

# PROTECTION OF PV SYSTEMS



# Photovoltaic Array Overcurrent Protection

## NH gPV fuse selection

Define panel data:

- $I_{SC\_MOD\_STC}$
- $I_{MOD\_MAX\_OCPR}$
- $U_{OC\_STC}$
- number of panels
- number of strings



PV Array overcurrent protection



Apply NH PV fuse to + and - pole of string

PV array overcurrent protection:

$$I_n > 1,25 \times I_{SC\_ARRAY} \text{ - the short circuit current of the PV array at STC}$$

$$I_n \leq 2,4 \times I_{SC\_ARRAY}$$

$$I_{SC\_ARRAY} = I_{SC\_MOD\_STC} \times \text{No. of PV strings}$$

ETI as one of the most important European producer of overcurrent protection equipment and devices participating in many working groups for standards development at International Electrotechnical Commission (IEC). ETI is member of maintenance team MT9 belonging to the 32B group, working on the part 6 of the IEC 60269 dealing with supplementary requirements for fuse-links for the overcurrent protection of solar photovoltaic energy systems.

gPV fuse link must be selected acc. standard IEC 62548

# NH gPV 1000V - Fuse-links

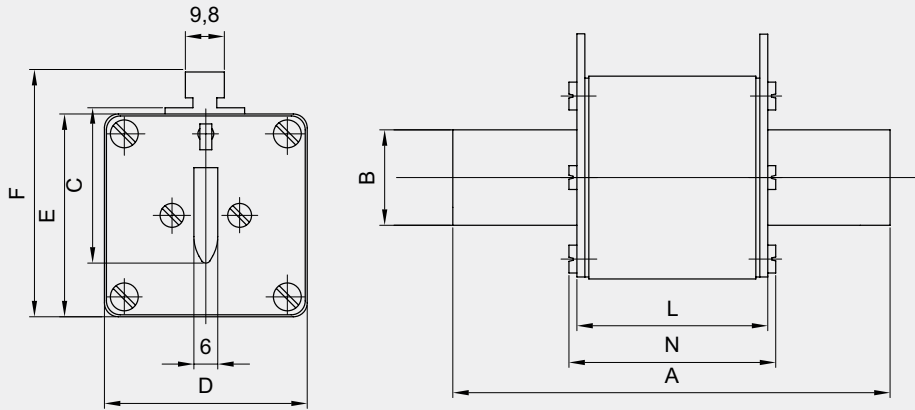
General characteristics	
Rated voltage	1000V d.c. (NH1, 2, 3: L/R=1ms; NH0, 1C: L/R=2ms)
Breaking capacity	30kA d.c. (NH1, 2, 3), 20kA d.c. (NH0, 1C)
Standards	IEC 60269-6
Application	Fuse link for DC application. Applied in fuse base PK1, 2, 3 1000V d.c..



NH gPV 1000V d.c.														
Size	$I_n$ [A]	gPV Standard indicator Code No. Pic.1	gPV $S_{110}$ screw contact Code No. Pic.2	gPV $U_{110}$ screw contact Code No. Pic.3	gPV G screw contact with centre trip indicator for microswitch MK Code No. Pic.4	Power dissipation $(0,7 \times I_n^2)$ [W]	Power dissipation [W]	Pre-arcing Joule integral [I <sup>2</sup> t] (L/R = 1ms)	Operating Joule integral [I <sup>2</sup> t] (L/R = 1ms)	Weight [g]	Packaging [pcs]			
0	32	004110381	-	-	-	7,6	7,6	52	430	280	3/45			
	40	004110383	-	-	-	8,8	8,8	96	730					
	50	004110384	-	-	-	11,0	11,0	155	920					
	63	004110385	-	-	-	13,5	13,5	290	1.760					
	80	004110386	-	-	-	17,0	17,0	520	3.160					
	100	004110387	-	-	-	21,0	21,0	1.110	5.280					
	125	004110388	-	-	-	22	22	2.800	11.340					
1C	160	004110389	-	-	-	32	32	5.950	20.750	300	3/45			
	32	004110371	-	-	-	7,6	7,6	52	430					
	40	004110373	-	-	-	8,8	8,8	96	730					
	50	004110374	-	-	-	11,0	11,0	155	920					
	63	004110375	-	-	-	13,5	13,5	290	1.760					
	80	004110376	-	-	-	17,0	17,0	520	3.160					
	100	004110377	-	-	-	21,0	21,0	1.110	5.280					
1	125	004110378	-	-	-	22	22	2.800	11.340	500	3/24			
	160	004110379	-	-	-	32	32	5.950	20.750					
	200	004110342	-	-	-	11	27	4.400	29.000					
	2	200	004110343	004110292	004110296	004110346	11	26	4.400			29.000	650	1/16 (G screw contact: 2/12)
		250	004110344	004110293	004110297	004110347	15	36	6.000			38.000		
	3	160	004110456	-	-	-	15	38	5.000			10.000	1200	3/15 (G screw contact: 2/8)
		200	004110455	-	-	-	18	45	10.000			20.000		
250		004110458	-	-	-	18	44	20.000	40.000					
315		004110460	004110294	004110298	004110232	24	54	40.000	80.000					
350		004110459	004110348	004110349	004110233	25	55	45.000	90.000					
400		004110457	004110295	004110299	004110234	24	58	46.000	138.000					



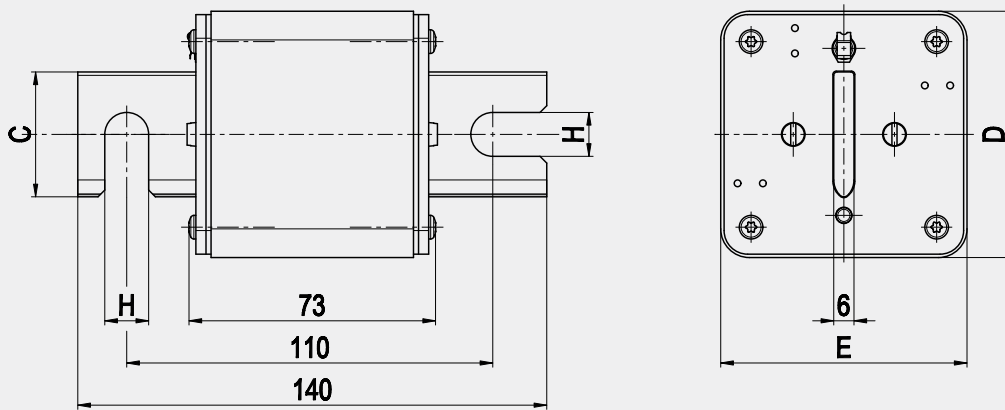
Pic.1



Standard indicator

Size	A	B	C	D	E	F	L	N
1	135	24	42	51	51	67	70	74
2	150	30	48	61	61	71	70	74
3	150	37	60	73	73	87	70	74

