

WHITE PAPER

Ekip UP

The easy solution to make ships digital



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Applications

Ekip UP is the new electronic retrofitting kit that, in just one hour, can extend the capital expenditure investment in existing marine assets with a digital upgrade for metering, protection and connectivity.

Around the world, thousands of ships sail with aged and basic electrical equipment. Over the last 10 years, more than **7 million low-voltage circuit breakers** without advanced features have been installed in marine applications.

Moreover, 15% of these **switching devices do not even have embedded trip units**; they use external protection relays, especially on vessel generators.

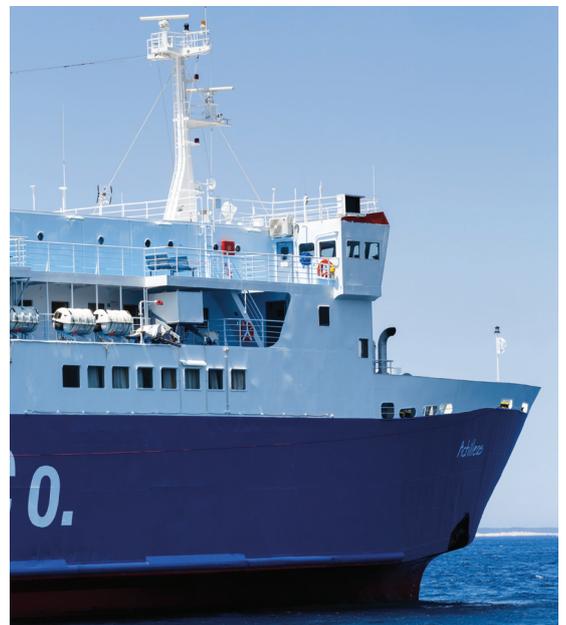
Crane vessels and ferry boats in particular use several breakers without digital functions. This is more important for incoming air circuit breakers, like **ABB Megamax and Emax**, situated in the existing switchgear, because they are the mains for onboard electrical distribution.

The same happens for circuit **breakers from other brands**. This installed base needs revamping for protection to maintain safety and reliability.

At the same time, ship owners want to add metering and connectivity functions to efficiently analyze the energy flows inside their plants and implement energy-saving actions. Such renovations require a as short a shutdown as possible, because these **vessels must work 24/7**.

Of course, the investment should not be huge, because the remaining life expectancy for these 10-20-year-old marine resources is not very long and must be extended as much as possible to **optimize the asset capital expenditure**.

Making ships digital can overcome these barriers.



Solutions



Ship owners are looking for an easy, quick and cost-effective way to upgrade their assets. Ekip UP is the innovative **electronic retrofitting kit** for digitizing low-voltage plants without changing the installed base. Digital retrofitting is accomplished in a very short time and ensures reduced investment on existing marine electrical systems.

In **just one hour**, every switchgear protection device can be maintained and upgraded. This means that, with Ekip UP, revamping the ship takes half the time compared to equipment replacement.

Indeed, current circuit breakers are kept alive in the plant, ensuring through appropriate service expertise that they are mechanically sound and that they only need an electronic retrofit. **Up to 6300A**, any vendor's switchgear busbars are not affected, thanks to plug-in sensors, so the switchgear's design need not be changed.

The Ekip UP solution, ready for nominal plant conditions up to 6300A and 1150V, **grants up to 70% overall cost savings** for hardware components and service man-hours, compared to traditional retrofitting approaches. This affordable way unlocks the digitalization obstacles on old ships.

Digital unit product range and plug-in current sensors



| |  |  |  |  |  |
|-------------------|---|---|--|---|---|
| | Ekip UP Monitor | Ekip UP Protect | Ekip UP Protect + | Ekip UP Control | Ekip UP Control+ |
| Control | | | | ● | ● |
| Protection | | ● | ● | | ● |
| Metering | ● | ● | ● | ● | ● |

- = standard functions
- = advanced functions

Solutions

Safety protections

Ekip UP units have 35 built-in ANSI protections for power distribution and generation.

These relays work with switch disconnectors and circuit breakers to enhance plant reliability.

