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CcM4

Energy meter to **measure three-fase** + **neutral** circuit breaker electrical values

USER MANUAL

CcM4

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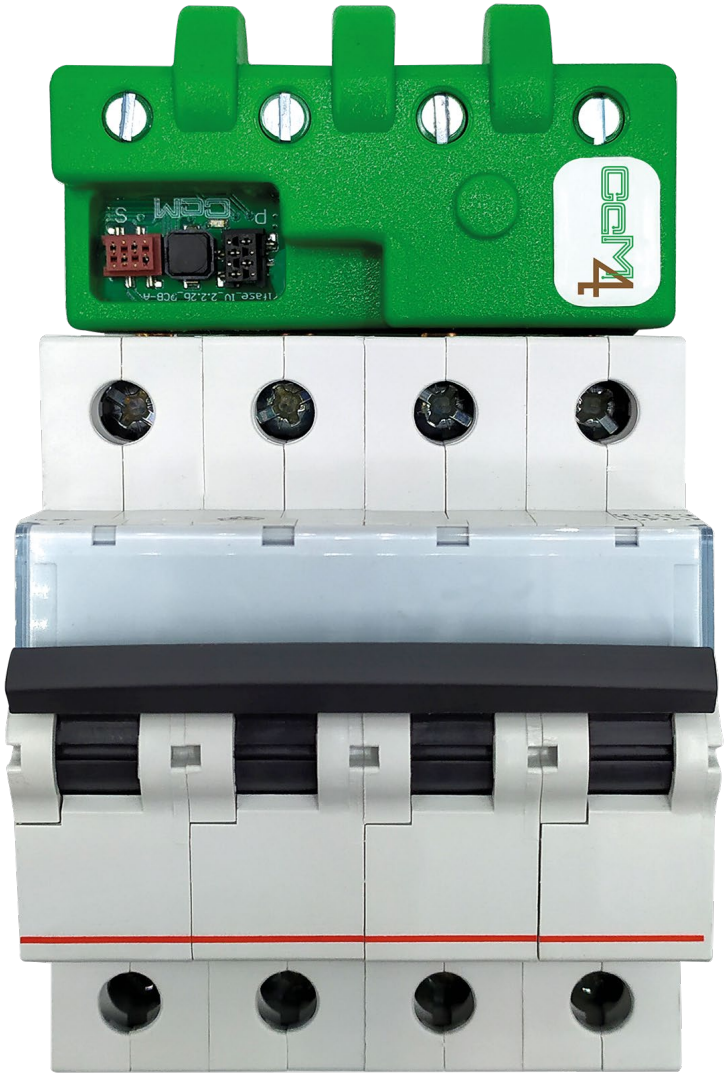

CcM4

1. INTRODUCTION

CcM4 is one of the devices from the CcM product family designed to measure electrical parameters (voltage, current, energy, harmonics distortion, etc.) in three-phase installations with a neutral wire.
The CcM product range consists of a set of devices used for the monitoring of electrical parameters inside the electrical switchboard in single- and three-phase installations. It is best suitable for installation in thermal-magnetic switches or residual-current circuit breakers.

CcM4, in particular, is one of the "principal" CcM product family devices (CcM4, CcM3 and CcM2). Their function is two-fold. To work as a slave of the general master (PLC or PC, Windows/Linux, o directly with the CcMaster) inside the principal bus and as a master inside the secondary bus, commanding other devices of the CcM family – CcM1-C and CcM3-C secondary devices.

The user is able to access the data from CcM4 through RS-485 communication cable, using Modbus RTU protocol or through one of the free software tools offered, such as CcManager (configuration, viewing and storing in a local network) or the Energy CcM webpage (viewing and storing data in the cloud). It is also possible to add CcM WiFi peripheral to obtain data through a WiFi network and analyse the data using the **EnergyCcM App** and the **Scada Web** (scada.energyccm.com).

As it can be combined and used with different devices within the product range, the CcM product family offers multiple configuration options and allows users to configure the most convenient solution for both, their domestic and industrial installations. Installations can be wireless, connected with a communication cable or mixed. The devices can be connected to each other and create communication buses, establishing configurable master-slave hierarchies.

CcM4, for instance, behaves similarly to an energy meter or a grid analyzer. Inserted directly into a thermal-magnetic switch or a residual-current circuit breaker, the device is connected in series with the consumption line, registering voltage, intensity, power, active and reactive energy as well as harmonics in each of the phases.

1.1 CONTENTS OF THE BOX

Inside the box you should find:

- 1x CcM4
- 1x flat cable RS-485 of 1m with already crimped male connector
- 4x male connectors RS-485 which may be crimped to the cable
- Data sheet

1.2 DEVICE DOCUMENTATION

CcM4 documentation includes this manual and its technical sheet. All documents can be downloaded from our website **www.energyccm.com.**

1.3 ABOUT THIS MANUAL

The aim of this manual is to explain and describe as clearly as possible the correct use and features of the CcM4 device, within the CcM product family. For this purpose, it includes technical data as well as user instructions and specifications to provide information about its correct functioning.

This document is subject to regular updates. The contents of this manual might change partially or completely and it is the responsibility of the users to make sure that they are using the latest version of the user manual. Monsol Electronic reserves the right to modify the manual without previous notice.

2. TECHNICAL SPECIFICATIONS

Maximum operation current	63 Arms
Current measurement range	[0.2 – 63] Arms
Maximum allowed voltage	300 Vrms
Signal frequency	50/60 Hz
Current measurement error	< 0.5 % RD
Voltage measurement error	< 0.2 % RD
Active energy measurement error	< 1 % RD
Reactive energy measurement error	< 2 % RD
Communication protocol	Modbus RTU
Average response time	0.1 s
Maximum consumption	1 W
Power supply	85 – 300 Vrms
Total dimensions	72 x 50 x 32 mm
Comb dimensions	5 x 12 x 3 mm

2.1 ENVIRONMENTAL CONDITIONS

Operating altitude	0...2000 m
Operating temperature	-25...+50 °C
Overvoltage category	III (according to IEC 61010-1 +IEC 61010-2-030)
Protection degree	IP20
Pollution degree	2
Relative humidity	0...95 % a 45 °C
Protection against overcurrent	External device (thermal-magnetic switches or residual-current circuit breakers)

The mains supply voltage may fluctuate up to ±10 % of the nominal voltage. Similarly, temporary overvoltages may occur on the mains supply voltage, ensuring proper operation of the device.

