X3M

Energy Data Manager

User Manual

Version 7 September 2005
The document can be modified without prior information.

ELECTREX
the energy saving technology

Index

INTRODUCTION

We thank you for choosing an Electrex instrument
We invite you to carefully read this instructions manual for the best use of the **X3M** 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
Electrex 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

Electrex accepts the return of instruments for repair **only** when authorized in advance. For instrument purchased directly, the repair authorization must be requested to Electrex directly by using the enclosed RMA form. We recommend otherwise to contact 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 Electrex 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: **Electrex S.r.l.**
  Via Claudia 96 - 41056 Savignano s/P (MO) - 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 tems.	

Space reserved to ELECTREX

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 ELECTREX 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 unfavorable conditions.
  4) After serious damage occurred during transport

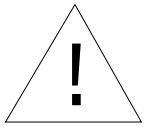
The instruments must be installed in respect of all the local regulations.

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.

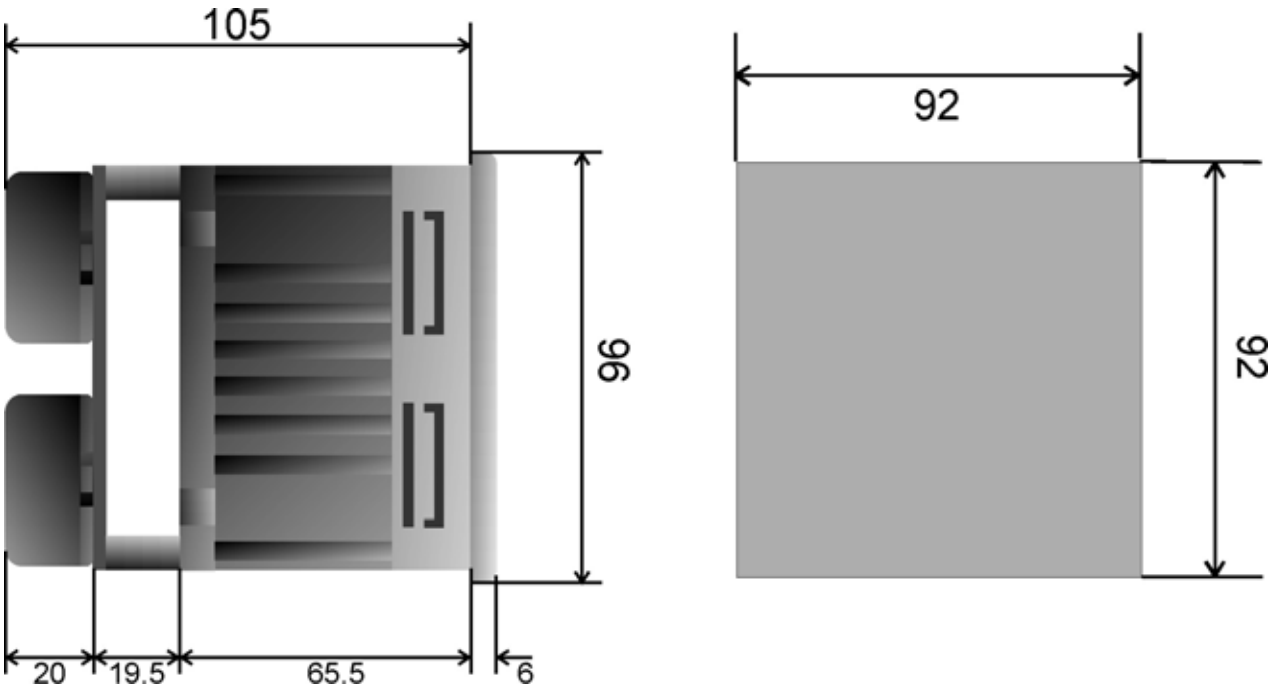
Precautions: Failure to respect the following instructions may irreversibly damage to the instrument.



- 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.

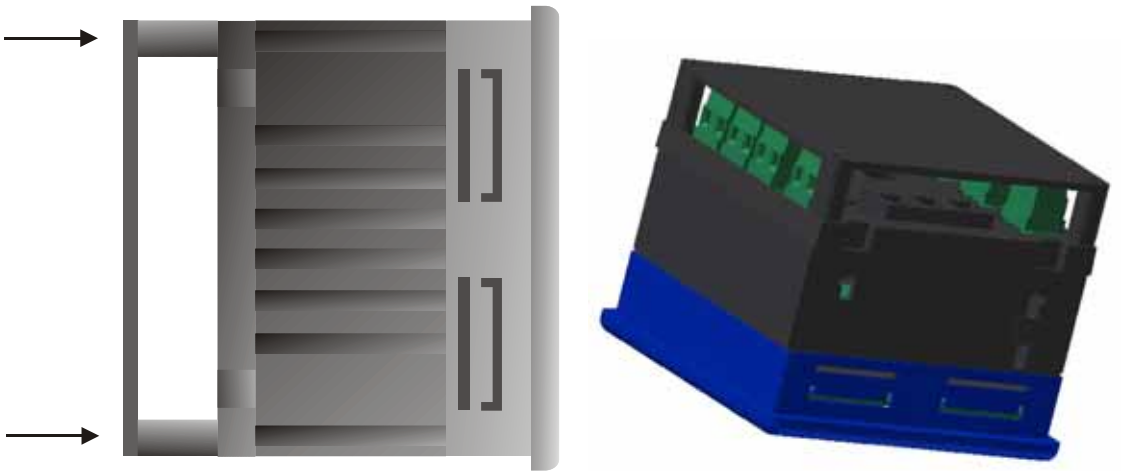
3 Mounting

3.1 Dimensions (mm)

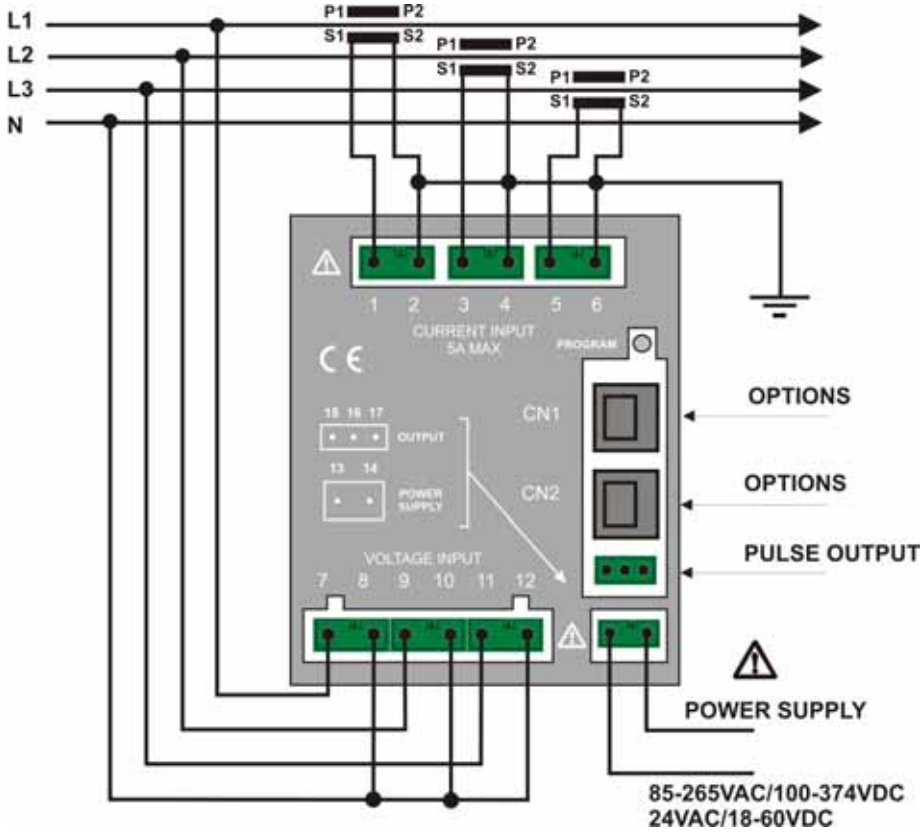


3.2 Fixing and blocking

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.

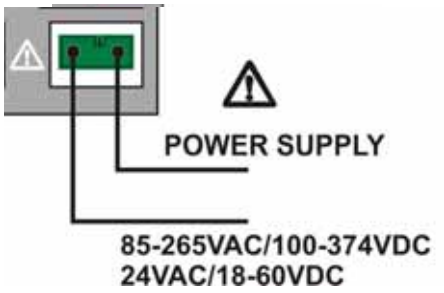


4 Wiring Diagrams



4.1 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 2,5 mm^2.



4.2 Measurement Connections

4.2.1 Voltage connection

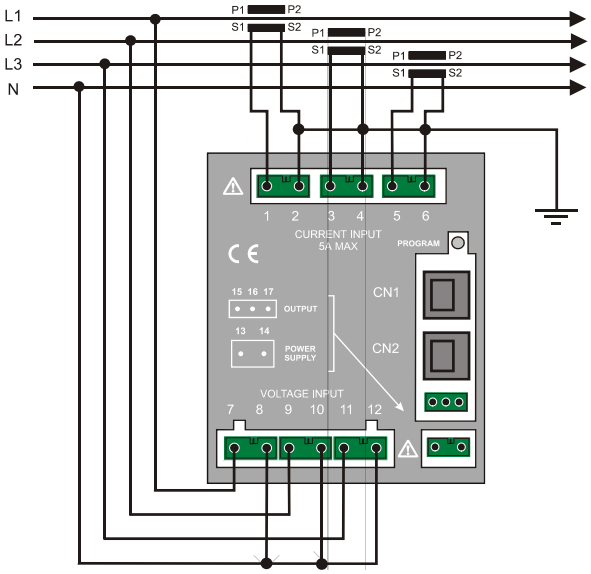
Use cables with max cross-section of 2,5 mm^2 and connect them to the terminals marked VOLTAGE INPUT on the instrument according to the applicable diagrams that follow.

4.2.2 Current connection

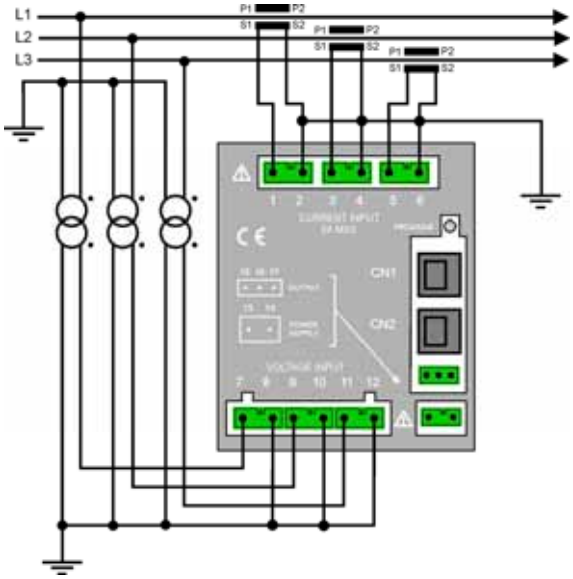
It is necessary to use external CTs with a primary rating adequate to the load to be metered and with a 5A secondary rating. The number of CTs to be used (1, 2 or 3) depends upon the type of network.
Connect the CT output(s) to the terminals marked CURRENT INPUT of the instrument according to the applicable 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 2,5 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.

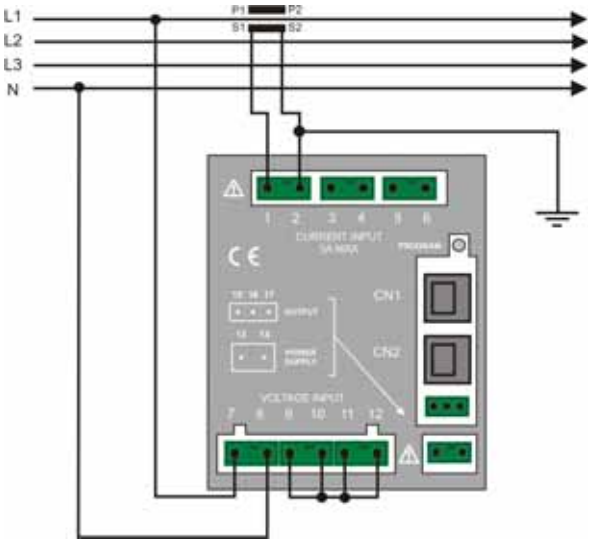
4.2.3 4W Star Connection (4 wires)



Low voltage 3 CTs
Configuration 3P 4W



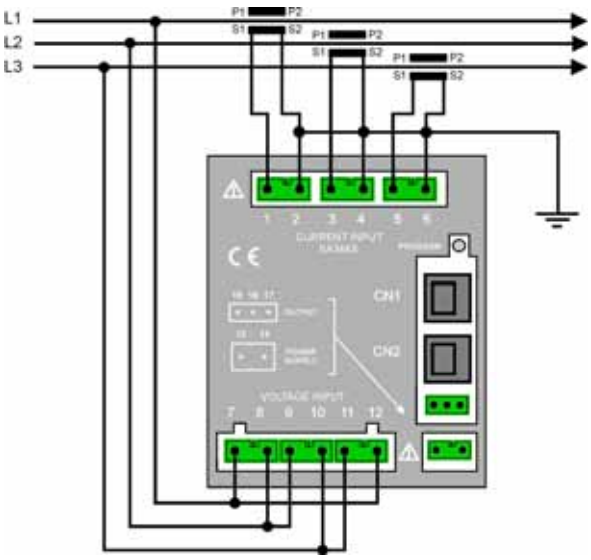
Average or high voltage 3 TCs 3 CTs
Configuration 3P 4W



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

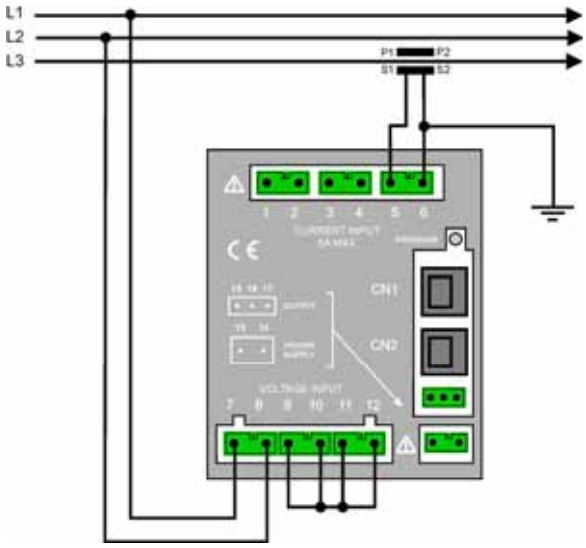
4.2.4 3W Delta Connection (3 wires)

Connection with 3 CTs



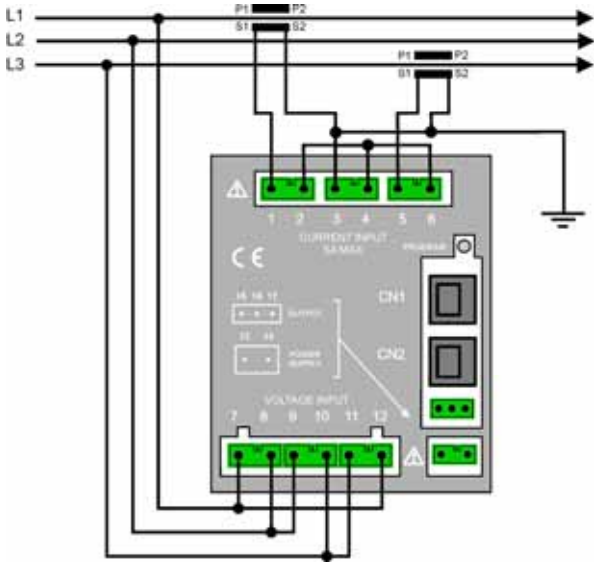
Low Voltage 3 CTs
3P 3W Configuration

Connection with 1CT

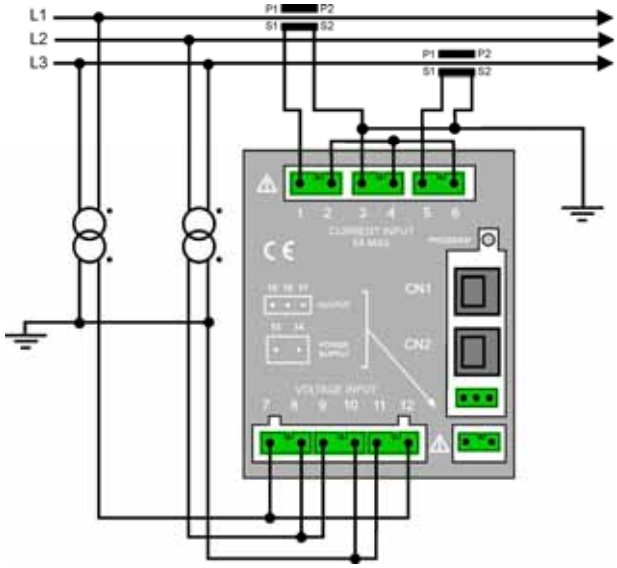


Low Voltage 1 CT (Balanced and symmetric)
3P-b 3W Configuration

4.2.4.1 L1 L3 Phase Connection with 2 CTs

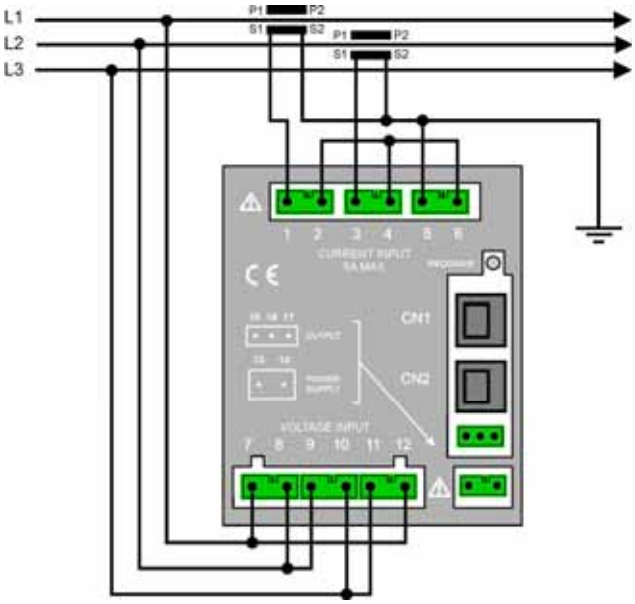


Low Voltage
3P 3W Configuration

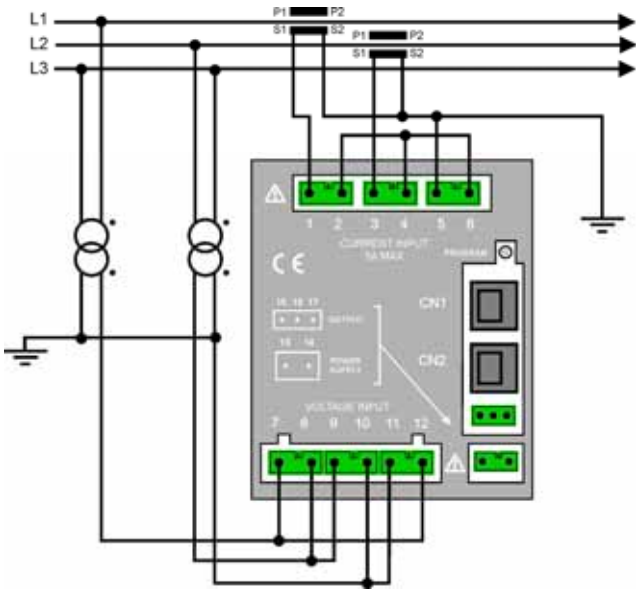


Average or High Voltage
3P 3W Configuration

4.2.4.2 L1 L2 Phase Connection with 2 CTs

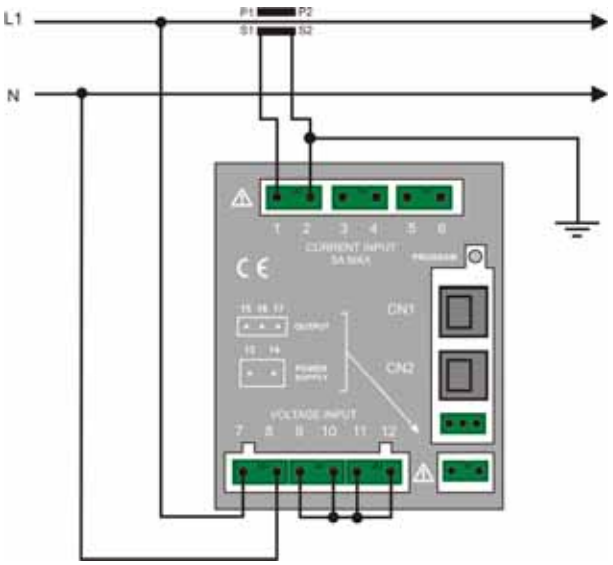


Low Voltage 2 CTs
3P 3W Configuration



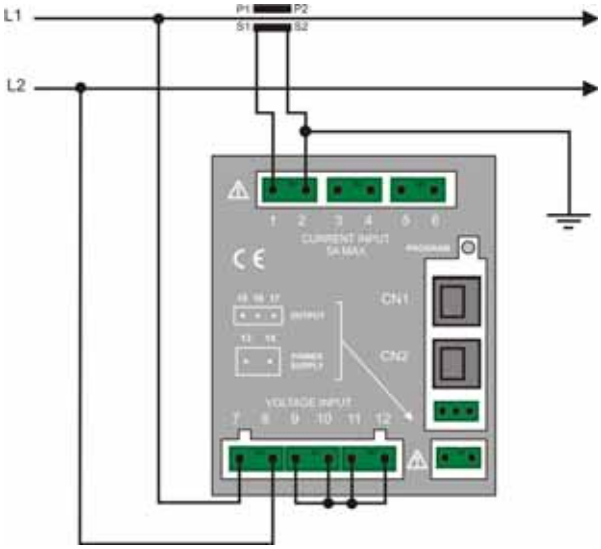
Average or High Voltage 2 CTs 2 TCs
3P 3W Configuration

4.2.5 2 Wire Connection (single phase)



Low Voltage Neutral phase 1 Ct
1P 2W Configuration

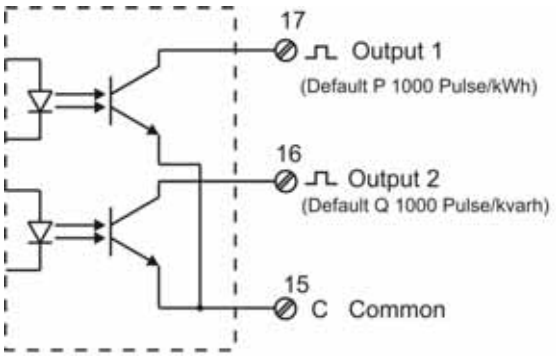
4.2.6 2 Wire Connection (double phase)

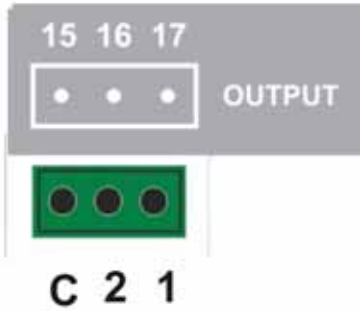


Low Voltage phase 1 CT
2P 2W Configuration

4.3 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

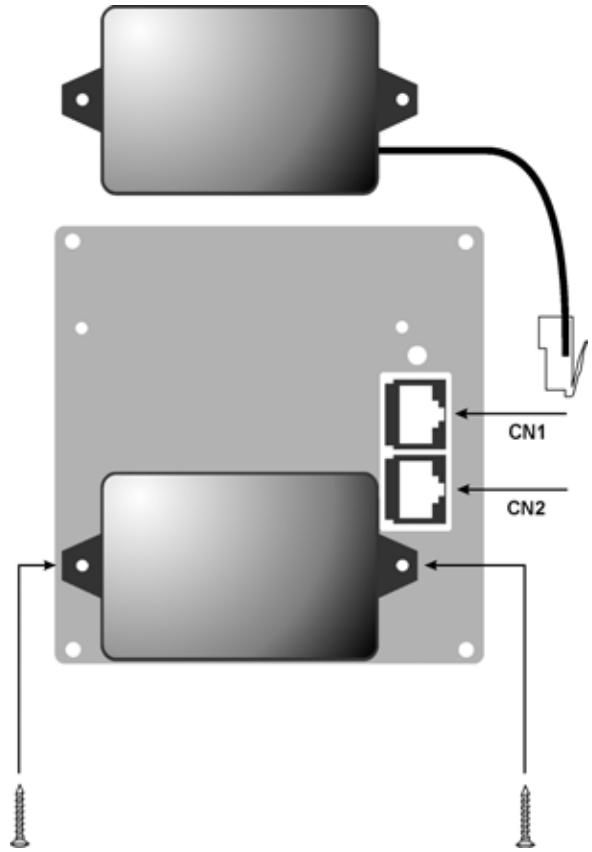
Example: CT = 100/5; PT = 20.000/100 $K_P = \frac{20 \times 200}{1000} = 4 kWh / pulse$ or **kWh** = Pulse count / 4

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.

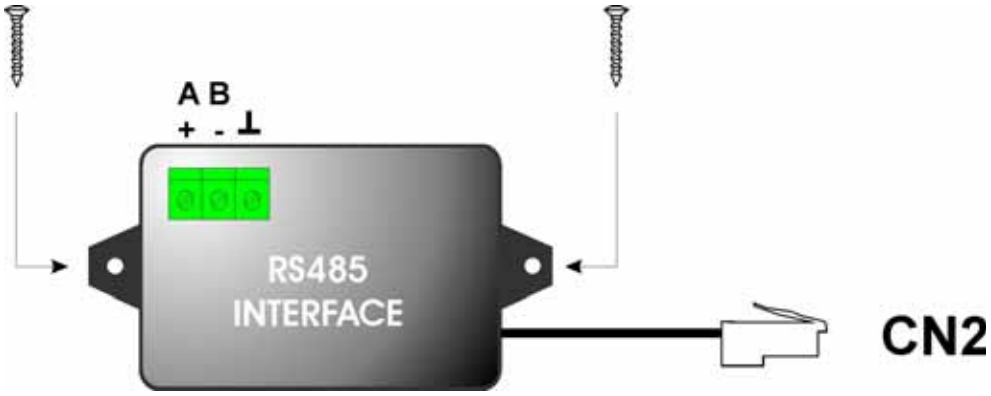
4.4 Connecting Optional Components

The optional components of X3M 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

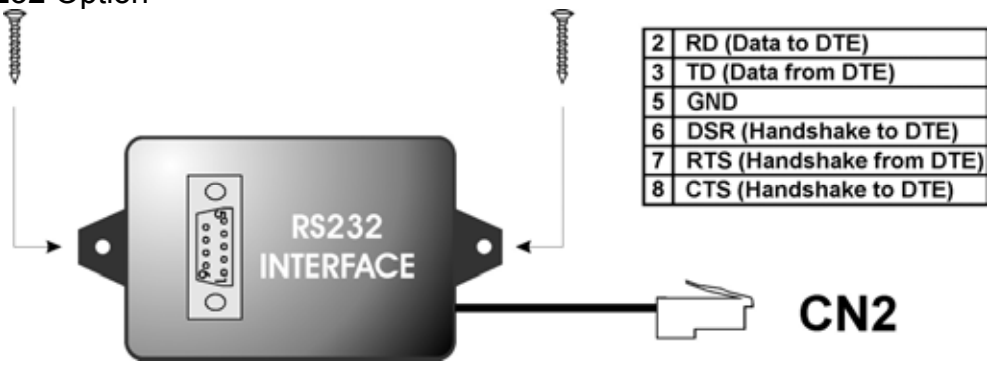


CN1 = 4-20 mA module or Hardware key
CN2 = RS485 or RS232 interface

4.4.1 RS485 Option

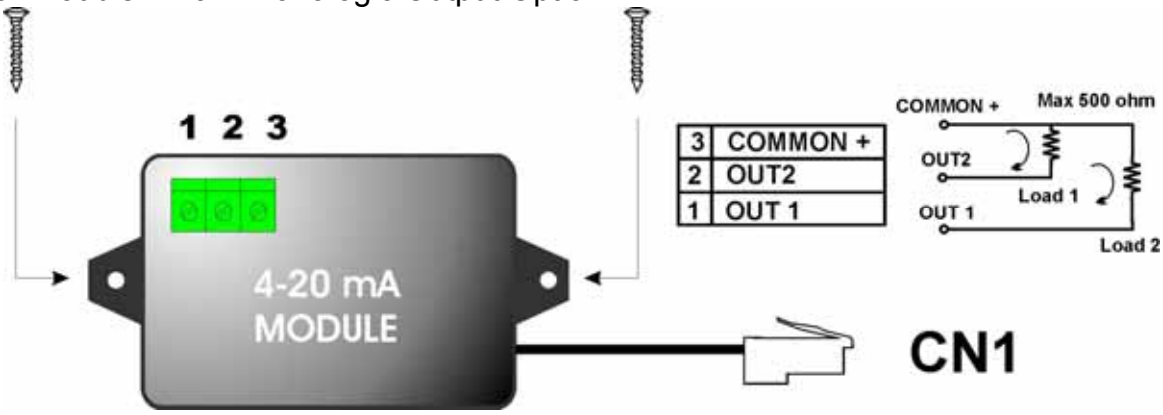


4.4.2 RS232 Option



2	RD (Data to DTE)
3	TD (Data from DTE)
5	GND
6	DSR (Handshake to DTE)
7	RTS (Handshake from DTE)
8	CTS (Handshake to DTE)

4.4.3 Double 4-20 mA analogic Output Option

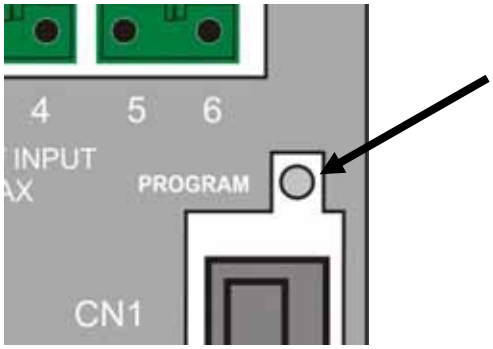


3	COMMON +
2	OUT2
1	OUT 1

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.

