User manual

LEGGI E CONSERVA QUESTE ISTRUZIONI

READ AND SAVE THESE INSTRUCTIONS

CAREL

Technology & Evolution

LEGGI E CONSERVA QUESTE ISTRUZIONI

READ AND SAVE THESE INSTRUCTIONS

We wish to save you time and money!
We can assure you that the thorough reading of this manual will guarantee correct installation and safe use of the product described.

IMPORTANT WARNINGS

BEFORE INSTALLING OR WORKING ON THIS APPLIANCE, PLEASE CAREFULLY READ AND FOLLOW THE INSTRUCTIONS DESCRIBED IN THIS MANUAL.

This appliance has been manufactured to operate risk-free for its specific purpose, as long as:
- it is installed, operated and maintained according to the instructions contained in this manual;
- the environmental conditions and the voltage of the power supply correspond to those specified.

All other uses and modifications made to the device which are not authorised by the manufacturer are considered incorrect, and consequently, liability for injury or damage caused by the incorrect use of the device lies exclusively with the user.
Please note that this unit contains live electrical components and therefore all service and maintenance operations must be performed with the unit disconnected from the mains power supply by specialist and qualified personnel who are aware of the necessary precautions.

Disposal of the parts of the controller

The controller is made up of metal and plastic parts and contains a lithium battery. All these parts must be disposed of according to the local legislation in force.

General warnings - operating environments and connections

The following conditions represent correct installation:

- do not install the instrument in environments with the following characteristics: wide and rapid fluctuations in ambient temperature; temperature and relative over the allowed limit; exposure to direct pressurised jets of water; high levels of magnetic and/or radio frequency interference (e.g. from transmitting antennae);
- use cable ends suitable for the corresponding terminals. Loosen each screw and insert the cable ends, then tighten the screws. When the operation is completed, slightly tug the cables to check that they are sufficiently tight;
- separate as much as possible the signal cables from the cables carrying inductive loads and power cables to avoid possible electromagnetic disturbance. Never insert power cables (including the electrical cables) and probe signal cables in the same conduits. Do not install the probe cables in the immediate vicinity of power devices (contactors, circuit breakers or similar);
- reduce the path of the probe cables as much as possible, and avoid spiral paths that enclose power devices. To extend the probe cables, use cables with a minimum cross-section of at least 0.5mm2;
- the cables connected to the contacts on the controller must be rated for the maximum operating temperature, determined by considering the maximum ambient temperature envisaged, added to the heating up of the controller itself, equal to 20°C;
- suitably protect the load power lines on the controller with devices (circuit breakers) rated according to the loads connected.

Safety for operators and precautions when handling the controller.

To protect the safety of operators and safeguard the controller, before doing any work on the panel always disconnect the power supply. Electrical damage may occur to the electronic components as a result of electrostatic discharges from the operator. Suitable precautions must be therefore be taken when handling these components, specifically:

- before handling any controller, touch an earthed object (not touching the card does not prevent a spike, as static electricity can produce a 10000V spike discharge which can form an arc of about 1cm);
- all materials must be kept inside their original package as long as possible. If necessary, take the controller from its package and place it into an antistatic package without touching the back of the board with your hands;
- absolutely avoid non-antistatic plastic bags, polystyrene or sponges, and do not pass the controller directly to other operators (to prevent from electrostatic induction and discharges).

IMPORTANT!

Never connect the digital outputs on the controller to loads of primary importance!
No liability is accepted for any damage caused to the utilities due to incorrect installation.

CONTENTS

Glossary:

loop = group of screens divided according to the type of access (user, maintenance, installer…)
screen = page on the display showing the information.
priority = order for switching the loads on and off in the event of excess power consumption
set point = working point
shed = disconnect (the load)
CT= Current Transducer

1. INTRODUCTION

Energy² is a panel-mounted microprocessor electronic controller, specially designed to acquire readings on electricity consumption so as to analyse the profile of the load at the point of delivery from the electricity company (point where the electricity is drawn from the mains) and consequently to manage the electrical loads.
In order to achieve precise monitoring of the loads and consequently substantial savings in electricity, demand needs to be controlled using a versatile system that can easily be adapted to the needs of various types of systems, and whose method of analysis and control strategies refer specifically to the billing criteria applied by the electricity company.

1.1 The main objectives of Energy²

The system allows the customer to a number of important results, such as:

- Centralise management using just one controller and subsequently transfer to the supervisory system of all the data corresponding to energy consumption, ensuring precise monitoring;
- Limit, where possible, exceeding the contracted power supply rating, by the intelligent management of the loads;
- Avoid contractual surcharges, such as:
  - the application of an increase in the power rating, even for just occasional excesses;
  - one-off connection charges due to occasional excesses;
- Improve the use of the electricity by activating loads at programmable times, so as to highlight and eliminate any wastage;
- Optimise certain loads, such as the air-conditioning or heating systems, with functions such as OPTIMUM START-STOP and DUTY CYCLING;
- Identify the most suitable electrical contract for effective requirements through the continuous control of energy usage.

It has been demonstrated the exact knowledge of specific energy requirements and careful management of consumption can significantly reduce the electricity costs for any company.

1.2 Models available

Energy² is available in two versions: Large and Small.
The Large version has 15 relay outputs available for the deactivation/activation of the loads (5 of which changeover) and one alarm, for a total of 16 outputs managed by the software
The Small version, on the other hand, features 4 relay outputs for managing the utilities, and one alarm (changeover), for a total of 5 outputs, all controlled by the software.
Both models ensure ample flexibility and consequently the possibility to be used in many different applications.

Code	Description
ENERGY2120	Energy² Large electrical panel
ENERGY7060	Energy² Small electrical panel

Table 1.1

1.3 Main features of the Energy² range

Power supply

The models in the range are supplied at 230 Vac and power is signalled by an indicator light. Two fuses are fitted for the electronics plus a further thermal-magnetic overload for the digital outputs on the board and all the non-electronic parts of the panel.

Appearance and ergonomics

The appearance has been designed to fit in harmoniously with the new lines of supermarket controllers.

Display and keypad

Energy² is fitted with a backlit 4 x 20 LCD, a 6 button keypad and 4 LEDs, controlled by the software application, all built into the plastic case of the controller.

Duty cycling

Electricity consumption can be optimised by disabling or enabling the operation of the heating or cooling devices for a certain time, according to the deviation from the set point.

Optimum start-stop

This function is used to improve the management of the air-conditioning system, calculating the pre-start (morning) and pre-stop times (evening), required to reach, in an optimum time, the comfort temperature inside the building, without wasting electricity.

Changeover contacts

In the Large model there are 5 relay outputs with changeover contacts (NC/NO), selectable by software, so as to ensure the operation of the critical utilities in the event of faults on the controller. The Small version, on the other hand, has just one output with changeover contacts, used for the alarm.

RTC (Real Time Clock)

Both versions are fitted with a real time clock.

Light sensor

In the Large model only, a new feature has been introduced for in the management of the loads: all 15 loads can be controlled by a twilight sensor, according to a parameter set in the software.
This function, for example, can optimise the use of outside lights and, as a consequence, the power consumption.

Screen protection
Access can be limited at a software level, with 4 different passwords, to avoid tampering by unauthorised persons.

Serial connection
The controllers feature an RS485 serial output (two wires plus shield) for network connection to supervisory or telemaintenance systems.

Index of protection
The panel and the plastic cover provide IP65 index of protection.

Product testing and CE mark
The products are 100 % functional tested. In addition, quality and safety are guaranteed by the Carel ISO 9001 certified design and production system, and by the CE mark on the product.

Electromagnetic compatibility
The Energy² series is compliant with the EU standards on electromagnetic compatibility.

1.4 Functions

Energy² controls the expected active power consumption in the timing period. This period (typically 15 or 30 minutes) is the reference time adopted by the electricity companies to bill the energy used by the customer.
The power consumption, calculated based on this time, is then used for billing and checking the actual energy rating available by contract.
The temporary exceeding of power limits is tolerated, and the control action (deactivation of the loads) only commences when the mean value envisaged exceeds the maximum set.
By deactivating the utilities, energy consumption is optimised, thus avoiding having to pay penalties, surcharges or the application of higher tariffs (depending on the country and the laws in force).
The control action is performed by acting on the electrical loads connected to Energy², and deactivating those that are not strictly required for a short period of time, so as to bring consumption back within the allowed limits. The loads that are deactivated are then reconnected as soon as the conditions of the installation allow.
For each electrical load, the method of disconnection, the priority and the on and off times can be set.

Energy² can acquire the active power data to manage energy consumption in two different modes, selected by software: **PULSE** (impulse signal) or **ANALOG** (analogue signal).

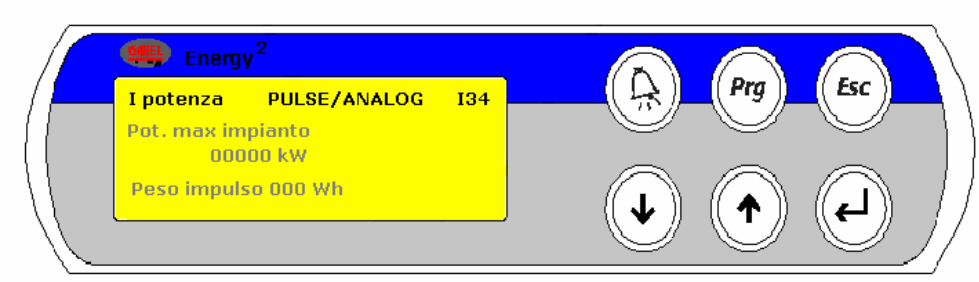


Figure 1.1

PULSE: this mode is used if, upon customer request, the electricity company has installed a signal emitter board connected directly to the meter. This interface usually provides impulses relating to the active energy, the reactive energy, two contacts to signal the change in the current rate band, and at times a reset signal for the consumption calculation time (typically 15 or 30 minutes).
Energy² can interface to this board, interpreting the active power signal, and reading the contacts to change the rate band and reset signal, where present.
If the signal emitter board is not fitted, an external three-phase power analyser will be required, providing an impulse signal relating to consumption (shown in the options proposed by CAREL at the end of the manual).
This device, connected to the three-phase power supply via external transducers, can measure the voltage, the phase current, the displacement (cos φ), the active, reactive and apparent power.
The impulse signal representing the energy consumed by the installation, at the output of the device, is read by Energy², and is managed for counting consumption, processing all the values and managing the utilities connected.

ANALOG: this mode must be selected if the consumption signal derives directly from a CT (current transducer) with 4 to 20 mA output (shown in the options proposed by CAREL at the end of the manual).
In this reading mode, the current signal is sent to a dedicated analogue input on Energy², which counts consumption and consequently manages all the utilities connected

IMPORTANT: ANALOG mode cannot be used with the Small version of Energy².

2. Energy² LARGE – ENERGY2120

This version is set out as an electrical panel on 18 + 18 DIN rail modules (Fig. 2.1) fitted at the top with a CAREL programmable controller, complete with software and "Built-in" terminal, and at the bottom with a terminal block for connecting the electrical loads, the probes and the other devices envisaged.
The power supply to the controller is managed by a main disconnecting switch and signalled by an indicator light.

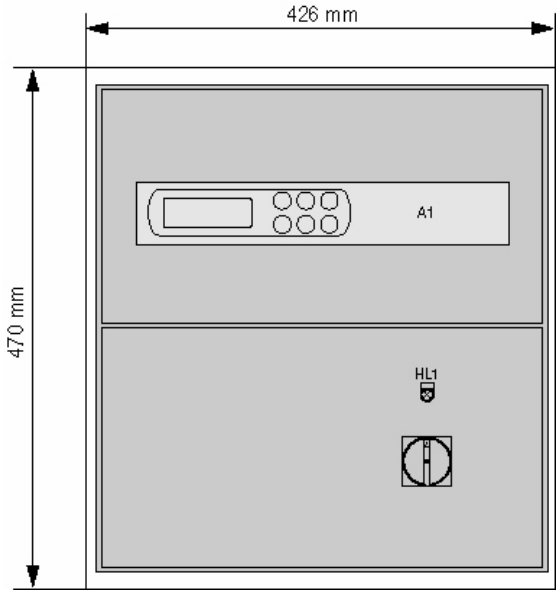


Figure 2.1

2.1 Terminal block

The terminal block inside the panel (Fig. 2.2) is divided into five sections, marked with a different code:
XA= digital outputs
XA1= digital inputs
XA2= analogue output
A2= power impulse converter, 2 DIN modules (PCO208DI00)
XA3= analogue inputs

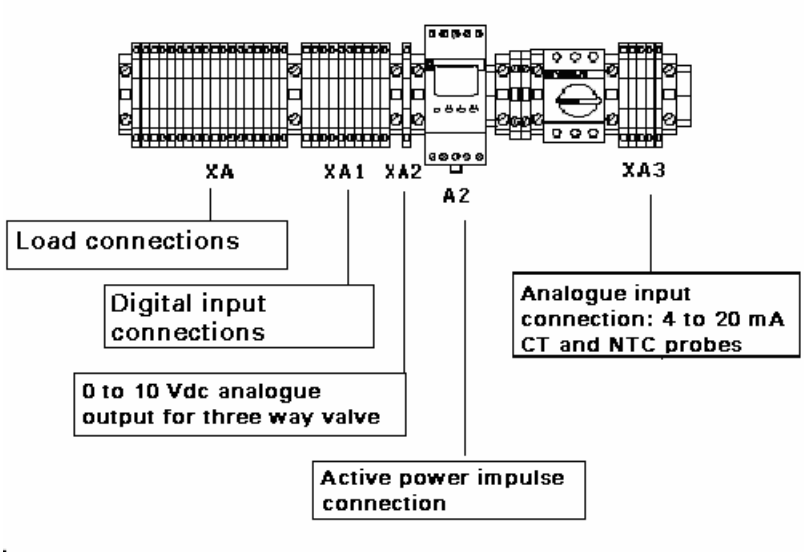


Figure 2.2

2.1.1 (XA) Digital outputs

Terminal block XA is connected the utilities (max 15 loads), configured via software, that Energy² will deactivate or reactivate if the power input exceeds the maximum consumption set point for the installation, keeping account of the times and the priorities set.
For the connections, refer to the table below:

TERMINAL no		DESCRIPTION
N1-NO1	(normally open)	Enable Load 1
N2-NO2	(normally open)	Enable Load 2
N3-NO3	(normally open)	Enable Load 3
N4-NO4	(normally open)	Enable Load 4
N5-NO	(normally open)	Enable Load 5

N6-NO6 (normally open)	Enable Load 6
N7-NO7 (normally open)	Enable Load 7
N8-NO8 / NC8 (changeover)	Enable Load 8
N9-NO9 (normally open)	Enable Load 9
N10-NO10 (normally open)	Enable Load 10
N11-NO11 (normally open)	Enable Load 11
N12-NO12 / NC12 (changeover)	Enable Load 12
N13-NO13 / NC13 (changeover)	Enable Load 13
N14-NO14 / NC14 (changeover)	Enable Load 14
N15-NO15 / NC15 (changeover)	Enable Load 15
N16-NO16 (normally open)	General alarm

Table 2.1

The load relays (on terminal block XA) all have voltage outputs (230 Vac) and have a maximum capacity of 8 A, resistive.

IMPORTANT: the current running through the common terminals must not exceed the rated current of any single terminal, that is, 8 A resistive for the plug-in terminals.

The 16 relays on the Large model are divided as follows: 11 with normally open contacts and 5 with changeover contacts, all protected by 250 Vac varistors.

2.1.2 Electrical connection of loads with N.O. relays (normally open)

Digital outputs 1, 2, 3, 4, 5, 6, 7, 9, 10, 11 and 16 (see table 2.1) have normally open power contacts. In this case, if the controller measures excess power and these outputs are enabled, the relay, de-energising, opens the contacts. In the event of power failures to the controller, the relay contacts remain open. Check if this may represent a problem, and if necessary use the N.C. configuration.

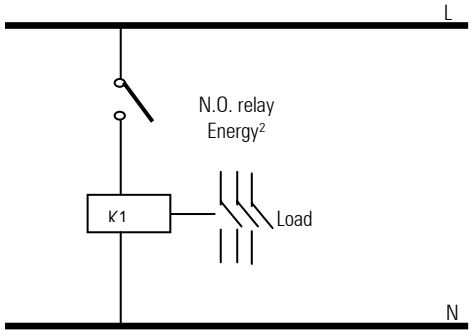


Fig 2.3

2.1.3 Electrical connection of loads with N.C. relays (normally closed)

Digital outputs 8-12-13-14-15 (see table 2.1), on the other hand, have power relays with changeover contacts. By software, from the screens relating to the "configuration of the loads" (see "Installer loop"), the status of the relay can be selected in normal conditions: open (N.O.) or closed (N.C.).
If N.O. is selected, the relays behave as in the previous example. Vice-versa, if N.C. is selected, the controller measures excess power and these outputs have previously been enabled for the disconnection of the utilities, the relay contacts will open (as set in the software).
In the event of a power failure to the controller, the relays will return to or remain in the closed status. This mode is used to not deactivate the utilities of primary importance if Energy² is shutdown or if there are technical problems with the controller.

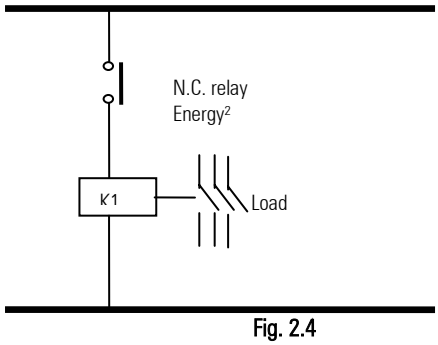


Fig. 2.4

2.1.4 (XA1) Digital inputs

On terminal block XA1, the wiring has the meaning shown in the following table:

TERMINAL no	DESCRIPTION
ID1-C1	Indication of the peak hour rate band (from the signal emitter board)
ID2-C2	Indication of the top rate band (from the signal emitter board)
ID5-C5	15 minute timing signal (from the signal emitter board)
ID6-C6	Extension of operation outside of the time bands
ID7-C7	Twilight ON/OFF input
ID8-C8	NC (future implementations)
ID9-C9	NC (future implementations)
ID10-C10	NC (future implementations)
ID11-C11	NC (future implementations)
ID12-C12	NC (future implementations)

Table 2.2

N.B.: The digital inputs corresponding to the active and reactive energy signals are not shown in the table, as these must be wired to the power impulse converter board (A2).

2.1.5 (XA2) Analogue outputs

Terminal block XA2 provides the user an analogue output (0 to 10 Volt) for the management of a three-way valve::

TERMINAL no	DESCRIPTION
Y1-0	3-way valve (air-conditioning)

Table 2.3

For further details on the management of the three-way valve, see the chapter "The program".

2.1.6 (A2) Power impulse converter board: energy signal connection

If Energy² is used in PULSE operating mode (mains power analyser or signal emitter board, see "Installer" screen I34), the wiring corresponding to the inputs for reading the impulses will be connected directly to the terminal block on the hardware board (A2), according to the diagram shown below:

INPUT n°	DESCRIPTION
5 (G)	Power supply to board (already wired)
6 (G0)	Power supply ground (already wired)
6 (common) – 7 (signal)	Impulses proportional to the active energy consumed by the user (impulse from external board)
6 (common) – 8 (signal)	Impulses proportional to the reactive energy consumed by the user (from board)*

Table 2.4

*currently the application does not manage reactive energy impulses.

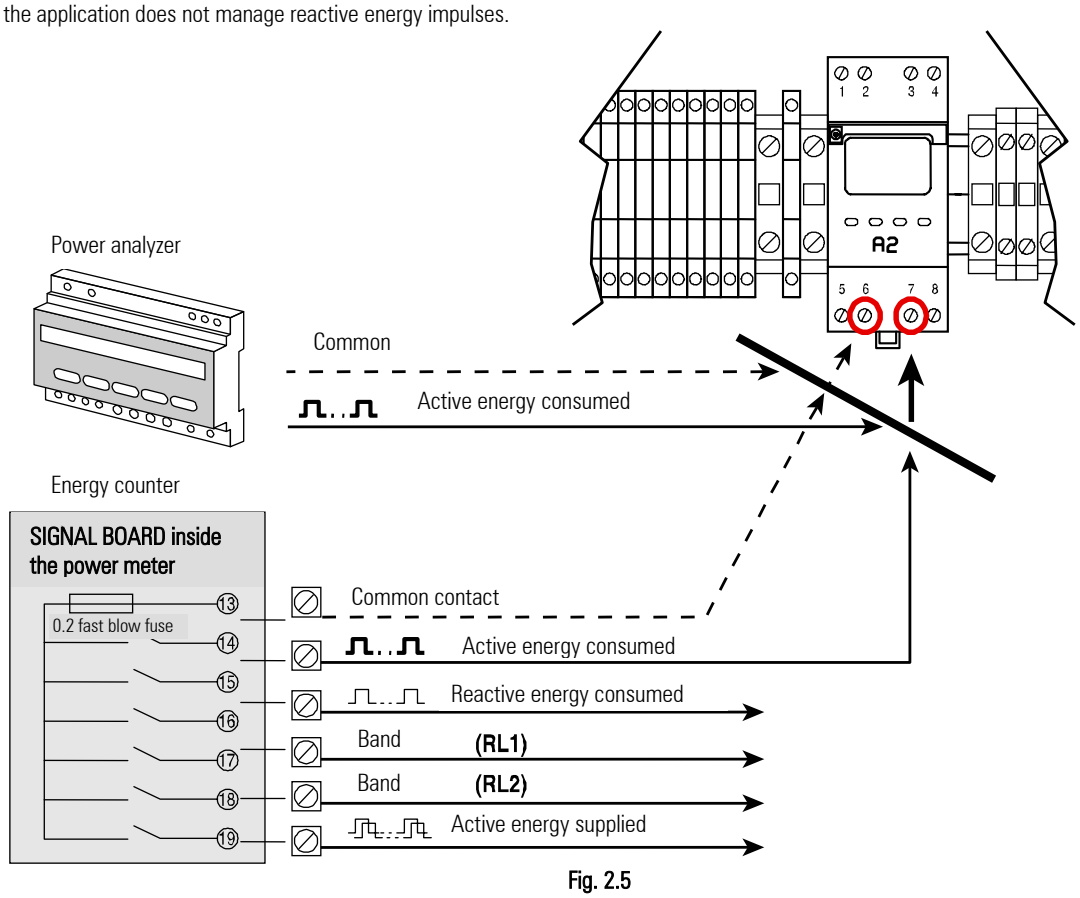


Fig. 2.5

NOTE: In the connection diagram shown above, for both types of active energy signal (from signal board and power analyser), the connection terminals are: no. 6 for the common contact and no. 7 for the active energy impulse signal. Terminal no. 8 that relates to the reactive energy supplied by the board is currently not managed.

