

Manual

F22 calculator

USERS MANUAL F22

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1 General

Congratulations! You have purchased one competent heat energy calculator for debiting. We hope that you will experience years of trouble free and accurate energy calculation. The calculator is flexible and has many features to fit your metering demands now and in the future. Some of these extra add on features are possible to fit the calculator after delivery.

1.1 Introduction

Heating is often required to achieve a comfortable indoor temperature throughout the whole the year. Installing a boiler in single house or housing complex and distribute the heat is the most common way of heating.

With growing population and environment awareness the district heating has grown popular. To build a larger boiler to heat a town or part of town is often more environmental safe than several smaller boilers. The pollution from a master boiler is often better, cleaned than several small boilers. Energy outtake from the fuel is often better when using boilers for district heating even when the heat loss in transfer distance is greater. The district heating boilers are also less sensitive to a specific fuel and price variation. District heating companies can resort too many different fuel types such as oil, gas, coal, wood and waist, for example waist from wood industry.

One very clear advantage for a house owner is less maintenance for the boiler. In the Scandinavian countries the heating cost is also lower, using district heating. Water is the most common heat carrier for heating. When other medium is used or when water mixtures are used, for example water + 20% glycol, the calculator must be clearly marked for this mixture or medium. When there is no marking, the calculator is generally only to be used for water.

When distributing energy, there is a need to measure and securely divide the heat energy cost between the consumers. The device to measure the heating energy is called "heat meter". There are several laws and regulations that an approved heat meter must comply to. A heat meter normally consists of one calculator, two temperature sensors and one flow sensor. The devices in the heat meter can be individually approved for the heat metering or approved together. When the devices are approved together, the heat meter is often called "compact heat meter".

The calculator algorithm in approved calculator must be tested and verified by an independent accredited laboratory, e.g. SP in Sweden, PTB in Germany, to ensure metering quality for the debiting company and heat energy subscriber.

1.2 F22 Calculator

F22 is a calculator that calculates the heat energy consumption of a single heat user. To make for the calculator work, the calculator must be connected to two temperature sensors and one flow sensor. We assume that these devices (temperature sensors and flow sensor) are working properly and that they are correctly connected.

The main calculator function is to store accumulated energy and accumulated volume. F22 has two energy registers and one flow register. In addition to these registers, the F22 has two pulse counters. 37 monthly values and two account days are also stored in the calculator. For more information on the monthly values and account days, see 1.5.1 “Monthly values”.

To acquire the stored values press/hold the “display button” and the data will be displayed in the calculator display. Data from F22 can also be retrieved electronically via an M-Bus output and two pulse outputs.

The calculator algorithm is for the liquid water. Only use this calculator to measure heat energy form water and not from other liquid or a water mixtures. The calculator can be used to measure cooling energy, and then the temperature sensors are shifted.

1.2.1 Flex calculator family

The F22 calculator is a member in the Flex calculator family. Flex, also named “Fx”. Calculator’s functions can easily “recognize” through the whole Flex family range. The same way of handling from the simplest calculator to the most complex calculator with added functionality. Which reduces additional education when a new member of the Flex family is introduced. The same “feel and touch” will be recognized throughout the Flex family.

1.3 Principle of energy measurement

The principle of heat energy transfer is simple. Hot water to 60-90 deg C and in some cases even to a higher temperature is distributed. The hot water is led in pipes to the heating consumer. The heating consumer has normally a heat exchanger that retrieves energy from the heated water pipe and the used cold water is distributed back.

The calculator is designed for a closed district system. The water may not be removed, e.g. tapped out.

The hot water pipe is called supply, high (H) or hot. The coldwater return pipe, low (L) is called return pipe. See alternative naming below.

Heat energy measurement is done by a combination of several devices. Energy measurement consists of:

1. Calculator
2. Two paired temperature sensors, resistance thermometers, Pt100 or Pt500
3. Flow sensor, that emits pulses

The calculator (1) measures the temperature difference between the temperature sensors (2) and register pulse emitted from the flow sensor (3) and then makes an energy calculation.

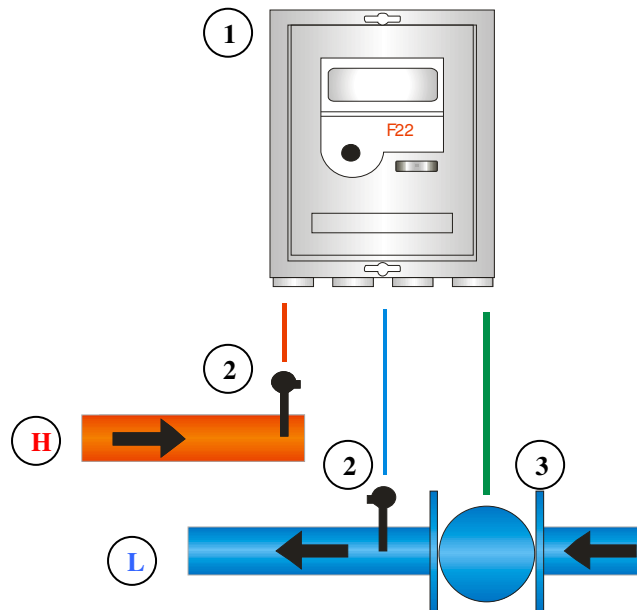


Fig. 1.3, Principle of energy measurement

1.3.1 Nomenclature and alternative naming

The nomenclature for the heat energy industry is not unified, because of great difference between the users. Different words are used to explain the same thing. The words, mostly according to EN1434, are recommended and underlined.

Calculator

The calculator is the device that calculates and presents the metering data.

Calculator is also named: *Heat meter, Calorie meter, BTU meter or Energy meter*

Flow sensor

The flow sensor is the device that registers the volume. Pulses are sent from flow sensor to the calculator. Each pulse represents specific volume, example one pulse represents 1 [l/p]. How much each pulse is worth (in volume) must be correctly set on the calculator. In display sequence "63" the pulse weight can be viewed.

Temperature sensors, register temperature

Supply, high (H)

In order for the energy calculation be correct the sensor placing in the calculator must be correctly set, e.g. the temperature sensors and the flow sensor placing in the pipes. Supply end is where the hot water enters.

Supply is also named: *Forward, high (H), hot and enter*

Return, low (L)

Where the cold water is returned.

Return is also named: *Cold, Cool or low (L)*

1.4 Operating conditions

All electronics have limitations like response time, battery capacity, component life length and so on. Fulfil the operation conditions for the best calculator performance.

Battery powered calculators have operation limitations for the battery consumption. For trouble free usage of the calculator, follow limitations to apply battery powered calculators, see 1.4.5 Operating conditions.

1.4.1 Flow sensor requirement

The flow sensor must be approved for usage in a district heating system. The difference of a “general flow sensor” is that the “general” flow sensor normally does not have the quality required for district heating. The flow sensor for district heating must be designed for constant flow, hot water and must be able to resist particles that can appear in a district heating system.

There are different types of flow sensors and flow sensor technique. The calculator calculates flow pulses from the flow sensor, so the flow sensor must emit pulses that correlate to a volume, the pulse value.

1.4.2 Paired temperature sensors PT100 / PT500

The temperature sensors must also be approved for district heating. The temperature sensors must be paired and the sensor cable length must be equal in length. This is very important when the calculator’s algorithm depends on the temperature difference between the temperature sensors. The quality of the energy calculation is highly depended on high accuracy in temperature difference measurement. The F22 is constructed for the 2-wire temperature sensor connection. 4-wire temperature sensors connecting technique can’t be used in F22.

1.4.3 Medium, heat conveying liquid

The F22 calculator algorithm is designed for only measuring energy outtake for the heat conveying liquid water. **Note:** A water mixture requires a different calculator algorithm than the medium water.

MF4 is a calculator that has algorithm for water mixture (water + glycol).

1.4.4 Operating environment

Operating temperature: 5 – 55°C
Humidity: 0 – 95% REL non condensing

Storage / transport: -20 – 70°C

1.4.5 Operating conditions for battery supplied calculators

The usage of the calculator is different. The battery life expectancy is valid when following definition of normal operating condition, see below. Limits, where the calculator performs without risking the battery life expectancy:

- M-Bus telegram reading (all protocols), maximum once per day. Higher reading frequency on M-Bus reduces battery life.
- Maximum flow sensor pulses emitted at the average rate of 1,5 [p/min] and with the maximum temperature difference at 50 [degrees K]. The average shall be based on the whole lifetime of the battery. The calculator shall also have standard decimal setting, see standard decimal setting, see also appendix.
- Configuration by using the “FlexServ” (Flex service program) must be done carefully. With the “FlexServ” the user can seriously reduce the battery life expectancy and affect the calculation. Use factory settings when possible, the settings in which the calculator was delivered.
- Set in operating mode (display sequence “10”) when using the calculator, see also 3.6 operating mode. When calculator is set to Service-/Init- or Test-mode the battery lifetime expectancy can be reduced. Avoid setting the calculator into other modes than operating mode for longer periods of time (>2h in total).
- Installing the calculator in large M-Bus loops (>250 slaves) can reduce the battery life expectancy.
- The pulse value and flow direction for the flow sensor must be correctly set in calculator.

1.4.6 Operating conditions mains supplied

Following points must be fulfilled for best performance of the calculator.

- Configuration by using the “FlexServ” (Flex service program) must be done carefully. With the “FlexServ” the user can seriously reduce the battery life expectancy and affect the calculator calculation. Use factory settings when possible, the settings in which the calculator was delivered.
- Set in operating mode (display sequence “10”) when using the calculator, see also 3.6 operating mode. When calculator is set to Service-/Init-/Test-mode, the calculator measurement can be affected negative.
- Connect the mains when using calculator. When mains power is disconnected the backup-battery is used for powering the calculator. This will reduce backup-battery life expectancy*.
- The pulse value and flow direction of the flow sensor must be correctly set in the calculator.

* Only applicable in mains powered calculators.

1.5 Calculator specifics

The calculator stores additional data besides accumulated energy and flow. The calculator specifics are explained below.

1.5.1 Monthly values

The calculator has up to 37 monthly registers. The monthly values' register can be viewed in sequence 40. In these registers monthly values are stored at the end of each month at "00:00". The monthly value is a snap shot of calculator values at the end of each month. The values to be stored are:

- Date when values are stored
- Accumulated energy
- Volume, according to flow sensor
- Volume, according to energy calculation
- Pulse register 1
- Pulse register 2
- Possible error code and duration

When the maximum number of monthly values is reached, normally 37 values, the calculator replaces the "oldest" value with a "new" one.

The monthly values can be read on the display and over the M-Bus using remote reading. The order of presentation for the monthly values is the "newest" value first and then the previously stored value will be presented and so on.

See also 3.6.2 Table operation mode for more information.

1.5.2 Account days

Some users prefer to read all their meters at the same time twice a year, at two predicated days (specific dates). These are called account days. The F22 has the possibility to store two account days. The values of the account days can be viewed in display "30" on display.

The user can specify the account days using the "service mode" or the "FlexServ program". Values stored in the account day registers are the same set of values as for monthly register, see monthly values 1.5.1 above. The account day is default set to:

Account day 1: 1 January (0101)
Account day 2: 1 July (0701)

Data of the account day will be stored at the day shift. E.g. in a calculator with default set account days. The calculator will store the account day values at 00:00, 1:st of January and at 00:00, 1:st of July each year.

The "newest" value will be presented first and then the previously stored account day. The "old" account day values will be replaced, when "new ones" are to be stored. See also Table operation mode 3.6.2 for more information.

1.5.3 Pulse counter 1 and 2

The calculator has 2 pulse inputs for external devices. These inputs can be set to act as volume accumulators in [m³]. Choosing the pulse weight for the pulse inputs can be done, when ordering the calculator or using the “FlexServ” program.

To set the pulse inputs to pulse counter, set the pulse weight to: **1000 [l/p], 0 decimals**

Example: 1000 [l/p], 0 decimals - 1 m³ per pulse (One pulse, one increment of display). See 3.6.2 Table operation mode sequence “13” and “14”.

1.5.4 Placing of flow sensor

The algorithm for calculating the energy is different depending on which end of the pipes, e.g. supply pipe (hot, H) or return pipe (low, L) the flow sensor is placed. The flow sensor placing must be correctly set in the calculator for correct measuring result.

Recommended flow sensor placing is in the return (cold, L) pipe, see 1.3 principle of energy measurement. This end of the pipes is normally the “cooler side” for the flow sensor. The performance of the flow sensor and long time stability of the flow sensor is often better, when placed at Low end of the pipes (L).

The flow sensor placing can be altered on the calculator. Set the calculator into “service mode” and then change flow sensor placing by using the “display-button”, see also 7 Service for more information. The flow sensor placing can also be altered by using the “FlexServ” program.

- Flow sensor placing is displayed on display sequence “64”.

1.5.5 Serial number

Every calculator has a unique serial number that differentiates it for other calculators. The serial number can be read on sequence “63”. As the display only displays seven digits the eightieth digit will be displayed in as the last digit for the sequence, see figure below.

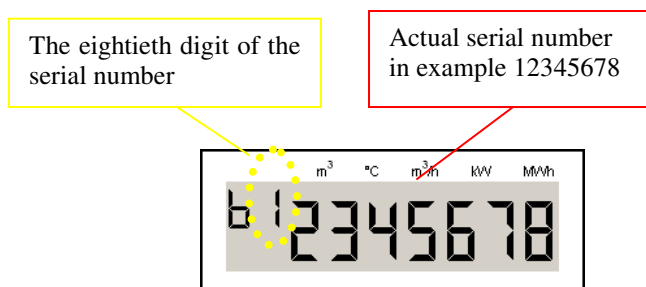


Fig. 1.5.7, Display sequence 63 serial number of calculator.

1.5.6 Limitation for M-Bus communication

The calculator can be equipped with M-Bus communication. The M-Bus is according to EN1434 the M-Bus standard and the recommendation according to M-Bus user group. Calculator has as standard an optical interface for M-Bus communication and for configuration.

An option board on slot “PL1” is required, so that the calculator will communicate in an M-Bus loop (two wire M-Bus loop).

Battery powered calculators may not be connected into loops with more than 250 M-Bus slaves. Maximum one M-Bus reading per day or otherwise the battery life expectancy will be affected.

Extreme M-Bus communication, e.g. when the calculator is flooded by the M-Bus communication. The calculator will then prioritize the M-Bus over the display update. This will result in strange calculator behaviour, e.g. locked display and slow display button response.

Flooding of the M-Bus communication will not affect the calculator measurement.

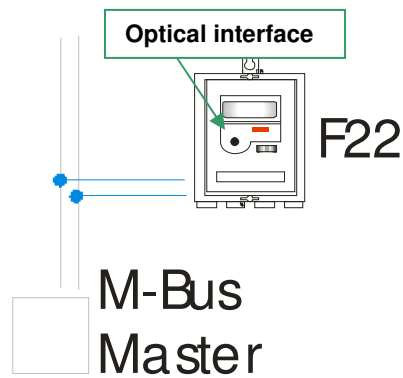


Fig 1.5.6, F22 connected to M-Bus loop.

1.5.7 Power cut (only mains powered)

Mains powered

When the mains power is cut, the calculator will run following sequence:

1. Automatically switch over to the backup battery.
2. Store calculator data to the EEPROM.
3. Generate an error code “0000080” on display sequence 15. See Error Codes, 3.6.3 (Only when selected in the calculator programming).
4. Alarm pulse 250 [ms] will be emitted from the alarm output.

The F22 calculator can be equipped with a backup battery (both mains and battery driven calculators). This battery will supply the calculator with power, when main power is cut. The backup battery will last up to 10 [years] at normal usage of calculator, maximum one M-Bus reading per day and normal energy values.

