



Inverters for photovoltaic applications

TGS2 TELE GLOBAL SERVICE INSTRUCTION MANUAL

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1 INTRODUCTION

The Tele Global Service system for solar power plants, known as TGS2, is a service offered by SIAC to allow automatic monitoring of Photovoltaic Plant status.

The system is based on a computer service which SIAC offers its customers, making it possible to control plants, provide prompt service, and furnish reports on the quality of the plants themselves.

The TGS2 system offered by SIAC has certain hardware requirements for insertion in the plant to be monitored, and has a predefined mode of connection between the various devices present in the plant itself that the system can monitor.

Once the necessary hardware is installed, the TGS offers a range of services:

1. It allows automatic collection of the plant data at 5 minute intervals
2. It analyses the data acquired and assesses whether there are alarm situations requiring signalling to the technical staff in charge of this function
3. It offers the customer a user-friendly interface, consisting of a self-installing Java-type Client application. All that is required for access is an internet connection with a link to the actual application.
4. In addition, the system makes it possible to send mails with daily reports of all the alarms that may have occurred and a weekly report containing an evaluation of the Energy produced for each site and for each individual Inverter for the period in question.

In order to perform the operations listed, the Photovoltaic Plant is divided logically into subsections.

The devices analysed and monitored are: SIAC SOLEIL Solar Inverters, both old and new generation (SOLEIL DSP) and parallel boxes with CSP-12 string control.

2 TGS2 SUPERVISION ARCHITECTURE

From the logic viewpoint, supervision is based on hierarchical subdivision, where objects of equal complexity are grouped together to constitute an object of superior complexity. This option is suggested by the topological organisation of the plant itself.

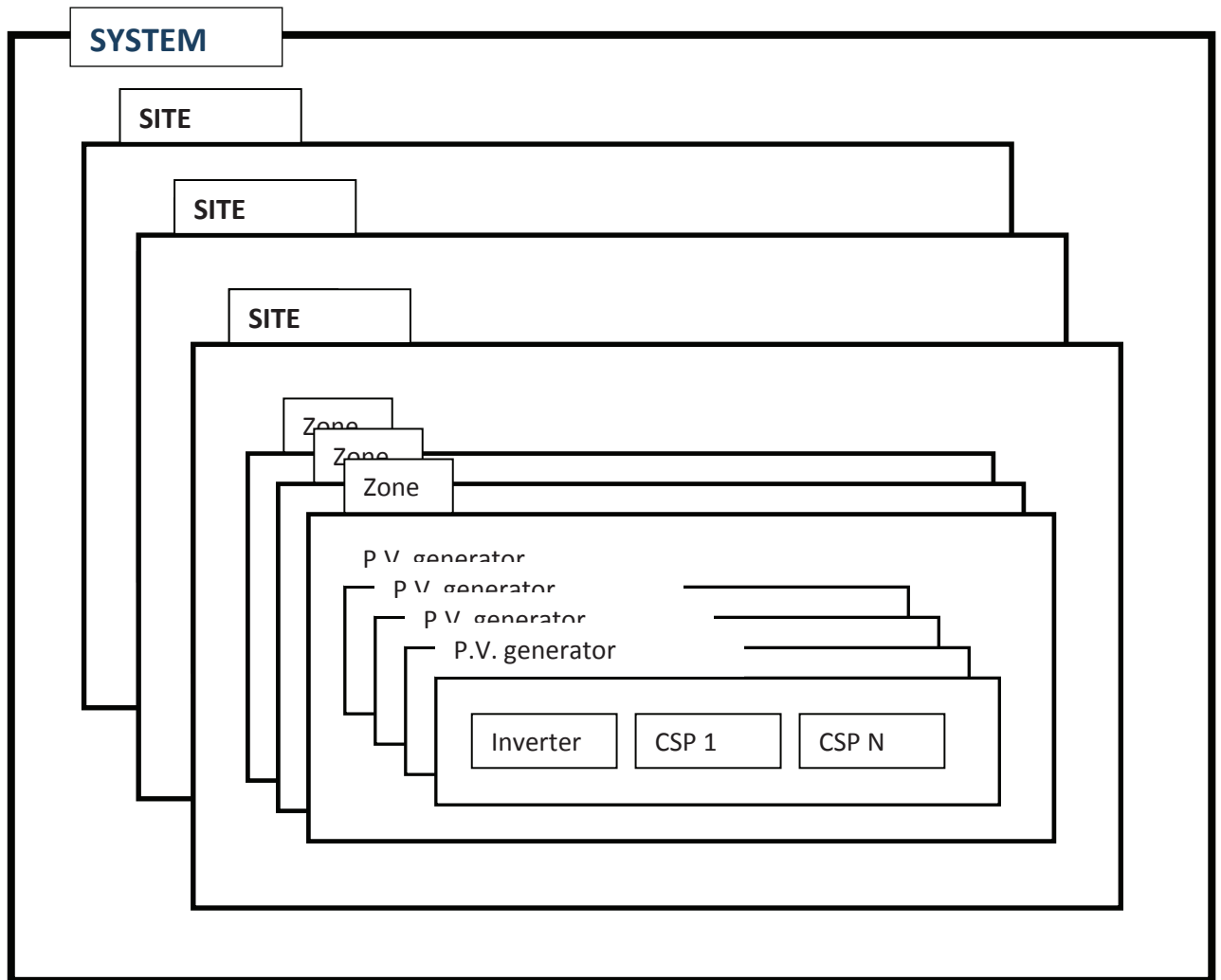
Starting from the “atomic” object, the hierarchies are subdivided in the following way:

Level	Object	Note
0	Inverter	These are the “atomic” objects
	Parallel box	
1	P.V. generator	This is the grouping of: <ul style="list-style-type: none"> • 1 inverter • N parallel boxes • one or more concentrators
2	Zone	This is the grouping of: <ul style="list-style-type: none"> • several “P.V. generators”
3	Site	This is the grouping of several “zones”
4	System	This is the grouping of several “sites”

Notes:

1. As may be deduced from the table, the **P.V. generator** (Photovoltaic Generator) is composed of an Inverter and the parallel boxes relating to the Inverter itself, indicated by the number **N**.
2. A **concentrator** is an auxiliary device that can be internal (in the SOLEIL DSP inverters) or external (in the old generation SOLEIL Inverters, or when there are more than 8 parallel boxes) and is used to collect data from the parallel boxes and make it available in the Modbus protocol, just as the Inverters themselves. Each concentrator can manage up to a maximum of 8 Parallel Boxes.
3. A **Zone** is a Logic-Physical grouping with up to 8 P.V. Generators.
4. A **Site** is a collection of several Zones (or even one only)
5. A **System** is a collection of sites belonging to the same group or client or director.

From the graphic viewpoint:



3 SYSTEM REQUIREMENTS

To be able to install the TGS2 system at your plant, it is essential to have certain Hardware requirements at hand and make certain cabling arrangements between the various devices.

3.1 Necessary hardware

To be able to enable the TGS2 system, it is essential to have a Modem provided by SIAC and RS485/Ethernet Gateways installed in a rack.

3.1.1 Modem

The modem is a TIESSE IMOLA 2220 model, and is supplied by SIAC



This modem makes it possible to offer numerous services.

Specifically, the GPRS connection to the data network is optimised with regard to transmission quality and traffic cost, thanks to the transmission of control messages and the use of inactivity timers and external antennas to improve signal quality.

Main characteristics:

- Ethernet: 5 10/100 Mbps RJ45 ports
- GPRS/GSM connection: dual band EGSM 900 and GSM 800
 - Max. upload speed: 21.4Kbps

- Max. download speed: 85.6Kbps
- ADSL connection: Full rate ADSL and ADSL2/2+ RJ11 port
- ADSL: upload speed up to 1Mbps, download up to 8Mbps
- ADSL2/2+: upload speed up to 3.5 Mbps, download up to 24Mbps
- ADSL encapsulation: RFC 2684, RFC2384, RFC2516
- Supports the SNMP protocol
- Services: telnet server, SSH server
- Dimensions: 270x192x46 mm
- Power supply: 240 V AC (internal power supply unit)

The modem is factory preset by SIAC prior to installation in the field.

It is configured to be always connected to the GPRS or ADSL networks (whichever is available) and thus allows constant access through an external application, which is the core of the service itself.

By default, a GPRS connection is configured by means of an internal SIM card.

The SIM should be from the operator TIM, for ITALY. In general, it should be from an operator offering a GPRS service through a public APN that can be reached from any point on the internet network and with good signal coverage.

Inside the modem, there is also a router with two Ethernet ports: one service port, eth0, and another port, eth1, with a built-in switch offering 5 inputs.

The router is programmed to divert the messages arriving over certain ports via GPRS to other IPs and over other ports via eth1.

The TCP ports used are from 49200 onwards, which are ports that are unused in any other communication standard (http, TCP, FTP, etc.).

In the case where signal strength is insufficient, SIAC can provide an auxiliary antenna to replace the default modem antenna.



The antenna offers an omnidirectional gain of 5.1 dB in the 900 to 1800 Hz frequency range.

3.1.2 Ethernet/Modbus Gateway

Ethernet/Modbus gateways are used to transfer the remote Modbus TCP signal to Modbus RTU over the RS485 bus.

SIAC offers two models of Gateway which are interchangeable except for the power supply.

One model is the ADAM 4572



And the other is the Datexel DAT3580-MBTCP



Both models are tested and configured by SIAC.

The aforementioned devices are programmed to have a predefined IP address, which varies depending on the **Zone** that should be monitored.

3.1.3 Inverter

The Zones are composed of PV generators, which are in turn composed of an Inverter, which can be a SOLEIL or SOLEIL DSP model (as in the examples in Figure 1 and Figure 2).



Figure 1 SOLEIL DSP Inverter



Figure 2 SOLEIL Inverter

3.1.4 CSP-12

Each Inverter has one or more **CSP-12** units connected.



The TGS2 can manage up to 16 CSP-12 units for each PV Generator.

3.1.5 Concentrator

The **concentrator** (or the assembly of concentrators) is a card controlling the N CSP-12 units belonging to the same PV Generator.

Each **SOLEIL DSP** inverter has an onboard concentrator, making it possible to manage up to 8 CSPs. In the case where the number of CSPs is greater than 8, it is necessary to add additional external auxiliary concentrators (one for every 8 CSPs associated with the inverter).



Figure 3 Concentrator

3.1.6 Carlo Gavazzi UTF Meter

As an optional extra, the TGS2 can monitor a Carlo Gavazzi UTF meter.

The meters that can be monitored are those belonging to the **EM24** and **EM26** families.

From each meter, the following data can be read:

Total energy input to the grid;

Total energy drawn from the grid;

Reactive energy input to the grid.

In addition, the system performs an evaluation of the Energy Input to the Grid over the course of the previous month (e.g.: if the current month is April, data is reported for the Energy Input to the Grid for the previous March).

It is possible to include a Meter for each Zone. The meter may be the following:



Figure 4. UTF meter

3.1.7 Weather Station

As an optional extra, the TGS2 can monitor an external Weather Control Unit in order to measure the environmental parameters relating to: Irradiation, Ambient temperature, Cell temperature and Wind speed.

The Weather Control Unit is supplied with an IP65 box. The Box has a terminal block for connecting the power supply and the sensors required. Data is accessed using an RS485 type connection. The cabling passes out of the box through appropriate cable glands.

The following Sensors are present for measuring environmental parameters:

- 1) **CELLSOL 200** Solar cell for estimating solar irradiation.
- 2) **TEMPSOL1000** Self-adhesive 2 wire PT1000 Probe for measuring the temperature of the photovoltaic panels
- 3) **IKE20001K** 2-wire PT1000 probe for measuring the ambient temperature
- 4) **DWSVDBC05** Anemometer with AISI303 stainless steel rotor and PVC body for measuring wind speed.

3.1.8 Auxiliary Contacts Device

As an optional extra, the TGS2 can Integrate an **Auxiliary Contacts Device**.

This device makes it possible to monitor up to 4 Digital Contacts, one of which should always be linked to Medium Voltage Switch status.

The others are generally indicated as **Auxiliary contact 1**, **Auxiliary contact 2** and **Auxiliary contact 3**.

Each contact is associated with an event.

Each contact is NO (Normally Open) hence, the alarm condition corresponds to the Contact Closed.

3.2 Physical connections

To allow the TGS to operate correctly, it is essential the cabling between the various devices to be monitored is laid out correctly. In addition, it is essential to comply with several design rules when analysing the site to be monitored.

For the MODBUS connection, use a screened, twisted pair EIA-RS485 cable with typical impedance of 120 Ohm (e.g. **Belden P/N 9841**).

No more than two cables should ever be connected to the terminal blocks of each device, but connections should be made as a long chain of devices.

The plant to be monitored is divided into Zones, each of which can monitor up to a maximum of 8 **PV Generators**.

Each **PV Generator** consists of an Inverter and up to 16 monitorable CSP-12 units.

The **CSP-12** units can be monitored by means of a device known as a concentrator, mentioned in chapter 2 and described in section 0.

3.2.1 RS485 connections between the CSP-12 and the Inverter or concentrator terminal block

Each concentrator device has its related boxes connected in accordance with the following outline:

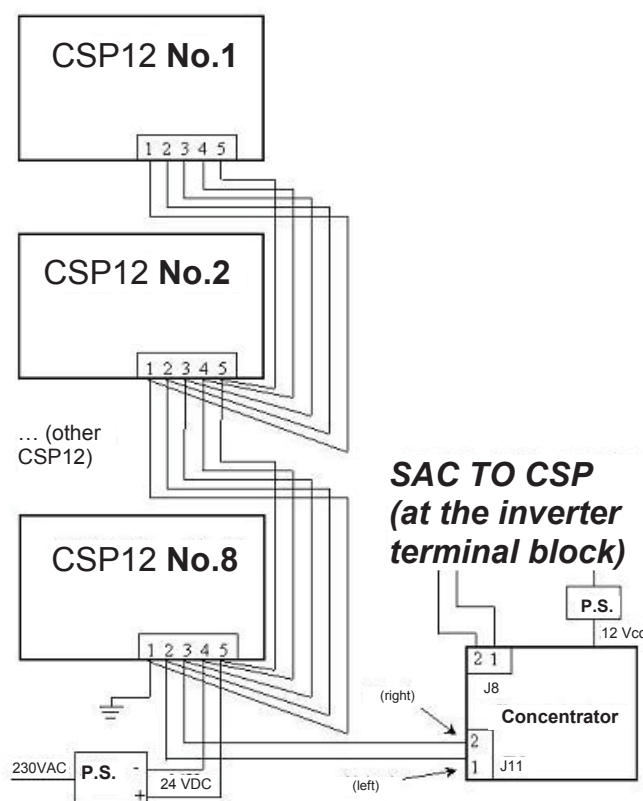


Figure 5 CSP-12 – Concentrator connections

3.2.1.1 Connections between the CSP-12 units and the SOLEIL Inverter terminal block

The outline shown in Figure 3 and in Figure 5 is used for the SOLEIL inverters, which only have external Concentrators.

The connections between the external concentrator and the related CSP units are shown below:

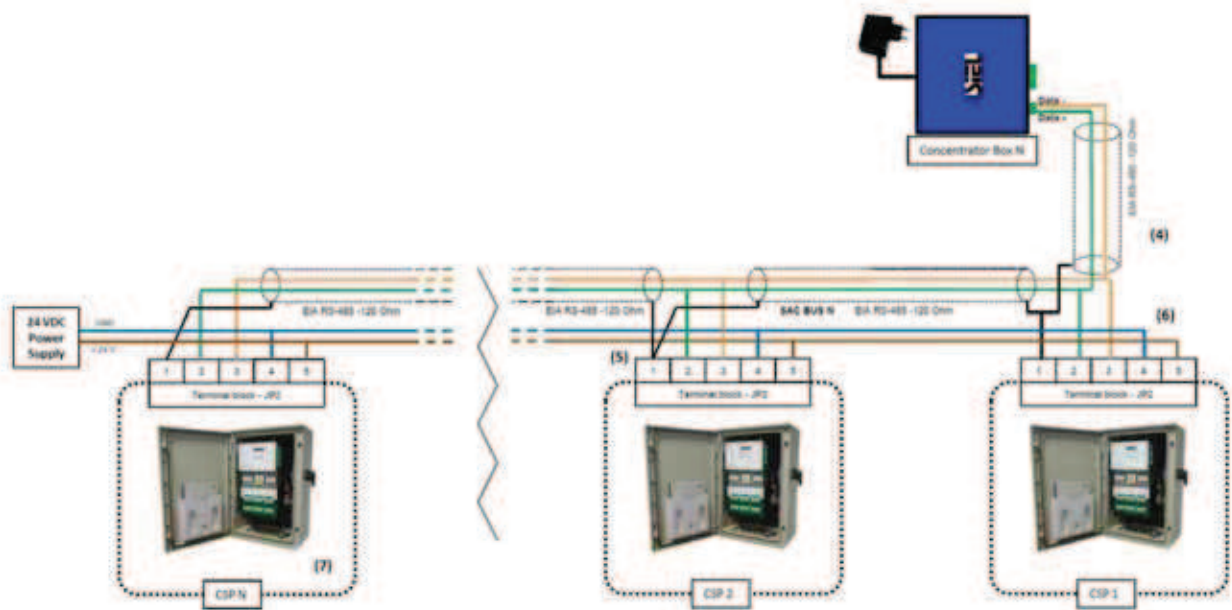


Figure 6 Diagram of the connections between the CSP12 units and the external concentrator

It is necessary to bear in mind that:

- the RS485 CSP BUS, namely the bus that starts at CSP 1 and terminates at the concentrator, passing through all the CSP units present (up to 8), should have a cable length of no greater than 1000 m. Should it be necessary to exceed this length, it will be necessary to divide the CSPs over several concentrators.
- External concentrators are powered using a 230 VAC/12 VDC power supply (provided) and thus require access to a 230 VAC outlet (one power outlet for each concentrator).
- The CSP units should be powered using a 230 VAC/24 VDC power supply (not provided). The maximum power consumption for each CSP unit is 70 mA, hence, the power supply should be scaled according to the number of CSP units to be powered from the same device.

3.2.1.2 Connections between the CSP-12 units and the SOLEIL DSP Inverter terminal block

The layout shown in Figure 3 becomes that shown in Figure 6 for SOLEIL DSP connections, where the internal device is used, this is connected to terminals 25 (Data +) and 26 (Data -) on the terminal block, while the cable screening is connected to terminal 29.

