60.7	1.5		3	2	2	1	0
56	594	59.4	1.5		3	2	2	1	0
57	3764	37.64	2.5		2	1	1	0	0
59	1403	140.3	0.6		3	2	2	1	0
60	957	95.7	1		3	2	2	1	0
61	646	64.6	1.5		3	2	2	1	0
62	404	40.4	2.5		3	2	2	1	0
63	1224	122.4	0.6/1.0	0		2	2	1	0
64	852	85.2	1.5	0		2	2	1	0
65	599	59.9	2.5	0		2	2	1	0
74	1224	122.4	0.6/1.0		3	2	2	1	0
75	852	85.24	1.5		3	2	2	1	0
76	599	59.92	2.5		3	2	2	1	0

Note:
PICOCAL delivered with flow meter

2.6 k-factor Reference

The meter employs Dr. D. Stuck's tables as the basis for the k-factor. Six tables have been drawn up, based on this theory, which without interpolation accurately indicate all possible k-factors.

Dr. Stuck's k-factor is stated as the basis for calculating energy in MJ. However, PICOCAL, calculates energy in MCal, which is why the following tables are divided by 4,1868 in relation to Stuck's figures.

Meter in return pipe, Δt: 82...123 K

Return temp. °C	k-factor	Return temp. °C	k-factor	Return temp °C	k-factor
0.0 - 3.1	1.000717	54.4 - 57.5	0.99632	108.8 - 111.9	0.992188
3.2 - 6.3	1.000908	57.6 - 60.7	0.99591	112.0 - 115.1	0.992188
6.4 - 9.5	1.001003	60.8 - 63.9	0.99534	115.2 - 118.3	0.992188
9.6 - 12.7	1.001027	64.0 - 67.1	0.9947	118.4 - 121.5	0.992188
12.8 - 15.9	1.001003	67.2 - 70.3	0.99419	121.6 - 124.7	0.992188
16.0 - 19.1	1.00086	70.4 - 73.5	0.99372	124.8 - 127.9	0.992188
19.2 - 22.3	1.000717	73.6 - 76.7	0.99324	128.0 - 131.1	0.992188
22.4 - 25.5	1.000502	76.8 - 79.9	0.99279	131.2 - 134.3	0.992188
25.6 - 28.7	1.000263	80.0 - 83.1	0.99219		
28.8 - 31.9	0.999952	83.2 - 86.3	0.99219		
32.0 - 35.1	0.999642	86.4 - 89.5	0.99219		
35.2 - 38.3	0.99914	89.6 - 92.7	0.99219		
38.4 - 41.5	0.998758	92.8 - 95.9	0.99219		
41.6 - 44.7	0.998328	96.0 - 99.1	0.99219		
44.8 - 47.9	0.997898	99.2 - 102.3	0.99219		
48.0 - 51.1	0.997444	102.4 - 105.5	0.99219		
51.2 - 54.3	0.996823	105.6 - 108.7	0.99219		

Table 1

Meter in return pipe, Δt: 41...82 K

Return temp. °C	k-factor	Return temp. °C	k-factor	Return temp. °C	k-factor
0.0 - 3.1	0.999164	54.4 - 57.5	0.98942	108.8 - 111.9	0.974247
3.2 - 6.3	0.999068	57.6 - 60.7	0.98856	112.0 - 115.1	0.973292
6.4 - 9.5	0.998901	60.8 - 63.9	0.9877	115.2 - 118.3	0.972599
9.6 - 12.7	0.998662	64.0 - 67.1	0.98653	118.4 - 121.5	0.97193
12.8 - 15.9	0.99828	67.2 - 70.3	0.98564	121.6 - 124.7	0.97193
16.0 - 19.1	0.997778	70.4 - 73.5	0.98495	124.8 - 127.9	0.97193
19.2 - 22.3	0.997372	73.6 - 76.7	0.98387	128.0 - 131.1	0.97193
22.4 - 25.5	0.996894	76.8 - 79.9	0.98299	131.2 - 134.3	0.97193
25.6 - 28.7	0.996369	80.0 - 83.1	0.98182		
28.8 - 31.9	0.995796	83.2 - 86.3	0.98096		
32.0 - 35.1	0.994983	86.4 - 89.5	0.9801		
35.2 - 38.3	0.994314	89.6 - 92.7	0.97926		
38.4 - 41.5	0.993622	92.8 - 95.9	0.97843		
41.6 - 44.7	0.992881	96.0 - 99.1	0.97733		
44.8 - 47.9	0.992117	99.2 - 102.3	0.97625		
48.0 - 51.1	0.991065	102.4 - 105.5	0.97575		
51.2 - 54.3	0.990253	105.6 - 108.7	0.97499		

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Meter in return pipe, Δt: 0...41 K

Return temp. °C	k-factor	Return temp. °C	k-factor	Return temp. °C	k-factor
0.0 - 3.1	1.000119	54.4 - 57.5	0.98586	108.8 - 111.9	0.965098
3.2 - 6.3	0.999451	57.6 - 60.7	0.98478	112.0 - 115.1	0.963641
6.4 - 9.5	0.998925	60.8 - 63.9	0.98376	115.2 - 118.3	0.962566
9.6 - 12.7	0.998232	64.0 - 67.1	0.98213	118.4 - 121.5	0.961515
12.8 - 15.9	0.997635	67.2 - 70.3	0.98137	121.6 - 124.7	0.960463
16.0 - 19.1	0.997014	70.4 - 73.5	0.97981	124.8 - 127.9	0.959436
19.2 - 22.3	0.996154	73.6 - 76.7	0.97864	128.0 - 131.1	0.958433
22.4 - 25.5	0.995485	76.8 - 79.9	0.97747	131.2 - 134.3	0.957143
25.6 - 28.7	0.994768	80.0 - 83.1	0.9759		
28.8 - 31.9	0.994004	83.2 - 86.3	0.9747		
32.0 - 35.1	0.993215	86.4 - 89.5	0.97353		
35.2 - 38.3	0.992093	89.6 - 92.7	0.97234		
38.4 - 41.5	0.991209	92.8 - 95.9	0.97117		
41.6 - 44.7	0.990277	96.0 - 99.1	0.97002		
44.8 - 47.9	0.989322	99.2 - 102.3	0.96849		
48.0 - 51.1	0.987984	102.4 - 105.5	0.96734		
51.2 - 54.3	0.986933	105.6 - 108.7	0.96622		

Table 3

Meter in flow pipe, Δt: 82...123 K

Flow temp. °C	k-factor	Flow temp. °C	k-factor	Flow temp. °C	k-factor
0.0 - 3.1	0.969756	54.4 - 57.5	0.96976	108.8 - 111.9	0.951911
3.2 - 6.3	0.969756	57.6 - 60.7	0.96976	112.0 - 115.1	0.949236
6.4 - 9.5	0.969756	60.8 - 63.9	0.96976	115.2 - 118.3	0.947898
9.6 - 12.7	0.969756	64.0 - 67.1	0.96976	118.4 - 121.5	0.945222
12.8 - 15.9	0.969756	67.2 - 70.3	0.96976	121.6 - 124.7	0.943239
16.0 - 19.1	0.969756	70.4 - 73.5	0.96976	124.8 - 127.9	0.941257
19.2 - 22.3	0.969756	73.6 - 76.7	0.96976	128.0 - 131.1	0.938605
22.4 - 25.5	0.969756	76.8 - 79.9	0.96976	131.2 - 134.3	0.936622
25.6 - 28.7	0.969756	80.0 - 83.1	0.96976		
28.8 - 31.9	0.969756	83.2 - 86.3	0.96806		
32.0 - 35.1	0.969756	86.4 - 89.5	0.96636		
35.2 - 38.3	0.969756	89.6 - 92.7	0.96467		
38.4 - 41.5	0.969756	92.8 - 95.9	0.96295		
41.6 - 44.7	0.969756	96.0 - 99.1	0.96063		
44.8 - 47.9	0.969756	99.2 - 102.3	0.95812		
48.0 - 51.1	0.969756	102.4 - 105.5	0.95602		
51.2 - 54.3	0.969756	105.6 - 108.7	0.95397		

