MS1 – 7352 Ed04

USER MANUAL FOR ENERIUM 100/110/200/210/300/310 POWER MONITORS

Power Monitor **232 / 332 / 333**

TABLE OF CONTENTS

1 SAFETY

1.1 Preamble

- Read the following recommendations before installing and using the device.
- You have just purchased an ENERIUM 100, 110, 200, 210, 300 or 310 power monitor. Thank you for choosing it.
- Make sure the device is intact and undamaged as soon as you receive it. In the event of any problems, please contact the after-sales department for any repairs or replacements.
- To get best use from your device please read this manual carefully and apply its storage, installation and operating instructions with care.
- The device described in this manual is intended to be used by trained staff only.
- Any maintenance operations must be carried out by qualified and authorised personnel only.
- For correct and safe use and for all maintenance operations it is essential that staff follow standard safety procedures.
- This device is intended to be used in Category III, pollution degree 2 installation conditions in accordance with IEC 61010-1.
- Before installation, check that the supply voltage matches that of the ENERIUM device.

1.2 Initial precautions

1.2.1 Safety precautions

- Before installing this electrical device and any associated peripherals, check that the power is disconnected and isolated in accordance with current safety norms.

1.2.2 Precautions against parasitics

- Although the *ENERIUM* is protected from electrical and electromagnetically induced interference, keep away from the immediate vicinity of equipment generating significant electrical noise (high-power switches, busbars, etc.) The quality of data communication on the data bus depends heavily on taking such precautions.

1.2.3 Precautions in the event of breakdowns

- When safe operation is no longer possible, the instrument must be switched off and isolated. This applies when:
    - The device is visibly damaged during operation (whether the device still operates or not),
    - The device does not work after prolonged storage in poor conditions,
    - The device no longer works following severe damage during transport.

1.3 Cleaning instructions

- When the monitor is disconnected from the mains, clean the outer surface using only a dry cloth. Do not use abrasives or solvents. Prevent the connector terminals getting wet.

2 WARRANTY, RESPONSIBILITY AND INTELLECTUAL PROPERTY

2.1 Warranty

- Unless expressly stipulated, the warranty runs for twelve months after the date of supply of the monitor (extract from our General Conditions of Sale, available on request).

2.2 Intellectual property rights

- This manual is the property of *ENERDIS* and is protected by copyright. It may not be distributed, reproduced, or translated, in whole or in part, in any manner and in any form whatsoever.
- *ENERIUM* is a registered *ENERDIS* trademark.

2.3 Maintenance

- As no electrical or electronic part is end user-replaceable, the monitor must be returned to the *Manumesure* after-sales service centre.

2.4 Equipment end-of-life

- This product falls within the scope of the Directive 2012/19/CE on waste electrical and electronic equipment (WEEE).
- Contact the company ENERDIS for information regarding the dismantling and end of life equipment.

3 OVERVIEW

3.1 Packing

- Each delivered product should contain, at least, the following parts:

Designation	No. Off
ENERIUM 100,110, 200, 210, 300 or 310 power monitor	1
CD-ROM containing: ▪ This manual in pdf format ▪ E.Set configuration software (with a 30-day trial version of E.View/E.View+) ▪ The USB driver for the optical head accessory	1
Simplified operating instructions (A4 format)	1
ENERIUM 100, 200 or 300 table brackets	4
ENERIUM 110, 210 or 310 DIN rail brackets	2

- Alternative parts depending on the option chosen:

Designation	No. Off
Removable connectors for optional cards	0 to 4

3.2 Optional accessories and documentation

Designation	Comment	Code
USB optical head	To enable local communication	P01330401
E.View software	Display software (Tabular)	P01330401
E.View+ software	Display software (Graphical)	P01330401
E.Online software	Multi-energy application software	P01335075
Mapping and control words manual	Manual	MS0-7423
Load curves operating manual	Manual	MS0-7389
Recording curves operating manual	Manual	MS0-7390
User manual power quality measurements	Manual	MS1-7530
DIN rail and cabinet fixing kit	Allows fitting on DIN rails and to the cabinet base	P01330401
E.Set / E.View / E.view+ manual	User manual	MS0-7376
Firmware update	Instruction manual	MS0-7419

3.3 Overview

- ENERIUM 100, 110, 200, 210, 300 and 310 power monitors are 144 x 144 format monitors, conforming to DIN 43700, for electrical networks of all types, for all measurement, display and supervisory applications on low and medium voltage networks.
- ENERIUM 100, 110, 200, 210, 300 and 310 conform to the NF EN 61557-12 power measurement standard.
- ENERIUM 100 and 110 conform to the (1) (IM2) 232 measurement index.
- ENERIUM 200 and 210 conform to the (1) (IM2) 332 measurement index.
- ENERIUM 300 and 310 conform to the (1) (IM2) 333 measurement index.
- ENERIUM power monitors process more than 50 network quantities (U, V, I, P, Q, S, PF, tanφ, real, reactive and apparent energy, THD, etc.).
- The information collected is available on the front panel of the monitor in 5 languages, via a backlit LCD display, as well as via an RS485 digital output using ModBus/RTU or ASCII, or Ethernet using Modbus/TCP.
- One or more optional outputs generate an alarm signal, send pulse counts or manage analog outputs.
- It can be programmed locally or remotely, enabling the monitor to be integrated into an installation rapidly.
- The power monitor is available in six different models: ENERIUM 100, 110, 200, 210, 300 and310.
- Models 110, 210 and 310 have no display; equivalent models with a display are the 100, 200 and 300.

The ENERIUM 300 monitor

(1) Source : http://www.gimelec.fr

3.4 Model comparison

- The table below shows the main characteristics of the 100, 110, 200, 210, 300 and 310 models.

	Enerium 100	Enerium 110	Enerium 200	Enerium 210	Enerium 300	Enerium 310
Measurements						
Calculation and measurement of the neutral current	✓	✓	✓	✓	✓	✓
3- or 4-wire capability	✓	✓	✓	✓	✓	✓
Tan φ	✓	✓	✓	✓	✓	✓
Harmonics up to order	25	25	50	50	50	50
400 Hz network	-	-	-	-	-	-
EN 50160	-	-	-	-	✓	✓
Waveforms (64 samples per cycle)	-	-	-	-	✓	✓
Display						
Custom screens	✓	-	✓	-	✓	-
Power Quality	-	-	-	-	✓	✓
I/O cards						
Optional card(1)	4	4	4	4	4	4
Alarms						
Basic	16	16	16	16	16	16
Global	8	8	8	8	8	8
Event journal records	1024	1024	1024	1024	1024	1024
Curves						
Load curve	-	-	8 quantities chosen from 10 possible ones(2)	8 quantities chosen from 10 possible ones(2)	8 quantities chosen from 10 possible ones(2)	8 quantities chosen from 10 possible ones(2)
Recording curve	✓	✓	✓	✓	✓	✓
Communication						
Optical (front panel)	✓	-	✓	-	✓	-
Optical (rear panel)	✓	✓	✓	✓	✓	✓
Ethernet (Modbus / TCP) (3)	✓	✓	✓	✓	✓	✓
RS485 (Modbus RTU or ASCII) (3)	✓	✓	✓	✓	✓	✓
IP address parameters at the front	✓	-	✓	-	✓	-
Graphs						
Phasor	✓	-	✓	-	✓	-
Harmonics	-	-	✓	-	✓	-
Fixing						
LCD display	✓	-	✓	-	✓	-
DIN Rail	✓	✓	✓	✓	✓	✓
Panel	✓	-	✓	-	✓	-
Inside cabinet	With fixing kit4)	✓	With fixing kit4)	✓	With fixing kit4)	✓

	Enerium 100	Enerium 110	Enerium 200	Enerium 210	Enerium 300	Enerium 310
LED counter	✓	-	✓	-	✓	-

(1) The card options are type 2 analog outputs, 2 analog inputs, 2 digital outputs and 2 digital inputs.
(2) P+, P-, Q1, Q2, Q3, Q4, S+, S-, E-TOR1, E-TOR2, TOR3, TOR4, TOR5, TOR6, TOR7, TOR8, ANAI1, ANAI2, ANAI3, ANAI4, ANAI5, ANAI6, ANAI7 and ANAI8.
(3) The RS485 and Ethernet interfaces cannot both be present simultaneously.
(4) See § 4Mechanical Construction

3.5 Terminology

Measurements	Meaning
Vi, Ui	Phase-Ground (Neutral) Voltage
Uij	Phase-Phase Voltage

4 MECHANICAL CONSTRUCTION

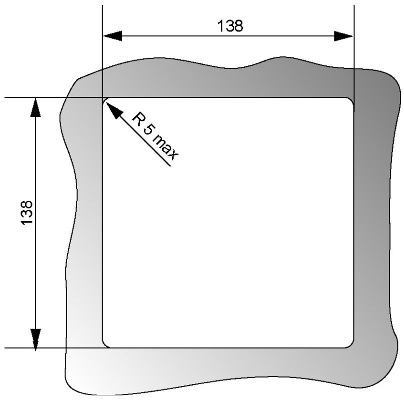
4.1 Preamble

Overall dimensions (mm)	See below
Weight	With display: 800 g & without display: 700 g
Fixing	Panel mounting, DIN Rail to DIN 43700, inside cabinet
Cutout size	138 x 138 mm
Fixing	See paragraphs 4.2 and 4.3 (Optional DIN Rail and paragraph 3.2 Page 5)
Rating plate	At the rear of the equipment

4.2 Version with display (Models 100/200/300)

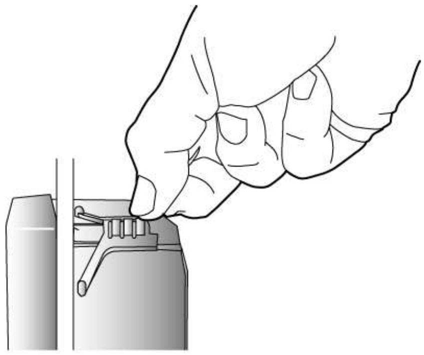
- Fixing can be by panel, DIN Rail, or inside the cabinet Proceed as follows:
- For panel fixing:

- Make a cutout as shown below:



Panel cutout dimensions

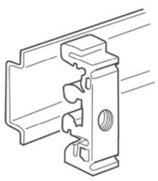
- Insert the *ENERIUM* in the cutout from the front.
- Slide the four panel fasteners and push them until they lock the *ENERIUM* into place.



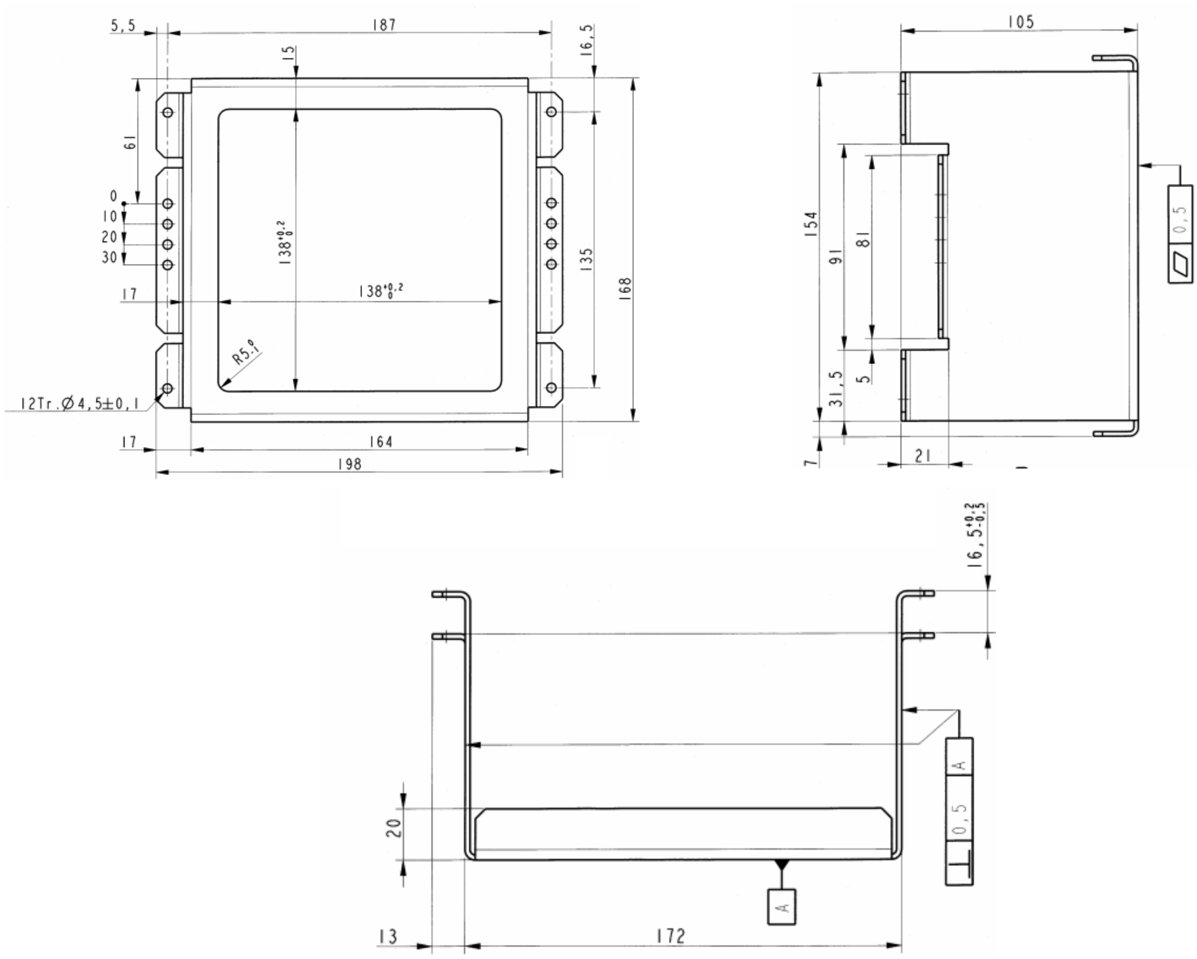
Insert into the panel by lifting up the front and sliding it in

- For DIN Rail and fixing inside the cabinet:

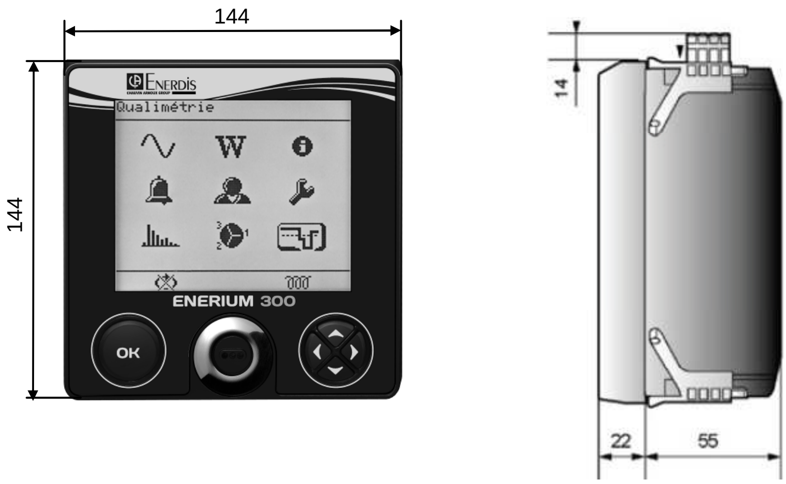
- DIN Rail fixing :
  - Insert the *ENERIUM* in the cutout in the support fixture.
  - Fit the DIN Rail clips in the support fixture.
  - Connect up the device.
  - Clip everything to the DIN Rail in the cabinet.
- Fixing inside the cabinet:
  - Insert the *ENERIUM* in the cutout in the support fixture.
  - Connect up the device.
  - Bolt everything into the cabinet.



Fixing clips



Support fixture for the DIN Rail and the inside of the cabinet

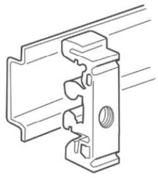


Overall dimensions in millimetres

4.3 Version without display (Models 110/210/310)

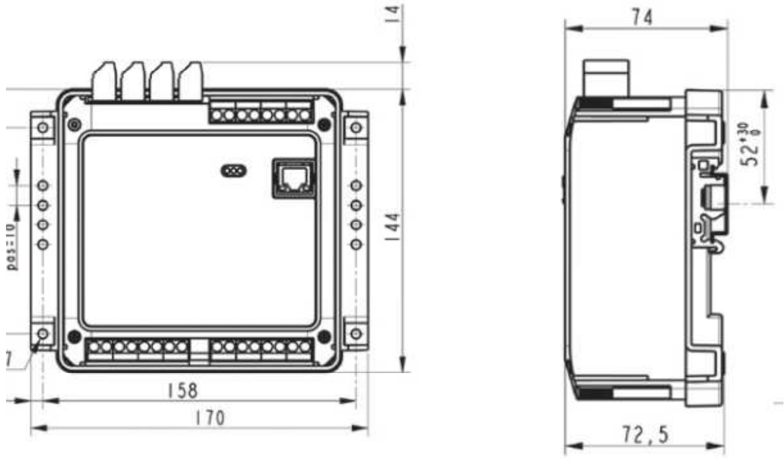
- ❑ Fixing of these models can be by DIN Rail or inside the cabinet Proceed as follows:

- Clip the two supports (see below) on the DIN Rail (spacing of 158 mm between bolts).
- Bolt the monitor on the two supports (for height levels are possible).



Support for DIN Rail mounting

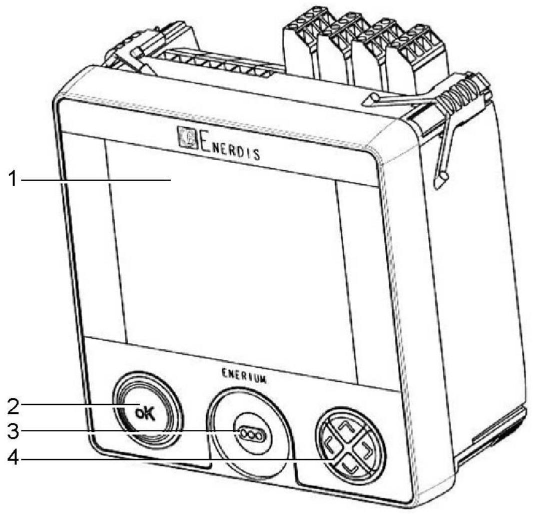
- To fix the monitor inside the cabinet, screw the unit directly into the cabinet.



Overall dimensions in millimetres

5 FRONT VIEW

- This section shows which components are accessible from the front for each model.



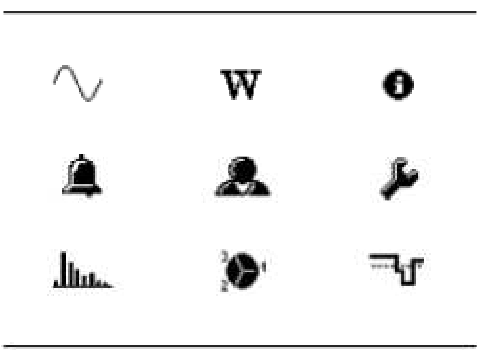
Front face of the ENERIUM 100, 200 or 300

No.	Function
1	LCD screen
2	"OK" confirmation key
3	Front optical interface
4	Navigation keys

5.1 Display screen

5.1.1 Introduction

- The screen is a positive transmissive type LCD, has 128 lines of 160 pixels and is back-lit.
- The backlight is activated by pressing one of the two buttons and switches off if no key press is detected for 3 minutes
- The contrast and brightness are adjustable via local or remote communication.
- The main menu appears as follows:



Main menu

- This screen enables:
  - numerous measured and electrical quantities to be displayed
  - Parameters to be displayed and changed
- For the ENERIUM 100, the  ,  and  icons are not available.
- For the ENERIUM 200, the  icon is not available.
- For the ENERIUM 300, all icons are available.

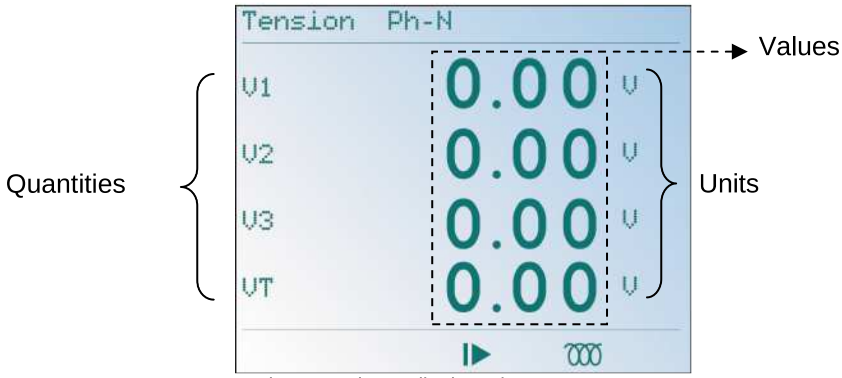
5.1.2 The upper part

- The upper part shows the name of the screen being displayed.

Display of the input phase-neutral voltages

5.1.3 The central part

- The central part gives an indication of the value of quantities displayed together with the corresponding units.



