Tripping units "Smart Unit" +SU

- **Tripping units SU for ACBs line Ex9A**
- **Selected and ordered separately, delivered as premounted accessory in the ACB only**
- **32-bit DSP technology**
- **SU3.0 series with LSI protection**
  SU4.0 series with LSIG protection
- **LCD display for all versions, coloured indication of status for variants A, P and H**
- **Optional communication function**
- **Wide range of other protective and alarm functions**
- **Net analysing possibility**

The Smart Units (SU) for Ex9A air circuit breaker series are the most advance and versatile tripping unit from the whole portfolio, they bring modern state of the art digital technology to measure, analyze and protect against different type of problems that may occur in any industrial as well as commercial application on which the biggest accuracy, reliability and flexible control is required.

These SU are offered in many types to fit in any installation requirement. According to the protective functionalities they are categorized as:

- SU3.0: Basic protective unit with Long overload, Short overload and Instantaneous protection (LSI). It also implements and additional optional inverse time Short overload protection (LSSdI) for all the 3 or 4 poles.
- SU4.0: Smart unit with built in protections from 3.0 with an additional Ground fault protection (LSI-G). This additional protective function can be achieved by software calculations or by an external current transformer attached to the ground connection. This unit is helpful in applications that requires control of the leakage current on ground conductors, such as transformer stations. The G protection is adjustable: (0.2 — 1.0) × I_n, with an optional inverse time protection setting.

According to the analyzing functionalities that the SU may have implemented, they are categorized as:

- SUx.xA: Amper-meter unit. Capable of measure and analyze the current that flows on all the poles, and react according to the configured warning thresholds and protective settings.
- SUx.xP: Power-meter unit. Capable of measure and analyze currents, voltages, phases, power direction and other network characteristics. It would be able to either protect and alert of any circumstance that exceeds the warning thresholds or the protective settings.
- SUx.xH: Harmonic analyzer unit. Capable of measuring the same things as the P and A type, with the addition of Harmonic analysis. Capable to alert and protect against any unwanted power network situation. This unit has premounted the advanced accessories +ZSI, +COM Modbus and +DO.
- The implementation of several software accessories increase even more the functionalities and possibilities that those controllers may provide, for example: Modbus communication, Digital Inputs/Outputs, ZSI among others.

The flexiblity of these units allows the Ex9A series to be according utilization type B breakers.

Certification marks

CE

The Smart Unit must always be ordered as a premounted accessory, therefore, it is only offered the premounted version in our catalogues. In case that any service spare part is required please contact our technical support team.

These units may be equipped with additional software accessories such as:

+COM Modbus: Communication interface Modbus RTU over RS485.

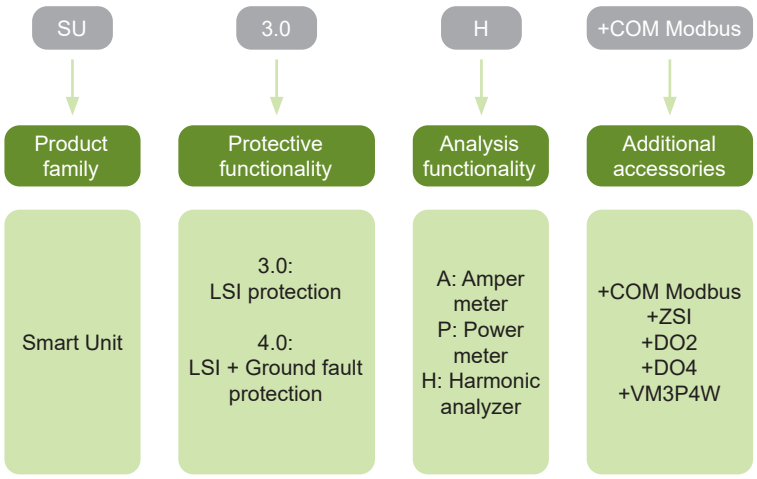
+ZSI: Zone Selective interlock. Software feature to coordinate several accessories and improve selectivity functionalities.

+DO2: Programmable Digital Outputs (2 outputs) for Smart Units equipped with +ZSI.

+DO4: Programmable Digital Outputs (4 outputs), this option is not compatible with the +ZSI feature.

+VM3P4W: Software option to enable the measurement and analysis on 3 Pole / 4 Wires installations.

Type Key



Certification marks

CE

Tripping units "Smart Unit" +SU

Measurement and analysis distribution table

	Function overview	Smart Unit measurement type		
		A	P	H
Protection functions	Overload protection	■	■	■
	Overload pre-alarm	■	■	■
	Short-circuit short delay protection	■	■	■
	Short-circuit instantaneous protection	■	■	■
	Ground-fault protection (4.0 only), alarm	■	■	■
	Earth leakage protection (5.0 only), alarm	■	■	■
	MCR & HSISC protection	■	■	■
	Unbalanced current protection, alarm	■	■	■
	Neutral conductor protection	■	■	■
	Temperature protection, alarm	■	■	■
	Thermal memory	■	■	■
	Overvoltage protection, alarm	–	■	■
	Undervoltage protection, alarm	–	■	■
	Unbalanced Voltage protection, alarm	–	■	■
	Over-frequency protection, alarm	–	■	■
	Under-frequency protection, alarm	–	■	■
	Phase rotation protection	–	■	■
	Reverse Power protection	–	■	■
	Harmonic Wave protection	–	–	■
Measurement functions	Current measurement	■	■	■
	Voltage measurement	–	■	■
	Frequency measurement	–	■	■
	Unbalanced Voltage measurement	–	■	■
	Phase rotation detection	–	■	■
	Power Factor measurement	–	■	■
	Electric energy measurement	–	■	■
	Harmonic Wave analysis	–	–	■
Maitenance functions	8 latest fault record	■	■	■
	8 latest alarm record	■	■	■
	8 latest operations record	■	■	■
	Historic current peak value	■	■	■
	Contact wear indication	■	■	■
	Operating cycles	■	■	■
	Clock function	■	■	■
	Self diagnosis	■	■	■
Optional	Zone Selective Interlock (ZSI)	–	–	■
	Communication function (Modbus)	–	–	■
	Programmable DO outputs	–	–	■

Smart Units A-type for Ex9A series

A-type - LSI protection with analysis of currents

- **Selective protection (LSI)**
- Monochrome LCD display for alarm and fault indication
- Real-time status indicator
- Load monitoring
- External power supply must be connected via secondary terminals (#1, 2). External power source enhace time accuracy and the reaction time against power grid faults.
- Setting range of tripping units SU (all versions):
  I_R = 0.4 - 1 x I_n
  I_{sd} = 1.5 - 10 x I_R
  I_i = 2 - 15 x I_n
- Fine setting of tripping parameters via LCD menu
- Protection functions (overload, short-circuit, unbalance, neutral conductor, temperature)
- Measurement functions (current, thermal)

Analysis type	Suitable frame size	Ext. power supply	Article No.	Type
Current	Ex9A16	230 V AC	112288	+SU30A 11 AC230
Current	Ex9A16	400 V AC	112289	+SU30A 11 AC400
Current	Ex9A16	24 V DC	112290	+SU30A 11 DC24
Current	Ex9A25	230 V AC	112306	+SU30A 12 AC230
Current	Ex9A25	400 V AC	112307	+SU30A 12 AC400
Current	Ex9A25	24 V DC	112308	+SU30A 12 DC24
Current	Ex9A32 / 40	230 V AC	112324	+SU30A 13 AC230
Current	Ex9A32 / 40	400 V AC	112325	+SU30A 13 AC400
Current	Ex9A32 / 40	24 V DC	112326	+SU30A 13 DC24

A-type - LSIG protection with analysis of currents

- **Selective protection (LSI) + Ground-fault protection (G)**
- Monochrome LCD display for alarm and fault indication
- Real-time status indicator
- Load monitoring
- External power supply must be connected via secondary terminals (#1, 2). External power source enhace time accuracy and the reaction time against power grid faults.
- Ground fault protection is realized as differential current calculation from the measurement of each of the poles independently.
- Setting range of tripping units SU (all versions):
  I_R = 0.4 - 1 x I_n
  I_{sd} = 1.5 - 10 x I_R
  I_i = 2 - 15 x I_n
- Fine setting of tripping parameters via LCD menu
- Protection functions (overload, short-circuit, unbalanced, neutral conductor, temperature, ground fault)
- Measurement functions (current, thermal)

Analysis type	Suitable frame size	Ext. power supply	Article No.	Type
Current	Ex9A16	230 V AC	112291	+SU40A 11 AC230
Current	Ex9A16	400 V AC	112292	+SU40A 11 AC400
Current	Ex9A16	24 V DC	112293	+SU40A 11 DC24
Current	Ex9A25	230 V AC	112309	+SU40A 12 AC230
Current	Ex9A25	400 V AC	112310	+SU40A 12 AC400
Current	Ex9A25	24 V DC	112311	+SU40A 12 DC24
Current	Ex9A32 / 40	230 V AC	112327	+SU40A 13 AC230
Current	Ex9A32 / 40	400 V AC	112328	+SU40A 13 AC400
Current	Ex9A32 / 40	24 V DC	112329	+SU40A 13 DC24

Smart Units P-type for Ex9A series

P-type - LSI protection with analyses of currents, voltages and powers

- **Selective protection (LSI)**
- Three-colour backlight LCD display for alarm and fault indication
- Real-time status indicator
- Load monitoring
- External power supply must be connected via secondary terminals (#1, 2). External power source enhace time accuracy and the reaction time against power grid faults.
- Setting range of tripping units SU (all versions):
  I_R = 0.4 - 1 x I_n
  I_{sd} = 1.5 - 10 x I_R
  I_i = 2 - 15 x I_n
- Fine setting of tripping parameters via LCD menu
- For voltage based measurement and analyses, system voltages must be connected to secondary terminals #24-27
- Protection functions (overload, short-circuit, unbalance, neutral conductor, temperature, overvoltage, undervoltage, voltage unbalance, frequency, phase sequence, reverse power protection)
- Measurement functions (current, thermal, voltage, frequency, phase, power factor, electric energy)
- If voltage based measurement and analyses are intended to be performed by 3P ACB in 4wire system, please add item +VM-3P4W to ordered ACB

Analysis type	Suitable frame size	Ext. power supply	Article No.	Type
Power	Ex9A16	230 V AC	112294	+SU30P 11 AC230
Power	Ex9A16	400 V AC	112295	+SU30P 11 AC400
Power	Ex9A16	24 V DC	112296	+SU30P 11 DC24
Power	Ex9A25	230 V AC	112312	+SU30P 12 AC230
Power	Ex9A25	400 V AC	112313	+SU30P 12 AC400
Power	Ex9A25	24 V DC	112314	+SU30P 12 DC24
Power	Ex9A32 / 40	230 V AC	112330	+SU30P 13 AC230
Power	Ex9A32 / 40	400 V AC	112331	+SU30P 13 AC400
Power	Ex9A32 / 40	24 V DC	112332	+SU30P 13 DC24

