Contents

Technical data

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Breaking capacities
Tripping characteristics

Miniature circuit breaker (magnetic trip setting)			BS EN 60898** Breaking capacity (A)		BS EN 60947-2* Breaking capacity (A)			
Type	**Ratings (A)**	**Page**	**1 P 240V**	**2,3,4P 415V**	**1 P 220V/240V**	**2,3,4P 220V/240V**	**2,3,4P 380V/415V**	**2,3,4P 440V**
C60HB MCB (type B: 3 - 5In)	1A - 63A	12/13	10,000	10,000	15,000	30,000	15,000	10,000
C60HC MCB (type C: 5 - 10In	1A - 63A	12/13	10,000	10,000	15,000	30,000	15,000	10,000
C60HD MCB (type D: 10 - 14In)	1A - 63A	12/13	10,000	10,000	15,000	30,000	15,000	10,000
C120 HB MCB	10A - 125A	17	15,000	15,000	15,000	30,000	15,000	10,000
C120 HC MCB	10A - 125A	18	15,000	15,000	15,000	30,000	15,000	10,000
C120 HD MCB	10A - 125A	19	15,000	15,000	15,000	30,000	15,000	10,000
NG125 N	10A - 125A	35	-	-	25,000	50,000	25,000	20,000
NG125 H	10A - 80A	38	-	-	36,000	70,000	36,000	30,000

* Breaking capacities quoted are Icu. Ics = 50% of Icu.
** Breaking capacities quoted are Icn. Ics = 75% of Icn.

Note: For UL/CSA approved MCBs consult us.
Maximum operating voltage 440V + 10%

Magnetic tripping characteristics (50/60Hz)

BS EN 60898/BS EN 60947-2			
Type	**In min.**	**In max.**	**Typical applications**
B	3	5	Moderately inductive, e.g. commercial and general industrial
C	5	10	Highly inductive, e.g. heavy industrial
D	10	14	More highly inductive, e.g transformers, motors and certain lighting systems

Note: BS EN 60898 calibration temperature 30°C
BS EN 60947-2 calibration temperature 40°C

8

Temperature derating Multi 9

The maximum permissable current in a device depends on the ambient temperature in which it is placed.
Ambient temperature is the temperature inside the enclosure or switchboard in which the devices have been installed.
The reference temperature is in the coloured column for the various circuit-breakers.
When several simultaneously operating circuit-breakers are mounted side by side in a small enclosure, the temperature rise inside the enclosure causes a reduction in the current rating. A reduction cœfficient of the order of 0.8 must therefore be allocated to the rating (already derated if it depends on the ambient temperature).

Example

The table below shows how to determine the following for a C60 depending on the ambient temperature and the installation mode:

- The service current which must not be exceeded for a rating of 20 A (reference temperature 30 °C)
- The ratings which must be adopted (in bold) to allow a service current of 20 A

Service current which must not be exceeded (A)

Installation conditions		**Single C60**		**Several C60a in the same enclosure (calculed using the reduction coefficient indicated below)**	
Temperature (°C)		**30 °C**	**40 °C**	**30 °C**	**40 °C**
	nominal rating (A)	**real rating (A)**	**real rating (A)**	**real rating (A)**	**real rating (A)**
C60	20	20	19	20 x 0.8 = 16	19 x 0.8 = 15.2
	25	25	23.7	25 x 0.8 = 20	23.7 x 0.8 = 18.96
	32	32	30.4	32 x 0.8 = 25.6	30 x 0.8 = 24

Max current (A) according to ambient temperature

Déclic, DPN, DPN N

Temperature (°C)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
Rating (A)									
1	1.04	1.02	**1**	0.98	0.96	0.93	0.91	0.89	0.86
2	2.08	2.04	**2**	1.96	1.91	1.87	1.82	1.77	1.72
3	3.16	3.08	**3**	2.92	2.83	2.75	2.66	2.57	2.47
6	6.26	6.13	**6**	5.87	5.73	5.60	5.45	5.31	5.16
10	10.5	10.3	**10**	9.73	9.45	9.17	8.87	8.57	8.25
16	16.7	16.4	**16**	15.6	16.2	14.8	14.4	14	13.5
20	20.9	20.4	**20**	19.5	19	18.7	18	17.5	17
25	26.1	25.5	**25**	24.4	23.8	23.3	22.7	22.1	21.4
32	33.6	32.8	**32**	31.2	30.3	29.4	28.5	27.6	26.7
40	42	41	**40**	39	37.9	36.8	35.7	34.6	33.4

C60H : curve B and C

Temperature (°C)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
Rating (A)									
1	1.05	1.02	**1**	0.98	0.95	0.93	0.90	0.88	0.85
2	2.08	2.04	**2**	1.96	1.92	1.88	1.84	1.80	1.74
3	3.18	3.09	**3**	2.91	2.82	2.70	2.61	2.49	2.37
4	4.24	4.12	**4**	3.88	3.76	3.64	3.52	3.36	3.24
6	6.24	6.12	**6**	5.88	5.76	5.64	5.52	5.40	5.30
10	10.6	10.3	**10**	9.70	9.30	9.00	8.60	8.20	7.80
16	16.8	16.5	**16**	15.5	15.2	14.7	14.2	13.8	13.3
20	21.0	20.6	**20**	19.4	19.0	18.4	17.8	17.4	16.8
25	26.2	25.7	**25**	24.2	23.7	23.0	22.2	21.5	20.7
32	33.5	32.9	**32**	31.4	30.4	29.8	28.4	28.2	27.5
40	42.0	41.2	**40**	38.8	38.0	36.8	35.6	34.4	33.2
50	52.5	51.5	**50**	48.5	47.4	45.5	44.0	42.5	40.5
63	66.2	64.9	**63**	61.1	58.0	56.7	54.2	51.7	49.2

Temperature derating Multi 9

Max current (A) according to ambient temperature
C60 : curve D

Temperature (°C)	20	25	30	35	40	45	50	55	60
Rating (A)									
1	1.10	1.08	1.05	1.03	**1**	0.97	0.95	0.92	0.89
2	2.18	2.14	2.08	2.04	**2**	1.96	1.90	1.86	1.80
3	3.42	3.30	3.21	3.12	**3**	2.88	2.77	2.64	2.52
4	4.52	4.40	4.24	4.12	**4**	3.88	3.72	3.56	3.44
6	6.48	6.36	6.24	6.12	**6**	5.88	5.76	5.58	5.46
10	11.4	11.1	10.7	10.4	**10**	9.60	9.20	8.80	8.40
16	17.9	17.4	16.9	16.4	**16**	15.5	15.0	14.4	13.9
20	22.2	21.6	21.2	20.6	**20**	19.4	18.8	18.2	17.6
25	27.7	27.0	26.5	25.7	**25**	24.2	23.5	22.7	21.7
32	35.2	34.2	33.6	32.9	**32**	31.0	30.4	29.4	28.4
40	44.4	43.6	42.4	41.2	**40**	38.8	37.6	36.4	34.8
50	56.0	54.5	53.0	51.5	**50**	48.5	46.5	45.0	43.0
63	71.8	69.9	67.4	65.5	**63**	60.4	57.9	55.4	52.9

DPN Vigi, DPN N Vigi

Temperature (°C)	20	25	30	35	40	45	50	55	60
Rating (A)									
1	1.04	1.02	**1**	0.98	0.96	0.93	0.91	0.89	0.86
2	2.08	2.04	**2**	1.96	1.91	1.87	1.82	1.77	1.72
3	3.16	3.08	**3**	2.92	2.83	2.75	2.66	2.57	2.47
6	6.26	6.13	**6**	5.87	5.73	5.60	5.45	5.31	5.16
10	10.5	10.2	**10**	9.75	9.49	9.23	8.96	8.67	8.38
16	16.8	16.4	**16**	15.6	16.2	14.8	14.3	14.9	13.4
20	21	20.5	**20**	19.5	19	18.5	17.9	17.4	16.8
25	26.1	25.5	**25**	24.4	23.9	23.3	22.7	22.1	21.4
32	33.4	32.7	**32**	31.2	30.5	29.7	28.9	28	27.1
40	41.6	41.8	**40**	39.2	38.3	37.4	36.5	35.6	34.6

Temperature derating Multi 9

Max current (A) according to ambient temperature
NG125

Temperature (°C)	20	25	30	35	40	45	50	55	60
Rating (A)									
10	11	10.75	10.5	10.25	**10**	9.75	9.5	9.25	9
16	17.6	17.2	16.8	16.4	**16**	15.6	15.2	14.8	14.4
20	22	21.5	21	20.5	**20**	19.5	19	18.5	18
25	27.5	26.87	26.25	25.62	**25**	24.37	23.75	23.12	22.5
32	35.2	34.4	33.6	32.8	**32**	31.2	30.4	29.6	28.8
40	44	43	42	41	**40**	39	38	37	36
50	55	53.75	52.5	51.25	**50**	48.75	47.5	46.25	45
63	69.3	67.72	66.15	64.57	**63**	61.42	59.85	58.27	56.7
80	88	86	84	82	**80**	78	76	74	72
100	110	107.5	105	102.5	**100**	97.5	95	92.5	90
125	137.5	134.3	131.2	128.1	**125**	121.8	118.7	121.8	112.5

C120 in accordance with BS EN 60898

Temperature (°C)	20	25	30	35	40	45	50	55	60
Rating (A)									
10	10.8	10.4	**10**	9.6	9.2	8.7	8.2	7.7	7.2
16	17.0	16.5	**16**	15.5	14.9	14.3	13.7	13.1	12.4
20	21.5	20.7	**20**	19.2	18.4	17.6	16.7	15.7	14.8
25	27.3	26.2	**25**	23.7	22.4	21.0	19.5	17.8	16.0
32	34.3	33.2	**32**	30.8	29.5	28.2	26.8	25.4	23.8
40	43.3	41.7	**40**	38.3	36.4	34.5	32.5	30.3	28.0
50	54.4	52.2	**50**	47.7	45.2	42.6	39.8	36.9	33.6
63	68.1	65.6	**63**	60.3	57.5	54.5	51.3	48.0	44.4
80	85.9	83.0	**80**	76.9	73.6	70.2	66.6	62.8	58.7
100	109.1	104.7	**100**	95.1	90.0	84.5	78.7	72.4	65.4
125	136.7	131.0	**125**	118.7	112.1	105.0	97.4	89.2	80.1

C120 in accordance with BS EN 60947-2

Temperature (°C)	20	25	30	35	40	45	50	55	60
Rating (A)									
10	11.7	11.3	11	10.5	**9.5**	9.0	8.4	7.8	7.2
16	18.6	18.0	17	16.9	**15.6**	15.0	14.3	13.6	12.4
20	23.4	22.6	22	21.0	**19.2**	18.2	17.2	16.1	14.8
25	29.8	28.6	27	25.9	**22.9**	21.2	19.4	17.5	16.0
32	37.4	36.2	35	33.6	**30.8**	29.2	27.7	26.0	23.8
40	47.2	45.4	44	41.7	**37.6**	35.4	33.0	30.5	28.0
50	59.3	56.9	55	52.0	**46.4**	43.4	40.2	36.7	33.6
63	74.2	71.5	69	65.7	**59.4**	56.0	52.3	48.4	44.4
80	93.7	90.5	87	83.8	**76.5**	72.6	68.4	64.0	58.7
100	118.9	114.1	109	103.7	**92.1**	85.7	78.9	71.3	65.4
125	149.0	142.8	136	129.4	**114.4**	106.2	97.2	87.3	80.1

RCCB and I-NA switches in accordance with BS EN 60947-3

Temperature (°C)	25	30	40	50	60
Rating (A)					
16	20	19	**16**	15	13
25	32	30	**25**	23	20
40	46	44	**40**	36	32
63	75	70	**63**	56	50
80	95	90	**80**	72	65
100	123	120	**100**	95	90
125	135	133	**125**	118	110

Note: *the thermal protection device (overload) placed upstream from the residual current circuit breaker should take the values indicated in the table above into account.*

Table 1: fluorescent lighting

Depending on the power supply and the number and types of lighting units, the table gives the circuit breaker rating based on the following assumptions:

- Installation in an enclosure with an ambient temperature of 25°C (derating coefficient = 0.8)
- Power of ballast: 25% of tube power
- Power factor: 0.6 for non-compensated fluorescent lighting. 0.86 for compensated fluorescent lighting

Circuit breakers mounted in an enclosure with an ambient exterior temperature of 25°C: derating coefficient = 0.8.

