

P161, P162, P163

Feeder protection

P60 Agile enhances Alstom's range of IEDs by providing a 'One Box solution' for protection, control and monitoring of electrical power systems.



Compact | Multifunction | Versatile

P60 Agile One Box solutions

The P60 range is suitable as main or backup protection for a wide range of typical applications and covers all common power system earthing arrangements such as solid, resistive, or resonant earthing and isolated networks. The colour touch-screen HMI with provision for bay mimic display and integrated control / interlocking functions maximises the application range of the P60 family. The fully programmable nature of P60 Agile makes it an extremely versatile and cost effective solution for all switchgear applications with varied protection requirements.

Alstom's one box solution brings touch-screen technology into the substation. Switchgear control and single-line diagram presentation is achieved thanks to the full-colour, graphical HMI.

The P16x series comprises the P161, P162 and P163 feeder management IEDs. Each requires a shallow depth of only 95 mm behind the panel, for ease of mounting within any switchgear cabinet. High performance features include 1.5 ms GOOSE, graphical logic, colour bargraph displays. IEC 61850, Modbus, Profibus DP, CANBUS and IEC 60870-5-103 protocols are available for full system integration.

CUSTOMER BENEFITS

- Bay visibility: large HMI with configurable views
- One box solution: protection, control and measurements
- Integration into existing substation automation: choice of communication protocols
- High performance (1.5 ms) IEC 61850-8-1 GOOSE
- Low depth design for installation in switchgear LV compartment



HUMAN MACHINE INTERFACE

The P60 Agile has a state-of-the-art HMI with intuitive and easy navigation across the full range of its features and functionality. The membrane keypad hosts up to 6 function keys and eight programmable LEDs, in addition to a USB port for communication with the PC-based configuration software.

The default HMI may be configured to display user preferences such as the single line diagram or load flow parameters such as voltages or currents instead of the Main Menu shown. The IED's touchscreen along with hotkeys facilitate quick and convenient access to the whole menu system.

Up to four user-defined pages are available in the home menu, with easy touch-screen navigation from one to the next.



Figure 2 Main menu screen

SWITCHGEAR CONTROL

The P60 Agile offers comprehensive switchgear control, aided by the dynamic single-line-diagram display, ON/OFF switching via the function keys and programmable bay and inter-bay interlocks. Up to five (5) switchgear elements may be switched by the P60 Agile bay control models. The single line diagram for the bay or a subset of the substation, along with relevant data such as measurements or alarms, may be generated by the user via the P60 configuration tool, aided by integrated graphical icons. Remote controls are facilitated by the relay's SCADA communication interfaces.

The provision of such powerful control capability within the relay (the "one box" concept) negates the need for external controls, switches and annunciation on the panel. Equipment cost and panel engineering time is reduced. For ease of operability and security of the command, dedicated open and close push buttons are provided on the P60 Agile front panel.



Figure 3 Typical one box solution mounting in switchgear

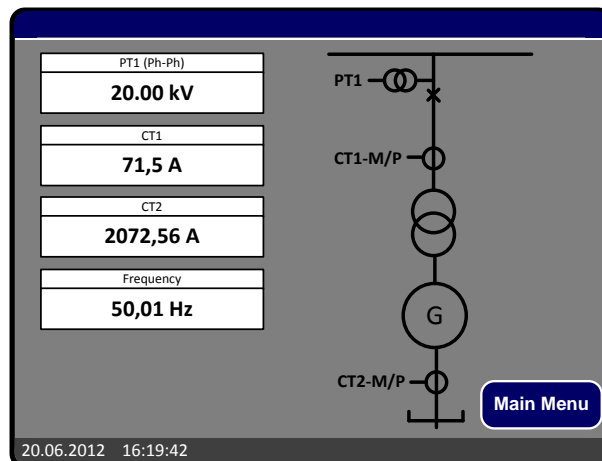


Figure 4 Example single line diagram (SLD) display

Protection + Control + Measurement + Recording = **One-box solution**

APPLICATIONS

Feeder protection

All models of P60 Agile provide full-featured overcurrent and earth fault protection, with six stages and a choice of definite-time or IDMT characteristics, including reset curves.

