

## [1] Introduction

The **Mult-K Plus** is a digital micro-processed instrument, to be installed on a panel's door, allowing the measurement of up to 44 electrical parameters at an alternate current system (AC). The parameter reading can be performed locally or remotely.

It can be equipped with a **mass memory**, which allows the history storage of up to ten electrical greatnesses with a minimum interval of 1 minute.

There is also the option of supplying the **Mult-K Plus** with special external current transformers (split core).

## [2] Operation principle

By means of the voltage and current signals from the system to be measured (mono-phase, two-phase or three-phase), the **Mult-K Plus** calculates the electrical parameters, using a high resolution internal A/D converter, with 64 samples per cycle. The refresh rate of the electrical parameters is 400 ms.

The **Mult-K Plus** can be applied either on low voltage or on high voltage systems, once it is possible to program the relation of the PT (potential transformer) or of the CT (current transformer) involved in the measurement.

## [3] Applications

- Substation automation;
- Industrial and premise automation;
- Circuits and electrical equipment analysis;
- Survey of the loading curve and history of an electric circuit;
- Costs allotment;
- Analogical instruments replacement;
- Any application involving electrical parameter measurements.

## [4] Measured greatnesses

Measurement of up to 44 electrical parameters, as follows:

- Voltage (phase-phase, phase-neutral and three-phase)
- Frequency
- Current (per phase and three-phase)
- Active power (per phase and three-phase)
- Reactive power (per phase and three-phase)
- Apparent power (per phase and three-phase)
- Power Factor (per phase and three-phase)
- THD (per voltage and current phase, until the 31st order)
- Active demand (average and maximum)
- Apparent demand (average and maximum)
- Active power (positive and negative)
- Reactive power (positive and negative)
- Maximum (voltage and current)



*Illustrative photo*

## [5] Accuracy

- Voltage, current, power: 0,2%\*
- Frequency: 0.1Hz
- Power factor: 0,5%\*
- Energy: 0,5%
- THD: <3%

(at 25°C, observing the recommended voltage and current ranges)

\* Accuracy refers to the scale background

## [6] Electrical Characteristics

### AUXILIARY SUPPLY

- Nominal: 12\*, 24 or 48Vdc / 120-220Vac
  - Utilization range: 80 to 120% of nominal value
- TOP Source: 85-265Vac and 100-375Vdc
- Internal consumption: < 10 VA

\* Utilization range of 90 to 120% of nominal value.

### VOLTAGE INPUT (MEASUREMENT)

- Operation range: 20 to 500Vac (F-F)
- Overcharge: 1.5 x Vmax (1s)
- Operation frequency: 44 to 72Hz
- Internal consumption: < 0.5 VA

### CURRENT INPUT (MEASUREMENT)

- Nominal (In): 1Aac or 5Aac
- Minimal indication: 20mA
- Full Scale:
  - 1.5 x In (standard)
  - 2 x In (optional)\*
- Short duration overload:
  - 20 x In (1 s)
- Internal consumption: < 0.5 VA

\*Only for nominal current of 5Aac, full scale of 10Aac.

**[7] Mechanical Characteristics**DISPLAY

- Type: 7 segments – 4 columns x 3 rows
- Size: 10 mm
- Color: Red (high brightness)

ENCLOSURE

- Material: thermoplastic (ABS V0)
- Protection grade: IP-40 for front panel (option for IP-54) and IP-20 for enclosure (option for IP-40)

ASSEMBLY

- Type: panel's door (overlap)
- Assembling position: any
- Fastening: side latches

ELECTRICAL CONNECTIONS

- Type: quick coupling terminal
- Protection grade: IP-00
- Maximum cable to be used: 2.5mm<sup>2</sup>

**[8] Relevant environmental conditions**

- Operation temperature: 0 to 60°C
- Storage and transport temperature: -25 to 60° C
- Relative air humidity: 90% maximum (without condensation)
- Temperature coefficient: 50ppm / °C

