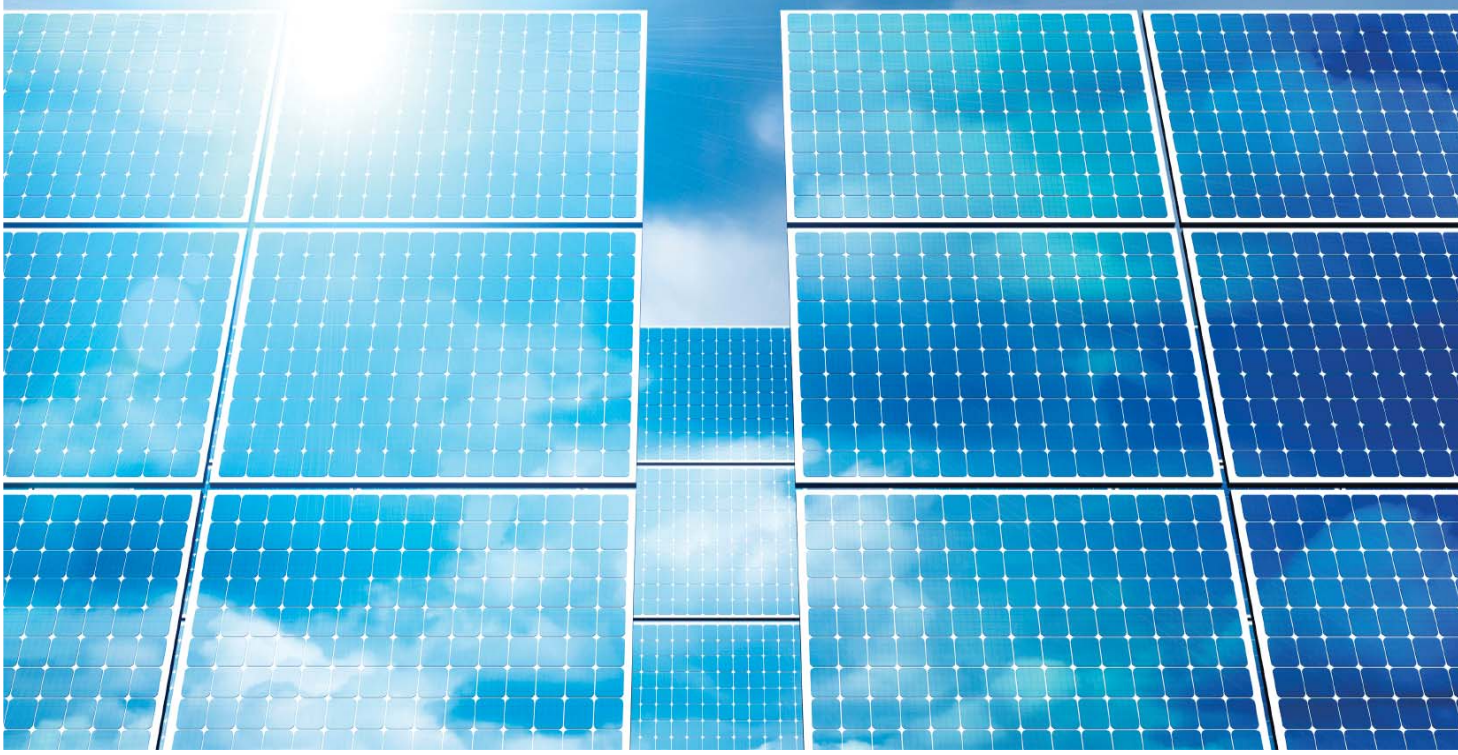
Bussmann series photovoltaic application guide

BUSSMANN SERIES

Complete and reliable solar fusible circuit protection



Powering Business Worldwide

Eaton has more than 100 years of proven technical innovation to help make your operation more productive while protecting your equipment.

Solar Photovoltaic (PV) systems have, over the last 50 years, evolved into a mature, sustainable and adaptive technology. The installations and demand for PV systems increase the need for effective electrical protection. PV systems, as with all electrical power systems, must have appropriate overcurrent and overvoltage protection.

Eaton has worked closely with solar system manufacturers and through coordinated research and development, has produced revolutionary new fuse links which, combined with its combiner box, offer complete protection for PV systems.

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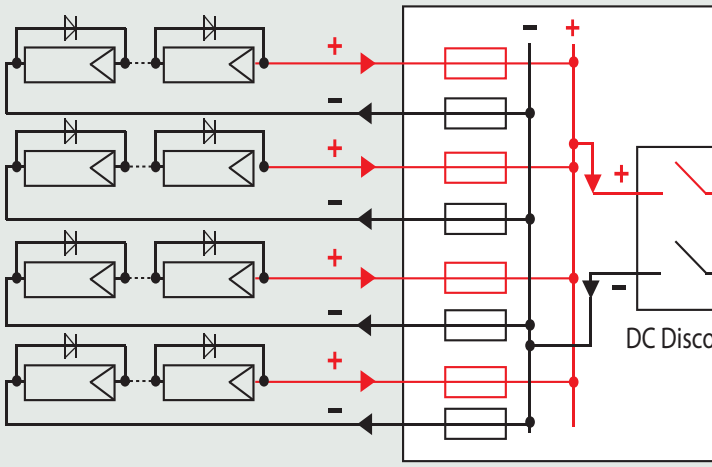
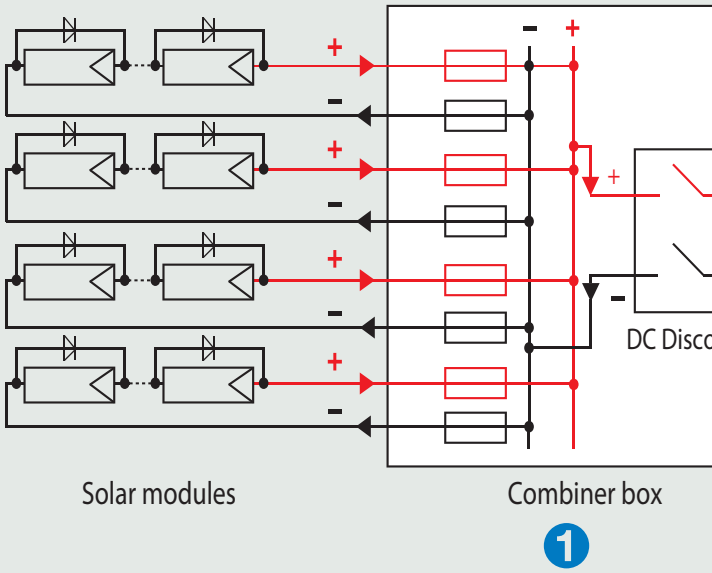
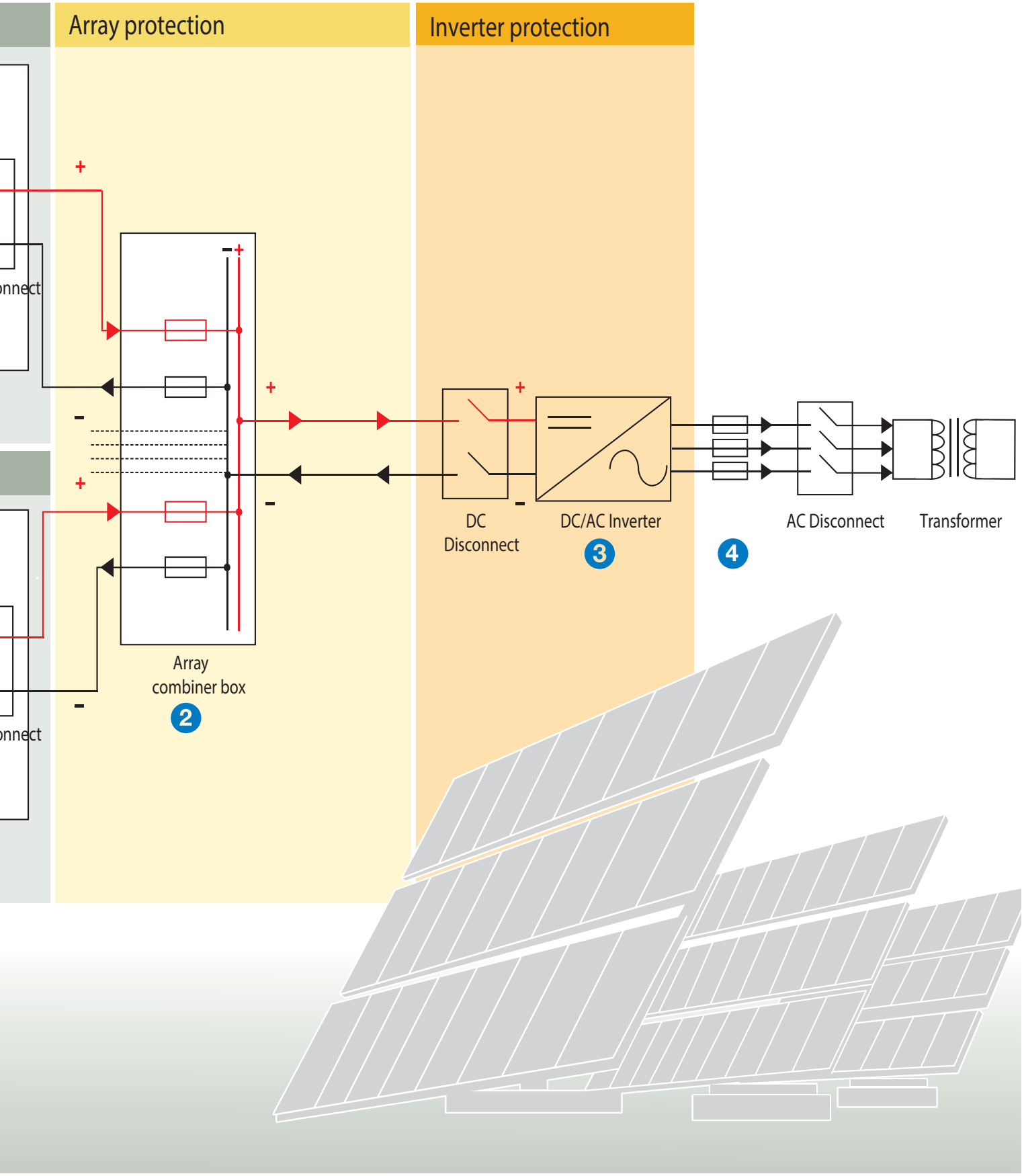
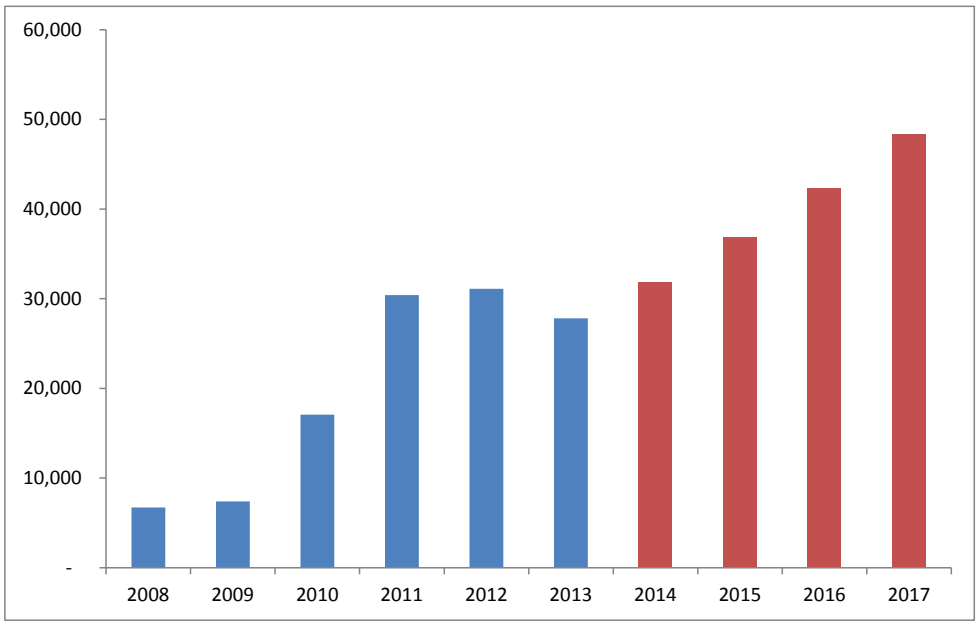





