EKRA

ED2

Protection and Control Devices for Medium Voltage

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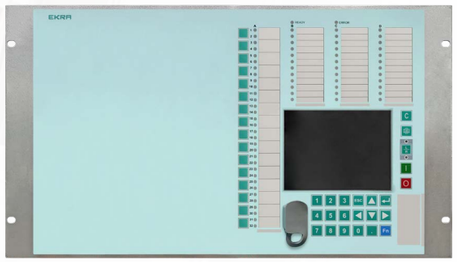
ED2 Series IEDs

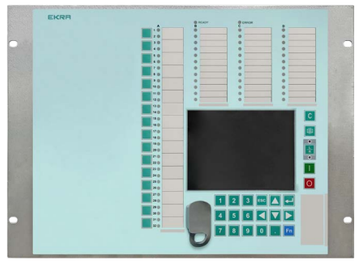
ED2 series IEDs provide independent platform for the protection, control and monitoring of generators, motors, transformers, busbars, transmission lines and feeders. The IEDs are based on long-term field experience and focus on the challenges our customers face.

ED2 series IEDs are applied for protection of medium voltage (MV), high voltage (HV) and extra high voltage (EHV) installations at power system frequency of 50 (60) Hz.

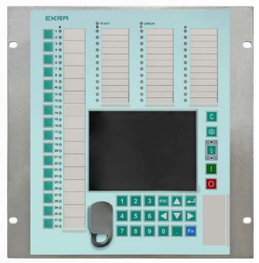
ED2 series IEDs are available in four case sizes:



1 x 19”



3/4 x 19”



1/2 x 19”

1/3 x 19”

Protection Devices For Medium Voltage Application

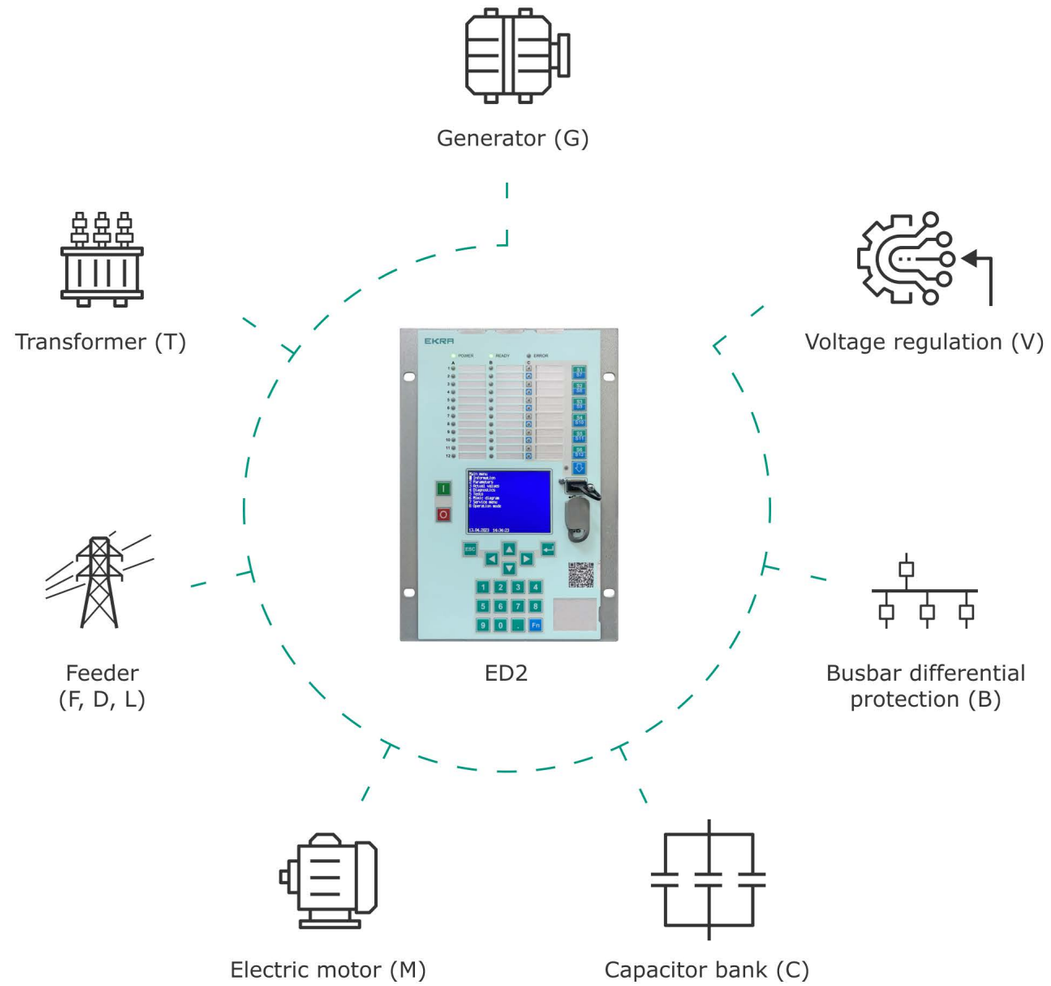
ED2 IED with 1/3 x 19” case size is the right solution for electrical distribution and machine protection. The IEDs provide advanced protection with flexibility, programmability and communications for maximum system reliability.

Our highly skilled engineers and technicians applied all their knowledge to the design and manufacture of these innovative protection IEDs.

ED2 IEDs with 1/3 x 19” case size are multifunctional devices, designed for protection, control and automation of feeders of the medium voltage (from 1 kV to 66 kV) networks with all types of neutral earthing.

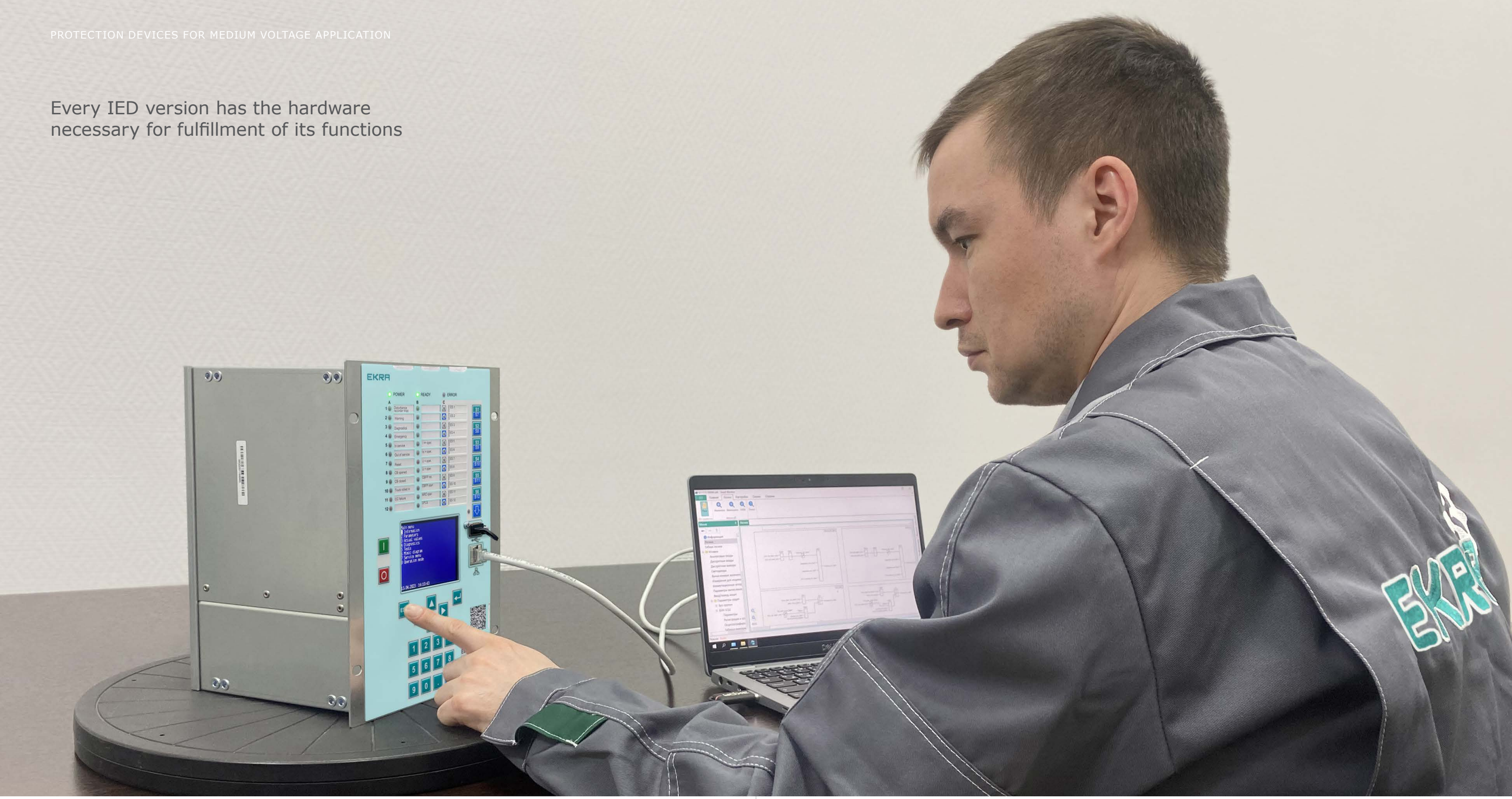
Depending on the application, there are several versions of ED2 devices:

- ED2-G – generator protection;
- ED2-T – transformer differential protection;
- ED2-F – overcurrent protection;
- ED2-D – line distance protection;
- ED2-L – short line differential protection;
- ED2-M – motor protection;
- ED2-C – capacitor bank protection;
- ED2-B – busbar differential protection;
- ED2-V – voltage protection or voltage regulation.



APPLICATION	G-0101	T-0201	T-0203	L-0302	D-0303	D-0603	F-0202	F-0301	F-0402	F-0602	M-0501	M-0502	M-0503	C-1601	B-1401	V-1301	V-1501
Generator protection	●																
Transformer differential protection		●	●														
Short line differential protection				●													
Line distance protection					●	●											
Overcurrent protection							●	●	●	●							
Motor protection											●	●	●				
Capacitor bank protection														●			
Busbar differential protection															●		
Voltage protection, voltage regulation																●	●

Every IED version has the hardware necessary for fulfillment of its functions



HARDWARE	G-0101	T-0201	T-0203	L-0302	D-0303	D-0603
Current inputs	7	7	7	7	4	4
Voltage inputs	4	4	4	4	7	8
Binary inputs	24	24	32	24	24	32
Binary outputs	24	24	16	24	24	16
Communication interfaces RS-485/Ethernet	2/2	2/2	2/2	2/2	2/2	2/2

HARDWARE	F-0202	F-0301	F-0402	F-0602	M-0501	M-0502	M-0503	C-1601	B-1401	V-1301	V-1501
Current inputs	4	5	4	4	4	7	7	7	11	5	0
Voltage inputs	4	4	8	8	4	4	4	4	0	6	5
Binary inputs	32	24	24	24	24	24	24	24	24	24	24
Binary outputs	16	24	24	24	24	24	24	24	24	24	24
Communication interfaces RS-485/Ethernet	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2

ED2 operation panel

Programmable pushbuttons with LEDs to control 12 electronic switches

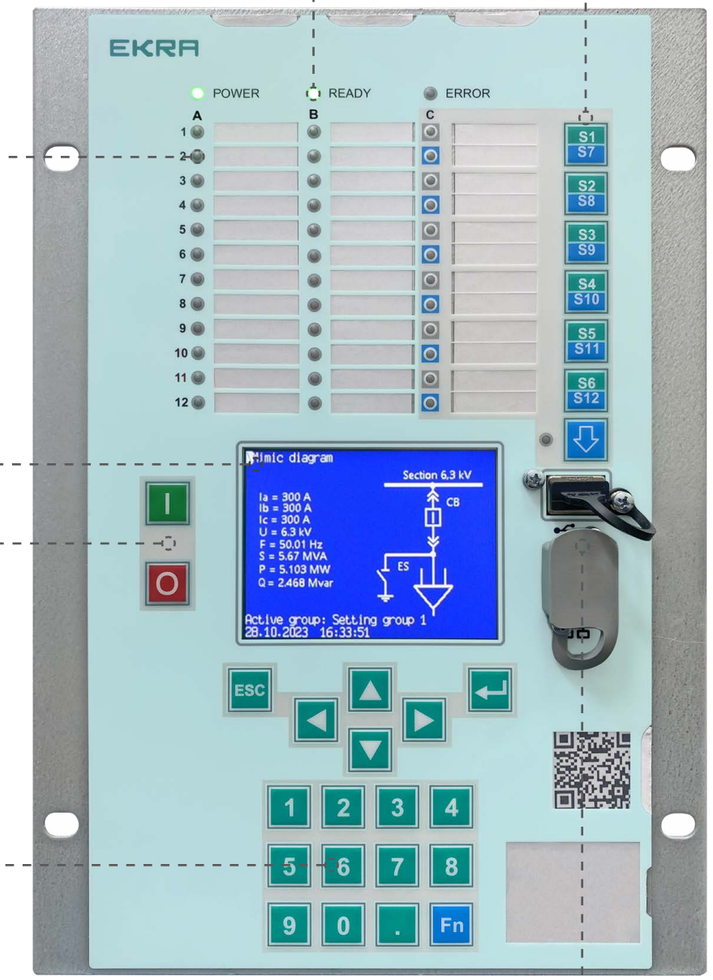
3 LEDs signaling the IED actual state

24 three-color freely configurable LEDs signaling the protection actuation

Graphical display showing the feeder mimic diagram with positions of switching devices as well as current, voltage, power, frequency and other measurements

Switching devices control buttons

Keyboard
- Menu navigation
- Keypad



Service ports:
- USB-A port to download waveforms and update IED firmware without PC
- Ethernet port for PC

ED2 rear view

Up to 12 analog inputs with wide measuring range and programmable selecting of the rated value

Replaceable fuse to protect IED against power supply malfunction

Power supply:
- 110 / 125 VDC
- 220 / 250 VDC
- 220 VAC

PPS and IRIG-B hardware time synchronization

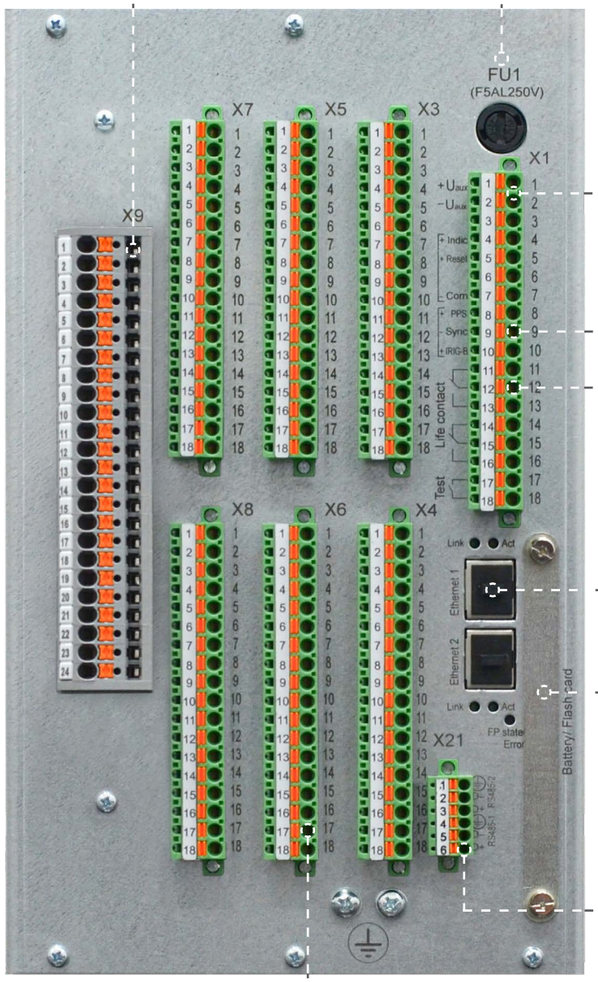
2 service inputs and 3 service outputs

2 x Ethernet communication interfaces.
Supported protocols:
- Modbus TCP / IP
- IEC 60870-5-104
- IEC 61850-8-1 (GOOSE, MMS)

Service compartment for memory card

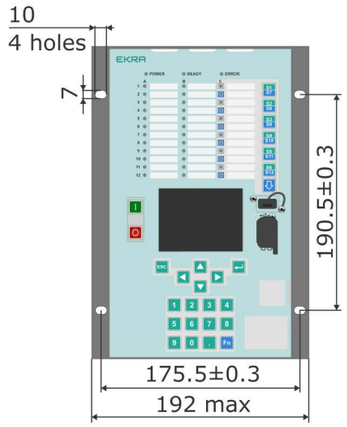
2 x RS485 communication interfaces.
Supported protocols:
- Modbus RTU
- IEC 60870-5-103

Freely configurable binary inputs/outputs (24/24 or 32/16)

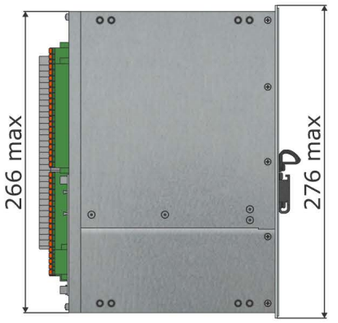


ED2 series devices are made on a common platform and are installed in the relay compartments of complete switchgear, on panels, in protection and control cabinets.

