SUBSTATION AUTOMATION

Ingeteam

INGETEAM
SUBSTATION AUTOMATION



Ingeteam has supplied **protection, control, and automation** solutions for electrical substations for **more than 50 years**. More than **10,000 installations** with our technology have been performed for the energy **transmission and distribution** and **renewable energy** generation industries.

Ingeteam makes available to our clients a **network of professionals**, covering **4 continents** to offer both service and assistance during each phase of their projects, from the initial project definition phase to the end of the useful life of the devices.

Index

ELECTRICAL GRID DIGITALIZATION

The electrical grid is facing important changes, due to the **increase in the demand for electricity** and the need to **reduce CO_2 emissions** to achieve a **more sustainable energy model**.

Energy transmission and distribution systems face the challenge of **guaranteeing the stability of the grid** under this new model based on distributed generation, primarily associated with the **integration of renewable energy plants**.

Fossil fuel-based energy systems are centralized and easy to predict. However, the production of new sources of energy takes place at various locations, and is therefore discontinuous and subject to variability, making the process more complex.

Digitalization of the grid makes it possible to have accurate information available about grid parameters at any given time. Real-time control of the grid provides the operator with **essential and accurate information** to improve proactive decision-making. With optimal information, it is possible to generate systems that are more efficient and reliable.

Protection, control and automation systems are key elements that guarantee a **reliable, efficient, and sustainable electrical grid**.

Ingeteam's range of products, solutions, and services facilitate digitalization of the electrical grid at all levels, reducing conventional cabling requirements and generating settings that are **safer and more environmentally friendly**.

Our equipment and services combine **protection, control, and measuring** functionalities, with the **latest technology** required by advanced communication processes. This, in turn, enables data acquisition, analysis, and sharing between systems, with the **highest degree of reliability and security**.

The control solutions offered by Ingeteam enable **acquisition and management of grid data and parameters** to identify situations, detect potential risks, and react appropriately, thereby prolonging the service life of grid components and resources.

More than **50 years of activity** in the electricity transmission and distribution sector attest to the high standard of availability, reliability, and flexibility provided by Ingeteam solutions. This ensures a trouble-free implementation of the requirements of each customer.

The range of Ingeteam products includes position control equipment, protection relays, substation remote control systems, and gateways, as well as substation SCADA equipment with its corresponding software tools.

PROTECTION AND CONTROL SYSTEMS

Ingeteam offers control solutions based on the **IEC 61850 standard**, comprised by intelligent electronic devices (IEDs) that control each electrical position and supply the collected data to a **SCADA** system, enabling operations, programming, analysis and reporting of all substation data, both locally and remotely.

Functions

- Local or remote control of any component
- Synchronization of all the components in the system
- Acquisition of statuses, events, and alarms
- Grid quality measurements and information
- Protection programming and fault registration
- Analysis and decision-making information
- Data records and logs
- User profile and password-based access control
- Control of communications between system components
- Automation of position and/or substation processes (logical sequences as per IEC 61131 standard)
- Acquisition of switch maintenance parameters
- System self-checks

Redundancy

With the aim of creating secure, reliable, and highly available systems, Ingeteam products work with **various types** of redundancy, whether applied to power supplies, HMI, or communications.

Ingeteam equipment is designed so the same hardware can be used to select various types of **PRP/HSR redundancy** protocols, which provide tolerance of communication network failures without losing network operability, as set forth in the **IEC 62439-3 standard**. This provides engineers with the necessary flexibility to choose the best communications architecture for their systems, according to the needs of the project.

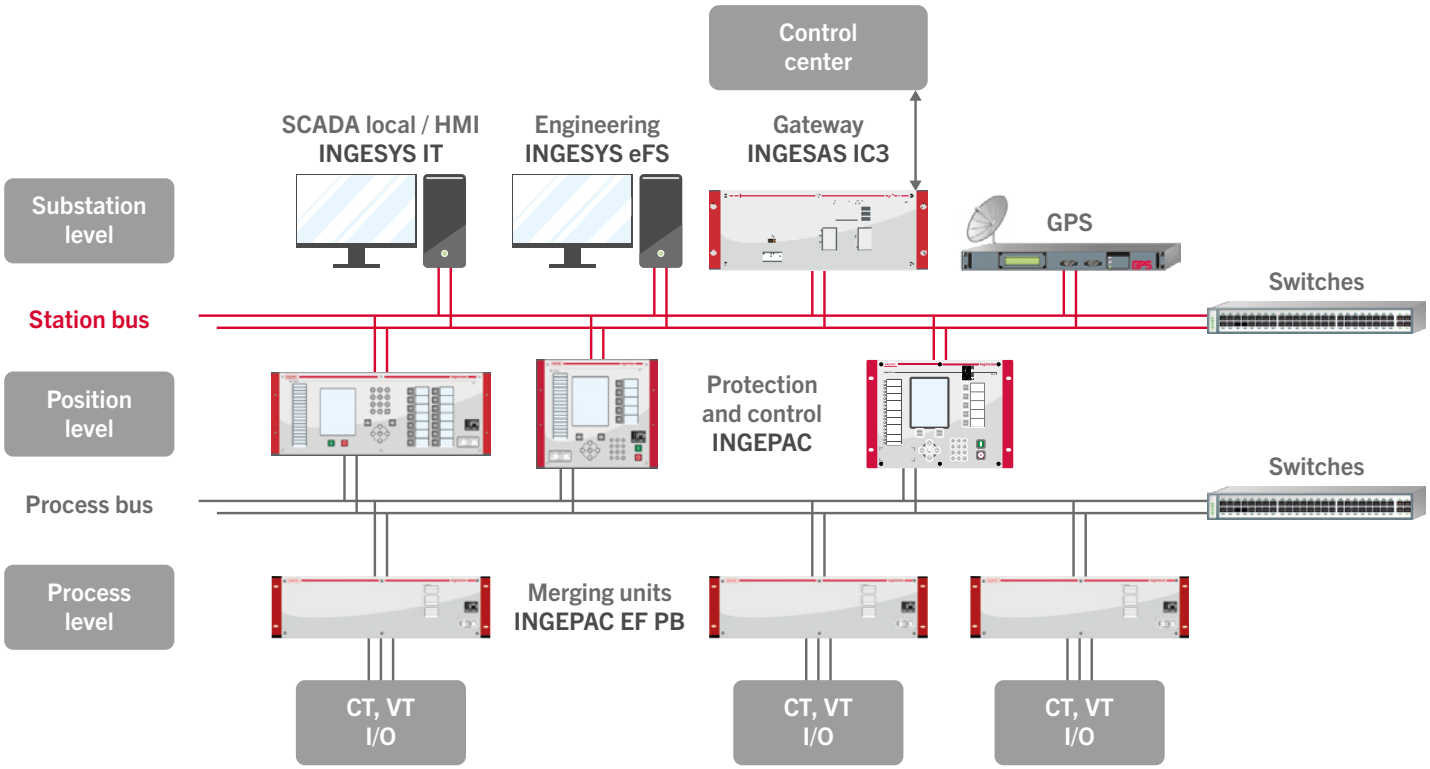
Synchronization

Ingeteam equipment is capable of handling both **millisecond** precision, achieved with NTP or SNTP time protocols, and the most demanding **1 µs** precisions of the **IEEE 1588 PTP v2** protocol, required in the process bus.

Cybersecurity

The equipment and systems have been designed taking into consideration international cybersecurity standards, such as **IEEE 1686-2013** (IEEE Standard for Intelligent Electronic Devices Cyber Security Capabilities), **IEC 62351** (Power systems management and associated information exchange - Data and communications security) and **IEC 62443-4** (Security for industrial automation and control systems).

Ingeteam systems use cryptographic techniques with a variety of algorithms and coding standards, such as **HTTPs** or **sFTP**. They are also equipped with other cybersecurity functions, such as role-based username/password access, control of access ports, and security event auditing.