Array protection
Inverter protection
+
-
+
-
+
-
+
-
Array
combiner box
2
DC
Disconnect
DC/AC Inverter
3
4
AC Disconnect
Transformer

Introduction

With the rising energy costs of fossil fuels and their impact on the environment, the focus on renewable energy has gained strength, which has led to an increase in the size of Photovoltaic (PV) installations from 1.4 GW in 2000 to 137 GW in 2013. This rapid growth in PV installations has challenged system designers, manufacturers and standards organizations due to the special demands associated with PV installation in terms of current, voltage, and ambient temperature. These requirements have also been considered in the development of international protection standards for PV installations, which Eaton, the leading name in electrical protection, has used to develop PV specific protection devices.



Global annual photovoltaic installations (Megawatt). Source: EPIA

IEC 60269-6 gPV standard

Unlike typical grid connected AC systems, the available short-circuit current within PV systems is limited and the overcurrent protective devices need to operate effectively on low levels of fault current. For this reason Eaton has conducted extensive research and development of fuse links that are specifically designed and tested to safely protect PV systems with high DC voltages and low fault currents.

Figure 1

The International Electrotechnical Commissions (IEC) recognise the protection of PV systems is different to standard electrical installations. This is reflected in IEC 60269-6 which defines specific characteristics that a fuse link is required to meet for protecting PV systems, utilisation class gPV. Eaton's Bussmann series string and branch PV fuse links have been specifically designed to meet this standard. However, Eaton's Bussmann series PV fuse links exceed the requirements of IEC 60269-6 as they operate at 1.35 x I_n (1.35 times the nominal current). They also meet the requirements of UL 2579 and are thus suitable for protecting PV modules in reverse current situations.

Whilst the standard does not recognise a specific symbol, the combination of the symbols for fuse link and strings are often used to indicate a fuse link is suitable for protecting strings in PV systems, see Figure 1.

Photovoltaic module construction

- A photovoltaic (PV) cell is usually between 4" and 6" square.
- A number of individual cells are combined in a module (often called a panel).
- A number of PV modules in series is referred to as a string.
- A number of strings in parallel is referred to as an array.

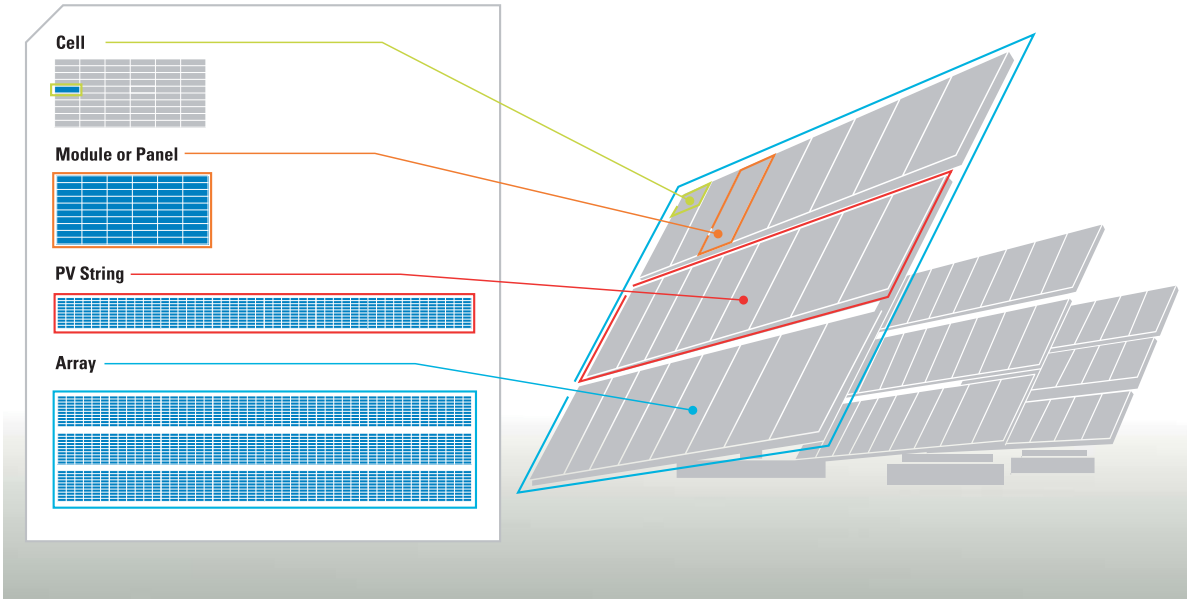


Figure 2

Photovoltaic module output

The voltage output of a PV module is defined by the number of cells in series that form the module.

The current output of a PV module is dependent on the area of a cell.

The most widely used solar modules are made with 4", 5" and 6" poly-crystalline silicon cells. This type of module using 6" cells, can achieve approximately 8 Amps maximum power point (MPP) current per module with a typical voltage output of around 30 Volts.

With thin film technology typical output is 2.5 Amps and 40 Volts.

The maximum power point current of the modules vary between manufacturers of equal solar cell dimensions. When selecting the appropriate fuse links, the specified Short Circuit Current (I_{SC}) and reverse current characteristics specified by the manufacturers should be used.

The specifications provided by the module manufacturer should be consulted to confirm the output currents and voltages of the modules under the range of conditions expected for the proposed installation. These conditions are influenced by the ambient temperature, the incident angle of sunlight and the amount of solar energy reaching the module. These are usually mentioned as coefficients on the manufacturer's specifications.

Manufacturers also suggest the maximum series fuse rating or a reverse current rating. Both of these are based on modules surviving 1.35 time this rating for two hours.

Overview of string protection

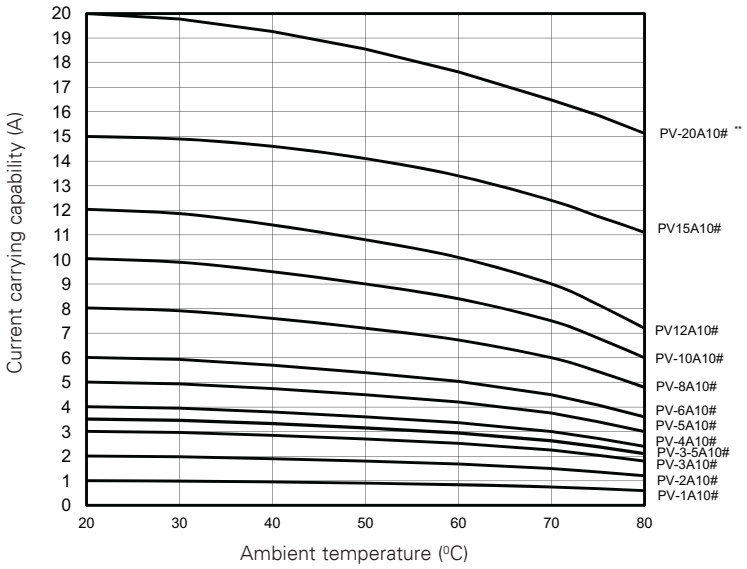
Depending on the desired capacity of the Photovoltaic (PV) system, there may be several PV strings connected in parallel to achieve higher currents and subsequently more power.

PV systems that have three or more strings connected in parallel need to have each string protected. Systems that have less than three strings will not generate enough current to damage the modules in the event of a fault. Therefore they do not present a safety hazard, provided the conductor is sized correctly, based on local codes and installations requirements.

Where three or more strings are connected in parallel, a fuse link in each string will protect the cables and modules from overcurrent faults and help minimise any safety hazards. It will also isolate the faulted string so that the rest of the PV system can continue to generate electricity.

It should be remembered that PV modules current output changes with the module temperature as well as the amount of sun they are exposed to. The exposure is dependant on irradiance level, incline as well as shading effect from trees, buildings or clouds. In operation, fuse links, as thermal devices, are influenced by ambient temperature. The current capability of Eaton's Bussmann series PV string fuse links should be derated according to the curves below.

PV String fuse link derating with temperature



Combiner box

10 x 38, 14 x 51, 14 x 65 mm photvoltaic fuse links

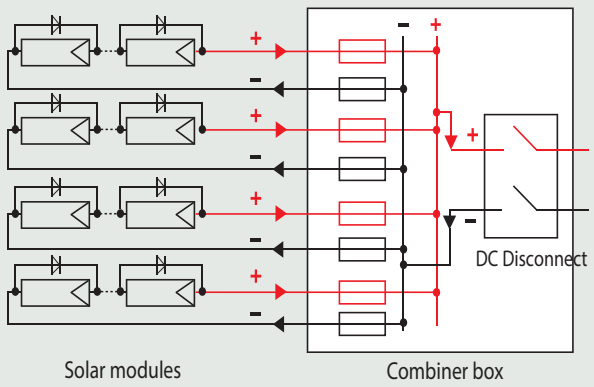
CHPV Fuse holder

In-line fuse holder

BM series fuse block

Surge protection devices

String protection



How to select fuse links for string protection

Whilst a full study of all the parameters is recommended, the following factors should be used: 1.56 for current and 1.2 for voltage when selecting the fuse link. These cover most variations due to installation. The same method should be adopted for crystalline and thin film modules.If your PV installation is subject to extremes of high altitude, high irradiance, or low temperature, please consult Eaton's technical team (bulehighspeedtechnical@eaton.com).

