Circutor

MYeBOX 150, MYeBOX 1500

Methods of measurement / Formulas

APPLICATION NOTES

(M084E0201-03-20A)

C UL US
LISTED
MEASURING EQUIPMENT
E237816

DISCLAIMER

CIRCUTOR, SA reserves the right to make modifications to the device or the unit specifications set out in this instruction manual without prior notice.

CIRCUTOR, SA on its web site, supplies its customers with the latest versions of the device specifications and the most updated manuals.

www.circutor.com

	**CIRCUTOR,** recommends using the original cables and accessories that are supplied with the device.

CONTENTS

REVISION LOG

Table 1: Revision log.

Date	Revision	Description
06/19	M084E0201-03-19A	Initial Version
02/20	M084E0201-03-20A	Changes in the following sections: 7.2.

1.- SIGNAL SAMPLING, MEASURE AND PARAMETER AGGREGATION

The device samples every voltage and current input signal at a rate of 128 samples per cycle, which becomes a sampling frequency of 6400Hz per signal for 50Hz and a frequency of 7680Hz per signal for 60Hz.

The time aggregations are based on IEC 61000-4-30 class A:

- ✓ Full cycle updated every half cycle.
- ✓ 10 / 12 cycles values (for nominal frequencies of 50Hz / 60Hz).
- ✓ 150 / 180 cycles values (for nominal frequencies of 50Hz / 60Hz).
- ✓ 10 minute values.

MYeBOX also has additional time aggregations:

- ✓ 1 second values.
- ✓ 1 minute values.
- ✓ 15 minute values.
- ✓ 1 hour values.
- ✓ 1 day values.

The objective of this paper is to define the measuring method of the main values within the device.

2.- 10 CYCLE INTERVAL MEASURES (50Hz)

2.1.- VOLTAGE PHASE TO NEUTRAL

The 10 cycle RMS **Voltage to neutral** of every phase is calculated by the root mean square of the whole 10 cycle period interval samples.

$$Up = \sqrt{\frac{1}{1280} x \sum_{j=1}^{1280} {u_p}_j^2}$$

Equation 1: Voltage Phase - Neutral.

2.2.- VOLTAGE PHASE TO PHASE

The 10 cycle RMS **Voltage phase to phase** is calculated by making the vector difference of the two involved phases and then, The 10 cycle RMS value is calculated by the root mean square of the whole 10 cycle period interval difference samples.

$$Upg = \sqrt{\frac{1}{1280} x \sum_{j=1}^{1280} \left({u_p}_j - {u_g}_j\right)^2}$$

Equation 2: Voltage Phase - Phase.

2.3.- CURRENT

The 10 cycle RMS **current** of every phase is calculated by the root mean square of the whole 10 cycle period interval samples.

$$Ip = \sqrt{\frac{1}{1280} x \sum_{j=1}^{1280} {i_p}_j^2}$$

Equation 3: Current.

2.4.- ACTIVE POWER

The 10 cycle RMS **Active Power** of every phase is calculated by the scalar product of the whole 10 cycle period interval samples of Voltage and Current.

$$Pp = \sqrt{\frac{1}{1280} x \sum_{j=1}^{1280} {u_p}_j \; x \; {i_p}_j}$$

Equation 4: Active Power.

2.5.- REACTIVE POWER

The 10 cycle RMS **Reactive Power** of every phase is calculated by the vector product of the whole 10 cycle period interval samples of Voltage and Current which is achieved shifting the current vector 90º.

$$Qp = \sqrt{\frac{1}{1280} x \sum_{j=1}^{1280} u_{p_j} \; x \; i_{p_{j+90º}}}$$

Equation 5: Reactive Power.

2.6.- APPARENT POWER

The 10 cycle **Apparent Power** of every phase is calculated by the product of the 10 cycles RMS Voltage and Current.

$$Sp = Up \; x \; Ip$$

Equation 6: Apparent Power.

