

## PV PLANT CONTROL SYSTEM

The INGECON® SUN Plant Controller helps the grid operator to manage the PV plant performance and to guarantee the quality and stability of the electricity supply.

### Maximum PV plant control

An advanced algorithm combined with a fast and efficient communications system, with 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 inverters, ensuring compliance with the grid operator's requirements at the

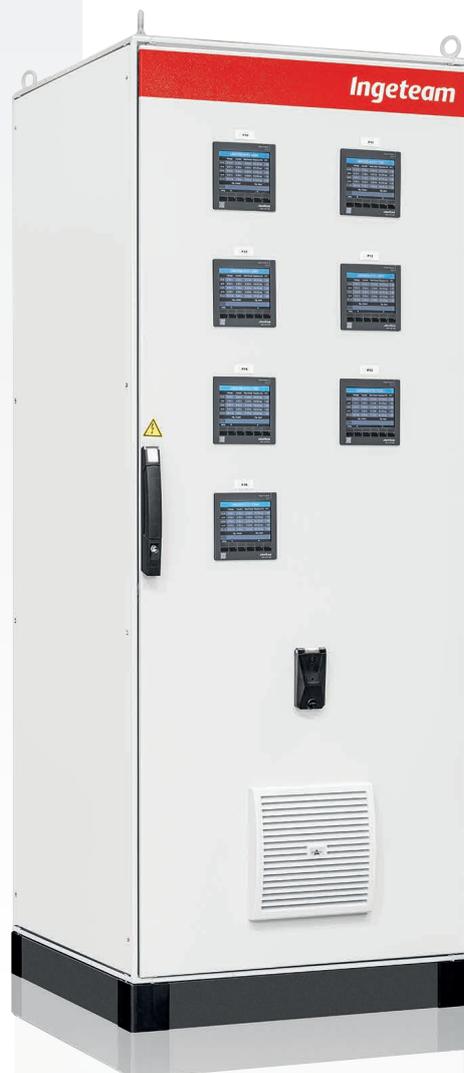
PV plant connection point. It is also possible to manage energy storage systems and other devices such as diesel generators, through the use of INGECON® SUN STORAGE Power inverters.

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 dynamically receives the grid operator's setpoints. For this purpose, a number of communication protocols are incorporated such as Modbus TCP / RTU, DNP3, IEC 60870-5-101, IEC 60870-5-104 and OPC UA. Likewise, it is also possible to add digital and analogue I/O modules in order to extend the communication capabilities with third-party devices.

Furthermore, the INGECON® SUN Plant Controller permits communication with the plant SCADA to transmit the connection point data. It is also possible a manual control for temporary maintenance or engineering operations.



## Plant Controller

### Description of the complete system

A PV plant with a plant controller typically consists of:

- INGECON® SUN Plant Controller, comprising two basic systems: metering and control. It can additionally incorporate a communication channel with the grid operator in order to receive the operating setpoints.
- INGECON® SUN PV inverters connected to the PV array.
- INGECON® SUN STORAGE battery inverters connected to the energy storage system.
- SCADA, plant monitoring system.

- Communications network. Connecting the INGECON® SUN Plant Controller with the different inverters, transmitting the operating setpoints and monitoring the status of the equipment.

