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Power Protection

Technical Redline

ED.03

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Technical Data

Circuit Protection T1

People Protection T2
Add-on Devices T3
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Line protection by means of MCB's

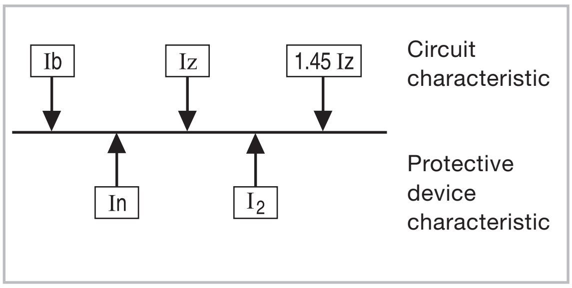
Protective devices shall be capable of breaking any overcurrent up to and including the prospective short-circuit current at the point where the device is installed. One of the protective devices complying with those conditions is the MCB.

Protection against overloads

According to IEC 60364-4-43 protective devices shall be provided to break any overload current flowing in the circuit conductors before such a current could cause a temperature rise detrimental to insulation, joints or surrounding goods to the conductors.

The operating characteristics of a device protecting a cable against overload shall satisfy the two following conditions:

$$I_B \leq In \leq Iz$$
$$I_2 \leq 1.45\, Iz$$



I_B= Current for which the circuit is designed.
I_Z= Continuous current carrying capacity of the cable.
In= Nominal current of the protective device.
I_2= Current ensuring effective operation of the protective device.

In and I_2 are values provided by the manufacturer of the protective device. Calculation of the cable cross section shall be done following the national wiring regulations as well as the IEC 60364-5-523 standard.

The maximum current admissible by the conductor (Iz) depends of following factors:
1. Conductor cross-section.
2. Insulation material.
3. Composition of the conductor.
4. Ambient temperature.
5. Emplacement and canalisation.

Protection of phase conductor
Protection of overcurrent shall be provided for all phase conductors; it shall cause the disconnection of the conductor in which the overcurrent is detected, but not necessarily of other live conductor except in the following cases:
In TT or TN systems, for circuits supplied between phases and in which the neutral conductor is not distributed, overcurrent detection need to be provided for one of the phase conductors, provided that the following conditions are simultaneously fulfilled:
- There is, in the same circuit or on the supply side a differential protection intended to cause disconnection of all the phase conductors;
- The neutral conductor is not distributed from an artificial neutral point of the circuit situated on the load side of the differential protective device.

In IT systems it is mandatory to protect all the phase conductors.

Protection of neutral conductor
IT system
In IT systems it is strongly recommended that the neutral conductor should not be distributed. However, when the neutral conductor is distributed, it is generally necessary to provide overcurrent detection for the neutral conductor of every circuit, which will cause the disconnection of all live conductors of the corresponding circuit, including the neutral conductor. This measure is not necessary if:
- The particular neutral conductor is effectively protected against short-circuit by a prospective device placed on the supply side.
- or if the particular circuit is protected by a RCD with a rated residual current not exceeding 0,15 times the current-carrying of the corresponding neutral conductor. This device shall disconnect all the live conductors of the corresponding circuit, including the neutral conductor.

TT & TN systems
Where the cross sectional area of the neutral conductor is at least equal or equivalent to that of the phase conductors, it is not neccesary to provide overcurrent detection for the neutral conductor or a disconnecting device for that conductor. Where the cross sectional area of the neutral conductor is less than that of the phase conductor, it is neccesary to provide overcurrent detection for the neutral conductor , appropiate to the cross-sectional area of that conductor; this connection shall cause the disconnection of the phase conductor, but not neccesarily of the neutral conductor.

However, overcurrent detection does not need to be provided for the neutral conductor if the following two conditions are simultaneously fulfilled:
- The neutral conductor is protected against short-circuit by the protective device for the phase conductors of the circuit, and
- The maximum current likely to traverse the neutral conductor is, in normal service, clearly less than the value of the current-carrying capacity of that conductor.

	$S_N=S_F$	$S_N<S_F$			
System	**III+N**	**III+N**	**III**	**I+N**	**II**
TN-C , PEN conductor	3P	3P	–	P	–
TN-S separate PE & N conductors	3PN	3PN	3P	PN	2P
TT	3PN+ RCD	3PN+ RCD	3P+ RCD	PN+ RCD	2P+ RCD
IT	4P 3PN+ RCD	4P	3P	2P	2P

S_N = Cross-section of neutral conductor
S_F = Cross-section of phase conductor
P = Protected pole
RCD = Residual current device
N = Neutral pole

Protection against short-circuit

According to IEC 60364 protective devices shall be provided to break any short-circuit current flowing in the circuit conductors before such a current could cause danger due to thermal and mechanical effects produced in conductors and connections.
To consider that an installation is well protected against short-circuits, it is required that the protective device complies with the following conditions:

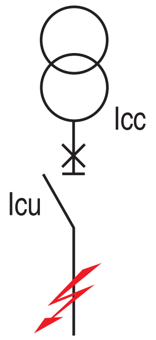
- The breaking capacity shall not be less than the prospective short-circuit current at the place of its installation.

Icu≥Icc

- Let-through energy I^2t smaller than admissible energy of the cable.

- According to IEC 60364-4-473 there are some cases where the omission of devices for protection against overload is recommended for circuits supplying current-used equipment where unexpected opening of the circuit could cause danger.
  Examples of such a cases are:
  - Excitation circuit of rotating machines.
  - Supply circuit of lifting magnets.
  - Secondary circuits of current transformers.

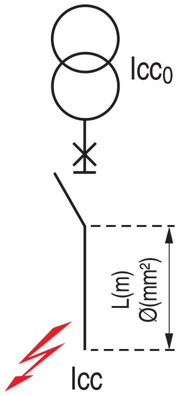
As in those cases the Iu>Iz, it is necessary to verify the short-circuit value at the point of the installation to ensure the protection (Icc min)



Icc: Maximum value of the short-circuit current in that point.

Icu: Short-circuit capacity of the protective device.

Calculation of Icc
The value of the short-circuit current flowing at the end of a cable depends on the short-circuit current flowing at the begining of the cable (transformer terminals), the cross section as well as its length.



Short-circuit current at the transformer terminals (Icc_0)
Three phase oil transformer - 400V

Transformer power kVA	Voltage Ucc in %	In A rms	Icc_0 kA rms
250	4	352	8.7
315	4	443	10.9
400	4	563	13.8
500	4	704	17.1
630	4	887	21.6
800	4.5	1126	24.1
1000	5	1408	27
1250	5.5	1760	30.4
1600	6	2253	35.5
2000	6.5	2816	40.5
2500	7	3520	46.6
3150	7	4435	57.6

Calculation of the short-circuit current in function of:
Icc_0, cross-section and length of the conductor.
The following table provides information to calculate approximately the short-circuit current at a relevant point of the installation

Line protection - Copper conductor

mm^2	Length of the line in m																						
1.5															0.9	1.3	1.6	3.1	6.2	7.8	9.4	13	16	31
2.5													1.0	1.3	1.6	2.1	2.6	5.1	10	13	16	21	26	51
4												0.8	1.6	2.1	2.5	3.4	4.2	8.2	16	21	25	34	42	82
6												1.2	2.5	3.1	3.8	5.1	6.4	12	25	31	38	51	64	123
10										0.8	1.1	2.1	4.1	5.2	6.3	8.4	11	21	41	52	63	84	106	205
16								0.8	1.0	1.3	1.7	3.3	6.6	8.3	10	13	17	33	66	83	100	135	170	329
25							1.1	1.3	1.6	2.1	2.6	5.1	10	13	16	21	26	51	103	130	157	211	265	514
35							1.5	1.8	2.2	3.0	3.7	7.2	14	18	22	30	37	72	144	182	219	295	371	719
50						1.0	2.2	2.6	3.1	4.2	5.3	10	21	26	31	42	53	103	205	259	314	422	530	
70						1.4	3.0	3.6	4.4	5.9	7.4	14	29	36	44	59	74	144	288	363	439	590	742	
95			0.8	0.9	1.0	2.0	4.1	4.9	6.0	8.0	10	20	39	49	60	80	101	195	390	493	596	801		
120		0.9	1.0	1.2	1.3	2.5	5.2	6.2	7.5	10	13	25	49	62	75	101	127	246	493	623	752			
150	0.8	1.0	1.1	1.3	1.4	2.7	5.6	6.8	8.2	11	14	27	54	68	82	110	138	268	536	677	818			
185	1.0	1.2	1.3	1.5	1.7	3.2	6.7	8.0	9.7	13	16	32	63	80	97	130	163	317	633	800	967			
240	1.2	1.5	1.7	1.9	2.1	3.9	8.3	10	12	16	20	39	79	100	120	162	203	394	789	996				
300	1.4	1.7	2.0	2.2	2.5	4.7	10	12	14	19	24	47	95	120	145	195	244	474	948					
400	1.6	1.9	2.2	2.4	2.7	5.1	11	13	16	21	26	51	103	130	157	211	265	514						
500	1.7	2.1	2.4	2.7	3.0	5.7	12	14	17	23	29	57	114	144	174	234	294	571						
625	1.8	2.1	2.5	2.8	3.1	5.8	12	15	18	24	30	58	117	147	178	240	301	584						
2x95	1.2	1.4	1.6	1.8	2.1	3.9	8.2	9.9	12	16	20	39	78	99	119	160	201	390	781	986				
2x120	1.5	1.8	2.1	2.3	2.6	4.9	10	12	15	20	25	49	99	125	150	202	254	493	986					
2x150	1.6	2.0	2.3	2.5	2.8	5.4	11	14	16	22	28	54	107	135	164	220	276	536						
2x185	1.9	2.3	2.7	3.0	3.3	6.3	13	16	19	26	33	63	127	160	193	260	327	633						
2x240	2.4	2.9	3.3	3.7	4.2	7.9	17	20	24	32	41	79	158	199	241	324	407	789						
3x95	1.8	2.2	2.5	2.8	3.1	5.9	12	15	18	24	30	59	117	148	179	240	302	585						
3x120	2.3	2.7	3.1	3.5	3.9	7.4	16	19	23	30	38	74	148	187	226	304	381	739						
3x150	2.5	3.0	3.4	3.8	4.2	8.0	17	20	25	33	41	80	161	203	245	330	415	804						
3x185	2.9	3.5	4.0	4.5	5.0	9.5	20	24	29	39	49	95	190	240	290	390	490	950						
3x240	3.6	4.4	5.0	5.6	6.2	12	25	30	36	49	61	118	237	299	361	486	610							

Icc at the origin of the cable

Icc_0 (kA)	Short-circuit current at the end of the cable																						
100	94	93	92	91	90	83	70	66	62	55	49	33	20	16	14	11	8.8	4.7	2.4	1.9	1.6	1.2	1.0	0.5
90	85	84	84	83	82	76	65	62	58	52	47	32	19	16	14	11	8.7	4.7	2.4	1.9	1.6	1.2	1.0	0.5
80	76	76	75	74	74	69	60	57	54	48	44	31	19	16	14	11	8.6	4.7	2.4	1.9	1.6	1.2	1.0	0.5
70	67	67	66	66	65	61	54	52	49	44	41	29	18	15	13	10	8.5	4.6	2.4	1.9	1.6	1.2	1.0	0.5
60	58	57	57	57	56	54	48	46	44	40	37	27	18	15	13	10	8.3	4.6	2.4	1.9	1.6	1.2	0.9	0.5
50	49	48	48	48	47	45	41	40	38	35	33	25	17	14	12	9.8	8.1	4.5	2.4	1.9	1.6	1.2	0.9	0.5
40	39	39	39	39	38	37	34	33	32	30	28	22	15	13	12	9.3	7.8	4.4	2.3	1.9	1.6	1.2	0.9	0.5
35	34	34	34	34	34	33	30	30	29	27	26	21	15	13	11	9.0	7.6	4.4	2.3	1.9	1.6	1.2	0.9	0.5
30	29	29	29	29	29	28	27	26	25	24	23	19	14	**12**	11	8.6	7.3	4.3	2.3	1.8	1.5	1.2	0.9	0.5
25	25	25	24	24	24	24	23	22	22	21	20	17	12	11	9.9	8.2	7.0	4.2	2.3	1.8	1.5	1.2	0.9	0.5
20	20	20	20	20	20	19	18	18	18	17	17	14	11	10	9.0	7.5	6.5	4.0	2.2	1.8	1.5	1.1	0.9	0.5
15	15	15	15	15	15	15	14	14	14	13	13	12	9.4	9	7.8	6.7	5.9	3.7	2.1	1.7	1.5	1.1	0.9	0.5
10	9.9	9.9	9.9	9.9	9.9	9.8	9.6	9.5	9.4	9.2	9.1	8.3	7.1	7	6.2	5.5	4.9	3.3	2.0	1.6	1.4	1.1	0.9	0.5
7	7.0	7.0	7.0	7.0	6.9	6.9	6.8	6.8	6.7	6.6	6.5	6.1	5.5	5	4.9	4.4	4.1	2.9	1.8	1.5	1.3	1.0	0.8	0.5
5	5.0	5.0	5.0	5.0	5.0	5.0	4.9	4.9	4.9	4.8	4.8	4.5	4.2	4	3.8	3.5	3.3	2.5	1.7	1.4	1.2	1.0	0.8	0.5
4	4.0	4.0	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.8	3.7	3.4	3	3.2	3.0	2.8	2.2	1.5	1.3	1.2	0.9	0.8	0.4
3	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.8	2.7	3	2.5	2.4	2.3	1.9	1.4	1.2	1.1	0.9	0.7	0.4
2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	2	1.8	1.7	1.7	1.4	1.1	1.0	0.9	0.8	0.7	0.4
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1	0.9	0.9	0.9	0.8	0.7	0.7	0.6	0.5	0.5	0.3

- Values shorter than 0.8m or longer than 1 km are not considered.
- All values are for voltage 400V.

Correction coefficient

Voltage	K
230V	0.58
660V	1.65

Example

Cable with cross section 95 mm^2 Cu, 45 m length, and short-circuit current at the transformer terminals of 30 kA.
Estimated short-circuit current of **12 kA** at the end of the cable.

Line protection - Aluminium conductor

mm²	Length of the line																						
1.5															1.0	1.9	3.8	4.8	5.8	7.9	9.9	19	
2.5													0.8	1.0	1.3	1.6	3.2	6.4	8.1	9.7	13	16	32
4												1.0	1.3	1.6	2.1	2.6	5.1	10	13	16	21	26	51
6												1.5	1.9	2.3	3.1	3.9	7.6	15	19	23	31	39	76
10											1.3	2.5	3.2	3.9	5.2	6.6	13	25	32	39	52	66	127
16									0.8	1.1	2.0	4.1	5.2	6.2	8.4	11	20	41	52	62	84	105	204
25							0.8	1.0	1.3	1.6	3.2	6.4	8.1	9.7	13	16	32	64	81	97	131	164	319
35						0.9	1.1	1.4	1.8	2.3	4.5	8.9	11.3	14	18	23	45	89	113	136	183	230	446
50						1.3	1.6	1.9	2.6	3.3	6.4	13	16.1	19	26	33	64	127	161	195	262	329	637
70					0.9	1.9	2.3	2.7	3.7	4.6	8.9	18	22.5	27	37	46	89	178	225	272	366	460	892
95					1.2	2.5	3.1	3.7	5.0	6.2	12	24	30.6	37	50	62	121	242	306	370	497	625	
120				0.8	1.5	3.2	3.9	4.7	6.3	7.9	15	31	39	47	63	79	153	306	387	467	628	789	
150				0.9	1.7	3.5	4.2	5.1	6.8	8.6	17	33	42	51	68	86	166	333	420	508	683	858	
185			0.8	0.9	1.0	2.0	4.1	5.0	6.0	8.1	10	20	39	50	60	81	101	197	393	497	600	807		
240		0.9	1.0	1.2	1.3	2.4	5.2	6.2	7.5	10	13	24	49	62	75	100	126	245	490	618	747			
300	0.9	1.1	1.2	1.4	1.5	2.9	6.2	7.4	9.0	12	15	29	59	74	90	121	152	294	588	743	898			
400	1.2	1.4	1.6	1.8	2.0	3.8	8.0	9.5	12	16	19	38	76	95	115	155	195	378	756	954				
500	1.4	1.7	1.9	2.2	2.4	4.6	9.6	12	14	19	23	46	91	115	139	187	235	455	911					
625	1.7	2.0	2.3	2.6	2.9	5.5	12	14	17	23	28	55	110	139	168	226	283	550						
2x95		0.9	1.0	1.1	1.3	2.4	5.1	6.1	7.4	9.9	12	24	48	61	74	99	125	242	484	612	739	994		
2x120	0.9	1.1	1.3	1.4	1.6	3.1	6.4	7.7	9.3	13	16	31	61	77	93	126	158	306	612	773	934			
2x150	1.0	1.2	1.4	1.6	1.8	3.3	7.0	8.4	10	14	17	33	67	84	102	137	172	333	665	840				
2x185	1.2	1.4	1.7	1.9	2.1	3.9	8.3	9.9	12	16	20	39	79	99	120	161	203	393	786	993				
2x240	1.5	1.8	2.1	2.3	2.6	4.9	10	12	15	20	25	49	98	124	149	201	253	490	979					
3x95	1.1	1.3	1.5	1.7	1.9	3.6	7.6	9.2	11	15	19	36	73	92	111	149	187	363	727	918				
3x120	1.4	1.7	1.9	2.2	2.4	4.6	9.7	12	14	19	24	46	92	116	140	188	237	459	918					
3x150	1.5	1.8	2.1	2.4	2.6	5.0	11	13	15	20	26	50	100	126	152	205	257	499	998					
3x185	1.8	2.2	2.5	2.8	3.1	5.9	12	15	18	24	30	59	118	149	180	242	304	590						
3x240	2.2	2.7	3.1	3.5	3.9	7.3	15	19	22	30	38	73	147	186	224	301	379	734						

Icc_o (kA) — Icc at the origin of the cable	Short-circuit current at the end of the cable																						
100	94	93	92	91	90	83	70	66	62	55	49	33	20	16	14	11	8.8	4.7	2.4	1.9	1.6	1.2	1.0	0.5
90	85	84	84	83	82	76	65	62	58	52	47	32	19	16	14	11	8.7	4.7	2.4	1.9	1.6	1.2	1.0	0.5
80	76	76	75	74	74	69	60	57	54	48	44	31	19	16	14	11	8.6	4.7	2.4	1.9	1.6	1.2	1.0	0.5
70	67	67	66	66	65	61	54	52	49	44	41	29	18	15	13	10	8.5	4.6	2.4	1.9	1.6	1.2	1.0	0.5
60	58	57	57	57	56	54	48	46	44	40	37	27	18	15	13	10	8.3	4.6	2.4	1.9	1.6	1.2	0.9	0.5
50	49	48	48	48	47	45	41	40	38	35	33	25	17	14	12	9.8	8.1	4.5	2.4	1.9	1.6	1.2	0.9	0.5
40	39	39	39	39	38	37	34	33	32	30	28	22	15	13	12	9.3	7.8	4.4	2.3	1.9	1.6	1.2	0.9	0.5
35	34	34	34	34	34	33	30	30	29	27	26	21	15	13	11	9.0	7.6	4.4	2.3	1.9	1.6	1.2	0.9	0.5
30	29	29	29	29	29	28	27	26	25	24	23	19	14	12	11	8.6	7.3	4.3	2.3	1.8	1.5	1.2	0.9	0.5
25	25	25	24	24	24	24	23	22	22	21	20	17	12	11	9.9	8.2	7.0	4.2	2.3	1.8	1.5	1.2	0.9	0.5
20	20	20	20	20	20	19	18	18	18	17	17	14	11	10	9.0	7.5	6.5	4.0	2.2	1.8	1.5	1.1	0.9	0.5
15	15	15	15	15	15	15	14	14	14	13	13	12	9.4	9	7.8	6.7	5.9	3.7	2.1	1.7	1.5	1.1	0.9	0.5
10	9.9	9.9	9.9	9.9	9.9	9.8	9.6	9.5	9.4	9.2	9.1	8.3	7.1	7	6.2	**5.5**	4.9	3.3	2.0	1.6	1.4	1.1	0.9	0.5
7	7.0	7.0	7.0	7.0	6.9	6.9	6.8	6.8	6.7	6.6	6.5	6.1	5.5	5	4.9	4.4	4.1	2.9	1.8	1.5	1.3	1.0	0.8	0.5
5	5.0	5.0	5.0	5.0	5.0	5.0	4.9	4.9	4.9	4.8	4.8	4.5	4.2	4	3.8	3.5	3.3	2.5	1.7	1.4	1.2	1.0	0.8	0.5
4	4.0	4.0	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.8	3.7	3.4	3	3.2	3.0	2.8	2.2	1.5	1.3	1.2	0.9	0.8	0.4
3	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.8	2.7	3	2.5	2.4	2.3	1.9	1.4	1.2	1.1	0.9	0.7	0.4
2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9	2	1.8	1.7	1.7	1.4	1.1	1.0	0.9	0.8	0.7	0.4
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1	0.9	0.9	0.9	0.8	0.7	0.7	0.6	0.5	0.5	0.3

- Values shorter than 0.8m or longer than 1 km are not considered.
- All values are for voltage 400V.

Correction coefficient

Voltage	K
230V	0.58
660V	1.65

Example

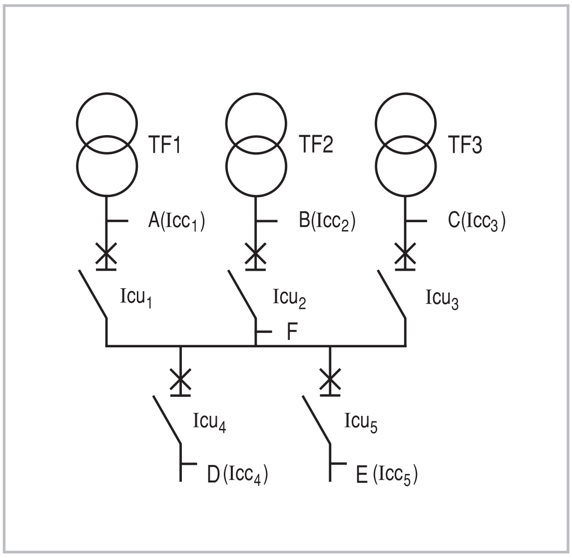
Cable with cross section 150 mm² Al, 65 m length, and short-circuit current at the transformer terminals of 10 kA. Estimated short-circuit current of **5.5 kA** at the end of the cable.

Transformers in parallel

In the case of several transformers in parallel there are some points of the installation where the Icc is the sum of the short-circuit currents provided by each transformer .

The short-circuit capacity of the protective devices shall be calculated taking into consideration the following criteria:

Short-circuit in A: $Icu_1 \geq Icc_2 + Icc_3$
Short-circuit in F: $Icu_2 \geq Icc_2$
Short-circuit in D: $Icu_4 \geq Icc_1 + Icc_2 + Icc_3$



Let-through energy

The standard IEC 60364 describes that the current limiting of the conductors (K^2S^2) shall be equal or greater than the let-throught energy (I^2t) quoted by the protective device. The K coefficient depends on the conductor insulation.
S is the cross section of the conductor.

$$I^2t \leq K^2S^2$$

Copper conductor

Insulation	PVC	Rubber	Polyethylene XLPE
K=	115	135	146
Cross section mm^2	Maximum admissible value $K^2S^2 \times 10^3$		
1.5	30	41	48
2.5	83	114	133
4	212	292	341
6	476	656	767
10	1 323	1 823	2 132
16	3 386	4 666	5 457
25	8 266	11 391	13 323
35	16 201	22 326	26 112
50	33 063	45 563	53 290
70	64 803	89 303	104 448
95	119 356	164 481	192 377
120	190 440	262 440	306 950
150	297 563	410 063	479 610
185	452 626	623 751	729 540
240	761 760	1 049 760	1 227 802

Aluminium conductor

Insulation	PVC	Rubber	Polyethylene XLPE
K=	74	87	94
Cross section mm^2	Maximum admissible value $K^2S^2 \times 10^3$		
10	548	757	884
16	1 402	1 938	2 262
25	3 423	4 731	5 523
35	6 708	9 272	10 824
50	13 690	18 923	22 090
70	26 832	37 088	43 296
95	49 421	68 310	79 745
120	78 854	108 994	127 238
150	123 210	170 303	198 810
185	187 416	259 049	302 412
240	315 418	435 974	508 954

Maximum protected cable length in the event of short-circuit (Icc minimum)

The following values are applicable in case that the protective device does not exist or is over-rated. They are calculated according to the formula:

$$Icc = \frac{0.8 \cdot U \cdot S}{1.5 \cdot \rho \cdot 2 \cdot L} \cdot K$$

U: Voltage 400V
0,8: Reduction coefficient due to impedances
S: Conductor cross section
ρ: Cu resistivity: 0.025 Ω mm^2/m
L: Conductor length
K: Correction coeffecient

It is possible to determinate the maximum cable length protected in the event of short-circuit current in function of:

- The nominal current
- The nominal voltage
- The conductor characteristic
- The magnetic tripping characteristic of the protective device

The short-circuit current at any point of the installation shall be high enough to disconnect the protective device.

To ensure the MCB disconnection, we needed to take into consideration the following table

Maximum protected cable length in case of short-circuit

For network 3x400 V without N, Tripping characteristic C (Im: 10 x In)

In (A)	0,5	1	2	4	6	10	16	20	25	32	40	50	63	80	100	125	160	250	400	630	800	1000	1250	1600	2000
S mm^2										Maximum protected length (m) for Cu conductor															
1.5	1778	889	444	222	148	89	56	44	36	28	22														
2.5		1481	741	370	237	148	93	74	59	46	37	30	24												
4			1185	593	356	237	148	119	95	74	59	47	38	30											
6			1778	889	593	356	222	178	142	111	89	71	56	44	36										
10				1481	948	593	370	296	237	185	148	119	94	74	59	47									
16					1481	948	593	474	379	296	237	190	150	119	95	76	59								
25						1481	926	741	593	463	370	296	235	185	148	119	93								
35							1296	1037	830	648	519	415	329	259	207	166	130	83							
50							1852	1481	1185	926	741	593	470	370	296	237	185	119							
70									1659	1296	1037	830	658	519	415	332	259	166	104						
95										1759	1407	1126	**894**	704	563	450	352	225	141						
120											1778	1422	1129	889	711	569	444	284	178	113					
150											1932	1546	1227	966	773	618	483	309	193	123					
185												1827	1450	1142	914	731	571	365	228	145	114				
240													1806	1422	1138	910	711	455	284	181	142	114			
300														1709	1368	1094	855	547	342	217	171	137			
400														1852	1481	1185	926	593	370	235	185	148	119		
500															1646	1317	1029	658	412	261	206	165	132		
625															1684	1347	1052	673	421	267	210	168	135	105	
2x95													1787	1407	1126	901	704	450	281	179	141	113			
2x120														1778	1422	1138	889	569	356	226	178	142	114		
2x150														1932	1546	1237	966	618	386	245	193	155	124		
2x185															1827	1437	1142	731	457	290	228	183	146	114	
2x240																1462	1422	910	569	361	284	228	182	142	114
3x95															1689	1820	1056	676	422	268	211	169	135	106	
3x120																1351	1333	853	533	339	267	213	171	133	107
3x150																1707	1449	928	580	368	290	232	186	145	116
3x185																1855	1713	096	685	435	243	274	219	171	137
3x240																		365	853	542	427	341	273	213	171

Example

Network 3x400+N with a copper conductor of 95mm^2 cross-section and using as a protection device a MCB C63.
Maximum cable length:
Lmax= **894**x0.58x0.5=259m

Correction coefficients

Tripping characteristic	K1
Curve B	x 2
Curve D	x 0.5
Curve Im	x 10/Im

Voltage	K2
2 x 230 V	x 0.58
3 x 400V + N	x 0.58
230V Phase-N	x 0.58
3 x 400V + N/2	x 0.39

Conductor	K3
Aluminium	x 0.62

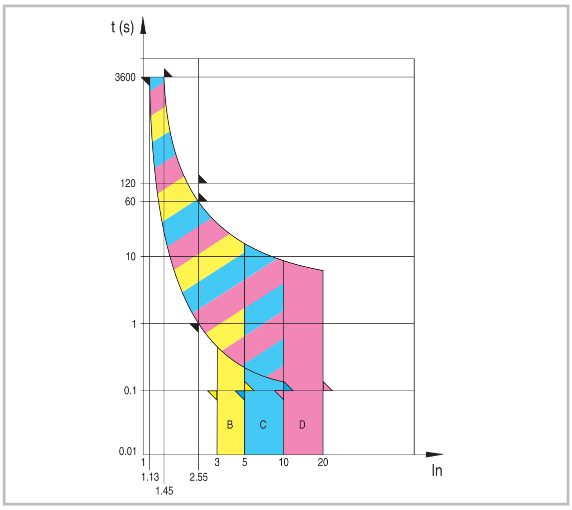
Cross section>120 mm^2	K4
120	x 0.90
150	x 0.85
185	x 0.80
240	x 0.75
300	x 0.72

Number of cables in parallel	K5
1	x 1.00
2	x 2.00
3	x 2.65
4	x 3.00
5	x 3.20

Characteristics according to EN/IEC 60898

Miniature Circuit Breakers are intended for the protection of wiring installations against both overloads and short-circuits in domestic or commercial wiring installations where operation is possible by uninstructed people.

Tripping characteristic curves B, C and D



Magnetic release
An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The standard distinguishes three different types, following the current for instantaneous release: type B,C,D.

Icn (A)	Test current	Tripping time	Applications
B	3 x In 5 x In	0.1 < t < 45s (In ≤ 32A) 0.1 < t < 90s (In > 32A) t < 0.1s	Only for resistive loads such as: - electrical heating - water heater - stoves
C	5 x In 10 x In	0.1 < t < 15s (In ≤ 32A) 0.1 < t < 30s (In > 32A) t < 0.1s	Usual loads such as: - lighting - socket outlets - small motors
D	10 x In 20 x In	0.1 < t < 4s(**) (In ≤ 32A) 0.1 < t < 8s (In > 32A) t < 0.1s	Control and protection of circuits having important transient inrush currents (large motors)

** if In ≤ 10A, t < 8s

Thermal release
The release is initiated by a bimetal strip in the event of overload. The standard defines the range of releases for specific overload values. Reference ambient temperature is 30°C.

Test current	Tripping time
1.13 x In	t ≥ 1h (In ≤ 63A) t ≥ 2h (In > 63A)
1.45 x In	t < 1h (In ≤ 63A) t < 2h (In > 63A)
2.55 x In	1s < t < 60s (In ≤ 32A) 1 s < t < 120s (In > 32A)

Rated short-circuit breaking capacity (Icn)
Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO

After the test the MCB is capable , without maintenance to withstand a dielectric strength test at a test voltage of 900V. Moreover the MCB shall be capable of tripping when loaded with 2.8 In within the time corresponding to 2.55 In but greater than 0.1s.

Service short-circuit breaking capacity (Ics)
Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO-t-CO

After the test the MCB is capable , without maintenance to withstand a dielectric strength test at a test voltage of 1 500V. Moreover the MCB shall not trip when a current of 0.96 In. The MCB shall trip within 1h when current is 1.6 In.

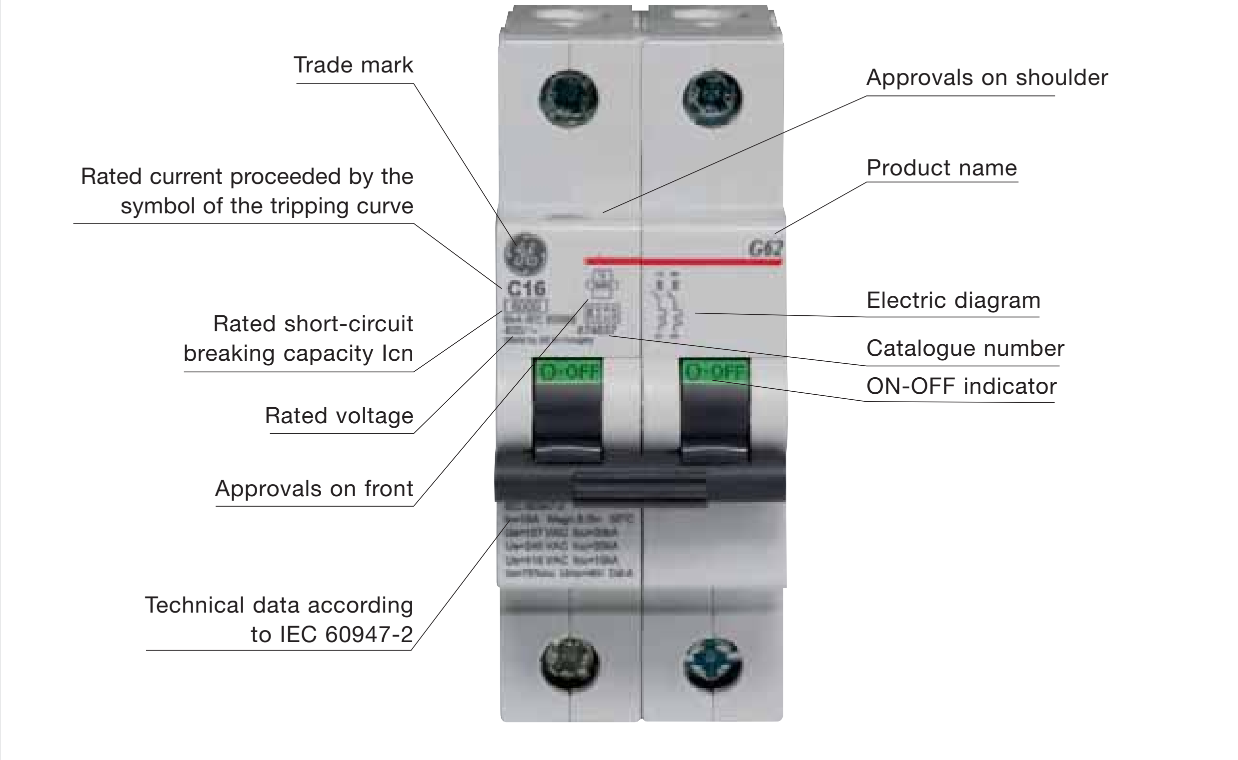
O - Represents an opening operation
CO - Represents a closing operation followed by an automatic opening.
t - Represents the time interval between two successive short-circuit operations: 3 minutes.

The relation between the Rated short-circuit capacity (Icn) and the Rated service short-circuit breaking capacity (Ics) shall be as follows:

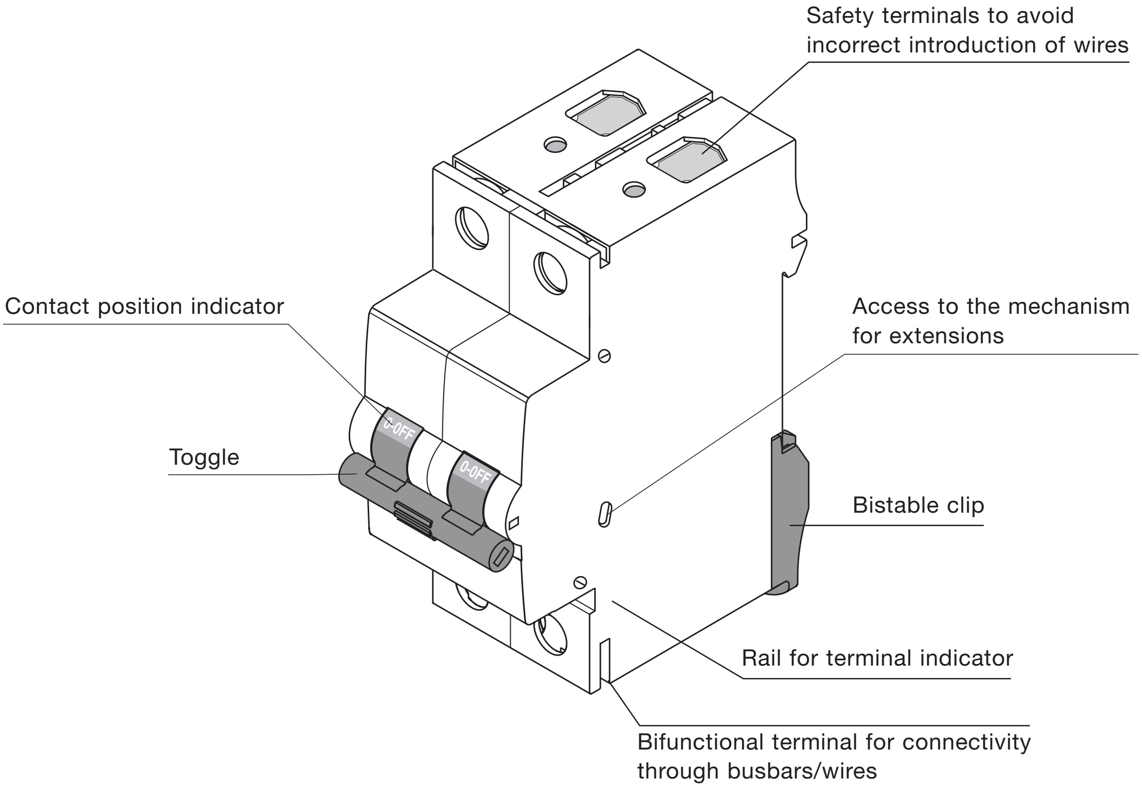
Icn (A)	Ics (A)
≤ 6000	6000
> 6000 ≤ 10000	0.75 Icn min. 6000
> 10000	0.75 Icn min. 7500

Information on product according to EN/IEC 60898

Example: 2P MCB C characteristic 16A



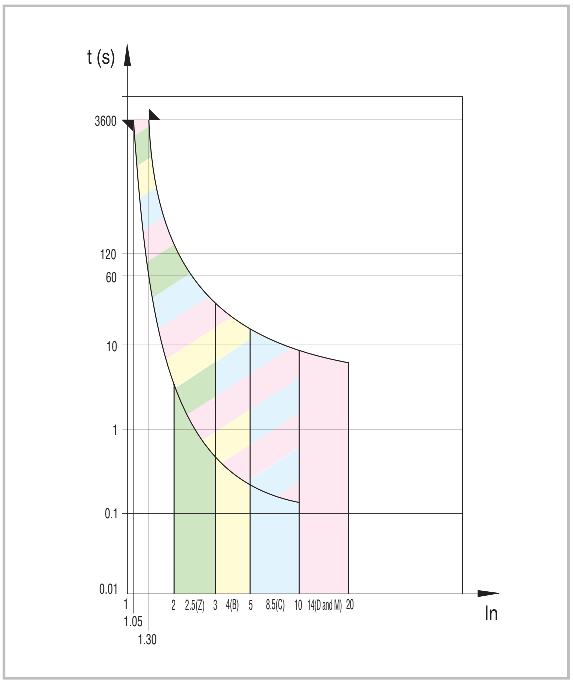
Use of an MCB



Characteristics according to EN/IEC 60947-2

Miniature Circuit Breakers are intended for the protection of the lines against both overloads and short-circuits in industrial wiring installations where normally operation is done by instructed people.

Tripping characteristic curves B, C, D and Z



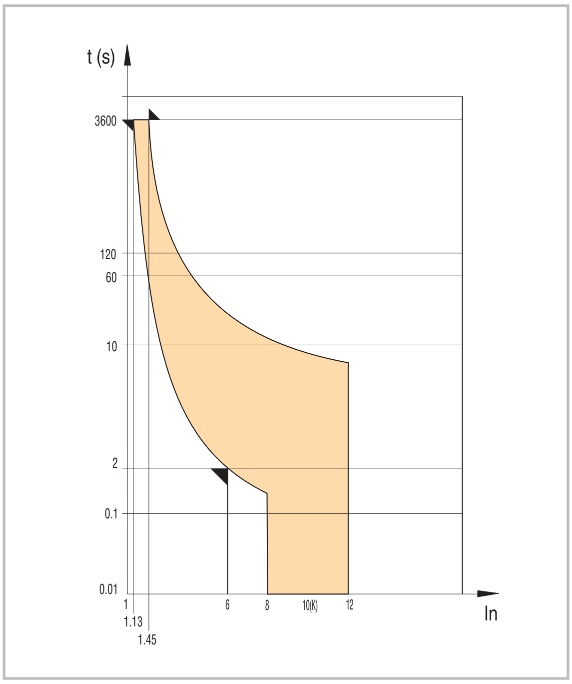
Magnetic release
An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The standard leaves the calibration of magnetic release to the manufacturer's discretion.

GE offers instantaneous tripping ranges:
- Z: 2.5 In
- B: 4 In
- C: 8.5 In (7.5 In for 63A)
- D and M: 14 In

Thermal release
The release is initiated by a bimetal strip in the event of overload. The standard defines the range of release for two special overload values.
Reference ambient temperature is:
- 50°C for G60 and G100 (B, C, D)
- 40°C for GT10 and GT25 (B, C, D)
- 40°C for EP100 and EP250 (Z)

Test current	Tripping time
1.05 x In	t ≥ 1h (In ≤ 63A) t ≥ 2h (In > 63A)
1.30 x In	t < 1h (In ≤ 63A) t < 2h (In > 63A)

Tripping characteristic curve K



Magnetic release
An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The standard leaves the calibration of magnetic release to the manufacturer's discretion.

GE offers instantaneous tripping ranges:
- K: 10 In
Motors starting I = 6 In, tripping > 2s.

Thermal release
The release is initiated by a bimetal strip in the event of overload. The standard defines the range of release for two special overload values.
Reference ambient temperature is:
- 45°C for EP60 and EP100 (K)

Test current	Tripping time
1.13 x In	t ≥ 1h (In ≤ 63A) t ≥ 2h (In > 63A)
1.45 x In	t < 1h (In ≤ 63A) t < 2h (In > 63A)

Short-circuit test

Rated ultimate short-circuit breaking capacity (Icu)
Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 1000V. Moreover the MCB shall be capable of tripping when loaded with 2,5 In within the time corresponding to 2 In but greater than 0.1s.

Rated service short-circuit breaking capacity (Ics)
Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO-t-CO

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of twice its rated insulation voltage with a minimum of 1000V. A verification of the overload releases on In and moreover the MCB shall trip within 1h when current is 1.45 In
(for In < 63A) and 2h (for In > 63A).

O - Represents an opening operation
CO - Represents a closing operation followed by an automatic opening.
t - Represents the time interval between two successive short-circuit operations: 3 minutes.

Category A: Without a short-time withstand current rating.

Utilization category	Application with respect to selectivity
A	Circuit breakers not specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay provided for selectivity under short-circuit conditions, and therefore without a short-time withstand current rating according to 4.3.5.4
B	Circuit breakers specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay (which may be adjustable), provided for selectivity under short-circuit conditions. Such circuit-breakers have a short-time withstand current rating according to 4.3.5.4

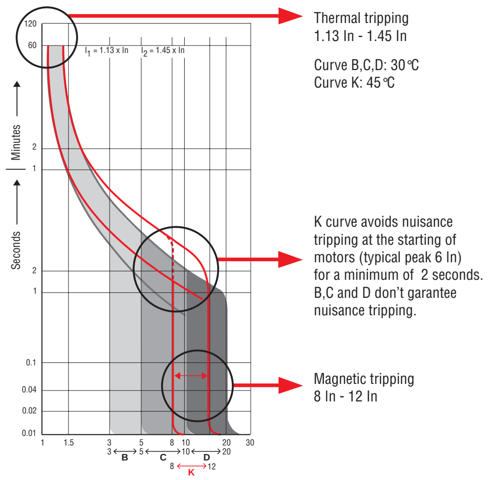
Tripping characteristic curves and their applications

B: Protection of generators, long distance cables, resistive loads, people protection in TN systems.
C: General purpose, resistive and inductive loads.
D: High inductive loads, transformers LV/LV with high peak current.
K: Motors, pumps, fans, transformers, lamps groups, avoiding nuisance tripping.
Z: Protection of electronic loads (semi conductors etc.) and secundary measurement circuits, long distance cables allowing cost saving with smaller section.

Circuits feeding motors

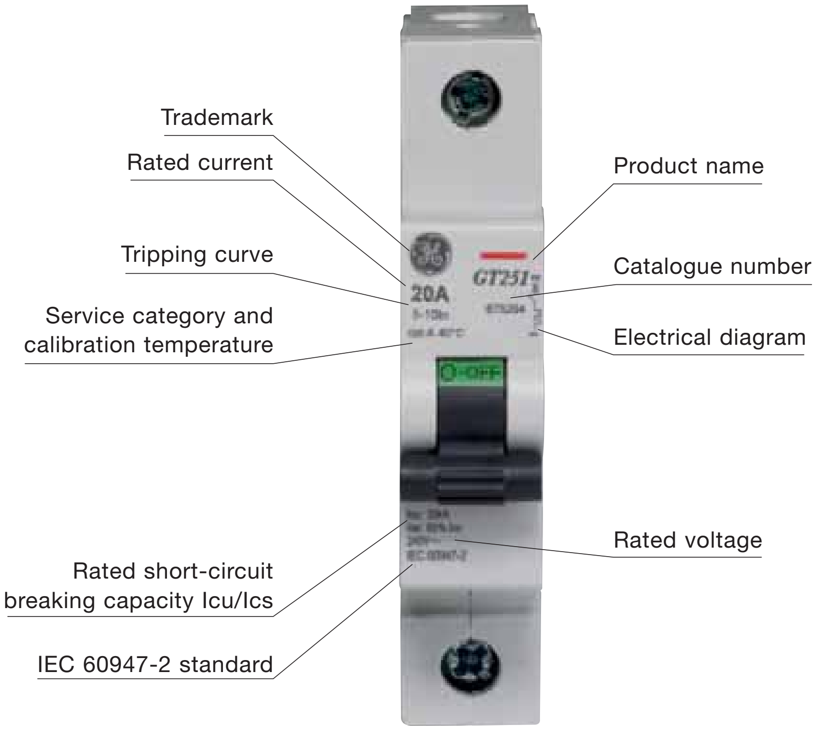
Advantages of K-curve protection

Curve K (EN/IEC 60947-2) versus B, C, D (EN/IEC 60898)

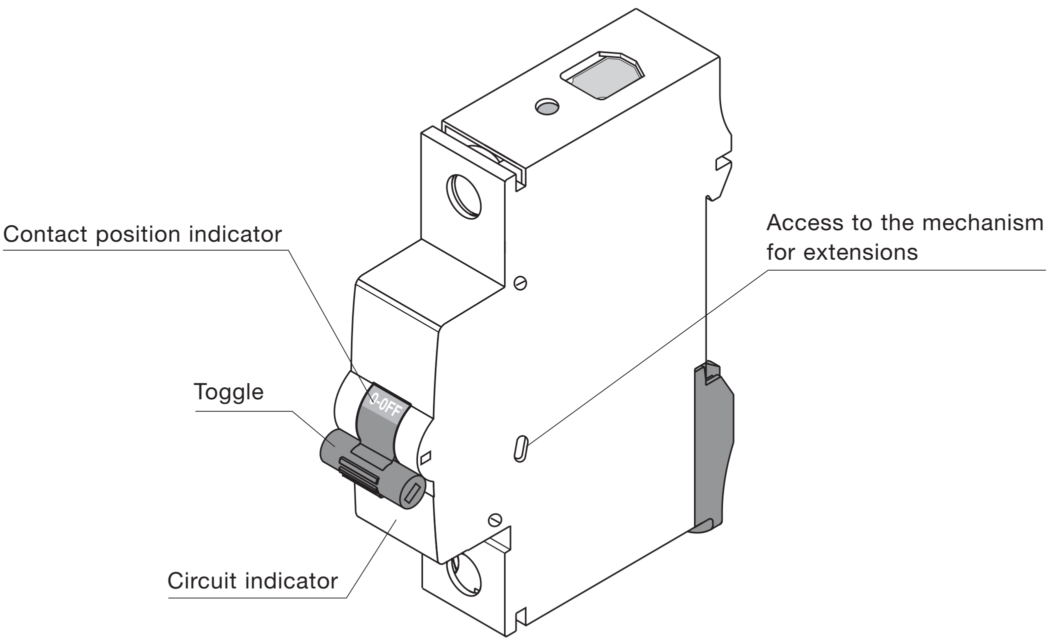


Information on product according to EN/IEC 60947-2

Example: EP250 1P 20A 5 to 10 Iu

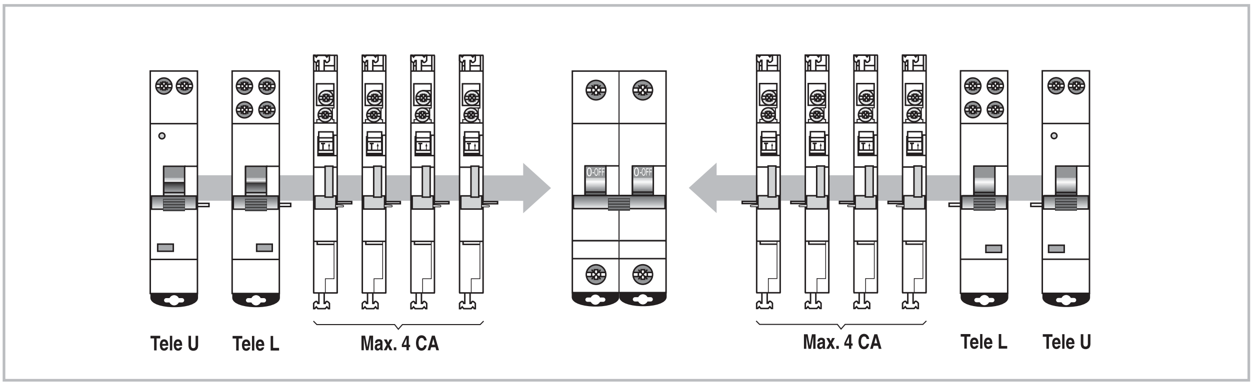


Use of an MCB



ACCESS TO THE MECHANISM FOR EXTENSIONS

Connection of the extensions.
It is possible to couple any auxiliary contact, shunt trip, undervoltage release or motor driver either on the right or the left hand side, following the stack-on configuration of the extensions in page T3.14

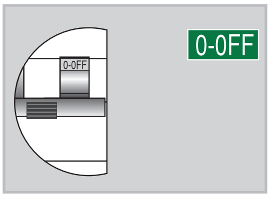


TOGGLE

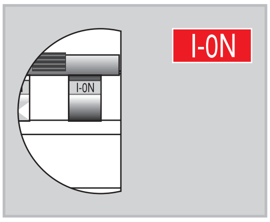
To switch the MCB ON or OFF

CONTACT POSITION INDICATOR

Printing on the toggle to provide information of the real contact position.



O-OFF
Contacts in open position. Ensure a distance between contacts > 4mm.



I-ON
Contacts in closed position. Ensure continuity in the main circuit.

Technical Data

T1

Definitions related to MCB's

MCB= Miniature Circuit Breakers

Short-circuit (making and breaking) capacity
Alternating component of the prospective current, expressed by its r.m.s. value, which the circuit-breaker is designed to make, to carry for its opening time and to break under specified conditions.

Ultimate or rated short-circuit breaking capacity (Icn - EN/IEC 60898)
A breaking capacity for which the prescribed conditions, according to a specified test sequence do not include the capability of the MCB to carry 0.96 times its rated current for the conventional time.

Ultimate short-circuit breaking capacity (Icu - EN/IEC 60947-2)
A breaking capacity for which the prescribed conditions, according to a specified test sequence do not include the capability of the MCB to carry its rated current for the conventional time.

Service short-circuit breaking capacity (Ics - EN/IEC 60898)
A breaking capacity for which the prescribed conditions according to a specified test sequence include the capability of the MCB to carry 0.96 times its rated current for the conventional time.

Service short-circuit breaking capacity (Ics - EN/IEC 60947-2)
A breaking capacity for which the prescribed conditions according to a specified test sequence include the capability of the MCB to carry its rated current for the conventional time.

Prospective current
The current that would flow in the circuit, if each main current path of the MCB were replaced by a conductor of negligible impedance.

Conventional non-tripping current (Int)
A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping.

Conventional tripping current (It)
A specified value of current which causes the circuit breaker to trip within a specified time.

Open position
The position in which the predetermined clearance between open contacts in the main circuit of the MCB is secured.

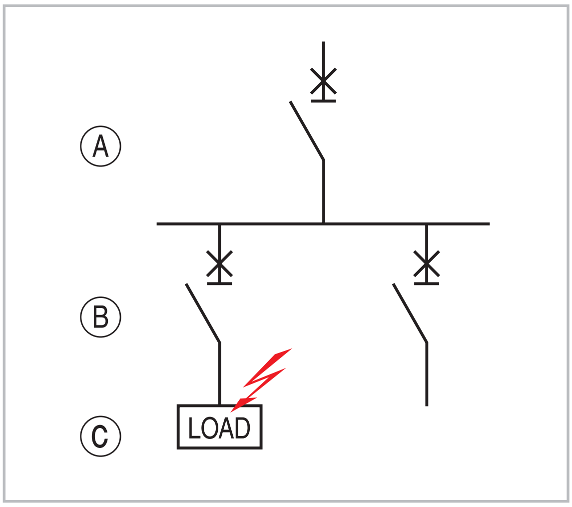
Closed position
The position in which the predetermined continuity of the main circuit of the MCB is secured.

Maximum prospective peak current (Ip)
The prospective peak current when the initiation of the current takes place at the instant which leads to the highest possible value.

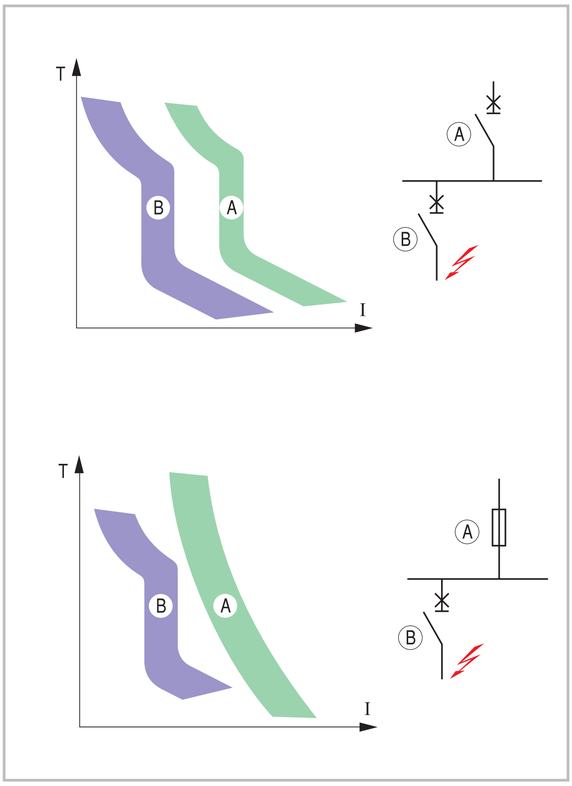
Notes

Selectivity

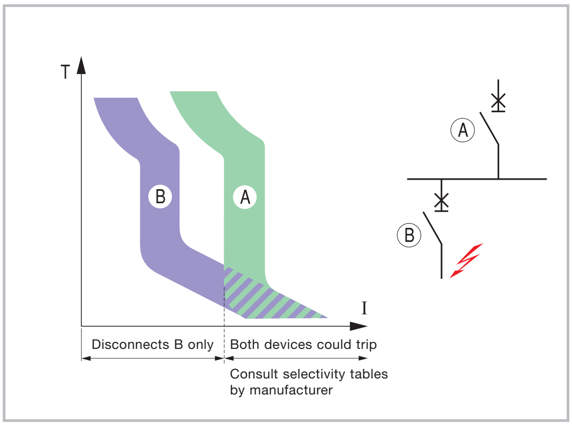
An installation with some protective devices in series (a protective device must be placed at the point where a reduction of the cross sectional area of the conductors or another change causes modification in the characteristics of the installation) is considered as selective when, in the event of short-circuit, the installation is interrupted only by the device which is immediately upstream of the fault point. Selectivity is ensured when the characteristic time/current of the upstream MCB (A) is above the characteristic time /current of the downstream MCB (B).
The let-through energy (I^2t) of the downstream protective device shall be lower than the one of the upstream protective device. Selectivity may be total or partial.



Total selectivity
Selectivity is total in the event of a short-circuit fault and only disconnects the protective device B immediately upstream of the fault point.



Partial selectivity
Selectivity is partial when the no disconnection of the protective device (A) is ensured only up to a certain level of the current.
In figure below is shown that selectivity is total up to the point of overlapping curves. From this point total selectivity can not be assured and selectivity curves based on tests by the manufacturer should be consulted.



Selectivity - Upstream MCB's / Downstream MCB's C or G & RCBO's DM

MCB's		Upstream Curve C G60-G100-GT25								Hti			S90
Downstream	In	10A	16A	20A	25A	32A	40A	50A	63A	80A	100A	125A	10-100A
Curve B	6A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
	10A	-	-	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
C45	16A	-	-	-	-	0.23	0.27	0.35	0.45	4.0	T	T	T
C60	20A	-	-	-	-	-	0.27	0.35	0.45	4.0	T	T	T
DM60	25A	-	-	-	-	-	0.27	0.35	0.45	3.5	1.5	1.5	T
DM100 (1)	32A	-	-	-	-	-	-	0.35	0.45	3.5	1.5	1.5	T
	40A	-	-	-	-	-	-	-	-	-	1.5	1.5	T

MCB's		Upstream Curve C G60-G100-GT25								Hti			S90
Downstream	In	10A	16A	20A	25A	32A	40A	50A	63A	80A	100A	125A	10-100A
Curve B	6A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
	10A	-	-	0.15	0.18	0.23	0.27	0.35	0.45	6.0	T	T	T
G60	16A	-	-	-	-	0.23	0.27	0.35	0.45	4.0	6.0	6.0	T
G100	20A	-	-	-	-	-	0.27	0.35	0.45	4.0	6.0	6.0	T
G250	25A	-	-	-	-	-	0.27	0.35	0.45	3.5	6.0	6.0	T
DME60	32A	-	-	-	-	-	0.27	0.35	0.45	3.5	6.0	6.0	T
DME100	40A	-	-	-	-	-	-	-	-	1.6	5.0	5.0	T
	50A	-	-	-	-	-	-	-	-	-	-	-	T
	63A	-	-	-	-	-	-	-	-	-	-	-	T

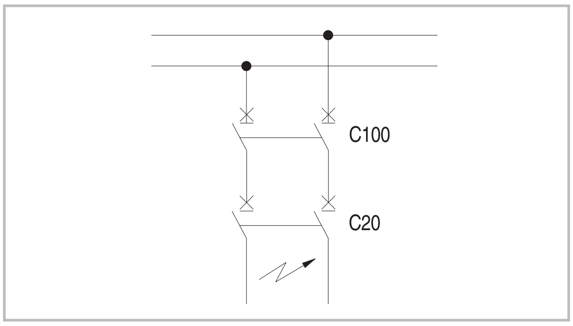
MCB's		Upstream Curve C G60-G100-GT25								Hti			S90
Downstream	In	10A	16A	20A	25A	32A	40A	50A	63A	80A	100A	125A	10-100A
Curve C	2A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
	3A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
C45	4A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
C60	6A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	4.5	T	T	T
DM60	10A	-	-	0.15	0.18	0.23	0.27	0.35	0.45	4.5	T	T	T
DM100 (2)	16A	-	-	-	-	0.23	0.27	0.35	0.45	2.0	5.0	5.0	T
	20A	-	-	-	-	-	0.27	0.35	0.45	2.0	5.0	5.0	T
	25A	-	-	-	-	-	0.27	0.35	0.45	1.5	4.5	4.5	T
	32A	-	-	-	-	-	-	0.35	0.45	1.5	2.3	2.3	T
	40A	-	-	-	-	-	-	-	0.45	-	2.3	2.3	T

MCB's		Upstream Curve C G60-G100-GT25								Hti			S90
Downstream	In	10A	16A	20A	25A	32A	40A	50A	63A	80A	100A	125A	10-100A
Curve C	0.5A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
	1A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
G30	2A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	T	T	T	T
G45	3A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	9.0	T	T	T
G60	4A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	9.0	6.0	6.0	T
G100	6A	0.07	0.10	0.15	0.18	0.23	0.27	0.35	0.45	4.5	6.0	6.0	T
GT25	10A	-	-	0.15	0.18	0.23	0.27	0.35	0.45	4.5	6.0	6.0	T
DME60	16A	-	-	-	-	0.23	0.27	0.35	0.45	2.0	6.0	6.0	T
DME100	20A	-	-	-	-	-	0.27	0.35	0.45	2.0	**5.0**	5.0	T
	25A	-	-	-	-	-	0.27	0.35	0.45	1.5	4.5	4.5	T
	32A	-	-	-	-	-	-	0.35	0.45	1.5	2.3	2.3	T
	40A	-	-	-	-	-	-	-	0.45	-	2.3	2.3	T
	50A	-	-	-	-	-	-	-	-	-	-	-	T
	63A	-	-	-	-	-	-	-	-	-	-	-	T

(1) Icc limited to 6 kA for C60, DM60, DM100
(2) Icc limited to 10 kA for DM100
T = Total : selective untill the Icu of the downstream device

Example

A combination of an MCB C20 with an upstream MCB C100 guarantees selectivity up to a short-circuit level of **5** kA.



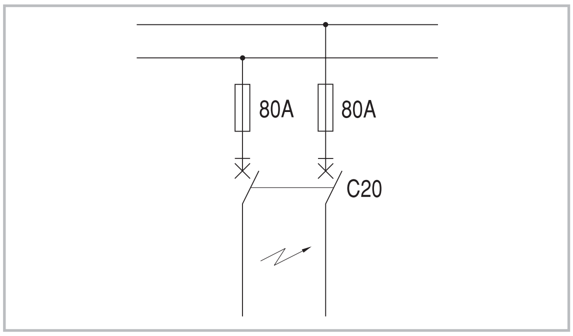
Selectivity - Upstream Fuses gL-gG / Downstream MCB's G60

Downstream Curve B G60 DME60 — In	Upstream Fuses gG-gL 6A	10A	16A	20A	25A	35A	50A	63A	80A	100A	125A
6A	-	-	-	-	1.2	3.0	4.0	6.0	6.0	6.0	6.0
10A	-	-	-	-	0.9	1.6	3.0	4.8	6.0	6.0	6.0
13A	-	-	-	-	0.9	1.5	2.7	4.2	6.0	6.0	6.0
16A	-	-	-	-	-	1.4	2.4	3.8	5.8	6.0	6.0
20A	-	-	-	-	-	1.1	2.1	3.2	4.8	6.0	6.0
25A	-	-	-	-	-	-	1.9	2.9	4.4	6.0	6.0
32A	-	-	-	-	-	-	1.7	2.6	3.8	5.9	6.0
40A	-	-	-	-	-	-	-	2.4	3.4	5.3	6.0
50A	-	-	-	-	-	-	-	-	-	4.4	6.0
63A	-	-	-	-	-	-	-	-	-	4.4	6.0

Downstream Curve C G60 DME60 — In	Upstream Fuses gG-gL 6A	10A	16A	20A	25A	35A	50A	63A	**80A**	100A	125A
0.5	0.2	1.0	4.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
1A	0.1	0.3	1.0	4.4	6.0	6.0	6.0	6.0	6.0	6.0	6.0
2A	-	0.2	0.4	0.7	0.8	5.3	6.0	6.0	6.0	6.0	6.0
4A	-	-	0.3	0.6	0.7	1.9	4.2	6.0	6.0	6.0	6.0
6A	-	-	-	-	0.6	1.5	2.9	4.6	6.0	6.0	6.0
10A	-	-	-	-	-	1.4	2.5	4.0	6.0	6.0	6.0
13A	-	-	-	-	-	0.8	2.4	3.9	5.7	6.0	6.0
16A	-	-	-	-	-	-	2.3	3.6	5.4	6.0	6.0
20A	-	-	-	-	-	-	-	3.2	**4.6**	6.0	6.0
25A	-	-	-	-	-	-	-	-	4.3	6.0	6.0
32A	-	-	-	-	-	-	-	-	3.7	5.8	6.0
40A	-	-	-	-	-	-	-	-	-	5.1	6.0
50A	-	-	-	-	-	-	-	-	-	-	6.0
63A	-	-	-	-	-	-	-	-	-	-	6.0

Downstream Curve D G60 Type D — In	Upstream Fuses gG-gL 6A	10A	16A	20A	25A	35A	50A	63A	80A	100A	125A
0.5	0.1	0.3	1.0	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
1A	-	0.2	0.5	1.2	6.0	6.0	6.0	6.0	6.0	6.0	6.0
2A	-	-	0.3	0.6	1.6	3.5	6.0	6.0	6.0	6.0	6.0
4A	-	-	-	-	0.8	2.0	3.6	6.0	6.0	6.0	6.0
6A	-	-	-	-	0.6	1.7	2.8	5.0	6.0	6.0	6.0
10A	-	-	-	-	-	-	2.3	3.7	5.4	6.0	6.0
13A	-	-	-	-	-	-	-	3.6	5.0	6.0	6.0
16A	-	-	-	-	-	-	-	-	4.8	6.0	6.0
20A	-	-	-	-	-	-	-	-	-	6.0	6.0
25A	-	-	-	-	-	-	-	-	-	6.0	6.0
32A	-	-	-	-	-	-	-	-	-	-	-
40A	-	-	-	-	-	-	-	-	-	-	-
50A	-	-	-	-	-	-	-	-	-	-	-
63A	-	-	-	-	-	-	-	-	-	-	-

Example
A combination of an MCB G62 C20 with an upstream fuse 80A guarantees selectivity up to a short-circuit level of **4.6** kA.



Selectivity - Upstream Fuses BS / Downstream MCB's G60

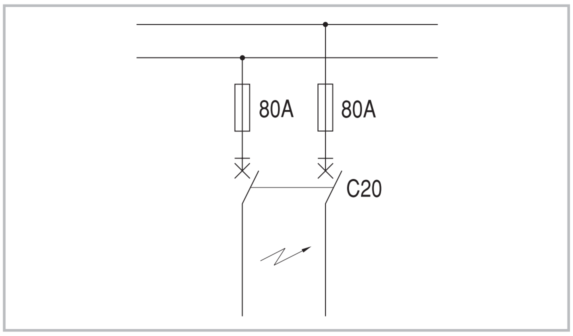
Downstream	In	Upstream Fuses BS1361 40A	63A	80A	100A	125A	160A
Curve B	6A	2.3	6.0	6.0	6.0	6.0	6.0
	10A	1.8	5.0	6.0	6.0	6.0	6.0
G60	16A	1.5	4.2	5.8	6.0	6.0	6.0
DME60	20A	1.3	3.4	4.8	5.3	6.0	6.0
	25A	-	3.2	4.3	4.7	6.0	6.0
	32A	-	2.8	3.8	4.2	6.0	6.0
	40A	-	2.7	3.6	4.0	5.6	6.0
	50A	-	-	-	3.7	5.3	6.0
	63A	-	-	-	3.2	4.5	6.0

Downstream	In	Upstream Fuses BS1361 40A	63A	80A	100A	125A	160A
Curve C	6A	2.0	5.3	6.0	6.0	6.0	6.0
	10A	1.6	4.2	5.5	6.0	6.0	6.0
G60	16A	1.4	3.8	5.0	5.7	6.0	6.0
DME60	20A	1.2	3.4	**4.2**	4.8	6.0	6.0
	25A	-	3.0	3.9	4.4	6.0	6.0
	32A	-	2.8	3.4	3.9	5.8	6.0
	40A	-	2.5	3.1	3.5	5.3	6.0
	50A	-	-	-	3.2	4.7	6.0
	63A	-	-	-	2.9	4.2	6.0

Downstream	In	Upstream Fuses BS1361 40A	63A	80A	100A	125A	160A
Curve D	6A	1.7	6.0	6.0	6.0	6.0	6.0
	10A	1.4	3.9	5.2	5.8	6.0	6.0
G60	16A	1.4	3.6	4.7	5.2	6.0	6.0
	20A	1.2	3.1	4.1	4.6	6.0	6.0
	25A	1.0	2.8	3.7	4.1	6.0	6.0
	32A	-	2.3	3.2	3.5	5.4	6.0
	40A	-	2.1	2.9	3.3	5.0	6.0
	50A	-	-	-	3.0	4.7	6.0
	63A	-	-	-	2.6	4.2	6.0

Example

A combination of an MCB G62 C20 with an upstream fuse 80A guarantees selectivity up to a short-circuit level of **4.2** kA.



Selectivity - Upstream Fuses gL-gG / Downstream MCB's G100

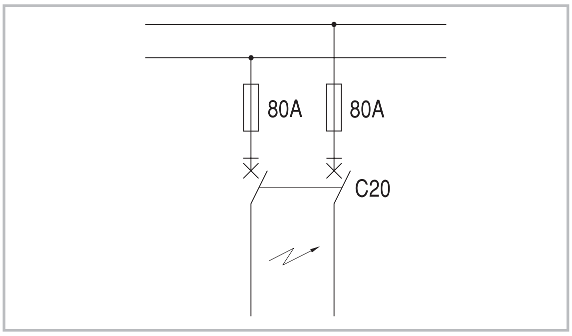
Downstream	In	Upstream Fuses gG-gL 6A	10A	16A	20A	25A	35A	50A	63A	80A	100A	125A	160A
Curve B	6A	-	-	-	-	0.7	1.7	3.5	5.7	10.0	10.0	10.0	10.0
	10A	-	-	-	-	0.6	1.6	3.0	4.8	7.3	10.0	10.0	10.0
G100	13A	-	-	-	-	0.5	1.5	2.7	4.2	6.5	10.0	10.0	10.0
DME100	16A	-	-	-	-	-	1.4	2.4	3.8	5.8	10.0	10.0	10.0
	20A	-	-	-	-	-	1.1	2.1	3.2	4.8	7.6	10.0	10.0
	25A	-	-	-	-	-	-	1.9	2.9	4.4	6.9	10.0	10.0
	32A	-	-	-	-	-	-	1.7	2.6	3.8	5.9	9.5	10.0
	40A	-	-	-	-	-	-	-	2.4	3.4	5.3	9.0	10.0
	50A	-	-	-	-	-	-	-	-	-	4.4	8.0	10.0
	63A	-	-	-	-	-	-	-	-	-	4.4	6.8	10.0

Downstream	In	Upstream Fuses gG-gL 6A	10A	16A	20A	25A	35A	50A	63A	80A	100A	125A	160A
Curve C	0.5	0.2	1.0	4.0	6.0	8.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	1A	0.1	0.3	1.0	4.4	7.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
G100	2A	-	0.2	0.4	0.7	0.8	5.3	10.0	10.0	10.0	10.0	10.0	10.0
DME100	4A	-	-	0.3	0.6	0.7	1.9	4.2	10.0	10.0	10.0	10.0	10.0
	6A	-	-	-	-	0.6	1.5	2.9	4.6	7.5	10.0	10.0	10.0
	10A	-	-	-	-		1.4	2.5	4.0	6.2	10.0	10.0	10.0
	13A	-	-	-	-	-	0.8	2.4	3.9	5.7	9.7	10.0	10.0
	16A	-	-	-	-	-	-	2.3	3.6	5.4	7.3	10.0	10.0
	20A	-	-	-	-	-		-	3.2	4.6	6.8	10.0	10.0
	25A	-	-	-	-	-	-	-	-	4.3	5.8	10.0	10.0
	32A	-	-	-	-	-	-	-	-	3.7	5.1	9.0	10.0
	40A	-	-	-	-	-	-	-	-	-	-	8.5	10.0
	50A	-	-	-	-	-	-	-	-	-	-	7.0	10.0
	63A	-	-	-	-	-	-	-	-	-	-	6.4	10.0

Downstream	In	Upstream Fuses gG-gL 6A	10A	16A	20A	25A	35A	50A	63A	80A	100A	125A	160A
Curve D	0.5	0.1	0.3	1.0	5.0	7.5	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	1A	-	0.2	0.5	1.2	7.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
G100	2A	-	-	0.3	0.6	1.6	2.6	8.0	10.0	10.0	10.0	10.0	10.0
Type D	4A	-	-	-	-	0.8	1.8	3.6	8.0	10.0	10.0	10.0	10.0
	6A	-	-	-	-	0.6	1.7	2.8	4.5	7.3	10.0	10.0	10.0
	10A	-	-	-	-	-	-	2.3	3.6	5.5	10.0	10.0	10.0
	13A	-	-	-	-	-	-	-	3.3	5.3	8.5	10.0	10.0
	16A	-	-	-	-	-	-	-	-	5.0	7.7	10.0	10.0
	20A	-	-	-	-	-	-	-	-	-	6.8	10.0	10.0
	25A	-	-	-	-	-	-	-	-	-	6.1	8.0	10.0
	32A	-	-	-	-	-	-	-	-	-	-	6.8	10.0
	40A	-	-	-	-	-	-	-	-	-	-	-	10.0
	50A	-	-	-	-	-	-	-	-	-	-	-	10.0
	63A	-	-	-	-	-	-	-	-	-	-	-	9.5

Example

A combination of an MCB G102 C20 with an upstream fuse 80A guarantees selectivity up to a short-circuit level of **4.6** kA.