Communication architecture example

SUBSTATION AUTOMATION

Bay control unit

INGEPAC EF CD

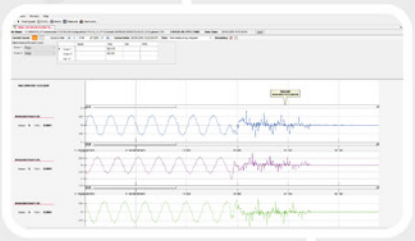
Feeder protection control

INGEPAC EF MD

INGEPAC DA PT

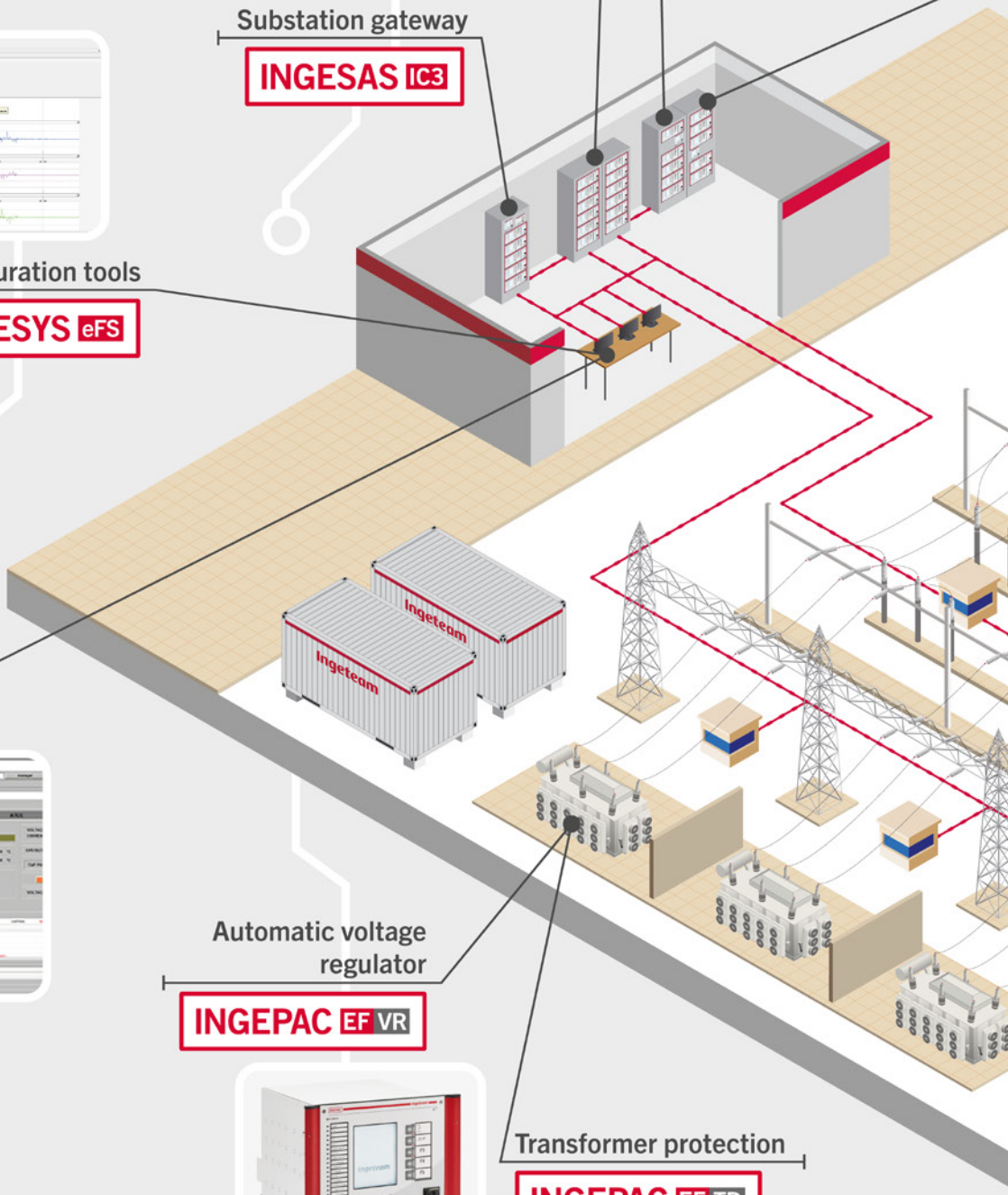
Substation gateway

INGESAS IC3



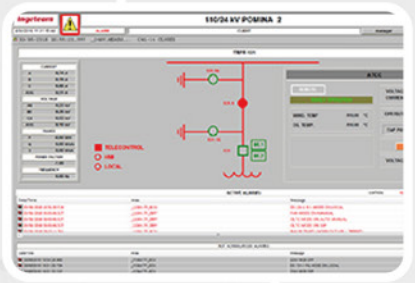
Engineering & configuration tools

INGESYS eFS



HMI / SCADA

INGESYS IT

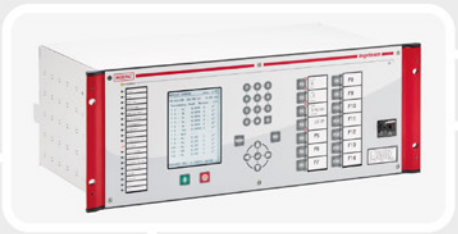


Automatic voltage regulator

INGEPAC EF VR

Transformer protection

INGEPAC EF TD



Distance protection

INGEPAC EF ZT

Line differential protection

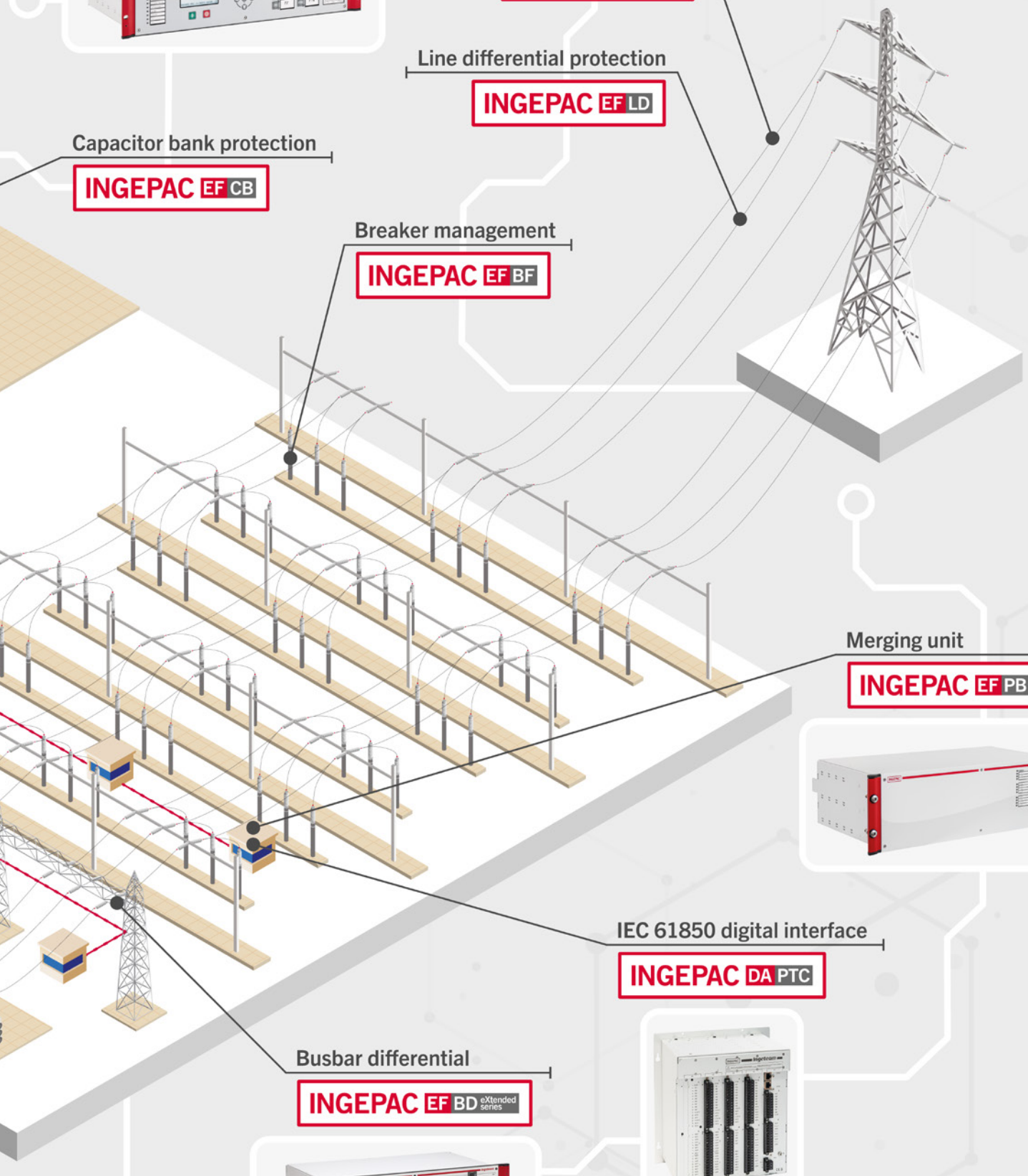
INGEPAC EF LD

Capacitor bank protection

INGEPAC EF CB

Breaker management

INGEPAC EF BF



Merging unit

INGEPAC EF PB

IEC 61850 digital interface

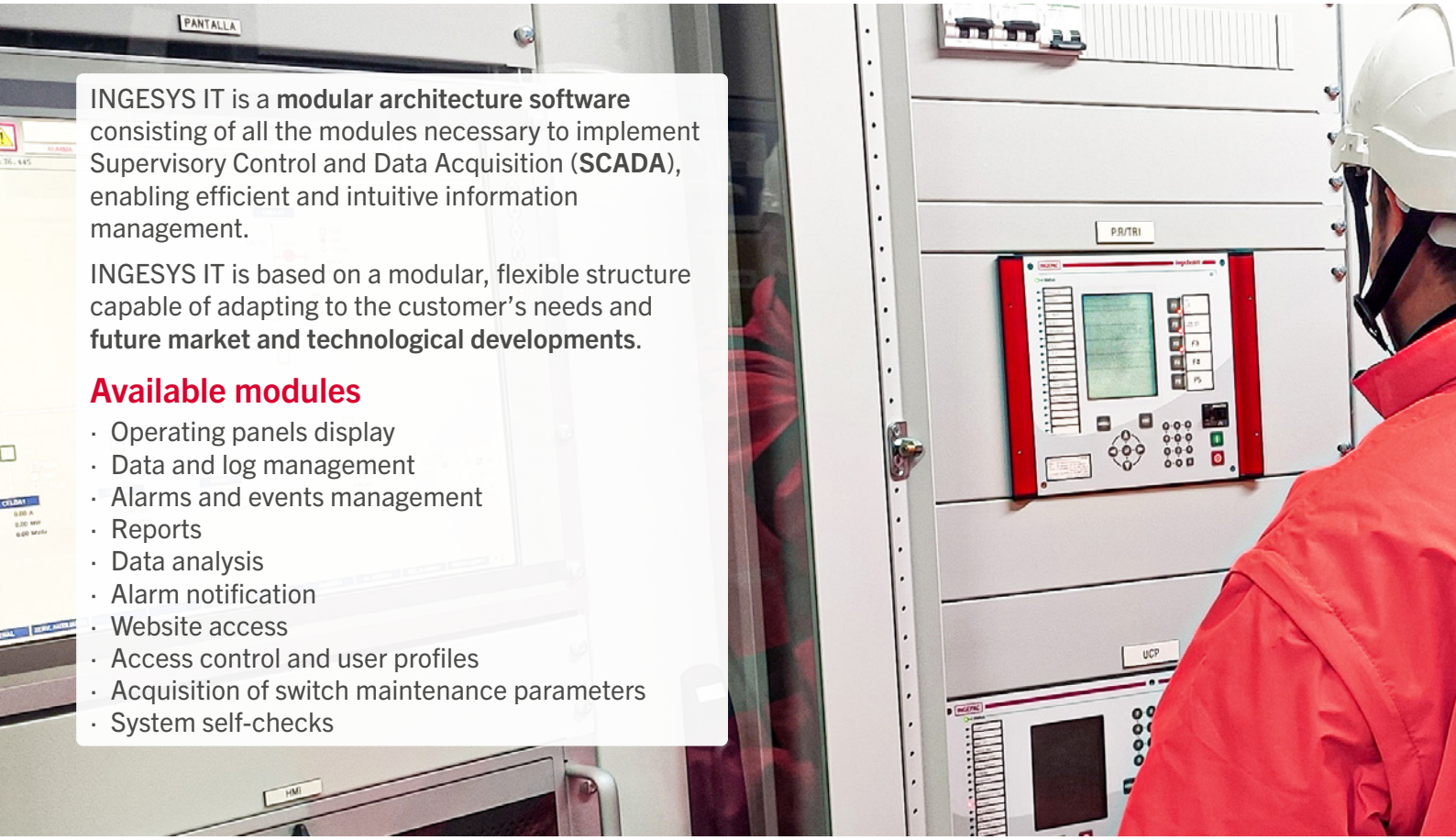
INGEPAC DA PTC

Busbar differential

INGEPAC EF BD eXtended series

HMI / SUBSTATION MONITORING

INGESYS IT

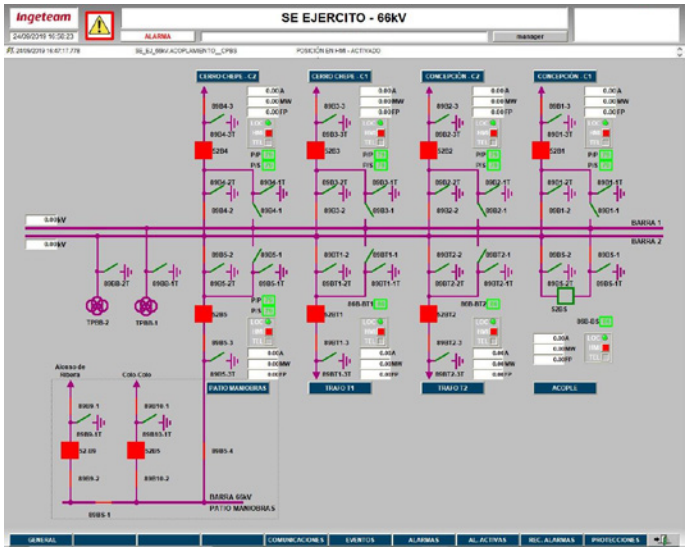


INGESYS IT is a **modular architecture software** consisting of all the modules necessary to implement Supervisory Control and Data Acquisition (**SCADA**), enabling efficient and intuitive information management.

