



## TRANSFORMING RENEWABLE POWER SOURCES INTO SMART POWER PLANTS PLANT CONTROL SYSTEM COMPLYING WITH THE MOST DEMANDING GRID CODES

The INGECON® SUN Plant Controller helps the Grid Operator to manage the power plant performance and to guarantee the quality and stability of the electric supply.

### Maximum plant control

A set of advanced control algorithms combined with a fast and efficient communications system, with configurable response times of less than one second, allows for a precise control of the active and reactive power delivered by the plant to the grid.

The INGECON® SUN Plant Controller controls the PV and/or BESS inverters, ensuring compliance with the Grid Operator's requirements at the Point of Connection.

This is a flexible system that can easily be adapted to the needs and configurations of each particular plant, whilst complying with the country-specific standards and regulations.

### Continuous communication with all the devices

The Power Plant Controller can dynamically receive setpoints from different control governors, such as the local SCADA or the Grid Operator. For this purpose, a number of communication protocols can be incorporated such as DNP3, IEC 60870-5-101/104 or OPC UA, considering that Modbus TCP is always available by default.

Furthermore, the INGECON® SUN Plant Controller permits communication with any SCADA to transmit the data related with control, Point of Connection, status of inverters or the communication with the different devices. It is also possible to perform maintenance or engineering operations by commanding the Power Plant Controller.

### Accurately benchmarked against simulations

Simulation models of PSCAD, PSS®E, PowerFactory, Anatem or ETAP of the INGECON SUN Plant Controller are supported to verify compliance with any control requirement. Furthermore, Power Plant Controller can be run in a Hardware-In-The-Loop environment and provide a benchmark result against simulation models and reality.

## TRANSFORMING RENEWABLE POWER SOURCES INTO SMART POWER PLANTS

### Plant control system complying with the most demanding grid codes

#### PRODUCTION CONTROL

Some of the active power control functions that can be activated in the INGECON® SUN Plant Controller are:

##### Active Power Curtailment.

It controls the plant's output power, limiting it to a desired value.

##### Solar Power Reserve.

The INGECON® SUN Plant Controller incorporates an innovative control strategy to guarantee an active power reserve with no need to include storage systems (depending on the availability of the PV resource), although it is also compatible with the addition of an ESS.

##### Ramp Rate Control.

This control, ensures that the variation in the power plant's output conforms to the established setpoint. In order to be able to control any power variation, it is necessary to add an ESS with enough capacity.

##### Fast Frequency Regulation.

The system adjusts the power production depending on the frequency variations.

##### Energy Time Shifting.

This control mode enables an advanced power generation planning, making the power plant's production profile follow a desired schedule.

##### Individual feeder Curtailment.

When there is need for curtailing the active power of certain group of inverters or MV feeders, the INGECON® SUN Plant Controller allows the enabling of individual closed control loops for each cluster, while ensuring the curtailment at Point of Connection is not surpassed.

##### Hybrid Firming Dispatch.

An energy storage system allows for a more optimised use of solar energy, utilising the energy stored to compensate the surplus or shortfalls of solar power, while controlling the active power injected to the grid.

##### SOC Control.

Power Plant Controller can control the power exchange of all the BESS converters so that a SOC target is reached in a smooth and stable manner. Furthermore, in normal operation, the control algorithm equalizes the SOC value of each individual BESS with the objective of reducing the differences with respect to the average SOC of the plant

#### GRID SUPPORT

Some of the reactive power control functions that can be enabled in the INGECON® SUN Plant Controller are:

##### On Demand Q.

The system developed by Ingeteam allows to control the reactive power output, adjusting it to a given reference.

##### Power Factor Control.

Regulation of the power factor at the Point of Connection.

##### Voltage Droop Control.

According to an established Droop gain, the system calculates the necessary reactive power at the Point of Connection, proportional to the existing voltage difference.

##### Automatic Voltage Regulation.

The INGECON® SUN Plant Controller makes it possible to regulate the plant voltage at the Point of Connection through a control system applied to the voltage closed loop, providing the maximum reactive power capability if needed.

##### Black Start Capability.

The system can restore the electric supply during a blackout by creating an AC network to power the loads.

##### Q at Night Capability.

With this mode, the reactive power at the Point of Connection can be regulated up to any desired value, 24 hours a day.

##### Power Oscillations Damping.

In those places where the grid is divided in different interconnected zones, the power plant can suffer from low-frequency oscillations. The Plant Controller allows implementing a control strategy to minimise these oscillations in both stationary and transitory regimes, although Ingeteam's voltage control loop already damps any voltage oscillation measured on the grid.