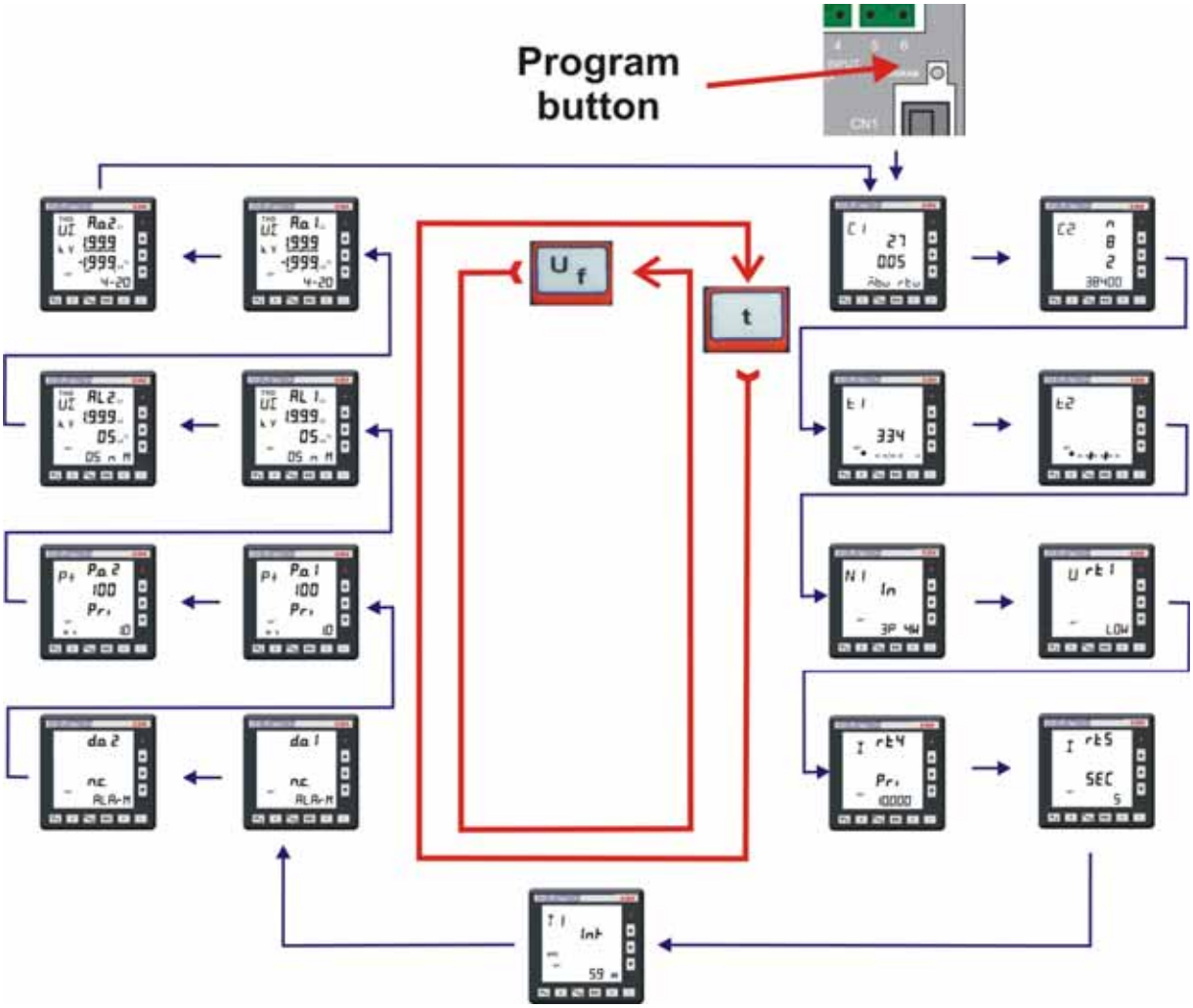
The various fields can be selected by pressing the ▶ button which also allows navigating to all the Setup pages

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 t advances to the next page, while U f 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.

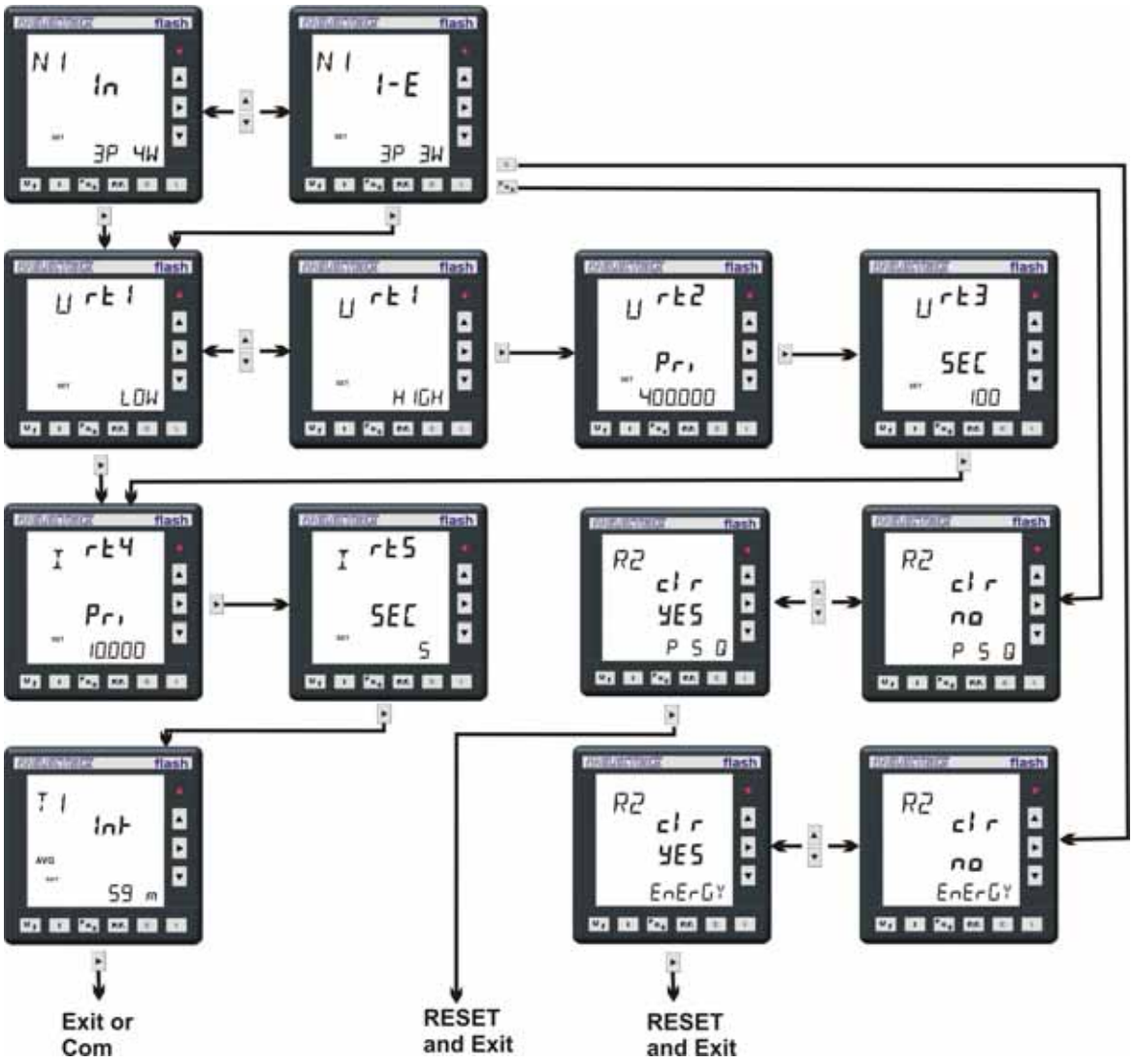
- a pressure of the E key opens the energy counters reset page.

- a pressure of the P Q S 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 λ,
- 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 **[00005/5]**.

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 [t] key advances to the next page, the [U f] 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:

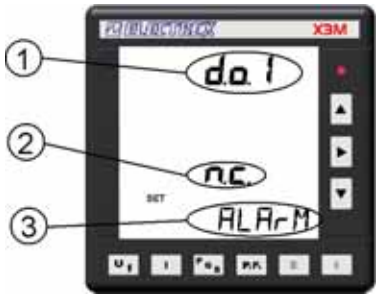
- Mode: it may be configured to RTU or to ASC (ASCII) mode.
- Slave Address
- Transmission delay; it stands for the time delay the instrument will wait prior to reply to a data query. It is expressed in milliseconds, the default value is 100 msec and a 0 setting is also possible.

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 impulse output, selecting among:

P+ Imported Active Power (import)
Q+ Inductive reactive Power with imported Active Power
Q- Capacitive reactive Power with imported Active Power
S+ Apparent Power with imported Active Power
P- Exported Active Power (export)
Q+ Inductive reactive Power with exported Active Power
Q- Capacitive reactive Power with exported Active Power
S- Apparent Power with exported Active Power

(4) Pr1 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 	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

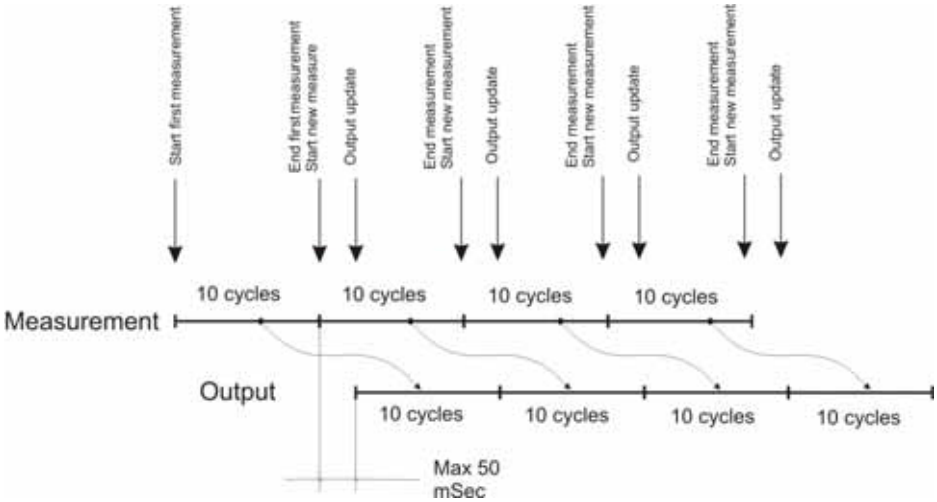
The procedure for alarm 2 is identical.

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:

Λ	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.

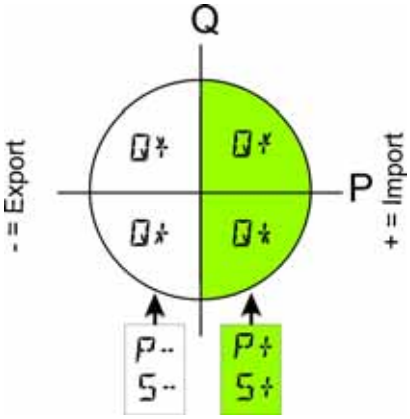
To set up the analog output the Modbus Holding Registers from 80 to 91 have to be used.
Refer to chapter 9 for the details.

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:

P+ Imported Active Power (import)
Q+ Inductive reactive Power with imported Active Power.
Q+ Capacitive reactive Power with imported Active Power
S+ Apparent Power with imported Active Power
P- Exported Active Power (export)
Q+ Inductive reactive Power with exported Active Power
Q+ Capacitive reactive Power with exported Active Power
S- Apparent Power with exported Active Power

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



5.1.2.7 Clock calendar configuration (for X3M-D only)

The X3M-D is equipped with a clock/calendar with internal battery having a 15 years life time.
The clock/calendar supports the time zone handling functions and the automatic change from Standard Time to Daylight Saving Time and vice versa.
The instrument is set by default to the Europe/Rome time and time zone.
The clock/calendar setting is covered by the last two SETUP pages.

Clock format
The following Time formats are foreseen:

Coordinated Universal Time (UTC): commonly known as GMT (Greenwich Mean Time): it is the universal time, applicable to any place on earth.

Standard Time: it is the local time of a specific time zone, based on the sun cycles (known as Solar Time

Daylight Saving Time it is the local time of a specific time zone when an offset on standard time is applied (DST offset). The introduction of this offset allows to increase the availability of hours with natural light in the summer evenings.

Wall time: it is how we refer to the clock time in each time zone. The Wall time actually coincides with the Daylight Saving Time or the Standard Time depending whether an offset Solar time is occurring or not.

The difference between Standard Time and UTC time is called GMT offset.
Summarizing:
GMT offset = UTC – Standard Time
Wall Time = Standard Time + DST offset = UTC + GMT offset + DST offset

The instrument RTC supports the following time information:

- UTC Date/time
- Time zone identification

Starting from the UTC time, the instrument automatically calculates the local time (Wall Time) of any place on earth
The pertinent time zone is entered to the instrument by a numeric index (time zone index) either on the set up procedure or on a MODBUS register.

NOTE: The instrument clock operates in UTC, therefore a correct time zone attribution is essential. Check whether the time zone entry is correct before modifying the clock. Otherwise a wrong time setting could be involuntarily programmed

The clock is updated by using the local time or “wall time” that the instrument converts in UTC, consequently, if the time zone is wrong, the clock will be wrong too.

(1) It identifies the time programming page N° 1.

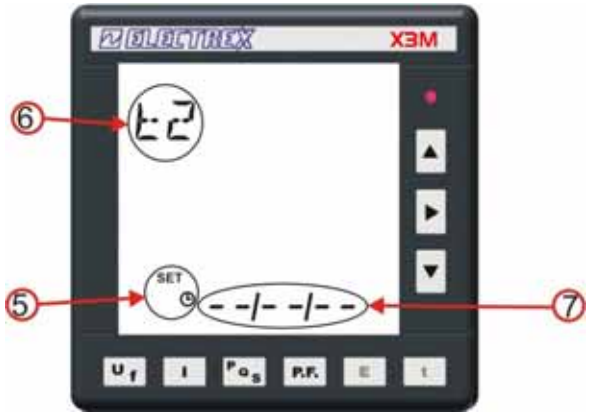
(2) Time zone 334 = Europe/Rome is valid all over central Europe. See the enclosed layout to identify the right time zone

(3) Time Configuration in hours and minutes. Starting the selection the configuration is – –:– –

Pushing the button ▼ and ▲ it is possible to visualize the actual time and date and modify them, first the hours then the minutes. The hour change will occur only exiting the programming mode. The hour change will influence the data storage thus it is important to operate modifications only if strictly necessary, otherwise leave to the instrument management software the clock update.. If you maintain the configuration – –:– – the clock will not be modified. Should modifications be edited and clock changes be avoided, it is necessary to set the display to – –:– – which is located after the last valid hour or minute (i.e. beyond 11 pm or under 12 am).

(4) Identifies the standard time. 12:30 -- while 12:30 S identifies the daylight saving or summer time.

(5) Identifies the clock set up page.



In the second page of clock set up it is possible to program the calendar.

(6) It identifies the time programming page N° 2.

(7) Area of calendar setting and starting from left: year, month, day 04 1206. Even for the date it is possible to avoid the modification saving, switching to the initial position – –/– –/– – which does not save modifications.

5.1.2.7.1 Clock set up with Modbus registers.

To set up the calendar clock the Modbus Holding Registers from 140 to 165 have to be used.
Refer to chapter 9 for the details.

5.1.2.7.2 Time zones

The pertinent time zone is entered to the instrument by a numeric index (*time zone index*).
The time zone index and the standard time zone names are shown in the charts below:

Standard Timezone Name (FW > 1.06)	X3M-D Timezone Index
Africa/Abidjan	0
Africa/Accra	1
Africa/Addis_Ababa	2
Africa/Algiers	3
Africa/Asmera	4
Africa/Bamako	5
Africa/Bangui	6
Africa/Banjul	7
Africa/Bissau	8
Africa/Blantyre	9
Africa/Brazzaville	10
Africa/Bujumbura	11
Africa/Cairo	12
Africa/Casablanca	13
Africa/Ceuta	14
Africa/Conakry	15
Africa/Dakar	16
Africa/Dar_es_Salaam	17
Africa/Djibouti	18
Africa/Douala	19
Africa/El_Aaiun	20
Africa/Freetown	21
Africa/Gaborone	22
Africa/Harare	23
Africa/Johannesburg	24
Africa/Kampala	25
Africa/Khartoum	26
Africa/Kigali	27
Africa/Kinshasa	28
Africa/Lagos	29
Africa/Libreville	30
Africa/Lome	31
Africa/Luanda	32
Africa/Lubumbashi	33
Africa/Lusaka	34
Africa/Malabo	35
Africa/Maputo	36
Africa/Maseru	37
Africa/Mbabane	38
Africa/Mogadishu	39
Africa/Monrovia	40
Africa/Nairobi	41
Africa/Ndjamena	42
Africa/Niamey	43
Africa/Nouakchott	44
Africa/Ouagadougou	45
Africa/Porto-Novo	46
Africa/Sao_Tome	47
Africa/Timbuktu	48

Standard Timezone Name (FW > 1.06)	X3M-D Timezone Index
Africa/Tripoli	49
Africa/Tunis	50
Africa/Windhoek	51
America/Adak	52
America/Anchorage	53
America/Anguilla	54
America/Antigua	55
America/Araguaina	56
America/Argentina/Buenos_Aires	66
America/Argentina/Catamarca	71
America/Argentina/ComodRivadavia	400
America/Argentina/Cordoba	76
America/Argentina/Jujuy	109
America/Argentina/La_Rioja	401
America/Argentina/Mendoza	121
America/Argentina/Rio_Gallegos	402
America/Argentina/San_Juan	403
America/Argentina/Tucuman	404
America/Argentina/Ushuaia	405
America/Aruba	57
America/Asuncion	58
America/Bahia	59
America/Barbados	60
America/Belem	61
America/Belize	62
America/Boa_Vista	63
America/Bogota	64
America/Boise	65
America/Cambridge_Bay	67
America/Campo_Grande	68
America/Cancun	69
America/Caracas	70
America/Cayenne	72
America/Cayman	73
America/Chicago	74
America/Chihuahua	75
America/Costa_Rica	77
America/Cuiaba	78
America/Curacao	79
America/Danmarkshavn	80
America/Dawson	81
America/Dawson_Creek	82
America/Denver	83
America/Detroit	84
America/Dominica	85
America/Edmonton	86
America/Eirunepe	87
America/El_Salvador	88
America/Fortaleza	89

Standard Timezone Name (FW > 1.06)	X3M-D Timezone Index
America/Glace_Bay	90
America/Godthab	91
America/Goose_Bay	92
America/Grand_Turk	93
America/Grenada	94
America/Guadeloupe	95
America/Guatemala	96
America/Guayaquil	97
America/Guyana	98
America/Halifax	99
America/Havana	100
America/Hermosillo	101
America/Indiana/Knox	102
America/Indiana/Marengo	103
America/Indiana/Vevay	104
America/Indianapolis	105
America/Inuvik	106
America/Iqaluit	107
America/Jamaica	108
America/Juneau	110
America/Kentucky/Monticello	111
America/La_Paz	112
America/Lima	113
America/Los_Angeles	114
America/Louisville	115
America/Maceio	116
America/Managua	117
America/Manaus	118
America/Martinique	119
America/Mazatlan	120
America/Menominee	122
America/Merida	123
America/Mexico_City	124
America/Miquelon	125
America/Monterrey	126
America/Montevideo	127
America/Montreal	128
America/Montserrat	129
America/Nassau	130
America/New_York	131
America/Nipigon	132
America/Nome	133
America/Noronha	134
America/North_Dakota/Center	135
America/Panama	136
America/Pangnirtung	137
America/Paramaribo	138
America/Phoenix	139
America/Port_of_Spain	141
America/Port-au-Prince	140
America/Porto_Velho	142
America/Puerto_Rico	143
America/Rainy_River	144

Standard Timezone Name (FW > 1.06)	X3M-D Timezone Index
America/Rankin_Inlet	145
America/Recife	146
America/Regina	147
America/Rio_Branco	148
America/Santiago	149
America/Santo_Domingo	150
America/Sao_Paulo	151
America/Scoresbysund	152
America/St_Johns	153
America/St_Kitts	154
America/St_Lucia	155
America/St_Thomas	156
America/St_Vincent	157
America/Swift_Current	158
America/Tegucigalpa	159
America/Thule	160
America/Thunder_Bay	161
America/Tijuana	162
America/Toronto	163
America/Tortola	164
America/Vancouver	165
America/Whitehorse	166
America/Winnipeg	167
America/Yakutat	168
America/Yellowknife	169
Antarctica/Casey	170
Antarctica/Davis	171
Antarctica/DumontDUrville	172
Antarctica/Mawson	173
Antarctica/McMurdo	174
Antarctica/Palmer	175
Antarctica/Rothera	176
Antarctica/Syowa	177
Antarctica/Vostok	178
Asia/Aden	179
Asia/Almaty	180
Asia/Amman	181
Asia/Anadyr	182
Asia/Aqtau	183
Asia/Aqtobe	184
Asia/Ashgabat	185
Asia/Baghdad	186
Asia/Bahrain	187
Asia/Baku	188
Asia/Bangkok	189
Asia/Beirut	190
Asia/Bishkek	191
Asia/Brunei	192
Asia/Calcutta	193
Asia/Choibalsan	194
Asia/Chongqing	195
Asia/Colombo	196
Asia/Damascus	197

Standard Timezone Name (FW > 1.06)	X3M-D Timezone Index
Asia/Dhaka	198
Asia/Dili	199
Asia/Dubai	200
Asia/Dushanbe	201
Asia/Gaza	202
Asia/Harbin	203
Asia/Hong_Kong	204
Asia/Hovd	205
Asia/Irkutsk	206
Asia/Jakarta	207
Asia/Jayapura	208
Asia/Jerusalem	209
Asia/Kabul	210
Asia/Kamchatka	211
Asia/Karachi	212
Asia/Kashgar	213
Asia/Katmandu	214
Asia/Krasnoyarsk	215
Asia/Kuala_Lumpur	216
Asia/Kuching	217
Asia/Kuwait	218
Asia/Macau	219
Asia/Magadan	220
Asia/Makassar	221
Asia/Manila	222
Asia/Muscat	223
Asia/Nicosia	224
Asia/Novosibirsk	225
Asia/Omsk	226
Asia/Oral	227
Asia/Phnom_Penh	228
Asia/Pontianak	229
Asia/Pyongyang	230
Asia/Qatar	231
Asia/Qyzylorda	232
Asia/Rangoon	233
Asia/Riyadh	234
Asia/Saigon	235
Asia/Sakhalin	236
Asia/Samarkand	237
Asia/Seoul	238
Asia/Shanghai	239
Asia/Singapore	240
Asia/Taipei	241
Asia/Tashkent	242
Asia/Tbilisi	243
Asia/Tehran	244
Asia/Thimphu	245
Asia/Tokyo	246
Asia/Ulaanbaatar	247
Asia/Urumqi	248
Asia/Vientiane	249
Asia/Vladivostok	250

Standard Timezone Name (FW > 1.06)	X3M-D Timezone Index
Asia/Yakutsk	251
Asia/Yekaterinburg	252
Asia/Yerevan	253
Atlantic/Azores	254
Atlantic/Bermuda	255
Atlantic/Canary	256
Atlantic/Cape_Verde	257
Atlantic/Faeroe	258
Atlantic/Madeira	259
Atlantic/Reykjavik	260
Atlantic/South_Georgia	261
Atlantic/St_Helena	262
Atlantic/Stanley	263
Australia/Adelaide	264
Australia/Brisbane	265
Australia/Broken_Hill	266
Australia/Darwin	267
Australia/Hobart	268
Australia/Lindeman	269
Australia/Lord_Howe	270
Australia/Melbourne	271
Australia/Perth	272
Australia/Sydney	273
CET	274
EET	275
Etc/GMT	276
Etc/GMT+1	277
Etc/GMT+10	278
Etc/GMT+11	279
Etc/GMT+12	280
Etc/GMT+2	281
Etc/GMT+3	282
Etc/GMT+4	283
Etc/GMT+5	284
Etc/GMT+6	285
Etc/GMT+7	286
Etc/GMT+8	287
Etc/GMT+9	288
Etc/GMT-1	289
Etc/GMT-10	290
Etc/GMT-11	291
Etc/GMT-12	292
Etc/GMT-13	293
Etc/GMT-14	294
Etc/GMT-2	295
Etc/GMT-3	296
Etc/GMT-4	297
Etc/GMT-5	298
Etc/GMT-6	299
Etc/GMT-7	300
Etc/GMT-8	301
Etc/GMT-9	302
Etc/UCT	303

Standard Timezone Name (FW > 1.06)	X3M-D Timezone Index
Etc/UTC	304
Europe/Amsterdam	305
Europe/Andorra	306
Europe/Athens	307
Europe/Belfast	308
Europe/Belgrade	309
Europe/Berlin	310
Europe/Brussels	311
Europe/Bucharest	312
Europe/Budapest	313
Europe/Chisinau	314
Europe/Copenhagen	315
Europe/Dublin	316
Europe/Gibraltar	317
Europe/Helsinki	318
Europe/Istanbul	319
Europe/Kaliningrad	320
Europe/Kiev	321
Europe/Lisbon	322
Europe/London	323
Europe/Luxembourg	324
Europe/Madrid	325
Europe/Malta	326
Europe/Minsk	327
Europe/Monaco	328
Europe/Moscow	329
Europe/Oslo	330
Europe/Paris	331
Europe/Prague	332
Europe/Riga	333
Europe/Rome	334
Europe/Samara	335
Europe/Simferopol	336
Europe/Sofia	337
Europe/Stockholm	338
Europe/Tallinn	339
Europe/Tirane	340
Europe/Uzhgorod	341
Europe/Vaduz	342
Europe/Vienna	343
Europe/Vilnius	344
Europe/Warsaw	345
Europe/Zaporozhye	346
Europe/Zurich	347
Indian/Antananarivo	348
Indian/Chagos	349
Indian/Christmas	350
Indian/Cocos	351
Indian/Comoro	352
Indian/Kerguelen	353
Indian/Mahe	354
Indian/Maldives	355
Indian/Mauritius	356

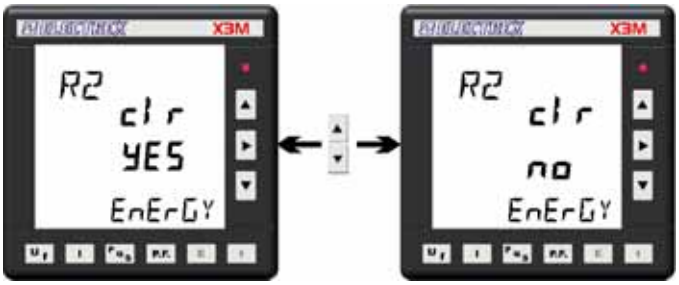
Standard Timezone Name (FW > 1.06)	X3M-D Timezone Index
Indian/Mayotte	357
Indian/Reunion	358
MET	359
Pacific/Apia	360
Pacific/Auckland	361
Pacific/Chatham	362
Pacific/Easter	363
Pacific/Efate	364
Pacific/Enderbury	365
Pacific/Fakaofo	366
Pacific/Fiji	367
Pacific/Funafuti	368
Pacific/Galapagos	369
Pacific/Gambier	370
Pacific/Guadalcanal	371
Pacific/Guam	372
Pacific/Honolulu	373
Pacific/Johnston	374
Pacific/Kiritimati	375
Pacific/Kosrae	376
Pacific/Kwajalein	377
Pacific/Majuro	378
Pacific/Marquesas	379
Pacific/Midway	380
Pacific/Nauru	381
Pacific/Niue	382
Pacific/Norfolk	383
Pacific/Noumea	384
Pacific/Pago_Pago	385
Pacific/Palau	386
Pacific/Pitcairn	387
Pacific/Ponape	388
Pacific/Port_Moresby	389
Pacific/Rarotonga	390
Pacific/Saipan	391
Pacific/Tahiti	392
Pacific/Tarawa	393
Pacific/Tongatapu	394
Pacific/Truk	395
Pacific/Wake	396
Pacific/Wallis	397
Pacific/Yap	398
WET	399

The X3M-D features a built-in database including all the information (*time zone rules*) which allow to calculate the GMT and DST offsets at any time in each time zones listed in the charts. By knowing the GMT and the DST offset, the instrument is able to convert from universal time to local time and vice versa. The database with the time zone data is compiled from the pack distributed by *elsie.nci.nih.gov* (*tzdataXXXXX.tar.gz*) and it is integrated in the instrument firmware. Database updates are therefore possible only by installing a new version of firmware.

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 Pqs key to display the powers reset page or the E 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:

[U f] Voltage and frequency visualizations.

[I] Current visualization.

