

## HV Back-up Fuse-Links according to IEC 60 282-1



HV fuse-links have been used for reliable protection in medium-voltage switchgear and controlgear and systems for decades.

They protect apparatus and equipment against the thermal and dynamic effects of short-circuits. The outstanding features of Limitor HV fuse-links from Ferraz Shawmut are:

- High breaking capacity
- High current limitation
- Low switching voltage
- Quick breaking
- Non-ageing

Limitor HV fuse-links conform to the following standards:

- IEC 60 282-1: High-voltage fuse-links "current limiting fuse-links". This international standard is identical to the German standard VDE 0670 T4.
- IEC 60 787: Application guide for the selection of fuse-links of high-voltage fuse-links for transformer circuit applications
- VDE 0670 T303/IEC 60 420: High-voltage alternating current switch-fuse combinations
- DIN 43 625: High-voltage fuse-links, rated voltages 3,6 to 36kV (fuse-link dimensions)
- DIN 43 624: High-voltage fuse-links, rated voltages 3/3,6 to 30/36kV (single-pole fuse-link bases)

The quality management system of Ferraz Shawmut is certified to the international standard DIN ISO 9001 (EN 29001).

Ferraz Shawmut operates a certified environment management system. Ferraz Shawmut manufactures HV fuse-links with dimensions conforming to DIN 43 625 with striker for indoor and outdoor use, where the striker serves for actuating a tripfree mechanism as well as an indicator due to its red colour. In addition to the HV fuse-links shown in this brochure, Ferraz Shawmut also manufactures a wide range of special fuse-links in special dimensions. If you have a particular application that requires special fuse-link protection problems, simply ask the Ferraz Shawmut team, we are there for you.

### General characteristics

#### Back-up fuse-links

Back-up fuse-links have a "rated minimum breaking current" from which the fuse-links are able to interrupt current. Backup fuse-links are not supposed to operate below their "minimum breaking current" (below  $I_3$ ). Their operating range is from  $I_3$  to the maximum rated breaking current ( $I_1$ ). For the assignment of back-up fuse-links, it is important to note that the lowest short circuit current is higher at the site of the HV back-up fuse-link than  $I_3$  ( $I_{kmin} > I_3$ ). If the short circuit current is lower than the minimum breaking current, additional protection must be provided.

#### Striker

The striker of HV fuse-links in this product list has an effective length of 30 mm and is a «medium» type. This classification results from the energy released by the striker between the points A and B (within the first 20 mm of the operating distance). The initial force is about 80N, the force at the end of free movement is about 15N.

The striker serves for actuation of the trip-free mechanism of the switch

#### Rated voltage range

It is important for HV fuse-links that they must be operated at the voltage for which they have been rated. Accordingly, the operating voltage corresponds to the maximum rated voltage of the fuse-link. Owing to the switching voltage occurring during arcing, the fuse-link cannot be used at lower voltages without limitation. A lower operating voltage at which the fuselink can still be used without exceeding the system insulation level during extinction must therefore be taken into account. From these two values results the permissible voltage range of the fuse-link, which is shown on the fuse-links or in the technical data, e.g. 10/24kV.

**Breaking capacity I1**

The breaking capacity is also referred to as the "rated maximum breaking current". This clearly indicates that this is the maximum current which can be interrupted by the fuselink. I1 of the fuse-link must be greater than the maximum short circuit current at the site of the fuse-link ( $I1 > Ik_{max}$ ).

**Minimum breaking current I3**

The minimum breaking current is referred to as the "rated minimum breaking current". This value must be specified for back-up fuse-links. From this current, back-up fuse-links are capable to breaking fault currents. The fuse-links must be assigned to the system so that no fault current below I3 can occur at the site of the fuse-link (due to the system parameters or other protective devices).

**Power dissipation of a fuse-link Pwarm**

The power dissipation of a HV fuse-link is specified at the rated current of the fuse-link. For protection with HV fuse-links, it should be noted that the operating current is normally half the rated current. Because of the physical relationships, the actual power dissipation is less than a quarter of the value Pwarm for HV fuse-links shown in the technical data table.