Table 4

Meter in flow pipe, Δt: 41...82 K

Flow temp. °C	k-factor	Flow temp. °C	k-factor	Flow temp. °C	k-factor
0.0 - 3.1	0.990492	54.4 - 57.5	0.98354	108.8 - 111.9	0.953727
3.2 - 6.3	0.990492	57.6 - 60.7	0.9822	112.0 - 115.1	0.951314
6.4 - 9.5	0.990492	60.8 - 63.9	0.98127	115.2 - 118.3	0.94957
9.6 - 12.7	0.990492	64.0 - 67.1	0.97895	118.4 - 121.5	0.947802
12.8 - 15.9	0.990492	67.2 - 70.3	0.97714	121.6 - 124.7	0.946034
16.0 - 19.1	0.990492	70.4 - 73.5	0.97542	124.8 - 127.9	0.94429
19.2 - 22.3	0.990492	73.6 - 76.7	0.97372	128.0 - 131.1	0.941949
22.4 - 25.5	0.990492	76.8 - 79.9	0.97203	131.2 - 134.3	0.940205
25.6 - 28.7	0.990492	80.0 - 83.1	0.96976		
28.8 - 31.9	0.990492	83.2 - 86.3	0.96806		
32.0 - 35.1	0.990492	86.4 - 89.5	0.96636		
35.2 - 38.3	0.990492	89.6 - 92.7	0.96467		
38.4 - 41.5	0.990492	92.8 - 95.9	0.96295		
41.6 - 44.7	0.989178	96.0 - 99.1	0.96063		
44.8 - 47.9	0.987888	99.2 - 102.3	0.95891		
48.0 - 51.1	0.986598	102.4 - 105.5	0.95717		
51.2 - 54.3	0.984854	105.6 - 108.7	0.95542		

Table 5

Meter in flow pipe, Δt: 0...41 K

Flow temp. °C	k-factor	Flow temp. °C	k-factor	Flow temp. °C	k-factor
0.0 - 3.1	0.996703	54.4 - 57.5	0.98354	108.8 - 111.9	0.95688
3.2 - 6.3	0.996703	57.6 - 60.7	0.9822	112.0 - 115.1	0.954826
6.4 - 9.5	0.996703	60.8 - 63.9	0.98084	115.2 - 118.3	0.953297
9.6 - 12.7	0.996703	64.0 - 67.1	0.97946	118.4 - 121.5	0.951792
12.8 - 15.9	0.996703	67.2 - 70.3	0.97757	121.6 - 124.7	0.950287
16.0 - 19.1	0.996703	70.4 - 73.5	0.97613	124.8 - 127.9	0.948782
19.2 - 22.3	0.996703	73.6 - 76.7	0.97468	128.0 - 131.1	0.946799
22.4 - 25.5	0.996703	76.8 - 79.9	0.9732	131.2 - 134.3	0.945342
25.6 - 28.7	0.996703	80.0 - 83.1	0.97121		
28.8 - 31.9	0.995127	83.2 - 86.3	0.96971		
32.0 - 35.1	0.993669	86.4 - 89.5	0.96818		
35.2 - 38.3	0.991806	89.6 - 92.7	0.96665		
38.4 - 41.5	0.990492	92.8 - 95.9	0.9651		
41.6 - 44.7	0.989178	96.0 - 99.1	0.96304		
44.8 - 47.9	0.987888	99.2 - 102.3	0.96149		
48.0 - 51.1	0.986598	102.4 - 105.5	0.95996		
51.2 - 54.3	0.984854	105.6 - 108.7	0.95841		

Table 6

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2.7 Battery

PICOCAL is supplied with a lithium D-cell battery which, under normal operating conditions, will function perfectly for 15 years.

Normally, we would not recommend replacing the battery and thereby extending the lifetime of PICOCAL beyond 15 years.

Lithium batteries should be handled with care. Return batteries to the supplier – or to an approved centre – for destruction.

2.8 Type Number

PICOCAL's type number is created using the following number system.

65 - P - □ - □ - □ - □ - □□□

Energy unit					
kWh/MWh display	1				
GJ display	2				
Temperature sensors					
No temperature sensors		0			
Pt500, sensor set for pockets – 1.5 m cable	(A)	1			
Pt500, short, direct sensor set – 1.5 m cable	(F)	5			
Adapter ring for flow meter					
Hydrometer			1		
Metron			2		
Werhle			4		
GWF Unico 2			5		
Flow meter					
PICOCAL without flow meter				0	
PICOCAL with flow meter, $Q_s(Q_n)$ 0.6 m^3/h				1	
PICOCAL with flow meter, $Q_s(Q_n)$ 1.5 m^3/h				2	
PICOCAL with flow meter, $Q_s(Q_n)$ 2.5 m^3/h				3	
Country code					

Note: Pt500 sensor sets in ( ) indicate new types.

3. Temperature Sensors

3.1 Sensor Element

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

°C	Ω
0	500.00
10	519.51
20	538.97
30	558.36
40	577.70
50	596.99
60	616.21
70	635.38
80	654.48
90	673.54
100	692.53
110	711.46
120	730.34
130	749.16

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

a) Less cable resistance in the sensor cable and change-over resistance in the connections.

b) Greater Ohm change per degree centigrade gives better accuracy in the calculator's analogue/digital converter.

c) The temperature sensors can be matched as a pair with greater accuracy.

3.2 Pairing

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

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

Kamstrup checks the deviation of temperature sensors by first immersing them in a thermostatically controlled bath at 40°C. They are then split up into 50 groups, determined by the deviation at this temperature. Each group has a tolerance of ±0.01°C.

All the sensors in a group are tested again in a thermostatically controlled bath at 130°C and again split into groups, this time 32 groups ±0.01°C. The grouping is again determined by the individual sensors accuracy at 130°C.

Depending on authority requirements, some of the sensors, randomly picked from the batch, or all of the sensors are tested at 85°C.

The temperature sensors that are grouped together both at 40°C and 130°C form matched pairs which should not be split up.

3.3 Sensor Marking

Temperature sensors are fitted with a name plate which shows the catalogue number and the serial number for that particular sensor. The sensors must be ordered as a pair.

The catalogue number for ordering sensor pairs together with PICOCAL is not the same as the number the sensors are marked with. The number on the sensors pertains to that particular sensor set.

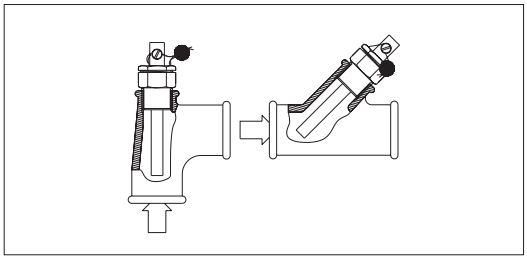
Each sensor has a serial No., which is indicated on the plastic label. The sensor for the return pipe has the same number as the sensor for the flow pipe.