3. SAFETY INSTRUCTIONS

Please read and follow all the below safety instructions and precautions before installation and use of the CcM4 device.

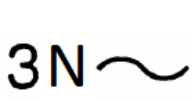
3.1 SYMBOLS

General caution

Electrical hazard

General information

Prohibited



3-phase + neutral current

Reinforced insolation

CE marking

3.2 PURPOSE

This device is designed to measure voltage, current, power, energy and harmonics distortion in a three-phase electric installation directly connected to upstream or downstream of the thermal-magnetic switch or a residual-current circuit breaker in both, industrial and domestic use.
The system devices should only be used for this purpose. Monsol Electronic is not liable for any damages caused by an inappropriate installation, use or maintenance of the system.

To ensure safe use, the system modules must only be used in compliance with the instructions in this manual. Legal and safety regulations must also be considered to ensure correct use.

3.3 TRANSPORT DAMAGE CHECK

Immediately after receiving the package, make sure that the packaging as well as the device have no signs of damage. At the same time, check that the order is complete, having in mind the contents of the box defined in section 1.1. If the packaging shows any sign of damage, impact or tear, damage of the system modules themselves should be suspected and they should not be installed. If this occurs, please contact Monsol Electronic's customer service.

Telephone: **+34 952 02 05 84**
E-mail: **info@energyccm.com**
Web: **www.energyccm.com**
Address: **Monsol Electronic**
Calle la Gitanilla, 17, Nave 1
29004 Málaga (Spain)

3.4 STAFF

This system should be installed, handled and replaced solely by qualified staff. The final user of this manual is staff who is capable of handling the devices.
Qualification of the staff mentioned herein must meet all the safety-related standards, regulations and legislation applicable to the installation and operation of this system in the country concerned.

The responsibility to select qualified staff always lies with the company that the staff works for. It is also the responsibility of the company to assess the ability of the worker to carry out any kind of work and ensure their safety. At the same time, staff must comply with workplace health and safety regulations. It is the responsibility of the company to provide their staff with the training necessary for handling electrical devices and to make sure that they familiarize themselves with the contents of this user manual.

3.5 SPECIAL HAZARDS

The devices are designed to form a part of an industrial or domestic electrical installation. Corresponding safety measures must be observed. Additional safety requirements should be specified by the company who has installed or configured the system.

High amount of current constantly circulates through the system and any physical contact could cause a serious injury. Please ensure that only qualified staff has access to the devices and make sure that the system is switched off or disconnected during handling.

3.6 INSTALLATION PLACE

The devices within the CcM family should be installed in watertight enclosures that comply with IP65 standards outdoors and IP55 standards indoors to be protected from corrosion and humidity.

3.7 ALTERATIONS

It is strictly prohibited to carry out any kind of alterations or modifications to the system.

3.8 CLEANING AND MAINTENANCE

Cleaning and maintenance works should only be carried out when the devices are disconnected from the grid. Before taking any action, make sure that the system has been correctly disconnected, preventing the current to go through them, generally deactivating the circuit breaker where the device is connected.

Do not try to repair the device on your own in case of any malfunction. If this occurs, contact Monsol Electronic's customer service. The system does not require any special cleaning or maintenance, except for standard physical maintenance required by any current conducting electrical device connected with screws and terminals that need to be tightened.

3.9 GENERAL HAZARDS RESULTING FROM NON-COMPLIANCE WITH SAFETY STANDARDS

The technology employed in the manufacturing of the system modules ensures safe handling and operation. Nonetheless, the system might pose hazards if it is used by unqualified staff or handled in a way that is not specified in this user manual.

Any person in charge of the installation, putting into operation, maintenance or replacement of a CcM family device must first read and understand this user manual, especially the safety recommendations.

3.10 GENERAL SAFETY REQUIREMENTS

Operator.

The person in charge of handling the electrical device is responsible for the safety of persons and property.

Disconnection.

Before starting any work, disconnect the circuit breaker and check the absence of voltage in every cable that supplies voltage to the working site.

Prevention from inadvertent connection.

Avoid re-connection of the system using signs, closing or blocking the working site. Accidental reconnection might cause serious injuries.

Verification of absence of voltage in the system.

Determine conclusively, using a voltmeter, that there is no voltage in the system. Check all the terminals to make sure that there is no voltage in the system (every single phase).

Covering the adjacent components conducting voltage and restricting the access to electrical devices.

Cover all the system components conducting voltage which could cause injuries while carrying out the works. Confirm that dangerous areas are clearly marked.

4. DEVICE DESCRIPTION

In Figure 1 the CcM4 is displayed.

Figure 1 Picture of the CcM4 device

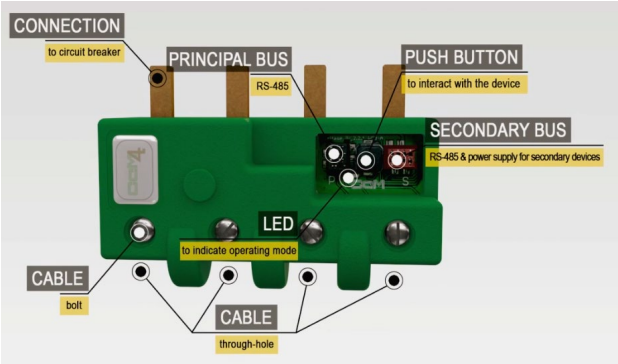


Figure 2 Graphic description of CcM4

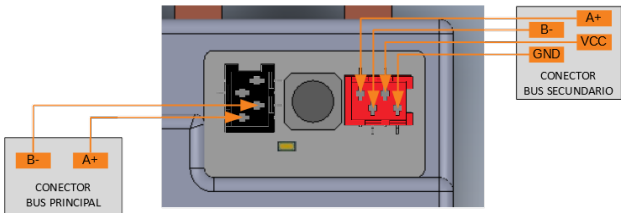


Figure 3 Detail of the CcM4 connectors

As depicted in Figure 2, the device consists of:

- **CONNECTION COMB**: It is a metallic contact, through which electric current is fed before it leaves through the cable connected on the opposite end. These combs are inserted in the hosting thermal-magnetic switch or residual-current circuit breaker.
- **LED:** This is a status LED that indicates operating mode of the device.
- **PUSH BUTTON:** A push button to interact with the device.
- **CABLE THROUGH-HOLE:** The hole serves as an entrance for the electric cable, which is fastened by the upper bolt.
- **CABLE BOLT:** Once the electric cable, through which the measured electric current will flow, is inserted, the bolt will ensure that it stays fixed in the right place at all times.
- **BLACK PRINCIPAL BUS CONNECTOR** (detail Figure 3): Connection bus RS-485 (without power supply). It comprises of two data signals (A+ and B-) required to communicate with the remaining devices of the bus. This bus will provide connection to other principal devices of this product range such as CcM4, CcM3 or CcM2.