2.7.- POWER FACTOR

The 10 cycle **Power Factor** of every phase is calculated by the division of the 10 cycles RMS Active Power and Reactive Power.

$$PFp = \frac{Pp}{Sp}$$

Equation 7: Power factor.

2.8.- Cos φ

The 10 cycle **Cos φ** of every phase is calculated by the Power Triangle method, involving the 10 cycles Power Active and Power Reactive.

$$\text{Cos}\varphi p = \frac{Pp}{\sqrt{Pp^2 + Qp^2}}$$

Equation 8: Cos φ

2.9.- VOLTAGE AND CURRENT HARMONICS

The 10 cycle **Voltage and Current harmonics** are calculated by means of a 10 cycle window FFT without gaps between windows as is specified in IEC 61000-4-30 class A method. Making the harmonics soubgroups specified in the IEC 61000-4-7.

The final values are given in % relative to the fundamental value.

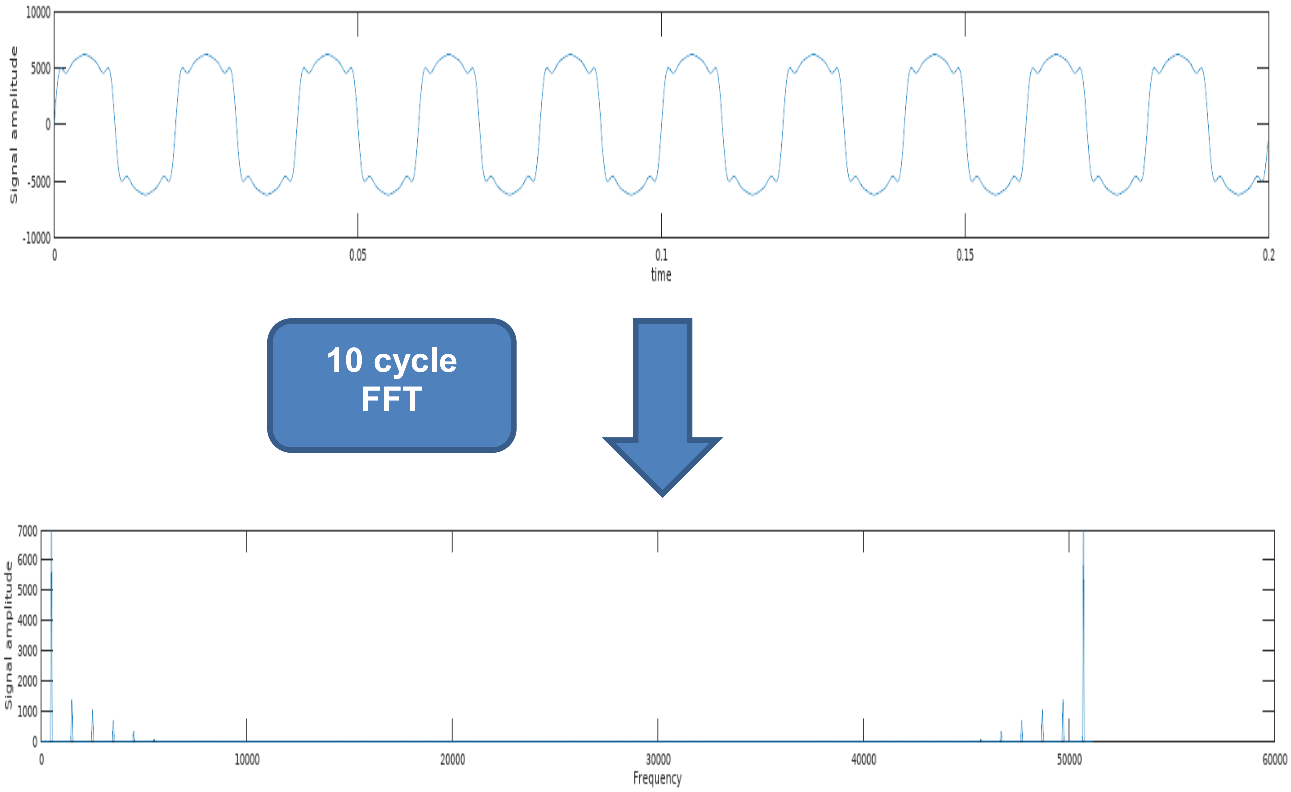

Figure 1: Voltage and current harmonics.

$$f(t) = c_0 + \sum_{m=1}^{1024} c_m \sin\left(\frac{m}{N} w_1 t + \varphi_1\right)$$

Equation 9: Voltage and current harmonics.