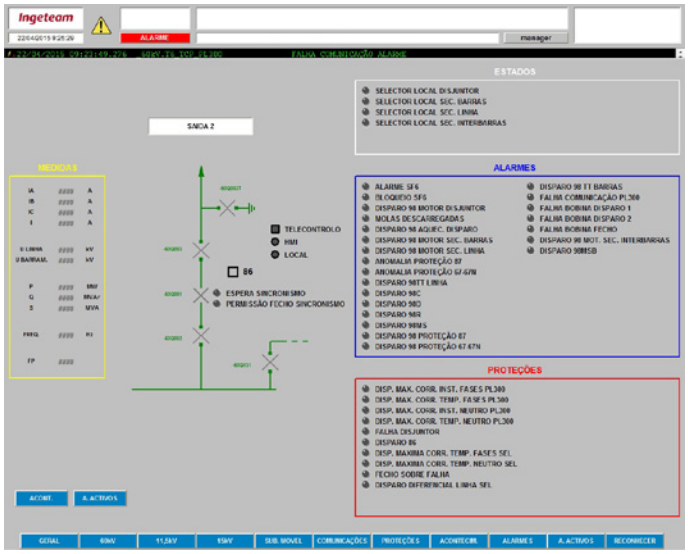
INGESYS IT is based on a modular, flexible structure capable of adapting to the customer's needs and **future market and technological developments**.

Available modules

- Operating panels display
- Data and log management
- Alarms and events management
- Reports
- Data analysis
- Alarm notification
- Website access
- Access control and user profiles
- Acquisition of switch maintenance parameters
- System self-checks



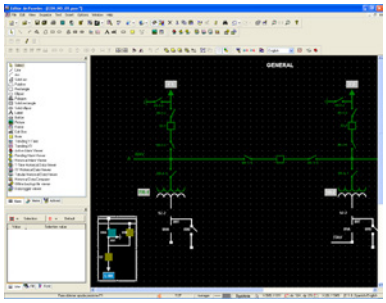
Substation single-line diagram



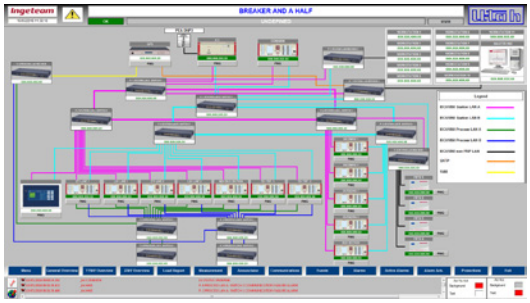
Position control screen

Real time control and data acquisition

Functions	· Graphical representation of data and measurements · HTML5-based web operation panels with JavaScript support, compatible with the latest browsers · Local substation control · Presentation, management, acknowledgment, and storage of substation alarms and events · Alarms are organized into areas depending on the level of severity · Alarm notification via email or SMS, based on shift calendar and severity rules · Management of communications with all the position control units via an IEC 61850 client for controlling, operating, configuring, and signaling all the positions in the substation · Exporting of alarms and events logs to text files · Management of user access levels based on profiles, with restricted controls, access configurations, etc. · Store and display of historical metering data logging · Periodic Excel reports based on historical data
Substation's dynamic mimic diagrams	· Active alarms pages · Alarms pending acknowledgment pages · Historical alarms pages · Events pages · Historical events pages · Alarms and events reports · Pages with trend curve measurements and historical data logs · Pages with substation and bay mimic diagrams · System status pages · Historical data pages, trend curves · Reports pages
Communications	· SNMP for managing the communications network, substation unit alarms integrated into the panels, and system alarms · High availability thanks to redundant communication mechanisms and to the node's redundancy · SNTP synchronization · Communication with different VLANs via IEEE 802.1Q
Cybersecurity	· User account management (roles and user levels) under IEC 61351 and IEEE 1686 standards · Syslog remote log concentration service · Centralized user accounts using LDAP authentication · Firewall management
Protocols	· IEC 61850 (client / server) · IEC 60870-5-101 (master / slave) · IEC 60870-5-103 (master / slave) · IEC 60870-5-104 (master / slave) · DNP3 TCP/IP and serial DNP3 (master / slave) · PROCOME (master) · MODBUS TCP/IP and MODBUS RTU (master / slave) · OPC DA (client / server) and OPC-XML-DA (client / server) · OPC UA (client / server)



Panel editor



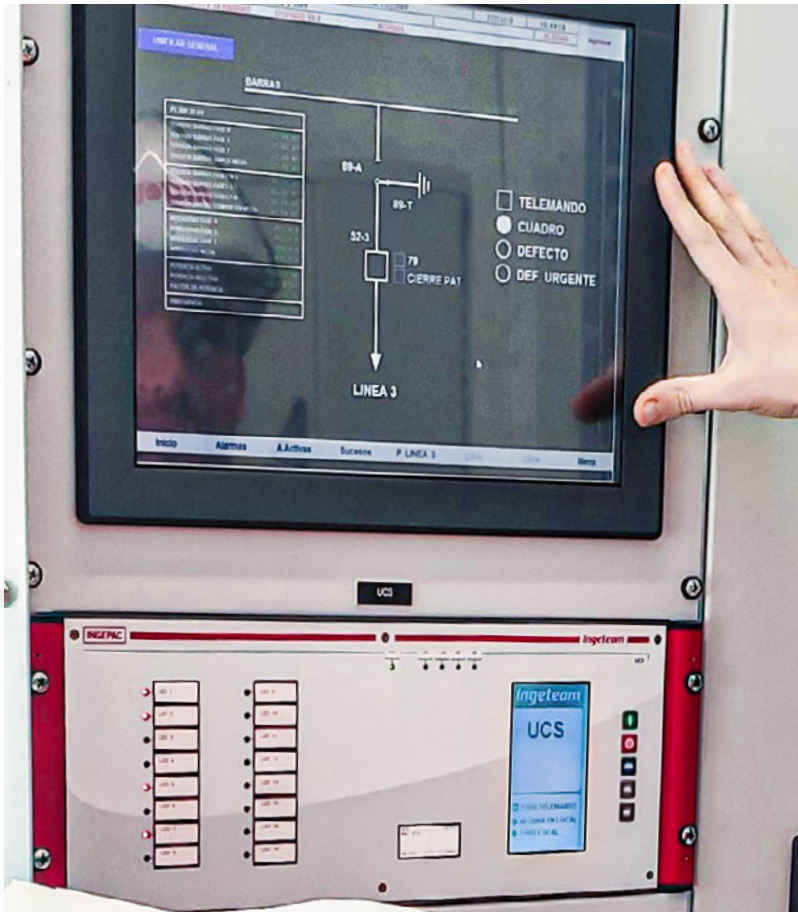
Communication status

ENGINEERING TOOLS

INGESYS eFS

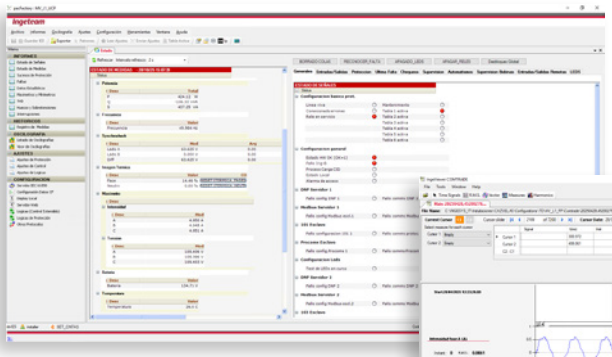
Ingeteam provides its INGESYS eFS software for the **configuration and operation** of an automated substation as per the **IEC 61850 standard**, thereby reducing costs and time in both the engineering and operation stages.

INGESYS eFS consists of several software packages that facilitate engineering tasks on substation automation systems.

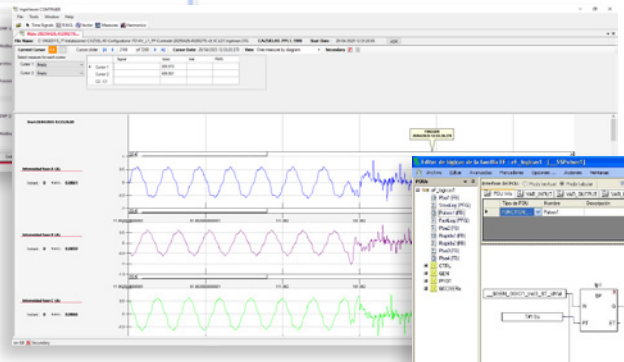


Requirements covered

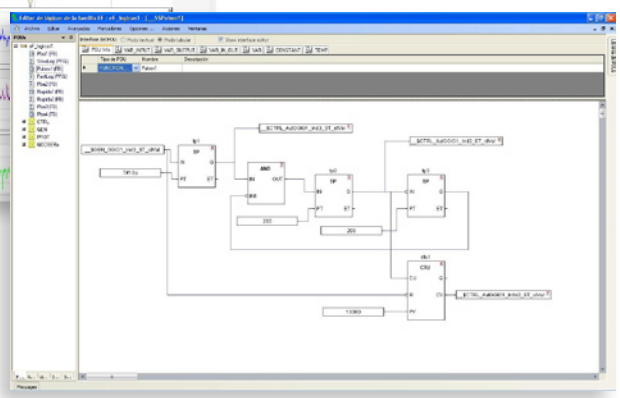
- Logic programming under IEC 61131-3 standard
- Design of architectures and electrical diagrams
- Definition of operating philosophies
- Transfer of information and configurations
- Integration of third-party communication protocols
- Standard-based configuration files
- Protection functions
- Control functions
- Remote control functions
- Measurements



