REACTIVE ENERGY REGULATOR

Controller MASTER control VAR

INSTRUCTION MANUAL

CE

4.9.- COMMUNICATIONS

Controller MASTER control VAR units have an RS-485 serial communication output with the **Modbus RTU** ® communications protocol.

4.9.1. CONNECTIONS

The RS -485 cable should be wired with a twisted pair cable with mesh shield (minimum 3 wires), with a maximum distance between the **Controller MASTER control VAR** and the master unit of 1200 metres.
A maximum of 32 **Controller MASTER control VAR** units can be connected to this bus.

Use an intelligent RS-232 to RS-485 network protocol converter (M54020 intelligent converter) to establish the communications with the master unit. This converter does away with the need for the Pin 7 connection on the RS-485 side.

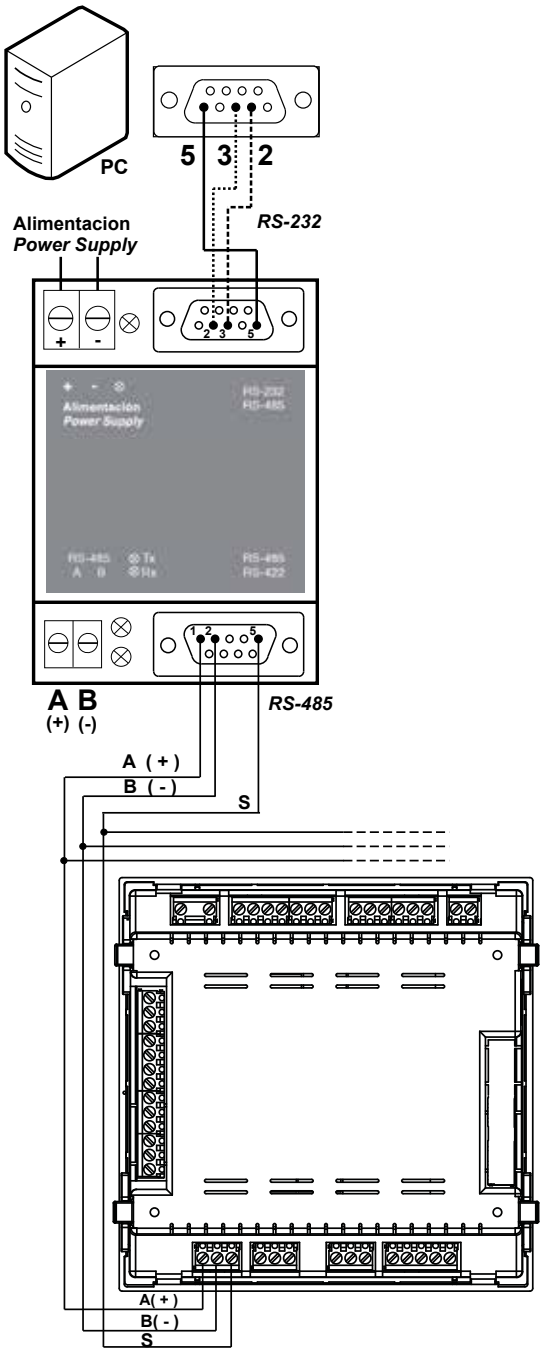


Figure 16: RS-485 Connection diagram.

4.9.2. PROTOCOL

The Modbus protocol is an industry communication standard which enables networking of multiple units, with one master and several slaves. It allows individual master-slave dialogue and also enables commands in broadcast format.
In the Modbus protocol, the **Controller MASTER control VAR** unit uses the RTU (Remote Terminal Unit) mode.

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

The Modbus functions implemented in the unit are as follows:

Function 01. Reading the status of the relays.
Functions 03 and 04. Reading logs.
Function 05. Writing a relay.
Function 0F. Writing multiple relays.
Function 10. Writing multiple logs.

