

Technical data

## High-voltage high-breaking capacity VV fuse-links

Technical data										
rated voltage	Dimension "e" according to DIN and IEC	rated current	Striker type	Rated breaking capacity	Rated minimum breaking current	cold resistance	power dissipation	pre-arcing I <sup>2</sup> t value	total I <sup>2</sup> t value	
[kV]	(mm)	I <sub>n</sub> [A]		(kA)	(A)	[mΩ]	[W]	[A <sup>2</sup> s]	[A <sup>2</sup> s]	
3/7.2	192	1	C-type, D-type	63	12	1170	3			
		2			12	580	4	6,1	57	
		4			20	370	9	17,3	164	
		6			25	260	10	36	340	
		6,3			25	260	10	36	340	
		10			43	75	9	165	1.450	
		16			56	44	13,5	320	5.200	
		20			70	27	12,5	450	7.000	
		25			87	21	16	700	10.000	
		31,5			110	18	23,5	1.400	15.000	
		32			110	18	25	1.400	15.000	
		40			140	13	28,5	3.200	27.000	
		50			175	10,5	35,5	5.800	44.000	
		63			220	7,5	42,5	12.000	70.000	
		80			280	5,9	59	19.000	140.000	
		100			360	4,8	73	35.000	202.000	
		125			450	3,9	101	55.000	300.000	
		160			600	3	144	94.000	580.000	
	292	292	2	C-type, D-type	63	12	580	4	6,1	57
			4			20	370	9	17,3	164
			6			25	260	10	36	340
			6,3			25	260	10	36	340
			10			43	75	9	165	1.450
			16			56	44	13,5	320	5.200
			20			70	27	12,5	450	7.000
			25			87	21	16	700	10.000
			31,5			110	18	23,5	1.400	15.000
			32			110	18	25	1.400	15.000
			40			140	13	28,5	3.200	27.000
			50			175	10,5	35,5	5.800	44.000
			63			220	7,5	42,5	12.000	70.000
			80			280	5,9	59	19.000	140.000
			100			360	4,8	73	35.000	202.000
			125			450	3,9	101	55.000	300.000
			160			600	3	144	94.000	580.000
			200			1000	2,1	155	151.780	789.270
	250	1250	1,7	196	228.610	1.188.800				
	442	442	2	C-type, D-type	63	12	840	4,7	6,1	57
			4			20	530	11,7	17,3	164
			6			25	270	13,4	36	340
			6,3			25	270	13,4	36	340
			10			43	90	11	165	1.450
16			56			53	16	320	5.200	
20			70			32	15	450	7.000	
25			87			25	19	700	10.000	
31,5			110			21,5	28	1.400	15.000	
32			110			21,5	30	1.400	15.000	
40			140			15,5	34	3.200	27.000	
50			175			12,6	43	5.800	44.000	
63			220			9	51	12.000	70.000	
80			280			7,1	71	19.000	140.000	
100			360			5,8	88	35.000	202.000	
125			450			4,7	121	55.000	300.000	
160			600			3,6	173	94.000	580.000	
200			1000			2,65	195	151.780	789.270	
250			1250			2,2	253	228.610	1.188.800	
315			1575			1,75	320	368.640	1.916.930	

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rated voltage	Dimension "e" according to DIN and IEC	rated current	Striker type	Rated breaking capacity	Rated minimum breaking current	cold resistance	power dissipation	pre-arcing I <sup>2</sup> t value	total I <sup>2</sup> t value		
[kV]	(mm)	I <sub>n</sub> [A]		(kA)	(A)	[mΩ]	[W]	[A <sup>2</sup> s]	[A <sup>2</sup> s]		
6/12	192	2	C-type, D-type	50	12	980	6	6,1	57		
		4			20	650	15	17,3	164		
		6			27	435	21	36	340		
		6,3			27	435	21	36	340		
		10			42	130	15	165	1.450		
		16			64	70	23	320	5.200		
		20			80	44	21	450	7.000		
		25			100	33	28	700	10.000		
		31,5			126	29	38	1.400	15.000		
		32			126	29	41	1.400	15.000		
		40			160	21	48	3.200	27.000		
		50			200	16,5	54	5.800	44.000		
		292			C-type, D-type	63	1	12	1970	5	
	2		12	980			6	6,1	57		
	4		20	650			15	17,3	164		
	6		25	435			21	36	340		
	6,3		25	435			21	36	340		
	10		43	130			15	165	1.450		
	16		56	70			23	320	5.200		
	20		70	44			21	450	7.000		
	25		87	33			28	700	10.000		
	31,5		110	29			38	1.400	15.000		
	32		110	29			41	1.400	15.000		
	40		140	21			48	3.200	27.000		
	50		175	16,5			54	5.800	44.000		
	63		220	12			62	12.000	70.000		
	80		280	9			75	19.000	140.000		
	100		360	6,7			114	35.000	202.000		
	125		450	5,2			138	55.000	300.000		
	160	600	4,1	179	94.000	580.000					
	442	C-type, D-type	63	2	12	980	6	6,1	57		
				4	20	650	15	17,3	164		
				6	25	435	21	36	340		
6,3				25	435	21	36	340			
10				43	130	15	165	1.450			
16				56	70	23	320	5.200			
20				70	44	21	450	7.000			
25				87	33	28	700	10.000			
31,5				110	29	38	1.400	15.000			
32				110	29	41	1.400	15.000			
40				140	21	48	3.200	27.000			
50				175	16,5	54	5.800	44.000			
63				220	12	62	12.000	70.000			
80				280	9	75	19.000	140.000			
100				360	6,7	114	35.000	202.000			
125				450	5,2	138	55.000	300.000			
160				600	4,1	179	94.000	580.000			
200				1000	3,3	238	151.780	789.270			
537				C-type, D-type	63	160	600	4,1	179	94.000	580.000
						200	1000	3,3	238	151.780	789.270
						250	1250	2,65	305	228.610	1.188.800

