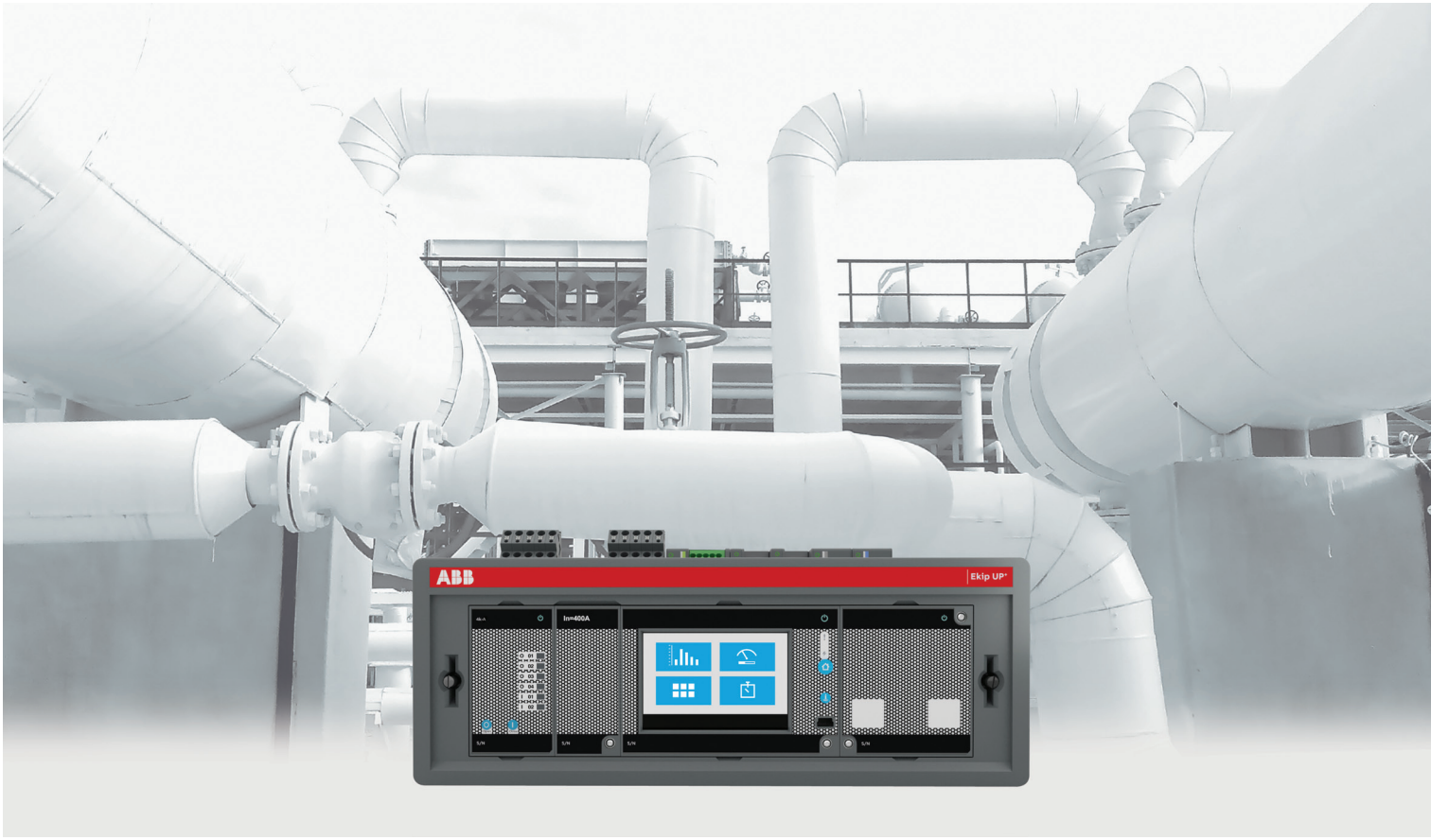
WHITE PAPER

Ekip UP+

The protection relay designed for low voltage power-stations, as well as mining and oil&gas plants



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Applications

Setting configurations no longer is a mission for a few experts. Instead, it becomes a matter of just a click with Ekip UP⁺, the first relay manufactured in the same factory with mechanical switching parts to protect utility power stations as well as oil and gas and mining low-voltage electrical distribution systems.