2.1.7 (XA3) Analogue inputs

Terminal block XA3 is connected to the analogue signals provided by the devices envisaged (electronic CTs with 4 to 20 mA output, NTC probes, twilight device with 4 to 20 mA output), following the connections described in the table below:

TERMINAL n°	DESCRIPTION
B1 (CT-) - +Vdc (CT+)	4 to 20 mA input for overall consumption via CT
B2 (CT-) - +Vdc (CT+)	4 to 20 mA input for refrigeration consumption (opt.)
B3 (CT-) - +Vdc (CT+)	4 to 20 mA input for air-conditioning consumption (opt.)
B4-GND	CAREL NTC probe 1 (ambient temperature, considered as external)
B5-GND	CAREL NTC probe 2 (water temperature for 3-way valve)
B6 - +Vdc	Signal from 4 to 20 mA twilight device
B7-GND	CAREL NTC probe 3 (inside temperature)

Table 2.5

3. Energy² SMALL – ENERGY7060

This version is set out as an electrical panel on 12 +12 DIN rail modules. It differs from the LARGE version due to the more compact Built-In terminal and the programmable controller with more limited functions. This may be the ideal solution for simple energy monitoring by supervisor.

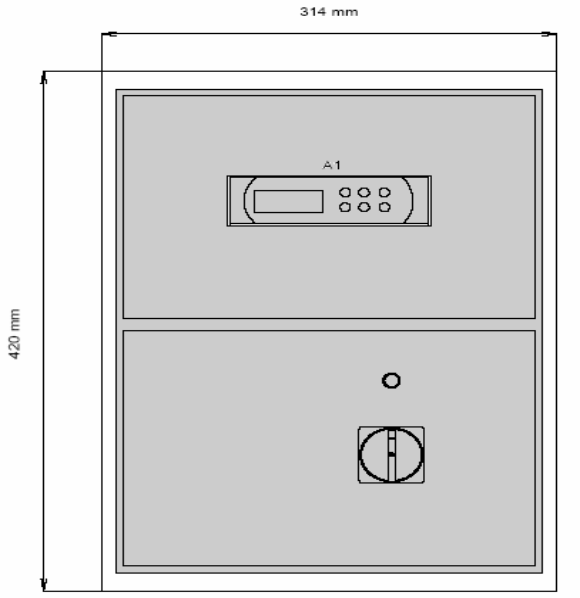


Fig. 3.1

3.1 Small terminal block

The terminal block inside the panel (Fig. 3.1) is divided into four sections, marked with a different code:
XA= digital outputs
XA1= digital inputs
XA3= analogue inputs
A2= power impulse converter, 2 DIN modules (PCO208DI00)

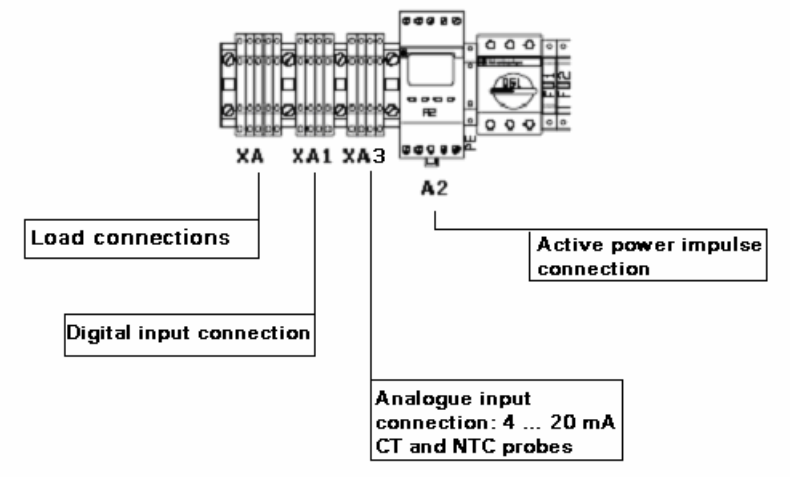


Fig. 3.2

3.1.1 (XA) Digital outputs

As for model ENERGY2120, specifically:

TERMINAL no		DESCRIPTION
N1-NO1	(normally open)	Enable Load 1
N2-NO2	(normally open)	Enable Load 2
N3-NO3	(normally open)	Enable Load 3
N4-NO4	(normally open)	Enable Load 4
N5-NO5/ NC5	(changeover)	General alarm

Table 3.1

The 5 relays on the Small model are divided as follows: 4 with normally open contacts and one relay with changeover contacts, all protected by 250 Vac varistors.

3.1.2 Electrical connection of loads with N.O. relays (normally open)

As for model Energy 2120, however relating to relays 1, 2, 3 and 4.

3.1.3 Alarm output connection with N.C. relays (normally closed)

As for model Energy 2120, however relating to relay no 5.

3.1.4 (XA1) Digital inputs

As for model Energy 2120, however relating to ID1, ID 2, ID 5 and ID 6,

3.1.5 (A2) Power impulse converter board: energy signal connection

As for model Energy 2120

Note: the Small model only manages PULSE mode

3.1.6 (XA3) Analogue inputs

Terminal block XA3 is connected to the analogue signals provided by the devices envisaged (electronic CTs with 4 to 20 mA output, NTC probes) following the connections described in the table below:

TERMINAL n°	DESCRIPTION
B1 (CT-) - +Vdc (CT+)	4 to 20 mA input for refrigeration consumption (opt.)
B2 (CT-) - +Vdc (CT+)	4 to 20 mA input for air-conditioning consumption (opt.)
B3-GND	CAREL NTC probe 1 (ambient temperature, considered as external)
B4-GND	CAREL NTC probe 2 (inside temperature)

Table 3.2

NOTE: compared to the Large version, there is no 4 to 20 mA analogue input for measuring the overall consumption of the installation, relating to the twilight sensor and the NTC input for the water temperature, for the management of the 3 way valve in the air-conditioning system.

4. USER INTERFACE

4.1 Display

The display used is a backlit LCD, 4 rows x 20 columns. The values and the information relating to the operation of the device are displayed alternating with a series of screens. The buttons on the terminal can be used to move around the screens, as described below:

```
x Row0
Home Row1
 Row2
 Row3
```

If the cursor is located in the top left corner (Home), pressing the ⇧ or ⇩ buttons accesses the successive screens associated with the selected branch.

If a screen includes fields for setting the values, pressing ↵ moves the cursor to these fields.

Once having reached the field for setting the desired value, the value can be modified, within the set limits, by pressing the ⇧ or ⇩ .buttons.

Having set the desired value, to save it press ↵ again.

The **contrast of the display** can also be adjusted, pressing ↵ and Esc together and then using ⇧ or ⇩ to increase or decrease the contrast, respectively.

Pressing the ⇧, ⇩, ↵ buttons together allows the user to quickly check the inputs and outputs.

4.2 Built-In terminal

The built-in terminal has 6 buttons (see Figure 4.1):

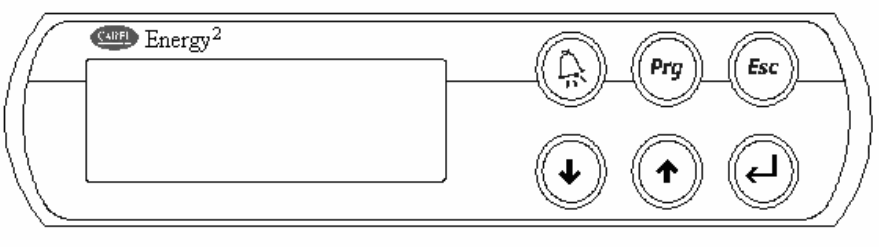


Fig. 4.1

ALARM	PROG	ESC
UP	DOWN	ENTER

with the following functions:

Button	Function	Description
	ALARM	Used to display the alarms, to reset them manually and to mute the buzzer. If the button is lit up (red), at least one alarm is active; if the LED is flashing, an alarm with automatic reset has been generated and is no longer active.
⇧ or ⇩	UP - DOWN	Scroll the various screens when the cursor is in the top left corner of the display. If the cursor is inside a numeric field, the buttons increase or decrease the value that the cursor is positioned on. If it is a selection field, pressing the buttons displays the options available.
↵	ENTER	Used to move the cursor around the screens and to save the values of the set parameters. When the button is lit up, the unit is ON.
Esc	ESC	Used to go back a selection, i.e. to the previous menu from inside a sub-menu: User; Maintenance; Installer and Language. Pressed from inside the branch selection screen (S1), returns to the main screen (P1).
Prg	PROG	Pressed once from the main menu accesses the screens for selecting the main branches (S1). Pressed again inside any screen, returns to the screens for selecting the main branches (S1), but never to the main menu.
Esc + ↵	ON/OFF	Switches the unit on or off. The light on the Enter button indicates the status of the unit.

Table 4.1

4.3 Screens

The main menu is made up of screens from P1A to P21, without password protection, being display only. These contain all the main information on the unit and relating to the power measured.
The main screen (P1) displays the date and the time, the status of the unit (ON/OFF), the instant power consumed and the maximum power limit (set point).
Scrolling the screens with or displays the power counters (total, monthly and annual), the forecasts of consumption for the year and month in progress, the status of the loads connected to the digital outputs, the operating mode, the temperature of the probes connected and the version of the application.
All this information is sufficient to monitor the overall situation of the controller.

To access the branches of the software, press Prg.
This accesses a menu (S1) of four different access screens, depending on the level: User; Maintenance; Installer; Language.

The or buttons move the cursor, and the current string is highlighted in capitals. Pressing accesses the current branch. The password is required to access the unit configuration branches, with the exclusion of the fourth branch, for setting the language.

The branches are as follows:

```
+--------------------+
|User set          S1|
|Maint set           |
|Installer set       |
|Language            |
+--------------------+
```

- USER screens: password-protected (0000, modifiable), indicated by the symbol ❶ in the table of parameters.

These show the time bands (standard or special) associated with the starts and the stops of the loads managed, as well as the time and date, the operating hours of the devices.
In addition, the maximum power limit can be set according to the rate band, and the parameters can be set for serial communication and to change the password.

- MAINTENANCE screens: password-protected (0000, modifiable), indicated by the symbol ❶ in the table of parameters.

These are used to set the rate bands (seasonal, weekly and daily), depending on the tariff plan by contract with the electricity company, as well as to modify the temperature probe offset and reset the electricity counters.
IMPORTANT: Screen M22 that refers to the status of the active and reactive power impulse at the input to Energy², is not displayed, unless the PULSE operating mode has been selected (screen I34).

- INSTALLER screens: password-protected (5555, modifiable), indicated by the symbol ❷ in the table of parameters.

These are used to modify the main parameters of the controller; access is strictly reserved for authorised personnel with detailed knowledge of the installation.
This section is in fact used to set the maximum power ratings of the installation, the mode for reading the signal, the corresponding adjustments of the signal (for impulses, the weight of the impulse; for analogue signals, the calibration of the signal converted to kW power), the maximum power ratings of the utilities being managed and the priority for switching on and off the loads, relating to the times.

- LANGUAGE screens: not password-protected, indicated by the symbol ❸ in the table of parameters.

These are used to set the language (Italian/English) for displaying the screens.

4.3.1 List of the screens

Below is the list of the screens shown on the display.
The columns in the table below, excluding the first that relates to the screens in the main menu, represent the "cycles" (loops) of screens accessible when pressing the Prg button, divided by branch: USER, MAINTENANCE, INSTALLER, LANGUAGE. After having pressed Prg from the main menu, the first screen S1 is displayed; then use or to enter the desired branch. Pressing accesses the screens relating to the selected branch.
The symbol PSW indicates that the password is required.

N.B. The screens highlighted with a grey background are not present in the software for the Small version.

MAIN MENU	User ⓪	Maintenance ❶	Installer ❷	Language ❸
P1	UP (PSW)	MP (PSW)	IP (PSW)	L1
P2	UL	ML	IL	
P3	Config. loads	Set rate bands	Config. loads	
P4	U1	M1	I1	
P5	U2	M2	I2	
P6	U3	M3	I3	
P7	U4	M4	I4	
P8	U5	M5	I5	
P9	U6	M6	I6	
P10	U7	M7	I7	
P11	U8	M8	I8	
P12	U9	M9	I9	
P13	U10	M10	I10	
P14	U11	M11	I11	
P15	U12	M12	I12	
P16	U13	M13	I13	
P17	U13	M14	I14	
P18	U14	M15	I15	
P19	U15	M16	I16	
P20	U16	Probe offsets	I17	
P21	U17	M17	I18	
	U18	Reset counters	I19	
	U19	M18	I20	
	U20	M19	I21	
	U21	Aux DI and pwd	I22	
	U22	M22	I23	
	U23	M23	I24	
	U24		I25	
	U25		I26	
	U26		I27	
	U27		I28	
	U28		I29	
	U29		I30	
	U30		I31	
	Set time bands		I32	
	U31		I33	
	U32		Power settings	
	U33		I34	
	U34		I35	
	U35		I36	
	U36		I37	
	U37		I38	
	U38		I39	
	U39		I40	
	U40		I41	
	U41		I42	
	U42		Set alarms	
	U43		I43	
	U44		I44	
	U45		I45	
	U46		I46	
	Set point		I47	
	U47		I48	
	U48		I49	
	U49		I50	
	U50		Change password	
	U51		I51	
	U52			
	U53			
	U54			
	U55			
	U56			
	Set communication			
	U57			
	U58			
	U59			

Table 4.2

5. CONNECTING TO THE INSTALLATION

The controller can be connected to the mains in different ways:
If a signal emitter board is present (installed on the electronic meter provided by the electricity company), this can be interfaced and the consumption data measured directly.
If no signal is available, a three-phase power analyser can be installed, providing an output signal of the energy consumption as impulses (CAREL recommends and supplies a specific model, see the options available).
If the three-phase system is balanced, a current transducer can be installed on one of the phases to measure the current, which is then converted by the software to manage the power and the energy consumption.

5.1 From signal emitter to Energy²

If a signal emitter board is available, installed by the electricity company upon customer request, Energy² can be interfaced directly to the meter, thus allowing the real-time reading of the output signals relating to the active energy, the current rate band and at times, when featured on the board, synchronisation of the count of peaks in consumption with the power meter.

The signal board is installed inside the case, and the corresponding terminals are available externally. The customer should install a fast-blow fuse with a rating of less than 0.2 A, to avoid, in the event of excess current, blowing the fuse installed inside the meter.

Example of connection between the signal emitter and Energy²:

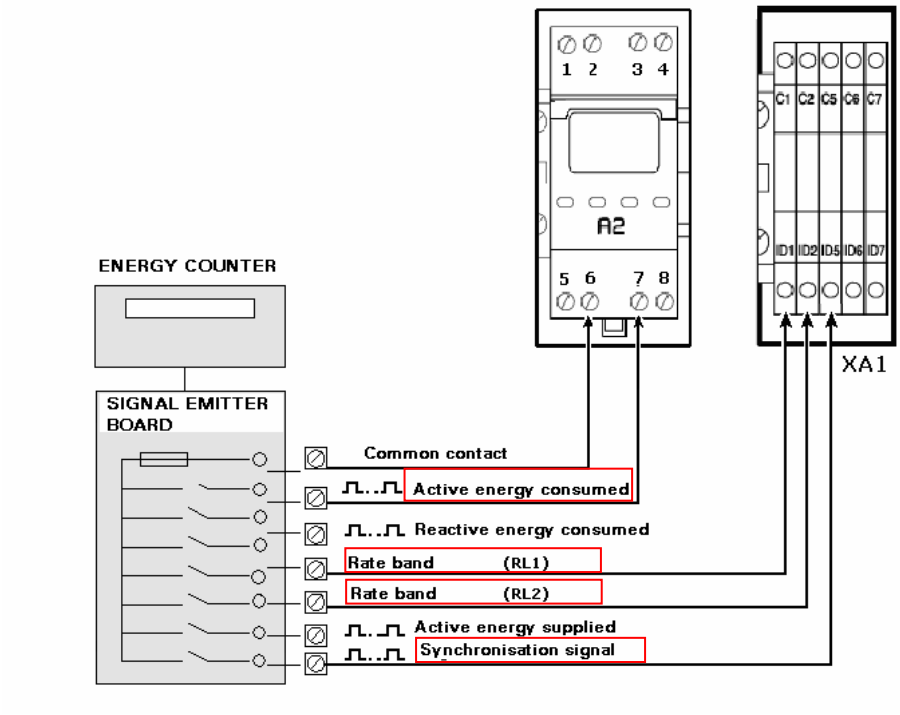


Figure 5.1

Energy² is compatible with the technical specifications of the signal emitter boards: it considers the energy impulse constant, that is, the number of impulses (see "Technical specifications of the signal board") for each kilowatt/hour of active energy, identifies and adapts to the current rate band and interfaces to the board, synchronising with the timing period (15, 30, 45, 60 min on the clock) for measuring the consumption, based on the signal provided (where present)

The following are examples of the technical specifications of two different brands of signal emitter boards:

ISKA board

Technical specifications of the signal board			Rate time band ID code *			
Energy impulses	Active energy constant	10000 imp./kWh	Rate bands relating to the CIP 45/90 provision		Contact RL1	Contact RL2
	Inductive reactive energy constant	10000 imp./kvarh	Winter period	Summer period		
	Impulse duration	80ms	October to March	April to September (August only F4)		
Contacts	Max voltage	500 Vdc or peak ac	F1 – Peak hours	F2 – High load hours	Closed	Open
	Max current	1A	F2 – High load hours	F3 – Medium load hours	Open	Closed
	Switching power	50 VA	F4 – No-load hours	F4 – No-load hours	Open	Open
	Insulation voltage	2000 Vac	* The code is associated with the customer terminal block on site by the electricity company technicians			
	Built-in fuse	0.2A slow-blow				

Table 5.1

Siemens board

Technical specifications of the signal board			Rate time band ID code *			
Energy impulses	Active energy constant	8,000 imp./kWh	Rate bands relating to the CIP 45/90 provision		Contact RL1	Contact RL2
	Inductive reactive energy constant	8,000 imp./kvarh	Winter period	Summer period		
	Impulse duration	80ms	October to March	April to September (August only F4)		
Contacts	Max voltage	500 Vdc or peak ac	F1 – Peak hours	F2 – High load hours	Closed	Open
	Max current	1A	F2 – High load hours	F3 – Medium load hours	Open	Closed
	Switching power	50 VA	F4 – No-load hours	F4 – No-load hours	Open	Open
	Insulation voltage	2000 Vac	* The code is associated with the customer terminal block on site by the electricity company technicians			
	Built-in fuse	0.2A slow-blow				

Table 5.2

5.1.1 Active energy consumed

To measure the active energy from the board, connect the cables as shown in the diagram in Figure 5.1. The features of the output impulse signal from the board (main meter) then need to be known.
In the technical specifications of the two models of board shown above (Table 5.1 and 5.2), this value is found under the item "Active energy constant": in the first case it is 8000 imp /kWh, and in the second case 10000 imp/kWh.
This value corresponds to the maximum number of impulses required to achieve a consumption of 1 kW/h on the electronic meter.
One kW/h consumed on the meter is never a real value but rather a conventional value that reduces the flow of data.
Each meter, in fact, provides a value called the "multiplication constant" (SHUNT), depending on the model of the meter, for example 200, 400, 800, 1200, and so o.
The consumption monitored by the meter must be multiplied by this value to achieve the effective consumption.
Therefore, if the meter indicates 1 kW/h, multiplying by the constant (SHUNT), corresponds to 200, 400, 800, 1200, etc. kW/h consumed.

N.B.: Contact the electricity company or the manufacturer of the meter for the precise value of SHUNT.

Knowing the number of impulses per kW/h and the value of SHUNT, the weight of the impulse can be set correctly on screen I 34 (installer loop / power setting) of Energy².
In addition, it should be stressed that the function of board A2 is to reduce the flow of impulses at the input to Energy². In fact, this converter counts 8 impulses at the input and generates 1 at the output.