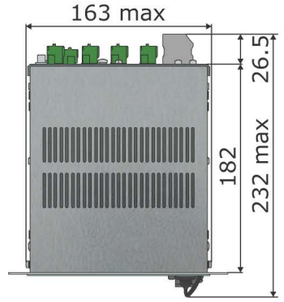
Mounting the IED



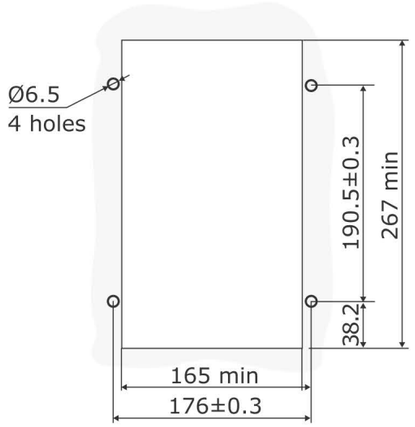
Front view



Side view

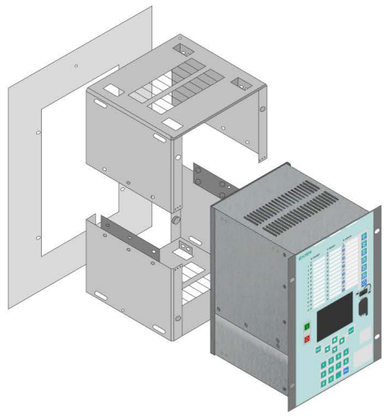


Top view



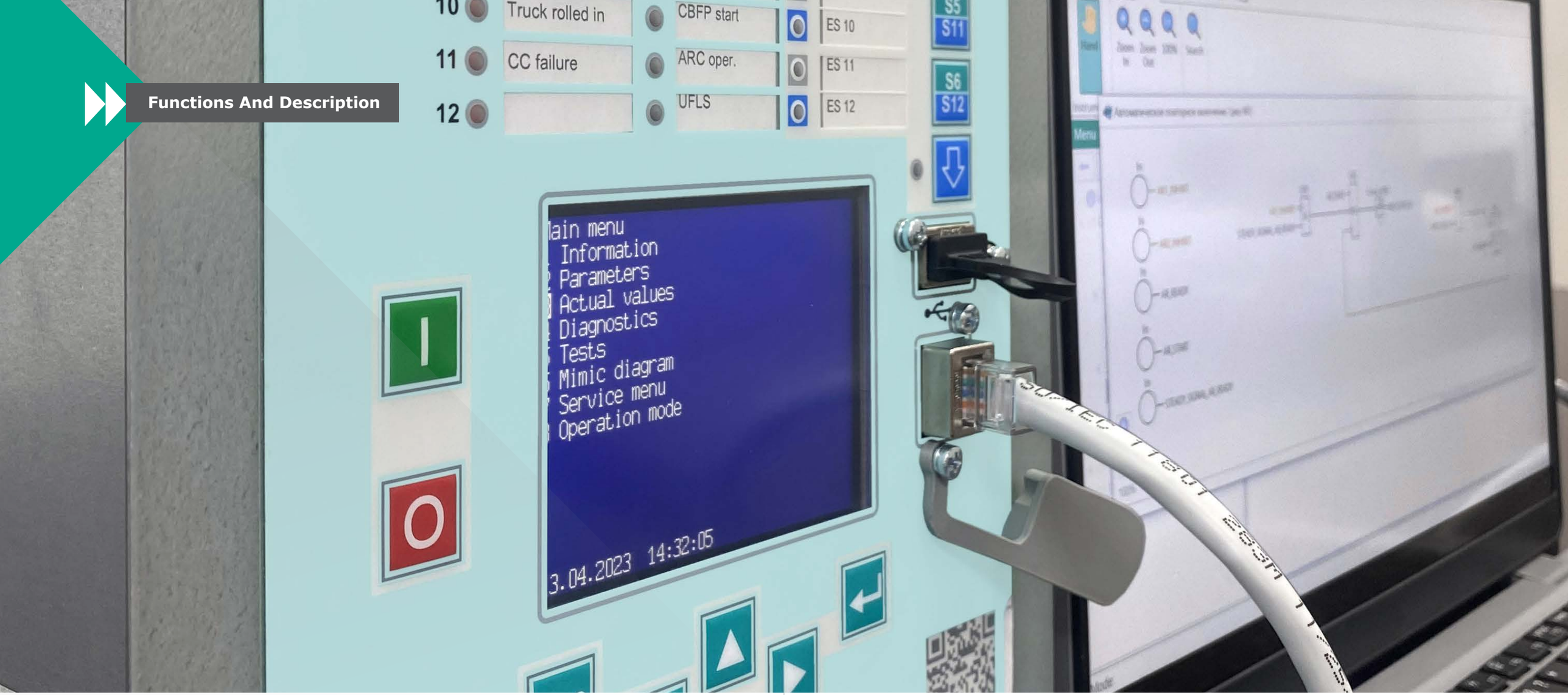
Panel-cut out dimensions for flush mounting the IED

Also the IED can be wall or semi-flush mounted with the use of different mounting kits



Wall mounting the IED

Semi-flush mounting the IED



PROTECTION	ANSI CODE	G-0101	T-0201	T-0203	L-0302	D-0303	D-0603	F-0202	F-0301	F-0402	F-0602	M-0501	M-0502	M-0503	C-1601	B-1401	V-1301	V-1501
Distance protection	21					3	2											
Overexcitation protection	24	○	○	○				○										
Undervoltage protection	27	2	2	2	2	2	2		2		2	2	2	2	2			3
Reverse power protection	32R	●										●	●	●				
Undercurrent protection	37											●	●	●				
Loss of excitation protection	40	●																
Unbalanced load protection	46	●																
Phase discontinuity protection	46PD	●	●	●	●	●	●		●	●	●	●	●	●	●	●		
Negative sequence overvoltage protection	47	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●

PROTECTION	ANSI CODE	G-0101	T-0201	T-0203	L-0302	D-0303	D-0603	F-0202	F-0301	F-0402	F-0602	M-0501	M-0502	M-0503	C-1601	B-1401	V-1301	V-1501
Thermal overload protection (machines and transformers)	49	3	3	3								2	2	2	3			
Generator rotor overload protection	49R	3																
Overcurrent protection	50/51/ 51V/67	3	3 HV/ 2 LV	3 HV/ 2 LV	3	3	3	2[1)]	3	3	3	3	3	3	3	3[2)]		
Additional overcurrent relay	50/51	2	2	2	2	2	2	2	2	2	2	2	2			4[3)]		
Circuit breaker failure	50BF	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Double earth-fault protection	50G/50N	●			●	●	●		●	●	●	●	●	●	●			
Reverse interlocking scheme	50RIS	●					●			●	●					●		
Cable backup protection	51B						●											
Neutral overcurrent protection	51G								●									
Zero sequence overcurrent protection – measured/calculated	51G/51N		●	●				●										
Overcurrent protection based on higher harmonics	51HH														2			
Motor start-up supervision	51R											●	●	●				
Negative sequence overcurrent protection	51_2/ 67_2		3 HV/ 3 LV															
Overvoltage protection	59	●	●	●	●	●	●		●		●	●	●	●	●			●
Zero sequence overvoltage protection – calculated	59N	●																
Unbalance protection	60C														2			
Gas protection	63		●	●				●	●									
Loss of mains protection	67/81U										●							
Power swing blocking	68					●												
Out-of-step protection	78	●										●	●					
Overfrequency protection	81O	2																
Underfrequency protection	81U	2										4	4	4				
Busbar differential protection	87B															●		
Generator differential protection	87G	●																
Motor differential protection	87M												●					
Short line differential protection	87SL				●													
Transformer differential protection	87T		●	●														
Arc Protection	ARC	●	●	●	●	●	●		●	●	●	●	●	●	●	●		
Earth-fault protection	EFP	●			●	●	●		●	●	●	●	●	●	●			●
Protection against ferroresonance	FP	○									○							○
Restricted earth-fault protection	REF							○										

AUTOMATION	ANSI CODE	G-0101	T-0201	T-0203	L-0302	D-0303	D-0603	F-0202	F-0301	F-0402	F-0602	M-0501	M-0502	M-0503	C-1601	B-1401	V-1301	V-1501
Synchronism check	25					●	●			●	●							
Cooling automation	51CA		●	●														
Autoreclose	79				●	●	●		●		●				●			
Frequency-actuated autoreclose	79FR																	●
Voltage regulator	90V																●	
Automatic load transfer/ Load scheme restoration	ALT/LSR						●			●	●					●		
Underfrequency load shedding	UFLS																	●
CONTROL AND MONITORING																		
Fault locator	21FL					●			●									
Circuit breaker control	52	●		●	●	●	●	●	●	●	●	●	●	●	●	●		
Tripping logic	94	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Circuit breaker wearing monitoring		●		●	●	●	●	●	●	●	●	●	●	●	●	●		
SUPERVISION																		
CT supervision	CTS	●			●	●	●		●	●	●	●	●	●	●			
VT supervision	VTS	●	●	●	●	●	●		●	●	●	●	●	●	●			●
MEASUREMENT																		
Frequency		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Power (active, reactive, apparent power)		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	
Power factor		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	
RMS current values		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
RMS line voltage values		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
RMS phase voltage values		●	●	●	●	●	●	●	●	●	●				●		●	●

● — Basic

○ — Optional

Note:

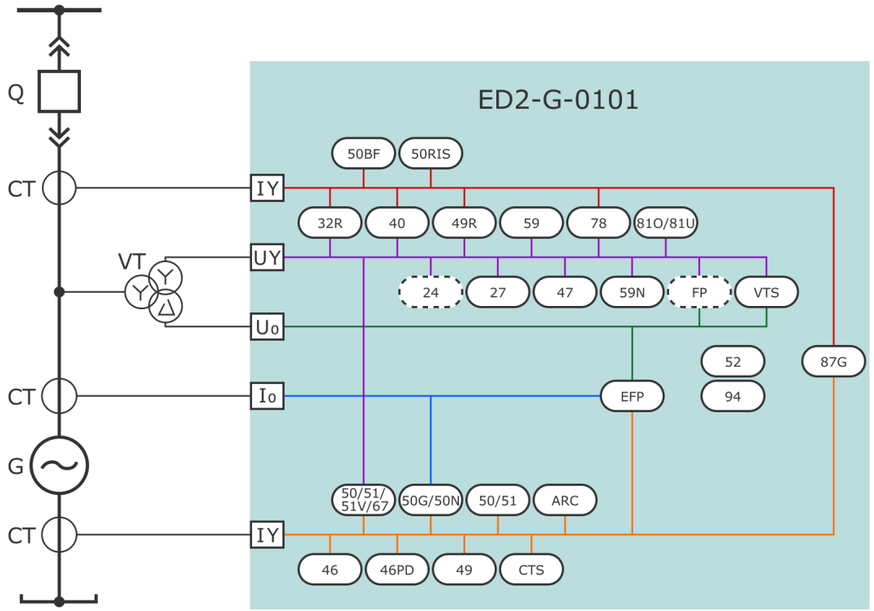
1) Overcurrent protection, without direction selecting. 50/51/51V only.
2) Overcurrent protection is applied on bus-tie circuit breaker. Does not have an option of direction selecting, with that voltage-controlled start is made from external signals.
3) By one overcurrent relay for each outgoing feeder.

Generator protection
ED2-G-0101

IED is designed for protection of generator and its circuit breaker control automation.

ED2-G-0101 is connected to two three-phase groups of current transformers, one of which is installed at the line side of generator, the other – at the neutral side of generator, and also to the voltage transformer at the line side of generator.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection of generator.



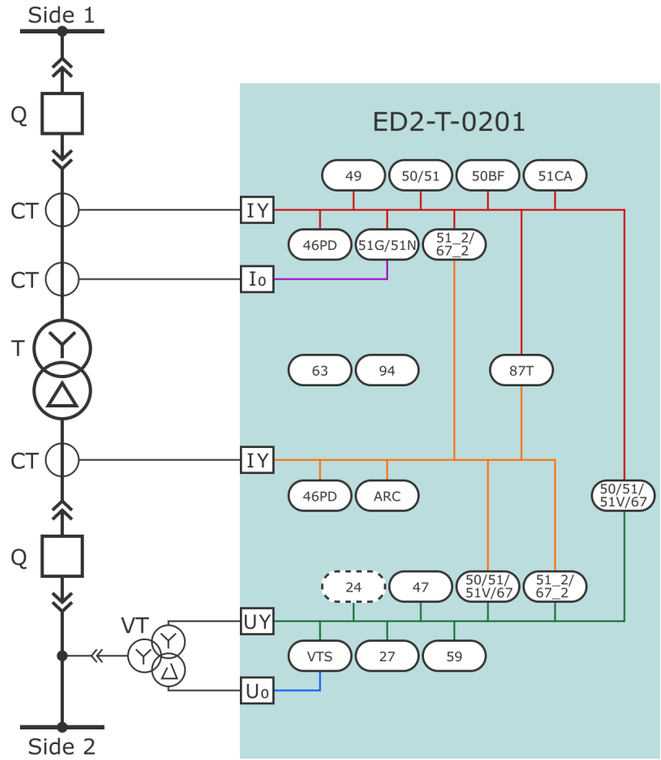
PROTECTION	
24	Overexcitation protection (optional)
27	Undervoltage protection
32R	Reverse power protection
40	Loss of excitation protection
46	Unbalanced load protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
49	Thermal overload protection
49R	Generator rotor overload protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit breaker failure
50G/50N	Double earth-fault protection
50RIS	Reverse interlocking scheme
59	Overvoltage protection
59N	Zero sequence overvoltage protection – calculated
78	Out-of-step protection
81O/81U	Over/underfrequency protection
87G	Generator differential protection
ARC	Arc protection
EFP	Earth-fault protection
FP	Protection against ferroresonance (optional)
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

Transformer differential protection
ED2-T-0201

IED is designed for differential protection of transformer.

Device is connected to two three-phase groups of current transformers, one of which is installed at the HV side, the other – at the LV side of power transformer, and also to the voltage transformer at the LV side.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection of transformer.



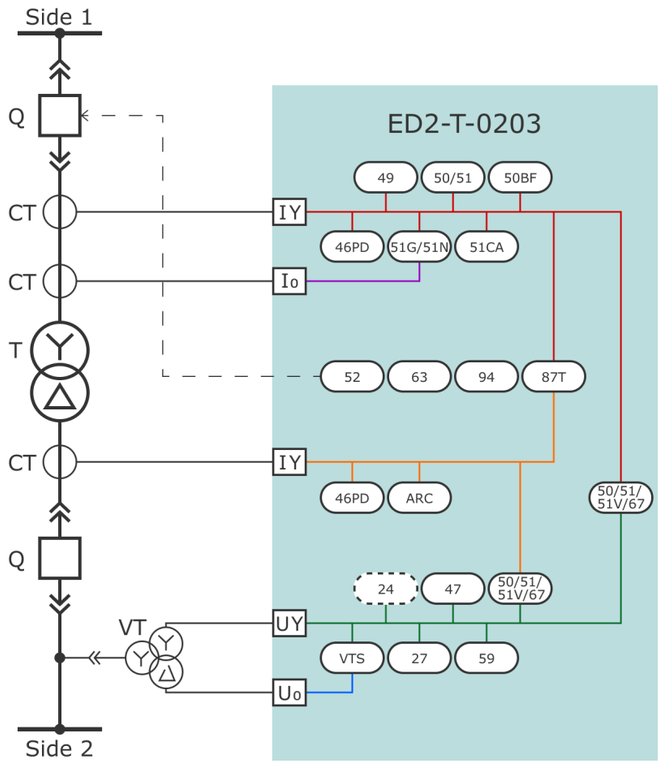
PROTECTION	
24	Overexcitation protection (optional)
27	Undervoltage protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
49	Thermal overload protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit breaker failure
51G/51N	Zero sequence overcurrent protection – measured/calculated
51_2/67_2	Negative sequence overcurrent protection
59	Overvoltage protection
63	Gas protection
87T	Transformer differential protection
ARC	Arc protection
AUTOMATION	
51CA	Cooling automation
CONTROL AND MONITORING	
94	Tripping logic
SUPERVISION	
VTS	VT supervision

Transformer differential protection ED2-T-0203

IED is designed for differential protection of transformer and circuit breaker control automation of HV side.

Device is connected to two three-phase groups of current transformers, one of which is installed at the HV side, the other – at the LV side of power transformer, and also to the voltage transformer at the LV side.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection of transformer.



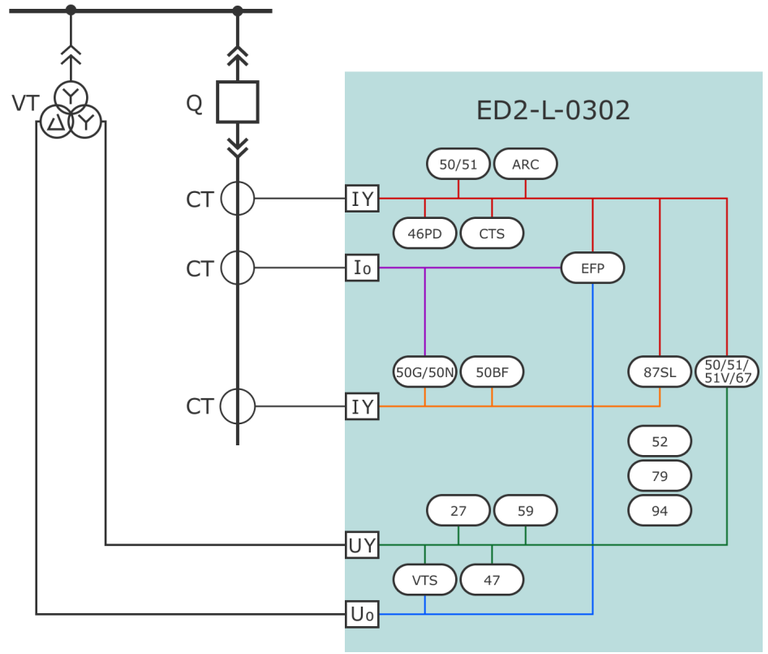
PROTECTION	
24	Overexcitation protection (optional)
27	Undervoltage protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
49	Thermal overload protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit breaker failure
51G/51N	Zero sequence overcurrent protection – measured/calculated
59	Overvoltage protection
63	Gas protection
87T	Transformer differential protection
ARC	Arc protection
AUTOMATION	
51CA	Cooling automation
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
VTS	VT supervision

Short line differential protection ED2-L-0302

IED is designed for protection of short line and its circuit breaker control automation.

Device is connected to two three-phase groups of current transformers, located at the line ends, and also to the section voltage transformer.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection of line.



PROTECTION	
27	Undervoltage protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit breaker failure
50G/50N	Double earth-fault protection
59	Overvoltage protection
87SL	Short line differential protection
ARC	Arc protection
EFP	Earth-fault protection

AUTOMATION	
79	Autoreclose
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

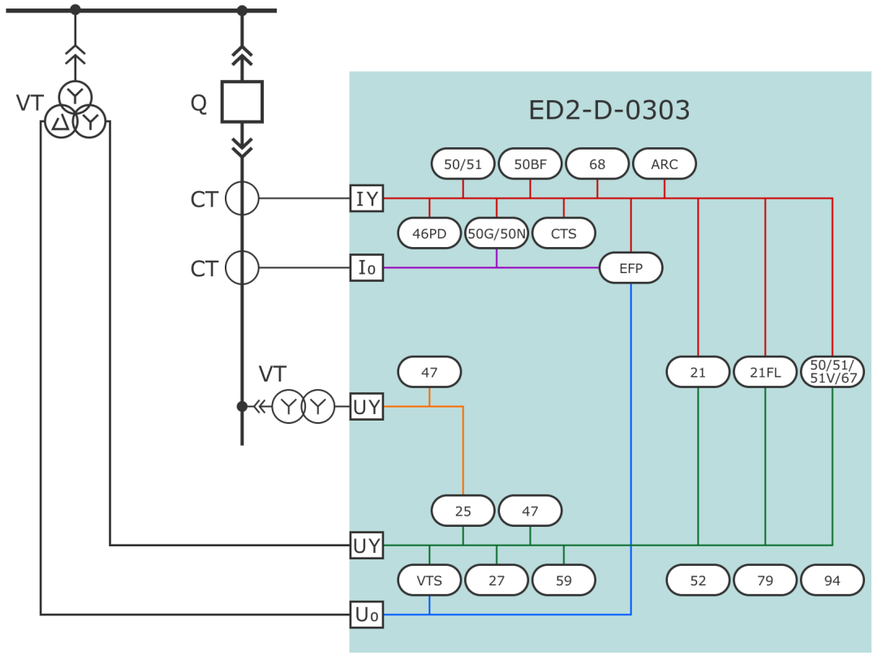
Line distance protection
ED2-D-0303

IED is designed for protection of outgoing line and its circuit breaker control automation.

ED2-D-0303 is connected to three-phase group of current transformers, located on protected line, and also to the section voltage transformer.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection of line.

To implement the function of line voltage presence monitoring and synchrocheck, there is an option of connection to a separate voltage transformer located on protected line.



PROTECTION	
21	Distance protection
27	Undervoltage protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
59	Overvoltage protection
68	Power swing blocking
ARC	Arc protection
EFP	Earth-fault protection

AUTOMATION	
25	Synchronism check
79	Autoreclose
CONTROL AND MONITORING	
21FL	Fault locator
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

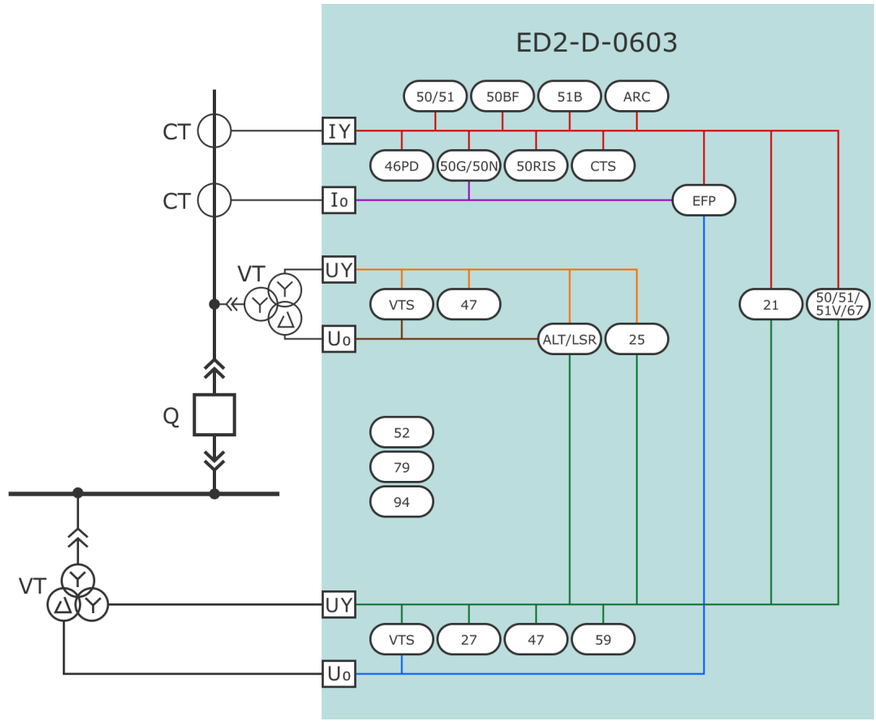
Line distance protection
ED2-D-0603

IED is designed for protection of input and its circuit breaker control automation.