Define PV module specifications

I_{sc}
Short-circuit current of one module at Standard Test Conditions (STC)

V_{oc}
Open circuit voltage of one module at STC

N_s
Number of modules in series per string

N_p
Number of strings in parallel per array

$I_{mod\_max\_OCPR}$
The PV module maximum overcurrent protection rating specified by IEC 61730-2 (this is often specified by module manufacturers as the maximum series fuse rating)

If $N_p > 3$

The fuse link's ratings should be selected as follows:

- **Voltage rating ≥ 1.20 x V_{oc} x N_s**
- **Current rating ≥ 1.56 x I_{sc}**
- **Check the current carrying capability of the selected fuse, after derating at the ambient temperature of the fuse, still satisfies the above criteria**
- **Current rating ≤ $I_{mod\_max\_OCPR}$**
- **Current rating ≤ I_z = string cable rating**

Eaton recommends using fuse links in both positive and negative cables, each with adequate voltage rating (as above)

OR

If $N_p \leq 3$ and the cable is rated at 1.56 x I_{sc}

For PV installations with three or less parrallel strings and string cables adequately sized, fusing may be needed if local installation regulations or codes require them

However Eaton recommends fuse links protection in all PV systems as unpredicted fault currents may occur in the event of inverter failure or where batteries are connected to the strings.

OR

If $N_p \leq 3$ and the cable is not rated at 1.56 x I_{sc}

Select fuse link to protect cable:

- **Fuse link current rating ≤ I_z = string cable rating**
- **Voltage rating ≥ 1.20 x V_{oc} x N_s especially if a battery is connected**

String protection — worked example

Once it has been determined that the maximum short-circuit current exceeds the cable's continuous current rating, the recommendations for selecting the correct PV string fuse link are as follows:

Manufacturer's PV Module specifications

PV Module description

- Cell type: polycrystalline sillicon
- Cell size: 125mm² (5")
- Number of cells and connection: 72 in series
- Maximum system voltage: 1000 VDC

Electrical data

- Open circuit voltage (Voc): 43.1 V
- Short-circuit current (Isc) : 5.37 A
- Maximum series fuse rating ($I_{mod\_max\_OCPR}$): 15 A

PV Installation set-up

- 18 modules in series per string (N_s = 18)
- Maximum 60°C module
- Minimum -30°C module
- Maximum 45°C ambient fuse link
- 4 strings in parallel (N_p = 4)
- Cable size: 2.5mm² => cable rating I_z =11.5 A at 60°C (manufacturer's data)

Calculation

- Cable rating ≥ 1.56 x I_{sc} = 1.56 x 5.37 = 8.38 A. Selected cable I_z=11.5 A ⇒ OK
- String max short circuit current I_{sc_string} = (N_p -1) x 1.25* x I_{sc}
  = (4-1) x 1.25* x 5.37
  = 20.1 A

I_{sc_string} (20.1A) > I_z (11.5 A), therefore string fuse links are needed.

- Minimum fuse current rating $I_n \geq 1.56 \times I_{sc}$
  = 1.56 x 5.37 = 8.38 A
- Maximum fuse current rating $I_n \leq I_{mod\_max\_OCPR}$ = 15 A
- Maximum fuse current rating $I_n \leq I_Z$ = 11.5 A
- Minimum fuse voltage rating $U_n \geq 1.2 \times V_{oc} \times N_s$
  = 1.2 x 43.1 x 18 = 931 V

The selected fuse link needs to be rated at 10 A and 1000 V d.c.
Eaton's Bussmann series catalogue is PV-10A10F.
The selected fuse link has current carrying capability of 9.3A at 45°C ambient temperature (see curve page 8), which is greater than the min fuse current rating (8.38 A). Therefore, the fuse link selected will protect the cables and the modules against reverse current faults.

* The ratio of 1.25 allows for current increase in modules due to higher irradiance level and temperature for most applications

Overview of array protection

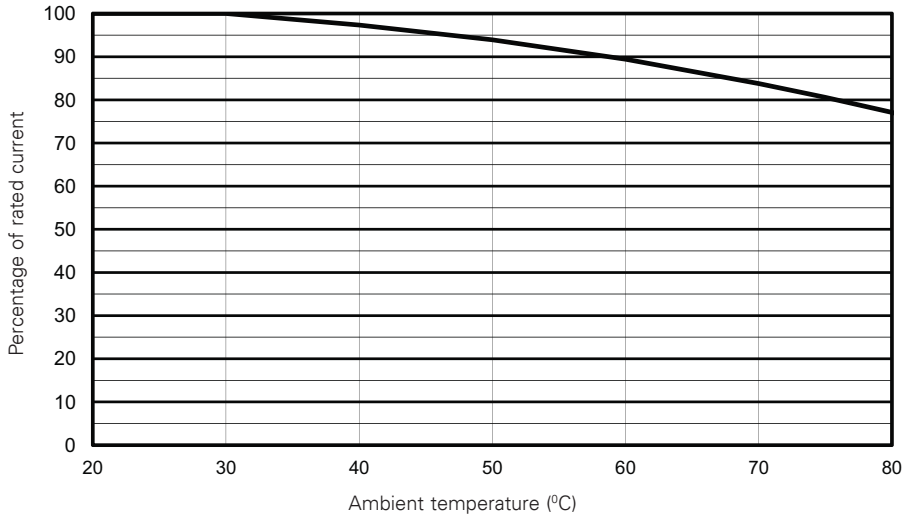
Depending on the desired capacity of the Photovoltaic (PV) system, there may be several PV strings connected in parallel to achieve higher currents and subsequently more power.

A fuse link on each array will protect the cables from fault current and help minimise any safety hazards. It will also isolate the faulted array so that the rest of the PV system can continue to generate electricity.

A fuse link positioned in the cable that carries the combined output of a number of strings should be protected by array fuse links. If a number of arrays are subsequently combined then a further fuse link should be incorporated.

It should be remembered that the characteristics of PV modules vary with module temperature as well as irradiance level. In operation fuse links are influenced by ambient temperature.

PV Array fuse link derating with temperature

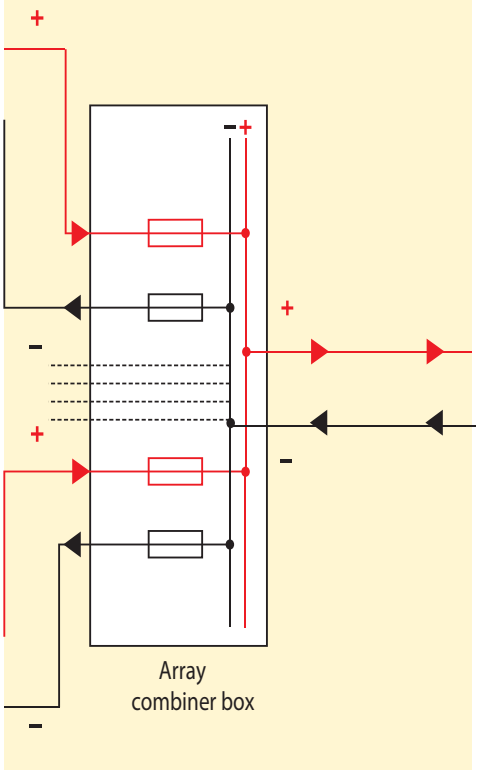


Surge protection devices

NH Style photovoltaic fuse links and fuse holders

XL Style photovoltaic fuse links and fuse bases

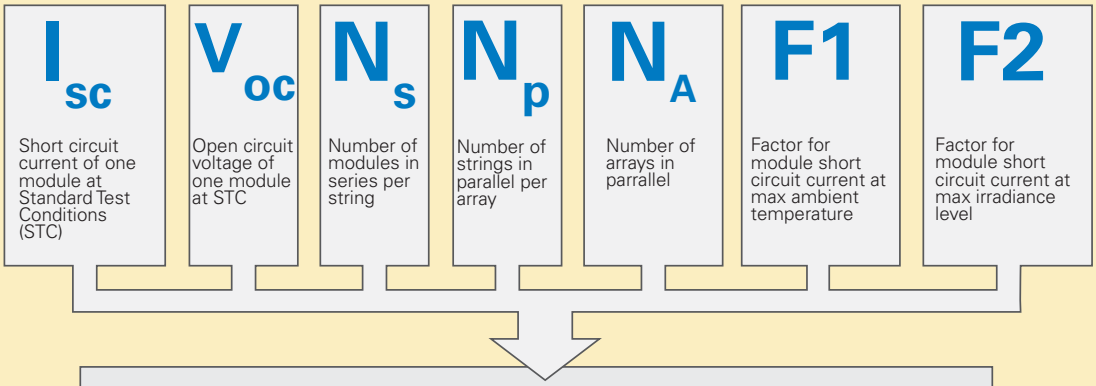
Array protection



How to select fuse links for array protection

Whilst a full study of all the parameters is recommended, in general the following factors should be used: 1.56 for current and 1.2 for voltage when selecting the fuse link. These cover most variations due to installation. If your have concerns that your PV installation may be subject to extremes of high altitude, high irradiance, high or low temperature, please consult Eaton's technical team (bulehighspeedtechnical@eaton.com).

Define PV module specifications



The fuse link's ratings should be selected as follows:

- **Voltage rating ≥ 1.20 x V_{oc} x N_s**
- **Current rating ≥ 1.56 x I_{sc} x N_p**
- **Check the current carrying capability of the selected fuse, after derating at the ambient temperature of the fuse, still satisfies the above criteria**
- **Current rating ≤ I_z = array cable rating**

Eaton recommends using fuse links in both positive and negative cables, each with adequate voltage rating (as above). Selectivity with string fuse links may not be achieved under some fault conditions.

Array protection — worked example

Manufacturer's PV Module specifications

- I_{sc} = 5.37 A
- V_{oc} = 43.1 V
- Temperature coefficient of short circuit current α = 0.053%/°C

PV Installation set-up

- Max irradiance level 1000W/m² => Irradiance factor F2 = 1
- 18 modules in series per string (N_s = 18)
- Maximum 60°C module => Temperature factor F1 = 1+ α x (T - 25°C) = 1.02
- Minimum -30°C module
- Maximum 45°C ambient fuse link. Derating factor for array fuses current carrying capability is 0.95 at 45°C ambient temperature (see page 11).
- Array cable size: 25mm² => cable rating I_z = 98 A at 60°C (Manufacturer's data)
- 8 strings in parallel (N_p = 8)
- 4 arrays in parallel (N_A = 4)

Calculation

- Cable rating ≥ 1.56 x I_{sc} x N_p
  = 1.56 x 5.37 x 8 = 67 A

Selected cable I_z = 98 A ⇒ OK.

