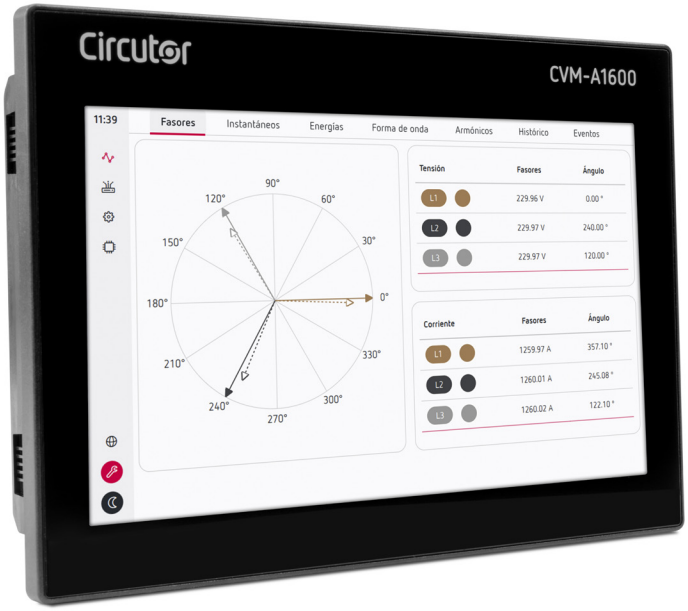
Power quality analyzer

CVM-A1600



INSTRUCTION MANUAL

(M476B01-03-26A)

CE


22
PAP

SAFETY PRECAUTIONS

Follow the warnings described in this manual with the symbols shown below.



DANGER
Warns of a risk, which could result in personal injury or material damage.



ATTENTION
Indicates that special attention should be paid to a specific point.

If you must handle the unit for its installation, start-up or maintenance, the following should be taken into consideration:



Incorrect handling or installation of the device may result in injury to personnel as well as damage to the device. In particular, handling with voltages applied may result in electric shock, which may cause death or serious injury to personnel. Defective installation or maintenance may also lead to the risk of fire.

Read the manual carefully prior to connecting the device. Follow all installation and maintenance instructions throughout the device's working life. Pay special attention to the installation standards of the National Electrical Code.



Refer to the instruction manual before using the device

In this manual, if the instructions marked with this symbol are not respected or carried out correctly, it can result in injury or damage to the device and / or installations.

CIRCUTOR S.A.U. reserves the right to modify features or the product manual without prior notification.

DISCLAIMER

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

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

www.circutor.com





CIRCUTOR S.A.U. recommends using the original cables and accessories that are supplied with the device.

COMMITMENT TO TRANSPARENCY AND DATA ACCESS (Data Act)

Commitment to Transparency and Data Access (Data Act)

CIRCUTOR maintains a firm commitment to transparency and equitable access to the data generated by its connected electronic devices and related services. In compliance with **Regulation (EU) 2023/2854 (Data Act)**, the company makes available to its customers the relevant information regarding the data generated through the use of such products and services, under the terms established by the applicable regulations.

What data are generated?

CIRCUTOR's connected devices may collect and generate technical and operational data, such as:

- Operating and measurement parameters of the devices, including electrical quantities (energy, power, voltage, current, among others) and thermal variables;
- Device operating states;
- System events, including electrical events and power quality events;
- Device operation logs;
- Number of switching operations and device operating time.

These data do not generally include personal information, which is processed in accordance with the **General Data Protection Regulation** (**GDPR**) and **CIRCUTOR**'s Privacy Policy.

How to access and share these data?

Customers may directly access the generated data or request their download, provision, or transfer to authorised third parties through the following channels:

- Email: **data-act@circutor.com**
- Standard communication interfaces (such as REST APIs in different formats, industrial protocols, or messaging services);
- Download mechanisms via web platforms or interfaces integrated into the device itself;
- Remote communications through protocols such as OCPP, MQTT, or IEC 60870-5-102.

The available access and communication options will depend on the product. For detailed information on the supported protocols, interfaces, and access methods, please refer to the communications section of this manual.

For further information on formats, security measures, access conditions, and procedures, please consult:

https://circutor.com/en/company/commitment/eu-data-act/

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Note: *The images of the devices are for illustrative purposes only and may differ from the original device.*

REVISION LOG

Table 1: Revision log.

Date	Revision	Description
11/25	M476B01-03-25A	Initial version
10/26	M476B01-03-26A	Modifications to the sections: 4.1. - 4.2. - 4.2.1. - 5.5.2. - 5.7.2. - 5.8.1. - 5.8.2. - 6.2.1. - 6.3.2. - 7. - 7.2. - 7.5. -7.6. - 8. - 8.2.1. - 8.2.2. - 8.2.3. -8.2.4. -8.2.5. -8.2.6. - 8.3.2. - 8.3.3. - 8.5.2.5 - 8.6.1. - 8.8.5. -8.6.2. - 9. - A.2.11.

SYMBOLS

Table 2: Symbols.

Symbol	Description
CE	Compliant with the applicable European Directive.
	Device safety class: Class II
	Device covered by European Directive 2012/19/EU. At the end of its service life, do not dispose of the device in household waste. Comply with local regulations regarding the recycling of electrical and electronic equipment.
⎓	Direct current.
~	Alternating current.

1.- VERIFICATION UPON RECEPTION

Upon receipt of the device, check the following points:

a) The device matches the specifications of your order.
b) The device has not suffered damage during transport.
c) Perform an external visual inspection of the device before connecting it.
d) Check that the following items are supplied:

- Installation guide,
- GPS Antenna,
- Wi-Fi Antenna,

If any damage or discrepancy is observed upon receipt, contact the carrier and/or **CIRCUTOR**'s after-sales service.

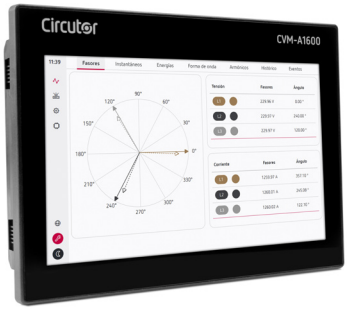
2.- PRODUCT DESCRIPTION

The **CVM-A1600** is a power quality analyser that measures, calculates, records and displays the main electrical parameters, as well as power quality parameters, in single-phase networks, two-phase networks with and without neutral, balanced three-phase networks with ARON measurement, and unbalanced three-phase networks. Measurement is performed using true RMS values through four voltage inputs and four current inputs.

The electrical parameters and quality events are measured and calculated in accordance with **IEC 61000-4-30**, Edition 3. Full compliance with **IEC 62586-2** is guaranteed for the test methods.

The **CVM-A1600** incorporates a web server that allows remote access to real-time and historical parameters and to the device configuration, as well as access to **CIRCUTOR's Scout** electrical supervision platform.

The device is modular and expandable through expansion modules with different functionalities. See **Table 4**.



The **CVM-A16xx-ITF** models measure current through /5 A or /1 A current transformers, or through MC1 and MC3 series efficient transformers.

The device features:

- 8-inch **touchscreen** for displaying all parameters.
- **RS-485** communications with **Modbus RTU®** protocol.
- **Ethernet** communications with Modbus/TCP protocol and **Wi-Fi** connectivity.
- **GPS** for internal clock synchronisation and global positioning.
- **Digital inputs**, **Digital outputs** and **Relay outputs**, depending on the model (see **Table 3**)

Table 3: Inputs and Outputs.

Model	Digital Outputs	Relay Outputs	Digital Inputs
CVM-A1610-ITF	-	-	-
CVM-A1611-ITF	6	2	6
CVM-A1612-ITF	12	4	12

Table 4: Expansion Modules.

Model	Digital Outputs	Relay Outputs	Digital Inputs
M-CVM-A1600-D6IO-R2O	6	2	6

3.- INSTALLATION OF THE DEVICE

3.1.- PRELIMINARY RECOMMENDATIONS



To ensure the safe use of the device, it is essential that personnel handling it comply with the safety measures established by the regulations in force in the country where it is being used, wear the necessary personal protective equipment, and observe the various warnings provided in this instruction manual.

The installation of the **CVM-A1600** device must be carried out by authorised and qualified personnel.

Before handling, modifying the wiring or replacing the device, disconnect the power supply and the measurement inputs.

It is essential to keep cables in perfect condition to prevent accidents or damage to people or facilities.

The manufacturer of the device shall not be held liable for any damage resulting from failure by the user or installer to follow the warnings and/or recommendations contained in this manual, or from the use of non-original products or accessories from other manufacturers.

If an anomaly or fault is detected in the device, do not perform any measurement with it.

Verify the environment before starting a measurement. Do not perform measurements in hazardous or explosive environments.



Before carrying out any maintenance, repair work or handling of any of the device connections, disconnect the device from all power sources, including both the device power supply and the measurement inputs.
If you suspect a malfunction of the device, contact **CIRCUTOR**'s after-sales service.

3.2.- INSTALLATION



When the device is connected, the terminals, opening covers or removing components may provide access to hazardous live parts. The device must not be used until installation has been fully completed.

The device must be installed inside an electrical panel or enclosure and is designed for panel mounting.

To install the device, follow the steps below:

① Make the panel cut-out according to the dimensions shown in **Figure 1** (**DIN IEC 61554**).

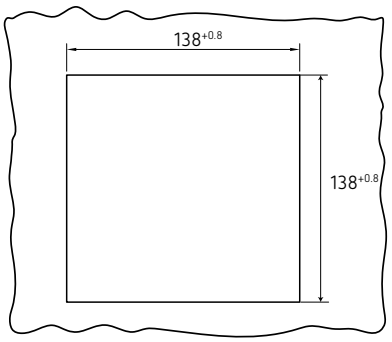


Figure 1: Panel cut-out.

② Insert the device into the panel cut-out.

③ Position the fixing elements as shown in **Figure 2** until they click into place.

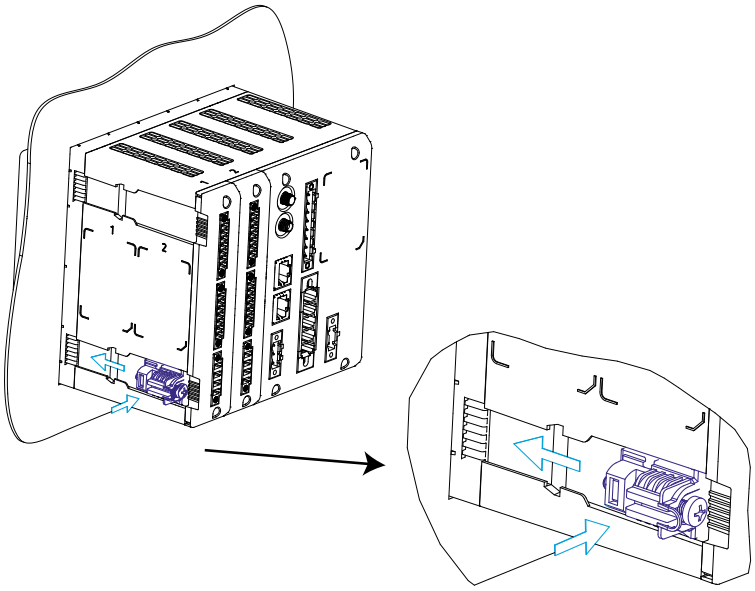


Figure 2: Install the fixing elements.

④ Secure the fixing elements using a **PH2** screwdriver. Maximum tightening torque: **0.2 Nm** (**Figure 3**.)

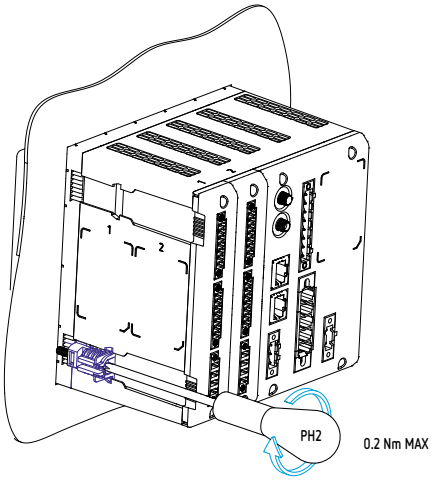


Figure 3:Panel mounting.

To remove the device from the panel, follow the steps below:

① Loosen the fixing elements using a **PH2** screwdriver, **Figure 4**.

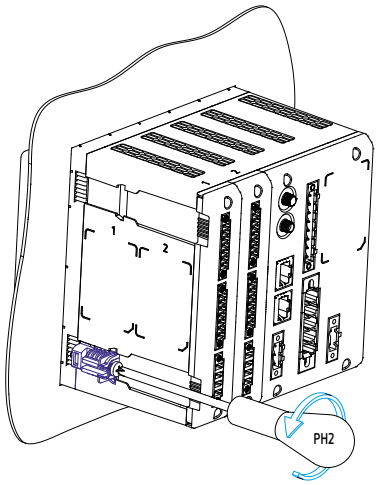


Figure 4: Loosening the fixing elements.

② Press the fixing element while removing it, as shown in **Figure 5.**

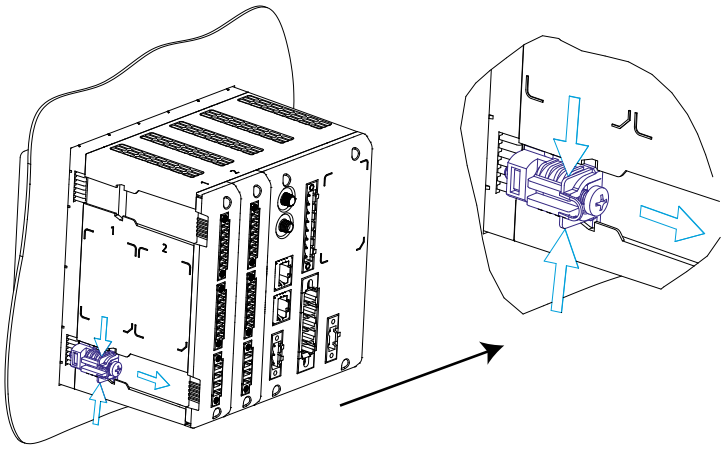


Figure 5: Removing the fixing element.

③ Finally, remove the device from the panel.

3.2.1.- ELECTRICAL INSTALLATION

The device must be connected to a power supply circuit protected by gL-type fuses (**IEC 60269**) or Class M fuses, rated between 0.5 A and 2 A. A circuit breaker or equivalent device must be provided to disconnect the device from the power supply.

3.3.- EXPANSION MODULE INSTALLATION

> When the device is connected, access to the terminals, opening covers or removing components may provide access to hazardous live parts. The device must not be used until installation has been fully completed.

To install the expansion module, follow the steps below:

① Remove the slot cover where the expansion module is to be installed by unscrewing the two retaining screws using a screwdriver, **Figure 6.**

Table 5: Required tools.

Required tools

T8

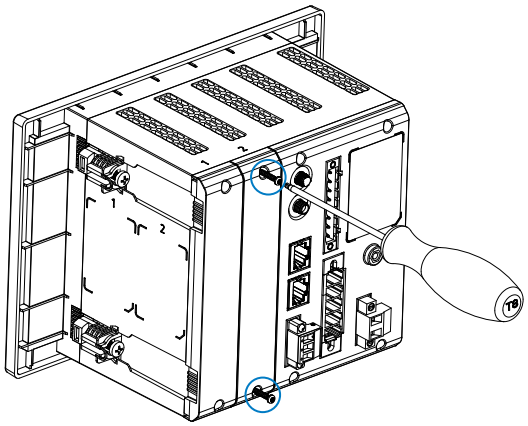


Figure 6: Step 1.

② Insert the module into the slot guide (**Figure 7**).

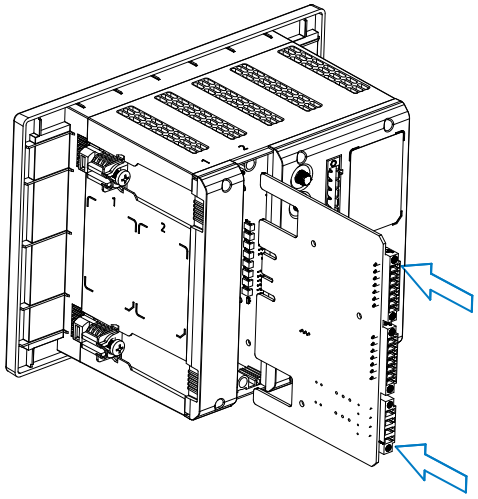


Figure 7: Step 2.

③ Install the new slot cover (**Figure 8**).

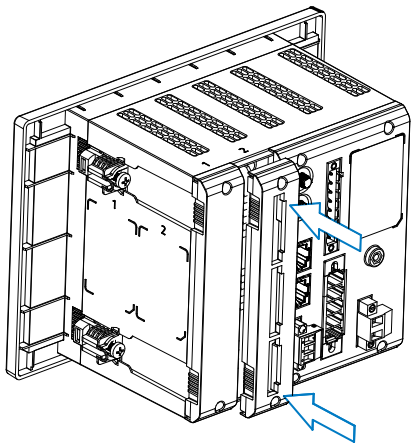


Figure 8: Step 3.

④ Secure the new slot cover with the two retaining screws using a Torx screwdriver (**Figure 9**).

Table 6: Required tools.

Required tools	
T8	0.8 ... 1 Nm

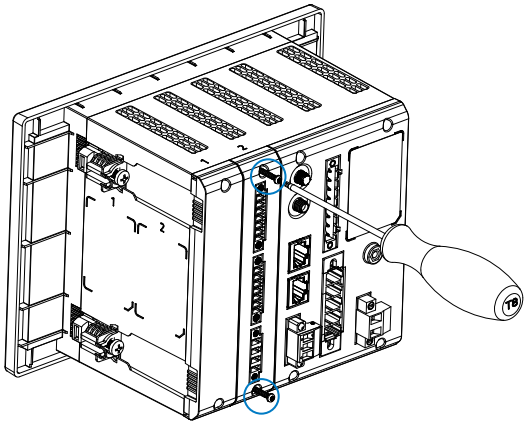


Figure 9: Step 4.

⑤ Place the label supplied with the module in the designated area on the side of the device. The label must be placed in the same slot in which the module has been installed, **Figure 10**.

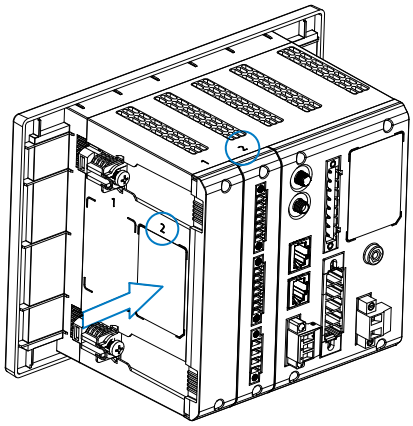


Figure 10: Step 5.

3.4.- DEVICE TERMINALS

3.4.1.- MODEL CVM-A1610-ITF

Table 7: CVM-A1610-ITF terminal assignment.

CVM-A1610-ITF terminals			
1	**A1(+)**, Power supply	12	**/3s1,** Current input L3
2	**A2(-)**, Power supply	13	**/3s2,** Current input L3
3	***U*1**, Voltage input L1	14	**/Ns1,** Neutral current input
4	***U*2**, Voltage input L2	15	**/Ns2,** Neutral current input
5	***U*3**, Voltage input L3	16	**A(+)**, RS-485
6	***UN***, Neutral voltage input	17	**B(-)**, RS-485
7	***U*4**, Reference voltage input	18	**S**, GND for RS-485
8	**/1s1,** Current input L1	19	‹···› **1**, Ethernet connector
9	**/1s2,** Current input L1	20	‹···› **2**, Ethernet connector
10	**/2s1,** Current input L2	**GPS**	GPS Antenna
11	**/2s2,** Current input L2	((ᵍ))	Wi-Fi Antenna

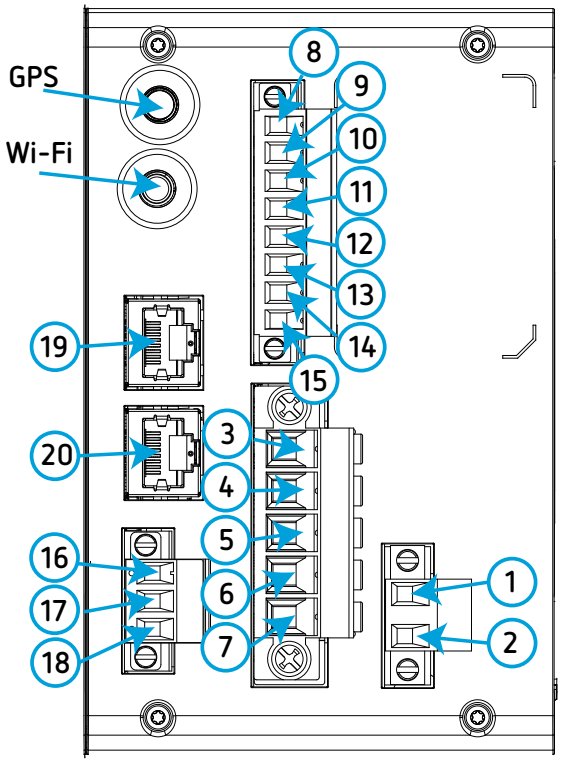


Figure 11: CVM-A1610-ITF terminals.

3.4.2.- MODEL CVM-A1611-ITF

Table 8: CVM-A1611-ITF terminal assignment.

CVM-A1611-ITF terminals			
1	**A1(+)**, Power supply	12	**/3s1,** Current input L3
2	**A2(-)**, Power supply	13	**/3s2,** Current input L3
3	***U*1**, Voltage input L1	14	**/Ns1,** Neutral current input
4	***U*2**, Voltage input L2	15	**/Ns2,** Neutral current input
5	***U*3**, Voltage input L3	16	**A(+)**, RS-485
6	***U*N**, Neutral voltage input	17	**B(-)**, RS-485
7	***U*4**, Reference voltage input	18	**S**, GND for RS-485
8	**/1s1,** Current input L1	19	‹···› **1**, Ethernet connector
9	**/1s2,** Current input L1	20	‹···› **2**, Ethernet connector
10	**/2s1,** Current input L2	GPS	GPS Antenna
11	**/2s2,** Current input L2	(( ))	Wi-Fi Antenna
Inputs / Outputs			
21	**COM**, Digital Inputs Common	30	**DO2**, Digital Output 2
22	**DI1**, Digital Input 1	31	**DO3**, Digital Output 3
23	**DI2**, Digital Input 2	32	**DO4**, Digital Output 4
24	**DI3**, Digital Input 3	33	**DO5**, Digital Output 5
25	**DI4**, Digital Input 4	34	**DO6**, Digital Output 6
26	**DI5**, Digital Input 5	35	**ROC**, Relay Output 1 (Common)
27	**DI6**, Digital Input 6	36	**RO1**, Relay Output 1
28	**COM**, Digital Outputs Common	37	**ROC**, Relay Output 2 (Common)
29	**DO1**, Digital Output 1	38	**RO2**, Relay Output 2

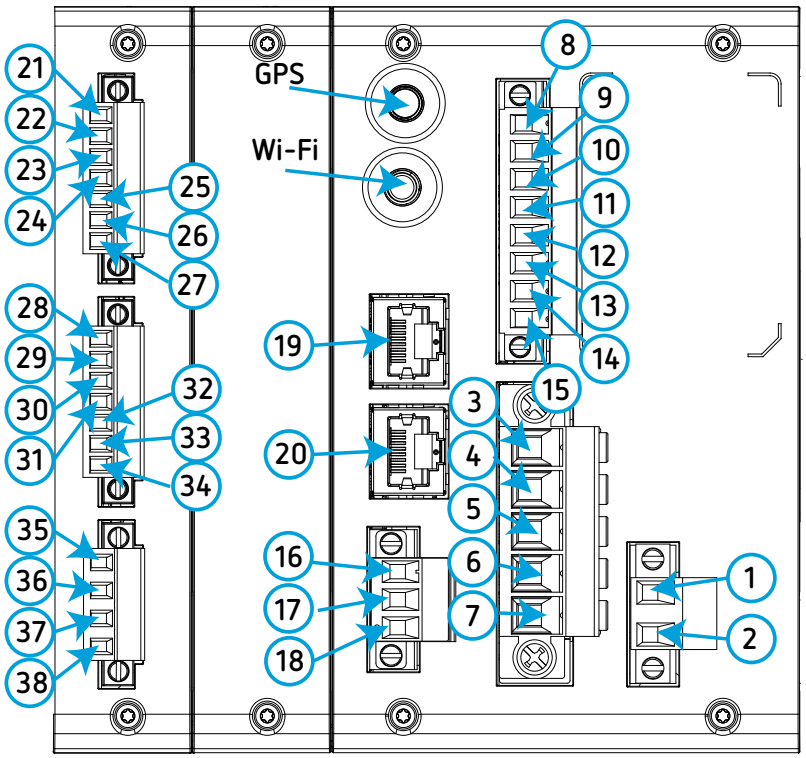


Figure 12: CVM-A1611-ITF terminals.

3.4.3.- MODEL CVM-A1612-ITF

Table 9: CVM-A1612-ITF terminal assignment.

CVM-A1612-ITF terminals			
1	**A1(+)**, Power supply	12	**/3s1,** Current input L3
2	**A2(-)**, Power supply	13	**/3s2,** Current input L3
3	***U1***, Voltage input L1	14	**/Ns1,** Neutral current input
4	***U2***, Voltage input L2	15	**/Ns2,** Neutral current input
5	***U3***, Voltage input L3	16	**A(+)**, RS-485
6	***UN***, Neutral voltage input	17	**B(-)**, RS-485
7	***U4***, Reference voltage input	18	**S**, GND for RS-485
8	**/1s1,** Current input L1	19	⇠⇢ **1**, Ethernet connector
9	**/1s2,** Current input L1	20	⇠⇢ **2**, Ethernet connector
10	**/2s1,** Current input L2	GPS	GPS Antenna
11	**/2s2,** Current input L2	((•))	Wi-Fi Antenna

Inputs / Outputs					
SLOT1	SLOT2		SLOT1	SLOT2	
21	39	**COM**, Digital Inputs Common	30	48	**DO2,** Digital Output 2
22	40	**DI1**, Digital Input 1	31	49	**DO3,** Digital Output 3
23	41	**DI2,** Digital Input 2	32	50	**DO4,** Digital Output 4
24	42	**DI3,** Digital Input 3	33	51	**DO5,** Digital Output 5
25	43	**DI4,** Digital Input 4	34	52	**DO6,** Digital Output 6
26	44	**DI5,** Digital Input 5	35	53	**ROC,** Relay Output 1 (Common)
27	45	**DI6,** Digital Input 6	36	54	**RO1,** Relay Output 1
28	46	**COM,** Digital Outputs Common	37	55	**ROC,** Relay Output 2 (Common)
29	47	**DO1,** Digital Output 1	38	56	**RO2,** Relay Output 2

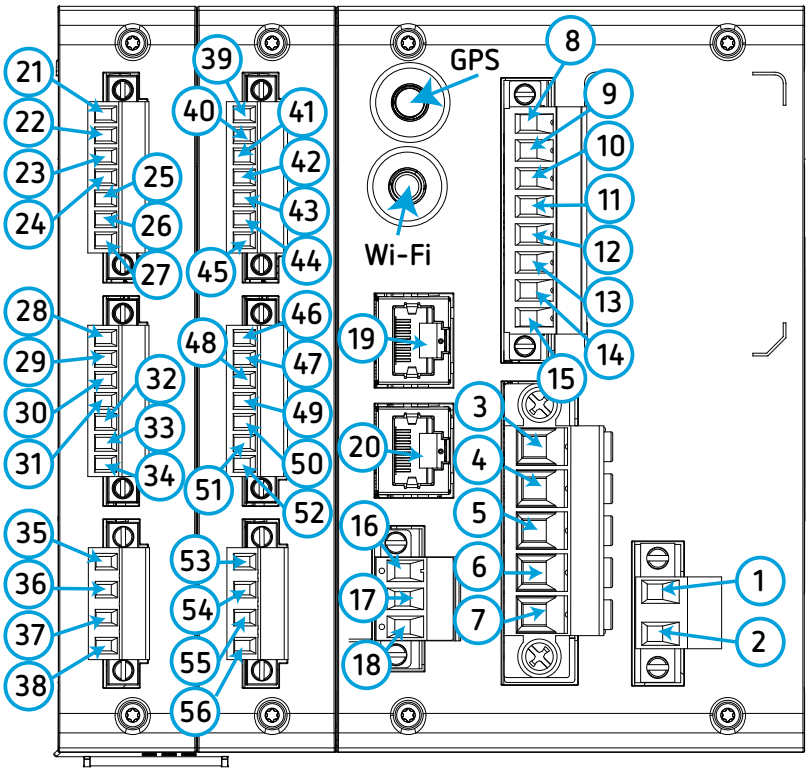


Figure 13: CVM-A1612-ITF terminals.

3.5.- WIRING DIAGRAMS

3.5.1.- THREE-PHASE NETWORK MEASUREMENT WITH 4-WIRE CONNECTION (CVM-A16xx-ITF).

Installation Type: **3PH4W**

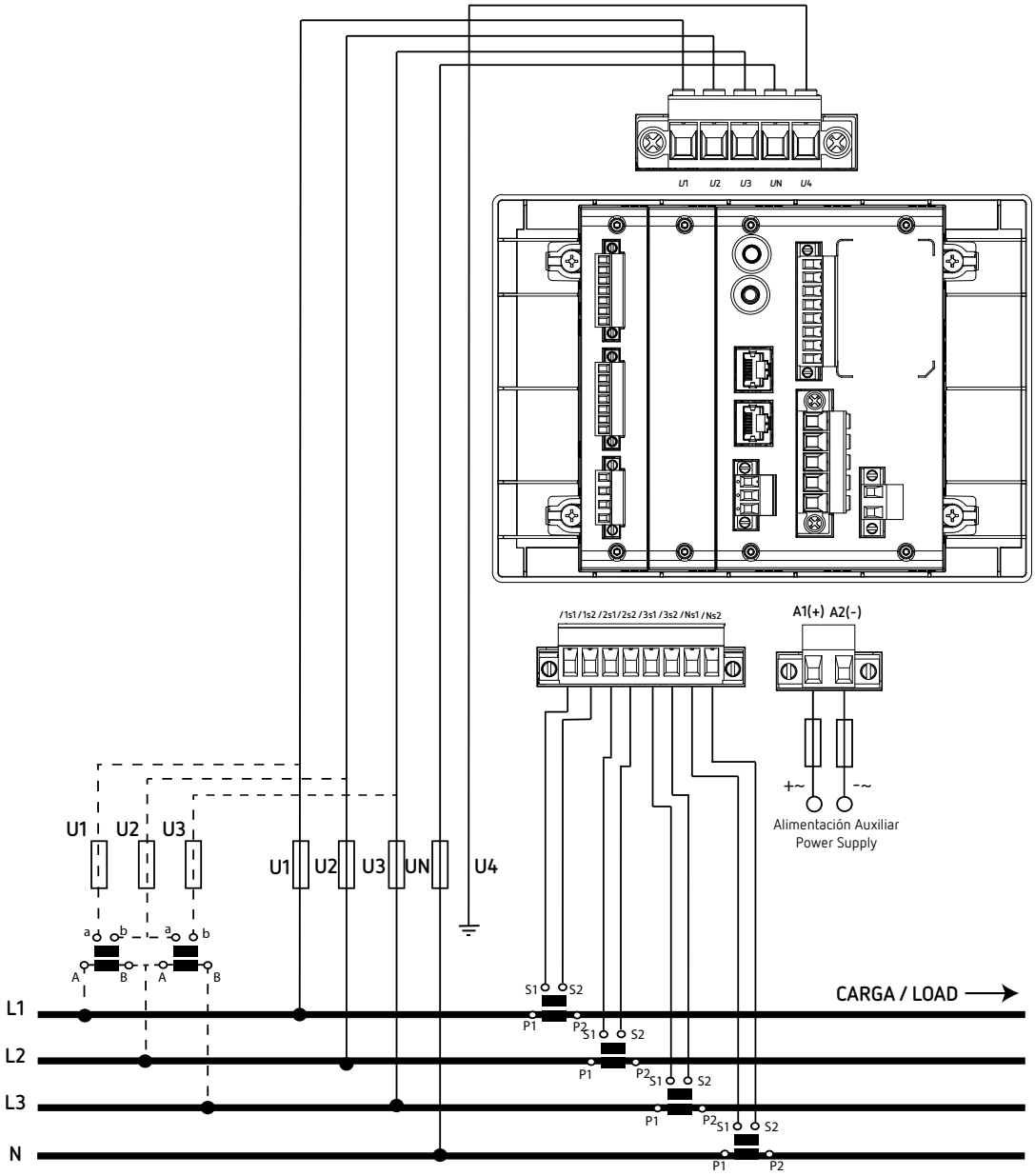


Figure 14: Three-phase measurement with 4-wire connection (Current transformer secondary: /1A, /5A or MC1 (/0.250)).

The secondary current of the **MC1** current transformer is fixed at 0.250 A.

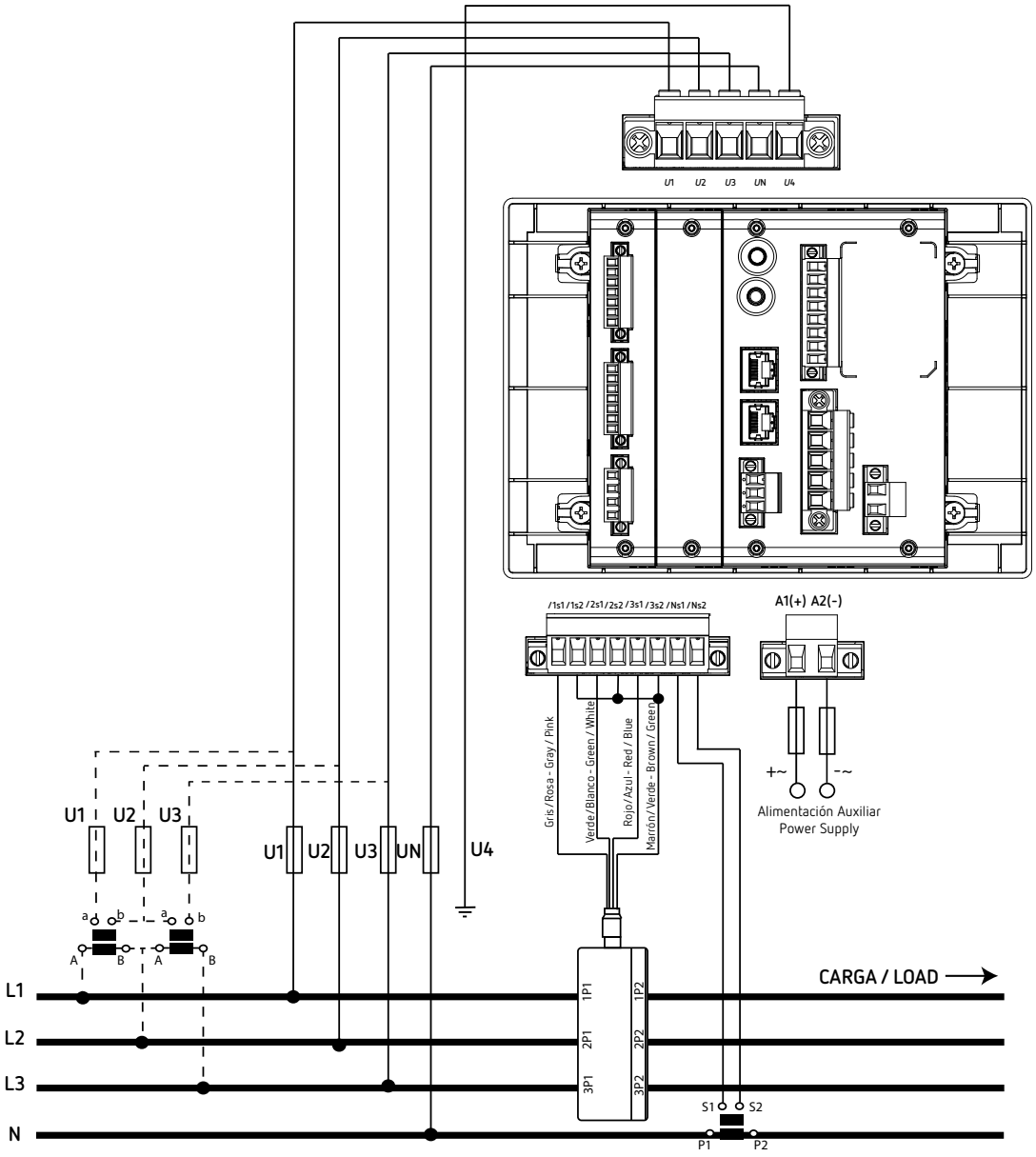


Figure 15: Three-phase measurement with 4-wire connection (Transformer type MC3 (/0.250)).

The secondary current of the **MC3** current transformer is fixed at 0.250 A.

3.5.2.- THREE-PHASE NETWORK MEASUREMENT WITH 3-WIRE CONNECTION (CVM-A16xx-ITF).

Installation Type: **3PH3W**

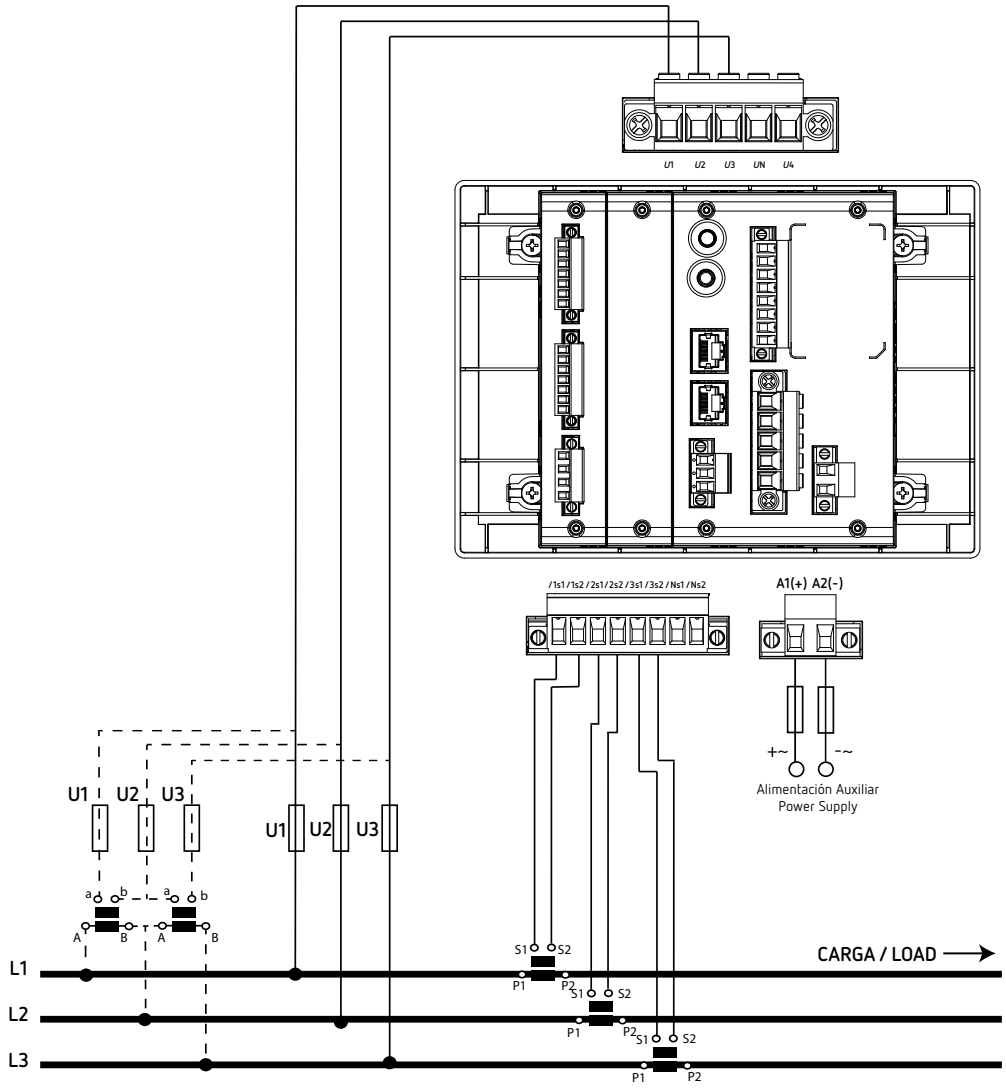


Figure 16: Three-phase measurement with 3-wire connection (Current transformer secondary: /1A, /5A or MC1 (/0.250)).

The secondary current of the **MC1** current transformer is fixed at 0.250 A.

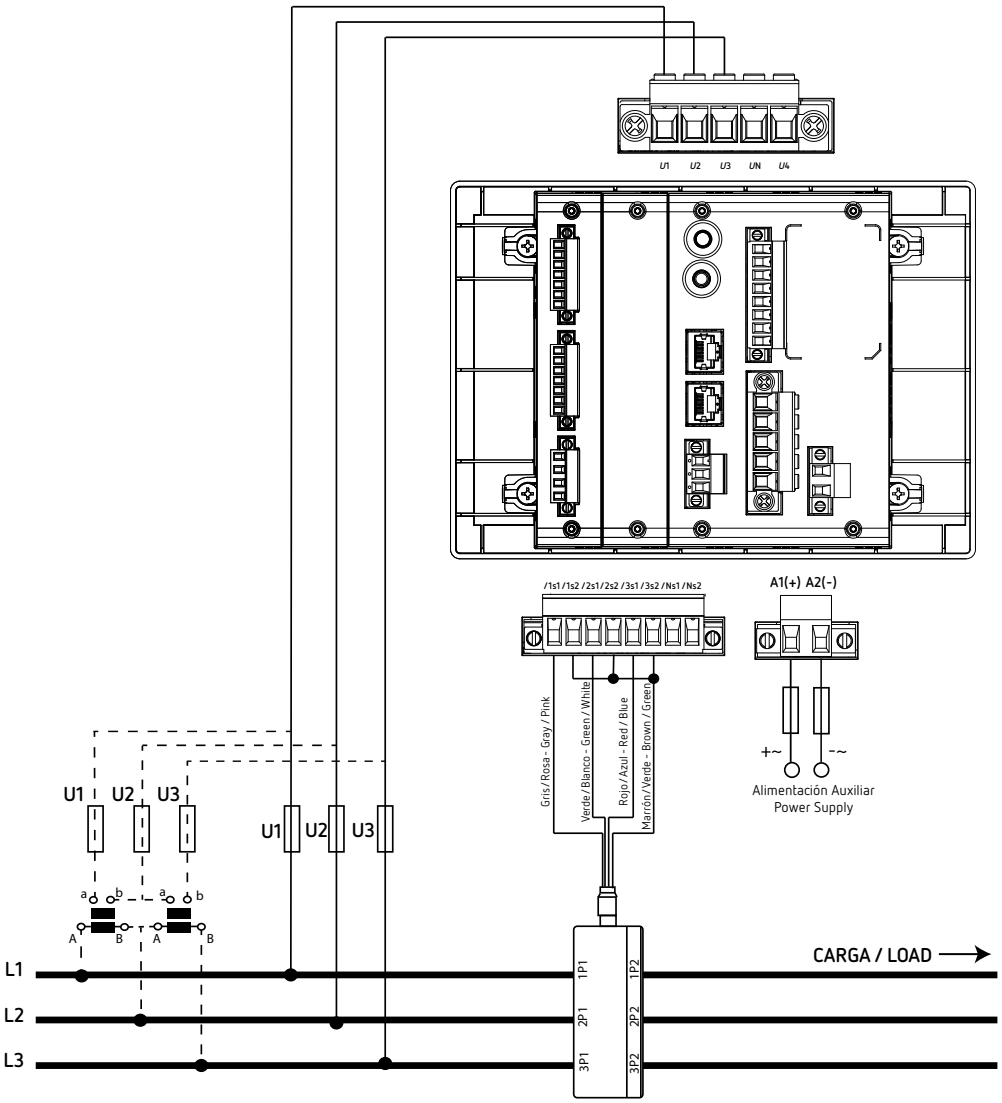


Figure 17: Three-phase measurement with 3-wire connection (Transformer type MC3 (/0.250)).

The secondary current of the **MC3** current transformer is fixed at 0.250 A.

3.5.3.- THREE-PHASE NETWORK MEASUREMENT WITH 3-WIRE CONNECTION AND 3 VOLTAGE TRANSFORMERS (CVM-A16xx-ITF).

Installation Type: **3PH3W**

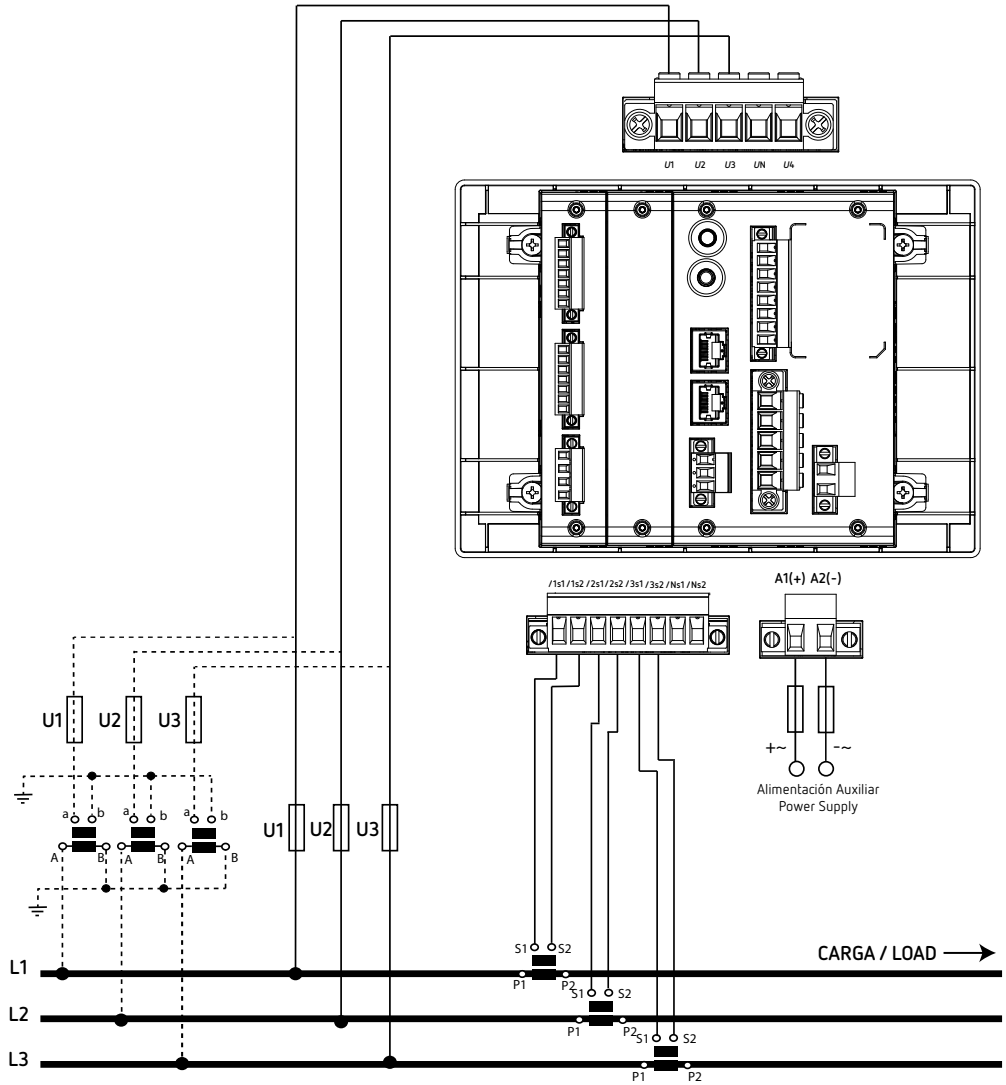


Figure 18: Three-phase measurement with 3-wire connection and 3 voltage transformers (Current transformer secondary: /1A, /5A or MC1 (/0.250)).

The secondary current of the **MC1** current transformer is fixed at 0.250 A.

3.5.4.- THREE-PHASE NETWORK MEASUREMENT WITH 3-WIRE CONNECTION AND ARON-CONNECTED TRANSFORMERS (CVM-A16xx-ITF).