[Pos] 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

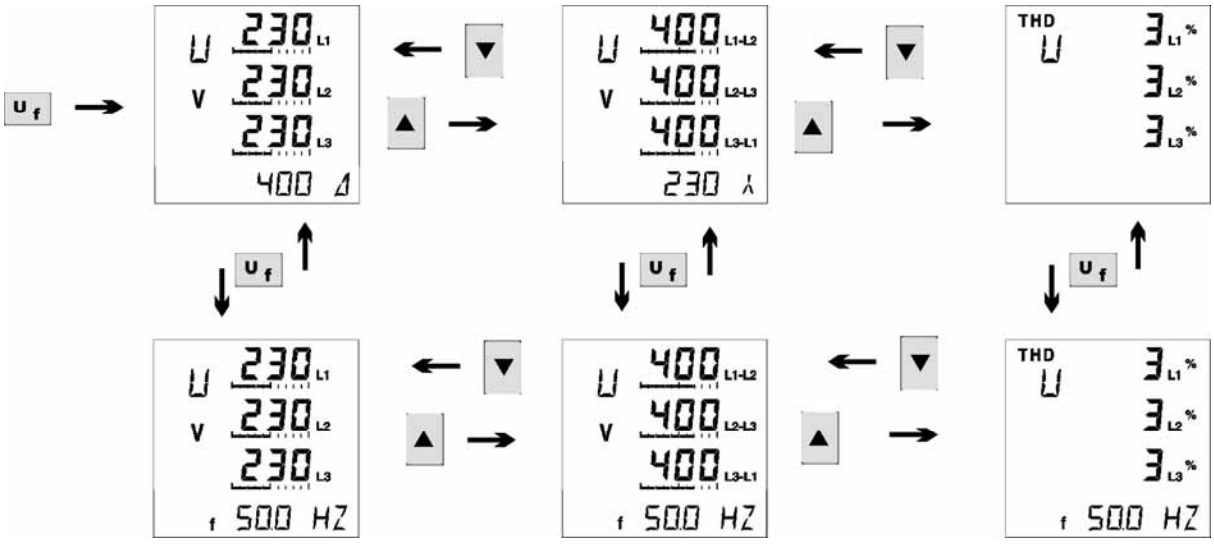
By pressing once the [U f] key, a first voltage readings page is prompted showing the phase-neutral voltages and, on the bottom right side of the display, the average 3-phase system voltage.

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.

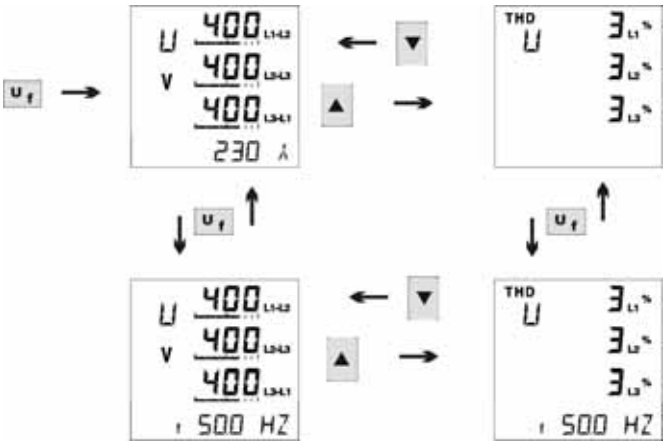
Another pressure of the [▲] key prompts the total harmonic distortion readings of the voltage of each phase.

By pressing again the [U f] key the frequency is shown on the lower right side on thedisplay.

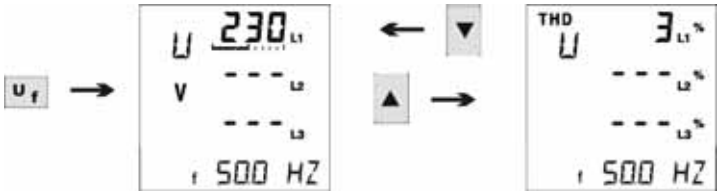
5.2.1.1.1 3P 4 W Configuration



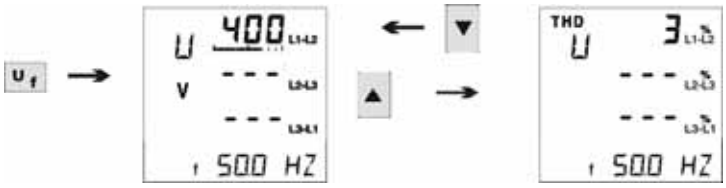
5.2.1.1.2 3P 3 W Configuration



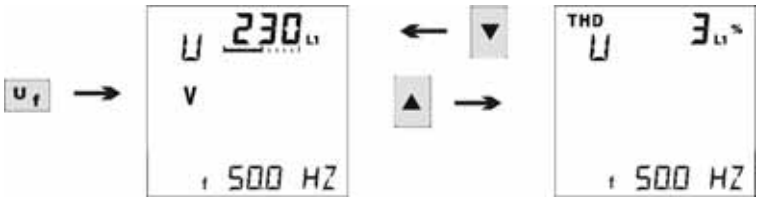
5.2.1.1.3 3P-b 4W Configuration



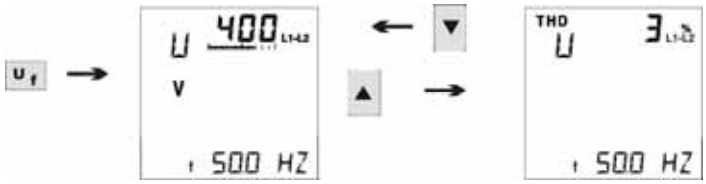
5.2.1.1.4 3P-b 3W Configuration



5.2.1.1.5 1P 2W Configuration



5.2.1.1.6 2P 2W Configuration

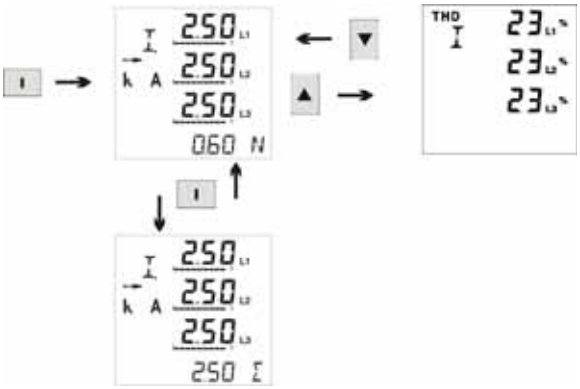


5.2.1.2 Current readings

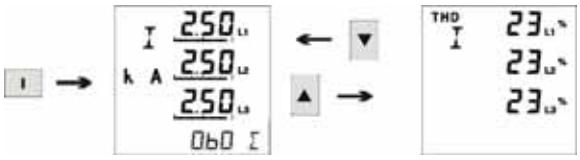
By pressing the [I] key, the current readings page is prompted showing the currents of each phase as well as the neutral current.

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

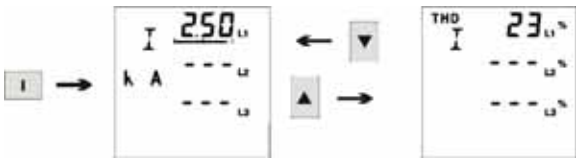
5.2.1.2.1 3P 4W Configuration



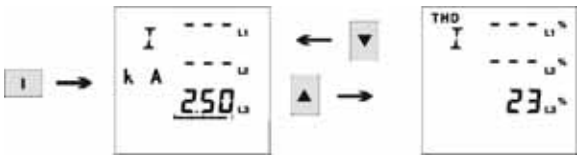
5.2.1.2.2 3P 3W Configuration



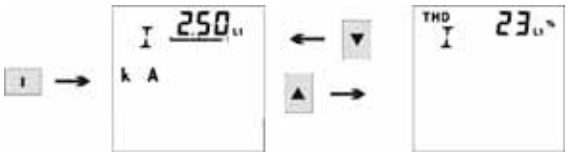
5.2.1.2.3 3P-b 4W Configuration



5.2.1.2.4 3P-b 3W Configuration



5.2.1.2.5 1P 2W and 2P 2W Configuration

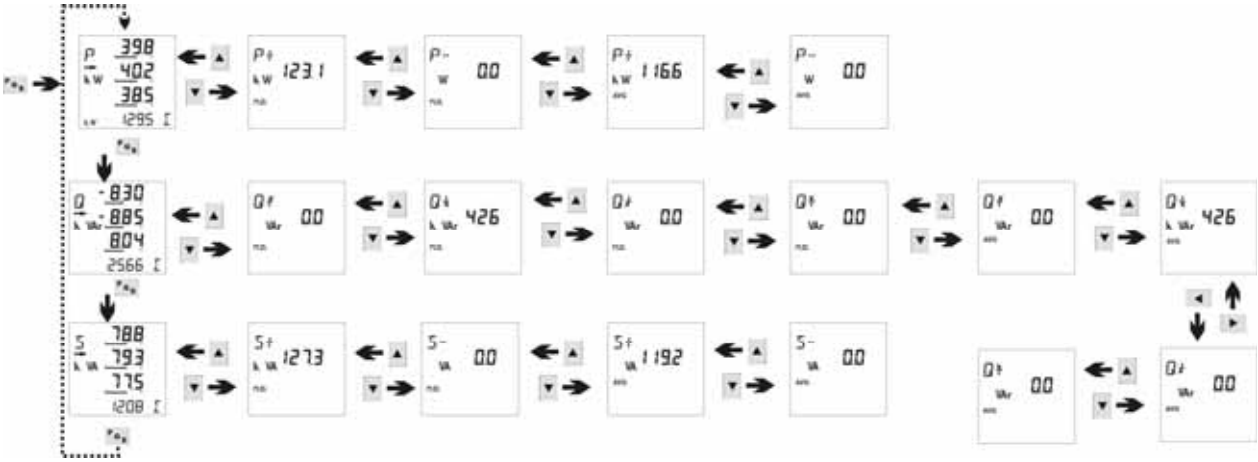


5.2.1.3 Powers

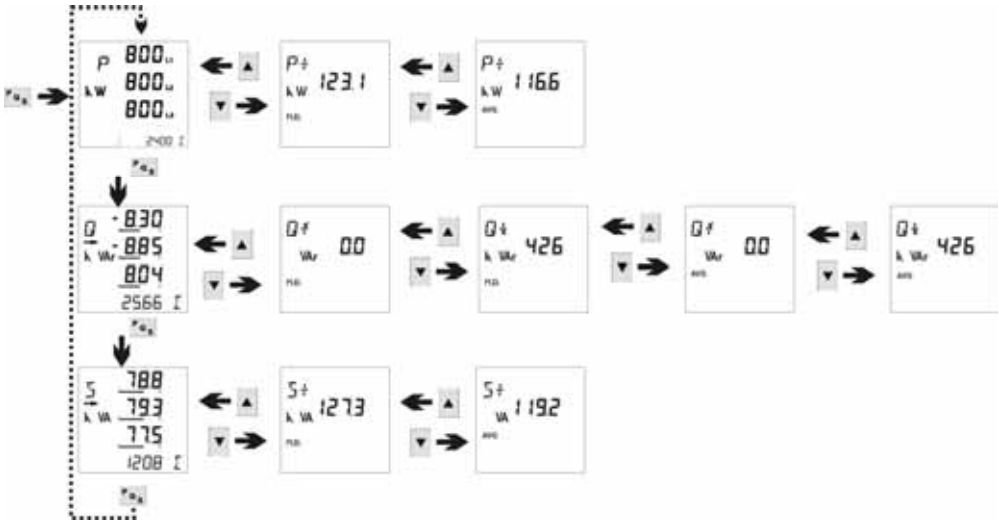
By pressing the [PQS] key the power reading pages for P Active Power, Q Reactive power and S Apparent power are scrolled in sequence.

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

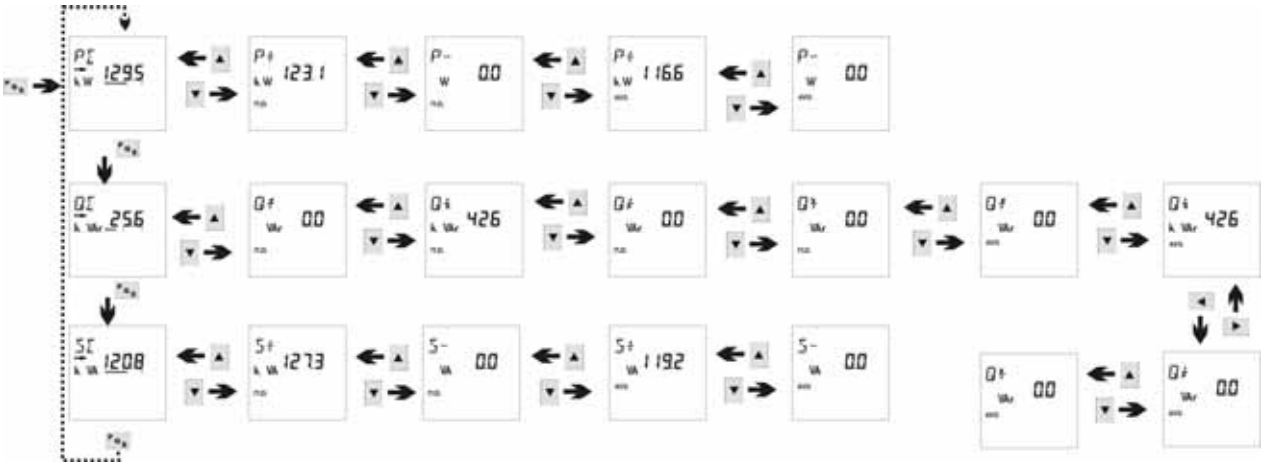
5.2.1.3.1 3P 4W Configuration



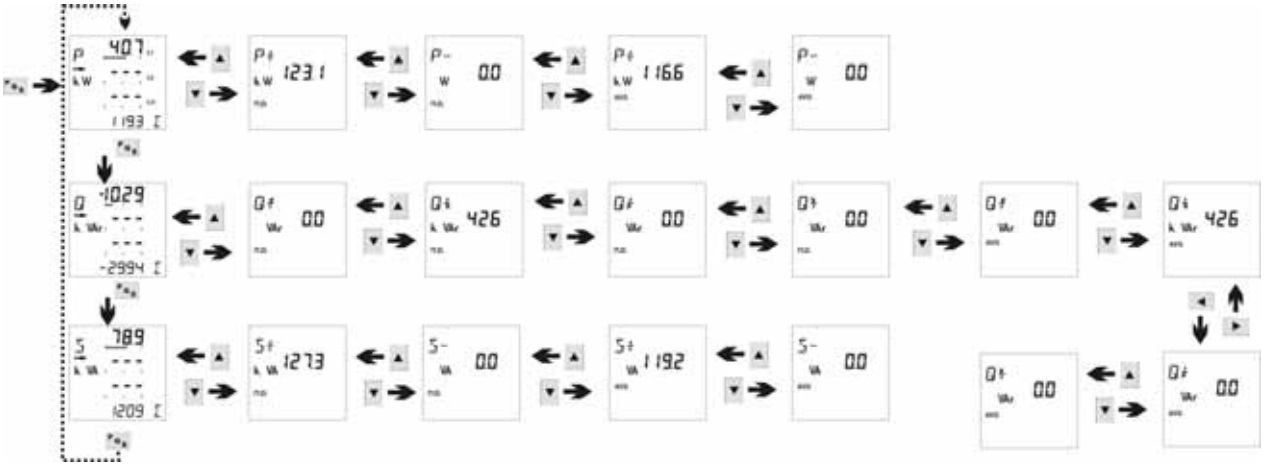
5.2.1.3.2 3P 4W only Import Configuration.



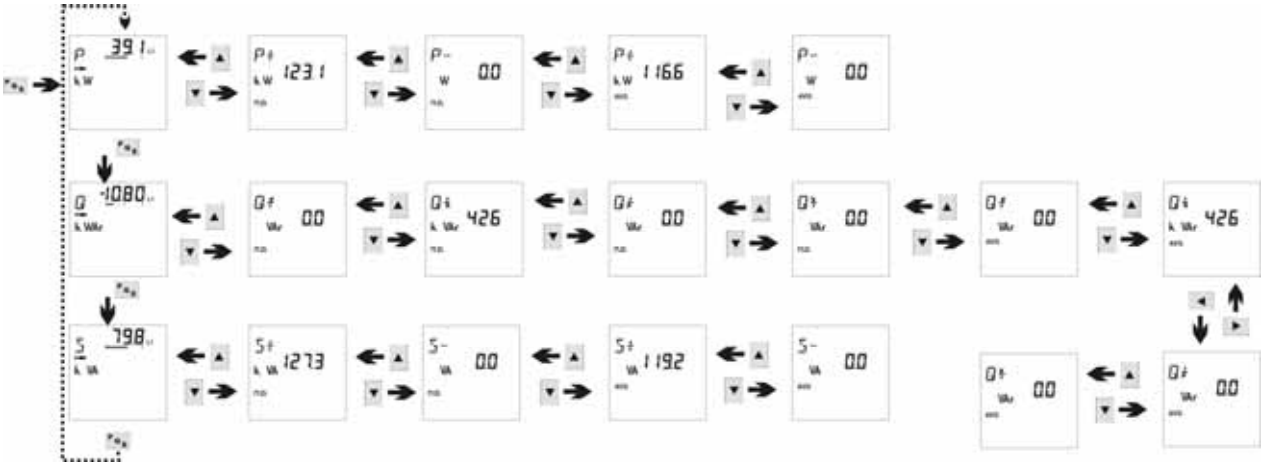
5.2.1.3.3 3P 3W / 3P-b 3W / 2P 2W Configuration



5.2.1.3.4 3P-b 4W Configuration



5.2.1.3.5 1P 2W Configuration

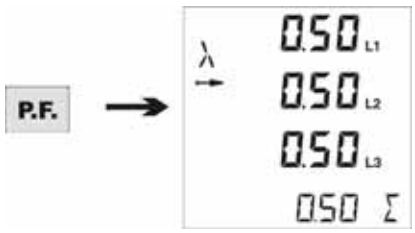


5.2.1.4 P.F. Visualization

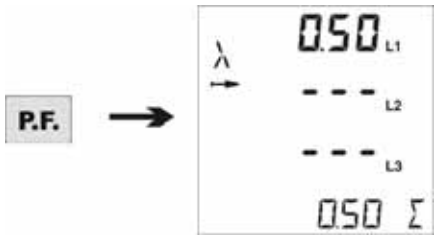
By pressing the P.F. key, the power factor readings page is prompted showing the PF of each phase as well as the 3-phase reading. Only one page is displayed.

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

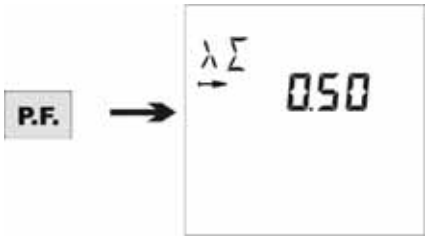
5.2.1.4.1 3P 4W Configuration



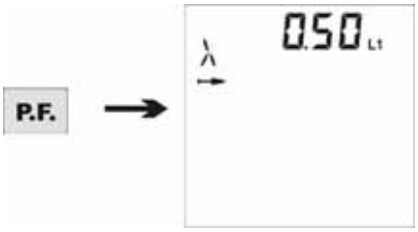
5.2.1.4.2 3Pb 4W Configuration



5.2.1.4.3 3P 3W e 3Pb 3W Configuration

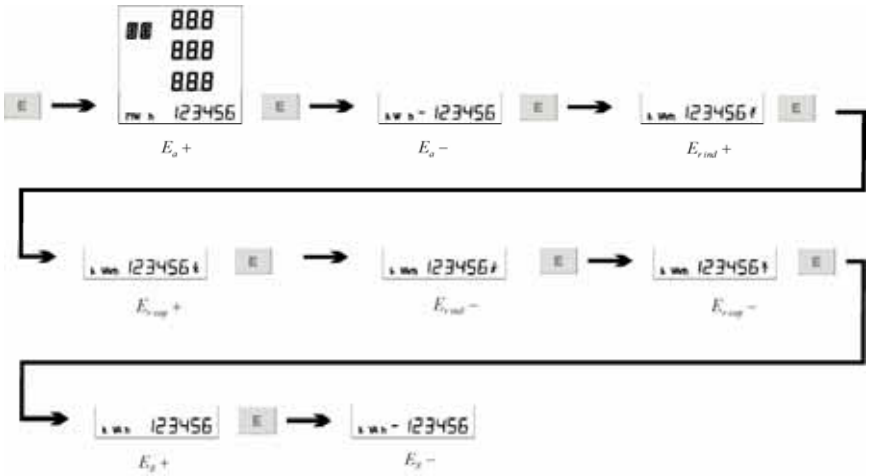


5.2.1.4.4 1P 2W e 2P 2W Configuration

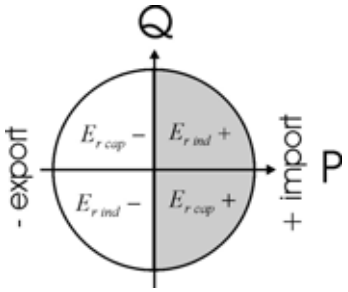


5.2.1.5 Energy

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^+) Imported active energy (import)

(E_a^-) Exported active energy (export)

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

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

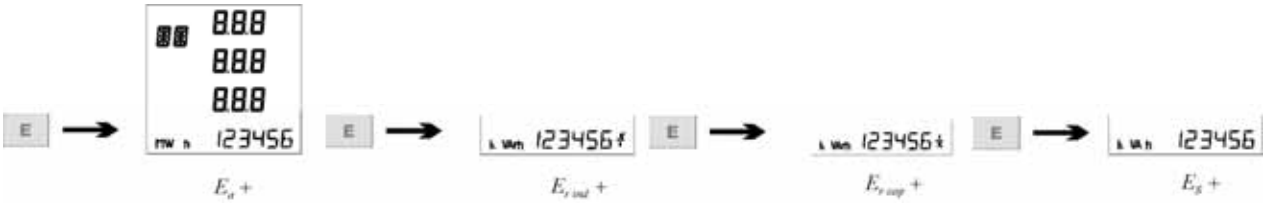
($E_{r\,ind}^-$) Inductive reactive energy with exported Active Power

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

(E_s^+) Apparent Energy with imported Active Power

(E_s^-) Apparent Energy with exported Active Power

5.2.1.6 Only Import Energy Display



5.2.1.7 Tariff Energies and Tariff Maximum Demand

By pressing the P Qs key for 2 seconds from any page, it is possible to display the Energy counters and the Max Demand of each tariff.

The top left symbol identifies the parameter being displayed and the Maximum Demand reading is shown next to it.
The tariff number is indicated on the top right while the energy reading is indicated below.

All the energy and MD readings applicable to the 8 parameters of a 4 quadrant measurement are foreseen.

Press shortly the P Qs key to scroll the different parameters.

Press the ▼ and ▲ keys to scroll the different tariffs.

To move back to the traditional reading mode, press the P Qs key again for 2 seconds.

NB
In the case the instrument is not loaded with a proper calendar file or in the case some tariffs are not included in the calendar, dashes will be displayed in place of the readings.

5.2.1.8 Calendar Clock and 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.

6 Instrument Description

6.1 Introduction

X3M 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 real time sampling of the three phases voltage and current, makes it suitable to supervise the voltage and quick current variations quality.
It can verify when a maximum or minimum threshold is exceeded in every single voltage/current cycle
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 precision even when rapidly changing loads are present (e.g. electric welding machines).
X3M 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 X3M suitable for use in both high and low voltage networks.
It can measure the energy and the Maximum Demand on the 4 quadrants (active, reactive and apparent) divided according to the Tariff time bands with internal calendar. The instrument can handle 2 different calendars, one of which operates while the other can be automatically activated at a programmed date and time.
It contains a 2MByte flash disk memory where data are stored according to record files according to ModBus standard and can be read and written using the ModBus functions: “write general file” and “read general file”.
The time is kept by a compensated, stabilized quartz clock and can be extracted in most required formats. By programming the time zone, the changes from standard to daylight saving time are automatically handled in any country. The clock has a backup battery, with a 15 year lifetime, and can be set either using the modbus protocol or the keyboard.
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.
X3M 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 impulses 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 Wh 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 Storage

The instrument stores the following data according to user programmable services

- Load curves. It stores on files, according to a pre-defined schedule, the content of one or more than one ModuBus registers (input registers and/or holding registers)
- System log. It includes the instrument history from the start with all the functioning altering operations.
- Configuration log. It records the configuration modifications
- Event log. It records the following events on file:
    - Power failure
        - Power voltage loss (power down).
        - Power voltage return (power up).
    - Interruption
        - Loss of one or more phase voltage (phase-neutral or phase-phase if star connected) below a programmable threshold value (voltage loss).
        - Return of one or more phase voltage above of a programmable threshold value (voltage return)
    - Over current
        - Overshoot of one or more line currents of the programmable threshold value (over current).
        - Instrument reset
- RMS value maximum and minimum (1 Sec)
- Definition of the calendar ranges: it includes the tariff structure.
- Tariff counters: It includes the following energy counters +Ea, -Ea, ++Er, -+Er, +-Er, --Er, +Es, -Es for the 4 quadrants and for each of the 8 tariff options.
- Peak values: contains the maximum - or peak - power values (averaged over the integration period) on 4 quadrants or each of the 8 tariff options

6.6 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.

6.7 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.

6.8 Pulse Output

The two outputs, if in association with pulse, can be referred to one of the 8 power value available on a 4 quadrant system.
The output pulse can be freely programmed both on frequency and duration and referred to the instrument Full Scale or to the measuring cell (with CT and PT) Full Scale.
It is possible to program the output value either according to impulse number and impulse weight
The two outputs are factory programmed one proportional to the active energy while the other to the reactive energy, the output frequency is 1000 pulses per kWh (or kvarh) and 50 ms pulse time.
The pulses number is referred to the instrument Full Scale without the CT and TV scale factors.

6.9 Alarms

X3M 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.

6.10 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.

6.11 Clock / Calendar

X3M is equipped with a clock/calendar provided with a 15 years buffer battery.
It is updated when manufactured with the Europe/Rome time and time zone The clock/calendar is equipped with the time zone managing functions.
It manages the automatic change from Standard Time to Daylight Saving Time and vice versa

6.11.1 Clock Format

The following Times are programmed":

Coordinated Universal Time (UTC): previously known as GMT (Greenwich Mean Time): it is the universal time, shared by any earth location

Standard Time: it is the local time of a specific time zone, based on the sun cycles (known as Standard Time

Daylight Saving Time it is the local time of a specific time zone when an offset on standard time is valid (DST offset). The introduction of this offset allows to increase the natural light duration in the summer evenings.

Wall time: it is how we refer to the clock time in ach time zone. The Wall time is equal to Daylight Saving Time or to Standard Time according to weather an offset on sun cycle time is occurring or not.

The difference between Standard Time and UTC time is named GMT offset.
Summarizing:
GMT offset = UTC – Standard Time
Wall Time = Standard Time + DST offset = UTC + GMT offset + DST offset

The instrument RTC stores the following time information:

- Date/time
- UTC;
- It identifies the time zone it belongs to.

X3M, starting from the UTC time can autonomously calculate the local time (Wall Time) of any place on earth
The zone it belongs to is indicated to the instrument through a numeric index (time zone index) either on the display or on a MODBUS register.

6.12 Memory

Non volatile data memory without buffer battery, capable to store data for more than 15 years.
It is structured as a disk with file system and directory and it can be accessed via Modbus protocol.

6.12.1 Dimensions

2 Mbytes Flash Disk
2.088.960 bytes available space
Organized in 4096 allocation units from 510 bytes each.
As each file occupies at least an allocation unit, a maximum of 4096 files can coexist on disk

6.12.2 Memory Read/Write.

Disk access via Modbus functions.
"Write General File".
"Read General File".
The data on disk are organized in record files, as per ModBus standard

6.12.3 File Structure

Each file is individualized by a numeric index of 2 bytes (FILE NUMBER, from 0 to 65535).
It can contain max 10000 records, addressed from 0 to 9999.
Each record can be max 238 bytes.

6.12.4 Record Structure

All the records of the same file must have the same size and the same structure.
The only exception is represented by the 0 record, which can have different dimension and structure from the successive records (from 1 to 9999).

6.13 Average and peak Energy

While the X3M 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 measures in the four quadrants.

6.14 Tariff Time Bands

It is possible to store, inside the instrument, a calendar file which organizes the consume according to different tariff bands. The tariff scheme can present different values during the day and the day scheme can present different formats during the year.
It is possible to have a maximum of 8 tariffs with max 24 tariff changes a day.
Thanks to its internal clock, the instrument can divide the energy consumes on 8 different tariff counters (range) which are stored inside the data memory
The peak values are memorized in the same way (Max Demand) for each tariff on another memory file.

7 System Architecture

7.1 General Features

7.1.1 X3M

Energy and Supply quality 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.
- Clock/calendar provide 15 years back up battery with management of standard/daylight saving time (DST Daylight Saving Time) time zones
- Insertion on electric single phase networks and on balanced symmetrical three phase 3 wire networks
- Software upgrade on line
- Life Timer;
- Backlit 256 segments 63 x 65 mm LCD display with white electro-luminescent lamp;
- Immediate measurement indication through bargraph;
- Calibration verification LED through optical devices;
- Easy to use, thanks to the 9 button keyboard with explicit function indication;
- Insertion on electric 3 phase unbalanced 3 or 4 wire networks, single phase networks and on balanced symmetrical three phase 3or 4 wire networks
- 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 by 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;
- Din 96 x 96 mm panel mounting;
- Easy connection thanks to plug in terminals (with safety screws);
- Compliant with all the international standards.
- Measurement of voltage and current total harmonic distortion;
- Measurement of the total harmonic distortion (THD) of voltages and currents;
- Average and peak powers (on 4 displays) with programmable integration time;
- Internal energy counters (on 4 displays).
- 2 digital outputs (DIN 43864) with programmable functions:
  - Pulse outputs for energy counting;
  - Event signaling (alarms);
  - Remote control of external devices.
- Data Memory
  - Dimensions
    - 2 Mbytes Flash disk.
    - 2.088.960 bytes available memory.
    - Organized in 4096 allocation units from 510 bytes each.
    - As each file occupies at least an allocation unit a maximum of 4096 files can co-exist on disk
  - Reading.
    - Disk Access via Modbus functions.

- "Write General File".
- "Read General File".

- The data on disk are organized in record files, according to ModBus standard.

– Files Structure
  - Each file is identified by a numeric index of 2 bytes (FILE NUMBER, from 0 to 65535).
  - It can store a maximum of 10000 records, addressed from 0 to 9999.
  - Each record cannot be more than 238 bytes.