P-type - LSIG protection with analyses of currents, voltages and powers

- **Selective protection (LSI) + Ground-fault protection (G)**
- Three-colour backlight LCD display for alarm and fault indication
- Real-time status indicator
- Load monitoring
- External power supply must be connected via secondary terminals (#1, 2). External power source enhace time accuracy and the reaction time against power grid faults.
- Ground fault protection is realized as differential current calculation from the measurement of each of the poles independently.
- Setting range of tripping units SU (all versions):
  I_R = 0.4 - 1 x I_n
  I_{sd} = 1.5 - 10 x I_R
  I_i = 2 - 15 x I_n
- Fine setting of tripping parameters via LCD menu
- For voltage based measurement and analyses, system voltages must be connected to secondary terminals #24-27
- Protection functions (overload, short-circuit, unbalance, neutral conductor, temperature, overvoltage, undervoltage, voltage unbalance, frequency, phase sequence, reverse power protection)
- Measurement functions (current, thermal, voltage, frequency, phase, power factor, electric energy)
- If voltage based measurement and analyses are intended to be performed by 3P ACB in 4wire system, please add the item +VM3P4W to ordered ACB

Analysis type	Suitable frame size	Ext. power supply	Article No.	Type
Power	Ex9A16	230 V AC	112297	+SU40P 11 AC230
Power	Ex9A16	400 V AC	112298	+SU40P 11 AC400
Power	Ex9A16	24 V DC	112299	+SU40P 11 DC24
Power	Ex9A25	230 V AC	112315	+SU40P 12 AC230
Power	Ex9A25	400 V AC	112316	+SU40P 12 AC400
Power	Ex9A25	24 V DC	112317	+SU40P 12 DC24
Power	Ex9A32 / 40	230 V AC	112333	+SU40P 13 AC230
Power	Ex9A32 / 40	400 V AC	112334	+SU40P 13 AC400
Power	Ex9A32 / 40	24 V DC	112335	+SU40P 13 DC24

Smart Units H-type for Ex9A series

H-type - LSI protection with complete net analysis

- **Selective protection (LSI)**
- Three-colour backlight LCD display for alarm and fault indication
- Real-time status indicator
- Load monitoring
- Premounted communication, ZSI function and programmable DO
- External power supply must be connected via secondary terminals (#1, 2). External power source enhace time accuracy and the reaction time against power grid faults.
- Setting range of tripping units SU (all versions):
  I_R = 0.4 - 1 x I_n
  I_{sd} = 1.5 - 10 x I_R
  I_i = 2 - 15 x I_n
- Fine setting of tripping parameters via LCD menu
- For voltage based measurement and analyses, system voltages must be connected to secondary terminals #24-27
- Protection functions (overload, short-circuit, unbalance, neutral conductor, temperature, overvoltage, undervoltage, voltage unbalance, frequency, phase sequence, reverse power protection, current/voltage harmonics (THD))
- Measurement functions (current, thermal, voltage, frequency, phase, power factor, electric energy, harmonics (THD))
- If voltage based measurement and analyses are intended to be performed by 3P ACB in 4wire system, please add item +VM-3P4W to ordered ACB

Analysis type	Suitable frame size	Ext. power supply	Article No.	Type
Harmonics	Ex9A16	230 V AC	112300	+SU30H 11 AC230
Harmonics	Ex9A16	400 V AC	112301	+SU30H 11 AC400
Harmonics	Ex9A16	24 V DC	112302	+SU30H 11 DC24
Harmonics	Ex9A25	230 V AC	112318	+SU30H 12 AC230
Harmonics	Ex9A25	400 V AC	112319	+SU30H 12 AC400
Harmonics	Ex9A25	24 V DC	112320	+SU30H 12 DC24
Harmonics	Ex9A32 / 40	230 V AC	112336	+SU30H 13 AC230
Harmonics	Ex9A32 / 40	400 V AC	112337	+SU30H 13 AC400
Harmonics	Ex9A32 / 40	24 V DC	112338	+SU30H 13 DC24

H-type - LSIG protection with complete net analysis

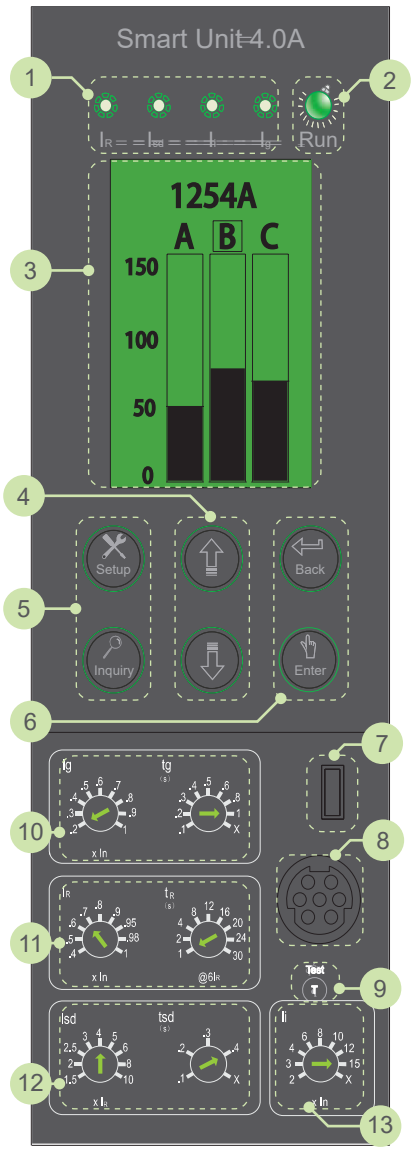
- **Selective protection (LSI) + Ground-fault protection (G)**
- Three-colour backlight LCD display for alarm and fault indication
- Real-time status indicator
- Load monitoring
- Premounted communication, ZSI function and programmable DO
- External power supply must be connected via secondary terminals (#1, 2). External power source enhace time accuracy and the reaction time against power grid faults.
- Ground fault protection can be realized as differential residual current function or source ground fault function. Source ground fault function requires a use of external transformer WEC (ordered separately). WEC transformer measures actual current through PE conductor (usually grounding of transformer neutral point).
- Ground fault by means of differential residual current as default. When source ground fault function with WEC is required, please add the item +GECT to ordered ACB.
- Setting range of tripping units SU (all versions):
  I_R = 0.4 - 1 x I_n
  I_{sd} = 1.5 - 10 x I_R
  I_i = 2 - 15 x I_n
- Fine setting of tripping parameters via LCD menu
- For voltage based measurement and analyses, system voltages must be connected to secondary terminals #24-27
- Protection functions (overload, short-circuit, unbalance, neutral conductor, temperature, overvoltage, undervoltage, voltage unbalance, frequency, phase sequence, reverse power protection, current/voltage harmonics (THD))
- Measurement functions (current, thermal, voltage, frequency, phase, power factor, electric energy, harmonics (THD))
- If voltage based measurement and analyses are intended to be performed by 3P ACB in 4wire system, please add the item +VM3P4W to ordered ACB

Analysis type	Suitable frame size	Ext. power supply	Article No.	Type
Harmonics	Ex9A16	230 V AC	112303	+SU40H 11 AC230
Harmonics	Ex9A16	400 V AC	112304	+SU40H 11 AC400
Harmonics	Ex9A16	24 V DC	112305	+SU40H 11 DC24
Harmonics	Ex9A25	230 V AC	112321	+SU40H 12 AC230
Harmonics	Ex9A25	400 V AC	112322	+SU40H 12 AC400
Harmonics	Ex9A25	24 V DC	112323	+SU40H 12 DC24
Harmonics	Ex9A32 / 40	230 V AC	112339	+SU40H 13 AC230
Harmonics	Ex9A32 / 40	400 V AC	112340	+SU40H 13 AC400
Harmonics	Ex9A32 / 40	24 V DC	112341	+SU40H 13 DC24

Technical Data Smart Units

General overview of the tripping units for ACBs

Smart Unit interface description

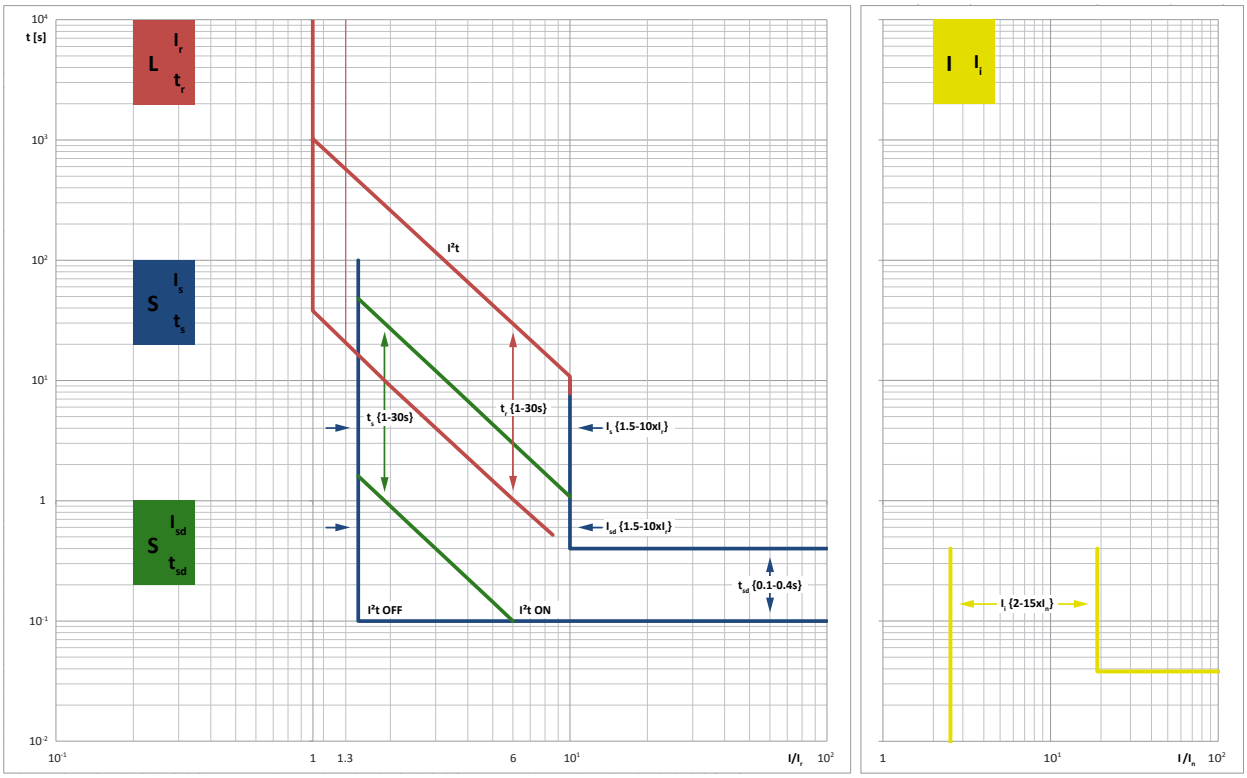


1	LED fault reason indicators (I_r, I_{sd}, I_i, I_g or $I_{\Delta n}$)
2	Running (real-time status) LED indicator
3	LCD
4	Navigation buttons
5	Setup and Review buttons
6	Enter and Back buttons
7	Lockhole of front transparent cover
8	Communication port for service and testing purposes
9	Test button (for tripping test and reset of alarm and protection functions)
10	Ground protection (I_g, t_g) setting buttons (SU 4.0) only Leakage protection ($I_{\Delta n}$, Δt) setting buttons (SU 5.0) only
11	Long-time delay (I_R, t_R) setting buttons
12	Short-circuit short delay current (I_{sd}, t_{sd}) setting buttons
13	Short-circuit instantaneous current (I_i) setting buttons