**Time-current characteristic (I/t characteristic)**

The time-current characteristic shows the correlation between current and time up to the melting of a fuse-element. The virtual time (tvs) is specified to enable a comparison of the I/t characteristics of fuse-links below 100ms. For co-ordination with other protective devices, e.g. load interrupter switches or circuit breakers, the melting integral I<sup>2</sup>t must be referred to for melting times below 100ms.

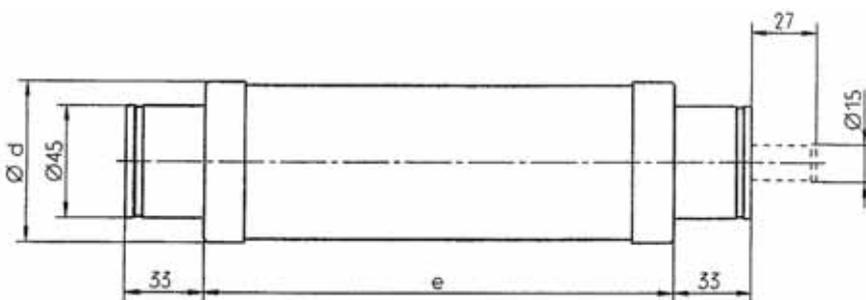
**Current limitation**

At high short circuit currents, HV fuse-links interrupt current within several milliseconds that means, the sinusoidal current does not reach its peak value and that HV fuse-links are current limiting devices. This is a significant advantage compared to mechanical switches whose contacts take longer to open and interrupt currents at natural zero. During this time, the peak short-circuit current is able to freely develop its dynamic force. By using HV fuse-links, this surge current is limited within several ms to a fraction of its peak value and the design of the subsequent system can be reduced in terms of dynamic forces.

**Switching voltage**

So that HV fuse-links perform a current-limiting action, the short circuit current must be limited and reduced as it increases.

This requires a switching voltage that exceeds the driving system voltage and forces the current to zero. This switching voltage must not exceed the specified permissible value of 2.2 times the peak value of the maximum rated voltage. Limitor HV fuse-links are within this limit.