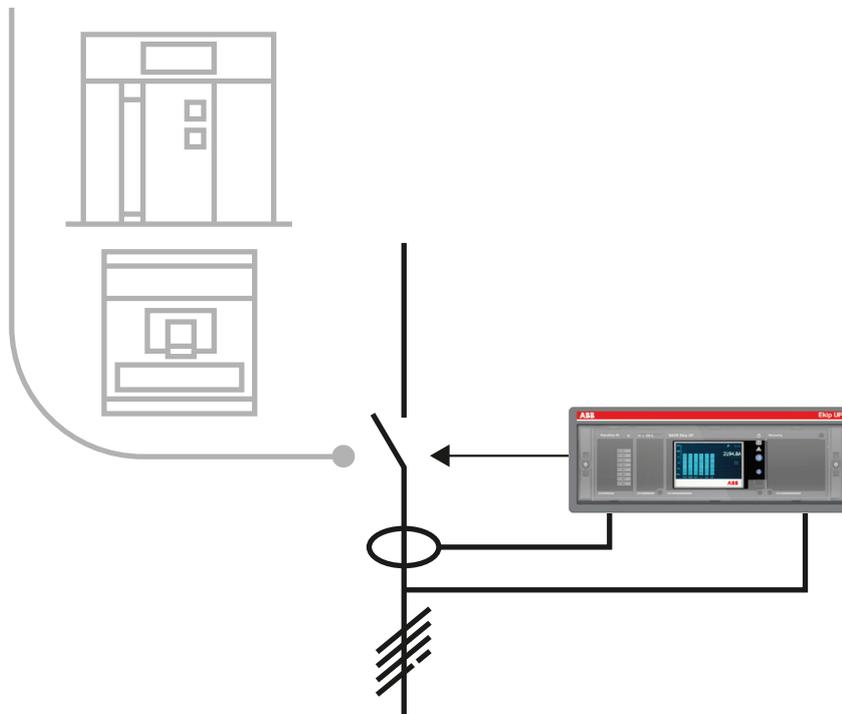
- **Together with a circuit breaker**, Ekip UP works as a back-up protection unit for trip coils and/or releases.

For breakers installed in the ship's power distribution system where the tripping devices (current sensors, trip unit, trip coil) have started to fail after several years, Ekip UP Protect provides a redundancy without impacting the existing asset and its performance:

Icu = Icu of the circuit breaker

In general, a check on switchgear certification is not needed.

Ekip UP used with whatever circuit breaker



In some cases, the breaker trip unit must be replaced, but it has become obsolete and is no longer available for sale (for example, PR11X on Emax breakers). In these situation, the Ekip UP digital unit is the perfect retrofit solution.

Through the support of an ABB Service team, which evaluates the mechanical efficiency of the device and provides the required spare parts (like coils or motor operators), it is possible to downrate the breaker to a switch disconnector and add Ekip UP as a protection unit with a dedicated transforming kit, bypassing the equipped protections.

Breaking capacity is reduced to switchgear compliance level:

Icu = Icw (1s) of the downrated circuit breaker

Usually a check on certification is required¹.

¹ It depends on the specific country's standards and regulations



—
Specific set of protections Ekip G



—
Product manual Ekip UP

• **Together with a switch disconnecter**, Ekip UP Ekip UP acts on its shunt opening/closing coils, updating the asset with protections. In this way, for either greenfield or brownfield installations, the digital relay ensures breaking capacity equal to the switch-disconnector’s ability to withstand current²:

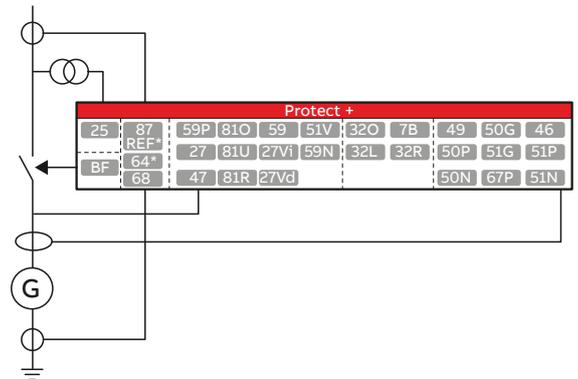
$$I_{cu} = I_{cw} (1s) \text{ of the switch disconnecter}$$

This is typical of marine generators, where a specific set of protections based on voltage, current, power and frequency is available in the Protect+ version, together with the other ones for power distribution. Through the Ekip Synchrocheck module, ANSI25 is achieved in both dead and live busbar mode.

