

Guideline for DC 24 V Systems in Machine Construction and Process Control



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Guideline DC 24 V Systems in Machine Construction and Process Control

- Planning aspects
 - Power supply, load characteristics
 - Protection, wiring
 - Requirements of the Machinery Directive and Low Voltage Directive
 - International standards and approvals
- Professional overcurrent protection and power distribution for DC 24 V systems
- Flexible power distribution for centralised and decentralised control cabinet concepts

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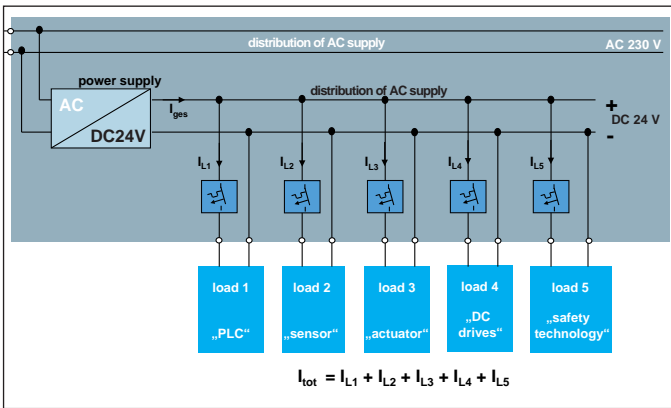
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Requirements and planning aspects

Systematics of a DC 24 V system



Tasks and questions of electrical planning

1. Power supply

- Type, manufacturer, current rating, output characteristics, behaviour in the overload range, price?
- Utilisation rate of power supply in dynamic range of system?
- Current reserve for simultaneity factors or system extensions (up to 80 % utilisation)?

2. Load characteristics

- What loads have to be protected?
- What is the dynamic characteristic of the load current during switch-on or on duty in a group protection of several loads?

3. Overcurrent protection

- Current rating and trip curve of circuit breaker: fast or delayed?
- Total current consumption when protecting a group of devices?
- Selectivity ensured in the event of short circuit/overload? Can the occurring short circuit currents be calculated?
- Reaction of loads when the DC 24 V control voltage dips?

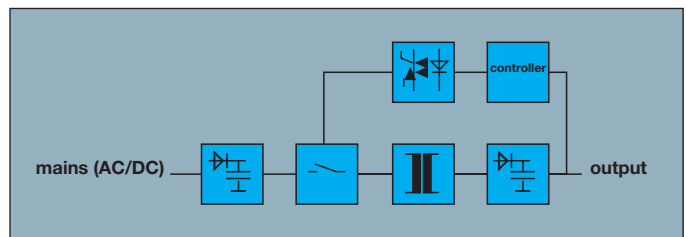
4. Wiring

- What cable lengths have to be expected?
- What are the cable cross sections in the string in questions: Sensor cables 0.25 mm², wiring 1 / 1.5 / 2.5 mm², mixed forms? I²t value, ampacity?
- Can the breaker trip due to cable attenuation?
- Wiring time for all load lines (plus, protected load output, minus, FE) and auxiliary contacts in the control cabinet?

DC 24 V control voltage level Power supply

Supply voltage DC 24 V

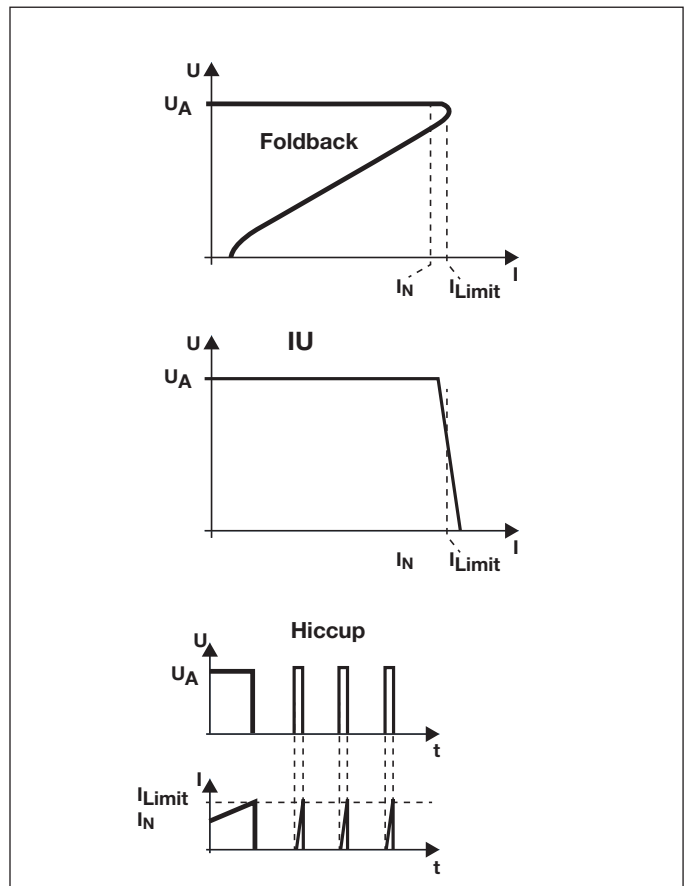
- DC 24 V control voltage: Switch-mode power supplies (SMPS) widely replace conventional transformer power supplies (TPS). Reasons: Size, weight, efficiency.
- Output characteristics of the SMPS differ significantly from the TPS curve:
 - **TPS:** high overload capacity, as power $P = U \times I \sim \text{const.}$
 - **SMPS:** Overload behaviour depends on manufacturer, type and current rating of the SMPS (5 A / 10 A / 20 A / 40 A): often the output voltage is turned down already at 1.1 ... 1.5 times rated current \Rightarrow self-protection of the SMPS (I/U curve) or switch-off (foldback curve / hiccup mode).
- What's the use of a short-time boost function of the output current e.g. 3 times rated current for 20 ms, 6 times rated current for 12 ms?



Schematic diagram of switch-mode power supply

Power supply

Characteristic curve of the switch-mode power supply



DC control voltage level Load characteristics

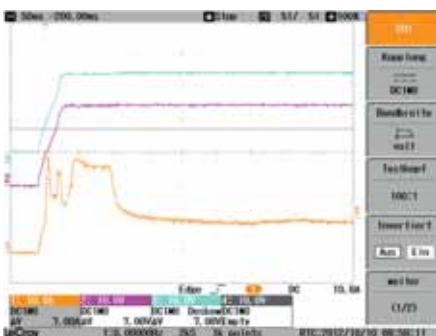
Load characteristics

(switch-on, dynamic processes in operation)

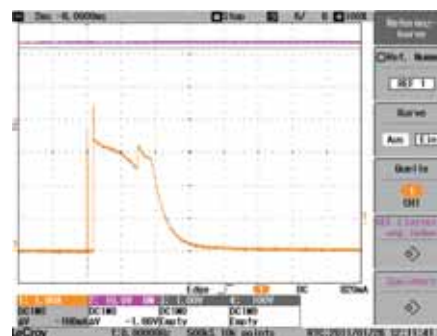
Electronic system components (PLC, safety technology, industrial computers, user terminals, sensors, drive controls, field bus modules, magnetic valve distributors etc.) have a high input capacity, i.e. high inrush currents. **Reason:** A great number of EMC and buffer capacitors in the DC24V input, number will continue to rise as the EMC standards for voltage dips in DC systems will be adjusted. DC24V motors (including brushless DC motors) and e.g. fans have high inrush currents.



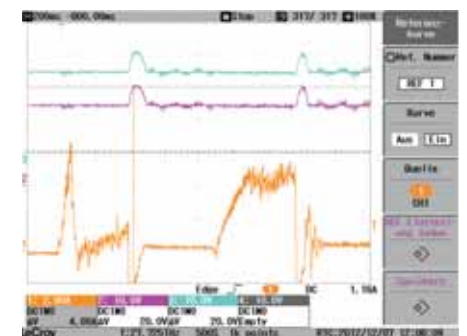
DC control voltage level Load characteristics / typical current-voltage curves



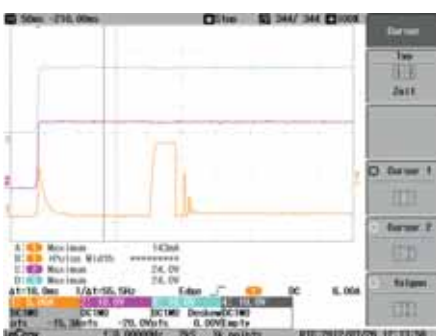
drive control



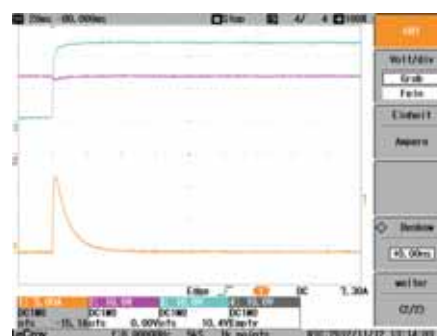
PLC



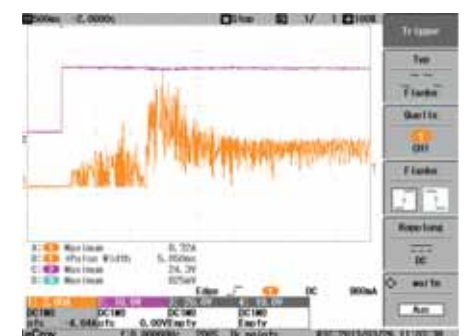
DC drive



industrial PC



safety technology



DC motor

Overcurrent protection Standards and Approvals

Standard	IEC 60947-2 EN 60947-2 DIN EN 60947-2 VDE 0660-101	IEC 60934 EN 60934 DIN EN 60934 VDE 0642	IEC 60898 EN 60898 DIN EN 60898 VDE 0642	UL 489	UL 1077	UL 2367	UL 508 (is partly replaced by UL60947-4-1A)
Type	MCBs	CBEs	MCBs	MCCBs	CBEs	Electronic overcurrent protection	General; Control cabinet components
Application:	MCBs with main contact for connection to circuits up to AC 1000 V and DC 1500 V, is also used for: protection of cables and devices in industrial applications Low-voltage switchgear and controlgear - Part 2: Circuit-breakers (moulded-case circuit breakers MCCB)	Protection of appliances (for household and similar) for the protection of circuits within electrical resources Circuit breaker for equipment (CBE) for household and similar applications	MCBs for indoor installations and similar purposes Circuit breakers for overcurrent protection for household and similar installations (miniature circuit breakers MCB)	Protection of branch circuits Molded-case circuit breakers for branch circuit protection	Additional protection equipment for the use in electrical production means Supplementary Protectors for Use in Electrical Equipment	Electronic overcurrent protection device Solid-state overcurrent protectors (for supplementary overcurrent protection; for secondary circuits)	Industrial Control Equipment Industrial Control Equipment
Application area	up to AC 1000V up to DC 1500V	up to AC 440 V max. 125A up to DC 250 V, max. 125A	up to AC 440 V max. 125A up to DC 220 V, max. 125A	up to AC 600 V up to 220 V plus	up to AC 600 V up to DC 600 V	up to DC 60 V	up to 1500 V
Short circuit current	values which are reached, e.g. $I_{cn} = 5 \text{ kA}$	values which are reached, e.g. $I_{cn} = 800 \text{ A}$	max. 25kA (AC) max. 10kA (DC)	5 kA / 10kA	200 A, 1 kA, 2 kA, 3,5 kA, 5 kA	min. 250A	
Dielectric strength	$U_i \leq 300V: 1.5kV, 5 \text{ s}$ $U_i \leq 800V: 2.0kV, 5 \text{ s}$	AC250V: 1.5kV / 1 min AC440V: 2.0kV / 1 min		1 kV + 2 U_n , 1 min	1 kV + 2 U_n , 1 min		
E-T-A devices comply with the standard	4230-T (E) under preparation: ESS31-T, ESS20, 2216, ..	4220-T (Icn bis6 kA), 2210, 201, 3600, 3900, 8340, 8345, etc1180, 1180 ESS20 / ESS31-T	NO	4230-T (U) 8345 4220-T at AC 120V (ICN up to 5 kA) (File E223877)	201, 2210 2216-S, 3600, 3900, 1180, 8340, 8345, 4420-T, 4230-T (E), ESS20 / ESS31-T (File E673200)	ESX10 / ESX10-T / REF16-S (File E306740)	ESX10 / ESX10-T / REF16-S
Comment	Selected tests in accordance with this standard can be conducted. Self-certification.	Circuit breakers for equipment protection, protection of control voltages	not applicable to CBEs	not applicable to CBEs	Circuit breakers for equipment protection, protection of control voltages	Acc. to UL same application as CBEs due to integral current limitation	Typical applications in industrial switchgear, acc. to UL same application as CBEs due to integral current limitation

Electro-mechanical circuit breakers thermal-magnetic

Fast DC curves (A, Z, F1 or B) in the lower tolerance band:
Magnetic short circuit trip at 3 ... 5 x I_N or 4.5...7.5 x I_N of CBE

Start-up of electronic system components often not possible as a **high** inrush current trips the breaker.

Medium delayed DC curves (C, M1): trip at 7.5 ... 15 x I_N
SMPS cannot supply the current required for tripping the breaker, **the output voltage is turned down (I/U curve) or disconnected** (foldback, hiccup).