Every year, around $1 billion worth of low-voltage circuit breakers and switch disconnectors is installed at conventional and hydro generation plants, refinery and petrochemical sites, mining and metal industry locations.
These markets are growing from global macro trends like urbanization and modernization. The shift of population from countryside to cities increases the industrialization of extensive urban areas, so the need for power generation grows.

Meanwhile, new digital technologies are ready to replace old electro-mechanical products to enable advanced connectivity and control inside power grids.
The revamping of existing sites also is driven by environmental targets like IED (Industrial Emissions Directive) or the most stringent BREF values (the European references on the Best Available Techniques for the different industrial sectors).

In the mentioned market segments, almost all the **switching devices are protected by external electronic relays** for several reasons:

- **Project speed up**
  The design routing of the external relay plus circuit breaker of medium-voltage switchgear is replicated in low voltage to keep the same approach. Sometimes the relay enables additional protection and communication performances beyond embedded solutions.
- **Reliability analysis**
  Instead of having a trip unit embedded in the circuit breaker, having the protection release outside the mechanical part splits the failure risks.
- **Ease of maintenance**
  When an aged mechanical part must be replaced, with the separated unit the protection settings are not impacted and there's no need for any configuration upload.
- **Testing capability**
  Periodic secondary current injection tests are allowed on external relays through direct signals from generators to the related current and voltage sockets.

In the switchgear, the relays are typically used for primary protection of the switch disconnectors and sometimes as backup for circuit breakers to increase redundancy.

They protect feeders (mains, incomings, departures), generators (diesel gensets, co-generators, wind and mini-hydro turbines), motors and transformer/busbars. Feeder and generator relays represent more than 65% of low voltage share.

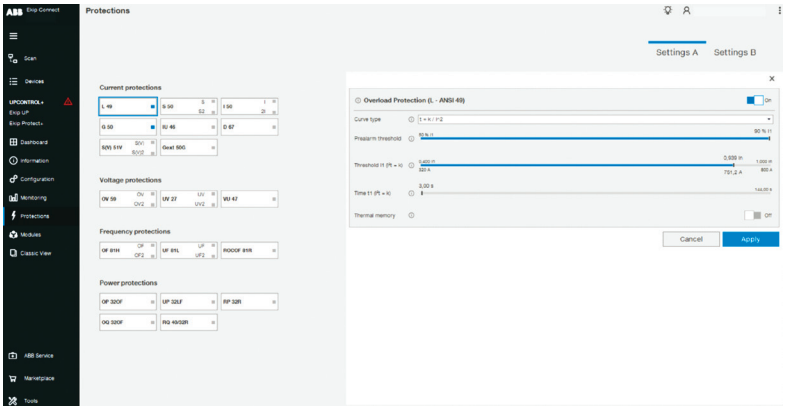
Solutions

Ekip UP⁺ is not only the answer for safety protection and service continuity in power stations, oil and gas, and mining, but it is also the first range of protection relays based on specific requirements of low-voltage plants.

For example, with a color touch-screen display and a graphics-friendly Ekip Connect commissioning tool, Ekip UP⁺ does not require skilled engineers to manage protection relays.

The result of reduced service activities is a **30% reduction in overall costs** for the solution compared to traditional relays created for more complex medium-voltage applications.