**[9] Serial Interface**

- Type: RS-485 with two wires, protocol MODBUS-RTU
- Speed: 9600, 19200, 38400 or 57600bps (configurable)
- Data format: 8N1, 8N2, 8E1, 801 (configurable)
- Address: 1 to 247 (configurable)
- Protocol: MODBUS-RTU
- Information encoding:

MODBUS-RTU beginning with version 3.0:

*FlexData* mapping, with configurable floating point IEEE 754 (32 bits), reading formats at 16 bits (totally signaled and not signaled) and floating point of 24 bits for mass memory.

- Cable: For RS-485, a shielded cable must always be used, with at least two ways (2x24 AWG), minimum section of 0.25mm<sup>2</sup> and characteristic impedance of 120ohms.

**[10] Pulses Output (optional)**

- Type: open collector
- Parameters: positive active power (output 1) and positive reactive power (output 2)
- Pulse width: 200ms
- Maximum current: 1mA
- Maximum frequency: 1Hz

**[11] Applicable software programs**

- Software for reading and parameterization: Network MB5 5.19 or higher (freely supplied by KRON)
- Compatible with supervisory applications, CLPs and concentrators that support MODBUS-RTU protocol

## [12] Connection Diagrams

Terminal description:

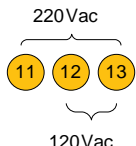
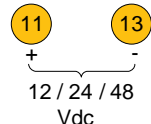
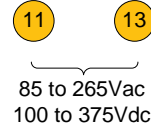
Terminal	Description	Terminal	Description
1	Voltage Vc	11	Auxiliary supply
2	Voltage Vb	12	
3	Voltage Va	13	
4	Neutral	14	Serial: DATA-
5	Current Ic	15	Serial DATA+
6	Current ●Ic	16	Serial: Ground
7	Current Ib	17	Reactive Pulse: C
8	Current ●Ib	18	Reactive Pulse: E
9	Current Ia	19	Active Pulse: C
10	Current ●Ia	20	Active Pulse: E

### Version E-13

Version **E-13** of Mult-K Plus has three digital inputs and one relay output, however, it does not have pulses output. Therefore, for this case, we have:

Terminal	Description	Terminal	Description	Terminal	Description
1	Voltage Vc	9	Current Ia	29	NO – Relay output
2	Voltage Vb	10	Current ●Ia	30	Common: Relay output
3	Voltage Va	11	Auxiliary supply	31	Digital Input 1: C
4	Neutral	12		32	Digital Input 1: E
5	Current Ic	13		33	Digital Input 2: C
6	Current ●Ic	14	Serial: DATA-	34	Digital Input 2: E
7	Current Ib	15	Serial DATA+	35	Digital Input 3: C
8	Current ●Ib	16	Serial: Ground	36	Digital Input 3: E