Technical data

Technical data										
rated voltage	Dimension "e" according to DIN and IEC	rated current	Striker type	Rated breaking capacity	Rated minimum breaking current	cold resistance	power dissipation	pre-arcing I <sup>2</sup> t value	total I <sup>2</sup> t value	
[kV]	(mm)	I <sub>n</sub> [A]		(kA)	(A)	[mΩ]	[W]	[A <sup>2</sup> s]	[A <sup>2</sup> s]	
10/17.5	292	2	C-type, D-type	50	12	1400	8	6,1	57	
		4			20	900	17	17,3	164	
		6			27	670	35	36	340	
		6,3			27	670	35	36	340	
		10			42	160	20	165	1.450	
		16			64	95	31	320	5.200	
		20			80	58	29	450	7.000	
		25			100	45	36	700	10.000	
		31,5			126	38	51	1.400	15.000	
		32			126	38	53	1.400	15.000	
		40			160	28	64	3.200	27.000	
		50			200	21,5	75	5.800	44.000	
		63			252	16,5	100	12.000	70.000	
		80			320	12,5	130	19.000	140.000	
		100			400	9	145	35.000	202.000	
	367	C-type, D-type	63	1	12	2800	6			
				2	12	1400	8	6,1	57	
				4	20	900	17	17,3	164	
				6	25	670	35	36	340	
				6,3	25	670	35	36	340	
				10	42	160	20	165	1.450	
				16	56	95	31	320	5.200	
				20	70	58	29	450	7.000	
				25	87	45	36	700	10.000	
				31,5	110	38	51	1.400	15.000	
				32	110	38	53	1.400	15.000	
				40	140	28	64	3.200	27.000	
				50	175	21,5	75	5.800	44.000	
				63	220	16,5	100	12.000	70.000	
				80	280	12,5	130	19.000	140.000	
	100	360	9	145	35.000	202.000				
	125	450	7,5	210	55.000	300.000				
	160	600	5,6	290	94.000	580.000				
	442	C-type, D-type	63	2	12	1400	8	6,1	57	
				4	20	900	17	17,3	164	
				6	25	670	35	36	340	
				6,3	25	670	35	36	340	
				10	42	160	20	165	1.450	
				16	56	95	31	320	5.200	
				20	70	58	29	450	7.000	
				25	87	45	36	700	10.000	
				31,5	110	38	51	1.400	15.000	
				32	110	38	53	1.400	15.000	
				40	140	28	64	3.200	27.000	
				50	175	21,5	75	5.800	44.000	
63				220	16,5	100	12.000	70.000		
80				280	12,5	130	19.000	140.000		
100				360	9	145	35.000	202.000		
125	450	7,5	210	55.000	300.000					
160	600	5,6	290	94.000	580.000					

Technical data

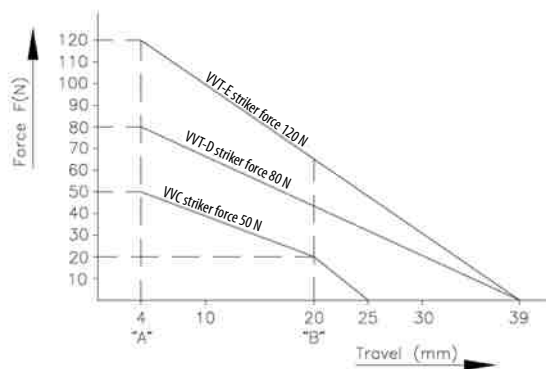
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[kV]	(mm)	I <sub>n</sub> [A]		(kA)	(A)	[mΩ]	[W]	[A <sup>2</sup> s]	[A <sup>2</sup> s]	
10/24	292	2	C-type, D-type	31,5	12	2040	12	6,1	57	
		4			20	1300	35	17,3	164	
		6			27	900	56	36	340	
		6,3			27	900	56	36	340	
		10			42	230	25,5	165	1.450	
		16			64	125	42	320	5.200	
		20			80	76	39,5	450	7.000	
		25			100	59	49	700	10.000	
		31,5			126	52	75	1.400	15.000	
		32			126	52	59	1.400	15.000	
		40			160	38	94	3.200	27.000	
		50			200	29	110	5.800	44.000	
		63			252	21,5	137	12.000	70.000	
		442			C-type, D-type	63	1	12	3900	9
	2		12	2040			12	6,1	57	
	4		20	1300			35	17,3	164	
	6		25	900			56	36	340	
	6,3		25	900			56	36	340	
	10		42	230			25,5	165	1.450	
	16		56	125			42	320	5.200	
	20		70	76			39,5	450	7.000	
	25		87	59			49	700	10.000	
	31,5		110	52			75	1.400	15.000	
	32		110	52			79	1.400	15.000	
	40		140	38			94	3.200	27.000	
	50		175	29			110	5.800	44.000	
	63		220	21,5			137	12.000	70.000	
	80		280	16			174	19.000	140.000	
	100		355	12,9			220	35.000	202.000	
	125		473	11,9			317	49.000	220.000	
	537		C-type, D-type	63			2	12	2040	12
		4			20	1300	35	17,3	164	
		6			25	900	56	36	340	
		6,3			25	900	56	36	340	
		10			42	230	25,5	165	1.450	
		16			56	125	42	320	5.200	
20		70			76	39,5	450	7.000		
25		87			59	49	700	10.000		
31,5		110			52	75	1.400	15.000		
32		110			52	79	1.400	15.000		
40		140			38	94	3.200	27.000		
50		175			29	110	5.800	44.000		
63		220			21,5	137	12.000	70.000		
80		280			16	174	19.000	140.000		
100		355			12,9	220	35.000	202.000		
125		473			11,9	317	49.000	220.000		
160		600			5,6	290	94.000	580.000		