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 Designa-

tions,” which is also known as the ANSI code. All the details for each protection is available in the product manual.

Ekip UP for generator protection



The protections listed are aligned with the Std. IEC 60034-1 “Rotating electrical machines – Part 1: Rating and performance” or IEEE C37.102 “Guide for AC Generator Protection” and the Std.

| ANSI Code | Short description |
|-----------|---|
| 51N, 51P | Time-delayed overcurrent protection, time delay up to 0.8s, settable 0.6 to 10xIn, excludable, with thermal memory and provision to offset inrush |
| 50 | Instantaneous overcurrent protection, settable up to 15xIn, with provision to offset inrush currents |
| 50N TD | Earth fault protection, settable 0.1 to 1xIn, excludable, with provision to offset inrush currents |
| 46 | Current unbalance protection |
| 50G TD | Earth fault protection |
| 64 50N | Residual current protection |
| 87REF | Differential ground fault protection |
| 81O | Underfrequency protection |
| 81U | Over-frequency protection |
| 32R | Reverse active power protection |
| 78 | 3-phase power factor (cos-phi) |
| 67P | Directional overcurrent protection (forward and back) |
| 27Vd/27Vi | Undervoltage Protection (also for direct and negative sequence) |
| 59P | Overvoltage protection |
| 59N | Residual overvoltage protection |
| 32OF | Active overpower protection |
| 32OF | Reactive overpower protection |
| 32LF | Active underpower protection |
| 40/32R | Loss of field or reverse reactive power protection |
| 51V | Voltage controlled overcurrent protection |
| 81R | Rate of change of frequency protection |
| 25 | Synchrocheck (Live and dead busbars) |

² As is declared in its own documentation.

Solutions



Load Shedding innovation

Ekip UP display with generator protections



IEEE 242 “Protection and Coordination of Industrial and Commercial Power Systems,” the prescriptions provided by the shipping registers, such as RINA or DNV.

The protection functions available on Ekip UP can be activated individually and thus enable the user to build the package of protections that meet the protection requirements of his own ship asset.

By assuming the voltage variation range for the generators used in first-category electrical systems to be the values from 400V to 1000V, and by considering a range of rated currents of the generator from 400A to 6300A, it is possible to determine the range of power of the synchronous machines for which Ekip UP could be used.

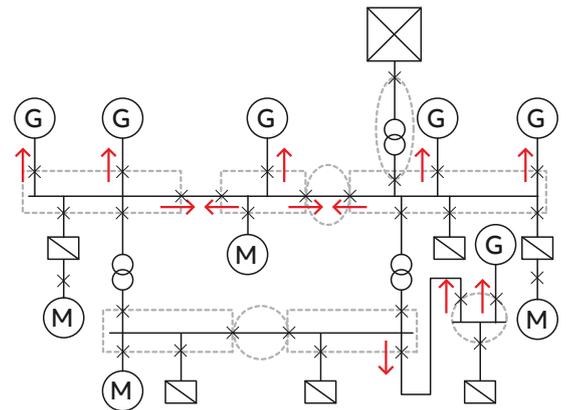
It would result in an approximate range of 300kVA to 10MVA, according to the standardized power values provided by the various manufacturers.

- Ekip UP Protect+ provides advanced features for protection schemes to increase vessel service continuity.

Thanks to built-in directional protection and selectivity capability, it enables zone logic discrimination based on the boundary node approach, available in hard-wired and/or digital bus, like the proprietary Ekip Link or IEC61850.

Embedded technology unlocks the ability to program the transfer switch and load-shedding logics, as well.