ED2-D-0603 is connected to three-phase group of current transformers, located at the protected input, and also to the section voltage transformer.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection of input.

To implement the function of line voltage presence monitoring and synchrocheck, there is an option of connection to a separate voltage transformer located on protected line.



PROTECTION	
21	Distance protection
27	Undervoltage protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
50RIS	Reverse interlocking scheme
51B	Cable backup protection
59	Overvoltage protection
ARC	Arc protection
EFP	Earth-fault protection

AUTOMATION	
25	Synchronism check
79	Autoreclose
ALT/ LSR	Automatic Load Transfer/ Load Scheme Restoration
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

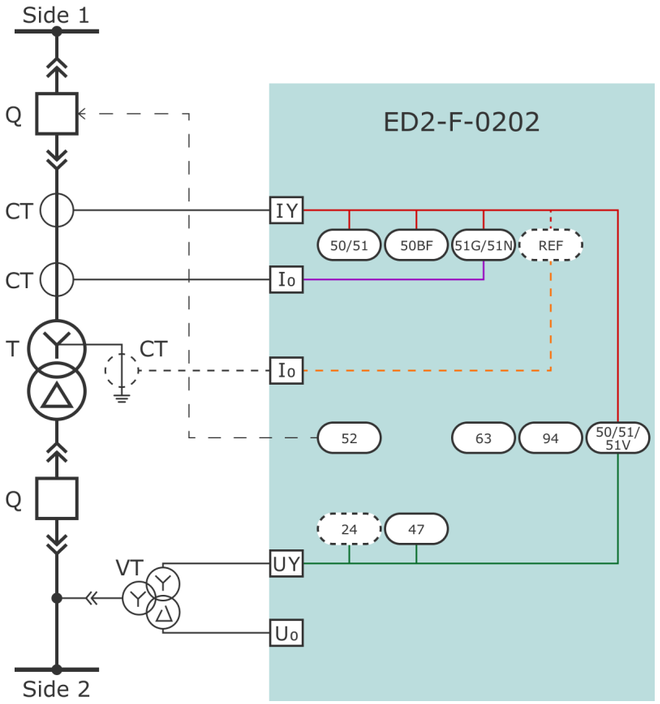
Overcurrent protection
ED2-F-0202

IED is designed for transformer protection and its HV circuit breaker control automation.

Device is connected to three-phase group of current transformers, located at the HV side of power transformer and to voltage transformer, located at the LV side of power transformer.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection of line.

I0 input, connected to current transformer installed in the earthed neutral circuit of transformer winding, is used for optional REF protection.



PROTECTION	
24	Overexcitation protection (optional)
47	Negative sequence overvoltage protection
50/51/51V	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit Breaker Failure
51G/51N	Zero sequence overcurrent protection – measured/calculated
63	Gas protection
REF	Restricted earth-fault protection (optional)

CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring

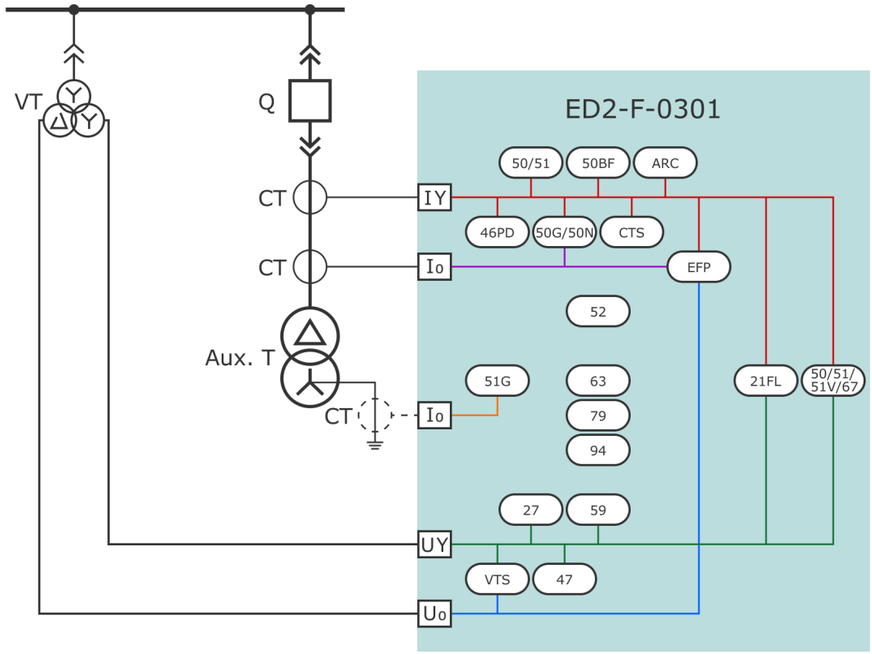
Overcurrent protection
ED2-F-0301

IED is designed for outgoing line or AuxT protection and circuit breaker control automation.

Device is connected to three-phase group of current transformers, located on the protected feeder, and also to the section voltage transformer.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection of line.

I0 input, connected to current transformer installed in the earthed neutral circuit of 0.4 kV AuxT winding, is used for backup protection from short circuits.



PROTECTION	
27	Undervoltage protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
51G	Neutral overcurrent protection
59	Overvoltage protection
63	Gas protection
ARC	Arc protection
EFP	Earth-fault protection

AUTOMATION	
79	Autoreclose
CONTROL AND MONITORING	
21FL	Fault locator
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

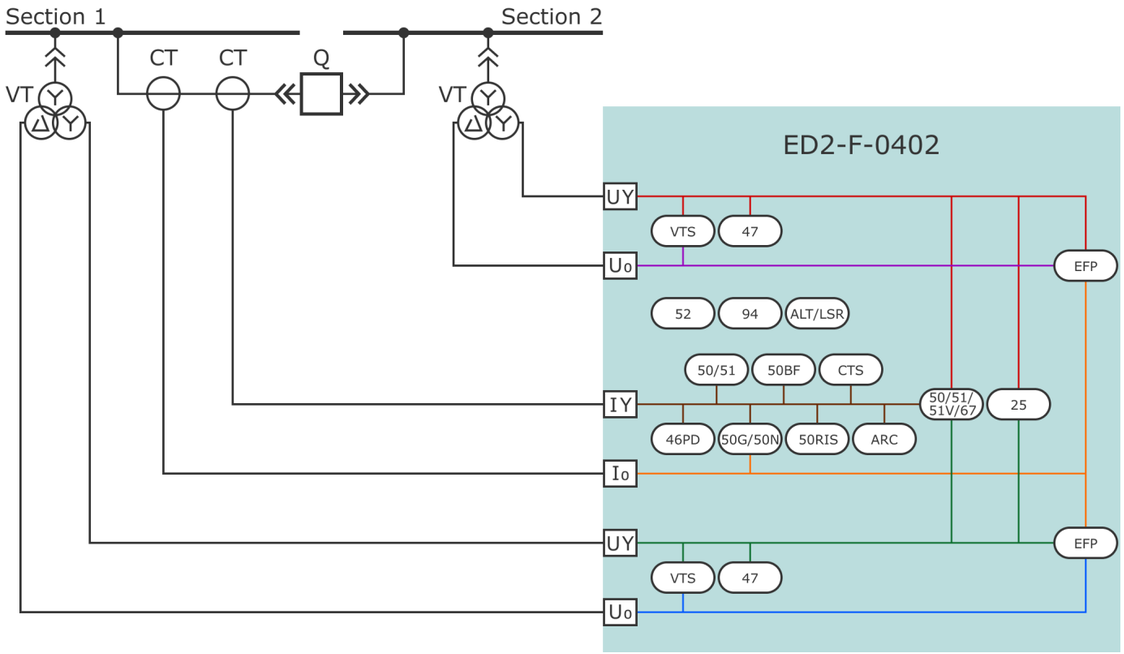
Overcurrent protection
ED2-F-0402

IED is designed for bus-tie protection and control automation of bus-tie breaker with synchrocheck function.

Device is connected to two voltage transformers, located on two adjacent sections, which can be united by a bus-tie breaker.

For feeder protection, there is a three-phase current input between two sections, connected to three-phase group of current transformers on the protected feeder.

In IED separate I_0 current input and two U_0 voltage inputs of zero sequence are provided for earth-fault protection.



PROTECTION	
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
50RIS	Reverse interlocking scheme
ARC	Arc protection
EFP	Earth-fault protection

AUTOMATION	
25	Synchronism check
ALT/ LSR	Automatic Load Transfer/ Load Scheme Restoration
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

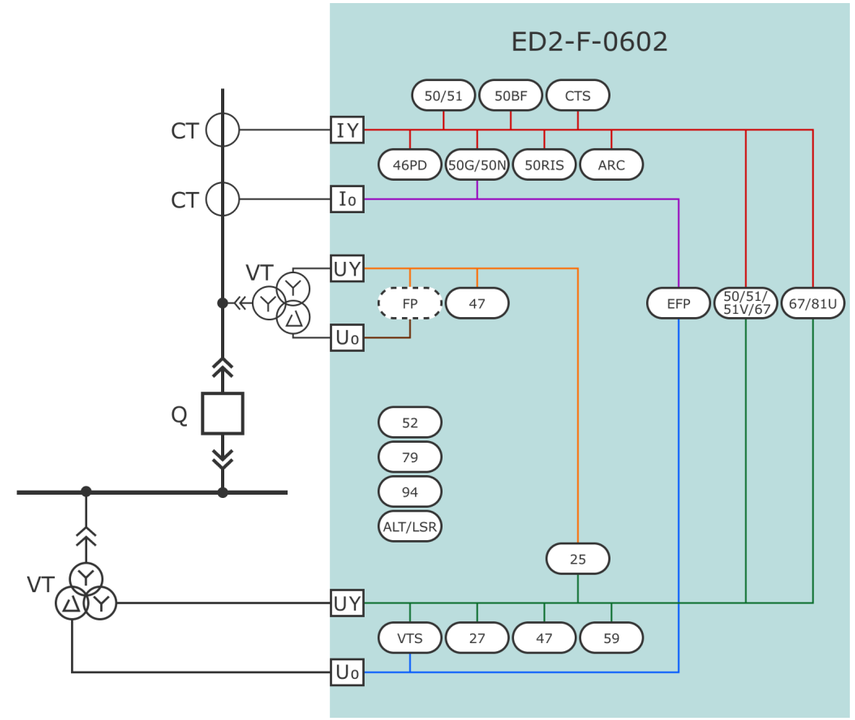
Overcurrent protection
ED2-F-0602

IED is designed for protection of input and its circuit breaker control automation.

Device is connected to section voltage transformer and three-phase group of current transformers, located at the section input.

Connection to voltage transformer at the section input serves for the normal mode restoration function and voltage presence monitoring (including synchrocheck).

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection.



PROTECTION	
27	Undervoltage protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
50RIS	Reverse interlocking scheme
59	Overvoltage protection
67/81U	Loss of mains protection
ARC	Arc protection
EFP	Earth-fault protection
FP	Protection against ferroresonance (optional)

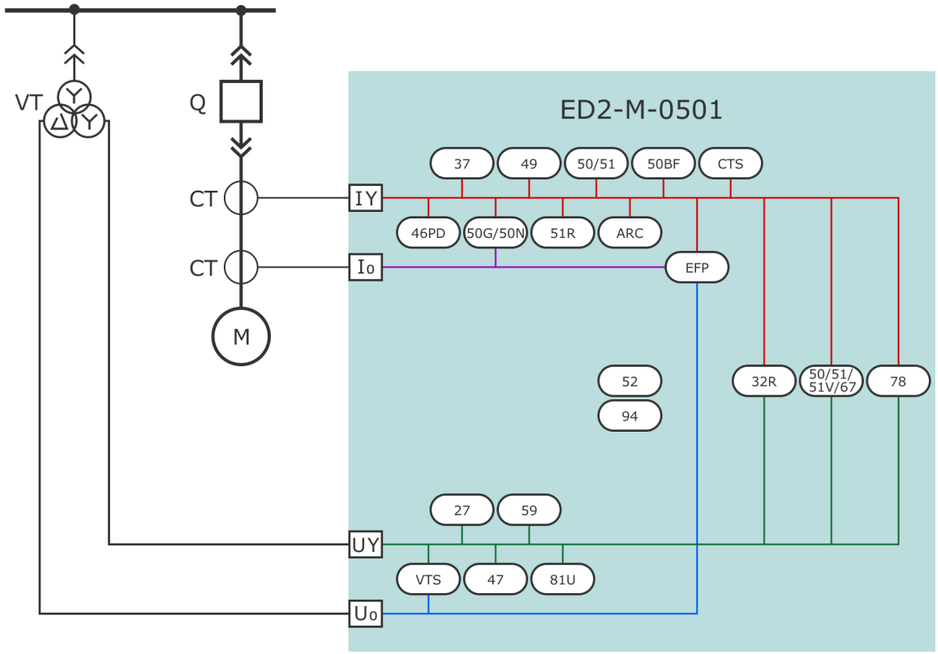
AUTOMATION	
25	Synchronism check
79	Autoreclose
ALT/ LSR	Automatic Load Transfer/ Load Scheme Restoration
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

Motor overcurrent protection ED2-M-0501

IED is designed for motor protection and its circuit breaker control automation.

Device is connected to section voltage transformer and three-phase group of current transformers at the feeder connected to electric motor.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection.



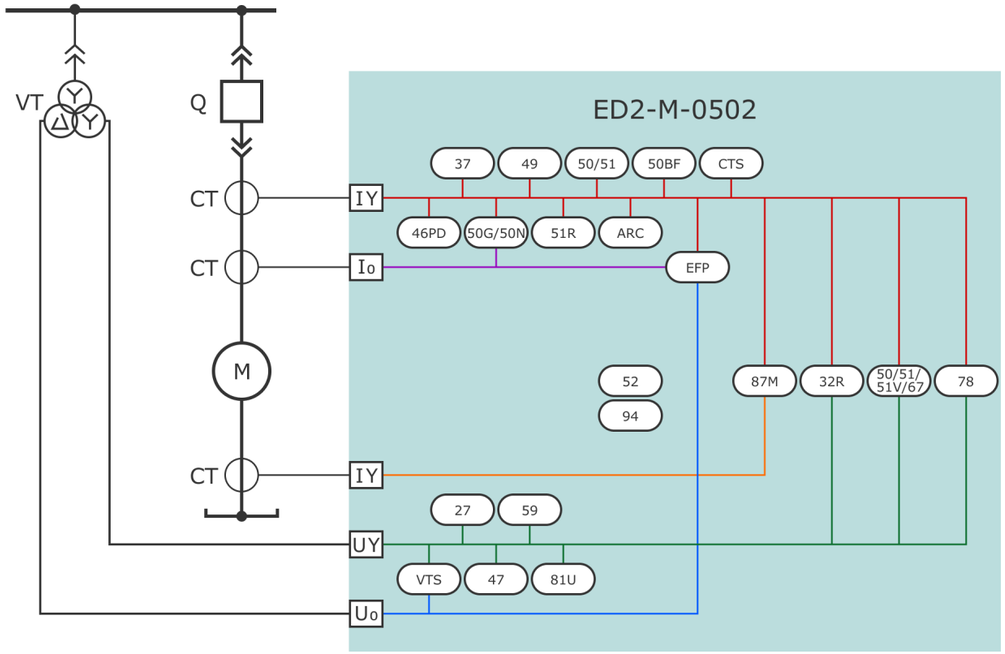
PROTECTION	
27	Undervoltage protection
32R	Reverse power protection
37	Undercurrent protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
49	Thermal overload protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
51R	Motor start-up supervision
59	Overvoltage protection
78	Out-of-step protection
81U	Underfrequency protection
ARC	Arc protection
EFP	Earth-fault protection
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

Motor differential protection ED2-M-0502

IED is designed for motor protection and its circuit breaker control automation.

Device is connected to two three-phase groups of current transformers, one of which is installed at the side of electric motor line outputs, the other – at the side of electric motor zero outputs, and also to the section voltage transformer.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection.



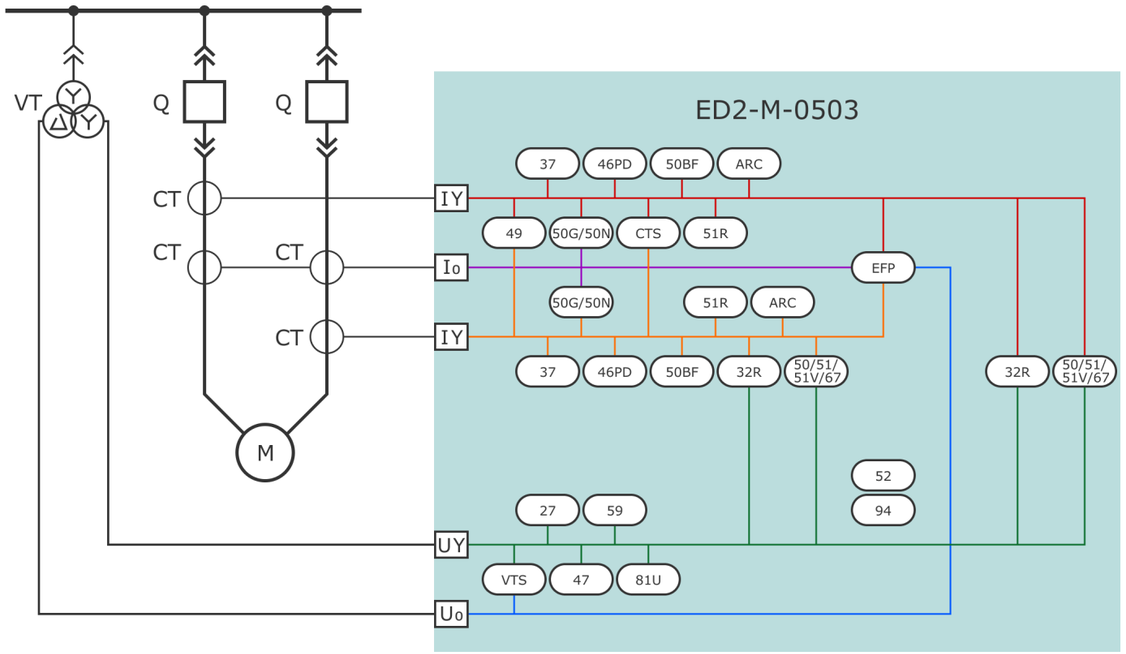
PROTECTION	
27	Undervoltage protection
32R	Reverse power protection
37	Undercurrent protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
49	Thermal overload protection
50/51/51V/67	Overcurrent protection
50/51	Additional overcurrent relay
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
51R	Motor start-up supervision
59	Overvoltage protection
78	Out-of-step protection
81U	Underfrequency protection
87M	Motor differential protection
ARC	Arc protection
EFP	Earth-fault protection
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

Motor overcurrent protection (double-speed motor) ED2-M-0503

IED is designed for double-speed motor protection and its circuit breakers control automation.

Device is connected to two three-phase groups of current transformers, one of which is installed at the side of cable line of electric motor first speed, the other – at the cable line of electric motor second speed, and also to the section voltage transformer.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection.



