

Smart Controller / Meter Concentrator

Overview

Part of the SmartGate product family, the G Smart is an innovative controller for distribution networks that integrates both MV and LV network control and monitoring. While targeting advanced transformer station automation and MV circuit/feeder automation together with smart metering gateway, G Smart units can also be applied in advanced smart grid applications. By integrating multiple automation functions with downstream LV smart meter data collection and management through multiple standard communication interfaces, G Smart enables true smart grid solutions from MV and LV network automation through street lighting, demand-side management, EV smart charging and microgeneration control.


The G Smart includes built-in Web server, I/O, data storage, fault detection, communications, condition monitoring, local energy metering and power quality analysis, as well as extensive self-monitoring. Full programmability in IEC 61131-3 languages along with software APIs allow user-defined algorithms and advanced applications to be implemented according to the needs of each project.

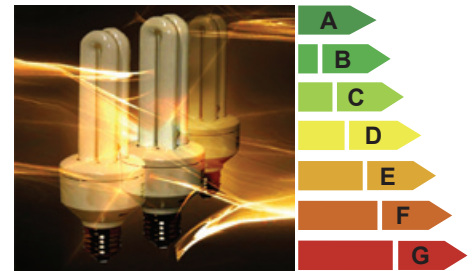
Virtual G Smart, a software-only variant of the G Smart controller, is also available for smart metering data collection applications.



A SmartGate Product

Other SmartGate Products

GRemote Smart RTU	Smart distribution RTU and automation controller including support for open automation based on IEC 61850, IEC 60870-5, DNP, IEC 61131-3 and other standards.
GFault Fault Detector	Standalone fault detector device or small RTU for distribution networks.
 automation studio Integrated Engineering Environment	Engineering tool for device configuration and management, including automation functions according to the IEC 61131-3 standard.



Key Features

- Advanced Smart Grid Controller
- Multiple Communication Options
- Local MV/LV Substation Automation
- Street Lighting Control
- Smart Metering Gateway
- Local Metering and Power Quality Analysis
- IEC 61131-3 User-Defined Automation

Customer Benefits

- Increase the Network Reliability and QoS
- Reduce Energy Costs and Losses
- Improve Network Operation Efficiency
- High Availability and Low Maintenance
- Straightforward Meter Management
- Support for Advanced Applications
 - Active Demand-Side Management
 - EV Smart Charging Control
 - Dispersed Microgeneration Management
 - Energy Storage Management



Product Features

Construction and I/O Interfaces

The standard factory device provides 8 digital inputs and 8 digital outputs. There are two optional expansion cards available, one for I/O capacity extension with additional 16 digital inputs and 8 digital outputs, and another for power quality measurement and management.

The **G Smart** is CE marked and is designed to fulfill all applicable international requirements, including isolation, immunity and emission. G Smart supply nominal voltage nominal is 230 VAC. +- 20%, 50 or 60Hz, and can be supplied up to three, although it is possible to be feed from 80 to 265VAC or even from 88 to 300VDC.

Communication Interfaces

The **G Smart** includes a wide range of communication options to enable multiple system architectures. The serial interfaces are commonly used for connectivity between **SmartGate** family products or third party devices on the TAN (Transformer Area Network), the PLC port is mainly used for interfacing LV meters and the GPRS/UMTS modem or Ethernet ports are used to integrate the system in the WAN. All communication interfaces include extensive self-monitoring, including online data and statistics.

Management Interface

For diagnostics and device management both the Ethernet ports as well as the two USB ports and one RS232 port can be used. Mounted on the device, four diagnostic LEDs are available (POWER, RUN and active and reactive power optical pulse counters).

Through the Ethernet ports **G Smart** provides an embedded web server for diagnostics, management, control and record extraction regarding all available functions on the device, including management of downstream units such as smart meters or external modules.

