Flash N

Electric Energy Analyzer

User Manual

Version 8 November 2005
This document is subject to modification without prior notice.

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INTRODUCTION

We thank you for choosing an Electrex instrument
We invite you to carefully read this instructions manual for the best use of the **FLASH** instruments.

1.1 COPYRIGHT

1.2 WARRANTY

This product is covered by a warranty against material and manufacturing defects for a period of 36 months period from the manufacturing date
The warranty does not cover the defects that are due to:
• Negligent and improper use
• Failures caused by atmospheric hazards
• Acts of vandalism
• Wear out of materials
Akse reserves the right, at its discretion, to repair or substitute the faulty products
The warranty is not applicable to the products that will result defective in consequence of a negligent and improper use or an operating procedure not contemplated in this manual.

1.3 RETURN AND REPAIR FORMALITIES

Akse accepts the return of instruments for repair **only** when authorized in advance. For instrument purchased directly, the repair authorization must be requested to Akse directly by using the enclosed RMA form. We recommend otherwise contacting your local distributor for assistance on the return/repair formalities. In both the cases, the following information must be supplied:

- Company full data
- Contact name for further communication
- Product description
- Serial number
- Description of the returned accessories
- Invoice / Shipping document number and date
- Detailed description of the fault and of the operating condition when the fault occurred

The Akse repair lab will send the authorization number to the customer directly or to the distributor as per applicable case.
The RMA authorization number shall be clearly marked on the packaging and on the return transport document.
WARNING: *Failure to indicate the RMA number on the external packaging will entitle our warehouse to refuse the delivery upon arrival and to return the parcel at sender's charge.*

The material must be shipped:
- within 15 working days from the receipt of the return authorization number
- free destination i.e. all transport expenses at sender's charge.
- to the following address: **Akse S.r.l.**
  Via Aldo Moro, 39 - 42100 Reggio Emilia (RE) - Italy
  Atn. Repair laboratory
- the units covered by warranty must be returned in their **original packaging**.

1.3.1 RE-SHIPPING OF REPAIRED PRODUCT

The terms for re-shipment of repaired products are ex-works, i.e. the transport costs are at customer charge.
Products returned as detective but found to be perfectly working by our laboratories, will be charged a fixed fee (40.00 Euro + VAT where applicable) to account for checking and testing time irrespective of the warranty terms.

1.3.2 Return Material Authorization (RMA form)

Request for the authorization number for the return of goods

Date:	
Company:	
Contact name:	
TEL:	FAX:
Product description:	
Serial number:	
Description of the returned accessories (if any):	
Original purchase Invoice (or Shipping document) number and date. NB: The proof of purchase must be provided by the customer. Failure to complete this area will automatically void all warranty.	
Detailed description of the malfunction and of the operating conditions when the fault occurred	
☐ Tick off for a quotation	
Should a product be found by our laboratories to be perfectly working, a fixed amount of **40 Euro** (+VAT if applicable) will be charged to account for checking and testing time irrespective of the warranty terms.	

Space reserved to AKSE

R.M.A. No.

The RMA number shall be clearly indicated on the external packaging and on the shipping document:. Failure to observe this requirement will entitle the AKSE warehouse to refuse the delivery.

2 Safety

This instrument was manufactured and tested in compliance with IEC 61010 class 2 standards for operating voltages up to 250 VAC rms phase to neutral.
In order to maintain this condition and to ensure safe operation, the user must comply with the indications and markings contained in the following instructions:

- When the instrument is received, before starting its installation, check that it is intact and no damage occurred during transport.
- Before mounting, ensure that the instrument operating voltages and the mains voltage are compatible then proceed with the installation.
- The instrument power supply needs no earth connection.
- The instrument is not equipped with a power supply fuse; a suitable external protection fuse must be foreseen by the contractor.
- Maintenance and/or repair must be carried out only by qualified, authorized personnel
- If there is ever the suspicion that safe operation is no longer possible, the instrument must be taken out of service and precautions taken against its accidental use.
- Operation is no longer safe when:
  1) There is clearly visible damage.
  2) The instrument no longer functions.
  3) After lengthy storage in unfavourable conditions.
  4) After serious damage occurred during transport

The instruments must be installed in respect of all the local regulations.

2.1 Operator safety

Warning: Failure to observe the following instructions may lead to a serious danger of death.

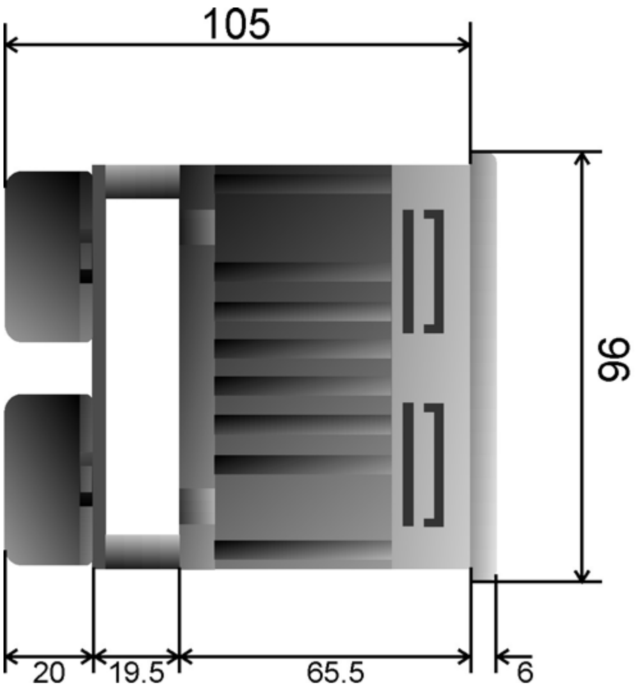
- During normal operation dangerous voltages can occur on instrument terminals and on voltage and current transformers. Energized voltage and current transformers may generate lethal voltages. Follow carefully the standard safety precautions while carrying out any installation or service operation.
- The terminals of the instrument **must** not be accessible by the user after the installation. The user should only be allowed to access the instrument front panel where the display is located.
- Do not use the digital outputs for protection functions nor for power limitation functions. The instrument is suitable only for secondary protection functions.
- The instrument must be protected by a breaking device capable of interrupting both the power supply and the measurement terminals. It must be easily reachable by the operator and well identified as instrument cut-off device.
- The instrument and its connections must be carefully protected against short-circuit.

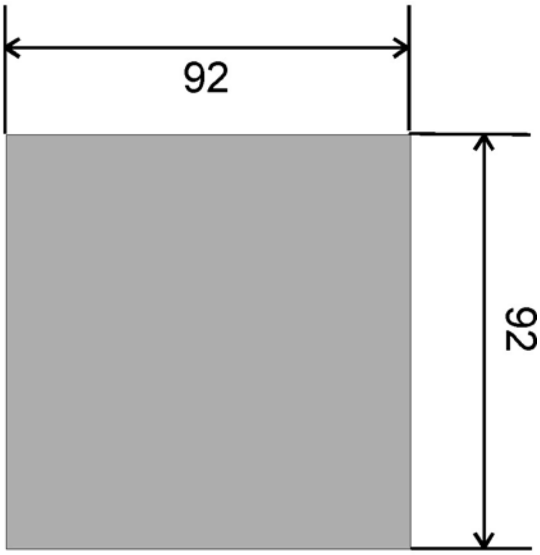
Precautions: Failure to respect the following instructions may irreversibly damage to the instrument.

- The instrument is equipped with PTC current limiting device but a suitable external protection fuse should be foreseen by the contractor.
- The outputs and the options operate at low voltage level; they cannot be powered by any unspecified external voltage.
- The application of currents not compatible with the current inputs levels will damage to the instrument.

3 Mounting

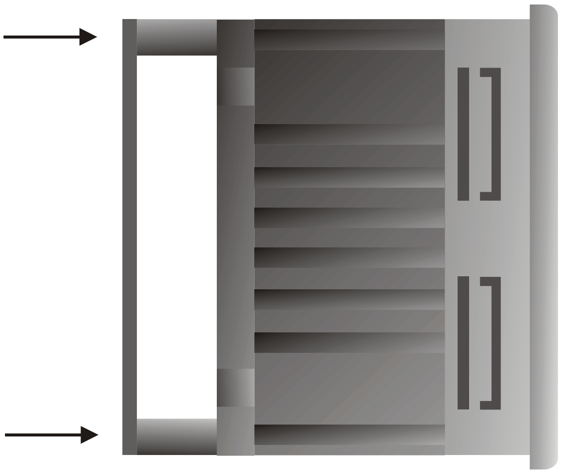
3.1 Dimensions (mm)

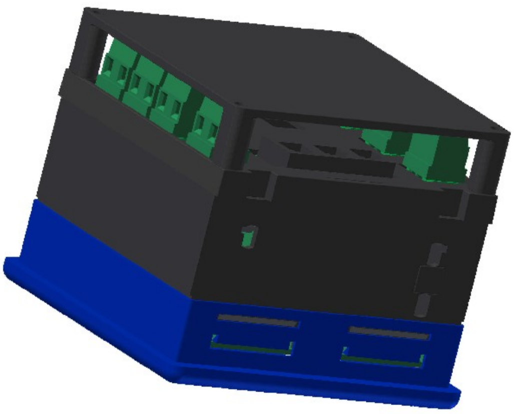




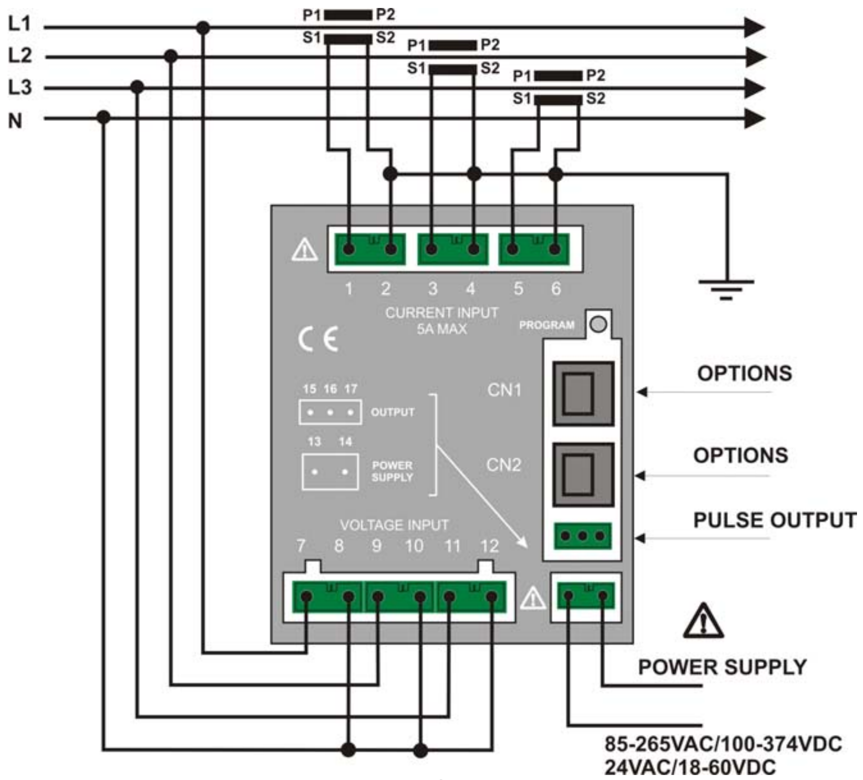
3.2 Fixing and blocking

The connection terminals of the instrument are held in place by a plastic panel, which must be mounted using 4 screws (supplied). This set up will prevent the disconnection of the current measurement terminals.

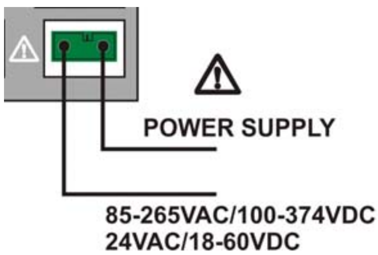




4 Wiring Diagrams



Power Supply



The instrument is fitted with a separated power supply with extended functioning range. The terminals for the power supply are numbered (13 and 14). Use cables with max cross-section of 4 mm^2.

4.1 Measurement Connections

4.1.1 Voltage connection

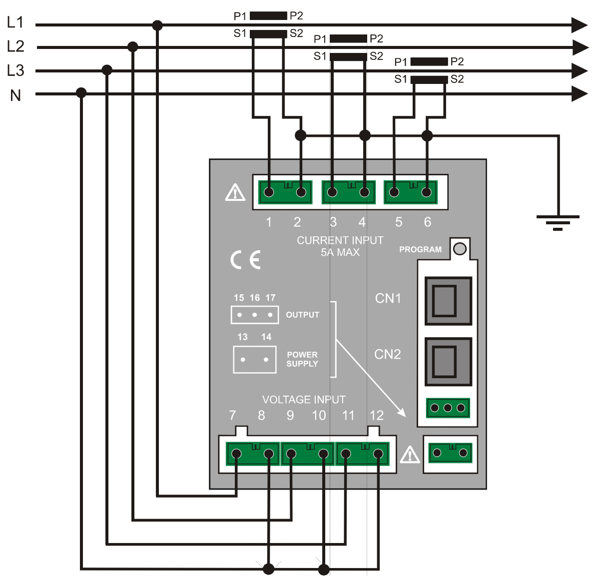
Use cables with max cross-section of 4 mm^2 and connect them to the terminals marked VOLTAGE INPUT on the instrument according to the applicable diagrams that follow.

4.1.2 Current connection

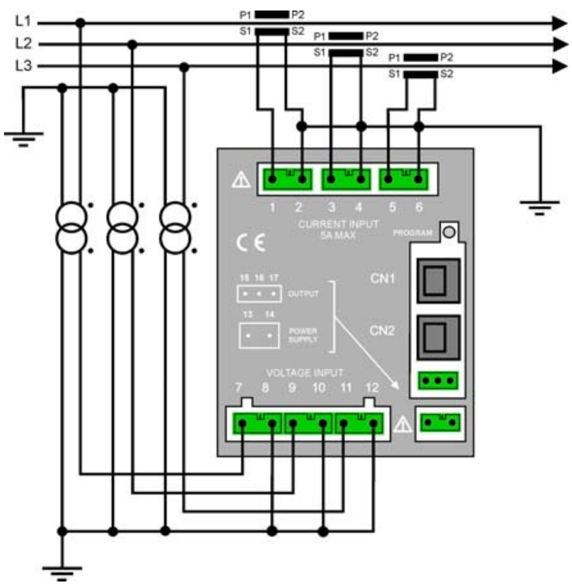
It is necessary to use external CTs with a primary rating adequate to the load to be metered and with a 5A secondary rating. The number of CTs to be used (1, 2 or 3) depends upon the type of network.
Connect the CT output(s) to the terminals marked CURRENT INPUT of the instrument according to the applicable diagrams that follow.
Use cables with cross-section adequate to the VA rating of the CT and to the distance to be covered. The max cross-section for the terminals is 4 mm^2.
N.B. The CT secondary must always be in short circuit when not connected to the instrument in order to avoid damages and risks for the operator.

Warning: THE PHASE RELATIONSHIP AMONG VOLTAGE AND CURRENT SIGNALS MUST BE CAREFULLY RESPECTED. ALL DISREGARD OF THIS RULE OR OF THE WIRING DIAGRAM LEADS TO SEVERE MEASUREMENT ERRORS.

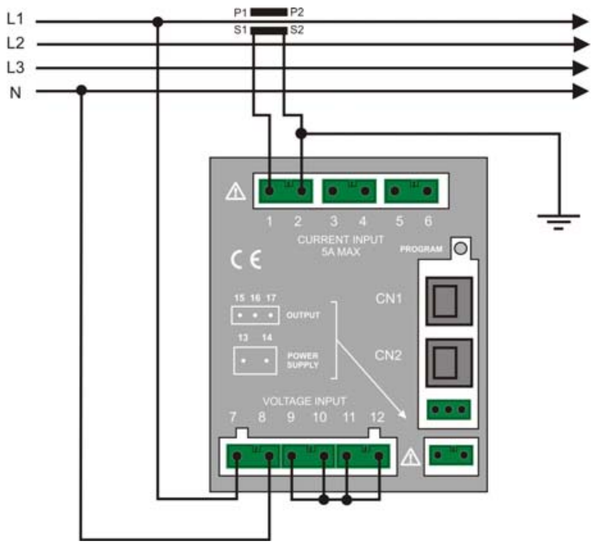
4.1.3 4W Star Connection (4 wires)



Low voltage 3 CTs
Configuration 3P 4W



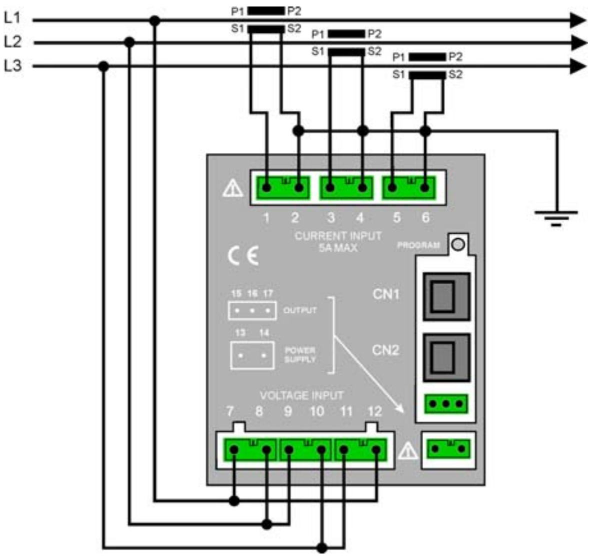
Medium/High Voltage 3 PTs 3 CTs
Configuration 3P 4W



Low Voltage 1 CT (balanced and symmetric)
Configuration 3P-b 4W

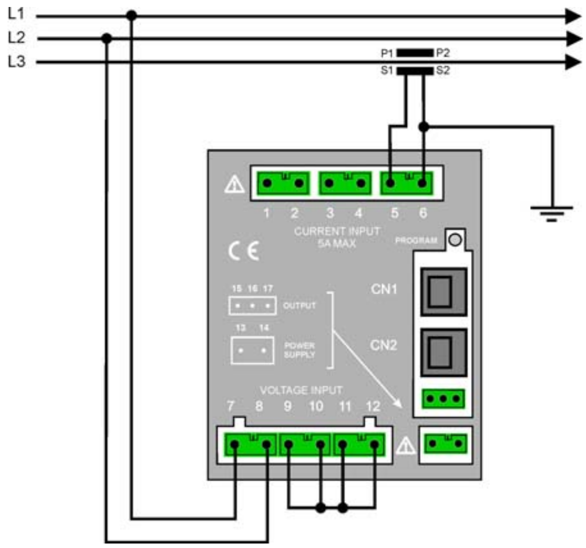
4.1.4 3W Delta Connection (3 wires)