3.4 Sensor Types

PICOCAL can be supplied with two different temperature sensor sets – all with 1.5 metre cable. The function of all three sensor types is identical. However, they are fitted in different ways. The most important characteristics of the two types are listed in the following paragraph.

	65-Px-Xxx-xxx
Pt500 Sensor set for pockets	(A) 1
Pt500 Short, direct sensor set	(F) 5

65-Px-1xx-xxx



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

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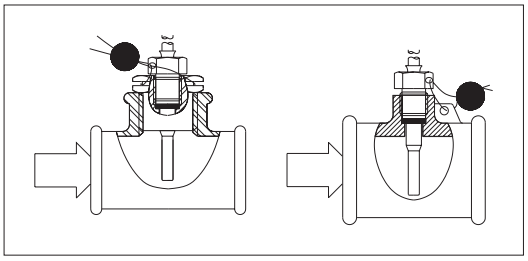
The brass tube is fitted in a sensor pocket which has an internal dimension of 6 mm and an external dimension of 8 mm. The sensor pocket is supplied with a ½" BSP connection in stainless steel in 65, 90 and 140 mm lengths. (Please refer to data sheet 5810-009 for further information).

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

65-Px-5xx-xxx



The Pt500 short, direct sensor is designed in accordance with European standards for thermal energy meters, pr EN 1434 (previously CEN TC-176). The sensor is designed for fitting directly into the measuring medium – without a sensor pocket.

This sensor also comprises a ø3.5 mm diameter, 2-wire silicone cable. The sensor tube is made of stainless steel and has a diameter of ø4 mm at the end where the sensor element is.

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

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

3.5 Sensor Cable

As mentioned previously, the temperature sensor comprises silicone cable. This is both heat resistant and flexible.

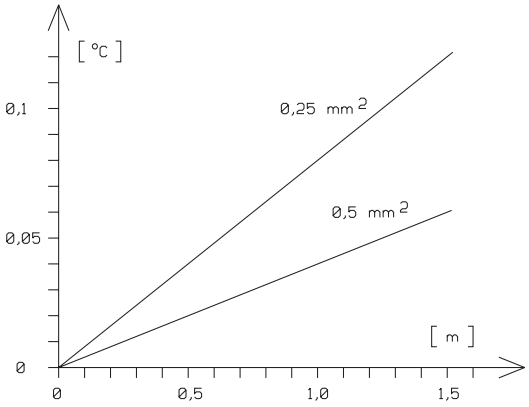
The wire cross-section is 0.5 mm^2 for 65-Px-1xx-xxx which corresponds to 0.04°C/metre. The two other sensor types have a wire cross section of 0.25 mm^2, which corresponds to 0.08°C/metre.

The figures stated apply to 2 individual wires in a 1 metre length.

With all three sensor types the cable length for the forward and return sensors must be identical.

If the lengths are not the same, the cable resistance will affect the measurement of the differential temperature.

We would generally advise customers to use the temperature sensors with the 1.5 metre cable supplied. If the cable is too long, the excess can be rolled up and secured with cable strips.



4. Flow Meters

4.1 Pulse Signals

PICOCAL can be coded to work with a wide range of vane wheel meters, based on the magnetic pick-up (see YY-table in paragraph 2.5).

The rotating magnet in the flow meter is tracked by PICOCAL's integral electronic pickup, which is based on a magnetic Hall-element. This design is ideal for use with this type of vane wheel meter, which has high frequency pulsing (20...300 pulses per litre).

4.2 Flow Meter Types

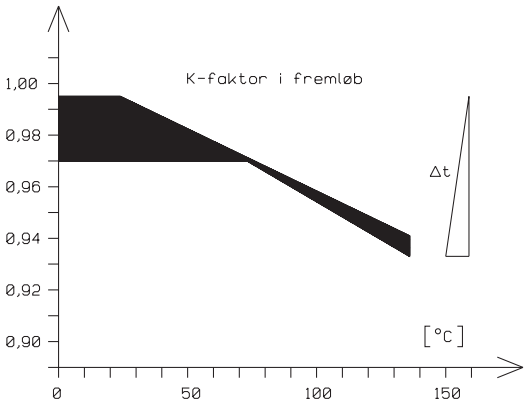
PICOCAL is supplied either as a compact energy meter with temperature sensors and a single-jet, vane wheel meter for Q_s 0.6 - 1.5 and 2.5 m^3/h, or as a calculator with temperature sensors which can be fitted on a number of vane wheel meters from various manufacturers. A mechanical adapter ring ensures that the meter is fitted correctly. Please contact Kamstrup A/S for further information.

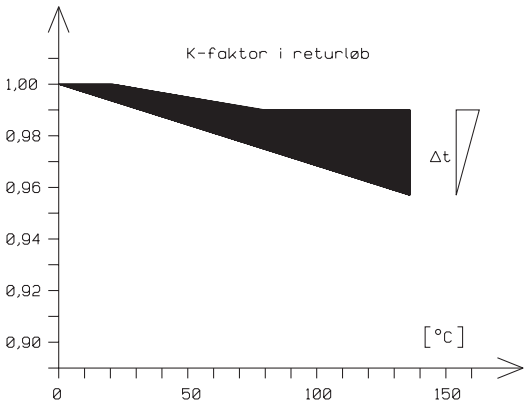
4.3 Installing the Flow Meter

PICOCAL can be programmed for flow meter installation in either the flow or return pipe (please see paragraph 2.5, The Z-Group).

The reason for programming this information is that a given amount of energy has a larger water volume at the high temperature in the flow pipe, compared to the low temperature in the return pipe. Compensation is made for the water's positive expansion coefficient by using two sets of k-tables – one for the flow pipe and one for the return.

PICOCAL's correction for density, together with the waters specific heat is based on Dr. D. Stuck's k-tables. The internal correction for flow and return pipes respectively can be seen in the graphs below.





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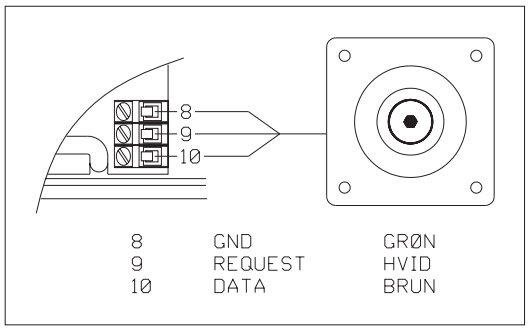
5. Data Acquisition with Hand-held Terminal

PICOCAL is usually supplied with a signal port for serial data communication or data transmission of pulses for thermal energy.

The measured data, which is read via the signal port, is the same as the data displayed.

The signal port is galvanically separated from the calculator via optocouples which eliminate the risk of destroying data put into PICOCAL by means of the signal port. Data will not be lost, even if the port is wilfully damaged. The only damage will be to the optocoupler.

To connect the data output electrically, the seal on PICOCAL's lid must be broken. Loosen the lid by unscrewing the screws in each side. Do not remove the verification cover. The data cables must then be lead through the cable retainer and connected to terminals 8-9-10.



5.1 Standard Data Output

The data format is standard serial ASCII code with a baud rate of 1200 bits per second. 1 Start bit, 8 data bits, 2 stop bit and non parity bits are used. Each data register comprises six digits, ending with a space. The last data register ends with a carriage return.