- Array max short circuit current I_{sc_Array} = (N_A -1) x N_p x I_{sc} x F1 x F2
  = (4-1) x 8 x 5.37 x 1.02 x 1 = 131 A

I_{sc_Array} (131 A) > I_z (98A), therefore array fuse links are required.

- Minimum fuse current rating I_n ≥ 1.56 x I_{sc} x N_p
  = 1.56 x 5.37 x 8 = 67 A
- Maximum fuse current rating: I_n ≤ I_z = 98 A
- Minimum fuse voltage rating U_n ≥ 1.2 x V_{oc} x N_s
  = 1.2 x 43.1 x 18 = 931 V

The selected fuse link needs to be rated at 80 A and 1000 V d.c. Eaton's Bussmann series part number would be **PV-80ANH1** or **PV-80A-01XL**. The selected fuse link has current carrying capability of 80 x 0.95 = 76 A at 45°C ambient temperature (see curve page 11), which is greater than the min fuse current rating (67 A).

Solar PV fuse links offering specifications

Body type	Body size	Fuse type	Catalogue number	Rated currentt (A)	Rated voltage (V d.c.)	Standards				Data sheet number	Page number
						gPV[1]	UL	CCC	CSA		
Cylindrical	10x38 mm	Ferrule	PVM-(amps)	4 -10, 12, 15, 20, 25, 30 A	600		✓		✓	2153	15
		Ferrule	PV-(amps)A10F	1-3, 3,5, 4-6, 8, 10, 12,15, 20, 25[5] A	1000	✓	✓	✓[2]	✓	720110	16-17
		Bolt fixing	PV-(amps)A10-T								
		PCB (one pin)	PV-(amps)A10-1P								
		PCB (two pins)	PV-(amps)A10-2P								
	14x51 mm	Ferrule	PV-(amps)A14F	15, 20 / 25, 32 A	1100 / 1000	✓	✓	✓[3]	✓[3]	720132	18
	14x65 mm	Ferrule	PV-(amps)A14LF	15, 20 / 25, 32 A	1500 / 1300	✓	✓	✓[3]	✓[3]	720139	19 - 20
		With tags	PV-(amps)A14L-T								
		With 10mm fixings	PV-(amps)A14LF10F								
NH	NH1	NH	PV-(amps)ANH1	32, 40, 50, 63, 80, 100, 110, 125, 160, 175, 200 A	1000	✓	✓	✓[3]	✓	720133	21 - 26
	NH2		PV-(amps)ANH2	160, 200, 250 A							
	NH3		PV-(amps)ANH3	300, 315, 350, 355, 400 A							
Flush end	2	Flush end	PV-(amp)AF2	160, 200, 250 A	1000	✓	✓	✓[3]	✓[3]	5785583	27 - 28
	3		PV-(amp)AF3	315, 355, 400 A						5785584	
Square Body	01XL	Bladed	PV-(amps)A-01XL	63, 80, 100, 125, 160 A	1000	✓	✓	✓[3]	✓[3]	10201	29 - 35
		Bolted	PV-(amps)A-01XL-B								
		Bladed	PV-(amps)A-01XL-15	50, 63, 80, 100, 125, 160[4] A	1500	✓	✓	✓[3]	✓[3]		
		Bolted	PV-(amps)A-01XL-B-15								
	1XL	Bladed	PV-(amps)A-1XL	200 A	1000	✓	✓	✓[3]	✓[3]		
		Bolted	PV-(amps)A-1XL-B								
	1XL	Bladed	PV-(amps)A-1XL-15	100, 125, 160, 200 A	1500	✓	✓	✓[3]	✓[3]		
		Bolted	PV-(amps)A-1XL-B-15								
	2XL	Bladed	PV-(amps)A-2XL	160, 200, 250, 315, 355 A	1000	✓	✓	✓[3]	✓[3]		
		Bolted	PV-(amps)A-2XL-B								
		Bolted	PV-(amps)A-2XL-3B								
		Bladed	PV-(amps)A-2XL-15	125, 160, 200, 250 A	1500	✓	✓	✓[3]	✓[3]		
		Bolted	PV-(amps)A-2XL-B-15								
		Bolted	PV-(amps)A-2XL-3B-15								
	3L	Bladed	PV-(amps)A-3L	350, 400, 500, 600 A	1000	✓	✓	✓[3]	✓[3]		
		Bolted	PV-(amps)A-3L-B								
		Bladed	PV-(amps)A-3L-15	250, 315, 355, 400 A	1500	✓	✓	✓[3]	✓[3]		
		Bolted	PV-(amps)A-3L-B-15								

[1] IEC 60269-6, [2]1 to 15A only, [3] Pending, [4] 160A rated 1200V d.c., [5] Catalogue number PV10M-25

Fuse holders & blocks

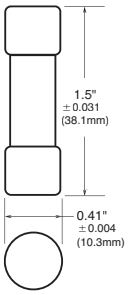
Fuse size	Holder/ Block series	Catalogue number	Poles	Rated voltage (V d.c.)	Description	Data sheet Number
10x38 mm	CHPV	CHPV1U	1	600 / 1000	IP20 Finger-safe holder	720147
		CHPV1IU	1		IP20 Finger-safe holder with indication	
		CHPV2U	2		IP20 Finger-safe holder	
		CHPV2IU	2		IP20 Finger-safe holder with indication	
	BM	BM6031 (Terminal type)	1		Open fuse blocks	1104
		BM6032 (Terminal type)	2			
		BM6033 (Terminal type)	3			
	HPV	HEB (Loadside and lineside terminal)	N/A		In-line fuse holders	2157
14x51 mm	CH14	CHPV141U / CHPV141IU	1	1000[1]	IP20 Finger-safe holder	2053
NH1	SD-D	SD1-D-PV	1	1500[1]	IP20 Finger-safe holder[2]	720149
NH2		SD2-D-PV	1			
NH3		SD3-D-PV	1			
01XL	SD	SB1XL-S	1	1500	Block	720146
1XL		SB1XL-S	1			
2XL		SB2XL-S	1			
3L		SB3L-S	1			

[1] Self certified.
[2] Requires range of protection accessories.

10 x 38 mm photovoltaic fuse links, 4 to 30 A, 600 V d.c., PVM series

Description

A range of UL 2579 fast-acting 600 V d.c. Midget fuses specifically designed to protect solar power systems in extreme ambient temperature, high cycling and low level fault current conditions (reverse current, multi-array fault).



Catalogue number

PVM-(amp rating)

Fuse size

10 x 38 mm

Standard/Approvals

UL Listed 2579, Guide JFGA, File E335324, CSA Component Certified C22.2

Packaging

10

Technical data

Voltage:	600 V d.c. to UL 2579
Current:	4-30 A
Interrupting rating:	50 kA DC

Recommended fuse blocks / fuse holders

- Open fuse blocks:
  - BM Series (data sheet 1104)
- Modular fuse holder:
  - CHPV 1000 V d.c. (data sheet 720147)
- Fuseclips:
  - 1A3400 Series (data sheet 2131)
- In-line fuse holders:
  - HPV Series (data sheets 2157)

Catalogue numbers

Catalogue number	Rated current (A)	Rated voltage (V d.c.)
PVM-4	4	600 (UL)
PVM-5	5	
PVM-6	6	
PVM-7	7	
PVM-8	8	
PVM-9	9	
PVM-10	10	
PVM-12	12	
PVM-15	15	
PVM-20	20	
PVM-25	25	
PVM-30	30	

Power loss (Watts)

Catalogue number	Rated current (A)	Power loss (Watts)	
		0.8 I_n	I_n
PVM-10	10	1.04	1.86
PVM-15	15	1	1.72
PVM-30	30	1.65	2.91

BM Series

CHPV

1A3400

HPV

Data sheet: 2153

10 x 38 mm photovoltaic fuse links, 1 to 25 A, 1000 V d.c., PV-A10 series

Description

A range of fuse links in a 10 x 38 mm package specifically designed for the protection and isolation of photovoltaic strings. The fuse links are capable of interrupting low overcurrents associated with faulted PV (reverse current, multi-array fault) strings.

Catalogue number

PV-(amp rating)A10F (Cylindrical)

PV-(amp rating)A10-T (Bolt Fixing)

PV-(amp rating)A10-1P (PCB fixing 1 pin)

PV-(amp rating)A10-2P (PCB fixing 2 pin)

Class of operation
gPV

Fuse size
10 x 38 mm

Standards/Approvals

IEC 60269-6, UL 2579

(File number E335324)

CCC (1 to 15A), RoHS compliant

Packaging

MOQ: 10

Packaging 100% recyclable

Technical data

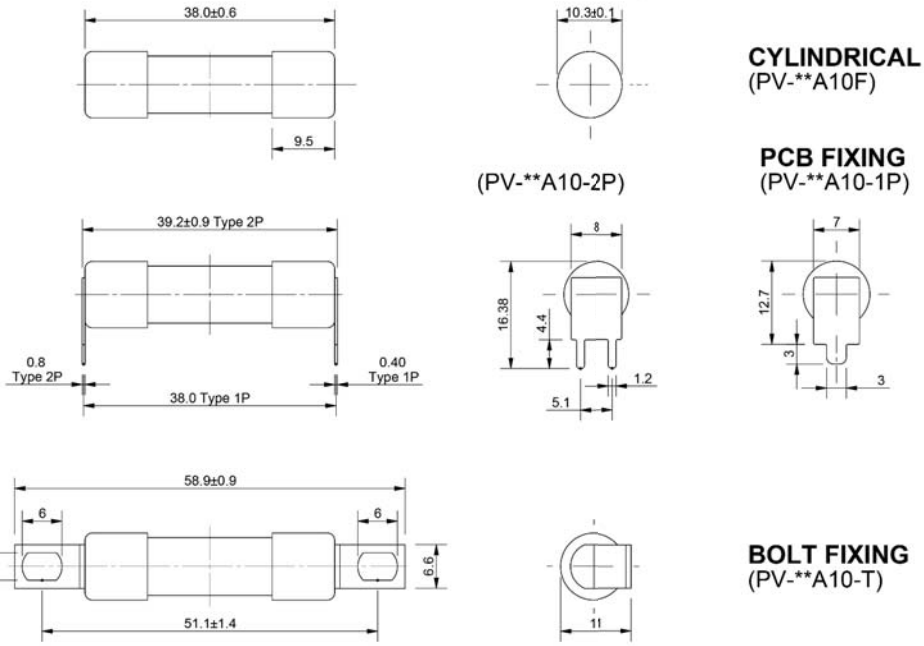
Rated voltage	1000 V d.c.
Rate current	1-3, 3.5, 4-6, 8, 10, 12, 15, 20, 25 A
Rated breaking capacity	50 kA (1 to 20 A), 20 kA (25 A only)
Min interrupting rating	1.3 x I_n for 1-15 A, 1.5 x I_n for 20 A, 2 x I_n for 25 A
PV Fuse coordination w/	Thin film cells and 4", 5" and 6" crystalline silicon cells
Time constant	1-3 ms