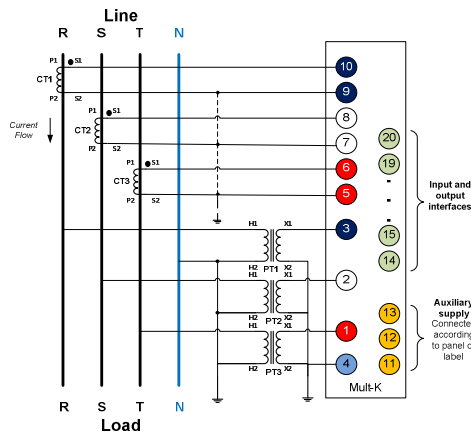
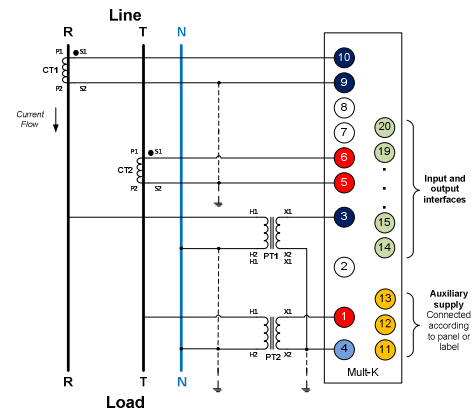
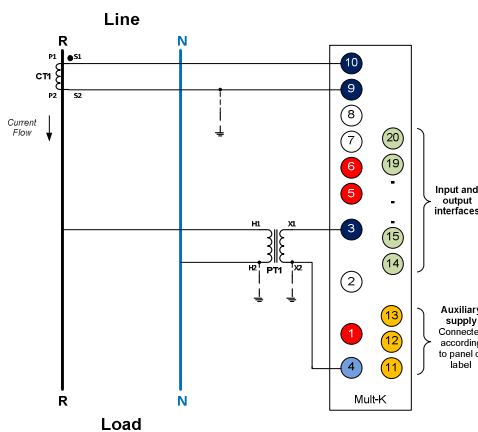
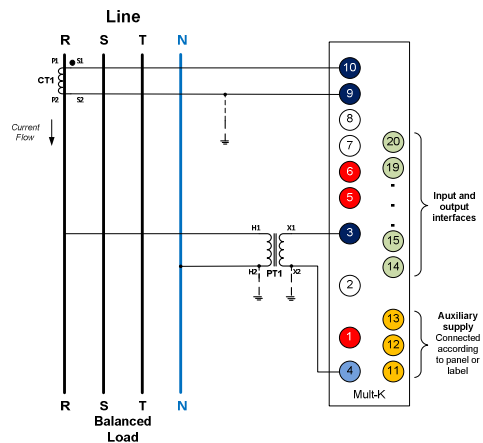
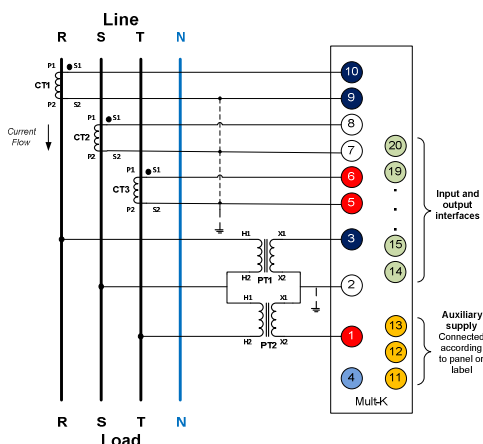
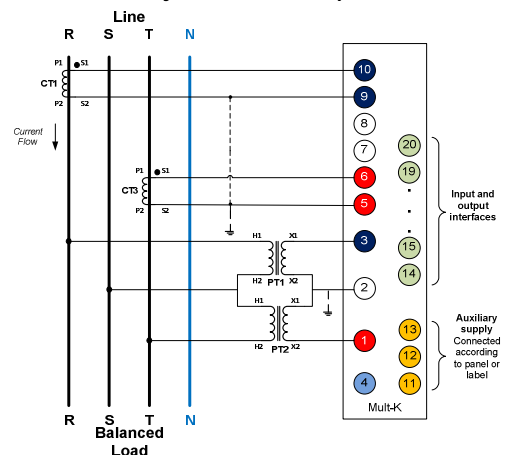
### Description of terminals related to the auxiliary supply:

Power source (120 or 220 Vac)	Power source DC (12/24/48 Vdc)	Power source TOP (85 to 265 Vac and 100 to 375 Vdc)
	 <p>Respect polarities</p>	 <p>There is no polarity for direct current signal.</p>

### Recommendations

- Recommended cable: minimum section of 1.5mm<sup>2</sup> for auxiliary voltage and supply.
- For current signal, the sizing depends on the distance and power of the CTs involved.
- The auxiliary supply (terminals 11, 12 and 13) must always be made according to the label affixed on the instrument.
- In the case of utilization of the TOP SOURCE, the supply must be connected to terminals 11 and 13 respecting the characteristic limits, without the need of observing the polarization if the input signal is either continuous or alternate.