Technical Data Smart Units

General overview of the tripping units for ACBs

General overview of the LSI current characteristics



Long / Short / Instantaneous protection

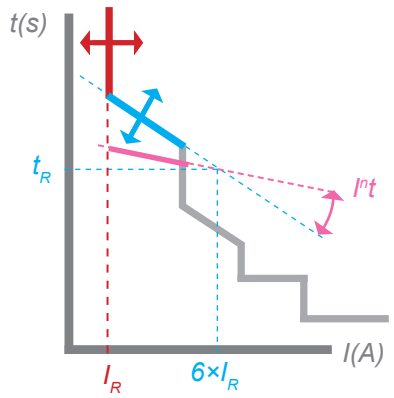
Long / Short / Instantaneous overload protection common to all the tripping units variants		
Ir	Long over-load	Initial value of the current on which the long overload protection will actuate. Range on power distribution unit: (0.4 — 1.0) × I_n
tr	Long over-load	Delay time for the long overload to trip when an overload is detected at 6 × I_R. Range on power distribution unit: 1 — 30 s
Is	Short over-load	Initial value of the current on which the short overload protection will be applied if "inverse time" option is ON. Range: 1.5 × I_R — 1.0 × I_{sd}
ts	Short over-load	Delay time to trip when a short overload is detected. This delay depends on the long overload delay setting with a ratio of: ts = t_R / 10
Isd	Short over-load	Initial value of the current on which the short overload protection will be applied. Range: 1.5 — 10 × I_R
tsd	Short over-load	Constant time delay for the short overload protection to trip. Range: 0.1 — 0.4 s
Ii	Instantane-ous protec-tion	Initial value of the current on which the instantaneous protection will actuate. Range: (2 — 15) × I_n

Technical Data Smart Units

Tripping units for ACBs

Long- time overload protection settings

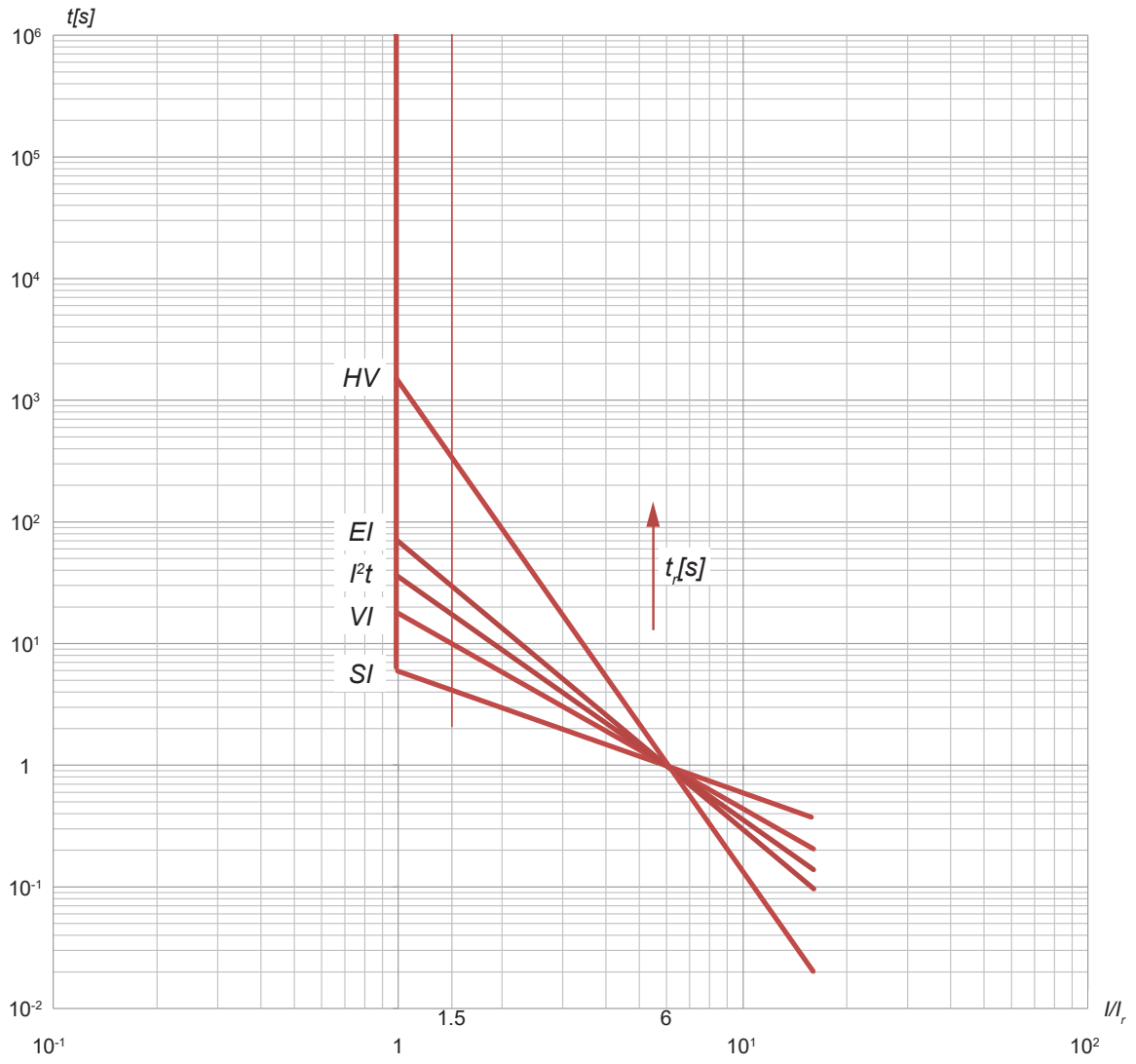
Current setting (power distribution)		I_r	0.4-0.5-0.6-0.7-0.8-0.9-0.95-0.98-1 × I_n
		resolu-tion	1 A step via SU menu
Thermal memory (cooling duration for thermal capacity)		instantaneous / 30min	
Time delay setting		t_R (@6×I_R)	1-2-4-8-12-16-20-24-30 s
I/I_r		= 1.05	< 2h without trip
		= 1.30	< 1h trip
Inverse time limit functions for t_R (can be selected in the menu of SU tripping unit)			



Tripping curve shape (Inverse time limit functions I^nt) *default I^2t*			Time delay at different curves delay settings t_R (@6 x I_R)									
			I fault	t_R=30s	t_R=24s	t_R=20s	t_R=16s	t_R=12s	t_R=8s	t_R=4s	t_R=2s	t_R=1s
SI: Standard inverse time	Delay setting	$t = (6 \times I_R / I)^1 \times t_R$	1.5 × I_R	120	96	80	64	48	32	16	8	4
	Current setting (activity range)	1.05 × I_R < I < I_{sd}	6 × I_R	30	24	20	16	12	8	4	2	1
	Accuracy	± 10 %	7.2 × I_R	25	20	16.66	13.33	10	6.66	3.33	1.66	0.833
VI: Very intense inverse time	Delay setting	$t = (6 \times I_R / I)^{1+⅓} \times t_R$	1.5 × I_R	300	240	200	160	120	80	40	20	10
	Current setting (activity range)	1.05 × I_R < I < I_{sd}	6 × I_R	30	24	20	16	12	8	4	2	1
	Accuracy	± 10 %	7.2 × I_R	22.16	17.72	14.77	11.81	8.86	5.90	2.95	1.47	0.73
I^2t: General inverse time (default)	Delay setting	$t = (6 \times I_R / I)^2 \times t_R$	1.5 × I_R	480	384	320	256	192	128	64	32	16
	Current setting (activity range)	1.05 × I_R < I < I_{sd}	6 × I_R	30	24	20	16	12	8	4	2	1
	Accuracy	± 10 %	7.2 × I_R	20.83	16.67	13.89	11.11	8.33	5.56	2.78	1.39	0.69
EI(G): Extremely inverse time (generators)	Delay setting	$t = (6 \times I_R / I)^{2+⅓} \times t_R$	1.5 × I_R	762	609.6	508	406.4	304.8	203.2	101.6	50.8	25.4
	Current setting (activity range)	1.05 × I_R < I < I_{sd}	6 × I_R	30	24	20	16	12	8	4	2	1
	Accuracy	± 10 %	7.2 × I_R	19.60	15.68	13.06	10.45	7.84	5.22	2.61	1.30	0.65
HV: High voltage fuse inverse time	Delay setting	$t = (6 \times I_R / I)^{4+⅙} \times t_R$	1.5 × I_R	9676	7741	6451	5161	3870	2580	1290	645.1	322.5
	Current setting (activity range)	1.05 × I_R < I < I_{sd}	6 × I_R	30	24	20	16	12	8	4	2	1
	Accuracy	± 10 %	7.2 × I_R	14.03	11.22	9.35	7.48	5.61	3.74	1.87	0.93	0.46

Tripping units for ACBs

Current characteristics - L protection



L Protection (Long time delay overload protection)

Coarse setting of I_R and t_R by means of rotary knobs located in the front interface of the tripping unit SU. Fine setting is accessible via SU menu.
Time delay is set as an inverse time function of current on which several curve types can be chosen.

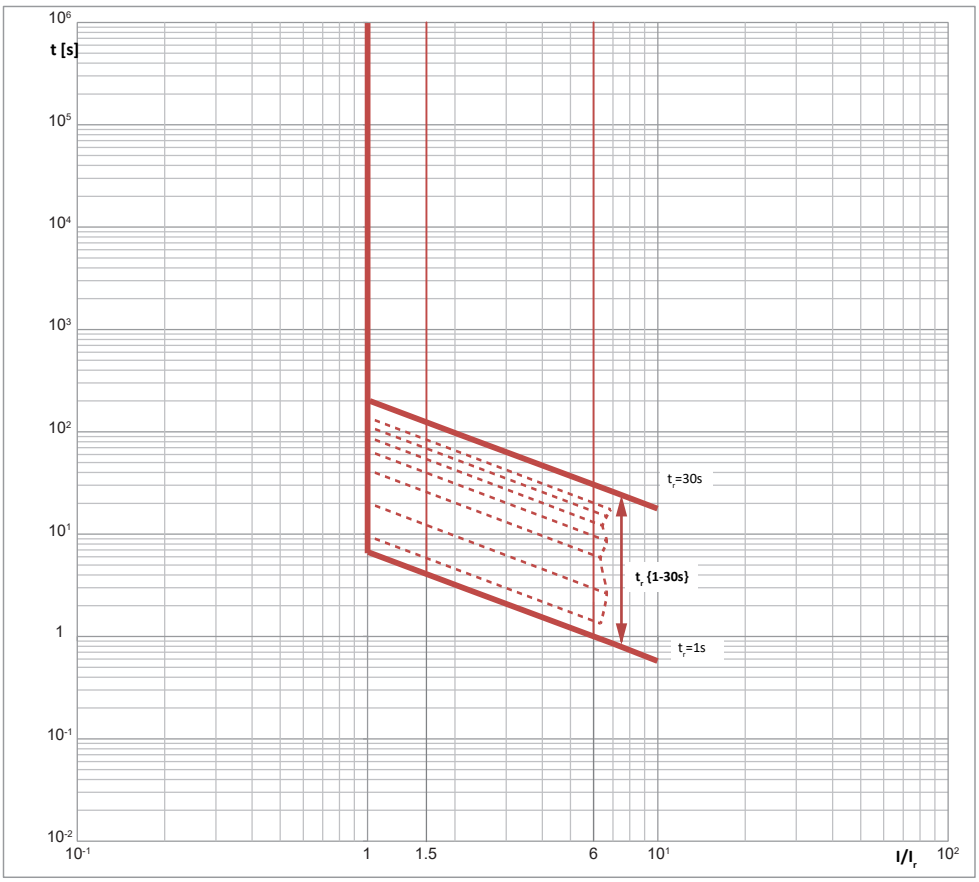
- SI: Standard inverse curve.
- VI: Very intese curve.
- I2t: General purpose inverse time curve.
- EI: Extremely inverse time curve.
- HV: High Voltage inverse time curve.