Connection with 3 CTs



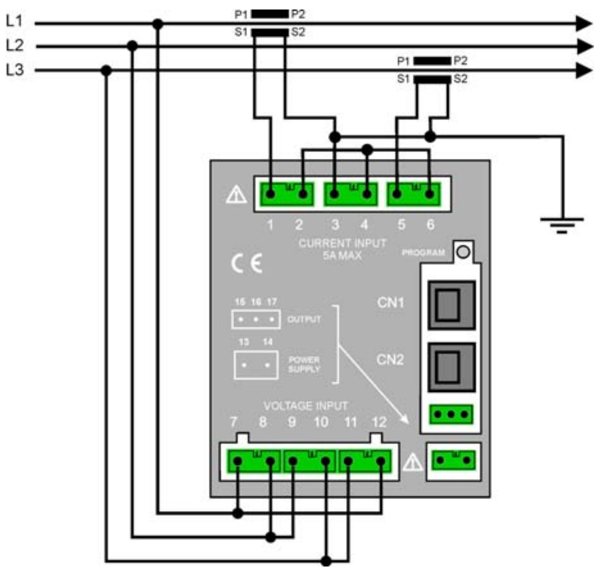
Low Voltage 3 CTs
3P 3W Configuration

Connection with 1CT

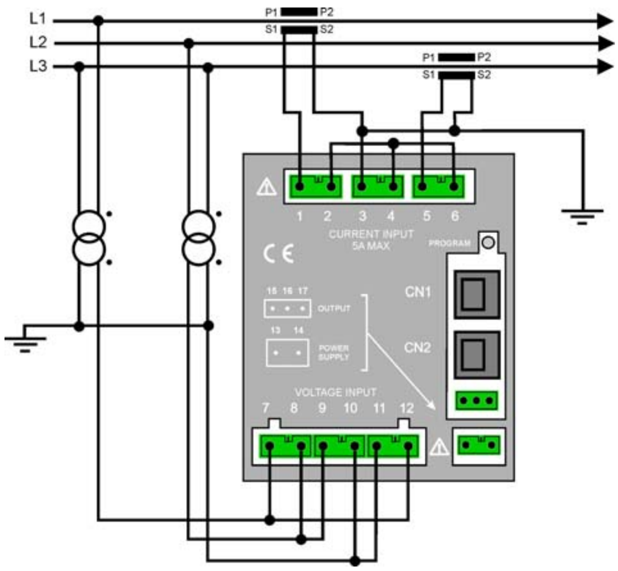


Low Voltage 1 CT (Balanced and symmetric)
3P-b 3W Configuration

4.1.4.1 L1 L3 Phase Connection with 2 CTs

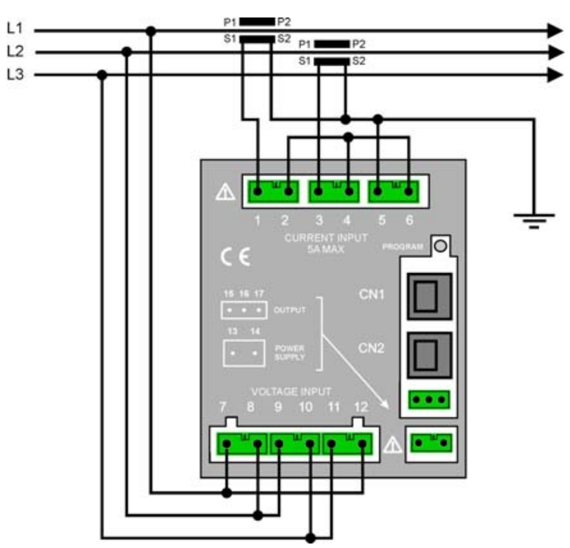


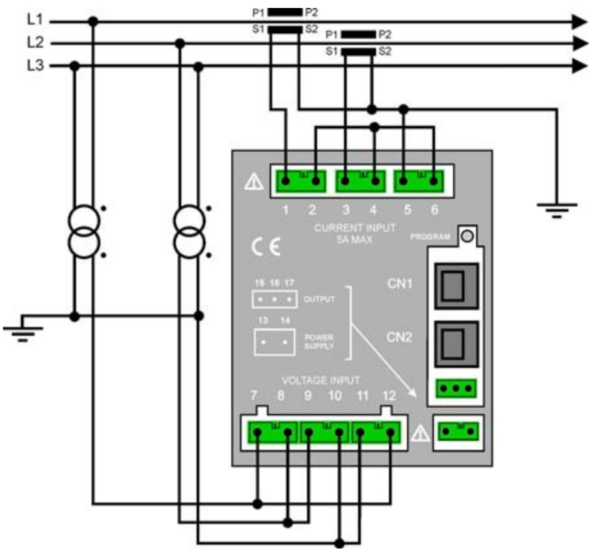
Low Voltage
3P 3W Configuration



Medium/High Voltage
3P 3W Configuration

4.1.4.2 L1 L2 Phase Connection with 2 CTs

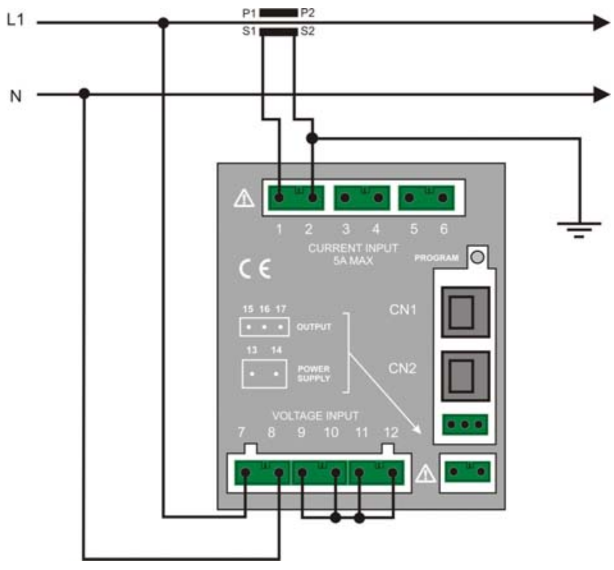




Low Voltage 2 CTs
3P 3W Configuration

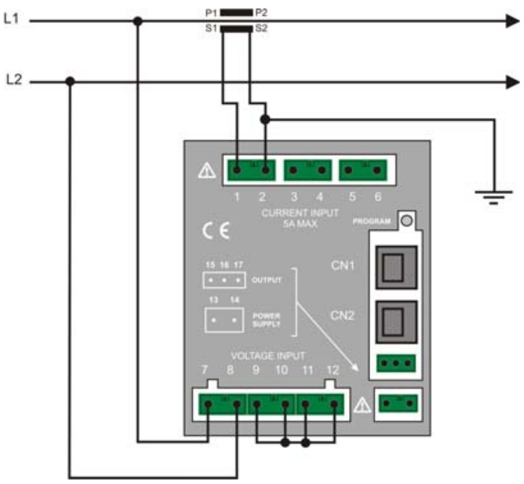
Medium/High Voltage 2 CTs 2 PTs
3P 3W Configuration

4.1.5 2 Wire Connection (single phase)



Low Voltage Neutral phase 1 Ct
1P 2W Configuration

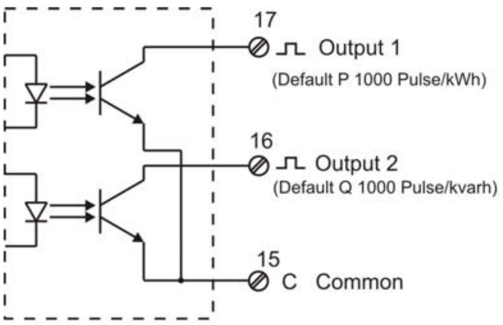
4.1.6 2 Wire Connection (double phase)

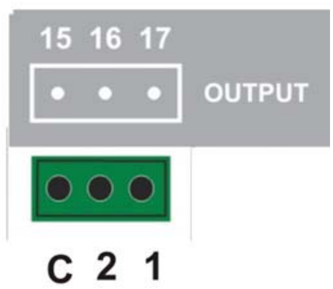


Low Voltage phase 1 CT
2P 2W Configuration

4.2 Output Connection

The instrument is equipped with two opto-isolated transistor outputs rated 27 Vdc, 27 mA (DIN 43864 standards).
The outputs working mode is set by default to operate as pulse output proportional to the Active energy (output 1) and to the Reactive energy (output 2). They support an output rate of 1.000 pulses per kWh (or kvarh) referred to the instrument input range without any CT and PT multiplier.





In order to calculate the energy value of each pulse the following formula must be considered.

$$K_P = \frac{K_{CT} \times K_{PT}}{Pulse / kWh}$$

Where: K_p = energy of each pulse; K_{CT} = CT ratio ; K_{PT} = PT ratio ;

Pulse/kWh = Pulse rate

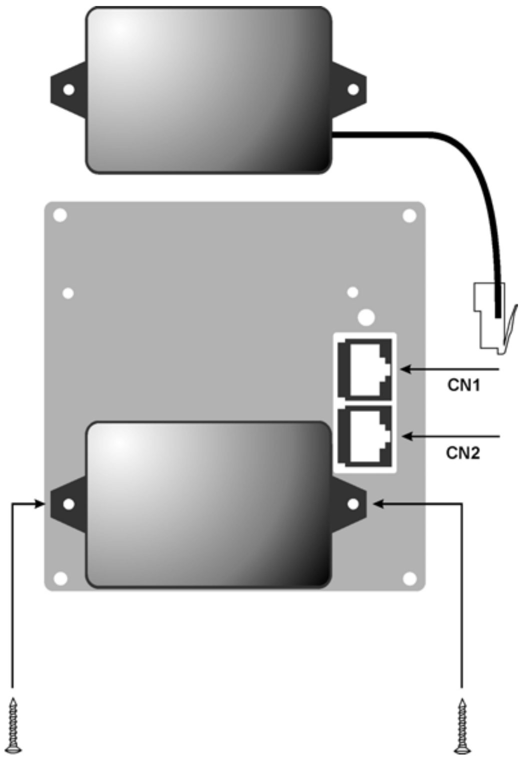
Example: CT = 100/5; PT = 20.000/100 $K_P = \frac{20 \times 200}{1000} = 4 kWh / pulse$ or **kWh** = Pulse count / 4

Other pulse rate settings may be however programmed as described in the instrument set up section.

The operating mode of the digital outputs may also be changed to work as alarm output or as remote output device controlled by the Modbus protocol as described in the instrument set up section.

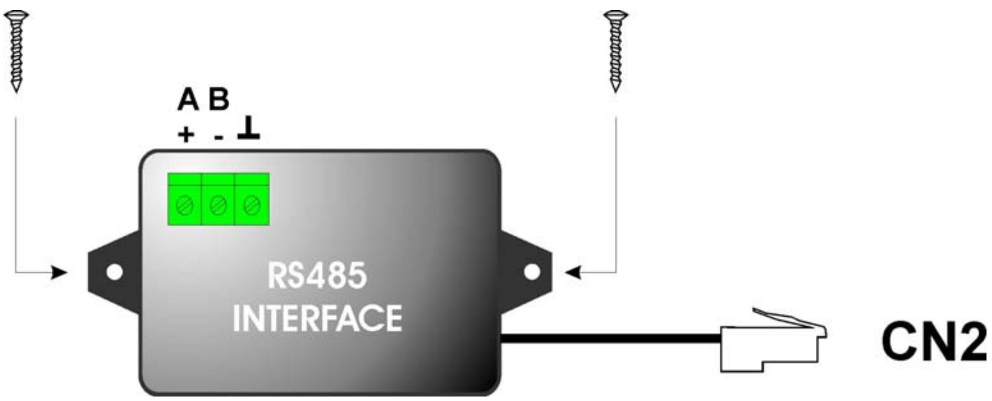
4.3 Connecting Optional Components

The optional components of FLASH are assembled on the back panel of the instrument, where the RJ45 connectors are located
The optional component feature settings are only displayed when one of them is connected to the instrument

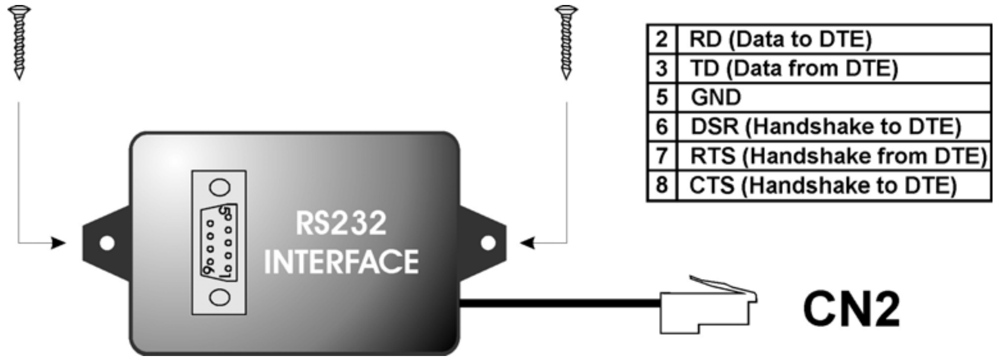


CN1 = 4-20 mA module or Hardware key
CN2 = RS485 or RS232 interface

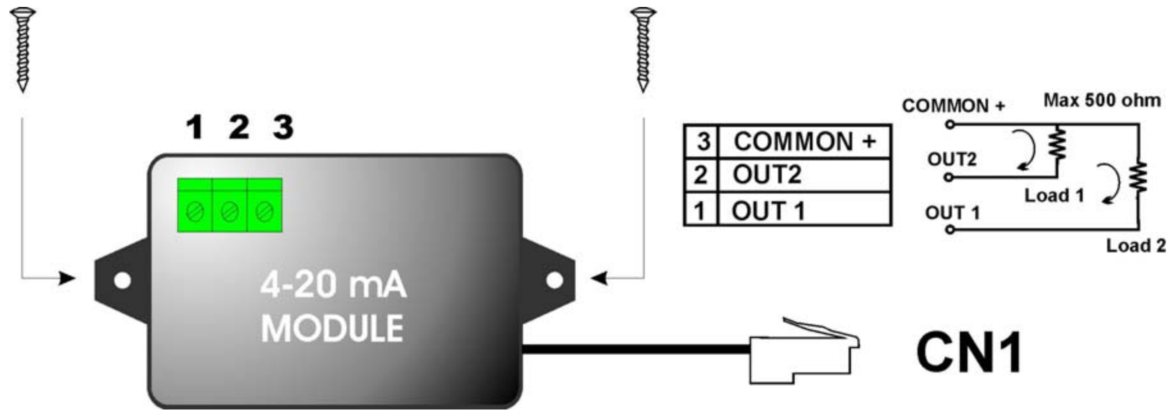
4.3.1 RS485 Option



4.3.2 RS232 Option



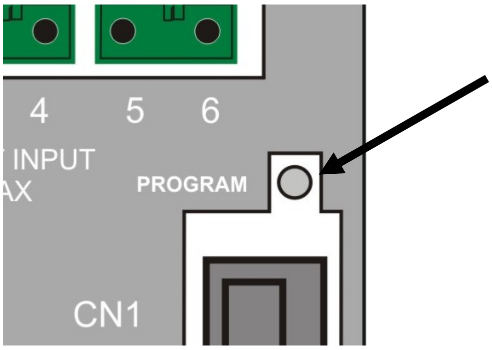
4.3.3 Double 4-20 mA analogic Output Option



Self powered output, do not use external power supply.

5 Instrument Use

The programming procedure allows to vary the instrument functioning parameters.
You can enter the procedure with the button Program located at the back of the instrument.



In this environment, you can enter the measurement parameters and the network configuration.

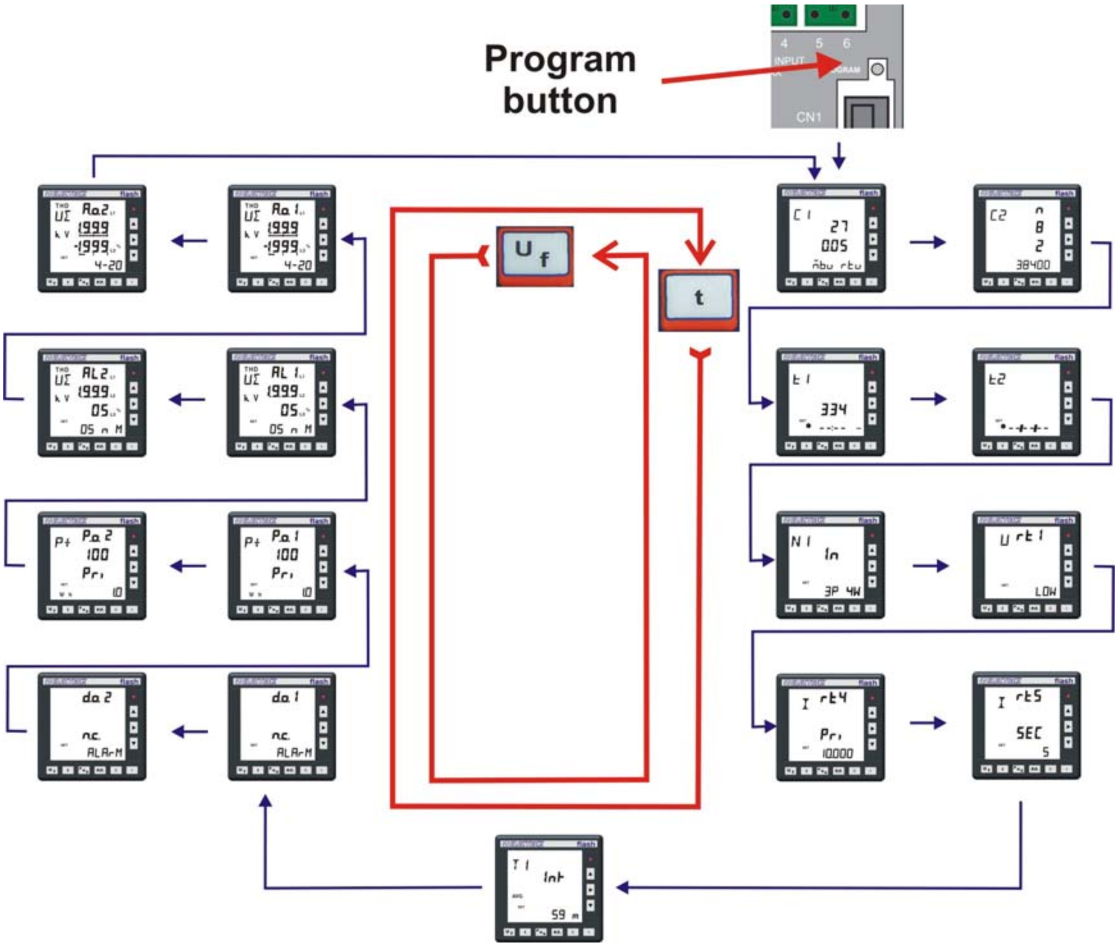
The various fields can be selected by pressing the  button which also allows navigating to all the Setup pages

Pressing the  and  buttons you can modify the selected input fields (flashing)
The content of a field can be either numeric or a parameter controlling the device behavior.

The button  advances to the next page, while  selects the previous page

By pressing the button PROGRAM (while in any configuration page) the menu is exited and the configuration saved.

5.1.1 Set up sequence



Within the first page of the instrument set up menu, the following functions are available too.

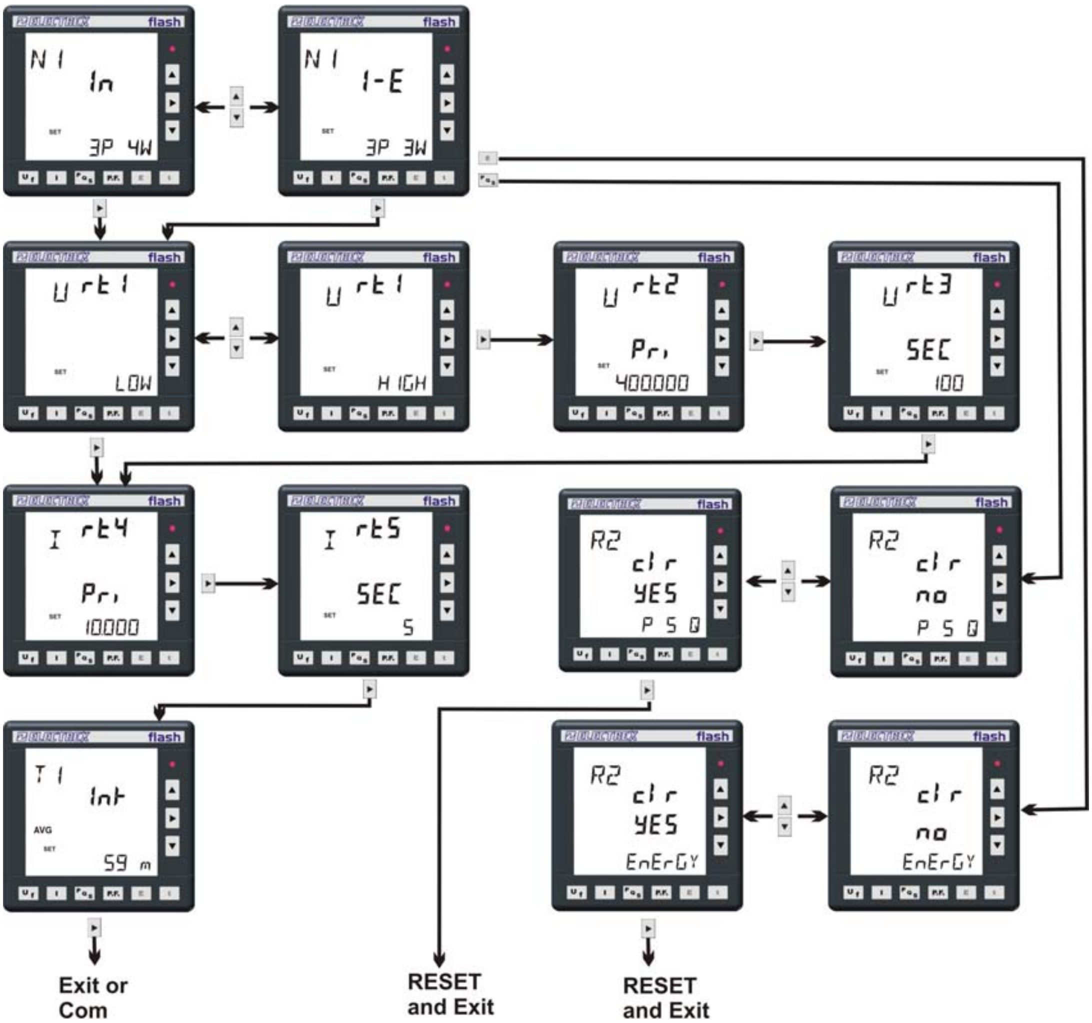
- a pressure of the  key opens the energy counters reset page.

- a pressure of the  key opens the reset page of the average and maximum demand.

Here below the page format and the programming flow.

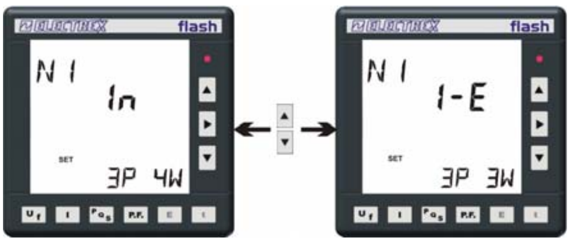
NOTE: all the modifications to the instrument programming parameters are effective only when you exit the programming page pressing the PROGRAM button located on the instrument rear panel.

5.1.2 Configuration Procedure



5.1.2.1 Electrical system configuration

The first programming page shows the configuration of the type of electrical system.