Dimensions — mm

Cylindrical

PCB Fixing

Bolt Fixing



Data sheet: 720110

10 x 38 mm photovoltaic fuse links, 1 to 25 A, 1000 V d.c., PV-A10 series

Technical data

Cylindrical catalogue number	Bolt fixing catalogue number	PCB fixing catalogue number (1 Pin)	PCB fixing catalogue number (2 Pin)	Rated current (A)	Rated voltage (V d.c.)	Energy integrals I^2t (A^2s)		Watts loss (W)	
						Pre-arcing	Total at 1000 V d.c.	0.8 I_n	I_n
PV-1A10F	PV-1A10-T	PV-1A10-1P	PV-1A10-2P	1	1000 (IEC/UL)	0.15	0.4	0.8	1.5
PV-2A10F	PV-2A10-T	PV-2A10-1P	PV-2A10-2P	2		1.2	3.4	0.6	1.0
PV-3A10F	PV-3A10-T	PV-3A10-1P	PV-3A10-2P	3		4	11	0.8	1.3
PV-3-5A10F	PV-3-5A10-T	PV-3-5A10-1P	PV-3-5A10-2P	3.5		6.6	18	0.9	1.4
PV-4A10F	PV-4A10-T	PV-4A10-1P	PV-4A10-2P	4		9.5	26	1.0	1.5
PV-5A10F	PV-5A10-T	PV-5A10-1P	PV-5A10-2P	5		19	50	1.0	1.6
PV-6A10F	PV-6A10-T	PV-6A10-1P	PV-6A10-2P	6		30	90	1.1	1.8
PV-8A10F	PV-8A10-T	PV-8A10-1P	PV-8A10-2P	8		3	32	1.2	2.1
PV-10A10F	PV-10A10-T	PV-10A10-1P	PV-10A10-2P	10		7	70	1.2	2.3
PV-12A10F	PV-12A10-T	PV-12A10-1P	PV-12A10-2P	12		12	120	1.5	2.7
PV-15A10F	PV-15A10-T	PV-15A10-1P	PV-15A10-2P	15		22	220	1.7	2.9
PV-20A10F	PV-20A10-T	PV-20A10-1P	PV-20A10-2P	20		34	350	2.1	3.6
PV10M-25	-	-	-	25		325	1860	1.65	2.91

Recommended fuse blocks / fuse holders

- Open fuse blocks:
  - BM Series (data sheet 1104), self certified for 1000 V d.c.
- Modular fuse holders:
  - CHPV (data sheet 720147)
- Fuseclips:
  - 1A3400 Series (data sheet 2131)
- In-Line fuse holders:
  - HPV Series (data sheet 2157)

BM Series

CHPV

1A3400

HPV

14 x 51 mm photovoltaic fuse links, 15 to 32 A, 1000/1100 V d.c., PV-A14F series

Description

A range of 14 x 51 mm fuse links specifically designed for protecting and isolating photovoltaic strings. These fuse links are capable of interrupting low overcurrents associated with faulted PV systems (reverse current, multi-array fault).

Catalogue number

PV-(amp rating)A14F

Class of operation

gPV

Fuse size

14 x 51 mm

Standards / Approvals

IEC 60269-6, UL 2579

(File number E335324)

RoHS compliant, pending CCC

Packaging

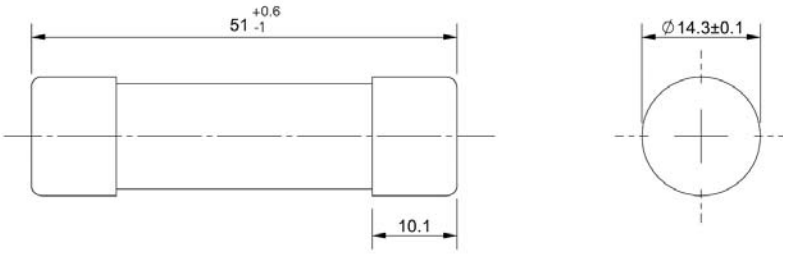
MOQ: 10

Packaging 100% recyclable.

Technical data

Rated voltage	1100 V d.c. IEC/UL (15 & 20A) 1000 V d.c. IEC/UL (25 & 32A)
Rated current	15-32 A
Rated breaking capacity	10 kA
Min interrupting rating	1.5 x I_n for 15-20 A, 1.75 x I_n for 25 - 32 A
PV Fuse coordination w/	Thin film cells and 4", 5" and 6" crystalline silicon cells
Time constant	1-3 ms

Dimensions — mm



Catalogue number	Rated current (A)	Rated voltage (V d.c.)	Energy integrals I^2t (A^2s)		Watts loss (W)	
			Pre-arcing	Total at rated voltage	0.8 I_n	I_n
PV-15A14F	15	1100	14	265	2.1	4
PV-20A14F	20		27	568	2.7	5
PV-25A14F	25	1000	65	943	2.7	5.1
PV-32A14F	32		120	1740	3.3	6.2

Recommended fuse holders

- Finger-safe fuse holders:
  - Without indicator: CHPV141U
  - With indicator: CHPV141IU

Data sheet: 720132

14 x 65 mm photovoltaic fuse links, 3.5 to 32 A, 1300/1500 V d.c., PV-A14L series

Description

A range of 14 x 65mm fuse links specifically designed for protecting and isolating photovoltaic strings. These fuse links are capable of interrupting low overcurrents associated with faulted PV systems (reverse current, multi-array fault).

Technical data

Rated voltage	1300 V d.c. IEC/UL (25 & 32A) 1500 V d.c. IEC/UL (15 & 20A)
Rate current	3.5, 15, 20, 25 and 32 A
Rated breaking capacity	10 kA
Min interrupting rating	2 x I_n
PV Fuse coordination w/	Thin film cells and 4", 5" and 6" crystalline silicon cells
Time constant	1-3 ms

Catalogue number

Cylindrical
PV-(amp rating)A14LF

Cylindrical with tags
PV-(amp rating)A14L-T

Cylindrical with 10mm fixings:
PV-(amp rating)A14LF10F

Class of operation

gPV

Fuse size

14 x 65 mm

Standards / Approvals

IEC 60269-6, UL 2579

(File number E335324)

RoHS compliant, pending CCC

Accessories

Fuse clips: 5592-01 for -LF
5960-07/5960-09 for -10F

Packaging

MOQ: 10

Packaging 100% recyclable.

Catalogue number					Energy integrals I^2t (A^2s)		Watts loss (W)	
Cylindrical	Cylindrical with tags	Cylindrical with 10mm fixings	Rated current (A)	Rated voltage (V d.c.)	Pre-arcing	Total at rated voltage	0.8 I_n	I_n
PV-3.5A14LF	N/A	PV-3.5A14LF10F	3.5	1500	7	26	1.8	3.3
PV-15A14LF	PV-15A14L-T	PV-15A14LF10F	15		16	190	2.9	5.1
PV-20A14LF	PV-20A14L-T	PV-20A14LF10F	20		34	400	3.8	6.9
PV-25A14LF	PV-25A14L-T	PV-25A14LF10F	25	1300	65	550	4.1	7.5
PV-32A14LF	PV-32A14L-T	PV-32A14LF10F	32		105	900	5.7	10.4

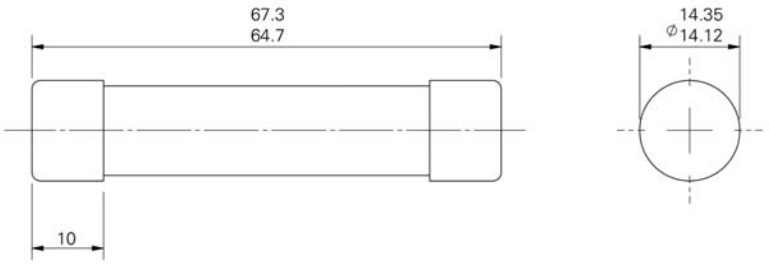
Recommended fuse holder

- CHPV15V85 for PV-xxA14LF10F only

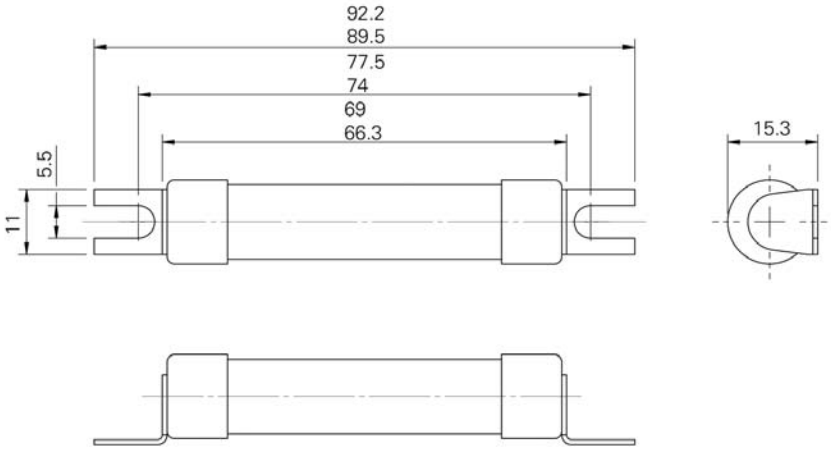
Data sheet: 720139

14 x 65 mm photovoltaic fuse links, 15 to 32 A, 1300/1500 V d.c., PV-A14L series

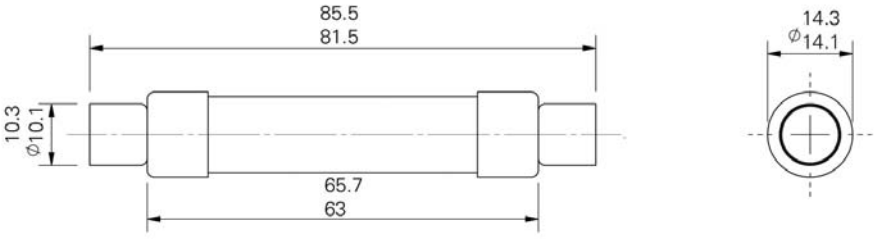
Dimensions - mm



Cylindrical PV-(amp rating)A14LF



Cylindrical with Tags PV-(amp rating)A14L-T



Cylindrical with 10mm Fixings PV-(amp rating)A14LF10F

Data sheet: 720139

NH Photovoltaic fuse links, 32 to 400 A, 1000 V d.c., PV-ANH series

Description

A range of NH size fuse links specifically designed for protecting and isolating photovoltaic array combiners and DC disconnects. These fuse links are capable of interrupting low overcurrents associated with faulted PV systems (reverse current, multi-array fault).