Selectivity - Upstream Fuses BS / Downstream MCB's G100

Downstream	In	Upstream Fuses BS1361 40A	63A	80A	100A	125A	160A
Curve B	6A	2.3	6.8	10.0	10.0	10.0	10.0
	10A	1.8	5.0	7.0	8.0	10.0	10.0
G100	16A	1.5	4.2	5.8	6.5	9.6	10.0
DME100	20A	1.3	3.4	4.8	5.3	7.5	10.0
	25A	-	3.2	4.3	4.7	7.0	10.0
	32A	-	2.8	3.8	4.2	6.0	10.0
	40A	-	2.7	3.6	4.0	5.6	10.0
	50A	-	-	-	3.7	5.3	10.0
	63A	-	-	-	3.2	4.5	10.0

Downstream	In	Upstream Fuses BS1361 40A	63A	80A	100A	125A	160A
Curve C	6A	2.0	5.3	6.0	6.0	6.0	10.0
	10A	1.6	4.2	5.5	6.0	6.0	10.0
G100	16A	1.4	3.8	5.0	5.7	6.0	10.0
DME100	20A	1.2	3.4	4.2	4.8	6.0	10.0
	25A	-	3.0	3.9	4.4	6.0	10.0
	32A	-	2.8	3.4	3.9	5.8	10.0
	40A	-	2.5	3,1	3.5	5.3	10.0
	50A	-	-	-	3.2	4.7	10.0
	63A	-	-	-	2.9	4.2	9.4

Downstream	In	Upstream Fuses BS1361 40A	63A	80A	100A	125A	160A
Curve D	6A	1.7	10.0	10.0	10.0	10.0	10.0
	10A	1.4	3.9	5.2	5.8	8.8	10.0
G100	16A	1.4	3.6	4.7	5.2	7.6	10.0
	20A	1.2	3.1	4.1	4.6	6.8	10.0
	25A	1.0	2.8	3.7	4.1	6.1	10.0
	32A	-	2.3	3.2	3.5	5.4	10.0
	40A	-	2.1	2.9	3.3	5.0	10.0
	50A	-	-	-	3.0	4.7	10.0
	63A	-	-	-	2.6	4.2	9.6

Circuit Protection

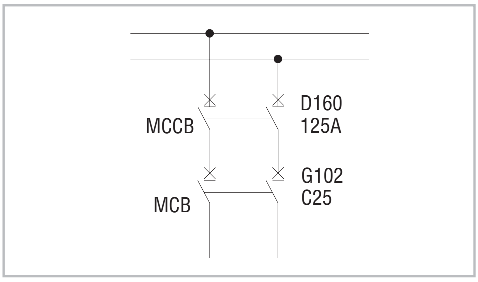
Selectivity - Upstream MCCB's Record / Downstream MCB's ElfaPlus

Downstream \ Upstream		D125-D125L							D160 - D250 - DH 160 - DH250 - D160L - D250L								D400 - DH400 - D400L				D400S DH400S	D630 DH630 D630L DH800	D630S DH630S D800S	D1250 D1250S
	(A)	16A	25A	40A	63A	80A	100A	125A	25A	40A	63A	100A	125A	160A	200A	250A	200A	250A	320A	400A	All	All	All	All
Curve B	6	0.5	2.0	3.2	3.5	T	T	T	4.0	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	10		1.6	2.0	2.8	T	T	T	2.5	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
C45-60 /	16			1.2	1.4	4.0	T	T		3.0	T	T	T	T	T	T	T	T	T	T	T	T	T	T
DM60-100	20			1.2	1.4	4.0	T	T			T	T	T	T	T	T	T	T	T	T	T	T	T	T
(1)	25				1.3	3.5	1.5	1.5			3.0	T	T	T	T	T	T	T	T	T	T	T	T	T
	32				1.3	3.5	1.5	1.5				T	T	T	T	T	T	T	T	T	T	T	T	T
	40				1.3	3.5	1.5	1.5				T	T	T	T	T	T	T	T	T	T	T	T	T
Curve B	6	0.5	2.0	3.2	3.5	T	T	T	4.0	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	10		1.6	2.0	2.8	6.0	T	T	2.5	6.0	7.5	T	T	T	T	T	T	T	T	T	T	T	T	T
G60 /	16			1.2	1.4	4.0	6.0	6.0		3.5	6.0	T	T	T	T	T	T	T	T	T	T	T	T	T
DME60	20			1.2	1.4	4.0	6.0	6.0		3.5	4.5	T	T	T	T	T	T	T	T	T	T	T	T	T
	25				1.3	3.5	6.0	6.0			4.5	T	T	T	T	T	T	T	T	T	T	T	T	T
	32				1.3	3.5	6.0	6.0			3.0	7.5	T	T	T	T	T	T	T	T	T	T	T	T
	40					1.6	5.0	5.0			2.0	7.5	7.5	T	T	T	T	T	T	T	T	T	T	T
	50											6.0	7.5	T	T	T	T	T	T	T	T	T	T	T
	63											6.0	7.5	T	T	T	T	T	T	T	T	T	T	T
Curve B	6	0.5	2.0	3.2	3.5	10.0	10.0	10.0	4.0	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	10		1.6	2.0	2.8	6.0	10.0	10.0	2.5	6.0	7.5	T	T	T	T	T	T	T	T	T	T	T	T	T
G100 /	16			1.2	1.4	4.0	6.0	6.0		3.5	6.0	10.0	T	T	T	T	T	T	T	T	T	T	T	T
DME100	20			1.2	1.4	4.0	6.0	6.0		3.5	4.5	10.0	T	13.0	T	T	T	T	T	T	T	T	T	T
	25				1.3	3.5	6.0	6.0			4.5	10.0	10.0	13.0	T	T	T	T	T	T	T	T	T	T
	32				1.3	3.5	6.0	6.0			3.0	7.5	10.0	10.0	10.0	T	T	T	T	T	T	T	T	T
	40					1.6	5.0	5.0			2.0	7.5	7.5	10.0	10.0	T	T	T	T	T	T	T	T	T
	50											6.0	7.5	10.0	10.0	T	T	T	T	T	T	T	T	T
	63											6.0	7.5	10.0	10.0	T	T	T	T	T	T	T	T	T
Curve B	6	0.5	2.0	3.2	3.5	10.0	10.0	10.0	4.0	T	T	T	T	15.0	T	T	T	T	T	T	T	T	T	T
	10		1.6	2.0	2.8	6.0	10.0	10.0	2.5	6.0	7.5	T	T	15.0	T	T	T	T	T	T	T	T	T	T
GT25	16			1.2	1.4	4.0	6.0	6.0		3.5	6.0	10.0	T	15.0	T	T	T	T	T	T	T	T	T	T
	20			1.2	1.4	4.0	6.0	6.0		3.5	4.5	10.0	T	13.0	15.0	T	T	T	T	T	T	T	T	T
	25				1.3	3.5	6.0	6.0			4.5	10.0	10.0	13.0	15.0	15.0	T	T	T	T	T	T	T	T
	32				1.3	3.5	6.0	6.0			3.0	7.5	10.0	10.0	10.0	15.0	T	T	T	T	T	T	T	T
	40					1.6	5.0	5.0			2.0	7.5	7.5	10.0	10.0	15.0	T	T	T	T	T	T	T	T
	50											6.0	7.5	10.0	10.0	15.0	T	T	T	T	T	T	T	T
	63											6.0	7.5	10.0	10.0	15.0	T	T	T	T	T	T	T	T

(1) Icc limited to 6 kA for C60, DM60
Icc limited to 10 kA for DM100
T = Total : selective untill the Icu of the downstream device
OR the Icu of the upstream device

Example

A combination of an MCB G102 C25 with an upstream D160 160A guarantees selectivity up to a short-circuit level of **10** kA.



Selectivity - Upstream MCCB's Record / Downstream MCB's ElfaPlus

Downstream \ Upstream	(A)	D125-D125L							D160 - D250 - DH 160 - DH250 - D160L - D250L								D400 - DH400 - D400L				D400S DH400S	D630 DH630 D630L DH800	D630S DH630S D800S	D1250 D1250S
		16A	25A	40A	63A	80A	100A	125A	25A	40A	63A	100A	125A	160A	200A	250A	200A	250A	320A	400A	All	All	All	All
Curve C	2	0.5	2.0	3.5	4.5	T	T	T	3.5	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	3	0.5	2.0	3.5	4.5	T	T	T	1.6	5.0	T	T	T	T	T	T	T	T	T	T	T	T	T	T
C 45-60 /	4	0.3	1.2	1.8	1.6	T	T	T	1.5	2.0	5.0	T	T	T	T	T	T	T	T	T	T	T	T	T
DM 60-100	6		1.2	1.8	1.6	4.5	T	T		1.0	4.0	T	T	T	T	T	T	T	T	T	T	T	T	T
(1)	10		1.2	1.4	1.5	4.5	T	T			2.5	T	T	T	T	T	T	T	T	T	T	T	T	T
	16			1.0	1.2	2.0	5.0	5.0			2.5	T	T	T	T	T	T	T	T	T	T	T	T	T
	20			1.0	1.2	2.0	5.0	5.0			2.0	T	T	T	T	T	T	T	T	T	T	T	T	T
	25			0.4	0.8	1.5	4.5	4.5			2.0	T	T	T	T	T	T	T	T	T	T	T	T	T
	32				0.5	1.5	2.3	2.3				T	T	T	T	T	T	T	T	T	T	T	T	T
	40						2.3	2.3				T	T	T	T	T	T	T	T	T	T	T	T	T
Curve C	6		1.2	1.7	1.6	4.5	T	T		1.0	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	10		1.2	1.4	1.5	4.5	T	T			T	T	T	T	T	T	T	T	T	T	T	T	T	T
G45	16			1.0	1.2	2.0	T	T			4.5	T	T	T	T	T	T	T	T	T	T	T	T	T
	20			1.0	1.2	2.0	T	T			4.5	T	T	T	T	T	T	T	T	T	T	T	T	T
	25			0.4	0.8	1.5	4.5	4.5			3.0	T	T	T	T	T	T	T	T	T	T	T	T	T
	32				0.5	1.5	2.3	2.3			3.0	T	T	T	T	T	T	T	T	T	T	T	T	T
	40						2.3	2.3			2.0	T	T	T	T	T	T	T	T	T	T	T	T	T
Curve C	0.5	1.5	6.0	8.0	10.0	10.0	10.0	10.0	9.0	10.0	6.0	T	T	T	T	T	10.0	T	T	T	T	T	T	T
	1	1.5	6.0	8.0	10.0	10.0	10.0	10.0	9.0	10.0	6.0	T	T	T	T	T	10.0	T	T	T	T	T	T	T
G60 /	2	0.5	2.0	3.5	4.5	10.0	10.0	10.0	3.5	9.0	6.0	T	T	T	T	T	10.0	T	T	T	T	T	T	T
DME60	3	0.5	2.0	3.5	4.5	9.0	10.0	10.0	1.6	5.0	6.0	T	T	T	T	T	10.0	T	T	T	T	T	T	T
	4	0.3	1.2	1.8	1.6	9.0	6.0	6.0	1.5	2.0	6.0	T	T	T	T	T	10.0	T	T	T	T	T	T	T
	6		1.2	1.8	1.6	4.5	6.0	6.0		1.0	6.0	T	T	T	T	T	10.0	T	T	T	T	T	T	T
	10		1.2	1.4	1.5	4.5	6.0	6.0			6.0	T	T	T	T	T	10.0	T	T	T	T	T	T	T
	16			1.0	1.2	2.0	5.0	5.0			4.5	T	T	T	T	T	10.0	T	T	T	T	T	T	T
	20			1.0	1.2	2.0	5.0	5.0			4.5	T	T	T	T	T	10.0	T	T	T	T	T	T	T
	25			0.4	0.8	1.5	4.5	4.5			3.0	T	T	T	T	T	10.0	T	T	T	T	T	T	T
	32				0.5	1.5	2.3	2.3			3.0	7.5	T	T	T	T	10.0	10.0	T	T	T	10.0	T	T
	40						2.3	2.3			2.0	7.5	7.5	T	T	T	10.0	10.0	T	T	T	10.0	T	T
	50										2.0	4.5	6.0	T	T	T	10.0	10.0	T	T	T	10.0	T	T
	63											4.5	6.0	T	T	T	10.0	10.0	T	T	T	10.0	T	T
Curve C	0.5	1.5	6.0	8.0	10.0	10.0	10.0	10.0	9.0	10.0	6.0	10.0	10.0	13.0	T	T	10.0	T	T	T	T	T	T	T
	1	1.5	6.0	8.0	10.0	10.0	10.0	10.0	9.0	10.0	6.0	10.0	10.0	13.0	T	T	10.0	T	T	T	T	T	T	T
G100 /	2	0.5	2.0	3.5	4.5	10.0	10.0	10.0	3.5	9.0	6.0	10.0	10.0	13.0	T	T	10.0	T	T	T	T	T	T	T
DME100	3	0.5	2.0	3.5	4.5	9.0	10.0	10.0	1.6	5.0	6.0	10.0	10.0	13.0	T	T	10.0	T	T	T	T	T	T	T
	4	0.3	1.2	1.8	1.6	9.0	6.0	6.0	1.5	2.0	6.0	10.0	10.0	13.0	T	T	10.0	T	T	T	T	T	T	T
	6		1.2	1.8	1.6	4.5	6.0	6.0		1.0	6.0	10.0	10.0	13.0	T	T	10.0	T	T	T	T	T	T	T
	10		1.2	1.4	1.5	4.5	6.0	6.0			6.0	10.0	10.0	13.0	T	T	10.0	T	T	T	T	T	T	T
	16			1.0	1.2	2.0	5.0	5.0			4.5	10.0	10.0	13.0	T	T	10.0	T	T	T	T	T	T	T
	20			1.0	1.2	2.0	5.0	5.0			4.5	10.0	10.0	10.0	T	T	10.0	T	T	T	T	T	T	T
	25			0.4	0.8	1.5	4.5	4.5			3.0	10.0	10.0	10.0	10.0	T	10.0	T	T	T	T	T	T	T
	32				0.5	1.5	2.3	2.3			3.0	7.5	10.0	10.0	10.0	T	10.0	10.0	T	T	T	10.0	T	T
	40						2.3	2.3			2.0	7.5	7.5	10.0	10.0	T	10.0	10.0	T	T	T	10.0	T	T
	50										2.0	4.5	6.0	10.0	10.0	T	10.0	10.0	T	T	T	10.0	T	T
	63											4.5	6.0	10.0	10.0	T	10.0	10.0	T	T	T	10.0	T	T
Curve C	0.5	1.5	6.0	8.0	10.0	10.0	10.0	10.0	9.0	10.0	6.0	10.0	10.0	13.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	1	1.5	6.0	8.0	10.0	10.0	10.0	10.0	9.0	10.0	6.0	10.0	10.0	13.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	2	0.5	2.0	3.5	4.5	10.0	10.0	10.0	3.5	9.0	6.0	10.0	10.0	13.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	3	0.5	2.0	3.5	4.5	9.0	10.0	10.0	1.6	5.0	6.0	10.0	10.0	13.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	4	0.3	1.2	1.8	1.6	9.0	6.0	6.0	1.5	2.0	6.0	10.0	10.0	13.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	6		1.2	1.8	1.6	4.5	6.0	6.0		1.0	6.0	10.0	10.0	13.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	10		1.2	1.4	1.5	4.5	6.0	6.0			6.0	10.0	10.0	13.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	16			1.0	1.2	2.0	5.0	5.0			4.5	10.0	10.0	13.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	20			1.0	1.2	2.0	5.0	5.0			4.5	10.0	10.0	10.0	15.0	15.0	10.0	T	T	T	T	T	T	T
	25			0.4	0.8	1.5	4.5	4.5			3.0	10.0	10.0	10.0	10.0	15.0	10.0	T	T	T	T	T	T	T
	32				0.5	1.5	2.3	2.3			3.0	7.5	10.0	10.0	10.0	15.0	10.0	10.0	T	T	T	10.0	T	T
	40						2.3	2.3			2.0	7.5	7.5	10.0	10.0	15.0	10.0	10.0	T	T	T	10.0	T	T
	50										2.0	4.5	6.0	10.0	10.0	15.0	10.0	10.0	T	T	T	10.0	T	T
	63											4.5	6.0	10.0	10.0	15.0	10.0	10.0	T	T	T	10.0	T	T
Hti	80													1.9	2.4	2.5	7.0	T	T	T	6.5	T	T	T
	100														2.4	2.5	7.0	T	T	T	6.5	T	T	T
	125															2.5	7.0	T	T	T	6.5	T	T	T

(1) Icc limited to 6 kA for C60, DM60
Icc limited to 10 kA for DM100
T = Total : selective untill the Icu of the downstream device
OR the Icu of the upstream device

Selectivity - Upstream MCCB's Record Plus / Downstream MCB's Redline

Downstream \ Upstream	In (A)	Record Plus™ type																				
		FD160E							FD160S							FD160N, H & L						
		40	50	63	80	100	125	160	40	50	63	80	100	125	160	40	50	63	80	100	125	160
		Selectivity limit in kA																				
Redline G60 B/C curve	≤16	0.6	2.5	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	20	0.6	2.5	3	T	T	T	T	3.5	T	T	T	T	T	T	3.5	T	T	T	T	T	T
	25	-	0.8	1.2	T	T	T	T	1.6	3.5	T	T	T	T	T	1.6	3.5	T	T	T	T	T
	32	-	-	1.2	3	T	T	T	-	-	T	T	T	T	T	-	-	T	T	T	T	T
	40	-	-	-	3	4	T	T	-	-	-	T	T	T	T	-	-	T	T	T	T	T
	50	-	-	-	1.2	1.5	T	T	-	-	-	3.5	T	T	T	-	-	-	3.5	T	T	T
	63	-	-	-	-	1.5	2	T	-	-	-	-	T	T	T	-	-	-	-	T	T	T
G100 B/C curve	≤16	0.6	2.5	6	6	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	20	0.6	2.5	2.5	6	8	T	T	3.5	T	T	T	T	T	T	3.5	T	T	T	T	T	T
	25	-	0.8	1.2	6	6	T	T	1.6	3.5	T	T	T	T	T	1.6	3.5	T	T	T	T	T
	32	-	-	1.2	3	6	8	T	-	-	6	6	T	T	T	-	2.5	T	T	T	T	T
	40	-	-	-	3	4	6	6	-	-	-	6	T	T	T	-	-	T	T	T	T	T
	50	-	-	-	1.2	1.5	6	6	-	-	-	3.5	8	T	T	-	-	-	3.5	T	T	T
	63	-	-	-	-	1.5	2	2	-	-	-	-	8	T	T	-	-	-	-	8	T	T
GT25 B/C curve	≤16	0.6	2.5	6	6	10	T	T	10	10	T	T	T	T	T	10	10	T	T	T	T	T
	20	0.6	2.5	3	6	8	T	T	3.5	10	T	T	T	T	T	3.5	10	T	T	T	T	T
	25	-	0.8	1.2	6	6	10	T	1.6	3.5	15	15	T	T	T	1.6	3.5	15	15	T	T	T
	32	-	-	1.2	3	6	8	10	-	-	6	6	10	T	T	-	-	10	10	T	T	T
	40	-	-	-	3	4	6	6	-	-	-	6	10	T	T	-	-	10	10	15	T	T
	50	-	-	-	1.2	1.5	6	6	-	-	-	3.5	8	10	T	-	-	-	3.5	10	T	T
	63	-	-	-	-	1.5	2	2	-	-	-	-	8	10	T	-	-	-	-	8	T	T
Hti - B/C curve	80	-	-	-	-	-	1.9	1.9	-	-	-	-	-	2.5	2.5	-	-	-	-	-	2.5	2.5
	100	-	-	-	-	-	-	1.9	-	-	-	-	-	-	2.5	-	-	-	-	-	-	2.5
S90 - C curve	≤32	0.6	0.8	0.9	1.2	1.5	1.9	1.9	0.8	1	1.2	15	15	15	15	0.8	1	1.2	15	15	15	15
	40	-	-	0.9	1.2	1.5	1.9	1.9	-	-	1.2	15	15	15	15	-	-	1.2	15	15	15	15
	50	-	-	-	1.2	1.5	1.9	1.9	-	-	-	15	15	15	15	-	-	-	15	15	15	15
	63	-	-	-	-	1.5	1.9	1.9	-	-	-	-	15	15	15	-	-	-	-	15	15	15
	80	-	-	-	-	-	1.9	1.9	-	-	-	-	-	15	15	-	-	-	-	-	15	15
	100	-	-	-	-	-	-	1.9	-	-	-	-	-	-	15	-	-	-	-	-	-	15

* T = Total: selective unil the lowest Icu value of the two devices placed in series.

Selectivity - Upstream MCCB's Record Plus / Downstream MCB's Redline

Downstream \ Upstream	In (A)	Record Plus™ type																
		FE160N, H & L - TML					FE160N, H & L - TMLD			FE160N, H & L - SMR1			FE250N, H & L - TMLD			FE250N, H & L - SMR1		
		63	80	100	125	160	100	125	160	63	125	160	125	160	200&250	125	160	250
		Selectivity limit in kA																
Redline G60 B/C curve	≤20	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	25	1.2	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	32	1.2	3	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	40	-	3	4	T	T	T	T	T	-	T	T	T	T	T	T	T	T
	50	-	1.2	1.5	T	T	T	T	T	-	T	T	T	T	T	T	T	T
	63	-	-	1.5	2	T	-	T	T	-	T	T	T	T	T	T	T	T
G100 B/C curve	≤16	6	6	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	20	2.5	6	8	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	25	1.2	6	6	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	32	1.2	3	6	8	T	T	T	T	T	T	T	T	T	T	T	T	T
	40	-	3	4	6	6	T	T	T	T	T	T	T	T	T	T	T	T
	50	-	1.2	1.5	6	6	T	T	T	-	T	T	T	T	T	T	T	T
	63	-	-	1.5	2	2	-	T	T	-	T	T	T	T	T	T	T	T
GT25 B/C curve	≤16	6	6	10	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	20	2.5	6	8	T	T	T	T	T	T	T	T	T	T	T	T	T	T
	25	1.2	6	6	10	T	T	T	T	T	T	T	T	T	T	T	T	T
	32	1.2	3	6	8	10	T	T	T	T	T	T	T	T	T	T	T	T
	40	-	3	4	6	6	T	T	T	T	T	T	T	T	T	T	T	T
	50	-	1.2	1.5	6	6	T	T	T	-	T	T	T	T	T	T	T	T
	63	-	-	1.5	2	2	-	T	T	-	T	T	T	T	T	T	T	T
Hti - B/C curve	80	-	-	-	1	2	-	T	T	-	T	T	-	T	T	-	T	T
	100	-	-	-	-	2	-	-	T	-	-	T	-	T	T	-	T	T
	125	-	-	-	-	-	-	-	T	-	-	T	-	-	T	-	-	T
S90 - C curve	≤32	0.6	0.8	0.95	1.2	1.5	T	T	T	T	T	T	T	T	T	T	T	T
	40	-	-	0.9	1.2	1.5	T	T	T	T	T	T	T	T	T	T	T	T
	50	-	-	-	1.2	1.5	T	T	T	-	T	T	T	T	T	T	T	T
	63	-	-	-	-	1.5	-	T	T	-	T	T	T	T	T	T	T	T
	80	-	-	-	-	1.5	-	T	T	-	T	T	-	T	T	-	T	T
	100	-	-	-	-	-	-	-	T	-	-	T	-	T	T	-	T	T

* T = Total: selective unil the lowest Icu value of the two devices placed in series.

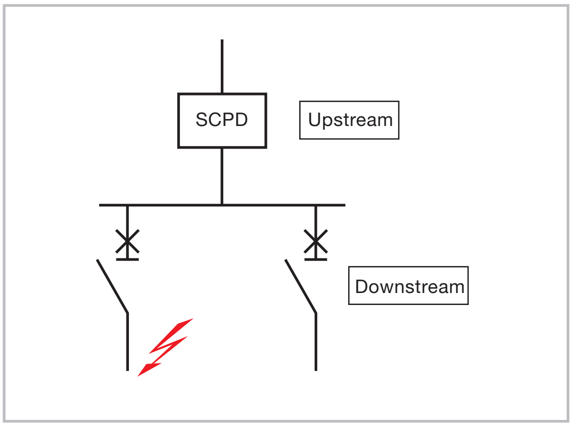
Association (back-up protection)

Association consist the use of an MCB with lower breaking capacity than the presumed one at the place of its installation. If another protective device installed upstream is co-ordinated so that the energy let-through by these two devices does not exceed that which can be withstood without damage by the device placed downstream and the conductor protected by these devices.

In the event of short-circuit, both protective devices will disconnect, therefore the selectivity between them is considered as partial.

Association reduces the cost of the installation in case of high short-circuit currents.

To obtain association between a breaker and a protective device, several conditions linked to the components characteristic must be fullfilled. Those have been defined by calculation and testing.



SCPD: Short-Circuit Protective Device

Upstream: Fuses / Downstream: MCB's Redline Icc max 100 kA*

*80 kA, 400V with 10 x 38 cartridge fuses

Downstream: MCB's ElfaPlus		Upstream: fuses			
Series	In (A)	Type gG min. rating (A)	Type gG max. rating (A)	Type aM min. rating (A)	Type aM max. rating (A)
Curve C	1	4	–	2	–
	2	8	63	4	63
	3	10	63	6	63
	6	20 (10*)	80	10 (10*)	63
G60	10	25 (16*)	80	16 (6*)	80
G100	16	40 (20*)	80	20 (10*)	80
GT25	20	50 (32*)	100	25 (16*)	80
	25	63 (40*)	100	32 (20*)	80
	32	80 (50*)	100	40 (25*)	100
	40	100 (50*)	125	50 (32*)	125
	50	125 (63*)	160	63 (40*)	160
	63	160 (80*)	160	80 (50*)	160
Hti	80	160	200	125	125
	100	200	200	125	125
	125	250	250	125	125

* In case of MCB with B characteristics

Back-up - Upstream MCB's Redline / Downstream MCB's Redline

Voltage 400/415V, Icc max. In kA

Downstream			Upstream					
			G60	G100	GT25	GT25	GT25	Hti
	Icu (kA)		10kA	15kA	25kA	20kA	15kA	10kA
		In (A)	0.5 ... 63	0.5 ... 63	< 32	32 ... 40	50 ... 63	80 ... 60
G45	6	6 ... 40	10	15	25	20	15	10
G60	10	0.5 ... 63	-	15	25	20	15	-
G100	15	0.5 ... 63	-	-	25	20	15	-

Voltage 230/240V, Icc max. In kA

Downstream			Upstream					
			G60	G100	GT25	GT25	GT25	Hti
	Icu (kA)		20kA	30kA	50kA	40kA	30kA	16kA
		In (A)	0.5 ... 63	0.5 ... 63	< 25	32 ... 40	50 ... 63	80 ... 125
C45	5	2 ... 32	20	30	50	40	30	16
C60	6	2 ... 32	20	30	50	40	30	16
DM60	10	6 ... 40	-	30	50	40	30	-
DM100	15	6 ... 40	-	-	50	40	30	-
G45	10	6 ... 40	20	30	50	40	30	16
G60-DME60	20	0.5 ... 63	-	30	50	40	30	-
G100-DME100	30	0.5 ... 63	-	-	50	40	30	-

Back-up - Upstream MCCB's Record / Downstream MCB's Redline

Voltage 230/240V, Icc max. In kA

Downstream			Upstream													
			D125	D125L	D160	DH160	D160L	D250	DH250	D250L	D400	DH400	D400L	D630	DH630	D630L
	Icu (kA)		100kA	130kA	70kA	80kA	130kA	70kA	80kA	130kA	50kA	70kA	130kA	70kA	80kA	130kA
		In (A)														
C45	5	2 ... 32	10	10	-	-	-	-	-	-	-	-	-	-	-	-
C60	6	2 ... 32	15	15	-	-	-	-	-	-	-	-	-	-	-	-
G45	10	6 ... 40	40	90	40	45	45	40	40	40	-	-	-	-	-	-
G60-DME60	20	0.5 ... 63	50	130	50	50	50	50	50	50	22	22	25	22	22	22
G100-DME100	30	0.5 ... 63	70	130	60	65	100	65	60	75	50	50	25	22	22	22
GT25	50	< 25	80	130	70	80	100	70	80	100	50	50	70	-	-	-
GT25	40	> 32	80	130	65	65	100	65	65	100	50	50	70	-	-	-
GT25	30	> 32	80	130	65	65	100	65	65	100	50	50	70	-	-	-
Hti	15	80 ... 125	30	130	30	30	100	30	30	100	30	30	30	-	-	-

Voltage 400/415V, Icc max. In kA

Downstream			Upstream															
			D125	D125L	D160	DH160	D160L	D250	DH250	D250L	D400	DH400	D400L	D630	DH630	D630L	D800	DH800
	Icu (kA)		25kA	100kA	30kA	50kA	100kA	35kA	50kA	100kA	35kA	50kA	100kA	35kA	50kA	100kA	50kA	70kA
		In (A)																
G45	6	6 ... 40	15	50	20	30	40	25	30	40	-	-	-	-	-	-	-	-
G60	10	0.5 ... 63	22	100	30	40	50	35	40	50	22	22	25	22	22	25	22	22
G100	15	0.5 ... 63	22	100	30	40	50	35	40	50	22	22	25	22	22	25	22	22
GT25	25	0.5 ... 63	22	100	30	40	50	35	40	50	-	-	25	-	-	-	-	-
GT25	20	0.5 ... 63	22	100	30	40	50	35	40	50	-	-	25	-	-	-	-	-
GT25	15	0.5 ... 63	22	100	30	40	50	35	40	50	-	-	25	-	-	-	-	-
Hti	10	80 ... 125	25	50	15	15	50	15	15	50	-	-	20	-	-	-	-	-

Back-up - Upstream RecordPlus / Downstream Redline

Voltage 230/240V, Icc max. In kA

Downstream	Icu (kA)	In (A)	Upstream FD160E 36kA	FD160S 50kA	FD160N 85kA	FD160H 100kA	FD160L 200kA	FE250N 85kA	FE250H 100kA	FE250L 200kA
C45	5	2 ... 32	10	10	10	-	-	-	-	-
C60	10	2 ... 32	15	15	15	-	-	-	-	-
G45	10	6 ... 40	15	15	15	-	-	-	-	-
G60	20	0.5 ... 63	22	25	36	85	85	36	85	85
G100	30	0.5 ... 63	30	36	50	100	100	50	100	100
GT25	50	≤ 25	36	50	85	100	100	85	100	100
GT25	40	32-40	30	36	65	100	100	65	100	100
GT25	30	50-63	25	30	50	100	100	50	100	100
Hti	15	80 ... 125	25	30	50	100	100	50	100	100
S90	25	10 ... 100	36	50	85	100	100	85	100	100

Voltage 400/415V, Icc max. In kA

Downstream	Icu (kA)	In (A)	Upstream FD160E 25kA	FD160S 30kA	FD160N 50kA	FD160H 80kA	FD160L 150kA	FE250N 50kA	FE250H 80kA	FE250L 150kA
G45	5	6 ... 40	10	15	15	-	-	-	-	-
G60	10	0.5 ... 63	15	22	30	36	40	30	36	40
G100	15	0.5 ... 63	20	25	36	40	50	36	40	50
GT25	25	≤ 25	-	30	40	50	50	40	50	50
GT25	20	32-40	-	30	36	40	50	36	40	50
GT25	15	50-63	-	25	36	40	50	36	40	50
Hti	10	80 ... 125	15	25	36	40	50	36	40	50
S90	25	10-100	-	25	36	40	50	36	40	50

Selectivity: Upstream MCB S90 / Downstream Redline

Voltage 400/415V, Icc max. In kA

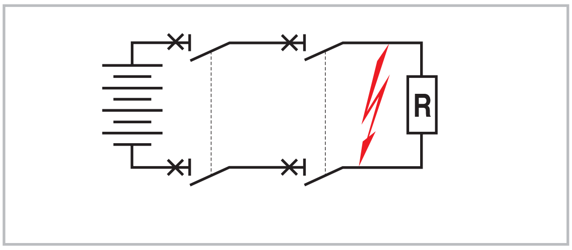
Downstream	Icu (kA)	In (A)	Upstream S90 25kA ≤ 100	S90H 50kA ≤ 80
EP60	10	0.5 ... 63	20	40
EP100	15	0.5 ... 63	25	50
EP250	25	≤ 25	25	50
EP250	20	32-40	25	50
EP250	15	50-63	25	50

Use in DC

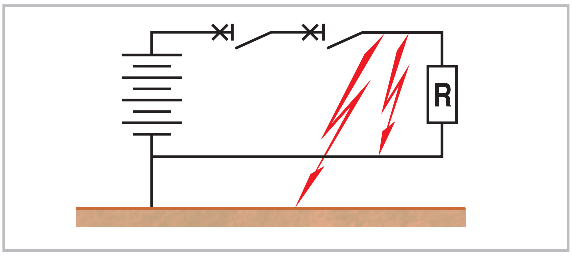
Selection criteria
The selection of an MCB to protect a D.C. installation depends on the following parameters:
- The nominal current
- The nominal voltage of the power supply, which determines the number of poles to switch the device
- The maximum short-circuit current, to determine the short-circuit capacity of the MCB
- Type of power supply

In the event of an insulation fault, it is considered as an overload when one pole or an intermediate connection of the power supply is connected to earth, and the conductive parts of the installation are also connected to earth.

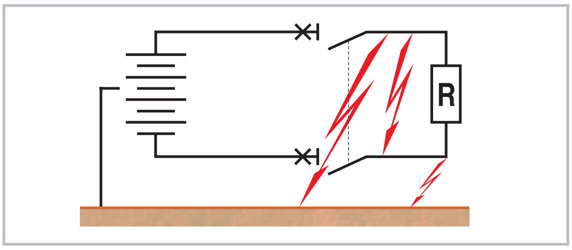
Insulated generator
In insulated generators there is no earth connection, therefore an earth leakage in any pole has no consequence. In the event of fault between the two poles (+ and –) there is a short-circuit in the installation which value will depend on the impedance of the installation as well as of the voltage Un.
Each polarity shall be provided with the appropriate number of poles.



Generator with one earthed pole
In the event of a fault occuring in the earthed pole (-) there is no consequence. In the event of a fault between the two poles (+ and -) or between the pole + and earth, then there is a short-circuit in the installation which value depends on the impedance of the installation as well as of the voltage Un. The unearthed pole (+) shall be provided with the necessary numbers of poles to break the maximum short-circuit.



Generator with centre point earth connection
In the event of short-circuit between any pole (+ or -) and earth, there is a Isc<Isc max because the voltage is Un/2. If the fault occurs between the two poles there is a short-circuit in the installation which value depends on the impedance of the installation as well as the voltage Un.
Each polarity shall be provided with the necessary number of poles to break the maximum short-circuit at Un/2.



Use of standard MCB in DC (acc. to IEC 60947-2)
For MCB's designed to be used in alternating current but used in installations in direct current, the following should be taken into consideration:
- For protection against overloads it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is similar in alternating current.
- For protection against short-circuits it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is 40% higher than the one in alternating current.

Use of special MCB (UC) in DC (acc. to IEC 60898-2) (UC= Universal Current)
For MCB's designed to work in both alternating and direct current, it is necessary to respect the polarity of the terminals since the device is equipped with a permanent magnet.

Use in DC selection table

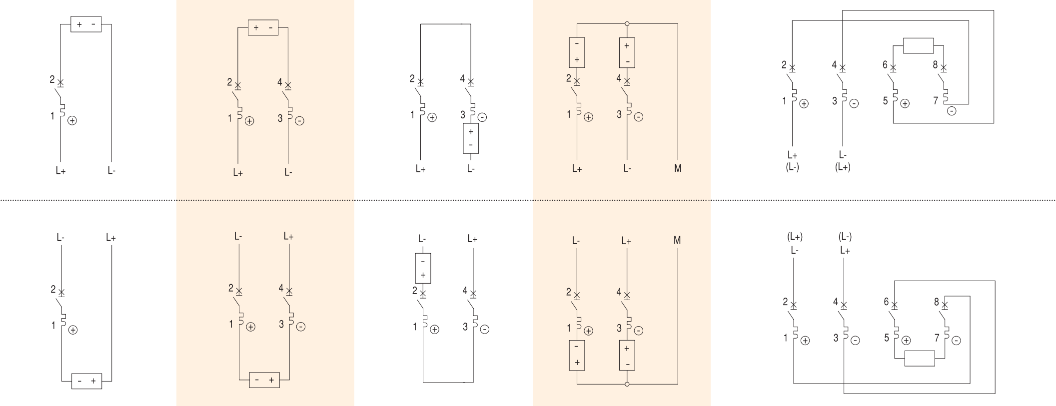
Series	Rated current (A)	≤ 60 V 1 pole Icu (kA)	≤ 125 V 2 poles in series Icu (kA)	250 V 1 pole Icu (kA)	440 V 2 poles in series Icu (kA)
G60(1)	0.5....63A	20	25	-	-
G100(1)	0.5....63A	25	30	-	-
GT10(1)	0.5....63A	20	25	-	-
EP100UC	6....25A	-	-	6	6

(1) Nominal voltage for G60/G100/GT10: 48/110VDC
Maximum voltage for G60/G100/GT10: 53/120VDC

Installation of MCB's series EP100 UC in direct current

Example of utilisation for maximum voltage between lines according to the number of poles

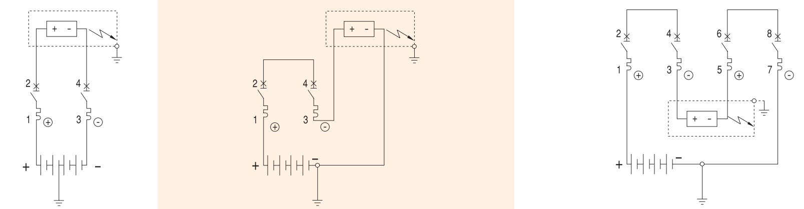
MCB's	EP 100 UC 1P	EP 100 UC 2P			EP 100 UC 4P *
Maximum voltage between lines	250 V ⎓	250 V ⎓	440 V ⎓	440 V ⎓	440 V ⎓ (poles inversion)
Maximum voltage between lines and earth	250 V ⎓	250 V ⎓	440 V ⎓ (1)	250 V ⎓	250 V ⎓
Power supply at bottom terminals					
Power supply at top terminals					



(1) Negative pole connected to earth * On request

Example of utilisation for different voltages between line and earth than between two lines

MCB's	EP 100 UC 2P		EP 100 UC 4P *
Maximum voltage between lines	440 V ⎓ Multipole breaking	440 V ⎓ Multipole breaking	440 V ⎓ Multipole breaking
Maximum voltage between lines and earth	250 V ⎓ Generator with centre point earth connection	440 V ⎓ Generator without earth connection or with one earthed pole	440 V ⎓ Generator without earth connection or with one earthed pole

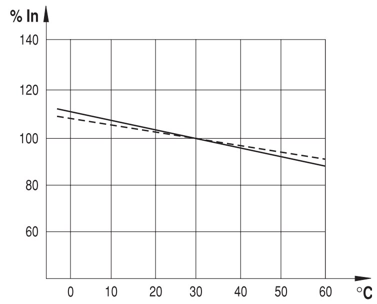


* On request

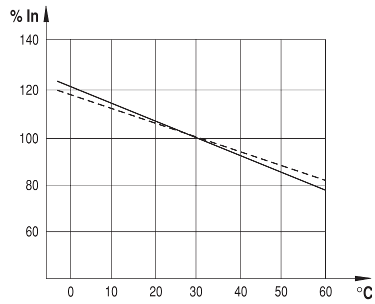
Influence of ambient air temperature on the rated current

The thermal callibration of the MCB's was carried out at ambient temperature of 30°C. Ambient temperatures different from 30°C influence the bimetal and this results in earlier or later thermal tripping.

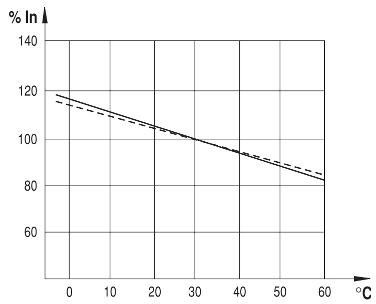
0,5 - 6A



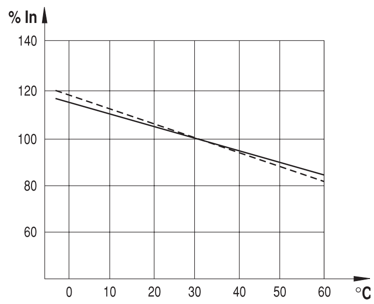
10A



16 - 40A



50 - 63A



——— : 1P (Single pole)
- - - - - - - : mP (Multipole)

Influence of air temperature (IEC/EN 60898)

1 pole	Calibrated at 30°C						
In	0°	10°	20°	30°	40°	50°	60°
0.5	0.57	0.55	0.52	0.5	0.48	0.46	0.43
1	1.13	1.11	1.04	1	0.96	0.91	0.87
2	2.27	2.22	2.09	2	1.91	1.82	1.73
3	3.40	3.32	3.13	3	2.87	2.73	2.60
4	4.53	4.43	4.18	4	3.82	3.65	3.47
6	6.80	6.65	6.27	6	5.73	5.47	5.20
10	12.33	11.56	10.78	10	9.23	8.45	7.67
16	18.67	17.78	16.89	16	15.11	14.23	13.34
20	23.33	22.22	21.11	20	18.89	17.78	16.67
25	29.17	27.78	26.39	25	23.62	22.23	20.84
32	37.33	35.56	33.78	32	30.23	28.45	26.68
40	46.67	44.44	42.23	40	37.79	35.57	33.35
50	57.50	55.00	52.50	50	47.50	45.00	42.50
63	72.45	69.30	66.15	63	59.85	56.70	53.55

n poles	Calibrated at 30°C						
In	0°	10°	20°	30°	40°	50°	60°
0.5	0.55	0.53	0.52	0.5	0.49	0.47	0.46
1	1.09	1.06	1.03	1	0.97	0.94	0.91
2	2.18	2.12	2.06	2	1.94	1.88	1.82
3	3.27	3.18	3.09	3	2.91	2.82	2.73
4	4.36	4.24	4.12	4	3.88	3.76	3.64
6	6.54	6.36	6.18	6	5.82	5.64	5.46
10	11.67	11.11	10.56	10	9.45	8.89	8.33
16	17.81	17.42	16.71	16	15.29	14.58	13.87
20	22.27	21.78	20.89	20	19.11	18.23	17.34
25	27.83	27.22	26.11	25	23.89	22.78	21.67
32	35.63	34.84	33.42	32	30.58	29.16	27.74
40	44.53	43.56	41.78	40	38.23	36.45	34.68
50	59.50	56.33	53.17	50	46.83	43.67	40.50
63	74.97	70.98	66.99	63	59.01	55.02	51.03

Tripping current as a function of the frequency

All the MCB's are designed to work at frequencies of 50-60 Hz, therefore to work at different values, consideration must be given to the variation of the tripping characteristics. The thermal tripping does not change with variation of the frequency but the magnetic tripping values can be up to 50% higher than the ones at 50-60 Hz.
For DC current magnetic tripping is 50% higher.

Tripping current variation

60Hz	100Hz	200Hz	300Hz	400Hz
1	1.1	1.2	1.4	1.5

Power losses

The power losses are calculated by measuring the voltage drop between the incoming and the outgoing terminals of the device at rated current.

Power losses per pole MCB Series G

In (A)	Voltage drop (V)	Energy loss Pw (W)	Resistance Z (mOhm)
0.5	2.23	1.12	4458.00
1	1.27	1.27	1272.00
2	0.62	1.24	310.00
3	0.52	1.56	173.00
4	0.37	1.49	93.00
6	0.26	1.57	43.60
8	0.16	1.24	19.40
10	0.16	1.56	15.60
13	0.16	2.01	11.90
16	0.16	2.57	10.10
20	0.14	2.76	6.90
25	0.13	3.19	5.10
32	0.10	3.07	3.00
40	0.10	4.00	2.50
50	0.09	4.50	1.80
63	0.08	5.16	1.30

Power losses per pole MCB Series Hti

In (A)	Voltage drop (V)	Energy loss Pw (W)	Resistance Z (mOhm)
80	0.08	6.00	0.90
100	0.08	7.50	0.75
125	0.08	9.50	0.60

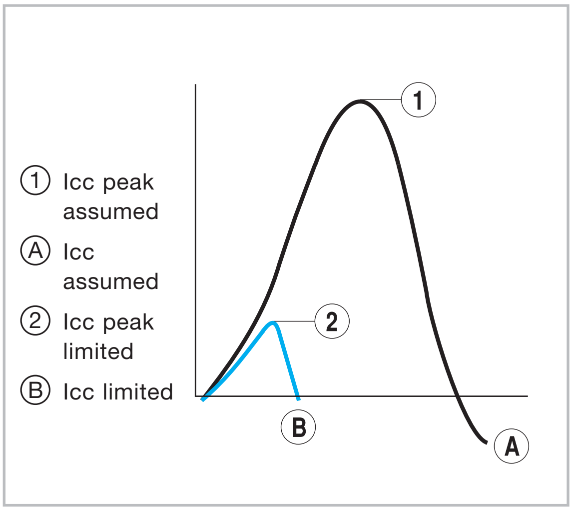
Power losses per pole MCB Series C

In (A)	Voltage drop (V)	Energy loss Pw (W)	Resistance Z (mOhm)
2	0.82	1.60	400.00
4	0.57	2.30	144.00
6	0.21	1.30	36.10
10	0.13	1.30	13.00
16	0.11	1.80	7.03
20	0.14	2.80	7.00
25	0.10	2.50	4.00
32	0.09	3.00	2.93

Limitation curves

Let-through energy I^2t
The limitation capacity of a MCB in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.

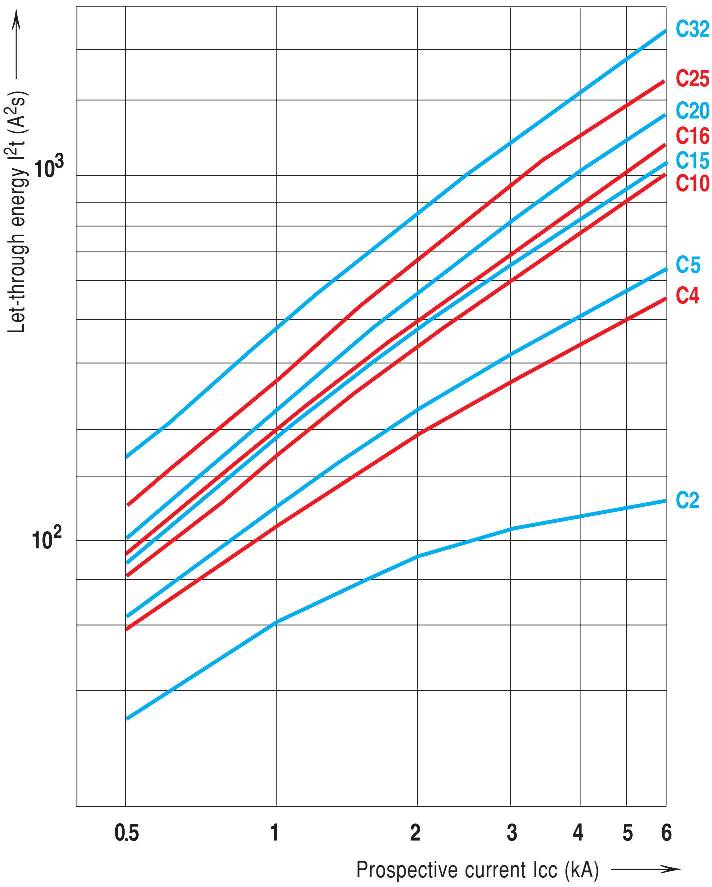
Peak current Ip
It is the value of the maximum peak of the short-circuit current limited by the MCB.



See page T1.33 up to T1.44

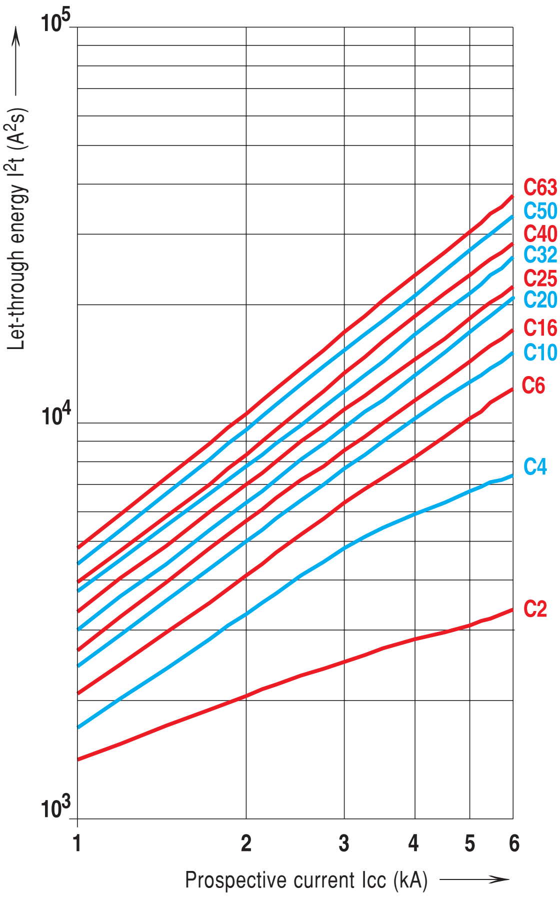
C45-C60 Curve 1P+N / 1 module

I^2t Let-through energy at 230V



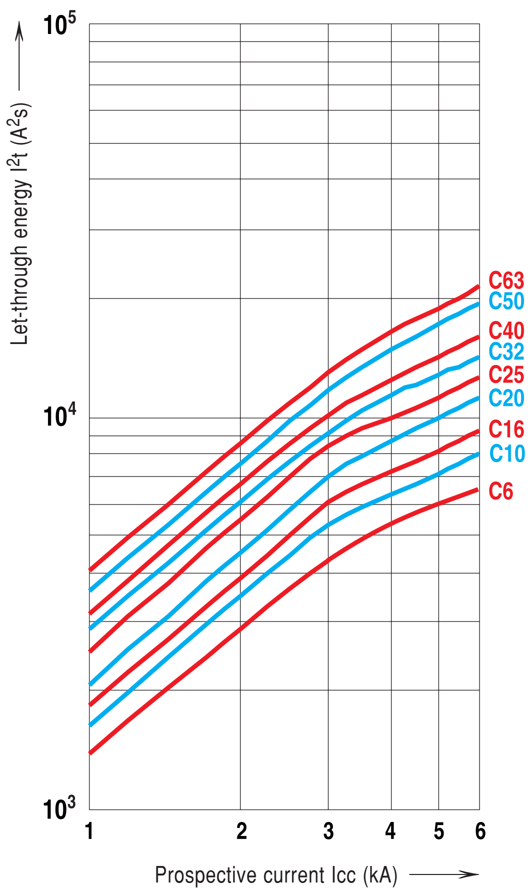
G45 Curve C 1P, 1P+N, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

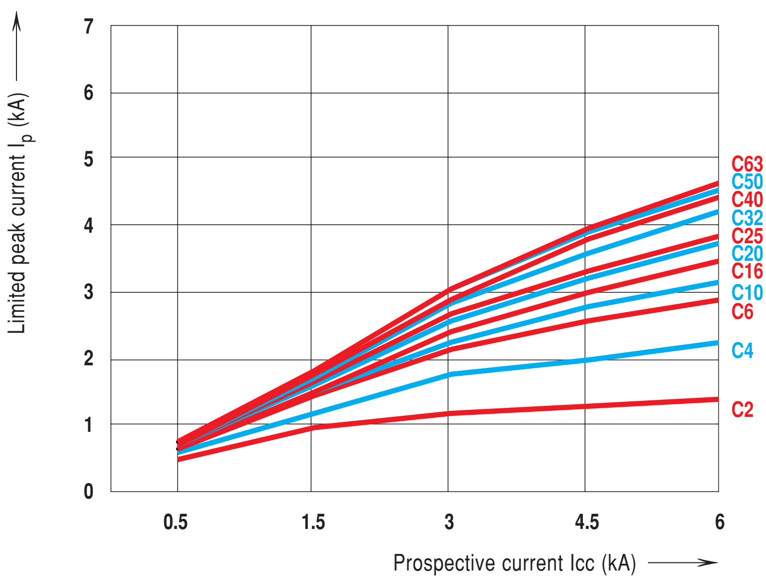


G45 Curve C 2P

I^2t Let-through energy at 230 V

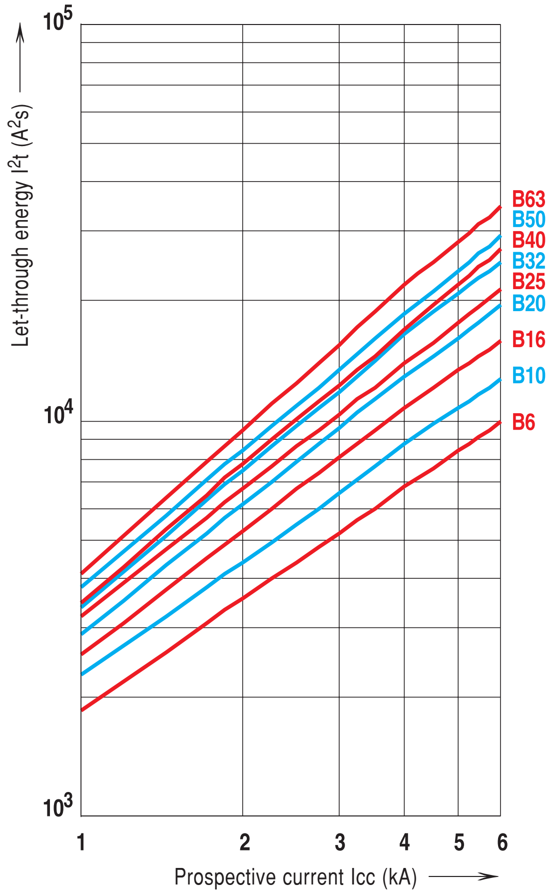


Ip Limited peak current at 230/400 V



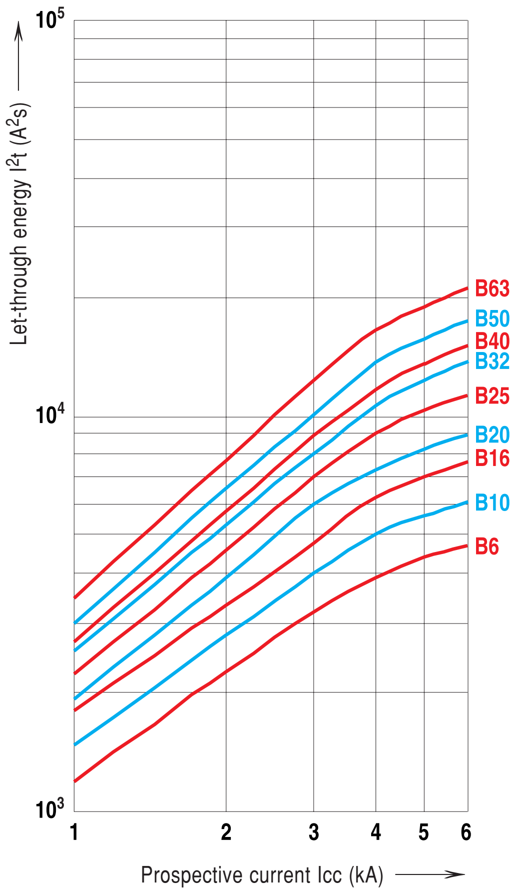
G45 Curve B 1P, 1P+N, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

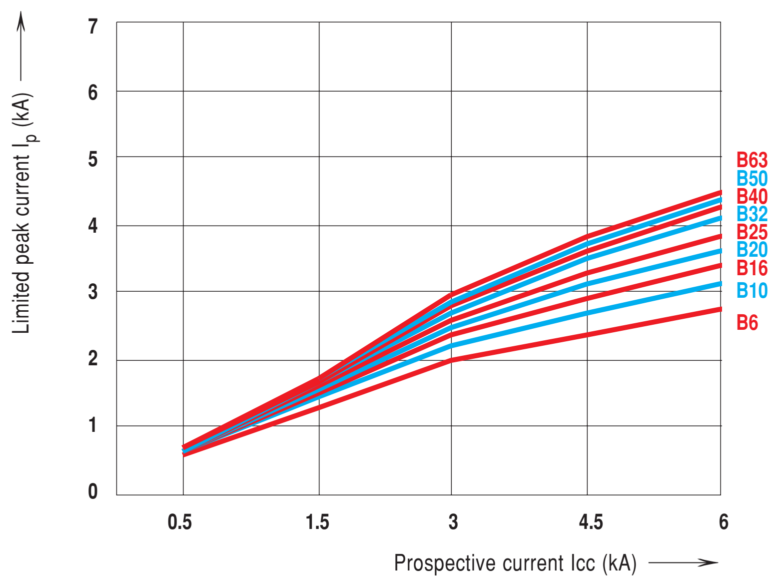


G45 Curve B 2P

I^2t Let-through energy at 230 V

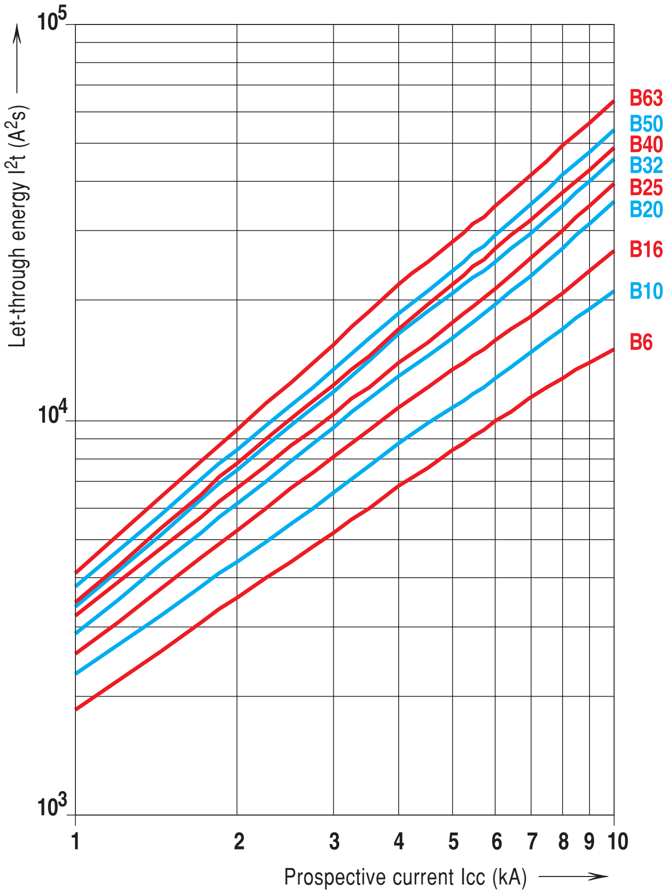


Ip Limited peak current at 230/400 V



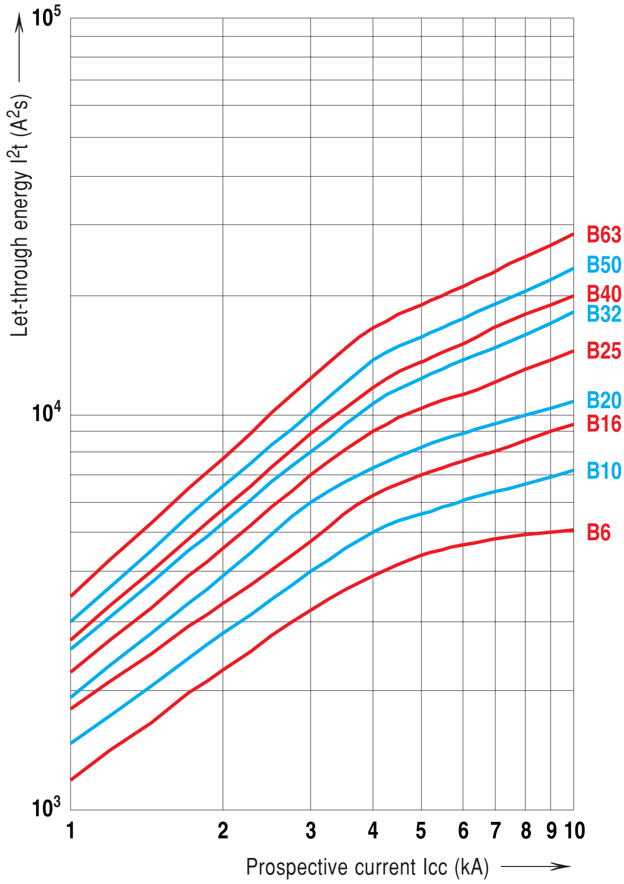
G60 Curve B 1P, 1P+N, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

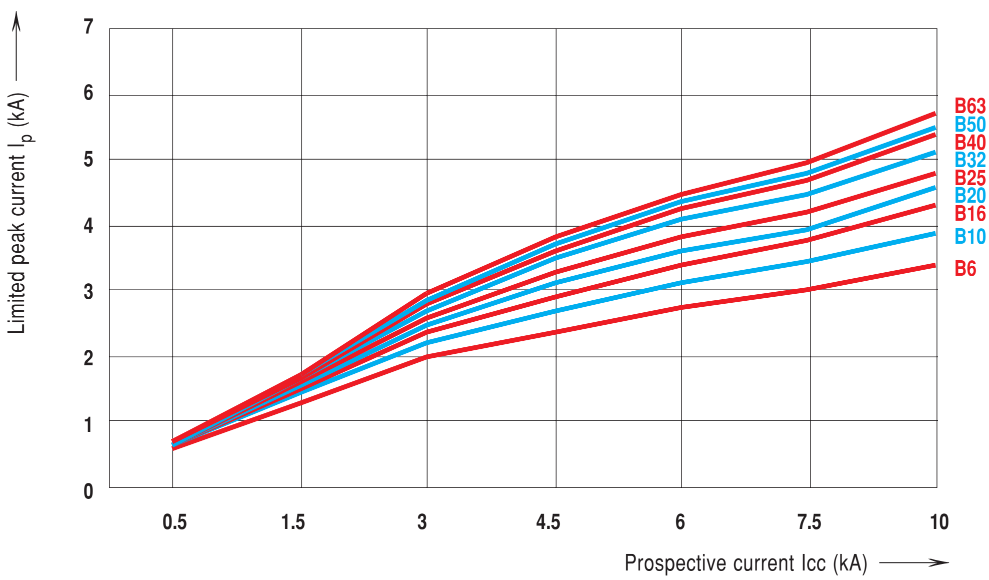


G60 Curve B 2P

I^2t Let-through energy at 230 V

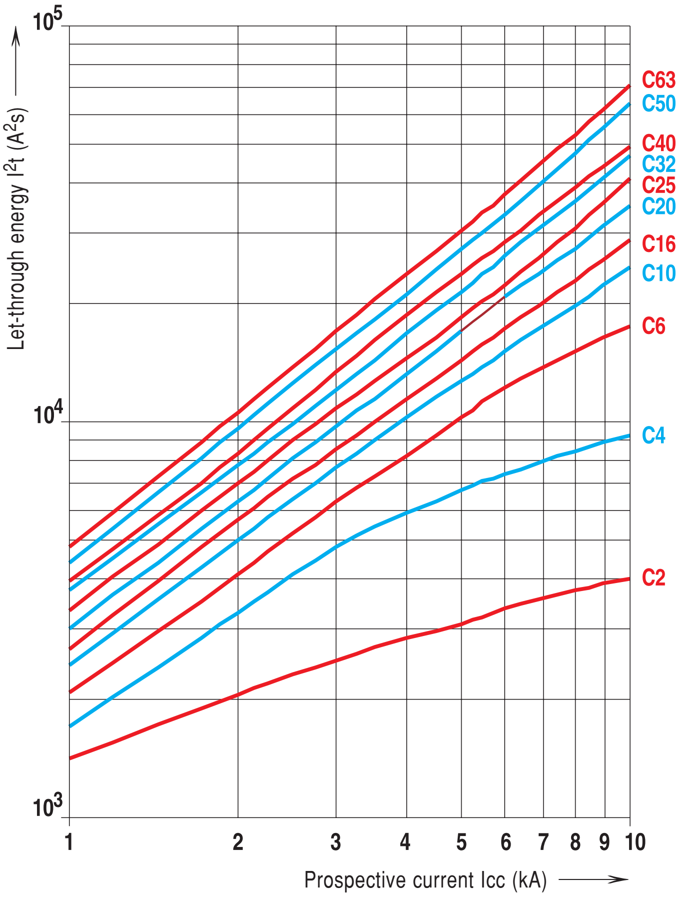


Ip Limited peak current at 230/400 V



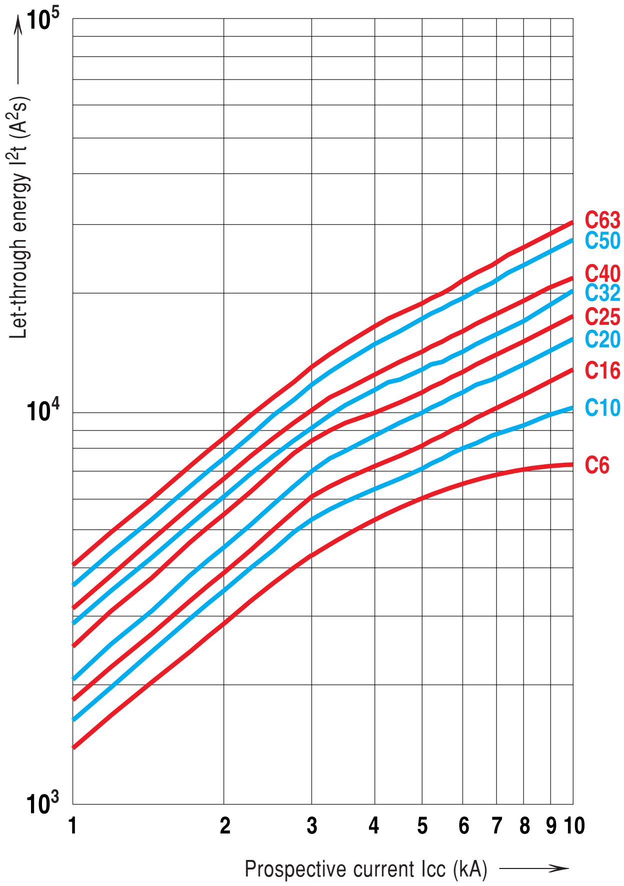
G60 Curve C 1P, 1P+N, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

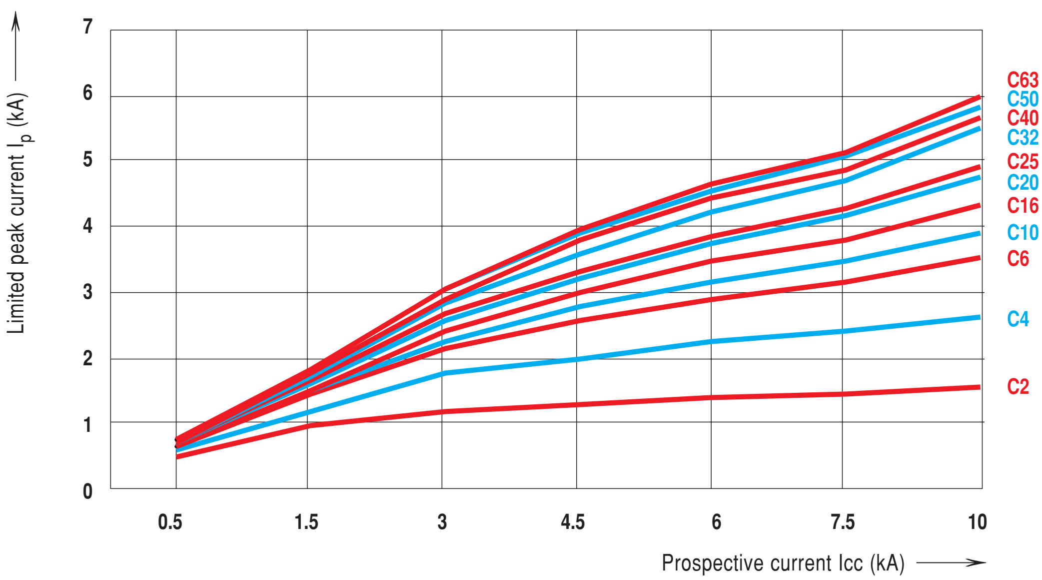


G60 Curve C 2P

I^2t Let-through energy at 230 V

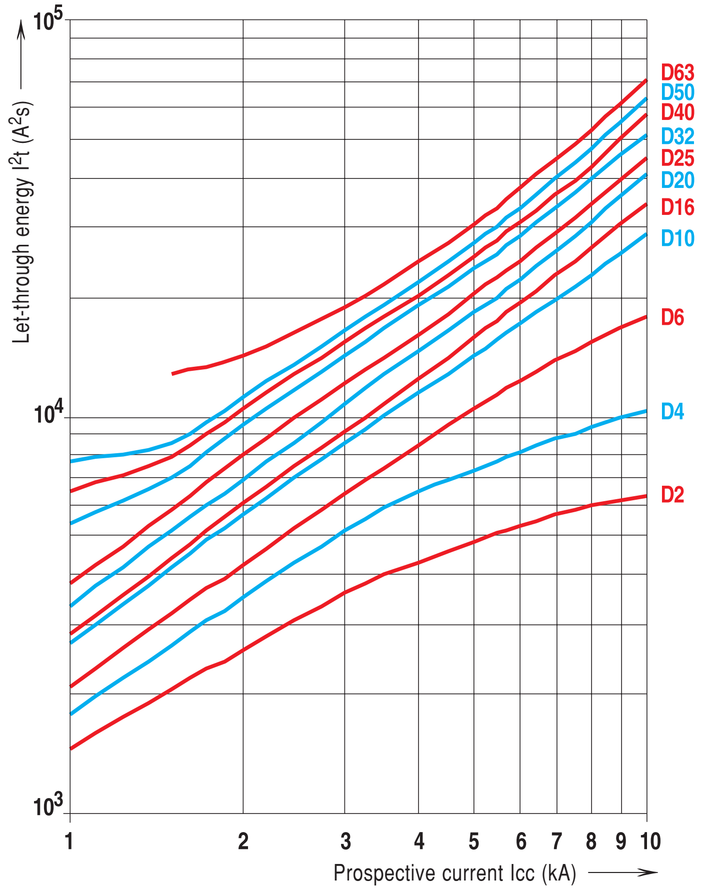


Ip Limited peak current at 230/400 V



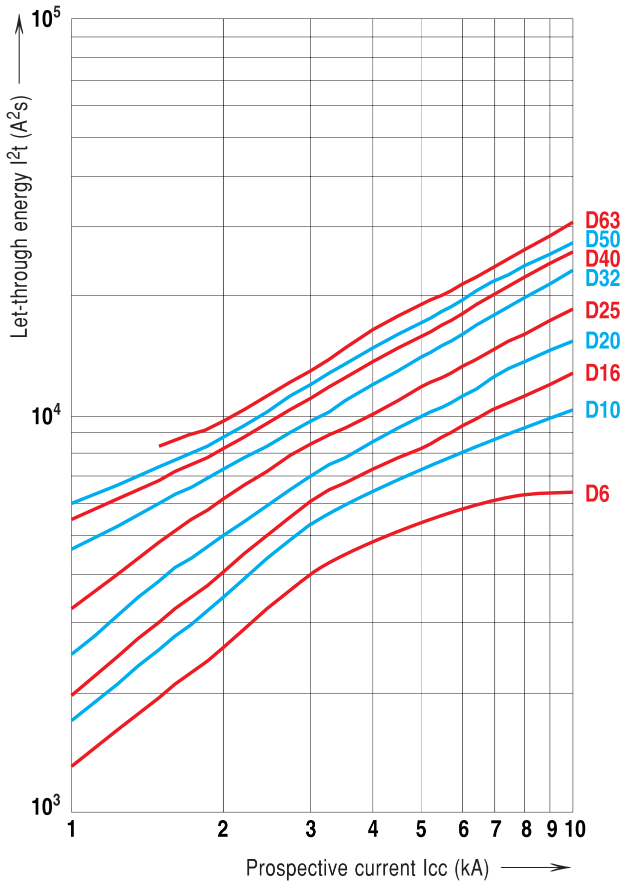
G60 Curve D 1P, 1P+N, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