Using the data request input, you can access two types of data:

1) Normal Data
Current is sent through the optocoupler for data request (2...20 mA) for at least 12 msec. Not more than 1 second after, PICOCAL will send the following on the data output.

2) Monthly data
Power is sent through the optocoupler for data request (2...20 mA) for 1...4 msec. Max. 1 second later PICOCAL will send the data shown below.

1) Normal data	Meter No.	Energy	m³	T_{flow}	T_{return}	T_{diff}	Flow	Info	Hour counter
	6 digits	6 digits	6 digits	6 digits	6 digits	6 digits	6 digits	6 digits	6 digits

2) Monthly data	Meter No.	Energy	m³	Info/Hours
	6 digits	6 digits	6 digits	6 digits
	12 months			

5.2 Addressable Data Output

The data output can be programmed by the factory as addressable (see paragraph 2.5, The W-Group). This function enables a large number of meters to be connected to a common data net.

An address (1...126) is entered into the meter memory (EEPROM). The meter will then only supply data on the data output if the relevant address is received on the data request input. As in the above, normal and monthly data can be read from an addressable meter.

The request signal must comprise a 6.66 msec. long request pulse followed by 1 start bit and 8 data bits (bit No. 0 to bit No. 7). Bit No. 0...6 indicates the address and bit No. 7 indicates whether the data is normal or monthly (0 and 1 respectively).

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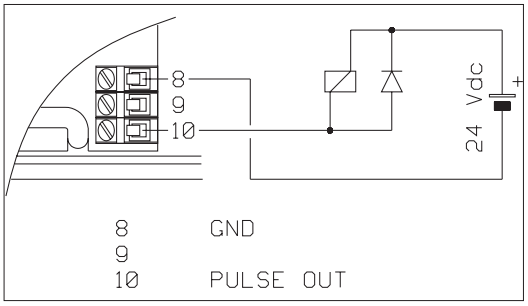
5.3 Pulse Output

The data output can also be used as a pulse output, provided that the meter is coded for this (please refer to paragraph 2.5, The W-Group). The meter sends a pulse for the smallest energy digit used to update the display. E.g. PICOCAL with 0.6 m^3/h (YY=22) will emit 1 pulse/kWh.

The pulse duration is 50 msec. Maximum voltage between terminals is 27 VDC, maximum current during the pulse being 27 μA.

PICOCAL can if required be delivered with a pulse duration of 100 msec.



NB
If the request input receives a signal, the data output will respond – even though the signal is coded to energy pulses.

To connect the pulse output remove the seal, if any, on the PICOCAL lid then loosen the screws on each side, using a screwdriver. The verification cover must not be removed. Lead the pulse wires through the cable retainer and connect them to terminals 8 and 10.

5.4 Customer Number/Meter Number

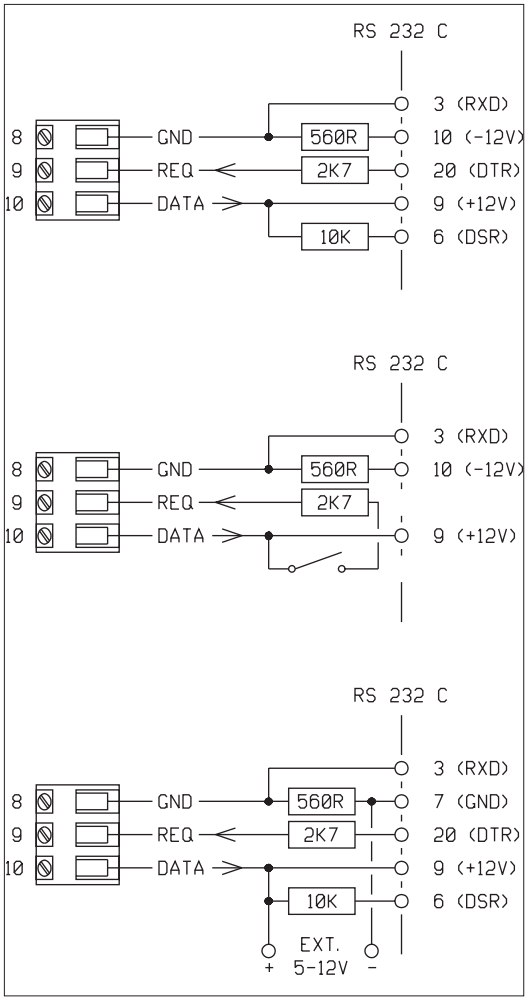
A customer or meter number can be stored in PICOCAL. This number will identify the meter when reading data. The number can be entered using a MULTITERM II hand-held data terminal, test unit and adapter cable. Any number from 1 to 65535 can be used, both numbers inclusive. Zero may not be used.

The number can also be entered using the verification Equipment type 66- 99-381 and the PC software METERTOOL type 66-99-211. See paragraph 9.

5.5 Computer Connection

PICOCAL's serial data output consists of optocouples which require pull-up and pull-down resistance when PICOCAL is to be connected to a computer's serial port. The drawing opposite shows three examples of how to connect PICOCAL to a computer.

When connecting in order to read data Verificationequipment type 66-99-381 can be used together with METERTOOL.



5.6 Test Plug

PICOCAL is equipped with a 12-pole test plug which is used for certain reset functions and also during verification (please refer to paragraphs 6 & 8 respectively).

Please be very careful with all connections in the test plug, as there is direct connection to the micro-processor potential.

The test plug may only be connected to external equipment during factory programming or verifying, following procedures that are approved by Kamstrup A/S.

The test plug has the following pin connections:

Pin 1-2
Serial data to and from the calculator. The voltage level is 3.6 VDC in respect to pin 10. The function is described in paragraph 5, Data Acquisition.

Pin 3-7-8
The temperature sensor connecting terminals are accessible on these terminals. Pin 7 is common to both flow and return pipe sensors. Pin 3 is for the flow pipe and pin 8 for the return pipe.

These pin connections should only be used during function testing. Use connecting terminals for accuracy tests and verification.

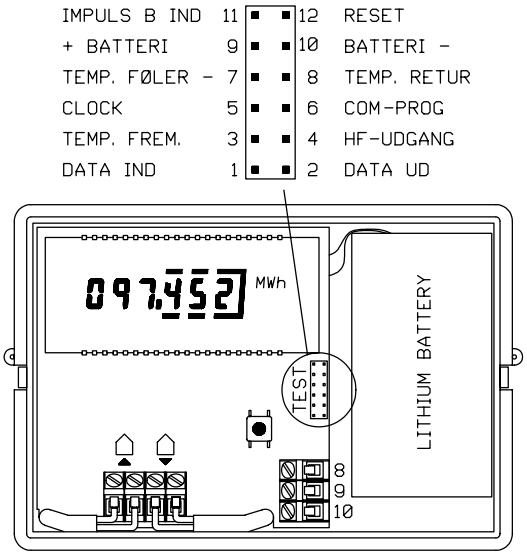
Pin 4
At each energy integration a burst of Quick-figure is sent on this pin. For further information pertaining to this function, please read paragraph 7, Verification.

A pull-up resistor of 100 kΩ must be connected between pins 4 and 9 when a HF output is required. This also activates the display to show Quick-figure. 2½ minutes after the pull-up resistor is removed, the display will change to energy indication.

Pin 5-6
Test pin for reading the factory program.

Pin 9-10
Battery supply (3.65 VDC) directly from the lithium battery. May not be shorted under any circumstances!

Pin 11-12
These test pins are used in connection with the adapter cable and test unit (please refer to paragraph 6, Reset Functions).