The central part displays the measurements

5.1.4 The lower part

- The lower part shows the states of the various icons

Icons on the lower part of the screen

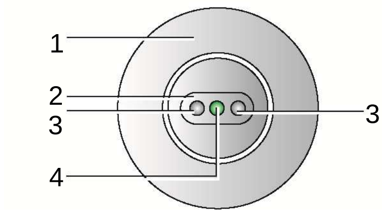
Icon	Meaning
	Flashing symbol, indicating that at least one global alarm is active
	Fixed symbol, indicating a phase sequence error for voltage inputs
	Flashing symbol, indicating that communication is in progress via the local or remote interfaces
	Fixed symbol, indicating that automatic screen scrolling mode is active
	Fixed symbol, indicating that the network is capacitive
	Fixed symbol, indicating that the network is inductive
	Fixed symbol, indicating that the network is a generator (not shown in receiver mode)

5.2 Optical interface

5.2.1 Introduction

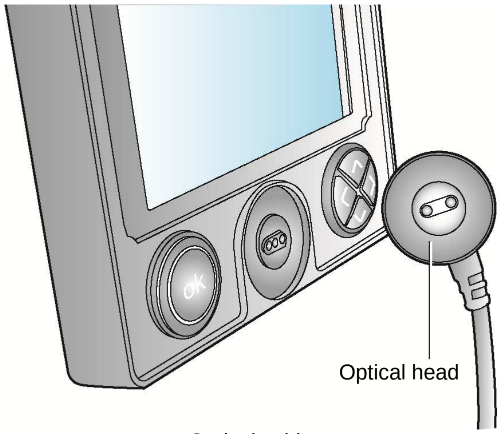
- The optical interface consists of the following parts:

No.	Function
1	Metal washer
2	Locating device
3	Infrared communication transmitter and receiver
4	Green metrology LED and visual indicator



5.2.2 Description

- The optical interface allows parameters to be set, the downloading of measurements stored locally on the ENERIUM to be sent to a PC, and the firmware to be updated, via the optical cable (accessory sold separately, paragraph 3.2 Page 5).

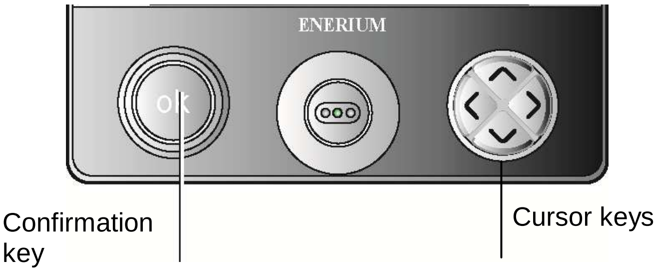


Optical cable

5.2.3 Characteristics

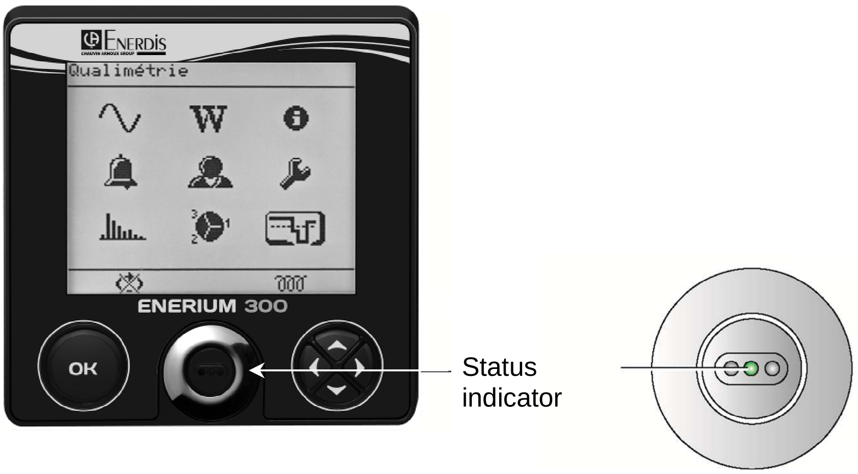
Item	Characteristics
Protocol	ModBus in RTU mode
Transmission format	38400 baud fixed speed 1 start bit 8 data bits No parity 1 stop bit 0 ms turnaround time Responds to all slave addresses from 1 to 247
Digital I/O	Optical (infrared) ensures bidirectional optical transmission
Indicator	Integral green metrology LED (pulse counting)
Connector	Optical connection with no electrical contact, paragraph 3.2 on Page 5

5.2.4 Keys



Key	Function
OK	Confirm selected choice or parameters Entry to/Exit from edit mode
	Move cursor left. Return to preceding menu.
	Move cursor right.
	Menu: move cursor down Parameter setting: decrement value Lookup: go to next screen
	Menu: move cursor up Parameter setting: increment value Lookup: go to previous screen

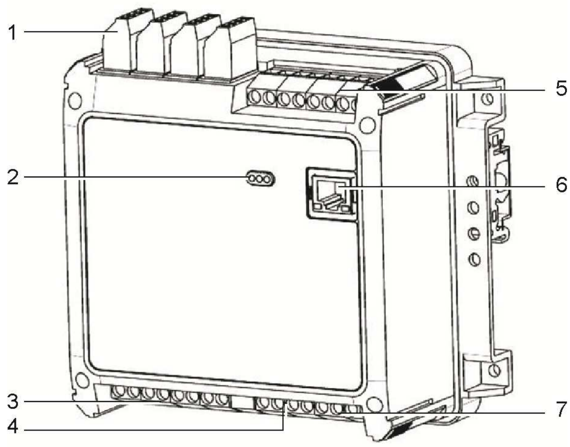
5.2.5 Front status indicator



Indicator	Indication
Unlit	*ENERIUM* disconnected
Flashing	ENERIUM 100/200/300: Visual indication of the energy counter for the user or the optical cable. ENERIUM 110/210/310: No counter information available
Rapid flashing	*ENERIUM* faulty: Embedded software is faulty or requires an update *ENERIUM* awaiting embedded software to be loaded Communication is not possible and the screen is faulty.

6 REAR VIEW

- This section describes which components are accessible from the rear, for each model:



Rear view of the ENERIUM 100, 200 and 300
Rear view of the ENERIUM 110, 210 and 310

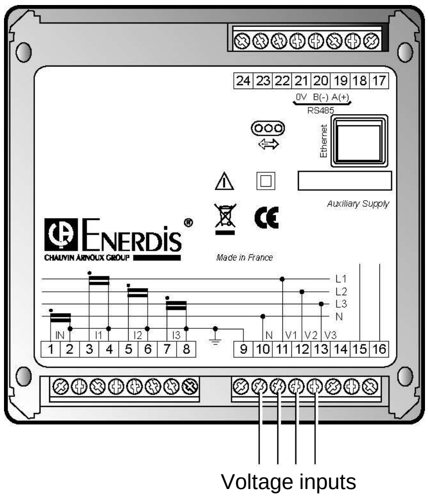
No.	Function
1	Optional card connector block (digital or analog)
2	Rear optical interface
3	Current input terminals
4	Voltage input terminals
5	RS485 connector
6	Ethernet connector
7	Auxiliary source connector

6.1 Measurement inputs

6.1.1 Voltage measurement inputs

6.1.1.1 Location

- The voltage input terminals are labelled 9 to 13 on the rear right lower label.



6.1.1.2 Characteristics

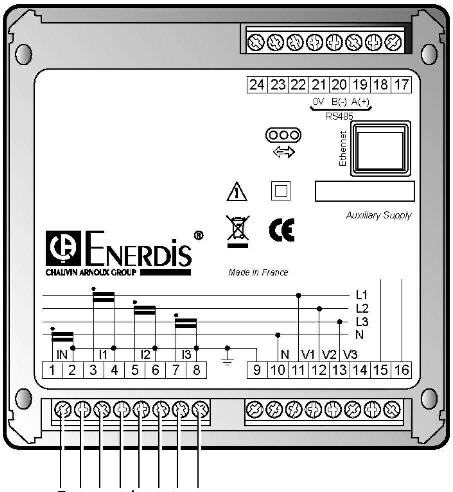
Variables	Range
Nominal phase voltage	57.7/230 V
Nominal line voltage	100/400 V
Maximum line voltage	520V
Crest factor	2
Frequency	42.5 Hz to 69 Hz
24-hour overvoltage	800 V
Per-phase consumption	0.1 VA
Impedance	1 MΩ

Variables	Range
Non-removable terminals	5 screw terminals for rigid and flexible cables of between 4 and 6 mm² Maximum torque: 0.8 Nm

6.1.2 Current measurement inputs

6.1.2.1 Location

- The current input terminals are labelled 1 to 5 on the rear right lower label.



Current inputs

6.1.2.2 Characteristics

Variables	Range
Starting current	5 mA
Normal input current	5 A
Maximum input current	6.5 A
Crest factor	3
Frequency	42.5 Hz to 69 Hz
24-hour overcurrent	10A
Short-term overcurrent	250 A, over 1s
Per-phase consumption	< 0.2 VA
Non-removable terminals	8 screw terminals for rigid and flexible cables of between 4 and 6 mm² Maximum torque: 0.8 Nm

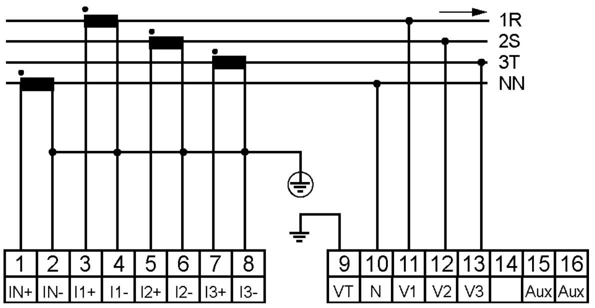
6.1.3 U and I protection

- The use of fuses on the voltage inputs and a system for short-circuiting the input current is highly recommended.

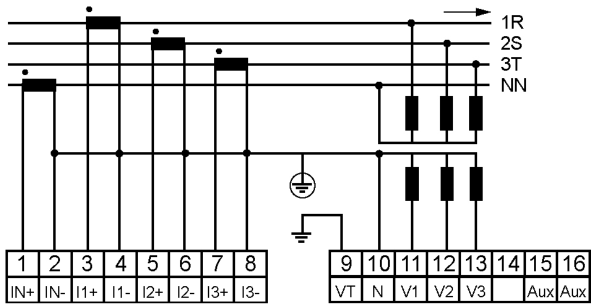
6.1.4 Recommended connection diagrams

- The voltage and current inputs are connected according to the type of installation selected. The recommended connection diagrams are as follows:

6.1.4.1 Unbalanced three-phase, 4 wire – 4 TC



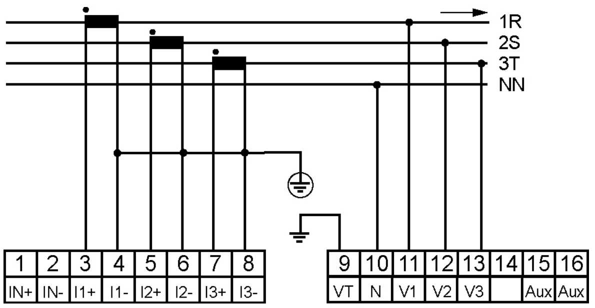
Direct voltage input



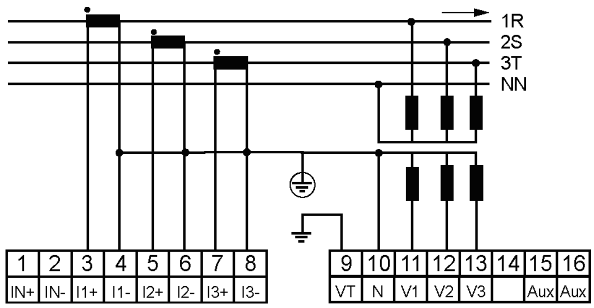
Voltage input 3 TP star

3

6.1.4.2 Balanced three phase, 4 wire – 3 TC

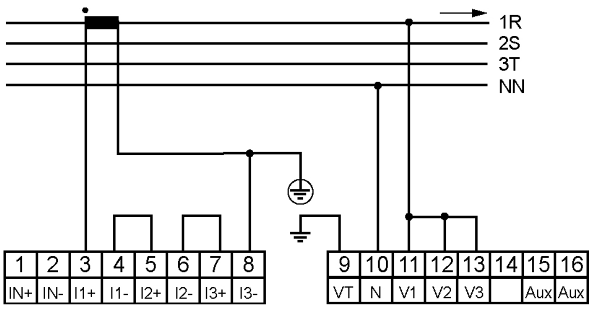


Direct voltage input

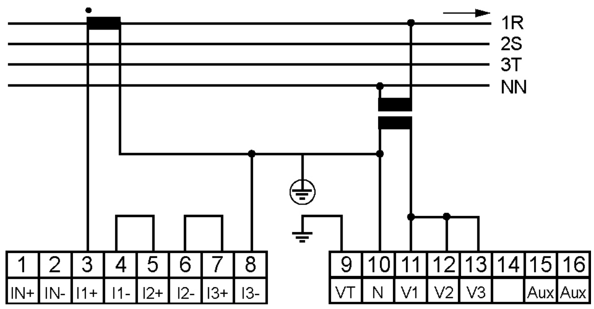


Voltage input 3 TP star

6.1.4.3 Unbalanced three-phase, 4 wire – 1 TC

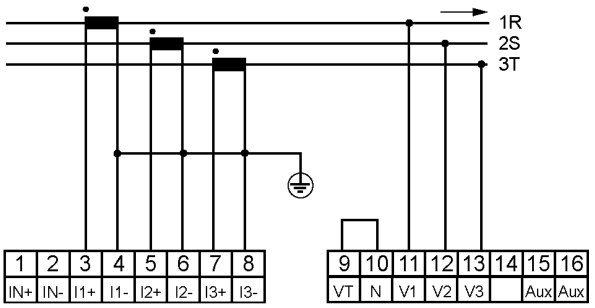


Direct voltage input

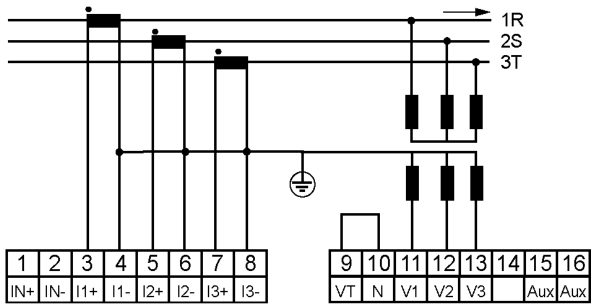


Voltage input 1 TP

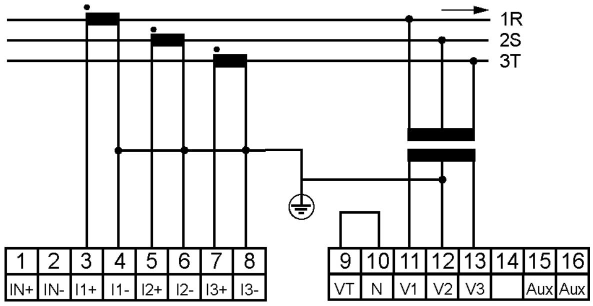
6.1.4.4 Unbalanced three-phase, 3 wire – 3 TC



Direct voltage input

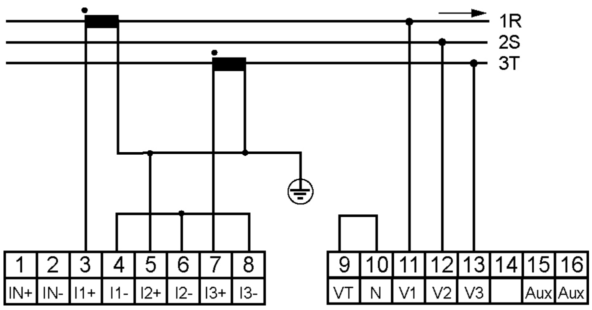


Voltage input 3 TP star

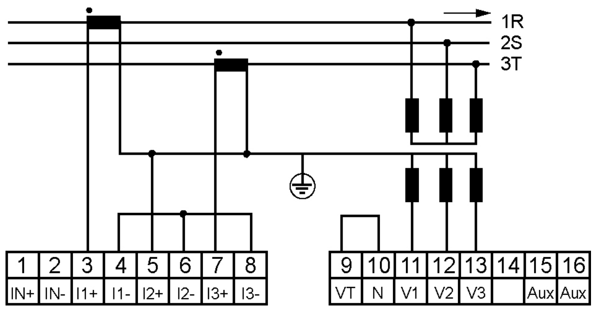


Voltage input 3 TP delta

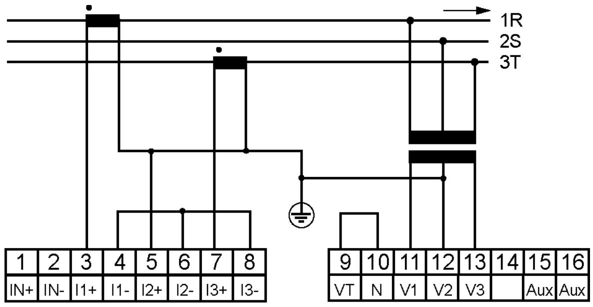
6.1.4.5 Unbalanced three-phase, 3 wire – 2 TC



Direct voltage input

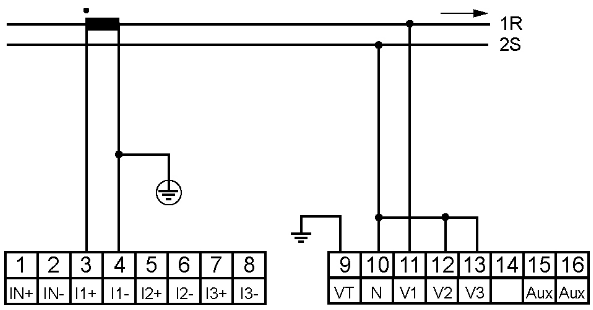


Voltage input 3 TP star

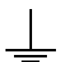


Voltage input 3 TP delta

6.1.4.6 Unbalanced three-phase, 2 wire – 1 TC



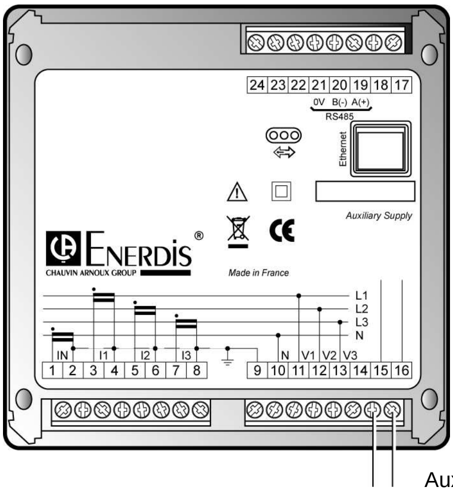
Direct voltage input

 *: Protective earth*  *: Signal earth*

6.2 Auxiliary source

6.2.1 Location

- The auxiliary source terminals are labelled 15 to 16 on the rear right lower label.



Auxiliary source inputs

- Following a break in the auxiliary source, critical data are stored in non-volatile memory (paragraph 21.8).

6.2.2 Characteristics

Source	Characteristics
High Level supply (*)	80 Vac/dc to 265 Vac/dc Frequency in the range 42.5 Hz to 69 Hz Polarity-insensitive
Low Level supply (*)	19 Vdc to 58 Vdc
Consumption	< 20 VA – 10 W
Non-removable terminals	2 screw terminals for rigid and flexible cables of between 4 and 8 mm² Maximum torque: 0.8 Nm

(*) One or other. Power provided by the manufacturer

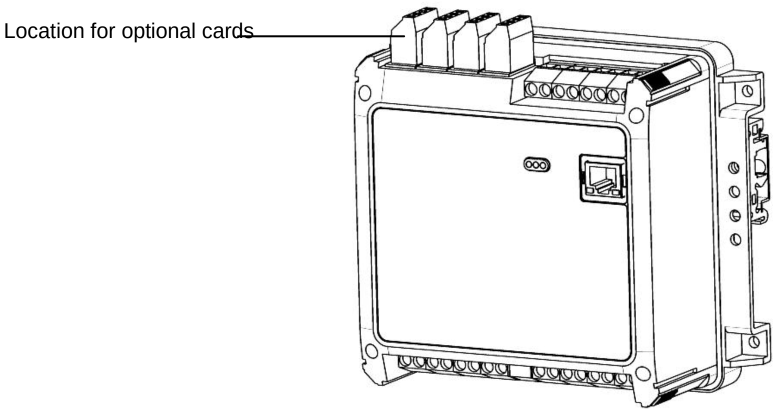
6.2.3 Connection

- Ensure correct polarity if using the Low Level supply.
- Connect the AC or DC power supply as paragraph 6.2.1.
- A fuse or circuit breaker must be used.

6.3 Optional cards

6.3.1 Location

- Four types of card are available:
  - Card with 2 analog outputs;
  - Card with 2 analog inputs;
  - Card with 2 digital outputs;
  - Card with 2 digital inputs;
- The connector block for each of these cards is in the upper rear face of the *ENERIUM*.