Where:

w_1 : Angular frequency of the fundamental $w_1=2\pi f_1$ $(f_1=50\text{Hz})$

T_w : Width or duration of the time window $T_w=NT_1$ $T_1=1/f_1$ $(T_w=200\text{ms})$
Over which the Fourier Transform I performed

c_m : Frequential component amplitude $f_{m=\frac{m}{N}f_m}$

N : Number of fundamental periods within the window width. $(N = 10 \text{ periods})$

c_0 : d.c. component

M : Ordinal number (order of the spectral line) related to the frequency basis $f=1/T_w$

The voltage magnitude of the power system may fluctuate spreading out the energy of harmonic components to adjacent interharmonic frequencies. To improve the assessment accuracy of the voltage, the output components C_k for each 5Hz of the DFT are grouped as follows:

$$G_{sg,n} = \sqrt{\sum_{i=-1}^{1} C_{k+i}^{2}}$$

Equation 10: $G_{s,g,n}$

When the individual harmonic is given in % format, this percentage has been calculated referred to the fundamental value:

$$H_n(\%) = \frac{G_{sg,n}}{G_{sg,1}} x100$$

Equation 11: H_n(%)

The **Total Harmonic Distorsion**:

$$THD = \sqrt{\sum_{n=2}^{50} \left(\frac{G_n}{G_1}\right)^2}$$

Equation 12: THD.

Where G is the rms value of the harmonic component.

2.10.- VOLTAGE AND CURRENT UNBALANCE

The 10 cycle **unbalance** is evaluated using the method of symmetrical components specified in IEC61000-4-30 class A, where:

U_1 : Positive sequence component
U_2 : Negative sequence component
U_0 : Zero sequence component

Are calculated based on the FFT development (fundamental component module and angle):

Direct Voltage / Current

$$U_1 = \frac{V1_{\propto 1} + V2_{\propto 2-240º} + V3_{\propto 3-120º}}{3}$$

Equation 13: Direct Voltage / Current.

Inverse Voltage / Current

$$U_2 = \frac{V1_{\propto 1} + V2_{\propto 2-120º} + V3_{\propto 3-240º}}{3}$$

Equation 14: Inverse Voltage / Current.

Homopolar Voltage / Current

$$U_0 = \frac{V1_{\propto 1} + V2_{\propto 2} + V3_{\propto 3}}{3}$$

Equation 15: Homopolar Voltage / Current.

Negative sequence unbalance ratio u_2 (voltage / current unbalance)

$$K_d = u_2 = \frac{U_2}{U_1} x100\% = \frac{negative\ sequence}{positive\ sequence} x100\%$$

Equation 16: Negative sequence unbalance ratio.

Zero sequence unbalance ratio u_0 (voltage / current asimmetry)

$$K_a = u_0 = \frac{U_0}{U_1} x100\% = \frac{zero\ sequence}{positive\ sequence} x100\%$$

Equation 17: Zero sequence unbalance ratio.

2.11.- VOLTAGE AND CURRENT CREAST FACTOR

It is the ratio between the peak value and the RMS value.

$$Voltage\ CF(\%) = \frac{MAX(\left|u_{p_1}\right|, \dots, \left|u_{p_{1280}}\right|)}{U_p}$$

Equation 18: Voltage CF.

$$Current\ CF(\%) = \frac{MAX(|i_1|, \dots, \left|i_{p_{1280}}\right|)}{I_p}$$

Equation 19: Current CF.