The black colour of this female connector only serves to differentiate it from the red female connector, both are compatible with the red male connectors, which are supplied along with the flat cable.

- **RED SECONDARY BUS CONNECTOR** (detail Figure 3): Connection bus RS-485. It comprises of two power supply signals (VDC and GND) and the data signals (A+ and B-). This bus will provide connection to the secondary CcM1-C devices. These will communicate with the CcM4 device, which manages the bus as its own master.

4.1 IDENTIFICATION

In the enclosure of the equipment, the user will find an identification sticker with a QR code like the one shown in Figure 4, in which the serial number of the device is coded. This serial number is unique and is also written next to the QR code.

Figure 4 Identification QR code

5. INSTALLATION

Due to electrical hazard during installation, it will be necessary to ensure that the installation zone meets the necessary safety conditions.

In order to install CcM4, follow these steps:

5.1 STEP 1: SAFETY

Make sure that the protection device is deactivated (thermal-magnetic switch or residual-current circuit breaker) by activation of the break switch marked in green in the following figures.

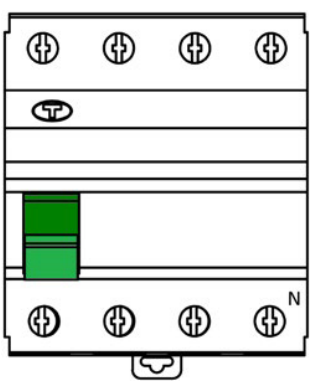


Figure 5 Residual-current circuit breaker

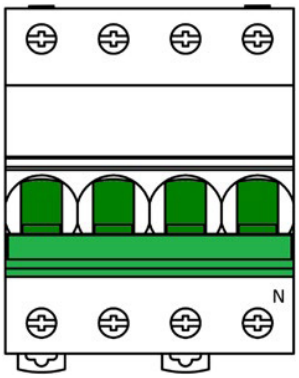


Figure 6 Thermal-magnetic switch

5.2 STEP 2: DISCONNECTION OF THE CURRENT LINES

Loosen the bolts of lines L1, L2, L3 and N of the lower part (output current) and unplug the cables coming from the thermal-magnetic switch or residual-current circuit breaker (Figure 7).

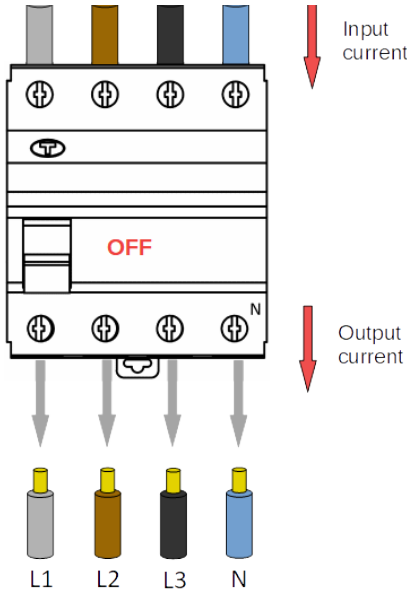


Figure 7 Disconnection of the current lines

5.3 STEP 3: CONNECTION OF THE CABLES TO CCM4

Once you unplug the output current cables, plug them at the back (the part furthest from the connection comb) of the CcM4 device and tighten the bolts to hold the cables (Figure 8).

The protective device is supposed to have the neutral wire on the right, you should verify the position of the neutral wire in the protective devices. Otherwise, see section 5.4.

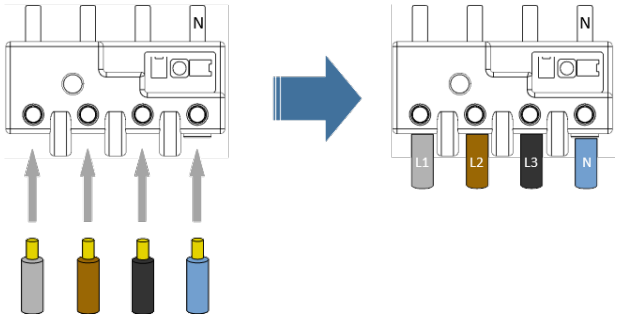


Figure 8 Connection of the cables in CcM4

CAUTION! Make sure that the cable of the NEUTRAL wire is connected in the through-hole of the CcM4 designated for the NEUTRAL wire and marked with "N".

5.4 STEP 4: CONNECTION OF CCM4 TO THE SWITCH

Once all the electric cables are inserted in the cable through-holes of the CcM4 device, connect it to the protection device (thermal-magnetic switch or residual-current circuit breaker) by inserting the combs in the cable through-holes located in the output current cables and tighten the bolts of the thermal-magnetic switch or residual-current circuit breaker until it is held properly and connects to electricity (Figure 9).

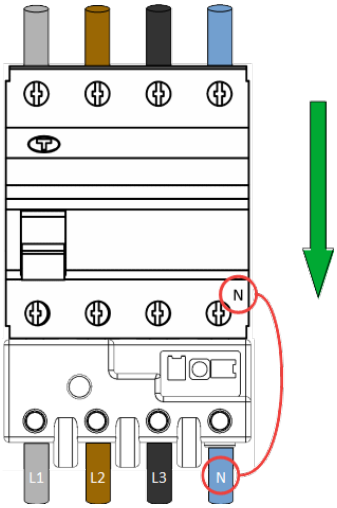


Figure 9 Connection of CcM4 to the switch with the neutral wire on the right

IMPORTANT! The device considers the positive charge to be flowing from the comb into the cable through-hole. If the device is connected in the opposite direction at the opposite end of the switch, the power values will appear with a minus sign and CcM4 will not be protected by the thermal-magnetic switch/residual-current circuit breaker. It is therefore recommended to install the device on the output current cables when possible.