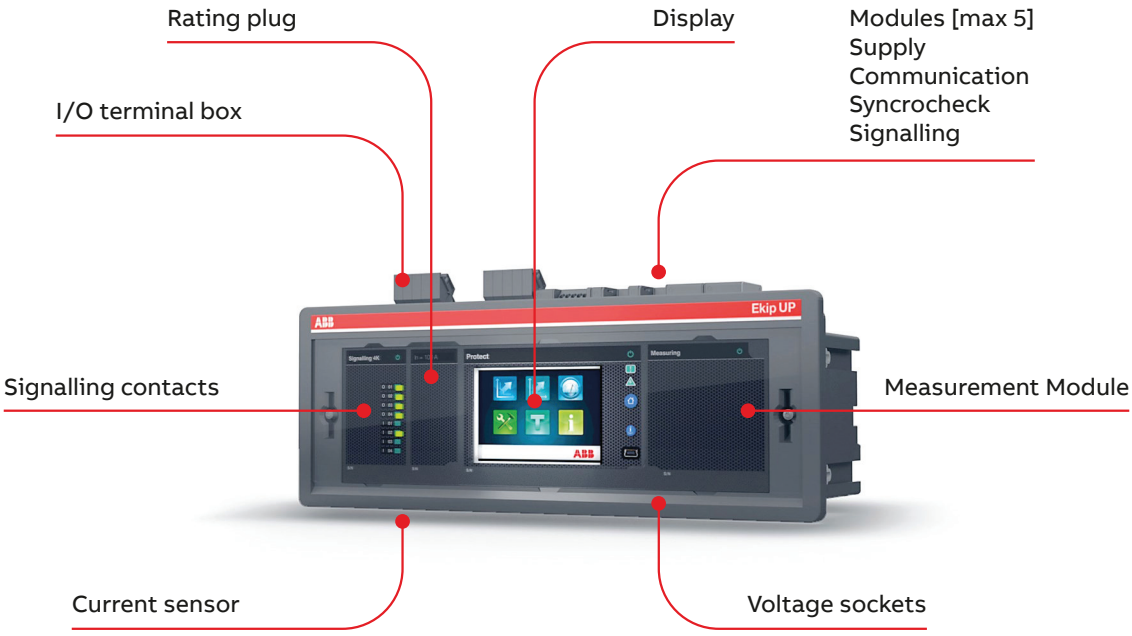
Commissioning protections in one click



Ekip UP⁺'s **modular approach** allows the facility to purchase only what is needed at this stage in terms of signalling, connectivity and advanced protection, such as a Synchrocheck module or restricted earth fault function, and to add evolving features like load-shedding logics or interface systems later through software packages and a simple plug-and-play technique.

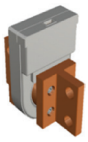
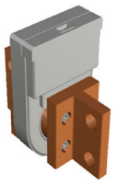
These digital units **do not require voltage transformers**[1] nor use traditional current transformers, so they use less wiring and fewer components than conventional relays developed for medium- voltage applications, saving substantial space.

Ekip UP⁺ relays work instead with current sensors up to 6300A based on **Rogowski coil technology**, shrinking the footprint for monitoring and control compared to current transformers and ensuring better linearity performance for high kA fault currents. **Open style sensors** unlock the upgrade of existing low-voltage switchgear, especially in electrical distribution revamping projects for oil and gas.



[1] Up to Ue=690V, for 690V<Ue≤1150V VTs are requested.

Rogowski coils

Type A		Type B		Type C	
	In: up to 2000 A Busbars: 2x60x10mm Kit: 3p/4p		Iu: 400 A Busbars: 1x30x10mm Cables: 1x240mm²		In: up to 6300 A
	In: up to 6300 A Busbars: 4x10x100mm Kit: 3p/4p		Kit: 3p/4p Iu: 1600A Cables: 2 x 2 x 11mm Kit: 3p / 4p Iu: 2500A Busbars: 2x60x10mm Kit: 3p / 4p		Positioning device

To provide evidence of solution reliability, ABB **tests** the complete measuring chain at the feeder factory site for **100%** of products that are shipped, giving the customer the production calibration reports with primary current injection tests. **Software-based protection tests** are available with the Ekip Connect commissioning tool, while secondary injection tests can be executed during FAT with most common signal generator brands.
Ekip UP⁺ is the first relay in the market manufactured in the same factories as circuit breakers and switch disconnectors so as to ensure unique technology-provider liability for the complete switching system.

