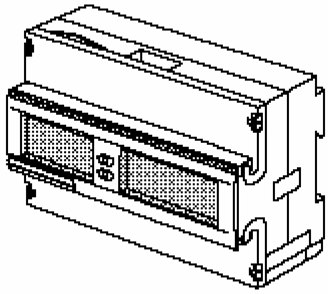

DELTAplus/DELTAmax Meter User's Manual

Rev G

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TABLE OF CONTENTS

1 GENERAL

This manual contains information about the DELTAplus/DELTAmax meter, which is a family of electronic electricity meters manufactured by ABB AB, Cewe-Control.

The purpose of this manual is to give the user a good overview and understanding of the many functions and features the DELTAplus/DELTAmax meter offers. It also describes general metering aspects. The end goal is to help the user to use the meter in the most optimal and correct way and to give the proper service and support to maintain the highest stability and lifetime.

The degree of the DELTAplus/DELTAmax meter functions is controlled by its hardware (electronic boards, mechanics, etc), software (resided in a small computer inside the meter) and the meter type specific programming done when it is produced (stored in a non-volatile EEPROM memory).

Features (both hardware and software) which are not standard (incorporated in all meters) are pointed out in the manual as options.

WARNING! The voltages connected to the DELTAplus/DELTAmax meter are dangerous and can be lethal. Therefore it must be insured that the terminals are not touched during operation. When installing the DELTAplus/DELTAmax meter all voltages must be switched off.

2 PRODUCT DESCRIPTION

This chapter contains a description of the basic functions and practical handling of the DELTAplus/DELTAmax meter. Functionality regarding communication is described in chapter 6.

2.1 FAMILY OVERVIEW

The DELTAplus/DELTAmax meter is a product family consisting of a broad range of electronic electricity meters, primarily used for DIN-rail mounting in a closed environment. The meter exists in 2 basic types, one "direct connected meter" which is aimed to be connected directly to the mains supply and one "transformer rated meter" aimed to be connected via external current transformers and optionally voltage transformers.

All DELTAplus/DELTAmax meters follow ABB's pro M-standard, which defines mechanical dimensions, way of mounting (35 mm DIN-rail) and design outlook.

All DELTAplus/DELTAmax meters are type approved according to international electricity meter IEC standards. All meter types are approved according to IEC 62052-11 which contains general requirements for electricity meters and IEC 62053-21 which contains particular requirements for active electricity energy meters. Depending on functionality the meters can also be type approved to other standards. Combined meters which also measure reactive electricity energy are approved according to IEC 62053-23 which contains particular requirements for reactive electricity energy meters. Meter types which have a built in clock are approved according to IEC 62054-21 which contains particular requirements for time switches. These standards cover technical aspects regarding climatic conditions, electrical requirements, electromagnetic compatibility (EMC), accuracy and some mechanical requirements.

The meter is equipped with an easy to read liquid crystal display (LCD) which displays all the important information. With the use of two buttons (under the sealable cover) and a light sensitive sensor (handled by a small torch) additional information can be viewed.

The DELTAplus/DELTAmax meter normally has a polarity independent solid state (semiconductor) relay which generates pulses proportional to the measured energy and a red light emitting diode (LED) on the front which flashes in proportion to measured energy.

All DELTAplus/DELTAmax meters have an infra-red communication port on the left side using the Meter-bus (M-bus) protocol. Optionally the meter can also be equipped with a 2-wire electrical bus. The different alternatives that exists are M-Bus, LonWorks and EIB.

When the DELTAplus/DELTAmax meter is used with external voltage transformers (VT's) and current transformers (CT's) the transformer ratios can easily be set by using the two buttons under the sealable cover. The energy value(s) shown in normal mode in the display is the real (primary) energy consumption.

2.2 METER PARTS

The different parts of the meter are depicted below, accompanied by a short description of each part.

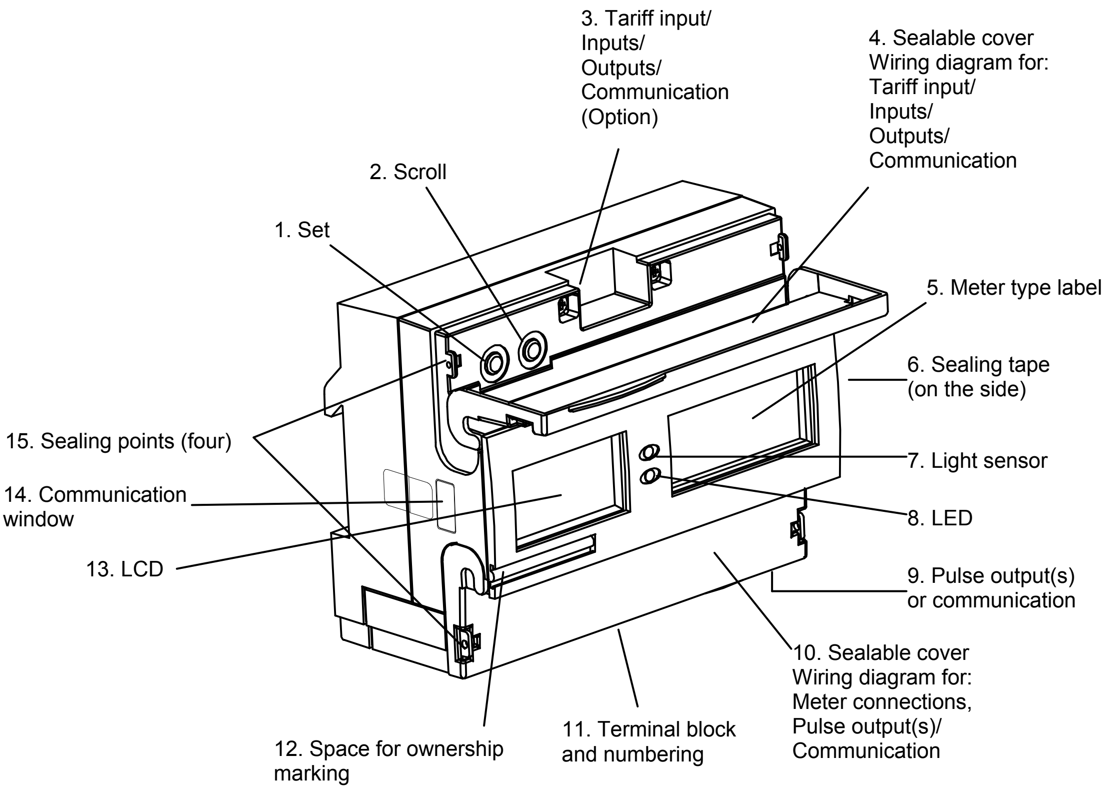


Fig. 2-1 Meter parts

-Position 1: Set button
Used when programming the meter.

-Position 2: Scroll-button
Used when viewing different information and when programming the meter.

-Position 3: Terminal for tariff inputs/Inputs/Outputs/Communication
As an option the meter can be equipped with tariff inputs or digital inputs/outputs or communication capabilities. In this case the meter will have terminals mounted in the place indicated in the picture.

-Position 4 and 10: Sealable covers
The meter contains 2 sealable covers, which cover all the terminals. On the inside of the covers there are wiring diagrams for all terminals covered by the sealable cover.

-Position 5: Meter type label
Label with important information about the meter.

-Position 6: Sealing tape
A piece of tape sealing the meter, which will leave traces on the meter in case it is broken.

-Position 7: Light sensor
The meter has a light sensor which can be used to view different information in the meter.

-Position 8: LED
The meter has a red Light Emitting Diode that flashes in proportion to the consumed energy.

-Position 9: Pulse output(s) or communication

Here the meter has terminals for either pulse output(s) or communication (M-bus or LON) purposes.

-Position 10: See position 4.

-Position 11: Terminal block
All the voltages and currents sensed by the meter are connected here.

-Position 12: Space for ownership marking
A small label, marking ownership, can be inserted here.

-Position 13: LCD
A 7-digit Liquid Crystal Display displaying data and settings.

-Position 14 Communication window
For use of external communication devices.

-Position 15: Sealing points
The meter has 2 sealable covers with 2 sealable points on each, where thread seals can be used to seal the meter (covers all meter connections and the 2 buttons).

2.3 METER TYPES

As mentioned above the DELTAplus/DELTAmax meter product family is divided into two groups:

- Direct connected meters for currents ≤ 80A
- Transformer rated meters (also often called CT-meter) for currents > 80A using external current transformers (CT's) with secondary current ≤ 6A and optionally external voltage transformers (VT's).

Both groups are divided into subgroups:

- One or three phase connection
- Active energy measurement
- Combined energy measurement (both active and reactive)
- 4-quadrant energy measurement (measure export and import energy)
- Tariff controlled meters
- Meters equipped with communication option
- Meters equipped with clock
- Meters equipped with inputs and/or outputs

The meter type is reflected on the front label, see figure below.

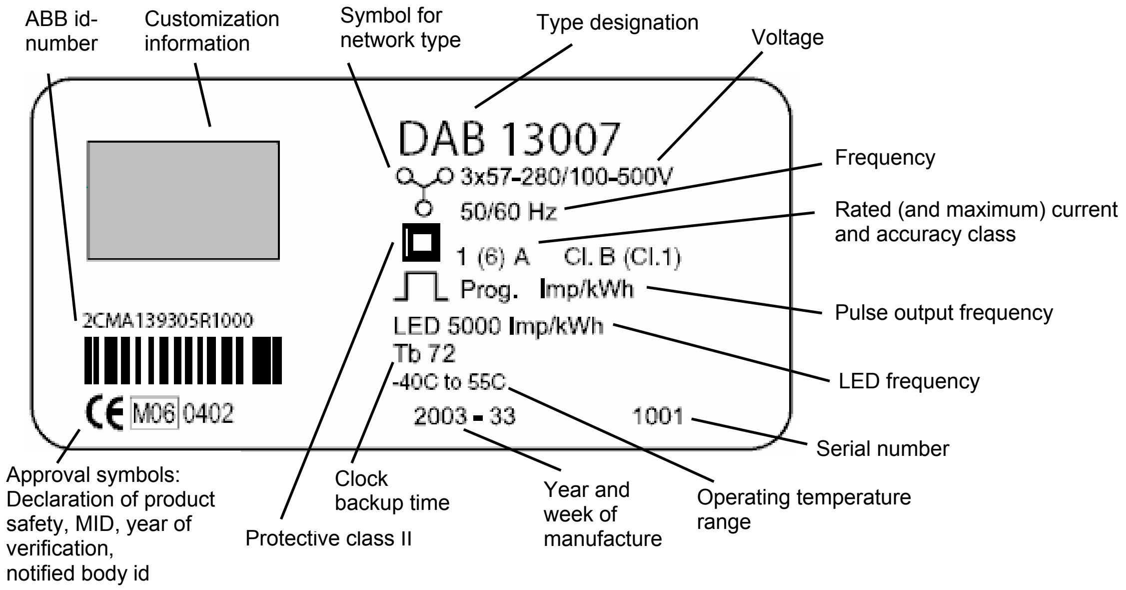


Fig. 2-2 Meter type label

Note that the nominal voltage spans over a range, 57 to 288 V AC from phase to neutral and 100 to 500 V AC from phase to phase.

A meter is identified with its type designation. For explanation of the positions in the type designation see further down in this chapter.

2.3.1 NETWORK TYPE

The network type symbol tells how many measurement elements the meter contains. In each element one voltage and one current is measured and used in the energy measurement. The energy in all elements is added to give the total energy consumption. Meters with 1, 2 and 3 elements exist, see figure below.

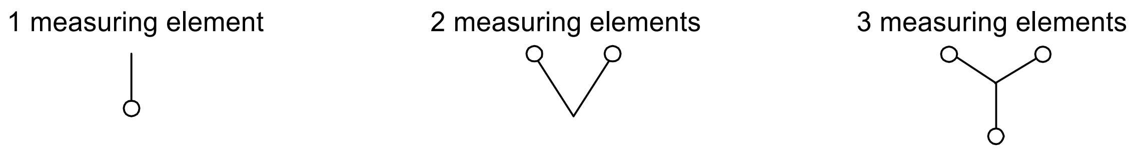


Fig. 2-3 Network symbol

Meters with 1 measuring element are used in single phase metering having a system with 2 wires.

Meters with 2 measuring elements are used in 3-phase metering having a system with 3 wires (2-watt-meter-method).

Meters with 3 measuring elements are used in 3-phase metering having a system with 4 wires (3-watt-meter-method).

2.3.2 TYPE DESIGNATION

Below are tables with explanation for all positions in the type designation for the meters.

STANDARD METERS WITHOUT COMMUNICATION OPTION

Type □□□□□□

Pos	1	2	3	4	5	6-8
Basic						
Standard	D					
Stotz	S					
Measurement						
Active import - CTVT connected		A				
Active import - direct connected		B				
Active and reactive import (combined) - CTVT connected		C				
Active and reactive import (combined) - direct connected		D				
Active import and export - CTVT connected		E				
Active import and export - direct connected		F				
Active and reactive import and export (combined) - CTVT connected		G				
Active and reactive import and export (combined) - direct connected		H				
Communication						
Opto, pulse output			B			
Accuracy						
Class 1				1		
Class 2				2		
Voltage						
1 x 57-288 V					1	
3 x 100-500 V					2	
3 x 57-288 / 100-500 V					3	
Optional functionality						
No options						x00
2 tariffs controlled by 1 input						xx1
4 tariffs controlled by 2 inputs						xx2
2 tariffs controlled by communication commands						xx3
4 tariffs controlled by communication commands						xx4
2 tariffs controlled by internal clock or via communication, time dependant functions						xx5
4 tariffs controlled by internal clock or via communication, time dependant functions						xx6
Time dependant functions						xx7
2 tariffs controlled by 1 input, time dependant functions						xx8
4 tariffs controlled by 2 inputs, time dependant functions						xx9
2 inputs (40V)						x2x
2 outputs (230V)						x4x
1 in / 1 out (230V)						x5x
1 in / 1 out (40V)						x6x
2 pulse outputs in combined meters, 1 in all others (230V)						x7x
Property markings						1xx
Verification and inspection						2xx
Property markings, verification and inspection						3xx

STANDARD METERS WITH M-BUS COMMUNICATION

Type

	Pos 1	2	3	4	5	6-8
Basic						
Standard	D					
Stotz	S					
Measurement						
Active import - CTVT connected		A				
Active import - direct connected		B				
Active and reactive import (combined) - CTVT connected		C				
Active and reactive import (combined) - direct connected		D				
Active import and export - CTVT connected		E				
Active import and export - direct connected		F				
Active and reactive import and export (combined) - CTVT connected		G				
Active and reactive import and export (combined) - direct connected		H				
Communication						
M-Bus, opto			M			
Accuracy						
Class 1				1		
Class 2				2		
Voltage						
1 x 57-288 V					1	
3 x 100-500 V					2	
3 x 57-288 / 100-500 V					3	
Optional functionality						
No options						x00
2 tariffs controlled by 1 input						xx1
4 tariffs controlled by 2 inputs						xx2
2 tariffs controlled by communication commands						xx3
4 tariffs controlled by communication commands						xx4
2 tariffs controlled by internal clock or via communication, time dependant functions						xx5
4 tariffs controlled by internal clock or via communication, time dependant functions						xx6
Time dependant functions						xx7
2 tariffs controlled by 1 input, time dependant functions						xx8
4 tariffs controlled by 2 inputs, time dependant functions						xx9
2 inputs (40V)						x2x
2 outputs (230V)						x4x
1 in / 1 out (230V)						x5x
1 in / 1 out (40V)						x6x
2 pulse outputs in combined and export/import meters, 1 in all others (230V)						x7x
Property markings						1xx
Verification and inspection						2xx
Property markings, verification and inspection						3xx

STANDARD METERS WITH LONWORKS COMMUNICATION

Type

Pos	1	2	3	4	5	6-8
Basic						
Standard	D					
Stotz	S					
Measurement						
Active import - CTVT connected		A				
Active import - direct connected		B				
Active and reactive import (combined) - CTVT connected		C				
Active and reactive import (combined) - direct connected		D				
Communication						
LonWorks, opto			L			
Accuracy						
Class 1				1		
Class 2				2		
Voltage						
1 x 57-288 V					1	
3 x 100-500 V					2	
3 x 57-288 / 100-500 V					3	
Optional functionality						
No options						x00
2 tariffs (230V in)						xx1
2 tariffs (Com)						xx3
4 tariffs (Com)						Xx4
1 input (40V)						x1x
1 output (230V)						x3x
1 pulse output (230V)						x7x
Property markings						1xx
Verification and inspection						2xx
Property markings, verification and inspection						3xx

STANDARD METERS WITH EIB COMMUNICATION

Type

Pos	1	2	3	4	5	6-8
Basic						
Standard	D					
Stotz	S					
Measurement						
Active import - CTVT connected		A				
Active import - direct connected		B				
Active and reactive import (combined) - CTVT connected		C				
Active and reactive import (combined) - direct connected		D				
Communication						
EIB, opto, pulse output			E			
Accuracy						
Class 1				1		
Class 2				2		
Voltage						
1 x 57-288 V					1	
3 x 100-500 V					2	
3 x 57-288 / 100-500 V					3	
Optional functionality						
No options						x00
2 tariffs (Com)						xx3
4 tariffs (Com)						xx4
Property markings						1xx
Verification and inspection						2xx
Property markings, verification and inspection						3xx

2.4 ENERGY INDICATOR

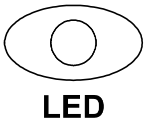


Fig. 2-4 Energy indicator

The red LED in the middle of the front is an indicator that flashes in proportion to the active energy and can be used when testing and verifying the meter. Every pulse means that a certain amount of energy has been registered, that is, it has a certain pulse frequency. This frequency is marked on the nameplate.

In combined meters (measuring both active and reactive energy) it's also possible to have the LED flash in proportion to the reactive energy, see section 2.7.2.9 for more information.

In 4-quadrant meters the LED flashes for both imported and exported energy.

2.5 BUTTONS

The DELTAplus/DELTAmax meter has two user buttons behind the sealable cover.

2.5.1.1 SET BUTTON

This is the "**programming**" button. It is used to reach *Set Mode*, activate a change operation and to confirm a changed setting.

2.5.1.2 SCROLL BUTTON / LIGHT SENSOR

The scroll button and the light sensor lies functionally in parallel, that is pressing the scroll button for a certain amount of time has the same effect as putting light onto the light sensor for the same amount of time. The light sensor is placed below the text "SCROLL" and the "torch picture" on the front of the meter, see picture below. When the meter is sealed only the light sensor can be used. In the text below only the scroll button is mentioned but everything said is also applicable to the light sensor.

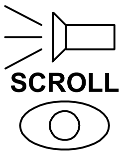


Fig. 2-5 Light sensor

With the scroll button, the information displayed can be changed, such as going to different display modes or proceeding to the next quantity. No settings can be altered by this button.

The scroll button has two different functions depending for how long time it is pressed:

> -Short scroll
> When the scroll button is pressed for up to two seconds, it displays the next value. This can be used if you don't want to wait for the next quantity to be displayed or you can enter single step mode to view a value for longer time.
>
> -Long scroll
> When the scroll button is pressed for between 2 and 10 seconds it executes an "Escape", see below. When a long scroll is performed in *Normal Mode* the DELTAplus/DELTAmax meter switches to *Alternative Mode.* When a long scroll is performed in *Alternative Mode* the DELTAplus/DELTAmax meter switches to *Instrumentation Mode*.

Notes:

The activity starts when the button **is released**.

Do not press more than one button at a time.

A long scroll in *Set Mode* lets you step back (”Escape”). This can be used, for example, to exit a pending set operation without altering the setting.

There is always a ”time out” of two minutes (default).
If a button is not pressed during this time the DELTAplus/DELTAmax meter does an ”Escape” and steps one activity back and continues doing so until *Normal Mode* is reached again.

If the scroll button is pressed for more than **ten seconds** the DELTAplus/DELTAmax meter ignores it.

2.6 DISPLAY INFORMATION

From the display you can get all the information, such as energy consumption, active settings, error status etc. The most important information is either displayed continuously or automatically displayed sequentially one quantity at a time. Information that is not necessary to be viewed all the time can be displayed by using either the button or the light sensitive sensor.

The display is two inches wide and has up to 7 characters with a height of 7 mm. The illustration below shows all segments (forming characters and symbols) that can appear on the display in different display modes.

Note: In every mode, the energy continues to be measured, the energy registers are updated and the meter generates pulses.

2.6.1 DISPLAY OVERVIEW

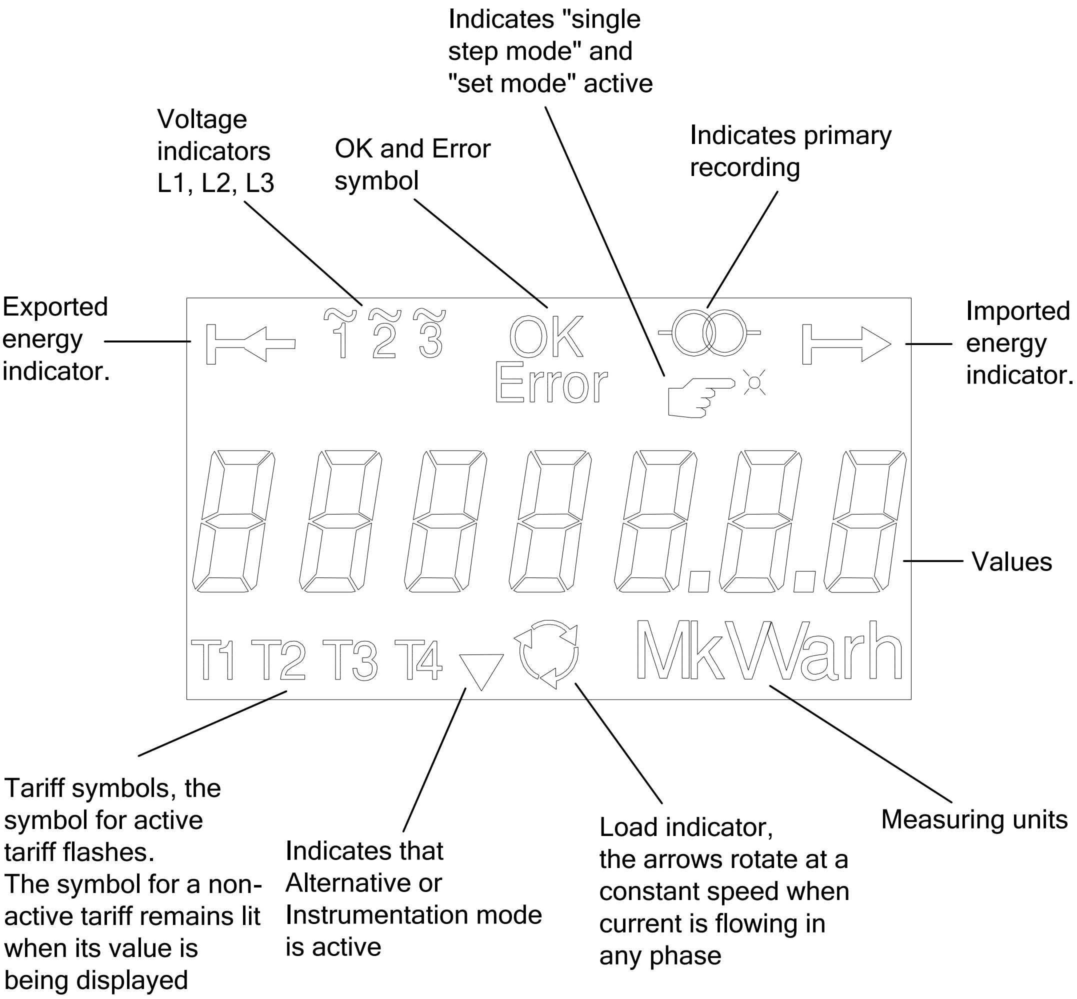


Fig. 2-6 DELTAplus/DELTAmax meter LCD

2.6.2 VOLTAGE INDICATORS

Fig. 2-7 Voltage indicators

These indicate voltage element presence/absence where a blinking segment means voltage absent and a segment in a steady on state means voltage present.

2.6.3 OK AND ERROR SYMBOLS

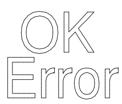


Fig. 2-8 Status symbols

The OK and Error segments constantly indicate the overall status of the meter. Only one of the segments is lit at a time. Besides indicating the status of the meter itself, they are also used to indicate the result of an installation check, which is a function where the meter itself every second checks the installation. If the result of the installation check detected **no** errors and no meter errors are pending the OK symbol is **on.** If an installation error was detected or a meter error is pending the Error symbol is on. The error segment will be kept on as long as any error is pending.

Information regarding pending errors can be viewed in alternative mode where each error have an error code. Installation errors lies between 100-128 and date and time error have error code 140 and 141. Internal meter errors lies between 200-201. If any of the internal errors occur the meter functionality cannot be guaranteed and the meter shall be taken out of service.

For more information regarding the installation check and installation errors see chapter 4.3.

2.6.4 7-SEGMENT 7 CHARACTERS AND UNIT

All values, such as energy, power, voltage and current etc, are displayed by using the 7-segment 7 characters and the unit segments. There are also 2 decimal points to enable display of values with 1 or 2 decimals. The figure below shows an example where the active energy without a decimals with unit kWh and the reactive total power with 1 decimal and unit var is displayed.

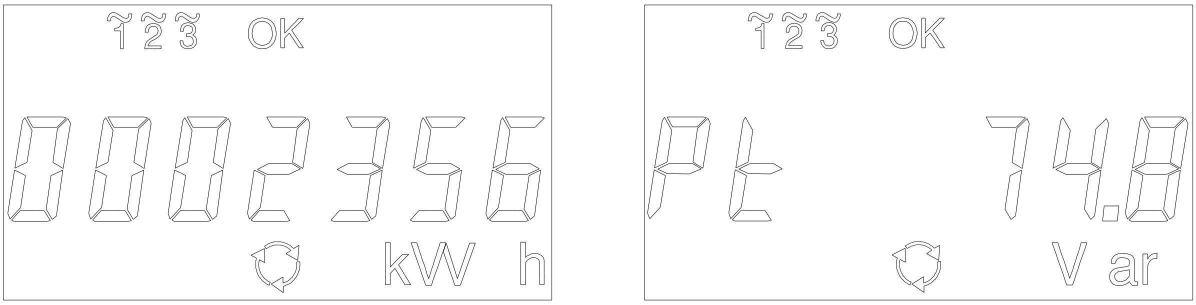


Fig. 2-9 Display of active energy and reactive power

2.6.5 INDICATION OF ACTIVE TARIFF

Fig. 2-10 Tariff indicators

Active tariff is indicated with a constant flashing of the tariff indicator for example "T1" for tariff 1. When a value for a tariff which is not active is displayed its indicator remains lit.

The only time when the active tariff is not blinking is when a total energy register is displayed or an LCD test is pending (all segments on).

2.6.6 LOAD INDICATOR

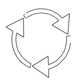


Fig. 2-11 Load indicator

There are three arrows, which will rotate as soon as the current is above the start current level in at least one of the measuring elements. The rotating speed is constant and independent of the measured energy. If the metering is below the start current level all the arrows are constant and not rotating.

If the total active energy is positive the arrows is rotating in the forward direction and if the total active energy is negative the arrows is rotating backwards. If the total energy is negative the import energy registers will stand still and the total export energy register will increase in 4-quadrant meters.

2.6.7 INDICATION OF IMPORT/EXPORT ENERGY

Fig. 2-12 Export/Import energyf indicators

In DELTAmax meters, which register both imported and exported energy, the export and import energy indicators are used to indicate what energy is displayed. The export energy indicator are displayed when an exported energy is displayed, that is energy delivered from the measured device out on the mains net. The import energy indicator are displayed when an imported energy is displayed, that is energy delivered from the mains net to the measured load.

In DELTAplus meters, which register only imported energy, these 2 segments are not used.

2.7 DISPLAY MODES

The DELTAplus/DELTAmax meter display system is divided into different display modes: *Normal*, *Alternative* and *Instrumentation Mode*. They are distinguished from each other by the small triangle at the bottom middle of the LCD which is off in *Normal Mode*, continuously on in *Alternative Mode* and flashing in *Instrumentation Mode*. There is also a Set *Mode* where different programmable settings can be modified. Some information are always displayed on the LCD, irrespective of active mode. Below in the figure are depicted the display system with its different modes and the different information displayed.

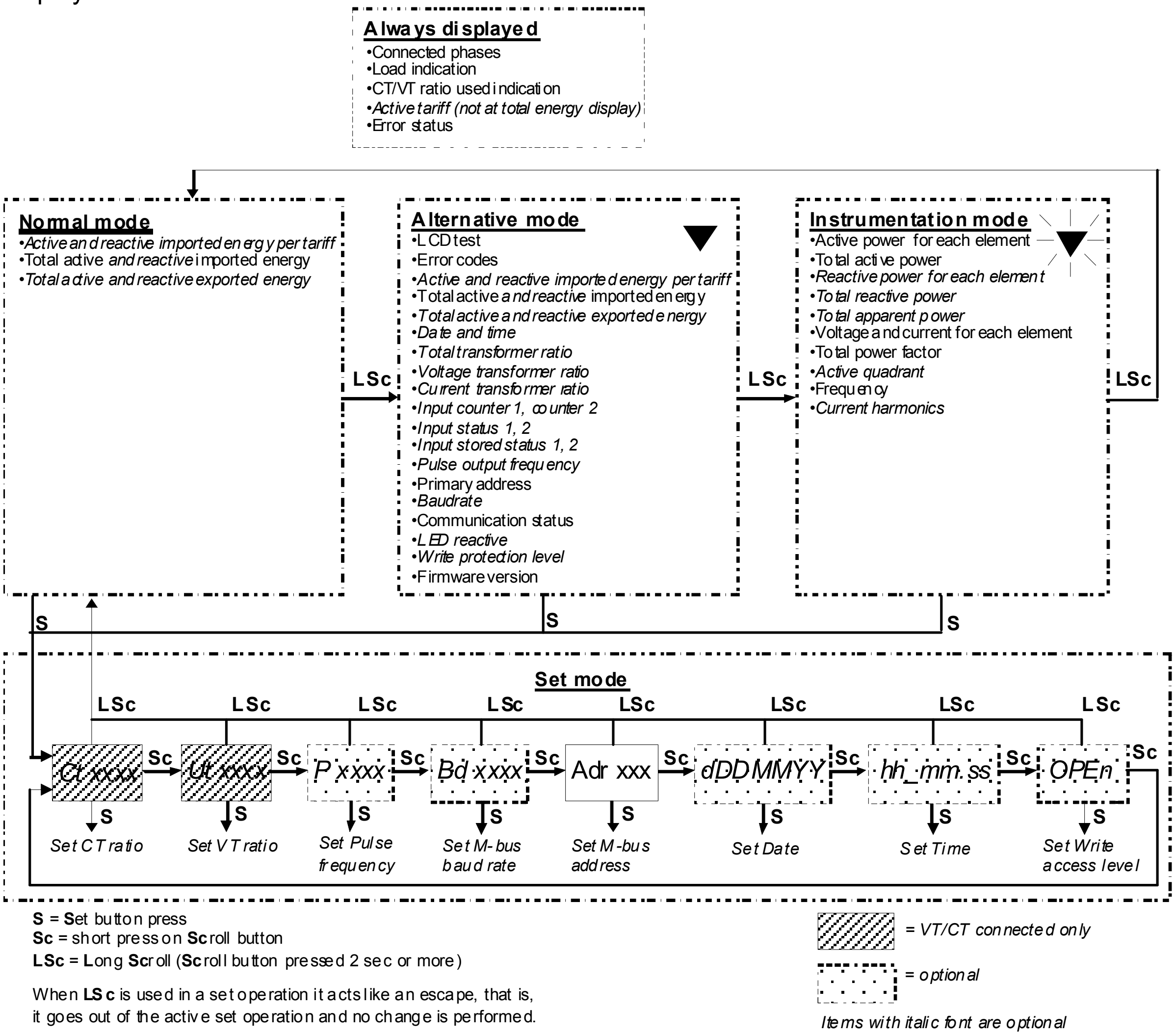


Fig. 2-12 Display system

2.7.1 NORMAL MODE

Normal Mode is the "normal" display condition where the most important quantities, normally the energies which are used for billing, are displayed sequentially and automatically one at a time. Normally each quantity is being displayed for 6 seconds. When the last quantity has been displayed it will start all over again displaying the first quantity. If the "scroll" button is pressed shortly it's possible to single step and view a quantity for longer time.

All meters will be in *Normal Mode* after power up.

Normal mode will always be reached after some time if no buttons are pressed as the meter automatically steps back until it reaches *Normal Mode*.

The *Normal Mode* can only be interrupted by entering the *Set Mode* or the *Alternative Mode*.

Below is described the format for the energy display in *Normal Mode*.

2.7.1.1 Energy display in Normal mode

In *Normal Mode* the energy registers are displayed in kWh (kvarh) without decimals in direct connected meters. In tariff meters the tariff indicators are used to indicate which tariff energy register that are displayed (see section 2.6.5), see example in figure below where the tariff 2 active energy register is displayed (T1 is blinking indicating that tariff 1 is the currently active tariff).

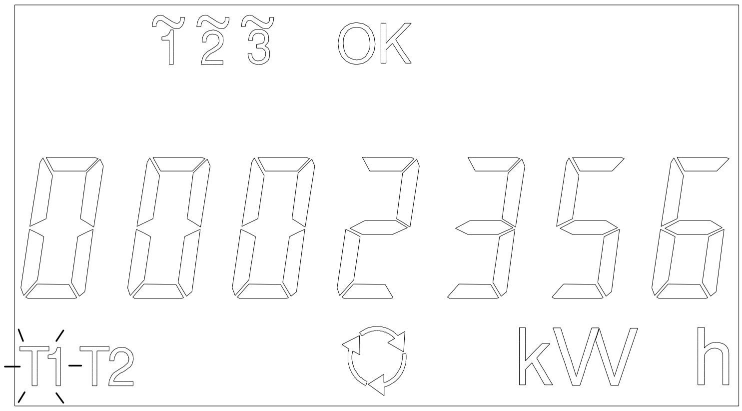


Fig. 2-13 Normal Mode energy display in direct connected meter

In all transformer rated meters set to secondary metering (CT = VT = 1) the energy is displayed in kWh (kvarh) with 1 decimal in Normal Mode.

At primary metering (CT*VT > 1) the displayed values in Normal mode is shifted "one step" to the left for every factor of 10 in the transformer ratio settings, see below:

Transformer ratio	Energy format displayed
CT x VT < 10:	kWh (kvarh),1 decimal
10 < CT x VT < 100:	kWh (kvarh), without decimal
100 < CT x VT < 1000:	MWh (Mvarh), 2 decimals
1000 < CT x VT < 10 000:	MWh (Mvarh), 1 decimal
CT x VT >10 000 :	MWh (Mvarh), without decimal

The figure below shows an example where the reactive energy (unit kvarh) is displayed when the transformer ratio is 50.

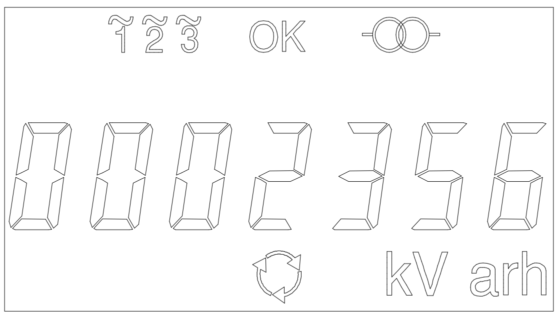


*Fig. 2-14 Display of reactive energy with CT*VT = 50*

The internal meter energy registers are kept in secondary form and multiplied by the programmed transformer ratios and displayed on the LCD in primary form in Normal mode.

2.7.2 ALTERNATIVE MODE

The *Alternative Mode* is reached from *Normal Mode* by pressing the scroll button (or activating the light sensor) for more than two seconds ("long scroll").

The DELTAplus/DELTAmax meter indicates being in *Alternative mode* by the triangle (▽) being permanently lit:

If no button is pressed after entering *Alternative mode* the different display items will be automaticaly displayed one at a time in sequence. If the scroll button is pressed shortly it single steps ("hand" symbol on) and each item can be viewed longer time.

Below is described the information shown in *Alternative Mode*.

2.7.2.1 LCD test

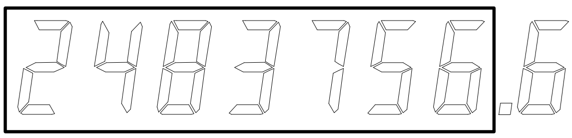
The first display item in *Alternative Mode* is a display test where all LCD segments are set (see figure 2.6 which displays all LCD segments):

2.7.2.2 Error information

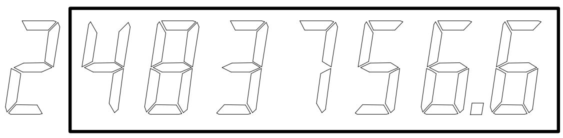
After the LCD test the installation check errors and internal meter errors are displayed. If no errors are detected the text "no Err" is displayed. The error codes are displayed as "Err xxx" (error code xxx). The different errors are explained in chapter 0.

2.7.2.3 Energy display in Alternative mode

In Alternative mode the energy registers are displayed in kWh (kvarh) with 1 decimal in direct connected meters, see figure below which illustrate the difference between Normal and Alternative mode.



Normal mode



Alternative mode

Fig. 2-15 Energy display in Normal/Alternative Mode in direct connected meters

In transformer rated meters the secondary energy in kWh (kvarh) with 2 decimals is displayed (irrespective of the transformer ratio settings).

In tariff meters the tariff indicators are used to indicate which tariff energy register that are displayed (see section 2.6.5)

2.7.2.4 Transformer ratio

The transformer ratio settings is displayed (in transformer rated meters). The total transformer ratio (CT*VT) is displayed as "t xxxxxx", the current transformer ratio (CT) as "Ct xxxx" and the voltage transformer ratio (VT) as "Ut xxxx".