As previously mentioned, the CcM4 device neutral must ALWAYS match the neutral of the thermal-magnetic switch/residual-current circuit breaker. In Figure 9 the neutral of the switch is supposed to be located on the right. In case it is on the left, you should connect the CcM4 at the opposite end of the switch, as per Figure 10.

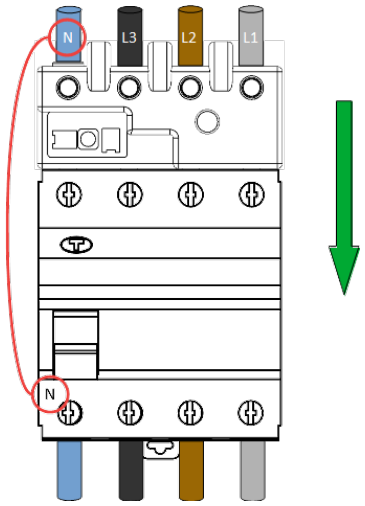


Figure 10 Connection of CcM4 to the switch with the neutral wire on the left

The unidirectional mode is configured by default in the CcM4 (section 6.2.1), meaning that the device will automatically detect the direction of the current flow and designate is as the direction of energy consumption of the building. This way, the user can connect the device to the top of the bottom of the circuit breaker without worrying about the power sign.

The device shall ALWAYS be connected after the main protection of the building.

In the case of an advanced installation (for example, a self-consumption installation), it will be interesting for the user to configure the bidirectional mode, described in section 6.2.2.

5.5 STEP 5: COMMUNICATION

The communication in the principal bus between the CcM4 device and its general master can be established in two ways: wireless or using a communication cable.

5.5.1 Wireless.

Using the CcM WiFi peripheral. Check the installation manual and CcM WiFi configuration to learn more about this solution available at: **www.energyccm.com.**

5.5.2 Via communication cable.

Connecting an RS-485 cable to the connector of the principal bus (black) to handle communication with the CcM4 device. In this case, it is recommended to use the CcManager management software together with the USB adaptor RS-485, even though it is also possible to use any software, which enables sending Modbus RTU commands via the connection of the RS-485 cable. Check the installation manual and CcManager configuration to learn more about this solution available at **www.energyccm.com.**

In case you opt for the connection via communication cable, you should connect the flat four wire cable supplied with the connector (red), which is already crimped in the black female connector of the principal bus of the CcM4 (Figure 11), marked with a 'P' on the board.

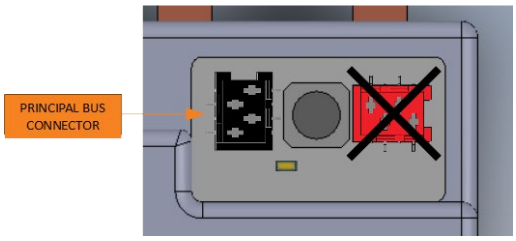


Figure 11 Detail of black connector of the principal bus

The supplied cable has a male connector (red) already crimped on one end of the cable; it may be used straight away. Nevertheless, if you need a connector in other position, you should use the provided male connectors (red) as indicated in Figure 12

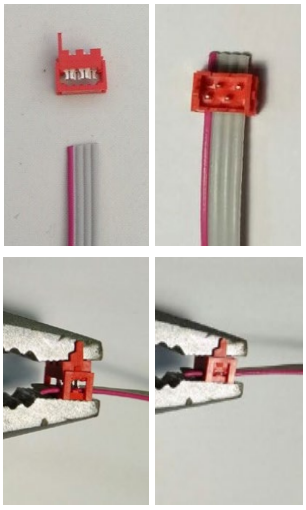


Figure 12 Crimp connector for RS-485 cable

Make sure that the polarisation slot of the connector is placed on the side of the red cable, which makes up one of the four wires of the flat cable.

You can regulate the distance between connectors and crimp them according to the distance that you consider most adequate for your installation and/or the existing distance between the devices connected to the same cable or bus. **Take into consideration that all the supplied male connectors are red regardless of whether they will be connected to the principal bus (female black connector) or to the secondary one (female red connector).**

The cable connectors have polarity (polarisation slot) placed in a way that they cannot be connected to the connector of the CcM device in the other way. For correct use, the polarisation slot of the connector must match the through-hole of the female connector installed at the secondary bus input of the CcM4 device.

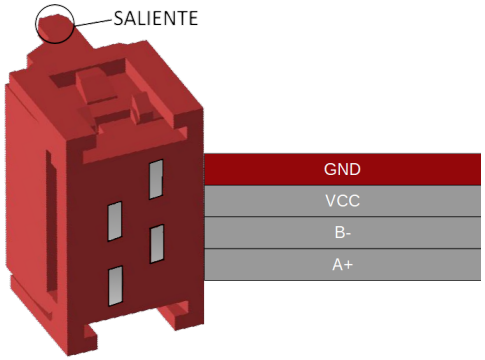


Figure 13 Connector RS-485

With any modification that you make to the supplied flat cable (crimping of new connectors, cutting the cable to make it shorter, etc.), you need to make sure that ***all the devices connected to the cable in question have no power supply using the power cut in the thermal-magnetic switch or residual-current circuit breaker.*** *Failure to meet this requirement could produce a short circuit between the signals that travel through the bus resulting in damage to the connected device.*

The internal communication between the CcM4 and a secondary device (CcM1-C or CcM3-C) takes place via the secondary bus, through which it is possible to connect the secondary devices from the CcM family to the CcM4. In this bus the CcM4 will act as an information hub (master). For that purpose, an RS-485 cable should be installed similarly as described above, but this time it should be connected to the red female connector of the secondary bus (see Figure 14), marked with an 'S' on the board.