3.- 12 CYCLE INTERVAL MEASURES (60Hz)

3.1.- VOLTAGE PHASE TO NEUTRAL

The 12 cycle RMS **Voltage to neutral** of every phase is calculated by the root mean square of the whole 12 cycle period interval samples.

$$Up = \sqrt{\frac{1}{1536} x \sum_{j=1}^{1536} {u_p}_j^2}$$

Equation 20: Voltage Phase - Neutral.

3.2.- VOLTAGE PHASE TO PHASE

The 12 cycle RMS **Voltage phase to phase** is calculated by making the vector difference of the two involved phases and then, The 12 cycle RMS value is calculated by the root mean square of the whole 12 cycle period interval difference samples.

$$Upg = \sqrt{\frac{1}{1536} x \sum_{j=1}^{1536} {u_p}_j^2 - {u_g}_j^2}$$

Equation 21: Voltage Phase - Phase.

3.3.- CURRENT

The 12 cycle RMS **current** of every phase is calculated by the root mean square of the whole 12 cycle period interval samples.

$$Ip = \sqrt{\frac{1}{1536} x \sum_{j=1}^{1536} {i_p}_j^2}$$

Equation 22: Current.

3.4.- ACTIVE POWER

The 12 cycle RMS **Active Power** of every phase is calculated by the scalar product of the whole 12 cycle period interval samples of Voltage and Current.

$$Pp = \sqrt{\frac{1}{1536} x \sum_{j=1}^{1536} {u_p}_j \ x \ {i_p}_j}$$

Equation 23: Active Power.

3.5.- REACTIVE POWER

The 12 cycle RMS **Reactive Power** of every phase is calculated by the vector product of the whole 12 cycle period interval samples of Voltage and Current which is achieved shifting the current vector 90º.

$$Qp = \sqrt{\frac{1}{1536} x \sum_{j=1}^{1536} u_{p_j} \; x \; i_{p_{j+90º}}}$$

Equation 24: Reactive Power.

4.- 1 SECOND INTERVAL MEASURES

4.1.- VOLTAGE PHASE TO NEUTRAL

The 1 second **Voltage** value is the square mean of the 10/12 cycle **Voltage** values and it is updated every second in the display. It is also used as a base for the calculation of the additional time aggregations.

$$Up_{1s} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} Up_j^2}$$

Equation 25: Voltage phase to neutral.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the second.

4.2.- VOLTAGE PHASE TO PHASE

The 1 second **Voltage phase to phase** value is the square mean of the 10/12 cycle **Voltage phase to phase** values and it is updated every second in the display. It is also used as a base for the calculation of the additional time aggregations.

$$Upg_{1s} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} Upg_j^2}$$

Equation 26: Voltage phase to phase.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the second.

4.3.- CURRENT

The 1 second **Current** value is the square mean of the 10/12 cycle **Current** values and it is updated every second in the display. It is also used as a base for the calculation of the additional time aggregations.

$$Ip_{1s} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} Ip_j^2}$$

Equation 27: Current.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the second.

4.4.- ACTIVE POWER

The 1 second **Active Power** value is the mean of the 10/12 cycle **Active Power** values and it is updated every second in the display. It is also used as a base for the calculation of the additional time aggregations.

$$Pp_{1s} = \frac{1}{N} x \sum_{j=1}^{N} Pp_j$$

Equation 28: Active power.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the second.

4.5.- REACTIVE POWER

The 1 second **Rective Power** value is the mean of the 10/12 cycle **Reactive Power** values and it is updated every second in the display. It is also used as a base for the calculation of the additional time aggregations.

$$Qp_{1s} = \frac{1}{N} x \sum_{j=1}^{N} Qp_j$$

Equation 29: Reactive power.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the second.

4.6.- APPARENT POWER

The 1 second **Apparent Power** value calculation is based on the 1 second Voltage and Current RMS values.

$$Sp_{1s} = Up_{1s}\ x\ Ip_{1s}$$

Equation 30: Apparent power.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the second.