2.7.2.5 Pulse output frequency

The pulse output frequency is displayed (in meters with pulse output(s)) as "P xxxxx" where xxxxx is the frequency in impulses/kWh (kvarh).

2.7.2.6 Baud rate

The M-bus baud rate is displayed (in meters with electrical M-bus) as "bd xxxx" where xxxx is the baud rate in bits/seconds.

2.7.2.7 Primary address

The M-bus primary address is displayed as "Adr xxx" where xxx is the primary address.

2.7.2.8 Communication status

The M-bus communication status is displayed as "C-xxxxx" where xxxxx are different codes that reflect what's happening on the bus. In meters with electrical M-bus it displays the status of the electrical M-bus and in all other meters the status of the the infrared (IR) communication port.

As long as there are no messages addressed to the meter "C------" is displayed. Note that messages on the bus with different baud rate than the meter baud rate or messages addressed to other meters will not be displayed ("C------" displayed).

This can be used as an aid when trouble-shooting communication.

When a message addressed to the meter is detected it displays "C-A x" while communicating. The letter A stands for that the meter is addressed and x denotes different internal communication states. Possible states: 1 : Idle (waiting for command), 2-3 : Receiving states, 4-7 : Transmitting states.

When errors are detected "C-Erxxx" is displayed where xxx is a number that varies depending on the error. Possible error codes: 301 : Checksum error in received message, 302 : Write access not allowed, 303 : Syntax error (protocol error in received message), 304 : Uart error (for example parity error), 305 : Timeout error, 306 : Wrong password.

This display item will be displayed for 4 hours if the scroll button is not pressed (short or long scroll) or until power off. It is displayed only in single step mode.

2.7.2.9 LED reactive

On combined meters it is possible to have the red LED energy indicator to flash in proportion to the reactive energy instead of the active energy (which it normally does). This is done by single stepping to the "LED reactive" display item. When this is reached the text "LEd rEA" is displayed.

It will stay in this mode until: 4 hours have passed if the scroll button is not pressed (by short or long scroll) or a power outage occurs. The pulse frequency for the reactive energy flashing is the same as for the active energy (marked on the nameplate).

In combined 4-quadrant meters the LED will flash for both imported and exported reactive energy.

This item is not displayed in auto scroll.

2.7.2.10 Input counter(s)

The input counter registers are displayed with 7 digits (maximum value 9 999 999). The unit which is displayed (factory setting) is normally "r" (as in "rotations" or "revolutions") for input counter 1 and "rh" for input counter 2.

2.7.2.11 Input status

The current input status is displayed as "InP1 X" and "InP2 X" where X is 0 or 1 (1 means voltage applied to input).

2.7.2.12 Input stored status

The input activity stored status is displayed as "InPA1 X" and "InPA2 X" where X is 0 or 1 (1 means voltage has at least once been applied to the input).

2.7.2.13 Date

In meters with internal clock the date is displayed as "dxxxxxx" where xxxxxx is day, month and year. The 13:th of may 2007 will for example be displayed as "d130507".

If the date is not set "d------" is displayed.

2.7.2.14 Time

In meters with internal clock the time is displayed as "xx_xx.xx" where xx_xx.xx is hours, minutes and seconds. The time 23:37:58 will for example be displayed as "23_37.58".

If the time is not set "--_--.--" is displayed.

2.7.2.15 Write protection level

The active write protection level is displayed. In meters with internal clock some of the programmable parameters for the time dependant function can be write protected. 3 different protection levels exist: Open for write accesses ("Open" displayed), open by password for write accesses ("Open P" displayed) and closed for write accesses ("CLoSEd" displayed).

2.7.2.16 Firmware version

The firmware version is displayed as "xxx-xxx" where the first 3 digits is the total firmware version and the 3 last digits is the metrological version. For example, a firmware with total version 4.01 and metrological version 1.02 will be displayed as "401-102".

2.7.3 INSTRUMENTATION MODE

In this mode it is possible to see additional information about the connected currents and voltages.

The *Instrumentation Mode* is reached from *Alternative Mode* by pressing the scroll button (or activating the light sensor) for more than two seconds ("long scroll").

The DELTAplus/DELTAmax meter indicates being in this mode by flashing the triangle (▽).

If no button is pressed after entering *Instrumentation mode* the different display items will be automaticaly displayed one at a time in sequence. If the scroll button is pressed shortly it single steps ("hand" symbol ☞ on) and each item can be viewed longer time.

The instrumentation quantities are displayed in primary form, that is, the measured secondary values are multiplied by the transformer ratios when displayed on the LCD.

A long scroll will take the meter back to *Normal mode*.

Below is described the information shown in *Instrumentation Mode*.

2.7.3.1 Power

The format of the power displayed depends on the magnitude. The table below shows the format for different absolute magnitudes.

Power (kW/kvar/kVA)	Power format displayed
P < 1 :	W/var/VA, no decimal
1 < P < 10 :	kW/kvar/kVA with 2 decimals
10 < P < 100 :	kW/kvar/kVA with 1 decimal
100 < P < 1000 :	kW/kvar/kVA, no decimal
1000 < P < 10 000 :	MW/Mvar/MVA with 2 decimals
10 000 < P < 100 000 :	MW/Mvar/MVA with 1 decimal
100 000 < P < 1 000 000 :	MW/Mvar/MVA, no decimal

The per element and total active power are displayed on all meters. In combined meters also the per element and total reactive power and total apparent power are displayed.

The power is presented in the format "Px XXXX unit" where x is the element number (1-3) or "t" for the total power (for example "P2 2293 var" for the element 2 reactive power or "Pt 15.78 kVa" for the total apparent power).

2.7.3.2 Voltage

The format of the voltage displayed depends on the magnitude. The table below shows the format for different magnitudes.

Voltage (kV)	Voltage format displayed
U < 1 :	Volt with 1 decimal
1 < U < 10 :	Volt, no decimal
10 < U < 100 :	kV with 2 decimals
100 < U < 1000 :	kV with 1 decimal
U ≥ 1000 :	kV, no decimal

The voltage is displayed for each element in the format "Ux XXX.X unit" with x being the element number (for example "U1 230.4 V").

2.7.3.3 Current

The format of the current displayed depends on the magnitude. The table below shows the format for different magnitudes.

Current (Amperes)	Current format displayed
I < 100 :	Amperes with 2 decimals
100 < I < 1000 :	Amperes with 1 decimal
1000 < I < 10 000 :	Amperes, no decimal
1000 < I < 10 000 :	Amperes, no decimal
I ≥ 10 000 :	kA with 2 decimals

The current is displayed in the format "Ax XX.XX unit" (for example "A3 22.93 a" for a current of 22.93 Amperes on phase 3).

2.7.3.4 Power factor

Power factor is displayed with 2 decimals in the format "Pfx X.XX" where x is the element number (1-3) or "t" for the total power (for example Pft 0.44). Normally only the total power factor is displayed.

For definition of the different quadrants see section 5.1.

2.7.3.5 Active quadrant

In combined meters the total active quadrant is displayed in the format "Lt X" where X is the active quadrant number 0-4, for example "Lt   1" if the total load is in quadrant 1 (inductive load). Zero is presented if the load is zero.

For definition of the different quadrants see section 5.1.

2.7.3.6 Frequency

The frequency is measured in hertz with 2 decimals and displayed in the format "Fr XX.XX" (for example Fr 50.03).

2.7.3.7 Current harmonics

The total current harmonic distorsion of the harmonics measured is displayed in percent with 1 decimal in the format "dx XXX.X" if it is less than or equal to 999.9 % where x is the phase number (1-3). No decimal will be displayed ("dx XXXX") if the harmonic is bigger than or equal to 1000 %. The separate harmonics is displayed in percent with 1 decimal in the format "dxy XX.X" if it is less than or equal to 99.9 % where x is the phase number (1-3) and y is the harmonic number (2-9). No decimal will be displayed ("dxy XXX") if the harmonic is bigger than or equal to 100 %. The separate harmonic frequencies measured is multiples of the fundamental frequency (normally around 50 or 60 Hz) up to the 9:th harmonic but not higher than 500 Hz. At 60 Hz for example the 9:th harmonic will have frequency 540 Hz and will then not be measured. If the harmonic have not been measured "dxy --.-" is displayed.

The current harmonics (2-9) together with the fundamantal is measured sequentially one at a time (approximately 1 harmonic each second). Each harmonic is calculated according to:

$$I_n / I_f \bullet 100\%$$

and the total current harmonic distorsion for the harmonics measured is calculated according to:

$$\sqrt{\sum_{n=2}^{9} I_n^2} / I_f \bullet 100\%$$

where I_f is the fundamental current and I_n is the current for harmonic with number n.

At each measurement the harmonic is set to 0 if the rms value of the current is below a certain lower limit.

Note that as only the harmonics up to 500 Hz is measured and because the harmonics is measured one at a time is not a true total harmonic distorsion which would require that all harmonics up to infinite frequency would be measured and that all harmonics including the fundamental would be measured at the same time.

Note also that presence of harmonics over 500 Hz will result in folding distorsion as the sampling frequency is 1000 Hz. The folding distorsion can affect the measurements below 500 Hz and give erroneous results.

Due to the possible presence of folding distorsion and the fact that the harmonics is measured sequentially one at a time it is recommended that the harmonic measurement results of the meter is used as a tool to detect presence of harmonics and not as an exact instrument to get very precise results.

In the event log function of the meter (see section 2.12.5) it is possible to log presence of harmonics. A percentage limit for the total harmonic distorsion of the harmonics measured is then set and the start time/date and duration will be logged if this limit is exceeded.

2.7.4 SET MODE

Set mode is reached by pressing the Set button while being in Normal, Alternative or Instrumentation mode. For a flowchart on Set mode see figure 2-12 in section 2.7 (optional settings are in *italic* style). After reaching Set mode the different set items and its respective setting can be viewed by pressing the scroll button (short scroll). To activate the change procedure the set button is pressed when the set item to be changed are displayed. The "hand" symbol (☞) is flashing while the change procedure is active. Doing a "long scroll" while the set operation is pending lets you to exit without altering the setting ("Escape").

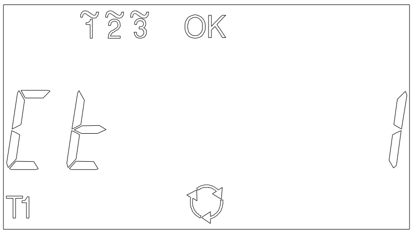
When all settings have been done the Normal mode is reached by doing a "long scroll".

Below are listed the different settings that can be modfied in Set mode and the change operation procedure.

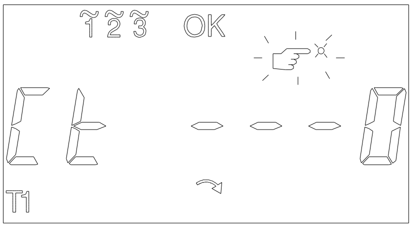
2.7.4.1 Current transformer ratio (CT)

Allows you to set the current transformer ratio (only on transformer rated meters). The allowable range is 1 – 9999.

When the set button is pressed while the present current transformer ratio is shown in set mode



it becomes possible to change the ratio. The "hand" symbol ( ) is flashing and the first digit in the current transformer ratio is displayed (always starts with 0)



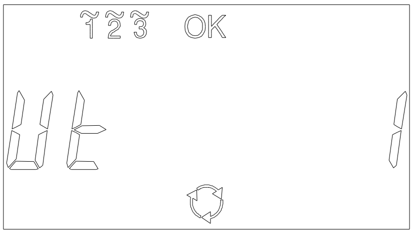
The first digit is increased by 1 for every press on the scroll button. The chosen value is confirmed by pressing the set button. The same procedure is then done for the other digits. If the transformer ratio set was bigger than 1 (primary metering) the "primary metering" symbol ( ) will be on.

Note that the allowable maximum total transformer ratio (CT*VT) is 999 999.

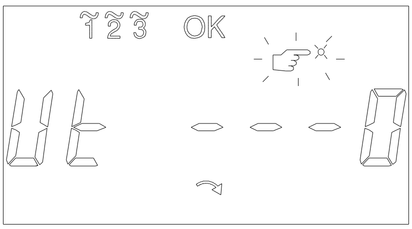
2.7.4.2 Voltage transformer ratio (VT)

Allows you to set the voltage transformer ratio (only on transformer rated meters). The allowable range is 1 – 9999.

When the set button is pressed while the present voltage transformer ratio is shown in set mode



it becomes possible to change the ratio. The "hand" symbol ( ) is flashing and the first digit in the voltage transformer ratio is displayed (always starts with 0)



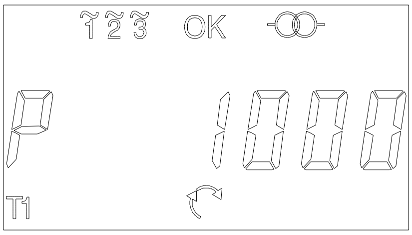
The first digit is increased by 1 for every press on the scroll button. The chosen value is confirmed by pressing the set button. The same procedure is then done for the other digits. If the transformer ratio set was bigger than 1 (primary metering) the "primary metering" symbol ( ) will be on.

Note that the allowable maximum total transformer ratio (CT*VT) is 999 999.

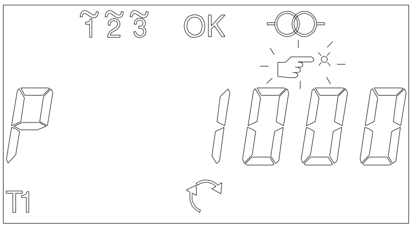
2.7.4.3 Pulse output frequency

Allows you to set the pulse output frequency (only on meters with pulse output(s)). The frequency is selected from a list. The pulse output(s) are primary which means that the CT and VT ratio are considered, see information regarding pulse outputs in section 2.11.

When the set button is pressed while the pulse frequency is displayed in set mode



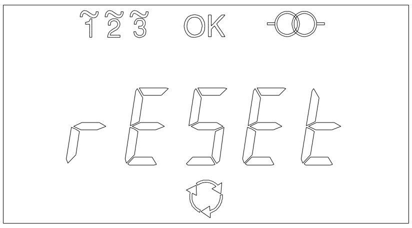
the ”hand symbol ( ) will flash, and you can go through all values with the scroll button (short scroll) and select the preferred value with the set button.



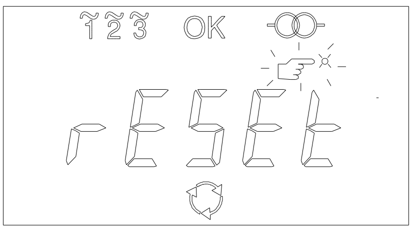
2.7.4.4 Reset of energy registers

Allows you to reset energy registers. This is an option and is normally present only in some “special meters”.

When the set button is pressed while “rESEt” is displayed in set mode



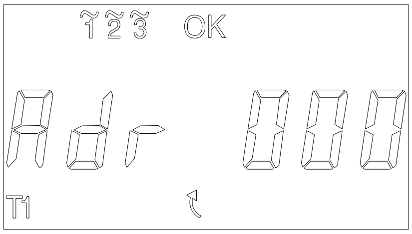
the hand ( ) will start flashing. If then the set button is pressed all registers except the total are set to zero (both active and reactive).



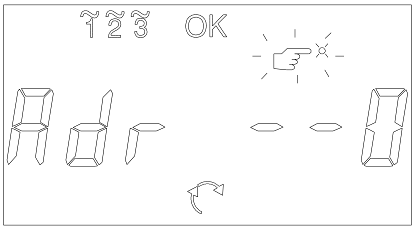
2.7.4.5 Primary address

Allows you set the M-bus primary address.

When the set button is pressed while the primary address is displayed in set mode



the "hand" symbol ( ) starts flashing and the first digit in the address is displayed (always starts with 0)

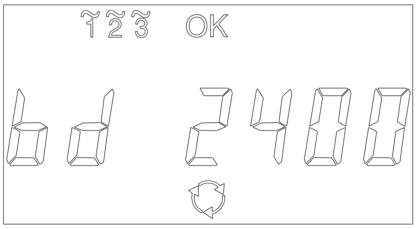


The first digit is increased by 1 for every short press on the scroll button. The chosen value is confirmed by pressing the set button. The same procedure is then done for the 10-digit and finally the 100-digit. When the 100-digit is confirmed and the meter will start to use the new address. It is only possible to select valid addresses (0-250). A selected primary address can be used both for the optical port and the electrical M-bus (if present).

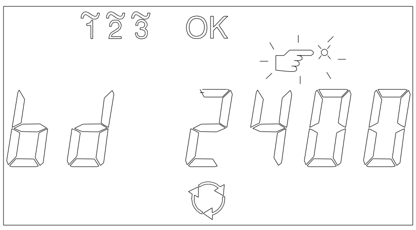
2.7.4.6 Baud rate

Allows you set the M-bus electrical bus baud rate (only in meters with electrical M-bus).

When the set button is pressed while the baud rate is displayed in set mode



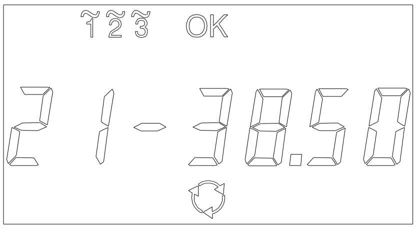
the "hand" symbol ( ) begins flashing, and you can now go through all 6 values (300 – 9600 baud) with the short scroll button, and select the preferred value with the set button.



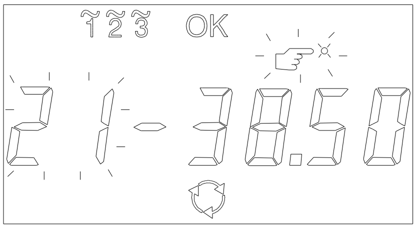
2.7.4.7 Time

Allows setting of the time.

When the SET button is pressed while the time (hour, minute, second) is displayed in Set mode

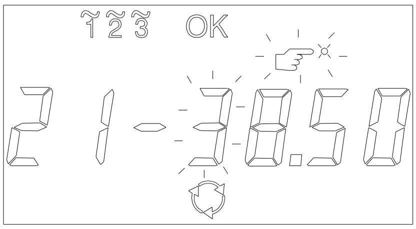


the "hand" symbol ( ) and the hour digits starts flashing

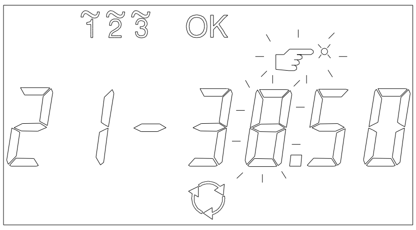


The hour digits are increased by 1 for every short press (possible values 0-23) on the SCROLL button. The chosen value is confirmed by pressing the SET button.

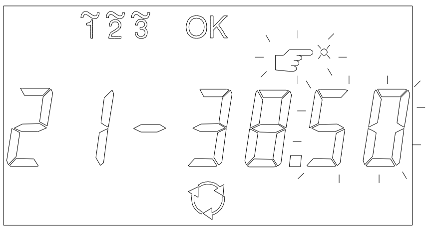
The minute tens digit then starts flashing and is increased for every short press (possible values 0-5) on the SCROLL button. The chosen value is confirmed by pressing the SET button.



The minute unit digit then starts flashing and is increased for every short press (possible values 0-9) on the SCROLL button. The chosen value is confirmed by pressing the SET button.



The second digits then starts flashing and is set to zero at every short press on the SCROLL button. The second digits are confirmed by pressing the SET button which completes the time set operation.

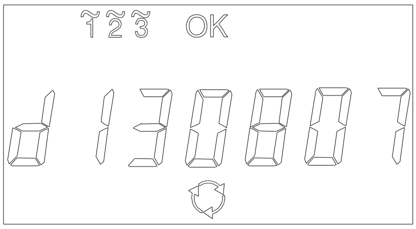


It is also possible to set time via communication. For details see chapter 6.

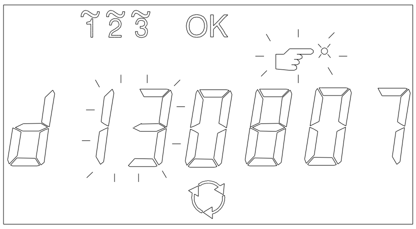
2.7.4.8 Date

Allows setting of the date.

When the SET button is pressed while the date (day:month:year) is displayed in Set mode (13:th of august year 2007 in figure below)

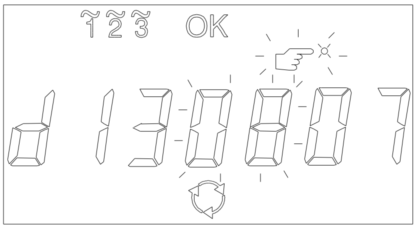


the "hand" symbol () and the day digits starts flashing

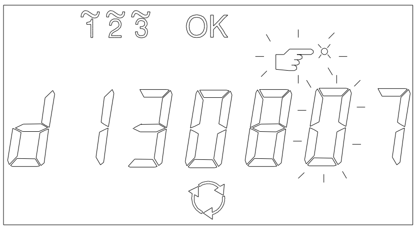


The day digits are increased by 1 for every short press (possible values 1-31) on the SCROLL button. The chosen value is confirmed by pressing the SET button.

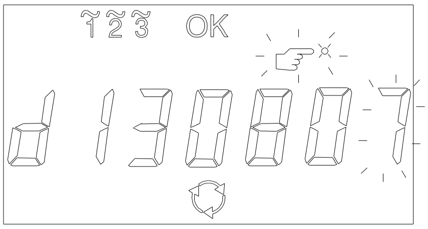
The month digits then starts flashing and is increased for every short press (possible values 1-12) on the SCROLL button. The chosen value is confirmed by pressing the SET button.



The year tens digit then starts flashing and is increased for every short press (possible values 0-9) on the SCROLL button. The chosen value is confirmed by pressing the SET button.



The year unit digit then starts flashing and is increased at every short press (possible values 0-9) on the SCROLL button. When the chosen value is confirmed by pressing the SET button the new date is set.



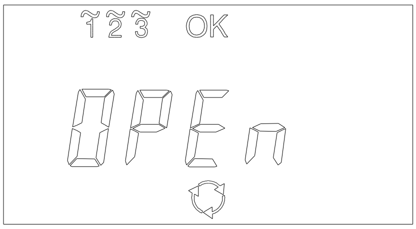
It is also possible to set date via communication. For details see chapter 6.

2.7.4.9 Communication write access level

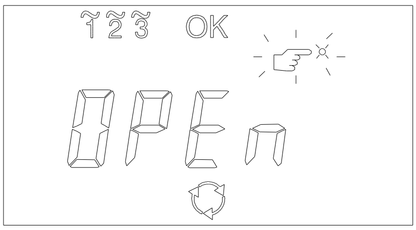
Allows setting of communication write access level. 3 levels exist:

- Open (“OPEn” displayed on the LCD). In this level the meter will accept all types of user related commands without restrictions. It should be mentioned that it is not possible to change any constants affecting the basic energy measuring accuracy.
- Open by password (“OPEn P” displayed on the LCD): In this level the meter will accept protected user related commands after sending a correct password to the meter. It should be mentioned that it is not possible to change any constants affecting the basic energy measuring accuracy.
- Closed (“CloSEd” displayed on the LCD): In this level the meter is closed for all user related commands.

When the SET button is pressed while the communication write access level is displayed in Set mode



the ”hand” symbol ( ) starts flashing



The communication write access level is changed for every short press on the SCROLL button. The chosen level is confirmed by pressing the SET button.

If it is in any of the open levels it is also possible to set the write access level via communication. For details see chapter 6.

The communication write access level does not affect the reading of the meter and it is always possible to read data from the meter.

Information about which commands use the write access level protection are found in chapter 6.

2.8 INSTRUMENTATION

The instrumentation functions in the DELTAplus/DELTAmax meter, with all measurements enabled, consist of measuring frequency, per phase reading of voltage, current, phase angle and current harmonics, per phase and total reading of active/reactive/apparent power, power factor, power factor angle, active quadrant and a power fail counter. It also includes displaying some of these quantities on the LCD and communicating the results over the communication interface(s).

Normally only a subset of the instrumentation quantities are displayed on the LCD and sent out over the communication interface(s).

All measurements are done in parallell and updated approximately once a second except for the current harmonics where the harmonics (numbers 2-9) are measured sequentially one at a time (one harmonic number approximately once a second) and power fail counter which is incremented at startup.

All instrumentation data accuracy are defined within the voltage range ±20 % of the stated nominal voltage and within the current range 5 % of the base current to the maximum current. The accuracy of all instrumentation data except the voltage and current phase-angles and current harmonics are the same as the IEC 62053-21 stated energy metering accuracy. The accuracy for the voltage and current phase-angles are ±2 degrees. The accuracy for the current harmonics varies with the harmonic amplitude and the harmonic number and are are valid provided that no harmonics above 500 Hz exists:

Harmonic number	1 % < distorsion ≤ 5 %	5 % < distorsion ≤ 10 %	10 % < distorsion ≤ 20 %	20 % < distorsion ≤ 50 %	50 % < distorsion ≤ 100 %
2	± 0.5 %	± 1.0 %	± 2 %	± 4 %	± 6 %
3	± 0.7 %	± 1.5 %	± 3 %	± 6 %	± 9 %
4	± 1.0 %	± 2.0 %	± 4 %	± 8 %	± 12 %
5	± 1.2 %	± 2.5 %	± 5 %	± 10 %	± 15 %
6	± 1.5 %	± 3.0 %	± 6 %	± 12 %	± 18 %
7	± 1.7 %	± 3.5 %	± 7 %	± 14 %	± 21 %
8	± 2.0 %	± 4.0 %	± 8 %	± 16 %	± 24 %
9	± 2.5 %	± 5.0 %	± 10 %	± 20 %	± 30 %

For distorsion levels below 1 % there's an absolute uncertainty of ± 0.5 %.

The accuracy of the total harmonic distorsion will vary as it is dependant on all harmonics present which in turn have different accuracy and also amplitude depndant accuracy.

For information regarding presentation of the instrumentation values on the LCD see section 2.7.3. For information regarding communication formats of the instrumentation values on the LCD see chapter 6.

As mentioned above the current harmonics (2-9) together with the fundamantal is measured sequentially one at a time (approximately 1 harmonic each second). Each harmonic is calculated according to:

$$I_n / I_f \bullet 100\%$$

and the total current harmonic distorsion for the harmonics measured is calculated according to:

$$\sqrt{\sum_{n=2}^{9} I_n^2} / I_f \bullet 100\%$$

where I_f is the fundamental current and I_n is the current for harmonic with number n.

At each measurement the harmonic is set to 0 if the rms value of the current is below a certain lower limit (normally 5% of the basic current).

Note that as only the harmonics up to 500 Hz is measured, and because the harmonics is measured one at a time, it is not the true total harmonic distorsion that is calculated. Measuring the true total harmonic distorsion require that all harmonics up to infinite frequency is measured and that all harmonics including the fundamental would be measured at the same time.

Note also that presence of harmonics over 500 Hz will result in folding distorsion as the sampling frequency is 1000 Hz and that the folding distorsion can affect the harmonic measurements below 500 Hz.

Due to the possible presence of folding distorsion and the fact that the harmonics is measured sequentially one at a time it is recommended that the harmonic measurement results of the meter is used as a tool to detect presence of harmonics and not as an exact instrument to get very precise results.

The meter have internally 3 different current ranges with different amplification in order to cover the complete current range. If the current range switches during a harmonic meaurement the measurement is uncertain and will not be accepted. To get a valid measurement the meter uses a retry scheme. If the retry scheme does not give a valid measurement the harmonic will be marked as "not available". Other possible causes for a harmonic to be marked "not available" are invalid frequency and interruptions on the phase voltage.

In the event log function of the meter (see section 2.12.5) it is possible to log presence of harmonics. A percentage limit for the total harmonic distorsion measured is then set and the start time/date and duration will be logged if this limit is exceeded.

The meter also have a power fail counter which is incremented by one after each power fail (meter switched off and on). The maximum value of the counter is 255. When the counter have reached the maximum value it will keep this value irrespective of the number of power fails. It is possible to reset (set to 0) the power fail counter via communication (see section 6.1.4.2.4).

2.9 INPUTS AND OUTPUTS

As an option the meter can be equipped with inputs and/or outputs: Either 1 or 2 inputs or outputs or 1 input and 1 output.

The inputs/outputs are built with optocouplers and are galvanically isolated from all other meter electronics.

The inputs consists beside of the optocouplers of interface/protection circuitry towards the outside world. The microcontroller inside the meter reads the status of the inputs via the optocouplers.

2 versions exist for the input and input/output boards, one for low voltages and one for high voltages. The versions with only outputs handle both low and high voltages. All types handle both DC and AC voltage (polarity independent).

An input that is not connected (left floating) is the same as having voltage "off".

The outputs are built with with solid state MOSFET-optocouplers with polarity independent outputs. The equivalent circuitry of the outputs is an ideal relay in series with a resistor.

For technical data regarding inputs/outputs see chapter 3.

2.9.1 FUNCTIONALITY OF INPUTS

The inputs count pulses, register activity and current status.

This data can be read via the communications bus or read on the LCD.

Inputs can also function as as tariff inputs to control the active tariff, see section 2.10.

The input counters and activity status are saved at a power failure and restored at power up.

The 2 input counter registers are displayed with 7 digits (maximum value 9 999 999). The unit which is displayed (factory setting) is normally ”r” (as in ”rotations” or ”revolutions”) for input counter 1 and ”rh” for input counter 2.

The current input status is displayed as ”InP1 X” and ”InP2 X” where X is 0 or 1 (1 means voltage applied to input). Input activity stored status is displayed as ”InPA1 X” and ”InPA2 X” where X is 0 or 1 (1 means voltage has at least once been applied to the input since it was reset).

The stored status can be reset via the communications bus.

On meters with internal clock and inputs the following additional functions for the inputs can be used: Load profile, monthly values and maximum demand. For information regarding these functions see sections describing these functions.

2.9.2 FUNCTIONALITY OF OUTPUTS

The outputs are controlled via communication or via the internal clock.

The status of the outputs can be read via the communication bus.

When the outputs are controlled via communication the status of the outputs is saved at a power failure and restored at power up.

The output relays are always open if the meter is not powered.

2.10 TARIFF INPUTS

DELTAplus/DELTAmax meters with tariff functionality (option) have the tariffs controlled either via communication, the internal clock or by 1 or 2 tariff inputs. Tariff control via inputs are done by applying a proper combination of "voltage" or "no voltage" to the input(s). Each combination of "voltage"/"no voltage" will result in that the meter will register the energy in a particular tariff register. In combined meters with both active and reactive metering both quantities are controlled by the same inputs and the active tariff for the active and reactive energy will always be the same.

2.10.1 CONNECTIONS

The tariff inputs consist of 2 inputs numbered 15 (T_{IN1}) and 16 (T_{IN2}) and a 3:rd common input numbered 13, see below. For 2-tariff meters T_{IN1} is used. For 4-tariff meters both T_{IN2} and T_{IN1} are used.

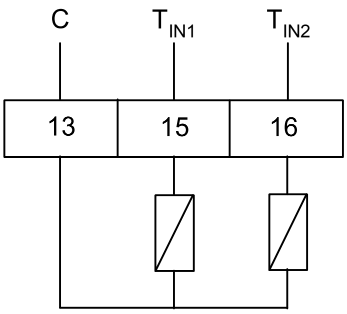


Fig. 2-16 Tariff input connection diagram

For more data regarding the tariff inputs see section 2.9 and section 3.3.1 (technical data for high voltage inputs).

2.10.2 INDICATION OF ACTIVE TARIFF

The active tariff is reflected on the LCD by blinking with one of the 4 segments "T1", "T2", "T3" and "T4". "T1" blinks if tariff 1 is active, "T2" if tariff 2 is active etc. The active tariff segment will always blink except when the total active or reactive energy is displayed where all "Tx" segments are off.

2.10.3 INPUT CODING

The normal coding of the inputs is binary as described below. Reservations should be made however for "special meters" where different coding is required.

Meter with 4 tariffs:
The inputs have the following "input voltage -> active tariff" table:

T_{IN1}/T_{IN2} = off/off -> Tariff 1 active ("T1" blinks on the LCD)
T_{IN1}/T_{IN2} = on/off -> Tariff 2 active ("T2" blinks on the LCD)
T_{IN1}/T_{IN2} = off/on -> Tariff 3 active ("T3" blinks on the LCD)
T_{IN1}/T_{IN2} = on/on -> Tariff 4 active ("T4" blinks on the LCD)

Meter with 2 tariffs:

T_{IN1}/T_{IN2} = off/off -> Tariff 1 active
T_{IN1}/T_{IN2} = on/off -> Tariff 2 active
T_{IN1}/T_{IN2} = off/on -> Tariff 2 active
T_{IN1}/T_{IN2} = on/on -> Tariff 2 active

Note: With the above coding it's enough to use only one input (T_{IN1} or T_{IN2}), the other input can be left floating.

2.11 PULSE OUTPUTS

All DELTAplus/DELTAmax meters except those with internal M-bus and LONWORKS communication are as standard equipped with one or two pulse outputs, on which the meter sends out a certain amount of pulses per kilowatt hour (kilovar hour for reactive pulse outputs).

There also exist types with 1 or 2 extra pulse outputs (type xxxxxx7x, see section 2.3.2).

The pulse output for imported active energy always have terminals numbered 20 and 21. Pulse outputs for active energy have a label marked with “kWh” and reactive pulse outputs with “kvarh”. On DELTAmax meters, which register both imported and exported energy, a “+” after kWh/kvarh is used for import and “-” for import (for example “kWh+” for active imported energy). For a complete picture of pulse ouput configurations and terminal numbers and markings see section 4.2.6

The pulse outputs are primary, which means that the pulses are sent out in proportion to the true primary energy. For transformer rated meters this is done by using the current and voltage transformer ratios (CT and VT ratio) programmed into the meter. For direct connected meters there are no external transformers used and the amount of pulses sent out are in proportion to the energy flowed through the meter.

The pulse outputs are galvanically isolated from the rest of the electronics in the meter.
They fulfil and supersede the German DIN 43 864 standard (often called S0) and the IEC standard 62053-31.

The outputs have a maximum voltage and current specified to 247 Volt AC, 350 V DC 100 mA. They are built with MOSFET-optocouplers with polarity independent outputs. The equivalent circuitry of the outputs is depicted below and consists of an ideal relay and a series resistor of around 20 Ω.

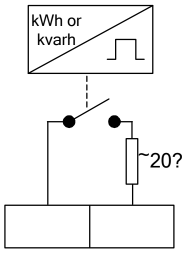


Fig. 2-17 Pulse output equivalent schematic diagram

2.11.1 PULSE FREQUENCY AND PULSE LENGTH

The pulse frequency is programmable (marked on the nameplate) with the pulse frequency selected from a list using the buttons. The pulse length is fixed and is normally set to 100 ms. Regarding the choice of pulse frequency, it should be noted that there is a risk that the pulses may go into each other if the power is too high. In this case the meter may send out a new pulse (closes the relay) before the previous pulse has been terminated (relay opened) and the pulse will be missed. The worst case scenario is that the relay can be closed all the time. To avoid this problem a calculation should be made to work out the maximum pulse frequency allowed at a particular site based upon an estimated maximum power and the meter pulse output data.

The formula to use when doing this calculation is:

Max pulse frequency = 1000 * 3600 / U / I / n / (Ppause + Pwidth)

where U and I is the estimated maximum element voltage (in volts) and current (in amperes), n the number of elements (1 - 3), Pwidth and Ppause is the pulse width and the required pulse pause (in seconds). A reasonable minimum pulse pause is 0.03 (30 ms) which conforms to the S0 standard. Note U and I have to be the primary values in a transformer rated meter if the CT and VT for the external transformers are programmed into the meter.

For example in a direct connected 3-element meter with estimated maximum voltage and current of 250 V and 65 A and pulse width 100 ms and required pulse pause 30 ms the maximum allowed pulse frequency will be:

1000 * 3600 / 250 / 65 / 3 / (0.030 + 0.100)) = 568 impulses / kWh (kvarh)

Another example: In a transformer rated 3-element meter with estimated maximum voltage and current of 63 * 100 V = 6300 V (VT ratio 100) and 6 * 50 A = 300 A (CT ratio 50) and pulse width 100 ms and required pulse pause 30 ms the maximum allowed pulse frequency will be:

1000 * 3600 / 6300 / 300 / 3 / (0.030 + 0.100) = 6.16 impulses / kWh (kvarh)

For technical data on pulse outputs see chapter 3.

2.12 INTERNAL CLOCK AND TIME DEPENDANT FUNCTIONS

In DELTAplus/DELTAmax meters equipped with internal clock the meter keeps track of date and time and are equipped with various time dependant functions such as load profile, maximum demand, monthly values, event log, outputs controlled by time and in tariff meters with internal clock the tariffs are normally controlled via the internal clock. Below these functions are described.

Details regarding reading/writing of time/date and reading of the time dependant functions via communication is given in chapter 6.

The internal clock and time dependant functions are not available in meters with internal LON or EIB communication.

Parameters controlling the functionality of the internal clock and the time dependant functions can be programmed into the meter via the infrared optical port or the M-bus interface (in meters equipped with electrical M-bus interface). Program for setting these parameters is supplied by ABB.

2.12.1 INTERNAL CLOCK

The internal clock have a built in calendar and automatically keeps track of leap year and daylight savings time (DST). Use of DST is optional.

Backup of the clock during power failure is done with a super capacitor.

The time is controlled from a quartz crystal based real time clock.

Time and date is set via the buttons (for details see chapter 2.7.4.7and 2.7.4.8) or via communications (for details see chapter 6).

The internal clock is approved according to the standard IEC 62054-21 which contains particular requirements for time switches. The stated accuracy is less than 5 ppm at room temperature when controlled from the quartz crystal based real time clock.

2.12.2 PREVIOUS VALUES

At every monthly or daily change all energy register and input counter values are stored together with a date/time stamp. All total energy values are stored and in tariff meters also the tariff registers are stored. Whether the values are stored at monthly or daily changes is programmable (via communication). The option to choose monthly or daily values are only present in meters with firmware versions 4.00 or higher. In lower versions monthly values is always used.