7.1.2 Options

7.1.2.1 RS485 Port

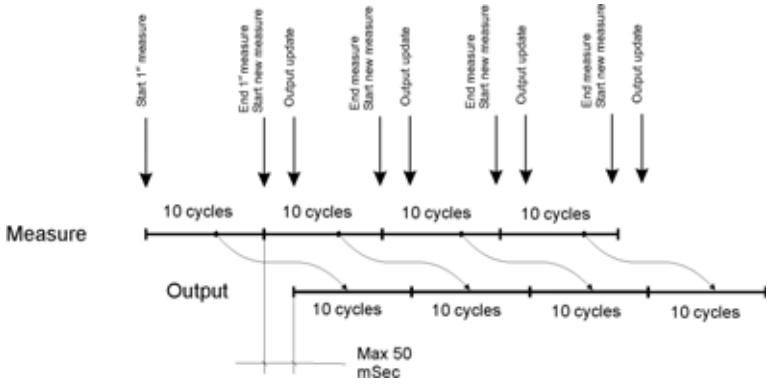
RS485 optically insulated interface module with programmable speed from 2400 bps to 38400 bps.
It is connected to the instrument via a connector and then can be easily fixed at the back with screws.
It can be network connected with other instruments up to 1000 m maximum distance and up to 128 instruments.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

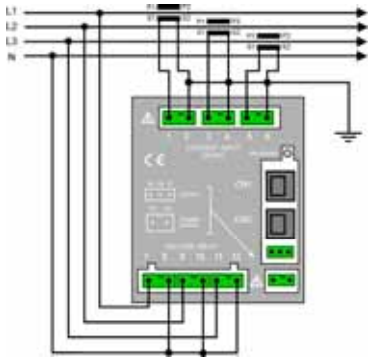


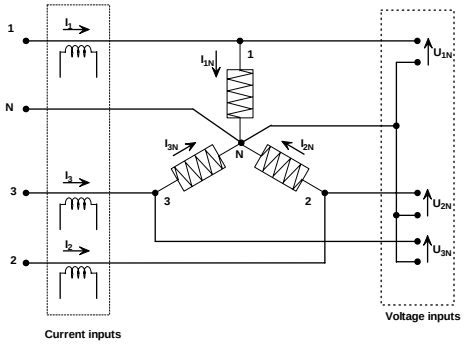
For the average power the output update is every minute due to the parameter itself.
It can be set to a 0 value (4 or 0 mA) a positive or negative value of the selected parameter and to nevertheless set to 20 mA end of scale, a lower value than the instrument end of scale. The end of scale provides for 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 %

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

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

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

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

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

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

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

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

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 $\quad P_\Sigma = P_1 + P_2 + P_3$

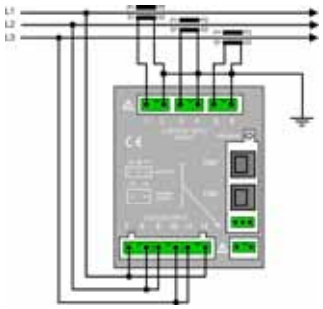
Total reactive Power: Q_Σ $\quad Q_\Sigma = Q_1 + Q_2 + Q_3$

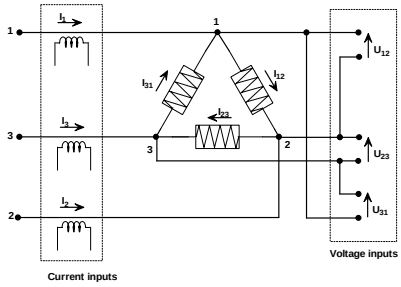
Total apparent Power: S_Σ $\quad S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$

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:

Phase-phase Voltages: 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)

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

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

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

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

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

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

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

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

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

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

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

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

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

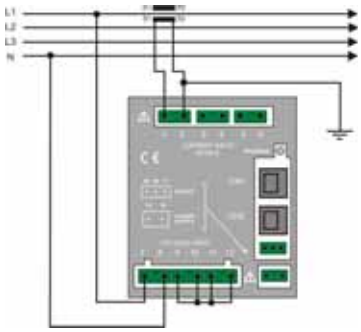
Three phase reactive Power: Q_Σ $Q_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{12}(n + M/4)\, I_1(n) - \sum_{n=0}^{M-1} U_{23}(n + M/4)\, I_3(n)\right]$

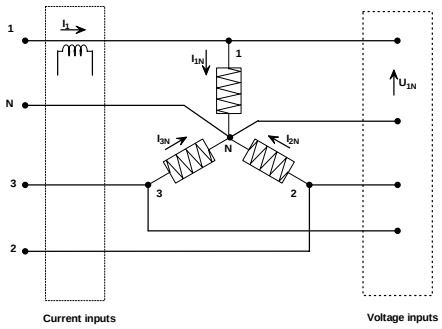
Three phase apparent Power: S_Σ $S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$

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 $x < 0$.

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

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

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

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

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

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

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

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

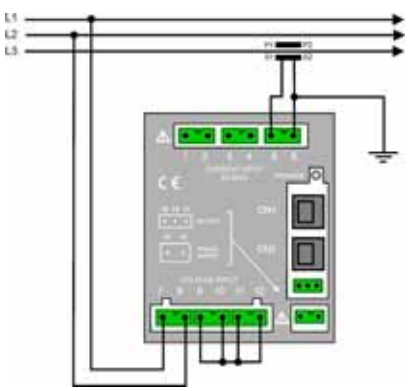
Total reactive Power: Q_Σ $\quad Q_\Sigma = Q_1 * 3$

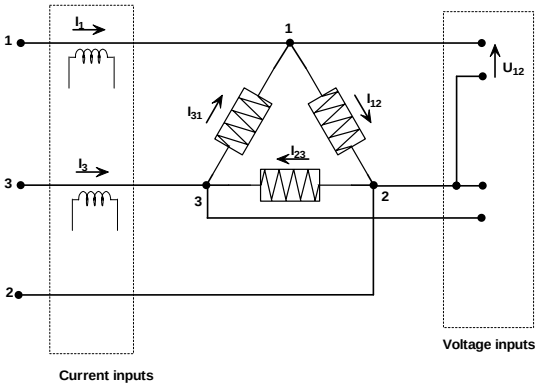
Total apparent Power: S_Σ $\quad S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$

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

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

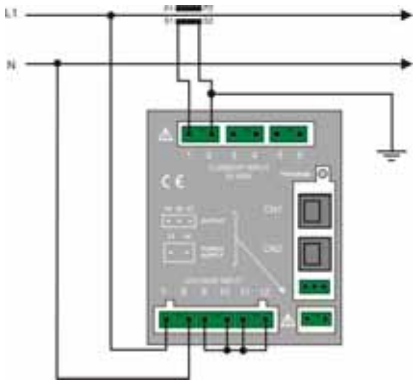
Three phase reactive Power: Q_Σ $$Q_\Sigma = \frac{1}{M}\left[\sum_{n=0}^{M-1} U_{23}(n)\, I_1(n)\right]\sqrt{3}$$

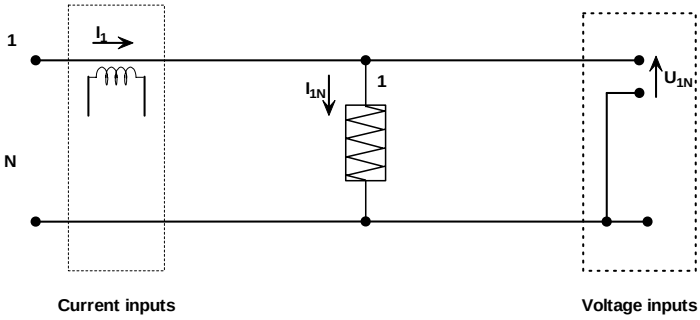
Three phase apparent Power: S_Σ $$S_\Sigma = \sqrt{P_\Sigma^2 + Q_\Sigma^2}$$

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

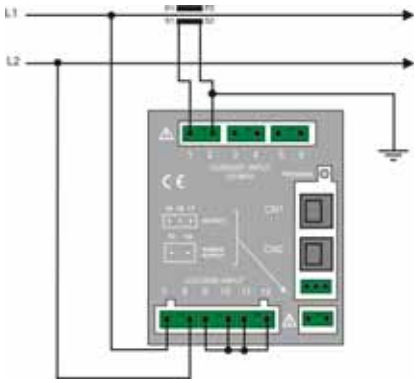
Phase reactive Powers : Q_1 $$Q_1 = \frac{1}{M}\sum_{n=0}^{M-1} U_{1N}(n+M/4)\, I_1(n)$$

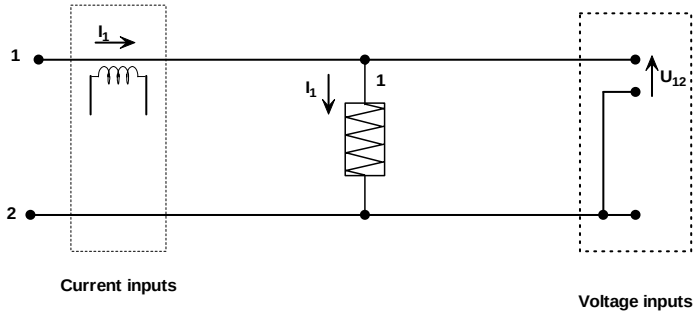
Phase apparent Powers: S_1 $$S_1 = U_1 I_1$$

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

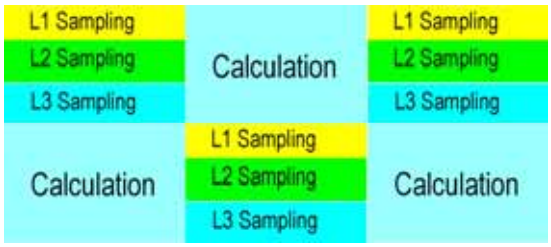
Phase apparent Power: S_Σ $$S_\Sigma = U_{12} I_1$$

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

X3M 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)

X3M 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 X3M.
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.

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
140 : 155	Byte Array ASCIIZ String	Active Timezone Name		This group of registers is updated on each read access to the first register. Read queries not including the first address, will give not updated values. Write queries involving at least one register of these, initiate a search in the timezone names table. On success, the clock will be adjusted according to the rules of the specified timezone. On fail, the instrument answers with an exception response of type 04.
156	Integer Word	Active Timezone Index	0-n	See Updated Timezones Table
157 158	Bitmapped (4 bytes)	Wall Time: Day, Month, Year, Century	⊙⊙⊙⊙⊙⊙⊙⊙ ○○○○○○○○ ○○○○○○○○ ○○○○○○○○ Bits 31 ÷ 24: Century ○○○○○○○○ ⊙⊙⊙⊙⊙⊙⊙⊙ ○○○○○○○○ ○○○○○○○○ Bits 23 ÷ 16: Year ○○○○○○○○ ○○○○○○○○ ⊙⊙⊙⊙⊙⊙⊙⊙ ○○○○○○○○ Bits 15 ÷ 8: Month ○○○○○○○○ ○○○○○○○○ ○○○○○○○○ ⊙⊙⊙⊙⊙⊙⊙⊙ Bits 7 ÷ 0: Day of Month	Only date values in the range of 1/1/2004 and 31/12/2099 will be accepted. If an invalid combination is settled for Century, Year, Month and Day fields, the instrument answers with an exception response of type 04. These registers must be written within the same modbus query. The instrument answers with an exception response of type 04, to those write query involving only one of these registers.
159 160	Bitmapped (4 bytes)	Wall Time: Seconds, Minutes, Hours, DST flag	⊙⊙⊙⊙⊙⊙⊙○ ○○○○○○○○ ○○○○○○○○ ○○○○○○○○ Bits 31 ÷ 25: Unused ○○○○○○○⊙ ○○○○○○○○ ○○○○○○○○ ○○○○○○○○ Bit 24: DST flag ○○○○○○○○ ⊙⊙⊙⊙⊙⊙⊙⊙ ○○○○○○○○ ○○○○○○○○ Bits 23 ÷ 16: Hours ○○○○○○○○ ○○○○○○○○ ⊙⊙⊙⊙⊙⊙⊙⊙ ○○○○○○○○ Bits 15 ÷ 8: Minutes ○○○○○○○○ ○○○○○○○○ ○○○○○○○○ ⊙⊙⊙⊙⊙⊙⊙⊙ Bits 7 ÷ 0: Seconds	DST flag = 1 means Daylight Saving Time in use. The DST flag's value will be ignored if written date/ time values are not compatible with it. If an invalid combination is settled for Hours, Minutes and Seconds fields, the instrument answers with an exception response of type 04. These two registers must be written within the same modbus query. The instrument answers with an exception response of type 04 to those write query involving only one of these registers.

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
161 162	Integer (4 bytes)	Universal Time as UNIX Timestamp Format		Number of elapsed seconds since Unix Epoch Time (January 1, 1970 00.00.00) not including neither leap seconds nor timezone offsets. Only date values in the range of 1/1/2004 and 31/12/2099 will be accepted, otherwise the instrument answers with an exception response of type 04. These two registers must be written within the same modbus query.
163	Integer Word	GMT offset		Minutes west from GMT. *UTC Time* + (*GMT offset* * 60) + (*DST offset* * 60) = *Local Time* (*Wall Clock Time*) in Unix Time Stamp format. This is a read only register.
164	Integer Word	DST offset		Minutes offset from Standard Time during Daylight Saving Time. *UTC Time* + (*GMT offset* * 60) + (*DST offset* * 60) = *Local Time* (*Wall Clock Time*) in Unix Time Stamp format. This is a read only register.
165	Bitmapped Word	DST flag	○○○○○○○○ ○○○○○○○⊙ Bit 0: DST flag ⊙⊙⊙⊙⊙⊙⊙⊙ ⊙⊙⊙⊙⊙⊙⊙○ Bits 15 ÷ 1: Not used	DST flag = 1 means Daylight Saving Time in use. The DST flag's value will be ignored if not compatible with the value specified in the following two. This register with the following two, must be written within the same modbus query.
166 167	Integer (4 bytes)	Wall Time as UNIX Timestamp Format		Number of elapsed seconds since Unix Epoch Time (January 1, 1970 00.00.00) plus *GMT offset* and *DST offset*. Leap seconds are not included. Only date values in the range of 1/1/2004 and 31/12/2099 will be accepted. If values outside out of range value is settled, the instrument raises an exception response of type 04. These two registers with the previous one, must be written within the same modbus query.

Holding Registers				
Addr.	**Type**	**Description**	**Range [Unit] or Bitmap**	***Notes***
168 169	Integer (4 bytes)	Time of Next Changeover (Daylight Saving Time to Standard Time or viceversa) as UNIX Timestamp Format		Unix Time Stamp of next changeover from Standard Time to Daylight Saving Time or viceversa

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  are available only in Import/Export configuration.

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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_{LN}	U_{LL}	×	×	U_{1N}	U_{2N}	U_{3N}	U_{12}	U_{23}	U_{31}	×	×	×	×	×	×	$U_{1N\div3N}$	$U_{12\div31}$
2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
3	×	×	×	I_N	I_Σ	I_1	I_2	I_3	×	×	×	×	×	×	×	×	×	$I_{1\div3}$	×
4	×	×	×	×	P_Σ	P_1	P_2	P_3	×	×	×	$P_{IMP,WC}$	$P_{EXP,WC}$	×	×	×	×	×	×
5	×	×	×	×	Q_Σ	Q_1	Q_2	Q_3	×	×	×	×	×	$Q_{L\ IMP,WC}$	$Q_{C\ IMP,WC}$	$Q_{L\ EXP,WC}$	$Q_{C\ EXP,WC}$	×	×
6	×	×	×	×	S_Σ	S_1	S_2	S_3	×	×	×	$S_{IMP,WC}$	$S_{EXP,WC}$	×	×	×	×	×	×
7	×	×	×	×	PF_Σ	PF_1	PF_2	PF_3	×	×	×	×	×	×	×	×	×	×	×
8	×	×	×	×	×	$THD_{U_{1N}}$	$THD_{U_{2N}}$	$THD_{U_{3N}}$	×	×	×	×	×	×	×	×	×	$THD_{U_{1N\div3N}}$	$THD_{U_{12\div31}}$
9	×	×	×	×	×	THD_{I_1}	THD_{I_2}	THD_{I_3}	×	×	×	×	×	×	×	×	×	$THD_{I_{1\div3}}$	×

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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_{LL}	×	×	×	×	×	U_{12}	U_{23}	U_{31}	×	×	×	×	×	×	×	$U_{12\div31}$
2	f	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
3	×	×	×	×	I_Σ	I_1	I_2	I_3	×	×	×	×	×	×	×	×	×	$I_{1\div3}$	×
4	×	×	×	×	P_Σ	×	×	×	×	×	×	$P_{IMP,WC}$	$P_{EXP,WC}$	×	×	×	×	×	×
5	×	×	×	×	Q_Σ	×	×	×	×	×	×	×	×	$Q_{L\ IMP,WC}$	$Q_{C\ IMP,WC}$	$Q_{L\ EXP,WC}$	$Q_{C\ EXP,WC}$	×	×
6	×	×	×	×	S_Σ	×	×	×	×	×	×	$S_{IMP,WC}$	$S_{EXP,WC}$	×	×	×	×	×	×
7	×	×	×	×	PF_Σ	×	×	×	×	×	×	×	×	×	×	×	×	×	×
8	×	×	×	×	×	×	×	×	$THD_{U_{12}}$	$THD_{U_{23}}$	$THD_{U_{31}}$	×	×	×	×	×	×	×	$THD_{U_{12\div31}}$
9	×	×	×	×	×	THD_{I_1}	THD_{I_2}	THD_{I_3}	×	×	×	×	×	×	×	×	×	$THD_{I_{1\div3}}$	×

3Ph-4W Balanced																			
		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	×	×	×	×	×	$P_{IMP,VG}$	$P_{EXP,VG}$	×	×	×	×	×	×
	5	×	×	×	×	Q_Σ	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP,VG}$	$Q_{C\ IMP,VG}$	$Q_{L\ EXP,VG}$	$Q_{C\ EXP,VG}$	×	×
	6	×	×	×	×	S_Σ	S_1	×	×	×	×	×	$S_{IMP,VG}$	$S_{EXP,VG}$	×	×	×	×	×	×
	7	×	×	×	×	×	PF_1	×	×	×	×	×	×	×	×	×	×	×	×	×
	8	×	×	×	×	×	$THD_{U,N}$	×	×	×	×	×	×	×	×	×	×	×	×	×
	9	×	×	×	×	×	THD_L	×	×	×	×	×	×	×	×	×	×	×	×	×

3Ph-3W Balanced																			
		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	×	×	×	×	×	×	$P_{IMP,VG}$	$P_{EXP,VG}$	×	×	×	×	×	×
	5	×	×	×	×	Q_Σ	×	×	×	×	×	×	×	×	$Q_{L\ IMP,VG}$	$Q_{C\ IMP,VG}$	$Q_{L\ EXP,VG}$	$Q_{C\ EXP,VG}$	×	×
	6	×	×	×	×	S_Σ	×	×	×	×	×	×	$S_{IMP,VG}$	$S_{EXP,VG}$	×	×	×	×	×	×
	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	×	×	×	×	×	$P_{IMP,VG}$	$P_{EXP,VG}$	×	×	×	×	×	×
5	×	×	×	×	×	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP,VG}$	$Q_{C\ IMP,VG}$	$Q_{L\ EXP,VG}$	$Q_{C\ EXP,VG}$	×	×
6	×	×	×	×	×	S_1	×	×	×	×	×	$S_{IMP,VG}$	$S_{EXP,VG}$	×	×	×	×	×	×
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	×	×	×	×	×	$P_{IMP,VG}$	$P_{EXP,VG}$	×	×	×	×	×	×
5	×	×	×	×	×	Q_1	×	×	×	×	×	×	×	$Q_{L\ IMP,VG}$	$Q_{C\ IMP,VG}$	$Q_{L\ EXP,VG}$	$Q_{C\ EXP,VG}$	×	×
6	×	×	×	×	×	S_1	×	×	×	×	×	$S_{IMP,VG}$	$S_{EXP,VG}$	×	×	×	×	×	×
7	×	×	×	×	×	PF_1	×	×	×	×	×	×	×	×	×	×	×	×	×
8	×	×	×	×	×	×	×	×	$THD_{U_{12}}$	×	×	×	×	×	×	×	×	×	×
9	×	×	×	×	×	THD_{I_1}	×	×	×	×	×	×	×	×	×	×	×	×	×

9.4.3 X3M Input registers

In this chapter the X3M 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	%	$THD_{U_{1N}}$	⇒ **3P4W, 3P-b 4W, 1P2W**
		Phase to phase Voltage, THD		$THD_{U_{12}}$	⇒ **3P3W, 3P-b 3W, 2P2W**
202 203	Float IEEE754	Phase to neutral Voltage, THD	%	$THD_{U_{2N}}$	⇒ **3P4W**
		Phase to phase Voltage, THD		$THD_{U_{23}}$	⇒ **3P3W**
204 205	Float IEEE754	Phase to neutral Voltage, THD	%	$THD_{U_{3N}}$	⇒ **3P4W**
		Phase to phase Voltage, THD		$THD_{U_{31}}$	⇒ **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}	⇒ **3P4W, 3P-b 4W, 1P2W**
				f_{12}	⇒ **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**

Addr.	Type	Description	Unit	Symbol	System config / Notes
242 243	Float IEEE754	Phase Reactive Power (+/-)	var	Q_2	⇒ **3P4W**
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 imported Active Power, AVG	W	$P_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
278 279	Float IEEE754	Total imported inductive power, AVG	var	$Q_{m\ ind} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
280 281	Float IEEE754	Total imported capacitive power, AVG	var	$Q_{m\ cap} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
282 283	Float IEEE754	Total imported apparent power, AVG	VA	$S_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
284 285	Float IEEE754	Total exported Active Power, AVG	W	$P_m -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
286 287	Float IEEE754	Total exported 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 exported capacitive power, AVG	var	$Q_{m\ cap} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**

Addr.	Type	Description	Unit	Symbol	System config / Notes
290 291	Float IEEE754	Total exported apparent power, AVG	VA	$S_m -$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
292 293	Float IEEE754	Total imported Active Power, MD	W	$P_{Max} +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
294 295	Float IEEE754	Total imported inductive power, MD	var	$Q_{Max\ ind} +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
296 297	Float IEEE754	Total imported capacitive power, MD	var	$Q_{Max\ cap} +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
298 299	Float IEEE754	Total imported apparent power, MD	VA	$S_{Max} +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
300 301	Float IEEE754	Total exported Active Power, MD	W	$P_{Max} -$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
302 303	Float IEEE754	Total exported 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 exported 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 exported apparent power, MD	VA	$S_{Max} -$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
308 : 326		NOT USED			Return undefined valued, if read.
327 328	Integer (4 bytes)	Imported active energy	kWh/10	$E_a +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
329 330	Integer (4 bytes)	Imported inductive energy	kvarh/10	$E_{r\ ind} +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
331 332	Integer (4 bytes)	Imported capacitive energy	kvarh/10	$E_{r\ cap} +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
333 334	Integer (4 bytes)	Imported apparent energy	kVAh/10	$E_S +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W
335 336	Integer (4 bytes)	Exported active energy	kWh/10	$E_a -$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W ⇒ Import/ Export only
337 338	Integer (4 bytes)	Exported 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)	Exported 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)	Exported 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)	Imported active energy (Hi Resolution)	Wh/10	$E_a +$	⇒ 3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W

Addr.	Type	Description	Unit	Symbol	System config / Notes
349 350 351 352	Integer (8 bytes)	Imported 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)	Imported 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)	Imported 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)	Exported 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)	Exported 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)	Exported 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)	Exported 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 imported Active Power, AVG	W	$P_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
14 15	Float IEEE754	Total imported apparent power, AVG	VA	$S_m +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
16 17	Float IEEE754	Total imported Active Power, MD	W	$P_{Max} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
18 19	Float IEEE754	Total imported apparent power, MD	VA	$S_{Max} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W**
20 21	Float IEEE754	Imported 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	Imported 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**
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	Float	Phase Active Power (+/-)	W	P_2	⇒ **3P4W**

Addr.	Type	Description	Unit	Symbol	Wirings / Notes
43	IEEE754				
44 45	Float IEEE754	Phase Active Power (+/-)	W	P_3	⇒ **3P4W**
46 47	Float IEEE754	Voltage Input Frequency	Hz	f_{1N}	⇒ **3P4W**
				f_{12}	⇒ **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	Exported 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	Exported capacitive energy	kvar	$E_{r\ cap} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
80 81	Float IEEE754	Exported inductive energy	kvar	$E_{r\ ind} -$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**
82 83		NOT USED			Return undefined valued, if read.
84 85	Float IEEE754	Total imported 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 imported inductive power, AVG	var	$Q_{m\ ind} +$	⇒ **3P4W, 3P-b 4W, 1P2W, 3P3W, 3P-b 3W, 2P2W** ⇒ **Import/ Export only**

Addr.	Type	Description	Unit	Symbol	Wirings / Notes
96 : 125		NOT AVAILABLE			Return undefined valued, if read.
126 127	Float IEEE754	Phase to neutral Voltage, THD	%	$THD_{U_{1N}}$	⇒ **3P4W**
		Phase to phase Voltage, THD		$THD_{U_{12}}$	⇒ **3P3W**
128 129	Float IEEE754	Line current, THD	%	THD_{I_1}	⇒ **3P4W, 3P3W**
130 131	Float IEEE754	Phase to neutral Voltage, THD	%	$THD_{U_{2N}}$	⇒ **3P4W**
		Phase to phase Voltage, THD		$THD_{U_{23}}$	⇒ **3P3W**
132 133	Float IEEE754	Line current, THD	%	THD_{I_2}	⇒ **3P4W, 3P3W**
134 135	Float IEEE754	Phase to neutral Voltage, THD	%	$THD_{U_{3N}}$	⇒ **3P4W**
		Phase to phase Voltage, THD		$THD_{U_{31}}$	⇒ **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 X3M coils

Proprietary X3M coils area.

X3M 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 File organization and management in the X3M flash memory.

10.1 File system

X3M uses a "*Flash-Disk*" for the storage of its configuration parameters, readings and other operating information.

Data on disk are organized in record files, as specified by the Modbus standard.
Files are accessed through the Modbus functions *"Write General File"* and *"Read General File".*

Available space is 2.088.960 bytes, organized in 4.096 allocation units of 510 bytes each. As each file occupies at least one allocation unit, there may be at most 4096 disk files.

Each file is uniquely identified by a 2-byte index (*file number*, 0 to 65535) and can contain up to 10,000 records, numbered from 0 to 9,999. The record max size is 238 bytes.

Records in the same file must all share the same size. The only exception to this rule is record 0, whose size may differ from the others. Record 0 is also called the *file header*: All other records (data records) are the file *body*.

The first four bytes of record 0 are called "*record definition structure"* and contain information that is essential for file data access, such as:

- Header size;
- Size for each record in the data area;
- Information pertaining to the file organization and content:

  - RAW Flag:
    0 = Structured file;
    1 = Raw file;

  - NON HOMOGENEOUS Flag:
    0 = all data records share the same format (homogeneous file);
    1 = the file structure is such as to allow saving data records of different formats (non homogeneous file);

  - OUTPUT Flag:
    0 = The instrument treats this file as read only file (e.g. configuration file);
    1 = This file is written by the instrument (e.g. report);

  - DIRECTORY Flag: when set (flag == 1) the file is a disk *directory*;

The structure of X3M files is detailed in the following pages.

Generic file structure					
Record Number	**Record Size (bytes)**	**Field Name and Size**		**Type**	**Value**
0	**h** (h ≤ 238)	Record definition structure (4 bytes)	Header Size (**1 byte**)	Unsigned integer	**h**
			Data record size (**1 byte**)	Unsigned integer	**d**
			Reserved (**1 byte**)	Unsigned integer	**0**
			Reserved (**1 byte**)	Unsigned integer	**0**
			Reserved (**1 byte**)	Unsigned integer	**0**
			Reserved (**1 byte**)	Unsigned integer	**0**
			DIRECTORY Flag (**1 bit**)	Flag	-
			OUTPUT Flag (**1 bit**)	Flag	-
			NON HOMOGENEOUS Flag (**1 bit**)	Flag	-
			RAW Flag (**1 bit**)	Flag	-
		Other header fields		-	-
1	**d** (d ≤ 238)	Data		-	-
2	**d**	Data		-	-
⋮	⋮	⋮		⋮	⋮
N (N ≤ 9999)	**d**	Data		-	-

All numeric values in file fields are in *big-endian* order.

Each file contains the following information:
Name (alphanumeric string of 36 characters max length);
Creation date/time;
Last modification date/time.

This information is accessible through the disc *directories* as explained further on in this document.

It should be noted that file names need not be unique: it is therefore possible to have more than one file bearing the same name. Files are uniquely identified by their *file number* only.

10.1.1 Types of file

The X3M classifies the possible 65.536 files in 256 “types” according to the value of most significant byte of the *file number*. The least significant byte is used to identify the possible 256 files belonging to each type.

The designation that will be used in the following pages will be:

type.number

where *type* and *number* are hexadecimal values in the interval 00 and FF.

Example

02.07 it identifies the 7th file of type 2 (modbus index 0207h ≡ 519 decimal)
03.8B it identifies the 139th file of type 3 (modbus index 038Bh ≡ 907 decimal)

Each file type is dedicated to a specific service:

- The file types 1-254 are reserved for storage of the field readings and for the instrument configuration parameters:
    - Type 1: Load profiles logging;
    - Type 2: System logs;
    - Type 3: Configuration logs;
    - Type 4: Events log (voltage losses and overcurrent);
    - Type 5: Peaks logging;
    - Type 6: Time-of-use tariff calendar;
    - Type 7: Time-of-use energy counters;
    - Type 8: Time-of use maximum demand;
    - Type 253: user defined files;
    - Type 254: user defined files;
- The file type 255 is reserved for access to the memory area containing the instrument firmware (firmware up/download);
- The file type 0 designates the disk “*directories*”.

10.1.2 File structure

There are two file categories:

- files containing structured information, whose fields have an assigned type (*structured files*)
- files containing “raw” data, without defined fields, or field types (*raw files*)

Raw files are distinguished by the *RAW FILE* flag in the *record definition structure*

10.1.3 Structured Files

Structured files are mostly used to save on disc the values of variables allocated in the device volatile memory. These variables can be used to hold configuration values (*input variables*) or to hold the results of the analysis and data logging functions (*output variables)*

.