The respective characteristic curves may be selected from the SU menu settings. The option selected by default is the I^2t characteristic curve.

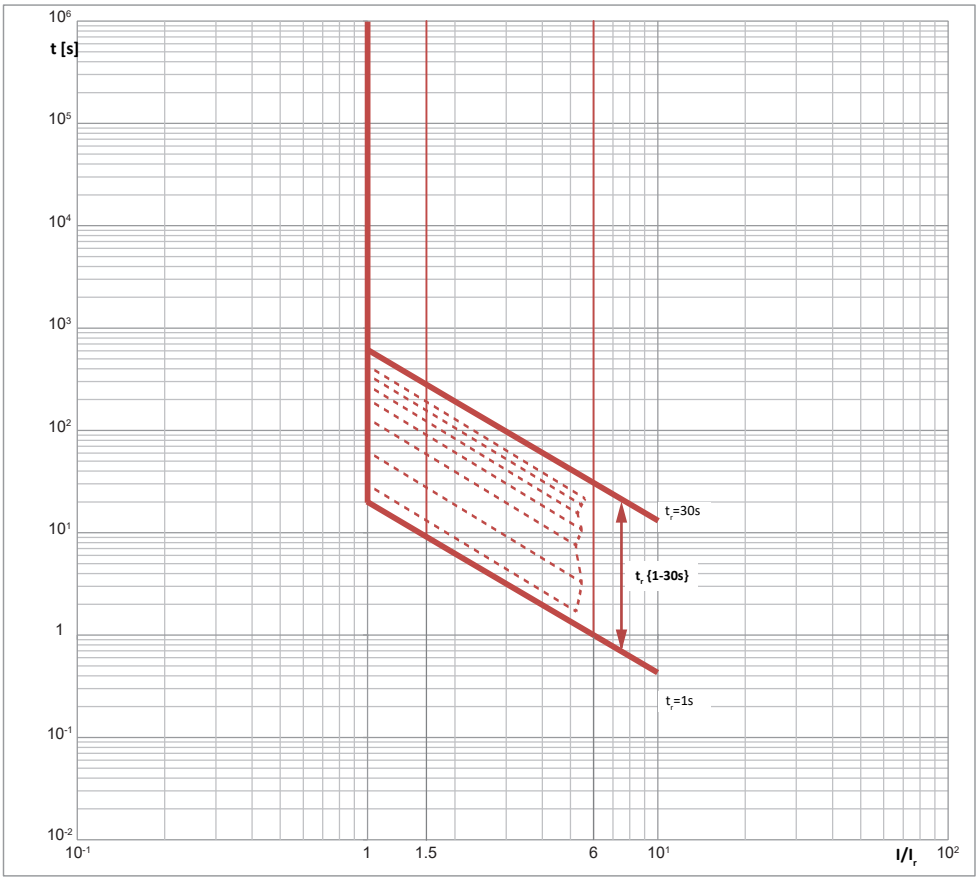
Tripping units for ACBs

Current characteristics - L protection

SI: Standard inverse curve



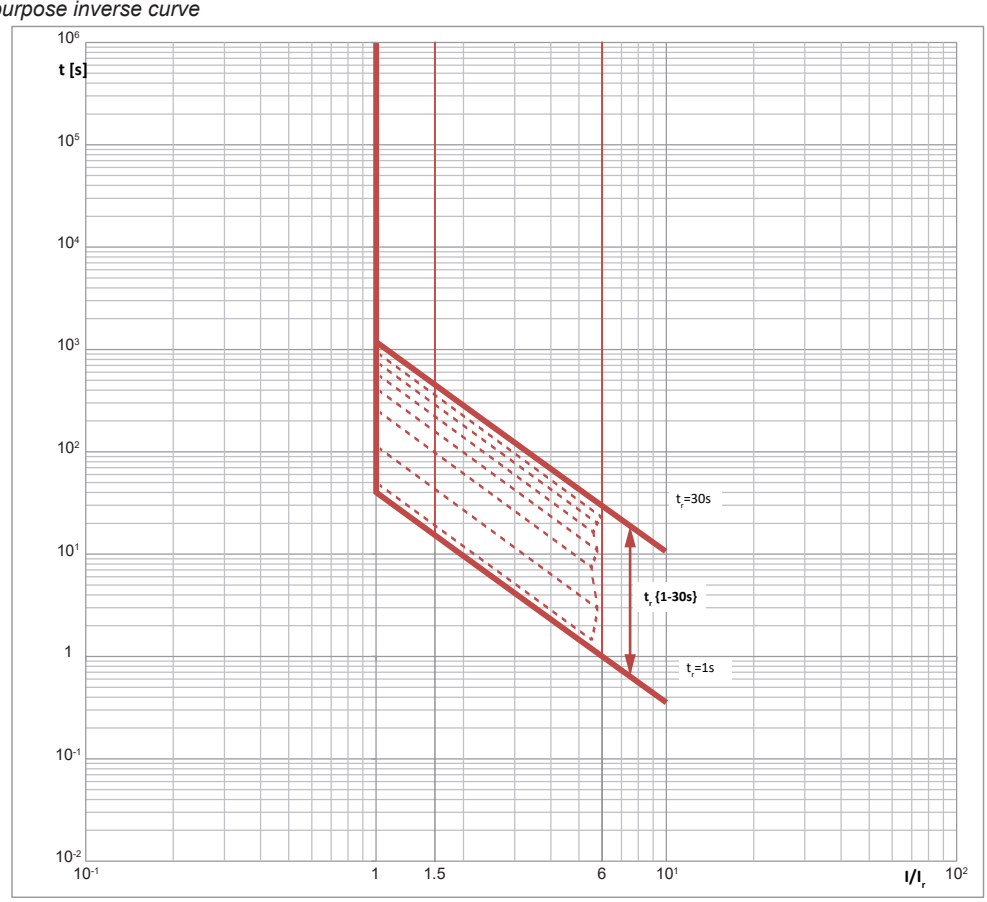
VI: Very intense curve



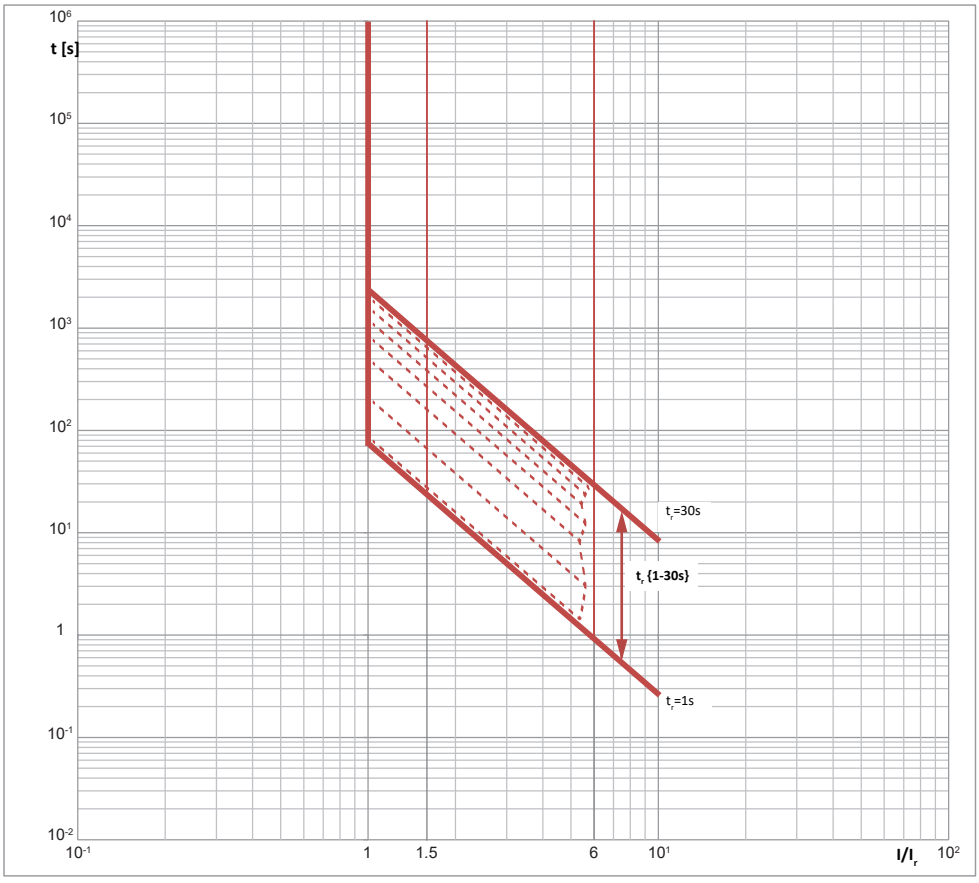
Tripping units for ACBs

Current characteristics - L protection

I2t: general purpose inverse curve



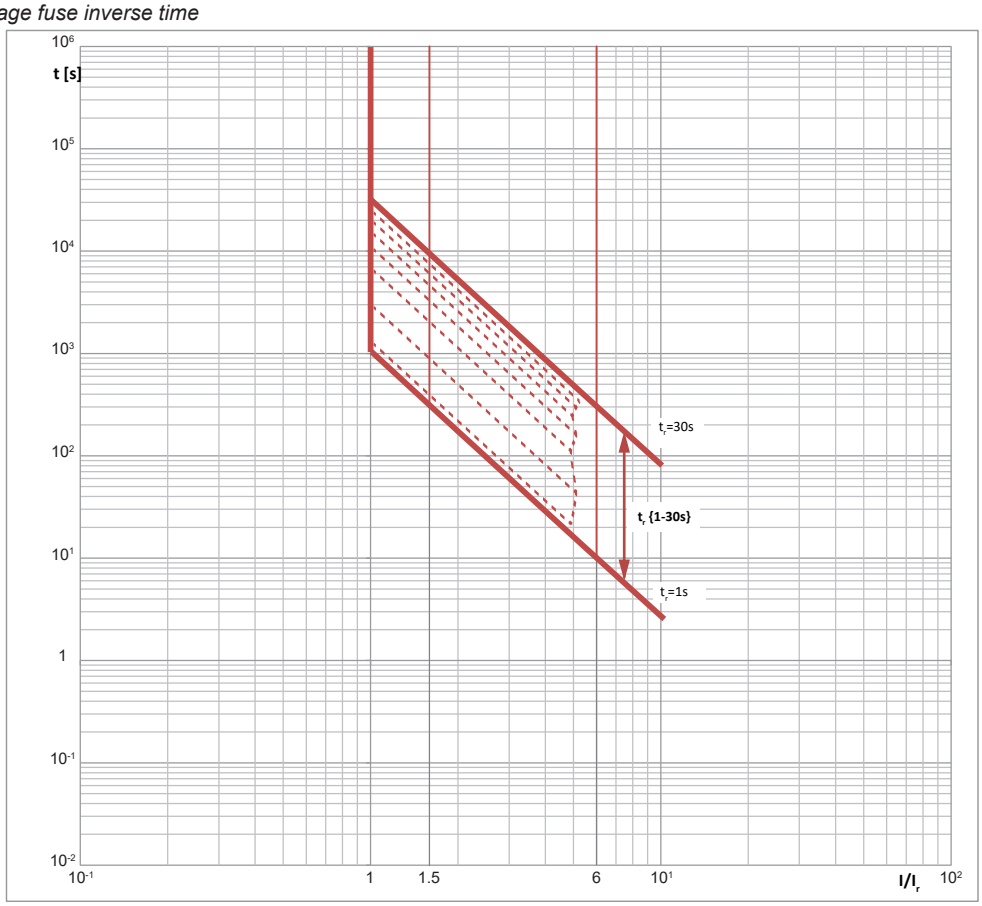
EI: Extremely inverse curve



Tripping units for ACBs

Current characteristics - L protection

HV: High voltage fuse inverse time

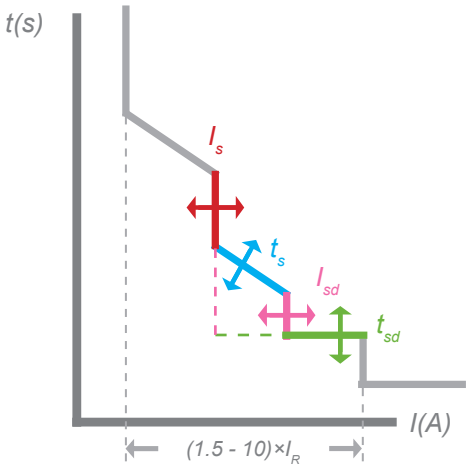


Technical Data Smart Units

Tripping units for ACBs

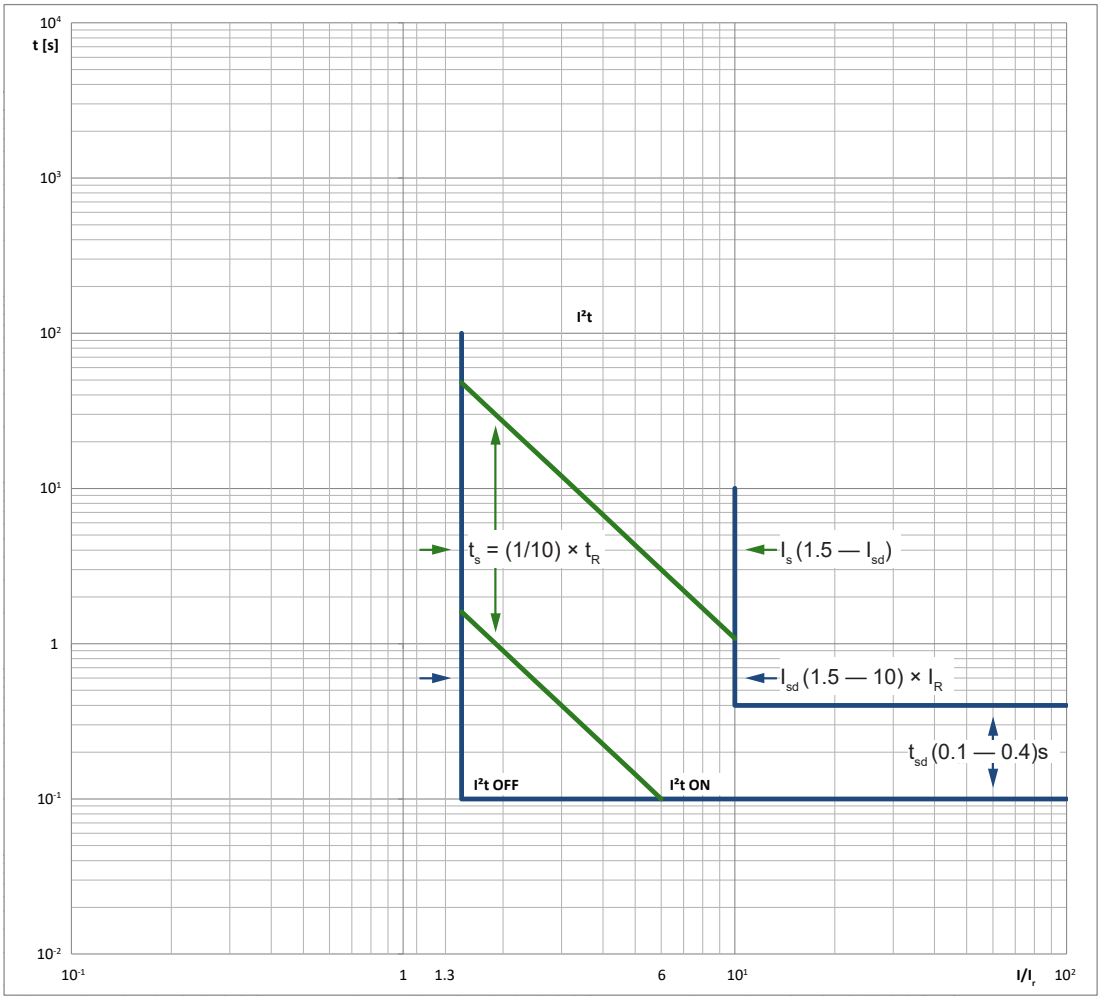
Short- time overload protection settings

	Short overload protection (inverse time curve), current setting		
	Current threshold setting (optional)	I_s	(1.5 — 10) × I_R ≤ I_s ≤ I_{sd}
		resolution	1 A step via SU menu
		active range	I_s ≤ I ≤ I_{sd}
		OFF	setting I_s = I_{sd}
	Short overload protection (inverse time curve) time delay setting		
	Time delay setting	t_s	Fixed: t_s = t_R / 10
		Curve	Same as I_R
	Short overload protection (constant time), current setting		
	Current threshold setting	I_{sd}	1.5-2-2.5-3-4-5-6-8-10 × I_R
		resolution	1 A step via SU menu
		active range	I_s ≤ I ≤ 10 × I_R
	Short overload protection (constant time), delay time setting		
	Time delay setting	t_{sd}	1.5-2-2.5-3-4-5-6-8-10 x I_R
		Accuracy	± 10 %



Tripping units for ACBs