To correctly calibrate the weight of the impulse (screen I34, Fig. 5.1.1.2), this division factor must be considered (ratio 8:1, as shown in figure 5.2

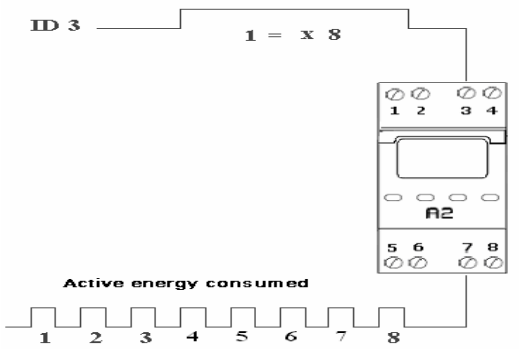


Figure 5.2

The following formula simplifies operation, remembering the need to know the value of SHUNT and the active energy constant (see the technical specifications of the board):

$$impulse\ .weight = 8000 \times \left(\frac{SHUNT}{active\ .energy\ .constnt} \right)$$

Example no. 1 refers to the technical specifications of the signal board shown in Table 5.1

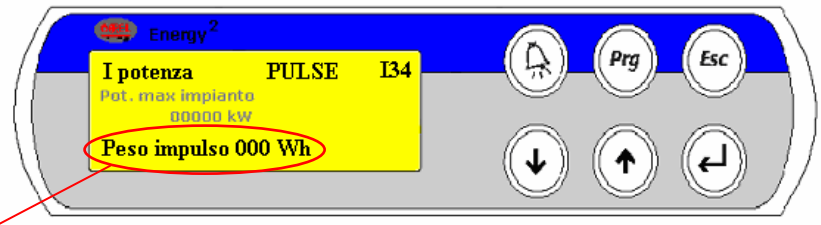


Figure 5.3

Active energy constant: 10 000 imp/kWh = 1 kWh
SHUNT= 800

→ 10 000 imp = 800 kWh

Each 10,000 impulses the effective consumption is 800 kWh

applying the formula:

$$impulse\ .weight = 8000 \times \left(\frac{800}{10000} \right)$$

1 imp = 640 Wh → This is the correct value to be set on screen I34 (Fig. 5.3) under the section "Impulse weight"

Example no. 2 refers to the technical specifications of the signal board shown in table 5.2

8000 imp/kWh = 1 kWh
SHUNT= 400

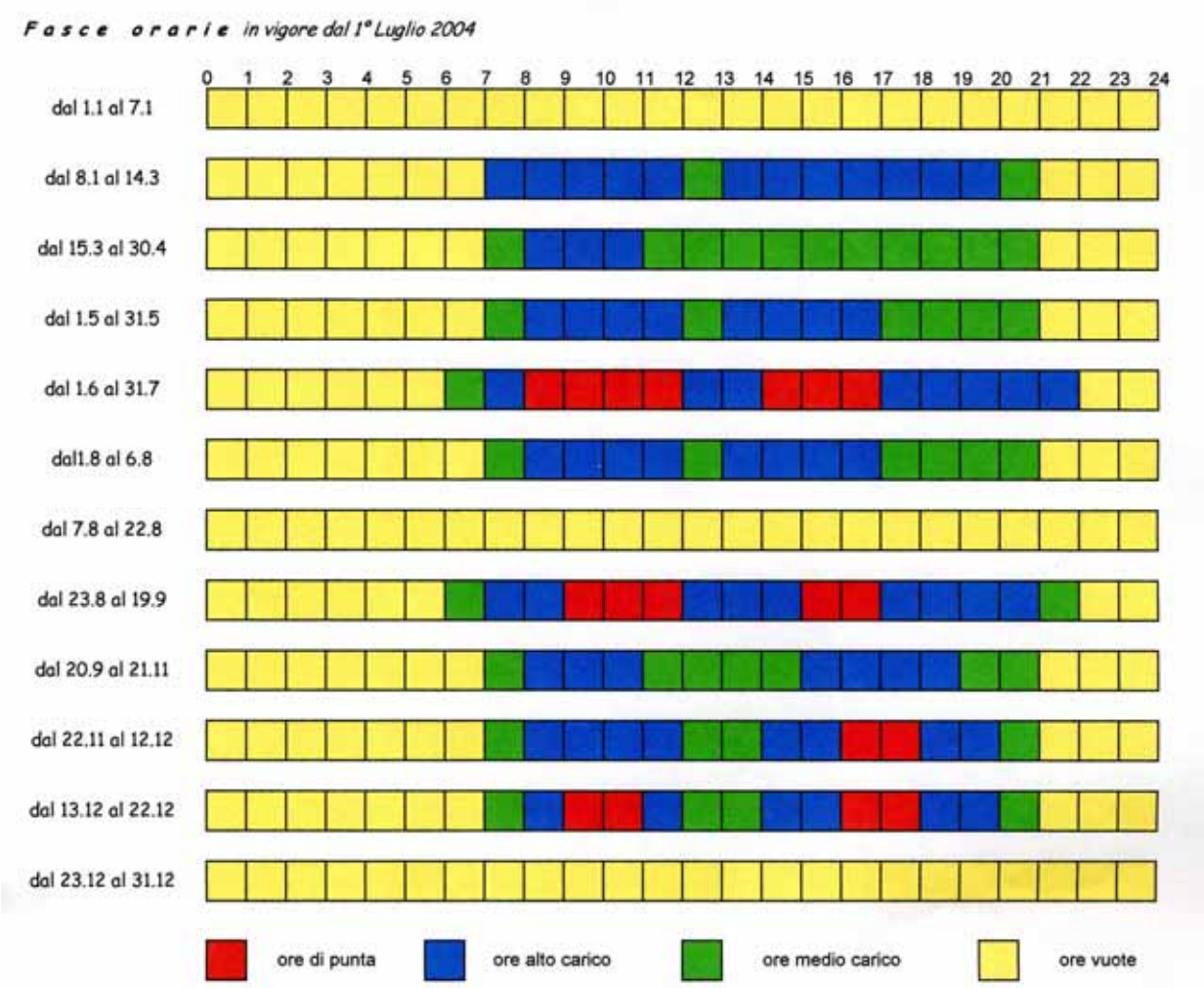
8000 imp = 400 kWh → **Each 8000 impulses the effective consumption is 400 kWh**

$$imp = 8000 \times \left(\frac{400}{8000} \right)$$

1 imp = 400 Wh → This is the correct value to be set on screen I34 (Fig. 5.3), under the section "Impulse weight"

5.1.2 Contracts by rate bands

The time bands for contracts that have different rates at different times are substantially periods within the day and the month when the electricity has different costs, depending on the national current demand at that moment.
These are divided into four rate bands: F1 (peak hours), F2 (high load hours), F3 (medium load hours) and F4 (no-load hours).
Table 5.3 below shows a rate plan relating to the entire year, divided into the four rate bands.
In Italy, for example, all electricity companies, both public utilities and private companies, must follow such a rate plan, established according to the statistics on national consumption from the previous years.



Sono in ogni caso considerate **ore vuote** tutte le ore dei sabati e delle domeniche dell'anno e delle festività infrasettimanali dell'1 e 6 gennaio, del lunedì dell'Angelo, 25 aprile, 1 maggio, 2 giugno, 15 agosto, 1 novembre, 8.25.26 dicembre

Ore per fascia		F1	F2	F3	F4			F1	F2	F3	F4
2004	1 gen - 31 mar	260	715	-	1.209	2005	1 gen - 7 gen	-	-	-	168
	1 apr - 30 apr	-	63	231	426		8 gen - 14 mar	-	552	92	940,0
	1 mag - 31 mag	-	168	126	450						
	1 giu - 31 lug	301	344	43	776		15 mar - 30 apr	-	96	352	680
	1 ago - 6 ago	-	40	30	74		1 mag - 31 mag	-	176	132	436
	7 ago - 22 ago	-	-	-	384		1 giu - 31 lug	294	336	42	792
	23 ago - 19 set	100	180	40	352		1 ago - 6 ago	-	40	30	74
	20 set - 21 nov	-	308	308	896		7 ago - 22 ago	-	-	-	384
	22 nov - 12 dic	28	112	56	308		23 ago - 19 set	100	180	40	352
	13 dic - 22 dic	32	48	32	128		20 set - 21 nov	-	308	308	896
	23 dic - 31 dic	-	-	-	216		22 nov - 12 dic	28	112	56	308
							13 dic - 22 dic	32	48	32	128
							23 dic - 31 dic	-	-	-	216
	1 apr - 31 dic	461	1.263	509	3.134						
Spin 2004	1 gen - 31 - dic	721	1.978	509,0	4.343		1 gen - 31 dic	454	1.848	1.084	4.434

Table 5.3

Energy² can adapt automatically the current rate band, and for each of these can associate a maximum limit of power available, so as to optimise consumption in the times when the electricity costs less.

If the two output contacts RL1 and RL2 are present on the signal board, corresponding to the change in the current rate band, connect the reference cables to the digital inputs ID 1 and ID2 respectively on Energy², as shown in Figure 5.1.1

Then access the screens of the software and from screen I37 (Fig. 5.4) enable the rate bands from DI (Digital Input):

Enabling this parameter activates the functions of digital inputs ID 1 and ID2 for the change in rate band.

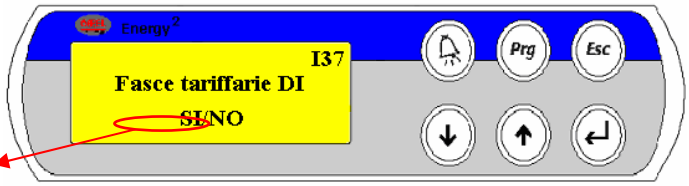


Figure 5.4

The combination of these two digital inputs allows the controller to automatically adapt to the current rate band, and depends on the corresponding month and season.
Combination of the contacts:

CONTACT RL1 (DI 1)	CONTACT RL2 (DI 2)	Screen M21	SEASON 0	SEASON 1	SEASON 2	Saturday/Sunday/Holiday
CLOSED	CLOSED	0-0	F4	F4	F4	F4
CLOSED	OPEN	0-1	F4	F2	F3	F4
OPEN	CLOSED	1-0	F4	F1	F2	F4
OPEN	OPEN	1-1	F4	-	-	F4

Table 5.4

Subsequently, for each rate band (F1, F2, F3, F4), set a maximum limit of power that cannot be exceeded, in screens U47 and U48 of the software:

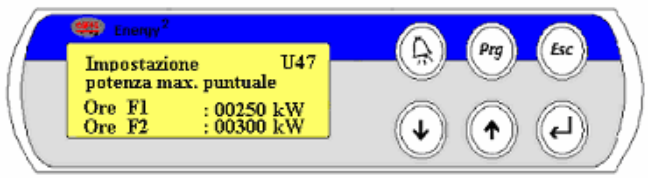


Fig. 5.5

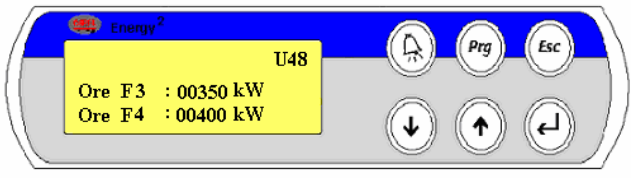


Fig. 5.6

Depending on the combination of the contacts from the signal board, Energy² adapts the maximum limit of power available for that rate band so as to optimise consumption depending on requirements.
The possibility to manage four different power set points in fact allows the disconnection of the utilities to be delayed or brought forward, depending on the power input. The current rate band expressed in terms of "Maximum power" (previously set in screens U47 and U48), is visible on the main screen of the software:

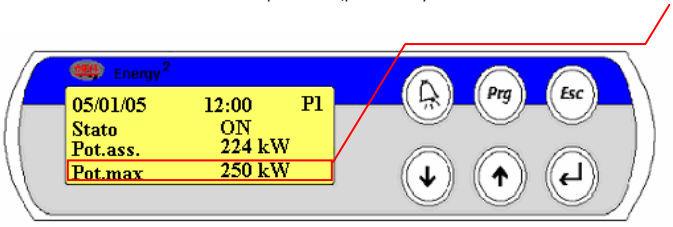


Fig. 5.7

The value highlighted in red on screen P1 will automatically change, based on the combinations of the two contacts RL1 and RL2, shown in table 5.4. This takes the value relating to the maximum instant power in the current band Fx, set in screens U47 and U48.

Vice-versa, if the two contacts RL1 and RL2 are not featured on the board, or if Energy² has been connected to another power reading device, the parameter in screen I37 must be set to NO.

The functions of digital inputs ID 1 and ID2 on Energy² for the change in rate band are disabled. This activates the automatic management of the rate bands set by software.

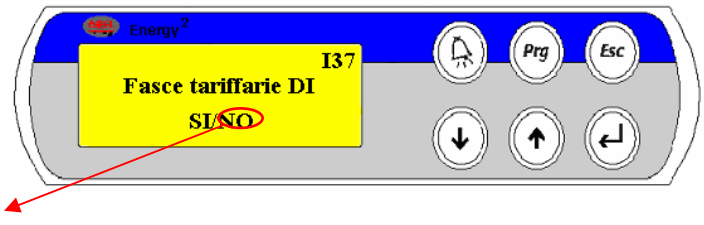


Fig. 5.8

The rate bands can be defined by software, setting "NO" on screen I37 that corresponds to the selection of the RATE BANDS defined by PROGRAM. The procedure is described below.

- First of all, make sure that the date, the time and the weekday week is set correctly in screen U31 (see User loop / Set time bands).

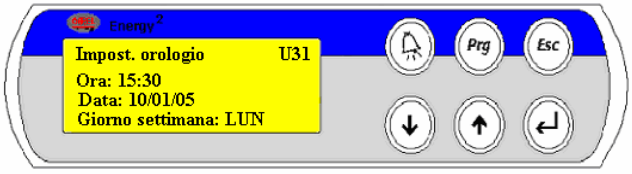


Fig. 5.9

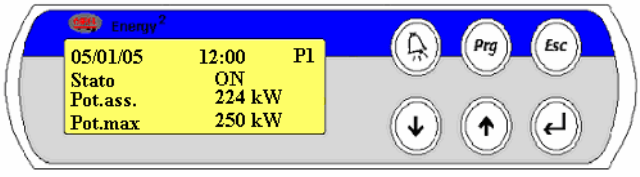


Fig. 5.10

- Then set the seasonal bands, assigning a value between 0 and 2 to each month of the year (0=no-load hours; 1=winter period; 2=summer period). This configuration is completely versatile and has been especially designed to be able to adapt to any rate plan in any country.

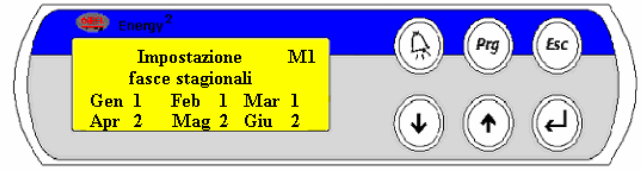


Fig. 5.11

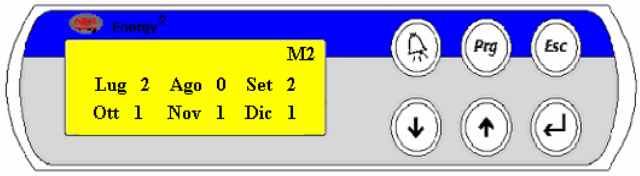


Fig. 5.12

In the months of the year configured with the value 0, there will be just one time band, that is, always that corresponding to the no-load period with the lowest cost. The months assigned the value 1, on the other hand, take the time band for the winter period, and 2 for the summer period.

- At this stage, the weekly bands also need to be configured, that is, the days of the week that can be associated with a different rate band depending on the reference month and the season (0, 1 or 2). For each day of the week, the options are "load" (NV) and "no load" (V) (with reference to Italian rates, full days are normally weekdays).

NOTE: Setting a day of the week to V means attributing this the characteristics of season 0. On the other hand, selecting NV attributes the characteristics established for season 1, if in one of the months set to 1, or the characteristics established for season 2, if in one of the months set to 2.

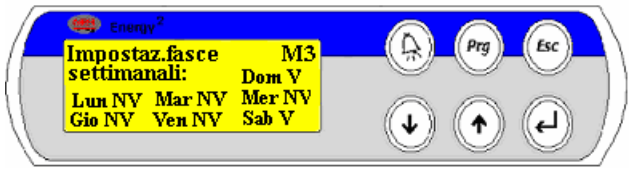


Fig. 5.13

If, for example, the clock displays the month of January, which was previously assigned to season 1, and the day of the week is Monday, set to NV, this takes bands F1, F2, F3, F4 relating to season 1.

- Finally, set the times for F1, F2, F3, F4 relating to seasons 0, 1, and 2. To do this, go to M4 and the following screens, and modify the times for each band:

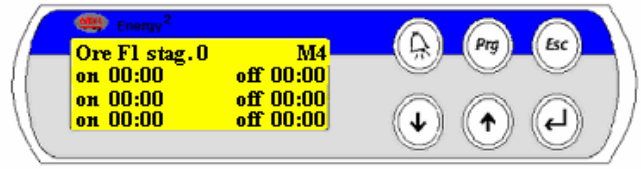


Fig. 5.14

5.2 From mains power analyser to Energy²

The following describes model of mains power analyser, listed in the options, that has been tested by CAREL.

The mains power analyser is able to calculate the active power consumed by measuring all the required data: voltage, current intensity, displacement and frequency.
Before connecting the mains power analyser to Energy², check the connections: CT and connections to the power line.
Three current transducers must be installed on the main line of the three-phase system. The current transducers must be selected based on the maximum consumption of the installation, with corresponding end scale.
Depending on how the calibration parameter of the CT is set on the instrument (see the corresponding instruction sheet), the energy impulse at the output of the mains power analyser has a different weight in terms of kW/h.
The weight of the output impulse is a fundamental value that also needs to be set in the Energy² software on screen I37, as already shown in Figure 5.3.

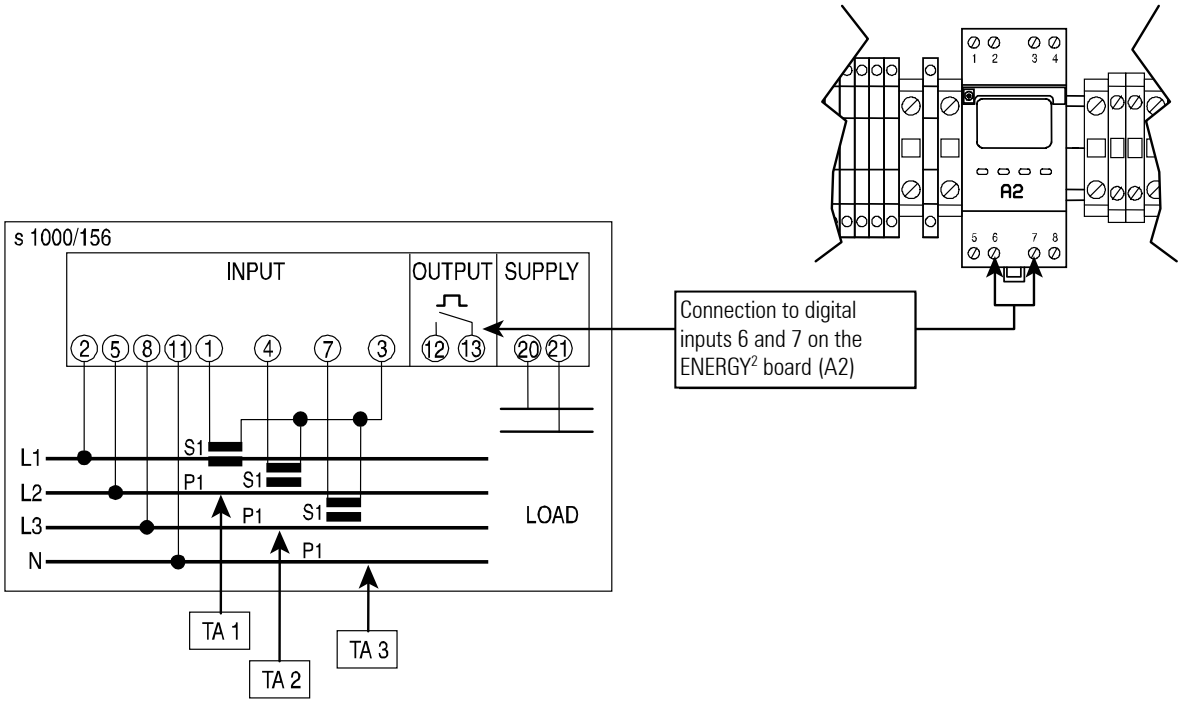


Figure 5.15

As can be seen in Figure 5.15, the output impulse from the mains power analyser is interfaced directly to board A2, the power impulse converter. It should be remembered that converter A2 counts eight impulses at the input and generates one at the output, which consequently will have a weight in "watt-hour" that is eight times higher than the output impulse of the mains power analyser.
If the output impulse of the mains power analyser has a weight of 100 Wh, considering that this interfaces to the impulse converter A2, each impulse counted by Energy² will correspond to eight times the weight of the impulse from the mains power analyser. In example no. 1, one impulse will have a weight of 800 Wh and this value is the data to be entered in screen I37 to correctly calibrate Energy².

5.3 From electronic CTs to Energy² (only with balanced load)

If the signal board is not available and the mains power analyser cannot be installed, electronic CTs can be connected directly to the three-phase line, providing a 4 to 20 mA output signal. Energy² can in fact interpret these signals, measuring the current input of the installation and converting it into power input.
NOTE: This type of connection is recommended if the three-phase system is balanced.