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6. Reset Functions

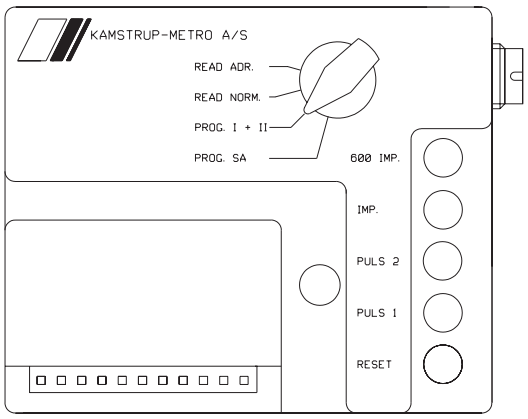
6.1 Power ON Reset

When battery voltage is connected to PICOCAL all values are retrieved from the EEPROM. Furthermore, information code 1 is registered.

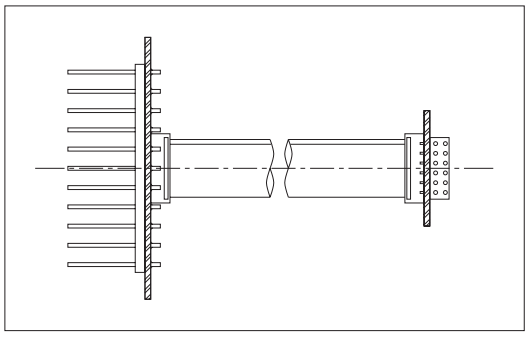
This function will not normally occur when the meter is installed on the customer's premises, as the battery is fitted at the factory and designed to last the meter's lifetime.

NB
A test unit, type 65-61-821 and an adapter cable, type 65-61-860 must be used to perform the following reset functions; 6.2, 6.3 and 6.4. Alternatively, the verification unit type 66-99-381 and the METERTOOL software type 66-99-211 can be used.

Connect the adapter cable between PICOCAL's 12-pole test plug and the 11-pole molex plug on the test unit.



Test unit, type No. 65-61-821



Adapter cable, type No. 65-61-860

6.2 Total Reset

This is the most comprehensive reset function. The arrow key will be set at month 1 and the 730 hour (monthly counter) will be set at zero. Energy, water, information and hourly registers will be set at zero. Press the key on the PICOCAL front panel whilst pressing the IMP-key on the test unit. Hold both keys down while pressing the RESET key on the test unit for at least 2 seconds. Release the RESET key on the test unit and then the other two keys.

Use the key on the front of PICOCAL to read kWh/MWh/GJ, m^3, hour counter and information code in the display and check that these are now set at zero. If this is not the case, repeat the above procedure.

6.3 Reset Information Codes

This reset function cancels all information codes and can be used once a fault has been corrected.

Press the IMP key on the test unit, keep applying pressure whilst pressing the RESET key. After min 2 seconds release the RESET key and the IMP key.

Check that the information code is now showing "0" in the display. If not, repeat the procedure.

6.4 Reset Hour Counter

This reset function resets the hour counter and can be used during installation to synchronize the hour counter in a number of PICOCAL's.

Press the key on the front of PICOCAL, keep pressure on the key whilst pressing the "RESET" key on the test unit. After min. 2 seconds release the "RESET" key and then the key on PICOCAL.

Check that the hour counter is now showing "0" in the display. If not, repeat the procedure.

6.5 Reset with METERTOOL

Reset ALL	METERTOOL + front button
Reset INFO CODE	METERTOOL
Reset Hour Counter	METERTOOL + front button

See METERTOOL paragraph 8.7.

6.6 Other Functions

When PICOCAL is connected to the test unit, type 65-61-821 and the adapter cable, type 65-61-860, you can also test PICOCAL's operation. The test takes approx. 10 minutes (600 integrations). You can also input a customer number using MULTITERM II. Please refer to manual Nos. 5510-640 and 5510-595 for further information.

The same test and input can be done using the METERTOOL. See chapter 9 Verification.

MULTITERM WORKABOUT cannot be used for these functions. However, together with the test bracket it can be used for reading standard data (menu 1).

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7. Verification

7.1 Quick Figure

The quick-figure is **only** used when verifying PICOCAL. The meters highest resolution is defined as the Quick-figure, which can be calculated a follows for every energy integration:

$$\text{Quick-figure} = m^3 \times \Delta t \times k_{Gcal} \times A$$

The multiplication factor "A" depends on [m^3] placement of the decimal point in the display (the actual decimal point placement for [m^3] readout can be seen in the YY table in paragraph 2.5). k_{Gcal} tables can be seen in paragraph 2.6.

Decimal point placement [m^3]	Multiplication factor A
2 : 0000.00	10000
1 : 00000.0	1000
0 : 000000	100

The current Quick-figure can be accessed as pulses on the test plug (pin 4) – see the description of the test plug under paragraph 5.6.

The pulses can be measured by means of a battery-driven frequency counter connected between the Quick-output (pin 4) and the battery plus pole (pin 9). If a frequency counter with a high impedance is used, it may be necessary to fit a pull-up resistor (100 kΩ) from pin 4 to pin 9.

The Quick-figure is given for each energy integration as a pulse burst with a frequency of approx. 25 kHz.

While verifying a Q_s 0.6 m^3/h, 16,680 pulses will normally be emitted, corresponding to 10 energy integrations or 100 litres. It is the accumulated Quick-figure – as described in paragraph 7.3, which is used when verifying.

7.2 Energy Calculation

The "true" energy admitted to PICOCAL during verification must be calculated carefully as this "true" energy forms the basis for calculating the meters verification divergence.

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

m^3 is the admitted (or simulated) amount of water during verification. If PICOCAL has a Q_s 0.6 m^3/h flow meter and a YY code of 22, the calculator will be programmed to receive 166.8 volume pulses per litre.

If for example 16,680 volume pulses are admitted during verification, this corresponds to 16680/166.8 = 100 litres, or 0.1 m^3.

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

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

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

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

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7.3 ∑ Quick Figure

The sum of the Quick figure, e.g. determined while verifying, is called the ∑ Quick figure. The number can be up to *999999* and is accessed through the data output and the HF output, pin 4 on the test plug.

The ∑ Quick figure is also shown in PICOCAL's display when a resistor of 100 kΩ is connected between pins 4 and 9 on the test plug.

The accumulated Quick figure, which PICOCAL, under ideal circumstances, should emit during verification, can be determined as a calculation of the "true" energy multiplied by the high-resolution Quick factor:

Quick = E_{GJ} x Q_{GJ} or E_{MWh} x Q_{MWh},

Example:
PICOCAL, programmed for Q_s 0.6 m^3/h flow meter placed in the flow pipe.

16,680 volume pulses are admitted (corresponding to 0.1 m^3) and the temperature is simulated as:

t_F = 49.00°C and t_R = 40.00°C (Δt = 9 K)

E_{MJ} = m^3 x Δt x k_{STUCK} = 0.1 x 9 x 4.1316 = 3.71844 [MJ]

Quick = E_{MJ} /1000 x Q_{GJ} = 3.71844/1000 x 2.388.900 = 8883

where

Q	0000.00 m^3	00000.0 m^3
Q_{GJ}	2,388,900	238,900
Q_{MWh}	8,600,000	860,000
	eg YY = 22	eg YY = 27

In connection with above forms the placing of commas in the YY-table as regards m^3 read-out must be taken into consideration

7.4 The Nominal Quick Figure

By specifying "ideal" conditions the nominal Quick Figure while verifying PICOCAL can be determined. These nominal Quick figures can naturally only be used as guidelines or in respect to a function test. Prior to final verification, corrections must be made for temperature deviations etc.