Moreover, Ekip UP⁺ incorporates an embedded network analyzer function that furnishes insights into power quality (e.g., harmonics, voltage sags and spikes) to help increase productivity in the plant's electrical distribution together with nine communication protocols, resulting in an all-in-one digital platform with multi-function targets.

Safety protections

All Ekip UP⁺ units are CE-marked and cULus-listed. They conform to the Standard IEC 60255 - "Measuring relays and protection equipment" and UL 508, CSA C22.2 No. 14-13 - "Standard for Industrial Control Equipment."
Interfacing with every low-voltage circuit breaker or switch disconnector, the digital unit offers 35 ANSI protections built into Ekip UP⁺ Protect for distribution feeders.

Advanced protections (generator protections, motor protections, adaptive protections) and advanced functions (power controller, load shedding and IPS) can be upgraded directly from the online ABB Ability Marketplace™

The available protection functions are coded in compliance with the IEEE C37.2 "IEEE Standard for Electrical Power System Device Function Numbers, Acronyms, and Contact Designations" which is also known as the ANSI code.

BASIC PROTECTIONS

Name (ABB code)	Type of protection
L	Overload with inverse long-time delay
S	Selective short-circuit
S2	Short-circuit with adjustable delay
I	Instantaneous short-circuit
G	Earth fault with adjustable delay
MCR	Instantaneous short-circuit on circuit-breaker closing
2I	Instantaneous short-circuit programmable
IU	Current unbalance
Neutral	Differet protection on neutral phase
Harmonic distortion	Distorted waveforms
T	Abnormal temperatures
Hardware Trip	Internal connection errors
Iinst	Instantaneous short-circuit at high currents
Rc	Residual current
Gext	External earth fault with adjustable delay
D	Directional short-circuit with adjustable delay
UV	Minimum voltage
OV	Maximum voltage
UV2	Minimum voltage
OV2	Maximum voltage
Phase Sequence	Phase sequence error
VU	Voltage unbalance
RV	Residual voltage
UF	Minimum frequency
OF	Maximum frequency
UF2	Minimum frequency
OF2	Maximum frequency
RP	Reverse active power
cos ϕ	Minimum cos ϕ
VS Warnings	Line-to-line voltage signalling
FS Warnings	Line-to-line voltage frequency signalling
VS2 Warnings	Line-to-line voltage signalling
FS2 Warnings	Line-to-line voltage frequency signalling

GENERATOR PROTECTIONS

Name (ABB code)	Type of protection
S (V)	Voltage control short-circuit
RQ	Reverse reactive power
OQ	Maximum reactive power
OP	Active overpower
UP	Active underpower
ROCOF	Rate of change of frequency
S2 (V)	Voltage control short-circuit
Startup	Temporary exclusion of the trip thresholds

MOTOR PROTECTIONS

Name (ABB code)	Type of protection
R JAM	Motor block (post startup)
R STALL	Motor block (always activated)
UC	Under-current
U	Phase loss
PTC	Maximum temperature