Applications involving non directional earth fault are covered by the P161, applications involving directional earth fault are covered by the P162, and the P163 provides full directional control of phase and earth fault elements in four independent stages. Harmonic stabilisation for inrush, voltage control and customisable directional characteristic boundaries all add to the versatility of the feeder protection functions. Sensitive earth fault (SEF) applications are also covered by the P60 Agile with a choice of CTs for the neutral input.

Core balance CTs may be connected for maximum sensitivity, also the neutral displacement voltage may be fed from a broken-delta VT where available. The integral multi-shot autoreclosing function supplements the application of feeder protection where transient faults on overhead lines are expected.

Distributed generation protection

The P163 relay features two-stage voltage vector surge protection for islanding applications, with the enhanced security of supervision by load current change. Three stages of df/dt (rate of change of frequency) are also available in the P163, with the flexibility of configurable hysteresis and supervision by frequency thresholds and/or direction.

The P163 also features under/overvoltage and under/overfrequency protection with twelve (12) stages each and the possibility of assigning the measurement to any of the three-phase VTs signals in the relay hardware on a per-stage basis, thereby securing the applications against the loss of a single VT input.

Dynamic grid support

The P60 is designed with the need for availability of modern high voltage and medium voltage networks in mind. In the event of single or multiple short circuits in medium or high voltage networks, immediate mains decoupling of distributed generation may be allowed only under specific conditions defined by the operators.

The P60 Agile includes custom functions for fault ride-through with up to ten (10) permissible voltage dips and for reactive power direction protection, and has been certified in accordance with the requirements of the BDEW utilities' standard, Germany.

FUNCTIONAL OVERVIEW

Programmable Logic Control (PLC)

The P60 Agile relays feature comprehensive programmable logic, with logic gates, flip-flops, counters, timers and timed switches. Users can customise the logic associated with protection functions via the PLC, combining outputs from the function block, binary input signals and inter-device signals (IEC 61850 GOOSE) in the PLC. Up to 500 logic gates can be programmed.

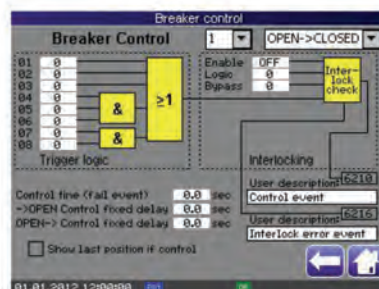


Figure 5: Simplicity of logic programming provided by P60 Agile

Configuration of breaker or switchgear element control utilises similar logic capability, with customisable triggering logic, interlocking and bypass features for each control action (eg: opening, closing, earthing) associated with the switchgear element.

User-programmable alarm conditions can trigger on-screen customised text alarms. Each text field can be up to 40 characters, enabling alarms to be simple and explicit for maintenance/operational personnel.

Each alarm, and each entry in the event record can be colour-highlighted to correspond with the urgency, or customer classification desired.

Four alternative settings groups are provided, such that P60 Agile may adapt to switched or emergency feeding scenarios.

Front port setting and interrogation

The USB front port provided on the P60 Agile relay is used for the configuration of settings, logic, and other downloadable data. An additional mini-USB port is available at the side of the housing which provides the same functionality as the front USB port. Alternatively, setting and interrogation may be made from the menu system accessible on the front HMI. Password protection is provided, with the touch-screen providing a virtual keypad display for fast entry of the password.

Rear communications

P60 Agile supports up to 3 rear communication ports for SCADA communication. Port 1 is dedicated for MODBUS, Port 2 and Port 3 can be configured for IEC 60870-5-103, Profibus DP, IEC 61850 as per the ordering options available. The rear serial communications ports can be configured to operate at baud rates up to 57.6 kbit/s. The IEC 61850 protocol is available with single port point-to-point connection, and redundant options. Accurate time synchronisation can be achieved using SNTP.

Fast IEC 61850 GOOSE

128 GOOSE inputs and 128 GOOSE outputs are available, offering best-in-class GOOSE performance (typically 1.5 ms response time).