When power fails, the calculator stores all data to the EEPROM at dayshift. When power is cut from both mains and backup battery and the calculator loses all recorded data in temporary memory, there are three (3) cases:

1. All data stored after dayshift will be lost, see storing values, 1.5.8
2. All data stored after the save by short circuit the “Save data button” will be lost, see 3.8 Save data button. Only when the “save data button” is short circuit after a dayshift.
3. The power failure is short and the memory does not erase itself.

1.5.8 Storing values

The calculator stores the measured values at each dayshift (at 00:00 each day) or when “Save data” button is short circuit. See 1.5.7 Power cut.

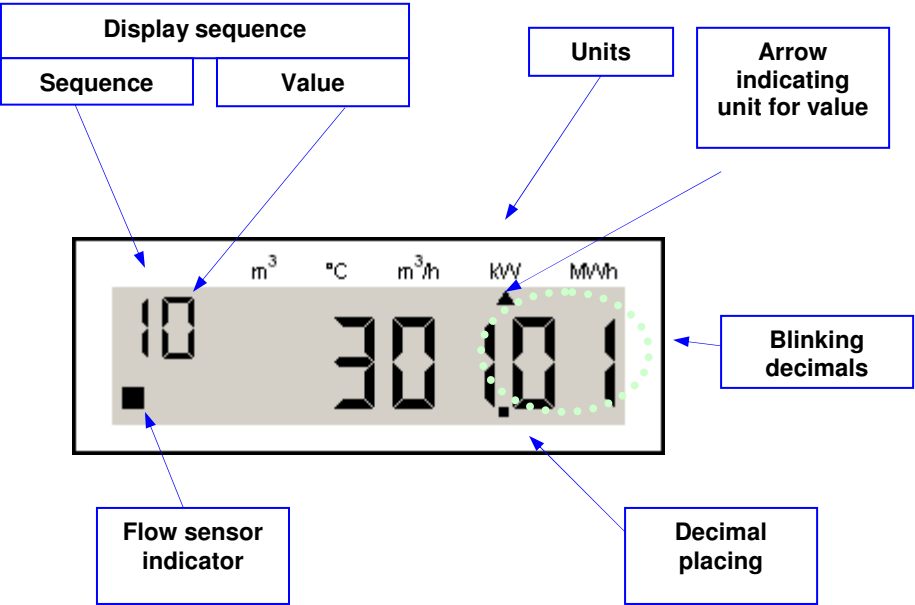
Power off at error or when disconnecting connector to mains power in calculator. Depending on circumstances there will be two cases:

1. The calculator will lose values and reset the time back for maximum 60 seconds, normally in “very short power off” (less than 1min.).
2. The calculator will lose all measured values in the temporary memory. When power is back on to meter the meter will read the EEPROM values stored at day change and reset the internal clock to “00:00”

The “very short power off” can vary depending on ambient temperature, connected input/output from 0 to several minutes.

1.5.9 Calculator display

The calculator has a 7+1 digit display. According to EN1437 the decimals in the energy register must be clearly marked.



1.6 Zero sequence current

When connecting the calculator to input or outputs one need to be aware of the possibility of “Zero sequence current” can cause problems in the input/output systems, such as no signals, error readings, parity errors and in worst case damaged circuits in the system.

1.6.1 Description of zero sequence current

The phenomena are common in electrical circuits that are not galvanic separated and devices connected to ground. The two different grounds have often a small potential difference and a current will appear between the two grounds, the current uses the non-galvanic separated I/O and the wires to travel through the calculator causing problems. The zero sequence current in these systems can be considerable.

Fig 1.6.1 and fig 5.21: To illuminate the problem we use the flow sensor as a grounded object 1. Of course the problem can exist between pulse inputs, pulse output, alarm input or input/output through option board that are not galvanic separated (e.g. analogue input board).

Note: The majority of the flow sensors are galvanic separated. Please contact your agent for further information.

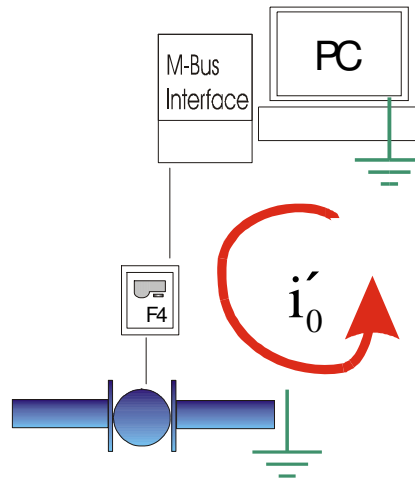


Fig 1.6.1, Zero sequence current between the M-Bus loop connected to ground through the PC and the grounded flow sensor. The current i'_0 runs through the system and causes disturbance.

Solution:

- Avoid connecting to two “grounds” to calculator.

Products:

- FCRC-2 Option board to galvanic separate pulse inputs, outputs and alarm outputs. Placed on slot PL2 in F22.

2 Installation

The installation of the F22 is quite simple. This chapter of the user manual will try to guide the user through the steps. The installation guide is divided into several parts. 2.2 Connection board, where connecting flow sensor and temperature sensors are described. 2.3 Setting the calculator into operation mode. 2.4 dimension, 2.5 connecting peripherals, pulse inputs, pulse outputs, alarm output and other devices. 2.7 Installation check.

There are several versions of F22. Mains supplied F22 Extended (E) version is used in the installation guide. Note that some of the functions or connections are not available in other versions of the F22, especially the Basic (B) version of F22. See 2.8 Different versions of F22. The versions of F22 are:

- “ “ – Basic version
- “E” – Extended version
- “R” – Radio version

2.1.1 Installing procedure (simplified)

1. Connect the calculator.
2. Set calculator into normal mode.
(Do not leave installed calculator in any other display modes).
3. Make an installation check.

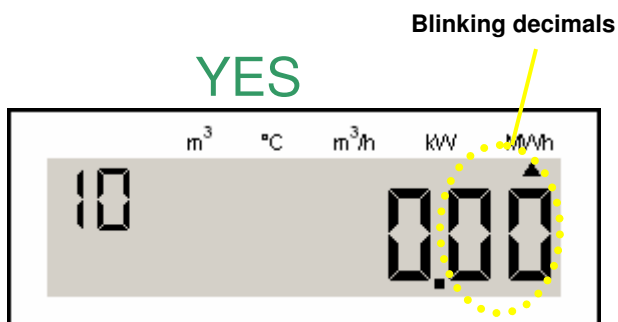


Fig 2a, Operation (normal) mode. Calculator must be set into this mode in order to measure.

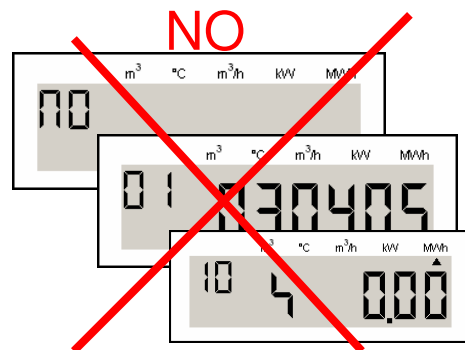


Fig 2b, NOT operation (normal) mode.

upper display Transport mode
middle display Service mode
lower display Test mode

2.2 Connection board

For connection of U2500, see 2.2.3 connecting U2500 sensor.

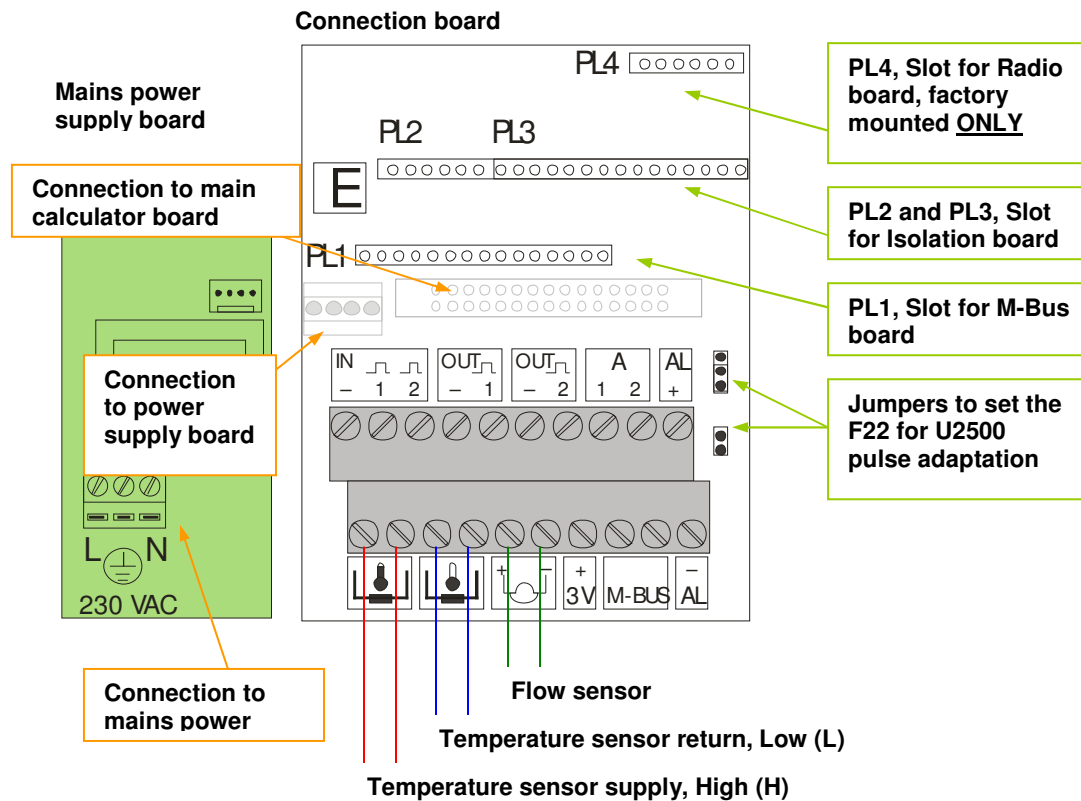
















Fig 2.1, Connection board F22

Connection

- **Temperature sensors.**
It is important to connect the temperature sensors High (H) and Low (L) correctly, otherwise the calculator will not work properly. PT100/PT500 are polarity insensitive.
- **Flow sensors.**
The direction of the pipe (H) or (L) is important for energy calculation. To set this in the calculator, see 7 Service for more information. The flow sensor input should be constructed for output of the type “open collector”. These types of outputs are standard for district heat flow sensors. The connection is normally polarity insensitive. Some flow sensors require external power supply. The connection board can supply +3 [V] and max. 20 [mA] to a flow sensor.
The pulse value must also be correctly set, normally the calculator is delivered preset for the flow sensor, also 7 Service for more information.
- **Mains supply**
230V – 50Hz. There are different versions of mains power supply boards. Check marking on the mains power board, if uncertain.

2.2.1 Connection board legend

Symbol legend of the connection board.

	Temperature sensor supply, high (H)
	Temperature sensor return, low (L)
	Flow sensor, pulse input
	Pulse input 1 and pulse input 2, common “-“
	Pulse output 1, energy (display sequence 10)
	Pulse output 2, volume (display sequence 11)
	M-Bus output (only if M-Bus board installed in slot PL1).
	Function board output (factory mounted function board)
	Alarm output
	+3V output to supply flow sensor
	Basic version F22
	Extended version F22
	Radio version F22
	X-version F22

2.2.1.1 Cable area for connection terminals

- Connection board: max. 1.5mm²
- Mains supply board terminals: Cable area 0.25 – 2.5mm²

2.2.2 Connection according to EN1434

The connection numbering according to EN1434.

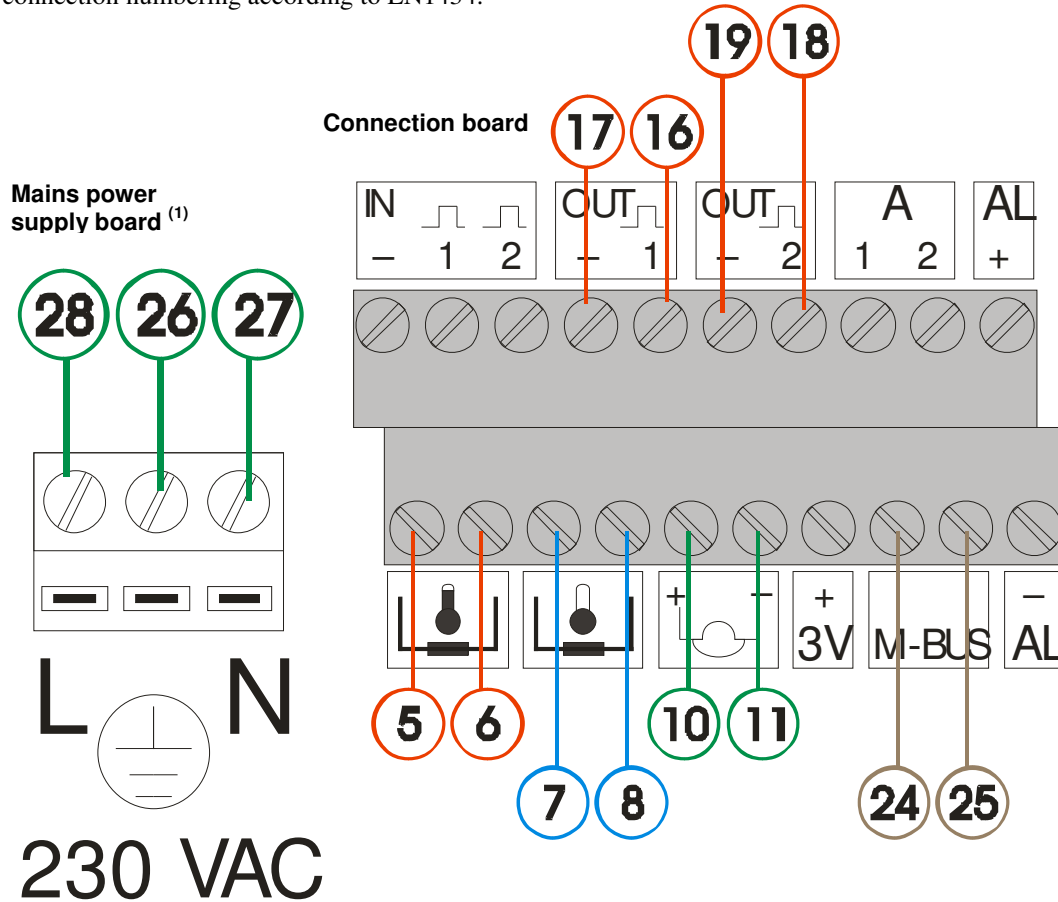


Fig 2.1.2, Calculator connection terminal numbering according to EN1434-2.
(1) Only in mains supplied calculators.

No*	Signal description
5	High temperature sensor
6	High temperature sensor
7	Low temperature sensor
8	Low temperature sensor
10	Flow sensor signal input (+)
11	Flow sensor signal input (-)
16	Pulse 1 output (+)
17	Pulse 1 output (-)
18	Pulse 2 output (+)
19	Pulse 2 output (-)
24	M-Bus interface**
25	M-Bus interface**
26	Earth symbol
27	N (neutral)
28	L (line)

Table 2.1.2, Numbering according to EN1434-2

* according to EN1434-2 numbering of terminals

** Only when M-Bus board is installed into slot PL1.
M-Bus Polarity insensitive and isolated

2.2.3 U2500 flow sensor

U2500 is an ultra sonic flow sensor. This flow sensor requires a pulse adaptation. F22 has an U2500 pulse adaptation circuit built on the connection board. With jumpers “J1” and “J2” the F22 can be set for U2500 pulse adaptation, see figure below.