### Operating mode

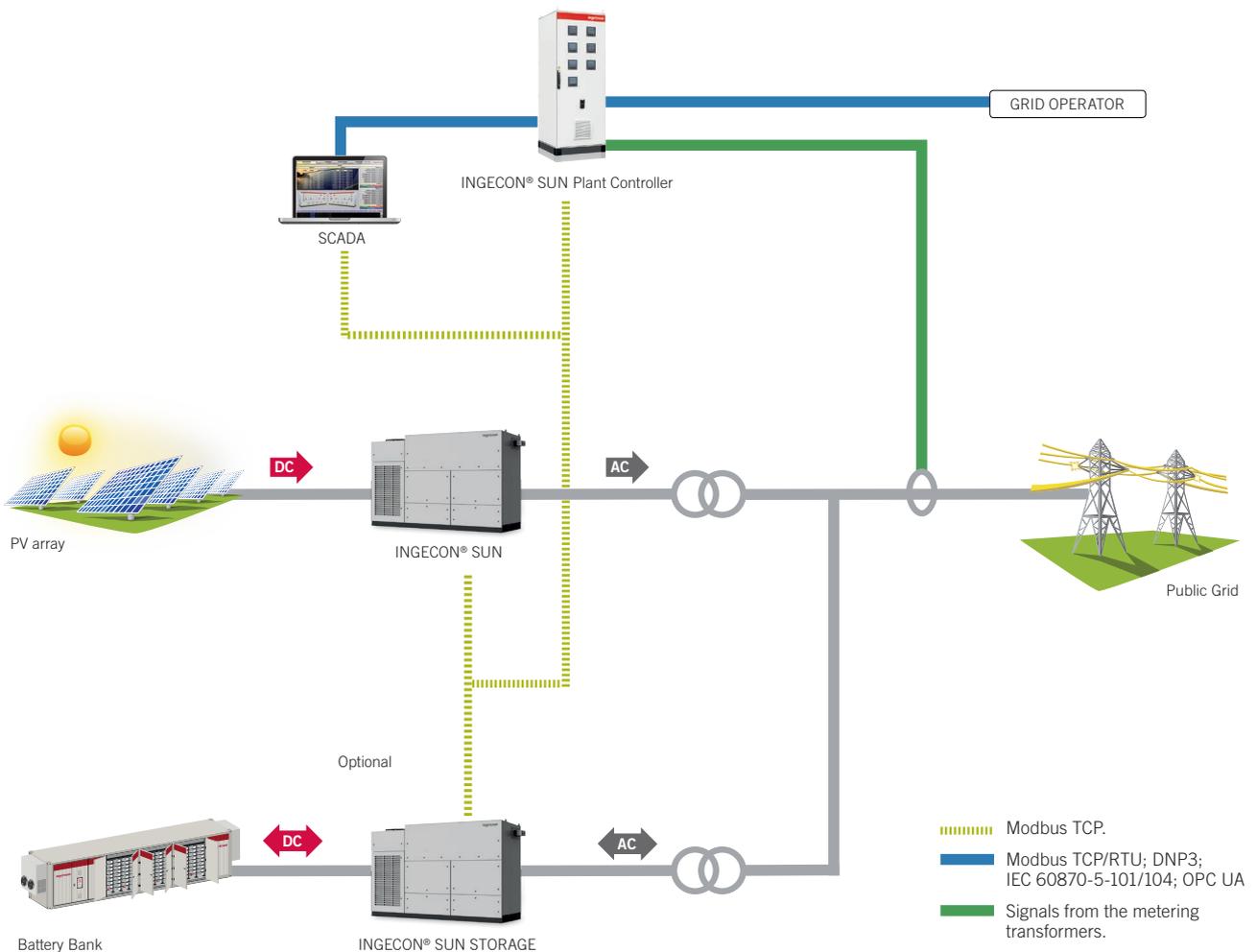
For the control, the INGECON® SUN Plant Controller takes the following data:

- Active power, reactive power, voltage and frequency at the point of connection, provided by the integrated metering unit.
- Grid operator requirements. To establish references for parameters such as voltage at the point of connection, ac-

tive and reactive power, power ramps, active power reserve, etc. These requirements can be predetermined either by the grid operator or by the plant operator or dynamically modified through an external setpoint.

- Instantaneous values of the various elements inside the plant: inverters, batteries, weather stations, reactive power compensation systems.
- With all these data, the controller can determine the optimum operating setpoints for each inverter integrated into the system and transmit the setpoints through the communications network.

### Schema



## System Features

### Production Control

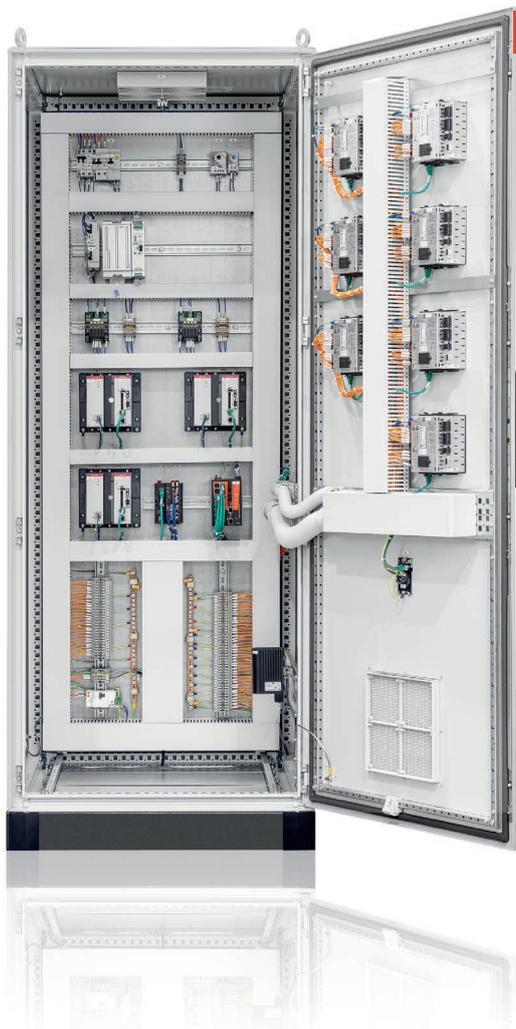
Some of the active power control functions that can be implemented in the INGECON® SUN Plant Controller are:

- **Active Power Curtailment.** It controls the PV plant's output power, limiting it to a desired value.
- **Ramp Rate Control.** It controls the power generated by the inverters, ensuring that the variation in the plant power output conforms to the established setpoint. So as to control any power variation, it is necessary to add an energy storage system.
- **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 unmatch the consumption profile.
- **P Open Loop.** This operating mode allows for controlling the active power generated at the inverter's terminals, and thus any inverter working point.
- **Hybrid Self-Consumption.** 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.
- **Uninterrupted Power Supply.** When a grid-tied system becomes an isolated one as a consequence of a distant interruptor opening, the power plant can create an AC grid in order to feed the loads.
- **Stand-Alone Generation.** In this mode, one of the inverters will create an AC grid by generating an AC voltage and frequency for the loads and the other inverters.
- **Solar Power Reserve.** The INGECON® SUN Plant Controller incorporates a 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.