Installation Type: **ARON**

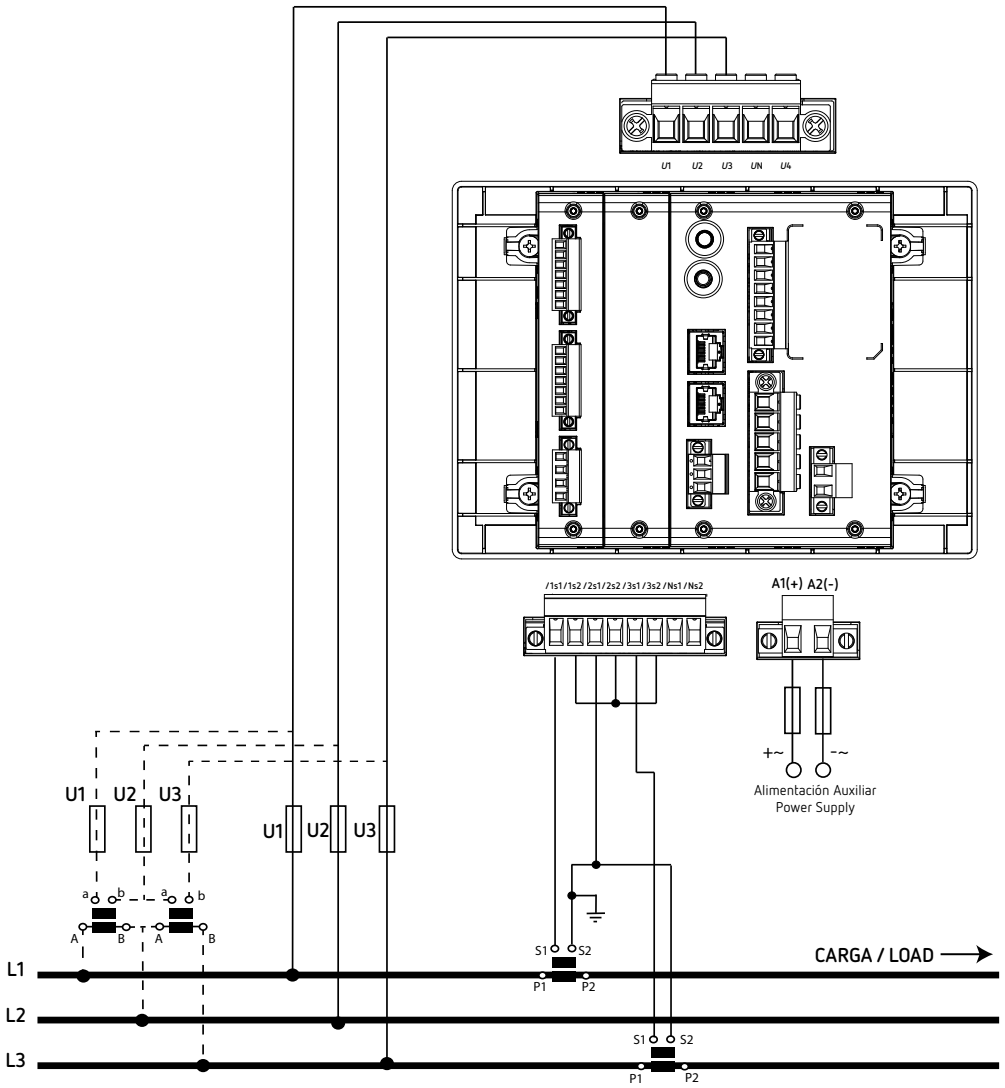


Figure 19: Three-phase Network Measurement with 3-Wire Connection and ARON-Connected Transformers (Current Transformer Secondary: /1A, /5A or MC1 (/0.250)).

The secondary current of the **MC1** current transformer is fixed at 0.250 A.

3.5.5.- TWO-PHASE NETWORK MEASUREMENT WITH 3-WIRE CONNECTION (CVM-A16xx-ITF).

Installation Type: **2PH3W**

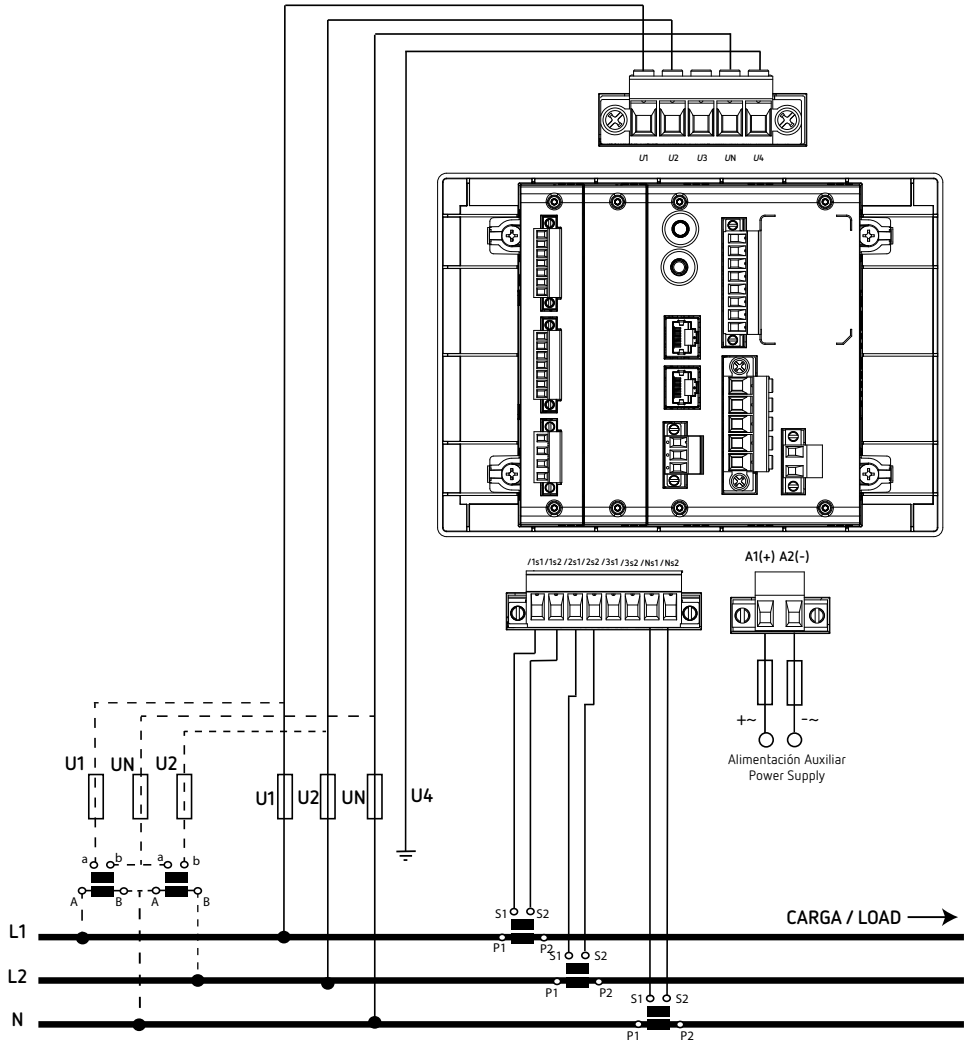


Figure 20: Two-phase measurement with 3-wire connection (Current transformer secondary: /1A, /5A or MC1 (/0.250)).

The secondary current of the **MC1** current transformer is fixed at 0.250 A.

3.5.6.- SINGLE-PHASE PHASE-TO-NEUTRAL NETWORK MEASUREMENT WITH 2-WIRE CONNECTION (CVM-A16xx-ITF).

Installation Type: **1PH2W**

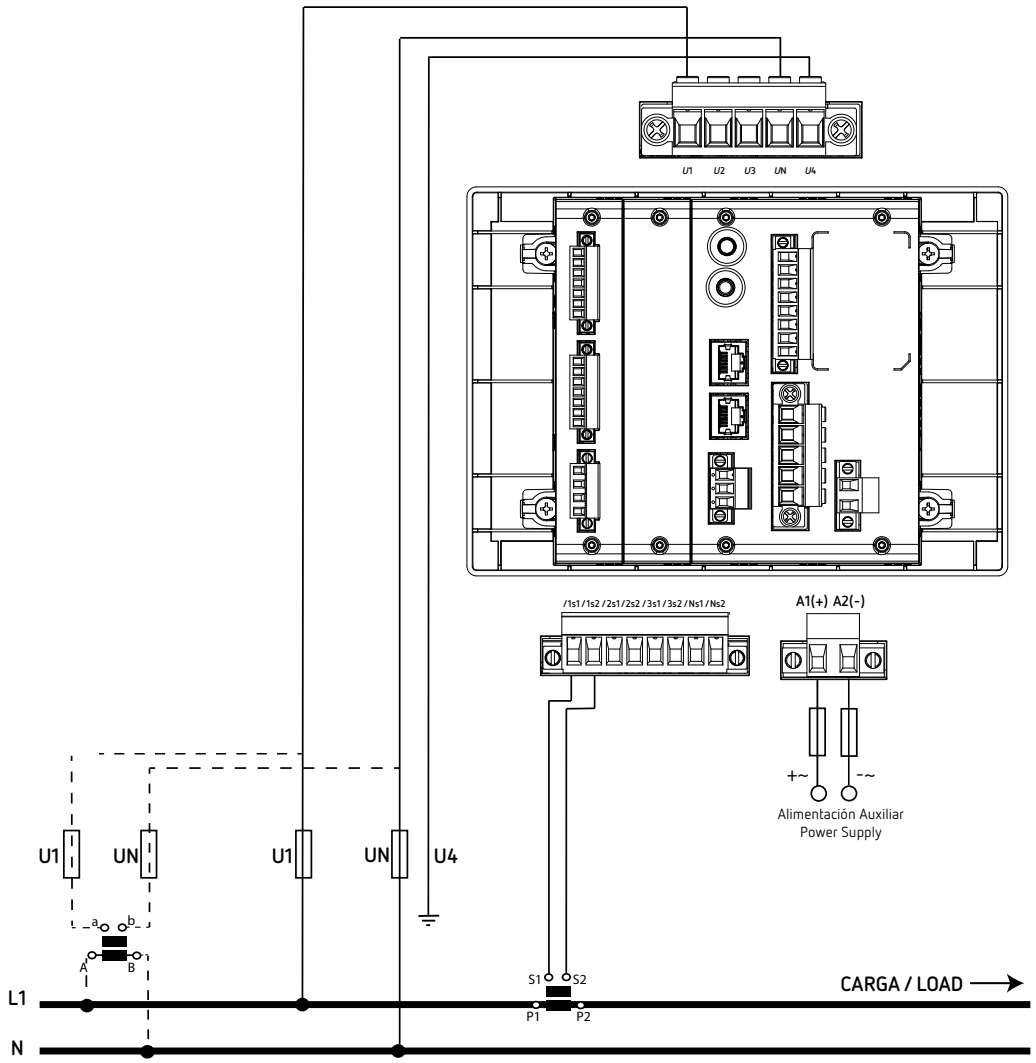


Figure 21: Single-phase Phase-to-Neutral Measurement with 2-Wire Connection (Current transformer secondary: /1A, /5A or MC1 (/0.250)).

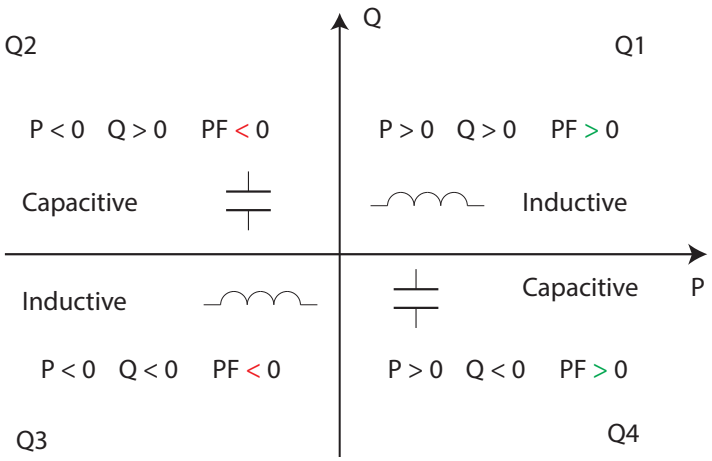
The secondary current of the **MC1** current transformer is fixed at 0.250 A.

4.- OPERATION

4.1.- OPERATING PRINCIPLE

The **CVM-A1600** is a power quality analyzer for all four quadrants (consumption and generation). The device works according to **IEC** measurement convention.

Operation in the 4 quadrants (Q1, Q2, Q3, Q4)



cos φ values in the receiver operating mode (Q1,Q4)

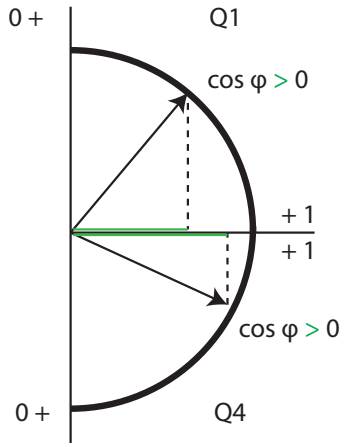


Figure 22: IEC measurement convention.

Apart from the basic functions of any analyzer, the **CVM-A1600**:

✓Measures and calculates quality parameters and captures waveforms of quality events.

✓ Saves and displays power supply failures. These can be viewed in tabular form or as an **ITIC** curve.

✓ Includes a database for recording all parameters and events recorded by the device.

✓Through the device display or its Web page, it is possible to view real-time measured data, waveforms and harmonics, as well as access the parameters stored in memory and generate, on demand or on a scheduled basis, a compliance report that assesses the various variables against the limits established in the **EN 50160** and **IEEE 519** standards. In addition, data stored in memory can be downloaded in a **PQDIF** (*Power Quality Data Interchange Format*) file or in accordance with the **Código Red de México**.

✓ Allows waveforms of quality events to be downloaded in **COMTRADE** (*Common Format for Transient Data Exchange*) format, in accordance with the **IEEE C37.111** standard, for subsequent analysis.

✓ The device is 100% modular and can be expanded using the different expansion modules that can be incorporated into the device.

4.2.- MEASUREMENT PARAMETERS

The device measures and displays different types of parameters:

✓ Electrical parameters,
✓ Quality parameters, such as overvoltages, sags, and outages, in accordance with **EN50160**.

Note: *For some parameters, an abbreviation is shown. This abbreviation is used in the screen design of* ***Dashboard*** *(See "***5.2.- DASHBOARD"** *and "**8.1.- DASHBOARD"**)* and *in the configuration of Digital Outputs in Variable Mode* (See ***"5.5.2.- DIGITAL OUTPUTS"*** and ***"8.4.2.- DIGITAL OUTPUTS"***).

Note: *The calculation formulas used by the* ***CVM-A1600*** *can be found in annex* ***"ANNEX A.- CALCULATION FORMULAS".***

Table 10: Measurement parameters of CVM-A1600 (Table 1).

Parameter	L1	L2	L3	Total	N
Phase-Neutral Voltage (U_{Ph-N})	V_AN	V_BN	V_CN	-	V_NG
Phase-Phase Voltage (U_{Ph-Ph})	V_AB	V_BC	V_CA	-	-
Voltage THD (THD U_{Ph-N})	THD_V_AN	THD_V_BN	THD_V_CN	-	THD_V_NG
Voltage THD (THD U_{Ph-Ph}) (1)	THD_V_AB	THD_V_BC	THD_V_CA	-	THD_V_NG
Voltage Harmonics	✓	✓	✓	-	-
Voltage Interharmonics	✓	✓	✓	-	-
Voltage Phasors	✓	✓	✓	-	-
Positive-Sequence Voltage Component (Ph-N) (1)	✓	✓	✓	SEQ_POS_V_PN	-
Positive-Sequence Voltage Component (Ph-Ph) (1)	✓	✓	✓	SEQ_POS_V_PP	-
Negative-Sequence Voltage Component (Ph-N) (1)	✓	✓	✓	SEQ_NEG_V_PN	-
Negative-Sequence Voltage Component (Ph-Ph) (1)	✓	✓	✓	SEQ_NEG_V_PP	-
Zero-Sequence Voltage Component (Ph-N) (1)	✓	✓	✓	SEQ_ZERO_V_PN	-
Zero-Sequence Voltage Component (Ph-Ph) (1)	✓	✓	✓	SEQ_ZERO_V_PP	-
Voltage unbalance (Ph-N)(1)	✓	✓	✓	UNBAL_V_PN	-
Voltage unbalance (Ph-Ph)(1)	✓	✓	✓	UNBAL_V_PP	-
Voltage asymmetry (Ph-N)(1)	✓	✓	✓	ASYM_V_PN	-
Voltage asymmetry (Ph-Ph)(1)	✓	✓	✓	ASYM_V_PP	-
Instantaneous flicker (Pinst)(1)	✓	✓	✓	-	-
Short-term flicker (Pst)(1)	✓	✓	✓	-	-
Long-term flicker (Plt)(1)	✓	✓	✓	-	-
Voltage crest factor(1)	✓	✓	✓	-	-
Undervoltage Percentage(1)	✓	✓	✓	-	-
Overvoltage Percentage(1)	✓	✓	✓	-	-

Table 10 (Continuation): Measurement parameters of CVM-A1600 (Table 1).

Parameter	L1	L2	L3	Total	N
Undervoltage (1)	✓	✓	✓	-	-
Overvoltage (1)	✓	✓	✓	-	-
Mains Signalling Voltage (1)	✓	✓	✓	-	-
Mains Signalling Counter Above Threshold (1)	✓	✓	✓	-	-
Mains Signalling Counter Below Threshold (1)	✓	✓	✓	-	-

Table 11: Measurement parameters of CVM-A1600 (Table 2).

Parameter	L1	L2	L3	Total	N
Current (I)	I_AN	I_BN	I_CN	-	I_NG
Current THD (THDI)	THD_I_AN	THD_I_BN	THD_I_CN	-	THD_I_NG
Current TDD (1)	✓	✓	✓	-	✓
Current harmonics	✓	✓	✓	-	-
Current interharmonics	✓	✓	✓	-	-
Current phasors	✓	✓	✓	-	-
Positive sequence component in current (1)	✓	✓	✓	SEQ_POS_I	-
Negative sequence component in current (1)	✓	✓	✓	SEQ_NEG_I	-
Zero sequence component in current (1)	✓	✓	✓	SEQ_ZERO_I	-
Current unbalance (1)	✓	✓	✓	UNBAL_I	-
Current asymmetry (1)	✓	✓	✓	ASYM_I	-
Current crest Factor (1)	✓	✓	✓	-	-
K-Factor(1)	✓	✓	✓	-	-

Table 12: Measurement Parameters of CVM-A1600 (Table 3).

Parameter	L1	L2	L3	Total	N
Frequency(1)	FREQ_10s	-	-	-	-

Table 13: Measurement Parameters of CVM-A1600 (Table 4).

Parameter	L1	L2	L3	Total
Active Power (P)	P_AN	P_BN	P_CN	P_TOT
Fundamental Active Power (P_1)	P1_AN	P1_BN	P1_CN	P1_TOT
Harmonic Active Power (1)	✓	✓	✓	✓
Consumed Active Power (1)	✓	✓	✓	✓
Generated Active Power (1)	✓	✓	✓	✓
Consumed Fundamental Active Power (1)	✓	✓	✓	✓
Generated Fundamental Active Power (1)	✓	✓	✓	✓
Current distortion power (1)	✓	✓	✓	✓
Voltage distortion power (1)	✓	✓	✓	✓
Reactive Power (Q)	Q_AN	Q_BN	Q_CN	Q_TOT
Fundamental Reactive Power (1)	✓	✓	✓	✓
Inductive Reactive Power (1)	✓	✓	✓	✓

Table 13 (Continuation): Measurement Parameters of CVM-A1600 (Table 4).

Parameter	L1	L2	L3	Total
Capacitive Reactive Power (1)	✓	✓	✓	✓
Consumed Reactive Power (1)	✓	✓	✓	✓
Generated Reactive Power (1)	✓	✓	✓	✓
Consumed Inductive Reactive Power (1)	✓	✓	✓	✓
Consumed Capacitive Reactive Power (1)	✓	✓	✓	✓
Generated Inductive Reactive Power (1)	✓	✓	✓	✓
Generated Capacitive Reactive Power (1)	✓	✓	✓	✓
Consumed Fundamental Reactive Power (1)	✓	✓	✓	✓
Generated Fundamental Reactive Power (1)	✓	✓	✓	✓
Consumed Fundamental Inductive Reactive Power (1)	✓	✓	✓	✓
Generated Fundamental Inductive Reactive Power (1)	✓	✓	✓	✓
Consumed Fundamental Capacitive Reactive Power (1)	✓	✓	✓	✓
Generated Fundamental Capacitive Reactive Power (1)	✓	✓	✓	✓
Harmonic Distortion Reactive Power (1)	✓	✓	✓	-
Effective Distortion Reactive Power (1)	-	-	-	✓
Non-active Power (N)	N_AN	N_BN	N_CN	N_TOT
Inductive Non-active Power (1)	✓	✓	✓	✓
Capacitive Non-active Power (1)	✓	✓	✓	✓
Apparent Power (S)	S_AN	S_BN	S_CN	S_TOT
Fundamental Apparent Power (S_1)	S1_AN	S1_BN	S1_CN	S1_TOT
Effective Fundamental Apparent Power (1)	-	-	-	✓
Non-Fundamental Apparent Power (1)	✓	✓	✓	-
Effective Non-Fundamental Apparent Power (1)	-	-	-	✓
Harmonic Apparent Power (1)	✓	✓	✓	✓
Unbalance Apparent Power (1)	-	-	-	✓

Table 14: Measurement Parameters of CVM-A1600 (Table 5).

Parameter	L1	L2	L3	Total
Power Factor (PF)	PF_AN	PF_BN	PF_CN	PF_TOT
Fundamental Power Factor (DPF)	DPF_AN	DPF_BN	DPF_CN	DPF_TOT
Consumed Inductive Power Factor (1)	✓	✓	✓	✓
Generated Inductive Power Factor (1)	✓	✓	✓	✓
Consumed Fundamental Inductive Power Factor (1)	✓	✓	✓	✓
Generated Fundamental Inductive Power Factor (1)	✓	✓	✓	✓
Consumed Capacitive Power Factor (1)	✓	✓	✓	✓
Generated Capacitive Power Factor (1)	✓	✓	✓	✓
Consumed Fundamental Capacitive Power Factor (1)	✓	✓	✓	✓
Generated Fundamental Capacitive Power Factor (1)	✓	✓	✓	✓
Consumed Harmonic Power(1)	✓	✓	✓	✓
Generated Harmonic Power (1)	✓	✓	✓	✓

Table 15:Measurement Parameters of CVM-A1600 (Table 6).

Parameter	Total
Consumed three-phase active energy	P_ENERGY_CON_TOT
Generated three-phase active energy	P_ENERGY_GEN_TOT
Three-phase fundamental reactive energy in Q1	Q_ENERGY_Q1_TOT
Three-phase fundamental reactive energy in Q2	Q_ENERGY_Q2_TOT
Three-phase fundamental reactive energy in Q3	Q_ENERGY_Q3_TOT
Three-phase fundamental reactive energy in Q4	Q_ENERGY_Q4_TOT
Three-phase apparent energy	S_ENERGY_TOT

(1) Parameter recorded in the database only.

4.2.1.- QUALITY PARAMETERS

Power quality control requires defining the TRMS of the voltage level, subsequently used by the analyzer to record events. According to Standard **EN-61000-4-30**, the RMS value must be calculated for all the AC magnitudes or each cycle and refresh every ½ cycle. If the RMS value exceeds certain programmed thresholds, this is understood as an **event**.

The device detects quality parameters such as overvoltages, gaps and voltage outages. **Figure 23** shows an example of these events.

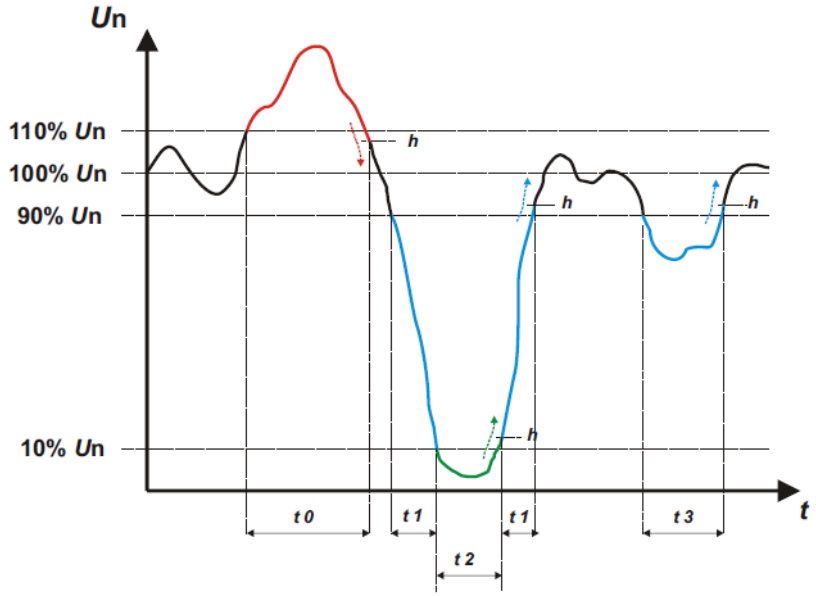


Figure 23: Example of quality events.

✓ **Voltage Swell**

A swell event is shown in the time interval **t0** in **Figure 23.** The duration of the event is the time that the signal stays above the configured threshold value (***"5.7.3.- QUALITY"*** and ***"8.5.2.- QUALITY"***). In this example it is 110% of the rated voltage plus the time the signal takes to fall below the configured value, including a hysteresis of 2%.

✓ **Voltage dip**

The **t1** and **t3** time intervals in **Figure 23** show two voltage dips. The duration of the event is equal to the time during which the signal is below the configured threshold value (***"5.7.3.- QUALITY"*** and ***"8.5.2.- QUALITY"***), in this example, it is 90% of the rated voltage.

✓ Voltage outage (Interrupt)

The **t2** time interval in **Figure 23** shows an outage or interruption event. The duration of the event is equal to the time during which the signal is below the configured threshold value (***"5.7.3.- QUALITY"*** and ***"8.5.2.- QUALITY"***), in this example, it is 10% of the rated voltage, plus the time the signal takes to increase the value, including a 2% hysteresis

✓ Rapid voltage changes (RVC)

A rapid voltage change (RVC) is a sudden change in the voltage between two stable states, where the voltage does not exceed the thresholds of a dip. It may be said to be a dip, but of a smaller size (***"5.7.3.- QUALITY"*** and ***"8.5.2.2.- RAPID VOLTAGE CHANGES (RVC)"***).

✓ Voltage transients

The algorithm for calculating voltage transients relies on detecting transients that exceed a threshold in blocks of 5120 samples (when the base frequency is 50 Hz). Specifically, this threshold is calculated automatically (dynamic threshold) as per **Equation 1.**

$$Threshold_n = max\{x_{i+1} - x_i\}_n$$

Equation 1: Threshold.

Where:

i: number of samples [1, 5119] (Frequency: 50 Hz)
i: number of samples [1, 6143] (Frequency: 60 Hz)
n: the number of blocks of 5120 samples. (Frequency: 50 Hz)
n: the number of blocks of 6144 samples. (Frequency: 60 Hz)

The threshold is calculated as the maximum value of the difference between two consecutive samples in block n of size 5120.

This threshold is used as the detection limit of the transient in block **n+1**. If a transient has not occurred in block **n+1**, the threshold is automatically recalculated with the data from block **n+1**. This will be used as the detection threshold for block **n+2** (multiplied by the sensitivity), and so on.

For example, in **Figure 24**, the threshold calculated for block **n** is the maximum of 1.9 V, 2.1 V and 2.3 V, that is, 2.3 V (similar to calculating the maximum slope in the block). If there is a difference between consecutive samples in block **n+1** greater than 2.3 V multiplied by the sensitivity value, a transient is detected.

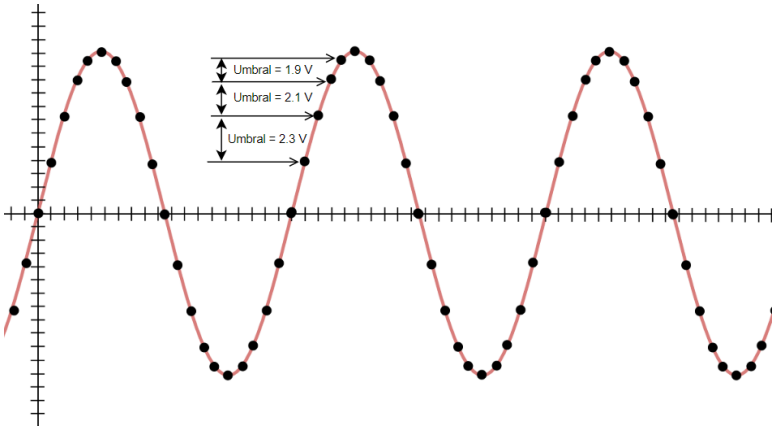


Figure 24: Threshold in block n.

Another parameter involved in the algorithm is the **Sensitivity**. This helps to dampen the algorithm's response to false positives.

Two parameters have to be set to calculate voltage transients:

• **Sensitivity:** The user must enter a value between 0 and 100%. This value is converted into a Sensitivity coefficient (from 1.05 to 10) that is used to modify the threshold value calculated in the previous block, as per **Equation 2** and **Equation 3**.

$$Sensitivity\ coefficient = Sensitivity * \frac{(1.05-10)}{100} + 10$$

Equation 2: Sensitivity coefficient.

$$Threshold_n = Threshold_{n-1} * Sensitivity\ coefficient$$

Equation 3: Threshold as a function of sensitivity.

• **Samples:** In order to be considered a voltage transient, the condition must persist during the number of samples selected by the user, from 1 to 10.
Below are two transient detection examples for the same voltage input signal with minimum sensitivity and maximum sensitivity.

In **Figure 25** it has been configured:
Sensitivity = 0% → **Sensitivity coefficient =** 10

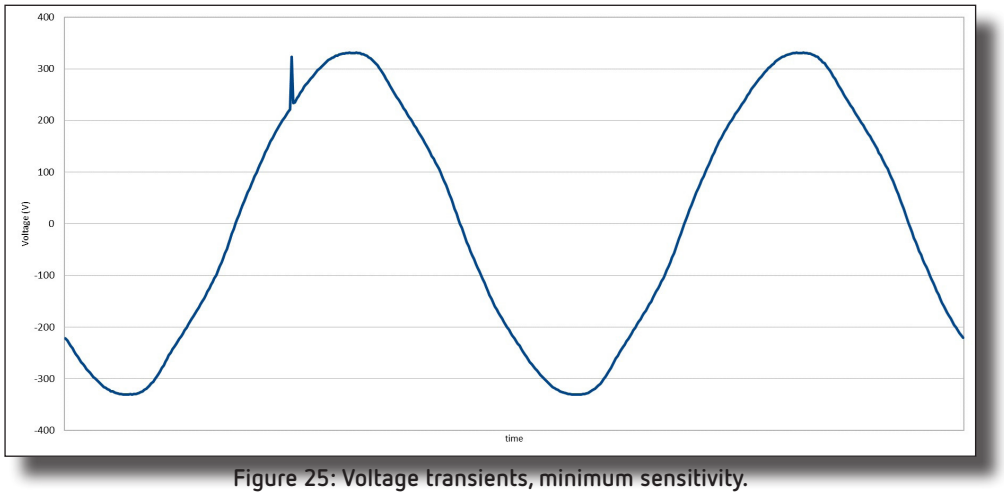


Figure 25: Voltage transients, minimum sensitivity.

In **Figure 26** it has been configured:
Sensitivity = 100% → **Sensitivity coefficient =** 1.05

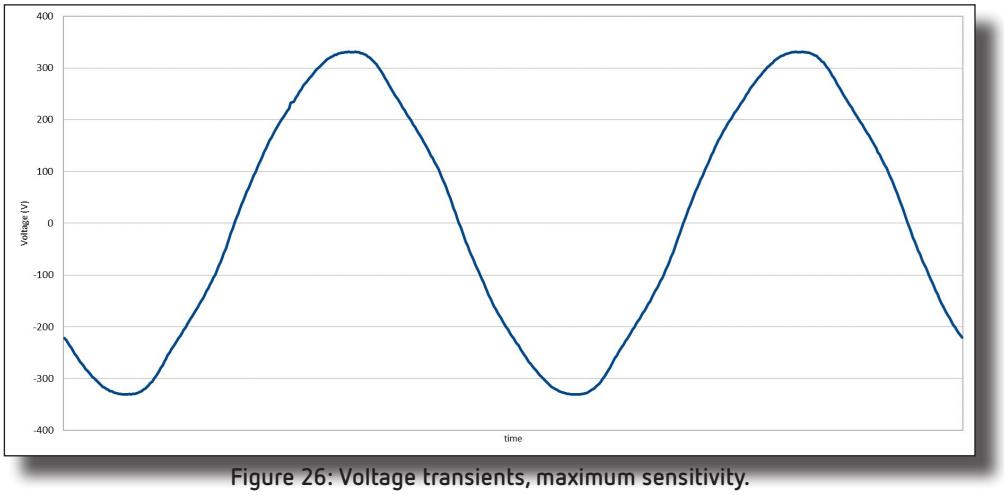


Figure 26: Voltage transients, maximum sensitivity.

Note that with the maximum sensitivity, smaller disturbances can be detected.

The voltage transients can be configured via the display or through the web page, see ***"5.7.3.- QUALITY"*** and ***"8.5.2.4.- VOLTAGE TRANSIENTS".***

✓ **Current transients**

Due to the variability of the current waveform, the device implements two calculation algorithms, one to detect slow transients and another to detect fast transients.

Slow transients

The formula, **Equation 4**, for detecting slow current transients is the absolute difference between two consecutive RMS values, normalized with respect to the most recent RMS value. The RMS values selected to carry out this operation are those corresponding to one cycle of the fundamental wave, updated every half-cycle.

$$\frac{\left|U_{rms\left(\frac{1}{2}\right)i} - U_{rms\left(\frac{1}{2}\right)i-1}\right|}{U_{rms\left(\frac{1}{2}\right)i}} * 100 \geq U_{slow} * k_{slow}$$

Equation 4: Slow transients.

This value is updated whenever the number of samples corresponding to one half-cycle of the fundamental wave elapses, since passes through zero do not have to be binding in order to define the signal periods in the current waveform.

Three parameters have to be set to calculate slow transients:

- **Slow threshold (U_{slow}):** percent value from 1 to 100%, relative to the nominal current value.
- **Slow sensitivity (K_{slow}):** value used to dampen sensitivity to false positives based on the specific characteristics of each mains. This value is calculated from the value programmed by the user based on **Equation 5**, with a higher sensitivity allowing smaller transients to be calculated.

$$K_{slow} = 5 - \text{Slow detection sensitivity}$$

Equation 5:K_{slow}

• **Slow inhibitory cycles:** Number of cycles until the end of the transient that are inhibited to detect new current transients, to avoid saturating the system during highly non-linear consumption periods.

Current Transient configuration can be performed via the display or through the web page. See ***5.7.3.- QUALITY"*** and ***"8.5.2.5.- CURRENT TRANSIENTS".***

Below are two slow transient detection examples for the same current input signal, with minimum and maximum sensitivities.

In **Figure 27** it has been configured:
Slow threshold: 10%
Slow detection sensitivity: 1 → K_{slow} = 4

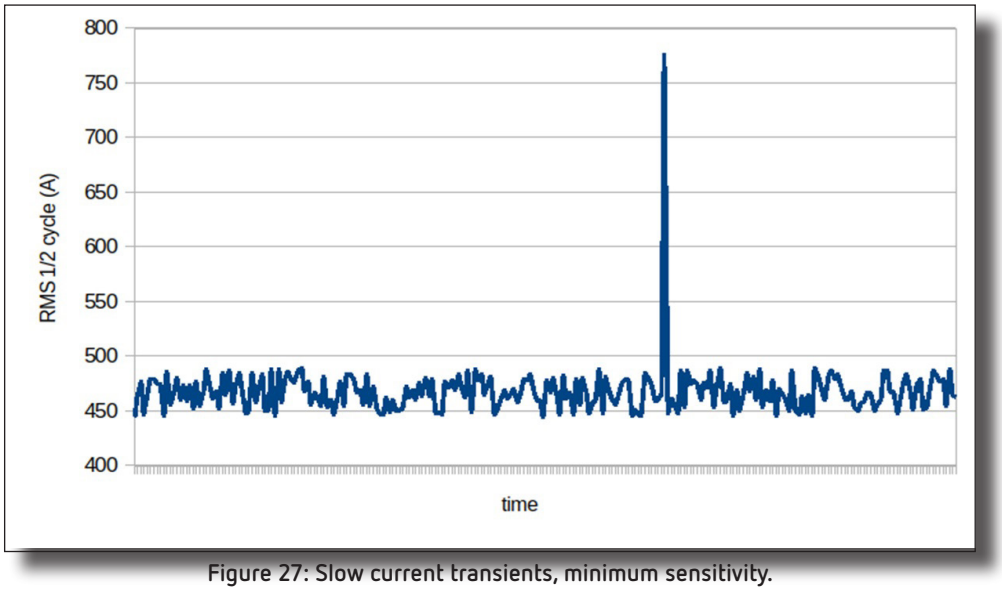


Figure 27: Slow current transients, minimum sensitivity.

In **Figure 28** it has been configured:
Slow threshold: 10%
Slow detection sensitivity: 4 → K_{slow} = 1

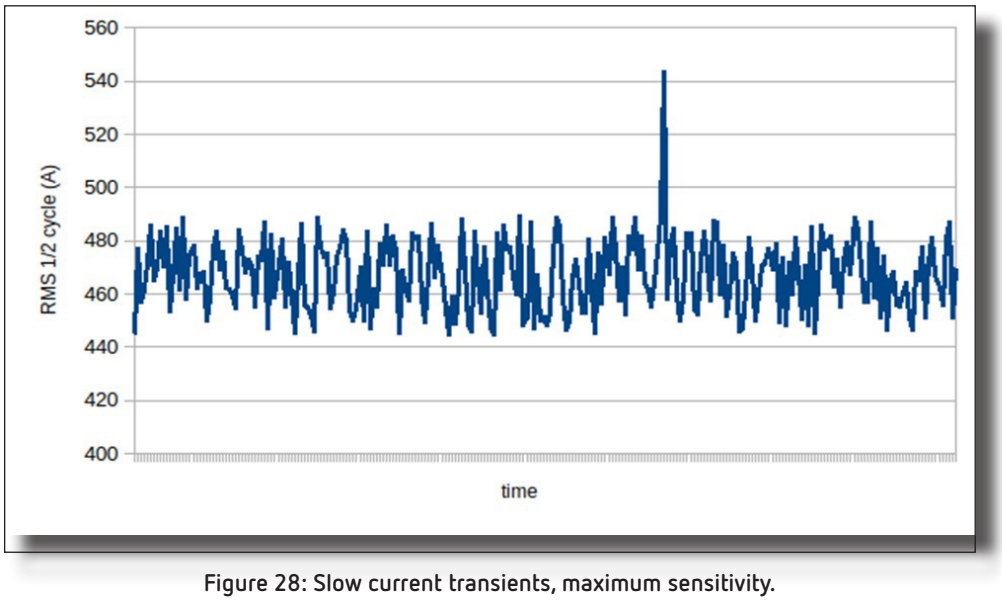


Figure 28: Slow current transients, maximum sensitivity.

Note that with the maximum sensitivity, smaller disturbances can be detected.

Fast transients

The formula selected for detecting fast current transients, **Equation 6**, is the absolute difference between two consecutive samples, normalized with respect to the last RMS cycle value available (updated every half-cycle).
The normalization, considering the latest available RMS value, is only done if the latter value is greater than 1. Otherwise, only the absolute difference between samples is taken (to prevent very small RMS current values from causing fast transients in conventional situations).

$$\begin{cases} \dfrac{|x_n - x_{n-1}|}{U_{rms\left(\frac{1}{2}\right)i}} \times 100 \geq U_{fast} \times k_{fast} & U_{rms\left(\frac{1}{2}\right)i} > 1 \\ |x_n - x_{n-1}| \times 100 \geq U_{fast} \times k_{fast} & U_{rms\left(\frac{1}{2}\right)i} \leq 1 \end{cases}$$

Equation 6:Fast transients.

Three parameters have to be set to calculate fast transients:

- **Fast threshold (U_{fast}):** percent value from 1 to 100%, relative to the nominal current value.
- **Fast sensitivity (K_{fast}):** value used to dampen sensitivity to false positives based on the specific characteristics of each mains. This value is calculated from the value programmed by the user based on **Equation 7**, with a higher sensitivity allowing smaller transients to be calculated.

$$K_{fast} = 5 - \text{Fast detection sensitivity}$$

Equation 7:K_{fast}.

- **Fast inhibitory cycles:** Number of cycles until the end of the transient that are inhibited to detect new current transients, to avoid saturating the system during highly non-linear consumption periods.

Current Transient configuration can be performed via the display or through the web page. See ***"5.7.3.-QUALITY"*** and ***"8.5.2.5.-CURRENT TRANSIENTS".***

Below are two fast transient detection examples for the same current input signal, with minimum and maximum sensitivities.

In **Figure 29** it has been configured:
Fast threshold: 40%
Fast detection sensitivity: 1 → $K_{fast} = 4$

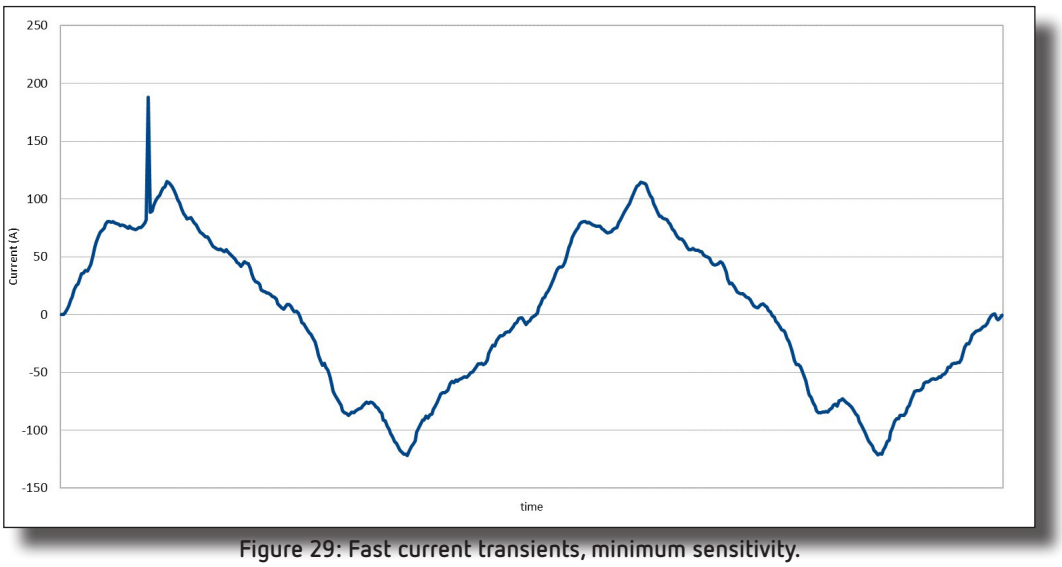


Figure 29: Fast current transients, minimum sensitivity.

In **Figure 30** it has been configured:
Fast threshold: 40%
Fast detection sensitivity: 4 → $K_{fast} = 1$

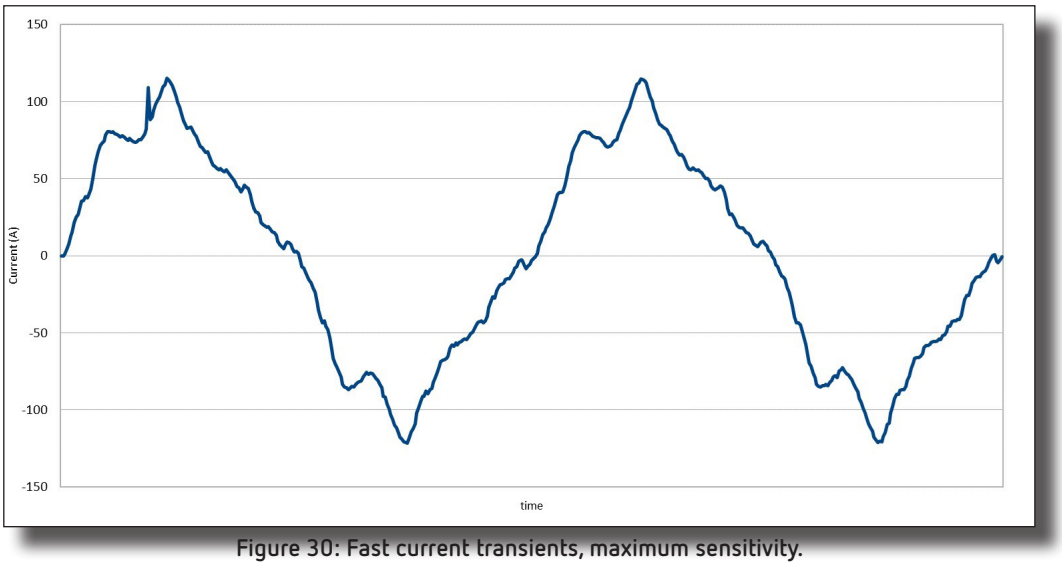


Figure 30: Fast current transients, maximum sensitivity.

Note that with the maximum sensitivity, smaller disturbances can be detected.

4.3.- DISPLAY

The device features an 8" colour touchscreen display, where all device parameters can be viewed and configured (**Figure 31**):

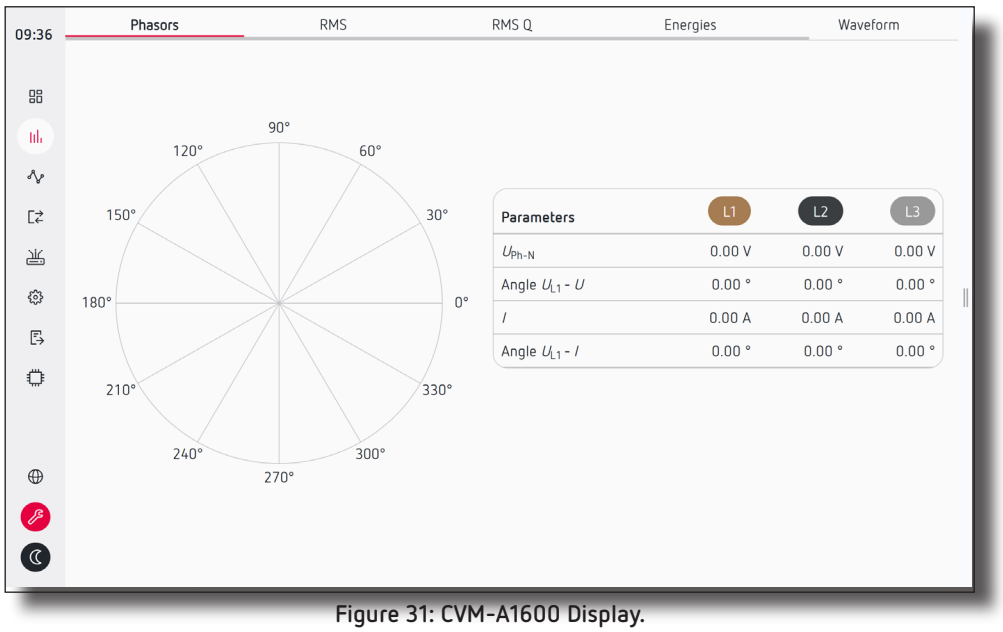


Figure 31: CVM-A1600 Display.

The different device menus can be accessed from the left-hand side:

Dashboard, customer-customisable screen.
Instantaneous, display of the instantaneous values measured by the device.
Measure, display of the historical values measured by the device.
I/O, display and configuration of the device inputs and outputs (menu available on **CVM-A1611-ITF** and **CVM-A1612-ITF** models).
Communications, display and configuration of the device communications.
Configuration, configuration of the device parameters.
Exports, configuration of data exports.
System, display of system information.

It is also possible:

Language, change the display language.
Administrator login / Administrator logout, enable or disable modification of the device configuration.
Night mode , change the display background colour.

4.4.- DIGITAL INPUTS

Depending on the model,**Table 16**, the **CVM-A1600** features digital inputs that can be configured to detect a change of state.

Table 16: Digital Inputs.

Model	Digital Inputs
CVM-A1610-ITF	-
CVM-A1611-ITF	6
CVM-A1612-ITF	12

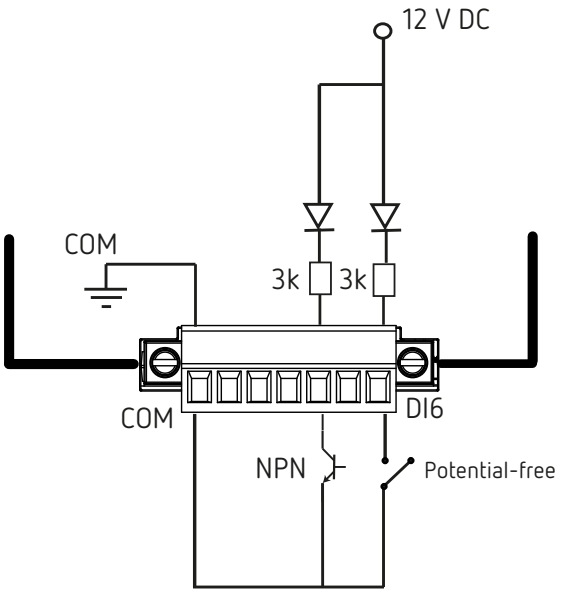


Figure 32: CVM-A1600 Digital Inputs.

See *"5.5.1.-DIGITAL INPUTS"* and *"8.4.1.- DIGITAL INPUTS"* to view and configure the device's digital inputs.

4.5.- DIGITAL OUTPUTS

Depending on the model,**Table 17**, the **CVM-A1600** features programmable digital outputs that can operate:

- ✓Manually, allowing the user to activate or deactivate the output.
- ✓According to a variable, the output is activated when the programmed conditions are met.
- ✓According to the state of an input.
- ✓According to a quality event.
- ✓According to an energy variable.

Table 17: Digital outputs.

Model	Digital outputs
CVM-A1610-ITF	-
CVM-A1611-ITF	6
CVM-A1612-ITF	12

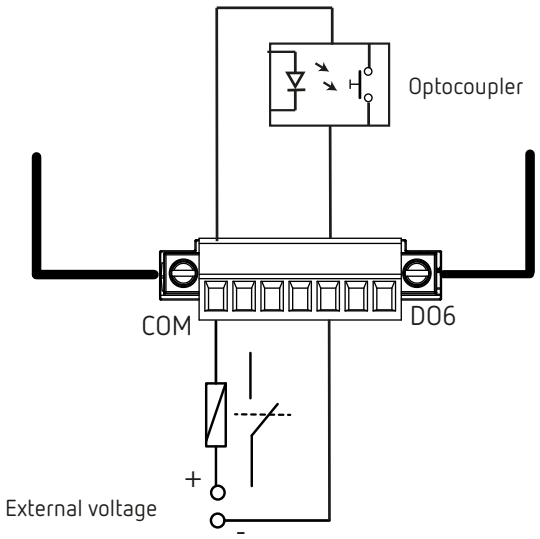


Figure 33: CVM-A1600 Digital Outputs.

See ***"5.5.2.- DIGITAL OUTPUTS"*** and ***"8.4.2.- DIGITAL OUTPUTS"*** to view and configure the device digital outputs.