4.7.- POWER FACTOR

The 1 second **Power Factor** value calculation is based on the 1 second Active Power and Apparent Power RMS values.

$$PFp_{1s} = \frac{Pp_{1s}}{Sp_{1s}}$$

Equation 31: Power factor.

4.8.- Cos φ

The 1 second **Cos φ** value calculation is based on the 1 second Active Power and Apparent Power and Reactive Power RMS values, using the Power Triangle.

$$\mathrm{Cos}\varphi p_{1s} = \frac{Pp_{1s}}{\sqrt{{Pp_{1s}}^2 + {Qp_{1s}}^2}}$$

Equation 32: cos φ.

4.9.- VOLTAGE AND CURRENT HARMONICS

The 1 second **Voltage and Current Harmonics** value calculation is the square mean of the 10/12 cycles harmonics result

$$G_{sg,n_{1s}} = \frac{1}{N}\sqrt{\sum_{i=1}^{N} {C_{sg,n}}_i^2}$$

Equation 33: Voltage and Current harmonics.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the second.

The 1s **Total Harmonic Distorsion** calculation is based in the 1s harmonics result:

$$THD = \sqrt{\sum_{n=2}^{50}\left(\frac{G_{sg,n_{1s}}}{G_{sg,1_{1s}}}\right)^2}$$

Equation 34: THD.

Where **G** is the rms value of the harmonic component in 1s.

4.10.- VOLTAGE AND CURRENT UNBALANCE

The 1 second Voltage and Current Positive sequence component (direct), Negative sequence component (inverse) and Zero sequence component (homopolar) value calculation are the square mean of the 10/12 cycles values result.

U_1 : Positive sequence component
U_2 : Negative sequence component
U_0 : Zero sequence component

$$U1_{1s} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U1_j^2}$$

Equation 35: U_1.

$$U2_{1s} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U2_j^2}$$

Equation 36: U_2.

$$U0_{1s} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U0_j^2}$$

Equation 37: U_0.

With the above values, the Voltage / Current unbalance and asymmetry are calculated:

Negative sequence unbalance ratio u_2 (voltage / current unbalance)

$$K_{d_{1s}} = u_{2_{1s}} = \frac{U2_{1s}}{U1_{1s}} x100\% = \frac{negative\ sequence}{positive\ sequence} x100\%$$

Equation 38: Negative sequence unbalance ratio.

Zero sequence unbalance ratio u_0 (voltage / current asimmetry)

$$K_{a_{1s}} = u_{0_{1s}} = \frac{U0_{1s}}{U1_{1s}} x100\% = \frac{zero\ sequence}{positive\ sequence} x100\%$$

Equation 39: Zero sequence unbalance ratio.

4.11.- VOLTAGE AND CURRENT CREAST FACTOR

The 1 second **Voltage and Current creast factor** are the maximum of every 10/12 cycles values included in the 1 second period interval.

$$Voltage\ CF_{1s}(\%) = \frac{MAX(\left|u_{p_1}\right|, \dots, \left|u_{p_{samples\ x\ N}}\right|)}{U_p}$$

Equation 40: Voltage CF.

$$Current\ CF_{1s}(\%) = \frac{MAX(|i_1|, \dots, \left|i_{p_{samples\ xN}}\right|)}{I_p}$$

Equation 41: Current CF.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the second and **samples** is the number of samples observed in one time window, 1280 for 50Hz and 1536 for 60Hz.

4.12.- K-FACTOR

K-Factor is a weighting of the harmonic load currents according to their effects on transformer heating.
The algorithm used to compute **K-Factor** is based on IEEE C57.110. The 1 second **K-Factor** calculation is based on the 1second harmonics results

$$K - factor\ _{1s}(\%) = \frac{\sum_{h=1}^{25}\left(G_{sg,h_{1s}} x\ h\right)^2}{\sum_{h=1}^{25} G_{sg,h_{1s}}{}^2}\ x\ 100$$

Equation 42: K-Factor.