PROTECTION	
27	Undervoltage protection
32R	Reverse power protection
37	Undercurrent protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
49	Thermal overload protection
50/51/51V/67	Overcurrent protection
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
51R	Motor start-up supervision
59	Overvoltage protection
81U	Underfrequency protection
ARC	Arc protection
EFP	Earth-fault protection
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

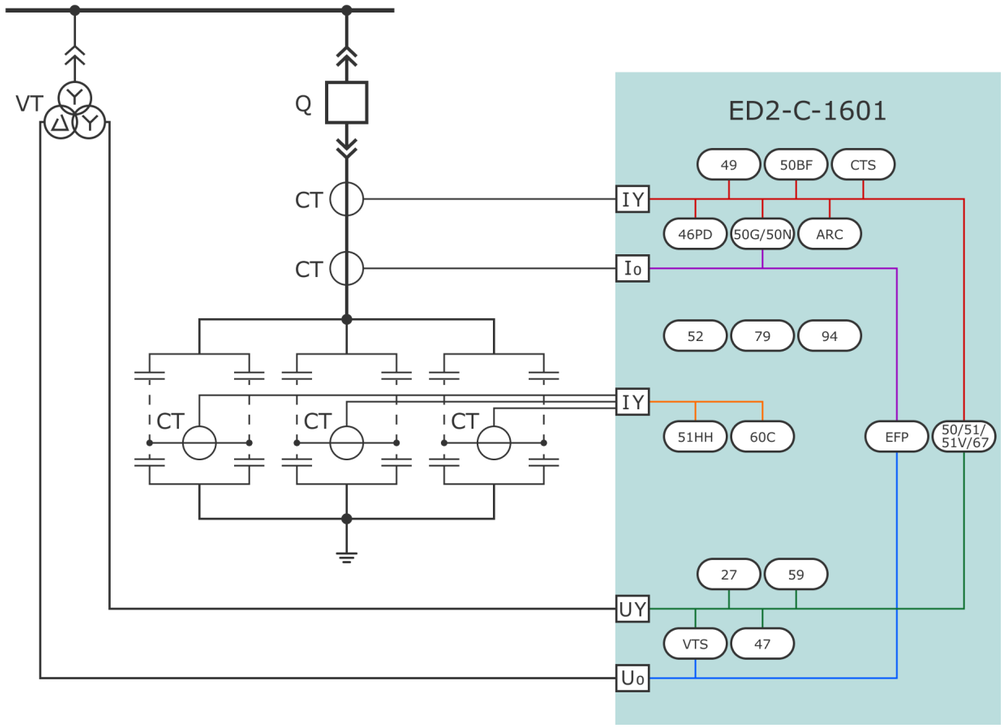
Capacitor bank protection ED2-C-1601

IED is designed for protection of capacitor bank and its circuit breaker control automation.

For protection of capacitor bank serve IED inputs connected to three-phase group of current transformers, installed on every phase of capacitor bank.

Device is connected to three-phase group of line current transformers and to section voltage transformer for protection of cable line from section to the capacitors module.

In IED separate zero-sequence current and voltage inputs I_0 and U_0 are provided for earth-fault protection.



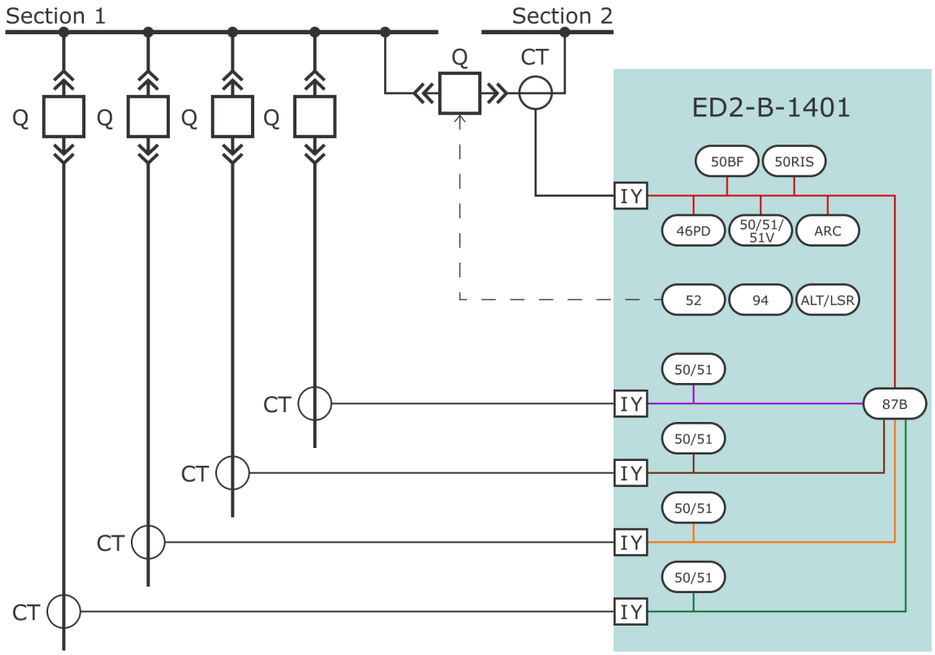
PROTECTION	
27	Undervoltage protection
46PD	Phase discontinuity protection
47	Negative sequence overvoltage protection
49	Thermal overload protection
50/51/51V/67	Overcurrent protection
50BF	Circuit Breaker Failure
50G/50N	Double earth-fault protection
51HH	Overcurrent protection based on higher harmonics
59	Overvoltage protection
60C	Unbalance protection
ARC	Arc protection
EFP	Earth-fault protection

AUTOMATION	
79	Autoreclose
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring
SUPERVISION	
CTS	CT supervision
VTS	VT supervision

Busbar differential protection ED2-B-1401

IED serves for busbar differential protection for 4 feeders and automation, control and signaling of bus-tie breaker.

Differential protection has two-phase design and is connected to three-phase bus-tie breaker and to the current transformers in “fork” connection, installed in circuits of A and C phases of feeders.



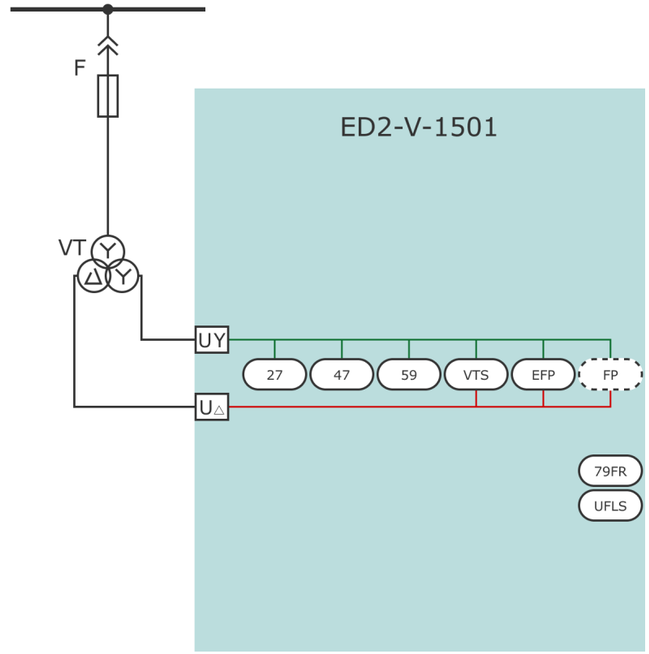
PROTECTION	
46PD	Phase discontinuity protection
50/51/51V 50/51	Overcurrent protection
50BF	Circuit Breaker Failure
50RIS	Reverse interlocking scheme
87B	Busbar differential protection
ARC	Arc protection

AUTOMATION	
ALT/ LSR	Automatic Load Transfer/ Load Scheme Restoration
CONTROL AND MONITORING	
52	Circuit breaker control
94	Tripping logic
	Circuit breaker wearing monitoring

Voltage protection ED2-V-1501

IED serves for monitoring and automation of busbar section voltage transformer.

Device is connected to busbar section voltage transformer.



PROTECTION	
27	Undervoltage protection
47	Negative sequence overvoltage protection
59	Overvoltage protection
EFP	Earth-fault protection
FP	Protection against ferroresonance (optional)

AUTOMATION	
79FR	Frequency-actuated autoreclose
UFLS	Underfrequency load shedding
SUPERVISION	
VTS	VT supervision

PROTECTION

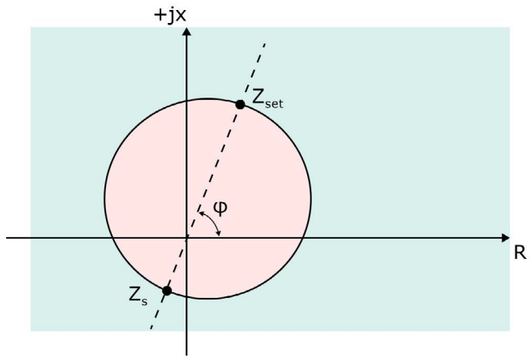
Distance protection (21)

Distance protection algorithm is based on comparison of active and reactive components of the measured impedance with relevant settings.

Distance protection includes blocking in case of voltage circuits malfunction.

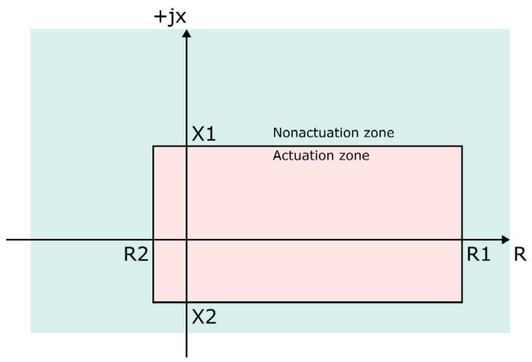
- Distance protection of **incoming feeders** has two zones against phase-to-phase short circuits:

The first zone has circular actuation characteristics in the form of circumference with possible shift to any quadrant of the complex plane of resistances. This characteristic is optimal for offset from the start and self-start modes of electric motors energized from bus sections.



First zone of the distance protection of incoming feeders

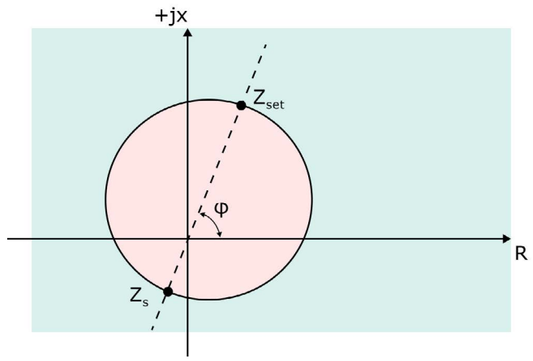
The second zone has rectangular actuation characteristics with possible shift to any quadrant of the complex plane of resistances. The characteristic is shown in the figure.



Second zone of the distance protection of incoming feeders

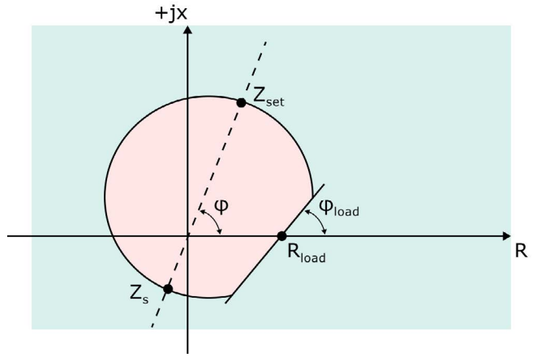
- Distance protection of **outgoing feeders** has three zones against phase-to-phase short circuits:

The first and second zones have circular actuation characteristics with possible shift to any quadrant of the complex plane of resistances.



The first and second zones of the distance protection of outgoing feeders

The third zone has an option to additionally set up a load mode using a straight line, which starts at a point on the abscissa, and the inclination angle.



The third zone of the distance protection of outgoing feeders

Overexcitation protection (24)

The protection serves to protect generators and transformers from the excessive magnetic flux, which causes saturation and creates additional losses from eddy currents.

The protection reacts to ratio change of the actual voltage value to the frequency U/f.

Undervoltage protection (27)

The protection actuates at symmetrical decrease of all three measured line voltages below actuation setting and closed position of circuit breaker.

The protection has two stages. Each stage uses an individual measuring element of the minimum voltage and independent time delay for actuation. Action of every stage can be set up separately.

The protection is blocked, if there are failures of voltage circuits or the external binary signal is present.

Reverse power protection (32R)

This protection prevents the damages to turbine-generator unit when the power to the turbine has been cut. In this case, generator switches to motoring mode with applying torque to the turbine that can damage turbine blades. It is therefore necessary to timely disconnect the generator from the network, when such operation is detected.

The reverse power protection actuates, if active power is supplied from the busbars to the generator, within the actuation time set by the setting.

Undercurrent protection (37)

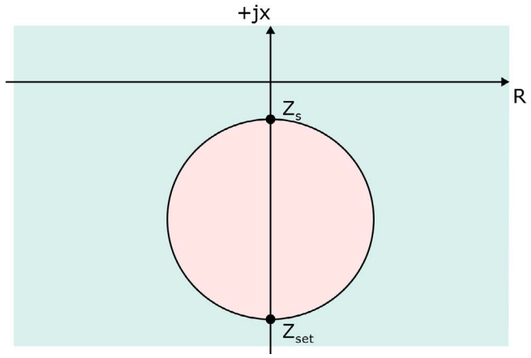
This protection is designed to protect units from emergency operation modes, related to the low phase current flow.

The protection actuates when all phase currents are less than the set value during the set time.

Loss of excitation protection (40)

Loss of excitation protection is designed to protect generator at loss or lack of generator's excitation, which lead to dangerous voltage conditions with loss of stability and switching into the out-of-step mode. The protection operation depends on availability of option for generator to switch into the out-of-step mode.

The protection is implemented based on the Z element and is connected to instrument transformers, installed in the generator's circuit, and is enabled at phase-to-phase voltage and relevant difference of phase currents. The protection is enabled when the generator is connected to the network.



Actuation characteristic of loss of excitation protection

Unbalanced Load Protection (46)

Unbalanced Load Protection reacts to the increase of negative-sequence current and functions as a backup protection from external unbalanced short circuits and a protection against unbalanced overloads.

Phase discontinuity protection (46PD)

Protection reacts to the ratio of the negative-sequence current I_2 to the positive-sequence current I_1. At normal operation mode, ratio of I_2 to I_1 is close to zero, and at phase break, the ratio becomes close to one.

Negative sequence overvoltage protection (47)

The protection reacts to increase of the actual negative sequence voltage value and designated for the VT primary winding supervision, for example, if one or two fuses have blown.

Thermal overload protection (49)

Thermal overload protection is designed to prevent the development of thermal damages to the protected equipment in case of symmetric overloads.

The protection initiates signal at short-term overloads and tripping at long-term overloads, thus preventing overheating and further reducing of the insulation resistance of generator/motor/transformer windings.

Generator rotor overload protection (49R)

The protection reacts to the rotor relative current, simulated based on the current and voltage of the generator's stator in accordance with the Potier phasor diagram.

For correct simulation of rotor current both in the balanced and out-of-step modes of excitation system operation, the converter element is designed as three-phase and its outgoing signal is proportional to the mean value of the sum of the rectified currents of three phases.

Overcurrent protection (50/51/51V/67)

According to device type design, overcurrent protection (OCP) can have 2 or 3 stages.

Depending on settings, each OCP stage can be made directional and/or have an option to start by voltage.

The first stage of the overcurrent protection is made with independent time-current characteristic, and has an option of additional automatic desensitization of setting at the moment of circuit breaker closing. The first stage of transformer protection IEDs also have the blocking from magnetizing in-rush currents.

The second and third stages of OCP can be made both with dependent time-current actuation characteristics and with independent ones. User can select from 15 characteristics available:

- Independent/Definite Time
- IEC Normal inverse
- IEC Very inverse
- IEC Extremely inverse
- IEC Ultra inverse
- IEC Short time inverse
- IEC Long time inverse
- ANSI Normal Inverse
- ANSI Moderately Inverse
- ANSI Very Inverse
- ANSI Extremely Inverse
- Steep
- Flat
- User curve, set by equation
- User curve, set by points

For the second and the third stages, there is also an option for automatic acceleration of actuation at circuit breaker closing.

Additional overcurrent relay (50/51)

According to the device type design, two additional backup current relays can be provided. There is a possibility to choose actuation and resetting characteristics for every device.

Circuit breaker failure (50BF)

In case of short circuit on the protected feeder and consequent actuation of protection, if the circuit breaker for some reasons does not trip the short-circuit current, then the circuit breaker failure protection issues a command to trip the above adjacent circuit breakers, through which the SC point is fed.

Double earth-fault protection (50G/50N)

Double earth-fault protection is designed for operation in cases when one breakdown spot is in the protected feeder phase and second one – in other phase of any bay, galvanically connected with the protected feeder. Upon such type of fault, the flow of currents, close to two-phase short-circuit current by the value, are possible.

In this case, to prevent the considerable damages it is necessary to ensure the fastest disabling of the protected object.

Reverse interlocking scheme (50RIS)

RIS represents a wide area protection, designed to trip short circuits on the switchgear buses in the shortest possible time.

The protection is not located in one IED, but distributed over protections of inputs, bus-tie breakers and outgoing feeders.

The input IEDs and bus-tie breakers have the current protection tripping stage.

At the start of own OCP, the outgoing feeders IEDs generate the RIS blocking signal, which comes on to the binary inputs of the protection input devices and bus-tie breaker. Receipt and transfer of binary signals is possible using the communication protocols, such as IEC 61850.

Cable backup protection (51B)

Backup current protection is needed because the main distance protection of inputs with circular characteristics is offset from the start and autostart modes of electric motors, and therefore, does not react to multi-phase SC on the end of long-distance cables. The backup protection serves to prevent the power plant's auxiliary cable network from burning out due to the three-phase SC in any point.

The three-phase measuring current element of the maximum operation initiates the protection. The protection blocking element is represented by the power direction relay, which settings are specified for the current relay to actuate when the current is directed from the load (electric motor) to the system.

Zero sequence overcurrent protection – measured/calculated (51G/51N)

The protection has one stage. Depending on the selected protection settings, this stage can react to the measured zero-sequence current 3I0 or to the calculated zero-sequence current, result of the sum of phase currents of transformer's HV side. This or other stage can be chosen depending on the selected protection settings.

Neutral overcurrent protection (51G)

Provides backup protection of auxiliary transformer windings from short-circuits. Protection consists of measuring element of zero-sequence current with independent time-current characteristic and two independent time delays.

Overcurrent protection based on higher harmonics (51HH)

The protection has two stages, each of them reacting to the actual value of the maximum from three phase currents, calculated in consideration of higher harmonics. The action of every stage is specified by the settings.

Motor start-up supervision (51R)

This function is applied for the determination of operation mode of electric motor by the current changes.

There are three modes of the motor: «Braking/restrain», «Start» and «Operation». When determining the operating mode, the maximum of the phase currents is compared with the setting of the rated motor load current. The function also allows determining the jamming of electric motor's rotor.

Negative sequence overcurrent protection (51_2/67_2)

The protection is applied to protect the two-winding transformer from unbalanced short circuits. The protection has three stages at the transformer HV side and three stages at the transformer LV side. Depending on the settings, the protection can be implemented as directional.

Every stage has the possibility to select actuation characteristics, and use the manual acceleration from external signal and automatic acceleration upon circuit breaker closing.

The protection is offset from the magnetizing in-rush current of transformer.

Overvoltage protection (59)

The overvoltage protection (OVP) serves for prevention of continuous equipment operation at the voltage value higher than that permitted by the operation requirements. OVP is made single-stage, actuates when any of the line voltages surpasses the actuation setting.

Zero sequence overvoltage protection – calculated (59N)

The protection is used for general nonselective earth-fault signaling. The protection reacts to the actual value of zero-sequence voltage, calculated on the basis of the measurement of three phase voltages.

This protection is sensitive to stable and transient arc faults in every point of the galvanically connected circuit.

Unbalance protection (60C)

Unbalance protection has two actuation stages and designed to protect the capacitor bank from internal damages, when one capacitor in the line is damaged or the capacitors line is closed.

Unbalance protection is connected to three-phase group of current transformers, installed in every phase of capacitor bank for measuring the unbalance current and reacts to the tripled phase zero-sequence current.

Gas protection (63)

Gas protection is used for the protection from damages inside the transformer's tank, followed by electric arc or parts heating, that lead to decomposition of oil and insulating materials, and to volatile gas generation. In the gas protection there is a possibility to initiate a signal in case of low gas generation and oil level decrease and initiate tripping in case of intensive gas generation and further oil level decrease.