Single phase system: 230V
Three phase + N system: 400V between phases

Types of	Power of tubes (W)	Number of lighting units per phase lighting unit												
Single phase	**18**	4	9	29	49	78	98	122	157	196	245	309	392	490
non-compensated	**36**	2	4	14	24	39	49	61	78	98	122	154	196	245
	58	1	3	9	15	24	30	38	48	60	76	95	121	152
Single phase	**18**	7	14	42	70	112	140	175	225	281	351	443	562	703
compensated	**36**	3	7	21	35	56	70	87	112	140	175	221	281	351
	58	2	4	13	21	34	43	54	69	87	109	137	174	218
Two phase 2x18 =	**36**	3	7	21	35	56	70	87	112	140	175	221	281	351
compensated 2x36 =	**72**	1	3	10	17	28	35	43	56	70	87	110	140	175
2x58 =	**118**	1	2	6	10	17	21	27	34	43	54	68	87	109
MCB rating		**1**	**2**	**6**	**10**	**16**	**20**	**25**	**32**	**40**	**50**	**63**	**80**	**100**

Calculation: non-compensated fluorescent lighting example (star connection)

$$\text{Number} = \frac{(\text{rating} \times 0.8)\ (U \times 0.6)}{(P \times 1.25)}$$

Table 2: high pressure discharge lamps

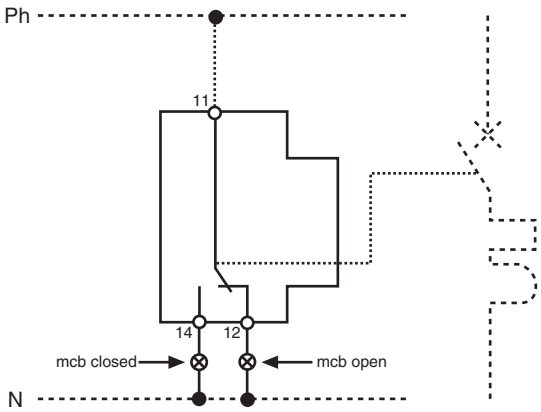
Table valid for 230V and 400V, with compensated or non-compensated ballast.

Mercury vapour + fluorescent substance	Rat. (A)
P(1) ≤ 700W	**6**
P(1) ≤ 1000W	**10**
P(1) ≤ 2000W	**16**
Mercury vapour + metal halides	
P(1) 375W	**6**
P(1) 1000W	**10**
P(1) 2000W	**16**
High pressure sodium vapour lamps	
P(1) 400W	**6**
P(1) 1000W	**10**

Electrical auxiliaries

For C60/C120 MCBs

Auxiliary ON/OFF switch (OF), Alarm switch (SD), Shunt trip unit (MX), Under voltage release (MN)



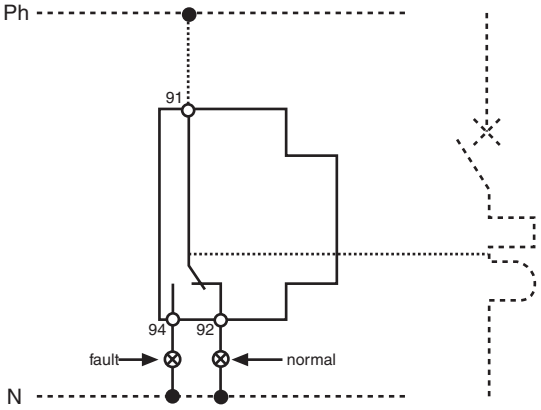
Auxiliary ON/OFF switch (OF) to indicate the 'open' or 'closed' position of a circuit breaker

Assembly

Clip on the left side of the circuit breaker.

Applications

Audible or visual indication of the open or closed state of the circuit. The indication can be given on the front of a cubicle or enclosure or grouped on a control desk. Can be used in conjunction with an alarm switch.



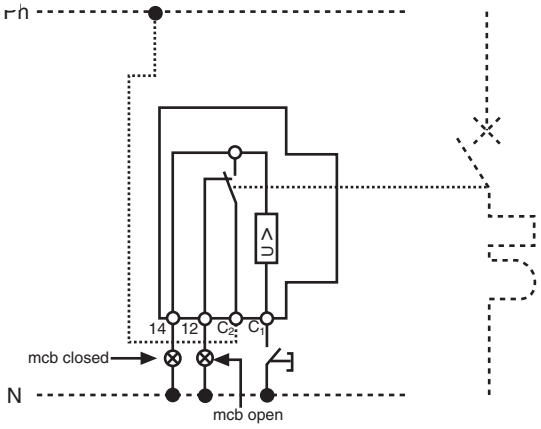
Alarm switch (SD) to indicate circuit breaker opening on a fault (tripped)

Assembly

Clip on the left side of the circuit breaker.

Applications

Audible or visual indication of a fault on an electrical circuit in air conditioned rooms, passenger and goods lifts, ventilation etc. May be used in conjunction with an auxiliary ON/OFF switch.



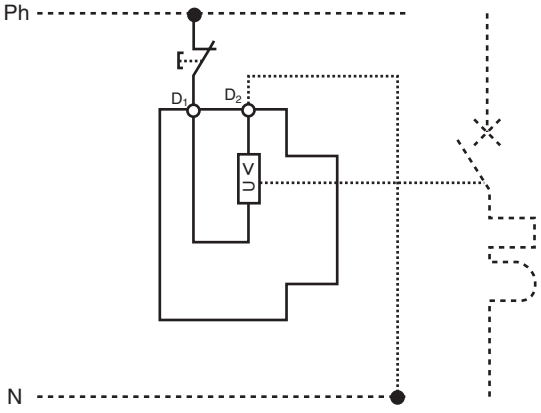
Shunt trip unit (MX) for remote tripping

Assembly

Clip on the left side of the circuit breaker.

Applications

Remote opening of electrical circuits.



Under voltage release unit (MN) to ensure automatic tripping in case of under voltage and for remote tripping by EMERGENCY STOP push button

Assembly

Clip on the left side of the circuit breaker.

Applications

Automatic tripping of a circuit breaker whenever the voltage drops sufficiently below its nominal rated voltage. Remote tripping of a circuit breaker by 'emergency stop' or other N.C. push button.

8

Safety perimeters - utilisation limits

Vigi modules and RCCB-ID residual current circuit breakers

Implementation and operation

- ■ The test button (T) checks that the circuit breaker is working properly: verification is recommended once a month
- ■ The residual current circuit breaker is reset whilst closed
- ■ The earth leakage module can be reset in 2 ways:
- □ By resetting the Vigi module first then the circuit breaker
- □ Or by resetting the Vigi module and circuit breaker at the same time (locking operating handles)

Note: never allow the protection conductor to pass through the residual current circuit- breaker or Vigi module.

Fluorescent lighting

- ■ Do not exceed 400 m of cables for 30 mA sensitivity
- ■ Do not exceed 12 x 65 watt tubes per phase and 24 tubes with the “si” type, for non-compensated lighting

Protection of circuits and the residual current circuit breaker

- ■ This is usually achieved using a circuit breaker or gG fuse with a rating adapted to the conductors’ cross-section. The residual current circuit breaker is thus protected against overvoltages and shortcircuits

Application examples

- ■ IΔn: 10 or 30 mA
- □ Protection against direct contact
- □ Protection against indirect contact in IT and TN earthing systems (breaking of protection conductor, etc.)
- □ In highly-exposed situations (building sites, stalls, swimming pools, etc.).
- ■ IΔn: 300 mA
- □ Sites with fire risks
- □ Protection against indirect contact in TT earthing system
- ■ IΔn: selective 300 mA s
- ■ protection against indirect contact,
- □ In TT earthing system
- □ Allows vertical discrimination with earth leakage protection devices ⩽ 30 mA placed downstream

Very important!

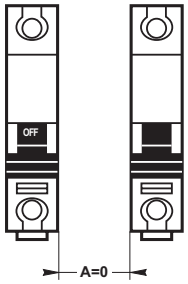
Use of the earth leakage function in harsh environments

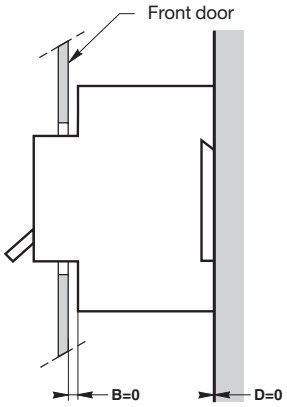
Safety of persons

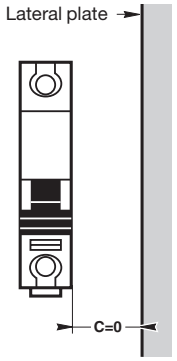
- ■ An electrical installation can be subject to numerous elements:
- □ Water, humidity
- □ Dust
- □ Corrosive substances, etc
- ■ These elements act in variable degrees depending on the installation site:
- □ Camp site (humidity, salt spray, etc.)
- □ Swimming pool (chlorine)
- □ Laboratories (corrosive vapours), etc
- ■ In all of these cases:
- □ Refer to the installation standard
- □ Put the device in an IP 55 tight enclosure with a corrosion inhibitor or isolate the area where the earth leakage device is located using a tight door
- □ Air the site with clean air

Safety perimeters - utilisation limits

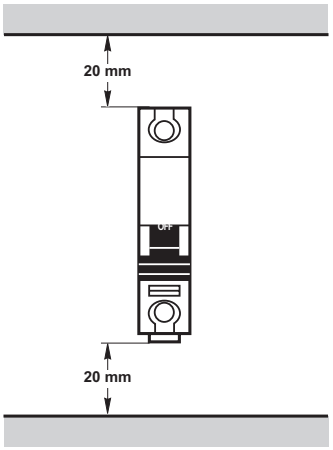
Safety perimeters







Bare sheetmetal



Utilisation limits

Upstream	Utilisation limits	
	Vibrations (IEC 60068-2-6)	Impacts (IEC 60068-2-27)
Downstream		
C60/C120	6 g	30 g/11 ms
RCCB	3 g level S2	30 g/11 ms

8

Safety perimeters - utilisation limits

High altitude temperature derating

Influence of altitude on the circuit breaker's characteristics
The IEC 60947.2 construction standard stipulates the dielectric characteristics to be respected. It follows that altitude has no effect on the characteristics of ID circuit breakers up to 2000 m.
Any higher, and it is nécessary to take the fall in dielectric withstand and the air's cooling powers into account. The ID circuit breakers, designed to work in these conditions, should be built or used in accordance with an agreement which should be drawn up between the constructor and the user.

The table below shows corrections that are to be made depending on altitude. The ID circuit breaker's breaking capacity remains the same.

Altitude (m)	2000	3000	4000
Dielectric withstand (V)	2500	2200	1950
Maximum operating voltage (V)	440	440	440
Thermal rating	In	0.96 In	0.93 In

Derating in chemical atmospheres

Metal parts
- Chlorine Cl_2
- Nitrogen dioxide NO_2
- Sulphurous hydrogen H_2S
- Sulphurous anhydride SO_2

Copper
- The copper sulphur Cu^2S layer's thickness doubles in the presence of chlorine compared with a normal environment
- The same happens with nytrogen dioxide

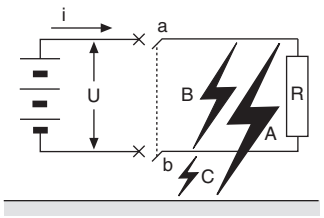
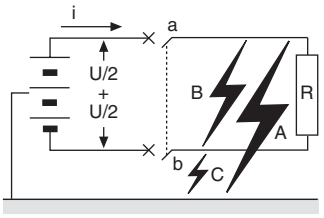
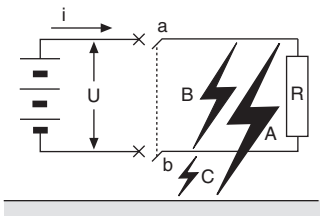
Silver
The silver or silver-plated contacts go black and create an insulating layer of sulphur in the presence of anhydride or sulphurous hydrogen. This insulating sulphur causes excessive overheating of contacts and eventually leads to their destruction.
The presence of chlorine, for example in humid areas, mixed with sulphurous hydrogen increases the thickness of the silver suplur by 7 and adding suphurous hydrogen and nitrogen dioxide increases the thickness of sulphurous silver by 20.

Practical advice
- Devices which are installed in oil refineries, steel works, paper mills, synthetic fibre (nylon) factories and in general in sulphur chemical factories, will be exposed to sulphurising which chemists refer to as oxidisation by analogy with the chemical reaction which causes oxidisation by oxygen.
- It must not be thought that the devices installed in "technical" areas are protected from this oxidisation process. Air intakes, which keep the area's pressure higher than the atmospheric pressure, are "too short"; often the air drawn in is clearly less poluted than the air near the ground, but it is polluted enough for the devices to go black five or six years after their installation.
- There is no cure for this oxidisation, just advice: a device's nominal rating is multiplied by 0.6 or a maximum of 0.8 if it is to be installed in a factory where sulphurous gas may be released, the aim being to prevent overheating which speeds up the oxidisation reaction.