Catalogue number

PV-(amp rating)ANH(size)

Class of operation

gPV

Fuse size

NH Size 1, 2 and 3

Optional microswitches

170H0236, 170H0238

Standards / Approvals

IEC 60269-6, UL 2579

(File number E335324)

CSA Listed

RoHS compliant, pending CCC

Packaging

MOQ: 3

Packaging 100% recyclable.

Technical data

Rated voltage	1000 V d.c.
Rated current	32–400 A
Rated breaking capacity	50kA
Time constant	1-3ms

Fuse size	Rated current (A)	Rated voltage (V d.c.)	Energy integrals I^2t (A^2s)		Watts loss (W)		Catalogue number		
			Pre-arcing	Total at 1000 V d.c.	0.8 I_n	I_n	Blade without bolt holes	Blade with bolt holes	Blade with bolt holes and lugs
NH1	32	1000 (IEC/UL)	80	720	4.3	8.5	PV-32ANH1		
	40		185	1670	4.6	9	PV-40ANH1		
	50		400	3600	5.4	10.5	PV-50ANH1		
	63		470	4300	6.1	12	PV-63ANH1		
	80		640	5760	7.9	15.5	PV-80ANH1		
	100		1300	11700	8.4	16.5	PV-100ANH1		
	110		2100	18900	9	18.5	PV-110ANH1		
	125		2600	23400	8.9	17.5	PV-125ANH1		
	160		5200	46800	12.2	24	PV-160ANH1		
	175		8300	74700	15	29	PV-175ANH1		
	200		10200	82000	13	25	PV-200ANH1		
NH2	160		4600	37000	14	28	PV-160ANH2		
	200		9500	76000	16	32	PV-200ANH2		
	250		26000	129000	23	35	PV-250ANH2		
NH3	300		32500	260000	27	44	PV-300ANH3		
	315		32500	260000	27	44	PV-315ANH3		
	350		51600	412800	28	46	PV-350ANH3		
	355		51600	412800	28	46	PV-355ANH3		
	400		76000	608000	30	50	PV-400ANH3		
NH1	63	1000 (IEC/UL)	470	4300	6	12		PV-63ANH1-B	PV-63ANH1-BL
	80		640	5760	8	15		PV-80ANH1-B	PV-80ANH1-BL
	100		1300	11700	8	16		PV-100ANH1-B	PV-100ANH1-BL
	125		2600	23400	9	17		PV-125ANH1-B	PV-125ANH1-BL
	160		5200	46800	14	27		PV-160ANH1-B	PV-160ANH1-BL
	200		10200	82000	13	25		PV-200ANH1-B	PV-200ANH1-BL
NH2	160		4600	37000	14	28		PV-160ANH2-B	PV-160ANH2-BL
	200		9500	76000	16	32		PV-200ANH2-B	PV-200ANH2-BL
	250		17000	136000	19	38		PV-250ANH2-B	PV-250ANH2-BL
NH3	315		32000	260000	26	44		PV-315ANH3-B	PV-315ANH3-BL
	355		38000	310000	29	48		PV-355ANH3-B	PV-355ANH3-BL
	400		61000	490000	32	50		PV-400ANH3-B	PV-400ANH3-BL

Data sheet: 720133

NH Photovoltaic fuse links, 32 to 400 A, 1000 V d.c., PV-ANH series

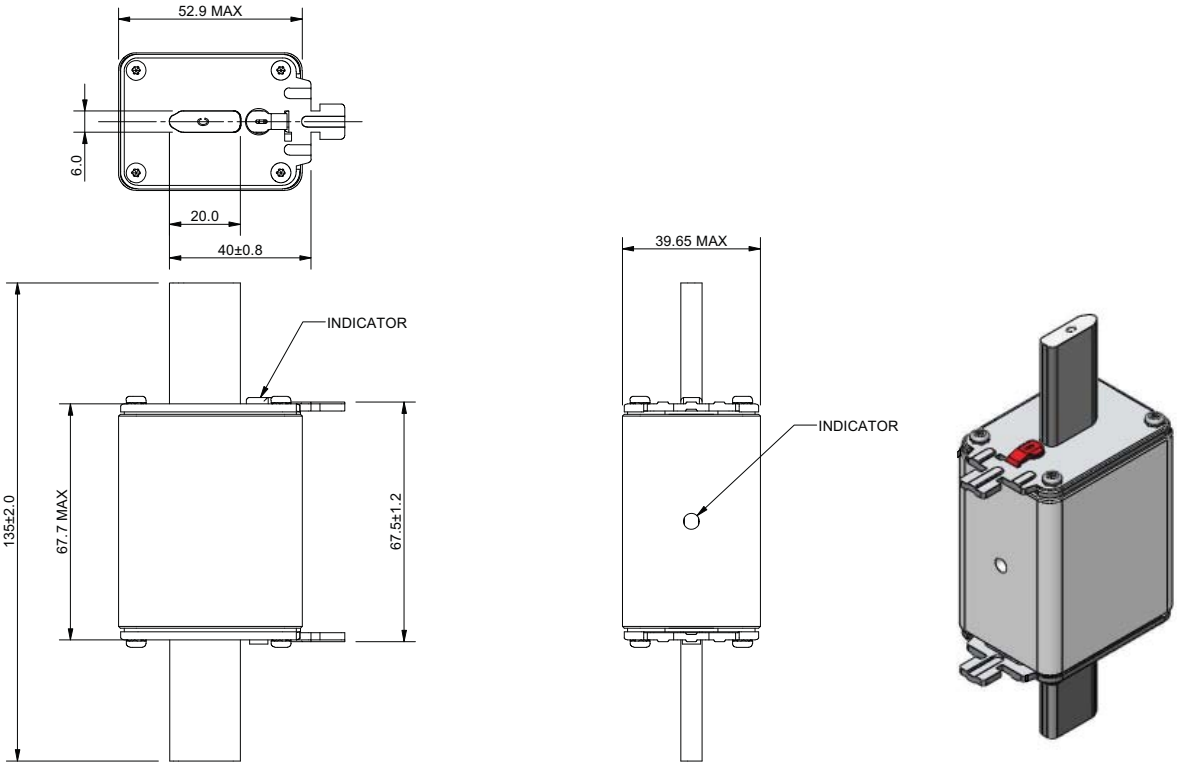
Recommended fuse bases

- SD(size)-D-PV single-pole, certified at 1500V d.c. (data sheet 720149)

Recommended microswitches

- 170H0236 or 170H0238

Dimensions - blade without bolt holes - mm

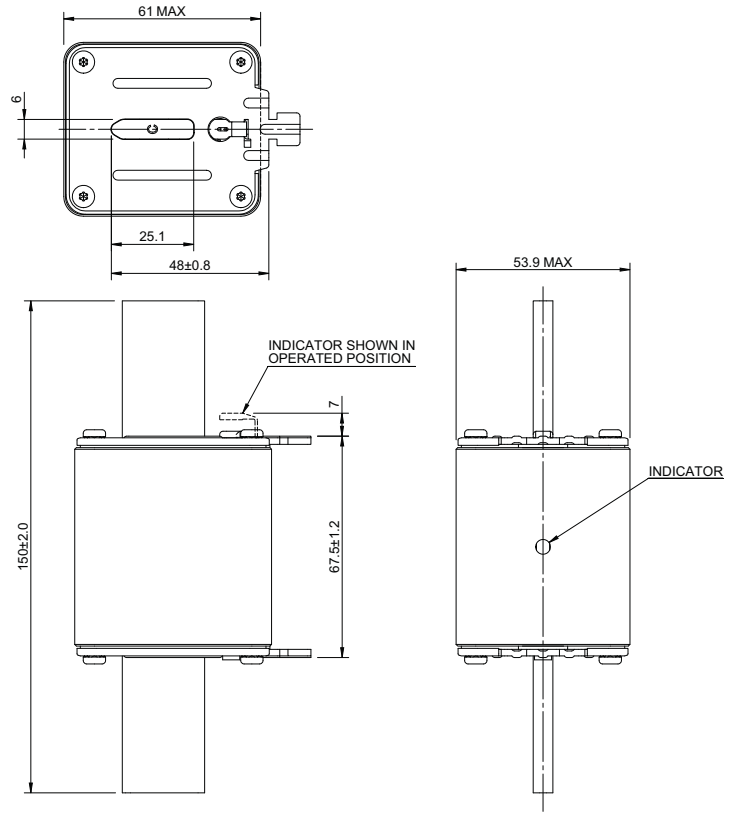


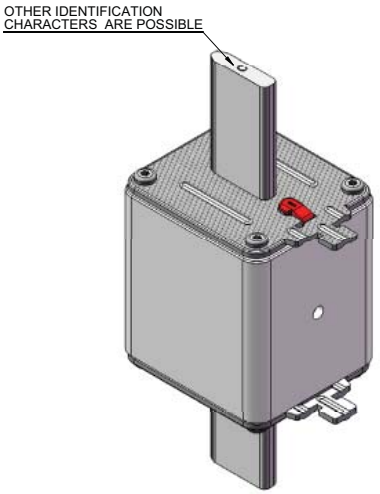
NH Size 1

Data sheet: 720133

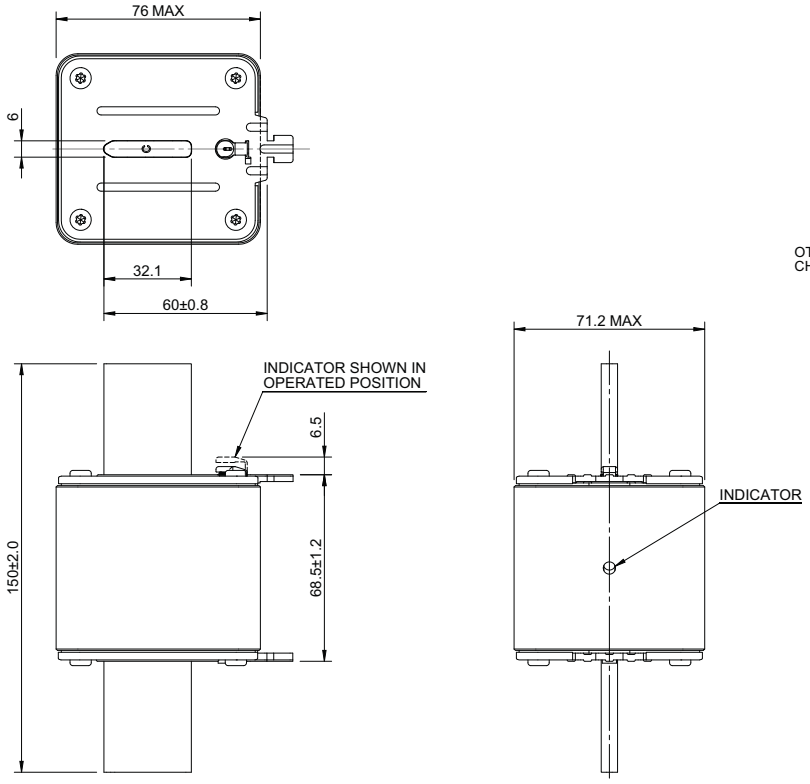
NH Photovoltaic fuse links, 32 to 400 A, 1000 V d.c., PV-ANH series