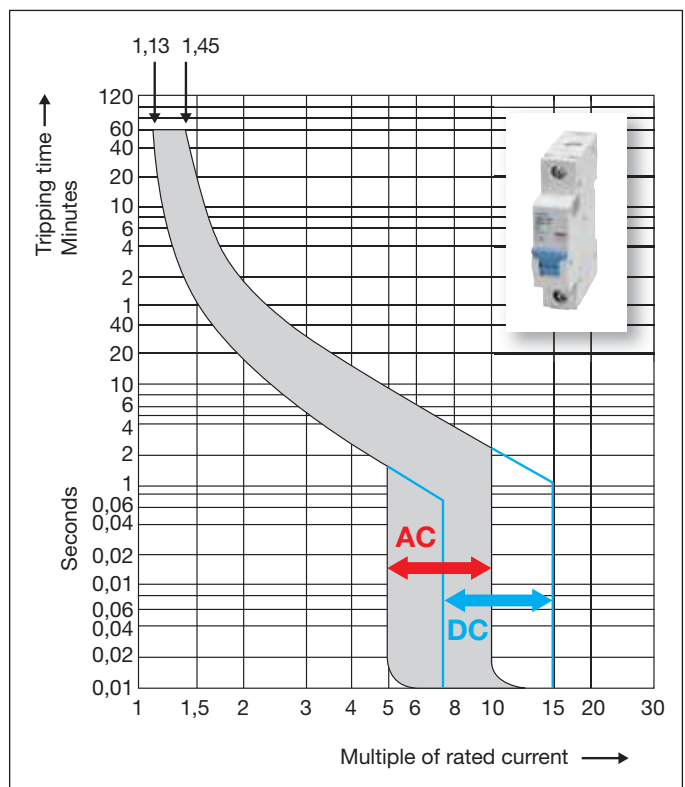
MCBs to IEC / EN 60898 C characteristics

Thermal-magnetic, C characteristics / AC

- thermal:** trips between 1.13 and 1.45 times rated current
- magnetic:** trips between **5** and **10** times rated current

Thermal-magnetic, C characteristics / AC

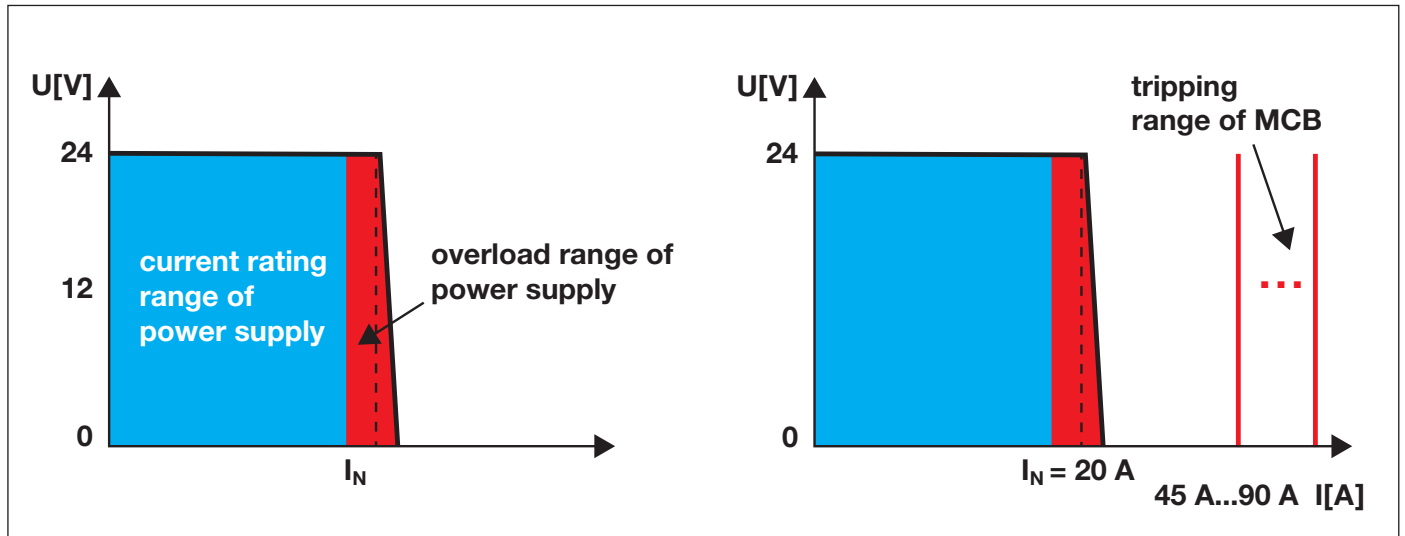
- thermal:** as with AC, trips between 1.13 and 1.45 times rated current
- magnetic:** trips between **7.5** and **15** times rated current



Trip characteristics C

Short circuit in SMPS output MCBs with C characteristics

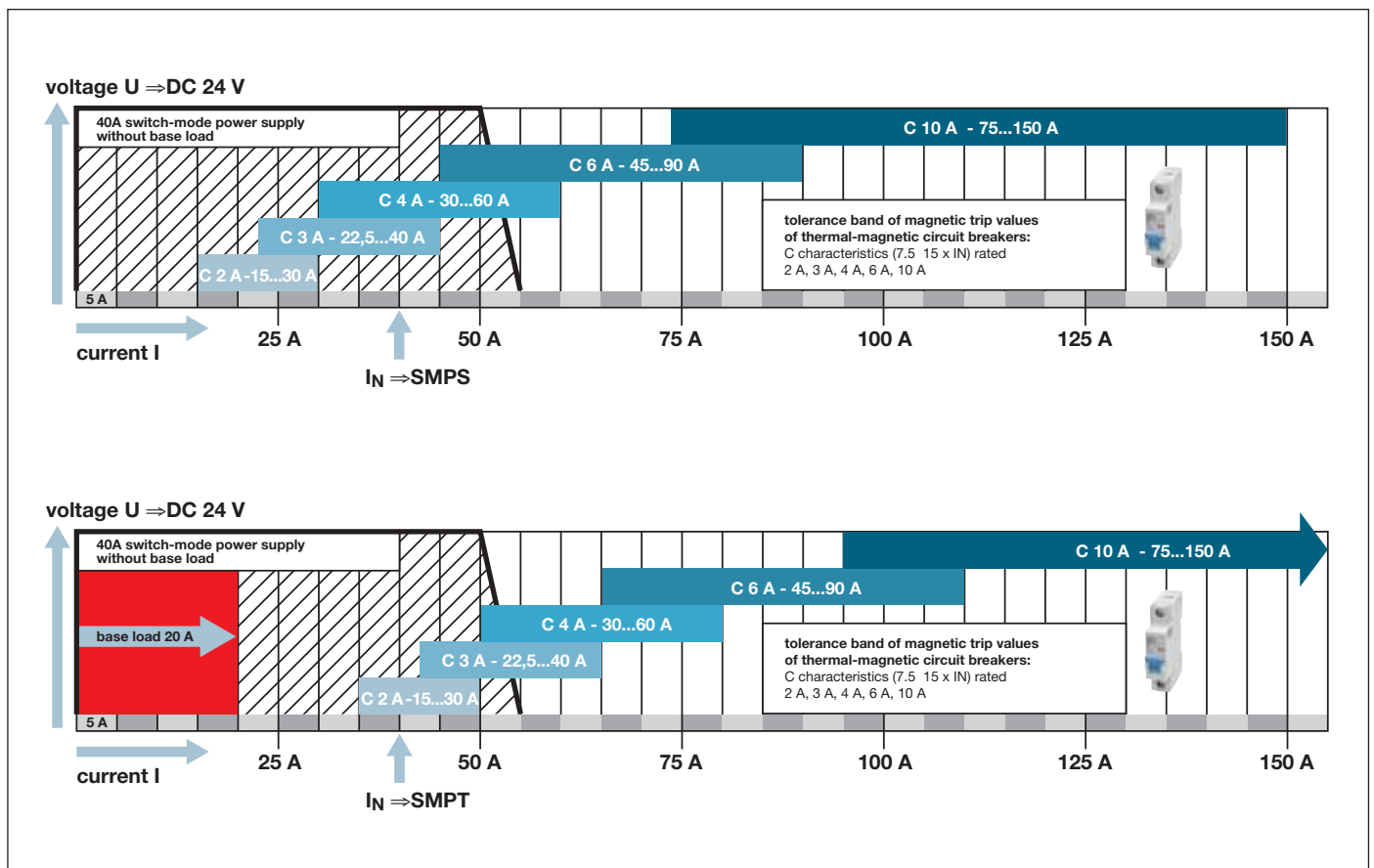
The magnetic trip range of the C breaker is no longer in the acceptable overload range of the power supply: The DC 24 V output voltage breaks down.



Graphical calculation

Trip at short circuit SMPS / MCB with C characteristics

Often the power supply cannot provide the trip current required for magnetic tripping and turns down the output voltage.



Overcurrent protection with thermal-magnetic circuit breakers

Characteristic curves

Thermal Magnetic Circuit Breakers						thermal trip level: ... times of rated current		magnetic trip level after t < 100ms: ... times of rated current	
trip curve	voltage	DC factor	manufacturer	type	rated current I _N	T-u	T-o	M-u	M-o
Z	AC		ABB	Typ S201	1,05	1,05	1,20	2,00	3,00
Z	DC	1,5			1,05	1,05	1,20	3,00	4,50
B	AC				1,13	1,13	1,45	3,00	5,00
B	DC	1,5			1,13	1,13	1,45	4,50	7,50
C	AC				1,13	1,13	1,45	5,00	10,00
C	DC	1,5			1,13	1,13	1,45	7,50	15,00
K	AC				1,05	1,05	1,20	8,00	12,00
K	DC	1,5			1,05	1,05	1,20	12,00	18,00
D	AC				1,13	1,13	1,45	10,00	20,00
D	DC	1,5			1,13	1,13	1,45	15,00	30,00
F1	DC only	1,3	E-T-A	Typ 4220-T	1,01	1,01	1,40	2,00	4,00
F2	AC				1,01	1,01	1,40	3,00	5,00
F2	DC	1,3			1,01	1,01	1,40	4,00	6,50
M1	AC				1,01	1,01	1,40	5,00	10,00
M1	DC	1,3			1,01	1,01	1,40	7,00	13,00
T1	AC				1,01	1,01	1,40	10,00	20,00
T1	DC	1,3	1,01	1,01	1,40	13,00	26,00		
A	AC		SIEMENS	Typ 5SY4	1,13	1,13	1,45	2,00	3,00
A	DC	1,4			1,13	1,13	1,45	2,80	4,50
B	AC				1,13	1,13	1,45	3,00	5,00
B	DC	1,4			1,13	1,13	1,45	4,20	7,00
C	AC				1,13	1,13	1,45	5,00	10,00
C	DC	1,4			1,13	1,13	1,45	7,00	14,00
D	AC				1,13	1,13	1,45	10,00	20,00
D	DC	1,4			1,13	1,13	1,45	14,00	28,00

Types of Circuit Breakers (thermal magnetic)				
trip curve	standard / EU	standard / UL	standard / IEC	remark
A, B, C, D	EN 60898 EN600947-2	UL 1077 UL 489	IEC 60898 IEC 600947-2	MCB (Miniature Circuit Breakers) Circuit Breaker
Z, K	EN600947-2	UL 489	IEC 600947-2	Circuit Breaker
F1, F2 M1, T1	EN600934	UL 1077	IEC 60943	CBE (Circuit Breaker for Equipment)

comparable magnetic (= undelayed) trip curves	
A, Z, F1	
B, F2	
C, M1	
D, T1	

Ampacity of cables vs. current rating of protection

The ampacity of the cables has been added as follows:

● **rated cross section:**

0.14 mm² to 0.5 mm² following VDE 0891 T1

● **rated cross section:**

0.75 mm² to 150 mm² following VDE 0100 T1

● Protection is provided by a blade fuse or an MCB

● **Example:**

at 0.34 mm² ⇒ max. I_N = 3 A at 30 °C

cross section in mm ² , Cu wire	ambient temperature = 30 °C max. operating temperature = 60 °C		ambient temperature = 40 °C max. operating temperature = 60 °C conversion factor = 0,82
	max. load in A	CBE/MCB-Current rating in A	max. load in A
0,14	2	1	1,6
0,25	4	2	3,3
0,34	6	3	4,9
0,50	9	4	7,4
0,75	12	6	9,8
1	15	10	12,3
1,5	18	16	14,8
2,5	26	20	21,3
4	34	25	27,9
6	44	35	36,1
10	61	50	50,0
16	82	63	67,2
25	108	80	88,6
35	135	100	110,7
50	168	125	137,8
70	207	160	169,7
95	250	200	205,0
120	292	250	239,4
150	335	350	274,7

Caution:

This table is only an excerpt from the mentioned standards. Other vital parameters such as heat radiation on cables, laying modes and conditions, insulating materials of the cables as well as other ambient temperatures etc. have to be considered.

Wiring

Length, cross section, resistance

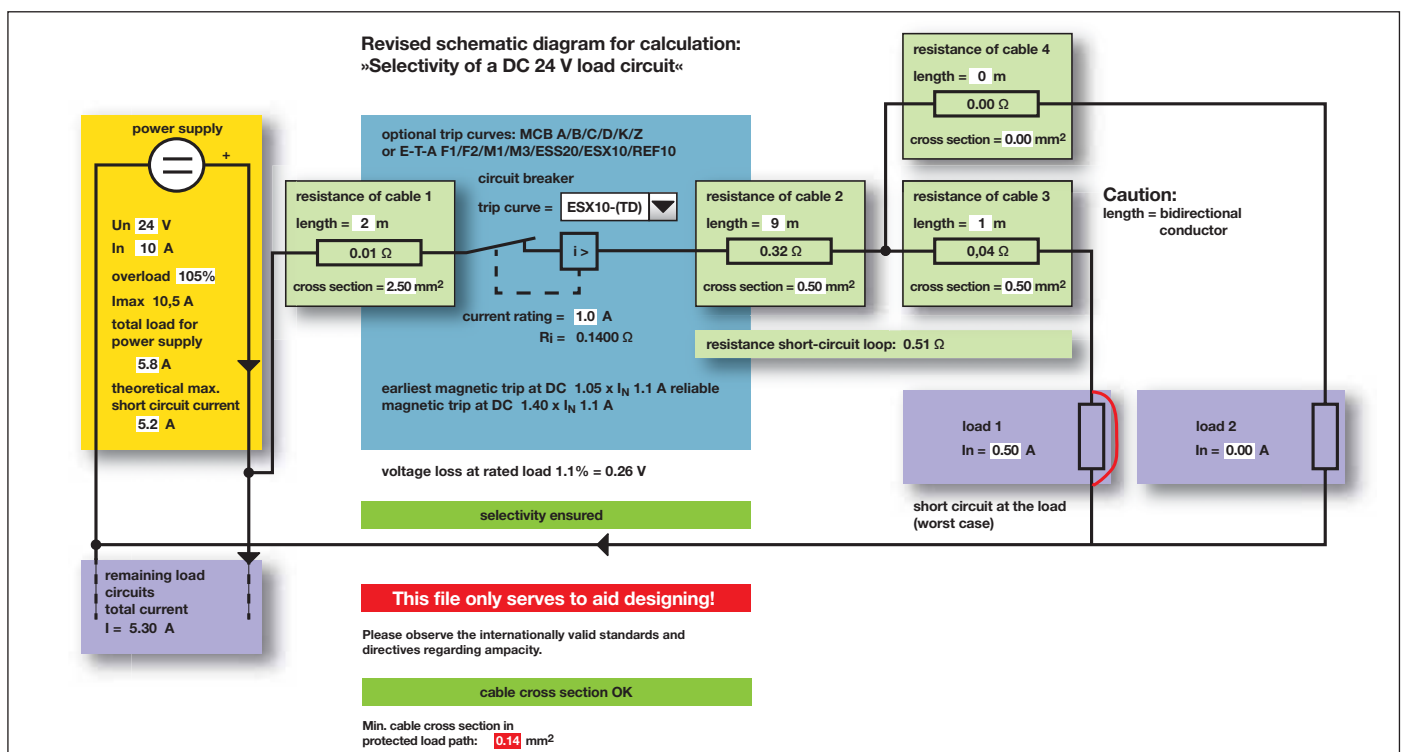
Line impedance defines the max. trip current in DC24V applications