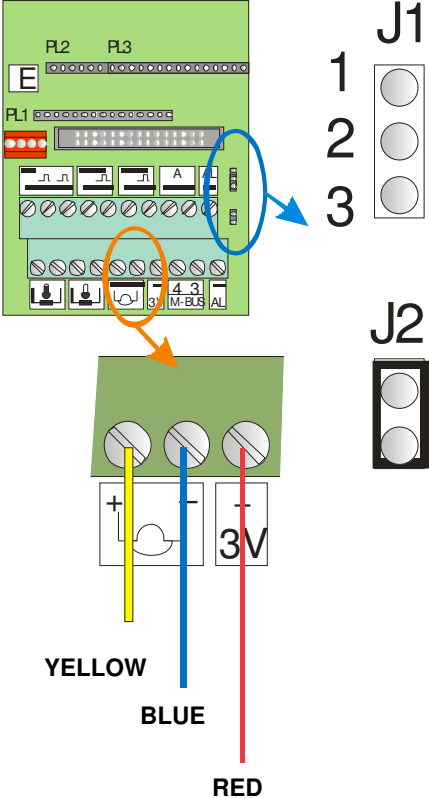


Fig. 2.1.3, U2500 connection and jumpers setting F22 connection board

2.2.4 Standard jumpers setting for flow sensor

For standard flow sensor the jumpers must be set as figure below.

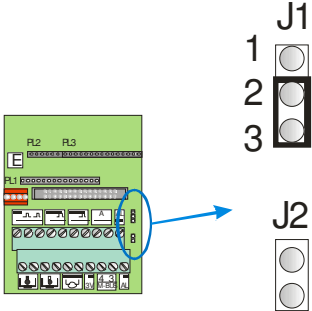


Fig. 2.1.4, Jumper settings default

2.3 Setting the calculator into operating mode

The calculator has several display modes. The display mode sets the calculator into different mode, which enables the user to do different things in the calculator. Example in service mode some of the calculator setting can be altered. See also 3.3 display modes.

The calculator is delivered in “transport mode”, a power save mode where the calculator does not measure or calculate. In order to complete the installation the calculator must be set into “operation mode”. The easiest way to enter operation mode is:

1. to hold the display button pressed until the service mode is reached.
2. to hold the display button until service display sequence “A0” is reached.
3. to change the number in display sequence “A0” to 1.
4. to hold the display button until the calculator is set to operation mode.

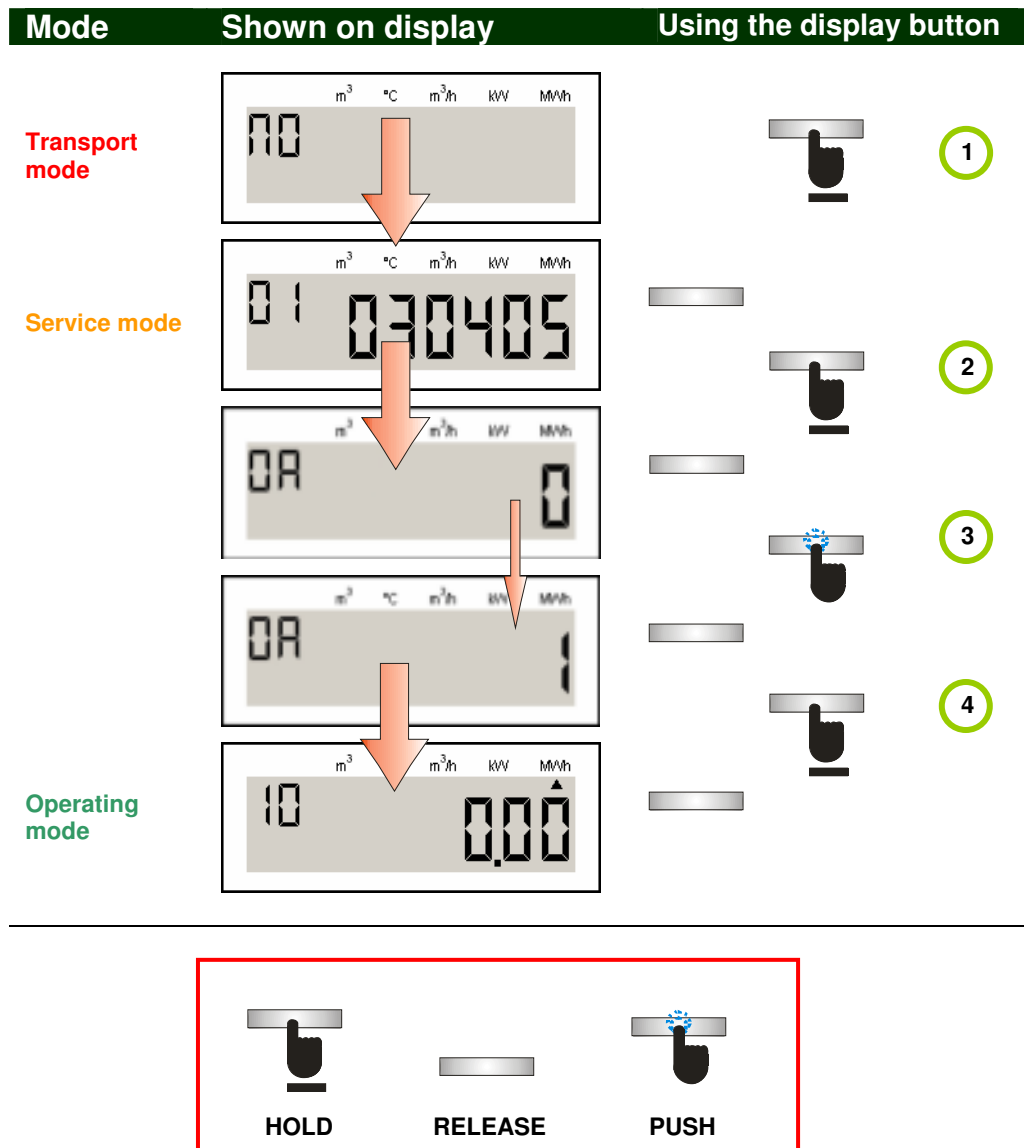
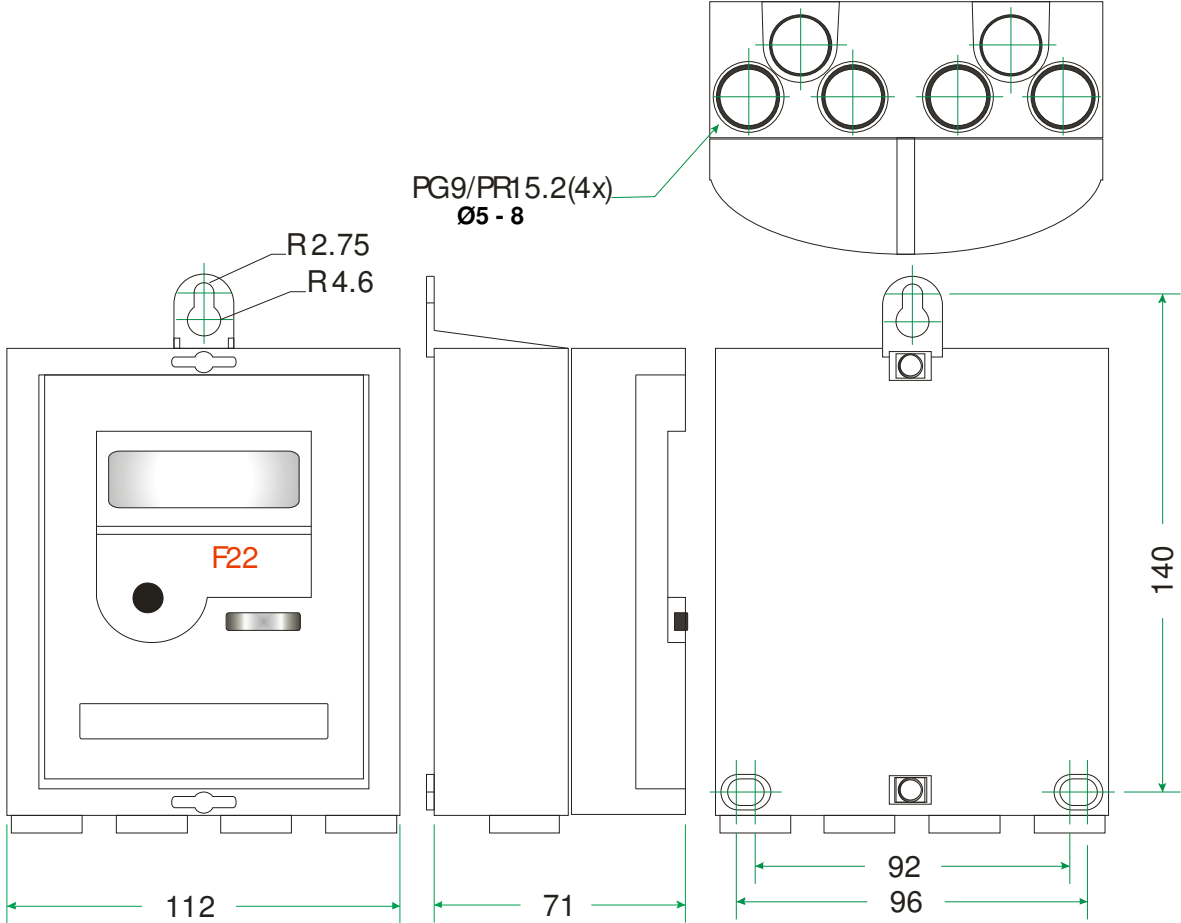


Fig. 2.2, Setting the calculator into operation mode to complete installation

2.4 Dimensions

All dimensions in [mm]

Hole distance on F22 is like RV8x.

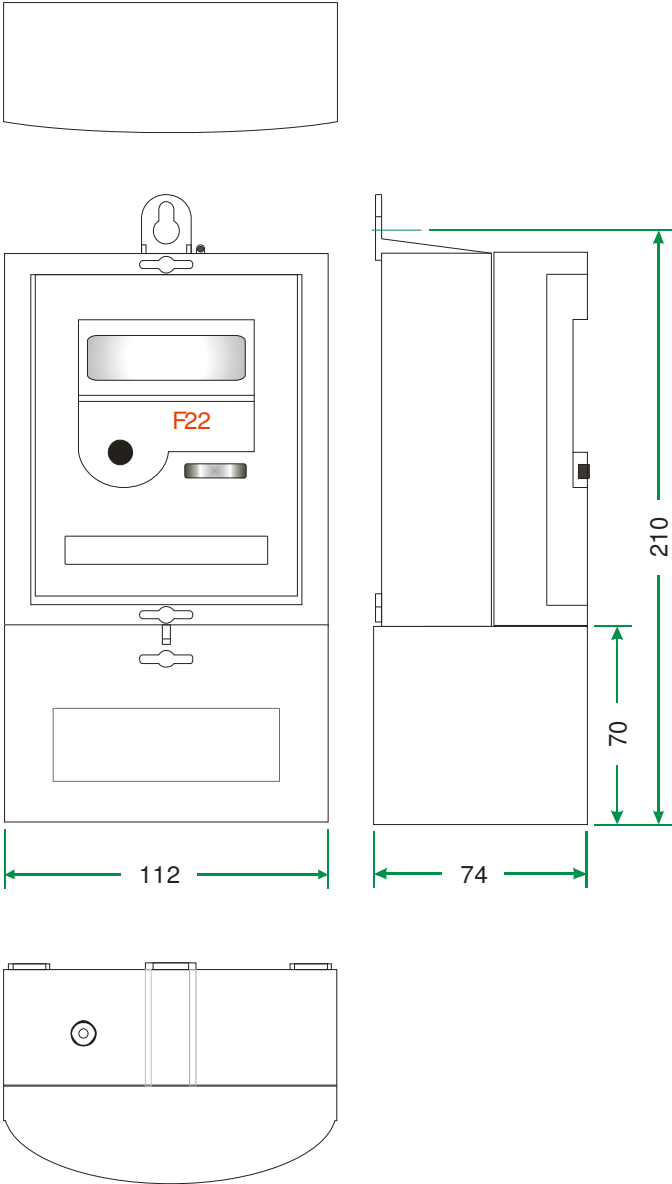


2.4.1 Dimensions F22 with cover (option)

All dimensions in [mm]

F22 with cover has will cover the hole distance as RV9x.

The F22 can be fitted with a cable cover (FT-F22-ADAPT-01). This cover can be mounted at factory or after delivery at site.



2.5 Connecting peripherals

Corrected connected flow sensor and temperature sensor are required to make the calculator calculate and measure correctly. Beside these devices the calculator can be connected to other devices, for example M-Bus master, other flow sensors, pulse counters.

2.5.1 Pulse inputs

The calculator has two pulse inputs and two corresponding registers. Pulses registered on the pulse input are accumulated to the corresponding pulse register. Other devices or meters can be connected to these inputs, e.g. cold- and hot water meters, gas, electricity and other meters.

When the pulse weight is set **1000** [l/p], the pulse inputs will act as pulse counters, one pulse will increment the register one step. The pulse inputs can also be set to be a volume register with the unit [m³], e.g. (2.5, 25, 250, 100 [l/p] and so on). When ordered, the pulse weight is the same for the both pulse registers. Using “FlexServ” the registers can be set to have different pulse weights.

The inputs are designed for outputs of the type open collector. The input supplies +3 [V] to the open collector output. To make the input recognize a pulse, the duration must exceed 40 [ms] at the voltage 0 [V]. The maximum signal cable length is 15 [m]. The specifications for the input are:

Maximum voltage	[V]	3
Maximum current	[μA]	4
Maximum frequency	[Hz]	12
Minimum pulse length (contact closure)	[ms]	40

Table 2.4.1a, Technical data for pulse inputs

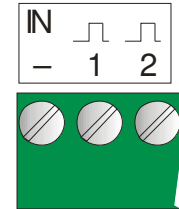


Fig 2.4.1a, Pulse input

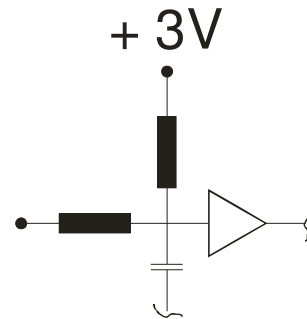


Fig. 2.4.1b, Schematics pulse input

Isolation board “FCRC-2” (OPTION)

The inputs can be isolated from the calculator using an isolation board (FCRC-2) placed on card slot “PL2”. This board is strongly recommended, when using the pulse inputs. Importance of isolated inputs cannot be emphasized strong enough. The advantages are clear and some advantages are longer cable length, isolated calculator, less disturbance, higher signal carrier voltage. The specifications for the input with isolation board are:

Maximum voltage	[V]	48
Maximum current	[mA]	100
Maximum frequency	[Hz]	12
Minimum pulse length (contact closure)	[ms]	40

Table 2.4.1b, Technical data for pulse inputs with an isolation board (FCRC-2)

Display

The accumulated pulses will be stored in the calculator and can be viewed on the display.

1. Accumulated pulses from input 1, display sequence “13”
2. Accumulated pulses from input 2, display sequence “14”

2.5.2 Pulse outputs

The calculator can be connected to other devices that can accumulate pulses to register energy and volume. The calculator has two pulse outputs. The outputs have their own common on the F22 connection board.

- Pulse output 1, energy (display sequence 10)
- Pulse output 2, volume (display sequence 11)

The output is of the type open collector. The output requires 3 – 30 [V] to power the output circuits. The technical specifications of the output are:

Voltage range	[V]	3 – 30
Maximum current	[mA]	20
Pulse duration	[ms]	250

Table 2.5.2a, Technical data for pulse outputs

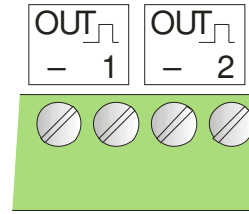


Fig. 2.5.2, Pulse outputs

Isolation board, “FCRC-2” (OPTION)

The outputs can be isolated from the calculator using an isolation board (FCRC-2) placed on card slot “PL2” on F22 connection board. The output will then act as open relay and close at every pulse emitted. The technical specification on the output of a calculator with install isolation board is:

Maximum voltage	[V]	48
Maximum current	[mA]	100
Pulse duration	[ms]	250
On-resistance R_{on}	[Ω]	35

Table 2.5.2b, Technical data for pulse outputs with an isolation board (FCRC-2)

Pulse weight for the pulse output

Pulse weight for the pulse output can be different depending on configuration on the calculator. Pulse weight for the pulse output depends on unit and pulse weight for flow sensor in calculator. The pulse weight for the pulse output can vary from one calculator to the next.