Protection adjustment

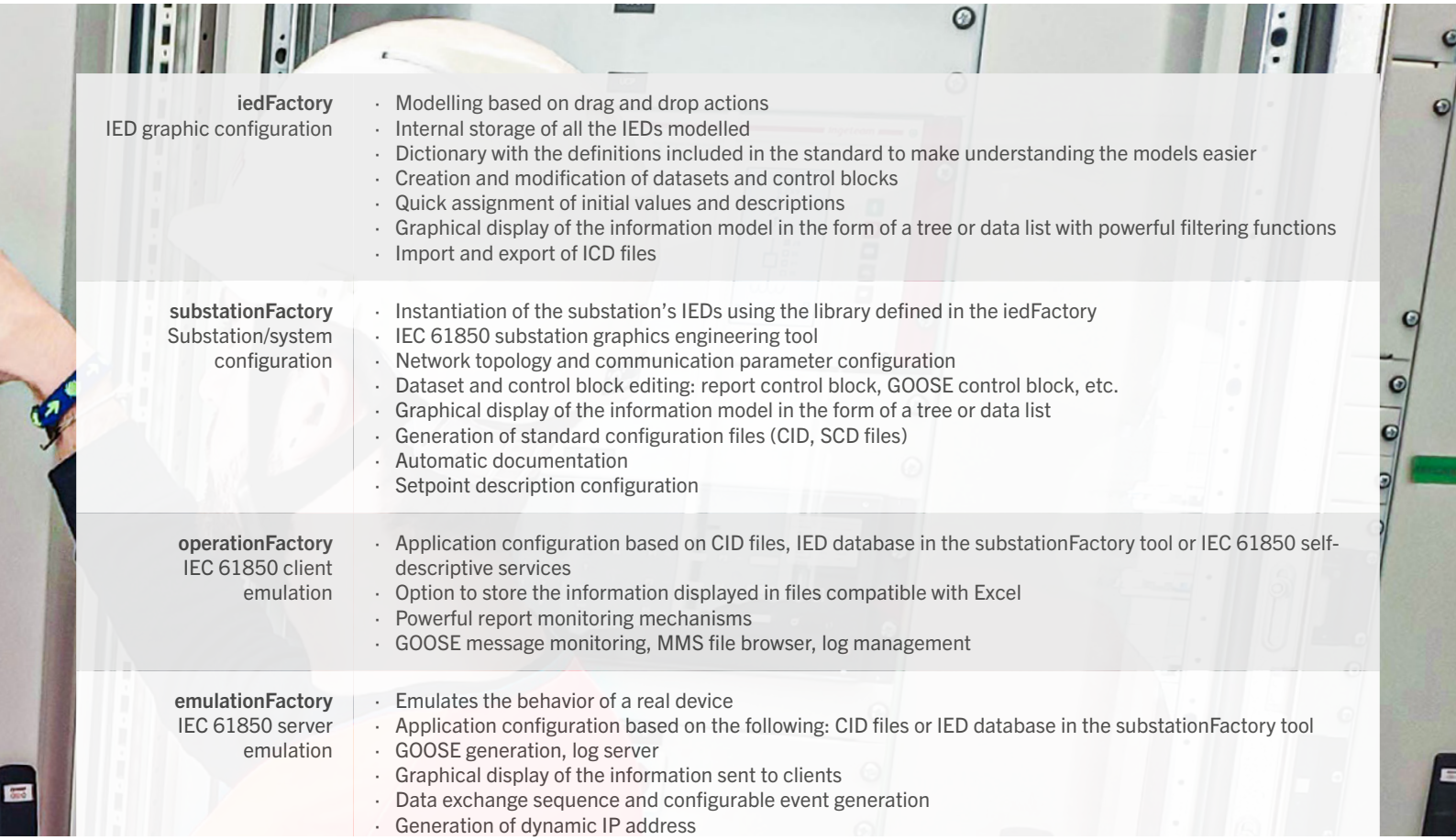


COMTRADE file viewer



Logics editor

System setup, analysis and maintenance software



iedFactory IED graphic configuration	· Modelling based on drag and drop actions · Internal storage of all the IEDs modelled · Dictionary with the definitions included in the standard to make understanding the models easier · Creation and modification of datasets and control blocks · Quick assignment of initial values and descriptions · Graphical display of the information model in the form of a tree or data list with powerful filtering functions · Import and export of ICD files
substationFactory Substation/system configuration	· Instantiation of the substation's IEDs using the library defined in the iedFactory · IEC 61850 substation graphics engineering tool · Network topology and communication parameter configuration · Dataset and control block editing: report control block, GOOSE control block, etc. · Graphical display of the information model in the form of a tree or data list · Generation of standard configuration files (CID, SCD files) · Automatic documentation · Setpoint description configuration
operationFactory IEC 61850 client emulation	· Application configuration based on CID files, IED database in the substationFactory tool or IEC 61850 self-descriptive services · Option to store the information displayed in files compatible with Excel · Powerful report monitoring mechanisms · GOOSE message monitoring, MMS file browser, log management
emulationFactory IEC 61850 server emulation	· Emulates the behavior of a real device · Application configuration based on the following: CID files or IED database in the substationFactory tool · GOOSE generation, log server · Graphical display of the information sent to clients · Data exchange sequence and configurable event generation · Generation of dynamic IP address
gooseScan GOOSE message analyzer	· Configuration of the application based on: SCL files (CID / SCD) · Multi-window display of the status of each GOOSE · Identification of GOOSE refreshed and expired · Recognition of updated GOOSE for quick identification
mergeFactory SCL files comparison tool	· Navigation in the IEC 60850-6 directory tree, with connection between both trees · Summary presentation of the differences · Comparison of standard sections: communications, substation, IED, and Data Type Templates · Comparison of SAddr initialization, settings, DataSet and control block, descriptions, etc. · Comparison of private sections
pacFactory Configuring and managing Ingeteam IEDs	· Relay setting tool · CID file generation · Configuration of communication network parameters: IP address, mask, etc. · IEC 61850 protocol configuration: datasets, report control blocks, GOOSE messages · CID file transfer via sFTP to the device
recordCollector / recordNotifier Data concentrator for electrical protections	· Automatically collects events, fault and oscillographic files from the IEDs in COMTRADE format · Storage in a local or remote repository · File transfer via SFTP/FTP protocol
IngeViewer Viewing and analysis of COMTRADE files	· View and compare signals, represented as a function of time · Perform operations on signals, facilitating their analysis and comparison · Phasor and harmonics displays · View measurements collected by the device

SUBSTATION
RTU / GATEWAY

INGESAS IC3

INGESAS IC3 performs **gateway** and **remote** functions, allowing implementation of substation control logic and high-level **communication with SCADA**.

INGESAS IC3 is high-performance modular equipment designed for substations that provides high availability and reliability thanks to its **redundant mechanisms**: redundant power supply, Hot-Hot / Hot-Standby systems, etc.

Its functionalities can also be implemented on an **industrial PC** for projects that require a specific hardware configuration due to concrete customer needs, such as additional communication ports, microprocessor, memory, etc.

INGESAS IC3 form factor 0

INGESAS IC3 includes a **web server** based on **HTML5** that enables viewing of fully configurable panels from any smartphone, tablet, or PC, without installing any additional application.

INGESAS IC3 includes **firewall** and **cybersecurity** functions that ensure correct use of the functionality.

INGESAS IC3 form factor 4

Substation control unit

	INGESAS IC3 form factor 0	INGESAS IC3 form factor 4
Description	Substation control unit in modular chassis with physical inputs and outputs and LED signaling	Substation control unit in high-density communications chassis
Enclosure	19" rack with 7 auxiliary slots	19" industrial computer with SSD RAID1
Communication ports	4 Ethernet ports, 2 single and 2 switch with 2 outputs 2 RS232 / RS485 serial ports USB front port download/upload configuration	8 RJ45 Ethernet ports 10 RS232 /RS422 / RS485 serial ports USB: 2 front + 3 rear + 1 internal
LEDs	11 signalization + 5 status	4 programmable + 5 status + communication status LEDs
Power supply (redundant optionally)	24 / 48 / 125 / 220 Vdc (Vac available)	100-240 Vdc
I/O card module	8 DI & 4 DO	N/A
Synchronization	SNTP / IEEE 1588 v2 / IRIG-B or telecontrol protocols	SNTP / IEEE 1588 v2 / telecontrol protocols
HMI	Servidor web HMI basado en HTML5	
IEC 61131-3 logics	Yes	
Redundancy (IEC 62439-3)	PRP / HSR	
Cybersecurity	The device incorporates roles and privileges according to the IEC 62351 and IEEE 1686 standards LDAP authentication Firewall HTTPs, sFTP, SSH Syslog auditory log	
Protocols	IEC 61850 (client / server) IEC 60870-5-101 (master / slave) IEC 60870-5-103 (slave) IEC 60870-5-104 (master / slave) DNP3 (client / server & master / slave) PROCOME (master / slave) OPC UA (client / server) SNMPV2c (client)	

UCA International Users Group

IEC 61850

dnp Distributed Network Protocol

IEC

Modbus MEMBER

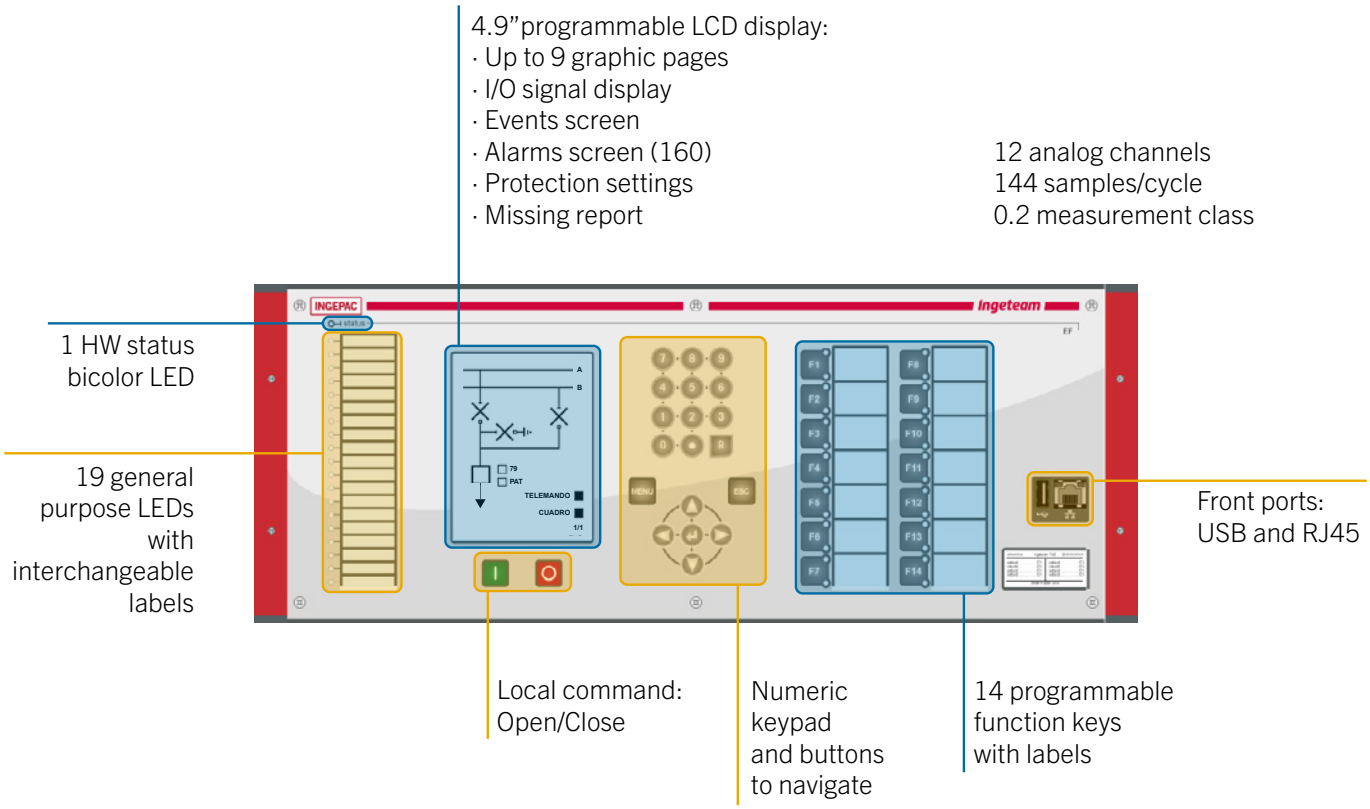
PROTECTION AND CONTROL

INGEPAC EF is a range of high-performance intelligent electronic devices, developed on a **native IEC 61850 platform**, for control and protection applications of electrical positions in high-voltage and medium-voltage substations.