Loss of mains protection (67/81U)

Loss of mains protection is designed for detection of load loss at substations with two independent synchronically operating power sources (transformers, supply inputs). The protection reacts to frequency decrease on the bus section and change of power flow on the input. The function initiates disabling of the input breakers.

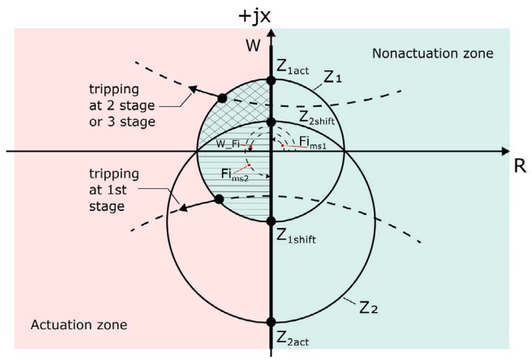
Power swing blocking (68)

Power swing blocking is used to prevent maloperation of the distance protection at power swings in the power supply system. Power swing blocking is designed to react to the speed of phasors changing of negative-sequence and positive-sequence currents.

Out-of-step protection (78)

Out-of-step operation is characterized by large fluctuations of active and reactive power that can lead to major accidents. Out-of-step protection is designed to eliminate generator's out-of-step operation, not accompanied by excitation loss.

The protection operation principle is based on impedance control in the connection place of measuring CTs and VTs and has special actuation characteristics.



Actuation characteristic of out-of-step protection

Phase-sensitive element W actuates at deviation of angle between EMF of generator and system for more than 180º.

Actuation characteristic of Z_1 element determines the control zone of power swing center. Actuation characteristic Z_2 divides this zone to two sections:

- with the power swing center in the generator-transformer unit (1st stage). If out-of-step operation is prohibited for generator, the tripping signal is generated after a time delay T_1, after resistance hodograph is out of element Z_1 actuation characteristic, with the condition that before this the resistance hodograph was in the zone restricted by Z_1, Z_2 and W characteristics.

If out-of-step operation is permitted for generator, the protection counts the turns and acts on tripping upon reaching the set number.

- with the power swing center in the electrical system (2nd and 3rd stage). Actuation signals are generated after the time delays T_2 and T_3 when the hodograph is out of Z_1 characteristic, taking into account that before this, the hodograph was in the zones, restricted by the characteristics of elements Z_1 and W and did not enter the Z_2 element zone.

Under/Overfrequency protection (81U/81O)

Under/overfrequency protection ensures the functioning of the protected equipment in the permissible operating range of frequencies.

Underfrequency protection has two stages and actuates, if the frequency value is less than the set actuation frequencies.

Overfrequency protection has two stages and actuates, if the frequency value is more than the set actuation frequencies.

Busbar differential protection (87B)

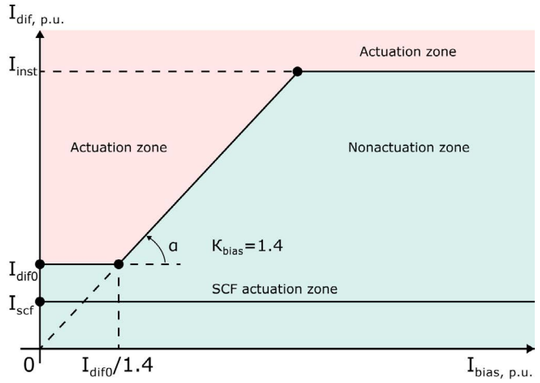
This protection is designed as a three-phase and is connected to the current transformers in "fork" connection, installed in the circuits of phase A and C of the circuit breakers adjacent to the section. This connection protects the busbar with four feeders and one bus-tie breaker.

The protection allows changing the current transformers polarity via software and automatic equalizing of currents by module.

A differential instantaneous overcurrent with actuation current I_{inst} ensures the reliability of protection at high short-circuit currents in its operation zone.

An additional differential sensitive current function (SCF) with the actuation current I_{scf} ensures quick tripping in the testing mode.

This is a biased differential protection, with horizontal and inclined areas of actuation characteristics with the constant bias ratio of 1.4.



Actuation characteristic of busbar differential protection

Generator differential protection (87G)

The protection is connected to two groups of current transformers, one of which installed at the output of the stator's winding, the other– at the neutral.

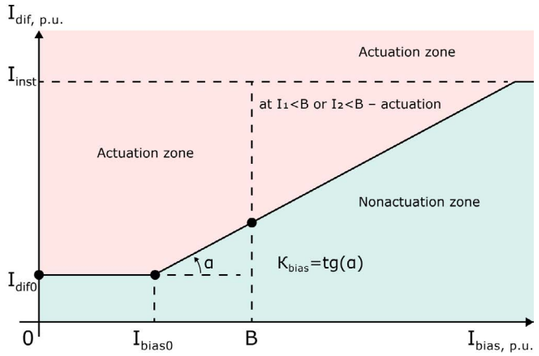
The protection allows changing the current transformers polarity via software and automatic equalizing of currents by module.

The IED performs both phase-by-phase and three-phase generator differential protection, that ensures reliable operation at inter-winding faults in one phase, as well as phase-to-phase short circuits and double earth-faults.

The protection provides suppression of higher harmonic components in the monitored current, including harmonics multiple of three.

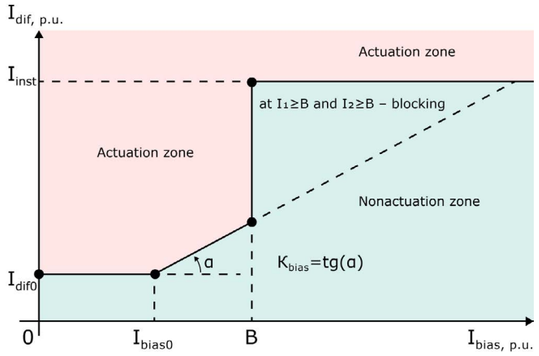
A differential instantaneous overcurrent with actuation current I_{inst} ensures the reliability of protection at high short-circuit currents in its operation zone.

This is a biased differential protection, with horizontal and inclined areas of actuation characteristics.



Actuation characteristic of busbar differential protection

An additional blocking zone in the characteristic is provided in order to avoid false actuations of protection at high currents of external short circuits. This zone is activated when currents from the first and second group of current transformers I_1 and I_2 exceed the B setting value.



Additional blocking zone in actuation characteristic of generator differential protection

Motor differential protection (87M)

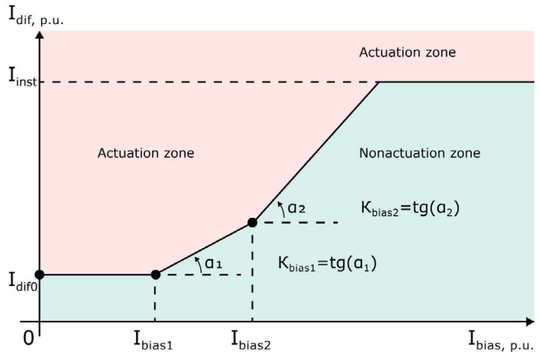
This protection is designed as a three-phase and connected to the current transformers at the side of the stator's windings output and at the neutral. Ensures the fast-operating protection from multi-phase short circuits.

The protection allows changing the current transformers polarity via software and automatic equalizing of currents by module.

The protection provides blocking from magnetizing in-rush current based on relation of second harmonic component of the differential current to the fundamental harmonic component.

A differential instantaneous overcurrent with actuation current I_{inst} ensures the reliability of protection at high short-circuit currents in its operation zone.

This is a biased differential protection, with one horizontal and two inclined areas of actuation characteristics.



Actuation characteristic of electric motor differential protection

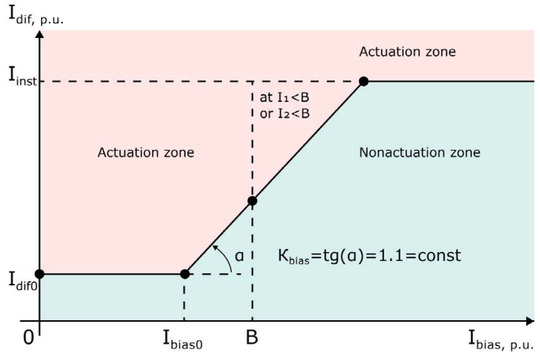
Short line differential protection (87SL)

IED with 87SL function, connected to the current transformers on the line ends, ensures fast-operating protection from all types of short circuits.

The protection allows changing the current transformers polarity via software and automatic equalizing of currents by module.

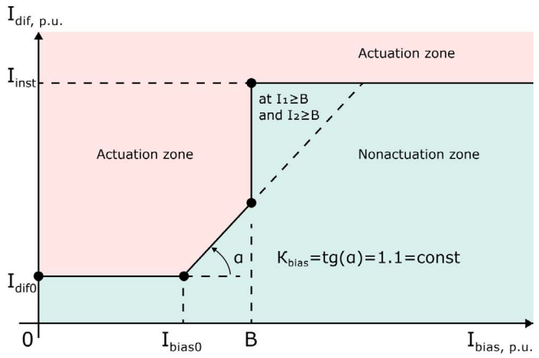
A differential instantaneous overcurrent with actuation current Iinst ensures the reliability of protection at high short-circuit currents in its operation zone.

This is a biased differential protection, with horizontal and inclined areas of actuation characteristics with the constant bias ratio of 1.1.



Actuation characteristic of short line differential protection

An additional blocking zone in the characteristic is provided to avoid false actuations of protections at high currents of external short circuits. This zone is activated when currents from the first and second group of current transformers I_1 and I_2 exceed the B setting value.



Additional blocking zone in actuation characteristic of short line differential protection

Transformer differential protection (87T)

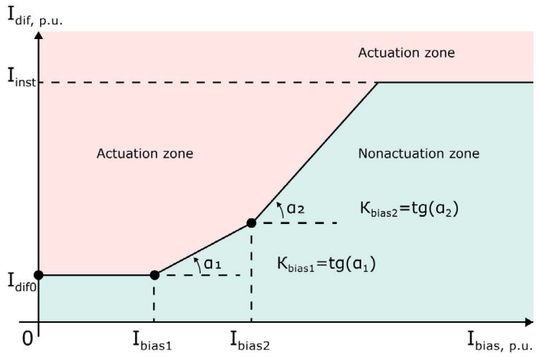
Differential protection is connected to the current transformers, installed on every side of the protected two-winding transformer and ensures protection from all types of short circuits inside the protected zone.

The protection allows changing the current transformers polarity via software and automatic equalizing of currents by module and angle.

The protection provides blocking from magnetizing in-rush current based on relation of second harmonic component of the differential current to the fundamental harmonic component.

A differential instantaneous overcurrent with actuation current I_{inst} ensures the reliability of protection at high short-circuit currents in its operation zone.

This is a biased differential protection, with one horizontal and two inclined areas of actuation characteristics.



Actuation characteristic of transformer differential protection

Arc protection (ARC)

Protection is designed for fast elimination of arc faults in the switchgear bays. The protection receives an external binary signal from the arc protection device, reacting to different physical phenomena that follow arc faults (air expansion during arc burning, light flashes).

The protection has two independent actuation time delays.

Application of a condition of short-circuit current flow is possible, in order to increase the reliability and exclude false actuations.

Earth-fault protection (EFP)

Function allows to implement the signaling of single-phase earth-fault and detection of damaged feeder.

The implementation method of earth-fault protection at the object is determined by the neutral earthing mode, zero-sequence electrical values parameters and RPA connection circuit solutions developed by a design center.

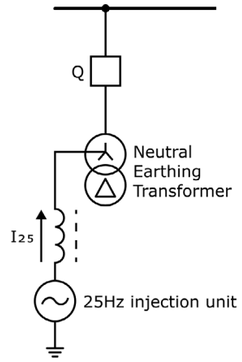
The software implementation of measuring elements in IED allows flexible configuration of IED for the requirements of the protected object through enabling/disabling the set of measuring elements.

Depending on the neutral earthing method, the following implementations of functions are possible:

- For networks with the neutral high-resistance earthing and low-resistance earthing a two-stage zero-sequence overcurrent protection is used as an earth-fault protection.
- For networks with the isolated neutral, a two-stage zero-sequence overcurrent protection is also used. If selectivity is not provided, it is possible to additionally use a directional properties.
- The following variants are available for networks with the compensated neutral:

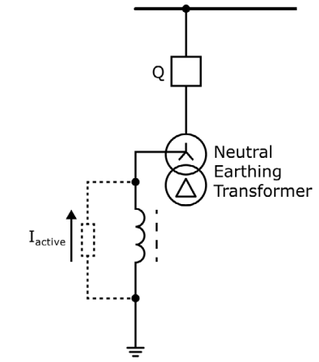
◇ Monitoring of the higher harmonic omponents in the zero-sequence current. Operation principle of this protection is based on the comparison of the root mean square value (measured or calculated) of the 5th, 7th and 11th harmonics sum with the mathematically formed electric value, proportional to the current at the external single-phase short circuit.

◇ Applying of the principle of superposition of control current with 25 Hz frequency. Implementation of this protection requires installation of the additional source of control current.



Installation of the additional source of control current

◇ Applying of the artificially increased active component of earth-fault current. This protection is implemented by means of the parallel connection of earthing resistor to arc-suppression coils with such a resistance that current active component is equal to 15-20% of earth-fault capacitive current.



Installation of additional earthing resistor

Protection against ferroresonance (FP)

Protection against ferroresonance is used when there is VT with anti-resonance group in the system. This VT design includes a zero-sequence transformer that acts as a protection of the measuring unit of molded transformers from ferroresonance processes.

If there are ferroresonance processes upon the earth-fault, the protection opens the contacts of intermediate relay, thus deshunting the secondary winding of zero-sequence transformer.

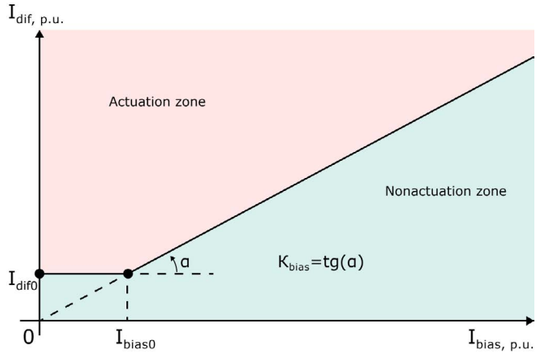
Hence, inductive resistance of the zero-sequence transformer›s winding, included into the VT high-voltage windings neutral, rapidly increases, and ferroresonance processes are automatically eliminated. Elimination of earth-fault automatically switches the scheme to the initial position.

Restricted earth-fault protection (REF)

The protection is intended for preventing the development of damages in case of earth-faults in transformer windings.

The protection is connected to star-connected current transformers installed on the side of the winding outputs and to the CT in the neutral of this winding.

The operation principle of the protection is based on the measurement of zero-sequence differential current of the protected winding and its comparison with the actuation current. For offset from unbalance currents in case of external short circuits and in out-of-step mode, bias characteristic is used.



Actuation characteristic of restricted earth-fault protection

AUTOMATION

Synchronism check (25)

The function serves for adherence to specifications, under which the circuit breaker closing for parallel operation with the system is permitted.

Main features:

- estimation and comparison of voltage modules;
- estimation of phasor shift between two voltage phasors and synchrocheck with the set advance time;
- estimation of difference between frequencies of two voltages.

Cooling automation (51CA)

This function is used to control the cooling automation of transformer. Cooling automation is actuated by the increase of the current over the setting value, after the time delay.

Autoreclose (79)

Autoreclose serves for quick recovery of power supply through automatic reclosure of circuit breakers, tripped by the relay protection devices.

Two AR cycles are available, as well as AR operation with voltage presence monitoring in the busbar section, as well as AR inhibit.

When the AR actuation signal is generated in accordance with a set time delay and readiness signal, a one-time pulse signal is generated to close the breaker in each AR cycle.

Frequency-actuated autoreclose (79FR)

Frequency-actuated autoreclose (79FR) serves for acceleration of the power recovery to consumers, disconnected from the network by underfrequency load shedding actuation. The 79FR function actuates after the power grid frequency is restored, and sends a pulse to connect the previously disconnected consumers.

Blocking of 79FR at the actuation of protections acting on tripping, and at the command tripping is available. 79FR can operate with voltage presence control at the busbar section.

Automatic voltage regulator (90V)

The function forms commands to increase and decrease OLTC step number for the regulation of voltage in the set point.

The regulation can be blocked at:

- reaching the final regulation stages;
- low oil temperature in OLTC tank;
- detection of overcurrent in the regulated or monitored section;
- overvoltage;
- zero-sequence and negative-sequence voltage, exceeding over the permissible maximum;
- voltage reduction below the permissible minimum.

Automatic Load Transfer / Load Scheme Restoration (ALT/ LSR)

Automatic Load Transfer ensures the automatic transfer of power from the main source to the backup one. ALT algorithm acts on the tripping of circuit breaker of its own section input and further closing of backup (bus-tie) breaker.

Start of ALT scheme is performed in case of any tripping of input breaker and absence of blocking signals.

The function of restoring normal network operation mode allows to perform back-switching procedure, in other words, trip the backup (bus-tie) breaker and close the main (input) one.

Two operation modes are provided: with power supply interruption to consumers, when first trips the bus-tie breaker, then after confirmation of its tripping, the own input switch is closed. Alternatively, without power interruptions, when first the input switch closes, then after confirmation of its closing, the bus-tie breaker is tripped.

Underfrequency load shedding (UFLS)

Underfrequency load shedding presents a system of connected load regulation by disconnecting the consumers in case of sharp frequency drop, depending on the class of significance. In other words, the power is interrupted to the least significant part of consumers.

Three sequences of UFLS are implemented in the device, each of them can be put to a separate binary output.

There are three operation modes of UFLS output relays:

- pulse;
- tracking, when relay is hold until the starting element of UFLS stage is released;
- continuous, when UFLS relay is hold at the operation mode until the frequency increases to the value of 79FR actuation.

CONTROL AND MONITORING

Fault Locator (21 FL)

Start condition to initiate calculation of fault location is an actuation of at least one of the feeder protections.

The location algorithm is based on remote measuring of reactive resistance up to the place of fault, which allows quick and exact location of phase-to-phase short circuit on the line.

Calculation of the fault location is made for three-phase and phase-to-phase short circuit.

Circuit breaker control (52)

Breaker control function is designed for normal (not emergency) control of switching equipment. The control commands can be generated via local or remote control. Additionally it is possible to control directly from IED (using special control buttons “I”, “O”).

Tripping logic (94)

Tripping from external circuits allows circuit breaker tripping from adjacent devices, signals from which can be received via binary inputs or digital communication channels.

Circuit breaker wearing monitoring

The function is designed for breaker state monitoring for the actual operation period. The breaker state monitoring is performed by means of switching and mechanical life calculation.