If the meter is powered during a monthly change (or daily change if daily values is used) the time stamp will be 00:00:00 (or 00:00:01) and the date stamp the 1:st of the month entered. If there is a power fail during the monthly (or daily) change the registers are stored when the meter starts up after the power outage and the date/time stamp will be set to the date/time when the meter is powered up. If the power outage lasts over more than one monthly (or daily) change no monthly (or daily) values will be stored for the months (or daily) passed while the meter was not powered.

The number of monthly values to be stored are programmable from 0 up to 127 (in firmware versions lower than 4.00 max 31). Note that changing the number of previous values will erase all previous values. It will also erase all load profile, maximum demand and event log data due to the fact that data for these functions are stored after monthly values in the EEPROM and changing the number of previous values change the addresses for aftercoming data and requires reset of this data.

It is possible to erase all previous values by sending a special command, for details see chapter 6.

If the maximum number of values have been stored and new values are stored the oldest values will be overwritten.

As mentioned above the previous values are stored at a monthly or daily change. Therefore, when adjusting time, it should be avoided to change backwards into a previous month (or day if daily values is used) because this will then trigger storage of previous values both when going into the previous month (day) and when going into the new month (day).

The previous values are not displayed on the LCD and can only be read via communications. For details see chapter 6.

No previous values will be stored if date and/or time is not set.

2.12.3 LOAD PROFILE

In the load profile function each day is divided into intervals with a certain length where the energy consumption in each interval is stored. The possible interval lengths are 15, 30 or 60 minutes and is programmable.

The quantities that can be stored are:

- Total active imported energy
- Total active exported energy (only in 4-quadrant meters)
- Total reactive imported energy (only in combined meters)
- Total reactive exported energy (only in combined 4-quadrant meters)
- Number of pulses registered on input 1 (only on meters equipped with input 1)
- Number of pulses registered on input 2 (only on meters equipped with input 2)

Which quantities to be stored is programmable (with the restrictions mentioned above). All quantities use the same interval length.

Note that changing the interval length or the quantities to be stored will erase all load profile data.

The load profile function always use normal time irrespective if daylight savings time is active or not.

Each load profile data value are associated with a status value. The status value gives information such as:

- Interval is longer or shorter than defined length (deviation limit in seconds is programmable)
- Power outage occured during interval
- Data overflow
- Data not available
- Data error

Intervals which have not been passed yet or that haven't been passed through regular time flow will be marked "not available". This will for example happen if the time is changed forward over a number of intervals. If for example the time is changed forward from 11:23:43 to 14:13:55 and 60 minute intervals is used the 2 intervals between 12:00 to 14:00 will be marked "not available". Another case where intervals will be marked "not available" is when load profile is cleared in the middle of a day. In this case the previous intervals of that day will be marked "not available".

If there is a power fail lasting over a complete day or several days no data will be stored for these days.

The maximum number of load profile days that can be stored depends on several things:

- Interval length. Shorter interval length gives less number of maximum days. For example, changing the interval length from 60 to 30 minutes gives half or half-1 the maximum amount of days that can be stored.
- Maximum number of monthly values, maximum demand values and events to log selected. Load profile data, monthly values, maximum demand values and events are stored in the EEPROM memory and increasing the maximum number of monthly values, maximum demand values and events results in less amount of memory available for load profile.
- Number of quantities stored in load profile. For example using load profile for 2 quantities instead of 1 gives half or half-1 the maximum amount of days that can be stored.

It is possible to erase all load profile data values by sending a special command, for details see chapter 6.

If the maximum number of days have been stored and new values are stored the oldest dayily values will be overwritten.

If the date is set to another date than the current date the meter will always start a new load profile day record. Therefore, when adjusting time, it should be avoided to change backwards into the previous date (which will then start a new load profile day record). Note also that, as load profile always uses the normal time, changing the time backwards from 01:xx:xx to 00:xx:xx when daylight savings time is active will mean that normal time will change backwards into the previous date and start a new load profile day record.

The load profile values are not displayed on the LCD and can only be read via communications. For details see chapter 6.

No load profile data will be stored if date and/or time is not set.

2.12.4 MAXIMUM DEMAND

In the maximum demand function the time is divided into intervals with a certain length and the mean power in each interval is measured and the maximum mean value is stored together with a date/time stamp. The possible interval lengths are 15, 30 or 60 minutes and is programmable.

A set of maximum demand values are calculated and stored for each month. It is however also possible to start a new period at any time by sending a special “freeze maximum demand” command via communication, for details see chapter 6.

For each set of maximum demand values the end date/time of the period is stored.

The quantities that can be stored are active and reactive import power and number of pulses registered on input 1 and 2 (pulses/interval). Storage of reactive max demand is only done on combined meters and storing of pulses requires meters with corresponding input. All quantities use the same interval length.

Note that the max demand for inputs is different compared to the max demand for active and reactive power in that the actual number of pulses in the interval is registered and not the mean value pulses per timeunit. This means that if the pulse input frequency is constant and the interval is changed for example from 15 to 30 minutes the input max demand will increase by a factor of 2. The max demand for active and reactive power however will not change if the interval is changed if the power is constant.

In tariff meters the maximum demand is stored for each tariff for the energies.

Note that maximum demand for active and reactive export power is not registered in 4-quadrant meters.

If the time is changed backwards (risk of longer interval than specified) the pending interval calculations are ended and a new interval calculations are started. The same thing happens at a total power failure.

If there is a power fail lasting over one complete month or months (or day or days if daily values is used) no data will be stored for these month or months (or day or days if daily values is used).

The maximum number of maximum demand values to be stored are programmable from 0 up to 127 (in firmware versions lower than 4.00 max 31). Note that changing the number of maximum demand values will erase all maximum demand data. It will also erase all load profile and event log data due to the fact that data for these quantities are stored after maximum demand values in the EEPROM and changing the number of maximum demand values change the addresses for data aftercoming data and requires reset of this data.

It is possible to erase all maximum demand data by sending a special command, for details see chapter 6.

If the maximum number of values have been stored and new values are stored the oldest values will be overwritten.

The maximum demand values are not displayed on the LCD and can only be read via communications. For details see chapter 6.

No maximum demand data will be stored if date and/or time is not set.

2.12.5 EVENT LOG

The event log function can log the following events:

- Overvoltage on each phase
- Undervoltage level 1 on each phase

- Undervoltage level 2 on each phase
- Phase voltage outage
- Negative power
- Total power outage
- Presence of current harmonics

For the over- and undervoltage events a percentage level with respect to a nominal voltage is given which is programmable. The phase voltage outage level use the same level as undervoltage level 2.

The negative power event will be logged if abnormal negative power is detected.

For current harmonics a percentage level for the total harmonic distorsion of the harmonics measured can be set and the event will be logged if that limit is exceeded.

For the different events there exist a programmable minimum time before the event is registered.

For each registered event the start date/time and the duration (in seconds) is stored. The event is registered when the time limit have passed. Because of this the start date/time of events sent out may sometimes not be in chronological sequence.

A total power outage will always end a pending event (except for the event total power outage which it will start).

The number of events to be stored are programmable from 0 up to 255. Note that changing the number of events will erase all load profile data due to the fact that data for this quantity is stored after the event log data in the EEPROM and changing the number of events change the addresses for data aftercoming data and requires reset of the load profile data.

It is possible to erase all event log data by sending a special command, for details see chapter 6.

If the maximum number of events have been stored and new events are stored the oldest events will be overwritten.

The events are not displayed on the LCD and can only be read via communications. For details see chapter 6.

No event log data will be stored if date and/or time is not set.

2.12.6 TARIFF CONTROL BY CLOCK

In tariff meters with internal clock the tariffs normally are controlled via the internal clock. This is done by programming the meter to activate desired tariff at specific switchpoints in time.

It is possible to define up to 4 different day types and 4 different seasons with different tariff schemes for each combination of day type and season. The day types are defined on a weekly basis and the season switches are defined on a yearly basis.

It is possible to define yearly cyclic dates where a specific day type or season switch is specified.

It is also possible to define specific dates where a specific day type is specified.

The active tariff is displayed on the LCD (see section 2.6.5) and can also be read via communication.

If date and/or time is not set a programmable default tariff will be active.

2.12.7 OUTPUTS CONTROL BY CLOCK

In meters with internal clock equipped with outputs the outputs can be controlled via the internal clock. This is done by programming the meter to switch on/off the outputs at specific switchpoints in time.

It is possible to define up to 4 different day types and 4 different seasons with different switch schemes for each combination of day type and season. The day types are defined on a weekly basis and the season switches are defined on a yearly basis.

It is possible to define yearly cyclic dates where a specific day type or season switch is specified.

It is also possible to define specific dates where a specific day type is specified.

The daytypes specified by specific dates have highest priority, after which comes the daytypes specified by yearly cyclic dates and the weekly specified daytypes have lowest priority.

If date and/or time is not set a programmable default state for the ouputs will be active.

The output state is not displayed on the LCD and can only be read via communication, se chapter 6 for details.

2.12.8 TOTAL POWER OUTAGE TIME

In meters with internal clock the total power outage time is accumulated. As total power outage is considered when the meter is switched off.

The meter must have a valid time and date when it's switched off and on in order for the power outage time to be accumulated. If the time and date is not valid the total power outage time will not be changed.

The total power outage time is read out via communication (see section 6.1.4.1) where it is sent in days, hours, minutes and seconds.

It is possible to reset the total power outage time via communication (see section 6.1.4.2.15).

2.13 ELECTRONICS

The electronics inside the meter consist of a main board (always used) and optionally an input/out board and a communication board.

2.13.1 MAIN BOARD

Below a block diagram of the meter main board is displayed.

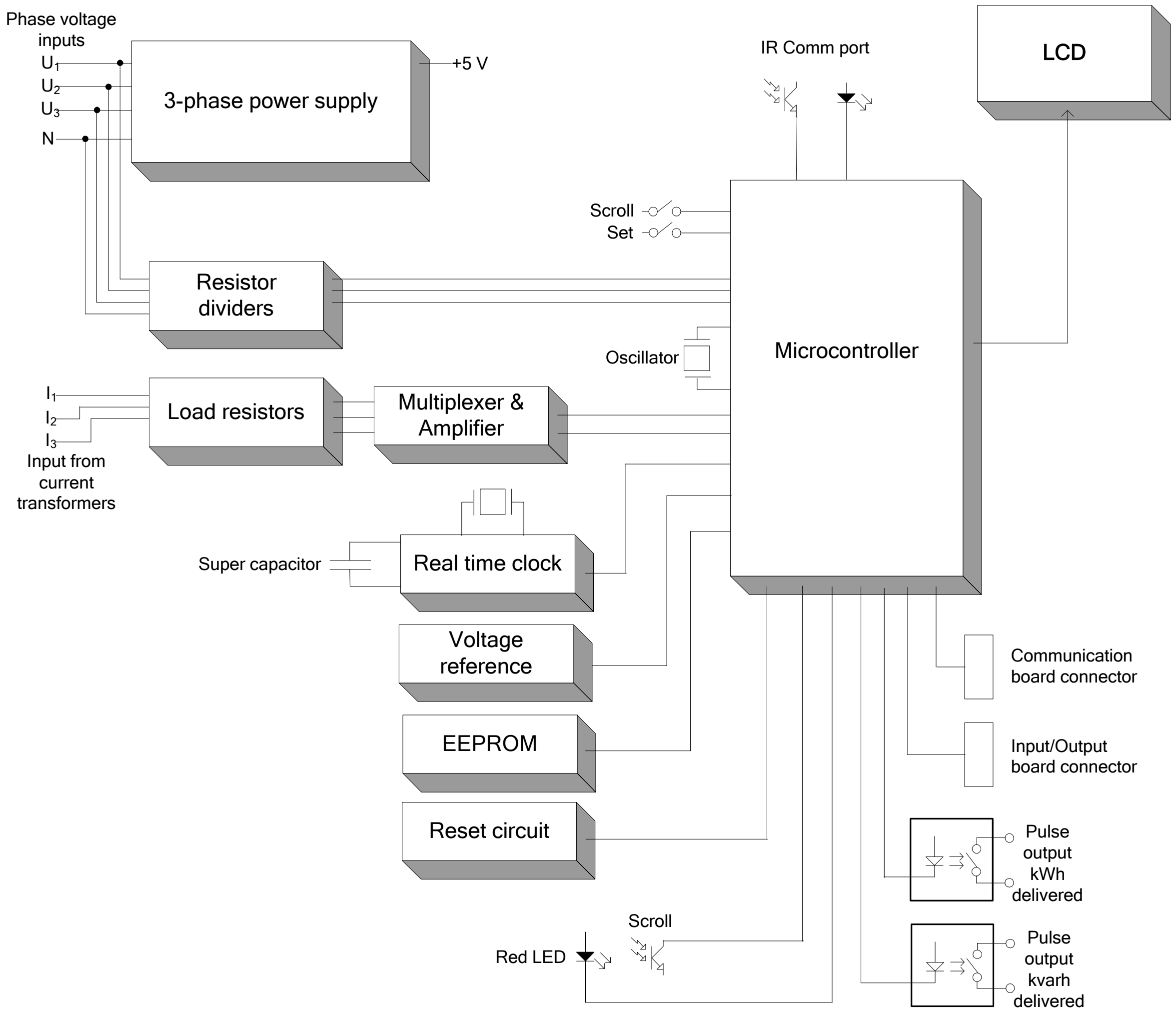


Fig. 2-18 Main board block diagram

The meter hardware (options not included) can be divided into the following parts:

- A microcontroller that performs the energy measurement. The device is calibrated via registers to fulfil the accuracy class requirements stated in IEC 62053-21. Besides the energy measurement it also contains functions for detecting low voltage (power fail), detecting absence of phase voltages, measuring of voltage, current, power, frequency and phase angles etc. The microcontroller also handles the LCD, the EEPROM, the buttons, the driving of the LED, the communication and the pulse outputs etc.

- An LCD (liquid crystal display) for display of accumulated energy, transformer ratio, pulse rate, voltage, current, power, status and error information etc.

- The current is measured with current transformers through which the current to measure flows. The output current from the transformer flows through load resistors to produce voltages, which via multiplexer and amplifier are fed to the microcontroller. The mains voltage is divided by resistor dividers and fed into the microcontroller

- 2 push buttons called ”scroll” and ”set” to control the display on the LCD and for programming of transformer ratios, pulse output frequency etc. The ”scroll” button is in most cases used to display the next quantity or item in a sequence whereas the ”set” button is used for programming the meter.

- An oscillator that clocks the microcontroller.

- A 3-phase wide voltage range power supply that generate +5V for feeding the electronics (microcontroller, EEPROM etc).

- A voltage reference used by the microcontroller A/D-converters that is the reference for all current and voltage samples.

- A red LED (light emitting diode) that flashes with a certain energy pulse frequency (imp/kWh).

- A phototransistor which that lies functionally in parallel with the scroll button. Putting a short flash of light on the phototransistor, for example with a torch, causes the same action as pressing the scroll button. A plastic light pipe leads down to the phototransistor mounted on the board.

- 1 or 2 optoisolated pulse outputs which give a certain amount of pulses per kWh (kvarh).

- An interface which can be connected to an input/output board.

- EEPROM for storing energy (1 total and 4 tariff registers for both active and reactive delivered energy), historic values (load profile, monthly values, event log etc), calibration- and initialization values for the microcontroler and for meter specific values which are used by the firmware in the microcontroller. The data retention time for stored data in the EEPROM is more than 40 years.

- A communications-interface for connection to an internal communication board.

- An infra-red communications-interface consisting of a phototransistor and a LED for connection to an external communication unit.

- A quartz crystal controlled real time clock used to keep track of date/time. The real time clock uses a super capacitor as backup source at power outages.

2.13.2 INPUT/OUTPUT BOARDS

The DELTAplus/DELTAmax meter can be equipped with different options with input(s) and/or output(s). The following basic configurations exist:

- 1 input
- 2 inputs
- 1 input and 1 output
- 1 output
- 2 outputs

The principal schematics are depicted in figures below. All inputs and outputs are galvanically isolated from the rest of the meter electronics by optocouplers.

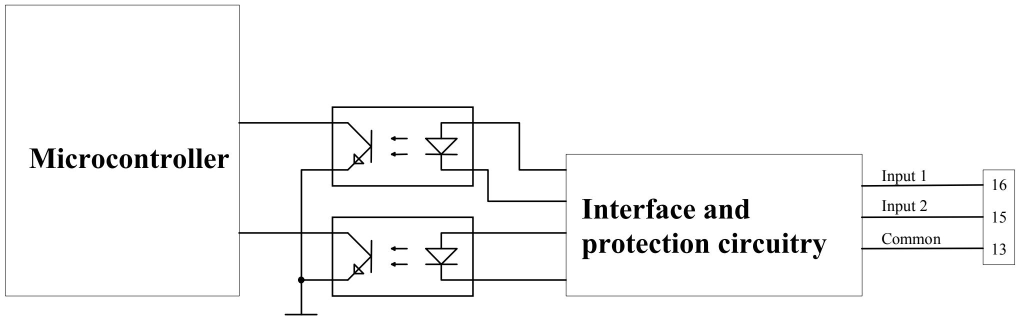


Fig. 2-19 Block diagram for 2 inputs

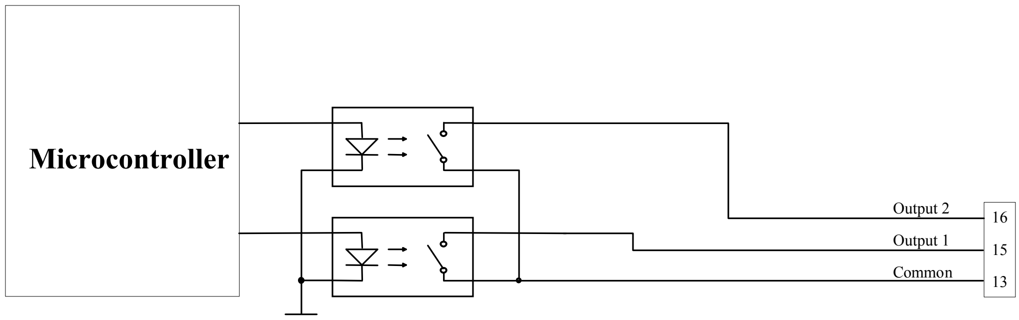


Fig. 2-20 Block diagram for 2outputs

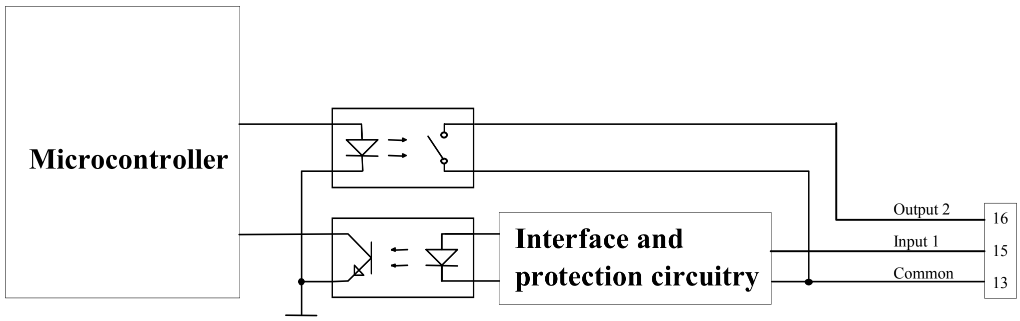


Fig. 2-21 Block diagram for 1 input and 1output

The inputs consists of an optocoupler and interface circuitry towards the outside world. The microcontroller inside the meter reads the status of the inputs via the optocouplers. 2 versions exist for the input and input/output boards, one for low voltages (max 40V) and one for high voltages (max 276 V). The versions with 1 or 2 outputs handle both low and high voltages.

The input impedance on the inputs is resistive and has a resistance of 80 - 85 kΩ on the high voltage version and 8-13 kΩ on the low voltage version. An input that is not connected (left floating) is the same as having voltage "off".

The outputs consists of an optocoupler of solid state type. They are built with MOSFET-optocouplers with polarity independent outputs. The equivalent circuitry of the outputs is an ideal relay in series with a resistor of typically 40 Ω.

2.13.3 COMMUNICATION BOARDS

The DELTAplus meter can be equipped with 3 different 2-wire communication option boards:

- Lonworks

- EIB
- Meter bus (M-bus)

The Lonworks board and EIB board contains a microcontroller handling the communication towards the external bus.

The DELTAmax meter can only be equipped with the M-bus board.

For M-bus the communication is handled by the main board microcontroller and the M-bus board contains a transceiver that converts the signals to M-bus levels.

All 3 communication buses are galvanically isolated from the rest of the meter electronics.

2.14 DELTAPLUS/DELTAMAX MEASUREMENT METHODS

The metering calculation in the meter is done by the microcontroller.

The DELTAplus/DELTAmax meter exist in 3 basic versions: single phase, 2-element and 3-element meter. The formulas used when calculating the active energy is as follows:

Single phase meters: $K * U * I * \cos\varphi$. K is a calibration constant, U the voltage, I the current and φ the phase angle between the voltage and current.

2-element meters: $K1 * (U1 - U2) * I1 * \cos\varphi_1 + K2 * (U3 - U2) * I3 * \cos\varphi_2$. K1 and K2 are calibration constants, U1-U3 the phase voltages, I1 and I3 are the phase 1 and phase 3 currents and $\varphi1$ and $\varphi2$ are the phase angles between the voltage and current in each element.

3-element meters: $K1 * U1 * I1 * \cos\varphi_1 + K2 * U2 * I2 * \cos\varphi_2 + K3 * U3 * I3 * \cos\varphi_3$. K1-K3 are calibration constants, U1-U3 the phase voltages, I1-I3 the phase currents and $\varphi1$-$\varphi3$ are the phase angles between the voltage and current in each element.

The formulas for calculating the reactive energy are the same except that all $\cos\varphi$ factors are changed to $\sin\varphi$.

The DELTAplus meter only registers positive energy. If the energy is negative the register(s) for positive energy are not affected (stands still).

DELTAmax meters register both positive and negative energy in separate registers. If the energy is negative the register(s) for positive energy are not affected (stands still) and vice versa.

For more information regarding measurement methods see chapter 5.

2.15 DIMENSIONS

Below the dimensions for the direct and transformer rated meter are displayed. The 2 pictures to the left are for the transformer rated meter and the picture to the upper right is for the direct connected meter. The side view dimensions given is applicable to all types. The dimensions in the direct connector terminal block conform to the standard DIN 43857.

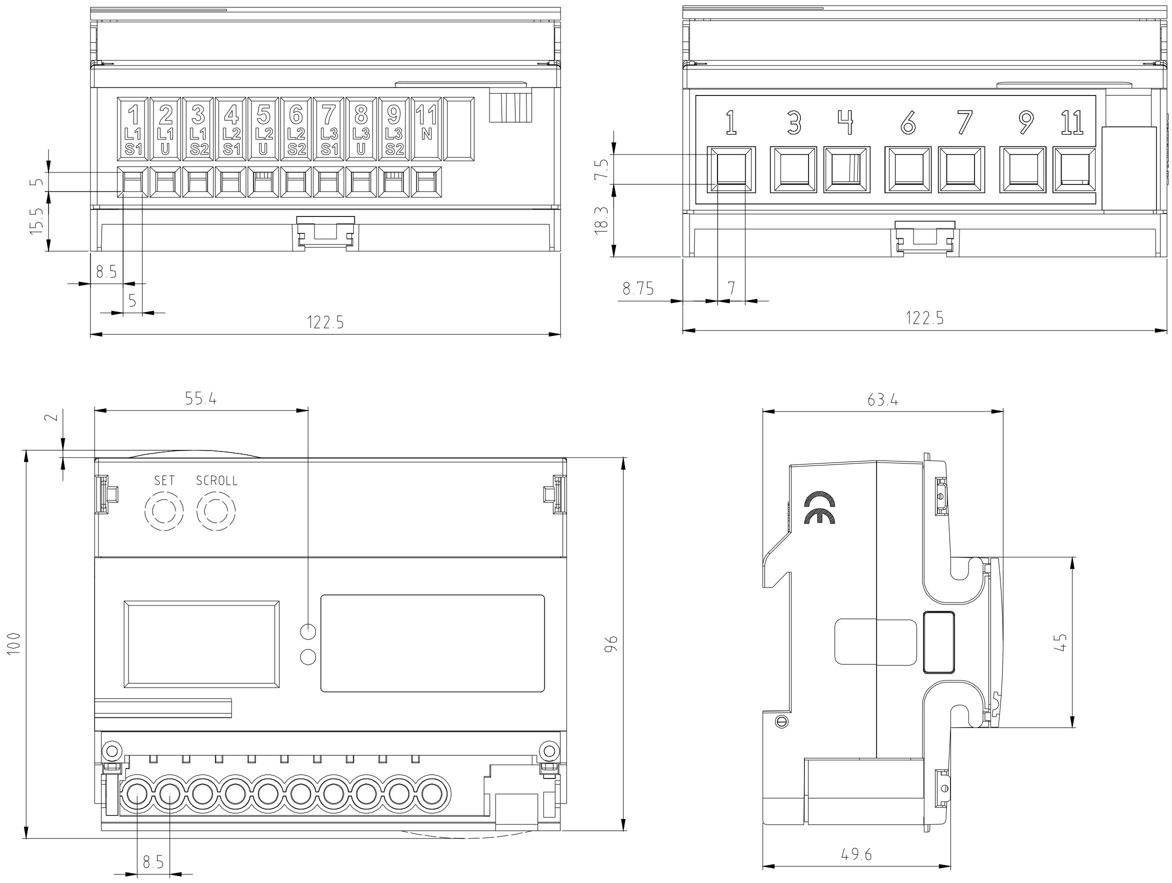


Fig. 2-22 Meter dimensions

3 TECHNICAL DATA

3.1 DIRECT CONNECTED METER

3.1.1 VOLTAGE/CURRENT INPUTS

Nominal voltage:
3 x 57-288 / 100-500 V (4-wire, 3-element)
3 x 100-500 V (3 wire, 2-element)
1 x 57-288 V (Single phase)
Voltage range: -20% to +15% of nominal voltage.
Power dissipation voltage circuits: Less than 1 VA, 1 W per phase
Power dissipation: Less than I^2 * k VA on all inputs where I is current in amperes and k is less than 0.0005 (typically 0.0003)
Base current: 5 A
Reference current: 5 A
Maximum current: 80 A
Transitional current: 0.5 A
Minimum current: 0.25 A
Starting current: < 20 mA
Terminal wire area: 1.0 - 25 mm^2
Recommended tightening torque: 2.5 Nm

3.1.2 GENERAL DATA

Frequency: 50/60 Hz ± 5%
Accuracy: According to IEC 62053-21 Cl. 2 or Cl. 1 for active energy,
According to IEC 62053-23 Cl. 2 for reactive energy,
In MID approved meters according to MID class A or B
Display of energy: LCD with 7 digits, height 7 mm

3.1.3 MECHANICAL DATA AND TESTS

Material: Polycarbonate in transparent front glass, bottom case, upper case and terminal cover. Glass reinforced polycarbonate in terminal block.
Protection class: II
Glow wire test according to IEC 695-2-1
Dust and water protection acc. to IEC 60529 protection class IP51 mounted in protective enclosure
IP20 on terminal block without protective enclosure
Weight: 0.338 kg

3.1.4 ENVIRONMENT DATA AND TESTS

Operating temperature range: -40°C to +55°C
Storage temperature range: -40°C to +70°C
Humidity: 75% yearly average, 95% on 30 days/year
Resistance to heat and fire: Terminal 960°C, cover 650°C (IEC 60695-2-1)

3.1.5 PULSE OUTPUT (STANDARD ON ALL METERS EXCEPT LON, MBUS)

Current: 0 - 100 mA
Voltage: 0 - 247 V AC, 350 V DC (polarity independent)
Terminal wire area: 0 - 2.5 mm^2 (except combined meters 0 – 0.5 mm^2)
Pulse output freq: Programmable
Pulse width: 100 ms as standard
Recommended tightening torque: 0.5 Nm

3.1.6 VISIBLE PULSE INDICATOR

Red LED with frequency 1000 imp/kWh

Pulse width: 40 ms

3.1.7 STANDARDS

IEC 62052-11, IEC 62053-21 class 1 & 2, IEC 62053-23 class 2
IEC 62054-21
Measurement instrument directive (MID), category A & B, electrical environmental class E2 and electrical environmental class M2
EN 50470-1, EN 50470-3 category A & B
Pulse output according to IEC 62053-31 (S0, DIN 43864)

3.1.8 ELECTROMAGNETIC COMPATIBILITY (EMC) AND INSULATION PROPERTIES

According to IEC 62052-11, IEC 62053-21 and IEC 62053-23:
Impulse voltage test: 6 kV 1.2/50μs (IEC 600-60).
Surge voltage test: 4 kV 1.2/50μs (IEC 61000-4-5).
Fast transient burst test: 4 kV (IEC 61000-4-4).
Immunity to electromagnetic HF-Fields: 80 MHz - 2 GHz at 10 V/m (IEC61000-4-3)
Immunity to conducted disturbance: 150kHz – 80MHz (IEC 61000-4-6)
Radio frequency emission according to CISPR 22 class B
Electrostatic discharge (ESD): 15 kV for (IEC 61000-4-2).

3.2 TRANSFORMER RATED METER

3.2.1 VOLTAGE INPUTS

Nominal voltage:
3 x 57-288 / 100-500 V (4-wire, 3-element)
3 x 100-500 V (3 wire, 2-element)
1 x 57-288 V (Single phase)
Voltage range: -20% to +15% of nominal voltage.
Power dissipation: Less than 1 VA, 1 W per phase
Terminal wire area: 0.5 - 6 mm^2
Recommended tightening torque: 2 Nm

3.2.2 CURRENT INPUTS

Rated current: 1 A
Reference current: 1 A
Maximum current: 6 A
Transitional current: 0.05 A
Minimum current: 0.02 A
Starting current: < 2 mA
Power dissipation: $< I^2 * k$ VA on all inputs where I is current in amperes and k is less than 0.002
Terminal wire area: 0.5 - 10 mm^2
Recommended tightening torque: 2 Nm

3.2.3 GENERAL DATA

Frequency: 50/60 Hz ± 5%
Accuracy: According to IEC 62053-21 Cl. 1 for active energy,
According to IEC 62053-23 Cl. 2 for reactive energy, ,
In MID approved meters according to MID class A or B
Display of energy: LCD with 7 digits, height 7 mm.

3.2.4 MECHANICAL DATA AND TESTS

Material: Polycarbonate in transparent front glass, bottom case, upper case and terminal cover. Glass reinforced polycarbonate in terminal block.
Protection class: II
Glow wire test according to IEC 695-2-1
Dust and water protection acc. to IEC 60529 protection class IP51 mounted in protective enclosure

IP20 on terminal block without protective enclosure
Weight: 0.304 kg

3.2.5 ENVIRONMENT DATA AND TESTS

Operating temperature range: -40°C to +55°C
Storage temperature range: -40°C to +70°C
Humidity: 75% yearly average, 95% on 30 days/year
Resistance to heat and fire: Terminal 960°C, cover 650°C (IEC 60695-2-1)

3.2.6 PULSE OUTPUT (STANDARD ON ALL METERS EXCEPT LON, MBUS)

Current: 0 - 100 mA
Voltage: 0 - 247 V AC, 350 V DC (polarity independent)
Terminal wire area: 0 - 2.5 mm^2 (except Combined meters 0 – 0.5 mm^2)
Pulse output freq: programmable (primary registering)
Pulse width: 100 ms as standard
Recommended tightening torque: 0.5 Nm

3.2.7 TRANSFORMER RATIOS

Programmable voltage ratio (VT): 1 - 9999
Programmable current ratio (CT): 1 – 9999
Max total transformer ratio (VT * CT): 999999

3.2.8 VISIBLE PULSE INDICATOR

Red LED with frequency 5000 imp/kWh (secondary registering)
Pulse width: 40 ms

3.2.9 STANDARDS

IEC 62052-11, IEC 62053-21 class 1, IEC 62053-23 class 2
IEC 62054-21
Measurement instrument directive (MID), category A & B, electrical environmental class E2 and electrical environmental class M2
EN 50470-1, EN 50470-3 category A & B
Pulse output according to IEC 62053-31 (S0, DIN 43864)

3.2.10 ELECTROMAGNETIC COMPATIBILITY (EMC) AND INSULATION PROPERTIES

According to IEC 62052-11, IEC 62053-21 and IEC 62053-23:
Impulse voltage test: 6 kV 1.2/50µs (IEC 600-60).
Surge voltage test: 4 kV 1.2/50µs (IEC 61000-4-5).
Fast transient burst test: 4 kV (IEC 61000-4-4).
Immunity to electromagnetic HF-Fields: 80 MHz - 2 GHz at 10 V/m (IEC61000-4-3)
Immunity to conducted disturbance: 150kHz – 80MHz (IEC 61000-4-6)
Radio frequency emission according to CISPR 22 class B
Electrostatic discharge (ESD): 15 kV for (IEC 61000-4-2).

3.3 OPTIONS

3.3.1 INPUTS

Max. Wire size: 2.5 mm^2
Data for low voltage inputs:

Voltage range 0 – 40 V AC/DC.
0 V to 2 V is interpreted as "off ".
4.5 V to 40 V is interpreted as "on".
Input resistance: 8 - 13 kΩ.
Power consumption: Less than U * U / 8000 where U is voltage in volts.
Minimum pulse length and pause: 30 ms

Data for high voltage inputs:
Voltage range 0 – 276 V AC/DC.
0 V to 20 V AC/DC is interpreted as "off ".
45 V to 276 V AC/DC is interpreted as "on".
Input resistance: 80 - 85 kΩ.
Power consumption: Less than U * U / 80000 where U is voltage in volts.
Minimum pulse length and pause: 30 ms

3.3.2 OUTPUTS

Data for low voltage outputs:
Voltage range 0 – 40 V DC/AC.
Output resistance: 12 – 25 Ω
Maximum current: 100 mA.
Data for high voltage outputs:
Voltage range 0 – 400 V DC, 0 - 282 V AC.
Output resistance: 30 - 55 Ω
Maximum current: 100 mA.

3.3.3 INTERNAL CLOCK

Data for internal clock:

- Approved according to IEC 62052-11 which contains general requirements for electricity meters and time switches and IEC 62054-21 which contains particular requirements for time switches.
- Accuracy specified in IEC 62054-21: Time error less than 5 ppm (less than 0.5 second error per day) at reference temperature (25 degrees centigrade).
- Backup by super capacitor with backup time more than 3 days. Typical backup time at room temperature is 7 days.

4 INSTALLATION

WARNING! The voltages connected to the DELTAplus/DELTAmax meter are dangerous and can be lethal. Therefore all voltages must be switched off when installing the DELTAplus/DELTAmax meter.

4.1 MOUNTING

The DELTAplus/DELTAmax meter can be mounted in different ways.
We will guide you through the ways you can mount your DELTAplus/DELTAmax meter.

For some of the mounting modes you need additional accessories (for part numbers see chapter 7).

4.1.1 DIN-RAIL MOUNTED

The DELTAplus/DELTAmax meter is aimed to be mounted on a DIN-rail designed according to the standard DIN 50022. In this case no extra accessories are needed and the meter is fastened on the rail so that the (black) plastic snap piece on the back of the meter snaps onto the rail.

4.1.2 WALL MOUNTED

The recommended way to mount the meter on a wall is to mount a separate DIN rail (see picture below) on the wall and mount the meter on this.

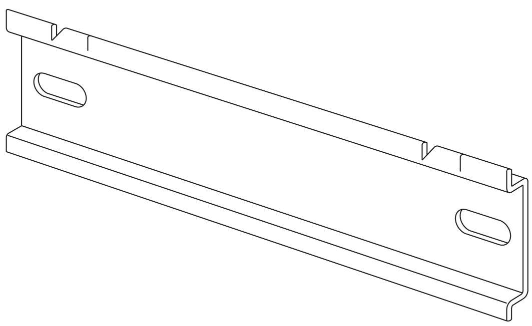


Fig. 4-1 DIN-rail used for wall mounting

When the DELTAplus/DELTAmax meter is wall mounted a long cover is sometimes needed, see figure below

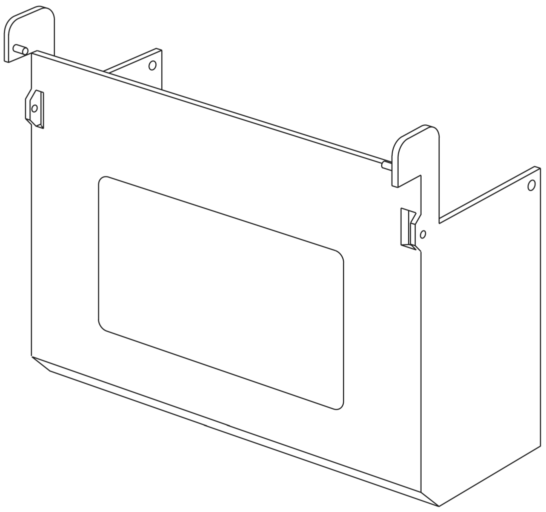


Fig. 4-2 Long cover

4.1.3 FLUSH MOUNTED

To flush-mount the meter a flush-mount kit is used, see figure below.

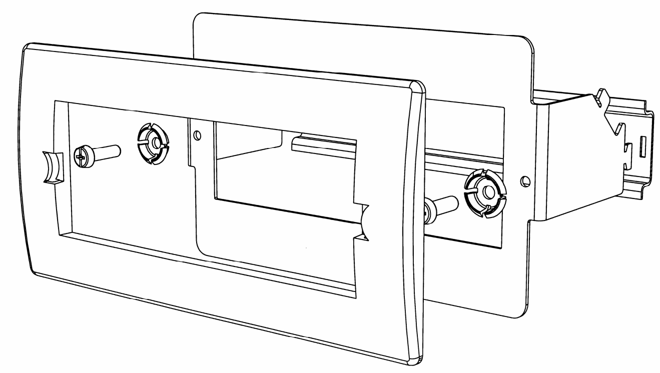


Fig. 4-3 Flush-mount kit

4.2 WIRING DIAGRAMS

Below is described how to connect the different types of DELTAplus/DELTAmax meters to your electricity network. The terminal numbers given in the pictures are also marked in the plastic on the terimal block of the meter.