Solutions

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Ekip UP⁺ thecnical manual

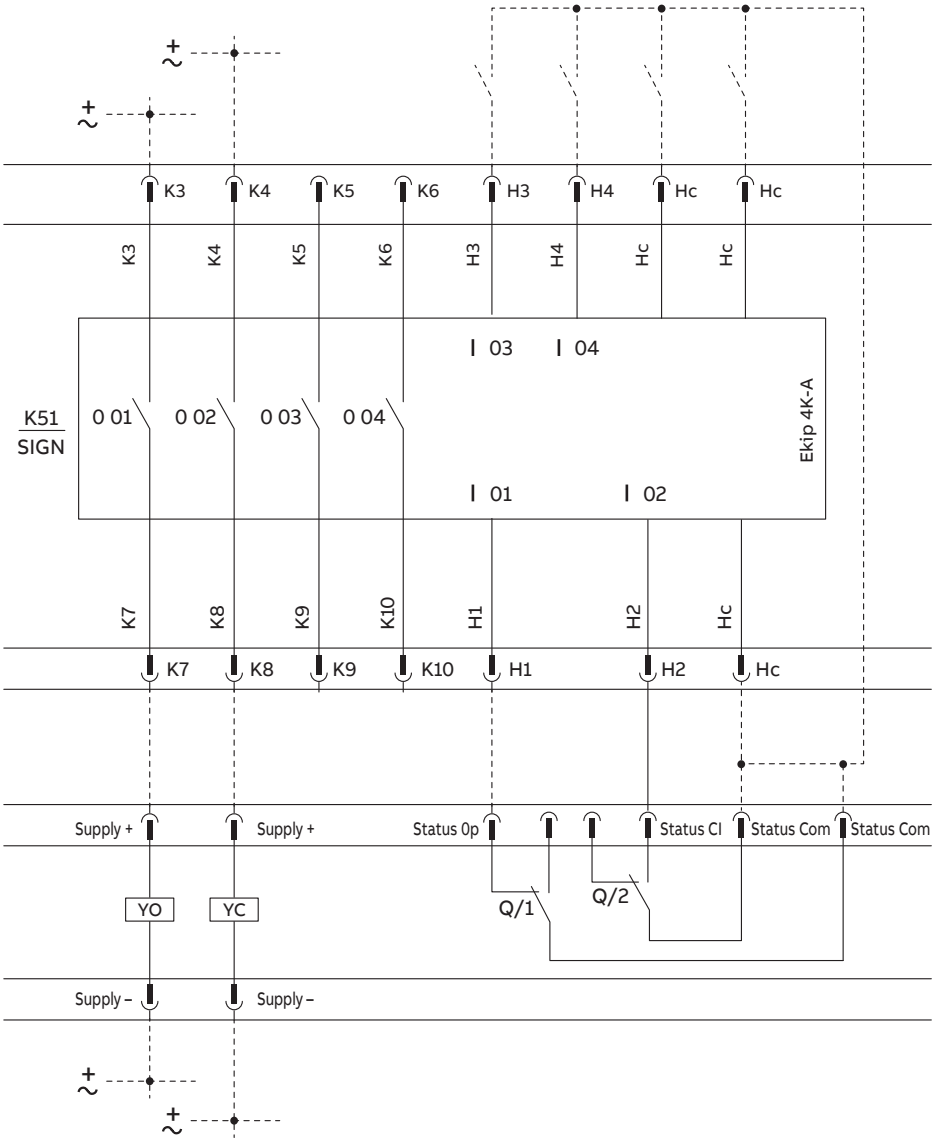
Ekip UP⁺ + switch disconnector
Together with a switch disconnector, Ekip UP⁺ acts on its shunt opening/closing coils, updating the asset with protections.

This is the typical protection scheme in oil and gas and mining plants. In this way, the digital relay ensures a breaking capacity equal to the switch-disconnector's ability to withstand current[2]:
Icu = Icw (1s) of the switch disconnector.

Considering the switching current and voltage of the Ekip Signalling 4k module, as given in the product technical manual, the ratings of the opening (or undervoltage) and closing releases are up to 250Vac and 150Vdc ones[3].

Default wiring is according to the diagram below. Other connections are possible according to flexible I/O settings configurable on the display or the Ekip Connect commissioning tool.

Electrical diagram



[2] As it is declared in its own documentation.
[3] If different, an auxiliary relay may be needed, and its timing should be considered for the opening/closing commands.