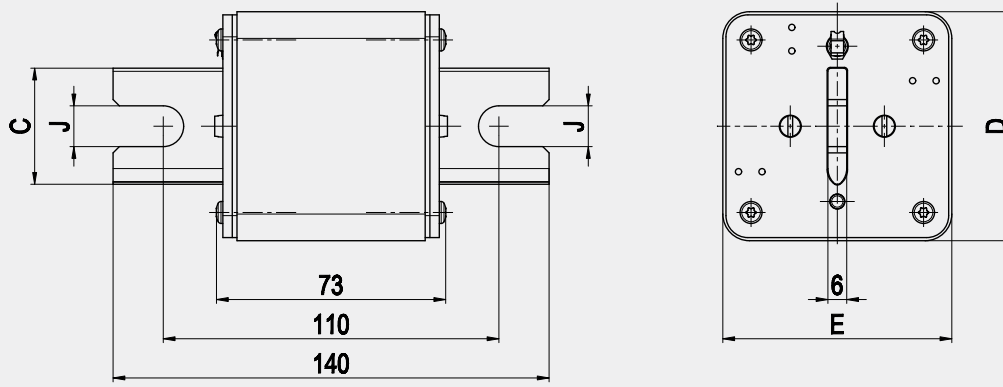
Pic.2



S<sub>110</sub> screw contact

Size	C	E	D	H
2	30	60	60	11
3	37	73	73	11

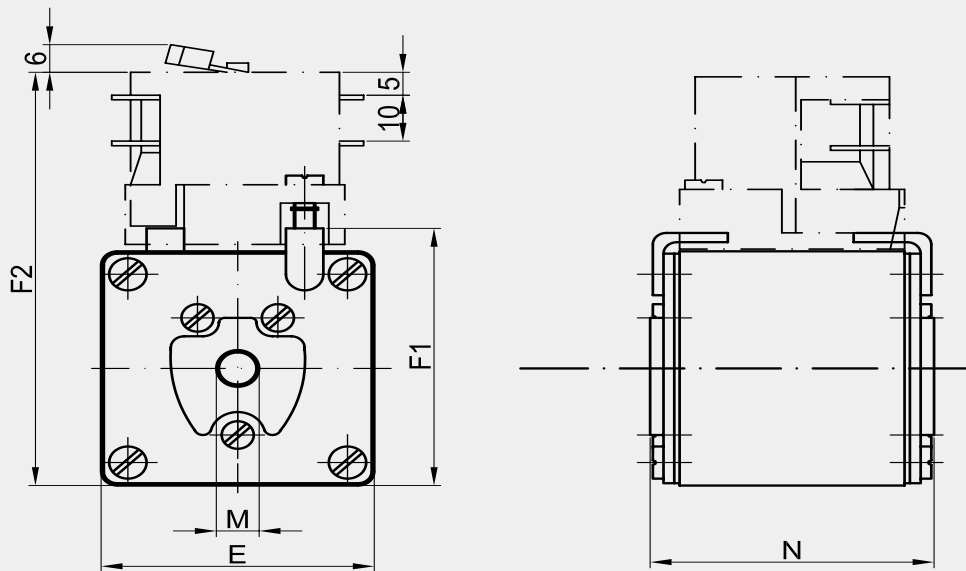
Pic.3



**U<sub>110</sub> screw contact**

Size	C	J	E	D
2	30	13	60	60
3	37	13	73	73

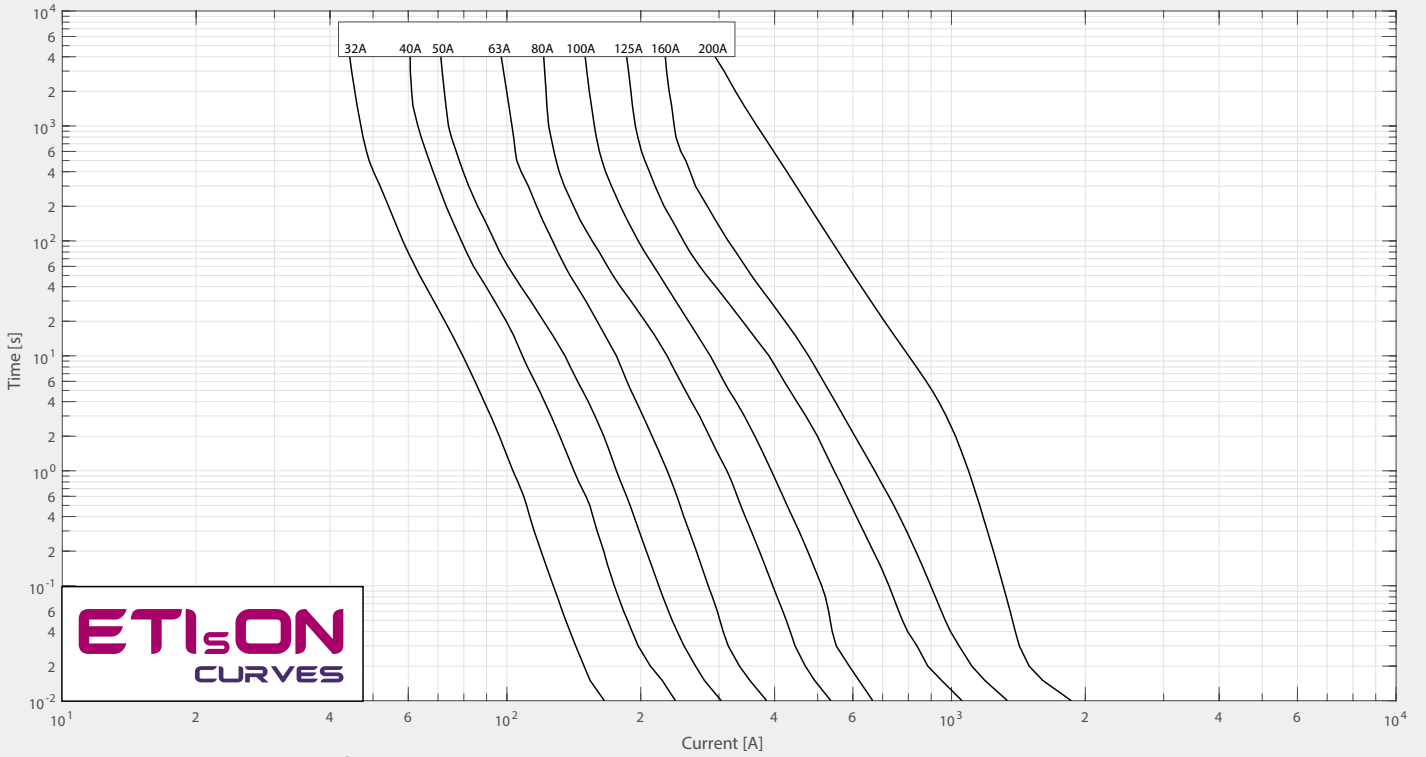
Pic.4



**G screw contact**

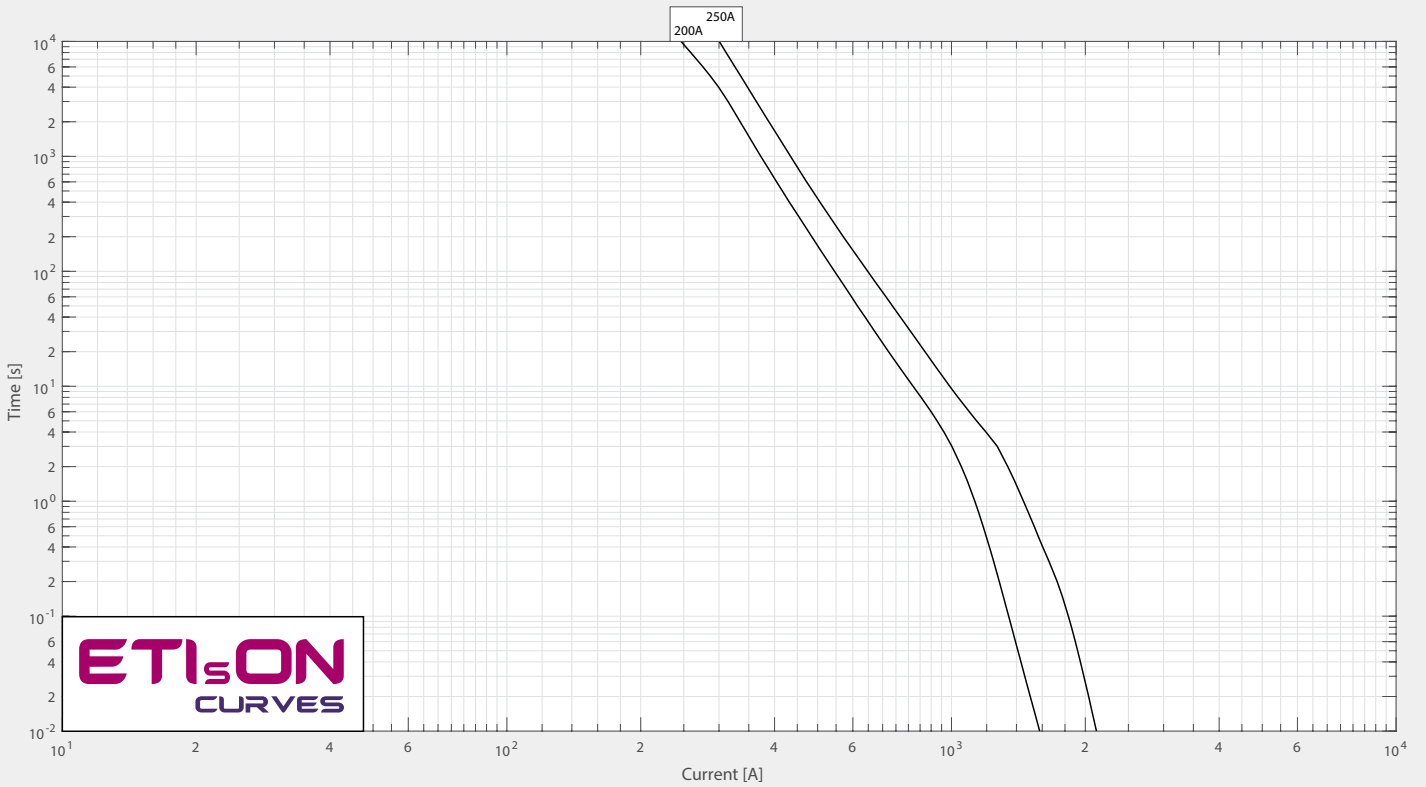
Size	D	E	F1	F2	M	N
2	60	60	65	99	M10	75
3	75	75	80	114	M12	75