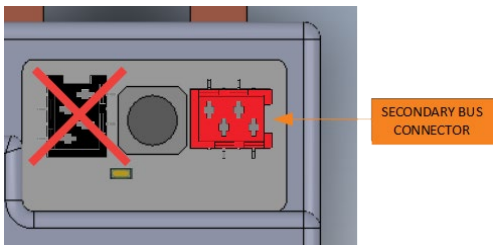


Figure 14 Detail of red connector of the secondary bus

In the box of the secondary devices, there is a four-wire flat cable with an already crimped red connector together with four red male connectors, which will be used to connect the secondary devices.

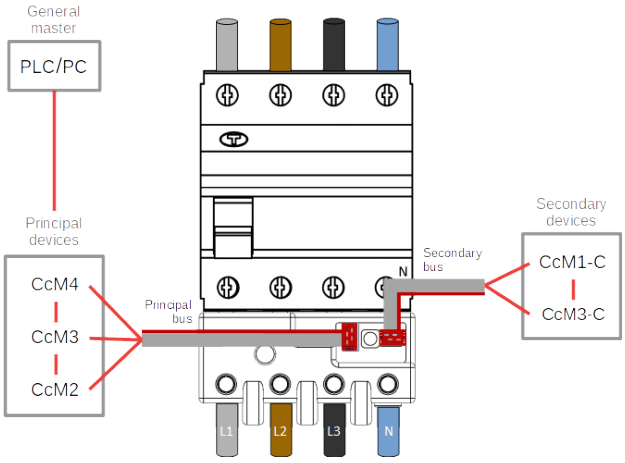


Figure 15 Connection of the principal and secondary buses

6. OPERATION

6.1 OPERATING MODES

The device has three operating modes, which may be configured using the push button

6.1.1 Reading Mode

It is the default mode. The CcM4 takes snapshot measures and the LED flashes twice every 5 seconds to indicate that everything works correctly.

6.1.1.1 Measurements

The CcM4 is able to take measurements of each phase of the following parameters:

- Voltage RMS
- Current RMS
- Power factor
- Active, reactive and apparent power
- Active, reactive and apparent energy
- Voltage and current harmonics distortion
- Signal frequency
- Temperature

In order to read each parameter, see the memory map on section 7.
Likewise, the CcM4 device is able to detect whether there have been any power supply breakdown, reading register 34:

Register 34 value	Meaning
'000' (0)	No breakdown
'001' (1)	Phase 1 power supply breakdown (*)
'010' (2)	Phase 2 power supply breakdown
'011' (3)	Phases 1 and 2 power supply breakdown
'100' (4)	Phase 3 power supply breakdown
'101' (5)	Phases 1 and 3 power supply breakdown
'110' (6)	Phases 2 and 3 power supply breakdown
'111' (7)	Phases 1, 2 and 3 power supply breakdown

Table 1 Reboot flag values

(*) Note that when there is a power failure on phase 1, the device is turned off regardless of the status of the other phases.

Once the register has been read, its value returns to '000'.

6.1.2 Synchronisation mode

This mode is selected to pair the CcM4 with other secondary devices (CcM1-C and CcM3-C) via the secondary bus in order to change the address of the CcM4 (ID) inside the principal bus. To activate this mode, the push button should be pressed for more than 3 seconds (and less than 10), and the status LED will start flashing fast indicating its correct activation. In order to return to the reading mode, the push button should be pressed just once again.

6.1.3 Reset mode

Activation of this mode will start the CcM4 and restore the default values losing any potentially stored pairing of secondary devices information and returning to the factory ID Modbus "1" (for more information regarding the address allocation see section 6.4.2). The cumulative energy records are not reset in this mode; in order to reset all the values, a specific Modbus command is needed. To perform this task, the user shall write '0x8484' in the register 500 (see the memory map in section 7).
To perform this reset operation, it is necessary to

keep the push button pressed for more than 10 seconds, after which the LED will remain permanently lit and the button can be released. Subsequently, the CcM4 device will return to the reading mode, with address "1" without any associated secondary device (CcM1-C or CcM3-C).

6.2 CURRENT FLOW DIRECTION CONFIGURATION

Two working modes are defined depending on the direction of the current flowing through the device: unidirectional or bidirectional. These work modes can be configured by the user using the CcManager (see user manual available at **www.energyccm.com**) or directly through a Modbus command, typing in the register 504 (see memory map in section 7). In the case of having a CcM WiFi connected, it is possible to configure it through the embedded configuration website or the Energy CcM application for Android devices (see CcM WiFi user manual).

6.2.1 Unidirectional mode

Default mode (value '0' in register 504). Only one direction of the current flow is considered (consumed energy), which is detected by the CcM device. In this manner, the user does not have to worry about the power sign, regardless of where in the circuit breaker (upper or lower part) he or she has installed the CcM4. In other words, it does not matter whether the current flows from the combs to the CcM4 rear side or vice-versa, all of the current will be considered positive (consumed energy).

6.2.2 Bidirectional mode

User configurable mode (value '1' in register 504). In this mode, both current flow directions are considered, being able to measure and store the energy consumed and generated, taking as a reference the current flow defined in Figure 16. Every electrical parameter (current, active and reactive power, active and reactive energy, etc.) will be measured with respect to this reference.

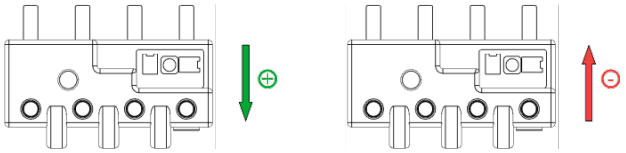


Figure 16 Positive and negative current flow direction (by default)

If desired by the user, on account of the position of the CcM4 installed in the distribution board, he or she would be able to reverse the current flow reference, and thus the device will consider as positive the current flowing from the cable hole to the comb (value '2' in register 504).

6.3 CONNECTION CONFIGURATION

There are many possible connection schemes when using the CcM4 device together with the rest of the devices of the CcM family. We can divide them in the following groups:

- Principal bus
- Secondary bus

These two groups do not exclude each other, which means that both types of buses may be configured at the same time within the same CcM4 device.