Examining the display sequence and the display connected to the pulse output, it will reveal the pulse weight for the pulse output. The display sequence that are connected to the output are:

- 10, energy – pulse output 1
- 11, volume – pulse output 2

The last digit and the unit will show the pulse weight of the pulse output. One increment of the last digit in the display will result in one pulse emitted on the pulse output.

Example: See fig. 2.5.2b, display sequence “10”, energy, pulse output 1. The unit is [MWh] and the display shows “0.25”. The pulse weight of the pulse output is then 0.01 [MWh]. Every pulse emitted will be 0.01 [MWh] (10 [kWh]).

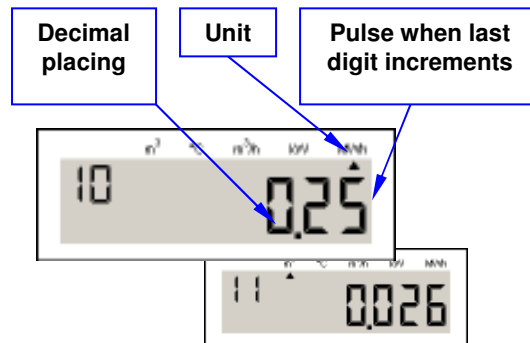


Fig. 2.5.2b, Display sequence 10 energy and 11 volume

2.5.3 M-Bus (OPTION)

Meter-Bus (M-Bus) is a standard communication protocol for meter reading. F22 has many different M-Bus connection possibilities. The M-Bus in the calculator is according to EN1434-3 and M-Bus users group. For more information, see 1.5.6 M-Bus limitation, 2.5.4 M-Bus communication and www.M-Bus.com. M-Bus is a strictly master-slave system, the master always initializes the communication. There are several ways to communicate M-Bus to the calculator, see below. **Note:** The calculator has only one M-Bus output, with several ways to communicate, e.g. optical output, M-Bus board, RS232 M-Bus board.

Optical interface

The calculator has an optical output. Using an optical interface the calculator can be read or configured using M-Bus. In order to conserve battery energy the calculator optical is set to sleep. The output must be awake before the calculator can communicate using the optical output. An “opto-wakeup sequence” must be sent to the optical output before the calculator can communicate using this output.

2-wire M-Bus (OPTION)

Using 2-wire M-Bus is the common way to communicate with an M-Bus slave. With 2-wire M-Bus the calculator can be connected to an M-Bus loop with several other M-Bus slaves to be remotely read. The general M-Bus loop consists primarily of a master (PC and M-Bus interface) and several slaves.

The F22 requires an M-Bus board “FCM2-21DM” placed in slot “PL1” in order to communicate with 2-wire M-Bus. Features for the output are:

- Polarity insensitive
- Galvanic isolated output
- Use communication cable (screened and twisted cable)
- Cable area 0.25 [mm²] – 1.5 [mm²] can be used

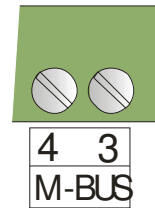


Fig. 2.5.3a, 2-wire M-Bus output

M-Bus RS232 (OPTION)

When communicating the calculator directly to PC or via modem, an RS232 output is to be preferred. The “RS232 output” does not require an M-Bus interface. Using RS232 the calculator can be directly connected to the PC’s serial port (D-Sub). To use the RS232 the RS232 M-Bus board “FCM2-21DR” must be placed in slot “PL1”. Then connect according to table below.

Terminal	Function	9-Pole D-Sub
1	RXD →	2
2	DTR ←	4
3	TXD ←	3
4	GND --	5

Table 2.5.3, RS232 connection

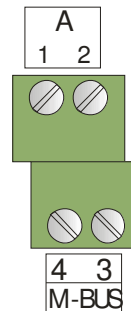


Fig. 2.5.3b, Terminals to use for RS232 M-Bus output

2.5.4 M-Bus communication

The calculator has two communication addresses according to M-Bus. The communication address is required when communicating with one specific slave, to read its data. There are a few things that clearly differentiate M-Bus from other serial field busses. See 1.5.6 M-Bus limitation for calculator.

2.5.4.1 Primary address

Primary address is a value from 1-250. The primary address can be changed in the “service mode” or by using the “FlexServ” version 2 or higher.

When using primary addressing two or more meters within the M-Bus loop may not use the same primary address. Otherwise a communication collision will occur and the slave will not be able to communicate to the master. The primary address must be unique for each calculator in the M-Bus loop when using primary addressing.

2.5.4.2 Secondary address

The secondary communication address consists of an eight-digit number. Secondary address is normally set to be the same as the calculator’s serial number (S/N).

2.5.4.3 Recommendation M-Bus addressing

Two or more M-Bus slaves in an M-Bus loop may not use the same primary address. If two or more slaves have the same primary address the slaves with the same primary address will respond at the same time and a collision will occur and getting data from these slaves through the M-Bus master will be impossible. This is why secondary addressing is recommended when the same secondary address is very rare.

On most of the M-Bus reading programs the user can choose how to address the calculator, e.g. by the primary or secondary address. The transfer and communication speed of the calculator will not be affected by choosing the primary or the secondary addressing in M-Bus.

2.5.4.4 M-Bus address in calculator display

The calculators M-Bus address can be viewed in the display.

- Primary address in display sequence “60”
- Secondary address in display sequence “61”

The interpretation of the calculator’s secondary address is done in the same way as the interpretation of calculator serial number, see 1.5.5 Calculator serial number for more information.

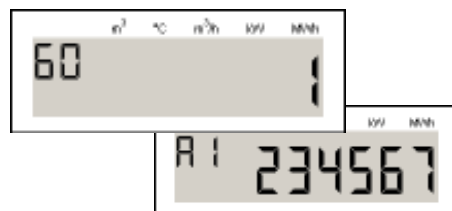


Fig 2.5.4.4, Display sequence “60”, primary address “1” and “61” secondary address “1234567”

2.5.4.5 Standard baud rate

Standard baud rate is: **300 baud**. There is a clear M-Bus construction advantage using this baud rate. With lower baud rate longer cable length can be used more slaves can be connected and so on. Using M-Bus commands the baud rate can also be changed in the remote reading program. The calculator can be ordered with 2400 baud.

2.5.4.6 Change baud rate

Using M-Bus command the baud rate can be changed. The calculator has a baud rate changing safety function. When baud rate is changed the calculator must communicate with the new set baud rate within one hour otherwise the calculator will go back to the previous baud rate.

2.5.5 Alarm output connection

The calculator has one alarm output. The alarm output will emit a pulse 250 [ms] every hour as long as an “external alarm” exists. See 3.6.3 Error codes for more information. The duration of the alarm pulse can be altered from 125 [ms] to 12,2 [s] in 125 [ms] steps using the “FlexServ” program. **Note:** Changing pulse duration will affect both alarm output and pulse output likewise.

“External alarm” in “Fx” calculators means no mains supply.

The output is of the type open collector, a “TTL” output. The output requires 3 – 30 [V] to power the output circuits. The technical specifications of the output are:

Voltage range	[V]	3 – 30
Maximum current	[mA]	20
Pulse duration	[ms]	250

Table 2.4.4a, Technical data for alarm output



Fig. 2.4.4., Alarm output

Isolation board, “FCRC-2” (OPTION)

The outputs can be isolated from the calculator using an isolation board (FCRC-2) placed on card slot “PL2”. The output will then act as open relay and close 250 [ms] at every alarm pulse. The technical specification of the output on a calculator with install isolation board “FCRC-2”:

Maximum voltage	[V]	48
Maximum current	[mA]	100
Pulse duration	[ms]	250

Table 2.4.4b, Technical data for alarm output with an isolation board (FCRC-2)

2.5.6 Connecting +3 V output

The calculator has one output to power supply other external devices and this output is called the “+3V” output. When connecting the “+3V”, output the connection must share a common (GND) with another output or input on the F22 connection terminals. Example figure 2.4.5 the “+3V” share the “flow sensor input common”. Technical specification:

Voltage	[V]	3.6
Max current	[mA]	20

Table 2.4.5, Technical data for “+3V” output.

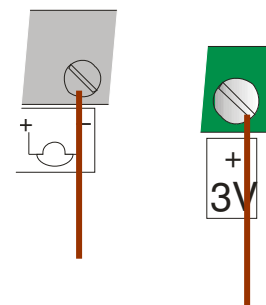


Fig. 2.4.5, Connecting +3V to external supply

2.6 Installing option boards

The F22 has several option boards. These boards can be mounted prior to delivery or mounted after at site.

- Isolation board “FCRC-2”, isolates pulse inputs, outputs and alarm output.
- M-Bus board “FCM2-xxxM”, 2-wire isolated M-Bus.
- RS232/M-Bus “FCM2-xxxR”, RS232/M-Bus board (isolated).

Option board installation procedure:

1. Remove the connector to mains power
2. Place the board in correct slot. (M-Bus boards on slot PL1 and Isolation board in slot PL2.) Ensure that the facade side is aligned with the connection board and the component side is facing the terminals. Check that all pins are connected.
3. Place the mains power connector back.

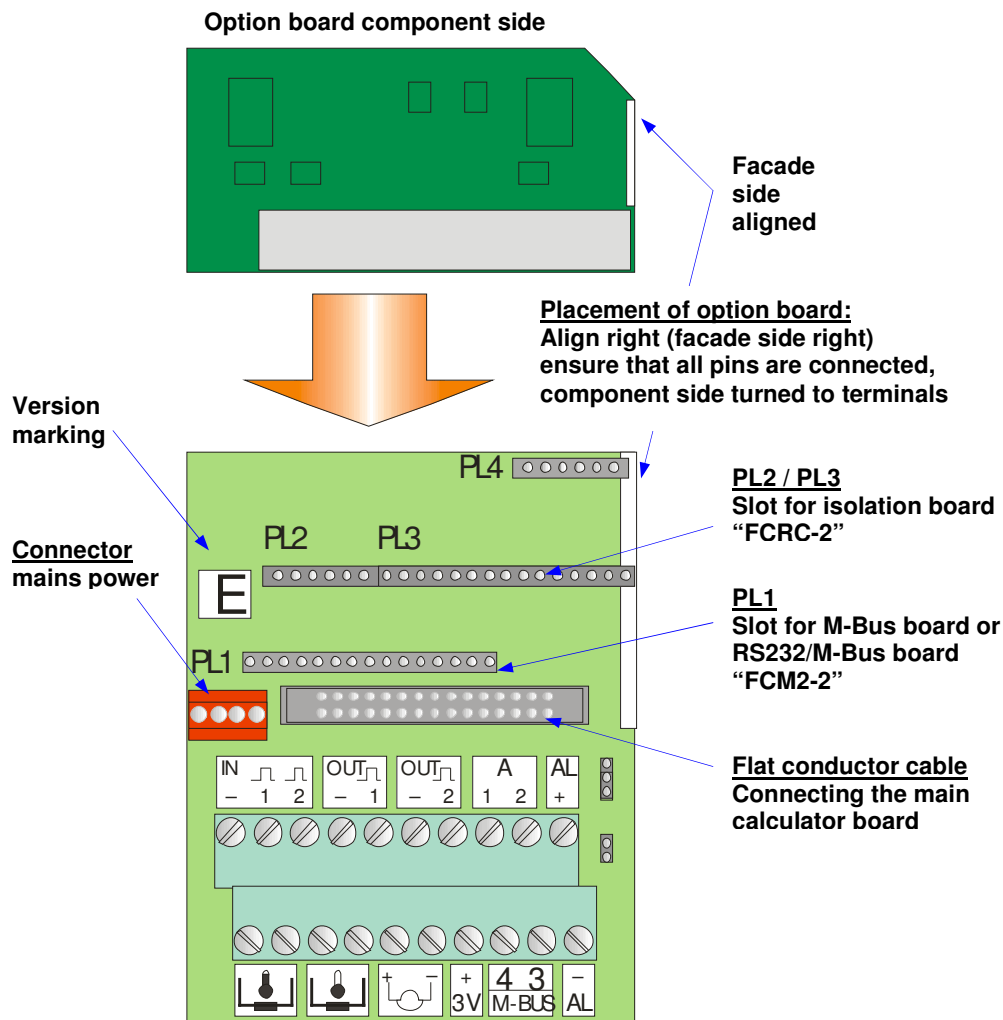


Fig. 2.6, Install option boards

2.7 Installation check

After installation check the installation:

1. Display set on operation mode (normal mode)
2. Flow sensor pulse
3. Temperature sensor are correctly connected
4. Check pulse value set in calculator and placement
5. Check error codes

2.7.1 Operation mode

Check that display is set on operation mode.

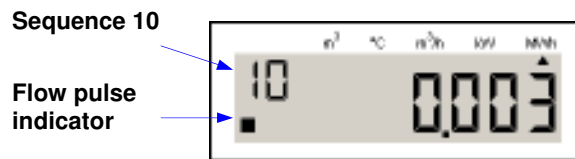


Fig 2.7.1, Operation (normal) mode

2.7.2 Flow sensor pulse

The square in the display blinks when calculator receives a flow sensor pulse.

2.7.3 Temperature sensors correctly connected

The temperatures from the temperature sensors can be viewed in the display on display sequence “22” high (H) and “23” low (L) and temperature difference at “24”



Fig. 2.7.3a, Display sequence “22” temperature high (H) and “23” temperature low (L)

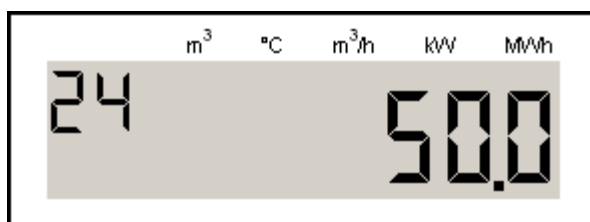


Fig. 2.7.3b, Temperature difference at display sequence “24”

2.7.4 Check flow sensor pulse value and placement

The pulse value and flow sensor placement (High (H) or Low (L)) must be correctly set. The flow sensor settings can be viewed in the calculator on display. Check also that the pulse weight of flow sensor is correctly set in calculator. Check that:

1. Flow sensor pulse weight is correctly set in calculator
2. Placing of flow sensor, (H) or (L)

On display sequence “63” and “64” placing. In example below the flow sensor pulse weight is 2.5 [l/p] and the flow sensor is placed on low (L), cold, return end of the pipes.



Fig. 2.7.4, Display sequence “63” pulse value for flow sensor and “63” placement

2.7.5 Check error codes

Check error codes on display. The codes can be viewed in display sequence “15”. See 3.6.3 Error codes.