Conditions for $Quick_{NOM}$:

t_R = 40.00°C
t_F = 49.00°C - 61.00°C or 80.00°C

Q_s	Δt	Flow meter installation	Pulses/10 int.	$Quick_{NOM}$ /0.1 m^3
0.6	9	Flow	16680	8883
0.6	21	Flow	16680	20602
0.6	40	Flow	16680	38843
0.6	9	Return	16680	8912
0.6	21	Return	16680	20803
0.6	40	Return	16680	39667
1.5	9	Flow	6070	8883
1.5	21	Flow	6070	20602
1.5	40	Flow	6070	38843
1.5	9	Return	6070	8912
1.5	21	Return	6070	20803
1.5	40	Return	6070	39667
				$Quick_{NOM}$ /1 m^3
2.5	9	Flow	29820	8883
2.5	21	Flow	29820	20602
2.5	40	Flow	29820	38843
2.5	9	Return	29820	8912
2.5	21	Return	29820	20803
2.5	40	Return	29820	39667

8. Programming via METERTOOL

8.1 Introduction

METERTOOL for PICOCAL is a Windows software, which can be installed on a PC and used to program and verify the calculator. METERTOOL is developed with a view to offering distributors, utilities and laboratories a simple and effective access to programming and verification of the calculator.

8.2 PC and Printer Requirements

METERTOOL is suitable for installation under Windows 95/98/NT/2000 on Pentium based PCs with at least 16 MB RAM, 20 MB free hard disk and VGA monitor min. 640 x 480. Recommended 800 x 600 or higher.

In order to be able to install the program, the PC must be supplied with a 680 MB CD-drive.

To facilitate programming/verification of PICOCAL the verification equipment type 66-99-381 between the calculator and PC is used.

The program can be set up to use the PC's COM1...8.

The program can meanwhile be used for printing labels for PICOCAL. The printer must be compatible with Windows and be suitable for printing small self-adhesive label sheets.

The printer is connected to the computer's parallel port, LPT1.

Kamstrup A/S recommends e.g. an OKI 610ex, OKI 410ex or a HP4 laser printer, but other printer types can also be used.

Sheets with original self-adhesive labels, type 2008-245, can be ordered from Kamstrup A/S.

8.3 Installing of Software

Please check that the computer has min. 20 MB free space on the hard disk, e.g. by means of Windows File Manager. Close all active Windows programs before installing the program.

Insert the CD in the drive and follow the program's instructions as they appear on your screen.

When the installation is completed, the icon "METERTOOL" will appear in the Start menu.
Path: Start/Program/Kamstrup METERTOOL/ PICOCAL.
Double click on the new icon "PICOCAL" to start the program.

Please note: If the right printer driver is not installed, the program will not be able to print labels or certificates.

8.4 Connecting PICOCAL to PC

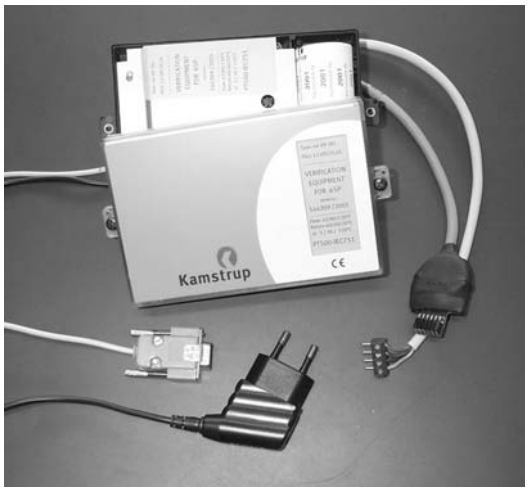
The calculator is programmed for serial data transmission between the calculator and the computer. The data can be transmitted by means of verification equipment, e.g. type 66-99-381.

The top cover is carefully removed by using a screw-driver, and the programming plug and testing cables are mounted.

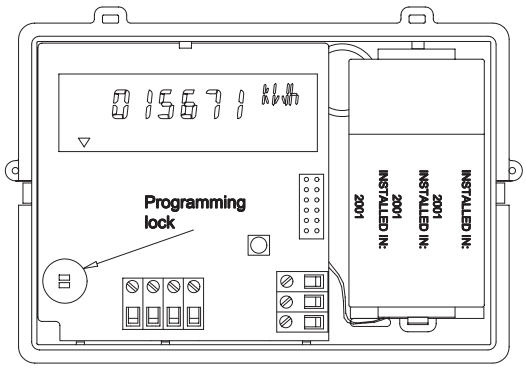
If only programming is required, it is sufficient only to mount the programming plug

NB. When the programming plug is mounted the verification seal will break.

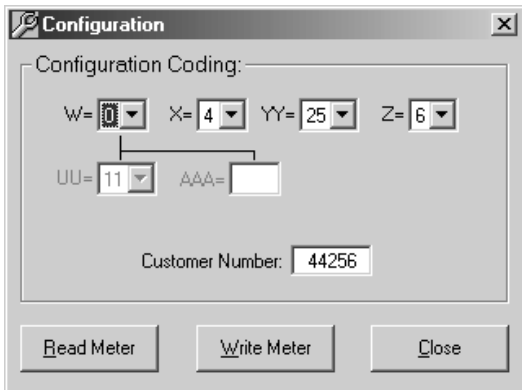
If the computer has a 25-pole COM-plug, a 9M/25F adapter, type 66-99-120 must be used.



8.5 Reading PICOCAL



NB: Reprogramming from GJ to kWh/MWh is not possible.



Connect the serial data communication as described in the previous paragraph and start the program by clicking on the icon "PICOCAL".
Choose the button "Read meter" and data will be transmitted from the meter and shown on the monitor.
It is important to be familiar with PICOCAL's functions before programming.
Connect the programming plug to PICOCAL when programming.

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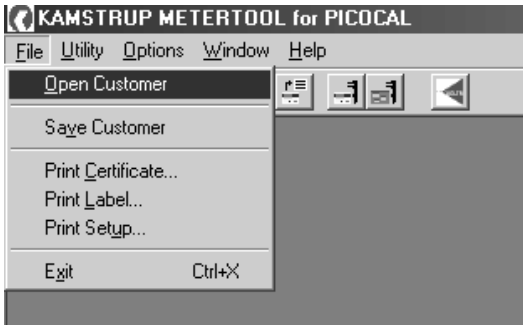
The calculator program is protected by a programming lock (see picture). The lock must be short-circuited (short-circuit pen 66-99-278) in order to make programming possible

When the programming plug is connected, PICOCAL can be reprogrammed including legal data and serial number.

The data required is transferred to PICOCAL by activating "Write Meter".

Please note that the data logging memory in the calculator will not be changed/erased during programming.

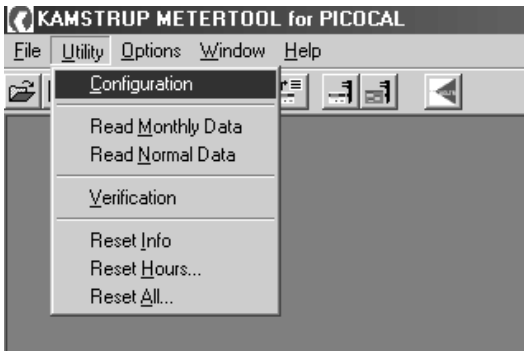
8.6 File



Under the menu "File" one of the following functions can be selected:

Open Customer	Fetch stored customer settings from the data base.
Save Customer	Save new customer settings in the data base.
Print Certificate	Starts print of test certificate.
Print Label	Starts print of side label.
Print Setup	Printer setup for printing side label and certificate.
Exit	Terminates METERTOOL.