Current characteristics - S protection



S protection (Short delay short circuit protection)

The coarse setting of I_{sd} and t_{sd} can be made by means of the mechanical selectors at tripping unit SU. The fine setting is accessible via the SU menu.

Time delay can be set as an inverse time function of current ($I^n t$) or as constant time t_{sd} ($I^n t$ ***OFF***). For setting the $I^n t$ = ***OFF*** is required to adjust $I_s = I_{sd}$ in the SU menu. The inverse function is expressed as:

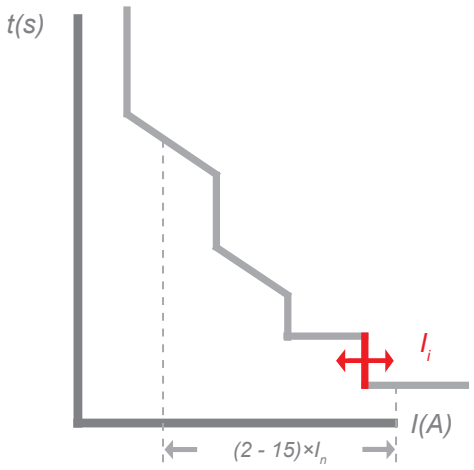
$t_s = ((6 \times I_R) / I)^n \times t_R / 10$,

The same type of tripping curve is used in the I_s inverse time parameter than the one used in the t_r setting. SI, VI, I²t, EI or HV will be used according to the user selection.
This protective function is active in the range 1.5 — 10 × $I_R \leq I_s \leq I_{sd}$. When actual current I reaches the value of I_{sd}, the function turns to constant time limit mode, i.e. time delay is switched to t_{sd}. Minimum tripping time in the time inverse mode is also given by t_{sd}.

Tripping units for ACBs

Instantaneous - time short circuit protection settings

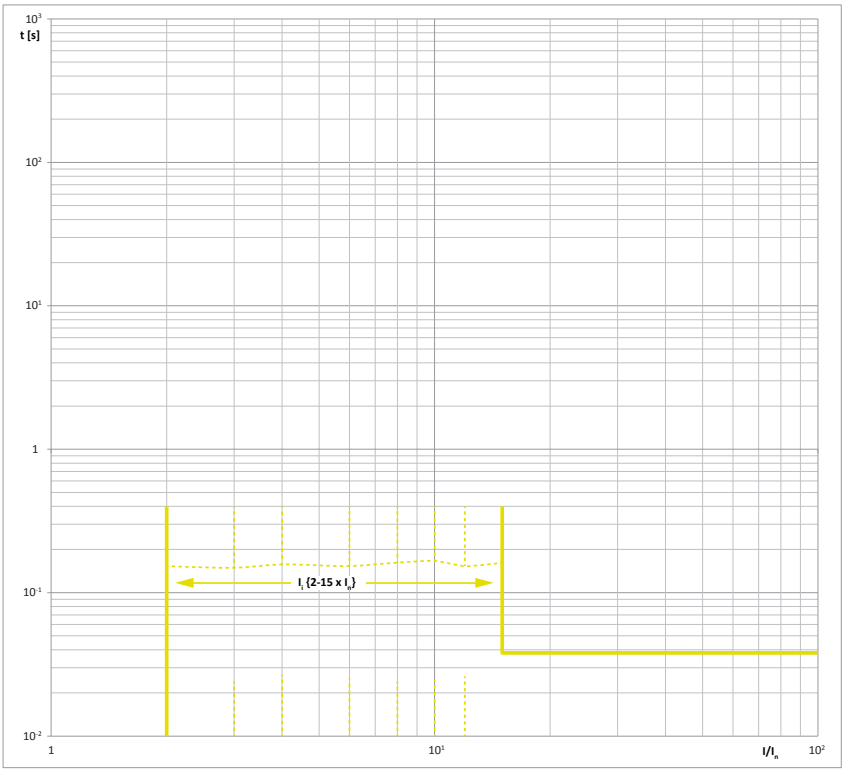
Short circtuir instantaneous protection, current setting				
Current threshold setting (optional)	I_i	(2 — 15) × I_n		
	resolution	step 1 A for I_n ≤ 2000 A step 2 A for I_n > 2000 A via SU menu		
	accuracy	± 15 %		
	I/I_i	< 0.85	not trip	
		> 1.15	< 40 ms trip	
	Maximum tripping time	< 40 ms trip		



Current characteristics - I protection

I protection (Instantaneous short circuit protection)