Circuits supplied with DC current
Choosing a circuit breaker

The choice of circuit breaker type, for protection of a DC installation, depends mainly on the following criteria:

- Nominal current which is used to choose current rating
- Nominal voltage which is used to determine the number of serial-connected poles contributing to breaking
- The maximum short circuit current at the installation point, used to define breaking capacity
- The type of network (see below)

Type of networks		**Earthed networks**		**Unearthed networks**
Diagrams and various possible faults		The source has an earthed polarity	The source has an earthed mid-point	
				
Analysis of each fault	fault **A**	Maximum Isc only the positive polarity is concerned	Isc close to maximum Isc only the positive polarity is concerned at half voltage U/2	No effect
	fault **B**	Maximum Isc both polarities are concerned	Maximum Isc both polarities are concerned	Maximum Isc both polarities are concerned
	fault **C**	No effect	Same as fault A but this time the negative polarity is concerned	No effect
The most unfavourable case		Fault A	Faults A and C	Fault B
Distribution of the breaking poles		All the poles effectively contributing to breaking are serial-connected on the positive polarity (1) (2)	On each polarity provide the number of poles required to break maximum Isc at voltage U/2	Distribute the number of poles required for breaking on each polarity

(1) or negative if it is the positive polarity that is earthed
(2) provide an additional pole on teh earthed polarity if the aim is isolation

Short circuit current at the terminals of an accumulator battery

When its terminals are short-circuited, an accumulator battery delivers a current given by Ohm's law:

$$Isc = \frac{Vb}{Ri}$$

Vb = maximum discharge voltage (battery charged at 100 %).
Ri = internal resistance equivalent to all the cells (value normally given by the manufacturer according to battery Ampere/hour capacity).

240 V DC
300 A
500 Ah
Ri = 0.5 mΩ/cell

Example
What is the short circuit current at the terminals of a stationary battery with the following characteristics:
- Capacity: 500 Ah
- Maximum discharge voltage: 240 V (110 x 2.2 V cells)
- Discharge current: 300 A
- Backup time: 1/2 hour
- Internal resistance: 0.5 mΩ per cell

Answer
$Ri = 110 \times 0.5.10^{-3} = 55.10^{-3}$

$$Isc = \frac{240}{55.10^{-3}} == 4.4KA$$

As shown in the calculation above, shortcircuit currents are relatively small.
Note: if internal resistance is not known, the following approximate formula can be used:
Isc = kC where C is the battery capacity expressed in Ampere/hour and k is a co-efficient close to 10 and in all cases always less than 20.

Choosing DC circuit-breakers

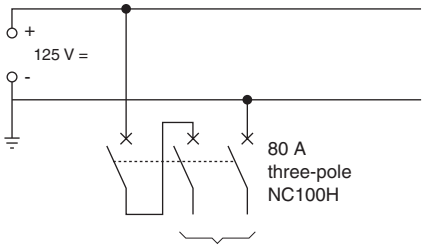
Type	Rated current (A)	Breaking capacity (kA) (L/R < 0.015 s) (The number of poles contributing to breaking is given in brackets)								Overload protection thermal	Magnetic threshold overrating coefficient
		24/48V	60V	125V	125V	250V	500V	750V	1000V		
Multi 9											
C60H	1-2-3-6-10-16-20-25-32-40-50-63	20 (1P)		25 (2P)	40 (3P)	50 (4P)				Ditto AC	1.38
C120H	10-16-20-25-32-40-50-63-80-100-125	15 (1P)		15 (1P)		15 (2P)				Ditto AC	1.4

(1) The C32H-DC special DC circuit-breaker is equipped with a permanent magnet, which requires strict respect of polarities
(2) For memory:
MP1 Im adjustable from 800 to 1600 A
MP2 Im adjustable from 1200 to 2500 A
MP3 Im adjustable from 2000 to 4000 A
P21-1250 Im adjustable from 1600 to 3200 A
P41-1250 Im adjustable from 3200 to 6400 A
(3) There are 7 versions of the dina 1500/3000 A trip units - 3/6 kA - 6/12 kA - 12/20 kA - 9/18 kA - 12/24 k A - 20/40 kA. Note: the masterpact switches, HI type in the three-pole version with a rating from M08 to M63, can be used in DC up to 125 V DC (one pole on the positive polarity, one pole on the negative polarity and one pole not used).

Circuits supplied with DC current
Choosing a circuit breaker

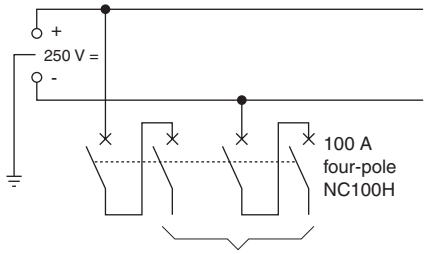
Examples

How to provide protection of a 80 A outgoer on a 125 V DC network whose negative polarity is earthed: Isc = 15 kA?



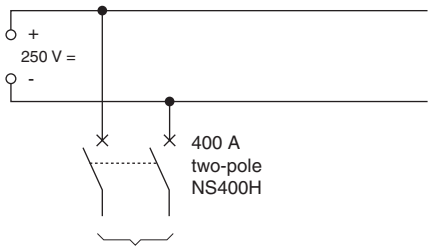
The chart opposite informs us that a NC100H (30 kA, 2P, 125 V) circuit-breaker must be used. The chart on the previous page informs us that both poles must be placed on the positive polarity. An additional pole can be placed on the negative polarity to guarantee isolation.

How to provide protection of a 100 A outgoer on a 250 V DC network whose mid-point is earthed: Isc = 15 kA?



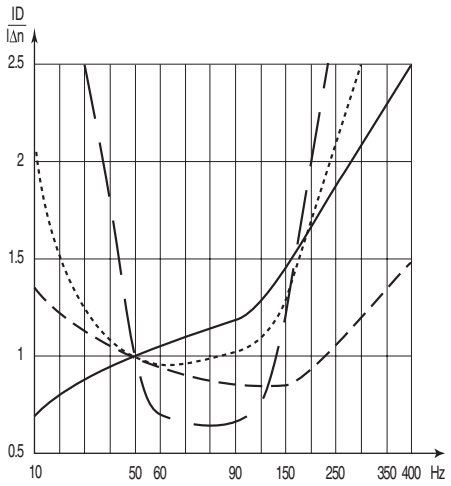
Each pole will be subjected to a maximum of U/2 = 125 V. The chart opposite informs us that a NC100H (30 kA, 2P, 125 V) or NS100N (50 kA, 1P, 125 V) or NS160N (50 kA, 1P, 125 V) circuitbreaker must be used. The chart on page 9/11 informs us that both poles must contribute to breaking at the voltage 125 V.

How to provide protection of a 400 A outgoer on a 250 V DC unearthed network: Isc = 35 kA?



The chart opposite informs us that a NS400H (85 kA, 1P, 250 V) circuit breaker must be used. At least 2 poles must contribute to breaking The chart page 9/11 informs us that the number of poles required for breaking must be distributed over each polarity.

Use in 400Hz Multi 9



The greater part of Multi 9 circuit breakers are used on 400 Hz networks.
Short-circuit currents at 400 Hz generator terminals do not, in general, exceed the nominal current by more than 4 times. Therefore, breaking capacity problems are very rare.

Multi 9 circuit breakers

- The C120 and NG125 circuit breakers cannot be used on 400 Hz network.

For the others :

- No thermal derating
- Increase of magnetic thresholds:
  - Coefficient 1.5 for DPN, DPN N and DPNa
  - Coefficient 1.48 for C60
  - Coefficient 1.40 for NC100
- Residual current circuit breakers from the Multi 9 range can be used on 400 Hz networks. It should be noted that the mA threshold varies depending on the network's frequency (see curves below).

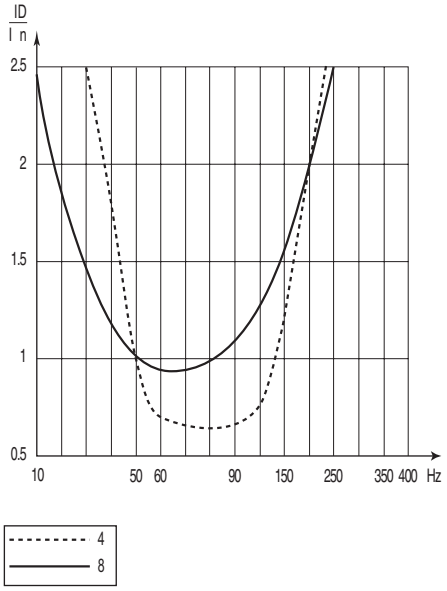
Note:
In 400 Hz, the test circuit for residual current devices may present the risk of not functioning when actioning the test button because of threshold variation.
According to international studies (IEC 60479-2), the human body is less sensitive to a 400 Hz current that passes through the body; so well that, even though the residual current device has had its frequency desensitised, these devices still ensure the protection of persons. The method for choosing residual current devices in 400 Hz is thus the same as that for 50 Hz.

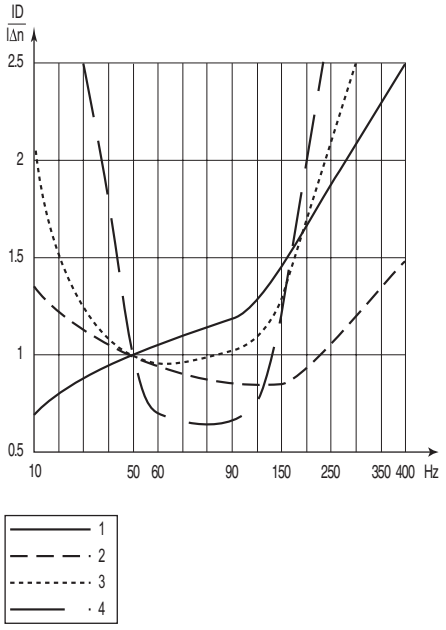
RCCB

Operating residual current variation curves

Type	Rating (A)	Curve n°				
		Sensitivity (mA)				
		10	30	100	300	500
AC						
	25	2	1	-	1	1
	25-40	-	1	1	1	1
	63-80-100	-	2	1	1	1
A						
	16-25-40-63	-	3	-	2	2
A si, SiE						
		-	4	-	4	-
Selective Ⓢ (AC, A)						
		-	-	-	2	2

8





DPN Vigi, DPN N Vigi

Operating residual current variation curves

Type	Rating (A)	Curve number		
		Sensitivity (mA)		
		10	30	300
AC				
	25	8	8	8
A si				
		-	4	4

Vigi C60 module

Operating residual current variation curves

Vigi C60 module 130/230 V - 50 Hz

Type	Rating (A)	Curve number				
		Sensitivity (mA)				Sensitivity (A)
		10	30	100	300	1
AC						
	25	2	1	1	-	-
	63	-	2	1	-	-

Vigi C60 module 230/400 V - 50 Hz

AC						
	25	2	1	1	-	-
	40-63	-	2	1	-	-
A						
	25-63	3	3	2	2	-

All types

Sélectif s						
		-	4	2	2	2

Vigi C60 module

A si						
		-	4	-	4	4

For use in conjunction with motor starters and transformers

Motor starters

In general miniature circuit breakers can give only short circuit protection to motor loads due to the high starting currents which may be encountered; typically 3 - 12 times full load current (FLC).

Assumptions

The tables give recommended MCB ratings for motors up to 37kW based on the following assumptions:

■ **Direct-on-line starting**

☐ Starting current = 7 x FLC
☐ Run up time = 6seconds, motors <3kW
☐ 10 seconds, motors < 22kW
☐ Running currents = average values only (individual manufacturer's figures will vary). four pole motors, i.e. speed approx. 1500rpm

For higher inertia loads, i.e. hoists or fans, run up times may be considerably longer than those assumed above. The rating of the MCB must take account of the greater run up time and starting current. The required MCB rating can be determined by reference to time/current curves (consult us).

■ **Star/delta starting**

Since, during the changeover from star to delta, a high current surge in the order of DOL values may be met, the MCB rating selected should be the same as that recommended for DOL starting.