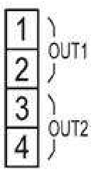


6.3.2 Characteristics

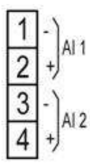
Item	Characteristics
Maximum number of optional cards	4 from *ENERIUM*
Non-removable terminals	2 x 2 screw terminals for rigid and flexible cables of between 0.2 and 2.5 mm² (22-14 AWG) Maximum torque: 0.8 Nm

6.3.3 Connection

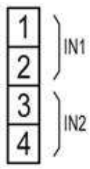
- The following figures show the wiring for the different card options:



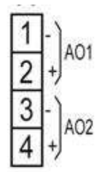
Card with 2 digital outputs



Card with 2 analog inputs



Card with 2 digital inputs



Card with 2 analog outputs

6.4 Card option - 2 analog outputs

6.4.1 Preamble

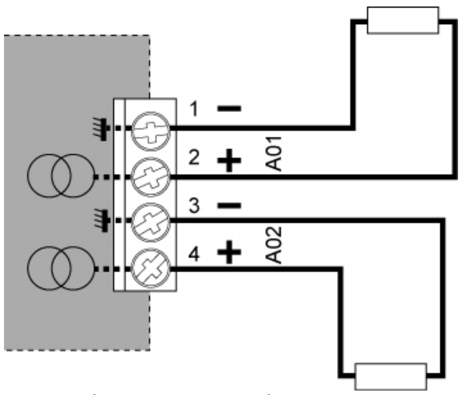
- This card has two independent analog outputs, each generating a DC current proportional to the quantities created by *ENERIUM*. Using local or remote communication the user assigns a quantity to be monitored to each analog output (V, U, I, P, Q, S, PF, cos (φ), Tan (φ) and frequency).
- The transfer function is a simple linear law. When the input rises and exceeds the maximum value of the input, the output is locked at the maximum value of the output. When the input falls and is less than the minimum value of the input, the output is locked at the minimum value of the output.
- It is possible to lock an analog output to a value between the minimum and maximum allowed by sending a control word using local or remote communication. The output is automatically unlocked after 30 seconds or after restarting the product.
- The details of the management of each of the two analog outputs (quantity allocation, etc.) are defined in document MSO-7423 - Mapping and control words, available from the Enerium website at (http://www.enerium.enerdis.com).

6.4.2 Characteristics

Item	Characteristics
Number of inputs	2
Output signal	Direct current
Maximum resistive load	10 V/ I output
Maximum capacitive load	0.1 µF
Response time	500 ms
Isolation between outputs	1 kV – 1 min
Limits (min and max)	-22 mA ≤ I_{sortie} ≤ + 22 mA

6.4.3 Connection

- Connect the load and the connecting cable as follows:



Analog output connections

Card output	Terminal	Function
A01	1	Cold (-) analog output A01
A01	2	Hot (+) analog output A01
A02	3	Cold analog output A02
A02	4	Hot analog output A02

6.5 Card option - 2 analog inputs

6.5.1 Preamble

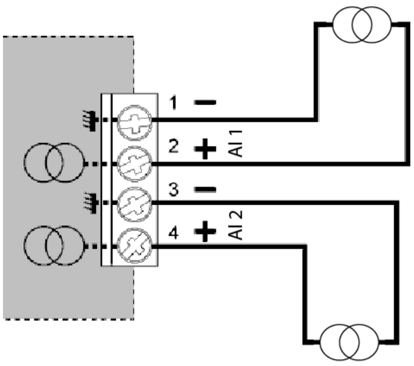
- This card has two independent analog inputs.
- The quantity assigned to the analog input is the called "primary view". The minimum and maximum values of this quantity can be set between -2^{31} and $+2^{31}$, with a resolution of one hundredth.
- The unit of this quantity is a parameterised string of up to eight characters.
- The value of the "secondary view" analog input is measured by the monitor at a frequency of 1000 Hz, and then integrated over a second. This measurement is then converted into a "primary view" value, according to a simple linear law that is always positive. This may be exceeded by 10%.
- A 32-character label can be associated with each analog input. This measurement is stored in the Modbus memory field.
- The details of the management of each of the two analog inputs is defined in document MSO-7423 - Mapping and control words, available from the Enerium website at (http://www.enerium.enerdis.com).

6.5.2 Characteristics

Item	Characteristics
Number of inputs	2
Input impedance	50 Ω
Permanent overcurrent	2.5 times In, i.e. 50 mA over 24 hours
Transient overcurrent	50 times In, i.e. 1 A for 1s repeated 5 times every 300s
Power absorbed	<50 mW
Limits (min and max)	0 mA ≤ I_{sortie} ≤ + 22 mA

6.5.3 Connection

- Connect the load and the connecting cable as follows:



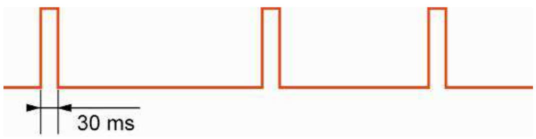
Analog input connections

Card output	Terminal	Function
AI1	1	Cold analog input AI1
AI1	2	Hot analog input AI1
AI2	3	Cold analog input AI2
AI2	4	Hot analog input AI2

6.6 Card option - 2 digital outputs

6.6.1 Preamble

- This card has two independent individual digital outputs, each programmable in alarm or pulse mode only via the communication interfaces available.
- Each logic output has a solid state relay providing isolation between the control and the output.
- At each, using local or remote communication the user sets one of the two output modes:
  - **Alarm mode:** the output is activated when a magnitude measured or calculated by *ENERIUM* crosses a threshold (minimum or maximum) that is assigned to it for a time longer than the configured time. This basic alarm is disabled when the quantity again crosses the threshold, at a hysteresis of close to 5%.
  - **Pulse mode:** In pulse mode, this digital output generates pulses proportional to the power assigned to it.



Example of pulse train timing in pulse mode

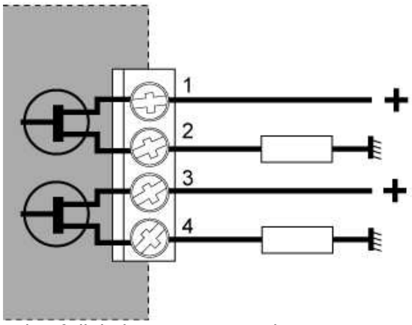
  - o Pulse mode settings are as follows:
    - Power selection: Real generator, receiver; reactive quadrants 1,2,3,4; apparent generator, receiver
    - Choice of weighting: 1 to 100k (Wh, VARh, VAh)
    - Choice of pulse width: 30 to 500 ms.
- The pulse rate is smoothed over a second to the nearest millisecond.
- It is possible to lock the pulse output in the High or Low state by sending a control word, or through the *E.set* and *E.view*, software, using local or remote communication. The output is automatically unlocked after 10 minutes or after restarting the product.
- The detail of the management of each of the two digital outputs (quantity allocation, etc.) is defined in document MSO-7423 - Mapping and control words, available from the Enerium website at (http://www.enerium.enerdis.com).

6.6.2 Characteristics

Item	Characteristics
Number of inputs	2
Maximum permissible current	≤ 100 mA
Maximum permissible voltage	275 Vac / Vdc
Pulse mode output	In accordance with IEC 62053-31 (1998)
Isolation between outputs	2.2 kV – 1 min
Contact type	Dry contact
Type of protection	SSR

6.6.3 Connection

- Connect the load and the connecting cable as follows:



Example of digital output connections

Card output	Terminal	Function
OUT1	1-2	Digital output 1 Polarity-insensitive
OUT2	3-4	Digital output 2 Polarity-insensitive

6.7 Card option - 2 digital inputs

6.7.1 Preamble

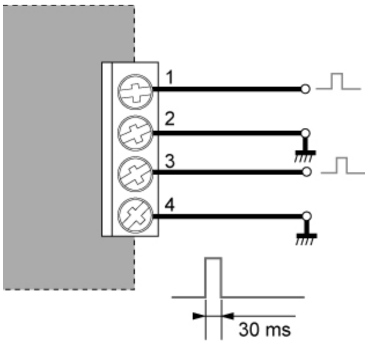
- This card has two independent digital inputs, each programmable in impulse or synchronisation mode via the communication interfaces available.
  - **Pulse mode**: when the input is configured in *Pulse* mode, the received pulses are multiplied by the weightings of the pulses on this input and are then summed in an accumulator. The pulse weighting is adjustable from 0.0001 to 999,9999
  - **Synch Input mode:** the input is used to synchronise the recordings or to manage alarms. It can also be used to synchronize the *ENERIUM's* internal clock; in this case when a pulse is detected at this input, the *ENERIUM* automatically returns its internal clock to on the hour, if the internal clock is less than 5 seconds adrift from on the hour.
- The detail of the management of each of the two digital inputs is defined in document MSO-7423 - Mapping and control words, available from the Enerium website at (http://www.enerium.enerdis.com).

6.7.2 Characteristics

Item	Characteristics
Number of inputs	2
Input signal	DC
Maximum Input signal amplitude	110 Vdc
Logic levels	Amplitude < 5 V: is read as logical 0 Amplitude < 10 V: is read as logical 1 The signal width must be at least 30 ms
Power absorbed	< 0.5 W per digital input
Isolation between inputs	2.2 kV – 1 min

6.7.3 Connection

- Connect the load and the connecting cable as follows:



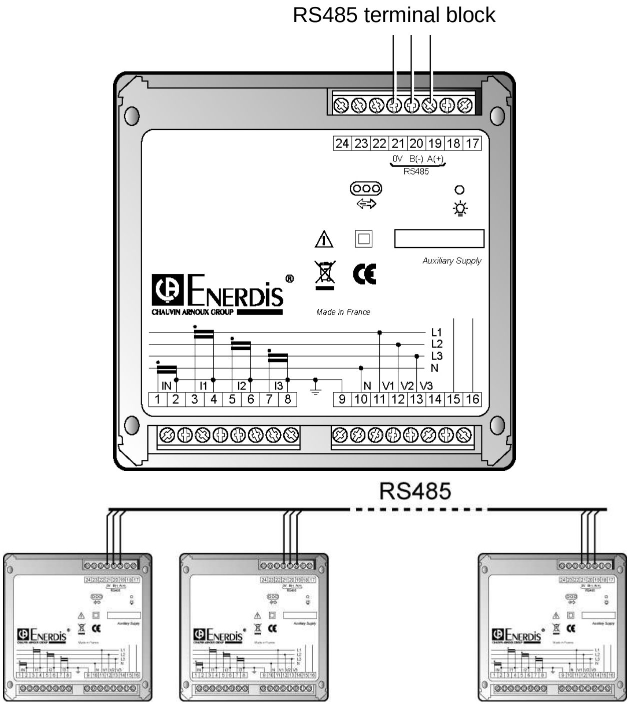
Example of digital output connections in impulse mode.

Card input	Terminal	Function
IN1	1-2	Signal A and earth. Polarity-insensitive
IN2	3-4	Signal B and earth. Polarity-insensitive

6.8 RS485 communication

6.8.1 Location

- The settings for the RS485 option are given in paragraph 12.2, on Page 47.



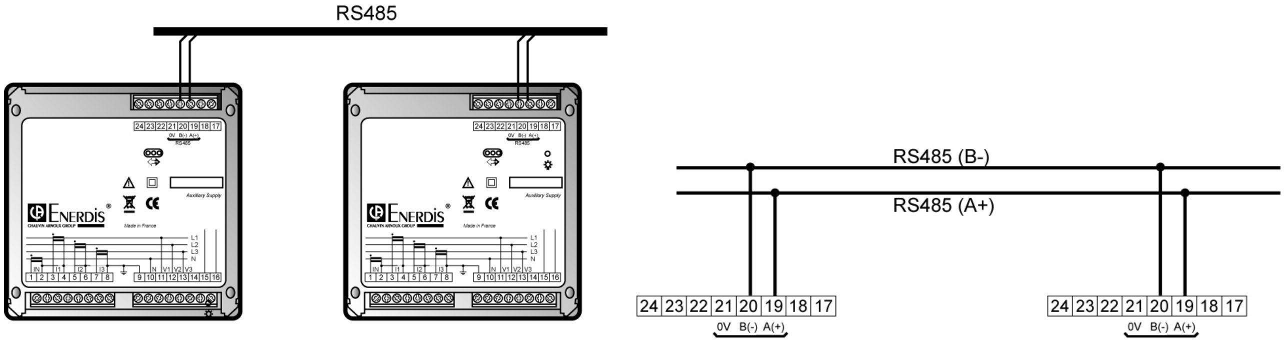
Up to 247 ENERIUMs can be connected on the same RS485 communication link

6.8.2 Characteristics

Item	Characteristics
Protocol	ModBus mode RTU & ASCII
Connector	Shielded 2-wire, half duplex
Non-removable terminals	3 screw terminals for rigid and flexible cables of between 4 and 6 mm² Maximum torque: 0.8 Nm

6.8.3 Connection in a clean environment

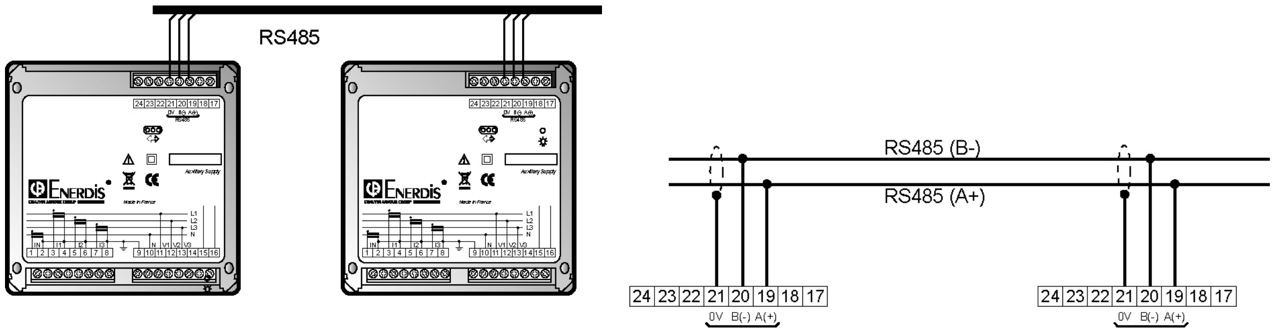
- For a RS485 network in a clean electrical environment, should be used, use a twisted pair cable if possible. This cable should be connected to terminals 19 (A+) and 20 (B-).
- The convention adopted for terminals (A) and (B) corresponds to EIA485, specifying logic level "1" on the line corresponds to VB> VA and a logic level "0" corresponds to VA> VB.



RS485 link connection (standard connection)

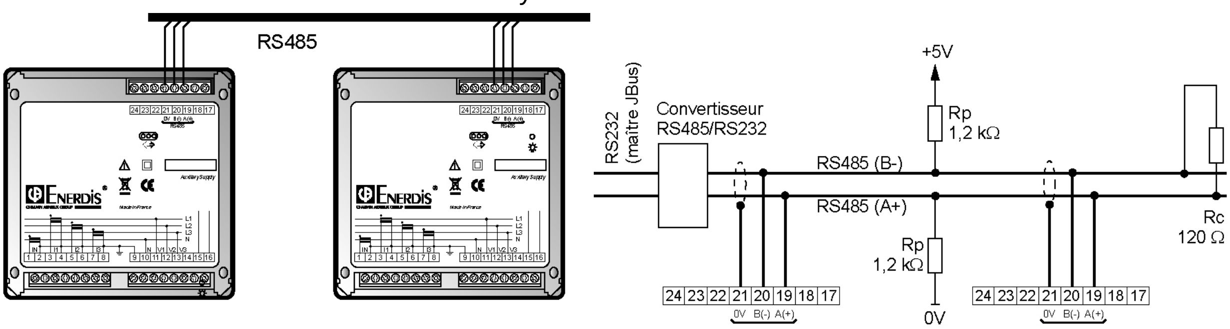
6.8.4 Connection in a noisy environment

- With screening:
  - In the case of particularly noisy electrical environment, a screened twisted pair should be used with the screen connected to the 0V terminal of the *ENERIUM.*



RS485 link connection in a noisy electrical environment (with screening)

- With screening and resistances (bias and load):
  - To improve the quality of transmission in noisy environments, it is possible to polarise the line at a single point. This polarisation sets the resting level, in the absence of transmission, by two 1.2 kΩ resistors between the 0 V and 5 V lines. These resistors are sometimes included in RS485/RS232 converters. It is sometimes necessary to connect the two ends of the bus via a 120Ω resistor.

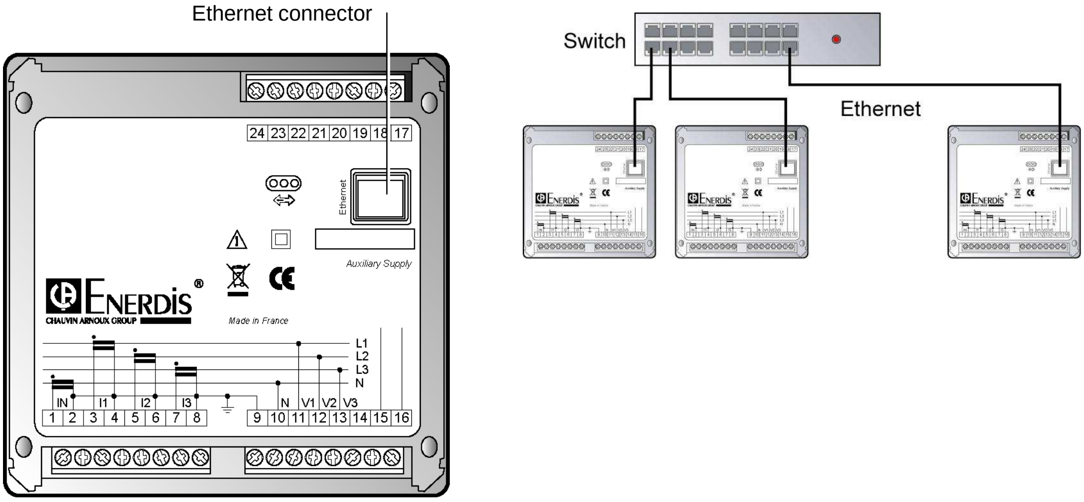


RS485 link connection in an electrically noisy environment with load and bias resistors

6.9 Ethernet communication

6.9.1 Location

- The settings for the Ethernet option are given in paragraph □, on Page 49.



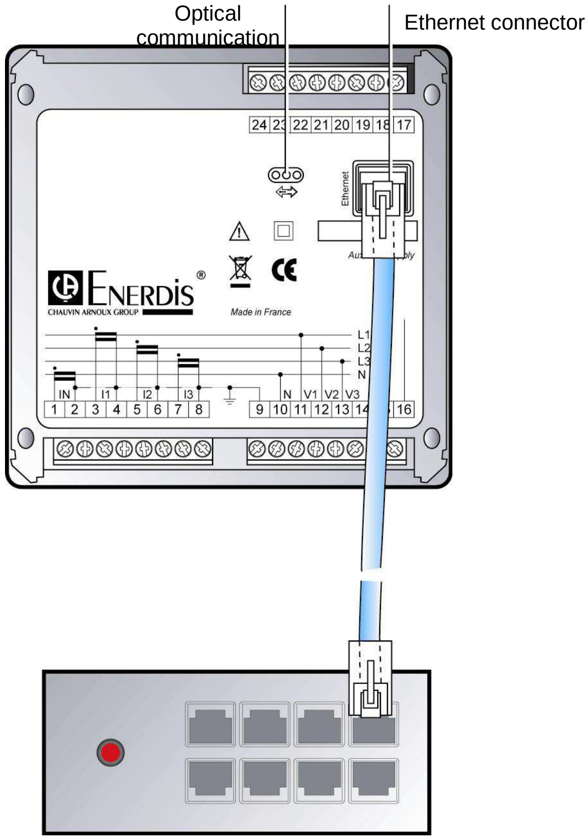
- NB: a crossover cable is recommended for communication between a PC and an *ENERIUM.*

6.9.2 Characteristics

Item	Characteristics
Protocol	ModBus / TCP
Speed	10/100 Base T
Maximum length	Transmission up to 100 m max
Connector	8-pin RJ45 plug

6.9.3 Connection

- Connect the RJ45 Ethernet plug on each *ENERIUM* to an RJ45 input of a switch (or hub) via an Ethernet cable (straight cable for connection to a switch, crossover cable for connection to a PC).

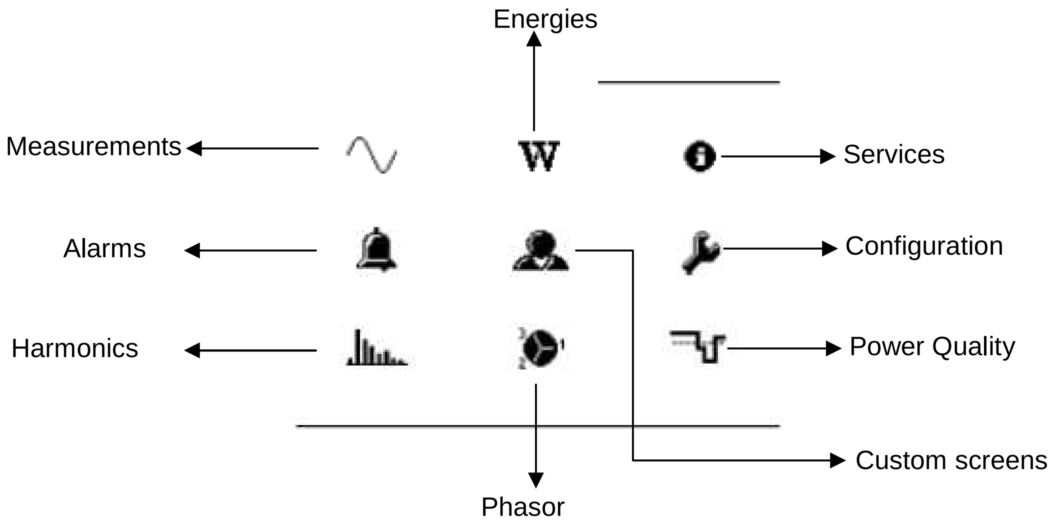


Connecting an Ethernet link to a switch

7 MAIN SCREEN AND MAIN MENUS

7.1 Main screen

- As soon as it is connected, a loading screen appears for a few seconds. All monitor functions are then activated.
- A progress bar below the "ENERDIS" line shows the loading status of the equipment.
- The main menu is then displayed.