trip current $I = U/R_{total}$; $I = 24 \text{ V}/1.19 \text{ Ohm}$;
 $I = 20.17 \text{ A}$ bei 50 m, 1.5 mm²

resistivity copper $R_0 = 0.0178 \text{ (Ohm} \times \text{mm}^2\text{)/m}$								
cable cross section A in mm ²		0.14;	0.25;	0.34;	0.5;	0.75;	1;	1.5;
		total cable resistance R_{total} in Ohm = $(R_0 \times 2 \times L)/A$						
distance L in metres (one-way length)	5	1.27	0.71	0.52	0.36	0.24	0.18	0.12
	10	2.54	1.42	1.05	0.71	0.27	0.36	0.24
	15	3.81	2.14	1.57	1.07	0.71	0.53	0.36
	20	5.09	2.85	2.09	1.42	0.95	0.71	0.47
	25	6.36	3.56	2.62	1.78	1.19	0.89	0.59
	30	7.63	4.27	3.14	2.14	1.42	1.07	0.71
	35	8.90	4.98	3.66	2.49	1.66	1.25	0.83
	40	10.17	5.70	4.19	2.85	1.90	1.42	0.95
	45	11.44	6.41	4.71	3.20	2.14	1.60	1.07
	50	12.71	7.12	5.24	3.56	2.37	1.78	1.19
	75	19.07	10.68	7.85	5.34	3.56	2.67	1.78
	100	25.43	14.24	10.47	7.12	4.75	3.56	2.37
	125	31.79	17.80	13.09	8.90	5.93	4.45	2.97
	150	38.14	21.36	15.71	10.68	7.12	5.34	3.56
	175	44.50	24.92	18.32	12.46	8.31	6.23	4.15
	200	50.86	28.48	20.94	14.24	9.49	7.12	4.75
225	57.21	32.04	23.56	16.02	10.68	8.01	5.34	
250	63.57	35.60	26.18	17.80	11.87	8.90	5.93	

E-T-A planning tool:

Easy calculation of a DC 24 V system





Overview of electronic protection DC 24 V

Innovative and professional

Product	ESS20-00x	ESS31-T	ESX10 ESX10-S	ESX10-TA	ESX10-TB	ESX10-TD	REF16-S1xx	ESS22-T
Type	electronic circuit breaker	electronic circuit breaker	electronic circuit protector	electronic circuit protector	electronic circuit protector	electronic circuit protector	electronic circuit protector	electronic circuit breaker
Technical Data								
rated voltage	DC 24 V	DC 24 V	DC 24 V	DC 24 V	DC 24 V	DC 24 V	DC 24 V	DC 24 V
operating voltage	DC 18...32 V	DC 18...30 V	DC 18...32 V	DC 18...32 V	DC 18...32 V	DC 18...32 V	DC 18...30 V	DC 18...32 V
current rating I_N	- fixed current ratings 0,5A - 10A - adjustable current ratings 1A/2A und 3A/6A	- fixed current ratings 0,5A - 12A	- fixed current ratings 0,5A - 12A (- adjustable current ratings 1A...10A in 1A steps)	- fixed current ratings 0,5A - 12A	- fixed current ratings 0,5A - 16A	- adjustable current ratings 0,5/1/2A 2/3/4A 2/4/6A 6/8/10A	- fixed current ratings 0,5A - 10A	- fixed current ratings 0,5A - 10A
number of ways	1-way	1-way	1-way	1-way	1-way	1-way	1-way	1-way
manual ON/OFF/reset	push button	push button	Slide switch	Slide switch	Slide switch	Slide switch	Slide switch	Slide switch
trip (error)	- electronically Power- MOSFET - physically	- electronically Power- MOSFET - physically	- electronically Power- MOSFET	- electronically Power- MOSFET	- electronically Power- MOSFET	- electronically Power- MOSFET	- electronically Power- MOSFET	- electronically Power- MOSFET - physically, relay
overload disconnection	typ. $1.1 \times I_N$	typ. $1.2 \times I_N$	typ. $1.1 \times I_N(1.2 \times I_N)$	typ. $1.1 \times I_N$	typ. $1.1 \times I_N$	typ. $1.1 \times I_N$	typ. $1.25 \times I_N$	typ. $1.1 \times I_N$
overload trip time	typ. 3s	typ. 500ms	typ. 3s	typ. 3s	typ. 3s	typ. 3s	typ. 130ms - 800ms	typ. 3s
short circuit current	typ. $1.8 \times I_N$	typ. $1.2 \times I_N$	typ. $1.8 \times I_N(1.4 \times I_N)$	typ. $1.8 \times I_N$	typ. $1.8 \times I_N$	typ. $1.4 \times I_N$	typ. $1.25 \times I_N$	typ. $1.4 \times I_N$
short circuit trip time	typ. 100ms - 3s	typ. 100ms - 3s	typ. 100ms - 3s	typ. 100ms - 3s	typ. 100ms - 3s	typ. 100ms - 3s	typ. 130ms - 800ms	typ. 100ms - 3s
max. switch-on capacity	75,000µF	up to 40,000µF	75,000µF (40,000µF)	75,000µF	75,000µF	75,000µF	20,000µF	20,000µF
signalling	- make contact - break contact - change-over	- make contact - break contact	- make contact - change-over - contact	- without	- make contact - break contact - status output	- make contact - break contact - status output	- make contact - break contact - status output	- make contact - break contact
signal Input	- without	- without	- remote ON/OFF - remote reset	- without	- remote ON/OFF - remote reset	- remote ON/OFF - remote reset	- remote ON/OFF - remote reset	- remote ON/OFF - remote reset
General Data								
mounting method	- plug-in on terminal block 17plus or SVS for rail mounting	- plug-in on terminal block 17plus or SVS for rail mounting	- plug-in on terminal block 17plus or SVS for rail mounting	- rail mounting	- rail mounting	- rail mounting	- plug-in on terminal block 80Plus and 81Plus for rail mounting	- rail mounting
terminal design	spring-load terminals	spring-load terminals	spring-load terminals	screw terminals	screw terminals	screw terminals	- push-in terminals, Socket 80Plus - screw terminals, Socket 81Plus	screw terminals
temperature range	0...+50 °C	0...+50 °C	0...+50 °C	0...+50 °C	0...+50 °C	0...+50 °C	-25 °C...+50 °C	0...+50 °C
dimensions (w x h x d) without terminal block	12.5 x 105 x 60 mm	12.5 x 105 x 60 mm	12.5 x 70 x 60 mm	12.5 x 80 x 83 mm	12.5 x 80 x 83 mm	12.5 x 80 x 83 mm	12.1 x 52 x 45 mm	22.5 x 85 x 92 mm
with terminal block	12.5 x 147.5 x 60mm	12.5 x 147.5 x 60mm	12.5 x 112.5 x 60mm	n/v	n/v	n/v	12.5 x 78 x 45 mm	
Approvals	- UL1077 - EN60934	- UL1077 - EN60934	- UL2367 - UL508 - CSA22.2 No.14 - IEC/EN 60079-0/-14/-15 - ATEX	- UL2367 - UL508 - UL 1604 class I, div. 2 - CSA22.2 No.14/ 142/213 - IEC/EN 60079-0/-14/-15 - ATEX	- UL2367 - UL508 - UL 1604 class I, div. 2 - UL 1604 class 1, div. 2 - CSA22.2 No.14 / 142 / 213 - IEC/EN 60079-0/-14/-15 - ATEX	- UL2367 - UL508 - UL 1604 class I, div. 2 - UL 1604 class 1, div. 2 - CSA22.2 No.14 / 142 / 213 - IEC/EN 60079-0/-14/-15 - ATEX	- UL2367 - cULus 508 listed	- UL1077 - EN60934

Electronic circuit breaker ESS20 (single pole), plug-in type

Product characteristics

- rated voltage DC24V (18 ... 32 V), also battery-buffered
- current ratings
 - adjustable: 1 A/2 A, 3 A/6 A
 - fixed: 0,5 A, 1 A, 2 A, 3 A, 4 A, 6 A, 8 A, 10 A
- electronic, current limiting trip curve
- with physical isolation in accordance with UL1077 and VDE approval to IEC/EN60934
- capacitive loads up to 75,000,000µF and motors possible
- aux. contact break contact or make contact
- LED status indication
- manual ON/OFF switch

- integral fail-safe element
- for power distribution systems
 - Module 17plus, SVSxx and **Power-D-Box®**

Features and benefits:

- narrow width of only 12.5mm
- physical isolation
- plug-in type
- a single trip curve for all types of loads
- projectable protection through current limitation
- approval to UL1077 and VDE (IEC/EN60934)



Electronic circuit breaker ESS31-T (single pole) for rail mounting

Product characteristics

- rated voltage DC24V (18 ... 30 V), also battery-buffered
- fixed current ratings: 0,5 A, 1 A, 2 A, 3 A, 3,6 A, 4 A, 6 A, 8 A, 10 A, 12 A
- electronic, current limiting trip curve
- with physical isolation in accordance with UL1077 and VDE approval to IEC/EN60934
- capacitive loads up to 40,000µF and motors possible
- aux. contact N/C or N/O
- LED status indication
- manual ON/OFF switch
- integral fail-safe element
- for rail mounting and for mounting side-by-side
- integral power distribution system up to 40A load distribution

Features and benefits:

- narrow width of only 12.5 mm
- physical isolation
- a single trip curve for all types of loads
- reliable protection through current limitation
- approval to UL1077 and VDE (IEC/EN60934)



Electronic circuit protector ESX10/ESX10-S (1-pole), pluggable

Product characteristics

- rated voltage DC24V (18 ... 32 V), also battery-buffered
- current ratings:
 - fixed: 0.5 A, 1 A, 2 A, 3 A, 4 A, 6 A, 8 A, 10 A, 12 A
 - adjustable: 1 A...10 A (ESX10-S...)
- electronic, current limiting trip curve
- approval to UL 2367 as overcurrent protector, UL508 UL 1604 class I div.2, CSA 22.2, GL, ATEX, NEC class 2 (max. 3A)
- capacitive loads up to 75,000 µF and motors possible
- aux. contact, status output SF, remote ON/OFF, remote reset
- LED status indication
- manual ON/OFF and reset switch
- integral fail-safe element
- for power distribution systems Module 17plus, SVSxx and **Power-D-Box®**

Features and benefits:

- narrow width of only 12.5mm
- plug-in type
- a single trip curve for all types of loads
- projectable protection through current limitation
- approval to UL 2367 as overcurrent protector UL 508, UL 1604 class I div.2, CSA 22.2, GL, ATEX, NEC class 2 (max. 3 A)



Electronic circuit protector ESX10-T (single pole) for rail mounting

Product characteristics

- rated voltage DC24V (18 ... 32 V), also battery-buffered
- current ratings:
 - fixed values: 0.5 A, 1 A, 2 A, 3 A, 4 A, 6 A, 8 A, 10 A, 12 A, 16 A
 - switchable: 0.5A/1A/2A, 2A/3A/4A, 2A/4A/6A, 6A/8A/10A
- electronic, current limiting trip curve
- capacitive loads up to 75,000 µF and motors possible
- aux. contact, status output SF, remote ON/OFF, remote reset
- LED status indication
- manual ON/OFF and reset switch
- integral fail-safe element
- approval to UL 2367 as overcurrent protector cUL 508, UL1604 class I div.2, CSA22.2, GL, ATEX, NEC class 2 (max. 3 A)
- for rail mounting and multi-way side-by-side mounting
- integral power distribution system up to 40 A load distribution



Electronic circuit protector ESX10-TA and ESX10-TB

Features and benefits:

- narrow width of only 12.5 mm
- adjustable and fixed current ratings
- for rail mounting and mounting side-by-side
- a single trip curve for all types of loads
- projectable protection through current limitation
- approval to UL 2367 as overcurrent protector UL 508, UL 1604 class I div.2, CSA 22.2, GL, ATEX, NEC class 2 (max. 3 A)



Electronic circuit protector
ESX10-TB on symmetrical rail

Electronic circuit protector
ESX10-TD

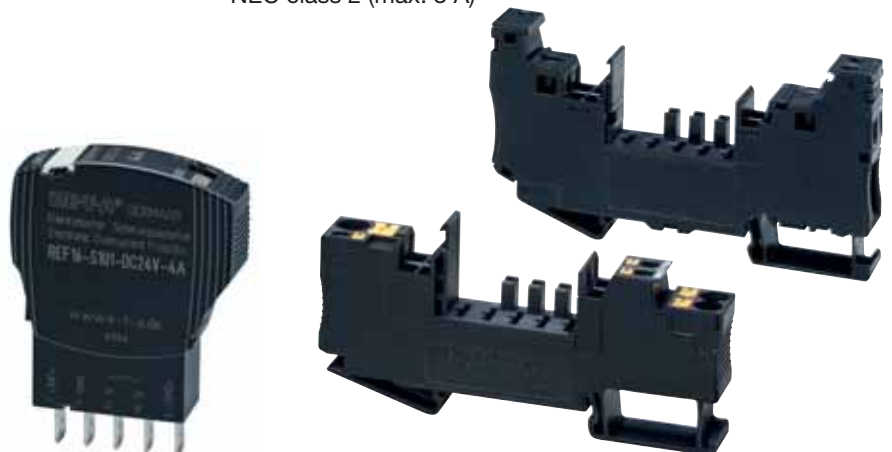
Electronic circuit protector REF16-S (single pole), plug-in type

Product characteristics

- rated voltage DC 24 V (18 ... 30 V)
- fixed current ratings: 0.5 A, 1 A, 2 A, 3 A, 4 A, 6 A, 8 A, 10 A
- electronic, current limiting trip curve
- capacitive loads up to 20,000 µF and motors possible
- auxiliary contact, status output SF remote ON/OFF (relay function), remote reset
- LED status indication
- manual ON/OFF and reset switch
- integral fail-safe element
- approval to UL 2367 as »Overcurrent Protector«, UL 508
- for socket 80PLUS (push-in terminals) and 81PLUS (screw terminals)