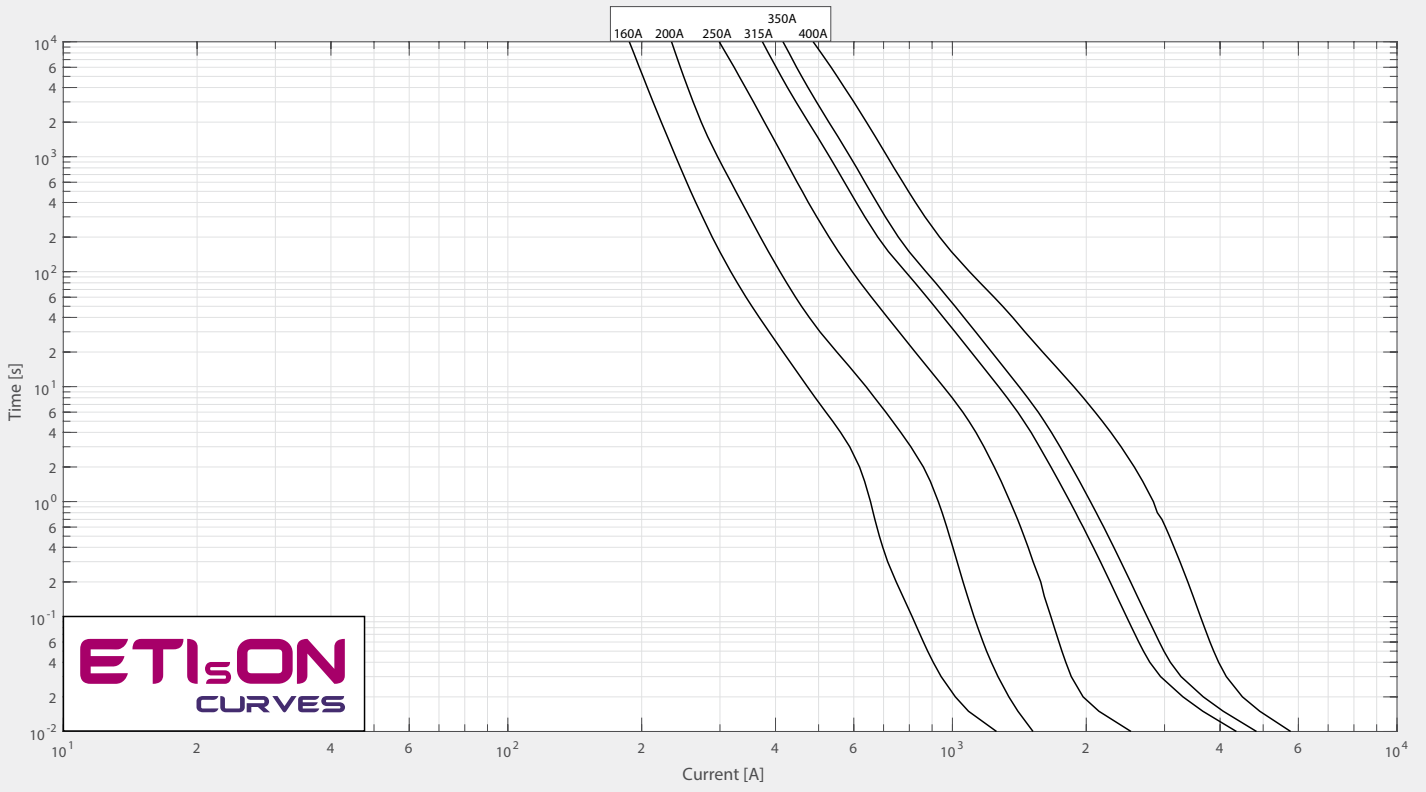


NHO, 1C, 1 gPV 1000V t-I characteristics

Green protect - gPV



NH2 gPV 1000V t-I characteristics



NH3 gPV 1000V t-l characteristics

# NH gPV 1100V - Fuse-links

General characteristics		UL file: E347771
Rated voltage	1100V d.c. (L/R = 2ms)	
Breaking capacity	10 kA d.c. (NH 3L 630A: 30kA d.c.)	
Standards	UL 2579, UL 248-1, IEC 60269-6	
Application	Fuse link for DC application. Applied in fuse base PK XL 1500V.	



NH gPV 1100V d.c.										
Size	$I_n$ [A]	Standard indicator (pic.1)	$S_{170}$ screw contact (pic.2)	$U_{170}$ screw contact (pic.3)	Power dissipation (0,7xI <sub>n</sub> ) P <sub>d</sub> [W]	Power dissipation [W]	Pre-arcing Joule integral [I <sup>2</sup> t] (L/R = 2ms)	Operating Joule integral [I <sup>2</sup> t] (L/R = 2ms)	Weight [g]	Packaging [pcs]
1XL	63	004110391	004110472	004110487	7	15,7	2.800	3.500	750	1/17
	80	004110392	004110473	004110488	7	16	4.500	5.500		
	100	004110393	004110474	004110489	8,3	19	7.500	9.000		
	125	004110394	004110475	004110490	9,7	22	13.000	15.000		
	160	004110395	004110476	004110491	13,2	30	25.000	30.000		
2XL	200	004110396	004110477	004110492	15	34,8	39.000	80.000	1050	1/15
	250	004110397	004110478	004110493	15,9	36	55.000	75.000		
3L	315	004110398	004110479	004110494	19,3	44	90.000	120.000	1360	1/10
	350	004110399	004110480	004110495	23	53,6	170.000	230.000		
	400	004110400	004110481	004110496	26	58	195.000	260.000		
	450	004110401	004110482	004110497	28	64,8	250.000	350.000		
	500*	004110485	004110486	004110498	34	85	130.000	250.000		
	630**	004110629	004110628	004110627	37	98	150.000	370.000		
		004110449	/	004110484	46	119	180.000	450.000		

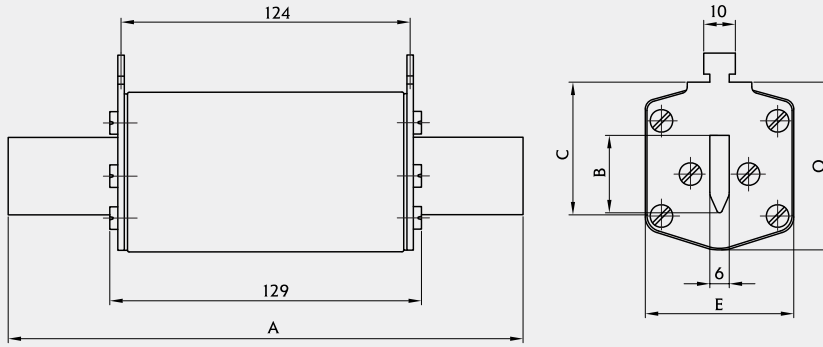
\*size 73x73; dimensions on page 52 (3L).