The DELTAplus/DELTAmax meter must always be protected by fuses on the incoming side. In order to allow the maintenance of the transformer rated DELTAplus/DELTAmax meter, it is recommended that there should be a short circuiting terminal block installed near the DELTAplus/DELTAmax meter. In transformer rated meters the DELTAplus/DELTAmax meter voltage supply must be protected by a maximum 10A fuse.

4.2.1 DIRECT CONNECTED METERS

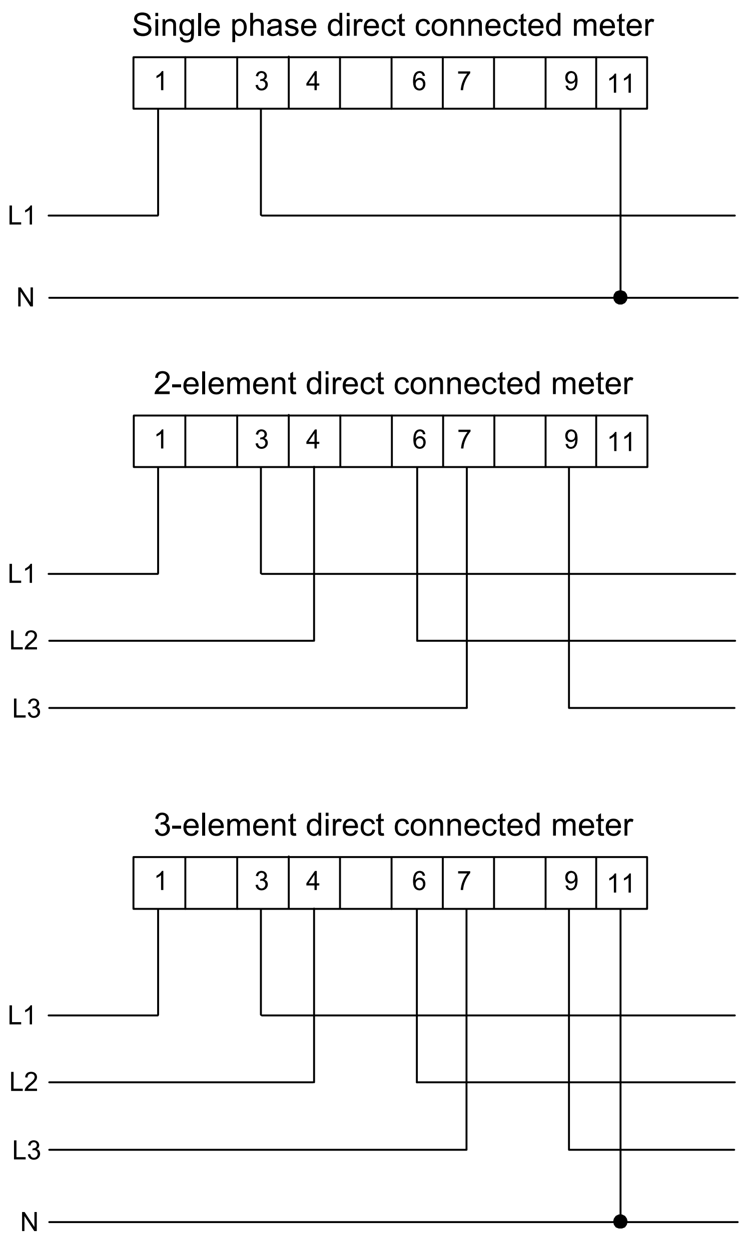
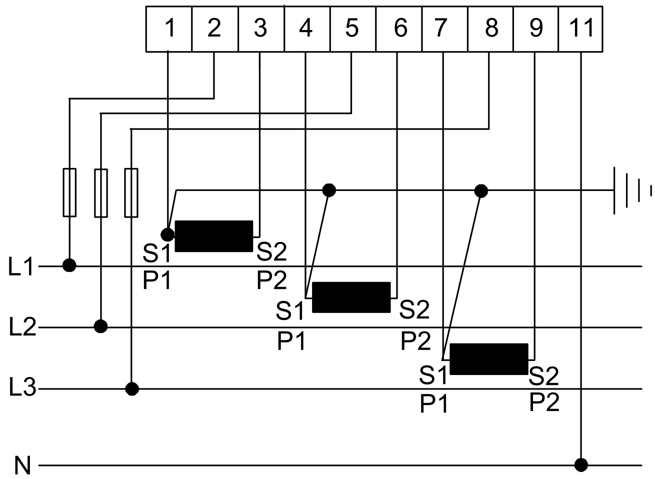


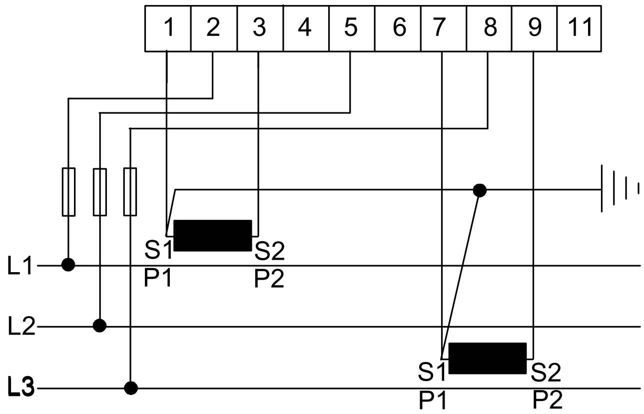
Fig. 4-4 Wiring diagrams for direct connected meters

4.2.2 TRANSFORMER RATED METERS WITHOUT VOLTAGE TRANSFORMER

3-element transformer rated meter



2-element transformer rated meter



Single phase transformer rated meter

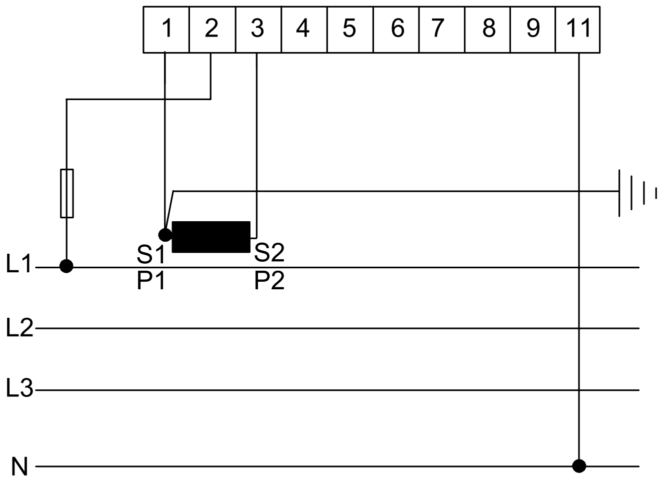


Fig. 4-5 Wiring diagrams for transformer rated meters without voltage transformers

4.2.3 TRANSFORMER RATED METER WITH VOLTAGE TRANSFORMER

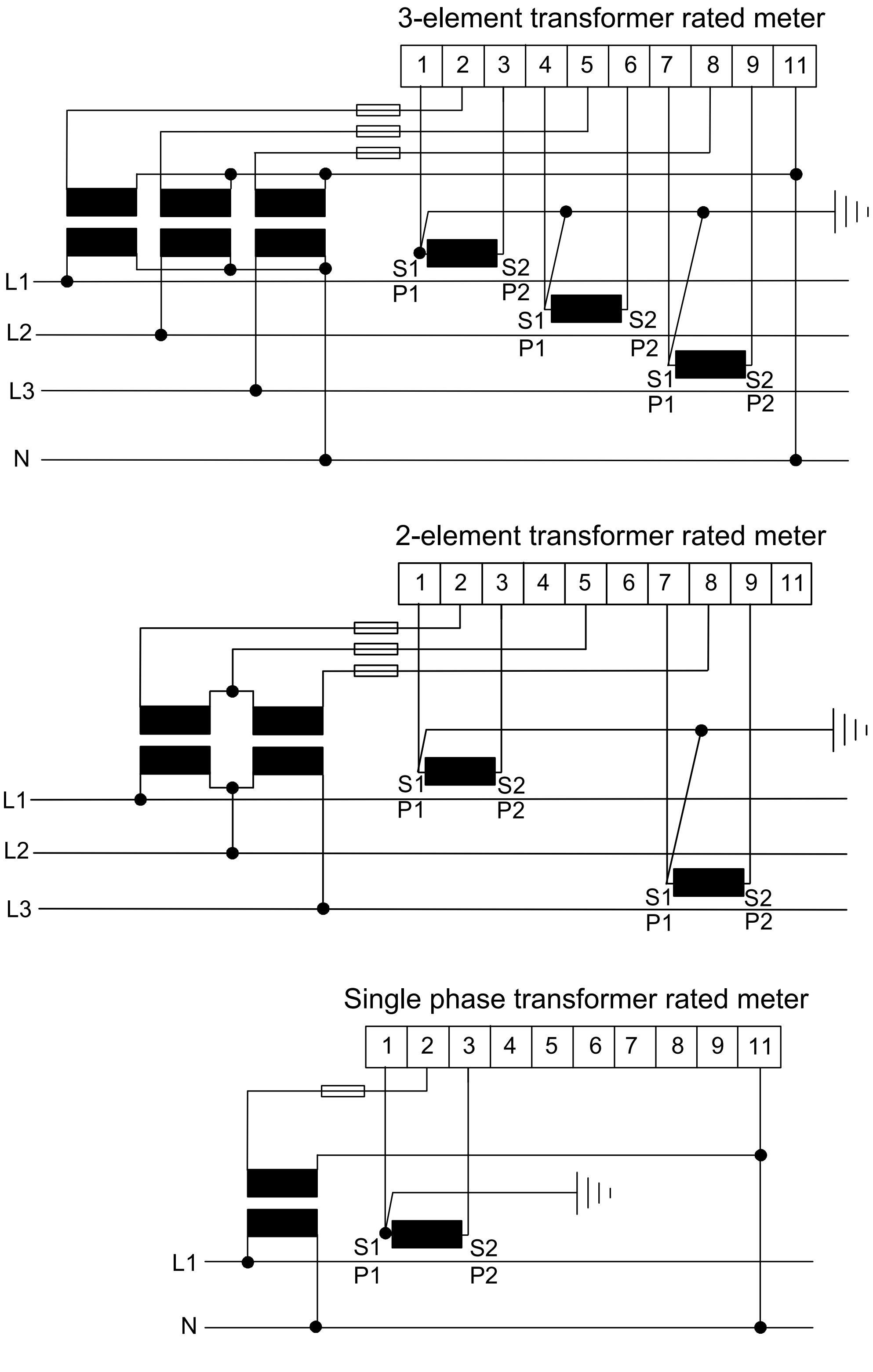


Fig. 4-6 Wiring diagrams for transformer rated meters with voltage transformers

4.2.4 INPUTS/OUTPUTS

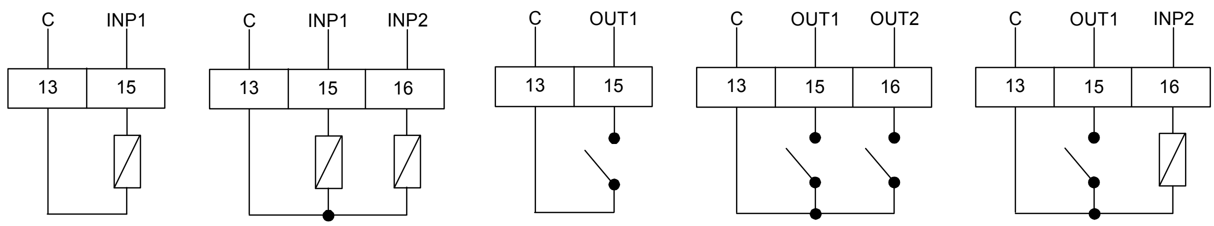


Fig. 4-7 Input/output variants.

4.2.5 TARIFF INPUTS

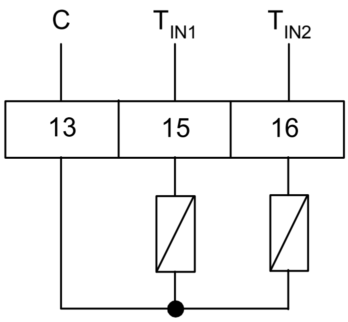


Fig. 4-8 Tariff input connection diagram

4.2.6 PULSE OUTPUTS

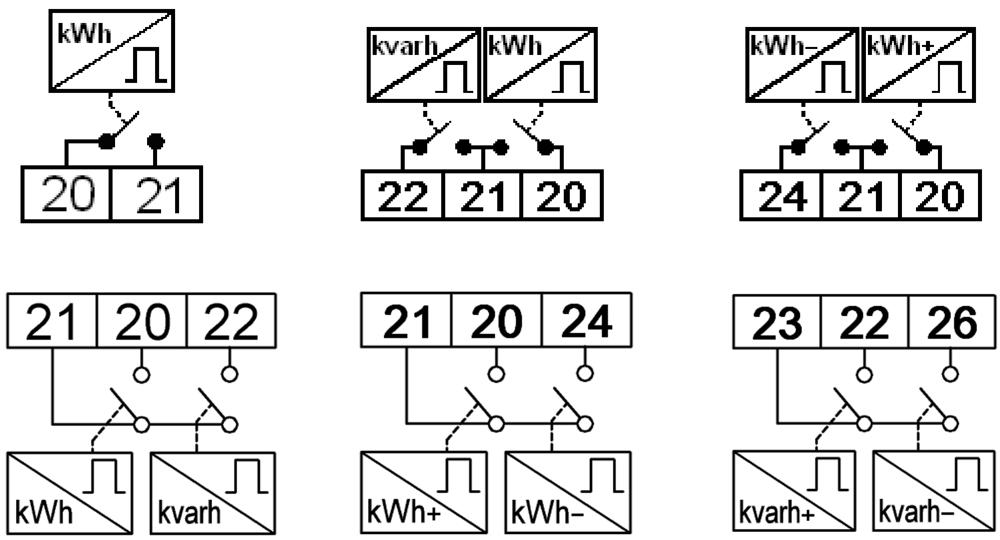


Fig. 4-9 Pulse output connection diagrams

4.2.7 COMMUNICATION

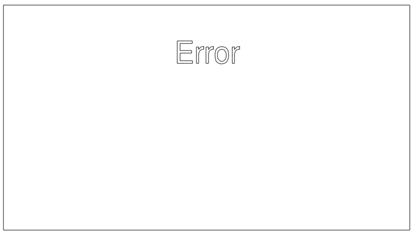
For information regarding installation of communication see chapter 6.

4.3 INSTALLATION TEST

In all DELTAplus/DELTAmax meters an automatic installation check is performed to detect an incorrect installation. The test is run automatically on a regular basis in the background (approximately every second).

The installation check is a very good aid to find and correct installation errors. However, it is still the installer that has the final responsibility that the meter is installed correctly. It should be pointed out that there are combinations of incorrect connections which fall within the normal allowed conditions and that will not be detected by the DELTAplus/DELTAmax meter. These combinations are however unusual and the check will discover a high percentage of all incorrect installations that occur in practice.

If any error is detected the ”Error” segment is displayed (and the ”OK” segment is off). If the meter detects total negative power, the arrows will rotate backwards. The error codes are read on the LCD in *Alternative Mode*.



4.3.1 TEST PROCEDURE

The tests made in the installation test are phase voltage presence and connection test and checking of the polarity of the active power. Below is a description of these tests.

4.3.1.1 Phase voltage presence test

This test is done by measuring the element voltages and comparing it against predefined thresholds. If the voltage is below this threshold it is assumed that the voltage is not present. The result of this this test is reflected on the LCD phase voltage indicators (1, 2, 3 with a ~ above; referred to with 1~, 2~, 3~ from now on), LCD "Error" segment and in the error codes (error code 100-102). A flashing 1~, 2 or, 3~ segment means the corresponding phase is low or disconnected.

4.3.1.2 Phase connected to neutral test

The meter checks if any of the phases are mixed up with the neutral. It does this by comparing the ratio of the 3 phase voltages. If any of the ratios are close to square root of 3 it signals this error. This test is only made on 3-element meters.

4.3.1.3 Power measurement

The active power is measured and the sign is checked in all DELTAplus/DELTAmax meters that measure energy in only one direction (from utility to customer, that is imported energy). Note that this check is not activated in 4-quadrant meters, as it is natural that the energy can flow in both directions in these meters. In these meters a manual check is recommended where a known load is connected and the individual element power values are inspected to be reasonable.

In 3-element meters the active power sign check is done individually on each phase as well as on the total (phase power summed together).

In 2-element meters only the total power is checked. The individual elements are not checked because having negative active power on one element can be a normal case in a 2-element meter when having a highly reactive load (power factor angle of more than 60 degrees). At the extremes of having a completely capacitive or inductive load the phase angle between voltage and current will be 120 degrees on one element. The total active power however should always be positive.

There is a lower limit of absolute power below which the negative power test is not performed: 0.2 W for transformer rated meters and 2 W for direct connected meters. This limit works individually for each test (individual phases on 3-element meters and the total on all meters). The reason for having a lower limit is to not receive erroneous results due to disturbances at very low input signals.

Thus it is necessary to insure that the power consumed (on each phase in 3-element meters and the total on all meters) is higher than this low limit when doing the installation check so that the test will be complete.

ERROR CODES

Information about the errors in the form of error-codes can be found in A*lternative Mode*. Below is a list of all the error codes together with an error description and hints of what can be the cause of the errors.

Error code	Description
100	Phase 1 voltage is missing or low
101	Phase 2 voltage is missing or low
102	Phase 3 voltage is missing or low
123	Power in phase 1 negative **Hints:** Current connections reversed. Main current flowing in the wrong direction through current transformer. Incorrect connection of phase voltages Current transformers connected to wrong current input.
124	Power in phase 2 negative **Hints:** Current connections reversed. Main current flowing in the wrong direction through current transformer. Incorrect connection of phase voltages Current transformers connected to wrong current input.
125	Power in phase 3 negative **Hints:** Current connections reversed. Main current flowing in the wrong direction through current transformer. Incorrect connection of phase voltages. Current transformers connected to wrong current input.
126	Total active power negative **Hints:** One or more current connections reversed. Main current flowing in the wrong direction through one or more current transformers. Incorrect connection of phase voltages. Current transformers connected to wrong current input.
128	Phase voltage connected to meter neutral terminal. **Hints:** Incorrect connection of phase voltages and neutral
140	Time not set. **Hints:** Set time with buttons or via communication
141	Date not set. **Hints:** Set date with buttons or via communication
200-203	Internal error. Contact supplier.

Note that all power checks (code 123-126 in case of error) are not activated in 4-quadrant meters.

5 MEASUREMENT METHODS

There are a lot of different ways to measure energy. This chapter contains information about measurement theory and the most common measurement methods. It can be used to understand the meter behavior better and to pick the correct measurement method with respect to cost and accuracy.

For information about the specific internal measurement methods used in the different DELTAplus/DELTAmax meters see chapter 2.

In many households a single-phase connection is used and a single-phase meter can be used.

In a 3-phase system with a current-carrying neutral conductor the 3-watt meter method is needed for a correct measurement and for billing purposes this is in most cases is a requirement.

High voltage installations often have no current-carrying neutral and therefore the two-watt meter measurement method can be used.

In many cases it is desired to simplify the measurement and/or to reduce the cost. In these cases simplified methods can be used of which the most common methods are mentioned below. These methods most often require a balanced load, which means that the impedance is the same in all phases giving the same current amplitude and phase angle in all phases. It should be mentioned that even if the load is perfectly balanced the accuracy will be decreased if the incoming voltages are not perfectly balanced (same voltage amplitude on all phases and exact 120 degrees phase angle between the phases).

5.1 ACTIVE AND REACTIVE POWER

Active power is needed to perform work, which is the purpose of delivering electricity. To understand the need for the utility to measure the active energy is easy, as it needs this information to bill its customer correctly. Usually the more energy the customer consumes the higher the accuracy of the meter needs to be. Normally 4 accuracy classes are used: 2%- (small consumers. e.g. households), 1%-, 0.5%- and 0.2%-meters with defined power levels for each class.

Also from a customer point of view it is easy to understand the need to measure the active energy as it can give him information about how to decrease the consumption and reduce the bill. It can also be used to distribute the internal costs within for example in industry, building complexes such as office complexes, shopping centers, airports, marinas, camping places. A further use is for distributing costs when centralized utility measuring of many households is used (block of flats, many houses with only one utility billing point) etc.

Sometimes there is also a need to measure the reactive energy. Consumer equipment often introduces a phase shift between current and voltage due to the fact that the load has a more or less reactive component, e.g. motors that have an inductive component etc. A reactive load will increase the current which means that the power source generator and the size of the power lines have to increase which in turn means higher cost for the utility. A higher current also means that the line losses increase. Because of that, the maximum permissible phase shift is sometimes governed in the terms of the consumers contract with the electricity supplier. If the consumer exceeds some specified maximum reactive load, they will be liable to an extra charge. This type of contract will require a utility meter that measures reactive energy and/or power. Also from the customer point of view it may be of big interest to measure reactive energy/power as it gives knowledge on the nature of the load; how big different loads are and how they vary in time. This knowledge can be used in the planning how to decrease the reactive power/energy to decrease the electricity bill. This can be done for example by installing compensation equipment, usually in the form of capacitor banks or distribute the load more evenly in time.

Resistive loads don't give rise to any phase shifts. Inductive loads have phase shift in one direction with the current lagging the voltage, while capacitive loads produces a phase shift in the opposite direction with the current leading the voltage, see fig. 5-1 below where the voltage and current phasor diagram is depicted for a pure resistive, inductive and capacitive load. As a result, inductive and capacitive loads can be used to compensate each other.

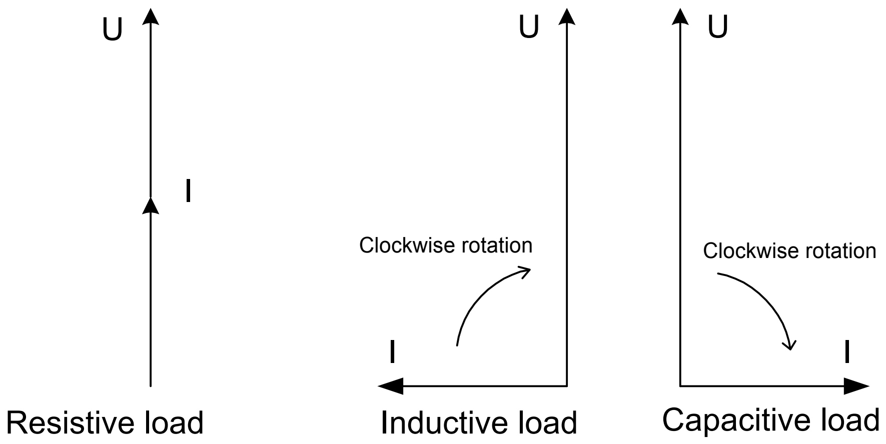


Fig. 5-1 Vector diagram for resistive, inductive and capacitive load.

A load that consumes both reactive and active energy can be divided into active and reactive components. The angle between the apparent power (U*I) vector and the active power component is described as phase displacement angle or power factor angle, often referred to as φ**,** see figure below. Cos φ is referred to as the power factor.

Active power = P = U · I · cos φ (unit W)
Reactive power = Q = U · I · cos φ (unit var)
Apparent power = S = U · I (unit VA)

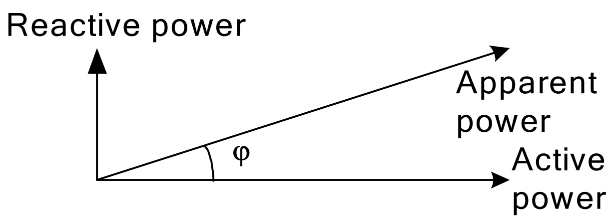


Fig. 5-2 Vector diagram for load with both active and reactive component

The type of load can be represented geometrically by 4 power quadrants, see figure below.

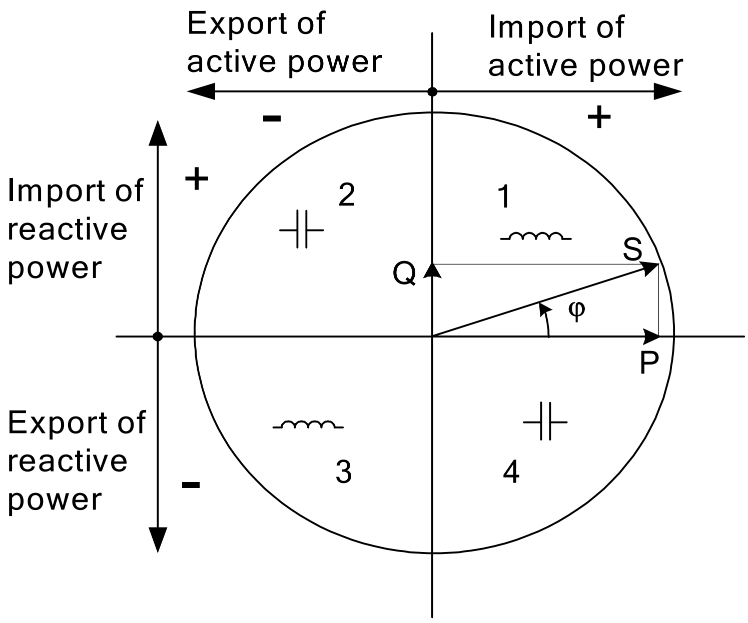
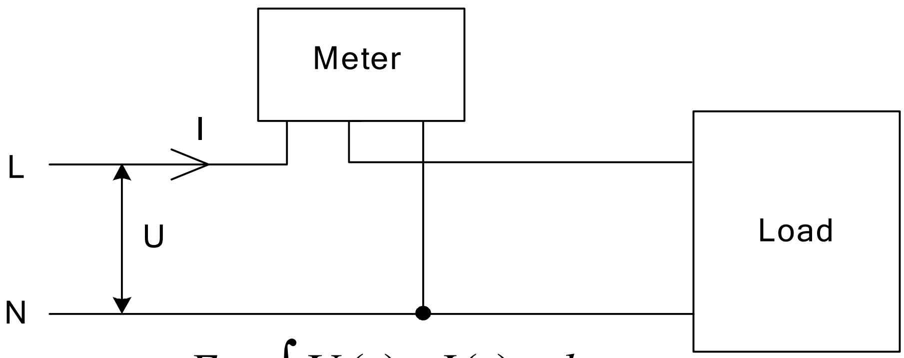


Fig. 5-3 The 4 power quadrants

In quadrant 1 the load is inductive and active and reactive energy is imported (energy delivery from utility to customer). In quadrant 2 the load is capacitive and active energy is exported and reactive energy is imported. In quadrant 3 the load is inductive and active and reactive energy is exported. In quadrant 4 the load is capacitive and active energy is imported and reactive energy exported.

5.2 SINGLE PHASE METERING

In a 2-wire installation a single-phase meter is used. Normally the 2 wires are a phase voltage and the neutral, see fig. 5-4 below where a direct connected single phase meter is measuring the active energy E consumed by a load.



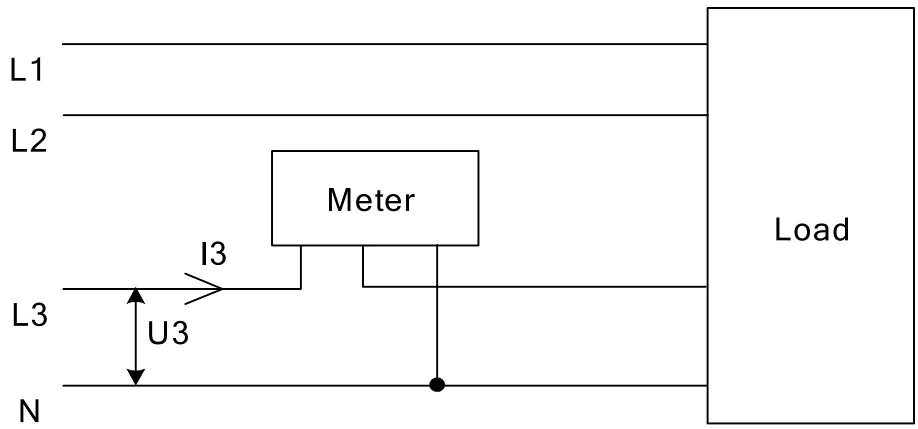
$$E = \int U(t) \bullet I(t) \bullet dt$$

Fig. 5-4 Single phase measurement.

The active energy consumed by the load is the product of momentary voltage and current integrated over the desired measuring time period, see mathematical formula above in the picture.

In the case where no harmonics is present and the rms value of the voltage and current is constant the active power can be expressed as $P = U_{rms} \bullet I_{rms} \bullet \cos\varphi$ where φ is the phase angle between the voltage and the current.

In three phase systems the single-watt meter method only gives correct results in a balanced system (same voltage, current and power factor in all phases). This method should not be used for accurate measurement but can be used when high accuracy is not needed to simplify the measurement and reduce the cost.

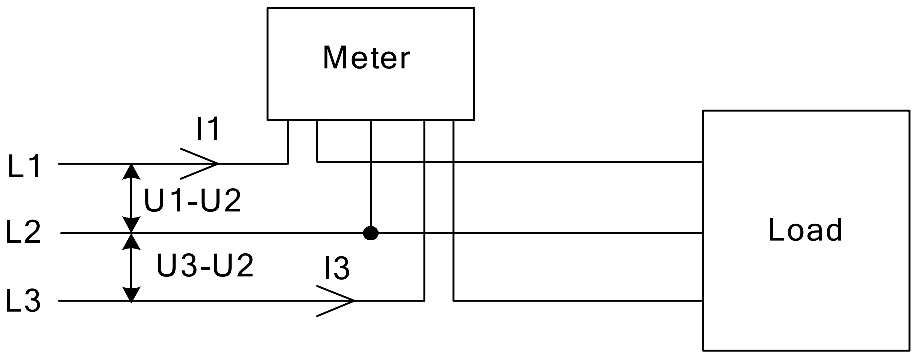


$$E = 3 \bullet \int U3(t) \bullet I3(t) \bullet dt$$

Fig. 5-5 Single phase measurement in 3-phase system.

5.3 3-PHASE 2-ELEMENT METERING

The 2-element metering method (also called two-watt meter method) is used in systems with 3 wires, normally a 3-phase system that does not have a neutral conductor, see example in figure below where a direct connected 2-element meter is measuring the active energy E consumed by a load. A 2-element meter can be used irrespectively of the load being balanced or not.



$$E = \int ((U1(t) - U2(t)) \bullet I1(t) + (U3(t) - U2(t)) \bullet I3(t)) \bullet dt$$

Fig. 5-6 2-element measurement.

In a 2-element meter the L2 voltage is used as the voltage reference and the voltage difference between that voltage and the L1 and L3 voltage are measured and multiplied by its respective current. The active energy consumed by the load is the product of momentary voltages U1-U2 and U3-U2 and the currents I1 and I2 integrated over the desired measuring time period, see mathematical formula above in the picture.

In the case where no harmonics are present and the rms values of the voltages and currents are constant the total active power can be expressed as:

Ptot = P1 + P3 = (U1-U2) x I1 x cos φ12 + (U3-U2) x I3 x cos φ32,

where φ12 is the phase angle between the (U1-U2) voltage and the I1 current and φ32 is the phase angle between the (U3-U2) voltage and the I3 current. This is illustrated below in a vector diagram which depicts the vectors for the phase voltages (U1, U2, U3), the phase currents (I1, I2, I3) and the element voltages (U1-U2, U3-U2) for a pure resistive load where the phase currents are in phase with its respective phase voltages. The phase angles between the element voltages and the current by which it is multiplied is φ32 where φ12 which for a pure resistive load is -30 and 30 degrees. If the phase voltages is 230 V and phase currents is 10 A the phase-to-phase voltages (U1-U2 and U3-U2) will be $230 \bullet \sqrt{3}$ and the power in the 2 elements will be P1= $230 \bullet \sqrt{3} \bullet 10 \bullet \cos(30) = 3450$ W and P3= $230 \bullet \sqrt{3} \bullet 10 \bullet \cos(-30) = 3450$ W.

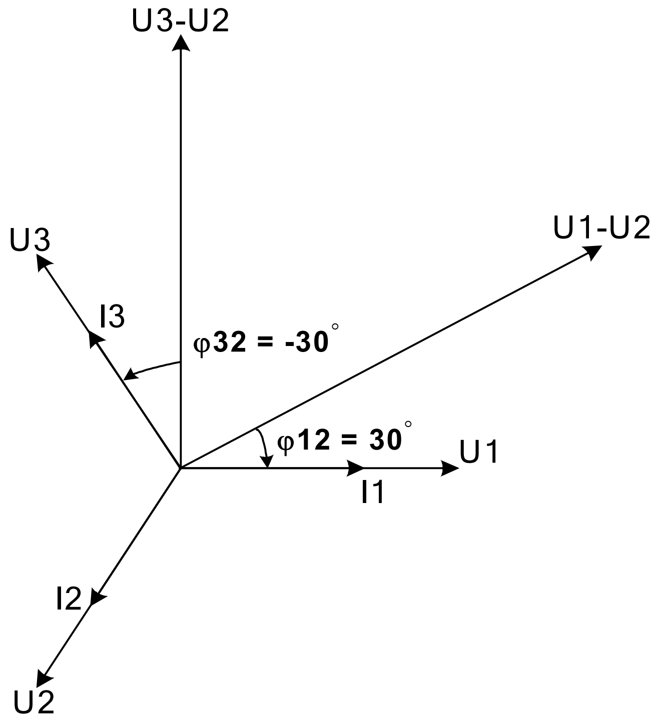


Fig. 5-7 Vector diagram for 2-element meter with pure resistive load.

Below is another example with a vector diagram for a balanced inductive load with power factor 0.95 (phase angle between voltage and current on each phase is arccos(0.95) = 18.2 degrees). The phase angles between the element voltages and the current by which it is multiplied in this case is $18.2 - 30 = -11.8$ and $30 + 18.2 = 48.2$ degrees. If the phase voltages is 230 V and phase currents is 10 A the power in the 2 elements will be P1 = $230 \bullet \sqrt{3} \bullet 10 \bullet \cos(48.2) = 2655.3$ W and P3 = $230 \bullet \sqrt{3} \bullet 10 \bullet \cos(-11.8) = 3899.5$ W resulting in a total power of $2655.3 + 3899.5 = 6554.8$ W.

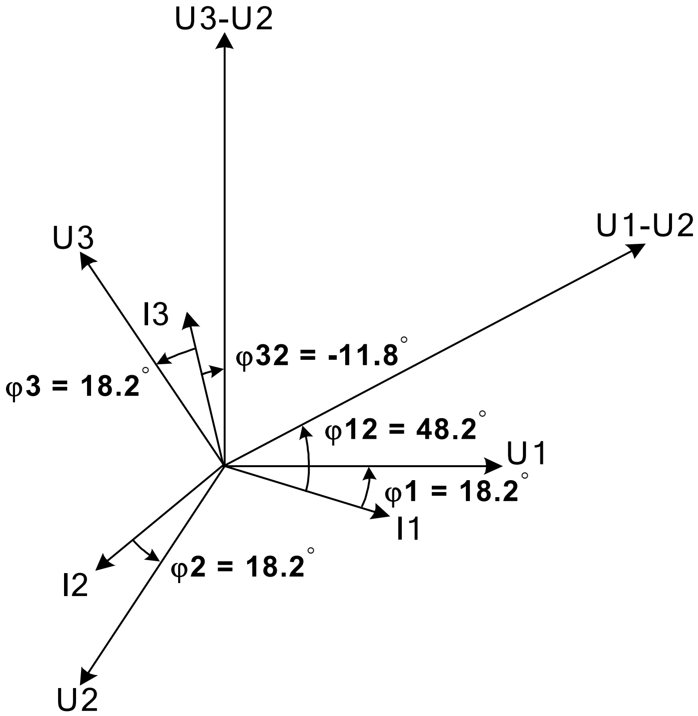


Fig. 5-8 Vector diagram for 2-element meter with a balanced inductive load with power factor 0.95.

Note that on a 2-element meter the power on one element can even be negative. This is the case for example for a balanced inductive load with power factor less than 0.5. For a balanced inductive load with power factor 0.45 (phase angle between voltage and current on each phase is arccos(0.45) = 63.3 degrees), phase voltages 225 V and phase currents 15 A the power on the 2 elements will be P1 = $225 \bullet \sqrt{3} \bullet 15 \bullet \cos(-93.3) = -336.5$ W and P3 = $225 \bullet \sqrt{3} \bullet 15 \bullet \cos(33.3) = 4885.9$ W and the total power Ptot = $-336.5 + 4885.9 = 4549.4$ W.

2-element metering can also be used in a 4-wire system under condition that the current in the neutral connection is zero. Using it in a system having a non-zero neutral current will decrease the accuracy but can sometimes be justified if the current is small compared to the line currents or if high accuracy is not required.

It is also possible to use this method measuring only one current, see figure below. This method will only give correct result in a balanced system. Note that the current flows backwards through phase 1 and 3 and that the phase voltages not are connected to the normal inputs when the current transformer is connected to phase 1 and 3.