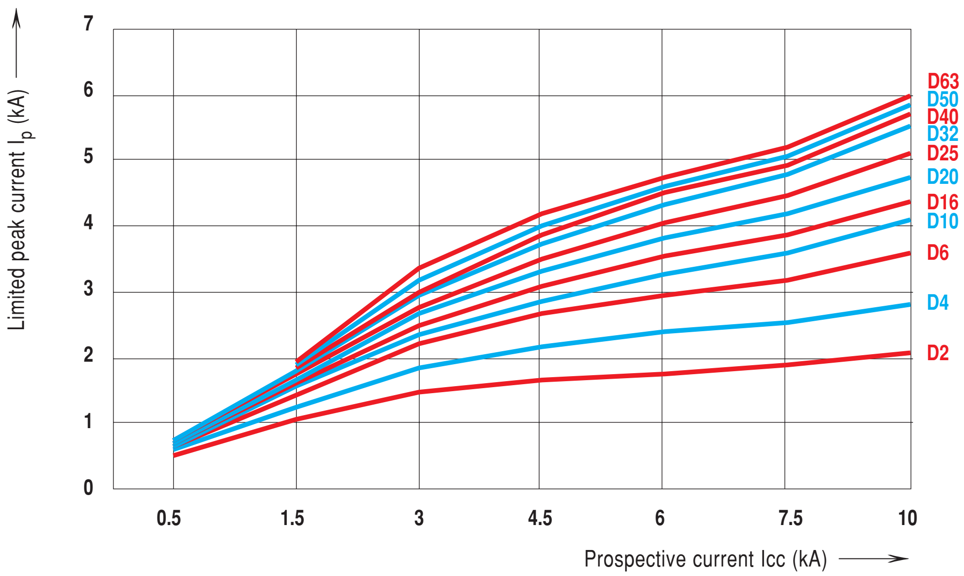


G60 Curve D 2P

I^2t Let-through energy at 230 V

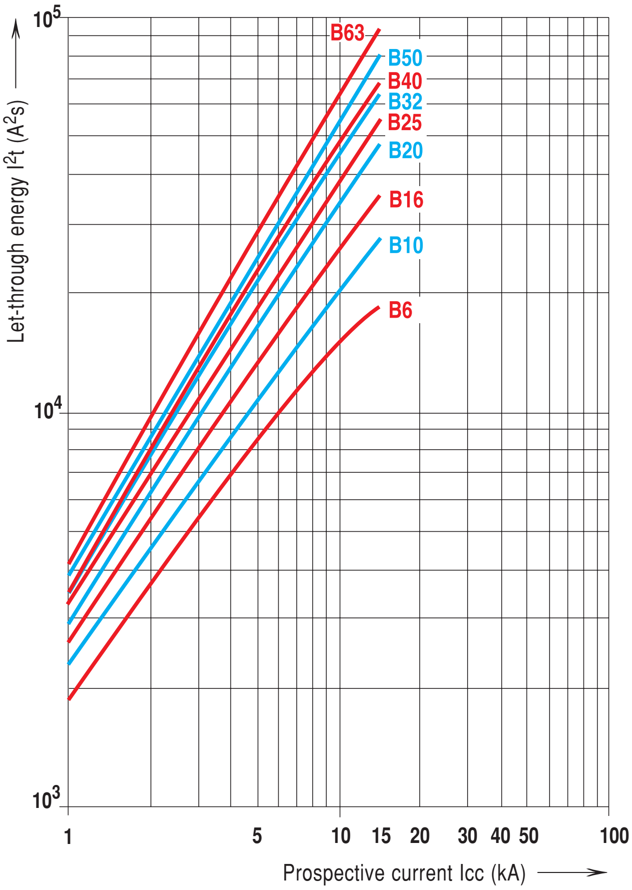


Ip Limited peak current at 230/400 V



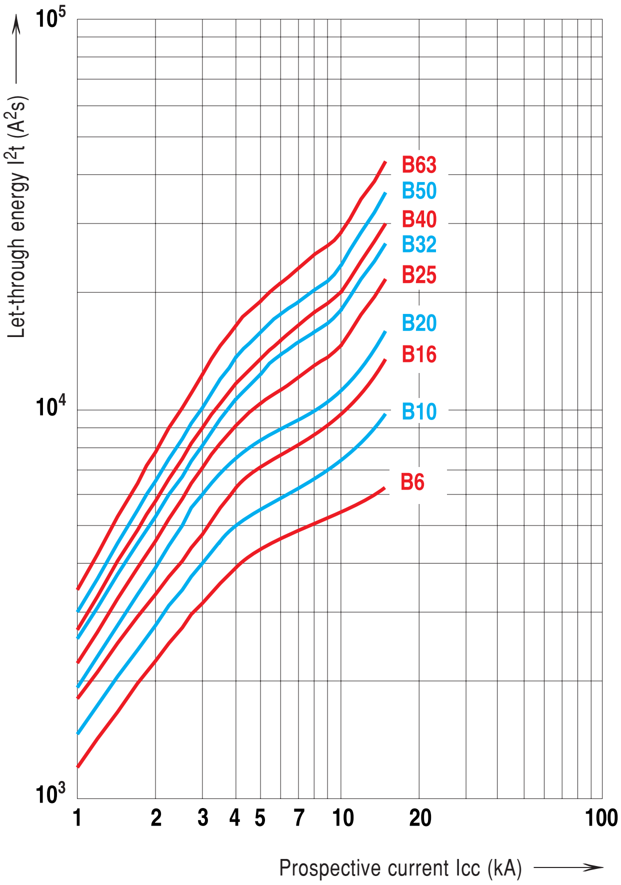
G100 Curve B 1P, 1P+N, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

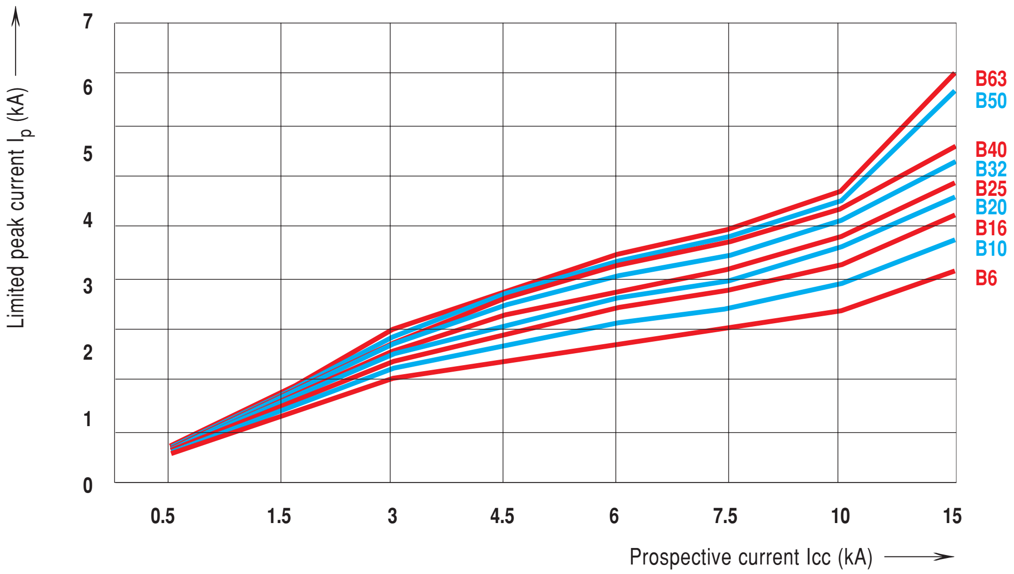


G100 Curve B 2P

I^2t Let-through energy at 230 V

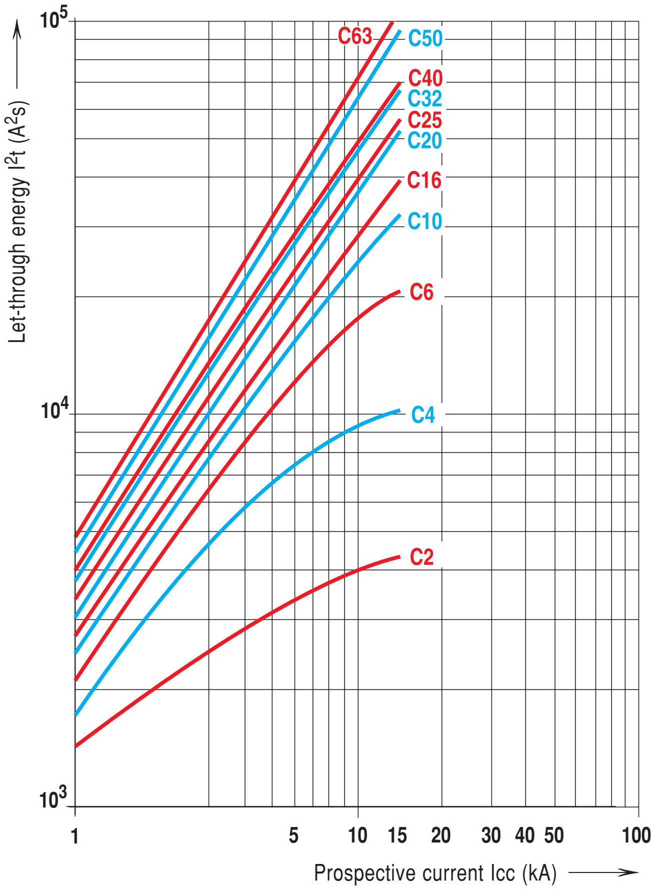


Ip Limited peak current at 230/400 V



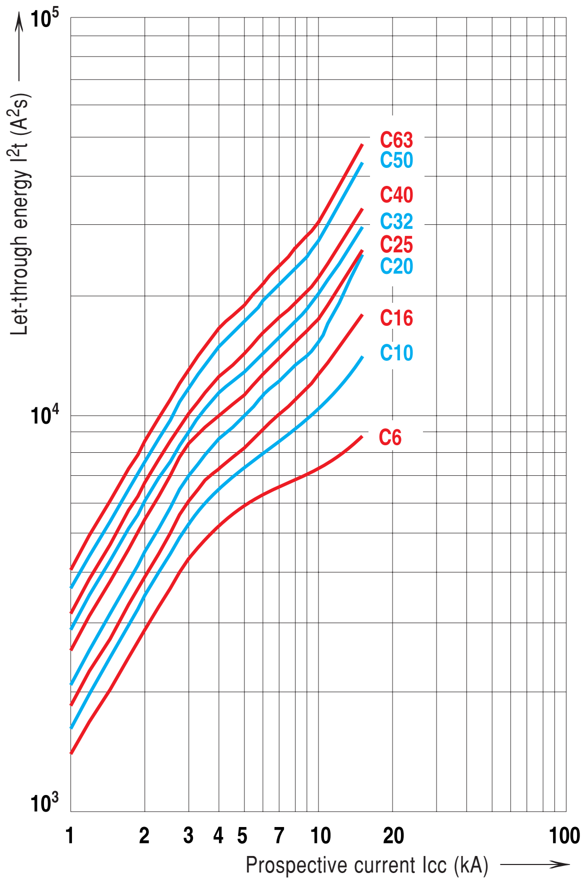
G100 Curve C 1P, 1P+N, 2P, 3P+N

I^2t Let-through energy at 230/400 V

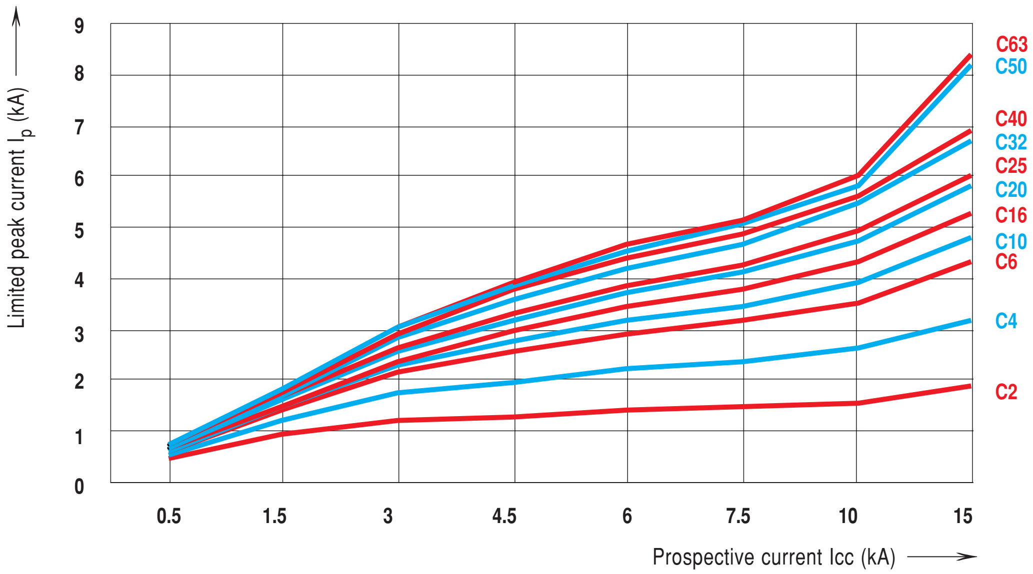


G100 Curve C 2P

I^2t Let-through energy at 230 V

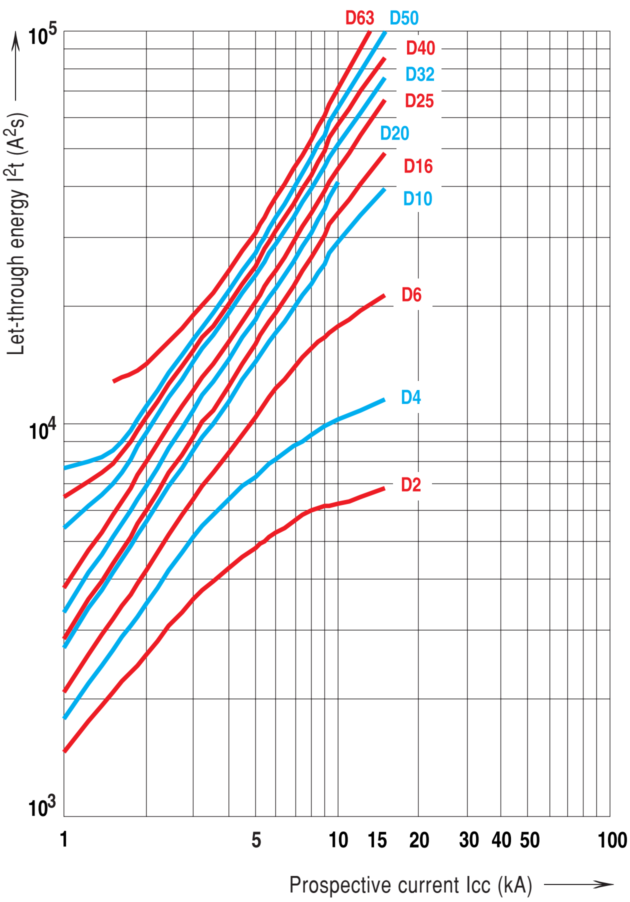


Ip Limited peak current at 230/400 V



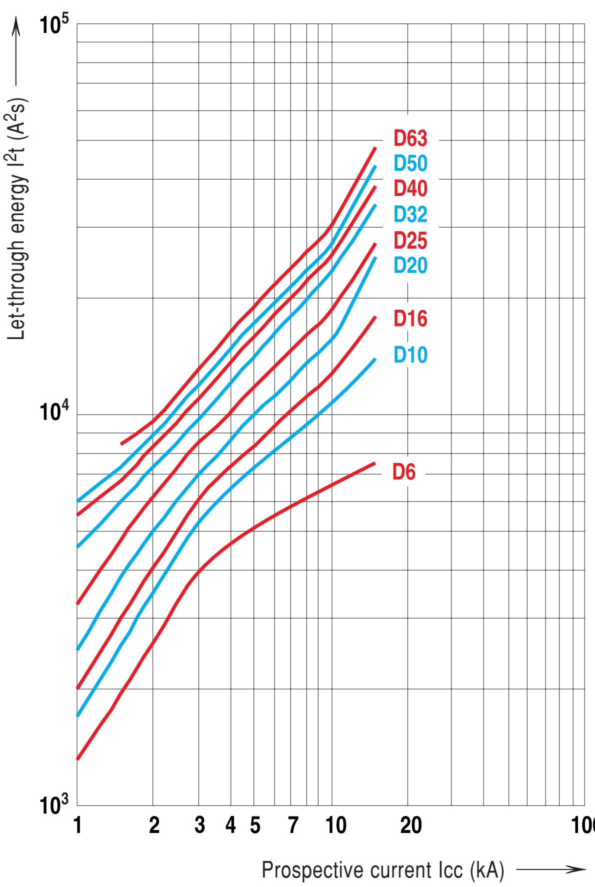
G100 Curve B 1P, 1P+N, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

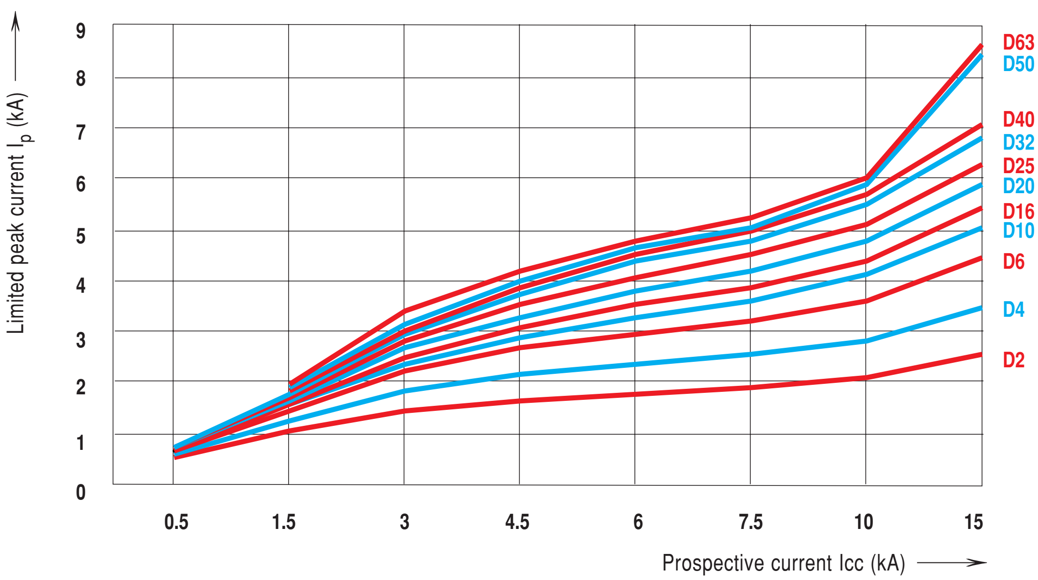


G100 Curve B 2P

I^2t Let-through energy at 230 V

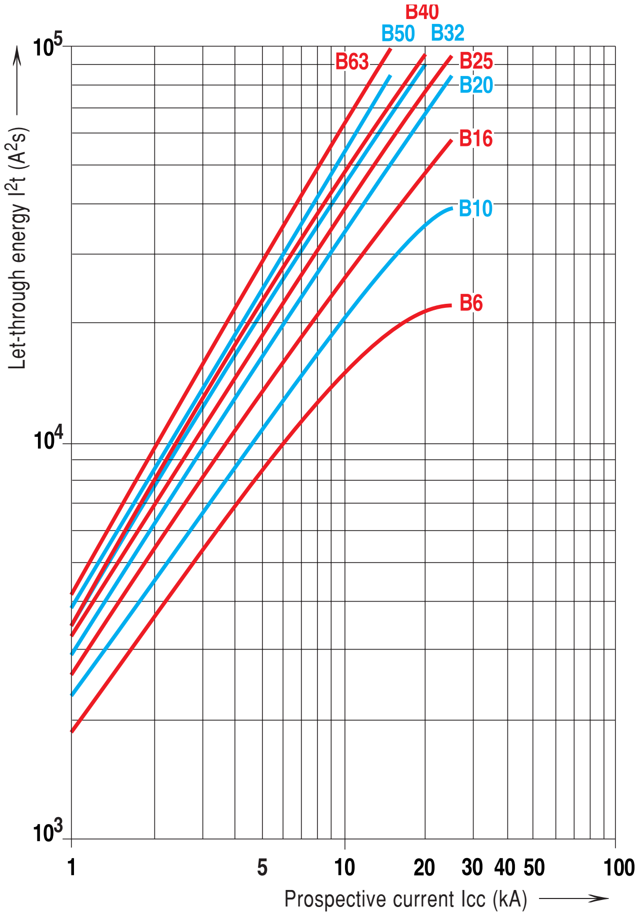


Ip Limited peak current at 230/400 V



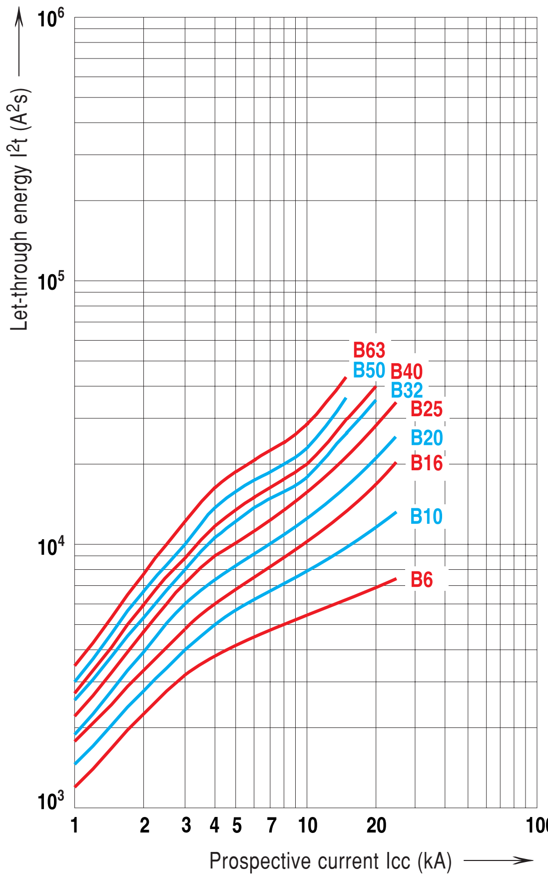
GT25 Curve B 1P, 2P, 3P, 4P

I²t Let-through energy at 230/400 V

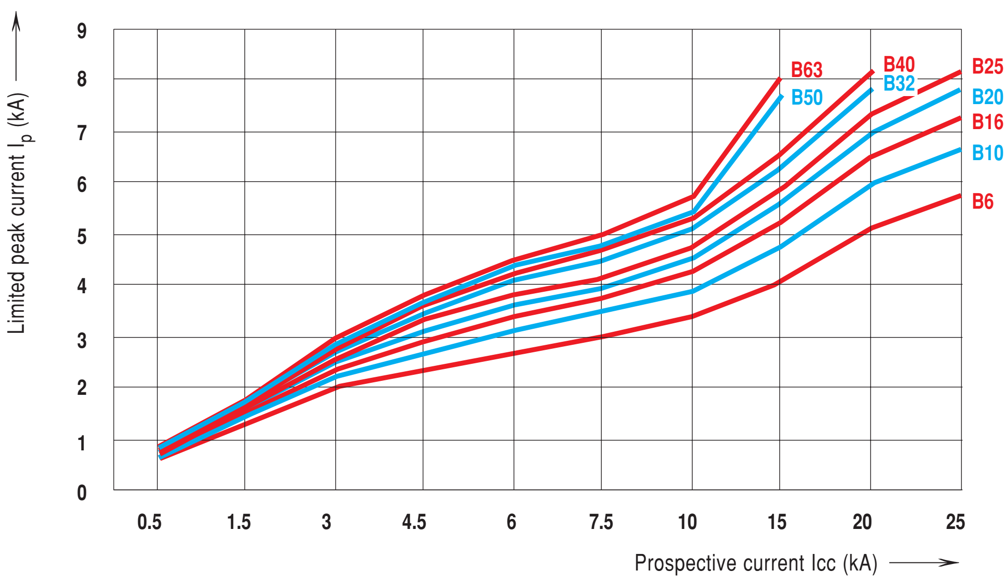


GT25 Curve B 2P

I²t Let-through energy at 230 V

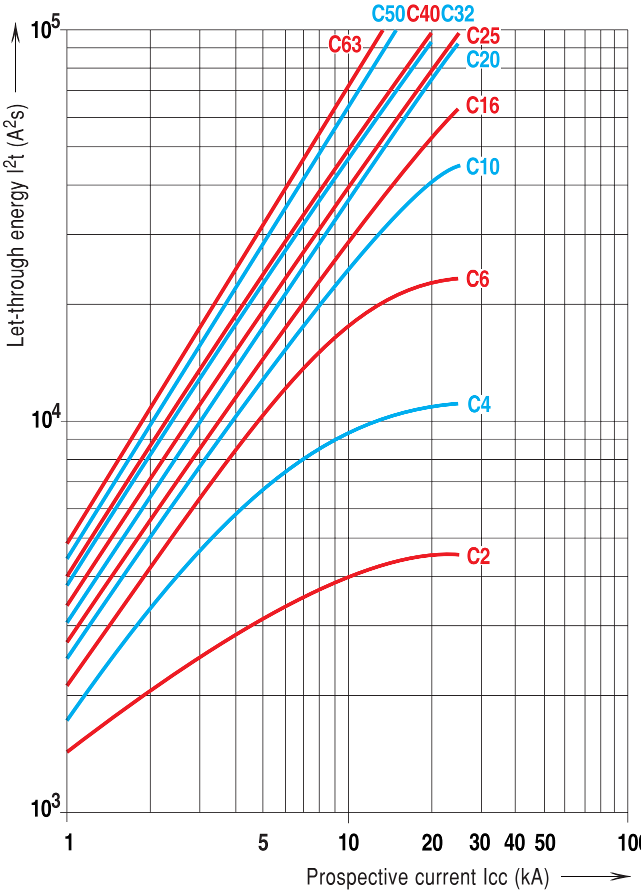


Ip Limited peak current at 230/400 V



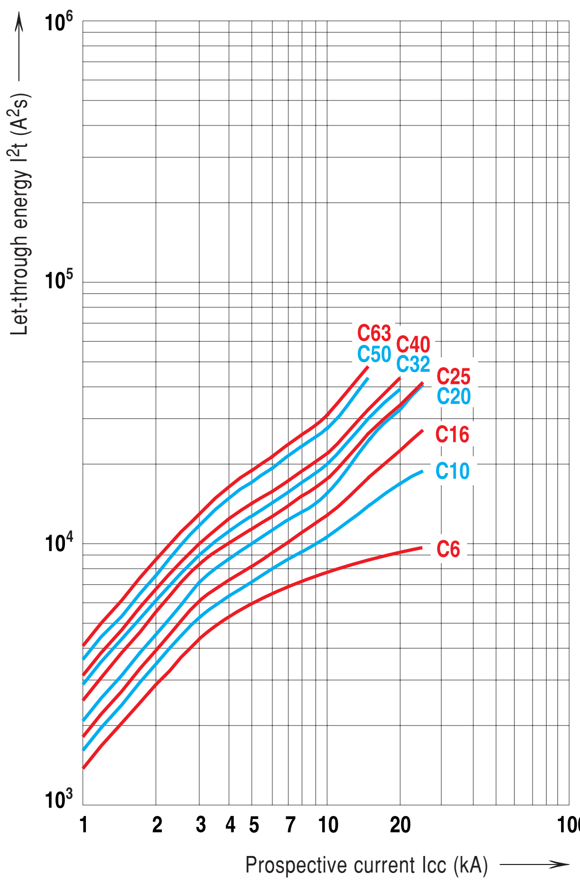
GT25 Curve C 1P, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

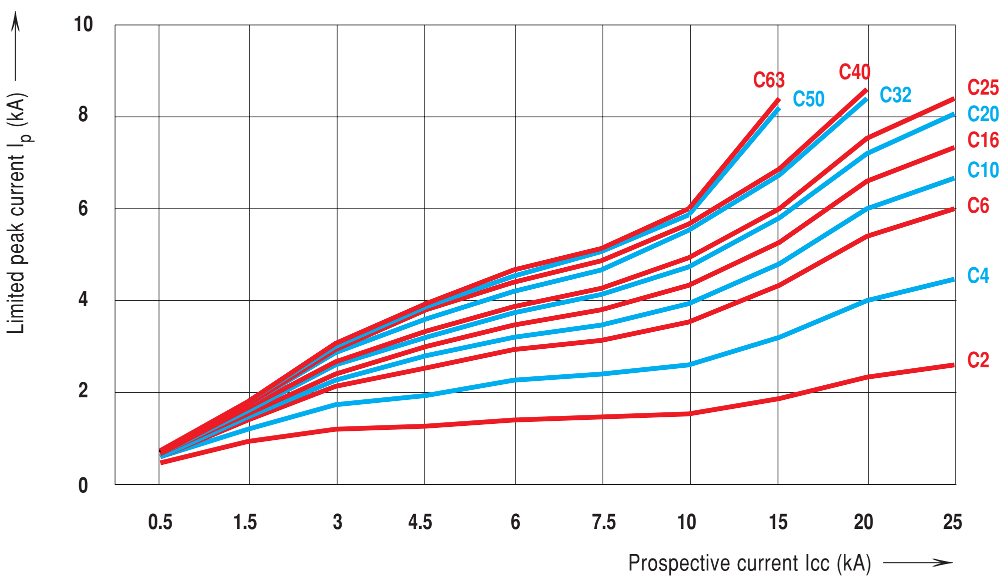


GT25 Curve C 2P

I^2t Let-through energy at 230 V

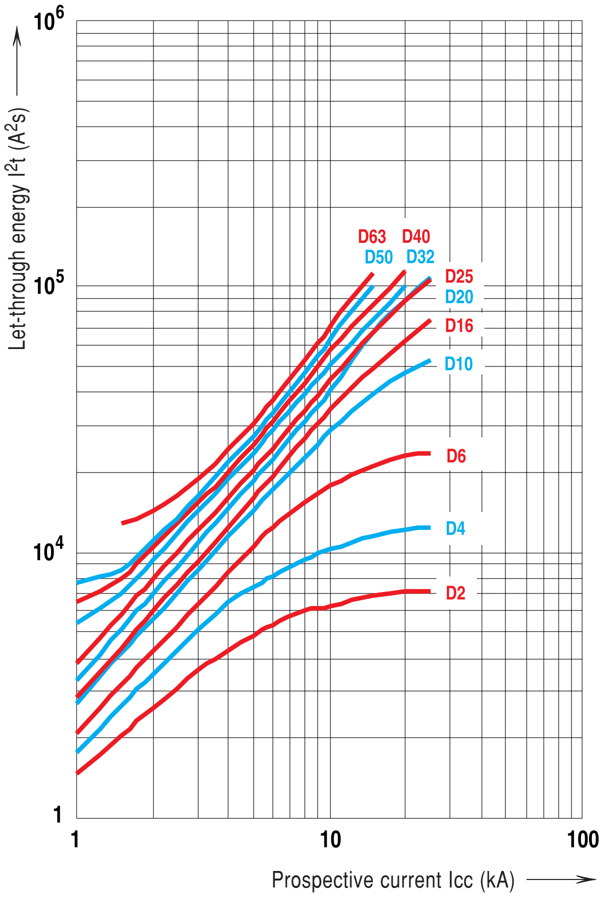


Ip Limited peak current at 230/400 V



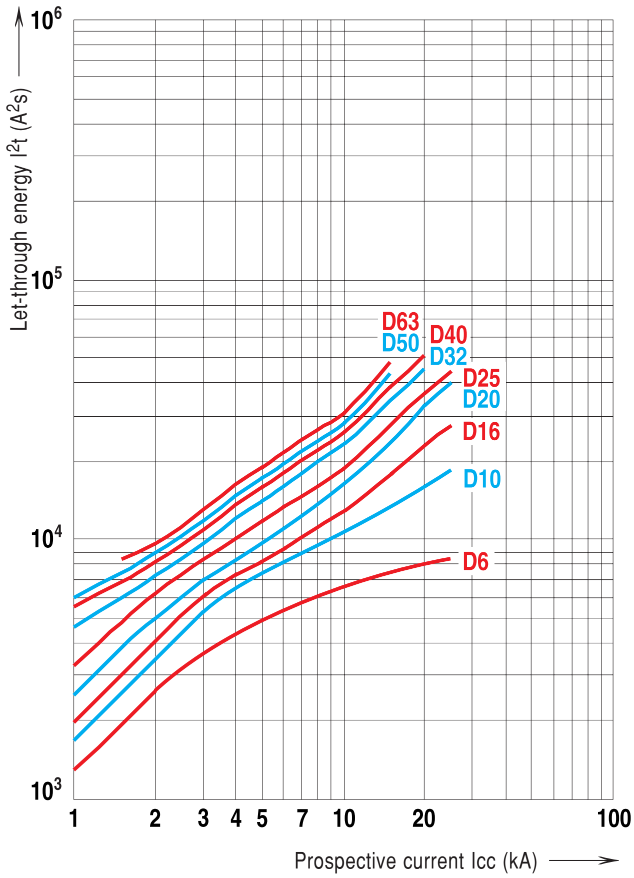
GT25 Curve D 1P, 2P, 3P, 4P

I^2t Let-through energy at 230/400 V

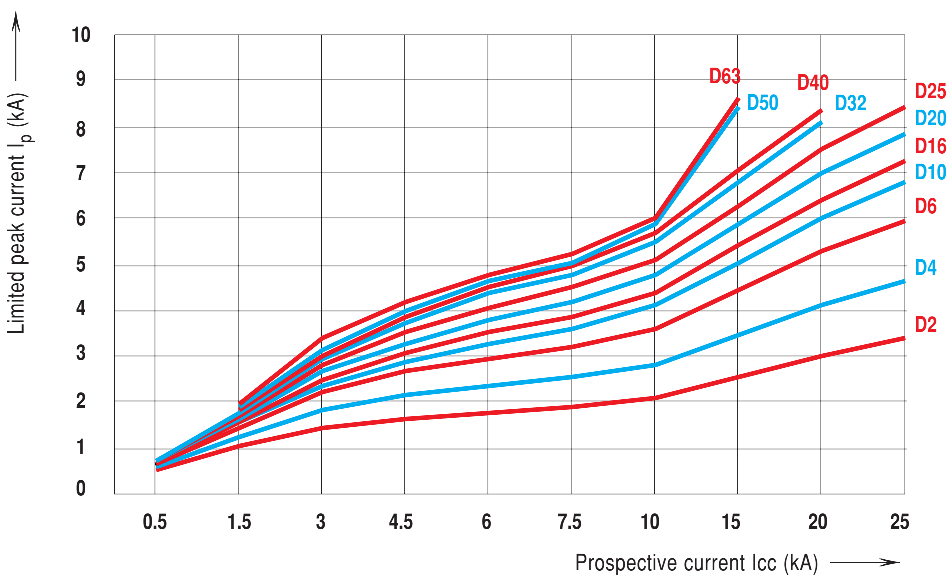


GT25 Curve D 2P

I^2t Let-through energy at 230 V



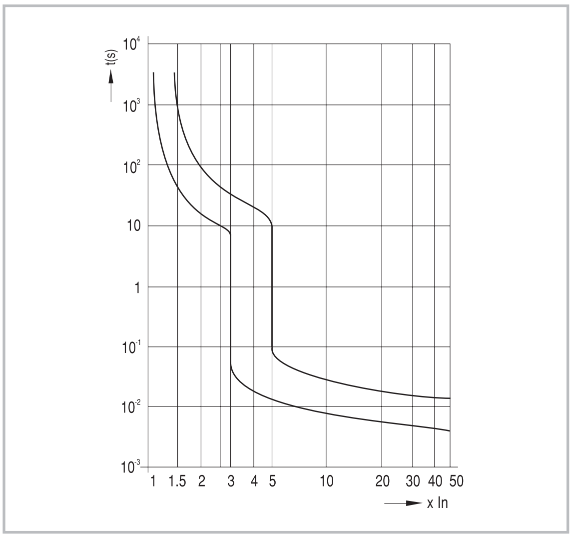
Ip Limited peak current at 230/400 V



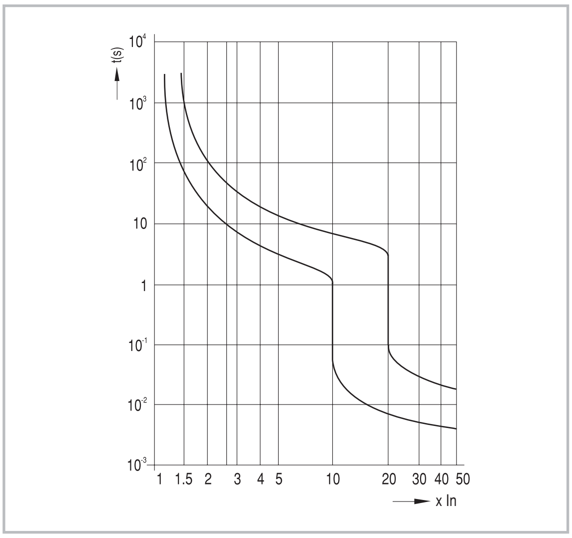
Tripping curves acc. EN/IEC 60898

The following tables show the average tripping curves of the GE MCB's based on the thermal calibration as well as the magnetic characteristic.

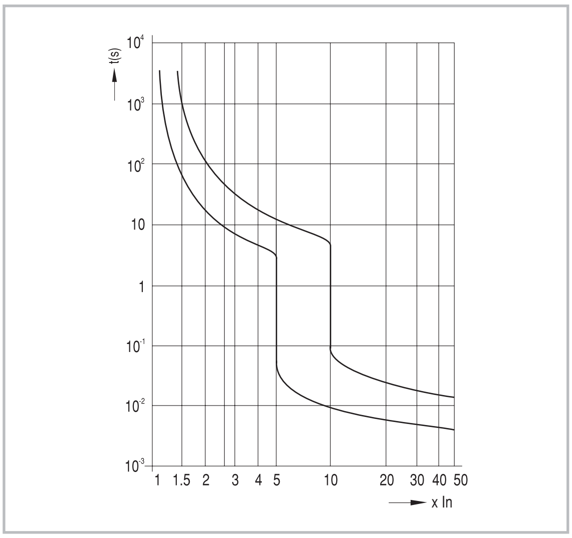
Curve B



Curve D



Curve C



Selective circuit breaker S90

Application

The selective circuit breaker ElfaPlus S90 often serves as gang switches in distribution boards with the highest demand on selectivity and operating convenience.
The ElfaPlus S90 are used as higher protection element in a installation with different MCB's.

The S90 breaker are equipped additional to the main current path with another two circuits:
- Parallel current path that contains a resistor R for current limitation.
- Measuring circuit with magnet impulses to close the main contact

Function

The selective main circuit breaker ElfaPlus S90 is a miniature circuit breaker employed as superordinate protective element in series with traditional MCB's. The unit, in order to switch selectively has in addition to the main current path (fig. 1) another paralelle current path with a currentlimiting resistor R and a measuringcircuit with a solnenoid drive to close the main contact.

Manual closing (fig. 1 and fig. 2)
If the selective circuit breaker is manually switched-on, first of all the contact K2 closes and the operating current flows via the parallel current path. At the same time contact K3 and hence the measuring circuit are closed (fig. 1). Only then is the main contact K1 closed and the operating current flows via the main current path (fig. 2). As the parallel current path owing to resistor R has a higher resistance than the main current path, no mentionable current continues to flow there. On K1 closing, K3 in the measuring circuit is reopened.

Fig. 1 Manual closing: K2 and K3 close

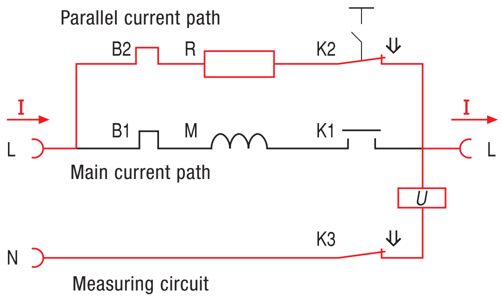
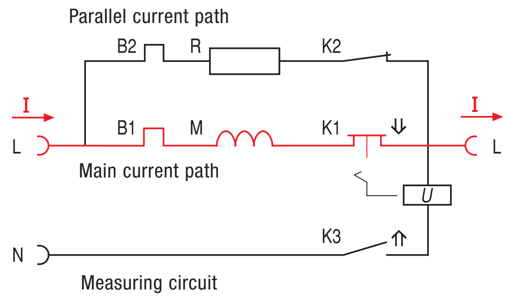
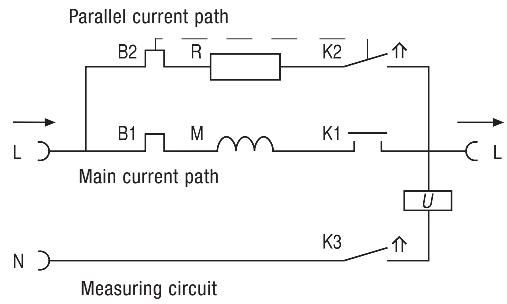


Fig. 2 No fault main contact:
K1 closes, K3 opens (K1-K2 closed)



Fault closure lockout (fig. 3)
If the MCB is closed onto an existing fault, the measuring circuit that measures the voltage between line and neutral at the output of the ElfaPlus S90,prevents the main contact K1 closing. The breaker can not be closed onto the fault and no high current can flow. After a short time contacts K1 and K3 are reopened due to the bimetal trip B2 and the current limited by resistor R in the parallel current path (maximum 5 times rated current) is interrupted.
This fault closure lockout thus protects the installation but also the operating personel.

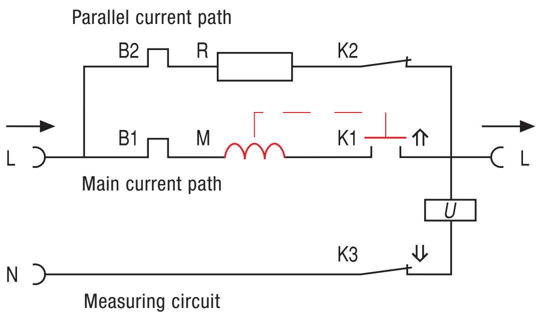
Fig. 3 Existing fault: K1 does not close. B1 opens K2 and k3 after max. 1s.



Selective fault tripping (fig. 4 and fig. 2)
If the selective circuit is switched-on (K1 closed) and a fault occurs downstream of an MCB, the fault current is interrupted either by the MCB alone or with the help of the operating main contact K1. Contact K2 remains closed, and current can still flow via parallel current path, even when the arc at the main contact K1 is quenched (fig. 4).
If the downstream MCB has isolated the fault from the installation, in the ElfaPlus S90 the main contact is reclosed (fig. 2). Loads lying parallel to the faulted circuit are immediatelly supplied with current, at first via the parallel current path and shortly after again via the main current path.

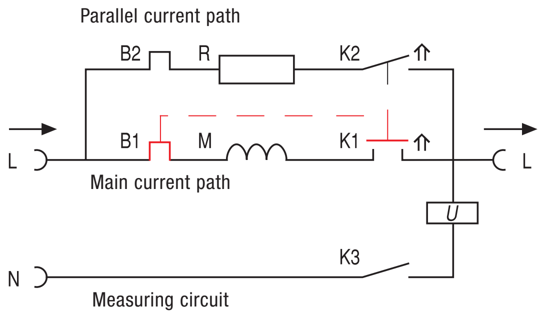
Fault upstream of MCB (fig. 4 and fig. 3)
If the fault occurs between the ElfaPlus S90 and the downstream MCB (or if some reasons a fault behind a miniature circuit breaker is not cleared by it), after quenching of the arc a current limited by resistor R still flows at the contact point K1 via the parallel current path (fig. 4) untill contact K2 is also opened due to the bimetal B2 (fig. 3)

Fig. 4 Fault while unit closed:
K1 opens and K3 closes



Opening on overload (fig. 5)
If an overload current flows fot too long, the bimetal trip B1 in the main current path operates and opens contact K1 and K2 in the main and parallel current paths.

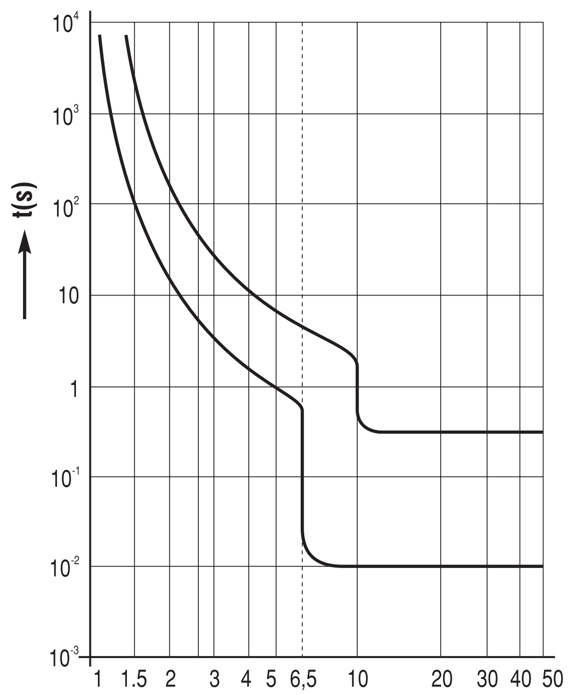
Fig. 5 Overload:
B1 opens and K1 and K2



Manual opening
On manual opening the contacts are opened not only in the main current path but also in the parallel current path (K1 and K2)

Tripping curve

Curve C according to EN/IEC 60898



Text for specifiers

MCB Series G60/100

- According to EN/IEC 60898 standard
- For DIN rail mounting according to DIN EN/IEC 50022; EN/IEC 50022; future EN/IEC 60715; IEC 60715 (top hat rail 35 mm)
- Grid distance 35 mm
- Working ambient temperature from -25°C up to +50°C
- Approved by CEBEC, VDE, KEMA, IMQ...
- 1 pole is a module of 18 mm wide
- Nominal rated currents are: 0.5/1/2/3/4/6/10/13/16/20/25/32/40/50/63 A
- Tripping characteristics: B,C,D,K
- Number of poles: 1P, 1P+N, 2P, 3P, 3P+N, 4P
- The short-circuit breaking capacity is: 3/4,5/6/10kA, energy limiting class 3
- Terminal capacity from 1 up to 35mm^2 rigid wire or 1,5 up to 25 mm^2 flexible wire.
- Screw head suitable for flat or Pozidriv screwdriver
- Can be connected by means of both pin or fork busbars on bottom terminals
- The toggle can be sealed in ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP20 and they are sealable
- Isolator function thanks to the printing Red/Green on the toggle.
- Maximum voltage between two phases; 440V~
- Maximum voltage for utilisation in DC current: 48 V 1P and 110 V 2P
- Two position rail clip
- Mechanical shock resistance 40g (direction x, y, z) minimum 18 shocks 5 ms halfsinusoidal acc. to IEC 60068-2-27
- Vibrations resistance: 3g (direction x, y, z) minimum 30 min. according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
    - Auxiliary contact
    - Shunt trip
    - Undervoltage release
    - Motor operator
    - Panel board switch
- MCB's have a circuit indicator for easy circuit identification
- Add-on RCD can be coupled

MCB Series GT25

- According to EN/IEC 60947.2 standard
- For DIN rail mounting according to DIN EN/IEC 50022; EN/IEC 50022; future EN/IEC 60715; IEC 60715 (top hat rail 35 mm)
- Working ambient temperature from -25°C up to +50°C
- 1 pole is a module of 18 mm wide
- Nominal rated currents are: 0,5/1/2/3/4/6/10/13/16/20/25/32/40/50/63 A
- Tripping characteristics: B,C
- Number of poles: 1P, 2P, 3P, 4P
- The short-circuit capacity is: 10/15/25/50 kA
- Terminal capacity from 1 up to 35mm^2 rigid wire or 1,5 up to 25 mm^2 flexible wire
- Screw head suitable for flat or Pozidriv screwdriver
- Can be connected by means of both pin or fork busbars on bottom terminals
- The toggle can be sealed in ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP20 and they are sealable
- Isolator function thanks to the printing Red/Green on the toggle.
- Maximum voltage between two phases; 440V~
- Maximum voltage for utilisation in DC current: 48 V 1P and 110 V 2P
- Two position rail clip
- Mechanical shock resistance 40g (direction x, y, z) minimum 18 shocks 5 ms halfsinusoidal acc. to IEC 60068-2-27
- Vibrations resistance: 3g (direction x, y, z) minimum 30 min. according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
    - Auxiliary contact
    - Shunt trip
    - Undervoltage release
    - Motor operator
    - Panel board switch
- MCB's have a circuit indicator for easy circuit identification
- Add-on RCD can be coupled

MCB Series EP100 UC

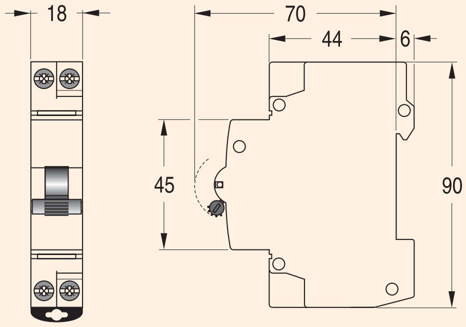
- According to EN/IEC 60898-2 standard
- For DIN rail mounting according to DIN EN/IEC 50022; EN/IEC 50022; future EN/IEC 60715; IEC 60715 (top hat rail 35 mm)
- Grid distance 35 mm
- Working ambient temperature from -25°C up to +50°C
- 1 pole is a module of 18 mm wide
- Nominal rated currents are: 0,5/1/2/3/4/6/10/13/16/20/25/32/40/50/63 A
- Tripping characteristics: B, C
- Number of poles: 1P, 2P
- The short-circuit breaking capacity is: 6 kA, "energy limiting" class 3
- Terminal capacity from 1 up to 35mm^2 rigid wire or 1,5 up to 25 mm^2 flexible wire
- Screw head suitable for flat or Pozidriv screwdriver
- Can be connected by means of both pin or fork busbars on top or bottom terminals
- The toggle can be sealed in ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP20 and they are sealable
- Isolator function thanks to the printing Red/Green on the toggle.
- Maximum voltage: 1P - 250 V ⎓
2P - 440 V ⎓ . Poles in series
- Two position rail clip
- Mechanical shock resistance 40g (direction x, y, z) minimum 18 shocks 5 ms halfsinusoidal according to IEC 60068-2-27
- Vibrations resistance: 3g (direction x, y, z) minimum 30 min. according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
    - Auxiliary contact
    - Shunt trip
    - Undervoltage release
    - Motor operator
    - Panel board switch
- MCB's have a circuit indicator for easy circuit identification
- Add-on RCD can be coupled

MCB Series Hti

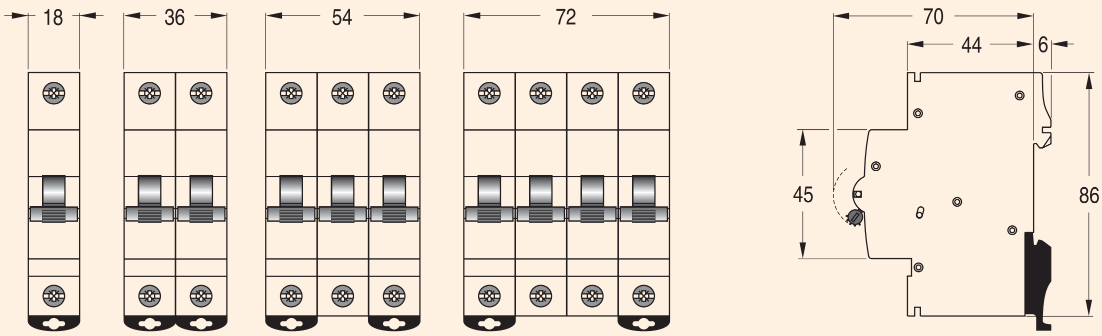
- According to EN/IEC 60947.2 standard
- For DIN rail mounting according to DIN EN/IEC 50022; EN/IEC 50022; future EN/IEC 60715; IEC 60715 (top hat rail 35 mm)
- Working ambient temperature from -25°C up to +50°C
- 1 pole is a module 1,5 module (27mm)
- Nominal rated currents are: 80/100/125A
- Tripping characteristics: B, C, D
- Number of poles: 1P, 2P, 3P, 4P
- The short-circuit capacity is: 10kA
- Terminal capacity from 2,5 up to 70mm^2
- The toggle can be sealed in ON or OFF position
- Both incoming and outgoing terminals have a protection degree of IP20 and they are sealable
- Isolator function thanks to the printing red/green on the toggle. It can be used as main switch
- Maximum voltage between two phases: 440V~
- Two position rail clip
- Mechanical shock resistance 40g (direction x, y, z) minimum 18 shocks 5 ms halfsinusoidal according to IEC 60068-2-27
- Extensions can be added
    - Auxiliary contact
    - Shunt trip
- Endurance:
    - Mechanical: 10.000 operations
    - Electrical: 4000 operations
- Add-on RCD can be coupled

Dimensional drawings

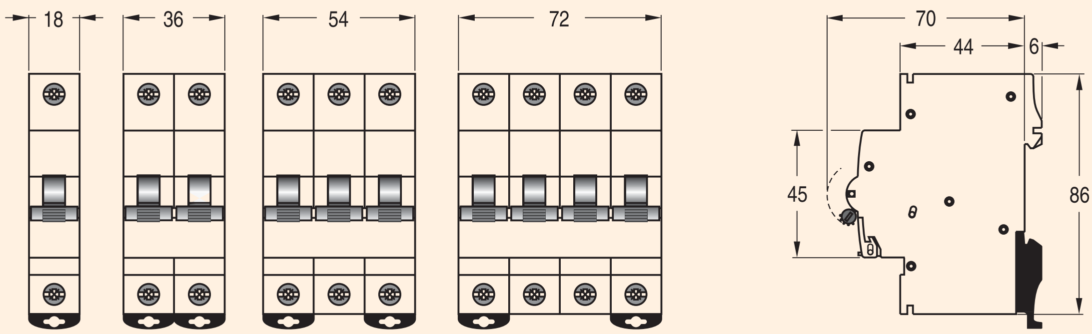
Miniature Circuit Breakers - Series C



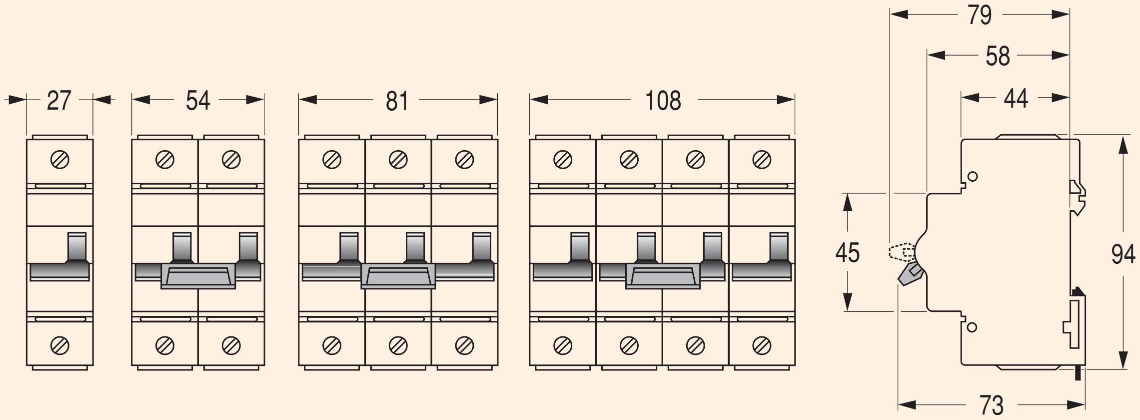
Miniature Circuit Breakers - Series G & GT



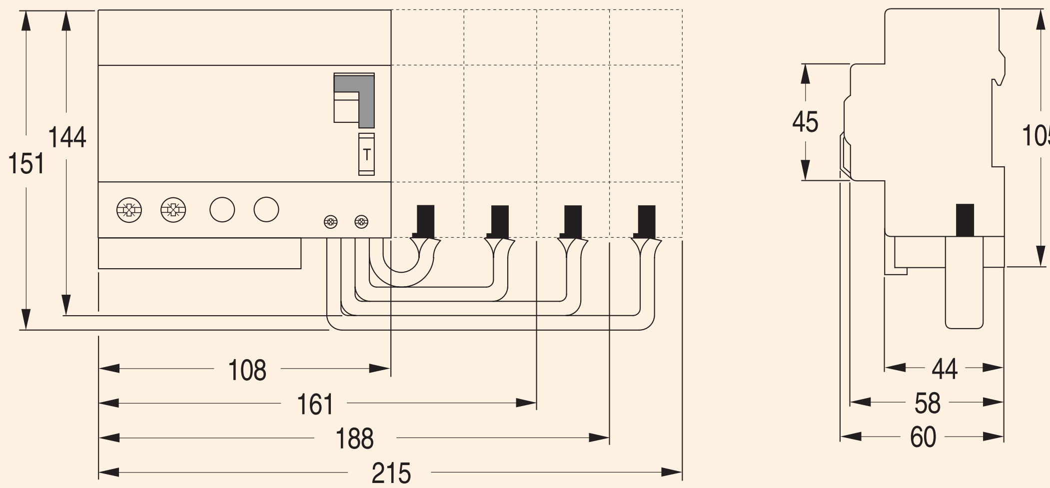
Miniature Circuit Breakers - Series EP100 UC



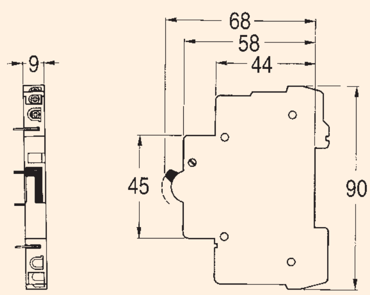
Miniature Circuit Breakers - Series Hti



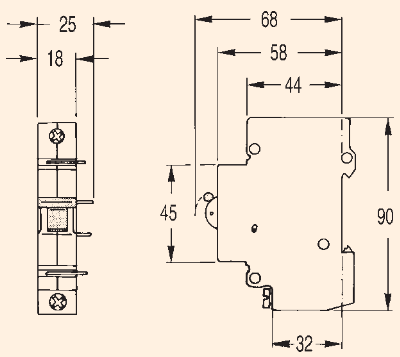
Add-on RCD's for Series Hti



Auxiliary contact - Series Hti



Shunt trip - Series Hti



Residual current devices
Technical Data

Protection against electric shocks

Effects of current passing through the human body

Present thinking on the effects of electrical current passing through the human body is based on information from many sources.

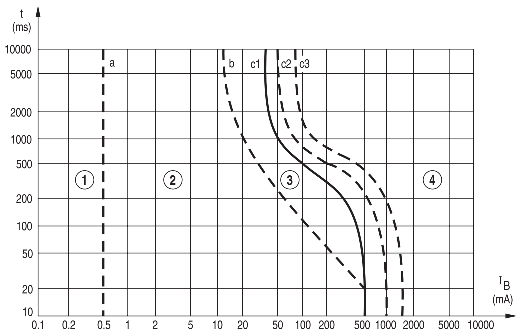
- Experiments on animals
- Clinical observation
- Experiments on dead human beings
- Experiments on live human beings

We must remember that we are considering here the effects of shock current. Other factors must be considered when setting safety requirements:
- Probability of fault
- Probability of contact with live or faulty parts
- Experience
- Technical possibilities
- Economics

The degree of danger to people depends mainly on the magnitude and duration of current flow through the human body. The major parameter, which influences the current magnitude, is the impedance of the human body.

The effects of electrical current on people are specified in figure 1 (table time/current IEC 60479-1).

Time / current zones of effects of AC current (15Hz to 100 Hz) on persons (fig. 1)



Zones	Physiological effects:
Zone 1	Usually no reaction effects.
Zone 2	Usually no harmful physiological effects.
Zone 3	Usually no organic damage to be expected. Likelihood of muscular contractions and difficulty in breathing, reversible disturbances of formation and conduction of impulses in the heart, including atrial fibrillation and transient cardiac arrest without ventricular fibrillation increasing with current magnitude and time.
Zone 4	In addition to the effects of Zone 3, probability of ventricular fibrillation increasing up to about 5% (curve c_2), up to about 50% (curve c_3) and above 50% beyond curve c_3. Increasing with magnitude and time, pathophysiological effects such as cardiac arrest, breathing arrest and heavy burns may occur.

Risk of electric shock

Electric shock is produced when the human body is in contact with conductive surfaces at different potentials. There are two kind of contact which causes electric shock:
- Direct contact
- Indirect contact

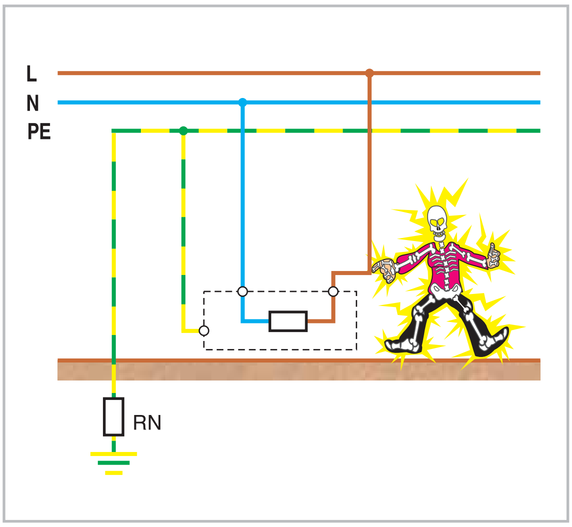
The main causes of electric shock are:
- Defect of insulation in the high/low voltage transformer
- Overvoltages due to atmospheric sources
- Ageing of the load or wiring insulation
- Live parts not sufficiently protected

In IEC 61200-413, derived from IEC 60479, it is explained how the maximum safety voltage is a function of the environmental conditions and the prospective touch voltage is a function of the maximum tripping time.
Maximum safety voltage:
- U_L= 24V (wet conditions)
- U_L= 50V (dry conditions)

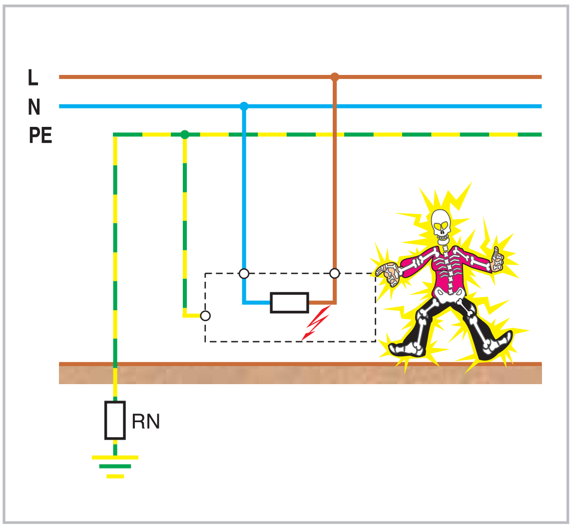
Tripping time in function of touch voltage

Prospective touch voltage (V)	U_L = 50V maximum tripping time (s)	
	ac	dc
< 50	5	5
50	5	5
75	0.6	5
90	0.45	5
120	0.34	5
150	0.27	1
220	0.17	0.4
280	0.12	0.3
350	0.08	0.2
500	0.04	0.1

Direct contact
When a person accidentally touches a live part of the installation not connected to an earth electrode. In this situation the person becomes part of the electric circuit by means of body resistance and earth resistance.



Indirect contact
When a person touches a metal part of the load, which is earthed, and accidentally makes contact with an electrical conductor due to a loss of insulation.



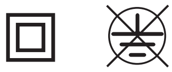
How to prevent direct and indirect contact

Protection against electric shock shall be provided by applying the following concepts according to IEC 60364-4-41:

Protection against direct and indirect contact
Protection by means of the use of very low voltage:
- SELV (safety extra low voltage)
- PELV (protective extra low voltage)
- FELV (functional extra low voltage)

Protection against direct contact
Prevention of direct contact can be summarised as follows:
- Insulate conductor with appropriate materials
- Using barriers or enclosures with appropriate IP degree
- Designing the installation with appropriate safety distances
- Complementary protection by using RCD $\leq$ 30 mA

Protection against indirect contact
To prevent indirect contact there are different ways of protection:
<u>Using materials that ensure a class II protection</u>



<u>Protection in non conductive environments</u>
All the exposed conductive parts must be under normal circumstances in such a way that people can not touch any live part.
This installation will not necessitate any protective conductors.
Walls and floors shall be isolated with a resistance no less than:
- 50 kΩ for installations with nominal voltage <500V
- 100 kΩ for installations with nominal voltage >500V

<u>Protection by means of local equipotential links in installations not connected to earth</u>
The equipotential link must not be connected to earth either through the exposed conductive parts or the protective conductors.

<u>Protection by means of electric (galvanic) isolation</u>
By using isolation transformers.

<u>Protection by automatic disconnection of the installation</u>
Necessary in the case of risk of physiological effects on persons, due to the amplitude and duration of the touch voltage.
This kind of protection requires a good co-ordination among the connections to Earth, the characteristics of the protective conductor and the protective device.

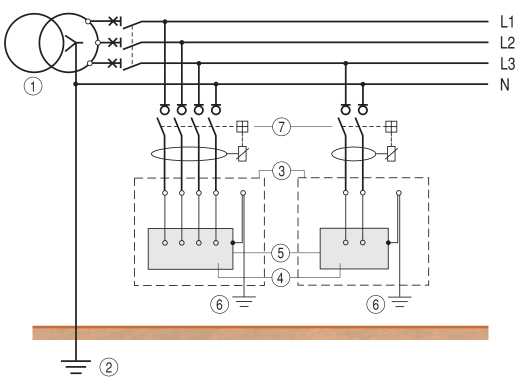
- Connection to Earth and protective conductor.
All the exposed conductive parts must be earthed by means of protective conductors according to any of the different installation distribution systems.

- Protective device.
The protective device must isolate the installation from the source of energy in case any exposed conductive part becomes live. Such a device ensures that the safety voltage (U_L) does not exceed 50V or 120V ⎓ ripple free.

Installation distribution systems

TT system
A system having one point of the source of energy directly earthed, the exposed conductive parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the source.

TT wiring diagram



① Source of energy
② Source earth
③ Consumers' installation
④ Equipment in installation
⑤ Exposed conductive part
⑥ Installation earth electrode
⑦ Residual current device

In the case of isolation fault, the potential of the exposed conductive parts will suddenly increase causing a dangerous situation of electric shock. This can be avoided with the use of RCD's with the proper sensitivity in function of touch voltage.

To ensure safety conditions in the installation, the earth values shall comply with:

$$R_A \times I_{\Delta n} \leq 50V$$

R_A = Earth resistance value of the installation.
$I_{\Delta n}$ = Residual operating current value of the RCD.

Sensitivity in function of earth resistance values

Safety voltage	Sensitivity						S
	0.01A	0.03A	0.1A	0.3A	0.5A	1A	0.3A
50V	5000 Ω	1666Ω	500Ω	166Ω	100Ω	50Ω	83Ω
25V	2500 Ω	833Ω	250Ω	83Ω	50Ω	25Ω	41Ω

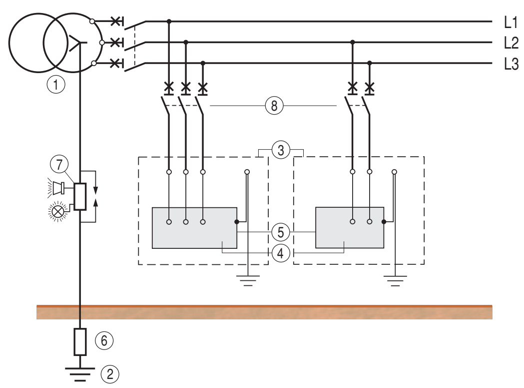
IT system
A system having no direct connection between live parts and earth, the exposed conductive parts of the electrical installation connected to an earth electrode.
The source is either connected to earth through a deliberately introduced earthing impedance or is isolated from earth.
In case of an insulation fault the value of the current is not high enough to generate dangerous voltages. Nevertheless protection against indirect contact must be provided by means of an insulation monitoring device which shall provide visual and sonorous alarm when the first fault occurs. The service interruption by means of breakers must be done in case of a second fault according to the following tripping conditions:

To ensure safety conditions in the installation, it shall comply with:

$$R_A \times Id \leq 50V$$

R_A = Earth resistance value of the installation.
Id = Fault current value of the first fault.

IT wiring diagram



① Source of energy
② Source earth
③ Consumers' installation
④ Equipment in installation
⑤ Exposed conductive part
⑥ Earthing impedance
⑦ Isolation controller
⑧ Protective device for the second fault

Maximum tripping time

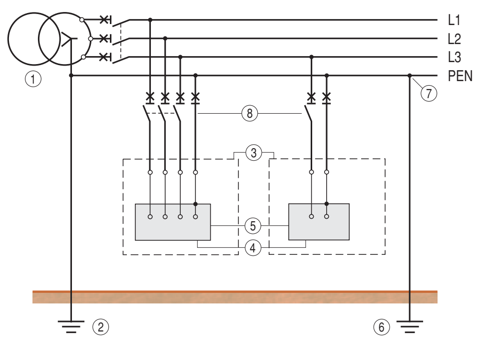
Uo/U (V)	Tripping time(s) UL=50V	
Uo= Voltage phase/neutral U= Voltage between 2 phases	No distributed Neutral	Distributed Neutral
127/220	0.8	0.8
230/400	0.4	0.4
400/690	0.2	0.2
580/1000	0.1	0.1

TN system
A system having one or more points of the source of energy directly earthed, the exposed conductive part of the installation being connected to that point by protective conductors. In case of an insulation fault a short-circuit (phase – neutral) is caused in the installation.

There are two types of TN systems: TN-C and TN-S

TN-C, a system in which neutral and protective functions are combined in a single conductor throughout the system.

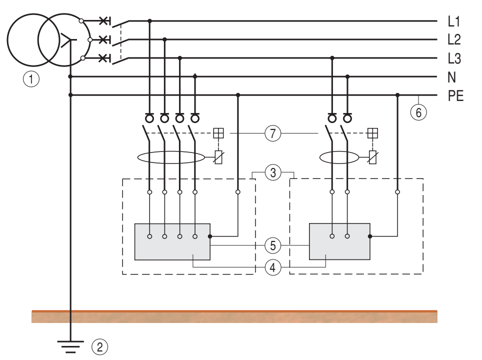
TN-C wiring diagram



① Source of energy
② Source earth
③ Consumers' installation
④ Equipment in installation
⑤ Exposed conductive part
⑥ Additional source Earth
⑦ Combined protective and neutral conductor PEN
⑧ Short-circuit protective device

TN-S, a system having separate neutral and protective conductors throughout the system.