The first selection sets the type of electrical system and the type of wiring used:

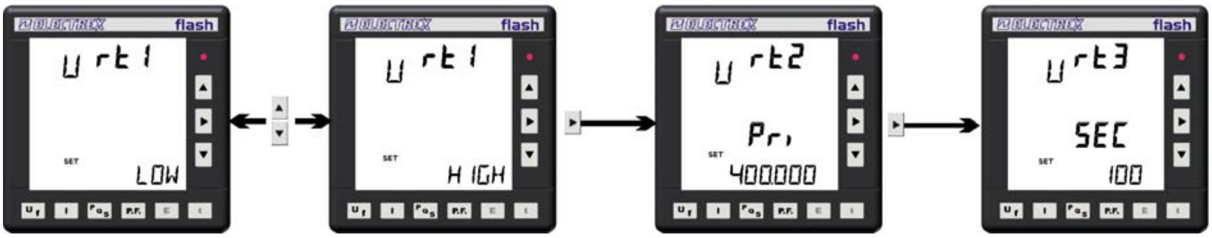
- 3 phase 4 wire system 3P 4W, Star ⅄,
- 3 phase 3 wire system 3P 3W, delta Δ,
- balanced 3 phase 4 wire system (1 CT only) 3P-b 4W,
- balanced 3 phase 3 wire system 3P-b 3W,

- single phase system 1P 2W
- double phase system 2P 2W.

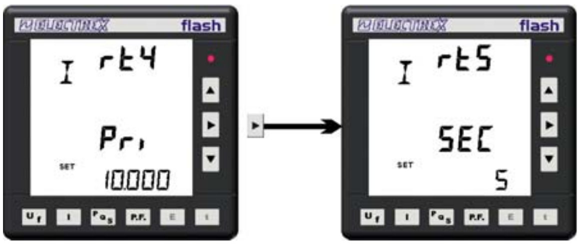
The second selection sets whether the operating mode is:

- Import only user In
- Import-Export system I-E.

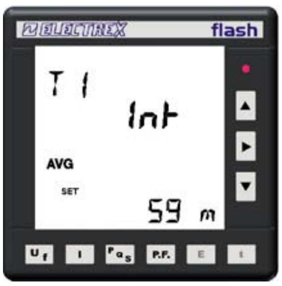
The instrument is set by default to 3P 4W and Import only In mode. and automatically corrects possible CTs connection errors
The following page enables to set the type of voltage measurement.



If the voltage measurement is direct in low voltage, select LOW; the menu passes directly to the currents setting page.
If the voltage measurement is made on the HT side and/or via a voltage transformer, select HIGH and proceed to the next page for setting the Volatge transformer (PT) primary and secondary values
Enter the PT rated primary and secondary values indicated on the PT label; the values taken by measurement are unsuitable to this purpose. The primary and the secondary values must be integers, the ratio can also be fractional. The instrument is set by default to LOW .
After the voltage setting, the current set up page is prompted for programming the CT values; it requires the entry of the CT primary rating and the CT secondary rating.



Ensure to enter the CT rated primary and secondary values as indicated on the CT label.
When using 2 or 3 current transformers ensure that all the current transformers have the same ratings.
The instrument is set by default to **[00001/1]**.
The next page allows to set the integration time for calculating the Average and the Maximum Demand.



The value is expressed in minutes in a 1 to 60 min. range.

The instrument supports two average values: one calculated by using the sliding window method and the other one calculated on a fixed time basis. The time setting that is programmed by keyboard is the average demand integration time with the sliding window method. The Maximum Demand too is calculated on the sliding window basis.
The integration time on a fixed time basis is used for storing the energy data however this setting is available only as a MODBUS register via serial port setting.

5.1.2.2 Communication Parameters Configuration

This menu appear only upon connection to the instrument of an RS-485 or an RS-232 optional module.
The setting of the RS485 communication characteristics requires to scroll the programming pages with two keys;
The  key advances to the next page, the  key returns to the previous page

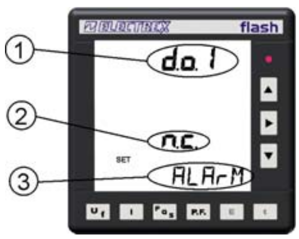
The first page is the following:
This page enables the setting of respectively:
- communication speed
- number of data bits
- parity
- stop bits

All these data are correlated depending upon the stop bit value.

Additional parameters regarding the MODBUS communication protocol may be set in the next page:
- Mode: it may be configured to RTU or to ASC (ASCII) mode.
- Slave Address
- Transmission delay; it stands for the time delay the instrument will wait prior to reply to a data query. It is expressed in milliseconds, the default value is 100 msec and a 0 setting is also possible.

5.1.2.3 Output Configuration

The instrument is equipped with 2 digital outputs that are set by default to operate as pulse outputs proportional to P_{Σ} (output 1) and Q_{Σ} (output 2) at a rate of 1.000 pulses per kWh (or kvarh) referred to the instrument range without any CT and PT multiplier.
The operating mode of digital outputs may be changed to operate as alarm output or as remote output device controlled by the Modbus protocol.
When operating on the Modbus protocol, in order to ensure a protection to the outputs in case of communication failure, it is possible to configure a watchdog timer (programmable from 0 to 60 minutes; 0 = disabled).
The following entry fields are prompted (example for output 1):

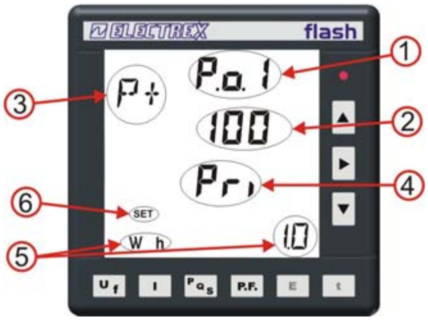


(1) Digital out number being programmed.
(2) Contact: it configures the rest state of the output transistor.
    n.c. normally closed or **n.o.** normally open:
(3) Mode of operation**:**
    PULSE (default setting) for operation as pulse output
    ALARM for operation as alarm contact output

REM Remote for operation as remote output device controlled via Modbus

5.1.2.4 Pulse characteristics configuration

If the PULSE selection is operated, the following page is shown allowing the configuration of the pulse characteristics:



Where:

(1) Pulse output number being programmed.
(2) Pulse duration in mSec; programmable from 50 up to 900 in steps of 10
(3) Identifies the quantity proportional to the Pulse output, selecting among:

- Import Active Power (import)
- Inductive reactive Power with import Active Power
- Capacitive reactive Power with import Active Power
- Apparent Power with import Active Power
- Export Active Power (export)
- Inductive reactive Power with export Active Power
- Capacitive reactive Power with export Active Power
- Apparent Power with export Active Power

(4) Pri the pulses take into account the CT and PT ratio and are referred to their primary readings
SEC the pulses are referred to the CT (and PT) secondary reading without any multiplier .
(5) Pulse **weight**: programmable from 0,1 Wh up to 1 MWh through all the intermediate steps.
Example: 1.0 Wh = 1000 pulses/kWh.
(6) Identifies SETUP.

5.1.2.4.1 Pulse output set up with Modbus registers.

To set up the pulse output the Modbus Holding Registers from 120 to 127 have to be used.
Refer to chapter 9 for the details.

5.1.2.5 Alarm Configuration

The Instrument is equipped with two alarms that are triggered by a programmable threshold on anyone of the measured parameters.
The types of alarm available are: maximum, minimum and 1-of-3.
A minimum alarm is triggered when the selected parameter is lower than the alarm threshold.
A maximum alarm is triggered when the selected parameter exceeds the alarm threshold.
A 1-of-3 alarm is triggered when anyone of the phase readings, whichever the phase involved, trespasses the alarm threshold – this alarm can be either maximum or minimum. On a 1-of-3 current alarm, the threshold is expressed as percentage (rather than a value) that stands for the unbalance between the phases. The alarm therefore triggers when the percent difference between two of the three phases exceeds the threshold; it is calculated as 100 x (I_{max} – I_{min})/I_{max}.
All alarms allow also the setting of an hysteresys and a delay time.
The **hysteresys** (in percent) sets the difference between the triggering threshold and the end threshold (this prevents repeated alarm triggering when the reading oscillates around the trigger value). Example: a 5% hysteresys on a threshold of 100, triggers the alarm when the reading exceeds 100 but it will switch off the alarm when the reading becomes lower than 95.
The **delay time** sets a time delay for triggering on the alarm after its actual occurrence (or triggering off after its actual end).

The alarm setup procedure is activated from the output configuration screen or at the end of page configuration using the ▶ button or the t button.

The fields meaning of Alarm 1 is as follows:

(A) Alarm No. identification (**AL1** = alarm 1 that may be associated to output 1)

(1)Parameter type applying to Alarm 1. The possible choices are:

--	Disabled
U	Voltage
f	Frequency
I	Current
P	Active Power
Q	Reactive Power
S	Apparent Power
λ (PF)	Power Factor
THD_U	Total Harmonic Distortion (voltage)
THD_I	Total Harmonic Distortion (current)

(2) Quantity definition: The possible definitions are:

Y	Average star value (voltage, current and THD only).
Δ	Average system voltage (voltage and voltage THD only)

n	Neutral value (current only)
Σ	Three phase power (only on active, reactive, apparent power)
L1	Phase 1 quantity.
L2	Phase 2 quantity.
L3	Phase 3 quantity.
L1-L2	Phase L1 phase L2 value (Phase to phase Voltages and THD only)
L2-L3	Phase L2 phase L3 value (Phase to phase Voltages and THD only)
L3-L1	Phase L3 phase L1 value (Phase to phase Voltages and THD only)
1di 3 Δ	Alarm on all three phases. The symbols L1-L2, L2-L3 and L3-L1 are flashing (voltage and THD only).
1di 3 ⅄	Alarm on all the three phases. The symbols L1, L2 and L3 are flashing (voltage,current and THD only).
AVG	Alarm on average powers.

(3)Threshold voltage: programmable in the range –1999 +1999

(4)Decimal point position. The quantity can be scaled by powers of ten by using the m, K, M symbols and the decimal point. Range is between 10-3 and 109.

(5)Hysteresis value, from 0% to 99%

(6)Latency time, from 0 to 99 seconds

(7)Output trigger type. n=normal (the relay is active for the duration of the alarm), p=pulsed (the alarm triggering generates a pulse).

(8) Alarm type: M=max; m=min

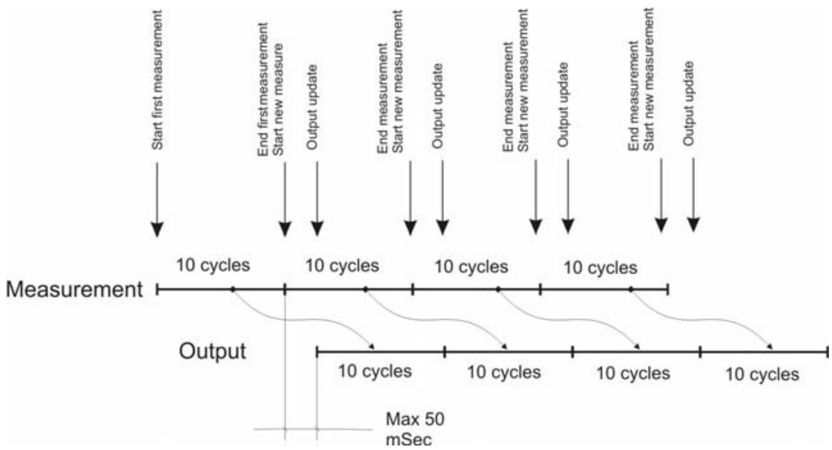
The procedure for alarm 2 is identical.

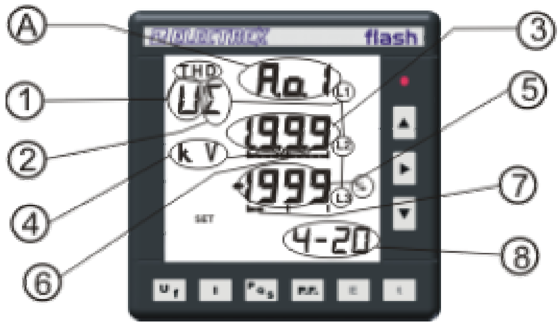
5.1.2.5.1 Alarm set up with Modbus registers.

To set up the alarm t the Modbus Holding Registers from 95 to 106 have to be used.
Refer to chapter 9 for the details.

5.1.2.6 Analog 4-20 mA Outputs Configuration.

The instrument supports two 4-20 mA or 0-20 mA analog outputs with 500 ohms maximum load. Each output is to one of the parameters handled by the instrument.
The output is updated every 10 cycles of the network frequency (i.e. every 200mSec with 50 Hz mains) with a maximum delay of 50 mSec from the actual measurement.





(A)Output identification, A.o.1 = Analog output 1.
(1) Parameter applying. The possible choices are:

--	Disabled
U	Voltage
f	Frequency
I	Current
P	Active Power
Q	Reactive Power
S	Apparent Power
λ (PF)	Power Factor
THD_U	Total Harmonic Distortion (Voltage)
THD_I	Total Harmonic Distortion (Current)

(2) Parameter definition: The possible choices are:

Y	Average star value (applicable to voltage, current and THD only).
Δ	Average system value (applicable to voltage and THD only).
n	Neutral value (applicable to current only)
Σ	Three phase value (applicable to active, reactive and apparent power only)
L1	Phase 1 Value.

L2	Phase 2 Value.
L3	Phase 3 Value.
L1-L2	Phase-phase (L1-L2) value (applicable to system voltages and THD only)
L2-L3	Phase-phase (L2-L3) value (applicable to system voltages and THD only)
L3-L1	Phase-phase (L3-L1) value applicable to system voltages and THD only)
AVG	Average value (applicable to average powers - demand - only).

(3) Threshold voltage: programmable in the range –1999 +1999

(4) The quantity can be scaled by powers of ten by using the m, K, M symbols and the decimal point. Range is between 10-3 and 109.

(5) Beginning of range value (4 or 0 mA), programmable from –1999 to 1999.

(6) It can be associated to the above value and it identifies it as end of scale value (end of range symbol). It cannot be modified.

(7) Associated to the value above identifies it as beginning of range value (empty on 0 mA, two marks on 4 mA). It cannot be changed

(8) Output type: 4-20 mA or 0-20 mA.

Output 2 requires the same procedure

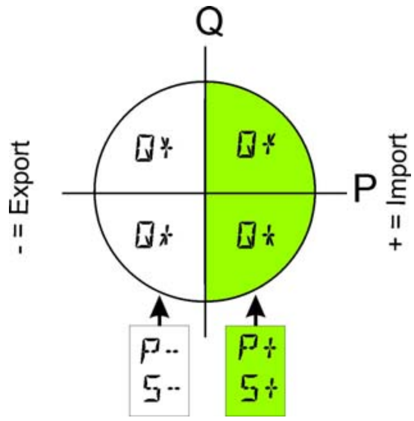
5.1.2.6.1 Analog output set up with Modbus registers.

To set up the analog output the Modbus Holding Registers from 80 to 91 have to be used.
Refer to chapter 9 for the details.

5.1.2.6.2 4-20 mA output configuration of the average AVG values

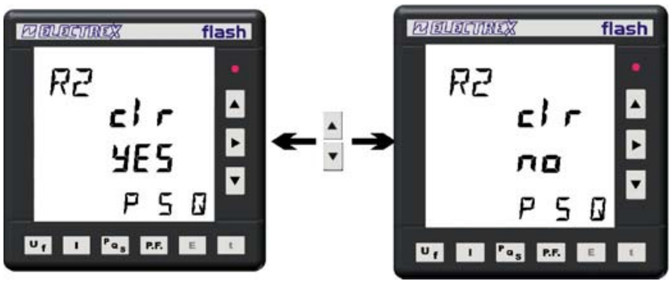
In Import-Export mode, the instrument can provide the measuring on the 4 dials, but the selection can be made on a dial at a time.
In selection mode, the measures are visualized as follows:

Import Active Power (import)
Inductive reactive Power with import Active Power.
Capacitive reactive Power with import Active Power
Apparent Power with import Active Power
Export Active Power (export)
Inductive reactive Power with export Active Power
Capacitive reactive Power with export Active Power
Apparent Power with export Active Power



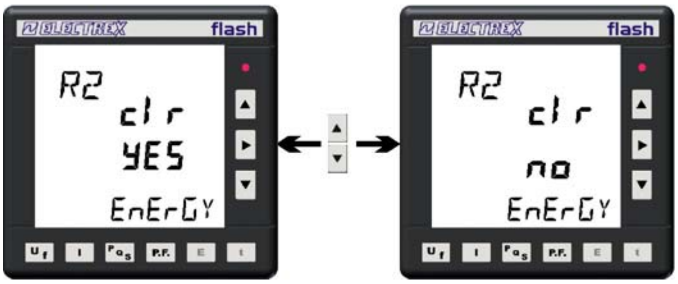
The quadrant selection is operated according to the following trigonometric convention:

5.1.3 Reset Procedure



In order to reset the Average Powers, the Maximum Demand and the Energy counters it is necessary to:

- Enter into the programming menu by pressing the PROGRAM button.
- Press the  key to display the powers reset page or the  key to display the energy counters reset page.
- Select YES to reset, NO to skip. Resetting is confirmed by pressing the  key that executes the reset and returns automatically to the readings pages.
- The reset operation clears all the average powers and the Maximum Demand.



It is also possible to exit the procedure, at any time without resetting, by pressing the PROGRAM button.

5.2 Readings

5.2.1 Readings selection keys

The visualization of the measurements is through buttons:

Uf Voltage and frequency visualizations.
I Current visualization.
PQS Power visualization.
P.F. Power factor visualization
E Energy visualization.
t Functioning time visualization.
▲ ▼ These buttons allow you to move up and down in the measurement pages.
▶ This button is not used in measurement visualization.

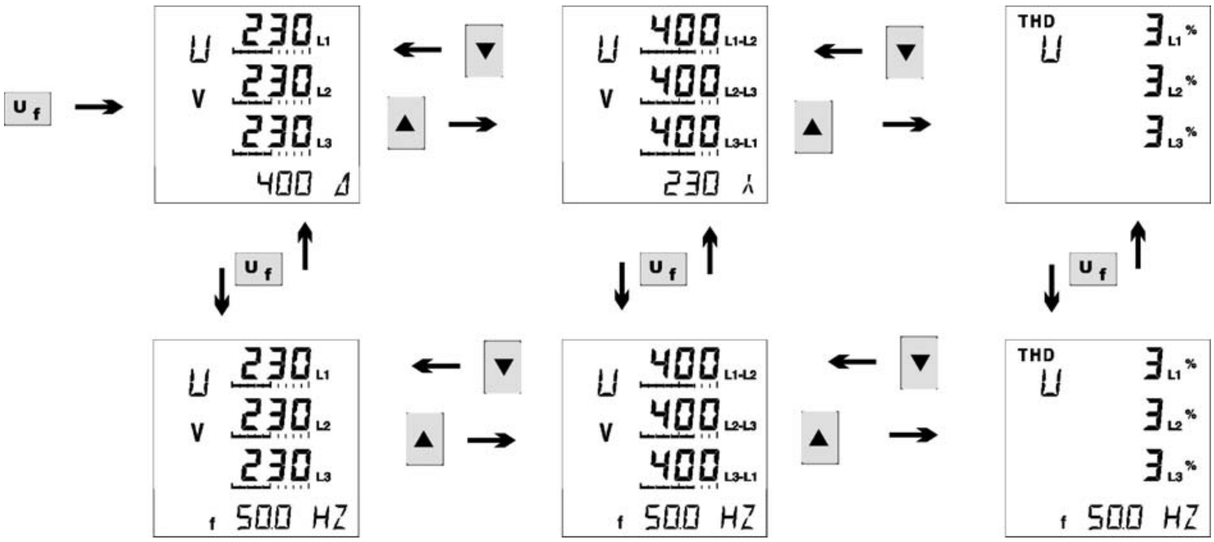
5.2.1.1 Voltage and Frequency Readings

By pressing once the Uf key, a first voltage readings page is prompted showing the phase-neutral voltages and, on the bottom right side of the display, the average 3-phase system voltage.

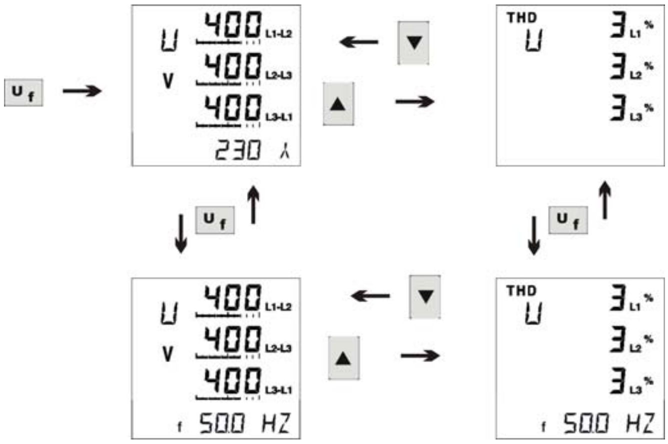
By pressing the ▲ key, a second voltage readings page is prompted showing the phase-phase voltages and, on the bottom right side of the display, the average phase-neutral system voltage.

Another pressure of the ▲ key prompts the total harmonic distortion readings of the voltage of each phase.
By pressing again the Uf key the frequency is shown on the lower right side on thedisplay.