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ABB Sace Emax 2

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New Sace Emax

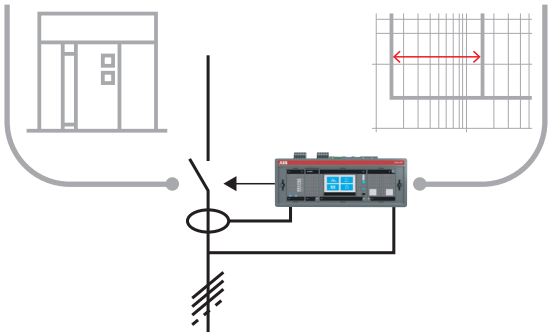
Considering Ekip UP⁺ as driving a switch disconnector of the ABB SACE New Emax and Emax 2 and GE Entelliguard G series through opening the actuator, the following timing should be considered in series and in sum to get the overall clearing time:

1. Ekip UP⁺ protections timing (depending on specific protection setting according to technical manual).
2. Ekip Signalling 4k.01 digital output commutation timing: 7ms
3. Mechanical breaking time through direct connection to opening coil:

a. SACE Emax 2 trip time by the mean of open releases is 35ms;
b. SACE New Emax trip time by the mean of open releases is 60ms.
c. GE Entelliguard G trip time by mean of shunt trip release is 20ms.

4. Clearing time depends significantly on the fault parameters (current, voltage, power factor, transients' phenomena in the faults current, etc.). Considering short-circuit AC conditions and for a rated voltage no higher than 690V, it can be assumed for both, ABB SACE Emax 2 and ABB New Emax, to be from 25ms to 40ms. For GE Entelliguard G the clearing time is 16ms.

For short-circuit, the maximum times[4] are shown below.



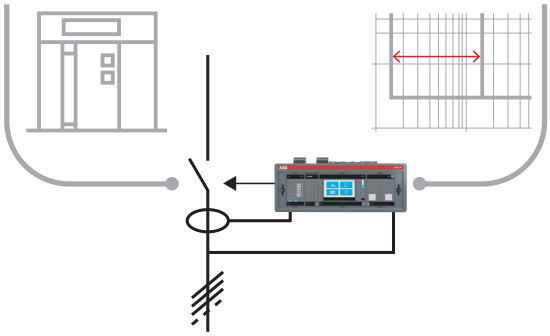
Ekip UP⁺	Max breaking time [ms]	Max clearing time [ms]
Emax 2/MS	75	115
New Emax/MS	100	140
GE Entelliguard G	60	76

Ekip UP⁺ + circuit breaker
Ekip UP⁺ plus a circuit breaker compose a consistent backup tripping system, besides adding protections to the embedded trip unit.

This is the typical protection scheme in utility power-station sites. The digital unit works independently from the embedded trip unit, having its own sensors and electronic boards.

Additionally, it can send the tripping command to shunt releases, as mentioned above, to operate another opening system rather than the tripping coil. In some circuit breakers, this also means another operating mechanism furnishes 100% redundancy. Conversely, there are breakers that can be opened through digital input triggered to "external trip" and then by their own trip coil. In these cases, Ekip UP⁺ is quicker to grant selectivity performances together with additional redundancy to shunt opening releases[5].
This is possible for ABB SACE New Emax and Emax 2 circuit breakers.

If managed in this mode, the short-circuit times change accordingly.



Ekip UP⁺	Max breaking time [ms]	Max clearing time [ms]
Emax 2/CB	65	85
New Emax/CB	70	110

These data are based with 0s delay on digital input.

[4] They also consider conservative tolerances.
[5] There are circuit breakers for which it is possible to mount two shunt opening releases or one plus undervoltage release

Solutions

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Network analyzer

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Connectivity modules

Connectivity and asset management

Besides protections, Ekip UP⁺ Protect provide up to 3,000 data points relating to measurements, status and protection settings to supervision systems inside utility, oil-and-gas and mining facilities. With embedded native protocols like IEC61850 or Modbus TCP/IP, it is also possible to realize digital selectivity schemes among low-voltage and medium-voltage relays.

- Ekip UP⁺ has embedded metering capability from typical electrical parameters to full power quality for energy monitoring.
- All the info is available on the color touch-screen display as well as by connectivity protocols for site SCADA.
- Also, two dataloggers are available for current and voltage, which support diagnostic after faults.