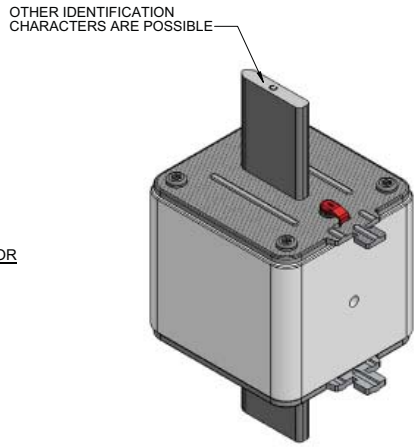
Dimensions - blade without bolt holes - mm





NH Size 2



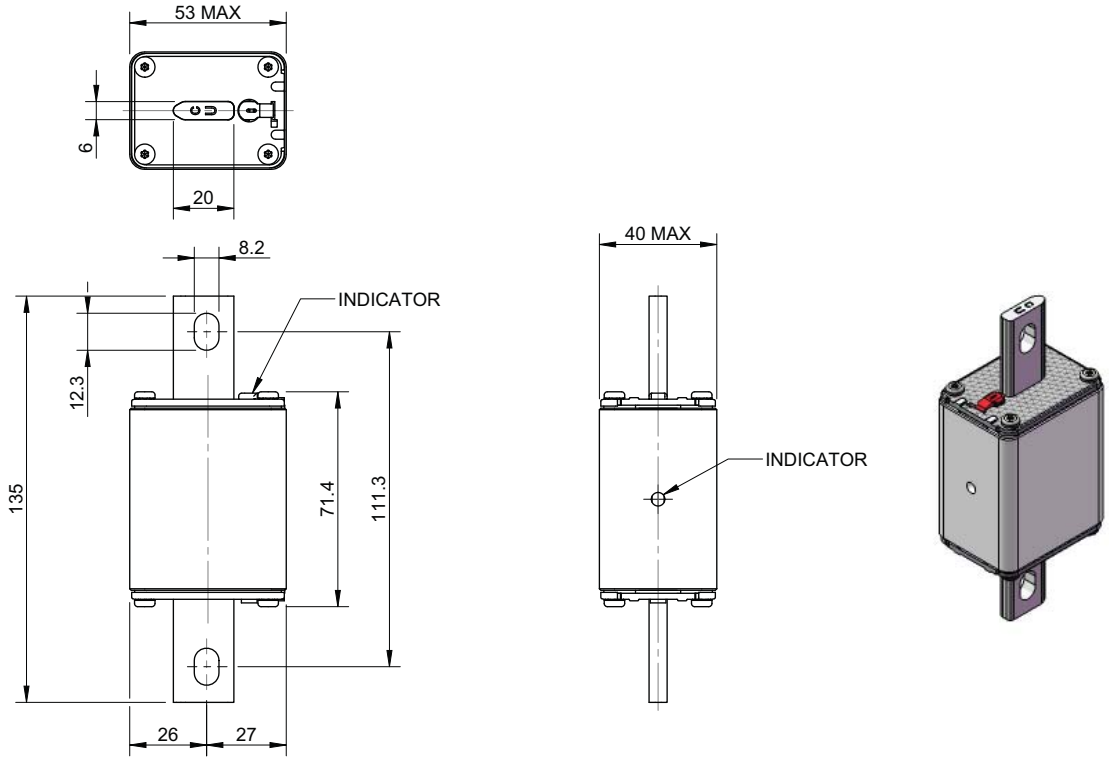


NH Size 3

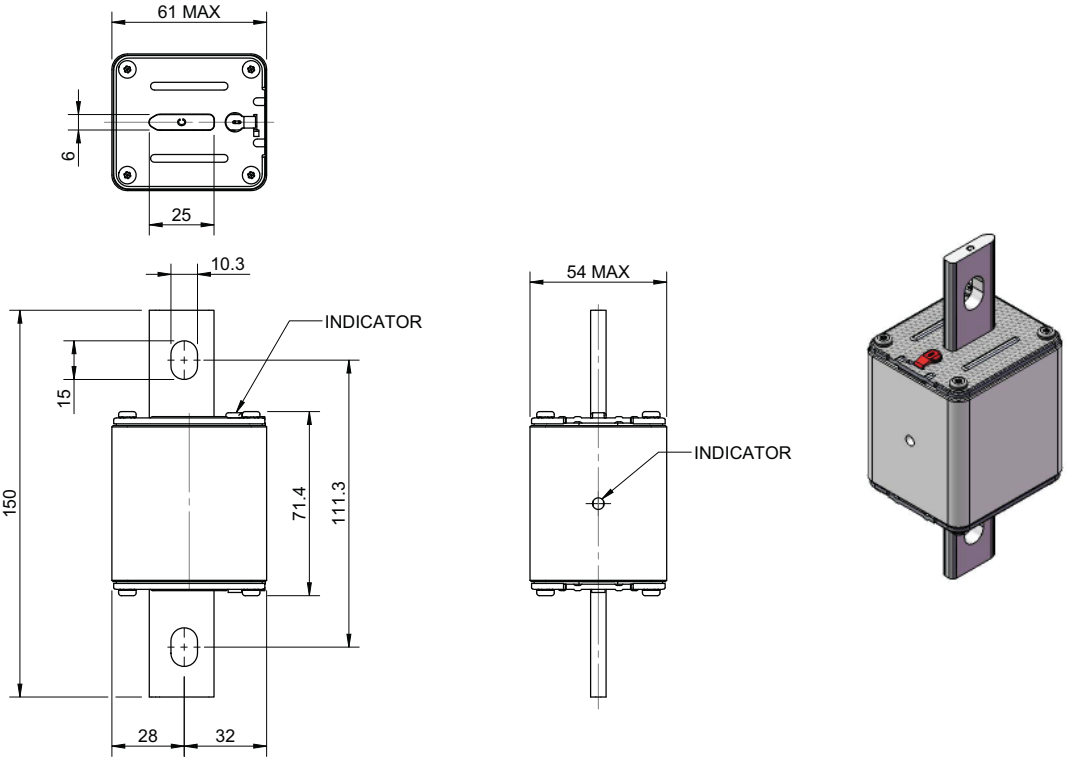
Data sheet: 720133

NH Photovoltaic fuse links, 32 to 400 A, 1000 V d.c., PV-ANH series

Dimensions - Blade with bolt holes - mm



NH Size 1

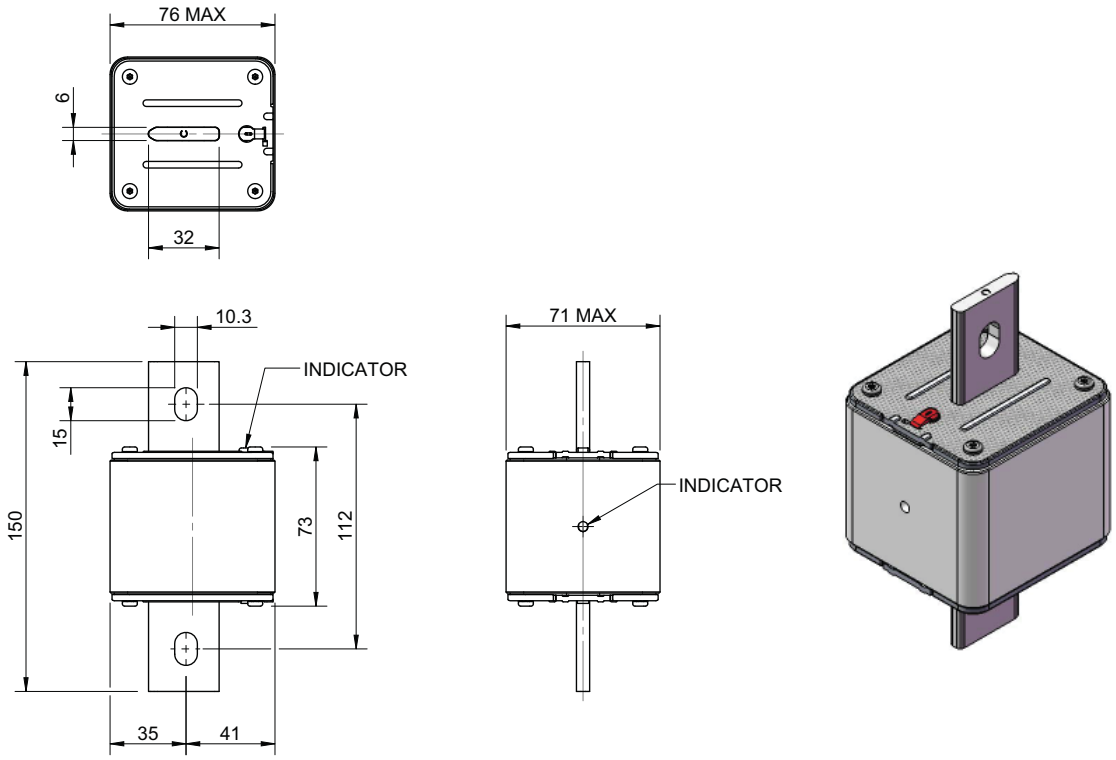


NH Size 2

Data sheet: 720133

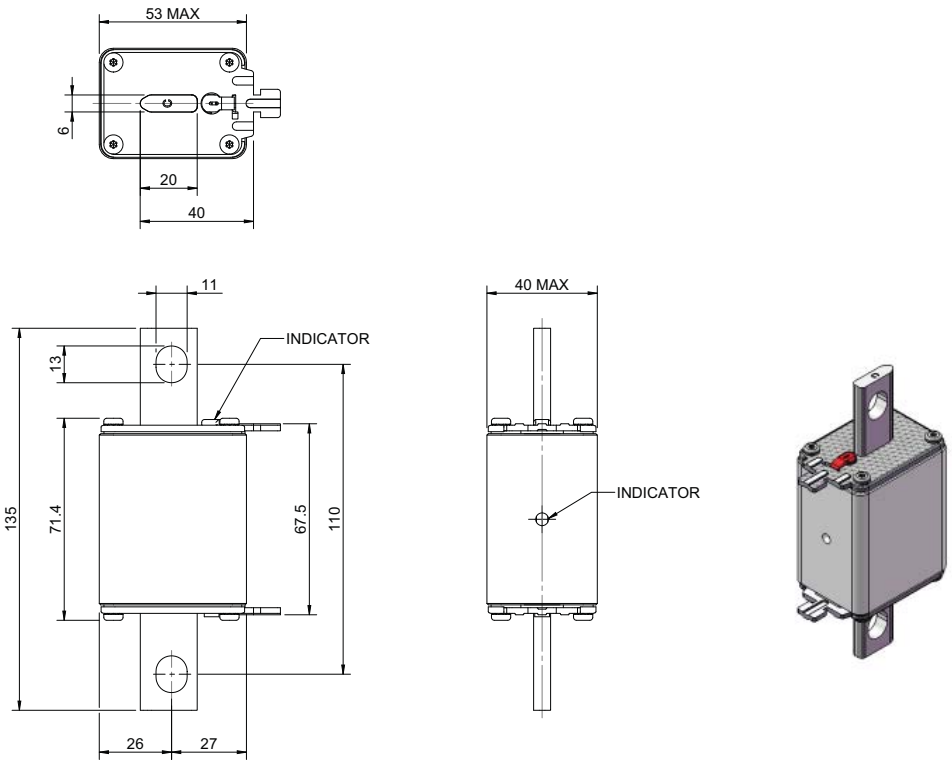
NH Photovoltaic fuse links, 32 to 400 A, 1000 V d.c., PV-ANH series

Dimensions - Blade with bolt holes - mm



NH Size 3

Dimensions - Blade with bolt holes and lugs - mm

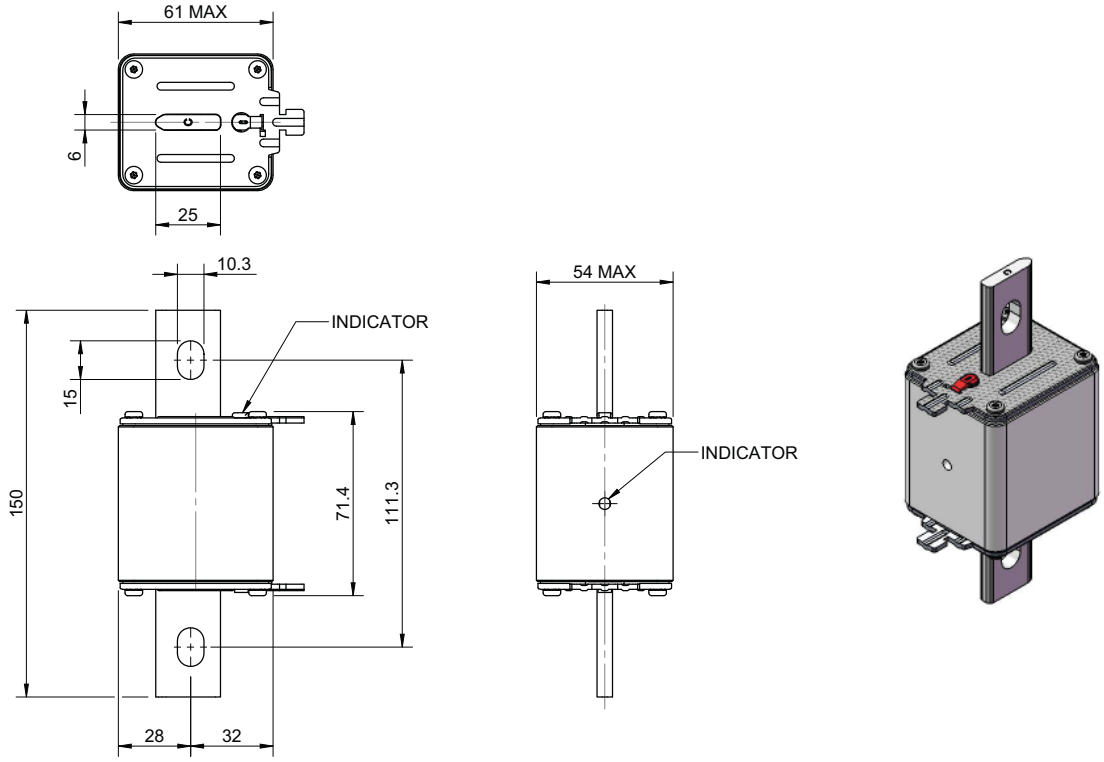


NH Size 1

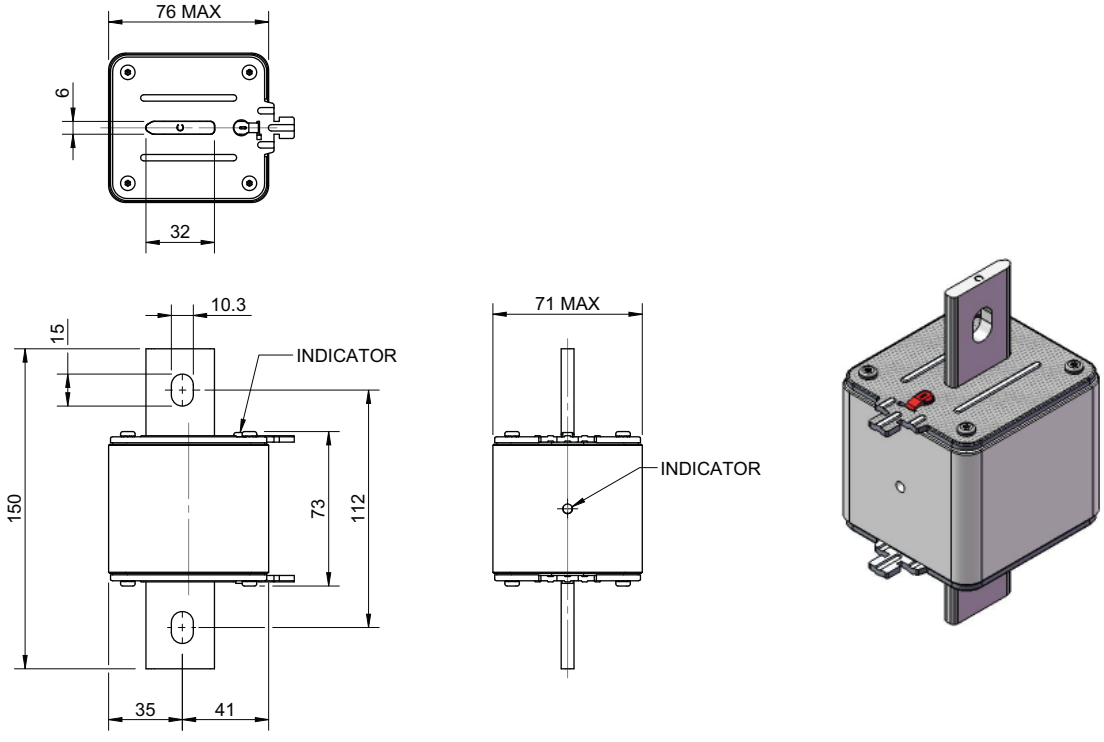
Data sheet: 720133

NH Photovoltaic fuse links, 32 to 400 A, 1000 V d.c., PV-ANH series

Dimensions - Blade with bolt holes and lugs - mm



NH Size 2



NH Size 3