Table 1 - 3 phase 415Vac D.O.L. starting

			Recommended MCB		
kW	hHp	Running I	**C60HB**	**C60HC**	**C60HD**
0.12	0.166	0.65	2	2	1
0.18	0.25	0.7	2	2	1
0.25	0.33	0.87	4	2	1
0.37	0.5	1.35	4	4	2
0.55	0.75	1.55	4	4	2
0.75	1.0	1.93	6	4	4
1.1	1.5	2.5	6	6	4
1.5	2	3.5	10	10	6
2.2	3	4.8	16	10	10
3	4	6.4	20	20	10
3.75	5	7.8	25	25	16
4	5.5	8.1	25	25	16
5.5	7.5	11	32	32	16
7.5	10	14.4	50	50	20
9.33	12.5	17.3	63	50	20
11	15	21	63	63	25
13	17.5	25	-	-	32
15	20	28	-	-	40
18.5	25	35	-	-	50
22	30	40	-	-	50
30	40	54	-	-	63
37	50	65.5	-	-	-

Table 2 - 1 phase 240Vac D.O.L. starting

kW	Hp	Running I	**C60HB**	**C60HC**	**C60HD**
0.12	0.166	0.95	4	2	1
0.18	0.25	1.5	4	4	2
0.25	0.33	1.7	6	4	2
0.37	0.5	3	10	6	4
0.55	0.75	4.5	16	10	6
0.75	1	5.5	16	16	10
1.1	1.5	8.5	25	25	16
1.5	2	10.5	32	32	20
2.2	3	15.5	40	40	25
3	4	20	63	63	32
3.75	5	24	-	63	40
5.5	7.5	34	-	-	50
6.3	8.5	36.5	-	-	63
7.5	10	45	-	-	63
11	15	66.5	-	-	-

Transformers

High inrush currents are also produced when transformers are switched on, typically 10 - 15 times full load current.

Assumptions

The tables give recommended MCB ratings for single phase transformers up to 12500VA and three phase transformers up to 30000VA based on the following formula.

Table 3 - 3 phase transformers 415Vac supply

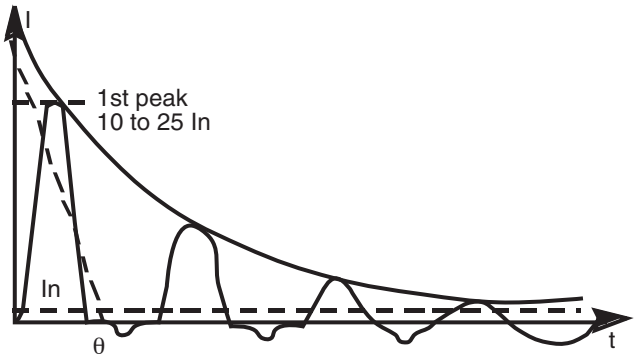
VA	Primary In (A)	C60HB	C60HC	C60HD
500	0.7	4	2	1
750	1.04	6	4	2
1000	1.39	10	6	4
2000	2.78	16	10	6
5000	6.95	40	25	16
10000	13.89	-	50	25
15000	20.84	-	63	32
20000	27.78	-	-	50
25000	34.73	-	-	63
30000	41.67	-	-	63

Table 4 - 1 phase transformers 240Vac supply

VA	Primary In (A)	C60HB	C60HC	C60HD
50	0.21	2	-	-
100	0.42	4	2	1
250	1.04	6	4	2
500	2.08	16	10	4
1000	4.17	25	16	10
2500	10.42	63	32	16
5000	20.84	-	63	32
10000	41.66	-	-	63
12500	52.08	-	-	-

Inrush currents

When LV/LV transformers are switched on, very high inrush currents are produced which must be taken into account when choosing overcurrent protection devices. The peak value of the first current wave often reaches 10 - 15 times the rated rms current of the transformer and may reach values of 20 - 25 times the rated current even for transformers rated less than 50kVA. This transient inrush current decays very quickly (in a few milliseconds).



P25M circuit breakers

Choice of motor supply cable size
When selecting the cable size the starting current of the motor and the permissible voltage drop must be taken into account. The cable must be capable of carrying a permanent service current at least equal to the sum of In + Is/3 where:
In = rated current
Is = starting current (4 - 8 In) depending on the motor.

Voltage drop
The permissible voltage drop from the start of the installation to the motor in question is 6% for public distribution systems. If the torque of the machine to be driven is low during starting it is only necessary to check the voltage drop for the rated current of the motor. If the starting torque is high (grinding mills, goods lifts, etc.) the voltage drop should be checked for the starting current.

P25M motor circuit breaker
This protects motors against overloads and short circuits. P25M type circuit breaker has on each pole a thermal release for protection against overloads and a magnetic release for protection against short circuits. For high short circuit currents use the limiter block, Ref. 21115. For ratings from 0.16A - 10A. 415V or from 0.16 - 18A, 240V; in this case the breaking capacity of the P25M circuit breaker is unlimited.

Applications
The P25M circuit breaker is particularly suitable for protecting **small machine tools** and similar machines, with **local control.**

Thermal release settings
The thermal releases are supplied set to the bottom value of the setting range. Simultaneous setting of the thermal releases can be carried out by opening the cover and adjusting the dial on the front face of the P25M. It is recommended that the thermal releases be set to the current that the motor absorbs in normal service and not to its rated current so as to provide effective close protection.

Ambient temperature compensation
Close protection against thermal overload is enhanced by thermal releases which are ambient temperature compensated over the range - 20°C - +60°C. During overload conditions, tripping is delayed at lower ambient temperatures, from - 20°C - +20°C, and is accelerated at higher ambient temperatures, from 20°C - +60°C.

Protection of the line supplying the motor
Every circuit and every motor must be protected against overloads and short circuits.

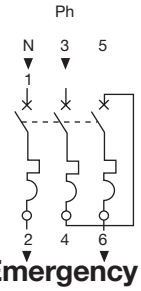
Phase failure protection
The P25M protects each phase separately and interrupts all three phases in the event of a loss of phase. Single phasing sensitivity is achieved by means of a differential trip which accelerates tripping should phase failure occur.

P25M circuit breakers

Auxiliaries:

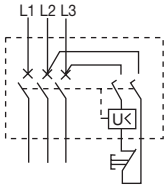
- Alarm switch.
- ON/OFF switch.
- Shunt trip release or undervoltage release (emergency stop).

Single phase connection



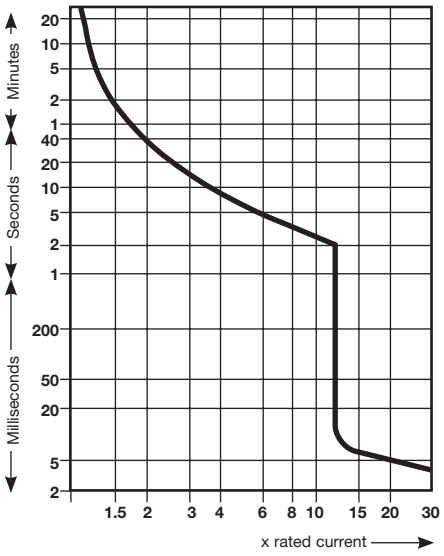
Two poles of the apparatus must be connected in series for the single phase supply

Emergency switch wiring



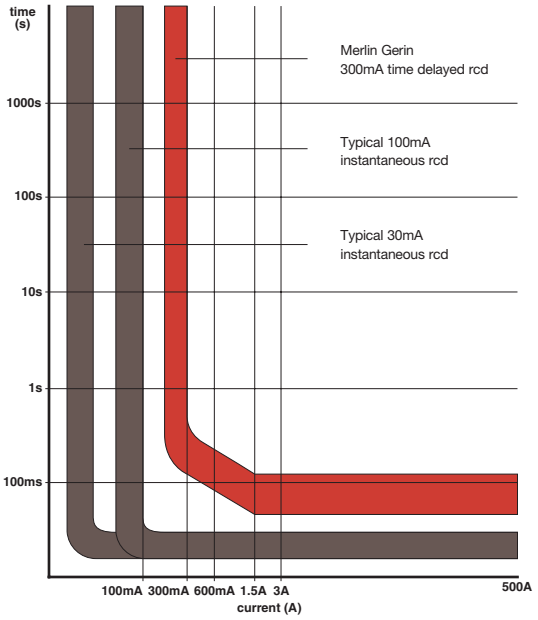
The early closing of the auxiliary contact is necessary to enable the closing of the circuit breaker equipped with an undervoltage release

Time/current characteristics



Rating In (A)	Settings	Part number	Standard power ratings kW: of 3-phase motors 50 - 60Hz AC-3 category					
			230	400	415	440	500	690
0.16	0.1 - 0.16	**21100**	-	-	-	-	-	-
0.25	0.16 - 0.25	**21101**	-	-	-	-	-	-
0.40	0.25 - 0.40	**21102**	-	-	-	-	-	-
0.63	0.40 - 0.63	**21103**	-	-	-	-	-	0.37
1.0	0.63 - 1	**21104**	-	-	-	0.37	0.37	0.55
1.6	1 - 1.6	**21105**	-	0.37	-	0.55	0.75	1.1
2.5	1.6 - 2.5	**21106**	0.37	0.75	1.1	1.1	1.1	1.5
4.0	2.5 - 4	**21107**	0.75	1.5	1.5	1.5	2.2	3
6.3	4 - 6.3	**21108**	1.1	2.2	2.2	3	3.7	4
10	6 - 10	**21109**	2.2	4	4	4	5.5	7.5
14	9 - 14	**21110**	3	5.5	5.5	7.5	9	11
18	13 - 18	**21111**	4	7.5	9	9	10	15
23	17 - 23	**21112**	5.5	9	11	11	11	18.5
25	20 - 25	**21113**	5.5	11	11	11	15	22

Types of RCD



Two families of RCD are offered in this catalogue

(1) Those without overcurrent protection (RCDs) e.g. RMGs

(2) Those with overcurrent protection (RCBOs) e.g. C60H rcbo's and DPN

Miniature circuit breakers combined with a residual current device, this RCD/MCB combination can be realised in the form of the C60H RCBO combined RCD/MCB or by combining a vigi module with an MCB. All of these units can be used to protect individual circuits or as devices mounted within individual enclosures. Individual out going circuits within type A or type B MCB distribution boards can be protected by installing RCD/MCB combinations on that particular outgoing way. Groups of circuits can be protected within distribution boards by selection of either split load or dual incomer units with selected circuits protected by RCD incoming devices. Complete distribution systems can be given RCD protection by installing an RMG RCD in a separate enclosure ahead of the distribution board or by using a distribution board having an incoming RCD.

Unwanted tripping

The principal reasons for unwanted tripping of RCDs are lack of discrimination between RCD's (see following paragraph) and transient earth leakage currents, which have various causes such as lightning strikes, switching surges (caused by switching inductive loads) or switching capacitive loads (RF filter networks, mineral insulated cables etc) All Merlin Gerin RCDs and RCD/MCBs incorporate a filtering device which minimises their response to transients, virtually eliminating unwanted tripping.

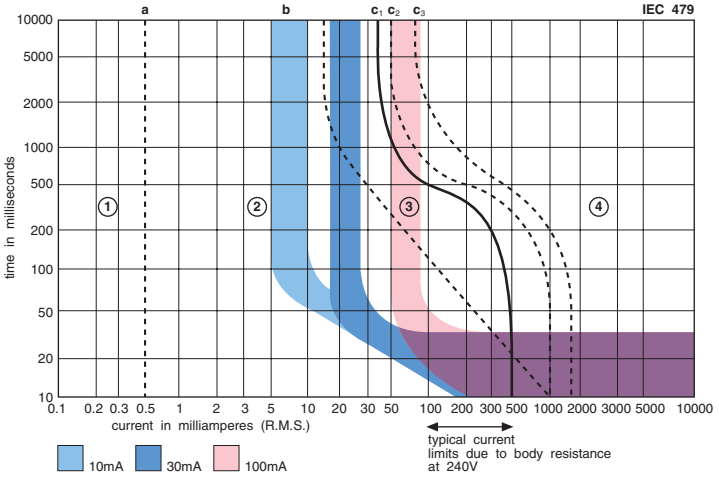
Discrimination of RCDs

Figure 3: characteristic of 231 16, 300mA time delayed RCD with 10, 30 and 100mA instantaneous devices superimposed to show discrimination. Wherever two or more RCDs are installed in series with one another, measures must be taken to ensure that they discriminate properly - in the event of an earth fault, only the device next upstream should operate. RCDs do **not** discriminate on rated residual operating current sensitivity alone. In other words, a 100mA device upstream of a 30mA device will not offer inherent discrimination. To provide the necessary discrimination, RCDs can be provided with an inbuilt time delay mechanism, usually 50ms. This inbuilt time delay is sufficient to allow the downstream device to open the circuit before the upstream device starts to operate. Such an RCD must be used as the incomer to a split load board incorporating two RCDs.

(fig. 3)

IEC publication 479 "effects of currents passing through the human body"

TIME/CURRENT ZONES OF EFFECTS OF A.C. CURRENT (15 - 100HZ) ON PERSONS WITH STANDARD RCD CHARACTERISTICS SUPERIMPOSED



Zone Physiological Effects

1 Usually no reaction effects

2 Usually no harmful physiological effects

3 Usually no organic damage to be expected. Likelihood of muscular contraction and difficulty of breathing reversible disturbances of formation and conduction of impulses in the heart and transient cardiac arrest without ventricular fibrillation increases with current magnitude and time

4 In addition to the effects of zone 3 probability of ventricular fibrillation increased up to 5% (Curve C2) up to 50% (Curve C3) and above 50% beyond Curve C3 Increasing with magnitude and time. pathyphysiological effects such as cardiac arrest, breathing arrest and heavy burns may occur.