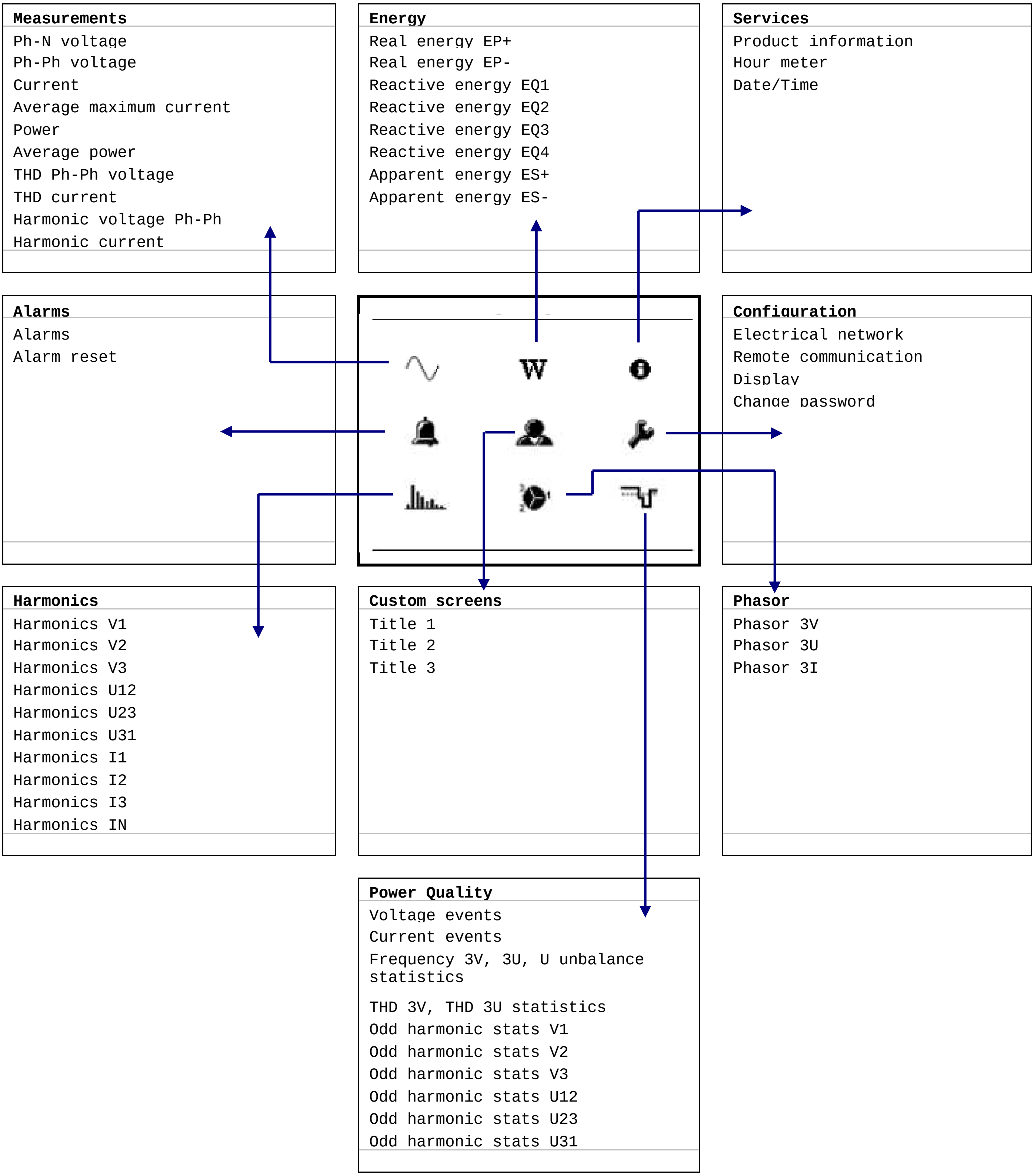
- When the monitor is restarted, the last screen displayed is the one shown before the auxiliary source was turned off. If the last screen was a setup screen, the main menu is displayed.

7.2 Electrical quantities and units

Quantity	Unit	Designation
EP	Wh	Real energy in watt-hours
EQ	Varh	Reactive energy in reactive volt-ampere-hours
ES	VAh	Apparent energy in volt-ampere-hours
F	Hz	Frequency in Hertz
FP		Power factor
Hxx Ia	%	Level of harmonic current of order 'xx' in conductor a (a = 1, 2 or 3)
Hxx Uab	%	Level of harmonic line voltage of order 'xx' (ab = 12, 23 or 31)
I	A	True rms line current
I Max DMD	A	Average peak current
In	A	True rms neutral current
P	W	Real power in watts
Pavg	W	Average real power in watts
Q	Var	Reactive power in vars
S	VA	Apparent power in VA
Savg	VA	Average apparent power in VA
THD I	%	Current THD
THD U	%	Line voltage THD
U	V	True line voltage in volts
V	V	Phase voltage in volts
VT	V	True RMS voltage between neutral and earth in volts

7.3 Menus and sub-menus

- All menus accessible from the main menu are shown below



Flowchart of all the main ENERIUM menus.

-

8 MEASUREMENTS SCREEN

- This screen displays the menu for selecting basic measurements (V, U, I, P, Q, S, PF, THD, H, etc.).

8.1 The screens

- This section presents each of the screens accessible by selecting the icon and pressing the OK key.

8.1.1 Voltage Ph-N

- Displays the phase single voltage of each phase to neutral. The value VT is the voltage between neutral and ground.

Voltage Ph-N		
V1	**230.00**	V
V2	**230.00**	V
V3	**230.00**	V
VT	**5.00**	V

Example

8.1.2 Voltage Ph-Ph

- Displays the line voltage between phases (U_{12}, U_{23}, U_{31}) and the frequency.

Voltage Ph-Ph		
V1	**400.00**	V
V2	**400.00**	V
V3	**400.00**	V
F	**50.00**	Hz

Example

8.1.3 Current

- Displays the line and neutral currents.

Current		
I1	**2.000**	kA
I2	**2.000**	kA
I3	**2.000**	kA
IN	**5.000**	A

Example

8.1.4 Current max dmd

- Displays the average maximum current average on each line. The integration time can be changed only via the communication port.

Current max dmd		
I1MaxDMD	**2.100**	kA
I2MaxDMD	**2.100**	kA
I3MaxDMD	**2.100**	kA
INMaxDMD	**5.000**	A

Example

8.1.5 Power

- Displays the instantaneous real (P), reactive (Q) and apparent (S) power.
- Displays the power factor (PF).

Power		
S	**1.380**	MVA
P	**1.380**	MW
Q	**0.0**	VAR
PF	**1.000**	

Example

8.1.6 Power dmd

- Displays the average real (P) and apparent (S) power over a period defined by local or remote communication.

Power dmd		
Pavg	**1.380**	MW
Savg	**1.380**	MVA

Example

8.1.7 THD voltage Ph-Ph

- Displays the harmonic distortion for the three line voltages.

THD voltage Ph-Ph		
THD U12	**3.00**	%
THD U23	**3.00**	%
THD U31	**3.00**	%

Example

8.1.8 THD current

- Displays the harmonic distortion for the four currents.

THD current		
THD I1	**5.00**	%
THD I2	**5.00**	%
THD I3	**5.00**	%

Example

8.1.9 Harmonics voltage Ph-Ph

- Display the highest harmonic rates and their orders for the three line voltages. Every indication is as follows (example):
  - `H03 U12`: highest rate of harmonic overtones of order 3 on line voltage U12.

Harmonics voltage Ph-Ph		
H03 U12	**2.00**	%
H03 U23	**2.00**	%
H03 U31	**2.00**	%

Example

8.1.10 Harmonics current

- Displays the highest harmonic rates and their orders for the three currents. Every indication is as follows (example):
  - `H05 I1`: highest rate of harmonics of the 5th order of current I1.

Harmonic current		
H05 I1	**2.00**	%
H05 I2	**3.00**	%
H05 I3	**4.00**	%

Example

8.2 Display rules

8.2.1 Voltage display rules

- The display of a voltage (phase or line) is formed of four digits, with a floating point. The following table shows the position of the decimal point and the unit used in accordance with the measured value.

V <	Display
10	9.999 V
100	99.99 V
1,000	999.9 V
10,000	9.999 kV
100,000	99.99 kV
1,000,000	999.9 kV

8.2.2 Current display rules

- The display of a current is formed of four digits, with a floating point. The following table shows the position of the decimal point and the unit used in accordance with the measured value.

I <	Display
10	9.999 A
100	99.99 A
1,000	999.9 A
10,000	9.999 kA
100,000	99.99 kA

8.2.3 Frequency display rules

- The display of a frequency is formed of four digits, with a fixed point. Here is the position of the decimal point and the unit used: 99.99 Hz.

8.2.4 Power display rules

- The display of a power (real, reactive, apparent) is formed of four digits, with a floating point. The following table shows the position of the decimal point and the unit used in accordance with the measured value.

P	Display
10	9.999 u
100	99.99 u
1,000	999.9 u
10,000	9.999 ku
100,000	99.99 ku
1,000,000	999.9 ku
10,000,000	9.999 Mu
100,000,000	99.99 Mu

For real power 'u' is a W. For reactive power 'u' is a VAR. For apparent power 'u' is a VA.

8.2.5 Harmonics display rules

- The display of a harmonic (of order x) or the rate of total harmonic distortion is formed of four digits. The position of the decimal point is adjusted according to the measured value.

8.2.6 Power factor display rules

- The display of a power factor is formed of three digits, with a fixed point (9.99). The unit is represented by a logo.
- In the case of a lagging power factor, the unit is the icon.
- In the case of a leading power factor, the unit is the icon.

8.2.7 Hour meter display rules

- The hour meter display is formed of six digits, with a fixed point. Here is the position of the decimal point and the unit used: 99999999.99 H.

9 ENERGIES SCREEN

- This screen displays the menu for selecting the measurements for active reactive and apparent energies.

9.1 The screens

- This section presents each of the screens accessible by selecting the W icon and pressing the OK key.

9.1.1 Active energy EP+

- Displays the readings of the two positive active active energy meters in receiver mode, accumulated since the *ENERIUM* was powered up. The total value is equal to the concatenation of the two values.

```
Active Energy EP+
                  MWh
              231
                  kWh
          457.897
```

Example: Display of an energy corresponding to 231,457.897 kWh

9.1.2 Active energy EP-

- Displays the readings of the two negative active energy meters in receiver mode, accumulated since the *ENERIUM* was powered up. The total value is equal to the concatenation of the two values.
- The data is read in the same way as described in paragraph 9.1.1. The only difference is the title EP+, which becomes EP-.

9.1.3 Reactive energy EQ1

- Displays the readings of the two positive reactive energy meters in receiver mode (quadrant 1), accumulated since the *ENERIUM* was powered up. The total value is equal to the concatenation of the two values.

```
Reactive energy EQ1
                MVARh
            231
                kVARh
        457.897
```

Example: Indicates a reading corresponding to 231,457.897 kVARh

9.1.4 Reactive energy EQ2

- Displays the readings of the two positive reactive energy meters in receiver mode (quadrant 2), accumulated since the *ENERIUM* was powered up. The total value is equal to the concatenation of the two values, as shown (example):
- The data is read in the same way as described in paragraph 9.1.3. The only difference is the title EQ1, which becomes EQ2.

9.1.5 Reactive energy EQ3

- Displays the readings of the two positive reactive energy meters in receiver mode (quadrant 3), accumulated since the *ENERIUM* was powered up. The total value is equal to the concatenation of the two values, as shown (example):
- The data is read in the same way as described in paragraph 9.1.3. The only difference is the title EQ1, which becomes EQ3.

9.1.6 Reactive energy EQ4

- Displays the readings of the two positive reactive energy meters in receiver mode (quadrant 4), accumulated since the *ENERIUM* was powered up. The total value is equal to the concatenation of the two values, as shown (example):
- The data is read in the same way as described in paragraph 9.1.3. The only difference is the title EQ1, which becomes EQ4.

9.1.7 Apparent energy ES+

- Displays the absolute readings of the two apparent energy meters in receiver mode, accumulated since the *ENERIUM* was powered up. The total value is equal to the concatenation of the two values.

Apparent energy ES+
MVAh
231
kVAh
457.897

Example: Indicates a reading corresponding to 231,457.897 kVAh

9.1.8 Apparent energy ES-

- Displays the absolute readings of the two apparent energy meters in receiver mode, accumulated since the *ENERIUM* was powered up. The total value is equal to the concatenation of the two values, as shown (example):
- The data is read in the same way as described in paragraph 9.1.7. The only difference is the title ES+, which becomes ES-.

9.2 Energy display rules

- The first line shows the higher order energy meter reading in the form 999999 Muh. The second line shows the lower order energy meter in the form 999.999 kuh. The letter "u" is W, VAR or VA.

10 SERVICES SCREEN

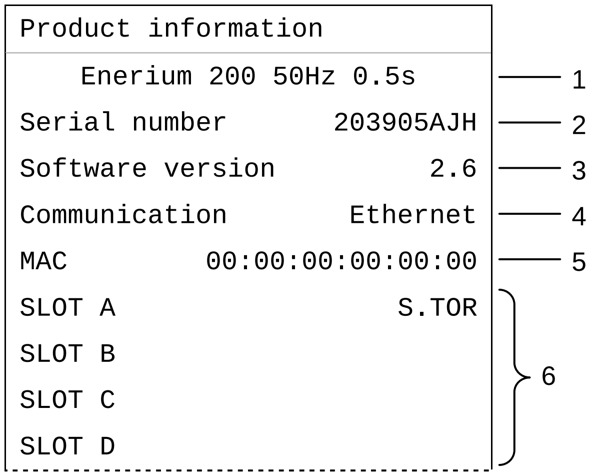
- This screen displays the selection menu for the information particular to the monitor, hour meters and internal time stamp.

10.1 The screens

- This paragraph presents each of the screens accessible by selecting the icon and pressing the **OK** key.

10.1.1 Product information

- The following information is displayed:

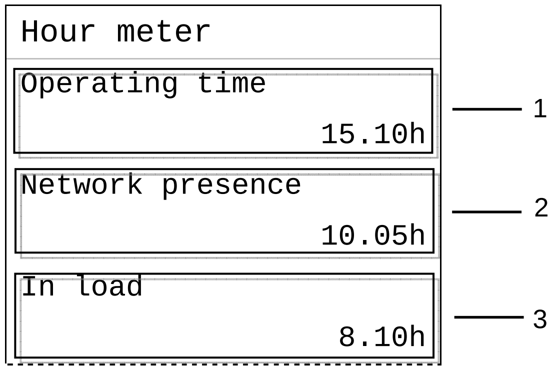


Example

Number	Indication
1	ENERIUM model (100, 200, 300), mains frequency and accuracy class
2	ENERIUM serial number
3	Version number of embedded software
4	Displays ”Empty” if no comms card installed, else Ethernet or RS485
5	Displays ”Empty” if no Ethernet card installed, else the MAC address
6	Displays ”Empty” if no I/O card installed, else displays the I/O card type installed

10.1.2 Hour meter

- Details of three hour counters are displayed:

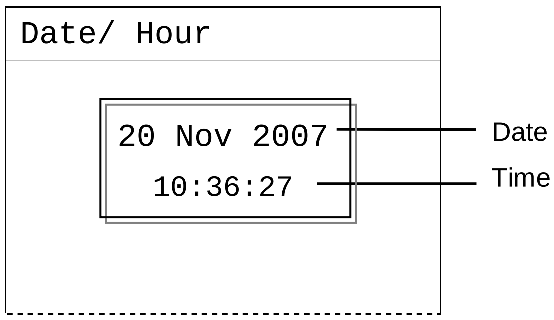


Example

Number	Indication
1	The "**Operating time**" hour meter indicates the time for which the (auxiliary) supply voltage has been connected to the ENERIUM. This indication is useful for *ENERIUM* maintenance.
2	The **"Network Presence"** hour meter shows the time for which at least one phase voltage from among V1 [1s], V2 [1s] and V3 [1s] has been nonzero. This indication is useful for the maintenance of the load being monitored.
3	The **"In load"** hour meter is the time during which at least one current from I1 [1s], I2 [1s] and I3 [1s] is nonzero. This indication is useful for the maintenance of the load being monitored.

10.1.3 Date and hour

- The following information is displayed:



Example

- NB: Date and time are retained for at least 20 days after monitor has been switched off.

11 ALARMS SCREEN

- This screen displays the menu for selecting alarms (status of the alarms and the associated relays for the digital outputs) and resetting any possibly latched alarms.

11.1 The screens

- This section presents each of the screens accessed by selecting the icon and pressing the **OK** key.

11.1.1 Alarms

- The following information is displayed:

Alarms		01
Number	Status	Relay
1	-	-
2	-	-
3	-	-
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-

Example

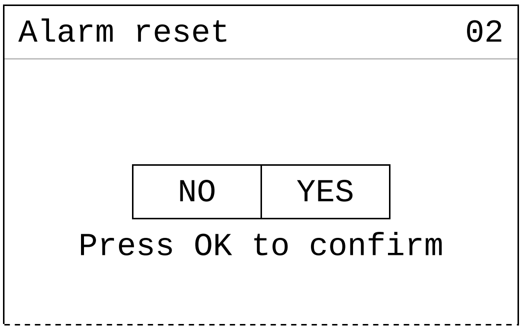
- This screen displays, for each of the eight global alarms, the status of the active or activated alarm in the first column (status) and the status of the associated digital outputs (relays) in a second column (relay).

Indication	Explanation
`Number`	Global alarm number (a global alarm is possibly a combination of two basic alarms)
`Status`	Monitor alarm status (active or non-active) - Alarm not programmed ○ Alarm programmed inactive ● Alarm programmed active
`Status`	Associated relay status - Relay non not associated with an alarm ○ Relay associated with an alarm, but inactive ● Relay associated with an alarm and active

- Setting the alarms (number, NO/NC, timing, threshold, quantity measured) is possible only by local or remote communication.

11.1.2 Alarm reset

- This screen allows the alarms to be reset (acknowledgment of the alarm of the associated digital outputs) by selecting YES.



Example

- To reinitialise the alarms, proceed as follows:
  - The `Alarm reset` screen is displayed.
  - Press **OK** to start
  - Press to highlight YES (black background).
    - To exit this procedure without resetting the alarms, press to highlight `NO` (black background).
  - Press **OK** to confirm.
- Resetting can also be done remotely and locally via the optical head using E.SET/E.VIEW software.

12 CUSTOM SCREENS

- This screen displays the menu for selecting one of the three groups of screens defined via local or remote communication.
- This is done by starting from the main menu, selecting the  icon and pressing the OK key.
- Each of the three screens, called `Title 1`, `Title 2` and `Title 3` can be freely configured by the user via local or remote communication. Each of these screens group together, in a screen specified by the user, a set of four measurements that the user wishes to display simultaneously. Any combination of display data are available from the quantities measured by the *ENERIUM* (see document MSO-7423 - Mapping and control words, downloadable from the Enerium website (http://www.enerium.enerdis.com).
- This section presents each screen accessible from the Custom `Screens` (after pressing the OK key) in their factory configurations.

12.1.1 Title1: “S-P-Q-Tan(φ)”

- When not redefined by the user this screen displays:
  - Line 1: Three-phase S
  - Line 2: Three-phase P
  - Line 3: Three-phase Q
  - Line 4: Tan(φ)

12.1.2 Title 2: “V1-U12-I1-PF1”

- When not redefined by the user this screen displays:
  - Line 1: V1
  - Line 2: U12
  - Line 3: I1
  - Line 4: PF1

12.1.3 Title 3: “In: H03 H05 H07 H09”

- When not redefined by the user this screen displays:
  - Line 1: H03
  - Line 2: H05
  - Line 3: H07
  - Line 4: H09

13 CONFIGURATION SCREEN

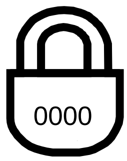
- This screen displays the *ENERIUM Configuration* screen
- This is done by starting from the main menu, selecting the icon and pressing the OK key.
- When selected, the display appears as follows if no password has been set:

```
Configuration

Electrical network
Remote communication
Display
Password modification
```

- If a password has already been set, it is needed to access the `Configuration` screen.
- Proceed as follows:
  - Use the keys to change the highlighted value (black background)
  - Use the keys to move the cursor.
  - Press **OK** to confirm.
- If the password has been lost, *E.set* software from *ENERDIS* allows it to be read.
- The default password is 0000.

Configuration



Enter password

Example

13.1 Electrical network

- This information defines the ratios of the voltage and current transformers upstream of the *ENERIUM*.
- As all measurements are being seen on the primary side of the client transformers, the client transformer values are set in the *ENERIUM.* The product of the primary CT and the primary PT must not exceed 693.0 MW (maximum three-phase power = $\sqrt{3}$ x 693 MW = 1.2 GW).
- Proceed as follows:
  - The `Configuration` screen is displayed.
  - Select the line `Electrical network` and press **OK** to display the `Electrical network` screen.

Electrical network	
Primary PT	000400
Secondary PT	400
Primary CT	05000
Secondary CT	5
Primary CT IN	0100
Secondary CT IN	5
3 wires / 4 wires	4 wires
Config. IN	Measured
Uc voltage	000230

Example

13.1.1 PT primary

- Defines the maximum line voltage of the potential transformer primary. Proceed as follows:
  - When the `Electrical network` screen is displayed, press **OK** to select `PT primary`.
  - Press **OK** to select the value to be changed.
  - Use the keys to change the displayed value and to move the cursor.
    - o The primary line voltage of the PT can lie between 100 V and 650,000 V. This can be set in steps of 1 V.
  - Press **OK** to confirm.