\*\* 30kA, not UL certified

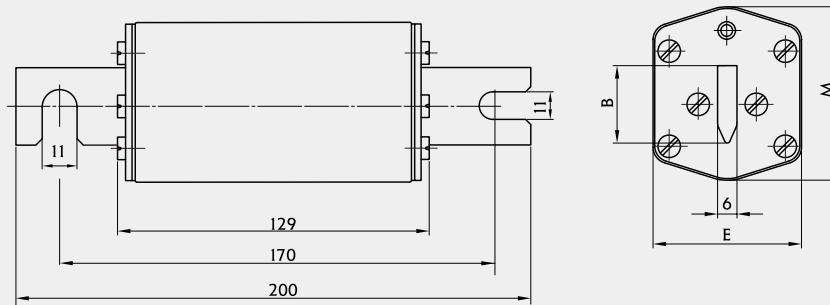




Picture 1

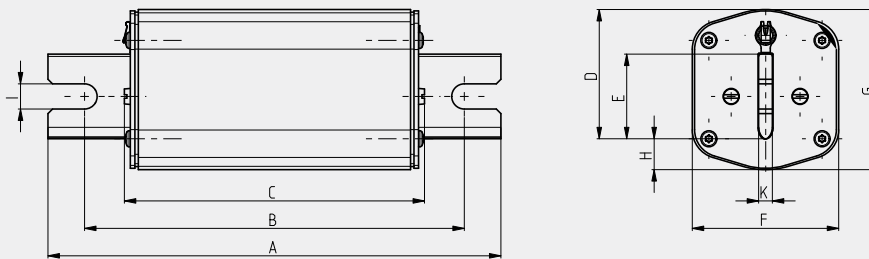


Picture 2



Size	Dimensions [mm]								
	A	B	C	E	G	P	R	M	O
1XL	194	24	40	46	61,5	20,5	13,7	50	52
2XL	209	30	48	54	71	27,3	16,2	59	61
3L	209	37	60	64	82	35,6	17,0	70	74

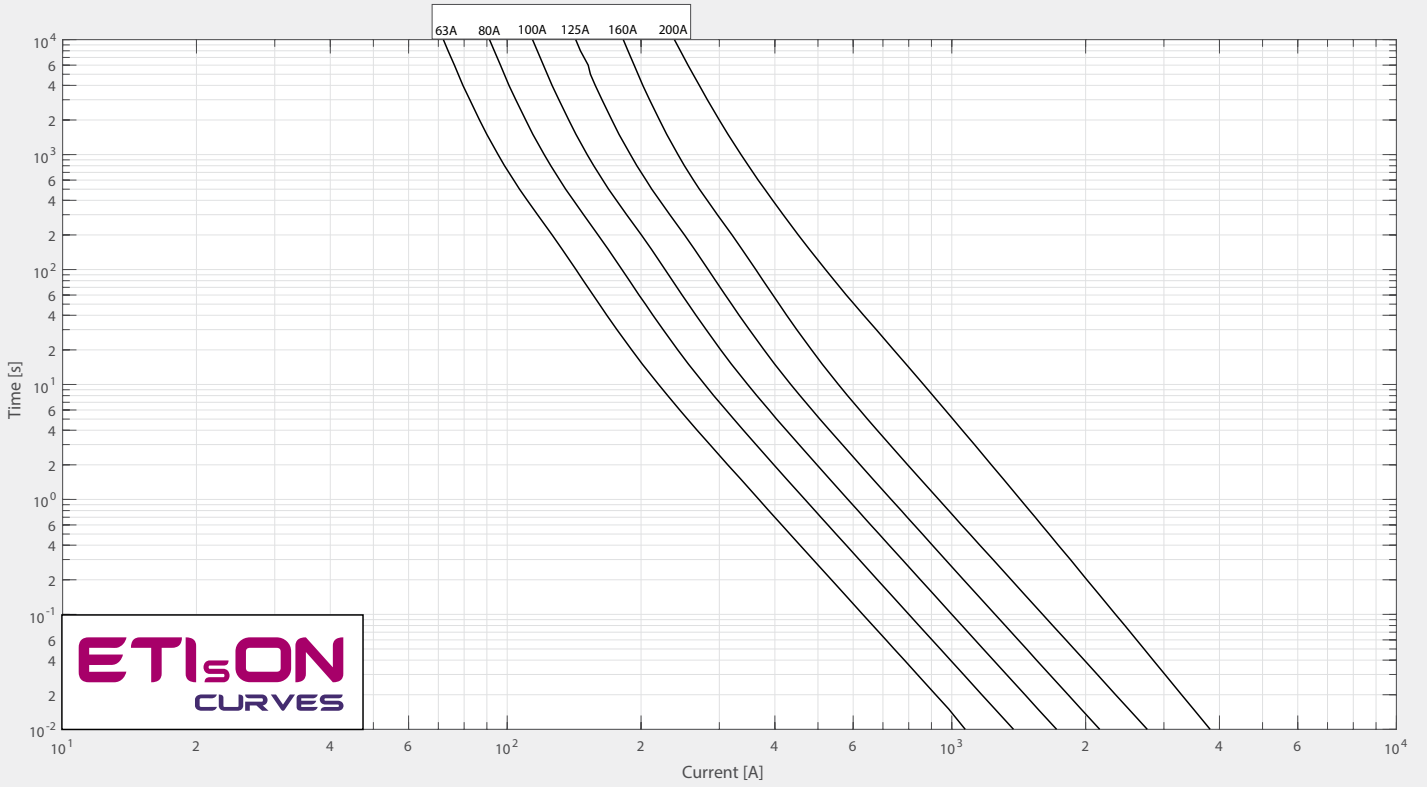
Picture 3



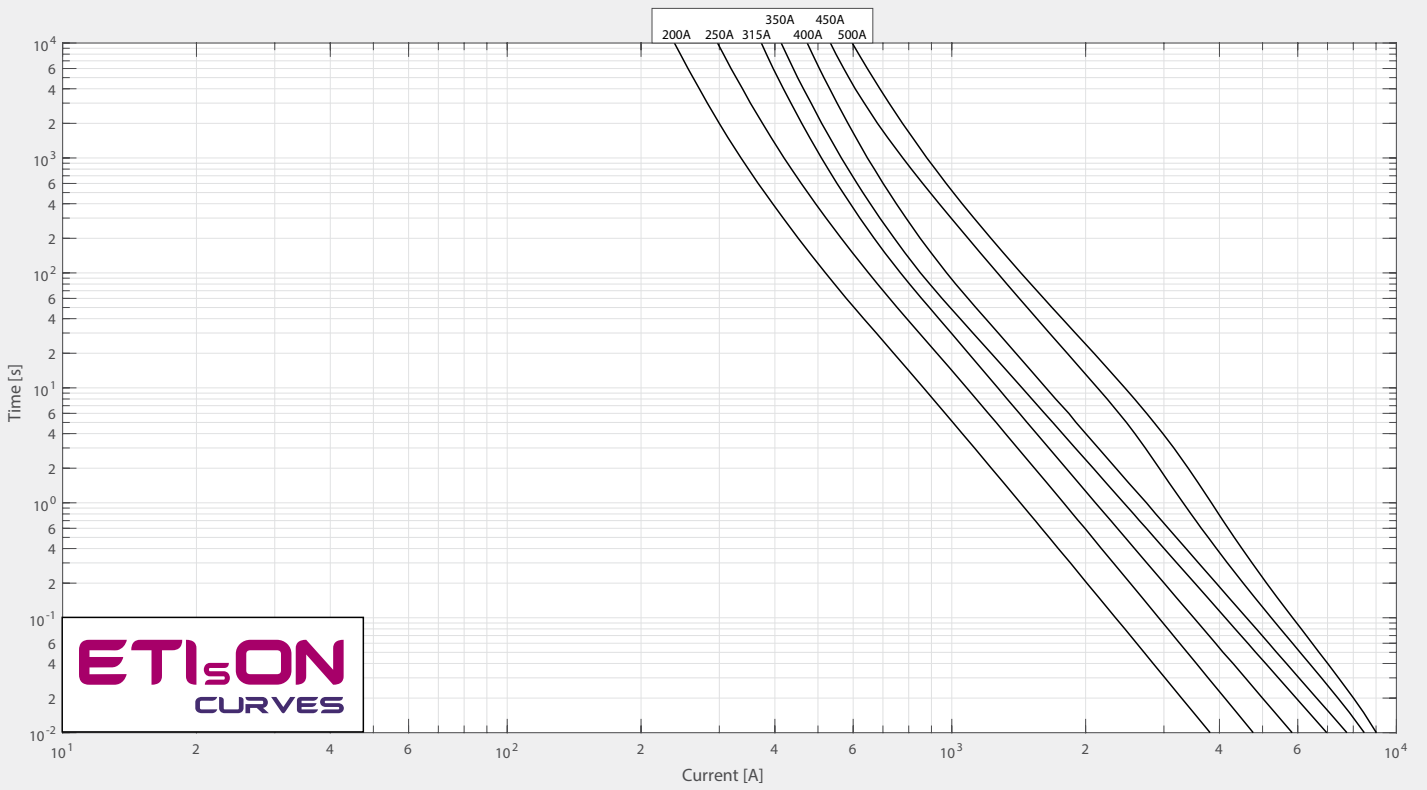
Size	Dimensions [mm]									
	A	B	C	D	E	F	G	H	K	I
1XL	197	170	133	40	24	46	50	16	6	11
2XL	200	170	130	48	30	54	59	18	6	13
3L	200	170	130	60	37	64	70	23	6	13