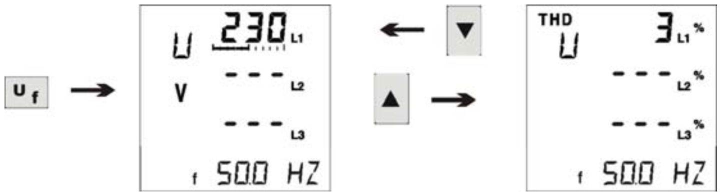
5.2.1.1.1 3P 4 W Configuration



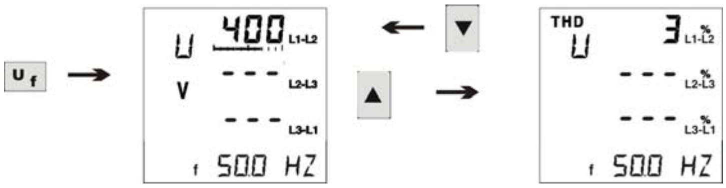
5.2.1.1.2 3P 3 W Configuration



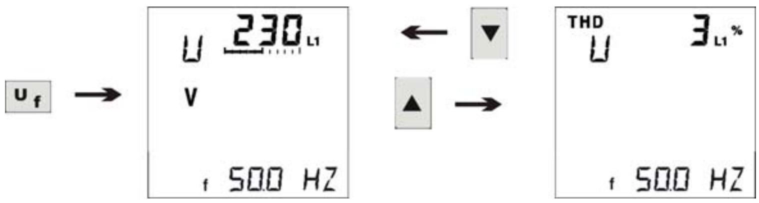
5.2.1.1.3 3P-b 4W Configuration



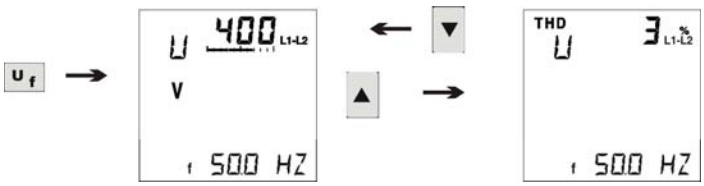
5.2.1.1.4 3P-b 3W Configuration



5.2.1.1.5 1P 2W Configuration



5.2.1.1.6 2P 2W Configuration

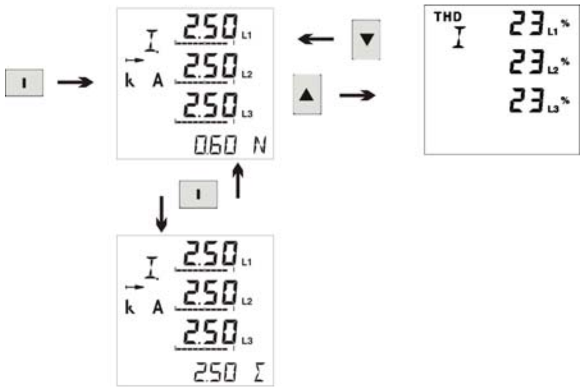


5.2.1.2 Current readings

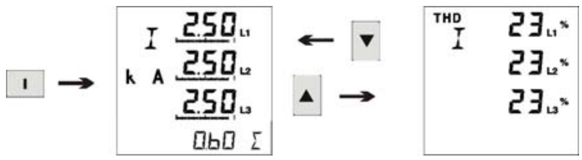
By pressing the key, the current readings page is prompted showing the currents of each phase as well as the neutral current.

A pressure of the key prompts the total harmonic distortion readings of the current of each phase.

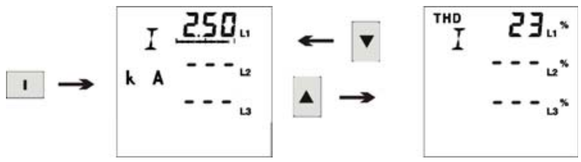
5.2.1.2.1 3P 4W Configuration



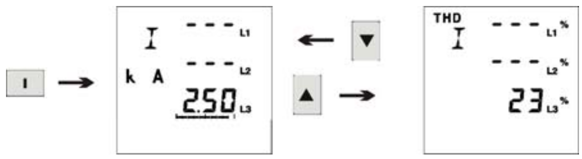
5.2.1.2.2 3P 3W Configuration



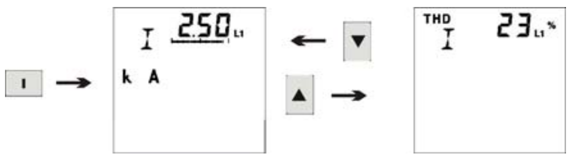
5.2.1.2.3 3P-b 4W Configuration



5.2.1.2.4 3P-b 3W Configuration



5.2.1.2.5 1P 2W and 2P 2W Configuration

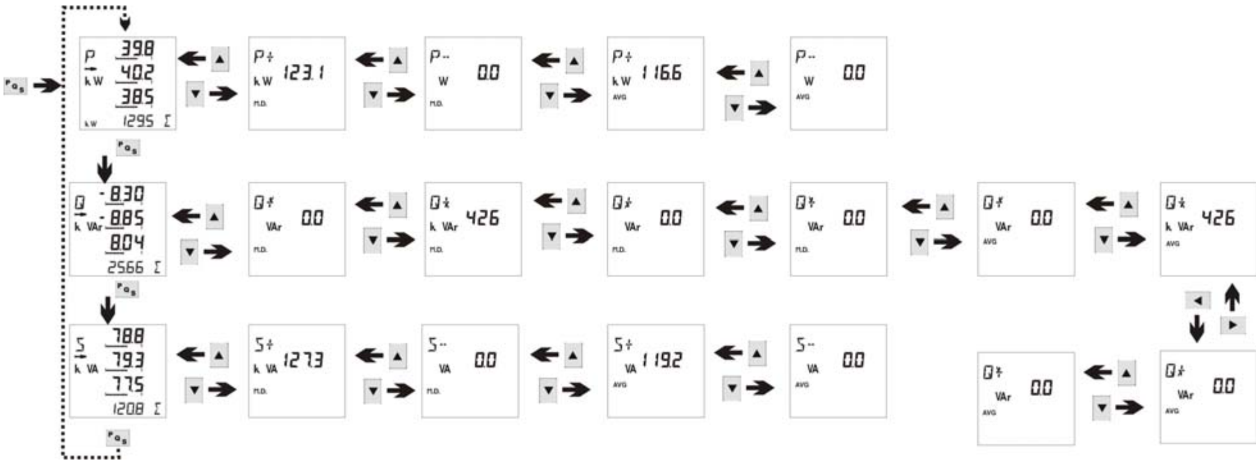


5.2.1.3 Powers

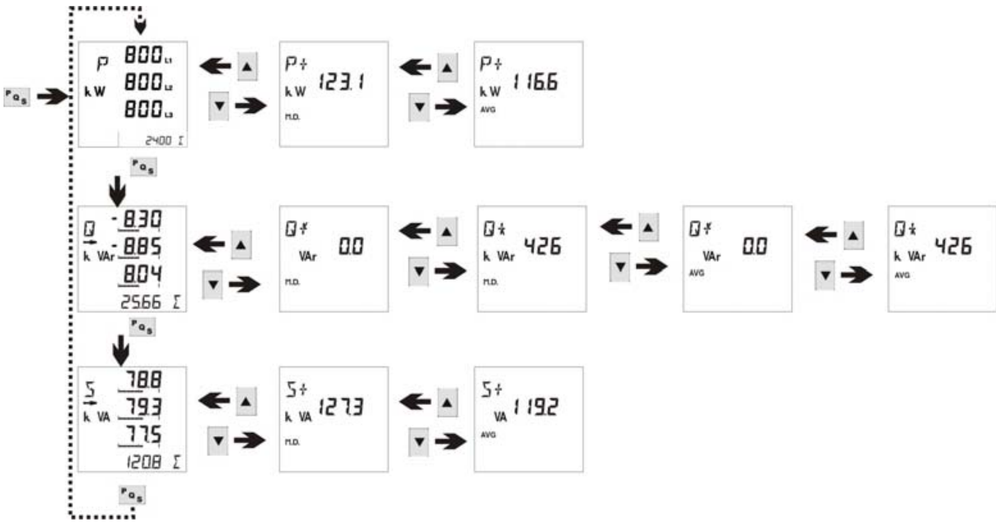
By pressing the PQS key the power reading pages for P Active Power, Q Reactive power and S Apparent power are scrolled in sequence.

By pressing the ▲ and ▼ keys the average and the maximum powers (Demand and Maximum Demand readings) are displayed.

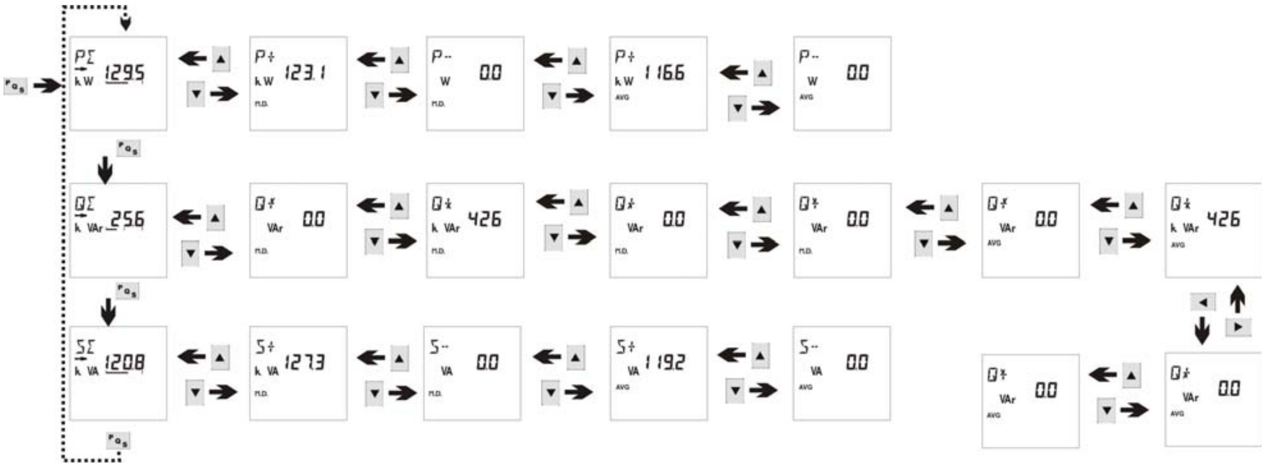
5.2.1.3.1 3P 4W Configuration



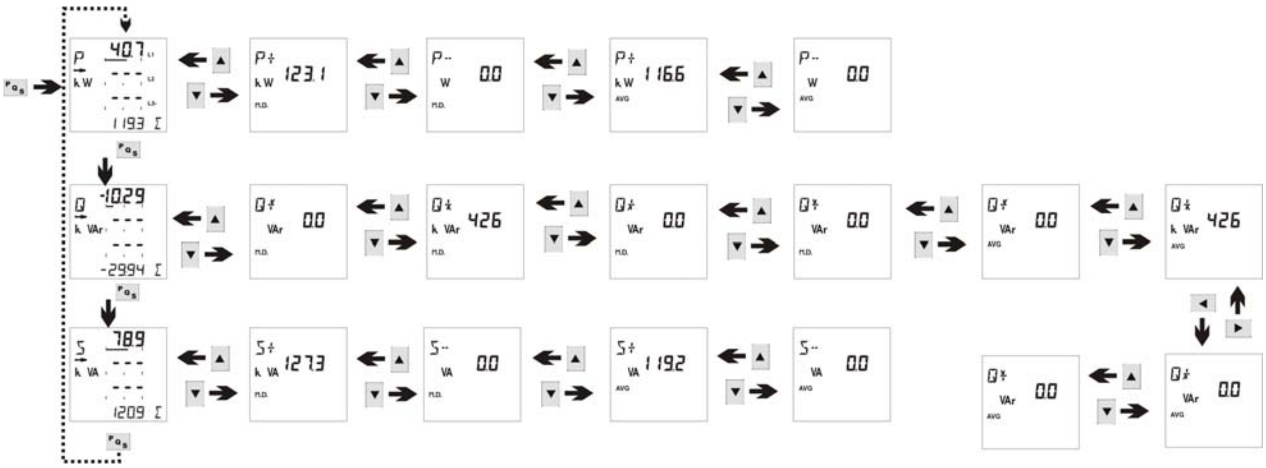
5.2.1.3.2 3P 4W only Import Configuration.



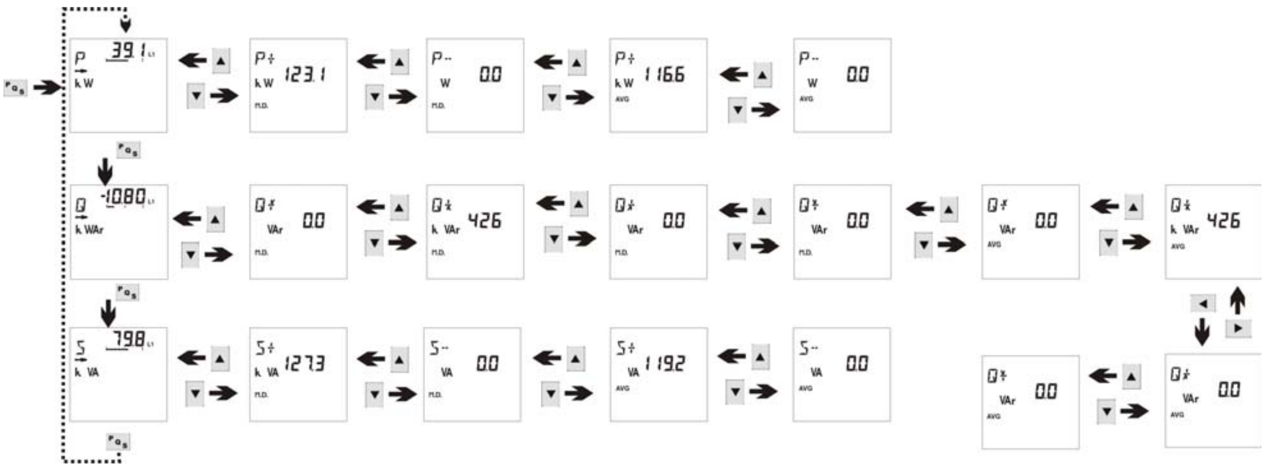
5.2.1.3.3 3P 3W / 3P-b 3W / 2P 2W Configuration



5.2.1.3.4 3P-b 4W Configuration



5.2.1.3.5 1P 2W Configuration

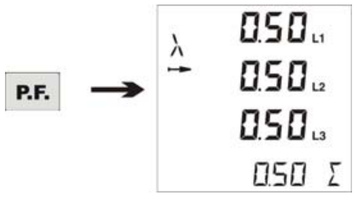


5.2.1.4 P.F. Visualization

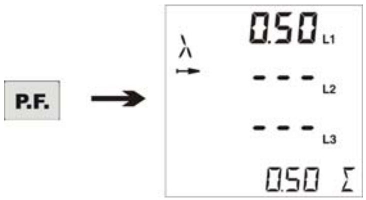
By pressing the P.F. key, the power factor readings page is prompted showing the PF of each phase as well as the 3-phase reading. Only one page is displayed.

The – sign ahead of the value identifies a capacitive (leading) reading.

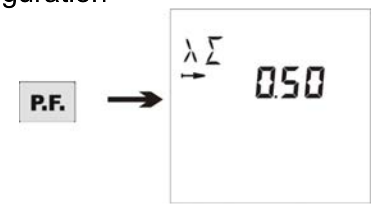
5.2.1.4.1 3P 4W Configuration



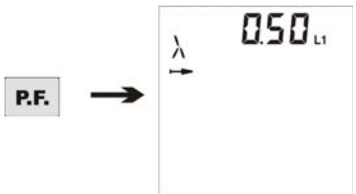
5.2.1.4.2 3Pb 4W Configuration



5.2.1.4.3 3P 3W e 3Pb 3W Configuration

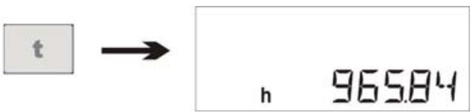


5.2.1.4.4 1P 2W e 2P 2W Configuration



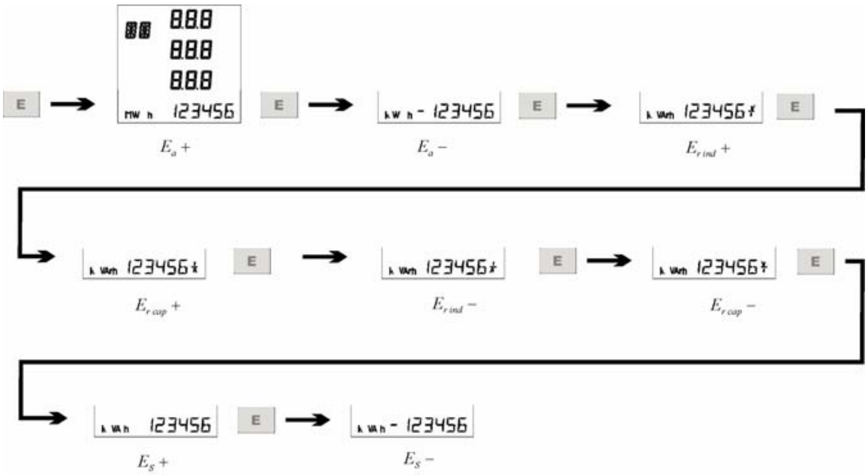
5.2.2 Life Time

By pressing the t key the instrument calendar clock (time and date) and the life time reading are displayed.
The life time is the instrument operating time (when powered on) since it was manufactured.
The readings is expressed in hours and hour hundredths; it can reach 99.999 hours equal to 11 years. The life time reading reset is not possible.

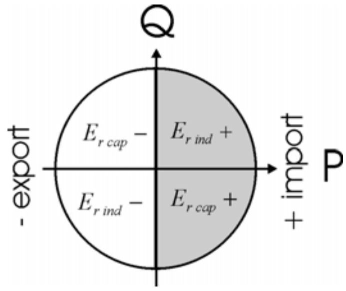


5.2.2.1 Energy

By pressing repeatedly the E key, the several energy readings will be displayed consecutively on the lower right part of the screen.
The energy readings may be recalled at any time irrespective the readings page being displayed.
The energy readings will however disappear upon selection of another readings page but they may be recalled, at any time, by pressing the E key.



The quadrant selection is operated according to the following trigonometric convention:
Where:



(E_a^+) Import active energy (import)

(E_a^-) Export active energy (export)

($E_{r\,ind}^+$) Inductive reactive energy with import Active Power.

($E_{r\,cap}^+$) Capacitive reactive energy with import Active Power

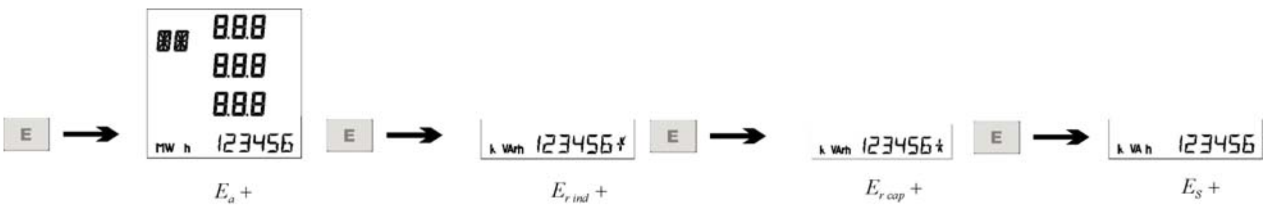
($E_{r\,ind}^-$) Inductive reactive energy with export Active Power

($E_{r\,cap}^-$) Capacitive reactive energy with export Active Power

(E_s^+) Apparent Energy with import Active Power

(E_s^-) Apparent Energy with export Active Power

5.2.2.2 Only Import Energy Display



6 Instrument Description

6.1 Introduction

FLASH is a microprocessor based energy analyzer with high flexibility and accuracy.
The patented digital measuring system guarantees high performance with age and thermal stability. This is achieved through sophisticated strategies of automatic offset compensation - used throughout the measurement chain – and through a Phase Locked Loop (PLL) sampling probe.

The automatic rescaling feature on current inputs allows a wide measuring range - from *20mA* to *6A* in direct connection.
All "true-RMS" measures are obtained with continuous sampling of the voltage and current waveforms: this guarantees maximum accuracy even when rapidly changing loads are present (e.g. electric welding machines).
FLASH can be programmed to analyze three phase networks, both on three and four wires with low or high voltage with 1, 2 or 3 CTs in addition to single phase measurements. The option of setting any required conversion factor on the voltage and current inputs makes FLASH suitable for use in both high and low voltage networks.