13.1.2 PT secondary

- Defines the maximum line voltage of the potential transformer secondary. Proceed as follows:
  - Select the line `Secondary PT` with the keys and press **OK**.
  - Use the keys to change the highlighted value and to move the cursor.
    - o The secondary line voltage of the PT can lie between 100 V and 480 V. This can be set in steps of 1 V.
  - Press **OK** to confirm.

13.1.3 CT Primary CT and CT IN

- Defines the maximum current of the current transformer primary. Proceed as follows:
  - Select the line `Primary` CT with the keys and press **OK**.
  - Use the keys to change the highlighted value and to move the cursor.
    - The primary current of the CT can lie between 1 A and 25,000 A. This can be set in steps of 1 A.
  - Press **OK** to confirm.

13.1.4 CT secondary and CT IN

- Defines the maximum current of the current transformer secondary. Proceed as follows:
  - Select the line `Secondary CT` with the keys and press **OK**.
  - Use the keys to change the highlighted value.
    - The secondary current of the CT can lie between 1 A and 5 A. This can be set in steps of 1 A.
  - Press **OK** to confirm.

13.1.5 3 wire/4 wire

- Defines the type of network being monitored. Proceed as follows:
  - Select the line `3 wires / 4 wires` with the keys and press **OK**.
  - Use the keys to change the displayed value.
    - **3 wire**: no distributed neutral.
    - **4 wire**: distributed neutral.
  - Press **OK** to confirm.

13.1.6 IN configuration

- Defines if the neutral current is measured or calculated. Proceed as follows:
  - Select the line Config. `IN` with the keys and press **OK**.
  - Use the keys to change the displayed value.
    - **Measured:** In is measured.
    - **Calculated:** In is calculated.
  - Press **OK** to confirm.

13.1.7 Uc voltage (Only for the ENERIUM 300)

- Defines the nominal voltage Uc. Proceed as follows:
  - Select the line Uc `voltage` with the keys and press **OK**.
  - Use the keys to change the highlighted value.
    - The nominal Uc voltage can lie between 40 V and 780,000 V.
  - Press **OK** to confirm.
- Importance of the Uc voltage:
  - Enables the power quality thresholds to be set.

13.2 RS485 communication

- Proceed as follows:
  - The `Configuration` screen is displayed.
  - Select the line `Remote communication` with the keys and press **OK**.

Remote communication	
Protocol	RTU
Slave address	014
Speed (baud)	115200
Parity	No
Stop bits	1
Data bits	8
Response (ms)	0
ASCII timeout(ms)	01000

Example

13.2.1 Protocol

- When the `Remote communication` screen is displayed, press **OK** to select `Protocol`.
- Press OK to select the (protocol) value to be changed.
- Use the keys to change the highlighted value and to move the cursor. The valid protocols are RTU or ASCII.
- Press OK to confirm.

13.2.2 Slave address

- When the `Remote communication` screen is displayed, press **OK**to select `Slave address`.
- Press OK to select the (address) value to be changed.
- Use the keys to change the highlighted value and to move the cursor. Valid addresses are from 001 to 247 inclusive.
- Press OK to confirm.

13.2.3 Speed (baud)

- Select the line `Speed (baud)` with the keys and press **OK**.
- Use the keys to change the displayed value (transmission speed in baud).
  - The predefined values are `2400`, `4800`, `9600`, `19200`, `38400` and `115200`.
- Press OK to confirm.

13.2.4 Parity

- Select the line `Parity` with the keys and press **OK**.
- Use the keys to change the displayed (parity) value. The predefined values are `No`, `Odd` and `Even`.
- Press OK to confirm.

13.2.5 Stop bits

- Select the line `Stop bits` with the keys and press **OK**.
- Use the keys to change the displayed value (number of stop bits). The displayable values are `1` and `2`.
- Press OK to confirm.

13.2.6 Data bits

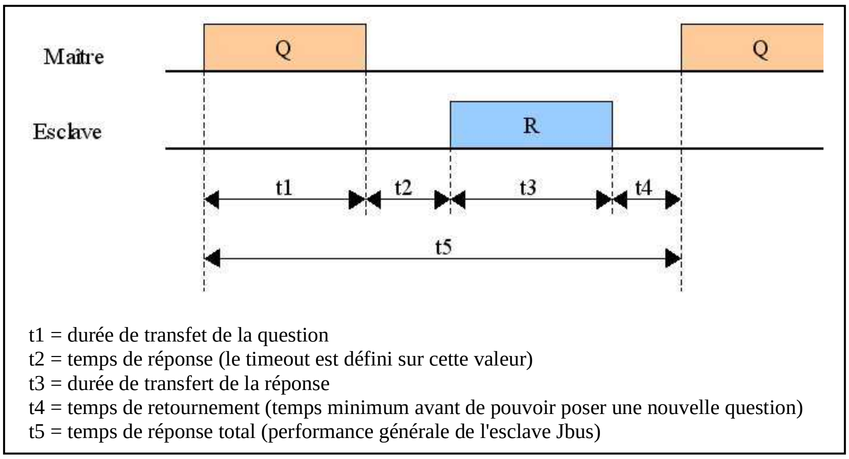
- Select the line `Data bits` with the keys and press **OK**.
- Use the keys to change the displayed value (number of data bits). The displayable values are 8 in RTU mode and 8 or 7 in ASCII mode.
- Press OK to confirm.

13.2.7 Response (ms)

- This parameter operates in RTU or ASCII mode.
- Select the line `Response(ms)` with the keys and press OK.
- Use the keys to change the displayed value (response time in ms). The displayable values go from `0` to `500` in steps of 50.
  - The response time, in milliseconds, is the time between when the RS485 frame has been received and when the *ENERIUM* answers. This value should be set based on the number of *ENERIUMs* connected to the RS485 line and the quality of the fieldbus.
  - **NB:** a response time set to 0 ms is not the real response time which is equal to the internal frame processing time, approximately 35 ms. For the other values, the time set is the real response time.
- Press OK to confirm.
- Timeline of the communication exchange

Master

Slave



t1 = Request transfer time
t2 = Response time
t3 = Response transfer time
t4 = Turnaround time
t5 = Total response time

13.2.8 ASCII timeout (ms)

- Select the line `ASCII timeout` with the keys and press **OK**.
- Use the keys to change the displayed (timeout in ms) value. The displayable values go from `1000` to `10000` in steps of 1 ms.
  - The timeout in milliseconds is the maximum time allowed between the receipt of two ASCII characters. If this is exceeded, communication is reset.
- Press **OK** to confirm.

13.3 Remote Ethernet communication

- Proceed as follows:
  - The `Configuration` screen is displayed.
  - Select the line `Remote communication` with the keys and press **OK**.

```
Remote communication
IP Address      000.000.000.000
Subnet mask     255.255.000.000
Gateway         000.000.000.000
```

Example

- Configuring the IP address, the subnet mask and the gateway can also be done remotely and locally via the optical head using E.SET/E.VIEW software.

⚠ *We recommend that "Device Installer" software is not used for setting up remote communications with ENERIUM V2 monitors. (An ENERIUM V2 is distinguishable by its accuracy class on the label on its rear face, while a ENERIUM V1 does not have this).*

13.3.1 IP address

- When the `Remote communication` screen is displayed, press **OK** to select `IP address`.
- Press **OK** to select the (address) value to be changed.
- Use the keys to change the highlighted value and to move the cursor.
- Press **OK** to confirm.

13.3.2 Mask

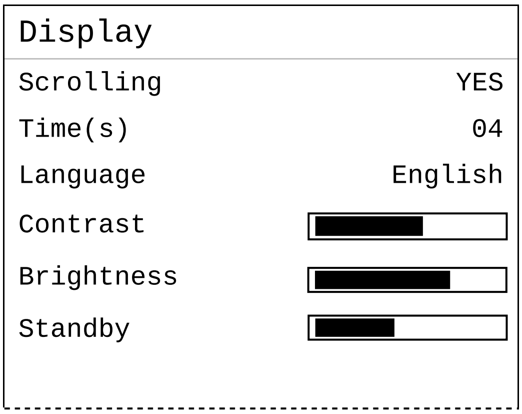
- Select the line `Mask` with the keys and press **OK**.
- Use the keys to change the highlighted value and to move the cursor.
- Press **OK** to confirm.

13.3.3 Gateway

- Select the line `Gateway` with the keys and press **OK**.
- Use the keys to change the highlighted value and to move the cursor.
- Press **OK** to confirm.

13.4 Display

- This information defines the following display features:
  - **Scrolling**: activates or deactivates scrolling on custom screens.
  - **Time**: display duration for each of the custom screens.
  - **Language:** message display language.
  - **Contrast**: contrast level of the LCD display.
  - **Brightness**: brightness level of the LCD display.
  - **Password:** sets the password for accessing the `Configuration` screen.
- Proceed as follows to access the sub-menus:
  - The `Configuration` screen is displayed.
  - Select the line `Display` with the keys and press **OK**.



Example

13.4.1 Scrolling

- Enables or disables the ability to scroll the measurement screens and the associated display times. Proceed as follows:
  - When the `Display` screen is displayed, press **OK** to select `Scrolling`.
  - Press **OK** to select the value to be changed.
  - Use the keys to change the displayed value. The displayable values are `Yes` and `No`.
    - **NO:** the display screens do not scroll. Only the manually selected screen will be displayed continuously.
    - **YES**: the display screens having been defined in *E.view, E.set* will be displayed cyclically one after the other at a frequency determined by the value of `Time`(see below).
    - Any of the display screens can be put into this list, in any order and even more than once.
    - It is possible to set automatic scrolling up to a maximum of 16 display screens. The list of screens to scroll is configurable via local or remote communication.
    - Pressing any key will stop the automatic scrolling mode and enables navigation through the different screens using the keys. If no key is pressed for 10 seconds and the automatic scrolling mode is still active, then the screens automatically start scrolling again.
  - Press **OK** to confirm.

13.4.2 Time (s)

- Defines the display duration for each of the selected screens. Proceed as follows:
  - Select the line `Time(s)` with the keys and press **OK**.
  - Use the keys to change the highlighted value and to move the cursor.
    - o The allowable values are from `01` to `10`.
  - Press **OK** to confirm.

13.4.3 Language

- Defines the message display language. Proceed as follows:
  - Select the line `Language` with the keys and press **OK**.
  - Use the keys to change the active language.
    - o The available languages are English, French, German, Italian and Spanish.
  - Press **OK** to confirm.

13.4.4 Contrast

- Sets the contrast level of the LCD display. Proceed as follows:
  - Select the line `Contrast` and press **OK**.
  - Use the keys to change the contrast level. The longer the bar, the greater the contrast.
  - Press **OK** to confirm.

13.4.5 Brightness

- Sets the brightness level of the LCD display. Proceed as follows:
  - Select the line `Brightness` and press **OK**.
  - Use the keys to change the brightness level. The longer the bar, the greater the brightness.
  - Press **OK** to confirm.

13.4.6 Standby

- Sets the brightness level of the LCD display in standby mode. Proceed as follows:
  - Select the line `Standby` and press **OK**.
  - Use the keys to change the brightness level in standby mode. The longer the bar, the greater the brightness in standby mode.
  - Press **OK** to confirm.

13.5 Password

13.5.1 Changing the password

- If the password is different from "0000" (the factory setting corresponding to free access), a password will be requested when entering the *Configuration* screen.
- Proceed as follows:
  - Select the line `Password` with the keys and press **OK**.

- Use the keys to change the highlighted value and to move the cursor.
  - o The range of admissible codes is the ASCII character set.
  - o If a code other than `0000` is enabled, access to the `Configuration` screen will be possible only after entering the correct password.
- Press **OK** to confirm.

❑ The password is active for only about 30 seconds after it has been defined. Thus the home screen of the *Configuration* menu can be changed immediately, without the password needing to be entered, if the 30 seconds have not yet passed.

13.5.2 Return

❑ It is essential to return to the main menu by pressing the key to exit *Configuration* mode and block access to this mode if a password has been entered.

❑ No way of returning automatically to the main menu is provided. However, if the power to the monitor is interrupted, it restarts on the main menu and not on the last screen displayed, as it usually does.

13.6 Default parameters

❑ This table shows the default parameters in the Configuration menu set when the unit is supplied.

Com.RS485 (*)		**Com. Ethernet (*)**		**Display**		**Electrical network**	
Address	001	IP address	000.000.000.000	Scrolling	NO	PT primary	400
Speed	9600	Subnet mask	255.000.000.000	Time	03	PT secondary	400
Parity	No	Gateway	000.000.000.000	Language	French	CT primary	5
Stop bits	1			Contrast	128	CT secondary	5
Turnaround	50			Brightness	240	Primary neutral voltage	100
				Password	0000	Secondary neutral voltage	5
						3 wire / 4 wire	4 wire

** RS485 and Ethernet communications cannot both be present simultaneously.*

13.7 Parameters not modifiable by the keyboard

❑ While some parameters can be modified directly from the navigation keys on the display, others can be set only through local or remote communication.

❑ Setting parameters using local or remote communication can be carried out using *E.set* (setting) or *E.view* (visualisation) software.

❑ Any other software or PLC compatible with the ModBus RTU standard allows setting the *ENERIUM* parameters.

14 HARMONICS SCREEN

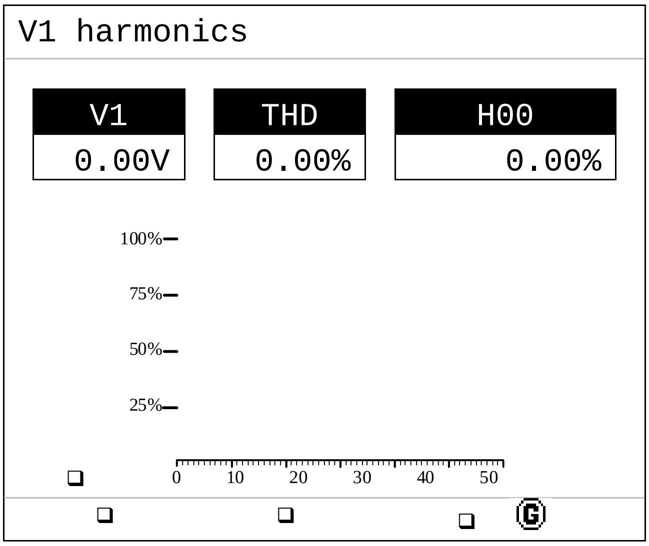
- This screen displays the *Harmonics* menu on the ENERIUM 200 and 300 only. It allows the graphical display of harmonics, row by row, the three phase voltages, the three line voltages, the three currents and the corresponding distortion rates.

14.1 The screens

- This section shows each of the screens accessed by selecting the icon and pressing the OK key.

14.1.1 V1 harmonics

- Press the OK key to display the harmonics and additional data related to voltage V1. The display shows, for example as follows:



Example

- The horizontal axis indicates the orders of harmonics from 1 to 50. Order 0 corresponds to the DC component and rows 1-50 correspond to harmonics.
- The vertical axis (0-100%) indicates the percentage harmonic rate relative to the fundamental (order 1).
- **V1**: Instantaneous phase voltage in volts.
- **Hxx**: value, as a % of the fundamental, relative to the largest harmonic found in the orders 1-50.
- **THD**: total harmonic distortion (formula used is in paragraph 22.15, on Page 78).

14.1.2 V2, V3, U12, U23, U31, I1, I2, I3 and IN harmonics

- Displays harmonics and additional data for the quantity selected. Refer to paragraph *14.1.1 – V1 harmonics* on page 54 for details.

15 PHASOR DIAGRAMS SCREEN

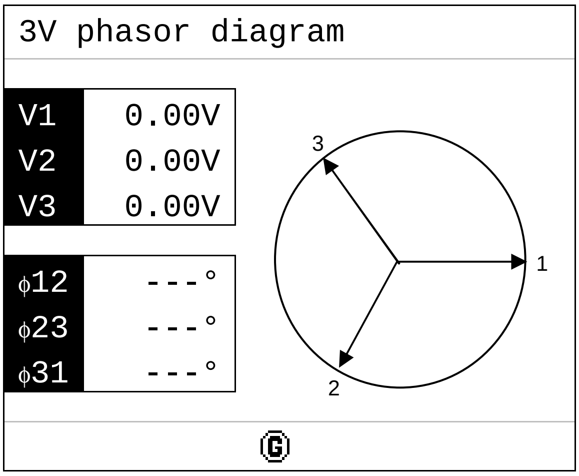
- This screen displays the phasor diagram menu and gauges on the *ENERIUM 200* and *ENERIUM 300* only. It allows the graphical display of the three phase and line voltages and the currents in the form of a phasor diagram.

15.1 The screens

- This section shows each of the screens accessed by selecting the icon and pressing the OK key.

15.1.1 3V phasor diagram

- Press the OK key to display the phasor diagram of the three phase voltages and additional data. The display is as follows:

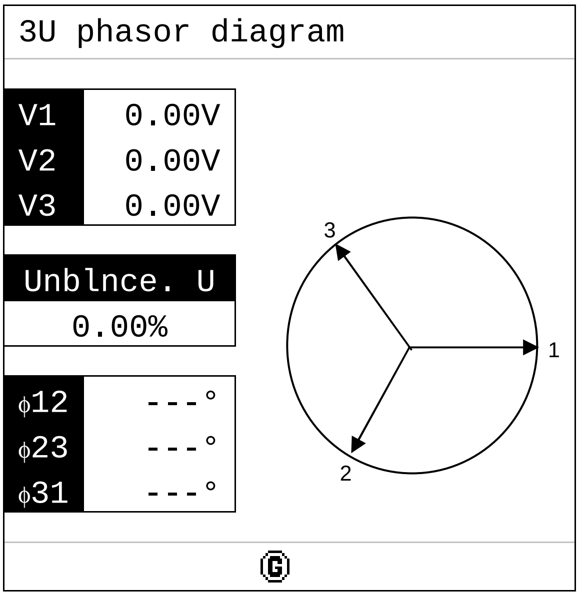


Example

- The information is as follows:
  - **V1**: instantaneous phase voltage V1 in volts.
  - **V2**: instantaneous phase voltage V2 in volts.
  - **V3**: instantaneous phase voltage V3 in volts.
  - **Φ12**: phase relationship, in degrees, between voltage V1 and phase voltage V2.
  - **Φ23**: phase relationship, in degrees, between voltage V2 and phase voltage V3.
  - **Φ31**: phase relationship, in degrees, between voltage V3 and phase voltage V1.

15.1.2 3U phasor diagram

- Press the **OK** key to display the phasor diagram of the three line voltages and additional data. The display is as follows:

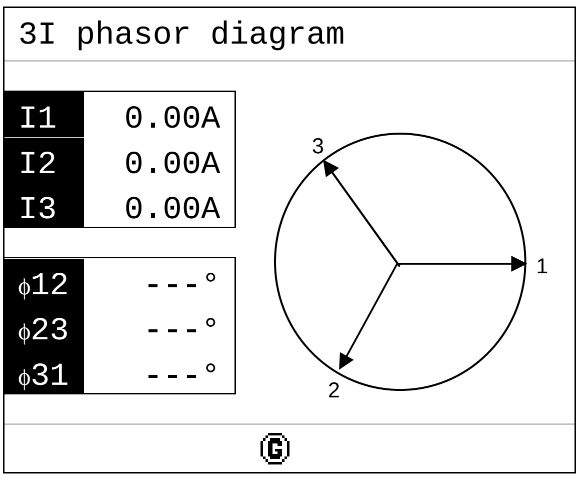


Example

- The information is as follows:
  - **U12**: instantaneous line voltage U12 in volts.
  - **U23**: instantaneous line voltage U23 in volts.
  - **U31**: instantaneous line voltage U31 in volts.
  - **Φ12**: phase relationship, in degrees, between line voltage U12 and line voltage U23.
  - **Φ23**: phase relationship, in degrees, between line voltage U23 and line voltage U31.
  - **Φ31**: phase relationship, in degrees, between line voltage U31 and line voltage U12.
- Unbalance indicator. Indicates the degree of imbalance across the voltages. A properly balanced system has a degree close to zero.

15.1.3 3I phasor diagram

- Press the OK key to display the phasor diagram of the three line voltages and additional data. The display is as follows:



Example

- The information is as follows:
  - **I1**: instantaneous current I1 in amperes.
  - **I2**: instantaneous current I2 in amperes.
  - **I3**: instantaneous current I3 in amperes.
  - **Φ12**: phase difference, in degrees, between phase current I1 and phase current I2.
  - **Φ23**: phase difference, in degrees, between phase current I2 and phase current I3.
  - **Φ31**: phase difference, in degrees, between phase current I3 and phase current I1.

16 POWER QUALITY SCREEN

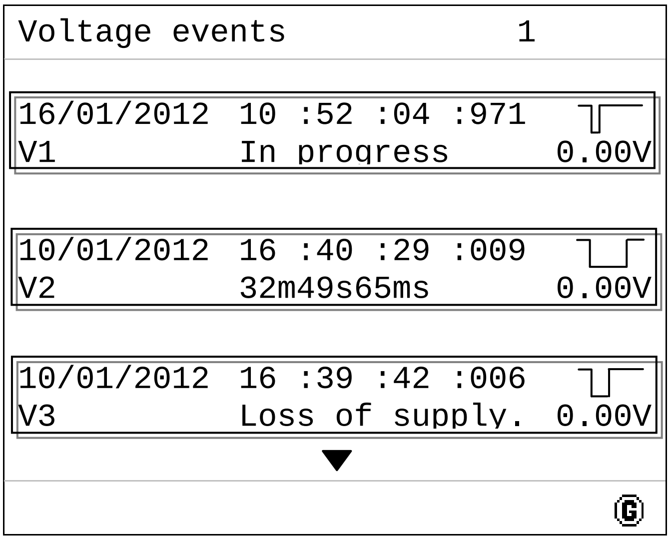
- This screen displays the *power quality* menu on the EN*ERIUM 300* only. It enables the graphical display of:
  - EN50160 statistics.
  - Dip, outage and overvoltage events.
- For additional information relating to the power quality functions, contact *ENERDIS* to obtain a copy of the document MS1-7530 – User manual power quality measurements

16.1 The screens

- This section shows each of the screens accessed by selecting the icon and pressing the OK key.