4.6.- RELAY OUTPUTS

Depending on the model, **Table 18**, the **CVM-A1600** features programmable relay outputs that can operate:

- ✓Manually, allowing the user to activate or deactivate the output.
- ✓According to a variable, the output is activated when the programmed conditions are met.
- ✓According to the state of an input.
- ✓According to a quality event.

Table 18: Relay outputs.

Model	Relay outputs
CVM-A1610-ITF	-
CVM-A1611-ITF	2
CVM-A1612-ITF	4

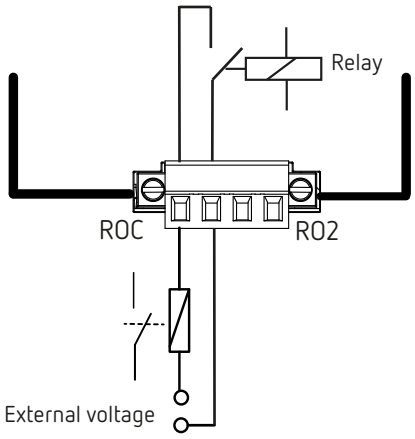


Figure 34: CVM-A1600 Relay Outputs.

See ***"5.5.2.- DIGITAL OUTPUTS"*** and ***"8.4.2.- DIGITAL OUTPUTS"*** to view and configure the device digital outputs.

5.- VIEWING AND CONFIGURATION

5.1.- DEVICE START-UP

Once the **CVM-A1600** is powered up, the following screen is displayed while the device software is loading (**Figure 35**).



Figure 35: Loading screen.

Once device initialisation is complete, the device main screen is displayed (**Figure 36**).

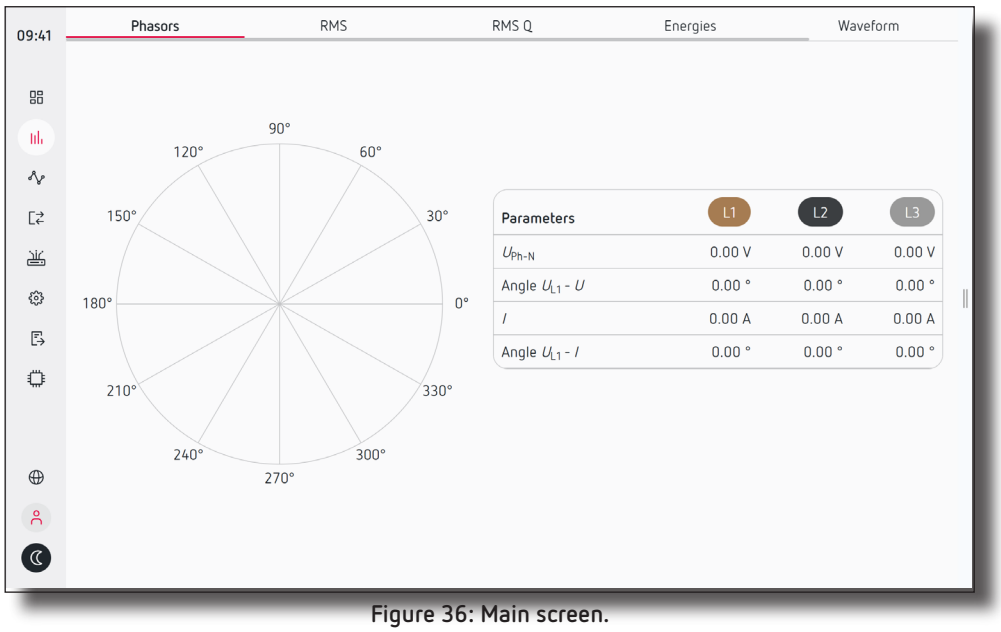


Figure 36: Main screen.

The device viewing and configuration menu can be accessed from the left-hand side of the screen:

Dashboard → display of the customer-customisable screen.
Instantaneous → display of the instantaneous values measured by the device.
Measure → display of the historical values measured by the device.
I/O → display and configuration of the device inputs and outputs (menu available on **CVM-A1611-ITF and CVM-A1612-ITF** models).
Communication → configuration of the device communications.

Configuration → configuration of the device parameters.
Exports → configuration of data exports.
System → display of system information.

It is also possible to:

Change the web page language.
Switch the web page to night mode.
Log in as administrator.

To modify the device configuration, it is necessary to log in as administrator. To do so, press , in the lower left-hand corner. The screen shown in **Figure 37** is displayed.

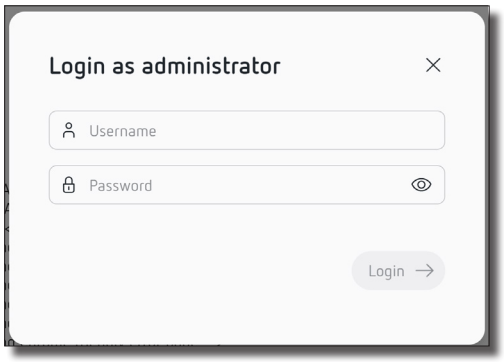


Figure 37: Log In.

Table 19: Administrator Access.

Administrator Access	
Username	admin
Password	circutor

Press to log out of the administrator session.

5.2.- DASHBOARD

The **Dashboard** screen, **Figure 38,** is a customisable screen where the user can configure the parameters to be displayed and add images.



Figure 38: Dashboard screen.

Press to enter edit mode, and then press **+** to add the variables to be displayed. The screen shown in **Figure 39** is displayed. Up to 8 variables can be included on the **Dashboard** screen.

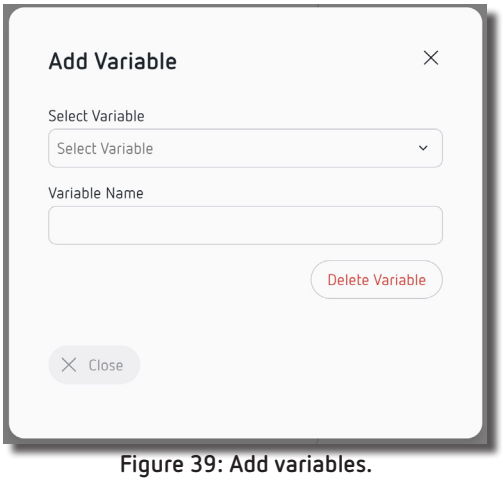


Figure 39: Add variables.

✓**Select variable**: Select the variable to be displayed on the **Dashboard** screen. **Table 10**, **Table 11**, **Table 12**, **Table 13** and **Table 14** provide a description of the variables corresponding to the abbreviations shown in this parameter.

✓**Variable Name:** Name of the variable to be displayed.

Images must be uploaded from the web page, see ***"8.1.- DASHBOARD".***

5.3.- INSTANTANEOUS

5.3.1.- PHASORS

The **Phasors** screen, **Figure 40,** shows the graphical representation and numerical value of the voltage and current phasors.

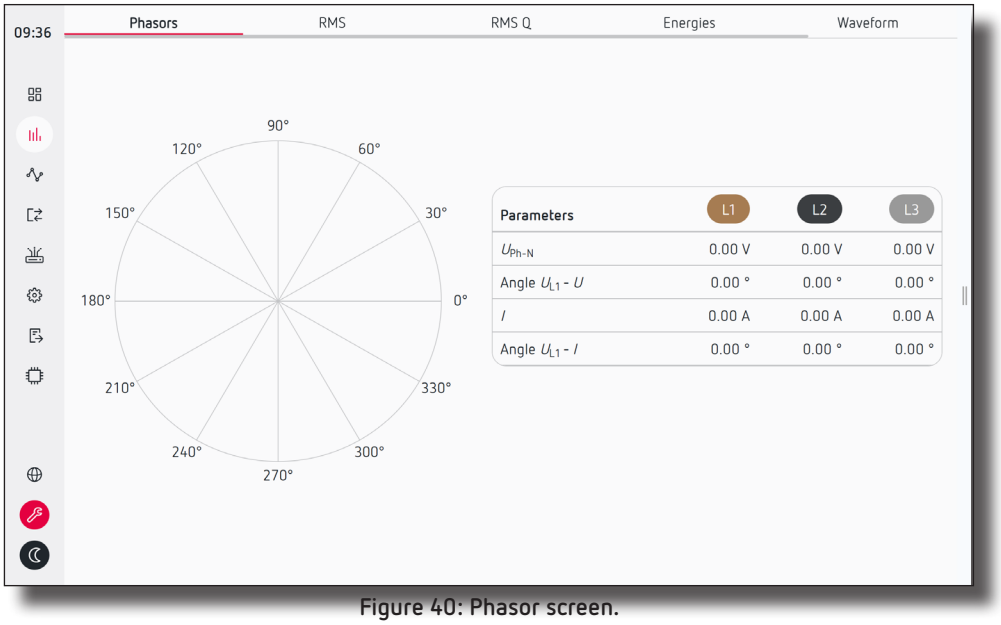


Figure 40: Phasor screen.

Note: *Angles are calculated relative to the Phase 1 voltage angle.*

5.3.2.- RMS

The **RMS** screen, **Figure 41,** shows the instantaneous values of the parameters measured by the **CVM-A1600**.

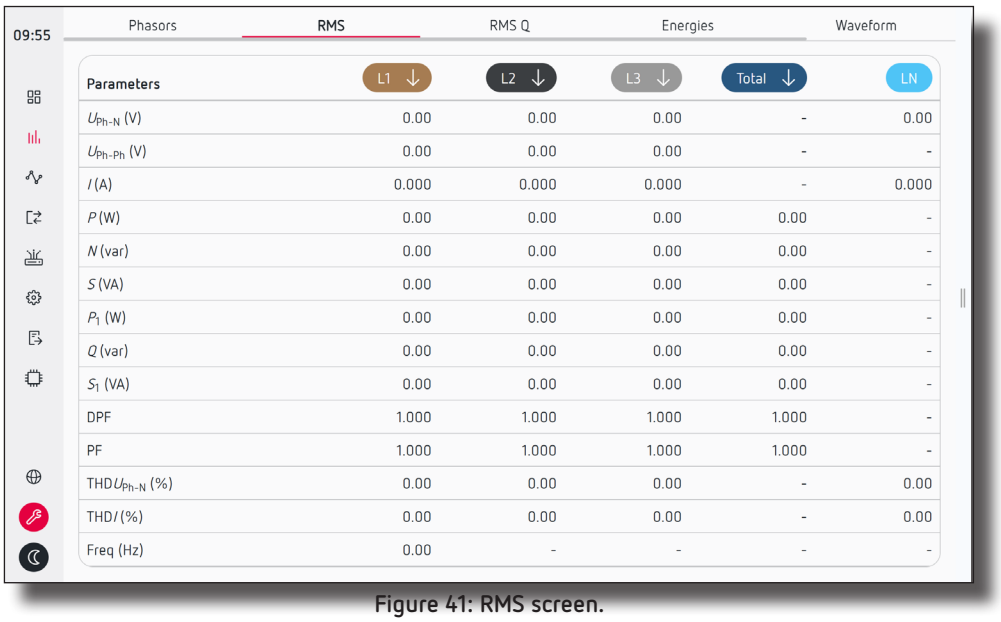


Figure 41: RMS screen.

5.3.3.- RMS Q

The **RMS Q** screen, **Figure 42,** shows the instantaneous values of the quality parameters measured by the **CVM-A1600**.



Figure 42: RMS Q screen.

5.3.4.- ENERGIES

The **Energies** screen **Figure 43,** displays the energies measured by the **CVM-A1600**.

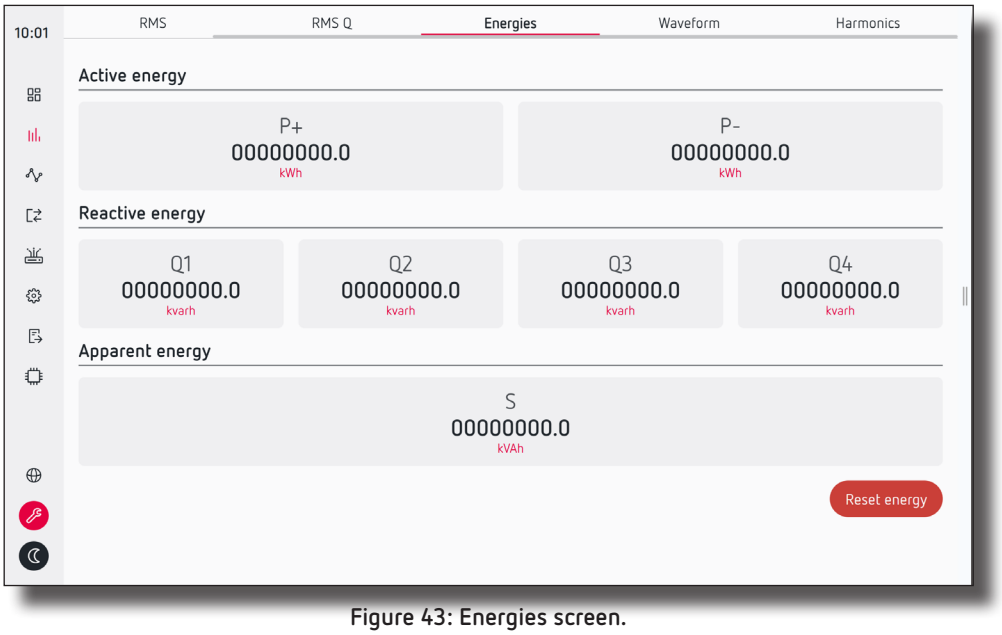


Figure 43: Energies screen.

Press **Reset energy** to reset the energy values.

Note: *Energy counters reset the accumulated register upon reaching the maximum values of 100 GWh (Active Energy), 100 Gvarh (Reactive Energy) and 100 GVAh (Apparent Energy).*

5.3.5.- WAVEFORM

The **Waveform** screen, **Figure 44,** displays the voltage and current waveforms or the RMS values of one cycle measured by the **CVM-A1600**, depending on the option configured in section ***"5.7.3.- QUALITY - Waveform"*** or ***"8.5.2.6.- WAVEFORM"***.

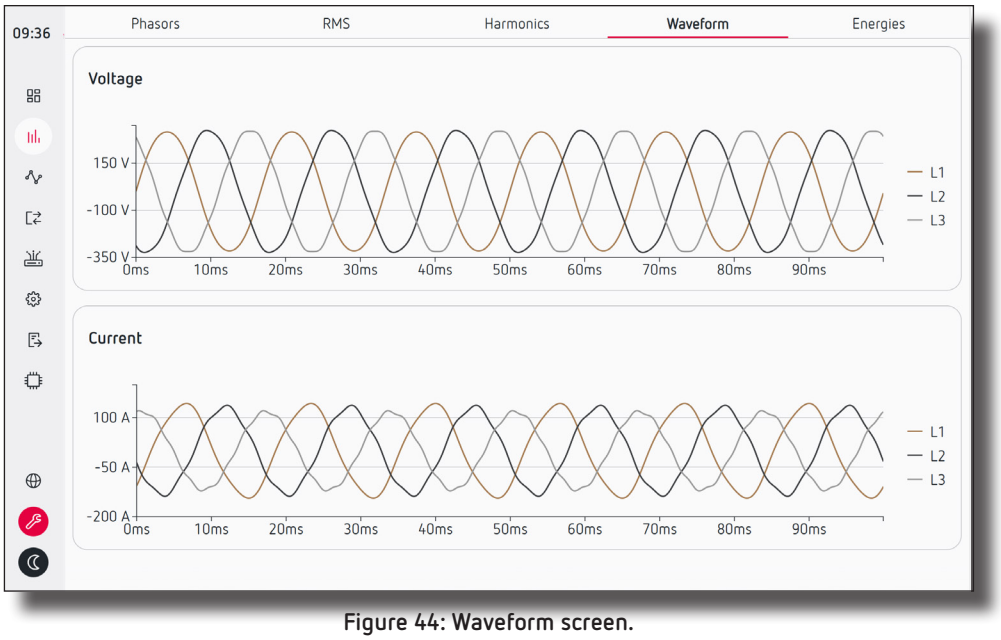


Figure 44: Waveform screen.

5.3.6.- HARMONICS

The **Harmonics** screen, **Figure 45,** displays the voltage and current harmonics.

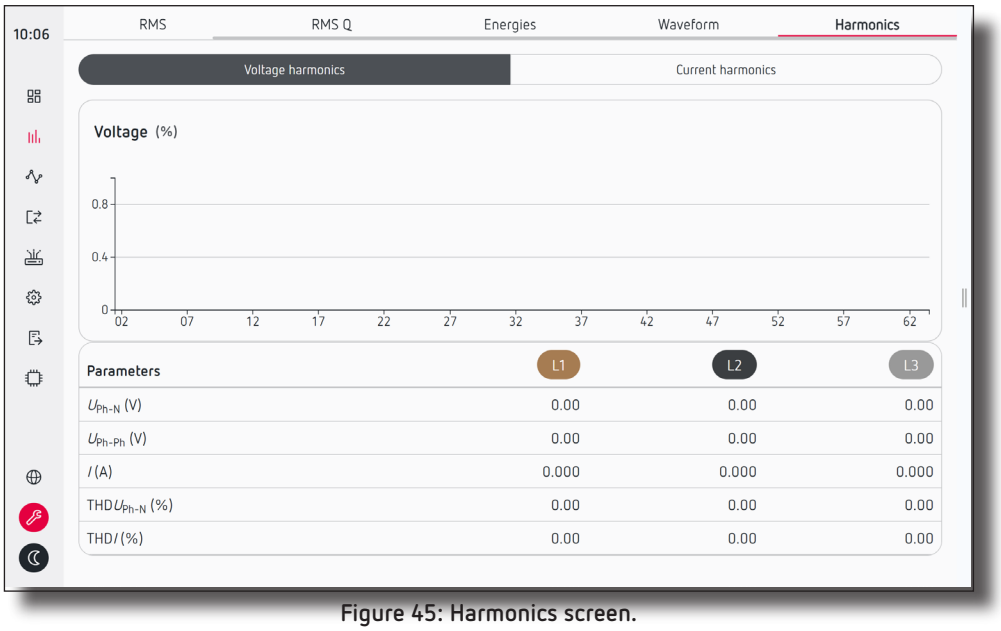


Figure 45: Harmonics screen.

The **CVM-A1600** represents harmonics originating from the source with a positive sign in the calculated harmonic %.
Harmonics originating from the load are represented with a negative sign in the calculated harmonic %.
If the power harmonic does not have sufficient magnitude or its angle is too close to 90° or 270°, the sign of the harmonic % is positive. (See ***"A.2.12.- VOLTAGE AND CURRENT HARMONICS"***).

5.4.- MEASURE

5.4.1.- HISTORIC

On the **Historic** screen, **Figure 46,** historical values shown in **Table 20** can be viewed by selecting the periodicity and the start and end dates.

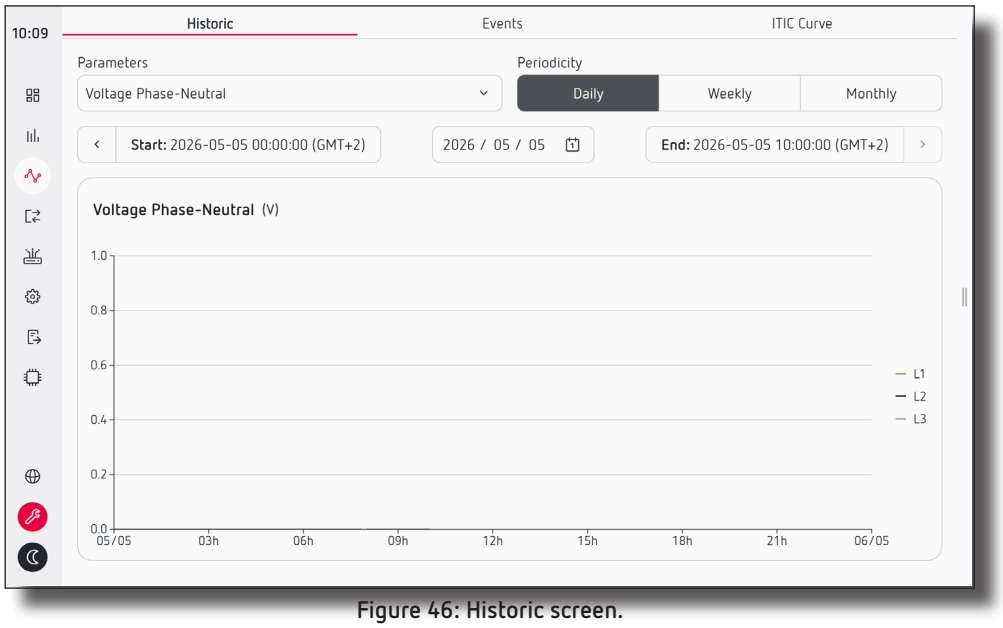


Figure 46: Historic screen.

Table 20: Parameters displayed on the Historic screen.

Historic screen parameters		
Generic	Voltage Phase-Neutral	Voltage Phase-Phase
	Voltage Neutral	Current
	Earth leakage current	Displacement power factor
	Power factor	Total harmonic distortion voltage
	Total harmonic distortion current	Total demand distortion current
	Crest factor voltage	Crest factor current
	K-factor	Negative sequence voltage unbalance
	Zero sequence voltage unbalance	Negative sequence current unbalance
	Zero sequence current unbalance	Short-term flicker
Power	Active Power	Reactive power
	Apparent Power	
Frequency	Frequency	
Energy	Active energy	Reactive energy
	Apparent energy	
Flicker PLT	Long term flicker	

5.4.2.- EVENTS

The **Events** screen (**Figure 47**) displays the quality events listed in **Table 21** that have been detected by the device on a specific date.

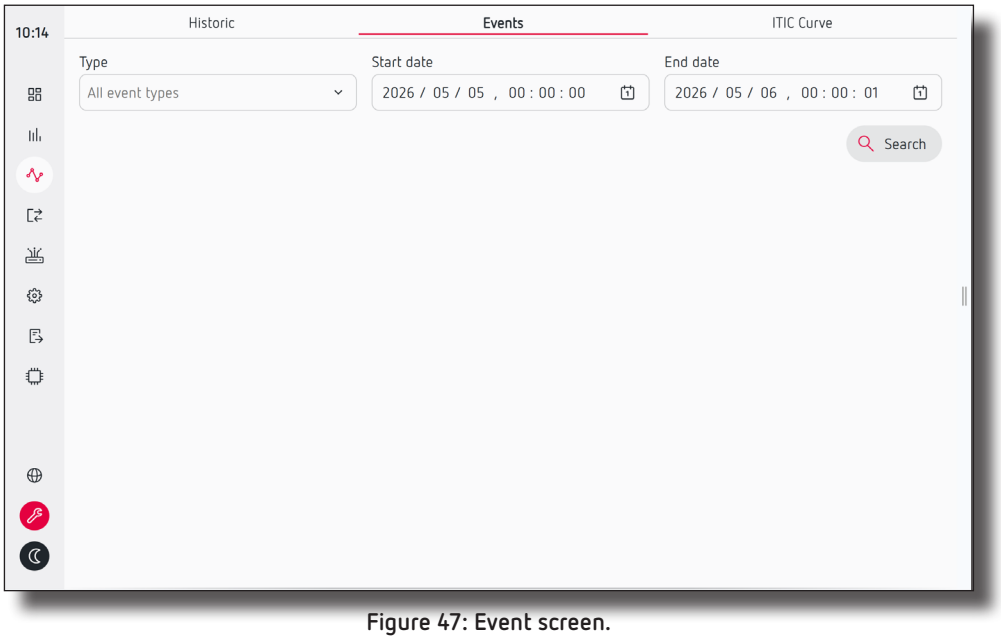


Figure 47: Event screen.

Table 21: Events.

Events		
Events	All types of events	Dip
	Swell	Interruption
	Voltage Transients	Current slow transients
	Current fast transients	Mains signalling voltage
	Rapid voltage changes	

Press **Search** to start event search.

5.4.3.- ITIC CURVE

On the **ITIC Curve** screen, **Figure 48,** the **ITIC** (*Information Technology Industry Council*) voltage curve is displayed.

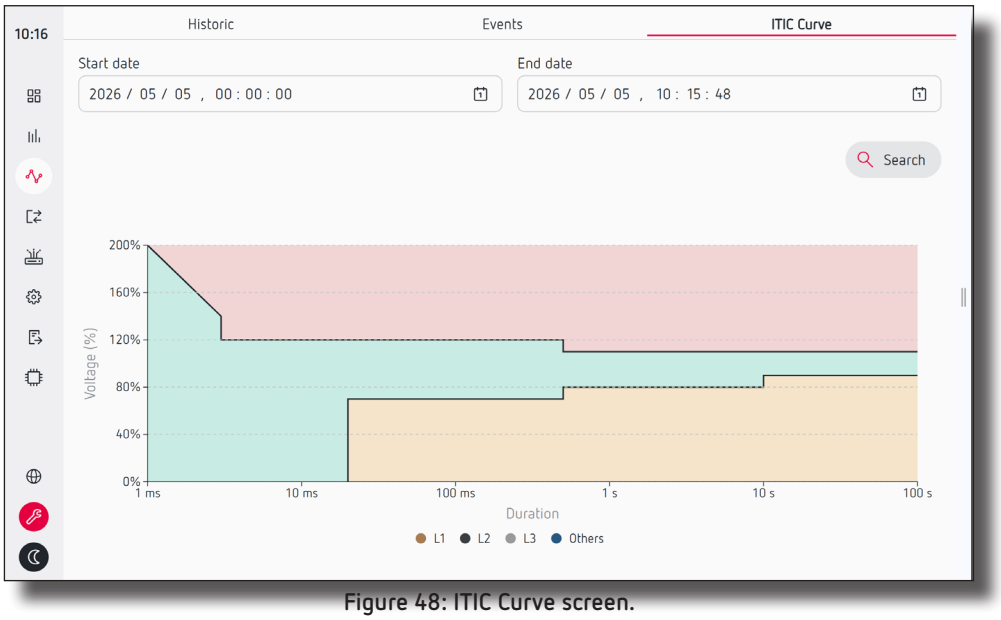


Figure 48: ITIC Curve screen.

The **ITIC** curve is a graph that defines the tolerance limits of the installation to voltage variations in the electrical network.
The graph shows which combinations of voltage and disturbance duration can:

- Not cause problems to the installation (safe operation zone, green colour).
- Cause temporary failures or incorrect operation (intermediate zone, orange colour).
- Damage the installation (damage zone, red colour).

5.5.- I/O

Note: *Visible menu in the models **CVM-A1611-ITF** and **CVM-A1612-ITF**.*

5.5.1.- DIGITAL INPUTS

On the **Digital inputs** screen, **Figure 49,** the device digital inputs can be viewed and configured.
The **CVM-A1611-ITF** model has 6 digital inputs and the **CVM-A1612-ITF** model has 12 digital inputs.

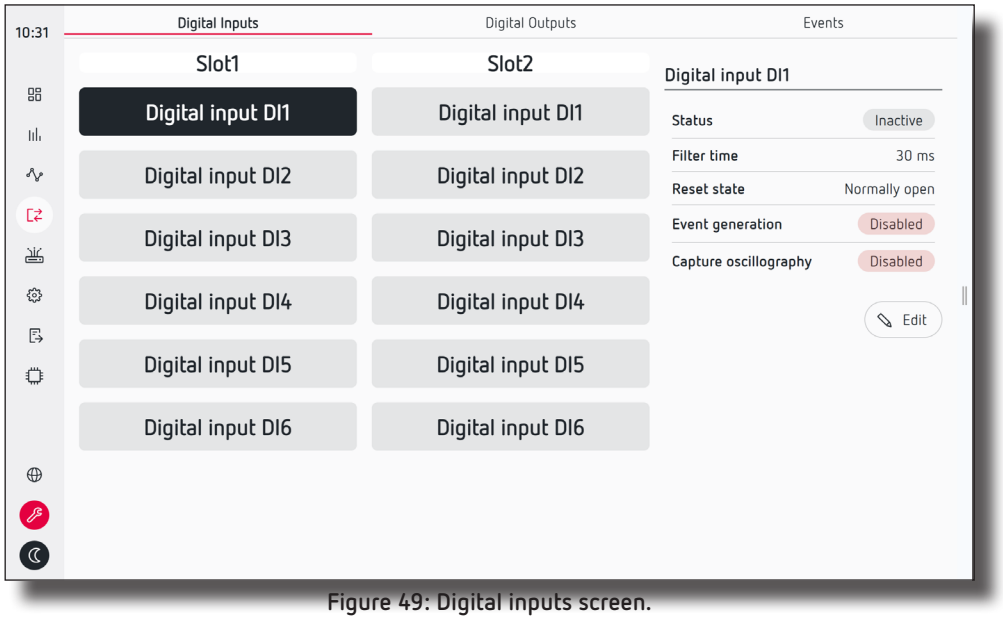


Figure 49: Digital inputs screen.

By pressing the inputs, the status of each input is displayed.
A green colour indicates that the input is **active**, while a grey colour indicates that the input is **inactive**.

Press ✎ to access the Digital Input configuration screen (**Figure 50).**

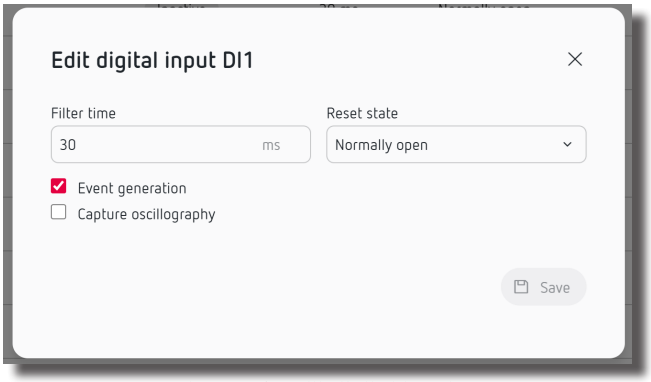


Figure 50: Edit digital input.

✓**Filter time**: Select the filtering time, that is, the delay used to determine the activation of the digital input,**Table 22**.

Table 22: Configuration Values: Filter time.

Filter time	
Minimum value	10 ms
Maximum value	10000 ms

✓**Reset state**: Select the state of the digital input when it is deactivated, **Table 23**.

Table 23: Configuration Values: Reset state.

Reset state	
Possible Values	Normally closed
	Normally open

☑ **Event generation**, select whether or not to save the events generated by the digital input. If enabled, the events are displayed in ***"5.5.3.- EVENTS"*** and ***"8.4.3.- EVENTS"***.

☑ **Capture oscillography**, select whether or not to display the events generated by the digital input. If enabled, the events are displayed in ***"5.5.3.- EVENTS"*** and ***"8.4.3.- EVENTS"***.

5.5.2.- DIGITAL OUTPUTS

On the **Digital Outputs** screen (**Figure 51**) the device Digital outputs and Relay outputs can be viewed and configured.

The model **CVM-A1611-ITF** features 6 digital outputs and 2 relay outputs.
The model **CVM-A1612-ITF** features 12 digital outputs and 4 relay outputs.

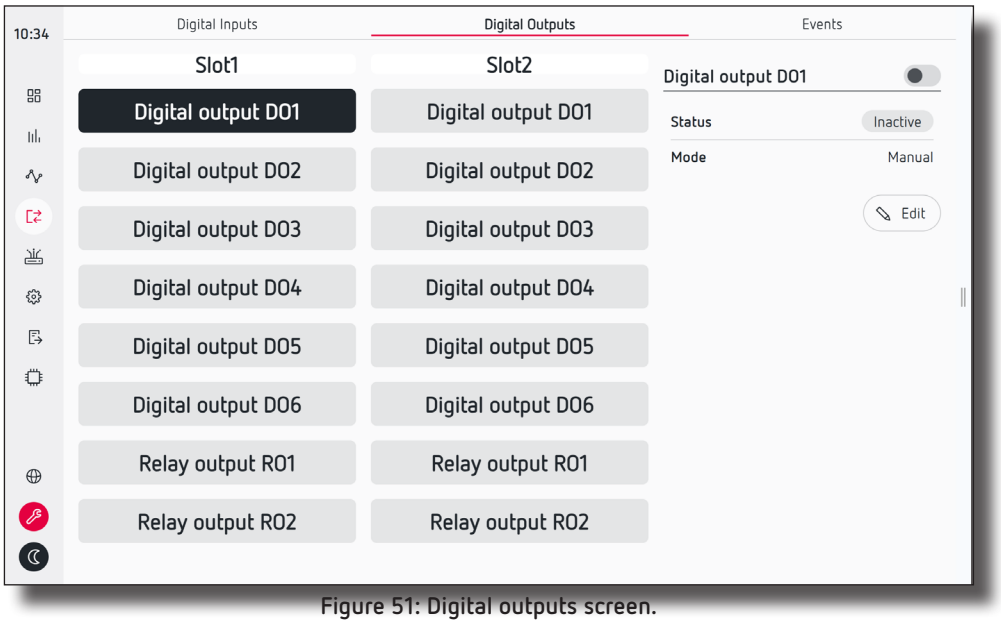


Figure 51: Digital outputs screen.

Pressing on the outputs displays the status of each one.
A red colour indicates that the output is **active**, while a grey colour indicates that the output is **inactive**.

Press ✎ to access the Digital Output programming screen (**Figure 52**).

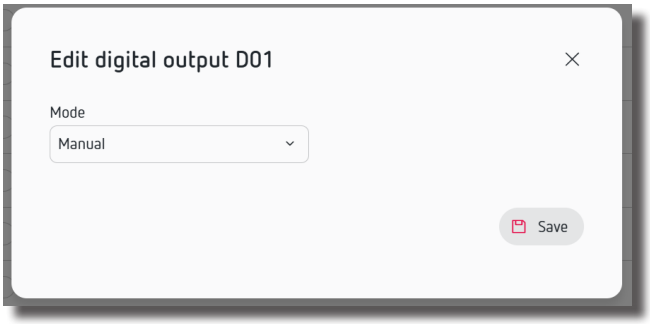


Figure 52: Edit digital output: Manual mode.

✓**Mode**: Select the operating mode of the digital output, **Table 24**.

Table 24: Configuration values: Mode.

Mode	
Possible Values	**Manual**: The digital output is manually activated from the web page or from the device screen.
	Variable: The digital output is activated based on an electrical variable.
	Input: The digital output is activated based on the status of a digital input.
	Measure flagged: The digital output is activated while a quality event (overvoltage, dip or interruption) is being detected.
	Energy: The digital output is activated based on an energy variable.

Depending on the operating mode, the configuration parameters change.

5.5.2.1.- Mode: Manual

When manual mode is selected, the user can activate the Digital Output or Relay Output by enabling the button .

5.5.2.2.- Mode: Variable

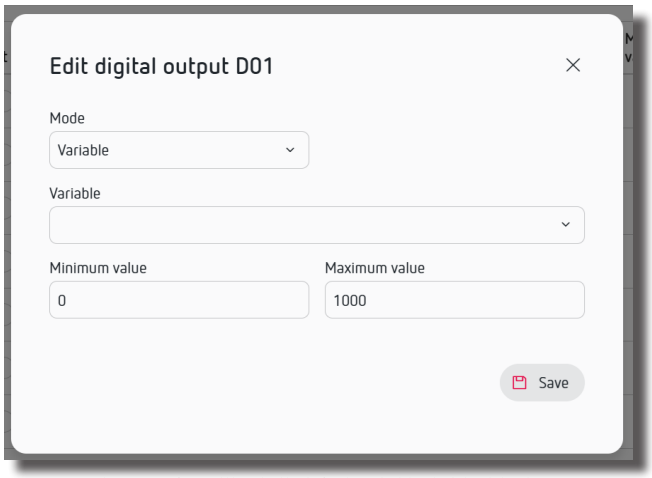


Figure 53: Edit Digital Output: Variable Mode.

✓**Variable**: Select the variable that will activate the digital output. **Table 10**, **Table 11**, **Table 12**, **Table 13** and **Table 14** provide a description of the variables corresponding to the abbreviations shown in this parameter.

✓**Maximum value**: Value below which the alarm is triggered.
✓**Minimum value**: Value above which the alarm is triggered.

Note: *In the event of an inverted limit configuration (**Maximum Value** lower than **Minimum Value**), the activation criterion becomes "out of range", activating when the measured value is lower than the **Maximum Value** or higher than the **Minimum Value**.*

Press **Save** to save the device configuration.

5.2.2.3.- Mode: Input

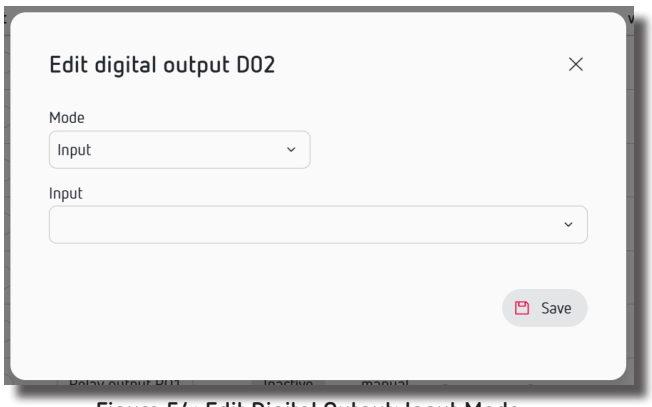


Figure 54: Edit Digital Output: Input Mode.

✓**Input**: Select the input that will activate the Digital Output.

Press **Save** to save the device configuration.

5.5.2.4.- Mode: Measure flagged

When this mode is enabled (**Figure 55)** the digital output is activated while a quality event (overvoltage, dip or interruption) is being detected.

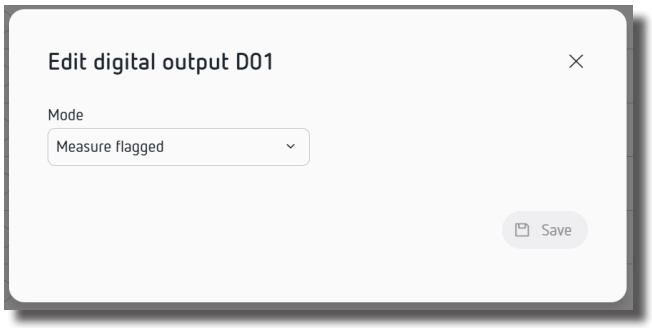


Figure 55: Edit Digital Output: Measure flagged Mode.

Press **Save** to save the device configuration.

5.5.2.5.- Mode: Energy

When this mode is enabled (**Figure 56**), the digital output is activated based on an energy variable.

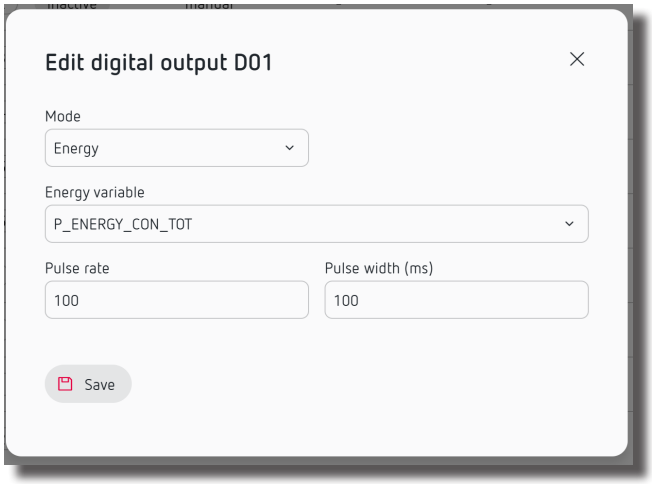


Figure 56: Edit Digital Output: Energy Mode.

✓**Energy variable**: Select the variable that will activate the digital output. **Table 15** provides a description of the variables corresponding to the abbreviations shown in this parameter.

✓**Pulse rate**: Energy equivalent to each pulse of the digital output, expressed in W·h/pulse, var·h/pulse or VA·h/pulse.
✓**Pulse width**: Pulse width in ms.

Note: *The energy used to generate the pulses is the energy accumulated every 3 seconds.*

Press **Save** to save the device configuration.

5.5.3.- EVENTS

On the **Events** screen (**Figure 57**) the events generated by the digital inputs of the **CVM-A1600** are displayed.

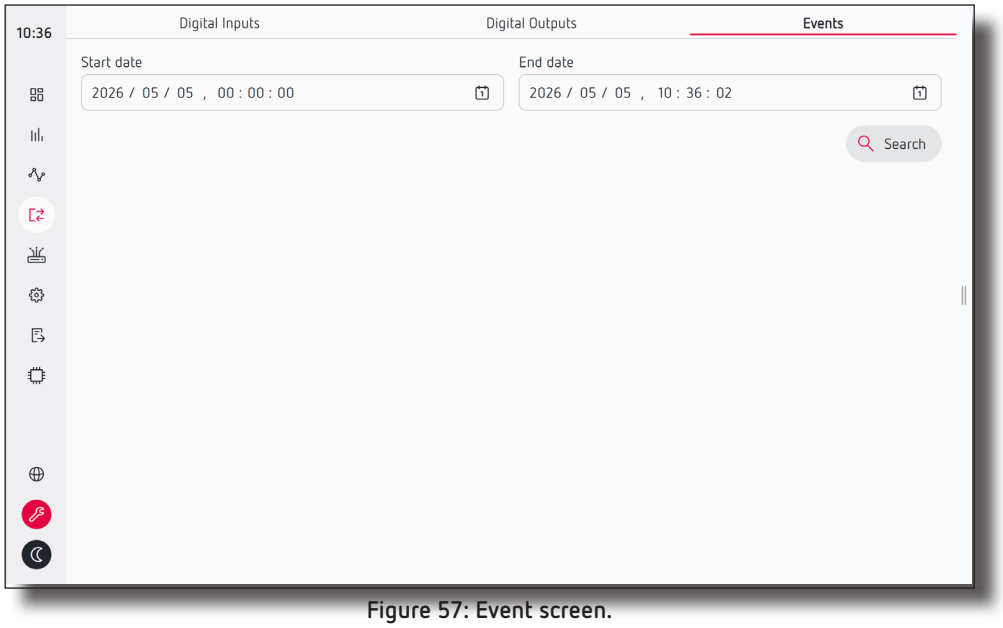


Figure 57: Event screen.

✓**Start date:** Start date of the events.
✓**End date:** End date of the event display.
Press **Search** to start the event search.

5.6.- COMMUNICATIONS

5.6.1.- ETHERNET

On the **Ethernet** screen (**Figure 58**) the Ethernet communications of **Ports 1** and **2** can be viewed and configured.

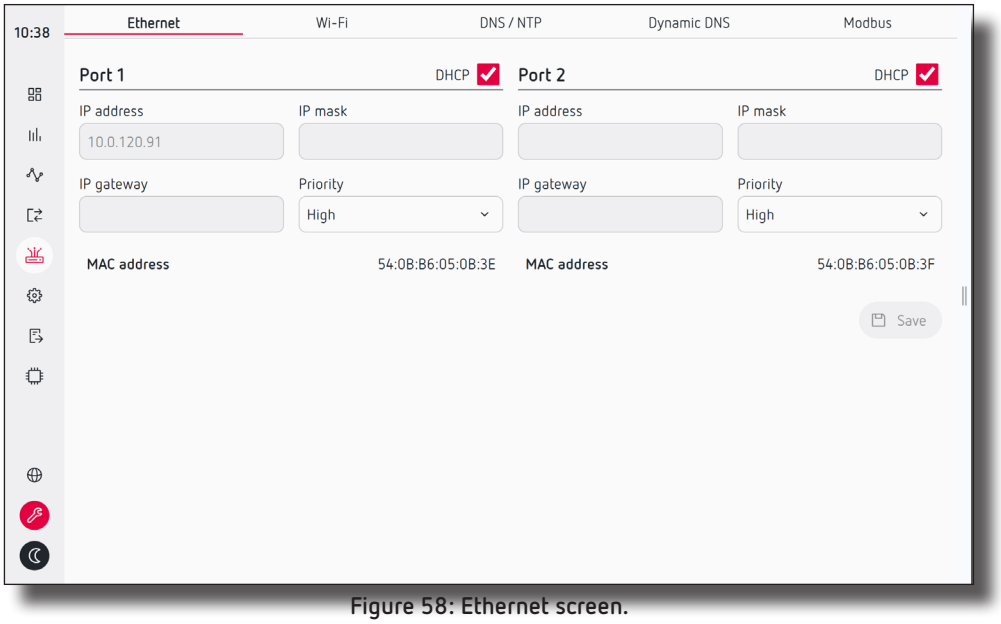


Figure 58: Ethernet screen.

DHCP ☑ : If DHCP is enabled, the IP address is dynamically assigned by a central server and no additional parameters need to be configured.
If this option is disabled, ☐, the IP address is fixed and the following parameters need to be configured:

✓**IP address**: IP address.

✓**IP mask**: IP subnet mask.

✓**IP gateway**: gateway.

✓**Priority**: selects the priority of the Ethernet communications when accessing the Internet. If the priority of all interfaces (Ethernet and Wi-Fi) is the same, the **CVM-A1600** connects to the Internet using the first interface with an active connection.

✓**MAC Address**: device MAC address, non-configurable parameter.

Press **Save** to save the device configuration.

5.6.2.- Wi-Fi

On the **Wi-Fi** screen (**Figure 59**), the Wi-Fi communications can be viewed and configured.

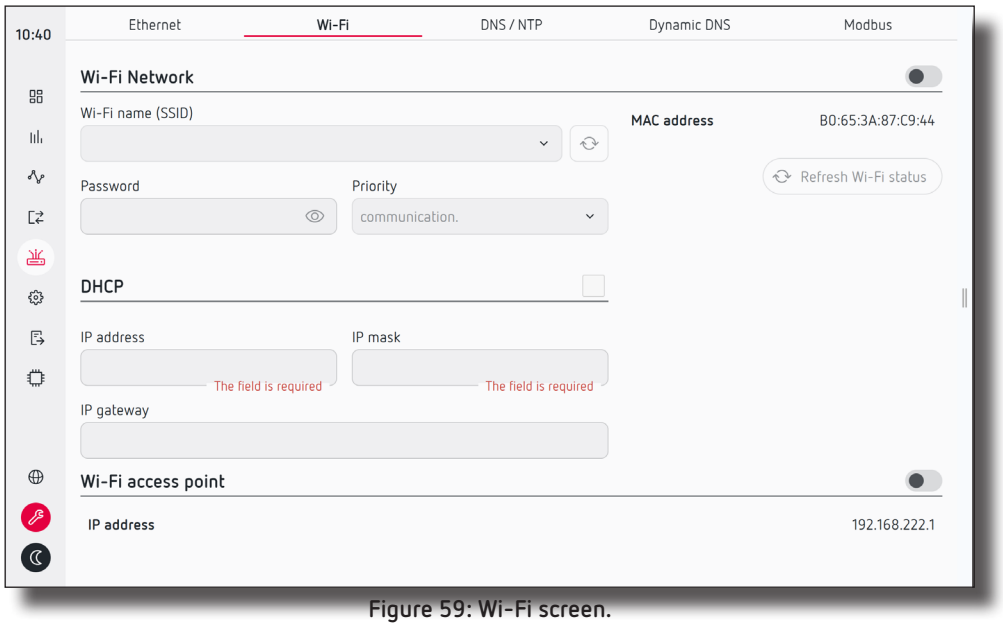


Figure 59: Wi-Fi screen.

Wi-Fi Network Enables or disables Wi-Fi communications. If enabled, the following parameters must be configured:

✓**Wi-Fi name (SSID):** Wi-Fi network name. Press ⟳ to refresh the list of Wi-Fi networks.

✓**Password:** Network access password.

✓**Priority:** the priority of the Wi-Fi communications is selected for internet access. If the priority of all interfaces (Ethernet and Wi-Fi) is the same, the **CVM-A1600** connects to the Internet using the first interface with an active connection.

DHCP ☑ : If DHCP is enabled, the IP address is dynamically assigned by a central server and no additional Parameters need to be configured.
If this option is disabled, ☐, the IP address is fixed and the following parameters need to be configured:

✓**IP address**: IP address.

✓**IP mask**: IP mask.

✓**IP Gateway**: gateway.

Press 🖫 **Save** to save the device configuration.

✓**Connection status**: Wi-Fi connection status.

✓**MAC Address**: MAC address of the device, non-configurable parameter.

Press ⟳ **Refresh Wi-Fi status**, to refresh the list of Wi-Fi networks.

Wi-Fi access point : Enable or disable the device as a Wi-Fi access point.

The access point name is **CIR-XXXX**, where **X** represents the last four digits of the device serial number.
Password: the last eight digits of the device serial number.

✓**IP Address:** device IP address, non-configurable parameter. (**192.168.222.1**)

5.6.3.- DNS/NTP

On the **DNS/NTP** screen (**Figure 60**) the **DNS** (*Domain Name System*) and **NTP** (*Network Time Protocol*) addresses can be viewed and configured.

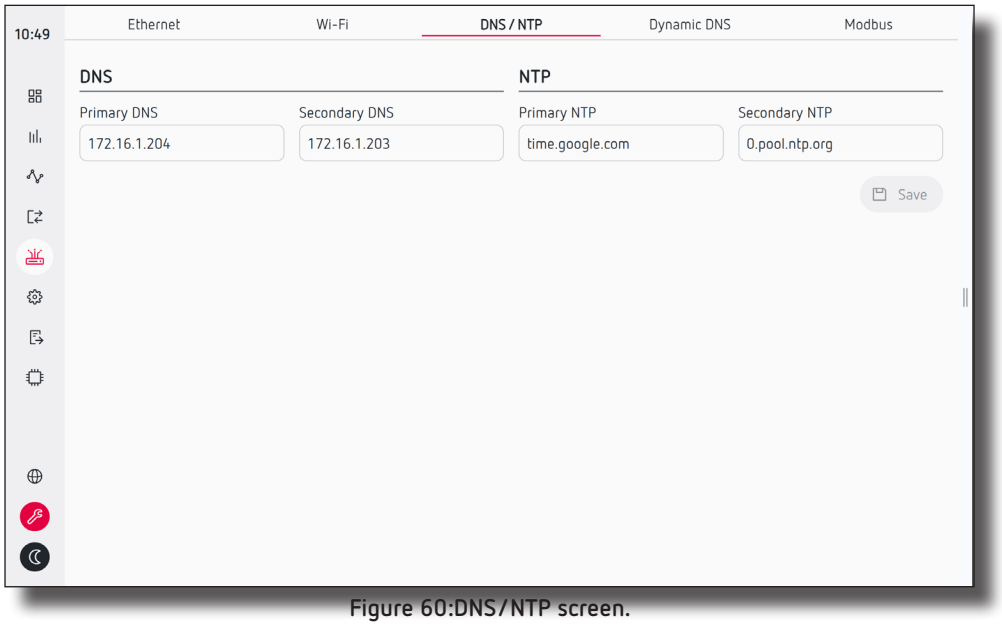


Figure 60:DNS/NTP screen.