8

How to implement a surge arrester system?

Lightning protection devices prevent damage to equipment and ensure the system's continuity of service.

PRF1 Master

Quick PRD

Selecting a surge arrester

Surge arrester selection is performed in three stages:
- Estimate the value of the equipment to be protected
- Determine the type of building
- Assess the risk of lightning impact according to the site

Choice of technology

To maintain the system's continuity of service, a surge arrester must be installed downstream of a disconnection device.
A circuit breaker, thoroughly appropriate for this type of function, well coordinated with the surge arrester, is the ideal solution.

There are two technologies to provide this coordination:
- Surge arresters with integral disconnector (ready to wire) which incorporate their own disconnection circuit breaker: Combi PRF1, Quick PF, Quick PRD
- Modular surge arresters: the disconnector to be added on has been coordinated with the surge arrester to ensure complete safety in the surge arrester's end-of-life stage: PRF1, PF, PRD

Withdrawable cartridge

Indicator lamp

The choice of ease of installation

The solution of a surge arrester and disconnector combined in a single product (Combi PRF1, Quick PF, Quick PRD) ensures optimum performance.
In this case the regulatory constraints and obligations for installation between disconnector and surge arrester are allowed for in the product.
Only the power supply and earth connections have to be performed.

Remote indication

Simplified maintenance

To facilitate maintenance:
- Rapid pinpointing of the operation to be performed: through indication of its state by indicator lamp
- Remote indication of surge arrester state by choosing a surge arrester provided with "remote reporting"
- A range of surge arresters with withdrawable cartridges to simplify maintenance

Quick PRD withdrawable cartridge

How to implement a surge arrester system?

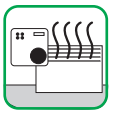
1 Estimate the value of the equipment to be protected

To estimate its value, consider:

- The cost of the equipment in financial terms
- The economic impact if the equipment goes down

- Domestic equipment:
  - Audio-video, computers
  - Household appliances
  - Burglar alarm

- Sensitive equipment:
  - Burglar alarm
  - Fire alarm
  - Access control
  - Video surveillance



- Building equipment:
  - Automated heating or air-conditioning
  - Lift

- Professional equipment:
  - Programmable machine
  - Computer server
  - Sound or light control system

- Heavy equipment:
  - Medical infrastructure
  - Production infrastructure
  - Heavy computer processing

2 Determine the electrical architecture of buildings

Lightning protection can be calculated for an entire building or for part of a building that is electrically independent

Depending on the size of the building and the extent of its electrical system, one or more surge arresters must be used in the various switchboards in the installation.

- Detached house
- Apartment, small semi-detached house
- Communal part of a building
- Professional premises
- Tertiary and industrial buildings:
  - Single switchboard, main switchboard
  - Distribution board
  - Sensitive equipment more than 30 m from the switchboard

3 Understand the risk of the impact of lightning on the site

Lightning is attracted by high points that conduct electricity. They can be:

- Natural: tall trees, mountain crest, wet areas, ferrous soil
- Artificial: chimney, aerial, pylon, lightning conductor

Indirect effects can be incurred within a fifty metre radius around the point of impact.

Location of the building

- In an urban, peri-urban, grouped housing area

- In an area where there is a particular hazard (pylon, tree, mountainous region, mountain crest, wet area or pond)

- In flat open country

- In an exceptionally exposed area (lightning conductor on a building less than 50 metres away)

Selection guide
Domestic equipment

1 Equipment to be protected

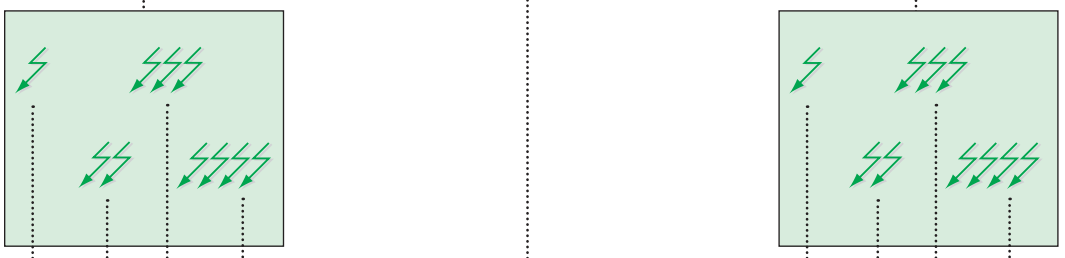
Domestic equipment

Audio-video, computers, household appliances, burglar alarm, etc.

2 Determine the architecture of the building

- **Detached house, Professional premises**
- **Apartment, small semi-detached house**
- **Communal part of a building**

3 Risk level of the impact of a lightning strike



Choice of type of surge arrester

Detached house, Professional premises	Apartment, small semi-detached house	Communal part of a building
Quick PF	PF	PF40
PF40		PF65
Combi PRF1 + PF40		Combi PRF1 + PF40
Combi PRF1 + PF40		Combi PRF1 + PF40

8

Lightning also propagates through telecommunications networks.
It can damage all the equipment connected to these networks.

Protection of telecommunications equipment	
Choice of surge arresters	**PRC**
Analogue telephone networks < 200 V	■

Selection guide
Sensitive equipment
Building equipment

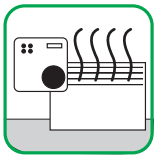
1

Equipment to be protected

Sensitive equipment:

Burglar alarm,
fire alarm,
access control,
video-surveillance, etc.

Building equipment:



Automated heating or air-conditioning, lift, etc.

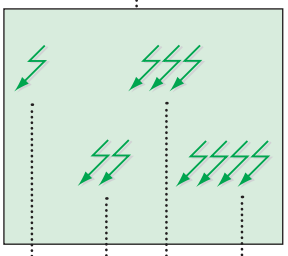
2

Determine the architecture of the building

- Single switchboard, main switchboard
- Distribution board
- Dedicated protection, more than 30 m from a switchboard

3

Risk level of the impact of a lightning strike



Choice of type of surge arrester

Single switchboard, main switchboard				Distribution board	Dedicated protection, more than 30 m from a switchboard
Quick PRD20r	Quick PRD40r	Quick PRD40r	Combi PRF1 or PRF1 Master + PRD40 or Quick PRD40r	Quick PRD40r	Quick PRD8r

Alternative solution

PRD20	PRD40	PRD40	Combi PRF1 or PRF1 Master + PRD40	PRD40	PRD8
OR				OR	OR
PF20	PF40	PF40	Combi PRF1 or PRF1 Master + PF40	PF40	PF8

8

Selection guide
Professional equipment

1 Equipment to be protected

Professional equipment

Programmable machine,
server,
sound or light control system,
etc.

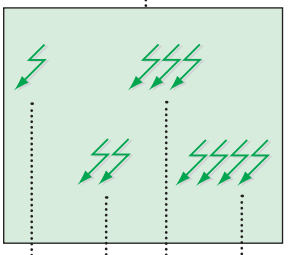
2 Determine the architecture of the building

Single switchboard, main switchboard

Distribution board

Dedicated protection, more than 30 m from a switchboard

3 Risk level of the impact of a lightning strike



Choice of type of surge arrester

Alternative solution

Single switchboard, main switchboard				Distribution board	Dedicated protection, more than 30 m from a switchboard
Quick PRD40r	PRD65	PRD65	Combi PRF1 or PRF1 Master + Quick PRD40r	Quick PRD20r	Quick PRD8r
PRD40	PRD65	PRD65	Combi PRF1 or PRF1 Master + PRD40	PRD20	PRD8
OR				OR	OR
PF40	PF65	PF65	Combi PRF1 or PRF1 Master + PF40	PF20	PF8

8

Selection guide
Heavy equipment

1 Equipment to be protected

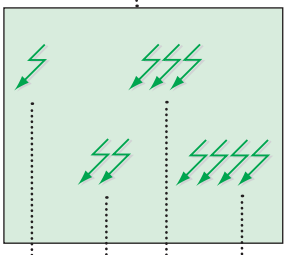
Heavy equipment

Medical, production, or heavy computer processing infrastructure, etc.

2 Determine the architecture of the building

- **Single switchboard, main switchboard**
- **Distribution board**
- **Dedicated protection, more than 30 m from a switchboard**

3 Risk level of the impact of a lightning strike



Choice of type of surge arrester

Single switchboard, main switchboard				Distribution board	Dedicated protection, more than 30 m from a switchboard
PRD65	Combi PRF1 + Quick PRD40r	Combi PRF1 or PRF1 Master + Quick PRD40r	Combi PRF1 or PRF1 Master + Quick PRD40r	Quick PRD20r	Quick PRD8r

Alternative solution

Single switchboard, main switchboard				Distribution board	Dedicated protection, more than 30 m from a switchboard
PRD65	Combi PRF1 + PRD40	Combi PRF1 or PRF1 Master + PRD40	Combi PRF1 or PRF1 Master + PRD40	PRD20	PRD8
OR				OR	OR
PF65	Combi PRF1 + PF40	Combi PRF1 or PRF1 Master + PF40	Combi PRF1 or PRF1 Master + PF40	PF20	PF8

Lightning can also propagate through telecommunications and computer networks.
It can damage all the equipment connected to these networks: telephones, modems, computers, servers, etc.

Protection of telecommunications and computer equipment

Choice of surge arresters	PRC	PRI
Analogue telephone networks < 200 V	■	
Digital networks, analogue lines < 48 V		■
Digital networks, analogue lines < 6 V VLV load supply < 48 V		■

Dimensions
Section 9

Choice of disconnector

The disconnector is necessary to ensure the safety of the installation

■ One of the surge arrester parameters is the maximum current (Imax 8/20 µs wave) that it can withstand without degradation. If this current is exceeded, the surge arrester will be destroyed; it will be permanently short circuited and it is essential to replace it.

The fault current must therefore be eliminated by an external disconnector installed upstream.

The disconnector provides the complete protection required by a surge arrester installation, i.e.:

□ It must be able to withstand standard test waves:
- It must not trip at 20 impulses at In
- It can trip at Imax without being destroyed

□ The surge arrester disconnects if it short-circuits.

■ The ready-to-cable surge arresters with an integrated disconnection circuit breaker are:

□ Combi PRF1
□ Quick PF
□ Quick PRD.

Surge arrester / disconnection circuit breaker correspondence table

Types	Isc	Surge arresters	6 kA	10 kA	15 kA	25 kA	36 kA	50 kA	70 kA
Type 1	**35 kA** *(1)*	PRF1 Master	NH 160 A gL/gG fuse						
			NS160N 160 A					NS160H 160 A	
	25 kA *(1)*	PRF1	D125	NH 125 A gL/gG fuse					
Type 2	**65 kA** *(2)*	PF65, PRD65	C60N 50 A Curve C		C60H 50 A Curve C	Contact us			
	40 kA *(2)*	PF40, PRD40	C60N 40 A Curve C		C60H 40 A Curve C	Contact us			
	20 kA *(2)*	PF20, PRD20	C60N 25 A Curve C		C60H 25 A Curve C	Contact us			
	8 kA *(2)*		C60N 20 A Curve C		C60H 20 A Curve C				

Isc: prospective short-circuit current at the point of installation.
(1) Iimp.
(2) Imax.

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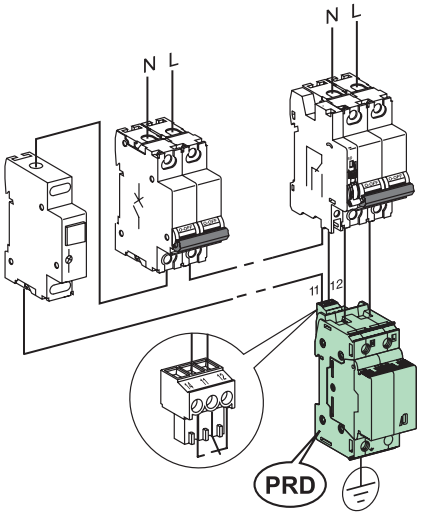
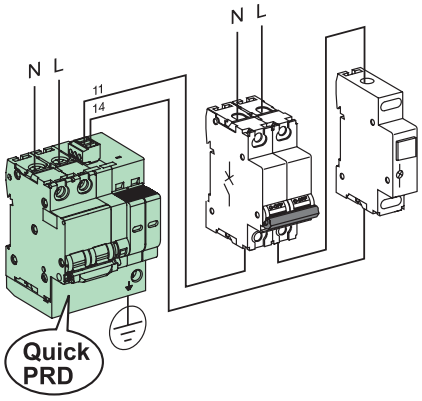
End-of-life indication of the surge arrester



Example of indication for PRD.



Example of indication for Quick PRD.

Various indication devices are provided to warn the user that the loads are no longer protected against atmospheric overvoltages.