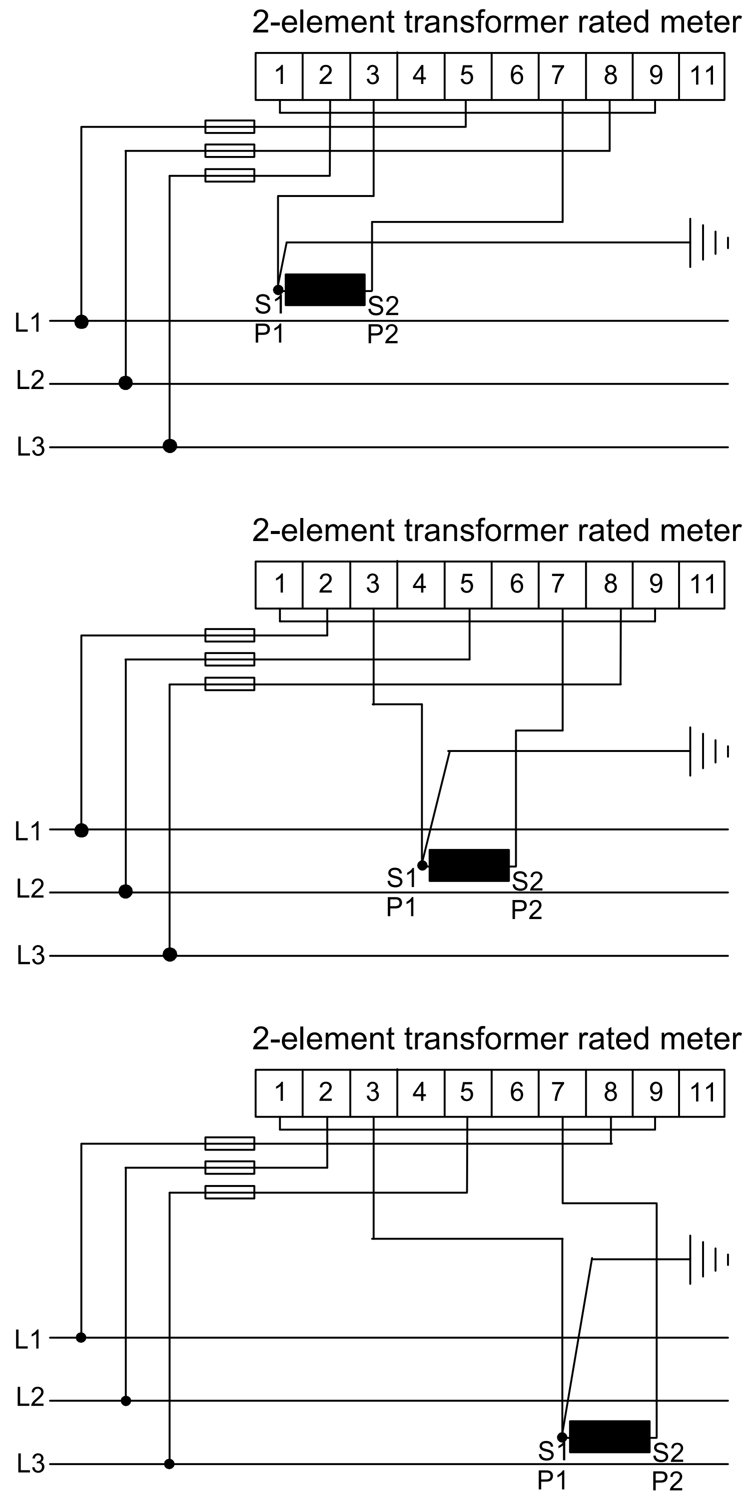
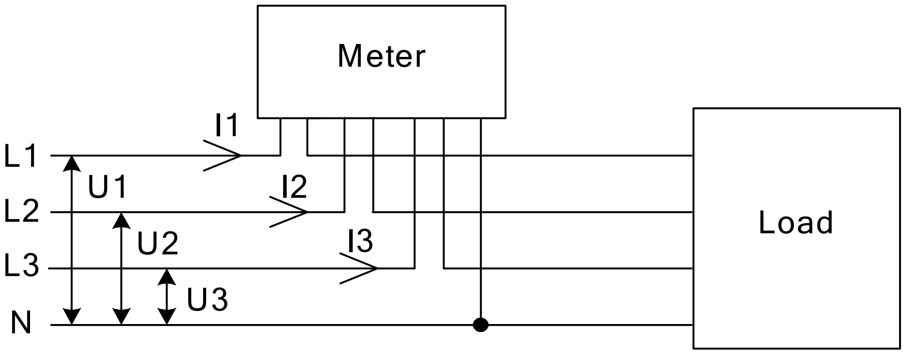


Fig. 5-9 2-element measurement with only 1 current transformer.

5.4 3-PHASE 3-ELEMENT METERING

The three-watt meter method is normally used in three phase systems having a neutral conductor, see example in figure below where a direct connected 3-element meter is measuring the active energy E consumed by a load.



$$E = \int (U1(t) \bullet I1(t) + U2(t) \bullet I2(t) + U3(t) \bullet I3(t)) \bullet dt$$

Fig. 5-10 3-element measurement.

In a 3-element meter the neutral voltage is used as the voltage reference and the voltage difference between the neutral voltage and the L1, L2 and L3 voltages are measured and multiplied by its respective current. The active energy consumed by the load is the product of momentary voltages U1, U2 and U3 and the currents I1, I2 and I3 integrated over the desired measuring time period, see mathematical formula above in the picture.

In the case where no harmonics are present and the rms values of the voltages and currents are constant the total active power can be expressed as:

$$Ptot = P1 + P2 + P3 = U1 \bullet I1 \bullet \cos \varphi 1 + U2 \bullet I2 \bullet \cos \varphi 2 + U3 \bullet I3 \bullet \cos \varphi 3,$$

where φ1, φ2 and φ3 is the phase angles between the phase voltage and its respective current.

This is illustrated below in a vector diagram which depicts the vectors for the phase voltages (U1, U2, U3) and the phase currents (I1, I2, I3) for an unbalanced load with a capacitive load with power factor 0.8 on phase 1 (phase angle between voltage and current -36.87 degrees), an inductive load with power factor 0.9 on phase 2 (phase angle between voltage and current is 25.84 degrees) and an inductive load with power factor 0.45 on phase 3 (phase angle between voltage and current is 63.26 degrees). If the phase voltages are U1=230 V, U2=228 V and U3=227 V and the phase currents are I1=8 A, I2=23 A and I3=15 A the total power will be:

$$Ptot = P1 + P2 + P3 = 230 \bullet 8 \bullet 0.8 + 228 \bullet 23 \bullet 0.9 + 227 \bullet 15 \bullet 0.45 =$$
$$1472.00 + 4719.60 + 1532.25 = 7723.85 \text{ W}$$

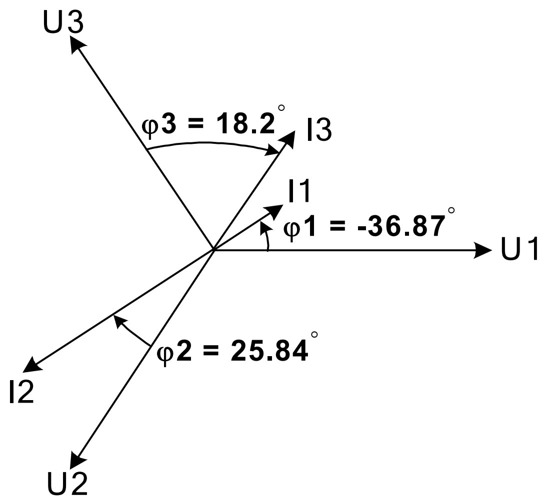


Fig. 5-11 Vector diagram for a 3-element meter with an unbalanced load.

Sometimes it is desired to use a 3-element meter without having the neutral connected, see figure below. It can be done with both transformer rated and direct connected meters.

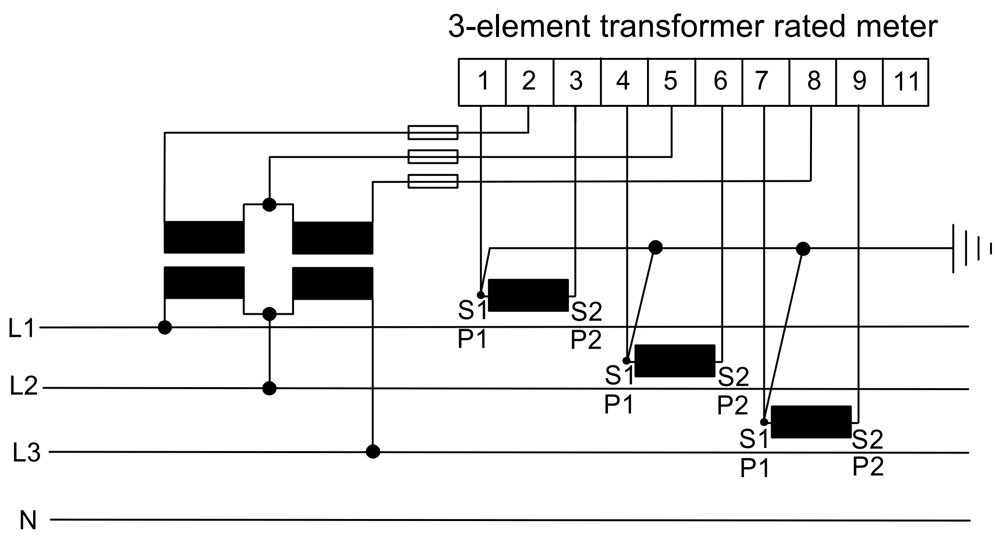


Fig. 5.12 3-element measurement without neutral connected.

This can for example be desired in cases where a voltage transformer without a neutral is being used for the moment but where a change to a voltage transformer with neutral will be made sometime in the future. To save the trouble of changing the meter at that time a 3-element meter is used from the beginning. Using a 3-element meter without having the neutral connected will decrease the accuracy due to the fact that the floating neutral connection on the meter (terminal 11) will lie at a different level than the true neutral (N) because of impedance imbalance inside the meter, resulting in the phase voltages not being correct. The imbalance error is usually however rather small (typically 0-2%) and if the currents are balanced the total error in the energy measurement will be very small, as a too small energy measurement on one element will be compensated by approximately opposite errors for the other phases.

It is also possible to use a 3-element meter with only 2 current transformers, see figures below which shows this type of connection with and without the neutral available. Note that if the current transformers are connected to protective earth it must be connected in only one point. Both methods require a balanced system (voltages and currents the same in all 3 phases). It shall also be mentioned that having a floating neutral (figure 5.10) also can give additional errors in the measured voltages due to impedance unlinearity and imbalance inside the meter.

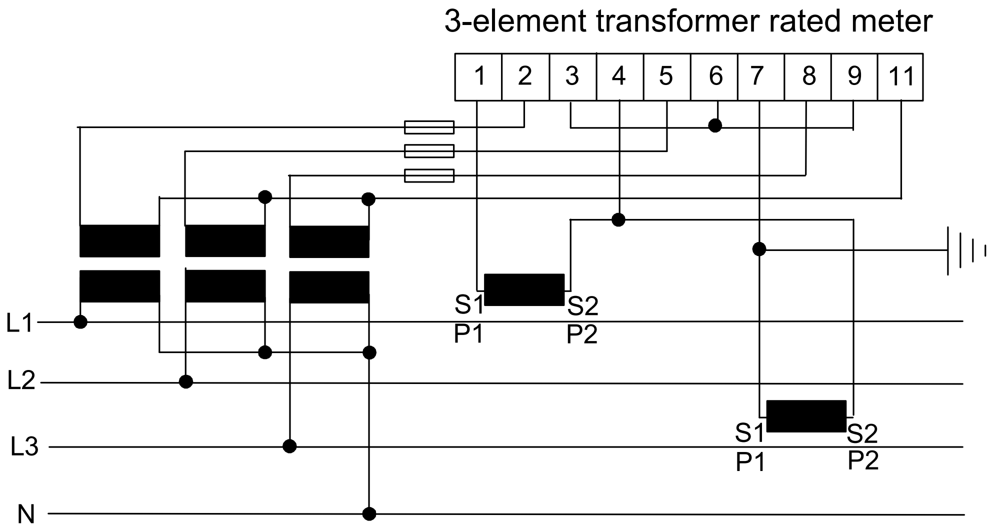


Fig. 5-13 Using a 3-element meter with 2 current transformers.

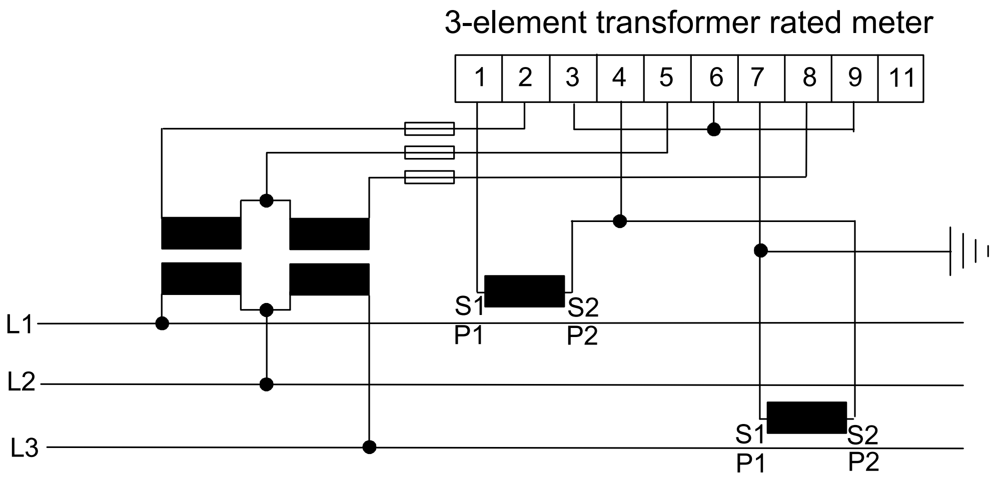


Fig. 5-14   Using a 3-element meter with 2 current transformers and floating neutral.

5.5 SUMMATION

It is possible to sum the current from several current transformers into one meter, see the example below where 2 loads are summed in a 3-element meter. It is of course also possible to use in a single phase or 2-element meter.

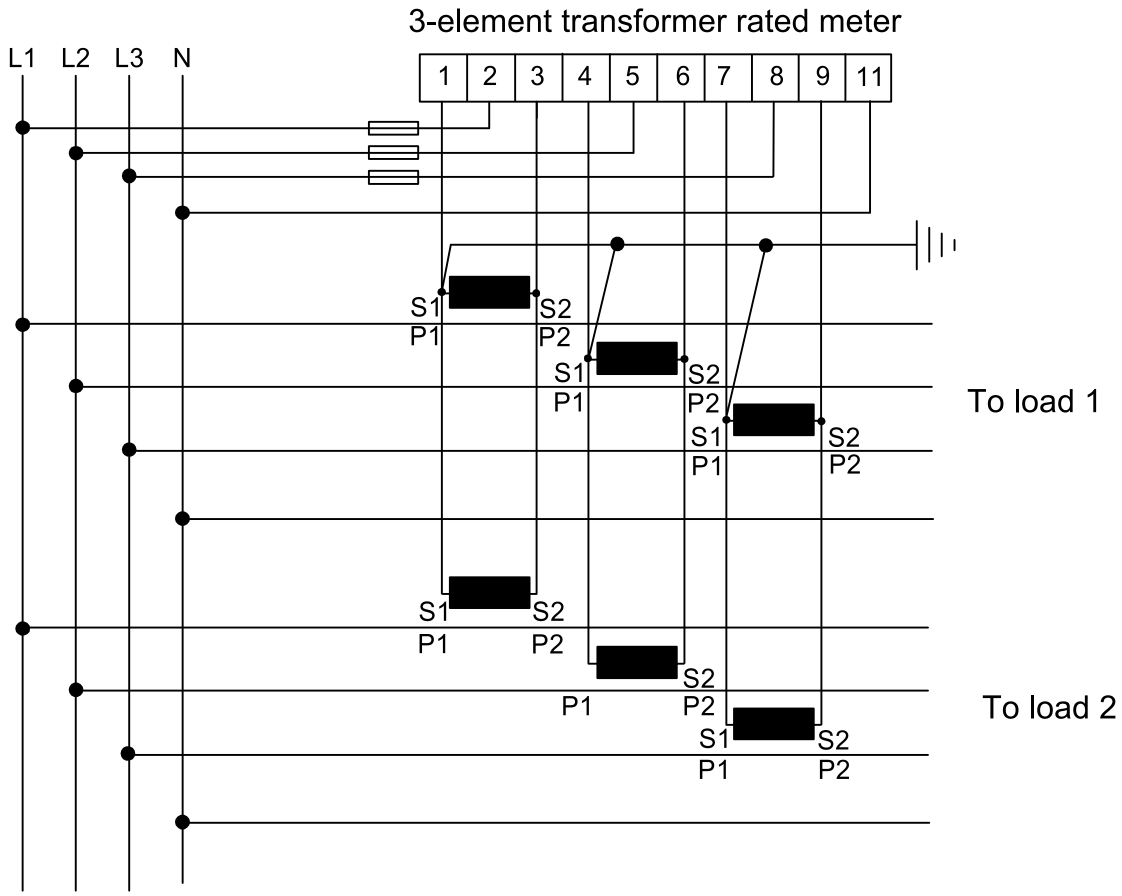


Fig. 5-15 Summation of loads.

6 COMMUNICATION

Reading a meter through a communication interface gives a number of advantages compared to manual reading:

- The time it takes to read a number of meters is much shorter. This makes it also possible to perform continuous readings.
- The risk of getting wrong values because of mistakes during manual reading is reduced to a minimum.
- The values are stored electronically, which makes it easier to process them further.

All DELTAplus/DELTAmax meters have an optical interface on the left side of the meter. For communication via the optical interface the M-Bus protocol is used.

As an option the DELTAplus/DELTAmax meter can be equipped with an interface for serial communication. Three different types are available for DELTAplus meters: M-Bus, LonWorks and EIB. For DELTAmax meters only M-bus is available. Common for the three interfaces is that they all use twisted pair cable as communication media. All meters in a network are individually addressable. The number of meters that can be connected in one network depends on the type of system and the installation.

This chapter describes the M-bus and LonWorks communication. All protocol information mentioned concerning M-bus is valid for both the optical port and the electrical M-bus interface except regarding setting of baudrate as the baudrate is fixed to 2400 baud on the optical interface.

6.1 M-BUS

The M-Bus (Meter Bus) is a bus system for the remote reading of meters. It is a master-slave system for communication on twisted pair where all meters are slaves. The M-bus protocol can also be used on other medias than twisted pair. For information regarding M-bus see also internet address www.m-bus.com.

6.1.1 COMMUNICATION OBJECTS

Register	Description
Active import energy, total	Total cumulative active imported energy
Active import energy, tariff 1	Cumulative active imported energy tariff 1
Active import energy, tariff 2	Cumulative active imported energy tariff 2
Active import energy, tariff 3	Cumulative active imported energy tariff 3
Active import energy, tariff 4	Cumulative active imported energy tariff 4
Reactive import energy, total	Total cumulative reactive imported energy
Reactive import energy, tariff 1	Cumulative reactive imported energy tariff 1
Reactive import energy, tariff 2	Cumulative reactive imported energy tariff 2
Reactive import energy, tariff 3	Cumulative reactive imported energy tariff 3
Reactive import energy, tariff 4	Cumulative reactive imported energy tariff 4
Active export energy, total	Total cumulative active exported energy
Reactive export energy, total	Total cumulative reactive exported energy
CT ratio	Current transformer ratio
VT ratio	Voltage transformer ratio
Outputs	Read and set status of outputs
Inputs, current state	Read current state of input 1 and 2
Inputs, stored state	Read and reset stored state of input 1 and 2
Inputs, counter	Read and clear input pulse counter 1 and 2
Pulse frequency	Read the pulse frequency
Current, L1	Instantaneous current in the L1 phase
Current, L2	Instantaneous current in the L2 phase
Current, L3	Instantaneous current in the L3 phase
Voltage, L1-N	Instantaneous voltage between L1 and neutral
Voltage, L2-N	Instantaneous voltage between L2 and neutral
Voltage, L3-N	Instantaneous voltage between L3 and neutral
Voltage, L1-L2	Instantaneous voltage between L1 and L2
Voltage, L2-L3	Instantaneous voltage between L3 and L2
Active Power, Total	Instantaneous total active power
Active Power, element 1	Instantaneous active power in element 1
Active Power, element 2	Instantaneous active power in element 2
Active Power, element 3	Instantaneous active power in element 3
Reactive Power, Total	Instantaneous total reactive power
Reactive Power, element 1	Instantaneous reactive power in element 1
Reactive Power, element 2	Instantaneous reactive power in element 2
Reactive Power, element 3	Instantaneous reactive power in element 3
Apparent Power, Total	Instantaneous total apparent power
Apparent Power, element 1	Instantaneous apparent power in element 1
Apparent Power, element 2	Instantaneous apparent power in element 2
Apparent Power, element 3	Instantaneous apparent power in element 3
Voltage phase angle, element 1	Instantaneous voltage phase angle for element 1 (element 1 voltage is reference)
Voltage phase angle, element 2	Instantaneous voltage phase angle for element 2 (element 1 voltage is reference)
Voltage phase angle, element 3	Instantaneous voltage phaseangle for element 3 (element 1 voltage is reference)
Current phase angle, element 1	Instantaneous current phase angle for element 1 (element 1 voltage is reference)

Register	Description
Current phase angle, element 2	Instantaneous current phase angle for element 2 (element 1 voltage is reference)
Current phase angle, element 3	Instantaneous current phase angle for element 3 (element 1 voltage is reference)
Phase angle, Total power	Instantaneous phase angle for total power
Phase angle, element 1 power	Instantaneous phase angle for element 1 power
Phase angle, element 2 power	Instantaneous phase angle for element 2 power
Installation check	Read result of and clear installation check
Current quadrant, Total	Quadrant in which the meter is measuring
Power fail counter	Read and reset power fail counter
Total power outage time	Read and reset total power outage time
Current tariff	Read and set current tariff
Manufacturer	Manufacturer information
FW-version	Firmware version
Error flags	Read error flags
Date and time	Read and set date and time
Monthly values	Read monthly values
Load profile	Read load profile data
Event log	Read event log data
Maximum demand	Read maximum demand data
Current harmonics	Read THD and harmonics on each current measured

6.1.2 PHYSICAL INTERFACE

The physical interface allows serial half-duplex asynchronous communication. Since the bus has a master-slave structure, where there must and can be only one master, the meters cannot communicate with each other.

6.1.2.1 Optical interface

The DELTAplus/DELTAmax meter has an optical interface located on the left side. Physical characteristics of the interface correspond to the standard IEC 61107. Communication speed is 2400 bps.

6.1.2.2 Optional board

As an option the DELTAplus/DELTAmax meter can be equipped with an electrical M-Bus interface. The board fulfils the M-bus standard specification with the following electrical characteristics:

Bus voltage	
Maximum permanent bus voltage	+50V
Minimum permanent bus voltage	-50V
Operating bus voltage	+-(12 - 42V)
Receive conditions	
Space (USpace)	12 - 21V
Mark (UMark)	>= USpace + 10V
Maximum space state time	50ms
Maximum space state duty cycle	0.92
Transmit conditions	
Definition: unit load (UL)	1.5mA
Current consumption at mark state (IMark)	<= 1UL
Current consumption at space state	IMark + (11 - 20mA)
Communication speed	300 - 4800 bps (default 2400)

Electrical characteristics of the M-Bus interface.

6.1.3 PROTOCOL DESCRIPTION

The M-Bus protocol is based on the international standard IEC 60870, but it doesn't use all of the specified functions.

When there is no communication on the bus it is in Mark-state.
Each communicated byte consists of eleven bits. The bits are one start-bit (space), eight data-bits, one parity bit (even) and one stop-bit (mark). The least significant bit is transmitted first.

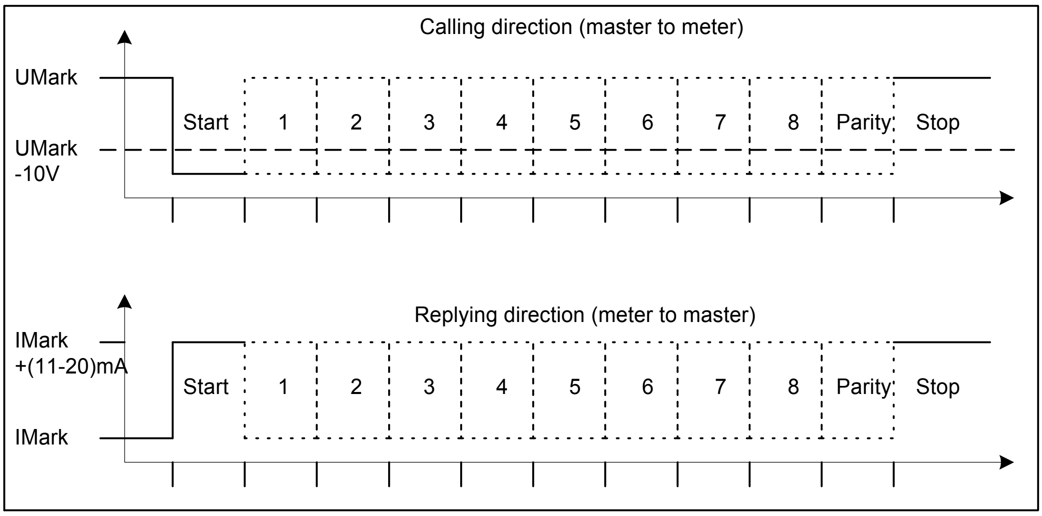


Fig. 6-1 Transmission of a Character in Calling and Replying Direction

6.1.3.1 Telegram formats

The telegram formats are structured according to format class FT1.2. The FT1.2 format fulfils the data integrity class I2, including a Hamming Distance of four. Three telegram formats are used. The start character identifies the different telegram formats.

Single Character	Short Frame	Long Frame
E5h	Start (10h)	Start (68h)
	C-field	L-field
	A-field	L-field
	Check Sum	Start (68h)
	Stop (16h)	C-field
		A-field
		CI-field
		User Data (0-252 byte)
		Check Sum
		Stop (16h)

Telegram Formats

- **Single Character** - The Single Character format consists of a single character (E5h) and is used to acknowledge received telegrams.
- **Short Frame** - The Short Frame format is identified by its start character (10h) and consists of five characters. Besides the C- and A-fields it includes the check sum and the stop character 16h.
- **Long Frame** - The Long Frame format is identified by its start character (68h) and consists of a variable number of characters. After the start character the L-field is transmitted twice, then the start character once again followed by the C-, A- and CI-fields. The user data (0 - 252 bytes) is transmitted after the CI-field followed by the check sum and the stop character (16h).

6.1.3.1.1 Field descriptions

All fields used in the telegram frames have a length of one byte (8 bits).

- Length Field (L-field)
The L-field gives the quantity of the user data inputs plus 3 (for the C-, A- and CI-fields). It is transmitted twice in telegrams using the long frame format.

- Control Field (C-field)
The C-field contains information of the direction of the data flow, error handling and
Besides labeling the functions and the actions caused by them, the control field specifies the direction of data flow, and is responsible for various additional tasks in both the calling and replying directions.

Bit number	7	6	5	4	3	2	1	0
To the meter	0	PRM	FCB	FCV	F3	F2	F1	F0
From the meter	0	PRM	0	0	F3	F2	F1	F0

Coding of the Control Field

- The primary message bit (PRM) is used to specify the direction of data flow. It is set to 1 when a telegram is sent from a master to the meter and to 0 in the other direction.
- The frame count bit valid (FCV) is set to 1 by the master to indicate that the frame count bit (FCB) is used. When the FCV is set to 0, the meter ignores the FCB.
- The FCB is used to indicate successful transmission procedures. A master shall toggle the bit after a successful reception of a reply from the meter. If the expected reply is missing, or the reception of it is faulty, the master resends the same telegram with the same FCB. The meter answers, to a REQ_UD2-request with toggled FCB and a set FCV, with a RSP_UD containing the next telegram of a multi-telegram answer. If the FCB is not toggled it will repeat the last telegram. The actual values will be updated in a repeated telegram. On receipt of a SND_NKE the meter clears the FCB. The meter uses the same FCB for primary addressing, secondary addressing and point-to-point communication.
- The bits 0 to 3 (F0, F1, F2 and F3) of the control field are the function code of the message.

Name	C-field (binary)	C-field (hex)	Telegram	Description
SND_NKE	0100 0000	40	Short Frame	Initialization of Meter
SND_UD	01F1 0011	53/73	Long Frame	Send User Data to Meter
REQ_UD2	01F1 1011	5B/7B	Short Frame	Request for Class 2 Data
RSP_UD	0000 1000	08	Long Frame	Data Transfer from Meter to Master after Request

Function Codes

- Address Field (A-field)
The address field is used to address the recipient in the calling direction, and to identify the sender of information in the receiving direction. The size of this field is one byte, and can therefore take values from 0 to 255.

- The address 0 is given to meters at manufacturing.
- The addresses 1 to 250 are given to the meters as individual primary addresses. The address can be set either via the bus (secondary addressing) or via the buttons (see 2.7.2.7). The primary address can be viewed in *Alternative Mode* and is displayed as "Adr xxx" with xxx being the primary address.
- The addresses 251 and 252 are reserved for future use.
- The address 253 (FDh) is used by the secondary addressing procedure.
- The address 254 (FEh) is used for point-to-point communication. The meter replies with its primary address.
- The address 255 (FFh) is used for broadcast transmissions to all meters. None of the meters replies to a broadcast message.

- Control Information Field (CI-field)
The CI-field codes the type and sequence of application data to be transmitted in the frame. Bit two (counting begins with bit 0, value 4), called M-bit or Mode bit, in the CI-field gives information about the

used byte sequence in multi-byte data structures. For communication with the DELTAplus/DELTAmax meter, the Mode bit shall not be set (Mode 1) meaning the least significant byte of a multi-byte record is transmitted first.

CI	Application
51h	Data send
52h	Selection of slaves
B8h	Set baud rate to 300 baud
B9h	Set baud rate to 600 baud
BAh	Set baud rate to 1200 baud
BBh	Set baud rate to 2400 baud
BCh	Set baud rate to 4800 baud
BDh	Set baud rate to 9600 baud

CI-field codes to use by the master

The meter uses code 72h in the CI-field for responses to requests for user data.

-User Data
The User Data contains the data to be sent to the recipient.

Fixed Data Header	Data Records	MDH
12 Byte	variable number of bytes	1 Byte

Structure of the User Data meter to master

Data Records
variable number of bytes

Structure of the User Data master to meter

Fixed Data Header

Identification No	Manufacturer	Version	Medium	Access No	Status	Signature
4 Byte	2 Byte	1 Byte	1 Byte	1 Byte	1 Byte	2 Byte

Structure of the Fixed Data Header

- **Identification Number** is the 8-digit serial number of the meter (BCD coded).
- **Manufacturer** is set to 0442h meaning ABB.
- **Version** specifies the version of the protocol implementation. Different protocol versions exist for DELTAplus/DELTAmax meters: 2, 5, 6 and 8. Differences exist between the different versions. Note however that even though a function is supported in firmware it may be disabled in part.icular meter types. Major differences between protocol versions:
  -Time and most time dependant functions are supported in protocol version bigger than or equal to 5.
  - Exported energy and current harmonic measurement are supported only in protocol version bigger than or equal to 8.
- **Medium** byte is set to 02h to indicate electricity.
- **Access Number** is a counter that counts successful accesses.
- **Status** byte is used to indicate the meter status:

Bit	Meaning
0	Meter busy
1	Internal error
2	Power low
3	Permanent error
4	Temporary error
5	Installation error (DELTAplus/DELTAmax meter specific)
6	NOT USED
7	NOT USED

- **Signature** is set to 00 00h.

Data Records

The data, together with information regarding coding, length and the type of data is transmitted in data records. The maximum total length of the data records is 234 bytes.

Data Record Header (DRH)				Data
Data Information Block (DIB)		Value Information Block (VIB)		
DIF	DIFE	VIF	VIFE	
1 Byte	0-10 Bytes	1 Byte	0-10 Bytes	0-n Bytes

Structure of a Data Record (transmitted from left to right)

Each Data record consists of a data record header (DRH) and the actual data. The DRH in turn consists of the data information block (DIB) to describe the length, type and coding of the data, and the value information block (VIB) to give the value of the unit and the multiplier.

Data Information Block (DIB)

The DIB contains at least one byte (Data Information Field, DIF), and is in some cases expanded with, a maximum of 10, DIFE's (Data Information Field Extension).

Bit 7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Extension Bit	LSB of storage number	Function Field		Data Field : Length and coding of data			

Structure of the Data Information Field (DIF)

- The **Extension Bit** is set when next byte is a DIFE.
- The **LSB of storage number** is normally set to 0 to indicate actual value. (1 = stored value)
- The **Function Field** is set to 00 for instantaneous values and 01 for maximum values.
- The **Data Field** shows the format of the data:

Code	**Meaning**	**Length in Byte**
0000	No data	0
0001	8 Bit Integer	1
0010	16 Bit Integer	2
0100	32 Bit Integer	4
0111	64 Bit Integer	8
1010	4 digit BCD	2
1011	6 digit BCD	3
1100	8 digit BCD	4
1101	Variable length (ASCII)	Variable
1110	12 digit BCD	6

Coding of the Data Field

- The **Extension Bit** is set when next byte is a DIFE:

Bit 7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Extension Bit	Unit	Tariff		Storage Number			

Structure of the Data Information Field Extension (DIFE)

- **Unit** is used on power and energy values to tell what type of power/energy the data is. It is also used to define the number of inputs/outputs and to specify sign of offset when accessing event log data

- **Tariff** is used on energy values to give tariff information. (0 = Total, 1-4 = Tariff 1-4)
- **Storage Number** is set to 0 in values read to indicate momentary values and storage number bigger than 0 to indicate previously stored values (values stored at some timepoint in the past)

Value Information Block (VIB)

The VIB follows a DIF or DIFE without a set extension bit. It contains one Value Information Field (VIF) and is in some cases expanded with up to 10, Value Information Field Extensions (VIFE).

Bit 7	6	5	4	3	2	1	0
Extension Bit	Value Information						

Structure of the Value Information Field (VIF)

Value Information contains information about the value (unit, status etc).
The Extension Bit is set when next byte is a VIFE.

In case VIF or VIFE = FFh the next VIFE is manufacturer specific. The manufacturer specific VIFE has the same construction as a VIF. If the extension bit of the manufacturer specific VIFE is set, and the VIFE is less than 1111 1000, the next byte is a standard VIFE, otherwise it is the first data byte. If the extension bit of the manufacturer specific VIFE is set and the VIFE is bigger or equal to 1111 1000, the next byte is an extension of manufacturer specific VIFE's.

VIF-Code	Description	Range Coding	Range
E000 0nnn	Energy	$10^{(nnn-3)}$ Wh	0.001Wh to 10000Wh
E010 1nnn	Power	$10^{(nnn-3)}$ W	0.001W to 10000W
E010 00nn	On time (duration)	nn = 00 seconds nn = 01 minutes nn = 10 hours nn = 11 days	
E110 110n	Time point	n = 0: date n = 1: time & date	Data type G Data type F or 6 byte bcd coding
E111 1000	Fabrication No		00000000 to 99999999
E111 1010	Bus Address		0 to 250
1111 1011	Extension of VIF-codes		Not used by the DELTAplus/DELTAmax meter
1111 1101	Extension of VIF-codes		True VIF is given in the first VIFE and is coded using Table FD
1111 1111	Manufacturer Specific		Next VIFE is manufacturer specific

Codes for Value Information Field (VIF)

Codes for Value Information Field Extension (VIFE) used with extension indicator FDh
If the VIF contains the extension indicator FDh the true VIF is contained in the first VIFE.

VIFE-Code	Description
E000 1010	Manufacturer
E000 1100	Version
E000 1110	Firmware Version
E001 0111	Error Flags (binary)
E001 1010	Digital Output (binary)
E001 1011	Digital Input (binary)
E001 1100	Baud rate
E010 01nn	Interval length, 00 : seconds, 01 : minutes), 10 : hours, 11 : days
E100 nnnn	10^{nnnn-9} Volts

E101 nnnn	10nnnn-12 A
E110 0001	Cumulating Counter
E001 0110	Password

Table FD

Codes for Value Information Field Extension (VIFE)
The following values for VIFE's are defined for an enhancement of VIF's other than FDh and FBh:

VIFE-Code	Description
E010 0111	per measurement (interval)
E010 0111	per measurement (interval)
E010 0111	per measurement (interval)
E011 1001	Start date(/time) of
E110 1f1b	Date (/time) of, b = 0 : end of, b = 1 : begin of , f is not used in meter, always 0
1111 1111	Next VIFE is manufacturer specific

Manufacturer specific VIFE-Codes

VIFE-Code	Description
E000 0000	Total
E000 0001	L1
E000 0010	L2
E000 0011	L3
E000 0101	L1 – L2
E000 0110	L3 – L2
E001 0000	Pulse frequency
E001 0010	Transformer ratio (CT * VT)
E001 0011	Tariff
E001 0100	Installation check
E001 0101	Status of values
E001 0111	Current quadrant
E001 1000	Power fail counter
E100 0nnn	Phase angle voltage (degrees $*10^{nnn-3}$)
E100 1nnn	Phase angle current (degrees $*10^{nnn-3}$)
E101 0nnn	Phase angle power (degrees $*10^{nnn-3}$)
E101 1nnn	Frequency (Hz $*10^{nnn-3}$)
E110 0nnn	Power factor ($*10^{nnn-3}$)
E110 1000	Current Transformer ratio (CT ratio)
E110 1001	Voltage Transformer ratio (VT ratio)
E110 1010	Change communication write access level
E110 1011	Change primary time source for internal clock
E110 1100	Total power outage time
E110 1111	Event type
E111 0000	Measurement period
E111 1000	Extension of manufacturer specific vife's, next vife(s) used for numbering
E111 1001	Extension of manufacturer specific vife's, next vife(s) specifies actual meaning
E111 1110	Extension of manufacturer specific vife's, next vife(s) used for manufacturer specific record errors/status

VIFE-Codes for reports of record errors (meter to master)

VIFE-Code	Type of Record Error	Error Group
E000 0000	None	
E001 0101	No data available (undefined value)	
E001 1000	Data error	Data Errors

VIFE-Codes for object actions (master to meter)

VIFE-Code	Action	Description
E000 0111	Clear	Set data to zero
E000 1011	Freeze data	Freeze data to storage number

2:nd manufacturer specific VIFE followed after VIFE 1111 1000 (F8 hex):

VIFE-Code	Description
Ennn nnnn	Used for numbering (0-127)

2:nd manufacturer specific VIFE followed after VIFE 1111 1001 (F9 hex):

VIFE-Code	Description
E000 0001	DST, day of week, day type, season
E000 0010	Quantity specification of maximum demand
E000 0011	Quantity specification of previous values
E000 0100	Quantity specification of load profile
E000 0101	Quantity specification of event log
E000 0110	Tariff source
E000 0111	LCD error suppress mask
E001 0000	Readout request of active imported energy load profile in format energy register values at end of intervals
E001 0001	Readout request of active imported energy load profile in format energy consumption per interval
E001 0010	Rreadout request of reactive imported energy load profile in format energy register values at end of intervals
E001 0011	Readout request of reactive imported energy load profile in format energy consumption per interval
E001 0100	Readout request of input 1 counter load profile profile in format counter register values at end of intervals
E001 0101	Readout request of input 1 counter load profile in format number of counts per interval
E001 0110	Readout request of input 2 counter load profile profile profile in format counter register values at end of intervals
E001 0111	Readout request of input 2 counter load profile in format number of counts per interval
E001 1000	Readout request of maximum demand
E001 1001	Readout request of previous values
E001 1010	Readout request of event log
E001 1011	Readout request of current harmonics
E001 1100	Readout request of active exported energy load profile in format energy register values at end of intervals
E001 1101	Readout request of active exported energy load profile in format energy consumption per interval
E001 1110	Rreadout request of reactive exported energy load profile in format energy register values at end of intervals
E001 1111	Readout request of reactive exported energy load profile in format energy consumption per interval

2:nd manufacturer specific VIFE followed after VIFE 1111 1110 (FE hex):

VIFE-Code	Description
E000 opsl	Data status for load profile, o = overflow, p = power outage during interval, s = short interval, l = long interval

-Data
The Data follows a VIF or a VIFE without the extension bit set.