An example of the connections when there are more than 8 CSP-12 units on the same inverter is:

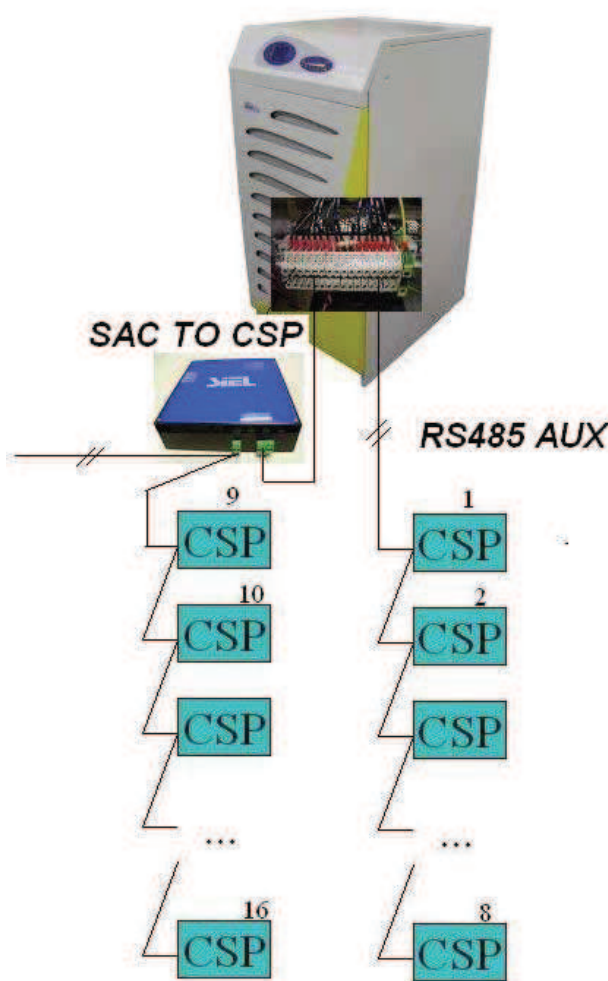


Figure 7 Connections between the CSPs and the internal and external concentrators

It is essential to remember that that:

- the RS485 CSP BUS, namely the bus that starts at CSP 1 and terminates at the concentrator, passing through all the CSP units present (up to 8), should have a cable length of no greater than 1000 m. Should it be necessary to exceed this length, it will be necessary to divide the CSPs over several concentrators.
- External concentrators are powered using a 230 VAC/12 VDC power supply (provided) and thus require access to a 230 VAC outlet (one power outlet for each concentrator).
- The CSP units should be powered using a 230 VAC/24 VDC power supply (not provided). The maximum power consumption for each CSP unit is 70 mA, hence, the power supply should be scaled according to the number of CSP units to be powered from the same device. In the 35 terminal layout, the power supply cables are taken from terminals 34 and 35, as in Figure 13.

3.2.2 Physical RS485 connections between concentrator and Inverter devices

Each zone is characterised by a **Modbus Local Network** using RS485s terminating on a Modbus Ethernet Gateway described in section 3.1.2.

Each Gateway has its own IP address. These addresses are preconfigured by SIAC.

Each object inside the zone has its own Modbus address, associated with the gateway IP address. The maximum number of PV generators that can be connected to the Gateway (for example, an ADAM 4572) is 8, if the RS485 chain itself does not exceed 1200 m in length.

The logic structure of the zone is described in the example figure below, where, for each Generator present, there is an inverter and two CSP-12 units, while the Gateway is depicted as an ADAM 4572:

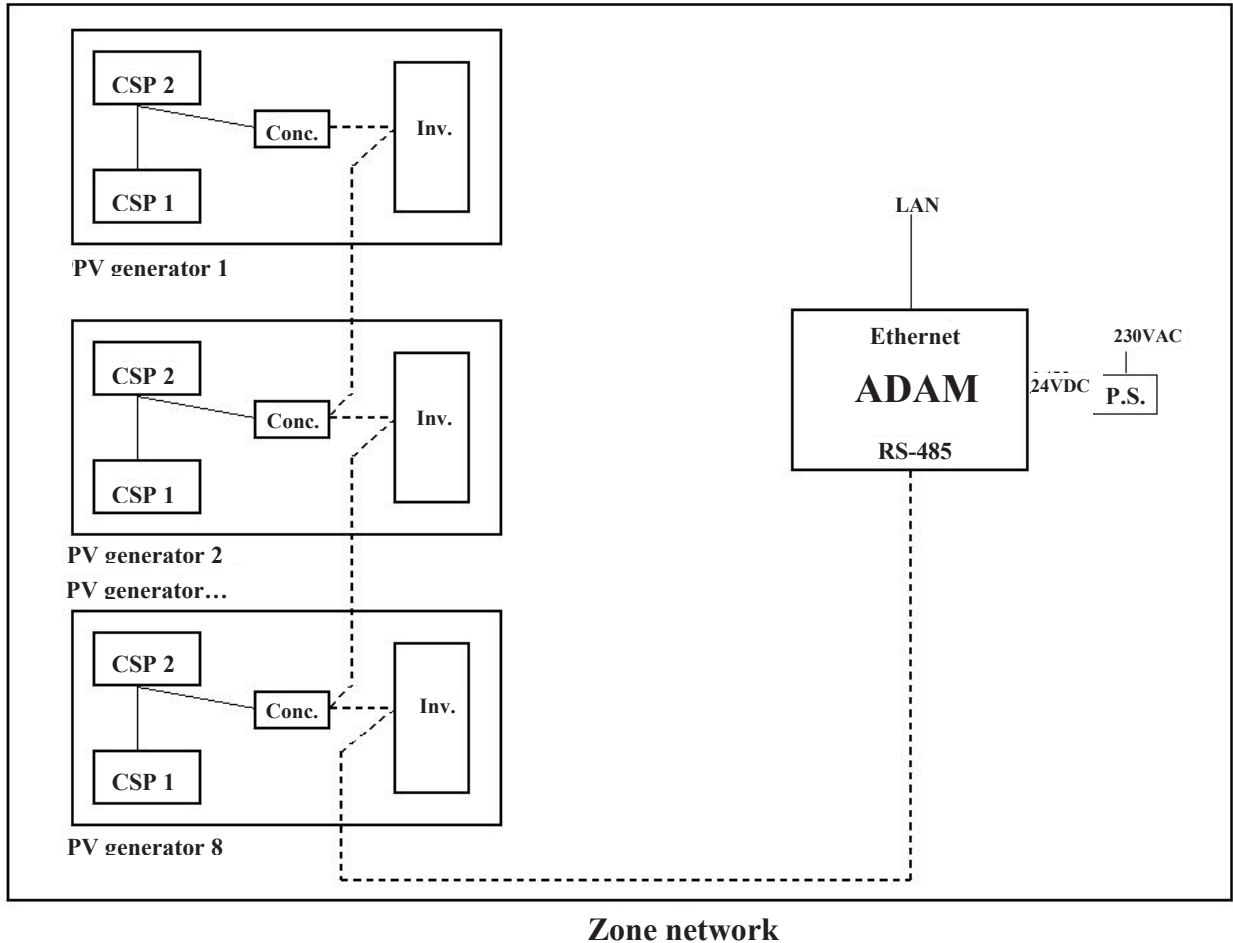


Figure 8 Zone network

Many zone networks make up a **Site Network**. When several Zones belong to areas that are geographically remote from one another, it may be possible to physically extend a LAN network connecting them. This LAN should be set up to connect the various Gateway devices to one another and the Modem/Router provided by SIAC.

The site Router is obligatory and is used to gather all the LAN cables coming from the Modbus/Ethernet adapters. The modem provided by SIAC is a device integrating an actual modem and two Ethernet ports, one of which is the service port (ETH0) and the other one to be used (ETH1). In turn, port **Eth1** has a Switch with 5 input ports. These 5 ports are all equivalent.

Port **Eth0** is service only, and is used by system maintenance personnel.

It is physically possible to connect the Gateways directly to one of the **Eth1** ports on the Modem/Router provided by SIAC if the Zones are no more than 5 and if the distances make it possible to port the Gateways in the area where the Modem is located.

In the case where there are more Zones, it is necessary for the installer to add an external auxiliary **switch** to be connected to one of the **Eth1** ports.

In the case where it is not possible (due to distance limits on the RS485 bus) to port the Gateways directly on the Gateway, it is essential for the installer to set up a small LAN network dedicated to that purpose. SIAC suggests the network be setup using fiberoptics in order to make it immune from electromagnetic disturbance present in the plant. The schematic diagram is as follows:

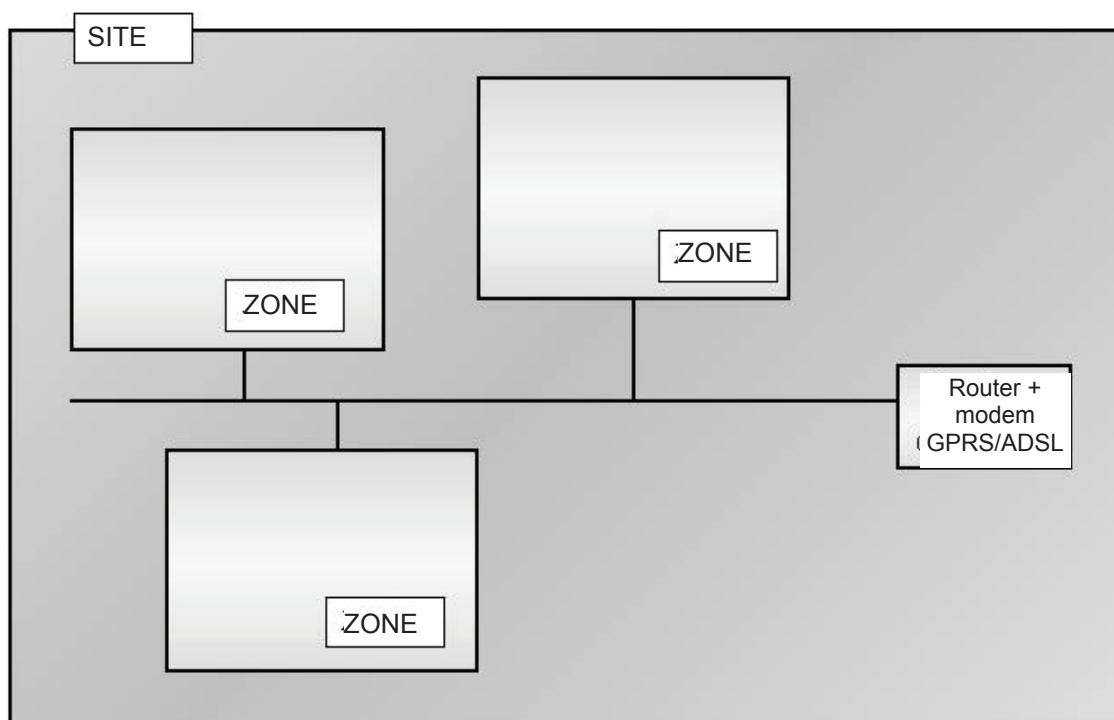


Figure 9 Site Network Layout

3.2.3 Notes and details for proper TGS2 system cabling

For proper communication function, it is essential that certain minor details be observed during installation. In particular: since the inverter may be the source of electromagnetic disturbances directed into the power connections, and consequently irradiated to the surrounding environment, it is recommended that signal cables be kept as far apart from power cables as possible, in particular, laying AC power cables in the same cable ducts used for communications cables should be avoided. Where this is not possible, it is good practice to electrically screen power cables, encasing them inside specific metal

conduits. Depending on the model of Inverter available, one of the following example layouts should be adopted.

The examples shown relate to various versions of **SOLEIL DSP** Inverters with 30, 33, 34, 35 pin terminal boards, one layout relating to 35 terminal 500 kW inverters and one layout relating to **SOLEIL Analogue** Inverters.