Type 1 surge arresters (with gas filled spark gap)

PRF1 1P 260 V, Combi 1P+N and 3P+N and PRF1 Master

These surge arresters have a light indicating that the module is in good working order. This indicator light requires a minimum operating voltage of 120 V AC.

- The light does not come on:
  - if the operating voltage is ⩽ 120 V AC
  - if there is no network voltage
  - if the spark-over electronics are defective

Type 2 surge arresters (varistor, varistor + gas filled spark gap)

PF, PRD

At end of life, the surge arrester or the cartridge are destroyed.

- This can occur in two ways:
  - Internal end-of-life disconnection: the accumulated electric shocks cause the varistors to age, resulting in an increase in leakage current

Above 1 mA, a thermal runaway occurs and the surge arrester disconnects.

- External end-of-life disconnection: this occurs in the event of an excessive overvoltage (direct lightning strike on the line); above the discharge capacity of the surge arrester, the varistor(s) are dead short-circuited to earth (or possibly between phase and neutral). This short-circuit is eliminated when the mandatory associated disconnection circuit breaker opens

Quick PRD and Quick PF

Whatever the hazards of the power supply network, Quick PRD and Quick PF incorporate a perfectly coordinated disconnector.

- In the event of lightning strikes < Imax: like all surge arresters, they have internal anti-ageing protection
- In the event of a lightning strike > Imax: Quick PRD and Quick PF are self-protected by their integrated disconnector
- In the event of neutral disconnection or phase-neutral reversal occurring on the power supply:

Quick PRD and Quick PF are self-protected by their integrated disconnector.
To simplify maintenance work, Quick PRD is fitted with local indicators and draw-out cartridges that are mechanically combined with the disconnector.

Quick PRD has indicator lights on the cartridges and on the integrated disconnector, so that the work to be carried out can quickly be located.
For safety reasons, the disconnector opens automatically when a cartridge is removed. It cannot be set until the cartridge is plugged in.
When changing the cartridge, a phase/neutral failsafe system ensures that it can be plugged in safely.

Operating state continuous display

Quick PRD has an integrated reporting contact to send information about the operating state of the surge arrester from a remote location.
Monitoring the surge arresters installed throughout the installation makes it possible to be continuously aware of their operating state and to ensure that the protection devices are always in good working order.

- A reporting contact gives the alert:
  - At end of life of a cartridge
  - If a cartridge is missing, as soon as it has been removed
  - If a fault occurs on the line (short-circuit, neutral disconnection, phase-neutral reversal)
  - In the event of local manual operation (handle down)

Quick PF has an optional indication reporting auxiliary (SR) that sends information about the operating state of the surge arrester from a remote location.

Installing surge arresters in a box or cabinet

Connections

These must be as short as possible. In fact, one of the essential characteristics for equipment protection is the maximum level of voltage that the equipment can withstand at its terminals. A surge arrester with a protection level suitable for the equipment to be protected should be chosen (fig. 35). The total length of the connections is L = L1 + L2 + L3. It represents an impedance of roughly 1 µH/m for high frequency currents.
Application of the rule $\Delta U = L \frac{di}{dt}$

with an 8/20 µs wave and a current of 8 kA leads to a voltage of 1,000 V peak per metre of cable.

$$\Delta U = 1.10^{-6} \times \frac{8.10^{3}}{8.10^{-6}} = 1000\ V$$

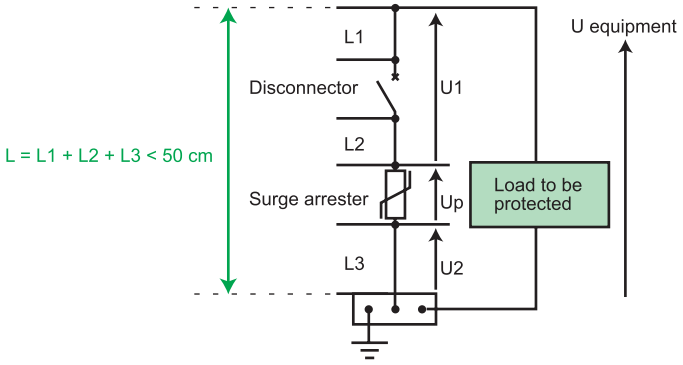


Fig. 35 - surge arrester connection: L < 50 cm

This gives U equipment = Up + U1 + U2.
If L1 + L2 + L3 = 50 cm, this will result in a voltage surge of 500 V for a current of 8 kA.

Wiring rules

Rule 1
The first rule to be respected is not to exceed a distance of 50 cm when connecting the surge arrester to its disconnection circuit-breaker. The surge arrester connections are shown in figure 36.

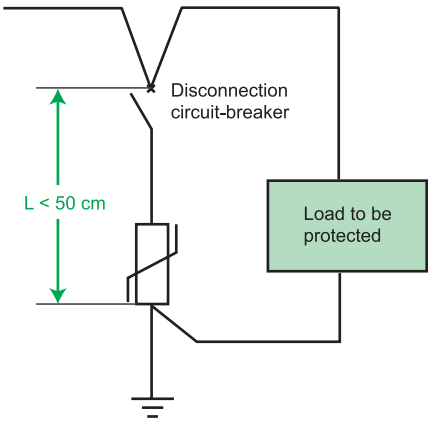


Fig. 36 - diagram of the connections

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Installing surge arresters in a box or cabinet

Rule 2

The outgoing feeders of the protected conductors must be connected right at the terminals of the surge arrester and disconnection circuit-breaker (fig. 37).

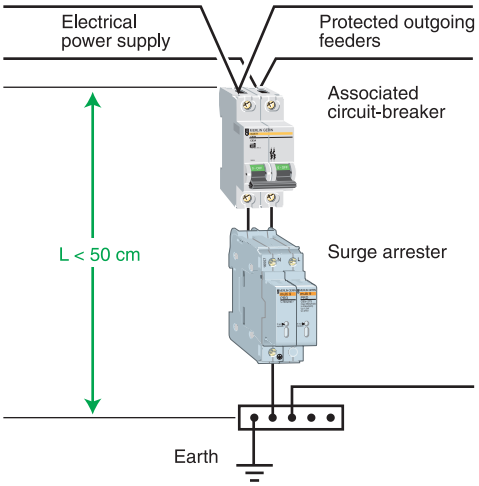


Fig. 37 - the connections are right at the surge arrester's terminals.

Rule 3

The phase, neutral and PE incoming wires must be tightly coupled to reduce the loop surfaces (fig. 38).

Rule 4

The surge arrester's incoming wires must be moved away from the outgoing wires to avoid mixing the polluted cables with the protected cables (fig. 38).

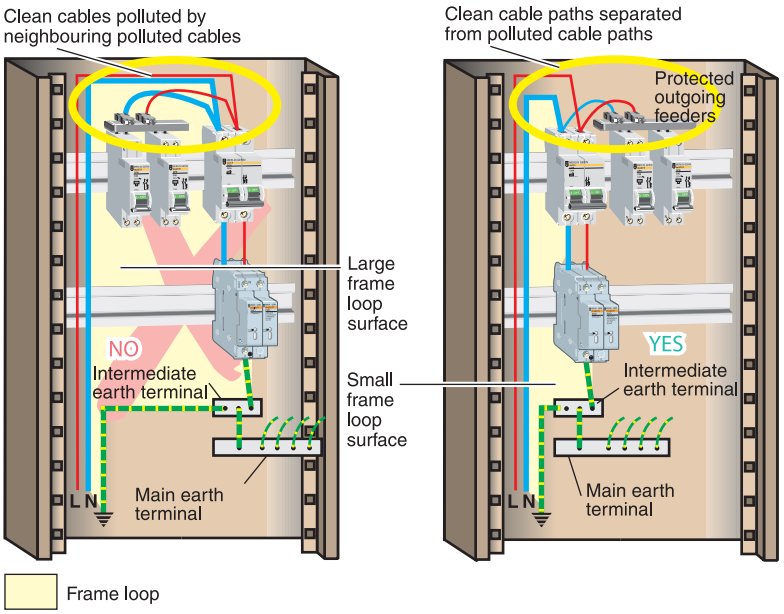


Fig. 38 - example of wiring precautions to be taken in a box (rules 2,3,4,5)

Rule 5

The cables must be flattened against the metallic frames of the box in order to minimise the frame loops and thus benefit from a disturbance screening effect.
If the box is made of plastic and the loads particularly sensitive, it must be replaced by a metal box.
In all cases, you must check that the metallic frames of the boxes or cabinets are frame grounded by very short connections.
Finally, if screened cables are used, extra lengths which serve no purpose ("pigtails"), must be cut off as they reduce screening effectiveness.

Installing surge arresters in a box or cabinet

Layouts for installing surge arresters in a box

To respect the rule of the shortest possible wiring - L < 50 cm - the phases and neutral should be directly connected to the disconnection circuit-breaker and the earth link should be connected to the surge arrester's earth terminal (fig. 39).

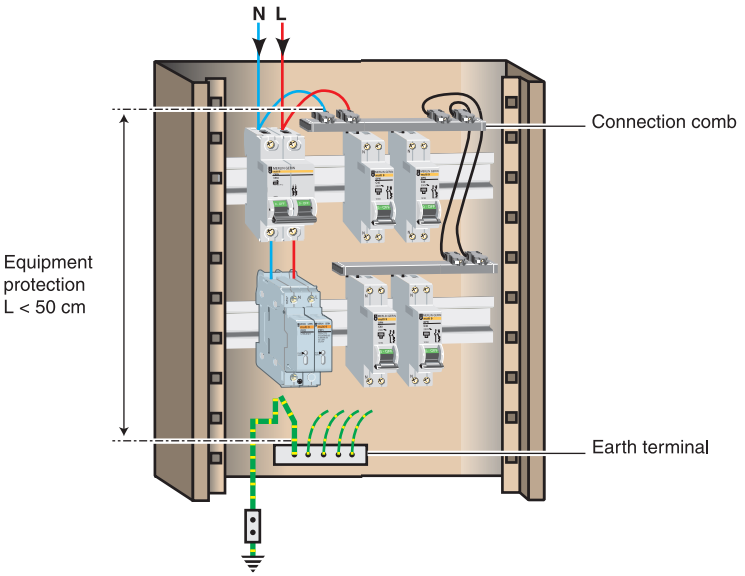


Fig. 39 - example of a surge arrester installation layout for household applications

It is advisable to use this type of wiring in small installations (e.g. domestic). Connection combs should be used as far as possible as they provide optimum wiring.
The wiring layout shown in figure 40 is the most practical, especially for service sector and industrial applications which regularly require maintenance or wiring modifications.
For this purpose, the following is added:

- A phase/neutral wiring distribution terminal block as close as possible to the associated circuit breaker
- An intermediate earth terminal block as close as possible to the surge arrester

The protection of sensitive equipment will be ensured from these terminal blocks. The length of the general supply cables and earth cable will therefore no longer make any difference.

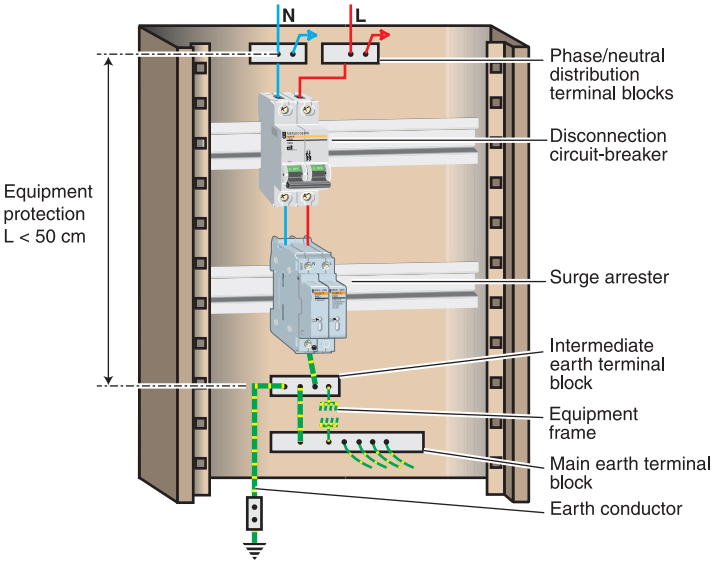


Fig. 40 - example of shortest wiring for the service sector and industry

Installing surge arresters in a box or cabinet

Power supply incoming feeder via the top

Example of layout for installing the surge arrester and its associated disconnector on different symmetrical rails (fig. 41)

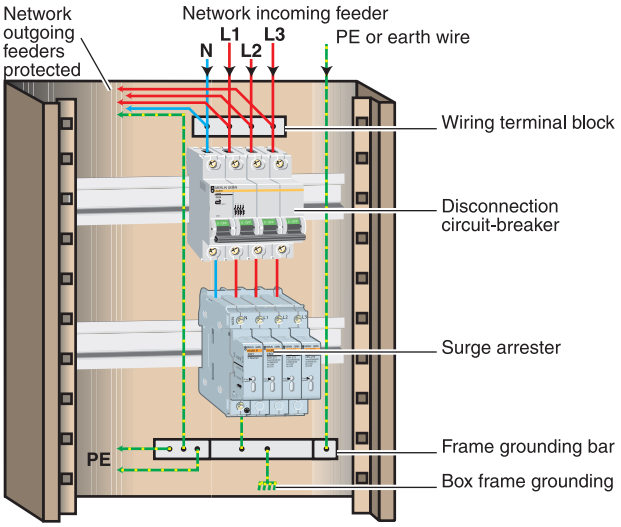


Fig. 41 - example of a surge arrester installation on different symmetrical rails.