5.- 10 SECONDS INTERVAL MEASURES

5.1.- FREQUENCY

Frequency is measured counting the number of cycles by detecting zero crossing during the 10s time clock interval. The **frequency** is calculated by dividing the number of whole periods by the time duration of whole periods.

$$f_{10s} = \frac{\sum_{t=0}^{10s\ clock} Zero\ crossings}{time\ elapsed}$$

Equation 43: Frequency.

6.- 10 MINUTES INTERVAL MEASURES

6.1.- VOLTAGE PHASE TO NEUTRAL

The 10 minutes **Voltage** value is the square mean of the 10/12 cycle **Voltage** values:

$$Up_{10min} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} Up_j^2}$$

Equation 44: Voltage Phase-Neutral.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in 10 minutes period.

6.2.- VOLTAGE PHASE TO PHASE

The 10 minutes **Voltage phase to phase** value is the square mean of the 10/12 cycle **Voltage phase to phase** values.

$$Upg_{10min} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} Upg_j^2}$$

Equation 45: Voltage Phase-Phase.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in 10 minutes period.

6.3.- CURRENT

The 10 minutes **Current** value is the square mean of the 10/12 cycle **Current** values.

$$Ip_{10min} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} Ip_j^2}$$

Equation 46: Current.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in 10 minutes period.

6.4.- ACTIVE POWER

The 10 minutes **Active Power** value is the mean of the 10/12 cycle **Active Power** values.

$$Pp_{10min} = \frac{1}{N} x \sum_{j=1}^{N} Pp_j$$

Equation 47: Active Power.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in 10 minutes period.

6.5.- REACTIVE POWER

The 10 minutes **Reactive Power** value is the mean of the 10/12 cycle **Reactive Power** values.

$$Qp_{10min} = \frac{1}{N} x \sum_{j=1}^{N} Qp_j$$

Equation 48: Reactive Power.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in 10 minutes period.

6.6.- APPARENT POWER

The 10 minutes **Apparent Power** value is the product of the 10 minutes Voltage and Current values.

$$Sp_{1s10min} = Up_{10min} \; x \; Ip_{10min}$$

Equation 49: Apparent Power.

6.7.- POWER FACTOR

The 10 minutes **Power Factor** value is the division of the 10 minutes Active Power value and Apparent Power value.

$$PFp_{10min} = \frac{Pp_{10min}}{Sp_{10min}}$$

Equation 50: Power factor.

6.8.- Cos φ

The 10 minutes **Cos φ** value is calculated by means of the Power Triangle and based on the 10 min Active Power, Reactive Power and Apparent Power values.

$$Cos\varphi p_{10min} = \frac{Pp_{10min}}{\sqrt{{Pp_{10min}}^2 + {Qp_{10min}}^2}}$$

Equation 51: Cos φ.

6.9.- VOLTAGE AND CURRENT HARMONICS

The 10 minutes **Voltage and Current harmonics** values are the square mean of the 10/12 cycle **Voltage and Current harmonic** values values.

$$G_{sg,n_{10min}} = \frac{1}{N}\sqrt{\sum_{i=1}^{N} {C_{sg,n_i}}^2}$$

Equation 52: Voltage and Current harmonics.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in 10 minutes period.
The 10 minutes **Total Harmonic Distorsion** is calculated through the 10 minutes single harmonics values :

$$THD_{10min} = \sqrt{\sum_{n=2}^{50} \left(\frac{G_{sg,n_{10min}}}{G_{sg,1_{10min}}}\right)^2}$$

Equation 53: THD.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in 10 minutes period.

6.10.- VOLTAGE AND CURRENT UNBALANCE

The 10 minute Voltage and Current Positive sequence component (direct), Negative sequence component (inverse) and Zero sequence component (homopolar) value calculation are the square mean of the 10/12 cycles values result during the 10 minute interval.