Exception codes

If the bit with greatest weight of the byte corresponding to the function in the reply of the unit is 1, this indicates that the next byte is an exception code.

Table 11: Exception codes, Modbus communications.

Exception code	Description
01	Incorrect function. The function number is not implemented.
02	Incorrect address or number of logs out of limits
03	Data error. A CRC error has occurred
04	Peripheral error. An error occurred when accessing a peripheral (EE-PROM, card, etc.)
06	Slave error or Slave busy. Retry sending.

Example:

Address	Function	Exception code	CRC
0A	84	01	XXXX

Address: 0A, Peripheral number: 10 in decimal.
Function: 84, Reading function 04 with bit no. 7 at 1.
Exception code: 01, see **Tabla 9.**
CRC: 16-bit CRC.

For reasons of operational security of the unit, communication frames of more than 80 bytes are not accepted (sent or received).

4.9.3. MODBUS MEMORY MAP

A.- *Measurement Variables*

For these variables **Function 04** is implemented: reading logs.
The Modbus addresses of all the tables are hexadecimal.

Table 12: Modbus memory map: measurement variables (Table 1)

Parameter	Instantaneous	Maximum	Minimum	Units
L1 phase voltage	00-01	200-201	300-301	V/100
L1 Current	02-03	202-203	302-303	mA
L1 Active Power	04-05	204-205	304-305	W
L1 Inductive Reactive Power	06-07	206-207	306-307	varL
L1 Capacitive Reactive Power	08-09	208-209	308-309	varC
L1 Reactive Power	0A-0B	20A-20B	30A-30B	var
L1 Apparent Power	0C-0D	20C-20D	30C-30D	VA
L1 Reactive Power Consumed	0E-0F	20E-20F	30E-30F	var
L1 Reactive Power Generated	10-11	210-211	310-311	var
L1 Power Factor(1)	12-13	212-213	312-313	-
L1 Cos φ(1)	14-15	214-215	314-315	-
L1 kW sign(1)	16-17	-	-	+1 or -1
L1 kvar sign(1)	18-19	-	-	+1 or -1
L2 phase voltage	1A-1B	21A-21B	31A-31B	V/100
L2 Current	1C-1D	21C-21D	31C-31D	mA
L2 Active Power	1E-1F	21E-21F	31E-31F	W
L2 Inductive Reactive Power	20-21	220-221	320-321	varL
L2 Capacitive Reactive Power	22-23	222-223	322-323	varC
L2 Reactive Power	24-25	224-225	324-325	var
L2 Apparent Power	26-27	226-227	326-327	VA
L2 Reactive Power Consumed	28-29	228-229	328-329	var
L2 Reactive Power Generated	2A-2B	22A-22B	32A-32B	var
L2 Power Factor(1)	2C-2D	22C-22D	32C-32D	-
L2 Cos φ(1)	2E-2F	22E-22F	32E-32F	-
L2 kW sign(1)	30-31	-	-	+1 or -1
L2 kvar sign(1)	32-33	-	-	+1 or -1
L3 phase voltage	34-35	234-235	334-335	V/100
L3 Current	36-37	236-237	336-337	mA
L3 Active Power	38-39	238-239	338-339	W
L3 Inductive Reactive Power	3A-3B	23A-23B	33A-33B	varL
L3 Capacitive Reactive Power	3C-3D	23C-23D	33C-33D	varC
L3 Reactive Power	3E-3F	23E-23F	33E-33F	var
L3 Apparent Power	40-41	240-241	340-341	VA
L3 Reactive Power Consumed	42-43	242-243	342-343	var
L3 Reactive Power Generated	44-45	244-245	344-345	var
L3 Power Factor (1)	46-47	246-247	346-347	-
L3 Cos φ(1)	48-49	248-249	348-349	-
L3 kW sign (1)	4A-4B	-	-	+1 or -1
L3 kvar sign (1)	4C-4D	-	-	+1 or -1