Layout for installing the surge arrester and its asociated disconnector on the same symmetrical rail (figure 42).

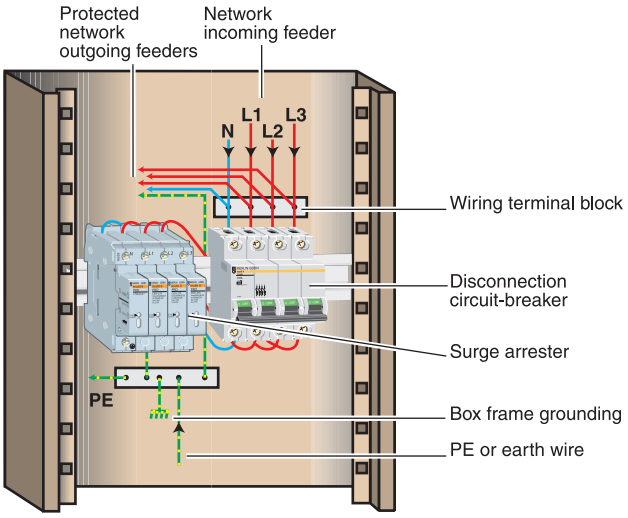


Fig. 42 - example of a surge arrester installation on the same symmetrical rail.

Installing surge arresters in a box or cabinet

Power supply incoming feeder via the bottom (fig. 43)

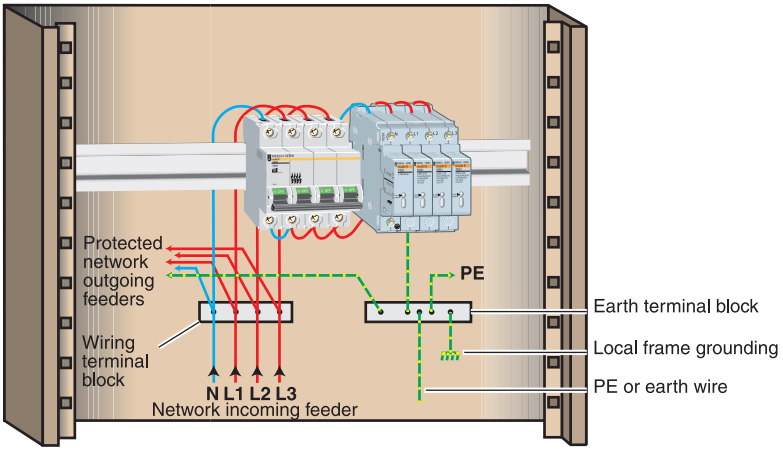


Fig. 43 - example of surge arrester installation with power supply incoming feeder via the bottom.

Cable sections

The standard requires a surge arrester connection cable section of 10 mm² when there is a lightning conductor and at least 4 mm² in other cases.

CT contactors

Use of multi 9 contactors from 16 to 100 A

For automation needs in the housing, tertiary and industrial sectors, the range of modular CT contactors is used for:

- ■ Power control of final circuits for housing and the tertiary sector:
  - □ Lighting (luminous signs, shop windows, safety lighting, etc.)
  - □ Heating, heat pumps, ovens
  - □ Hot water for domestic use
  - □ Small utility motors (pumps, fans, barriers, garage doors, etc.)
  - □ Emergency stops and safety systems
  - □ Air conditioning
- ■ Energy distribution control:
  - □ Load shedding and restoration
  - □ Source changeover, etc

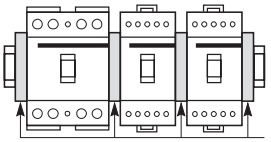
Characterisation on load types

Standard IEC 61095 applies to electromechanical contactors for domestic and similar purposes. It differs from standard IEC 60947.4 (designed for industrial applications) by specific requirements relating to safety of persons and equipment in premises and corridors accessible to the general public.

Applications	Industrial: IEC 60947.4	Domestic: IEC 61095
Motor	AC3	AC7b
Heating	AC1	AC7a
Lighting	AC5a and b	AC5a and b

Use for temperatures between 50 and 60 °C

When contactors are mounted in enclosures with an internal temperature of between 50 and 60 °C, a spacer, catalogue number 27062, must be placed between each contactor.



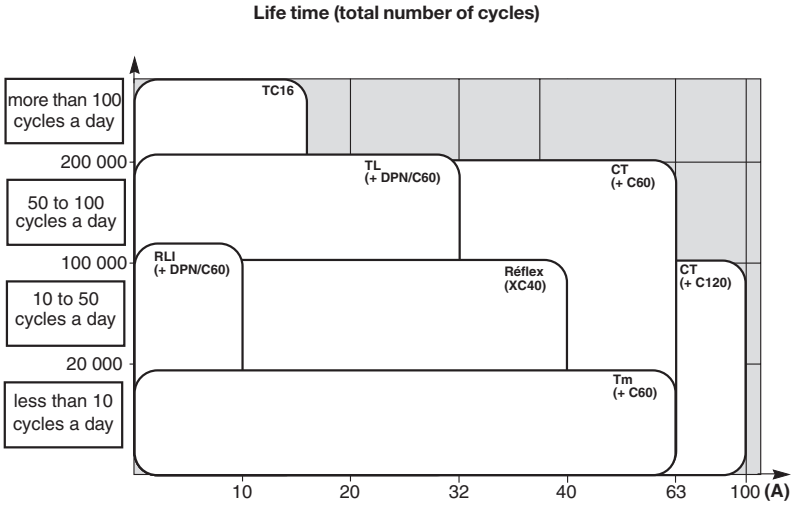
Spacer part number 27062

Positioning the remote control contactors

This table positions each device according to:

- ■ The number of cycles (total or daily)
- ■ The power to be controlled

It provides information on the protection circuit-breaker to be associated.



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CT contactors

Lighting application

- The following tables concern all the contactors from the CT range, with or without manual control, for 230 V single-phase lighting circuits
- They indicate the contactor rating to be chosen according to the number and type of lamps to be controlled. As a guideline, maximum power is also given
- To obtain an equivalence on:
  - Three-phase + neutral circuits: multiply the number of lamps and the power indicated in the table by 3
  - Three-phase without neutral circuits: multiply the number of lamps and the power indicated in the table by 1.7

Type of lighting application 230 V single-phase circuit	Maximum number of lamps for a given rating CT contactors				
Power (W)	16 A	25 A	40 A	63 A	100 A
Incandescent lamp with or without halogen gas					
40	38	57	115	172	250
60	30	45	85	125	187
75	25	38	70	100	150
100	19	28	50	73	110
150	12	18	35	50	75
200	10	14	26	37	55
300	7	10	18	25	37
500	4	6	10	15	22
1000	2	3	6	8	12
12 V halogen lamp (on ELV electromagnetic transformer)					
20	15	23	42	63	94
50	10	15	27	42	63
75	8	12	23	35	52
100	6	9	18	27	40
150	4	6	13	19	28
26 mm fluorescent tube (single parallel-corrected)					
15	15	20	40	60	90
18	15	20	40	60	90
20	15	20	40	60	90
36	15	20	40	60	90
40	15	20	40	60	90
58	10	15	30	43	64
65	10	15	30	43	64
115	5	7	14	20	30
140	5	7	14	20	30
26 mm fluorescent tube (single uncorrected)					
15	22	30	70	100	150
18	22	30	70	100	150
20	22	30	70	100	150
36	20	28	60	90	135
40	20	28	60	90	135
58	13	17	35	56	84
65	13	17	35	56	84
115	7	10	20	32	48
140	7	10	20	32	48
26 mm fluorescent tube (dual serial-corrected)					
2 x 18	30	46	80	123	180
2 x 20	30	46	80	123	180
2 x 36	17	25	43	67	100
2 x 40	17	25	43	67	100
2 x 58	10	16	27	42	63
2 x 65	10	16	27	42	63
2 x 118	6	10	16	25	37
2 x 140	6	10	16	25	37
26 mm fluorescent tube (4 tubes, serial correction)					
4 x 18	15	23	46	69	100
Electronic ballast (1 x 26 mm tube)					
18	74	111	222	333	500
36	38	58	117	176	260
58	25	37	74	111	160
Electronic ballast (2 x 26 mm tubes)					
2 x 18	36	55	111	166	250
2 x 36	20	30	60	90	135
2 x 58	12	19	38	57	85

CT contactors

Electronic compact lamp (low consumption)					
Type of lighting application 230 V single-phase circuit	Maximum number of lamps for a given rating CT contactors				
Power (W)	16 A	25 A	40 A	63 A	100 A
7	133	200	400	600	900
11	80	120	240	360	540
15	58	88	176	264	396
20	44	66	132	200	300
23	38	57	114	171	256
Low pressure sodium vapour lamp (without correction)					
18	18	34	57	91	
35	4	9	14	24	
55	5	9	14	24	
90	3	6	9	19	
135	2	4	6	10	
180	2	4	6	10	
Low pressure sodium vapour lamp (with parallel correction)					
18	14	21	40	60	
35	3	5	10	15	
55	3	5	10	15	
90	2	4	8	11	
135	1	2	4	6	
180	1	2	5	7	
High pressure sodium vapour lamp (without correction)					
70	8	12	20	32	
150	4	7	13	18	
250	2	4	8	11	
400	1	3	5	8	
1000	-	1	2	3	
High pressure sodium vapour lamp (with parallel correction)					
70	6	9	18	25	
150	6	9	18	25	
250	2	3	6	9	
400	2	4	8	12	
1000	1	2	4	6	

Heating application

- The following table concerns all the contactors in the CT range, with or without manual control, for 230 V single-phase and 400 V three-phase heating circuits
- It indicates the contactor rating to be chosen according to the power to be controlled and the number of operations a day

230 V heating				
Type of heating application	Maximum power (kW) for a given rating CT contactors			
Number of operations / day	25 A	40 A	63 A	100 A
25	5,4	8,6	14	21,6
50	5,4	8,6	14	21,6
75	4,6	7,4	12	18
100	4	6	9,5	14
250	2,5	3,8	6	9
500	1,7	2,7	4,5	6,8
400 V heating				
25	16	26	41	63
50	16	26	41	63
75	14	22	35	52
100	11	17	26	40
250	5	8	13	19
500	3,5	6	9	14

Small motor application

- The following table concerns all the contactors in the CT range, with or without manual control, for 230 V single-phase and 400 V three-phase circuits
- It indicates the contactor rating to be chosen according to the power of the motor to be controlled

Small motor application type		Maximum power (kW) for a given rating CT contactors		
	Voltage	25 A	40 A	63 A
Asynchronous single phase motor with capacitor				
	230 V	1,4	2,5	4
Asynchronous three phase motor				
	400 V	4	7,5	15
Universal motor				
	230 V	0,9	1,4	2,2

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TL impulse relays

Impulse relays are used to control circuits composed of resistive loads (incandescent lamps, low voltage halogen lamps, convectors) or inductive loads (fluorescent tubes, discharge lamps):

- The table opposite gives the power or maximum number of lamps which can be installed on a 230 V single-phase circuit
- For 230/400 V three-phase + neutral circuits, multiply these values by 3
- For 230 V three-phase circuits without neutral, multiply these values by 1.7