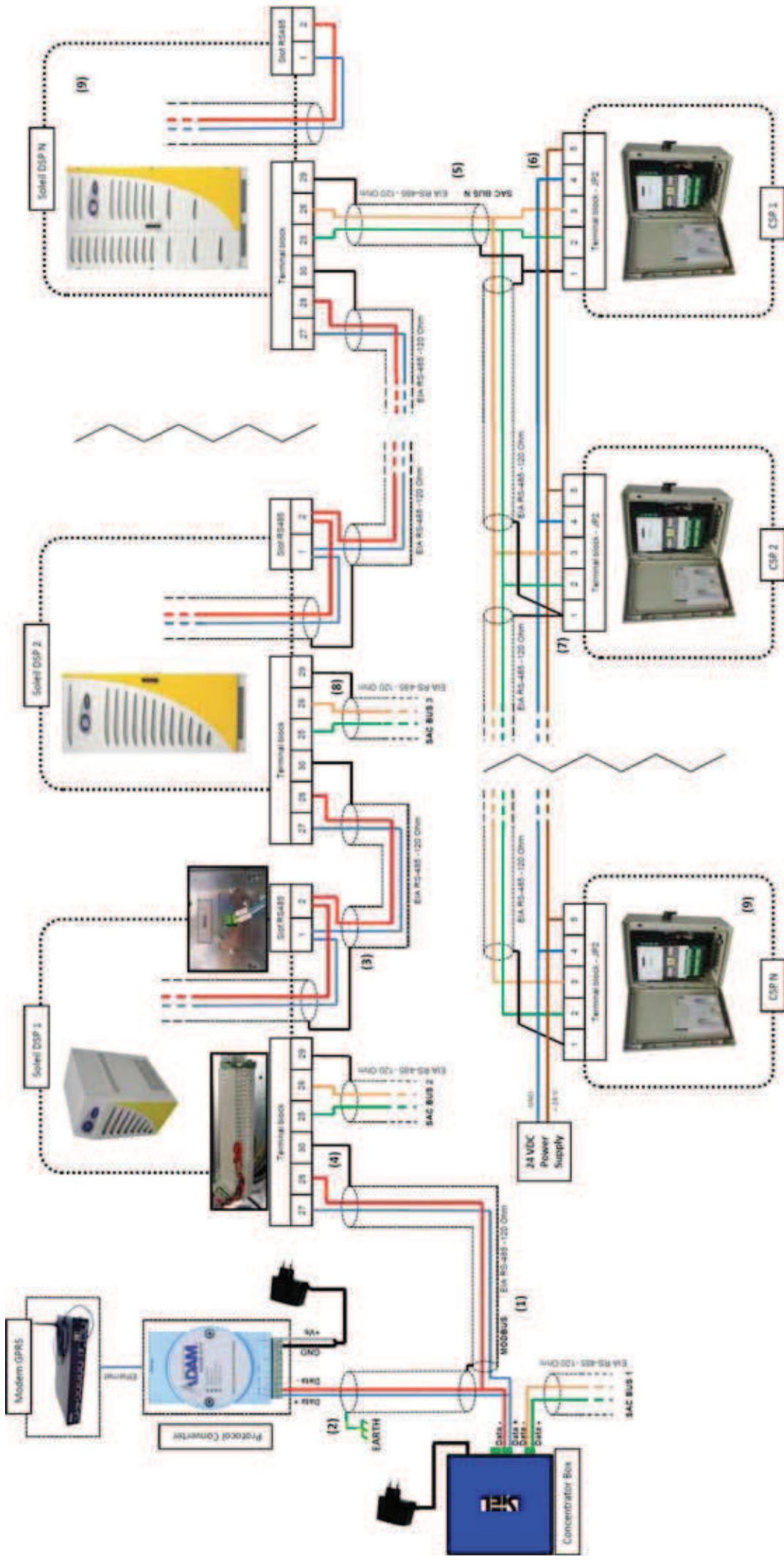


Figure 10 Communications wiring layout with 30 terminal Soleil DSP inverters

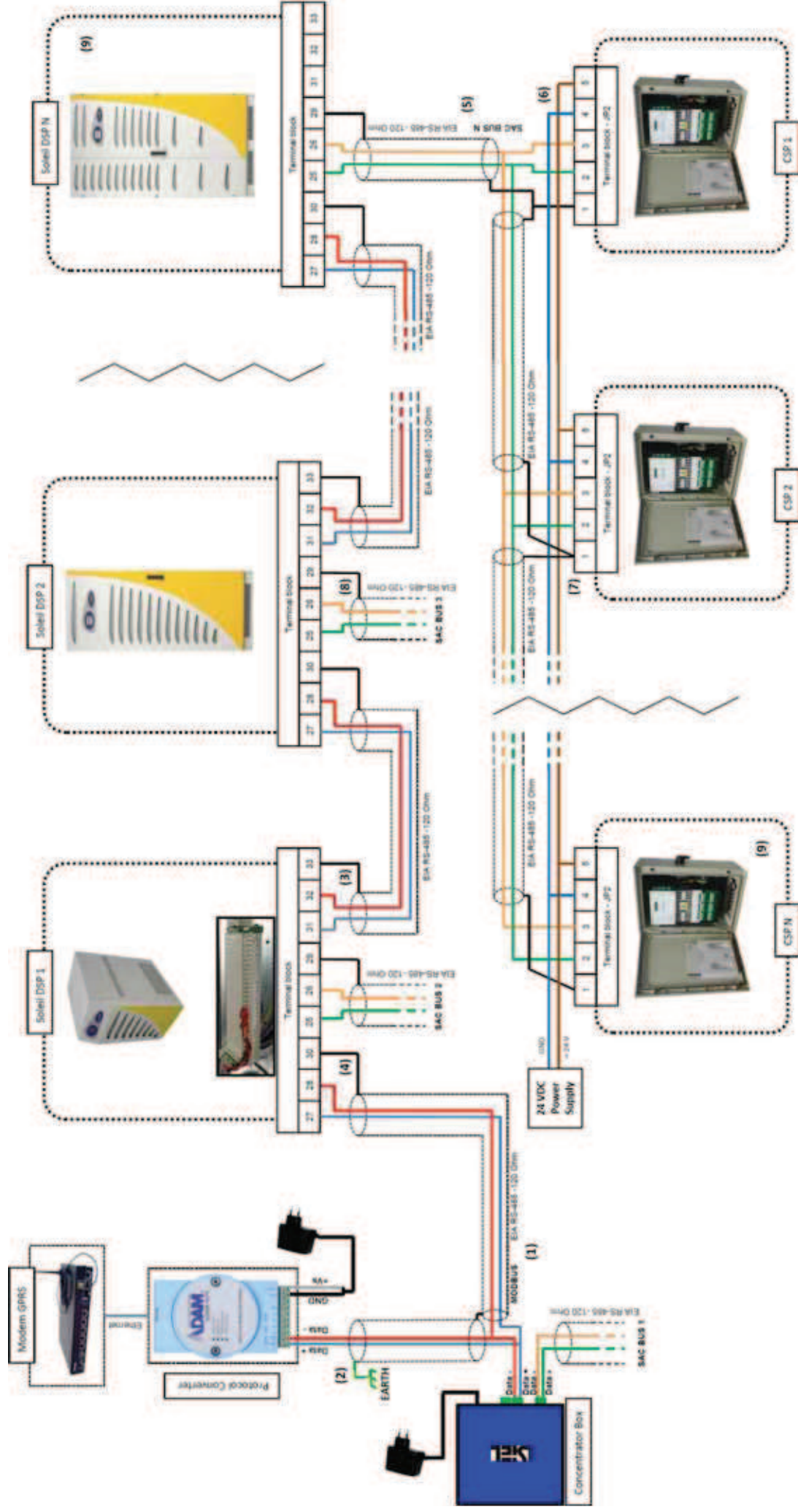


Figure 11 Communications wiring layout with 33 terminal Soleil DSP inverters

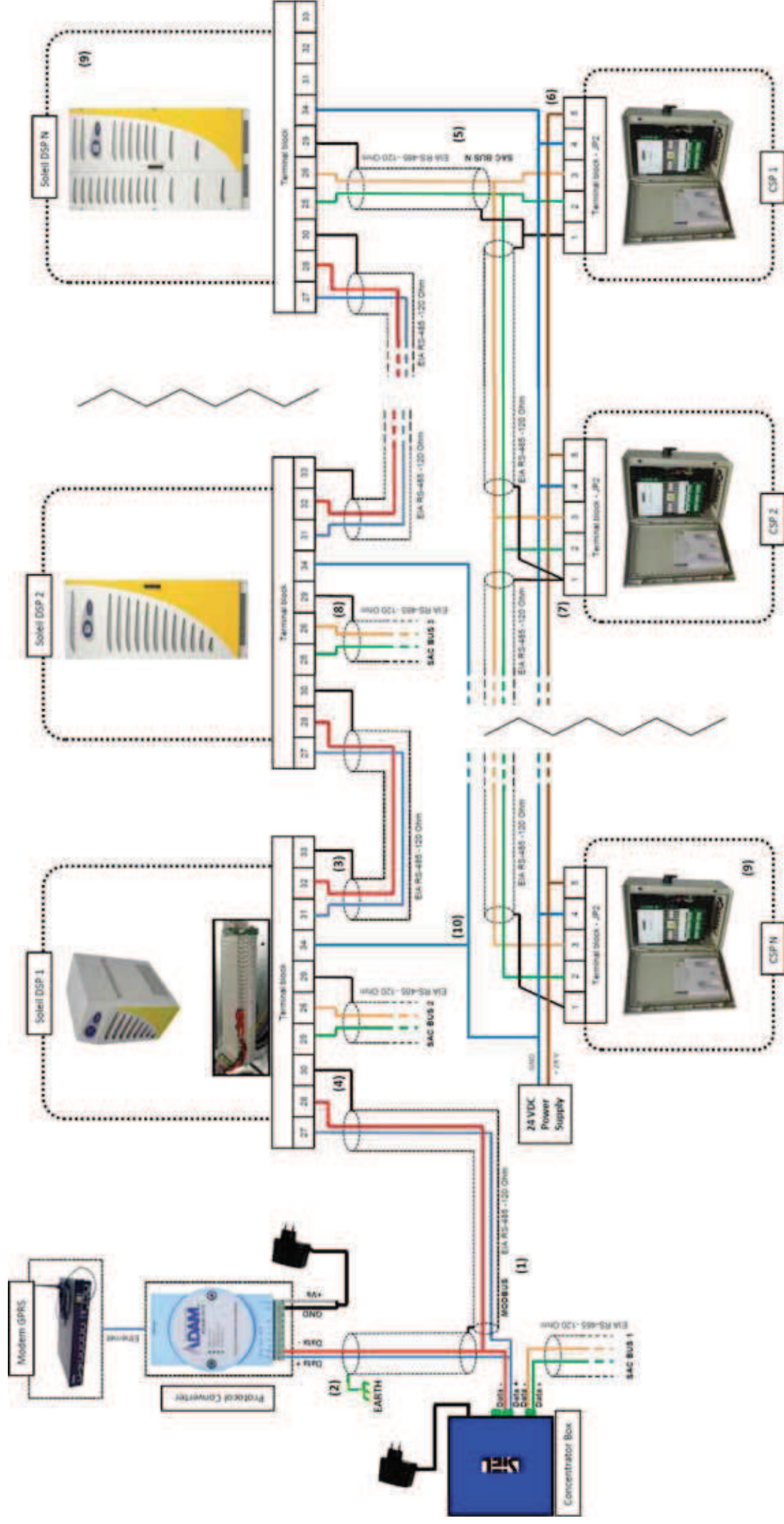


Figure 12 Communications wiring layout with 34 terminal Soleil DSP inverters

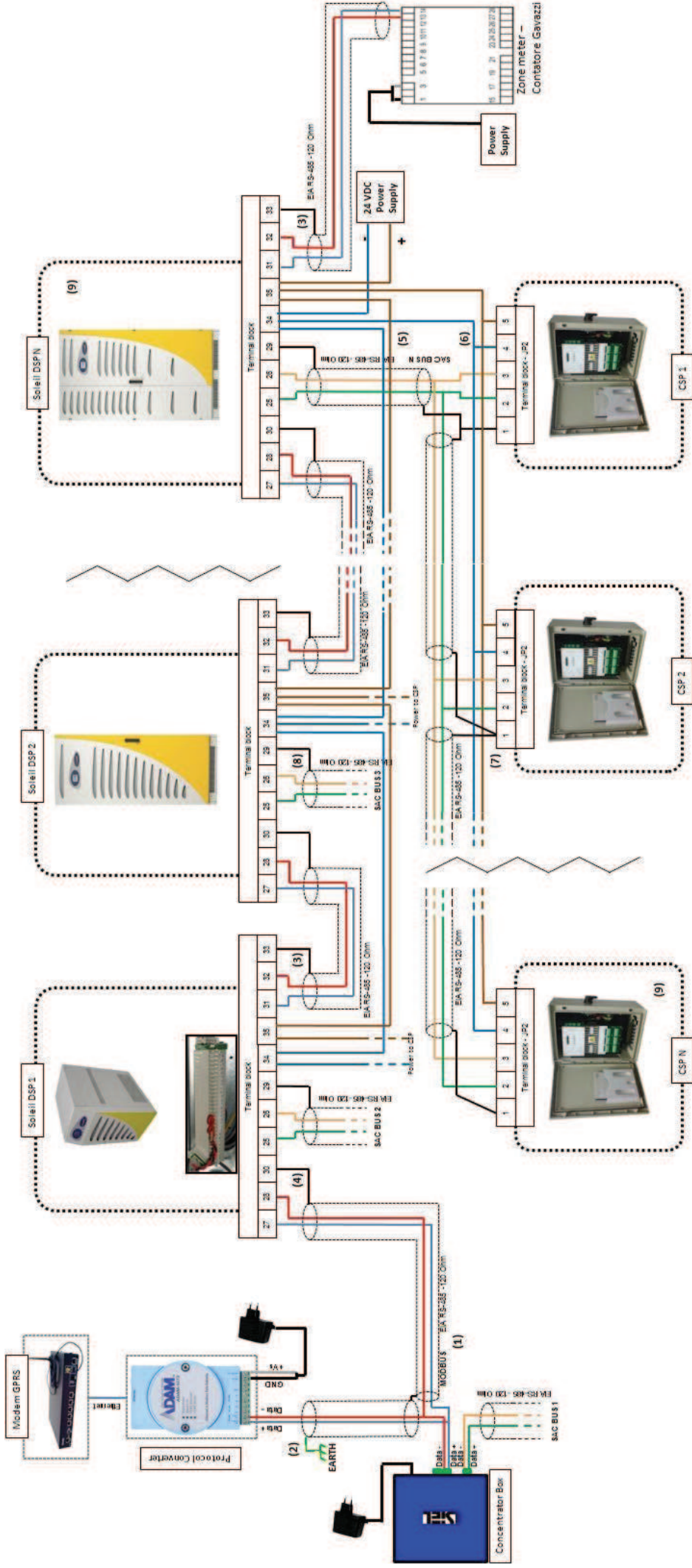


Figure 13 Communications wiring layout with 35 terminal Soleil DSP inverters

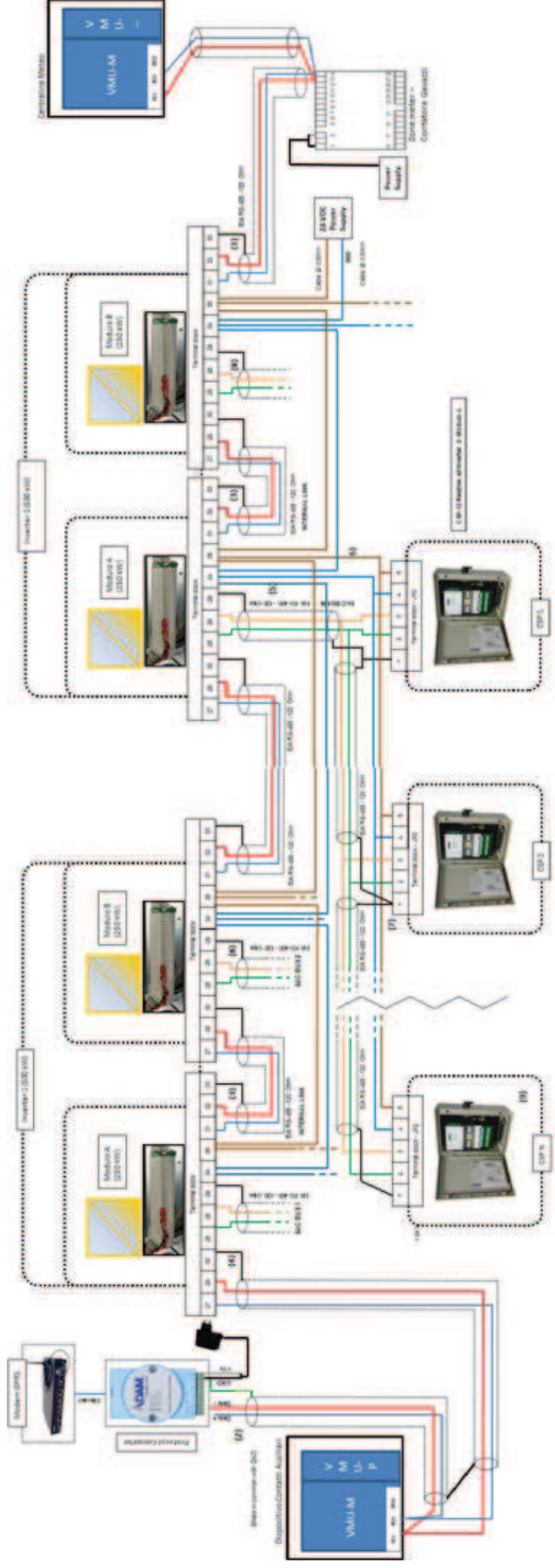


Figure 14 Communications wiring layout with 35 terminal Soleil DSP inverters with auxiliary connections

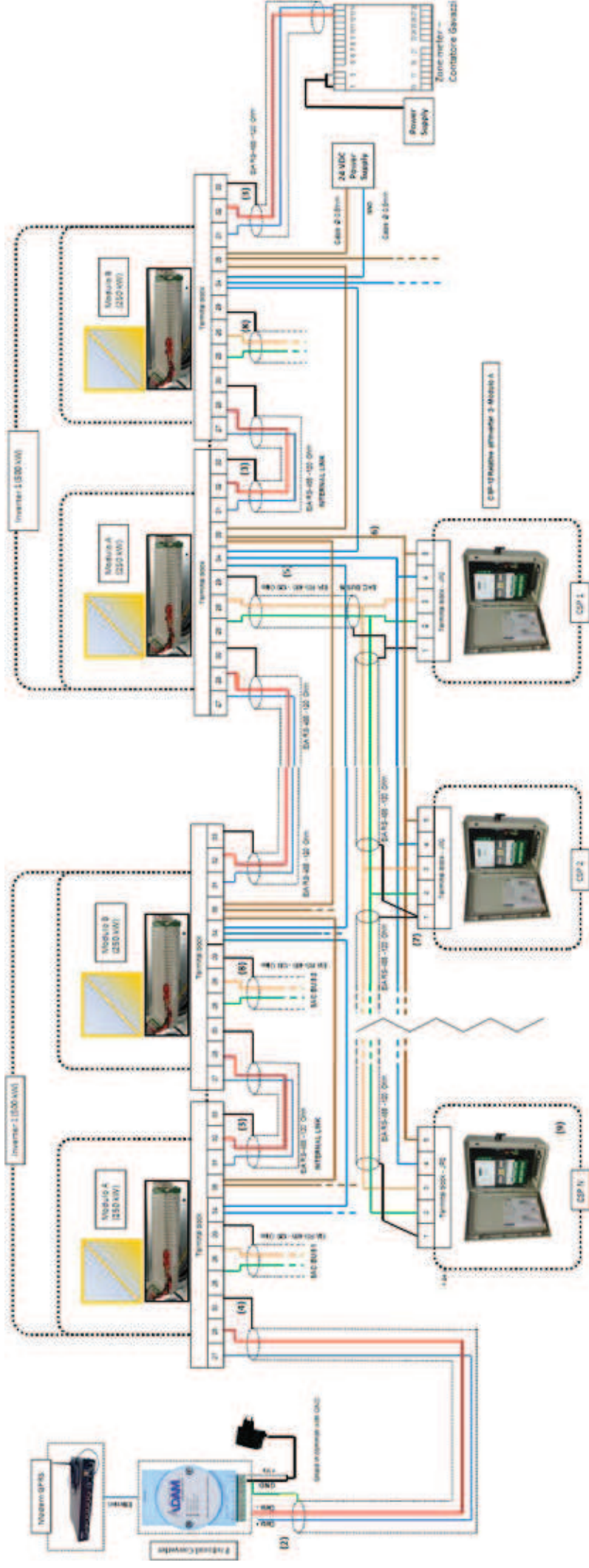


Figure 15 Communications wiring layout with 35 terminal Soleil DSP 500 kW inverters

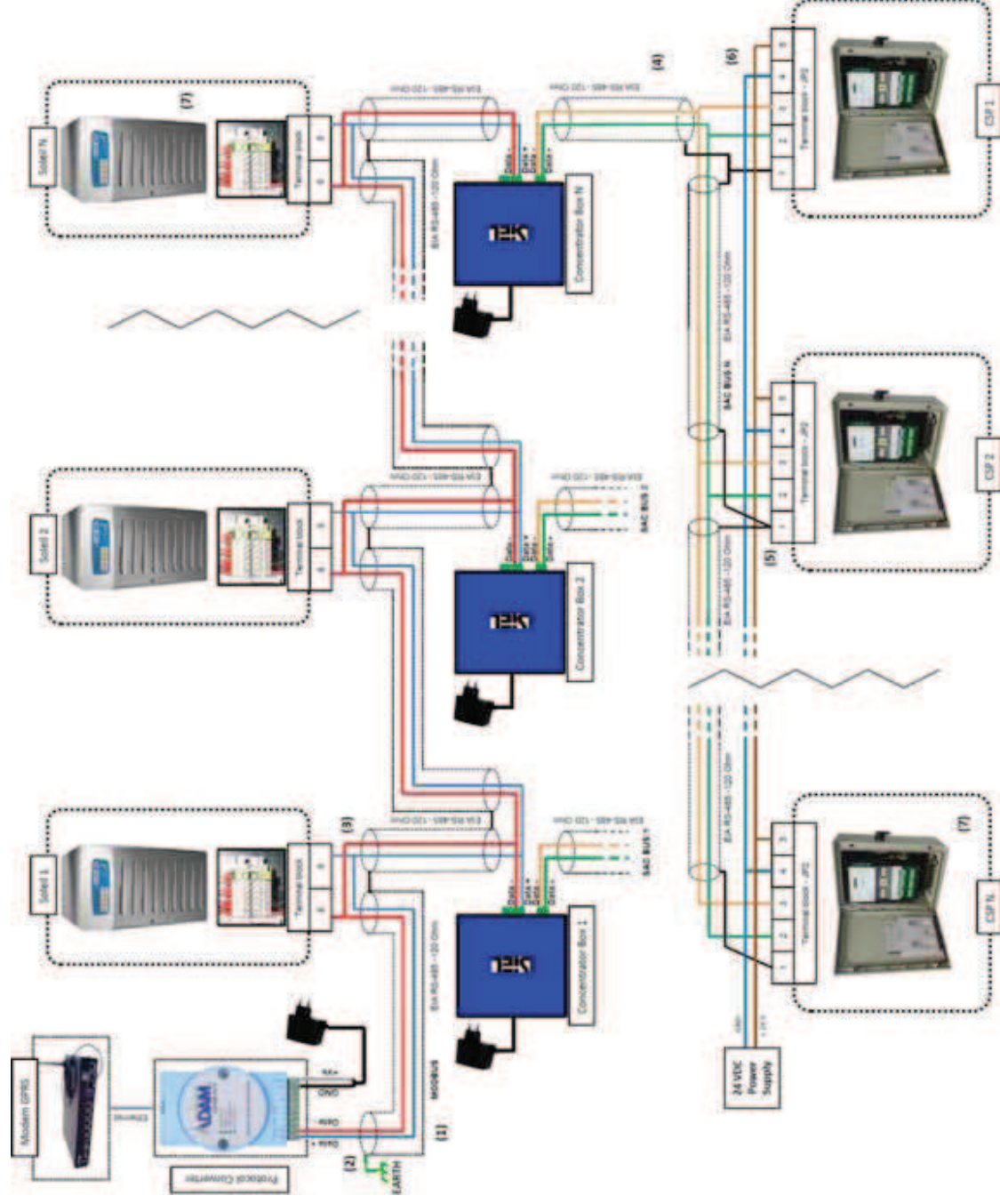


Figure 16 Communications wiring layout with Soleil Analogue inverters

In addition, it is essential to bear in mind the following notes in reference to Figure 10, Figure 11, [Figure 12 Communications wiring layout with 34 terminal Soleil DSP inverters](#)

and Figure 13:

(1) For the MODBUS connection, use a screened, twisted pair EIA-RS485 cable with typical impedance of 120 Ohm (e.g. Belden P/N 9841). The maximum length of the chain should not exceed 1,200 m.

(2) Connect the cable screening to the “earthing” at the protocol converter terminal.

(3) With reference to the outline in Figure 10:

remove enough of the sheathing on the screened cable to join the screening from the input cable to that of the prewired cable at the RS485 slot.

With reference to the outlines in Figure 11 and Figure 12: connect the screening of the MODBUS output cable to terminal 33 of the inverter.

With reference to Figure 16, remove enough of the sheathing on the screened cable to join the screening from the input cable to that of the output cable.

(4) Connect the screening of the MODBUS input cable to terminal 30 of the inverter.

(5) For the SAC BUS connection (between the Concentrator and its CSP-12 units), use a screened, twisted pair EIA-RS485 cable with typical impedance of 120 Ohm (e.g. Belden P/N 9841). The maximum length of the chain should not exceed 1,200 m.

(6) With reference to Figure 13, the CSP-12 power cables run between terminals 34 (-) and 35 (+) to terminals 4 and 5 respectively on the CSP-12 units.

The power supply is common to all, while all terminals 34 and 35 on the terminal blocks of all inverters are linked in common as shown in the layout.

CAUTION!!!

Do not invert the CSP12 communication power supply polarity.

Do not invert the communication terminals (2-3) with the power supply terminals (4-5) on the CSP12.

(7) Join the screening from SAC cables at terminal JP2-1 on the CSP12.

(8) Connect the screening of the SAC input cable to terminal 29 of the inverter.

(9) It is essential to insert the line termination resister on the terminal component of each bus:
for plants based on SOLEIL DSP inverters:

BUS	DEVICE	ACTION
Modbus	Inverter RS485 SLOT	Close JP1

	Concentrator	Close JP21
SAC BUS	CSP-12	J6 in position 1-2

For plants based on SOLEIL Analogue inverters:

BUS	DEVICE	ACTION
Modbus	Inverter RS485 SLOT	Close JP6
	Concentrator	Close JP21
SAC BUS	CSP-12	J6 in position 1-2

3.3 Logic settings for the devices

After having prepared and cabled all the devices in accordance with the instructions in the previous section, it is necessary to set the devices in accordance with the predefined modbus addresses, both the Inverters and the Concentrators.

Depending on the type of plant, the following schemes are followed.