Features and benefits:

- narrow width of only 12.5mm
- fixed current ratings
- for rail mounting and mounting side-by-side
- a single trip curve for all types of loads
- projectable protection through current limitation
- approval to UL 2367 as overcurrent protector UL 508, UL 1604 class I div.2, CSA 22.2, GL, ATEX, NEC class 2 (max. 3 A)



Electronic circuit protector ESS22-T (double pole)

Product characteristics

- rated voltage DC24V (18 ... 32 V), also battery-buffered
- fixed current ratings:
0.5 A, 1 A, 2 A, 3 A, 4 A, 6 A, 8 A, 10 A
- electronic, current limiting trip curve
- with physical isolation in accordance with UL1077 and VDE approval to IEC/EN60934
- capacitive loads up to 20,000 μF and motors possible
- aux. contact N/O or N/C
- remote ON/OFF, remote reset
- LED status indication
- manual ON/OFF switch
- integral fail-safe element
- for direct rail mounting

Features and benefits:

- narrow width of only 22.5mm
- 2-pole physical isolation
- for direct rail mounting
- a single trip curve for all types of loads
- projectable protection through current limitation
- approval to UL1077 and VDE (IEC/EN60934)
- **meets the requirements of EN 60204-1, para 9.4.3.1**
»Double pole protection of ungrounded DC 24 V systems«



Electronic circuit breaker
ESS22-T (2-pole)

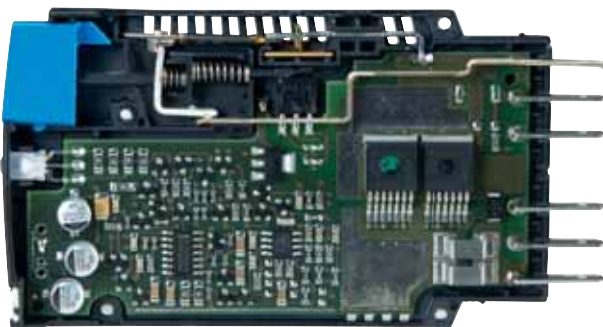
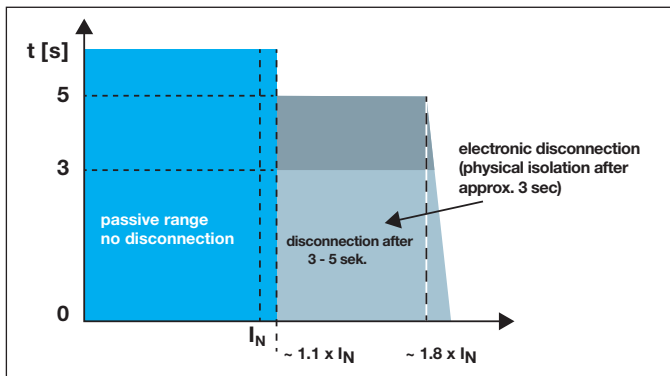
Basic trip curve

Electronic overcurrent protection

Example: Electronic circuit breaker ESS20

Electronic current limitation to $1.8 \times I_N$ at short circuit or start-up

- time slot 100 ms... 3 s
(loading time for capacitive loads, start-up of DC motors)
- electronic disconnection at overcurrent



Electronic circuit breaker ESS20

Overcurrent protection with electronic circuit breakers

Characteristic curves

Electronic Circuit Breaker / Electronic Overcurrent Protector						overload trip level typically $1.1 \times I_N$		current limitation at overload or short-circuit
trip curve	trip curve comp.	voltage	manufacturer	type	rated current I_N	min.	max.	$I_{Limit}^{*1)}$
EH	B, C, d	nur DC	E-T-A	ESS20	0.5...10 A	1.05	1.35	typically $1.8/1.5 \times I_N$
E	B, C, d	nur DC		ESX10	0.5...12 A	1.05	1.35	typically $1.8/1.5/1.3 \times I_N$
E	B, C, d	nur DC		ESX10-T	0.5...12 A	1.05	1.35	typically $1.8/1.5/1.3 \times I_N$

min. = lower limit of trip level / overload
max. = higher limit of trip level / overload
 I_{Limit} = current limitation, dependend I_N

d-curve?
Protection of small DC motors

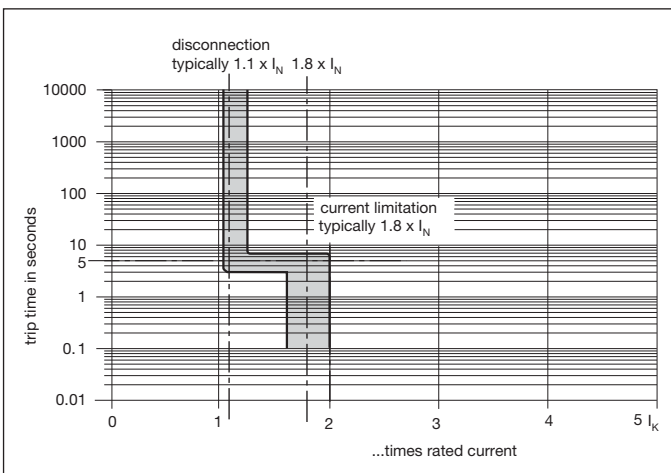
Types of Circuit Breakers (electronic)				
trip curve	standard/ EU	standard/ UL	standard/ IEC	remark
EH (electronic hybrid)	EN 60934	UL 1077	IEC 60934	Supplementary Protector CBE (Circuit breaker for equipment)
E (electronic)	open	UL 2367, UL 508 (UL1077/ *2)	open	Solid-State or Electronic Overcurrent Protector

- In a range of $1.1...1.8 \times I_N^{*1)}$ the trip time is typically 3 s.
- The electronic current limitation typically begins at $1.8 \times I_N$. **This means: under all overload conditions (independent of power supply and load circuit resistance) typically 1.8 times rated current is applied until disconnection.** The trip time varies between 100 ms and 3 s depending on the multiple of the current rating or at short circuit (I_k).
- Without the current limitation getting into effect at typically $1.8 \times I_N$ there would be a much higher overcurrent in the event of an overload or short circuit.

*2) Due to the integral current limitation, the types ESX10 or ESX10-T (just like type ESS20) can be used as »Supplementary Protectors« directly at the DC 24 V output of a circuit breaker for the protection of the cables and loads in the control cabinet.

Overload disconnection (OL) typically $1.1 \times I_N$ ($1.05...1.35 \times I_N$)

- *1) current limitation typically $1.8 \times I_N$ at $I_N = 0.5 A...6 A$
- current limitation typically $1.5 \times I_N$ at $I_N = 8 A...10 A$
- current limitation typically $1.3 \times I_N$ at $I_N = 12 A$
- current limitation typically $1.15 \times I_N$ at $I_N = 16 A$



Electronic circuit breaker
ESS20



Electronic circuit protector
ESX10-T



Electronic circuit protector
ESX10

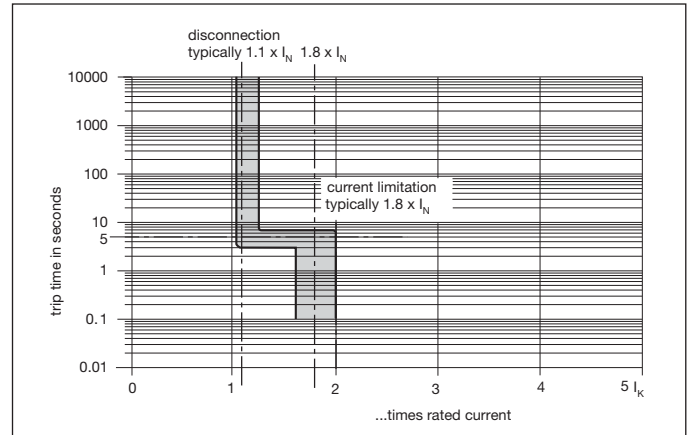
Characteristic curves

Electronic overcurrent protection

Electronic circuit breaker ESS20

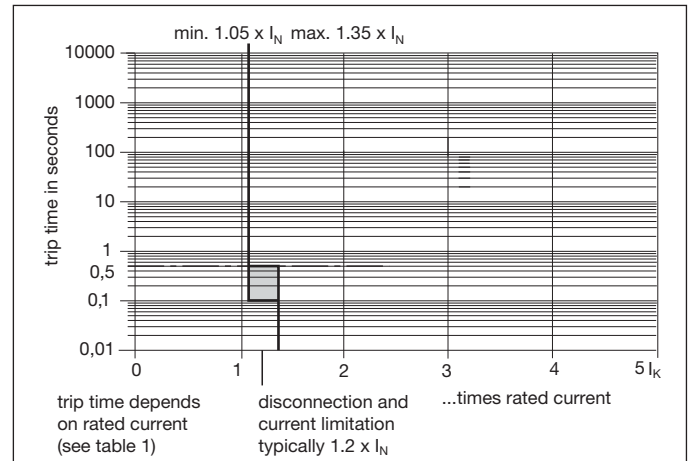
- In a range of $1.1 \dots 1.8 \times I_N^{*1}$ the trip time is typically 5 s.
- Electronic current limitation typically starts at $1.8 \times I_N^{*1}$ **This means: under all overload conditions (independent of power supply and load circuit resistance) typically 1.8 times rated current is applied until disconnection^{*1}**. The trip time is between 100 ms (short circuit I_k) up to approx. 5 s (in the event of overload with high cable attenuation).
- Without the current limitation getting into effect at typically $1.8 \times I_N$ there would be a much higher overcurrent in the event of an overload or short circuit.
- When the ESS20-0.. has detected an overload or short circuit condition, the LED will change from GREEN to ORANGE. The LED goes out when the circuit breaker has tripped.
- Reset of the circuit breaker is only possible after the integral bimetal has cooled down (approx. 10 s).

*1) current limitation typically $1.8 \times I_N$ at $I_N = 0.5 \text{ A} \dots 6 \text{ A}$
 current limitation typically $1.5 \times I_N$ at $I_N = 8 \text{ A} \dots 10 \text{ A}$



Electronic circuit breaker ESS31-T

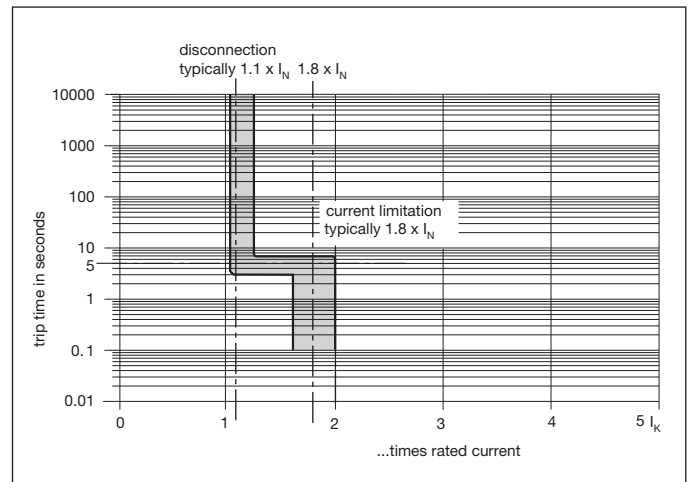
- The overload trip time is typically 500 ms (e.g. ESS31-T-...-6 A)
- The electronic current limitation typically begins in at $1.2 \times I_N$. **This means: under all overload conditions (independent of power supply and load circuit resistance) typically 1.2 times rated current is applied until disconnection^{*1}**. The corresponding current limitation value I_{Limit} depends on the current rating of the device I_N .
- Without the current limitation getting into effect at typically $1.2 \times I_N$ there would be a much higher overcurrent in the event of an overload or short circuit.
- Reset of the circuit breaker is only possible approximately 10 sec after tripping.



Electronic circuit protector ESX10...

- In a range of $1.1 \dots 1.8 \times I_N^{*1}$ the trip time is typically 3 s.
- The electronic current limitation typically begins in at $1.8 \times I_N$. **This means: under all overload conditions (independent of power supply and load circuit resistance) typically 1.8 times rated current is applied until disconnection^{*1}**. The trip time varies between 100 ms and 3 s depending on the multiple of the current rating or at short circuit (I_k).
- Without the current limitation getting into effect at typically $1.8 \times I_N$ there would be a much higher overcurrent in the event of an overload or short circuit.

*1) current limitation typically $1.8 \times I_N$ at $I_N = 0.5 \text{ A} \dots 6 \text{ A}$
 current limitation typically $1.5 \times I_N$ at $I_N = 8 \text{ A} \dots 10 \text{ A}$
 current limitation typically $1.3 \times I_N$ at $I_N = 12 \text{ A}$

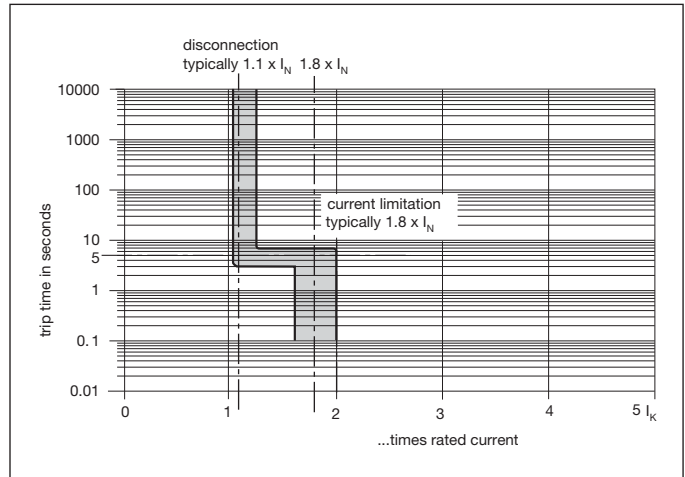


Characteristic curves

Electronic overcurrent protection

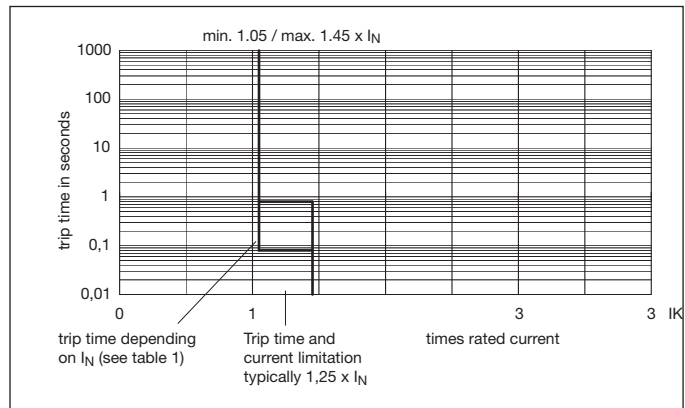
Elektronic circuit protector ESX10-S

- In a range of $1.1 \dots 1.8 \times I_N$ the trip time is typically 3 s (e.g. ESX10-TB-...-6A).
- The electronic current limitation typically begins in at $1.8 \times I_N$. **This means: under all overload conditions (independent of power supply and load circuit resistance) typically 1.8 times rated current is applied until disconnection.** The corresponding current limitation value $I_{L\text{limit}}$ depends on the current rating of the device I_N (see table 1) The trip time varies between 100 ms and 3 s depending on the multiple of the current rating or at short circuit (I_K).
- Without the current limitation getting into effect at typically $1.8 \times I_N$ there would be a much higher overcurrent in the event of an overload or short circuit.