DNS

✓**Primary DNS**: address of the primary DNS server.
✓**Secondary DNS**: address of the secondary DNS server.

NTP

✓**Primary NTP**: address of the clock synchronisation server (*Network Time Provider*).
✓**Secondary NTP**: secondary *Network Time Provider* address, in case the primary NTP fails.

Press **Save** to save the device configuration.

5.6.4.- DYNAMIC DNS

On the **Dynamic DNS** screen (**Figure 61**) the dynamic DNS server can be viewed and configured.

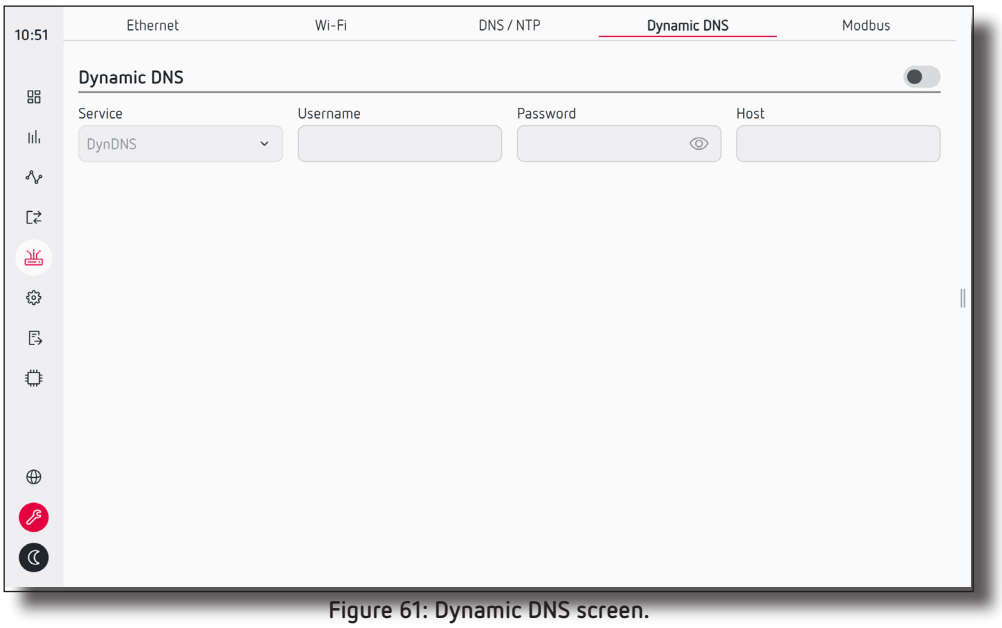


Figure 61: Dynamic DNS screen.

Dynamic DNS : Enables or disables Dynamic DNS. If enabled, it is necessary to configure the following parameters:

✓**Service:** Select the type of service, **Table 25.**

Table 25: Configuration values: Service.

Service	
Possible Values	**DynDNS**: Dynamic DNS service that automatically updates the IP address associated with a domain to allow stable remote access to devices and services.
	DNS-O-Matic: Intermediary service that distributes the same IP update to multiple dynamic DNS providers simultaneously.
	No-IP: Dynamic DNS platform that provides real-time updatable subdomains, facilitating remote access when the public IP address changes.

✓**Username:** DNS server username.
✓**Password:** DNS server access password.
✓**Host:** Server host name.

Press **Save** to save the device configuration.

5.6.5.- MODBUS

On the **Modbus** screen (**Figure 62**), the RS-485 communications with the **MODBUS RTU®** protocol can be viewed and configured.

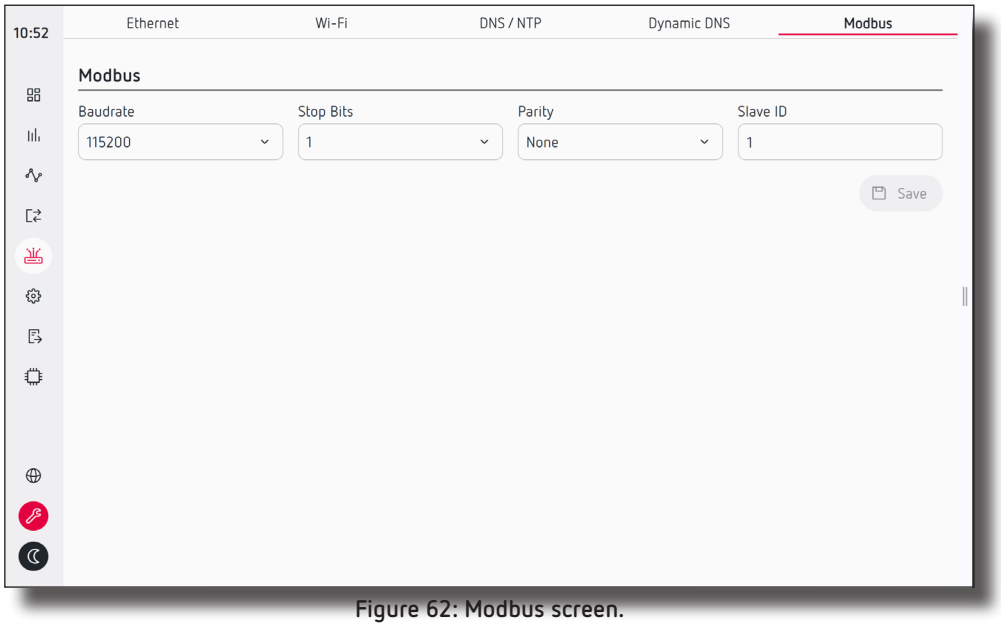


Figure 62: Modbus screen.

✓**Baudrate:** Select the Modbus communication baud rate, **Table 26**.

Table 26:Configuration values: Baudrate.

Baudrate		
Possible Values	4800 bps	9600 bps
	19200 bps	38400 bps
	57600 bps	115200 bps

✓**Stop Bits:** Number of stop bits, **Table 27**.

Table 27:Configuration values: Stop Bits.

Stop Bits	
Possible Values	1
	2

✓**Parity:** Communications parity, **Table 28.**

Table 28:Configuration values: Parity.

Parity	
Possible Values	None
	Even
	Odd

✓**Slave ID:** Device identification number.

Press **Save** to save the device configuration.

5.7.- CONFIGURATION

5.7.1.- BIOS

On the **BIOS** screen (**Figure 63**), the identification colours of each line are configured according to the regulations of the country where the device is installed.



Figure 63: BIOS screen.

Press **Save** to save the device configuration.

5.7.2.- INSTALLATION

On the **Installation** screen (**Figure 64**) the installation parameters of the **CVM-A1600** can be configured.



Figure 64: Installation screen.

Connection

✓**Installation type:** configuration of the installation type, **Table 29**.

Table 29: Configuration values: Installation type.

Installation type	
Possible Values	**1PH2W**: Single-phase phase-to-neutral network with 2-wire connection.
	2PH3W: Two-phase network with 3-wire connection.
	3PH4W: Three-phase network with 4-wire connection.
	3PH3W: Three-phase network with 3-wire connection.
	ARON: Three-phase network with 3-wire connection and transformers connected in Aron configuration.

Note: *When the installation type is changed, the database is automatically deleted.*

Voltage transformer ratio

✓**Primary:** primary voltage, **Table 30**.

Table 30:Configuration values: Primary voltage.

Primary voltage	
Minimum value	1.00 V
Maximum value	500000.00 V

✓**Secondary:** secondary voltage, **Table 31**.

Table 31:Configuration values: Secondary Voltage.

Secondary voltage	
Minimum value	1.00 V
Maximum value	1000.00 V

Current transformer ratio

✓**Primary:** primary current, **Table 32**.

Table 32:Configuration values: Primary current

Primary current	
Minimum value	1 A
Maximum value	20000.00 A

✓**Secondary:** secondary current, **Table 33**.

Table 33:Configuration values: Secondary current.

Secondary current	
Minimum value	0.2 A
Maximum value	5.000 A

Neutral current transformer ratio

✓**Primary:** primary neutral current, **Table 34**.

Table 34: Configuration values: Primary Neutral Current.

Primary Neutral Current	
Minimum value	1 A
Maximum value	20000.00 A

✓**Secondary:** secondary neutral current, **Table 35**.

Table 35: Configuration values: Secondary Neutral Current.

Secondary Neutral Current	
Minimum value	0.2 A
Maximum value	5.000 A

Primary nominal values

✓**Voltage (L-N):** Nominal voltage being measured by the **CVM-A1600**. The value to be programmed must be phase-to-phase or phase-to-neutral, depending on the installation type, but must always be referred to the primary side. This value is essential for the proper functioning of event recording, **Table 36**.

Example: *If a 22000/110 voltage transformer is connected, the programming must be:*
Primary voltage = 22000
Secondary voltage = 110
Voltage (Nominal voltage) = 22000

Table 36:Configuration values: Voltage (L-N).

Voltage (L-N)	
Minimum value	20.00 V
Maximum value	500000.00 V

✓**Current:** Nominal current measured by the device, which will be used to set the maximum and minimum percentages to record disturbances. By default, this value is **5 A**. It is recommended to program the same value as in the measuring transformers, **Table 37**.

Table 37:Configuration values: Current.

Current	
Minimum value	0.050 A
Maximum value	20000.000 A

✓**Frequency:** Nominal frequency of the network being analyzed. This parameter is necessary to calculate the RMS value of the signal in extreme quality networks, **Table 38**

Table 38:Configuration values: Frequency.

Frequency	
Possible Values	50 Hz
	60 Hz

Current direction

✓**L1:** Select the current direction of L1,**Table 39**.
✓**L2:** Select the current direction of L2,**Table 39**.
✓**L3:** Select the current direction of L3,**Table 39**.

Table 39:Configuration values: Current direction.

Current direction L1, L2, L3	
Possible Values	Normal
	Reversed

Phase sequence

✓**Voltage:** Select the voltage phase sequence,**Table 40**.

Table 40:Configuration values: Phase sequence (Voltage).

Phase sequence, Voltage		
Possible Values	U1 U2 U3	U2 U3 U1
	U1 U3 U2	U3 U2 U1
	U2 U1 U3	U3 U1 U2

✓**Current:** Select the current phase sequence, **Table 41**.

Table 41: Configuration values: Phase sequence (Current).

Phase sequence, Current		
Possible Values	I1 I2 I3	I2 I3 I1
	I1 I3 I2	I3 I2 I1
	I2 I1 I3	I3 I1 I2

Max/Min origin

✓**Origin:** Allows selection of the source of the maximum and minimum values corresponding to the user-defined period, **Table 42**.

Table 42: Configuration values: Max/Min origin.

Max/Min origin	
Possible Values	**200 ms,** The maximum and minimum values are calculated from RMS values aggregated over 200 ms intervals.
	1/2 cycle, The maximum and minimum values are calculated from ½-cycle RMS values, providing higher temporal resolution for peak detection.

Full load current (I_L)

✓**L1:** Maximum load current in L1, used for the calculation of TDD (Total Demand Distortion),**Table 43**.
✓**L2:**Maximum load current in L2, used for the calculation of TDD (Total Demand Distortion),**Table 43**.
✓**L3:**Maximum load current in L3, used for the calculation of TDD (Total Demand Distortion),**Table 43**.
✓**LN:**Maximum load current in LN, used for the calculation of TDD (Total Demand Distortion), **Table 43**.

Table 43:Configuration values: Full load current.

Full load current				
	L1	L2	L3	LN
Minimum value	0.050 A			
Maximum value	20000.000 A			

Short circuit current (I_{cc})

✓**Icc:** Short circuit current, **Table 44**.

Table 44:Configuration values: Short circuit current.

Short circuit current	
Minimum value	0.05 A
Maximum value	2000000000 A

Press **Save** to save the device configuration.

5.7.3.- QUALITY

On the **Quality** screen (**Figure 65**) the quality parameters of the device can be configured.

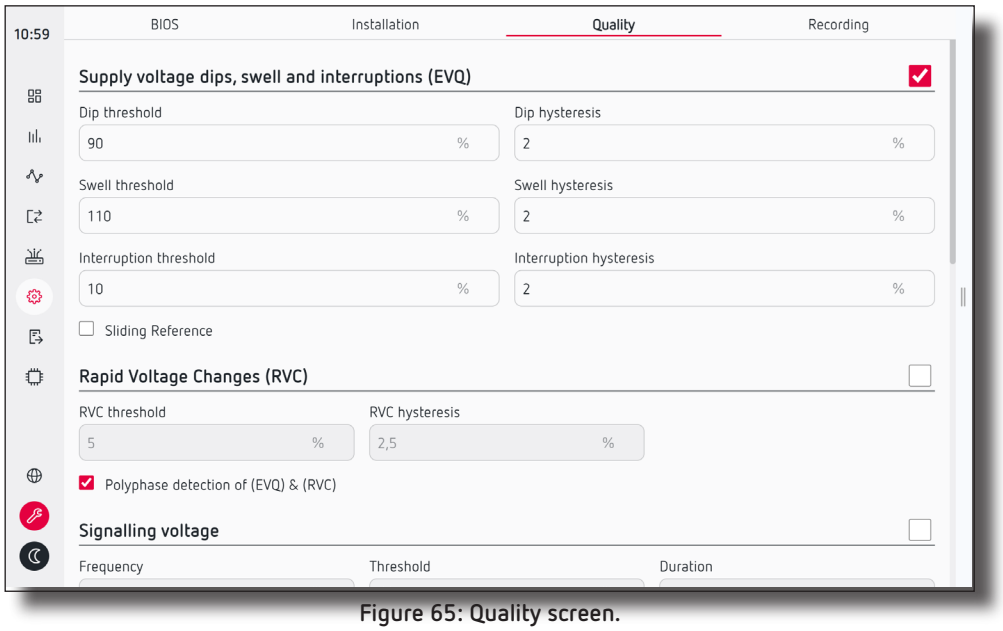


Figure 65: Quality screen.

Supply voltage dips, swell and interruptions (EVQ)

☑ Enable or disable the Supply voltage dips, swell and Interruptions parameters.

✓**Dip threshold**: A voltage dip is considered to occur when the RMS voltage value falls below the threshold programmed in this parameter. The value is configured as a % relative to the nominal voltage value, **Table 45**.

Table 45: Configuration Values: Dip threshold.

Dip threshold	
Minimum value	50.00 %
Maximum value	97.00 %

✓**Dip hysteresis**: dip hysteresis value, so that the triggering and resetting values of the event are not the same. The value is configured as a % of the **Dip threshold** value, **Table 46**.

Table 46: Configuration Values: Dip hysteresis.

Dip hysteresis	
Minimum value	0.00 %
Maximum value	100.00 %

✓**Swell threshold**: An overvoltage is considered to occur when the RMS voltage value exceeds the threshold programmed in this parameter. The value is configured as a % relative of the nominal voltage value, **Table 47**.

Table 47: Configuration Values: Swell threshold.

Swell threshold	
Minimum value	100.00 %
Maximum value	150.00 %

✓**Swell hysteresis**: overvoltage hysteresis value, to ensure the trip value and reset value of the event are not the same. The value is configured as a % of the **Swell Threshold** value**, Table 48**.

Table 48:Configuration values: Swell hysteresis.

Swell hysteresis	
Minimum value	0.00 %
Maximum value	100.00 %

✓**Interruption threshold**: an interruption is considered to occur when the RMS voltage value falls below the threshold programmed in this parameter. The value is configured as a % relative to the nominal voltage value, **Table 49**.

Table 49:Configuration values: Interruption threshold.

Interruption threshold	
Minimum value	1.00 %
Maximum value	20.00 %

✓**Interruption hysteresis**: interruption hysteresis value, to ensure the trip value and reset value of the event are not the same. The value is configured as a % of the **Interruption threshold** value**, Table 50**.

Table 50:Configuration values: Interruption hysteresis.

Interruption hysteresis	
Minimum value	0.00 %
Maximum value	100.00 %

☑ **Sliding reference**: enables or disables the Sliding Reference.
The Sliding Reference is the 1-minute average voltage value preceding a voltage dip or overvoltage. If the Sliding Reference voltage is enabled, the voltage levels for dip or overvoltage detection will be calculated based on the threshold percentages referenced to this voltage.

Rapid Voltage Changes (RVC)

☑ Enable or disable the RVC parameters.

✓**RVC threshold**: a rapid voltage change (RVC) is considered to occur when the RMS voltage value falls below the threshold programmed in this parameter. The value is configured as a % relative to the arithmetic mean of the prior 100 Urms ½ values, **Table 51**.

Table 51: Configuration values: RVC threshold.

RVC threshold	
Minimum value	0.00 %
Maximum value	100.00 %

✓**RVC hysteresis**: hysteresis value for RVC, ensuring the trigger and reset values of the event are not the same. The value is configured as a % of the **RVC Threshold** value, **Table 52**.

Table 52: Configuration values: RVC hysteresis.

RVC hysteresis	
Minimum value	0.00 %
Maximum value	100.00 %

Note: *To achieve a stable measurement voltage close to the Nominal Voltage, the configuration values must be higher than those programmed for dip detection. Otherwise, when the device detects a sag, it will no longer consider RVC detection.*

☑ **Polyphase detection of (EVQ) and (RVC)**: enables or disables Polyphase detection. Polyphase refers to the detection of sags, overvoltages, interruptions, and RVC across multiple phases. This means an event in any of the 3 phases, or more than one simultaneously, will result in a polyphase event according to the characteristics specified for each event in **IEC 61000-4-30**.

Signalling voltage

☑ Enable or disable signalling voltage detection.

Voltage signalling signals that may travel through the supply network are typically burst signals applied at non-harmonic frequencies to remotely control industrial devices or other devices.
The method used by the **CVM-A1600** to detect signalling voltage measures the level of a voltage signal at a specified carrier frequency.

✓**Frequency:** Frequency to be monitored,**Table 53**.

Table 53:Configuration values: Frequency.

Frequency	
Minimum value	0.00 Hz
Maximum value	3 kHz

✓**Threshold**: Detection threshold as a % of the Nominal Voltage, **Table 54**.

Table 54:Configuration values: Threshold.

Threshold	
Minimum value	0.3 %
Maximum value	100 %

✓**Duration**: Time period during which the specified values are recorded, **Table 55**.

Table 55:Configuration values: Duration.

Duration	
Minimum value	1 s
Maximum value	120 s

Voltage Transients

☑ Enable or disable voltage transient detection. For more information see "*4.2.1.- QUALITY PARAMETERS*".

✓**Sensitivity**: This parameter allows adjustment of the transient detection level to avoid false positives. The value is entered in %, **Table 56**.

Table 56:Configuration values: Sensitivity.

Sensitivity	
Minimum value	0%
Maximum value	100%

✓**Samples**: Number of samples used for voltage transient detection, **Table 57**.

Table 57:Configuration values: Samples.

Samples	
Minimum value	1
Maximum value	10

Current Transients

The device detects rapid and slow current transients independently, see "*4.2.1.- QUALITY PARAMETERS*".

☑ Enable or disable current transient detection.

✓**Slow detection sensitivity**: value used to reduce sensitivity to false positives, **Table 58**.

Table 58:Configuration values: Slow detection sensitivity.

Slow detection sensitivity	
Minimum value	1
Maximum value	4

✓**Slow detection cycles to trigger rearm:** Number of cycles until the end of the transient that are inhibited for detecting new current transients, **Table 59**.

Table 59:Configuration values: Slow detection cycles to trigger rearm.

Slow detection cycles to trigger rearm	
Minimum value	1
Maximum value	10

✓**Slow detection threshold:** Threshold value for detecting slow transients in %. The value is configured as a % of the nominal voltage value, **Table 60**.

Table 60:Configuration values: Slow detection threshold.

Slow detection threshold	
Minimum value	1.00 %
Maximum value	100 %

✓**Fast detection sensitivity**: value used to reduce sensitivity to false positives, **Table 61**.

Table 61:Configuration values: Fast detection sensitivity.

Fast detection sensitivity	
Minimum value	1
Maximum value	4

✓**Fast detection cycles to trigger rearm:** Number of cycles until the end of the transient that are inhibited for detecting new current transients, **Table 62**.

Table 62:Configuration values: Fast detection cycles to trigger rearm.

Fast detection cycles to trigger rearm	
Minimum value	1
Maximum value	10

✓**Fast detection threshold:** Threshold value for the detection of fast transients in %. The value is configured as a % of the nominal voltage value, **Table 63**.

Table 63:Configuration values: Fast detection threshold.

Fast detection threshold	
Minimum value	1.00 %
Maximum value	100 %

Waveform

✓**Oscillography type:** The waveform to be recorded by the device is selected, **Table 64**.

Table 64:Configuration values: Oscillography type.

Oscillography type	
Possible Values	**Disabled**, the device does not record waveforms.
	Waveform, the device records the waveform of the input signal.
	RMS, the device records 1-cycle RMS values updated every ½ cycle.

✓**Pre-trigger time:** recording time prior to the trigger condition, **Table 65**.

Table 65:Configuration values: Pre-trigger time.

Pre-trigger time	
Minimum value	20 ms
Maximum value	1000 ms

✓**Post-trigger time:** recording time after the trigger condition,**Table 66**.

Table 66:Configuration values: Post-trigger time.

Post-trigger time	
Minimum value	100 ms
Maximum value	4000 ms

✓**Maximum duration:** Maximum waveform recording time (Pre-trigger Time + Post-trigger Time), **Table 67**.

Table 67:Configuration values: Maximum duration.

Maximum duration	
Minimum value	1000 ms
Maximum value	60000 ms

THD/TDD Harmonics

✓**Harmonics for THD/TDD calculation:** Number of harmonics used to calculate THD and TDD, **Table 68**.

Table 68: Configuration values: Harmonics THD/TDD.

Harmonics THD/TDD	
Minimum value	2
Maximum value	64

Press **Save** to save the device configuration.

5.7.4.- RECORDING

On the **Recording** screen (**Figure 66**) the parameters to be recorded in the database are selected. Application Note **M294E0101-01-xxx** details the APIs (*Application Programming Interfaces*) available for accessing the database.
The API can also be downloaded from the following link:

https://docs.circutor.com/docs/QNA_REST_API.yaml

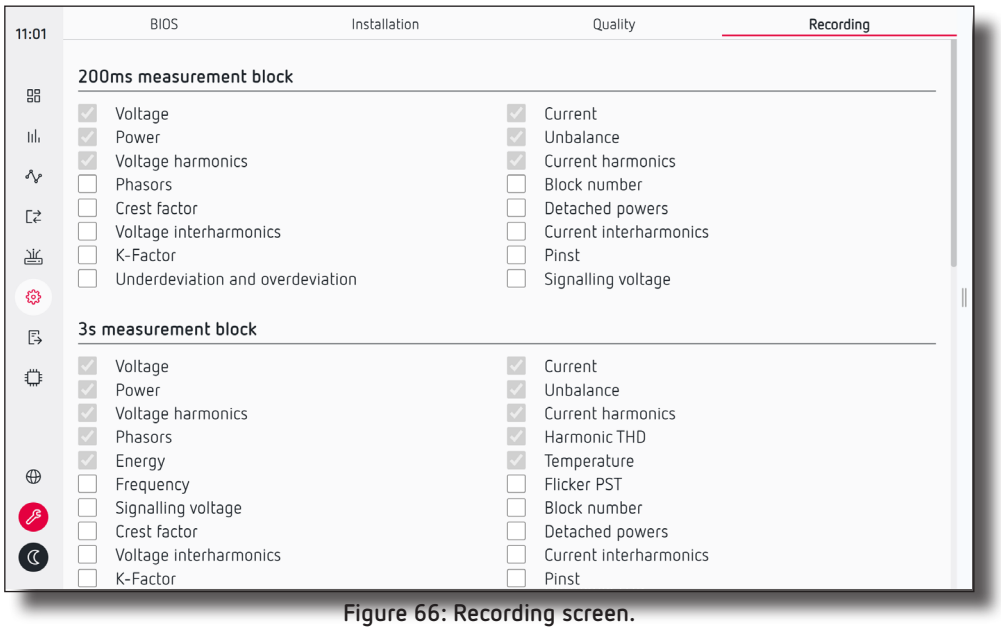


Figure 66: Recording screen.

The parameters can be recorded in different measurement blocks:

✓**200 ms measurement block**.
✓**3 s measurement block**.
✓**User measurement block**.

In this block, the user selects the recording period using the **User Recording Interval** parameter, **Table 69**.

Table 69: Configuration values: User recording interval.

User recording interval				
Possible Values	1 min	2 min	3 min	4 min
	5 min	6 min	10 min	12 min
	15 min	20 min	30 min	60 min

✓**Minimums measurement block**.
✓**Maximums measurement block**.

For each measurement block, depending on the selected global parameter, the device records certain parameters, see **Table 70**.

Table 70: Parameters Recorded According to the Global Parameter.

☑ Global parameter	Parameters	
☑ Voltage(2)	Phase-Neutral Voltage	Phase-Phase Voltage
	Earth - Neutral Voltage	-
☑ Current(2)	Current	-
☑ Power (2)	Active Power (P)	Fundamental Active Power (P_1)
	Reactive Power (Q)	Non-active Power (N)
	Apparent Power (S)	Fundamental Apparent Power (S_1)
	Power Factor (PF)	Fundamental Power Factor (DPF)
☑ Unbalance(2)	Positive sequence voltage component	Negative sequence voltage component
	Zero sequence voltage component	Voltage Unbalance
	Voltage asymmetry	Positive sequence current component
	Negative sequence component current	Zero sequence current component
	Current Unbalance	Current asymmetry
☑ Phasors(2)	Voltage Phasors	Current Phasors
☑ Crest factor	Voltage crest factor	Current crest factor
☑ K-Factor	K-Factor	
☑ Underdeviation and overdeviation	Percentage of undervariation	Percentage of overvariation
	Undervariation voltage	Overvariation voltage
☑ Signalling voltage	Mains Signalling Voltage	Mains Signalling Counter Above Threshold
	Mains Signalling Counter Below Threshold	
☑ Pinst	Instantaneous flicker	
☑ Detached powers	Harmonic Active Power	Current distortion power
	Voltage distortion power	Harmonic Distortion Reactive Power
	Effective Distortion Reactive Power	Effective Fundamental Apparent Power
	Unbalance Apparent Power	Non-Fundamental Apparent Power
	Effective Non-Fundamental Apparent Power	Harmonic Apparent Power
	Inductive Non-active Power	Inductive Reactive Power
	Capacitive Non-active Power	Capacitive Reactive Power
	Consumed Active Power	Active Power
	Consumed Fundamental Active Power	Generated Fundamental Active Power
	Harmonic of Consumed Active Power	Harmonic of Generated Active Power
	Consumed Reactive Power	Generated Reactive Power
	Consumed Fundamental Reactive Power	Generated Fundamental Reactive Power
	Consumed Inductive Reactive Power	Generated Inductive Reactive Power
	Consumed Fundamental Inductive Reactive Power	Generated Fundamental Inductive Reactive Power
	Consumed Capacitive Reactive Power	Generated Capacitive Reactive Power
	Consumed Fundamental Capacitive Reactive Power	Generated Fundamental Capacitive Reactive Power
	Consumed Inductive Power Factor	Generated Inductive Power Factor
	Consumed Fundamental Inductive Power Factor	Generated Fundamental Inductive Power Factor
	Consumed Capacitive Power Factor	Generated Capacitive Power Factor
	Consumed Fundamental Capacitive Power Factor	Generated Fundamental Capacitive Power Factor

Table 70 (Continuation): Parameters Recorded According to the Global Parameter.

☑ Global parameter	Parameters	
☑ Harmonic THD(2)	Voltage THD	Current THD
	Current TDD	
☑ Voltage harmonics(2)	Voltage Harmonics	
☑ Current harmonics(2)	Current Harmonics	
☑ Voltage Interharmonics	Voltage Interharmonics	
☑ Current Interharmonics	Current Interharmonics	
☑ Frequency(2)	Frequency	
☑ Flicker PST(2)	Short-Term Flicker	
☑ Block number	10/12-Cycle Block Counter	

(2) Parameters that are recorded by default in the database.

Energy meter

The device records the energy parameters shown in **Table 71**.

Table 71:Parameters Recorded in the Energy Meter.

Parameters		
ENERGY METER	Three-phase Active Energy Consumed	Three-phase Active Energy Generated
	Fundamental three-phase reactive energy Q1, Q2, Q3, Q4	Three-phase Apparent energy

✓**Energy recording interval:** Interval in energy logging, **Table 72**.

Table 72:Configuration values: Energy recording interval.

Energy recording interval						
Possible Values	1 min	2 min	3 min	4 min	5 min	6 min
	10 min	12 min	15 min	20 min	30 min	60 min

Press **Save** to save the device configuration.

5.8.- EXPORTS

5.8.1.- NOTIFICATIONS

On the **Notifications** screen (**Figure 67**), the notifications that the device can generate are displayed and configured.

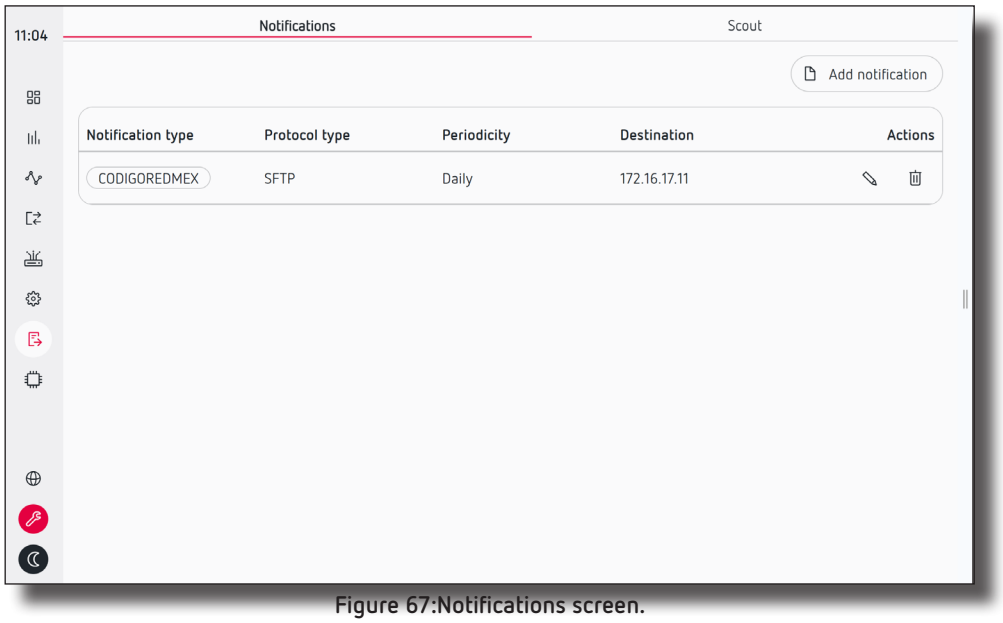


Figure 67:Notifications screen.

Press **Add notification** to add a new notification. The screen shown in **Figure 68** is displayed.

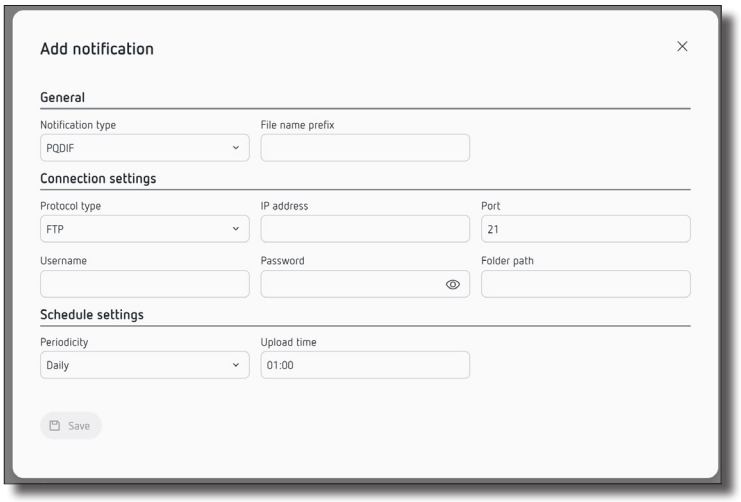


Figure 68: Add notification.

General

✓**Notification type:** Select the type of notification, see **Table 73.**

Table 73: Configuration values: Notification type.

Notification type	
Possible Values	**PQDIF** (*Power Quality Data Interchange Format*) standard file format developed by IEEE (IEEE Std 1159.3) for storing, exchanging, and analyzing power quality data. The output file is a **PQDIF** file.
	EN50160, pdf according to the standard EN50160.
	IEEE 519, PDF in accordance with the IEEE 519 standard.
	Código Red México, pdf according to the Mexican Grid Code.
	Quality Events, quality events generated by the **CVM-A1600**.

✓**File name prefix:** Prefix added to the name of the notification being sent.
Parameter available when selecting the type of notification: **PQDIF**, **EN50160, IEEE 519** and **Código Red México**.

✓**Language**: Select the language of the notification, **Table 74**.
Parameter available when selecting the type of notification: **EN50160 IEEE 519**, **Código Red México** and **Quality Events**.

Table 74: Configuration values: Language.

Language	
Possible Values	**ES**, Spanish
	EN, English

Connection settings

✓**Protocol type:** Protocol used for notification generation, see **Table 75**.

Table 75: Configuration values: Protocol type.

Protocol type	
Possible Values	**FTP** (*File Transfer Protocol*), Standard Protocol for file transfer. It does not use encryption, so data and credentials are sent in plain text.
	SFTP (Secure File Transfer Protocol), Secure file transfer Protocol based on SSH. It encrypts all communications and allows the generation of reports with high security.
	SMTP *(Simple Mail Transfer Protocol)*, Standard Protocol for sending emails between servers. It operates on plain text and does not encrypt communication on its own, so data may be transmitted without protection unless extensions like STARTTLS are used.

Note: ***Quality Event*** *notifications are only available using the* ***SMTP*** *protocol.*

When selecting as **Protocol type: FTP** or **SFTP**, the Parameters are:

✓**IP Address:** IP address of the server where notifications are sent.
✓**Port:** Server port.
✓**Username:** Server username.
✓**Password:** Password for the server user.
✓**Folder path:** Server path.

When selecting as **Protocol type: SMTP**, the Parameters are:

✓**Host**: Mail server host.
✓**Port**: Server port.
✓**Sender**: Sender email address.
✓**Password**: User password.
✓**Recipient**: Recipient email address.

Schedule settings

✓**Periodicity:** Frequency of notification generation, **Table 76**.

Table 76:Configuration values: Periodicity.

Periodicity	
Possible Values	Daily
	Weekly
	Monthly
	Occasionally

Note:*The option* ***Occasionally*** *is only available for the* ***Notification Type****:* ***PQDIF*** *and* ***Quality Events****.*

✓**Upload time:** Notification sending time.

When selecting as **Notification type: Quality events**, additionally the following must be configured:

✓**Silence time (min)**: Minimum time interval between successive emails, **Table 77**.

Table 77: Configuration values: Silence time (min).

Silence time (min)	
Minimum value	1 min
Maximum value	1440 min

5.8.2.- SCOUT

Scout is **CIRCUTOR**'s electrical monitoring platform that allows the **CVM-A1600** to be connected in order to provide centralised monitoring of electrical parameters, real-time visualisation of events and alarms, power quality analysis, and automatic reporting on installation performance.
On the **Scout** screen (**Figure 69**) , the connection of the device to the **Scout** platform can be configured.

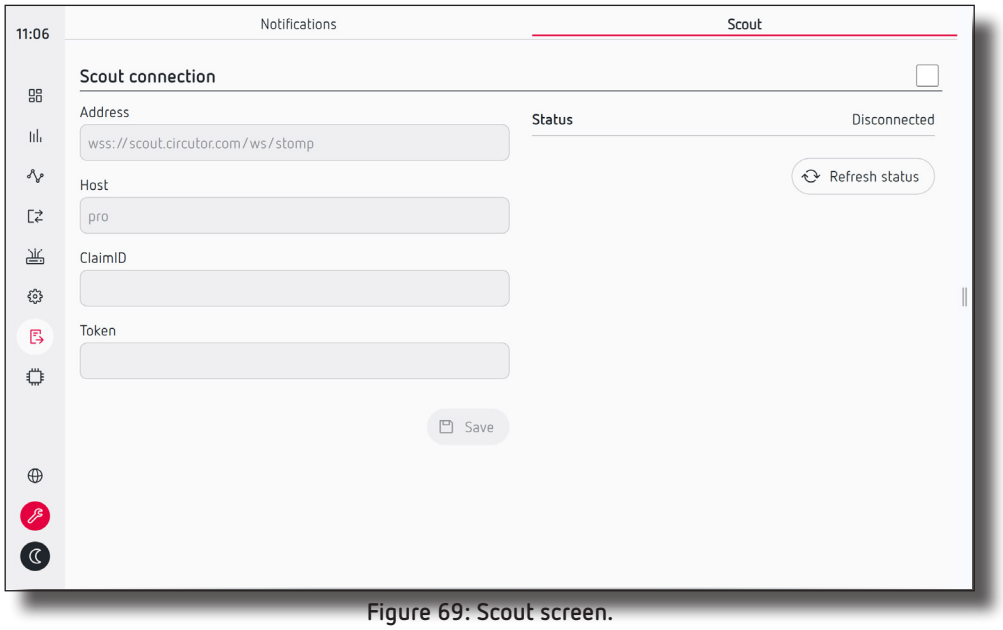


Figure 69: Scout screen.

<u>Scout connection</u>

☑ Enable or disable the connection of the device to the **Scout** platform.
Enabling this connection also enables remote firmware updates for the device and a remote access tunnel to its Web page.

If this option is enabled, the following parameters must be configured:

✓**Address:** URL of the platform.
✓**Host:** Virtual host of the STOMP server used for communication with the platform.
✓**ClaimID:** Unique identifier of the device on the platform.
✓**Token:** Authorisation key for communication with the platform.

Press **Save** to save the device configuration.

✓**Status:** Status of the connection to the platform.

Press **Refresh status** to refresh the connection status.

5.9.- SYSTEM

5.9.1.- INFO

On the **Info** screen (**Figure 70**), the device information can be viewed and modified.

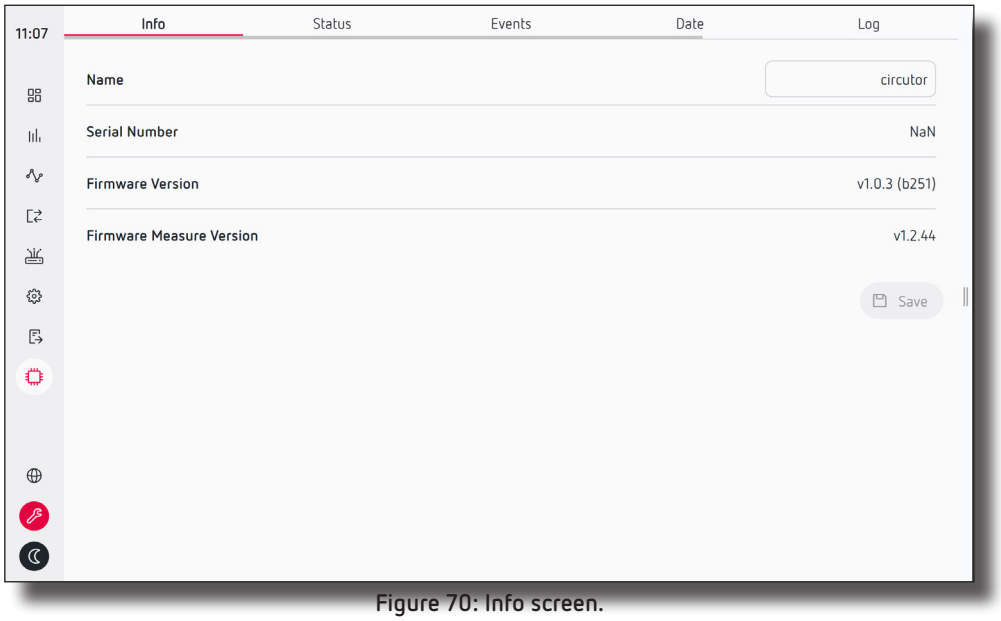


Figure 70: Info screen.

✓**Name**: device name.
✓**Serial Number**: device serial number.
✓**Firmware Version**: device firmware version.
✓**Firmware Measure Version**: measurement software version.

Press **Save** to save the device configuration.

5.9.2.- STATUS

On the **Status** screen (**Figure 71**) displays the device status information.

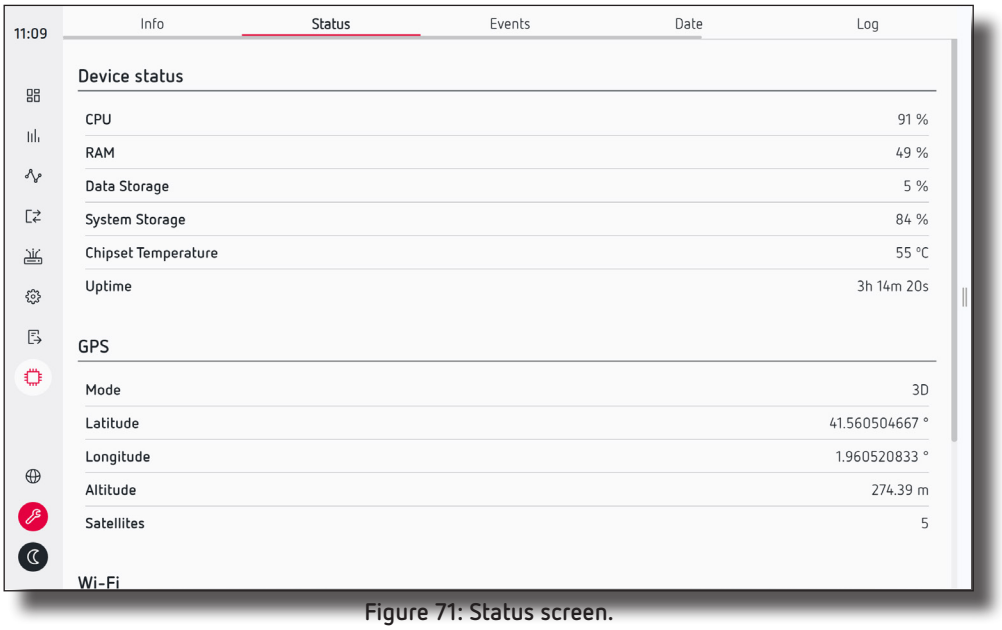


Figure 71: Status screen.

5.9.3.- EVENTS

On the **Events** screen (**Figure 72**), the system events generated by the **CVM-A1600** are displayed.

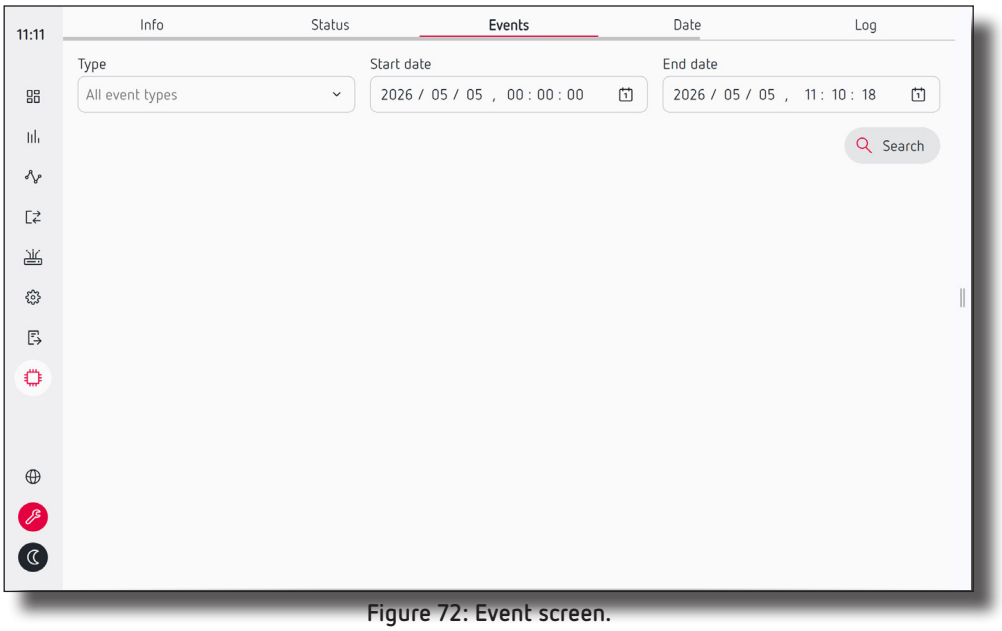


Figure 72: Event screen.

✓**Type:** Select the event type to be displayed, **Table 78**.

Table 78: Configuration values: Type.

Type		
Possible Values	All event types	Start
	Power off	Battery on
	Battery off	Config change
	Delete database	GPS sync
	No GPS sync	Export connected
	Firmware update success	Firmware update failed

✓**Start date:** Start date of the events.
✓**End date:** End date of the event display.

Press **Search** to start the event search.

5.9.4.- DATE

On the **Date** screen (**Figure 73**), the time zone, date and time of the device are configured.

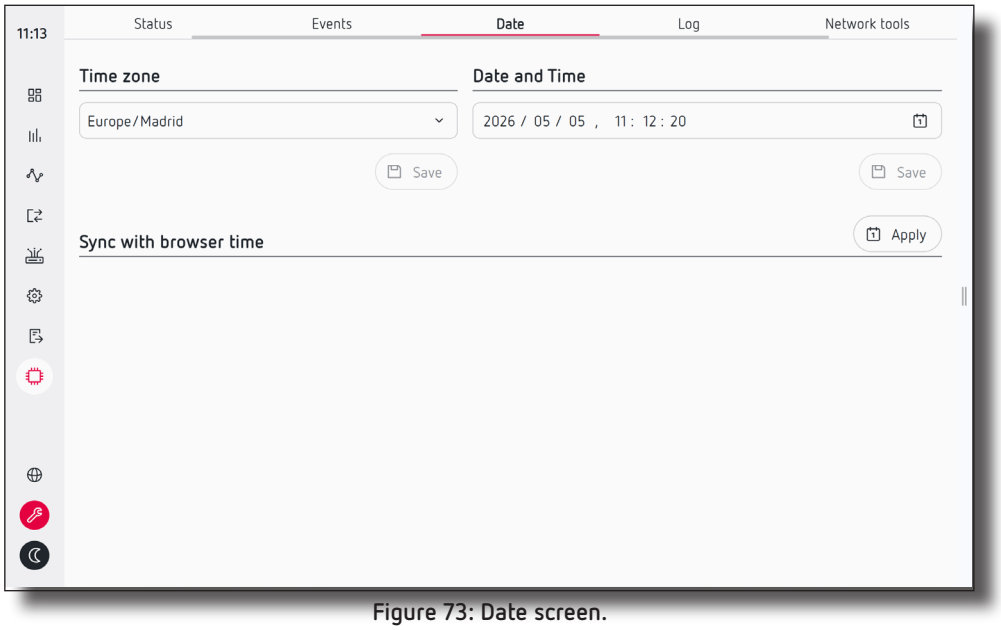


Figure 73: Date screen.

✓**Time zone:** time zone where the device is located.
✓**Date and Time:** Device date and time.

Sync with browser time

Allows the device date and time to be adjusted automatically using the time settings of the web browser from which the interface is accessed.

Press **Save** to save the device configuration.

5.9.5.- LOG

On the **Log** screen (**Figure 74**) the events registered in the device are displayed.



Figure 74: Log screen.

5.9.6.- NETWORK TOOLS

On the **Network tools** screen (**Figure 75**), the network status is displayed.

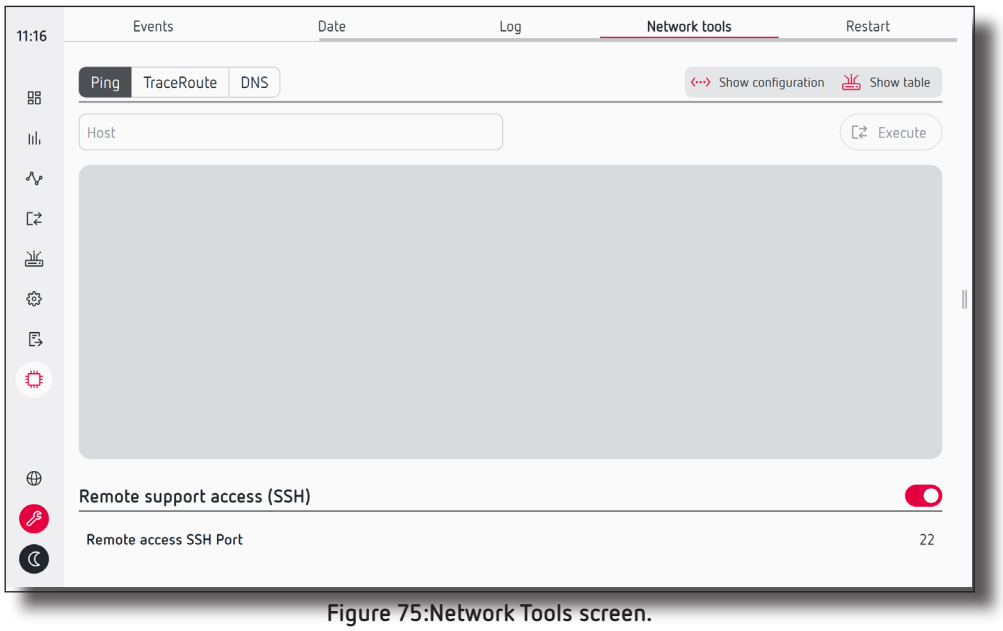


Figure 75:Network Tools screen.