gPV 1100V t-I characteristics



NH1XL



NH2XL, NH3L

Green protect - gPV

# NH 01XL gPV 1500V - Fuse-links

## General characteristics

Rated voltage	1500V d.c. (L/R=3ms)
Breaking capacity	30kA d.c.
Standards	IEC 60269-6, UL248-19
Application	Fuse link for DC application. Applied in fuse base PK1XL.

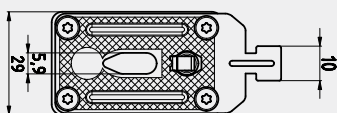
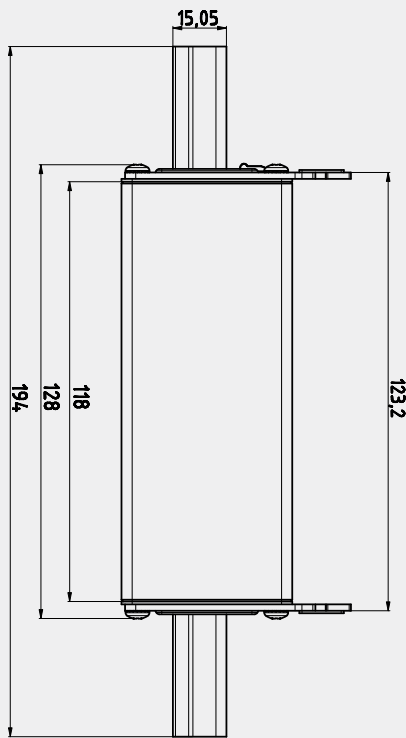


## NH gPV 1500V d.c.

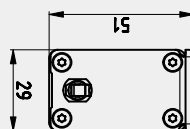
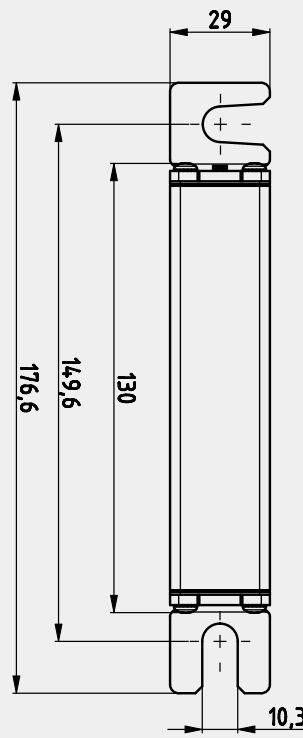
Size	$I_n$ [A]	gPV Standard indicator (pic.1)	gPV $S_{150}$ screw contact (pic.2)	gPV $U_{150}$ screw contact (pic.3)	Power dissipation ( $0,7 \times I_n$ ) $P_d$ [W]	Power dissipation [W]	Pre-arcing Joule integral [ $I^2t$ ] (L/R = 3ms)	Operating Joule integral [ $I^2t$ ] (L/R = 3ms)	Weight [g]	Packaging [pcs]
01XL	50	004110692	004110743	004110749	7	18	500	3.000	450	3/30
	63	004110693	004110744	004110750	8,5	22	1.000	6.000		
	80	004110694	004110745	004110751	9	21	2.000	15.000		
	100	004110695	004110746	004110752	11	29	3.500	25.000		
	125	004110696	004110747	004110753	13	36	4.000	30.000		
	160	004110697	004110748	004110754	17	46	6.000	48.000		



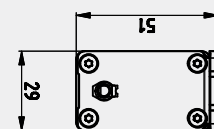
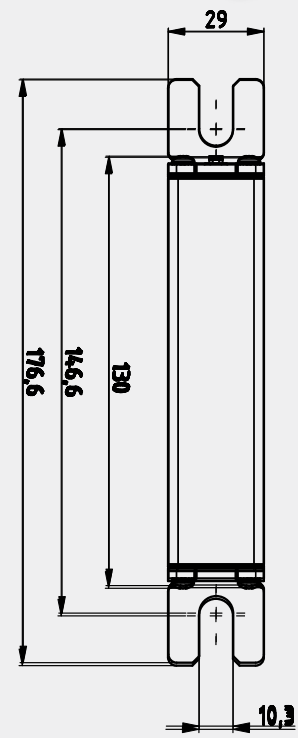
Green protect - gPV



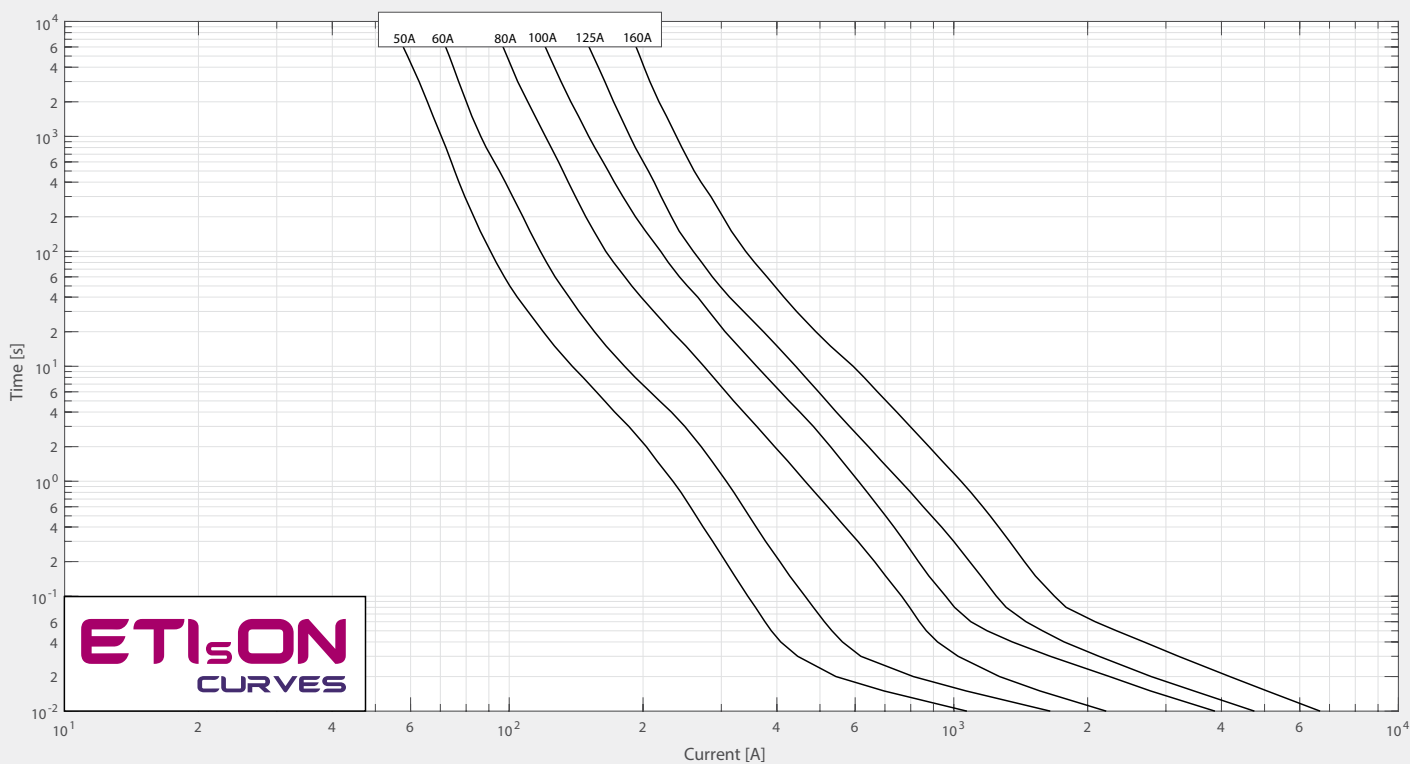
Picture 1



Picture 2



Picture 3



NH 01XL gPV 1500V t-I characteristics

# NH gPV 1500V - Fuse links



General characteristics		UL file E347771
Rated voltage	1500V d.c. (L/R=3ms)	
Breaking capacity	30kA d.c. NH1,2XL; 50kA d.c. NH3L	
Standards	IEC 60269-6, UL 248-19	
Application	Fuse link for PV applications. Applied in fuse base PK XL 1500V.	