16.1.1 Voltage events

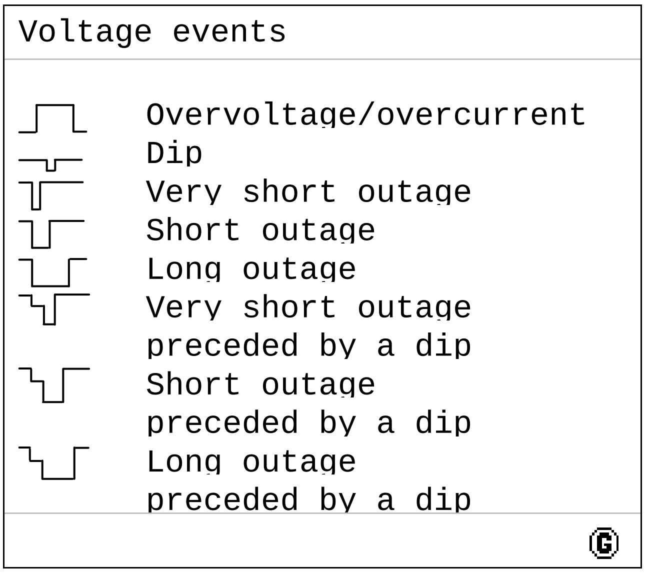
- Phase voltage events are displayed as follows:



Example

- The information is as follows:
  - **V1**: instantaneous phase voltage V1 events in volts.
  - **V2**: instantaneous phase voltage V2 events in volts.
  - **V3**: instantaneous phase voltage V3 events in volts.
- Use the keys to switch from one “voltage event” screen to another. The maximum number of "voltage event" screens is 342, which corresponds to 1024 events recorded.

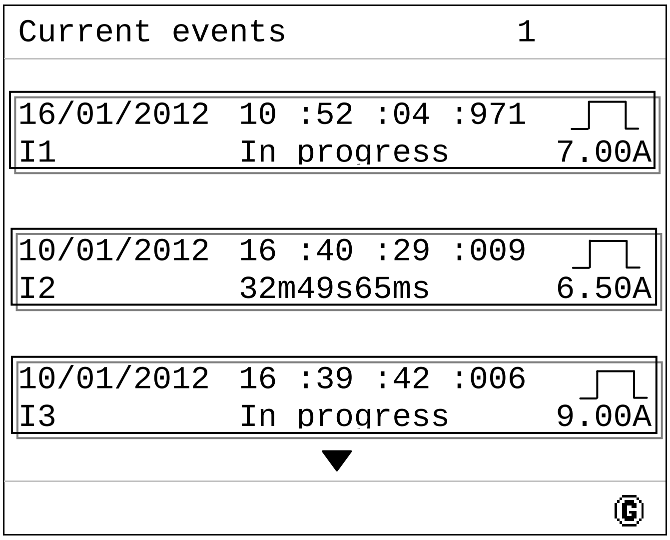
- Use the key to access the screen explaining the event symbols. The display is as follows:



Example

16.1.2 Current events

- The display of current events is as follows:

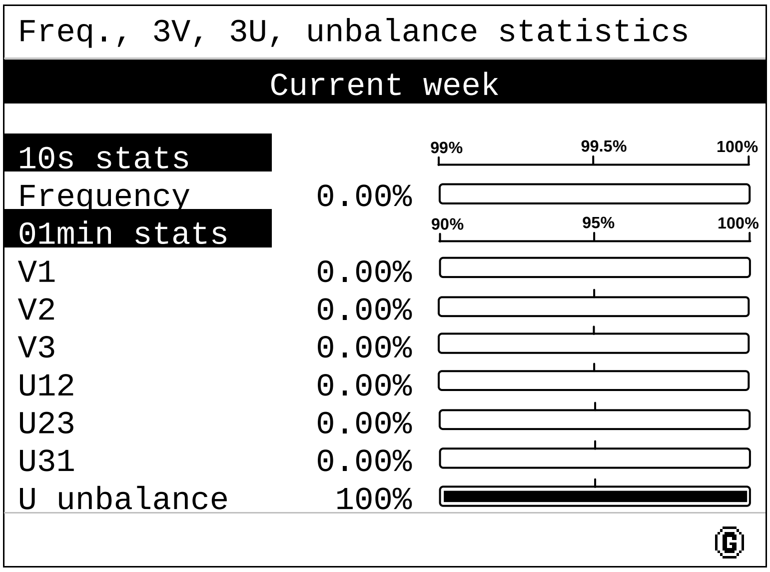


Example

- The information is as follows:
  - **I1**: phase current I1 events in amperes.
  - **I2**: phase current I2 events in amperes.
  - **I3**: phase current I3 events in amperes.
- Use the keys to switch from one “current event” screen to another. The maximum number of "current event" screens is 342, which corresponds to 1024 events recorded.
- Use the key to access the screen explaining the event symbols. The display is as in paragraph 16.1.1 on Page 58.

16.1.3 Frequency, 3V, 3U and unbalance statistics U (in accordance with EN50160)

- The statistical display of frequency, the three phase and line voltages and U unbalance is as follows:

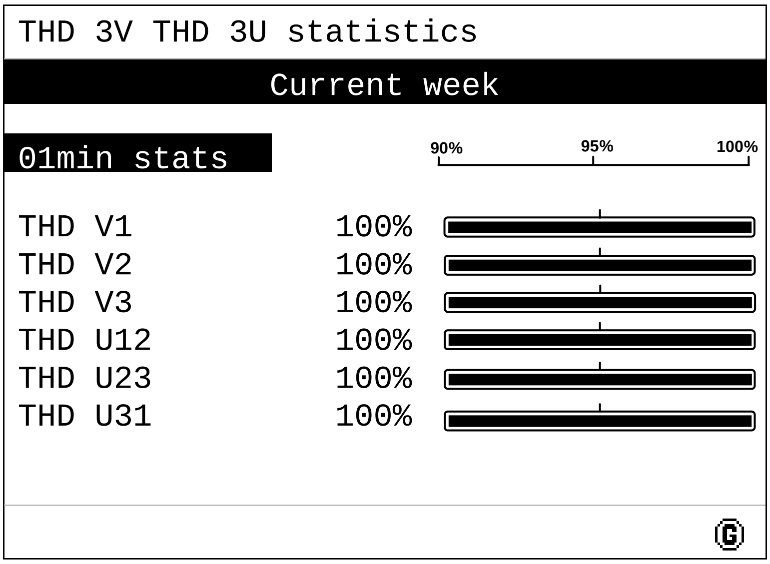


Example

- The information is as follows:
  - 10 second statistics:
    - o **Frequency**: Frequency statistics for the current week.
  - 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minute (selected by sending a command word via local or remote communication) statistics:
    - o **V1**: instantaneous phase voltage V1 statistics for the current week.
    - o **V2**: instantaneous phase voltage V2 statistics for the current week.
    - o **V3**: instantaneous phase voltage V3 statistics for the current week.
    - o **U12**: line voltage U12 statistics for the current week.
    - o **U23**: line voltage U23 statistics for the current week.
    - o **U31**: line voltage U31 statistics for the current week.
    - o **U unbalance**: U unbalance statistics for the current week.
- Press the key to display the previous week's frequency, phase voltage, line voltage and unbalance statistics. The display screen is as above, the only difference being that the title "Current week" becomes "Previous week"
- The frequency measurement blinks when it is lower than 995%.
- The V1, V2, V3, U12, U23, U31 and unbalance measurement blink when they are lower than 95%.

16.1.4 THD 3V, THD 3U statistics

- The display of phase and line voltages distortion statistics appears as follows:

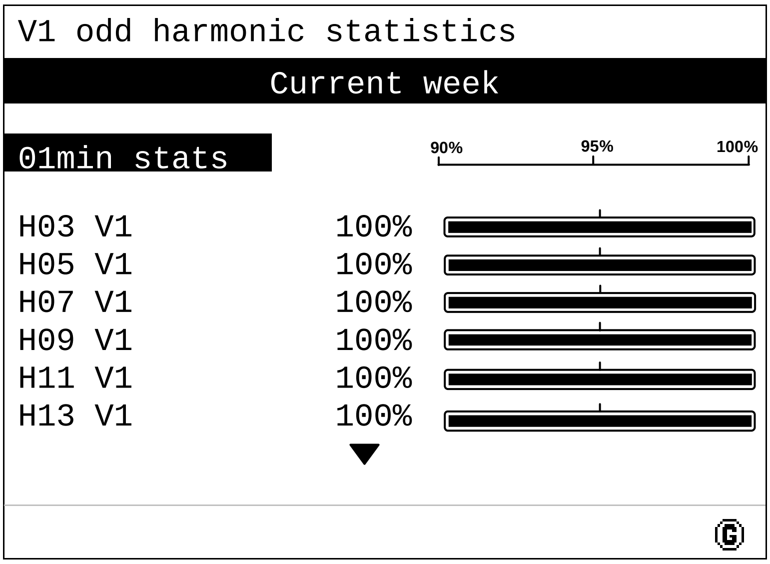


Example

- The information is as follows:
  - **THD V1**: THD statistics for the instantaneous phase voltage V1 for the current week.
  - **THD V2**: THD statistics for the instantaneous phase voltage V2 for the current week.
  - **THD V3**: THD statistics for the instantaneous phase voltage V3 for the current week.
  - **THD U12**: THD statistics for the line voltage U12 for the current week.
  - **THD U23**: THD statistics for the line voltage U23 for the current week.
  - **THD U31**: THD statistics for the line voltage U31 for the current week.
- Press the key to display the phase and line distortion rate statistics for the previous week. The display screen is as above, the only difference being that the title "**Current week**" becomes "**Previous week**"
- The measurements blink when they are lower than 95%.

16.1.5 Odd harmonic statistics V1

- The statistics of order 3 to 25 harmonics of phase voltage V1 are displayed as follows:



Example

- The information is as follows:
  - **H03 V1**: Current week's 3rd harmonic statistics for the instantaneous phase voltage V1.
  - **H05 V1:** Current week's 5th harmonic statistics for the instantaneous phase voltage V1.
  - **H07 V1:** Current week's 7th harmonic statistics for the instantaneous phase voltage V1.
  - **H09 V1**: Current week's 9th harmonic statistics for the instantaneous phase voltage V1.
  - **H011 V1**: Current week's 11th harmonic statistics for the instantaneous phase voltage V1.
  - **H13 V1**: Current week's 13th harmonic statistics for the instantaneous phase voltage V1.
- Use the keys to display the next and previous harmonics.
- Press the key to display the measured statistics for odd harmonics of orders 3 to 25 of phase voltage V1 for the previous week. The display screen is as above, the only difference being that the title "Current week" becomes "Previous week"
- The measurements blink when they are lower than 95%.

16.1.6 Odd harmonic statistics V2

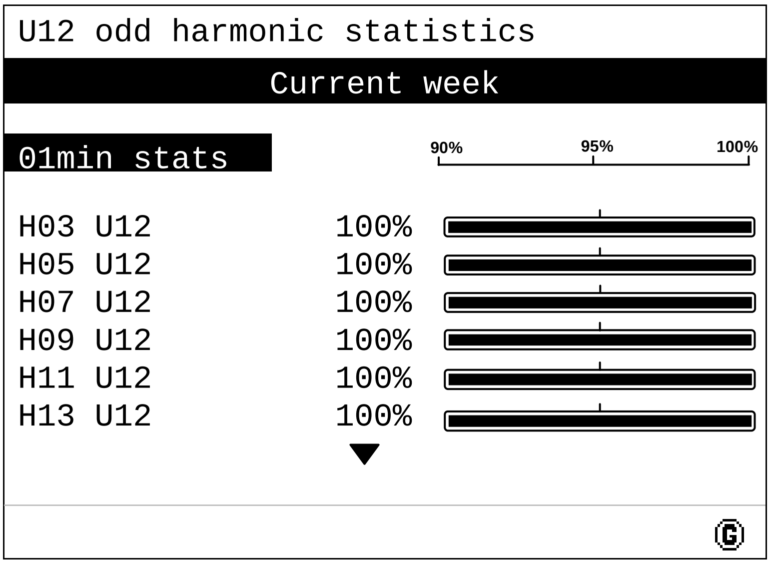
- The data is read in the same way as described in paragraph 16.1.5. The only difference is the title V1, which becomes V4.

16.1.7 Odd harmonic statistics V1

- The data is read in the same way as described in paragraph 16.1.5. The only difference is the title V1, which becomes V3.

16.1.8 Odd harmonic statistics U12

- The statistics of order 3 to 25 harmonics of line voltage U12 are displayed as follows:



Example

- The information is as follows:
  - **H03 U12**: Current week's 3rd harmonic statistics for the line voltage U12.
  - **H05 U12**: Current week's 5th harmonic statistics for the line voltage U12.
  - **H07 U12**: Current week's 7th harmonic statistics for the line voltage U12.
  - **H09 U12**: Current week's 9th harmonic statistics for the line voltage U12.
  - **H11 U12**: Current week's 11th harmonic statistics for the line voltage U12.
  - **H13 U12**: Current week's 13th harmonic statistics for the line voltage U12.
- Use the keys to display the next and previous harmonics.
- Press the key to display the measured statistics for odd harmonics of orders 3 to 25 of line voltage U12 for the previous week. The display screen is as above, the only difference being that the title "Current week" becomes "Previous week"
- The measurements blink when they are lower than 95%.

16.1.9 Odd harmonic statistics U23

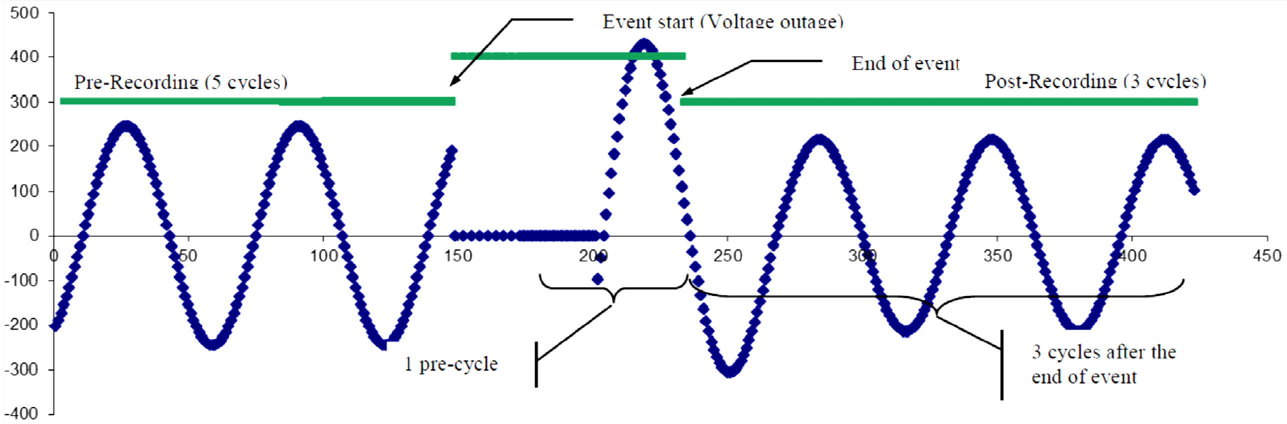
- The data is read in the same way as described in paragraph 16.1.8. The only difference is the title U12, which becomes U23.

16.1.10 Odd harmonic statistics U31

- The data is read in the same way as described in paragraph 16.1.8. The only difference is the title U12, which becomes U31.

17 WAVEFORMS MANAGEMENT

- This function is available only on ENERIUM models 300 and 310
- This curve is not displayable on the *ENERIUM's* screen but through using a specific application (E.view or any application developed by the user)
- The last 16 waveforms are available in the product:
  - Recording of the waveforms by FIFO (the oldest records are automatically replaced by the new ones)
  - The waveforms are stocked in the volatile memory of the product, if the power supply of the product switch off, the waveforms will be lost
- A waveform can include 1 up to 4 electrical parameters selected between following:
  - In 3 wires mode: U12, U23, U31, I1, I2 and I3
  - In 4 wires mode: V1, V2, V3, U12, U23, U31, I1, I2, I3 and IN (IN only in case of measured neutral current)
- The waveform capture is performed at the frequency of 64 measure points by cycle (1 cycle is referring to one network period, ex: 50Hz -> 20ms) and this on 150 cycles maximum
- The waveform capture can be associated to:
  - Manual trigger through modbus command
  - Automatic trigger when a specific pulse is received on the synchronization input
  - Automatic trigger associated to an event of quality electrical energy monitoring (Over voltage, Over current, short/medium/ large Voltage outage, short/medium/ large voltage outage following voltage dips)
- For the manual trigger throught modbus command and the automatic trigger linked to synchronization inputs, the product starts recording the waveform when the event occurs and stops recording 150 cycles later
- For the trigger associated to quality energy event shorter than 150 cycles, the record will include:
  - 5 cycles before the event start
  - 1 to 142 cycles maximum after the event start
  - 3 cycles after the end of the event
- For the trigger associated to quality energy event longer than 150 cycles, the record will include:
  - 5 cycles before the event start then
  - 141 cycles after the even start
  - 1 cycle before the event stop then
  - 3 cycles after the end of the event
- Remark: In case of trigger associated to quality energy event, if two consecutive events occurs on the same channel (example: dip followed by overvoltage on V1) then only the waveform of the first event will be recorded)
- Example:



18 LOAD CURVES

- This function is available only on ENERIUM models 200, 210, 300 on 310.
- This curve is not displayable on the *ENERIUM's* screen but through using a specific application (E.view or any application developed by the user).
- This load curve records from one to eight quantities among the variables defined in paragraph 21.2 on Page 70. The integration time of these quantities can be set to 5, 10, 12, 15, 20, 30 or 60 minutes.
- Each recording consists of a timestamp (date and time), a loss of sync status, return to sync, configuration change, power failure and the selected quantities (up to eight).
- The magnitudes are always sorted in the following order: P+, P-, S+, S-, Q1, Q4, Q2, Q3, TOR1, TOR2, TOR3, TOR4, TOR5, TOR6, TOR7, TOR8, ANAI1, ANAI2, ANAI3, ANAI4, ANAI5, ANAI6, ANAI7 and ANAI8.
- The size of curve is a function of the integration time. The number of quantities selected does not affect the size of curve.

IT (1)	5	10	12	15	20	30	60
RD (2)	17	34	40	51	68	102	204

(1): Integration time in minutes
(2): Size of curve in days

- All load curves can be reset by sending a command word via local or remote communication.
- For further information, please contact *ENERDIS* and ask for:
  - Document on the management of load curves (see paragraph 3.2).
  - Document on mapping and command words (see paragraph 3.2).

19 TREND CURVES

- These curves are not displayable on the *ENERIUM's* screen but can be controlled via the available communication interfaces and through using E.view or any application developed by the user.
- The monitor can record up to four trend curves The recording length can differ from one profile to another. This recording period is selected for each of the records between 1 and 59 seconds in steps of one second or from one of the predefined values: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 and 60 mins.
- The size of curve is a function solely of the recording time period The system is designed to store up to 4032 values.
- Example: for a recording time period set to 1 second, the storage register is full at the end of 4,032 seconds, or 1 hour, 7 minutes and 12 seconds.
- Depending on the allowed recording time period - from 1 second to 60 minutes - the record period is 1 hour, 7 minutes and 12 seconds to 168 days.
- The quantities that can be recorded are given in paragraph 21.5 on Page 71.
- There are three types of synchronisation to control the start and end of recording the electrical quantities previously selected:
  - The first type is called "**Date synchronisation**". Data recording starts or stops when the *ENERIUM* reaches the scheduled date and time.
  - The second type is called "**Digital input synchronisation**". Data recording starts or stops when the selected digital input changes state.
  - The third type is called "**Alarm synchronisation**". Data recording starts or stops when the selected global alarm is activated.
- There are five trend curve methods:
  - **Non-stop mode**: the recordings are held in a circular buffer, the oldest record being deleted by the most recent (FIFO buffer). In this mode, the three synchronization methods may be used to start recording. However, the recording can be stopped only by writing a control word via remote or local communication.
  - **Stop on buffer full mode**: in this mode, the three synchronisation methods may be used to start recording. The recording stops when the storage register is full.
  - **Immediate stop on sync mode**: once again, recordings are held in a circular buffer, the oldest record being deleted by the most recent (FIFO buffer). Recording starts as soon as a variable is assigned to the profile. Writing a "sync on digital input" or a "sync on alarm" or writing a control word via local or remote communication stops the recording immediately.
  - **Stop on 25%-75% centred sync mode:** recordings are made in the same way as in the third method above. But recording stops only when 75% of the profile curve contains data recorded after the stop command, which may be a "sync on digital input" or a "sync on alarm" or the writing of a control word via remote or local communication.
  - **Stop on 50%-50% centred sync mode:** recordings are made in the same way as in the third method above. But recording stops only when 50 % of the profile curve contains data recorded after the stop command, which may be a "sync on digital input" or a "sync on alarm" or the writing of a control word via remote or local communication.
- For further information, please contact *ENERDIS* and ask for:
  - Document MSO-7390 on trend curves.
  - Document MSO-7423 on mapping and command words.