<u>Ping</u>

✓**Host:** enter an IP address or a web address to check the device's connection to the Web or IP.

This tool is useful for verifying the device's connection to the **Scout** platform.

Press **Execute** to start the verification.

TraceRoute

✓**Host:** enter an IP or a Web address to view the path that data travels from the device to the Internet server.

Press **Execute** to start the verification.

DNS

✓**Host:** enter a domain name (DNS) to resolve it to its IP address.

Press **Execute** to start the verification.

Press **Show configuration** to display the configuration of the network interfaces.
Press **Show table** to display the routing table.

Remote support access (SSH)

Enable or disable remote access through the network port used by the device to accept **SSH** (*Secure Shell*) connections.

SSH is a secure protocol that enables remote access to a device for management via a console or secure file transfer.

✓**Remote access SSH port:** By default, **SSH** uses TCP port 22.

5.9.7.- RESTART

On the **Restart** screen (**Figure 76**), the device can be restarted.

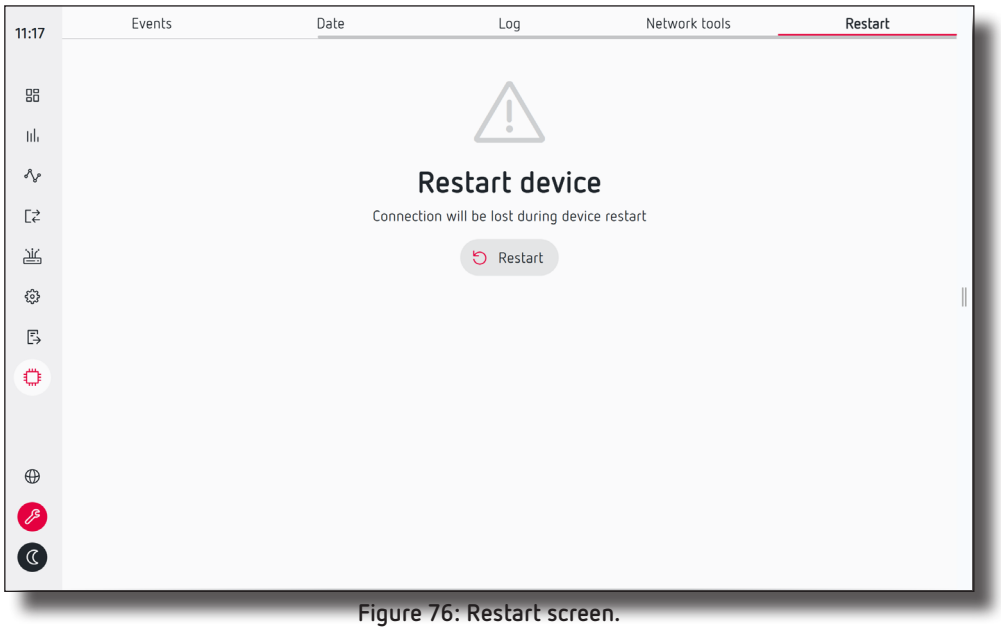


Figure 76: Restart screen.

6.- RS-485 COMMUNICATIONS

The **CVM-A1600** features an RS-485 communications port with the **MODBUS RTU®** protocol.

The RS-485 communications are configured on the "***5.6.5.- MODBUS***" screen and on the "***8.7.5.- MODBUS***" web page.

6.1.- WIRING

The RS-485 cable must consist of shielded twisted-pair cable (minimum 3 wires), with a maximum distance of 1200 metres between the **CVM-A1600** and the master unit.
A maximum of 32 **CVM-A1600** devices can be connected to this bus.

For communication with the master unit, an intelligent converter must be used.

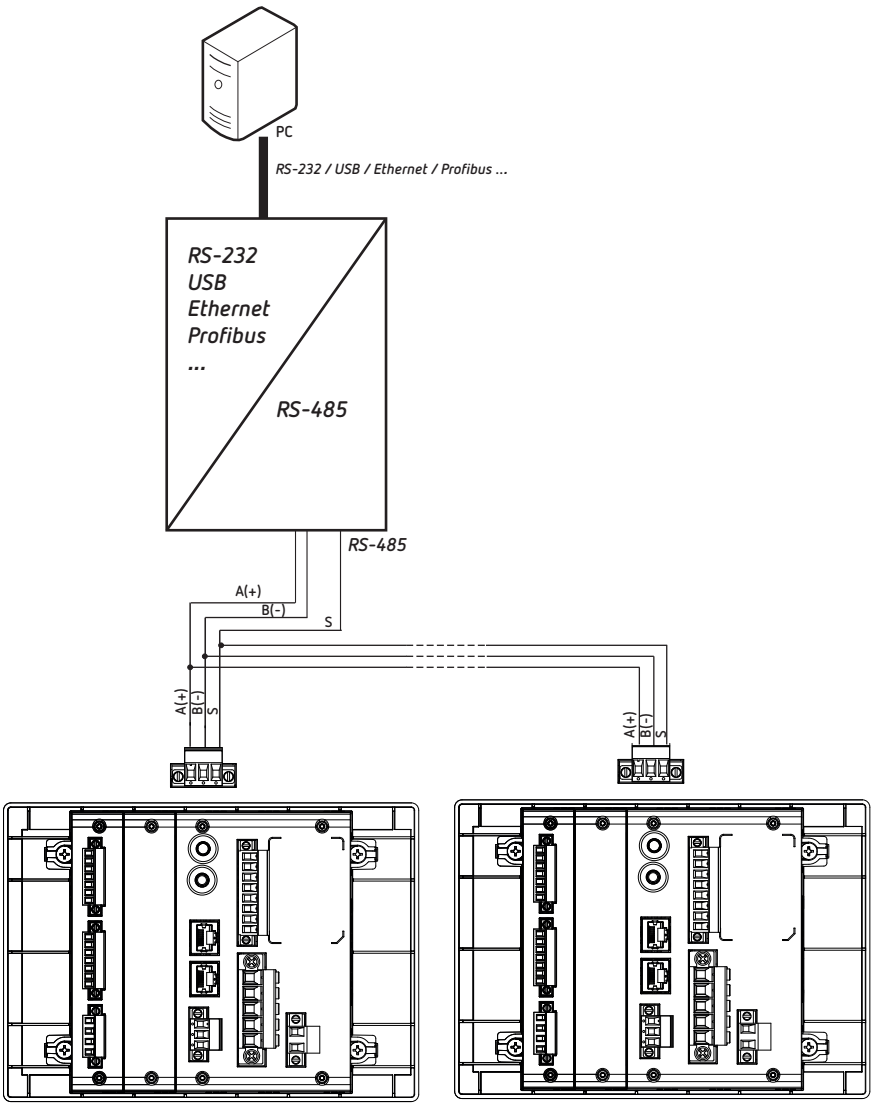


Figure 77: RS-485 Wiring Diagram.

6.2.- MODBUS PROTOCOL

The **MODBUS** protocol is an industrial communications standard that allows network connection of multiple devices, where there is a master and multiple slaves. It allows individual master-slave dialogue and also enables commands in broadcast format.
Within the **MODBUS** protocol, the **CVM-A1600** uses RTU (*Remote Terminal Unit*) mode.

In RTU mode, the start and end of a message are detected by silent intervals of at least 3.5 characters, and the 16-bit CRC error detection method is used.

The device implements **Function 0x04**: Read Registers.

6.2.1.- MODBUS QUERY EXAMPLE

Query: L1 Phase-to-Neutral Voltage Value.

Address	Function	Starting Register	No. of registers	CRC
0A	04	0000	0002	70B0

Address: 0A, Peripheral Number: 10 in decimal.
Function: 04, Read function.
Starting Register: 0000, register from which reading is to start.
No. of Registers 0002, number of records to read.
CRC: 70B0, CRC character.

Response:

Address	Function	No. of Bytes	Register No. 1	Register No. 2	CRC
0A	04	04	4354	8000	86B1

Address: 0A, Responding peripheral number: 10 in decimal.
Function: 04, Read function.
No. of bytes: 04, No. of bytes received.
Register: 43548000, L1 Phase-to-Neutral Voltage Value: 212.5 V
CRC: 86B1, CRC character.

Note: *The value of each register is in hexadecimal.*

6.3.- MODBUS MEMORY MAP

All **MODBUS** memory map addresses are in hexadecimal.

6.3.1.- MEASUREMENT VARIABLES

Table 79:Memory Map Modbus: Measurement variables.

3 s Measurement Block				
Parameter		Format	Address	Units
V_AN_3s	L1 Phase-to-Neutral Voltage	Float [32]	00-01	V
I_AN_3s	L1 Current	Float [32]	02-03	A
P_AN_3s	L1 Active Power (P)	Float [32]	04-05	W
S_AN_3s	L1 Apparent Power (S)	Float [32]	0A-0B	VA
PF_AN_3s	L1 Power Factor (PF)	Float [32]	0C-0D	-
DPF_AN_3s	L1 Fundamental Power Factor (DPF)	Float [32]	0E-0F	-
V_BN_3s	L2 Phase-to-Neutral Voltage	Float [32]	10-11	V
I_BN_3s	L2 Current	Float [32]	12-13	A
P_BN_3s	L2 Active power (P)	Float [32]	14-15	W
S_BN_3s	L2 Apparent power (S)	Float [32]	1A-1B	VA
PF_BN_3s	L2 Power factor (PF)	Float [32]	1C-1D	-
DPF_BN_3s	L2 Fundamental power factor (DPF)	Float [32]	1E-1F	-
V_CN_3s	L3 Phase-to-Neutral Voltage	Float [32]	20-21	V
I_CN_3s	L3 Current	Float [32]	22-23	A
P_CN_3s	L3 Active power (P)	Float [32]	24-25	W
S_CN_3s	L3 Apparent power (S)	Float [32]	2A-2B	VA
PF_CN_3s	L3 Power factor (PF)	Float [32]	2C-2D	-
DPF_CN_3s	L3 Fundamental power factor (DPF)	Float [32]	2E-2F	-
V_AB_3s	L1-L2 Phase-to-Phase Voltage	Float [32]	36-37	V
V_BC_3s	L2-L3 Phase-to-Phase Voltage	Float [32]	38-39	V
V_CA_3s	L3-L1 Phase-to-Phase Voltage	Float [32]	3A-3B	V
P_TOT_3s	Total Active Power (P)	Float [32]	42-43	W
S_TOT_3s	Total Apparent Power (S)	Float [32]	48-49	VA
PF_TOT_3s	Total Power Factor	Float [32]	4A-4B	-
DPF_TOT_3s	Total Fundamental Power Factor (DPF)	Float [32]	4C-4D	-
THD_V_AN_3s	Voltage THD L1	Float [32]	4E-4F	%
THD_V_BN_3s	Voltage THD L2	Float [32]	50-51	%
THD_V_CN_3s	Voltage THD L3	Float [32]	52-53	%
THD_I_AN_3s	Current THD L1	Float [32]	56-57	%
THD_I_BN_3s	Current THD L2	Float [32]	58-59	%
THD_I_CN_3s	Current THD L3	Float [32]	5A-5B	%
Q_AN_3s	Reactive Power (Q) L1	Float [32]	5E-5F	var
Q_BN_3s	Reactive Power (Q) L2	Float [32]	60-61	var
Q_CN_3s	Reactive Power (Q) L3	Float [32]	62-63	var
Q_TOT_3s	Total Reactive Power (Q)	Float [32]	64-65	var

6.3.2.- ENERGY VARIABLES

Table 80: Memory Map Modbus: Energy variables.

3 s Measurement Block				
Parameter		Format	Address	Units
P_ENERGY_CON_TOT_3s	Total Active Energy Consumed	Float [32]	520 - 521	kWh
Q_ENERGY_Q1_TOT_3s	Total Consumed Inductive Reactive Energy (Q1)	Float [32]	530 - 531	kvarhL
Q_ENERGY_Q2_TOT_3s	Total Consumed Capacitive Reactive Energy (Q2)	Float [32]	540 - 541	kvarhC
P_ENERGY_GEN_TOT_3s	Total Active Energy Generated	Float [32]	570 - 571	kWh
Q_ENERGY_Q3_TOT_3s	Total Generated Inductive Reactive Energy (Q3)	Float [32]	580 - 581	kvarhL
Q_ENERGY_Q4_TOT_3s	Total Generated Capacitive Reactive Energy (Q4)	Float [32]	590 - 591	kvarhC

7.- ETHERNET AND Wi-Fi COMMUNICATIONS

The **CVM-A1600** features Ethernet and Wi-Fi communications.

7.1.- USAGE ENVIRONMENT AND HEALTH

Wireless communications emit radio frequency electromagnetic energy, like other radio devices.

Because wireless communications operate under the guidelines found in radio frequency standards and recommendations, they are safe for users to use.

In some settings and situations the use of wireless communications may be restricted by the building's owner of representatives of the organisation.
These may include:

✓Use of wireless connections on board aircraft, in hospitals or near service stations, blasting areas, medical implants or electronic medical devices implanted in the human body (pacemakers, etc.).

✓ In any other setting where the risk of interference with other devices or services is a hazard.

If you are not sure of the applicable usage policy for wireless devices in a specific organisation (airport, hospital, etc.) we recommend requesting permission to use wireless communications.

7.2.- CYBERSECURITY BEST PRACTICES FOR INDUSTRIAL ENVIRONMENTS

This device features Ethernet and Wi-Fi communication interfaces and has been designed and manufactured in accordance with the following regulations:

✓ **Directive 2014/53/UE (RED)**:

- Electrical safety.
- Electromagnetic compatibility.
- Efficient use of the radio spectrum.

✓**Delegated Regulation (EU) 2022/30 (RED-DA) in accordance with requirement 3.3(d), as per standard EN 18031-1:**

- Protection against unauthorised access.
- Preservation of network integrity.
- Protection of the user's personal data.

To ensure secure operation, the following cybersecurity best practices must be applied during configuration and deployment:

✓**Minimum secure network requirements:**

- Install the device on private industrial networks (not on public or open networks).
- Segment the network using **VLANs** (Virtual Local Area Networks) or dedicated subnets.
- Use firewalls or perimeter devices to filter traffic.

• Enable only the ports and protocols required for the operation of the device.
• If not strictly necessary, block or restrict the device's access to the Internet.
• Restrict physical network access to authorised personnel only.

✓**Wi-Fi network security:**

• Connect the device only to Wi-Fi networks using **WPA2** or **WPA3** authentication.
• Avoid open networks, **WEP** (Wired Equivalent Privacy), or other obsolete and insecure protocols.
• If the Wi-Fi interface is not required for the installation, disable it from the device's communication menu to reduce risk.

✓**Password and authentication management:**

• The device requires the default password to be changed after the first use.
• Use passwords with the following characteristics (according to **NIST SP 800-63B**):
  - Minimum length of 15 characters.
  - Combination of uppercase, lowercase, numbers, and symbols.

These measures help prevent unauthorised access through brute force or dictionary attacks.

✓**Cryptography:**

• All interfaces of the device (Ethernet, Wi-Fi, REST API, Web interface) use secure cryptographic protocols:

  - **WPA2** or **WPA3** for Wi-Fi.
  - **TLS 1.2** or higher for encrypted communications.
  - Algorithms validated by **NIST** (National Institute of Standards and Technology).

• Obsolete technologies are not used, including: **WEP**, **SSL**, **Telnet**, and unencrypted **HTTP**.

✓**Updates and maintenance:**

• Firmware updates must be carried out exclusively from verified and trusted sources, thereby ensuring the integrity and authenticity of the software loaded onto the device.
• Prior to applying a new version, the system shall verify the validity of the digital signature associated with the firmware, ensuring it has not been tampered with.

• It is recommended to:

  - Establish preventive maintenance procedures.
  - Implement a periodic update plan as part of the cybersecurity policy.
  - Document updates as part of the device lifecycle management.

7.3.- Wi-Fi COMMUNICATIONS

Wi-Fi is one of the most widely-used wireless technologies today, used to connect electronic devices and exchange information between them without a physical connection.

The **CVM-A1600** features Wi-Fi communications in the 2.4 GHz and 5 GHz bands, compatible with dual-band Wi-Fi 6 standards (IEEE 802.11ax/ac/a/b/g/n).

Figure 78 shows the location of the Wi-Fi antenna.

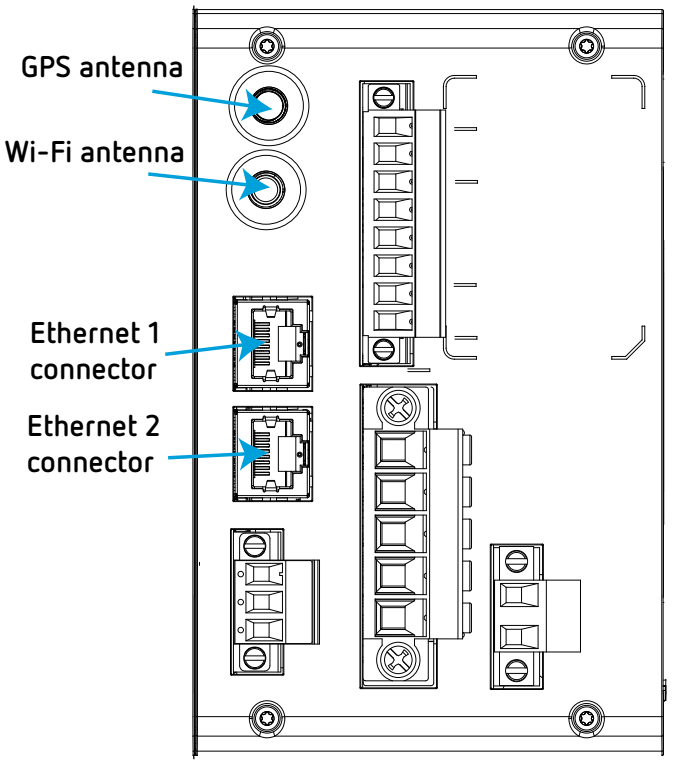


Figure 78: CVM-A1610-ITF Antennas.

7.4.- GPS

The **CVM-A1600** has GPS for clock synchronization according to the IEC 6100-4-30 standard, achieving an uncertainty < 50 ns.

A GPS antenna is provided with the device that needs to be installed for the communications to work correctly, see **Figure 78.**

7.5.- PQI COMMUNICATION PROTOCOLS

The **CVM-A1600** is a PQI (*Power Quality Instrument*) device intended to measure the quality of the electrical supply in accordance with the **IEC 62586-1** standard.

The device supports the **DNP3 (IEEE 1815)**, **IEC 60870-5-104** and **IEC 61850** communication protocols through its Ethernet and Wi-Fi interfaces, enabling its integration into supervisory control and data acquisition (SCADA) systems for monitoring the measured electrical variables.

For further information on the operation of these protocols and the available communication variables,

refer to the application note ***"PQI communication protocols (DNP3 - IEC 60870-5-104 - IEC 61850)" (M507E0101-03-26A)***.

7.6.- MODBUS TCP PROTOCOL

The **MODBUS** protocol is an industrial communication standard that enables information to be exchanged between different devices.

In its **MODBUS TCP** variant, communication takes place over TCP/IP using a client-server architecture. The supervisory system (client) sends requests to the device (server), which responds by providing the requested data.

The **CVM-A1600** features Modbus TCP communications through its Ethernet and Wi-Fi interfaces, using TCP port 502.

Refer to the Modbus map in section ***"6.3.- MODBUS MEMORY MAP"***.

7.6.1.- MODBUS TCP REQUEST EXAMPLE

Request: L1 phase-to-neutral voltage value (**V_AN_3s**).

Transaction ID	Protocol ID	Length	Unit ID	Function	Starting register	No. of registers
0001	0000	0006	0A	04	0000	0002

Transaction ID: 0001, request identifier.
Protocol ID: 0000, Modbus protocol identifier.
Length: 0006, number of remaining bytes in the frame, including the device identifier.
Unit ID: 0A, device identifier (10 in decimal).
Function: 04, read input registers function.
Starting register: 0000, register at which the reading is to begin.
No. of registers: 0002, number of registers to be read.

Response:

Transaction ID	Protocol ID	Length	Unit ID	Function	No. of bytes	Register No. 1	Register No. 2
0001	0000	0007	0A	04	04	4354	8000

Transaction ID: 0001, request identifier.
Protocol ID: 0000, Modbus protocol identifier.
Length: 0007, number of remaining bytes in the frame, including the device identifier.
Unit ID: 0A, device identifier (10 in decimal).
Function: 04, read input registers function.
No. of bytes: 04, number of data bytes received.
Registers: 43548000, L1 phase-to-neutral voltage value: 212,5 V.

Note: *The value of each register is in hexadecimal.*

8.- WEB PAGE

Access to the device configuration and monitoring web page is achieved through the device IP address. To access the web interface, the screen shown in **Figure 79**,is displayed, where the Username and Password must be entered. The default values are shown in **Table 81**.

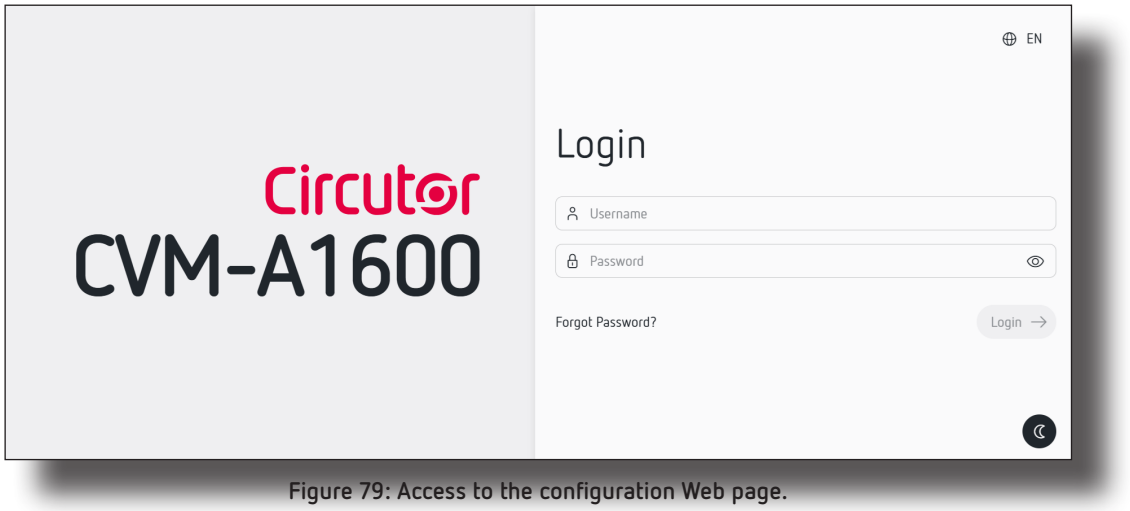


Figure 79: Access to the configuration Web page.

Table 81: Access to the configuration Web apge.

Access to the configuration Web page	
Username	admin
Password	circutor

If the access password has been forgotten, click the **Forgot Password?** option to change the password using the serial number of the device.

Note: *To complete password recovery, switch off the **CVM-A1600** within one minute of confirming the new password. This step verifies physical access to the device and prevents recovery from being completed entirely remotely.*

***Note:** At the top right corner, ⊕, it is possible to change the language of the Web page.*

Once access has been validated, the main screen (**Figure 80**) is is displayed.

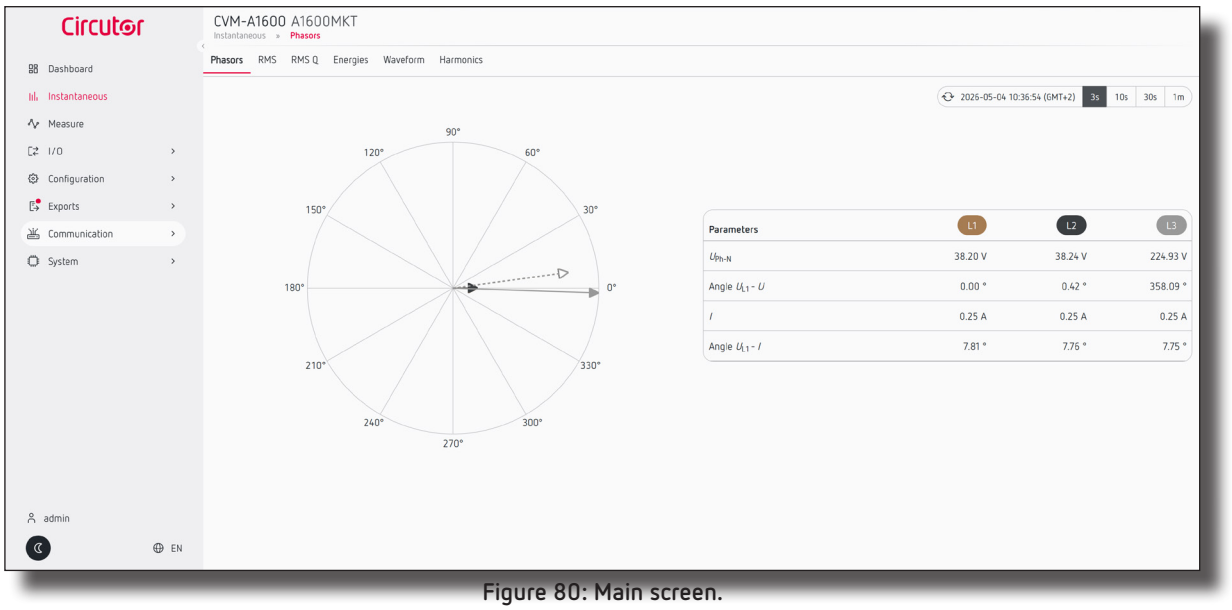


Figure 80: Main screen.

From this screen you can access the menu of the Web page:

Dashboard → User-customisable dashboard.
Instantaneous → Display of the instantaneous values measured by the device.
Measure → Display of the historical values measured by the device.
I/O → Display and configuration of the device inputs and outputs (Menu visible on the models **CVM-A1611-ITF** and **CVM-A1612-ITF**).
Configuration → Configuration of the device parameters.
Exports → Configuration of data exports.
Communications → Configuration of the device communications.
System → Display of system information.

On the Web page you can also:

Click to log out or change the access password.
Change the Web page language.
Switch the Web Page to night mode.

8.1.- DASHBOARD

The **Dashboard** screen, **Figure 81**, is a customisable screen where the user can configure the parameters to be displayed and add images.

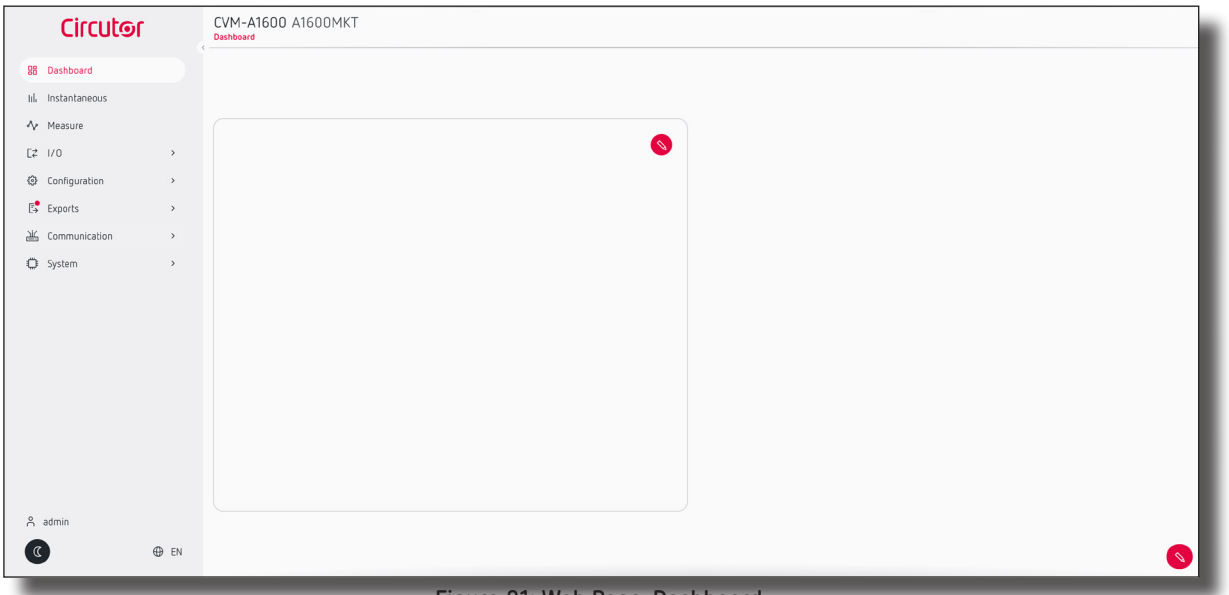


Figure 81: Web Page, Dashboard.

Click the icon in the box to upload an image.
The image must be in **SVG, JPEG** or **PNG** format and have a square aspect ratio (1:1), a minimum resolution of 800x800 pixels, and a size less than 1 MB.

Click the lower icon to enter edit mode, then click **+** to add the variables to be displayed. The screen shown in **Figure 82** is displayed. The **Dashboard** screen can display up to 8 variables.



Figure 82: Add variables.

✓**Select variable**: Select the variable to be displayed on the **Dashboard** screen. **Table 10**, **Table 11**, **Table 12**, **Table 13** and **Table 14** provide a description of the variables corresponding to the abbreviations shown in this parameter.

✓**Variable Name:** Name of the variable to be displayed.

Press **Save** to save the changes.

8.2.- INSTANTANEOUS

In the **Instantaneous** section, the instantaneous values measured by the device are displayed.

8.2.1.- PHASORS

On this screen, **Figure 83**, shows the graphical representation and numerical value of the voltage and current phasors.
The displayed values can be configured to refresh every **3s, 10 s, 30 s** or **1 m.**

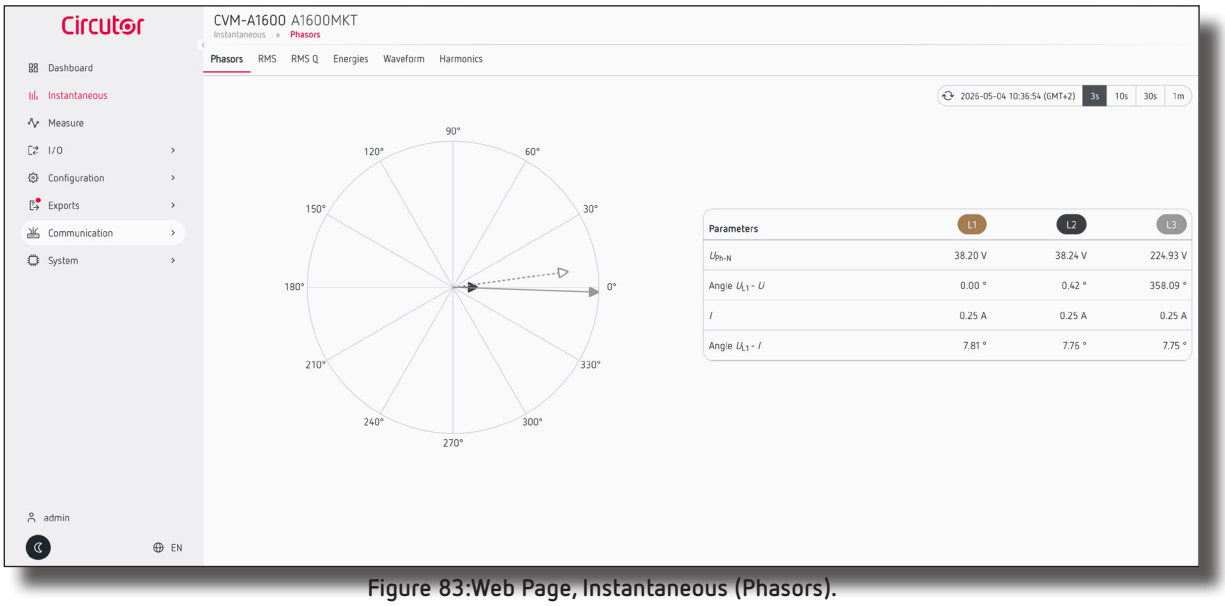


Figure 83:Web Page, Instantaneous (Phasors).

Note: *Angles are calculated relative to the Phase 1 voltage angle.*

8.2.2.- RMS

On this screen, **Figure 84**, the instantaneous values of the parameters measured by the **CVM-A1600** are displayed.
The displayed values can be configured to refresh every ⟳ **3s, 10 s**, **30 s** or **1 m.**

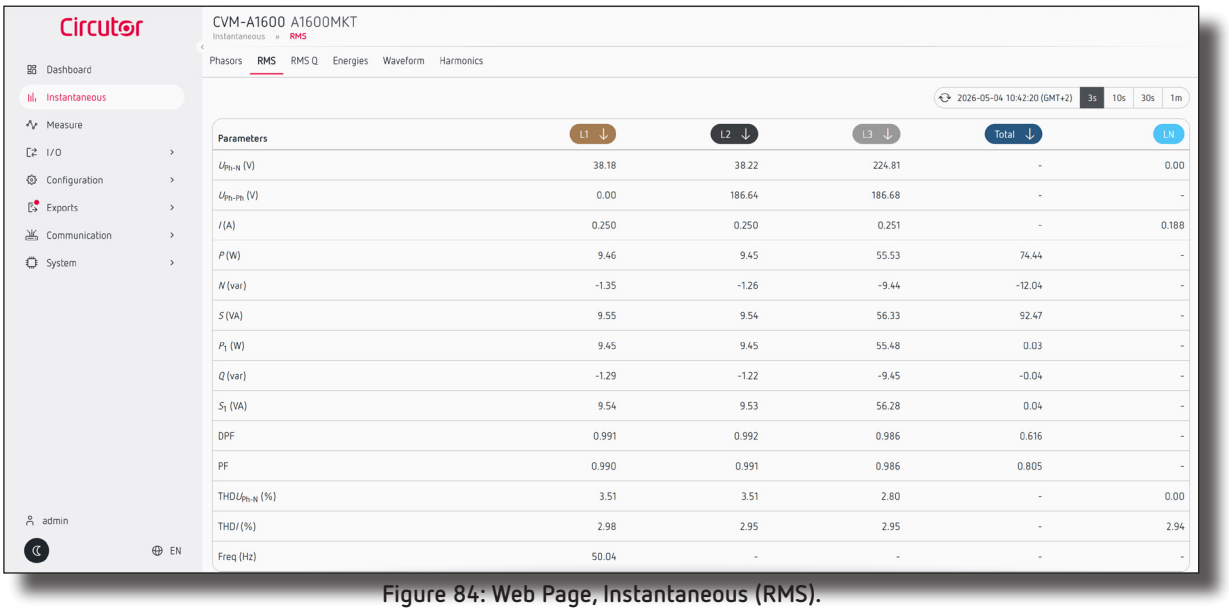


Figure 84: Web Page, Instantaneous (RMS).

8.2.3.- RMS Q

On this screen, **Figure 85**, the instantaneous values of the quality parameters measured by the **CVM-A1600** are displayed.
The displayed values can be configured to refresh every ⟳ **3s, 10 s**, **30 s** or **1 m.**

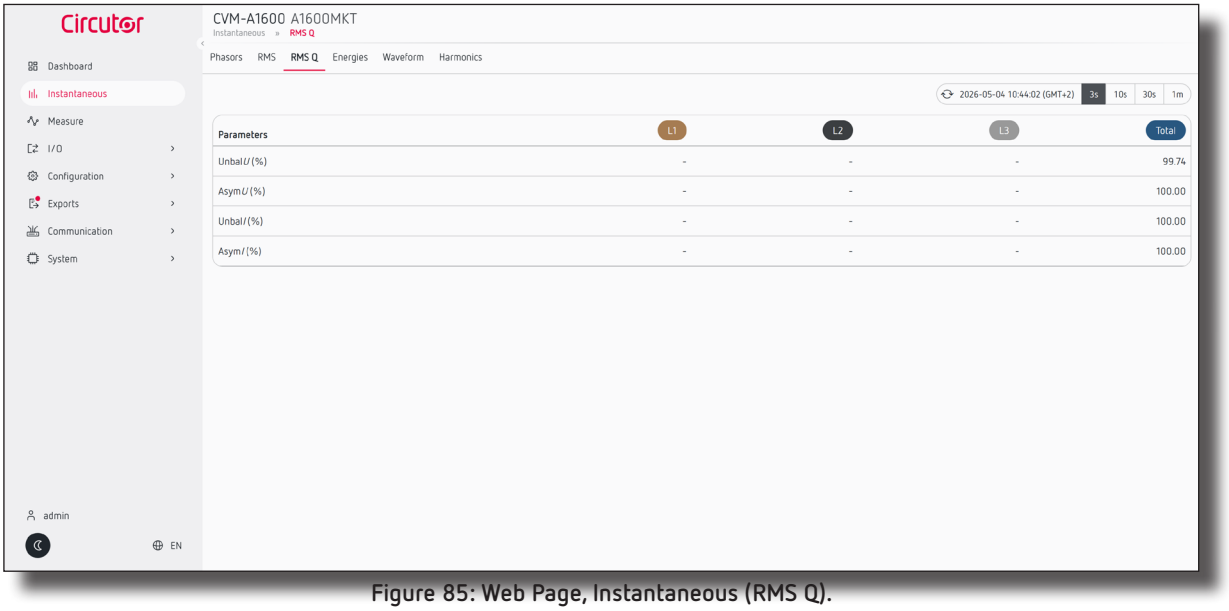


Figure 85: Web Page, Instantaneous (RMS Q).

8.2.4.- ENERGIES

On this screen, **Figure 86**, the energy values measured by the **CVM-A1600** are displayed.
The displayed values can be configured to refresh every ↻ **3s, 10 s**, **30 s** or **1 m.**

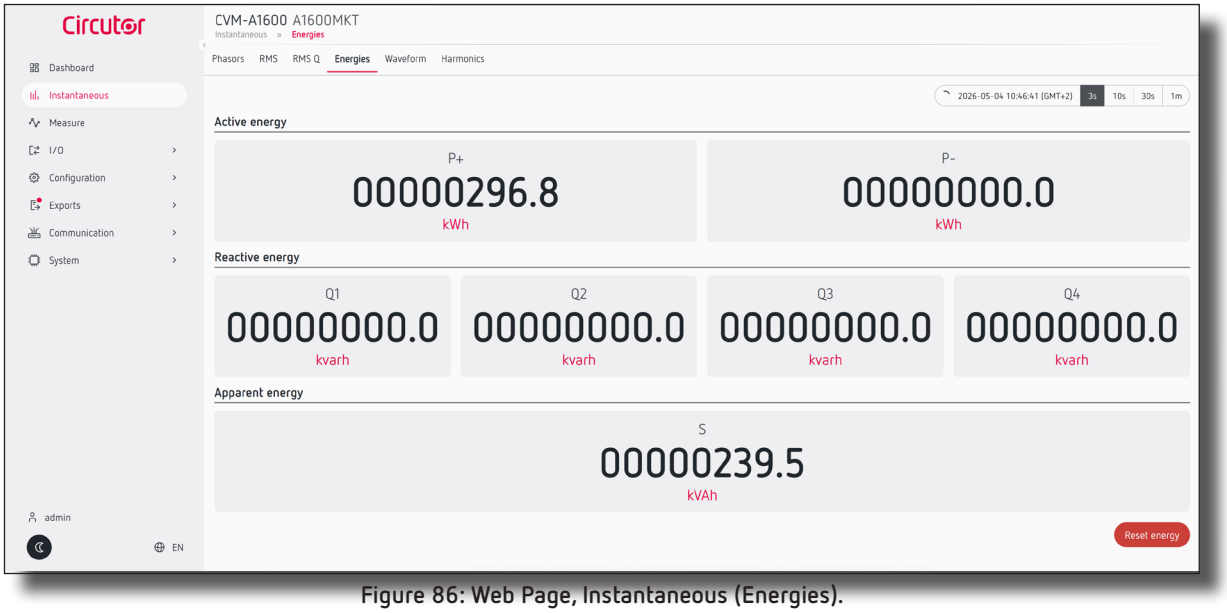


Figure 86: Web Page, Instantaneous (Energies).

Note: *Energy counters reset the accumulated register upon reaching the maximum values of 100 GWh (Active Energy), 100 Gvarh (Reactive Energy) and 100 GVAh (Apparent Energy).*

8.2.5.- WAVEFORM

On this screen, **Figure 87**, the waveforms or the 1-cycle RMS values of the voltage and current measured by the **CVM-A1600** are displayed, depending on the option configured in sections ***"5.3.5.- WAVEFORM"*** or ***"8.5.2.6.- WAVEFORM"*.**
The displayed values can be configured to refresh every ↻ **3s, 10 s**, **30 s** or **1 m.**

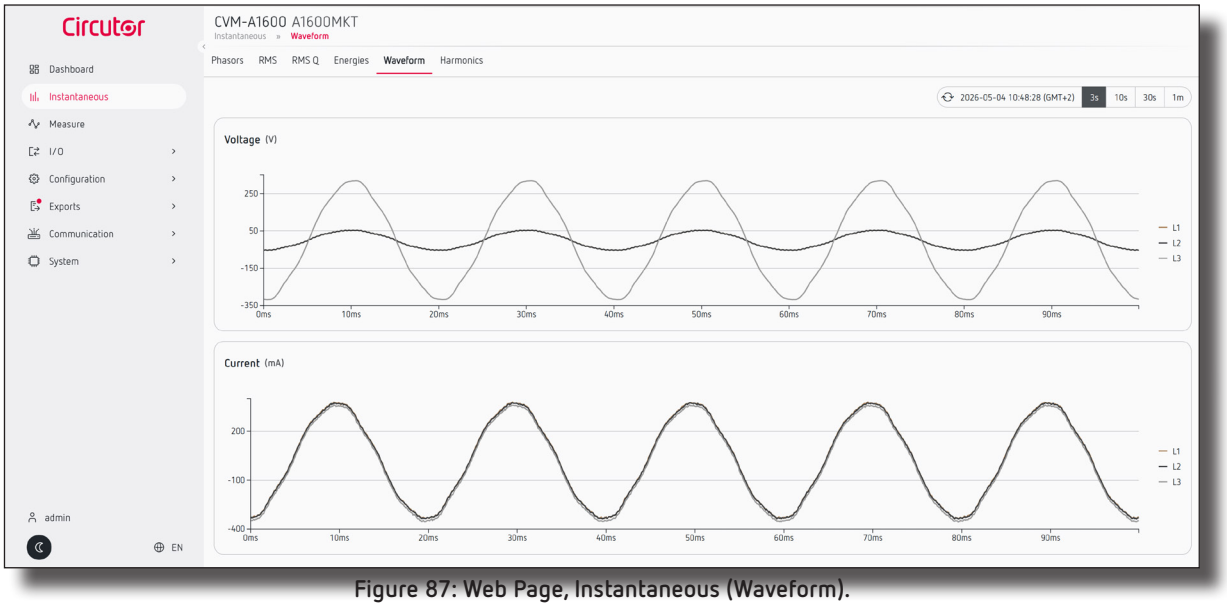


Figure 87: Web Page, Instantaneous (Waveform).

8.2.6.- HARMONICS

On this screen, **Figure 88**, the voltage and current harmonics are displayed.
The displayed values can be configured to refresh every **3s, 10 s**, **30 s** or **1 m.**

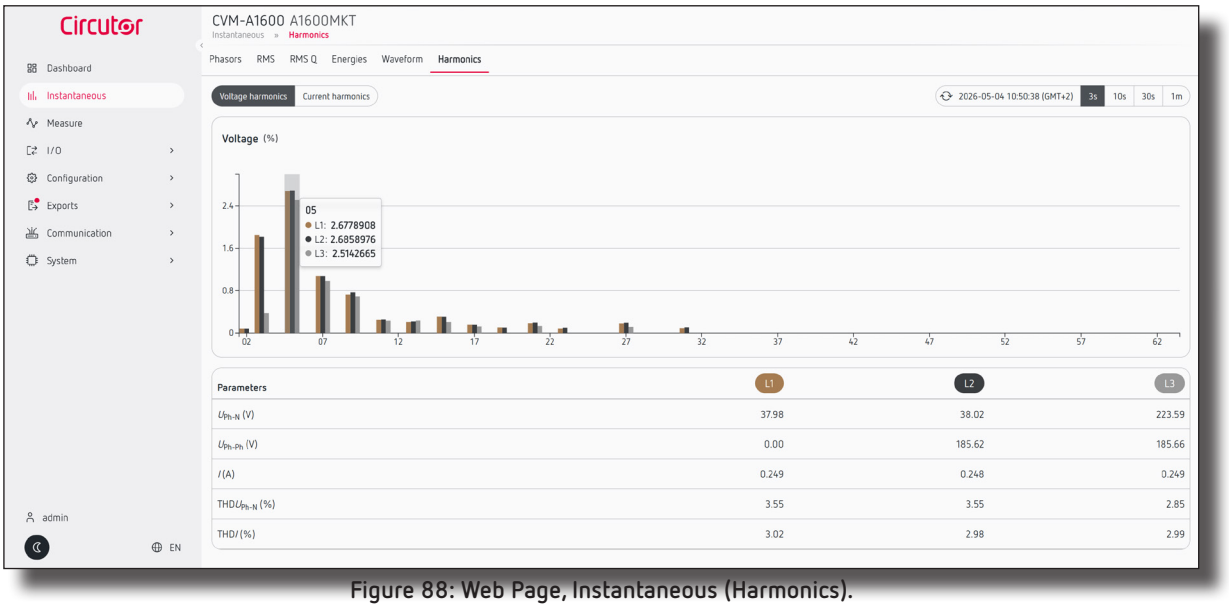


Figure 88: Web Page, Instantaneous (Harmonics).

The **CVM-A1600** represents harmonics originating from the source with a positive sign in the calculated harmonic %.Harmonics originating from the load are represented with a negative sign in the calculated harmonic %.
If the power harmonic does not have sufficient magnitude or its angle is too close to 90° or 270°, the sign of the harmonic % is positive. (See *"A.2.12.- VOLTAGE AND CURRENT HARMONICS"*).

8.3.- MEASURE

In the **Measure** section, the historical values measured by the device are displayed.

8.3.1.- HISTORIC

On this screen, **Figure 89**, the historical values listed in **Table 20** can be viewed by selecting the periodicity and the start and end dates.

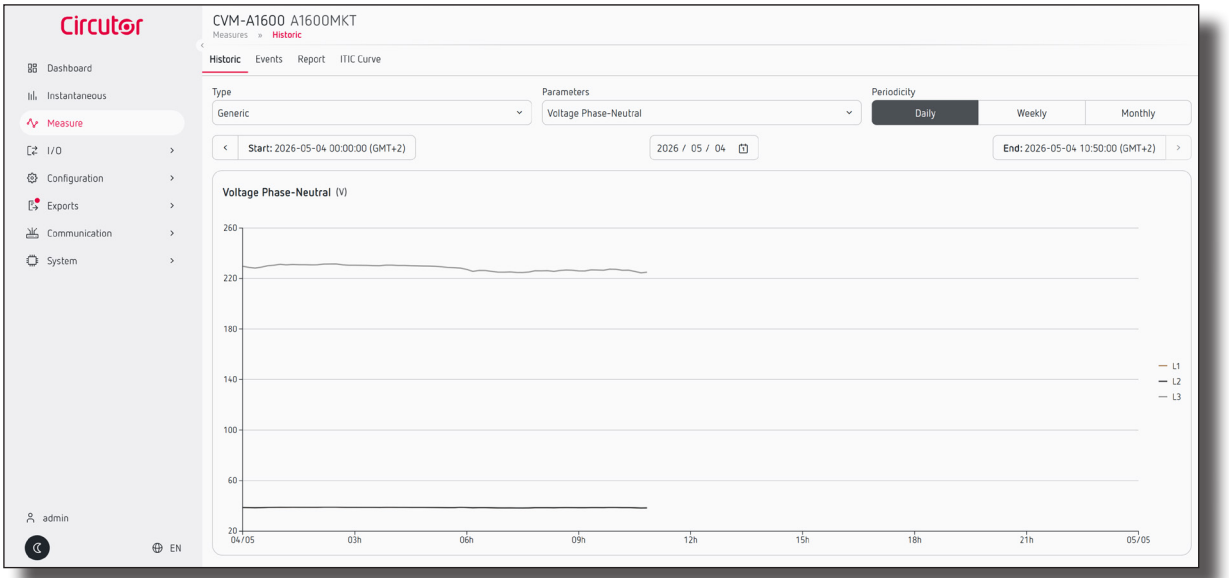


Figure 89: Web Page, Measure (Historic).

8.3.2.- EVENTS

On this screen, **Figure 90**, the quality events listed in **Table 21** that have been generated by the **CVM-A1600** are displayed by selecting the event type and the start and end dates.