Its processing capacity, high performance, multiple functionalities and modular hardware make it a **powerful and flexible solution** for the **automation** of any type of installation.

INGEPAC EF is a totally programmable device, which includes data acquisition and reporting components and diagnosis and supervision components that **alert of any type of incident**, thereby facilitating fault detection and maintenance of the installation and the equipment itself and contributing to the **extension of the service life of the entire system**.

2 formats aluminum box:
19” 4U rack with 7 I/O slots
19” 5U ½ rack with 2 I/O slots



Communications

- IEC 61850 certified by DNV in Ed.1 and Ed.2
- Redundancy, PRP and HSR under IEC 62439-3 standard, both in the station bus and the process bus
- Acquisition of sampled values as per IEC 61869-9 (NCIT) and IEC 61850-9-2LE (SAMU) standards
- Reception and transmission of MMS and GOOSE messages as per IEC 61850-8-1 standard
- Synchronization of IEEE 1588 v2 (PTP), SNTP, NTP, or other protocols
- Other protocols: DNP 3.0, Modbus, IEC 60870-5-103, IEC 60870-5-104

Cybersecurity and website access

- Firewall functionality
- Various levels of access via password
- Safe website access (HTTPs) and FTP (sFTP) from any device
- Security logs
- Disabling of communication ports
- Verification of firmware integrity during upgrading

Measurements and quality information

Breaker supervision

- Excessive number of trips
- kI2 breaker monitoring per pole
- Closing and trip circuit monitoring
- Breaker inactivity time monitoring

PROTECTION AND CONTROL

	INGEPAC EF LD	INGEPAC EF ZT	INGEPAC EF TD
Features	Line differential	Distance protection	Transformer differential
Protection functions	87, 87LG, 87REF, 5th harmonic overexcitation, V/f, 21, POTT (21), POTT (67N/67Q), SOTF, 68LE, 68FF, 78, 67, 67N, 50/51, 50N/51N, 50G/51G, 67Q, 46FA, 37, 49, 59, 27, 59N, 47, 81M/m, 81R, 32, 25, 79, 74TC/CC, 50BF, Stub bus, Fault locator	21, POTT (21), POTT (67N/67Q), SOTF, 68ZC, 68OP, 68FF, 67, 67N, 50/51, 50N/51N, 50G/51G, 67Q, 46FA, 37, 49, 59, 27, 59N, 47, 81M/m, 81R, 32, 25, 79, 79 (81), 74TC/CC, 50BF, Stub bus, Fault locator	87T, 87REF, 5th harmonic overexcitation, V/f, 27, 59, 81, 81R, 50/51, 67N, 50G/51G, 46 (67Q), 49, 32, 50BF
Depending on the model	Single breaker, breaker and a half, or with an adjacent transformer	Single breaker, breaker and a half, or with an adjacent transformer	2 or 3 windings or breaker and a half
Others	2 and 3 terminal lines	Up to 2 communication channels: FO, G703 or C37.94 (PUTT, POTT, DTT, etc.)	Valid for generators, motors or shunt reactors
Bay control	1 or 2 breakers	1 or 2 breakers	Yes
SV capturing	Yes, under IEC 61869-9 and IEC 61850-9-2LE (optional) standards		
Analog channels	Up to 12 (144 samples/cycle)		
LEDs	19 programmable + 1 status		
Communication ports	Front: RJ45 + USB | Rear: up to 2 Ethernet + 6 serial		
I/O card slots	7 or 2, depending on the enclosure (selectable modules)		
Modules	11 DI & 9 DO / 32 DI / 16 DI & 8 DO / 16 DI & 16 DO / 16 DI & 8 AI / 8 DI & 8 DO / 11 RTD & 4 AO		
Accuracy	Class 0.2		
IEC 61131-3 logics	Yes		
Redundancy (optional)	PRP / HSR (IEC 62439-3), link failover, switch mode		
Synchronization	SNTP / IEEE 1588 v2 / IRIG-B		
MMS and GOOSE messaging	Yes, under IEC 61850-8-1 standard		
Web server	Yes		
Cybersecurity	Firewall, HTTPs, sFTP, logs, RBAC, LDAP, CMS (PKCS#7), vulnerability management		
Protocols	IEC 61850, DNP3, IEC 60870-5-103, IEC 60870-5-104, Modbus, PROCOME		
Data acquisition	Event and fault register in non-volatile memory: measurements, quality, SOE, fault recorder, oscillography (COMTRADE files), PMU function in INGEPAC EF TD0 and INGEPAC EF MD2 models		

INGEPAC EF MD	INGEPAC EF BF	INGEPAC EF CD	INGEPAC EF CB	INGEPAC EF VR
Multifunction	Breaker failure	Bay control	Capacitor bank	Automatic voltage regulator
67, 67N, 67SN, 50/51, 50N/51N, 67Q, 46FA, 49, 59, 27, 59N, 47, 81M/m, 81R, 32, CLP, 50V/51V, 87N, 68FF, HCL, 25, 79, 79 (81), 74TC/CC, 50BF, Fault locator, Intermittent faults	50BF, 67, 67N, 50/51, 50N/51N, 50G/51G, 67Q, 46FA, 49, 59, 27, 59N, 47, 81M/m, 81R, 68FF, 25, 79, 74TC/CC, Fault locator	Bay control unit	67, 67N, 50/51, 50N/51N, 50Nu1/51Nu, 67Q, 46FA, 37, 59, 27, 59N, 47, 68FF, 79, 74TC/CC, 50BF	90T
67NA, 67NC, 50NS/51NS, 50G/51G, 37, 40, 78, 68ZC, SOTF, POTT (67/67Q),	Single breaker	0.2 measurement and synchronism	2 steps	Single or parallel power transformers
-	-	-	Reactive, calendar or hours supervision	Temperature supervision through RTDs inputs
Yes				
Yes, under IEC 61869-9 and IEC 61850-9-2LE (optional) standards			No	No
Up to 12 (144 samples/cycle)				
19 programmable + 1 status				
Front: RJ45 + USB | Rear: up to 2 Ethernet + 6 serial				
7 or 2, depending on the enclosure (selectable modules)				
11 DI & 9 DO / 32 DI / 16 DI & 8 DO / 16 DI & 16 DO / 16 DI & 8 AI / 8 DI & 8 DO / 11 RTD & 4 AO				
Class 0.2				
Yes				
PRP / HSR (IEC 62439-3), link failover, switch mode				
SNTP / IEEE 1588 v2 / IRIG-B				
Yes, under IEC 61850-8-1 standard				
Yes				
Firewall, HTTPs, sFTP, logs, RBAC, LDAP, CMS (PKCS#7), vulnerability management				
IEC 61850, DNP3, IEC 60870-5-103, IEC 60870-5-104, Modbus, PROCOME				
Event and fault register in non-volatile memory: measurements, quality, SOE, fault recorder, oscillography (COMTRADE files), PMU function in INGEPAC EF TD0 and INGEPAC EF MD2 models				

BUSBAR DIFFERENTIAL PROTECTION

INGEPAC EF BD eXtended series

The **INGEPAC EF eXtended series** platform represents the natural evolution of the INGEPAC EF product range, enabling users to confidently meet the challenges of current and future network digitalization.

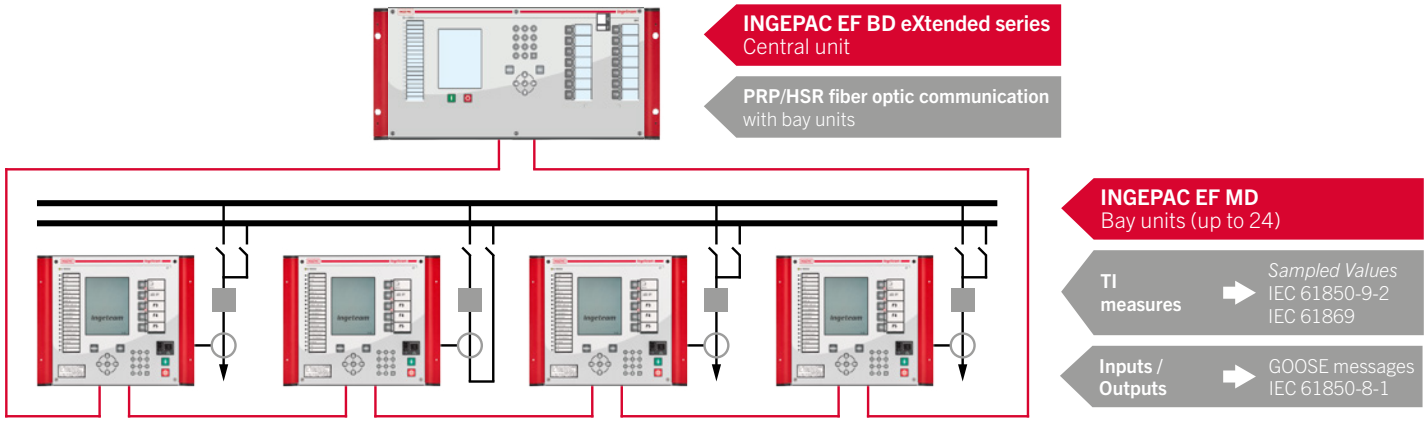
This high-performance series incorporates advanced **cybersecurity, communications, and intelligent network monitoring** features, guaranteeing reliable and secure performance in critical environments.

INGEPAC EF BD eXtended series acts as the **central unit of busbar protection**, the most critical element in substation protection systems.

Busbar differential protection is based on a **distributed architecture** based on the **IEC 61850 standard**, taking advantage of the communications between the INGEPAC EF BD eXtended series central unit and the INGEPAC EF bay units.