20 LOCAL AND REMOTE COMMUNICATION

- Local or remote communication, either via the applications *E.set* or *E.view* or from any specific application using the ModBus protocol in RTU mode (optical or RS485 interfaces) or Modbus TCP (Ethernet interface) allows setting parameters on, and downloading from, the ENERIUM.
- For more information on the ModBus/RTU and ModBus/TCP/RTU protocols, contact ENERDIS asking for document MS0-7423 – Mapping and command words.

20.1 *E.Set* and *E.View* applications

- The reader is advised to refer to MS0-7376, the manual for these two applications.
- *E.set* enables the ENERIUM with its optional cards to be completely configured, either locally via the optical interface or remotely via the RS485 Modbus RTU or ASCII interface or Modbus TCP via the RJ45 interface.
- *E.view* enables complete downloading of the measurements and recordings made on the *ENERIUM*, either locally via the optical interface or remotely via the RS485 Modbus RTU or ASCII interface or Modbus TCP via the RJ45 interface.

20.2 Specific application

20.2.1 Local communication via the optical interface

- Communication support is described in paragraph 5.2.
- Communication is in *half duplex* mode.
- The functions implemented on the monitor are:
  - Function 03: Read N words
  - Function 04: Read N words
  - Function 08: Read diagnostic counters (see details below)
  - Function 16: Write N words
- The diagnostic counters are:
  - Reset counters to zero
  - Number of frames received without CRC
  - Number of frames received with CRC
  - Number of exception responses
  - Number of frames addressed to this station (not broadcast)
  - Number of broadcast requests received
  - Number of NAK replies
  - Number of slave not ready replies
  - Number of unprocessed characters
  - Number of replies excluding Function 08
- It is also possible to download a new application to the monitor, only via the optical interface. In this case a different ModBus protocol is used.

20.2.2 Remote communication via the RS485 interface

- Communication support is described in paragraph 6.8 and the settings in paragraph 13.2.
- Communication is in *half duplex* mode.
- The functions implemented on the monitor are:
  - Function 03: Read N words
  - Function 04: Read N words
  - Function 08: Read diagnostic counters (see details below)

- Function 16: Write N words

- The diagnostic counters are:
  - Reset counters to zero
  - Number of frames received without CRC
  - Number of frames received with CRC
  - Number of exception responses
  - Number of frames addressed to this station (not broadcast)
  - Number of broadcast requests received
  - Number of NAK replies
  - Number of slave not ready replies
  - Number of unprocessed characters
  - Number of replies excluding Function 08
- The processing of a frame addressed to slave 00 (that is to say, to all the slaves on the network) has been implemented. The monitor then returns no response.
- The default settings are given in paragraph 13.5 on Page 52.

20.2.3 Remote communication via the Ethernet interface

- Communication support is described in paragraph 6.9 and the settings in paragraph 13.3.
- Depending on the state of the network, communication is in *half* or *full duplex* mode.
- The *ENERIUM* is configured with a valid IP address 000.000.000.000 in DHCP (Dynamic Host Configuration Protocol). An IP address is then automatically assigned to the monitor by the DHCP server on the network.
- To determine the IP address and the assigned subnet mask, use applications *E.set* or *E.view* and execute the command: Network Search/New Channel (*Recherche* sous *Réseau/Nouveau canal)* with Channel type set to *Ethernet* and *Port numbe*r set to 502
- Knowing the serial number of the monitor being sought for, all that is needed is to establish correspondence between the IP address and the serial number to obtain the monitor's IP address.
- The default settings are given in paragraph 13.6 on Page 53.

21 CHARACTERISTICS

- The so-called instantaneous quantities are refreshed every second, except for THDs, which are refreshed every six seconds.
- The average quantities are calculated on a programmable basis from 0 to 30 minutes. These quantities are updated every tenth of a period.

21.1 Measurements

Quantity	1S	MIN	MAX	AVG	MIN AVG	MAX AVG
V1, V2, V3, VGround	●	●	●	●		●
U12, U23, U31	●	●	●	●		●
I1, I2, I3, In	●	●	●	●		●
P1, P2, P3	●		● (1)	● (1)		
Pt	●	● (1)	● (1)	● (1)		● (1)
Q1, Q2, Q3	●		● (1)	● (1)		
Qt	●	● (1)	● (1)	● (1)		● (1)
S1, S2, S3	●		●	●		
St	●	●	●	●		●
FP1, FP2, FP3	●			● (1)		
FPt	●			● (1)	● (1)	● (1)
Cosφ1, Cosφ2, Cosφ3	●			● (1)		
Cosφt	●			● (1)	● (1)	● (1)
Tanφ	●			● (1)	● (1)	● (1)
Frequency	●	●	●	●		
V1, V2, V3 peak factor	●			●		●
I1, I2, I3 peak factor	●			●		●
U unbalance	●			●		●
V1, V2, V3, U12, U23, U31, I1, I2, I3, In - Harmonics (2) of order 1 to 50	●					
THD V1, V2, V3, U12, U23, U31, I1, I2, I3	●			●		●
THD In	●		●	●		●
Hour meters: Network presence, on charging, Uptime	●					
Real energy Receiver, Generator	●					
Reactive energy Q1, Q2, Q3, Q4	●					
Apparent energy Receiver, Generator	●					
Pulse counter input (0 to 8)	●					
Analog input (0 to 8)	●	●	●	●	●	●

(1) Measured both in generator and receiver mode
(2) Up to order 25 for *Enerium 100/110, Up to order 50 for Enerium 200/210/300/310*

21.2 Load curves

Quantity	AVERAGE
Pt Gen, Pt Rec	● (1)
Qt q1,q2,q3,q4	● (1)
St Gen, St Rec	● (1)
Digital inputs (0 to 8)	● (1)
Analog inputs (0 to 8)	●

(1) Not available on *ENERIUM 100/110*

21.3 Alarms

Quantity	1 sec	AVERAGE
V1, V2, V3, VGround	●	
U12, U23, U31	●	
I1, I2, I3, In	●	
Pt	●	● (1)
Qt	●	● (1)
St	●	●
FPt	●	
Cosφt	●	
Tanφ	●	● (1)
Frequency	●	
U unbalance	●	
THD I1, I2, I3, In	●	
THD U12, U23, U31	●	
Digital input (0 to 8)	●	
Analog input (0 to 8)	●	●
Hour meters: Network presence, on charging, Uptime	●	

(1) Measured both in generator and receiver mode

21.4 Analog outputs

Quantity	1 sec
V1, V2, V3, VGround	●
U12, U23, U31	●
I1, I2, I3, In	●
P1, P2, P3	●
Pt	●
Q1, Q2, Q3	●
Qt	●
S1, S2, S3	●
St	●

Quantity	1 sec
FP1, FP2, FP3	●
FPt	●
Cosφ1, Cosφ2, Cosφ3	●
Cosφt	●
Tanφ	●
Frequency	●

21.5 Trend curves

Quantity	1 sec	AVG
V1, V2, V3	●	●
VGround	●	
U12, U23, U31	●	●
I1, I2, I3, In	●	●
P1, P2, P3		● (1)
Pt	●	● (1)
Qt	●	
St	●	
FP1, FP2, FP3		● (1)
FPt	●	● (1)
Cosφ1, Cosφ2, Cosφ3, Cosφt		● (1)
Tanφ		● (1)
Frequency		●
V1, V2, V3 peak factor		●
I1, I2, I3 peak factor		●
U unbalance	●	
THD V1, V2, V3	●	●
THD U12, U23, U31	●	●
THD I1, I2, I3, In	●	●
Analog input (0 to 8)	●	●

(1) Measured both in generator and receiver mode

21.6 Inherent errors

- Conforms to the monitoring standard NF EN 61557-12
- A 23℃ ±2℃, 50 Hz (except for the quantity F)
- V_{nom}/U_{nom} = 230 V/400 V for PT secondary > 100 V
- V_{nom}/U_{nom} = 57.7 V/400 V for PT secondary > 100 V
- I_{nom} = 5A

Quantity	Conditions	0.5s accuracy (1)	0.2s accuracy (2)
V	V between [10% and 120%] of V_{nom}	±0.5% of the reading	±0.2% of the reading
U	U between [10% and 120%] of U_{nom}	±0.5% of the reading	±0.2% of the reading
I	I between [5% and 130%] of I_{nom}	±0.5% of the reading	±0.2% of the reading

Quantity	Conditions	0.5s accuracy (1)	0.2s accuracy (2)
F	F between [42.5 Hz and 69 Hz]	±0.1 Hz	
P	FP equal to 1 V between [80% and 120%] of V_{nom} I between [1% and 5%[of I_{nom} I between [5% and 130%] of I_{nom}	 ±1% of the reading ±0.5% of the reading	 ±0.4% of the reading ±0.2% of the reading
	FP between [0.5 inductive and 0.8 capacitive] V between [80% and 120%] of V_{nom} I between [2% and 10%[of I_{nom} I between [10% and 130%%] of I_{nom}	 ±1% of the reading ±0.6% of the reading	 ±0.5% of the reading ±0.3% of the reading
Q	Sin (φ) = 1 V between [80% and 120%] of V_{nom} I between [2% and 5%[of I_{nom} I between [5% and 130%[of I_{nom}	 ±0.625% of the reading ±0.5% of the reading	 ±0.25% of the reading ±0.2% of the reading
	Sin (φ) between [0.5 inductive and 0.5 capacitive] V between [80% and 120%] of V_{nom} I between [5% and 10%[of I_{nom} I between [10% and 130%] of I_{nom}	 ±0.625% of the reading ±0.5% of the reading	 ±0.25% of the reading ±0.2% of the reading
	Sin (φ) between [0.25 inductive and 0.25 capacitive] V between [80% and 120%] of V_{nom} I between [10% and 130%] of I_{nom}	±0.625% of the reading	±0.25% of the reading
S	V between [80% and 120%] of V_{nom} I between [2% and 5%[of I_{nom} I between [5% and 130%] of I_{nom}	 ±1% of the reading ±0.5% of the reading	 ±1% of the reading ±0.2% of the reading
Cos(φ)	Cos(φ) between [0.5 inductive and 0.5 capacitive]	±0.02	
	Cos(φ) between [0.2 inductive and 0.2 capacitive]	±0.05	
Tan(φ)	Tan(φ) between [1.732 inductive and 1.732 capacitive]	±0.02	
	Tan(φ) between [4.90 inductive and 4.90 capacitive]	±0.05	
FP	FP between [0.5 inductive and 0.5 capacitive]	±0.02	
	FP between [0.2 inductive and 0.2 capacitive]	±0.05	
Active E	FP equal to 1 I between [1% and 5%[of I_{nom} I between [5% and 130%] of I_{nom}	 ±1% of the reading ±0.5% of the reading	 ±0.4% of the reading ±0.2% of the reading
	FP between [0.5 inductive and 0.8 capacitive] I between [2% and 10%[of I_{nom} I between [10% and 130%%] of I_{nom}	 ±1% of the reading ±0.6% of the reading	 ±0.5% of the reading ±0.3% of the reading
Reactive E	Sin (φ) = 1 I between [2% and 5%[of I_{nom} I between [5% and 130%[of I_{nom}	 ±0.625% of the reading ±0.5% of the reading	 ±0.25% of the reading ±0.2% of the reading

Quantity	Conditions	0.5s accuracy (1)	0.2s accuracy (2)
	Sin (φ) between [0.5 inductive and 0.5 capacitive] I between [5% and 10%[of I_{nom} I between [10% and 130%] of I_{nom}	 ±0.625% of the reading ±0.5% of the reading	 ±0.25% of the reading ±0.2% of the reading
	Sin (φ) between [0.25 inductive and 0.25 capacitive] I between [10% and 130%] of I_{nom}	±0.625% of the reading	±0.25% of the reading
Apparent E	I between [2% and 5%[of I_{nom} I between [5% and 130%] of I_{nom}	±1% of the reading ±0.5% of the reading	±1% of the reading ±0.2% of the reading
Harmonics by order	-	±0.5% of the reading	
THD	-	±0.5% points	
Hour meter (HM)	-	±20 ppm	
Time	T = 23℃	±20 ppm (i.e. ± 52 seconds in 30 days)	

(1) Only for *ENERIUM 100/110/200/210*
(2) Only for *ENERIUM 200/210/300/310*

21.7 Environmental constraints

21.7.1 Climatic constraints

Operating temperature	-10℃ to 55℃ (K55 in accordance with NF EN 61557-12)
Operating humidity	Up to 95% at 40℃
Storage temperature	-25℃ to +70℃

21.7.2 Safety constraints

Pollution level	2
Fire resistance	Conforms to UL94 for safety level V1
Installation category	III

21.7.3 Mechanical constraints

Protection class	To IEC 60529, for the following level of safety: IP 51 (on the front panel) IP 20 (on the rear panel)
Mechanical shock	Conforms to IEC 61010-1
Vibration	CEI 60068-2-6 (Method A)
Free fall with packaging	At a height of 1m, in accordance with NF H 0042-1

21.7.4 EMC

- Conforms to IEC 61326-1

Access	Standards	Level
Casing	IEC 61000-4-2: Electrostatic discharges	4 kV contact ; 4 kV air
	IEC 61000-4-3: Electromagnetic field	3 V/m (80 MHz to 1 GHz) 3 V/m (1.4 GHz to 2 GHz) 1 V/m (2 GHz to 2.7 GHz)
AC power (including protective earth)	IEC 61000-4-11: Voltage peaks	0% over ½ cycle 0% over 1 cycle 70% over 25/30 cycles
	IEC 61000-4-11: Short outages	0% over 250/300 cycles
	IEC 61000-4-4: Fast transient bursts	1 kV (5/50 ns, 5 kHz)
	IEC 61000-4-5: Surges	0.5 kV line to line 1 kV line to ground
	IEC 61000-4-6: Disturbances induced by RF fields	3 V (150 kHz to 80 MHz)
DC power	IEC 61000-4-4: Fast transient bursts	1 kV (5/50 ns, 5 kHz)
	IEC 61000-4-5: Surges	0.5 kV line to line 1 kV line to ground
	IEC 61000-4-6: Disturbances induced by RF fields	3 V (150 kHz to 80 MHz)
Input/output Signal/control (including access lines connected to a functional earth)	IEC 61000-4-4: Fast transient bursts	0.5 kV (5/50 ns, 5 kHz)
	IEC 61000-4-5: Surges	1 kV line to ground
	IEC 61000-4-6: Disturbances induced by RF fields	3 V (150 kHz to 80 MHz)

21.8 Saving information

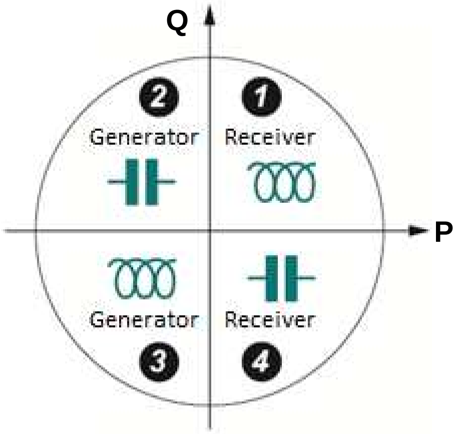
- The information saved following a power outage are:

Settings
Average values
Minimum values
Maximum values
Energy meter readings
Pulse counter readings
Event histories
Hour meters
Load curves
Trend curves

Item	Characteristics
Information retention	10 years at 25℃

22 FORMULAE AND CALCULATION METHODS

22.1 Convention



The quadrants used by ENERIUM.

22.2 Phase voltages

- Measurements are made are as follows:
  - $V_L[1s] = \sqrt{\frac{1}{5} \times \sum_1^5 V_L^2[10T]}$ For F = 50Hz OR $V_L[1s] = \sqrt{\frac{1}{5} \times \sum_1^5 V_L^2[12T]}$ For F = 60Hz
  - With $V_L[10T] = \sqrt{\frac{1}{10} \times \sum_1^{10} V_L^2[T]}$, $V_L[12T] = \sqrt{\frac{1}{12} \times \sum_1^{12} V_L^2[T]}$ AND $V_L[T] = \sqrt{\frac{1}{128} \times \sum_1^{128} v_L^2}$ with L = 1, 2, 3, T

22.3 Line voltages

- Measurements are made are as follows:
  - $U_{ab}[1s] = \sqrt{\frac{1}{5} \times \sum_1^5 U_{ab}^2[10T]}$ For F = 50Hz OR $U_{ab}[1s] = \sqrt{\frac{1}{5} \times \sum_1^5 U_{ab}^2[12T]}$ For F = 60Hz
  - With $U_{ab}[10T] = \sqrt{\frac{1}{10} \times \sum_1^{10} U_{ab}^2[T]}$ OR $U_{ab}[12T] = \sqrt{\frac{1}{12} \times \sum_1^{12} U_{ab}^2[T]}$
  - And $U_{ab}[T] = \sqrt{\frac{1}{128} \times \sum_1^{128} (v_a - v_b)^2}$ ab = 12, 23 or 31

22.4 Current

- Measurements are made are as follows:
  - $I_L[1s] = \sqrt{\frac{1}{5} \times \sum_1^5 I_L^2[10T]}$ For F = 50Hz OR $I_L[1s] = \sqrt{\frac{1}{5} \times \sum_1^5 I_L^2[12T]}$ For F = 60Hz
  - With $I_L[10T] = \sqrt{\frac{1}{10} \times \sum_1^{10} I_L^2[T]}$ OR $I_L[12T] = \sqrt{\frac{1}{12} \times \sum_1^{12} I_L^2[T]}$ L = 1, 2, 3, N
  - For L = 1, 2, 3 : $I_L[T] = \sqrt{\frac{1}{128} \times \sum_1^{128} i_L^2}$

- For L = N : $I_L[T]=\sqrt{\frac{1}{128}\times\sum_{1}^{128}(i_1+i_2+i_3)^2}$

22.5 Real power

- Measurements are derived from “10 period" real power measurements for a system set at 50 Hz and "12 period" real power measurements for a system set at 60 Hz. The formulae are:
  - $P_L[1s]=\frac{1}{5}\times\sum_{1}^{5}P_L[10T]$ For F = 50Hz OR $P_L[1s]=\frac{1}{5}\times\sum_{1}^{5}P_L[12T]$ For F = 60Hz
  - With $P_L[10T]=\frac{1}{10}\times\sum_{1}^{10}P_L[T]$ OR $P_L[12T]=\frac{1}{12}\times\sum_{1}^{12}P_L[T]$
  - And $P_L[T]=\frac{1}{128}\times\sum_{1}^{128}v_L\times i_L$ L = 1, 2, 3
  - $P[1s]$ is the sum of the real powers averaged over a second:
    - o $P[1s]=P_1[1s]+P2[1s]+P3[1s]$

22.6 Power rotation direction

- The products measure the power rotation direction "averaged over a second".
  - If P[1s] is positive, the power rotation direction is Receiver.
  - If P[1s] is negative, the power rotation direction is Generator.

22.7 Reactive power

- The monitors measure reactive power "averaged over a second" on each phase Q1[1s], Q2 [1s] and Q3 [1s], and the three-phase reactive power "averaged over a second" Q [1s].
- The measurements are derived from other measurements, according to the following formula:
  - $\mathrm{Q_L[1s]=SignQ_L[1s]\sqrt{S_L^2[1s]-P_L^2[1s]}}$ L = 1, 2, 3
  - $SignQ_L[1s]$ is the sign of the reactive power, derived from the simplified Hilbert transform.
- For F = 50Hz : $SignQ_L[1s]=$ Sign of $\sum_{i=1}^{6400}\sqrt{v_{(i-1)}*(i_1-i_{(i-2)})}$
- For F = 60Hz : $SignQ_L[1s]=$ Sign of $\sum_{i=1}^{7800}\sqrt{i_{(i-1)}*(i_1-i_{(i-2)})}$
  - Q[1s] is the sum of the "averaged over a second" reactive powers Q[1s] = Q_1[1s] + Q_2[1s] + Q_3[1s].

22.8 Apparent power

- The monitors measure reactive power "averaged over a second" on each of the three phases S1[1s], S2 [1s] and S3 [1s], as well as the three-phase apparent power "averaged over a second" S [1s].
- The measurements are derived from other measurements, according to the following formula:
  - $S_L[1s]=V_L[1s]\times I_L[1s]$. L = 1, 2 or 3
  - S[1s] is the sum of the "averaged over a second" apparent powers S[1s] = S_1[1s] + S_2[1s] + S_3[1s].

22.9 Power factor

- The monitors measure power factors (PF) "averaged over a second" on each of the three phases PF_1[1s], PF_2 [1s] and PF_3 [1s], as well as the three-phase power factor "averaged over a second" PF [1s].
- The measurements are derived from other measurements, according to the following formula:
  - $PF_L[1s] = \frac{P_L[1s]}{S_L[1s]}$ L = 1, 2, 3 or nothing for the three-phase quantity
- Each of these quantities is associated with a quadrant. If P_x [1s] and Q_x [1s] (x = 1, 2, 3, or nothing for the three-phase quantity) have the same sign, then the quadrant is inductive, otherwise it is capacitive.