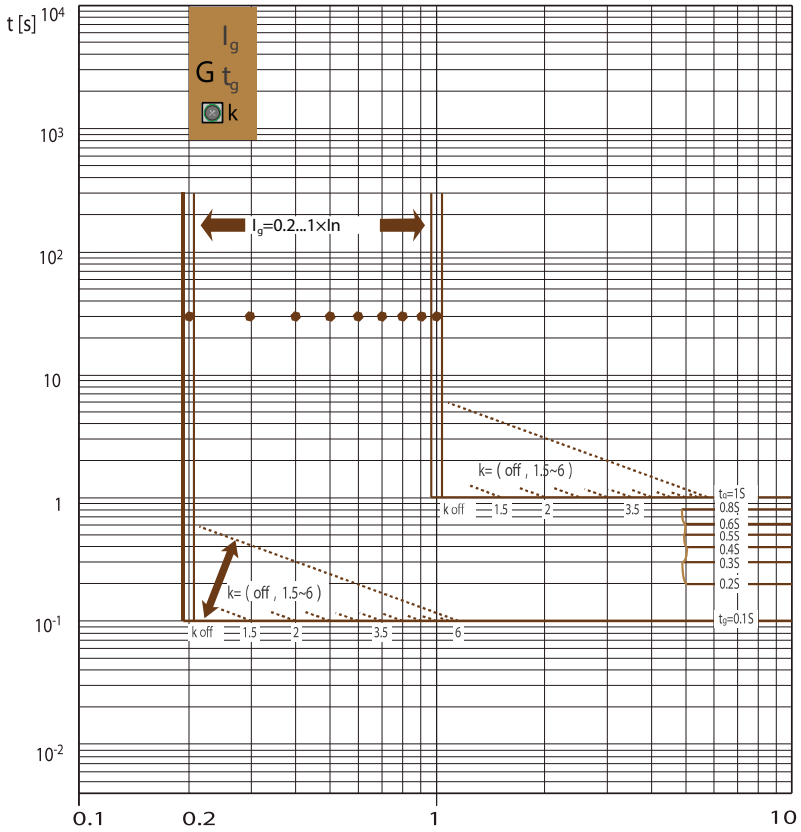
Coarse setting of I_i by means of mechanical selectors at tripping unit SU. Fine setting is accessible via SU menu.



Setting range of I_i protection.

General overview of the tripping units for ACBs

General overview of the G current characteristics



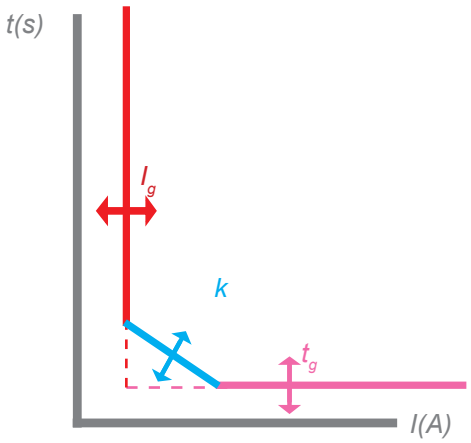
Ground leakage fault protection

Additional ground / earth protection specific for 4.0 and 5.0 smart unit types respectively		
Ig	Ground fault current thre-shold	Initial value of the current on which the ground fault protection will be applied. Range: (0.2 — 1.0) × I_n
tg	Ground fault time delay setting	Delay time for the ground fault protection to trip when a ground fault is detected. Range: OFF / 0.1 — 1 s
Cr	Ground fault inverse time coefficient	Parameter to control the inverse-time curve area on the ground protection characteristics. Range: OFF / 1.5 — 6;

Technical Data Smart Units

Tripping units for ACBs

Ground fault protection settings (SU4.0 only)

	Current setting	Ig	0.2-0.3-0.4-0.5-0.6-0.7-0.8-0.9-1.0 x I_n	
		resolution	1A steps	
	Thresholds	<0.8	do not trip	
		>1	trip	
	Inverse time delay	K	$t = t_g \times K \times I_g/I$	
		range	1.5-6 / OFF	
		OFF	$t = t_g$ (i.e. function OFF)	
		resolution	0.5 steps	
		accuracy	± 10 %	
	Fixed time delay	tg	0.1-0.2-0.3-0.4-0.5-0.6-0.8-1 s / OFF (X)	
		accuracy	± 10 %	
Detection type		Differential residual current vector sum (internal current transformers), default option if not specified otherwise		
Alarm type		Display / DO output (alarm & trip settings)		
Alarm start threshold		Ig	0.2 - 1.0 I_n	
		resolution	1A steps	
Alarm stop threshold		Ig	0.2 - 1.0 I_R	
		resolution	1A steps	
		time delay	0.1s steps	

Tripping units for ACBs

Current characteristics - G protection

G protection (Ground fault protection)

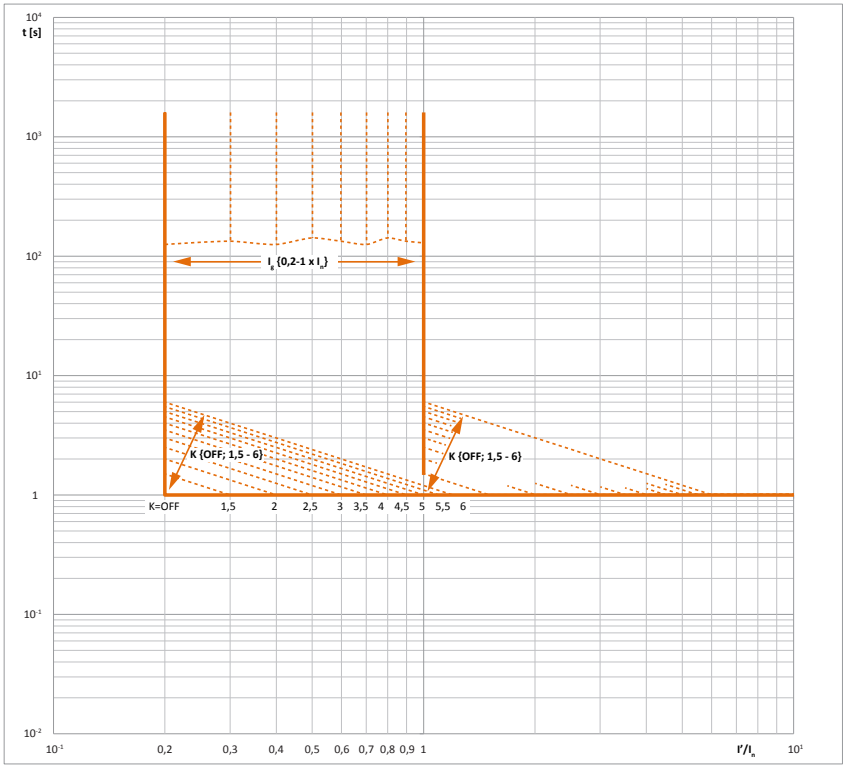
Protection against residual currents to grouding or PE conductors caused by (short-circuit) connection of L conductor with PE potential.

Inverse time limit function $I_g t$ is defined by factor K set in SU menu.

Tripping time is defined as $t = t_g \times K \times I_g / I'$ for currents $I' < K \times I_g$

For current $I \geq K \times I_g$, the function turns to Fixed time limit with $t = t_g$. The inverse function is deactivated by selecting K as OFF in the tripping unit menu.

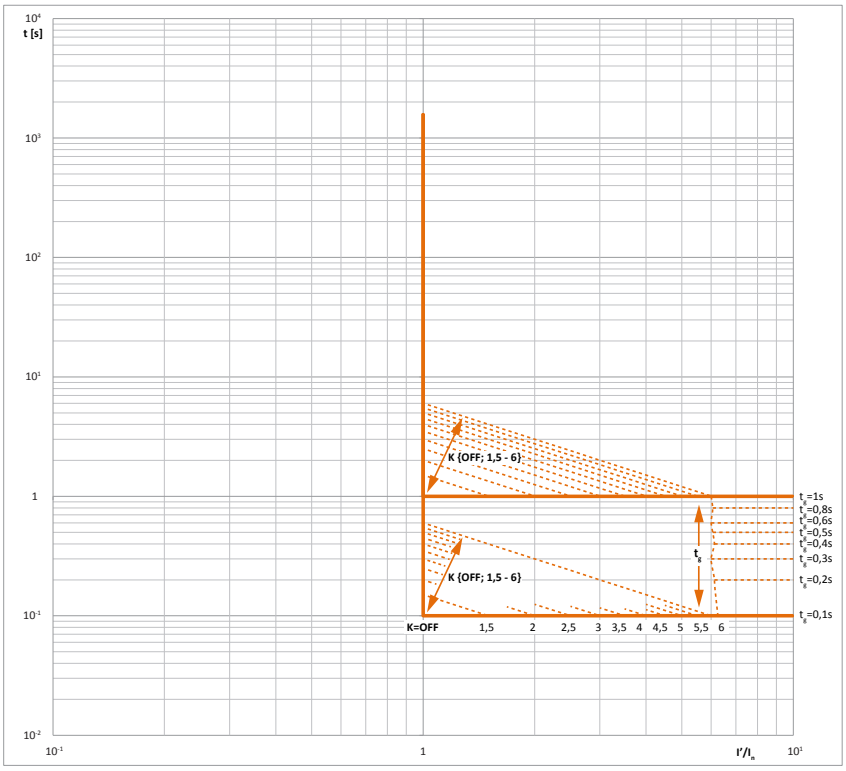
Parameter I_g is value set via button on the front panel of tripping unit. Can be smoothly adjusted in SU. Parameter I' defines actual ground fault current.



Setting range of G protection curve, parameter I_g.

Tripping units for ACBs

Current characteristics - G protection



Setting range of G protection curve, parameter t_g.

Tripping units for ACBs

Function parameter settings

Current unbalance alarm and protection			
Working modes		OFF - Alarm - trip	
I_{unbal} threshold setting	I_{unbal}	5 - 60 %	step 1 %
I_{unbal} calculation		$I_{unbal\ A,\ B,\ C}$ = 100% x $\lvert I_{A,\ B,\ C} - I_{avg}\rvert$ / I_{AVG}; $I_{avg} = (I_A+I_B+I_C)/3$	
Alarm type		Display / DO output	
Alarm startup threshold		> 1.1 x set value	
Alarm return threshold		< 0.9 x set value	
Time delay	t	0.1 - 40 s	step 0.1 / 1 s
Neutral protection - for protection of N-pole with 3P breaker			
Protection value	I_N	50%, 100%, 150%, 200% x I_R and I_{sd} (I_{sdN} max 10 x I_n); OFF	
Availability		4P ACB, 3P ACB with N protection and NEC transformer	
Temperature alarm and protection of control unit			
Working modes		OFF - Alarm - trip	
Tripping threshold	T_{SU}	25 - 80 °C	step 0.5 °C
Alarm type		Display / DO output	
Alarm startup threshold		60 - 80 °C	step 0.5 °C
Alarm return threshold		25 - 60.5 °C	step 0.5 °C
Time delay	t	1 - 1200 s	step 1 s
Tripping threshold		> 1.1 x set value	
Closing threshold		< 0.9 x set value	
Tripping delay		40 ms	
Undervoltage alarm and protection			
Measured voltages		U_{AB} (L1-L2), U_{BC} (L2-L3), U_{AC} (L1-L3)	
Working modes		OFF - Alarm - trip	
Activation		if all voltages U_{AB}, U_{BC}, U_{AC} < U_{min}	
Tripping threshold	U_{min}	100 - 800 V	step 1 / 10 / 100 V
Alarm type		Display / DO output	
Alarm startup threshold		100 - 800 V	step 1 / 10 / 100 V
Alarm return threshold		200 - 800 V	step 1 / 10 / 100 V
Time delay	t	0.2 - 60 s	step 0.1 / 1 / 10 s
Closing threshold		> 1.1 x set value	
Tripping threshold		< 0.9 x set value	
Tripping delay		40 ms	
Overvoltage alarm and protection			
Measured voltages		U_{AB} (L1-L2), U_{BC} (L2-L3), U_{AC} (L1-L3)	
Working modes		OFF - Alarm - trip	
Activation		if all voltages U_{AB}, U_{BC}, U_{AC} < U_{min}	
Tripping threshold	U_{max}	100 - 900 V	step 1 / 10 / 100 V
Alarm type		Display / DO output	
Alarm startup threshold		250 - 900 V	step 1 / 10 / 100 V
Alarm return threshold		100 - 900 V	step 1 / 10 / 100 V
Time delay	t	0.2 - 60 s	step 0.1 / 1 / 10 s
Tripping threshold		> 1.1 x set value	
Closing threshold		< 0.9 x set value	
Tripping delay		40 ms	