Fig. 2.7.5, Display sequence “15” error code

2.8 Different F22 versions

See below for different versions of F22. The versions are:

- “ “ - Basic version
- “E” - Extended version
- “R” - Radio version

2.8.1 Basic version (B)

- Mains supply or battery supply
- Ample connection space
- PT100/PT500 temperature sensors, 2-wire method
- M-Bus option board (with galvanic separation)

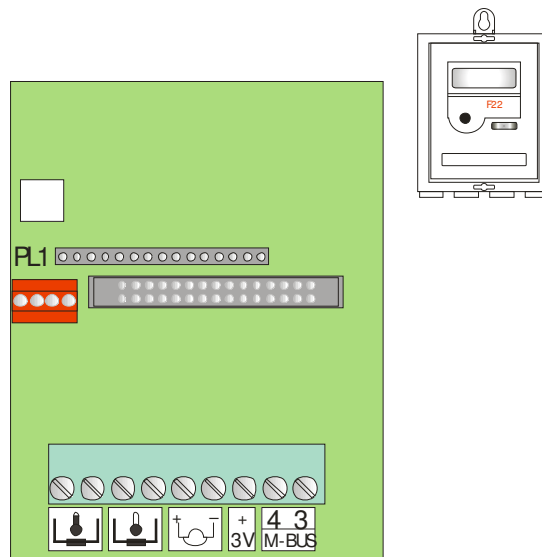


Fig. 2.8.1, Connection board F22 Basic version and casing

2.8.2 Extended version (E)

- Mains supply or battery supply
- Ample connection space
- PT100/PT500 temperature sensors, 2-wire method
- U2500 pulse adaptation possible using jumpers
- 2 pulse inputs
- Pulse output, energy and volume
- Alarm output
- M-Bus as option board (with galvanic separation)
- Isolation board as option board

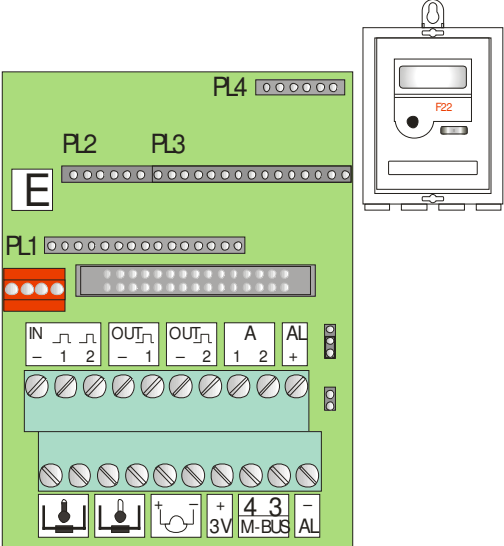


Fig. 2.8.2, Connection board F22 Extended version "E" and casing

2.8.3 Radio version (R)

- Mains supply or battery supply
- Ample connection space
- PT100/PT500 temperature sensors, 2-wire method
- U2500 pulse adaptation possible using jumpers
- 2 pulse inputs
- Pulse output, energy and volume
- Alarm output
- Isolation board as option board
- Radio board mounted on connection board and calibrated
- Box fitted with antenna

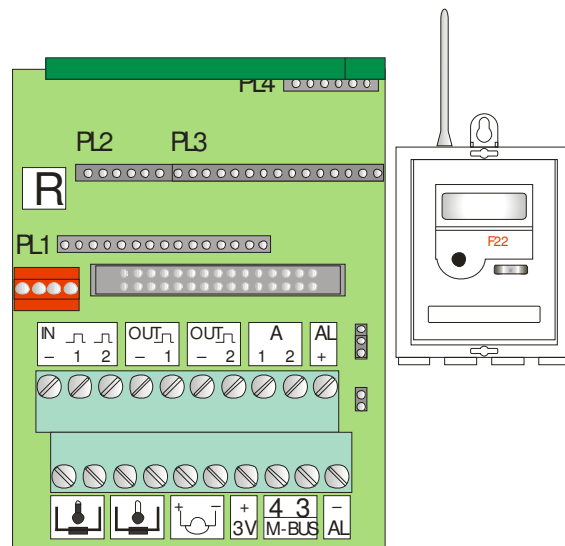


Fig. 2.8.1, Connection board F22 Radio version and casing with antenna.

3 Handling

The calculator has one 7+1 digit display and one display button, several other buttons and two jumpers, this is explained below.

3.1 Display button

The calculator has a display and display button. Using the Display button one can toggle between different sequences and in combination with “buttons” set the calculator into different modes.

There are two ways to operate the display button to maneuver in the display. Example below is how to maneuver in operation mode (normal mode):

- Push (press)
To toggle between values in a sequence.
- Hold
Hold the display button pressed until the display change sequence.
- Release
Release the button when display enters correct sequence.



Fig. 3.1, Use the display button to maneuver, hold, release and push

Handling for the other display modes, see 3.3 display modes.



Fig 3.1, Display button

3.2 Display

The calculator is equipped with an LCD (Liquid crystal display). The units on display label and decimal placing are different depending on calculator configuration. One example on display:

1. Display sequence, in this case “10”, default position, (the position the calculator returns to after 60 seconds of “push-button” inactivity). The digit “1” displays the sequence and the “0” displays the order in the sequence. The digits together form the display sequence “10”, see fig. 3.1b (below).

2. Volume pulse indicator square, indicates a flow pulse emitted from flow sensor. The square can also indicate that an error has been detected.

At error (revers to normal); the square will appear as long as the calculator does not receive any pulse, and disappear shortly when receiving a volume pulse.

At high frequency (2Hz or more); The square will appear steadily and disappear on error.

3. Value, max. seven (7) digits

4. Different units on display label, depend on ordering configuration of calculator.

5. Value unit indicator arrow, the triangle points of the correct unit on the display label for the unit. (Only when the calculator is correctly set).

6. Decimal placing.

7. Blinking decimals.

Note: the digits after the decimal placing “blink” only in sequence “10” in accordance with EN1434. According to the standard the decimals on the display must be clearly marked.

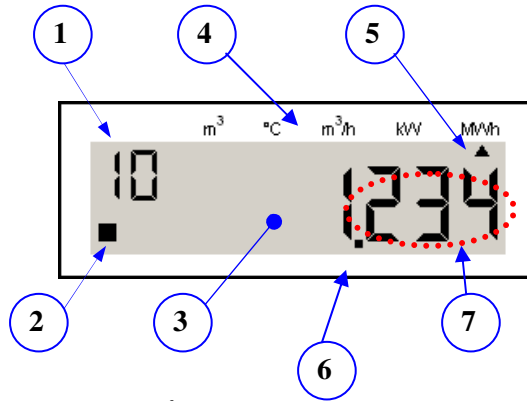


Fig 3.2, Display, m³, C...

3.2.1 Display test

In accordance with EN1434 all calculators must have display test. In the calculator the display test is on sequence “12”.

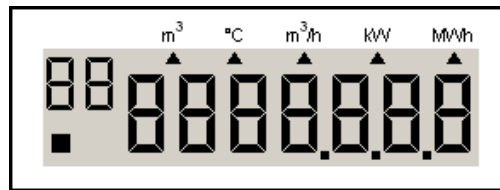


Fig. 3.2.1, Display test display sequence “12”

3.3 Display modes

The calculator can be set in different display modes depending on what data that shall be accessed in the calculator. To enter the different modes, the seals must be broken and a recommended tool should be used, see below. The calculator is normally delivered in “Transport mode”. Depending on programming the calculator can be delivered in other display modes as well.

The sequences in the different display modes can vary depending on different programming of the calculator. The display modes are:

1. Transport mode.
2. Service mode, programming by only using the “Push button”.
3. Test mode (test and programming mode). By setting the calculator in test mode and using the “service program” version 2 or higher the calculator can be programmed.
4. Normal mode, operating mode, working mode.

Note: Avoid setting the calculator into “service/ initial mode” or “testing mode” for longer time periods (1 hour), otherwise the battery life length expectancy will be affected.

3.3.1 Display mode on delivery

On delivery the calculator is set in Transport mode. The calculator must be set in operating mode before completing the installation.

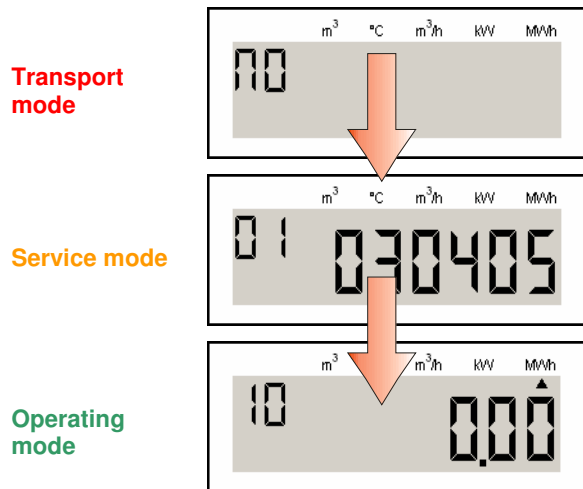


Fig 3.2.1, On delivery, Transport mode, Service mode then operating mode

3.4 Transport mode

The calculator normally is delivered in transport mode. In transport mode the calculator “sleeps”, no measurements and no communication from or to the calculator will be performed. In transport mode only the system clock and (if any) option board will be supported with minimum power requirements. The calculator’s “operating time” (display sequence 50) will be in a stand still.

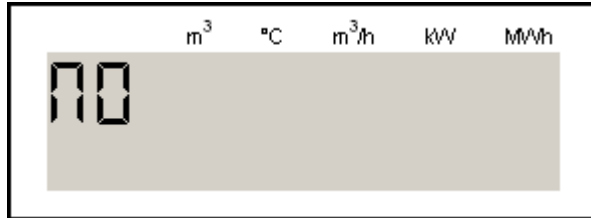


Fig. 3.5, Sequence transport mode

3.4.1 Exit “Transport mode”

Hold “Push button” pressed (approximately 5 seconds) until the “no” sign disappears. The display sequence changes to “00” or “10” depending on calculator settings. In most settings the calculator enters the INIT-mode. The INIT-mode is indicated by display sequence “00”, see initiation mode 3.3.2 for further information.

3.4.2 Setting the calculator in transport mode

Using the “FlexServ program” version 2.0 or higher the calculator can be set in “Transport mode”. Only to be used by authorized personnel.

3.5 Service mode and Service button

The calculator has a “Service mode”. In this mode the user can change some settings on the calculator using the display button. “00” (“0x”) is shown on the display when calculator is set in service mode. Service button is used to set the calculator in “Service mode”. In the service mode the user can alter the following calculator settings:

Service Sequence	Description
00	Time, hhmm
01	Date, YYMMDD
02	Pulse value (without decimal placing 4 digits) for flow sensor.
03	Pulse value decimal placing, 0-4
04	Account days 1, MMDD
05	Account days 2, MMDD
06	Primary communication address (set with 3 digits) e.g. “5” is set “005”.
07	Reset stored error time, 0 = Reset stored error time (default) 1 = Do <u>not</u> reset error time
08	Flow sensor placing, 0 = installed at low end (L) 1 = installed at high end (H)
09	Recommended battery replacement date, YYMMDD. Do not change without consulting Elster.
0A	Exit service sequence. 1 = Exit 0 = Stay in service mode

Table 3.1, Service display sequence,
hh – Hour, mm – Minutes, YY – Year, MM – month, DD – Day.

Note: The display sequence in “Service mode” may vary depending on calculator configuration.

WARNING: Altering the values in the service mode may vary, depending on calculator configuration

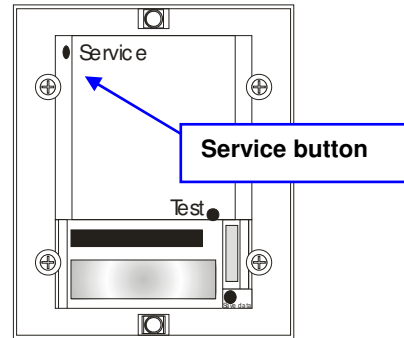


Fig. 3.2a, Location of the service button



Fig 3.1, Display button

3.5.1.1 Setting the calculator in “Service mode”:

1. HOLD “Service button” pressed using a screwdriver then HOLD “Display button” pressed.
2. Wait for approximately 5 seconds
3. Display sequence changed to “00”
4. RELEASE “Display button”
5. RELEASE “Service button”



Fig. 3.2b, Service mode, Time “4:04”

Tool: Screwdriver or any other suitable dull object.

3.5.1.2 Exit “Service mode”:

There are two ways in exiting “Service mode”.

1. The same procedure as entering the “Service mode”
2. HOLD display button pressed until service sequence “0A” is reached. PUSH display button to “1”. HOLD display button pressed until calculator exits “Service mode”.



Fig. 3.2d, Exit service mode “1” in service sequence “0A”

3.5.2 Maneuver in Service mode

To change settings in the service mode, use the display button. The value to be changed will blink. To change value push the display button until correct value is acquired. Hold the display button pressed to reach next value or service display sequence.

Note: The calculator will only store the values, when next service display sequence is reached.

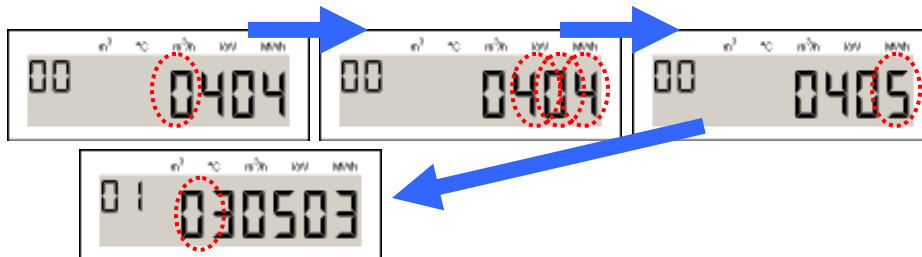


Fig. 3.5.2b, Service mode, change time from “4:04” to “4:05”

To change value digit, push “display button” until correct value digit is acquired.

To change value digit, hold “display button” pressed until required value digit starts to blink. **Note:** The changed value digit is changed, only when the next value digit is selected and starts to blink. E.g. do not exit service mode when the changed value digit is still blinking. Ensure that the change has been carried out by the calculator, by first reaching the next service sequence (example from “01” to “02”) before exiting the service mode.

To enter next sequence, hold the “display button” until next service sequence appears on display, see fig. 3.2b.

To exit Service mode in service sequence “0A”:

1. Hold “Push button” until display sequence “0A” appears.
2. Release the “Push button”
3. Press “Push button” once to change the value digit to “1” (exit INIT mode).
4. Hold “Push button” to exit the INIT mode, the display sequence should read “10”, normal mode.

3.5.3 Service-mode at installation (initialization mode)

After exiting the transport mode the calculator enters the initial mode (Service mode). The initial mode is in most calculators the same as service mode and in some calculators a reduced service mode. The handling and usage of the calculator in initial mode is the same as for service mode. The only way to enter initial mode is after transport mode or using the “FlexServ” program.

Note: Do not use the “Flex” service program without proper education or consulting Elster.

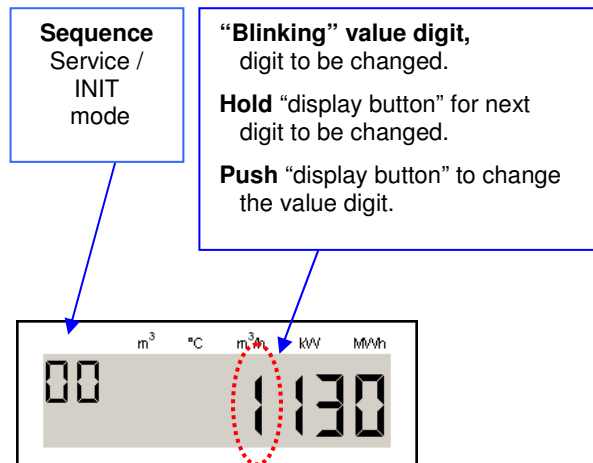


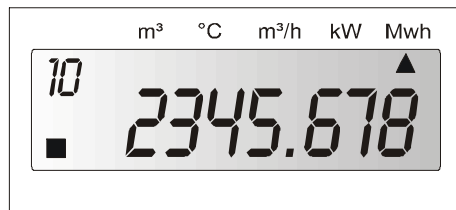
Fig. 3.5.2c, Service mode

3.6 Operating mode (normal mode)

The calculator has a normal state mode, operating mode. In this operating mode the calculator set to measure and communicate measured data.