## [12] Connection Diagrams (continued)

**TL-00: Three-phase Star (3F + N)**

**TL-01: Two-phase (2F + N)**

**TL-02: Monophase (1F + N)**

**TL-03: Balanced Three-phase (3F + N, with measurement of just 1 element)**

**TL-48: Three-phase Delta (3F)**

**TL-49: Three-phase Delta (3F, with measurement of just 2 elements)**


- In the case of using external transformers, those shall be of measurement.
- The use of a PT (potential transformer) is unnecessary for voltages below 500 Vac. (F-F).
- **Never** leave the secondary of the CTs in the open mode, do not use fuses or circuit breakers in series with the current circuit and do not use the CTs with operation current above the permitted level. It is recommended the installation of an admeasurement block.
- The grounding indicated by dots in the diagrams are recommended for safety reasons and do not directly interfere in the instrument's measurement or accuracy.

**[13] Mass Memory (optional)**

**Application:** It is a non-volatile memory (the data are not lost in case of lack of auxiliary supply), which allows to record the historical behavior of up to 10 (ten) electrical greatneses.

The mass memory of the **Mult-K Plus** can be configured with a minimum interval of 1 minute and maximum interval of 540 minutes (9 hours), and the time until filling the memory will depend on the quantity of greatneses chosen and on this storage interval.

The information is stored in a floating point format, 24 bits, containing its date and time, originated from an internal clock existing on the multimeter.

- Type: non-volatile memory (retentive)
- Capacity: 512 kBytes
- Storage mode: circular (when memory capacity is exhausted, older data is erased to write new data, by sectors) or linear (when memory capacity is exhausted, data is no longer stored).
- Quantity of greatneses possible of being stored: 1 to 10 greatneses
- Minimum interval between writings: 1 minute
- Maximum interval between writings: 540 minutes (9 hours)

The stored data can be collected through a serial interface, utilizing CLPs, data concentrators, supervisory applications or software RedeMB5 (freely supplied). This software permits to export the information to a text file, with no formatting (text – “txt”), facilitating the composition of graphics using Excel, for instance.

The table below contains the maximum information quantity that can be stored, varying according to the number of selected greatneses:

Quantity of greatneses	Total of registers	Examples of time to fill the memory for a 15 minutes interval (in days)
1	58236	606
2	43677	454
3	34940	364
4	29118	303
5	24958	260
6	21837	227
7	19405	202
8	17470	182
9	15877	165
10	14559	152


## [14] Special External Transformers

With **Mult-K Plus**, it is possible to use special external current transformers of the **split core** type. This allows the installation to be performed without the need of disconnecting the main power.

### Split Core

Besides the easiness of installation, they have reduced dimensions, facilitating, for instance, its utilization on locations with space limitation.

The **clamp** can be opened and closed up to 50 times without resulting in measurement changes.

	Maximum Current
	120Aac
	200Aac
	300Aac

### Considerations and Recommendations



The special external transformers must always be connected according to the phase indicated in the label. For instance, a transformer with inscription “**PHASE A**” must only be connected to inputs “**Ia**” and “**la**” from the meter. The procedure is analogue for phases **B** and **C**.

Each instrument is supplied with its **own** set of these transformers and there is no way of using another one, even if it has the same nominal current value.