Type of measurement	Short description
Instantaneous	Currents (L1, L2, L3, N, rms) Earth fault current (rms) L-L voltage (V12, V23, V31, rms) L-N voltage (V1, V2, V3, rms) Phase sequence Frequency (Hz) Active power (P1, P2, P3, Ptot) Reactive power (Q1, Q2, Q3, Qtot) Apparent power (S1, S2, S3, Stot) Power factor (cos-phi) Peak factor (L1, L2, L3, N)
Cumulative measurement	Active power Ep (tot, + and -) Reactive power Eq (tot, + and -) Apparent power Es (tot)
Network analyzer	Average volts/hour (Vmin= 0.75-0.95 xVn, Vmax= 1.05-1.25 xVn, Events/day in past year and total events) Short voltage interruptions Short voltage spikes, sags and swells Voltage unbalance and micro-interruptions Harmonics analysis (THDv, THDi, V/I up to 50th order) 2 independent registers for V/I/P with sampling frequency user-settable from 1200 to 9600Hz
Time-stamped values	Currents (Imin, Imax) L-L voltage (Vmin, Vmax) Reactive power (Qmean, Qmax) Apparent power (Smean, Smax) Time-stamp of last 200 events
Data logging	Currents (L1, L2, L3, N, Ig) Voltages (V12, V23, V31) Active power (Pmean, Pmax) Max recorded duration Recording stop delay Recording intervals = 5 to 120 min, user-settable
Trip and opening data/info	Type of protection on trip Fault values per phase based on trigger (see note below) Time-stamping (date, time, progressive number)
Maintenance indicators	Last 30 trips info (see note below) Last 200 events info (time-stamped) Mechanical operations (can be sent to alarm) Total number of trips (see note below) Total operating time (hours) Last maintenance performed (date) Maintenance required indication Unit ID (type, assigned name and serial number)
Self-diagnosis	Internal connections checks CB failure to open (ANSI 50BF) (see note below) Over-temperature (pre-alarm and alarm)

- Native connectivity ensures the connection of the relay to the local SCADA, DCS, RTUs, PLCs and cloud-based platform. With spread Ekip Com connectivity modules, there is no need of any protocol converter, but each one can be chosen according to architecture needed on site, with as many as four modules together providing redundancy.

Protocol	Ekip Com Module	Ekip Com Redundant Module
Modbus RTU	Ekip Com Module RS-485	Ekip Com R Module RS-485
Modbus TCP	Ekip Com Module TCP	Ekip Com R Module TCP
Profibus-DP	Ekip Com Profibus	Ekip Com R Profibus
Profinet	Ekip Com Profinet	Ekip Com R Profinet
EtherNet/IP™	Ekip Com EtherNet/IP™	Ekip Com R EtherNet/IP™
DeviceNet™	Ekip Com DeviceNet™	Ekip Com R DeviceNet™
IEC61850	Ekip Com IEC61850	Ekip Com R IEC61850
Open ADR	Ekip Com Open ADR	-
Cloud connectivity	Ekip Com Hub	-

- When an internet connection is available, Ekip UP⁺ directly uploads a digital twin of the switchgear to the cloud monitoring platform ABB Ability™ EAM.

Thanks to a built-in Ekip Com Hub gateway, the digital unit sends the information about the switch disconnector or the circuit breaker linked with it, together with data collected from others existing meters, if any. This is achieved through Ekip UP⁺'s own measuring capabilities and Modbus-network connectivity pooling data from up to 200 devices per plant. No additional meters or gateways are needed.

If Ekip UP⁺ is installed together with an ABB SACE Emax circuit breaker/switch disconnector, GE Enetelliguard G circuit breaker/switch disconnector or ABB SACE Emax 2 switch disconnector, it enables the Predict function on ABB Ability™ EAM. The predictive maintenance algorithm is based on utilization category, asset aging, switching operations, current flows and environmental conditions through temperature measurements available from the Ekip 3T cartridge module on Ekip UP⁺.