TN-S wiring diagram



① Source of energy
② Source earth
③ Consumers' installation
④ Equipment in installation
⑤ Exposed conductive part
⑥ Protective conductor
⑦ Short-circuit protective device (MCB or RCD)

The short-circuit caused by the insulation fault shall be switched by a protective device which should be fast enough according to the following conditions:

1. To ensure safety conditions in the installation, the protective device shall comply with:

$$Z_S \times Ia \leq U_0$$

Z_S = Total impedance of the fault ringlet (including the impedance's of the source of energy, the active conductor and the protective conductor).
Ia = Fault current which ensures the operating of the protective device. (In case of RCD: Ia=Idn)
U_0 = Rated voltage phase-earth

Maximum tripping time

Voltage Phase/neutral Uo (V)	Maximum tripping time (s) ac
127	0.8
230	0.4
400	0.2
>400	0.1

2. The breaking speed is provided by the magnetic tripping system of the breaker or by the protective fuse.

3. In case of long cables the short-circuit current may not reach the tripping values of the protective device, therefore we need to use RCD's (TN-S).

4. To verify that the fault current generated is high enough to trip the protective device, we should take into account the following parameters:

4.1. Tripping characteristic of the protective device:
MCB's: B characteristic (3-5 x In)
C characteristic (5-10 x In)
D characteristic (10-20 x In)

MCCB's: According to the magnetic calibration

Fuses: According to the time/current characteristic: - gI
- gG
- aM

4.2. Rated current of the protective device (In).

4.3. Installation impedance
Length and cross section of cables.
See tables on B.6

People Protection

T2

Maximum protected cable length for people protection (indirect contact)

TN 3 x 400V, UL = 50V, m = 1 by means of fuses gI-gG

gG fuses Copper conductor In (A)	16	20	25	32	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1000
S mm^2																			
1.5	99	86	40	21	13	7													
2.5		134	110	67	41	25	13	8											
4			183	139	108	67	46	24	14	7.3									
6				214	165	139	94	55	33	20	10								
10					275	226	172	130	90	57	30	17.5							
16							283	217	168	128	86	53	30						
25								336	257	197	155	118	73	42					
35									367	283	220	172	134	59	48				
50										379	299	229	179	136	93	58			
70											441	336	268	202	134	124	55		
95												472	367	278	215	172	109	63	
120													462	346	268	215	145	109	52
150													483	373	283	231	151	124	79
185														441	336	273	185	147	107
240															504	315	215	172	126

Maximum protected cable length for people protection (indirect contact)

TN 3 x 400V, UL = 50V, m = 1 by means of MCB's & MCCB's

Curve C (Im: 10 x In) Copper conductor In (A)	0,5	1	2	4	6	10	16	20	25	32	40	50	63	80	100	125	160	250	400	630	800	1000	1250	1600
S mm^2																								
1.5	1232	616	308	154	103	62	38	31	25	19	15													
2.5		1026	513	257	171	103	64	51	41	32	26	21	16											
4		1642	821	411	274	164	103	82	66	51	41	33	26	21										
6			1232	616	411	246	154	123	99	77	62	49	39	31	25									
10				1026	684	411	257	205	164	128	103	82	65	51	41	33								
16				1642	1095	657	411	328	263	205	164	131	104	82	66	53	41							
25					1711	1026	642	513	411	321	257	205	163	128	103	82	64							
35						1437	898	718	575	449	359	287	228	180	144	115	90	57						
50							1283	1026	821	642	513	411	326	257	205	164	128	82						
70							1796	1437	1150	898	718	575	456	359	287	230	180	115	72					
95								1950	1560	1219	975	780	619	488	390	312	244	156	98					
120									1971	1540	1232	985	782	616	493	394	308	197	123	78				
150										1673	1339	1071	850	669	536	428	335	214	134	85				
185										1978	1582	1266	1005	791	633	506	396	253	158	100	79			
240											1971	1577	1251	985	788	631	493	315	197	125	99	79		
300												1895	1504	1184	947	758	592	379	237	150	118	95		
400													1629	1283	1026	821	642	411	257	163	128	103	82	
500													1810	1426	1140	912	713	456	285	181	143	114	91	
625													1851	1458	1166	933	729	467	292	185	146	117	93	73
2x95											1950	1560	1238	975	780	624	488	312	195	124	98	78		
2x120												1971	1564	1232	985	788	616	394	246	156	123	99	79	
2x150													1700	1339	1071	857	669	428	268	170	134	107	86	
2x185														1582	1266	1013	791	506	316	201	158	127	101	79
2x240														1971	1577	1261	985	631	394	250	197	158	126	99
3x95													1857	1463	1170	936	731	468	293	186	146	117	94	73
3x120														1848	1478	1182	924	591	370	235	185	148	118	92
3x150															1607	1285	1004	643	402	255	201	161	129	100
3x185															1899	1519	1187	760	475	301	237	190	152	119
3x240																1892	1478	946	591	375	296	236	189	148

Correction coefficients

Tripping characteristic	K1	Voltage	K2	Conductor	K3	Cross section of PE(N) conductor	K4
Curve B	x 2	3 x 230V	x 0.58	Aluminium	0.62	m = Sphase / Spe(n)	
Curve D	x 0.5					m = 0.5	x 2
Curve K	x 1.6					m = 1	x 1
Curve Gi	x 0.8					m = 2	x 0.67
Curve Im	x 10/Im					m = 3	x 0.5
						m = 4	x 0.4

Example

3-phase TN system Un = 230 V protected with MCCB 80A (Im = 8 x In). Phase conductor 50 mm^2 copper and PE conductor 25 mm^2 copper.

L_{max} = **257** x $\frac{10}{8}$ x 0.58 x 0.67 = 125m

What is an RCD?

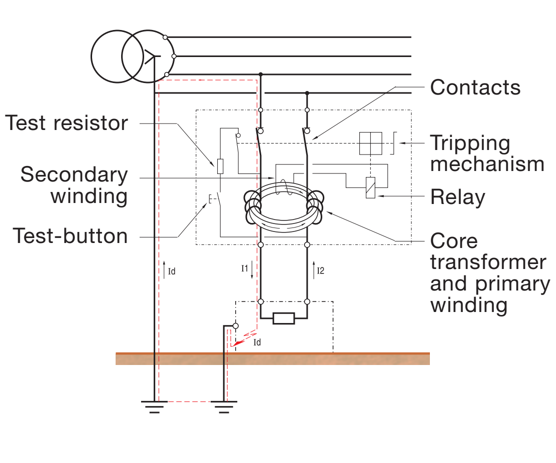
The RCD (Residual Current Device) is a device which intends to protect people against indirect contact, the exposed conductive parts of the installation being connected to an appropriate earth electrode. It may be used to provide protection against fire hazards due to a persistent earth fault current, without the operation of the overcurrent protective device.

RCD's having a rated residual operating current not exceeding 30 mA are also used as a means for additional protection in case of failure of the protective means against electric shock (direct contact).

WORKING PRINCIPLE

The main components of a RCD are the following:
- The core transformer: which detects the earth current fault.
- The relay: when an earth fault current is detected the relay reacts by tripping and opening the contacts.
- The mechanism: Element to open and close the contacts either manual or automatically.
- The contacts: To open or close the main circuit.

The RCD constantly monitors the vectorial sum of the current passing through all the conductors. In normal conditions the vectorial sum is zero (I1+I2=0) but in case of an earth fault, the vectorial sum differs from zero (I1+I2=Id), this causes the actuation of the relay and therefore the release of the main contacts.



Definitions related to RCD's

RCCB = Residual Current Circuit Breaker without overcurrent protection

RCBO = Residual Current Circuit Breaker with overcurrent protection

Breaking capacity
A value of AC component of a prospective current that a RCCB is capable of breaking at a stated voltage under prescribed conditions of use and behavior.

Residual making and breaking capacity (I∆m)
A value of the AC component of a residual prospective current which a RCCB can make, carry for its opening time and break under specified conditions of use and behavior.

Conditional residual short-circuit current (I∆c)
A value of the AC component of a prospective current which a RCCB protected by a suitable SCPD (short-circuit protective device) in series, can withstand under specific conditions of use and behavior.

Conditional short-circuit current (Inc)
A value of the AC component of a residual prospective current which a RCCB protected by a suitable SCPD in series, can withstand under specific conditions of use and behavior.

Residual short-circuit withstand current
Maximum value of the residual current for which the operation of the RCCB is ensured under specified conditions and above which the device can undergo irreversible alterations.

Prospective current
The current that would flow in the circuit, if each main current path of the RCCB and the overcurrent protective device (if any) were replaced by a conductor of negligible impedance.

Making capacity
A value of AC component of a prospective current that a RCCB is capable to make at a stated voltage under prescribed conditions of use and behavior.

Open position
The position in which the predetermined clearance between open contacts in the main circuit of the RCCB is secured.

Close position
The position in which the predetermined continuity of the main circuit of the RCCB is secured.

Tripping time
The time which elapses between the instant when the residual operating current is suddenly attained and the instant of arc extinction in all poles.

Residual current (I∆n)
Vector sum of the instantaneous values of the current flowing in the main circuit of the RCCB.

Residual operating current
Value of residual current which causes the RCCB to operate under specified conditions.

Rated short-circuit capacity (Icn)
Is the value of the ultimate short-circuit breaking capacity assigned to the circuit breaker.
(Only applicable to RCBO)

Conventional non-tripping current (Int)
A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping. (Only applicable to RCBO)

Conventional tripping current (It)
A specified value of current which causes the circuit breaker to trip within a specified time.
(Only applicable to RCBO)

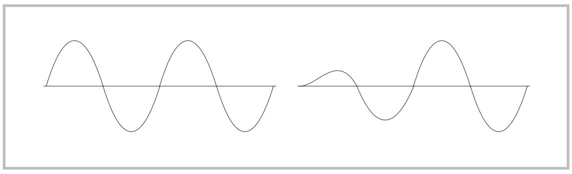
RCD's classification acc. EN/IEC 61008/61009

RCD's may be classified according to:

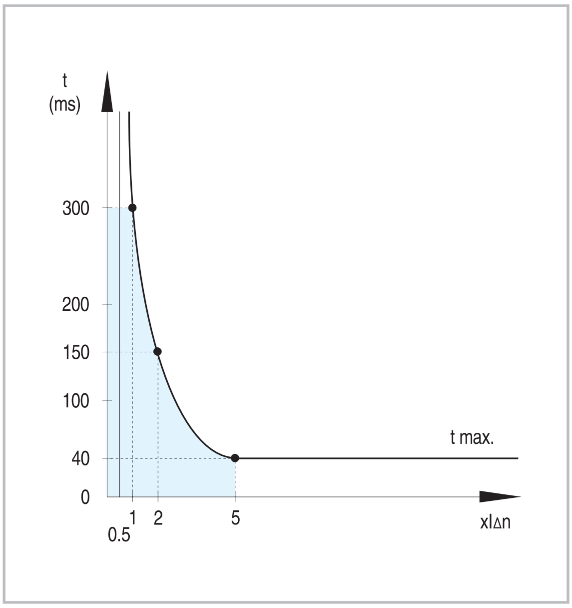
- The behavior in presence of dc current (types for general use).
  - Type AC
  - Type A
- The time-delay (in presence of residual current)
  - RCD's without time delay: type for general use
  - RCD's with time delay: type S for selectivity

Type AC

The type AC RCDs are designed to release with sinusoidal residual currents which occur suddenly or slowly rise in magnitude.



Residual current	Tripping time
0.5 x IΔn	t = ∞
1 x IΔn	t = < 300 ms
2 x IΔn	t = < 150 ms
5 x IΔn	t = ≤ 40 ms

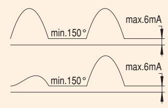
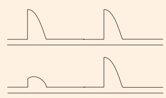
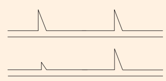


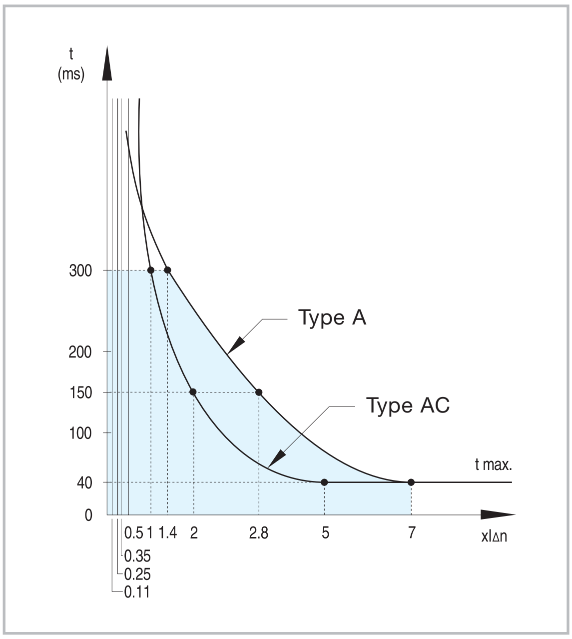
Tripping curve type AC

Type A

Certain devices during faults can be the source of non-sinusoidal earth leakage currents (DC components) due to the electronic components e.g.: diodes, thyristors.....
The type A RCD's are designed to ensure that under this conditions the residual current devices operate on sinusoidal residual current and also with pulsating direct current(*) which occur suddenly or slowly rise in magnitude.

(*) Pulsating direct current: current of pulsating wave form which assumes, in each period of the rated power frequency, the value 0 or a value not exceeding 0,006 A dc during one single interval of time, expressed in angular measure of at least 150º.

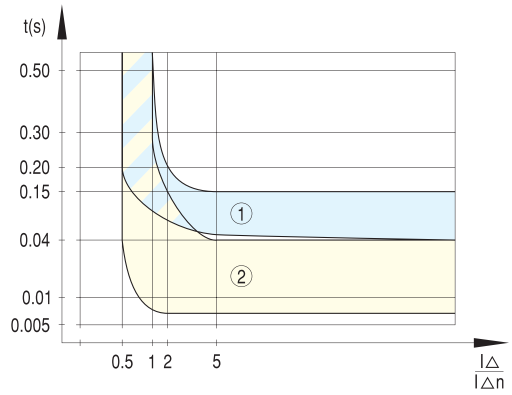
	Residual current	Tripping time
1. For sinusoidal residual current		
	0.5xIΔn	t = ∞
	1 xIΔn	t = < 300ms
	2 xIΔn	t = < 150ms
	5 xIΔn	t = < 40ms
2. For residual pulsating direct current		
	At point of wave 0°	
	0.35xIΔn	t = ∞
	1.4 xIΔn	t = < 300ms
	2.8 xIΔn	t = < 150ms
	7 xIΔn	t = < 40ms
	At point of wave 90°	
	0.25xIΔn	t = ∞
	1.4 xIΔn	t = < 300ms
	2.8 xIΔn	t = < 150ms
	7 xIΔn	t = < 40ms
	At point of wave 135°	
	0.11xIΔn	t = ∞
	1.4 xIΔn	t = < 300ms
	2.8 xIΔn	t = < 150ms
	7 xIΔn	t = < 40ms



Tripping curve type A

Type S S

RCD's type A or AC have instantaneous tripping. In order to provide full people protection in vertical installation (no class II) with more than one circuit, as well as to ensure the service in the installation in case of earth leakage in one of the circuits or to avoid unwanted tripping because of harmonics, high connection currents due to the use of motors, reactive loads, or variable speed drivers, we need to use selective RCD's at the top of the installation. Any RCD type S is selective to any other instantaneous RCD installed downstream with lower sensitivity.



① RCCB selective
② RCCB instantaneous

Selectivity

Vertical selectivity

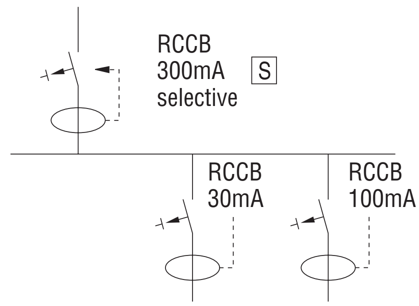
In an installation with RCD's installed in series we need to pay special attention to the vertical selectivity, in order to ensure that in case of earth leakage only the RCD which is immediately upstream of the fault point will operate.

Selectivity is ensured when the characteristic time/current of the upstream RCD (A) is above the characteristic time /current of the downstream RCD (B). To obtain vertical selectivity we should take into consideration the following parameters:

The RCD placed at the top of the installation shall be Type S. The residual operating current of the RCCB installed downstream shall have a lower residual operating current than the RCD installed upstream according to:

I△n downstream < I△n upstream/3

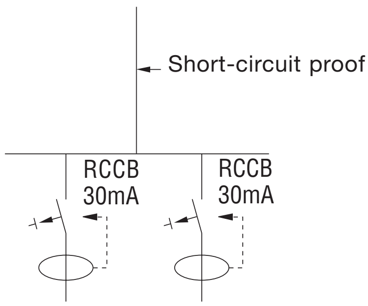
Vertical selectivity



Horizontal selectivity

To have horizontal selectivity in an installation with RCD's we need to avoid the use of RCD in cascading. Every single circuit of the installation shall be provided with a RCD of the appropriate residual operating current. The connection between the back-up protective device and the RCD must be short-circuit proof (Class II).

Horizontal selectivity



Nuisance tripping

Type AI (High immunity to nuisance tripping)
Electric equipment incorporates more and more electronic components which causes nuisance tripping to the conventional 30mA RCD's type A or AC (always in the most critical moment like weekends, areas with no people presence…) due to overvoltages or high frequency currents produced by atmospheric disturbances, lighting equipment (electronic balasters), computers, appliances, connections to long cables which induce a high capacity to ground, etc.

Some times the filter incorporated on the standard RCD's type A or AC which are protected to prevent nuisance tripping against current peak up to 250 A 8/20 µs, does not avoid 100% unwanted tripping. Therefore GE Power Controls has developed a new RCD generation which protects against nuisance tripping of peak currents up to 5000 A 8/20 µs.

Installations with either lighting equipment incorporating electronic balasters or computers.

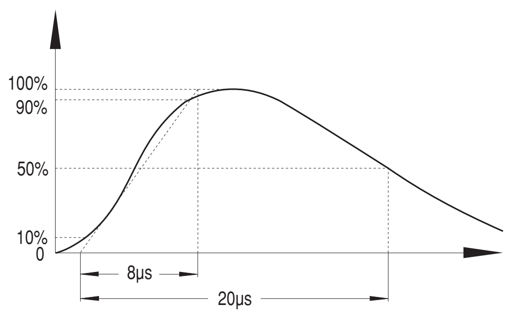
The most typical problem in these installations is the tripping of the RCD when switching the equipment ON-OFF. It is recommended that, in case several devices are installed in the same line, the sum of all leakages shall not exceed 1/3 I∆n since any disturbance in the line can trip the RCD. For this kind of installation it is recommended to split up circuits or to **use type AI RCD's.**

RCD's type AI or ACI have a tripping characteristic according to EN/IEC 61008/61009.

All RCD's have a high level of immunity to transient currents, against current impulses of 8/20 µs according to EN/IEC 61008/61009 and VDE 0664.T1

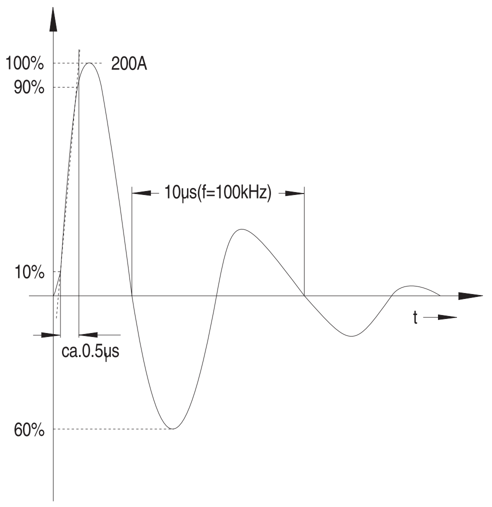
Type A, AC ....250 A 8/20 µs
Type S ....3000 A 8/20 µs
Type Ai ....3000 A 8/20 µs
Type Si ....5000 A 8/20 µs

Curve 8/20 µs



RCD's have a high level of immunity against ring wave currents of high frequency according to EN/IEC 61008/61009

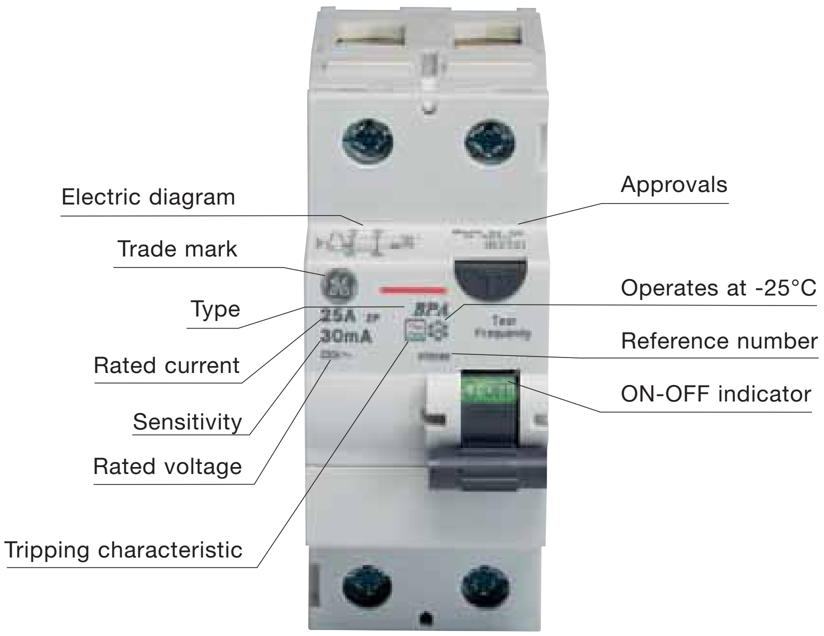
Curve 0.5 µs - 100 kHz - 200 A - EN/IEC 61008/61009



Product identification of an RCCB Series BPC/BDC and its use

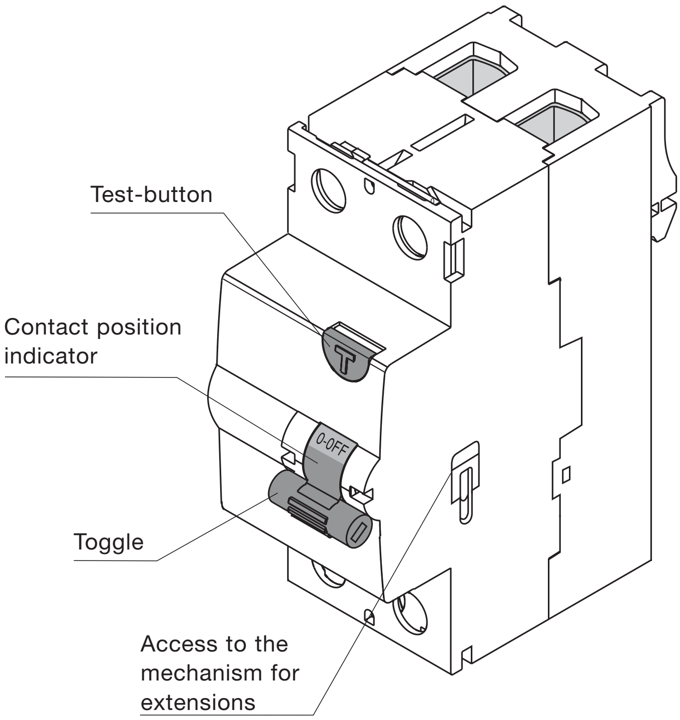
Information on product

Example: RCCB 2P 25A 30mA Type A



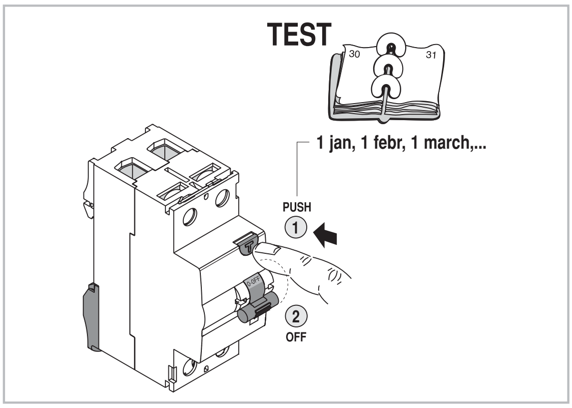
Use of an RCCB

RCCB BPC/BDC



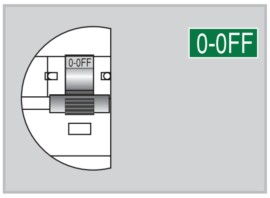
TEST-BUTTON

To ensure the correct functioning of the RCCB, the test button T shall be pressed frequently. The device must trip when pressed.



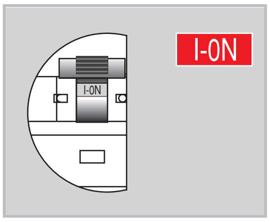
CONTACT POSITION INDICATOR

Printing on the toggle to provide information of the real contact position.



O-OFF

Contacts in open position. Ensure a distance between contacts > 4mm.



I-ON

Contacts in closed position. Ensure continuity in the main circuit.

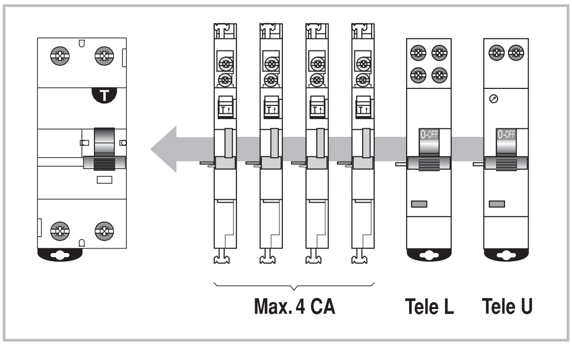
ALL CABLES MUST BE CONNECTED TO THE RCCB

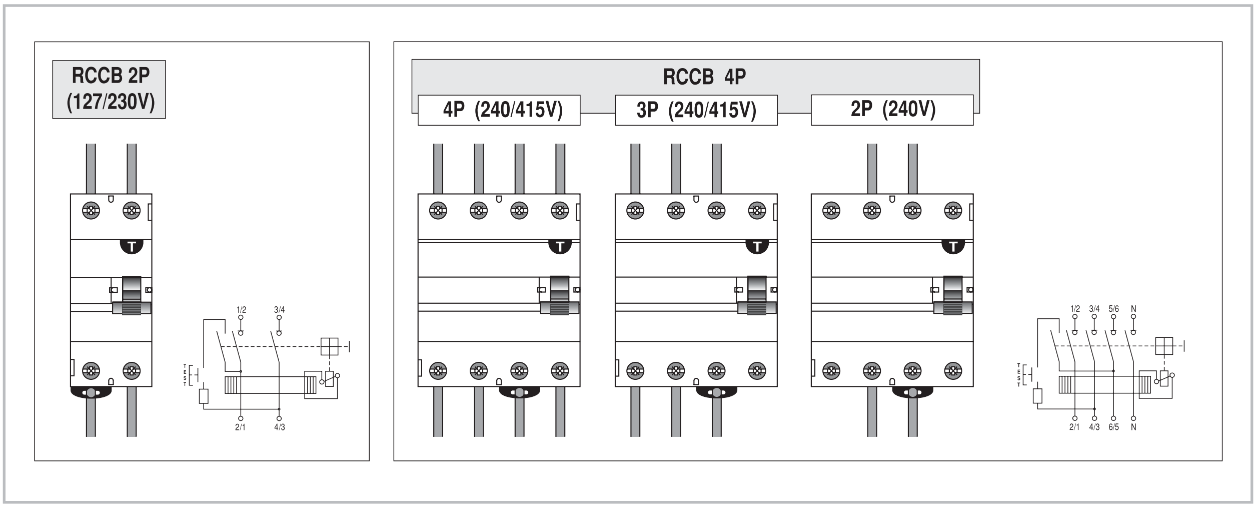
All conductors, phases and neutral, that constitute the power supply of the installation to be protected, must be connected to the RCCB to either upper or lower terminals according to one of the following diagrams.

ACCESS TO THE MECHANISM FOR EXTENSIONS

To couple extensions we need to remove the cap on the right hand side, in order to get access to the mechanism.

It is possible to add any auxiliary contact, shunt trip, undervoltage release or motor operator, following the stack-on configuration of the extensions in chap. T3.



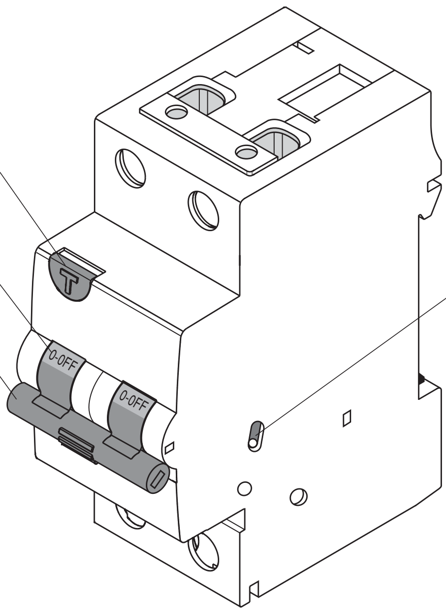


Product identification of an RCBO series DM and its use

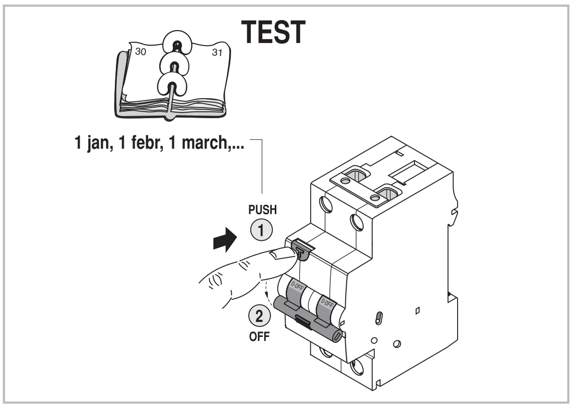
Information on product

Example: RCBO 1P+N C16 30mA Type A

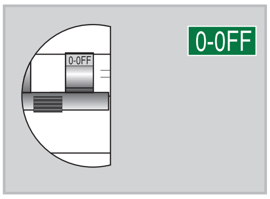
Use of an RCBO



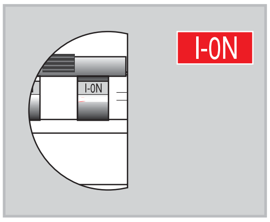
TEST-BUTTON
To ensure the correct functioning of the RCBO, the test button T shall be pressed frequently. The device must trip when the test button is pressed.



CONTACT POSITION INDICATOR
Printing on the toggle to provide information of the real contact position.



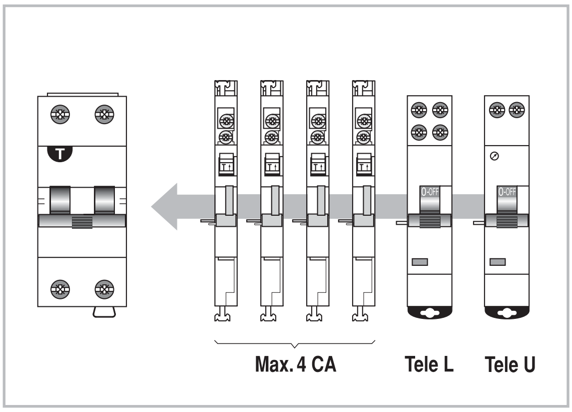
O-OFF
Contacts in open position. Ensure a distance between contacts > 4mm.



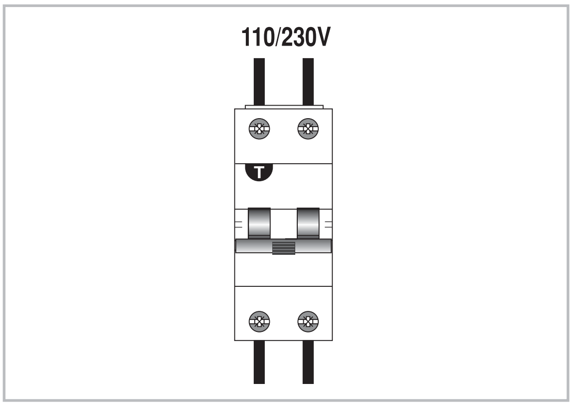
I-ON
Contacts in close position. Ensure continuity in the main circuit.

TOGGLE
To switch the RCBO ON or OFF

ACCESS TO THE MECHANISM FOR EXTENSIONS
It is possible to add any auxiliary contact, shunt trip, undervoltage release or motor operator, following the stack-on configuration of the extensions in page C.3.



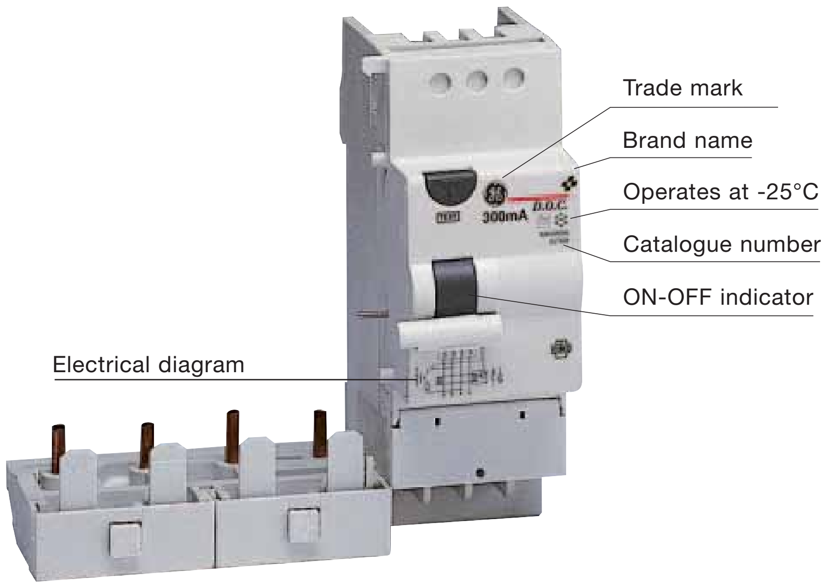
ALL CABLES MUST BE CONNECTED TO THE RCCB
All conductors, phase and neutral, that constitute the power supply of the installation to be protected, must be connected to the RCBO to either upper or lower terminals according to the following diagram.



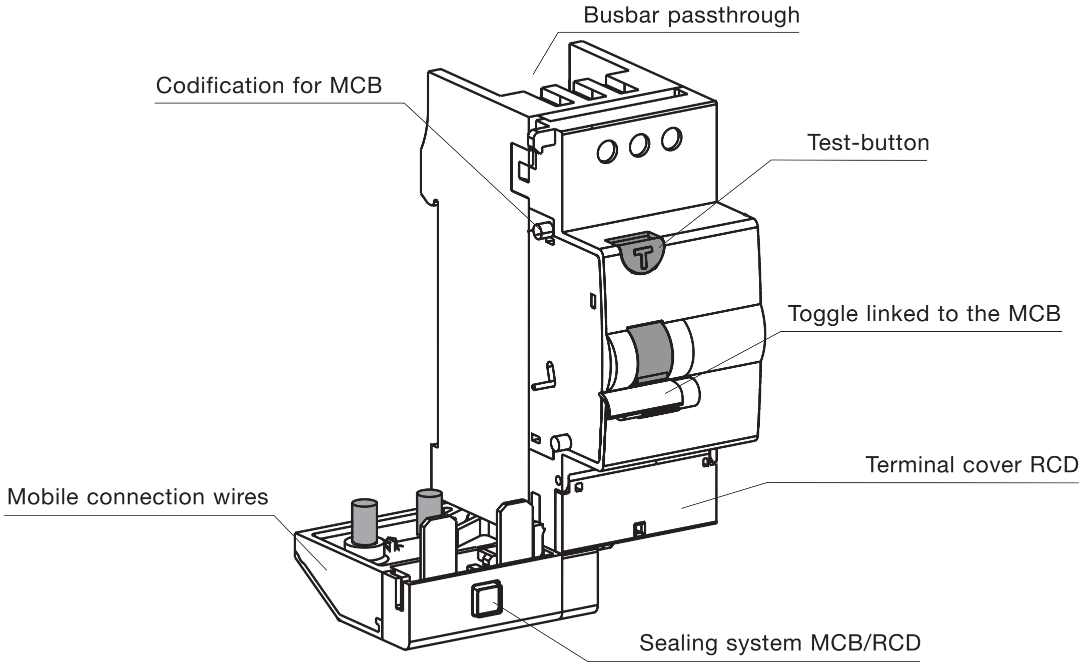
Product identification of an add-on RCD and its use

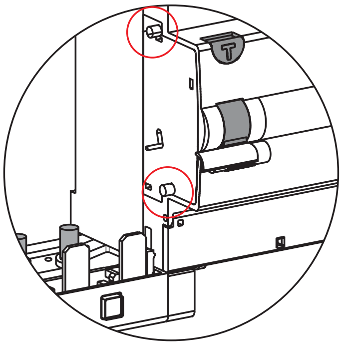
Information on product

Example: Add-on RCD



Use of an add-on RCD





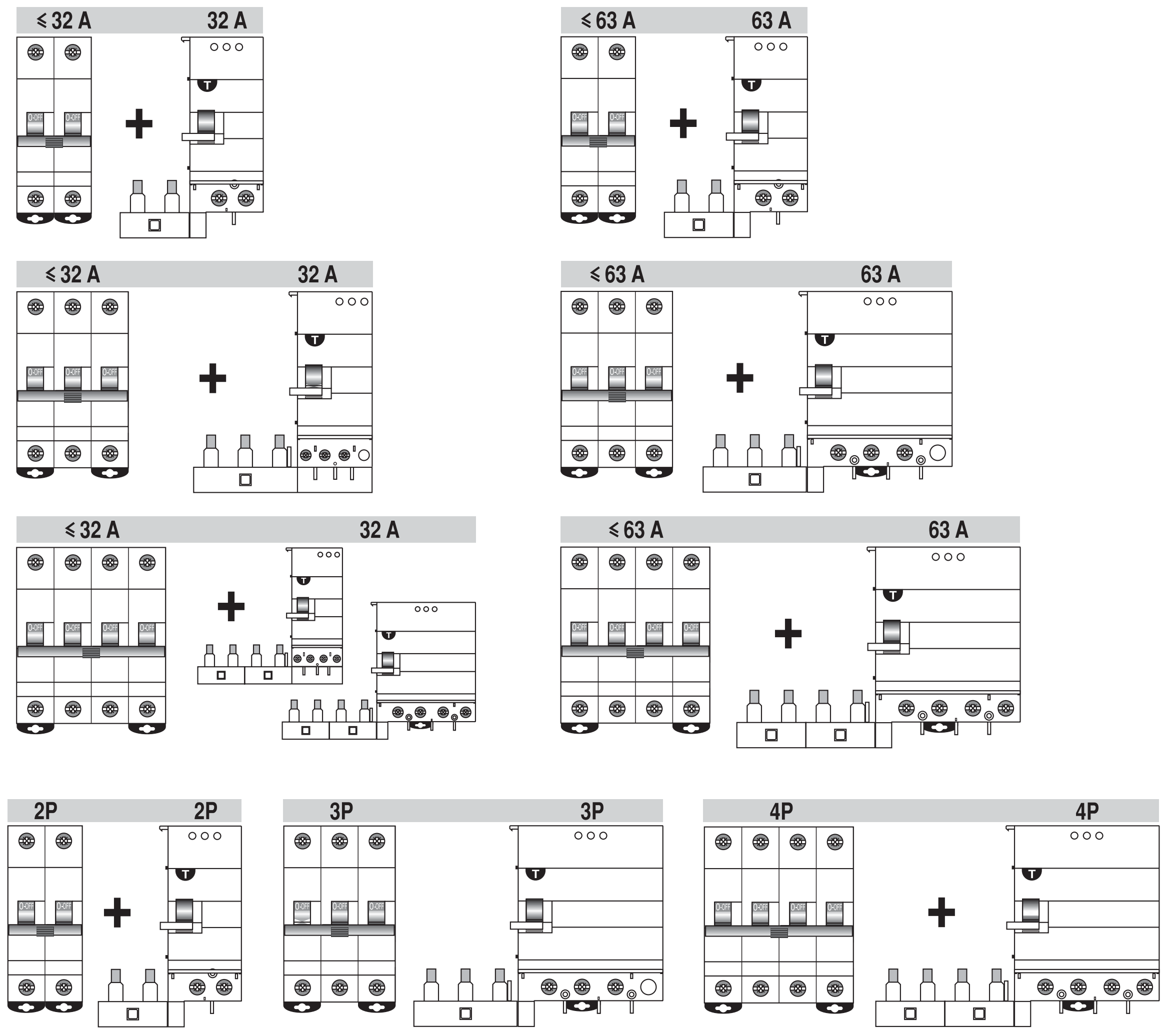
CONDITIONS FOR ASSEMBLY

The annex G of the EN/IEC 61009-1 standard says:

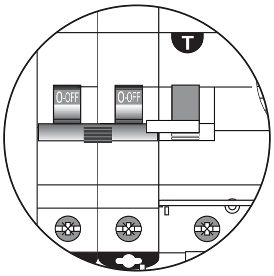
- It shall not be possible to assemble a MCB of a given rated current with an add-on RCD unit of a lower maximum current.
- It shall not be possible to assemble an add-on RCD with a MCB having no provision for switching the associated neutral.

To comply with the mentioned conditions it is implemented on the add-on RCD a codification system which avoids any wrong assembly.

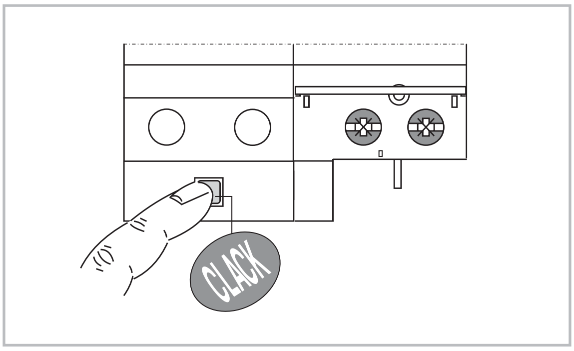
The correct assembly shall be done as follows:



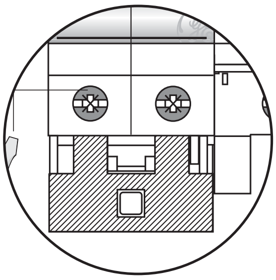
TOGGLE
To switch the add-on RCD ON or OFF. The toggle is overlapped with the one of the coupled MCB and both can be swithced on at the same time.

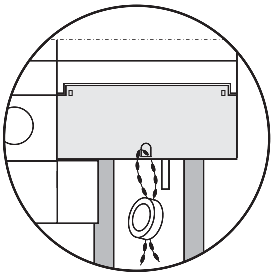


UNMANIPULATION SEALING SYSTEM
To seal the combination MCB/RCD once the assembly is finished. Any manipulation after sealing the combined unit, visible damage will remain.

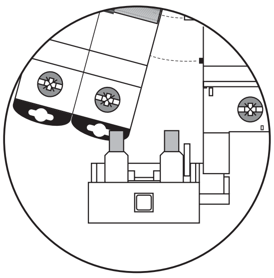


TERMINAL COVERS
Unlosable terminal covers for the MCB bottom terminals as well as for the RCD terminals are provided.



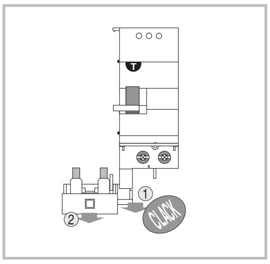


MOBILE CONNECTION
For an easy and quick assembly the connection wires are bi-stable

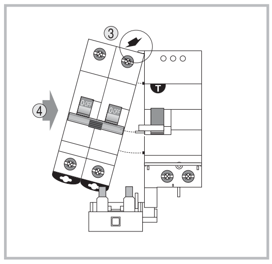


HOW TO ASSEMBLE ADD-ON RCD+MCB

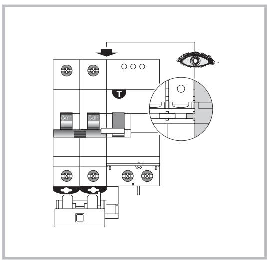
Pull down the connector block.



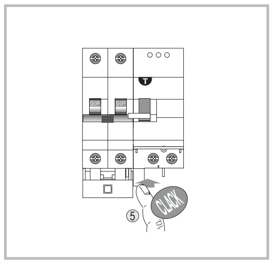
Place the RCD and the MCB along side one another, both in OFF position.



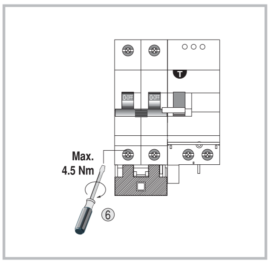
Make sure the coupling is well done.



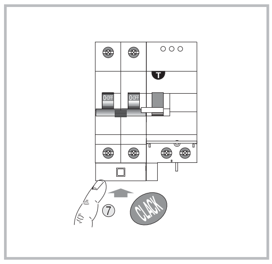
Push up the connector block.



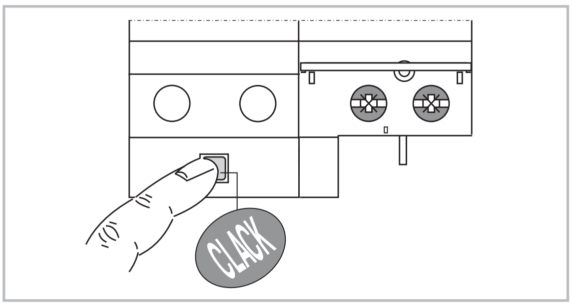
Maximum screwing torque 4,5 Nm



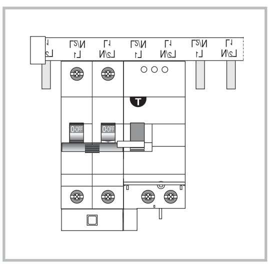
Push up the MCB cover terminals



Once tested the correct electrical functioning of the combined unit, seal the combined unit by means of the sealing button.



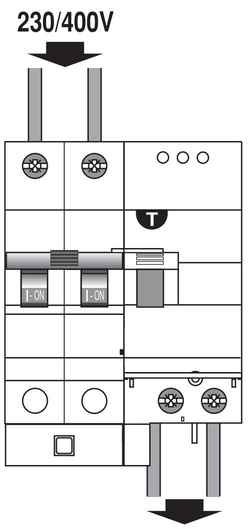
BUSBAR PASSTHROUGH
The add-on RCD permitts the passthrough of both pin and fork busbars at the top terminals.

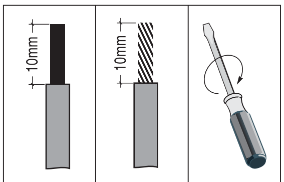


ALL CABLES MUST BE CONNECTED TO THE RCBO

In order to protect the RCD in the proper way, it is recommended to feed the combined unit (MCB/RCD) by the MCB (top terminals), in such a way the MCB provides back up protection to the RCD.

All conductors, phases and neutral, that constitute the power of the installation to be protected must be connected to the MCB/RCD combination.

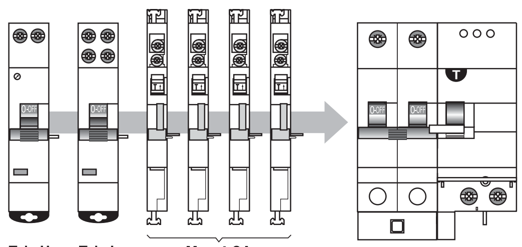




		max.	max.	max.
2 P	2 mod	35 mm	25 mm	4.5 Nm
3 P 4 P	4 mod	35 mm	25 mm	4.5 Nm
4 P	2 mod	16 mm	10 mm	2.5 Nm

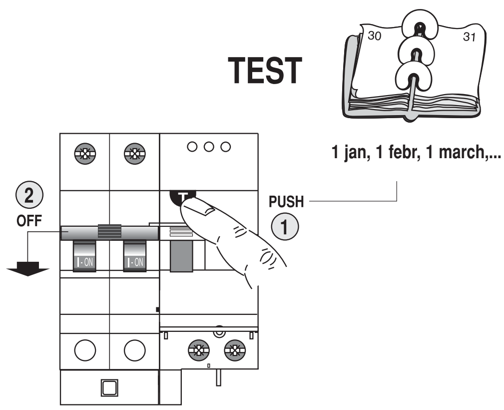
ACCESS TO THE MECHANISM FOR EXTENSIONS

It is possible to add any auxiliary contact, shunt trip, undervoltage release or motor operator on the left hand side, following the stack on configuration of the extensions in chap. T3.



TEST-BUTTON

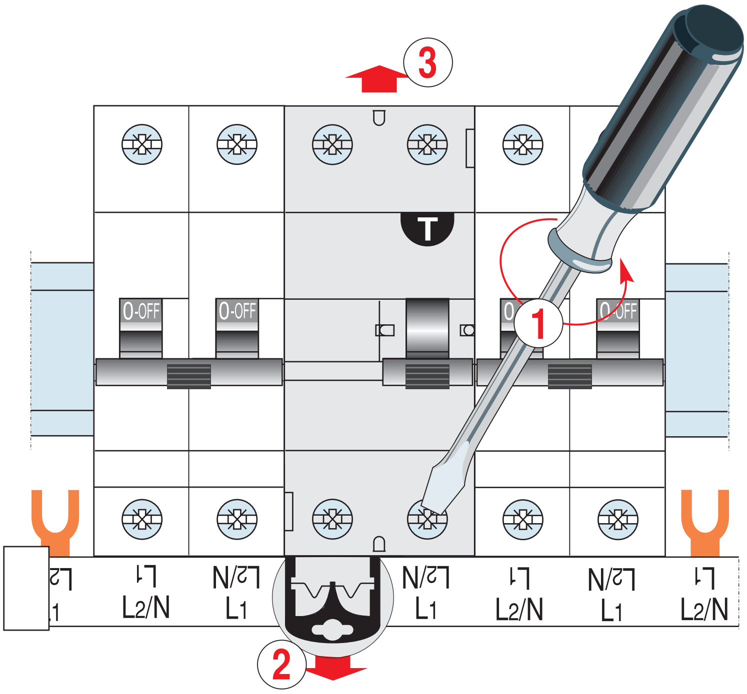
To ensure the correct functioning of the RCBO, the test-button T shall be pressed frequently.
The device must trip when the test button is pressed.



Easy DIN-rail extraction

RCCB’s can easilly be removed from the DIN rail when installed with busbars just taking into consideration the following instructions.

Pin and fork busbar - bottom terminals



① Open the terminals totally
② Unclick the DIN rail clip
③ Lift the RCCB up and remove it from the DIN rail

Product related information

Influence of air ambient temperature in the rated current

Influence of temperature in RCCB

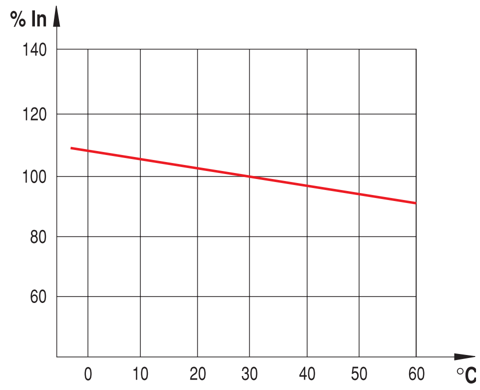
The maximum value of the current which can flow through a RCCB depends of the nominal current as well as the ambient air temperature. The protective device placed up-stream of the RCCB must ensure the disconnection at the values in the following table:

In	25°C	30°C	40°C	50°C	60°C
16 A	19	18	16	14	13
25 A	31	28	25	23	25
40 A	48	44	40	36	32
63 A	76	69	63	57	51
80 A	97	88	80	72	65
100 A	121	110	100	90	81
125 A	151	137	125	112	101

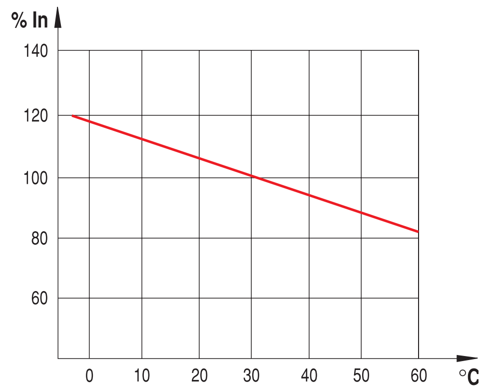
Influence of temperature in RCBO's

The thermal calibration of the RCBO was carried out at an ambient temperature of 30°C. Ambient temperatures different from 30°C influence the bimetal and this results in earlier or later thermal tripping.

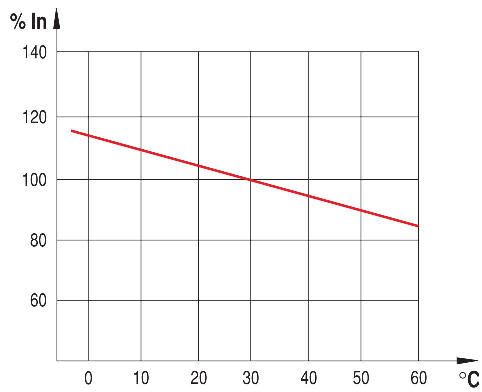
0.5 - 6A



10A



16 - 40A



Tripping current as a function of the frequency

All the RCD's are designed to work at frequencies of 50-60 Hz, therefore to work at different values, we must consider the variation of the tripping sensitivity according tables below. It should be taken into consideration that there is a no tripping risk when pushing the test-button, due to the fact that such action is made by means of a internal resistor with a fixed value.

RCCB Series BDC/BPC/BPA/BPS and Add-on RCD DOC

Type AC	10 Hz	30 Hz	50 Hz	100 Hz	200 Hz	300 Hz	400 Hz
30mA	3.63	1.50	0.80	1.63	2.40	3.03	4.63
100mA	0.75	0.74	0.80	1.18	1.69	2	2.46
300mA	0.62	0.71	0.80	1.15	1.45	1.84	2.16
500mA	0.80	0.72	0.80	1.15	1.52	1.79	2.12
Type A							
30mA	7.57	2.40	0.75	1.63	2.53	3.70	9.23
100mA	4.50	1.85	0.75	1.22	2.17	4.35	10.85
300mA	3.56	1.55	0.75	1.18	2.10	4.40	17.10
500mA	3.24	1.39	0.75	0.95	12.17	25.40	33.06

RCBO Series DM/DMA

Type AC	10 Hz	30 Hz	50 Hz	100 Hz	200 Hz	300 Hz	400 Hz
30mA	0.62	0.65	0.80	0.91	1.24	1.55	1.88
100mA	0.74	0.71	0.80	0.95	1.16	1.38	1.59
300mA	0.80	0.74	0.80	0.97	1.19	1.44	1.64
500mA	1.10	0.81	0.80	0.89	1.18	1.38	1.68
Type A							
30mA	8.17	3.13	0.75	1.70	3.10	3.52	3.67
100mA	6.81	2.71	0.75	1.43	2.35	2.58	2.71
300mA	6.20	2.16	0.75	0.49	0.87	0.74	0.95
500mA	4.34	1.53	0.75	0.39	0.59	0.62	0.64

Protection of RCCB

RCCB's are not overcurrent protected. Therefore we don't need to consider both protection against short-circuits and overloads.

Protection against short-circuits
COORDINATION OF RCCB's WITH MCB's OR FUSES, BACK-UP PROTECTION

RCCB's protected with a SCPD have to be able to withstand, without damage, short-circuit currents up to its rated conditional short-circuit capacity. The SCPD has to be carefully selected, since the association of this device with the RCCB is interrupting the short-circuit of the installation.

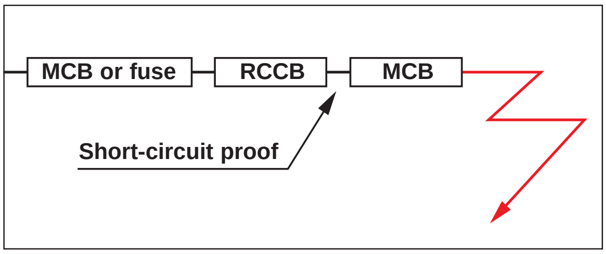
The value of the presumed short-circuit current at the point where the RCCB is installed shall be lower than the values of the following table:

The RCCB and the protective device must be installed in the same switchboard, paying special attention to the connection between these two devices since if the SCPD is installed downstream of the RCCB such a connection must be short-circuit proof.
SCPD = Short-Circuit Protective Device.

RCCB co-ordination with MCB or fuses

	UPSTREAM PROTECTION										
	MCB'S							FUSES			
RCCB EFI/EHFI	G60 up to 40A	G100 ≤ 40A	GT25 > 40A	GT25 ≤ 40A	GT25 > 40A	Hti 80...125A	S90	Fuse 160A	Fuse 250A	Fuse 400A	Fuse 630A
DOWNSTREAM G60 ≤ 25A	6 kA	10 kA	10 kA	10 kA	10 kA	–	25 kA	–	–	–	–
DOWNSTREAM G100 ≤ 25A	–	25 kA	25 kA	25 kA	25 kA	10 kA	25 kA	16 kA	10 kA	10 kA	10 kA
DOWNSTREAM G100 > 25A	–	25 kA	25 kA	25 kA	25 kA	10 kA	25 kA	10 kA	10 kA	10 kA	10 kA
DOWNSTREAM Fuse 25A	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA	100 kA

The values indicated in the table are the maximum short-circuit current in kA rms.
For RCCB's 2P 230V c.a. and 4P 400 V c.a.



Power losses

The power losses are calculated by means of measuring of the voltage drop between the incoming and the outgoing terminal of the device at rated current.

Power loss per pole:

Power losses per pole RCCB BDC/BPC/BPA

In (A)	16	25	40	63	80	100
Z (mOhm)	9.94	3.75	2.15	1.30	1.30	0.87
Pw (W)	2.55	2.33	3.43	5.15	8.30	8.70

Power losses per pole RCBO DM/DMA

In (A)	4	6	10	16	20	25	32	40
Z (mOhm)	125.00	53.00	16.30	9.80	7.10	5.60	4.70	3.60
Pw (W)	2.00	1.91	1.63	2.51	2.84	3.50	4.81	5.76

Power losses per pole MCB G Add-on RCD DOC

In (A)	6	10	13	16	20	25	32	40	50	63
Z (mOhm)	45.4	17.4	13.7	11.9	8.7	6.9	4.8	3.6	2.9	2.4
Pw (W)	1.6	1.7	2.3	3	3.5	4.3	4.9	5.8	7.3	9.6

Power losses per pole RCBO DME/DMAE

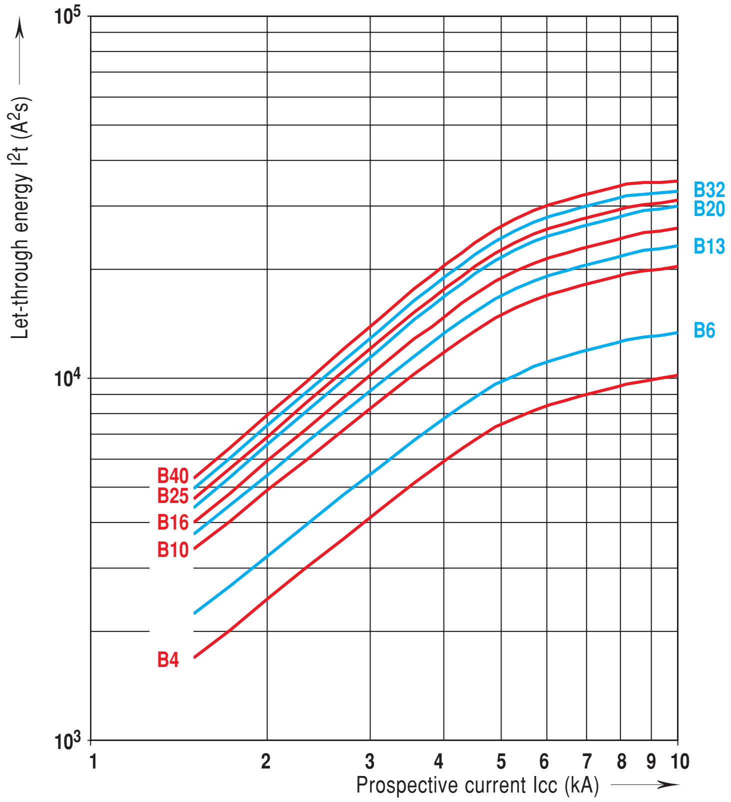
In (A)	6	8	10	13	16	20	25	32	40	50	63
Voltage drop	0.26	0.16	0.16	0.155	0.162	0.138	0.128	0.096	0.1	0.09	0 .082
Z (mOhm)	43.6	19.4	15.6	11.9	10.1	6.9	5.1	3	2.5	1.8	1.3
Pw (W)	1.57	1.242	1.56	2.011	2.566	2.76	3.188	3.188	4	4.5	5.16

RCBO let-through energy I^2t

The limitation of an RCBO in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.

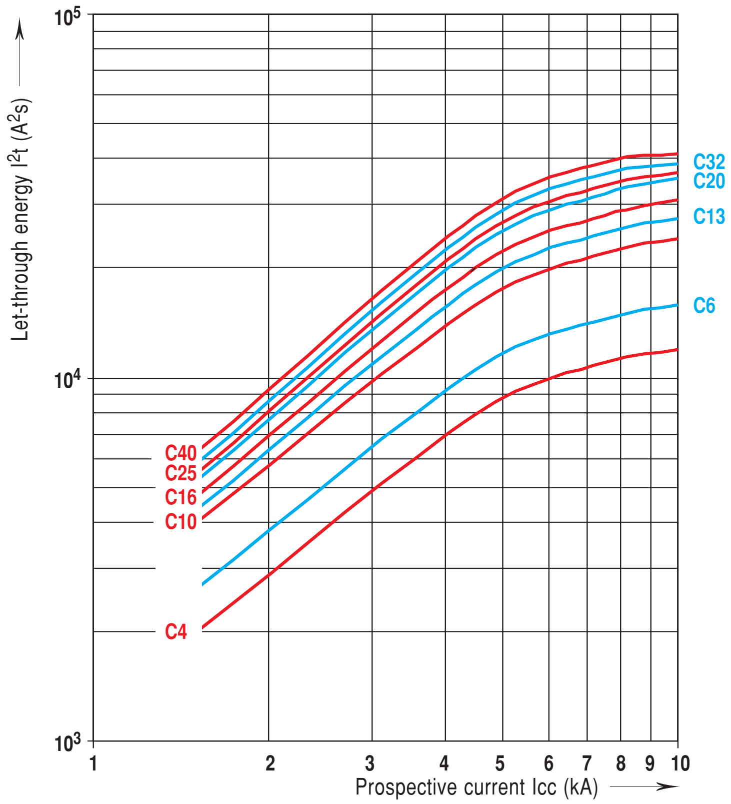
Series DM - Curve B

Let-through energy at 230 V



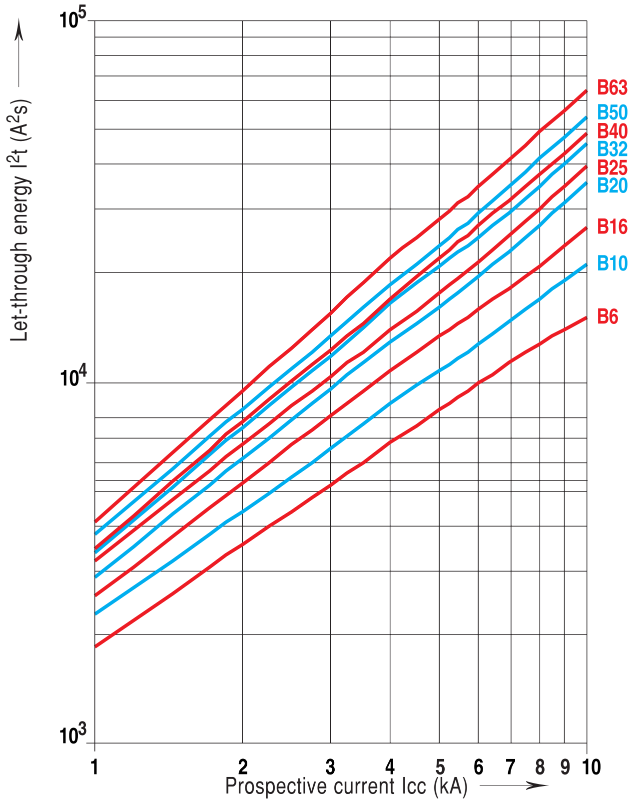
Series DM - Curve C

Let-through energy at 230 V



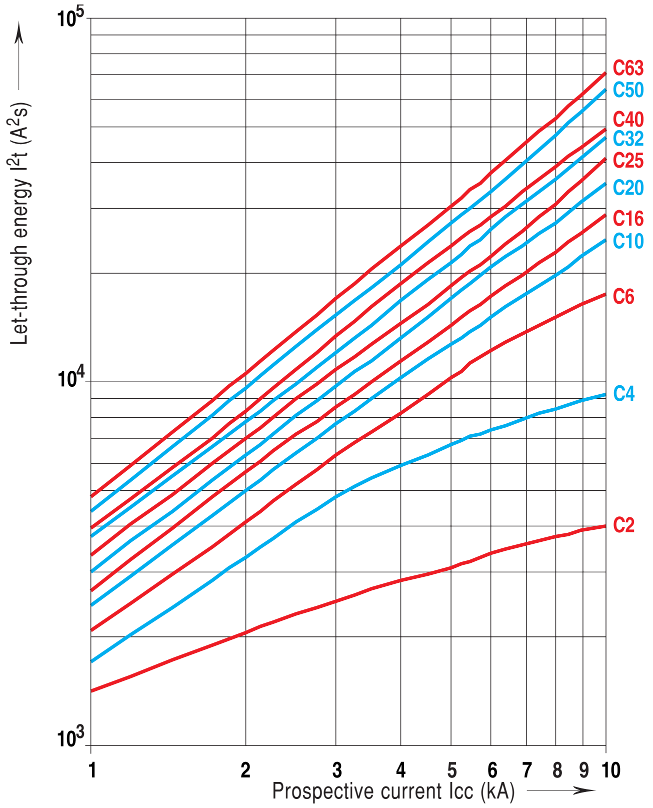
Series DME - Curve B

Let-through energy at 230 V



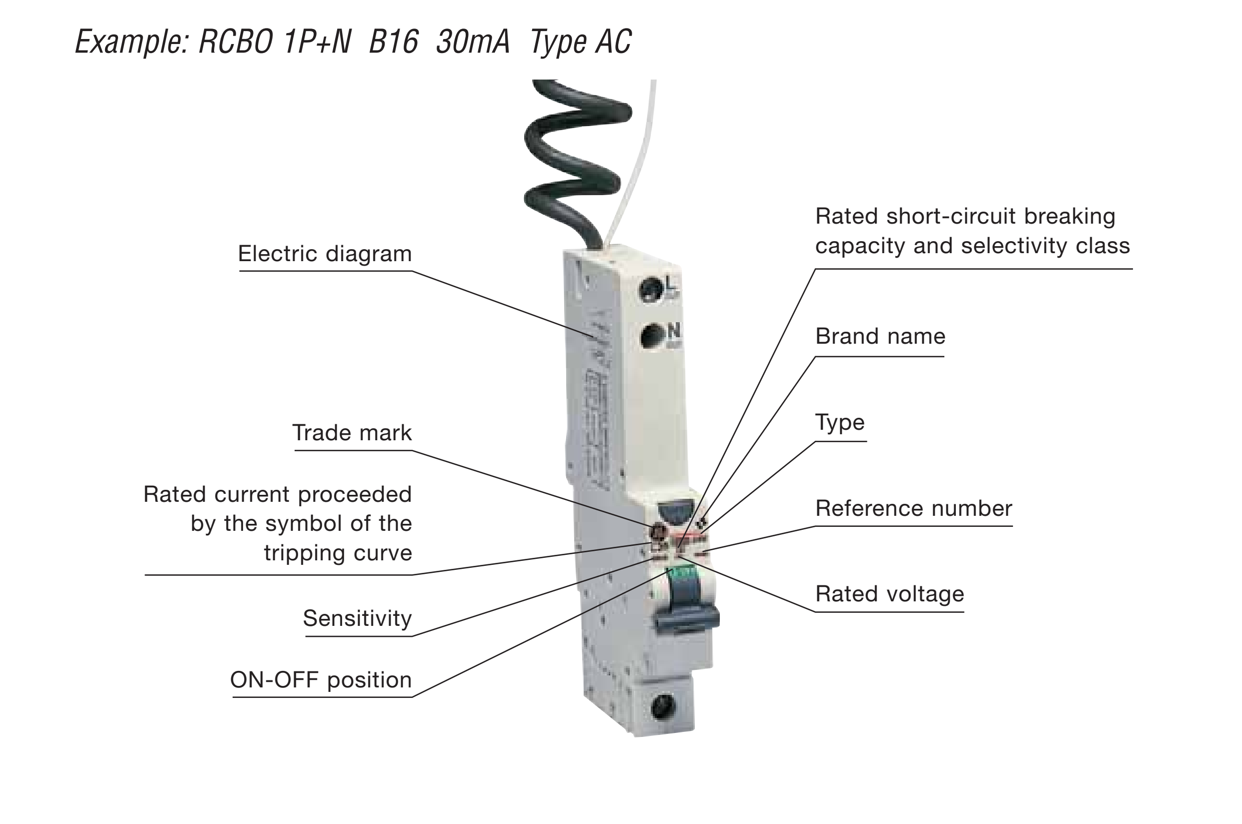
Series DME - Curve C

Let-through energy at 230 V

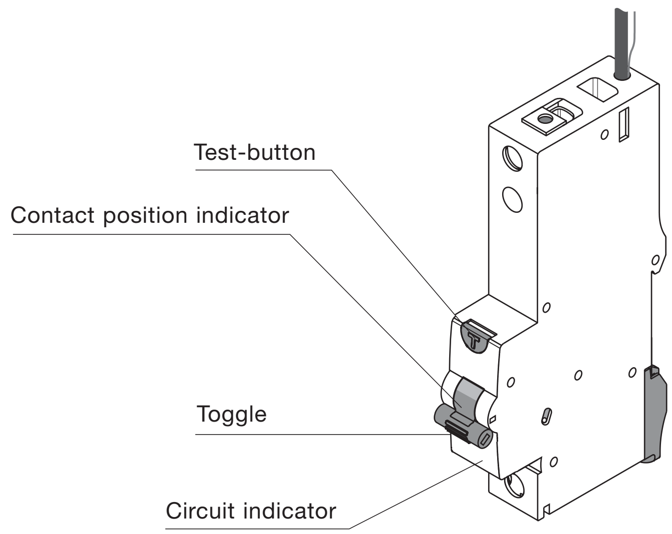


Product identification of an RCBO Series DME and its use

Information on product

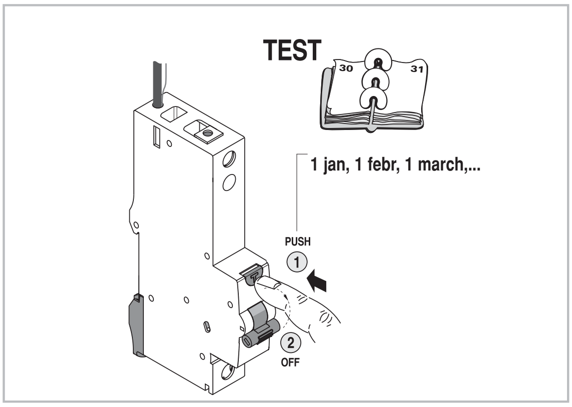


Use of an RCBO



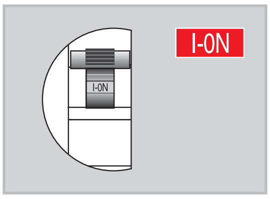
TEST-BUTTON

To ensure the correct functioning of the RCBO, the test-button T shall be pressed frequently. The device must trip when the test-button is pressed.