6.3.1 Principal bus

The principal bus is the one, which connects the general master to the principal devices of the CcM family.
As described in section 5.5.2, in order to create a principal bus, the black bus from the CcM4 designated for this purpose will be used and one or more principal devices will be connected to the same cable. The principal devices may be CcM4, CcM3 or CcM2; for more information see the manuals of the devices CcM3 and CcM2 from the CcM product range.
In Figure 17 you will see an example of a principal bus connection consisting of two CcM4 devices.

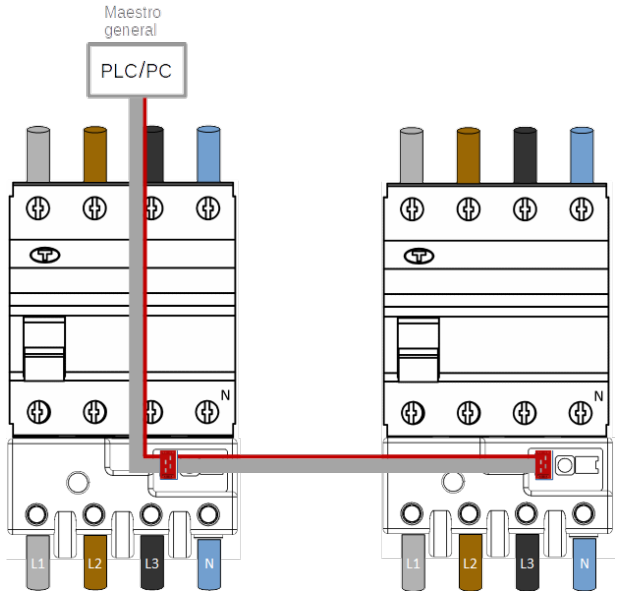


Figure 17 Connection of principal bus CcM4

By default, all the CcM4 have a set address Modbus "1". In order to be able to set other addresses within the principal bus, review section 6.4 Address setting.

6.3.2 Secundary bus

The secondary bus is the one, which connects a principal device of the CcM family to one or more secondary devices (CcM1-C and CcM3-C). The data from the secondary devices will be redirected by the principal device via the principal bus.

As described in section 5.5.2, in order to create a secondary bus, the red connector of the CcM4 designated for this purpose will be used and one or more secondary devices will be connected to the same cable. The devices will be the CcM1-C or CcM3-C and they will connect to the thermal-magnetic switch or residual-current circuit breaker as shown in Figure 18 (for more information, review the installation and configuration manual of the secondary device under consideration).

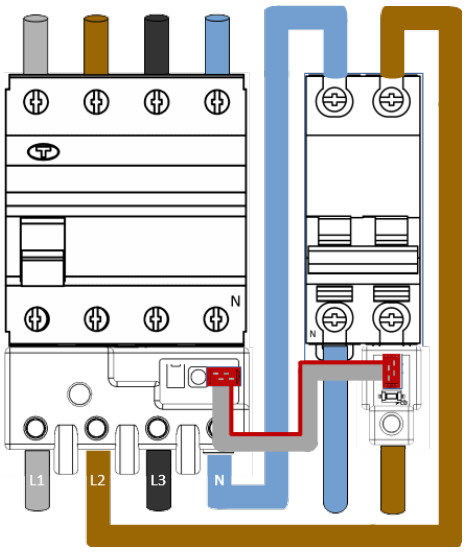


Figure 18 Connection of the secondary bus

6.4 COMMUNICATION

By default, the communication with the CcM4 device will take place via the communication port RS-485 described above. It will also be possible to implement a wireless communication via the CcM WiFi module (for more information review the CcM WiFi manual available at www.energyccm.com).

6.4.1 Parameters of the RS-485 communication interface

The CcM4 device supports the Modbus RTU over TCP protocol with the following parameters:

Baudrate	9600 bps
Format	8N1
Mode	Asynchronous
Range of addresses	1...247

Table 2 Parameters of the RS-485 interface

6.4.2 Address setting

6.4.2.1 Address of the principal devices

The default Modbus address of the CcM4 device is "1". This means that in order to connect various CcM principal devices to one principal bus, their address must be changed to avoid collisions in the bus.

There are two options to change the address of a CcM4:

- Using the CcManager software tool (see the CcManager manual). For that purpose, synchronisation mode of the CcM4 device in question should be activated (section 6.1.2) and the tool may be used to set the required address.

IMPORTANT! In order to successfully perform this operation, only one principal device in the bus should be in the synchronisation mode, the remaining ones should be either in the reading mode or switched off.

- Using the standard Modbus commands. It is possible to assign addresses through commands sent from the Modbus device. There may be two different cases:

  – If the CcM4 device address that will be changed is known. The device in question must be in synchronisation mode and afterwards the command to change its address will be sent to it (see for the memory map of the CcM4 in section 7).

  – If the address of the CcM4 device that will be changed is unknown. The device in question must be only in synchronisation mode; the remaining devices of the bus must be either in reading mode or switched off. Subsequently, the Modbus command to modify the address using the broadcast address (255) will be sent.

6.4.2.2 Address of the secondary devices

Once connected to the secondary bus between the master of the secondary bus (CcM4) and the different slaves (secondary devices CcM1-C or CcM3-C), the CcM4 will be in charge of setting the secondary device addresses. For that purpose, the steps below should be followed.

In case that the devices are not completely new from the factory and are being reused, or when it is not clear what their addresses are, we recommend resetting all the devices in order to return them to the original default setting.

1. Set the CcM4 in synchronisation mode.

2. Set the secondary CcM that you wish to pair in synchronisation mode (keep the secondary CcM button pressed for more than 3 seconds), while leaving the remaining secondary devices of the bus in reading mode. Automatically, the CcM4 will assign an available address to the secondary CcM in question; afterwards, the secondary CcM will automatically return to the reading mode.

3. Repeat the operation for all the secondary devices (CcM1-C or CcM3-C) to be connected to the secondary bus of the CcM4.

4. Once finished, return the CcM4 in the reading mode by pressing the button only once. After leaving the synchronisation mode and returning to the reading mode, the status LEDs of the secondary CcMs will flash once and in sequence as per their set order in the bus as a confirmation of the pairing of the secondary devices with the principal device (CcM4).