It can measure the energy and the peak on the 4 quadrants (active, reactive and apparent).
The instrument firmware is kept in flash memory and can be updated through a serial port, using the same communication protocol. The upgrade uses special security provisions to ensure continued operations even in presence of communication failures.
All input, output, and power supply ports are electrically separated for maximum safety and noise reduction under any operating conditions.
The in-house testing and calibration process is completely automated: a conformity certificate and calibration report are supplied with each unit.
The custom designed LCD display has three 3 ½ digit lines and a 7 digit line and an extended symbol and character set, allowing the simultaneous display of 4 measurements. Three 11-segment bar graphs give immediate feedback on the overall measuring process.
The wide keyboard, with its 9 silicon rubber coated keys, clearly marked with function, allows a simple and intuitive use of the instrument.
FLASH is completely programmable, from either the keyboard or a PC remote connection (only for models with communication port). It is therefore the ideal solution for all the power measurement and management needs in the industrial environment.
The instrument is equipped with two optically insulated transistor driven outputs with capacity load of 27 Vdc 27 mA according to 43864 Din standard.
They can be used either as pulse output or as alarm and are fully programmable by the user on different parameters and with different pulse frequency and duration.
The factory setting is with one output is proportional to the active energy, while the other to the reactive energy and an output frequency of 1000 pulses per kWh (or kvarh) and 50 ms pulse time.
The pulses number is referred to the instrument end of range without the CT and VT scale factors.

6.2 Simplicity and versatility

Keyboard programming is extremely easy and allows setting of:

- Connection type (star and delta)
- Low Tension or Medium Tension
- Setting of CTs and VTs values (freely settable)
- Integration time (1-99 min.)
- RS485 features (speed, parity and data format)
- Alarm threshold for the Active Power.
- Analog output.
- Pulses
- ...and all other functions available

The sameFunctions can be programmed via PC

6.3 Total harmonic distortion Measurement (THD)

The instrument gives an evaluation of the energy quality by sampling the total harmonic distortion of the 3 voltages and 3 currents.

These functions are extremely useful to control the quality of the energy supplied by the Public Utility, because of the large number of distorting loads in industrial plants.

6.4 Energy Measurement

Energy is displayed on a 6 digit display with floating point.

The energy counters are stored on counters with minimum definition equal to 0,1 kWh and maximum counting equal to 99.999.999,9 kWh.

8 counters are available +Ea, -Ea, ++Er, -+Er, +-Er, --Er, +Es, -Es on 4 total quadrants and for each one of the 8 tariff ranger

6.5 Calibration Led

A red led is located on the instrument front panel pulsing with a 1000 pulse/kWh (or kvarh) and 50 ms pulse duration. The pulses number is referred to the instrument end of range without the CT and VT scale factors.

6.6 Digital Outputs

The two outputs are (mostly) used as pulse output on active/reactive power or as output for the internal triggers. In other configurations, where the instruments is controlled – by a PC or PLC - through the RS485 port, the outputs can be used for signaling remote activation/deactivation.

6.7 Pulse Output

The instrument, even in its basic version, is equipped with two transistor optically insulated outputs with capacity load of 27 Vdc 27 mA according to 43864 Din standard and output frequency of 1000 pulses per kWh (or kvarh) and 50 ms pulse time.

One output is proportional to the active energy while the other to the reactive energy.

The pulses number is referred to the instrument end of range without the CT and TV scale factors.

It is possible to program the output value either according to pulse number and pulse weight

6.8 Alarms

FLASH is triggered and programmed by switchboard and/or Holding registers with MODBUS protocol.

The advanced functions of the Energy Brain configuration software allow to customize each of the two alarms on any available parameter either as a minimum or max alarm. Two different thresholds of the same measurement can be programmed.

Minimum value and maximum value special alarms on voltage are available that can be applied on any of the three phases, one maximum value alarm on current that can be applied on any of the three phases and an unbalanced alarm on any of the three current phases.

A further flexibility in customization is provided by the possibility to program the alarm management through:

- Delay time (between 1 and 59 sec.) that is activation delay. Example: avoid alarms due to short signal peaks.
- Hysteresis, that is the cycle between the alarm activation value and the alarm deactivation value. It is an extremely useful function to avoid ringing and false triggering. Example: Current alarm set on 100A Max with 5% Hysteresis. The alarm is activated at 100 A and is deactivated at 95 A. The two alarms can be associated singularly to:
- Output relays. In this case the output relays are activated by the exceeded threshold
- RS485 data line. The relays are disabled and the alarm consolidation are disabled and the alarm condition is available as information on information on RS485. data line.

6.9 Communication

The device can be connected to a PC through an optional RS485 or RS232 port using the MODBUS communication protocol (MODBUS, developed by AEG-MODICON, is a standard in the PLC industry and widely utilized by SCADA systems for industrial plants management).
Data read by the device can be read as the content of numeric registers, in the standard mantissa/exponent floating point IEEE format.
The communication port can be operated at any speed between 2400 bps through 38400 bps without wait states between 2 requests with a limitation on the number of registers equal to 124 registers (62 parameters)
When using the optional RS485 port, the connection uses a standard telephone pair without need of signal regeneration/amplification for distances up to 1,000 m. Up to 128 devices can be connected on the same network branch. Using line amplifiers, it is possible to connect up to 247 instruments or 1,000 m network segments.

6.10 Average and peak Energy

While the FLASH was designed to measure energy consumption (the so called import mode), it can be configured to work in import/export mode. When in import mode, the device automatically compensates wiring errors on CTs (e.g. for current flow). On the other hand, when in import/export mode, all the energy, average and peak counters are open for measurement in the four quadrants.

7 System Architecture

7.1 General Features

7.1.1 FLASH

Energy Analyzer

- Very accurate and stable measurement system thanks to the digital signal elaboration;
- Continuous sampling of the wave shape of voltages and currents;
- Offset automatic compensation of the measurement chain;
- Current inputs with automatic scale change;
- True-RMS measurements (up to the 31st harmonic);
- Class 1 on the Active Power in compliance with IEC EN 61036;
- Neutral current calculation;
- Working temperature -20/+60 °C.
- Programmable digital outputs
- Insertion on electric 3 phase unbalanced 3 or 4 wire networks, single phase networks and on balanced symmetrical three phase 3or 4 wire networks
- Software upgrade on line
- Life Timer;
- LCD display with white white LED baclight;
- Calibration verification LED through optical devices;
- Easy to use, thanks to the 9 button keyboard with explicit function indication;
- To be used with low or high voltages (programmable relationship between VTs and CTs);
- Extended range power supply (*85 ÷ 265 Vac*, *100 ÷ 374 Vdc*) separated from the measurement inputs;
- 2 slots for optional expansion modules:
    - RS-232 o RS-485 Communication port;
    - 4-20 mA Double analogue output;
    - Further devices for future applications;
- Galvanic insulation among all input and output ports;
- Firmware which can be upgraded to support new functions;
- 6 unit Din rail mounting;
- Compliant with all the international standards.
- Measurement of the total harmonic distortion (THD) of voltages and currents;
- Average and Max Demand powers (on 4 quadrants) with programmable integration time;

- Internal energy counters (on 4 quadrants).
- 2 digital outputs (DIN 43864) with programmable functions:
  - Pulse outputs for energy counting;
  - Event signaling (alarms);
  - Remote control of external devices.

7.1.2 Options

7.1.2.1 RS485 Port

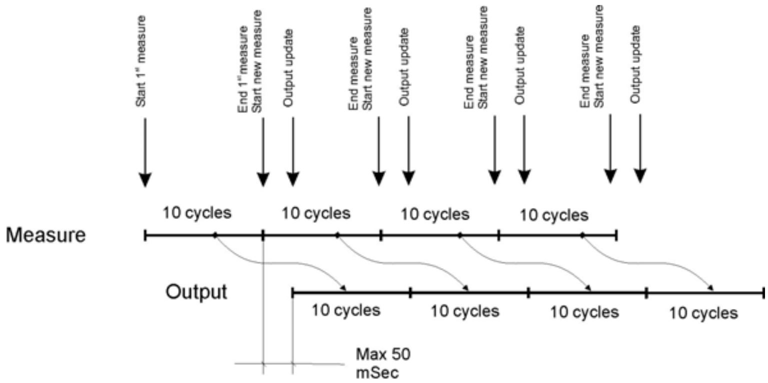
RS485 optically insulated interface module with programmable speed from 2400 bps to 38400 bps.
It is connected to the instrument via a connector and then can be easily fixed at the back with screws.
It can be network connected with other instruments up to 1000 m maximum distance and up to 128 instruments. For longer distances or more instruments, an amplifier is necessary.

7.1.2.2 RS232 Port

RS232 optically insulated interface module with programmable speed from 2400 bps to 38400 bps.
It is connected to the instrument via a connector and then can be easily fixed at the back with screws.

7.1.2.3 2 x 4-20 mA Analog Output

4-20 o 0-20 mA analogue double output, galvanically insulated with high accuracy and reliability.
The output is the result of a conversion from digital to analogue with definition higher than 10 bit, maintaining the original measurement accuracy.
The two outputs can be linked to any measurement parameter with update every 200 ms on primary parameters.

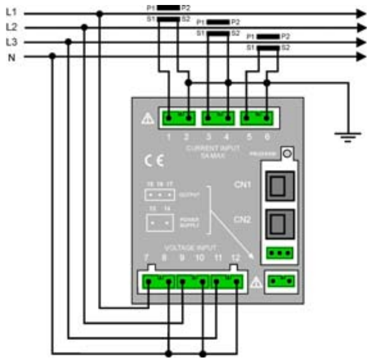


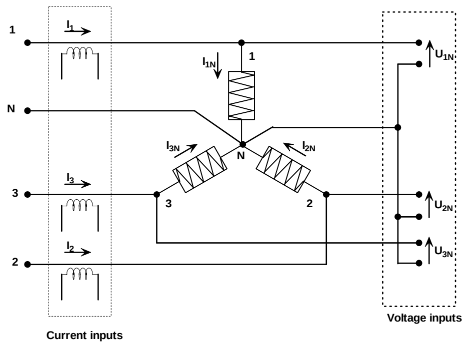
For the average power the output update is every minute due to the parameter itself.
It can be set to a 0 value (4 or 0 mA) a positive or negative value of the selected parameter and to nevertheless set to 20 mA end of scale, a lower value than the instrument end of scale. The end of scale provides for an operation margin up to 24 mA.
If the parameter has a value different from the set ones, the output will be 0 mA.

8 Parameters and formulas

For each type of connection, the available readings as well as the formulas used for their calculation are provided.
The redings not available will be displayed as – – – in place of the value.

8.1 3P 4W Three phase with 4 wire neutral





8.1.1 Available Reading:

1 Frequency:

Voltage frequency V_{1N} : f

2 RMS amplitude:

Phase Voltages: U_{1N}, U_{2N}, U_{3N}

Average Phase Voltages: U_{λ}

Phase-phase Voltages: U_{12}, U_{23}, U_{31}

Mean Phase-phase Voltage: U_{Δ}

Phase Current: I_1, I_2, I_3

Neutral Current: I_N

Mean three phase Current: I_{Σ}

3 Total harmonic Distortion (in percentage):

Phase Voltages THD: $THD_{U_{1N}}, THD_{U_{2N}}, THD_{U_{3N}}$

Mean 3 phase voltage THD: $THD_{U_{\lambda}}$

Phase Current THD: $THD_{I_1}, THD_{I_2}, THD_{I_3}$

Mean 3 phase current THD: $THD_{I_{\Sigma}}$

4 Power (on the short period):

Phase Active Powers: P_1, P_2, P_3

3 Phase Active Power: P_{Σ}

Phase reactive Powers: Q_1, Q_2, Q_3

3 Phase Reactive Power: Q_{Σ}

Phase apparent Powers: S_1, S_2, S_3

3 Phase Apparent Power: S_{Σ}

5 Power Factor:

Phase Power Factor: $\lambda_1, \lambda_2, \lambda_3$

3 Phase Power Factor: λ_{Σ}

6 Energies:

Active Energy (import): E_a^+

Active Energy (export): E_a^-

Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

Apparent Energy with import Active Power: E_s^+

Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period "Sliding Average",

Average import Active Power: P_{AVG}^+

Average export Active Power: P_{AVG}^-

Average inductive reactive Power with import Active Power: $Q_{AVG\,ind}^+$

Average capacitive reactive Power with import Active Power: $Q_{AVG\,cap}^+$

Average inductive reactive Power with export Active Power: $Q_{AVG\,ind}^-$

Average capacitive reactive Power with export Active Power: $Q_{AVG\,cap}^-$

Average apparent Power with import Active Power: S_{AVG}^+

Average apparent Power with export Active Power: S_{AVG}^-

8 Maximum Demand:

M.D. of import Active Power $P_{M.D.}^+$

M.D. of export Active Power: $P_{M.D.}^-$

M.D. of inductive reactive Power with import Active Power: $Q_{M.D.ind}^+$

M.D. of capacitive reactive Power with import Active Power: $Q_{M.D.cap}^+$

M.D. of inductive reactive Power with export Active Power: $Q_{M.D.ind}^-$

M.D. of capacitive reactive Power with export Active Power: $Q_{M.D.cap}^-$

M.D. of apparent Power with import Active Power: $S_{M.D.}^+$

M.D. of apparent Power with export Active Power: $S_{M.D.}^-$

9 Time:

Life Timer t

8.1.2 Measurement Formulas:

Phase Voltages: U_{1N}, U_{2N}, U_{3N}

$$U_{1N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}^2(n)}; \qquad U_{2N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{2N}^2(n)}; \qquad U_{3N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{3N}^2(n)}$$

Phase-phase Voltages: U_{12}, U_{23}, U_{31}

$$U_{12} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} [U_{1N}(n) - U_{2N}(n)]^2}; \quad U_{23} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} [U_{2N}(n) - U_{3N}(n)]^2}; \quad U_{31} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} [U_{3N}(n) - U_{1N}(n)]^2}$$

where:

$U_{1N}(n), U_{2N}(n), U_{3N}(n)$ are the star voltage samples;

M is the number of samples taken over a period (64);

M

Star Voltages THD $THD_{U_{1N}}, THD_{U_{2N}}, THD_{U_{3N}}$ in %

$$THD_{U_{1N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{1N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{1N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{1N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{U_{2N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{2N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{2N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{2N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{U_{3N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{3N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{3N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{3N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Line Currents (coincident with the phase currents): I_1, I_2, I_3

$$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}; \qquad I_2 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_2^2(n)}; \qquad I_3 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_3^2(n)}$$

$I_1(n), I_2(n), I_3(n)$ are the samples of the line currents.

Neutral Current I_N

$$I_N = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} [I_1(n) + I_2(n) + I_3(n)]^2}$$

Phase Currents THD: $THD_{I_1}, THD_{I_2}, THD_{I_3}$

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{I_2}=100\sqrt{\frac{\sum_{n=0}^{N-1} I_2^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_2(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2+\left[\sum_{n=0}^{N-1} I_2(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}}-1}$$

$$THD_{I_3}=100\sqrt{\frac{\sum_{n=0}^{N-1} I_3^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_3(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2+\left[\sum_{n=0}^{N-1} I_3(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}}-1}$$

Phase Active Powers: P_1, P_2, P_3;

$$P_1=\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n)\, I_1(n); \qquad P_2=\frac{1}{M}\sum_{n=0}^{M-1} U_{2N}(n)\, I_2(n); \qquad P_3=\frac{1}{M}\sum_{n=0}^{M-1} U_{3N}(n)\, I_3(n)$$

Phase reactive Powers: Q_1, Q_2, Q_3

$$Q_1=\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n+M/4)\, I_1(n); \qquad Q_2=\frac{1}{M}\sum_{n=0}^{M-1} U_{2N}(n+M/4)\, I_2(n);$$

$$Q_3=\frac{1}{M}\sum_{n=0}^{M-1} U_{3N}(n+M/4)\, I_3(n)$$

Phase apparent Powers: S_1, S_2, S_3 $\quad S_1=U_1 I_1 \quad S_2=U_2 I_2 \quad S_3=U_3 I_3$

Phase Power Factors: $\lambda_1, \lambda_2, \lambda_3$ $\quad \lambda_1=\frac{P_1}{S_1} sign(Q_1) \quad \lambda_2=\frac{P_2}{S_2} sign(Q_2) \quad \lambda_3=\frac{P_3}{S_3} sign(Q_3)$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

Average star Voltage U_λ $\quad U_\lambda=\frac{U_{1N}+U_{2N}+U_{3N}}{3}$

Mean phase-phase Voltage U_Δ $\quad U_\Delta=\frac{U_{12}+U_{23}+U_{31}}{3}$

Average THD of the star voltages: THD_{U_λ} $\quad THD_{U_\lambda}=\frac{THD_{U_{1N}}+THD_{U_{2N}}+THD_{U_{3N}}}{3}$

Three phase Current I_Σ $\quad I_\Sigma=\frac{S_\Sigma}{U_\Delta\sqrt{3}}$

Average THD of the phase currents: THD_{I_Σ} $\quad THD_{I_\Sigma}=\frac{THD_{I_1}+THD_{I_2}+THD_{I_3}}{3}$

Total Active Power: P_Σ $\quad P_\Sigma=P_1+P_2+P_3$

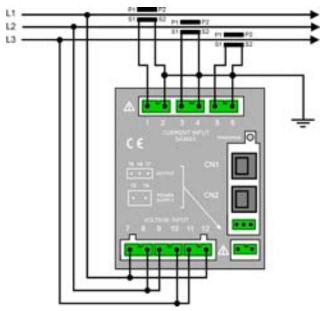
Total reactive Power: Q_Σ $\quad Q_\Sigma=Q_1+Q_2+Q_3$

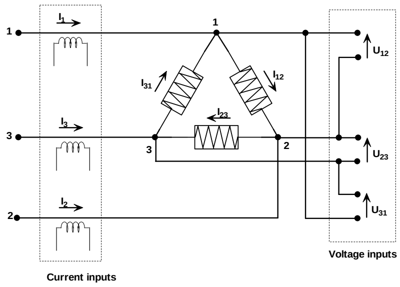
Total apparent Power: S_Σ $\quad S_\Sigma=\sqrt{P_\Sigma^2+Q_\Sigma^2}$

3 Phase Power Factor: λ_Σ $\quad \lambda_\Sigma=\frac{P_\Sigma}{S_\Sigma} sign(Q_\Sigma)$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.2 3P 3W Three phase without neutral





8.2.1 Available Reading:

1 Frequency:

Voltage frequency V_{1N} : f

2 RMS amplitude:

Phase-phase Voltages: U_{12}, U_{23}, U_{31}

Mean Phase-phase Voltage: U_{Δ}

Line Currents: I_1, I_2, I_3

Mean three phase Current: I_{Σ}

3 Total harmonic distortion (in percentage):

THD of the Phase to phase Voltages $THD_{U_{12}}, THD_{U_{23}}, THD_{U_{31}}$

Average THD of the Phase to phase Voltages $THD_{U\Delta}$

THD of the line currents: $THD_{I_1}, THD_{I_2}, THD_{I_3}$

Average THD of the line currents $THD_{I_{\Sigma}}$

4 Power (on the short period):

3 Phase Active Power: P_{Σ}

3 Phase Reactive Power: Q_{Σ}

3 Phase Apparent Power: S_{Σ}

5 Power Factor:

3 Phase Power Factor: λ_{Σ}

6 Energies:

Active Energy (import): E_a^+

Active Energy (export): E_a^-

Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

Apparent Energy with import Active Power: E_s^+

Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period "Sliding Average",:

Import average Active Power: P_{AVG}^+

Export average Active Power: P_{AVG}^-

Average inductive reactive Power with import Active Power: $Q_{AVG\ ind}^+$

Average capacitive reactive Power with import Active Power: $Q_{AVG\ cap}^+$

Average inductive reactive Power with export Active Power: $Q_{AVG\ ind}^-$

Average capacitive reactive Power with export Active Power: $Q_{AVG\ cap}^-$

Average apparent Power with import Active Power: S_{AVG}^+

Average apparent Power with export Active Power: S_{AVG}^-

8 Maximum demand:

M.D. of import Active Power: $P_{M.D.}^+$

M.D. of export Active Power: $P_{M.D.}^-$

M.D. of inductive reactive Power with import Active Power: $Q_{M.D.ind}^+$

M.D. of capacitive reactive Power with import Active Power: $Q_{M.D.cap}^+$

M.D. of inductive reactive Power with export Active Power: $Q_{M.D.ind}^-$

M.D. of capacitive reactive Power with export Active Power: $Q_{M.D.cap}^-$

M.D. of apparent Power with import Active Power: $S_{M.D.}^+$

M.D. of apparent Power with export Active Power: $S_{M.D.}^-$

9 Time:

Life Timer t

8.2.2 Measurement Formulas:

<u>Phase-phase Voltages:</u> U_{12}, U_{23}, U_{31}

$$U_{12} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{12}^2(n)}; \qquad U_{23} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{23}^2(n)}; \qquad U_{31} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{31}^2(n)}$$

$U_{12}(n), U_{23}(n), U_{31}(n)$ are the Phase to phase Voltages samples.
M is the number of samples taken over a period (64)

<u>Phase to phase Voltages THD</u> $THD_{U_{12}}, THD_{U_{23}}, THD_{U_{31}}$ in %

$$THD_{U_{12}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{12}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{12}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{12}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{U_{23}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{23}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{23}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{23}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{U_{31}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{31}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{31}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{31}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

<u>Phase Current:</u> I_1, I_2, I_3

$$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}; \qquad I_2 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_2^2(n)}; \qquad I_3 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_3^2(n)}$$

$I_1(n), I_2(n), I_3(n)$ are the line current samples.
<u>Phase Current THD</u>: $THD_{I_1}, THD_{I_2}, THD_{I_3}$

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{I_2} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_2^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_2(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_2(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

$$THD_{I_3} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_3^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_3(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_3(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

<u>Mean phase-phase Voltage</u> U_Δ $$U_\Delta = \frac{U_{12} + U_{23} + U_{31}}{3}$$

<u>Average THD of the Phase to phase Voltages</u>: THD_{U_Δ} $$THD_{U_\Delta} = \frac{THD_{U_{12}} + THD_{U_{23}} + THD_{U_{31}}}{3}$$

<u>Three phase current</u>: I_Σ $$I_\Sigma = \frac{S_\Sigma}{U_\Delta \sqrt{3}}$$

<u>Average THD of the phase Currents</u>: THD_{I_Σ} $$THD_{I_\Sigma} = \frac{THD_{I_1} + THD_{I_2} + THD_{I_3}}{3}$$

<u>Three phase Active Power</u>: P_Σ $$P_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{12}(n)\, I_1(n) - \sum_{n=0}^{M-1} U_{23}(n)\, I_3(n)\right]$$

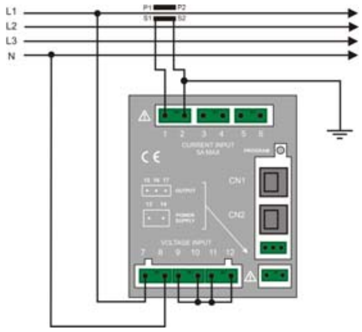
<u>Three phase reactive Power</u>: Q_Σ $$Q_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{12}(n + M/4)\, I_1(n) - \sum_{n=0}^{M-1} U_{23}(n + M/4)\, I_3(n)\right]$$

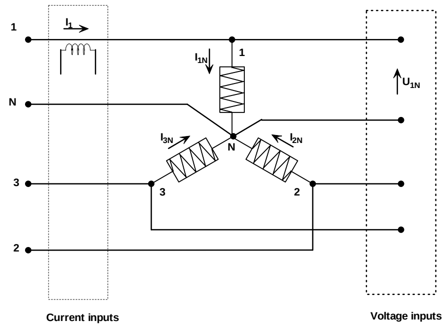
<u>Three phase apparent Power</u>: S_Σ $$S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$$

<u>Three phase Power Factor</u>: λ_Σ $$\lambda_\Sigma = \frac{P_\Sigma}{S_\Sigma} sign(Q_\Sigma)$$

where *sign*(*x*) is equal to 1 with $x > 0$, to -1 with $x < 0$.