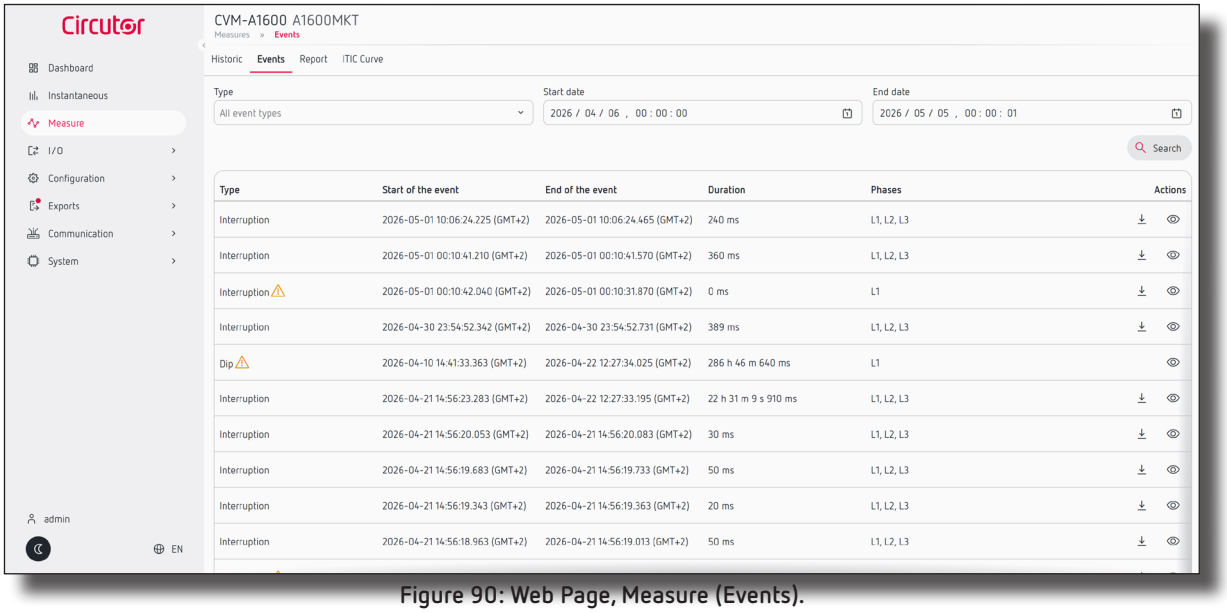


Figure 90: Web Page, Measure (Events).

To view the details of an event, click the 👁 icon in the **Actions** column.

In the **Event details** window, click ⬇ **Download waveform** to download the waveform in **COMTRADE** (*Common Format for Transient Data Exchange*) format, in accordance with the **IEEE C37.111** standard, for subsequent analysis.

8.3.3.- REPORT

On this screen, **Figure 91**, a statistical study can be generated according to:

- **PQDIF** (*Power Quality Data Interchange Format*), a standard file format developed by IEEE (IEEE Std 1159.3) to store, exchange, and analyze power quality data. The output file is a **pqdif**.
- **EN50160**, the output file is a **pdf** generated according to the standard.
- **Código Red de México**, the output file is a **pdf**.
- **IEEE 519** standard: the output file is a **pdf** in accordance with the standard.

Report scheduling can be configured in sections ***"5.8.1.- NOTIFICATIONS"*** and ***"8.6.1.- NOTIFICATIONS"***.

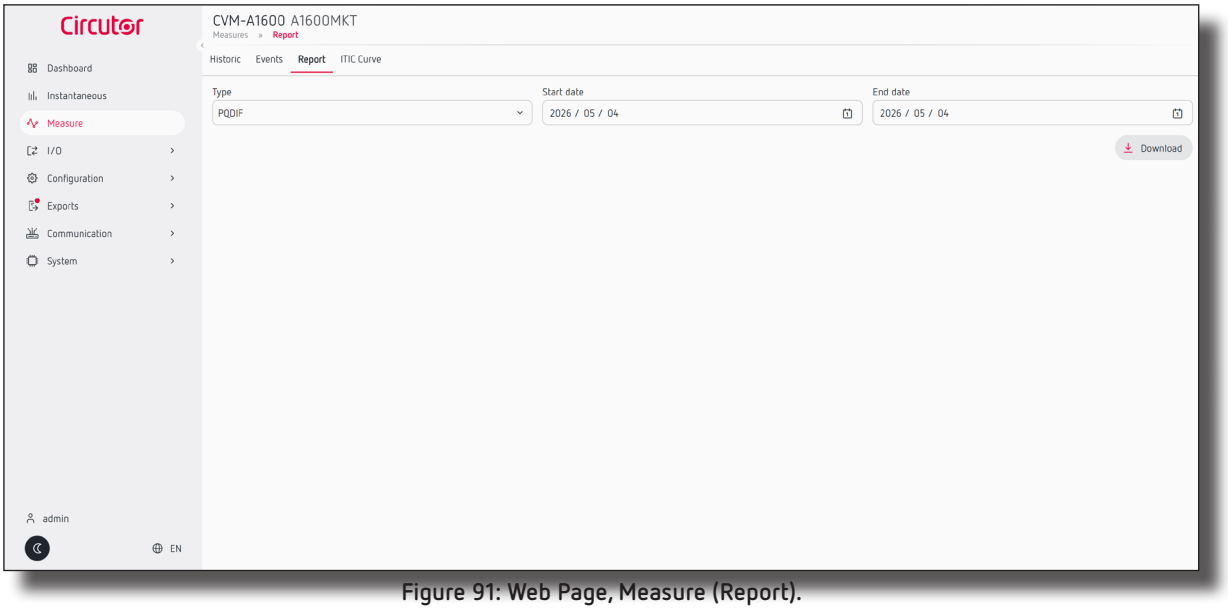


Figure 91: Web Page, Measure (Report).

8.3.4.- ITIC CURVE

On this screen, **Figure 92**, the **ITIC** (*Information Technology Industry Council*) voltage curve is displayed.

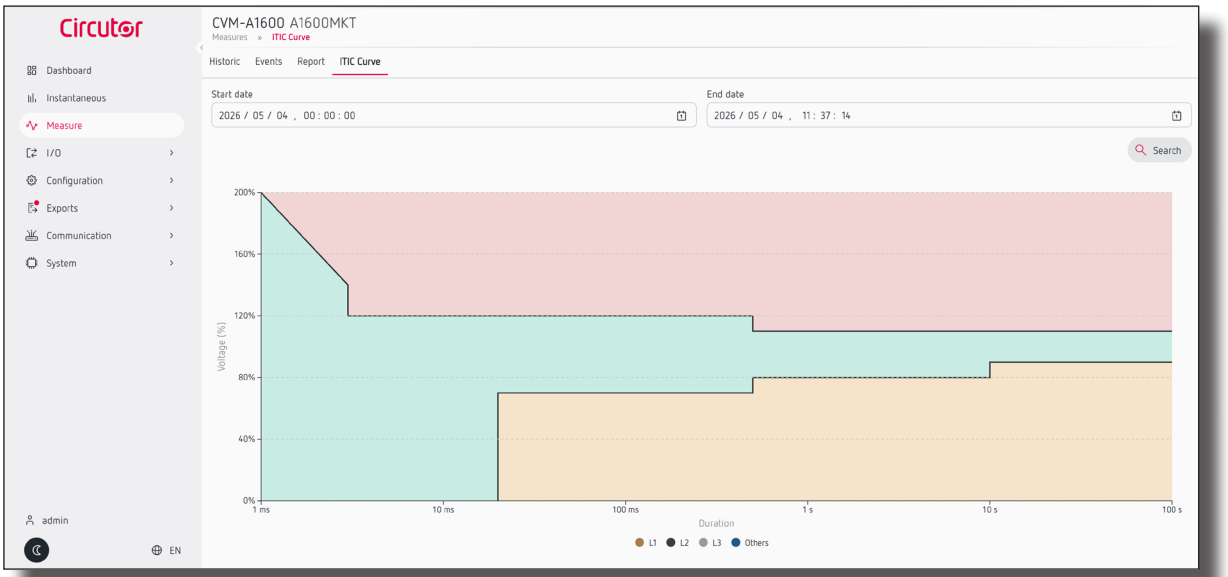


Figure 92: Web Page, Measure (ITIC Curve).

The **ITIC** curve is a graph that defines the tolerance limits of the installation to voltage variations in the electrical network.
The graph shows which combinations of voltage and disturbance duration can:

- Not cause problems to the installation (safe operation zone, green colour).
- Cause temporary failures or incorrect operation (intermediate zone, orange colour).
- Damage the installation (damage zone, red colour).

8.4.- I/O

Note: *Visible menu in the models **CVM-A1611-ITF** and **CVM-A1612-ITF**.*

In the **I/O** section, the device inputs and outputs are displayed and configured.

8.4.1.- DIGITAL INPUTS

On this screen, **Figure 93**, the status and configuration of the device digital inputs are displayed.
The **CVM-A1611-ITF** model features 6 digital inputs and the **CVM-A1612-ITF** model features 12 digital inputs.



Figure 93: Web Page, I/O (Digital Inputs).

Press ✎ to access the Digital Input configuration screen, **Figure 94.**

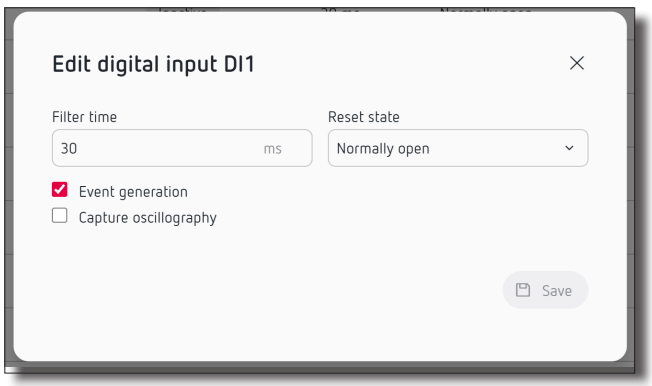


Figure 94:Edit Digital input.

✓**Filter time**: Select the filtering time, that is, the delay used to determine the activation of the digital input,**Table 22**.

✓**Reset state**: Select the state of the digital input when it is deactivated, **Table 23**.

☑ **Event generation**, select whether or not to save the events generated by the digital input. If enabled, the events are displayed in ***"5.5.3.- EVENTS"*** and ***"8.4.3.- EVENTS"***.

☑ **Capture oscillography**, select whether or not to display the events generated by the digital input.

If enabled, the events are displayed in ***"5.5.3.- EVENTS"*** and ***"8.4.3.- EVENTS"***.

Press **Save** to save the changes.

8.4.2.- DIGITAL OUTPUTS

On this screen, **Figure 95**, the status and configuration of the device digital outputs and relay outputs are displayed.

The model **CVM-A1611-ITF** features 6 digital outputs and 2 relay outputs.
The model **CVM-A1612-ITF** features 12 digital outputs and 4 relay outputs.

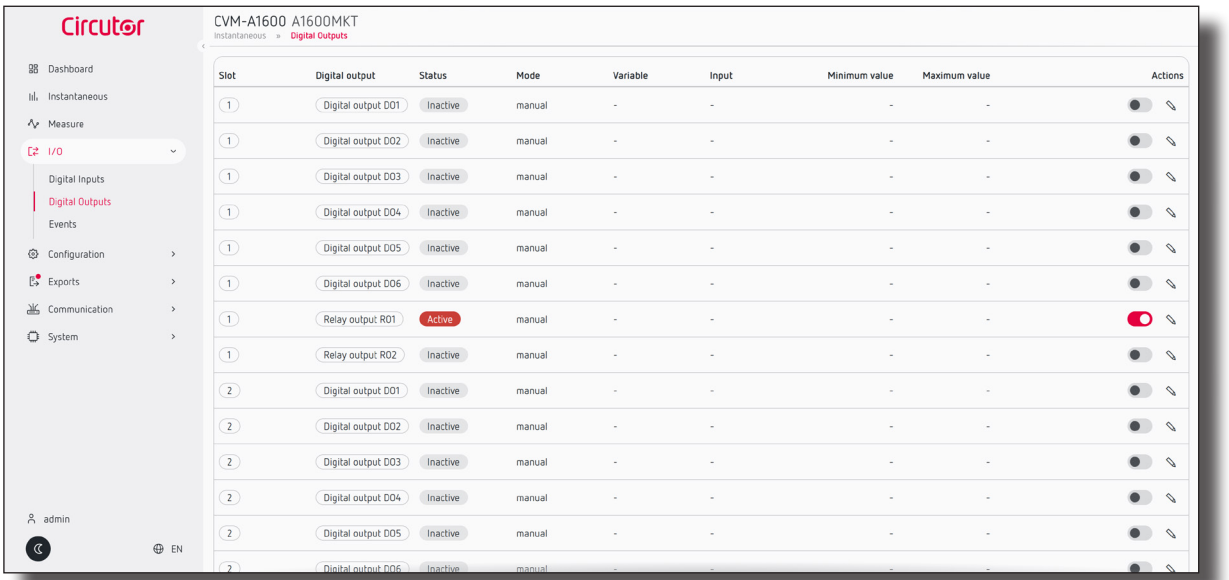


Figure 95: Web Page, I/O (Digital Outputs).

Press to access the Digital Output programming screen, **Figure 96.**

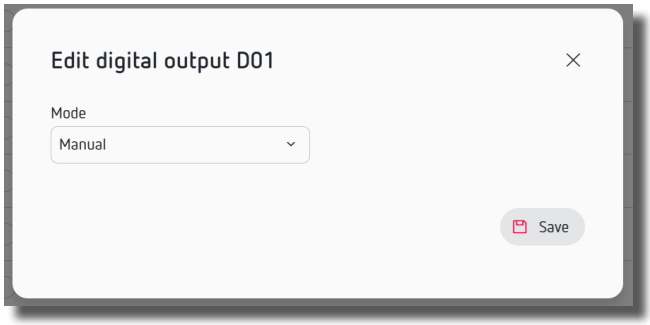


Figure 96: Edit digital output: Manual mode.

✓**Mode**: Select the operating mode of the digital output, **Table 24**.

Depending on the operating mode, the configuration parameters change.

8.4.2.1.- Mode: Manual

When Manual Mode is selected, **Figure 96**, the user can activate the digital output or relay output by enabling the switch .

8.4.2.2.- Mode: Variable

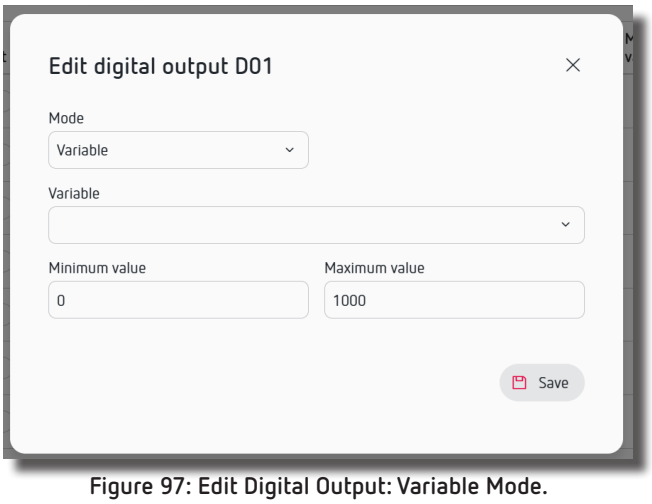


Figure 97: Edit Digital Output: Variable Mode.

✓**Variable**: Select the variable that will activate the digital output. **Table 10**, **Table 11**, **Table 12**, **Table 13** and **Table 14** provide a description of the variables corresponding to the abbreviations shown in this parameter.
✓**Maximum value**: Value below which the alarm is triggered.
✓**Minimum value**: Value above which the alarm is triggered.

Note: *In the event of an inverted limit configuration (**Maximum Value** lower than **Minimum Value**), the activation criterion becomes "out of range", activating when the measured value is lower than the **Maximum Value** or higher than the **Minimum Value**.*

Press **Save** to save the device configuration.

8.4.2.3.- Mode: Input

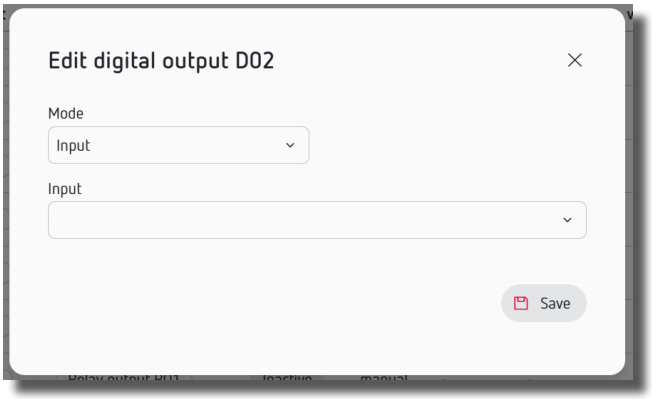


Figure 98: Edit Digital Output: Input Mode.

✓**Input**: Select the input that will activate the Digital Output.

Press **Save** to save the device configuration.

8.4.2.4.- Mode: Measure flagged

When this mode is enabled (**Figure 99)** the digital output is activated while a quality event (overvoltage, dip or interruption) is being detected.

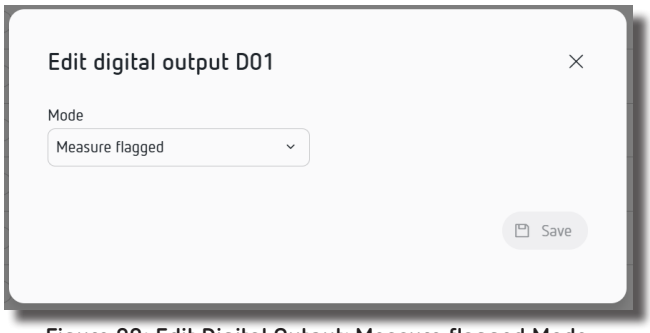


Figure 99: Edit Digital Output: Measure flagged Mode.

Press **Save** to save the device configuration.

8.4.2.5.- Mode: Energy

When this mode is enabled (**Figure 100)**, the digital output is activated based on an energy variable.

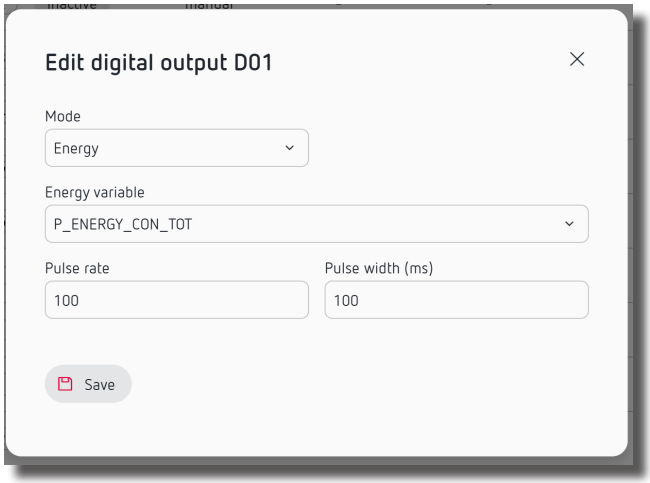


Figure 100: Edit Digital Output: Energy Mode.

✓**Energy variable**: Select the variable that will activate the digital output. **Table 15** provides a description of the variables corresponding to the abbreviations shown in this parameter.

✓**Pulse rate**: Energy equivalent to each pulse of the digital output, expressed in W·h/pulse, var·h/pulse or VA·h/pulse.
✓**Pulse width**: Pulse width in ms.

Note:*The energy used to generate the pulses is the energy accumulated every 3 seconds.*

Press **Save** to save the device configuration.

8.4.3.- EVENTS

On this screen, **Figure 101**, the events generated by the **CVM-A1600** digital inputs are displayed.

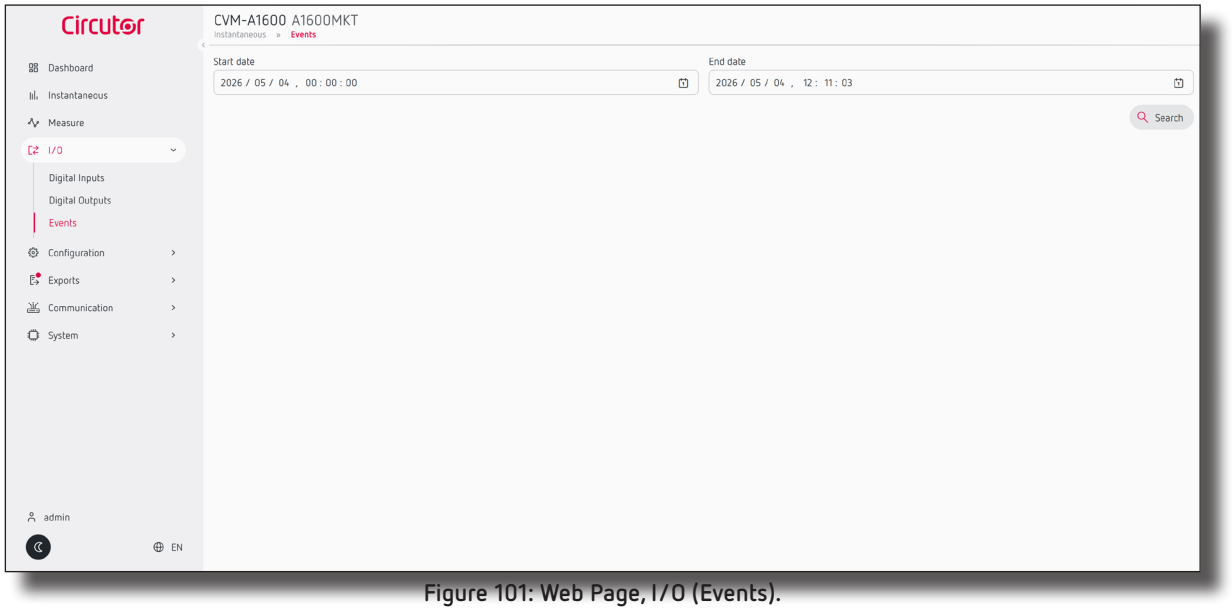


Figure 101: Web Page, I/O (Events).

Once the start and end dates have been selected, press Search.

8.5.- CONFIGURATION

In the **Configuration** section, the different parameters of the device are configured.

8.5.1.- INSTALLATION

On this screen, **Figure 102**, the installation parameters of the **CVM-A1600** are configured.

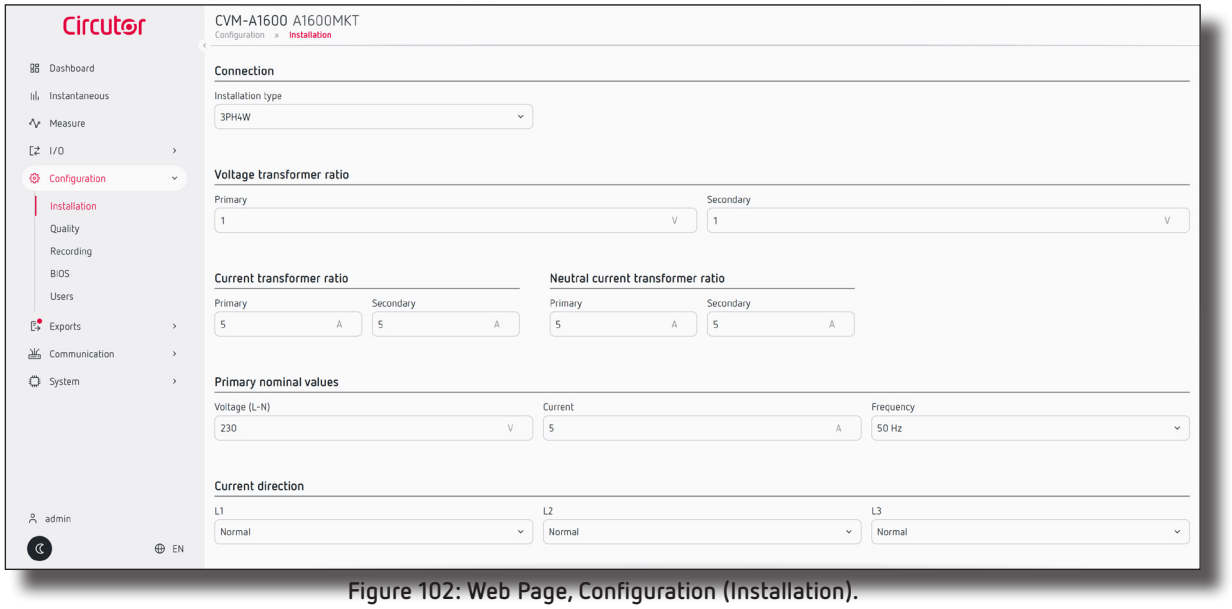


Figure 102: Web Page, Configuration (Installation).

8.5.1.1.- CONNECTION



Figure 103: Web Page, Configuration (Connection).

✓**Installation type:** configuration of the installation type, **Table 29**.

Note: *When the installation type is changed, the database is automatically deleted.*

8.5.1.2.- VOLTAGE TRANSFORMER RATIO

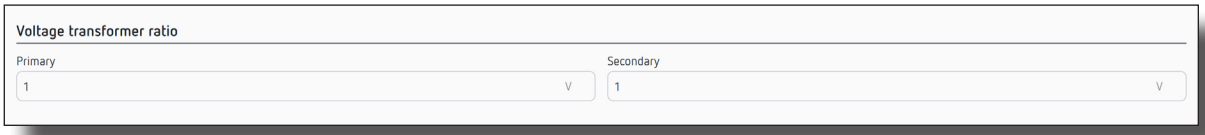


Figure 104: Web Page, Configuration (Voltage transformer ratio).

✓**Primary:** primary voltage, **Table 30**.
✓**Secondary:** secondary voltage, **Table 31**.

8.5.1.3.- CURRENT TRANSFORMER RATIO

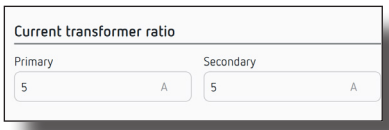


Figure 105: Web Page, Configuration (Current transformer ratio).

✓**Primary:** primary current, **Table 32**.
✓**Secondary:** secondary current, **Table 33**.

8.5.1.4.- NEUTRAL CURRENT TRANSFORMER RATIO



Figure 106: Web Page, Configuration (Neutral Current transformer ratio).

✓**Primary:** primary neutral current, **Table 34**.
✓**Secondary:** secondary neutral current, **Table 35**.

8.5.1.5.- PRIMARY NOMINAL VALUES



Figure 107: Web Page, Configuration (Primary nominal values).

✓**Voltage (L-N):** Nominal voltage being measured by the **CVM-A1600**. The value to be programmed must be phase-to-neutral and always referenced to the primary. This value is essential for the proper functioning of event recording, **Table 36**.
Example: *If a 22000/110 voltage transformer is connected, the programming must be:*

Primary voltage = 22000
Secondary voltage = 110
Voltage (Nominal voltage) = 22000

✓**Current:** Nominal current measured by the device, which will be used to set the maximum and minimum percentages to record disturbances. By default, this value is 5 A. It is recommended to program the same value as in the measuring transformers, **Table 37**.

✓**Frequency:** Nominal frequency of the network being analyzed. This parameter is necessary to calculate the RMS value of the signal in extreme quality networks, **Table 38**

8.5.1.6.- CURRENT DIRECTION

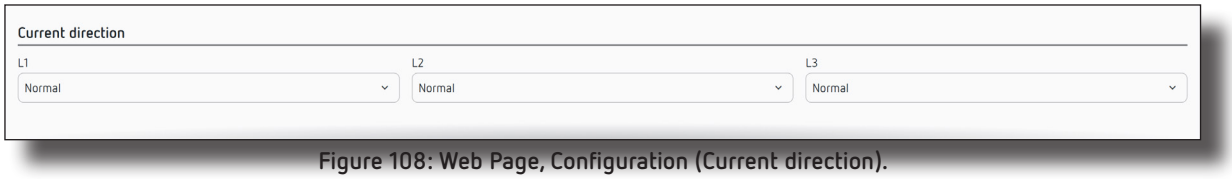


Figure 108: Web Page, Configuration (Current direction).

✓**L1:** Select the current direction of L1,**Table 39**.
✓**L2:** Select the current direction of L2,**Table 39**.
✓**L3:** Select the current direction of L3,**Table 39**.

8.5.1.7.- PHASES SEQUENCE



Figure 109: Web Page, Configuration (Phase sequence).

✓**Voltage:** Select the voltage phase sequence,**Table 40**.
✓**Current:** Select the current phase sequence, **Table 41**.

8.5.1.8.- MAX/MIN ORIGIN

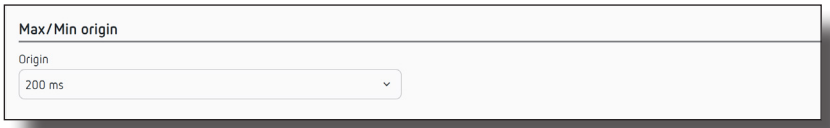


Figure 110: Web Page, Configuration (Max/Min origin).

✓**Origin:** Allows selection of the source of the maximum and minimum values corresponding to the user-defined period, **Table 42**.

8.5.1.9.- FULL LOAD CURRENT (I_L)

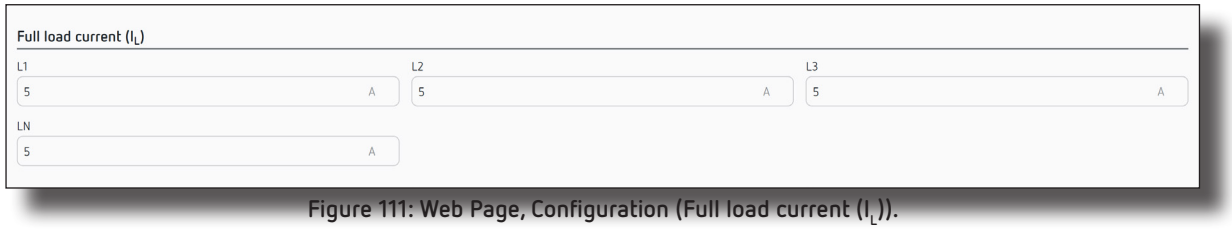


Figure 111: Web Page, Configuration (Full load current (I_L)).

✓**L1:** Maximum load current in L1, used for the calculation of TDD (Total Demand Distortion),**Table 43**.

✓**L2:**Maximum load current in L2, used for the calculation of TDD (Total Demand Distortion),**Table 43**.
✓**L3:**Maximum load current in L3, used for the calculation of TDD (Total Demand Distortion),**Table 43**.
✓**LN:**Maximum load current in LN, used for the calculation of TDD (Total Demand Distortion), **Table 43**.

8.5.1.10.- SHORT CIRCUIT CURRENT (I_{CC})



Figure 112: Web Page, Configuration (Short circuit current (I_{cc})).

✓**Icc:** Short circuit current, **Table 44**.

Press **Save** to save the device configuration.

8.5.2.- QUALITY

On this screen, **Figure 113**, the device power quality parameters are configured.

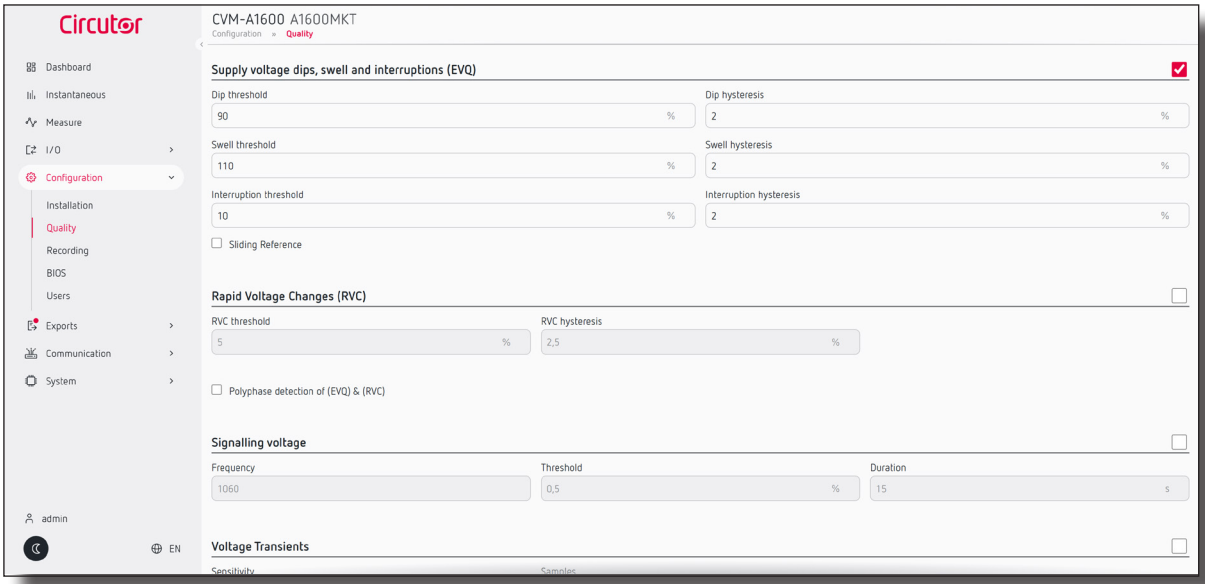


Figure 113: Web Page, Configuration (Quality).

8.5.2.1.- SUPPLY VOLTAGE DIPS, SWELL AND INTERRUPTIONS (EVQ)

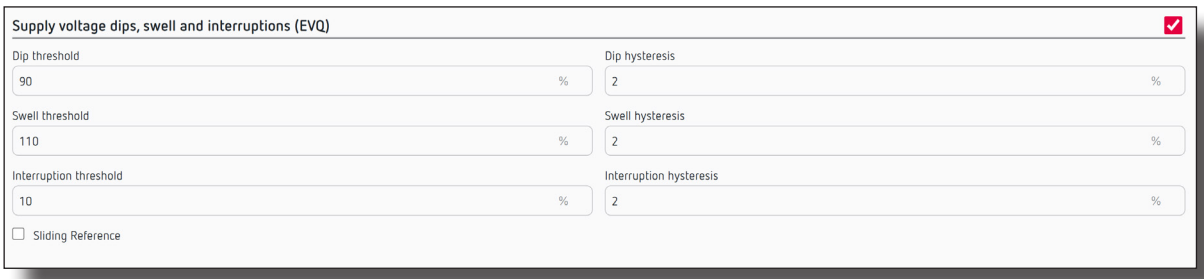


Figure 114: Web Page, Configuration (Supply voltage dips, swell and interruptions EVQ)).

☑ Enable or disable the Supply voltage dips, swell and Interruptions parameters.

✓**Dip threshold**: A voltage dip is considered to occur when the RMS voltage value falls below the

threshold programmed in this parameter. The value is configured as a % relative to the nominal voltage value, **Table 45**.

✓**Dip hysteresis**: dip hysteresis value, so that the triggering and resetting values of the event are not the same. The value is configured as a % of the **Dip threshold** value, **Table 46**.

✓**Swell threshold**: An overvoltage is considered to occur when the RMS voltage value exceeds the threshold programmed in this parameter. The value is configured as a % relative of the nominal voltage value, **Table 47**.

✓**Swell hysteresis**: overvoltage hysteresis value, to ensure the trip value and reset value of the event are not the same. The value is configured as a % of the **Swell Threshold** value**, Table 48**.

✓**Interruption threshold**: an interruption is considered to occur when the RMS voltage value falls below the threshold programmed in this parameter. The value is configured as a % relative to the nominal voltage value, **Table 49**.

✓**Interruption hysteresis**: interruption hysteresis value, to ensure the trip value and reset value of the event are not the same. The value is configured as a % of the **Interruption threshold** value**, Table 50**.

☑ **Sliding reference**: enables or disables the Sliding Reference.
The Sliding Reference is the 1-minute average voltage value preceding a voltage dip or overvoltage. If the Sliding Reference voltage is enabled, the voltage levels for dip or overvoltage detection will be calculated based on the threshold percentages referenced to this voltage.

8.5.2.2.- RAPID VOLTAGE CHANGES (RVC)

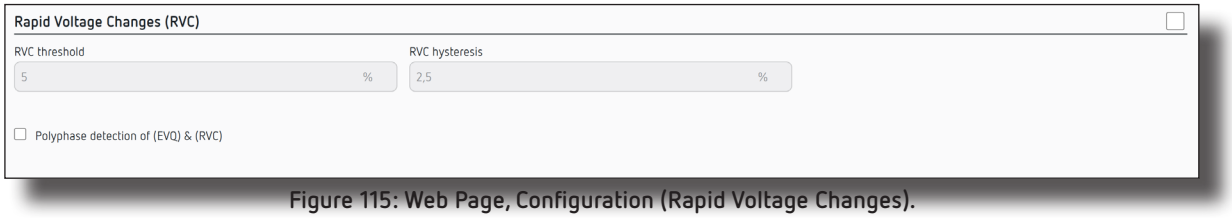


Figure 115: Web Page, Configuration (Rapid Voltage Changes).

☑ Select activation or deactivation of the RVC parameters.

✓**RVC threshold**: a rapid voltage change (RVC) is considered to occur when the RMS voltage value falls below the threshold programmed in this parameter. The value is configured as a % relative to the arithmetic mean of the prior 100 Urms ½ values, **Table 51**.

✓**RVC hysteresis**: hysteresis value for RVC, ensuring the trigger and reset values of the event are not the same. The value is configured as a % of the **RVC Threshold** value, **Table 52**.

☑ **Polyphase detection of (EVQ) and (RVC)**: enables or disables Polyphase detection. Polyphase refers to the detection of sags, overvoltages, interruptions, and RVC across multiple phases. This means an event in any of the 3 phases, or more than one simultaneously, will result in a polyphase event according to the characteristics specified for each event in **IEC 61000-4-30**.

Note: *To achieve a stable measurement voltage close to the Nominal Voltage, the configuration values must be higher than those programmed for dip detection. Otherwise, when the device detects a sag, it will no longer consider RVC detection.*

8.5.2.3.- SIGNALLING VOLTAGE



Figure 116: Web Page, Configuration (Signalling voltage).

☑ Enable or disable signalling voltage detection.

Voltage signalling signals that may travel through the supply network are typically burst signals applied at non-harmonic frequencies to remotely control industrial devices or other devices.
The method used by the **CVM-A1600** to detect signalling voltage measures the level of a voltage signal at a specified carrier frequency.

✓**Frequency:** Frequency to be monitored,**Table 53**.
✓**Threshold**: Detection threshold as a % of the Nominal Voltage, **Table 54**.
✓**Duration**: Time period during which the specified values are recorded, **Table 55**.

8.5.2.4.- VOLTAGE TRANSIENTS

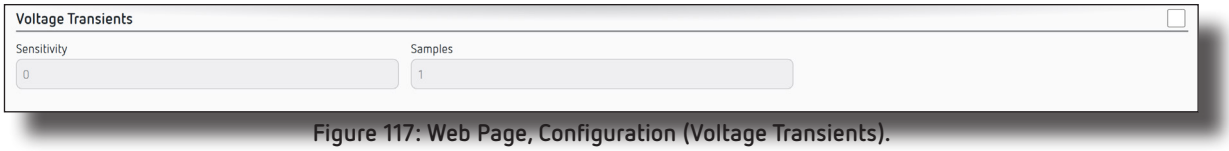


Figure 117: Web Page, Configuration (Voltage Transients).

☑ Enable or disable voltage transient detection.

✓**Sensitivity**: This parameter allows adjustment of the transient detection level to avoid false positives. The value is entered in %, **Table 56**.
✓**Samples**: Number of samples used for voltage transient detection, **Table 57**.

For more information see ***"4.2.1.- QUALITY PARAMETERS".***

8.5.2.5.- CURRENT TRANSIENTS

The device detects rapid and slow current transients independently, see "***4.2.1.- QUALITY PARAMETERS***".

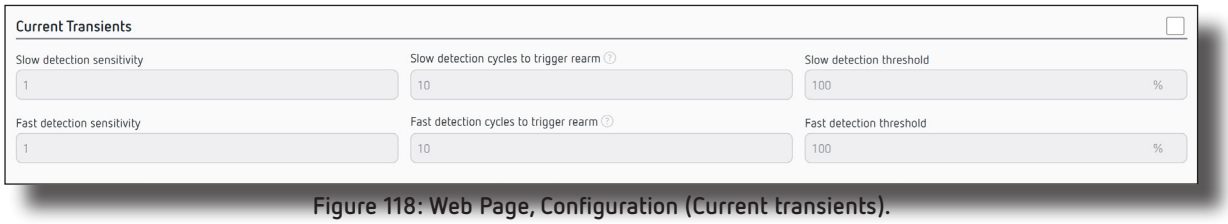


Figure 118: Web Page, Configuration (Current transients).

☑ Enable or disable current transient detection.

Parameters for slow transient calculation:

✓**Slow detection sensitivity**: value used to reduce sensitivity to false positives, **Table 58**.
✓**Slow detection cycles to trigger rearm:** Number of cycles until the end of the transient that are inhibited for detecting new current transients, **Table 59**.

✓**Slow detection threshold:** Threshold value for detecting slow transients in %. The value is configured as a % of the nominal current value, **Table 60**.

Parameters for fast transient calculation:

✓**Fast detection sensitivity**: value used to reduce sensitivity to false positives, **Table 61**.

✓**Fast detection cycles to trigger rearm:** Number of cycles until the end of the transient that are inhibited for detecting new current transients, **Table 62**.

✓**Fast detection threshold:** Threshold value for the detection of fast transients in %. The value is configured as a % of the nominal current value, **Table 63**.

8.5.2.6.- WAVEFORM

In this section, the waveform to be displayed on the ***"5.3.5.- WAVEFORM"*** screen or on the ***"8.2.5.- WAVEFORM"*** Web Page is selected.

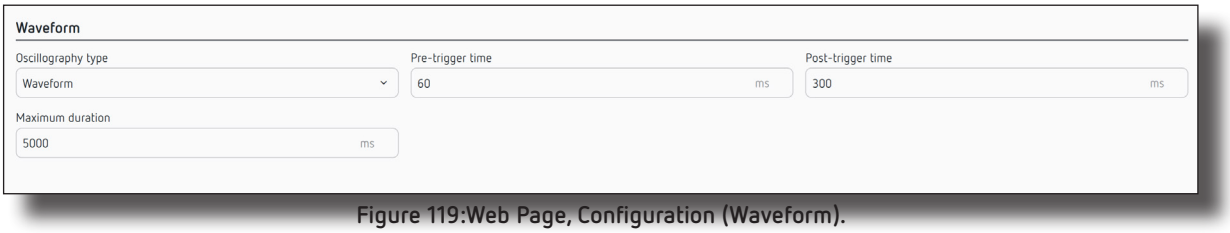


Figure 119:Web Page, Configuration (Waveform).

✓**Oscillography type :** Select one of the following options, **Table 82**.

Table 82: Configuration values: Oscillography type.

Oscillography type	
Possible values	**Disabled**, the device does not record waveforms.
	Waveform, the device records the waveform of the input signal.
	RMS, the device records the RMS values over 1 cycle, updated every ½ cycle.

✓**Pre-trigger time:** recording time prior to the trigger condition, **Table 65**.

✓**Post-trigger time:** recording time after the trigger condition,**Table 66**.

✓**Maximum duration:** Maximum waveform recording time (Pre-trigger Time + Post-trigger Time), **Table 67**.

8.5.2.7.- THD/TDD HARMONICS

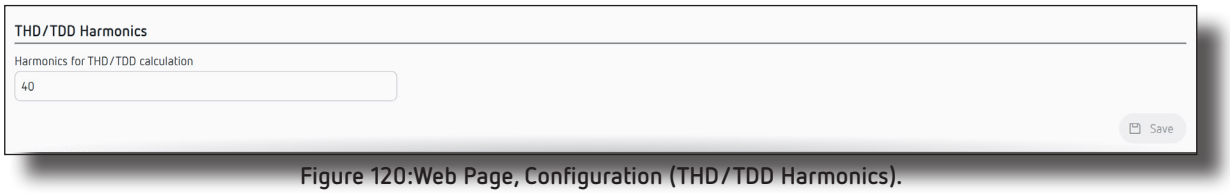


Figure 120:Web Page, Configuration (THD/TDD Harmonics).

✓**Harmonics for THD/TDD calculation:** Number of harmonics used to calculate THD and TDD, **Table 68**.

Press **Save** to save the device configuration.

8.5.3.- RECORDING

On this screen, **Figure 121**, the parameters to be recorded in the database are selected. The APIs (Application Programming Interfaces) available for accessing the database are described in Application Note **M294E0101-01-xxx**.
The API can also be downloaded from the following link:

https://docs.circutor.com/docs/QNA_REST_API.yaml

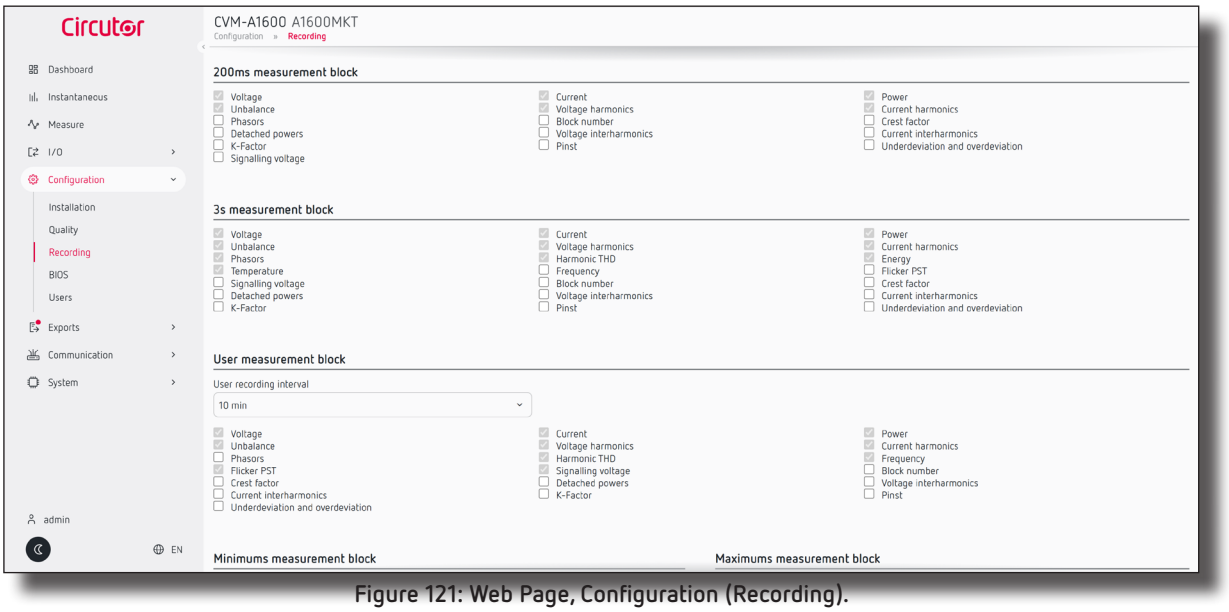


Figure 121: Web Page, Configuration (Recording).

The parameters can be recorded in different measurement blocks:

✓**200 ms measurement block**.
✓**3 s measurement block**.
✓**User measurement block**.

In this block, the user selects the recording period using the **User Recording Interval** parameter, **Table 69**.

✓**Minimums measurement block**.
✓**Maximums measurement block**.

For each measurement block, depending on the selected global parameter, the device records certain parameters, see **Table 70**.

<u>Energy meter</u>

The device records the energy parameters shown in **Table 71**.

Press **Save** to save the configuration and send it to the device.

8.5.4.- BIOS

On this screen, **Figure 122**, the colour coding for each line is configured according to the regulations of the country where the device is installed.

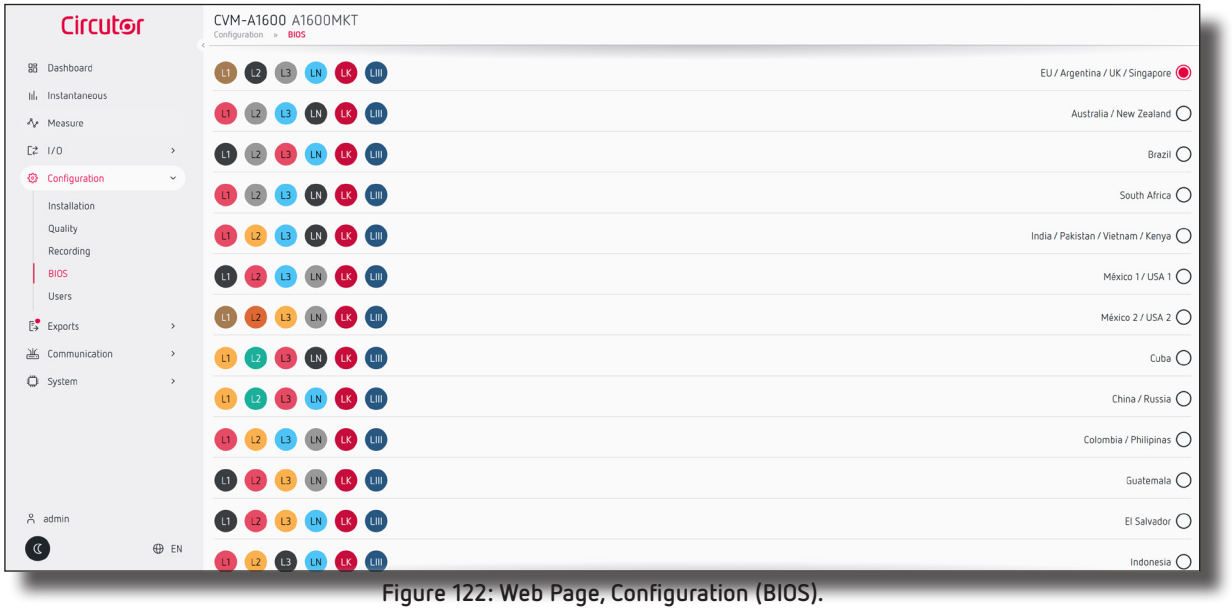


Figure 122: Web Page, Configuration (BIOS).

Press **Save** to save the device configuration.

8.5.5.- USERS

On this screen, **Figure 123**, the permissions of the different **CVM-A1600** users can be managed, their passwords can be changed, and new users can be created.