**NEW!**

NH gPV 1500V d.c.										
Size	$I_n$ [A]	Standard indicator (pic.1)	gPV $S_{170}$ screw contact (pic.2)	$U_{170}$ screw contact (pic.3)	Power dissipation (0,7xl) <sub>n</sub> P <sub>d</sub> [W]	Power dissipation [W]	Pre-arcing Joule integral [I <sup>2</sup> t] (L/R = 3ms)	Operating Joule integral [I <sup>2</sup> t] (L/R = 3ms)	Weight [g]	Packaging [pcs]
1XL	50	004110621*	004110622	004110623	6	14	800	3500	950	1/15
	63	004110560*	004110591	004110606	6,2	14	1.500	6.000		
	80	004110561*	004110592	004110607	7	16	5.000	15.000		
	100	004110562*	004110593	004110608	8,3	19	10.000	26.000		
	125	004110563*	004110594	004110609	9,7	22	15.000	37.000		
	160	004110564*	004110595	004110610	13,2	30	19.000	48.000		
2XL	200	004110565*	004110596	004110611	13,7	32,5	22.000	75.000	1350	1/9
	200	004110566*	004110597	004110612	15,9	36	42.000	75.000		
	250	004110567*	004110598	004110613	19,3	44	73.000	132.000		
3L	315	004110630*	004110635	004110640	22,2	57	65.000	300.000	1970	1/9
	350	004110631*	004110636	004110641	23,7	61	75.000	350.000		
	400	004110632*	004110637	004110642	26,8	67	85.000	450.000		
	450	004110633*	004110638	004110643	29	75	130.000	600.000		
	500	004110634*	004110639	004110644	44,3	79	160.000	700.000		
	630	004110647*	004110648	004110649	40	102	280.000	1.600.000		



\* possible to mount microswitch NV55



Green protect - gPV





General characteristics		UL file E347771
Rated voltage	1500V d.c. (L/R=3ms)	
Breaking capacity	50kA d.c.	
Standards	IEC 60269-6, UL 248-19	
Application	Fuse link for PV applications. Applied in fuse base PK XL 1500V.	



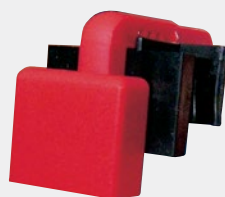
**NEW!**

NH gPV 1500V d.c.									
Size	I <sub>n</sub> [A]	gPV		Power dissipation (0,7xI <sub>n</sub> ) P <sub>d</sub> [W]	Power dissipation [W]	Pre-arcing Joule integral [I²t] (L/R = 3ms)	Operating Joule integral [I²t] (L/R = 3ms)	Weight [g]	Packaging [pcs]
		S <sub>170</sub> screw contact (pic.4)	U <sub>170</sub> screw contact (pic.5)						
3L MS	315	004110729	004110734	22,2	57	65.000	300.000	1970	1/9
	350	004110730	004110735	23,7	61	75.000	350.000		
	400	004110731	004110736	26,8	67	85.000	450.000		
	450	004110732	004110737	29	75	130.000	600.000		
	500	004110733	004110738	44,3	79	160.000	700.000		



It is possible to mount microswitch NV55 to all fuse links in the above table.

Green protect - gPV



General characteristics		UL file E347771
Rated voltage	1500V d.c. (L/R=3ms)	
Breaking capacity	70kA d.c. (IEC 60947-3: test sequence IV) / 50kA d.c. (IEC 60269-6), UL 248-19	
Standards	IEC 60269-6, IEC 60947-3: test sequence IV, UL 248-19	
Application	Fuse link for battery protection applications. Applied in fuse base PK 3L 1500V.	



**NEW!**

NH gPV 1500V d.c.										
Size	$I_n$ [A]	Standard indicator (pic.1)	$S_{170}$ screw contact (pic.2)	$U_{170}$ screw contact (pic.3)	Power dissipation ( $0,7xI_n$ ) $P_d$ [W]	Power dissipation [W]	Pre-arcing Joule integral [I <sup>2</sup> t] (L/R = 3ms)	Operating Joule integral [I <sup>2</sup> t] (L/R = 3ms)	Weight [g]	Packaging [pcs]
3L	315	004110714*	004110719	004110724	22,2	57	65.000	300.000	1970	1/9
	350	004110715*	004110720	004110725	23,7	61	75.000	350.000		
	400	004110716*	004110721	004110726	26,8	67	85.000	450.000		
	450	004110717*	004110722	004110727	29	75	130.000	600.000		
	500	004110718*	004110723	004110728	44,3	79	160.000	700.000		