-Manufacturer Data Header (MDH)
The manufacturer data header (MDH) is either made up by the character 1Fh that indicates that more data will follow in the next telegram, or by 0Fh indicating the last telegram.

-Check Sum
The Check Sum is used to recognize transmission and synchronization faults. It is calculated from the arithmetical sum, of the bytes from the control field to the last user data, without taking carry digits into account.

6.1.3.2 Communication process

The Data Link Layer uses two kinds of transmission services:

Send / Confirm	SND / CON
Request / Respond	REQ / RSP

After the reception of a correct telegram the meter waits between 35 and 80ms before answering. A received telegram is considered as correct if it passes the following tests:

- Start /Parity /Stop bits per character
- Start /Check Sum /Stop characters per telegram format
- The second Start character, the parity of the two field lengths, and the number of additional characters received (= L Field + 6) with a long frame
- If the received data is reasonable.

The time between a confirm or respond message from the meter until the next message sent to the meter must be at least 20 ms.

Send / Confirm Procedure
SND_NKE
This procedure serves to start up after the interruption or beginning of communication. After receiveing NKE the meter will always send out the 1:st telegram after receiving REQ_UD2 (see description below). If the meter was selected for secondary addressing it will be deselected. The value of the frame count bit FCB is cleared in the meter, i.e. it expects that the first telegram from a master with FCV=1 contains an FCB=1. The meter either confirms a correct reception with the single character acknowledge (E5h) or omits the confirmation if it did not receive the telegram correctly. Example: Sending NKE to a meter with primary address 5 will look as: `10 40 05 45 16.`

SND_UD
This procedure is used to send user data to the meter. The meter either confirms a correct reception with the single character acknowledge (E5h) or omits the confirmation if it did not receive the telegram correctly.

Request / Respond Procedure
REQ_UD2 / RSP_UD
The master requests data from the meter using the REQ_UD2 telegram. The meter will either transfer its data with RSP_UD, or gives no response indicating that the request has not been received correctly or that the address does not match. The meter indicates to the master that there is more data in the next telegram by sending 1Fh as the last user data.

6.1.3.2.1 Selection and Secondary Addressing

It is possible to communicate with the meter using secondary addressing. The secondary addressing takes place with help of a selection:

68h	0Bh	0Bh	68h	53h	FDh	52h	ID1-4	Man 1-2	Gen	Med	CS	16h

Structure of a telegram for selecting a meter

The master sends a SND_UD with the control information 52h to the address 253 (FDh) and fills the specific meter secondary address (identification number, manufacturer, version and medium) with the values of the meter that is to be addressed. The address FDh and the control information 52h is the indication for the meter to compare the following secondary address with its own, and to change into the selected state should it match. In this case the meter answers the selection with an acknowledgement (E5h), otherwise it doesn't reply. Selected state means that the meter can be addressed with the bus address 253 (FDh).

During selection individual positions of the secondary addresses can be occupied with wildcards. Such a wildcard means that this position will not be taken into account during selection. In the identification number each individual digit can be wild-carded by a wildcard nibble Fh while the fields for manufacturer, version and medium can be wild-carded by a wildcard byte FFh.

The meter will remain selected until it receives a selection command with non-matching secondary addresses, a selection command with CI=56h, or a SND_NKE to address 253.

6.1.4 TELEGRAMS

The communication can be divided in two parts. One part is reading data from the meter and the other part is sending data to it. This section describes telegrams sent to and received from the DELTAplus/DELTAmax meter.

The data readout procedure starts when the master sends a REQ_UD2 telegram to the meter. The meter responds with a RSP_UD telegram. A typical readout is a multi-telegram readout. The last DIF in the user data part of the telegram is 1F to indicate that there is more data in the next telegram.

For DELTAplus/DELTAmax meters there are at least 3 telegrams to read. In meters with internal clock there are more telegrams to read where the most recent monthly values will be sent out in telegram 4, the 2:nd most recent monthly values in telegram 5 (if it exist) and so on until all stored montly values have been read. If no monthly values exist in a meter with internal clock all data in the 4:th telegram will be marked with status byte signifying "no data available" (15 hex).

Data for load profile, maximum demand and event log are read by first sending a read request command and then sending a REQ_UD2 telegram to the meter. The meter then responds with a telegram containing the requested data. It is also possible to read out monthly values using this method. A detailed description with examples of reading load profile, maximum demand, monthly values and event log is found in chapter 6.

Using SND_UD telegrams data can be sent to the meter. The following is possible to perform with SND_UD telegrams:

- Set tariff
- Set primary address
- Change baud rate
- Reset power fail counter
- Reset power outage time register
- Set CT ratio
- Set VT ratio
- Set transformer ratio (sets the CT ratio and is only implemented for backward compatibility.)
- Select status information on values
- Reset of stored state of inputs
- Reset of counters (inputs)
- Set outputs
- Set date and time
- Send password
- Set password
- Freeze maximum demand registers
- Set communication access level
- Set tariff source
- Suppress LCD error display
- Read request of load profile
- Read request of monthly values
- Read request of maximum demand
- Read request of event log
- Read request of current harmonics
- Read/write load profile settings
- Read/write monthly value settings
- Read/write maximum demand settings
- Read/write event log settings
- Read/write miscellaneous user configurable settings

To change baud rate in the DELTAplus/DELTAmax meter a SND_UD telegram is sent containing information about which baud rate to change to. If the meter accepts the new baud rate it will acknowledge with the old baud rate. After acknowledging, the meter changes to the new baud rate. If it does not detect a valid telegram, not necessarily with its own address, on the new baud rate within 30 seconds it changes back to the old baud rate. This is done to prevent a meter to be unreachable in an installation where the network makes it impossible to communicate on the new baud rate. The baud rate can also be changed via the buttons.

The read/write settings commands for load profile, monthly values, maximum demand, event log and miscellaneous user configurable settings are not described in this manual as special programs supplied by ABB exist that handle these settings.

6.1.4.1 Examples of telegram 1-4 readouts

Example of the 1st telegram (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	C5	L-field, calculated from C field to last user data
3	1	C5	L-field, repeated
4	1	68	Start character
5	1	08	C-field, RSP_UD
6	1	xx	A-field, address
7	1	72	CI-field, variable data respond, LSB first
8-11	4	xxxxxxxx	Identification Number, 8 BCD digits
12-13	2	4204	Manufacturer: ABB
14	1	02	Version
15	1	02	Medium, 02 = Electricity
16	1	xx	Number of accesses
17	1	xx	Status
18-19	2	0000	Signature (0000 = no encryption)
20	1	0E	DIF size, 12 digit BCD
21	1	04	VIF for units kWh with resolution 0,01kWh
22-27	6	xxxxxxxxxxxx	Active imported energy, Total
28	1	8E	DIF size, 12 digit BCD
29	1	10	DIFE, tariff 1
30	1	04	VIF for units kWh with resolution 0,01kWh
31-36	6	xxxxxxxxxxxx	Active imported energy, Tariff 1
37	1	8E	DIF size, 12 digit BCD
38	1	20	DIFE, tariff 2
39	1	04	VIF for units kWh with resolution 0,01kWh
40-45	6	xxxxxxxxxxxx	Active imported energy, Tariff 2
46	1	8E	DIF size, 12 digit BCD
47	1	B0	DIFE, tariff 3
48	1	00	DIFE,
49	1	04	VIF for units kWh with resolution 0,01kWh
50-55	6	xxxxxxxxxxxx	Active imported energy, Tariff 3
56	1	8E	DIF size, 12 digit BCD
57	1	80	DIFE,
58	1	10	DIFE, tariff 4
59	1	04	VIF for units kWh with resolution 0,01kWh
60-65	6	xxxxxxxxxxxx	Active imported energy, Tariff 4
66	1	8E	DIF size, 12 digit BCD
67	1	80	DIFE,
68	1	40	DIFE, unit 2
69	1	04	VIF for units kvarh with resolution 0,01kvarh
70-75	6	xxxxxxxxxxxx	Reactive imported energy, Total
76	1	8E	DIF size, 12 digit BCD
77	1	90	DIFE, tariff 1
78	1	40	DIFE, unit 2
79	1	04	VIF for units kvarh with resolution 0,01kvarh
80-85	6	xxxxxxxxxxxx	Reactive imported energy, Tariff 1
86	1	8E	DIF size, 12 digit BCD
87	1	A0	DIFE, tariff 2
88	1	40	DIFE, unit 2
89	1	04	VIF for units kvarh with resolution 0,01kvarh
90-95	6	xxxxxxxxxxxx	Reactive imported energy, Tariff 2

Example of the 1st telegram (continued) (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
96	1	8E	DIF size, 12 digit BCD
97	1	B0	DIFE, tariff 3
98	1	40	DIFE, unit 2
99	1	04	VIF for units kvarh with resolution 0,01kvarh
100-105	6	xxxxxxxxxxxx	Reactive imported energy, Tariff 3
106	1	8E	DIF size, 12 digit BCD
107	1	80	DIFE,
108	1	50	DIFE, tariff 4, unit 2
109	1	04	VIF for units kvarh with resolution 0,01kvarh
110-115	6	xxxxxxxxxxxx	Reactive imported energy, Tariff 4
116	1	01	DIF size, 8 bit integer
117	1	FF	VIF next byte is manufacturer specific
118	1	13	VIFE current tariff
119	1	xx	Current tariff
120	1	0C	DIF size, 8 digit BCD
121	1	FF	VIF next byte is manufacturer specific
122	1	12	VIFE transformer ratio
123-125	3	xxxxxx	Transformer ratio
126	1	0A	DIF size, 4 digit BCD
127	1	FF	VIF next byte is manufacturer specific
128	1	68	VIFE current transformer ratio
129-130	2	xxxx	Current transformer ratio
131	1	0A	DIF size, 4 digit BCD
132	1	FF	VIF next byte is manufacturer specific
133	1	69	VIFE voltage transformer ratio
134-135	2	xxxx	Voltage transformer ratio
136	1	0E	DIF size, 12 digit BCD
137	1	6D	VIF time/date
138-143	6	xxxxxxxxxxxx	Time and date (sec,min,hour,day,month,year)
144	1	01	DIF size, 8 bit integer
145	1	FF	VIF next byte is manufacturer specific
146	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
147	1	01	VIF DST, day of week, day type, season
148	1	xx	DST, day of week, day type, season DST data in bit 0: 1:DST active, 0:DST inactive Day of week data in bit 1-3: 001-111:Monday-Sunday Daytype data in bit 4-5: 00-11: Daytype 1-4 Season data in bit 6-7: 00-11: Season 1-4
149	1	07	DIF size, 64 bit integer
150	1	FD	VIF extension of VIF-codes
151	1	17	VIFE error flags (binary)
152-159	8	xxxxxxxxxxxxxxxx	64 Error flags
160	1	01	DIF size, 8 bit integer
161	1	FF	VIF next byte is manufacturer specific
162	1	18	VIFE Power fail counter
163	1	xx	Power fail counter
164	1	0E	DIF size, 12 digit BCD
165	1	FF	VIF next byte is manufacturer specific
166	1	6C	VIFE Power outage timer
167-172	6	xxxxxxxxxxxx	Power outage time (sec, min, hour, days, lsb first)

Example of the 1st telegram (continued) (all values are hexadecimal).

173	1	0D	DIF size, variable length, ASCII coding
174	1	FD	VIF extension of VIF-codes
175	1	0E	VIFE Firmware
176	1	08	Byte specifying length, see note below
177-184	8	xxxxxxxxxxxxxxxx	Firmware version (ASCII coded, lsb byte first), see note below
185	1	8E	DIF size, 12 digit BCD
186	1	40	DIFE, unit 1
187	1	04	VIF for units kWh with resolution 0,01kWh
188-193	6	xxxxxxxxxxxx	Active exported energy, Total
194	1	8E	DIF size, 12 digit BCD
195	1	C0	DIFE, unit bit 0
196	1	40	DIFE, unit bit 1, unit bit0-1-> unit 3
197	1	04	VIF for units kvarh with resolution 0,01kvarh
198-203	6	xxxxxxxxxxxx	Reactive exported energy, Total
204	1	1F	DIF, more records will follow in next telegram
205-226	22	000000000000000 000000000000000 00000000000000	PAD bytes
227	1	xx	CS checksum, calculated from C field to last data
228	1	16	Stop character

Note regarding firmware version: In firmware version 3.17 and above it is sent out with 8 ASCII characters as "Dabc-def", where 'D' stands for "DELTAplus/DELTAmax", "abc" is the total firmware version (for example "317" for version 3.17) and "def" is the metrological version (for example "100" for version 1.00), that is the part of the firmware handling the basic metrology functions. In firmware version below 3.17 only the total firmware version is sent out (with 4 characters as "Dabc").

Example of the 2nd telegram (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	C1	L-field, calculated from C field to last user data
3	1	C1	L-field, repeated
4	1	68	Start character
5	1	08	C-field, RSP_UD
6	1	xx	A-field, address
7	1	72	CI-field, variable data respond, LSB first
8-11	4	xxxxxxxx	Identification Number, 8 BCD digits
12-13	2	4204	Manufacturer: ABB
14	1	02	Version
15	1	02	Medium, 02 = Electricity
16	1	xx	Number of accesses
17	1	xx	Status
18-19	2	0000	Signature (0000 = no encryption)
20	1	04	DIF size, 32 bit integer
21	1	29	VIF for units W with resolution 0,01W
22-25	4	xxxxxxxx	Active power, Total
26	1	04	DIF size, 32 bit integer
27	1	A9	VIF for units W with resolution 0,01W
28	1	FF	VIFE next byte is manufacturer specific
29	1	01	VIFE L1
30-32	4	xxxxxxxx	Active power, L1
33	1	04	DIF size, 32 bit integer
34	1	A9	VIF for units W with resolution 0,01W
35	1	FF	VIFE next byte is manufacturer specific
36	1	02	VIFE L2
37-39	4	xxxxxxxx	Active power, L2
40	1	04	DIF size, 32 bit integer
41	1	A9	VIF for units W with resolution 0,01W
42	1	FF	VIFE next byte is manufacturer specific
43	1	03	VIFE L3
44-46	4	xxxxxxxx	Active power, L3
47	1	84	DIF size, 32 bit integer
48	1	80	DIFE (Unit = 0)
49	1	40	DIFE (Unit = 1, => xx10 (2))
50	1	29	VIF for units var with resolution 0,01var
51-53	4	xxxxxxxx	Reactive power, Total
54	1	84	DIF size, 32 bit integer
55	1	80	DIFE (Unit = 0)
56	1	40	DIFE (Unit = 1, => xx10 (2))
57	1	A9	VIF for units var with resolution 0,01var
58	1	FF	VIFE next byte is manufacturer specific
59	1	01	VIFE L1
60-62	4	xxxxxxxx	Reactive power, L1
63	1	84	DIF size, 32 bit integer
64	1	80	DIFE (Unit = 0)
65	1	40	DIFE (Unit = 1, => xx10 (2))
66	1	A9	VIF for units var with resolution 0,01var
67	1	FF	VIFE next byte is manufacturer specific
68	1	02	VIFE L2
69-71	4	xxxxxxxx	Reactive power, L2

Example of the 2nd telegram (continued) (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
72	1	84	DIF size, 32 bit integer
73	1	80	DIFE (Unit = 0)
74	1	40	DIFE (Unit = 1, => xx10 (2))
75	1	A9	VIF for units var with resolution 0,01var
76	1	FF	VIFE next byte is manufacturer specific
77	1	03	VIFE L3
78-80	4	xxxxxxxx	Reactive power, L3
81	1	84	DIF size, 32 bit integer
82	1	C0	DIFE (Unit = 1)
83	1	40	DIFE (Unit = 1, => xx11 (3))
84	1	A9	VIF for units VA with resolution 0,01VA
85-87	4	xxxxxxxx	Apparent power, Total
88	1	84	DIF size, 32 bit integer
89	1	C0	DIFE (Unit = 1)
90	1	40	DIFE (Unit = 1, => xx11 (3))
91	1	A9	VIF for units VA with resolution 0,01VA
92	1	FF	VIFE next byte is manufacturer specific
93	1	01	VIFE L1
94-96	4	xxxxxxxx	Apparent power, L1
97	1	84	DIF size, 32 bit integer
98	1	C0	DIFE (Unit = 1)
99	1	40	DIFE (Unit = 1, => xx11 (3))
100	1	A9	VIF for units VA with resolution 0,01VA
101	1	FF	VIFE next byte is manufacturer specific
102	1	02	VIFE L2
103-105	4	xxxxxxxx	Apparent power, L2
106	1	84	DIF size, 32 bit integer
107	1	C0	DIFE (Unit = 1)
168	1	40	DIFE (Unit = 1, => xx11 (3))
109	1	A9	VIF for units VA with resolution 0,01VA
110	1	FF	VIFE next byte is manufacturer specific
111	1	03	VIFE L3
112-114	4	xxxxxxxx	Apparent power, L3
115	1	0A	DIF size, 4 digit BCD
116	1	FD	VIF extension of VIF-codes
117	1	C8	VIFE for units V with resolution 0,1V
118	1	FF	VIFE next byte is manufacturer specific
119	1	01	VIFE L1
120-121	2	xxxx	Voltage L1 – N
122	1	0A	DIF size, 4 digit BCD
123	1	FD	VIF extension of VIF-codes
124	1	C8	VIFE for units V with resolution 0,1V
125	1	FF	VIFE next byte is manufacturer specific
126	1	02	VIFE L2
127-128	2	xxxx	Voltage L2 – N
129	1	0A	DIF size, 4 digit BCD
130	1	FD	VIF extension of VIF-codes
131	1	C8	VIFE for units V with resolution 0,1V
132	1	FF	VIFE next byte is manufacturer specific
133	1	03	VIFE L3
134-135	2	xxxx	Voltage L3 – N

Example of the 2nd telegram (continued) (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
136	1	0A	DIF size, 4 digit BCD
137	1	FD	VIF extension of VIF-codes
138	1	C8	VIFE for units V with resolution 0,1V
139	1	FF	VIFE next byte is manufacturer specific
140	1	05	VIFE L1 – L2
141-142	2	xxxx	Voltage L1 – L2
143	1	0A	DIF size, 4 digit BCD
144	1	FD	VIF extension of VIF-codes
145	1	C8	VIFE for units V with resolution 0,1V
146	1	FF	VIFE next byte is manufacturer specific
147	1	06	VIFE L2 – L3
148-149	2	xxxx	Voltage L3 – L2
150	1	0A	DIF size, 4 digit BCD
151	1	FD	VIF extension of VIF-codes
152	1	DA	VIFE for units A with resolution 0,01A
153	1	FF	VIFE next byte is manufacturer specific
154	1	01	VIFE L1
155-156	2	xxxx	Current L1
157	1	0A	DIF size, 4 digit BCD
158	1	FD	VIF extension of VIF-codes
159	1	DA	VIFE for units A with resolution 0,01A
160	1	FF	VIFE next byte is manufacturer specific
161	1	02	VIFE L2
162-163	2	xxxx	Current L2
164	1	0A	DIF size, 4 digit BCD
165	1	FD	VIF extension of VIF-codes
166	1	DA	VIFE for units A with resolution 0,01A
167	1	FF	VIFE next byte is manufacturer specific
168	1	03	VIFE L3
169-170	2	xxxx	Current L3
171	1	0A	DIF size, 4 digit BCD
172	1	FF	VIF next byte is manufacturer specific
173	1	59	VIFE Frequency with resolution 0.01Hz
174-175	2	xxxx	Frequency
176	1	1F	DIF more records will follow in next telegram
177-197	21	000000000000000 000000000000000 000000000000	PAD bytes
198	1	xx	CS checksum, calculated from C field to last data
199	1	16	Stop character

Example of the 3rd telegram (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	D4	L-field, calculated from C field to last user data
3	1	D4	L-field, repeated
4	1	68	Start character
5	1	08	C-field, RSP_UD
6	1	xx	A-field, address
7	1	72	CI-field, variable data respond, LSB first
8-11	4	xxxxxxxx	Identification Number, 8 BCD digits
12-13	2	4204	Manufacturer: ABB
14	1	02	Version
15	1	02	Medium, 02 = Electricity
16	1	xx	Number of accesses
17	1	xx	Status
18-19	2	0000	Signature (0000 = no encryption)
20	1	02	DIF size, 4 digit BCD
21	1	FF	VIF next byte is manufacturer specific
22	1	60	VIFE power factor with resolution 0,001
23-24	2	xxxx	Power factor, Total
25	1	02	DIF size, 16 bit integer
26	1	FF	VIF next byte is manufacturer specific
27	1	E0	VIFE power factor with resolution 0,001
28	1	FF	VIFE next byte is manufacturer specific
29	1	01	VIFE L1
30-31	2	xxxx	Power factor, L1
32	1	02	DIF size, 16 bit integer
33	1	FF	VIF next byte is manufacturer specific
34	1	E0	VIFE power factor with resolution 0,001
35	1	FF	VIFE next byte is manufacturer specific
36	1	02	VIFE L2
37-38	2	xxxx	Power factor, L2
39	1	02	DIF size, 16 bit integer
40	1	FF	VIF next byte is manufacturer specific
41	1	E0	VIFE power factor with resolution 0,001
42	1	FF	VIFE next byte is manufacturer specific
43	1	03	VIFE L3
44-45	2	xxxx	Power factor, L3
46	1	02	DIF size, 16 bit integer
47	1	FF	VIF next byte is manufacturer specific
48	1	52	VIFE phase angle power with resolution 0.1°
49-50	2	xxxx	Phase angle power, Total
51	1	02	DIF size, 16 bit integer
52	1	FF	VIF next byte is manufacturer specific
53	1	D2	VIFE phase angle power with resolution 0.1°
54	1	FF	VIFE next byte is manufacturer specific
55	1	01	VIFE L1
56-57	2	xxxx	Phase angle power, L1
58	1	02	DIF size, 16 bit integer
59	1	FF	VIF next byte is manufacturer specific
60	1	D2	VIFE phase angle power with resolution 0.1°
61	1	FF	VIFE next byte is manufacturer specific
62	1	02	VIFE L2
63-64	2	xxxx	Phase angle power, L2

Example of the 3rd telegram (continued) (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
65	1	02	DIF size, 16 bit integer
66	1	FF	VIF next byte is manufacturer specific
67	1	D2	VIFE phase angle power with resolution 0.1°
68	1	FF	VIFE next byte is manufacturer specific
69	1	03	VIFE L3
70-71	2	xxxx	Phase angle power, L3
72	1	02	DIF size, 16 bit integer
73	1	FF	VIF next byte is manufacturer specific
74	1	C2	VIFE phase angle voltage with resolution 0.1°
75	1	FF	VIFE next byte is manufacturer specific
76	1	01	VIFE L1
77-78	2	xxxx	Phase angle voltage, L1
79	1	02	DIF size, 16 bit integer
80	1	FF	VIF next byte is manufacturer specific
81	1	C2	VIFE phase angle voltage with resolution 0.1°
82	1	FF	VIFE next byte is manufacturer specific
83	1	02	VIFE L2
84-85	2	xxxx	Phase angle voltage, L2
86	1	02	DIF size, 16 bit integer
87	1	FF	VIF next byte is manufacturer specific
88	1	C2	VIFE phase angle voltage with resolution 0.1°
89	1	FF	VIFE next byte is manufacturer specific
90	1	03	VIFE L3
91-92	2	xxxx	Phase angle voltage, L3
93	1	02	DIF size, 16 bit integer
94	1	FF	VIF next byte is manufacturer specific
95	1	CA	VIFE phase angle current with resolution 0.1°
96	1	FF	VIFE next byte is manufacturer specific
97	1	01	VIFE L1
98-99	2	xxxx	Phase angle current, L1
100	1	02	DIF size, 16 bit integer
101	1	FF	VIF next byte is manufacturer specific
102	1	CA	VIFE phase angle current with resolution 0.1°
103	1	FF	VIFE next byte is manufacturer specific
104	1	02	VIFE L2
105-106	2	xxxx	Phase angle current, L2
107	1	02	DIF size, 16 bit integer
108	1	FF	VIF next byte is manufacturer specific
109	1	CA	VIFE phase angle current with resolution 0.1°
110	1	FF	VIFE next byte is manufacturer specific
111	1	03	VIFE L3
112-113	2	xxxx	Phase angle current, L3
114	1	01	DIF size, 8 bit integer
115	1	FF	VIF next byte is manufacturer specific
116	1	17	VIFE current quadrant
117	1	xx	Current quadrant, total
118	1	01	DIF size, 8 bit integer
119	1	FF	VIF next byte is manufacturer specific
120	1	97	VIFE current quadrant
121	1	FF	VIF next byte is manufacturer specific
122	1	01	VIFE L1
123	1	xx	Current quadrant, L1

Example of the 3rd telegram (continued) (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
124	1	01	DIF size, 8 bit integer
125	1	FF	VIF next byte is manufacturer specific
126	1	97	VIFE current quadrant
127	1	FF	VIF next byte is manufacturer specific
128	1	02	VIFE L2
129	1	xx	Current quadrant, L2
130	1	01	DIF size, 8 bit integer
131	1	FF	VIF next byte is manufacturer specific
132	1	97	VIFE current quadrant
133	1	FF	VIF next byte is manufacturer specific
134	1	03	VIFE L3
135	1	xx	Current quadrant, L3
136	1	81	DIF size, 8 bit integer
137	1	40	DIFE (Unit = 1)
138	1	FD	VIF extension of VIF-codes
139	1	1B	VIFE digital input
140	1	xx	Input 1 current state
141	1	81	DIF size, 8 bit integer
142	1	80	DIFE,
143	1	40	DIFE (Unit = 2)
144	1	FD	VIF extension of VIF-codes
145	1	1B	VIFE digital input
146	1	xx	Input 2 current state
147	1	C1	DIF size, 8 bit integer, storage number 1
148	1	40	DIFE (Unit = 1)
149	1	FD	VIF extension of VIF-codes
150	1	1B	VIFE digital input
151	1	xx	Input 1, stored state (1 if current state has been 1)
152	1	C1	DIF size, 8 bit integer, storage number 1
153	1	80	DIFE,
154	1	40	DIFE (Unit = 2)
155	1	FD	VIF extension of VIF-codes
156	1	1B	VIFE digital input
157	1	xx	Input 2, stored state (1 if current state has been 1)
158	1	8E	DIF size, 12 digit BCD
159	1	40	DIFE (Unit = 1)
160	1	FD	VIF extension of VIF-codes
161	1	61	VIFE cumulating counter
162-167	6	xxxxxxxxxxxx	Counter 1 (input 1)
168	1	8E	DIF size, 12 digit BCD
169	1	80	DIFE,
170	1	40	DIFE (Unit = 2)
171	1	FD	VIF extension of VIF-codes
172	1	61	VIFE cumulating counter
173-178	6	xxxxxxxxxxxx	Counter 2 (input 2)
179	1	81	DIF size, 8 bit integer
180	1	40	DIFE (Unit = 1)
181	1	FD	VIF extension of VIF-codes
182	1	1A	VIFE digital output
183	1	xx	Output 1, current state

Example of the 3rd telegram (continued) (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
184	1	81	DIF size, 8 bit integer
185	1	80	DIFE,
186	1	40	DIFE (Unit = 2)
187	1	FD	VIF extension of VIF-codes
188	1	1A	VIFE digital output
189	1	xx	Output 2, current state
190	1	0F	DIF indicating that this is the last telegram
191-216	26	000000000000000 000000000000000 000000000000000 0000000	PAD bytes
217	1	xx	CS checksum, calculated from C field to last data
218	1	16	Stop character

Example of the 4th telegram (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	9C	L-field, calculated from C field to last user data
3	1	9C	L-field, repeated
4	1	68	Start character
5	1	08	C-field, RSP_UD
6	1	xx	A-field, address
7	1	72	CI-field, variable data respond, LSB first
8-11	4	xxxxxxxx	Identification Number, 8 BCD digits
12-13	2	4204	Manufacturer: ABB
14	1	02	Version
15	1	02	Medium, 02 = Electricity
16	1	xx	Number of accesses
17	1	xx	Status
18-19	2	0000	Signature (0000 = no encryption)
20	1	CE	DIF size, 12 digit BCD, storage number bit 0
22	1	00	DIFE, storage number bit 1-4
22	1	ED	VIF for time/date point
23	1	6B	VIFE indicating end of period
24-29	6	xxxxxxxxxxxx	Time and date (sec,min,hour,day,month,year)
30	1	CE	DIF size, 12 digit BCD, storage number bit 0
31	1	00	DIFE, storage number bit 1-4
32	1	04	VIF for units kWh with resolution 0,01kWh
33-38	6	xxxxxxxxxxxx	Active energy, total
39	1	CE	DIF size, 12 digit BCD, storage number bit 0
40	1	10	DIFE, tariff 1, storage number bit 1-4
41	1	04	VIF for units kWh with resolution 0,01kWh
42-47	6	xxxxxxxxxxxx	Active energy, tariff 1
48	1	CE	DIF size, 12 digit BCD, storage number bit 0
49	1	20	DIFE, tariff 2, storage number bit 1-4
50	1	04	VIF for units kWh with resolution 0,01kWh
51-56	6	xxxxxxxxxxxx	Active energy, tariff 2
57	1	CE	DIF size, 12 digit BCD, storage number bit 0
58	1	30	DIFE, tariff 3, storage number bit 1-4
59	1	04	VIF for units kWh with resolution 0,01kWh
60-65	6	xxxxxxxxxxxx	Active energy, tariff 3
66	1	CE	DIF size, 12 digit BCD, storage number bit 0
67	1	80	DIFE, tariff bits 0-1, storage number bit 1-4
68	1	10	DIFE, tariff bits 2-3, tariff 4
69	1	04	VIF for units kWh with resolution 0,01kWh
70-75	6	xxxxxxxxxxxx	Active energy, tariff 4
76	1	CE	DIF size, 12 digit BCD, storage number bit 0
77	1	80	DIFE, storage number bit 1-4, unit bit 0
78	1	40	DIFE, unit bit 1
79	1	04	VIF for units kvarh with resolution 0,01kvarh
80-85	6	xxxxxxxxxxxx	Reactive energy, total
86	1	CE	DIF size, 12 digit BCD, storage number bit 0
87	1	90	DIFE, tariff 1, storage number bit 1-4, unit bit 0
88	1	40	DIFE, unit bit 1
89	1	04	VIF for units kvarh with resolution 0,01kvarh
90-95	6	xxxxxxxxxxxx	Reactive energy, tariff 1

Example of the 4th telegram (continued) (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description
96	1	CE	DIF size, 12 digit BCD, storage number bit 0
97	1	A0	DIFE, tariff 2, storage number bit 1-4, unit bit 0
98	1	40	DIFE, unit bit 1
99	1	04	VIF for units kvarh with resolution 0,01kvarh
100-105	6	xxxxxxxxxxxx	Reactive energy, tariff 2
106	1	CE	DIF size, 12 digit BCD, storage number bit 0
107	1	B0	DIFE, tariff 3, storage number bit 1-4, unit bit 0
108	1	40	DIFE, unit bit 1
109	1	04	VIF for units kvarh with resolution 0,01kvarh
110-115	6	xxxxxxxxxxxx	Reactive energy, tariff 3
116	1	CE	DIF size, 12 digit BCD, storage number bit 0
117	1	80	DIFE, tariff bits 0-1, storage number bit 1-4, unit bit 0
118	1	50	DIFE, tariff 4, unit bit 1
119	1	04	VIF for units kvarh with resolution 0,01kvarh
120-125	6	xxxxxxxxxxxx	Reactive energy, tariff 4
126	1	CE	DIF size, 12 digit BCD, storage number bit 0
127	1	40	DIFE, storage number bit 1-4, unit bit 0
128	1	FD	VIF FD -> next VIFE specifies type of value
129	1	61	Cumulation counter
120-125	6	xxxxxxxxxxxx	Number of pulses registered on input 1
126	1	CE	DIF size, 12 digit BCD, storage number bit 0
127	1	80	DIFE, storage number bit 1-4, unit bit 0
128	1	40	DIFE, unit bit 1
129	1	FD	VIF FD -> next VIFE specifies type of value
130	1	61	Cumulation counter
131-136	6	xxxxxxxxxxxx	Number of pulses registered on input 2
137	1	1F	DIF, more records will follow in next telegram
138-150	13	000000000000000 00000000000	PAD bytes
151	1	xx	CS checksum, calculated from C field to last data
152	1	16	Stop character

6.1.4.2 Sending data to the meter

Below are described telegrams possible to send to the DELTAplus/DELTAmax meter. Some telegrams contain data and some not. Data sent in the telegram are sometimes stored in the meter, sometimes used by the meter when performing a certain action. Telegrams containing no data usually initiates a certain action in the meter.

Some of the commands can be protected by a password or be closed completely. 3 levels of write protection exist: "Open", "open by password" and "closed". In the level "open" the meter will always accept the command (if the meter is correctly addressed and the syntax and checksum is correct). In the level "open by password" the command must be preceded by a "send password" command (see section 6.1.4.2.16) directly followed by the command in order for the meter to accept the command. In the level "closed" it will never accept the command. Note that the meter will answer with an acknowledge character (E5 hex) even if it is closed. The acknowledge character only signifies that the meter was correctly addressed and that the syntax and checksum was correct.

The protection level can be set via the buttons (see section 2.7.4.9) or via the command "set write access level" (see section 6.1.4.2.22). Information regarding which commands is affected by the write protection level is found below in the command description. Commands not affected by the write protection level only require a correct message with correct address, syntax and checksum to be accepted. It must also of course be a meter which have the functionality associated with the command. It must for example be a meter with internal clock for the "set date/time" command to have any effect.

Having a password with only zeros in the "open by password" level have the same effect as if it is open.

If password is used and it is forgotten the meter must be opened with the buttons. When the meter is open a new password can be sent to the meter with the "set password" command.

6.1.4.2.1 Set tariff

In tariff meters where the tariffs are controlled via communication the active tariff is set by the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	07	L-field, calculated from C field to last user data
3	1	07	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	01	DIF size, 8 bit integer
9	1	FF	VIF next byte is manufacturer specific
10	1	13	VIFE tariff
11	1	xx	New tariff
12	1	xx	CS checksum, calculated from C field to last data
13	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.2 Set primary address

The primary address is set either via the buttons or by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	06	L-field, calculated from C field to last user data
3	1	06	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	01	DIF size, 8 bit integer
9	1	7A	VIF Bus Address
10	1	xx	New primary address
11	1	xx	CS checksum, calculated from C field to last data
12	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.3 Change baud rate

The baud rate of the electrical M-bus interface is set either via the buttons or by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	03	L-field, calculated from C field to last user data
3	1	03	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	Bx	CI-field, New baud rate
8	1	xx	CS checksum, calculated from C field to last data
9	1	16	Stop character

Note that this command does not affect the baud rate of the optical IR interface which is fixed to 2400 baud.

This command is not affected by the write protection level set.

6.1.4.2.4 Reset power fail counter

The power fail counter is reset to 0 by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	07	L-field, calculated from C field to last user data
3	1	07	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	00	DIF size, no data
9	1	FF	VIF next byte is manufacturer specific
10	1	98	VIFE no of power fails
11	1	07	VIFE clear
12	1	xx	CS checksum, calculated from C field to last data
13	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.5 Set current transformer (CT) ratio

The current transformer ratio (CT) is set by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	0A	DIF size, 4 digit BCD
9	1	FF	VIF next byte is manufacturer specific
10	1	68	VIFE CT ratio
11-12	2	xx xx	New CT ratio
13	1	xx	CS checksum, calculated from C field to last data
14	1	16	Stop character

Note that the maximum total transformer ratio (CT * VT) must be less than 1 000 000.

This command is not accepted by a direct connected meter.

This command is not affected by the write protection level set.

6.1.4.2.6 Set voltage transformer (VT) ratio

The voltage transformer ratio (VT) is set by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	0A	DIF size, 4 digit BCD
9	1	FF	VIF next byte is manufacturer specific
10	1	69	VIFE VT ratio
11-12	2	xx xx	New VT ratio
13	1	xx	CS checksum, calculated from C field to last data
14	1	16	Stop character

Note that the maximum total transformer ratio (CT * VT) must be less than 1 000 000.

This command is not accepted by a direct connected meter.

This command is not affected by the write protection level set.

6.1.4.2.7 Set transformer ratio (CT*VT)

This command sets the CT ratio and is only implemented for backward compatibility. If using the command the maximum ratio sent shall be less than 10 000.