8.3 3P-b 4W Balanced Three phase with neutral





8.3.1 Available Reading:

1 Frequency:

Voltage frequency V_{1N} : f

2 RMS Amplitude:

Star Voltage: U_{1N}

Phase Current: I_1

3 Total harmonic Distortion (in percentage):

Star Voltage THD: $THD_{U_{1N}}$

Phase Current THD: THD_{I_1}

4 Power (on the short period):

Phase Active Power: P_1

3 Phase Active Power: P_Σ

Phase Reactive Power: Q_1

3 Phase Reactive Power: Q_Σ

Phase apparent Powers: S_1

3 Phase Apparent Power: S_Σ

5 Power Factor:

Phase Power Factor: λ_1

3 Phase Power Factor: λ_Σ

6 Energies:

Active Energy (import): E_a^+

Active Energy (export): E_a^-

Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

Apparent Energy with import Active Power: E_s^+

Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period "Sliding Average",

Import average Active Power: P_{AVG}^+

Export average Active Power: P_{AVG}^-

Average inductive reactive Power with import Active Power: $Q_{AVG\,ind}^+$

Average capacitive reactive Power with import Active Power: $Q_{AVG\,cap}^+$

Average inductive reactive Power with export Active Power: $Q_{AVG\,ind}^-$

Average capacitive reactive Power with export Active Power: $Q_{AVG\,cap}^-$

Average apparent Power with import Active Power: S_{AVG}^+

Average apparent Power with export Active Power: S_{AVG}^-

8 Maximum Demand:

M.D. of import Active Power: $P_{M.D.}^+$

M.D. of export Active Power: $P_{M.D.}^-$

M.D. of inductive reactive Power with import Active Power: $Q_{M.D.ind}^+$

M.D. of capacitive reactive Power with import Active Power: $Q_{M.D.cap}^+$

M.D. of inductive reactive Power with export Active Power: $Q_{M.D.ind}^-$

M.D. of capacitive reactive Power with export Active Power: $Q_{M.D.cap}^-$

M.D. of apparent Power with import Active Power: $S_{M.D.}^+$

M.D. of apparent Power with export Active Power: $S_{M.D.}^-$

9 Time:

Life Timer t

8.3.2 Measurements Formulas:

Phase Voltages: U_{1N} $$U_{1N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}^2(n)}$$

where:

$U_{1N}(n)$ are the samples of the star voltages;

M is the number of samples on a period (64);

Star voltages THD $THD_{U_{1N}}$ in %

$$THD_{U_{1N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{1N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{1N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{1N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Line Current (coincident with the phase current): I_1 $$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}$$

$I_1(n)$ are the samples of the line currents.

Phase current THD: THD_{I_1}

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Active Power: P_1; $$P_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n)\, I_1(n)$$

Phase reactive Power: Q_1 $$Q_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n + M/4)\, I_1(n)$$

Phase apparent Power: S_1 $$S_1 = U_1 I_1$$

Phase Power Factor: λ_1 $$\lambda_1 = \frac{P_1}{S_1} sign(Q_1)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

Total Active Power: P_Σ $$P_\Sigma = P_1 * 3$$

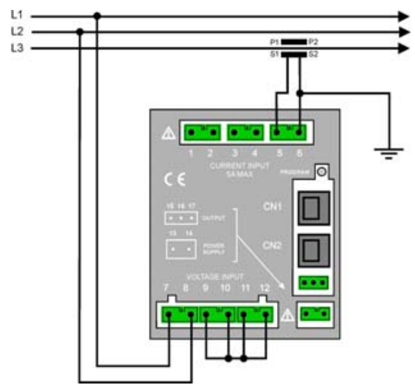
Total reactive Power: Q_Σ $$Q_\Sigma = Q_1 * 3$$

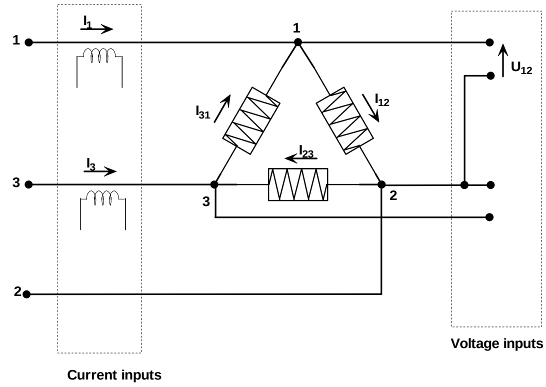
Total apparent Power: S_Σ $$S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$$

Total Power Factor: λ_Σ $$\lambda_\Sigma = \lambda_1$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.4 3P-b 3W Balanced three Phase without neutral 3 wires





8.4.1 Available Reading:

1 Frequency:

Voltage frequency V_{23} : f

2 RMS amplitude:

Phase-phase Voltages: U_{12}

Phase Current: I_3

3 Total harmonic distortion (in percentage):

Phase to phase Voltages THD: $THD_{U_{12}}$

Phase Current THD: THD_{I_3}

4 Power (on short period):

3 Phase Active Power: P_Σ

Total reactive Power: Q_Σ

Total apparent Power: S_Σ

5 Power Factor:

Total Power Factor: λ_Σ

6 Energies:

Active Energy (import): E_a^+

Active Energy (export): E_a^-

Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

Capacitive reactive Energy with import Active Power : $E_{r\,cap}^+$

Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

Apparent Energy with import Active Power: E_s^+

Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period "Sliding Average",

Import average Active Power:	P^+_{AVG}
Export average Active Power:	P^-_{AVG}
Average inductive reactive Power with import Active Power:	$Q^+_{AVG\,ind}$
Average capacitive reactive Power with import Active Power:	$Q^+_{AVG\,cap}$
Average inductive reactive Power with export Active Power:	$Q^-_{AVG\,ind}$
Average capacitive reactive Power with export Active Power:	$Q^-_{AVG\,cap}$
Average apparent Power with import Active Power:	S^+_{AVG}
Average apparent Power with export Active Power:	S^-_{AVG}

8 Maximum demand:

M.D. of import Active Power:	$P^+_{M.D.}$
M.D. of export Active Power:	$P^-_{M.D.}$
M.D. of inductive reactive Power with import Active Power:	$Q^+_{M.D.\,ind}$
M.D. of capacitive reactive Power with import Active Power:	$Q^+_{M.D.\,cap}$
M.D. of inductive reactive Power with export Active Power:	$Q^-_{M.D.\,ind}$
M.D. of capacitive reactive Power with export Active Power:	$Q^-_{M.D.\,cap}$
M.D. of apparent Power with import Active Power:	$S^+_{M.D.}$
M.D. of apparent Power with export Active Power:	$S^-_{M.D.}$

9 Time:

Life Time t

8.4.2 Measurement Formulas:

Phase-phase Voltages: U_{12}

$$U_{12} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{12}^2(n)}$$

Where: $U_{12}(n)$ are the samples of the chained values.
M is the number of sampling on a period (64)

Phase to phase Voltages THD $THD_{U_{23}}$ in %

$$THD_{U_{12}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{12}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{12}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{12}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Line Currents : I_3

$$I_3 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_3^2(n)}$$

$I_1(n)$ are the samples of the line currents.

THD of the phase currents: THD_{I_3}

$$THD_{I_3} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_3^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_3(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_3(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Three phase Active Power: P_Σ

$$P_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{23}(n + M/4)\, I_1(n)\right]\sqrt{3}$$

Three phase reactive Power: Q_Σ

$$Q_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{23}(n)\, I_1(n)\right]\sqrt{3}$$

Three phase apparent Power: S_Σ

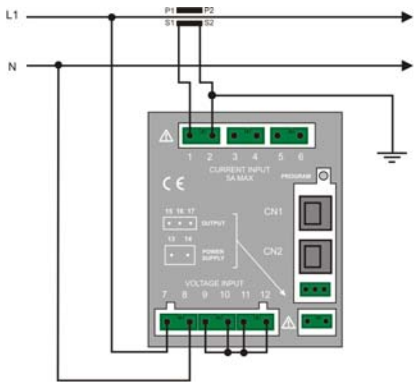
$$S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$$

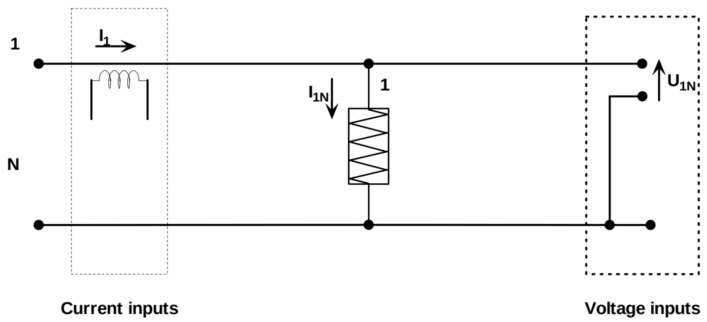
Three phase Power Factor: λ_Σ

$$\lambda_\Sigma = \frac{P_\Sigma}{S_\Sigma} sign(Q_\Sigma)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.5 1P (2W) Single phase





8.5.1 Available Reading:

1 Frequency:

Voltage Frequency V_{1N} : f

2 RMS Amplitude:

Voltage: U_{1N}

Phase Current: I_1

3 Total harmonic Distortion (in percentage):

Voltage THD: $THD_{U_{1N}}$

Phase Current THD: THD_{I_1}

4 Power (on short period):

Active Power: P_1

Reactive Power: Q_1

Apparent Power: S_1

5 Power Factor:

Power Factor : λ_1

6 Energies:

Active Energy (import): E_a^+

Active Energy (export): E_a^-

Inductive reactive Energy with import Active Power: $E_{r\,ind}^+$

Capacitive reactive Energy with import Active Power: $E_{r\,cap}^+$

Inductive reactive Energy with export Active Power: $E_{r\,ind}^-$

Capacitive reactive Energy with export Active Power: $E_{r\,cap}^-$

Apparent Energy with import Active Power: E_s^+

Apparent Energy with export Active Power: E_s^-

7 Average Power integrated over the programmed integration period "Sliding Average",

Import average Active Power:	P_{AVG}^{+}
Export average Active Power:	P_{AVG}^{-}
Average inductive reactive Power with import Active Power:	$Q_{AVG\ ind}^{+}$
Average capacitive reactive Power with import Active Power:	$Q_{AVG\ cap}^{+}$
Average inductive reactive Power with export Active Power:	$Q_{AVG\ ind}^{-}$
Average capacitive reactive Power with export Active Power:	$Q_{AVG\ cap}^{-}$
Average apparent Power with import Active Power:	S_{AVG}^{+}
Average apparent Power with export Active Power:	S_{AVG}^{-}

8 Maximum Demand:

M.D. of import Active Power:	$P_{M.D.}^{+}$
M.D. of export Active Power:	$P_{M.D.}^{-}$
M.D. of inductive reactive Power with import Active Power:	$Q_{M.D.ind}^{+}$
M.D. of capacitive reactive Power with import Active Power:	$Q_{M.D.cap}^{+}$
M.D. of inductive reactive Power with export Active Power:	$Q_{M.D.ind}^{-}$
M.D. of capacitive reactive Power with export Active Power:	$Q_{M.D.cap}^{-}$
M.D. of apparent Power with import Active Power:	$S_{M.D.}^{+}$
M.D. of apparent Power with export Active Power:	$S_{M.D.}^{-}$

9 Time:

Life Timer t

8.5.2 Measurement Formulas:

Voltage: U_{1N}

$$U_{1N} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{1N}^2(n)}$$

$U_{1N}(n)$ are the samples of the star voltages;

M is the number of samples on a period (64);

Star voltages THD $THD_{U_{1N}}$ in %

$$THD_{U_{1N}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{1N}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{1N}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{1N}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Current: I_1

$$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}$$

Where: $I_1(n)$ are the samples of the line currents.

Phase current THD: THD_{I_1}

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Active Powers: P_1

$$P_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n)\, I_1(n)$$

Phase reactive Powers : Q_1

$$Q_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n + M/4)\, I_1(n)$$

Phase apparent Powers: S_1

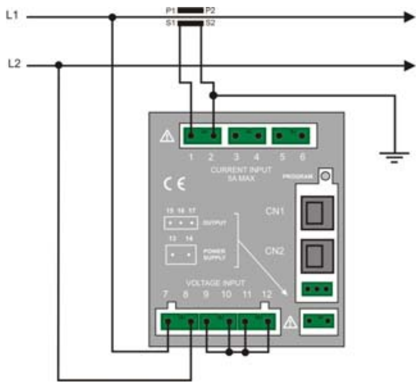
$$S_1 = U_1 I_1$$

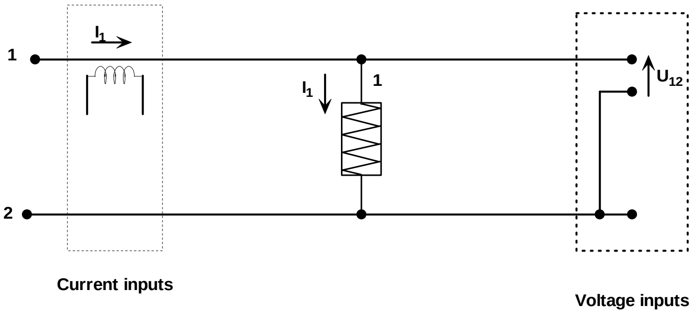
Phase Power Factors: λ_1

$$\lambda_1 = \frac{P_1}{S_1} sign(Q_1)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.6 2P (2W) Double phase





8.6.1 Available Reading:

1 Frequency:

Voltage frequency V_{12} : f

2 RMS amplitude:

Voltage: U_{12}

Phase Current: I_1

3 Total harmonic distortion (in percentage):

Voltage THD : $THD_{U_{12}}$

Phase Current THD: THD_{I_1}

4 Power (on short period):

Active Power: P_Σ

Reactive Power: Q_Σ

Apparent Power: S_Σ

5 Power Factor:

Power Factor: λ_Σ

6 Energies:

Active Energy (import): E_a^+

Active Energy (export): E_a^-

Inductive reactive Energy with import Active Power: $E_{r\ ind}^+$

Capacitive reactive Energy with import Active Power: $E_{r\ cap}^+$

Inductive reactive Energy with export Active Power: $E_{r\ ind}^-$

Capacitive reactive Energy with export Active Power: $E_{r\ cap}^-$

Apparent Energy with import Active Power: E_s^+

Apparent Energy with export Active Power: E_s^-

7 Average Power taken on a time interval (sliding window) of programmable amplitude:

Import average Active Power: P_{AVG}^+

Export average Active Power: P_{AVG}^-

Average inductive reactive Power with import Active Power: $Q_{AVG\,ind}^+$

Average capacitive reactive Power with import Active Power: $Q_{AVG\,cap}^+$

Average inductive reactive Power with export Active Power: $Q_{AVG\,ind}^-$

Average capacitive reactive Power with export Active Power: $Q_{AVG\,cap}^-$

Average apparent Power with import Active Power: S_{AVG}^+

Average apparent Power with export Active Power: S_{AVG}^-

8 Maximum Demand:

M.D. of import Active Power: $P_{M.D.}^+$

M.D. of export Active Power: $P_{M.D.}^-$

M.D. of inductive reactive Power with import Active Power: $Q_{M.D.ind}^+$

M.D. of capacitive reactive Power with import Active Power: $Q_{M.D.cap}^+$

M.D. of inductive reactive Power with export Active Power: $Q_{M.D.ind}^-$

M.D. of capacitive reactive Power with export Active Power: $Q_{M.D.cap}^-$

M.D. of apparent Power with import Active Power: $S_{M.D.}^+$

M.D. of apparent Power with export Active Power: $S_{M.D.}^-$

9 Time:

Life Timer t

8.6.2 Measurements Formulas:

Voltage: U_{12} $$U_{12} = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} U_{12}^2(n)}$$

$U_{12}(n)$ are the samples of the star voltages;
M is the number of samples taken on a period (64);

Star voltage THD $THD_{U_{12}}$ in %

$$THD_{U_{12}} = 100\sqrt{\frac{\sum_{n=0}^{N-1} U_{12}^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} U_{12}(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} U_{12}(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Phase Current: I_1 $$I_1 = \sqrt{\frac{1}{M}\sum_{n=0}^{M-1} I_1^2(n)}$$

$I_1(n)$ are the samples of the line current.

Phase current THD: THD_{I_1}

$$THD_{I_1} = 100\sqrt{\frac{\sum_{n=0}^{N-1} I_1^2(n)}{\frac{2}{N}\left\{\left[\sum_{n=0}^{N-1} I_1(n)\cos\left(\frac{2\pi n}{N}\right)\right]^2 + \left[\sum_{n=0}^{N-1} I_1(n)\sin\left(\frac{2\pi n}{N}\right)\right]^2\right\}} - 1}$$

Active Power: P_Σ $$P_\Sigma = \frac{1}{M}\sum_{n=0}^{M-1} U_{12}(n)\, I_1(n)$$

Reactive Power : Q_Σ $$Q_\Sigma = \frac{1}{M}\sum_{n=0}^{M-1} U_{12}(n + M/4)\, I_1(n)$$

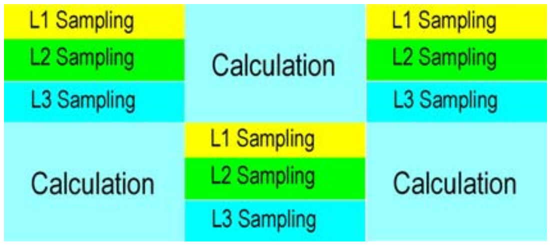
Phase apparent Power: S_Σ $$S_\Sigma = U_{12} I_1$$

Phase Power Factor: λ_Σ $$\lambda_\Sigma = \frac{P_1}{S_1} sign(Q_1)$$

where *sign*(*x*) is equal to 1 with *x* > 0, to -1 with *x* < 0.

8.6.3 Sampling:

The signals to be measured are sampled with a sampling frequency f_c equal to 64 times the network frequency f : shortly, the number of samples per wave is fixed at 64 even with frequency variation.
The sampling is continuous on all waveform. Every 10 wave the samples are passed to the calculation part and the sampling restart for the next 10 waves.



8.6.4 Grid frequency Measurement:

The minimum measurable frequency is about 38 Hz.
The A/D converter is stopped out of the range 45 ÷ 65 Hz.
The frequency measurement is taken on phase L1 voltage.
The instrument can measure the fundamental frequency even in presence of very distorted waveforms and/or very low signal (few Volt).

8.7 Average values and energy Calculation.

8.7.1 Energy counting

FLASH is equipped with 8 “non volatile” energy counters which can count up to a maximum of 99999999.9 kWh (either kvarh or kVAh) with a resolution equal to 0.1 kWh (either kvarh or kVAh). The value of these counters can be read either by communication port or display. When the highest value 99999999.9 is reached, the counting starts again from zero (roll-over).