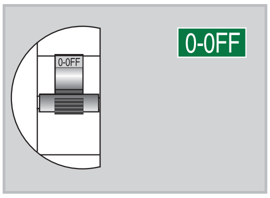
CONTACT POSITION INDICATOR

Printing on the toggle to provide information of the real contact position.



I-ON

Contacts in closed position. Ensure continuity in the main circuit.



O-OFF

Contacts in open position. Ensure a distance between contacts > 4mm.

TOGGLE

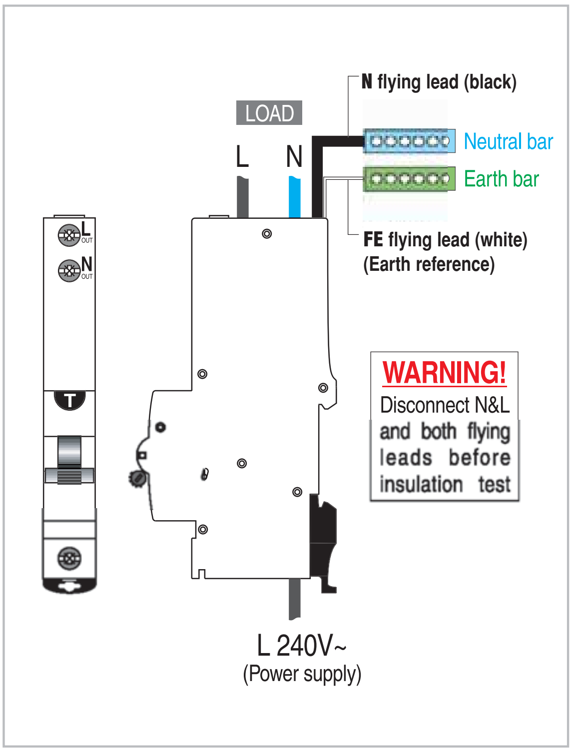
To switch the RCBO ON or OFF

CABLE CONNECTION

The power supply (L) must be done at the bottom terminal, and the supply Neutral flying cable (black) shall be connected to the Neutral bar.

Load connection shall be done in both terminals at the top side (L out / N out).

The earth reference cable (FE white) ensures protection against earth leakage in case of loss of supply Neutral.



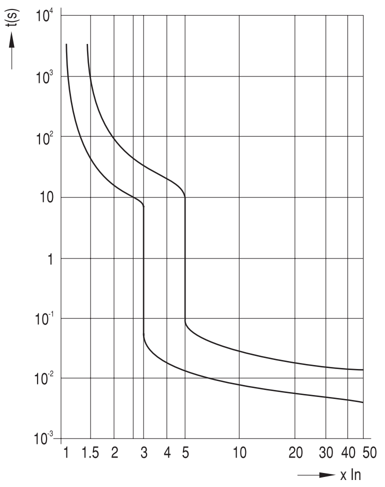
Technical Data

T2

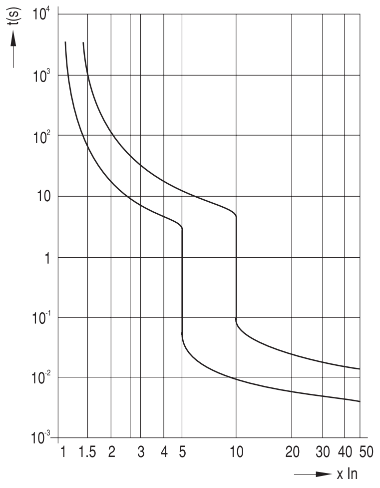
RCBO tripping curves acc. EN/IEC 61009

In the following tables it is possible to see the average tripping curves of the RCBO's in function of the thermal calibration as well as of the magnetic characteristic.

Curve B



Curve C



Text for specifiers

RCCB

- According to EN/IEC 61008 standard.
- Intended to detect residual sinusoidal currents (type AC) or residual pulsating direct currents (type A).
- Resistance against nuisance tripping according to VDE 0664 T1 and EN/IEC 61008.
- Working ambient temperature from –25°C up to +40°C for type A and from –5° C up to +40°C for type AC.
- Approved by CEBEC, KEMA...
- The RCCB are 2P and 3P+N with 2 and 4 modules wide.
- The Neutral pole in the 3P+N RCCB is on the right hand side. The N pole closes first of all poles and opens last of all poles.
- Nominal rated currents are: 16, 25, 40, 63, 80*A.
- Nominal residual currents are: 10, 30, 100, 300, 500 mA.
- The test circuit is protected against overloads.
- All RCCB's have a minimum short-circuit resistance of 10kA when they are back-up protected by means of MCB's or fuses.
- The making and breaking capacity is 500 A.
- The residual making and breaking capacity is 1.500 A.
- Terminal capacity from 1 up to 50 mm^2 rigid wire or 1,5 up to 50 mm^2 flexible wire.
- The devices 10,30,100 mA type A or AC have always vertical selectivity with devices 300 mA type S.
- The selective types have a delayed tripping time in comparison with the instantaneous ones (type A, AC) with sensitivity lower than 300mA.
- Both incoming and outgoing terminals have a protection degree of IP20 and are sealable.
- Isolator function due to the printing Red/Green on the toggle.
- Auxiliary contacts can be added on the right hand side.
- RCCB's can be released by means of shunt trip or undervoltage release.
- RCCB's can be remotely controled by means of a motor operator.

Add-on RCD

- According to EN/IEC 61009 standard.
- Intended to detect residual sinusoidal currents (type AC) or residual pulsating direct currents (type A).
- Resistance against nuisance tripping according to VDE 0664 T1 and EN/IEC 61009.
- Working ambient temperature from –25°C up to +40°C for type A and from –5°C up to +40°C for type AC.
- Approved by CEBEC, KEMA…
- Add-on RCD widths are:
  - 2P - 2 modules 32 A & 63 A
  - 3P - 2 modules 32 A & 4 modules 63 A
  - 4P – 2 or 4 modules 32 A & 4 modules 63 A
- Nominal rated currents are: 0,5 – 63 A & 80 – 125 A
- Nominal residual currents are: 30, 100, 300, 500, 1000 mA.
- The test circuit is protected against overloads.
- The short-circuit capacity depends on the associated MCB:

  G30 ....3000 A   G60 ....6000 A
  G45 ....4500 A   G100 ....10000 A

- The residual making and breaking capacity depends of the associated MCB:

  G30 ....3000 A   G60 ....6000 A
  G45 ....4500 A   G100 ....7500 A

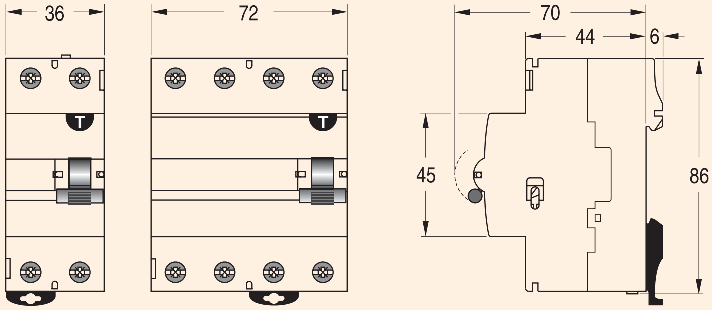
- Terminal capacity:
  - 2P-2 modules 32 A & 63 A ....35 mm^2
  - 3P-2 modules 32 A................................16 mm^2
  - 3P-4 modules 63 A................................35 mm^2
  - 4P-2 modules 32 A................................16 mm^2
  - 4P-4 modules 32 A & 4 modules 63 A....35 mm^2
- The devices 10, 30, 100 mA type A or AC have always vertical selectivity with devices 300 mA type S.
- The selective types have a delayed tripping time in comparison with the instantaneous ones (type A, AC) with sensitivity lower than 300 mA.
- Both incoming and outgoing terminals (MCB+Add-on RCD) have a protection degree of IP20 and they are sealable.
- A codification system between MCB and RCD avoid a incorrect assembly (i.e. MCB 50 A coupled with RCD 32 A).
- Auxiliary contacts can be added on the left hand side of the MCB part.
- It can be released by means of shunt trip or under-voltage release.
- It can be remotely controled by means of a motor operator. The toggle of MCB and RCD are independent, so it is possible to identify the reason of the release.

RCBO

- According to EN/IEC 61009 standard.
- Intended to detect residual sinusoidal currents (type AC) or residual pulsating direct currents (type A).
- Resistance against nuisance tripping according to VDE 0664 T1 and EN/IEC 61009.
- Working ambient temperature from –25°C up to +40°C for type A and from –5°C up to +40°C for type AC. Approved by CEBEC, KEMA…
- The RCBO 1P+N is 2 modules wide or 1 module wide.
- The Neutral pole is on the left hand side. The N pole closes first of all poles and opens last of all poles.
- Nominal rated currents are: 4 up to 40 A.
- Characteristic B & C.
- Nominal residual currents are: 10, 30, 100, 300, 500, 1000 mA.
- The test circuit is protected against overloads .
- The short-circuit capacity is 10 kA, with selectivity class 3.
- The making and breaking capacity is 500 A
- The residual making and breaking capacity is 7500 A.
- Terminal capacity from 1 up to 25 mm^2 rigid in the top terminals and from 1 up to 35 mm^2 in the bottom terminals.
- The devices 10, 30, 100 mA type A or AC have always vertical selectivity with devices 300 mA type S.
- Both incoming and outgoing terminals have a protection degree of IP20.
- Isolator function due to the printing Red/Green on the toggle.
- Auxiliary contacts can be added on the right hand side.
- RCBO's can be released by means of shunt trip or undervoltage release.
- RCBO's can be remotely controled by means of a motor operator.

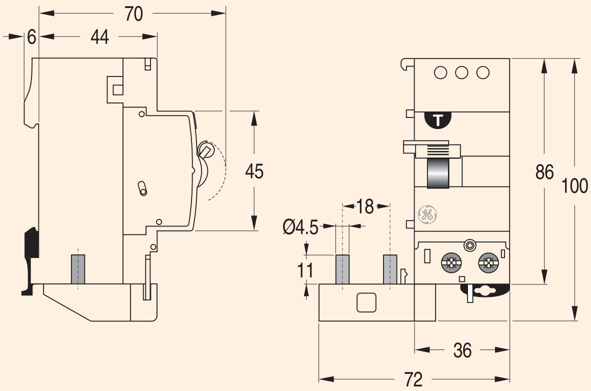
Dimensional drawings

RCCB's - Series BP

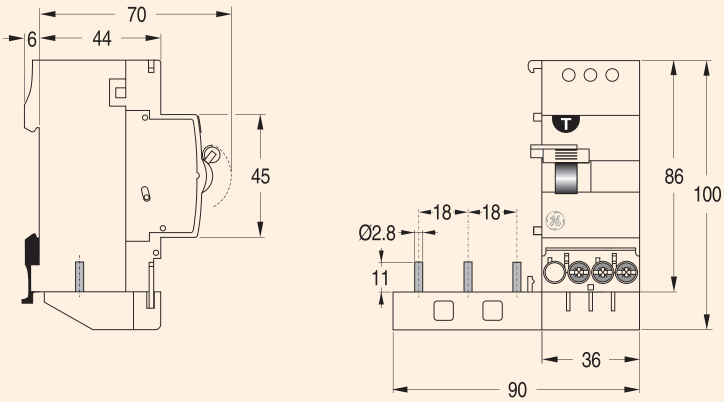


Add-on RCCB - Series Diff-o-Click

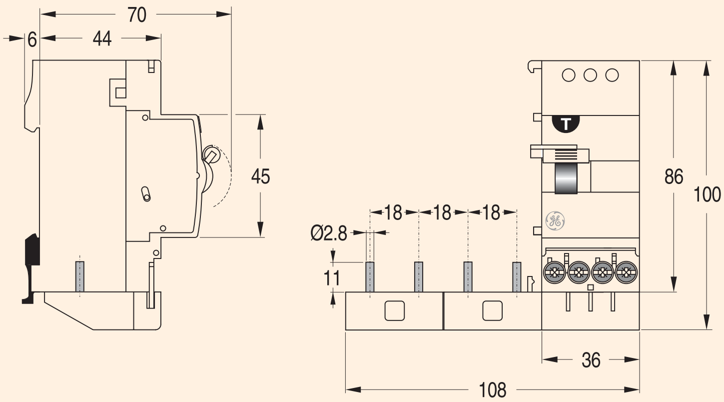
2P 32A
2P 63A



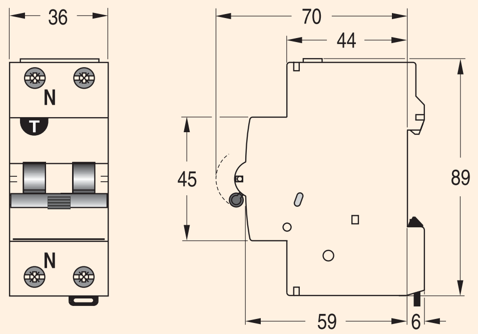
3P 32A



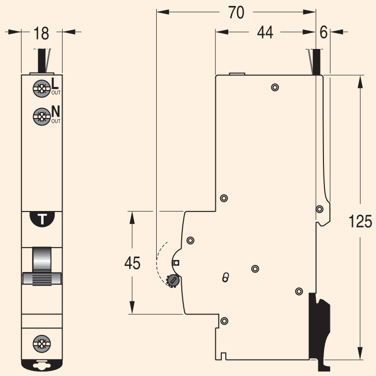
4P 32A



RCBO's - Series DM

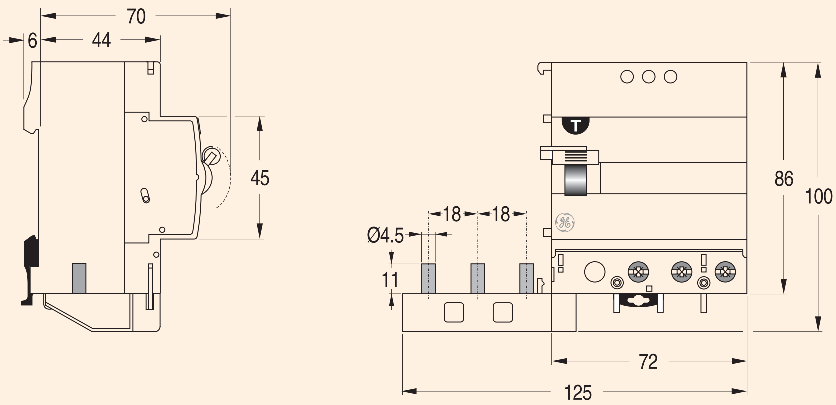


RCBO's - Series DME

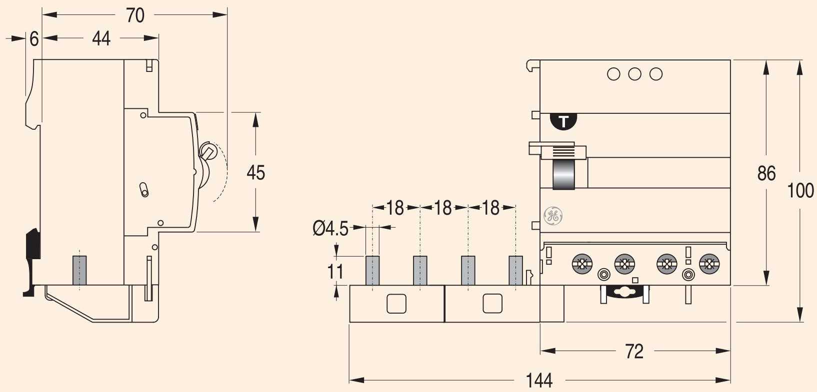


Add-on RCCB - Series Diff-o-Click

3P 63A



4P 63A



Add-on auxiliary devices
Technical Data

Circuit Protection T1

People Protection T2

Add-on Devices T3

Comfort Functions T4

Extensions

All MCB's (except G20) , RCCB's (except Delta B) & RCBO's are designed to accept the same family of extensions.

The extensions intended to be coupled to a main device are the following:
- Display contacts
- Shunt trip
- Undervoltage release
- Emergency release
- Motor operator
- Panel board switch

Display contacts

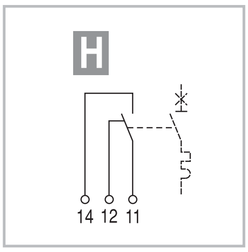
The display contact lets you know the real contact position of the associated main device. It is also possible to know whether the associated device has been automatically released or it has been manually operated. The display contacts CA and CB fulfil the requirements of the EN/IEC 62019 & EN 60947-5-1 standards.

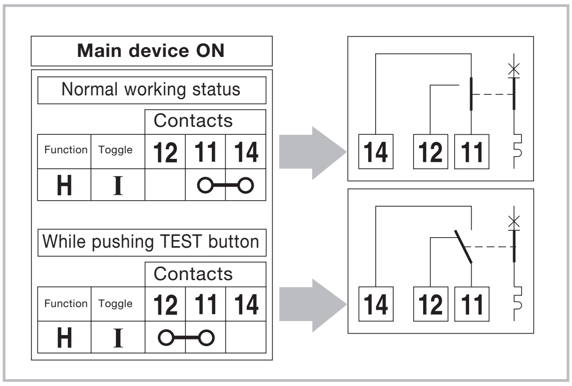
Display contacts				CA / CB	CA G
Contacts				Silver	Gold
Maximum current	AC 14	240 V	A	5	5
	DC 12	60 V	A	1	1
		48 V ⎓	A	2	2
		24 V ⎓	A	4	4
Minimum application voltage	AC		V	24	12
	DC		V	24	12
Minimum application current	AC		mA	10	2
	DC		mA	200	25
Short-circuit resistance					
Protected by fuses 6A gG			A	1.000	1.000
Protected by MCB C6 or B6			A	1.000	1.000
Electrical endurance (operations)				10.000	10.000
Terminal capacity	rigid cable		mm^2	1 - 2.5	1 - 2.5
	flexible		mm^2	0.75 - 2.5	0.75 - 2.5
Terminal capacity for 2 rigid cables			mm^2	2 x 1.5	2 x 1.5
Torque			Nm	0.5	0.5

Display contact CA

Function H

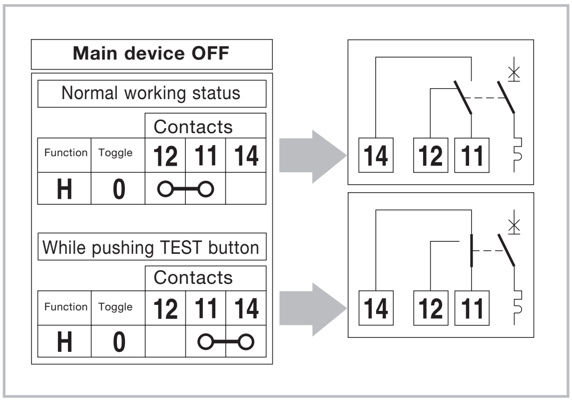
The function H (changeover contact) is intended to provide signalisation of the real status of the associated main device (ON/OFF).
While both devices are in the ON position there is





continuity between terminals 11-14, then when pressing the display contact test button the continuity changes over to terminals 11-12. When released, the contacts change over to the previous position 11-14.

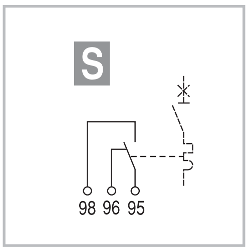
While both devices are in the OFF position there is

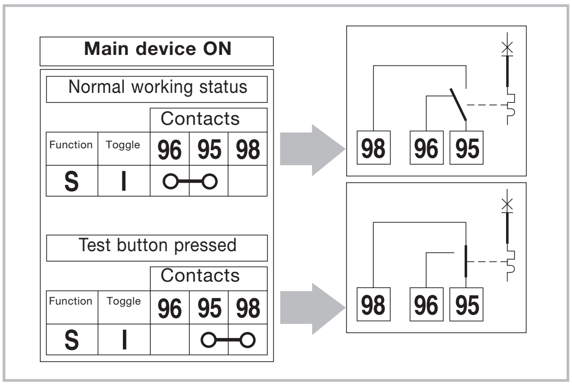


continuity between terminals 11-12, then when you press the display contact test button, the continuity changes over to terminals 11-14. When released, the contacts are change over to the previous position 11-12.

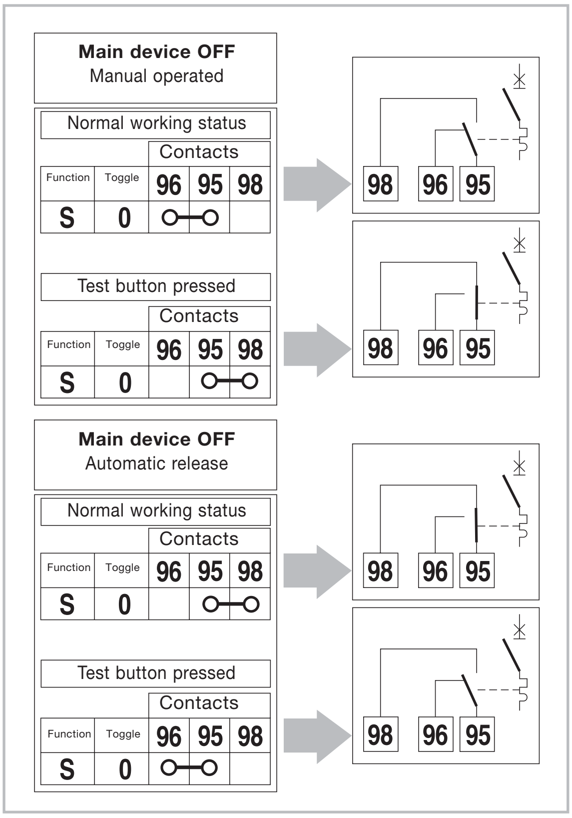
Function S

The function S (changeover contact) is intended to provide signalisation of the real status of the associated main device in case it releases automatically only.
The contacts do not change position during manual operation.





While both devices are in the ON position there is continuity between terminals 95-96, then when you press the display contact test button the continuity changes over to terminals 95-98. When released, the contacts change over to the previous position 95-96.

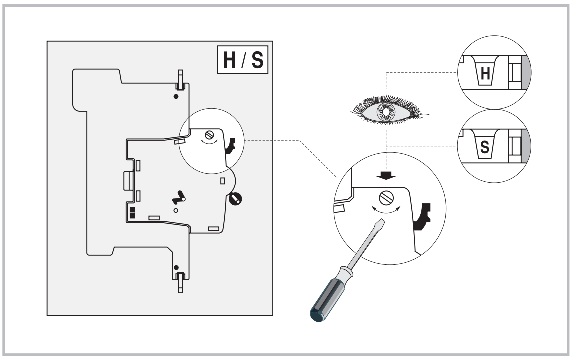


In the case of both devices being in the OFF position, it is needed to identify whether they have been manual operated or it was an authomatic release.

Manual operation
The contact positon of the display contact has not changed. There is continuity between terminal 95-96. When pressing the display contact test button, the continuity is changing over to terminals 95-98. When stop pressing, the contacts change over to the previous position 95-96.

Automatic release
The contact position of the display contact has changed. There is continuity between terminals 95-98. When pressing the display contact reset button, the continuity is changing over to terminals 95-96, and it remains in that position even when released.

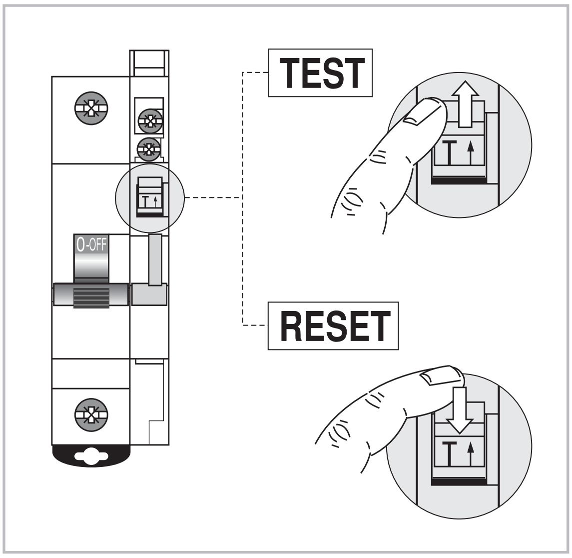
How to change the function S or H
Can be easily done before coupling it to the main device by using of a screwdriver to rotate the knob placed at the left-hand side of the auxiliary. An indication of the function appears at the window located in the upper shoulder.



① For the H function the terminals will be 11-12-14
② For the S function the terminals will be 95-96-98

Test & reset function
Test function
Allows testing of the control circuit (unstable changing of contact position) by moving the front button up or down, without effecting the electrical situation (ON/OFF) of the main device.

Reset function
By electrically switching off of the main device (due to overload, short-circuit or earth fault current), the changeover contact switches: a red line appears in the front button (visible indication of electrical fault in the installation). The changeover contact can be reset by pushing the test button down without changing the electrical situation (ON/OFF) of the main device.

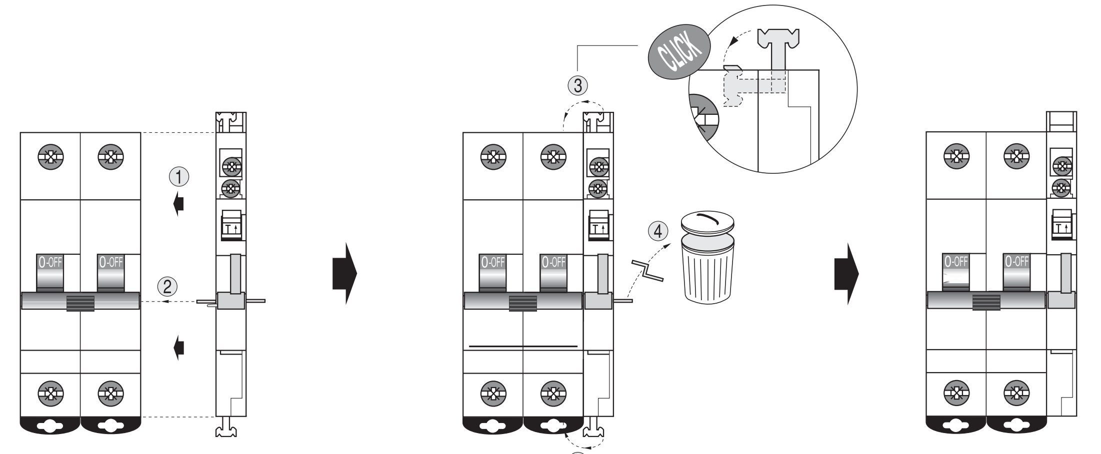


Gold plated contacts
Gold plated contacts are intended to be used in circuits with either low voltage (<24V) or low current (<200mA).

How to couple to the main device

The display contact (CA H and CA S/H) can easily be coupled either to the right or the left-hand side of the main device.

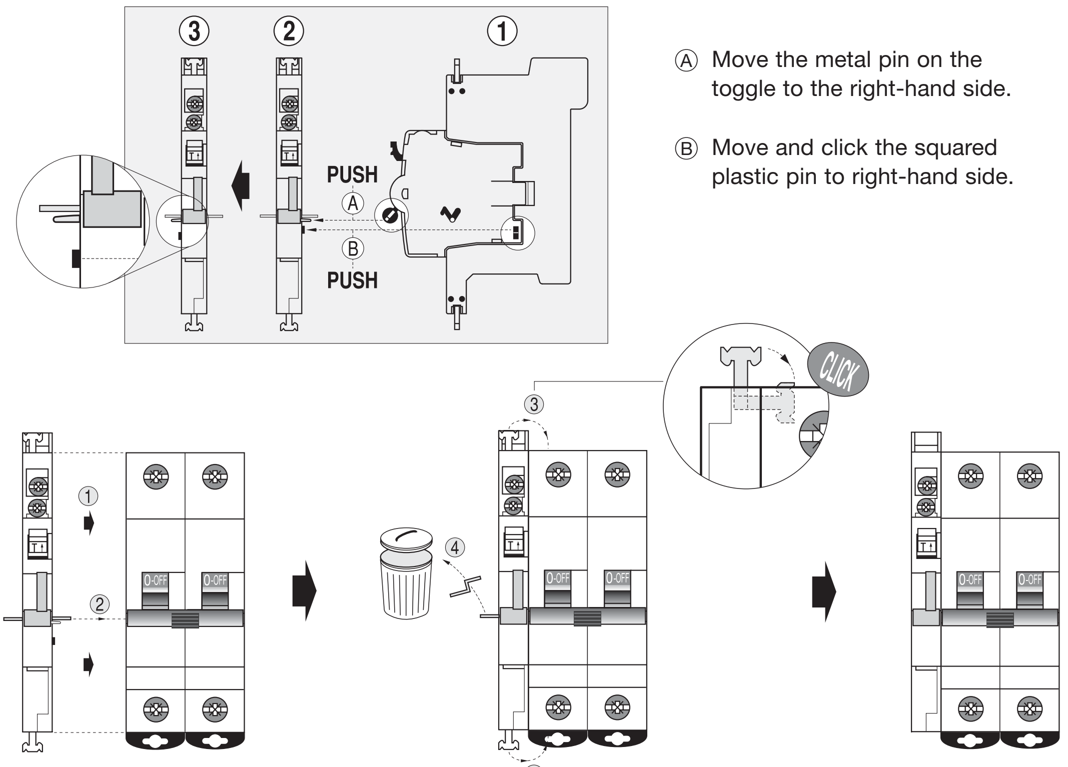
The display contacts are delivered as standard to be coupled on the **right-hand side** of the main device.



Attach the display contact to the main device, with both toggles in OFF position.

③ Click the two coupling parts into position.

The coupling on the **left-hand side** of any device can be easily done according the following instructions.



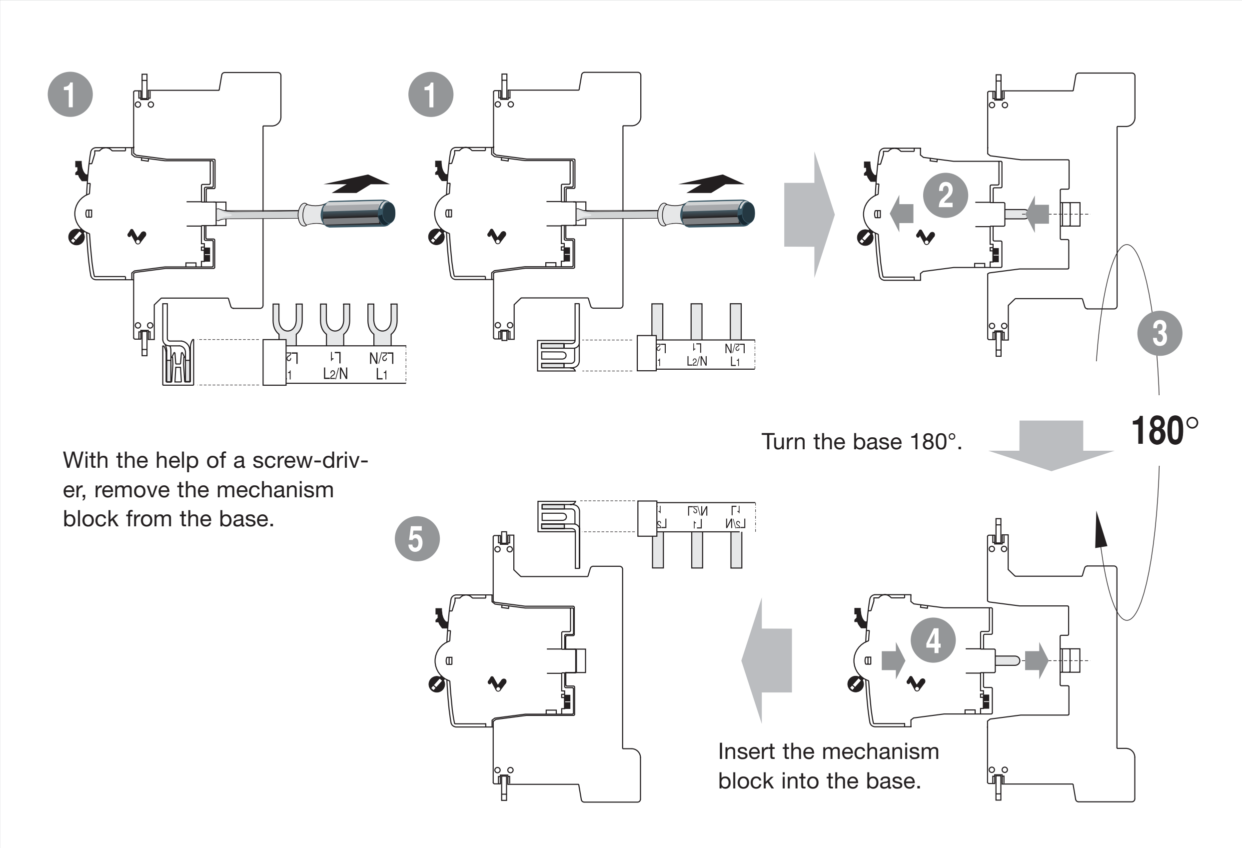
Ⓐ Move the metal pin on the toggle to the right-hand side.

Ⓑ Move and click the squared plastic pin to right-hand side.

Attach the display contact to the main device, with both toggles in OFF position.

③ Click the two coupling parts into position.

The display contact CA allows the passthrough of the PIN or FORK type busbars when they are installed at either the top or bottom terminal of the main device.
The CA display is delivered to allow the busbar passthrough at the bottom terminal. If you need busbar passthrough at the top terminals this can be achieved easily thanks to the innovative system base + contact block which allows the installer of the base position (busbar passthrough at top or bottom terminal).



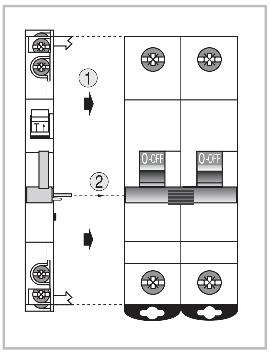
Display contact CB

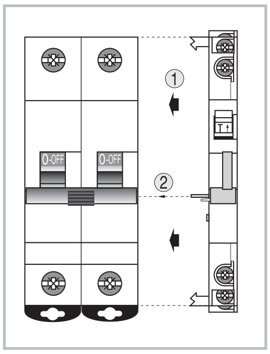
This device has a double function with one auxiliary contact H (bottom terminals) plus a changeable signal/auxiliary contact S/H (top terminals).

The functions H and S/H work identically to the functions of the CA displays.
The CB display contact does not permit the busbar to passthrough. There are two versions: one to be assembled to the right hand side of the main device and another one to be added on the left hand side. Does not permit the stack-on configuration.

How to couple to the main device

The display contact CB can be easly coupled on the right-hand side (CB SH/HH-R) or on the left-hand side (CB SH/HH-L) by placing the auxiliary contact and the main device one to another with both toggles in the OFF position.

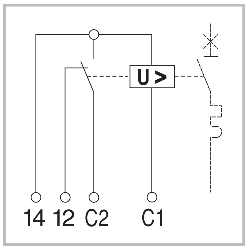




Shunt trip Tele L

The Tele L allows you to switch off any MCB, RCCB, or RCBO by means of push-buttons or any other automatic management processors. A built-in contact in series with the coil prevents burning damage if the voltage remains. A built-in contact provides signalisation of the device status (open/close).

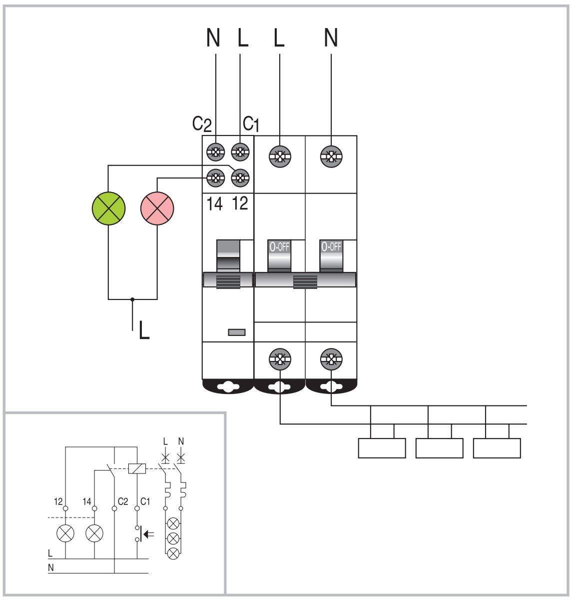
			Tele L 1	Tele L 2
Nominal voltage AC		V	110 to 415	24 to 60
Nominal voltage DC		V	110 to 125	24 to 48
Minimum voltage AC / DC		V	0.85 Un	0.85 Un
Closing current	110 V	A	0.3	-
	240 V	A	0.6	-
	415 V	A	1	-
	48 V	A	-	2
	24 V	A	-	1
Operating time	110 V	ms	10	-
	240 V	ms	4	-
	415 V	ms	2	-
	48 V	ms	-	10
	24 V	ms	-	4
Coil impedance		Ω	290	24
Electrical endurance	(operations)		2.000	2.000
Terminal capacity	rigid cable	mm^2	1 - 2.5	1 - 2.5
	flexible cable	mm^2	0.75 - 2.5	0.75 - 2.5
Terminal capacity for 2 rigid cables		mm^2	2 x 1.5	2 x 1.5
Torque		Nm	0.5	0.5



How to couple to the main device

The shunt trip can easily be coupled either to the right or the left-hand side of the main device (see fig. 1 and 2). The shunt trip (Tele L) can be coupled on the right-hand side of the main device (see fig. 1).

Application examples



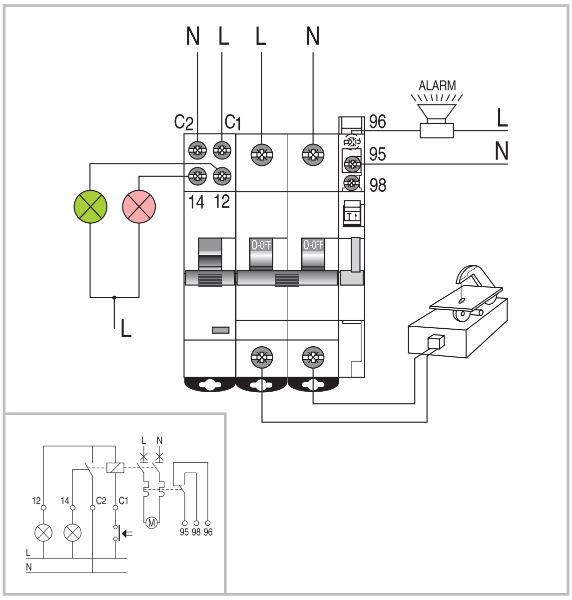
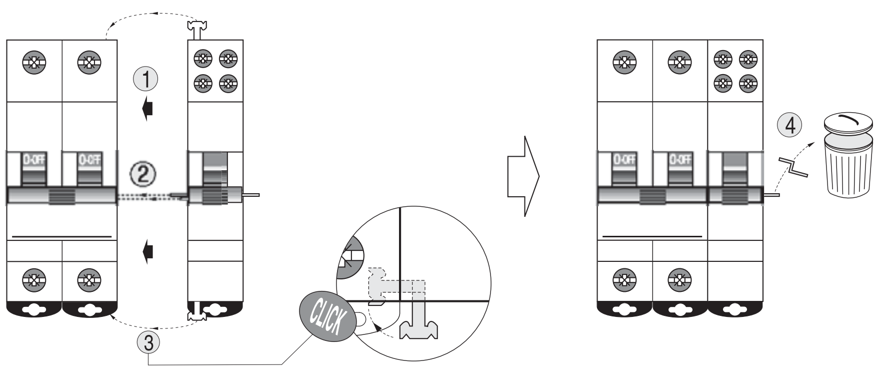


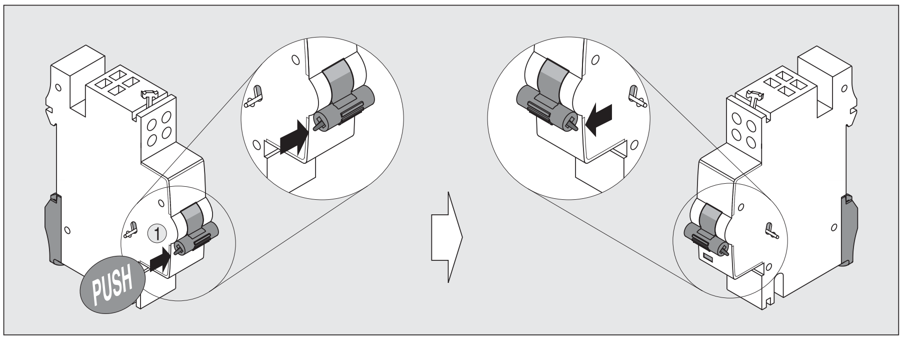
fig.1 To couple on the right-hand side



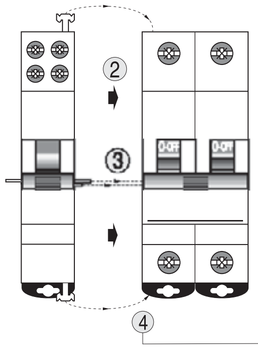
Place the shunt trip next to the main device with both toggles in OFF position.

Lock the coupling clips at the top, bottom and rear into position.

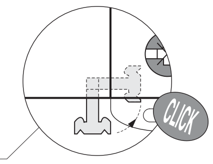
fig.2 To couple on the left-hand side: can be easily done according to the following instructions.

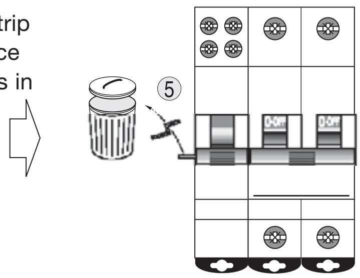


① With the help of a screwdriver, push the toggle pin to the right-hand side.



② Place the shunt trip to the main device
③ with both toggles in OFF position.

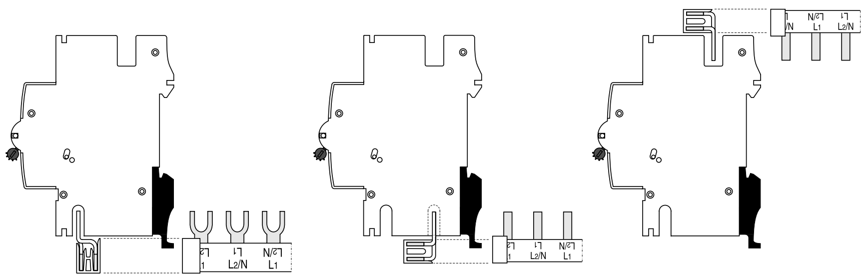




④ Lock the coupling parts in top and bottom as well as the coupling part in the back side into position.

⑤ Remove the metal pin on the left-hand side.

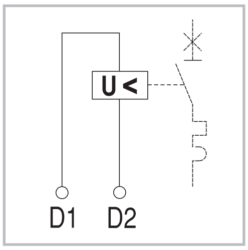
Busbar connection: the shunt trip Tele L allows the use of the PIN or FORK type busbars at the bottom terminals as well as the use of the PIN type busbars at the top terminals.



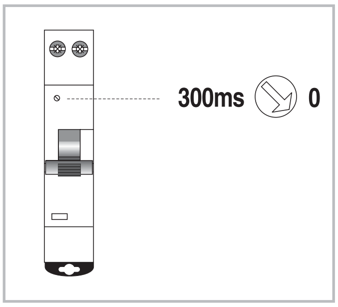
Undervoltage release Tele U

The Tele U releases the main MCB, RCCB, RCBO or modular switch in case the power supply drops below 0.5xUn. Time delay adjusting up to 300 ms. The Tele U can be switched on, once the voltage rises over 0,8xUn.

		Tele U 12	Tele U 24	Tele U 48	Tele U 230
Nominal voltage AC / DC	V	12	24	48	230
Tripping voltage	V	0.5 Un (±10%)	0.5 Un (±10%)	0.5 Un (±10%)	0.5 Un (±10%)
Tripping time	ms	0 - 300	0 - 300	0 - 300	0 - 300
Power consumption	VA	3	3	3	3
Frequency Hz	Hz	50 - 60	50 - 60	50 - 60	50 - 60
Electrical endurance (operations)		2.000	2.000	2.000	2.000
Terminal capacity rigid cable	mm^2	1 - 2.5	1 - 2.5	1 - 2.5	1 - 2.5
flexible cable	mm^2	0.75 - 2.5	0.75 - 2.5	0.75 - 2.5	0.75 - 2.5
Terminal capacity for 2 rigid cables	mm^2	2 x 1.5	2 x 1.5	2 x 1.5	2 x 1.5
Torque	Nm	0.5	0.5	0.5	0.5

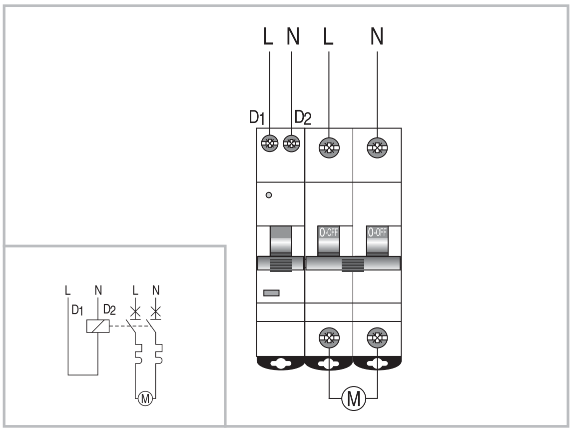


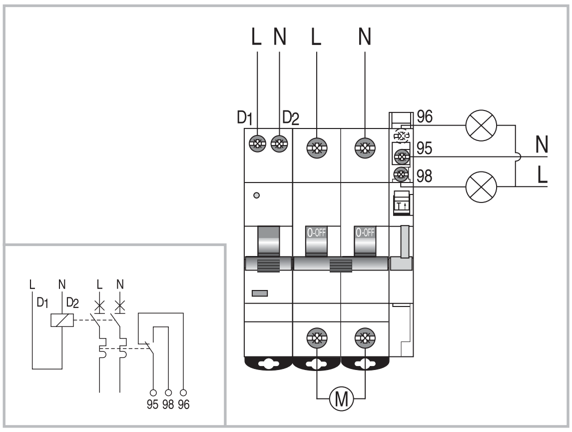
Time delay selector



In order to avoid unwanted tripping due to microcut in the power supply, it is possible to delay the tripping time of the Tele U from 0 up to 300ms.

Application examples

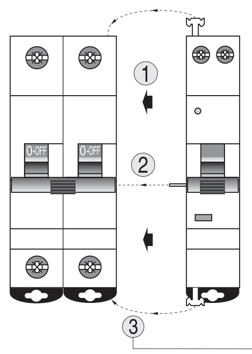




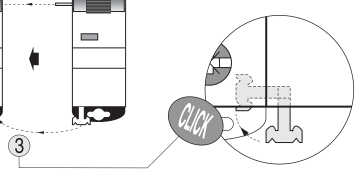
How to couple to the main device

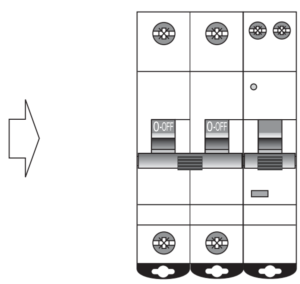
The undervoltage release can easily be coupled either on the right or the left-hand side of the main device. (see fig. 1 and fig. 2).
The undervoltage release is designed to be coupled on the right-hand side of the main device (see fig. 1).

fig.1 To couple on the right-hand side



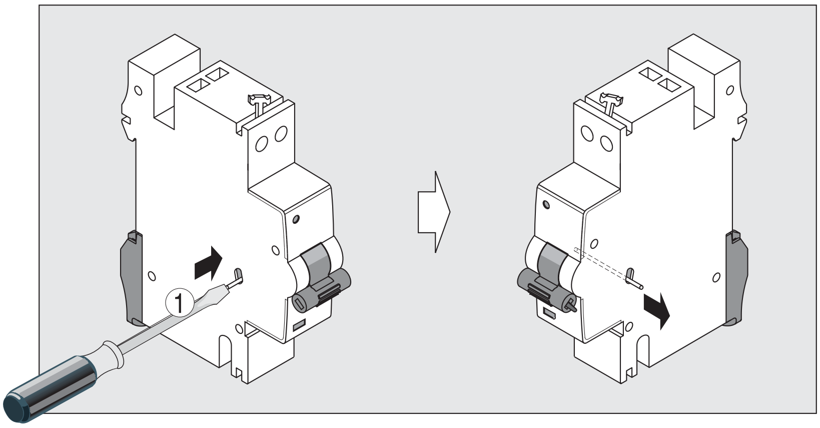
Click the coupling parts in top and bottom as well as the coupling part in the back side into position.



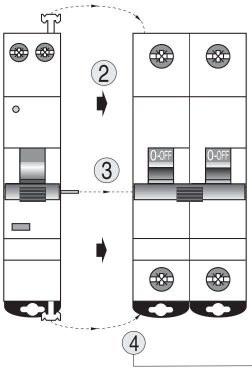


Place the undervoltage release to the main device, with both toggles in OFF position.

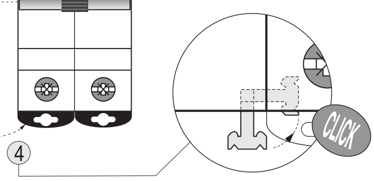
fig.2 To couple on the left-hand side: can be easily done according to the following instructions.

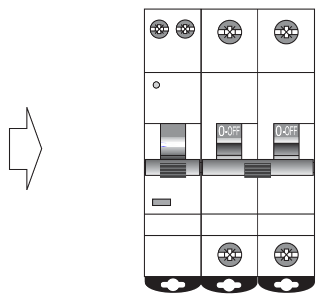


With the help of a screwdriver, push both tripping pin and toggle pin to the right-hand side.



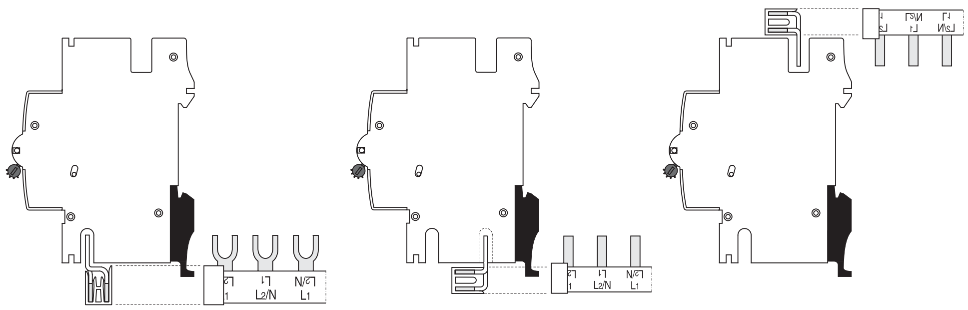
Place the undervoltage release to the main device, with both toggles in the OFF position.



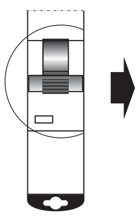


Click the coupling parts in top and bottom as well as the coupling part in the back side into position.

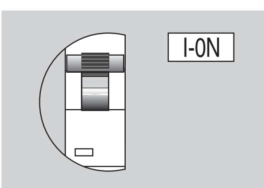
Busbar passthrough: the undervoltage release allows the passthrough of the PIN or FORK type busbars at the bottom terminals as well as the passthrough of the PIN type busbars at the top terminals.



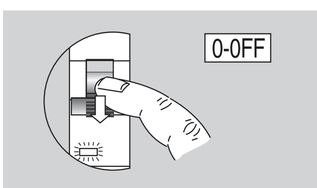
Tripping indicator: provides local information of the device status.



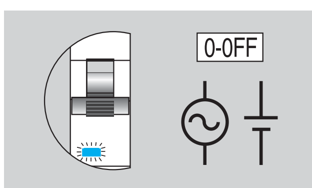
White indicator
Toggle in ON position:
the undervoltage release is working normally



Toggle in OFF position:
the undervoltage release has been manually operated



Blue indicator
The undervoltage release has been electrically activated



U < 0.5 Un ±10%

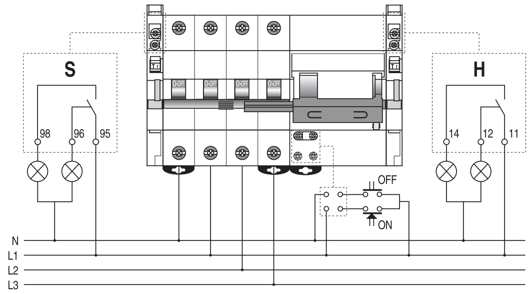
Motor operator Tele MP

The Tele M allows to open or close remotely any MCB, RCCB, RCBO or modular switch by means of push-buttons or any other automatic management processor (RCCO, PLC.)

The motor operator has a safety reset function which blocks the I-ON function, in case the main device trips due to a fault in the installation (earth leakage, overcurrent, short-circuit).
To switch on the main device after tripping it is needed first to give the motor operator an impulse in O-OFF, then the motor can be operated normally to switch ON.

Motor driver			
Nominal voltage AC		V	230 ±10%
Frequency		Hz	50
Power consumption		VA	35
Closing time		ms	< 500
Opening time		ms	< 200
Impulse time to open		ms	> 50
Impulse time to close		ms	> 50
Number of operations			120
Working temperature		°C	-25 up to +55
Electrical endurance	operations		20.000
Terminal capacity	rigid cable	mm^2	1 - 2.5
	flexible cable	mm^2	0.75 - 2.5
Terminal capacity for 2 rigid cables		mm^2	2 x 1.5
Torque		Nm	0.5

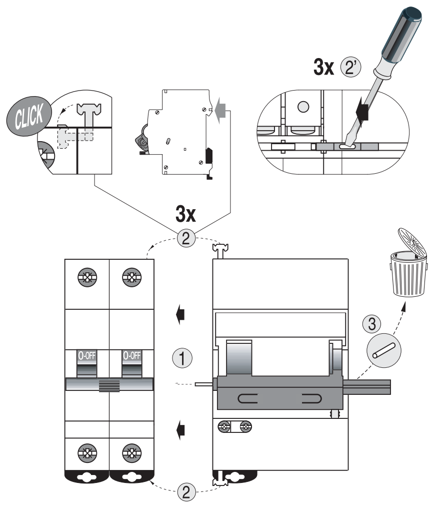
Application example

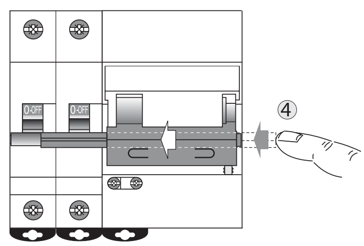


How to couple to the main device

The motor operator Tele MP can easily be coupled either to the right or the left-hand side of the main device. (see fig.1 and fig.2)

fig.1 To couple on the right-hand side





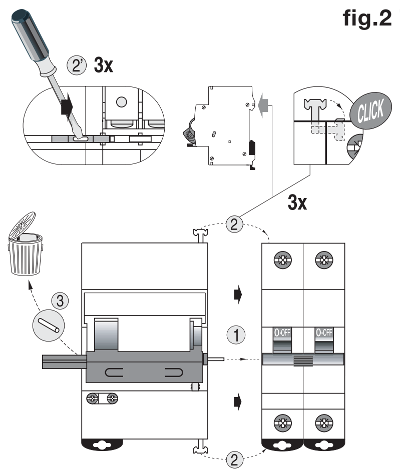
Place the motor operator next to the main device with both toggles in OFF position.

Lock the plastic and metal coupling clips at the top, bottom and rear into position.

Remove the metal pin on the right hand side of the motor.

Push the motor operator toggle over the main device toggle (maximum 1.5 modules).

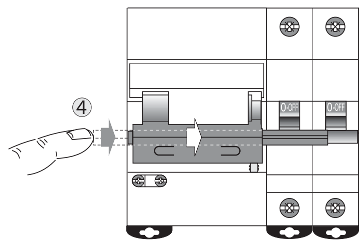
fig.2 To couple on the left-hand side



Place the motor operator next to the main device with both toggles in OFF position.

Lock the plastic and metal coupling clips at the top, bottom and rear into position.

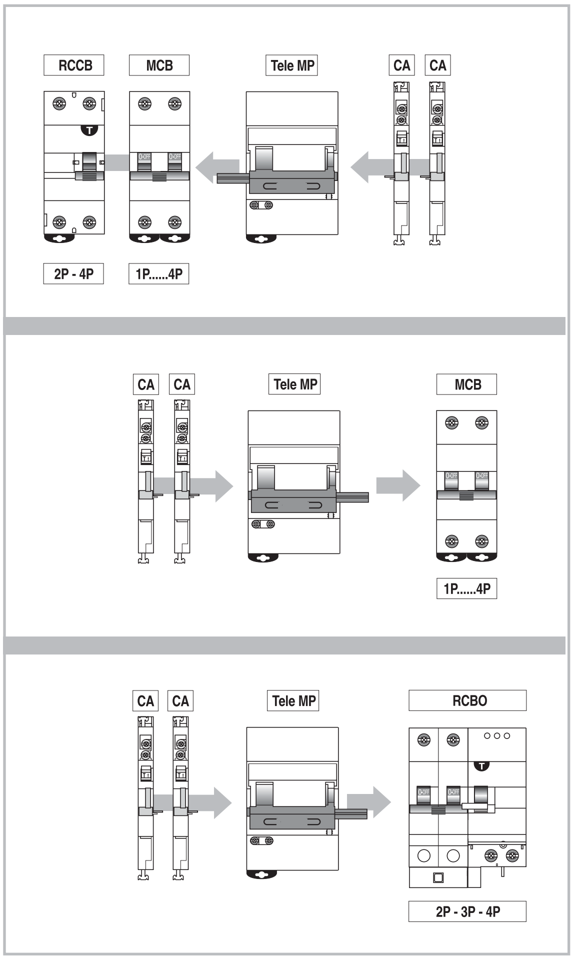
Remove the metal pin on the left-hand side of the motor.



Push the motor operator toggle over the main device toggle (maximum 1.5 modules).

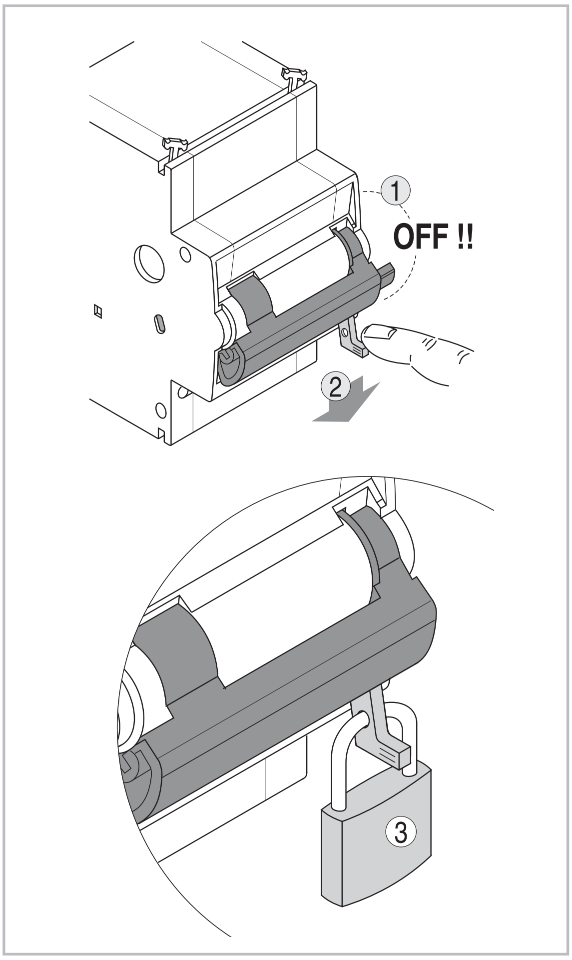
Extensions

Extensions can be added either on the left or the right-hand side of the motor operator according to the following configuaration.



Padlocking

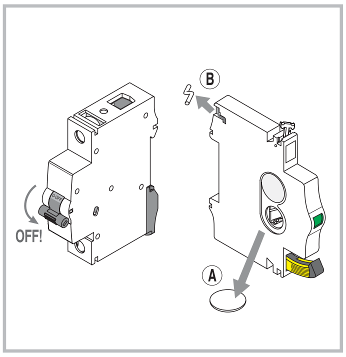
The motor operator can be blocked electrically in the OFF position by means of a safety-sealing handle, which can be locked with one padlock.



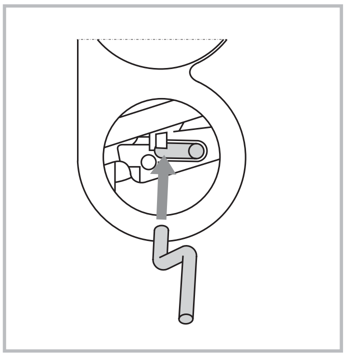
Panel board switch PBS

The panel board switch coupled to a main device is intended to switch off any MCB, RCCB or RCBO in case the front cover of the enclosure is removed. It is a mechanical safety device, which reduces the risk of electric shock in case of manipulation of the panel board.

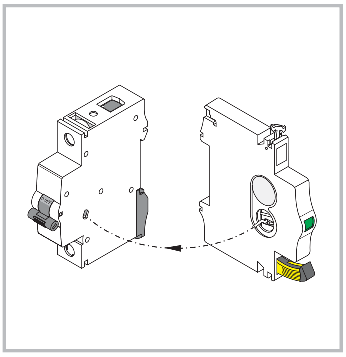
The panel board switch can easily be coupled either to the right or the left-hand side of the main device, according to the following instructions.



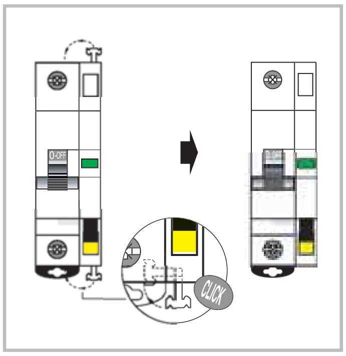
1. Ⓐ Remove the protective cover to gain access to the mechanism.
   Ⓑ Remove the pin from the lodging.



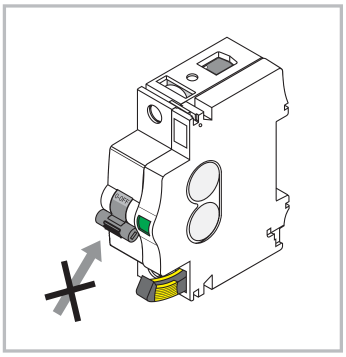
2. Place the pin into position.



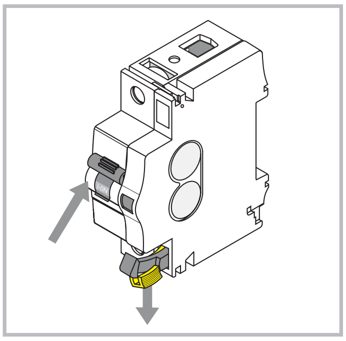
3. Place the panel board switch to the main device with the toggle in OFF position.



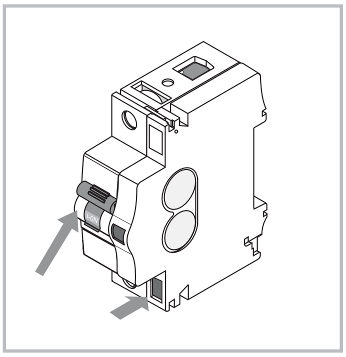
4. Click the two coupling parts into position.



5. The toggle of the main device can not be switched ON, if the button of the panel board switch is not pressed by the enclosure front cover.



6. The main device can be switched ON without the need of placing the enclosure front cover into position, by pulling down the yellow part of the button.



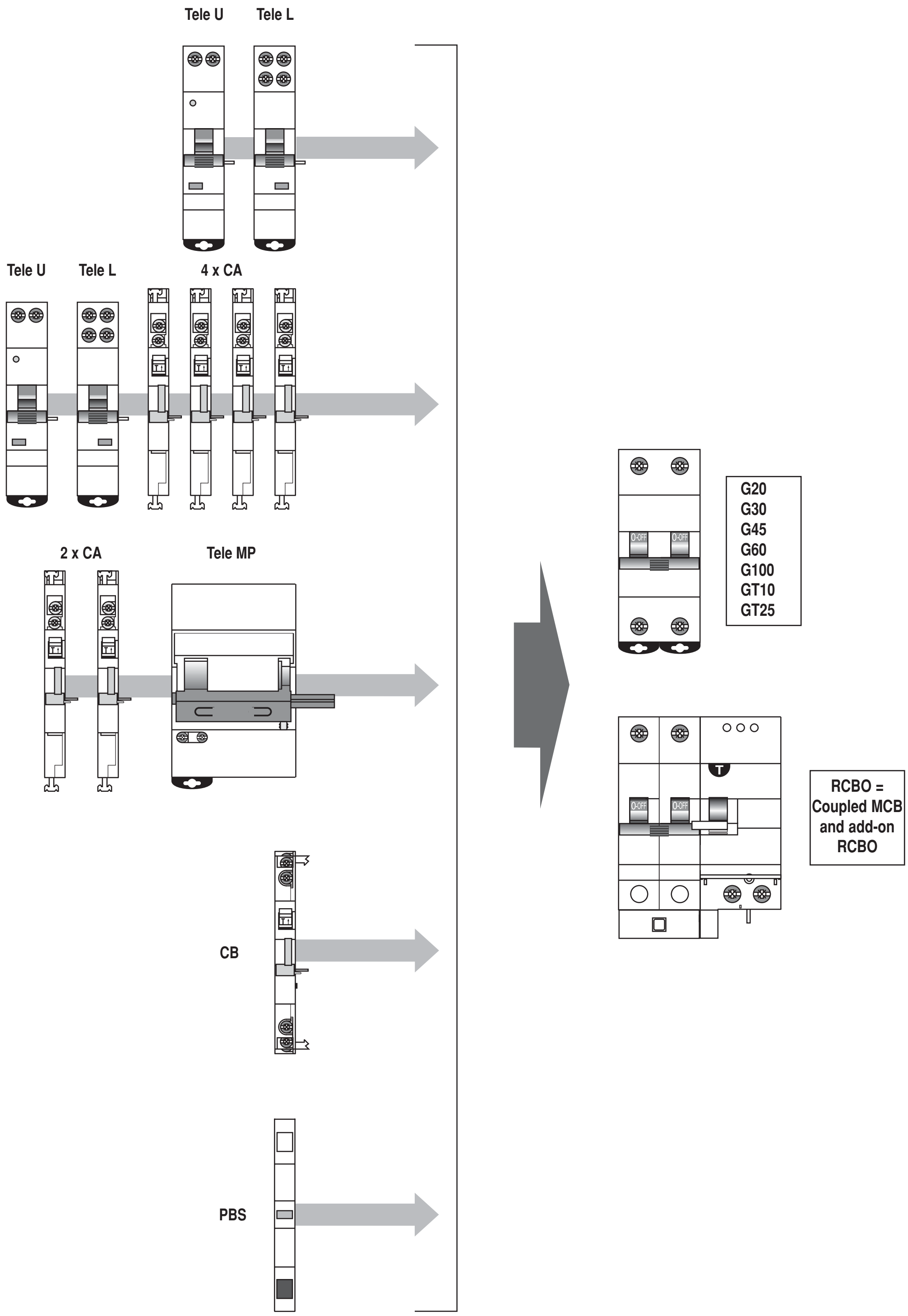
7. The main device can be switched ON normally when the enclosure front cover is placed into the closed position.

Stack-on configuration

To all MCB's, RCCB's and RCBO's it is possible to add extensions alongside taking into consideration the following configuration.

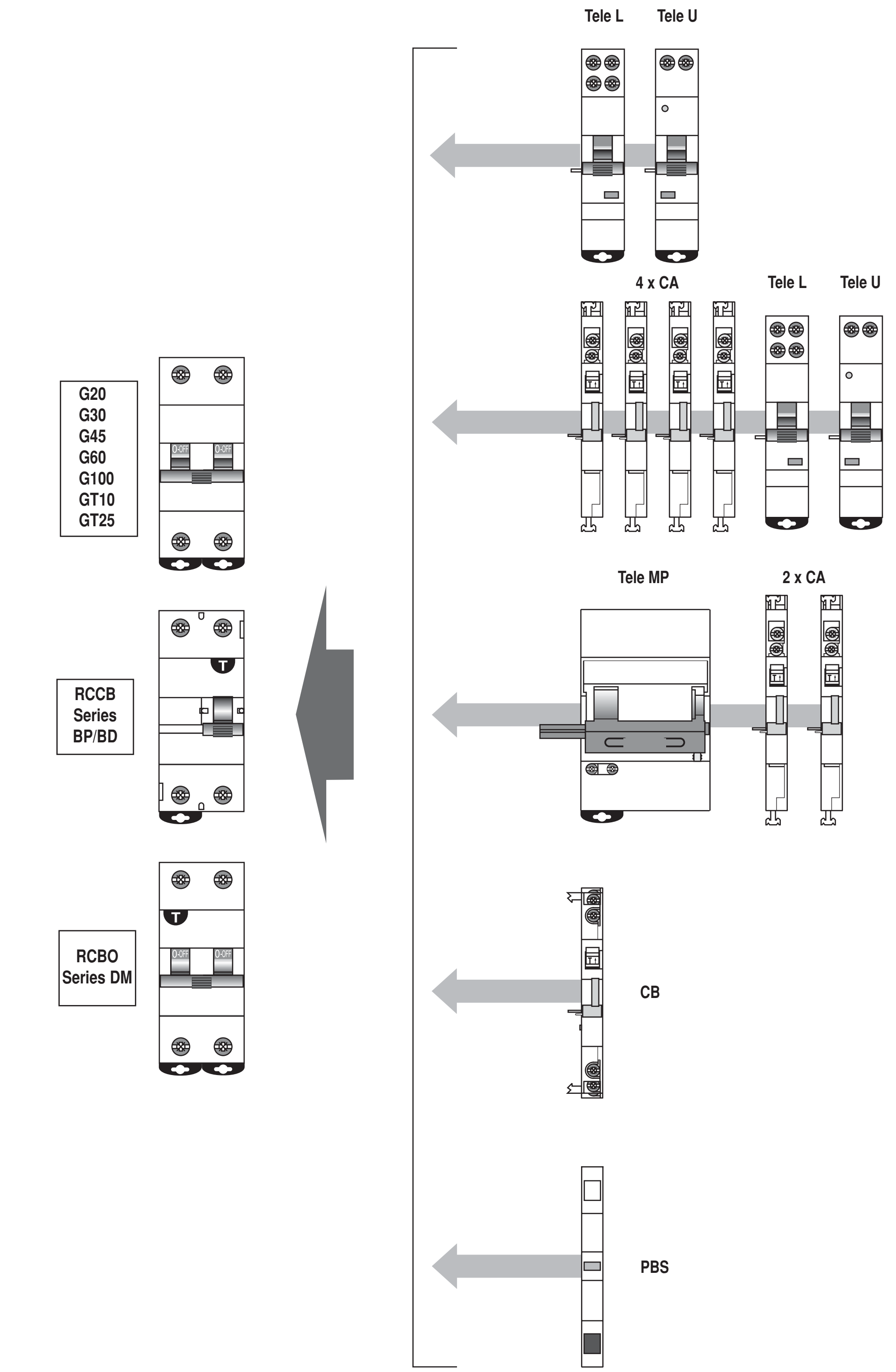
CA	Display contact H or S/H
CB	Display contact H + S/H
Tele L	Shunt trip
Tele U	Undervoltage release
Tele MP	Motor operator
PBS	Panel board switch

Assembly on the left-hand side



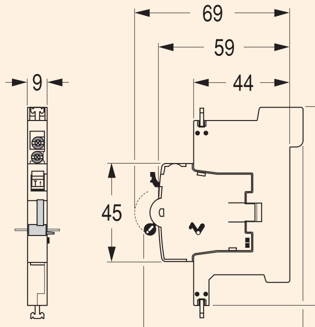
CA	Display contact H or S/H
CB	Display contact H + S/H
Tele L	Shunt trip
Tele U	Undervoltage release
Tele MP	Motor operator
PBS	Panel board switch

Assembly on the right-hand side

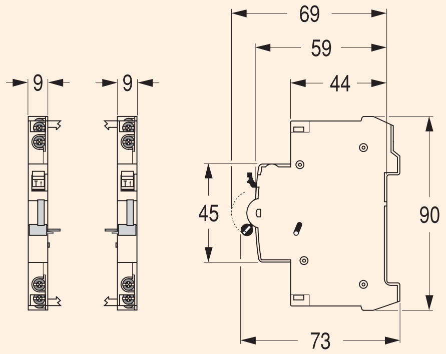


Dimensional drawings

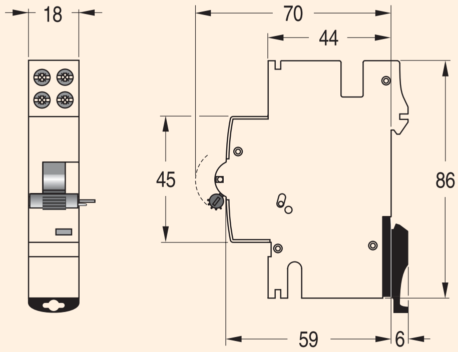
Auxiliary - Series CA



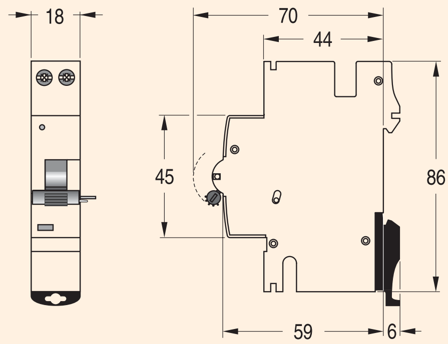
Auxiliary - Series CB



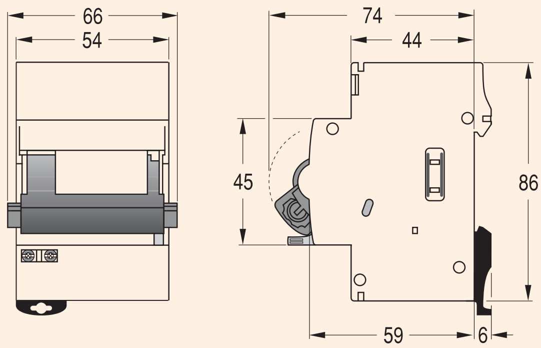
Shunt Trip Tele L



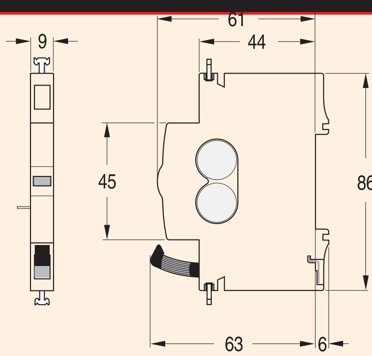
Undervoltage Release Tele U



Motor Driver Tele MP



PBS - Panel board switch



Comfort functions
Technical Data

Aster

Switches and push-buttons

Introduction

The Aster family of devices covers 3 sub-families:
- Switches and push-buttons 16 and 32A
- Rotary switches 32, 40 and 63A
- Mains disconnect switches in 40, 63, 80 and 100A.