Each structured file contains one or more “*Variable definition structures”* describing the variables format and content:

Variable definition structure					
Field Size	**Field Name**		**Field Type**	**Field Description**	**Values**
1 byte	Reserved		Unsigned integer	Reserved	**0**
1 byte	Descriptor list size		Unsigned integer	Size(in bytes) of the descriptor list container in the structure	**s**
s bytes	Descriptor List	Descriptor 1	-	A list of descriptors defining the variables stored in the file.	-
		Descriptor 2			
		:			
		Descriptor m			

Structured files can be of two types:

- HOMOGENEOUS FILES containing data records sharing the same format;
- NON HOMOGENEOUS FILES, containing data records whose format may differ

Homogeneous files contain - in the file header - a single variable definition structure.

Non-homogeneous files contain a variable definition structure per data record: their header contains only the record definition structure.

Homogeneous and non-homogeneous files can be distinguished by the value of the NON HOMOGENEOUS *FILE* flag, in the record definition structure.

10.1.4 Descriptors

Each descriptor listed in the "*variable definition structure*" defines a file variable. The structure of a generic descriptor is as follows:

Generic descriptor			
Filed Size	**Field Name**	**Field Type**	**Field Description**
1 byte	Descriptor size	Unsigned Integer	Descriptor size (in bytes)
1 bit	External allocation flag	Flag	flag=0 indicates that the variable is stored within the descriptor; If flag=1 the variable is stored externally.
1 bit	Single allocation flag	Flag	This flag is significant only if the variable is allocated externally to the descriptor; flag=0 indicates that the file contains only one copy of the variable; If flag=1 means the file contains multiple copies.
6 bits	Variable type ID	Unsigned Integer	Numeric index: identifies the data type of the variable defined by this descriptor.
Varies with the value of the field *"Variable type ID"*	Variable Identification	Varies with the value of the field *"Variable type ID"*	A parameter (which may be simple or a structure) identifying the defined variable.
Varies with the value of the field *"Variable type ID"*	Variable	Varies with the value of the field *"Variable type ID"*	Variable defined by this descriptor (which may be simple or a structure). **This field is present only if the external allocation flag is set to 0**.

Descriptors – and the variables they define - are further classified, as follows, according to the values of the external allocation and single allocation flags:

Variable Descriptor Types in structured files		
External Allocation Flag	**Single Allocation Flag**	**Descriptor Type**
0	0	Internal allocation
0	1	
1	0	External multiple allocation
1	1	External single allocation

The following variable types are defined:

Variable types			
Name		**ID**	**Description**
Generic Types	*Word*	01h	2 bytes: signed or unsigned integer
	DoubleWord	02h	4 bytes: signed or unsigned integer or single accuracy IEEE-754 float
	QuadWord	03h	8 bytes: signed or unsigned integer or double accuracy IEEE-754 float
	Byte pair	04h	Structure having two fields, each consisting of one byte (signed or unsigned integer).
	Byte Array	05h	Variable length byte array (alphanumeric ASCIIZ string or array of signed or unsigned integers)
Date/Time	*Unix Timestamp*	06h	Number of *non leap* seconds since the so called *Unix Epoch* (1/1/1970 00:00:00)
	Unix Timestamp + offset	07h	Structured type including the following fields: – Number of *non leap* seconds since the so called *Unix Epoch* (1/1/1970 00:00:00); – GMT offset in minutes (signed); – DST offset in minutes (signed).
	Unix Timestamp + DST flag	08h	Structured type including the following fields: – Number of *non leap* seconds since the so called *Unix Epoch* (1/1/1970 00:00:00); – Flag indicating if, at this instant, STANDARD TIME or DAYLIGHT SAVING TIME is in effect.
	Date	09h	Structured type including the following fields: Century, Year, Month, Day
	Time	0Ah	Structured type including the following fields: Hours, Minutes, Seconds, DST flag
	Date/Time	0Bh	Structured type including the following fields: Century, Year, Month, Day, Hours, Minutes, Seconds, DST flag
Modbus Registers	*Input Registers Group*	0Ch	Structured type including a group of contiguous input registers
	Holding Registers Group	0Dh	Structured type including a group of contiguous holding registers
	Arithmetic Operation between 2 Input Registers	0Eh	Structured type defining an arithmetic operation (e.g. comparison) to be carried out between two input registers

The following table indicates the formats of each variable type and of the corresponding parameters:

<table>
<tr><th colspan="3">Variable types</th></tr>
<tr><th>Type Name</th><th>Type ID</th><th>Variable</th><th>Variable Identification</th></tr>
<tr><td>Word</td><td>01h</td><td>
<table>
<tr><th>Field Size (bytes)</th><th>Field Name</th><th>Field Type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field SIze (bytes)</th><th>Field Name</th><th>Field Type</th><th>Description</th></tr>
<tr><td>2</td><td>WORD</td><td>Signed or unsigned integer</td><td>2 byte data</td></tr>
</table>
</td></tr>
<tr><td>DoubleWord</td><td>02h</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>4</td><td>DWORD</td><td>Signed or unsigned integer or single precision IEEE754 float</td><td>4 byte data</td></tr>
</table>
</td></tr>
<tr><td>QuadWord</td><td>03h</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>8</td><td>QWORD</td><td>Signed or unsigned integer or double precision IEEE754 float</td><td>8 byte data</td></tr>
</table>
</td></tr>
<tr><td>Byte pair</td><td>04h</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>1</td><td>BYTE 1</td><td>Signed or unsigned integer</td><td rowspan="2">Structure: 2 fields, one byte each</td></tr>
<tr><td>1</td><td>BYTE 2</td><td>Signed or unsigned integer</td></tr>
</table>
</td></tr>
</table>

Variable types

<table>
<tr><th>Type Name</th><th>Type ID</th><th>Variable</th><th>Variable Identification</th></tr>
<tr><td>Byte Array</td><td>05h</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
<tr><td>2</td><td>Array Size</td><td>unsigned integer</td><td>Array size (bytes)</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>1</td><td>BYTE 1</td><td>Signed or unsigned integer or ASCII character</td><td rowspan="4">Array of signed or unsigned integers or an ASCIIZ string with an N maximum length. If the string is N character, the final NULL can be omitted.</td></tr>
<tr><td>1</td><td>BYTE 2</td><td>Signed or unsigned integer or ASCII character</td></tr>
<tr><td>:</td><td>:</td><td>:</td></tr>
<tr><td>1</td><td>BYTE N</td><td>Signed or unsigned integer or ASCII character</td></tr>
</table>
</td></tr>
<tr><td>Unix Epoch Time</td><td>06h</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>4</td><td>UNIX TIMESTAMP</td><td>unsigned integer</td><td>Number of non leap seconds since the so called Unix Epoch (1/1/1970 00:00:00)</td></tr>
</table>
</td></tr>
<tr><td>Unix Epoch Time + offset</td><td>07h</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>4</td><td>UNIX TIMESTAMP</td><td>unsigned integer</td><td>Number of non leap seconds since the so called Unix Epoch (1/1/1970 00:00:00)</td></tr>
<tr><td>2</td><td>GMT offset</td><td>signed integer</td><td>GMT offset in minutes</td></tr>
<tr><td>2</td><td>DST offset</td><td>signed integer</td><td>DST offset in minutes</td></tr>
</table>
</td></tr>
</table>

Variable types

<table>
<tr><th>Type Name</th><th>Type ID</th><th>Variable</th><th>Variable Identification</th></tr>
<tr><td>Unix Epoch Time + DST flag</td><td>08h</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>4</td><td>UNIX TIMESTAMP</td><td>unsigned integer</td><td>Number of non leap seconds since the so called Unix Epoch (1/1/1970 00:00:00)</td></tr>
<tr><td>1</td><td>DST flag</td><td>Boolean</td><td>Flag indicating if, at this instant, STANDARD TIME or DAYLIGHT SAVING TIME is in effect.</td></tr>
<tr><td>1</td><td>Reserved</td><td>-</td><td>Reserved</td></tr>
</table>
</td></tr>
<tr><td>Date</td><td>09h</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>1</td><td>Century</td><td>unsigned integer</td><td>Century</td></tr>
<tr><td>1</td><td>Year</td><td>unsigned integer</td><td>Year</td></tr>
<tr><td>1</td><td>Month</td><td>unsigned integer</td><td>Month</td></tr>
<tr><td>1</td><td>Day</td><td>unsigned integer</td><td>Day</td></tr>
</table>
</td></tr>
<tr><td>Hour</td><td>0Ah</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>1</td><td>Ore</td><td>unsigned integer</td><td>Hours</td></tr>
<tr><td>1</td><td>Minutes</td><td>unsigned integer</td><td>Minutes</td></tr>
<tr><td>1</td><td>Seconds</td><td>unsigned integer</td><td>Seconds</td></tr>
<tr><td>1</td><td>DST flag</td><td>Boolean</td><td>Flag indicating if, at this instant, STANDARD TIME or DAYLIGHT SAVING TIME is in effect.</td></tr>
</table>
</td></tr>
</table>

Variable types

<table>
<tr><th>Type Name</th><th>Type ID</th><th>Variable</th><th>Variable Identification</th></tr>
<tr><td>Date/Hour</td><td>0Bh</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Variable ID</td><td>unsigned integer</td><td>Numeric index identifying the variable defined by the descriptor</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>1</td><td>Century</td><td>unsigned integer</td><td>Century</td></tr>
<tr><td>1</td><td>Year</td><td>unsigned integer</td><td>Year</td></tr>
<tr><td>1</td><td>Month</td><td>unsigned integer</td><td>Month</td></tr>
<tr><td>1</td><td>Day</td><td>unsigned integer</td><td>Day</td></tr>
<tr><td>1</td><td>Hour</td><td>unsigned integer</td><td>Hour</td></tr>
<tr><td>1</td><td>Minute</td><td>unsigned integer</td><td>Minute</td></tr>
<tr><td>1</td><td>Seconds</td><td>unsigned integer</td><td>Seconds</td></tr>
<tr><td>1</td><td>DST flag</td><td>Boolean</td><td>Flag indicating if, at this instant, STANDARD TIME or DAYLIGHT SAVING TIME is in effect.</td></tr>
</table>
</td></tr>
<tr><td>Input Register Group</td><td>0Ch</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Address</td><td>unsigned integer</td><td>Address of the first input register in this group</td></tr>
<tr><td>2</td><td>Register Number</td><td>unsigned integer</td><td>Number of (contiguous) registers in this group</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>REGISTER 1</td><td>-</td><td>Register 1</td></tr>
<tr><td>2</td><td>REGISTER 2</td><td>-</td><td>Register 2</td></tr>
<tr><td>...</td><td>...</td><td>-</td><td>...</td></tr>
<tr><td>2</td><td>REGISTER N</td><td>-</td><td>Register N</td></tr>
</table>
</td></tr>
<tr><td>Holding Register Group</td><td>0Dh</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Address</td><td>unsigned integer</td><td>Address of the first holding register in this group</td></tr>
<tr><td>2</td><td>Register Number</td><td>unsigned integer</td><td>Number of (contiguous) registers in this group</td></tr>
</table>
</td><td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>REGISTER 1</td><td>-</td><td>Register 1</td></tr>
<tr><td>2</td><td>REGISTER 2</td><td>-</td><td>Register 2</td></tr>
<tr><td>...</td><td>...</td><td>-</td><td>...</td></tr>
<tr><td>2</td><td>REGISTER N</td><td>-</td><td>Register N</td></tr>
</table>
</td></tr>
</table>

Variable types

<table>
<tr><th>Type Name</th><th>Type ID</th><th>Variable</th><th>Variable Identification</th></tr>
<tr>
<td>Arithmetic Operation between 2 Input Registers</td>
<td>0Eh</td>
<td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2</td><td>Address of A</td><td>unsigned integer</td><td>Address of input register A. If the “Type of A” field indicates a 32-bit data type, the instruments will operate on a pair of contiguous registers starting at this address.</td></tr>
<tr><td>1</td><td>Type of A</td><td>unsigned integer</td><td>Data type stored in A:

1 →Signed 16 bit integer
2 → Signed 32 bit integer
3 → Float 32 bit IEEE754</td></tr>
<tr><td>1</td><td>Operation ID</td><td>unsigned integer</td><td>Operation type:

0→minimum value assumed by A.
1→ maximum value assumed by A
2→minimum value assumed by A when B is positive
3→maximum value assumed by A when B is positive
4→minimum value assumed by A when B is negative
5→maximum value assumed by A when B is negative</td></tr>
<tr><td>2</td><td>Address of B</td><td>unsigned integer</td><td>Address of input register B. If the “Type B” field indicates a 32-bit data type, the instruments will operate on a pair of contiguous registers starting at this address.</td></tr>
<tr><td>1</td><td>Type of B</td><td>unsigned integer</td><td>Data type stored in B:

1 →Signed 16 bit integer
2 → Signed 32 bit integer
3 → Float 32 bit IEEE754</td></tr>
<tr><td>1</td><td>Reserved</td><td>-</td><td>Reserved</td></tr>
</table>
</td>
<td>
<table>
<tr><th>Field size (bytes)</th><th>Field name</th><th>Field type</th><th>Description</th></tr>
<tr><td>2 or 4 bytes, according to the data type of the selected input registers</td><td>Result</td><td>-</td><td>The result of the operation</td></tr>
</table>
</td>
</tr>
</table>

10.1.5 Homogenous files

Homogenous files always contain a single *"variable definition structure"* allocated in the header and contiguous to the *"record definition structure"*. All the descriptors contained in this structure define a variable that can be allocated either in the file header (in the descriptor) or in the data area. The area where the variable is allocated is described by the status of the *external allocation flag* contained in the descriptor.

Data record all share the same structure and contain only the variables specified by the descriptor list contained in the header.

Variables allocated in the data area are distinguished in single and multiple allocation variables.

If no single external allocation descriptor is present, the data area is organized as follows:

- File growth is unlimited (except for possible limitations imposed to the service type and for the overall limit of 10,000 records established by the Modbus standard);
- Each data record stores all variables defined by external multiple allocation descriptors, in the same order in which the descriptors appear in the variable definition structure;

Structure of an Homogeneous File containing no external single allocation variables.						
Record Number	**Record Size (bytes)**	**Field name and size**			**Type**	**Value**
0	**h** (**h** ≤ 238)	Header definition structure (**4** bytes)		Header size (**1 byte**)	unsigned integer	**h**
				Data record size (**1 byte**)	unsigned integer	**d**
				Reserved (**1 byte**)	unsigned integer	**0**
				Reserved (**1 byte**)	unsigned integer	**0**
				Reserved (**1 byte**)	unsigned integer	**0**
				Reserved (**1 byte**)	unsigned integer	**0**
				DIRECTORY flag (**1 bit**)	Flag	**0**
				OUTPUT flag (**1 bit**)	Flag	-
				NON HOMOGENEOUS flag (**1 bit**)	Flag	**0**
				RAW flag (**1 bit**)	Flag	**0**
		Variable definition structure (**s+2** bytes)	Reserved (**1** byte)		unsigned integer	**0**
			Descriptor list size (**1** byte)		unsigned integer	**s**
			Descriptor list (**s** bytes)	Descriptor Vi **1**	-	-
				Descriptor Vi **2**		
				...		
				Descriptor Vi **p**		
				Descriptor Vem **1**	-	-
				Descriptor Vem **2**	-	-
				...	-	-
				Descriptor Vem **q**	-	-
		Possible unused space			-	-
1	**d** (**d** ≤ 238)	Vem **1**			-	-
		Vem **2**			-	-
		:			:	:
		Vem **q**			-	-
2	**d**	Vem **1**			-	-
		Vem **2**			-	-
		...			:	:
		Vem **q**			-	-
:	**:**	:			:	:
N (**N** ≤ 9999)	**d**	Vem **1**			-	-
		Vem **2**			-	-
		...			...	...
		Vem **q**			-	-

Vi = Internal allocation variable
Vem = External multiple allocation variable
If the data definition structure contains at least one external allocation descriptor, the data section of the file is organized as follows:

- the file has as many data records as single external allocation descriptors;
- the n^{th} data record contains:
  - the variable defined from the n^{th} single external allocation descriptor;
  - all the variables defined by external multiple allocation descriptors, in the order listed in the variable definition structure.

Structure of an Homogeneous File containing at least one external single allocation variable						
Record Number	**Record Size (bytes)**	**Field name and size**			**Type**	**Value**
0..	**h** (**h** ≤ 238)	Header definition structure (**4** bytes)		Header size (**1 byte**)	unsigned integer	**h**
				Data record size (**1 byte**)	unsigned integer	**d**
				Reserved (**1 byte**)	unsigned integer	**0**
				Reserved (**1 byte**)	unsigned integer	**0**
				Reserved (**1 byte**)	unsigned integer	**0**
				Reserved (**1 byte**)	unsigned integer	**0**
				DIRECTORY flag (**1 bit**)	Flag	**0**
				OUTPUT flag (**1 bit**)	Flag	-
				NON HOMOGENEOUS flag (**1 bit**)	Flag	**0**
				RAW flag (**1 bit**)	Flag	**0**
		Variable definition structure (**s+2** bytes)	Reserved (**1** byte)		unsigned integer	**0**
			Descriptor list size (**1** byte)		unsigned integer	**s**
			Descriptor list (**s** bytes)	Descriptor Vi **1**	-	-
				Descriptor Vi **2**		
				...		
				Descriptor Vi **p**		
				Descriptor Vem **1**	-	-
				Descriptor Vem **2**	-	-
				...	-	-
				Descriptor Vem **q**	-	-
				Descriptor Ves **1**		
				Descriptor Ves **2**		
				….		
				Descriptor Ves **r**		
		Possible unused space			-	-
1	**d** (**d** ≤ 238)	Ves **1**			-	-
		Vem **1**			-	-
		Vem **2**			-	
		...			...	...
		Vem **q**			-	-
2	**d**	Ves **2**			-	-
		Vem **1**			-	-
		Vem **2**			-	-
		...			...	...
		Vem **q**			-	-
...	**...**	...			...	...
r	**d**	Ves **r**			-	-
		Vem **1**			-	-
		Vem **2**			-	-
		...			...	...
		Vem **q**			-	-

Vi = Internal allocation variable
Vem = External multiple allocation variable
Ves = External single allocation variable

10.1.6 Non Homogeneous files

The non-homogeneous file format is as follows

NON HOMOGENEOUS file structure						
Record Number	**Record Type (bytes)**	**Field Name and size**			**Type**	**Value**
0	**4**	Record definition structure (**4** bytes)	Header size (**1 byte**)		Unsigned integer	**h**
			Data record size (**1 byte**)		Unsigned integer	**d**
			Reserved (**1 byte**)		Unsigned integer	**0**
			Reserved (**1 byte**)		Unsigned integer	**0**
			Reserved (**1 byte**)		Unsigned integer	**0**
			Reserved (**1 byte**)		Unsigned integer	**0**
			DIRECTORY Flag (**1 bit**)		Flag	**0**
			OUTPUT Flag (**1 bit**)		Flag	-
			NON HOMOGENEOUS flag (**1 bit**)		Flag	**1**
			RAW flag (**1 bit**)		Flag	**0**
1	**d** (d ≤ 238)	Variable definition structure (**s+2** bytes)	Reserved (**1** byte)		Unsigned integer	**0**
			Descriptor list size (**1** byte)		Unsigned integer	**s**
			Descriptor list (**s** bytes)	Descriptor 1	-	-
				Descriptor 2		
				...		
				Descriptor **n**		
		Possible unused space			-	-
2	**d**	Variable definition structure (**s+2** bytes)	Reserved (**1** byte)		Unsigned integer	**0**
			Descriptor list size (**1** byte)		Unsigned integer	**s**
			Descriptor list (**s** bytes)	Descriptor 1	-	-
				Descriptor 2		
				...		
				Descriptor **n**		
		Possible unused space			-	-
:	:	:			:	:
N (N <= 9999)	**d**	Variable definition structure (**s+2** bytes)	Reserved (**1** byte)		Unsigned integer	**0**
			Descriptor list size (**1** byte)		Unsigned integer	**s**
			Descriptor list (**s** bytes)	Descriptor 1	-	-
				Descriptor 2		
				...		
				Descriptor **p**		
		Possible unused space			-	-

The file header contains only the *"record definition structure"*
The data records (1...N) each contain a *"variable definition structure"*

10.2 Type 0 files

Type 0 files contain information about type 1÷255 files stored on the disk.
Because of this, type 0 files can be considered disk *"directories".*

By reading type 0 files, it is possible to retrieve information about the files on the disk.
By writing type 0 files, it is possible to create or to delete files.

A directory is a structured, homogeneous file that may contain the following output variables:

Directory – Output Variables allocated in type 0 files			
Name	**ID**	**Type**	**Description**
Firmware version	FF83h	BYTE PAIR (Unsigned integer, Unsigned integer)	Firmware version Byte 0 = Major version Byte 1 = Minor version
File number	0080h	WORD (Unsigned integer)	Modbus File Number (unique file identifier)
Record size	0081h	BYTE PAIR (Unsigned integer, Unsigned integer)	Size of records in the file Byte 0 = Header size Byte 1 = Data record size
File ID	0082h	BYTE PAIR (Unsigned integer, Unsigned integer)	File organization: Byte 0 = Reserved Byte 1 = File ID
Creation time	0083h	UNIX TIMESTAMP + OFFSET	Date/time of file creation
Last modification time	0084h	UNIX TIMESTAMP + OFFSET	Date/time of last modification
File size	0085h	DOUBLEWORD (Unsigned integer)	File size, in bytes
File status	0086h	BYTE PAIR (Unsigned integer, Unsigned integer)	File status: Byte 0 = File status Byte 1 = Reserved
File Name	0087h	BYTE ARRAY (ASCIIZ string)	File name

All data records in a directory describe a disk file.

- The ***n*** record in file 00.00, where ***1 ≤ n ≤ 9999***, contains information about the ***nth*** disk file, in file-number order.

- The ***n*** record in file 00.***T***, where ***1 ≤ n ≤ 256***, contains information about the ***nth*** disk file of type ***T***, in file-number order.

- The ***n*** record in file 00.***T***, where ***257 ≤ n ≤ 513***, contains information about type ***T*** file number ***n-257***.

Each record contains an instance of the variable called "*File status* " and one of the variable called *"Service status"*.

10.2.1 File status

Bit 2 (value 04h) of such variable is a flag (named "*empty flag*") that indicates if the corresponding *file number* is an actual disk file.
When bit 2 (value 04h) of "*File status*" variable is not set, the record contains information relating to a file actually present on disk. In the contrary, when bit 2 of "*File status*" variable is set, the only significant field within the file content is "*Size*" representing the free space on disk.

10.2.2 Service status

Bit 0 of "*Service status*" indicates the status of the service to which the file pertains.
1 = all OK ==> the configuration files are available and correct and the service is under execution.
0 = Error in the configuration file; service suspended until new and correct configuration file is written
The remaining bits indicate a well identified service status however they do not provide the same information therefore reference to each service must be considered for their meaning.

10.3 Type 1 files

Type 1 files are dedicated to the "*load profiles logging service* (*file number* from 01.00 to 01.FF).

This service is mainly designed for recording load profiles (evolution of the energy counters vs. time) by means of a periodical storage on file of the content of one or more Modbus registers (*input registers* and/or *holding registers*). It can therefore be used to record any group of parameters among those performed by the instrument.

File 01.00 is a *configuration file*. It contains the registers to be sampled and the sampling interval.
File 01.00 is a non-homogeneous structured file where each data record is a *configuration profile*. A validity time range may be specified for each profile. It is thus possible to program the instrument to automatically switch from a configuration profile to another at a given moment in time.
Each configuration profile contains:

- a descriptor for each configuration parameter (input variables) to which a value is assigned;
- a descriptor for each output variable that will be written to the instrument generated files.

Writing one or more valid configuration profiles in file 01.00 automatically activates the service. To disable the service, file 01.00 must be deleted.

The service will automatically generate a number of data files (one for each calendar day): each such file contains samples collected between 00:00:00 and 24:00:00 hours of the corresponding day (the sampling time is the system clock *wall time*).
The maximum number of data files on disk is 255 (files from 01.01 to 01.FF).

The name of the data files is the same as the configuration file valid at creation time.
The configuration file name is user defined.

The maximum number of data files to be stored on disk is configurable: after the maximum is reached, oldest files will be overwritten.

The data files written by the instrument are homogeneous structured files: after collecting each sample, a data record is appended at the end of the current data file, that is, the data file of the day when the sampling time occurs (*wall time*).

Samples are collected:

- at all times (*wall time*) multiples of the sampling interval, starting from time 00:00:00 (beginning of the day);
- each time one of the following events occur:
  - the instrument is turned on (after a power failure);
  - the instrument is reset;
  - the clock is set;
  - the service configuration is changed;
  - energy counters are reset;

Each data record contains:

- a sample of each variable listed in the configuration file;
- a time-stamp (with configurable format) of the sampling time;
- an identification designating the reason (event) which triggered the sampling;

The maximum size of a data file can be set during the configuration: if the size limit is exceeded within the same day, writing to the file is disabled until the day ends. Sampling is restarted the following day on a new file.

10.3.1 Service configuration

The “load profiles logging” service makes use of the following output variables:

Load Profile Logging service – Output Variables			
Name	**ID**	**Type**	**Description**
System clock UTC	FF80h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Hour (ID 0Ah) Date/Hour (ID 0Bh)	System clock, UTC
System clock WALL TIME	FF81h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Hour (ID 0Ah) Date/Hour (ID 0Bh)	System clock, WALL TIME
Timezone name	FF82h	BYTE ARRAY (ID 05h) ASCIIZ string	Timezone name in use
Firmware version	FF83h	BYTE ARRAY (ID 04h) Unsigned integer, Unsigned integer	Firmware version (Major version, Minor version)
Slave ID	FF84h	WORD (Unsigned integer)	Instrument slave ID (Modbus)
Serial number	FF85h	DOUBLEWORD (Unsigned integer)	Instrument serial number
Event ID	0180h	WORD (Unsigned integer)	Numeric code of the event initiating the sampling: 0 Power down 1 Power up 2 Service startup 3 Scheduled sample 4 Clock changed from 5 Clock changed to 6 Configuration changed 7 Counters reset 8 Runtime error

The service configuration parameters are stored in the following input variables:

Load Profile Logging Service – Input Variables						
Name	**ID**	**Type**	**Range**	**Default**	**Units**	**Description**
Max data-file size	FF00h	DWORD (ID 02h) Unsigned integer	-	The entire available disk space	Bytes	Maximum size allowed for a data file
Max data-file number	0100h	WORD (ID 01h) Unsigned integer	1÷255	60	-	Maximum number of files on disk allowed
Sampling interval	0101h	WORD (ID 01h) Unsigned integer	1÷60	15	Minutes	Sampling interval

Each configuration profile may contain:

- An *internal allocation* descriptor for each of the following input variables:
  - Max data-file number
  - Max data-file size
  - Sampling interval

  The value given by the descriptor is assigned to the corresponding input variable upon service initialisation.

  A default value is foreseen for each input variable used by the service; it is used when the variable is not set in the configuration profile.

- An *internal allocation* descriptor for each of these output variables:
  - System clock, UTC
  - System clock, WALL TIME
  - Timezone name
  - Slave ID
  - Serial number

  The value present in the descriptor is not used for these variables, as it will be overwritten by the data generated by the service itself.

Each time a new data file is created, the “load profiles logging” service copies, into the header, the variable definition structure defined by the current configuration profile.
The values contained in the internal allocation records relating to output variables are then overwritten – in the data file - by the values of the corresponding variables at creation time.

- An *external multiple allocation* descriptor for each of the following output variables:
  - System clock, UTC
  - System clock, WALL TIME
  - Event ID
  - Input registers
  - Holding registers

  These descriptors define the data area content of the files generated by this service: each data record contains the values of all the variables defined in the external multiple allocation descriptors in the order in which they are listed in the configuration profile. The stored values are those ones that sampled at record creation time.
  The “load profiles logging” service does not use external single allocation descriptors.

All internal allocation descriptors, defining variables not handled by the service, are copied *verbatim* in the data file.

10.4 Type 4 files

The type 4 files are dedicated to recording of events related to power quality.

The “Events service”, when configured, records the following events in its files:

- *Power Off*: power supply drop below the voltage level ensuring instrument energisation;
- *Power On*: power supply voltage return;
- *Voltage Dip* or *Voltage Sag:* voltage drop of one or more phases (Ph-N for star connection, Ph-Ph for delta connection) below a programmed set point for a short number of cycles (programmable limit).
- *Undervoltage Start:* same as *Voltage Dip/Sag* but having a duration exceeding the programmed limit in number of cycles.
- *Undervoltage End:* return of one or more line voltages within the programmed set point that generated the *Undevoltage Start* event.
- *Voltage Swell:* rise of one or more voltages above a programmed set point for a short number of cycles.
- *Overvoltage Start:* same as the *Voltage Swell* but having a duration exceeding the programmed limit in number of cycles.
- *Overvoltage End:* return of one or more line voltages within the programmed set point that generated the *Overvoltage Start* event.
- *Current Peak*: rise of one or more line currents above a programmed set point for a short number of cycles.
- *Overcurrent Start*: same as the *Current Peak* but having a duration exceeding the programmed limit in number of cycles.
- *Overcurrent End:* return of one or more line currents within the programmed set point that generated the *Overcurrent Start* event.
- *Config File Access*: modification of the configuration file;
- *Detection Started*.
- *Detection Suspended*: the measurement and detection functions are suspended, example, in the case of firmware up-grade.
- *Detection Resumed*: when measurement and detection functions are restarted.

The instrument discriminates Overcurrent Peaks and Overcurrents occurring with positive Active Power (import) and with negative Active Power (export).
It additionally classifies Overcurrents in two categories depending upon their duration and according to a programmable limit in number of cycles.
Overcurrents of duration below a given number of cycles are classified as *Current Peaks* with duration expressed in number of cycles. Overcurrents of duration above the set limit generate two distinct events: an *Overcurrent Start* and an *Overcurrent End*.