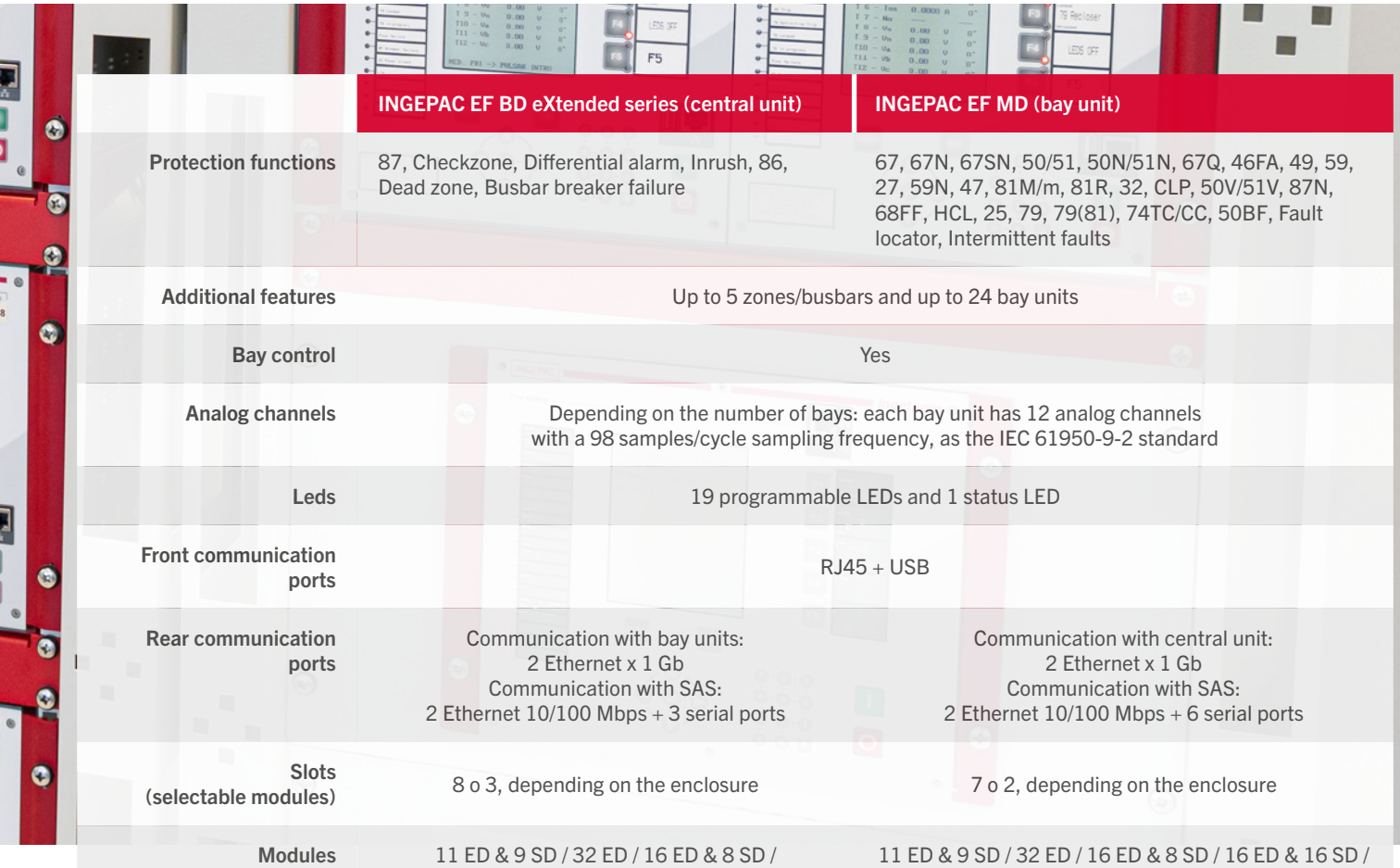
INGEPAC EF BD eXtended series processes all the information received from the INGEPAC EF units as **Multicast Sampled Values** type messages and will send the different trip orders to these units through **GOOSE messages**.

The proposed solution protects schemes of up to 5 zones and supports 24 bays.



The INGEPAC EF bay units fulfill two functions in this solution. They are not only the **protection relays** for the corresponding bays, but they also act as **bay units** for busbar differential protection, offering an **cost-effective and efficient** solution with a significant **reduction in space and wiring**.

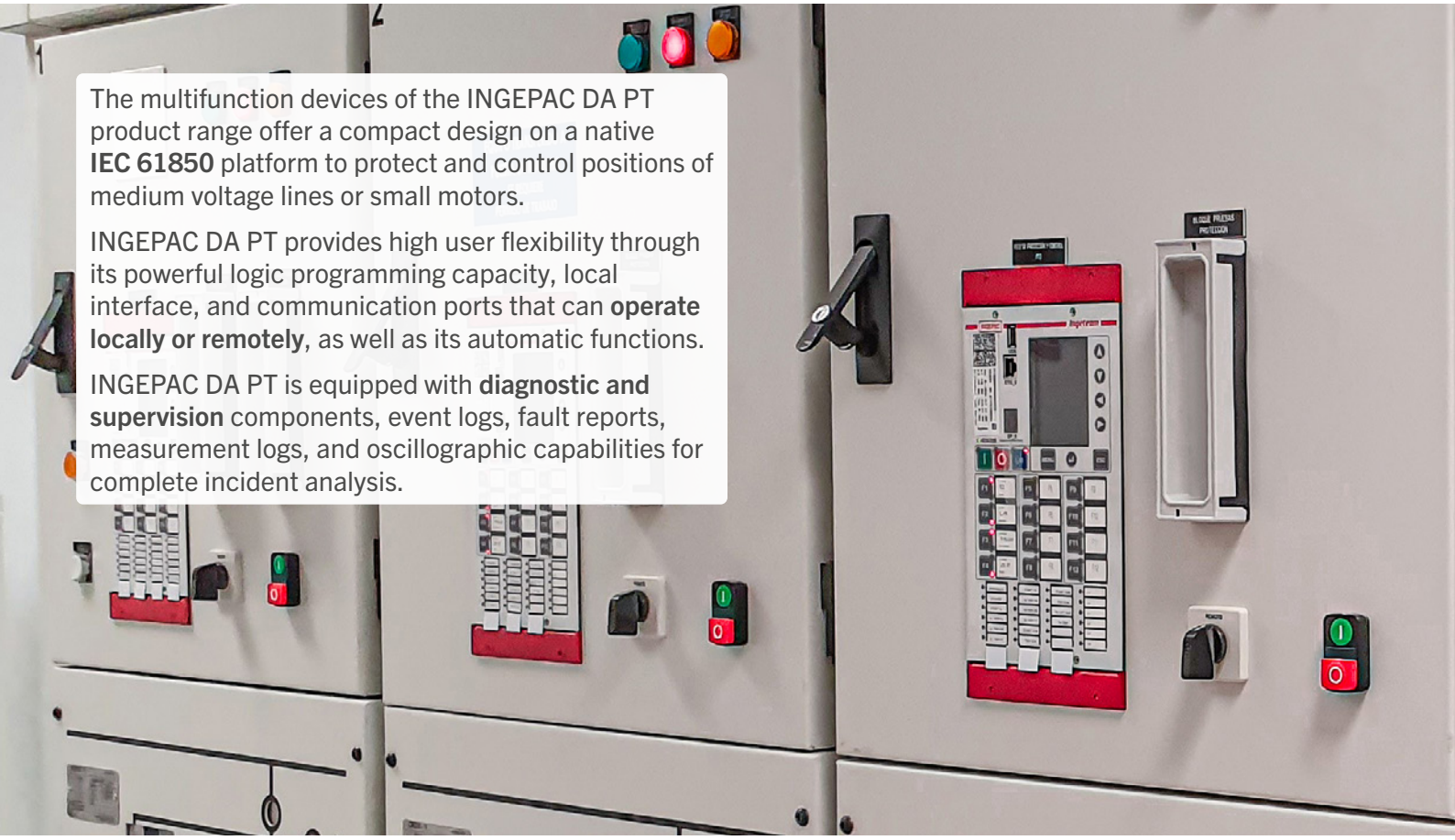
To ensure high availability and increase security, the units have **redundant PRP/HSR communications**, which guarantees that, in case of communication failure, there is no frame loss.



	INGEPAC EF BD eXtended series (central unit)	INGEPAC EF MD (bay unit)
Protection functions	87, Checkzone, Differential alarm, Inrush, 86, Dead zone, Busbar breaker failure	67, 67N, 67SN, 50/51, 50N/51N, 67Q, 46FA, 49, 59, 27, 59N, 47, 81M/m, 81R, 32, CLP, 50V/51V, 87N, 68FF, HCL, 25, 79, 79(81), 74TC/CC, 50BF, Fault locator, Intermittent faults
Additional features	Up to 5 zones/busbars and up to 24 bay units	
Bay control	Yes	
Analog channels	Depending on the number of bays: each bay unit has 12 analog channels with a 98 samples/cycle sampling frequency, as the IEC 61950-9-2 standard	
Leds	19 programmable LEDs and 1 status LED	
Front communication ports	RJ45 + USB	
Rear communication ports	Communication with bay units: 2 Ethernet x 1 Gb Communication with SAS: 2 Ethernet 10/100 Mbps + 3 serial ports	Communication with central unit: 2 Ethernet x 1 Gb Communication with SAS: 2 Ethernet 10/100 Mbps + 6 serial ports
Slots (selectable modules)	8 o 3, depending on the enclosure	7 o 2, depending on the enclosure
Modules	11 ED & 9 SD / 32 ED / 16 ED & 8 SD / 16 ED & 16 SD / 8 ED & 8 SD	11 ED & 9 SD / 32 ED / 16 ED & 8 SD / 16 ED & 16 SD / 16 ED & 8 EA / 8 ED & 8 SD / 11 RTD & 4 SA
Accuracy	Class 0.2	
IEC 61131-3 logics	Yes	
Redundancy (optional)	PRP / HSR (IEC 62439-3), link failover, switch mode Available both for communication between central unit and bay units and for SAS communication	
Synchronization	IEEE 1588 v2 between the central unit and bay units SNTP / IEEE 1588 v2 / IRIG-B for SAS synchronization	
Web server	Yes	
Cybersecurity	Firewall, HTTPs, sFTP, logs, RBAC, LDAP, CMS (PKCS#7), vulnerability management	
Protocols (SAS)	IEC 61850, DNP3, IEC 60870-5-103, IEC 60870-5-104, Modbus, PROCOME	
Data acquisition	Event and fault register in non-volatile memory: measurements, quality, SOE, fault recorder, oscillography (COMTRADE files) SAS: Substation Automation and Control System	

PROTECTION AND CONTROL

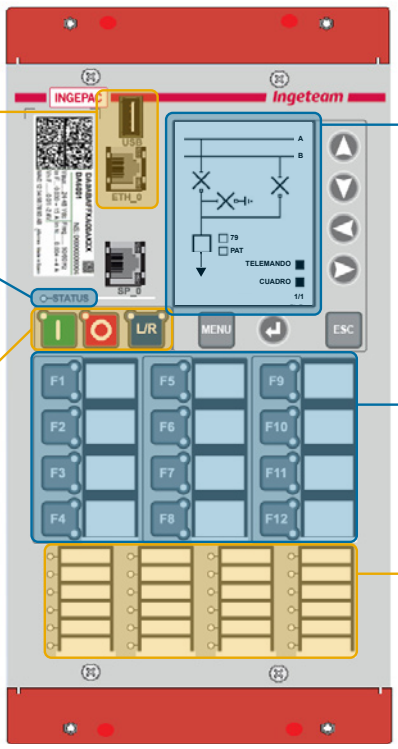
INGEPAC DA PT



The multifunction devices of the INGEPAC DA PT product range offer a compact design on a native **IEC 61850** platform to protect and control positions of medium voltage lines or small motors.

INGEPAC DA PT provides high user flexibility through its powerful logic programming capacity, local interface, and communication ports that can **operate locally or remotely**, as well as its automatic functions.

INGEPAC DA PT is equipped with **diagnostic and supervision** components, event logs, fault reports, measurement logs, and oscillographic capabilities for complete incident analysis.