Parameter	Instantaneous	Maximum	Minimum	Units
Three-phase phase voltage	4E-4F	24E-24F	34E-34F	V/100
Three-phase current	50-51	250-251	350-351	mA
Three-phase active power	52-53	252-253	352-353	W
Three-phase inductive power	54-55	254-255	354-355	varL
Three-phase capacitive power	56-57	256-257	356-357	varC
Three-phase reactive power	58-59	258-259	358-359	var
Three-phase apparent power	5A-5B	25A-25B	35A-35B	VA
Three-phase reactive power consumed	5C-5D	25C-25D	35C-35D	var
Three-phase reactive power generated	5E-5F	25E-25F	35E-35F	var
Three-phase power factor (1)	60-61	260-261	360-361	-
Three-phase cos φ(1)	62-63	262-263	362-363	-
Three-phase kW sign (1)	64-65	-	-	-
Three-phase kvar sign (1)	66-67	-	-	-
Frequency	68-69	268-269	368-369	Hz/10
L1-L2 Voltage	6A-6B	26A-26B	36A-36B	V/100
L2-L3 Voltage	6C-6D	26C-26D	36C-36D	V/100
L3-L1 Voltage	6E-6F	26E-26F	36E-36F	V/100
Neutral Current	70-71	270-271	370-371	mA
Leakage Current	72-73	272-273	372-373	mA
Temperature	74-75	274-275	374-375	ºC/10
L1 voltage THD %	7C-7D	27C-27D	-	% / 10
L2 voltage THD %	7E-7F	27E-27F	-	% / 10
L3 voltage THD %	80-81	280-281	-	% / 10
L1 current THD %	82-83	282-283	-	% / 10
L2 current THD %	84-85	284-285	-	% / 10
L3 current THD %	86-87	286-287	-	% / 10
Active energy consumed kWh	88-89	-	-	kWh
Active energy consumed Wh	8A-8B	-	-	Wh
Inductive energy consumed kvarLh	8C-8D	-	-	kvarLh
Inductive energy consumed varLh	8E-8F	-	-	varLh
Capacitive energy consumed kvarCh	90-91	-	-	kvarCh
Capacitive energy consumed varCh	92-93	-	-	varCh
Apparent energy consumed kVAh	94-95	-	-	kVAh
Apparent energy consumed VAh	96-97	-	-	VAh
Active energy consumed kWh	98-99	--	-	kWh
Active energy consumed Wh	9A-9B	-	-	Wh
Inductive energy generated kvarLh	9C-9D	-	-	kvarLh
Inductive energy generated varLh	9E-9F	-	-	varLh
Capacitive energy generated kvarCh	A0-A1	-	-	kvarCh
Capacitive energy generated varCh	A2-A3	-	-	varCh
Apparent energy generated kVAh	A4-A5	-	-	kVAh
Apparent energy generated VAh	A6-A7	-	-	VAh

(1) The **cosφ** and **Power factor** parameters are accompanied by the **kW sign** and **kva sign** parameters, which are used to determine the quadrant in which each phase is being measured. See **Figure 17**.

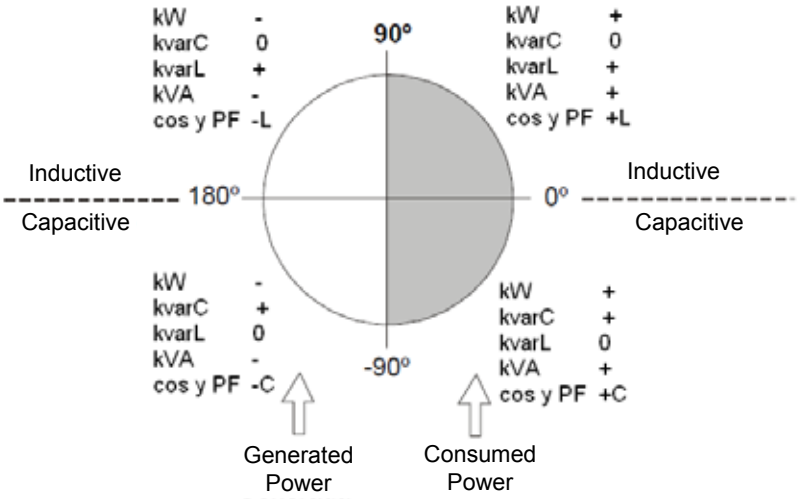


Figure 17: Diagram of the four measurement and compensation quadrants.