For more information regarding the operating modes of the secondary CcM device and its configuration, review the installation and configuration manual available at **www.energyccm.com.**

7. MEMORY MAP

ID AND CONTROL REGISTERS				
Description	Modbus register	Length	Type	Unit
Product identification code	0	1	R	hex
Serial Number	1	2	R	hex
Modbus ID	3	1	R/W	-
Detected secondary devices quantity	19	1	R	-

MEASUREMENT REGISTERS				
Description	Modbus register	Length	Type	Unit
RMS current - Phase 1	20	2	R	Arms x 100
RMS voltage - Phase 1	22	2	R	Vrms x 100
RMS current - Phase 2	24	2	R	Arms x 100
RMS voltage - Phase 2	26	2	R	Vrms x 100
RMS current - Phase 3	28	2	R	Arms x 100
RMS voltage - Phase 3	30	2	R	Vrms x 100
Voltage failure	34	1	R	-
Power factor - Phase 1	36	1	R	PF x 1000
Power factor - Phase 2	37	1	R	PF x 1000
Power factor - Phase 3	38	1	R	PF x 1000
Active energy - Phase 1, quandrants 1 and 4	40	2	R	Wh
Active energy - Phase 2, quandrants 1 and 4	42	2	R	Wh
Active energy - Phase 3, quandrants 1 and 4	44	2	R	Wh
Active energy - Phase 1, quandrants 2 and 3	46	2	R	Wh
Active energy - Phase 2, quandrants 2 and 3	48	2	R	Wh
Active energy - Phase 3, quandrants 2 and 3	50	2	R	Wh
Reactive energy - Phase 1, quandrant 1	52	2	R	VArh
Reactive energy - Phase 1, quandrant 2	54	2	R	VArh
Reactive energy - Phase 1, quandrant 3	56	2	R	VArh
Reactive energy - Phase 1, quandrant 4	58	2	R	VArh
Reactive energy - Phase 2, quandrant 1	60	2	R	VArh
Reactive energy - Phase 2, quandrant 2	62	2	R	VArh
Reactive energy - Phase 2, quandrant 3	64	2	R	VArh
Reactive energy - Phase 2, quandrant 4	66	2	R	VArh
Reactive energy - Phase 3, quandrant 1	68	2	R	VArh
Reactive energy - Phase 3, quandrant 2	70	2	R	VArh
Reactive energy - Phase 3, quandrant 3	72	2	R	VArh
Reactive energy - Phase 3, quandrant 4	74	2	R	VArh
Fundamental active energy - Phase 1	76	2	R	Wh

Fundamental active energy - Phase 2	78	2	R	Wh
Fundamental active energy - Phase 3	80	2	R	Wh
Fundamental reactive energy - Phase 1	82	2	R	VArh
Fundamental reactive energy - Phase 2	84	2	R	VArh
Fundamental reactive energy - Phase 3	86	2	R	VArh
Active power - Phase 1	88	2	R	W
Active power - Phase 2	90	2	R	W
Active power - Phase 3	92	2	R	W
Reactive power - Phase 1	94	2	R	VAr
Reactive power - Phase 2	96	2	R	VAr
Reactive power - Phase 3	98	2	R	VAr
Apparent power - Phase 1	100	2	R	VA
Apparent power - Phase 2	102	2	R	VA
Apparent power - Phase 3	104	2	R	VA
Harmonic distortion on voltage - Phase 1	106	2	R	THD% x 100
Harmonic distortion on current - Phase 1	108	2	R	THD% x 100
Harmonic distortion on voltage - Phase 2	110	2	R	THD% x 100
Harmonic distortion on current - Phase 2	112	2	R	THD% x 100
Harmonic distortion on voltage - Phase 3	114	2	R	THD% x 100
Harmonic distortion on current - Phase 3	116	2	R	THD% x 100
Fundamental RMS current - Phase 1	118	2	R	Arms x 100
Fundamental RMs voltage - Phase 1	120	2	R	Vrms x 100
Fundamental RMS current - Phase 2	122	2	R	Arms x 100
Fundamental RMs voltage - Phase 2	124	2	R	Vrms x 100
Fundamental RMS current - Phase 3	126	2	R	Arms x 100
Fundamental RMs voltage - Phase 3	128	2	R	Vrms x 100
Temperature - Phase 1	132	2	R	°C x 100
Temperature - Phase 2	134	2	R	°C x 100
Temperature - Phase 3	136	2	R	°C x 100
Frecuencia de línea - Fase 1	140	1	R	Hz x 100
Frecuencia de línea - Fase 2	141	1	R	Hz x 100
Frecuencia de línea - Fase 3	142	1	R	Hz x 100
Total active energy - Quandrants 1 and 4	144	2	R	Wh
Total active energy - Quandrants 2 and 3	146	2	R	Wh
Total reactive energy - Quandrant 1	148	2	R	VArh
Total reactive energy - Quandrant 2	150	2	R	VArh
Total reactive energy - Quandrant 3	152	2	R	VArh
Total reactive energy - Quandrant 4	154	2	R	VArh
Total apparent energy	156	2	R	VAh
Apparent energy - Phase 1	160	2	R	VAh
Apparent energy - Phase 2	162	2	R	VAh
Apparent energy - Phase 3	164	2	R	VAh

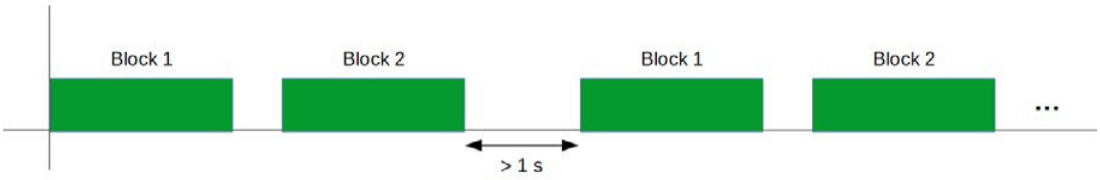
SECONDARY DEVICES REGISTERS				
Description	Modbus register	Length	Type	Unit
Current value	201	1	R	Arms x 100
Modbus ID	204	1	R	-
Serial Number	205	2	R	hex
Current value	208	1	R	Arms x 100
Modbus ID	211	1	R	-
Serial Number	212	2	R	hex
Current value	215	1	R	Arms x 100
Modbus ID	218	1	R	-
Serial Number	219	2	R	hex
Current value	222	1	R	Arms x 100
Modbus ID	225	1	R	-
Serial Number	226	2	R	hex
Current value	229	1	R	Arms x 100
Modbus ID	232	1	R	-
Serial Number	233	2	R	hex
Current value	236	1	R	Arms x 100
Modbus ID	239	1	R	-
Serial Number	240	2	R	hex
Current value	243	1	R	Arms x 100
Modbus ID	246	1	R	-
Serial Number	247	2	R	hex
Current value	250	1	R	Arms x 100
Modbus ID	253	1	R	-
Serial Number	254	2	R	hex