**NEVER DISCONNECT THE SPECIAL EXTERNAL TRANSFORMERS FROM THE METER WHILE THEY ARE CONNECTED TO THE LOAD.**

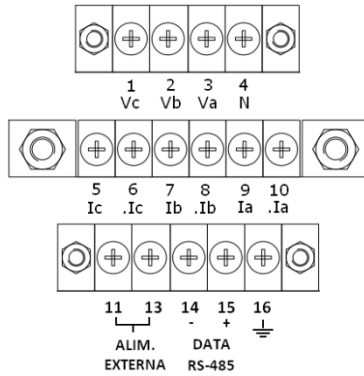
**THE REMOVAL OF THE CONNECTIONS IN THE ABOVE SITUATION WILL CAUSE DAMAGE TO THE METER AND HIGH SAFETY RISKS.**

**NOTE:** The maximum cable length that connects the special external transformers to the meter terminals is of 1 meter.

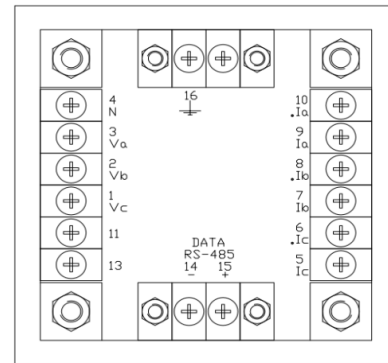
## [15] Lug Terminals

On Mult-K Plus, besides the quick terminal coupling connection, three options can be chosen with lug terminals:

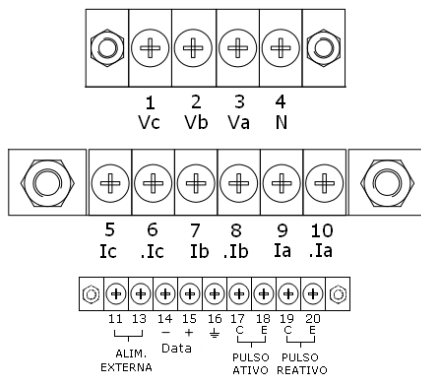
### Lug Terminal Type 1 – Horizontal Layout