**Dimension**

HV Back-up Fuse-Links according to IEC 60 282-1



Medium voltage fuses - European Fuses

Current (A)	Voltage (kV)	Cat.Number	Ref. number	Pack.
2	3/7,2	45DB72V2P	N1000098A	1
4	3/7,2	45DB72V4P	P1000099A	1
6,3	3/7,2	45DB72V6,3PD	S209293A	1
10	3/7,2	45DB72V10PD	T209294A	1
16	3/7,2	45DB72V16PD	V209295A	1
20	3/7,2	45DB72V20PD	W209296A	1
25	3/7,2	45DB72V25PD	X209297A	1
31,5	3/7,2	45DB72V32PD	Y209298A	1
40	3/7,2	45DB72V40PD	Z209299A	1
50	3/7,2	45DB72V50PD	A209300A	1
63	3/7,2	45DB72V63P	B209301A	1
80	3/7,2	45DB72V80P	C209302A	1
100	3/7,2	45DB72V100P	D209303A	1
125	3/7,2	45DB72V125PD	Q1000100A	1
160	3/7,2	45DB72V160P	R1000101A	1
200	3/7,2	45DB72V200P	S1000102A	1
1	6/12	45DB120V1P	T1000103A	1
2	6/12	45DB120V2P	V1000104A	1
4	6/12	45DB120V4P	W1000105A	1
6,3	6/12	45DB120V6,3P	F209305A	1
10	6/12	45DB120V10P	G209306A	1
16	6/12	45DB120V16P	H209307A	1
20	6/12	45DB120V20P	J209308A	1
25	6/12	45DB120V25P	K209309A	1
31,5	6/12	45DB120V32P	L209310A	1
40	6/12	45DB120V40P	M209311A	1
50	6/12	45DB120V50P	N209312A	1
63	6/12	45DB120V63P	P209313A	1
80	6/12	45DB120V80P	Q209314A	1
100	6/12	45DB120V100P	R209315A	1
125	6/12	45DB120V125P	X1000106A	1
160	6/12	45DB120V160P	Y1000107A	1
200	6/12	45DB120V200P	Z1000108A	1
6,3	10/17,5	45DB175V6,3P	T209317A	1
10	10/17,5	45DB175V10P	V209318A	1
16	10/17,5	45DB175V16P	W209319A	1
20	10/17,5	45DB175V20P	X209320A	1
25	10/17,5	45DB175V25P	Y209321A	1
31,5	10/17,5	45DB175V32P	Z209322A	1
40	10/17,5	45DB175V40P	A209323A	1
50	10/17,5	45DB175V50P	B209324A	1
63	10/17,5	45DB175V63P	C209325A	1
80	10/17,5	45DB175V80P	D209326A	1
100	10/17,5	45DB175V100P	E209327A	1
1	10/24	45DB240V1P	A1000109A	1
2	10/24	45DB240V2P	B1000110A	1
4	10/24	45DB240V4P	C1000111A	1
6,3	10/24	45DB240V6,3P	S209339A	1
10	10/24	45DB240V10P	T209340A	1
16	10/24	45DB240V16P	V209341A	1
20	10/24	45DB240V20P	W209342A	1
25	10/24	45DB240V25P	X209343A	1
31,5	10/24	45DB240V32P	Y209344A	1
40	10/24	45DB240V40P	Z209345A	1
50	10/24	45DB240V50P	A209346A	1
63	10/24	45DB240V63P	B209347A	1
80	10/24	45DB240V80P	C209348A	1
100	10/24	45DB240V100P	D209349A	1
125	10/24	45DB240V125P	D1000112A	1
160	10/24	45DB240V160P	E1000113A	1
200	10/24	45DB240V200P	F1000114A	1
2	20/36	45DB360V2P	G1000115A	1
4	20/36	45DB360V4P	H1000116A	1
6,3	20/36	45DB360V6,3PD	S209362A	1
10	20/36	45DB360V10PD	T209363A	1
16	20/36	45DB360V16PD	V209364A	1
20	20/36	45DB360V20PD	W209365A	1
25	20/36	45DB360V25PD	X209366A	1
31,5	20/36	45DB360V32PD	Y209367A	1
40	20/36	45DB360V40PD	Z209368A	1
50	20/36	45DB360V50PD	J1000117A	1
63	20/36	45DB360V63PD	K1000118A	1

## HV back-up fuse-links acc. to IEC 60282-1 with controlled power dissipation

Current (A)	Voltage (kV)	Cat. Number	Ref. number	Pack.
1	6/12	45DB120V1PT	L1000119A	1
2	6/12	45DB120V2PT	M1000120A	1
4	6/12	45DB120V4PT	N1000121A	1
6,3	6/12	45DB120V6,3PT	P1000122A	1
10	6/12	45DB120V10PT	Q1000123A	1
16	6/12	45DB120V16PT	R1000124A	1
20	6/12	45DB120V20PT	S1000125A	1
25	6/12	45DB120V25PT	T1000126A	1
31,5	6/12	45DB120V32PT	V1000127A	1
40	6/12	45DB120V40PT	W1000128A	1
50	6/12	45DB120V50PT	X1000129A	1
63	6/12	45DB120V63PT	Y1000130A	1
80	6/12	45DB120V80PT	Z1000131A	1
100	6/12	45DB120V100PT	A1000132A	1
125	6/12	45DB120V125PT	B1000133A	1
160	6/12	45DB120V160PT	C1000134A	1
200	6/12	45DB120V200PT	D1000135A	1
1	10/24	45DB240V1PT	E1000136A	1
2	10/24	45DB240V2PT	F1000137A	1
4	10/24	45DB240V4PT	G1000138A	1
6,3	10/24	45DB240V6,3PT	H1000139A	1
10	10/24	45DB240V10PT	J1000140A	1
16	10/24	45DB240V16PT	K1000141A	1
20	10/24	45DB240V20PT	L1000142A	1
25	10/24	45DB240V25PT	M1000143A	1
31,5	10/24	45DB240V32PT	N1000144A	1
40	10/24	45DB240V40PT	P1000145A	1
50	10/24	45DB240V50PT	Q1000146A	1
63	10/24	45DB240V63PT	R1000147A	1
80	10/24	45DB240V80PT	S1000148A	1
100	10/24	45DB240V100PT	T1000149A	1
125	10/24	45DB240V125PT	V1000150A	1