Front ports:
USB y RJ45

1 HW status bicolor LED

Local command: Open/Close/L/R

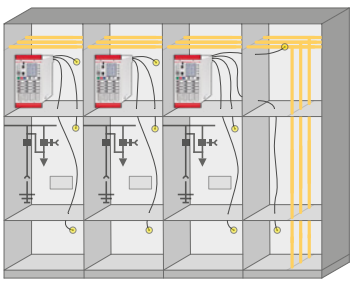
8 analog channels
32 samples/cycle
0.2 measurement class

3.5” programmable LCD display:
· Up to 9 graphic pages
· I/O signal display
· Events screen
· Alarms screen (160)
· Protection settings
· Missing report

12 programmable function keys with labels

24 general purpose LEDs with interchangeable labels

	INGEPAC DA PT1	INGEPAC DA PT6
Features	Feeder protection relay	Motor protection relay
Protection functions	67, 67N, 67SN, 67NA/NC, 50/51, 50N/51N, 50SN/51SN, 67Q, 46FA, 59, 27, 59N, 47, 81M/m, 81R, CLP, HCL, HLT, 68FF, 79, 25, 74TC/CC, 50BF, 32, 78, Fault locator	67, 67N, 67SN, 67NA/NC, 50/51, 50N/51N, 50SN/51SN, 67Q, 46FA, 59, 27, 59N, 47, 81M/m, 81R, CLP, HCL, HLT, 68FF, 79, 25, 74TC/CC, 50BF, 32, 78, Fault locator, 51LR, 37, 66, 48, 14
Optional	Arc detection, up to 4 optic sensor inputs	
Bay control	Yes	
Analog channels	Up to 8 (144 samples/cycle)	
Power supply	24 / 48 / 125 / 220 Vdc	
LEDs	24 programmable + 1 status	
Communication ports	Front: RJ45 + RS232/485 + USB / Rear: up to 2 Ethernet + 1 serial RS232/485	
I/O card slots	Up to 2 DI/DO/AI (selectable modules)	
Modules	15 DI & 8 DO / 24 DI & 16 DO / 13 DI / 8 AI	
Accuracy	Class 0.2	
IEC 61131-3 logics	Yes	
IEC 62439-3 redundancy	PRP / HSR	
Synchronization	SNTP / IEEE 1588 / IRIG-B	
MMS and GOOSE messaging	Yes, under IEC 61850-8-1 standard	
Web server	Yes	
Cybersecurity	Firewall, HTTPs, sFTP, logs, RBAC, LDAP, CMS (PKCS#7), vulnerability management	
Protocols	IEC 61850, DNP3, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, Modbus	
Data acquisition	Event and fault register in non-volatile memory. COMTRADE files	



Arc detection

INGEPAC DA PT has **up to 4 inputs for INGEPAC LSD optic sensors.** This enables detection of electrical arcs and provides **additional protection** to cells against these severe incidents, which endanger both the safety of the installations and the staff that maintains them.

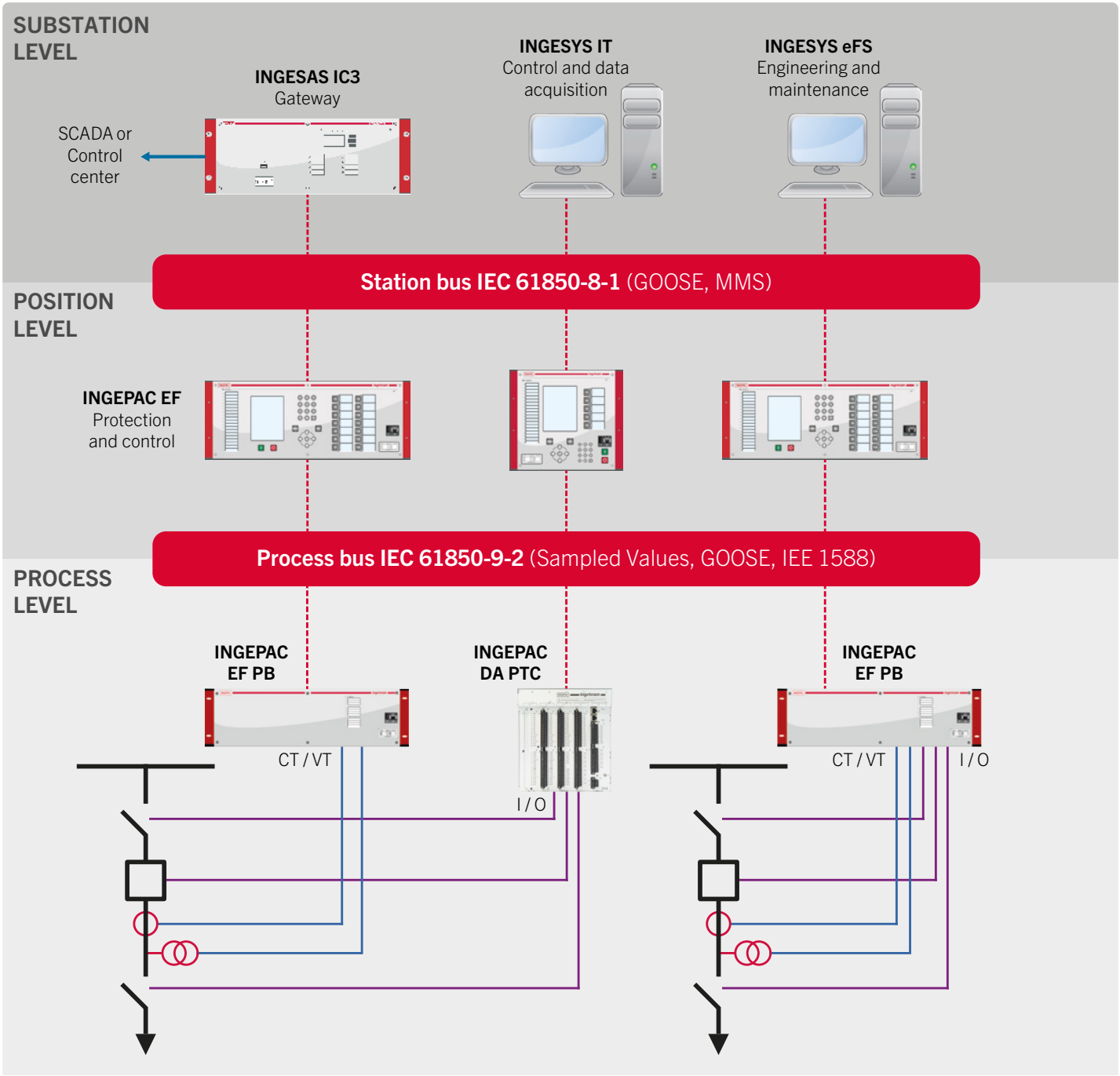
PROCESS BUS

INGEPAC EF PB

INGEPAC DA PTC

The process bus is a communications network based on the **IEC 68150-9-2 standard**, capable of digitalizing the information of the primary patio equipment (voltage transformers, current transformers, switches, etc.) to be transmitted via a **fiber optic network** to the protection, control, and measurement IEDs.

Ingeteam offers a range of equipment that act as the interface between the primary switchgear and the substation's protection and control system.

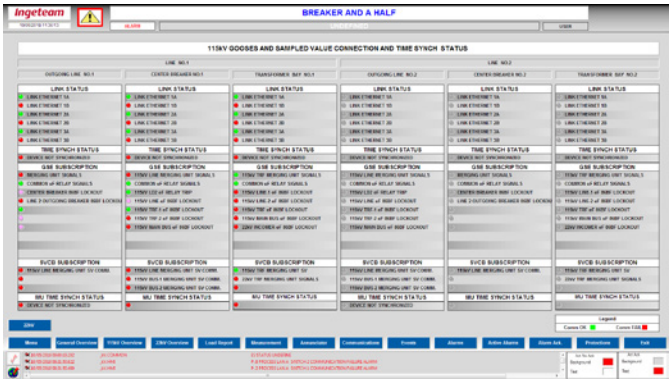


INGEPAC EF PB is the **merging unit** developed by Ingeteam that collects the analog signals from the measurement transformers, and transmits them through the process bus as **Sampled Values** (SV).

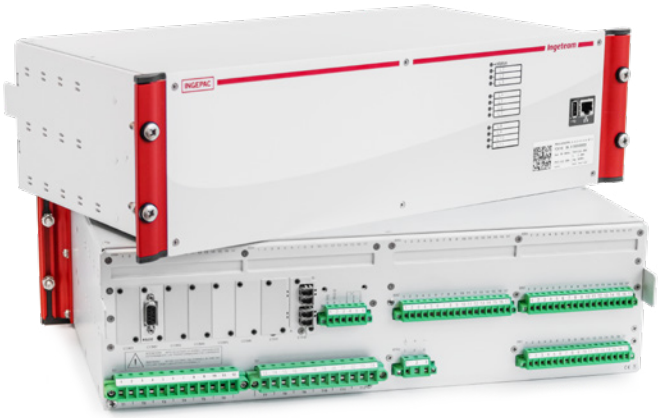
INGEPAC EF PB is an IEC 61850 server that can also transmit and receive digital signals such as **GOOSE messages** as per the IEC 61850-8-1 standard, allowing easy, reliable, and economic implementation of the process bus.

The merging units synchronize with the different IEDs through the IEEE 1588 v2 protocol, which provides an accuracy better than 1 microsecond, allowing the correct sampling of the analog measurements with the required precision.

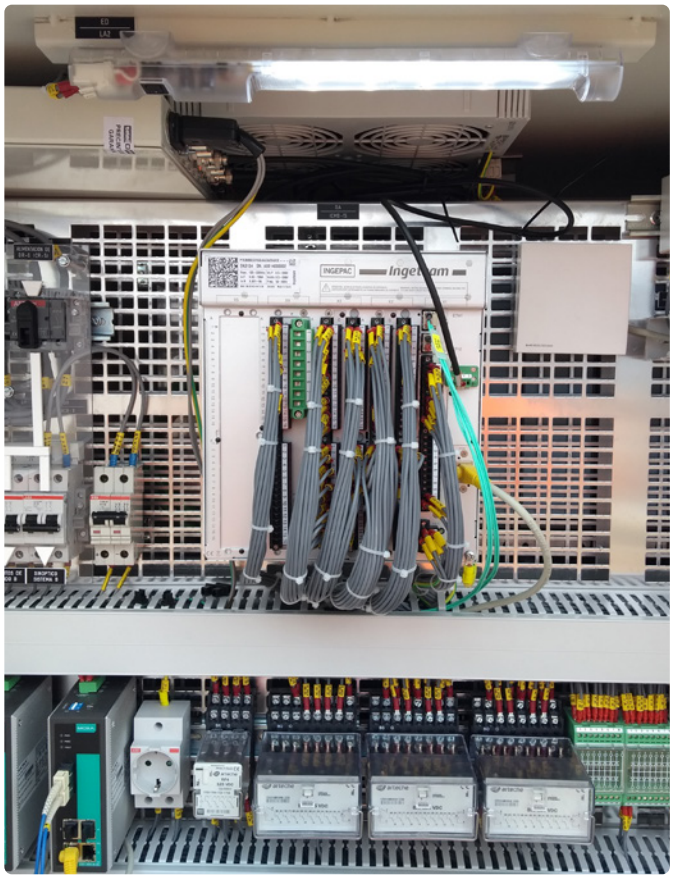
Complementary to the merging units, INGEPAC DA PTC product range acts as a **digital interface,** allowing the management of signals from switches, breakers, or any other primary component, suitable for use in both the process and station buses.