### Lug Terminal Type 2 – Rectangular Layout



### Lug Terminal Type 3 – Horizontal Layout with pulse outputs

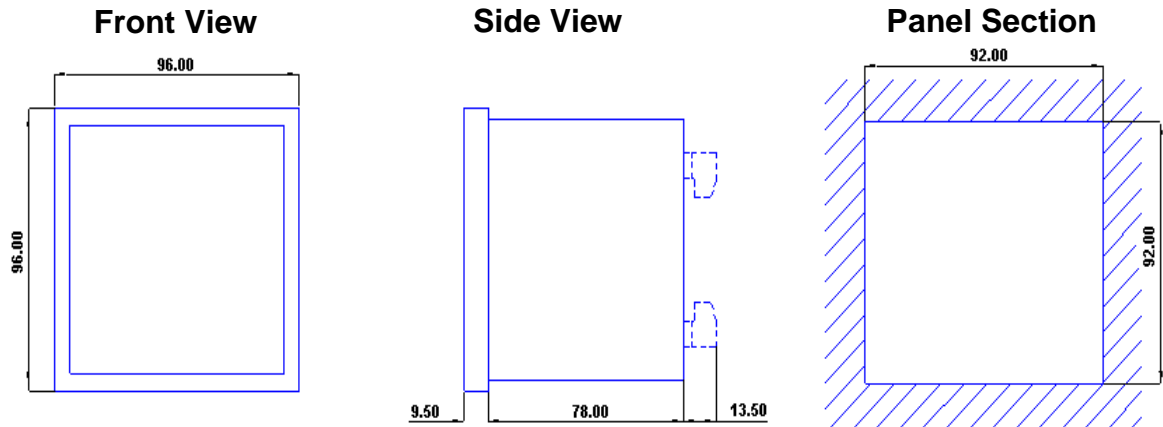
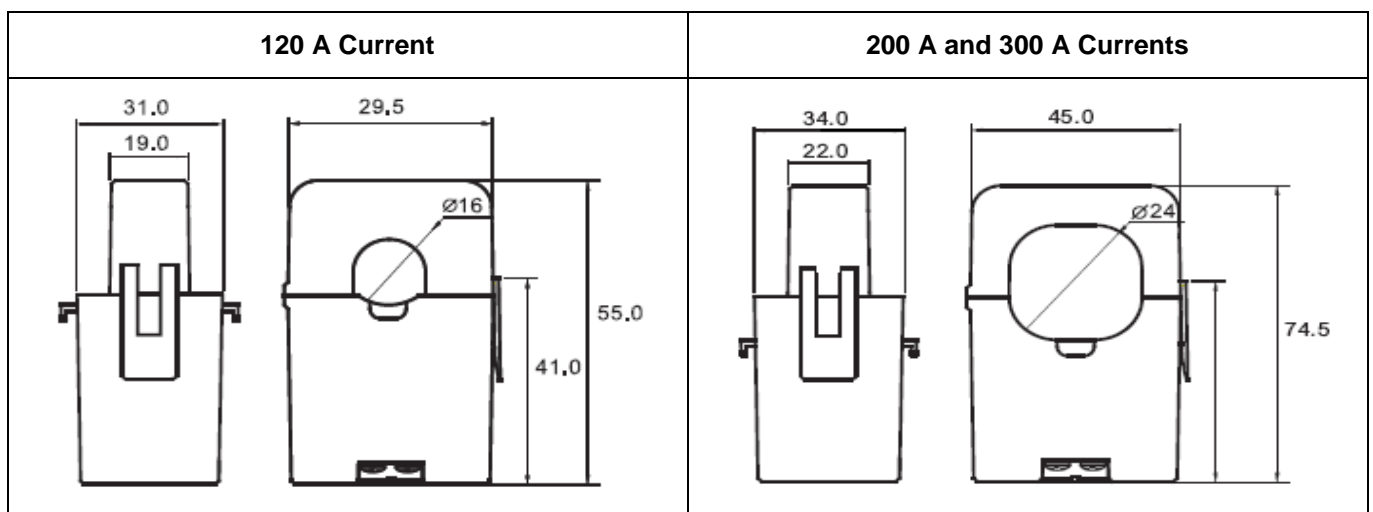


**NOTE:** Some versions of Mult-K Plus cannot be produced with lug terminals or are allowed to be produced with only one of the available types.

For further info, check section **Special Versions**.

**[16] Dimensions**

Dimensions in millimeters.

Tolerance:  $\pm 1$ mm**Special External Transformers: Split Core****[17] Normalizations**

The products of the Mult-K line meet the following standards:

- IEC 61000-4-2
- IEC 61000-4-3
- IEC 61000-4-4
- IEC 61000-4-5
- IEC 61000-4-6
- IEC 61000-4-8
- IEC 61000-4-11
- CISPR 11



## [18] Special versions

- **E-10: Hour-seasonal measurement**

Permits the measurement (and the allotment) of the electric energy in daily periods, that is, considering the peak hours and off-peak hours.

This version is mandatorily equipped with a mass memory and performs the hourly separation without the need for any external control.

- **E-11: Special Protocol**

Communication protocol implemented with codification of the floating point information, standard IEEE-754 and integer 16bits by means of function "0x04 - Read Input Register".

Enables the indication of a negative signal at the MMI for greatnesses: Active power, Reactive power and Power factor (per phase and three-phase). This version is not equipped with mass memory.

**Notes:**

- ✓ **Termination** : produced only with lug terminal type 1 (horizontal layout).
- ✓ **Current Input**: 5 Aac ( $I_{m\acute{a}x} = 10$  Aac)

- **E-12: Special for concessionaire 1**

Identification in the front panel through colors, calculation of neutral current and maximum and minimum voltages and currents. Does not have TL-01 implemented.

**Notes:**

- ✓ **Termination**: produced only with lug terminal type 2 (rectangular layout).