Table 13:Modbus memory map: measurement variables (Table 2)

Parameter	Instantaneous	Maximum	Units
L1 Fundamental Voltage Harmonic	400-401	484-485	V/100
L1 Voltage Harmonics	402-415	486-499	% / 10
L2 Fundamental Voltage Harmonic	416-417	49A-49B	mA
L2 Voltage Harmonics	418-42B	49C-4AF	% / 10
L3 Fundamental Voltage Harmonic	42C-42D	4B0-4B1	mA
L3 Voltage Harmonics	42E-441	4B2-4C5	% / 10
L1 Fundamental Current Harmonic	442-443	4C6-4C7	mA
L1 Current Harmonics	444-457	4C8-4DB	% / 10
L2 Fundamental Current Harmonic	458-459	4DC-4DD	mA
L2 Current Harmonics	45A-46D	4DE-4F1	% / 10
L3 Fundamental Current Harmonic	46E-46F	4F2-4F3	mA
L3 Current Harmonics	470-483	4F4-507	% / 10

Table 14:Modbus memory map: measurement variables (Table 3)

Parameter	Instantaneous
Relay variable	600
Alarm variable	605-606
Status of the outputs	610
Status of the digital inputs	615
No. of connections, of each of the 12 relays (6 in the **Controller MASTER control VAR 6** model)	625-63C

✓ **Relay variable**

Shows the status of the 12 (**Controller MASTER control VAR 12** model) or 6 (**Controller MASTER control VAR 6** model) output relays.
It is a 16-bit variable in which each bit indicates the status of a relay.

	Bit 15-14-13-12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Relay	-	12	11	10	9	8	7	6	5	4	3	2	1

Where **0**: relay disconnected (OFF).
1: relay connected (ON).

✓ **Alarm Variable**

Shows the status of the 17 possible alarms.
It is a 32-bit variable in which each bit indicates the status of an alarm.

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
E16	E15	E14	E13	E12	E11	E10	E09	E08	E07	E06	E05	E04	E03	E02	E01

Bit 32	Bit 31	Bit 30	Bit 29	Bit 28	Bit 27	Bit 26	Bit 25	Bit 24	Bit 23	Bit 22	Bit 21	Bit 20	Bit 19	Bit 18	Bit 16
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E17

Where **0**: alarm off (OFF).
1: alarm active (ON).

✓ **Status of the outputs**

Shows the status of the 4 outputs: Fan relay, alarm relay and the two digital outputs.
It is a 16-bit variable in which each bit indicates the status of an output.

Bit 15 to 4	Bit 3	Bit 2	Bit 1	Bit 0
-	Digital output 2	Digital output 1	Alarm relay	Fan relay
-	1: OFF 0: ON	1: OFF 0: ON	1: ON 0: OFF	1: ON 0: OFF

✓ **Status of the digital inputs**

Shows the status of the 2 digital inputs.
It is a 16-bit variable in which each bit indicates the status of an input.

Bit 15 to 2	Bit 1	Bit 0
-	Digital input 2	Digital input 1
-	1: ON 0: OFF	1: ON 0: OFF

B.- *Programming variables*

The following functions are implemented for these variables:

Function 04: reading logs.
Function 10: Writing multiple logs.