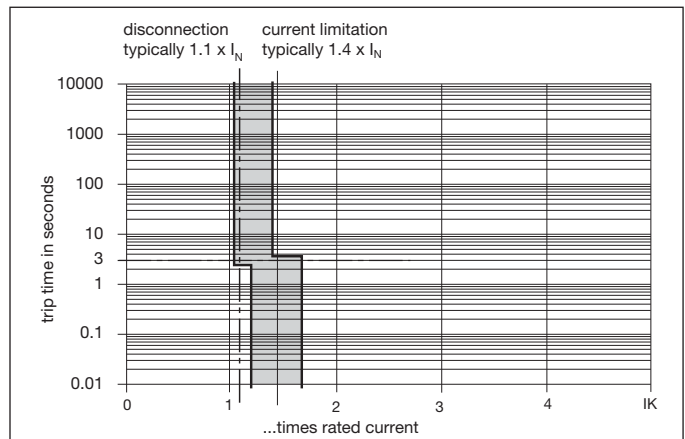
Electronic overcurrent protector REF16-S

- The trip time is typically between 80 ms to 800ms depending on the current rating (I_N).
- Electronic disconnection and/or current limitation begins at typically $1.25 \times I_N$. **This means: under all overload conditions (independent of power supply and load circuit resistance) typically 1.25 times rated current is applied.**
- Without the current limitation getting into effect at typically $1.25 \times I_N$ there would be a much higher overcurrent in the event of an overload or short circuit.



Electronic circuit breaker ESS22-T

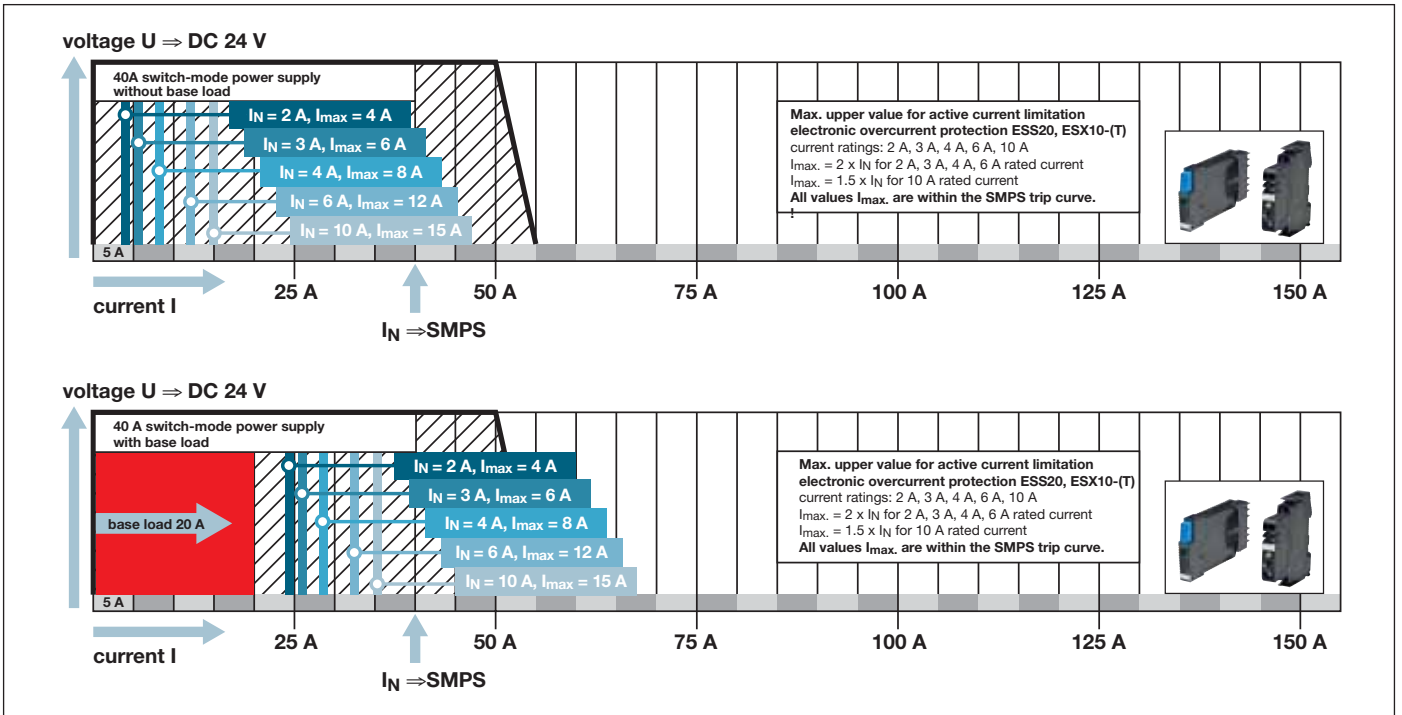
- In a range of $1.1 \dots 1.4 \times I_N$ the trip time is typically 3 s.
- The electronic current limitation typically begins in at $1.4 \times I_N$. **This means: under all overload conditions (independent of power supply and load circuit resistance) typically 1.4 times rated current is applied.** The trip time varies between 100 ms and 3 s depending on the multiple of the current rating or at short circuit (I_K).
- Without the current limitation getting into effect at typically $1.4 \times I_N$ there would be a much higher overcurrent in the event of an overload or short circuit.



Graphical calculation

Trip at short circuit SMPS / Electronic overcurrent protection

Active current limitation ensures trip at short circuit of the electronic overcurrent protection devices. The switch-mode power supply will not be overloaded and will reliably continue to supply the non-affected paths.



Reliable tripping

of ESS20, ESX10(-T) and REF16-S

resistivity copper $R_0 =$	0.0178 ($\Omega \times \text{mm}^2/\text{m}$)						
$U_B = \text{DC } 19.2 \text{ V}$ (=80% von 24 V)	The voltage drop at ESS20, ESX10 or REF16-S (R_i approx. 0.050Ω independent of I_N) and the tolerance of the switch-off point (typically $1.1 \times I_N = 1.05 \dots 1.25 \times I_N$) has already been taken into account.						
ESS20/ESX10: Rated current I_N (in A)	3.0	6.0					
Trip current $I_{\text{ab}} = \text{max. } 1.25 \times I_N$ (in A)	3.75	7.5	ESS20/ESX10 trip after 3...5 s, REF16 after 80...800 ms aus.				
R_{max} in Ohm = $(U_B/I_{\text{ab}}) - 0.050$	5.07	2.51					
ESS20/ESX10/REF16 reliably trip from 0 Ω to the max. circuit resistance R_{max} (*1)							
cable cross section A in mm^2	0.14	0.25	0.34	0.5	0.75	1.0	1.5
distance L in metres (one-way length)	total cable resistance $\Omega = (R_0 \times 2 \times L)/A$						
5	1.27	0.71	0.52	0.36	0.24	0.18	0.12
10	2.54	1.42	1.05	0.71	0.47	0.36	0.24
15	3.81	2.14	1.57	1.07	0.71	0.53	0.36
20	5.09	2.85	2.09	1.42	0.95	0.71	0.47
25	6.36	3.56	2.62	1.78	1.19	0.89	0.59
30	7.63	4.27	3.14	2.14	1.42	1.07	0.71
35	8.90	4.98	3.66	2.49	1.66	1.25	0.83
40	10.17	5.70	4.19	2.85	1.90	1.42	0.95
45	11.44	6.41	4.71	3.20	2.14	1.60	1.07
50 (*2)	12.71	7.12	5.24	3.56	2.37	1.78	1.19
75	19.07	10.68	7.85	5.34	3.56	2.67	1.78
100	25.43	14.24	10.47	7.12	4.75	3.56	2.37
125	31.79	17.80	13.09	8.90	5.93	4.45	2.97
150	38.14	21.36	15.71	10.68	7.12	5.34	3.56
175	44.50	24.92	18.32	12.46	8.31	6.23	4.15
200	50.86	28.48	20.94	14.24	9.49	7.12	4.75
225	57.21	32.04	23.56	16.02	10.68	8.01	5.34
250	63.57	35.60	26.18	17.80	11.87	8.90	5.93
Example 1:	max. distance at 1.5 mm^2 and 3 A		214 m (200 m corresp. to 4.75 Ohm, 214 m corresp. to 5.07 Ohm)				
Example 2:	max. distance at 1.5 mm^2 and 6 A		106 m (100 m corresp. to 2.37 Ohm, 106 m corresp. to 2.37 Ohm)				
Example 3:	mixed wiring: (control cabinet --- sensor/actuator level)		R1 = 40 m in 1.5 mm^2 and R2 = 5 m in 0.25 mm^2 R1 = 0.95 Ohm R2 = 0.71 = Ohm total (R1 + R2) = 1.66 Ohm				

Different supply lines and cable cross sections

rule of thumb (*1): ESS20/ESX10/REF16 rated 3 A can protect cable resistances of 5 Ω

rule of thumb (*2): at 1.5 mm^2 :
50 m distance = 100 m cable length = 1.2 Ω cable attenuation

Electronic overcurrent protection

Benefits


What are the user benefits of E-T-A's electronic overcurrent protection devices?

We meet the requirements of the updated Machinery Directive 2006/42/EC and EN60204-1 "Safety of machinery and electrical equipment", because:

- The electronic overcurrent protectors provide selective overcurrent protection: The faulty path is disconnected, the remaining components of the control technology (PLC, safety components, sensors, actuators, bus modules etc.) remain unaffected.
- The DC24V control voltage remains stable even in the event of a short circuit or overcurrent.
- Reliable trip at $1.1 \times I_N$ is ensured even with small cable cross sections and long load lines.
- Availability of the plant is increased significantly, as trouble shooting and maintenance becomes much easier.
- MCBs often cannot ensure selectivity and cable protection in DC 24 V systems. The overload or short circuit current is always determined by the total circuit resistance R_{total} . (R_{total} = cable resistance + internal resistance of protective element + contact resistance of terminals)
- Planning a DC 24 V application becomes much easier as the active current limitation to typically 1.8 times rated current provides a reliable planning factor for designing the size of the switch-mode power supply to be used and the size of the cable cross sections.
- In addition the current limitation increases typical life of relay and safety contacts in load circuits.
- The plug-in types (ESX10, REF16-S) allow quick change of the rating.
- In the event of repair works, removing the component establishes physical isolation and the current path is protected against re-connection. The types ESS20 and ESS31-T ensure physical isolation in the event of a failure (by bimetal operation).

Using electronic overcurrent protection is also a considerable contribution to cost reduction of the entire system:

- Switch-mode power supplies can now be used without problems.
- The narrow width of only 12.5 mm including auxiliary contacts allows smaller control cabinets.
- The single way design allows adjustment to the application in question or to the number of required load outputs. There are no extra costs through unused load outputs.
- E-T-A's electronic overcurrent protection holds a single trip curve for resistive, inductive and capacitive loads. Even DC drives can easily be actuated and protected with these protection devices. The selected current rating has only to be adjusted to the load current and the cable cross sections used. This makes planning much easier and helps to reduce costs for electrical design.
- Besides fixed current ratings, we can also offer switchable devices. They help to realise the entire overcurrent protection design with only one or two types.



The advantages of E-T-A's electronic overcurrent breakers and protectors at a glance:

- small width
- adjustable and fixed current ratings
- only one trip curve required
- ease of planning
- high system and plant availability
- cost reduction

Electronic overcurrent protection

Overview of approvals

Overview of standards

- **UL 1077** Supplementary Protectors for Use in Electrical Equipment
- **UL 2367** Solid State Overcurrent Protectors
- **UL 508** Industrial Control Equipment
- **UL 1604** Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations
- **UL 489** Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures
- **UL 60950-1** Information Technology Equipment - Safety - Part 1 General Requirements
- **UL 508A** Industrial Control Panels (requirements for control cabinets)

Excerpt from the UL508 approval of the ESX10-T (example):




The UL approval document of type ESX10-T (to UL508), file no. E322549 shows an information on page 2 under "General" that the ESX10-T can even be used as a "Supplementary Protector" due to its integral current limitation. = page 1)

(1) UL Comment

GENERAL:

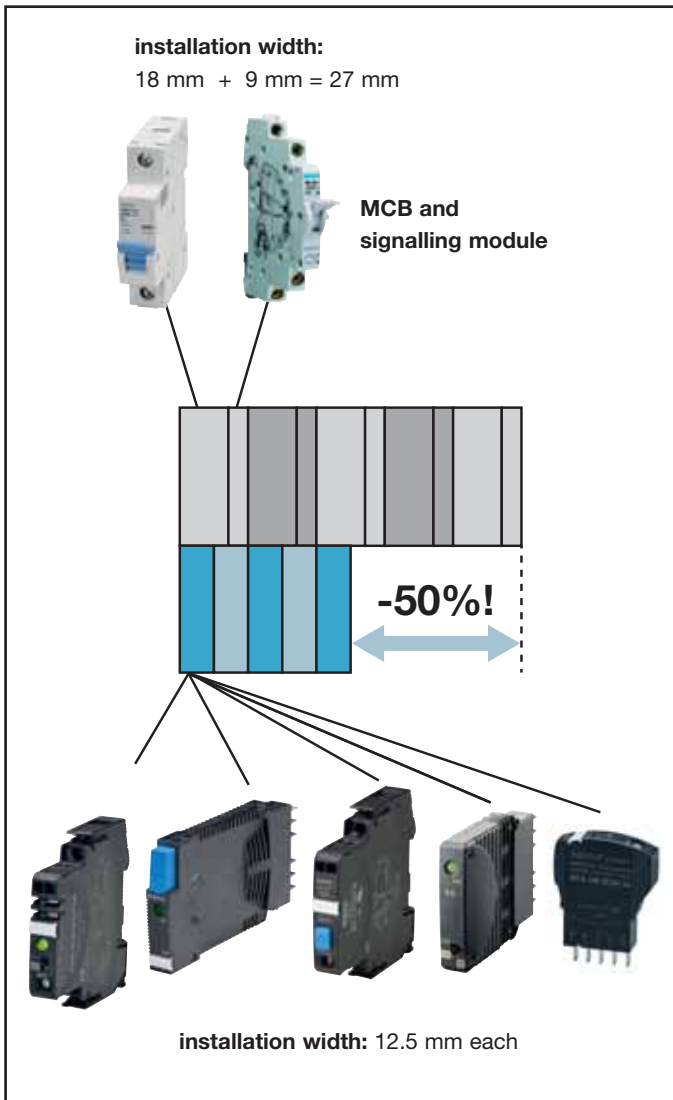
These devices are single pole electronic over-current switches which limit the overload current to 180 percent of rated current. They are intended to provide supplementary protection within electrical equipment.