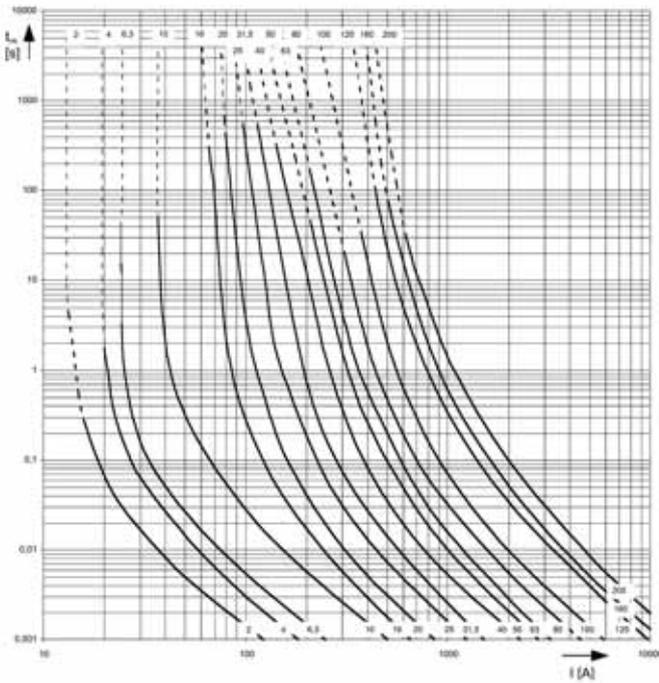


## HV General Purpose fuse-links acc. to IEC 60282-1

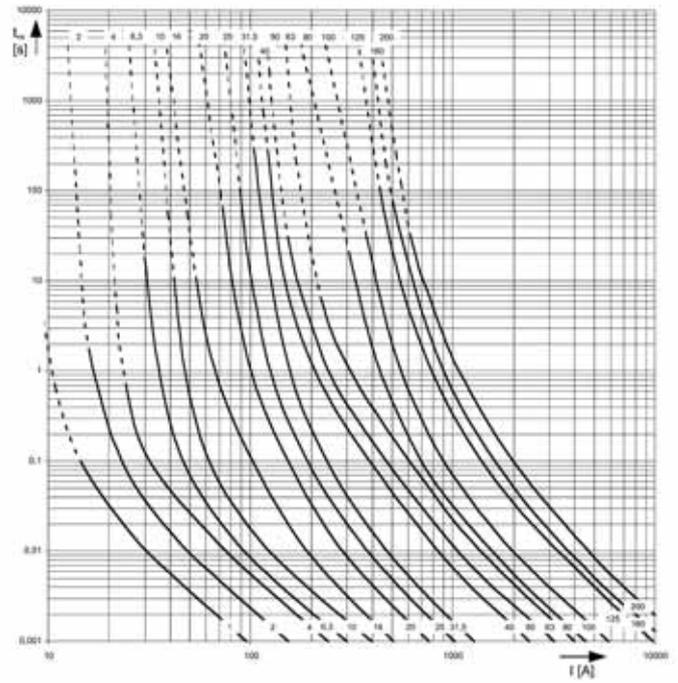
Current (A)	Voltage (kV)	Cat. Number	Ref. number	Pack.
6,3	6/12	45DG120V6,3P	W1000151A	1
10	6/12	45DG120V10P	X1000152A	1
16	6/12	45DG120V16P	Y1000153A	1
25	6/12	45DG120V25P	Z1000154A	1
40	6/12	45DG120V40P	A1000155A	1
50	6/12	45DG120V50P	B1000156A	1
4	10/24	45DG240V4P	C1000157A	1
6,3	10/24	45DG240V6,3P	D1000158A	1
10	10/24	45DG240V10P	E1000159A	1
16	10/24	45DG240V16P	F1000160A	1
25	10/24	45DG240V25P	G1000161A	1