- If the plant is based on SOLEIL DSP Inverters and each Inverter is connected to a maximum of 8 CSP-12 units, the following scheme is used, in which the Modbus address of the inverters and that of the boxes is indicated, in addition to the fact that the Modbus addresses of the various CSP-12 units and how the bank of dip-switches relating to each concentrator is set, is also indicated:

	Generator 1	Generator 2	Generator 3	Generator 4
Set of modbus addresses for CSPs in the on-board concentrator	1; 2;3;4;5;6;7;8 all dip-switches to ON	9;10;11;12;13;14;15; 16 dip-switch 4 to OFF	17;18;19;20;21;22;2 3;24 dip-switch 5 to OFF	25;26;27;28;29;30;3 1;32 dip-switches 4 and 5 to OFF
Modbus addresses for the Inverters	65	66	67	68

	Generator 5	Generator 6	Generator 7	Generator 8
Set of modbus addresses for CSPs in the on-	33;34;35;36;37;38;3 9;40	41;42;43;44;45;46;4 7;48	49;50;51;52;53;54;5 5;56	57;58;59;60;61;62;6 3;64

board concentrator	dip-switch 6 to OFF	dip-switches 4 and 6 to OFF	dip-switches 6 and 5 to OFF	dip-switches 4, 5 and 6 to OFF
Modbus addresses for the Inverters	69	70	71	72

- If the plant is comprised of Inverters, all with more than 8 CSP-12 units, then it is recommended that a Zone be composed of only 4 Generators, and the settings be in accordance with the following outline:

Set of modbus addresses for CSPs in the on-board concentrator	1; 2;3;4;5;6;7;8 all dip-switches to ON	9;10;11;12;13;14;15;16 dip-switch 4 to OFF	17;18;19;20;21;22;23;24 dip-switch 5 to OFF	25;26;27;28;29;30;31;32 dip-switches 4 and 5 to OFF
Modbus addresses for the Inverters	65	66	67	68
Set of modbus addresses for CSPs in the auxiliary concentrator	73; 74;75;76;77;78;79;80 dip-switches 7 and 4 to OFF	81;82;83;84;85;86;87;88 dip-switches 7 and 5 to OFF	89;90;91;92;93;94;95;96 dip-switches 7, 4 and 5 to OFF	97;98;99;100;101;102;103;104 dip-switches 7 and 6 to OFF

It should be remembered that:

- The Modbus address on the inverters is set by entering the display settings menu, as shown in the manual for the Inverter itself (cf. IV302)
- All concentrator cards have a bank of dip-switches which are set in accordance with the instructions given in the scheme. The location of the card itself depends on the capacity of the Inverter, and is indicated in the Inverter manual.

NB: it is best these operations be performed by skilled personnel.

- If the plant is based on SOLEIL Analogue Inverters, the scheme to be followed is:

	Generator 1	Generator 2	Generator 3	Generator 4
Set of modbus addresses for CSPs in the concentrator	9;10;11;12;13;14;15;16 dip-switch 4 to OFF	17;18;19;20;21;22;23;24 dip-switch 5 to OFF	25;26;27;28;29;30;31;32 dip-switches 4 and 5 to OFF	33;34;35;36;37;38;39;40 dip-switch 6 to OFF
Modbus addresses for the Inverters	1	2	3	4

	Generator 5	Generator 6	Generator 7	Generator 8
Set of modbus addresses for CSPs in the concentrator	41;42;43;44;45;46;47;48 dip-switches 4 and 6 to OFF	49;50;51;52;53;54;55;56 dip-switches 6 and 5 to OFF	57;58;59;60;61;62;63;64 dip-switches 4, 5 and 6 to OFF	65;66;67;68;69;70;71;72 dip-switch 7 to OFF

Modbus addresses for the Inverters	5	6	7	8
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	Zone 1	Zone 2	Zone 3	Zone 4
Set of modbus addresses for UTF meters	200	201	202	203

4 CHARACTERISTICS OF THE SERVICE

The service offered by SIAC is based on a system that simultaneously performs a dual service for the customer.

On the one hand, the service provides Data Server capabilities, with data recording, analysis and archiving functions. The service also offers an alerting system.

On the other hand, the service provides Web Server capabilities, offering the customer a Client application with which to monitor their system, which consists of their plants, and internet access to the log files stored in the system.

These points are described below.

4.1 Data Collection

SIAC provides a server on which the TGS2 service runs, and which uses the modems installed at the plants to collect data from all the Photovoltaic Plants subjected to monitoring and stores it.

The service collects the data at 5 minute intervals and, on completion of polling of the plant in question and on completion of data collection, files the data in .csv format and then performs an analysis in order to verify the presence of any Anomalies, Alarms, or simple changes in status.

The devices monitored are the Inverters and the CSP-12 units.

When the data sets are acquired from the various devices, these are then analysed and, based on the settings associated with the device itself, if there are any alarms or anomalies, the service performs the following actions:

- recording the Event
- sending a report email
- sending a report SMS message

These actions can all be enabled independently by SIAC for each event type envisaged.

4.1.1 Overview of *SOLEIL DSP* alarms and their meanings

The overview of the states and alarms reported by SOLEIL DSP includes:

Configurazione allarmi SOLEIL DSP					
Livello	Descrizione	Log File	Invia Mail	Invia SMS	Tempo filtro (min)
1	Desaturazione IGBT Inverter	SI	SI	SI	30
2	Sovracorrente Inverter	SI	SI	SI	
3	Sovratemperatura Inverter	SI	SI	SI	
4	Problemi comunicazione Signalling DSP board	SI	SI	SI	
5	Perdita Isolamento	SI	SI	SI	
6	Spegnimento d'emergenza	SI	SI	SI	
7	Intervento Protezione Esterna	SI	SI	SI	
8	Mancata comunicazione con dispositivo	SI	SI	NO	
9	Inverter fermo	NO	NO	NO	
10	Irraggiamento insufficiente	NO	NO	NO	
11	Presenza operatore umano	NO	NO	NO	
12	Terminatore rete chiuso	NO	NO	NO	
13	Tensione rete fuori dai limiti	NO	NO	NO	
14	Frequenza rete fuori dai limiti	NO	NO	NO	
15	Limitazione potenza AC per sovratemperatura	SI	NO	NO	
16	Intervento Fusibile Polo a terra	SI	SI	SI	
17	Inverter disabilitato	SI	SI	SI	
18	Mancanza comunicazione CAN	SI	SI	SI	
19	Sovratensione BUS DC	SI	SI	SI	

Figure 17 Overview of SOLEIL DSP alarms

Serious alarms are indicated in **Red**, anomalies in relation to normal operation are shown in **Yellow** and normal system status is shown in **Green**.

The alarms shown in **Red** are serious alarms where the intervention of a human operator may be necessary to restore proper Inverter function, and are the so-called protection alarms.

These alarms include:

- **Inverter IGBT desaturation:** this occurs under operating conditions that could damage power components.
- **Inverter overcurrent:** when an overcurrent is caused due to a fault
- **Inverter overheating:** when ambient conditions force the Inverter to operate in an unsuitable temperature zone.
- **Emergency shut-down:** also known as **EPO (Emergency power Off)**, implemented externally and enabled in case of danger
- **Inverter Disabled:** This alarm trips in two types of situations: automatically, and controlled by the Inverter itself and, always in concurrence with **Red** error other than those reported in this section. The other method is the deliberate manual shutdown by an operator. In both cases, the Inverter must be manually restarted by pressing the **ON** button on the display + the confirm button.
- **CAN communication failure:** This alarm indicates a communication problem between the Slot Adapter card and the DSP card. In this case, the Inverter is shut down to avoid hazardous situations.

When one of these alarms is present, the inverter shuts-down and intervention of a specialised inverter maintenance operative is necessary.

The other **Red** alarms are those that can occur if the alarm conditions deteriorate.

- **Signalling-DSP board communications problems:** when there is a connection and cabling problem inside the machine. Should this alarm appear briefly, no intervention is necessary. Should the alarm persist for more than 30 minutes, the intervention of a skilled operator is required.
- **Loss of insulation:** this occurs when the resistance between one of the two poles and ground drops below a predefined value. In this case, intervention from plant maintenance is necessary to restore operating conditions.
- **Tripping of an External Protection Device:** this occurs when a normally closed contact is opened. This contact may be used for remote Inverter shut-down or start-up.
- **Pole to ground fuse trip:** This occurs if the fuse connecting one of the two poles to ground is tripped.
- **DC BUS overvoltage:** this alarm trips if the Inverter DC voltage input has a no-load value greater than the maximum limit supported by the Inverter itself. In this case, the Inverter is shut-down until the voltage returns to within the specified working range.

➤ The **Yellow** alarms are anomalies, and are varied in nature and described below:

- **Inverter Disabled:** this occurs if a protective device trips or if the OFF button is pressed and the Inverter is voluntarily shut down. If the OFF button is pressed manually the Inverter must be restarted manually.
- **Human Operator Present:** This occurs when someone touches the touch screen display on the Inverter.
- **Insufficient Irradiation:** this occurs either when the input voltage is less than a minimum threshold value or the available input power is insufficient to deliver energy to the grid.
- **Mains Voltage out of range and Mains Frequency out of range:** These two messages relate to the grid AC voltage conditions. If the conditions are not favourable, the Inverter is shut down. As soon as favourable conditions are restored, the Inverter starts up autonomously.
- **AC Power Restriction due to Overheating:** This anomaly is an Inverter auto protection device that detects the temperature inside the Inverter and, if this is above a certain threshold, the output Power is restricted to 25% or 50%, depending on the temperature detected, in order to avoid reaching the maximum supported temperature which would result in the Inverter being blocked due to **Overheating**.
- **Device Communication Failure** is worthy of particular attention: this occurs under one of the following conditions:
 - **Inverter Modbus card fault:** In this case, the alarm and signalled and operation cannot be restored without intervention from a skilled operator;
 - **RS485 network fault:** in this case, the alarm will be connected to analogue alarms on all devices (Inverters and concentrators) located between the Inverter in question and the end of the Local RS485 network, or on one of the cards in the case of fault. In this case, intervention from plant maintenance staff is recommended prior to intervention from skilled technical staff;
 - **Gateway device power failure:** in this case, all devices in the Zone in question will be in the alarm state;
 - **Modem device power failure:** in this case, the entire plant monitored will be in the alarm state;

- If there is a temporary loss of power due to the operator, communication returns autonomously as soon as the GPRS signal is restored.

However, if communications are not restored to the system, it might be necessary to switch the modem off and then on again. This operation may be performed by site maintenance personnel.

- **Network remote control switch closed** is simply a status indicating when the machine is effectively delivering power to the grid.

From the outline in Figure 17 it is evident that for each of the States/Alarms just described, it is possible to enable their registration in a Log file, enable them to be sent by email or enable them to be sent by SMS.

These features can only be enabled by SIAC, but they are visible to the client.

In relation to the **Device Communication Failure** alarm, the **filter** field refers to the fact that this alarm is only signalled if it persists for a greater or equal length of time to that of the filter, indicated in minutes (for example 30 minutes). This is to ensure that temporary drops in the GPRS signal from telephone operator are not signalled as failures.

4.1.2 Overview of SOLEIL Analogue alarms and their meanings

The overview of the states and alarms reported by SOLEIL includes:

Configurazione allarmi SOLEIL						
Livello	Descrizione	Log File	Invia Mail	Invia SMS	Tempo filtro (min)	
1	Desaturazione inverter	SI	SI	SI		
2	Inverter in limitazione	SI	SI	SI		
3	Sovratemperatura	SI	SI	SI		
4	Problemi comunicazione inverter	SI	SI	SI		
5	Problemi comunicazione MP AUX	SI	SI	SI		
6	Perdita isolamento	SI	SI	SI		
7	Spegnimento d'emergenza	SI	SI	SI		
8	Mancata comunicazione con dispositivo	SI	SI	SI		
9	Inverter fermo	NO	NO	NO		
10	Irraggiamento insufficiente	NO	NO	NO		
11	Presenza operatore	NO	NO	NO		
12	Temperatura elevata	NO	NO	NO		
13	Terminatore di rete estratto	NO	NO	NO		
14	Inverter abilitato	NO	NO	NO		
15	Tensione fuori limite	NO	NO	NO		
16	Frequenza fuori limite	NO	NO	NO		

Figure 18 Overview of SOLEIL Analogue alarms

Serious alarms are indicated in **Red**, anomalies in relation to normal operation are shown in **Yellow** and normal system status is shown in **Green**.

- The alarms shown in **Red** are serious alarms where the intervention of a human operator may be necessary to restore proper Inverter function, and are the so-called protection alarms.

These alarms include:

- **Inverter Desaturation:** this occurs under operating conditions that might damage power components, or if there is a temporary overvoltage on the grid.
- **Inverter in Restriction:** when there is an overcurrent, as the result of a fault, or when irradiation conditions are limiting. This alarm state can occur frequently in the early hours of the morning and in the final hours before sunset, however, if the alarm is resolved within 5 or 10 minutes at most, the problem is negligible. If, on the other hand, an alarm occurs during full production and lasts for more than 10 minutes, then a proper Current Restriction occurs and the intervention of a skilled operative is required.
- **Overheating:** when ambient conditions force the Inverter to operate in an unsuitable temperature zone.
- **Emergency shut-down: (Emergency power Off)** implemented externally and enabled in case of danger.

When one of these alarms is present, the inverter shuts-down and intervention of a specialised inverter maintenance operative is necessary.

- The other **Red** alarms are serious, but can occur if the alarm conditions deteriorate.
 - **Inverter communication problems:** when there is a connection and cabling problem inside the machine. In this case, the intervention of a skilled operator is required.
 - **AUX MP communication problems:** when there are connection and cabling problems inside the machine, or as the result of a faulty card inside the Inverter. In this case, the intervention of a skilled operator is required.
 - **Loss of insulation:** this occurs when the resistance between one of the two poles and ground drops below a predefined value. In this case, intervention from plant maintenance is necessary to restore operating conditions.
-
- The **Yellow** coloured alarms are anomalies, and are varied in nature and described below:
 - **inverter stopped:** this occurs if a protective device trips or if the OFF button is pressed and the Inverter is voluntarily shut down.
 - **Insufficient Irradiation:** this occurs either when the input voltage is less than a minimum threshold value or the available input power is insufficient to deliver energy to the grid.
 - **Human Operator Present:** This occurs when someone touches the keypad on the Inverter.
 - **High Temperature:** this is an anomaly that occurs when the temperature exceeds a pre-alarm threshold, but the Inverter continues to function.
 - **Inverter enabled:** this occurs when the inverter is ready to produce or during energy production.
 - **Mains Voltage out of range and Mains Frequency out of range:** These two messages relate to the grid AC voltage conditions. If the conditions are not favourable, the Inverter is shut down. As soon as favourable conditions are restored, the Inverter starts up autonomously.
 - **Device Communication Failure** is worthy of particular attention: this occurs under one of the following conditions:
 - **Inverter Modbus card fault:** In this case, the alarm and signalled and operation cannot be restored without intervention from a skilled operator;

- **RS485 network fault:** in this case, the alarm will be connected to analogue alarms on all devices (Inverters and concentrators) located between the Inverter in question and the end of the Local RS485 network, or on one of the cards in the case of fault. In this case, intervention from plant maintenance staff is recommended prior to intervention from skilled technical staff;
- **Gateway device power failure:** in this case, all devices in the Zone in question will be in the alarm state;
- **Modem device power failure:** in this case, the entire plant monitored will be in the alarm state;
- If there is a temporary loss of power due to the operator, communication returns autonomously as soon as the GPRS signal is restored.

However, if communications are not restored to the system, it might be necessary to switch the modem off and then on again. This operation may be performed by site maintenance personnel.

- **Network remote control switch energised** is simply a status indicating when the machine is effectively delivering power to the grid.

From the outline in Figure 18 it may be deduced that for each of the States/Alarms just described, it is possible to enable their storage in a Log file, enable them to be sent by email or enable them to be sent by SMS.

These features can only be enabled by SIAC, but they are visible to the client.

- In relation to the **Device Communication Failure** alarm, the **filter** field refers to the fact that this alarm is only signalled if it persists for a greater or equal length of time to that of the filter, indicated in minutes (for example 30 minutes). This is to ensure that temporary drops in the GPRS signal from telephone operator are not signalled as failures.

4.1.3 Overview of CSP-12 alarms and their meanings

The overview of the states and alarms reported by the CSP-12s includes:

Configurazione allarmi CSP-12													
	Livello	Descrizione	Log file	Invia Mail	Invia SMS								
1		Corrente di stringa fuori range	SI	NO	NO								
		Controlla allarme dalle ore	11	:	00	:	00	alle ore	15	:	00	:	00
2		Allarme fusibile su polo positivo	NO	NO	NO								
3		Allarme fusibile su polo negativo	NO	NO	NO								
4		Stringa disconnessa	NO	NO	NO								
5		Connessa e in generazione	NO	NO	NO								
6		Connessa e NON in generazione	NO	NO	NO								
7		Allarme stato varistori	SI	SI	NO								
8		Allarme stato isolamento	SI	SI	NO								
						Tempo filtro (min)							
9		Allarme comunicazione tra CSP-12 e concentratore	SI	NO	NO	30							
10		Mancata comunicazione con dispositivo	SI	SI	NO	30							

Figure 19 Overview of CSP-12 alarms

The serious alarms, which are usually protection device alarms, are indicated in **Red**, anomalies in relation to normal operation are shown in **Yellow** and normal system status is shown in **Green**.

- The **Red** alarms are serious alarms, and so intervention by a human operator may be necessary to restore correct CSP-12 operation.

These alarms include:

- **Varistor Status Alarm:** this occurs when the Varistor card on the CSP signals a malfunction in the Varistors themselves. When this alarm is present, the intervention of a skilled operator is required.
- **Insulation Alarm:** this occurs when one of the two poles has lost its insulation to ground. This alarm requires an inspection by plant installation or maintenance personnel.
- **System Status Alarm:** when any device alarm state is present. This is always associated with a red alarm or a yellow anomaly explaining the cause.
- The **Yellow** alarms are anomalies relating to an individual string, and are varied in nature and described below:
 - **String Current out of range:** this signal refers to an individual, well-defined string, and its signalling indicates that its output differs from the mean of all the others by at least 30%, and that the situation has persisted for at least 10 minutes. This is to avoid spurious signals due to transient, non-uniform irradiation conditions on the connected strings. If the signalling persists, especially during hours of higher irradiation, it is essential to verify:
 - The Integrity of the modules;
 - The presence of any "Hot spots" on the strings
 - The string fuses are inserted correctly (support fins not tightened).

The **Check alarm from (time) ... to (time) ...** message is necessary because in the early hours of the morning and the final hours of the evening the panels can be subject to areas of shadow which might create **String current out of range** anomalies, which are acceptable and are not reported. The time range indicated can be modified by SIAC.

- **Positive pole fuse alarm:** this message indicates the fuse on the positive pole is faulty. the plant maintenance operatives can replace it with a spare fuse provided. N.B.: this message can also appear if the fins on the fuse holder are not sufficiently tightened.
- **Negative pole fuse alarm:** this message indicates the fuse on the negative pole is faulty. the plant maintenance operatives can replace it with a spare fuse provided. N.B.: this message can also appear if the fins on the fuse holder are not sufficiently tightened.