## Technical data

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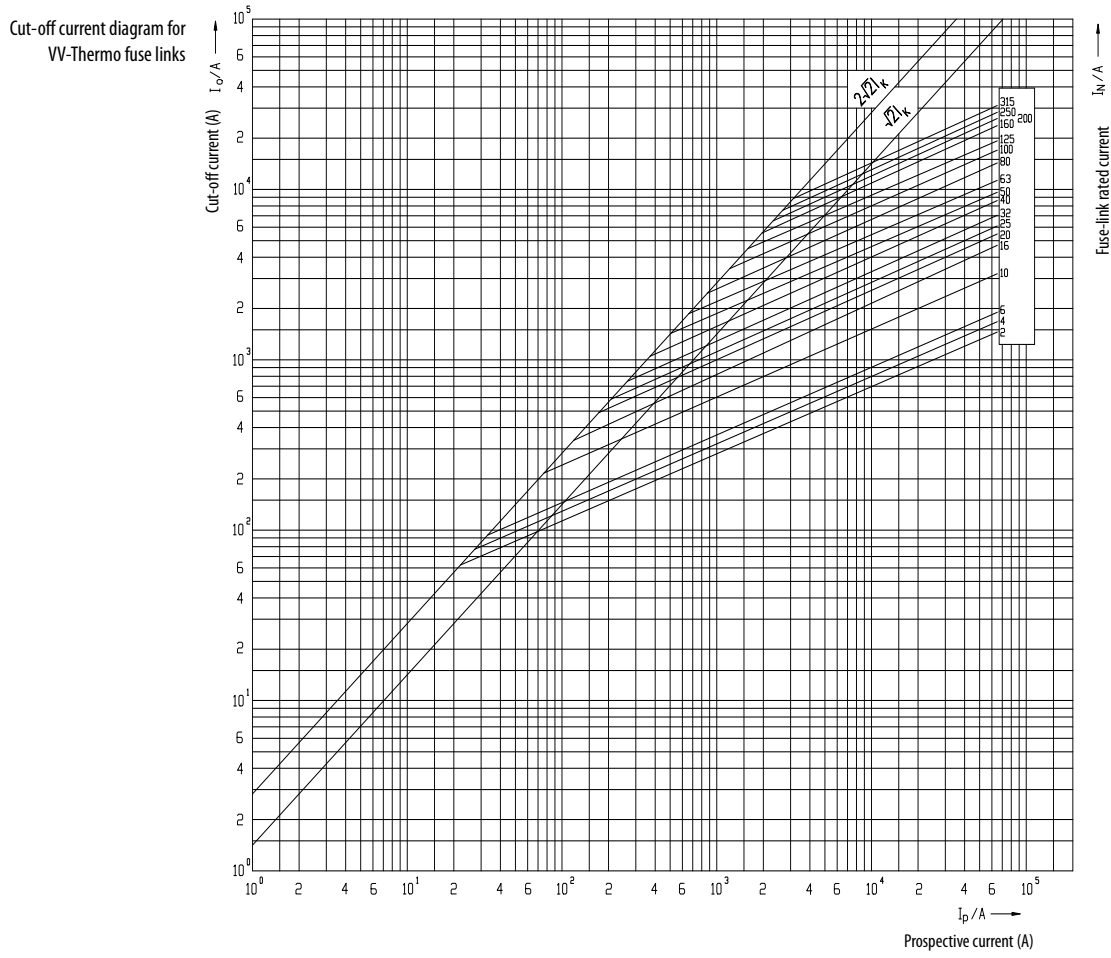
rated voltage	Dimension "e" according to DIN and IEC	rated current	Striker type	Rated breaking capacity	Rated minimum breaking current	cold resistance	power dissipation	pre-arcing I <sup>2</sup> t value	total I <sup>2</sup> t value
[kV]	(mm)	I <sub>n</sub> [A]		(kA)	(A)	[mΩ]	[W]	[A <sup>2</sup> s]	[A <sup>2</sup> s]
20/36	442	2	C-type, D-type	20	12	2900	17	6,1	57
		4			20	1870	45	17,3	164
		6			27	1300	73	36	340
		6,3			27	1300	73	36	340
		10			42	323	40	165	1.450
		16			64	177	60	320	5.200
		20			80	110	70	450	7.000
		25			100	83	80	700	10.000
	537	C-type, D-type	31,5	1	12	5800	14	6,1	57
				2	12	2900	17	17,3	164
				4	20	1870	45	36	340
				6	25	1300	73	36	340
				6,3	25	1300	73	36	340
				10	42	323	40	165	1.450
				16	56	177	60	320	5.200
				20	70	110	70	450	7.000
				25	87	83	80	700	10.000
				31,5	110	75	115	1.400	15.000
				32	110	75	120	1.400	15.000
				40	140	53	145	3.200	27.000
				50	175	41	150	5.800	44.000
				63	220	30	195	12.000	70.000
				80	280	22,5	230	19.000	140.000