22.10 Cos(φ)

- The monitors measure cos(φ) "averaged over a second" on each phase cos(φ_1)[1s], cos(φ_2)[1s], cos(φ_3)[1s], as well as the overall cos(φ) "averaged over a second", called cos(φ_g)[1s].
- cos(φ) is calculated from the following formula:
  - $\cos(\varphi_L)[1s] = \frac{1}{5} \times \sum_1^5 \cos(\varphi_L)[10T]$ For F = 50Hz, L = 1, 2, 3
  - $\cos(\varphi_L)[1s] = \frac{1}{5} \times \sum_1^5 \cos(\varphi_L)[12T]$ For F = 60Hz, L = 1, 2, 3
- And:
  - $\cos(\varphi_{global})[1s] = \frac{\cos(\varphi_1)[1s] + \cos(\varphi_2)[1s] + \cos(\varphi_3)[1s]}{3}$
  - With: $\cos(\varphi_L)[10T] = \cos(Angle\_V_L\_Fundamental[10T] - Angle\_I_L\_Fundamental[10T])$
  - And: $\cos(\varphi_L)[12T] = \cos(Angle\_V_L\_Fundamental[12T] - Angle\_I_L\_Fundamental[12T])$
- A quadrant is associated with each of these quantities.
  - If the angle is between 0° and 90° or between 180° and 270°, then the quadrant is inductive.
  - If the angle is between 90° and 180° or between 270° and 360°, then the quadrant is capacitive.

22.11 Peak factor

- Measurements are derived from “10 averaged over period" real power measurements for a system set at 50 Hz and "12 period" real power measurements for a system set at 60 Hz. The formulae are:

22.11.1 For voltages

- $FC_{VL}[1s] = \frac{1}{5} \times \sum_1^5 FC_{VL}[10T]$ For F = 50Hz OR $FC_{VL}[1s] = \frac{1}{5} \times \sum_1^5 FC_{VL}[12T]$ For F = 60Hz
- With: $FC_{VL}[10T] = \frac{Vpeak[10T]}{V[10T]}$
- And: $FC_{VL}[12T] = \frac{Vpeak[12T]}{V[12T]}$ With: $V[10T] = \sqrt{\frac{1}{1280} \times \sum_1^{1280} v_L^2}$ And: $V[12T] = \sqrt{\frac{1}{1536} \times \sum_1^{1536} v_L^2}$
  - With: $Vpeak[10T] = \max[abs(v_L)]$
  - And: $Vpeak[12T] = \max[abs(v_L)]$
  - L = 1, 2, 3

22.11.2 For currents

- $FC_{IL}[1s] = \frac{1}{5} \times \sum_{1}^{5} FC_{IL}[10T]$ For F = 50Hz OR $FC_{IL}[1s] = \frac{1}{5} \times \sum_{1}^{5} FC_{IL}[12T]$ For F = 60Hz
- With: $FC_{IL}[10T] = \frac{Ipeak\,[10T]}{I[10T]}$
- And: $FC_{IL}[12T] = \frac{Ipeak\,[12T]}{I[12T]}$ With: $I[10T] = \sqrt{\frac{1}{1280} \times \sum_{1}^{1280} i_L^2}$ And: $I[12T] = \sqrt{\frac{1}{1536} \times \sum_{1}^{1536} i_L^2}$
  - With: $Ipeak[10T] = max[abs(i_L)]$
  - And: $Ipeak[12T] = max[abs(i_L)]$
  - L = 1, 2, 3

22.12 Tan(φ)

- The monitors measure Tan(φ) globally "averaged over a second".
- Each of these quantities is associated with a quadrant. If P [1s] and Q [1s] (Three-phase quantity) have the same sign, then the quadrant is inductive, otherwise it is capacitive.
- $tg(\varphi_g)[1s] = \frac{Q[1s]}{P[1s]}$

22.13 Frequency

- Measurements are derived from “10 period" real power measurements for a system set at 50 Hz and "12 period" real power measurements for a system set at 60 Hz. The formulae are:
  - F[1s] = Sampling_F x $\frac{\mathbf{10}T}{Number\_of\_Samples\_over\_10T}$
  -
  - With the following constraint: Sampling_F = 128 * F[1s]

22.14 Harmonics

- The monitors measure the harmonic rates Hx "averaged over a second" order by order on the three phase voltages V1, V2, V3, the three line voltages U12, U23, U31 and three currents I1, I2, I3 in accordance with IEC 61000-4-7 (Edition 2). The measurements are derived from the hx[10T] harmonics, according to the following formula:
  - $H_x[1s] = \sqrt{\frac{\sum_{1}^{5} h_x^2[10T]}{\sum_{1}^{5} h_1^2[10T]}}$
- When the phase voltage, line voltage or the current is 0, then the harmonic distortion of the quantity involved is not calculated and is 0.
- *ENERIUM 50s* measure this up to order 25; *ENERIUM 150s* up to order 50.

22.15 Total harmonic distortion

- The monitors measure the total harmonic distortion "averaged over a second" for the three phase voltages THD_{V1}[1s], THD_{V2}[1s] and THD_{V3}[1s], the three line voltages THD_{U12}[1s], THD_{U23}[1s] and THD_{U31}[1s], as well as for the three currents THD_{I1}[1s], THD_{I2}[1s] and THD_{I3}[1s], as defined by IEC 60050-551-20.

- The measurements are derived from the harmonics already calculated, order by order, "averaged over a second", according to the following formula:
  - $THD = 100 \times \sqrt{\frac{\sum_{n=2}^{50} H_n^2}{H_1^2}}$
- When the phase voltage, line voltage or the current is 0, then the total harmonic distortion of the quantity involved is not calculated and is 0.

22.16 Energy and energy metering

- Products calculate the "averaged over a second" real energy EP[1s], reactive energy EQ[1s] and apparent energy ES[1s].
- The measurements are derived from other measurements already calculated, according to the following formula:
  - $EX[1s] = M[1s] \times \frac{N_{ech}}{3600 \times F_{ech}}$ X = P, Q or S
- Energies are measured in absolute values and are always positive.
- M is the measured quantity "averaged over a second" (Real, reactive and apparent). N_{ech} is the number of samples collected during the sampling window. F_{ech} is the sampling frequency.
- Depending on the quadrant, the measured energy is added to a total counter.
  - If P[1s] is positive, the energy measure EP[1s] is added to the real energy meter active in receiver mode CEP_R and the energy measure ES[1s] is added to the apparent energy meter in receiver mode CES_R.
  - If P[1s] is negative, the energy measure EP[1s] is added to the real energy meter active in generator mode CEP_G and the energy measure ES[1s] is added to the apparent energy meter in generator mode CES_G.
  - If P[1s] and Q[1s] are both positive, the energy measurement EQ[1s] is added to the reactive energy meter in the first quadrant, CEQ_1 . If P[1s] is negative and Q[1s] is positive, the energy measurement EQ[1s] is added to the reactive energy meter in the second quadrant, CEQ_2. If P[1s] is positive and Q[1s] is negative, the energy measurement EQ[1s] is added to the reactive energy meter in the fourth quadrant, CEQ_4. If P[1s] and Q[1s] are both negative, the energy measurement EQ[1s] is added to the reactive energy meter in the third quadrant CEQ_3.
- It is possible to reset all the energy counters to zero by sending a command word via local or remote communication. It is also possible to reset the value of one counter independently of another, once again by sending a command word via local or remote communication.

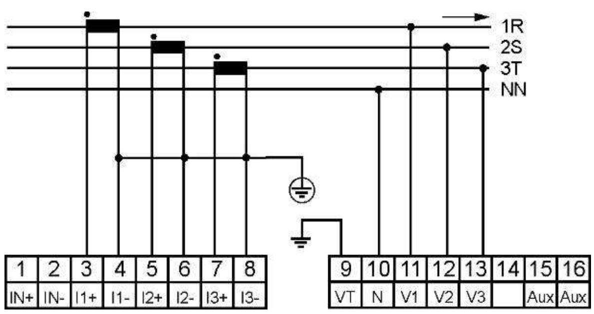
22.17 Unbalance

- The monitors calculate the unbalance voltage ratio, called Uvr[1s], every second, from measurements of line voltages "averaged over a second" and in accordance with the following algorithm:
  - Calculate Fact1 and Fact2, such that:
    - o $Fact1 = U_{12}{}^2[1s] + U_{23}{}^2[1s] + U_{31}{}^2[1s]$
    - o $Fact2 = U_{12}{}^4[1s] + U_{23}{}^4[1s] + U_{31}{}^4[1s]$
  - Calculate Fact3, such that:
    - o If $(3 \times Fact1^2 - 6 \times Fact2) < 0$
    - o Then $Fact3 = 0$
    - o Else $Fact3 = \sqrt{3 \times Fact1^2 - 6 \times Fact2}$
  - Calculate Fact4, such that:

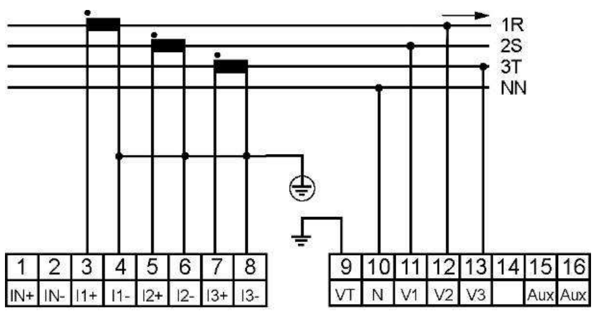
- If $(6 \times Fact2 - 2 \times Fact1^2) < 0$
- Then $Fact4 = 0$
- Else $Fact4 = \sqrt{6 \times Fact2 - 2 \times Fact1^2}$
- If $Fact4 > 0$
- Then $Uvr[1s] = 1000 \times \frac{(Fact1 - Fact3)}{Fact4}$
- Else $Uvr[1s] = 0$

22.18 Phase order

- This function performs a wiring test by checking the phase sequence of the voltage channels. The calculation is performed over 3 periods and every 10 periods of the input reference signal. If the phase sequence is incorrect, then a symbol appears in the bottom banner of the display screen.



Correct phase order



Incorrect phase order example (inversion V1 and V2)

22.19 Hour meter

- The monitors have three hour counters.
  - The first counter accumulates the time during which the power is on, that is to say the time during which the auxiliary source is present. This counter is called the "Uptime" hour meter.
  - A second counter accumulates the time during which at least one measurement of the "averaged over a second" phase voltages V_1[1s], V_2[1s] and V_3[1s] is non-zero. This counter is called the "Network Presence" hour meter.
  - A second counter accumulates the time during which at least one measurement of the "averaged over a second" phase voltages V_1[1s], V_2[1s] and V_3[1s] is non-zero. This counter is called the "Charging" hour meter.
-

22.20 Average measurements

- The averages are moving averages, being updated every tenth of the integration time. The integration time is common to all quantities. This integration time is selected from the predefined values: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 and 60 minutes.
- All average values can be reset by writing a control word via remote or local communication. Resetting consists of setting the value of the quantity to 0, with the exception of quantities of the type FP_x and cos (φ_x), which are reset to a value of 1.

22.20.1 RMS values

- The monitors calculate RMS values of "averaged over a second" quantities in the four quadrants. These averages are as follows:
  - V_1[avg], V2[avg], V3[avg]
  - U12[avg], U23[avg], U31[avg]
  - I1[avg], I2[avg], I3[avg], IN[avg]
- The averages listed above are calculated from the following formula:
  - $$X[avg] = \sqrt{\frac{1}{N} \times \sum_{i=1}^{N} X[1s]_i^2}$$

22.20.2 Arithmetic averages (A)

- The monitors calculate arithmetic average values of the "averaged over a second" quantities in the four quadrants. These average values are as follows:
  - S1[avg], S2[avg], S3[avg], S[avg]
  - F[avg], Des[avg]
  - THDV1[avg], THDV2[avg], THDV3[avg]
  - THDU12[avg], THDU23[avg], THDU31[avg]
  - THDI1[avg], THDI2[avg], THDI3[avg]
  - FCV1[avg], FCV2[avg], FCV3[avg]
  - FCI1[avg], FCI2[avg], FCI3[avg]
- The averages listed above are calculated from the following formula:
  - $$X[avg] = \frac{1}{N} \times \sum_{i=1}^{N} X[1s]_i$$

22.20.3 Arithmetic averages (B)

- The monitors calculate arithmetic average values of the "averaged over a second" quantities in the two quadrants in receiver mode. These average values are as follows:
  - P_1R[avg], P2R[avg], P3R[avg], PR[avg]
  - Q1R[avg], Q2R[avg], Q3R[avg], QR[avg]
- If P_x[1s] is positive or zero (receiver mode) it is the "averaged over a second" measured value which is included in the average. When P_x[1s] is negative (generator mode) it is set to 0, which is reflected in the average.

22.20.4 Arithmetic averages (C)

- The monitors calculate arithmetic average values of the "averaged over a second" quantities in the two quadrants in receiver mode. These average values are as follows:
  - FP1R[avg], FP2R[avg], FP3R[avg], FPR[avg]
  - cos(φ1)R[avg], cos(φ2)R[avg], cos(φ3)R[avg], cos(φg)R[avg]
- If P_x[1s] is positive or zero (receiver mode) it is the "averaged over a second" measured value which is included in the average. When P_x[1s] is negative (generator mode) it is set to 1, which is reflected in the average.

22.20.5 Arithmetic averages (D)

- The monitors calculate arithmetic average values of the "averaged over a second" quantities in the two quadrants in generator mode. These average values are as follows:

- $P_1G[avg]$, P2G[avg], P3G[avg], PG[avg],
- Q1G[avg], Q2G[avg], Q3G[avg], QG[avg]

❑ If $P_x[1s]$ is negative or 0 (generator mode) it is the "averaged over a second" measured value which is included in the average. When $P_x[1s]$ is positive or 0 (receiver mode) it is set to 0, which is reflected in the average.

22.20.6 Arithmetic averages (E)

❑ The monitors calculate arithmetic average values of the "averaged over a second" quantities in the two quadrants in generator mode. These average values are as follows:

- $FP_1G[avg]$, FP2G[avg], FP3G[avg], FPG[avg]
- cos(φ1)G[avg], cos(φ2)G[avg], cos(φ3)G[avg], cos(φg)G[avg]

❑ If $P_x[1s]$ is negative (generator mode) it is the "averaged over a second" measured value which is included in the average. When $P_x[1s]$ is positive or 0 (receiver mode) it is set to 1, which is reflected in the average.

22.21 Calculation of minima

❑ Each minimum is time-stamped (date and time the minimum is detected). All minima can be reset by writing a control word via remote or local communication. Resetting consists of setting the value of the quantity to 0, with the exception of the minima of quantities of the type FP_x and cos (φ_x), which are reset to a value of 1.

22.22 Quantity minima

22.22.1 Minima (A)

❑ The monitors calculate minima of the "averaged over a second" quantities in the four quadrants. These minima are as follows:

- $V_1[min]$, V2[min], V3[min]
- U12[min], U23[min], U31[min]
- I1[min], I2[min], I3[min], IN[min]
- F[min]

❑ The minima listed above are calculated from the following algorithm:

- If $(X[1s] < X[\min])$
- Then $(X[\min] = X[1s])$
  - With X = U_{ab}, I_L or F
  - ab=12, 23 or 31
  - L = 1, 2 or 3

22.22.2 Minima (B)

❑ The monitors also calculate minima of the "averaged over a second" quantities in the two quadrants in receiver mode. These minima are as follows:

- $P_1R[min]$, $P_2R[min]$, P3R[min], PR[min]
- Q1R[min], Q2R[min], $Q_3R[min]$, QR[min]

❑ The minima listed above are calculated from the following algorithm:

- If $(X[1s] < XR[\min])$ AND $(P[1s] \geq 0)$
- Then $(XR[\min] = X[1s])$ with X = P or Q

22.22.3 Minima (C)

- The monitors also calculate minima of the "averaged over a second" quantities in the two quadrants in generator mode. These minima are as follows:
  - P_1G[min], P_2G[min], P_3G[min], PG[min],
  - Q_1G[min], Q_2G[min], Q_3G[min], QG[min]
- The minima listed above are calculated from the following algorithm:
  - If $\left(X[1s] < XG[\min]\right)$ AND $\left(\mathrm{P}[1s] < 0\right)$
  - Then $\left(XG[\min] = X[1s]\right)$ with X = P or Q

22.23 Minima of average quantities

22.23.1 Minima (A)

- The monitors also calculate minima of the average quantities in the two quadrants in receiver mode. These minima are as follows:
  - FP1R[min avg], FP2R[min avg], FP3R[min avg], FPR[min avg]
  - cos(φ1)R[min avg], cos(φ2)R[min avg], cos(φ3)R[min avg], cos(φg)R[min avg]
- The minima listed above are calculated from the following algorithm:
  - If $\left(X[avg] < XR[\min\ avg]\right)$ AND $\left(\mathrm{P}[\mathrm{avg}] \geq 0\right)$
  - Then $\left(XR[\min\ avg] = X[avg]\right)$ with X = FP or cos(φ_g).

22.23.2 Minima (B)

- The monitors also calculate minima of the average quantities in the two quadrants in generator mode. These minima are as follows:
  - FP_1G[min avg], FP2G[min avg], FP3G[min avg], FPG[min avg]
  - cos(φ1)G[min avg], cos(φ2)G[min avg], cos(φ3)G[min avg], cos(φg)G[min avg]
- The minima listed above are calculated from the following algorithm:
  - If $\left(X[avg] < XG[\min\ avg]\right)$ AND $\left(\mathrm{P}[avg] < 0\right)$
  - Then $\left(XG[\min\ avg] = X[avg]\right)$ with X = FP or cos(φ).

22.24 Calculation of maxima

- Each maximum is time-stamped (date and time the minimum is detected). All maxima can be reset by writing a control word via remote or local communication. Resetting consists of setting the value of the quantity to 0, with the exception of the maxima of quantities of the type FP_x and cos (φ_x), which are reset to a value of 1.

22.25 Quantity maxima

22.25.1 Maxima (A)

- The monitors calculate maxima of the "averaged over a second" quantities in the four quadrants. These maxima are as follows:
  - V_1[max], V2[max], V3[max]
  - U12[max], U23[max], U31[max]

- I1[max], I2[max], I3[max], IN[max]
- F[max]
- S1[max], S2[max], S3[max], S[max]

❑ The maxima listed above are calculated from the following algorithm:

- If $(X[1s] > X[\max])$
- Then $(X[\max] = X[1s])$
  - o with X = U_{ab}, I_L, F or S
  - o ab=12, 23 or 31
  - o L = 1, 2 or 3

22.25.2 Maxima (A)

❑ The monitors also calculate maxima of the "averaged over a second" quantities in the two quadrants in receiver mode. These maxima are as follows:

- P_1R[max], P_2R[max], P3R[max], PR[max]
- Q1R[max], Q2R[max], Q3R[max], QR[max]

❑ The maxima listed above are calculated from the following algorithm:

- If $(X[1s] > XR[max])$ AND $(\mathrm{P}[1s] \geq 0)$
- Then $(XR[max] = X[1s])$ with X = P or Q.

22.25.3 Maxima (C)

❑ The monitors also calculate maxima of the "averaged over a second" quantities in the two quadrants in generator mode. These maxima are as follows:

- P_1G[max], P2G[max], P3G[max], PG[max],
- Q1G[max], Q2G[max], Q3G[max], QG[max]

❑ The maxima listed above are calculated from the following algorithm:

- If $(X[1s] > XG[\max])$ AND $(\mathrm{P}[1s] < 0)$
- Then $(XG[\max] = X[1s])$ with X = P or Q.

22.26 Maxima of average quantities

22.26.1 Maxima (A)

❑ The monitors calculate maxima of the average quantities in the four quadrants. These maxima are as follows:

- V_1[max avg], V2[max avg], V3[max avg]
- U12[max avg], U23[max avg], U31[max avg]
- I1[max avg], I2[max avg], I3[max avg], IN[max avg]
- Des[avg]
- THDV1[avg], THDV2[avg], THDV3[avg]
- THDU12[avg], THDU23[avg], THDU31[avg]
- THDI1[avg], THDI2[avg], THDI3[avg]
- FCV1[avg], FCV2[avg], FCV3[avg]
- FCI1[avg], FCI2[avg], FCI3[avg]
- S[max avg]

- The maxima listed above are calculated from the following algorithm:
  - If $\left(X[avg] > X[\max\ avg]\right)$
  - Then $\left(X[\max\ avg] = X[avg]\right)$

22.26.2 Maxima (B)

- The monitors also calculate maxima of the average quantities in the two quadrants in receiver mode. These maxima are as follows:
  - PR[max avg], QR[max avg],
  - FPR[max avg], cos(φg)R[max avg]
- The maxima listed above are calculated from the following algorithm:
  - If $\left(X[avg] > XR[\max\ avg]\right)$ AND $\left(\mathrm{P}[\mathrm{avg} \geq 0\right)$
  - Then $\left(XR[\max\ avg] = X[avg]\right)$

22.26.3 Maxima (C)

- The monitors also calculate maxima of the average quantities in the two quadrants in generator mode. These maxima are as follows:
  - PG[max avg], QG[max avg],
  - FPG[max], cos(φg)G[max]
- The maxima listed above are calculated from the following algorithm:
  - If $\left(X[avg] > XG[\max\ avg]\right)$ AND $\left(\mathrm{P}[avg] < 0\right)$
  - Then $\left(XG[\max\ avg] = X[avg]\right)$

22.27 Analog inputs

- Every second the monitors calculate the "one second" input current present on each analog input channel:
  - $\mathrm{ANAI}_{XV}[1\mathrm{s}] = \frac{1}{1000} \times \sum_{1}^{1000} \mathrm{ANAI}_{XV}[1\mathrm{kHz}]$ with x = a, b, c or d and v = 1 or 2.

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