➤ Device states and actual anomalies are listed below:

- **Connected and generating (green colour):** this means that the string indicated is producing correctly.
- **Connected and NOT generating:** this indicates the string is not producing energy, and this is normally the case during the early hours of the morning and the final hours of the evening, generally under conditions of poor irradiation. It becomes an anomaly if it occurs during the hours of greatest irradiation.
- **CSP-12 and concentrator communication alarm:** this message is signalled when a concentrator (either internal or external) cannot communicate with a given CSP-12 unit. This may be due to a fault with the CSP CPU itself, or to faulty wiring of the communication cables or a power fault affecting the CSP-12 communication circuit. In any case, inspection by plant maintenance personnel and possibly skilled operatives are necessary.
- **Device Communication Failure** is worthy of particular attention: this occurs under one of the following conditions:
 - **Inverter Modbus card fault:** In this case, the alarm is signalled and operation cannot be restored without intervention from a skilled operator;
 - **RS485 network fault:** in this case, the alarm will be connected to analogue alarms on all devices (Inverters and concentrators) located between the Inverter in question and the end of the Local RS485 network, or on one of the cards in the case of fault. In this case, intervention from plant maintenance staff is recommended prior to intervention from skilled technical staff;
 - **Gateway device power failure:** in this case, all devices in the Zone in question will be in the alarm state;
 - **Modem device power failure:** in this case, the entire plant monitored will be in the alarm state;
 - If there is a temporary loss of power due to the operator, communication returns autonomously as soon as the GPRS signal is restored.

However, if communications are not restored to the system, it might be necessary to switch the modem off and then on again. This operation may be performed by site maintenance personnel.

From the outline in Figure 19 it is evident that for each of the States/Alarms just described, it is possible to enable their registration in a Log file, enable them to be sent by email or enable them to be sent by SMS.

These features can only be enabled by SIAC, but they are visible to the client.

In relation to the **Device Communication Failure** and the **CSP-12 and Concentrator Communications** alarms, the **filter** field refers to the fact that this alarm is only signalled if it persists for a greater or equal

length of time to that of the filter, indicated in minutes (for example 30 minutes). This is to ensure that temporary drops in the GPRS signal from telephone operator are not signalled as failures. In the example, email alerting is also enabled on the second alarm, while for the first, only recording in the Log File is enabled.

4.1.4 Overview of UTF meter alarms

The overview of the UTF meter alarms is as follows:

Configurazione allarmi CONTATORE UTF					
Livello	Descrizione	Log file	Invia Mail	Invia SMS	Tempo filtro (min)
1	Mancata comunicazione con dispositivo	SI	SI	NO	30

Figure 20 Overview of UTF meter alarms

In this case, the only possible alarm is the **Device communication failure** alarm, which is managed by the same mechanism as the Inverters and the CSP-12 units (editors note: see the previous sections)

4.2 Mail and/or SMS services

The Mailing and SMS service makes it possible to inform the body or personnel in charge of site maintenance and alert them regarding alarms and/or anomalies, and inform them when they are resolved.

It is possible to create Mailing lists and SMS lists containing up to 10 addresses or phone numbers for each zone in the site.

The Mailing service is activated for all the Events/States/Alarms for which sending mail is enabled (in Figure 17, Figure 18 and Figure 19 , i.e. those marked YES in the Mail column), whereby each time the Event/Status/Alarm occurs, an email with the following characteristics is sent to the entire Mailing list:

Mail sender: TelegestioneImpiantiSolari@Sielups.com

Mail subject: **SiteName: Alarm Description**

And containing the following text:

```
7/10/2009 08:32:29 Alarm: SystemName\SiteName\ZoneN\GeneratorM\SOLEIL_DSP
[Reg.No.:xxxxxxx]: Device communication failure
```

Analogously, when the Event/Status/Alarm is no longer ongoing, an email is sent with the following text:

```
7/10/2009 08:42:29 Alarm End: SystemName\SiteName\ZoneN\GeneratorM\SOLEIL_DSP
[Reg.No.:xxxxxxx]: Device communication failure
```

In both cases, the coordinates of the device in question and its reg. number are indicated.

The SMS alerting system operates in a similar manner, and the text reported in the mail is sent as a text message to the numbers programmed.

4.3 Client Application

The Client application is the program provided to the customer for monitoring their plants, viewing current status, downloading log files and constructing graphs.

A customised public Web page is created for each customer requesting the TGS service for their plants, and the link delivered to the customer by SIAC.

Each customer will have a Web page appearing as follows:



Figure 21 Example Web page

The page contains three links:

Run Web Client (LAN version), which can only be used in the LAN network where the Server managing the service resides, and hence by SIAC.

Run Web Client (WAN version) relating to the option to download the Client Application to any PC connected to the Internet

Name_System log files, which is a link allowing access to the folders containing the log files, as described in section 0.

4.3.1 Web Application

Clicking on Run Web Client (WAN version) downloads a self-installing Java Web application.

This means the application requires Java to be installed on the PC. If the Java runtime is not installed on the PC used to access the internet, the application will download and automatically install everything required for proper execution of the application.

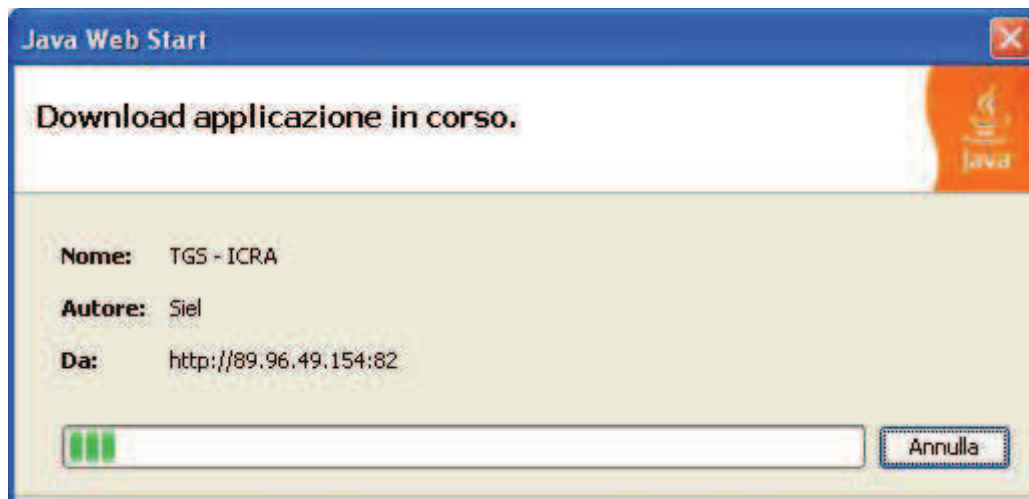
Each time the application is accessed, the following logo appears:



Figure 22 Java logo

Or an analogous logo.

The first time an application is downloaded a window like the following appears:



This shows the application and all its components being downloaded.

N.B.: The first time the application is downloaded to a given PC, or with each updated version of the application from SIAC, a few minutes are required for downloading. In all other cases, the download time is in the order of a few seconds.

The application resides in the temporary files, so if these are deleted, a new download is required the next time.

4.3.1.1 Main system screening

Once the application is downloaded, the following main window appears:



Figure 23 Main System Window

The top of the main window has a system bar showing:

System: "SYSTEM NAME": Status

Where **SYSTEM NAME** is indicative of the client or the group of plants relating to them;

the background is **Green** if no alarms or anomalies are present;

Yellow if at least one anomaly is present in at least one of the devices monitored at the site (for the definition of anomaly, refer to sections 0, 4.1.2 and 4.1.3);

Red if at least one alarm is present in at least one of the devices monitored at the site (for the definition of alarm, refer to sections 0, 4.1.2 and 4.1.3);

the **Status** is: “**OK**” if the background is **Green** or **Yellow**, while there is an “**Alarm**” if the background is **Red**.

The centre of the window has as many icons as the Plants being monitored by the System in question. The example shows two plants indicated by **Name_Site 1** and **Name_Site 2**.

The background image can be customised by providing SIAC with a bmp file with minimum resolution of 1014 x 711. If a higher resolution image is provided, SIAC will adapt it at their discretion.

The bottom centre of the window shows the **System Balance**:

Consuntivo Sistema	
Potenza istantanea (kW)	378.0
Energia prodotta giornaliera (kWh)	2511
Energia prodotta mensile (kWh)	17788
Energia prodotta totale (kWh)	172908
CO² risparmiata (kg)	91813.9

Figure 24 Zone Balance

The Balance table has 5 lines:

Momentary power (kW): represents the momentary power, evaluated in kW, for the entire area appearing in the window, and hence the sum of all the Inverters present in the Section.

Daily energy output (kWh): this represents the Energy produced from midnight until the time the application is observed. Again, this is the sum of the Energy produced by all the Inverters present in the Section from midnight on the day in question. The value is reset at midnight each day, and is expressed in kWh.

Monthly energy output (kWh): this represents the Energy produced from midnight on the first day of the month until the time the application is observed. Again, this is the sum of the Energy produced by all the Inverters present in the Section from midnight on the first day of the month in question. The value is reset at midnight on the last day, and is expressed in kWh.

Total energy output (kWh): this represents the sum total of the Energy produced by all the Inverters present in the Section, from the start of their production activity. The value is expressed in kWh

CO₂ saved (kg): this represents the Carbon Dioxide (CO₂) equivalent saved by having produced Energy from renewable sources. The value is expressed in kg, and is linked to the **Total energy produced**.

The background image can be customised using a .jpg image with minimum resolution of 1014 x 711.

Clicking **System** returns to the previous screen (Figure 23).

To the left of the window, there is a legend summarising the meanings of the individual LEDs and the icons representing the plants, and the **Performance Graphs** button.

4.3.1.2 Performance Graphs

Clicking the **Performance Graphs** button opens a window, as shown in Figure 25, showing the coordinates of the section analysed at the top. The graph can be used for qualitative analysis, comparing the irradiation received at the site and the power produced by the site on the same graph.

The irradiation graph is plotted in Blue, and its scale is shown on the Y axis on the left, while total power is plotted in red and its scale is shown on the Y axis on the right.

It should be remembered that the irradiation graph is calculated based on the mean for all the samples present in the System.

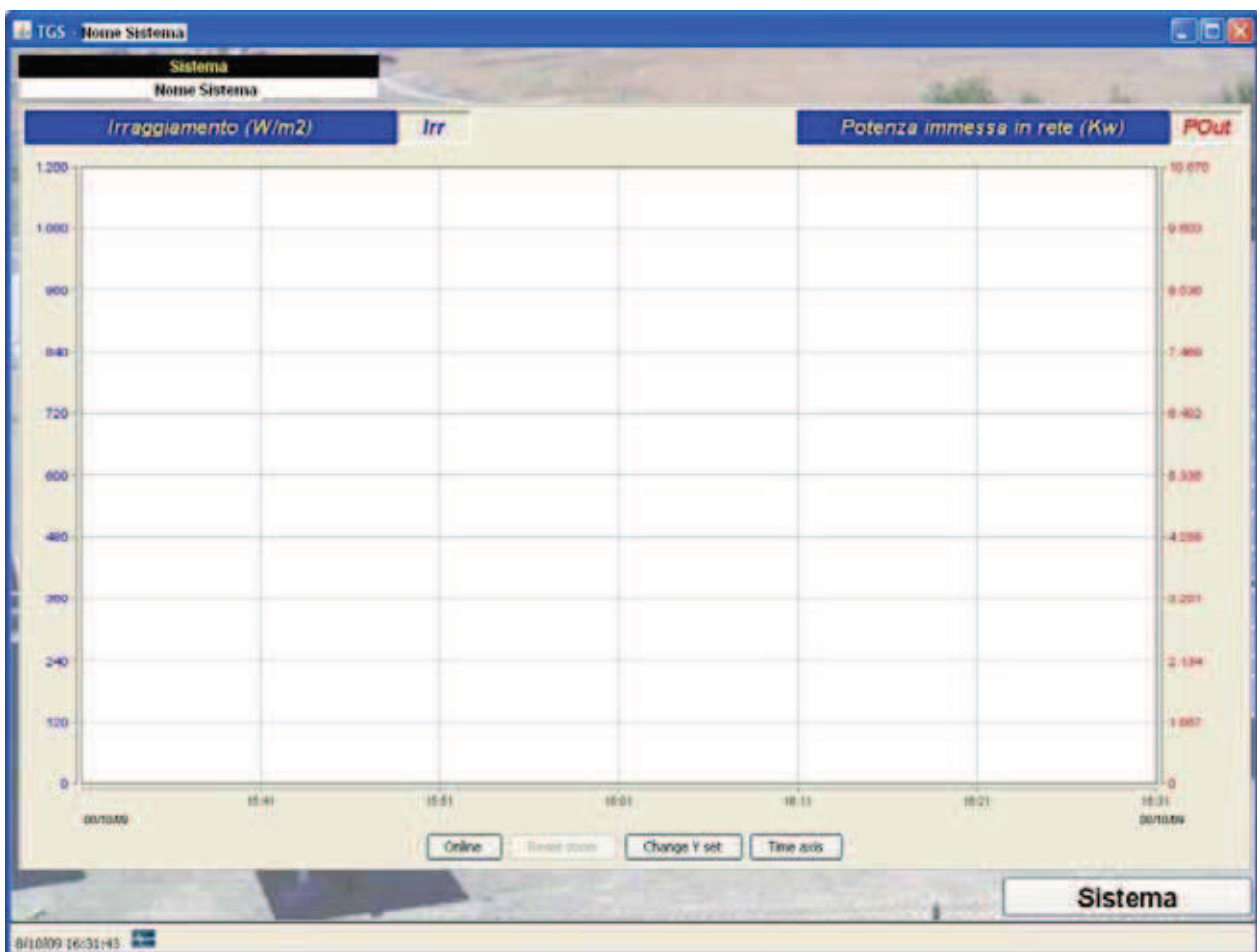


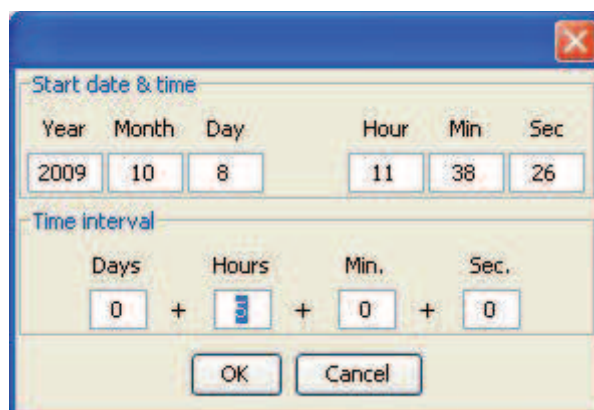
Figure 25 Performance Graphs

The graph has three buttons:

the **Online** button allows the construction of the two graphs as the data is collected, thus if the window is left open we would see the graphs being plotted over time. This is the default mode.

The **Change Y** button has no effect on this graph, and will be explained later:

On the other hand, the **Time axis** button makes it possible to set the time window to be monitored. Clicking this opens the following window:



The form can be used to set the graph start date and time (in the **Start date & time** section) and the time window duration (in the **Time interval** section). The example plots the graph from 11:38 on 08/10/2009 for a duration of 5 hours.

Pressing **OK** gives a result of the type shown here:

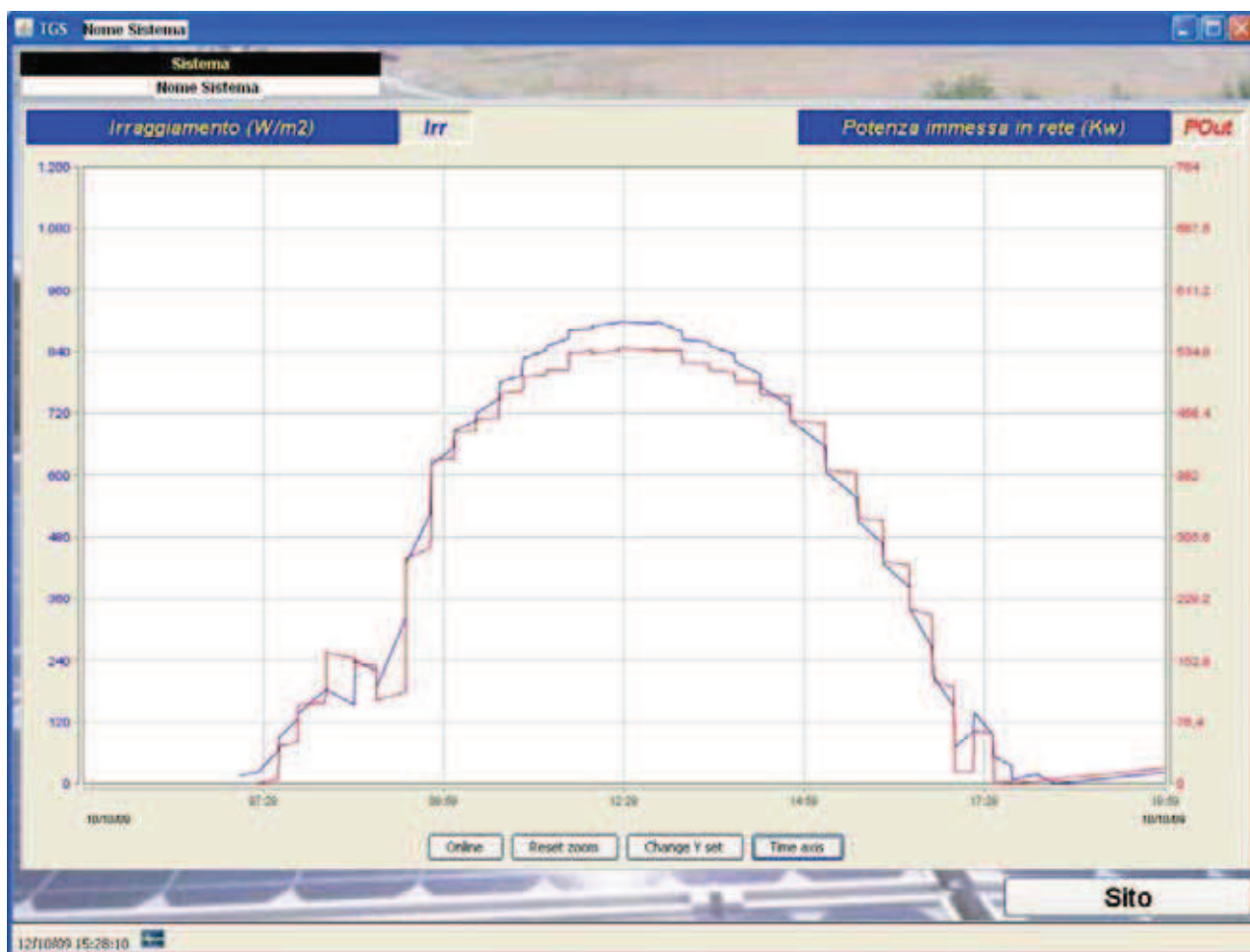


Figure 26 Example of performance graphs

It is possible to zoom in on areas of the graph, and all graphs in the application. To zoom in, simply select the area to be enlarged using the mouse, as in the example figure below:



The result of this operation is shown in Figure 27, where autoscaling is used for the right and left scales:



Figure 27. Zoom view of the section

Pressing **Reset Zoom** returns to the initial view (in example Figure 26).