Force / travel striker pin diagram

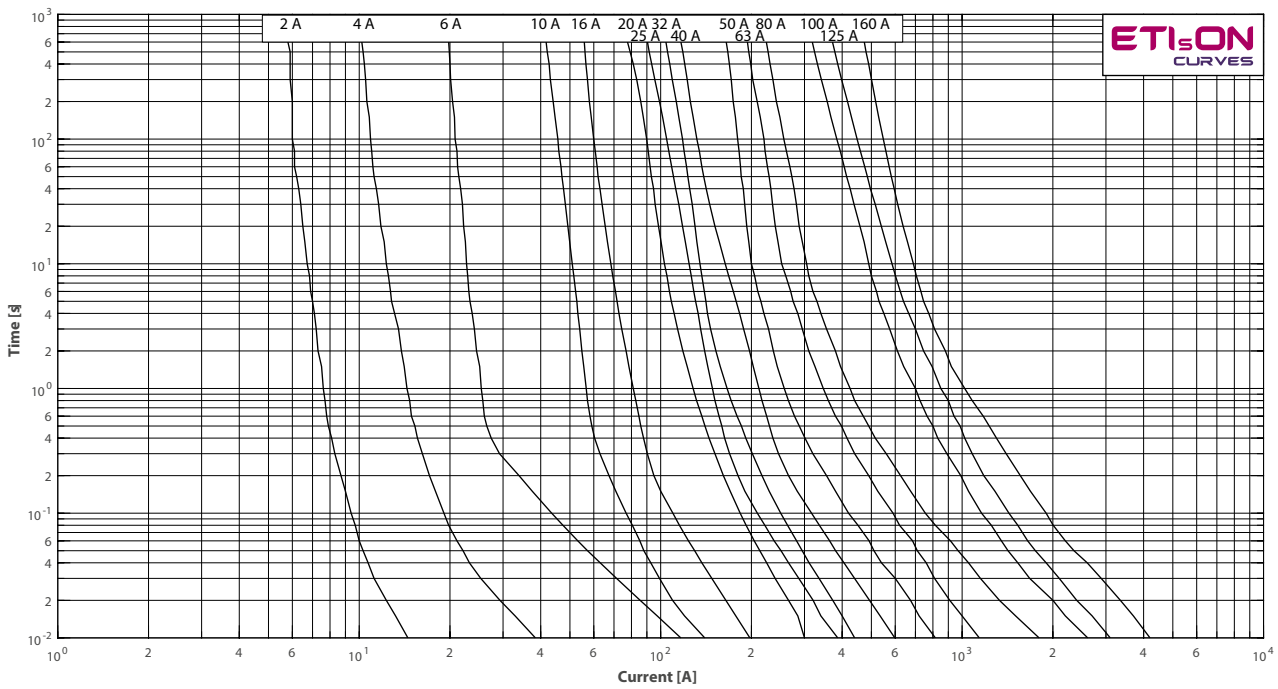


Connection in indoor switchgear, example:



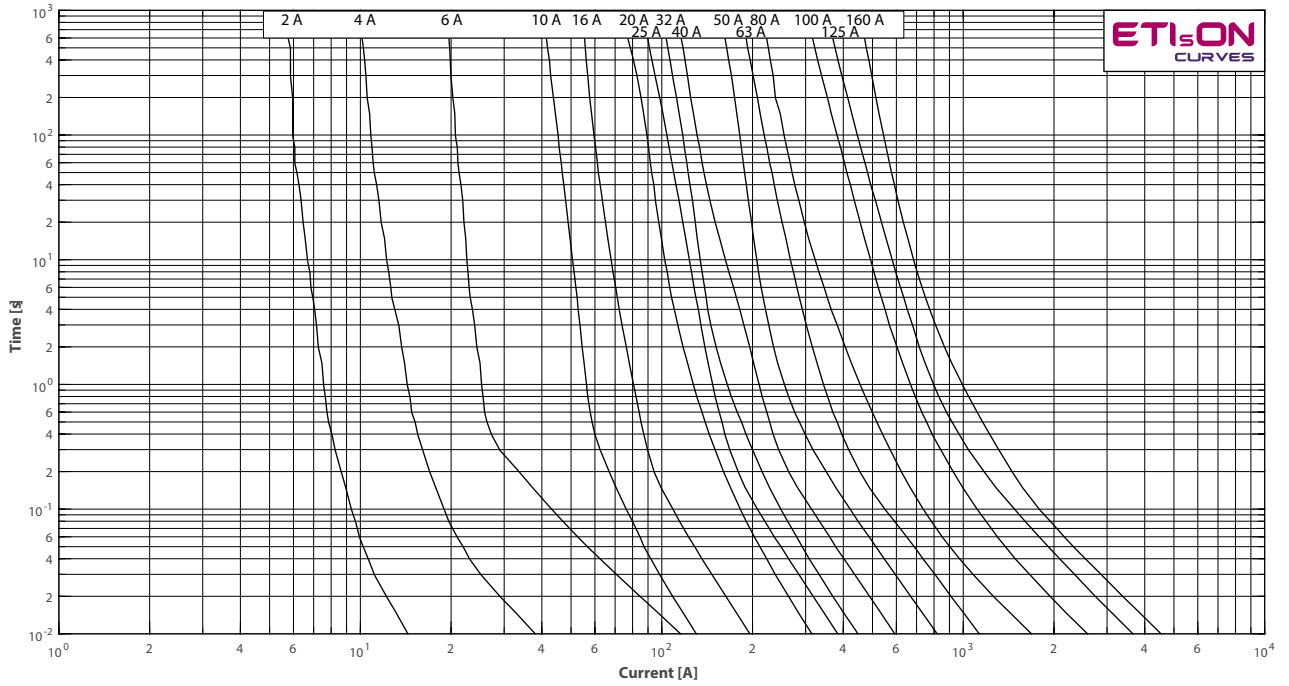


Time-current characteristics for VV-thermo fuse links  
7,2 kV

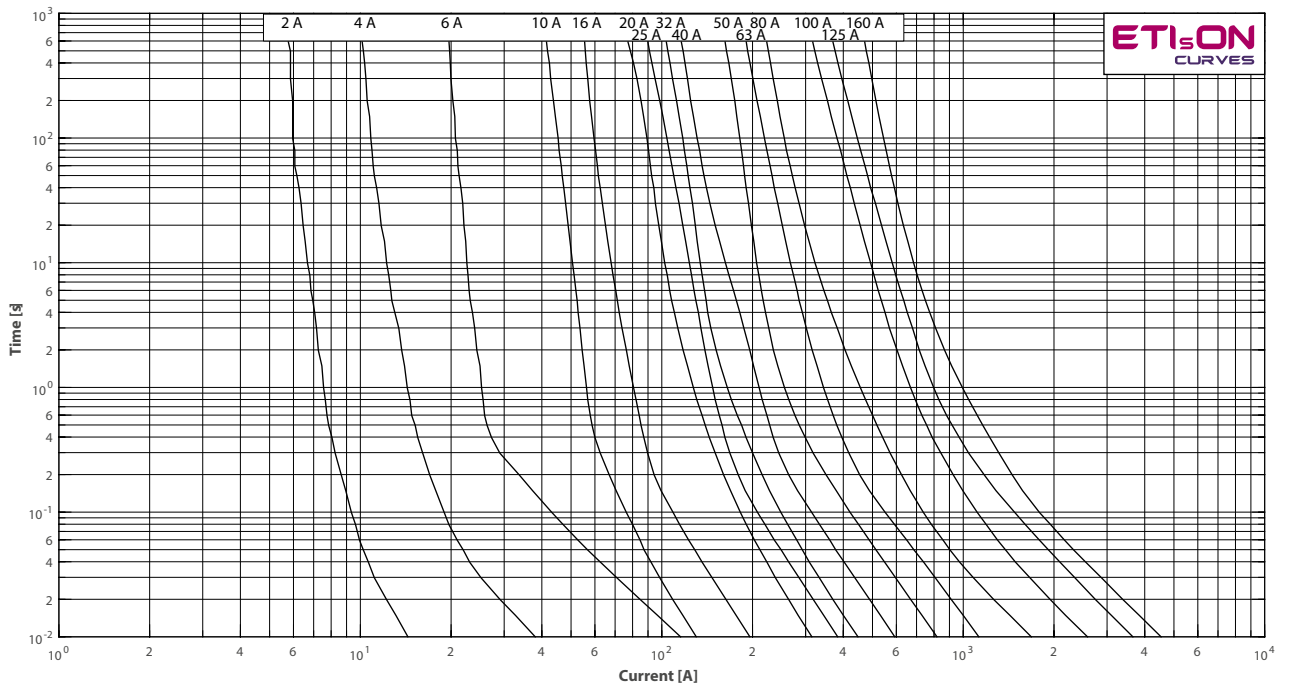


Technical data

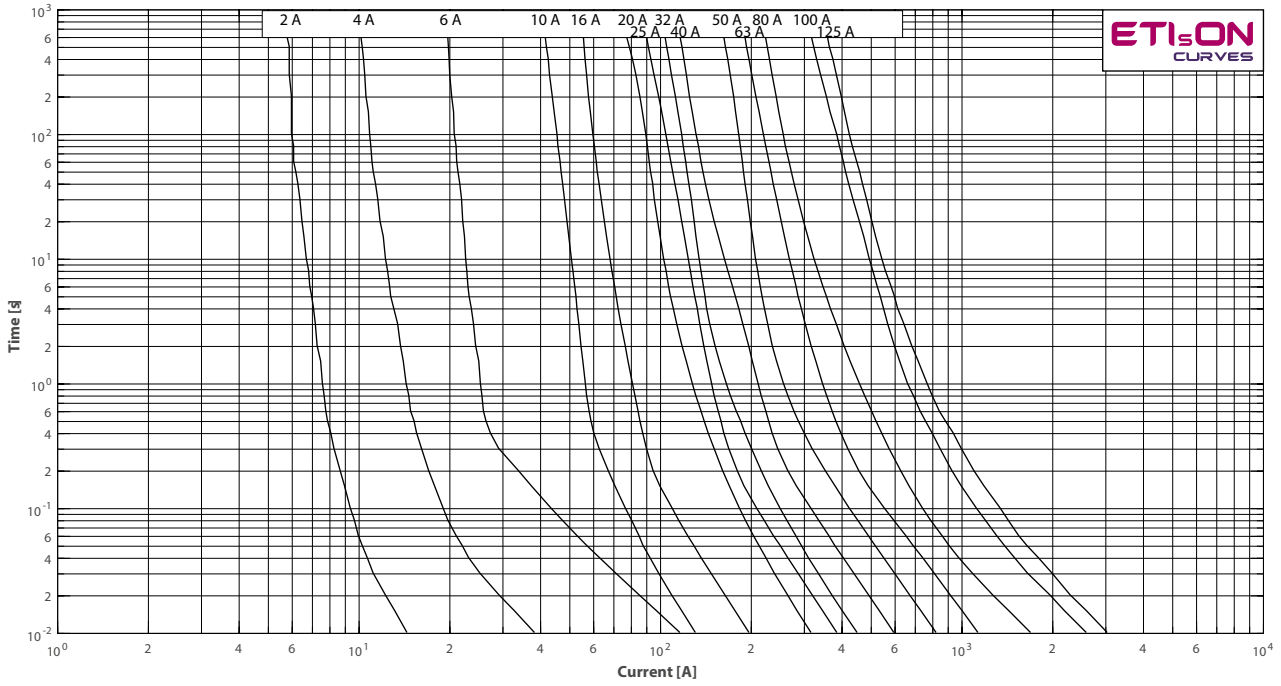
Time-current characteristics for VV-thermo  
fuse links  
12 kV