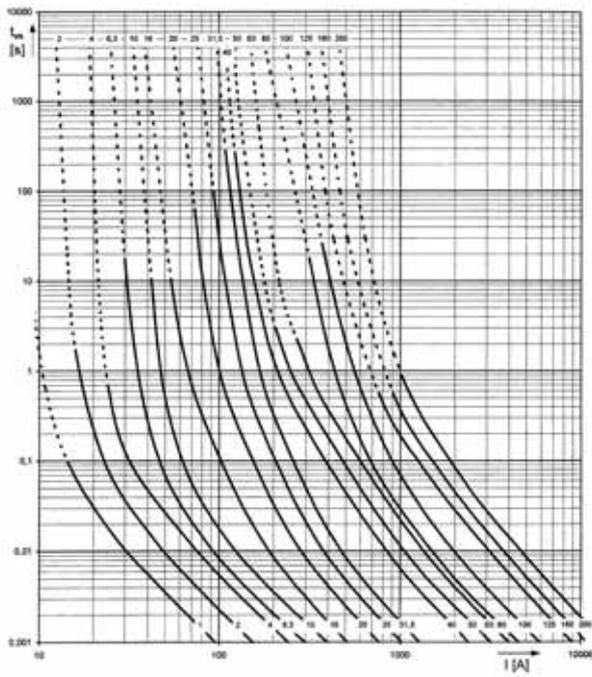
Time current characteristics



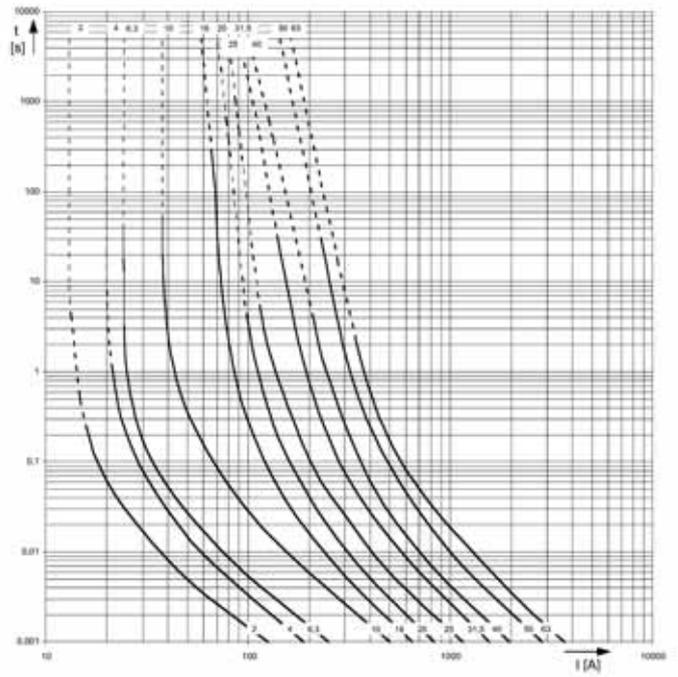
3/7,2 kV



6/12 kV



10/24 kV



20/36 kV

## Application

Limiter HV fuse-links type CPD meet the requirements of IEC 60282-1 and were specifically developed to be installed in compact sized enclosed SF6 insulated substations.

In these substations HV fuse-links are enclosed in narrow fuse compartments which on the one hand prevent efficient cooling of the fuse-links and on the other hand have a limited thermal power acceptance themselves. Overheating of fuse compartments in such enclosures is, however, not to be expected, if the fuse-links have been properly selected by their rated current according to the transformer to be protected (see table 3) and if the melting elements of the fuselins are in faultless condition (Fig. 8).