Approval mark	Type	Approvals / Standards as per 17 March 2014
	ESS20 Electronic Circuit Breaker 	UL 1077: Supplementary Protectors for Use in Electrical Equipment, File E67320 Comment: According to UL 508A, table SA 1.1, section 40.1.3 only devices approved to UL 1077 (»Supplementary Protectors«) may be used for overcurrent protection in control circuits which have been designed as »Industrial Control Panel« to UL 508A
	ESS31-T Electronic Circuit Breaker 	UL 1077: Supplementary Protectors for Use in Electrical Equipment, File E67320 Comment: According to UL 508A, table SA 1.1, section 40.1.3 only devices approved to UL 1077 (»Supplementary Protectors«) may be used for overcurrent protection in control circuits which have been designed as »Industrial Control Panel« to UL 508A
 In progress 	ESX10-T Electronic Overcurrent Protector 	UL 2367: Solid State Overcurrent Protectors File E306740 UL 508: Industrial Control Equipment File E322549 CSA C22.2 No. 142 > UL 508 UL1604: Electrical Equipment for Use in Hazardous Locations Class I div 2, Groups A, B, C, D; TC T5; File E320024 CSA C22.2 No. 213 > UL 1604 UL comment > see (1)
 In progress 	ESX10 Electronic Overcurrent Protector 	UL 2367: Solid State Overcurrent Protectors File E306740 UL 508: Industrial Control Equipment File E322549 CSA C22.2 No. 142 > UL 508 UL1604: see ESX10 UL comment > see (1)
	REF16-S Electronic Overcurrent Protector 	UL 2367: Solid State Overcurrent Protectors File E306740 UL 508: Industrial Control Equipment File E322549 CSA C22.2 No. 14 > UL 508 UL comment > see (1)
	REF16-S Electronic Overcurrent Protector 	UL 508: Industrial Control Equipment File E322549 UL comment > see (1)

Approval mark	Type	Approvals / Standards as per 17 March 2014
	17plus Power Distribution System (ESS20/ESX10) 	UL 60950-1: Information Technology Equipment – Safety – Part 1 General Requirements, File E216113
	SVS.. Power Distribution System (ESS20/ESX10)  here: SVS04-08	UL 508: Industrial Control Equipment Comment: UL approval for SVS under discussion, components (pcb, terminal blocks etc.) UL approved

Space-saving design, application and wiring

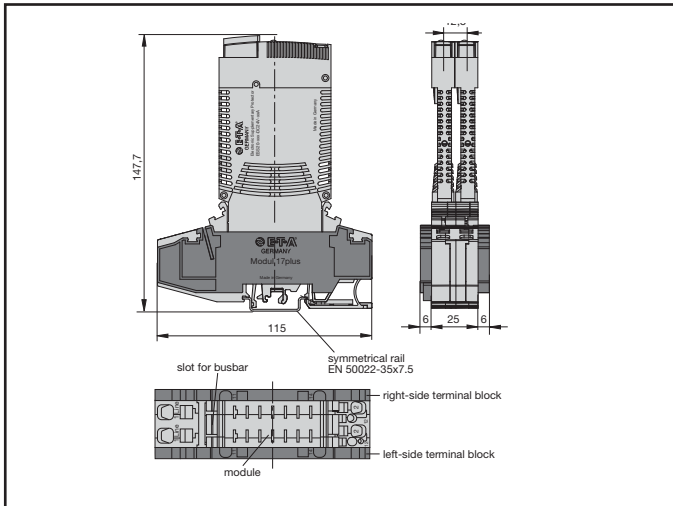
Electronic overcurrent protection



Flexible power distribution for centralised and decentralised control cabinet concepts

Standard solutions

Modular power distribution Module 17plus



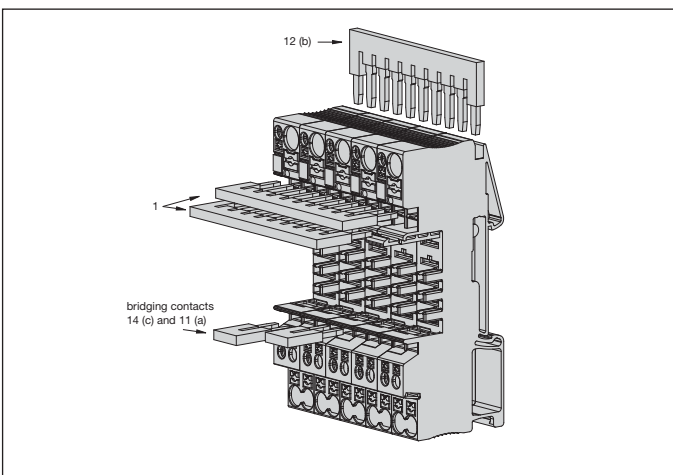
- modular power distribution system, total current max. 32A/ 50A
- two-way terminal block
- DC24V supply via busbars
- load output (protected): 1 x per way
- signal supply via left and right terminal blocks
- signalling already pre-wired, external protection required
- for all types ESS20-..., ESX10-1.., 2210-S21.



Power distribution system
Module 17plus

Standard solutions

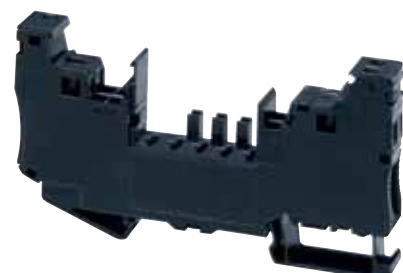
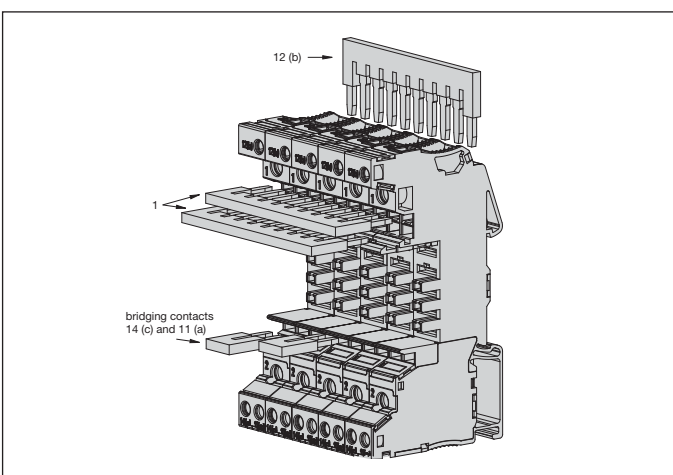
Socket 80Plus / 81Plus



- modular sockets, total current max. 32 A/41 A
- single way design
- PT terminals (80Plus)
- screw terminals (81Plus)
- retaining clips for a tight fit of the breakers
- DC 24 V+ and GND can bridged via jumpers
- load output (protected):
2 x per way (80Plus), 1 x per way 81Plus
- signal supply
- signalling variants via busbars
- for all breakers type REF16-S and 2216-S



socket 80plus





socket 80plus


Customer-specific solutions

Power distribution system SVS



product	number of slots	dimensions: d x w x h (without CBE, including rail) tolerances to DIN ISO 266 part 1 IT13	fitted with	max. ampacity a) total current b) l/way c) signalling	operating voltage	supply terminals a) +UB b) DV c) FE d) PE	load outputs per slot	minus outputs for load	signalling line entry / outputs	signalling	termination cross-sections a) supply b) load output c) signal output	remote (control input)	specials b) customers	bus-capable, connection
SVS02-x 	4/8/12/16	4 ways 52.1 x 109.5 x 105.4 8 ways 52.1 x 171.5 x 105.4 12 ways 52.1 x 233.5 x 105.4 16 ways 52.1 x 295.5 x 105.4	ESS20-003 ESX10-103 2210-S21x 3500	a) 40 A cont. load b) max. 8 A c) max 0.5 A	24 V DC/ max. 32 V DC	a) DC 24 V+ b) DC 24 V- c) FE functional earth loop-through 2 each termination	5 outputs per slot 1 x L+S group output (+) 1 x L+L protected load output 2 x minus 1 x FE	2 x per way	terminal X31 5-pole internal supply via insulated wire bridge (SC) external supply +24 V signal output (group signalling) (-) additional output -24 V (FE) additional output FE	group signalling, supply X31, signal circuit protected on power distribution system	a) screw terminals max. 10 mm ² b/c) B10 plug-in type screwless connectors or B20 plug-in type screw terminals max 2.5 mm ² (without wire end ferrules)	n/a	by means of the 1st CBE several ET200 sub-assemblies can be protected via group output L+S (L+S = electronic voltage, L+L = load voltage) b) BMW FFT EDAG Produktionssysteme Staudinger GmbH	n/a

product	number of slots	dimensions: dxwxh (without CBE, including rail) tolerance to DIN ISO 266 part 1 IT13	fitted with	max. ampacity a) total current b) l/way c) signalling	operating voltage	supply terminals a) +UB b) DV c) FE d) PE	load outputs per slot	minus outputs for load	signalling line entry / outputs	signalling	termination cross-sections a) supply b) load output c) signal output	remote (control input)	specials b) customers	bus-capable, connection
SVS04-x 	4/8/12/16	4 ways 52.1 x 125.5 x 105.4 6 ways 52.1 x 167.5 x 105.4 8 ways 52.1 x 211.5 x 105.4	ESS20-003 ESX10-103 2210-S21x 3600	a) 40 A cont. load b) max. 8 A c) max 0.5 A	24 V DC	a) DC 24 V+ b) DC 24 V- c) FE integral loop-through, for sub-distributions and connection of an external buffer module	5 outputs per slot 5x (L+) protected	15 x terminals X22-X24 30 x terminals X22-X24 Version K01	terminal X31 5-pole (-)DC 24 V supply of terminal X21 (S) supply group signalling DC 24 V (AS) output group signalling (GH) supply two-group signalling (AS) output group A (F5-F8) (B) output group B (F1-F4)	group signalling two-group signalling supply X31 aux. circuit protected on distribution rail	a) screwless terminals max. 10 mm ² b/c) B10 plug-in type screwless connectors or B20 plug-in type screw terminals or C10 screwless spring-loaded terminals max 2.5 mm ² (without wire end ferrules)	n/a	versions S80x terminals special marking versions S00x pre-fitted with ESS20 b) Grob Werke GmbH & Co.KG Osram GmbH	n/a

product	number of slots	dimensions: d x w x h (without CBE, including rail) tolerance to DIN ISO 266 part 1 IT13	fitted with	max. ampacity a) total current b) l/way c) signalling	operating voltage	supply terminals a) +UB b) DV c) FE d) PE	load outputs per slot	minus outputs for load	signalling line entry / outputs	signalling	termination cross-sections a) supply b) load output c) signal output	remote (control input)	specials b) customers	bus-capable, connection
SVS14-x 	4/8/12/16	10 ways 64.5 x 104 x 184 vertical mounting position	ESS20-003 ESX10-103 2210-S211 3600-P10 3900-P10	a) max. 25 A b) max. 8 A c) max. 0.5 A	24 V DC (18...32 V)	a) DC 24 V+ b) DC 24 V- loop-through 2 each termination	2 outputs per slot terminals X1-X10 (L+) protected load output 1 x each	1 x per way	terminal X31 2-pole (S1) external supply 24 V DC (+) (S2) signal output If the distribution rail is not completely fitted with circuit breakers, the open signal path (S2) to (S1) can be closed with the integral Si switch (per way). Close Si switch (switch over)	group signalling, supply X31 S1/S2	a) screw terminals marked max. 16 mm ² b) 2-pole double level terminal with screw terminal max. 4 mm ² marked c) 2-pole screw terminal, marked, max 2.5 mm ²	n/a	Caution: Provide external protection for signalling (0.5 A/fast) integral ammeter	n/a

product	number of slots	dimensions: d x w x h (without CBE, including rail) tolerance to DIN ISO 266 part 1 IT13	fitted with	max. ampacity a) total current b) l/way c) signalling	operating voltage	supply terminals a) +UB b) DV c) FE d) PE	load outputs per slot	minus outputs for load	signalling line entry / outputs	signalling	termination cross-sections a) supply b) load output c) signal output	remote (control input)	specials b) customers	bus-capable, connection
SVS16	4/8/12/16	8 ways 56.5 x 184 x 127.8 16 ways 56.5 x 284 x 127.8	ESX10-1x5 E-1048-7xx	a) max. 40 A b) max. 8 A c) via bus connection	24 V DC	load pcb a) 1+/2+ b) 1-/2- c) PE bus pcb a) 1+/2+ b) 1-/2- integral loop-through for sub-distribution and connection of an external buffer module	3 outputs per slot X1-X3 1 x + 1 x - 1 x PE	1 x per way	terminal X31 supply bus module 9-pole D-Sub connector X50 bus connection	single signalling via PROFIBUS	a) screwless terminals max. 10 mm ² load supply push-in terminal max. 1.5 mm ² bus supply b) three-level screwless spring-loaded terminals max. 1.5 mm ² screw terminals optional c) 9-pole D-Sub connector	via PROFIBUS	bus-capable power distribution system PROFIBUS b) Lead customer Arcelor Mittal Belgium	PROFIBUS