Table 15:Modbus memory map: programming variables (Table 1)

Unit parameters	
Configuration variable	**Address**
Serial number(1)	1000-1003
Frame number (1)	1010-1013
Version (1)	1020-1021
Hardware log (1)	1030-1033

(1) The parameters of the unit have only implemented **function 04**.

Table 16:Modbus memory map: programming variables (Table 2)

Communications			
Configuration variable	**Address**	**Valid data window**	**Default value**
Peripheral no.	1071	1 to 254	1
Speed	1072	0 (9600), 1 (19200)	1
Parity	1073	0 (none), 1 (odd), 2 (even)	0
Length	1074	0 (8 bits), 1 (7 bits)	0
Stop bits	1075	0 (1 bits), 1 (2 bits)	0

Table 17:Modbus memory map: programming variables (Table 3)

Transformation ratios			
Configuration variable	**Address**	**Valid data window**	**Default value**
Current primary	1090	1 - 10000	5
Current secondary	1091	0 (1 A), 1 (5 A)	1
Voltage primary	1092-1093	1 - 99999	1
Voltage secondary	1094-1095	1 - 99999	1

Table 18:Modbus memory map: programming variables (Table 4)

Connection type			
Configuration variable	**Address**	**Valid data window**	**Default value**
Connection type	1100	0 (3U.3C), 1 (3U.1C), 2 (2U.1C)	0
Phase(1)	1101	1 to 6 (**Table 38**)	1
Current 1 / 1 / 2	1102	1 (Phase 1 direct), 2 (Phase 2 direct), 3 (Phase 3 direct), 4 (Phase 1 reverse), 5 (Phase 2 reverse), 6 (Phase 3 reverse),	1
Current 2 (1)(2)	1103		2
Current 3 (1)(2)	1104		3

(1) Only used when the connection type is other than 3U.3C.
(2) Indicates the relationship between the assigned voltage and the current direction.

Example: If you see Current 1 = 1, Current 2 = 5 and Current 3 = 3, this means that:
Current 1 is assigned to voltage 1 in the direct direction, current 2 is assigned to voltage 2 in the reverse direction and current 3 is assigned to voltage 3 in the direct direction.

Table 19:Modbus memory map: programming variables (Table 5)

Status of the stages			
Configuration variable	**Address**	**Valid data window**	**Default value**
C1	1110	0 (Auto), 1 (On), 2 (OFF), 3 (OnNc)	0
C2	1111		0
C3	1112		0
C4	1113		0
C5	1114		0
C6	1115		0
C7	1116		0
C8	1117		0
C9	1118		0
C10	1119		0
C11	111A		0
C12	111B		0

Table 20:Modbus memory map: programming variables (Table 6)

Voltage level			
Configuration variable	**Address**	**Valid data window**	**Default value**
Voltage level	1121	0 (Low voltage) 1 (Medium/High voltage)	0

Table 21:Modbus memory map: programming variables (Table 7)

Display			
Configuration variable	**Address**	**Valid data window**	**Default value**
Lighting (Backlight)	1125	0 (Comes on when pressing a key) 1 (ON), 2 (OFF)	0
Light level	1126	0 -10 (Value % / 10)	7
Language	1127	0 (Spanish), 1 (English)	0
Advanced setup	1128	0 (OFF), 1 (ON)	0
Analogue bar	1129	0 (No), 1 (Current), 2 (ITHD) 3 (Connected power)	0

Table 22:Modbus memory map: programming variables (Table 8)

Target cos φ			
Configuration variable	**Address**	**Valid data window**	**Default value**
Target cos φ 1	1130	0 - 100 (Value x 100)	100
Target cos φ 2	1131		100
Target cos φ 3	1132		100
Target cos φ 4	1133		100
Target cos φ 1 type	1134	0 (Capacitive) 1 (Inductive)	1
Target cos φ 2 type	1135		1
Target cos φ 3 type	1136		1
Target cos φ 4 type	1137		1

Table 23:Modbus memory map: programming variables (Table 9)