### Grid Support

Some of the reactive power control functions that can be implemented 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.
- **Black Start Capability.** The system can restore the electric supply during a blackout by creating an AC network to power the loads.
- **Q Open Loop.** This operating mode allows for controlling the reactive power generated at the inverter's terminals, and thus any inverter working point.
- **Dynamic Reactive Compensation.** With this mode, the reactive power at the point of connection can be compensated up to any desired value, 24 hours a day.
- **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.
- **Voltage Droop Control.** According to an established Droop gain, the system selects the necessary reactive power at the point of connection, depending on the existing voltage difference.
- **Power Oscillations Damping.** In those places where the grid is divided in different interconnected zones, the power plant can suffer from low-frequency active power oscillations. The Plant Controller allows to implement a control strategy to minimise these oscillations in both stationary and transitory regimes.



#### INCLUDED ITEMS

- PLC.
- Power analyzer.
- Communications switch.
- Power supply.
- Protections.
- O&M socket.

#### OPTIONAL INPUTS / OUTPUTS

- Analogue inputs V/I.
- Analogue outputs V/I.
- Digital inputs.
- Digital outputs @24 Vdc or potential-free digital outputs.

INGECON® SUN Plant Controller	
<b>Power Analyzer</b>	
Energy metering accuracy	0.5 s / 0.2 s / 0.2 s
Voltage metering accuracy	0.2% / 0.1% / 0.1%
Current metering accuracy	0.2% / 0.2% / 0.1%
Frequency metering accuracy	10 mHz <sup>(1)</sup>
Power metering accuracy	0.5% / 0.2% / 0.2%
THD metering accuracy	Class 0.5 s
Voltage and current harmonics metering	1..40 / 1..63 / 1..63
Input voltage metering range	0..480 V @50 Hz / 0..347 V @60 Hz
Input current metering range	0..5 A
Other measurements	Unbalances / Rotation sequence / Positive, negative and homopolar sequences
Production quality registration (PQ)	Optional
Redundancy	Optional
<b>Power Supply</b>	
Voltage supply	85 Vac..264 Vac, 50 Hz..60 Hz
Typical consumption <sup>(2)</sup>	225 W
Maximum consumption <sup>(2)</sup>	270 W
UPS capacity <sup>(3)</sup>	15 Wh / 288 Wh
Redundancy	Optional
<b>Communication</b>	
Standard protocols	Modbus / TCP (client and server), FTP (client and server), NTP (client and server)
Compatible protocols	Modbus / RTU (Master and slave), 101 (Slave), 104 (Slave), DNP3 (Slave), OPC UA (Server)
Outer connectivity	10 / 100BaseT(X), 100BaseFX with patch panels
Managed communication	Yes, with SNMP v1/2/3, VLAN, DHCP, Flow control, NTP, MAC filter
Redundancy	Optional
<b>Compatibility</b>	
Inverters	IS 3Play, IS Power, ISS Power
Utilities	Main industry protocols
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
<b>O&amp;M Functions</b>	
Datalogger	4 GB Compact Flash memory
Equipment start up / stop	General start up or stop of the inverters, BESS and capacitor banks
Power plant surveillance	Monitoring of the status of every single element inside the plant
Others	Web server
<b>CPU</b>	
Typical processing time	< 10 ms
Clock	Internal RTC synchronizable through NTP
Surveillance system	Watchdog, working times surveillance, CPU temperature and input/output status
Redundancy	Optional
<b>General Data</b>	
Dimensions (H/W/D)	2,000 / 800 / 800 mm
Weight <sup>(2)</sup>	460 kg
Protection class	IP65
Impact resistance	IK10
Overvoltage protection	Type 2
Installation	Ground
Operating temperature	-20 to 50 °C / -4 to 122 °F
Storage temperature	-25 to 60 °C / -13 to 140 °F
Relative humidity (non-condensing)	10 - 90%
Maximum altitude <sup>(5)</sup>	2,000 m
Marking	CE
Standards	IEC 61000-4-30, IEC 62586-1, IEC 61131-3, IEC 60204-1, IEC 61439

**Notes:** <sup>(1)</sup> For voltages greater than 30% of the nominal voltage <sup>(2)</sup> Values measured with the highest possible number of hardware elements inside <sup>(3)</sup> If the installation does not feature an energy storage system, the autonomy will be 2 seconds <sup>(4)</sup> For other configurations, please contact Ingeteam's solar sales department <sup>(5)</sup> For installations beyond the maximum altitude, please contact Ingeteam's solar sales department.