Overcurrent protection

There are six stages of overcurrent protection provided in the P60 Agile family, with a choice of definite time, IEC Inverse or ANSI Inverse curves for time-coordinated tripping. The overcurrent protection features also include reset curves, blocking inputs and harmonic stabilisation to facilitate a variety of protection schemes. The function may be directionalised in relay models with three-phase voltage inputs.

Earth fault protection

The earth fault protection functions in the P60 Agile include sensitive earth fault, wattmetric earth fault, neutral voltage displacement and neutral admittance protection in addition to the standard residual current based protection. All the functions have multiple stages and permit flexible scheme configuration with instantaneous (start) and timed event outputs.

Voltage protection

The P163 provides comprehensive overvoltage and undervoltage protection, with up to twelve stages and phase-phase or phase-earth voltage as the measurand. The voltage measurement for each stage may be assigned to any one of the three VT inputs in the relay for maximum flexibility.

Protection functions are conveniently referenced according to their IEEE/ANSI function number.

P60 Agile protection function overview

ANSI	Function	P161	P162	P163
51/51N	IDMT overcurrent/earth fault protection	•	•	•
51SEF	Sensitive earth fault	•	•	•
50/50N	Definite time overcurrent/earth fault protection	•	•	•
95i	Inrush blocking	•	•	•
50BF	Breaker failure protection	•	•	•
67	Directional overcurrent protection			•
67N	Directional earthfault protection		•	•
	Neutral admittance		•	•
59N	Residual overvoltage		•	•
59	Overvoltage			•
27	Undervoltage			•
27T	Fault ride-through (BDEW)			•
27Q	Reactive power support (BDEW)			•
81O	Overfrequency			•
81U	Underfrequency			•
78	Vector surge			•
81R	Rate of change of frequency (df/dt)			•
32	Power protection			•
79	Multishot autoreclose	•	•	•
25	Check synchronising			•
CTS	CT supervision	•	•	•
VTS	VT supervision			•
74	Trip circuit monitoring	•	•	•
49	Thermal overload	•	•	•
32N	Wattmetric earth fault protection		•	•
46	Negative sequence overcurrent	•	•	•
51V	Voltage dependent overcurrent			•
CLP	Cold load pick-up	•	•	•
46BC	Broken conductor	•	•	•
64R	Restricted Earth Fault (REF)	•	•	•

PLATFORM OVERVIEW

The P60 Agile is designed for reliability with four powerful microprocessors and an integral cross-monitoring feature. The slim profile hardware (95 mm depth) makes it easy to fit into any switchgear compartment. The compact design together with the robust stainless steel housing provides rigidity, a wide operating temperature range, and maximum shock and bump capability for even the most demanding applications. The design pedigree draws from utility, industry, marine and genset installed base experience.

- The innovative design of the P60 allows functions to be distributed between hardware and software implementation. For example, the eight freely-programmable physical LEDs can be supplemented with virtual LEDs on the LCD screen.
- Terminal blocks on the rear of the device are typically pin-type and encapsulated, for safety of personnel even when a cabinet door is open.



HMI

Full colour touchscreen display	•
Programmable hotkeys	•
3 x status LEDs	•
8 x programmable LEDs	•
USB port	•

Communication

MODBUS, RS 485	•
PROFIBUS DP, RS485	(O)
IEC 60870-5-103, RS485 / FO	(O)
IEC 61850 station bus (RJ45 / FO)	(O)
IEC 61850 station bus, redundancy (RJ45 / FO)	(O)

Binary Inputs / Outputs

Digital inputs, wide range	18
Relay outputs	12

Analogue Inputs

Phase current inputs, 3 x 1 ph	•
Measurement class current inputs, 3 x 1 ph	(O)
Earth current input, 1 x 1 ph (or)	(O)
Sensitive current input, 1 x 1 ph	
Feeder voltage input, 1 x 3 ph	(M)
Busbar 1 voltage input, 1 x 3 ph	(M)
Busbar 2 voltage input, 1 x 3 ph	(M)
Neutral displacement voltage input, 1 x 1 ph	(M)