Example of discrimination scheme inside a marine plant



| Protection for synchronous generators | SnG < 500kVA | 500kVA < SnG < 1500kVA | SnG < 1500kVA |
|---|--------------|------------------------|---------------|
| Protections against loss of prime mover: | | | |
| - Active power directional protection | • | • | • |
| Protections against overloads: | | | |
| - Overload and overcurrent | • | • | • |
| - Current unbalance | • | • | • |
| Protections against failures of the excitation system: | | | |
| - Loss of field | - | • | • |
| - Under/Overvoltage | • | • | • |
| Protections against frequency variations: | | | |
| - Under/Overfrequency | • | • | • |
| Protections against network loss: | | | |
| - Rate of change of frequency | - | • | • |
| Protections against failures of the insulation system: | | | |
| - Starter earth fault | • | • | • |

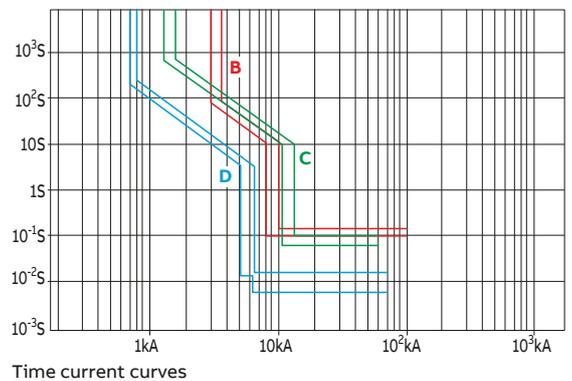
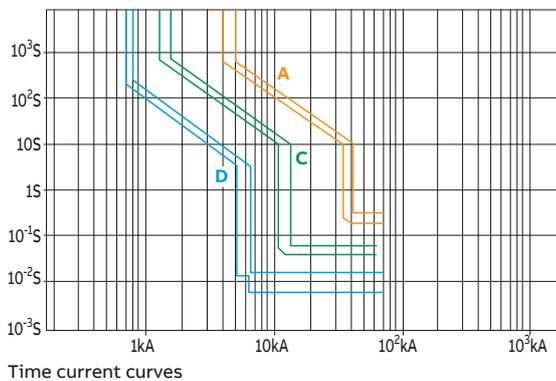
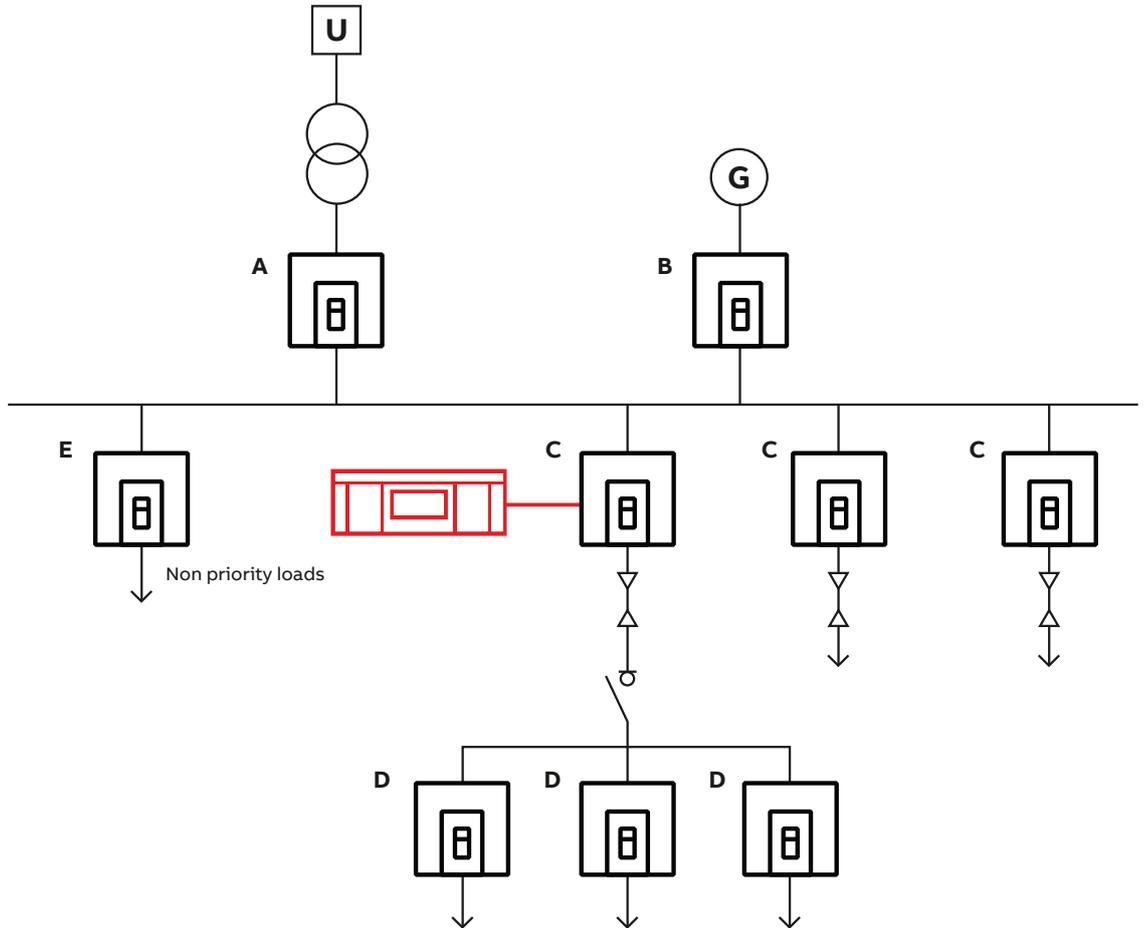