##### Q Production Profile

A Q-P profile curve can be configured so that reactive power target will correspond to the curve's output, which will change according to the active power export level.

#### OPERATION FUNCTIONALITIES

##### P Open Loop.

This operating mode allows for controlling the active power generated at the inverter's terminals, and thus any inverter working point.

##### Q Open Loop.

This operating mode allows for controlling the reactive power generated at the inverter's terminals, and thus any inverter working point.

##### Q-P curve Limitation

Up to 15 Q-P curves (5 levels of voltage and 3 levels of temperature) can be configured in order to establish reactive power limits for any active power level.

##### Q-V curve Limitation

With the purpose of supporting the voltage control of the grid and limiting the amount of reactive power allowed to exchange with the grid, a Q-V curve can be configured in the INGECON SUN Plant Controller.

##### Soft Shut Down

If the correspondent flag is enabled, after a deactivation of the Plant Generation, active power at POC is reduced to the technical minimum in a controlled way and reactive power is ramped to 0, before disconnecting all the inverters of the site.

##### Tap Changer Management

In case the control of the tap changer of the main transformer is required to be considered into the voltage control strategy, INGECON SUN Plant Controller includes an algorithm to do so.

##### Capacitor Banks Control

Sometimes, the connection and disconnection of the capacitor bank steps have to be coordinated with the inverter's production and grid's conditions. INGECON SUN Plant Controller includes some Finite State Machines to perform this coordination in a safely manner.

##### Ripple Control

Individual inverters can be selected to operate under Ripple control, which means they are taken out of the main control loop, and the open loop P and Q commands they will receive are the ones selected by the SCADA for each individual unit.

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## Plant control system complying with the most demanding grid codes

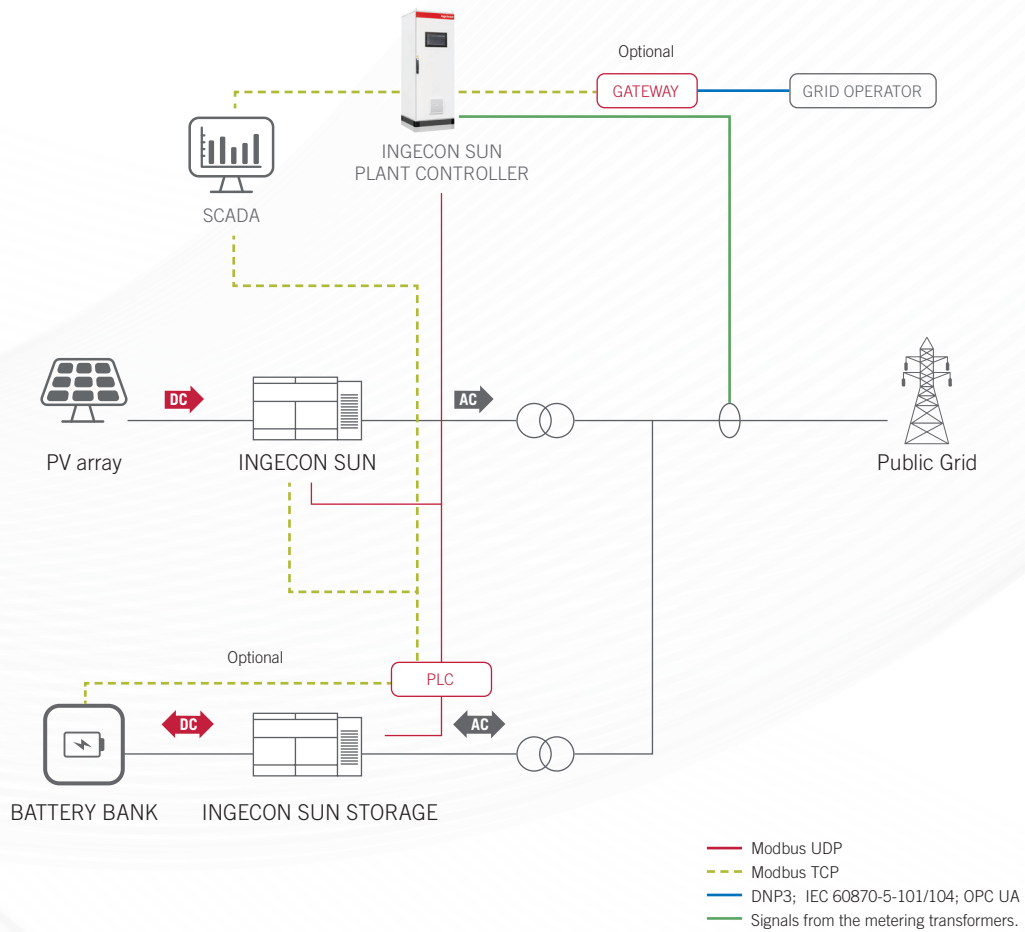
### INCLUDED ITEMS

- PLC.
- Power meter.
- Communications switch.
- Power supply.
- Industrial PC as engineering station

### OPTIONS

- HMI
- Hot Redundancy
- Gateway for Operator's protocols
- Remote measurement
- UPS.