General

Setting groups	4
Event logging	•
Alarm management	•
Disturbance recording	•

HARDWARE

Dimension (H x W x D)	250 x 210 x 95 (mm)
Cut out	232 x 192 (mm)
Auxiliary supply	24 V DC, 48 V DC, 60 V DC Or 110-220 V DC/ 110-230 V AC
Climatic conditions	- 25 °C to + 70 °C
Housing	Front IP54 Rear IP20

• Standard (O) Option (M) Model dependent

MEASUREMENTS, RECORDING, AND POST-FAULT ANALYSIS

Measurements

Analogue measurement values are clearly displayed on the HMI screen. A subset of principal values may be placed alongside the single line diagram, with the full suite of measurements accessible within the menu. Real-time measurements are shown as accurate, digital quantities, with a corresponding bar graph alongside. Each bar changes from green to orange and then red, annunciating normal loading, overloading and excessive loading in a way that is clearly visible by substation staff. Alternatively, voltage and current vector (polar) diagram displays may be consulted.

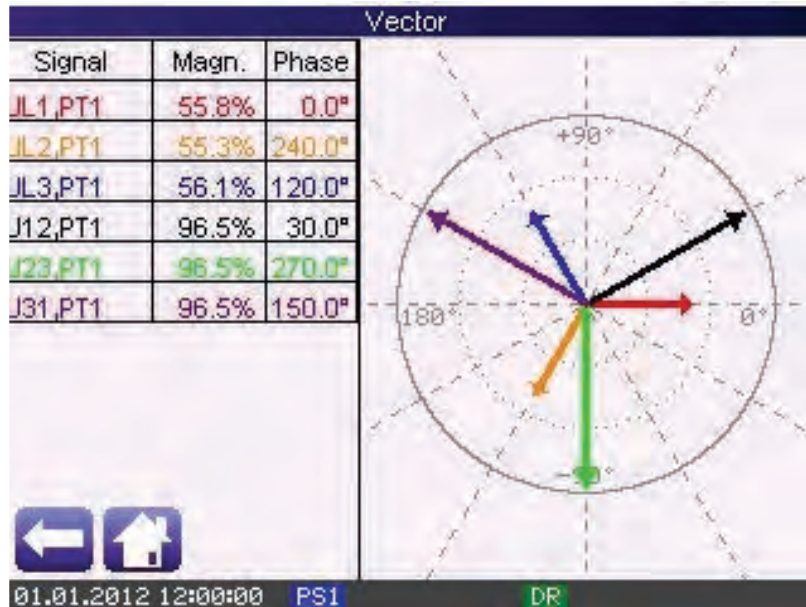


Figure 7 Vector display capability of P60 Agile

In addition to directly measured analogues, power (including power factor) and energy measurements are provided for the P163. Energy measurement is accumulated in all four quadrants: kWh, kVARh, import and export.

Operation logs count the number of operations of each switchgear device. For 3-position devices, the number of open and earthing operations are accumulated independently.

High accuracy metering

The P60 Agile platform offers measurement CT inputs optionally, for applications where high accuracy metering is called for. The measurement CT inputs are accurate to 0.5% for currents up to 2 In, and are intended for use in combination with an external metering class CT.