Function

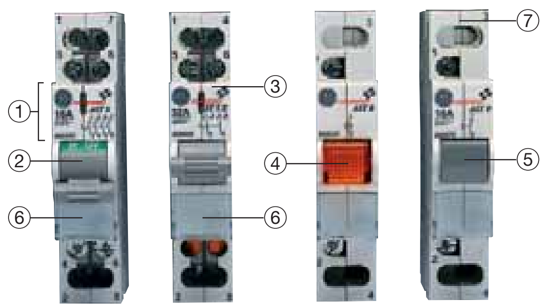
The 16 and 32A switches and push-buttons are mainly used to operate lighting and heating equipment in the commercial sector. For example in warehouses, shops, workshops, hospitals, etc.
Rotary switches are mainly used as main switch. Also in case of motor-loads, this switch can be used. In case absolute safe disconnection is required, the mains disconnect switch is to be used.

Switches and push-buttons

Features
Photo 1 shows the front view of the modular switches and push-buttons.
The main characteristics are printed in the upper part of the device ① These are:
- Switching capacity
- Operating voltage
- Wiring diagram
- 6-digit ordering code

Related to the switching capacity, a 16 and a 32A family exists.
All devices can be used up to 240V.
For the on-off switches, a green-on and red-off indication on the toggle itself is present to indicate the status of the switch ② .

photo 1



Alternatively, these devices are also available with an indication lamp ③ to indicate its status.
Push-buttons are available both with ④ and without ⑤ a lamp.
The function of the circuit that is operated by the switch or push-button can be indicated behind the circuit indicator ⑥ i.e. hall, living, garage, … .
The Pozidriv terminals ⑦ are clearly marked and are all captive.

Text for specifiers
- The modular switches and push-buttons all have the CEBEC approval mark
- The 1, 2, 3 and 4-pole 16 and 32A switches are available in only 1 module, while the 3 and 4-pole devices are also available in 2 modules
- All switches and push-buttons have a high interrupting capacity thanks to the double contact interruption per pole
- The captive Pozidriv terminals guarantee a solid, reliable connection for wires with a cross section going from 1.5 to 10mm^2
- The terminals have an IP20 protection degree,
- The devices are DIN-rail mountable
- The switches and push-buttons are equipped with a transparent circuit indicator
- The short-circuit resistance is at least 3kV
- The switches can be locked both in the on as well as in the off-position.
- Mains disconnect switches accept auxiliary contact add-on right or left hand side.

Rotary switches

Features
Photo 2 shows the front view of the rotary switches. The main characteristics are printed in the upper part of the device ①. These are:
- Rated current
- Operating voltage
- 6-digit ordering code

Related to the switching capacity, versions in 32A, 40A and 63A exist.
All devices can be used up to 415V.

photo 2

The Pozidriv terminals ② are clearly marked, are all captive and can be sealed by means of a terminal cover.
The disconnect function is visible at all times by means of the handle.
By using the shaft extension, the handle itself can be mounted on the door of an enclosure, while the switch itself can be mounted on the DIN-rail or panel (photo 3).

photo 3

Two handles are available: a standard (black, see fig.1) and an emergency handle (red, see fig.2).

Important:
In case the handle is mounted on the door, the panel can only be opened when the handle is in the OFF-position. The emergency handle can be sealed by means of up to 3 padlocks.

fig.1

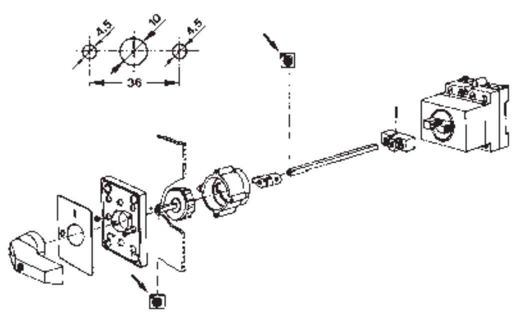
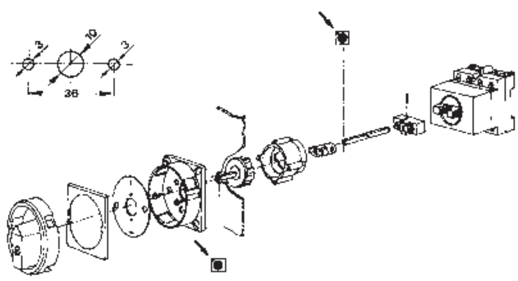


fig.2



Text for specifiers-The rotary switches all have the CEBEC and KEMA approval mark following IEC 947.3
- Due to its construction, the rotary switch can securely interrupt and as such is a disconnect switch. This, together with the high short-circuit resistance and the visible contact status, makes it possible to use this switch as a main switch,
- The housing is made of thermoplastic material with a high creepage-current resistance
- The movable contacts of the switch are operated as a paralel bridge with double interruption per pole. The short-circuit resistance is very high
- The rotary switches all have a width of 4 modules,
- Shaft extensions with standard and emergency-handles are available
- The rotary switches can be padlocked in the off-position
- The terminals can be sealed by means of a terminal cover

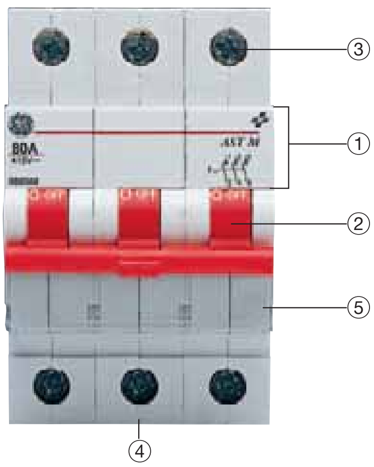
Mains disconnect switches

Features
Photo 4 shows the front view of the mains disconnect switches.
The main characteristics are printed in the upper part of the device ①. These are:
- Switching capacity
- Operating voltage
- Wiring diagram
- 6-digit ordering code

Related to the switching capacity, versions in 40, 63, 80 and 100A exist.
All devices can be used up to 440V.
The red handle ② draws the attention to the fact that this is a mains disconnect switch.

All types are equipped with 50mm^2 safety terminals ③ with captive Pozidriv screws. The terminal position is aligned with the terminal-position of the MCB's offering the benefit of interconnecting both devices with a pin or fork-type busbar.

photo 4



Easy DIN-rail extraction as implemented on the MCB's and RCD's is also applicable due to the same DIN-rail clip ④.
The function of the circuit that is operated by the switch can be indicated behind the circuit indicator ⑤ i.e. hall, living, garage, … .

Text for specifiers
- The mains disconnect switches all have the CEBEC approval mark
- 1 pole per module
- All switches have a high interrupting capacity thanks to the double contact interruption per pole
- The switches can be used as mains disconnect switches
- The captive Pozidriv terminals guarantee a solid, reliable connection for wires with a cross section going from 6 to 50mm^2
- The terminals have an IP20 protection degree
- DIN-rail mountable
- Equipped with a transparent circuit indicator
- The short-circuit resistance is better than 3kV
- The switches can be locked both in the on as well as the off-position
- The switches are suitable to be used in class AC22
- Auxiliary contact add-on possibilities on both sides

Contax

Contactors

Function

Contactors are electromechanically controlled switches, mainly used to control high power single- or multi-phase loads while the control itself can be (very) low power.
Typical applications are given in figure 1 to 3.

fig.1 Start-stop of a mono-phase lamp-load

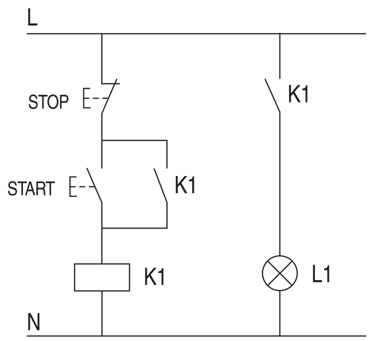


fig.2 Direct startup of cage motor

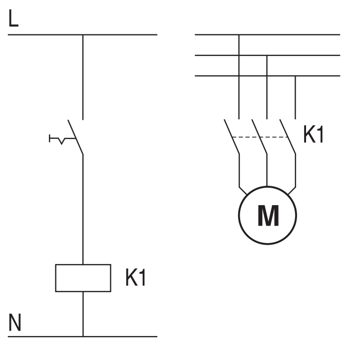
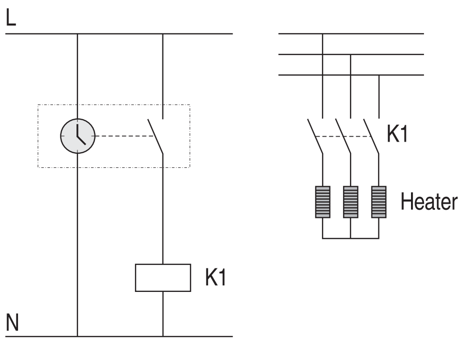


fig.3 Time-clock controlled on-off switching of a 3 phase electrical heater



Operation

As long as the control circuit (coil) is energised, the NO-contacts are closed and the NC-contacts are opened. From the moment the control circuit is de-energised again, the contacts return to their rest position. NO-contacts are opened and NC-contacts are closed.

Features and benefits

In photo 1, the front views of the 1, 2 and 3 module contactors are shown. The main characteristics of the device are printed in the upper part ①. These are:
- Switching capacity
- Coil voltage
- Wiring diagram
- 6-digit ordering code

photo 1

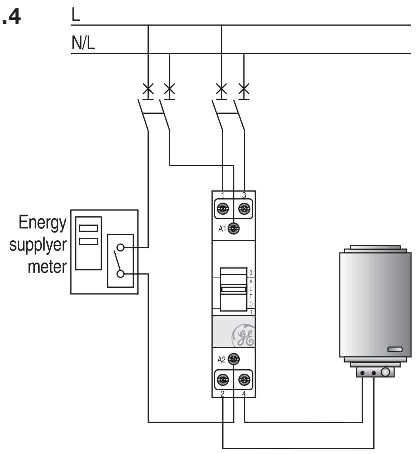
Related to switching capacity, a complete range is available: 20, 24, 40 and 63A. The 20A contactors have an AC-coil and as a consequence can only be used on AC. The 24, 40 and 63A-contactors all have a DC-coil which makes them absolutely noise-free (NO 50Hz-noise). A built-in rectifier bridge allows the use of AC as well as on DC at all times. The coils of all contactors are protected against over-voltages of up to 5kV by means of a built-in varistor. Infrequently used coil voltages are also available. The flag ③ indicates whether or not the coil is energised. The function of the contactor or the circuit that is operated by the contactor can be indicated behind the circuit indicator ④ i.e. hall, living, garage,… . The clearly marked Pozidriv terminals ⑤ are all captive.
Two NO or 1NO-1NC auxiliary contacts, used for remote indication of the contact position of the contactor, are available for the 24, 40 and 63A contactors (module types CTX 10 11 or CTX 10 20 respectively). The auxiliary contacts can only be mounted on the left side of the device (photo 2).

photo 2

Day-Night contactors

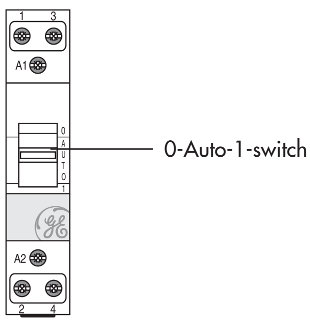
This contactor was designed to be used in dual tariff (Day-Night) applications. The number one application for this contactor is the control of an electrical water heater (fig.4).

fig.4



In general, a day-night contactor is controlled by an output contact of a dual-tariff meter. On and off impulses, sent by the energy-supplier over the powerline-network, are decoded in the meter and switch the output contact to the on or off state, switching in its turn the day-night contactor on or off.

fig.5



0-Auto-1-switch
The additional 0-Auto-1-switch allows the user to overrule the normal operation of the contactor (fig.5). For normal operation, this switch is in the Auto-position and the day-night contactor is operated by the output contact of the dual-tariff energy meter. In the example of the electrical water heater, the water will only be warmed up during off-peak hours (i.e. at night with minimum price per kWh)

O-position
Putting the lever in the O-position completely isolates the circuits controlled by the contactor, no matter what the position of the output contact on the dual-tariff meter, for example when the service is not required over a longer period.

1-position
With the lever in this position, the contactor is forced to its ”on” position. In the example of the electrical water heater, one would put the switch in this position after coming back from holidays to force the heating on if the switch was in the ”O” position during the holiday. Should, by coincidence, the user forget to switch the level to the auto-position again after the forced operation, the device will return automaticaly to the automatic operation as soon as the coil is energised (by the contact of the energy-supplier meter).

Switching capacity

Depending on the type of load, the switching capacity of a contactor can change drastically. Indeed, the interrupting capacity of any switch, not only a contactor, is quite different for DC than for AC or for pure ohmic loads than for inductive or capacitive loads. Tables 1 and 2 indicate the maximum current/power that the different contactor-families can switch reletive to the type of load. Typically for lighting applications, table 3 indicates in detail the number of lamps or transformers each family of contactors is capable of switching, reletive to the power per unit. As always, these figures are per phase and at 230V-50Hz.

Switching of heaters and motors (table 1)

	CTX 20	CTX 24	CTX 40	CTX 63
AC-1/AC-7a Switching of heaters				
Rated operational current Ie	20A	24A	40A	63A
	Two current paths connected parallel permit 1.6 x Ie (AC-1)			
Rated operational power				
230 V 1 ~	4.0 kW	5.3 kW	8.7 kW	13.3 kW
230 V 3 ~	-	9.0 kW	16.0 kW	24.0 kW
400 V 3 ~	-	16.0 kW	26.0 kW	40.0 kW
AC-3/AC-7b Switching of motors				
Rated operational current Ie	9A	9A	22A	30A
Rated operational power				
230 V 1 ~	1.3kW	1.3 kW	3.7 kW	5.0 kW
230 V 3 ~	-	2.2 kW	5.5 kW	8.0 kW
400 V 3 ~	-	4.0 kW	11.0 kW	15.0 kW

Switching of DC (table 2)

Type	Rated operational voltage Ue	DC-1 (L/R ≤ 1ms) 1 current path	DC-1 2 current paths series	DC-1 3 current paths series	DC-3 (L/R ≤ 2ms) 1 current path	DC-3 2 current paths series	DC-3 3 current paths series
CTX 24	24 VDC	24.0 A	24.0 A	24, 0 A	16.0 A	24.0 A	24.0 A
	48 VDC	21.0 A	24.0 A	24.0 A	8.0 A	18.0 A	24.0 A
	60 VDC	17.0 A	24.0 A	24.0 A	4.0 A	14.0 A	24.0 A
	110 VDC	7.0 A	16.0 A	24.0 A	1.6 A	6.5 A	16.0 A
	220 VDC	0.9 A	4.5 A	13.0 A	0.2 A	1.0 A	4.0 A
CTX 40	24 VDC	40.0 A	40.0 A	40.0 A	19.0 A	40.0 A	40.0 A
	48 VDC	23.0 A	40.0 A	40.0 A	10.0 A	20.0 A	40.0 A
	60 VDC	18.0 A	32.0 A	40.0 A	5.0 A	16.0 A	34.0 A
	110 VDC	8.0 A	17.0 A	30.0 A	1.8 A	7.0 A	18.0 A
	220 VDC	1.0 A	5.0 A	15.0 A	0.3 A	1.1 A	4.5 A
CTX 63	24 VDC	50.0 A	63.0 A	63.0 A	21.0 A	44.0 A	63.0 A
	48 VDC	25.0 A	43.0 A	63.0 A	11.0 A	22.0 A	47.0 A
	60 VDC	20.0 A	35.0 A	60.0 A	5.5 A	18.0 A	38.0 A
	110 VDC	9.0 A	19.0 A	33.0 A	2.0 A	8.0 A	21.0 A
	220 VDC	1.1 A	5.5 A	17.0 A	0.3 A	1.2 A	5.0 A

Switching for lamp load (table 3)

Lamp type	Lamp data		Permitted number of lamps per phase (230 V, 50 Hz) for contactor type				Capacitor
	Watt	In (A)	CTX 20	CTX 24	CTX 40	CTX 63	(µF)
Incandescent lamps	60	0.26	21	25	54	83	
	100	0.43	13	15	32	50	
	200	0.87	7	7	16	25	
	300	1.3	4	5	11	16	
	500	2.17	3	3	6	10	
	1000	4.35	1	1	3	5	
Fluorescent lamps	uncompensated and series compensation						
	15	0.35	25	30	100	155	
	20	0.37	22	26	85	140	
	40	0.43	17	20	65	105	
	42	0.54	13	16	52	85	
	65	0.67	10	12	40	60	
	115	1.5	4	5	18	28	
	140	1.5	4	5	18	28	
	two-lamp circuit						
	2x20	2x0.13	2x22	2x26	2x85	2x140	
	2x40	2x0.22	2x17	2x20	2x65	2x105	
	2x42	2x0.24	2x13	2x16	2x52	2x85	
	2x65	2x0.34	2x10	2x12	2x40	2x60	
	2x115	2x0.65	2x4	2x5	2x18	2x28	
	2x140	2x0.75	2x4	2x5	2x18	2x28	
	parallel compensation						
	15	0.11	6	8	15	67	4.5
	20	0.13	5	7	14	60	5
	40	0.22	6	8	15	67	4.5
	42	0.24	4	6	12	50	6
	65	0.65	4	5	10	43	7
	115	0.65	1	2	4	17	18
	140	0.75	1	2	4	17	18
High presure mercury vapor lamps eg. HQL, HPL	uncompensated						
	50	0.61	12	14	36	50	
	80	0.8	7	10	27	38	
	125	1.15	5	7	19	26	
	250	2.15	3	4	10	14	
	400	3.25	1	2	7	10	
	700	5.4	-	1	4	6	
	1000	7.5	-	1	3	4	
	2000/400V	8	-	1	3	4	
	parallel compensation						
	50	0.28	4	5	10	43	7
	80	0.41	3	4	8	37	8
	125	0.65	2	3	6	26	10
	250	1.22	1	2	3	15	18
	400	1.95	-	1	3	10	25
	700	3.45	-	-	1	5	45
	1000	4.8	-	-	1	4	60
	2000/400V	5.45	-	1	2	2	35
Lamps with electronic power supply units	Permitted number of electropower supply units per phase						
	1x18		15	24	55	76	
	2x18		8	18	34	48	
	1x36		12	16	34	47	
	2x36		7	11	20	29	
	1x58		11	14	32	46	
	2x58		6	8	17	24	

Table 3 (continued)

Lamp type	Lamp data: Watt	Lamp data: In (A)	Permitted number of lamps per phase (230 V, 50 Hz) for contactor type: CTX 20	CTX 24	CTX 40	CTX 63	Capacitor (µF)
Metal-halogen lamps eg. HQI, HPI	**uncompensated**						
	35	0.53	-	10	28	38	
	70	1	-	5	14	20	
	150	1.8	-	3	8	11	
	250	3	-	2	5	7	
	400	3.5	-	1	4	6	
	1000	9.5	-	-	1	2	
	2000	16.5	-	-	1	1	
	2000/400V	10.5	-	-	2	2	
	3500/400V	18	-	-	1	1	
	parallel compensation						
	35	0.25	-	5	11	30	6
	70	0.45	-	3	5	18	12
	150	0.75	-	1	3	9	20
	250	1.5	-	1	2	7	33
	400	2.5	-	1	2	6	35
	1000	5.8	-	-	-	2	95
	2000	11.5	-	-	-	1	148
	2000/400V	6.6	-	-	1	2	58
	3500/400V	11.6	-	-	-	1	100
Low pressure sodium vapor lamps	**uncompensated**						
	35	1.5	5	8	22	30	
	55	1.5	5	8	22	30	
	90	2.4	3	5	13	19	
	135	3.5	2	3	10	13	
	150	3.3	2	3	10	14	
	180	3.3	2	3	10	14	
	200	2.3	3	5	14	20	
	parallel compensated						
	35	0.31	-	1	4	15	20
	55	0.42	-	1	4	15	20
	90	0.63	-	1	3	10	30
	135	0.94	-	-	2	7	45
	150	1	-	-	2	8	40
	180	1.16	-	-	2	8	40
	200	1.32	-	1	3	12	25
High pressure sodium vapor lamps	**uncompensated**						
	150	1.8	-	4	15	20	
	250	3	-	3	9	15	
	330	3.7	-	2	8	10	
	400	4.7	-	1	6	8	
	1000	10.3	-	-	3	4	
	parallel compensated						
	150	0.83	-	1	3	15	20
	250	1.5	-	1	2	9	33
	330	2	-	-	2	7	40
	400	2.4	-	-	1	6	48
	1000	6.3	-	-	-	2	106

	Transformer data: Watt		Permitted number of transformers per phase (230 V, 50 Hz): CTX 20	CTX 24	CTX 40	CTX 63	
Transformers for halogen low voltage lamps	20		40	52	110	174	
	50		20	24	50	80	
	75		13	16	35	54	
	100		10	12	27	43	
	150		7	9	19	29	
	200		5	6	14	23	
	300		3	4	9	14	

Auxiliary contact (table 4)

		CTX 06 11 CTX 06 20
Rated current		6A
Rated operational current Ie at AC-15 for	≤ 240 V	4A
	≤ 415 V	3A
	≤ 500 V	2A
Minimum current density		12 V, 300 mA

Endurance

In general, the guaranteed number of operations at nominal load in AC1 is called the electrical service life. The Contax and Contax DN contactors all have an electrical service life of 150000 operations (Note: 1 cycle = NO → NC → NO = 2 operations).
However, if the load of the contactor is less than its nominal load, also the erosion of the contacts will be less and as a consequence, the electrical service life will increase.
The graphs in figure 8 show the relation between the number of operations and the maximum load allowed to obtain this life expectancy.

fig.8A
Endurance curve
(Operations vs. switching-off current)
AC-1/400 V 3- for CTX 24, 40, 63
AC-1/230 V 1- for CTX 20

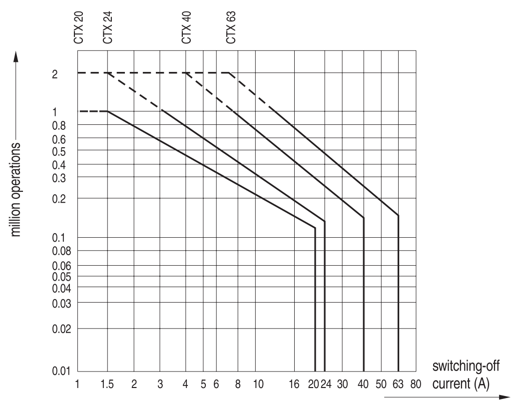
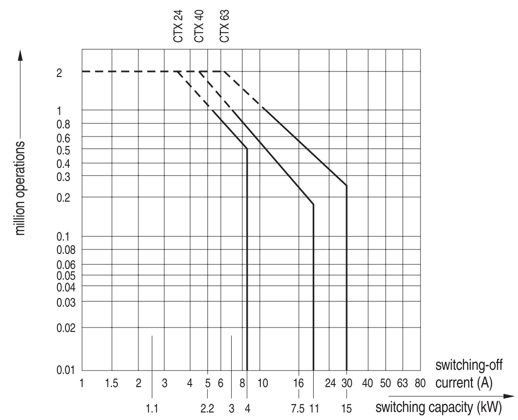


fig.8B
Endurance curve
(Operations vs. switching-off current (kW))
AC-3/400 V 3- for CTX 24, 40, 63
AC-3/230 V 1- for CTX 20



Example
An electrical heater (4.4kW, 230V, single phase) is used for 200 days per year. As an average, the thermostat switches 50 times a day on and off (= 100 operations).
The total number of operations per year is 20000 (200 days x 100 operations/day).
The current this heater draws is roughly 20A.
In this case,

- a 20A contactor will operate for 7.5 years (150000 / 20000),
- a 24A contactor will operate for 9 years (180000 / 20000),
- a 40A contactor will operate for 15 years (300000 / 20000),
- a 63A contactor will operate for 27 years (540000 / 20000).

General remarks

- Using contactors at low voltage, and especially when several devices can be operated simultaneously, ultimate care should be taken to the correct dimensioning of the step-down transformer.
- When several adjacent contactors are continuously energised (1 hour and more), the heat dissipation could influence the correct operation in a negative way. To avoid this, a spacer module should be installed between every third and fourth device (type designation CTX SP). This is not applicable for the 20A-contactors.

Text for specifiers

- Contactors all have a silent operation and therefore are preferably equipped with a DC-coil.
- An internal bridge rectifier allows the contactor to be used on AC (from 40 to 450Hz)as well as on DC (except for the 20A-contactor).
- The capacity of the load-terminals is from 1.5 to 10mm^2.
- The capacity of the control-terminals is from 0.5 to 4mm^2.
- The contactors are equipped with a flag which indicates the position of the coil (contacts).
- The protection-degree of the contactor is IP20.
- The devices are modular and DIN-rail mountable.
- Auxiliary contacts as well as spacers for heat dissipation are available.
- The power-supply voltage is allowed to vary in the range of 106%xUn .... 80%xUn without influencing the correct operation of the device.
- Day-Night contactors are available; these contactors have a 0-Auto-1 switch for manual operation. This switch cannot be blocked in the 1-position.
- The contactor is equipped with a transparent circuit indicator.

Contax R

Relays

Function

Relays are electromechanically controlled switches used to control single or multi-phase low to medium power loads while the control itself can be (very) low power.
Also, relays are often used as interfaces to obtain galvanic separation.
Typical applications are given in figure 1 and 2.

fig.1 Start-stop of lamp-load with relay

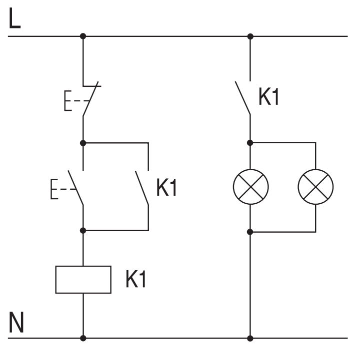
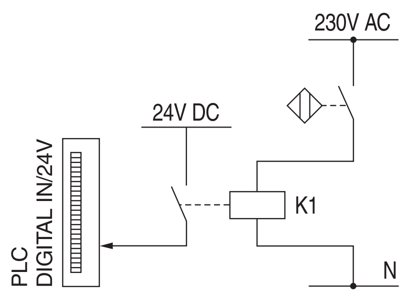


fig.2 Relay as interface between field and PLC



Operation

As long as the control circuit (coil) is energised, the NO-contacts of the relay are closed and the NC-contacts are opened. From the moment the control circuit is de-energised again, the contacts return to their rest position. NO-contacts are opened and NC-contacts are closed.

Features

Photo 1 shows the front view of a 1 and 2 module relay.
The main characteristics are printed in the upper part of the device ①. These are:
- Switching capacity
- Coil voltage
- Wiring diagram
- 6-digit ordering code.

Related to the switching capacity, only a 16A-family exists.
As can be seen in chapter D, only certain combinations of voltages, switching capacity and number of contacts are available of the shelf. Other combinations are available on request.
By means of the toggle on the front of the device ②, the contacts can be forced to their energised position.

photo 1

The position of each contact is visualised individually by means of a mechanical indicator ③.
The function of the relay or the circuit that is operated by the relay can be indicated behind the circuit indicator ④ i.e. hall, living, garage, … .
The Pozidriv terminals ⑤ are clearly marked and are all captive.

General remarks

- Using relays at low voltage, and especially when several devices can be operated simultaneously, ultimate care should be taken to the correct dimensioning of the step-down transformer.
- When several adjacent relays are continuously energised, the heat dissipation could irreversibly damage those devices. To avoid this, a spacer module should be installed between every second and third device (type designation PLS SP).

Technical performances

Tables 1 and 2 show in detail the maximum number of lamps and transformers respectively that each contact of a relay can switch at 230V-50Hz for the different types of loads.

Table 1

Lamp type	Lamp data		Perm. number of lamps
	P (W)	In (A)	16A
Incandescent	15	0.065	153
	25	0.108	92
	40	0.174	57
	60	0.260	38
	75	0.330	30
	100	0.430	23
	150	0.650	15
	200	0.870	11
	300	1.300	7
	500	2.170	4
Fluorescent uncompensated	18	0.370	14
	20	0.370	14
	30	0.365	14
	36	0.430	12
	40	0.430	12
	58	0.670	8
	65	0.670	8
Fluorescent 2-lamp circuit	2 x 18	0.370	39
	2 x 20	0.370	39
	2 x 30	0.365	39
	2 x 36	0.430	33
	2 x 40	0.430	33
	2 x 58	0.670	21
	2 x 65	0.670	21
Fluorescent paralel compensated	18	0.190	10
	20	0.190	10
	30	0.180	11
	36	0.220	9
	40	0.220	9
	58	0.340	6
	65	0.340	6
Metal Halogen uncompensated(I.e. HQI)	35	0.500	10
	70	1.000	5
	150	1.800	2
	250	3.000	1
	400	3.500	1
	1000	9.500	-
High pressure sodium vapor lamps - Uncompensated (I.e. NAV)	50	0.770	6
	70	1.000	5
	150	1.800	2
	250	3.000	1
	400	4.400	-
	1000	10.300	-
Low pressure sodium vapor lamps - Uncompensated (I.e. Sox)	18	0.350	15
	37	0.600	8
	56	0.590	9
	91	0.940	5
	135	0.950	5
	185	0.900	5
High pressure mercury vapor uncompensated (I.e. HQL)	50	0.600	8
	80	0.800	6
	125	1.150	4
	250	2.150	2
	400	3.250	1
	700	5.400	-
	1000	7.500	-
Lamps with electronic power supply (EVG's)	18	-	121
	36	-	60
	58	-	37

Table 2

Transformer type	Transformer data P (W)	Permitted number of transformers 16A
Transformers for low voltage halogen lamps	20	39
	50	15
	75	10
	100	7
	150	5
	200	3
	300	2

Text for specifiers

- 1 and 2 pole relays have a width of 1 module, 3 and 4 pole devices have a width of 2 modules.
- Permanent use of the control circuit is allowed although in this case a spacer-module must be added every second relay.
- The maximum switching frequency is equal to 1000/h at nominal load.
- The position of each contact is individually visualised.
- Manual closing of the contacts is possible at all time.
- The captive Pozidriv terminals guarantee a solid, reliable connection.
- The devices are DIN-rail mountable.
- The relay is equipped with a transparent circuit indicator.

Pulsar S

Impulse switches

Function

Impulse switches are electromechanical or electronically controlled switches used to control single or multi-phase medium-power loads while the control itself can be (very) low power. The device switches between 2 stable positions, each time a (brief) impulse energises its control circuit. Typical applications are given in figure 1 to 4.

fig.1

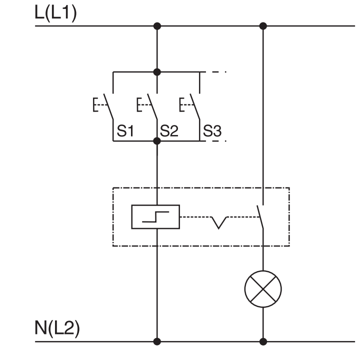


fig.2

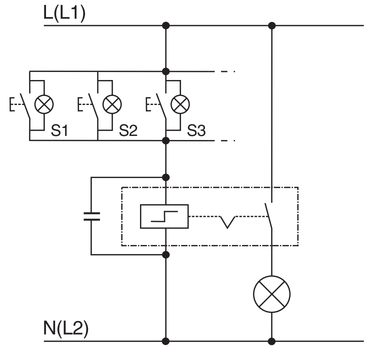


fig.3

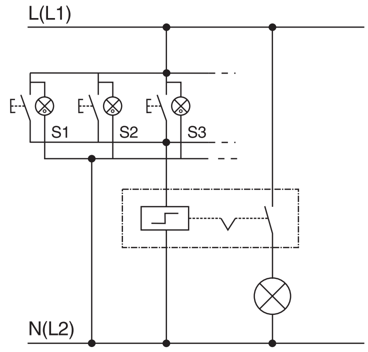
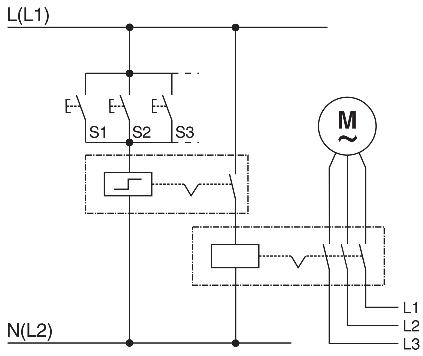


fig.4



Electromechanical impulse switches

In these devices, the two stable positions are established by means of a mechanical cam-mechanism that operates the contacts. The moving part of the coil pushes the cam-mechanism in to its next state each time the coil is energised.
Photo 1 shows the front view of the electromechanical impulse switches.
The main characteristics of the device are printed in the upper part of the device ①. These are:
- Switching capacity
- Coil voltage
- Wiring diagram
- 6-digit ordering code

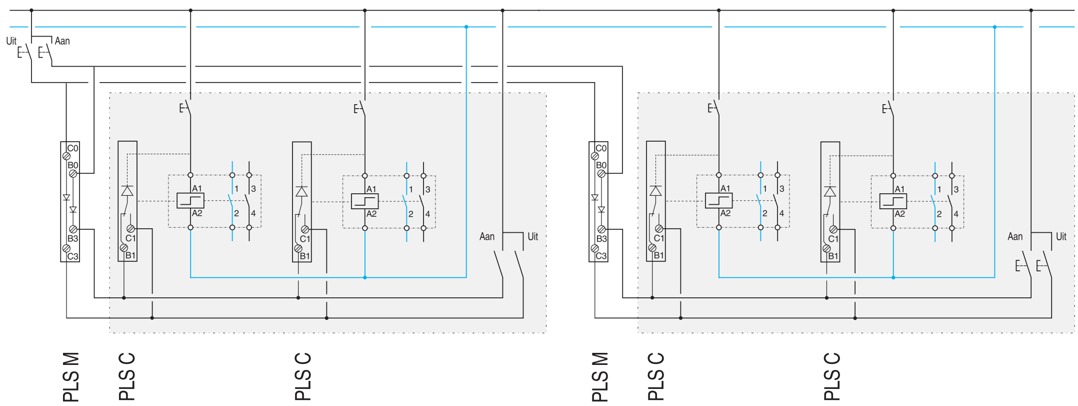
Related to the switching capacity, two families exist: 16A and 25A.
In both families, the following coil voltages are standard and available of the shelf: 12, 24, 48, 230 and 240V, and 12 and 24VDC.
Manual operation is possible by means of the toggle ② on the front of the device.
The position of each contact is shown at all time by means of a mechanical indicator ③.
The circuit that is operated by this impulse switch can be indicated behind the circuit indicator ④ i.e. hall, living, garage, ...
The Pozidriv terminals ⑤ are clearly marked and are all captive.

photo 1

photo 2

photo 3

fig.8



Remote indication of the contact position can be accomplished by means of the add-on auxiliary contact module PLS 0411 (photo 2). The auxiliary contact can only be mounted on the left side of the device.

Independent of coil voltage or number of contacts, always the same add-on module for centralised command PLS C can be used (photo 3). The centralised command module can only be mounted on the right side of the device.

Additionally, the PLS M multi-level centralised command module allows an almost unlimited number of hierarchical levels for grouped on off switching. Figure 8 shows the wiring for a multilevel centralised command application.

Both an auxiliary contact module and a central command module can be mounted on the same device at the same time.

Electromechanical step-by-step impulse switches

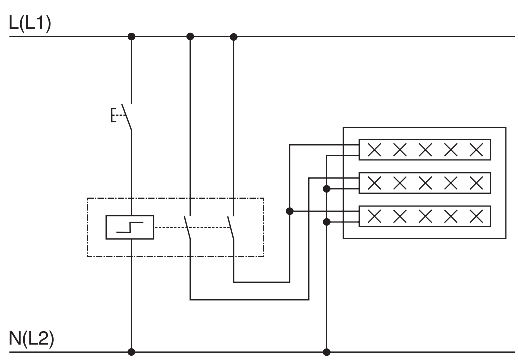
If two different circuits need to be operated with only one pushbutton, possibly from different places, step-by-step, multi-circuit impulse switches are the solution. The subsequent contact positions are shown in table 1.

Table 1

Step	Contact 1-2	Contact 3-4
1	Open	Open
2	Closed	Open
3	Closed	Closed
4	Open	Closed

Example: one hall with 3 rows of lights (see fig.9); in step 1, no lights are activated, in step 2 only the middle row is activated, in step 3 all rows are activated and in step 4 both outermost rows are activated. Assuming all lights have the same characteristics, in this way the light-intensity can be regulated in 4 steps: Off, 33%, 66% and 100%.

fig.9



Electronic impulse switches

Here the two stable positions are generated by means of a bi-stable electronic circuit that operates a build-in miniature relay. In photo 4 one can see the front view of this device with the cover closed as well as open.

The main characteristics are printed on the upper part of the device ①.
As opposed to the electromechanical impulse switches, manual operation is not possible.
The position of each contact is visualised by means of a LED ③.
The circuit that is operated by this impulse switch can be indicated behind the circuit indicator ④ i.e. hall, living, garage, … .

photo 4

The Pozidriv terminals ⑤ are clearly marked and are all captive.
The add-on-centralised command module cannot be applied to the electronic impulse switches. Instead, special electronic impulse switches with this function already built-in, are available. This reduces cabling time.

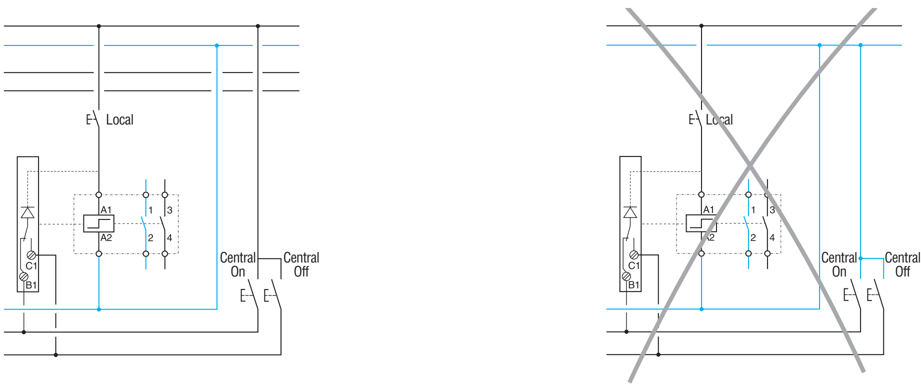
General remarks

- When using the centralised command function, make sure that the same polarity is used for the local command as for the central command. Figure 11 shows correct and erroneous connection of the centralised command module.
- Using impulse switches at low voltage, and especially when several impulse switches can be operated simultaneously (i.e. centralised command), ultimate care should be taken to the correct dimensioning of the step-down transformer (see also table 4 on page T4.17).
- When the control voltage is continuously applied, a spacer module PLS SP should be mounted between every second and third impulse switch.

Technical performances

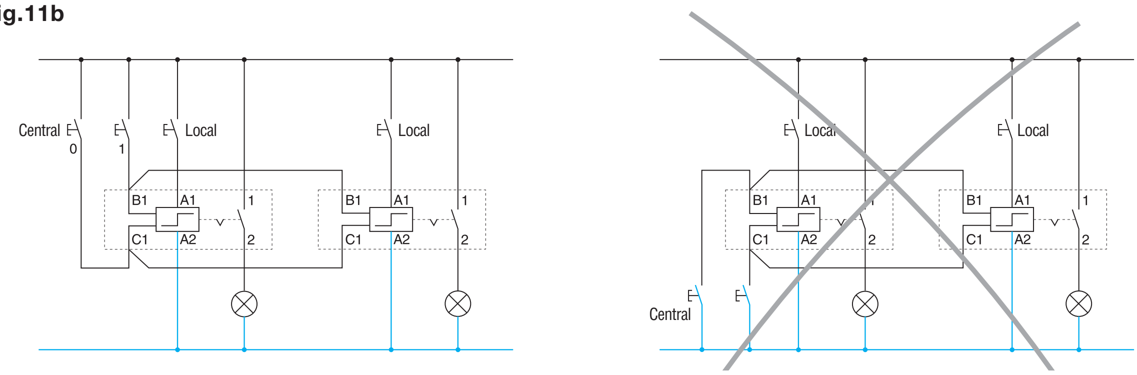
Tables 2 and 3 (next page) show in detail the maximum number of lamps or transformers that each contact of an impulse switch can switch at 230V-50Hz for the different families (16, 25 and 32A) and for different loads.

fig.11a



CORRECT WRONG

fig.11b



CORRECT WRONG

Switching of lamp load (table 2)

Lamp type	Lamp data		Permitted number of lamps		
	P (W)	In (A)	10 A	16 A	25A
Incandescent	15	0.065	66	153	240
	25	0.108	40	92	144
	40	0.174	25	57	90
	60	0.260	16	38	60
	75	0.330	13	30	48
	100	0.430	10	23	36
	150	0.650	6	15	24
	200	0.870	5	11	18
	300	1.300	3	7	12
	500	2.170	2	4	7
Fluorescent uncompensated	18	0.370	11	14	22
	20	0.370	11	14	22
	30	0.365	11	14	22
	36	0.430	9	12	19
	40	0.430	9	12	19
	58	0.670	6	8	12
	65	0.670	6	8	12
Fluorescent 2-lamp circuit	2x18	0.370	11	39	61
	2x20	0.370	11	39	61
	2x30	0.365	11	39	62
	2x36	0.430	9	33	52
	2x40	0.430	9	33	52
	2x58	0.670	6	21	33
	2x65	0.670	6	21	33
Fluorescent paralel compensated	18	0.190	-	10	21
	20	0.190	-	10	21
	30	0.180	-	11	22
	36	0.220	-	9	18
	40	0.220	-	9	18
	58	0.340	-	6	12
	65	0.340	-	6	12
Metal Halogen uncompensated (I.e. HQI)	35	0.500	-	10	16
	70	1.000	-	5	8
	150	1.800	-	2	4
	250	3.000	-	1	2
	400	3.500	-	1	2
	1000	9.500	-	-	-
High pressure sodium vapor lamps - Uncompensated (I.e. NAV)	50	0.770	-	6	10
	70	1.000	-	5	8
	150	1.800	-	2	4
	250	3.000	-	1	2
	400	4.400	-	-	1
	1000	10.300	-	-	-
Low pressure sodium vapor lamps - Uncompensated (I.e. Sox)	18	0.350	-	15	23
	37	0.600	-	8	13
	56	0.590	-	9	14
	91	0.940	-	5	8
	135	0.950	-	5	8
	185	0.900	-	5	9
High pressure mercury vapor uncompensated (I.e. HQL)	50	0.600	-	8	13
	80	0.800	-	6	10
	125	1.150	-	4	7
	250	2.150	-	2	3
	400	3.250	-	1	2
	700	5.400	-	-	1
	1000	7.500	-	-	-
Lamps with electronic power supply (EVG's)	18	-	36	121	190
	36	-	18	60	95
	58	-	11	37	58

Switching of transformers (table 3)

Transformer type	Transformer data	Permitted number of transformer		
	P (W)	10 A	16 A	25A
Transformers for low voltage halogen lamps	20	20	39	60
	50	8	15	24
	75	5	10	16
	100	4	7	12
	150	2	5	8
	200	2	3	6
	300	1	2	4

Number of impulse switches as function of voltage step-down transformer (table 4)

	TR B 5 5VA 12V	TR B 8 S 8VA 12V	TR B 10 10VA 12V	TR B 15 15VA 12V	TR S 15 15VA 12V	TR S 15 15VA 24V	TR S 25 25VA 12V	TR S 26 25VA 24V	TR S 40 40VA 12V	TR S 41 40VA 24V	TR S 63 63VA 12V	TR S 64 63VA 24V
PLS xx 10 13 (+ PLS C + PLS M)	1	1	2	3	3	0	5	0	8	0	12	0
PLS xx 10 25 (+ PLS C + PLS M)	0	0	0	0	0	3	0	5	0	8	0	12
PLS xx 11 13 (+ PLS C + PLS M)	1	1	2	3	3	0	5	0	8	0	12	0
PLS xx 11 25 (+ PLS C + PLS M)	0	0	0	0	0	3	0	5	0	8	0	12
PLS xx 20 13 (+ PLS C + PLS M)	1	1	2	3	3	0	5	0	8	0	12	0
PLS xx 20 25 (+ PLS C + PLS M)	0	0	0	0	0	3	0	5	0	8	0	12
PLS xx 22 13 (+ PLS C + PLS M)	0	0	0	1	1	0	2	0	3	0	5	0
PLS xx 22 25 (+ PLS C + PLS M)	0	0	0	0	0	1	0	2	0	3	0	5
PLS xx 40 13 (+ PLS C + PLS M)	0	0	0	1	1	0	2	0	3	0	5	0
PLS xx 40 25 (+ PLS C + PLS M)	0	0	0	0	0	1	0	2	0	3	0	5
PLS S xx 20 13	1	1	2	3	3	0	5	0	8	0	12	0
PLS S xx 20 25	0	0	0	0	0	3	0	5	0	8	0	12
PLS C xx xx 14	8	13	17	26	26	0	43	0	69	0	109	0
PLS C xx xx 26	0	0	0	0	0	37	0	61	0	98	0	154

Text for specifiers

- Depending on the application, electro-mechanic or electronic impulse can be used.
- 1 and 2 pole impulse switches have a width of 1 module, 3 and 4 pole devices have a width of 2 modules.
- The position of each contact is individually shown.
- Manual operation is possible at all time by means of a toggle.
- The captive Pozidriv terminals have a capacity of 2x(0.5 to 2.5)mm^2 for the control circuit and 1 to 10mm^2 for the load circuit.
- The terminals do guarantee a solid and reliable connection.
- Permanent use of the control circuit is allowed for the 1- and 2-pole devices, although in this case a spacer-module must be added every second impulse switch.
- The devices are DIN-rail mountable.
- The protection degree of the impulse switch is IP20.
- The impulse switch is equipped with a transparent circuit indicator.
- Add-on modules for distant reporting (auxiliary contact) and centralised command are available as well as all-in-one central command impulse switches and multi-circuit impulse switches.

Pulsar TS

Staircase switches

Function and range

A staircase light switch is a special purpose delay-off timer.
In addition to a delay-off timer, the staircase switch will allow a certain amount of (limited) current to pass through the coil without energisation. This current usually comes from illuminated push-buttons, used to help people in a dark staircase find these push-buttons.

The range of Pulsar TS staircase time switches includes:
- An electromechanical controlled device, with a very competitive cost and with an acceptable accuracy (see fig.1 for timing details)
- Electronic controlled devices for applications where a higher accuracy is needed (same timing diagram as for the electromechanical device, see fig.1)
- A device with a built-in 'end of light on' pre-warning by means of briefly switching off and on again the load at the end of the cycle (flasher function; can be used with all different kinds of loads) (see fig.2)
- A device with built-in 'end of light on' pre-warning by means of dimming the load at the end of the cycle (dim-function; can be used only with resistive and incandescent loads) (see fig.3)
- A dim add-on module which can be used in combination with the standard electromechanical as well as with the standard electronic staircase switch.

fig.1
Timing diagram for standard electro-mechanical and electronic staircase switch

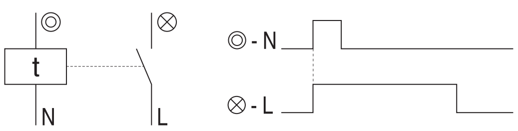


fig.2
Timing diagram for electronic staircase switch with flasher pre-warning

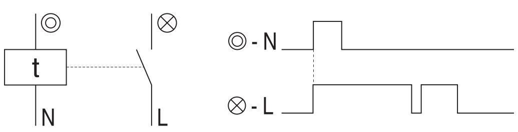
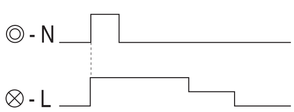


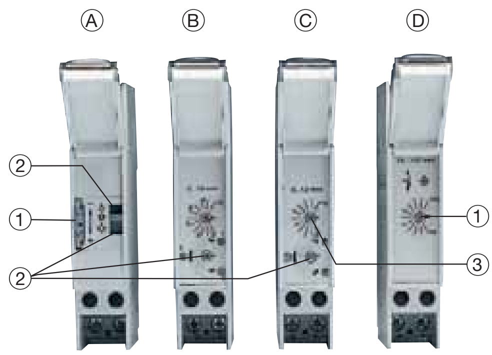
fig.3
Timing diagram for electronic staircase switch with dim-function



Features and benefits

Figures 4 and 5 show the front and what's behind the cover for the PLT S M Ⓐ, PLT S E Ⓑ and PLT S F Ⓒ staircase time switches and for the PLT S D Ⓓ dim add-on module.
Besides the delay-time dial ①, all staircase switches have a permanent on and off override switch ② and for the electronic devices an output status indication LED ③.

fig.4

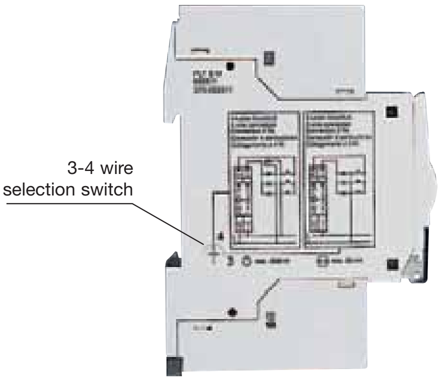


The function of the staircase time switch or the circuit that it operates can be indicated behind the circuit indicator ④ i.e. hall, staircase west, staircase east. The clearly marked Pozidriv safety terminals ⑤ are all captive.

fig.5

Also in this case, the function of the staircase time switch or the circuit that it operates can be indicated behind the circuit indicator ②.
All electronic staircase switches can be used in a 3- or 4-wire configuration (see below) without any special wiring or hardware-setting. For the electromechanical version however, the selection between a 3- or 4-wire wiring is accomplished by means of a switch on the side of the device as is shown in figure 7.

fig.7



3- and 4-wire wiring

Depending on the wiring execution in the field i.e. the way in which the wire-conducts are physically interconnecting the push-buttons, lamps and staircase switch, the cabling can be carried out in two different ways.
If there is only one tube or cable daisy-chaining all push-buttons and all lamps, then, as is shown in figure 8, a 3-wire wiring would be the most economic way of doing. For simplicity reasons the PE-conductor is not shown here.
However, in some cases one wiring-tube or cable is interconnecting all lamps with the staircase light switch and another tube or cable is interconnecting all push-buttons as shown in figure 9. Obviously in this case we cannot use one common wire for the push-buttons and for the lamps as in the above wiring diagram. For this setup, 4-wire wiring as shown in figure 9 is required. Also in this case the PE-conductor is not shown.

fig.8

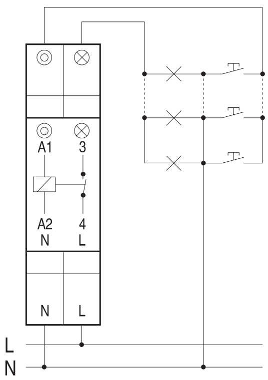
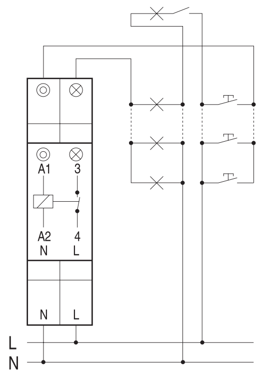


fig.9

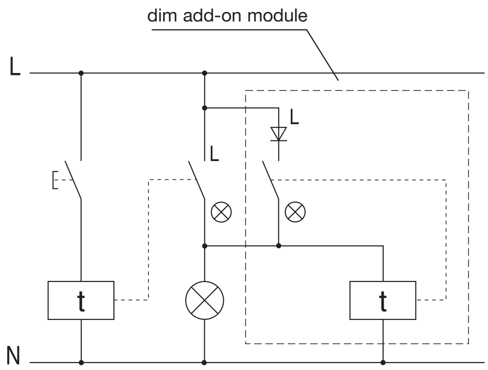


Wiring the dim add-on module

The dim add-on module is a universal usable add-on that can be used in combination with all types of staircase switches.

Operation (see fig.10 and fig.11)
When the staircase switch is energised through one of the push-buttons, its output contact energises the load and the dim add-on module. Therefore, the output contact of the dim-module is in its 'on' state. As soon as the time of the staircase switch has elapsed, its output contact opens. As the dim-module acts as a delay 'off' timer, its output contact remains closed. The level of the voltage supplied to the coil of the dim-module through its own contact however is not high enough to keep the coil energised. Indeed, because of the internal diode in series with the output contact, half of the supply voltage is cut away. This results in an RMS value of the voltage supplied to the coil of the dim-module and to the load being only half of the nominal supply voltage.

fig.10

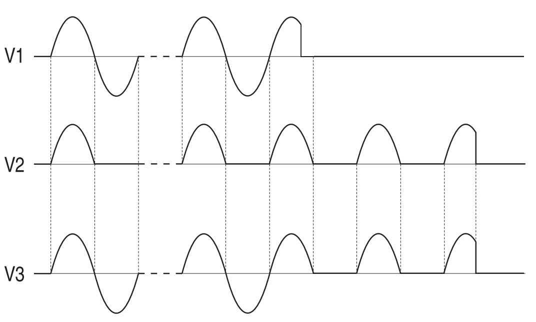


Staircase swithces

T4

Figure 11 shows in detail the different voltage-waveforms as function of time:
- V1 = supply voltage waveform passing the contact of the staircase switch,
- V2 = supply voltage waveform passing the contact of the dim-add-on module,
- V3 = resulting voltage waveform applied to the load.

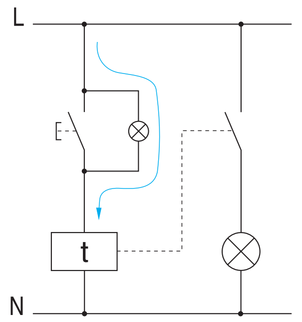
fig.11



Using illuminated push-buttons

All Pulsar TS staircase switches can be operated by means of illuminated push-buttons where the lamp is put directly in parallel to the push-button (see fig.12).

fig.12



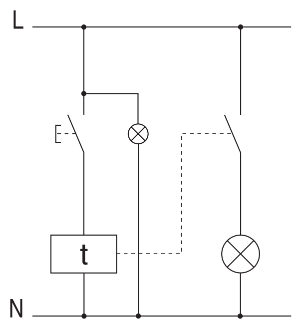
In this case the lamp extinguishes when the push-button is pushed and is constantly lit-up otherwise. While lit-up, the total current drawn by these lamps flows entirely through the coil of the staircase switch. Therefore, the number of illuminated push-buttons (lamps) that can operate one staircase switch is limited in order not to automatically energise the coil.
Table 1 below shows the maximum current allowed to flow through each of the different Pulsar TS staircase switches without energising them.

Table 1

PLT S M	PLT S E	PLT S F	PLT S D
50 mA	150 mA	150 mA	0 mA

When applying an additional wire as shown in figure 13, the current drawn by the bulbs of the illuminated push-buttons is sunk through this wire instead of through the coil of the staircase switch.
In this case an unlimited number of illuminated push-buttons can be put in parallel to operate the staircase switch.

fig.13



Applicable standards

All Pulsar TS staircase time switches are designed according to the following standards (latest version unless indicated otherwise):
- 669-2-3
- EN 50021-1
- EN 50082-2
- VDE 0632

Text for specifiers

- Devices based on electronic as well as on electromechanical technology are in the range.
- The NO output contact of the staircase switches is voltage-free for all devices in the range.
- All devices have a manual 'on/off' override switch.
- 4- or 3-wire cabling is possible with all devices.
- The devices are all DIN-rail mountable.
- An electronic add-on dim-module can be used in combination with both the electromechanical as well as with the electronic staircase switches.
- All staircase switches can be retriggered at all time.
- The range includes staircase switches with early turn-off prewarning by means of brief interruptions of the load circuit at the end of the cycle (flash-function) or by means of dimming the load at the end of the cycle (dim-function),
- The use of illuminated pushbuttons is possible at all time. To this respect, the total current flowing through the coil without energising it is at least 50mA for the electromechanical and at least 150mA for the electronic staircase switches.
- All devices have a transparent circuit indicator.
- The captive Pozidriv terminals have a capacity of 2x(0.5 to 2.5)mm^2 for the control circuit and 1 to 10mm^2 for the load circuit.
- The terminals guarantee a solid, reliable connection.

Pulsar T

Timing relays

Function

Use of incoming impulses to give predictable output-impulses.

Operating functions and applications

Figures 1 to 6 show the different timing functions together with the applications.

fig.1 Delay On (PLT ON)
Avoid drive-way light-up in case the movement detector "accidently" detects someone passing by.

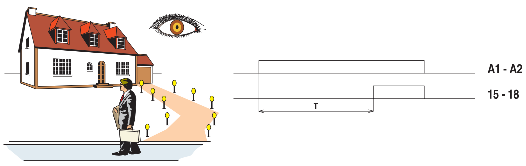


fig.2 Delay Off (PLT OF)
The use of a delay-off timer avoids the pump from switching on and off all the time
A hysteresis is built in.

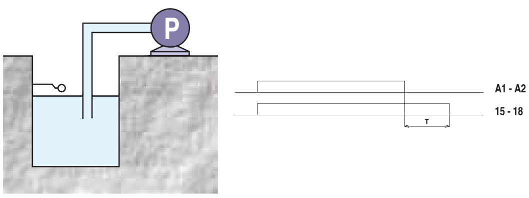


fig.3 Delay On and Off (PLT OO)
Ventilation in toilets etc.

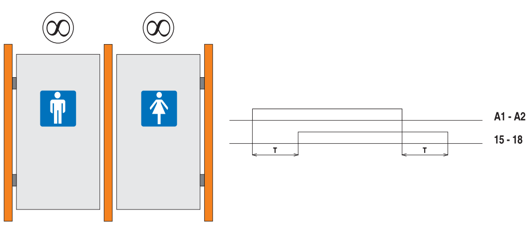


fig.4 Positive edge single shot (PLT PS)
Opening of automatic door. Energising the motor during a certain time "t" in order to open the door when movement is detected.

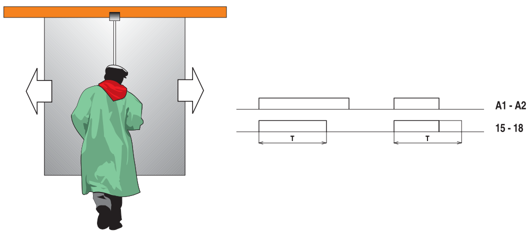


fig.5 Negative edge single shot (PLT NS)
Energising the motor during time "t" in order to close the door again when no movement is detected.

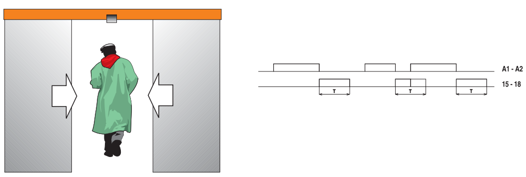
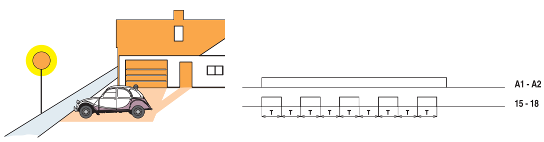


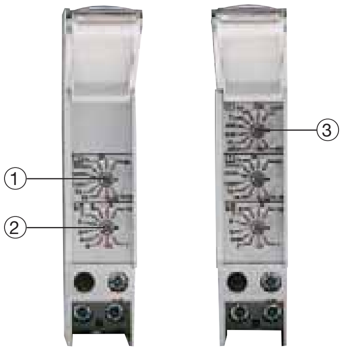
fig.6 Symmetrical flasher (PLT AS)
Flash-light.



Programming

Except for the multifunction timing relay, all devices have two dials to set the delay (see photo 1). The upper one ① is the preset of a time i.e. from 0.1 sec to 4 h. The lower one ② is the multiplier of this time. The product of both gives the actual time delay.

photo 1



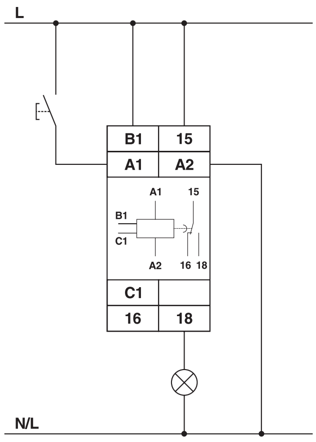
Examples
- Requested delay time is 7 minutes: put upper switch on 1 min and lower switch on 7.
- Requested delay time is 40 minutes: put upper switch on 5 min and lower switch on 8.
- Requested delay time is 3 hours: put upper switch on 1h and lower switch on 3.

In this way, the time range on these timing relays is presetable from 0.1 sec to 40h.

The additional dial ③ on the multifunction timing relay is used to select the function.

Wiring diagram

fig.8



Classic

Electromechanical timers

Introduction

The Classic family of electromechanical timers is used to switch loads on and off, according to a pre-programmed switch-plan, as a function of time.
This range of electromechanical timers covers 1- and 2-channel devices, net- or quartz-synchronised with a daily or/and weekly program.

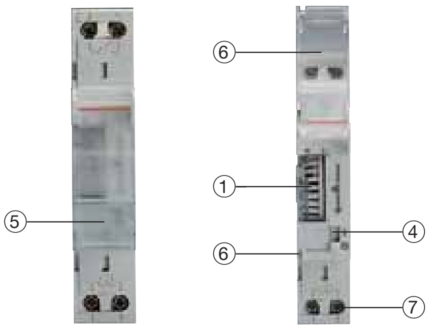
Operation

A motor drives a dial with switches. When put in their 'ON' state, these switches mechanically operate a contact. In this way, the 16A output-contact is switched over a period of time, according to the setting of the switches on the dial.
Besides the timed switching, the output can be manually forced to the ON- or OFF-state at any time.

Features and benefits

Photos 1 to 3 show the front of the CLS x 1, CLS x 3, CLS x 4 and CLS x 6 Classic timers.
The dials clearly indicate daily or weekly operation ①. The daily version has the shortest switching time of 30 minutes. The shortest switching time of the weekly version is 3 hours.
The different modes of operation are clearly marked with self-explaining symbols next to the switch.
The function of the timer or the circuit that it operates can be indicated behind the circuit indicator ③ i.e. heating, lighting, etc. By means of

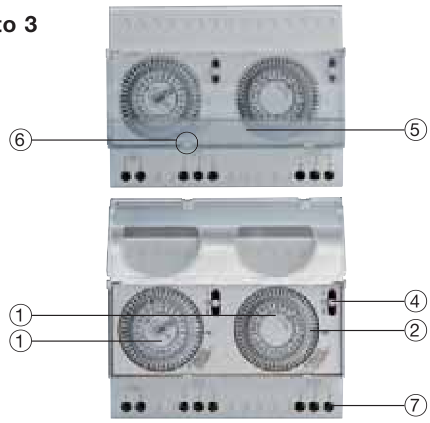
photo 1



the plastic cover, the timer can be sealed making it impossible to alter the program or the actual time ⑥.
The clearly marked Pozidriv safety terminals ⑦ are all captive.

photo 2

photo 3



Type-name definition

The type-name of a Classic timer is a unique designation that includes the main features of the timer. It is composed of 5 parts:
- CLS: abbreviation for Classic
- Q or S: quartz- or net-synchronised
- 11, 31, 41, 62 of which the first figure represents the width of the device in number of modules, while the second figure represents the number of channels
- D, W, DD or DW indicating daily, weekly or combined daily-daily or daily-weekly operation
- M indicating metal dial-switch execution.

Terminology

Program per channel
Examples
- 1x24x2 is a daily timer (1x24); minimum duration between 2 subsequent switchings (=shortest switching time) is 30 minutes (x2).
- 7x24:3 is a weekly timer (7x24); minimum duration between 2 subsequent switchings is 3 hours (:3).
- 1x24x4 & 7x24:12 is timer with a combined daily and weekly program (1x24 and 7x24); minimum duration between 2 subsequent switchings is 15 minutes for the daily dial (x4) and 2 hours for the weekly dial (:12).

Manual override
During normal operation, the output contact of the timer is operated according to the settings of the dial-switches. However, at all time it is possible to manually override this operation for each channel individually.
The different overrides are as follows (see also photo 5):
- 1: always forces the output of that channel to the on-status,
- 0: always forces the output of that channel to the off-status.

photo 4

Running reserve
The time during which a timer can continue to run without being externally supplied with power is called the running reserve. The 3, 4 and 6 module devices have a running reserve of 150 hours, while due to the limited space available, this is 50 hours for the 1 module electromechanical timer.

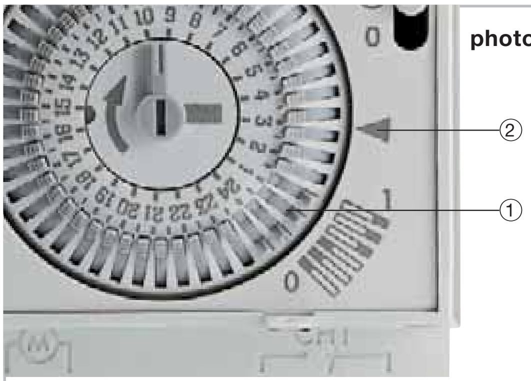


photo 5

Programming

As is illustrated in photo 6, the programming of the Classic timers is very easy: moving the dial-switches outwards ①, switches the output-contact to the on-position when this switch passes the contact ②, moving them inwards switches the output contact to the off-position.

In case dials with plastic switches are to be used
- This range covers 1 and 2 channel devices, with daily or/and weekly program, with or without running reserve.
- The voltage-free change-over output contact is capable of switching a resistive load of 16A/250V and an inductive load of 4A/250V.
- The shortest switch-on time for the daily version is 30 minutes and for the weekly version is 3 hours.
- The running reserve is 150 hours.
- The program is set by means of unlosable plastic switches on a dial.
- Manual override is possible at all time by means of a 0-clock-1-switch on the front of the device (for the 1 module device at least a clock-1 switch should be available).
- The electromechanical timers can be sealed in order to avoid accidental or deliberate alteration of time, date and program.
- All terminals have the safety-feature and have captive Pozidriv screws.
- The devices are DIN-rail mountable.
- The electromechanical timers all have a circuit indicator window, in order to easily identify their function (i.e. heating, lighting, etc.).

Galax

Digital timers

Introduction

The Galax family of digital timers is used to switch loads on and off, according to a pre-programmed switch-plan, as a function of time.
This range of microprocessor based timers goes from a simple 1-channel, quartz synchronised, daily programmable device with 12 programming steps, mainly used for domestic purposes, up to a 4-channel DCF-77 synchronised yearly timer with 400 programming steps for high-feature-demanding industry.
As will be shown below, the very easy and straightforward programming is the same for the whole range. For the high-end devices (yearly programmable), a Windows 95 (and up) compatible software exists as a further extension for easy programming, downloading to and uploading from the timer.

Operation

The 16A output relay contacts are switched according to the user pre-programmed sequence. The actual status of an output is clearly visualised at all time on the LCD (see below).
Besides the automatic switching, the output(s) can be manually forced to the ON- or OFF-state at any time.

Features and benefits

Photos 1 to 3 are showing the front of the 1/1 (GLX Q 1), 2/2 (GLX Q 2) and 6/4 (GLX Q 4) module/channel Galax timers respectively.

photo 1

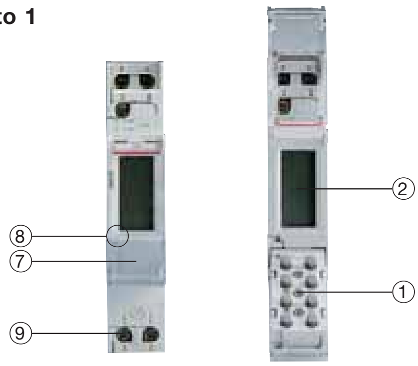
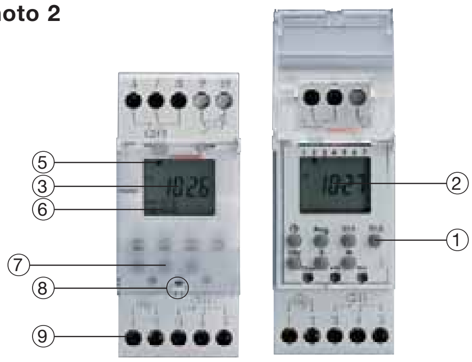
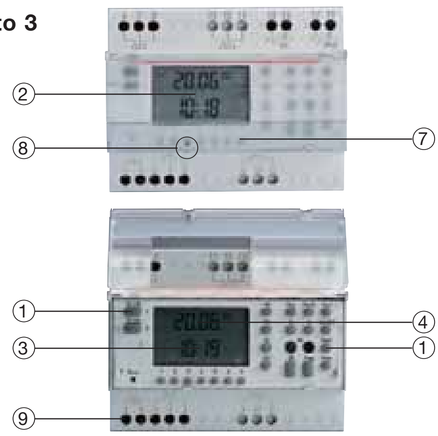


photo 2



Besides the self-explaining operating and programming keys ①, all devices have a Liquid Crystal Display (LCD) ②, displaying in a clear and straightforward way all parameters such as:
- Actual time (hh:mm) ③
- Date where applicable ④
- Day of the week where applicable (1…7; 1=monday) ⑤
- Channel 1, 2 and 4 operation ⑥ (for detailed explanation see the chapter concerning the programming below)
- Status on or off
- Operated by program
- Manual operation
- Fix on or off

photo 3



As always, the function of the timer or the circuit that it operates can be indicated behind the circuit indicator ⑦ i.e. hall, living, garage, … .
By means of the plastic cover, the timer can be sealed so the program and the actual time and date cannot be altered ⑧.
The clearly marked Pozidriv safety terminals ⑨ are all captive.
Table 1 summarises all features for the different devices in the range.