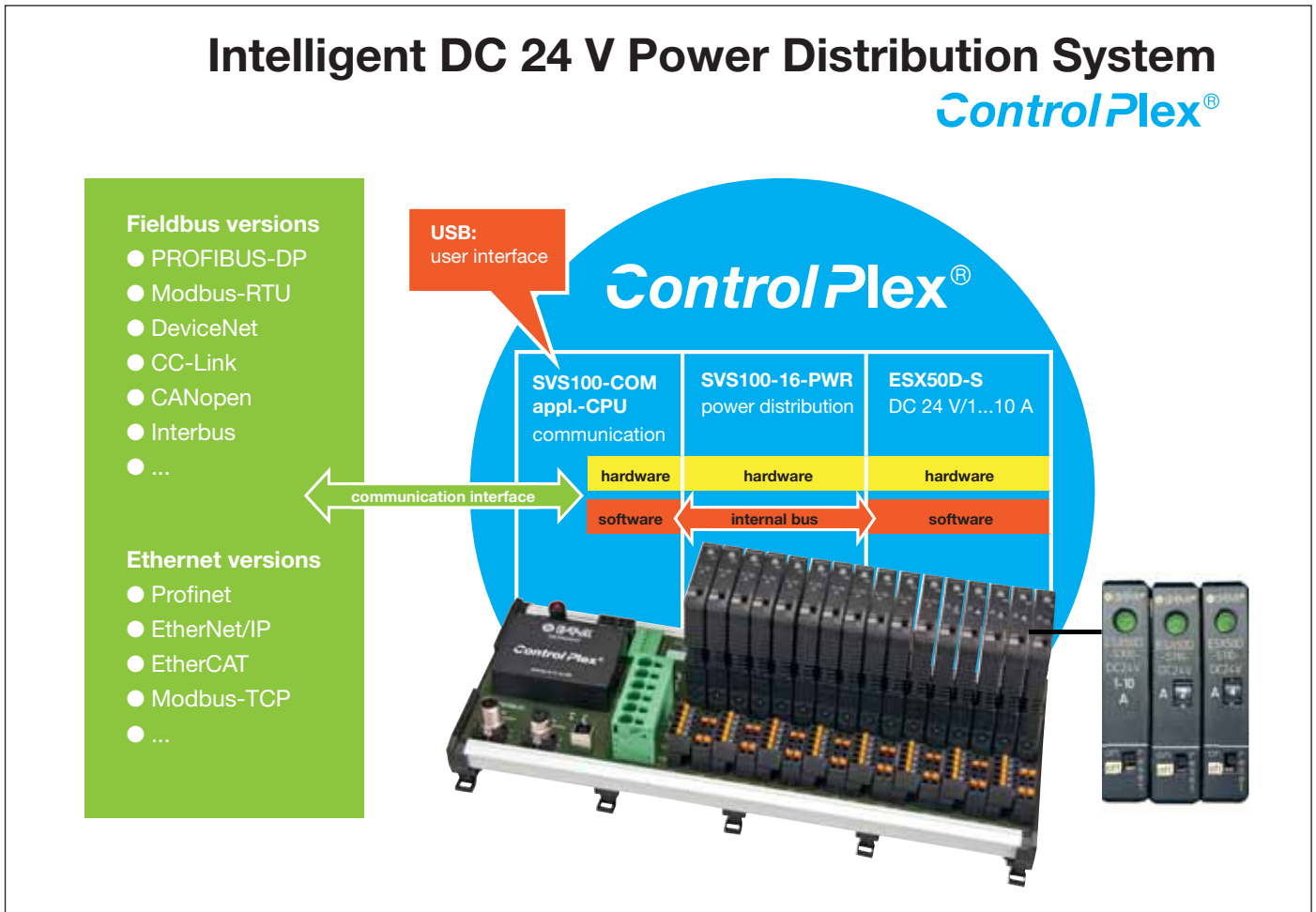


product	number of slots	dimensions: d x w x h (without CBE, including rail) tolerance to DIN ISO 266 part 1 IT13	fitted with	max. ampacity a) total current b) l/way c) signalling	operating voltage	supply terminals a) +UB b) DV c) FE d) PE	load outputs per slot	minus outputs for load	signalling line entry / outputs	signalling	termination cross-sections a) supply b) load output c) signal output	remote (control input)	specials b) customers	bus-capable, connection
SVS18	10	10 ways 50 x 185 x 142,3	ESS20-003 ESX10-103 max. 6 A	a) max. 25 A b) typically 3 A per slot typically 1.5 A per diode c) max. 0.5 A	24 V DC	a) L1 b) L2 2 x U1/U2 bridged each, bridge can be removed b) L- 3 x	max. 4 outputs per slot 2 x 1+/2+ 2 x 3-/4- 2 x U1/U2 2 x 0 V	2 x per way	terminal X31 total current 0.5A 13 1 x input 14 5 x output	group signalling terminals X31	a) push-in terminals max. 10 mm ² b) push-in terminals max. 2.5 mm ² c) push-in terminals max. 2.5 mm ²	n/a	a) supply of 2 different potentials possible U1/U2 per load output 2 redundancy diodes connected in parallel via jumpers (typically rated 3A) jumper can be removed (typically rated 1.5A) b) DOW Chemical	n/a



product	number of slots	dimensions: d x w x h (without CBE, including rail) tolerance to DIN ISO 266 part 1 IT13	fitted with	max. ampacity a) total current b) l/way c) signalling	operating voltage	supply terminals a) +UB b) DV c) FE d) PE	load outputs per slot	minus outputs for load	signalling line entry / outputs	signalling	termination cross-sections a) supply b) load output c) signal output	remote (control input)	specials b) customers	bus-capable, connection
SVS20	8	8 ways 56.4 x 210 x 142.3	ESS20-003 ESX10-103	a) max. 40 A b) max. 8 A c) max. 0.5 A	24 V DC	a) +/+/ b) -/-	10 load outputs per way 10 x L1/2/3/4/5/ 6/7/8/9	5-pole terminals X22-X28 total: 35 minus terminals	terminal X31 5-pole X31.1 (Out-S/GR1) signal output X31.2 (24 V DC+) ext. supply X31.3 (IN-GR) supply group signal X31.4 (PROT24) aux. circuit X31.5 (IN-S/Out-GR2)	group signalling two-group signalling supply X31 aux. circuit protected on distribution rail	a) screwless terminals max. 10 mm ² a)b)c) load outputs / minus terminals / signalling, plug-in type screwless connectors, marked max. 2.5 mm ²	n/a	10 protected load output terminals per slot external supply possible between load output terminals (L) and (I) per slot (safety disconnection) b) Grob/Daimler	n/a





ControlPlex®

Intelligent power distribution system SVS100

ControlPlex® consists of SVS100-PWR and SVS100-COM

- Power distribution backplane for 16 ways (or 8 ways)
- Supply +24 V, 0 V, PE 2 x 10 mm² each, max. 40 A
- All terminals: spring-loaded terminals or push-in
- To be used in decentralised IP67 systems and at the same time as IP20 solution
- Voltage supply for all ways F1 to F16 and of the loads is effected directly from the DC24V supply. The supply for the electronic control unit (COM module) can also be fed separately
- Protection for SVS100-COM is already integrated
- Additional integral total current measurement on the SVS100 (max. 50A)
- Complete wiring of US1, US2, 0 V, 0 V, PE per slot
- Joint US1 supply (SVS100-16-PWR)
 - A) 1 x US1 via F1 (7 x US2 output to F2, F3, ... , F8)
 - B) 1 x US1 via F9 (7 x US2 output to F10, F11, ... , F16)
- Extendable to 64 ways by way of cascading of the power distribution systems



Intelligent power distribution system SVS100

ControlPlex® Board

Intelligent power distribution system SVS100

ControlPlex® for electronic circuit protectors type **ESX50D-S**, plug-in types for F1 to F16, parameterisable current rating 1...10 A, per software with internal communication interface (right unit)

ESX50D version: "OFFLINE" rating adjustment directly on the unit via selector switch 1 A ... 10 A (left unit)

Features of type ESX50D-S

- A single trip curve for all types of loads (capacitive load up to 40,000µF, DC motors etc.)
- Adjustable alarm values for the load current, e.g. 90% (50% ... 100%)
- Indication of input voltage, load current, load voltage, limit values, unit temperature
- Status indication system voltage ("DC24V OK")
- Status indication per way (overload/short circuit)
- Adjustment of switch-on delay/disconnection sequences per software (e.g. for PROFlenergy)
- QUIT/RESET and ON and OFF operation per way possible (e.g. for PROFlenergy)
- Additional manual reset on the device possible
- Multicoloured LED, to be switched off ONLINE & OFFLINE, "Sleep Mode" (e.g. PROFlenergy)
- History memory ("HISTOMEMO"), event-triggered recording of measuring values

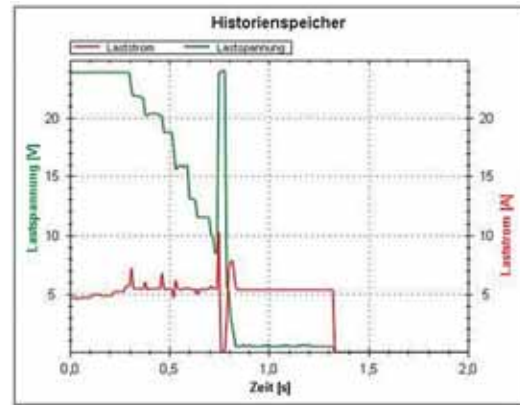
ControlPlex® Software and user dialogue platform

- Clear lay-out "At a glance: Everything hunky-dory".
- Parameterisable via USB or directly via communication interface e.g. current rating 1 A to 10 A in 1A steps, limit values, switch-on sequences ...

Optional: current rating adjustable directly on the unit

- All adjustments can be saved (internally or externally), documentation serves as a test record of machine/system. All future changes or replacements will be recorded.
- Ease of start-off without manual, only "Windows" and "Mouse" knowledge required.
- Start-up configuration is saved for machine approval, system documentation etc.
- Overcurrent parameters are not accessible to the user.

The only electronic trip curve for all DC 24 V load types makes electrical planning easy!



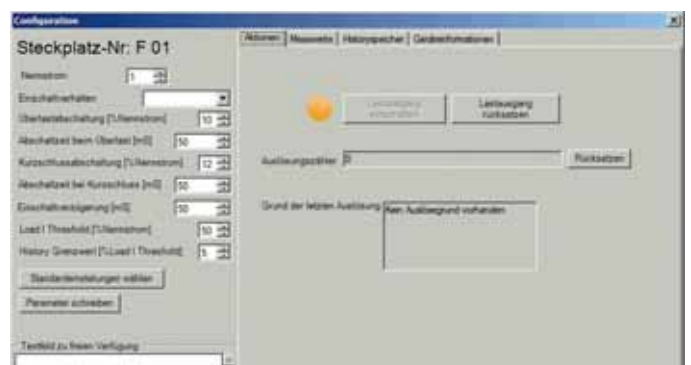
ControlPlex® HISTO-MEMO



Electronic circuit protector **ESX50D-S**



Software interface **ControlPlex®**



Menu "actions"

Customer-specific solutions
 from **Power-D-Box®** to control cabinet

Standard 19" box
PDB-P-L-ESS20-30A0-B1

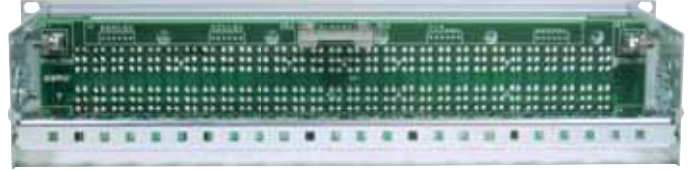
- for the electronic circuit breaker ESS20



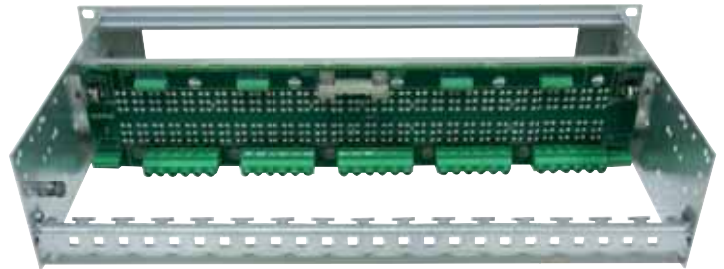
Electronic circuit breaker ESS20



front view

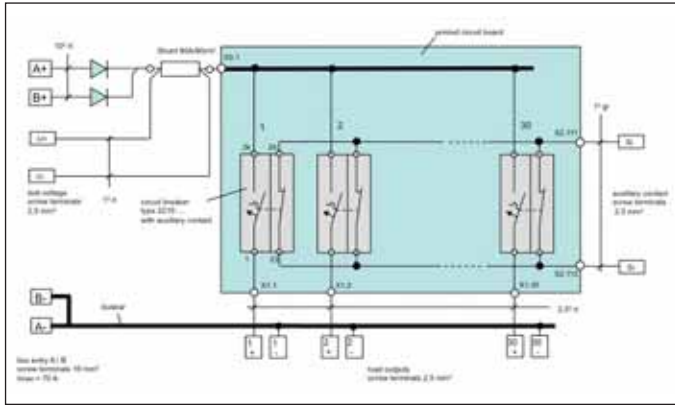


rear view

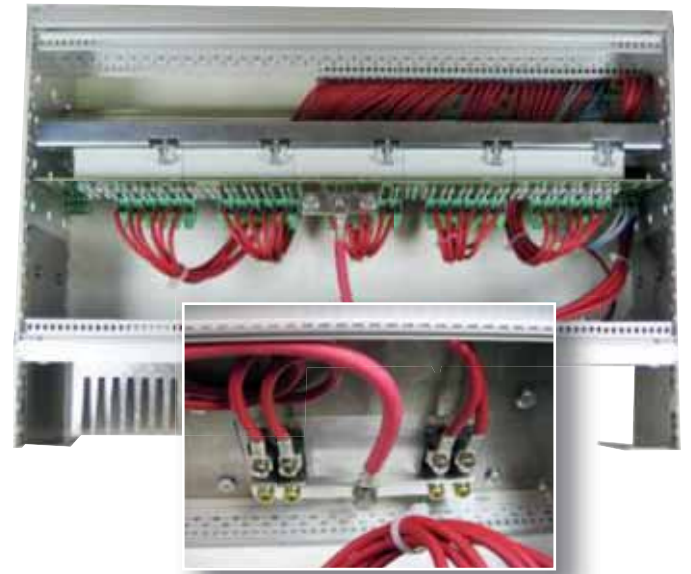
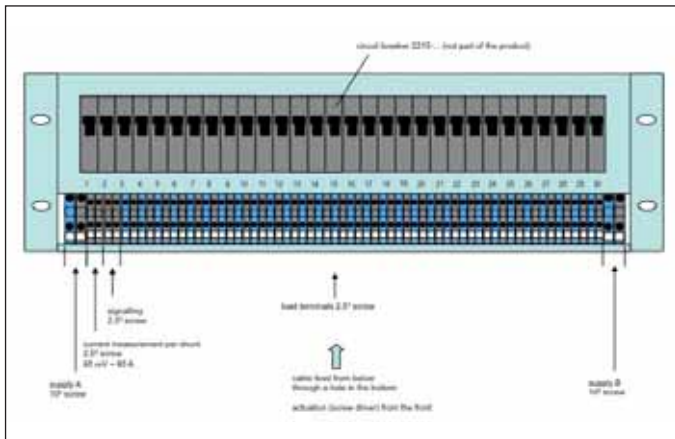