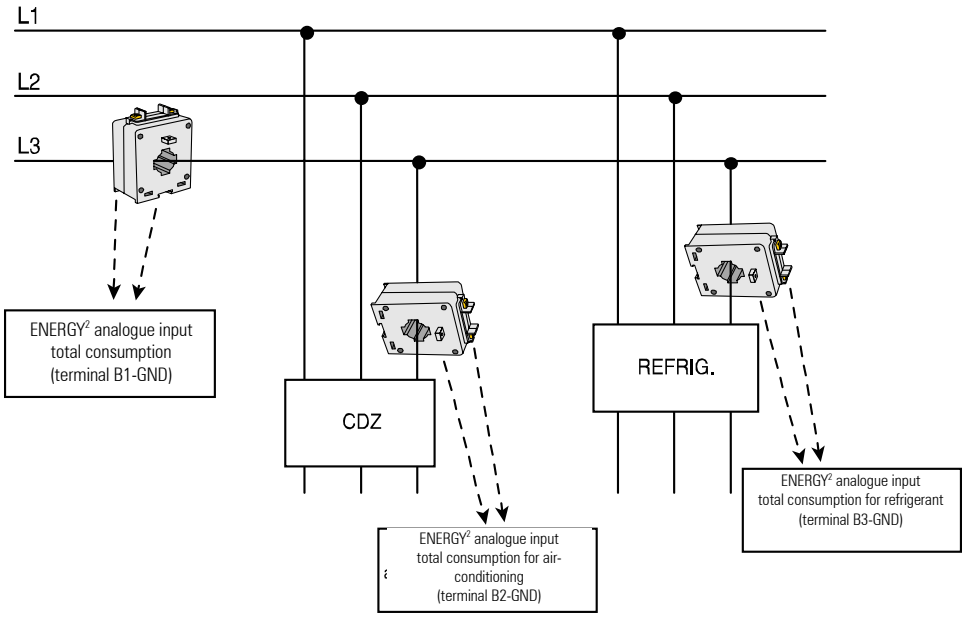


Figure 5.16

The diagram shows how each branch requires just one current transducer: one is installed on the three-phase system (if balanced) and the other two in refrigeration and air-conditioning (if present) power lines.

IMPORTANT: The Small model does not have the 4 to 20 mA analogue input for the total power reading of the installation.
In the Large model, on the other hand, this input is B1 and, depending on whether there is an external power supply to the CT, the second terminal will be GND or +Vdc.

To enable the reading using the electronic current transducer (in the Large model), first enable the corresponding analogue input, setting ANALOG mode on screen I34, under "Power settings" (Installer loop), as shown in Figure 5.17.

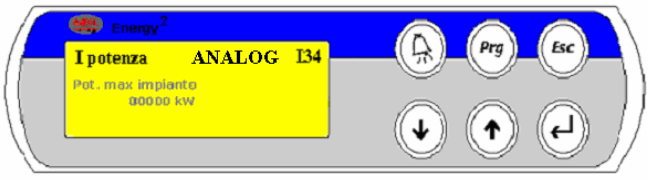


Fig. 5.17

The deactivation of the utilities in the event of excess power is then performed based on this signal.
The two other CTs can be installed on the secondary lines for monitoring the consumption of the refrigeration and air-conditioning systems. There is no control action based on these two signals, but rather simply the monitoring of the energy consumed, displayed on the graphs in the Energy software module.

5.3.1 Calibrating the electronic CTs

For the correct reading of these devices, screens I38, I40, I41 in the application must be set with the correct calibration of the 4 to 20 mA signal, depending on the features of the installation (see the example further on).
The screen shown in Fig. 5.18 corresponds to the calibration of the CT for the overall power of the installation (Large version only).

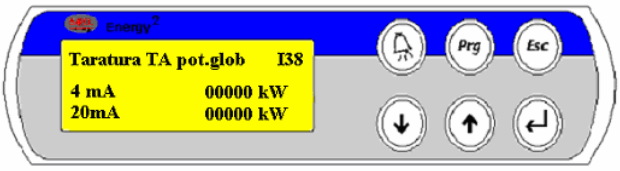


Fig. 5.18

A power value expressed in kW that corresponds exactly to the output signal of the CT must be assigned to the minimum (4 mA) and maximum (20 mA) signals.
To correctly calibrate these two values, the following must be known:

- the voltage of the individual phase (volts), according to the linked voltage, phase-to-neutral or phase-to-phase (star or delta),
- the maximum end scale of the CT installed (amperes), that is, the maximum current that can be measured by the CT,
- the displacement (cosφ).

When these three values are known, and considering the phases as being balanced, a minimum and maximum power value can be determined, corresponding to the power of the individual phase:

$$P = V \times I \times \cos \varphi$$

(power of one phase)

At this stage, depending on the voltage V:

- replacing V in the formula with the value of 400 volts, considering the linked voltage phase-to-phase, to determine the power of the three-phase system, the value needs to be multiplied by $\sqrt{3}$:

$$P = V \times I \times \cos\varphi \times \sqrt{3}$$

- if, on the other hand, V in the formula is replaced with the value of 230 volts, considering the linked voltage phase-to-neutral, the value needs to be multiplied by 3

$$P = V \times I \times \cos\varphi \times 3$$

NOTE: The value "I" in the formula must correspond to the maximum current end scale (in amperes) of the CT installed.

Example:

The end scale of the CT is 500 A, the voltage between phase and neutral is 230 V and the displacement (cosφ) is 0.9.

$$P = \frac{230\ V \times 500\ A \times 0.9}{1000} \times 3 \qquad P = \frac{310500}{1000}$$ (divide by 1000 to convert the value from W to kW) $$P = 310.5$$

by convention this can be rounded off to 310 kW.
The field relating to the 4 mA signal, if set to 0 kW, must correspond to no power consumed when the entire installation is off, while the field relating to the 20 mA signal must be set to 310 kW, equivalent to the maximum output that can be measured by the CT installed.

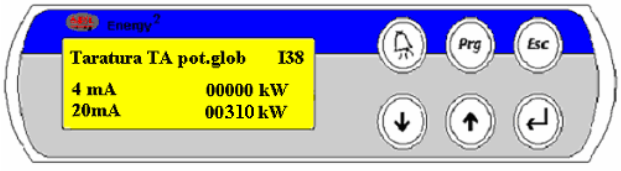


Fig. 5.19

6. FROM Energy² TO THE SUPERVISORY SYSTEM

Energy² is compatible with the Carel PlantVisor supervisory system, via the RS 485 serial output.
During configuration, set the protocol, the communication speed and the network address in User screen U57.
After this operation, the unit parameters can be modified directly from the supervisory system, as desired by the operator.

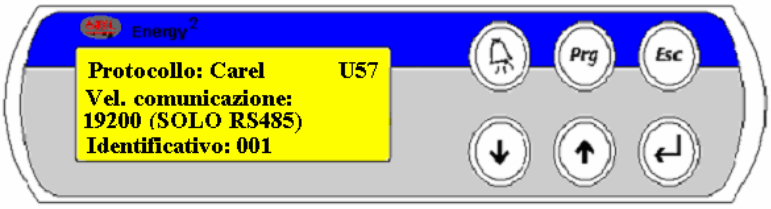


Fig. 5.20

Energy² is connected to the RS485 converter using a twisted-pair shielded cable, AWG20/22, with the shield connected to GND.

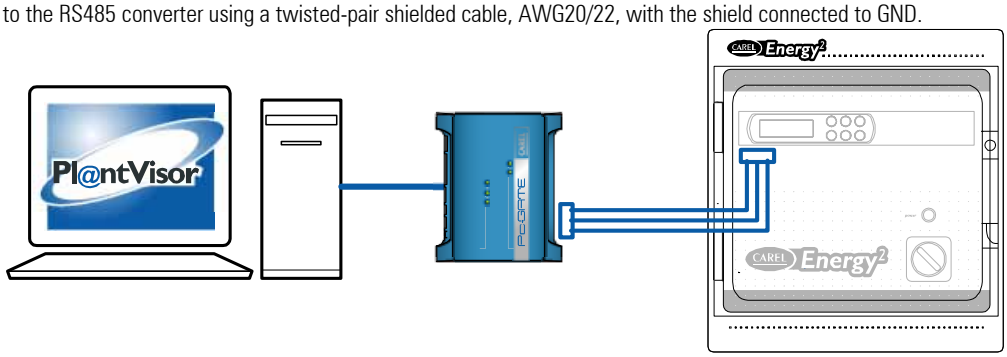


Fig. 5.21

Important notes for correct connection:

1. the polarity of the wires must be observed (TX+ and TX-)
2. the maximum length of the network must not exceed 1000m; branches must not exceed 5m;
3. do not fork the line (star connections);
4. all the instruments in the network must be powered by their own insulated power supply, and the secondary must not be earthed;
5. install a 1/4 W, 120 Ω resistor, supplied by CAREL, between the TX+ and TX- contacts on the furthest terminal from the RS485 converter
6. make sure that the network cables do not run near, or worse, in the same conduits as the power cables.

7. THE PROGRAM

7.1 Electricity management

The program evaluates, based on the values acquired, the energy consumed in the chosen reference period (15, 30, 45 or 60 min., set on screen I35) and, as a consequence, the average power over the interval (calculated as the ratio between energy consumed and duration of the cycle). If the power calculated is higher than that maximum set for that time of day (billing set point), the program disconnects a number of loads so as to bring the power consumed back below the threshold value.
The program can manage up to four different types of billing set point, and displays the status of the loads managed (On, Off), the maximum power reached since the start of the reference billing period (month or year) and the energy consumed since the start of the period.
The program furthermore displays the estimates of energy usage until the end of the reference billing period (month or year).

Energy² can acquire the information on the energy consumed in three modes:

- electronic board connected to the power meter (impulses);
- mains power analyser (impulses);
- direct measurement of the power input by CT (4 to 20 mA).

7.2 Management of priorities and utility energy values

The program manages up to 15 loads in the Large version and 4 loads in the Small version, which are disconnected in a set order of priority, so as to maintain the power input below the set point. In this way, the loads are switched off in the following order: the first load to be switched off is the load that has priority 1, while the last to be switched off has priority 15 (Large model) or 4 (Small model).
As regards switching the loads back on, the opposite is true. The first to restart is the load with priority 15 (Large) or 4 (Small), while the last to restart is the load with priority 1. All this is managed by the control algorithm, which reconnects the loads in such a way as to not exceed the max consumption set point (naturally respecting the times for each load). The energy values are defined by assigning the power rating to the load, and is considered as the energy that the load will consume until the end of the counting cycle (product of the power of the load and the remaining cycle time).

7.3 Times

The actions performed by Energy² on the utilities connected are subject to a series of set times.
Some of these have the function of ensuring operation that as much as possible reflects the characteristics of the loads managed.
The following times are used:
minimum off time for the utility (Minimum OFF) - Fig. 7.1;
maximum off time for the utility (Maximum Off) - Fig. 7.2;
minimum on time for the utility (Minimum On) - Fig. 7.3.

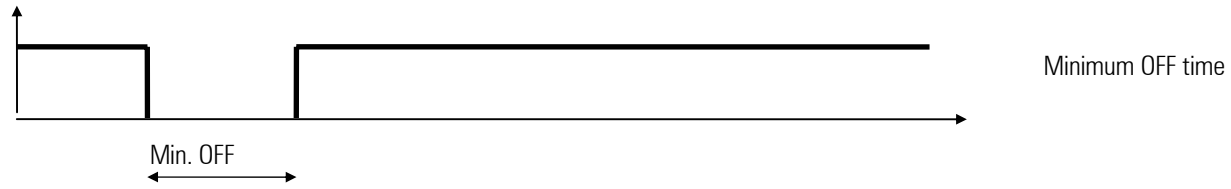


Fig. 7.1

This represents the minimum time the load must stay OFF, even if the load has a higher start priority.

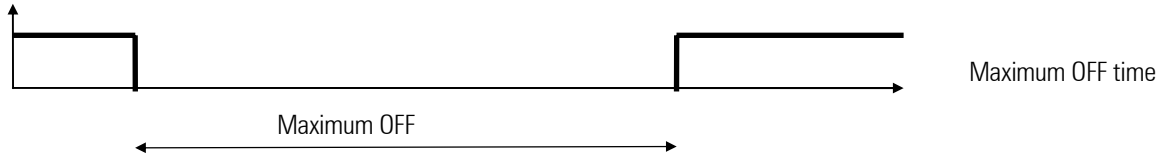


Fig. 7.2

This is the maximum off time for the load. After this time has elapsed since the load was last switched off, the enabling signal is sent irrespective of the priority and the energy that it will consume until the end of the cycle, even if this value exceeds the remaining energy quota and consequently the power limit.

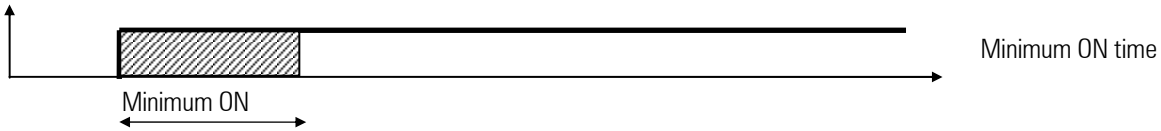


Fig. 7.3

This is the minimum on time for the load, during this time no condition can affect the enabling signal.

8. INITIALISING THE SOFTWARE

The following series of operations is used to initialise the system, and therefore should be read after having read the section on "The program".
Note: The system should only be switched ON after having completely programmed the controller.

The following is a list of the screens, with the description of the fields present. On the top right of each screen is the name of the screen itself, as shown on the display.

8.1 Main menu screens

```
+--------------------+
|00/00/00   00:00  P1|
|State       OFF     |
|Abs. Power. 00000 kW|
|Limit Power 00000 kW|
+--------------------+
```

When starting the system, the first screen displayed shows the date, the time (these will probably need to be set correctly in the corresponding screen), system status, instant power input and maximum power limit.

Pressing Esc and ↵ together in the start screen changes the status of the system (ON/OFF).

To return to screen P1 and the corresponding loop, press Esc from any screen.

To scroll to the other screens in the main menu, press the ↑ or ↓ buttons.

```
+--------------------+
|                  P2|
|    Refrigeration   |
|     consumption    |
|       00000kW      |
+--------------------+
```

This screen indicates the instant consumption in kW of the refrigeration section.

The value displayed varies according to the calibration of the electronic current transducer (with 4 to 20mA output) on screen I40, connected to analogue input defined for the consumption of the refrigeration system on Energy² (see the terminal block of analogue inputs for the Large and Small models).
The screen is enabled only if the maximum refrigeration power limit, set in screen I39, is greater than 0 kW/h.
This screen and the other screens in this loop are display-only screens.

```
+--------------------+
|                 P3|
|  Air conditioning  |
|    consumption     |
|       00000kW      |
+--------------------+
```

This screen indicates the instant consumption in kW of the air-conditioning section.
As above, but referring to screen I41

```
+--------------------+
|                 P4|
|   Total energy     |
|     counter        |
|    0000000000kWh   |
+--------------------+
```

Total energy counter in kW/h, relating to the overall consumption measured by electronic CT in ANALOG mode (analogue input B1, only for the Large model) or from the mains power analyser in PULSE operation, digital input ID3 (see screen I34).

```
+--------------------+
|                 P5|
|   Refrigeration    |
|   energy counter   |
|   0000000000kWh    |
+--------------------+
```

Energy counter in kW/h, relating to the consumption of the refrigeration section measured by the electronic current transducer with 4 to 20mA output (see the terminal block of analogue inputs on the Large and Small models).
The screen is enabled only if the maximum refrigeration power limit, set in screen I39 in the Installer loop, is greater than 0 kW.

```
+--------------------+
|                 P6|
|   Air conditioning |
|   energy counter   |
|   0000000000kWh    |
+--------------------+
```

As above, but referring to the consumption of the air-conditioning system.

```
+--------------------+
|                 P7|
|    Annual energy   |
|      counter       |
|   0000000000kWh    |
+--------------------+
```

Energy consumed annually.

```
+--------------------+
|                 P8|
|  Monthly energy    |
|      counter       |
|   0000000000kWh    |
+--------------------+
```

Energy consumed monthly.
Both the annual and monthly energy counter are reset automatically at the expiry of the corresponding period (year/month), or alternatively can be reset manually in screen M18.

```
+--------------------+
|  Max absorbed    P9|
|     power          |
|Curr. year  00000kW |
|Prev. year  00000kW |
+--------------------+
+--------------------+
|  Max absorbed   P10|
|     power          |
|Curr. month 00000kW |
|Prev. month 00000kW |
+--------------------+
```

Based on the data acquired and the daily average calculated by the system, Energy² can highlight the actual power usage in the current year or month, as well as for the previous year or month.
These values are useful for defining the best power contract to be stipulated with the electricity company.

```
+--------------------+
|                P11|
|  Foreseen yearly   |
| energy consumption |
|     0000000000kWh  |
+--------------------+
```

```
+--------------------+
|                 P12|
|  Foreseen monthly  |
| energy consumption |
|     0000000000kWh  |
+--------------------+
```

Energy² can estimate the forecast energy consumption in the current year and month, based on the data already acquired, and automatically update the estimate according to data from each day.

```
+--------------------+
|Loads state      P13|
|1:OFF      4:OFF    |
|2:OFF      5:OFF    |
|3:OFF      6:OFF    |
+--------------------+
```

Status of the digital outputs: 1-6 Large model; 1-4 Small model. ON means relay contact is energised, OFF it is de-energised.

```
+--------------------+
|Loads state      P14|
|7:OFF  10:OFF 13:OFF|
|8:OFF  11:OFF 14:OFF|
|9:OFF  12:OFF 15:OFF|
+--------------------+
```

Status of digital outputs 7-15.
Note: This screen is not featured on the Small model

```
+--------------------+
|                 P15|
|    Time schedule   |
|        bypass      |
|          No        |
+--------------------+
```

Indication of operation outside of the time bands. Enabled or disabled according to the status of digital input ID6.
If on the screens for the configuration of the loads (see User loop/Config. loads/Screens U2, U4, U6, U8, etc.) the operation of a load outside of the time bands is selected, and the status of digital input 6, displayed on this screen, will determine if it is enabled: YES = load enabled; NO = load not enabled.

```
+--------------------+
|                 P16|
|    Light sensor    |
|         No         |
|                    |
+--------------------+
```

Indicates whether light is present, displayed only if the type of twilight switch, set in "Installer" screen I32, is selected. Enabled or disabled according to the status of digital input ID7

```
+--------------------+
|Ambient temperat.P17|
|        00.0°C      |
|Internal temperat.  |
|        00.0°C      |
+--------------------+
```

Temperature measured by the probes installed in the outside environment (analogue input B4 in the Large model and B3 in the Small model) and inside (analogue input B7 in the Large model and B4 in the Small model).
The "ambient" probe and the inside probe are used for the *Optimum start/stop* and *Duty cycling* functions (see the corresponding paragraphs in the chapter "The program").

```
+--------------------+
|                 P18|
| Water Temperature  |
|       00.0°C       |
|                    |
+--------------------+
```

Water temperature measured by the probe connected to analogue input B5.
This probe is used for the management of the 3-way valve (see the corresponding paragraph in the chapter "The program").

```
+--------------------+
|                 P19|
|   Light intensity  |
|        000 (0-100) |
|                    |
+--------------------+
```

Displays, on a scale from 0 to 100, the intensity of light as the signal supplied by a twilight switch connected to analogue input B6, displayed only if the 4 to 20 mA twilight switch is set in "Installer" screen I32.

```
+--------------------+
|                 P20|
|  3Way valve        |
|  position  000.0%  |
|                    |
+--------------------+
```

Displays the opening (as a percentage) of the three-way valve connected to analogue output Y1-0. The opening of the three-way valve is related to the water temperature (see the corresponding paragraph in the chapter "The program").

```
+--------------------+
|    Carel S.p.A  P21|
|    Brugine (PD)    |
|     PCO2Energy     |
|Ver.0.0     00/00/00|
+--------------------+
```

Information on the version and the date of the software.
Note: Screens P16, P18, P19 and P20 are not present in the Small version, as the related functions are not managed.

8.2 Installer

Before programming or if the default values of the parameters need to be restored, the buffer memory should be reset (see the description of screen I33).
After manual initialisation, the installer must perform a series of operations in order to implement the main functions of the controller and ensure the correct operation of the unit:

switch the system off, if not already so, using the Esc and ↵ buttons.
establish the type of input for the power reading (PULSE or ANALOG), according to the type of installation performed, and set the maximum power limit for the installation as defined in the contract.
calibrate the current transducer for ANALOG mode, or the signal board, if the power reading is in PULSE mode or from mains power analyser.
for each load that is enabled, the following need to be set: priority, minimum OFF time, minimum ON time, maximum OFF time.

```
+--------------------+
|User set           S1|
|Maint set             |
|Installer set         |
|Language              |
+--------------------+
```

This screen is accessed by pressing Prg from any screen.

The ↓ button is used to change the position in one of the four fields in the screen, pressing the ↵ button enters the corresponding loop.
Below is a description of the loops that are accessed from this screen.
It is recommended to start from the "Installer" loop:

```
+--------------------+
|                   IP|
|Installer Password  |
|              0000  |
|                    |
+--------------------+
```

For this loop, the password is **5555**, entering the correct password and confirming with ↵ opens the installer menu.
It is recommended to change the password after the first access.

```
+--------------------+
|Load Config.       IL|
|Power set             |
|Alarms                |
|Pwd change            |
+--------------------+
```

The ↓ button is used to change the position in one of the four fields in the screen; pressing the ↵ button enters the corresponding loop.