Galax specifications (table 1)

	Daily	Weekly							Yearly	
	GLX Q 21 D 12	GLX Q 11 W 42	GLX Q 21 W 20	GLX Q 21 W 30	GLX Q 22 W 30	GLX Q 22 W 40	GLX Q 62 W 400	GLX Q 64 W 400	GLX Q 62 Y 400	GLX Q 64 Y 400
Program per channel	1X24X60	7X24X60	7X24X60	7X24X60	7X24X60	7X24X60	7X24X3600	7X24X3600	365X24X3600	365X24X3600
Number of modules	2	1	2	2	2	2	6	6	6	6
Number of channels	1	1	1	1	2	2	2	4	2	4
Number of programming steps	12	42	20	30	30	40	400	400	400	400
Block programming	no	yes	yes	yes	yes	yes	yes	yes	yes	yes
Manual override per channel	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Summer-Winter time change	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Cycle / Impulse function	no	no	no	no	yes	yes	yes	yes	yes	yes
Random function	no	yes	no	no	no	no	no	no	no	no
Clear function	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
Reset function	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Calendar / Holiday function	no	no/yes	no	no	no	no	yes	yes	yes	yes
DCF-77	no	no	no	no	no	no	no	no	yes	yes
PC-programmable	no	no	no	no	no	no	yes	yes	yes	yes
Running reserve	3 yr	150h	3 yr	3 yr	3 yr	3 yr	6 yr	6 yr	6 yr	6 yr

Type-name definition

The type-name of a Galax timer is a unique designation that includes the main features of the timer. It is composed of 5 parts:
- GLX: abbreviation for Galax
- Q: quartz synchronised
- 11, 21, 22, 62 or 64 of which the first figure represents the width of the device in number of modules, while the second figure represents the number of channels
- D, W or Y, indicating daily, weekly or yearly operation
- A figure representing the number of programming steps, going from 12 up to 400.

Terminology

Program per channel
Examples
- 1x24x60 is a daily timer (1x24); minimum duration between 2 subsequent switchings (=shortest switching time) is 1 minute (x60).
- 7x24x60 is a weekly timer (7x24); minimum duration between 2 subsequent switchings is 1 minute (x60).
- 365x24x3600 is a yearly timer (365x24); minimum duration between 2 subsequent switchings is 1 second (x3600).

Number of programming steps
This figure represents the total number of events that can be programmed in the device. An event is understood to be a change in the output-state.
Example:
If for one particular day, output 1 of a GLX Q 22 W 40 has to switch to the on-state at 8:45, output 2 at 10:25 and both have to be de-energised again at 11:45, three programming steps need to be used. After this sequence has been programmed, the timer has 37 free programming steps left.

Block-programming
Block-programming allows to repeat the same events on different days, without sacrificing additional programming steps.

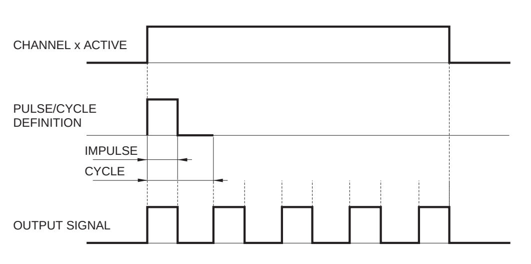
Coming back to the above example, if all events have to take place all days of the week except i.e. on Tuesday and Sunday, a normal timer would need 5x3=15 programming steps. By using the block-programming feature of the Galax timers, (=setting the appropriate days on or off for each individual event), indeed those events will be repeated on all appropriate days while the free number of programming steps remains the same as if those events were programmed only for one day. This again results in 37 free programming steps for the Galax timer compared to 25 for a timer without the block-programming feature.

Manual override
During normal operation, the output relay(s) of the timer is (are) operated according to the pre-programmed sequence. However, at all time it is possible to manually override this operation for each channel individually.
The different overrides are as follows:
- ON: forces the output-relay of that channel to its on-state until the next programmed off instruction for that same channel comes along. At this time, the timer automatically goes to normal operation again.
- FIX ON: always forces the output of that channel to the on-state, independently of any subsequent programmed off-instruction.
- FIX OFF: always forces the output of that channel to the off-state.

Summer-winter time change
The summer-winter time change can be done in 3 different ways:
- Automatic (AU): The summer-winter time switch-over takes place on predefined dates according to the summer time regulation of the European Union. These dates, up to the year 2096, are permanently stored in the timer and cannot be altered.
- Calculated (cHA): The user can select the week of the year and the day of the week on which the summer-winter time switch-over has to take place (for this and all forthcoming years).
- No switchover (no).

Cycle/Impulse function
Generating a impulse-train with short pulses and a short pauses with a standard timer would consume a huge part of the timer's free programming space. For example: changing the output of a timer once per second during 10 minutes, would require 600 programming steps. On top of that, the shortest switching time must not be longer than 1 second. For this kind of application, except for the most simple ones, all timers have a build in Cycle / Impulse function.
With this function, the duration of the impulse (output relay switched to the on-position) and the total period or cycle (duration of the impulse and pause together) can be defined. This sequence is repeated as long as the channel for which this has been programmed is active (see fig.4).

fig.1



In this way, instead of 600 programming steps for the above application, only 2 are required: one that activates the channel with this function, and one that deactivates it.

Remark
The impulse function can be used on its own as well, thus without using it in a cycle. In this case only one programming step is used for 2 events: switching the respective output to the on-state and switching it back to the off-state after the duration of the impulse has elapsed.

Random function
When activated, this function switches the output in a random way. Often this feature is used to simulate someone being present in a house, while actually no one is (i.e. during holidays).

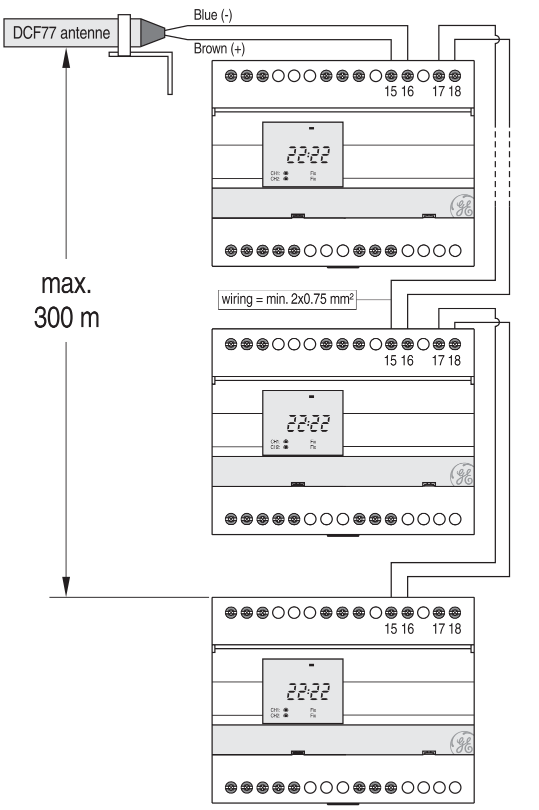
Clear function
This function allows the programmer to delete one program step without having to reprogram all subsequent steps. Subsequently pushing this button removes all programmed switching events from the memory.

Reset function
The actual time can be reset to 00:00 by simply pushing the reset button on the front of every timer. Resetting a Galax timer does not delete the programmed switching times.

Calendar/Holiday function
The yearly programmable timers have the possibility to repeat a switching program during a certain period.
i.e. programmed heating and lighting of a workshop:
- Lighting from 7:30 till 15:45, all year around except for the summer- (July 15 till August 15) and Christmas-holidays (i.e. December 25 till January 3), for the official holidays and also except for the weekends;
- Heating from 7:05 till 15:50, only during the heating-season (i.e. from October 1 till April 15), and obviously not during the Christmas-holidays (i.e. December 25 till January 3), the weekends and the official holidays.

DCF-77
When the accuracy of a timer is not high enough, the Frankfurter atom-clock can be used to synchronise the timer in order to virtually reduce the time-error to 0.
This atom-clock transmits the so-called DCF-77 radio signal (= message that includes all time and date related info).
By connecting the appropriate antenna to the timer (see fig.5), the signal is received and automatically the timer is synchronised at all time.

fig.2



Running reserve
The time during which a timer can continue to run without being externally supplied with power is called the running reserve. Except for the GLX Q 11 W 42, all Galax timers have a built-in lithium battery guaranteeing a running reserve of 3 or 6 years from factory.

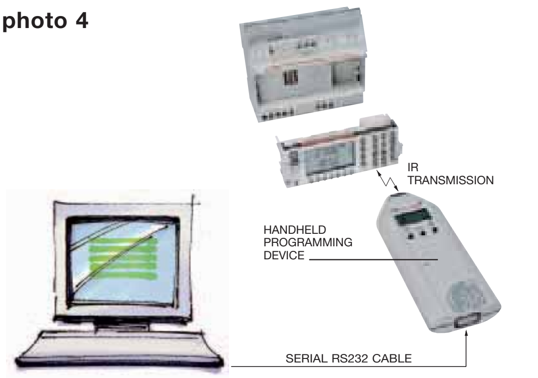
Programming

Programming Tools
Besides programming the GLX Q 6 digital timers manually, it is also possible use the Galax Programming Tool.
This tool consists of
- a Windows-95 (and up) compatible software with very easy to use and straightforward GUI
- a handheld programming device
- an RS232 serial cable to interconnect the programming device with the PC.

A normal programming sequence is as follows:
- The user installs the timer switch-plan on the PC;
- In a next step, this program is downloaded in the programming device through the serial cable. The programming device can store up to 4 different programs;
- Next, the programming device can be disconnected from the PC;
- Finally, one of the programs stored in the programming device is downloaded on to the GLX Q 6 timer.

Photo 4 shows a complete set-up of the programming environment.

photo 4



This very practical solution offers several advantages:
- Only one programming toolkit is required to program all GLX Q 6 devices.
- An unlimited number of timer-switch-plans can be stored on the PC.
- Small changes from one application to another don't require introducing manually the complete switch-plan over and over again. Instead, just open an existing switch-plan stored on the PC, make the modifications save it under another name, and download it.
- Because the IR-communication between the timer and the programming device is bi-directional, also uploading of a switch-plan that resides in a timer is possible, as is viewing this switch-plan on the PC again.
- The programming can be done in a quite office environment compared to the rather noisy "field".
- No long programming times on site.
- Less errors, less time spent, less cost.
- By removing the HMI from the timer (see also photo 4), the timer-base can already be installed on site, while the programming and testing is still going on.

Text for specifiers

- Digital timers from the same family all have the same programming philosophy.
- Digital timers are all microprocessor based and clocked by a quartz crystal to assure a solid time-base.
- The maximum allowable over-time-error of the digital timers is maximum 2.5sec/day at 20°C.
- The family of digital timers incorporates devices that can be synchronised by the DCF-77 signal. In this case the error equals to 0 sec/day.
- The DCF-77-compatible timers have a built in amplifier. No intermediate components between the timer and the antenna are required.
- 1, 2 and 4 channel digital timers available in the same family. The output of each channel is a voltage free change-over relay-contact.
- 1-module devices have a running reserve of at least 150h while the 2-and 6-module devices have a running reserve of at least 3 and 6 years respectively.
- The shortest switching time is maximum 1 minute (1 second for timers with impulse function). The programming accuracy is 1 minute or better.
- Depending on the type, devices with 12, 20, 30, 40, 42 and 400 programming steps are available.
- The range of digital timers must include devices with the block-programming feature.
- Manual override to ON, FIX ON and FIX OFF is possible at all time and per individual channel.
- The digital timer can switch from summer to winter time
  - in an automatic way, according to the European Unions' statutory summer time regulation (pre-programmed and not alterable), or
  - in a calculated way, always in the same week and on the same day of that week.
- All digital timers can be sealed in order to avoid accidental or deliberate alteration of time, date and program.
- A clear high-contrast LCD provides the user with all necessary information such as actual time, day of the week and date if applicable, output status per channel, summer/winter, manual override, etc.
- The digital timers all have a circuit indicator window, in order to easily identify their function.
- The yearly timers can be programmed by means of Windows 95 (or up) –compatible software. Down- and uploading is accomplished by the intermediate use of a handheld IR programming tool.
- All terminals have the safety feature and have captive Pozidriv screws.

Galax LSS

Light sensitive switches

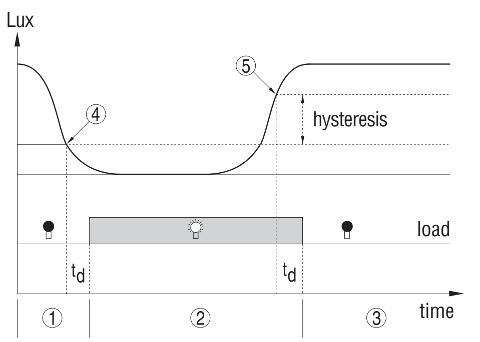
Function and range

A light sensitive or twilight switch is an electronic switch that switches its output-contact based on the intensity of the ambient light, measured by a photocell.
For DIN-rail mounting, a 1-channel, 2-channel and 1-channel with integrated digital timer are available. They all have a separate photocell delivered with them.
For wall mounting, an all-in-one device, integrating the photocell, the amplifier and the switch (relay) itself, is offered.

Operation

As long as the light intensity is above the switch-on threshold value, the output relay remains de-energised and the output contact is open (see ① in fig.1).
Once the light intensity drops below the switch-on threshold value ④ and stays below this threshold value during time td, after td, the output relay is energised, and the output contact switches over (see ② in fig.1).
When the intensity of the light rises above the switch-off threshold again, ⑤ again after a delay td the output relay is again de-energised (see ③ in fig.1).

fig.1

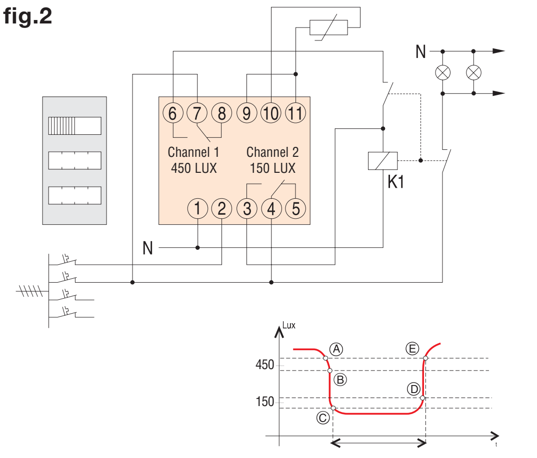


In order to avoid unstable behaviour, a hysteresis exists between the switch-on and switch-off threshold. Also a user pre-settable time delay t_d (0..100sec), both at switch-on as well as at switch-off, further reduces the chance of unstable behaviour.

Applications

User adjustable hysteresis
In case the built-in hysteresis does not respond to the users' requirements, by using a 2 channel light sensitive switch, the on- and off-threshold can be set completely independent of each other (see fig.2).

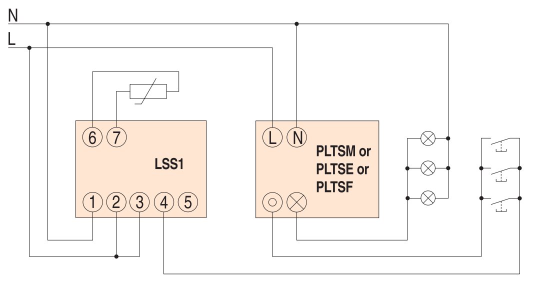
fig.2



Ⓐ **Light intensity > 450 Lux**
Both channel 1 and 2 are in their de-energised position; K1 doesn't pull and the lamps don't light-up.
Ⓑ **450 Lux > Light intensity > 150 Lux**
Channel 1 switches over while channel 2 stays de-energised. The lamps still don't lit-up.
Ⓒ **150 Lux > Light intensity**
Now also channel 2 switches over, energising K1, lighting up the lamps.
Ⓓ **150 Lux < Light intensity < 450 Lux**
Channel 2 is de-energised again, but K1 stays energised through channel 1 of the light sensitive switch.
Ⓔ **Light intensity > 450 Lux**
Channel 1 is de-energised again, K1 is no longer energised and the lamps are no longer lit-up.

Light sensitive switch in combination with a staircase switch
Figure 3 shows the correct way of using a light sensitive switch together with a staircase switch. This application is typically useful when throughout the day normal daylight enters the staircase and artificial light is not required.
Preferably the output contact of the light sensitive switch is in series with the coil and not with the load of the staircase switch for following reasons:

fig.3



- manual override at the level of the staircase is still possible,
- in case the operating push-buttons have indicating lamps, one can easily see if the staircase lights can be operated or not.

Multilevel/multichannel light sensitive operation with 1 photocell
Based on the external light intensity, the light intensity of a (large) room can be adjusted in order to keep the overall light intensity in the room unchanged (see fig.4 and table 1).

Remark
When using only 1 photocell with several (max 10) 2-channel light sensitive switches, only on 1 light sensitive switch terminal 10 needs to be connected to terminal 12 while on all others, terminal 10 is to be left open (see also fig.4 and table 1).

fig.4

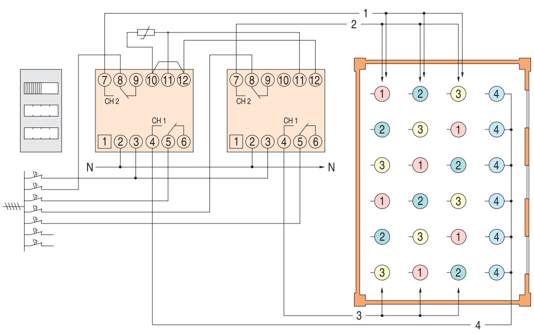


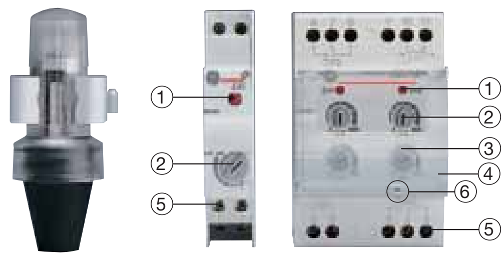
Table 1

Lux	Inner rows			Window row
	Group 1	Group 2	Group 3	Group 4
> 700	all lights on at all time			
< 600	on	off	off	off
< 500	on	on	off	off
< 400	on	on	on	off
< 300	on	on	on	on

Features and benefits

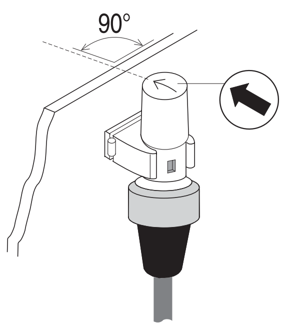
DIN-rail mountable devices
Photo 1 shows the front views of the 1- and 2-channel and 1-channel with integrated digital timer together with the photocell.
An LED ① indicates the status of each output contact (LED on: output relay energised, LED off: output relay de-energised).
By means of a potentiometer ②, the user can select in a continuous way the light intensity that he wants the twilight switch to switch. This threshold can be set between 2 and 500 lux. The hysteresis between the switch-on and switch-off threshold is fixed at 30% of the switch-on level. This means that the switch-off light intensity is at 130% of the switch-on light intensity.
In order to reduce instability and also to avoid nuisance switching, the user can also preset an on- and off-no-response delay, also by means of a potentiometer ③ .
As always, the function of the twilight switch or the circuit that is operated by it can be indicated behind the circuit indicator ④ i.e. garden lights, blinds, etc.
The clearly marked Pozidriv safety terminals ⑤ are all captive. Both the 2-channel as well as the 1-channel twilight switch with integrated digital timer can be sealed ⑥ .

photo 1



From the programming point of view, the 1-channel twilight switch with integrated digital timer has exactly the same features and possibilities as the GLX Q 21 W 20 digital timer (see page T4.26), except for the number of programming steps which is 30 instead of 20. Figure 6 shows the correct mounting of the photocell. The photocell has an IP65 degree of protection.

fig.6



Wall mountable device
This all-in-one device is shown in photo 2.
This complete device, including photocell, amplifier and output contact, has an IP54 degree of protection.

photo 2

Setting up a twilight switch for correct operation

1. Connect the light sensitive sensor or photocell to the appropriate terminals. In case only one sensor is used in combination with several 2-channel light sensitive switches, make sure to connect terminal 10 only once.
2. Connect the load in series with the output contact (i.e. for the one-channel with integrated digital timer, connect terminal 4 with the live, terminal 3 with one side of the load and the other side of the load with the neutral).
3. Put on the power supply (230V on terminals 1 and 2).
4. Put the no-response on- and off-delay to 0 sec.
5. Turn the knob for the setting of the light-intensity at switching completely to the left (minimum).
6. Wait for the intensity of the ambient light to reach the level at which you want the device to switch.
7. Now slowly turn the intensity knob to the maximum, and stop immediately after you see the LED lighting up (the output-contact has switched over simultaneously).
8. Set the on- and off-no-response delay to the desired value.
9. At this time, the light sensitive switch is set up correctly.

Remarks

1. If the LED is still off and you are at full scale, then the intensity of the ambient light is over 500 Lux at that time. A filter should be applied to the photocell and the procedure should be carried out again.
2. If while selecting the threshold, the no-response delay is other than 0, please bear in mind that the output-relay won't switch immediately.
3. Don't put the light-sensor near the light that will be energised since this of course will lead to unstable on- and off-switching of the light.

Text for specifiers

- The (programmable) twilight switch is a noise-free electronic device and has a voltage-free change-over output contact.
- The output status is shown through a LED on the front of the device.
- The one-channel twilight switch has a width of 1 module, while the 2-channel and the 1-channel with integrated digital timer has a width of 3 modules.
- The device is suitable for operating sun-blinds and shutters.
- At cos $\varphi = 1$, the output contact is capable of switching 16A while at cos $\varphi = 0.6$, a load of 2.5A can be switched. Switching of a higher load requires the intermediate use of a contactor.
- The off-threshold level is at least 30% higher than the on-threshold level.
- The no-response delay is user-presetable between 0 and 100 sec.
- One photocell operates one 1-channel twilight switch or up to ten (10) 2-channel twilight switches.
- Besides the modular and DIN-rail mountable devices, an all-in-one wall-mountable device is available.
- The protection degree of the twilight switch is IP20, while the photocell is IP65. For the all-in-one wall-mountable device, the degree of protection is IP54.
- The maximum cable length between the photocell and the light sensitive switch is 100m (2.5mm^2).
- For the DIN-rail mountable devices, the safety-terminals are all captive and have Pozidriv screws as a standard. Their capacity covers the range from 1x0.5mm^2 to 1x6mm^2 or 2x2.5mm^2.
- All DIN-rail-mountable devices are equipped with a transparent circuit indicator.

Additional specifications for programmable twilight switches:

- The twilight switch has a built-in digital time switch with week-program with at least 30 programming steps.
- Block programming is possible.
- Switching accuracy is 1 minute, which is also the shortest switching time.
- The running reserve is at least 3 years from factory.
- Summer-winter change occurs manually or fixed automatically.
- Manual override (fix-on, fix-off) is possible at all time.

Series T

Transformers

Function and range

Transformers are mainly used for 2 reasons:
- To galvanically separate one circuit from the other and / or
- To step down the energy supplier network voltage in order to supply low voltage circuits.

Two main different subfamilies exist in the complete Series T range of transformers:
- Bell transformers and
- Safety transformers.

For the range of the bell transformers, devices with 5, 10, 15 and 25VA output power are available, some with and some others without short-circuit protection, some with one combined secondary winding of multiple voltages 12/24V, others with two separate secondary windings for 8/12V.

This range also includes an 8VA/8V bell transformer with integrated on-off switch.

For the range of the safety transformers, the output-power covers the range of 15 up to 63VA, all have two separate secondary windings for 2 voltages (12/24V) and all are short-circuit proof.
All bell as well as safety transformers have double isolation.

Terminology

For more detailed information, please refer to the standard IEC 61558-2-6 (issued in 1997) which served as base for the definition of the below terminology.

Safety transformer
All Series T transformers have an output power below or equal to 63VA.

According to the above mentioned standard, the ratio between the output voltage at no-load and at rated output can be as high as 100%, at rated frequency and rated ambient temperature.

This means that with a nominal output voltage of 12V (at nominal load), the output voltage at no load is allowed to be as high as 24V.

However, for all Series T safety transformers, this ratio is limited to 105%.

Also, the real output voltage of the highest voltage output at rated output power, at rated supply voltage, at rated frequency and below or equal to the rated ambient temperature, is guaranteed not to differ more than 5% from the rated output voltage (above or below).

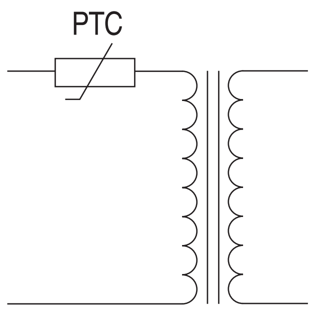
Bell transformer
Completely the same explanation as for the safety transformers can be given here except for the ratio between the output voltage at no-load and at rated output, which is limited to 150% in the case of the Series T bell transformers.

Short-circuit proof
Transformers can be short-circuit proof by construction or by integrating a PTC in the primary of the transformer.

Short-circuit protection by construction is achieved through the geometry of and material used in the transformer. In this case, the transformer saturates when trying to pull more secondary current than allowed. However this causes the transformer to excessively heat up.

A better way of protecting a transformer against overloads or even against destructive secondary short-circuits, is to include a PTC-resistance in the primary of the transformer (see fig.1).

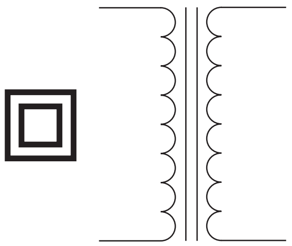
fig.1



In this way, an excessive high secondary current will 'ask' for an excessive high primary current. This high primary current will heat up the PTC, which in its turn will increase its resistance, limiting herewith the primary current.
All safety transformers and some bell transformers are protected against secondary shorts by means of a PTC in the primary winding of the transformer.

Double isolation
Double isolated transformers have two different isolations between their primary and secondary windings: the first being the wire-isolation, the second being the isolation formed by the resin-cast that is completely encapsulating the transformer. Both the symbol used to indicate double isolation as well as the schematic representation of a double isolated transformer are given in figure 2.

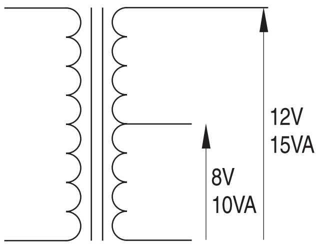
fig.2



One combined vs. two separate secondary windings or voltages

In a transformer with one combined secondary winding for 2 voltages, obviously the cross section of the wire is the same for the whole secondary winding. The different output voltages are derived by connecting at different places of the one secondary winding (see fig.3).

fig.3



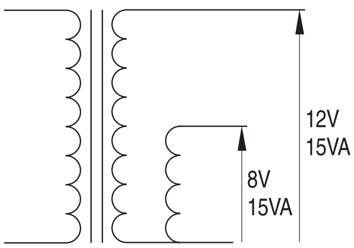
As a consequence, the output power is different for the different output voltages.

Let's assume the power of the transformer in figure 3 being 15VA and two secondary voltages being 12 and 8V. Obviously, the maximum output power that the transformer can deliver is directly depending on the maximum current that may flow through the secondary winding, the latter one being limited by the cross section of the wire.

In this example here, the cross section of the wire used in the secondary winding is such that a current, maximum equal to 1.25A, may flow at all time, generating an output-power of 12 x 1.25 = 15VA. For the 8V output, as the cross-section of the wire is the same as for the 12V output, so is the maximum current ! This means that in this case, the maximum output power is reduced to 8 x 1.25 = 10VA.

In a transformer with separate secondary windings, there exists one winding per output voltage (see fig.4).

fig.4



This allows different cross-sections for both secondary winding wires, making it possible to have the nominal output power at all the different output voltages.

Except for the 666650, 666651 and 666652, all Series T safety and bell transformers have their nominal power present at all output voltages.

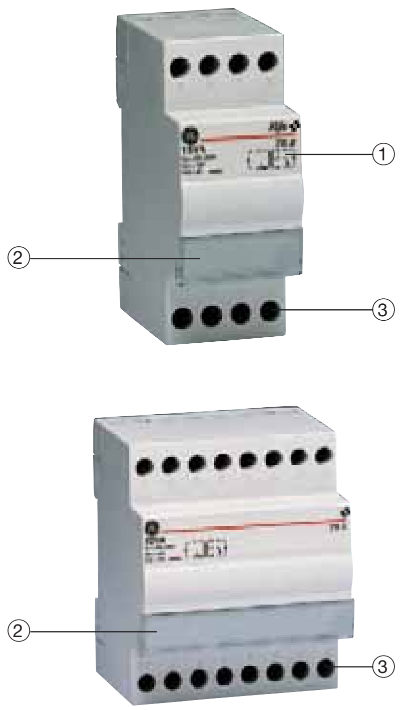
Features and benefits

In figure 5, the front views of the 2 and 4 module Series T transformers are shown.
As always, the main characteristics of the device are printed in the upper part ①.
These are:
- Output power
- Nominal rated primary voltage
- Secondary voltages
- Wiring diagram
- 6 digit ordering code.

From the point of view of output power, a complete range is available: 5, 10, 15, 25, 40, and 63VA, as bell transformer for an output power up to 25VA and as safety transformer from 15VA and up.
The range also includes a bell transformer with integrated on-off switch, a buzzer with integrated transformer, modular bells and modular buzzers on 24V as well as on 230V.

All Series T transformers are short-circuit proof, the 666650, 666651 and 666652 by construction, all the others by means of a PTC

fig.5



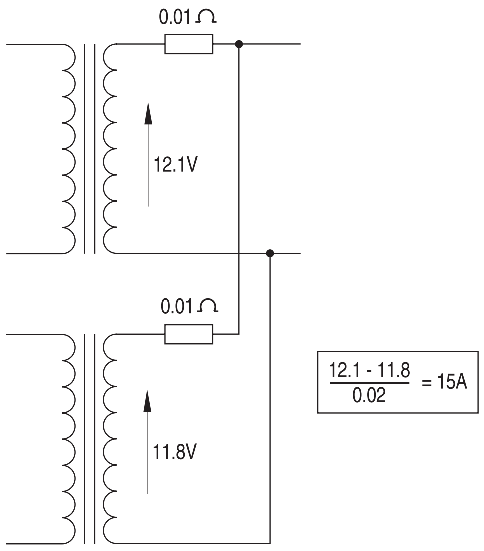
All Series T transformers have double isolation and except for the 666650, 666651 and 666652, all have the rated output power at each output voltage.

As always, the function of the transformer or the circuit that it supplies with power can be indicated behind the circuit indicator ② i.e. bell front door, power supply contactors, ...
The clearly marked Pozidriv terminals ③ are all captive.

General remarks

- DO NOT put secondary windings of transformers in parallel in order to increase the output power, as the slightest difference in output voltage will result in a huge current circulating in both secondary windings (see fig.6).

fig.6



- When supplying contactors or impulse switches at low voltage, and especially when several devices can be operated simultaneously (i.e. impulse switches with centralised command), care should be taken to correctly size the step-down transformer.

Text for specifiers

- All transformers have the CEBEC - IMQ - VDE approval marks.
- All transformers have their nominal output power available on all different output voltages.
- All transformers are protected against short-circuits. A direct short-circuit on the secondary winding will not result in a permanent damage due to excessive heating.
- All transformers have double isolation with an isolation voltage between the primary and the secondary winding of at least 3.75 kV.
- The transformers are cast resin.
- The captive Pozidriv cage terminals have a capacity of 1 to 16mm^2.
- The terminals guarantee a solid, reliable connection.
- The protection degree of the transformer is IP20.
- All transformers are modular and DIN-rail mountable.
- The transformers are all equipped with a transparent circuit indicator.

Series MT

Measurement Instruments

Function and range

The range of AC-measurement-instruments consists of 2 main families: analogue and digital.
The analogue family includes:
- voltmeters
- Ammeters
- frequency meters
- hour counters

The digital range consists of:
- voltmeters
- Ammeters
- frequency meters
- kWh meters
- energy meters
- net analysers

On top of this, several accessories complete the range:
- a complete range of current transformers,
- a complete range of corresponding scale-plates,
- selector switches for switching a single phase measurement instrument between the different phases of a 3-phase energy distribution system,
- a very user friendly Windows-95 (and up) software for use with the net-analyser
- an RS232-RS485/422 signal converter for interfacing between a PC and the net-analyser.

Terminology

Class
The accuracy or class of a measurement instrument is the maximum error between the displayed value and the real value.

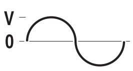
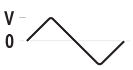
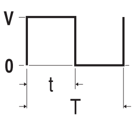
For an **analogue** measurement instrument, the class is equal to a percentage of the full scale. On a voltmeter with 300V full scale, a class of 1.5 means a maximum error on the reading of 4.5V, no matter what the actual reading is. This means that if a voltage of 228V is measured, the real value can be anything in between 232.5 and 223.5V, whereas if the reading would be 10V, the actual value would be between 5.5 and 14.5V.

On a **digital** measurement instrument, on top of the measurement-error, there is also a rounding error since the display does not have an unlimited number of digits. In this case, if the full scale is 300V and the display has 3 digits, a device with a class of 0.5% ± 1digit can have an error in the reading of maximum ± 2V, again as above, independent of the actual reading.

True-RMS versus Average AC-metering
Independently of the electrical signal waveform, a true-RMS meter (true root-mean-square meter) measures the correct electrical value (except for the class-error of course; see above). This means that a true-RMS-Ammeter would measure exactly the same current as would be measured by a DC-Ammeter, metering a current flowing through the same resistance, provoked by a DC-voltage equal to the RMS-value of the voltage waveform. Figure 1 shows different waveforms with their respective RMS-values.
An average-metering instrument on the other hand, measures the magnitude of the electrical signal and multiplies it with a factor. As this multiplier is only correct for one specific waveform (see figure 1), the measurement is incorrect, when measuring with this device an electrical signal with a waveform other than the one for which it was meant to be.

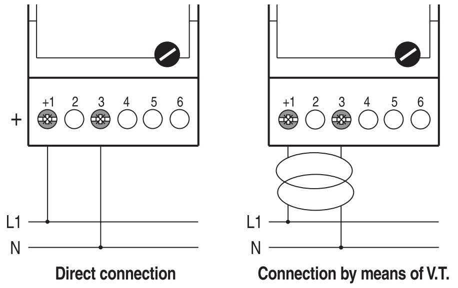
All Series MT analogue measurement instruments are true-RMS, all simple digital measurement instruments (V, A and W) are average-metering instruments and all high-end digital measurement instruments (kWh and net analysers) again are true-RMS measurement devices.

fig.1

Waveform Shape	Crest Factor (C.F.)	AC RMS	AC + DC RMS	Average Responding Error
	1.414	$\frac{V}{1.414}$	$\frac{V}{1.414}$	Calibrated for 0 error
	1.732	$\frac{V}{1.732}$	$\frac{V}{1.732}$	- 3.9 %
	$\sqrt{\frac{T}{t}}$	$\frac{V}{C.F.} \times \sqrt{1-\left(\frac{1}{C.F.}\right)^2}$	$\frac{V}{C.F.}$	- 46 % for C.F. = 4

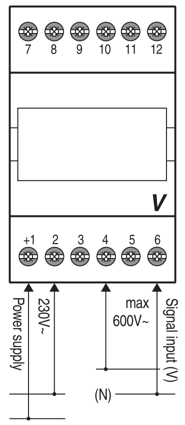
Voltmeter

fig.2 Connection diagram



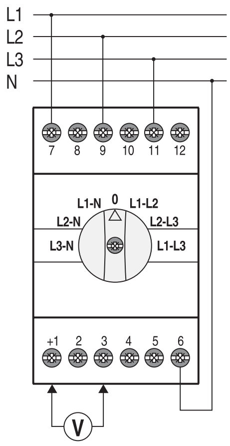
In the case of a digital voltmeter, besides the connection of the circuit of which the voltage needs to be measured, an independent auxiliary power supply needs to be connected as is shown in figure 3. The fact that the measuring circuit is different from the supply circuit makes this voltmeter extremely versatile, as it can be used to measure all voltages within its scale. This also minimises the measuring error due to the load-influence of the voltmeter itself.

fig.3



When using one single-phase voltmeter in a 3-phase system, the different line-to-line or line-to-neutral voltages can be measured by using the voltage selector switch (fig.4).

fig.4



Ammeter

Similar to the previous 3 figures, figures 5 to 7 show the connection diagrams for the Ammeters.

fig.5

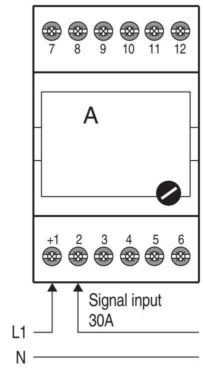


fig.6

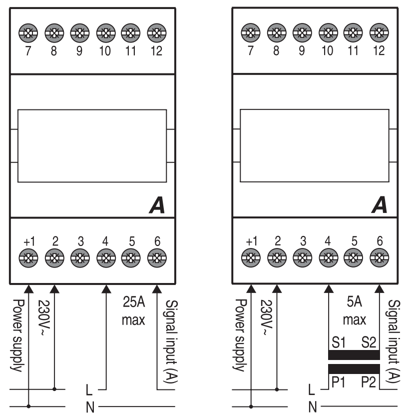
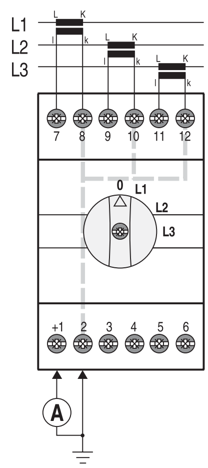


fig.7

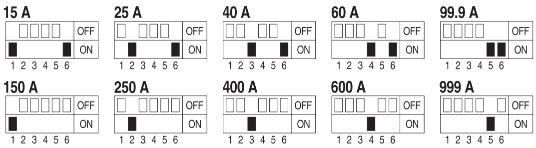


The scaleplates of the analogue Ammeters can be easily interchanged as is illustrated in photo 1.

photo 1

Using a digital Ammeter in combination with a current transformer, requires the correct set-up of the Ammeter. The multiplying factor is set by means of dip-switches as is shown in figure 8.

fig.8



Frequency meter and hour counter

Figures 9, 10 and 11 show the connection of the frequency meters and of the hour counters. Note that in the case of the digital frequency meter, the internal electronics are supplied externally through a separate auxiliary supply.

fig.9

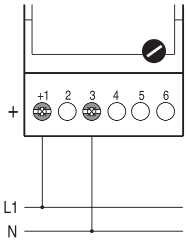


fig.10

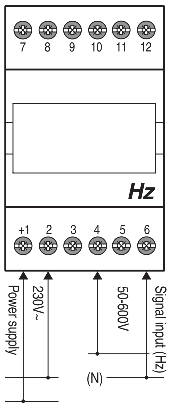
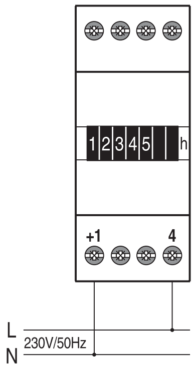


fig.11



Wattmeter

The single- and three-phase Wattmeters are connected as shown in figures 12 and 13.

fig.12

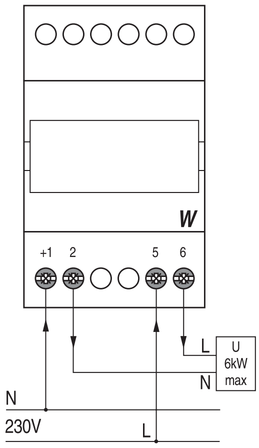
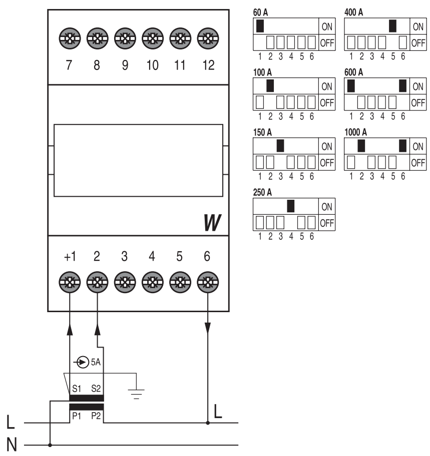


fig.13



Energy (kWh) meter

Figures 14 to 18 show the different ways of connecting the single and three-phase energy meters. The impulse output can be used to monitor the amount of consumed energy from distance (i.e. connection with counter-input-card of PLC).
Like the digital Ammeters, correct set-up of the current inputs is accomplished by means of dip-switches located at the front-top of the device (fig.19 next page).
The impulse output also needs to be correctly set-up. Figure 20 (next page) shows the setting of the dip-switches for the use of different current transformers and for different impulse output setups.

fig.16

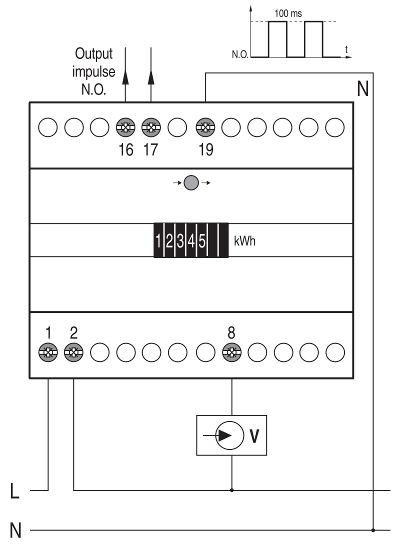


fig.14

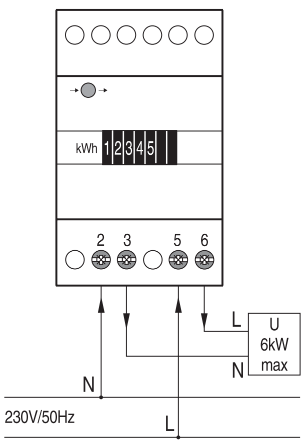


fig.17

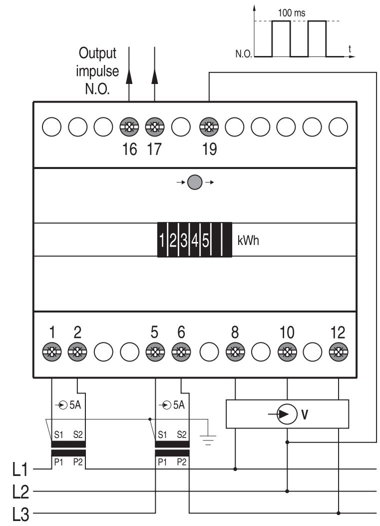


fig.15

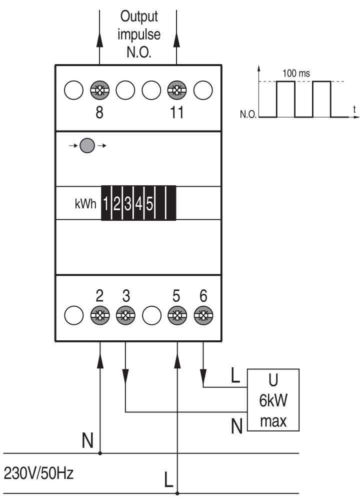


fig.18

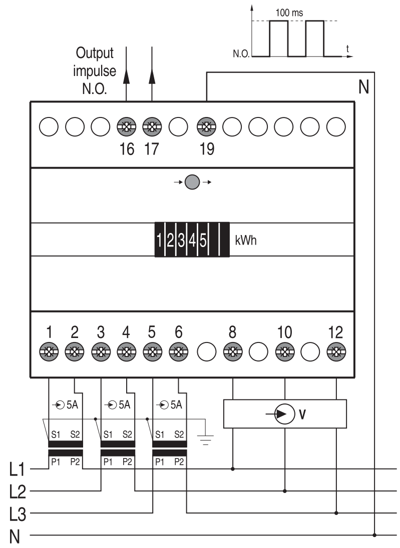
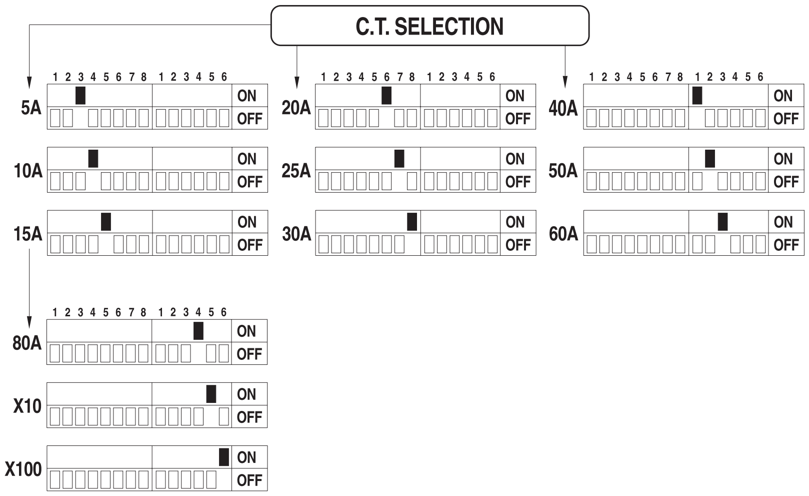
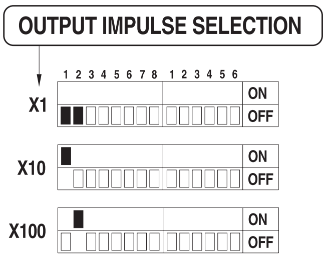


fig.19



C.T. SELECTION
1 2 3 4 5 6 7 8 1 2 3 4 5 6
ON
OFF
5A
10A
15A
20A
25A
30A
40A
50A
60A
80A
X10
X100

fig.20



OUTPUT IMPULSE SELECTION
1 2 3 4 5 6 7 8 1 2 3 4 5 6
ON
OFF
X1
X10
X100

Net analysers (Multi Meters)

The series MT DN 1 and MT DN 3 are electronic instruments especially developed for measuring and controlling several electrical parameters such as voltage, current, power, energy, harmonic distortion in a single or three phase network.
All the measured values can be viewed in real time on the analyser display or transmitted to a remote display (PC/PLC) through a serial interface RS 485 (except the harmonic waves).

Electrical parameters	Measured values	Computed values
Current	I1-I2-I3 (A)	
Active power	P1-P2-P3 (W)	
Reactive power	Q1-Q2-Q3 (VAR)	
Frequency	Fr (Hz)	
Apparent power		S1-S2-S3 (VA)
Power factor		Pf1-Pf2-Pf3 (cos φ)
Total active power		Pt (W)
Total reactive power		Qt (VAR)
Total apparent power		St (VA)
Total power factor		Pft (cos φ)
Harmonic distortion (numerical and graphic)		3xV and 3xI (h1…h15%)
Total harmonic distorsion		
Voltage crest factor		3xVthd and 3xIthd (%)
Current crest factor		3xVcrs
Totals integrated on time of S-Q-P-Pf-F		3xIcrs

The above measured values change automatically when the voltage and current ratios change

Technical features

Analyser version	V:427
Display	LCD back illuminated high performance 4 lines x 20 columns alphanumerical characters FFT semigraphic
Voltage input	150V - 300V - 600V
Secondary current	5A RMS (1A rms on request)
Measure method	128 scannings/period (for the 3 currents and 3 voltages)
Elaboration time	200 ms
Class	0.5% for voltage and current 0.3% for frequency 1% other parameters
Serial communication	RS 485 (2 wires op to insulated), 9600 baud
Protocol	MODBUS (other on request)
Memory	EEPROM 2kB
Address no.	0... 255
Power supply	230V + 10%/-20% (other on request)
Consumption	< 5VA
Dimensions	8 modules

Operation

Display and programming of the various parameters is done by 3 keys:
- UP (next)
- DOWN (previous)
- ENTER (confirmation on parameter alteration).

Press ENTER to light up the display.

With the display illuminated, the first page shows voltage, current, active power and power factor for all phases.

	L1	L2	L3
3xV	0000	0000	0000
3xA	0000	0000	0000
3xW	0000	0000	0000
3xPf	0000	0000	0000

By pressing UP, the second page displays the apparent, reactive and active power and cos φ for all phases.

	L1	L2	L3
3xVA	0000	0000	0000
3xVAR	0000	0000	0000
3xW	0000	0000	0000
3xPf	0000	0000	0000

By pressing UP again, the third page shows the total values of the power, frequency and the cos φ.
't1' is the time integration (0-15 min.) of the values of IPM and IPL shown on the fifth subpage (see below).

totals:			(t1 15 min.)
VA	0000		
VAR	0000	Fr	0000 Hz
W	0000	Pft	0000 ind (cap)

By pressing UP once more, the fourth page shows the total values (import or export) of the active and reactive energy. The arrows inform about the actual function of the analyser.

+kWh	(T)>	00000000.00
+kVARh	(T)>	00000000.00
-kWh	(T)>	00000000.00
-kVARh	(T)>	00000000.00

By pressing ENTER, the first subpage shows the values of the active/reactive energy of the 1st tariff meter.

+kWh	(1)	00000000.00
+kVARh	(1)	00000000.00
-kWh	(1)	00000000.00
-kVARh	(1)	00000000.00

By pressing ENTER, the second subpage shows the values of the active/reactive energy of the 2nd tariff meter.

+kWh	(2)	00000000.00
+kVARh	(2)	00000000.00
-kWh	(2)	00000000.00
-kVARh	(2)	00000000.00

By pressing ENTER, the third subpage shows the values of the active/reactive energy of the 3rd tariff meter.

+kWh	(3)	00000000.00
+kVARh	(3)	00000000.00
-kWh	(3)	00000000.00
-kVARh	(3)	00000000.00

By pressing ENTER, the fourth subpage shows the values of the active/reactive energy of the 4th tariff meter.

+kWh	(4)	00000000.00
+kVARh	(4)	00000000.00
-kWh	(4)	00000000.00
-kVARh	(4)	00000000.00

By pressing ENTER, the fifth subpage shows the actual peak values (IPM) and previous (IPL), integrated in 15 min., of the active/reactive energy

+kWh	IPM	00000000.00
+kVARh	IPM	00000000.00
+kWh	IPL	00000000.00
+kVAR	IPL	00000000.00

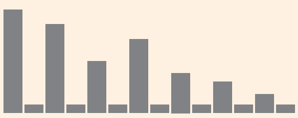
By pressing ENTER, the sixth subpage shows the registered values on two digital inputs, if connected.

cnt. 1	00000000.00
cnt. 2	00000000.00

By pressing UP, the fifth page shows the total harmonic distortions and the crest values of voltage and current, of the three phases.

	L1	L2	L3
3xVthd%	0000	0000	0000
3xVcrs	0000	0000	0000
3xIthd%	0000	0000	0000
3xIcrs	0000	0000	0000

By pressing UP, the sixth page shows in a numeric and graphic way, the distortion until the fifteenth harmonic wave.



V1
000%
h3
000%

By subsequently pressing ENTER, the relative importance (influence) of the different harmonics is displayed (h1, h2, ... h5). By pressing ENTER for more than 2 seconds, you can select the electrical quantity (V1, V2, V3, I1, ...) which you want the harmonic distortion to be displayed.

Configuration

By pressing the up- and down-keys simultaneously for more than two seconds, the configuration menu is entered.

CONFIG	V.427
Meter	System
Inputs	Outputs
Password	> exit

As long as the password is not entered, none of the submenus can be accessed and consequently none of the parameters can be altered. With the cursor (arrow) on "password" press the up- and down-keys simultaneously. On the display, "password ...." appears. Now press in sequence "up","up",'down", "up". You will see now "New password" on the display. Now it is possible to move the cursor i.e. to "meter" The cursor (arrow) can be moved by pressing enter.

By moving the cursor in front of "Meter" and by pushing the UP key, the meter submenu appears as shown below:

volt range	000 V
volt in mult	000 x
curr. range	0000 A
	> exit

As before, by pressing ENTER, you can change the position of the cursor.

>volt range: by pressing UP or DOWN, the input voltage is set (150V, 300V or 600V are the ranges; if you have 100V input, choose 150V)
>volt in mult: by pressing UP or DOWN, the multiplication factor is set (from 1x to 240x)
>curr. range: by pressing UP or DOWN, the primary current of the transformer is set, from 5A to 10000A (in steps of 5A)
>exit: by pressing UP or DOWN, you return to the CONFIG menu

By choosing System and pressing UP, the following screen appears:

baud rate	0000
net addr.	000
rst energy	(rst IPmax)
rst counts	>exit

>baud rate by pressing UP or DOWN, you can change the reading speed (bit/sec) between 1200, 2400, 4800 and 9600 baud
>net addr by pressing UP or DOWN, you can choose the address, from 1 to 255
>rst energy by pressing UP or DOWN, you can cancel the memorised energy values. By pressing ENTER, you see >rst IPmax and pressing UP or DOWN, you reset the actual values
>rst counts by pressing UP or DOWN, you reset the totals on the digital inputs
>exit by pressing UP or DOWN, you come back to the CONFIG menu

Again, to change the existing values, it is necessary to enter the password as explained before.

By choosing 'Inputs' and pressing UP, the following screen appears:

inp.1	000 /imp
inp.2	000 /imp
ener IP	15 min
tarifs: 2(4)	>exit

>inp.1 by pressing UP or DOWN, you change the 'weight' of the impulses on the digital input n° 1

>inp.2 by pressing UP or DOWN, you change the 'weight' of the impulses on the digital input n° 2

>ener IP by pressing DOWN, you can modify the integration time of the totals by pressing UP, you see the synchro-nisation screen of the input n° 1

inp.1	ener sync
inp.2	000 /imp
ener IP	inp 1
tariffs: 2(4)	>exit

As before, by pressing UP again you see the synchronisation screen of the input n° 2

inp.1	000 /imp
inp.2	ener sync
ener IP	inp 2
tariffs: 2(4)	>exit

As before, by pressing UP again, you can use the input n° 3 (available when only 2 tarifs are choosed)

inp.1	000 /imp
inp.2	000 /imp
ener IP	inp 3
tariffs: 2(4)	>exit

>tariffs by pressing UP or DOWN, you change the tariff n° 2 or 4 (on the screen with 'ener IP 15 min.' only)

>exit pressing UP or DOWN, you come back to the CONFIG menu

Again, to change the existing values, it is necessary to enter the password as explained above.
By choosing 'Outputs' and pressing UP, the following screen appears:

out1	out2	
al:	al:	
0000	0000	
-t: 00	-t:00	>exit

>out 1/out 2 by pressing UP or DOWN, you choose the alarm type (< min or > max)

>al by pressing UP or DOWN, you choose the parameters for which you want the alarm option (always ON-always OFF-Pft-Hz-Vx-V3-V2-V1-Ix-I3-I2-I1-Qt-Pt-pl kVARh-pl kWh)

>000 by pressing UP or DOWN, you change the numerical value of the alarm

>-t by pressing UP or DOWN, you change the alarm delays (0…15 sec)

>exit by pressing UP or DOWN, you come back to the CONFIG menu

Again, to change the existing values, it is necessary to enter the password as explained above.

Remark
Choosing 'Password' you can change the values into the various screens, as explained before, by pressing in sequence: UP-UP-DOWN-UP
You can also enter a secret, personalised password that must have a different sequence with respect to the password already mentioned above.

To enter a personalised password, go to the CONFIG menu, move the arrow to >Password; press UP or DOWN until you see >Password:..........; press in sequence UP-UP-DOWN-UP until you see >New password:..........; enter the new sequence, (different from the previous); the word 'repeat.........' appears, now repeat the new sequence and the new password is memorised.

To exit from the CONFIG menu, move the arrow to the >exit, then press UP.

Connection diagrams

fig.22 1-phase net analyser

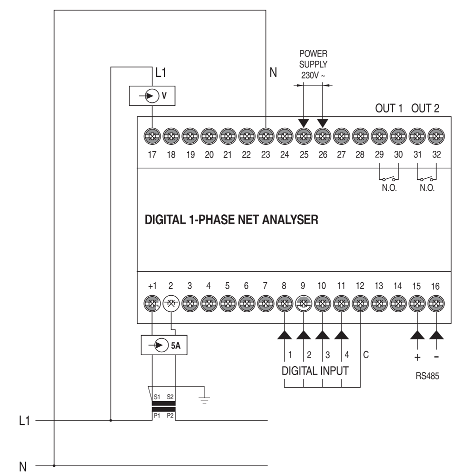
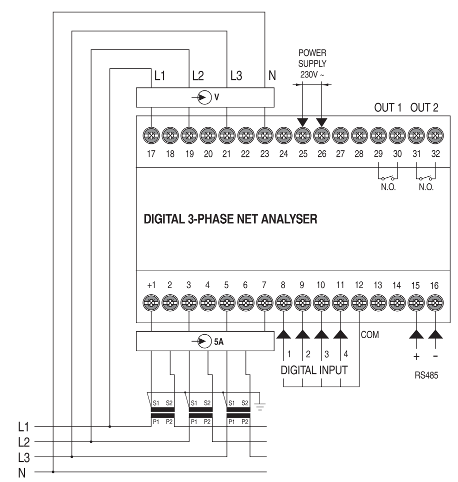


fig.23 3-phase net analyser



Typical setups for serial communication

fig.24

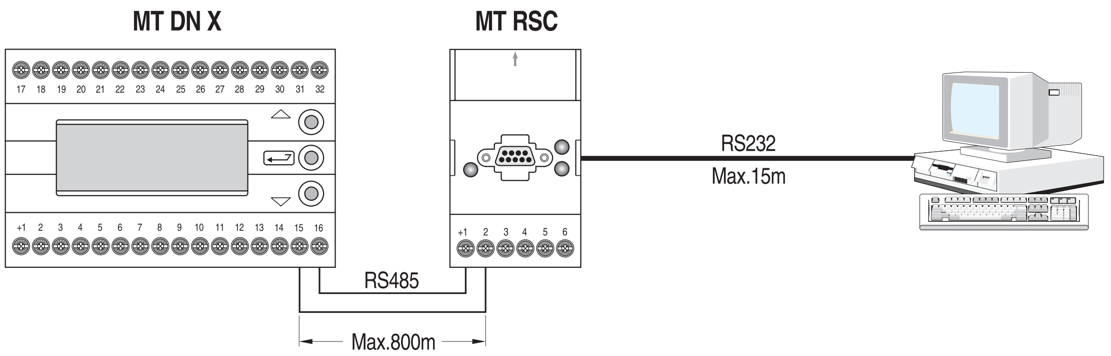


fig.25

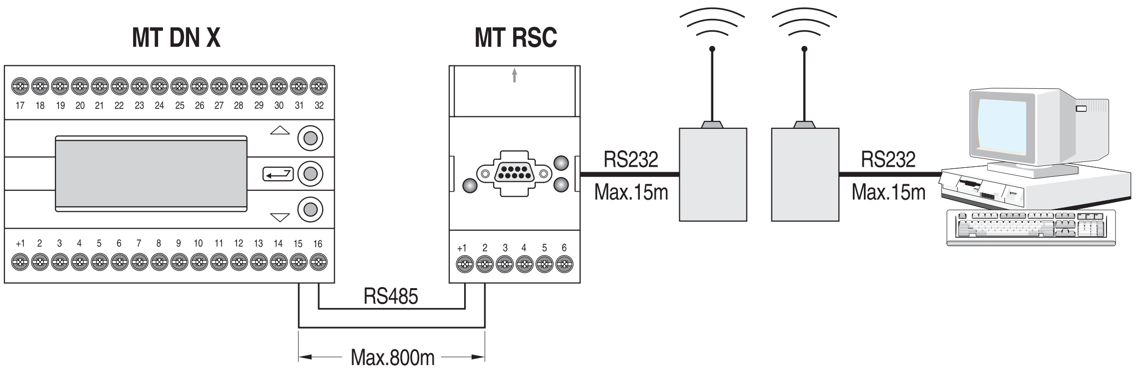
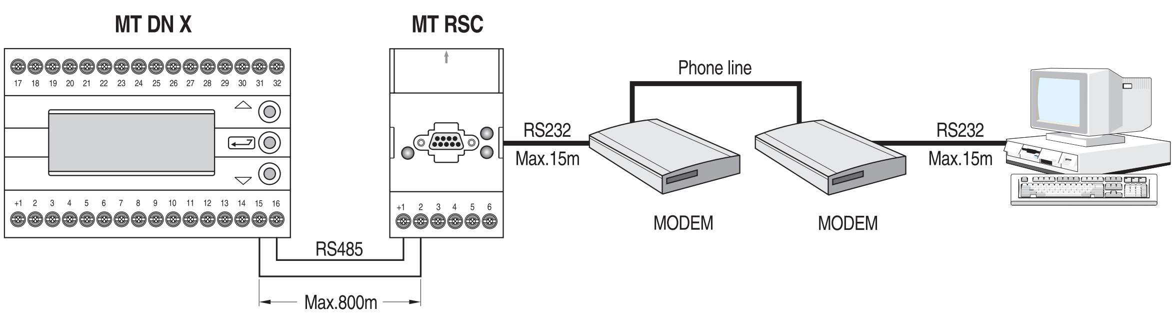


fig.26



SurgeGuard

Surge arresters

Introduction

In order to protect any type of electric or electronic equipment such as TV's, PLC's, computers, or even entire electrical installations against destructive overvoltage surges, the installer will nowadays use *Surge Arresters* or *Surge Protection Devices (SPD's.)*
Besides the trivial benefit of protecting the installation and the equipment against destructive overvoltage surges, the benefits indicated below are less obvious but most certainly more important:

- Avoid downtime; this secondary effect on a business may be much greater than just the cost of the PCB which was destroyed by the surge;
- Avoid equipment lifetime reduction by avoiding degradation of internal components due to long term exposure to low level transients;
- Avoid disruption or malfunction; although no physical damage is apparent, surges often upset the logic of microprocessor-based systems causing unexplained data loss, data and software corruption, system crashes and lock-ups.

When comparing the cost of installing SPD's with the downtime cost and the cost of repairing an electrical installation and to replace all hooked-up equipment after a serious surge has "visited", there is no further justification needed and the need to install SPD's, even in the smallest installation, becomes obvious.

Background

Disturbances
Table 1 summarises the different disturbances causing different problems while propagating in an electrical energy-distribution system.
Besides devices used to suppress overvoltage transients, typically characterised by a very big magnitude (1000's of volts) and very short duration (microseconds), devices for noise filtration (low voltage, low energy, random) are also offered.

Origin of Surges
The most commonly known "field"-surge generators are listed below:

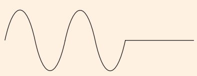
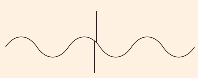
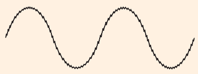
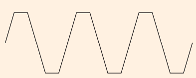
- Electronic dimmers based on the phase-cut principle
- Motors and transformers. At startup, they are a real short-circuit, generating a very high inrush-current
- Welding machines
- Lightning strikes, both direct or indirect (inductively coupled)
- Power-grid-switching by the energy-supplier.

Voltage-generation mechanism
As all surge originators are currents, the mechanism that translates this current into a voltage is:
U = -L x (di/dt) in which:

- U = generated voltage,
- L = inductance of the conductor in which the current is flowing,
- di = the change in current,
- dt = the time in which the current-change di took place.

As the change in current is very high, while the duration is very short, even with a low conductor inductance, the result of L x (di/dt) can become astronomical.

Disturbances in an electrical energy distribution system (table 1)

Problem	Description	Duration	Cause	Effect
Temporary interruption/long-term outage 	A planned or accidental loss of power in a localized area of community	Temporary: less than 1 minute Long-term: more than 1 minute	Equipment failure, weather, animals, human error (auto, accidents, etc)	Systems shut down
Sag/swell 	A decrease (sag) or increase (swell) in voltage	From milliseconds to a few seconds	Major equipment start-up or shutdown, short-circuits (faults), undersized electrical circuits	Memory loss, data errors, dim or bright lights, shrinking display screens, equipment shutdown
Transient 	A sudden change in voltage up to several thousand volts (also called an impulse, spike or surge)	Microseconds	Utility switching operations, starting and stopping of heavy equipment or office machinery, elevators, welding equipment, static discharges, lightning and storms	Processing errors, data loss, burried circuit boards or other equipment damage
Noise 	An unwanted electrical signal of high frequency from other equipment	Sporadic	Interference from appliances, microwave and radar transmissions, radio and tv broadcasts, arc welding, heaters, laser printers, loose wiring and improper grounding	Noise disturbs sensitive electronic equipment, but is usually not destructive (can cause processing errors and data loss)
Harmonic distorsion 	A distortion in the voltage due to the power supplies in some equipment	Sporadic	Power supplies in computers, adjustable speed drives, and fluorescent lighting	Overheating of motors, transformers, and wiring

Overvoltages and dito protection

All electrical and electronic devices on the market are normally designed according to the applicable standards. According to these standards (the normal operating voltage and the applicable creepage distances) the equipment and the installation must be able to withstand against a certain voltage, without being destroyed. In general, this voltage is called the _breakdown voltage_ and is equal to several times the normal operating voltage.

If the device is hit with a voltage above this breakdown voltage, no guarantee is given for the normal operation of the device and no guarantee is given that afterwards the device will still work properly. In the majority of cases where a device or installation is hit with a so-called _over-voltage_, the device or installation is completely ruined and becomes extremely dangerous towards the environment.

To avoid these severe surges from travelling through the installation, and destroying all connected devices, SurgeGuard SPD's should be installed.

The voltage at which an SPD clamps to is known as the _protection voltage_ Up (see below) and should always be lower than the breakdown voltage of the device or installation that is to be protected. Table 2 summarizes the 3 main categories of equipment with their respective protection levels.

Protection levels (table 2)

U_P=2.5kV	U_P=1.8kV	U_P=1kV
Electrical control devices (i.e. wiring devices), motors, transformers	Appliances (dish-washer, laundry machine, freezer, refrigerator, hot, ...)	PLC's, CNC-controllers, personal computer, computer network, fax, modem, hi-fi, VCR, TV, alarm system, medical scanning and monitoring equipment, ...

Solutions
Temporary Uninterruptible or standby power supply (for outages of about 15 minutes) Motor generator set (for outages of very short duration only) Long term Standby generator
Computer or equipment relocated to a different electrical circuit Voltage regulator Power line conditioner Uninterruptible power supply Motor generator
Surge suppressor Power line conditioner Motor generator
Isolation transformer Power line conditioner Motor generator Uninterruptible power supply Loose wiring and grounding problems corrected
Electrically separate loads that cause harmonic distortion Power line conditioner Uninterruptible power supply Motor generator Oversize electrical equipment so it does not overheat

Terminology

Before going into more detail in technology matters, this chapter clarifies most of the SPD-related terminology.

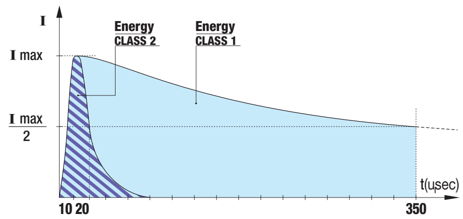
I_{MAX}

Is the maximum current the SPD can carry (deviate to ground). According to the standard, an SPD should be able to carry this current at least once.

Class

The Class of the SPD defines the amount of energy the device is able to deviate towards the protective ground. As surges are impulses, and since the amount of energy is proportional to the surface below the curve (see fig.1), the class can also be defined by giving the rise-time, the time to fall back to 50% and the magnitude (I_{MAX}) of the impulse (see also fig.1).

fig.1



In order to be able to compare different devices, 3 standardized impulse waveforms have been defined:

- 10/350 (Class 1) which has the highest energetic content,
- 8/20 (Class 2), and
- 4/10 (Class 3) with the lowest energetic content.

Class 1 devices are normally used for front-end protection, i.e. for high-energy deviation coming from direct lightning strikes whereas class 2 and class 3 devices are used at a lower level in order to reduce the residual voltage (U_P) as much as possible.

U_P

The protection voltage or residual voltage (U_P) is the voltage to which the SPD clamps when it is hit with a standardised impulse waveform for its specific class, with a magnitude equal to I_{NOM}.

I_{NOM}

Is the current that the SPD can deviate (minimum 20 times). This current is of course much lower than I_{MAX}.

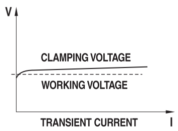
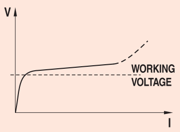
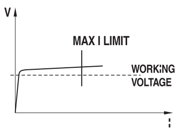
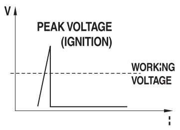
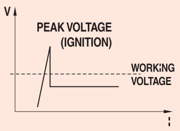
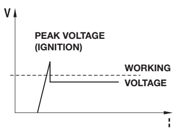
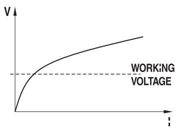
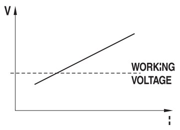
SPD-technology

Table 3 shows the various technologies that can be applied to protect an installation or equipment against overvoltages. Their respective main characteristics are also shown. To protect a mains-power distribution system from overvoltage surges, only Zinc-Oxide-Varistor (or more in general the Metal-Oxide-Varistor, in short the MOV), Gas-Tube and Spark-Gap technologies are used.

SurgeGuard SPD's

Class 2 SurgeGuard devices all have MOV-technology inside. Besides the MOV's, each phase is also equipped with a thermal fuse in order to take the device of-line in case the MOV breaks down and becomes a short-circuit (i.e. after thermal runaway). In addition, all devices have an optical fault-indicator and some have a voltage-free contact for distant reporting. This contact reflects the status of the thermal fuse, and thus indirectly also the status of the MOV. Once the indicator turns red or the contact has switched over, the SurgeGuard should be replaced as soon as possible.
The class 1 SurgeGuard devices are based on spark-gap technology. As a spark gap can never turn into a short-circuit, the class 1 devices don't have a thermal fuse and as a consequence neither an auxiliary contact nor an optical status indicator.