In operating mode the calculator accumulates energy, calculates and makes measurements. The calculator can also communicate by using M-Bus. Operating mode is:

- Operating mode for calculator when measuring
- Protected, calculator settings cannot be altered.
- Power save, all activity in the calculator that isn't necessary for measuring will be at a low.
- **Always set the calculator into operating mode.**



*Fig 3.6a, Display sequence "10" operating mode
(seq. 10 default sequence position)*

3.6.1 Sequences, operating mode

There are different sequences in operating mode. The sequences are grouped, accumulated values, momentary values, calculator settings and so on. See 3.6.2 table operation mode.

The two small digits on the upper left display show the display sequence. The sequences and values in the sequences can vary depending on setting in the calculator.

The first digit from left is the sequence number, see fig. 3.6b below. This number announces in which sequence currently is on display (1 to F).

The second digit from left is the value number and announces which value is displayed in the specific sequence. The value numbers loop within each sequence (there are a few exceptions).

Default position “10”

The calculator will return to default display sequence “10” after 60 seconds of “display button” inactivity.

See 3.6.2 Table operation mode

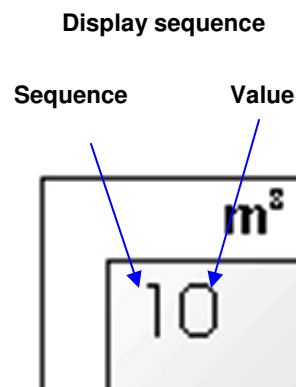





Fig 3.6b, Sequence and value together form display sequence.

3.6.1.1 Maneuver in operating mode

Hold the “Push button” to enter next sequence, release when correct sequence is reached. Repeat this procedure to enter next sequence. When exiting the last display sequence “F0”, the display will return to the first display sequence 10 (default position).

On exiting the sequence 30 and 40 the calculator will return to sequence 10.

- HOLD,  to enter next sequence.
- PUSH,  to toggle between the values in the sequence.
- RELEASE,  when correct sequence is reached

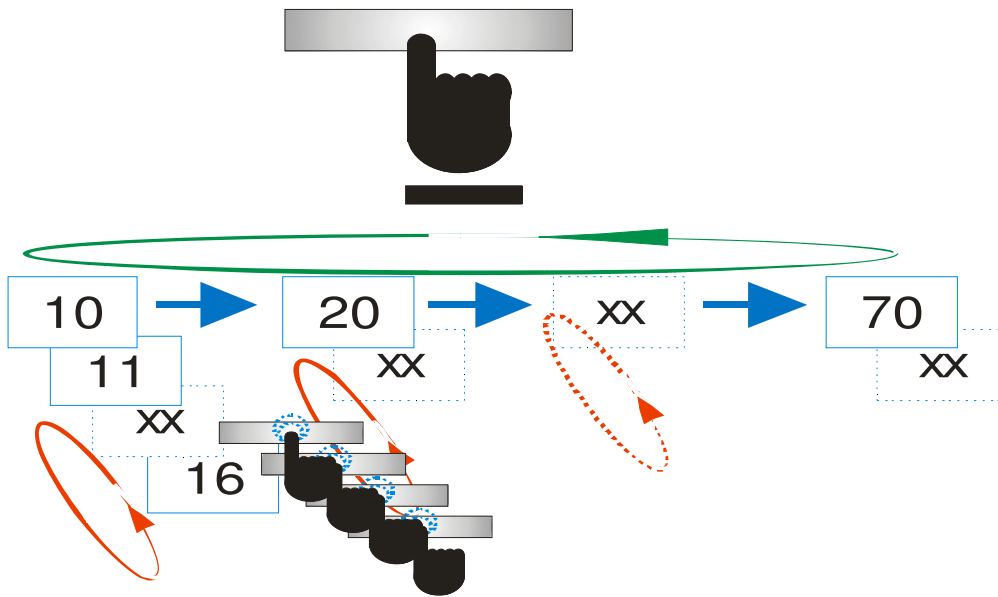


Fig. 3.6.1.1, Hold to enter next sequence. Push to toggle to next value

3.6.1.2 Read values

Press “Push button” to toggle to the next display value. After the last value in the specific sequence, the first value in this sequence will be displayed and so on.

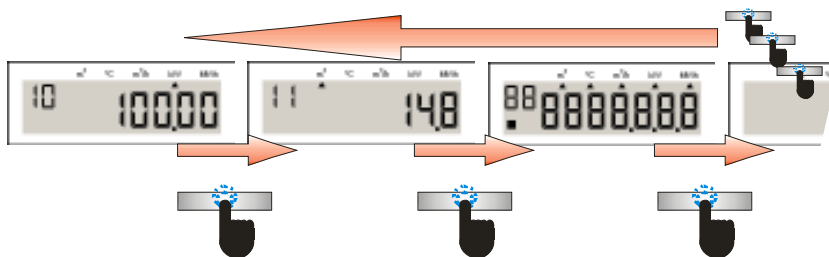


Fig. 3.6.1.2, Push display button to toggle between values in a sequence

3.6.1.3 Default position

When calculator is set in normal mode, the display will return to the default sequence “10” after 60s, (the return time can be altered by using the “FlexServ” program, version 2.0 or higher).

3.6.1.4 Blinking digits

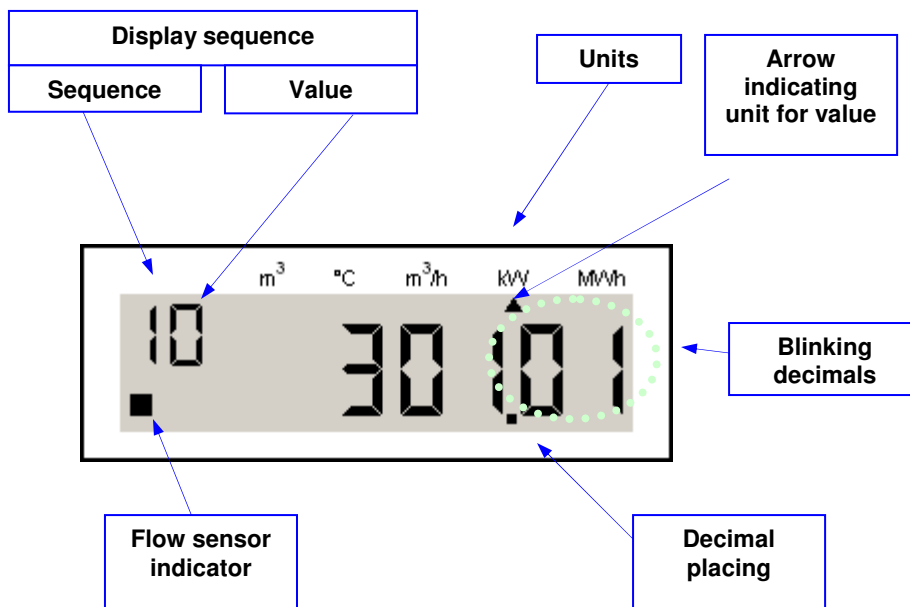
In accordance with EN1434 the digits after the decimal are blinking.

3.6.1.5 Unit arrow

An arrow will indicate the correct unit for the value, the display labels varies depending on calculator.

Example, calculator delivered with different display labelling depending on kWh, MWh, GJ or MBTU to be output by the calculator.

Note: When calculator is reprogrammed, the “service program” version 2.0 or higher, the label is not “automatically” changed.



3.6.2 Table operation mode

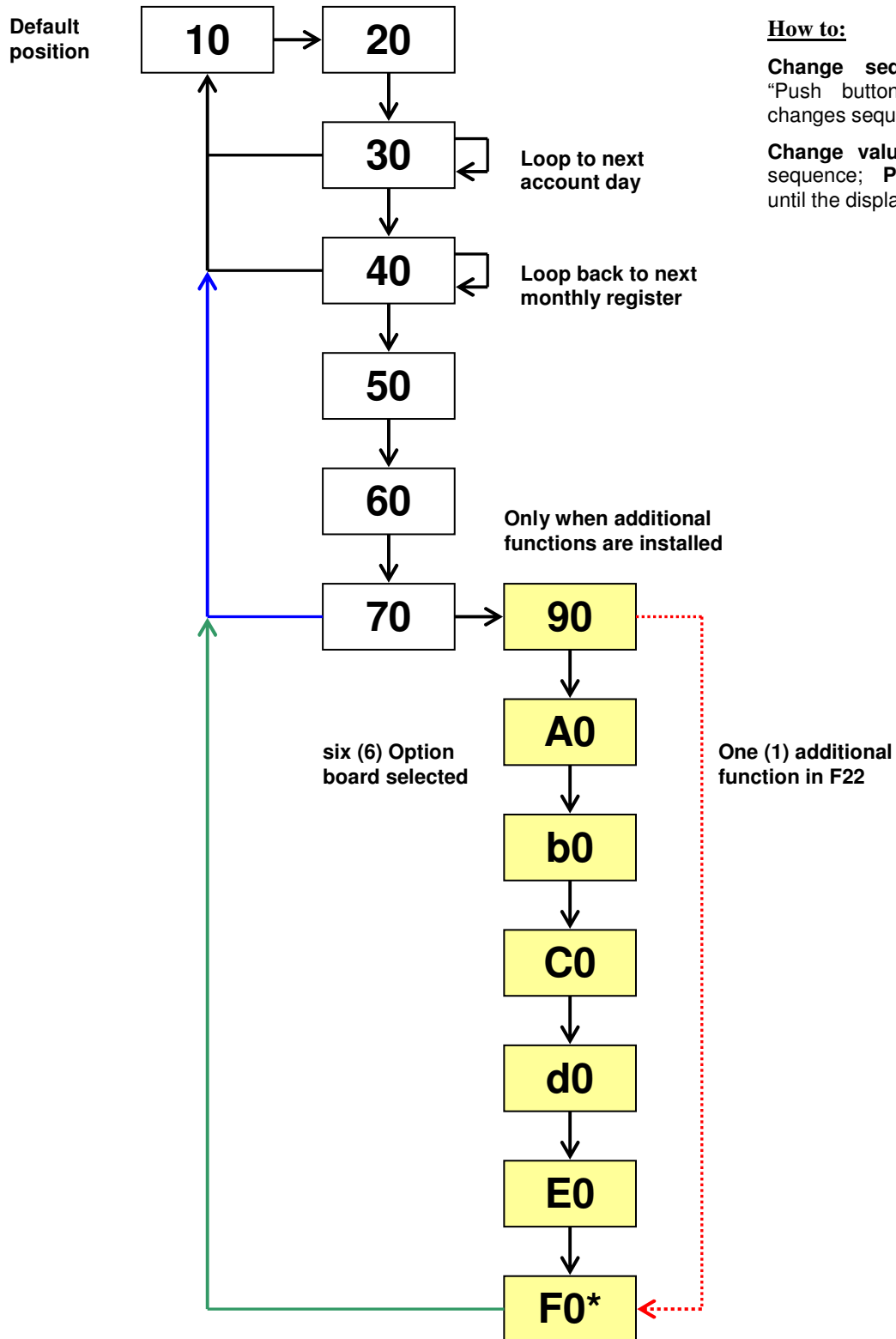
Description	
10	Accumulated energy (Default position)
11	Accumulated volume according to flow sensor ¹
12	Display test, see fig.3.2
13	Accumulated volume for pulse input 1, [m ³]
14	Accumulated volume for pulse input 2, [m ³]
15	Error code, see Error code
16	Error time, [Minutes]
20	Momentary power
21	Momentary flow
22	High temperature, 0 decimals
23	Low temperature, 0 decimals
24	Temperature difference, 1 decimals
30	Account days ² , when values are stored, [YYMMDD]
31	Account days ² , Accumulated energy
32	Account days ² , Accumulated volume according to flow sensor
33	Account days ² , Accumulated volume according to energy calculation
34	Account days ² , Accumulated volume pulse input 1, [m ³]
35	Account days ² , Accumulated volume pulse input 2, [m ³]
36	Possible error code, at time of storage of account days
37	Possible accumulated error time, at the time of storage account days, [Minutes]
3x	Following account days registers (loop back)
40	Monthly registers ³ , date when values are stored, [YYMMDD]
41	Monthly registers ³ , Accumulated energy
42	Monthly registers ³ , Accumulated volume according to flow sensor
43	Monthly registers ³ , Accumulated volume according to energy calculation
44	Monthly registers ³ , Accumulated volume pulse input 1, [m ³]
45	Monthly registers ³ , Accumulated volume pulse input 2, [m ³]
46	Possible error code, at time of storage of monthly register
47	Possible accumulated error time, at the time of storage, [Minutes]
4x	Following monthly registers (loop back)
50	Operating time, [Hours]
51	Relevant date, [YYMMDD]
52	Relevant time, [HH.MM]
53	Recommended date for battery replacement, [YYMMDD]
60	Communication address, Primary address
A0	Communication address, Secondary address (normally same as meter S/N)
bx	Calculator serial number (S/N) ⁴
63	Pulse value [l/p]
64	Placing of flow sensor, [H/L], L = Low
70	Accumulated volume corresponding to accumulated energy
71	Last remote read accumulated energy
72	Time since latest remote read accumulated energy, [Hours]
73	Accumulated total error time, [Minutes]
74	Previous error code
75	Time for previous error code, [Minutes]

- 1 The calculator has two registers for accumulated volume. Value 11, is incremented at the rate of arrived flow pulses. The other register, value 70 is incremented in conjunction with energy calculation.
- 2 In order to change to the next account day, keep pushing the button until the date starts to increment, then release the button. After the display 37, see table above, the next account day will display. **Note:** If one hold the "Push button" again, the display reverts to default position (seq. 10).
- 3 To change to another month, keep pushing the button until the date starts to increment. Release at the requisite month. After display 47, see above, the next stored date will be displayed. **Note:** If one hold the "Display button" again, the display reverts to default position (seq. 10).
- 4 The second digit from left in the sequence "bx" (e.g. x) will mark the most significant digit in the calculator serial number. Example: Calculator serial number is "0000 0015", the sequence will display "b0", and if the serial number is "8000 0015", the sequence will display "b8".

3.6.2.1 Display sequence normal mode (summary)

- 10 - Readout values 1 (accumulated values)
- 20 - Readout values 2 (momentary values)
- 30 - Account days
- 40 - Monthly registers
- 50 - Date and time
- 60 - Communication settings
- 70 - Calculator information
- 90 - Option board status
- A0 -F0 Option board sequences

3.6.2.2 Display sequence normal mode schematics



How to:

Change sequence; **HOLD** the "Push button" until the display changes sequence.

Change values within a specific sequence; **PUSH** "Push button" until the display changes value.

Fig 3.8, Display schematics for "normal mode"

* Only in F2/F22. No other sequences will be displayed in F22.

3.6.3 Error codes

Sometimes an error code will appear in display sequence “15”, “74” and on M-Bus. The error code message can be interpreted using the table below. The error codes consist of three (3) hexadecimal (Hex) digits, e.g. 0 – 15. Each digit can have up to 4 different error codes in combination. The correct error code can be acquired by combining the digits, see example below. The digits shall be read from the right to the left.

Example: “000005” = 1 + 4 = error 1 and error 4, low temperature sensor disconnected and high temperature sensors disconnected.

Display digit 1 first (from right)	1	Low temperature sensor disconnected
	2	Low temperature sensor short circuit
	4	High temperature sensor disconnected
	8	High temperature sensor short circuit
Display digit 2 second (from right)	1	Internal bus collision has occurred within 24 hours.
	2	I ² C error (internal bus error)
	4	Low flow
	8	Alarm input, low voltage*
Display digit 3 third (from right)	1	Battery expire
	2	Oscillator error
	4	Flow sensor error
	8	Not in use

Table 3.6.3a, Error code numbers

A good help is to use the table below to find out which error the calculator displays.