Technical Data Smart Units

Tripping units for ACBs

Function parameter settings

Voltage unbalance alarm and protection			
Measured voltages		U_{AB} (L1-L2), U_{BC} (L2-L3), U_{AC} (L1-L3)	
Working modes		OFF - Alarm - trip	
U_{unbal} tripping threshold	U_{unbal}	2 - 30 %	step 1 %
U_{unbal} calculation		U_{unbal} = 100% x Max($\|U_{AB}-U_{avg}\|$, $\|U_{BC}-U_{avg}\|$, $\|U_{AC}-U_{avg}\|$) / U_{avg} $U_{avg} = (U_{AB}+U_{BC}+U_{AC})/3$	
Alarm type		Display / DO output	
Alarm startup threshold		10 - 30 %	step 1 %
Alarm return threshold		2 - 10 %	step 1 %
Time delay	t	0.2 - 60 s	step 0.1 / 1 / 10 s
Underfrequency alarm and protection			
Working modes		OFF - Alarm - trip	
Frequency tripping threshold	F_{min}	45 - 65 Hz	step 0.5 Hz
Tripping time delay	t	0.2 - 5 s	step 0.1 / 1 s
Alarm type		Display / DO output	
Alarm startup threshold		45 - 48 Hz	step 0.5 Hz
Startup time delay		0.2 - 5 s	step 0.1 / 1 s
Alarm return threshold		45 - 65 Hz	step 0.5 Hz
Return time delay		0.2 - 36 s	step 0.1 / 1 / 10 s
Overfrequency alarm and protection			
Working modes		OFF - Alarm - trip	
Frequency tripping threshold	F_{max}	45 - 65 Hz	step 0.5 Hz
Time delay	t	0.2 - 5 s	step 0.1 / 1 s
Alarm type		Display / DO output	
Alarm startup threshold		52 - 65 Hz	step 0.5 Hz
Startup time delay		0.2 - 5 s	step 0.1 / 1 s
Alarm return threshold		45 - 52.5 Hz	step 0.5 Hz
Return time delay		0.2 - 36 s	step 0.1 / 1 / 10 s
Phase rotation alarm and protection			
Working modes		OFF - Alarm - trip	
Action sequence		ABC or ACB	
Alarm type		Display / DO output	
Reverse power protection			
Action threshold	P	5 - 500 kW	step 1 kW
Time delay	t	0.2 - 20 s	step 0.1 s
Alarm type		Display / DO output	

Tripping units for ACBs

Function parameter settings

Harmonic wave alarm and protection			
Working modes		OFF - Alarm - trip	
Tripping threshold		> 1.1 x set value	
Closing threshold		< 0.9 x set value	
Current harmonic alarm and protection			
Tripping threshold (total harmonic distortion)	THD	8 - 60 %	step 0.5 %
THD variant		to fundamental component (THD) and to total value of current (thd)	
Evaluated Harmonics		2^{nd} to 31^{st} of current	
Time delay	t	1 - 120 s	step 1 s
Alarm type		Display / DO output	
Voltage harmonic alarm and protection			
Tripping threshold (total harmonic distortion)	THD	4 - 10 %	step 0.1 %
THD variant		to fundamental component (THD) and to total value of voltage (thd)	
Evaluated Harmonics		2^{nd} to 31^{st} of voltage	
Time delay	t	1 - 120 s	step 1 s
Alarm type		Display / DO output	
Load monitor and protection			
Working modes		OFF - Mode1 - Mode2	
Inverse current function		as of L function (I_R)	
Activated functionality		DO outputs	
Shedding of both 2 loads L1 and L2			
Mode 1 threshold	L1	0.2 - 0.98 I_R	step 1 A
	L2	0.2 - 0.98 I_R	step 1 A
L1, L2 loads setting and evaluation		independent	
Delay time	t	20 - 80% t_R	step 1 %
Shedding and return of one load L1 and L1 return			
Mode 2 threshold	L1 startup	0.2 - 1.0 I_R	step 1 A
	L1 return	0.2 - 1.0 I_R	step 1 A
Delay time	L1 startup	20 - 80% t_R	step 1 %
	L1 return	10 - 600 s	step 1 s

Technical Data Smart Units

Tripping units for ACBs

Measuring functions

	Parameters	Display / Communication (comm. not for A version)	SU type
Actual current rms [A]	I_A, I_B, I_C, (I_N, I_g, $I_{\Delta n}$)	■ / ■	A, P, H
Maximum current rms [A]	I_A, I_B, I_C, (I_N, I_g, $I_{\Delta n}$)	■ / ■	A, P, H
Current unbalance [%]	$I_{unbal\ A,\ B,\ C} = 100\% \times \lvert I_{A,\ B,\ C} - I_{avg} \rvert / I_{avg}$; $I_{avg} = (I_A+I_B+I_C)/3$		
	I_{unbal}	■ / ■	A, P, H
Internal temperature of SU [°C]	T	■ / ■	A, P, H
Load level [%]	% of I_R	■ / ■	A, P, H
Actual voltage rms [V]	U_{AB}, U_{BC}, U_{AC}, U_{AN}, U_{BN}, U_{CN}	■ / ■	P, H
Average voltage rms [V]	$U_{avg} = (U_{AB}+U_{BC}+U_{AC})/3$	■ / ■	P, H
Voltage unbalance [%]	$U_{unbal} = 100\% \times \text{Max}(\lvert U_{AB}-U_{avg} \rvert, \lvert U_{BC}-U_{avg} \rvert, \lvert U_{AC}-U_{avg} \rvert) / U_{avg}$ $U_{avg} = (U_{AB}+U_{BC}+U_{AC})/3$		
	U_{unbal}	■ / ■	P, H
Frequency (phase A) [Hz]	f	■ / ■	P, H
Phase rotation	per phases A, B, C	■ / ■	P, H
Actual active power P [W]	P_A, P_B, P_C, P_{total}	■ / ■	P, H
Actual reactive power Q [VAr]	Q_A, Q_B, Q_C, Q_{total}	■ / ■	P, H
Actual apparent power S [VA]	S_A, S_B, S_C, S_{total}	■ / ■	P, H
Actual power factor	PF_A, PF_B, PF_C, PF_{total} (cos φ)	■ / ■	P, H
Total active energy [Wh]	E_P	■ / ■	P, H
Total reactive energy [VArh]	E_Q	■ / ■	P, H
Total apparent energy [VAh]	E_S	■ / -	P, H
Total supplied active energy [Wh]	E_{Pin}	■ / -	P, H
Total supplied reactive energy [VArh]	E_{Qin}	■ / -	P, H
Time for energy measurement is given by the time when ACB is switched ON. The time can be reseted in SU menu.			
Total consumed active energy [Wh]	E_{Pout}	■ / -	P, H
Total consumed reactive energy [VArh]	E_{Qout}	■ / -	P, H
Energy calculation reset	by reset function	■ / ■	P, H
Voltage waveform capture (1 cycle)	U_{AB}, U_{BC}, U_{AC}	■ / -	H
Current waveform capture (1 cycle)	I_A, I_B, I_C, I_N	■ / -	H
Voltage THD (up to 31st harmonics) [%]	THD, related to voltage of fundamental component for U_{AB}, U_{BC}, U_{AC}, U_{AN}, U_{BN}, U_{CN}	■ / -	H
Current THD (up to 31st harmonics) [%]	THD, related to current of fundamental component for I_A, I_B, I_C, I_N	■ / -	H
Voltage thd (up to 31st harmonics) [%]	thd, related to total voltage for U_{AB}, U_{BC}, U_{AC}, U_{AN}, U_{BN}, U_{CN}	■ / -	H
Current thd (up to 31st harmonics) [%]	thd, related to total current for I_A, I_B, I_C, I_N	■ / -	H
Harmonics amplitude spectrum of current for 3rd to 31st odd harmonics	I_A(FFT), I_B(FFT), I_C(FFT), I_N(FFT)	■ / -	H
Harmonics amplitude spectrum of voltage for 3rd to 31st odd harmonics	U_{AB}(FFT), U_{BC}(FFT), U_{AC}(FFT)	■ / -	H

Technical Data Smart Units

Tripping units for ACBs

Measuring ranges

	Parameters	Measuring range	Accuracy	SU type
Current measurement (RMS)	I_A, I_B, I_C, I_N	0 - 25 I_n	≤ 2 I_n ± 2 % > 2 I_n ± 5 %	all
Ground-fault current	I_g	0 - 10 I_n	≤ I_n ± 2 % > I_n ± 5 %	all 4.0
Line voltage	U_{AB} / U_{BC} / U_{CA}	0 - 1000 V	± 1%	P, H
Phase voltage	U_A / U_B / U_C	0 - 600 V	± 1%	P, H
Frequency (from phase A)	f	40 - 65 Hz	± 0.05 Hz	P, H
Active power	P	-32767 - +32767 kW	± 1.5 %	P, H
Reactive power	Q	-32767 - +32767 kVar	± 1.5 %	P, H
Apparent power	S	0 - 65535 kVA	± 1.5 %	P, H
Power factor	PF	-1.0 - +1.0	± 0.02	P, H
Input / output active electric energy	EP_{in} / EP_{out}	0 - 4294967295 kWh	± 2.5 %	P, H
Input / output reactive electric energy	EQ_{in} / EQ_{out}	0 - 4294967295 kVarh	± 2.5 %	P, H
Input / output apparent electric energy	ES_{in} / ES_{out}	0 - 4294967295 kVAh	± 2.5 %	P, H
Harmonic wave	I_A / I_B / I_C / I_N U_{AB} / U_{BC} / U_{CA} U_{AN} / U_{BN} / U_{CN}	3rd - 31st harmonics	± 3.5 %	H

Communication parameters

Communication protocol	Modbus-RTU
Communication address	0 - 255
Baud rate (bit/s)	9.6k / 19.2k / 38.4k / 115.2k