8.2.1 Power settings loop

The first parameters to be configured, inside the Installer loop, are those corresponding to settings of the power ratings of the installation, "Power settings".

```
+--------------------+
|Power I PULSE     I34|
|Max plant power     |  ——————→  Large model
|          00000  kW |
|weight pulse 000 Wh |
+--------------------+
```

This screen is used to decide the power input reading, between ANALOG and PULSE, valid only for the Large version: transmission
ANALOG = analogue transmission via electronic CTs with 4 to 20 mA output;
PULSE = from external signal emitter board or from mains power analyser that emits energy impulses.
Selecting PULSE, the last row will show the field relating to the weight of the impulse in Watt/hour, to be set depending on the features provided by the manufacturer of the board or listed on the technical specifications of the mains power analyser.
In the second row, on the other hand, set the maximum end scale for the power of the installation.

```
+--------------------+
|                   I34|
|Max plant power     |  ——————→  Small model
|          00000  kW |
|weight pulse 000 Wh |
+--------------------+
```

On the Small board, ANALOG or PULSE cannot be set, as this model does not have the input to measure the over power via CT, but only as impulses, and therefore PULSE mode is set automatically.

```
+--------------------+
|                I35|
|Int. time for calc. |
|consumption peaks   |
|             15 min|
+--------------------+
```

This screen is used to define the time for calculating the peaks in consumption: 15, 30, 45 or 60 min.
The peaks in consumption are calculated based on the time set, and the utilities are deactivated when the projection of the consumption based on the time selected here exceeds the power limit threshold, set on screens U47 and U48.
Electricity companies adopt the same control system, that is, the peaks in instant power are tolerated, however real "excess" consumption, that causes changes to the contract, occurs when the consumption is exceed in this time period.
For example:
In Italy, the reference time period is a quarter of an hour, which means that every 15 minutes (0-15, 15-30, 30-45, 45-0), the calculation is performed both by the electricity companies and by Energy².
If the maximum limit is, hypothetically, 500 kW, the power rating established on the contract, dividing this value by 60, the number of minutes in an hour, gives the maximum energy value available each minute, that is, 8.333 kW. This value is then multiplied by the reference time selected on screen I35, in our case 15 minutes, to calculate the energy available in the 15 minute period, that is, 125 kW/15 min.
Energy² checks the trend in consumption within this period and, if it believes that the projection of consumption will exceed the energy available, prevents the limit from being exceeded, deactivating the utilities so as to bring the consumption below the maximum limit allowed until the end of the period (see the section on programming for the deactivation of the utilities). At the end of the period, the count is reset and a new cycle starts.

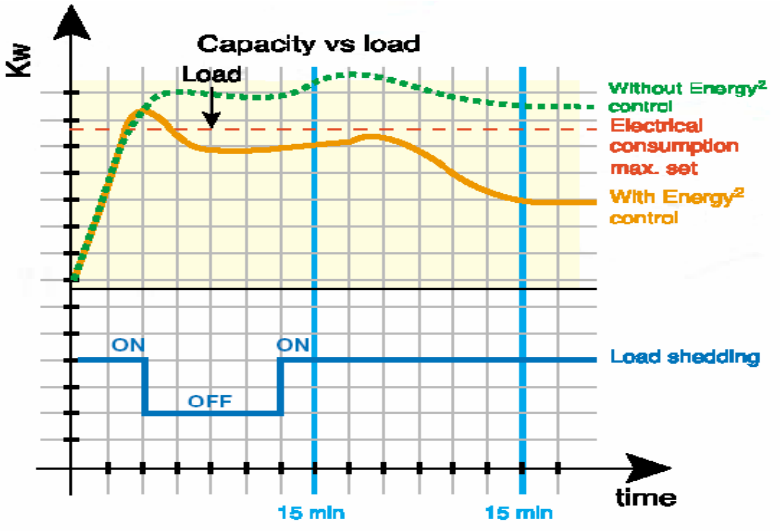


Fig. 8.1

These graphs are important for explaining how Energy² implements the control of energy consumption.

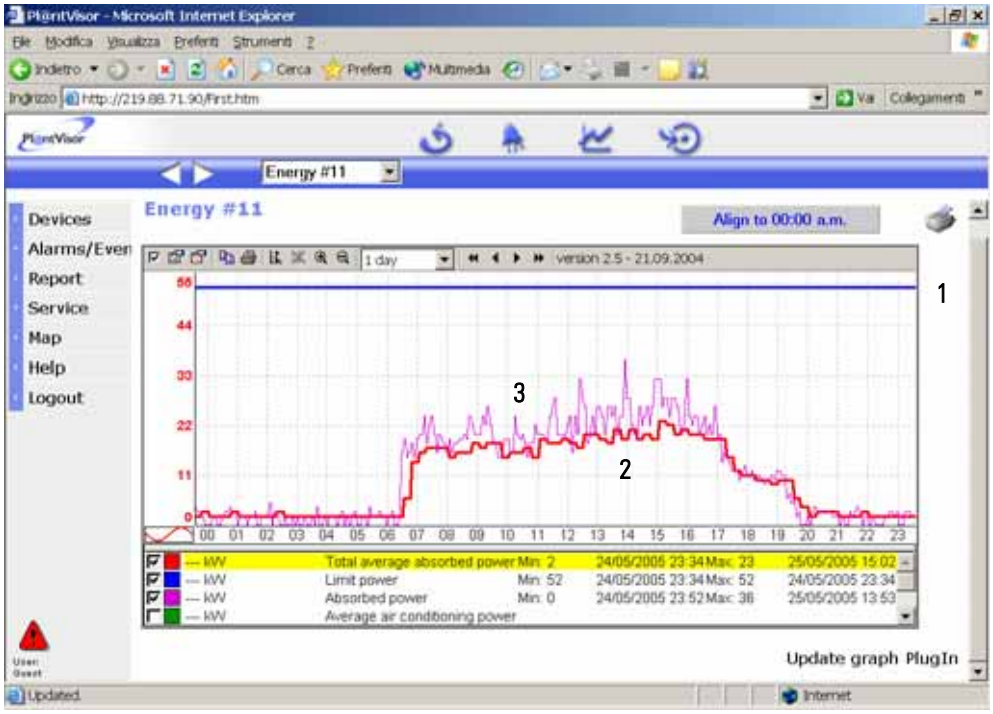


Fig. 8.2

The values shown in the graph in Figure 8.2 represent the 3 main values controlled by the system:

- the line indicated by number 1 represents the "**LIMIT POWER**", that is, the maximum power consumption setting that must not be exceeded in the reference period;
- the line indicated by number 2 corresponds to the "**TOTAL AVERAGE ABSORBED POWER**" and the graph of the data of energy consumed in the reference period (15-30 min). If the reference period is 15 minutes, the points on the graph coincide with the measurements made every 15 minutes. This line must NEVER exceed the "LIMIT POWER";
- the line indicated by number 3 represents the "**ABSORBED POWER**", that is, the instant power consumed by the installation. Excesses are allowed over the max "LIMIT POWER" for brief periods, however the Energy² control action will maintain the consumption value for reference period ("TOTAL AVERAGE ABSORBED POWER") below the "LIMIT POWER".

```
+--------------------+
|                 I36|
| Synchroniz. signal |
|        NO          |
|                    |
+--------------------+
```

When Energy² is connected to the signal board, a signal may be available that is used to synchronise the meter with the timing period for controlling peaks in consumption. The reference time described for screen I35 is supplied directly by the electricity company, and is read by digital input 5 provided specifically for this purpose. Consequently, selecting "YES", the controller waits until the status of digital input 5 changes, meaning the cycle will no longer be reset based on the built-in clock, but rather on this external signal (for the connection of the synchronicity signal, see paragraph "From signal emitter to Energy² ").

```
+--------------------+
|                 I37|
|Rate from           |
|digital inputs      |
|         NO         |
+--------------------+
```

The signal board also features signals RL1 and RL2 for the change in the current rate band (see the paragraph "Contracts by rate bands"). If selecting "YES", the controller waits for the signal on digital contacts ID1 and ID2 and adapts the rate bands according to the logic of the two contacts; on the other hand, choosing "NO" means the controller considers the programming of the rate bands set on the "Rate band setting" screens in the "Maintenance" loop, with reference to the built-in clock on Energy².

```
+--------------------+
|                 I38|
|Global power TA Set |
|4mA        00000  kW|
|20mA       00000  kW|
+--------------------+
```

If ANALOG power input mode, that is, measurement by CT has been set on screen I34, screen I38 is used to calibrate the input used for the measurement of overall power.
The 4 mA value must correspond to the minimum end scale of the CT (in general 0), while 20 mA must correspond to the maximum, that is, the maximum value read by the CT.
See the paragraph "Calibrating the electronic CTs" to correctly complete the settings on this screen.

```
+--------------------+
|Max Air C. power I39|
|       00000 kW     |
|Max refr. power     |
|       00000 kW     |
+--------------------+
```

This screen is used to enter the maximum power consumed by the refrigeration and the air-conditioning systems, if the corresponding electronic current transducers with 4 to 20mA output are installed. If these fields are entered with a value higher than zero, the screens will be enabled for calibrating the refrigeration (screen I40) and the air-conditioning (screen I41) current transducers, and all the others fields relating to the refrigeration and/or the air-conditioning systems (screens P2, P3, P5, P6 in the main menu).

```
+--------------------+
|                 I40|
|Refrigeration TA set|
|4mA         00000 kW|
|20mA        00000 kW|
+--------------------+
+--------------------+
|                 I41|
|Air cond. TA set    |
|4mA         00000 kW|
|20mA        00000 kW|
+--------------------+
```

Calibration of the current transducer relating to the refrigeration and air-conditioning systems respectively.
See the paragraph "Calibrating the electronic CTs" to correctly complete the settings on this screen.

```
+--------------------+
|                 I42|
|Power time refresh  |
|              0000  |
|                    |
+--------------------+
```

If PULSE power mode has been enabled on screen I34, the time for refreshing the calculation of the instant power must be entered on screen I42. The range of possible values is from 0 to 3600 seconds, and this time must be adequately set according to the frequency of impulses received by Energy². The value of the

instant power, calculated by the application, is shown on the display on the main screen P1 whenever this screen is open and, when the next impulse is read, the value is automatically updated even before the time has elapsed.

Important: In the event of lower consumption, the time between impulses must be set so as to prevent the instant power displayed from being zero.

8.2.2 Load configuration loop

The screens in this loop are used to establish some of the characteristics of the loads, in particular:

- Power in kW: expresses the power value assigned to the load. This value is used to determine the amount of energy that the load will consume until the end of the cycle for calculating the peaks in consumption (15, 30, 45, 60 minutes). If this value does not exceed the remaining energy quota, the load enabling signal is restored, otherwise the algorithm starts to examine the load with the lowest priority, without restoring the load in question. This does not necessarily coincide with the maximum power value of the load (for this point, also see "Utility energy management").
- Shed: setting shed = YES enables the disconnection of the load, shed=NO, disconnection of the load not enabled.
- **Note: the time band enabling signal is upstream of this, consequently if the time band enabling signal is not present, the load is off irrespective of whether this parameter is enabled or not.**
- Priority: this is the direct expression of the importance of the load; in the event of excess power consumption, the loads are disconnected following the order of priority assigned to them. The first to be disconnected is the load with the lowest priority.
- Enable light sensor = YES subjects the load to the signal from the twilight switch. If the twilight switch detects light, the load is not enabled, otherwise it is enabled. Setting this field to YES implies that the output is considered a light-related load.
- Min. ON time: this is the minimum on time of the load, during this time no condition will affect the enabling signal;
- Min. OFF time: this represents the minimum time the load must stay off. In this case, even if the load has higher switching on priority, it will stay OFF for the entire time set here so as to protect the utility against frequently switching ON/OFF;
- Maximum utility OFF time: this is the maximum off time relating to the load. After this time has elapsed since the load was last switched off, the enabling signal is sent independently of the priority and the energy that it will consume until the end of the cycle, even if this value exceeds the remaining energy quota and consequently the power limit.

```
+--------------------+
| Load # 1         I1|
|Power   00000kW     |
|Shed No  Priority 00|
|En. Light sens.  No |
+--------------------+
```

This function is not available on the Small version

When this screen is displayed, corresponding to load 1, pressing  accesses the parts of the screen so as to modify the parameters.

When the cursor flashes on the first row,  or  are used to set the power of the utility connected.

Pressing the  button confirms the data entered and moves to the next row, to enable load 1 for automatic on and off, as well as its priority in reference to the other loads configured.

After having modified the parameters, pressing  again moves to the last row, for enabling the load in relation to the light sensor (for further details, refer to the corresponding paragraph in the chapter "The program") .

Pressing  confirms the settings and moves the cursor home so as to allow access to the following screen.

For each of the loads that can be configured by the application, a similar screen is displayed by scrolling through the loop using the  button.

In particular, as regards the screens relating to loads 8-12-13-14-15 on the Large model, where the relay outputs have changeover contacts, the status of the relay in normal conditions can be set: NO = normally open; NC = normally closed.

```
+--------------------+
| Load # 8    NC  I15|
|Power   00000kW     |
|Shed No  Priority 00|
|En. Light sens.  No |
+--------------------+
```

Configuring these screens does not complete the programming of the loads, as they will need to be enabled in relation to the time bands (see the "Configure loads" screen inside the USER loop).

```
+--------------------+
|Timing load # 1   I2|
|Min off time  00000s|
|Max off time  00000s|
|Min on time   00000s|
+--------------------+
```

This screen and those relating to all the other loads are used to set the load on and off times if they are disconnected due to excess power (see the chapter "The program"):

- minimum off time for the utility;
- maximum off time for the utility (after this time has elapsed since last switched off, the enabling signal is present irrespective of the priority and the value of energy that it will consume until the end of the cycle, even if this value exceeds the remaining energy quota and consequently the power limit;
- minimum on time for the utility (during this time no condition can affect the enabling signal).

These settings are fundamental for safeguarding the utilities.

```
+--------------------+
|                 I9 |
| Digital Output #5  |
|   for aux.alarm    |
|          NC        |
+--------------------+
```

Only Small version

This screen is only present in the Small version, as digital output 5 with changeover contacts is used for the auxiliary alarm; the screen sets the logic of the contact: NO (normally open) or NC (normally closed).

```
+--------------------+
|Optm Start-Stop  I31|
|  enable on load #  |
|       (1-15) 00    |
|       0=no load    |
+--------------------+
```

This screen is used to enable the load for optimum start-stop (see chapter "The program").
If a load is enabled for this function, the corresponding analogue inputs must be connected to two temperature probes: ambient probe (external); internal temperature probe.

```
+--------------------+
|                 I32|
|Light sensor type   |
|on/off              |
|                    |
+--------------------+
```

This screen is used to choose the type of twilight sensor: on/off or 4 to 20mA.
If on/off is selected, the main menu will show screen P16, if, on the other hand, 4 to 20mA is selected, screen P19 will be enabled in the main menu and screen U49 will be displayed for setting the set point.

```
+--------------------+
|                 I33|
|Memory Reset        |
|             No     |
|                    |
+--------------------+
```

The last screen in the loop is used to reset the controller memory.
This operation is recommended when first starting the unit, before programming the parameters.
Note: all the parameters configured will be deleted and return to the default status. The buffer memory should therefore be reset before configuring the parameters.

8.2.3 Alarm setting loop

```
+--------------------+
|                 I43|
| Global power TA    |
|(Analog input #1)   |
|Enable alarm    No  |
+--------------------+
```

This alarm is not available on the Small version as the CT input for total power is not featured

Screen for enabling the alarm corresponding to the current transducer for total consumption connected to analogue input B1 on the Large model.

```
+--------------------+
|                 I44|
| Refrigeration TA   |
|(Analog input #2)   |
|Enable alarm    No  |
+--------------------+
+--------------------+
|                 I45|
|Air conditioning TA |
|(Analog input #3)   |
|Enable alarm    No  |
+--------------------+
```

Screens that activate, respectively, the alarm or cable interrupted signal relating to the CT measuring the consumption of the refrigeration system, connected to analogue input B2 on the Large model and B1 on the Small model, and the air-conditioning system, connected to analogue input B3 on the Large model and B2 on the Small model.

```
+--------------------+
|                 I46|
| Amb.temp.probe     |
|(Analog input #4)   |
|Enable alarm    No  |
+--------------------+
+--------------------+
|                 I47|
| Water temp.probe   |
|(Analog input #5)   |
|Enable alarm    No  |
+--------------------+
```

This alarm is not available on the Small version as the water probe input is not featured.

Screens that activate, respectively, the alarm or cable interrupted signal relating to the ambient temperature probe (external) connected to analogue input B4 on the Large model and B3 on the Small model, and the water temperature probe (for 3-way valve) connected to analogue input B5 on the Large model.

```
+--------------------+
|                 I48|
| Light sensor       |
|(Analog input #6)   |
|Enable alarm    No  |
+--------------------+
```

This alarm is not available on the Small version as the light sensor probe input is not

Screen to enable the alarm signal relating to the light sensor, connected to analogue input B6 on the Large model.

```
+--------------------+
|                 I49|
| Int.temp.probe     |
|(Analog input #7)   |
|Enable alarm    No  |
+--------------------+
```

Screen to enable the alarm signal corresponding to the internal temperature probe, connected to analogue input B7 on the Large model and B4 on the Small model.

```
+--------------------+
|                 I50|
|  Active power D3   |
| input enable alarm |
|         No         |
+--------------------+
```

If the power reading is managed in PULSE mode via digital input, this screen can enable an alarm on the digital input.
For the alarm to be generated, the following conditions must occur at the same time:

- the unit must be ON
- the power input must be zero for more than 10 minutes, that is, no impulse must be received in this period of time
- at least one load must be enabled for operation by time band or manually by digital contact

For further details on the analogue and/or digital inputs, refer to the paragraphs corresponding to the terminal blocks on the two models.

8.2.4 Change password loop

As mentioned, the password for the installer loop can be changed, see the following screen.

```
+--------------------+
|                 I51|
|Change password     |
|             0000   |
|                    |
+--------------------+
```

8.3 Maintenance

The Maintenance level is a second group of settings used in particular to set the bands for the applicable power rates, after having selected "NO" in screen I37. Otherwise the software waits for the external board (signal emitter) to determine the current power rates, providing an impulse signal ad Energy².

```
+--------------------+
|                  MP|
|Maint Password      |
|             0000   |
|                    |
+--------------------+
```

Entering the correct password, 0000 as default, and confirming by pressing  accesses the following menu.

```
+--------------------+
|Rates             ML|
|Probes Offset       |
|Counters Reset      |
|Aux ID, pwd ch.     |
+--------------------+
```

The  button is used to change the position in one of the four fields in the screen, pressing  enters the corresponding loop

8.3.1 Rate band setting loop

For further details see the paragraph "Contracts by rate bands".

```
+--------------------+
|                 M1 |
|  Yearly rate set   |
|Jan 0  Feb 0  Mar 0 |
|Apr 0  May 0  Jun 0 |
+--------------------+
```

```
+--------------------+
|                   M2|
|Jul 0  Aug 0  Sep 0 |
|Oct 0  Nov 0  Dec 0 |
|                    |
+--------------------+
```

For each month of the year, this screen is used to attribute a season, choosing from three possibilities:

- 0 is the no-load period;
- 1 is the winter period;
- 2 is the summer period.

```
+--------------------+
|Weekly rate set   M3|
|              Sun E |
|Mon E  Tue E  Wed E |
|Thu E  Fri E  Sat E |
+--------------------+
```

For each day of the week, the possible choices are "NV" (load) and "V" (no load). With reference to the Italian rates, "load" days are normally weekdays.

Note: setting a day of the week to "V" is the same as attributing the time characteristics established for season 0; setting it to "NV" attributes the time characteristics established for season 1, in the months in question, or vice-versa the time characteristics established for season 2.

```
+--------------------+
|F1 hours season 0 M4|
|on 00:00  off 00:00 |
|on 00:00  off 00:00 |
|on 00:00  off 00:00 |
+--------------------+
+--------------------+
|F2 hours season 0 M5|
|on 00:00  off 00:00 |
|on 00:00  off 00:00 |
|on 00:00  off 00:00 |
+--------------------+
+--------------------+
|F3 hours season 0 M6|
|on 00:00  off 00:00 |
|on 00:00  off 00:00 |
|on 00:00  off 00:00 |
+--------------------+
+--------------------+
|F4 hours season 0 M7|
|on 00:00  off 00:00 |
|on 00:00  off 00:00 |
|on 00:00  off 00:00 |
+--------------------+
```

Screen M4, plus the following screens are used for setting the daily bands F1, F2, F3, F4, relating to the seasons (0, 1, 2). For each of these there are 4 screens.

Example: for each season there are screens "hours F1 season X", "hours F2 season X", "hours F3 season X", "hours F4 season X". Inside each screen, then, up to three times can be set relating to the same rate band, as this may apply more than once on the same day.

```
+--------------------+
|                  M16|
|Defaults             |
|          No         |
|                     |
+--------------------+
```

In any case, the rate bands relating to Italian contract AV1 can be initialised automatically, setting the field on this screen to YES. The ON and OFF parameters are loaded into screens M1, M2, …, M15 corresponding to rate bands F1, F2, F3, F4. If some values do not coincide with the programming of the rate bands for desired contract, these can be changed manually after having initialised the standard values.

The variable is automatically reset to NO.

8.3.2 Probe offset loop

```
+--------------------+
|NTC Offset       M17|
|AI4 Probe   0.0 °C  |
|AI5 Probe   0.0 °C  |
|AI7 Probe   0.0 °C  |
+--------------------+
```

If the temperature value read by the NTC probes is not correct, it can be calibrated using a software offset.