C/K factor			
Configuration variable	**Address**	**Valid data window**	**Default value**
C/K factor	1138	0 - 100 (Value x 100)	100

Table 24:Modbus memory map: programming variables (Table 10)

Program			
Configuration variable	**Address**	**Valid data window**	**Default value**
Program	1139	1111-1999	1111

Table 25:Modbus memory map: programming variables (Table 11)

No. of stages			
Configuration variable	**Address**	**Valid data window**	**Default value**
No. of stages	113A	0-6 (Controller MASTER control VAR 6) 0-12 (Controller MASTER control VAR 12)	6 12

Table 26:Modbus memory map: programming variables (Table 12)

Connection and reclosing time			
Configuration variable	**Address**	**Valid data window**	**Default value**
Connection time	113B	0-999 seconds	10
Reclosing time	113C	0-999 seconds	50

Table 27:Modbus memory map: programming variables (Table 13)

Alarm: Voltage THD			
Configuration variable	**Address**	**Valid data window**	**Default value**
Low Value	1140	0 - 100 %	5
Hi Value	1141	0 - 100 %	10

Table 28:Modbus memory map: programming variables (Table 14)

Alarm: Current x I THD			
Configuration variable	**Address**	**Valid data window**	**Default value**
Low Value	1142	0 - 100 %	4
Hi Value	1143	0 - 100 %	5

Table 29:Modbus memory map: programming variables (Table 15)

Alarm: Temperature			
Configuration variable	**Address**	**Valid data window**	**Default value**
Low Value	1144	0 - 80 ºC	55
Hi Value	1145	0 - 80 ºC	70

Table 30:Modbus memory map: programming variables (Table 16)

Alarm: Leakage Current			
Configuration variable	**Address**	**Valid data window**	**Default value**
Search for the responsible stage	1146	0 (OFF), 1 (ON)	0
Value	1147	10 - 1000 mA	300
Stages enabled	1148	0 (No), 1 (Yes)	0

Table 31:Modbus memory map: programming variables (Table 17)

Alarm: Cos φ			
Configuration variable	**Address**	**Valid data window**	**Default value**
Values of Cos φ	1149	80 - 100 (Value x 100)	95
Current value	114A	0 - 9999 A	20
Type of Cos φ	114B	0 (Capacitive), 1 (Inductive)	1

Table 32:Modbus memory map: programming variables (Table 18)

Alarm: Fan			
Configuration variable	**Address**	**Valid data window**	**Default value**
Value	114C	0 - 80 ºC	35
Enabled	114D	0 (OFF), 1 (ON)	0

Table 33:Modbus memory map: programming variables (Table 19)

Alarm: Voltage			
Configuration variable	**Address**	**Valid data window**	**Default value**
Overvoltage value	114E-114F	0-99999	440
No Voltage Value	1150-1151	0-99999	360

Table 34:Modbus memory map: programming variables (Table 20)

No. of operations			
Configuration variable	**Address**	**Valid data window**	**Default value**
No. of operations	1152-1153	1-99999	5000

Table 35:Modbus memory map: programming variables (Table 21)

Enabling alarms			
Configuration variable	**Address**	**Valid data window**	**Default value**
Enable Alarm E01	1155	0 (OFF), 1 (ON)	1
Enable Alarm E02	1156		1
Enable Alarm E03	1157		1
Enable Alarm E04	1158		1
Enable Alarm E05	1159		0
Enable Alarm E06	115A		0
Enable Alarm E07	115B		0
Enable Alarm E08	115C		0
Enable Alarm E09	115D		0
Enable Alarm E10	115E		0
Enable Alarm E11	115F		0
Enable Alarm E12	1160		0
Enable Alarm E13	1161		0
Enable Alarm E14	1162		0
Enable Alarm E15	1163		0
Enable Alarm E16	1164		0
Enable Alarm E17	1165		0