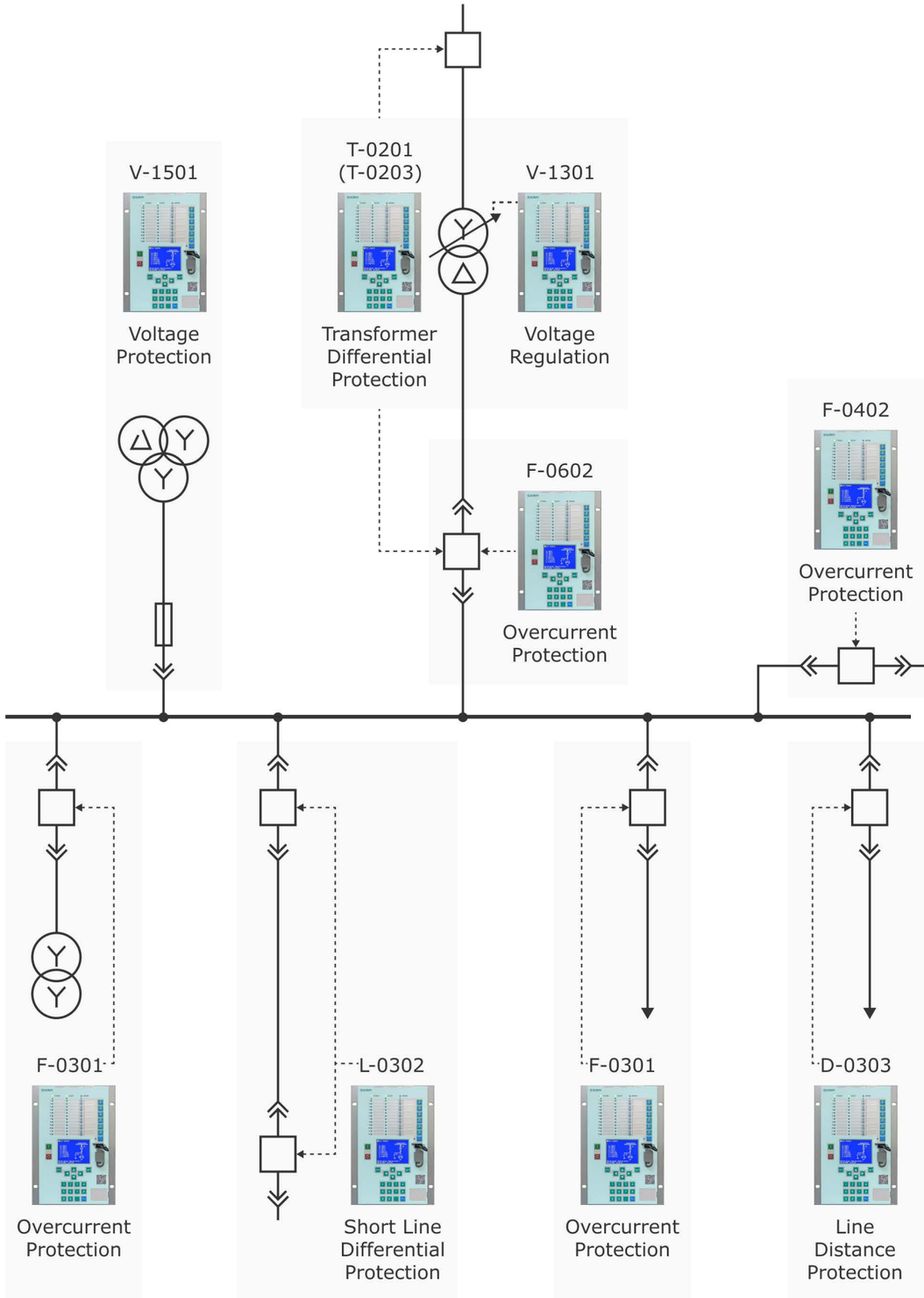
This function can:

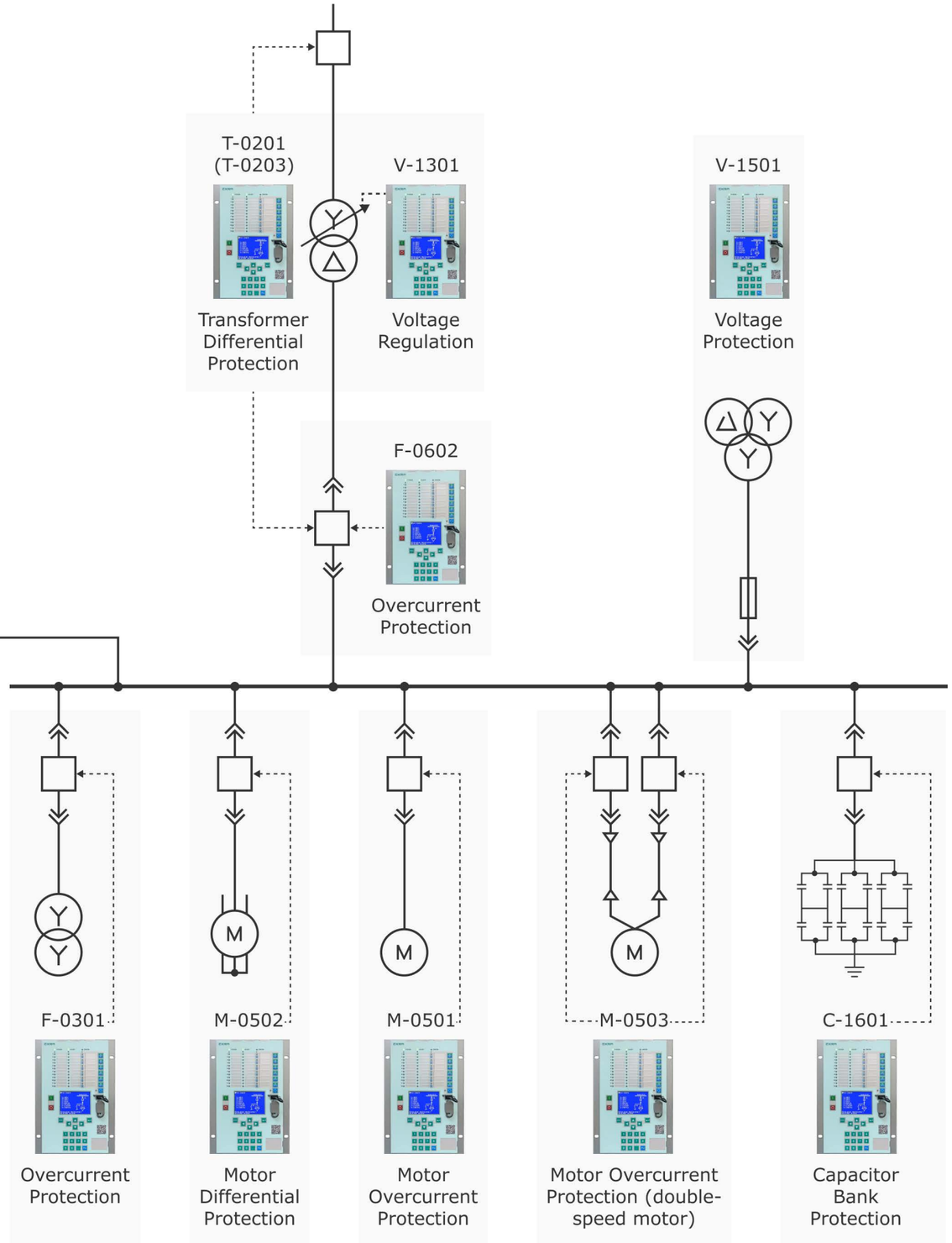
- register time of closing/opening with registration of the switched current for each phase separately;
- register the time of breaker being in on/off state;
- calculate the breaker life and provide information about the breaker remaining life (phase-by-phase);
- calculate the full time of breaker’s opening/closing, considering the time of open/close command issuing till removal/supply of power to coil.

The ED2 devices provide comprehensive functionality and can be implemented in a wide range of MV applications:

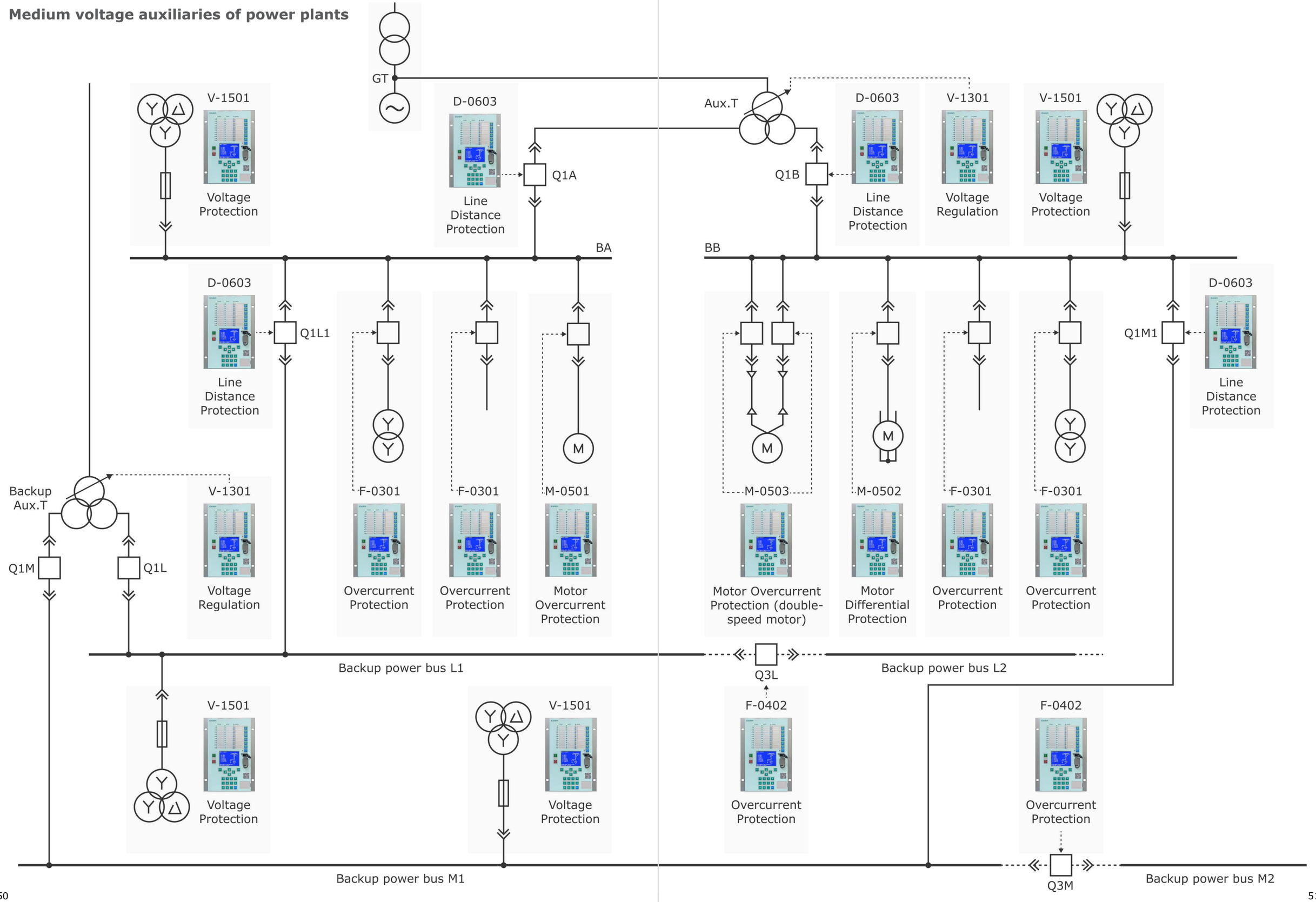
- Substations;
- Auxiliaries of power plants;
- Power generating units of enterprises;
- Industrial enterprises.

Medium voltage switchgears of substations





Medium voltage auxiliaries of power plants



Specifications

POWER SUPPLY			
Rated voltage of power supply, V	DC	110 / 125 220 / 250	
	AC	220	
Operating range, % from Ur		± 20	
Power consumption, max W		30	
IED readiness time after power supply, max s	readiness of RPA functions	1	
	device full readiness	30	
Fuse in power supply circuits, A		5	
Inrush current at energizing, max A		20 (during 10 ms)	

ANALOG INPUTS				
Total amount of analog inputs, max pcs		12		
Rated frequency, Hz		50 (60)		
Operating range of frequencies, Hz		45-55 (54-66)		
Rated value of current inputs, A	relay circuits	1 / 5 (set via program)		
	earth-fault protection circuits	0.2 / 0.6 0.05 / 0.15		
Thermal resistance of current inputs, A	relay circuits	100×Ir (during 1 s) 5×Ir (continuous)		
	earth-fault protection circuits	30 A (during 10 s) 10×Ir (continuous)		
Fundamental error of current measurement, no more	Range	(0.05 – 1.2)×Ir	(1.2 – 40)×Ir	
	Value	0.5%	1.0%	
Operating range of current circuits	relay circuits	(0.05 – 40)×Ir		
	earth-fault protection circuits	(0.005-2.5)×Ir (for Ir = 0.2 / 0.6 A) (0.05 – 40)×Ir (for Ir = 0.05 / 0.15 A)		
Dynamic withstand of current relay inputs, A		1250 (during 10 ms)		
Power consumption of current inputs, max VA		0.5		
Rated value of voltage inputs, V		100 – 120 (set via program)		
Operating range of input voltages, V		0 – 264		
Fundamental error of voltage measurement, no more	Range	0.3 – 5.77V	5.77 – 250V	250 – 264V
	Value	1.5%	0.5%	1.5%
Maximum permissible input voltage		400 V – 10 s 300 V – continuous		
Power consumption of voltage inputs, max VA		0.1 at Ur		

BINARY INPUTS			
Quantity, pcs		24 (32)	
Rated voltage, V	DC	24 48 110 / 125 220 / 250	
	AC	220	
Actuation voltage, V	DC	(0.72 – 0.76)×Ur	
	AC	0.73×Ur	
Reset voltage, V	DC	(0.67 – 0.7)×Ur	
	AC	0.55×Ur	
Current consumption in actuated state, mA		~2	
Resistance in non-actuated state, kOhm		~20	
Own actuation time (without time delays), ms		5	
Current pulse at Ur supply, mA		~40	
Maximum permissible input voltage, V		300 at Ur = 220 / 250	
Adjustable range of time offset from interferences, ms		0.0 – 9999	

BINARY OUTPUTS			
Maximum quantity, pcs		24 (16)	
Actuation time, ms		10 (max)	
Reset time, ms		5 (max)	
Thermal resistance of contacts, A		10 (continuous)	
		30 (during 0.2 s)	
Switching capacity of contacts	resistive load	making	2000 VA (250 VAC, 8 A, 50000 cycles), 75 W (250 VDC, 0.3 A)
		breaking	
	inductive load	making	L/R = 50 ms: 2200 W (220 VDC, 10 A) (during 1.0 s) 3300 W (220 VDC, 15 A) (during 0.3 s) 6600 W (220 VDC, 30 A) (during 0.2 s) 8800 W (220 VDC, 40 A) (during 0.03 s)
		breaking	L/R = 20 ms: 30 W (220 VDC, 0.14 A, 10000 cycles) L/R = 50 ms: 55 W (220 VDC, 0.25 A, 2000 cycles)

COMMUNICATION INTERFACES		
Number of RS-485 ports, pcs		2
Number of Ethernet ports, pcs	for configuration	1 – RJ45
	for communication	2 – RJ45 or LC (laser class 1)
Supported communication protocols		ModBus RTU ModBus TCP / IP IEC 60870-5-103 IEC 60870-5-104 IEC 61850-8-1 (GOOSE, MMS)
Network redundancy protocol		Link redundancy, PRP redundancy

TIME SYNCHRONIZATION	
Hardware	PPS IRIG-B
Software	SNTP ModBus RTU ModBus TCP / IP IEC 60870-5-103 IEC 60870-5-104 PTPv2

HUMAN-MACHINE INTERFACE	
Display	3.5” color display with resolution of 320×240 pixels
LEDs	36, programmable three-color (red/green/orange)
Programmable pushbuttons (electronic switches), pcs	6 (12)

DISTURBANCE RECORDER	
Disturbance recording of analog signals, pcs	up to 64
Disturbance recording of binary and logic signals, pcs	up to 1024
Maximum disturbance record duration, s	150 for 22 analog and 128 binary signals
Quantity of waveforms saved in the device memory, pcs	minimum 30
Sampling rate of disturbance recorder, Hz	1200 or 2400 (specified during configuration)
Disturbance recordings format	COMTRADE 2013

EVENT RECORDER	
Quantity of event records, pcs	7500
Resolution capability of event recorder, ms	1
Maximum quantity of registered signals, pcs	1024

DESIGN DATA		
By its design, the ED2 series device in its industrial version is represented as a module frame		
Design type		1/3×19″
Dimensions, WxDxH, mm		192×232×276 (height 6U)
Weight, kg		max 8
Device mounting methods		flush mounting, flush mounting with reduced installation depth, stand-alone mounting
Protection against access to hazardous parts to IEC 60529		IP2X
Enclosure protection to IEC 60529	front side	IP54
	rear side	IP20

INSULATION CHARACTERISTICS OF DEVICE	
Insulation resistance	min 100 MOhm at 1000 VDC
Electric strength of insulation of all circuits, except for communication ports and time synchronization	2 kV 50 Hz 1 min
Electric strength of insulation of communication ports and time synchronization (isolated interfaces only)	500 V 50 Hz 1 min
Electric strength of insulation of all circuits, except for communication ports and time synchronization, at impulse voltage test	5 kV (peak)
Electric strength of insulation of communication ports and time synchronization, at impulse voltage test (isolated interfaces only)	1 kV (peak)
Resistance of protective equipotential bonding	< 0.1 Ohm

OPERATION CONDITIONS	
Ambient temperature, °C	-25 … +55
Long-term storage and transportation temperature, °C	-40 … +70
Relative humidity, % at +20°C	max 98
Altitude, m	up to 2,000
Environment	non-explosive without current-conducting dust, aggressive gases and vapors in insulation – and metal-damaging concentrations
Pollution degree	I (no pollution or only dry, non-conducting pollution)

MECHANICAL TESTS		
Standards		IEC 60255-21, IEC 60068
Vibration test (sinusoidal)		IEC 60255-21-1, class 2
Shock test (half-sinusoidal)	IEC 60255-21-2	strength class 1
		stability class 2
Long-term shock impacts		IEC 60255-21-2, class 1
Seismic tests		IEC 60255-21-3, class 2

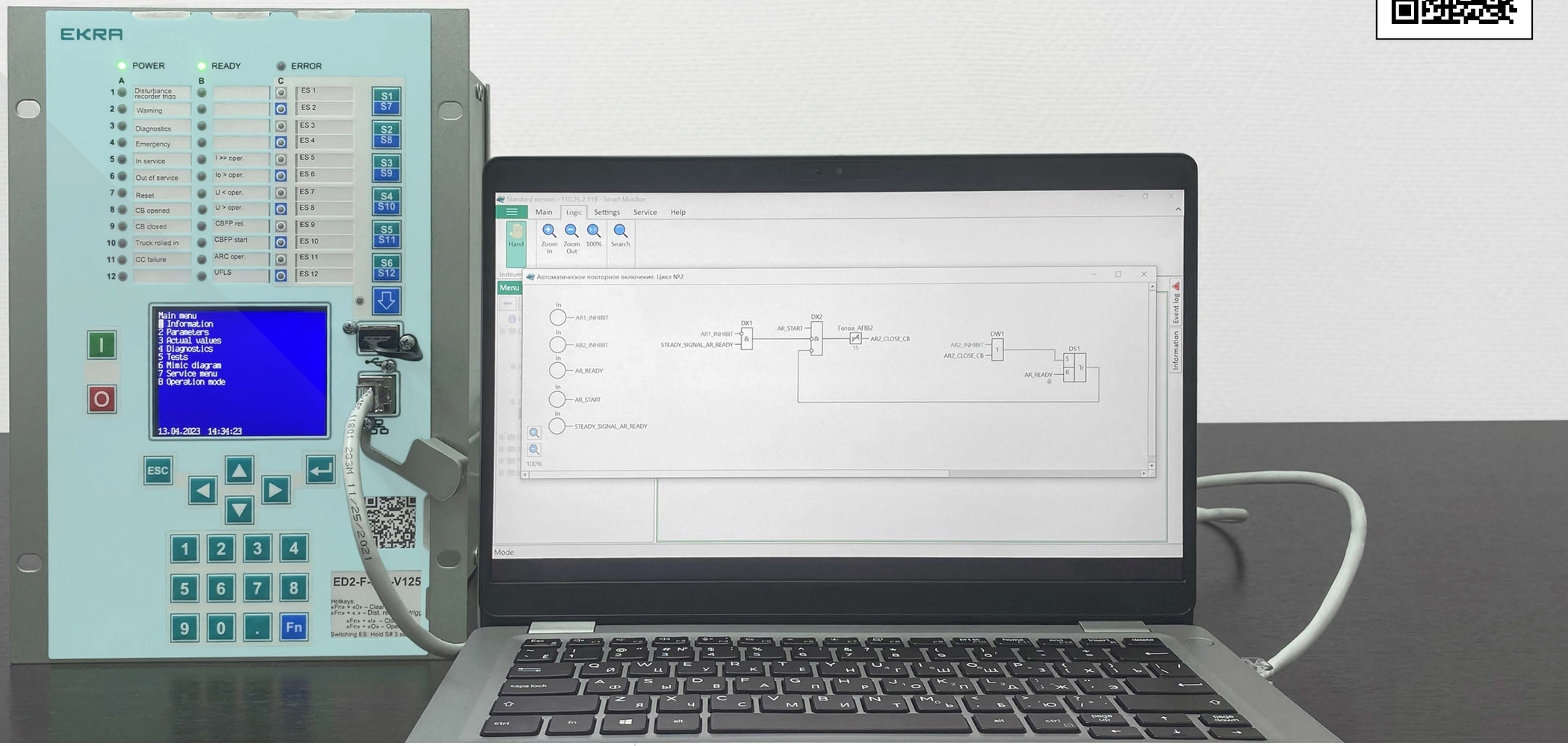
TESTS OF ELECTROMAGNETIC COMPATIBILITY	
Standards	IEC 60255-1 IEC 60255-27 IEC 61000-6-2
Testing for electrostatic discharge	IEC 61000-4-2
Testing for immunity to radiated radio-frequency electromagnetic field, frequency sweep / fixed frequencies	IEC 61000-4-3
Testing for immunity to electrical fast transient	IEC 61000-4-4
Testing for pulse overvoltage IEC 61000-4-5 (high energy microsecond impulse interference)	IEC 61000-4-5
Testing for immunity to conducted interference induced by radio-frequency electromagnetic fields, amplitude modulation / fixed frequencies	IEC 61000-4-6
Testing for resistance to power frequency magnetic field	IEC 61000-4-8
Pulsed magnetic field	IEC 61000-4-9
Testing for immunity to ring wave	IEC 61000-4-12
Testing for immunity to conducted interference at 50 Hz / in the frequency range from 0 to 150 kHz	IEC 61000-4-16
DC supply voltage ripple	IEC 61000-4-17
Testing for immunity to damped oscillatory waves	IEC 61000-4-18
Testing for dips and interruptions of DC power supply voltage	IEC 61000-6-5 IEC 61000-4-29

TESTS OF EMISSION	
Standards	IEC 60255-26 (product standards) IEC 61000-6-4 (main industry standards)
Conducted emissions on supply voltage lines	CISPR 22
Radiation	CISPR 11
	CISPR 22

ENVIRONMENTAL TESTS	
Testing at low temperatures	IEC 60068-2-1
Dry heat test	IEC 60068-2-2
Damp heat test, steady state	IEC 60068-2-78
Damp heat test, cyclic	IEC 60068-2-30

EKRASMS-SP SOFTWARE

Please, download EKRASMS-SP software complex from soft.ekra.ru or scan the QR-code



EKRASMS-SP software complex

EKRASMS-SP software complex is a set of software tools for configuration and operation of all ED2 series devices.