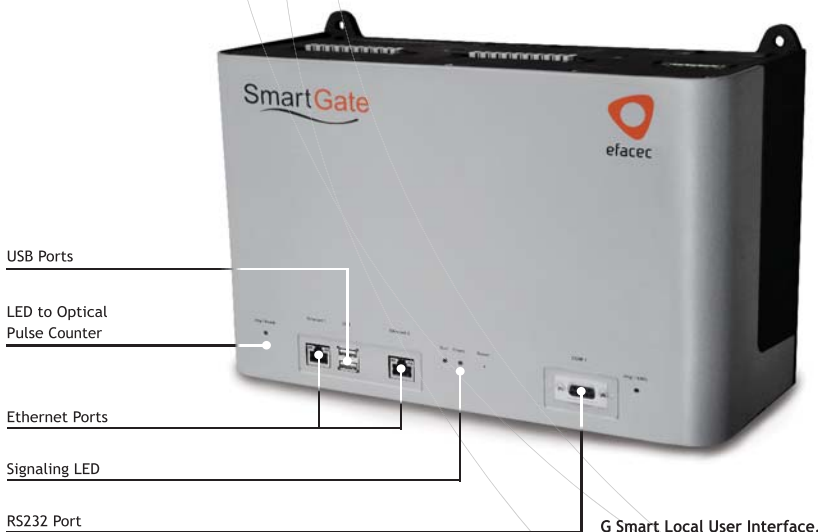
I/O	
Base I/O	
8 DI + 8 DO	●
Digital I/O Expansion Card	
16 DI + 8 DO Expansion Card	○
Metering and Measurement Expansion Card	
4 x Current inputs	○
3 x Voltage inputs	○
Storage	
SD Card	●
Power Supply	
230 VAC (80V to 265V, 50 or 60Hz)	●
88 to 300VDC	○

● - Base feature | ○ - Optional feature

Remote User Interface	
Embedded web server	●
Local User Interface	
2 LED (Run, Power)	●
2 x LED (for External Optical Pulse Counter)*	○
Reset Button	●
Diagnostic Communication Interfaces	
1 x RS232	●
2 x USB	●
Communication Interfaces	
2 x 10/100 BASE-TX (RJ 45)	●
1 x RS232	○
1 x RS485	○
1 x GPRS port	○
PLC (three phase, up to 1 module)	○
Yitran	○
PRIME	○
1 x RF Mesh (external module)	○

* Depends on availability of Metering and Measurement Expansion Card.

● - Base feature | ○ - Optional feature



G Smart Management, Supervision and Control.

Communication Protocols

The **G Smart** provides several communication protocols that allow integration in diverse system configurations. The common setup includes IEC 60870-5-104 (TCP/IP) for remote control, DLMS/COSEM or Web Services for remote management, DLMS/COSEM for LV network communications and MODBUS protocol for local station communication. Such protocols can be used through several interfaces such as Ethernet, GPRS/UMTS, RS485, PLC or RF Mesh.

Real-time clock synchronization can be performed via SNTP when the devices integrated in a network with a SNTP/NTP clock availability. Multiple NTP time servers are supported for redundancy as well as several NTP communication modes for enhanced flexibility.

Communication Protocols	
Telecontrol	
IEC 60870-5-104 (TCP/IP)	•
Others (Please Contact)	○
Remote Management	
DLMS/COSEM	•
Web Services	•
Others (Please Contact)	○
LV Network Communications	
DLMS/COSEM	•
Others (Please Contact)	○
Local Station Automation	
MODBUS	•
Others (Please Contact)	○
Clock Synchronization	
SNTP, Communication Protocol	•

• - Base feature | ○ - Optional feature

Web-based Interface

G Smart is shipped with a powerful HMI in an embedded web server that allows user-friendly and secure access to device configuration, system monitoring and control as well as meter network management. This functionality can be accessed securely with password protected user login through the Ethernet ports or GPRS/UMTS modem.

G Smart HMI modules allow, among other, to customize of all **G Smart**'s functions, perform device management and access all logs, visualize all data collected locally or received from remote meters. Locally stored information can also be exported to CSV files for offline analysis or visualized through lists with convenient filters.

For operational purposes it is also possible to create and deploy user-defined mimics like in any sophisticated HMI, including graphical animation and control execution. Device management includes task programming, configuration, measurements and historic visualization, firmware upgrades, etc.

Data and Event Logging

The **G Smart** provides a range of organized logs to help the user access important logged data. Through the Alarm List it is possible to check relevant alarms and its timestamps, corresponding to user defined operational constraints out of range values, equipment events, metering and power quality events, etc. The device Event log stores all **G Smart** related events for offline analysis. A specific Power Quality event Log is also available for events and statistics compliant with EN 50160.



G Smart Web Browser Interface.