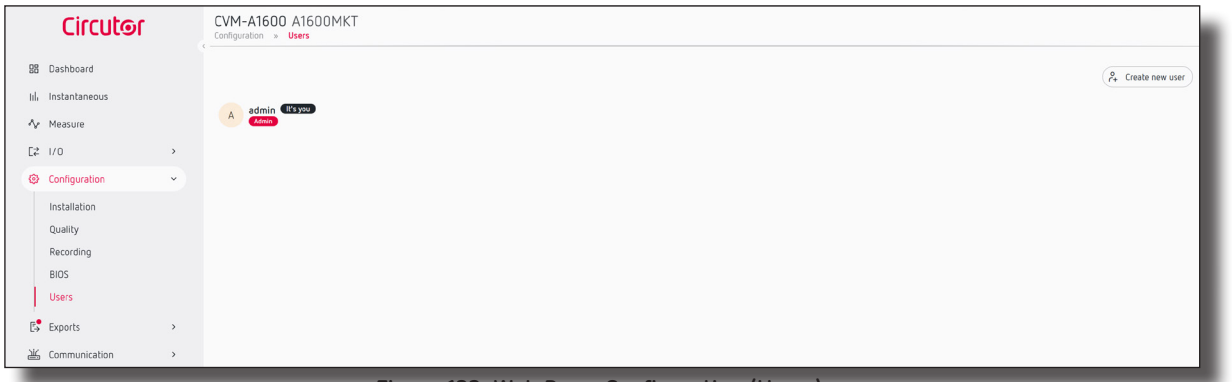


Figure 123: Web Page, Configuration (Users).

8.6.- EXPORTS

In the **Exports** section, data exports are configured.

8.6.1.- NOTIFICATIONS

In this section, the notifications that can be generated by the device are displayed and configured, **Figure 124**.

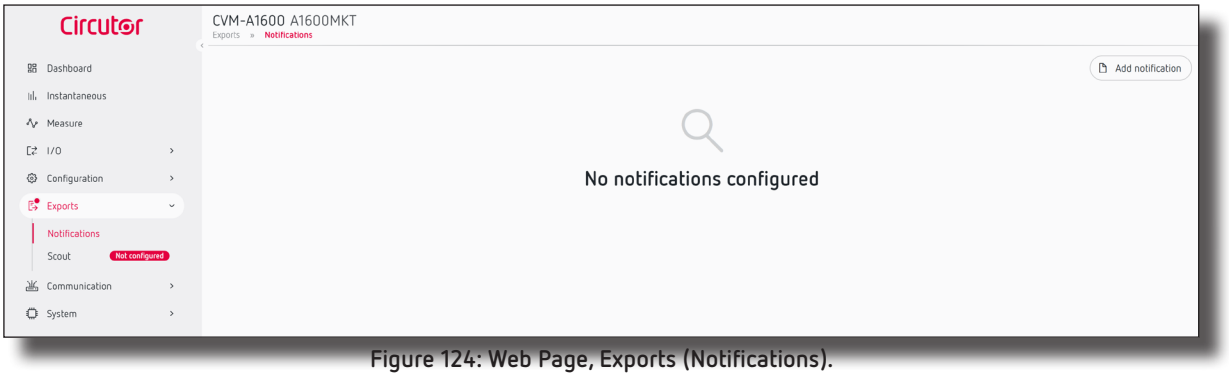


Figure 124: Web Page, Exports (Notifications).

Press **Add notification** to add a new notification. The screen shown in **Figure 125** is displayed.

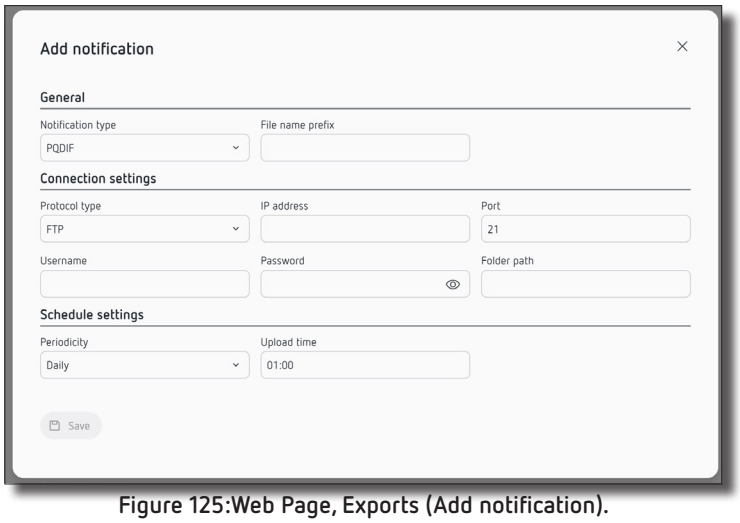


Figure 125:Web Page, Exports (Add notification).

General

✓**Notification type:** Select the type of notification, see **Table 73.**
✓**File name prefix:** Prefix added to the name of the notification being sent.
Parameter available when selecting the type of notification: **PQDIF**, **EN50160, IEEE 519** and **Código Red México**.

✓**Language**: Select the language of the notification, **Table 74**.
Parameter available when selecting the type of notification: **EN50160**, **IEEE 519**, **Código Red México** and **Quality Events**.

Connection settings

✓**Protocol type:** Protocol used for notification generation, see **Table 75**.

Note: ***Quality Event*** *notifications are only available using the* ***SMTP*** *protocol.*
When selecting as **Protocol type:** **FTP** or **SFTP**, the Parameters are:

✓**IP Address:** IP address of the server where notifications are sent.
✓**Port:** Server port.
✓**Username:** Server username.
✓**Password:** Password for the server user.
✓**Folder path:** Server path.

When selecting as **Protocol type: SMTP**, the Parameters are:

✓**Host**: Mail server host.
✓**Port**: Server port.
✓**Sender**: Sender email address.
✓**Password**: User password.
✓**Recipient**: Recipient email address.

Schedule settings

✓**Periodicity:** Frequency of notification generation, **Table 76**.
Note:*The option* ***Occasionally*** *is only available for the* ***Notification Type****:* ***PQDIF*** *and* ***Quality Events****.*

✓**Upload time:** Notification sending time.

When selecting as **Notification type: Quality events**, additionally the following must be configured:

✓**Silence time (min)**: Minimum time interval between successive emails, **Table 77**.

8.6.2.- Scout

Scout is **CIRCUTOR**'s electrical monitoring platform that allows the **CVM-A1600** to be connected in order to provide centralised monitoring of electrical parameters, real-time visualisation of events and alarms, power quality analysis, and automatic reporting on installation performance.
If the device connection has not been configured, the screen shown in **Figure 126** is displayed to begin the configuration.

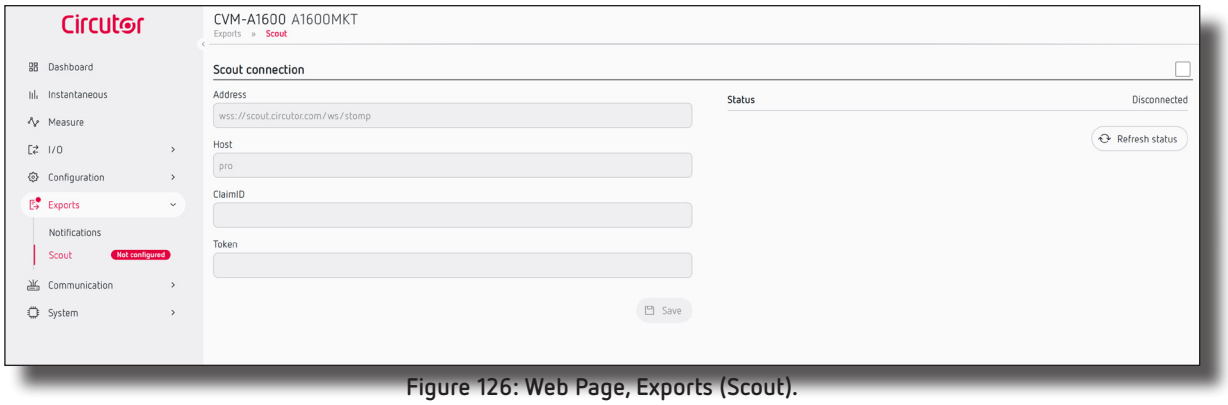


Figure 126: Web Page, Exports (Scout).

Connection to Scout: ☑ Select whether to enable or disable the connection of the **CVM-A1600** to the Scout platform.
Enabling this connection also enables remote firmware updates for the device and a remote access tunnel to its Web page.

If this option is enabled, the following parameters must be configured:

✓**Address:** URL of the platform.
✓**Host:** Virtual host of the STOMP server used for communication with the platform.
✓**ClaimID:** Unique identifier of the device on the platform.
✓**Token:** Authorisation key for communication with the platform.

Press 🖫 **Save** to save the device configuration.

✓**Status:** Status of the connection to the platform.

Press ⟳ **Refresh status** to refresh the connection status.

8.7.- COMMUNICATION

8.7.1.- ETHERNET

Ethernet communication settings for **Ports 1** and **2**, **Figure 127**.

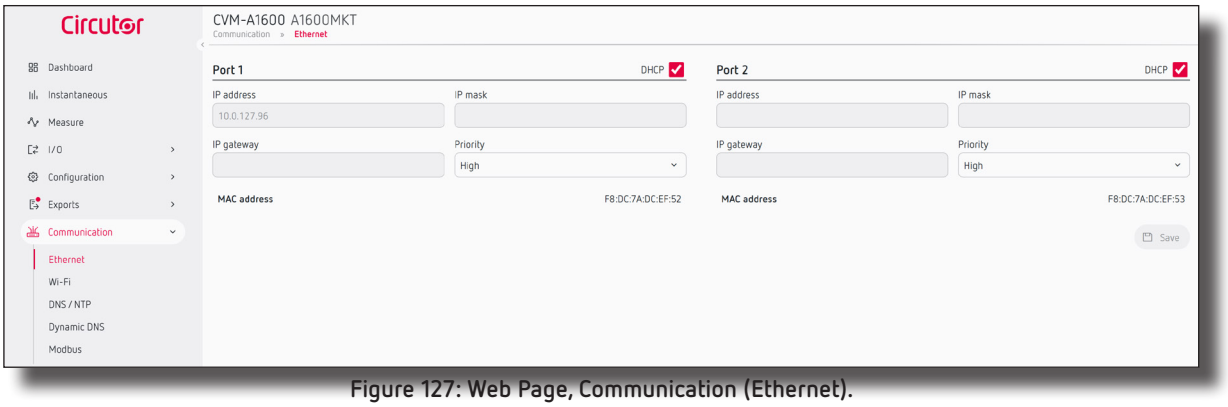


Figure 127: Web Page, Communication (Ethernet).

DHCP ☑ : If DHCP is enabled, the IP address is dynamically assigned by a central server and no additional parameters need to be configured.
If this option is disabled, ☐, the IP address is fixed and the following parameters need to be configured:

✓**IP address**: IP address.
✓**IP mask**: IP subnet mask.
✓**IP gateway**: gateway.
✓**Priority**: selects the priority of the Ethernet communications when accessing the Internet. If the priority of all interfaces (Ethernet and Wi-Fi) is the same, the **CVM-A1600** connects to the Internet using the first interface with an active connection.
✓**MAC Address**: device MAC address, non-configurable parameter.

Press 🖫 **Save** to save the configuration and send it to the device.

8.7.2.- Wi-Fi

Wi-Fi communications configuration, **Figure 128**.

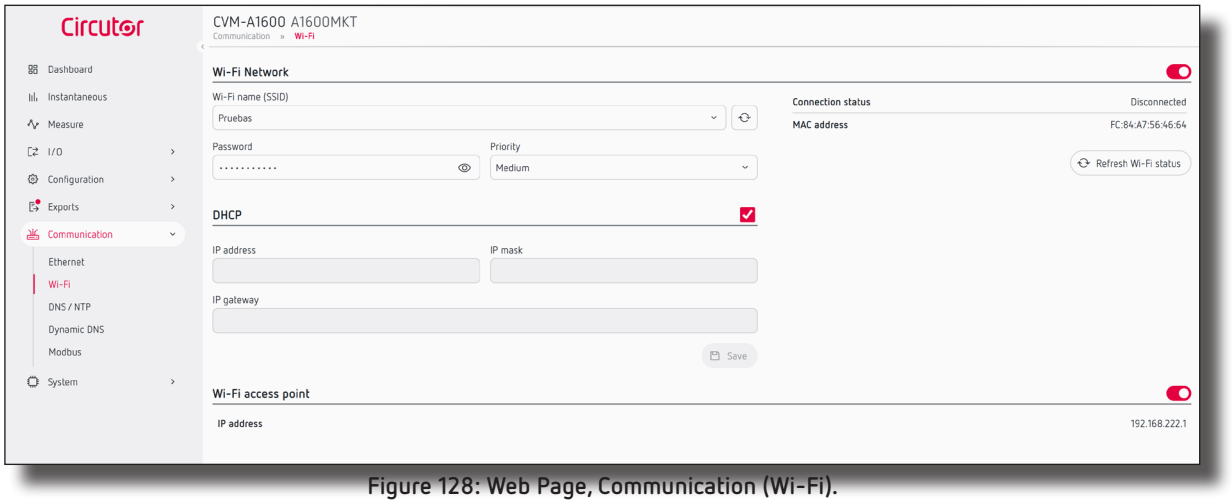


Figure 128: Web Page, Communication (Wi-Fi).

Wi-Fi Network Enables or disables Wi-Fi communications. If enabled, the following parameters must be configured:

✓**Wi-Fi name (SSID):** Wi-Fi network name. Press ⟳ to refresh the list of Wi-Fi networks.

✓**Password:** Network access password.

✓**Priority:** the priority of the Wi-Fi communications is selected for internet access. If the priority of all interfaces (Ethernet and Wi-Fi) is the same, the **CVM-A1600** connects to the Internet using the first interface with an active connection.

DHCP ☑ : If DHCP is enabled, the IP address is dynamically assigned by a central server and no additional Parameters need to be configured.
If this option is disabled, ☐, the IP address is fixed and the following parameters need to be configured:

✓**IP address**: IP address.

✓**IP mask**: IP mask.

✓**IP Gateway**: gateway.

Press 🖫 **Save** to save the device configuration.

✓**Connection status**: Wi-Fi connection status.

✓**MAC Address**: MAC address of the device, non-configurable parameter.

Press ⟳ **Refresh Wi-Fi status**, to refresh the list of Wi-Fi networks.

Wi-Fi access point : Enable or disable the device as a Wi-Fi access point.

The access point name is **CIR-XXXX**, where **X** represents the last four digits of the device serial number.
Password: the last eight digits of the device serial number.

✓**IP Address:** device IP address, non-configurable parameter. (**192.168.222.1**)

8.7.3.- DNS/NTP

On this screen, **Figure 129**, the **DNS** (*Domain Name System*) and **NTP** (*Network Time Protocol*) servers are configured.

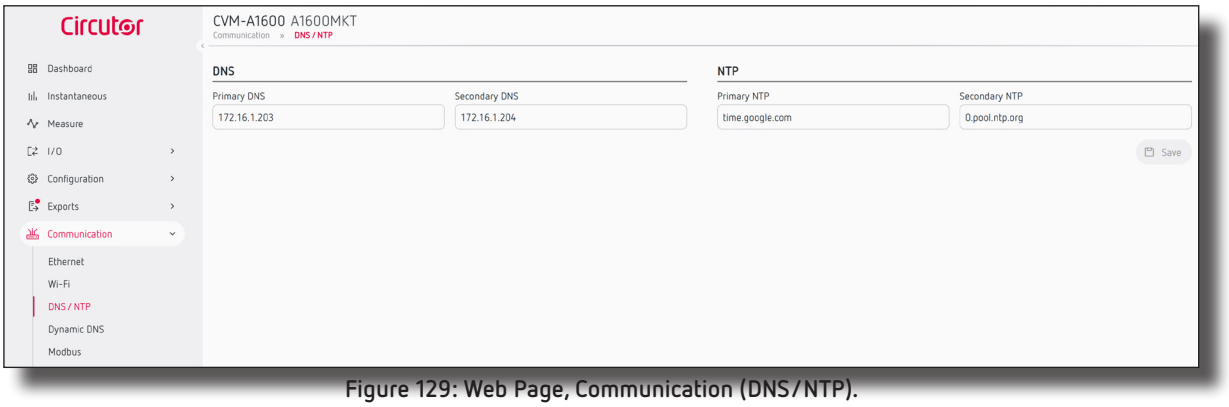


Figure 129: Web Page, Communication (DNS/NTP).

✓**Primary DNS**: address of the primary DNS server.
✓**Secondary DNS**: address of the secondary DNS server.
✓**Primary NTP**: address of the clock synchronisation server (*Network Time Provider*).
✓**Secondary NTP**: secondary Network Time Provider address, in case the primary NTP fails.

Press **Save** to save the configuration and send it to the device.

8.7.4.- DYNAMIC DNS

On this screen, **Figure 130**, the Dynamic DNS server is configured.



Figure 130:Web Page, Communication (Dynamic DNS).

Dynamic DNS : Enables or disables dynamic DNS. If enabled, it is necessary to configure the following parameters:
✓**Service:** Select the type of service, **Table 25.**
✓**Username:** DNS server username.
✓**Password:** DNS server access password.
✓**Host:** Server host name.

Press **Save** to save the configuration and send it to the device.

8.7.5.- MODBUS

On the **Modbus** screen, **Figure 131**, the RS-485 communications using the **MODBUS RTU®** protocol are displayed and configured.



Figure 131: Web Page, Communication (Modbus).

✓**Baudrate:** Select the Modbus communication baud rate, **Table 26**.
✓**Stop Bits:** Number of stop bits, **Table 27**.
✓**Parity:** Communications parity, **Table 28.**
✓**Slave ID:** Device identification number.

Press **Save** to save the configuration and send it to the device.

8.8.- SYSTEM

In the **System** section, device information is displayed, and the device can be updated and restarted.

8.8.1.- INFO

On this screen, **Figure 132**, the device information can be viewed or modified.

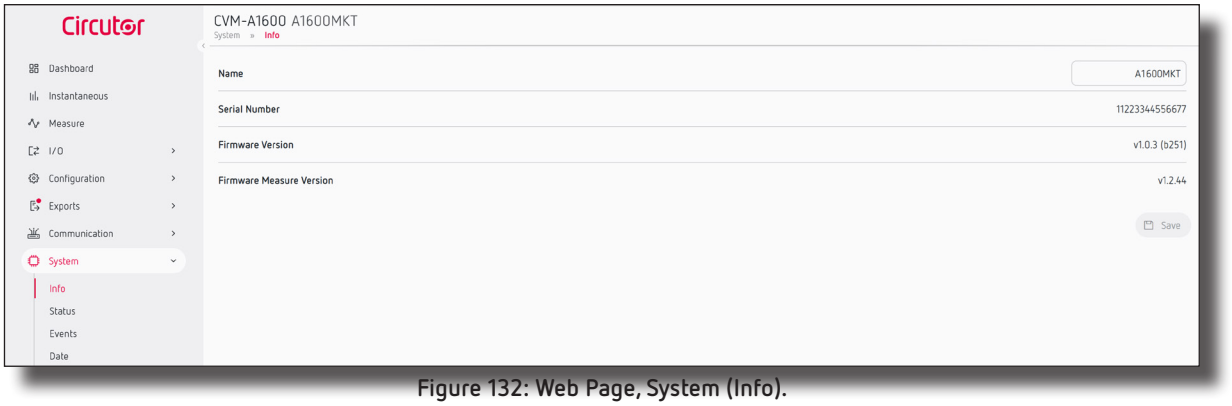


Figure 132: Web Page, System (Info).

✓**Name**: device name.
✓**Serial Number**: device serial number.
✓**Firmware Version**: device firmware version.
✓**Firmware Measure Version**: measurement software version.

Press **Save** to save the configuration and send it to the device.

8.8.2.- STATUS

On this screen, **Figure 133**, the device status information is displayed.

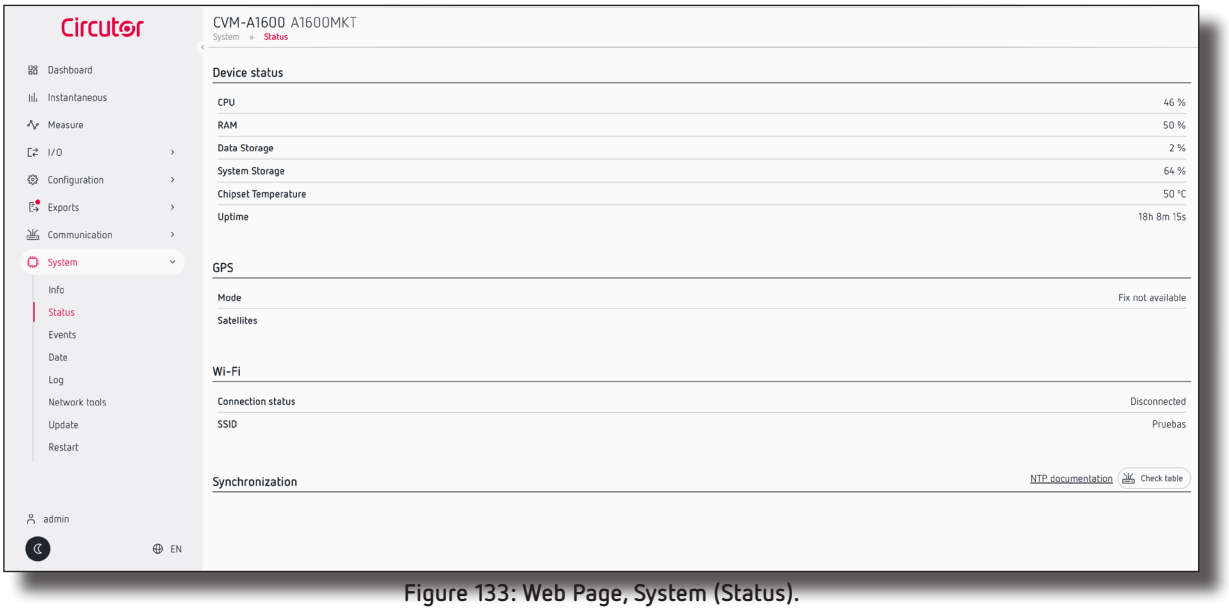


Figure 133: Web Page, System (Status).

8.8.3.- EVENTS

On this screen, **Figure 134**, the system events generated by the **CVM-A1600** on a specific date are displayed.

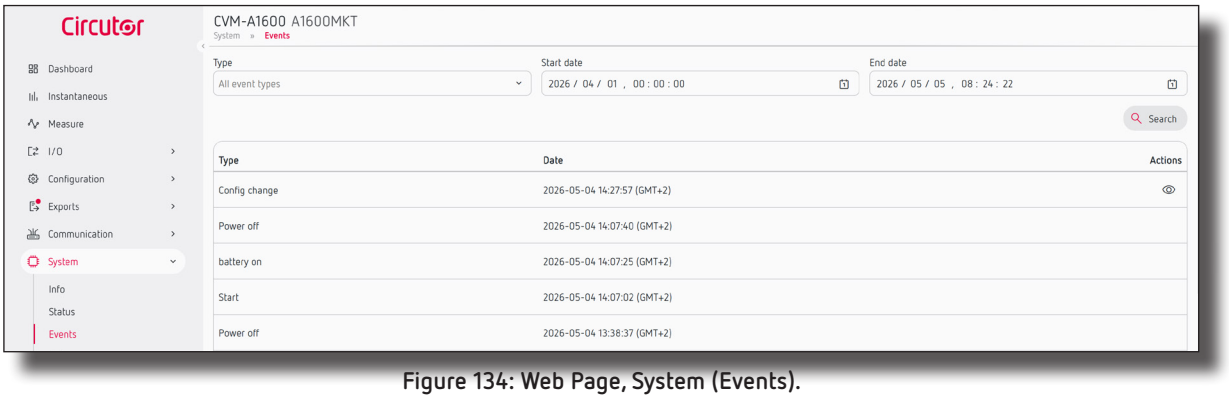


Figure 134: Web Page, System (Events).

The possible system events are listed in **Table 78**.
Once the event type and the start and end dates have been selected, press **Search**.

8.8.4.- DATE

On this screen, **Figure 135**, the device time zone, date, and time are configured.

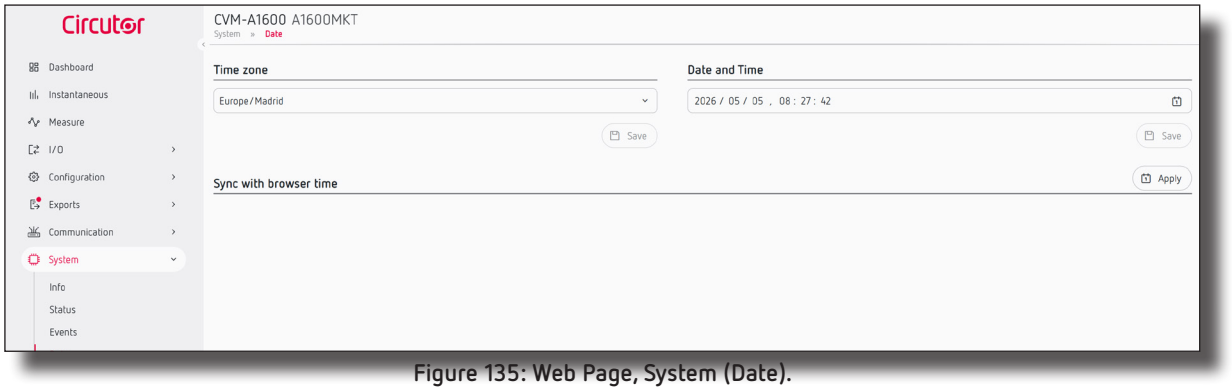


Figure 135: Web Page, System (Date).

✓**Time zone:** time zone where the device is located.
✓**Date and Time:** Device date and time.

Press **Save** to save the configuration and send it to the device.

8.8.5.- LOG

On this screen, **Figure 136**, all the events recorded by the device are displayed.
The displayed values can be configured to refresh every **3s, 10 s**, **30 s** or **1 m.**

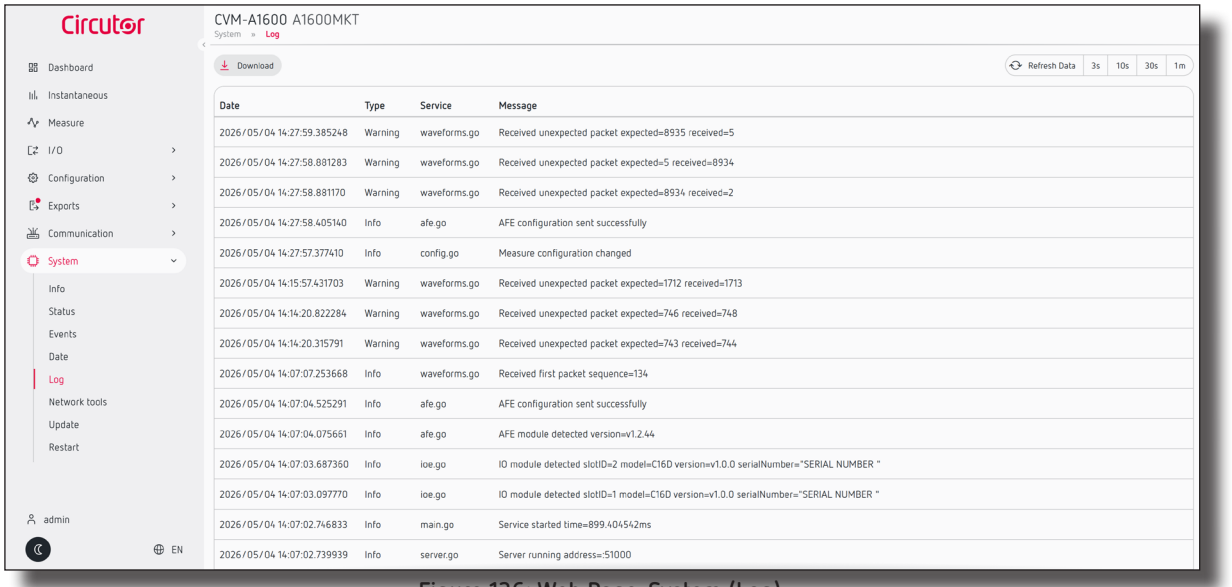


Figure 136: Web Page, System (Log).

The event log can be downloaded by pressing **Download**.

8.8.6.- NETWORK TOOLS

On this screen, **Figure 137**, the network status is displayed.

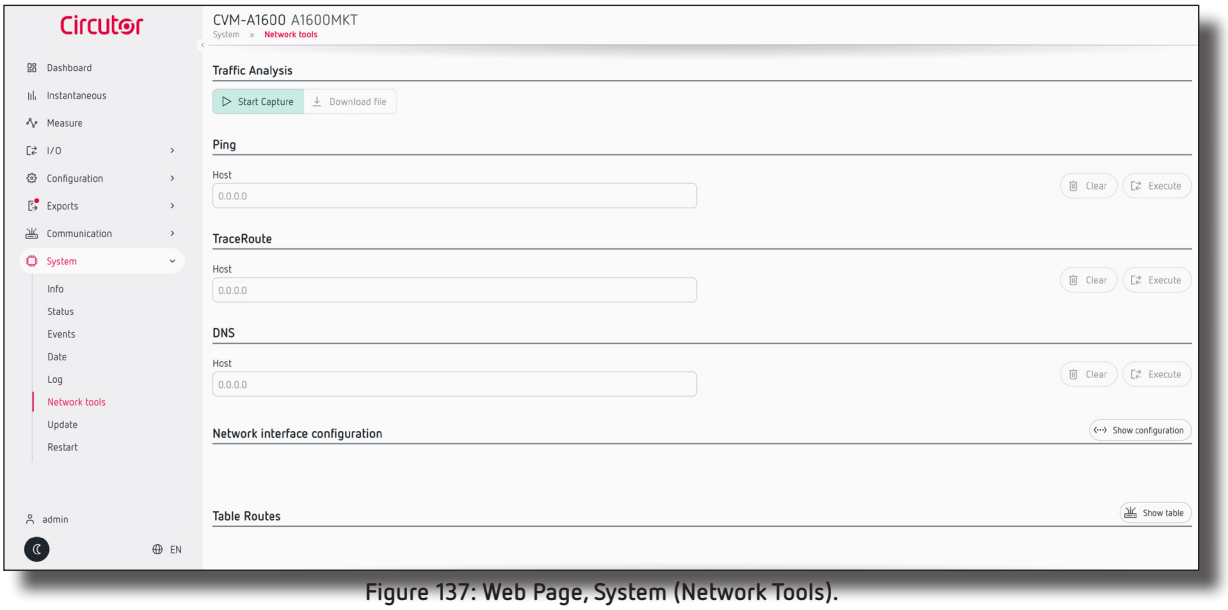


Figure 137: Web Page, System (Network Tools).

8.8.6.1.- Traffic Analysis

In this section, **Figure 138**, network traffic can be captured and downloaded.



Figure 138: Web Page, System (Traffic Analysis).

8.8.6.2.- Ping

In this section, **Figure 139**, an IP address or a web address can be entered to check the device's connection to the specified IP address or website.

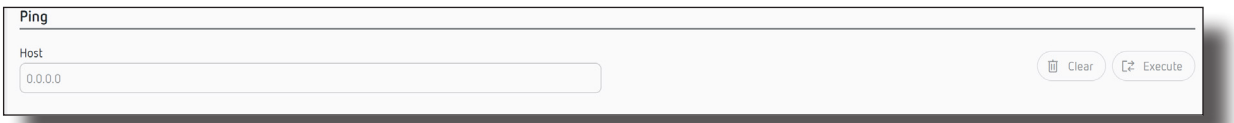


Figure 139: Web Page, System (Ping).

Press **Execute** to start the verification.

This tool is useful for verifying the device's connection to the **Scout** platform.

8.8.6.3.- TraceRoute

In this section, **Figure 140**, an IP address or a web address can be entered to trace the path that data takes from the device to the Internet server.



Figure 140: Web Page, System (TraceRoute).

Press **Execute** to start the verification.

8.8.6.4.- DNS

In this section, **Figure 141**, a domain name (DNS) can be entered to resolve it to its IP address.

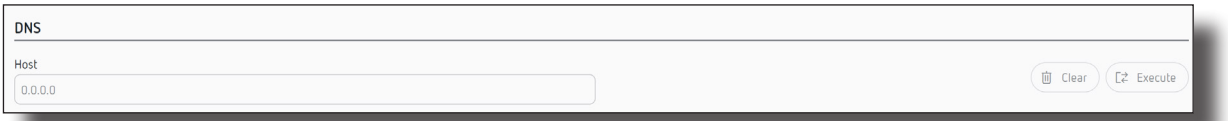


Figure 141: Web Page, System (DNS).

Press **Execute** to start the verification.

8.8.6.5.- NETWORK INTERFACES CONFIGURATION

Press **Show configuration**, **Figure 142**, to display the network interface configuration.

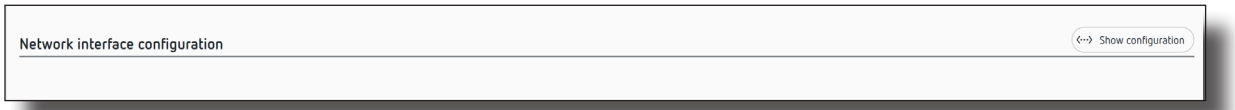


Figure 142: Web Page, System (Network interface configuration).

8.8.6.6.- TABLE ROUTES

Press **Show table** to display the routing table, **Figure 143**.



Figure 143: Web Page, System (Table Routes).

8.8.6.7.- REMOTE SUPPORT ACCESS (SSH)

Enable or disable remote access through the network port used by the device to accept **SSH** (*Secure Shell*) connections.
SSH is a secure protocol that enables remote access to a device for management via a console or secure file transfer, **Figure 144**.

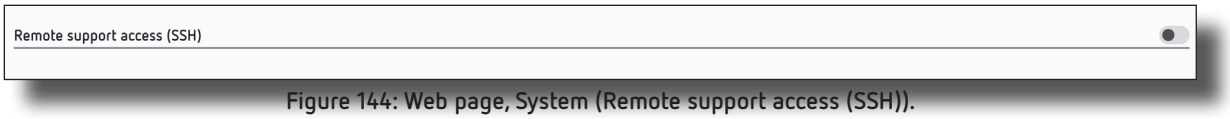


Figure 144: Web page, System (Remote support access (SSH)).

✓**Remote access SSH port:** By default, **SSH** uses TCP port 22.

8.8.7.- UPDATE

On this screen, **Figure 145**, the device firmware can be updated.

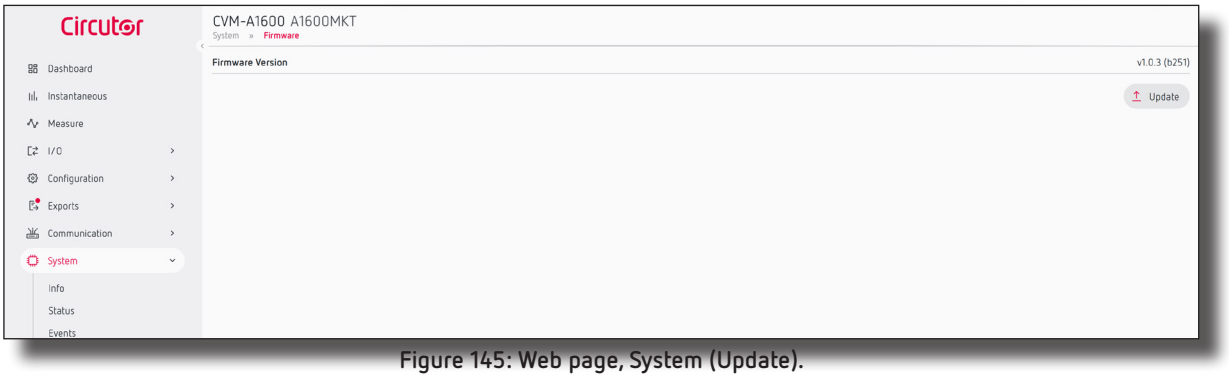


Figure 145: Web page, System (Update).

✓**Firmware version:** Firmware version.

Press Upgrade to start the device software update.

8.8.8.- RESTART

On this screen, **Figure 146**, the device can be restarted by pressing **Restart**.

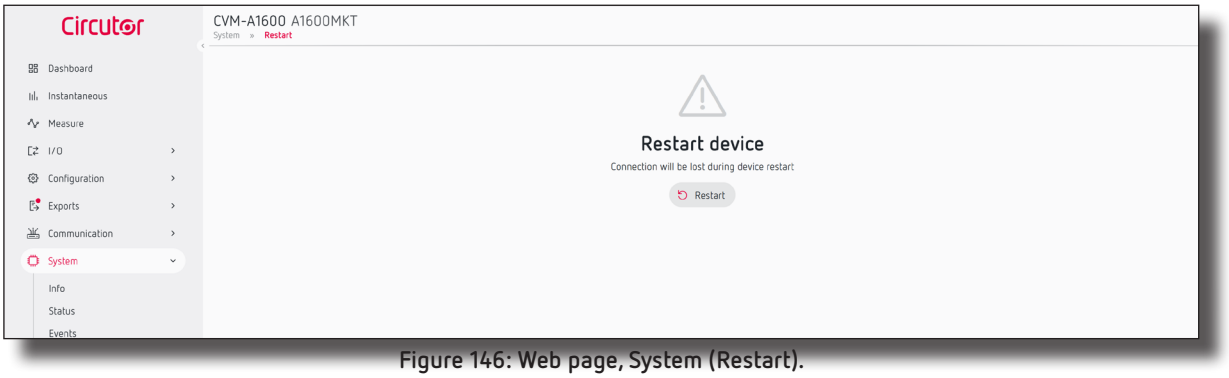


Figure 146: Web page, System (Restart).

9.- TECHNICAL FEATURES

AC Power supply			
Nominal voltage	100 ... 300 V ~		
Frequency	47 ... 63 Hz		
Consumption	CVM-A1610-ITF	CVM-A1611-ITF	CVM-A1612-ITF
	14 ... 20 VA	15 ... 21 VA	17 ... 23 VA
Installation category	CAT III 300 V (Altitude ≤ 2000 m), CAT II 300 V (Altitude: 5000 m)		

DC Power supply			
Nominal voltage	100 ...300 V ⎓		
Consumption	CVM-A1610-ITF	CVM-A1611-ITF	CVM-A1612-ITF
	8.5 ... 9 W	9.5 ... 10 W	10.6 ... 11 W
Installation category	CAT III 300 V (Altitude ≤ 2000 m), CAT II 300 V (Altitude: 5000 m)		

Control unit	
CPU	NXP i.MX93 dual-core Cortex™-A55 CPU, 1.7 GHz
RAM memory	2 GB
Flash memory	8 GB

Voltage measurement circuit		
Nominal voltage (Un)	Phase - Neutral	Phase - Phase
	110 ... 480 V ~	190 ... 830 V ~
Maximum measurement voltage	600 V ~	1000 V ~
Minimum measurement voltage (Vstart)	10 V ~	17 V ~
Frequency measurement range	42.5 ... 69 Hz	
Input impedance	2 MΩ	
Installation category	CAT III 600V (Altitude ≤ 2000 m), CAT III 300V (Altitude: 5000 m)	
Neutral voltage measurement		
Measurement range	10 ...600 V ~	-

Current measurement circuit (CVM-A16xx-ITF)			
Nominal current (In)	.../5A , .../1A or .../0.250 A		
Measurement range for class	In: .../5A	In: .../1A	In: .../0.250A
	0.01 ... 6 A	0.01 ... 1.2 A	0.01 ... 0.3 A
Maximum transient current	15 A	15 A	15 A
Minimum measurement current (Istart)	10 mA		
Consumption	≤ 0.9 VA		
Installation category	CAT III 600V		

Measurement accuracy (according to IEC 61557-12 for PMD SD/SS)(CVM-A16xx-ITF)			
	In: .../5 A	In: .../1 A	In: .../0.250 A
Phase voltage	± 0.1 % (Class 0.1) (46 ... 600 V)		
Neutral voltage	± 0.1 % (Class 0.1) (46 ... 600 V)		
Phase current [3]	0.1% (Class 0.1) (0.5 ... 6 A)	0.2% (Class 0.2) (0.1 ... 2 A)	0.2% (Class 0.2) (0.025 ... 0.3 A)
Neutral current [3]	0.2% (Class 0.2) (0.5 ... 6 A)	0.2% (Class 0.5) (0.1 ... 2 A)	0.5% (Class 0.5) (0.025 ... 0.3 A)
Frequency	0.02 (Class 0.02) (42.5 ... 69 Hz)		

(Continuation) Measurement accuracy (according to IEC 61557-12 for PMD SD/SS)(CVM-A16xx-ITF)			
	Class (.../5 A)	Class (.../1 A)	Class (.../0.250 A)
Active power [3]	0.2% (Class 0.2)	0.5% (Class 0.5)	0.5% (Class 0.5) (5 ... 120 % In)
Reactive power [3]	0.5% (Class 0.5)	1% (Class 1)	1% (Class 1) (5 ... 120 % In)
Apparent power [3]	0.2% (Class 0.2)	0.5% (Class 0.5)	0.5% (Class 0.5) (5 ... 120 % In)
Active energy (IEC 62053-22)	0.2 S (Class 0.2 S)	0.5 S (Class 0.5 S)	0.5 S (Class 0.5 S)
Reactive energy (IEC 62053-24)	0.5 S (Class 0.5 S)	1 S (Class 1 S)	1 S (Class 1 S)
Power factor	0.5% (Class 0.5)	0.5% (Class 1)	0.5% (Class 1)

[3]One resolution unit must be added to the specified accuracy.

Measurement resolution (according to IEC 61557-12 for PMD SD/SS)(CVM-A16xx-ITF)			
	In: .../5 A	In: .../1 A	In: .../0.250 A
Voltage	0.01 V		
Neutral voltage	0.01 V		
Phase current	0.001 A	0.001 A	0.001 A
Neutral current	0.001 A		
Frequency	0.001 Hz		
Active power	1 W	1 W	1 W
Reactive power	1 var	1 var	1 var
Apparent power	1 VA	1 VA	1 VA
Active energy (IEC 62053-22)	1 Wh	1 Wh	1 Wh
Reactive energy (IEC 62053-24)	1 varh	1 varh	1 varh
Power factor	0.01	0.01	0.01

Measurement accuracy (CVM-A16xx-ITF) (according to IEC 61000-4-30 for PQI-A-FI1-H) Un: 230 V		
	Range	Accuracy
Phase voltage	10 ... 150 % Un	± 0.1 Un (Class A)
Phase current	0.5 ... 10 A	0.2 % (Class A)
Frequency	42.5 ... 69 Hz	± 10 mHz (Class A)
Voltage THD	0.2 ... 100 %	Class I (IEC 61000-4-7), Class A (IEC 61000-4-30)
Voltage harmonics	0.08 ... 200 %	Class I (IEC 61000-4-7), Class A (IEC 61000-4-30)
Voltage interharmonics	0.08 ... 200 %	Class I (IEC 61000-4-7), Class A (IEC 61000-4-30)
Voltage dip	-	0.2% Un (Class A)
Short-duration overvoltage	-	0.2% Un (Class A)
Voltage interruptions	-	0.2% Un (Class A)
Rapid Voltage Changes (RVC)	-	Class A
Voltage transients	1000 Vpeak	25600 Hz (50 Hz), 30720 Hz (60 Hz)
Mains signalling voltage	-	Class A
Negative voltage deviation	-	Class A
Positive voltage deviation	-	Class A
Current THD	0.2 ... 100 %	Class I (IEC 61000-4-7), Class A (IEC 61000-4-30)
Current harmonics	0.08 ... 200 %	Class I (IEC 61000-4-7), Class A (IEC 61000-4-30)
Current interharmonics	0.08 ... 200 %	Class I (IEC 61000-4-7), Class A (IEC 61000-4-30)
Instantaneous flicker, Pinst	0 ... 10	Class F1 (IEC 61000-4-15), Class A (IEC 61000-4-30)
Short-term flicker, Pst	0 ... 10	Class F1 (IEC 61000-4-15), Class A (IEC 61000-4-30)
Long-term flicker, Plt	0 ... 10	Class F1 (IEC 61000-4-15), Class A (IEC 61000-4-30)

(Continuation) Measurement accuracy (CVM-A16xx-ITF) (according to IEC 61000-4-30 for PQI-A-FI1-H) Un: 230 V		
	Range	Accuracy
Voltage unbalance	0 ... 200 %	± 0.15 % (Class A)
Current unbalance	0 ... 200 %	± 0.15 % (Class A)
Current transients	21 A peak	25600 Hz (50 Hz), 30720 Hz (60 Hz)

Measurement resolution (CVM-A16xx-ITF) (according to IEC 61000-4-30 for PQI-A-FI1-H) Un: 230 V	
Voltage	0.01 V
Neutral voltage	0.01 V
Phase current	0.0001 A
Neutral current	0.0001 A
Frequency	0.001 Hz
Voltage THD	0.01 %
Voltage harmonics	0.01 %
Voltage interharmonics	0.01 %
Voltage dip	0.01 V
Overvoltage	0.01 V
Voltage interruptions	0.01 V
Rapid Voltage Changes (RVC)	0.01 V
Voltage transients	0.01 V
Mains signalling voltage	0.01 %
Negative voltage deviation	0.01 %
Positive voltage deviation	0.01 %
Current THD	0.01 %
Current harmonics	0.01 %
Current interharmonics	0.01 %
Instantaneous flicker, Pinst	0.01
Short-term flicker, Pst	0.01
Long-term flicker, Plt	0.01
Voltage unbalance	0.01 %
Current unbalance	0.01 %
Current transients	0.0001 A

RS-485 communications	
Fieldbus	RS-485
Communication protocol	Modbus RTU
Baud rate	4800- 9600 - 19200 - 38400-57600-115200
Stop bits	1 - 2
Parity	None - Even - Odd

Ethernet communications	
Quantity	2 independent ports
Type	Ethernet 10BaseT - 100BaseTx auto-detectable - 1000BaseT
Connector	RJ45
Protocols	HTTPS - NTP - DNS - WSS - SFTP - FTP - IEC61850 - SMTP - ModbusTCP - DNP3 - IEC 60870-5-104
Network connection mode The device supports dual IP addressing	Service IP: 100.0.0.1
	Dynamic IP - Static IP (Dynamic by default)

Wi-Fi communications	
Band	2.4 GHz, 5 GHz
Standards	Wi-Fi 6 dual-band (IEEE 802.11 ax/ac/a/b/g/n)
Protocols	HTTPS - NTP - DNS - WSS - SFTP - FTP - IEC61850 - SMTP - ModbusTCP - DNP3 - IEC 60870-5-104
Maximum output power	**IEEE 802.11a**: 18 dBm **IEEE 802.11b**: 20 dBm **IEEE 802.11g**: 18 dBm **IEEE 802.11n (HT20 and HT40)**: 17 dBm **IEEE 802.11ac (VHT20, VHT40, VHT80)**: 16 dBm **IEEE 802.11ax (HE20, HE40, HE80)**: 17 dBm

Digital outputs		
Model	CVM-A1611-ITF	CVM-A1612-ITF
Quantity	6	12
Type	Solid-state relay with volt-free output.	
Maximum voltage	48 V	
Maximum current	120 mA	
Maximum frequency	1 kHz	
Pulse width	1 ms	
Pulse duration	**Ton:** 0.3 ms, **Toff:** 0.7 ms	
Insulation	5 kV	

Relay outputs		
Model	CVM-A1611-ITF	CVM-A1612-ITF
Quantity	2	4
Maximum voltage (open contacts)	250 V ~ / 30 V ⎓	
Maximum current	3 A	
Maximum switching power	1500 VA / 180 W	
Electrical life (at maximum load)	$3x10^4$ cycles	
Mechanical life	$1x10^7$ cycles	
Installation category	CAT III 300 V (Altitude ≤ 2000 m), CAT II 300 V (Altitude: 5000 m)	
Insulation	4 kV	

Digital inputs		
Model	CVM-A1611-ITF	CVM-A1612-ITF
Quantity	6	12
Type	Volt-free contact	
Insulation	5 kV	
Input impedance	10 kΩ	
Maximum short-circuit current	0.4 mA	
Maximum open-circuit voltage	80 V ⎓	

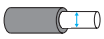
User interface	
Display	8-inch touchscreen (1280 × 800 pixels)

Battery	
Type	Supercapacitor
Voltage	6 x 1.8 V
Typical capacity	67 mWh
Charging time	20 min

(Continuation) Battery	
Charging ambient temperature	70 °C
Autonomy	20 s (without Modules)

GPS antenna	
Band	GPS / QZSS, GLONASS, Galileo, SBAS
Frequency	1575.42 ± 3 MHz
Bandwidth	10 MHz
VSWR	1.92 (maximum)
Axial ratio	3 dB (typical)
Gain @ Zenith	2 dBi (typical)
Impedance	50 Ω
Polarization	RHCP

Environmental features	
Operating temperature	-20 ... 70 °C
Storage temperature	-20 ... 80 °C
Relative humidity (non-condensing)	5 ... 95%
Maximum altitude	2000 m (CAT III 600V) 5000 m (CAT III 300V)
Protection degree IP	IP30, **Front:** IP40
Protection degree IK	IK08
Pollution degree	2
Use	Indoor

Mechanical features			
Terminals			
Power supply: 1,2	2.5 mm^2	0.5 Nm	⊘ 0.6 x 3.5
Voltage measurement: 3 ... 7	0.2 ... 6 mm^2	0.5 Nm (< 4 mm^2) 0.8 Nm (≥ 4 mm^2)	⊕ H1L
Current measurement: 8 ... 15	1.0 ... 2.5 mm^2	0.5 Nm	⊘ 0.6 x 3.5
RS-485: 16 ... 18	2.5 mm^2	0.5 Nm	⊘ 0.6 x 3.5
CVM-A1611-ITF Input and Outputs: 21 ... 38	0.5 ... 1.5 mm^2	0.3 Nm	⊘ 0.4 x 2.5
CVM-A1612-ITF Input and Outputs: 21 ... 56			
Dimensions	**Figure 147** (mm)		
Weight	**CVM-A1610-ITF**	**CVM-A1611-ITF**	**CVM-A1612-ITF**
	1080 g	1150 g	1220 g
Enclosure	UL94-V0 self-extinguishing plastic		

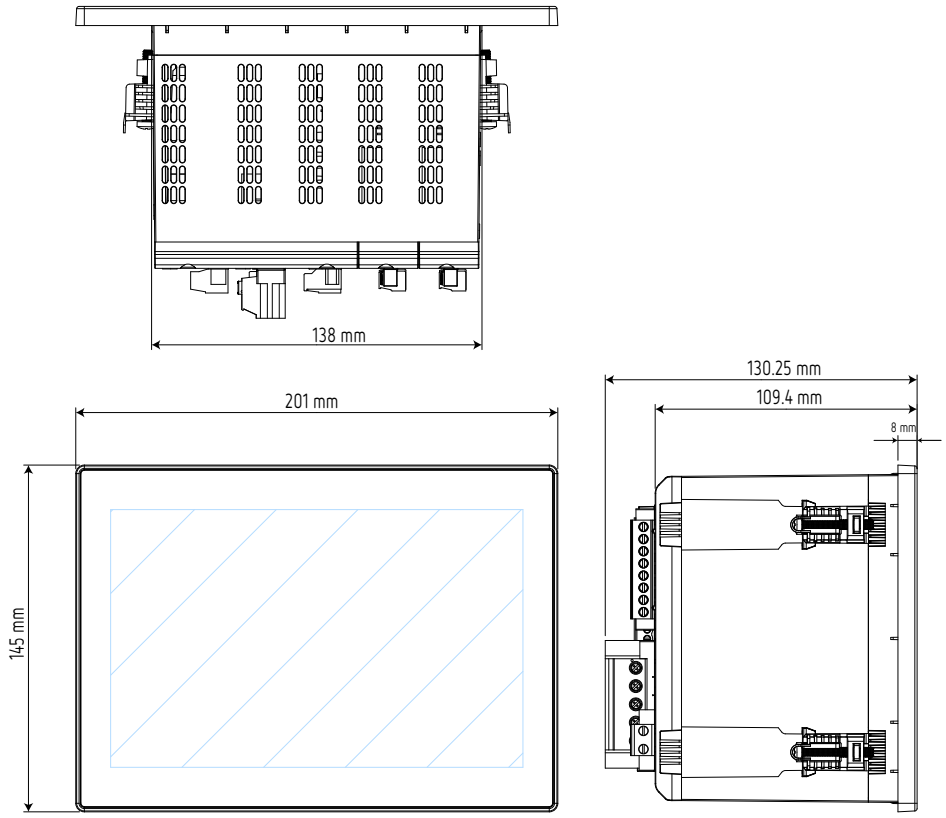


Figure 147: CVM-A1600 dimensions.