One or more of the melting elements connected in parallel may, however, be interrupted by transient currents caused by transformer inrush or lightning strikes. Fuse-links having one or more of the paralleled melting elements interrupted, dissipate significantly more heat than faultless fuse-links. There is a certain risk that the limited power acceptance of fuse compartments may be exceeded at or even below rated transformer current. HV back-up fuse-links type CPD prevent such potential overheating when installed in conjunction with a transformer switch having trip-free mechanism.

## High-voltage alternating current switch-fuse combinations acc. to IEC 62 271-105

In order to increase the utilization range of a switch, it is combined with current limiting HV fuse-links. This combination unit offers short-circuit protection in addition to load switching capacity. HV fuse-links provide short-circuit protection, while the switch interrupts the currents below the take-over current of the combination unit. In addition to the inrush current, short-circuit current on secondary terminal short-circuits and low voltage selectivity, the following switch characteristics should be taken into account:

- Rated transfer current ( $I_{transfer}$ )
- Fuse-initiated opening time of the switch ( $t_0$ )

Fig. 9 shows the rated transfer current ( $I_{transfer}$ ) as a vertical line.

The fuse-initiated opening time ( $t_0$ ) must be multiplied by 0,9 (procedure according to IEC 62 271-105) and a horizontal line be drawn. This results in an intersection that is characteristic to the switch and must be established for each switch individually.

## Function mode

The CPD striker system controls the power dissipation of the fuse according to Ohm's law (CPD means controlled power dissipation). The striker pin is released depending on the voltage drop across the fuse and, therefore depending on the power dissipation. The release voltage of the CPD striker system has been selected so that the fuse carrying the operating current  $I_B$  does not exceed the limiting value. The CPD striker system controls the power dissipation of the fuse and releases the transformer switch before the permissible power acceptance of the fuse compartment will be exceeded (Fig. 8).

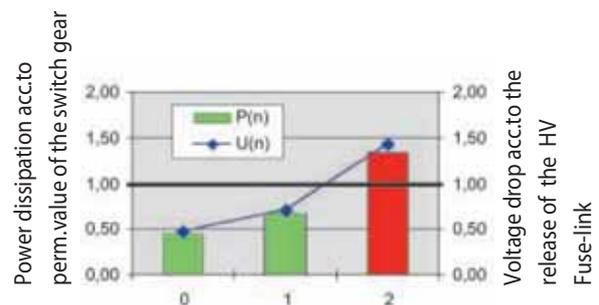


Fig. 8: Controlled power dissipation

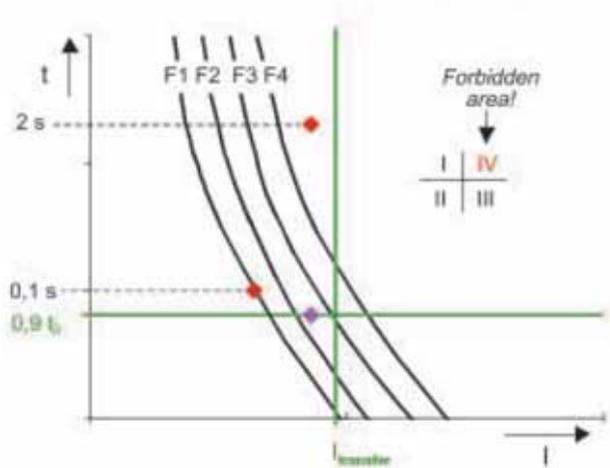


Fig. 9 : Selection of HV fuse-links acc. to IEC 62 271-105

This switch intersection divides the sheet into four quadrants (see Fig. 9).

Suitable for the switch-fuse combination are HV fuse-links only with a time-current characteristic that does not pass through quadrant IV ("forbidden area").

Generally suitable for use in switch-fuse combinations according to IEC 62 271-105 are all HV fuse-links with striker which meet this criterion.