Application Functions

MV/LV Station Automation and IEC 61131-3 Programming

The **G Smart** can be applied as a smart RTU and MV/LV station automation unit providing built-in functions, such as MV fault detection, transformer monitoring and control, MV circuit breaker control, and several measures (RMS values, power factor and others).

As a standards-based controller, the **G Smart** is programmable with IEC 61131-3 languages that enables to deploy user-defined programs such as MV self-healing sequences, generic switching sequences, alarm grouping and handling, among others. The IEC 61131-3 engine provides Boolean logic, integer and floating point arithmetic, standard blocks such as flip-flops, counters and timers. The programming environment is fully integrated in Automation Studio.

MV/LV Station Condition Monitoring

As more and more systems turn to condition monitoring for improved asset management, the **G Smart** becomes an invaluable help in performing local data acquisition and health assessment. Several operating conditions and alarms such as intrusion, fire, flood, transformer and the cabinet temperature, LV circuit status can be monitored, detected, reported and integrated for advanced algorithms.

Street Lighting Control

G Smart provides an optional software module for street light control, including not only manual control, status and lighting statistics, but also scheduling and management including:

- Time table: flexible user-defined scheduling, including support for schedule exceptions;
- Astronomic clock: street light is automatic controlled by sunrise and sunset time;
- Association to street light meters: street light schedule is setup via meter configuration and monitoring of lighting statistics, energy consumption monitoring and additional smart meter control is also available.

Configurations options can be locally managed through the web-interface or through remote central street light management platforms such as **eLumen**.

Smart Meter Management

The **G Smart** is completely prepared to communicate with Efacec or third-party smart meters. It offers several features for easy integration and management such as meter plug-and-play, automatic detection of powered smart meters, collection, storage and reporting of metering records and events, manage and control tariffs, power cuts, load profiles, billing data, etc.

MV and MV/LV Station Automation	
Smart RTU and MV Station Automation	
Chronological Event Log	•
Programmable Automation (IEC 61131-3)	○
Transformer Circuit Breaker Monitoring and Control	•
MV Circuit Breaker Monitoring and Control	
MV Fault Detection	
RMS Value of Phase Currents	
RMS Value of the Neutral Current	○*
RMS Value of Phases Voltages	
Power Factor (Per Phase)	
Active and Reactive Power (Three Phase)	
Station Condition Monitoring	
Intrusion	
Fire	
Flood/Humidity	
Temperature Monitoring of Transformer	•
Room/cubicle Temperature Monitoring	
LV Circuit Monitoring	
Street Lighting Control and Monitoring	
Via Local I/O	
Via Street Light Meters in Lighting Circuits	•

* Through external plug-and-play **G Fault** modules.

• - Base feature | ○ - Optional feature

Smart Meter Management and Meter Reading

LV Meter Concentrator (Residential Meters, Micro-Producers, etc)	
Meter Management (Tariffs, Power Cuts, Messaging, Contractual Max. Power, etc)	
Meter Plug-and-Play	
Automated Meter Reading (Load Profiles, Billing Data, etc)	
Automatic Meter Phase Association *	•
Energy Balance	
Load Unbalance**	
Clients Under Outage	
LV Fault Detection	
Demand-Side Management	

* Communication Protocol-Dependent.

** Requires Metering and Measurement Expansion Card.

• - Base feature

LV Energy Balance

Monitoring the relation between energy supplied by the power transformers and consumed by the attached clients is possible with the LV energy balance function, which provides a straightforward mechanism to detect technical and non-technical losses by generating alarms and reports. Multiple configuration options are available including multi-period energy balancing, multiple measured quantities and balancing parameters.

LV Load Unbalance

The function of load unbalance is part of a set of protection algorithms of **G Smart**. This function detects load unbalance between phases of the LV network according to established detection parameters, including fixed or relative levels, and generates convenient alarms or reports.

Clients under Outage

With this alarm function the user can quickly detect potential faults in the LV distribution cabling and/or outages of critical clients. Parameterization of this function includes minimum percentage of clients under outage for different priority levels and also different geographic areas.

LV Fault Detection

By correlating the aggregated smart meter communication failure data, **G Smart** can detect faults in the LV network. It can also provide geolocation and phase association information, not only to accurately detect LV circuit failures, but also to provide troubleshooting information to aid in the system restoration, thus decreasing the time under outage.