P60 Agile: full colour touch-screen technology within the substation

Records

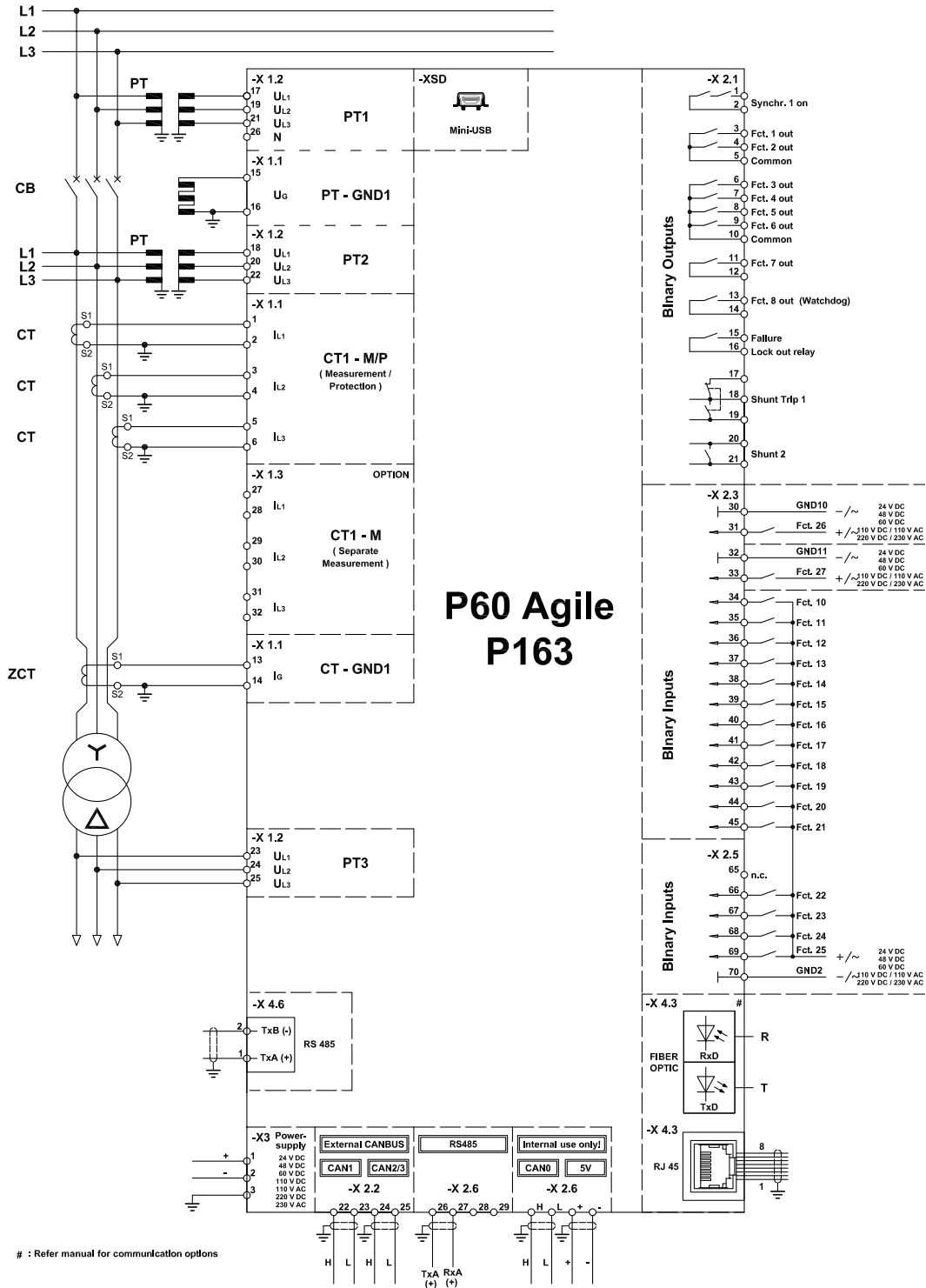
The P60 Agile relay records up to 10 000 sequence of event records in a FIFO buffer. Time-tagging is to a resolution of 1 ms. Disturbance recording stores the analogue waveforms and binary signal data to allow in-depth post-fault analysis. Typically ten disturbance records are stored.