Standards	
Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements	UNE-EN 55016-2-1
Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement	UNE-EN 55022
Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test	UNE-EN 61000-4-2
Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test	UNE-EN 61000-4-4
Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test	UNE-EN 61000-4-5
Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields	UNE-EN 61000-4-6
Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test	UNE-EN 61000-4-8
Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase	UNE-EN 61000-4-11
Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides	UNE-EN 61000-4-20
Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods	UNE-EN 61000-4-30
Power quality measurement in power supply systems – Part 2: Functional tests and uncertainty requirements	IEC 62586-2
Environmental testing – Part 2-1: Tests – Test A: Cold	UNE-EN 60068-2-1
Environmental testing – Part 2-2: Tests – Test B: Dry heat	UNE-EN 60068-2-2

(Continuation) Standards	
Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state	UNE-EN 60068-2-78
Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements	UNE-EN 61010-1
Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits	UNE-EN 61010-2-30
Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 12: Power metering and monitoring devices (PMD)	UNE-EN 61557-12
Common security requirements for radio equipment – Part 1: Internet connected radio equipment	EN 18031-1:2024
ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard for ElectroMagnetic Compatibility	ETSI EN 301 489-1 V2.2.3
ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Broadband Data Transmission Systems; Harmonised Standard for ElectroMagnetic Compatibility	ETSI EN 301 489-17 V3.3.1
ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 19: Specific conditions for Receive Only Mobile Earth Stations (ROMES) operating in the 1,5 GHz band providing data communications and GNSS receivers operating in the RNSS band providing positioning, navigation and timing data; Harmonised Standard for ElectroMagnetic Compatibility	ETSI EN 301 489-19 V2.2.1
Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)	EN 62311:2008

10.- MAINTENANCE AND TECHNICAL SERVICE

The device requires no maintenance.
Clean the display using only soapy water and dry it with a soft, dry cloth.

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

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

11.- 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, S.A. – Vial Sant Jordi, s/n
08232 Viladecavalls (Barcelona) Spain
(+34) 937 452 900 – info@circutor.com

(ES) DECLARACIÓN UE DE CONFORMIDAD

La presente declaración de conformidad se expide bajo la exclusiva responsabilidad de CIRCUTOR con dirección en **Vial Sant Jordi, s/n – 08232 Viladecavalls (Barcelona) España**

Producto:

Analizadores de calidad de suministro de clase A

Serie:

Analizador/Analyzer: CVM-A1600
Módulo/Module: M-CVM-A1600-D6IO-R2O

Marca:

CIRCUTOR

EL objeto de la declaración es conforme con la legislación de armonización pertinente en la UE, siempre que sea instalado, mantenido y usado en la aplicación para la que ha sido fabricado, de acuerdo con las normas de instalación aplicables y las instrucciones del fabricante

2014/35/EU: Low Voltage Directive	2014/30/EU: EMC Directive
2014/53/EU: Radio Equipment Directive	2011/65/EU + 2015/863/EU: RoHS Directive

Está en conformidad con la(s) siguiente(s) norma(s) u otro(s) documento(s) normativos(s):

IEC 61010-1:2010+AMD1:2016	IEC 61010-2-030:2023
IEC 61326-1:2020	ETSI EN 301 489-1 V2.2.3
ETSI EN 301 489-17 V3.3.1	ETSI EN 301 489-19 V2.2.1
EN 18031-1:2024	EN IEC 63000:2018

(EN) EU DECLARATION OF CONFORMITY

This declaration of conformity is issued under the sole responsibility of CIRCUTOR with registered address at **Vial Sant Jordi, s/n – 08232 Viladecavalls (Barcelona) Spain**

Product:

Class A power quality analyzer

Series:

Analizador/Analyzer: CVM-A1600
Módulo/Module: M-CVM-A1600-D6IO-R2O

Brand:

CIRCUTOR

The object of the declaration is in conformity with the relevant EU harmonisation legislation, provided that it is installed, maintained and used for the application for which it was manufactured, in accordance with the applicable installation standards and the manufacturer's instructions

2014/35/EU: Low Voltage Directive	2014/30/EU: EMC Directive
2014/53/EU: Radio Equipment Directive	2011/65/EU + 2015/863/EU: RoHS Directive

It is in conformity with the following standard(s) or other regulatory document(s):

IEC 61010-1:2010+AMD1:2016	IEC 61010-2-030:2023
IEC 61326-1:2020	ETSI EN 301 489-1 V2.2.3
ETSI EN 301 489-17 V3.3.1	ETSI EN 301 489-19 V2.2.1
EN 18031-1:2024	EN IEC 63000:2018

(FR) DÉCLARATION UE DE CONFORMITÉ

La présente déclaration de conformité est délivrée sous la responsabilité exclusive de CIRCUTOR dont l'adresse postale est **Vial Sant Jordi, s/n – 08232 Viladecavalls (Barcelone) Espagne**

Produit:

Analyseur de qualité d'alimentation de classe A

Série:

Analizador/Analyzer: CVM-A1600
Módulo/Module: M-CVM-A1600-D6IO-R2O

Marque:

CIRCUTOR

L'objet de la déclaration est conforme à la législation d'harmonisation pertinente dans l'UE, à condition d'avoir été installé, entretenu et utilisé dans l'application pour laquelle il a été fabriqué, conformément aux normes d'installation applicables et aux instructions du fabricant

2014/35/EU: Low Voltage Directive	2014/30/EU: EMC Directive
2014/53/EU: Radio Equipment Directive	2011/65/EU + 2015/863/EU: RoHS Directive

Il est en conformité avec la(les) suivante (s) norme(s) ou autre(s) document(s) réglementaire (s):

IEC 61010-1:2010+AMD1:2016	IEC 61010-2-030:2023
IEC 61326-1:2020	ETSI EN 301 489-1 V2.2.3
ETSI EN 301 489-17 V3.3.1	ETSI EN 301 489-19 V2.2.1
EN 18031-1:2024	EN IEC 63000:2018

Viladecavalls (Spain), 2/6/2026
Chief Executive Officer: Joan Comellas Cabeza

Circutor
NIF A-08513178
Vial Sant Jordi s/n.
08232 Viladecavalls
Barcelona (Spain)
t. +34 93 745 29 00

CIRCUTOR, S.A.U. – Vial Sant Jordi, s/n
08232 Viladecavalls (Barcelona) Spain
(+34) 937 452 900 – info@circutor.com

(DE)

KONFORMITÄTSERKLÄRUNG UE

Vorliegende Konformitätserklärung wird unter alleiniger Verantwortung von CIRCUTOR mit der Anschrift, Vial Sant Jordi, s/n – 08232 Viladecavalls (Barcelona) Spanien, ausgestellt

Produkt:

Netzqualitätsanalysator der Klasse A

Serie:

Analizador/Analyzer: CVM-A1600
Módulo/Module: M-CVM-A1600-D6I0-R20

Marke:

CIRCUTOR

Der Gegenstand der Konformitätserklärung ist konform mit der geltenden Gesetzgebung zur Harmonisierung der EU, sofern die Installation, Wartung undVerwendung der Anwendung seinem Verwendungszweck entsprechend gemäß den geltenden Installationsstandards und der Vorgaben des Herstellers erfolgt

2014/35/EU: Low Voltage Directive	2014/30/EU: EMC Directive
2014/53/EU: Radio Equipment Directive	2011/65/EU + 2015/863/EU: RoHS Directive

Es besteht Konformität mit der/den folgender/folgenden Norm/Normen oder sonstigem/sonstiger Regelwerk/Regelwerken

IEC 61010-1:2010+AMD1:2016	IEC 61010-2-030:2023
IEC 61326-1:2020	ETSI EN 301 489-1 V2.2.3
ETSI EN 301 489-17 V3.3.1	ETSI EN 301 489-19 V2.2.1
EN 18031-1:2024	EN IEC 63000:2018

(PT)

DECLARAÇÃO DA UE DE CONFORMIDADE

A presente declaração de conformidade é expedida sob a exclusiva responsabilidade da CIRCUTOR com morada em **Vial Sant Jordi, s/n – 08232 Viladecavalls (Barcelona) Espanha**

Producto:

Analisador de qualidade de fornecimento de classe A

Série:

Analizador/Analyzer: CVM-A1600
Módulo/Module: M-CVM-A1600-D6I0-R20

Marca:

CIRCUTOR

O objeto da declaração está conforme a legislação de harmonização pertinente na UE, sempre que seja instalado, mantido e utilizado na aplicação para a qual foi fabricado, de acordo com as normas de instalação aplicáveis e as instruções do fabricante.

2014/35/EU: Low Voltage Directive	2014/30/EU: EMC Directive
2014/53/EU: Radio Equipment Directive	2011/65/EU + 2015/863/EU: RoHS Directive

Está em conformidade com a(s) seguinte(s) norma(s) ou outro(s) documento(s) normativo(s):

IEC 61010-1:2010+AMD1:2016	IEC 61010-2-030:2023
IEC 61326-1:2020	ETSI EN 301 489-1 V2.2.3
ETSI EN 301 489-17 V3.3.1	ETSI EN 301 489-19 V2.2.1
EN 18031-1:2024	EN IEC 63000:2018

(IT)

DICHIARAZIONE DI CONFORMITÀ UE

La presente dichiarazione di conformità viene rilasciata sotto la responsabilità esclusiva di CIRCUTOR, con sede in **Vial Sant Jordi, s/n – 08232 Viladecavalls (Barcellona) Spagna**

prodotto:

Analizzatore di qualità dell'energia di classe A

Serie:

Analizador/Analyzer: CVM-A1600
Módulo/Module: M-CVM-A1600-D6I0-R20

MARCHIO:

CIRCUTOR

L'oggetto della dichiarazione è conforme alla pertinente normativa di armonizzazione dell'Unione Europea, a condizione che venga installato, mantenuto e utilizzato nell'ambito dell'applicazione per cui è stato prodotto, secondo le norme di installazione applicabili e le istruzioni del produttore.

2014/35/EU: Low Voltage Directive	2014/30/EU: EMC Directive
2014/53/EU: Radio Equipment Directive	2011/65/EU + 2015/863/EU: RoHS Directive

È conforme alle seguenti normative o altri documenti normativi:

IEC 61010-1:2010+AMD1:2016	IEC 61010-2-030:2023
IEC 61326-1:2020	ETSI EN 301 489-1 V2.2.3
ETSI EN 301 489-17 V3.3.1	ETSI EN 301 489-19 V2.2.1
EN 18031-1:2024	EN IEC 63000:2018

Viladecavalls (Spain), 2/6/2026
Chief Executive Officer: Joan Comellas Cabeza

Circutor
NIF A-08513178
Vial Sant Jordi s/n.
08232 Viladecavalls
Barcelona (Spain)
t. +34 93 745 29 00

CIRCUTOR, S.A. – Vial Sant Jordi, s/n
08232 Viladecavalls (Barcelona) Spain
(+34) 937 452 900 – info@circutor.com

(PL)

DEKLARACJA ZGODNOŚCI UE

Niniejsza deklaracja zgodności zostaje wydana na wyłączną odpowiedzialność firmy CIRCUTOR z siedzibą pod adresem: **Vial Sant Jordi, s/n – 08232 Viladecavalls (Barcelona) Hiszpania**

produk:

Analizator jakości zasilania klasy A

Seria:

Analizador/Analyzer: CVM-A1600
Módulo/Module: M-CVM-A1600-D6IO-R20

marka:

CIRCUTOR

Przedmiot deklaracji jest zgodny z odnośnymi wymaganiami prawodawstwa harmonizacyjnego w Unii Europejskiej pod warunkiem, że będzie instalowany, konserwowany i użytkowany zgodnie z przeznaczeniem, dla którego został wyprodukowany, zgodnie z mającymi zastosowanie normami dotyczącymi instalacji oraz instrukcjami producenta

2014/35/EU: Low Voltage Directive	2014/30/EU: EMC Directive
2014/53/EU: Radio Equipment Directive	2011/65/EU + 2015/863/EU: RoHS Directive

Jest zgodny z następującą(ymi) normą(ami) lub innym(i) dokumentem(ami) normatywnym(i):

IEC 61010-1:2010+AMD1:2016	IEC 61010-2-030:2023
IEC 61326-1:2020	ETSI EN 301 489-1 V2.2.3
ETSI EN 301 489-17 V3.3.1	ETSI EN 301 489-19 V2.2.1
EN 18031-1:2024	EN IEC 63000:2018

Circutor
NIF A-08513178
Vial Sant Jordi s/n
08232 Viladecavalls
Barcelona (Spain)
t. +34 93 745 29 00

Viladecavalls (Spain), 2/6/2026
Chief Executive Officer: Joan Comellas Cabeza

ANNEX A.- CALCULATION FORMULAS

A.1.- SIGNAL SAMPLING, MEASURE AND PARAMETER AGGREGATION

The device samples every voltage and current input signal at a rate of 512 samples per cycle, which becomes a sampling frequency of 25600 Hz per signal for 50Hz and a frequency of 30720 Hz 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 second values.
- ✓ 10 minute values (or a period selected by the customer).
- ✓ 2 hour values.

Note: *Power is calculated according to* ***IEEE1459***.

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

A.2.- 10/12 CYCLE INTERVAL MEASURES (50 Hz/60 Hz)

For a 50Hz measure, the basic period will be a 10 cycle period with a total number of samples: **N = 5120**
For a 60Hz measure, the basic period will be a 12 cycle period with a total number of samples: **N = 6144**

A.2.1.- VOLTAGE PHASE-NEUTRAL (U_{Ph-N})

The 10/12 cycle RMS **Voltage to neutral** of every phase is calculated by the root mean square of the period interval samples.

$$Up = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} u_{pj}^{2}}$$ Units: **V**

Equation 8: Voltage Phase - Neutral.

A.2.2.- VOLTAGE PHASE-PHASE (U_{Ph-Ph})

The 10/12 cycle RMS **Voltage phase to phase** is calculated by making the vector difference of the two involved phases. This RMS value is calculated by the root mean square of the whole cycle period interval difference samples.

$$Upg = \sqrt{\frac{1}{N} \sum_{j=1}^{N} \left(u_{pj} - u_{gj}\right)^{2}}$$ Units: **V**

Equation 9: Voltage Phase - Phase.

A.2.3.- CURRENT (*I*)

The 10/12 cycle RMS **current** of every phase is calculated by the root mean square of the whole period interval samples.

$$Ip=\sqrt{\frac{1}{N}x\sum_{j=1}^{N}i_{pj}^{2}}$$ Units: **A**

Equation 10: Current.

A.2.4.- COMBINED ACTIVE POWER (*P*)

The 10/12 cycle RMS **Active Power** of every phase is calculated by the scalar product of the whole interval samples of Voltage and Current.

Phase Combined Active Power:

$$Pp=\sqrt{\frac{1}{N}x\sum_{j=1}^{N}u_{pj}\,x\,i_{pj}}$$ Units: **W**

Equation 11: Phase combined Active Power.

Three-phase Combined Active Power:

$$P_{TOT}=P_A+P_B+P_C$$ Units: **W**

Equation 12: Three-phase combined Active Power.

A.2.5.- APPARENT POWER (*S*)

The 10/12 cycle **Apparent Power** of every phase is calculated by the product of the 10/12 cycles RMS Voltage and Current.

Phase Apparent Power:

$$Sp=Up\,x\,Ip$$ Units: **VA**

Equation 13: Phase apparent power.

Three-phase Apparent Power:

$$S_e=3\,x\,V_e\,x\,I_e$$ Units: **VA**

Equation 14: Three-phase apparent power.

A.2.6.- NONACTIVE POWER (*N*)

The 10/12 cycle RMS **Nonactive Power** of every phase is calculated from the Active Power and the Apparent Power.

Phase Nonactive Power:

$$Np=\sqrt{S_p^2-P_p^2}$$ Units: **var**

Equation 15: Phase nonactive power.

Three-phase Nonactive Power:

$$N_{TOT} = N_A + N_B + N_C \quad \text{Units: var}$$

Equation 16: Three-phase Nonactive Power.

A.2.7.- POWER FACTOR (*PF*)

The 10/12 cycle **Power Factor** of every phase is calculated by the division of the 10/12 cycles RMS Active Power and Apparent Power.

Phase Power Factor:

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

Equation 17: Phase Power Factor.

Three-phase Power Factor:

$$PF_{TOT} = \frac{P_{TOT}}{S_e}$$

Equation 18: Three-phase Power Factor.

A.2.8.- FUNDAMENTAL ACTIVE POWER (P_1)

The 10/12 cycle **fundamental Active Power** of every phase is calculated from the fundamental voltage, fundamental current and the angle between both.

Phase Fundamental Active Power:

$$Pp_1 = Vp_1 \, x \, Ip_1 \, x \cos\theta_{1p} \quad \text{Units: W}$$

Equation 19: Phase Fundamental Active Power.

Positive Sequence Active Power:

$$P^{pos} = 3 \, x \, V^{pos} \, x \, I^{pos} \, x \cos\theta^{pos} \quad \text{Units: W}$$

Equation 20: Positive Sequence Active Power.

A.2.9.- FUNDAMENTAL REACTIVE POWER (*Q*)

The 10/12 cycle **fundamental Reactive Power** of every phase is calculated from the fundamental voltage, fundamental current, and the angle between both.

Phase Fundamental Reactive Power:

$$Qp = Vp_1 \, x \, Ip_1 \, x \sin\theta_1 \quad \text{Units: var}$$

Equation 21: Phase Fundamental Reactive Power.

Positive Sequence Reactive Power:

$$Q^{pos} = 3\,x\,V^{pos}\,x\,I^{pos}\,x\,\sin\theta^{pos}$$ Units: **var**

Equation 22: Positive Sequence Reactive Power.

A.2.10.- FUNDAMENTAL APPARENT POWER (S_1)

The 10/12 cycle **fundamental Apparent Power** of every phase is calculated from the fundamental voltage and fundamental current.

Phase Fundamental Apparent Power:

$$Sp_1 = Vp_1\,x\,Ip_1$$ Units: **VA**

Equation 23: Phase Fundamental Apparent Power.

Fundamental Effective Apparent Power:

$$Se_1 = 3\,x\,Ve_1\,x\,Ie_1$$ Units: **VA**

Equation 24: Fundamental Effective Apparent Power.

A.2.11.- DISPLACEMENT POWER FACTOR (*DPF*)

The 10/12 cycle **DPF** of every phase is calculated from the fundamental Active Power and the fundamental Apparent values.

Phase Displacement Power Factor:

$$DPFp = \frac{Pp_1}{Sp_1}$$

Equation 25: Phase Displacement Power Factor.

Positive Sequence Power Factor:

$$DPF_{TOT} = \frac{P^{pos}}{S^{pos}}$$

Equation 26: Positive Sequence Power Factor.

A.2.12.- VOLTAGE AND CURRENT HARMONICS

The 10/12 cycle **Voltage and Current harmonics** are calculated by means of a 10/12 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.

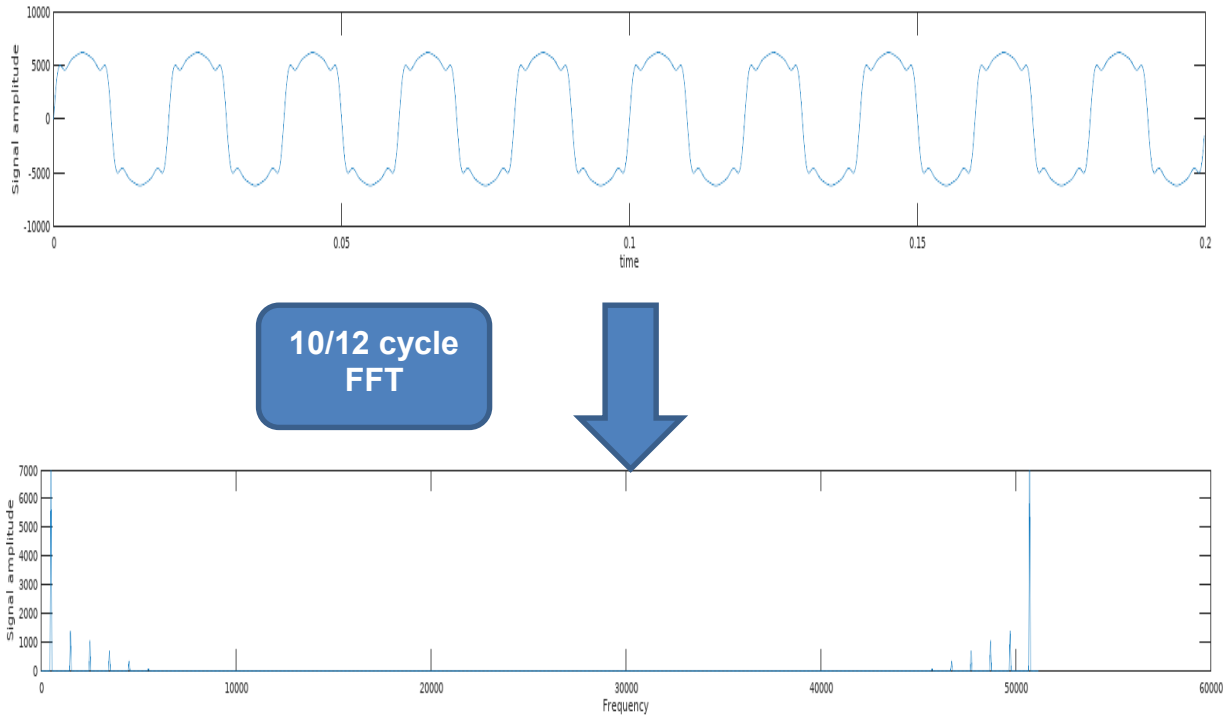


Figure 148: Voltage and current harmonics.

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

Equation 27: Voltage and current harmonics.

Where:

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

T_w : Width or duration of the time window $T_w=NT_1$ $T_1=1/f_1$ $(T_w=200ms)$
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 periods)

c_0 : DC 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 28: $G_{s,g,n}$

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

$$H_n(\%) = \frac{G_{sg,n}}{G_{sg,1}} x\,100$$

Equation 29: $H_n(\%)$

The Total Harmonic Distorsion:

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

Equation 30: THD.

Where **G** is the RMS value of the harmonic component.

Direction of harmonics:

Non-linear loads can cause a distorted current waveform; if this distortion is large enough, the voltage could fall during this current distortion.
In this case, voltage and current harmonics are generated with the same frequency, generating unwanted power.
It is therefore useful to know whether this harmonic comes from the load or the source, which is called **Direction of harmonics**.

To identify the direction of the harmonics, the power angle is calculated at the harmonic frequency. Depending on this angle, the current harmonic may come from the load or the source.

The Direction of harmonics calculation is more accurate if the power in this harmonic is high enough and if the angle of this power is sufficiently far from 90° or 270°.
For this reason, the **CVM-A1600** will only calculate the harmonic direction for secondary power harmonics greater than 1 W and angles greater than 15° away from 90° or 270°.

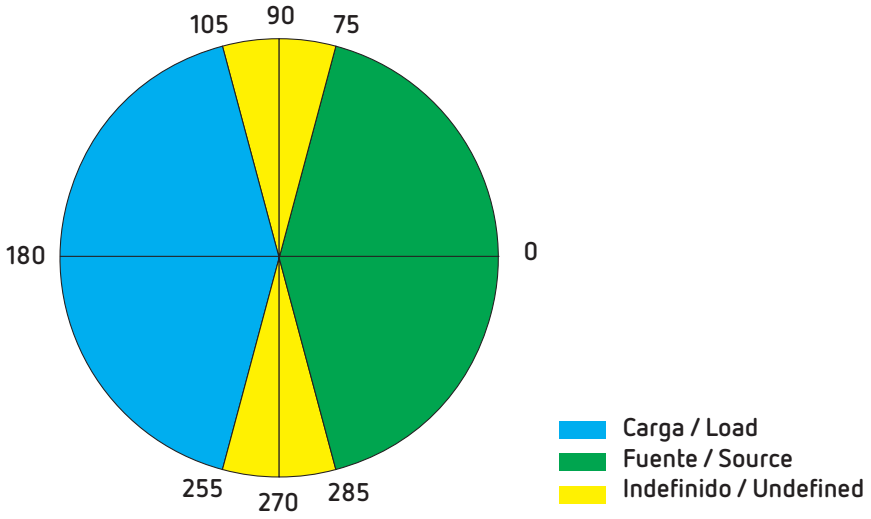


Figure 149:Direction of harmonics.

The **CVM-A1600** represents the harmonic from the source with a positive sign and the % calculated. The harmonic from the load is represented with a negative sign and the % calculated.

If the power harmonic is not large enough or its angle is too close to 90° or 270°, the sign of the %

harmonic is positive.

A.2.13.- VOLTAGE AND CURRENT INTERHARMONICS

The 10/12 cycle **Voltage and Current interharmonics** are calculated through a 10/12 cycle window FFT without gaps between windows as is specified in **IEC 61000-4-30** class A method.
Making the interharmonics soubgroups specified in the **IEC 61000-4-7** class I

As specified in **IEC61000-4-30** class A, group **Y isg,h** is used.

The output interharmonics components C_k for each 5Hz of the DFT are grouped as follows:

$$G_{isg,n}=\sqrt{\sum_{i=2}^{8} C_{k+i}^2}$$

Equation 31: $G_{isg,n.}$

Leaving the immediate harmonics bin as harmonic content.

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

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

Equation 32: $IH_n(\%)$.

A.2.14.- VOLTAGE AND CURRENT UNBALANCE

The 10/12 cycle **unbalance** is evaluated using the method of symmetrical components specified in **IEC 61000-4-30** 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:

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

Equation 33: Direct Voltage / Current.

Inverse Voltage / Current:

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

Equation 34: Inverse Voltage / Current.

Homopolar Voltage / Current:

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

Equation 35: Homopolar Voltage / Current.

Negative sequence unbalance ratio u_2 (voltage / current unbalance):

$$K_d = u_2 = \frac{U_2}{U_1} x\ 100\,\% = \frac{negative\ sequence}{positive\ sequence} x\ 100\,\%$$

Equation 36: Negative sequence unbalance ratio.

Zero sequence unbalance ratio u_0 (voltage / current asimmetry):

$$K_a = u_0 = \frac{U_0}{U_1} x\ 100\,\% = \frac{zero\ sequence}{positive\ sequence} x\ 100\,\%$$

Equation 37: Zero sequence unbalance ratio.

A.2.15.- VOLTAGE AND CURRENT CREAST FACTOR

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

$$Voltage\ CF = \frac{MAX\left(\left|u_{p1}\right|,\ldots,\left|u_{p1280}\right|\right)}{U_p}$$

Equation 38: Voltage CF.

$$Current\ CF = \frac{MAX\left(\left|i_1\right|,\ldots,\left|i_{p1280}\right|\right)}{I_p}$$

Equation 39: Current CF.

A.2.16.- 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 10/12 cycle **K-factor** calculation is based on the 10/12 cycle harmonics results.

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

Equation 40: K-Factor.

A.2.17.- FLICKER Pinst

The magnitude of **flicker** measures the annoyment provoked by the mains voltage signal to a human eye. This magnitude is measured according to **IEC61000-4-15 Class F1**.

Pinst is the instant value of flicker magnitude. It is the result of filtering every signal sample through the flicker filters. After some decimations, the 10/12 cycles **Pinst** is the maximum **Pinst** value wich will be classified to calculate the 10 min **Pst** (Short Term Flicker).

A.3.- 150 / 180 CYCLES INTERVAL MEASURES (50 Hz/60 Hz)

150 cycles for a 50 Hz signal and 180 cycles for a 60 Hz signal.
The data for the 150/180-cycle time interval shall be aggregated without gap from fifteen 10/12-cycle time intervals.

A.3.1.- VOLTAGE PHASE - NEUTRAL (U_{Ph-N})

The 150/180 cycles **Voltage** value is the square mean of the 10/12 cycle Voltage values and it is updated every 3 seconds.

$$Up_{150/180\,c}=\sqrt{\frac{1}{15}x\sum_{j=1}^{15}Up_j^2}$$ Units: **V**

Equation 41: Voltage Phase - Neutral.

Where 15 is the number of groups of 10/12 cycles included in a period of 150/180 cycles.

A.3.2.- VOLTAGE PHASE -PHASE (U_{Ph-Ph})

The 150/180 cycles **Voltage phase to phase** value is the square mean of the 10/12 cycle Voltage phase to phase values and it is updated every 3 seconds.

$$Upg_{150/180\,c}=\sqrt{\frac{1}{15}x\sum_{j=1}^{15}Upg_j^2}$$ Units: **V**

Equation 42: Voltage Phase - Phase.

Where 15 is the number of groups of 10/12 cycles included in a period of 150/180 cycles.

A.3.3.- CURRENT (*I*)

The 150/180 cycles **Current** value is the square mean of the 10/12 cycles Current values and it is updated every 3 seconds.

$$Ip_{150/180\,c}=\sqrt{\frac{1}{15}x\sum_{j=1}^{15}Ip_j^2}$$ Units: **A**

Equation 43: Current.

Where 15 is the number of groups of 10/12 cycles included in a period of 150/180 cycles.

A.3.4.- ACTIVE POWER (*P*)

The 150/180 cycles **Active Power** value is the mean of the 10/12 cycle Active Power values and it is updated every 3 seconds.

Phase Active Power:

$$Pp_{150/180c}=\frac{1}{15}x\sum_{j=1}^{15}Pp_j$$ Units: **W**

Equation 44: Phase Active Power.

Where 15 is the number of groups of 10/12 cycles included in a period of 150/180 cycles.

Three-phase Combined Active Power:

$$P_{TOT} = P_{A150/180} + P_{B150/180} + P_{C150/180}$$ Units: **W**

Equation 45: Three-phase Combined Active Power.

A.3.5.- APPARENT POWER (*S*)

The 150/180 cycles **Apparent Power** value calculation is based on the 10/12 cycle Voltage and Current RMS values.

Phase Apparent Power:

$$Sp_{150/180c} = Up_{150/180c} \, x \, Ip_{150/180c}$$ Units: **VA**

Equation 46: Phase Apparent Power.

Three-phase Apparent Power:

$$S_{e150/180c} = 3 \, x \, V_{e150/180c} \, x \, I_{e150/180c}$$ Units: **VA**

Equation 47: Three-phase Apparent Power.

A.3.6.- NONACTIVE POWER (*N*)

The 150/180 cycles **Nonactive Power** value is the mean of the 10/12 cycle Nonactive Power values and it is updated every 3 seconds.

Phase Nonactive Power:

$$Np_{150/180c} = \frac{1}{15} x \sum_{j=1}^{15} Np_j$$ Units: **var**

Equation 48: Phase Nonactive Power.

Where 15 is the number of groups of 10/12 cycles included in a period of 150/180 cycles.

Three-phase Nonactive Power:

$$N_{TOT} = N_{A150/180c} + N_{B150/180c} + N_{C150/180}$$ Units: **var**

Equation 49: Three-phase Nonactive Power.

A.3.7.- POWER FACTOR (*PF*)

The 150/180 cycles **Power Factor** value calculation is based on the 150/180 cycles Active Power and Apparent Power RMS values.

Phase Power Factor:

$$PFp_{150/180c} = \frac{Pp_{150/180c}}{Sp_{150/180c}}$$

Equation 50: Phase PF.

Three-phase Power Factor:

$$PF_{TOT\ 150/180\,c} = \frac{P_{TOT\,150/180c}}{S_{e\,150/180c}}$$

Equation 51: Three-phase Power Factor.

A.3.8.- FUNDAMENTAL ACTIVE POWER (P_1)

The 150/180 cycle **fundamental Active Power** of every phase is calculated as a mean of the 10/12 cycle fundamental active power values.

Phase Fundamental Active Power:

$$Pp_{1\,150/180\,c} = \frac{1}{15}\,x\sum_{j=1}^{15} Pp_1 \quad \text{Units: W}$$

Equation 52: Phase Fundamental Active Power.

Positive Sequence Active Power:

$$P^{pos}_{150/180c} = 3\,x\,V^{pos}_{150/180\,c}\,x\,I^{pos}_{150/180c}\,x\cos\theta^{pos}_{150/180\,c} \quad \text{Units: W}$$

Equation 53: Positive Sequence Active Power.

A.3.9.- FUNDAMENTAL REACTIVE POWER (Q)

The 150/180 cycle **Fundamental Reactive Power** of every phase is calculated as a mean of the 10/12 cycle fundamental reactive power values.

Phase Fundamental Reactive Power:

$$Qp_{1\,150/180\,c} = \frac{1}{15}\,x\sum_{j=1}^{15} Qp_1 \quad \text{Units: var}$$

Equation 54: Phase Fundamental Reactive Power.

Positive Sequence Reactive Power:

$$Q^{pos}_{TOT\,150/180\,c} = 3\,x\,V^{pos}_{TOT\,150/180\,c}\,x\,I^{pos}_{TOT\,150/180c}\,x\sin\theta^{pos}_{150/180c} \quad \text{Units: var}$$

Equation 55: Positive Sequence Reactive Power.

A.3.10.- FUNDAMENTAL APPARENT POWER (S_1)

The 150/180 cycle **Fundamental Apparent Power** of every phase is calculated from the 150/180 cycle fundamental voltage and fundamental current.

Phase Fundamental Apparent Power:

$$Sp_{1\,150/180\,c} = Vp_{1\,150/180\,c}\,Ip_{1\,150/180\,c} \quad \text{Units: VA}$$

Equation 56: Phase Fundamental Apparent Power.

Fundamental Effective Apparent Power:

$$Se_{1\,150/180c} = 3\,x\,Ve\,rsb\,1150/180\,c\,x\,Ie_{1\,150/180c}$$ Units: **VA**

Equation 57: Fundamental Effective Apparent Power.

A.3.11.- DISPLACEMENT POWER FACTOR (*DPF*)

The 150/180 cycle **DPF** of every phase is calculated from the 150/180 fundamental Active Power and the fundamental Apparent values.

Phase Displacement Power Factor:

$$DPFp_{150/180\,c} = \frac{Pp_{1\,150/180\,c}}{Sp_{1\,150/180\,c}}$$

Equation 58: Phase Displacement Power Factor.

Positive Sequence Power Factor:

$$DPF_{TOT\,150/180\,c} = \frac{P^{pos}_{150/180\,c}}{S^{pos}_{150/180\,c}}$$

Equation 59: Positive Sequence Power Factor.

A.3.12.- VOLTAGE AND CURRENT HARMONICS

The 150/180 cycle Voltage and Current Harmonics value calculation is the square mean of the 10/12 cycles harmonics result.

$$G_{sg,n150/180\,c} = \frac{1}{N}\sqrt{\sum_{i=1}^{N} C_{sg,ni}^{\,2}}$$

Equation 60: $G_{sg,n.}$

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

$$H_{n\,150/180c}(\%) = \frac{G_{sg,n\,150/180\,c}}{G_{sg,1\,150/180c}}\,x\,100$$

Equation 61: H_n(%).

The 150/180 cycle **Total Harmonic Distortion** calculation is based on the 150/180 harmonics result.

$$THD_{150/180\,c} = \sqrt{\sum_{n=2}^{50}\left(\frac{G_{sg,n150/180\,c}}{G_{sg,1150/180\,c}}\right)^2}$$

Equation 62: THD.

Where **G** is the rms value of the harmonic component in 150/180 cycle.

A.3.13.- VOLTAGE AND CURRENT INTERHARMONICS

The 150/180 cycle **Voltage and Current interharmonics** value calculation is the square mean of the 10/12 cycles interarmonics result.

$$G_{isg,n150/180c} = \frac{1}{N}\sqrt{\sum_{i=1}^{N} C_{isg,ni}^{2}}$$

$$IH_{n150/180c}(\%) = \frac{G_{isg,n150/180c}}{G_{isg,1\,150/180c}} x\,100$$

Equation 63: Voltage and current Interharmonics.

A.3.14.- VOLTAGE AND CURRENT UNBALANCE

The 150/180 cycle 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 composing the 150/180 cycle period.

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

$$U1_{150/180c} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U1_j^2}$$

Equation 64: Direct Voltage / Current.

$$U2_{150/180c} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U2_j^2}$$

Equation 65: Inverse Voltage / Current.

$$U0_{150/180c} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} U0_j^2}$$

Equation 66: Homopolar Voltage / Current.

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

Negative sequence unbalance ratio u_2 (voltage / current unbalance):

$$K_{d150/180c} = u_{2150/180c} = \frac{U2_{150/180c}}{U1_{150/180c}} x\,100\,\% = \frac{negative\ sequence}{positive\ sequence} x\,100\,\%$$

Equation 67: Negative sequence unbalance ratio.

Zero sequence unbalance ratio u_0 (voltage / current asimmetry):

$$K_{a150/180c} = u_{0150/180c} = \frac{U0_{150/180c}}{U1_{150/180c}} x\,100\,\% = \frac{zero\ sequence}{positive\ sequence} x\,100\,\%$$

Equation 68: Zero sequence unbalance ratio.

A.3.15.- VOLTAGE AND CURRENT CREST FACTOR

The 150/180 cycle Voltage and Current crest factor are the maximum of every 10/12 cycles values included in the 150/180 cycles period interval.

$$Voltage\,CF_{150/180c} = MAX\left(CF_{\square 1},\ldots,CF_{N}\right)$$

Equation 69: Voltage CF.

$$Current\,CF_{150/180c} = MAX\left(CF_{1},\ldots,CF_{N}\right)$$

Equation 70: Current CF.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the 150/180 cycles period and **samples** is the number of samples observed in one time window, 1280 for 50Hz and 1536 for 60Hz.

A.3.16.- 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 150/180 cycle **K-factor** calculation is based on the 150/180 cycle harmonics results

$$K-factor_{150/180\,c}(\%) = \frac{\sum_{h=1}^{25}\left(G_{sg,h150/180\,c}\,x\,h\right)^{2}}{\sum_{h=1}^{25} G_{sg,h150/180c}{}^{2}}\,x\,100$$

Equation 71: K-Factor.

A.3.17.- FLICKER Pinst

The 150/180 cycles **flicker Pinst** is the average of every 10/12 cycles **flicker Pinst** included into the 150/180 cycle period.

A.4.- 1 SECOND INTERVAL MEASURES

A.4.1.- SAMPLING FREQUENCY

1 s **Frequency** is measured counting the number of cycles by detecting zero crossing during the 1 s interval. This frequency is only used to update the **sampling frequency** and the related flicker filters.

This interval frequency is only available for the user into the 10min max / min frequency period.

$$f_{1s} = \frac{\sum_{t=0}^{1s\,clock} Zero\,crossings}{time\,elapsed}$$ Units: **Hz**

Equation 72: Sampling frequency.

A.5.- 10 SECONDS INTERVAL MEASURES

A.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.

$$f_{10\,s} = \frac{\sum_{t=0}^{10\,s\,clock} Zero\ crossings}{time\ elapsed}$$ Units: **Hz**

Equation 73: Frequency.

A.6.- 10 MINUTES INTERVAL MEASURES

A.6.1.- POWER FACTOR (*PF*)

The 5 minutes **Power Factor** value is the quotient between the 5 minutes Active Power value and Apparent Power value.

$$PFp_{5\,min} = \frac{Pp_{5\,min}}{Sp_{5\,min}}$$

Equation 74: Power Factor.

A.7.- 10 MINUTES INTERVAL MEASURES

A.7.1.- VOLTAGE PHASE-NEUTRAL ($U_{Ph\text{-}N}$)

The 10 minutes **Voltage** value is the square mean of the 10/12 cycles voltage value.

$$Up_{10\,min} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} Up_j^2}$$ Units: **V**

Equation 75: Voltage Phase-Neutral.

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

A.7.2.- VOLTAGE PHASE-PHASE ($U_{Ph\text{-}Ph}$)

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

$$Upg_{10\,min} = \sqrt{\frac{1}{N} x \sum_{j=1}^{N} Upg_j^2}$$ Units: **V**

Equation 76: Voltage Phase-Phase.

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

A.7.3.- CURRENT (*I*)

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

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

Equation 77: Current

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

A.7.4.- ACTIVE POWER (*P*)

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

Phase Combined Active Power:

$$Pp_{10\,min} = \frac{1}{N} x \sum_{j=1}^{N} Pp_j$$ Units: **W**

Equation 78: Phase Combined Active Power.

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

Three-phase Combined Active Power:

$$P_{TOT\,10\,min} = P_{A\,10\,min} + P_{B\,10\,min} + P_{C\,10\,min}$$ Units: **W**

Figure 150: Three-phase Combined Active Power.

A.7.5.- APPARENT POWER (*S*)

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

Phase Apparent Power:

$$Sp_{1s\,10\,min} = Up_{10\,min}\, x\, Ip_{10\,min}$$ Units: **VA**

Figure 151: Phase Apparent Power.

Three-phase Apparent Power:

$$S_{e\,10\,min} = 3\, x\, V_{e\,10\,min}\, x\, I_{e\,10min}$$ Units: **VA**

Equation 79: Three-phase Apparent Power.

A.7.6.- NONACTIVE POWER (*N*)

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

$$Np_{10\,min} = \frac{1}{N} x \sum_{j=1}^{N} Np_j$$ Units: **var**

Equation 80: Nonactive Power.

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

A.7.7.- POWER FACTOR (*PF*)

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

Phase Power Factor:

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

Equation 81: Phase Power Factor.

Three-phase Power Factor:

$$PF_{TOT\ 10min} = \frac{P_{TOT\,10\,min}}{S_{e\,10\,min}}$$

Equation 82: Three-phase Power Factor.

A.7.8.- FUNDAMENTAL ACTIVE POWER (P_1)

The 10 minutes **Fundamental Active Power** of every phase is calculated as a mean of the 10/12 cycle fundamental active power values.

Phase Fundamental Active Power:

$$Pp_{10\,min} = \frac{1}{N} x \sum_{j=1}^{N} Pp_1 \qquad \text{Units: } \mathbf{W}$$

Equation 83: Phase Fundamental Active Power.

Where **N** is the number of 10/12 cycle blocks included in the 10 min period.

Positive Sequence Active Power:

$$P^{pos}_{10\,min} = 3 x\, V^{pos}_{10\,min}\, x\, I^{pos}_{10min}\, x \cos\theta^{pos}_{10\,min} \qquad \text{Units: } \mathbf{W}$$

Equation 84: Positive Sequence Active Power.

A.7.9.- FUNDAMENTAL REACTIVE POWER (*Q*)

The 10 minutes **Fundamental Reactive Power** of every phase is calculated as a mean of the 10/12 cycle fundamental reactive power values.

Phase Fundamental Reactive Power:

$$Qp_{1\,10min} = \frac{1}{N} x \sum_{j=1}^{N} Qp_1 \qquad \text{Units: } \mathbf{var}$$

Equation 85: Phase Fundamental Reactive Power.

Where **N** is the number of 10/12 cycle blocks included inthe 10min period.

Positive Sequence Reactive Power:

$$Q_{10\,min}^{pos} = 3\,x\,V_{10\,min}^{pos}\,x\,I_{10min}^{pos}\,x\,\sin\theta_{10\,min}^{pos}$$ Units: **var**

Equation 86: Positive Sequence Reactive Power.

A.7.10.- FUNDAMENTAL APPARENT POWER (S_1)

The 10 minutes **Fundamental Apparent Power** of every phase is calculated from the 10 minutes fundamental voltage and fundamental current.

Phase Fundamental Apparent Power:

$$Sp_{1\,10min} = Vp_{1\,10\,min}\,Ip_{1\,10\,min}$$ Units: **VA**

Equation 87: Phase Fundamental Apparent Power.

Fundamental Effective Apparent Power:

$$Se_{1\,10\,min} = 3\,x\,Ve_{1\,10\,min}\,x\,Ie_{1\,10min}$$ Units: **VA**

Equation 88: Fundamental Effective Apparent Power.

A.7.11.- DISPLACEMENT POWER FACTOR (DPF)

The 10 minutes **DPF** of every phase is calculated from the 10 minutes fundamental Active Power and the fundamental Apparent values.

Phase Displacement Power Factor:

$$DPFp_{10\,min} = \frac{Pp_{1\,10\,min}}{Sp_{1\,10\,min}}$$

Equation 89: Phase Displacement Power Factor.

Positive Sequence Power Factor:

$$DPF_{TOT\,10\,min} = \frac{P_{10\,min}^{pos}}{S_{10\,min}^{pos}}$$

Equation 90: Positive Sequence Power Factor.

A.7.12.- 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.

$$G_{sg,n10min} = \frac{1}{N}\sqrt{\sum_{i=1}^{N} C_{sg,ni}^{\,2}}$$

Equation 91: $G_{sg,n}$.

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

$$H_{10minn}(\%) = \frac{G_{sg,n10min}}{G_{sg,110min}} x\,100$$

Equation 92: H(%).

The 10 minutes **Total Harmonic Distortion** is calculated through the 10 minutes single harmonics values:

$$THD_{10min} = \sqrt{\sum_{n=2}^{50} \left(\frac{G_{sg,n10min}}{G_{sg,110min}} \right)^2}$$

Equation 93: THD.

Where **G** is the rms value of the harmonic component in the 10 min period.

A.7.13.- VOLTAGE AND CURRENT INTERHARMONICS

The 10 minutes **Voltage and Current interharmonics** value calculation is the square mean of the 10/12 cycles interarmonics result.

$$G_{isg,n10min} = \frac{1}{N} \sqrt{\sum_{i=1}^{N} C_{isg,ni}^{\ 2}}$$

$$IH_{n10min}(\%) = \frac{G_{isg,n10min}}{G_{isg,110min}} x\,100$$

Equation 94: Voltage and current Interharmonics.

A.7.14.- 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 95: U_1.

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

Equation 96: U_2.

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

Equation 97: U_0.

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

Negative sequence unbalance ratio u_2 (voltage / current unbalance):

$$K_{d\,10min} = u_{2\,10\,min} = \frac{U\,2_{10\,min}}{U\,1_{10\,min}}\,x\,100\,\% = \frac{negative\ sequence}{positive\ sequence}\,x\,100\,\%$$

Equation 98: Negative sequence unbalance ratio.

Zero sequence unbalance ratio u_0 (voltage / current asimmetry):

$$K_{a\,10\,min} = u_{0\,10\,min} = \frac{U\,0_{10\,min}}{U\,1_{10\,min}}\,x\,100\,\% = \frac{zero\ sequence}{positive\ sequence}\,x\,100\,\%$$

Equation 99: Zero sequence unbalance ratio.

A.7.15.- VOLTAGE AND CURRENT CREST FACTOR

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

$$Voltage\ CF_{10\,min} = MAX\left(CF_{\square 1}, \ldots, CF_N\right)$$

Equation 100: Voltage CF.

$$Current\ CF_{10\,min} = MAX\left(CF_1, \ldots, CF_N\right)$$

Equation 101: Current CF.

Where **N** is the number of groups of 10 or 12 cycles (depending on the frequency) included in the 10min period and **samples** is the number of samples observed in one time window.

A.7.16.- 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 10 min **K-factor** calculation is based on the 10 minutes harmonics results.

$$K - factor_{10min}(\%) = \frac{\sum_{h=1}^{25}\left(G_{sg,h10\,min}\,x\,h\right)^2}{\sum_{h=1}^{25} G_{sg,h10\,min}^{\ 2}}\,x\,100$$

Equation 102: K-Factor.

A.7.17.- FLICKER Pinst

The 10min **flicker Pinst** is the average of every 10/12 cycles **flicker Pinst** included into the 10 min period.

A.7.18.- 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 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.

A.7.19.- 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 103: Frequency.

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

A.8.- 10 MINUTES MAXIMUM AND MINIMUM VALUES

A.8.1.- MAXIMUM AND MINIMUM VALUES

The 10 minutes **maximum and minimum values** are calculated from the 10/12 cycles values included into the 10 minutes period. With the special case of the frequency.

A.8.2.-FREQUENCY MAXIMUM AND MINIMUM VALUES

The 10 minute **maximum and minimum** frequency are calculated from the 1s sampling frequency.

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