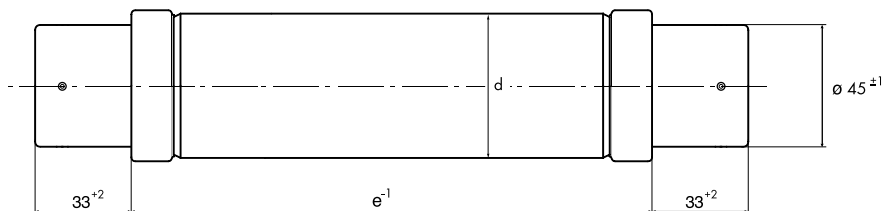
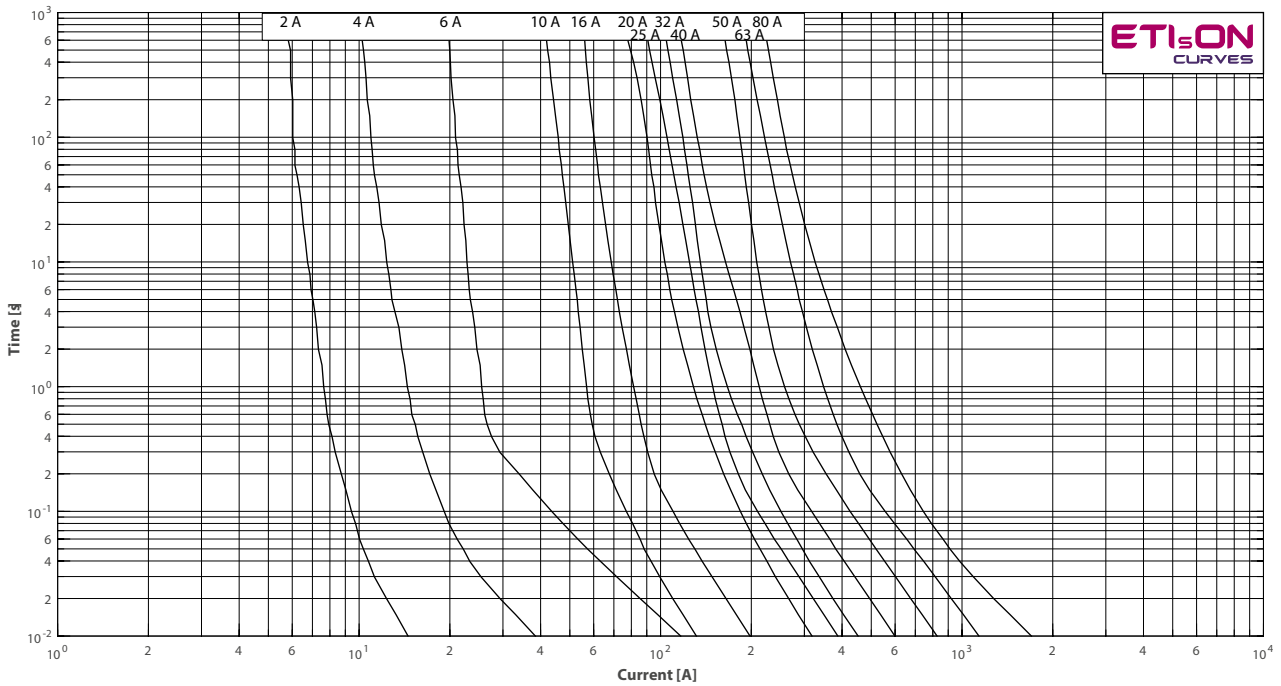
Time-current characteristics for VV-thermo  
fuse links  
17,5 kV



Time-current characteristics for VV-thermo fuse links  
24 kV



Time-current characteristics for VV-thermo fuse links  
36 kV





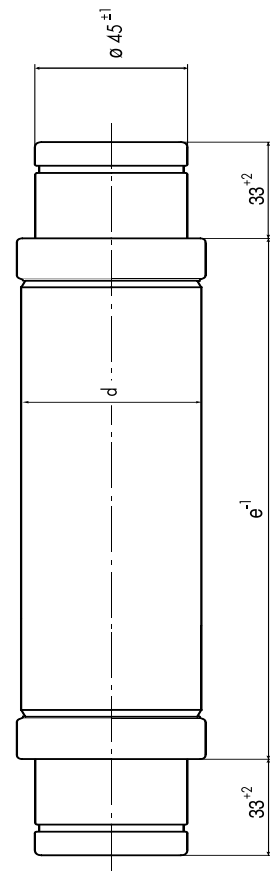
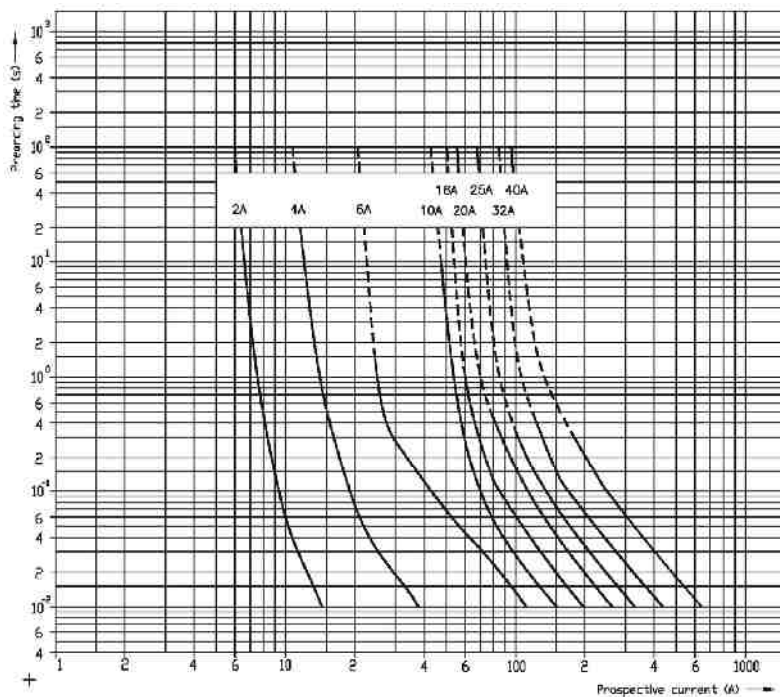
Technical data