Output associated with Alarm E01	1170	0 (No), 1 (Alarm relay), 2 (Digital output 1) 2 (Digital output 2)	0
Output associated with Alarm E02	1171		0
Output associated with Alarm E03	1172		0
Output associated with Alarm E04	1173		0
Output associated with Alarm E05	1174		0
Output associated with Alarm E06	1175		0
Output associated with Alarm E07	1176		0
Output associated with Alarm E08	1177		0
Output associated with Alarm E09	1179		0
Output associated with Alarm E10	1179		0
Output associated with Alarm E11	117A		0
Output associated with Alarm E12	117B		0
Output associated with Alarm E13	117C		0
Output associated with Alarm E14	117D		0
Output associated with Alarm E15	117E		0
Output associated with Alarm E16	117F		0
Output associated with Alarm E17	1180		0

C.- *Deleting parameters*

Parameters can be deleted using **Function 05**: writing a relay.

Table 36:Modbus memory map: deleting parameters

Deleting parameters		
Action	**Address**	**Value to be sent**
Deleting maximum values	200	FF
Deleting minimum values	210	FF
Deleting maximum and minimum values	220	FF
Deleting energies	230	FF
Deleting the stage search and stage enabling values of the leakage current alarm	240	FF
Deleting the no. of operations of all the relays	250	FF
Resetting alarms E14 and E15	260	FF
Restoring the default configuration values	300	FF

4.9.4. EXAMPLE OF A MODBUS QUERY

Query: Instantaneous value of the L1 phase voltage

Address	Func-tion	Initial log	No. of logs	CRC
0A	04	0000	0002	70B0

Address: 0A, Peripheral number: 10 in decimal.
Function: 04, Read function.
Initial Log: 0000, log from which to start reading.
No. of logs: 0002, number of logs to be read.
CRC: 70B0, CRC character.

Response:

Address	Func-tion	No. of Bytes	Log no. 1	Log no. 2	CRC
0A	04	04	0000	084D	8621

Address: 0A, Responding peripheral number: 10 in decimal.
Function: 04, Read function.
No. of bytes: 04, No. of bytes received.
Log: 0000084D, value of the L1 phase voltage: VL1 x 10: 212.5 V
CRC: 8621, CRC character.

5.- CONFIGURATION

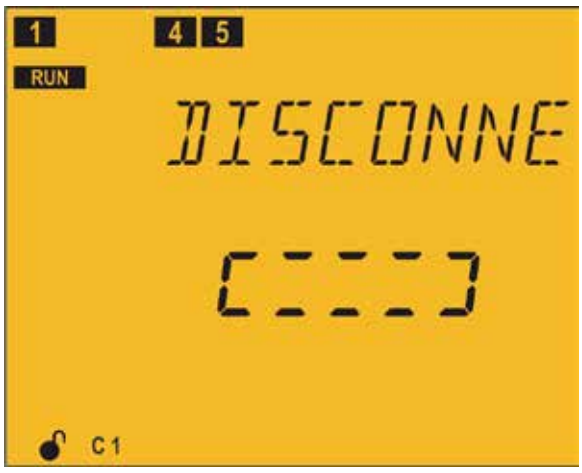
The various configuration parameters of the unit can be consulted and edited in the unit setup menu.
The unit always keeps the capacitors disconnected (except in the Plug&Play function).

This status is identified by the SETUP symbol in the unit status area of the display (**Figure 12**).

To access the setup menu, long keystroke the ☰ key (> 3 s).

The Password screen appears on the display.
The password to be entered is a combination of keys: ^ ☰ v ☰.
It is unique and cannot be configured.

If it is not entered correctly, the unit returns to the previous measurement screen.
If it is entered correctly and capacitors are connected, the disconnection screen appears.



Disconnection screen: used for the unit to automatically disconnect all the stages before entering the configuration.
While in this screen, the unit does not respond to the keypad.
The unit automatically exits this screen, and this can take a certain amount of time.