GOOSE and IEEE 1588 v2 monitoring screen



INGEPAC EF PB



Cabinet with INGEPAC DA PTC

PROCESS BUS

INGEPAC EF PB

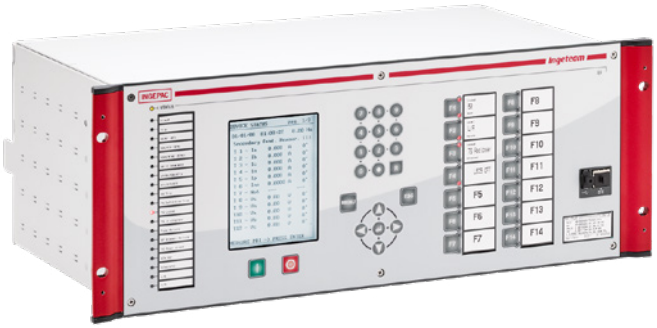
INGEPAC DA PTC

Fiber optic channeling of the process bus

Implementation of the process bus involves various economic, logistic, and security benefits.

Benefits

- Time savings in substation engineering and installation
- Copper cabling is reduced in a high percentage due to the use of optical fiber
- Smoother expansion and modernization of an existing substation
- Easier maintenance
- Reliable systems with multiple self-diagnosis and supervision systems
- Faster substation power-up
- Smaller protection circuits, enabling smaller CTs
- Increased security: process bus significantly reduces the risk for a current circuit to remain open
- More sustainable substations



INGEPAC EF is the range of IEDs with capacity to connect merging units or electronic transformers built to comply with **IEC 61850-9-2** or **IEC 61869-9** standards.

	INGEPAC EF PB	INGEPAC DA PTC
IEC 61850-9-2 sampled values	8 or 12, depending on the model	No
GOOSE	Yes, under IEC 61850-8-1 standard	
Enclosure	19” 3U rack / 19” 4U rack / 1/2 19” 5U rack	1/3 19” rack / 1/3 19” rack surface mount / 2/3 19” rack
I/O card slots	2, 3, or 6, depending on the format	2 or 4, depending on the format
Modules	11 ED & 9SD / 32 ED / 16 ED & 8 SD / 16 ED & 16 SD / 16 ED & 8 EA / 8 ED & 8 SD	15 ED & 8 SD / 24 ED & 16 SD / 13 ED / 8 EA (mA/V)
Power supply	24 / 48 / 125 / 220 Vdc	24 / 48 / 125 / 220 Vdc
Redundant power supply	Optional	No
LEDs	11 programmable + 1 status	Up to 24 programmable + 1 status
Front communication ports	RJ45 + USB	RJ45 + USB
Rear communication ports	Up to 6 serial and 2 Ethernet	1 serial and 2 Ethernet
IEC 61131-3 logics	Yes	Yes
Communications	PRP / HSR optional	PRP / HSR optional
Synchronization	IEEE 1588, PPS, SNTP, IRIG-B	IEEE 1588, SNTP, IRIG-B
Web server	Yes	
Cybersecurity	Firewall, HTTPs, sFTP, logs, RBAC, LDAP, CMS (PKCS#7), vulnerability management	
Event recorder	Yes	

STANDARDS AND CERTIFICATION

Design

As part of its commitment to quality and customer satisfaction, Ingeteam applies these processes and conducts comprehensive tests on all the equipment it manufactures, to ensure compliance with the highest quality standards and regulations.

Ingeteam equipment is certified by **independent external laboratories** in compliance with **international standards** for electric, climatic, and mechanical testing, thereby ensuring optimal performance.

The equipment designed by Ingeteam complies with the following directives and standards:

- Low Voltage Directive 2006/95/EC
- EMC Directive 2004/108/EC
- IEC 60255-1
- IEC 60255-26
- IEC 60255-27

Additional protection

Optionally, the equipment can be provided with a cover that grants a **frontal IP54 or IP55 protection** grade, as established in the **IEC 60529 standard**, recommended for settings where dust or particles in suspension may be present.

The manufacturing process of the equipment contemplates the option of providing additional protection to withstand exposure to **hostile surroundings** or high humidity or temperature weather conditions, thereby improving and prolonging equipment service life and reliability.

Communications

All the equipment manufactured by Ingeteam are designed on a **native IEC 61850 platform**, and have passed an external certification process performed by the **KEMA laboratory** that guarantees operation with other IEDs from other manufacturers that also comply with the standard.

In addition, Ingeteam is **ISO 27001** certified for **information security and privacy**, which guarantees the confidentiality and integrity of the data managed by the company.

Quality

Ingeteam Power Technology, S. A. holds the **ISO 9001** certification, which guarantees that it meets applicable legal and regulatory requirements and implements **continuous improvement** processes.

It also holds the **ISO 14001** certification, which specifies **environmental management**, and the **ISO 14067**, regarding the **carbon footprint** requirements, which attests to Ingeteam's commitment to the protection of the environment.

dnp Distributed Network Protocol

MANAGEMENT SYSTEM CERTIFICATION DNV·GL ISO 9001 = ISO 14001 ISO 45001

CE

ISO 14001

ISO 14067

IEC

IEEE

tecnalia

UCA International Users Group

CYBERSECURITY

The evolution of power grid control systems is growing sustained on **open standards and technologies**, which enable big benefits from an operational perspective but increases issues related to security.

Intelligent electronic devices (IEDs) must provide functions and features regarding the access, operation, configuration, firmware revision and data retrieval.

Reference international standards

- **IEC 62351:** Data and communications security (in development)
- **IEEE 1686-2013:** Intelligent electronic devices cybersecurity capabilities
- **IEC 62443:** Security for industrial automation and control systems

Access control

- Role-based access control (RBAC): user identification (ID) password management, role assignment
- Invalid access attempt
- Session management
- Access notifications message
- IED can be integrated into a system that manages accounts according to a directory server with LDAP protocol (Lightweight Directory Access Protocol).

Audit trail and logging

The device logs events to **Security.log**, a locally stored file based on the **IEC 62351-14** standard. In addition to file access (web or sFTP), the device allows security events to be automatically sent to a remote server using the **Rsyslog protocol**.

Port access control

All communications ports, whether physical or logical, can be enabled or disabled through configuration of the IED. Firewall functionality can be configured independently for each Ethernet port.

Hardening

The IED is an embedded device whose firmware only includes those software components that are necessary for the possible operating scenarios for which it has been designed and does not allow users to install additional software.

Malware protection

The system contains services designed to check that the applications running are authorized and that they maintain their integrity.

Signed firmware

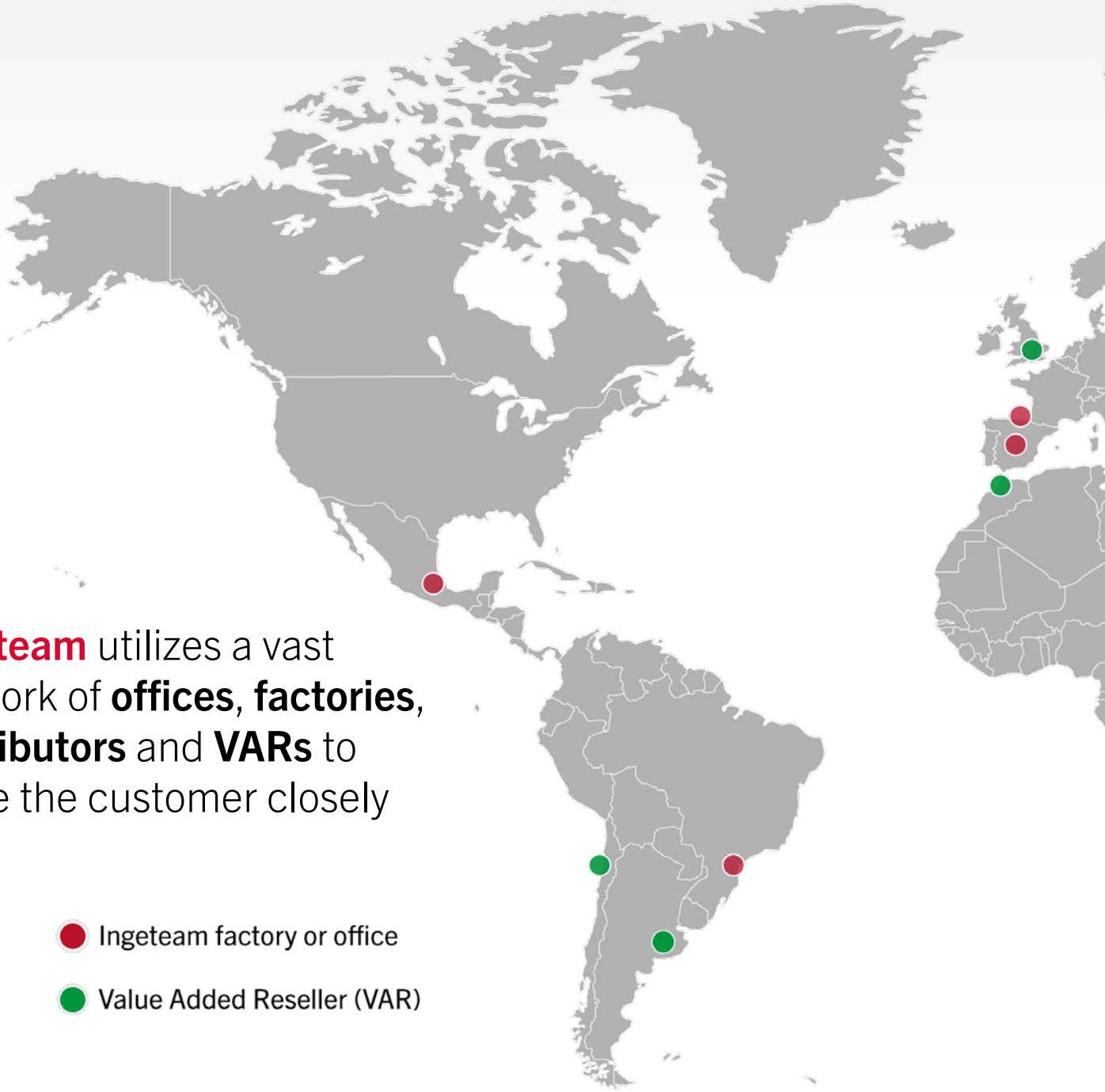
Firmware will be packed in a CMS/PKCS#7 container; the device can be configured to accept only digitally signed firmware.

Vulnerability management

Cryptographic features

- Web server by HTTPs
- File access by sFTP
- Firmware update packages digitally signed and encrypted, based on CMS/PKCS#7
- SNTP with key authentication
- Secure LDAP (LDAPs)
- Rsyslog with TLS

INTERNATIONAL PRESENCE



Ingeteam utilizes a vast network of **offices**, **factories**, **distributors** and **VARs** to serve the customer closely

- Ingeteam factory or office
- Value Added Reseller (VAR)

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Ingeteam contributes to a **safer**, **more reliable** and **sustainable** electrical network

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