CONTROL REGISTERS FOR DEVELOPERS				
Description	Modbus register	Length	Type	Unit
Energy registers restart (writing 0x8484)	500	1	W	-
Device restart (writing 0x8484)	501	1	W	-
Unidirectional/bidirectional working mode (section 6.2)	504	1	R/W	-

ACCESIBLE INVERTER REGISTERS				
Description	**Modbus register**	**Length**	**Type**	**Unit**
Protocol ID	800	1	R	-
Active power - Inverter phase 1	801	1	R	-
Active power - Inverter phase 2	802	1	R	-
Active power - Inverter phase 3	803	1	R	-
Active energy - Inverter phase 1	804	1	R	-
Active energy - Inverter phase 2	805	1	R	-
Active energy - Inverter phase 3	806	1	R	-
Inverter total active power	807	1	R	-
Inverter total active energy	808	1	R	-

Table 3 Memory map CcM4

To ensure data consistency, it is recommended to leave an interval of at least 1 second between requests of the entire data block.
For example, if the user structures the requests in two data blocks, they should be spaced as shown in the following figure:



ANNEX: APPLICATION IN THE PHOTOVOLTAIC SECTOR

As previously mentioned, the CcM4 device will consider by default as a positive direction the electric current which flows from the comb to the cable through-hole; obtaining the rest of the electrical parameters consistently to this reference.

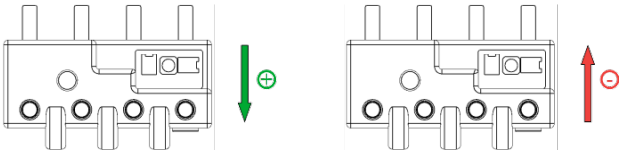


Figure 19 Positive and negative direction of the current flow in CcM4 (by default)

There are applications in which the negative direction of the current should be considered, such as metering of a source of power generation or an internal power supply (photovoltaic plant), cases in which the CcM4 should be set in bidirectional mode (section 6.2.2). Below we show an example of a self-consumption installation with capability to inject surplus energy to grid network.

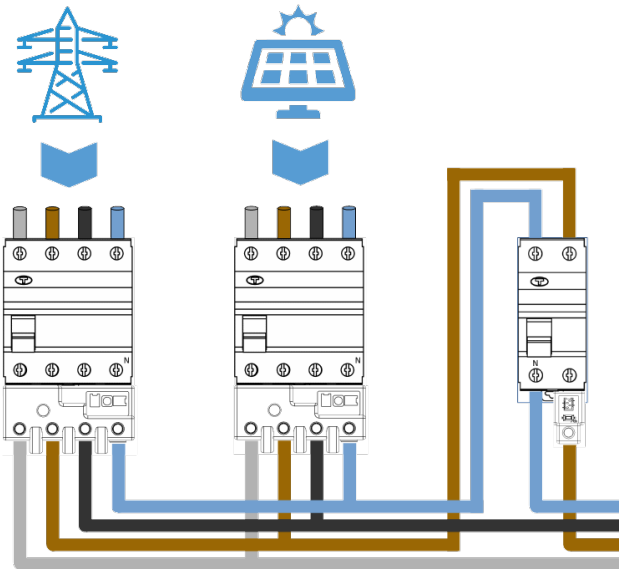


Figure 20 Self-consumption installation with capability to inject surplus energy to grid network

In case of a photovoltaic plant as the one described in Figure 20, the user can connect one CcM4 to the thermal-magnetic switch or residual-current circuit breaker of the power plant to monitor the generated energy and another one in the electrical network switch to monitor the consumed energy. In both cases, the direction of the current will be positive as well as the power.

Nevertheless, in case that the charge diminishes, it may occur that the generated energy is bigger than the consumed one, which will cause a return or injection of the surplus energy to the electricity network. In this case, the current flowing through the CcM4, which monitors the electricity network, will pass in the negative direction thus obtaining negative power.

The user should take into account the directions of the current in each case according to the installation because these will determine how the CcM4 will record and count the energy; as it stores the consumed energy and generated energy values separately. Therefore, in the case of Figure 19, the energy generated by the photovoltaic plant shall be stored in the energy records related to the positive current flow.

Other possible configuration is the following:

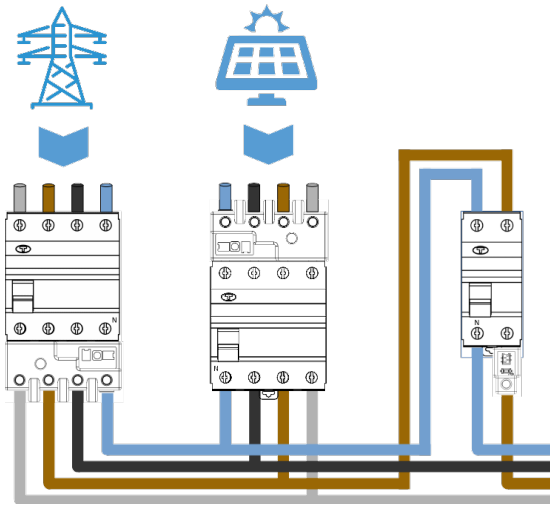


Figure 21 Self-consumption installation recording the generated energy

In case of Figure 21, the energy generated by the solar plant will be stored in the energy records related to the negative current flow.

The user may reverse the current flow direction reference as needed (Figure 19) while configuring the bidirectional mode.

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