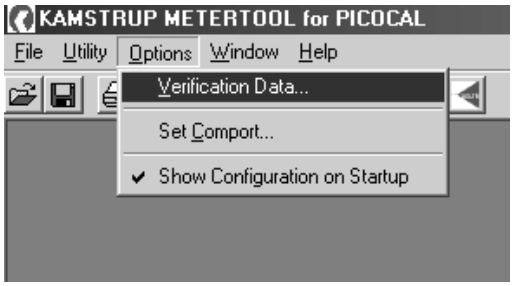
8.7 Utility



This menu gives access to the following dialog boxes:

Configuration	General view which is used when reading and programming.
Read Monthly Data	Retrieves monthly data from the meter.
Read Normal Data	Retrieves normal data from the meter
Verification	Test/Verification of calculator (see chapter 9)
Reset Info	Reset Info code
Reset Hours	Reset operating hour counter
Reset All	Reset all registers and readings

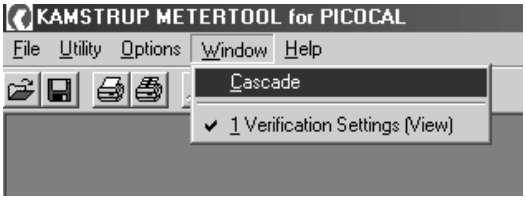
8.8 Options



The menu has a few settings which are not used very often:

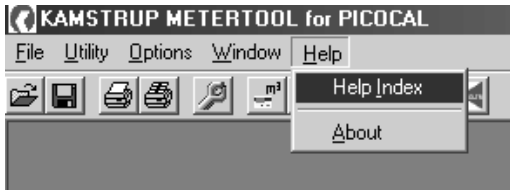
Verification data	See paragraph 9. Verification via METERTOOL.
Set ComPort	Indicates the choice of Com1...8.
Show Configuration	Indicates whether or not the configuration menu appears when starting up the program.

8.9 Window



Makes it possible to shift between displays, if several program parts are activated.

8.10 Help



Help Index	By activating the F1 key, it is possible to get help to the active menu.
About	Shows type number together with numbers and revisions of both program and data base.

NB: F1= Help with the active menu.

9. Verification via METERTOOL

Equipment description

Verification equipment type 66-99-381 is used for testing and verifying the PICOCAL calculator. The test includes volume simulation.

Different temperatures for both sensor inputs are simulated and, together with the volume simulation, form the basis of verification of the energy calculation.

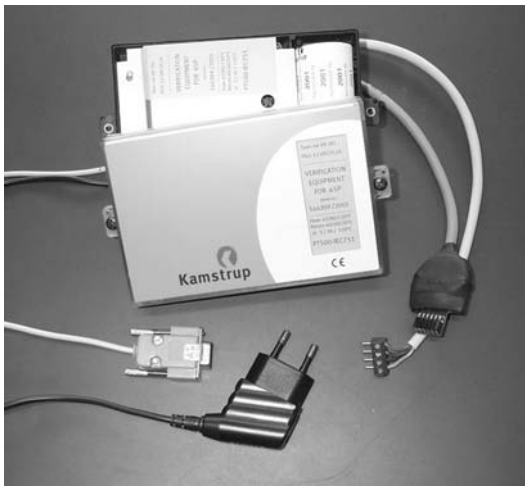
The equipment is primarily designed for use in laboratories which test and verify energy meters, but it can also be used to test meter operation.

The computer program METERTOOL type 66-99-211 is used to configure, test and verify.

All data communication between the computer and the integrator is transmitted via the computer's serial ports; COM1...8, which are connected to the
verification equipment. Please note that the equipment must be supplied via the associate mains adapter.

The computer must comply with demands specified in paragraph 7. *Programming via METERTOOL*.

Verification does not include temperature sensors and the flow part.



66-99-381	T1 [°C]	T2 [°C]
Standard	130	20
	80	60
	43	40

9.1 Function

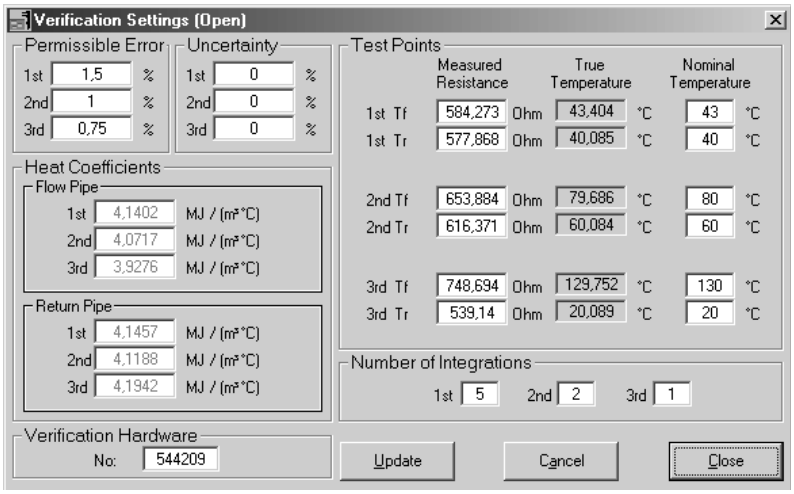
Verification equipment type 66-99-28x is mounted in a standard MULTICAL® base and contains battery, connection print, verification print, microprocessor, control relays and precision resistors.

During the test the calculator is supplied by the battery. The verification print is supplied via the associate external mains adaptor with 12 VDC. The microprocessor simulates the volume based on pulse frequency and the number of pulses per test point, which have been selected in METERTOOL. Temperature is simulated by means of permanent precision resistors which are changed automatically via relays controlled by the microprocessor.

After testing the computer reads all registers in the calculator and compares the values with the calculated values.

Deviation, determined for each test point – shown as a percentage – can be stored in the computer under the serial number of the tested PICOCAL. Saved testdata can be printed on a certificate.

9.2 Verification Data



The first time that METERTOOL and the verification equipment are used, a number of calibration data must be entered in the menu "Verification data". As these data are of crucial importance for the verification result, they are protected by a password which can only be disclosed by Kamstrup A/S.

Permissible error and uncertainty

Max. permissible error, indicated as a percentage, and the equipment's measuring uncertainty must be indicated under each of the three verification points; 1st, 2nd and 3rd. The "permitted error" minus "uncertainty" will be indicated as MPE on the verification certificate. According to EN 1434 is MPE $\pm(0{,}5 + \Delta\theta \text{ min}/\Delta\theta)\%$.

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Heat coefficient in flow and return

When the calibration values for the temperature simulators are entered in the program, it automatically calculates the true k-factor, according to the formula in EN 1434.

Test points

The test points 1st, 2nd and 3rd are determined by the size of the temperature simulation resistances fitted in the test equipment. The rated temperature points are indicated in the table in paragraph 9.