U_1 : Positive sequence component
U_2 : Negative sequence component
U_0 : Zero sequence component

$$U1_{10min} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U1_j^2}$$

Equation 54: U_1.

$$U2_{10min} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U2_j^2}$$

Equation 55: U_2.

$$U0_{10min} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U0_j^2}$$

Equation 56: U_0.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in 10 minutes period

With the above values, the Voltage / Current unbalance and asymmetry are calculated:

Negative sequence unbalance ratio u_2 (voltage / current unbalance)

$$K_{d_{10min}} = u_{2_{10min}} = \frac{U2_{10min}}{U1_{10min}} x100\% = \frac{negative\ sequence}{positive\ sequence} x100\%$$

Equation 57: Negative sequence unbalance ratio.

Zero sequence unbalance ratio u_0 (voltage / current asimmetry)

$$K_{a_{10min}} = u_{0_{10min}} = \frac{U0_{10min}}{U1_{10min}} x100\% = \frac{zero\ sequence}{positive\ sequence} x100\%$$

Equation 58: Zero sequence unbalance ratio.

6.11.- FREQUENCY

The 10 minute frequency value is the means of every 10 second frequency result

$$f_{10min} = \frac{\sum_0^N f_{10s}}{N}$$

Equation 59: Frequency.

Where N is the number of groups of 10 seconds included in 10 minutes period

6.12.- FLICKER Pst

Flicker is the visual human sensation of unsteadiness caused by a fluctuating light stimulus.
Flicker is measured according to IEC 61000-4-15.
It is calculated with the Voltage phase to neutral samples which are filtered, classified and weighted to simulate the human visual response and gives a Pst result every 10 minutes as IEC 61000-4-30 class A.

7.- MAXIMUM / MINIMUM VALUES

7.1.- INSTANTANEOUS MAX / MIN

The **instantaneous Max / Min** values are the maximum and minimum 10 / 12 cycles RMS values. These values are not recorded in the data base.

7.2.- RECORDED MAX / MIN

The **recorded Max / Min** during a period of every granularity are the maximum and minimum values of the 10/12 cycles RMS values during the current period.

With the exception of the 10 min granularity. This granularity does not record any maximum and minimum value.

8.- MAINTENANCE AND TECHNICAL SERVICE

In the case of any query in relation to device operation or malfunction, please contact the **CIRCUTOR, SA** Technical Support Service.

Technical Assistance Service
Vial Sant Jordi, s/n, 08232 - Viladecavalls (Barcelona)
Tel: 902 449 459 (España) / +34 937 452 919 (outside of Spain)
email: sat@circutor.com

9.- GUARANTEE

CIRCUTOR guarantees its products against any manufacturing defect for two years after the delivery of the units.

CIRCUTOR will repair or replace any defective factory product returned during the guarantee period.

• No returns will be accepted and no unit will be repaired or replaced if it is not accompanied by a report indicating the defect detected or the reason for the return.
•The guarantee will be void if the units has been improperly used or the storage, installation and maintenance instructions listed in this manual have not been followed. "Improper usage" is defined as any operating or storage condition contrary to the national electrical code or that surpasses the limits indicated in the technical and environmental features of this manual.
• **CIRCUTOR** accepts no liability due to the possible damage to the unit or other parts of the installation, nor will it cover any possible sanctions derived from a possible failure, improper installation or "improper usage" of the unit. Consequently, this guarantee does not apply to failures occurring in the following cases:
- Overvoltages and/or electrical disturbances in the supply;
- Water, if the product does not have the appropriate IP classification;
- Poor ventilation and/or excessive temperatures;
- Improper installation and/or lack of maintenance;
- Buyer repairs or modifications without the manufacturer's authorisation.

CIRCUTOR, SA
Vial Sant Jordi, s/n
08232 -Viladecavalls (Barcelona)
Tel.: (+34) 93 745 29 00 - Fax: (+34) 93 745 29 14
www.circutor.com central@circutor.com