Lighting

Maximum number of lamps on a 230 V single-phase circuit						Max. power TL16A	Max. power TL32A
Incandescent lamps							
Tungsten filaments (230 V)							
Power	**40W**	**60W**	**75W**	**100W**	**200W**		
Maximum no.	40	25	22	16	8	1600W	
Maximum no.	95	43	34	26	13		2600W
Halogen lamps (230 V)							
Power		**300W**	**500W**	**1000W**	**1500W**		
Maximum no.		5	3	1	1	1500W	
Maximum no.		8	5	2	1		2200W
ELV halogen lamps (12 or 24 V with transfo)							
Power		**20W**	**50W**	**75W**	**100W**		
Maximum no.		70	28	19	14	1400W	
Maximum no.		110	44	29	22		2200W
Fluorescent tubes							
Single with starter (not corrected) p.f. = 0,6							
Power			**18W**	**36W**	**58W**		
Maximum no.			70	35	21	1300W	
Maximum no.			186	93	55		3400W
Single with starter (parallel corrected) p.f. = 0,86							
Power			**18W**	**36W**	**58W**		
Maximum no.			50	25	16	1100W	
Maximum no.			133	66	42		2400W
Double with starter (series corrected) p.f. = 0,86							
Power			**2x18W**	**2x36W**	**2x58W**		
Maximum no.			56	28	17	2000W	
Maximum no.			148	74	45		5300W
HF single tubes and ballast p.f. = 0,96							
Power			**18W**	**36W**	**58W**		
Maximum no.			80	40	26	1300W	
Maximum no.			212	106	69		3400W
HF double tubes and ballast p.f. = 0,96							
Power			**2x18W**	**2x36W**	**2x58W**		
Maximum no.			40	20	13	1300W	
Maximum no.			106	53	34		3400W
Compact with electronic ballast without correction (incorporation)							
Power		**11W**	**15W**	**20W**	**23W**		
Maximum no.		50	45	35	30	800W	
Maximum no.		120	110	90	70		1800W
Compact with integrated electronic ballast (substitution)							
Power		**11W**	**15W**	**20W**	**23W**		
Maximum no.		80	60	50	45	1100W	
Maximum no.		180	150	120	100		2400W
Discharge lamps							
Low pressure sodium vapour p.f. = 0,96							
Power		**55W**	**90W**	**135W**	**180W**		
Maximum no.		24	15	10	7	1300W	
Maximum no.		63	40	26	18		3400W
High pressure sodium vapour or metallic iodides p.f. = 0,96							
Power			**250W**	**400W**	**1000W**		
Maximum no.			5	3	1	1300W	
Maximum no.			13	8	3		3400W
Heating							
230 V single-phase circuit							
Heating (AC1)						3600W	7200W

CT current transformers

Choosing a current transformer

Choice of a CT depends on 2 criteria:
- The Ip/5 A ratio
- The installation type

The Ip/5 A ratio

We recommend that you choose the ratio immediately higher than the maximum measured current (In).
Example: In = 1103 A; ratio chosen = 1250/5.
For small ratings from 40/5 to 75/5 and for an application with digital devices, we recommend that you choose a higher rating, for example 100/5.
This is because small ratings are less accurate and the 40 A measurement, for example, will be more accurate with a 100/5 CT than with a 40/5 CT.

The installation type

Choice of a CT model depends on the installation type:
- Insulated cables
- Mounting on bars

Important precaution

Never open the secondary circuit of a current transformer when the primary circuit is energised.
Prior to working on the secondary circuit, the secondary terminals of the current transformer must be short-circuited.

Determining the accuracy class of a CT

The accuracy class depends on the apparent power (VA) of the transformer and on consumption of the complete measurement system.
The latter allows for consumption of all the devices and the connecting cables.
For a given accuracy class, consumption of the measurement system must not exceed apparent power (VA) of the CT transformer.

Copper cable cross-section (mm^2)	Power in VA per doubled meter at 20 °C
1	**1**
1.5	**0.685**
2.5	**0.41**
4	**0.254**
6	**0.169**
10	**0.0975**
16	**0.062**

For each temperature variation per 10 °C bracket, the power drawn up by the cables increases by 4 %.

Merlin Gerin device	Consumption of the current input in VA
Ammeter 72 x 72 / 96 x 96	**1.1**
Analog ammeter	**1.1**
Digital ammeter	**0.3**
PM700, PM800, CM3000, CM4000	**0.15**
ME4zrt	**0.05**
PM9	**0.55**

Example: consumption of a measurement system at 20 °C

PM9		0.55 VA
4 meters of 2.5mm^2 doubled wires	+	16.4 VA
i.e. a measurement system consumption	=	**2.19 VA**

Based on the result, the CT accuracy class is determined (see previous page):
- Class 3 for a 75/5 ratio CT
- Class 1 for a 100/5 ratio CT
- Class 0.5 for a 125/5 ratio CT.

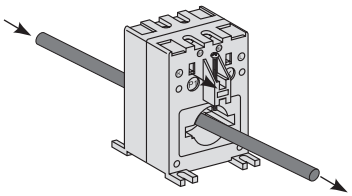
CT current transformers

Specific case of the motor starter

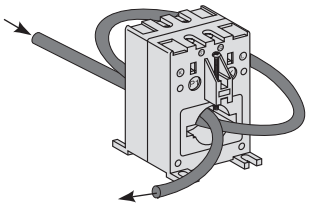
To measure motor starter current, you must choose a CT with primary current Ip = Id/2 (Id = motor starting current).

Practical advice

Use a current transformer to measure a nominal current of 50 A.



50/5 A CT: Imax = 50 A

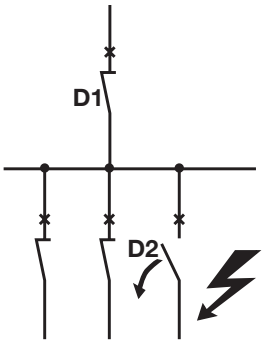


100/5 A CT, 2 cable openings: Imax = 50 A

To divide by 2 the nominal current of a transformer, you only need to pass the current to be measured twice through this transformer.

Discrimination

The table below indicates where total discrimination exists between devices.



Upstream	Compact		MGE1003X	MGE1253X	MGE1603X	MGE2003X	MGE2503X	MGE4003X	MGE6303X
Downstream circuit breaker		Rating (A)							
multi 9	C60H	10 - 16	■	■	■	■	■	■	■
		20 - 25		■	■	■	■	■	■
		32 - 40		■	■	■	■	■	■
		50 - 63		■	■	■	■	■	■

Note: For further information on this product range: consult us.

Guidance for motor loads

Specific “magnetic only” MCCBs are available for short circuit protection of motors. However, the standard MCCB may be used, as detailed below.

	Max motor size (kW)	Running current (A) @ 415V
16A	2.2	5.0
25A	3.7	7.5
40A	4	8.4
63A	9	17
80A	15	28
100A	22	40
125A	25	47
160A	33	60
200A	45	80
250A	69	128

Note:

■ These tables offer guidance only, for DOL starting assuming:
☐ A starting current of 7 x FLC
☐ Run-up time =8 seconds for motors
< 3kW
10 seconds for motors
> 3kW
■ The running current is a typical value and may vary from manufacturer to manufacturer

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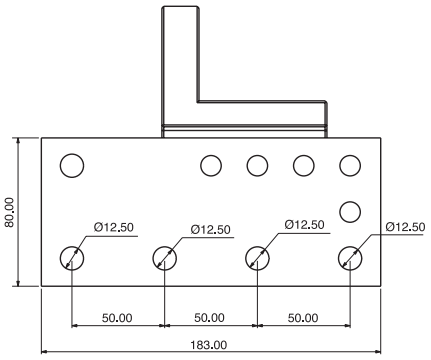
Current	Device		Possible terminal capacity for crimped lug (mm) Ø	@ L	Breaking capacity 415V
100A	MGP100	MCCB SP	6	25	25,000A @ 240V
100A	MGP100X	MCCB TP	6	25	36,000A
160A	MGP160X	MCCB TP	6	25	36,000A
250A	MGP250X	MCCB	8	25	36,000A
	MGP250NA	Switch disconnector	8	25	–
400A	MGP400X	MCCB	10	32	50,000A
	MGP400A	Switch disconnector	10	32	–
630A	MGP630X	MCCB	10	32	50,000A
	MGP630NA	Switch disconnector	10	32	–
800A	NS800		12	44	50,000A
	NS800NA	Switch disconnector	12	44	–
	MGP INC	Direct connection	10	32	–
	Outgoing	Earth connection	6	25mm tunnel	-
	Outgoing	Neutral connection	6	25	–
	Incoming	Earth connection	10	32	–
	Incoming	Neutral connection	12	40	–

Other connections available on request. If you require higher breaking capacity, consult us.

1600A Panelboard

Incoming connection details
4 - Ø12.5 holes on 50 mm pitch
Pole pitch = 70mm
Distance to gland plate = 708mm



Degrees of protection

Provided by enclosures

External influences

In many national and international standards, a large number of external influences to which an electrical installation can be subjected are indexed and coded: presence of water, presence of solid objects, risk of impact, vibrations, presence of corrosive substances, etc. These influences may be present with variable intensity depending on the conditions of installation: The presence of water may be in the form of a few drops or total immersion.

Protection index

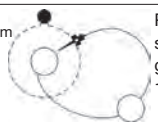
European standard EN60529 gives a protection code (IP) which characterises the ability of equipment to withstand the following external influences:

- Presence of solid bodies
- Presence of water

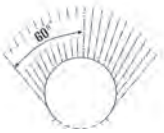
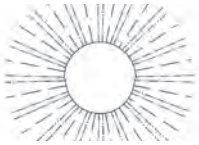
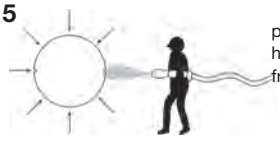
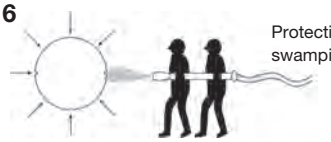
This code comprises two digits, depending on these external influences. The protection index is assigned to the equipment following a series of tests laid down in the respective standards.

Test according to EN60529

1st digit
Protection against solid bodies

0		no protection
1		Protection against solid bodies greater than 50 mm
2		Protection against solid bodies greater than 12.5mm
3		Protection against solid bodies greater than 2.5 mm
4		Protection against solid bodies greater than 1 mm
5		Protection against dust (no harmful deposits)
6		Total protection against dust

2nd digit
Protection against liquids

0		No protection
1		Protection against vertical drops of water (condensation)
2		Protection against drops of water falling up to 15° from vertical
3		Protection against rainwater up to 60° from vertical
4		Protection against water projected from all directions
5		protection against hosing with water from all directions
6		Protection against swamping with water
7		Protection against immersion

Example
IP 55

- Protection against dust (no harmful deposits)
- Protection against hosing with water from all directions

8

Earth Loop Impedance Values for Miniature Circuit Breakers

Type C60H
Type B

Rating	0.4 Sec	5 Sec
1A	46	46
2A	23	23
4A	11.5	11.5
6A	7.6	7.6
10A	4.6	4.6
16A	2.88	2.88
20A	2.3	2.3
25A	1.84	1.84
32A	1.44	1.44
40A	1.15	1.15
50A	0.92	0.92
63A	0.73	0.73

Type C60H
Type C

Rating	0.4 Sec	5 Sec
1A	23	29.49
2A	11.5	14.38
4A	5.75	7.42
6A	3.88	4.89
10A	2.3	2.95
16A	1.44	1.84
20A	1.15	1.47
25A	0.92	1.18
32A	0.72	0.92
40A	0.58	0.74
50A	0.46	0.59
63A	0.37	0.47

Type C60H
Type D

Rating	0.4 Sec	5 Sec
1A	16.43	29.49
2A	8.21	14.38
4A	4.11	7.42
6A	2.74	4.89
10A	1.64	2.95
16A	1.03	1.84
20A	0.82	1.47
25A	0.66	1.18
32A	0.51	0.92
40A	0.41	0.74
50A	0.33	0.59
63A	0.26	0.47

Type C120H
Type B

Rating	0.4 Sec	5 Sec
10A	4.6	4.6
16A	2.88	2.88
20A	2.3	2.3
25A	1.84	1.84
32A	1.44	1.44
40A	1.15	1.15
50A	0.92	0.92
63A	0.73	0.73
80A	0.57	0.57
100A	0.46	0.46
125A	0.36	0.36

Type C120H
Type C

Rating	0.4 Sec	5 Sec
10A	2.3	2.87
16A	1.44	1.79
20A	1.15	1.44
25A	0.92	1.15
32A	0.72	0.9
40A	0.58	0.71
50A	0.46	0.57
63A	0.37	0.45
80A	0.29	0.35
100A	0.23	0.28
125A	0.18	0.23

Type C120H
Type D

Rating	0.4 Sec	5 Sec
10A	1.64	2.87
16A	1.03	1.79
20A	0.82	1.44
25A	0.66	1.15
32A	0.51	0.9
40A	0.41	0.71
50A	0.33	0.57
63A	0.26	0.45
80A	0.21	0.35
100A	0.16	0.28
125A	0.13	0.23

Type NG125N/H
Type B

Rating	0.4 Sec	5 Sec
80A	0.57	0.57
100A	0.46	0.46
125A	0.36	0.36

Type NG125N/H
Type C

Rating	0.4 Sec	5 Sec
10A	2.3	2.87
16A	1.44	1.79
20A	1.15	1.44
25A	0.92	1.15
32A	0.72	0.9
40A	0.58	0.71
50A	0.46	0.57
63A	0.37	0.45
80A	0.29	0.35
100A	0.23	0.28
125A	0.18	0.23

Type NG125N/H
Type D

Rating	0.4 Sec	5 Sec
80A	0.21	0.35
100A	0.16	0.28
125A	0.13	0.23