Automated workstations (AWs) are created on the basis of EKRASMS-SP software complex and additional equipment for local networking.

EKRASMS-SP is supllied together with ED2 IEDs and includes the following:

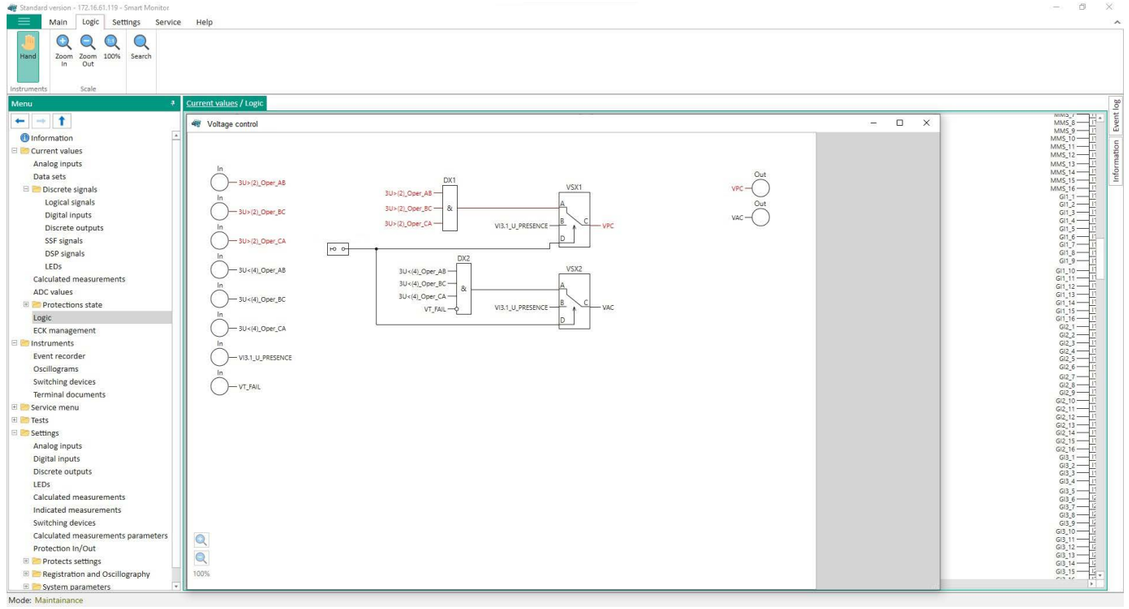
- ✓ **Health Monitor** – software for supervision of connected ED2 devices, and automatical downloading and mergeing waveforms from different devices;
- ✓ **Smart Monitor** – software for online access and setting the devices;
- ✓ **Configurator** – software for offline configuration of devices;
- ✓ **Waves** – software for viewing and analyzing waveforms.

Health Monitor software features:

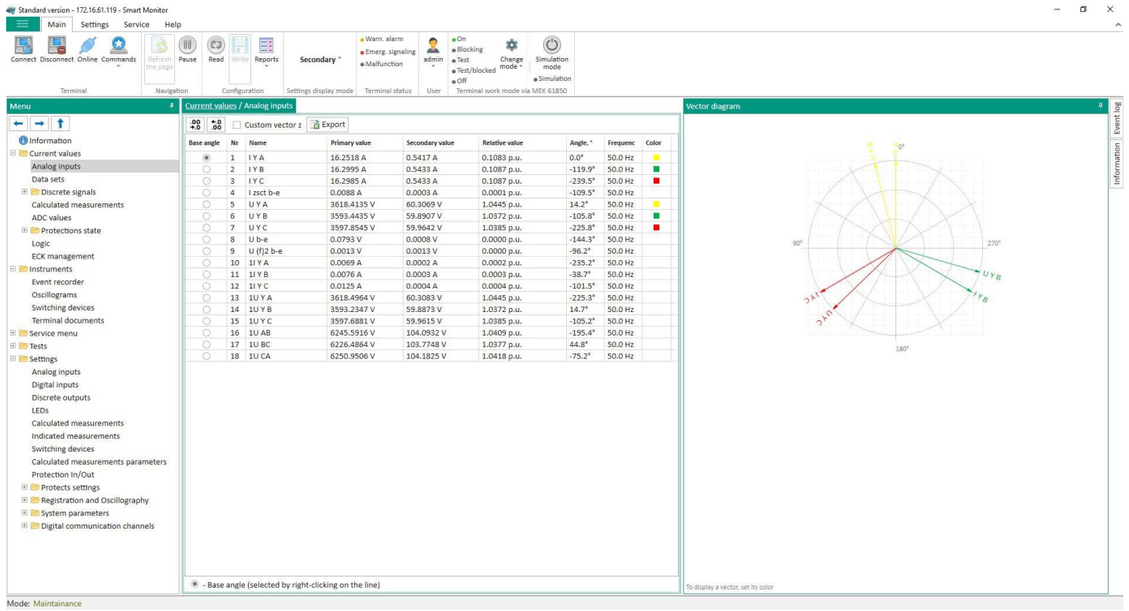
- ✓ Monitoring the state of ED2 devices in the network;
- ✓ Automatic downloading of waveforms to server and sending them via email;
- ✓ Automatic and manual merging of waveforms.

Smart Monitor software features:

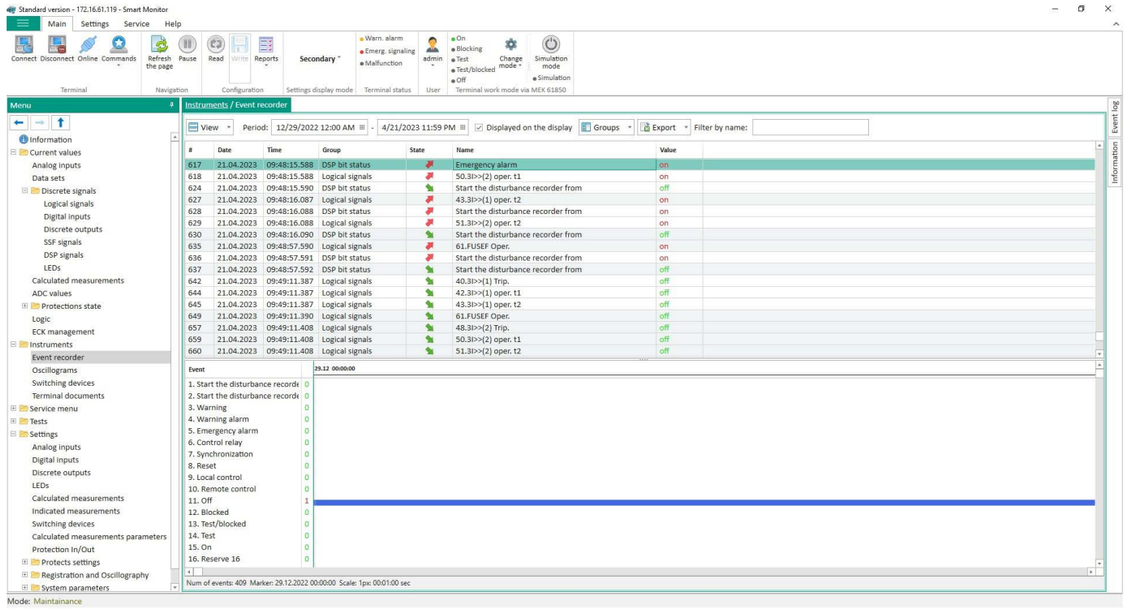
- ✓ Monitoring and displaying of measured and calculated actual values;
- ✓ Viewing, changing and saving of settings in IED;
- ✓ Real-time logic viewing;
- ✓ Emulation of protection and function logics;
- ✓ Signal emulation for Automation System;
- ✓ Connection to the device fault recorder and event recorder.



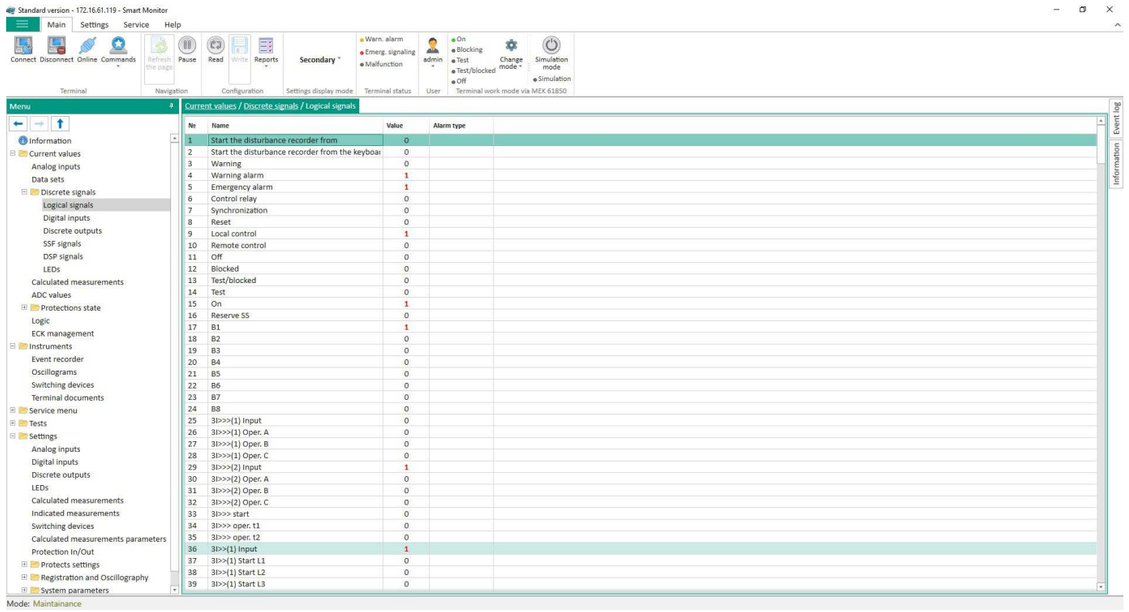
Actual state of programmable logic in Smart Monitor



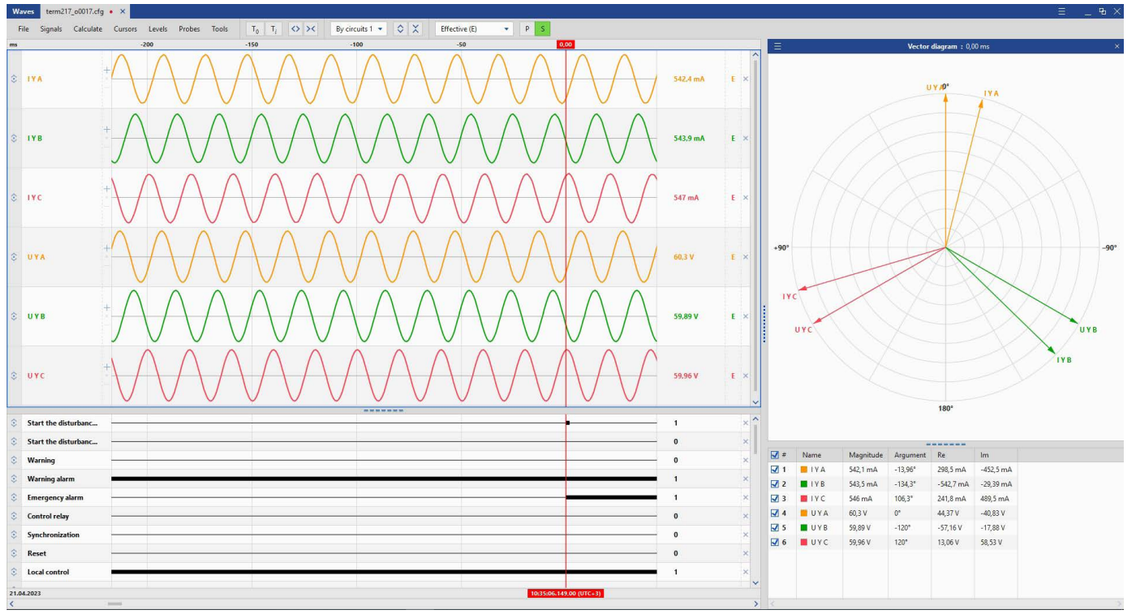
Viewing of measured and calculated analog values in Smart Monitor



Event recorder in Smart Monitor



Actual values of binary signals in Smart Monitor



Waves-assisted analysis of waveforms

Configurator program features (offline configuration):

- ✓ Viewing, changing and saving of settings;
- ✓ Configuration of protections logic and their connections;
- ✓ Setting displayed mimic diagram;
- ✓ Setting communication and time synchronization.

Waves features:

- ✓ Opening any waveforms in COMTRADE format;
- ✓ Viewing graphs and phasor diagrams of measured and calculated analog values and binary signals, performing mathematical operations with them;
- ✓ Synchronizing diagrams from different sources, superimposition and joining of several waveforms.

Integration into Automation System

Integration of ED2 device into Automation System allows upgrading the automation system level, thus improving the efficiency and reliability of the power system.

Interaction with Automation System ensures:

- transmission of measured and calculated parameters of the active mode and state of the monitored and protected equipment;
- transmission of emergency waveforms;
- transmission of event log data;
- transmission of interlocking signals;
- transmission of digital information (data on device actuations, self-diagnostics);
- receipt and execution of Automation System control commands.

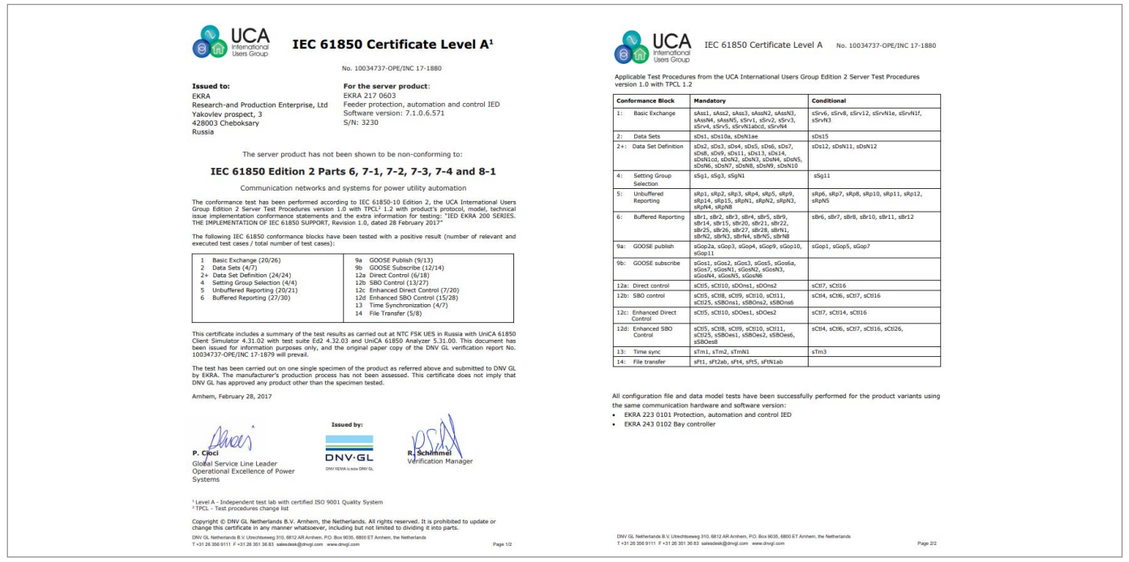
ED2 devices can integrate to Automation System via RS-485 and Ethernet. High data reception and transmission rates allow ED2 to quickly react to changes and events.

A vast variety of supported communication and time synchronization protocols allows flexible configuration of ED2, customizing for operation in different conditions, in compliance to the specific production requirements and integration of the device into other systems.

ED2 device supports the following data exchange and time synchronization protocols:

PROTOCOL	COMMUNICATION INTERFACE		TIME SYNCHRONIZATION
	RS-485	ETHERNET	
Modbus RTU	Primary/Secondary	-	+
Modbus TCP	-	Client/Server	+
IEC 60870-5-103	Primary/Secondary	-	+
IEC 60870-5-104	-	Server	+
IEC 61850-8-1 (MMS)	-	Client/Server	-
IEC 61850-8-1 (GOOSE)	-	Publisher/Subscriber	-
IEC 61850-9-2LE	-	Subscriber	-
PTPv2*	-	Client	+
SNTP*	-	Client	+

*Time synchronization only



IEC 61850 Certificate Level A[1]

No. 10034737-OPE/INC 17-1880

Issued to:
EKRA
Research-and Production Enterprise, Ltd
Yakovlev prospect, 3
428003 Cheboksary
Russia

For the server product:
EKRA 217 0603
Feeder protection, automation and control IED
Software version: 7.1.0.6.571
S/N: 3230

The server product has not been shown to be non-conforming to:

IEC 61850 Edition 2 Parts 6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems for power utility automation

The conformance test has been performed according to IEC 61850-10 Edition 2, the UCA International Users Group Edition 2 Server Test Procedures version 1.0 with TPCL[2] 1.2 with product's protocol, model, technical issue implementation conformance statements and the extra information for testing: "IED EKRA 200 SERIES. THE IMPLEMENTATION OF IEC 61850 SUPPORT, Revision 1.0, dated 28 February 2017"

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases):

1 Basic Exchange (20/26)	9a GOOSE Publish (9/13)
2 Data Sets (4/7)	9b GOOSE Subscribe (12/14)
2+ Data Set Definition (24/24)	12a Direct Control (6/18)
4 Setting Group Selection (4/4)	12b SBO Control (13/27)
5 Unbuffered Reporting (20/21)	12c Enhanced Direct Control (7/20)
6 Buffered Reporting (27/30)	12d Enhanced SBO Control (15/28)
	13 Time Synchronization (4/7)
	14 File Transfer (5/8)

This certificate includes a summary of the test results as carried out at NTC FSK UES in Russia with UniCA 61850 Client Simulator 4.31.02 with test suite Ed2 4.32.03 and UniCA 61850 Analyzer 5.31.00. This document has been issued for information purposes only, and the original paper copy of the DNV GL verification report No. 10034737-OPE/INC 17-1879 will prevail.