## High voltage fuse-links for liquid-immersed transformer protection

**Technical data**

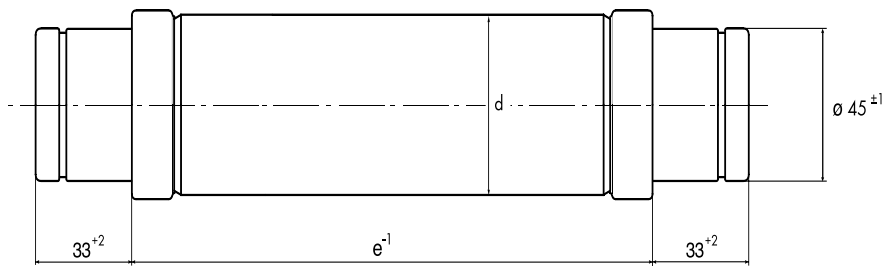
rated voltage	Dimension "e" according to DIN and IEC	rated current	Striker type	Rated breaking capacity	Rated minimum breaking current	cold resistance	power dissipation	pre-arcing I <sup>2</sup> t value	total I <sup>2</sup> t value
[kV]	(mm)	I <sub>n</sub> [A]		(kA)	(A)	[mΩ]	[W]	[A <sup>2</sup> s]	[A <sup>2</sup> s]
6/12	292	2A	VVT-D	50	12	980	6	6,1	57
		4A			20	650	15	17,3	164
		6A			25	435	21	36	340
		10A			46	87	8	161	1530
		16A			60	60,5	19	250	2270
		20A			80	47	22	430	3750
		25A			105	37	34	650	5500
		32A			130	27	43	1220	10100
		40A			178	21	54	2270	18100
10/24	292	2A	VVT-D	50	12	2040	12	6,1	57
		4A			20	1300	35	17,3	164
		6A			25	900	56	36	340
		10A			46	160	19	161	1530
		16A			60	106	35	250	2270
		20A			80	85	44	430	3750
	442	VVT-D	50	2A	12	2040	12	6,1	57
				4A	20	1300	35	17,3	164
				6A	25	900	56	36	340
				10A	46	160	19	161	1530
				16A	60	106	35	250	2270
				20A	80	85	44	430	3750
				25A	105	67	58	650	5500
				32A	130	48	71	1220	10100
				40A	178	37,5	95	2270	18100

Time-current characteristics



## High voltage fuses for protection of voltage transformers

Technical data									
rated voltage	Dimension "e" according to DIN and IEC	rated current	Striker type	Rated breaking capacity	Rated minimum breaking current	cold resistance	power dissipation	pre-arcing I <sup>2</sup> t value	total I <sup>2</sup> t value
[kV]	(mm)	I <sub>n</sub> [A]		(kA)	(A)	[mΩ]	[W]	[A <sup>2</sup> s]	[A <sup>2</sup> s]
10/24	235	2A	/	20	12	2040	14	6,1	57
		4A			20	1300	38	17,3	164



## Selection of fuses for transformer protection

For HV fuse-link rated current selection, following transformer technical features has to be known:

- Rated power  $P_n$  (kVA)
- Short-circuit voltage  $U_{cc}$  (%)
- Rated current  $I_{nt}$
- Inrush current usually between  $8-12 \times I_{nt}$
- Short-circuit current  $I_{cc}$
- Overload current usually  $1.4 I_{nt}$
- Maximum short-circuit duration. Standard 2 sec for transformers up to 630 kVA and 3 sec for higher rated powers

Following HV fuse-link technical features has to be known:

- Rated voltage  $U_n$  (kV)
- Rated current  $I_n$  (A)
- I/t Characteristics According to the curves
- Melting current (0.1 sec)  $I_{f(0.1sec)}$
- Melting current at 2s ec or 3sec melting time
- Minimum breaking current  $I_3$  (A)
- Breaking capacity  $I_1$  (kA)

General about transformer protection:

- Fuse-link rated voltage  $U_n$  must be higher then network voltage.
- Maximum fuse-link breaking current  $I_1$  must be higher then short circuit-current  $I_{cc}$ .
- Inrush current should not melt the fuse-link. Melting current at 100 msec must be higher than 12 times transformer rated current
- Fuse-link has to operate before the expected short-circuit current damage the transformer  $I_{cc} > I_f(2 \text{ sec})$  or  $I_{cc} > I_f(3 \text{ sec})$
- Fuse-link must be able to withstand possible short duration overloads.  $I_n \text{ FUSE} > 1.4 I_n \text{ TRAF0}$