8.7.2 Average Powers / maximum demand (m/Max)

FLASH has a sliding window integrator which computes the average value of each of the 8 power measurements on an integration interval that is programmable in the range of 1 through 60 minutes in one minute steps.
The integration interval slides on the time axis in one minute intervals (when all the values of the measurements are updated). The settings of the integration intervals are not memorized when the instrument is turned off. While the duration of the integration interval may differ from the HOLD period, the two intervals are both aligned on the minute boundary. A command can be sent on the communication port to synchronize the HOLD period (and therefore of the minute boundary of the integration interval) with an external clock. The maximal value of each of the average power measurements is memorized in a non-volatile register (maximum demand, MD).
Both the average and maximum demand values are available through the display and the communication port. A command can be sent (either from the keyboard or the communication port) to reset the maximum demand values to zero. Another command resets the average power values: it resets the measurements taken during the last integration interval, but not the measurements taken in the last minute (the step with which the integration window slides). This preserves the synchronization of the integration interval and of the HOLD interval on the minute boundary.

9 MODBUS Protocol

9.1 Foreword:

The instrument modbus protocol is implemented according to the document “*MODBUS Application Protocol Specification V1.1*”, available in www.modbus.org .

The following “Public functions” are implemented:

- (0x01) Read Coils
- (0x02) Read Discrete Inputs
- (0x03) Read Holding Registers
- (0x04) Read Input Registers
- (0x05) Write Single Coil
- (0x06) Write Single Register
- (0x07) Read Exception Status
- (0x08) Diagnostics
- (0x0F) Write Multiple Coils
- (0x10) Write Multiple Registers
- (0x11) Report Slave ID

Regarding the “Diagnostics” function, the following “Sub-functions” are implemented:

- (0x0000) Return Query Data
- (0x0001) Restart Communications Option
- (0x0004) Force Listen Only Mode

The only implemented function “User Defined” is marked “Change Slave Address” (function code 0x42).

Through two coils named SWAP BYTES and SWAP WORDS, it is possible to modify the memory area organization where the modbus registers mapping are. The configuration [SWAP BYTES = FALSE, SWAP WORDS = FALSE] correspond to a “Big-Endian” type organization (Motorola like): the most significant data byte whose size is bigger than byte is allocated at the lower address.

The order of the bigger than byte data transmitted on the serial line depend on the memory organization.
In the “Big-Endian” organization type, the most significant byte is the one transmitted first (standard modbus).

Vice versa, the configuration [SWAP BYTES = TRUE, SWAP WORDS = TRUE] corresponds to an “INTEL like” memory organization (the most significant byte at the higher address, that is less significant byte transmitted first on the serial line).

Note: In the released version, not all the listed commands are available, check in the following pages for availability.

The default configuration is “Big-Endian” (Motorola like) as the modbus standard specify and not “Little-Endian” as the previous instruments.

9.2 “Device dependent” Functions

9.2.1 (0x11) Slave ID Report

(0x11) Report Slave ID			
Byte	***Description***		***Value***
0	address		
1	function code		0x11
2	byte count		0x1F
3	slave ID		
4	run indicator status		0xFF
5	Application version major		
6	Application version minor		
7	Loader version major		
8	Loader version minor		
9	Serial number	MSB	
10			
11			
12		LSB	
13	byte/word swap		○○○○ ○○○⊙ - **Swap bytes**: 0 ≡ Standard; 1≡ Swapped ○○○○ ○○⊙○ - **Swap words**: 0 ≡ Standard; 1≡ Swapped ○○○○ ○⊙○○ - **Swap doublewords**: 0 ≡ Standard; 1≡ Swapped ○○○○ ⊙○○○ - **Swap words in float values**: 0 ≡ Standard; 1≡ Swapped ⊙⊙⊙⊙ ○○○○ - **Not Allocated** (Must be set to 0)
14	tx delay (ms)	MSB	
15		LSB	
16	N coils	MSB	
17		LSB	
18	N discrete inputs (input status)	MSB	
19		LSB	
20	N holding registers	MSB	
21		LSB	
22	N input registers	MSB	
23		LSB	
24	CN1 option ID		0x00 = NONE 0x0C = 2 x 4-20 mA 0x0D = DONGLE 0x0E = RS485 0x0F = RS232 0xFF = ERROR
25	CN2 option ID		
26	Application checksum	MSB	
27			
28			
29		LSB	
30	Loader Checksum	MSB	
31			
32			
33		LSB	
34	CRC		
35			

9.2.2 (0x07) Exception Status Read
Not available.

9.3 “User defined” Functions

9.3.1 (0x42) Slave Address Change

The instruments accepts query with function code 0x42 (change slave address) only of “Broadcast” type (address 0). Consequently, there is no answer.

Change Slave Address Query			
Byte	***Description***		***Value***
0	Broadcast Address		0x00
1	Function Code		0x42
2	Serial Number	MSB	
3			
4			
5		LSB	
6	New Slave Address		
7	CRC		
8			

9.4 Register Mapping

9.4.1 Holding registers

Registers from address 0 to 7 are compatible with the registers of the old instrument, in order to assure the backwards compatibility. The one described are the ones of the KILO (T).
Registers from address 70 to 79 specific for FLASH.
Registers from address 8 to 69 and from 132 to 139 are reserved for future expansions.

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
0	Integer Word	CT Ratio	1-9999 [A/A]	
1	Integer Word	VT Ratio	1-9999 [V/V]	
2	Integer Word	AVG Integration Time	1-60 [min]	
3		NOT USED		Return undefined valued, if read. Written values will be ignored.
4		NOT USED		Return undefined valued, if read. Written values will be ignored.
5		NOT USED		Return undefined valued, if read. Written values will be ignored.
6		NOT USED		Return undefined valued, if read. Written values will be ignored.
7	Integer Word	Digital Outputs Watchdog	0-65535 [min]	0 = Watchdog disabled
8 : 69		RESERVED		Return undefined valued, if read. Don't write in this area.
70	Bitmapped Word	Words/Bytes swap flags	○○○○ ○○○⦿ ○○○○ ○○○⦿ **Swap bytes**: 0 ≡ Standard; 1≡ Swapped ○○○○ ○○⦿○ ○○○○ ○○⦿○ **Swap words**: 0 ≡ Standard; 1≡ Swapped ○○○○ ○⦿○○ ○○○○ ○⦿○○ **Swap doublewords**: 0 ≡ Standard; 1≡ Swapped ○○○○ ⦿○○○ ○○○○ ⦿○○○ **Swap words in float values**: 0 ≡ Standard; 1≡ Swapped ⦿⦿⦿⦿ ○○○○ ⦿⦿⦿⦿ ○○○○ **Not Allocated** (Must be set to 0)	Standard means Motorola like and Swapped means Intel like. The same bit combination must be written in both low and high part of register. In this manner the "byte swap" setting is meaningless for this register.
71	Integer Word	Tx delay time	0-100 [s/100]	

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
72	Bitmapped Word	Network type	○○○○ ○○○○ ○○○○ ○○○⊙ **Network type**: 0 ≡ 4 wires (Star); 1 ≡ 3 wires (Delta) ○○○○ ○○○○ ○○○○ ○○⊙○ **Import/Export**: 0 ≡ Export disabled (2 quadrants); 1 ≡ Export enabled (4 quadrants) ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙○○ **Not Allocated**	
73	Integer Word	CT Primary	1-10000 [A]	
74	Integer Word	CT Secondary	1 or 5 [A]	
75 76	Integer (4 bytes)	VT Primary	1-400000 [V]	
77	Integer Word	VT Secondary	1-999 [V]	
78	Integer Word	AVG/MD powers integration time	1-60 [min]	
79	Integer Word	Counters hold time	1-60 [min]	
80	Integer Word	Analog out 1 - Quantity index	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Main Index**: (see tables on next paragraph) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Sub Index:** (see tables on next paragraph)	Accessing this register cause an exception response if 4-20mA option is not present.
81	Integer Word	Analog out 1 - Mode		Accessing this register cause an exception response if 4-20mA option is not present.
82 83	Float IEEE754	Analog out 1 - Scale begin value		Accessing this register cause an exception response if 4-20mA option is not present.
84 85	Float IEEE754	Analog out 1 - Scale end value		Accessing this register cause an exception response if 4-20mA option is not present.
86	Integer Word	Analog out 2 - Quantity index	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Main Index**: (see tables on next paragraph) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Sub Index:** (see tables on next paragraph)	Accessing this register cause an exception response if 4-20mA option is not present.
87	Integer Word	Analog out 2 - Mode		Accessing this register cause an exception response if 4-20mA option is not present.
88 89	Float IEEE754	Analog out 2 - Scale begin value		Accessing this register cause an exception response if 4-20mA option is not present.
90 91	Float IEEE754	Analog out 2 - Scale end value		Accessing this register cause an exception response if 4-20mA option is not present.

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
92	Bitmapped Word	Digital out 1 - Configuration	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Mode**: 00 ≡ Pulse; 01 ≡ Alarm; 10 ≡ Remote; 11 ≡ Not allowed ○○○○ ○○○○ ○○○○ ○⊙○○ - **Polarity**: 0 ≡ Normally opened; 1 ≡ Normally closed ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
93	Bitmapped Word	Digital out 2 - Configuration	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Mode**: 00 ≡ Pulse; 01 ≡ Alarm; 10 ≡ Remote; 11 ≡ Not allowed ○○○○ ○○○○ ○○○○ ○⊙○○ - **Polarity**: 0 ≡ Normally opened; 1 ≡ Normally closed ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
94	Integer Word	Digital Outputs Watchdog	0-65535 [min]	0 = Watchdog disabled
95	Integer Word	Alarm 1 - Quantity index	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Main Index**: (see tables on next paragraph) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Sub Index:** (see tables on next paragraph)	
96	Bitmapped Word	Alarm 1 - Mode	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Alarm coil driving mode**: 00 ≡ Normal 01 ≡ Pulsed 10 ≡ Not allowed 11 ≡ Not allowed ○○○○ ○○○○ ○○○○ ○⊙○○ **Alarm type:** 0 ≡ Min; 1≡ Max ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
97	Float IEEE754	Alarm 1 - Threshold		
99	Integer Word	Alarm 1 - Histeresys	0-99 [%]	
100	Integer Word	Alarm 1 - Latency	1-99 [s]	
101	Integer Word	Alarm 2 - Quantity index	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Main Index**: (see tables on next paragraph) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Sub Index:** (see tables on next paragraph)	

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
102	Bitmapped Word	Alarm 2 - Mode	○○○○ ○○○○ ○○○○ ○○⊙⊙ **Alarm coil driving mode**: 00 ≡ Normal 01 ≡ Pulsed 10 ≡ Not allowed 11 ≡ Not allowed ○○○○ ○○○○ ○○○○ ○⊙○○ **Alarm type:** 0 ≡ Min; 1≡ Max ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated**	
103	Float IEEE754	Alarm 2 - Threshold		
105	Integer Word	Alarm 2 - Histeresys	0-99 [%]	
106	Integer Word	Alarm 2 - Latency	1-99 [s]	
107 : 118		RESERVED		Return undefined valued, if read. Don't write in this area.
119	Bitmapped Word	Network type (extended)	○○○○ ○○○○ ○○○○ ○⊙⊙⊙ **Network type**: 0-5 0 ≡ 1P 2W, 1 ≡ 2P 2W, 2 ≡ 3P 4W, 3 ≡ 3P_3W, 4 ≡ 3P-b 4W, 5 ≡ 3P-b 3W ○⊙⊙⊙ ⊙⊙⊙⊙ ⊙⊙⊙⊙ ⊙○○○ **Not Allocated** ⊙○○○ ○○○○ ○○○○ ○○○○ **Import/Export**: 0 ≡ Export disabled (2 quadrants); 1 ≡ Export enabled (4 quadrants)	
120	Bitmapped Word	Pulse Out 1 - Quantity selection	○○○○ ○○○⊙ ○○○○ ○○○○ **Measurement scaling**: 0=scaled to signal at primary side of CT/VT; 1=scaled to signal at secondary side of CT/VT; ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Measurement selection:** 0-7 0=P+, 1=P-, 2=Qind+, 3=Qcap+, 4=Qind-, 5=Qcap-, 6=S+, 7=S- ⊙⊙⊙⊙ ⊙⊙⊙○ ○○○○ ○○○○ **Not Allocated**	
121	Integer Word	Pulse Out 1 - Pulse weight / Pulse Duration	⊙⊙⊙⊙ ⊙⊙⊙⊙ ○○○○ ○○○○ **Pulse Weight**: 0-7 (weight = 10^ (n-1) Wh) ○○○○ ○○○○ ⊙⊙⊙⊙ ⊙⊙⊙⊙ **Pulse Width**: 5-90 (mS * 10)	

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
122	Bitmapped Word	Pulse Out 2 - Quantity selection	○○○○ ○○○⦿ ○○○○ ○○○○ **Measurement scaling**: 0=scaled to signal at primary side of CT/VT; 1=scaled to signal at secondary side of CT/VT; ○○○○ ○○○○ ⦿⦿⦿⦿ ⦿⦿⦿⦿ **Measurement selection:** 0-7 0=P+, 1=P-, 2=Qind+, 3=Qcap+, 4=Qind-, 5=Qcap-, 6=S+, 7=S- ⦿⦿⦿⦿ ⦿⦿⦿○ ○○○○ ○○○○ **Not Allocated**	
123	Integer Word	Pulse Out 2 - Pulse weight / Pulse Duration	⦿⦿⦿⦿ ⦿⦿⦿⦿ ○○○○ ○○○○ **Pulse Weight**: 0-7 (weight = 10^ (n-1) Wh) ○○○○ ○○○○ ⦿⦿⦿⦿ ⦿⦿⦿⦿ **Pulse Width**: 5-90 (mS * 10)	
124 : 127	RESERVED		Return undefined valued, if read. Don't write in this area.	RESERVED
128	Bitmapped Word	Digital out 1 - Configuration	○○○○ ○○○○ ○○○○ ○○⦿⦿ **Mode**: 00 ≡ Pulse; 01 ≡ Alarm; 10 ≡ Remote; 11 ≡ Tariff ○○○○ ○○○○ ○○○○ ○⦿○○ **Polarity**: 0 ≡ Normally opened; 1 ≡ Normally closed ⦿⦿⦿⦿ ⦿⦿⦿⦿ ⦿⦿⦿⦿ ⦿○○○ **Not Allocated**	
129	Bitmapped Word	Digital out 2 - Configuration	○○○○ ○○○○ ○○○○ ○○⦿⦿ **Mode**: 00 ≡ Pulse; 01 ≡ Alarm; 10 ≡ Remote; 11 ≡ Tariff ○○○○ ○○○○ ○○○○ ○⦿○○ **Polarity**: 0 ≡ Normally opened; 1 ≡ Normally closed ⦿⦿⦿⦿ ⦿⦿⦿⦿ ⦿⦿⦿⦿ ⦿○○○ **Not Allocated**	
130 .. 139		RESERVED		Return undefined valued, if read. Don't write in this area.

9.4.2 Parameter selection tables

The following tables allow the selection of the parameters to be associated to the alarms and to analog outputs.
The Main index and the Sub index have to be specified in binary format (HEX).

All cells identified with [hatched box] are available only in Import/Export configuration.

3Ph-4W																				
		Sub Index																		
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Main Index	0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	1	×	U_{LN}	U_{LL}	×	×	U_{1N}	U_{2N}	U_{3N}	U_{12}	U_{23}	U_{31}	×	×	×	×	×	×	$U_{1N \div 3N}$	$U_{12 \div 31}$
	2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	3	×	×	×	I_N	I_Σ	I_1	I_2	I_3	×	×	×	×	×	×	×	×	×	$I_{1 \div 3}$	×
	4	×	×	×	×	P_Σ	P_1	P_2	P_3	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
	5	×	×	×	×	Q_Σ	Q_1	Q_2	Q_3	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
	6	×	×	×	×	S_Σ	S_1	S_2	S_3	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
	7	×	×	×	×	PF_Σ	PF_1	PF_2	PF_3	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	$THD_{U_{1N}}$	$THD_{U_{2N}}$	$THD_{U_{3N}}$	×	×	×	×	×	×	×	×	×	$THD_{U_{1N \div 3N}}$	$THD_{U_{12 \div 31}}$
	9	×	×	×	×	×	THD_{I_1}	THD_{I_2}	THD_{I_3}	×	×	×	×	×	×	×	×	×	$THD_{I_{1 \div 3}}$	×

3Ph-3W																				
		Sub Index																		
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Main Index	0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	1	×	×	U_{LL}	×	×	×	×	×	U_{12}	U_{23}	U_{31}	×	×	×	×	×	×	×	$U_{12 \div 31}$
	2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	3	×	×	×	×	I_Σ	I_1	I_2	I_3	×	×	×	×	×	×	×	×	×	$I_{1 \div 3}$	×
	4	×	×	×	×	P_Σ	×	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
	5	×	×	×	×	Q_Σ	×	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
	6	×	×	×	×	S_Σ	×	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
	7	×	×	×	×	PF_Σ	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	×	×	×	$THD_{U_{12}}$	$THD_{U_{23}}$	$THD_{U_{31}}$	×	×	×	×	×	×	×	$THD_{U_{12 \div 31}}$
	9	×	×	×	×	×	THD_{I_1}	THD_{I_2}	THD_{I_3}	×	×	×	×	×	×	×	×	×	$THD_{I_{1 \div 3}}$	×

3Ph-4W Balanced

Main Index \ Sub Index		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Main Index	0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	1	×	×	×	×	×	U_{1N}	×	×	×	×	×	×	×	×	×	×	×	×	×
	2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	3	×	×	×	×	×	I_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	4	×	×	×	×	P_Σ	P_1	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
	5	×	×	×	×	Q_Σ	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
	6	×	×	×	×	S_Σ	S_1	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
	7	×	×	×	×	×	PF_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	$THD_{U_{1N}}$	×	×	×	×	×	×	×	×	×	×	×	×	×
	9	×	×	×	×	×	THD_{I_1}	×	×	×	×	×	×	×	×	×	×	×	×	×

3Ph-3W Balanced

Main Index \ Sub Index		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Main Index	0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	1	×	×	×	×	×	×	×	×	U_{12}	×	×	×	×	×	×	×	×	×	×
	2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	3	×	×	×	×	×	×	×	I_3	×	×	×	×	×	×	×	×	×	×	×
	4	×	×	×	×	P_Σ	×	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
	5	×	×	×	×	Q_Σ	×	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
	6	×	×	×	×	S_Σ	×	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
	7	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	×	×	×	$THD_{U_{12}}$	×	×	×	×	×	×	×	×	×	×
	9	×	×	×	×	×	×	×	THD_{I_3}	×	×	×	×	×	×	×	×	×	×	×

1Ph-2W

Main Index	Sub Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	1	×	×	×	×	×	U_{1N}	×	×	×	×	×	×	×	×	×	×	×	×	×
	2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	3	×	×	×	×	×	I_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	4	×	×	×	×	×	P_1	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
	5	×	×	×	×	×	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
	6	×	×	×	×	×	S_1	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
	7	×	×	×	×	×	PF_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	$THD_{U_{1N}}$	×	×	×	×	×	×	×	×	×	×	×	×	×
	9	×	×	×	×	×	THD_{I_1}	×	×	×	×	×	×	×	×	×	×	×	×	×

2Ph-2W

Main Index	Sub Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	0	OFF	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	1	×	×	×	×	×	×	×	×	U_{12}	×	×	×	×	×	×	×	×	×	×
	2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	3	×	×	×	×	×	I_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	4	×	×	×	×	×	P_1	×	×	×	×	×	$P_{IMP_{AVG}}$	$P_{EXP_{AVG}}$	×	×	×	×	×	×
	5	×	×	×	×	×	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP_{AVG}}$	$Q_{C\ IMP_{AVG}}$	$Q_{L\ EXP_{AVG}}$	$Q_{C\ EXP_{AVG}}$	×	×
	6	×	×	×	×	×	S_1	×	×	×	×	×	$S_{IMP_{AVG}}$	$S_{EXP_{AVG}}$	×	×	×	×	×	×
	7	×	×	×	×	×	PF_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	×	×	×	$THD_{U_{12}}$	×	×	×	×	×	×	×	×	×	×
	9	×	×	×	×	×	THD_{I_1}	×	×	×	×	×	×	×	×	×	×	×	×	×

9.4.3 Flash N Input registers

In this chapter the FLASH original registers are listed with all the available measurements.