Example: 0000045

First digit 5 from right = Error code 4 + Error code 1 = Temperature sensors (low+high) disconnected

Second digit 4 from right = Error code 4 = Low Flow Error

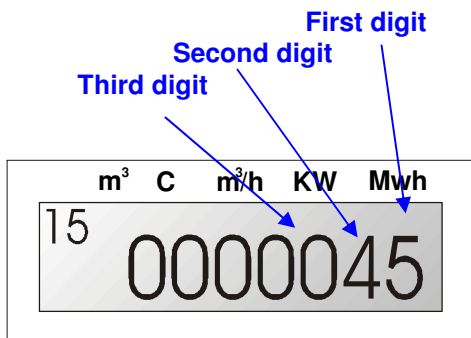


Fig 3.6.3c, error at display sequence “15” first digit “5”, second digit “4”

No.		Error number (s)
Hex.	Dec.	
0	0	0
1	1	1
2	2	2
3	3	1 + 2
4	4	4
5	5	4 + 1
6	6	4 + 2
7	7	4 + 2 + 1
8	8	8
9	9	8 + 1
A	10	8 + 2
B	11	8 + 2 + 1
C	12	8 + 4
D	13	8 + 4 + 1
E	14	8 + 4 + 2
F	15	8 + 4 + 2 + 1

Table 3.6.3b, Error hex decoding key

* “000080”, can vary depending on setting in the calculator.

1. No voltage (**default value**), the calculator will show this error code when there is no power supplied from the mains.
 2. External alarm set, alarm from an external device.
- This error code will also appear when the “Save data button” is short circuited, see also 3.8, Save data button.

3.7 Test mode (programming mode)

In the test mode all possible calculator parameters can be configured, with the “FlexServ” program version 2.0 or higher. A flash on the display will indicate test mode, see fig 3.7a.

In the test mode the calculator also activates the optical interface and emits high frequent pulses corresponding to the energy increment. See 6.4 Verifying the calculator for more information. The M-Bus and the display response in this mode will be slower and in some cases disturbed.

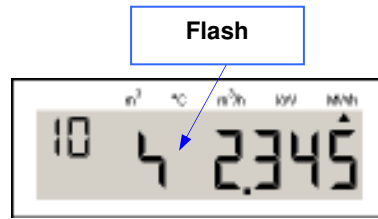


Fig 3.7a, Calculator set in “TEST mode”

3.7.1 Enter test mode

Hold the “test key”, a rubber key with an electric leading head and then hold the “display button” pressed (approximately 5 seconds). Then release the “Display button” and then the “test key”. The calculator will enter test mode. Display will show a “flash”, which indicates test mode.

Enter test mode:

- Short-circuit test button, by using a “test key”
- Hold “display button” pressed for 5 [s]
- Release “display button”
- Release the “test key”
- Flash will appear in the display

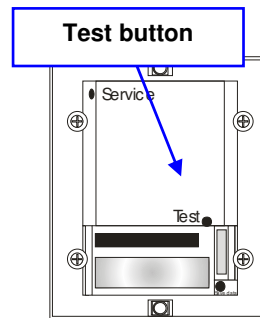


Fig. 3.7a, Location of test button



Fig 3.1, Display button

Tool: Test key

3.7.2 Exit test mode

To exit the same procedure as to “set the calculator into test mode”, see above 3.7.1 Setting calculator into test mode. The “flash” will disappear from the display upon exit.

Using the “FlexServ” program, the calculator can also exit test mode.

3.7.3 Higher energy consumption in test mode

In test mode the energy consumption will be greater than in the calculator normal operating mode. Avoid setting the calculator into “Test mode” for longer period than (>1h) or the battery/backup battery life length will be seriously reduced.

3.7.4 “FlexServ” program

“FlexServ” program version 2.00 (00-10-09) or later versions may be used to program F22. With the service program the calculator can be programmed (configured). This program is backward compatible, e.g. F2/22/3/4 can be programmed with the service program version 2.00 or higher. See also the Service program manual for further information.



Fig 3.7.3, Test key

In the “FlexServ” program:

Read type, the calculator programming is read into the service program.

Change mode, the display mode is changed. **Change type** will erase all previously stored calculator readout data.

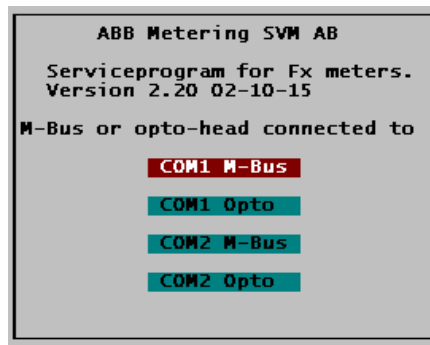
Note 1: Avoid setting the calculator into “Service mode” or “Testing mode” for longer time periods (1 hour), as battery life length will be affected.

Note 2: Calculators delivered with energy unit “BTU” and flow unit “USG/min” have fixed decimal setting.

Note 3: After configuring the calculator all registers will be reset. All stored measured data will be erased. This is a safety feature in the calculator to prevent data tampering.

Warning 1: Changing the programming by using the “FlexServ” program version 2.0 or higher can seriously affect the calculator behaviour, such as parameters as battery life length can be seriously reduced and measuring will be affected. Do not use the service program without proper education or consulting ELSTER.

Warning 2: When programming the F22 only use “FlexServ” program version 2.0 or higher, otherwise the calculator will be seriously damaged!



3.8 Save data

The calculator stores all measured values at day shift, each night at “00:00”. The measured data will then be stored in an EEPROM.

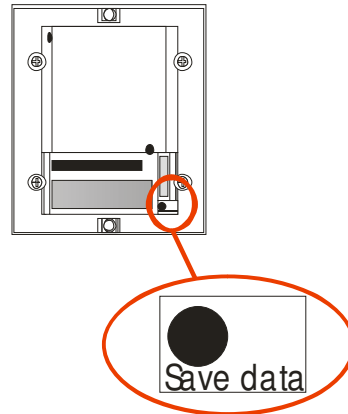
The save data button is used when saving data is necessary, when changing batteries or when installing option board. The calculator has a force save data function.

When the “Save data button” is short circuited, the calculator makes a reading and saves all data from temporary memory to the calculator EEPROM.

Note: Data from option boards or additional functions will not be saved.

Tool: Test key

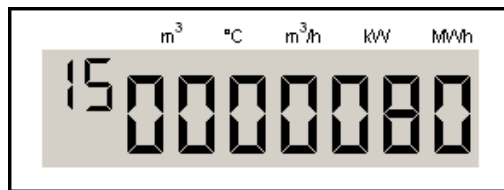
(Rubber key with a leading top to short circuit buttons.)



3.8a, F22 save data button

To save, use the “Test key” and short circuit the “Save data button”. The calculator will store all temporary data to the EEPROM.

Check “save data” procedure: The calculator will display an error code when data is properly saved. Prior to “save”, change the display sequence to number 15. Then short circuit the “Save data button” using a “Test key”. The code “0000080” will be displayed and confirm data storage, see 3.6.3 Error codes.



3.8b, Error code “080” displayed when data is saved

4 Seals, calculator protection

The “Fx” calculators are tampering protected with seals. To enter the calculator or to enter “Test mode”, “Service mode” or to enter the electronics inside the calculator several seals need to be broken, see placement of the seals below:

4.1 Seals on F22

1. Installation seal, installation and tampering protection.
2. Service seal, to protect the calculator entering service mode.
3. Test seal, to protect the calculator entering test mode.
4. Factory seal, protect electronic

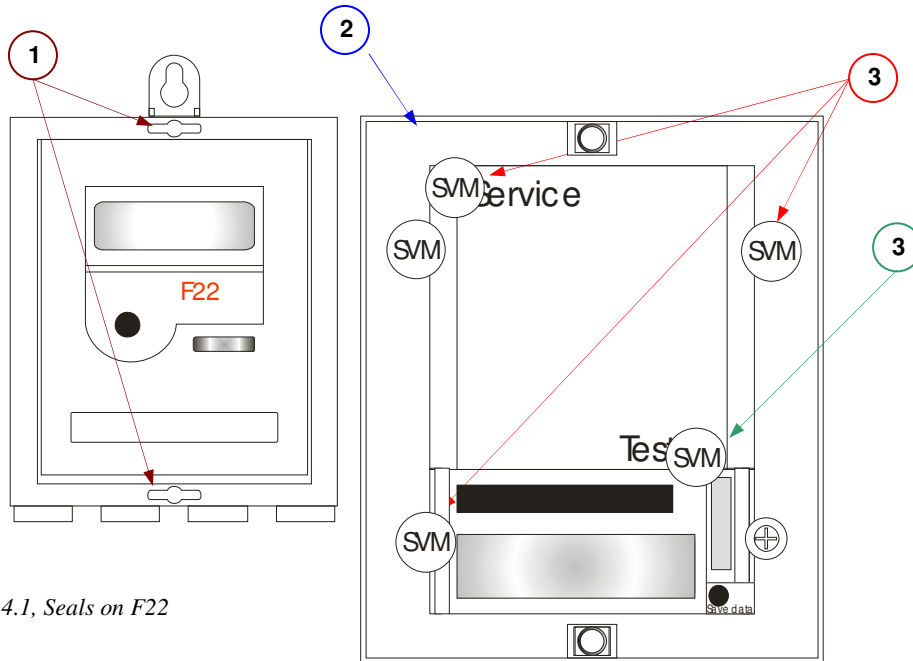


Fig. 4.1, Seals on F22

4.2 Neutral seals

With every delivery of the F2/3/4/22 four neutral seals are included. These neutral seals can be used after installation, when factory mounted seals need to be removed.



Fig 4.2, Neutral seals can be used after an installation.

4.3 Volume check

The F2/3/4/22 have an extra volume check, e.g. the calculator has two different accumulated volume registers:

- Volume accumulated from flow sensor (Display sequence 11)
(Display sequence 11)
- Volume accumulated from energy calculation, e.g. calculated from increment register.
(Display sequence 70)

This function, one extra flow register can prevent tampering of temperature sensor pulses programmed in meter and acts as an extra check. It is normal if there is a small difference between these two registers. When these registers differ too much the calculator can be incorrectly installed or tampered with.

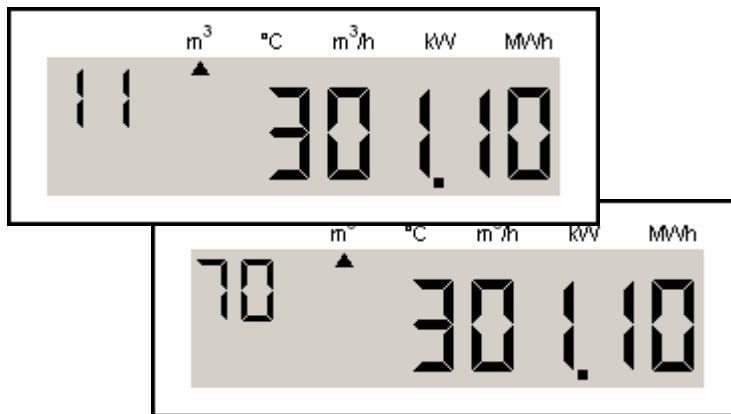
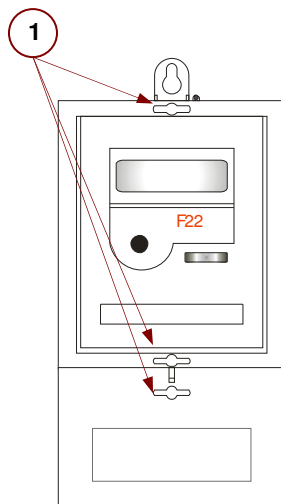


Fig. 4.2, Volume "11" and volume check "70"

4.4 Installation seal F22 with cover

The F22 can be fitted with a cover (FT-F22-ADAPT-01)

1. Installation seal, installation and tampering protection.



5 Calculation

F22 calculator is in accordance with EN1434:1997, part 1 and 2, measuring and calculating energy.

The calculator fulfils the requirements for environmental class C, in accordance with EN1434:1997 part 4.

The calculator saves energy to make the battery life length as long as possible. This is why the calculator measures and calculates in a specific order.

5.1 Calculation of flow

At each flow sensor pulse* the calculator checks the time counter against the calculators set "average power and flow", then the calculator updates it's record. If the time counter, with the resolution 1/128s, is shorter than the average time** the number of pulses will be stored for next calculation

The calculation depends on the timing between the pulses in the following cases:

- <5s calculation of the sum of the pulses received in 5s.
- >5s calculation at every pulse
- <60s calculation even if no pulse are received.

The flow calculation can also be initialized by M-Bus, OPTO-interface or "Save data" request

* Only when the flow pulses are emitted with lower frequency than every 5 seconds.

** Default average time set to 5 seconds. Using "Service program" version 2.0 or higher this time can be altered.

5.2 Momentary flow

The momentary flow is calculated at the end of an averaging period of 4 seconds, normally set in the calculator. The flow pulses registered at the period are used to calculate the momentary flow. The averaging period for momentary flow can be changed using the “Service program” version 2.0 or higher.

The flow calculation is based on how many pulses are received during the averaging period 4s and flow of the previous periods. There are two cases with following simplified formula applicable:

1. Normal condition $F = k \cdot \frac{N}{t}$

2. Shut off $F_- = k \cdot \frac{N_0}{t_0 + t_-}$

F	Flow
k	constant, varies depending on pulse setting (e.g. x [l/p]), decimal setting and energy units in calculator
N	number of pulses during the averaging period
t	time during pulses has been collected
t ₀	time during when the pulses have been accumulated
t ₋	time since the last pulse has been accumulated

When the calculator receives only a few pulses in each averaging period, the momentary flow in the display will vary with each period.

5.3 Calculation of power

The calculated flow, see above, is used by the meter to calculate the power and this value is added to the previously stored power values. The power is calculated at each flow pulse or at the maximum time for measurement (normally 60s is set in calculator).

6 Testing, programming & service

To ensure the functions in the calculator, test can be performed.

6.1 Programming the calculator

The calculator parameters can be configured by entering the calculator “Service mode” or “INIT mode”, see Service 7.4.

The calculator can also be set into “test mode”, see 3.3.4, in “test mode” even more calculator parameters can be configured. The “service program” 2.0 or higher can be used to program the calculator. When the calculator is “reprogrammed” all the stored calculator data (measured and calculated) will be erased from the calculator. Avoid losing any data by making a read and record the calculator data before “reprogramming” a calculator.

Warning; only “FlexServ program” version 2.0 or higher may be used to program the calculator, otherwise the calculator may be permanently damaged. Only to be used by trained professionals.

6.2 Display test

By selecting display sequence “12” the LCD display can be tested.

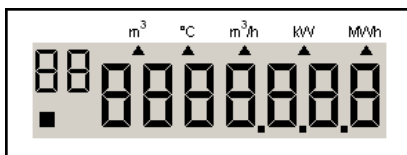


Fig. 6.2, Display test

6.3 Installation test

When installing the calculator it is necessary to verify calculator functions and the installation. Recommended procedure:

1. Wait for a flow sensor pulse, check for “sensor “indicator square” on calculator display, see also displays 3.2. Once the pulse is emitted, check that the temperature values display sequence “22” and “23” are correct.
2. Check that the real time clock is working properly and time is set correctly.

6.4 Verifying the calculator

Verification of the calculator's measurement accuracy is undertaken in the test mode, where the energy value/flow sensor pulse is issued via the HF-output at the service adapter. For each flow sensor pulse, measurement takes place on the temperature sensors and a pulse burst corresponding to the measured energy of the meter is issued.