Monitoring of Power Quality

The **G Smart**, when equipped with the Power Quality expansion board, can analyze, monitor and register power quality parameters from the local measured voltages. Measurements and their aggregation mechanism fulfill class A uncertainty requirements as well as measurement aggregation requirements and flagging concept according IEC 61000-4-30.

Furthermore, it is possible to monitor voltage parameters and generate alarms by setting operational thresholds and integration timers for frequency, voltage magnitudes, flicker, THD, harmonic content, voltage unbalance.

Concerning voltage disturbances, **G Smart** provides statistics that includes counters and total time for each type of disturbance and for each phase.

Beyond measurement and recording, **G Smart** also detects, stores and reports power quality events with millisecond precision, such as disturbances in the measured voltage value, alarms associated with monitoring, user actions.



Power Quality Monitoring*

Voltage Disturbance Analysis (Dips, Swells, Interruptions)	
Voltage Harmonic Measurement (up to 50th order)	
Total Voltage Harmonic Distortion	
Voltage Unbalance with Calculated U1, u0 and u2	
Flicker (Pst, Plt)	o
Frequency	
Power Quality Alarms	
Aggregated Measurement Recording	
Power Quality Data Export (PQDIF, CSV)	

* Requires Metering and Measurement Expansion Card.
o - Optional feature

Advanced Applications

The **G Smart** is also uniquely positioned to host a number of advanced applications such as smart load shedding and restoration, active demand-side management (DSM), combined microgeneration and storage control, electric vehicle smart charging or even more advanced applications like virtual power plant management.

Smart Load Shedding and Restoration

The **G Smart** provides the ability to perform real-time selective and iterative load shedding in the attached LV network, according to current load status shedding set points and load criticality. It also supports ensuing load restoration. By applying smart load shedding and restoration as a preventive function, distribution network QoS can be enhanced and finer-grain control over load and generation balancing achieved.

DSM Autonomous Controller

The **G Smart** can be equipped with an algorithm that manages the consumption of energy downstream, by sending DSM set-points to attached smart meters to reduce or restore the individual demand of each customer's selected circuits/appliances depending on previous commercial framework. Network operation can be autonomously optimized by combining local control with network set points, reducing technical losses and control of voltage profiles within the regulatory limits, hence resulting in QoS improvement and system performance enhancement with limited investment.

Electrical Vehicle Management

G Smart can monitor the EV charging stations, being responsible for the integration of the EV with the electrical network. Furthermore, not only it manages the operational data but it can also perform intelligent functions according to the real-time system condition. The **G Smart** processing capabilities allows smart charging strategies to be implemented, coordinating the EV charging cycles in order to minimize the impact on the distribution network operation. Moreover, when permitted by the EV manufacturer, vehicle-to-grid can be performed offering ancillary services and capacity availability for optimal renewable integration.