Characteristics and features of transient voltage suppression technology (table 3)

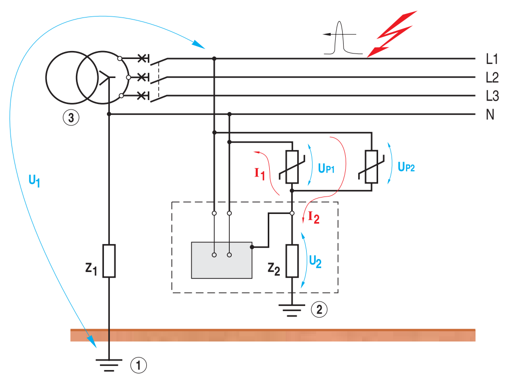
Device type	V-I characteristics	Leak-age	Follow on I	Clamping voltage	Energy capability	Capacitance	Response time	Cost
Ideal device		Zero to low	No	Low	High	Low or high	Fast	Low
Zinc oxide varistor		Low	No	Moderate to low	High	Moderate to high	Fast	Low
Zener		Low	No	Low	Low	Low	Fast	High
Growbar (zener + SCR Combination)		Low	Yes (latching Holdin I)	Low	Medium	Low	Fast	Moderate
Spark gap		Zero	Yes	High ignition voltage Low clamp	High	Low	Slow	Low to high
Triggered spark gap		Zero	Yes	Lower ignition voltage Low clamp	High	Low	Moderate	High
Selenium		Very high	No	Moderate to high	Moderate to high	High	Fast	High
Silicon carbide varistor		High	No	High	High	High	Fast	Relative low

Different earthing systems require different SPD’s

Depending on how the earthing of the power distribution system is implemented, single pole or multipole SPD’s are required in order to fully protect the installation and the hooked-up equipment against destructive overvoltages. For an in-depth explanation about the different existing earthing systems, please refer to page T2.4.
For the explanation below, we will always take the worst case example: a direct lightning-strike-hit on only one of the conductors of a 3-phase energy distribution system, discharging through this one conductor only. We have also simplified the drawings by only showing a varistor, and not the complete internal circuit including the thermal fuse, fault-indicator- and auxiliary-contact-circuit.

TT and TN-S earthing systems require multipole SPD’s
Figure 2 shows a ***TT-earthing system***, with varistors installed only between each live conductor and protective earth (PE), and also between the neutral and the PE.

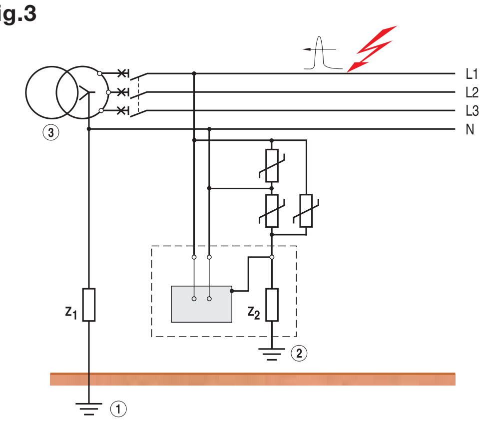
fig.2



Right after the direct lightning strike hit, the tremendous amount of free charges injected in to the conductor, generates a very strong electrical field, pushing these free charges as far apart as possible. As a result, an impulse-wave-shaped current travels away from the point of impact, in both directions along the conductor towards the PE, generating a voltage-drop across the conductor given by the law U = -L x (di/dt). Typically, a 10kA 8/20 current-impulse generates a voltage of 1250V across a wire with a length of 1m.
The varistor installed on the hit-by wire will clamp this generated voltage to a value corresponding to the instantaneous value of the current, given by the U-I-plot of the varistor (see table 3), and will deviate the current (I_2) towards the local PE.
Because of the relative high local PE-impedance (typically Z_2 = 10…30 ohm), the voltage-drop U_2 generated by I_2 could easily reach the level at which the varistor between local PE and Neutral starts to clamp, and therefore also starts to conduct current towards the PE of the energy supplier (I_1).
Once this happens, the bulk of the current will flow through this parallel path, since on the side of the energy supplier, the earthing as well as the generator itself (or secondary of an intermediate step-down transformer) has a very low impedance (typically Z_1 = 0.3…1 ohm).

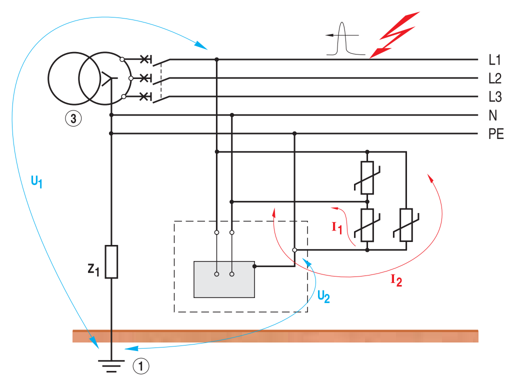
As you can easily see, the clamping voltage between live and neutral is $U_{P1} + U_{P2}$, which is roughly twice the clamping voltage of a varistor and not once as may be expected. This results in a very poor degree of protection. Therefore, in this case an ***additional varistor between each live conductor and the neutral*** is necessary to guarantee full protection (see fig.3).

fig.3



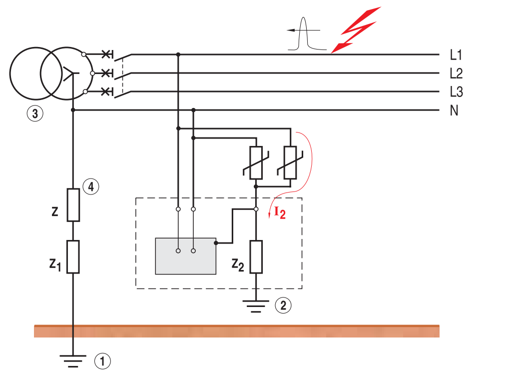
Based on the above explanation, you can easily see that in the case of a ***TN-S earthing system***, multi-pole SPD’s are required in order to fully protect the installation and hooked-up equipment against over-voltage-surges (fig.4).
Here however, since the impedance towards earth via the neutral-conductor is roughly the same as the one via the PE-conductor, both conductors will share the current–surge, roughly equally. Nonetheless, again the varistor between the neutral and PE will conduct current, because it will clamp the voltage across itself to its U_P and therefore again the clamping voltage between the live and the neutral becomes roughly twice U_P.

fig.4



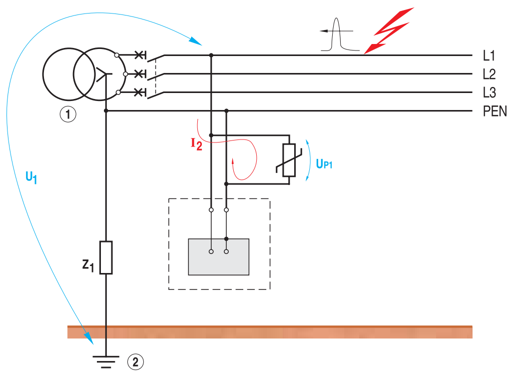
IT and TN-C earthing systems require single-pole SPD's
As can be seen in figure 5, the main difference between a TT- and an ***IT-earthing system*** is the high impedance Z through which the generator or the secondary of the step-down-transformer is grounded in an IT-system.
Therefore, the low-impedant current-path towards the PE of the energy-supplier which exits in a TT-system, no longer exists in an IT-system, and for this reason will never conduct current. So no additional varistors between the live conductors and the neutral are required to guarantee full protection.

fig.5



In case of a ***TN-C-earthing system***, the Neutral- and PE-conductor are combined in to one PEN-conductor (fig.6). Therefore there is no alternative parallel current path as it exists in a TN-S-system and thus the highest possible voltage between the neutral and a live conductor is equal to the clamping voltage of only one varistor.

fig.6

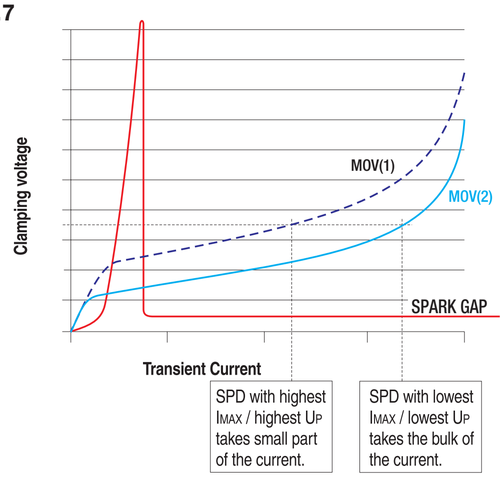


TN-C-S earthing systems
Last but not least, in a ***TN-C-S-earthing-system***, always use multipole SPD's where the neutral is separately available and the equipment requires the Neutral to be connected. Use single pole SPD's only if you are sure that the neutral is not separately available or if the neutral doesn't need to be connected to the equipment (i.e. for a 3-phase 400V delta motor).

Cascading of SPD's

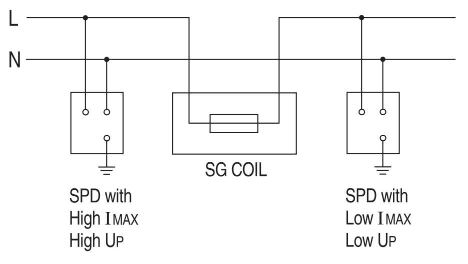
In areas where the exposure to lightning is very high, SPD's with a high I_{MAX}, must be installed (see below). In general, the U_P of those devices is too high to protect sensitive equipment like i.e. TV-, VCR-, and computer-equipment.
Therefore, besides these high I_{MAX} / high U_P front-end SPD's, devices with a lower U_P are to be installed in cascade (parallel) in order to bring the protection voltage down to a reasonable level.
Special care must be taken when two SPD's, both based on MOV-technology, are connected in parallel, especially when their electrical characteristics differ a lot from one another.
As can be seen in the graph of figure 7, when putting two MOV's direct in parallel, thus without any substantial wiring in between, the one with the lowest clamping voltage and lowest I_{MAX} will conduct the bulk of the current.

fig.7



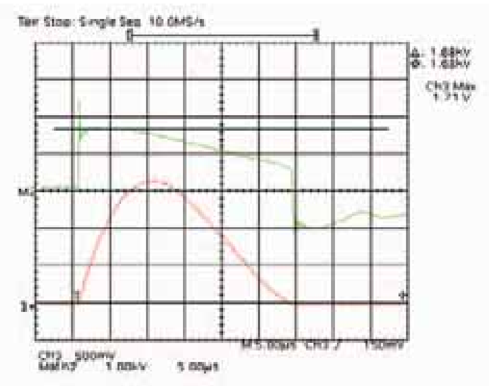
This set-up is completely missing its goal, since the MOV with the highest and not the one with the lowest I_{MAX} should conduct the largest portion of the current.
In order for this set-up to be effective, the interconnecting wire between both SPD's should have at least a length of 1m (the longer, the better) introducing a series inductor. If this is practically impossible, a real inductor should be installed between both SPD's (fig.8).

fig.8



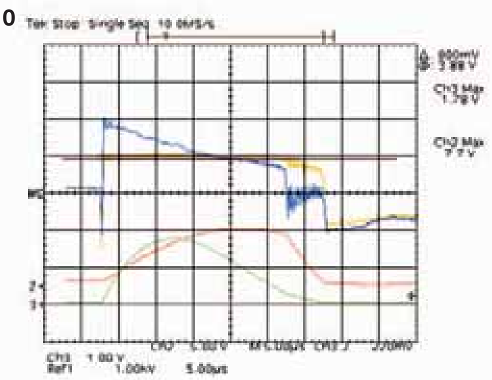
The SGC40 has a 15µH coil, capable of conducting 40A, included in the range for this purpose.
Figures 9 and 10 are illustrating the effect of cascaded MOV's.
Figure 9 shows the clamping of a 20kA-270V MOV alone. When the device is hit with a standard 20kA-8/20 impulse wave (red curve), the voltage at which the MOV clamps is 1.68kV (green curve).
Figure 10 shows the clamping of the same 20kA-270V MOV in parallel with an 80kA-320V MOV up-front. The interconnection between the two MOV's has a length of 1m and a cross-section of 32mm^2.
Applying the same standard 20kA-8/20 impulse wave (green curve) to this cascade, the voltage at which the 20kA-270V MOV clamps is much lower (900V) and much more stable (yellow curve).

fig.9



green: residual voltage
red: 8/20 current impulse

fig.10

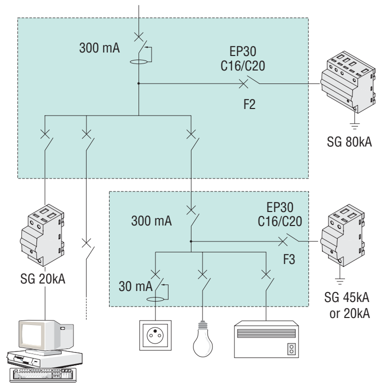


blue: residual voltage after 1st stage
yellow: residual voltage after 2nd stage
green: 8/20 current impulse
red: current through 2nd stage

Selection of up-stream circuit breaker

Eventhough all MOV-based SurgeGuard SPD's incorporate internal protection (thermal fuse), as a general rule, a circuit breaker or fused disconnect should be installed up-stream of the SPD. In all cases, even in the case where a general circuit breaker is already installed, it's advisable to add a circuit breaker (F2) just up-stream of the SPD, in a selective way (fig.11). This provides a means of disconnecting the SPD and not the entire installation should the surge arrester fail. It also allows the disconnection of the SPD for service or maintenance.

fig.11



To be effective, the circuit breaker or fuse directly up-stream of the SPD should be capable of cutting the theoretical short-circuit current at the place where the SPD is installed. In other words, the short-circuit current interrupting capacity of the circuit breaker should be at least equal to or preferably higher than the calculated short-circuit current.
For the different values of I_{MAX}, table 4 shows the necessary short-circuit interrupting capacity of the up-stream circuit breaker. These values were obtained by calculating the short-circuit current with only the short-circuit resistance of the SPD as the limiting factor.

Table 4

SPD I_{MAX}	Short-circuit interrupting capacity
80kA	EP100
45kA	EP60
20kA	EP30

An important consideration here, is that these are worst case values, because in a real installation several other resitances add up to the short-circuit resistance of the SPD, and therefore decrease the short-circuit current even further. The size of the circuit breaker will not affect the performance of the SPD. The circuit breaker size should be co-ordinated with the connecting wire and should be sized accordingly to the applicable National Electrical Code.

Features and benefits

What can be seen from the outside
Photo 1 shows a single and multipole SurgeGuard SPD. As always for the Elfa+ range of products, **the main characteristics are printed** in the upper part of the front of the device ①. These are:
- I_{MAX}
- Class
- U_P at I_{NOM}
- Operating voltage U_N
- Wiring diagram
- Single or multipole configuration.

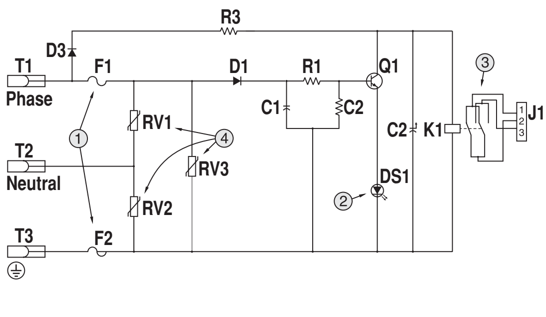
The I_{MAX} of the SurgeGuard SPD's goes from 20kA over 45 to 65kA for the plug-in class 2 devices, up to 80kA for the monobloc class 2 devices and up to 100kA for the class 1 devices.

photo 1

All types are equipped with 50mm^2 terminals ② with captive Pozidriv screws. The terminal-position is aligned with the terminal-position of the Elfa+ MCB's offering the benefit of interconnecting both devices with a pin- or fork-type busbar.
Easy DIN-rail extraction as is implemented on the MCB's and RCD's is also being used here due to the same DIN-rail clip used ③.
All single-pole SPD's are keyed plug-in-devices ④ and have a mechanical fault indicator, ⑤ while all multipole devices are mono-block (not plug-in) and have an LED fault indicator ⑥.
The whole range of class 2 SurgeGuard SPD's is available with or without a voltage-free auxiliary contact for remote indication ⑦.
Both the auxiliary contact as well as the fault indicator reflect the status of the thermal fuse, and thus indirectly also the status of the MOV (see explanation below and fig.13).
Once the fault indicator turns red and the auxiliary contact has switched over, the SurgeGuard should be replaced as soon as possible since from that moment on there is no overvoltage protection.

What's inside
Class 2 SurgeGuard devices all have MOV-technology inside. The wiring diagram of a single-phase multipole SurgeGuard is drawn in the figure below.
Besides the MOV's, each phase and the earth are also equipped with a thermal fuse ① in order to take the device OFF-line in case the MOV breaks down and becomes a short-circuit (i.e. after thermal runaway).
In addition, all devices have an optical fault indicator ② and some have a voltage-free contact for remote indication ③.
The class 1 SurgeGuard devices are based on spark-gap technology. As a spark gap can never turn into a short-circuit, the class 1 devices don't have a thermal fuse and as a consequence neither an auxiliary contact nor an optical status indicator.

fig.13



Selecting the correct SPD

The correct selection of an SPD is based on 3 factors:

IMAX
This key parameter is determined based on a risk analysis (see below) that takes into account:
- the number of lightning days per year (=keraunic level),
- the geometry of the facility,
- the environment directly in the neighbourhood of the facility,
- the way in which the power is distributed,
- the value (£) of the equipment to be protected
- etc.

UP
Determined by the sensitivity of the equipment to be protected. As a rule of thumb, the figures of table 2 above can be used for this purpose.

Power supplier network
As already explained above, different earthing-systems require different SPD's:
- Single-pole for IT and TN-C
- Multipole for TT and TN-S.
Also the voltage and the number of phases of the power supply have an influence on the selection of the SPD.

Determination of IMAX

Step 1: Facility exposure analysis
- The more lightning strikes per year, the higher the risk of the building being hit:
  Figure 14 shows the map of the world with isokeraunics superimposed on it. (Isokeraunic = line of same number of lightning days per year).
  For each area, a more accurate map should be available at the Metreologic Institute of the country.
  Locate the area of the facility and read the keraunic level.

Keraunic level above 80 (High risk)	4
Keraunic level between 30 and 80 (Medium risk)	2
Keraunic level below 30 (Low risk)	1

- The higher the building or the bigger its ground-surface, the higher the risk of the building being hit with a lightning-strike:

Multi-story building	4
Single story with roof <10m	2
Single story building	1

Ground surface more than 4500 m^2	4
Ground surface from 2000 to 4500 m^2	2
Ground surface less than 2000 m^2	1

- The higher the density of the buildings in the area, the lower the risk of your building being hit with a lightning strike:

Rural	4
Suburb	2
Downtown	1

- An overhead power supply has a higher risk of being hit by a lightning strike than an underground supply:

Overhead direct service drop	4
Overhead to facility then underground	3
Underground service from utility substation	2
Metropolitan service grid	1

- Also, the further the infrastructure is away from the nearest substation, the longer the power supply cables and thus the higher the risk:

600m to 3km from facility	4
300 m to 600m from facility	2
Less that 300 meters from facility	1

Facility Exposure Risk Level (FER-level)
Determine the facility exposure risk factor by adding the above scores and looking up the facility exposure risk level in the table below.

If the total (sum of above) is	FER-level
Less or equal to 11	LOW
Between 12 and 18	MEDIUM
Above or equal to 19	HIGH

Step 2: Function and value analysis

- Critical facilities like hospitals, air-traffic control centres, etc. cannot afford to be out of operation by losing expensive (sensitive) electronic equipment:

Mission critical / 24 hours critical	4
Critical / 8 hours critical	2
Non - critical / 8 hours commercial	1

Large concentration of sensitive equipment	4
Sensitive equipment only in certain areas	2
Very limited presence of sensitive equipment	1

- The higher the cost of the equipment to protect, the better it should be protected:

Above $ 100k	4
$ 100k to $ 30k	3
$ 30k to $ 10k	2
Less than $ 10k	1

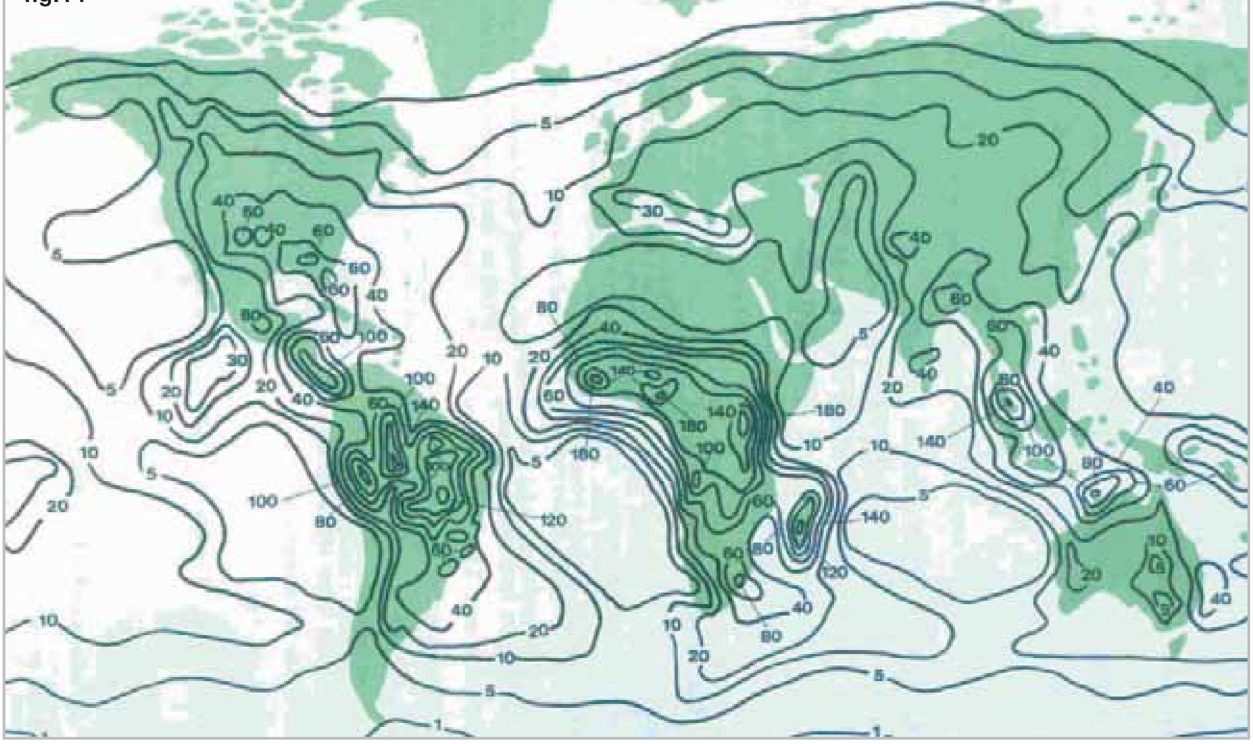
- Historical Data

Past history of power problems with damage	4
Past history of power problems without damage	2
No past history of power problems	1

Facility Function and Value Factor (FF&V-factor)
Determine your facility function and value factor by adding the above scores and looking up the facility function and value level in the table below

If the total (sum of above) is	FF&V-factor
Less or equal to 6	3
Between 7 and 11	2
Above or equal to 12	1

fig.14



Step 3: Lookup I_{MAX}
Based on the Facility Exposure Risk level (FER) and the Facility Function and Value factor (FF&V), table 5 advises the value of I_{MAX} of the SPD or SPD's to be installed.

Table 5

FACILITY LEVELS		INSTALLATION POINT					
FER	FF&V	Domestic		Industrial		Tertiary	
		MAIN PANEL	SUBPANEL	MAIN PANEL	SUBPANEL	MAIN PANEL	SUBPANEL
HIGH	Level 3	45kA	-	45kA (1)	20kA	45kA	20kA
	Level 2	65kA	-	65kA (1)	20kA	65kA	20kA
	Level 1	65kA (1)	20kA	65kA (1)	45kA	65kA (1)	45kA
MEDIUM	Level 3	45kA	-	45kA	20kA	45kA	20kA
	Level 2	45kA	-	80kA	20kA	65kA	20kA
	Level 1	45kA	20kA	65kA (1)	45kA	65kA (1)	20kA
LOW	Level 3	20kA	-	45kA	20kA	20kA	-
	Level 2	20kA	-	45kA	20kA	20kA	20kA
	Level 1	20kA	-	45kA	20kA	45kA	20kA

(1) Due to high protection needs, the Class 2 SPD needs to be installed together with the Class 1 for the positions marked with "(1)".
(2) If a lightning rod is installed on a building in Your facility or on a building in a radius of 5km around Your facility, or if some high towers, antennas or trees are in that same radius, we advise to install minimum a 65kA SPD.

Determination of the SurgeGuard type
The I_{MAX}-value found above, together with the operating voltage, the protection voltage and the kind of earthing system, determines the correct Surge-Guard type (Table 6).

Table 6

	Network	IT or TN-C single pole SPD			TT or TN-S multipole SPD		
U_N	I_{MAX}/U_P	2.5kV	1.8kV	1kV	2.5kV	1.8kV	1kV
230V	20kA	SG SP 2 20 2	SG SP 2 20 2	SG SP 2 20 2	SG MM 2 20 2	SG MM 2 20 2	SG MM 2 20 2
230V	45kA	SG SP 2 45 2	SG SP 2 45 2	SG SP 2 45 2	SG MM 2 45 2	SG MM 2 45 2	SG MM 2 45 2
230V	65kA	SG SP 2 65 2	SG SP 2 65 2	(1)			
400V	20kA	SG SP 2 20 4	SG SP 2 20 4	(1)	SG MM 2 20 4	SG MM 2 20 4	SG MM 2 20 4
400V	45kA	SG SP 2 45 4	(1)	(1)	SG MM 2 45 4	SG MM 2 45 4	SG MM 2 45 4
400V	65kA	SG SP 2 65 4	(1)	(1)	SG MM 2 80 4	SG MM 2 80 4	(1)

(1) If the protection level cannot be reached by using only one SPD, appropriate cascading is necessary. Example: To protect computer equipment in a facility with a high FER and a level 1 FF&V and with an IT or TN-C earthing system, according to table 5 a 65kA SPD with a U_P=1kV is required but not available. Therefore cascading a SurgeGuard SP 2 65 2 upfront of a SurgeGuard SP 2 20 2 downstream, with a SurgeGuard C40 in between if required would be the best solution.

Installation guidelines

Although the installation of an SPD is relatively easy and can be done very fast, correct installation is vital. Not just for the obvious reasons of electrical safety but also because a poor installation technique can significantly reduce the effectiveness of the SPD. Below some installation guidelines are summarised in order to assure the best possible protection against over-voltage surges you can achieve by applying SurgerGuard SPD's.

Install a high quality ground (PE) and avoid ground-loops
Proper grounding and bonding is important to achieve a source of equal potential, ensuring that electronic equipment is not exposed to differing ground potentials that would introduce ground loop currents. A high impedance towards ground introduces an additional voltage drop in series with the residual voltage of the SPD (fig.15), so the lower this impedance towards ground, the lower the total residual voltage across the load to be protected. Bonding was not a concern in past years because computers, and all other devices, were predominantly stand-alone devices and the ground connection was simply a safety measure for that single device. However, in recent years we have begun interconnecting various devices via data and signal cables. Now, with each device having a separate ground connection, currents begin to flow between these various ground connections increasing the possibility of equipment damage. Figure 16 overleaf shows correct bonded ground interconnection between PE, SPD and the equipment to be protected.

fig.15

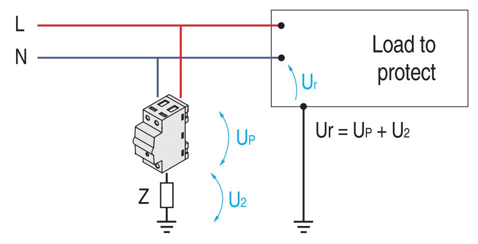
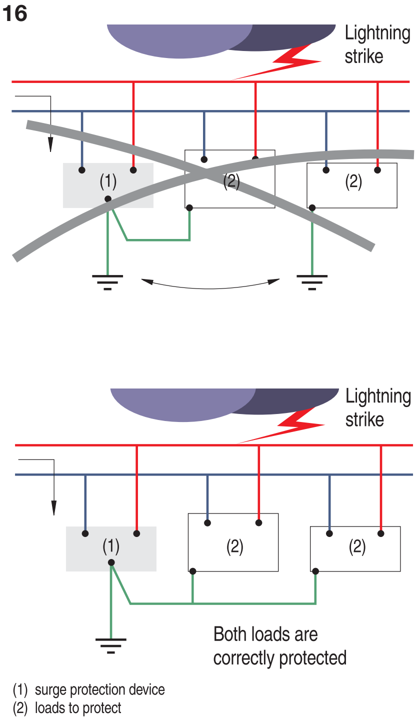


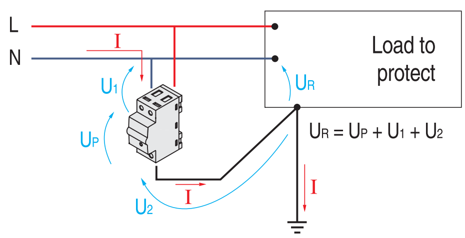
fig.16



Keep the lead length short

As the let-through or residual voltage of a SPD is the primary measurement of a protectors' effectiveness, special care needs to be taken when hooking up the device. Indeed, the let-through voltage is directly affected by the impedance of the connecting leads, thus by their length and cross section (see fig.17). Obviously, the performance of the entire circuit decreases as this impedance increases.

fig.17

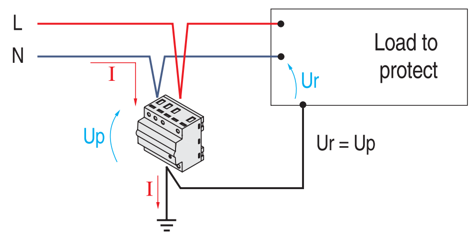


Increasing the conductor size will help to reduce the impedance. However, as at high frequencies the inductance is more important than the resistance, reducing the wire length (thus reducing the inductance) will have a much bigger impact than increasing the cross section (= reducing the resistance).
Also, increasing the cross section implies increasing the installation cost, while reducing the length implies reducing the installation cost.

Use Kelvin connections

Wherever possible, ordinary parallel connections as shown in figure 17 should be avoided and Kelvin connections as shown in figure 18 should be applied. This way of connecting virtually reduces the additional voltage-drop in the connecting wires to zero, obtaining the best U_P possible.

fig.18

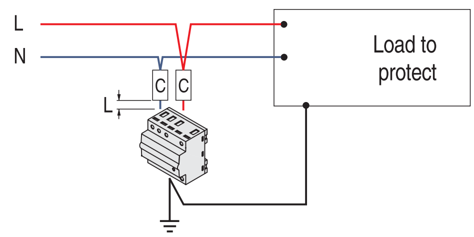


Theoretically, since the terminals of the SurgeGuard devices have a maximum capacity of 1x50mm^2 or 2x20mm^2, Kelvin connection is possible up to 63A. However, due to the excessive heating of the terminal at higher currents, we advise not to use Kelvin connections above 50A.

Install the SPD as close as possible to the up-stream circuit breaker

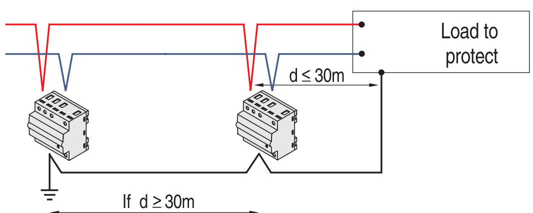
Again in order to reduce the additional volt drop as much as possible in the interconnecting wiring, keep the length (L) of those wires as short as possible (fig.19).

fig.19



Install the SPD as close as possible to the equipment to be protected

fig.20



Avoid installing an SPD downstream of a sensitive RCD
An MOV-based SPD always has a leakage current towards earth. Normally, this leakage current is in the µA-range and therefore negligible, but for a lot of SPD's on the market, (i.e. the multipole SurgeGuard devices), the optical indicator is a LED which also leaks current to ground. Unfortunately, the intensity of the multipole device is several mA's. As a result, installing an SPD downstream of a residual current device (RCD) could lead to nuisance tripping of the RCD. This doesn't influence the correct operation of the SPD, but indeed interrupts the service continuity.
We advise not to install a multipole SurgeGuard SPD downstream of an RCD with a sensitivity of less than 30mA.

Bound wires together
In addition to keeping the lines short, where possible tightly bind the lives and neutral together over as much of their length as possible, using cable ties, adhesive tape, or spiral wrap. This is a very effective way to cancel out inductance.

Avoid sharp bending and winding-up of conductors
Besides keeping the interconnecting wires as short as possible, we also advise not to bend those interconnecting wires in a sharp way, but instead apply smooth bendings.
Never coil up interconnecting wires.
Both coiling and sharp bending increase the inductance of the wire drastically.

Follow rigorously the product specific installation procedure
As each SurgeGuard device comes with a detailed instruction sheet, please read and follow these guidelines step by step during the installation of the SPD.

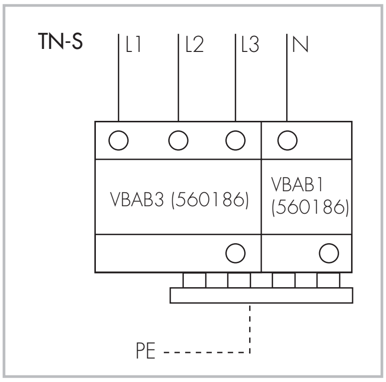
Regulations and standards

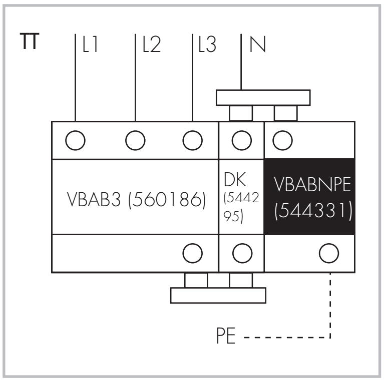
SurgeGuard SPD's are all designed according to the following standards (latest version unless indicated otherwise):
- IEC 61643-1, IEC1643-1
- EN 61024-1, EN/IEC 61000-4-4, EN/IEC 61000-4-5
- UL1449-2
- VDE 0110-1, VDE 0185 part 100, VDE 0185-103, VDE 0675-6 (A1 & A2), VDE 0100-534/A1
- BS 6651 (1992)
- AS 1768 (1991)
- ANSI C62.41

Text for specifiers

- In TT- and TN-S-systems only multipole SPD's are used while in IT- and TN-C systems only single-pole SPD's are used.
- In IT- and TN-S-systems, one SPD is used between each live-conductor and PE.
- The single-pole SPD's are all keyed plug-in devices while the multipole devices are all mono-block.
- All SPD's have a terminal capacity of 1x50mm^2 or 2x20mm^2; the Pozidriv terminals are captive.
- The SPD's can be interconnected with MCB's by means of a pin- or fork-type busbar.
- All SPD's have an optical fault indicator.
- A complete range is available: Class 1, Class 2 and decoupling inductors.
- Devices with a built-in voltage-free auxiliary contact for remote indication are available.
- All MOV-based SPD's must have a built-in thermal fuse.
- The power-supply voltage is allowed to vary in the range of 110% Un... 85% Un without damaging the SPD.

Technical data - Class I

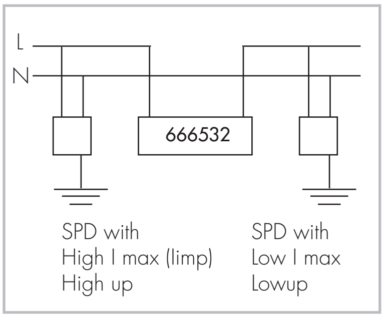




Decoupling element

Tested to (Standards)	IEC 85
Nominal current	40 A
Nominal inductance	15 uH
Nominal voltage	220-240 - 380-415Vac
Max. back-up fuse	35A gL
Short-circuit withstand capability with max. back-up fuse	50kA
DC resistance	3 mOhm
Operating temperature range	-35°...+70°
Number of modules	2
Ref. no.	**666532**

Application
Used in areas where the exposure to lightning is very high, two SPD must be installed, one of them, with high I max (limp Class I) and high Up and the second one with low Imax and low Up. If a Class I and Class II SPD are installed at 10 meters distance from each other, no decoupling coil is required. Decoupling coil is required if both products are installed in the same panel or with distances lower than 10m.

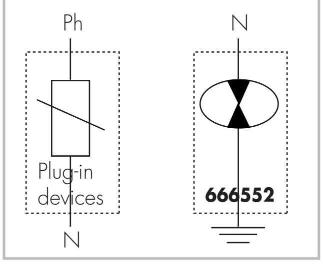


Plug-in devices (MOV technology & Gas technology for N-Earth device)

NEW

							N-PE Surge arrester
Ref. no. Surge arrester	**666545**	**666547**	**666549**	**666546**	**666548**	**666551**	**666552**
	666534	**666536**	**666541**	**666535**	**666538**	**666543**	**-----**
Tested to	IEC 61643-1	IEC 61643-1	IEC 61643-1	IEC 61643-1	IEC 61643-1	IEC 61643-1	IEC 61643-1
Designed according to	IEC 61643-1;EN 61024-1; EN/IEC 61000-4-4;EN 61000-4-5; UL1449-2; VDE 0110-1; VDE 0185 part 100; VDE 0100-534/A1; BS 6651 (1992); AS 1768 (1991); ANSI C62.41						IEC 61643-1; EN/IEC 61024-1; EN/IEC 61000-4-4; EN/IEC 61000-4-5; UL1449-2; VDE 0110-1; VDE 0185 part 100; VDE 0100-534/A1; BS 6651 (1992); AS 1768 (1991); ANSI C62.41
Class (CEI-IEC 61643-1/E DIN VDE 0675 part 6/A1)	II/C	II/C	II/C	II/C	II/C	II/C	II/C
Un/frequency	220-240Vac / 50-60Hz			220-240Vac / 50-60Hz			230Vac / 50-60Hz
Rated voltage (maximum continuous operating voltage) Uc	270V	270V	270V	480V	480V	480V	270 V
Isn (8/20)	5	10	20	5	10	20	20
I max (8/20)	20	45	65	20	45	65	40
Up at Isn (kV)	< 0.96	< 1	< 1.2	< 1.58	< 1.45	<1.95	<1.5
Response time ta	25ns	25ns	25ns	25ns	25ns	25ns	100 ns
Max. back-up fuse / MCB	20A / B or C	35A / B or C	50A / B or C	20A / B or C	35A / B or C	50A / B or C	
Operating temperature range	-30°...+75°	-30°...+75°	-30°...+75°	-30°...+75°	-30°...+75°	-30°...+75°	-30° ....+75°
Short-circuit withstand capability with max. back-up fuse	50kA	50kA	50kA	25kA	25kA	25kA	
Number of modules	1	1	1	1	1	1	1
Additional data for SG MM....C							
Type of contact	Dry contact	Dry contact	Dry contact	Dry contact	Dry contact	Dry contact	Not applicable
Cross sectional areas of remote alarm terminals	>1.5 mm^2	>1.5 mm^2	>1.5 mm^2	>1.5 mm^2	>1.5 mm^2	>1.5 mm^2	Not applicable
Ref. no.	**--------**	**666537**	**666542**	**-------**	**666539**	**666544**	**------**

TT systems (1+1 or 3+1 system)



Technical data - Class II

Surge arrester SG MM 2 20 2 (666525)

NEW

	TN-S	TT
Tested to	IEC 61643-1	IEC 61643-1
Designed according to	IEC 61643-1;EN 61024-1; EN/IEC 61000-4-4;EN 61000-4-5; UL1449-2; VDE 0110-1; VDE 0185 part 100; VDE 0100-534/A1; BS 6651 (1992); AS 1768 (1991); ANSI C62.41	
Class	II/C	II/C
Un/frequency	220-240Vac/50-60Hz	220-240Vac/50-60Hz
Rated voltage (maximum continuous operating voltage) Uc	270 V	270 V
In (8/20)	5 kA	5 kA
I max (8/20)	20 kA	20 kA
Up at In	<0.96 kV	<0.96 kV
Response time ta	25ns	25ns
Back-up fuse or MCB	20A /B or C	20A /B or C
Short-circuit withstand capability with max. back-up fuse	50kA	50kA
Number of modules	2	2

Surge arrester SG MM 2 20 4 (666526)

NEW

	TN-S	TT
Tested to	IEC 61643-1	IEC 61643-1
Designed according to	IEC 61643-1;EN 61024-1; EN/IEC 61000-4-4;EN 61000-4-5; UL1449-2; VDE 0110-1; VDE 0185 part 100; VDE 0100-534/A1; BS 6651 (1992); AS 1768 (1991); ANSI C62.41	
Class	II/C	II/C
Un/frequency	380-415Vac/50-60Hz	380-415Vac/50-60Hz
Rated voltage (maximum continuous operating voltage) Uc	270 V	270 V
In (8/20)	5 kA	5 kA
I max (8/20)	20 kA	20 kA
Up at In	0.96 kV	0.96 kV
Response time ta	25ns	25ns
Back-up fuse or MCB	20A /B or C	20A /B or C
Short-circuit withstand capability with max. back-up fuse	25kA	25kA
Number of modules	5	5

Surge arrester SG MM 2 45 2 (666527)

NEW

	TN-S	TT
Tested to	IEC 61643-1	IEC 61643-1
Designed according to	IEC 61643-1; EN/IEC 61024-1; EN/IEC 61000-4-4;EN 61000-4-5; UL1449-2; VDE 0110-1; VDE 0185 part 100; VDE 0100-534/A1; BS 6651 (1992); AS 1768 (1991); ANSI C62.41	
Class	II/C	II/C
Un (L-L) / frequency	220-240Vac/50-60Hz	220-240Vac/50-60Hz
Rated voltage (maximum continuous operating voltage) Uc	270V	270V
In (8/20)	10 kA	10 kA
I max (8/20)	45 kA	45 kA
Up at In	1kV	1kV
Response time ta	25ns	25ns
Back-up fuse or MCB	30A /B or C	30A /B or C
Short-circuit withstand capability with max. back-up fuse	50kA	50kA
Number of modules	2	2

Surge arrester SG MM 2 45 4 (666529)

NEW

	TN-S	TT
Tested to	IEC 61643-1	IEC 61643-1
Designed according to	IEC 61643-1;EN 61024-1; EN/IEC 61000-4-4;EN 61000-4-5; UL1449-2; VDE 0110-1; VDE 0185 part 100; VDE 0100-534/A1; BS 6651 (1992); AS 1768 (1991); ANSI C62.41	
Class	II/C	II/C
Un (L-L) / frequency	380-415Vac/50-60Hz	380-415Vac/50-60Hz
Rated voltage (maximum continuous operating voltage) Uc	270 V	270 V
In (8/20)	10 kA	10 kA
I max (8/20)	45 kA	45 kA
Up at In	1kV	1kV
Response time ta	25ns	25ns
Back-up fuse or MCB	30A /B or C	30A /B or C
Short-circuit withstand capability with max. back-up fuse	25kA	25kA
Number of modules	5	5

Surge arrester SG MM 2 45 4 C (666530)

NEW

	TN-S	TT
Tested to	IEC 61643-1	IEC 61643-1
Designed according to	IEC 61643-1;EN 61024-1; EN/IEC 61000-4-4;EN 61000-4-5; UL1449-2; VDE 0110-1; VDE 0185 part 100; VDE 0100-534/A1; BS 6651 (1992); AS 1768 (1991); ANSI C62.41	
Class	II/C	II/C
Un (L-L) / frequency	380-415Vac/50-60Hz	380-415Vac/50-60Hz
Rated voltage (maximum continuous operating voltage) Uc	270 V	270 V
In (8/20)	10 kA	10 kA
I max (8/20)	45 kA	45 kA
Up at In	1kV	1kV
Response time ta	25ns	25ns
Back-up fuse or MCB	30A /B or C	30A /B or C
Short-circuit withstand capability with max. back-up fuse	25kA	25kA
Number of modules	5	5
Additional data for SG MM....C		
Type of contact	Dry contact	Dry contact
Cross sectional areas of remote alarm terminals	<1.5 mm^2	<1.5 mm^2

Surge arrester SG MM 2 80 4 C (666533)

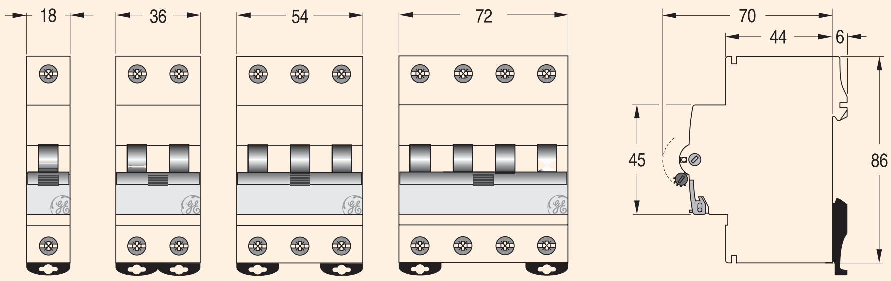
NEW

	TN-S	TT
Tested to	IEC 61643-1	IEC 61643-1
Designed according to	IEC 61643-1;EN 61024-1; EN/IEC 61000-4-4;EN 61000-4-5; UL1449-2; VDE 0110-1; VDE 0185 part 100; VDE 0100-534/A1; BS 6651 (1992); AS 1768 (1991); ANSI C62.41	
Class	II/C	II/C
Un (L-L) / frequency	380-415Vac/50-60Hz	380-415Vac/50-60Hz
Rated voltage (maximum continuous operating voltage) Uc	270 V	270 V
In (8/20)	20 kA	20 kA
I max (8/20)	80 kA	80 kA
Up at In	1.2 kV	1.2 kV
Response time ta	25ns	25ns
Back-up fuse or MCB	50A /B or C	50A /B or C
Short-circuit withstand capability with max. back-up fuse	25kA	25kA
Number of modules	5	5
Additional data for SG MM....C		
Type of contact	Dry contact	Dry contact
Cross sectional areas of remote alarm terminals	<1.5 mm^2	<1.5 mm^2

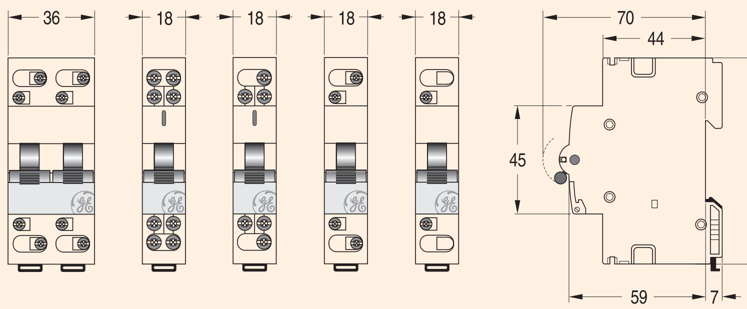
Filter

Capacity	Cx	1.5 uF
Standards		EN132400
Symetric attenuation	dB	40
Un	V	230
Umax	V	275
Operating temperature range	°C	-30°... +75°
Number of modules		1
Ref. no.		**666524**

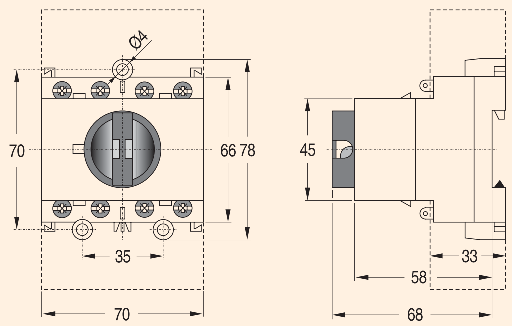
Mains disconnect switches - Aster



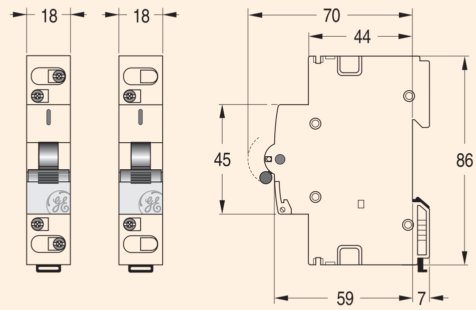
Switches - Aster



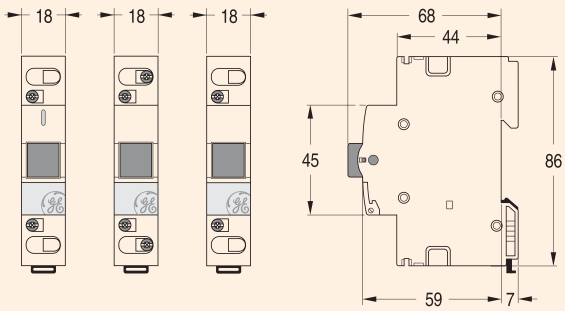
Rotary switches - Aster



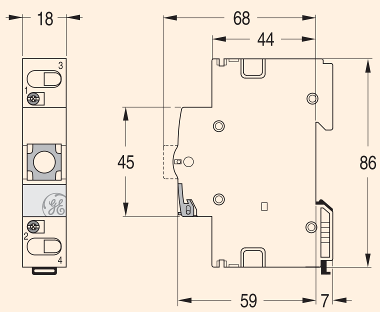
Switches with signal lamp - Aster



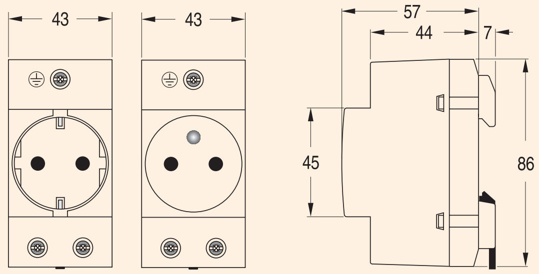
Push-buttons - Aster



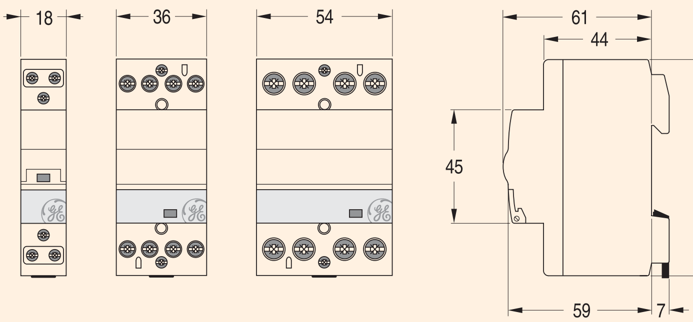
Indication lamp - Aster



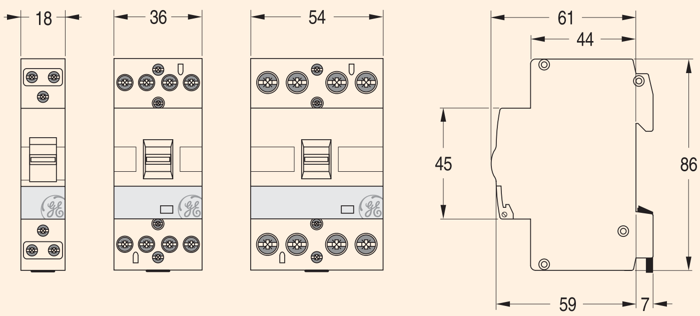
Socket-outlet - Series MSC



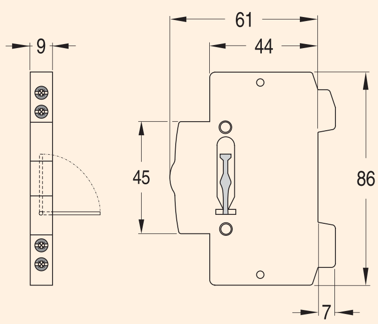
Contactors - Contax



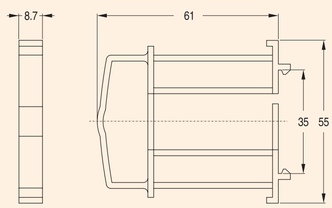
Contactors Day and Night - Contax



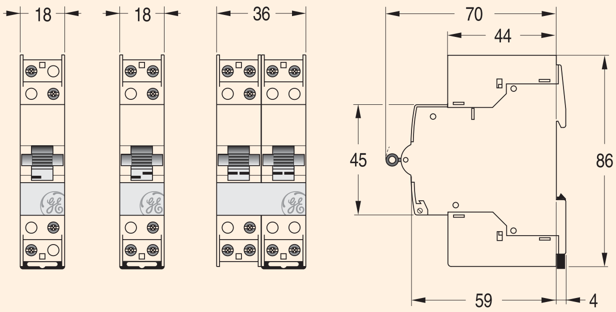
Contactors - Auxiliary contact



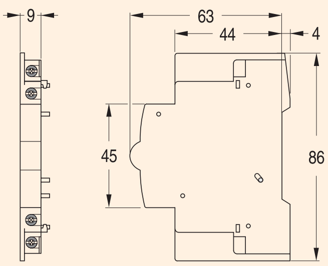
Contactors - Spacer



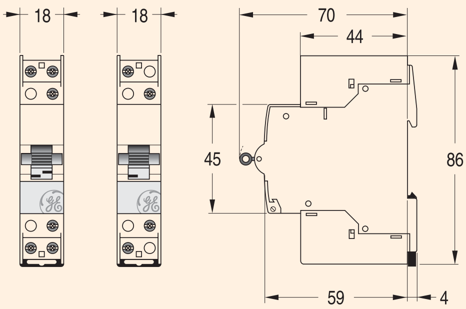
Relays - Contax R



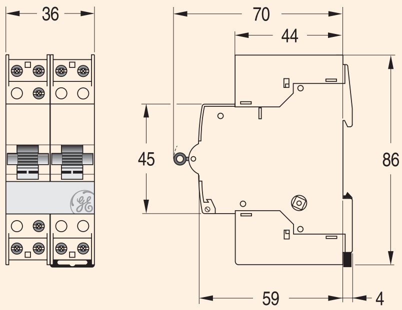
Relays - Auxiliary contact



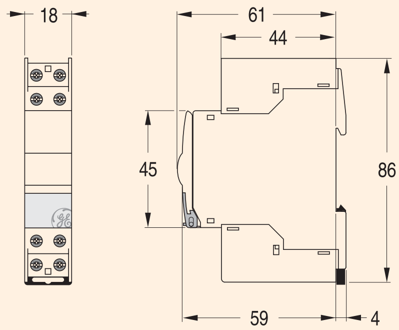
Impulse switches 1P - Pulsar S



Impulse switches 2P - Pulsar S

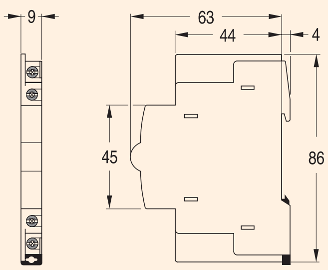


Electromechanical step-by-step - Pulsar S

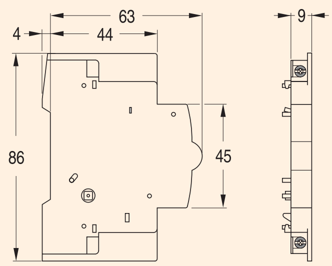


Impulse switches - Add-on module for electromechanical switches

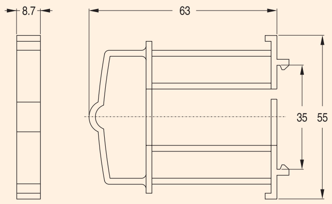
left mounting



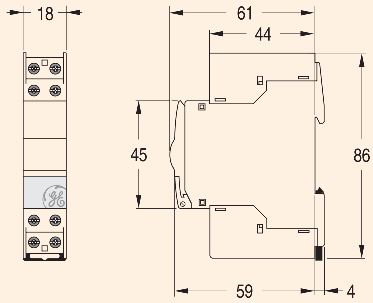
right mounting



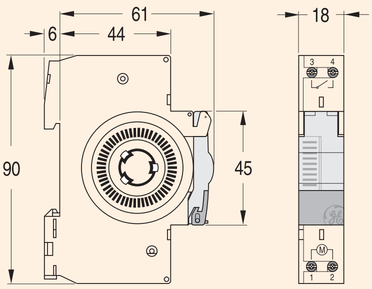
Impulse switches - Spacer



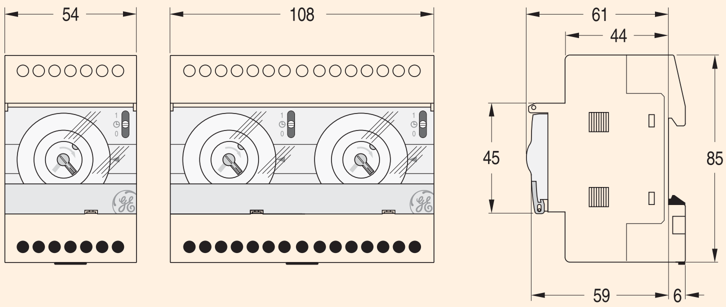
Staircase switches/Time relays - Pulsar T/TS



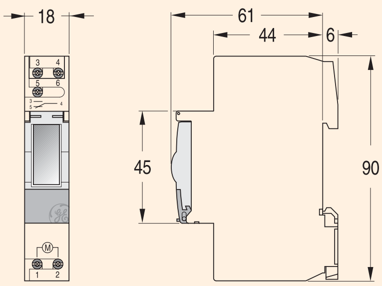
Analogue time switches 1 module - Classic



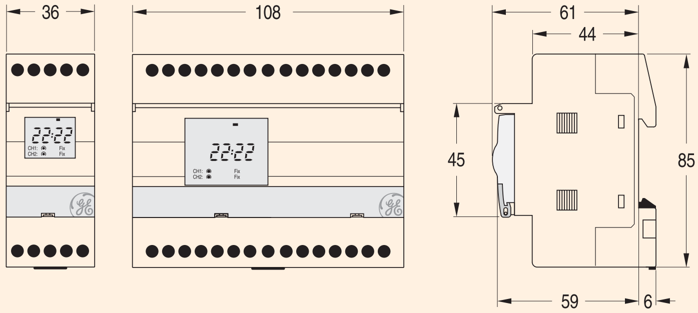
Analogue time switches 3 & 6 modules - Classic



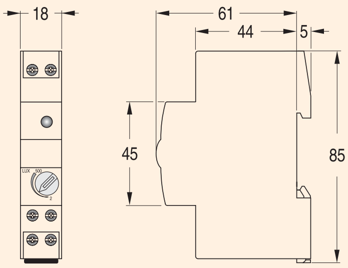
Digital time switches 1 module - Galax



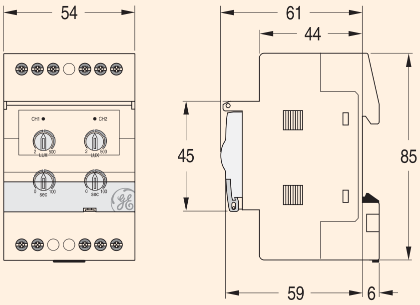
Digital time switches 2 & 6 modules - Galax



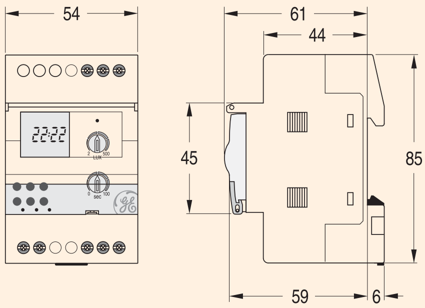
Light sensitive switch 1 module - Galax LSS



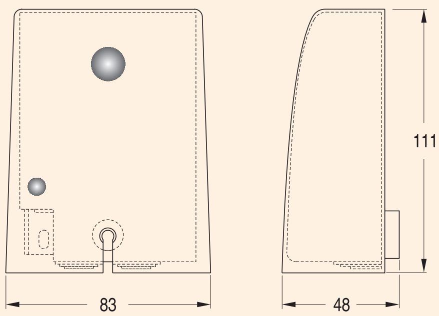
Light sensitive switches 3 mod. - Galax LSS



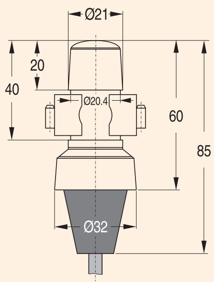
Light sensitive switch with digital clock - Galax LSS



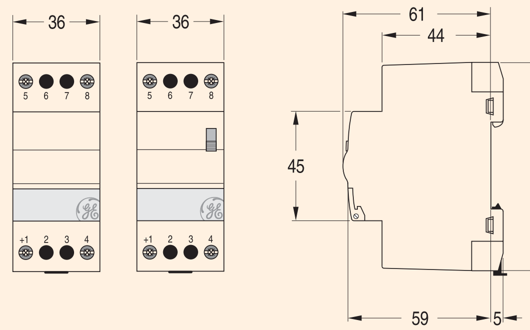
Light sensitive switch photocell incorporated



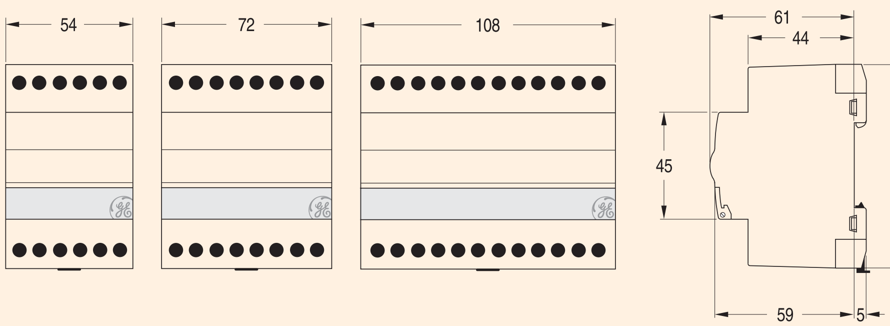
Light sensitive switches - Photocell



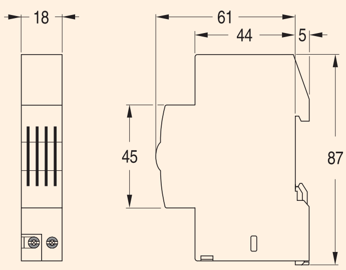
Bell transformers - Series T



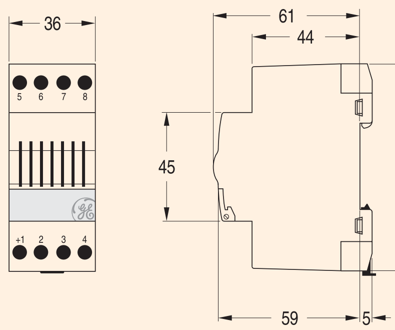
Safety transformers - Series T



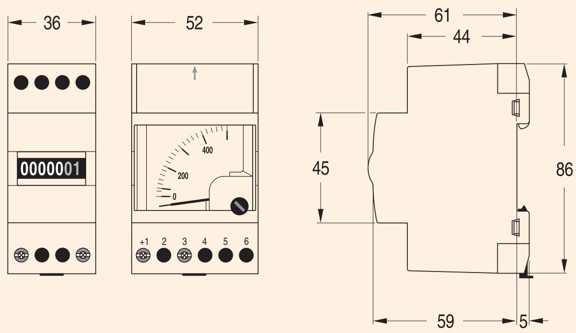
Buzzers and bells - 1 module



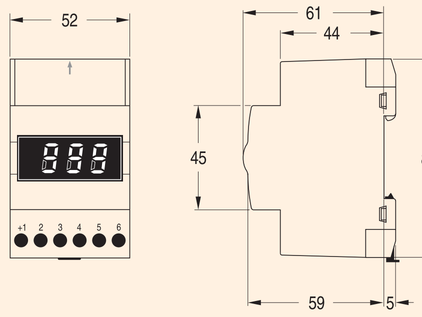
Buzzers and bells - 2 modules



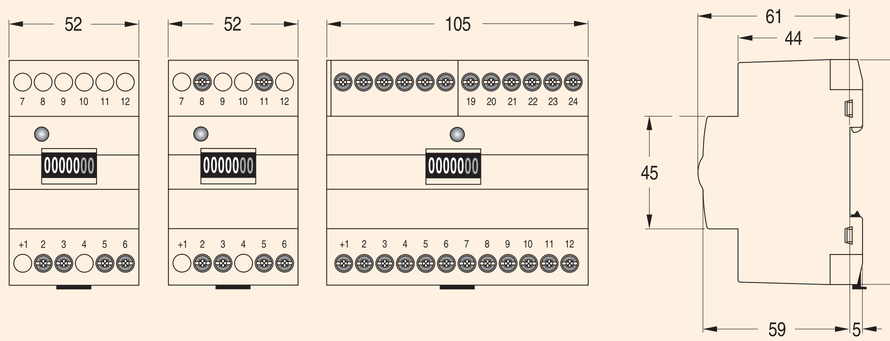
Analogue measurement instruments - Series MT



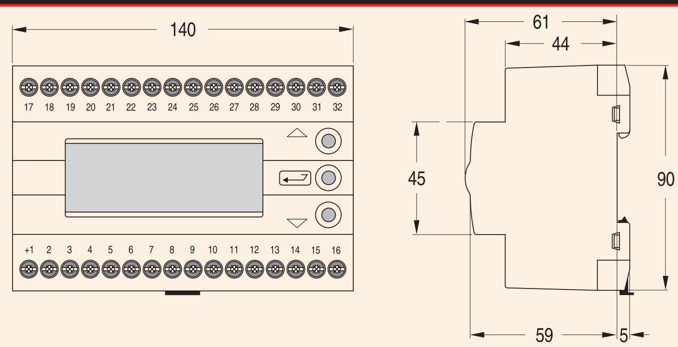
Digital measurement instruments - Series MT



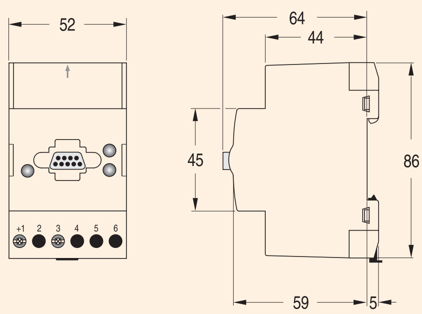
Energy meter - Series MT



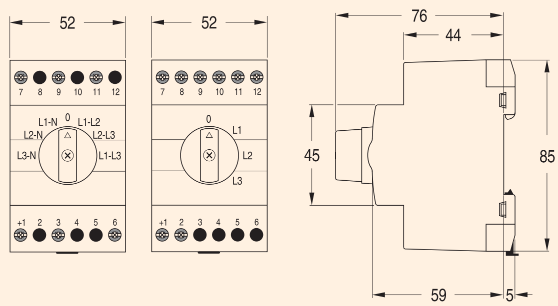
Network analyser - Series MT



Signal converter - Series MT

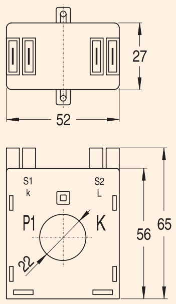


Selector switch - Series MT

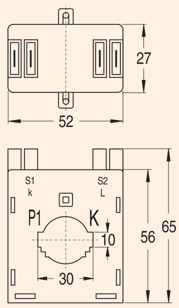


Current transformer - Series MT

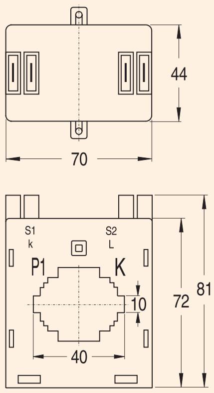
40 up to 80A



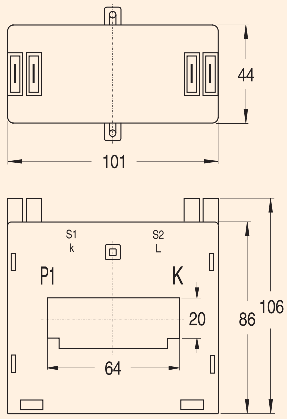
100 up to 400A



500 and 600A

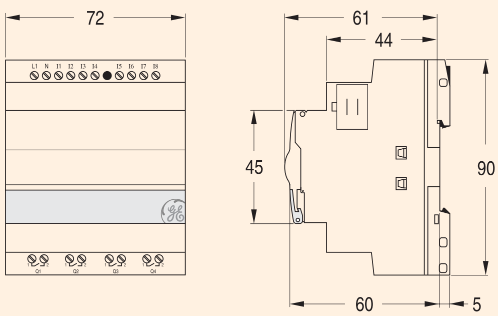


800 and 1000A

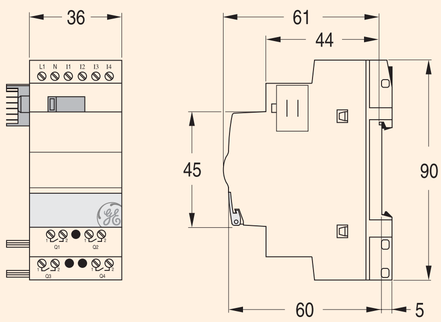


ElfaLogic

CPU

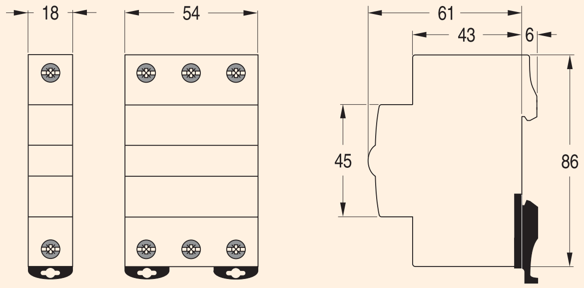


Expansion module



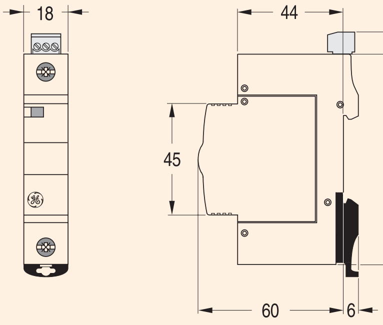
Surge arresters - SurgeGuard

Class 1



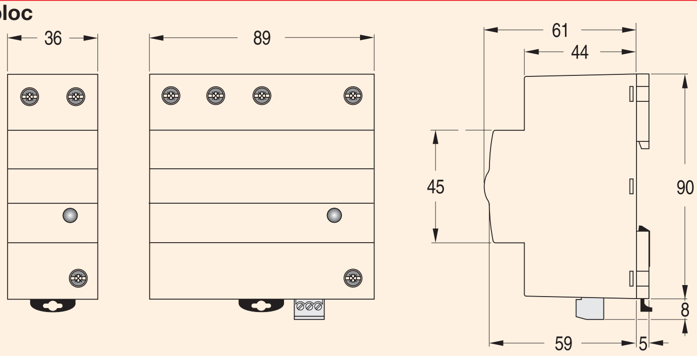
Surge arresters - SurgeGuard

Class 2 - Single pole plug-in

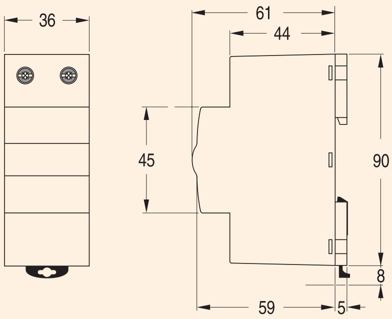


Surge arresters - SurgeGuard

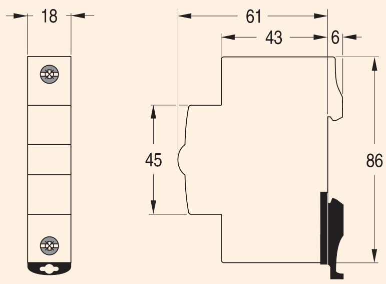
Class 2 - Multipole monobloc



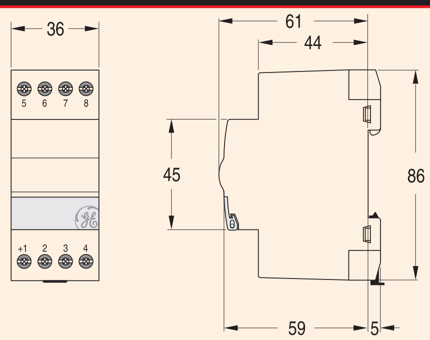
Decoupling coil - SurgeGuard



Sine wave tracker - SurgeGuard



Priority relay - Series PR



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GE POWER CONTROLS
International Sales
Nieuwevaart 51
B-9000 Gent - Belgium
Tel. +32/9 265 21 11
Fax +32/9 265 28 90
E-mail: gepcbel@gepc.ge.com

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