The bottom right section has the **Report Configuration** panel.

The **MAIL** button opens a configuration page, with a list of potential email addresses, to which the daily alarm report and weekly energy report emails are sent, if these reports are enabled:

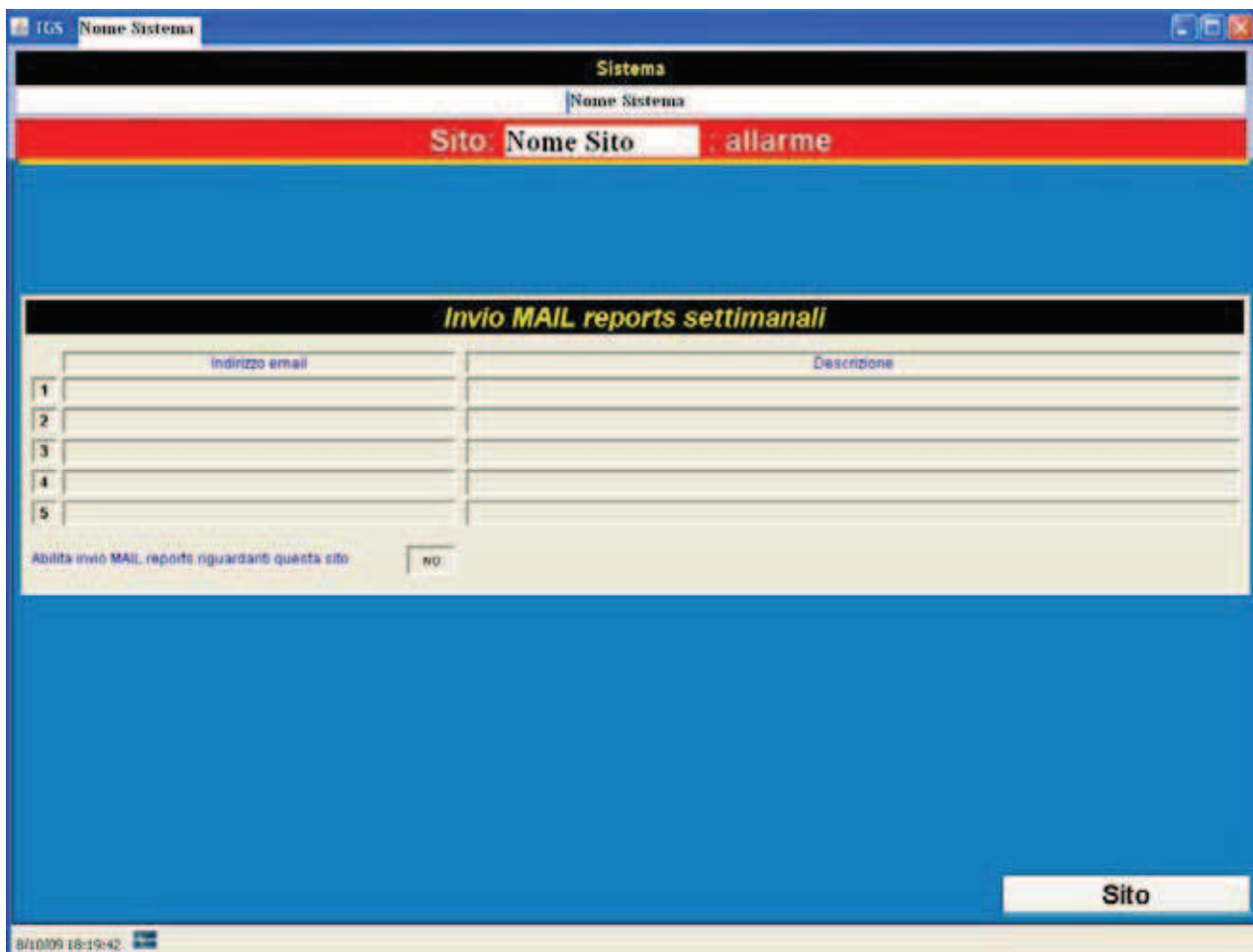


Figure 28 Report Mailing List settings screen

For further details on report mailing, see section 4.4.

All the other buttons (**CSP-12**, **UTF**, **Soleil DSP**, **Soleil**) are used to access pages showing the settings, alarm by alarm, for compiling the daily alarm reports.

The settings are selected by SIAC based on the nature of each individual alarm so that meaningful data is sent

4.3.1.3 Site Window

From the Figure 23 screen, clicking on one of the **Name_Site** icons opens the window relating to the site.

The Site window (where Site is understood as being Photovoltaic Plant) has a layout similar to that for the system:



Figura 29 Site Screen

The various **Zones** present at the Site are presented. The upper section shows the tree indicating to which System the Site shown belongs.

In the example shown in Figura 29 there are 4 sites, each with icon representing their status. The example shows all three potential states. Since in one Zone there is at least one alarm, its icon is **Red**, and this influences that status of the entire Site. For this reason, the background of the status bar above is **Red**.

The section to the lower left of the screen always shows the **legend** and the text **Performance graphs**. The characteristics of these graphs are identical to those described in section 0 with the sole difference that in this case they refer to the Site and not the System, both in terms of the irradiation and the Total power evaluated.

The **System** button returns the user to the main screen.

The background image can be customised by providing SIAC with a bmp file with minimum resolution of 1014 x 711. If a higher resolution image is provided, SIAC will adapt it at their discretion.

Clicking on **Site** returns the user to the previous screen.

N.B.: From this screen, it is only possible to display the configuration, but it is not possible to modify it. To modify the configuration, it is necessary to contact the service administrator, i.e. SIAC.

If the user clicks on the **Zone** icon from the screen in Figura 29, this opens the Zone screen.

4.3.1.4 Zone Screen

The **Zone** screen has a structure similar to the Site screen:

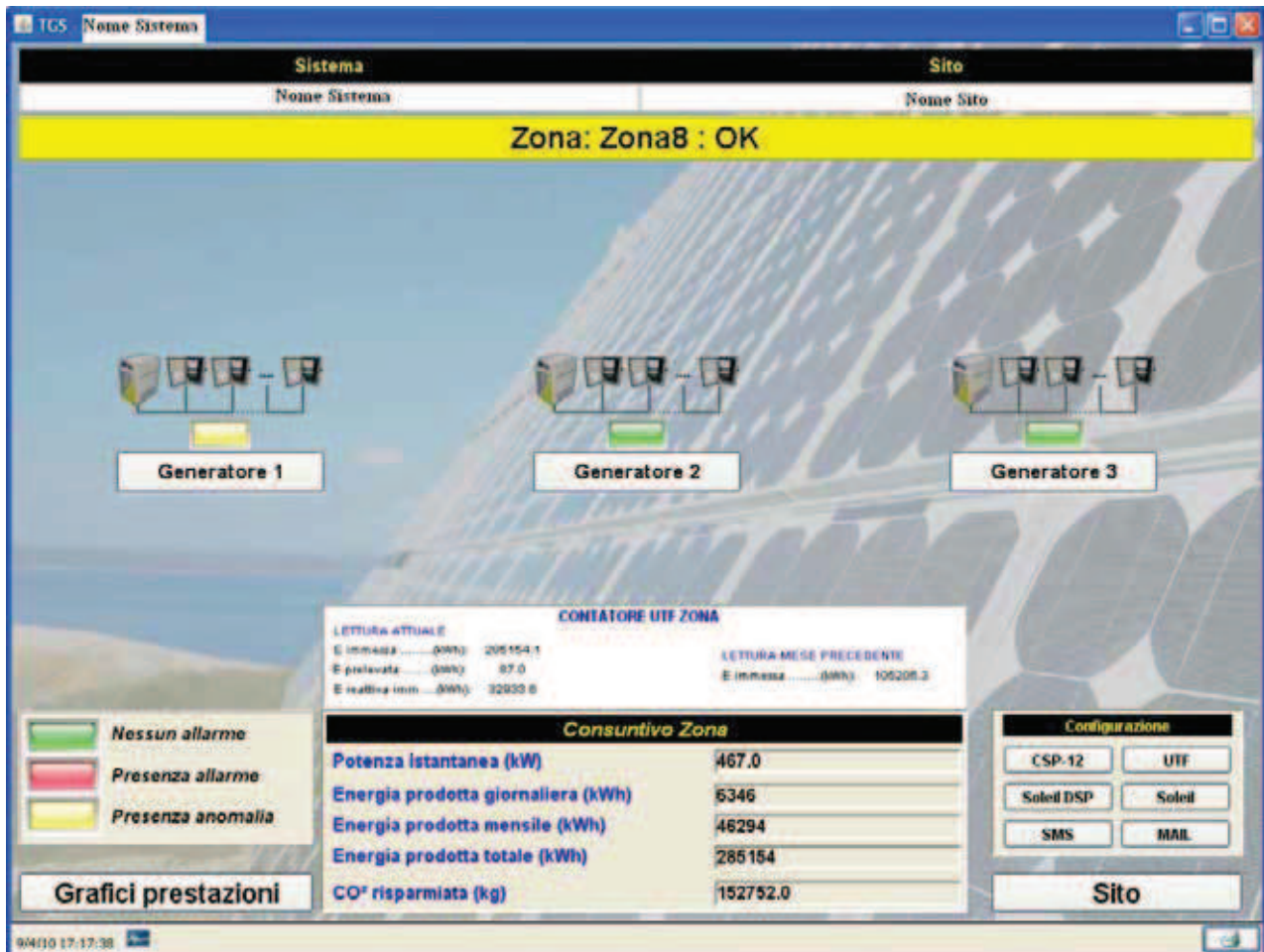


Figure 30 Zone Screen

This screen shows the various **Generators** present in the Zone, each with its own status LED. The example shows 4 Generators, but there can be between 1 and 8.

The top of the screen shows the tree for the Zone and the status bar with the name of the Zone and the status, with the background colour summarising the status.

The section to the lower left of the screen always shows the **legend** and the text **Performance graphs**. The characteristics of these graphs are identical to those described in section 0 with the sole difference that in this case they refer to the Zone and not the System or Site, both in terms of the irradiation and the Total power evaluated.

The bottom centre of the screen shows the **Zone Balance** window, with summary data relating to the Zone itself.

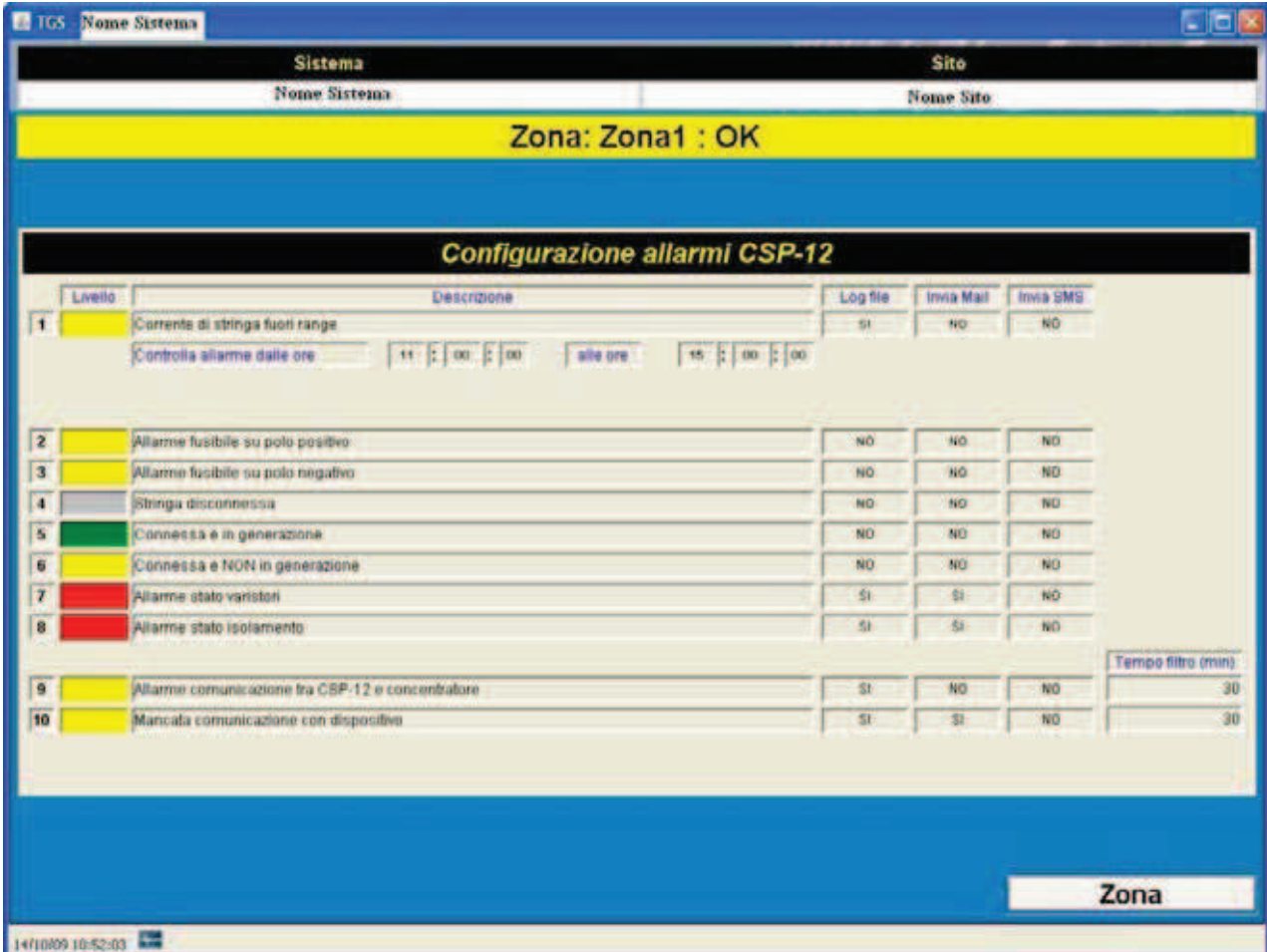
If the Zone has a **UTF Meter** then this is shown, as in the figure. The data reported is described in section 0.

The bottom right of the screen has 5 configuration links and a **Site** button.

Clicking on **Site** returns the user to the previous screen.

- Clicking the **CSP-12** link opens the window for configuring all the CSP-12 units relating to the Zone.

The meaning is explained in section 4.1.3.



Livello	Descrizione	Log file	Invia Mail	Invia SMG
1	Corrente di stringa fuori range	SI	NO	NO
Controlla allarme dalle ore: 11 : 00 : 00 alle ore: 15 : 00 : 00				
2	Allarme fusibile su polo positivo	NO	NO	NO
3	Allarme fusibile su polo negativo	NO	NO	NO
4	Stringa disconnessa	NO	NO	NO
5	Connessa e in generazione	NO	NO	NO
6	Connessa e NON in generazione	NO	NO	NO
7	Allarme stato varistori	SI	SI	NO
8	Allarme stato isolamento	SI	SI	NO
9	Allarme comunicazione tra CSP-12 e concentratore	SI	NO	NO
10	Mancata comunicazione con dispositivo	SI	SI	NO

Tempo filtro (min): 30

Zona

14/10/09 10:52:03

Figure 31 CSP-12 alarms screen

N.B.: From this screen, it is only possible to display the configuration, but it is not possible to modify it. To modify the configuration, it is necessary to contact the service administrator, i.e. SIAC.

- Clicking the **SOLEIL DSP** link opens the window for configuring all SOLEIL DSP Inverters relating to the Zone.

The meaning is explained in section 0.

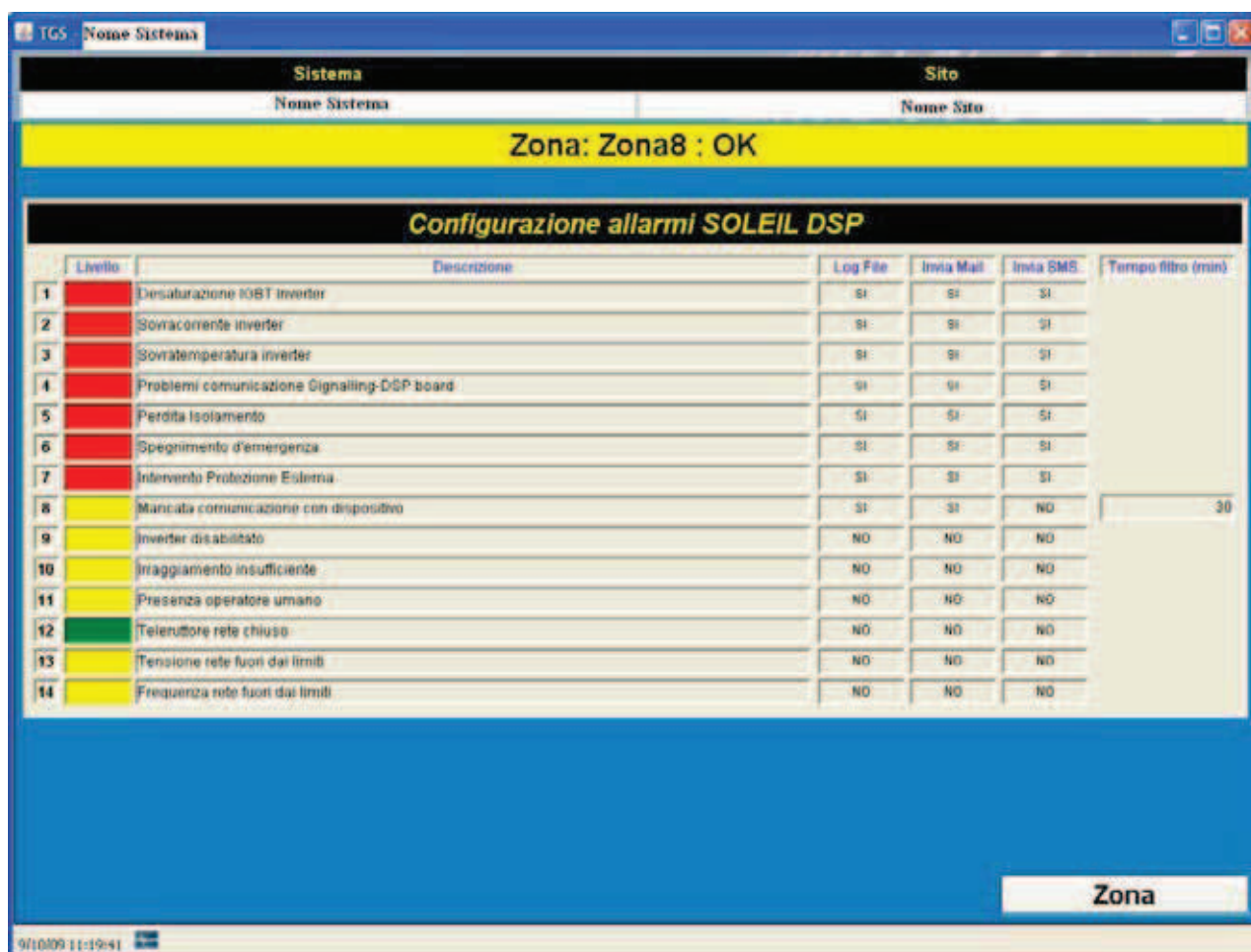


Figure 32 SOLEIL DSP alarms screen

N.B.: From this screen, it is only possible to display the configuration, but it is not possible to modify it. To modify the configuration, it is necessary to contact the service administrator, i.e. SIAC.