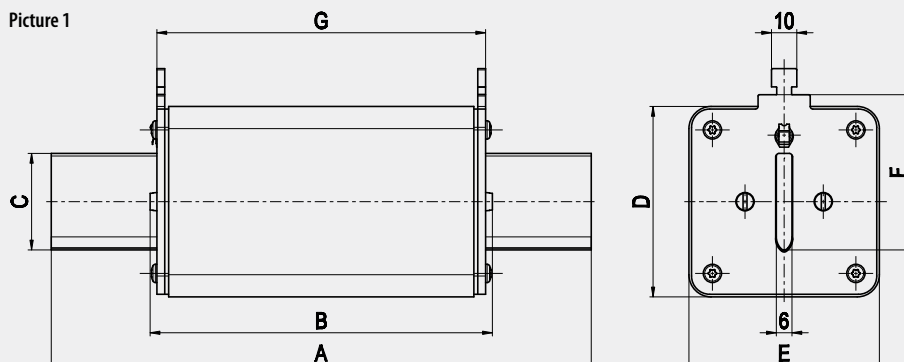
\* possible to mount microswitch NV55



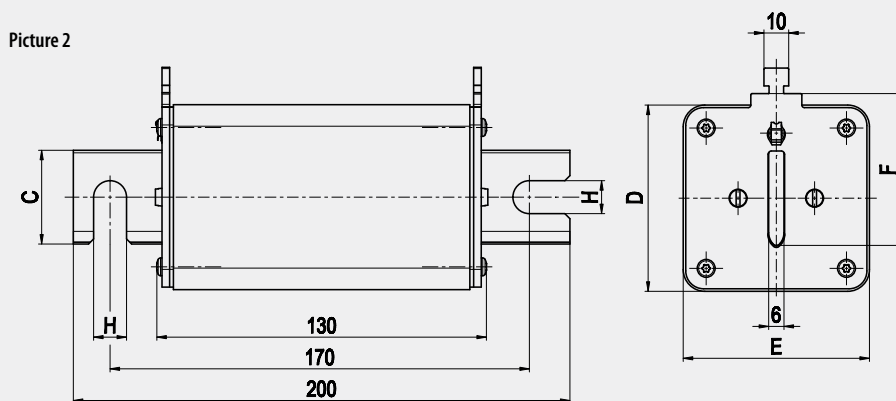
Green protect - gPV



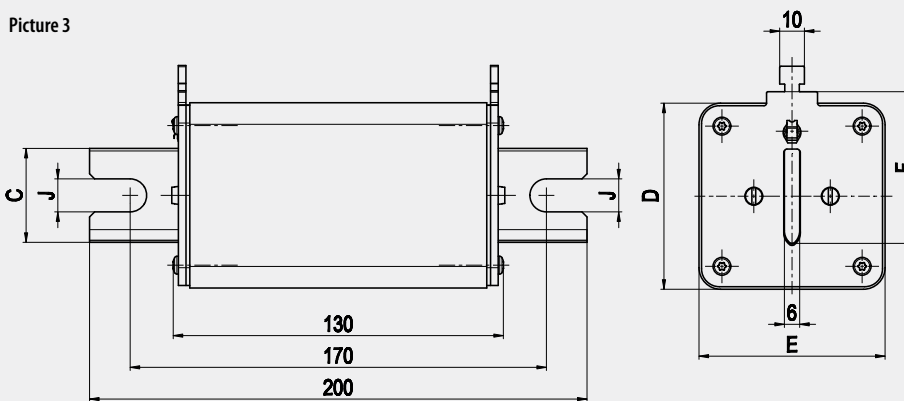
Picture 1



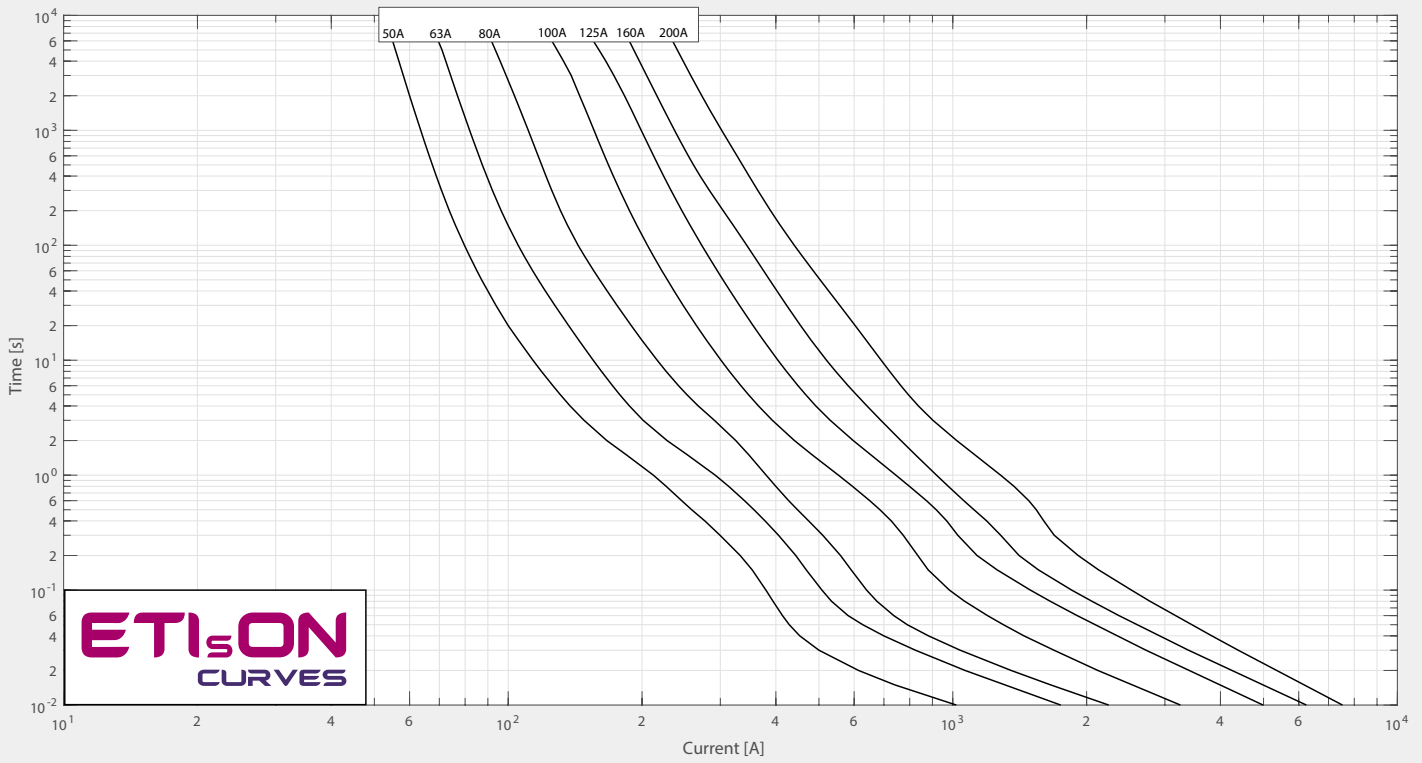
Picture 2



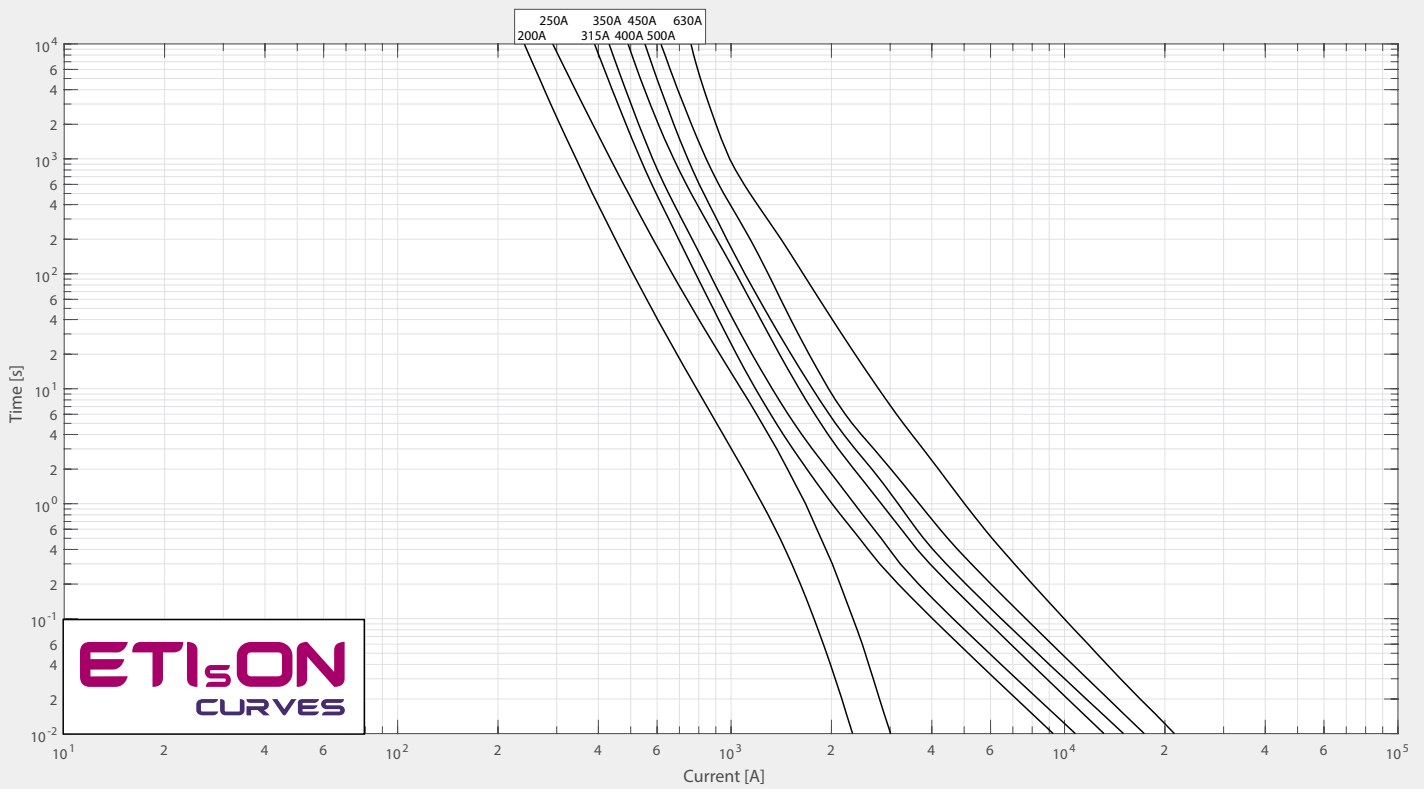
Picture 3



Size	Dimensions [mm]								
	A	B	C	D	E	F	G	H	J
1XL	192	131	24	51	51	43,5	125	11	11
2XL	208	130	30	60	60	48	126	11	13
3L	208	130	37	73	73	60	126	11	13