Ekip UP
technical catalog

Ekip UP also offers the ability to adapt the protection configuration with dual sets that can be changed according to conditions in the Protect+ version. For example, through a simple digital input, the short-circuit threshold can be reduced when the technician accesses the generator

room. Another typical case is in ship-to-shore connections or single generator failures, when short-circuit levels change and protections must be adapted to maintain selectivity onboard in all conditions. All the details are available in the technical catalog.

Example of shore to ship connection selectivity scheme



Solutions



Network analyzer



ABB Ability™ EDCS



Ekip Com connectivity modules

Energy and asset management

Ekip UP offers some 3,000 data measurements, with status and protection settings transmitted to supervision systems for energy efficiency analysis inside the low-voltage system.

- Ekip UP in all versions, from Monitor to Control+, 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 through connectivity protocols for vessel SCADA.

Two dataloggers are available for current and voltage, supporting diagnostics 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) |



ABB EQmatic



Power Controller function

With Ekip UP's open-style current sensor kits of different sizes and direct voltage connections up to 690V, these measurements are added to basic switchgear devices through a plug-and-play technique.

Current sensors based on Rogowski coil technology, without core-saturation effect, guarantee high flexibility, huge range linearity (from a few amps to 100 kA) without frequency limit, and easy detection of rapid current variations as well as harmonic contents.

The open-style current sensor does not need any external power supply nor shorting the secondary before disconnecting the coil.

If technicians are allowed to work under voltage conditions¹, the installation even can be executed without downtime.

- The digital units upgrade every circuit breaker with integrated native connectivity, ensuring their connection at the same time to the vessel SCADA, automation PLCs and ABB Ability™ EDCS cloud-based monitoring platform.

With spread Ekip Com connectivity modules, there is no need for any protocol converter, but each module can be chosen according to the architecture needed on site, with as many as four modules together providing redundancy.