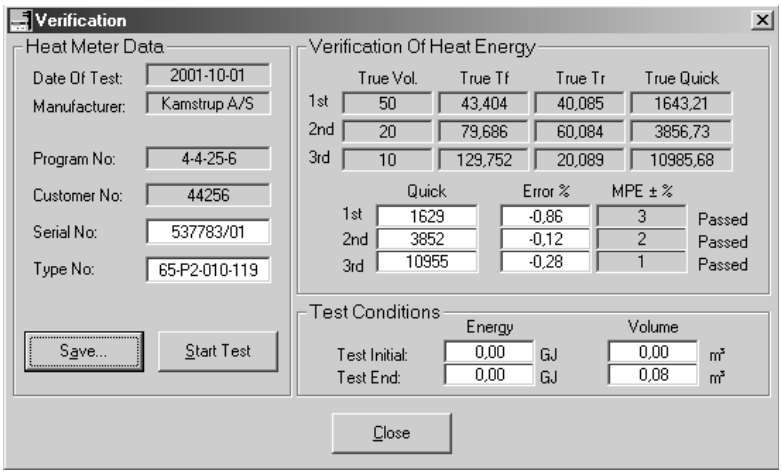
Measured resistance

In order to update the temperature simulators' calibration, the temperature resistances' latest measured resistance values are entered. A calibration sheet with declaration of measured resistance values for all simulators is supplied by Kamstrup A/S together with the verification equipment. The temperature simulators must be calibrated at Kamstrup A/S at least once a year.

Enter number of integrations

Enter the number of integrations required at each test point in this field. If the programming number is e.g. YY=19, 1000 volume pulses must be received for each integration corresponding to 0.01 m³. In case of doubt please see the YY-table in paragraph 2.5.

9.3 Verification



All necessary information can be transmitted directly from the calculator via serial data transmission, which simplifies verification. Before test or verification can be started, a control must be made to confirm that all verification data are correct. The procedure is started by clicking on "Start test".

The test takes between one and five minutes depending on the test type selected and the size of the meter.

When the test is completed, the results are shown on the monitor. If the results can be approved, click on "Save" and all verification data will be stored in the data base under the calculator serial number. It is possible to save data both on verification and control.

If a printed certificate with the test results is desired, select "Print" from the "File" menu.

9.4 Maintenance

Verification equipment type 66-99-381 is designed to work a number of years with a minimum of maintenance. The following must, however, be executed frequently in order to secure optimal operation:

Recalibration

On delivery, a calibration certificate is enclosed issued by Kamstrup A/S. The applied calibrated resistance values must be entered under "Verification data". The equipment must be recalibrated at least once a year.

Kamstrup

CERTIFICATE OF CALIBRATION

Verification Equipment for MULTICAL ® / MULTICAL® Compact / PICOCAL

Customer: **KM Lager**

Type No.: **66-99-381** Type of meter: **65-P**

Serial No.: **544209**

Procedure: Kamstrup A/S No.: 5509-405 QI

Test equipment:

DMM, Datron 1271 Kamstrup A/S No.: 14-021-010

Standard resistor, Vishay RTB 10 Kamstrup A/S No.: 14-061-020

This certificate provides traceabilty of measurement to recognised national/international standards.

Expanded Uncertainty: ± 15 ppm
(Coverage factor k=2)

Measurements:

		Nominal temperature [°C]	Nominal resistance [ohm]*	Measured resistance [ohm]	Calculated temperature [°C]*
T1	tF	43	583,495	**584,273**	43,404
	tR	40	577,704	**577,868**	40,085
T2	tF	80	654,484	**653,884**	79,686
	tR	60	616,210	**616,371**	60,084
T3	tF	130	749,160	**748,694**	129,752
	tR	20	538,968	**539,14**	20,089

*According to IEC 751/EN 60751 Amendment 2, 1995-07 "Industrial platinum resistance thermometer sensors"

Date: **2001-09-17** Calibrated by: **JDO** Tamb.: **22,6** °C

9.5 Alphabetical Register

The following alphabetical register explains the terms which appear on the monitor.

The register can both read as an integral part of the Technical Description, or used as a reference when a question arises.

A	
AAA	Data output address
C	
Com 1...8	The computer's serial data port no. 1....8
Config. Code	The meter's configuration number =WXYYZ-UU states selected data output, energy selection, configuration, flow meter code and display reading
Customer No.	11-digit customer number which can be read on the display
E	
EN1434	European standard for heat meters
Energy	The total energy (e.g. in kWh) is stored in the memory when the info code is changed
F	
Flow	The actual flow of water meter
H	
Hours	Number of operating hours
I	
Info	Actual info code
L	
Landscape	Means that sheets with front labels will be printed horizontally
M	
Meter No.	The serial number of the meter
mm	The number of milimeters with which the side label's print must be adjusted
MPE	(Maximum Permissible Error) Max. permitted error
O	
Open Customer	Retrieves saved set-ups from the database
P	
Print Label	Starts printing the label displayed
Print Certificate	Starts printing the calibration certificate
Program Number	See Config. Code
Q	
Quick	(Qsum) High resolusion measuring unit for heat energy
R	
Read meter	Reads the meters setting. All the meter's data are transmitted to the display
S	
Save Customer	Stores a setting in the data base
Start test	This command is used to start the automatic verification sequence
T	
Test initial	Registers the value before verification
Type No.	The meter's type number contains information on power supply, data module, sensor type, pick-up unit and language on the front label
U	
UU	Displays code which indicates the display reading selected
W	
W	Configuration of data output
Water	m³ consumed
Write Meter	Starts programming the meter. All data displayed will be transferred to the meter
WXYYZ-UU	The meters configuration number = WXYYZ-UU
X	
X	Displays read-out device
Y	
YY	Flow meter code. E.g. YY=19 is used with 100 imp/l for flowmeter Q_n = 0.6 m³/h
Z	
Z	Coding for installation in flow/return flow

10. Environmentally Correct Disposal

The Kamstrup heat meter has been constructed with a view to long-term, reliable operation at the heat consumer. As we know, however, all good things come to an end, and the heat meter is no exception. It must , of course, be disposed of with consideration for the environment.

Disposal by the supplier
Kamstrup can accept PICOCAL for environmentally correct disposal according to previous agreement. The disposal is free of charge to the customer, who must however pay the transportation costs to Kamstrup A/S.

Disposal by the customer
The lithium battery must be removed from the meter*) and sent to separate, approved destruction. It must not be possible to short-circuit the lead-in wires to the battery during transportation.

– If small quantities of meters are dismounted, the energy meter without battery can be handed in for industrial scrapping or for combustion with subsequent metal recycling.

– In case of dismounting of a big number of heat meters, the parts must be separated, sorted and handed in for separate destruction and recycling as described in the below-mentioned list.

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

Kamstrup A/S
Att.: Quality Control Dept.
Fax: +45 89 93 10 01
E-mail: energi@kamstrup.dk

Part	Information on materials	Recommended disposal
Lithium battery in PICOCAL - D-cell	Lithium and Thionyl-cloride >UN 3091< - D-cell: 4.9 g lithium	Approved destruction of lithium cells
PC boards in PICOCAL (LC-display and electrolytic capacitor are removed)	Copper epoxide laminate with soldered components	PC board scrap for concentration of noble metals
LC-display	Glass and liquid crystals	Approved scrap centre for LC-displays
Electrolytic capacitor	Can contain PCB	Approved destruction of electrolytic capacitors
Cables for flow meters and sensors	Copper with PVC- or silicone mantle	Cable recycling
Plastic parts, cast	Noryle and ABS	Plastic recycling
Packing	Recycled cardboard	Cardboard recycling

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