Technical Data Smart Units

Tripping units for ACBs

Main addresses for measurement data collection

Adress (dec)	Definition	Variable type	Unit	Attribute	Format
256	A-N Phase voltage	U_int	V	R	× 1
257	B-N Phase voltage	U_int	V	R	× 1
258	C-N Phase voltage	U_int	V	R	× 1
260	A-B Phase voltage	U_int	V	R	× 1
261	B-C Phase voltage	U_int	V	R	× 1
262	C-A Phase voltage	U_int	V	R	× 1
268	A Phase current	U_int	A	R	× 1, × 2 note 1
269	B Phase current	U_int	A	R	× 1, × 2 note 1
270	C Phase current	U_int	A	R	× 1, × 2 note 1
271	N Phase current	U_int	A	R	× 1, × 2 note 1
275	A phase current unbalance rate	U_int		R	%
276	B phase current unbalance rate	U_int		R	%
277	C phase current unbalance rate	U_int		R	%
278	Maximum current unbalance rate	U_int		R	%
280	A phase active power	Int	kW	R	×1
281	A phase reactive power	Int	kvar	R	×1
282	A phase apparent power	U_int	Kva	R	×1
283	B phase active power	Int	kW	R	×1
284	B phase reactive power	Int	kvar	R	×1
285	B phase apparent power	U_int	Kva	R	×1
286	C phase active power	Int	kW	R	×1
287	C phase reactive power	Int	kvar	R	×1
288	C phase apparent power	U_int	Kva	R	×1
289	System total active power	Int	kW	R	×1
290	System total reactive power	Int	kvar	R	×1
291	System total apparent power	U_int	Kva	R	×1
292	A phase power factor	Int		R	×0.01
293	B phase power factor	Int		R	×0.01
294	C phase power factor	Int		R	×0.01
295	System power factor	Int		R	×0.01
315	System total active power demand value	Int	kW	R	×1
316	System total reactive power demand value	Int	kvar	R	×1
317	System total apparent power demand value	Int	Kva	R	×1

Note 1: For rated current value ≥ 11 ×2, otherwise ×1
For complete Modbus map information please visit our website or contact our technical support

Technical Data Smart Units

Tripping units for ACBs

Main addresses for system status and history records data collection

Adress (dec)	Definition	Variable type	Unit	Attribute	Format
512	Running state(bit)	U_int		R	Check manual
513 514	Actual alarm(bit)	Long		R	Check manual
515	H: Actual fault type (char) L: Actual fault phase (char)	U_int		R	Check manual
516	Actual fault data 0	U_int		R	Check manual
517	Actual fault data 1	U_int		R	Check manual
518	Actual fault data 2	U_int		R	Check manual
519	Actual fault data 3	U_int		R	Check manual
520	Actual fault data 4	U_int		R	Check manual
521	Actual fault data 5	U_int		R	Check manual
522	Actual fault data 6	U_int		R	Check manual
523	Actual fault data 7	U_int		R	Check manual
772	fault data 0	U_int		R	Check manual
773	fault data 1	U_int		R	Check manual
774	fault data 2	U_int		R	Check manual
775	fault data 3	U_int		R	Check manual
776	fault data 4	U_int		R	Check manual
777	fault data 5	U_int		R	Check manual
778	fault data 6	U_int		R	Check manual
779	fault data 7	U_int		R	Check manual
1028	Contact wear percent	U_int		R/W	×0.01, resettable
1029	Total contact equivalent	U_int		R	×0.01
1030	Operation times	U_int		R/W	×1, resettable
1031	total operation times	U_int		R	×1

For complete Modbus map information please visit our website or contact our technical support

Main addresses for protection settings data collection

Adress (dec)	Definition	Variable type	Unit	Attribute	Format
1280	I_R Long overload protection value	U_int	A	R/W	× 1, × 2 note 1
1284	I_s Short inverse time overload protection value	U_int	A	R/W	× 1, × 2 note 1
1282	I_{sd} Short constant time overload protection value	U_int	A	R/W	× 1, × 2 note 1
1283	t_{sd} Short constant time delay value	U_int	20ms	R/W	20ms × (5-20)
1285	I_i Instantaneous short circuit value	U_int	A	R/W	× 1, × 2 note 1
1286	N phase protection setting	U_int		R/W	Check manual

Note 1: For rated current value ≥ 11 ×2, otherwise ×1
For complete Modbus map information please visit our website or contact our technical support

Tripping units for ACBs

Zone Selective Interlock (ZSI)

One of the fundamental functions of protective systems is selectivity. Selectivity dramatically increases operational reliability of distribution systems and installations. As an example see Fig. 1.

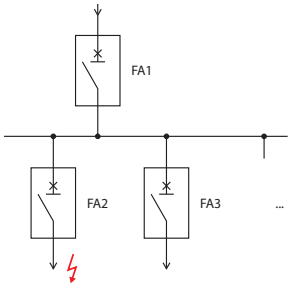


Fig. 1. Basic selective system.

If there is a short circuitry in downstream circuit to breaker FA2, both breakers FA2 and FA1 can trip. Such action of FA1 would, however, cause unavailability of electricity for circuit of FA3 and the other circuits which are not directly affected by the short circuitry. Protection and safety requirements would be fulfilled, but basic requirements for reliability of electricity supply are not kept.

Selectivity behaviour solves just this problem. Basic selectivity means that there is applied certain delay to tripping time of upstream breaker (FA1 in Fig. 1). The delayed trip assures that only downstream breaker will trip. It is set by parameters I_{sd} and t_{sd}.

Let us assume a circuit according to Fig. 2, without the green part for the first moment.

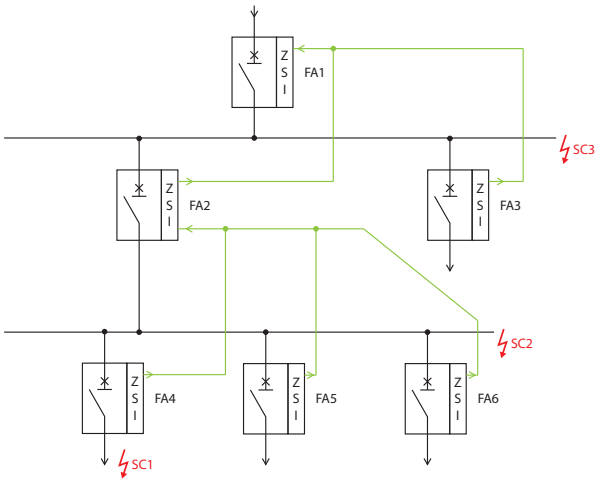


Fig. 2 Complex selective system with ZSI functionality.

In case of short circuitry SC1, the situation is the same as in the previous example. To assure selectivity, tripping of FA2 and FA1 must be delayed with respect to tripping time of FA4. Short circuitry SC2 shows that FA1 must be delayed towards FA2. For tripping times t_{sd} it means

$$t_{sd}\ FA4\ (FA5,FA6) < t_{sd}\ FA2 < t_{sd}\ FA1$$

This simple equation describes the selectivity conditions in standard range of short circuit currents (I_{sd}).

In case of deeper insight we can see, however, that this simple selective behaviour brings imperfections to protection of the system. For next description $t_{sd\ FA4\ (FA5,FA6)}$ = 100 ms, $t_{sd\ FA2\ (FA3)}$ = 250 ms, $t_{sd\ FA1}$ = 400 ms will be expected (typical values).

Let's assume case of SC2. This short circuit current should be tripped by FA2. Short time delay t_{sd} of FA2 is set to be selective with FA4, t_{sd} 250 ms is applied. This situation means that the short circuit current will flow through the affected circuit for 250 ms, but FA4 can never trip. It is obvious that the delayed tripping does not bring any selectivity in this case, but causes bigger damages of the affected circuit. Similar situation can be observed in case of SC3. The general selectivity requirement causes delay of the tripping 400 ms, but none of the downstream breakers can trip. Higher level of selective system we have, longer delay and thus bigger damages of affected circuit will appear.

Tripping units for ACBs

Zone Selective Interlock (ZSI)

Solution of above mentioned problem can be done by means of Zone Selective Interlock (ZSI). This additional system is depicted with green colour in Fig. 2. The whole idea of ZSI comes from simple principle of sharing information about evidence of short circuit current. Circuit breakers equipped with ZSI communicate perception of short circuitry via (digital) output of ZSI. This output signal is wired to ZSI input of upstream installed breaker. Several outputs can be connected in parallel to one input. ZSI module is able to initialize tripping of the breaker without respect to set t_{sd}.

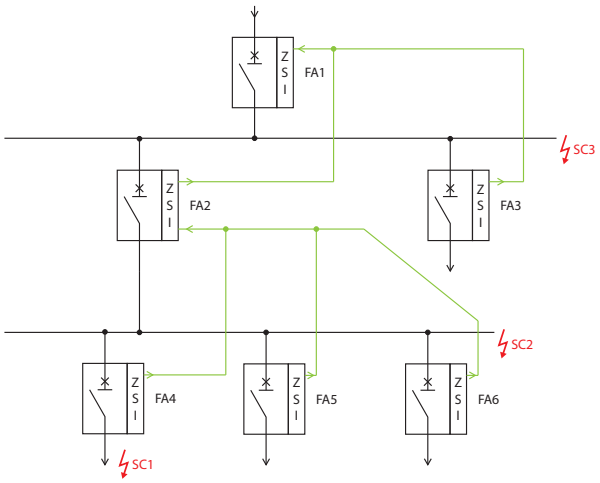


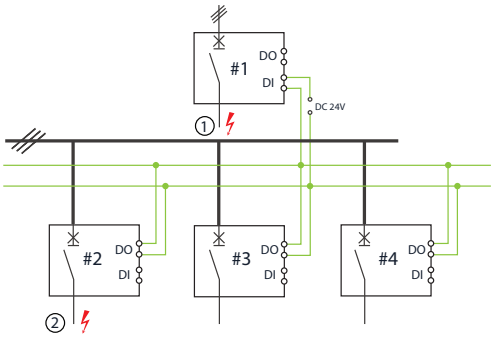
Fig. 2 Complex selective system with ZSI functionality.

In case of SC2, there is no ZSI signal from FA4 to FA2. Lack of the ZSI signal initializes the ZSI activation of tripping of FA2. As the result, FA2 trips in shorter time than $t_{sd\ FA2}$ which also significantly limits damage of the affected circuit.

The situation is similar in case of SC3. There is no ZSI signal from FA2 to FA1, breaker FA1 trips with t < $t_{sd\ FA1}$. When SC1 happens, ZSI outputs of both FA4 and FA2 signalize presence of short circuit current in theIR downstream circuits and neither $t_{sd\ FA2}$ nor $t_{sd\ FA1}$ is shortened. In the situation of SC2, the breaker FA1 receives ZSI information from FA2 and t_{sd} of FA1 is not affected.

The example shows that ZSI significantly reduces damages in case of short circuitry in all upstream circuits.

Actual connection diagram of Ex9A



Technical Data Smart Units

Tripping units for ACBs

ZSI electrical parameters

Total tripping time with activated ZSI	max. ca. 60 ms
Rated operating voltage of ZSI system external supply	24 V DC
Maximum output current of ZSI	48 mA
ZSI output secondary terminals	ZSI1: #15, 19 (COM) ZSI2: #16, 19 (COM)
Input current of ZSI	typically 8 mA
ZSI input secondary terminals	ZSI1: #20, 21 ZSI2: #22, 23
Contact potential	common for all DO outputs as well as with ZSI outputs, #19

DO electrical parameters

Rated operating voltage of external supply	24 V DC
Maximum output current of DO	48 mA
DO secondary terminals	#15, 16, 17, 18
Contact potential	common for all DO outputs as well as with ZSI outputs, #19

Wiring diagram