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

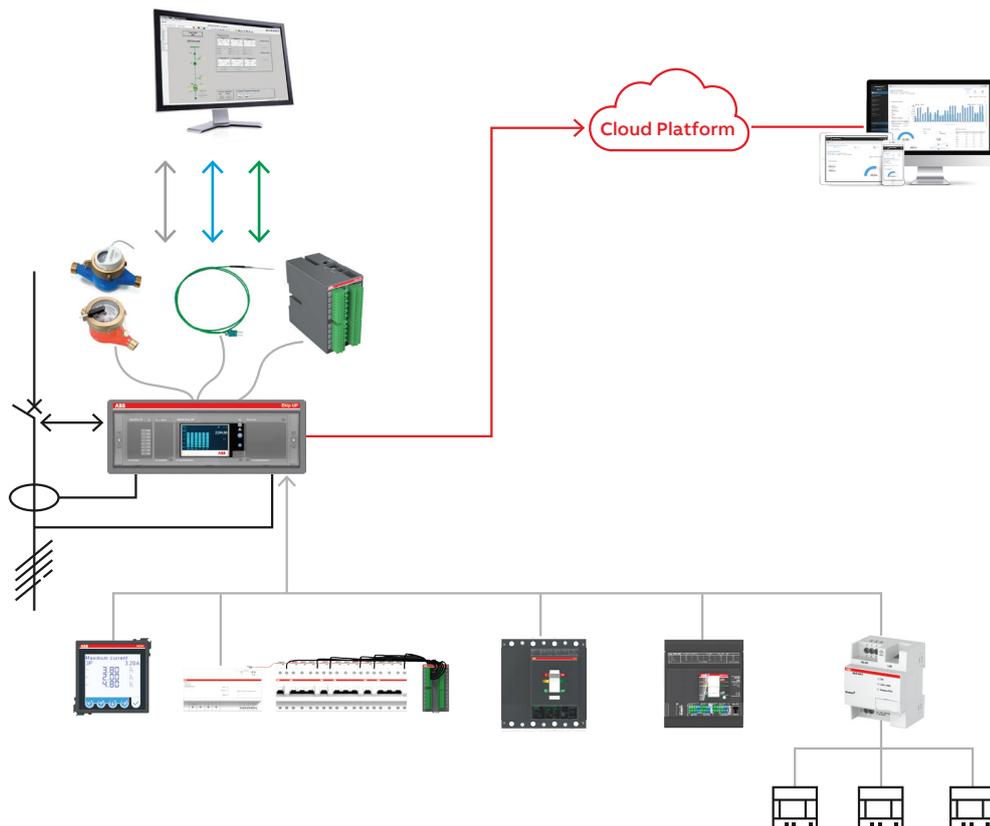
Through the built-in Ekip Com Hub gateway, the digital unit sends the circuit breaker upgraded information, including information from third-party breakers, together with data collected from others existing meters, if any.

This is achieved via Ekip UP's own measuring capability and Modbus-network connectivity pooling data from up to 200 devices per ship plant. No additional meters or gateways are needed. If the installed meters were not manufactured by ABB, they can be added in the same architecture through the ABB EQmatic integration device.

Remote energy monitoring makes it is possible to detect improvement actions on power quality and consumption, for example planning peak shaving logics embedded in Ekip UP Control and Control+ units.

| 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 | - |

Example of hybrid architecture with Ekip UP sending data to Scada and Ability™ cloud platform