Alarm management

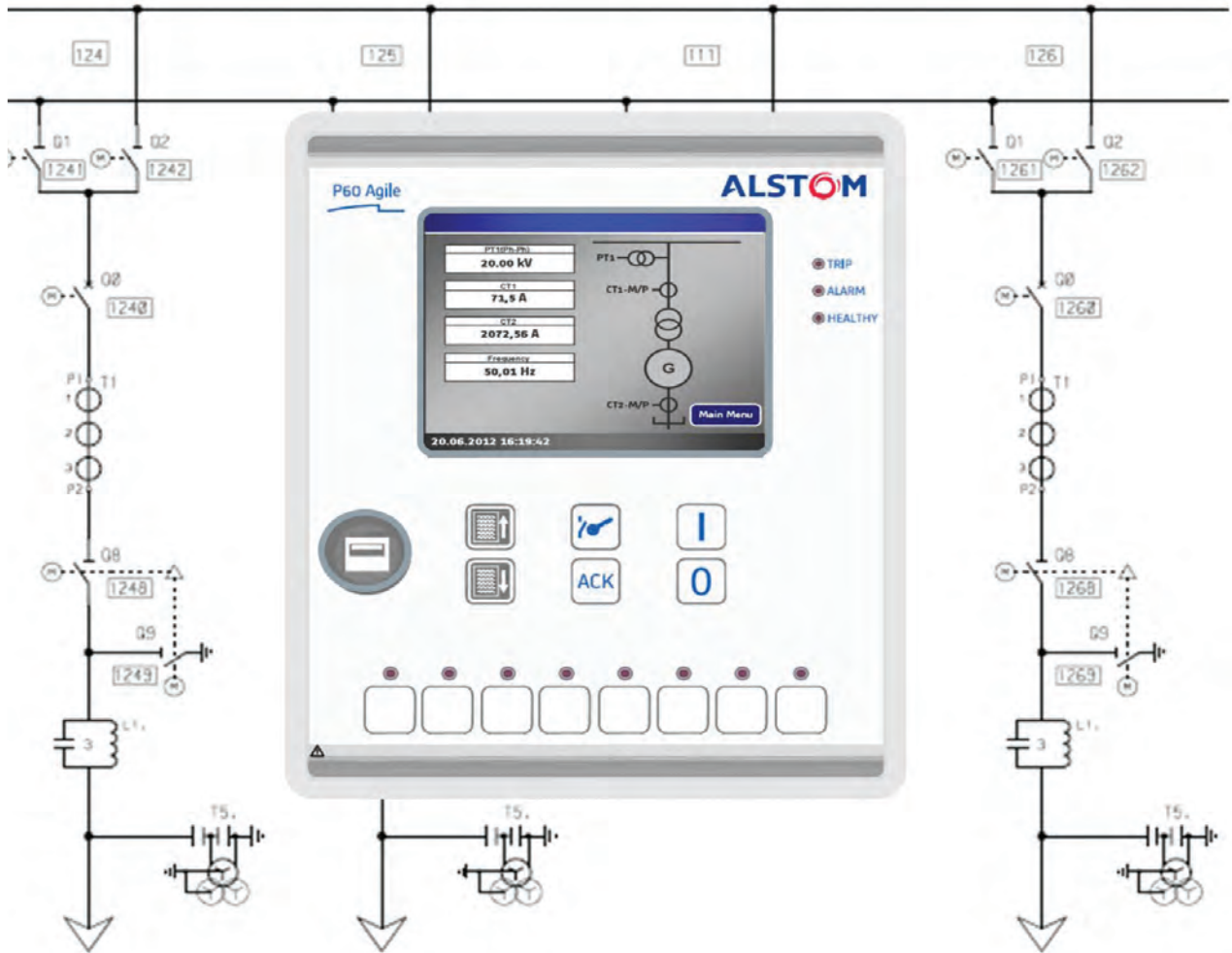
The P60 features include extensive alarm management capability, keeping in view its role as the protection, control and measurement device for a bay. The HMI display has a configurable Alarms page, which is opened on occurrence of any alarm. Alarm names may be configured by the user, along with a software LED which helps the user to recognise the alarm status – whether it is active, active and acknowledged or inactive and not acknowledged. The configuration tool allows the user to derive alarms as a combination of events available in the relay data model; up to 449 alarms may be defined, and allocated to alarm groups for efficiency.



P163 TYPICAL WIRING DIAGRAM



P60 Agile connection diagram



FEEDER DEVICE TRACK RECORD

- > CDG – Forerunner of feeder developments undertaken by Alstom since 1949
- > MCGG – World’s first mass-produced digital relay
- > KCGG/KCEG - First fully-numerical overcurrent relay launched in 1992 and sold over 20 000 units
- > P14x MiCOM series introduced in 1999. Worldwide application, with over 100 000 units delivered
- > P40 Agile launched in 2012
- > P60 Agile brings one box protection and control to the range

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