Line voltage variations too are discriminated into two categories depending upon their duration and according to a programmable limit in number of cycles.
Voltage variations of duration below a given number of cycles are classified as V*oltage Dips/Sags* and *Voltage Swells* Voltage variations above the set duration, generate two distinct events: an *Undervoltage Start* and an *Undervoltage End* or an *Overvoltage Start* and an *Overvoltage End.*

Events are recorded on a number of report-files - minimum 2 - specified by the user. A maximum size (in number of bytes) may be also specified for each file.
Upon reaching the maximum specified file size, events recording continues on a new file.
Upon reaching the specified number of files, oldest files will be overwritten by changing the name suffix (_001, _002, etc).

Whenever one of the above listed events occurs, a record is automatically appended to the report file.

Each record contains:

1. a time-stamp (with configurable format) of the sampling time
2. a description identifying simultaneously event type and current or voltage phase involved.

    - *Power On*;
    - *Power Off*;
    - *Voltage Sag / Dip*;
    - *Undervoltage, Start*;
    - *Undervoltage, End*;
    - *Voltage Swell*;
    - *Overvoltage Start*;
    - *Overvoltage End*;
    - *Import Current Peak*;
    - *Export Current Peak*;
    - *Import Overcurrent Start*;
    - *Import Overcurrent End*;
    - *Export Overcurrent Start*;
    - *Export Overcurrent End*;

3. A field indicating the duration, expressed in number of cycles, for Voltage Sags/Dips and Swells and for Current Peaks; it ill be zero for all other events.
4. A peak value indicating the maximum value attained by the parameter during the event; its representation is user configurable in the configuration file (DOUBLEWORD or FLOAT IEEE754).

N.B.: The terms used are those contemplated by the IEEE 1159 standards.

10.4.1 Service Configuration

This service makes use of the following output variables:

Events Service – Output variables				
Name	**ID**	**Type**	**Mandat.** [1]	**Description**
Time-stamp Hundredths	0480h	WORD (ID 01h) (Unsigned integer)	YES	Hundredths of second
Event ID	0481h	WORD (ID 01h) (Unsigned integer)	YES	Numerical code identifying the event
Event Duration	0482h	WORD (ID 01h) (Unsigned integer)	YES	Event duration (where applicable)
Peak Value	0483h	DOUBLEWORD (ID 02h) (Unsigned integer)	NO	Peak value (signed integer)
Peak Value	0484h	DOUBLEWORD (ID 02h) (Unsigned integer)	NO	Peak value (floating point)
System clock UTC	FF80h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Time (ID 0Ah) Date/Time (ID 0Bh)	YES[2]	System clock, UTC
System clock WALL TIME	FF81h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Time (ID 0Ah) Date/Time (ID 0Bh)	YES[2]	System clock, WALL TIME
Timezone name	FF82h	BYTE ARRAY (ID 05h) ASCIIZ string	NO	Timezone name in use
Firmware version	FF83h	BYTE PAIR (ID 04h) Unsigned integer, Unsigned integer	NO	Firmware version in use (Major version, Minor version)
Slave ID	FF84h	WORD (ID 01h) (Unsigned integer)	NO	Instrument slave ID (Modbus)
Serial number	FF85h	DOUBLEWORD (ID 02h) (Unsigned integer)	NO	Instrument serial number
Timezone index	FF87h	WORD (ID 01h) (Unsigned integer)	NO	Timezone index in use

[1] It specifies if the variable is, or not, mandatory for service start-up and operation.
[2] Setting of at least one time stamp variable is required for service start up.

The service configuration parameters are stored in the following input variables:

Events Service – Input variables						
Name	**ID**	**Type**	**Range**	**Default**	**Unit**	**Description**
Max data-file size	FF00h	DWORD (ID 02h) Unsigned integer	-	All space available on disk	bytes	Maximum admitted size for each data file
Max data-file number	0400h	WORD (ID 01h) Unsigned integer	1÷255	4	-	Maximum number of files allowed on disk
Voltage Dip/Sag & Undervoltage Threshold	0401h	DWORD (ID 02h) Unsigned integer	5÷100 % of F.S.	80	V	Triggering threshold for Voltage Dip/sag and Overvoltage start
Voltage Dip/Sag & Undervoltage Restore Threshold	0402h	DWORD (ID 02h) Unsigned integer	5÷100 % of F.S.	100	V	Restore threshold for Voltage Dip/sag and Overvoltage end
Voltage Dip/Sag Max Duration	0403h	WORD (ID 01h) Unsigned integer	1-11700[3]	72	cycles	Maximum duration of Voltage Dip/Sag
Voltage Swell & Overvoltage Threshold	0404h	DWORD (ID 02h) Unsigned integer		240	V	Triggering threshold for Voltage Swell and overvoltage start
Voltage Swell & Overvoltage Restore Threshold	0405h	DWORD (ID 02h) Unsigned integer		235	V	Restore threshold for Voltage Swell and overvoltage end
Voltage Swell Max Duration	0406h	WORD (ID 01h) Unsigned integer	1-11700[3]	72	cycles	Maximum duration of Voltage Swell
Current Peak & Overcurrent Threshold	0407h	DWORD (ID 02h) Unsigned integer		500	A/100	Triggering threshold for current peaks and Overcurrent start.
Current Peak & Overcurrent Restore Threshold	0408h	DWORD (ID 02h) Unsigned integer		450	A/100	Restore threshold for current peaks and Overcurrent end.
Current Peak Max Duration	0409h	WORD (ID 01h) Unsigned integer		11700	cycles	Maximum duration of Current peak
Events detection enable	040Ah	WORD (ID 01h) Unsigned integer		03h	bitmapped	○○○○ ○○○⊙ 1 ≡ Voltage Dip/Sag enabled ○○○○ ○○⊙○ 1 ≡ Voltage Swell enabled ○○○○ ○⊙○○ 1 ≡ Current Peaks enabled

[3] Equivalent to three minutes with 65Hz mains frequency

10.4.2 Example of configuration file: “Events.xmbf”

The file contains only the data indicated in the **Data (hex)** columns

RECORD #0: FILE HEADER	
RECORDS DEFINITION STRUCTURE	
Data (hex)	**Description**
04	Header size (Bytes)
EA	Data records size (Bytes)
00	Reserved
02	ID Flags

RECORD #1: DATA RECORD	
VARIABLES DEFINITION STRUCTURE	
Data (hex)	**Description**
00	Reserved
80	Descriptor List Size (Bytes)
08 02 FF 00 00 00 07 F6	Internal var: Max data-file size = 2038 Bytes
06 01 04 00 00 02	Internal var: Max number of report files = 2
08 02 04 01 00 00 00 1E	Internal var: Voltage Dip/Sag & Undervoltage Threshold = 30 V
08 02 04 02 00 00 00 28	Internal var: Voltage Dip/Sag & Undervoltage Restore Threshold = 40 V
06 01 04 03 00 46	Internal var: Voltage Dip/Sag Max Duration = 70 Cycles
08 02 04 04 00 00 01 04	Internal var: Voltage Swell & Overvoltage Threshold = 260 V
08 02 04 05 00 00 00 FA	Internal var: Voltage Swell & Overvoltage Restore Threshold = 250 V
06 01 04 06 00 46	Internal var: Voltage Swell Max Duration = 70 Cycles
08 02 04 07 00 00 09 C4	Internal var: Current Peak & Overcurrent Threshold = 2500 A/100
08 02 04 08 00 00 07 D0	Internal var: Current Peak & Overcurrent Restore Threshold = 2000 A/100
06 01 04 09 00 46	Internal var: Current Peak Max Duration = 70 Cycles
0C 07 FF 81 00 00 00 00 00 00 00 00	Internal var: Timestamp (main clock - WALL TIME) = 1 january 1970 0.00.00 +00:00 GMT +00:00 DST
08 02 FF 85 00 00 00 00	Internal var: Serial number = 0
06 01 FF 84 00 00	Internal var: Slave ID = 0
04 87 FF 81	External multiple var: Timestamp (main clock - WALL TIME)

RECORD #1: DATA RECORD	
04 81 04 80	External multiple var: sec/100
04 81 04 81	External multiple var: Event
04 81 04 82	External multiple var: Event duration [Cycles]
04 82 04 84	External multiple var: Peak Value
EMPTY SPACE	
FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF	(104 bytes)

10.4.3 Type 5 files

The type 5 files are dedicated to the service called “peaks logging service”.
This service logs on file the maximum and minim values (peak values) of any of the input or holding registers.
For any register - whose peak values will be logged *(target register)* a second one can be specified, which will act as *“reference register”*.

The following detection functions are available :

- Absolute minimum value of the *target register* (the *reference register* is ignored);
- Absolute maximum value of the *target register* (the *reference register* is ignored);
- Absolute minimum value of the *target register* with a *reference register* having positive values;
- Absolute minimum value of the *target register* with a *reference register* having positive values;
- Absolute minimum value of the *target register* with a *reference register* having negative values;
- Absolute minimum value of the *target register* with a *reference register* having negative values;

The use of the *reference register* is particularly useful, as example, for discriminating the peak value attained by a parameter in the import quadrant (consumption) from the value attained in the export quadrant (generation). The reference register to be considered to this purpose is always the register designating the import Active Power.

The report file generated by this service contains a data record for each peak value to be stored.
Each record contains the absolute maximum (or minimum) value of the corresponding *target register* and a time-stamp of the sampling time. Maximum and minimum values are overwritten when exceeded.
The time stamp format is user configurable on the configuration file.
It is possible to program the configuration file for recording other parameters too on top of *target registers*, in order to get a broader picture when the peak was detected.
The maximum number of *target registers* supported by the configuration file is approximately ten (it depends upon the number of internal allocation variables and of external multiple allocation variables.

10.4.4 Service configuration

This service makes use of the following output variables:

Peaks Recording Service – Output variables			
Name	**ID**	**Type**	**Description**
System clock UTC	FF80h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Time (ID 0Ah) Date/Time (ID 0Bh)	System clock, UTC
System clock WALL TIME	FF81h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Time (ID 0Ah) Date/Time (ID 0Bh)	System clock, WALL TIME
Timezone name	FF82h	BYTE ARRAY (ID 05h) ASCIIZ string	Name of timezone in use
Firmware version	FF83h	BYTE PAIR (ID 04h) Unsigned integer, Unsigned integer	Firmware version in use (Major version, Minor version)
Slave ID	FF84h	WORD (ID 01h) (Unsigned integer)	Instrument slave ID (Modbus)
Serial number	FF85h	DOUBLEWORD (ID 02h) (Unsigned integer)	Instrument serial number
Timezone index	FF87h	WORD (ID 01h) (Unsigned integer)	Timezone index in use

No configuration parameters are required by this service because both *target registers* and *reference registers* are allocated by a single descriptor that specifies the type of detection to be performed by the instrument.

10.4.5 Example of configuration file: “Peaks.xmbf”

The file contains only the data indicated in the **Data (hex)** columns.

RECORD #0: FILE HEADER	
RECORDS DEFINITION STRUCTURE	
Data (hex)	**Description**
04	Header size (Bytes)
EA	Data records size (Bytes)
00	Reserved
02	ID Flags

RECORD #1: DATA RECORD	
VARIABLES DEFINITION STRUCTURE	
Data (hex)	**Description**
00	Reserved
D4	Descriptor List Size (Bytes)
0C 07 FF 81 00 00 00 00 00 00 00 00	Internal var: Timestamp (main clock - WALL TIME) = 1 january 1970 0.00.00 +00:00 GMT +00:00 DST
06 01 FF 84 00 00	Internal var: Slave ID = 0
08 02 FF 85 00 00 00 00	Internal var: Serial number = 0
0A CE 00 D6 03 02 01 0C 03 00	External single var: Min U1N [V] with positive P
0A CE 00 D8 03 02 01 0C 03 00	External single var: Min U2N [V] with positive P
0A CE 00 DA 03 02 01 0C 03 00	External single var: Min U3N [V] with positive P
0A CE 00 D6 03 03 01 0C 03 00	External single var: Max U1N [V] with positive P
0A CE 00 D8 03 03 01 0C 03 00	External single var: Max U2N [V] with positive P
0A CE 00 DA 03 03 01 0C 03 00	External single var: Max U3N [V] with positive P
0A CE 00 E2 03 03 01 0C 03 00	External single var: Max I1 [A] with positive P
0A CE 00 E4 03 03 01 0C 03 00	External single var: Max I2 [A] with positive P
0A CE 00 E6 03 03 01 0C 03 00	External single var: Max I3 [A] with positive P
0A CE 00 EA 03 03 01 0C 03 00	External single var: Max P1 [W] with positive P
0A CE 00 EC 03 03 01 0C 03 00	External single var: Max P2 [W] with positive P
0A CE 00 EE 03 03 01 0C 03 00	External single var: Max P3 [W] with positive P
0A CE 00 F6 03 03 01 0C 03 00	External single var: Max S1 [VA] with positive P
0A CE 00 F8 03 03 01 0C 03 00	External single var: Max S2 [VA] with positive P
0A CE 00 FA 03 03 01 0C 03 00	External single var: Max S3 [VA] with positive P
0A CE 00 FC 03 02 00 FC 03 00	External single var: Min PF1 with positive PF1
0A CE 00 FE 03 02 00 FE 03 00	External single var: Min PF2 with positive PF2
0A CE 01 00 03 02 01 00 03 00	External single var: Min PF3 with positive PF3
04 87 FF 81	External multiple var: Timestamp (main clock - WALL TIME)
EMPTY SPACE	
FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF	(20 bytes)

10.5 Type 7 files

Type 7 files are dedicated to *Tariff Energy Counters* for time of use tariffs.
They are strictly related to type 6 files, e.g. calendar files, which determine the tariff changeover and the repartition of energies into groups of counters (one group for each tariff).

Each record of the report file is matched to a given tariff. It contains all the energy counters values supported by the instrument.

10.5.1 Service configuration

This service makes use of the following output variables:

Tariff Energy Counters service – Output variables				
Name	**ID**	**Type**	**Mandat.**[4]	**Description**
System clock UTC	FF80h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Time (ID 0Ah) Date/Time (ID 0Bh)	YES[5]	System clock, UTC
System clock WALL TIME	FF81h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Time (ID 0Ah) Date/Time (ID 0Bh)	YES**2**	System clock, WALL TIME
Timezone name	FF82h	BYTE ARRAY(ID 05h) ASCIIZ string	NO	Timezone name in use
Firmware version	FF83h	BYTE PAIR (ID 04h) Unsigned integer, Unsigned integer	NO	Firmware version in use (Major version, Minor version)
Slave ID	FF84h	WORD (ID 01h) (Unsigned integer)	NO	Instrument slave ID (Modbus)
Serial number	FF85h	DOUBLEWORD (ID 02h) (Unsigned integer)	NO	Instrument serial number
Timezone index	FF87h	WORD (ID 01h) (Unsigned integer)	NO	Timezone index in use
Tariff	07A0h	WORD (ID 01h) (Unsigned integer)	YES	Tariff index (1-n)
Ea imp	0780h	QUADWORD (ID 03h)	YES	Import Active energy (high resolution)

[4] It specifies if the variable is, or not, mandatory for service start-up and operation.
[5] Setting of at least one time stamp variable is required for service start up..

Tariff Energy Counters service – Output variables				
Name	**ID**	**Type**	**Mandat.[4]**	**Description**
Er ind imp	0781h	QUADWORD (ID 03h)	YES	Import Reactive energy inductive (high resolution)
Er cap imp	0782h	QUADWORD (ID 03h)	YES	Import Reactive energy capacitive (high resolution)
Es imp	0783h	QUADWORD (ID 03h)	YES	Import Apparent energy (high resolution)
Ea exp	0784h	QUADWORD (ID 03h)	YES	Export Active energy (high resolution)
Er ind exp	0785h	QUADWORD (ID 03h)	YES	Export Reactive energy Inductive (high resolution)
Er cap exp	0786h	QUADWORD (ID 03h)	YES	Export Reactive energy capacitive (high resolution)
Es exp	0787h	QUADWORD (ID 03h)	YES	Export Apparent energy (high resolution)

The service configuration parameters are stored in the following input variables:

Tariff Energy Counters Service – Input variables						
Name	**ID**	**Type**	**Range**	**Default**	**Unit**	**Description**
Max data-file size	FF00h	DWORD (ID 02h) Unsigned integer	-	All space available on disk	bytes	Maximum admitted size for each data file
Refresh Period	0700h	WORD (ID 01h) Unsigned integer	0..65535	0	s	Refresh interval of the report file. When not specified, it refreshes at each time band changeover or whenever the serial port requires a file reading.

10.5.2 Reset

The content of a report file may be reset by simply removing the file.
This operation will generate a temporary service stall of few tenths of sec.; after checking and validation of the configuration files a new report file will be generated.

10.5.3 Example of configuration file: “EnergyCounters.xmbf”

The file contains only the data indicated in the **Data (hex)** columns

The order of the external multiple allocation variables can be changed however the type cannot be changed (storage of counters in low resolution – e.g. in FLOAT IEEE754 format – is not allowed.
All external variables indicated as mandatory on the table below must be included in the descriptors list.

RECORD #0: FILE HEADER	
RECORDS DEFINITION STRUCTURE	
Data (hex)	**Description**
04	Header size (Bytes)
EA	Data records size (Bytes)
00	Reserved
02	ID Flags

RECORD #1: DATA RECORD	
VARIABLES DEFINITION STRUCTURE	
Data (hex)	**Description**
00	Reserved
26	Descriptor List Size (Bytes)
04 81 07 A0	External multiple var: Tariff
04 83 07 80	External multiple var: Ea imp [Wh/10]
04 83 07 81	External multiple var: Er ind imp [varh/10]
04 83 07 82	External multiple var: Er cap imp [varh/10]
04 83 07 83	External multiple var: Es imp [VAh/10]
04 83 07 84	External multiple var: Ea exp [Wh/10]
04 83 07 85	External multiple var: Er ind exp [varh/10]
04 83 07 86	External multiple var: Er cap exp [varh/10]
04 83 07 87	External multiple var: Es exp [VAh/10]
EMPTY SPACE	
FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF	(194 bytes)

10.6 Type 8 files

Type 8 files are dedicated to the storage of *Tariff Maximum Demands* for time of use tariffs.
They are strictly related to type 6 files, e.g. calendar files, that determine the tariff changeover and the repartition of Maximum demand into groups (one group for each tariff).
For further information please refer to "**Type 6 files".**

Each record of the report file is matched to a given tariff. It contains all the Maximum demand values supported by the instrument.

10.6.1 Service configuration

This service makes use of the following output variables:

Tariff Maximum Demands Service - Output variables				
Name	**ID**	**Type**	**Mandat.** [6]	**Description**
System clock UTC	FF80h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Time (ID 0Ah) Date/Time (ID 0Bh)	YES[7]	System clock, UTC
System clock WALL TIME	FF81h	Unix Timestamp (ID 06h) Unix Timestamp + offset (ID 07h) Unix Timestamp + DST flag (ID 08h) Date (ID 09h) Time (ID 0Ah) Date/Time (ID 0Bh)	YES[7]	System clock, WALL TIME
Timezone name	FF82h	BYTE ARRAY(ID 05h) ASCIIZ string	NO	Timezone name in use
Firmware version	FF83h	BYTE PAIR (ID 04h) Unsigned integer, Unsigned integer	NO	Firmware version in use (Major version, Minor version)
Slave ID	FF84h	WORD (ID 01h) (Unsigned integer)	NO	Instrument slave ID (Modbus)
Serial number	FF85h	DOUBLEWORD (ID 02h) (Unsigned integer)	NO	Instrument serial number
Timezone index	FF87h	WORD (ID 01h) (Unsigned integer)	NO	Timezone index in use
Tariff	08A0h	WORD (ID 01h) (Unsigned integer)	YES	Tariff index (1-n)

[6] It specifies if the variable is, or not, mandatory for service start-up and operation.
[7] Setting of at least one time stamp variable is required for service start up.

Tariff Maximum Demands Service - Output variables				
Name	ID	Type	Mandat. [6]	Description
MD P imp	0880h	DOUBLEWORD (ID 02h)	YES	Maximum Demand Import Active Power
MD Q ind imp	0881h	DOUBLEWORD (ID 02h)	YES	Maximum Demand Import Reactive power (inductive)
MD Q cap imp	0882h	DOUBLEWORD (ID 02h)	YES	Maximum Demand Import Reactive power (capacitive)
MD S imp	0883h	DOUBLEWORD (ID 02h)	YES	Maximum Demand Import Apparent power
MD P exp	0884h	DOUBLEWORD (ID 02h)	YES	Maximum Demand Export Active Power
MD Q ind exp	0885h	DOUBLEWORD (ID 02h)	YES	Maximum Demand Export Reactive power (inductive)
MD Q cap exp	0886h	DOUBLEWORD (ID 02h)	YES	Maximum Demand Export Reactive power (capacitive)
MD S exp	0887h	DOUBLEWORD (ID 02h)	YES	Maximum Demand Export Apparent power

The service configuration parameters are stored in the following input variables:

Tariff Maximum Demands Service – Input variables						
Name	ID	Type	Range	Default	Unit	Description
Max data-file size	FF00h	DWORD (ID 02h) Unsigned integer	-	All space available on disk	bytes	Maximum admitted size for each data file
Refresh Period	0800h	WORD (ID 01h) Unsigned integer	0..65535	0	s	Refresh interval of the report file. When not specified, it refreshes at each time band changeover or whenever the serial port requires a file reading.

10.6.2 Reset

The content of a report file may be reset by simply removing the file.
This operation will generate a temporary service stall of few tenths of sec.; after checking and validation of the configuration files a new report file will be generated.

10.6.3 Example of configuration file: “MaximumDemands.xmbf”

The file contains only the data indicated in the **Data (hex)** column
The order of the external multiple allocation variables can be changed subject however to the presence in the descriptors list of the mandatory variables as indicated by the tables.

RECORD #0: FILE HEADER	
RECORDS DEFINITION STRUCTURE	
Data (hex)	**Description**
04	Header size (Bytes)
EA	Data records size (Bytes)
00	Reserved
02	ID Flags

RECORD #1: DATA RECORD	
VARIABLES DEFINITION STRUCTURE	
Data (hex)	**Description**
00	Reserved
26	Descriptor List Size (Bytes)
04 81 08 A0	External multiple var: Tariff
04 82 08 80	External multiple var: MD P imp [W]
04 82 08 81	External multiple var: MD Q ind imp [var]
04 82 08 82	External multiple var: MD Q cap imp [var]
04 82 08 83	External multiple var: MD S imp [VA]
04 82 08 84	External multiple var: MD P exp [W]
04 82 08 85	External multiple var: MD Q ind exp [var]
04 82 08 86	External multiple var: MD Q cap exp [var]
04 82 08 87	External multiple var: MD S exp [VA]
EMPTY SPACE	
FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF	(194 bytes)

10.6.4 Clock / Calendar

X3M contains a clock/calendar with supporting the timezones and the transitions rules for automatic Daylight Saving Time and Standard Time change.

The following conventional denominations are used:

- *Coordinated Universal Time* (UTC), formerly known as GMT (*Greenwich Mean Time*): this is independent from the geographic location (hence “universal”);
- *Standard Time (ST)*: this is the local time to a given timezone, based on sun cycles (“solar time”);
- *Daylight Saving Time (DST)*: it is the local time to a given timezone when an offset (*DST* offset) is applied to ST. This offset is usually applied (by local laws and regulations) to increase the daylight hours during summer season.
- *Wall time*: this is the current clock time: it matches either ST or DST depending on the period of the year.

The difference between ST and UTC is called *GMT offset.*

Summarizing:

GMT offset = Standard Time – UTC
Wall Time = Standard Time + DST offset = UTC + GMT offset + DST offset

The instrument RTC (Real Time Clock) maintains the following time information:

- UTC Date/Time;
- Timezone ID;

The X3M, in this way, uses its internal UTC timing to compute the local time (*Wall Time*) anywhere on earth.

10.6.4.1 Timezones

The pertinent timezone is set by specifying a numeric *timezone index.* The correspondence between timezone index and standard name is listed in the table available on chapter “Set up” paragraph “Clock Set up”.

The X3M embeds a database of *timezone rules* that enables the instrument to determine the local GMT offset and DST offset at a given time for any of the available timezones and to consequently covert them into Universal and Local time.
The database with the *timezone rules* is compiled starting from the package published by *elsie.nci.nih.gov* (*tzdataXXXXX.tar.gz*) and it is embedded in the instrument firmware therefore an update of the timezone rules requires upgrading of the firmware.

10.6.4.2 Files

File FF.02 contains the timezones the instrument is supporting – in id order (see table).
FF.02 is a structured homogeneous file identified as follows:

- **Name =** name of the file by *elsie.nci.nih.gov* (e.g. "*tzdata2004g*") used to build the *timezone rules* of the X3M database.
- **Creation Date/Time =** date/time of database creation
- **Modification Date/Time =** date/time of database compilation

The n^{th} record of the file contains information about the timezone with index *n-1*.

The service that generates the FF.02 file uses the following output variables:

System clock – Output Variables allocated in file FF.02			
Name	**ID**	**Type**	**Description**
Timezone name	FF82h	BYTE ARRAY (ASCIIZ string)	Timezone name in use.
Firmware version	FF83h	BYTE PAIR (Unsigned integer, Unsigned integer)	Firmware version (Major version, Minor version)
Slave ID	FF84h	WORD (Unsigned integer)	Instrument slave ID (Modbus)
Serial number	FF85h	DOUBLEWORD (Unsigned integer)	Instrument serial number

10.6.4.3 Clock related Modbus registers

Holding Registers 140 to 169 are used for clock programming by Modbus protocol via serial port.
See chapter 9 for details.

10.6.5 Upgrading the firmware

Two modules, called *loader* and *application*, compose the X3M firmware:
- The application module contains all the codes enabling the measurement, data logging, display and communication functions.
- The loader implements the functions for programming the flash memory containing the firmware and makes possible its installation and its upgrade.

The X3M firmware is released as binary files whose name has the *x3m* extension. The file name also contains the version and an identification code of the module (the ID is an abbreviation of the module name). So, for instance:

- **X3M_DL-02.01.X3M**: file contains the *loader* module, version 2.01;
- **X3M_APP-01.00.X3M**: file contains the *application* module, version 1.00;
- **X3M_DL-02.01;X3M_APP-01.00.X3M**: file containing both modules.

The firmware upgrade is performed using the Modbus protocol through any supported communication interface (presently RS232 and RS485).
The flash memory access to the firmware area is possible through files FF.00 and FF.01.
File FF.00 supports read only access to the firmware area: by reading this file it is possible to obtain a copy of the installed firmware (FF.00 contains both the loader and the application module).
FF.01 supports read and write access to a backup area used for software upgrades.
At instrument power on and after each reset, the loader checks (through an algorithm) whether the backup area contains a valid copy of one of the firmware modules (*loader* and/or *application*).
If the version of one of the modules differs from the one currently installed (as determined by the file checksum) the loader upgrades the running firmware automatically.
To upgrade a new firmware, therefore, it is sufficient to copy, in the backup area, the content of the binary file shipped by Electrex and then to power down and restart the instrument.
Before sending the reset command, it is recommended to check that the backup area actually contains a copy of the new firmware module, so as to prevent possible problems during the file transfer phase. This check can be done by reading the 00.FF directory.
After resetting the instrument, the upgrade status can be verified ether by checking the outcome string of the *Report Slave ID* command, or by reading the name of the FF.00 file in the 00.FF directory relating to the installed modules.

Problems in the file transfer process (to the backup area) will not effect the instrument operations. However, when writing to file FF.01, all measurement functions are stalled.

The format of FF.00 and FF.01 files is as follows:

Files FF.00 and FF.01 format					
Record Number	**Record Size**	**Field size**	**Field type**	**Field description**	**Note**
0	2 bytes	1 byte	Unsigned integer	Header size	Fixed value: equals 2
		1 byte	Unsigned integer	Data record size	Fixed value: equals 238
n (1 <= n <= 1102)	238 bytes	Segment comprising bytes from position **(n-1)*238** to position **n*238-1** of the binary file (executable) containing the firmware.			Raw data

11 The XMBF.EXE utility (Electrex ModBus File)

11.1 Commands for PC handling of the files of the X3M memory.

In order to allow a simple and easy management of the standard MobBus files available in the memory of the X3M, a specific program was developed for file writing and reading that supports the "Read general file" and "Write general file" ModBus commands. For further ease of operation, the program supports also the file conversion to various formats with no need of specifically developed tools.
The same commands may also be invoked by other programs that require the data with no need of specific drivers development.
The XMBF.EXE is run from the DOS shell in command line mode by specifying the operation parameters as below indicated:

XMBF --<operation type> --<communication port> –<address> --<protocol format> --<file number> --<output format>

<operation type>	**--read**	→ download
	--write	→ upload
	--del	→ delete
	--create	→ create
	--reboot	→ instrument restart from zero
<communication port>	--ip=<ip address>	→ Instrument IP address.
	--ser=<com port>,<com speed>,<bits N°>, <parity>,<stop bits>	
	<com port>	→ PC communication port, example COM1
	<com speed>	→ transmission speed, example 38400
	<bits N°>	→ bit number, example 8
	<parity>	→ parity control, example n
	<stop bits>	→ stop bit number, example 2
<address>	**--addr**	→ instrument address
<protocol format>	**--mascii**	→ ModBus ASCII (default RTU if not specified)
<file number>	**--fnum**	→ identification number (exadecimal format) of the file in memory, example --fnum=07
<file name>	**--fname**	→ file or origin directory from PC
<output format>	**--txt**	→ saves the file to PC in text format
	--hex	→ saves the file to PC in HEX format
	--html	→ file in HTML format
	--xmbf	→ file in binary format
	--xls	→ file in comma separated value format compatible with spreadsheet programs like Excel, etc..
	no parameter	→ print to screen in TXT format
<destination>	**--dpath**=\<directory tree>	→ path of the destination directory.
	--dname=\<file name>	→ name of the destination file.

Example:.

C:\Programs\X3M\XMBF --read --ser=com1,38400,8,n,2 --addr=27 --fnum=0101 --html

It executes the program resident in C:\Programs\X3M and it transfers the 0101 file (load profiles) from the instrument at address 27 to PC via the serial port Com1 38400 bps 8 data bits, no parity, 2 stop bits and it saves it to a file named (0101)Loadprofiles.html in HTML format.