Solutions



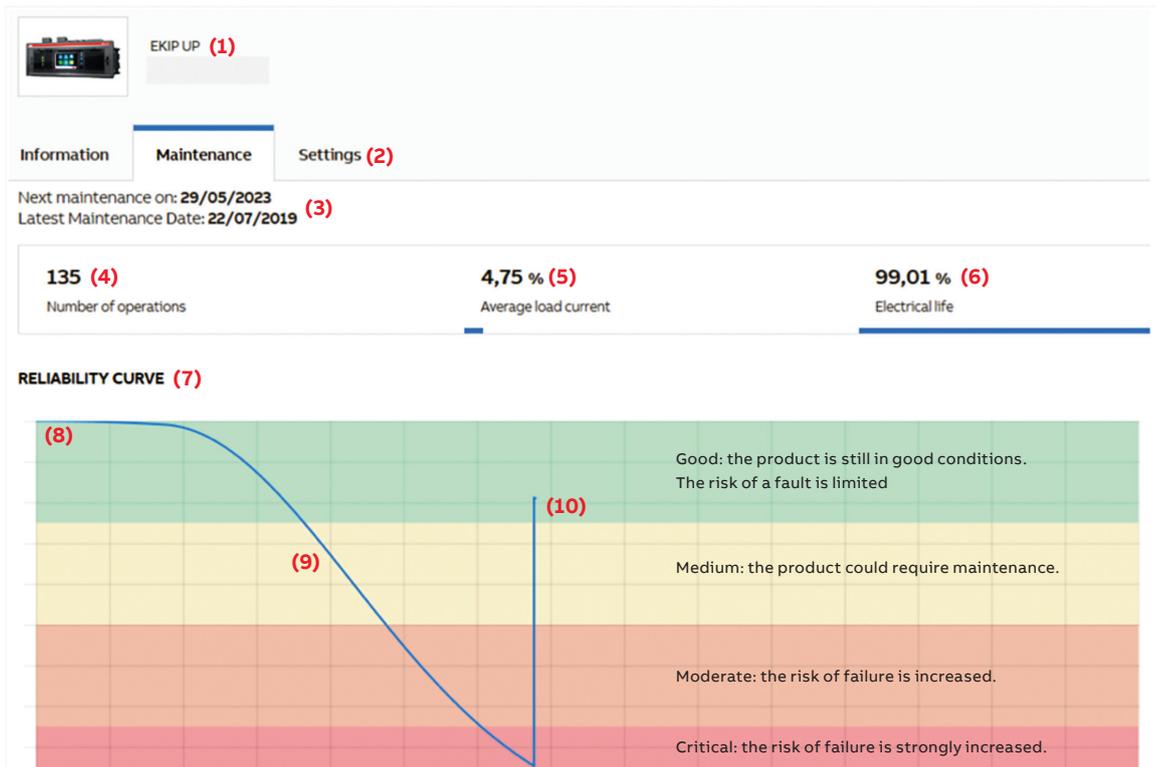
Ekip 3T

- If Ekip UP is installed together with an ABB SACE Emax circuit breaker/switch disconnecter, GE Enetelliguard G circuit breaker/switch disconnecter (coming soon) or ABB SACE Emax 2 switch disconnecter, it enables the Predict function on ABB Ability™ EDCS. The predictive maintenance algorithm is based on utilization category, asset aging, switching operations, current flows, and environmental conditions reflected in temperature measurements available through the Ekip 3T cartridge module for Ekip UP.

Of course, the design and testing know-how on asset performance makes the predictive algorithm consistent. This condition-based function reduces operational costs up to 35% and optimizes the maintenance scheduling, which is fundamental for 24/7 ships. 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.

Reliability curve on ABB Ability EDCS



Predictive maintenance

- (1) Ekip UP tag name
- (2) Here there are the settings related to circuit breaker or switch disconnecter 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

Approvals



Ekip UP technical catalog

Besides being certified according to relevant IEC and UL standards, the Ekip UP product range is approved by shipping registers like RINA and DNV-GL.

The Ekip UP solution is completely ready for ship upgrades.

For ordering codes, please consult the catalog.

TYPE APPROVAL CERTIFICATE

N. ELE395117CS

This is to certify that the product below is found to be in compliance with the applicable requirements of the RINA Type Approval system.

| | |
|--------------------------|--|
| Description | Monitoring, Protection and Control system for low voltage plants |
| Type | EKIP-UP |
| Applicant | ABB S.P.A. ABB SACE DIVISION Via Pescaria, 5 24123 Bergamo ITALY |
| Manufacturer | ABB S.P.A. ABB SACE DIVISION Via Enrico Fermi, 14 03100 Frosinone ITALY |
| Testing Standards | Rules for the Classification of Ships – Part C – Machinery Systems and Fire protection – Ch. 3 Sect. 6, Tab. 1 |

Issued in Genova on **February 01, 2018**

This certificate is valid until **January 31, 2023**

RINA Services S.p.A.
Valerio Bonanni

RINA Services S.p.A.
Via Caritea, 12 – 16128 Genova
Tel. +39 010 53851
Fax +39 010 5351800

TYPE APPROVAL CERTIFICATE

Certificate No: TAE00003DS
Revision No: 2

This is to certify:

That the Multifunction Relay

with type designation(s)
EKIP-UP

Issued to
ABB S.P.A. - ABB Sace Division
Bergamo BG, BG, Italy

is found to comply with
DNV GL rules for classification – Ships, offshore units, and high speed and light craft

Application :

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV GL.

| DNV GL. LOCATION CLASS | | | | | |
|------------------------|-------------|----------|-----------|-----|--|
| Type | Temperature | Humidity | Vibration | EMC | Enclosure |
| EKIP-UP | D | A | A | A | Required protection according to DNV GL Rules shall be provided upon installation on board |

Issued at **Hamburg** on **2019-04-16**

This Certificate is valid until **2024-02-19**.
DNV GL local station: **Milan**

Approval Engineer: **Didier Girardin**

Joannis Papanuskas
Head of Section

This Certificate is subject to terms and conditions overlaid. Any significant change in design or construction may render this Certificate invalid. The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

Form code: TA 251

Revision: 2016-12 www.dnvgl.com Page 1 of 3

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