In the Large version: outside, inside and water temperature on analogue inputs 4, 5 and 7.

In the Small version: outside and inside temperature on analogue inputs 3 and 4.

8.3.3 Reset counter loop

```
+--------------------+
|Counters Reset   M18|
|         Total   No |
|        Annual   No |
|        Monthly  No |
+--------------------+
+--------------------+
|                 M19|
|Refrigeration    No |
|Climatization    No |
|                    |
+--------------------+
```

The counters (screens M18 and M19) relating to total energy consumed (see screen P4), energy consumed in the year (see screen P7), in the reference month (P8), by the refrigeration system (see screen P5) and the air-conditioning system (see screen P6) can be manually reset.

Position the flashing cursor, using  or  , on the counter to be reset, select it by pressing  , set YES using  or  and confirm by pressing  .
In any case, all the counters, as previously described, are shown on the main menu.

8.3.4 Aux IO and change password loop

These screens are visible only if the input signal for the power reading is selected as PULSE (screen I34, see power settings loop in the "Installer" menu). Otherwise, the only screen visible will be M23 to change the password.

```
+--------------------+
|                 M20|
|Sincronization      |
|signal              |
|         0          |
+--------------------+
```

The status of the synchronisation signal (screen M20) can only be displayed the synchronisation signal has been enabled on screen I36 (see power settings loop in the "Installer" menu).
Digital input number 5 is used for this signal (ID5 - C5) on both models.

```
+--------------------+
|                 M21|
|Rate from           |
|digital inputs      |
|         00         |
+--------------------+
```

This screen displays the status of digital inputs 1 and 2 (ID1-C1 and ID2-C2) which determine the rate band depending on the combination of the contacts, if the two inputs have previously been enabled for this function (screen I37, see power settings loop in the "Installer" menu).
For further details, see the paragraph "Contracts by rate bands". Below is the logic of the contacts with the respective rate bands:

CONTACT RL1 (DI1)	CONTACT RL2 (DI2)	Screen M21	SEASON 0	SEASON 1	SEASON 2	Sat/Sun/Holidays
CLOSED	CLOSED	00	F4	F4	F4	F4
CLOSED	OPEN	01	F4	F2	F3	F4
OPEN	CLOSED	10	F4	F1	F2	F4
OPEN	OPEN	11	F4	-	-	F4

Table 8.1

```
+--------------------+
|                 M22|
|Energy pulses       |
|Active      0       |
|Reactive    0       |
+--------------------+
```

This screen displays the active and reactive energy impulses from board A2 (see paragraph "A2 power impulse converter").

```
+--------------------+
|                 M23|
|Change password     |
|              0000  |
|                    |
+--------------------+
```

As in the other levels, the password can be changed.

8.4 User

The following operations can be performed in this level:

- set the current date and time;
- configure the time bands available, setting for each the start time in hours and minutes;
- attribute the time bands to each load;
- set the maximum instant power limit. This set point represents the power level that cannot be exceeded throughout the day, so as to avoid the penalties envisaged in the contract with the electricity company;

- turn the system ON using Esc + ↵.

```
+--------------------+
|                 U59|
|Change user         |
|password            |
|             0000   |
+--------------------+
```

Entering the correct password, 0000 as default, and confirming by pressing ↵ accesses the menu.

```
+--------------------+
|Loads Config.     UL|
|Time schedule       |
|Setpoint            |
|Communication       |
+--------------------+
```

Position the flashing cursor in the field, using ↑ or ↓, and confirm by pressing ↵.

8.4.1 Load configuration loop

This section is used to define the operation of each load, on two screens:

```
+--------------------+
|   Time schedule  U1|
|     load # 1       |
|Standard 0          |
|Special 1N 2N 3N 4N |
+--------------------+
```

Time bands

The user can choose between standard, weekly and special bands. Moving to the STANDARD field, the corresponding band can be assigned to the load, choosing from 1 to 4, as follows:

- from 1 to 3 are the standard daily bands
- 4 represents the weekly band.

Moving to the SPECIAL BAND fields, each can be enabled independently, while as regards the STANDARD bands described previously, choosing one excludes the remaining three.

For the description of the time bands, see the "Time band setting" screens in the user loop.

```
+--------------------+
|  Enable load # 1 U2|
|                    |
|Time Sch. Bypass No |
|Duty cycling     No |
+--------------------+
```

Enable load

This screen is used to enable the load for: *operation outside of the band* (select YES) and *duty cycling* (wiring on ID6-C6).

Scrolling the screens inside the TIME BANDS and ENABLE LOAD loop displays the screens relating to the loads managed by the two versions of Energy².

8.4.2 Time band setting loop

The screens in this loop are used to define the time bands according to the requirements not only of the user, but also of the load. In fact there are 4 STANDARD bands (3 daily and 1 weekly) and each of these has 4 sub-bands called SPECIAL bands, which have priority over the standard bands. Each electrical load connected to Energy² and configured for operation with the time bands can be associated with one of the 4 STANDARD bands (maximum one per load) and with all 4 SPECIAL bands (up to 4 at the same time), taking the programming of the respective STANDARD band and any SPECIAL bands.

```
+--------------------+
|Date-Time set    U31|
|Hour: 00:00         |
|Date: 00/00/00      |
|WeekDay:            |
+--------------------+
```

The correct synchronisation of the date and the time is essential for the operation of the time bands, set on screen U31.

STANDARD BANDS (1, 2, 3, 4):

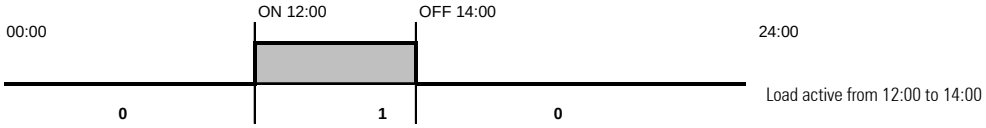
DAILY 1-2-3:

```
+--------------------+
|Daily T Sch. 1a  U32|
|On  00:00 Off 00:00 |
|Daily T Sch. 1b     |
|On  00:00 Off 00:00 |
+--------------------+
+--------------------+
| Daily T Sch. 2a U33|
|On  00:00 Off 00:00 |
|Daily T Sch. 2b     |
|On  00:00 Off 00:00 |
+--------------------+
+--------------------+
|Daily T Sch. 3a  U34|
|On  00:00 Off 00:00 |
|Daily T Sch. 3b     |
|On  00:00 Off 00:00 |
+--------------------+
```

These screens are used to enable different loads at different on and off time bands, according to the needs of the user.
If a load has previously been associated with the STANDARD band 1 (screen U1, U3, U5, ...) this screen is used to set the daily ON and OFF times that the load associated with this band refers to.
For further details, see the paragraph on the standard bands, in the chapter "The program".

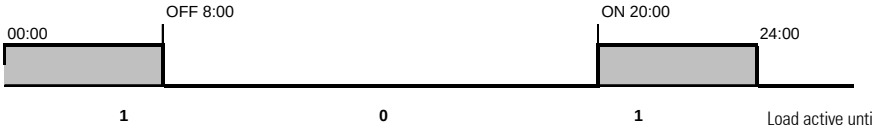
Example of programming the time bands

Two bands can be defined for each day, specifying the ON and OFF time for each band.
If the time specified in the ON field is equal to the time specified in the OFF field, the band is ignored (for example, the band ON 00:00 / OFF 00:00 has no effect).
If the time in the ON field is before the time in the OFF field, the load will be active in the period between the two times specified, while it will be inactive in the times outside of the specified band. (Fig. 1)
If the time in the ON field is after the time in the OFF field, the load will be inactive in the period between the two times specified, while it will be active in the times outside of the specified band. (Fig. 2)
As two bands can be defined for each day, the overall operation of the load (Fig 4) will depend on the sum effect of the two time bands (OR) (Fig. 3)
If the load must stay on all day, then the time band set must minimise the off band, as in the example shown in Fig. 5 in which the load is only off for one minute.
Alternatively, for continuous operation all day, two complementary bands can be overlapped, as shown in Figs. 6, 7 and 8



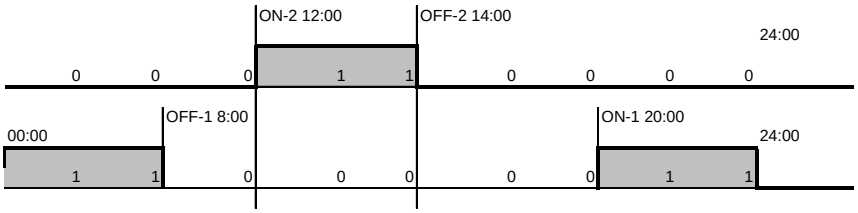
Load active from 12:00 to 14:00

Fig.1



Load active until 8:00 and after 20:00

Fig.2



ON-1 on time for the first band
ON-2 on time for the second band
OFF-1 off time for the first band
OFF-2 off time for the second band

Fig.3

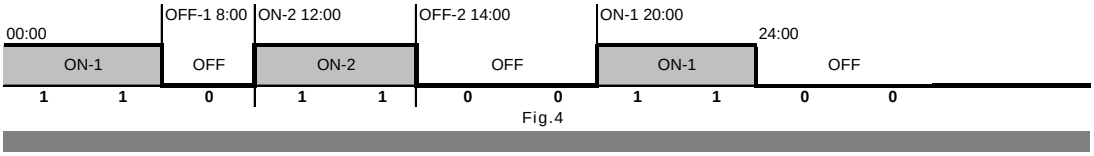


Fig.4

Fig.5

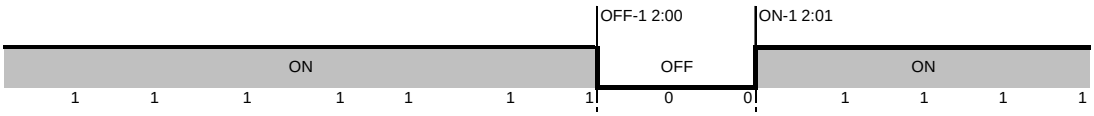


Fig.6

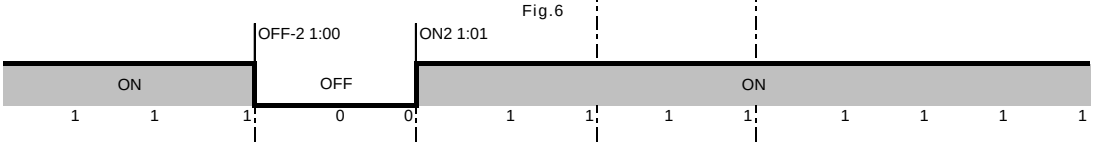


Fig.7

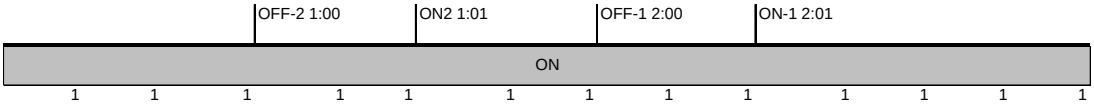


Fig.8

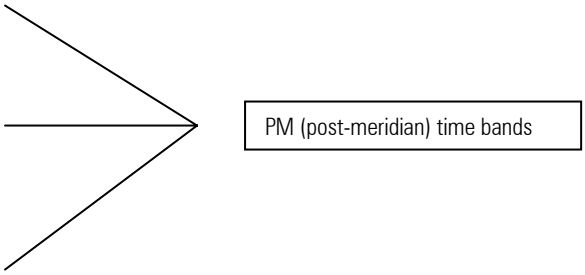
OFF-2 1:00

WEEKLY 4:

```
+--------------------+
|Week T Sch.(AM)  U35|
|      On      Off   |
|Sun  00:00   00:00  |
|Mon  00:00   00:00  |
+--------------------+
+--------------------+
|     On      Off U36|
|Tue 00:00    00:00  |
|Wed 00:00    00:00  |
|Thu 00:00    00:00  |
+--------------------+
+--------------------+
|     On      Off U37|
|Fri 00:00    00:00  |
|Sat 00:00    00:00  |
|                    |
+--------------------+
```

AM (anti-meridian) time bands

```
+--------------------+
|Week T Sch.(PM)  U38|
|       On      Off  |
|Sun  00:00   00:00  |
|Mon  00:00   00:00  |
+--------------------+
+--------------------+
|     On      Off U39|
|Tue 00:00    00:00  |
|Wed 00:00    00:00  |
|Thu 00:00    00:00  |
+--------------------+
+--------------------+
|     On      Off U40|
|Fri 00:00    00:00  |
|Sat 00:00    00:00  |
|                    |
+--------------------+
```



If a load has been associated with STANDARD band 4 (screen U1, U3, U5, ...), this screen is used to set the ON and OFF times for each day of the week that the load associated with this band refers to. It should be noted that two ON and two OFF actions can be set on the same day, as there is the distinction between AM (anti-meridian) and PM (post-meridian): U35, U36, U37 AM and U38, U39, U40 PM.
For further details. see the paragraph on the standard bands in the chapter "The program".

SPECIAL BANDS (1, 2, 3, 4):

SPECIAL 1:

```
+--------------------+
|                 U41|
| Special T Sch. # 1 |
| Italian Holidays   |
|   (implemented)    |
+--------------------+
```

If a load has been associated with SPECIAL band 1 (screen U1, U3, U5, to), the application will not enable the utility (forced OFF) on any national holiday, following the annual calendar. On all other days it will follow the programming of the STANDARD band set.

SPECIAL 2:

```
+--------------------+
|                 U42|
|Special T. Sch. # 2 |
| dd:00     mm:00    |
|                    |
+--------------------+
```

If a load has been associated with SPECIAL band 2 (screen U1, U3, U5, to), on the day of the month established in screen U42, the application will not enable the utility (forced OFF).
For further details. see the paragraph on the special bands in the chapter "The program".

SPECIAL 3:

```
+--------------------+
|                 U43|
|Special T. Sch. # 3 |
| dd:00     mm:00    |
|                    |
+--------------------+
+--------------------+
|Spec T. Sch.# 3a U44|
|On  00:00 Off 00:00 |
|Spec T. Sch.# 3b    |
|On  00:00 Off 00:00 |
+--------------------+
```

If a load has been associated with SPECIAL band 3 (screens U1, U3, U5 to), on the day of the month established in screen U43, the utility will be forced ON. Screen U44, on the other hand, can be used to set two ON and two OFF times on the same day.

SPECIAL 4:

```
+--------------------+
|                 U45|
|Special T. Sch. # 4 |
| dd:00     mm:00    |
|                    |
+--------------------+
+--------------------+
|Spec T. Sch.# 4a U46|
|On  00:00 Off 00:00 |
|Spec T. Sch.# 4b    |
|On  00:00 Off 00:00 |
+--------------------+
```

As above, but referring to SPECIAL BAND 4.

8.4.3 Set point loop

```
+--------------------+
|                 U47|
|Max power set       |
|F1 hours   :00000 kW|
|F2 hours   :00000 kW|
+--------------------+
+--------------------+
|                 U48|
|F3 hours   :00000 kW|
|F4 hours   :00000 kW|
|                    |
+--------------------+
```

Four different set points can be programmed, depending on the availability of power in the rate bands F1, F2, F3 and F4.
The value set here will be displayed on the main screen P1 ("Maximum power" not to be exceeded), according to the current rate band.
If the digital inputs have been enabled to the change the rate bands on screen I37, the application waits for the signals at digital inputs ID1 and ID 2 that, depending on their combination, will change the set point, defined here, corresponding to the current rate band.
Otherwise, the internal clock will establish the change in the set point depending on the rate programming set on screens M1 to M15.
Consequently, the desired power consumption can be customised depending on the most convenient rate band.
If, for example, the most economical band by contract is F4, a higher set point can be defined in screen U48, in the field relating to F4, so as to delay the deactivation of the utilities.
Oppositely, if the most costly band is F1, the set point can be lowered to bring forward the deactivation of the utilities, thus optimising power consumption.

```
+--------------------+
|                 U49|
|Ligth sensor        |
|Setp. (1-100)   000%|
|                    |
+--------------------+
```

→ Screen not available in the Small version, as the light sensor

This screen, enabled when the type of twilight switch used is set to 4 to 20mA, screen I32, is used to set the twilight set point (1-100%), which represents the threshold to be exceeded, in terms of light intensity, to deny the enabling signal to the light-related loads (see screens I1, I3, ...).

```
+--------------------+
|3 Way valve Set  U50|
|Fully open          |
|Low. Temp. 000.0 °C |
|Upp. Temp. 000.0 °C |
+--------------------+
```

→ Screen not available in the Small version, as the analogue output for the 3-way valve is not featured.

As mentioned, Energy² can also manage a 3-way valve, controlling the complete opening or closing of the valve, or proportionally, according to the installation water temperature.
In the latter case, the "Lower" and "Higher" temperature of the ramp need to be set. Obviously, the lower temperature must be less than the higher temperature.

```
+--------------------+
|                 U51|
| Internal Temp. Set |
|      00.0 °C       |
|                    |
+--------------------+
```

Screen for setting the internal temperature set point.
For further details on screens U50 and U51 see the chapter "The Program", paragraph "Management of the 3-way valve".

```
+--------------------+
|                 U52|
|Setpoint override   |
|Band       0.0 °C   |
|Offset     0.0 °C   |
+--------------------+
```

Screen for setting the compensation band and offset.
For further details, see the chapter "The Program" under the paragraph "Temperature set point compensation".

```
+--------------------+
|                 U53|
|Duty cycling set    |
|Cycle Time   000 min|
|                    |
+--------------------+
```

This screen is used to set the cycle time for the duty cycling function.

```
+--------------------+
|                 U54|
|Duty cycling set    |
|Min off time  000min|
|Max off time  000min|
+--------------------+
```

This screen is used to set the minimum off time and the maximum off time inside the duty cycling interval.

```
+--------------------+
|Duty cycling set U55|
|Winter temp.        |
|Min     00.0  °C    |
|Max     00.0  °C    |
+--------------------+
```

This screen establishes the minimum and maximum temperature for the duty cycling function in heating.

```
+--------------------+
|Duty cycling set U56|
|Summer temp.        |
|Min     00.0  °C    |
|Max     00.0  °C    |
+--------------------+
```

This screen establishes the minimum and maximum temperature for the duty cycling function in cooling.
For further information on screens U53, U54, U55 and U56 see the chapter "The Program", "Duty cycling" paragraph.

8.4.4 Communication setting loop

```
+--------------------+
|Protocol:CAREL   U57|
|Comm. speed:        |
|1200 (RS485/RS422)  |
|Ident.:          000|
+--------------------+
```

If Energy² is connected to a supervisory system, a number of parameters need to be set for correct communication. These are the transmission protocol (CAREL, Modem or Modbus), the communication speed and the ID (address) of the controller.

```
+--------------------+
|                 U59|
|Change user         |
|password            |
|             0000   |
+--------------------+
```

As in the other levels, the password can be changed.

8.5 Language

The last field in the SETTINGS menu is used to set the language. The possible options are English and Italian.

```
+--------------------+
|                  L1|
|      Language      |
|      ENGLISH       |
|                    |
+--------------------+
```

9. ON/OFF TIME BAND MANAGEMENT

The management of the time bands provides the on or off enabling signal to the various loads according to the clock built into the controller. For each day of the week, the user can set different types of time bands, specifying for each of these the on and off hours and minutes.
There are 2 groups of time bands: standard and special.

9.1 Standard bands

As regards the standard bands, there is the possibility to choose between four bands, three daily and one weekly.
For both types, the application uses two "daily sub-bands"; if the load is inside the time interval determined by the sub-bands, the time band enabling signal is sent. The use of both sub-bands is at the user's discretion; if only one sub-band is required, the second can be left at the default values, typically 00 for all the fields.

Sel.	TYPE OF BAND	DESCRIPTION
0	OFF	Utility always off
1	Band 1	Users can, at their own discretion, set two time daily bands, specifying the on and off times in hours and minutes.
2	Band 2	Users can, at their own discretion, set two time daily bands, specifying the on and off times in hours and minutes. Alternative to band 1.
3	Band 3	Users can, at their own discretion, set two time daily bands specifying the on and off times in hours and minutes. Alternative to bands 1 and 2.
4	Band 4	Activates the utility according to the weekly band.

Table 9.1

9.2 Special bands

TYPE OF BAND	DESCRIPTION
Special band 1	Selecting YES in this field enables the load to be switched off on national holidays.
Special band 2	Selecting YES in this field enables the load to be switched off on the day set on the screen.
Special band 3	Users can, at their own discretion, set two time bands, specifying the on and off times in hours and minutes. The day and month must be specified for this band.
Special band 4	Users can, at their own discretion, set two time bands, specifying the on and off times in hours and minutes. The day and month must be specified for this band.

Table 9.2

Special bands 3 and 4: enabling one of these bands will send the time band enabling signal independently of the standard bands. For bands 2, 3 and 4, the day, month and times are set on the screen.
For special bands 3 and 4, two sub-bands are also available.

In essence, special bands 1 and 2 are forced OFF bands, while the bands 3 and 4 are forced ON bands.
In the case where the standard and special bands coincide, the special band will determine the time band enabling signal. In the case where an OFF and ON special band coincide, the ON band will determine the enabling signal. In any case, the operation of each individual load (if the function is selected) can be extended outside of the time bands, by enabling digital input ID6.