- Clicking the **SOLEIL** link opens the window for configuring all SOLEIL Inverters relating to the Zone.

The meaning is explained in section 4.1.2.

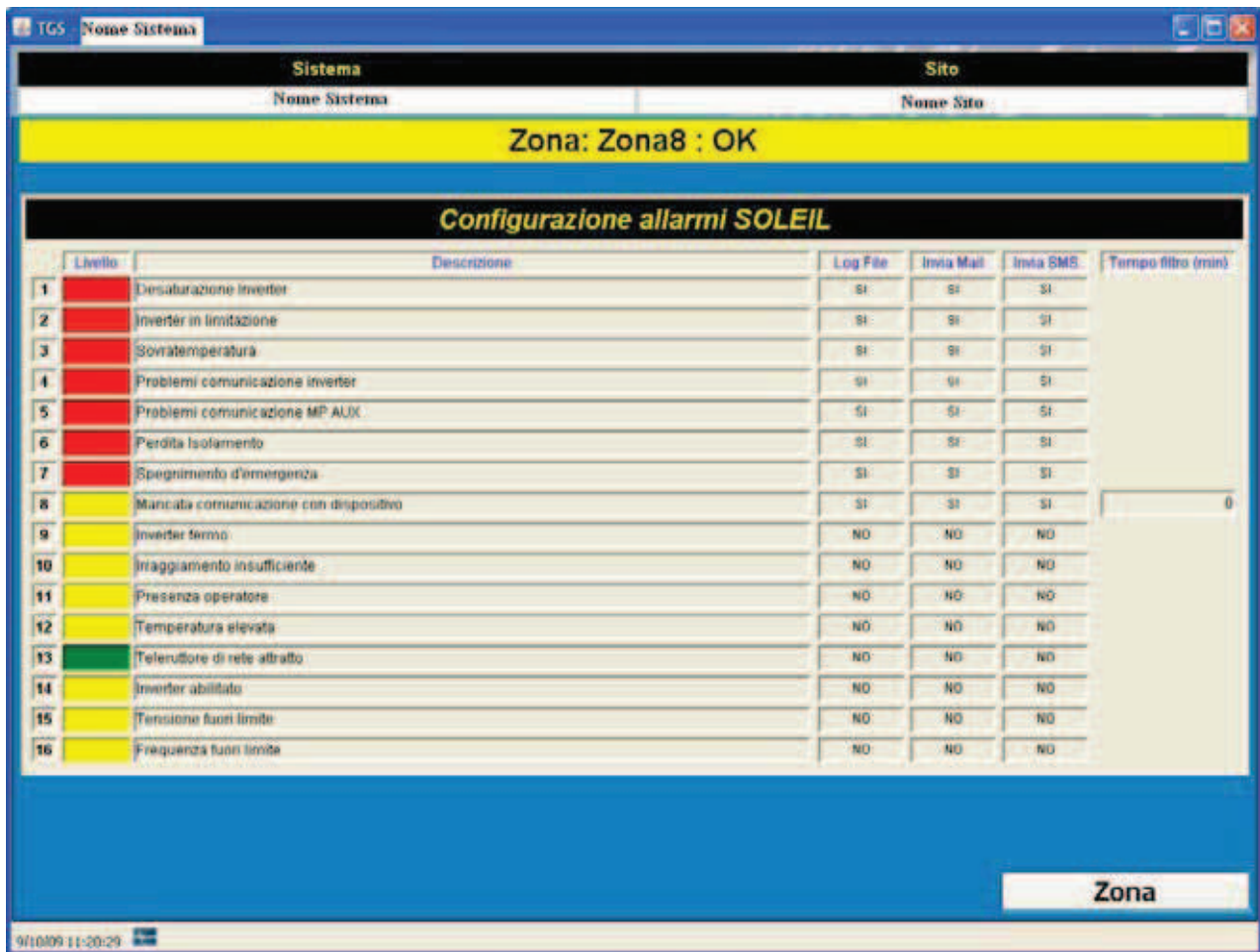


Figure 33 SOLEIL alarms screen

N.B.: From this screen, it is only possible to display the configuration, but it is not possible to modify it. To modify the configuration, it is necessary to contact the service administrator, i.e. SIAC.

- Clicking the **SMS** link opens the window for configuring all the SMS addressees relating to the Zone.

The meaning is explained in section 0.

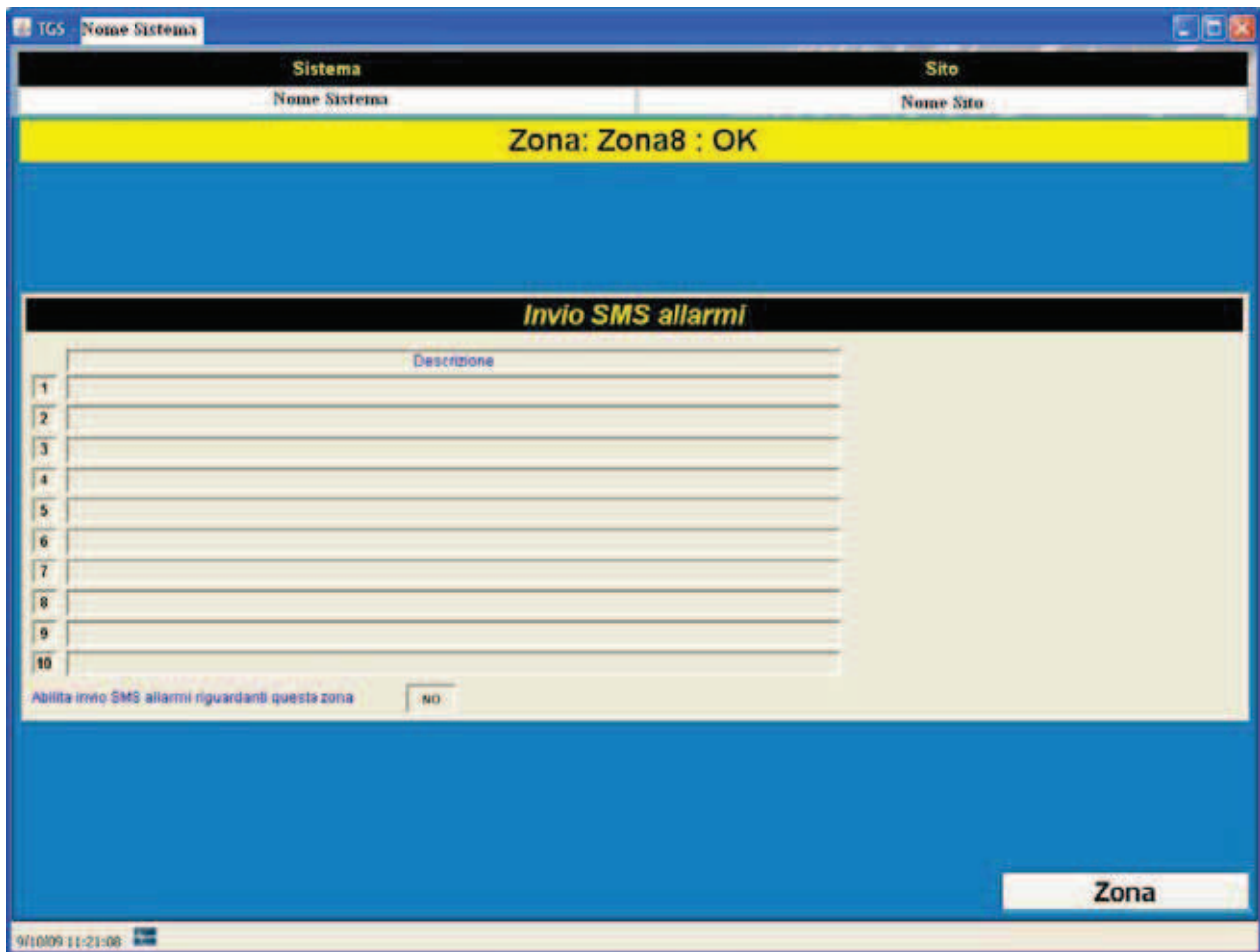


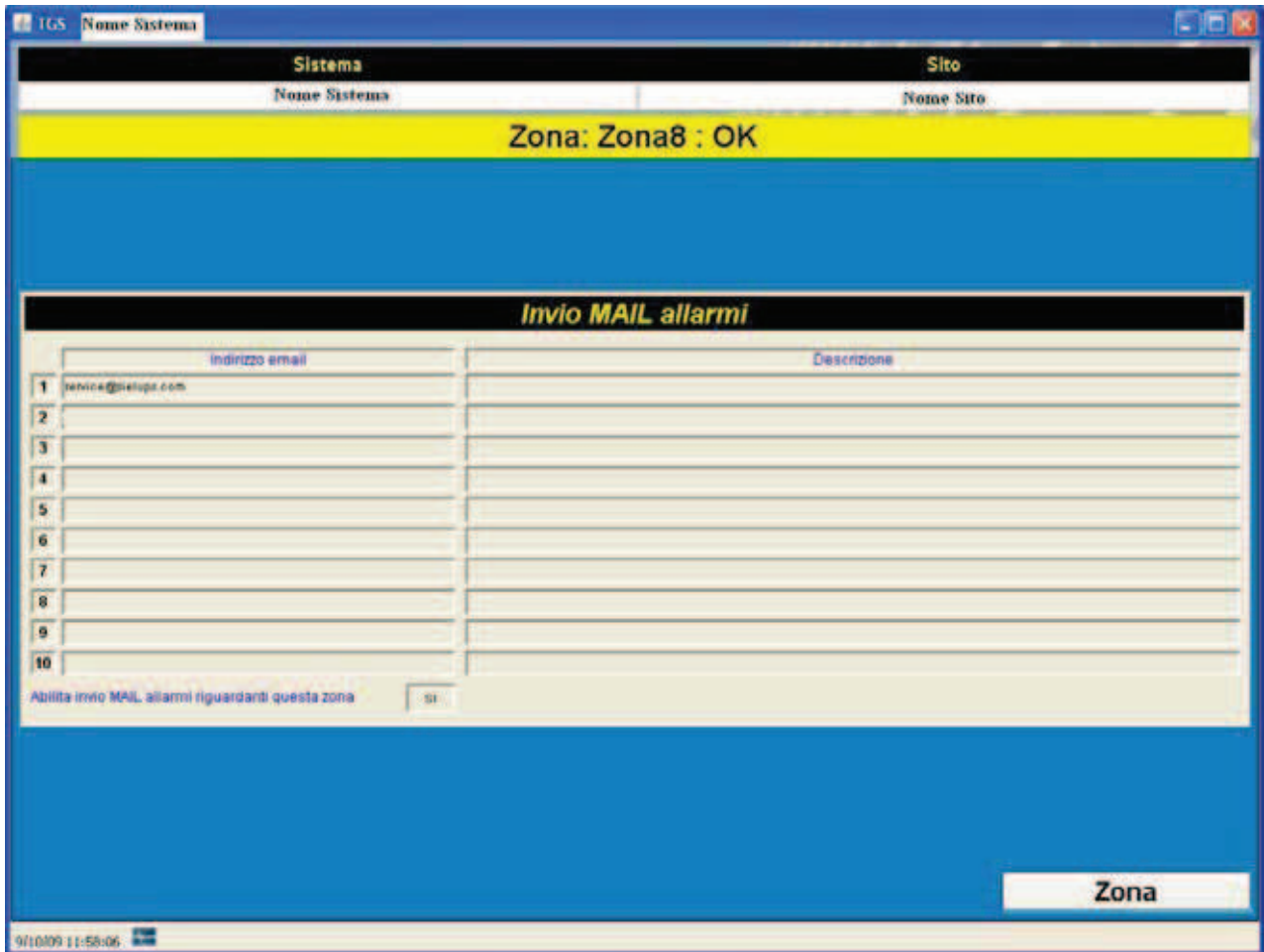
Figure 34 SMS settings screen

In the example in Figure 34 there are no names. Only names or aliases are published, but not the full telephone numbers.

N.B.: From this screen, it is only possible to display the configuration, but it is not possible to modify it. To modify the configuration, it is necessary to contact the service administrator, i.e. SIAC.

- Clicking the **MAIL** link opens the window for configuring all the Alarm email addressees relating to the Zone.

The meaning is explained in section 0.



	Indirizzo email	Descrizione
1	benice@pietopa.com	
2		
3		
4		
5		
6		
7		
8		
9		
10		

Abilita invio MAIL allarmi riguardanti questa zona ☒ SI

Zona

9/10/09 11:58:06

Figure 35 Email settings screen

N.B.: From this screen, it is only possible to display the configuration, but it is not possible to modify it. To modify the configuration, it is necessary to contact the service administrator, i.e. SIAC.

Clicking the **UTF** link enters the screen for configuring UTF Meter alarms. The meaning is explained in section 0.

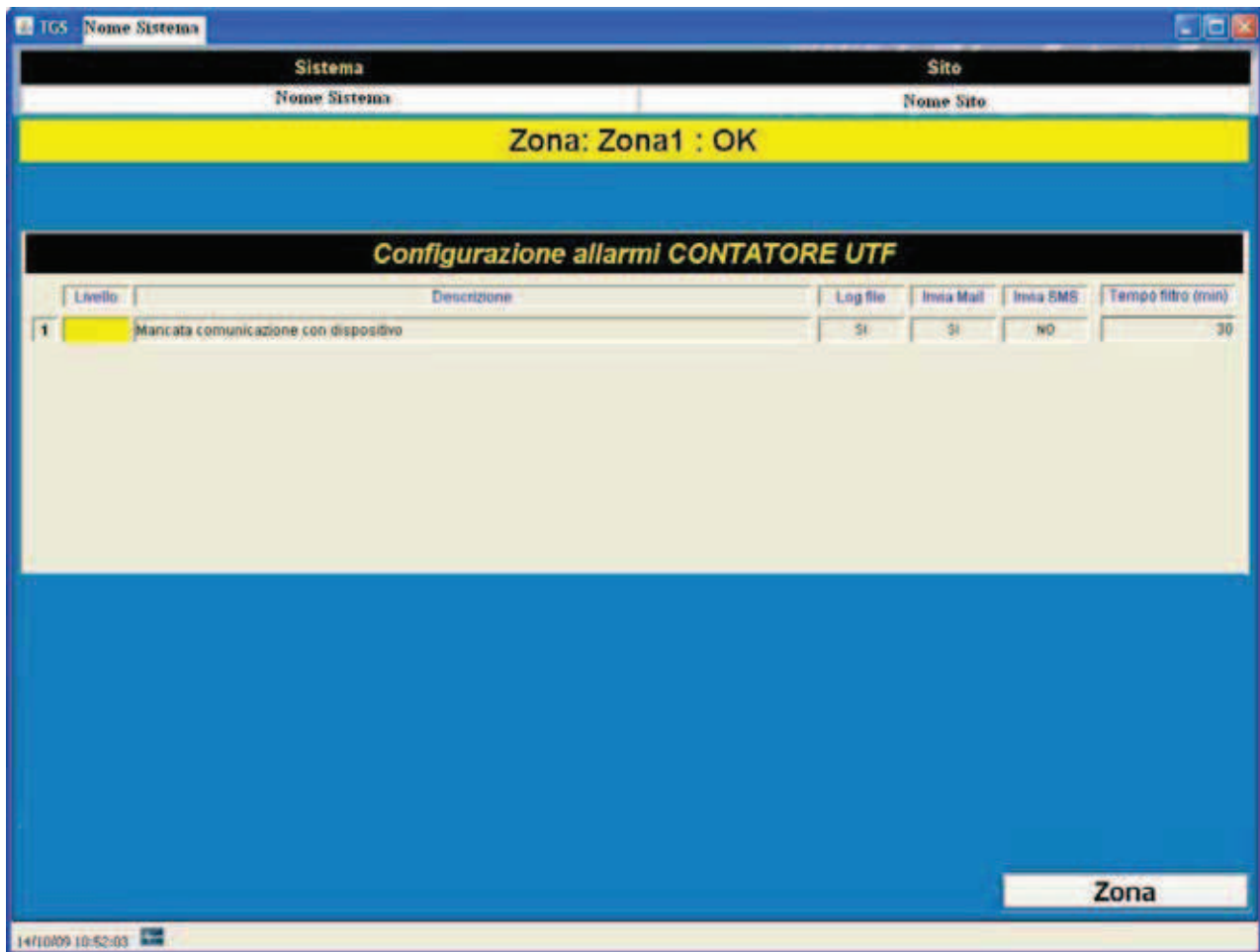


Figure 36 UTF Meter alarms screen

N.B.: From this screen, it is only possible to display the configuration, but it is not possible to modify it. To modify the configuration, it is necessary to contact the service administrator, i.e. SIAC.

4.3.1.5 Generator Screen

Clicking the Generator icon on the **Zone screen** Figure 30 opens the detail screen:



Figure 37 Generator screen

Each **Generator** is composed of a single Inverter, which can be Analogue or DSP an from 0 to a maximum of 16 CSP-12 units. In the example, there is a **SOLEIL DSP** Inverter and 2 **CSP-12** units.

The top of the screen shows the tree for the Generator and the status bar with the number of the Generator, which can be from 1 to 8, and the status, with the background colour summarising the status.

The section to the lower left of the screen always shows the **legend** and the text **Performance graphs**. The characteristics of these graphs are identical to those described in section 0 with the sole difference that in this case they refer to the Generator and not the System or Site, both in terms of the irradiation and the Total power evaluated.

The bottom centre of the screen shows the **Generator Balance** window, with summary data relating to the Generator itself.

The bottom right of the screen has a **Zone** button. Clicking this returns the user to the previous screen.

Clicking the icon for the Inverter or the CSP-12 accesses their details.

4.3.1.6 Inverter Detail Screen

The SOLEIL DSP Inverter detail screen is:



Figure 38 Soleil DSP Inverter detail screen

The SOLEIL Inverter detail screen is:



Figure 39 Soleil Inverter detail screen

Both have a summary of the Inverter with the status of the Inverter and a bar of LEDs, which are lit depending on the percentage Momentary Production in relation to the Nominal Power of the Inverter or that portion of the plant.

The lower part of the screen has a Status summary, with all the possible signals and the active signals indicated by a LED.

Above the screen is a summary of the General Data for the machine:

Serial number: this indicates the serial number of the machine.

Description: Optional. Can be used to enter a description of the machine.

Nominal power: this indicates the rating of the Inverter or, better still, the rating of the portion of the plant relating to that Inverter. In the example in Figure 38 Soleil DSP Inverter detail screen

it is 49.28.

Area: Optional. Can indicate the surface area of photovoltaic panels relating to that Inverter, expressed in m².

Operating hours: These are published by the application, and indicate the number of hours of production by the Inverter.

Even if in different positions, both screens have all the values for the machine, on both the DC input side and the AC grid side, in real time.

Both screens have 3 buttons for accessing the three graph sections.

The graphs are managed in an identical manner to that described for the **Performance Graphs** in section 0, both in relation to the choice of window to display, and in relation to the zoom mechanism.