To test (verify) the measurement accuracy of the calculator by means of HF-pulses proceed as follows:

1. While short circuiting the test button with "Test key", see fig. 2.2, hold the "Push button" until the display mode changes.
2. The calculator now enters test mode. This is indicated by a flash symbol being displayed.
3. Connect fixed resistance for simulation of Pt100 via terminal block units Nos. 5-6 (flow) and 7-8 (return).
4. Connect a pulse generator via terminal block unit Nos. 10-11 (connection 11 is ground) in order to simulate flow sensor pulses. Note: Voltage level is max. 3V.
5. Connect an OPTO-head/interface with HF-pulse interface at the front.
6. Simulate a flow sensor pulse after which the meter issues an (approximately) 20 kHz pulse burst corresponding to $100 \cdot k \cdot dt$ pulses via the HF-output. "k" is the energy factor. ($\text{kWh}/^\circ\text{C}/\text{m}^3$) and dt is the difference between simulated flow and return temperatures.
Example: $R_f=138.50\Omega$ (100.00°C), $R_r=127.07\Omega$ (70.00°C) $\Rightarrow dt=30.00^\circ\text{C}$, $k=1.141$ gives $100 \cdot 1.141 \cdot 30 = 3423$ pulses.
7. The next flow sensor pulse can be sent immediately after the HF-pulse burst from the meter has been dispatched.

To leave test mode proceed as follows:

1. While short circuiting the test button hold the "Display Button", see fig.2.2.
2. The calculator now enters *operation mode*.

To verify (test) the measurement accuracy of the meter with help of the display, first set up connections in accordance with points 3 and 4 above for testing by means of HF-pulses. Testing is undertaken in the meter's operation mode. Proceed as follows:

1. Supply flow sensor pulses until the energy display is incremented one step.
2. Supply flow sensor pulses with a maximum frequency of 12 Hz until the display has been stepped appropriate numbers of steps.
3. Errors in testing decrease with the number of steps made during the test. If the meter is programmed for 1.0 liter/pulse and resolution for display of energy is 0.001MWh, this means that 10 steps on the display correspond to 288.85 pulses from the flow sensor with selected temperatures in accordance with the above. The testing error is maximum + - 1 pulse, which, in the example, corresponds to 0.35%.

7 Service

When calculator is in for service, there can be a necessity to change the calculator configuration. These parameters can be changed in the “Service mode”, see below for detailed information. The “Service program” version 2.0 can be used to change even more parameters in the calculator. Recommended procedure to enter “service mode”:

1. Set calculator in “Service mode”, see 3.5 Service mode and service button.
2. Make the changes, see below for explanation and see also service mode display sequence 3.5 Service mode and service button.
3. Exit service mode when changes are done, the same procedure as when entering the “service mode”.
4. Replace the broken seals.
5. Sequence service mode, see also 3.5 service mode and service button.

7.4.0 Time

In the display sequence, "00" the time can be changed with the time format "HHMM"*.

7.4.1 Date

The date can be changed in the display sequence, "01", the format is "YYMMDD"*.

7.4.2 Pulse value

The weight of pulse values can be changed in display sequence,

"02", pulse value and

"03", decimal setting for pulse value.

The pulse value is always displayed with four (4) digits, in service sequence, value number "02". The decimal setting in service sequence, value number "03".

Example: "02" displays 2500 and "03" displays 3.

Pulse value: 2.5 l/p

7.4.4 Account days

To change the two account days, (two extra monthly registers) this can be done in the display sequence:

"04", Account day 1

"05", Account day 2.

The format is "MMDD"*. If the account days are set to "0000", the calculator will not store any values in account days.

7.4.6 Communication address (primary address)

The primary communication address can be changed in display sequence “06”. The communication address can be set with three (3) digits, with the value 0-250.

Example, address 5 on display: 0005

7.4.7 Resetting stored error time

To reset the stored error time set calculator to display sequence “07” and by changing the value to “0” the calculator will reset the error time.

Note: Set value to “1”, if the error time shall remain the same.

7.4.8 Placement of flow sensor placing

In display sequence “08” the flow sensor placement can be changed with the following format 1 or 0 where;

1. Flow sensor installed in low
(return, cold) pipe.
2. Flow sensor installed in high
(forward, hot) pipe.

7.4.9 Recommended date for battery replacement

In display sequence ”09” battery replacement date can be altered, format “YYMMDD”*

7.4.A Return to normal mode

In display sequence ”0A” the user can exit the “service mode” and return to normal mode (operating mode) without using the “service button”. Setting the value to

- “1” = exit “service mode”
- “0” = next service mode sequence

7.4.10 Clarifications on format

- * YY = Years with two digits
- MM = Months with two digits
- DD = Days with two digits
- hh = Hours with two digits
- mm = Minutes with two digits

Example: Account days, format “MMDD”, Display shows “1201”.
December (12) the first (01).

8 Technical data

8.1 Power supply

Battery	3.6V – 2.750Ah or Operation time max. 10 years
Mains	230V±10%, 45-65Hz, battery 2.750 Ah as a spare

Table 8.1, Power supply

Voltage drop, if voltage drop occurs during operation the meter goes to working on it's spare battery.

8.2 Temperature sensors

Approved and matching pares type PT100 or PT500 are to be used. Maximum sensor current (RMS): 4μA for PT100

Cable area [mm ²]	Maximum cable length for PT100 sensors [m]
0.22	2.5
0.50	5.0
0.75	7.5
1.50	15.0

Table 8.2, Cable areas for PT100

8.3 Flow sensors

Flow sensors with pulse output.

Frequency Max	[Hz]	12
Pulse Value	[l/p]	0.0001-9999
Pulse Length Min.	[ms]	40
Voltage Max.	[V]	3
Cable length Max.	[m]	15

Table 8.2, Flow sensor specifics

8.4 Temperature ranges

Temperature range	0 - 190 °C
Temperature difference	2 – 120K

Table 8.4, Temperature ranges

8.5 Ambient temperature & Temperature class

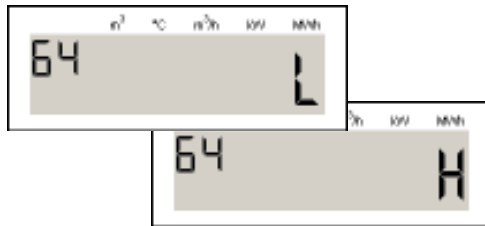
F22 comply with the prerequisites for Environmental Class C according to EN1434.

Ambient temperature Storage/Transport	-20 °C to +70 °C
Ambient temperature Operation	+5 °C to +55 °C

Table 8.5, Ambient temperature ranges.

8.6 Flow sensor placing

F22 can be configured for flow sensor placed in high or low end of the pipe (supply or return pipe). This is marked H = high or L = Low. In the display sequence “64.



8.7 Maximum values for power

The values below are valid for energy unit [MWh] and standard decimal setting.

Pulse values [l/p]	Maximum power [MW]
1.0	3.3
10.0	33.0
100.0	330.0
2.5	3.3
25.0	33.0
250.0	330.0

Table 8.7, maximum power at pulse values

8.8 Dynamic behaviour

Measurements are undertaken for each flow sensor pulse, provided the time between the pulses is five (5) seconds or longer. If the time between pulses is less than five seconds, measurement takes place each five seconds. When the period between the flow sensor pulses exceeds 60 seconds, a measurement takes place every 60th second. For this measurement only the temperature is updated.

8.9 Data output interfaces

M-Bus acc. to EN1434-3	OPTO-interface (EN60870-5) and bus connection (terminal)
------------------------	--

Table 8.9, Data output interfaces

8.10 Pulse outputs

F22 is equipped with two pulse outputs as standard of the type "Open collector" for energy (Pulse output 1) and volume (Pulse output 2). The pulse outputs can be galvanic separated from the calculator by installing an option board, "FCRC-2", see also 2.5.2 Pulse outputs for more information.

Pulse output 1

Energy, one (1) pulse per display update in the energy register (seq. "10").

Pulse output 2

Volume, one (1) pulse per display update in the flow register (seq. "11").

Pulse duration	[ms]	250
Voltage [V]		3 – 30
Max. Current	[mA]	20

Table 8.11, Pulse output data

8.11 Pulse inputs

F22 is equipped with two pulse inputs as standard. The pulse inputs can be used for measuring of other meter with pulse outputs, such as cold- and hot water meters, gas, electricity meters and other meters.

The pulse inputs can be set as volume registers. These registers accumulate the pulses into two volume registers with the value [m³], see also 2.5.1 Pulse inputs for more information.

Frequency	[Hz]	12
Min. Pulse duration	[ms]	40
Max. Voltage	[V]	3

Table 8.11, Pulse input data

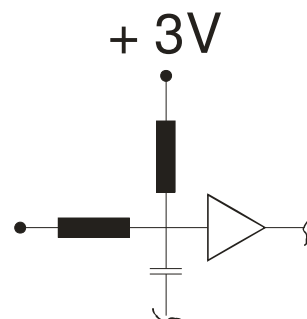


Fig. 8.11, Schematics pulse input

8.12 Alarm output

The F22 is equipped with one alarm output as standard of the type "Open collector". The alarm output sends a pulse every hour as long as an error code exists. The pulse duration 250ms for pulse and alarm output can be altered using the "Service program" version 2 or higher in 125ms steps.

Alarm frequency when an error exists		Once every hour
Pulse length	[ms]	250

9 Appendix

9.1 Decimal setting for F22

Pulse value [l/p]	MWh	GJ	m ³	KWh	MBTU	kW	m ³ /h
1.0	0.001	0.001	0.001	0.1	0.001	0.01	0.001
10	0.01	0.01	0.01	1	0.01	0.1	0.01
100	0.1	0.1	0.1	-	0.1	1	0.1
1000	1	1	1	-	1	1	1
2.5	0.001	0.01	0.01	0.1	0.01	0.01	0.001
25	0.01	0.1	0.1	1	0.1	0.1	0.01
250	0.1	1	1	-	1	1	0.1
2500	1	1	1	-	1	1	1

Table A1, The options marked “-“ should not be used. For the pulse inputs the decimal setting follow the same table setting as for the volume register [m³].

9.1.1 Decimal settings for F22 pulse inputs

Pulse value [l/p]	m ³
1.0	0.001
10	0.01
100	0.1
1000	1
2.5	0.01
25	0.1
250	1
2500	1

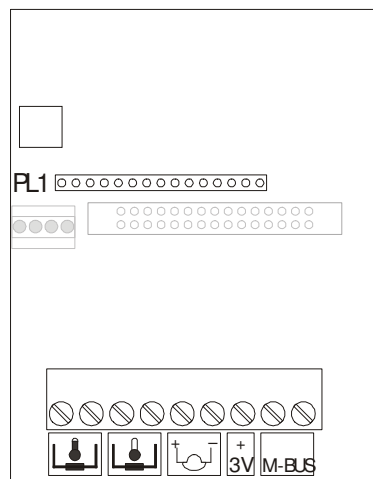
9.2 Article number of F22

9.2.1 Basic version [B]

The basic version is optimized for small installations with limited functionality.

F22 ABCDEFGHIJ KLM

A	1	Pt100 2-wire measurement, flow in return (low) temperature
A	2	Pt100 2-wire measurement, flow in supply (high) temperature
B	1	Battery supply
B	3	Mains supply 230VAC
C	1	Kt Input 2.5 l/p
C	2	Kt Input 25 l/p
C	3	Kt Input 250 l/p
C	4	Kt Input 2500 l/p
C	5	Kt Input 1 l/p
C	6	Kt Input 10 l/p
C	7	Kt Input 100 l/p
C	8	Kt Input 1000 l/p
D	0	KWh
D	1	MWh
D	2	GJ
E	-	Standard order
E	S	Special, Extra information at the order, e.g. customer information
F	9	No Pulse inputs or pulse outputs
G	1	No Backlight
H	0	Standard
I	B	Basic version
J	-	Standard
J	M	M-Bus0 two wire connection (option board)
KLM	X	Country code, 300 = Standard English

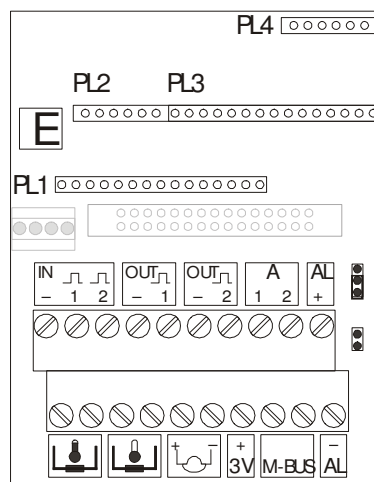


9.2.2 Extended version [E]

F22 extended version for more versatile usage. A calculator with pulse inputs, outputs, alarm outputs and option board functionality.

F22 ABCDEFGHIJ KLM

A	1	Pt100 2-wire measurement, flow in return (low) temperature
A	2	Pt100 2-wire measurement, flow in supply (high) temperature
B	1	Battery supply
B	3	Mains supply 230VAC
C	1	Kt Input 2.5 l/p
C	2	Kt Input 25 l/p
C	3	Kt Input 250 l/p
C	4	Kt Input 2500 l/p
C	5	Kt Input 1 l/p
C	6	Kt Input 10 l/p
C	7	Kt Input 100 l/p
C	8	Kt Input 1000 l/p
D	0	KWh
D	1	MWh
D	2	GJ
E	-	Standard order
E	S	Special, Extra information at the order, e.g. customer information
F	A	Pulse outputs, 2.5 l/p (+ pulse inputs), dec. 2
F	B	Pulse outputs, 25 l/p (+ pulse inputs), dec. 1
F	C	Pulse outputs, 250 l/p (+ pulse inputs), dec. 0
F	D	Pulse outputs, 2500 l/p (+ pulse inputs)
F	E	Pulse outputs, 1 l/p (+ pulse inputs), dec. 3
F	F	Pulse outputs, 10 l/p (+ pulse inputs), dec. 2
F	G	Pulse outputs, 100 l/p (+ pulse inputs), dec. 1
F	H	Pulse outputs. 1000 l/p (+ pulse inputs), dec. 0
G	1	No Backlight
H	0	Standard
I	E	Extended version
I	F	Extended version with antenna cover
J	1	Standard
J	M	M-Bus, two wire connection (option board)
KLM	x	Country code, 300 = Standard English



9.3 Data output table

The following data are accessible via the data output:

Data	M-Bus		SIOX	
	acc. EN 60870-5	Manu- factures Specific	820	Ext- ended
Flow sensor placing	X		X	X
Program version	X		X ⁵	X
Manufacturer	X			
Communication address	X		X	X
Meter number	X			X
Error code (limited)	X		X	X
Accumulated energy	X		X	X
Accumulated, volume 1 ¹	X		X	X
Accumulated, volume 2 ²	X			X
Flow temperature (high)	X		X	X
Return temperature (low)	X		X	X
Temperature difference	X		X	X
"Operation time" (operation time, error time)	X			X
Momentary flow	X		X	X
Momentary power	X		X	X
Time and date	X			X
Pulse register for pulse input 1	X			X ⁷
Pulse register for pulse input 2	X			X ⁷
Monthly values ³ data storage	X			X
Monthly values ³ accumulated energy	X			X
Monthly values ³ accumulated volume 1 ¹	X			X
Monthly values ³ accumulated volume 2 ²	X			X
Account days, same as monthly values, see above	X			X
High resolution energy		X	X	X
High resolution volume 1 ¹		X	X	X
High resolution volume 2 ²		X		X
Relevant error code		X		X
Accumulated time for relevant error		X		X
Previous error code		X	X ⁶	X ⁶
Previous accumulated time for relevant error		X		
Manufacturing number		X		
Pulse value		X		
Latest read energy via communication		X		
Time [h] since latest reading		X		
Recommended date for battery replacement				X
Error codes and accumulated error times during storage (see monthly registers and account days above)				X

Table 8.1, Data output

1. As per flow sensor.
2. Corresponding to energy registers.
3. 37 registers.
4. -
5. For being compatible towards existing system, the version number is fictitiously set to four.
6. Total error time.
7. The option board can be configured to display pulse value units.