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0A	L-field, calculated from C field to last user data
3	1	0A	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	0C	DIF size, 8 digit BCD
9	1	FF	VIF next byte is manufacturer specific
10	1	12	VIFE transformer ratio
11-14	4	xx xx xx xx	New transformer ratio
15	1	xx	CS checksum, calculated from C field to last data
16	1	16	Stop character

This command is not accepted by a direct connected meter.

This command is not affected by the write protection level set.

6.1.4.2.8 Select status information

Normally the DELTAplus/DELTAmax meter sends out the status information as the last VIFE only if it is not equal to zero. It is also possible to make the meter to always send out the status information as last vife or to make it to never send out the status information.

To change the way the status information is sent out the following command is sent (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	07	L-field, calculated from C field to last user data
3	1	07	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	01	DIF size, 8 bit integer
9	1	FF	VIF next byte is manufacturer specific
10	1	15	VIFE status of values (status byte on the values)
11	1	xx	0 = never, 1 = status if not OK, 2 = always
12	1	xx	CS checksum, calculated from C field to last data
13	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.9 Reset of stored state for input 1

Reset of stored state for input 1 is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	C0	DIF size, no data, storage number 1
9	1	40	DIFE unit = 1
10	1	FD	VIF extension of VIF-codes
11	1	9B	VIFE digital input
12	1	07	VIFE clear
13	1	xx	CS checksum, calculated from C field to last data
14	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.10 Reset of stored state for input 2

Reset of stored state for input 2 is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	09	L-field, calculated from C field to last user data
3	1	09	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	C0	DIF size, no data, storage number 1
9	1	80	DIFE unit = 0
10	1	40	DIFE unit = 2
11	1	FD	VIF extension of VIF-codes
12	1	9B	VIFE digital input
13	1	07	VIFE clear
14	1	xx	CS checksum, calculated from C field to last data
15	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.11 Reset of input counter 1

Reset of input counter 1 is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	80	DIF size, no data
9	1	40	DIFE unit = 1
10	1	FD	VIF extension of VIF-codes
11	1	E1	VIFE cumulating counter
12	1	07	VIFE clear
13	1	xx	CS checksum, calculated from C field to last data
14	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.12 Reset of input counter 2

Reset of input counter 2 is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	09	L-field, calculated from C field to last user data
3	1	09	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	80	DIF size, no data
9		80	DIFE unit = 0
10	1	40	DIFE unit = 2
11	1	FD	VIF extension of VIF-codes
12	1	E1	VIFE cumulating counter
13	1	07	VIFE clear
14	1	xx	CS checksum, calculated from C field to last data
15	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.13 Set output 1

Setting the state of output 1 is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	81	DIF size, 8 bit integer
9	1	40	DIFE unit = 1
10	1	FD	VIF extension of VIF-codes
11	1	1A	VIFE digital output
12	1	xx	Output 1, new state
13	1	xx	CS checksum, calculated from C field to last data
14	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.14 Set output 2

Setting the state of output 2 is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	09	L-field, calculated from C field to last user data
3	1	09	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	81	DIF size, 8 bit integer
9	1	80	DIFE unit = 0
10	1	40	DIFE unit = 2
11	1	FD	VIF extension of VIF-codes
12	1	1A	VIFE digital output
13	1	xx	Output 2, new state
14	1	xx	CS checksum, calculated from C field to last data
15	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.15 Reset of power outage time

Reset of power outage time is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	07	L-field, calculated from C field to last user data
3	1	07	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	00	DIF size, no data
9	1	FF	VIF next byte is manufacturer specific
10	1	EC	VIFE power outage time
11	1	07	VIFE Clear
12	1	xx	CS checksum, calculated from C field to last data
13	1	16	Stop character

This command is not affected by the write protection level set.

6.1.4.2.16 Send password

Password is sent by the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0E	L-field, calculated from C field to last user data
3	1	0E	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	Xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	07	DIF size, 8 byte integer
9	1	FD	VIF extension of VIF-codes
10	1	16	VIFE password
11-18	8	xxxxxxxxxxxxxxxx	Password
19	1	xx	CS checksum, calculated from C field to last data
20	1	16	Stop character

All commands protected by password must be preceded by this command. The sequence when sending a password protected command is thus:

- The password is sent with the "Send password" command.

- The meter answers with acknowledge.

- The command is sent.

- The meter answers with acknowledge.

Note that it is not possible to first send the password command followed by several password protected commands. In that case only the first password protected command will be accepted.

Note also that it is not allowed to send any other command between the "Send password" and the command (for example an "initialize" command).

There is a timeout of 2 seconds between the "send password" and the command. If the delay between the "send password" and the command is bigger than 2 seconds the command is not accepted.

If this timeout time of 2 seconds is not enough it is possible to prolong it in steps of seconds by inserting extra DIFE's in the command where the unit bits in the DIFE's controls the extra timeout (see section 6.1.3.1.1 for description of a DIFE). The unit bit in the first DIFE have value 1 (2^0), the unit bit in the second DIFE have value 2 (2^1), the unit bit in the third DIFE have value 4 (2^2) etc.

Examples:

Password command with password 1122334455667788, primary address 9, 1 second extra timeout:
68 0f 0f 68 73 09 51 87 40 fd 16 11 22 33 44 55 66 77 88 0b 16

Password command with password 1122334455667788, primary address 9, 3 seconds extra timeout:
68 10 10 68 73 09 51 87 c0 40 fd 16 11 22 33 44 55 66 77 88 cb 16

6.1.4.2.17 Set password

Password is set by the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0F	L-field, calculated from C field to last user data
3	1	0F	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	07	DIF size, 8 byte integer
9	1	FD	VIF extension of VIF-codes
10	1	96	VIFE password
11	1	00	VIFE write (replace)
12-19	8	xxxxxxxxxxxxxxxx	Password
20	1	xx	CS checksum, calculated from C field to last data
21	1	16	Stop character

Note that if the meter is password protected the old password must first be sent before the new is sent.

6.1.4.2.18 Set date and time

The date and time is set by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0B	L-field, calculated from C field to last user data
3	1	0B	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	0E	DIF size, 12 digit BCD
9	1	6D	VIF time/date
10-15	1	xxxxxxxxxxxx	Time and date (sec,min,hour,day,month,year)
16	1	xx	CS checksum, calculated from C field to last data
17	1	16	Stop character

This command is affected by the write protection level set.

Before sending the set date and time command an NKE should be sent, see section 6.1.3.2 (in case the meter is in the middle of a special data readout process where it will not respond to the set date and time command).

It is also possible to set the date and time having the date and time coded according to the M-bus data type F:

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	09	L-field, calculated from C field to last user data
3	1	09	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	04	DIF size, 32 bit integer
9	1	6D	VIF time/date
10-13	1	xxxxxxxx	Time and date. Min,hour,day,month,year coded accorded to M-bus datatype F: Minutes in bits 0-5. Valid values 0-59 Hours in bits 8-12. Valid values 0-23 Day in bits 16-20. Valid values 1-31 Month in bits 24-27. Valid values 1-12 Year in bits 21-23 and 28-31 (msb bits). Valid values 0-99 All other bits are unused
14	1	xx	CS checksum, calculated from C field to last data
15	1	16	Stop character

This command is affected by the write protection level set.

Note that the seconds are not included in this command

6.1.4.2.19 Set date

The date is set by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	07	L-field, calculated from C field to last user data
3	1	07	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	02	DIF size, 16 bit integer
9	1	6C	VIF date
10-11	1	xxxx	Date (day,month,year coded accorded to M-bus datatype G)
12	1	xx	CS checksum, calculated from C field to last data
13	1	16	Stop character

This command is affected by the write protection level set.

6.1.4.2.20 Reset maximum demand, monthly values, load profile or event log

All data for maximum demand, monthly values, load profile or event log is cleared by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	00	DIF size, no data
9	1	FF	VIF next byte is manufacturer specific
10	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
11	1	xx	VIFE specifies data to be cleared: 82 : Maximum demand 83 : Monthly values 84 : Load profile 85 : Event log
12	1	07	VIFE clear
13	1	xx	CS checksum, calculated from C field to last data
14	1	16	Stop character

This command is affected by the write protection level set.

6.1.4.2.21 Freeze maximum demand

The maximum demand values will be freezed and a new period started by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	00	DIF size, no data
9	1	FF	VIF next byte is manufacturer specific
10	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
11	1	82	VIFE specifying maximum demand
12	1	0B	VIFE freeze
13	1	xx	CS checksum, calculated from C field to last data
14	1	16	Stop character

This command is affected by the write protection level set.

6.1.4.2.22 Set write access level

The write access level is set by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	07	L-field, calculated from C field to last user data
3	1	07	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	01	DIF size, 8 bit integer
9	1	FF	VIF next byte is manufacturer specific
10	1	6A	VIFE write control
11	1	xx	Write control (1 : Closed, 2 : Open by password, 3 : Open)
12	1	xx	CS checksum, calculated from C field to last data
13	1	16	Stop character

This command is affected by the write protection level set.

6.1.4.2.23 Set tariff source

In tariff meters with internal clock and no tariff inputs the tariffs are controlled by either the internal clock or via communication.

The tariff source is set by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	01	DIF size, 8 bit integer
9	1	FF	VIF next byte is manufacturer specific
9	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
10	1	06	VIFE tariff source
11	1	xx	Tariff source (0 : Internal clock, 1 : Communication command)
12	1	xx	CS checksum, calculated from C field to last data
13	1	16	Stop character

This command is affected by the write protection level set.

This command only have effect in meters with internal clock where the tariffs can be controlled either from the internal clock or by command via communication.

6.1.4.2.24 Suppress LCD error display

Suppress of error indication on LCD can be done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0F	L-field, calculated from C field to last user data
3	1	0F	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	07	DIF size, 8 byte integer
9	1	FF	VIF next byte is manufacturer specific
10	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
11	1	07	VIFE time source
12-19	1	xxxxxxxxxxxxxxxx	Suppress data. LSB byte first. If bit 2 and 3 in databyte 0 are 1 display of error at date/time fail is suppressed, else it is not suppressed
20	1	xx	CS checksum, calculated from C field to last data
21	1	16	Stop character

This command is affected by the write protection level set.

Note that it is only bit 2 and 3 in byte 0 which are used. If both bits are 1 error display due to loss of date and/or time is suppressed.

6.1.4.3 Reading data from the meter that require a read request command

Some data in the meter can only be read by first giving a special read request command followed by giving a request user data 2 command. The read request command contain in some cases data specifying the date or time/date for the required data. The data read by this procedure is load profile, maximum demand, event log and harmonics. Monthly values is sent out by a normal M-bus readout but can also be read this way. Harmonic data can also be sent out in a normal M-bus readout but is normally not.

Below is described the read request commands and the format of the readout data.

6.1.4.3.1 Read request and readout of load profile data

Read request of load profile is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0A	L-field, calculated from C field to last user data
3	1	0A	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	02	DIF size, 2 byte integer
9	1	EC	VIF time point, date, M-bus data type G
10	1	FF	VIF next byte is manufacturer specific
11	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
12	1	xx	VIFE specifies data requested: 10 : Active import energy register values at end of interval 11 : Active import energy consumption per interval 12 : Reactive import energy register values at end of interval 13 : Reactive import energy consumption per interval 14 : Input 1 register values at end of interval 15 : Input 1 number of counts per interval 16 : Input 2 register values at end of interval 17 : Input 2 number of counts per interval 18 : Active export energy register values at end of interval 19 : Active export energy consumption per interval 1A : Reactive export energy register values at end of interval 1B : Reactive export energy consumption per interval
13-14	2	xxxx	Date (M-bus data type G, lsb byte sent first)
15	1	xx	CS checksum, calculated from C field to last data
16	1	16	Stop character

When sending the read request the readout quantity is specified in the last VIFE and the requested date is specified in the data. The format for the date is M-bus data type G which consist of 2 bytes coded according to the following:

Day in bits 0-4. Valid values 1-31
Month in bits 8-11. Valid values 1-12
Year in bits 5-7 and bits 12-15 (bit 5-7 is the lsb bits). Valid values 0-99

Example: 23:rd september 2006 (23/9-06) will be coded as (bit 15-0): 0000 1001 1101 0111 in binary format which will be 09D7 in hexadecimal format.

Before sending this command an NKE should always be sent, see section 6.1.3.2 (in case the meter is in the middle of another special data readout process where it will not respond correctly to the command).

If load profile data for the specified date is stored in the meter it will send out data for that day. If no data is stored in the meter for the specified date it will send out data from the nearest date backwards in time. Therefore the system should check the date sent out in the telegram to verify that it is the requested day that is sent out. If no data is stored in the meter for the specified date or any date backwards in time all data in the telegram will have status byte marked as "no data available" (15 hex).

After having read a complete day of load profile data it is possible to continue to read next stored day record (backwards in time) by continue sending REQ_UD2's. The last DIF in the telegram tell if there are more data or not (1F hex when more data exists and 0F hex if no more data exist).

The data will be sent out with 12 load profile values in each telegram. This means that 2 telegrams must be read for 1 day of load profile values when the interval length is 60 minutes. If the interval length is 30 minutes 4 telegrams must be read and if the interval length is 15 minutes 8 telegrams must be read.

Beside the interval data the date/time information for the day record and the interval length is sent out. When the load profile data is read out as consumption per interval the register value at the start of the 1:st interval is also sent out. The date/time information is sent out in format M-bus data type F which consist of 4 byte with bits 0-31 coded according to the following:

Minutes in bits 0-5. Valid values 0-59
Hours in bits 8-12. Valid values 0-23
Day in bits 16-20. Valid values 1-31
Month in bits 24-27. Valid values 1-12
Year in bits 21-23 and 28-31 (msb bits). Valid values 0-99
All other bits are unused

All fields have binary coding. When the load profile data is read out as consumption per interval the date/time information specifies the start of the 1:st interval and the date/time-stamp for the regsiter value in the frame sent out. When the load profile data is read out as register values the date/time information specifies the end of the 1:st interval the frame sent out.

It is also possible to start reading data within a day by sending the following read request command containing both date and time (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0E	L-field, calculated from C field to last user data
3	1	0E	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	0E	DIF size, 6 byte bcd
9	1	ED	VIF time/date
10	1	FF	VIF next byte is manufacturer specific
11	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
12	1	xx	VIFE specifies data requested: 10 : Active import energy register values at end of interval 11 : Active import energy consumption per interval 12 : Reactive import energy register values at end of interval 13 : Reactive import energy consumption per interval 14 : Input 1 register values at end of interval 15 : Input 1 number of counts per interval 16 : Input 2 register values at end of interval 17 : Input 2 number of counts per interval 18 : Active export energy register values at end of interval 19 : Active export energy consumption per interval

			1A : Reactive export energy register values at end of interval 1B : Reactive export energy consumption per interval
13-14	2	xxxxxxxxxxxx	Time/date (sec:min:hour / day-month-year)
15	1	xx	CS checksum, calculated from C field to last data
16	1	16	Stop character

If load profile data for the specified time/date is stored in the meter it will send out the dataframe containing the data for the specified time/date. If no data is stored in the meter for the specified date it will send out data from the nearest date backwards in time. Therefore the system should check the date sent out in the telegram to verify that it is the requested date that is sent out. If no data is stored in the meter for the specified date or any date backwards in time all data in the telegram will have status byte marked as "no data available" (15 hex).

Note that manufacturer specific coding of the status information is used to indicate the following status:

- Interval are too short or too long
- Data overflow in interval
- Power outage occurred during the interval.

When one or several of these status events occurred during the interval 3 the extra VIFE's FF FE 0x are sent out where x is bit 3-0 and have the following meaning if set:

Bit 3 = data overflow in interval,
bit 2 = power outage occurred during interval,
bit 1 = short interval,
bit 0 = long interval.

If the data item read is normal with no specific status associated with it no status-VIFE or 0 will be sent out. If the status is "data error" or "no data available" the standard M-bus status coding values will be sent out (18 hex or 15 hex).

The register values have same data and value information bytes (dif, dife's, vif, vife's) as for the momentary register vales but with stored number 1 to indicate that it is stored historical data.

Below are a number of commented practical examples of a number of load profile readouts where data sent to and read from the meter is shown. All data is in hexadecimal format. Comments are preceded with a semicolon.

Readout of 1 day of active energy load profile register values:

System sends read request command for active energy register values:

```
68 0A 0A 68 73 FE 51 02 EC FF F9 10 C5 04 81 16 ;Date 5:th of april, year 06
```

Meter sends out acknowledge:

```
E5
```

System sends out request UD2:

```
10 7B FE 79 16
```

Meter sends out data telegram:

```
68 A1 A1 68 08 00 72 44 47 24 00 42 04 02 02 16 00 00 00 ;Data header
44 ED 6B 00 01 C5 04 ;Date and time for first register value in telegram (end of 1:st interval)
01 FD 25 3C            ;Interval length (60 minutes)
4E 04 81 14 00 00 00 00 ;Register value end of 1:st interval: 14.81 kWh (status VIFE not sent -
                          > status = 0)
4E 04 98 15 00 00 00 00   ;Register value 15.98 kWh
4E 04 15 17 00 00 00 00
4E 04 13 18 00 00 00 00
4E 04 64 18 00 00 00 00
4E 04 78 19 00 00 00 00
4E 04 59 20 00 00 00 00
```

```
4E 04 71 21 00 00 00 00
4E 84 FF FE 04 80 22 00 00 00 00 ;Register value 22.80 kWh, manufacturer specific status =
                                  04 (total power outage occured during interval)
4E 04 98 23 00 00 00 00
4E 84 FF FE 01 17 25 00 00 00 00 ;Register value 25.17 kWh, manufacturer specific status =
                                  01 (interval long)
4E 04 39 26 00 00 00 00
1F                        ;Dif 1F -> Exist more load profile data
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ;Pad bytes
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
ED 16       ;Checksum and stop byte
```

System sends out request UD2:

```
10 5B FE 59 16
```

Meter sends out data telegram:

```
68 A1 A1 68 08 00 72 44 47 24 00 42 04 02 02 17 00 00 00 ;Data header
44 ED 6B 00 0D C5 04  ;Date and time for first register value in telegram (end of 1:st interval)
01 FD 25 3C            ;Interval length (60 minutes)
4E 84 FF FE 02 14 27 00 00 00 00 ;Register value 27.14 kWh, manufacturer specific status =
                                  02 (interval short)
4E 04 35 28 00 00 00 00
4E 04 53 29 00 00 00 00
4E 04 50 30 00 00 00 00
4E 84 FF FE 04 49 31 00 00 00 00
4E 84 FF FE 06 59 32 00 00 00 00 ;Register value 32.59 kWh, manufacturer specific status =
                                  06 (power outage occured during interval and interval
                                  short)
4E 04 53 33 00 00 00 00
4E 04 51 34 00 00 00 00
4E 04 68 35 00 00 00 00
4E 04 36 36 00 00 00 00
4E 04 55 37 00 00 00 00
4E 04 74 38 00 00 00 00
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00
BA 16
```

Readout of 1 day of active energy load profile interval values:

System sends read request command for active energy interval values:

```
68 0A 0A 68 73 FE 51 02 EC FF F9 11 C5 04 82 16 ;Date 5:th of april, year 06
```

Meter sends out acknowledge:

```
E5
```

System sends out request UD2:

```
10 7B FE 79 16
```

Meter sends out data telegram:

```
68 9E 9E 68 08 00 72 44 47 24 00 42 04 02 02 20 00 00 00 ;Data header
44 ED 6A 00 00 C5 04 ;Date and time (5:th of april, year 06, 00:00) for start of 1:st interval and of
                      register value
01 FD 25 3C            ;Interval length (60 minutes)
4E 04 64 13 00 00 00 00     ;Register value at start of 1:interval in telegram (13.64 kWh)
44 83 27 92 04 00 00  ;1:st interval value: Consumption 1.170 kWh (492 hex)
44 83 27 91 04 00 00  ;2:nd interval value: Consumption 1.169 kWh (491 hex)
44 83 27 90 04 00 00
```

```
44 83 27 D6 03 00 00
44 83 27 FD 01 00 00
44 83 27 77 04 00 00
44 83 27 27 03 00 00
44 83 27 61 04 00 00
44 83 A7 FF FE 04 3E 04 00 00 ;9:th interval value: Consumption 1.086 kWh (43E hex),
                               manufacturer specific status = 04 (total power outage
                               occured during interval)
44 83 27 9E 04 00 00
44 83 A7 FF FE 01 A4 04 00 00
44 83 27 C1 04 00 00
1F                    ;Dif 1F -> Exist more load profile data
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ;Pad bytes
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
56 16        ;Checksum and stop byte
```

System sends out request UD2:

```
10 5B FE 59 16
```

Meter sends out data telegram:

```
68 9E 9E 68 08 00 72 44 47 24 00 42 04 02 02 21 00 00 00 ;Data header
44 ED 6A 00 0C C5 04   ;Date and time (5:th of april, year 06, 12:00) for start of 1:st interval and
                       of register value
01 FD 25 3C            ;Interval length (60 minutes)
4E 04 39 26 00 00 00 00   ;Register value at start of 1:interval in telegram (26.39 kWh)
44 83 A7 FF FE 02 EE 02 00 00 ;1:st interval value: Consumption 0.750 kWh (2EE hex),
                               manufacturer specific status = 02 (interval short)
44 83 27 B8 04 00 00
44 83 27 9D 04 00 00
44 83 27 CA 03 00 00
44 83 A7 FF FE 04 E4 03 00 00
44 83 A7 FF FE 06 44 04 00 00
44 83 27 B1 03 00 00
44 83 27 CF 03 00 00
44 83 27 96 04 00 00
44 83 27 A9 02 00 00
44 83 27 9E 04 00 00
44 83 27 A8 04 00 00  ;12:th interval value: Consumption 1.192 kWh (4A8 hex)
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
40 16
```

Readout of 1 day of input 1 load profile register values:

System sends read request command for input 1 register values:

```
68 0A 0A 68 73 FE 51 02 EC FF F9 14 C5 04 85 16
```

Meter sends out acknowledge:

```
E5
```

System sends out request UD2:

```
10 7B FE 79 16
```

Meter sends out data telegram:

```
68 B9 B9 68 08 00 72 44 47 24 00 42 04 02 02 12 00 00 00  ;Data header
44 ED 6B 00 01 C5 04     ;Date and time for first register value in telegram (end of 1:st interval)
01 FD 25 3C              ;Interval length (60 minutes)
CE 40 FD 61 16 01 00 00 00 00 ;Register value end of 1:st interval: 161 pulses (status VIFE
                               not sent -> status = 0)
```

```
CE 40 FD 61 30 01 00 00 00 00 ;Register value 130 pulses
CE 40 FD 61 43 01 00 00 00 00
CE 40 FD 61 55 01 00 00 00 00
CE 40 FD 61 68 01 00 00 00 00
CE 40 FD 61 81 01 00 00 00 00
CE 40 FD 61 94 01 00 00 00 00
CE 40 FD 61 07 02 00 00 00 00
CE 40 FD 61 20 02 00 00 00 00 ;Register value 220 pulses
CE 40 FD 61 33 02 00 00 00 00
CE 40 FD 61 46 02 00 00 00 00
CE 40 FD 61 58 02 00 00 00 00
1F             ;More data exist
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
DD 16
```

System sends out request UD2:

```
10 5B FE 59 16
```

Meter sends out data telegram:

```
68 B9 B9 68 08 00 72 44 47 24 00 42 04 02 02 13 00 00 00
44 ED 6B 00 0D C5 04
01 FD 25 3C
CE 40 FD 61 71 02 00 00 00 00
CE 40 FD 61 88 02 00 00 00 00
CE 40 FD 61 05 03 00 00 00 00
CE 40 FD 61 18 03 00 00 00 00
CE 40 FD 61 31 03 00 00 00 00
CE 40 FD 61 44 03 00 00 00 00
CE 40 FD 61 56 03 00 00 00 00
CE 40 FD 61 69 03 00 00 00 00
CE 40 FD 61 82 03 00 00 00 00
CE 40 FD 61 95 03 00 00 00 00
CE 40 FD 61 08 04 00 00 00 00
CE 40 FD 61 21 04 00 00 00 00
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
34 16
```

Readout of 1 day of input 1 load profile interval values:

System sends read request command for input 1 interval values:

```
68 0A 0A 68 73 FE 51 02 EC FF F9 15 C5 04 86 16
```

Meter sends out acknowledge:

```
E5
```

System sends out request UD2:

```
10 7B FE 79 16
```

Meter sends out data telegram:

```
68 B8 B8 68 08 00 72 44 47 24 00 42 04 02 02 16 00 00 00
44 ED 6A 00 00 C5 04     ;Date and time (5:th of april, year 06, 00:00) for start of 1:st interval and
                         of register value
01 FD 25 3C              ;Interval length (60 minutes)
CE 40 FD 61 04 01 00 00 00 00 ;Register value at start of 1:interval in telegram (104 pulses)
C4 40 FD E1 27 0C 00 00 00 ;Consumption in 1:st interval: 12 pulses (C hex)
C4 40 FD E1 27 0E 00 00 00
C4 40 FD E1 27 0D 00 00 00
```

```
C4 40 FD E1 27 0C 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0C 00 00 00
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
E2 16
```

System sends out request UD2:

```
10 5B FE 59 16
```

Meter sends out data telegram:

```
68 B8 B8 68 08 00 72 44 47 24 00 42 04 02 02 17 00 00 00
44 ED 6A 00 0C C5 04
01 FD 25 3C
CE 40 FD 61 58 02 00 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 11 00 00 00
C4 40 FD E1 27 11 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0C 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
C4 40 FD E1 27 0D 00 00 00
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
4D 16
```

Readout of 1 day of input 2 load profile register values:

System sends read request command for input 2 register values:

```
68 0A 0A 68 73 FE 51 02 EC FF F9 16 AC 0C 76 16
```

Reading acknowledge

```
E5
```

Sending request UD2..
10 7b fe 79 16

Reading response..

```
68 C5 C5 68 08 00 72 42 10 00 00 42 04 02 02 15 20 00 00
44 ED 24 00 00 AC 0C
01 FD 25 3C
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
```

```
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
62 16
```

Sending request UD2..
10 5b fe 59 16

Reading response..

```
68 C5 C5 68 08 00 72 42 10 00 00 42 04 02 02 16
20 00 00
44 ED 24 00 00 AC 0C
01 FD 25 3C
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
CE 80 40 FD 61 52 23 00 00 00 00
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
63 16
```

Readout of 1 day of input 2 load profile interval values:

System sends read request command for input 2 interval values:

```
68 0A 0A 68 53 FE 51 02 EC FF F9 17 AC 0C 57 16
```

Reading acknowledge
e5

Sending request UD2..

```
10 7B FE 79 16
```

Reading response..

```
68 C5 C5 68 08 00 72 42 10 00 00 42 04 02 02 18
20 00 00
44 ED 24 00 00 AC 0C
01 FD 25 3C
CE 80 40 FD 61 52 23 00 00 00 00
C4 80 40 FD E1 27 EA 00 00 00
C4 80 40 FD E1 A7 FF FE 02 94 01 00 00
C4 80 40 FD E1 A7 FF FE 01 16 00 00 00
C4 80 40 FD E1 A7 FF FE 04 07 07 00 00
C4 80 40 FD E1 A7 FF FE 01 3A 00 00 00
C4 80 40 FD E1 A7 FF FE 02 26 00 00 00
C4 80 40 FD E1 A7 FF FE 02 1E 00 00 00
C4 80 40 FD E1 A7 FF FE 02 04 00 00 00
C4 80 40 FD E1 A7 FF FE 02 03 00 00 00
```

```
C4 80 40 FD E1 A7 FF FE 01 08 00 00 00
C4 80 40 FD E1 A7 FF FE 02 05 00 00 00
C4 80 40 FD E1 A7 FF FE 04 15 00 00 00
1F
00 00 00 00 00 00
66 16
```

Sending request UD2..
10 5b fe 59 16

Reading response..

```
68 C5 C5 68 08 00 72 42 10 00 00 42 04 02 02 19 20 00 00
44 ED 24 00 0C AC 0C
01 FD 25 3C
CE 80 40 FD 61 78 49 00 00 00 00
C4 80 40 FD E1 A7 FF FE 06 7F 00 00 00
C4 80 40 FD E1 A7 FF FE 04 19 02 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
C4 80 40 FD E1 A7 15 00 00 00 00
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
6F 16
```

6.1.4.3.2 Read request and readout of maximum demand data

Read request of maximum demand is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0A	L-field, calculated from C field to last user data
3	1	0A	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	02	DIF size, 2 byte integer
9	1	EC	VIF time point, date, M-bus data type G
10	1	FF	VIF next byte is manufacturer specific
11	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
12	1	18	VIFE specifies maximum demand
13-14	2	xxxx	Date (M-bus data type G)
15	1	xx	CS checksum, calculated from C field to last data
16	1	16	Stop character

When sending the read request a date is specified in the data. The meter then sends out the maximum demand data that have equal or older end of measurement period date/time stamp, starting with the data that are nearest in time compared to the date in the command. The format for the date is M-bus data type G which consist of 2 bytes coded according to the following:

Day in bits 0-4. Valid values 1-31
Month in bits 8-11. Valid values 1-12
Year in bits 5-7 and bits 12-15 (bit 5-7 is the lsb bits). Valid values 0-99

Example: 23:rd september 2006 (23/9-06) will be coded as (bit 15-0): 0000 1001 1101 0111 in binary format which will be 09D7 in hexadecimal format.

Before sending this command an NKE should always be sent, see section 6.1.3.2 (in case the meter is in the middle of another special data readout process where it will not respond correctly to the command).

If no data is stored in the meter equal to or older than the specified date all data in the telegram will have status byte marked as "no data available" (15 hex).

After having read a telegram with maximum demand data it is possible to continue to read next stored telegram (backwards in time) by continue sending REQ_UD2's. The last DIF in the telegram tell if there are more data or not (1F hex when more data exists and 0F hex if no more data exist).

All maximum demand data stored for a measurement period will be sent out in each telegram. The data sent out is the interval length, the maximum demand and date/time stamp for the maximum for all quantities and a date/time stamp for the end of the measurement period. Each maximum demand is followed by the date/time stamp for that maximum where the time given is the end of the interval.

The date/time information is sent out in format 6 byte bcd in order second, minute, hour, day, month and year.

The data for the currently pending period will be sent out with storage number set to 0, the most recent stored historical values will have storage number 1, the next set of historical values will have storage number 2 etc.

If data have not been generated for a quantity the maximum is set to 0 and the date/time is set to 00-00-00 / 00:00:00. This is the case for the currently pending period before any maximum demand have been stored, that is while the very first interval in a measurement period is pending. It will also happen if a particular tariff haven't been active in a measurement period.

If the data item read is normal with no specific status associated with it no status-VIFE will be sent out or 0 will be sent out. If the status is “data error” or “no data available” the standard M-bus status coding values will be sent out (18 hex or 15 hex).

Below are a number of commented practical examples of a maximum demand readouts where data sent to and read from the meter is shown. All data is in hexadecimal format. Comments are preceded with a semicolon.

System sends read request command for maximum demand:
68 0A 0A 68 73 FE 51 02 EC FF F9 18 C1 07 88 16

Meter sends out acknowledge:
E5

System sends out request UD2:
10 7B FE 79 16

Meter sends out data telegram:
68 E8 E8 68 08 00 72 44 47 24 00 42 04 02 02 04 00 00 00 ;Data header
01 FD 25 0F ;Interval length 15 minutes
94 10 29 60 57 2A 00 ;Current maximum demand (storage number 0) for active power tariff 1, VIF 29 -
> data in W with 2 decimals. Data = 2A5760hex = 27748.80 W
8E 00 ED 6B 00 15 00 01 07 06 ;Date/time stamp for maximum given above: 1:st of july 2006,
00:15:00 (hour:minute:second)
94 20 29 00 00 00 00 ;Current maximum demand (storage number 0) for active power tariff 2
; VIF 29 -> data in W with 2 decimals. Data = 0
8E 00 ED 6B 00 00 00 00 00 00 ;Date/time stamp for maximum given above is 00-00-00 / 00:00:00 ->
no maximum have been generated for this quantity
94 30 29 00 00 00 00
8E 00 ED 6B 00 00 00 00 00 00
94 80 10 29 00 00 00 00
8E 00 ED 6B 00 00 00 00 00 00
94 90 40 29 60 5E 0A 00
8E 00 ED 6B 00 15 00 01 07 06
94 A0 40 29 00 00 00 00
8E 00 ED 6B 00 00 00 00 00 00
94 B0 40 29 00 00 00 00
8E 00 ED 6B 00 00 00 00 00 00
94 80 50 29 00 00 00 00
8E 00 ED 6B 00 00 00 00 00 00
94 40 FD 61 00 00 00 00
8E 00 ED 6B 00 00 00 00 00 00
94 80 40 FD 61 00 00 00 00
8E 00 ED 6B 00 00 00 00 00 00
8E 00 ED EB FF 70 00 00 00 00 00 00 ;Date/time stamp for end of measurement period will always be
00-00-00 / 00:00:00 for the currently pending period
1F ;Did 1F -> More data exists
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ;Pad bytes
14 16 ;Checksum and stop byte

System sends out request UD2:
10 5B FE 59 16

Meter sends out data telegram:
68 E8 E8 68 08 00 72 44 47 24 00 42 04 02 02 05 00 00 00 ;Data header
01 FD 25 0F ;Interval length 15 minutes

D4 10 29 40 90 02 00 ;Maximum demand (storage number 1) for active power tariff 1, VIF 29 -> data in W with 2 decimals. Data = 29040hex = 1680.00 W
CE 00 ED 6B 26 29 01 03 06 06 ;Date/time stamp for maximum given above: 3:rd of june 2006, 01:29:26 (hour:minute:second)
D4 20 29 00 00 00 00 ;Maximum demand (storage number 1) for active power tariff 2, VIF 29 -> data in W with 2 decimals. Data = 0hex = 0 W
CE 00 ED 6B 00 00 00 00 00 00 ;Date/time stamp all zeros -> no maximum have been stored for this tariff
D4 30 29 50 30 02 00
CE 00 ED 6B 00 45 03 07 06 06
D4 80 10 29 C0 E0 04 00
CE 00 ED 6B 55 59 23 30 06 06
D4 90 40 29 A0 A0 00 00 ;Maximum demand (storage number 1) for reactive power tariff 1, VIF 29 -> data in var with 2 decimals. Data = A0A0hex = 411.20 var
CE 00 ED 6B 26 29 01 03 06 06 ;Date/time stamp for maximum given above: 3:rd of june 2006, 01:29:26 (hour:minute:second)
D4 A0 40 29 00 00 00 00
CE 00 ED 6B 00 00 00 00 00 00
D4 B0 40 29 30 89 00 00
CE 00 ED 6B 00 45 03 07 06 06
D4 80 50 29 A0 31 01 00
CE 00 ED 6B 55 59 23 30 06 06
D4 40 FD 61 00 00 00 00 ;Maximum demand (storage number 1) for input 1, VIF 29 -> data in number of pulses. Data = 0hex = 0 pulses
CE 00 ED 6B 00 00 00 00 00 00
D4 80 40 FD 61 00 00 00 00
CE 00 ED 6B 00 00 00 00 00 00
CE 00 ED EB FF 70 00 00 00 01 07 06 ;Date/time stamp for end of measurement period: 1:st of july 2006, 00:00:00 (hour:minute:second)
1F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C5 16

System sends out request UD2:
10 7B FE 79 16

Meter sends out data telegram:
68 E8 E8 68 08 00 72 44 47 24 00 42 04 02 02 06 00 00 00
01 FD 25 0F
94 11 29 80 81 08 00 ;Maximum demand (storage number 2) for active power tariff 1, VIF 29 -> data in W with 2 decimals. Data = 88180hex = 5574.40 W
8E 01 ED 6B 00 00 01 19 05 06 ;Date/time stamp for maximum given above: 19:th of may 2006, 01:00:00 (hour:minute:second)
94 21 29 30 10 01 00
8E 01 ED 6B 33 59 02 19 05 06
94 31 29 30 10 01 00
8E 01 ED 6B 25 59 03 22 05 06
94 81 10 29 80 A0 02 00
8E 01 ED 6B 00 00 05 24 05 06
94 91 40 29 70 15 02 00
8E 01 ED 6B 00 00 01 19 05 06
94 A1 40 29 E0 42 00 00
8E 01 ED 6B 33 59 02 19 05 06
94 B1 40 29 E0 42 00 00
8E 01 ED 6B 25 59 03 22 05 06
94 81 50 29 B0 A4 00 00
8E 01 ED 6B 00 00 05 24 05 06
94 41 FD 61 00 00 00 00
8E 01 ED 6B 00 00 00 00 00 00
94 81 40 FD 61 00 00 00 00

8E 01 ED 6B 00 00 00 00 00 00
8E 01 ED EB FF 70 00 00 00 01 06 06
0F
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
77 16

6.1.4.3.3 Read request and readout of previous values

Previous values is sent out in a normal readout sequence with start on the 4:th telegram with the most recently stored values having storage number 1, then the 2:nd most recently stored values with storage number 2 in the 5:th telegram etc until the oldest set of previous values have been sent out (ended with the DIF 0F to indicate the last telegram).

It is however also possible to read monthly values with start from a specific date and backwards in time by sending a read request.

Read request of previous values is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	0A	L-field, calculated from C field to last user data
3	1	0A	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	02	DIF size, 2 byte integer
9	1	EC	VIF time point, date, M-bus data type G
10	1	FF	VIF next byte is manufacturer specific
11	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
12	1	19	VIFE specifies monthly values
13-14	2	xxxx	Date (M-bus data type G)
15	1	xx	CS checksum, calculated from C field to last data
16	1	16	Stop character

The format for the date is M-bus data type G which consist of 2 bytes coded according to the following:

Day in bits 0-4. Valid values 1-31
Month in bits 8-11. Valid values 1-12
Year in bits 5-7 and bits 12-15 (bit 5-7 is the lsb bits). Valid values 0-99

Example: 23:rd september 2006 (23/9-06) will be coded as (bit 15-0): 0000 1001 1101 0111 in binary format which will be 09D7 in hexadecimal format.

Before sending this command an NKE should always be sent, see section 6.1.3.2 (in case the meter is in the middle of another special data readout process where it will not respond correctly to the command).