11.1.1 Short commands

The operating parameters may be written in short format too by using one letter only followed directly by the value with no = sign. The short commands table is given below.

--ip	→	**-i**
--ser	→	**-s**
--addr	→	**-a**
--read	→	**-r**
--write	→	**-w**
--del	→	**-d**
--fnum	→	**-f**
--xmbf	→	**-x**
--txt	→	**-t**
--html	→	**-h**
--hex	→	**-H**
--xls	→	**-l**
--fname	→	**-F**
--create	→	**-c**
--xmodem	→	**-X**
--mascii	→	**-A**
--reboot	→	**-R**
--dpath	→	**-p**
--dfile	→	**-f**

11.2 Operation type

These commands establish the operation that is required to be executed.

11.2.1 **--read** → Download

This command reads a file from the instrument flash disk by using the Modbus “read general file”
The file is read in the original binary format and saved, as is, into the working directory.
It is then converted to a destination file following the instructions of the Output Format.
If no other instructions are given, the file is converted to a TXT file and displayed on the computer screen.
This command does not change the content of the instrument flash disk.

11.2.2 **--write** → Upload

This command allows to write a file taken from the PC disk into the instrument flash disk. It must be used only for uploading the configuration files of the various services or the calendar files.
The file name must contain, to its beginning, the number of the destination file and the name that will be assigned to the report files generated by the service.
The upload file must be in xmbf (binary) format or in HEX format (in this case it will be automatically converted to binary by the **--write** command).
The command may only overwrite existing file(s) of same size; it will be otherwise necessary to cancel it first in the case of different size,
In the case of up load of a file not existing in the instrument, the **--create** command must be added to the command line.
It may be used for firmware dates of the instrument by uploading the file number (FF01), after its cancellation. A **--reboot** command or, alternatively, an instrument powering down and up again, are required in order to render operative the new firmware.

11.2.3 **--del** → Delete

It removes the file having the number that is specified. This command is executed directly with no request of confirmation and maximum care should therefore be used.
The “Delete” command allows to remove a list of files too. The file numbers to be removed must be specified on the same command line with comma separation.
Example: –fnum=0400,0100,FE02 deletes the 0400 file (i.e. the configuration file of Service 4), the 0100 file (i.e. configuration of the load profile service) and the FE02 file (i.e. a file configured and saved by the user).
The “Delete” command may be applied for removal of a directory file too (example: `--fnum=01`) and this will automatically remove all the files of the specified directory

WARNING: the “Delete” command with --fnum=0 will remove all the files in memory.

11.2.4 **--create** → Create

Command to be used together with the –write command when the file to be written does not exists.

11.2.5 **--reboot** → Instrument restart from zero

This command generates an instruction to the instrument that simulates a power off and a power on. It is used in order to render operative a firmware up-grade.

11.3 Communication port

The communication may be direct only via the following communication ports.

11.3.1 IP Address

It uses an Ethernet connexion and the IP address where the instrument is located must be specified.
The protocol used is Modbus over IP.

11.3.2 Com Port

It uses one of the physical ports of a PC that is programmed with the specified communication speed.
In the case of communication via a Modem, the connexion must be established separately.

11.4 Protocol format

Modbus supports both the RTU 8 bit format and the ASCII format. The instrument may be configured to both formats.
The program supports the RTU format as default setting but it may be set to support the ASCII format by means of the “**--mascii**” command.

11.5 Address

It identifies the Modbus address that is assigned to the instrument.
The default factory-set address is 27.

11.6 File number

It’s the number, in HEX format, of the file that needs to be downloaded.
The file number 0000H (a simple 0 is also accepted) represent the directory of the flash disk.

11.7 File Name

The file name identifies the name of the file that needs to be uploaded to the instrument.

The name must indicate (fnum)Servicename where:

(fnum) is the file number of the instrument where one requires to write the content of the origin file from the PC.

Servicename is the name that will be assigned to the files generated by the service being configured.

The upload file must be in xmbf (binary) format or in HEX format (in this case it will be converted to binary during the transfer).

11.8 Destination

It allows to establish a destination directory for the download file, different than the resident directory of the program. It also allows to change the file name with respect to the default name that is automatically generated by the program, that is (fnum)Servicename, example (0101)Loadprofiles.

11.8.1 **--dpath**=DestinationPath

It specifies the destination folder of the files. The path may be absolute or relative. A new folder is automatically created if not existing.

11.8.2 **--dfile**=DestinationFileName

It forces a name for the destination file. If no parameter is specified, the program uses the same name used in the instrument filesystem.

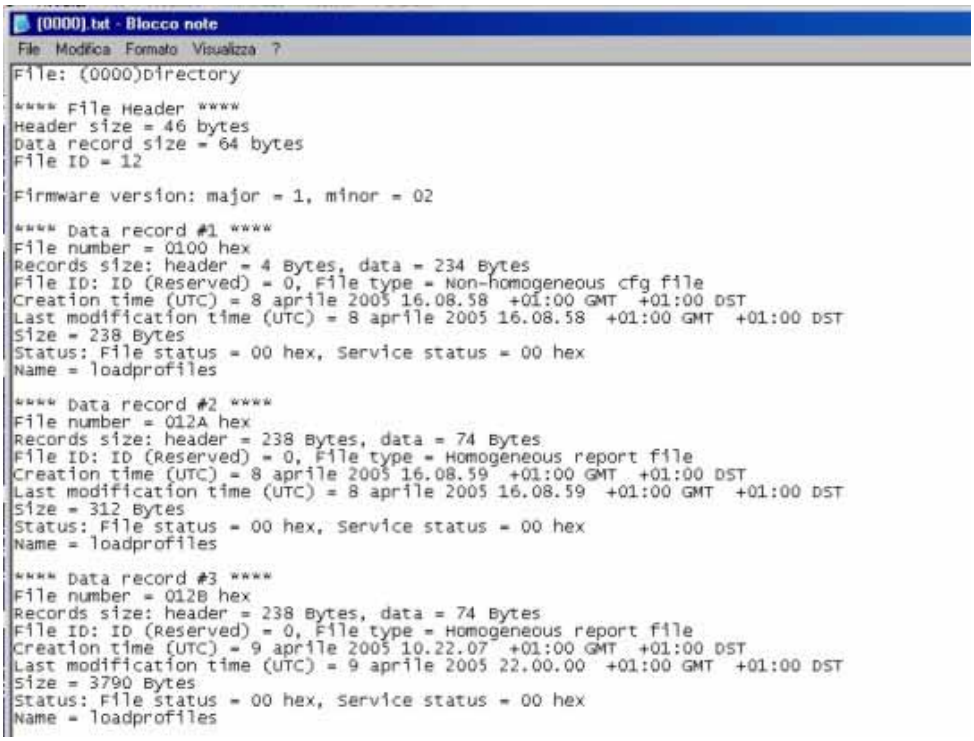
11.9 Output format

This command gives the possibility of rendering a file content into a structured and commented format for easier readability. The file structure is the one better described in the instrument manual; it is divided in records with the first one describing the structure of the file itself, the others records being the data.

The comments, or variable descriptors, used are taken from the X3M_01.map file that is resident in the same folder of the xmbf.exe file.
The file downloaded from the instrument can be saved in various formats according to the user needs.

11.9.1 TXT Output

A text file is generated where each paragraph corresponds to one record.
The “File header” corresponds to the record 0 of the file.



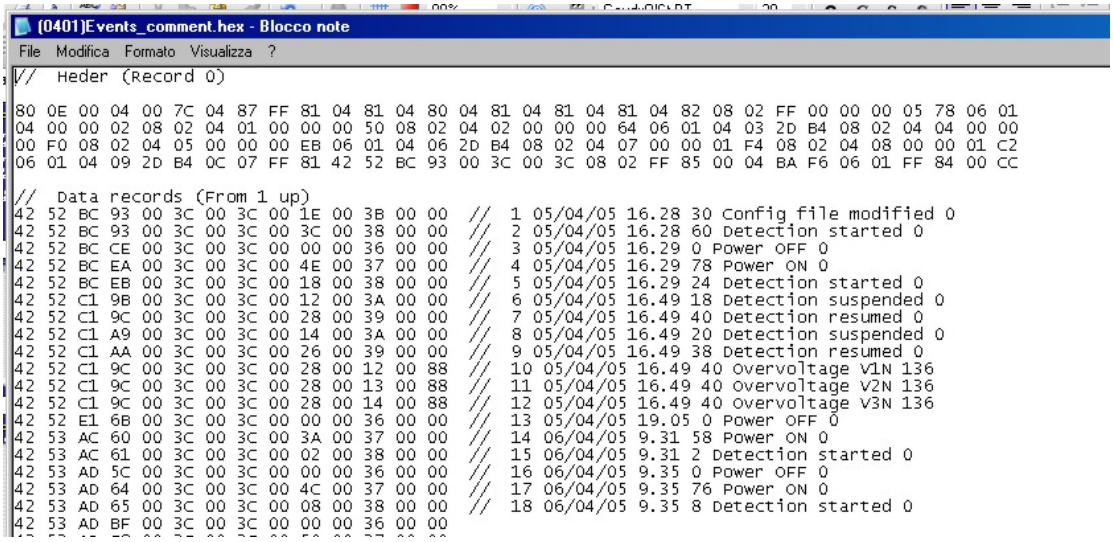
The example shows a TXT obtained by reading the 0000H directory file.

11.9.2 Print to screen

Should nothing be specified, the same output format will be displayed on the PC screen.

11.9.3 HEX output

An hexadecimal file is generated and saved, with separate and distinctly commented records



The comments are identified by the // characters.
Should this be a configuration file, the data part may be edited with Notepad, reconverted into a binary file by means of the hex2bin command and stored in the instrument by means of an Upload command.
This is the procedure that enables to modify the configuration of the various Services supported by the instrument.
The comments will be automatically eliminated during the re-conversion.

11.9.4 HTML Output

A browser readable HTML file is generated and saved.

(0401)Events

Size: 1390 bytes
Creation time (WALL): lunedì 6 giugno 2005 16.36.12 (GMT: +01.00, DST: +01.00)
Last modification time (WALL): mercoledì 8 giugno 2005 22.06.36 (GMT: +01.00, DST: +01.00)

File Header - Input variables	
Variable	**Value**
Max data-file size [Bytes]	1400
Max number of report files	2
Voltage loss threshold [V]	80
Voltage restore threshold [V]	90
Voltage interruption max duration [Cycles]	70
Overvoltage threshold [V]	260
Overvoltage restore threshold [V]	250
Overvoltage max duration [Cycles]	70
Overcurrent threshold [A/100]	600
Overcurrent restore threshold [A/100]	550
Overcurrent max duration [Cycles]	70

File Header - Output variables	
Variable	**Value**
Timestamp (main clock - WALL TIME)	6 giugno 2005 16.36.12 +01:00 GMT +01:00 DST
Serial number	307936
Slave ID	206

Data records					
Record number	**Timestamp (main clock - WALL TIME)**	**Timestamp hundreds [sec/100]**	**Event**	**Event duration [Cycles]**	**Peak Value**
1	6 giugno 2005 16.36.12 +01:00 GMT +01:00 DST	22	Detection resumed	0	0,00000
2	6 giugno 2005 16.36.12 +01:00 GMT +01:00 DST	22	Export Overcurrent restore I1	0	387,68225
3	6 giugno 2005 16.36.12 +01:00 GMT +01:00 DST	22	Export Overcurrent restore I2	0	387,83646
4	6 giugno 2005 16.36.12 +01:00 GMT +01:00 DST	22	Export Overcurrent restore I3	0	387,65826
5	6 giugno 2005 16.36.12 +01:00 GMT +01:00 DST	22	Import Overcurrent I1	0	0,00000
6	6 giugno 2005 16.36.12	22	Import Overcurrent I2	0	0,00000

	+01:00 GMT +01:00 DST				
7	6 giugno 2005 16.36.12 +01:00 GMT +01:00 DST	22	Import Overcurrent I3	0	0,00000
8	6 giugno 2005 17.47.34 +01:00 GMT +01:00 DST	52	Import Overcurrent restore I1	0	52,71437
9	6 giugno 2005 17.47.34 +01:00 GMT +01:00 DST	52	Import Overcurrent restore I2	0	53,13522
10	6 giugno 2005 17.47.34 +01:00 GMT +01:00 DST	52	Import Overcurrent restore I3	0	53,01883
11	6 giugno 2005 17.47.35 +01:00 GMT +01:00 DST	0	Power OFF	0	0,00000
12	7 giugno 2005 8.17.33 +01:00 GMT +01:00 DST	68	Power ON	0	0,00000
13	7 giugno 2005 8.17.34 +01:00 GMT +01:00 DST	16	Detection started	0	0,00000
14	7 giugno 2005 8.17.34 +01:00 GMT +01:00 DST	16	Import Overcurrent I1	0	0,00000
15	7 giugno 2005 8.17.34 +01:00 GMT +01:00 DST	16	Import Overcurrent I2	0	0,00000
16	7 giugno 2005 8.17.34 +01:00 GMT +01:00 DST	16	Import Overcurrent I3	0	0,00000
17	7 giugno 2005 8.36.30 +01:00 GMT +01:00 DST	94	Detection suspended	0	0,00000
18	7 giugno 2005 8.36.38 +01:00 GMT +01:00 DST	16	Detection resumed	0	0,00000
19	7 giugno 2005 8.37.17 +01:00 GMT +01:00 DST	72	Detection suspended	0	0,00000
20	7 giugno 2005 8.42.18 +01:00 GMT +01:00 DST	40	Detection resumed	0	0,00000
21	7 giugno 2005 9.08.36 +01:00 GMT +01:00 DST	54	Detection suspended	0	0,00000
22	7 giugno 2005 9.08.38 +01:00 GMT +01:00 DST	4	Detection resumed	0	0,00000
23	7 giugno 2005 9.08.38 +01:00 GMT +01:00 DST	4	Import Overcurrent restore I1	0	523,47253
24	7 giugno 2005 9.08.38 +01:00 GMT +01:00 DST	4	Import Overcurrent restore I2	0	523,73511
25	7 giugno 2005 9.08.38 +01:00 GMT +01:00 DST	4	Import Overcurrent restore I3	0	523,86774
26	7 giugno 2005 9.08.38 +01:00 GMT +01:00 DST	4	Export Overcurrent I1	0	0,00000
27	7 giugno 2005 9.08.38 +01:00 GMT +01:00 DST	4	Export Overcurrent I2	0	0,00000

The example shows parts of an event file in HTML format.

11.9.5 XLS output type

This type of output generates an XLS-formatted file suitable for Microsoft EXCEL® or for import by other spreadsheet programs.
The file format is as below indicated; the example refers to a Load Profile file.

(0120)LoadProfiles

Size (bytes):	7416
Creation time (WALL):	28/05/2005 0.00
Last modification time (WALL):	29/05/2005 0.00

File Header - Input variables

Variable	Value
Max data-file number	60
Sampling interval [min]	15
Max data-file size [Bytes]	65535

File Header - Output variables

Variable	Value
Timestamp (main clock - WALL TIME)	28 may 2005 0.00.00 +01:00 GMT +01:00 DST
Serial number	300001
Slave ID	204

Data records

Record number	Timestamp (main clock - WALL TIME)	Trigger event	Ea imp [Wh/10]	Er ind imp [varh/10]	Er cap imp [varh/10]	Es imp [VAh/10]	Ea exp [Wh/10]	Er ind exp [varh/10]	Er cap exp [varh/10]	Es exp [VAh/10]
1	28/05/2005 0.00	3	14428124	392187	2651429	14910357	0	0	0	0
2	28/05/2005 0.15	3	14430481	392187	2652197	14912845	0	0	0	0
3	28/05/2005 0.30	3	14433148	392187	2652883	14915604	0	0	0	0
4	28/05/2005 0.45	3	14435144	392187	2653698	14917762	0	0	0	0
5	28/05/2005 1.00	3	14437105	392187	2654428	14919858	0	0	0	0
6	28/05/2005 1.15	3	14439101	392187	2655082	14921963	0	0	0	0
7	28/05/2005 1.30	3	14441182	392187	2655727	14924143	0	0	0	0
8	28/05/2005 1.45	3	14443281	392187	2656443	14926362	0	0	0	0
9	28/05/2005 2.00	3	14445152	392187	2657197	14928385	0	0	0	0
10	28/05/2005 2.15	3	14447022	392187	2657934	14930398	0	0	0	0
11	28/05/2005 2.30	3	14449287	392188	2658387	14932712	0	0	0	0
12	28/05/2005 2.45	3	14451134	392188	2659204	14934732	0	0	0	0
13	28/05/2005 3.00	3	14453027	392188	2659971	14936778	0	0	0	0
14	28/05/2005 3.15	3	14455038	392188	2660620	14938893	0	0	0	0
15	28/05/2005 3.30	3	14457206	392188	2661328	14941178	0	0	0	0
16	28/05/2005 3.45	3	14459146	392188	2662114	14943275	0	0	0	0
17	28/05/2005 4.00	3	14461012	392188	2662878	14945295	0	0	0	0
18	28/05/2005 4.15	3	14462930	392188	2663630	14947360	0	0	0	0
19	28/05/2005 4.30	3	14465031	392188	2664231	14949547	0	0	0	0
20	28/05/2005 4.45	3	14466831	392188	2664977	14951501	0	0	0	0
21	28/05/2005 5.00	3	14468538	392188	2665771	14953385	0	0	0	0
22	28/05/2005 5.15	3	14470591	392188	2666437	14955547	0	0	0	0
23	28/05/2005 5.30	3	14472698	392188	2667226	14957800	0	0	0	0
24	28/05/2005 5.45	3	14474531	392188	2668068	14959821	0	0	0	0
25	28/05/2005 6.00	3	14476423	392188	2668822	14961859	0	0	0	0
26	28/05/2005 6.15	3	14478246	392188	2669611	14963848	0	0	0	0
27	28/05/2005 6.30	3	14480031	392188	2670255	14965749	0	0	0	0
28	28/05/2005 6.45	3	14481599	392188	2671001	14967489	0	0	0	0
29	28/05/2005 7.00	3	14483086	392188	2671772	14969167	0	0	0	0
30	28/05/2005 7.15	3	14484945	392188	2672572	14971197	0	0	0	0
31	28/05/2005 7.30	3	14486767	392188	2673221	14973136	0	0	0	0
32	28/05/2005 7.45	3	14488313	392188	2674077	14974905	0	0	0	0
33	28/05/2005 8.00	3	14489994	392188	2674781	14976733	0	0	0	0
34	28/05/2005 8.15	3	14492169	392188	2675321	14978993	0	0	0	0
35	28/05/2005 8.30	3	14494615	392188	2675636	14981460	0	0	0	0
36	28/05/2005 8.45	3	14497020	392188	2675985	14983892	0	0	0	0
37	28/05/2005 9.00	3	14499346	392188	2676444	14986264	0	0	0	0
38	28/05/2005 9.15	3	14502360	392188	2676808	14989305	0	0	0	0
39	28/05/2005 9.30	3	14506043	392188	2677062	14992998	0	0	0	0
40	28/05/2005 9.45	3	14510854	392188	2677670	14997849	0	0	0	0
41	28/05/2005 10.00	3	14516062	392188	2678126	15003079	0	0	0	0
42	28/05/2005 10.15	3	14521228	392188	2678446	15008257	0	0	0	0
43	28/05/2005 10.30	3	14526235	392188	2678788	15013277	0	0	0	0
44	28/05/2005 10.45	3	14530906	392188	2679179	15017966	0	0	0	0
45	28/05/2005 11.00	3	14535620	392188	2679827	15022726	0	0	0	0
46	28/05/2005 11.15	3	14540896	392190	2680364	15028034	0	0	0	0
47	28/05/2005 11.30	3	14546286	392195	2680678	15033438	0	0	0	0
48	28/05/2005 11.45	3	14551083	392195	2681195	15038264	0	0	0	0
49	28/05/2005 12.00	3	14555830	392195	2681560	15043028	0	0	0	0
50	28/05/2005 12.15	3	14560648	392196	2681967	15047865	0	0	0	0
51	28/05/2005 12.30	3	14565573	392196	2682662	15052855	0	0	0	0
52	28/05/2005 12.45	3	14569713	392196	2683660	15057114	0	0	0	0
53	28/05/2005 13.00	3	14573576	392196	2684743	15061129	0	0	0	0
54	28/05/2005 13.15	3	14576436	392196	2685523	15064097	0	0	0	0
55	28/05/2005 13.30	3	14579362	392196	2686138	15067091	0	0	0	0
56	28/05/2005 13.45	3	14581896	392196	2687008	15069771	0	0	0	0
57	28/05/2005 14.00	3	14584373	392196	2687805	15072377	0	0	0	0
58	28/05/2005 14.15	3	14588232	392196	2688545	15076309	0	0	0	0

Please note that the recorded data are the absolute values of the energy counters at sampling time.
With a sampling interval of 15 minutes, the values over one day are 96 + 1 initial value (at 00,00 hours) that is needed for the calculation of the energy over the 1st sampling period.

Time	P imp kW	Q ind imp kvar
0.15	0,9428	0
0.30	1,0668	0
0.45	0,7984	0
1.00	0,7844	0
1.15	0,7984	0
1.30	0,8324	0
1.45	0,8396	0
2.00	0,7484	0
2.15	0,748	0
2.30	0,906	0,0004
2.45	0,7388	0
3.00	0,7572	0
3.15	0,8044	0
3.30	0,8672	0
3.45	0,776	0
4.00	0,7464	0
4.15	0,7672	0
4.30	0,8404	0
4.45	0,72	0
5.00	0,6828	0
5.15	0,8212	0
5.30	0,8428	0
5.45	0,7332	0
6.00	0,7568	0
6.15	0,7292	0
6.30	0,714	0
6.45	0,6272	0
7.00	0,5948	0
7.15	0,7436	0
7.30	0,7288	0
7.45	0,6184	0
8.00	0,6724	0

If the data are used for drawing a load profile of Active Demand in kW it is necessary to:

- determine the energy readings of each period by calculating the difference of one period with respect to earlier period (e.g. value at 00,15 hours minus value at 00.00 hours, and so on.
- transform the value (expressed in 1/10 of kWh) into a kWh value by dividing the above difference by 10000.
- multiply the result by 4 (the value is referred to 15 min but it needs to be referred to 1 hour)

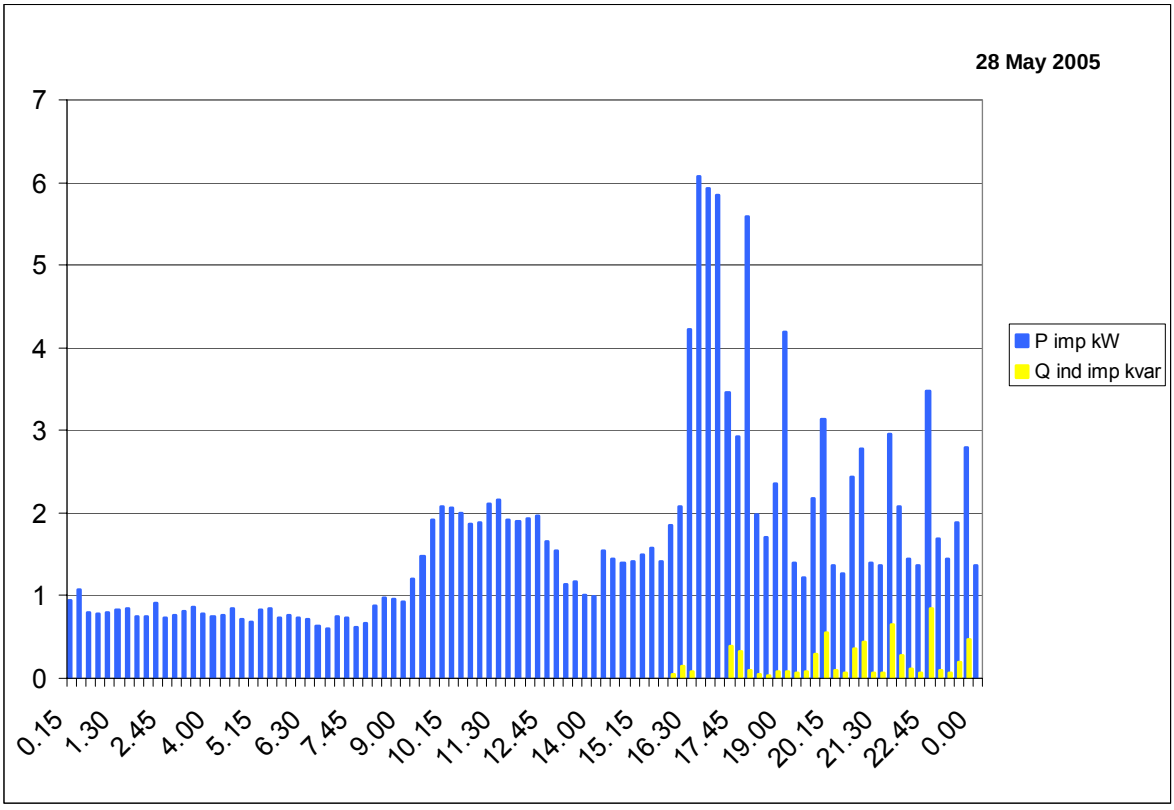
The formula to apply to the 1st cell is therefore : =(D19-D18)/10000*4
By *copying* the 1st cell and *pasting* it into the following cells the formula is extended to the entire column.

The same operation is applied to the import Reactive Energy, for determining the Reactive Demand in kvar, by copying and pasting the formulas in the side columns.

The left column was formatted to show time only by selecting the HOUR format for cell/column (in order to hide the date indication).

N.B. due to limited space, the example above shows only a portion of readings out of one day.

Upon graphing the data obtained, the resulting graph will show as below indicated.



11.10 Application examples

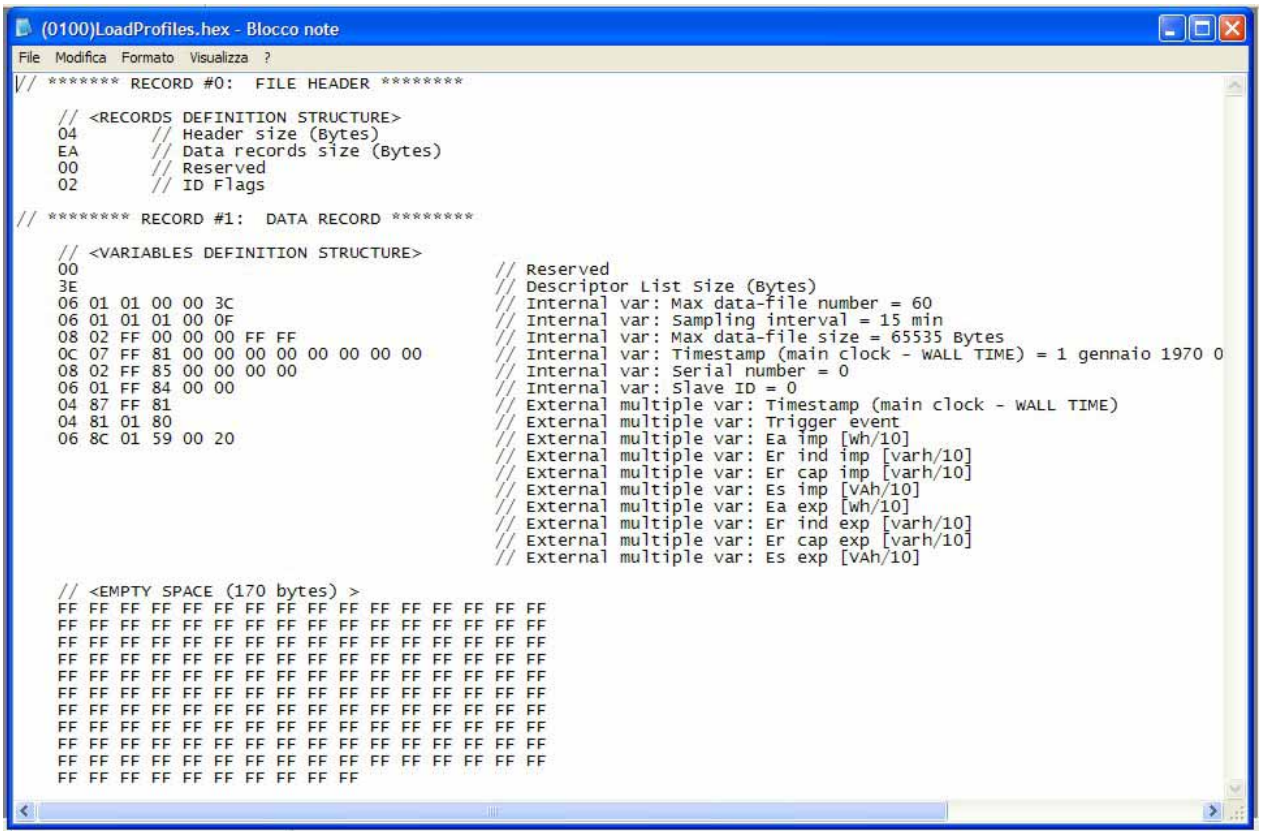
11.10.1 Changing the readings stored by Service (11) Load Profiles.

The instrument is supplied with a default configuration file designed for application with the Energy Brain software.
The default configuration foresees the storage of all the 8 energy counters values of the 4 quadrants.
The energy counters used for this service in combination with the Energy Brain software are at 64 bit (4 registers) in order to allow an accurate energy count from 1/10 of Wh up to 99.999.999 kWh.
It is essential to maintain these settings should the instrument be used with the Energy Brain software.