t-I characteristics NH 1XL



t-I characteristics NH 2XL & NH 3L



315 A							
cut-off	L/R						
Ip/kA	0,1 ms	0,5 ms	1 ms	1,5 ms	2 ms	2,5 ms	3 ms
10	10 kA	9 kA	9 kA	8 kA	8 kA	8 kA	8 kA
20	17 kA	13 kA	12 kA	11 kA	11 kA	10 kA	10 kA
30	22 kA	16 kA	14 kA	13 kA	12 kA	12 kA	12 kA
40	25 kA	19 kA	16 kA	14 kA	14 kA	13 kA	13 kA
50	28 kA	20 kA	17 kA	16 kA	15 kA	14 kA	14 kA
60	30 kA	21 kA	18 kA	17 kA	16 kA	16 kA	15 kA
70	33 kA	22 kA	19 kA	18 kA	17 kA	17 kA	16 kA
80	36 kA	26 kA	23 kA	20 kA	19 kA	19 kA	18 kA
90	38 kA	28 kA	24 kA	22 kA	20 kA	20 kA	19 kA
100	41 kA	30 kA	25 kA	23 kA	21 kA	21 kA	20 kA

350 A							
cut-off	L/R						
Ip/kA	0,1 ms	0,5 ms	1 ms	1,5 ms	2 ms	2,5 ms	3 ms
10	10 kA	10 kA	9 kA	9 kA	9 kA	8 kA	8 kA
20	18 kA	14 kA	13 kA	12 kA	12 kA	11 kA	11 kA
30	23 kA	17 kA	15 kA	14 kA	13 kA	13 kA	12 kA
40	27 kA	19 kA	17 kA	16 kA	15 kA	14 kA	14 kA
50	31 kA	21 kA	18 kA	17 kA	16 kA	16 kA	15 kA
60	32 kA	24 kA	19 kA	18 kA	17 kA	17 kA	16 kA
70	34 kA	25 kA	21 kA	20 kA	19 kA	18 kA	17 kA
80	38 kA	27 kA	24 kA	23 kA	21 kA	20 kA	20 kA
90	40 kA	30 kA	26 kA	24 kA	22 kA	21 kA	21 kA
100	43 kA	32 kA	27 kA	25 kA	23 kA	22 kA	22 kA

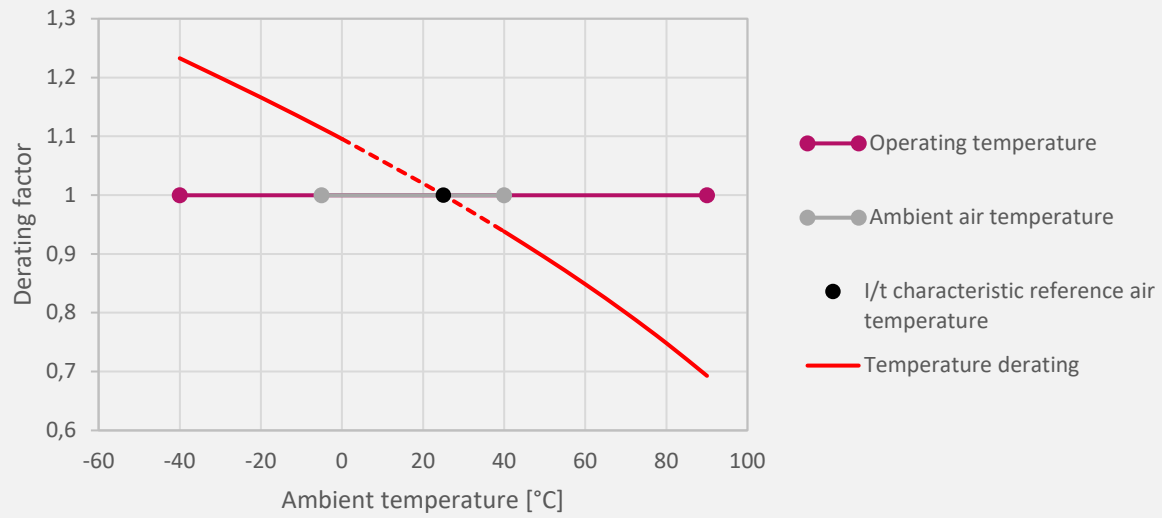
400 A							
cut-off	L/R						
Ip/kA	0,1 ms	0,5 ms	1 ms	1,5 ms	2 ms	2,5 ms	3 ms
10	10 kA	10 kA	10 kA	10 kA	9 kA	9 kA	9 kA
20	19 kA	16 kA	14 kA	13 kA	13 kA	12 kA	12 kA
30	24 kA	19 kA	17 kA	16 kA	15 kA	14 kA	14 kA
40	29 kA	21 kA	19 kA	18 kA	16 kA	16 kA	15 kA
50	33 kA	23 kA	21 kA	19 kA	18 kA	17 kA	16 kA
60	36 kA	25 kA	22 kA	20 kA	19 kA	19 kA	18 kA
70	38 kA	28 kA	23 kA	21 kA	20 kA	20 kA	19 kA
80	41 kA	30 kA	26 kA	25 kA	24 kA	23 kA	22 kA
90	45 kA	33 kA	29 kA	27 kA	25 kA	24 kA	23 kA
100	48 kA	35 kA	30 kA	28 kA	26 kA	25 kA	24 kA

450 A							
cut-off	L/R						
Ip/kA	0,1 ms	0,5 ms	1 ms	1,5 ms	2 ms	2,5 ms	3 ms
10	10 kA	10 kA	10 kA	10 kA	9 kA	9 kA	9 kA
20	20 kA	17 kA	16 kA	15 kA	14 kA	13 kA	13 kA
30	26 kA	21 kA	19 kA	18 kA	17 kA	16 kA	15 kA
40	32 kA	24 kA	21 kA	20 kA	18 kA	18 kA	17 kA
50	36 kA	27 kA	24 kA	22 kA	20 kA	19 kA	18 kA
60	41 kA	29 kA	25 kA	23 kA	22 kA	21 kA	19 kA
70	44 kA	32 kA	27 kA	25 kA	23 kA	22 kA	22 kA
80	48 kA	35 kA	30 kA	29 kA	27 kA	26 kA	25 kA
90	52 kA	37 kA	33 kA	30 kA	28 kA	27 kA	26 kA
100	55 kA	40 kA	35 kA	31 kA	29 kA	28 kA	27 kA

500 A							
cut-off	L/R						
Ip/kA	0,1 ms	0,5 ms	1 ms	1,5 ms	2 ms	2,5 ms	3 ms
10	10 kA	10 kA	10 kA	10 kA	9 kA	9 kA	9 kA
20	20 kA	17 kA	16 kA	15 kA	14 kA	14 kA	13 kA
30	28 kA	23 kA	20 kA	18 kA	17 kA	17 kA	16 kA
40	35 kA	27 kA	23 kA	21 kA	20 kA	19 kA	18 kA
50	40 kA	30 kA	26 kA	24 kA	22 kA	21 kA	20 kA
60	47 kA	33 kA	28 kA	26 kA	24 kA	23 kA	21 kA
70	50 kA	35 kA	30 kA	28 kA	26 kA	24 kA	23 kA
80	55 kA	39 kA	34 kA	31 kA	30 kA	28 kA	27 kA
90	59 kA	41 kA	36 kA	33 kA	32 kA	31 kA	29 kA
100	61 kA	44 kA	39 kA	35 kA	33 kA	32 kA	30 kA



Ambient air temperature of fuse-link



Legend:

$T_{amb}$  – Ambient Temperature

TDF – Temperature Derating Factor

$I_N$  – Nominal Current of Fuse-link

$I_{TDF}$  – Nominal Current Including Temperature Derating Factor

$$\text{Current calculation: } I_{TDF} = I_N \times \text{TDF}$$