If no data is stored in the meter for the specified date it will send out data from the nearest date backwards in time. If no previous values is stored in the meter equal or older than the specified date all data in the telegram will have status byte marked as "no data available" (15 hex).

After having read a telegram of previous values it is possible to continue to read next stored telegram with previous values (backwards in time) by continue sending REQ_UD2's. The last DIF in the telegram tell if there are more data or not (1F hex when more data exists and 0F hex if no more data exist).

All previous register values stored at the end of a period will be sent out in each telegram. Beside the previous register values a date/time stamp for the end of the period is sent out in the telegram. The date/time information is sent out in format 6 byte bcd in order second, minute, hour, day, month and year.

If the data item read is normal with no specific status associated with it no status-VIFE will be sent out or 0 will be sent out. If the status is “data error” or “no data available” the standard M-bus status coding values will be sent out (18 hex or 15 hex).

The register values have same data and value information bytes (dif, dife's, vif, vife's) as for the momentary register vales but with storage number bigger than zero to indicate that it is stored historical data.

Below are a number of commented practical examples of a number of previous value readouts where data sent to and read from the meter is shown. All data is in hexadecimal format. Comments are preceded with a semicolon.

System sends read request command for maximum demand with date 1:st of july 06:
68 0A 0A 68 73 FE 51 02 EC FF F9 19 C1 07 89 16

Meter sends out acknowledge:
E5

System sends out request UD2:
10 7B FE 79 16

Meter sends out data telegram:
68 9C 9C 68 08 00 72 44 47 24 00 42 04 02 02 09 00 00 00 ;Data header
;The date/time stamp and the monthly values have storage number 1, that is, it is the 1:st (most recent in time) set of monthly values
CE 00 ED 6B 00 00 00 01 07 06 ;Date/time stamp for previous values, here 01-07-06 / 00:00:00 (day-month-year / sec:min:hour)
CE 00 04 35 08 00 00 00 00 ;Monthly value for total active energy, here 8.35 kWh
CE 10 04 62 02 00 00 00 00 ;Monthly value for tariff 1 active energy, here 2.62 kWh
CE 20 04 27 02 00 00 00 00 ;Monthly value for tariff 2 active energy, here 2.27 kWh
CE 30 04 79 00 00 00 00 00 ;Monthly value for tariff 3 active energy, here 0.79 kWh
CE 80 10 04 65 02 00 00 00 00 ;Monthly value for tariff 4 active energy, here 2.65 kWh
CE 80 40 04 04 02 00 00 00 00 ;Monthly value for total reactive energy, here 2.04 kvarh
CE 90 40 04 64 00 00 00 00 00 ;Monthly value for tariff 1 reactive energy, here 0.64 kWh
CE A0 40 04 55 00 00 00 00 00 ;Monthly value for tariff 2 reactive energy, here 0.55 kWh
CE B0 40 04 19 00 00 00 00 00 ;Monthly value for tariff 3 reactive energy, here 0.19 kWh
CE 80 50 04 65 00 00 00 00 00 ;Monthly value for tariff 4 reactive energy, here 0.65 kWh
CE 40 FD 61 00 00 00 00 00 00 ;Monthly value for input 1 counter, here 0 pulses
CE 80 40 FD 61 00 00 00 00 00 00 ;Monthly value for input 2 counter, here 0 pulses
1F ;Dif 1F -> more monthly values exist
00 00 00 00 00 00 00 00 00 00 00 00 00 ;Pad bytes
62 16 ;Checksum and stop byte

System sends out request UD2:
10 5B FE 59 16

Meter sends out data telegram:
68 9C 9C 68 08 00 72 44 47 24 00 42 04 02 02 0A 00 00 00
8E 01 ED 6B 00 00 00 01 06 06 ;Date/time stamp for previous values, here 01-06-06 / 00:00:00 (day-month-year / sec:min:hour)
8E 01 04 17 05 00 00 00 00
8E 11 04 55 01 00 00 00 00
8E 21 04 27 02 00 00 00 00
8E 31 04 31 00 00 00 00 00
8E 81 10 04 04 01 00 00 00 00
8E 81 40 04 26 01 00 00 00 00
8E 91 40 04 38 00 00 00 00 00

8E A1 40 04 55 00 00 00 00 00
8E B1 40 04 07 00 00 00 00 00
8E 81 50 04 25 00 00 00 00 00
8E 41 FD 61 00 00 00 00 00 00
8E 81 40 FD 61 00 00 00 00 00 00
0F
00 00 00 00 00 00 00 00 00 00 00 00 00
E9 16

6.1.4.3.4 Read request and readout of event log data

Read request of event log is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	12	L-field, calculated from C field to last user data
3	1	12	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	8E or CE	DIF size, 6 byte bcd, storage number bit 0 is 0 or 1
9	1	8x or Cx	DIFE storage number bits 1-4, unit bit 6 is 0 or 1
10	1	8x	DIFE storage number bits 5-8
11	1	8x	DIFE storage number bits 9-12
12	1	0x	DIFE storage number bits 13-16
13	1	ED	VIF time/date
14	1	FF	VIF next byte is manufacturer specific
15	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
16	1	1A	VIFE specifies event log
17-18	6	xxxxxxxxxxxx	Time/date (sec:min:hour / day-month-year)
19	1	xx	CS checksum, calculated from C field to last data
20	1	16	Stop character

When sending the read request a readout reference date and time is specified in the data (6 byte bcd, see table above) and an event offset is specified in the storage number. The sign of the offset is specified in the unit bit in the first DIFE. If the offset is negative the meter will send out events from the specified event and backwards in time. If the offset is -1 the meter will start sending out events from the 1:st event found in memory that have date/time stamp before the specified date/time. If it the offset is -2 the meter will start sending out events from the 2:nd event that have date/time stamp before the specified date/time etc. If the offset is zero or positive the meter will send out events found in memory from the specified event and forward in time. If it the offset is 0 the meter will start sending out events from the 1:st event that have date/time stamp after the specified date/time. If it the offset is 1 the meter will start sending out events from the 2:nd event that have date/time stamp after the specified date/time etc. When the meter searches for the event date/time specified it starts with the most recent event registered and goes backwards in memory until an event is found that fulfils the start date/time specified.

Before sending this command an NKE should always be sent, see section 6.1.3.2 (in case the meter is in the middle of another special data readout process where it will not respond correctly to the command).

The data will be sent out with 5 events in each telegram. If less than 5 events is stored in the meter for the specified date/time and offset all data in the telegram after the last stored event will have status byte marked as "no data available" (15 hex).

After having read a telegram with events it is possible to continue to read events by continue sending REQ_UD2's. The last DIF in the telegram tell if there are more events or not (1F hex when more data exists and 0F hex if no more data exist).

The data sent out for each event is:

- Event type (1 byte binary coded). The different types of events that can be stored are listed below.
- Date/time stamp for start of the event (6 byte bcd in order sec:min:hour / day-month-year)
- Duration of the event (4 byte binary coded)

Event types:
0 : No event available
1 : Total power outage
2 : Power outage on phase 1
3 : Power outage on phase 2
4 : Power outage on phase 3
5 : Overvoltage on phase 1
6 : Overvoltage on phase 2
7 : Overvoltage on phase 3
8 : Undervoltage on phase 1, level 1
9 : Undervoltage on phase 2, level 1
10 : Undervoltage on phase 3, level 1
11 : Undervoltage on phase 1, level 2
12 : Undervoltage on phase 2, level 2
13 : Undervoltage on phase 3, level 2
14 : Not used
15 : Abnormal negative power
16 : THD current above trip level

If the data item read is normal with no specific status associated with it no status-VIFE will be sent out or 0 will be sent out. If the status is "data error" or "no data available" the standard M-bus status coding values will be sent out (18 hex or 15 hex).

Below are a number of commented practical examples of a number of event log readouts where data sent to and read from the meter is shown. All data is in hexadecimal format. Comments after sent or received bytes are preceded with a semicolon.

Readout of 4 telegrams of event log with offset -1:

System sends event log read request command (date/time 14/3-06 09:51:40), offset -1
`68 12 12 68 73 FE 51 CE C0 80 80 00 ED FF F9 1A 40 51 09 14 03 06 06 16`

Meter sends out acknowledge:
`E5`

System sends out request UD2:
`10 7B FE 79 16`

Meter sends out data telegram:
`68 7E 7E 68 08 00 72 42 10 00 00 42 04 02 02 05 00 00 00` ;Data header
`01 FF 6F 01` ;Total power outage
`0E ED 39 24 19 09 14 03 06` ;Time/date 39:24:09 / 14-03-06 (sec:min:hour / day-month-year)
`04 20 FE 00 00 00` ;Duration 254 seconds
`01 FF 6F 01` ;Total power outage
`0E ED 39 12 45 15 13 03 06` ;Time/date 12:45:15 / 13-03-06 (sec:min:hour / day-month-year)
`04 20 5B 00 00 00` ; Duration 91 seconds
`01 FF 6F 0F` ;Abnormal negative power
`0E ED 39 28 44 15 13 03 06`
`04 20 23 00 00 00`
`01 FF 6F 01` ;Total power outage
`0E ED 39 44 38 15 13 03 06`
`04 20 52 01 00 00`
`01 FF 6F 0D` ;Undervoltage on phase 3, level 2

0E ED 39 36 25 15 13 03 06
04 20 3E 00 00 00
1F ;Dif 1F -> More events exist
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ;Pad bytes
0A 16 ;Checksum and stopbyte

System sends out request UD2:
10 5B FE 59 16

Meter sends out data telegram:
68 7E 7E 68 08 00 72 42 10 00 00 42 04 02 02 06 00 00 00 ;Data header
01 FF 6F 0C ;Undervoltage on phase 2, level 2
0E ED 39 36 25 15 13 03 06 ;Time/date 36:25:15 / 13-03-06 (sec:min:hour / day-month-year)
04 20 3E 00 00 00 ;Duration 62 seconds
01 FF 6F 0B ; Undervoltage on phase 1, level 2
0E ED 39 36 25 15 13 03 06
04 20 3E 00 00 00
01 FF 6F 04 ;Power outage on phase 3
0E ED 39 36 25 15 13 03 06
04 20 3E 00 00 00
01 FF 6F 03 ;Power outage on phase 2
0E ED 39 36 25 15 13 03 06
04 20 3E 00 00 00
01 FF 6F 02 ;Power outage on phase 1
0E ED 39 36 25 15 13 03 06
04 20 3E 00 00 00
1F ;Dif 1F -> More events exist
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
30 16

System sends out request UD2:
10 7B FE 79 16

Meter sends out data telegram:
68 7E 7E 68 08 00 72 42 10 00 00 42 04 02 02 07 00 00 00 ;Data header
01 FF 6F 0A ;Undervoltage on phase 3, level 1
0E ED 39 46 24 15 13 03 06 ;Time/date 46:24:15 / 13-03-06 (sec:min:hour / day-month-year)
04 20 70 00 00 00 ;Duration 112 seconds
01 FF 6F 09 ;Undervoltage on phase 2, level 1
0E ED 39 46 24 15 13 03 06
04 20 70 00 00 00
01 FF 6F 08 ;Undervoltage on phase 1, level 1
0E ED 39 46 24 15 13 03 06
04 20 70 00 00 00
01 FF 6F 07 ;Overvoltage on phase 3
0E ED 39 54 22 15 13 03 06
04 20 18 00 00 00
01 FF 6F 06 ;Overvoltage on phase 2
0E ED 39 54 22 15 13 03 06
04 20 18 00 00 00
1F ;Dif 1F -> More events exist
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
E6 16

System sends out request UD2:
10 5B FE 59 16

Meter sends out data telegram:
68 7E 7E 68 08 00 72 42 10 00 00 42 04 02 02 08 00 00 00

01 FF 6F 05 ;Overvoltage on phase 1
0E ED 39 54 22 15 13 03 06
04 20 18 00 00 00
01 FF 6F 01 ;Total power outage
0E ED 39 45 22 15 13 03 06
04 20 03 00 00 00
01 Ff Ef 15 00 ;Status-VIFE 15 -> No data available
0E ED B9 15 00 00 00 00 00 00
04 A0 15 00 00 00 00
01 FF EF 15 00
0E ED B9 15 00 00 00 00 00 00
04 A0 15 00 00 00 00
01 FF EF 15 00
0E ED B9 15 00 00 00 00 00 00
04 A0 15 00 00 00 00
0F ;Dif 0F -> No more events exist
00 00 00 00 00 00
AD 16

Readout of 1 telegrams of event log with offset 0:

System sends event log read request command (date/time 13/3-06 15:39:55), offset 0
68 12 12 68 73 FE 51 8E 80 80 80 00 ED FF F9 1A 55 39 15 13 03 06 8E 16

Meter sends out acknowledge:
E5

System sends out request UD2:
10 7B FE 79 16

Meter sends out data telegram:
68 7E 7E 68 08 00 72 42 10 00 00 42 04 02 02 27 00 00 00 ;Data header
01 FF 6F 01 ;Total power outage
0E ED 39 44 38 15 13 03 06 ;Time/date 44:38:15 / 13-03-06 (sec:min:hour / day-month-year)
04 20 52 01 00 00 ;Duration 338 seconds
01 FF 6F 0F ;Abnormal negative power
0E ED 39 28 44 15 13 03 06 ;Time/date 28:44:15 / 13-03-06 (sec:min:hour / day-month-year)
04 20 23 00 00 00
01 FF 6F 01 ;Total power outage
0E ED 39 12 45 15 13 03 06
04 20 5B 00 00 00
01 FF 6F 01 ;Total power outage
0E ED 39 24 19 09 14 03 06
04 20 FE 00 00 00
01 FF EF 15 00 ;Status-VIFE 15 -> No data available
0E ED B9 15 00 00 00 00 00 00
04 A0 15 00 00 00 00
0F ;Dif 0F -> No more events exist
00 00 00 00 00 00 00 00 00 00 00 00
04 16

6.1.4.3.5 Read request and readout of current harmonics

Read request of current harmonics is done by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	07	L-field, calculated from C field to last user data
3	1	07	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	00	DIF size, no data
9	1	FF	VIF next byte is manufacturer specific
10	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
11	1	1B	VIFE specifies current harmonics
12	1	xx	CS checksum, calculated from C field to last data
13	1	16	Stop character

The meter will send out harmonic data for one phase in each telegram, which means 3 telegrams in a 3-element meter, 2 telegrams in a 2-element meter and 1 telegram in a single phase meter.

Before sending this command an NKE should always be sent, see section 6.1.3.2 (in case the meter is in the middle of another special data readout process where it will not respond correctly to the command).

Data sent out will be the total harmonic distorsion and the harmonics measured, normally those with numbers 2-9. Note that the total harmonic distorsion is calculated from the harmonics measured and is thus not the true total harmonic distorsion, which would require all harmonics (up to infinite frequency) to be measured. If any harmonic have frequency above 500 Hz it will not be measured and will be marked “not available” (see section 2.7.3.7).

Data may temporarily be marked “not available” if there are disturbances on the net (for example due to short voltage dips) making the frequency measurement invalid. Also directly after startup all harmonics will be marked “not available” as they haven't been measured yet. As the harmonics are measured sequentially one at a time they will be available one by one and after approximately 10 seconds after startup they are normally all available.

The telegram sent out containing harmonics will be (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	73	L-field, calculated from C field to last user data
3	1	73	L-field, repeated
4	1	68	Start character
5	1	08	C-field, RSP_UD
6	1	xx	A-field, address
7	1	72	CI-field, variable data respond, LSB first
8-11	4	xxxxxxxx	Identification Number, 8 BCD digits
12-13	2	4204	Manufacturer: ABB
14	1	05	Version
15	1	02	Medium, 02 = Electricity
16	1	xx	Number of accesses
17	1	xx	Status
18-19	2	0000	Signature (0000 = no encryption)
20	1	02	DIF size, 2 byte integer
21	1	FF	VIF next byte is manufacturer specific
22	1	ED	VIFE current harmonics
23	1	FF	VIF next byte is manufacturer specific
24	1	8x	VIFE phase x
25	1	FF	VIF next byte is manufacturer specific
26	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
27	1	00	Number 0 signifies total harmonics
28-29	2	xxxx	Total harmonics in percent with 1 decimal
30	1	02	DIF size, 2 byte integer
31	1	FF	VIF next byte is manufacturer specific
32	1	ED	VIFE current harmonics
33	1	FF	VIF next byte is manufacturer specific
34	1	8x	VIFE phase x
35	1	FF	VIF next byte is manufacturer specific
36	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
37	1	02	Harmonic number
38-39	2	xxxx	2:nd harmonic in percent with 1 decimal
40	1	02	DIF size, 2 byte integer
41	1	FF	VIF next byte is manufacturer specific
42	1	ED	VIFE current harmonics
43	1	FF	VIF next byte is manufacturer specific
44	1	8x	VIFE phase x
45	1	FF	VIF next byte is manufacturer specific
46	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
47	1	03	Harmonic number
48-49	2	xxxx	3:rd harmonic in percent with 1 decimal
50	1	02	DIF size, 2 byte integer
51	1	FF	VIF next byte is manufacturer specific
52	1	ED	VIFE current harmonics
53	1	FF	VIF next byte is manufacturer specific
54	1	8x	VIFE phase x
55	1	FF	VIF next byte is manufacturer specific
56	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
57	1	04	Harmonic number
58-59	2	xxxx	4:th harmonic in percent with 1 decimal

Harmonic data continued:

Byte No	Size (in bytes)	Value	Description
60	1	02	DIF size, 2 byte integer
61	1	FF	VIF next byte is manufacturer specific
62	1	ED	VIFE current harmonics
63	1	FF	VIF next byte is manufacturer specific
64	1	8x	VIFE phase x
65	1	FF	VIF next byte is manufacturer specific
66	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
67	1	05	Harmonic number
68-69	2	xxxx	5:th harmonic in percent with 1 decimal
70	1	02	DIF size, 2 byte integer
71	1	FF	VIF next byte is manufacturer specific
72	1	ED	VIFE current harmonics
73	1	FF	VIF next byte is manufacturer specific
74	1	8x	VIFE phase x
75	1	FF	VIF next byte is manufacturer specific
76	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
77	1	05	Harmonic number
78-79	2	xxxx	5:th harmonic in percent with 1 decimal
80	1	02	DIF size, 2 byte integer
81	1	FF	VIF next byte is manufacturer specific
82	1	ED	VIFE current harmonics
83	1	FF	VIF next byte is manufacturer specific
84	1	8x	VIFE phase x
85	1	FF	VIF next byte is manufacturer specific
86	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
87	1	05	Harmonic number
88-89	2	xxxx	5:th harmonic in percent with 1 decimal
90	1	02	DIF size, 2 byte integer
91	1	FF	VIF next byte is manufacturer specific
92	1	ED	VIFE current harmonics
93	1	FF	VIF next byte is manufacturer specific
94	1	8x	VIFE phase x
95	1	FF	VIF next byte is manufacturer specific
96	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
97	1	05	Harmonic number
98-99	2	xxxx	5:th harmonic in percent with 1 decimal
100	1	02	DIF size, 2 byte integer
101	1	FF	VIF next byte is manufacturer specific
102	1	ED	VIFE current harmonics
103	1	FF	VIF next byte is manufacturer specific
104	1	8x	VIFE phase x
105	1	FF	VIF next byte is manufacturer specific
106	1	F8	Extension of manufacturer specific vife's, next vife(s) used for numbering
107	1	05	Harmonic number
108-109	2	xxxx	5:th harmonic in percent with 1 decimal
110	1	1F	DIF, more records will follow in next telegram
111-119	9	000000000000000000	PAD bytes
120	1	xx	CS checksum, calculated from C field to last data
121	1	16	Stop character

It is also possible to send a read request where a specific phase is specified by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description
1	1	68	Start character
2	1	08	L-field, calculated from C field to last user data
3	1	08	L-field, repeated
4	1	68	Start character
5	1	53 / 73	C-field, SND_UD
6	1	xx	A-field, address
7	1	51	CI-field, data send, LSB first
8	1	01	DIF size, 8 bit integer
9	1	FF	VIF next byte is manufacturer specific
10	1	F9	VIF extension of manufacturer specific vife's, next vife specifies actual meaning
11	1	1B	VIFE specifies current harmonics
12	1	xx	Phase number (1-3)
13	1	xx	CS checksum, calculated from C field to last data
14	1	16	Stop character

The meter will start sending out harmonic data from the requested phase. If a phase number not supported by the meter is requested (for example phase 2 or 3 in a single phase meter) all data in the telegram will be marked "not available".

Below are a number of commented practical examples of a number of current harmonic readouts where data sent to and read from the meter is shown. All data is in hexadecimal format. Comments after sent or received bytes are preceded with a semicolon.

Readout of all current harmonic data from a 3-element meter:

System sends harmonic data read request command

```
68 07 07 68 73 fe 51 00 ff f9 1b d5 16
```

Meter sends out acknowledge:

```
E5
```

System sends out request UD2:

```
10 7b fe 79 16
```

Meter sends out data telegram:

```
68 73 73 68 08 00 72 56 34 12 00 42 04 05 02 dc 00 00 00 ;Data header
02 ff ed ff 81 ff f8 00 16 01 ;Total current harmonic distorsion for phase 1 = 27.8 %
02 ff ed ff 81 ff f8 02 00 00 ;2:nd current harmonic distorsion for phase 1 = 0 %
02 ff ed ff 81 ff f8 03 c2 00 ;3:rd current harmonic distorsion for phase 1 = 19.4 %
02 ff ed ff 81 ff f8 04 03 00
02 ff ed ff 81 ff f8 05 b6 00
02 ff ed ff 81 ff f8 06 03 00
02 ff ed ff 81 ff f8 07 53 00
02 ff ed ff 81 ff f8 08 03 00
02 ff ed ff 81 ff f8 09 02 00
1f ; Dif 1F -> More harmonic data exist
00 00 00 00 00 00 00 00 00
04 16
```

System sends out request UD2:

```
10 5b fe 59 16
```

Meter sends out data telegram:

```
68 73 73 68 08 00 72 56 34 12 00 42 04 05 02 dd 00 00 00 ;Data header
02 ff ed ff 82 ff f8 00 85 00 ;Total current harmonic distorsion for phase 2 = 13.3 %
02 ff ed ff 82 ff f8 02 02 00 ;2:nd current harmonic distorsion for phase 2 = 0.2 %
```

```
02 ff ed ff 82 ff f8 03 62 00 ;3:rd current harmonic distorsion for phase 2 = 9.8 %
02 ff ed ff 82 ff f8 04 04 00
02 ff ed ff 82 ff f8 05 5b 00
02 ff ed ff 82 ff f8 06 01 00
02 ff ed ff 82 ff f8 07 02 00
02 ff ed ff 82 ff f8 08 00 00
02 ff ed ff 82 ff f8 09 04 00
1f ; Dif 1F -> More harmonic data exist
00 00 00 00 00 00 00 00 00
70 16
```

System sends out request UD2:

```
10 7b fe 79 16
```

Meter sends out data telegram:

```
68 73 73 68 08 00 72 56 34 12 00 42 04 05 02 de 00 00 00 ;Data header
02 ff ed ff 83 ff f8 00 60 00 ;Total current harmonic distorsion for phase 3 = 9.6 %
02 ff ed ff 83 ff f8 02 00 00 ;2:nd current harmonic distorsion for phase 3 = 0 %
02 ff ed ff 83 ff f8 03 60 00 ;3:rd current harmonic distorsion for phase 3 = 9.6 %
02 ff ed ff 83 ff f8 04 02 00
02 ff ed ff 83 ff f8 05 04 00
02 ff ed ff 83 ff f8 06 00 00
02 ff ed ff 83 ff f8 07 01 00
02 ff ed ff 83 ff f8 08 02 00
02 ff ed ff 83 ff f8 09 03 00
0f ; Dif 0F -> No more harmonic data exist
00 00 00 00 00 00 00 00 00
e7 16
```

Readout of harmonic data starting from phase 2:

System sends harmonic data read request command

```
68 08 08 68 73 fe 51 01 ff f9 1b 02 d8 16
```

Meter sends out acknowledge:

```
E5
```

System sends out request UD2:

```
10 7b fe 79 16
```

Meter sends out data telegram:

```
68 73 73 68 08 00 72 89 34 29 00 42 04 06 02 2e 00 00 00 ;Data header
02 ff ed ff 82 ff f8 00 1a 05 ;Total current harmonic distorsion for phase 2 = 130.6 %
02 ff ed ff 82 ff f8 02 06 00 ;2:nd current harmonic distorsion for phase 2 = 0.6 %
02 ff ed ff 82 ff f8 03 70 03 ;3:rd current harmonic distorsion for phase 2 = 88.0 %
02 ff ed ff 82 ff f8 04 05 00
02 ff ed ff 82 ff f8 05 cc 02
02 ff ed ff 82 ff f8 06 07 00
02 ff ed ff 82 ff f8 07 0b 02
02 ff ed ff 82 ff f8 08 09 00
02 ff ed ff 82 ff f8 09 80 01
1f ; Dif 1F -> More harmonic data exist
00 00 00 00 00 00 00 00 00
c6 16
```

System sends out request UD2:

```
10 7b fe 79 16
```

Meter sends out data telegram:

```
68 73 73 68 08 00 72 89 34 29 00 42 04 06 02 2f 00 00 00 ;Data header
02 ff ed ff 83 ff f8 00 12 05 ;Total current harmonic distorsion for phase 3 = 129.8 %
```

```
02 ff ed ff 83 ff f8 02 09 00 ;2:nd current harmonic distorsion for phase 3 = 0.9 %
02 ff ed ff 83 ff f8 03 78 03 ;3:rd current harmonic distorsion for phase 3 = 88.8 %
02 ff ed ff 83 ff f8 04 04 00
02 ff ed ff 83 ff f8 05 db 02
02 ff ed ff 83 ff f8 06 09 00
02 ff ed ff 83 ff f8 07 00 02
02 ff ed ff 83 ff f8 08 0b 00
02 ff ed ff 83 ff f8 09 3f 01
0f ; Dif 0F -> No more harmonic data exist
00 00 00 00 00 00 00 00 00
89 16
```

6.1.4.4 Error/Information flags

Byte	Bit	Description
1	0	Eeprom Crc error
	1	Hardware error
	2	Date not set
	3	Time not set
	4	Two element meter
	5	Single phase meter
	6	Active energy
	7	Reactive energy
2	0	U1 missing
	1	U2 missing
	2	U3 missing
	3-7	(0)
3	0-7	(0)
4	0-6	(0)
	7	Negative power for element 1
5	0	Negative power for element 2
	1	Negative power for element 3
	2	Negative power total
	3	(0)
	4	Phase connected to neutral
	3-7	(0)
	5	(0)
	6-7	(0)
6	0-3	(0)
	4	Primary load profile energy values
	5	Primary linstrumentation and maximum demand values
	6-7	(0)
7,8	0-7	(0)

6.1.5 INSTALLATION

Cable type	Max. no of meters	Max. length
JYStY N*2*0.8	250	350m
Standard mains type (1.5mm²)	250	1000m

For telephone cabling with 0.6mm diameter wires either the maximum distance or the maximum number of meters has to be halved.

Connect the meter to the M-Bus network on the screw terminals according to the figure below.

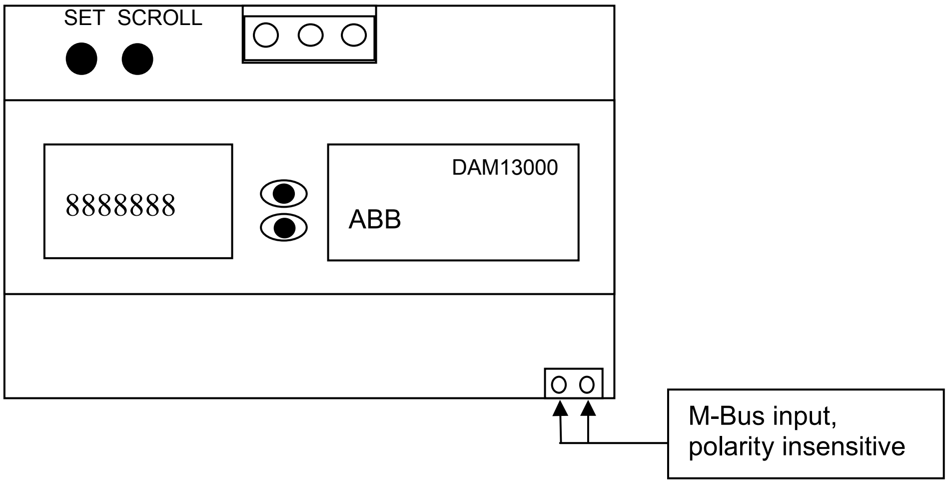


Fig. 6-2 Connecting M-Bus.

The baud rate and primary address can be set via the communication bus (see section 6.1.4.2.2) or with the buttons (see section 2.7.4.5).

As an aid when trouble-shooting, there is a special "communication" display item in A*lternative Mode* in which the current communication status is displayed (see section 2.7.2.8).

6.2 LONWORKS

LonWorks is a bus system for home and building automation. It is a decentralized system with distributed intelligence. LonWorks supports free topology and communication on various media.

The LonWorks interface in the DELTAplus meter consists of a separate PCB with a Neuron and an FTT-10A transceiver for communication on twisted pair. The transmission of data between the meter and the interface board is performed via internal communication. The interface board reads the meter cyclically. The reading interval is normally 30 seconds and can be changed via the network variable nciInternalUpdT.

6.2.1 TECHNICAL DATA (ADDITIONS TO THE BASIC METER)

Operating and display elements	Service LED and pin
Network interface	FTT-10A
Communication speed	78 kbps

A software clock is implemented in the LonWorks interface. This clock is based on a timer in the Neuron. It takes leap years but not summer/winter time changes into account. The clock will run approximately 2 seconds too fast or slow per 24 hours. There is no back up for the clock and it is cleared if power fails.

6.2.1.1 Communication objects

Node Object

Register	**Network variable name**	**Description**
	nviRequest	Supports RQ_NORMAL, RQ_UPDATE_STATUS and RQ_REPORT_MASK
	nvoStatus	
Time	nviTimeSet nvoTime	Set date and time in the software clock Date and time from the software clock
Node State	nvoNodeState	Bit0 - Master status bit. If any other bit is set, this bit is also set. Bit1 - Any application error. Bit2 - Power low. Bit3 - Permanent error. Bit4 - Temporary error. Bit5 - Installation error. Bits 6 - 8 Unused. Bit9 - Internal communication error. Bit 10 - No data available. Bit 11 - Hardware error. Bit 12 - Invalid time. Bits 13 - 15 Unused.
Meter ID	nvoMeterID	Meter serial number, 8 digits ASCII
Installation check	nviInstChkClr	Reset installation check result (with ST_ON)

Utility Data Logger registers (variable type SNVT_reg_val_ts)

Register	Network variable name	Description
Active energy total	nvoAEnergyTot	Total cumulative Active Energy
Active energy tariff 1	nvoAEnergyTf1	Cumulative Active Energy Tariff 1
Active energy tariff 2	nvoAEnergyTf2	Cumulative Active Energy Tariff 2
Active energy tariff 3	nvoAEnergyTf3	Cumulative Active Energy Tariff 3
Active energy tariff 4	nvoAEnergyTf4	Cumulative Active Energy Tariff 4
Reactive energy total	nvoREnergyTot	Total cumulative Reactive Energy
Reactive energy tariff 1	nvoREnergyTf1	Cumulative Reactive Energy Tariff 1
Reactive energy tariff 2	nvoREnergyTf2	Cumulative Reactive Energy Tariff 2
Reactive energy tariff 3	nvoREnergyTf3	Cumulative Reactive Energy Tariff 3
Reactive energy tariff 4	nvoREnergyTf4	Cumulative Reactive Energy Tariff 4
Transformer ratio	nvoTrfRatio	Read transformer ratio
Counter	nvoCounter nviCounterRst	Value of the pulse counter Reset pulse counter
Active power	nvoActPwrTot	Instantaneous total active power
Reactive power	nvoReactPwrTot	Instantaneous total reactive power
Apparent power	nvoAppPwrTot	Instantaneous total apparent power
Voltage L1-N	nvoVoltL1_N	Instantaneous voltage between L1 and neutral
Voltage L2-N	nvoVoltL2_N	Instantaneous voltage between L2 and neutral
Voltage L3-N	nvoVoltL3_N	Instantaneous voltage between L3 and neutral
Voltage L1-L2	nvoVoltL1_L2	Instantaneous voltage between L1 and L2
Voltage L2-L3	nvoVoltL2_L3	Instantaneous voltage between L3 and L2
Current L1	nvoCurrentL1	Instantaneous current in the L1 phase
Current L2	nvoCurrentL2	Instantaneous current in the L2 phase
Current L3	nvoCurrentL3	Instantaneous current in the L3 phase
Power factor	nvoPowerFact	Instantaneous total power factor

To reset the pulse counter, a value shall be sent to nviCounterRst (SNVT_reg_val) with raw = 0, unit = RVU_NONE and nr_decimals = 0.

Register	Network variable name	Variable type	Description
Tariff	nviTariff nvoTariffFb	SNVT_count	Set new tariff (range 1 -4) Current tariff
Input	nvoInputState nvoStoredState nviClrStdState	SNVT_lev_disc	Current state Stored state Clear stored state (with ST_ON)
Output	nviOutput nvoOutputFb	SNVT_lev_disc	Set state (ST_ON, ST_OFF) Current state
Error flags	nvoErrorFlags	8 * 8 byte	Internal error flags (described in 0)
Internal update timer	nciInternalUpdT	SNVT_time_sec	Data update interval in seconds. Allowed range 10 - 600 seconds. Reset node after modifying.

6.2.2 COMMISSIONING/OPERATION

Before the meter is commissioned the service LED is flashing, after commissioning it is off.

6.2.3 INSTALLATION

Cable type	Wire dia. / AWG	R_{loop} Ω/km	C nF/km	Vprop % of c
Belden 85102, single twisted pair, stranded 19/29, unshielded, 150°C	1.3 mm / 16	28	56	62
Belden 8471, single twisted pair, stranded 19/29, unshielded, 60°C	1.3 mm / 16	28	72	55
Level IV 22/AWG, twisted pair, Typically solid & unshielded	0.65 mm / 22	106	49	67
JY (St) Y 2x2x0.8, 4-wire helical twist, solid, shielded	0.8 mm / 20.4	73	98	41

If a shielded cable is used, the shield should be connected to earth ground via a single 470kΩ, 1/4 watt, <=10%, metal film resistor to prevent static charge build-up.

Connect the meter to the LonWorks network on the screw terminals according to fig. 6-3 below.

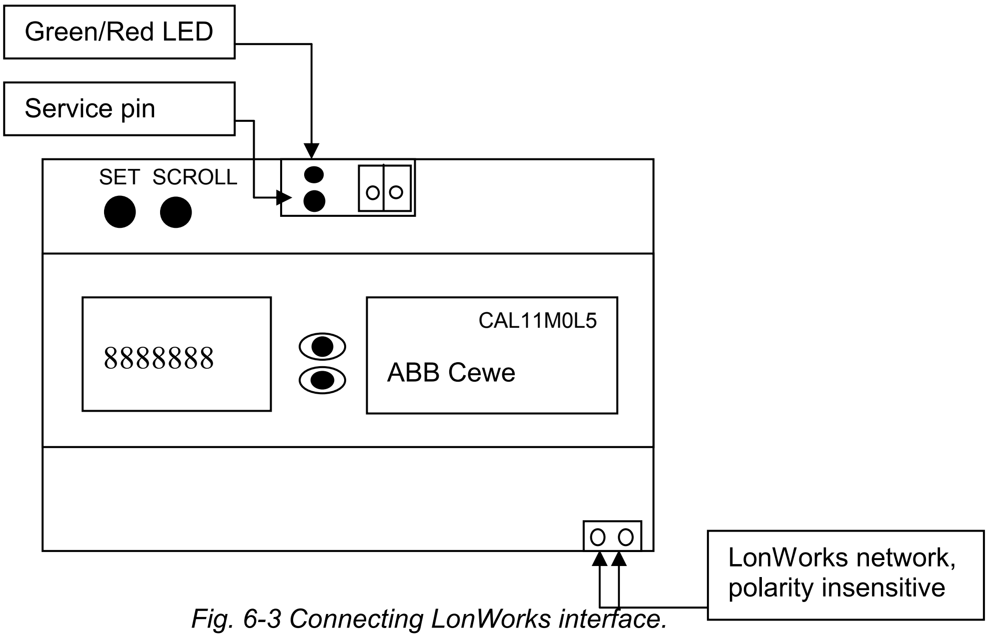


Fig. 6-3 Connecting LonWorks interface.

7 ACCESORIES

Accessory	Type	ABB part number
Communication adapter for M-Bus	CTM04000	2CMA 137 090 R1000
Communication adapter for RS232	CRM04000	2CMA 137 091 R1000
Communication adapter for Ethernet	CEM05000	2CMA 137 099 R1000
Communication adapter for LON PLC, A-band	CAL06000	2CMA 137 100 R1000
Communication adapter for LON PLC, C-band	CCL06000	2CMA 137 103 R1000
Communication adapter for GSM/GPRS	CGM06000	2CMA 137 104 R1000
Communication adapter for EIB/KNX	ZS/S 1.1	2CDG 110 083 R0011
DIN-rail (for wall-mounting)		2CMA 132 540 R1000
LONG cover (for wall-mounting)		2CMA 132 633 R1000
Front mounting kit (for panel-mounting)		2CMA 132 635 R1000
Time switch clock (for tariff control)	DTS 7/2	2CSM 122 100 R0601

8 SERVICE AND MAINTENANCE

8.1 RECALIBRATION

It should not be necessary to recalibrate the DELTAplus/DELTAmax meter during its lifetime as it is an electronic meter with no moving parts with electronics and voltage and current sensors that do not naturally degrade or change with time under specified environmental conditions. If a degradation in the accuracy is observed the meter has probably been partly damaged (for example due to lightning strike or extreme environmental conditions etc) and should be sent for repair or exchanged.

8.2 CLEANING

If the meter is dirty and needs to be cleaned, use lightly moistened tissue with a water based mild detergent. Make sure no liquid goes into the meter as this could damage the meter.