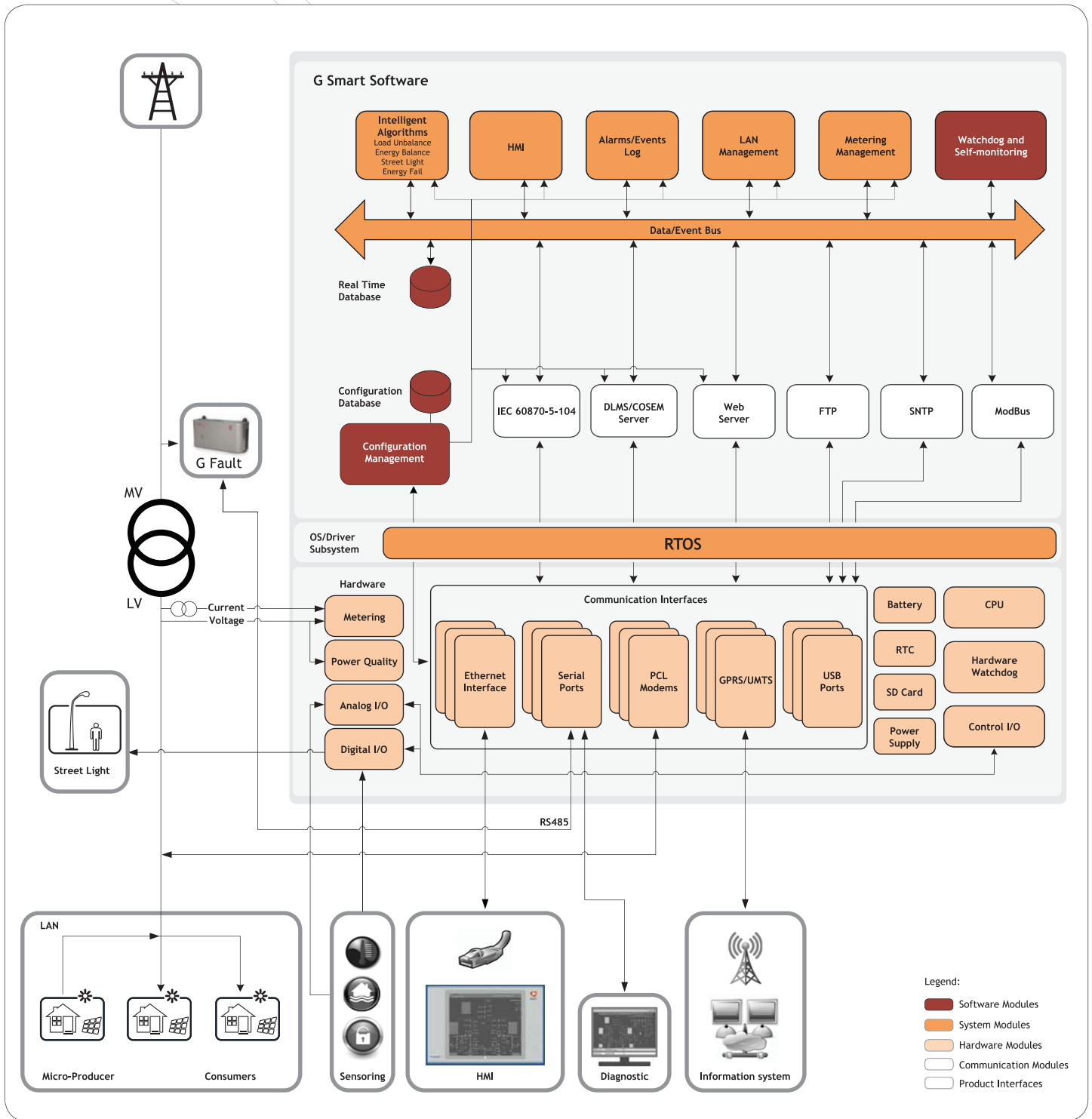
Virtual Power Plant

As yet another advanced smart grid scenario, the VPP comprises the aggregation of various distributed resources that can be used in the same manner as conventional generation. The **G Smart**, given its processing capabilities, control strategies and the concentration of data collected from lower voltage levels, is ideally suited to coordinate microgeneration unit clusters.

G Smart units may be applied as VPP management computers in advanced grid applications, by managing DER options according to technical and commercial VPP strategies. Intelligent control algorithms combine data obtained in from LV connected smart devices and dispatch solutions in real-time to microgeneration units and storage devices according to technical and market conditions.



Architecture



G Smart Product Architecture.

Application Overview

G Smart is a smart controller targeted for Smart Grid deployments. By bundling intelligent functions and capabilities, it is a focal point for smart monitoring, metering, management and control of advanced distribution networks in an economical, secure, safe and environmental friendly way.

Application Description	
<p>Advanced Transformer Station Automation</p> <ul style="list-style-type: none"> • RTU and MV cell monitor and control • MV fault detection • Local energy metering and power quality analysis • Station and transformer condition monitoring • Multiple transformer arrangements 	
<p>Smart Metering Gateway</p> <ul style="list-style-type: none"> • Meter reading/collector <ul style="list-style-type: none"> - Local storage • Meter management <ul style="list-style-type: none"> - Meter plug-and-play - Meter events - Tariffs - Messaging 	
<p>Integrated Smart Grid Applications</p> <ul style="list-style-type: none"> • Metering gateway • Local energy metering and power quality analysis • RTU and MV automation • Street light management • Microgeneration control • EV Integration and smart charging • Technical infrastructure management (MV and LV) 	
<p>Advanced Smart Grid Applications</p> <ul style="list-style-type: none"> • Demand-side management • Combined control of consumption, storage, EV charging and microgeneration • Islanded and grid-connected operation • Technical and economical energy management 	