This condition-based function reduces operational costs up to 35% and optimizes the maintenance scheduling. It becomes easy to know which spare parts are needed and when maintenance must be planned. These events can be shared to local SCADA through APIs.

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ABB Ability™ EAM

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Ekip Signalling 3T

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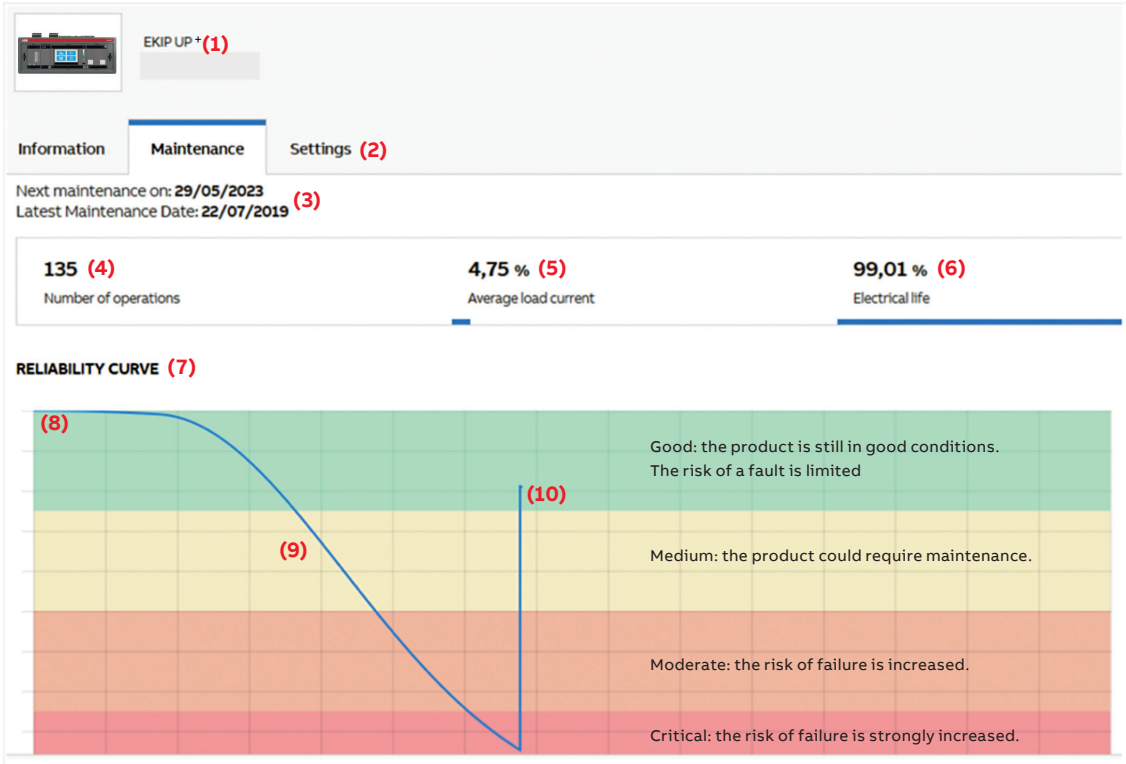
Predictive maintenance

Reliability curve on ABB Ability EAM



(1) Ekip UP⁺ tag name

(2) Here there are the settings related to circuit breaker or switch disconnector associated with Ekip UP⁺ and environmental installation conditions. For details, look at Predict technical documentation.

(3) Predictive maintenance scheduling (last and next). Next one is forecasted when reliability curve will change from Green to Yellow Zone during normal life. In case of fault, it will be speeded up and SMS/mail will notice maintenance manager.

(4) Opening/closing times counted

(5) Current utilization of the asset

(6) Real time residual life of switching asset

(7) Residual life expected during asset life

(8) Asset production and installation period

(9) Asset ageing curve without fault event

(10) Life expectancy restoration after asset maintenance by authorized personnel and Ekip UP⁺ installation

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