Ferraz Shawmut has assigned HV fuse-links to the switch-fuse combination and the transformers of all major manufactures. These documents are available on request.

## Clips

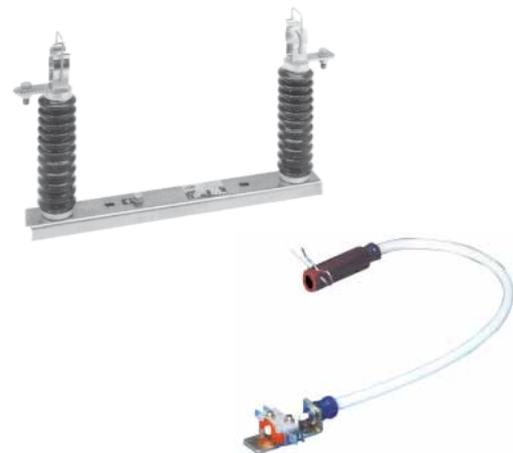
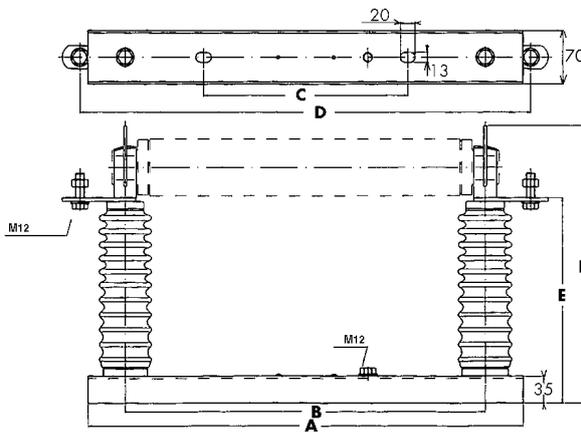
Size	Reference.Number	Catalog Number	Packaging
MR 45 + spring	L096472A	MR45R	1
MR 45 without connection lug	S210236B	MR55R	2

## Bases

Voltage (kV)	Size	Use	Reference.Number	Catalog Number	Packaging
7,2	SI 7,2/192	Indoor	G209421A	SI72V192	1
12	SI 12/292	Indoor	H209422A	SI120V292	1
17,5	SI 17,5/292	Indoor	J209423A	SI175V292	1
24	SI 24/442	Indoor	K209424A	SI 240V442	1
36	SI 36/537	Indoor	M209426A	SI360V537	1
12	SE 12/292	Outdoor	S210328A	SE120V292	1
17,5	SE 17,5/292	Outdoor	T210329A	SE175V292	1
24	SE 24/442	Outdoor	V210330A	SE240V442	1
36	SE 36/537	Outdoor	W210331A	SE360V537	1

## Bases with signalling

Voltage (kV)	Number of contacts	Reference.Number	Catalog Number	Packaging
12/36	1 NO/NF	E092855A	MC1-5NFLEXQS500	1
12/36	2 NO/NF	F092856A	MC1-9NFLEXQS500	1



Voltage (kV)	Length of fuse L (mm)	Size	Dielectric withstand (phase to ground)		Dimensions (mm)						Weight (kg)
			50Hz-1mn Kv Rms	1,2/50µs peak voltage	A	B	C	D	E	F	
7,2	192	SI 7,2/192	20	60	400	226	322	347	175	270	3,8
12	292	SI 12/292	28	75	424	324	200	445	175	270	4,1
17,5	292	SI 17,5/292	38	95	424	324	200	445	220	315	5,1
24	442	SI 24/442	50	125	576	476	270	597	270	365	5,5
36	537	SI 36/537	70	170	670	570	350	691	354	449	7,7
12	292	SE 12/292	28	75	424	324	200	445	261	356	7,5
17,5	292	SE 17,5/292	38	95	424	324	200	445	261	356	7,5
24	442	SE 24/442	50	125	576	476	270	597	309	404	8,8
36	537	SE 36/537	70	170	670	570	350	691	381	476	13,2