- If the **AC section** is opened, the following window is displayed:



Figure 40 AC section graphs

This window displays the following graphs:

Power Input to the Grid, expressed in kW;

The **Daily Energy** expressed in kWh. This graph starts at 0 each day at midnight and increases as a function of the Energy Produced, whereby each point represents the Energy produced up to that time of the day;

The **Current**, which represents the values of the 3 currents input to the grid. There are 3 overlapping graphs, one in red (R phase), one in blue (S phase) and one in green (T phase).

The **Voltage** which represents the values of the 3 grid voltages. Again in this case, the 3 graphs are overlapping, using the same colours as for the current.

The ordinate axis shows the scale of one of the three graphs. To change it, press **Change Y**. The example for the Currents shows the **IS** graph (in blue), and for the voltages, the ordinates of the **VT** graph are shown (in Green).

Clicking on **Previous** return the user to the details for the device.

- Clicking the **DC section** button opens the following window:



Figure 41 DC section graphs

This presents the following graphs:

Module Voltage shows the graph of the voltage measured at the Inverter input. The measurement is in V;

Module Current shows the graph of the current measured at the Inverter input. The measurement is in A;

Module power represents the module input power measured at the Inverter.

The **Previous** button returns the user to the details screen.

- Clicking the **Cells** button opens the following window:



Figure 42 Graphs of the cells

This window has the following graphs:

Irradiation (expressed in W/m^2): this represents the value of the irradiation measured by a sample cell or solarimeter connected to the inverter input. If the solarimeter is not directly present on that inverter, the cell irradiation of a reference Inverter is displayed. Reference inverter is understood as being an inverter selected within the Zone which has a sample cell connected, acting as a reference for all the others. Thus, an essential condition to obtain meaningful values is to have at least one sample cell per Zone.

Module Temperature (expressed in $^{\circ}C$): this represents the temperature of the modules, measured using a temperature probe positioned behind one module and connected to the inverter input. Again, here, the case for the reference Inverter applies.

4.3.1.7 CSP-12 detail window

Clicking on one of the CSP-12 icons in the **Generator** screen, as in Figure 37, opens the following window:

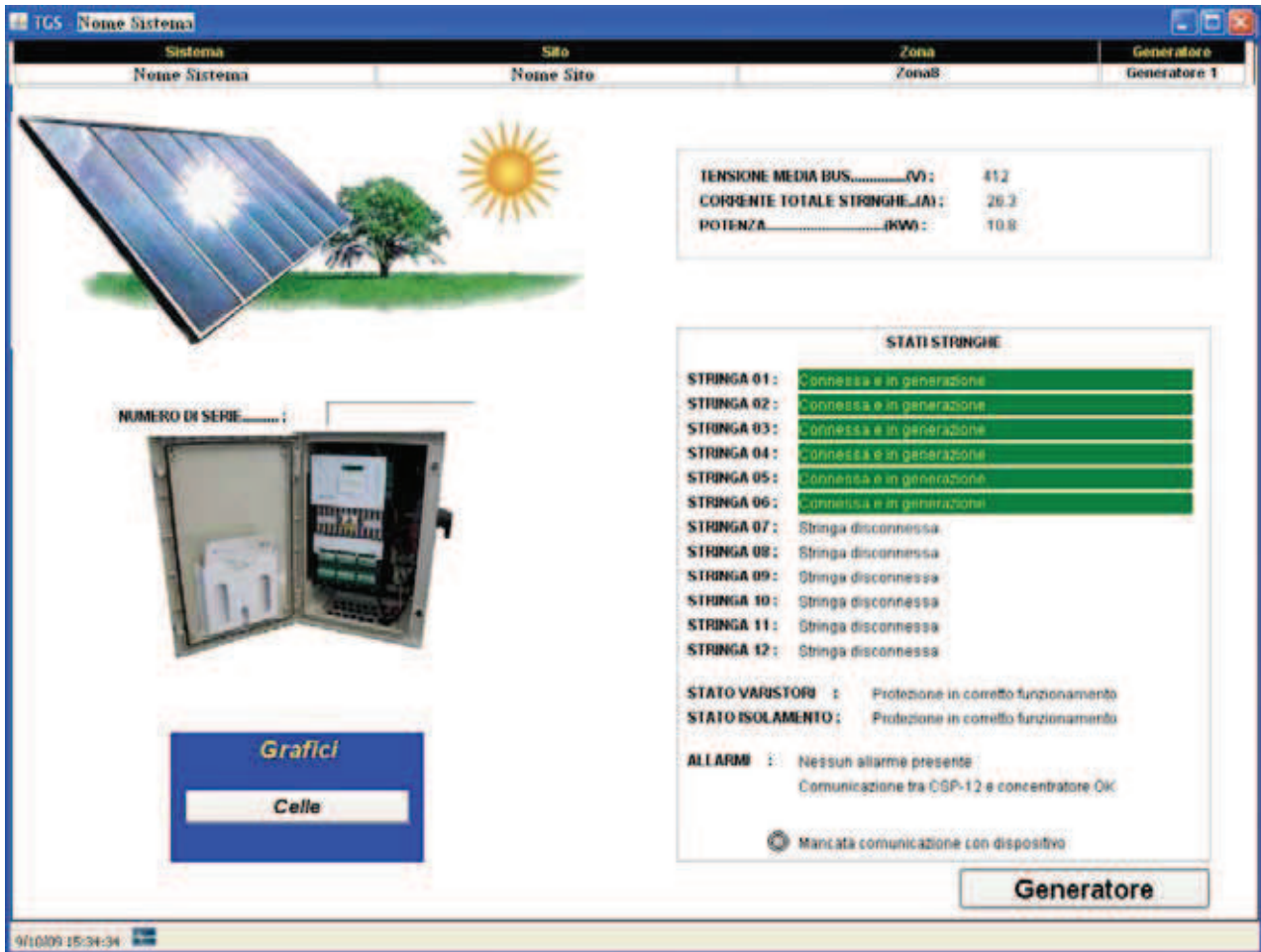


Figure 43 CSP-12 detail screen

The CSP-12 detail window presents:

the **Serial Number**: this is the serial number of the CSP-12 unit.

One section of analogue measurements, representing the **Mean Voltage** measured on the connected strings, the **Total String Current** representing the sum of the currents delivered by the individual strings, and the **Power**, which is the total power output by the Box.

One section with the States and/or Alarms for all the strings and the entire CSP-12, as described in section 4.1.3.

Clicking on **Generator** returns the user to the upper screen.

Clicking on **Cells** opens the graphs section, which is:

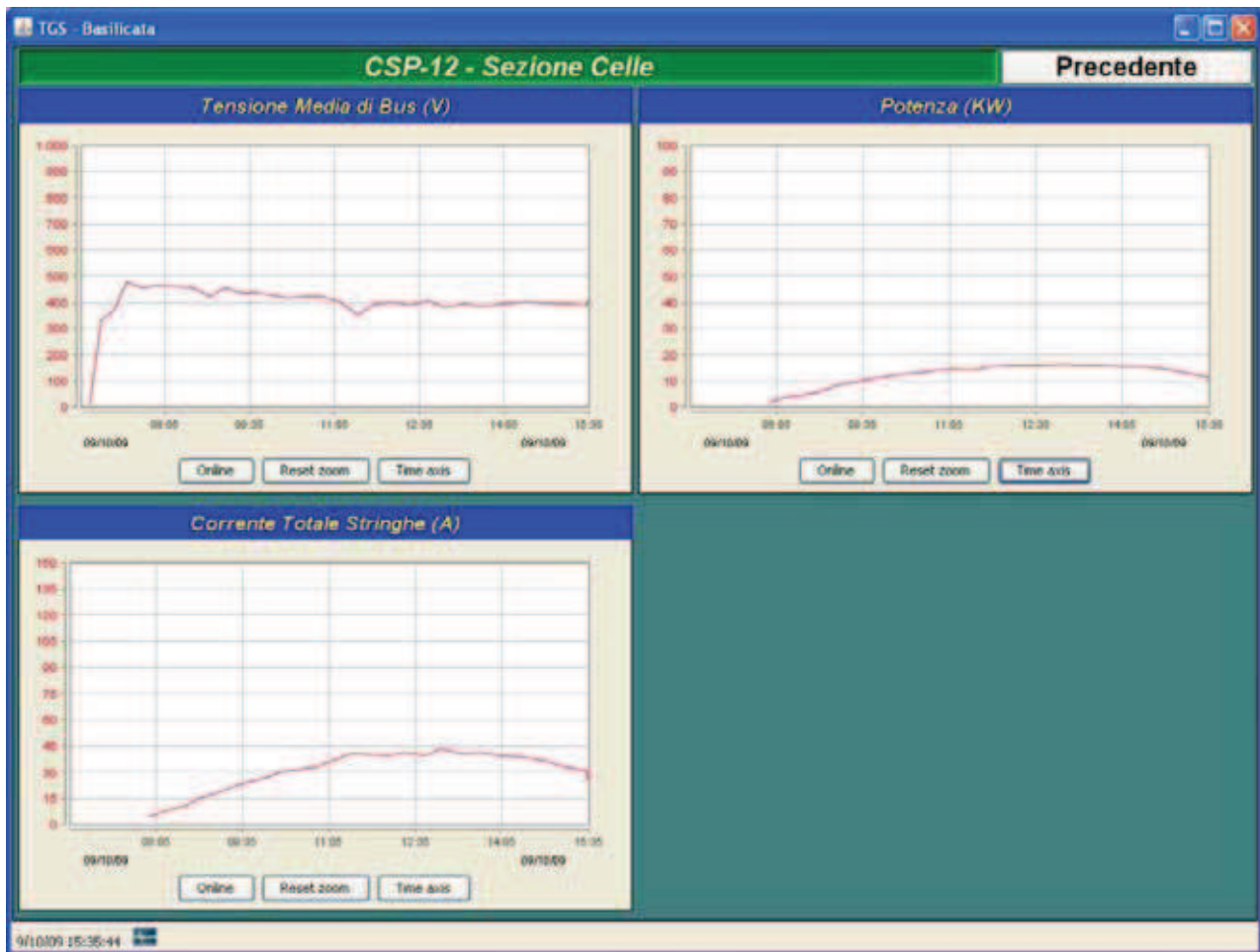


Figure 44 Cell section graphs

The three graphs report the three analogue values, displayed in the detail of the CSP-12.

4.3.2 Log Files

If the **System Name Log File** link is accessed from the dedicated Client web page, a page such as this is opened:

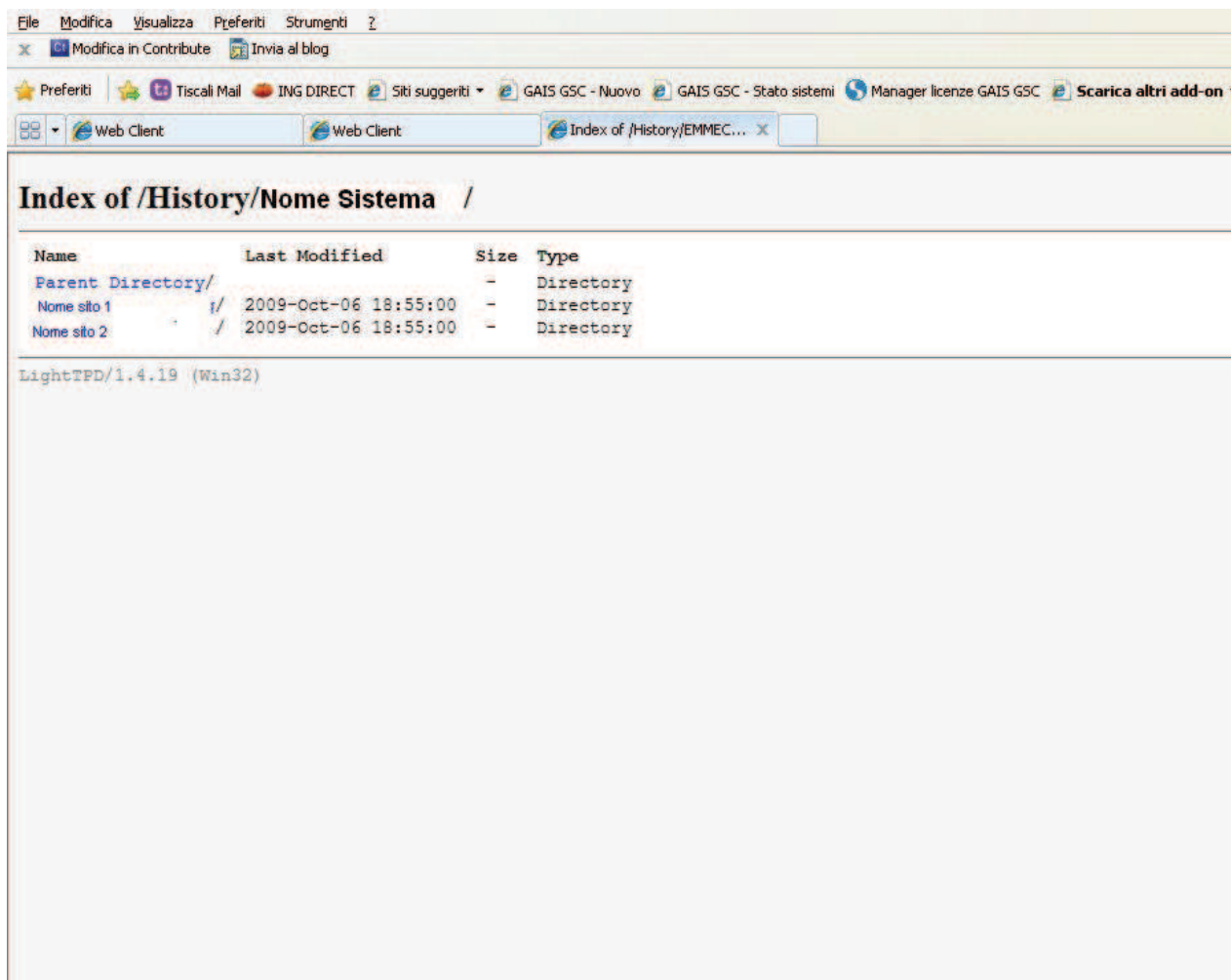


Figure 45. Log Web Page

The page displayed contains links to the sites present in the system.

The structure is like that of a folder, with sub-folders, where clicking on Site Name 1 opens a folder with as many links as there are Zones and so on, until reaching the individual device.

Inside the folder for the individual device are all the collected log files, in csv format.

Each day, the system generates up to 3 files for each device. A device is understood as being an atomic component, i.e. a SOLEIL or a SOLEIL DSP or a CSP-12.

The structure of the file-name is:

yyyy-mm-dd-SOLEILDSP[nn] where yyyy is the year, mm the month and dd the day, while nn represents the Modbus address assigned to the device in the field.

The file just described reports the data collected. The first line of the file shows a concise but clear description of the meaning of the field.

The file yyyy-mm-dd-STATI_SOLEILDSP[nn] reports the changes in Status;

The file yyyy-mm-dd-ALLARMI_SOLEILDSP[nn] reports all the alarms for the device in question. If there have not been any alarms on the stated day, the file is not generated.

The ending of the file is SOLEILDSP, SOLEIL or CSP-12 depending on the type of device in question.

- The data files for a SOLEIL DSP and for a SOLEIL have the following information in the columns:

dd/MM/yyyy H.mm.ss: represents the sample storage date and time;

VoutR (V), VoutS (V), VoutT (V): represent the 3 grid voltages;

IR (A), IS (A), IT (A): represent the 3 grid currents;

Pout (kW) : represents the Momentary Power Delivered;

Tamb (°C) : represents the ambient temperature;

Tcell (°C): represents the temperature of the Cell, measured using a temperature probe, if present;

Vcell (V): represents the cell input voltage;

Icell (A) : represents the cell input current;

Irr (W/m²) : represents the Irradiation measured by the sample cell, if present;

E_KWH: represents the portion of the total energy produced, in kWh. This a number varying between 0 and 999.9 kWh;

E-MWH: represents the portion of the total energy produced, in MWh;

H_USE_H and H_USE_L : represents the two operating hour components. The total hours are calculated thus: **Total hours = (65536 * H_USE_H) + H_USE_L;**

E_TOT_G(kWh): represents the Partial Daily Energy, expressed in kWh;

E_TOT(kWh): represents the Total energy, calculated by combining the fields E_KWH and E_MWH;

A_Input: represents a value from 0 to 100, which is percentage of an optional analogue input;

A_Output: represents a value from 0 to 100, which is percentage of an optional analogue output.

- The data files for a CSP-12 have the following information in the columns:

dd/MM/yyyy H.mm.ss: represents the sample storage date and time;

Vmean (V): represents the Mean voltage calculated for the Connected Strings

ITot (A) : represents the Total Current output from all the Connected Strings

Power (kW) : represents the Total Power output from all the Connected Strings.

4.4 Report mailing service

The report mailing service offers two services.

One makes it possible to send two mails per week and one is a mailing list defined for the system, as in Figure 28.

There are two mail messages which are prepared at midnight at the start of the week. For the TGS2 units, this day is Monday.

Each of the two mail messages contains a report file.

The sender is always TelegestioneImpiantiSolari@sielups.com

The subject is **Solar Plant Remote Management - Weekly ALARM Report**.

There is no message body, but a report file is attached.

The two report files that are to be found in both mail messages are in cvs format, and are:

yyyy-mm-dd1 to yyyy-mm-dd2 ALARMS Name_System Name Site.csv

and

yyyy-mm-dd1 to yyyy-mm-dd2 ENERGY Name_System Name Site.csv

In both files, yyyy-mm-dd1 and yyyy-mm-dd2 represent the start and end dates of the period for which the data is reported.

The former is an **Alarm File**, reporting all the alarms occurring at that site during the week observed.

The latter is an **Energy Report** reporting the weekly production data and the current month for each inverter for that site, divided by Zones, a summary of each Zone and a summary for the entire Site.

In addition, the file reports the **Energy Irradiated** (calculated in **Wh/m²**) on that Inverter, calculated from the irradiation value for the reference Inverter.

This value is used to calculate the **PR (Performance Ratio)** which is a plant quality parameter, calculated from the ratio of the Energy Irradiated and the Energy input to the Grid, according to the instructions reported in the document **CEI EN 61724 Measuring the performances of photovoltaic systems. Guidelines for the measurement, exchange and analysis of data**, 1999.

These values are calculated for the current week to which the mail refers, they are also calculated for the previous month and for the previous year.

The other service offered is a daily Alarm Report mailing with an attached Excel file.

The mail is prepared each day at 4 and analyses all the events from the previous day in order to provide the number of recurrences of significant alarms.

The sender is always TelegestioneImpiantiSolari@sielups.com

The subject is DAILY ALARMS Report System Name.

There is no message body, but a report file is attached.

The file has 7 columns with the following headings:

SYSTEM	SITE	ZONE	GENERATOR	DEVICE	ALARM	NUMBER OF EVENTS
--------	------	------	-----------	--------	-------	---------------------

Each row will then contain the number of recurrences for each alarm in relation to a certain device.

The alarms reported follow such criteria as the time band in which they occur and the minimum duration in order to be considered worthy of being counted.

If there have been no significant alarms during the day analysed, a mail is sent in any case which will be a single mail with just the heading shown in this section.