9.3 Optimum start/stop

This function, after a period of "auto-learning", optimises the starts and stops of the air-conditioning installation, while still guaranteeing that the ideal conditions are reached in the established times.
This is in practice a pre-start-up time in the morning, in which the system operates so as to reach the set point, and a pre-shut-down time in the evening, when, after a certain time, the daytime climatic conditions no longer need to be maintained.
This variable time may be less than the standard time set and, by optimising operation, involves considerable energy savings.
To calculate times, which are obviously modifiable based on the climatic conditions and the period, the program considers the following parameters:

- comfort set point (screen U51)
- temperature outside and inside the building (probes B4 / B7 on Energy² Large, probes B3 / B4 on Energy² Small)
- pre-start-up and pre-shut-down times in the three previous days, calculated by the controller.

This function can only be activated only on one output, associated with the management of the air-conditioning installation.

```
+--------------------+
|Optm Start-Stop  I31|
|  enable on load #  |
|       (1-15) 00    |
|       0=no load    |
+--------------------+
```

9.4 Temperature set point compensation

The management of the optimum start-stop function can be further improved by acting on the inside temperature set point, and compensating it based on the outside temperature, with consequent better perception of comfort and energy savings.
For example, imagine a commercial installation with an inside temperature (controlled by the air-conditioning installation) that is 10°C lower than the outside temperature, the temperature difference may disturb the people and affect the level of comfort; in fact, the maximum difference between the inside and outside temperature for optimum comfort should not exceed 6°C.
The compensation function in cooling operation in this case increases the set point by a few degrees, lowering the difference and making the inside climate more pleasant. To perform the compensation function, a temperature probe must be installed outside of the building. The function is managed based on the values of the compensation set point, differential and offset.

```
+--------------------+
|                U51|
| Internal Temp. Set |
|      00.0 °C       |
|                    |
+--------------------+
+--------------------+
|                U52|
|Setpoint override   |
|Band       0.0 °C   |
|Offset     0.0 °C   |
+--------------------+
```

The behaviour of the system is explained in the following graph.

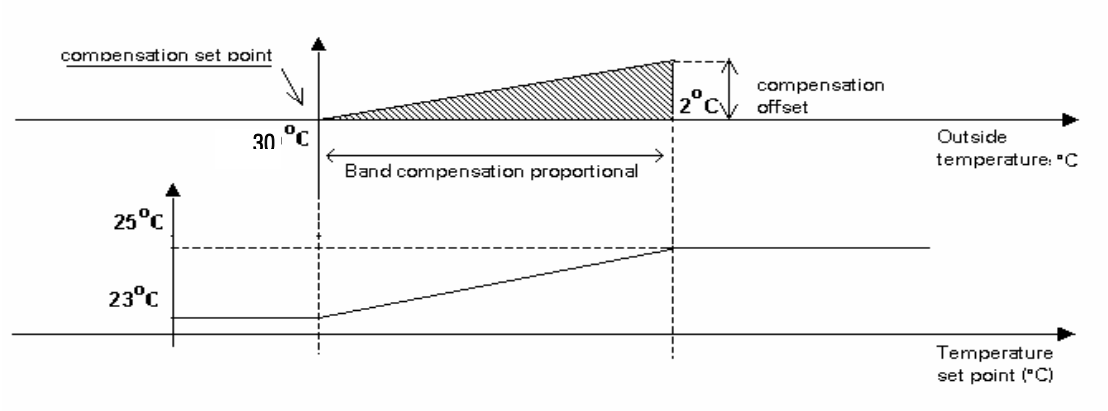


Fig. 9.1

As regards compensation in heating operation, similar observations can be made, with the difference that the compensation value calculated is subtracted from, rather than added to, the set point.

N.B.
The variations in the temperature set point due to the compensation function do not affect the actual set point of the installation, as they are managed by systems external to the Energy². The only effect may involve any optimum start-stop intervals.

9.5 Duty cycling

The duty cycling function disable the devices (heating or cooling) for a time that depends on the outside temperature and a series of parameters set on the screen (duty cycling interval, maximum off time, minimum off time). The function can be summarised by the following example:

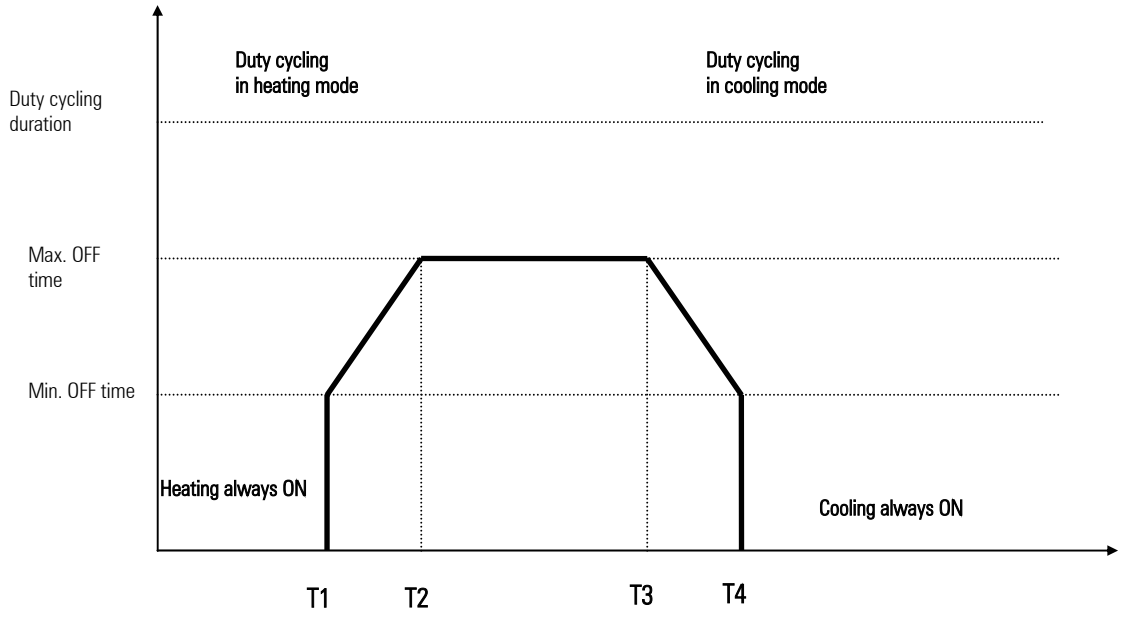


Fig. 9.2

Example:
If we set a duty cycling interval of 30 minutes, a maximum off time of 20 minutes, a minimum off time of 10 minutes and the temperatures T1 = -5°C, T2 = 5°C, T3 = 20°C and T4 = 30°C.
When the temperature is less than T1 (-5°C), the heating units (heaters or hot water coils) are enabled for continuous operation; when the outside temperature is between T1 (-5°C) and T2 (+5°C), the heating units stop every 30 minutes for a time that is proportional to the temperature: 10 minutes at -5°C, 20 minutes at 5°C. For temperatures above T2 (+5°C), the maximum off time is always enabled.
The same is true for cooling. Each load can be associated with the duty cycling function by selecting it on the screens in the "load configuration loop", user branch:

```
+--------------------+
|                U53|
|Duty cycling set    |
|Cycle Time   000 min|
|                    |
+--------------------+
+--------------------+
|                U54|
|Duty cycling set    |
|Min off time  000min|
|Max off time  000min|
+--------------------+
+--------------------+
|Duty cycling set U55|
|Winter temp.        |
|Min     00.0  °C    |
|Max     00.0  °C    |
+--------------------+
+--------------------+
|Duty cycling set U56|
|Summer temp.        |
|Min     00.0  °C    |
|Max     00.0  °C    |
+--------------------+
```

9.6 Management of the 3-way valve

Analogue output 1 is used to control a 3-way valve for air-conditioning, in proportional mode, as can be seen in the following graph.

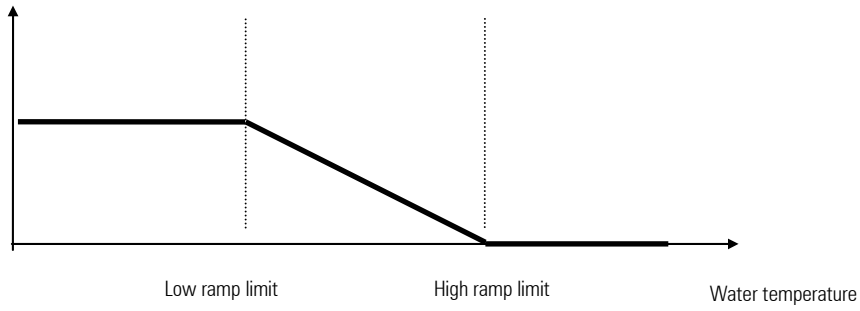


Fig. 9.3

When the water temperature is lower than the lower limit of the ramp, the 3-way valve is fully open, vice-versa, if the temperature is higher than the higher limit of the ramp, then the 3-way valve is completely closed. Between the limits it is controlled proportionally.

```
+--------------------+
|                P18|
| Water Temperature  |
|       00.0°C       |
|                    |
+--------------------+
+--------------------+
|3 Way valve Set  U50|
|Fully open          |
|Low. Temp. 000.0 °C |
|Upp. Temp. 000.0 °C |
+--------------------+
+--------------------+
|                P20|
|  3Way valve        |
|  position  000.0%  |
|                    |
+--------------------+
```

N.B. This function is not available on Energy² Small.

9.7 Twilight management

The load can be managed by an external twilight switch, either on/off or as an analogue sensor with threshold.

```
+--------------------+
|                 I32|
|Light sensor type   |
|on/off              |
|                    |
+--------------------+
+--------------------+
|                 U49|
|Ligth sensor        |
|Setp. (1-100)   000%|
|                    |
+--------------------+
+--------------------+
|                 P19|
|   Light intensity  |
|        000 (0-100) |
|                    |
+--------------------+
+--------------------+
| Load # 1         I1|
|Power   00000kW     |
|Shed No  Priority 00|
|En. Light sens.  Yes|
+--------------------+
```

N.B. This function is not available on Energy² Small.

10. LIST OF ALARMS AND SIGNALS

Pressing the button accesses the alarm loop. If no alarms are present, only one screen will be displayed, containing the message "No alarms" (AL0). If there are active alarms, the or buttons are used to display the alarms present, and pressing the button again mutes the siren.

To reset the alarms, press the button again after having muted the siren. If the causes of the alarm are still present, the system will activate the alarm again, starting the siren and setting digital output 16 to the on status. The following are all the possible alarms available.

Name	Message	Type	Checks
AL0	No alarms		This message appears when no alarm is detected
AL1	CT total power (Analogue in. 1) Out of range 4 to 20 mA	Warning	Check that the calibration of the CT is correct (screen I38 Installer loop) and that the range of the 4 to 20 mA signal is not exceeded
AL2	CT refrig. power (Analogue in. 2) Out of range 4 to 20 mA	Warning	As above but referring to screen I40, Installer loop
AL3	CT air-con power (Analogue in. 3) Out of range 4 to 20 mA	Warning	As above but referring to screen I41, Installer loop
AL4	Ambient temperature probe (Analogue in. 4) Out of range NTC	Warning	Check the wiring
AL5	Water temperature probe (Analogue in. 5) Out of range NTC	Warning	As above
AL6	Light sensor (Analogue in. 6) Out of range 4 to 20 mA	Warning	Check that the wiring is correct and that the signal does not exceed the associated range (4 to 20 mA)
AL7	Inside temp probe (Analogue in. 7) Out of range NTC	Warning	As for AL4
AL8	Clock board broken or missing	Serious	Check the correct connection of the board fitted on Energy².
AL9	Type T flash memory not working	Serious	Switch the unit off for a few seconds, then switch it back on again (Soft Reset). If this doesn't solve the problem, reset the buffer memory from screen I33
AL10	Excess power	Warning	If the instant power momentarily exceeds the maximum limit, no alarm is activated, however if the average of the peaks within the time period is greater than the power limit, then this warning is displayed. A situation may occur whereby the deactivation of the utilities by Energy² is not sufficient to bring the power input value below the maximum limit. At this stage, the electricity company may apply penalties or contractual changes.
AL11	Delayed synchronisation signal	Serious	This alarm is activated when the signal on digital input 5 is not detected by Energy²
AL12	Early synchronisation signal	Serious	When the signal on digital input 5 is detected by Energy² before the end of the time period
AL13	Power input error or DI 3 not connected	Serious	When the power reading is performed in PULSE mode via digital input and has been enabled on screen I50. For this alarm to be generated, the following conditions must occur AT THE SAME TIME: the power input must be zero for more than 10 minutes, that is, no impulses are read in this time the unit must be ON at least one load must be enabled for operation by time band or manually by digital contact

Table 10.1

11. LIST OF SUPERVISOR VARIABLES

Description	Type	Channel	Flow	Variable name
Rate band bit 1	DIG	1	R	ID_TARIFFA1
Rate band bit 2	DIG	2	R	ID_TARIFFA2
Enable operation outside of bands	DIG	3	R	EXT_TIME
Digital light sensor	DIG	4	R	INGRESSO_LUCE
Status of load no. 1 - 15	DIG	5-19	R	D1 – D15
Enable cut load 1 - 15	DIG	21-35	RW	SHED1-SHED15
Enable special band no. 1 on load no. 1 - 15	DIG	36-50	RW	ABILITAFS1C1 - ABILITAFS1C15
Enable special band no. 2 on load no. 1 - 15	DIG	51-65	RW	ABILITAFS2C1 - ABILITAFS2C15
Enable special band no. 3 on load no. 1 - 15	DIG	66-80	RW	ABILITAFS3C1 - ABILITAFS3C15
Enable special band no. 4 on load no. 1 - 15	DIG	81-95	RW	ABILITAFS4C1 - ABILITAFS4C15
Enable outside of time band load no. 1 - 15	DIG	96-110	RW	EXT_TIME1 - EXT_TIME15
Enable with light sensor load no. 1 - 15	DIG	111-125	RW	OVERLS1 - OVERLS15
Enable duty cycle load no. 1 - 15	DIG	126-140	RW	ABDC1 - ABDC15
Reset total energy counter	DIG	142	RW	RESET_TOT_KWH
Reset annual energy counter	DIG	143	RW	RESET_ANNO_KWH
Reset monthly energy counter	DIG	144	RW	RESET_MESE_KWH
Reset refrigeration energy counter	DIG	145	RW	RESET_CONT_REFRI
Reset air-conditioning energy counter	DIG	146	RW	RESET_CONT_CONDI
Type of light sensor	DIG	147	RW	SCELTA_SENSORE_LUCE
Initialise rate bands AV1	DIG	148	RW	INIZIALIZZA
Enable alarm on analogue input no. 1 - 7	DIG	149-155	RW	ABILITALLARME_IA1 - ABILITALLARME_IA7
System ON/OFF	DIG	167	RW	SYSON
Synch. signal	DIG	176	RW	SINCRO_EXT
Rate band from DI	DIG	177	RW	FT_DI
Enable alarm on energy input (D3)	DIG	178	RW	EN_AL_P
Set clock	DIG	179	RW	ch_time
Max. power input current month	ANA	9	R	POTENZA_MESE_MAX1
Max. power input previous month	ANA	10	R	POTENZA_MESE_PREC_MAX1
Max. power input current year	ANA	11	R	POTENZA_ANNO_MAX1
Max. power input previous year	ANA	12	R	POTENZA_ANNO_PREC_MAX1
Total energy consumed	ANA	13	R	THOUSANDWHTOT
Total energy consumed (thousands)	ANA	14	R	MILIONWHTOT
Total energy consumed (millions)	ANA	15	R	BILIONWHTOT
Expected monthly consumption	ANA	22	R	KWH_PREVISTI_MESE
Expected monthly consumption (thousands)	ANA	23	R	MWH_PREVISTI_MESE
Expected monthly consumption (millions)	ANA	24	R	GWH_PREVISTI_MESE
Expected annual consumption	ANA	25	R	KWH_PREVISTI_ANNO
Expected annual consumption (thousands)	ANA	26	R	MWH_PREVISTI_ANNO
Expected annual consumption (millions)	ANA	27	R	GWH_PREVISTI_ANNO
Temperature for complete opening of 3-way valve	ANA	29	RW	T_INF_RAMPA
Temperature for complete closing of 3-way valve	ANA	30	RW	T_SUP_RAMPA
Outside temperature set point	ANA	31	RW	TSETPO
Proportional band for set point compensation	ANA	32	RW	BAN_P_COMP
Set point compensation offset	ANA	33	RW	OFFCP
Energy consumed for refrigeration	ANA	41	R	THOUSANDWHREFRI
Energy consumed for refrigeration (thousands)	ANA	42	R	MILIONWHREFRI
Energy consumed for refrigeration (millions)	ANA	43	R	BILIONWHREFRI
Energy consumed for air-conditioning	ANA	44	R	THOUSANDWHCONDI
Energy consumed for air-conditioning. (thousands)	ANA	45	R	MILIONWHCONDI
Energy consumed for air-conditioning (millions)	ANA	46	R	BILIONWHCONDI
Min temperature heating duty cycle	ANA	50	RW	TDC1
Max temperature heating duty cycle	ANA	51	RW	TDC2
Min temperature cooling duty cycle	ANA	52	RW	TDC3
Max temperature cooling duty cycle	ANA	53	RW	TDC4
Outside temperature probe offset	ANA	54	RW	OFFSET_NTC4

Water temperature probe offset	ANA	55	RW	OFFSET_NTC5
Inside temperature probe offset	ANA	56	RW	OFFSET_NTC7
Total average power consumed	ANA	57	R	POTENZA_GLB
Average air-conditioning power	ANA	58	R	POTENZA_CONDI
Average refrigeration power	ANA	59	R	POTENZA_REFRI
Outside temperature	ANA	63	R	TEMP_AMB
Water temperature	ANA	64	R	TEMP_ACQ
Twilight sensor 4-20mA	ANA	65	R	CREPUSCOLARE4_20MA
Inside temperature	ANA	66	R	TEMP_INT
3-way valve position	ANA	67	R	V3VIE
Power input	ANA	69	R	ACT_POWER
Power limit	ANA	70	R	POTENZA_MAX3
Refrigeration power input	ANA	74	R	CONS_IST_REFRI
Air-conditioning power input	ANA	75	R	CONS_IST_CONDI
Rated power load 1 - 15	INT	1-15	RW	LOAD1 - LOAD15
Priority load no. 1-15	INT	16-30	RW	PRIORITAC1 - PRIORITAC15
Min OFF time load no. 1 - 15	INT	31-45	RW	TEMPO_MIN_OFF1 - TEMPO_MIN_OFF15
Max OFF time load no. 1 - 15	INT	46-60	RW	TEMPO_MAX_OFF1 - TEMPO_MAX_OFF15
Min ON time load no. 1 - 15	INT	61-75	RW	TEMPO_MIN_ON1 - TEMPO_MIN_ON15
Enable standard band for load no. 1-15	INT	76-90	RW	SCELTAFASCIAC1 - SCELTAFASCIAC15
Max. installation power	INT	91	RW	POTENZA_MAX
CT total input for 4 mA signal	INT	92	RW	POTENZA_4MA
CT total input for 20 mA signal	INT	93	RW	POTENZA_20MA
Power limit for F1	INT	95	RW	POTENZA_P
Power limit for F2	INT	96	RW	POTENZA_A
Power limit for F3 hours	INT	97	RW	POTENZA_M
Power limit for F4	INT	98	RW	POTENZA_V
Analogue light sensor (4 to 20mA) set point	INT	99	RW	SET_SENSORE_LUCE_4_20MA
Load enabled for optimum start-stop function	INT	100	RW	OPTIMUMSS
Refrigeration installation power	INT	101	RW	POTENZA_REFRI_MAX
Air-conditioning installation power	INT	102	RW	POTENZA_CONDI_MAX
CT refrigeration input for 4 mA signal	INT	103	RW	POTENZA_REFRI_4MA
CT refrigeration input for 20 mA signal	INT	104	RW	POTENZA_REFRI_20MA
CT air-conditioning input for 4 mA signal	INT	105	RW	POTENZA_CONDI_4MA
CT air-conditioning input for 20 mA signal	INT	106	RW	POTENZA_CONDI_20MA
Duration of the duty cycle	INT	107	RW	TIDC
Min duty cycle OFF Time	INT	108	RW	TSMIDC
Max duty cycle OFF Time	INT	109	RW	TSMDC
Refresh power	INT	112	RW	REFRESH_POTENZA
Set hours and min	INT	113	RW	OREMIN_ORARIO_ENERGY_CH
Set day and month	INT	114	RW	DAYMONTH_ENERGY_CH
Set YEAR	INT	115	RW	LYEAR
Set DAY OF THE WEEK (1= Sun;… 7= Sat)	INT	116	RW	LWEEKDAY
Time interval for consumption calculation (0= 15; 1= 30; 2= 45; 3= 60 min)	INT	117	RW	INT_INTEG
Weight of the impulse	INT	118	RW	PESO_IMPULSO
Type of power input (0= impulses; 1= analogue)	INT	119	RW	I_ENERGIA
Hours and min	INT	120	R	ORARIO_ENERGY
Month and day	INT	121	R	DAYMONTH_ENERGY
YEAR	INT	122	R	PYEAR
Day of the week (1= Sun;… 7= Sat)	INT	123	R	WEEKDAY
Not connected	ALR	0	R	OFFLINE
System alarm	ALR	20	R	ALL
Error on analogue input no. 1 - 7	ALR	156-162	R	MAL_IA1 - MAL_IA7
Power threshold exceeded	ALR	163	R	MAL_ESUBEROPOT
Clock error on board	ALR	164	R	MAL_CLK
Flash memory error	ALR	165	R	MAL_MEMFLASH
Overall alarm	ALR	166	R	MAN_GLB_AL
Delayed synchronicity signal	ALR	173	R	MAL_RIT_SINCRO