- **E-13: Hour-seasonal measurement with digital inputs and outputs.**

Besides what was implemented in **E-10** version, it has three digital inlets for water and gas measurements, and also has a relay output that can be used jointly with the digital inlets, with the feature of programming the relay to turn on or off.

Does not have TL-02 and TL-03 implemented and, like E-10 version, is mandatorily equipped with a mass memory.

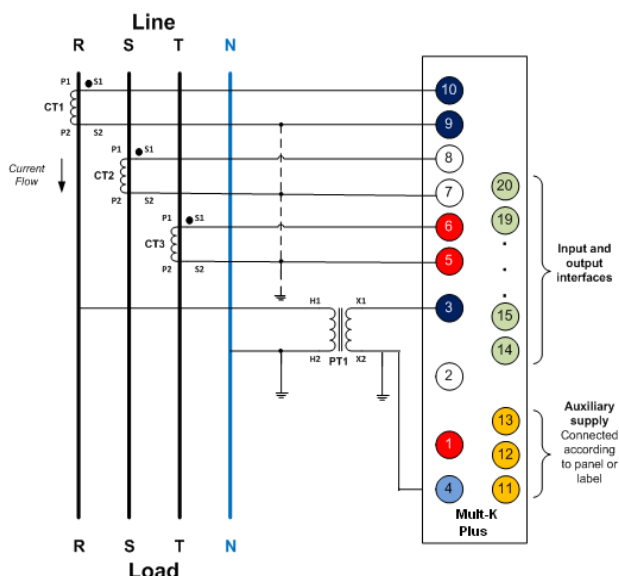
**Notes:**

- ✓ **Termination**: produced only with quick coupling terminals.
- ✓ **Current Input**: only 5 Aac ( $I_{m\acute{a}x} = 7,5$  Aac).

- **E-16: TL-05**

This version has TL-05 implemented. The TL-05 connection diagram uses only one reference for voltage measurement (R phase) and three references for current measurements.

**TL-05 (3Phases+N, with measurement of just one voltage reference)**



**Characteristics:**

Model:

- a. Does not have TL-02 and TL-03 implemented.
- b. Cannot be produced with a mass memory.

**Notes:**

- ✓ **Termination:** produced only with lug terminal type 2 (rectangular layout).
- ✓ **Auxiliary supply:** 48 Vdc or TOP source.
- ✓ **Current Input:** 5Aac (Imáx = 7,5Aac) only.
- ✓ **Output:** RS-485 only (It cannot be produced with pulse outputs)

TL-05 – Operation:

- a. The MMI follows the TL-00 pattern. In this case, there's no error code for phase sequence/missing phase.
- b. Voltages VB and VC are refreshed with the values obtained by VA measurement.
- c. Power Factor, active, reactive and apparent power, and Voltage DHT related to Phase A are calculated normally.

- d. Apparent power calculations for phases B and C are given by:

$$S2 = VB \times IB \quad S3 = VC \times IC$$

- e. Power Factor values for phases B e C are refreshed with the values calculated for phase A.
- f. Voltage DHT for phases B and C are refreshed with the values calculated for phase A.
- g. Active power calculations for phases B and C are given by:

$$P2 = S2 \times FP2 \quad P3 = S3 \times FP3$$

- h. Reactive power calculations for phases B and C are given by:

$$Q2 = \sqrt{S2^2 - P2^2} \quad Q3 = \sqrt{S3^2 - P3^2} .$$

They are refreshed with the same load type (inductive or capacitive, shown by + or – signs, respectively) of reactive power calculated for phase A.

- i. The following calculations are performed normally:
  - Current DHTs;
  - Three-phase greatnesses;
  - Energies and Demands.

**• Full Scale 10 Aac**

Made available upon order specification, version with support to measurement of up to 10 A.

**Notes:**

- ✓ **Termination:** Lug terminals only (types 1 or 2).
- ✓ **Auxiliar supply:** TOP Source only.
- ✓ **Output:** RS-485 only (It cannot be produced with pulse outputs)