Transformer rated capacity  Pt (kVA)	6/7,2 kV				10/12 kV				15/17.5kV				20/24 kV				30/36 kV			
	Transformer rated primary current I <sub>p</sub> (A) at	HV Fuse-link rated current	LV Fuse-Link NH gG	LV Fuse-Link NH gTr	Transformer rated primary current I <sub>p</sub> (A) at	HV Fuse-link rated current	LV Fuse-Link gG	LV Fuse-Link gTr	Transformer rated primary current I <sub>p</sub> (A) at	HV Fuse-link rated current	LV Fuse-Link gG	LV Fuse-Link gTr	Transformer rated primary current I <sub>p</sub> (A) at	HV Fuse-link rated current I <sub>p</sub>	LV Fuse-Link gG	LV Fuse-Link gTr	Transformer rated primary current I <sub>p</sub> (A) at	HV Fuse-link rated current I <sub>p</sub>	LV Fuse-Link gG	LV Fuse-Link gTr
		I <sub>HV</sub>				I <sub>HV</sub>				I <sub>HVmin</sub>				I <sub>HVmin</sub>				I <sub>HVmin</sub>		
6kV	(A)	(A)	(A)	10kV	(A)	(A)	(A)	15kV	(A)	(A)	(A)	20kV	(A)	(A)	(A)	30kV	(A)	(A)	(A)	
50	4,8	10	50	72	2,9	6	50	72	1,9	6	50	72	1,4	4	50	72	1,0	4	50	72
75	7,2	16	80	108	4,3	10	80	108	2,9	6	80	108	2,2	6	80	108	1,4	4	80	108
100	9,6	20	100	144	5,8	10	100	144	3,8	10	100	144	2,9	6	100	144	1,9	6	100	144
125	12,0	20	125	180	7,2	16	125	180	4,8	10	125	180	3,6	10	125	180	2,4	6	125	180
160	15,3	25	160	231	9,2	20	160	231	6,2	16	160	231	4,6	10	160	231	3,1	6	160	231
200	19,2	32	200	289	11,5	20	200	289	7,7	16	200	289	5,8	10	200	289	3,8	10	200	289
250	24,0	40	250	361	14,4	25	250	361	9,6	20	250	361	7,2	16	250	361	4,8	10	250	361
315	30,3	50	315	455	18,2	32	315	455	12,1	20	315	455	9,1	16	315	455	6,0	16	315	455
400	38,5	63	400	577	23,1	40	400	577	15,4	25	400	577	11,5	20	400	577	7,7	16	400	577
500	48,1	80	500	722	28,8	50	500	722	19,2	32	500	722	14,4	20	500	722	9,6	20	500	722
630	60,6	100	630	909	36,4	63	630	909	24,2	40	630	909	18,2	25	630	909	12,1	20	630	909
800	77,0	100	800	1.155	46,2	80	800	1.155	30,8	50	800	1.155	23,1	40	800	1.155	15,4	25	800	1.155
1000	96,2	125	1.000	1.443	57,7	80	1.000	1.443	38,5	63	1.000	1.443	28,9	50	1.000	1.443	19,2	32	1.000	1.443
1250	120,0	160	1250	**	72,2	100	1250	**	48,1	80	1250	**	36,1	63	1250	**	24,0	40	1250	**
1600	154,0	200*	1600	**	92,4	125	1600	**	61,6	100	1600	**	46,2	63	1600	**	30,8	50	1600	**
2000	192,5	250*	**	**	115,5	160	**	**	77,0	100	**	**	57,7	80	**	**	38,5	63	**	**

## Definitions and terms

### Back-up fuse-links

According to standard IEC 60282-1 Fifth edition (2002-01), item 3.3.3, Back-up fuse is current-limiting fuse capable of breaking, under specified conditions of use and behaviour, all currents from the rated maximum breaking current ( $I_1$ ) down to the rated minimum breaking current ( $I_3$ ).

Back-up fuse links should not operate below their minimum breaking current. If the short-circuit current of the transformer is lower than the minimum breaking current, additional protection must be provided.

### Rated voltage range voltages

ETI VV Thermo fuse-links must be operated at the rated voltage. At lower operating voltages without limitation provided, please contact ETI team.

### Breaking capacity $I_1$

This value (sometimes named "rated maximum breaking current" of current indicates, that this is the maximum current which can be interrupted by the fuse-link.  $I_1$  should be greater than the maximum expected short circuit current at the fuse-link site.

### Minimum breaking current $I_3$

This value (sometimes named "rated minimum breaking current" is specified for Back-up fuse-links. Up from this current, fuse-link is capable to breaking fault current.

### Power dissipation of a fuse-link $P_n$

The power dissipation of a VV Thermo fuse-link is specified at the rated current of the fuse-link. For calculations of protection with VV Thermo fuse-link, it should be noted, that operating current is normally below half of the rated current.

### Time-current characteristics

$I/t$  characteristics represents the correlation between current and time up to the melting of a silver fuse element. For coordination with other protection devices, melting integral must be referred for melting times below 100ms.

### Current limitation

This is most significant advantage of fuse-links compared to mechanical switches. Contacts of that switches need much longer time as fuse-link to interrupt fault currents. VV fuse-link interrupt fault current within few milliseconds and sinusoidal current does not reach its peak value.

### Switching voltages

Between current-limiting process, short circuit current must be limited and reduced as soon as possible. This require a switching voltage that exceed the normal system voltage and force the current to zero.

Permissible value of switching voltage is 2.2 times peak value of the maximum rated voltage.