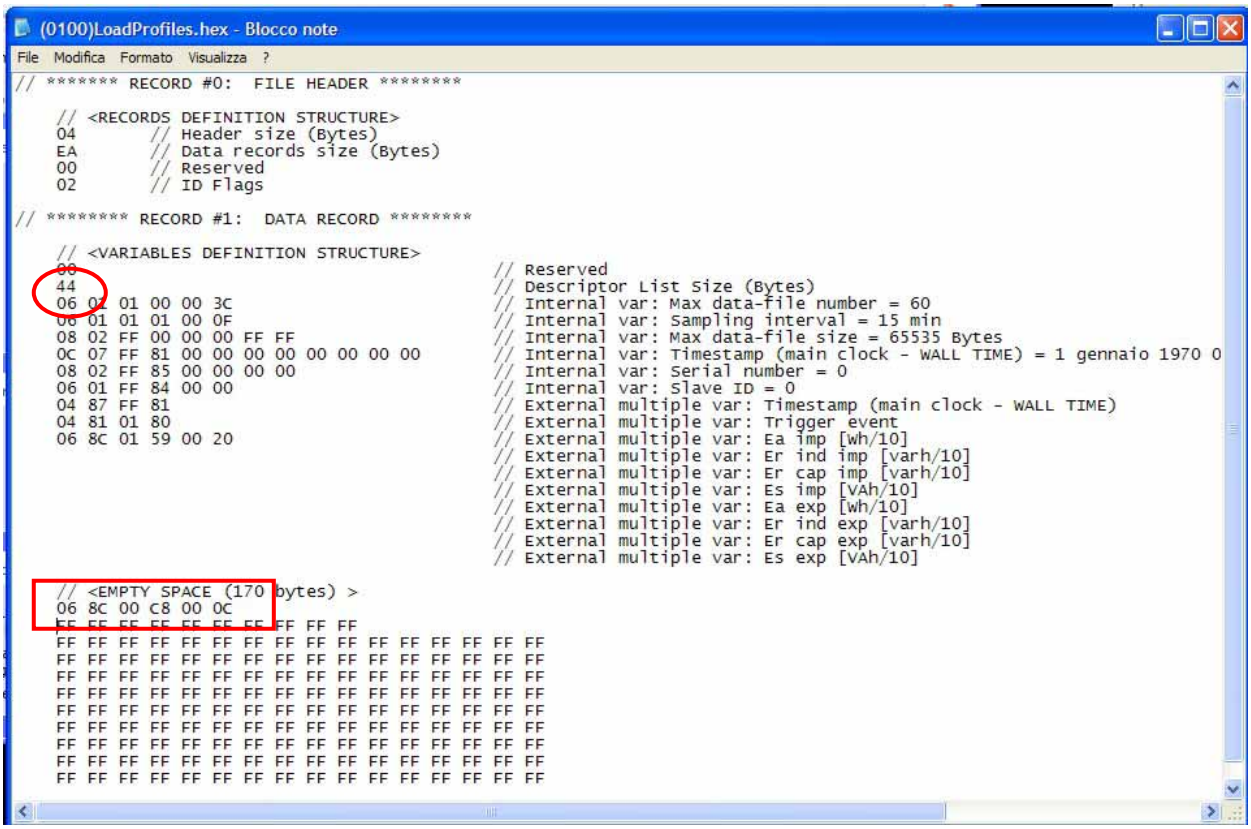
In order to change the configuration it is first necessary to download the existing configuration in HEX format by using the following command line.

```
C:\Programs\X3M\XMBF --read --ser=com1,38400,8,n,2 --addr=27 --fnum=0500 --hex
```

Edit then the file by means of the Notepad program.



The request is to store some other additional parameters; the specific case shows the three Voltage THDs an the three Current THDs.
The file was generated in such a way as to always have the maximum size; this prevents the need of cancellation of the old file when a new file is loaded.
For this purpose a number of FF was placed at the end of the data area for reaching the maximum file size that, being made of one record only, it may contain max 238 byte, equal to EEH byte.

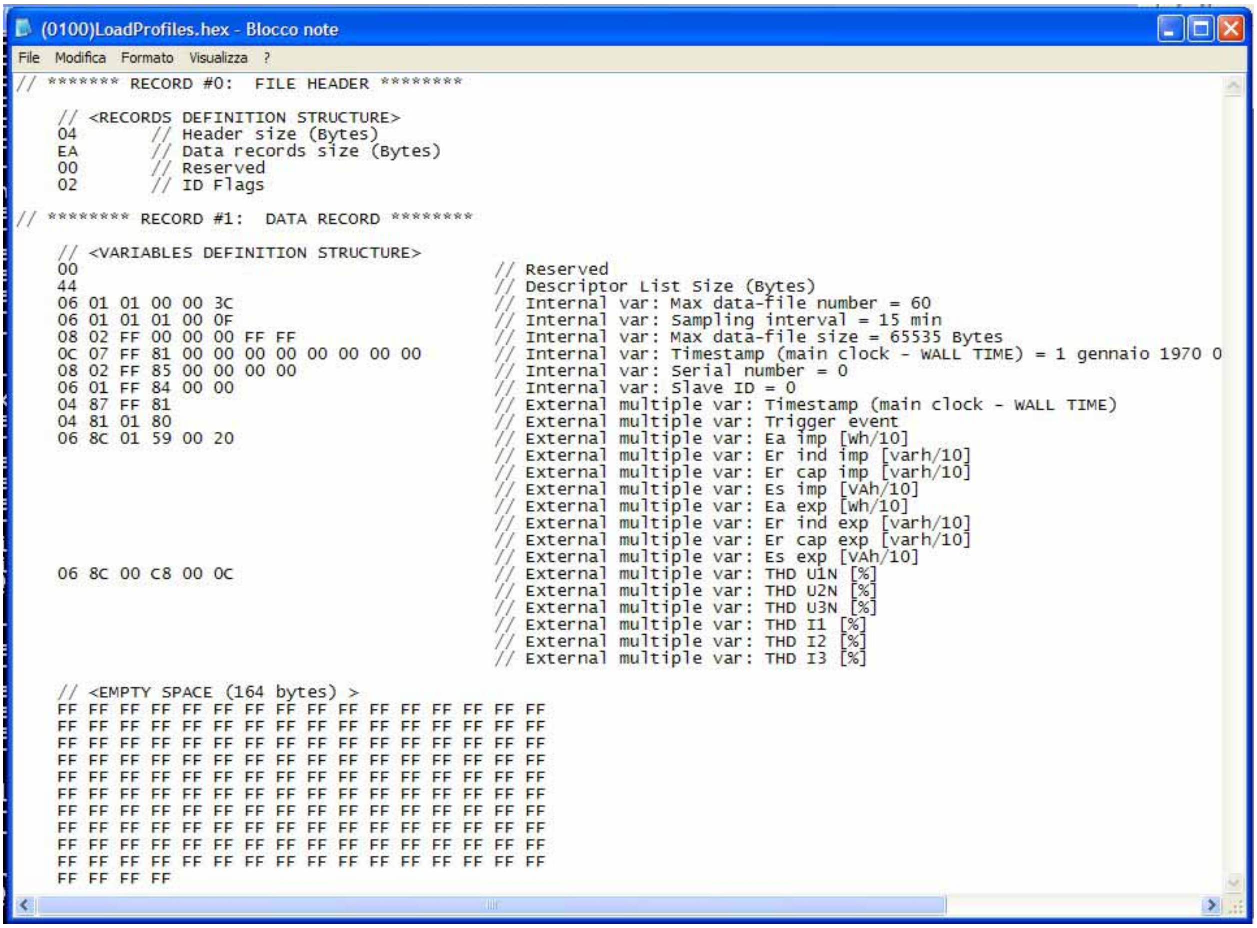


The modification is achieved by overwriting the first part of FF with the string identifying the readings that need to be added.
The example string shows the settings for the recording of external variables to be taken from the MODBS registers starting with C8H, corresponding to the 200 register, for a length of 0CH registers, corresponding to 12 ones.
They correspond to the first 12 Input Registers where the parameters required by the user are located
The “data records size” is unchanged whilst the “descriptor list size”, having added 6 significant bytes, changes from 3EH to 44H.

Upload the new file by means of the command:

C:\Programs\X3M\XMBF --write --ser=com1,38400,8,n,2 --addr=27 --fname=(0100)LoadProfiles.hex

Upon re-reading the file, after its up-date, and by opening the file with the Notepad program, the following window is obtained:



(0100)LoadProfiles.hex - Blocco note

File Modifica Formato Visualizza ?

```
// ******* RECORD #0:  FILE HEADER ********

    // <RECORDS DEFINITION STRUCTURE>
    04        // Header size (Bytes)
    EA        // Data records size (Bytes)
    00        // Reserved
    02        // ID Flags

// ******** RECORD #1:  DATA RECORD ********

    // <VARIABLES DEFINITION STRUCTURE>
    00                                      // Reserved
    44                                      // Descriptor List Size (Bytes)
    06 01 01 00 00 3C                       // Internal var: Max data-file number = 60
    06 01 01 01 00 0F                       // Internal var: Sampling interval = 15 min
    08 02 FF 00 00 00 FF FF                 // Internal var: Max data-file size = 65535 Bytes
    0C 07 FF 81 00 00 00 00 00 00 00 00     // Internal var: Timestamp (main clock - WALL TIME) = 1 gennaio 1970 0
    08 02 FF 85 00 00 00 00                 // Internal var: Serial number = 0
    06 01 FF 84 00 00                       // Internal var: Slave ID = 0
    04 87 FF 81                             // External multiple var: Timestamp (main clock - WALL TIME)
    04 81 01 80                             // External multiple var: Trigger event
    06 8C 01 59 00 20                       // External multiple var: Ea imp [Wh/10]
                                            // External multiple var: Er ind imp [varh/10]
                                            // External multiple var: Er cap imp [varh/10]
                                            // External multiple var: Es imp [VAh/10]
                                            // External multiple var: Ea exp [Wh/10]
                                            // External multiple var: Er ind exp [varh/10]
                                            // External multiple var: Er cap exp [varh/10]
                                            // External multiple var: Es exp [VAh/10]
    06 8C 00 C8 00 0C                       // External multiple var: THD U1N [%]
                                            // External multiple var: THD U2N [%]
                                            // External multiple var: THD U3N [%]
                                            // External multiple var: THD I1 [%]
                                            // External multiple var: THD I2 [%]
                                            // External multiple var: THD I3 [%]

    // <EMPTY SPACE (164 bytes) >
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
    FF FF FF FF
```

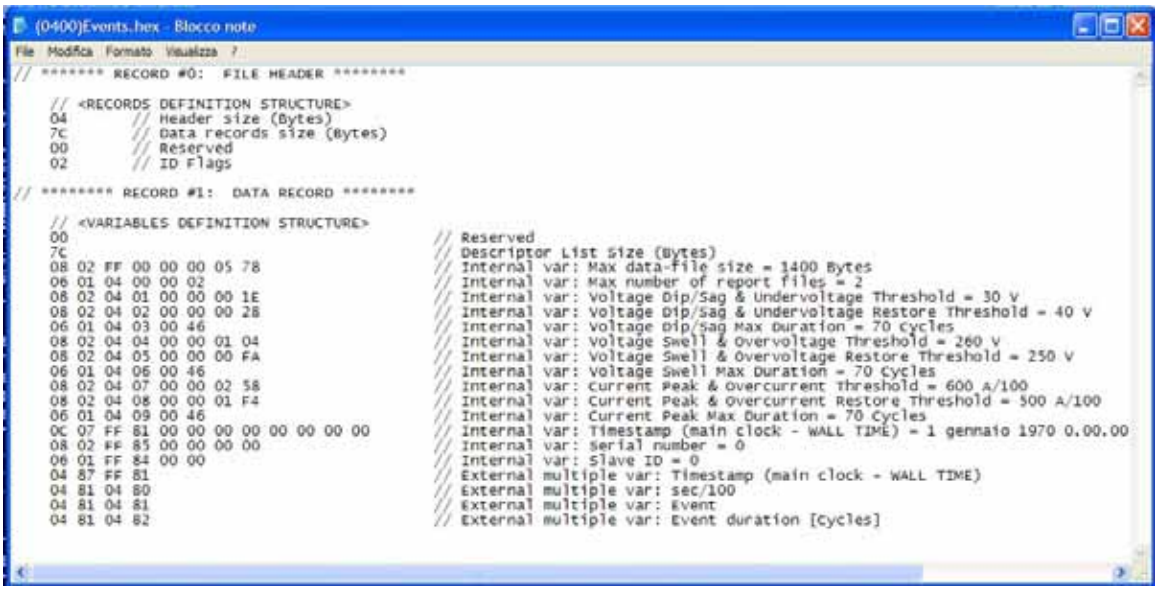
11.10.2 Changing the thresholds of Service (4) Events.

The thresholds for the Events Service are given in real value, same as displayed by the instrument, and they already take into account the CTs and VTs multiplying factors.
It is therefore essential to set the proper thresholds depending upon the type of measurement that is made.

In order to change the configuration it is first necessary to download the existing configuration in HEX format by means of the following command

```
C:\Programs\X3M\XMBF --read --ser=com1,38400,8,n,2 --addr=27 --fnum=0500 --hex
```

Open then the file by means of the Notepad program.



The data indicated are those of the default configuration file that is factory loaded.

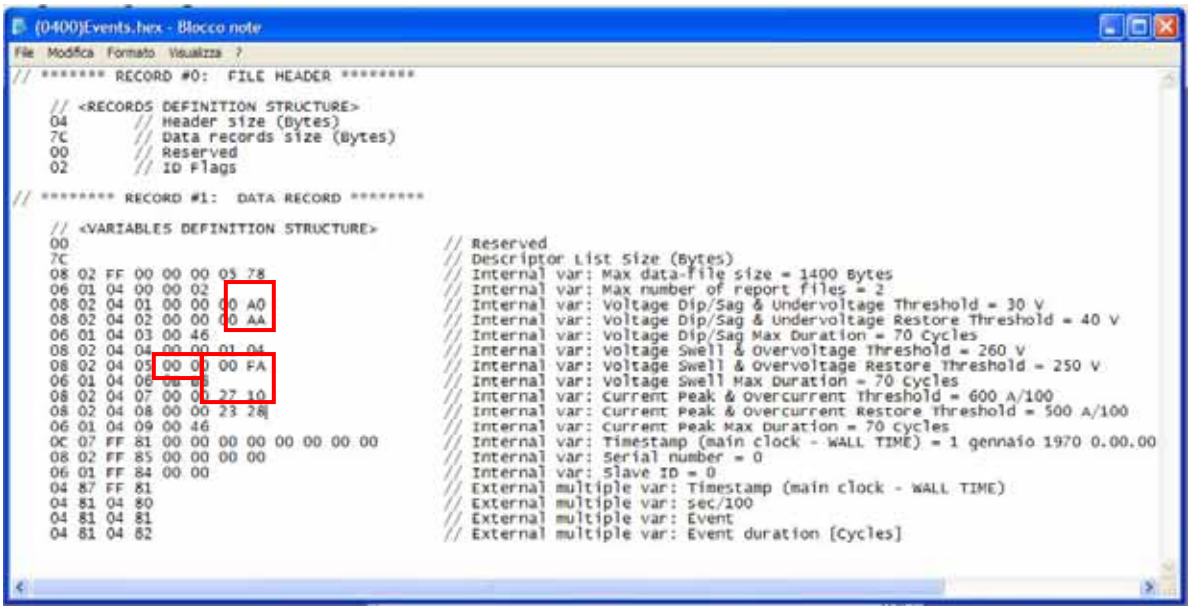
The request is to configure:

the threshold for detection of Voltage Sags (Dips) or Undervoltages to:
160 Volt triggering threshold
170 Volt restore threshold

the threshold for detection of Overcurrents and Current Peaks to:
100 Amps triggering value
90 Amps restore threshold

the time duration that discriminates a Voltage Swell from an Overvoltage:
1 minute duration for discriminating a Voltage Swell

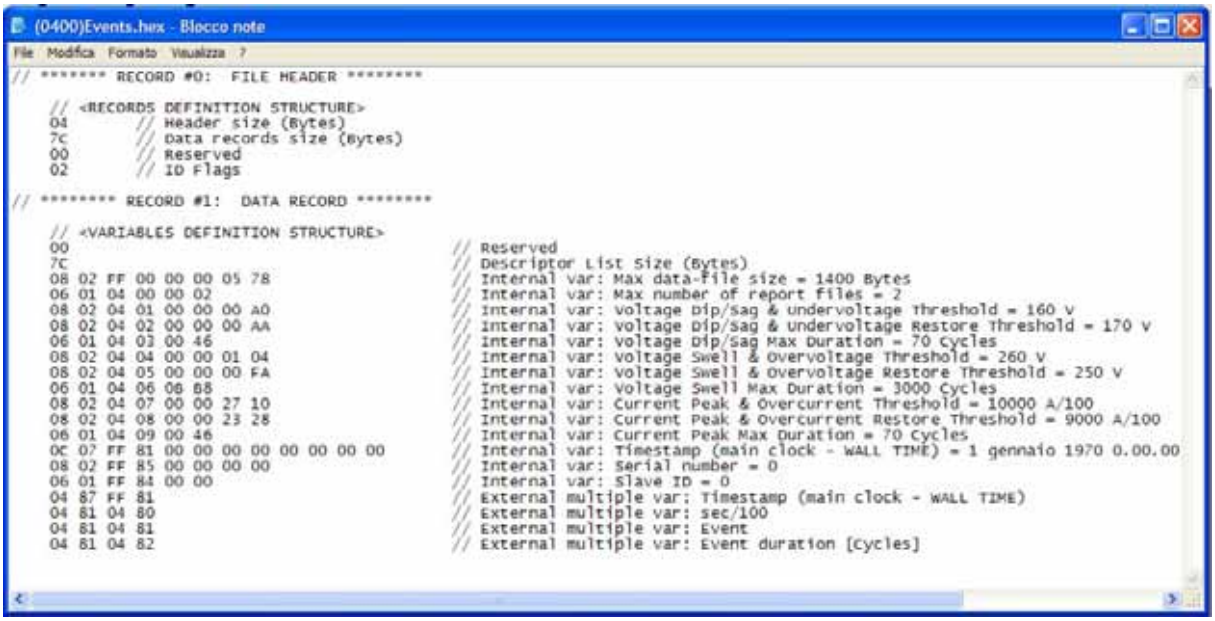
The decimal numbers should be converted into hexadecimal, by using the Windows calculator, and they are then replaced into the applicable fields.
The example show how to change the current threshold value. The new value has to be 100A.
Into the file the current has to be specified in 1/100 of A so we have to write 10.000 decimal that correspond to 2710H.



Upload the new file by means of the following command line:

```
C:\Programs\X3M\XMBF --write --ser=com1,38400,8,n,2 --addr=27
--fname=(0400)Events.hex
```

By re-reading the file after its up-date and by opening it file with the Notepad program, the following window is obtained:


(0400)Events.hex - Blocco note
File Modifica Formato Visualizza ?
// ******* RECORD #0: FILE HEADER ********
// <RECORDS DEFINITION STRUCTURE>
04 // Header size (Bytes)
7C // Data records size (Bytes)
00 // Reserved
02 // ID Flags
// ******** RECORD #1: DATA RECORD ********
// <VARIABLES DEFINITION STRUCTURE>
00 // Reserved
7C // Descriptor List Size (Bytes)
08 02 FF 00 00 00 05 78 // Internal var: Max data-file size = 1400 Bytes
06 01 04 00 00 02 // Internal var: Max number of report files = 2
08 02 04 01 00 00 00 A0 // Internal var: Voltage Dip/Sag & undervoltage Threshold = 160 V
08 02 04 02 00 00 00 AA // Internal var: Voltage Dip/Sag & undervoltage Restore Threshold = 170 V
06 01 04 03 00 46 // Internal var: Voltage Dip/Sag Max Duration = 70 Cycles
08 02 04 04 00 00 01 04 // Internal var: Voltage Swell & Overvoltage Threshold = 260 V
08 02 04 05 00 00 00 FA // Internal var: Voltage Swell & Overvoltage Restore Threshold = 250 V
06 01 04 06 06 B8 // Internal var: Voltage Swell Max Duration = 3000 Cycles
08 02 04 07 00 00 27 10 // Internal var: Current Peak & Overcurrent Threshold = 10000 A/100
08 02 04 08 00 00 23 28 // Internal var: Current Peak & Overcurrent Restore Threshold = 9000 A/100
06 01 04 09 00 46 // Internal var: Current Peak Max Duration = 70 Cycles
0C 07 FF 81 00 00 00 00 00 00 00 00 // Internal var: Timestamp (main clock - WALL TIME) = 1 gennaio 1970 0.00.00
08 02 FF 85 00 00 00 00 // Internal var: Serial number = 0
06 01 FF 84 00 00 // Internal var: Slave ID = 0
04 87 FF 81 // External multiple var: Timestamp (main clock - WALL TIME)
04 81 04 80 // External multiple var: sec/100
04 81 04 81 // External multiple var: Event
04 81 04 82 // External multiple var: Event duration [Cycles]

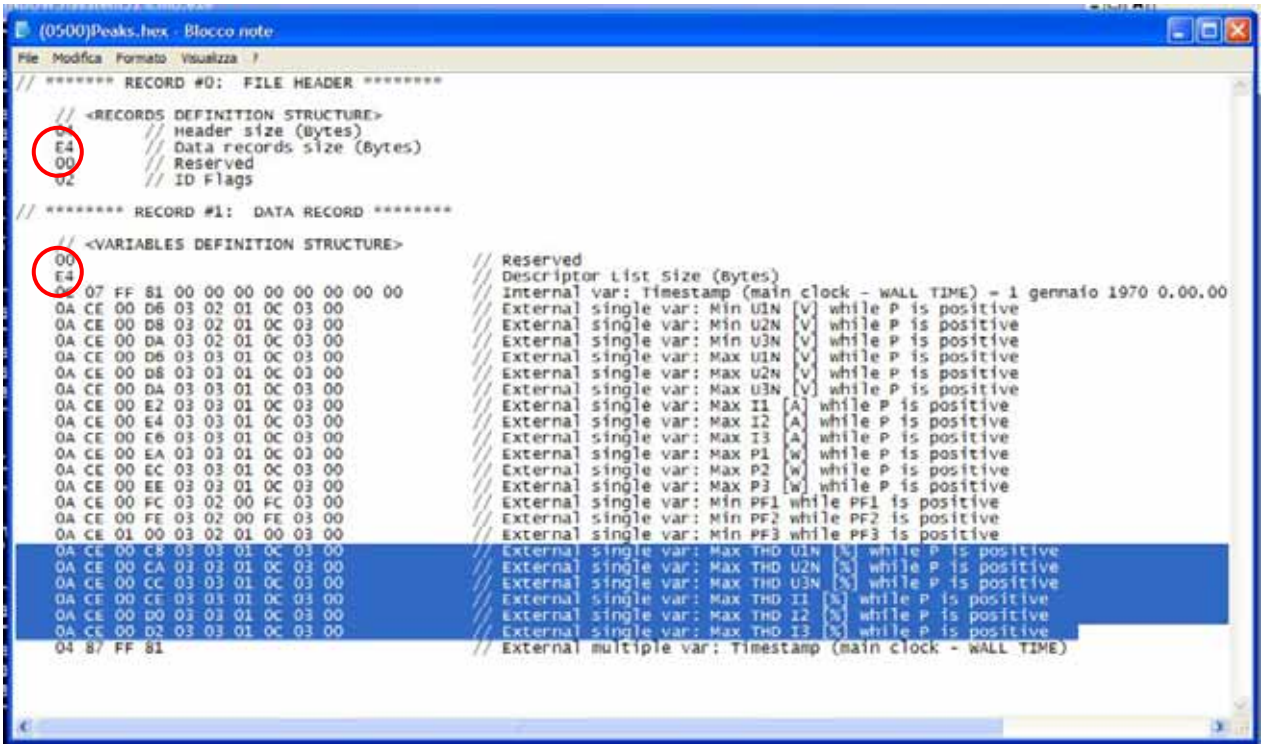
11.10.3 Changing the parameters stored by Service (5) Peaks

Read the configuration file of this service in Hex format by means of the following command:

C:\Programs\X3M\XMBF --read --ser=com1,38400,8,n,2 --addr=27 --fnum=0500 --hex

A file is downloaded and saved, named (0500)Peaks.hex, that is opened by means of the Notepad program.

The following picture shows the default configuration file of Service 5 Peaks.



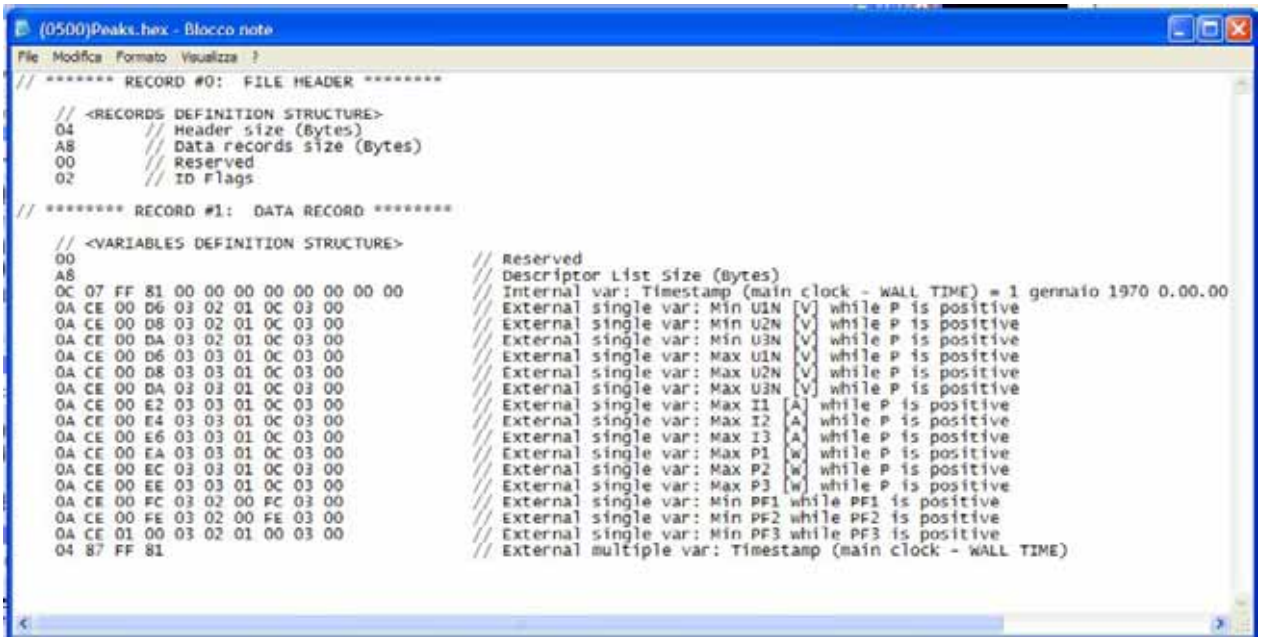
The picture shows the 21 parameters that are currently set where the recording of the Voltage THDs and Current THDs needs to be removed.

By means of the Notepad program, cancel the 6 lines identifying the parameters that need to be removed then modify the two data that establish the “Data records size” and the “Descriptor list size” by removing the 60 (3CH) bytes, that were eliminated, from E4.
The new value is A8H.
Save the file just edited.

The command line:
C:\Programs\X3M\XMBF --del --ser=com1,38400,8,n,2 --addr=27 --fnum=0500
erases the old file in the instrument because the new file is slightly different in size.

Upload the new file by means of the following command line:
C:\Programs\X3M\XMBF --write --ser=com1,38400,8,n,2 --addr=27
--fname=(0500)Peaks.hex --create

By re-reading the file, after its up-date, and by opening it with the Notepad program, the following window is obtained:



From now on, the Service will operate on the base of the new settings.

In order to have the data file updated, it is necessary to remove the existing one.

12 Technical Characteristics

Measurement sections:

Voltmetric Inputs:

500 Vrms phase-phase (crest factor max 1.7);

Amperometric Inputs:

5 Arms (crest factor max 1.7);

Frequency: 45 ÷ 65 Hz

Precision: 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: Guaranteed up 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 up to 100 mA*

Overload:

Voltmetric Inputs: max 900 Vrms peak value for 1 second

Amperometric 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 90% 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

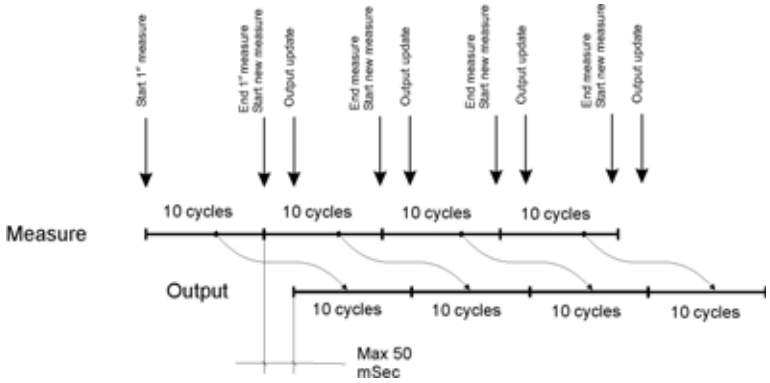
Counters: energy counters with 0.1 kWh resolution and maximum value 99,999,999.9 kWh (serial input).
Mount: DIN 96 x 96 mm.
Weight: 360 g (460 g with packaging).
Protection: IP51 on front, IP20 elsewhere.
Size: 96 x 96 x 90 mm (up to 105 mm max with options)
Outputs: 2 digital outputs for pulses or alerts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

Option

Galvanically Isolated RS485
Output isolation 1000 Vrms

Galvanically Isolated RS232
Output isolation 1000 Vrms

Galvanically Isolated Analog Port 4-20 mA
Output isolation 1000 Vrms
Output: self supplied 0 to 20 mA on 500 Ohm max
Precision: < 0.2% Reading.
Stability: 200 ppm/°C
Latency: 50 ms maximum
Update frequency: 10 grid cycles frequency



13 Firmware Revisions

v1.0

- First release

14 Order codes

Instruments

Designator	Description	Code
X3M	Three-phase energy data manager **(Power supply 100/230 V)**	**PFE 411-00**
X3M 24	Three-phase energy data manager **(Power supply 24 V)**	**PFE 411-00**

Options

Designator	Description	Code
RS485	Interface with optoinsulated RS485 port.	**PFE 420-00**
RS232	Interface with optoinsulated RS232 port.	**PFE 421-00**
2 ANALOGUE 4-20 mA OUTPUT	Double analogue output 4-20 or 0-20 mA programmable on any unit.	**PFE 422-00**

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