Special version 19" box S438 with de-coupling diodes
19BGT-3-ESS20-30R2RB-B1GR-LS438

- for the electronic circuit breaker ESS20



front view



top view and de-coupling diodes

Customer-specific solutions from **Power-D-Box**® to control cabinet

Control cabinet **SBG T018**

- economic and space-saving control cabinet design
- saves up to 50% of costs through use of cascadable power distribution systems for DC24V with slots for electronic circuit breakers

New possibilities provided by additional electronic sub-assemblies:

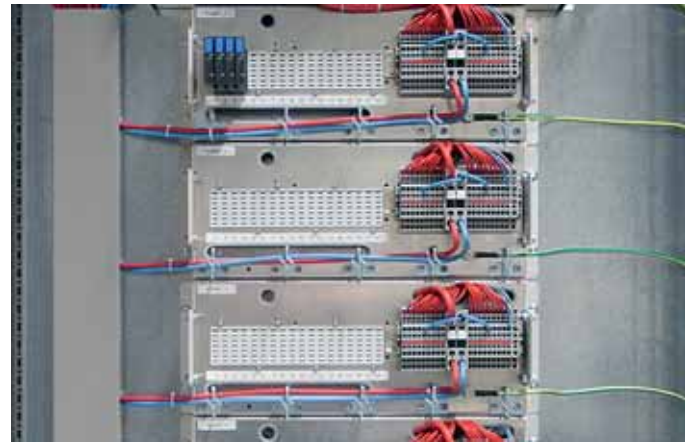
- intelligent alarm processing
- remote control
- bus connection
- emergency functions
- redundancy



power supplies, diode de-coupling and protection



*control cabinet **SBG T018***



load distribution modules



de-coupling module

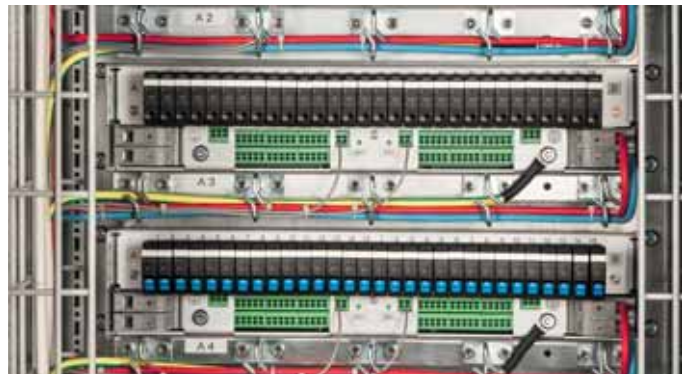
Customer-specific solutions
from **Power-D-Box**® to control cabinet



Demo control cabinet T029



Redundant power supply with diode de-coupling



Power Distribution Module (PDM) for ESS20, 2216 and REF16



Power distribution systems SVS for ESX10-S and ESS20



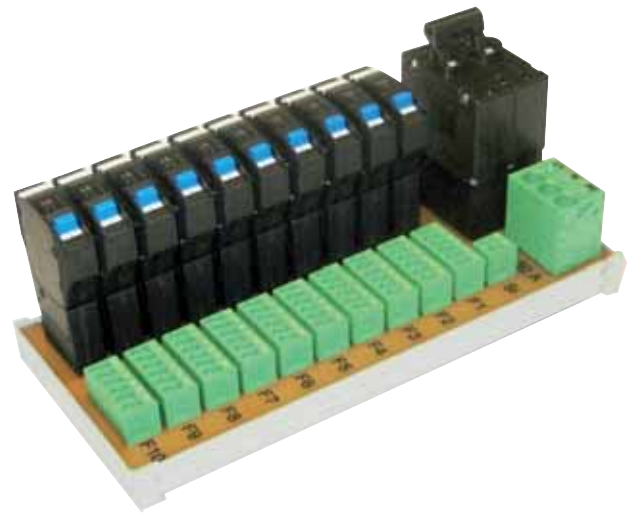
High current distribution by means of X8345-D01 and hydraulic-magnetic Circuit Breaker Type 8345

Customer-specific solutions from **Power-D-Box**® to control cabinet

AC power distribution system **SBG-V0071** for 10 load circuits protected with thermal-magnetic Circuit breaker **2216** and main switch (back-up fuse) through 2-pole, hydraulic-magnetic circuit breaker **8340-F**.



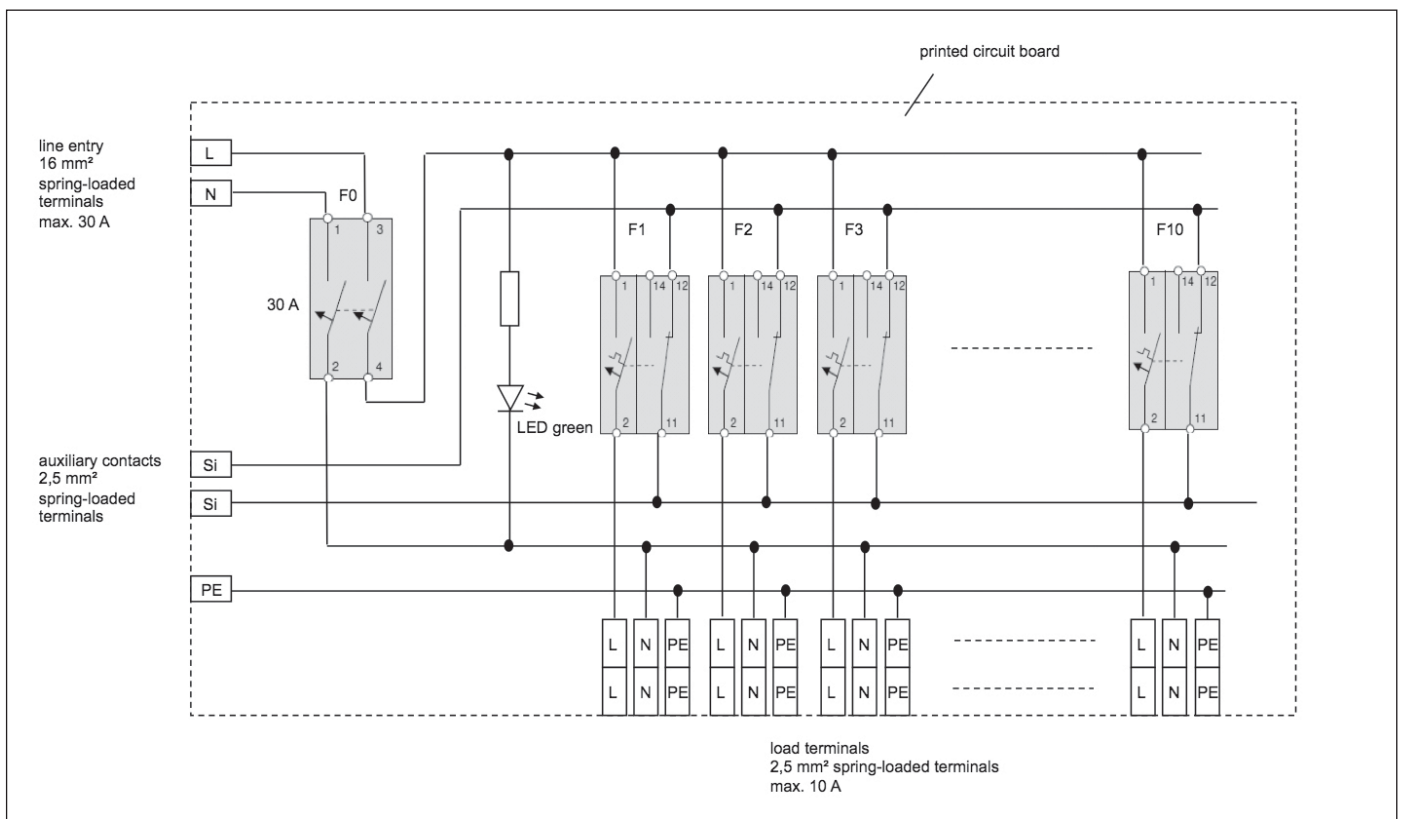
front view



top view



side view



Customer-specific solutions from **Power-D-Box**® to control cabinet

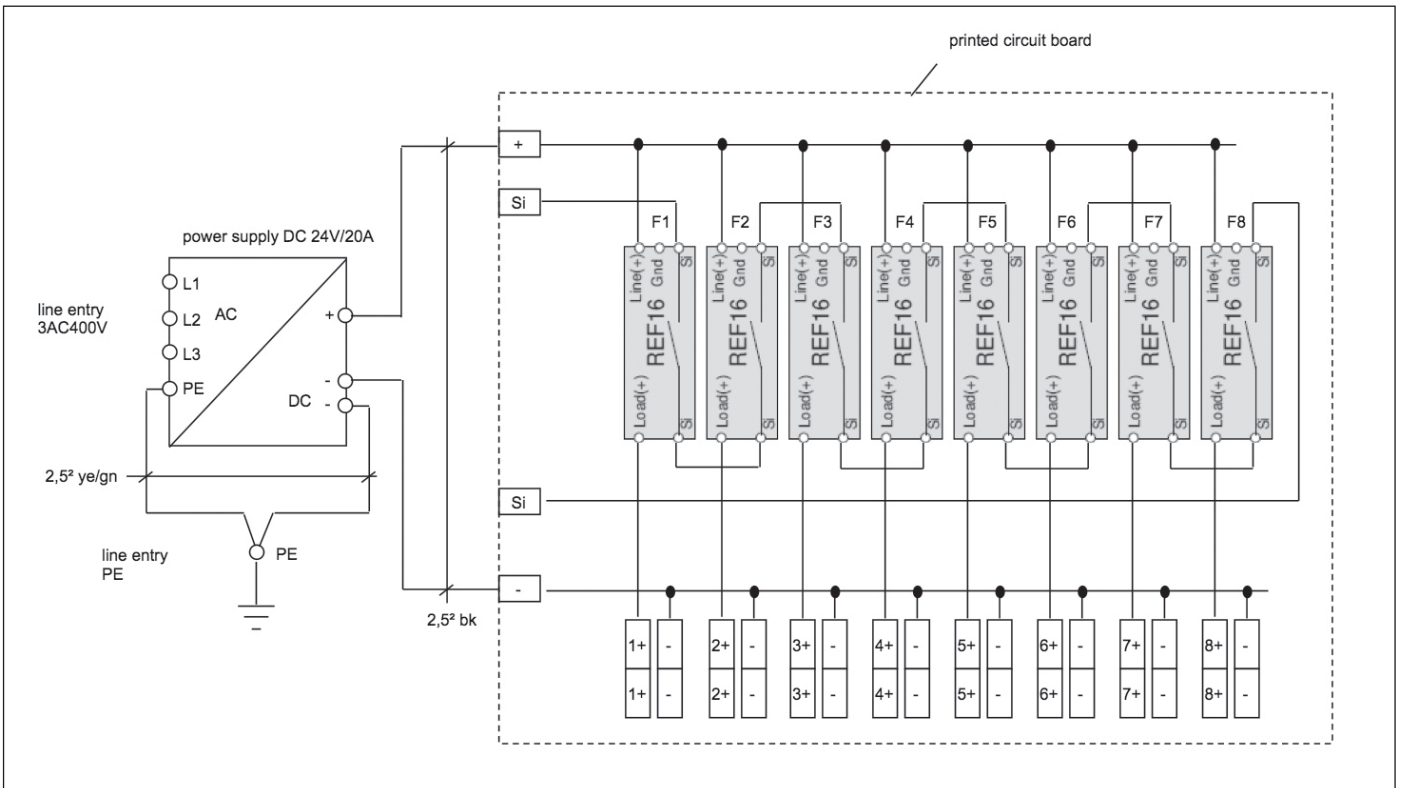
Power supply and protection module **SBG-V0057** with SMPS 20A and for eight load circuits, protected by electronic circuit protector type **REF16** for installation in control cabinets, compatible with servo outputs for motor drives



compact module with power supply



installation between servo converters



Customer-specific solutions from **Power-D-Box**® to control cabinet

Power Distribution Module (PDM) and Power Distribution Box (PDB) for thermal-magnetic circuit breaker type 2216 and electronic circuit protector type REF16-S

- Redundant (2 x 15 ways) or non-redundant (1 x 30 ways)
- Mounting on rear wall in control cabinet (PDM) or in 19" rack (PDB)
- Spring-loaded terminals on the rear or front
- Line entry up to 2 x 80A
- Group signalling
- Voltage monitoring optional



Power Distribution Module PDM fitted with REF16



Power Distribution Module PDM fitted with REF16 and 2216

E-T-A

A globe-spanning network



Europe

- Belgium
- Bosnia/Herzegovina
- Bulgaria
- Denmark
- Germany
- Finland
- France
- Ireland
- Italy
- Croatia
- Luxemburg
- Macedonia
- Montenegro
- Netherlands
- Norway
- Austria
- Poland
- Portugal
- Russia
- Sweden
- Switzerland
- Serbia
- Slovakia
- Slovenia
- Spain
- Czech Republic
- Turkey
- Hungary
- United Kingdom

America

- Argentina
- Brazil
- Chile
- Canada
- Mexico
- USA

Asia

- Brunei
- China
- Hong Kong
- India
- Indonesia
- Japan
- Korea
- Malaysia
- Philippines
- Singapore
- Taiwan
- Thailand

Africa

- South Africa
- Tunisia

Oceania

- Australia
- New Zealand



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