Early synchronicity signal	ALR	174	R	MAL_ANT_SINCRO
Input D3 fault or disconnected	ALR	175	R	MAL_POT_NULLA
Daily time band 1 ON hours and min AM	ANA	76	RW	OREMIN_ON_1A
Daily time band 1 ON hours and min PM	ANA	77	RW	OREMIN_ON_1B
Daily time band 2 ON hours and min AM	ANA	78	RW	OREMIN_ON_2A
Daily time band 2 ON hours and min PM	ANA	79	RW	OREMIN_ON_2B
Daily time band 3 ON hours and min AM	ANA	80	RW	OREMIN_ON_3A
Daily time band 3 ON hours and min PM	ANA	81	RW	OREMIN_ON_3B
Daily time band 1 OFF hours and min AM	ANA	82	RW	OREMIN_OFF_1A
Daily time band 1 OFF hours and min PM	ANA	83	RW	OREMIN_OFF_1B
Daily time band 2 OFF hours and min AM	ANA	84	RW	OREMIN_OFF_2A
Daily time band 2 OFF hours and min PM	ANA	85	RW	OREMIN_OFF_2B
Daily time band 3 OFF hours and min AM	ANA	86	RW	OREMIN_OFF_3A
Daily time band 3 OFF hours and min PM	ANA	87	RW	OREMIN_OFF_3B
Weekly time band 7 ON hours and min AM	ANA	88	RW	OREMIN_ON_WA7
Weekly time band 1 ON hours and min AM	ANA	89	RW	OREMIN_ON_WA1
Weekly time band 2 ON hours and min AM	ANA	90	RW	OREMIN_ON_WA2
Weekly time band 3 ON hours and min AM	ANA	91	RW	OREMIN_ON_WA3
Weekly time band 4 ON hours and min AM	ANA	92	RW	OREMIN_ON_WA4
Weekly time band 5 ON hours and min AM	ANA	93	RW	OREMIN_ON_WA5
Weekly time band 6 ON hours and min AM	ANA	94	RW	OREMIN_ON_WA6
Weekly time band 7 OFF hours and min AM	ANA	95	RW	OREMIN_OFF_WA7
Weekly time band 1 OFF hours and min AM	ANA	96	RW	OREMIN_OFF_WA1
Weekly time band 2 OFF hours and min AM	ANA	97	RW	OREMIN_OFF_WA2
Weekly time band 3 OFF hours and min AM	ANA	98	RW	OREMIN_OFF_WA3
Weekly time band 4 OFF hours and min AM	ANA	99	RW	OREMIN_OFF_WA4
Weekly time band 5 OFF hours and min AM	ANA	100	RW	OREMIN_OFF_WA5
Weekly time band 6 OFF hours and min AM	ANA	101	RW	OREMIN_OFF_WA6
Weekly time band 7 ON hours and min PM	ANA	102	RW	OREMIN_ON_WB7
Weekly time band 1 ON hours and min PM	ANA	103	RW	OREMIN_ON_WB1
Weekly time band 2 ON hours and min PM	ANA	104	RW	OREMIN_ON_WB2
Weekly time band 3 ON hours and min PM	ANA	105	RW	OREMIN_ON_WB3
Weekly time band 4 ON hours and min PM	ANA	106	RW	OREMIN_ON_WB4
Weekly time band 5 ON hours and min PM	ANA	107	RW	OREMIN_ON_WB5
Weekly time band 6 ON hours and min PM	ANA	108	RW	OREMIN_ON_WB6
Weekly time band 7 OFF hours and min PM	ANA	109	RW	OREMIN_OFF_WB7
Weekly time band 1 OFF hours and min PM	ANA	110	RW	OREMIN_OFF_WB1
Weekly time band 2 OFF hours and min PM	ANA	111	RW	OREMIN_OFF_WB2
Weekly time band 3 OFF hours and min PM	ANA	112	RW	OREMIN_OFF_WB3
Weekly time band 4 OFF hours and min PM	ANA	113	RW	OREMIN_OFF_WB4
Weekly time band 5 OFF hours and min PM	ANA	114	RW	OREMIN_OFF_WB5
Weekly time band 6 OFF hours and min PM	ANA	115	RW	OREMIN_OFF_WB6
Special time band 2 Day and month	ANA	116	RW	DAYMONTHSP2
Special time band 3 Day and month	ANA	117	RW	DAYMONTHSP3
Special time band 4 Day and month	ANA	118	RW	DAYMONTHSP4
Special time band 3 ON hours and min AM	ANA	119	RW	OREMIN_ON_AS3
Special time band 3 ON hours and min PM	ANA	120	RW	OREMIN_ON_BS3
Special time band 3 OFF hours and min AM	ANA	121	RW	OREMIN_OFF_AS3
Special time band 3 OFF hours and min PM	ANA	122	RW	OREMIN_OFF_BS3
Special time band 4 ON hours and min AM	ANA	123	RW	OREMIN_ON_AS4
Special time band 4 ON hours and min PM	ANA	124	RW	OREMIN_ON_BS4
Special time band 4 OFF hours and min AM	ANA	125	RW	OREMIN_OFF_AS4
Special time band 4 OFF hours and min PM	ANA	126	RW	OREMIN_OFF_BS4

Table 10.1

12. WIRING DIAGRAMS

12.1 Large

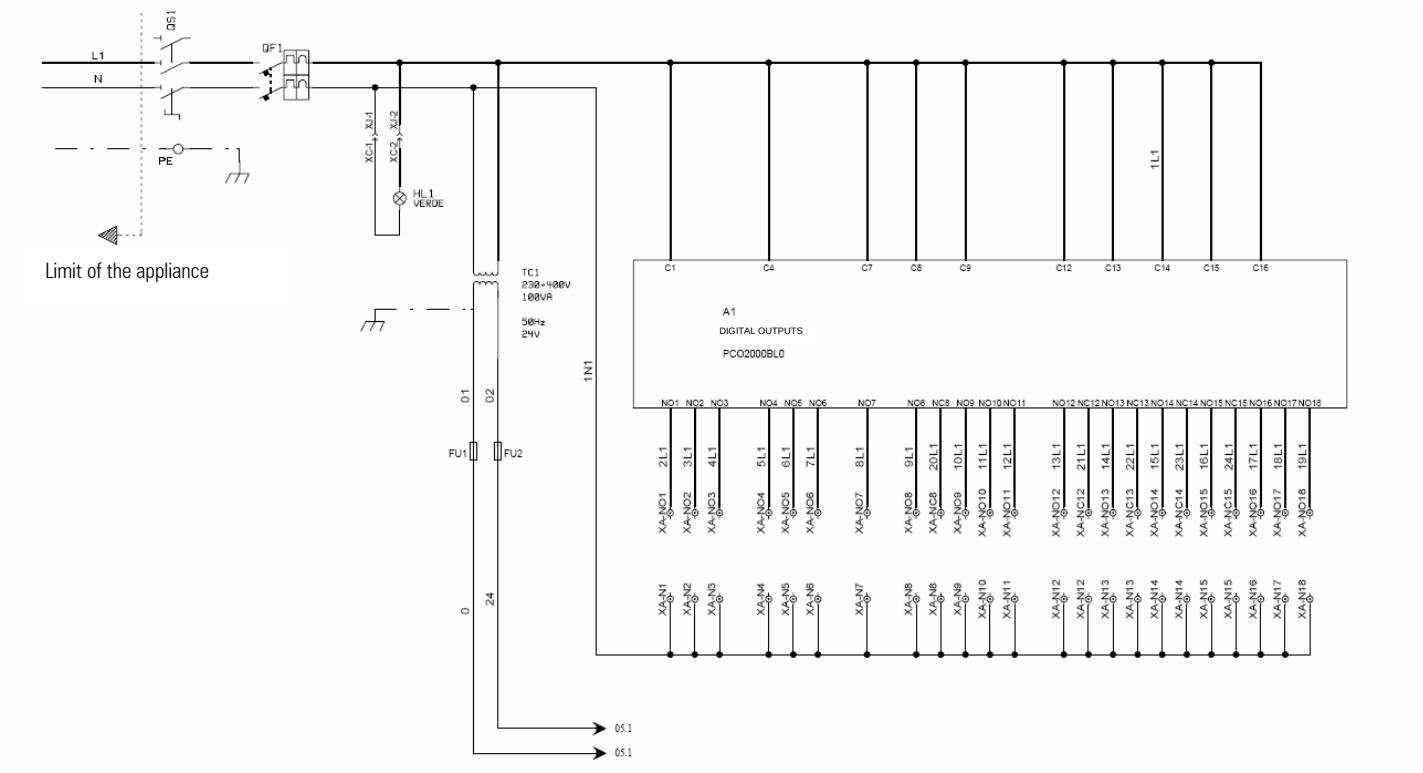


Fig. 12.1

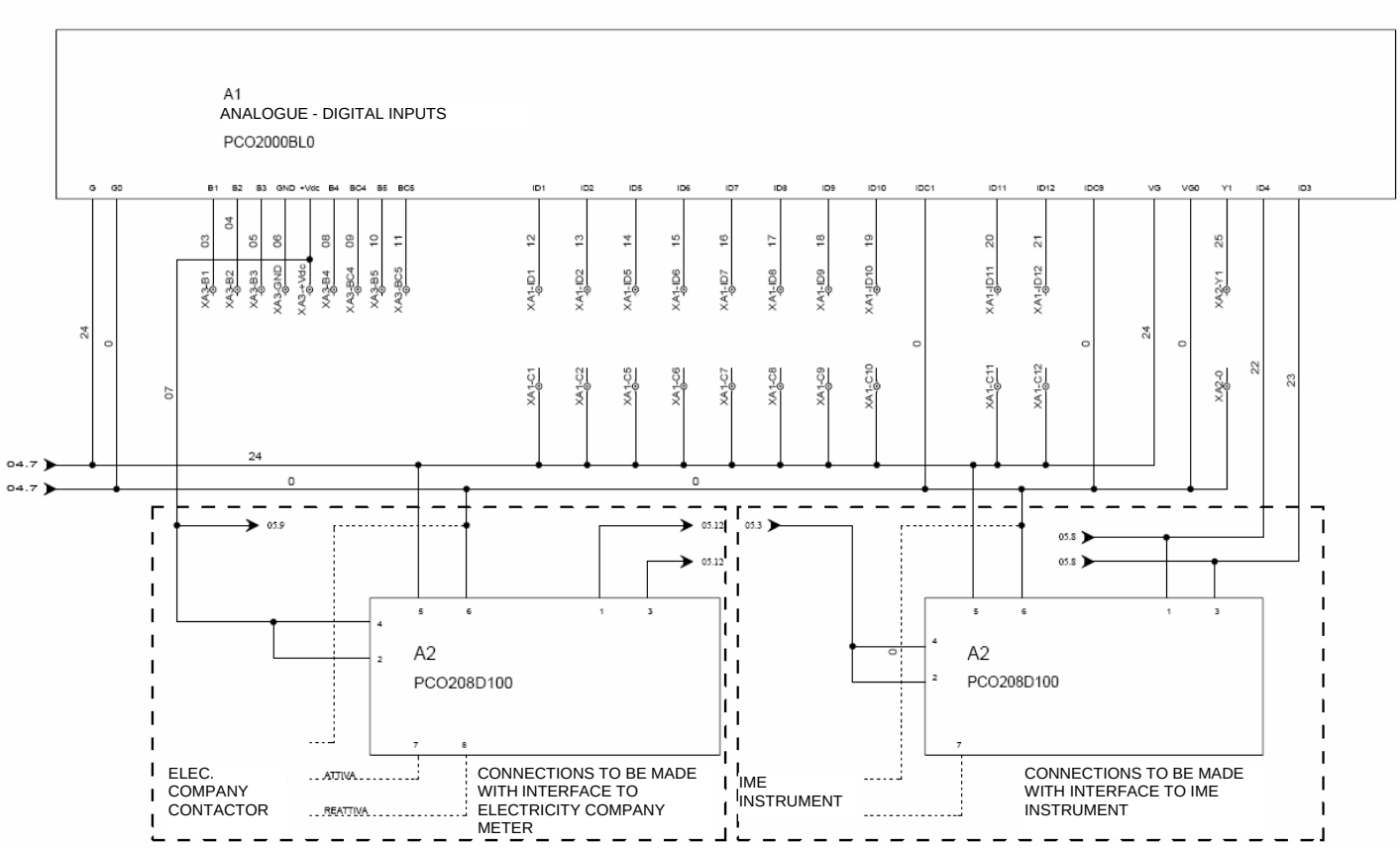


Fig. 12.2

12.2 Small

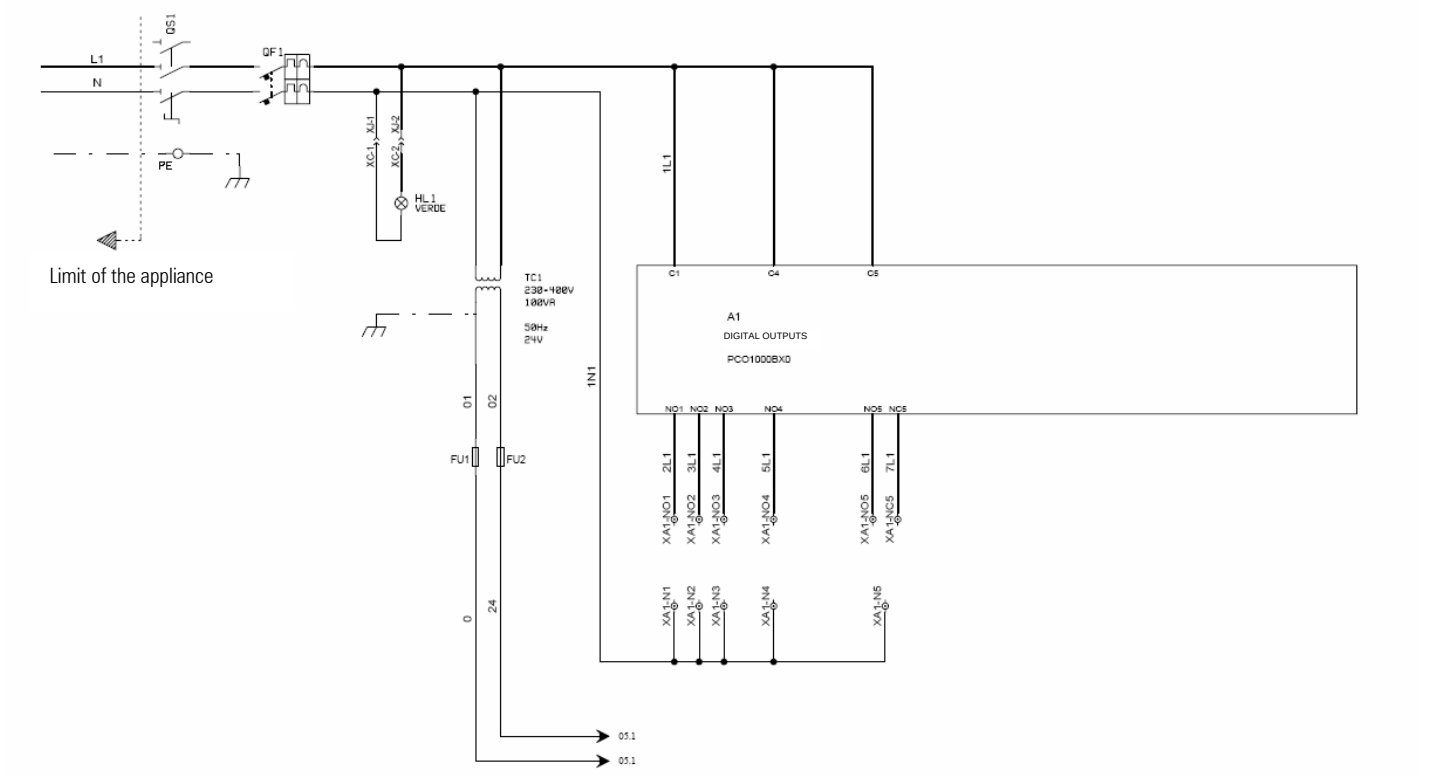


Fig. 12.3

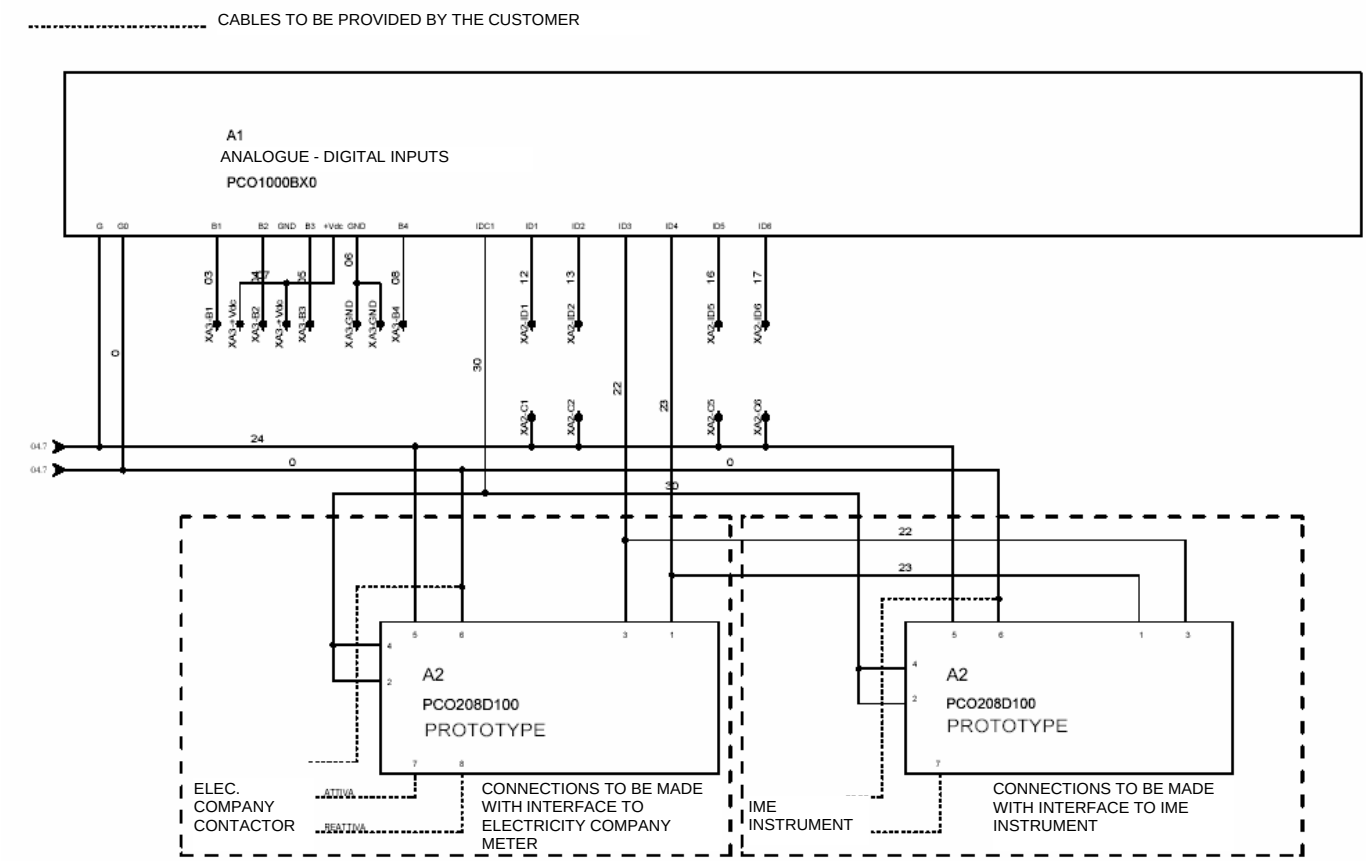


Fig. 12.4

13. TECHNICAL SPECIFICATIONS

power supply	1P + N + G 230Vac (+/- 10%) 50 Hz.
index of protection	IP40 front panel only, IP65 with door closed
storage conditions	• -20T70 °C • 20 to 80 %RH non-condensing
operating conditions	• -10T50 °C • 20 to 80 %RH non-condensing
environmental pollution	normal
power supply connection	direct to the switch
auxiliary connection	2.5 mm^2 terminals
colour	grey RAL 7035- smoked glass door
insulation	double
door guaranteed for life with opening > 180°	
environmental pollution	normal
class according to protection against electric shock	to be integrated into class I and/or II appliances
PTI of the insulating materials	250 V
period of stress across the insulating parts	Long
type of action of the device	1C
type of disconnection or microswitching	microswitching
category of resistance to heat and fire	category D (UL94-V0)
immunity against voltage surges	category 1
number of automatic operating cycles (e.g.: relays)	100 000
software class and structure	Class A
power supply to the electronic controller	22 to 40 Vdc and 24 Vac ± 15% 50/60 Hz. Maximum power input: 20 W
terminal block	Maximum voltage 250 Vac
CPU	H83002, 16 bit, 14 MHz
program memory (on FLASH MEMORY)	1 Mbyte at 16 bit (expandable up to 6 Mbyte)
data memory (static RAM)	256 KByte at 16 bit (expandable up to 1 MB)
parameter data memory	2 KByte at 16 bit (maximum limit: 400,000 writes per memory location)

NOTES:

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