Addr.	Type	Description	Unit	Symbol	System config / Notes
200 201	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{1N}}$ $THD_{U_{12}}$	⇒ **3P4W, 3P-b 4W, 1P2W** ⇒ **3P3W, 3P-b 3W, 2P2W**
202 203	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{2N}}$ $THD_{U_{23}}$	⇒ **3P4W** ⇒ **3P3W**
204 205	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{3N}}$ $THD_{U_{31}}$	⇒ **3P4W** ⇒ **3P3W**
206 207	Float IEEE754	Line current, THD	%	THD_{I_1}	⇒ **3P4W, 3P3W, 3P-b 4W, 1P2W**
208 209	Float IEEE754	Line current, THD	%	THD_{I_2}	⇒ **3P4W , 3P3W**
210 211	Float IEEE754	Line current, THD	%	THD_{I_3}	⇒ **3P4W , 3P3W, 3P-b 3W**
212 213	Float IEEE754	Voltage Input Frequency	Hz	f_{1N} f_{12}	⇒ **3P4W, 3P-b 4W, 1P2W** ⇒ **3P3W, 3P-b 3W, 2P2W**
214 215	Float IEEE754	Phase to Neutral Voltage, RMS Amplitude	V	U_{1N}	⇒ **3P4W, 3P-b 4W, 1P2W**
216 217	Float IEEE754	Phase to Neutral Voltage, RMS Amplitude	V	U_{2N}	⇒ **3P4W**
218 219	Float IEEE754	Phase to Neutral Voltage, RMS Amplitude	V	U_{3N}	⇒ **3P4W**
220 221	Float IEEE754	Phase to Phase Voltage, RMS Amplitude	V	U_{12}	⇒ **3P4W, 3P3W, 3P-b 3W, 2P2W**
222 223	Float IEEE754	Phase to Phase Voltage, RMS Amplitude	V	U_{23}	⇒ **3P4W, 3P3W**
224 225	Float IEEE754	Phase to Phase Voltage, RMS Amplitude	V	U_{31}	⇒ **3P4W, 3P3W**
226 227	Float IEEE754	Line current, RMS Amplitude	A	I_1	⇒ **3P4W, 3P3W, 3P-b 4W, 1P2W**
228 229	Float IEEE754	Line current, RMS Amplitude	A	I_2	⇒ **3P4W , 3P3W**
230 231	Float IEEE754	Line current, RMS Amplitude	A	I_3	⇒ **3P4W , 3P3W, 3P-b 3W**
232 233	Float IEEE754	Neutral Current, RMS Amplitude	A	I_N	⇒ **3P4W**
234 235	Float IEEE754	Phase Active Power (+/-)	W	P_1	⇒ **3P4W, 3P-b 4W, 1P2W**
236 237	Float IEEE754	Phase Active Power (+/-)	W	P_2	⇒ **3P4W**
238 239	Float IEEE754	Phase Active Power (+/-)	W	P_3	⇒ **3P4W**
240 241	Float IEEE754	Phase Reactive Power (+/-)	var	Q_1	⇒ **3P4W, 3P-b 4W, 1P2W**
242 243	Float IEEE754	Phase Reactive Power (+/-)	var	Q_2	⇒ **3P4W**

Addr.	Type	Description	Unit	Symbol	System config / Notes
244 245	Float IEEE754	Phase Reactive Power (+/-)	var	Q_3	⇒ 3P4W
246 247	Float IEEE754	Phase Apparent Power	VA	S_1	⇒ 3P4W, 3P-b 4W, 1P2W
248 249	Float IEEE754	Phase Apparent Power	VA	S_2	⇒ 3P4W
250 251	Float IEEE754	Phase Apparent Power	VA	S_3	⇒ 3P4W
252 253	Float IEEE754	Phase Power Factor (+/-)	-	λ_1	⇒ 3P4W, 3P-b 4W, 1P2W
254 255	Float IEEE754	Phase Power Factor (+/-)	-	λ_2	⇒ 3P4W
256 257	Float IEEE754	Phase Power Factor (+/-)	-	λ_3	⇒ 3P4W
258 259	Float IEEE754	Phase Voltage, Mean THD	%	THD_{U_λ} THD_{U_Δ}	⇒ 3P4W ⇒ 3P3W
260 261	Float IEEE754	Line current, Mean THD	%	THD_{I_Σ}	⇒ 3P4W, 3P3W
262 263	Float IEEE754	Phase to Neutral Mean Voltage, RMS Amplitude	V	U_λ	⇒ 3P4W
264 265	Float IEEE754	Phase to Phase Mean Voltage, RMS Amplitude	V	U_Δ	⇒ 3P4W, 3P3W
266 267	Float IEEE754	Three phase current, RMS Amplitude	A	I_Σ	⇒ 3P4W, 3P3W
268 269	Float IEEE754	Total Active Power (+/-)	W	P_Σ	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
270 271	Float IEEE754	Total reactive power (+/-)	var	Q_Σ	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
272 273	Float IEEE754	Total apparent power	VA	S_Σ	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
274 275	Float IEEE754	Total power factor (+/-)	-	λ_Σ	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
276 277	Float IEEE754	Total import Active Power, AVG	W	$P_m +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
278 279	Float IEEE754	Total import inductive power, AVG	var	$Q_{m\ ind} +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
280 281	Float IEEE754	Total import capacitive power, AVG	var	$Q_{m\ cap} +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
282 283	Float IEEE754	Total import apparent power, AVG	VA	$S_m +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
284 285	Float IEEE754	Total export Active Power, AVG	W	$P_m -$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
286 287	Float IEEE754	Total export inductive power, AVG	var	$Q_{m\ ind} -$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
288 289	Float IEEE754	Total export capacitive power, AVG	var	$Q_{m\ cap} -$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
290 291	Float IEEE754	Total export apparent power, AVG	VA	$S_m -$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only

Addr.	Type	Description	Unit	Symbol	System config / Notes
292 293	Float IEEE754	Total import Active Power, MD	W	$P_{Max}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
294 295	Float IEEE754	Total import inductive power, MD	var	$Q_{Max\ ind}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
296 297	Float IEEE754	Total import capacitive power, MD	var	$Q_{Max\ cap}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
298 299	Float IEEE754	Total import apparent power, MD	VA	$S_{Max}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
300 301	Float IEEE754	Total export Active Power, MD	W	$P_{Max}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
302 303	Float IEEE754	Total export inductive power, MD	var	$Q_{Max\ ind}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
304 305	Float IEEE754	Total export capacitive power, MD	var	$Q_{Max\ cap}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
306 307	Float IEEE754	Total export apparent power, MD	VA	$S_{Max}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
308	Integer Word	Hold counters, in progress interval elapsed time	s		
309	Integer Word	Hold counters, last expired interval duration	s		
310	Integer Word	Hold counters, last expired interval ID			
311 312	Integer Double Word	Hold counter, import active energy	kWh/10	E_a+_H	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
313 314	Integer Double Word	Hold counter, import inductive energy	kvarh/10	$E_{r\ ind}+_H$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
315 316	Integer Double Word	Hold counter, import capacitive energy	kvarh/10	$E_{r\ cap}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
317 318	Integer Double Word	Hold counter, import apparent energy	kVAh/10	E_S+_H	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
319 320	Integer Double Word	Hold counter, export active energy	kWh/10	E_a-_H	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
321 322	Integer Double Word	Hold counter, export inductive energy	kvarh/10	$E_{r\ ind}-_H$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
323 324	Integer Double Word	Hold counter, export capacitive energy	kvarh/10	$E_{r\ cap}-_H$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
325 326	Integer Double Word	Hold counter, export apparent energy	kVAh/10	E_S-_H	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
327 328	Integer (4 bytes)	Import active energy	kWh/10	E_a+	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W

Addr.	Type	Description	Unit	Symbol	System config / Notes
329 330	Integer (4 bytes)	Import inductive energy	kvarh/10	$E_{r\ ind}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
331 332	Integer (4 bytes)	Import capacitive energy	kvarh/10	$E_{r\ cap}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
333 334	Integer (4 bytes)	Import apparent energy	kVAh/10	E_S+	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
335 336	Integer (4 bytes)	Export active energy	kWh/10	E_a-	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
337 338	Integer (4 bytes)	Export inductive energy	kvarh/10	$E_{r\ ind}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
339 340	Integer (4 bytes)	Export capacitive energy	kvarh/10	$E_{r\ cap}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
341 342	Integer (4 bytes)	Export apparent energy	kVAh/10	E_S-	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
343 344	Integer (4 bytes)	Life Timer	S	t	
345 346 347 348	Integer (8 bytes)	Import active energy (Hi Resolution)	Wh/10	E_a+	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
349 350 351 352	Integer (8 bytes)	Import inductive energy (Hi Resolution)	varh/10	$E_{r\ ind}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
353 354 355 356	Integer (8 bytes)	Import capacitive energy (Hi Resolution)	varh/10	$E_{r\ cap}+$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
357 358 359 360	Integer (8 bytes)	Import apparent energy (Hi Resolution)	VAh/10	E_S+	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
361 362 363 364	Integer (8 bytes)	Export active energy (Hi Resolution)	Wh/10	E_a-	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
365 366 367 368	Integer (8 bytes)	Export inductive energy (Hi Resolution)	varh/10	$E_{r\ ind}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
369 370 371 372	Integer (8 bytes)	Export capacitive energy (Hi Resolution)	varh/10	$E_{r\ cap}-$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
373 374 375 376	Integer (8 bytes)	Export apparent energy (Hi Resolution)	VAh/10	E_S-	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only

9.4.4 Input Registers (backward compatibility area)

In this area the registers guaranteeing the compatibility with the previous ELECTREX products are listed. This allows compatibility with written software. The considered registers are KILO (T)'s.

Addr.	Type	Description	Unit	Symbol	Wirings / Notes
0 1	Float IEEE754	Three-phase voltage, RMS amplitude	V	U_{Δ}	⇒ **3P4W, 3P3W**
2 3	Float IEEE754	Three-phase current, RMS amplitude	A	I_{Σ}	⇒ **3P4W, 3P3W**
4 5	Float IEEE754	Total Active Power (+/-)	W	P_{Σ}	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
6 7	Float IEEE754	Total reactive power (+/-)	var	Q_{Σ}	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
8 9	Float IEEE754	Total apparent power	VA	S_{Σ}	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
10 11	Float IEEE754	Total power factor (+/-)	-	λ_{Σ}	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
12 13	Float IEEE754	Total import Active Power, AVG	W	$P_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
14 15	Float IEEE754	Total import apparent power, AVG	VA	$S_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
16 17	Float IEEE754	Total import Active Power, MD	W	$P_{Max} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
18 19	Float IEEE754	Total import apparent power, MD	VA	$S_{Max} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
20 21	Float IEEE754	Import active energy	KWh	$E_a +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
22 23		NOT USED			Return undefined valued, if read.
24 25	Float IEEE754	Import inductive energy	Kvarh	$E_{r\ ind} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
26 27	Integer (4 bytes)	Serial number		S/N	
28 29	Float IEEE754	Phase to neutral RMS Voltage	V	U_{1N}	⇒ **3P4W, 3P-b 4W, 1P2W**
		Phase to phase RMS Voltage		U_{12}	⇒ **3P3W, 3P-b 3W, 2P2W**
30 31	Float IEEE754	Phase to neutral RMS Voltage	V	U_{2N}	⇒ **3P4W**
		Phase to phase RMS Voltage		U_{23}	⇒ **3P3W**
32 33	Float IEEE754	Phase to neutral RMS Voltage	V	U_{3N}	⇒ **3P4W**
		Phase to phase RMS Voltage		U_{31}	⇒ **3P3W**
34 35	Float IEEE754	Line current, RMS amplitude	A	I_1	⇒ **3P4W, 3P3W, 3P-b 4W, 1P2W**
36 37	Float IEEE754	Line current, RMS amplitude	A	I_2	⇒ **3P4W , 3P3W**

Addr.	Type	Description	Unit	Symbol	Wirings / Notes
38 39	Float IEEE754	Line current, RMS amplitude	A	I_3	⇒ **3P4W , 3P3W, 3P-b 3W**
40 41	Float IEEE754	Phase Active Power (+/-)	W	P_1	⇒ **3P4W, 3P-b 4W, 1P2W**
42 43	Float IEEE754	Phase Active Power (+/-)	W	P_2	⇒ **3P4W**
44 45	Float IEEE754	Phase Active Power (+/-)	W	P_3	⇒ **3P4W**
46 47	Float IEEE754	Voltage Input Frequency	Hz	f_{1N} f_{12}	⇒ **3P4W** ⇒ **3P3W**
48 49	Float IEEE754	Phase reactive power (+/-)	var	Q_1	⇒ **3P4W, 3P-b 4W, 1P2W**
50 51	Float IEEE754	Phase reactive power (+/-)	var	Q_2	⇒ **3P4W**
52 53	Float IEEE754	Phase reactive power (+/-)	var	Q_3	⇒ **3P4W**
54 55	Float IEEE754	Phase apparent power	VA	S_1	⇒ **3P4W, 3P-b 4W, 1P2W**
56 57	Float IEEE754	Phase apparent power	VA	S_2	⇒ **3P4W**
58 59	Float IEEE754	Phase apparent power	VA	S_3	⇒ **3P4W**
60 61	Float IEEE754	Phase reactive power (+/-)	var	Q_1	⇒ **3P4W, 3P-b 4W, 1P2W**
62 63	Float IEEE754	Phase reactive power (+/-)	var	Q_2	⇒ **3P4W**
64 65	Float IEEE754	Phase reactive power (+/-)	var	Q_3	⇒ **3P4W**
66 67	Float IEEE754	Phase power factor (+/-)	-	λ_1	⇒ **3P4W, 3P-b 4W, 1P2W**
68 69	Float IEEE754	Phase power factor (+/-)	-	λ_2	⇒ **3P4W**
70 71	Float IEEE754	Phase power factor (+/-)	-	λ_3	⇒ **3P4W**
72 73		NOT AVAILABLE			Return undefined valued, if read.
74 75	Float IEEE754	Export active energy	kWh	$E_a -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
76 77		NOT USED			Return undefined valued, if read.
78 79	Float IEEE754	Export capacitive energy	kvar	$E_{r\ cap} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
80 81	Float IEEE754	Export inductive energy	kvar	$E_{r\ ind} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**

Addr.	Type	Description	Unit	Symbol	Wirings / Notes
82 83		NOT USED			Return undefined valued, if read.
84 85	Float IEEE754	Total import capacitive energy	kvar	$E_{r\ cap}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
86 : 93		NOT AVAILABLE			Return undefined valued, if read.
94 95	Float IEEE754	Total import inductive power, AVG	var	$Q_{m\ ind}+$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
96 : 125		NOT AVAILABLE			Return undefined valued, if read.
126 127	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{1N}}$ $THD_{U_{12}}$	⇒ **3P4W** ⇒ **3P3W**
128 129	Float IEEE754	Line current, THD	%	THD_{I_1}	⇒ **3P4W, 3P3W**
130 131	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{2N}}$ $THD_{U_{23}}$	⇒ **3P4W** ⇒ **3P3W**
132 133	Float IEEE754	Line current, THD	%	THD_{I_2}	⇒ **3P4W, 3P3W**
134 135	Float IEEE754	Phase to neutral Voltage, THD Phase to phase Voltage, THD	%	$THD_{U_{3N}}$ $THD_{U_{31}}$	⇒ **3P4W** ⇒ **3P3W**
136 137	Float IEEE754	Line current, THD	%	THD_{I_3}	⇒ **3P4W, 3P3W**
138 : 199		RESERVED			Return undefined valued, if read.

9.4.5 Coils (back compatibility)

Coils area compatible with the previous instruments:

Coils, back compatibility		
Address	*Description*	*Note:*
0	Clear AVG (1,3)	Reset all the power values in floating average
1	Clear AVG (1,3)	as 0001
2	Clear MD (1,3)	Reset all the power peak values
3	Clear MD (1,3)	as 0003
4	Clear energy counters (1)	Reset all the energy counters
5	Warm boot (1)	Reinitialize the instrument (does not reset the counters)
6	AVG/MD synchronization (1,3)	Synchronize the integration period
7	Clear MD (1,3)	as 0003
8	Not allocated	
9	Out 1 (3)	Controls output nr. 1 (if the alarm use is inhibited)
10	Out 2 (3)	Controls output nr. 2 (if the alarm use is inhibited)
11	Not allocated	
12	Digital outs watchdog enable (3)	Protection Timer on inputs in minutes
13	Not allocated	
14	Not allocated	
15	Not allocated	
16	Not allocated	
17	Swap words & bytes (2, 4)	Format Control of the memory stored data
18	Not allocated	

9.4.6 FLASH coils

Proprietary FLASH D coils area.

FLASH Coils		
Address	***Description***	***Note:***
64	Swap bytes (5)	Data format control in memory
65	Swap words (5)	Data format control in memory
66	Reset (warm boot) (1,2)	Reinitialize the device (does not reset the counters)
67	Clear energy counters (1,2)	Reset all the energy counters
68	Power integration synchronization (1,2)	Synchronize the integration time.
69	Clear AVG powers (1,2)	Reset all the power value in moving average
70	Clear MD powers (1,2)	Reset all the power peak values
71	NOT USED (1)	

(1) Reading the coil the result is always 1.
(2) The command is triggered on the leading edge, that is when the coil is set to 1 (TRUE). It is not necessary to set the coil to 0 after setting it to 1.
(4) Negative logic, to be compatible with Kilo:
Coil = 1 ⇨ Swap Bytes = Swap Words = FALSE (Motorola like, as Modbus standard)
Coil = 0 ⇨ Swap Bytes = Swap Words = TRUE (Intel like).
The measurement resets “Swap Bytes” flag status (negative).
(5) If set to 1 (TRUE), it inverts the bytes order (or word order) respect to the Modbus standard (Motorola like).

10 Technical Characteristics

Measurement sections:

Volt Inputs:

500 Vrms phase-phase (crest factor max 1.7);
impedence 2,4Mohm

Amp Inputs:

5 Arms (crest factor max 1.7);
burden 0,5VA

Frequency: 45 ÷ 65 Hz

Accuracy: Class 1 on active energy, compliant with CEI EN 61036;

Alternate Voltage Sensitivity, Range and Accuracy			
Nominal Range	Sensitivity[1]	Range	Accuracy[2]
500 V	400 mV	500 V	0.06 Range ± 0.35 Reading

- Nota 1: Minimal Reading 20 V

- Nota 2: Accuracy guaranteed down to 50 V

Alternate Current Sensitivity, Range and Accuracy			
Nominal Range	Sensitivity[1]	Range	Accuracy[2]
5 A	5 mA	6 A	0.06 Range ± 0.35 Reading
1 A	0.5 mA	1 A	0.06 Range ± 0.35 Reading

- Note 1: Minimal reading 10 mA

- Note 2: Accuracy guaranteed down to 100 mA

Overload:

Volt Inputs: max 900 Vrms peak value for 1 second

Amp Inputs: max 100 Arms peak value for 1 s.

Maximum voltage to ground: for both voltage and current conductors the maximum voltage to ground is 350 Vrms.

Power Supply: separated power supply 85-265Vac/100-374Vdc or 24Vac/18-60Vdc depending on types. Maximum voltage to ground 265 Vrms

Power Consumption: 5 VA

Cabling: use category II cables.

Operating Temperature: from -20 to +60 °C

Relative Humidity (R.H.): max 95% without condensation

Applicable Regulations: Safety CEI EN 61010 class 2, category II, pollution class II. To be positioned in a protective electrical enclosure making the cabling not accessible.

Electromagnetic Compatibility: CEI EN 61326-1 A

Display: Backlit 256 segment LCD 63 x 65 mm a, with white LED lamp.

Automatic range adjustment: 2 current ranges

Offset: automatic amplifier offset adjustment

Counters: energy counters with 0.1 kWh resolution and maximum value 99,999,999.9 kWh (serial input).
Mount: DIN 96 x 96 mm.
Weight: 360 g (460 g with packaging).
Protection: IP51 on front, IP20 elsewhere.
Size: 96 x 96 x 90 mm (up to 105 mm max with options)
Outputs: 2 digital outputs for pulses or alerts (Din 43864 27 Vdc 27 mA)

<u>Options</u>

Galvanically Isolated RS485

Output isolation 1000 Vrms

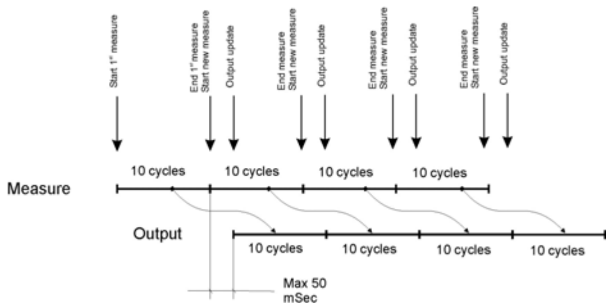
Galvanically Isolated RS232

Output isolation 1000 Vrms

Galvanically Isolated Analog 4-20 mA

Output isolation 1000 Vrms

Output: self supplied 0 to 20 mA on 500 Ohm max
Accuracy: < 0.2% of reading.
Stability: 200 ppm/°C
Latency: 50 ms maximum
Update frequency: 10 grid cycles frequency



11 Firmware Revisions

v1.11

- First release

12 Order codes

Instruments

Designation	Description	Code
FLASH N	Three-phase energy analyser **(Power supply 100/230 V)**	**PFE 405-50**
FLASH N 24	Three-phase energy analyser **(Power supply 24 V)**	**PFE 405-60**

Options

Designation	Description	Code
RS485 Interface (96)	Interface with opto-isolated RS485 port.	**PFE 420-00**
RS232 Interface (96)	Interface with opto-isolated RS232 port.	**PFE 421-00**
OUTPUT 2x 4-20 mA (96)	Double analogue output 4-20 or 0-20 mA programmable on all parameters.	**PFE 422-00**

13 DECLARATION OF CONFORMITY

Akse hereby declares that its range of products complies with the following directives
EMC 89/336/EEC 73/23CE 93/68 CE
and complies with the following product's standard **CEI EN 61326 – IEC 61326 CEI EN 61010 – IEC 1010**
he product has been tested in the typical wiring configuration and with peripherals conforming to the EMC directive and the LV directive.

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