The test has been carried out on one single specimen of the product as referred above and submitted to DNV GL by EKRA. The manufacturer's production process has not been assessed. This certificate does not imply that DNV GL has approved any product other than the specimen tested.

Arnhem, February 28, 2017

Issued by:

P. Cioci
Global Service Line Leader
Operational Excellence of Power Systems

DNV·GL

R. Schimmel
Verification Manager

[1] Level A - Independent test lab with certified ISO 9001 Quality System
[2] TPCL - Test procedures change list

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UCA International Users Group — IEC 61850 Certificate Level A No. 10034737-OPE/INC 17-1880

Applicable Test Procedures from the UCA International Users Group Edition 2 Server Test Procedures version 1.0 with TPCL 1.2

Conformance Block	Mandatory	Conditional
1: Basic Exchange	sAss1, sAss2, sAss3, sAssN2, sAssN3, sAssN4, sAssN5, sSrv1, sSrv2, sSrv3, sSrv4, sSrv5, sSrvN1aBcd, sSrvN4	sSrv6, sSrv8, sSrv12, sSrvN1e, sSrvN1f, sSrvN3
2: Data Sets	sDs1, sDs10a, sDsN1ae	sDs15
2+: Data Set Definition	sDs2, sDs3, sDs4, sDs5, sDs6, sDs7, sDs8, sDs9, sDs11, sDs13, sDs14, sDsN1cd, sDsN2, sDsN3, sDsN4, sDsN5, sDsN6, sDsN7, sDsN8, sDsN9, sDsN10	sDs12, sDsN11, sDsN12
4: Setting Group Selection	sSg1, sSg3, sSgN1	sSg11
5: Unbuffered Reporting	sRp1, sRp2, sRp3, sRp4, sRp5, sRp9, sRp14, sRp15, sRpN1, sRpN2, sRpN3, sRpN4, sRpN8	sRp6, sRp7, sRp8, sRp10, sRp11, sRp12, sRpN5
6: Buffered Reporting	sBr1, sBr2, sBr3, sBr4, sBr5, sBr9, sBr14, sBr15, sBr20, sBr21, sBr22, sBr25, sBr26, sBr27, sBr28, sBrN1, sBrN2, sBrN3, sBrN4, sBrN5, sBrN8	sBr6, sBr7, sBr8, sBr10, sBr11, sBr12
9a: GOOSE publish	sGop2a, sGop3, sGop4, sGop9, sGop10, sGop11	sGop1, sGop5, sGop7
9b: GOOSE subscribe	sGos1, sGos2, sGos3, sGos5, sGos6a, sGos7, sGosN1, sGosN2, sGosN3, sGosN4, sGosN5, sGosN6	
12a: Direct control	sCtl5, sCtl10, sDOns1, sDOns2	sCtl7, sCtl16
12b: SBO control	sCtl5, sCtl8, sCtl9, sCtl10, sCtl11, sCtl25, sSBOns1, sSBOns2, sSBOns6	sCtl4, sCtl6, sCtl7, sCtl16
12c: Enhanced Direct Control	sCtl5, sCtl10, sDOes1, sDOes2	sCtl7, sCtl14, sCtl16
12d: Enhanced SBO Control	sCtl5, sCtl8, sCtl9, sCtl10, sCtl11, sCtl25, sSBOes1, sSBOes2, sSBOes6, sSBOes8	sCtl4, sCtl6, sCtl7, sCtl16, sCtl26,
13: Time sync	sTm1, sTm2, sTmN1	sTm3
14: File transfer	sFt1, sFt2ab, sFt4, sFt5, sFtN1ab	

All configuration file and data model tests have been successfully performed for the product variants using the same communication hardware and software version:
- EKRA 223 0101 Protection, automation and control IED
- EKRA 243 0102 Bay controller

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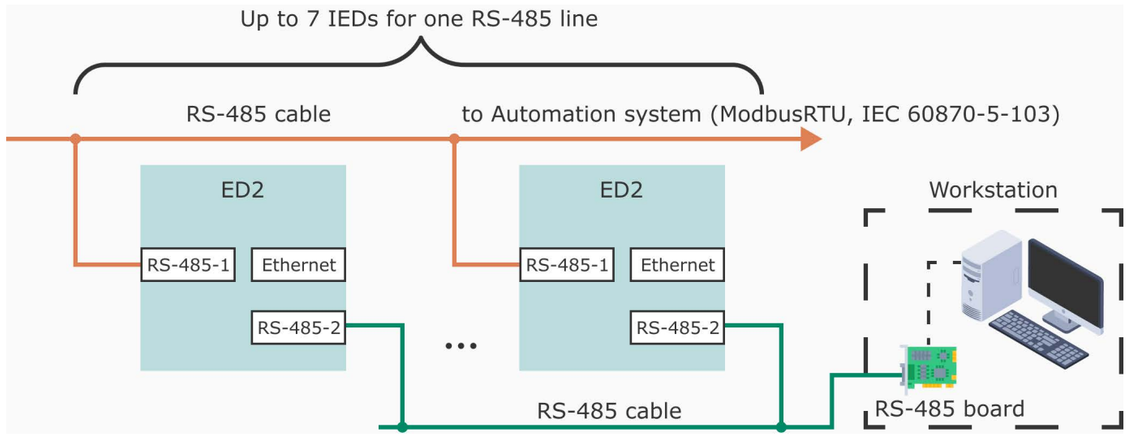
IEC 61850 Certificate

ED2 devices support software or software-hardware time synchronization. This ensures accuracy and conformity of time stamps, used for coordination of actions between different RPA devices. If software time synchronization is applied, its accuracy depends on the network configuration and is typically up to 500 ms.

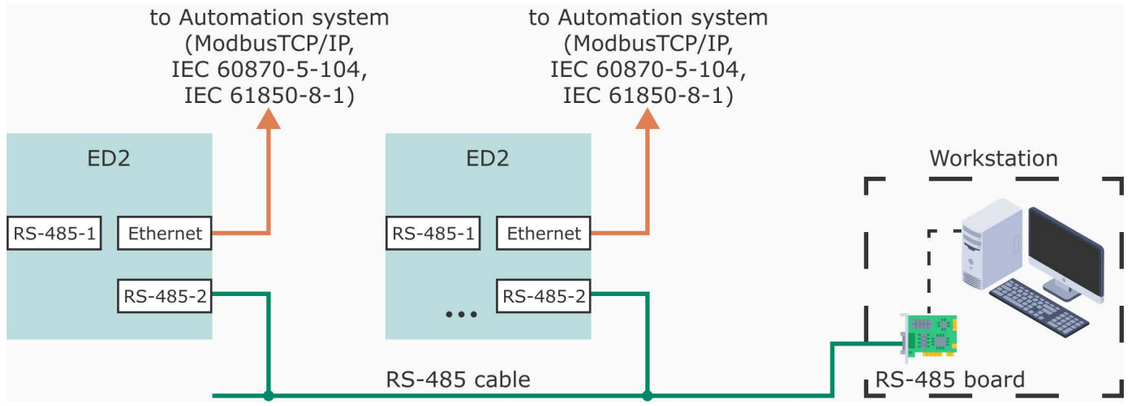
Synchronization accuracy of up to 1 ms is ensured by application of:
- hardware synchronization signals PPS or IRIG-B 003 in addition to software synchronization;
- hardware synchronization signals IRIG-B 007;
- software synchronization PTPv2.

ED2 devices support PRP and LinkBackup network redundancy to provide reliable and secure data transfer via Ethernet. The backup communication channel is created, which enables in case of main communication channel failure. Thus, uninterrupted operation of systems is ensured.

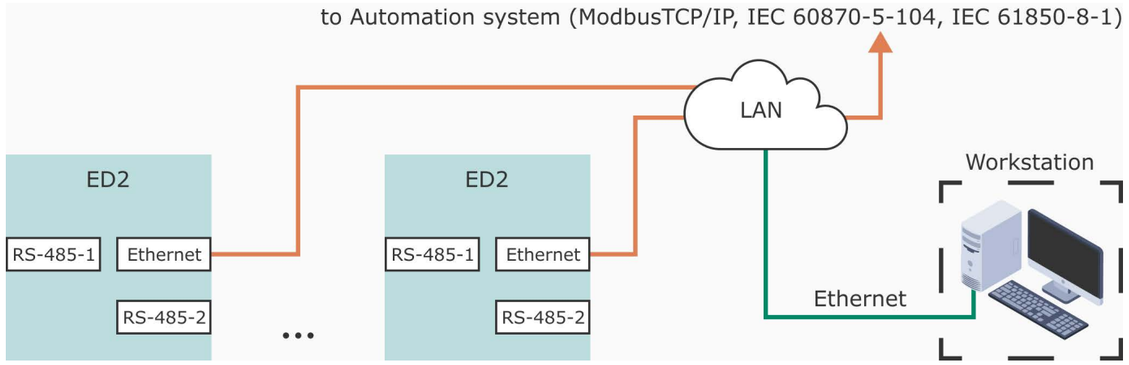
ED2 integration examples



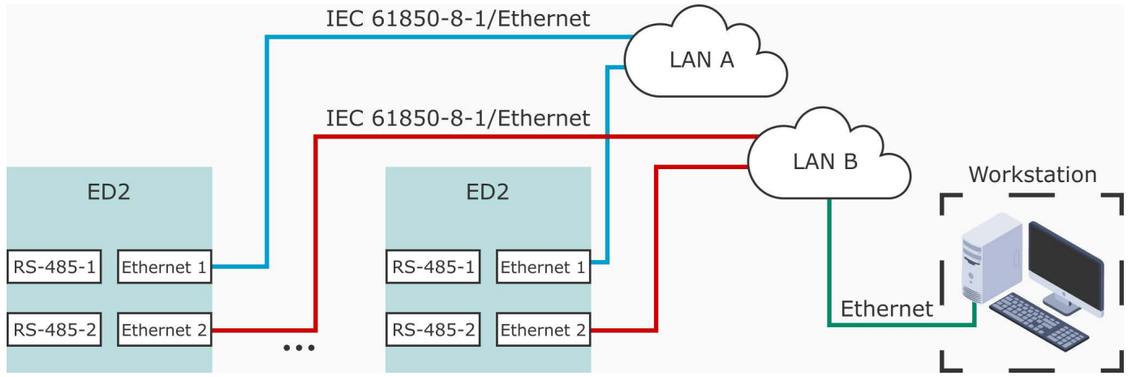
Interaction of ED2 with automation system and AW via RS-485 interface



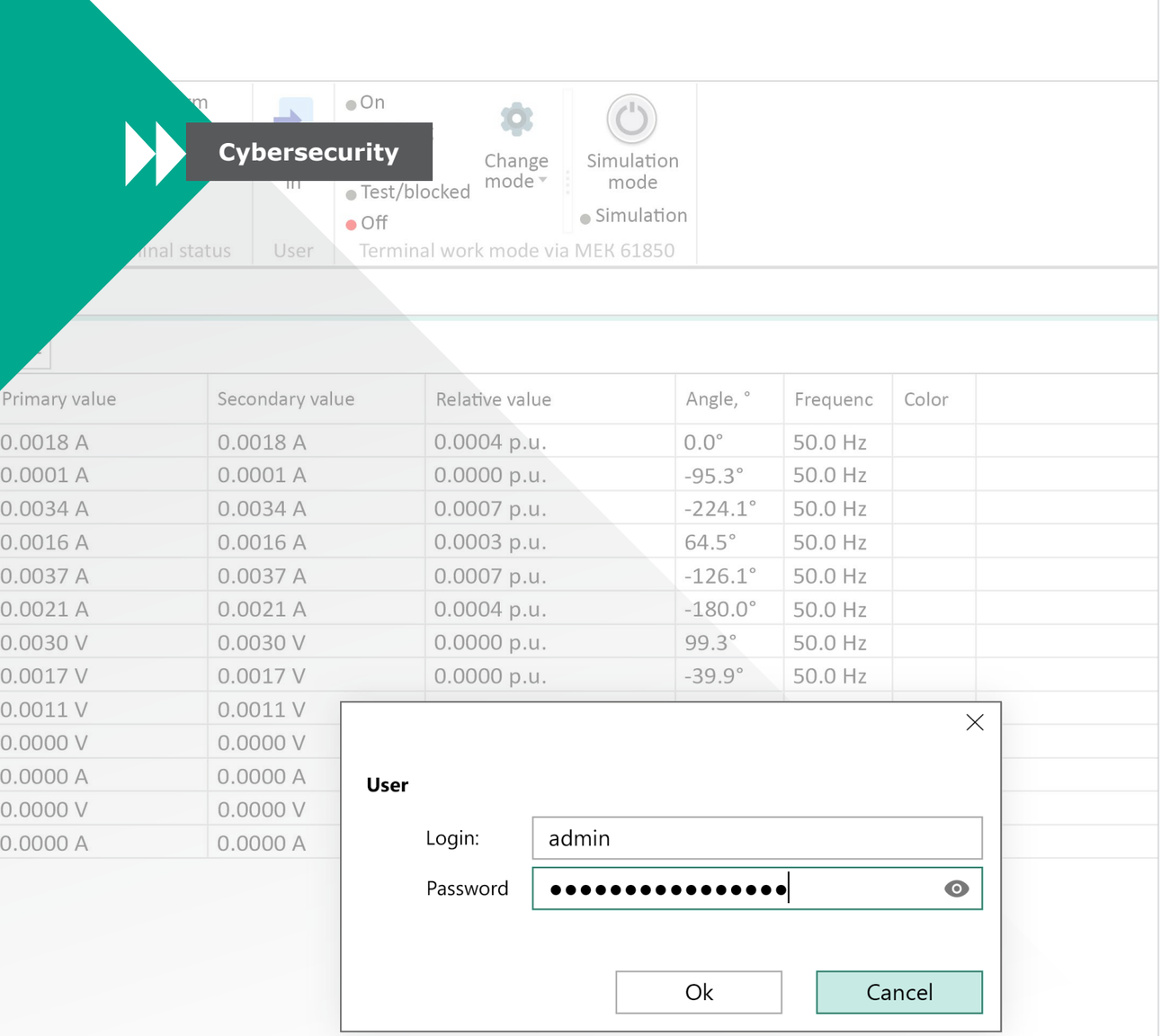
Interaction of ED2 with AW via RS-485 interface and automation system via Ethernet



Interaction of ED2 with automation system and AW via Ethernet



Interaction of ED2 with automation system via IEC 61850-8-1 with a duplicated Ethernet communication channel and with AW via Ethernet.



With the development of communication networks and integration of devices in them, cybersecurity becomes more and more important.

ED2 devices were developed considering the protection from cyber attacks, thanks to multi-level authentication and constant registering of attempts to access the device.

Authentication

For connection to the device, use Smart Monitor program, that ensures the integrity and confidentiality of transmitted data. Other programs do not allow access to the device and read or record data in them. This helps to prevent unauthorized access and manipulations with data.

Establishing connection after password check

Password for access can be set in the device, if needed. Remote access will be possible only after entering password by a user. The user will get access to read/ record data from device only after connection establishment. Authentication data are not openly transmitted via the network.

User access rights differentiation

Limitation of access for operating personnel to device configuration is made by several access levels (or roles), which are set by the user (administrator). User (administrator) can set the validity period of every user password, which increases the cyber security level by regular password changing. Every access level has permissible parallel connection checking, if its number is surpassed, every subsequent connection is blocked.

Security system events recording

Failed and unauthorized attempts of access are registered in special security log. This log has protection from deleting and can be viewed only by administrator.

Protection of files integrity

When loading files using Smart Monitor, these files are checked for unique identifiers, confirming their permission for loading. In case of mismatching identifiers, files loading to device is prohibited.

Extra safety measures

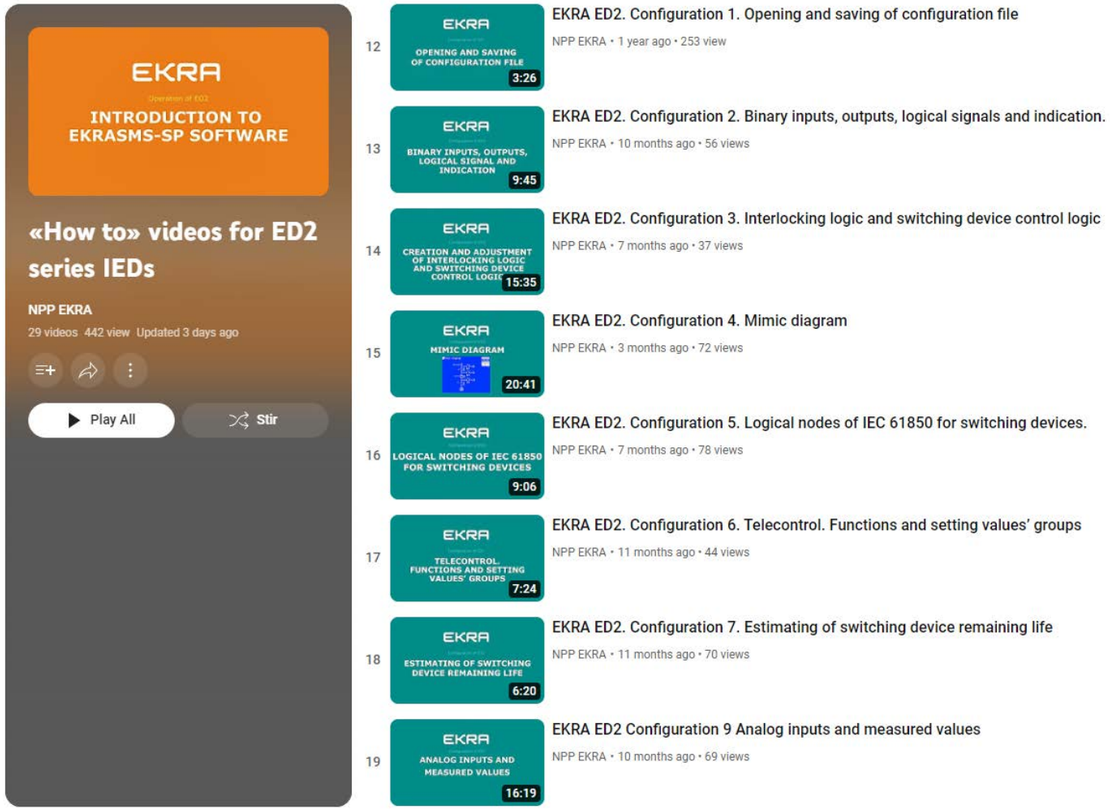
Cyber security should include external protection measures, such as:

1. Local network segmentation to separate VLANs;
2. Disconnection of unused active networking equipment services.

EKRA training center is a high-tech and well-equipped platform, where the theory and practice are presented by highly skilled teachers with a long experience in the electric power industry.

The purpose of training is to help learners to gain knowledge and skills necessary for commissioning, maintenance and operation of EKRA equipment.

Services – Training



YouTube channel of EKRA RPE Ltd. provides video tutorials on operation with ED2 devices. For convenience, video tutorials are grouped into the following categories:

- **Operation.** This category is provided for operation and maintenance personnel of facilities;
- **Configuration.** These video will be useful for maintenance personnel and start-up and adjustment organizations, when configuring IED for a specific project;
- **Testing.** This category contains video instructions on testing and checking of ED2 devices.

Video tutorials on operation with ED2 IED

State-of-the-art ED2 protection and control devices have successfully proven themselves with high reliability and flexible functionality.

Today, more than **7,000** IEDs for medium voltage are used in more than **400** power facilities and industrial plants, including **6** nuclear power plants.

Scan the QR-code to find more information on our website

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