### SCHEMATIC



Specifications included in this datasheet could change without notice. Please contact Ingeteam's sales department in case of any queries.

INGECON SUN\_PlantController\_Rev\_A2

POWER ANALYZER <sup>(1)</sup>

## INGECON® SUN Plant Controller

Energy metering accuracy	≤ 0.2%
Voltage metering accuracy	≤ 0.1%
Current metering accuracy	≤ 0.1%
Frequency metering accuracy	≤ 10 mHz <sup>(2)</sup>
Power metering accuracy	≤ 0.2%
Input voltage range	110 - 690 V
Input current range	10 mA - 5 A
Power quality registration (PQ)	Optional
Redundancy	Optional

## POWER SUPPLY

Voltage supply	100 - 240 Vac, 50-60 Hz / 110 - 250 Vdc
Typical consumption <sup>(3)</sup>	60 - 590 W
Maximum consumption <sup>(3)</sup>	72 - 710 W
UPS capacity <sup>(4)</sup>	Up to 960 W / 1.15 kWh
Redundancy	Optional

## COMMUNICATION

Standard protocols	Modbus TCP & UDP (client and server), FTP (client and server), NTP (client and server)
Compatible protocols <sup>(5)</sup>	IEC 60870-5-101/104 (Slave), DNP3 (Slave), OPC UA (Server)
Outer connectivity	Ethernet Copper, Optic Fiber (Single mode or Multi Mode)
Managed communication <sup>(6)</sup>	Yes, with SNMP v1/2/3, VLAN, DHCP, Flow control, NTP, MAC filter, Ring management
Redundancy	Optional

## COMPATIBILITY

Inverters	IS 3Play, IS 3Power & ISS 3Power (B & C Series)
Utilities	Main industry protocols, with the addition of a gateway
Batteries	Main manufacturers
SCADA	Main industry protocols
Reactive power compensation systems	Modbus or hard-wired interface
On load tap changer	Modbus or hard-wired interface
Weather Stations	Modbus interface

## O&amp;M FUNCTIONS

Datalogger <sup>(7)</sup>	4 GB Compact Flash memory
Equipment start up / stop	General and individual start up or stop of the inverters, BESS and capacitor banks
Power plant surveillance	Monitoring of the status of every single element inside Plant Controller's control scope
Others	Individual selection of inverters for night-time reactive power mode or open loop behavior, Manual clearing of restart blocking after a communication failure

## CPU

Typical processing time of control algorithms	≤ 2 ms
Control period	100- 200 ms (configurable)
Clock	Internal RTC synchronizable through NTP
Surveillance system	Watchdog, working times surveillance, CPU temperature and input/output status
Redundancy	Optional

## GENERAL DATA

Dimensions (H/W/D)	2158 / 807 / 826 mm
Weight <sup>(3)</sup>	215 - 290 kg
Protection class	IP55
Impact resistance	IK10
Overvoltage protection	Type 2
Installation	Ground
Operating temperature <sup>(8)</sup>	0 to 40 °C
Storage temperature	-20 to 50 °C
Maximum relative humidity (non-condensing)	95%
Marking	CE, UL
Electrical security standards compliant	IEC 61439-1&2, UL508A
Quality measurement standards compliant	IEC 61000-4-30, IEC 62586-1
Grid Code Compliance certificates	Spain: NTS SEPE&SENP, Germany: VDE-AR-N 4110/4120/4130
Other standards	IEC 61131-2,3

## Notes

(1) Final parameters depend on the actual analyzer model installed on site.

(2) For voltages greater than 30% of the nominal voltage.

(3) Values considered for the minimum and maximum possible amount of devices inside the cabinet, respectively.

(4) If the installation does not feature an energy storage system, the ride-through autonomy would be up to 400 ms.

(5) These protocols would be available with the addition of a communication gateway that is quoted as an extra.

(6) Final configuration and design of the communication network is outside of Ingeteam's scope of supply.

(7) Data accessible through an FTP server.

(8) Without the addition of any climatic management component such as heating resistor.

\* For other configurations, please contact Ingeteam's solar sales department.

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