Data sheet: 720133

PV Flush end, 160 to 400 A, 1000 V d.c., PV-AF Series

Description

A range of flush end package fuse links specifically designed for protecting and isolating photovoltaic array combiners and disconnects. These fuse links are capable of interrupting low overcurrents associated with faulted PV systems (reverse current, multi-array fault).

Catalogue number

PV-(amp rating)AF2 - size 2

PV-(amp rating)AF3 - size 3

Class of operation

gPV

Fuse size

2 and 3

Optional microswitches

- 170H0069

Standards / Approvals

Tested to IEC 60269-6,
RoHS compliant, pending UL, CCC and CSA

Packaging

MOQ: 2 for size 2 (PV-xAF2), 1 for size 3 (PV-xAF3)

Packaging 100% recyclable.

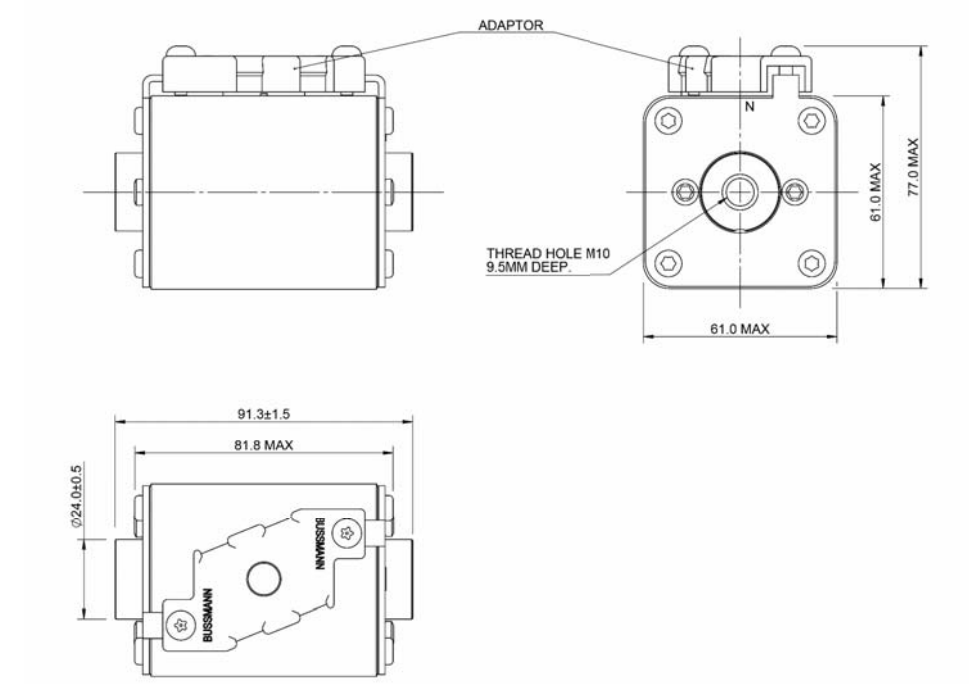
Technical Data

				Energy integrals I^2t (A^2s)		Watts loss (W)	
Catalogue number	Body size	Rated current (A)	Rated voltage (V d.c.)	Pre-arcing	Total at 1000 V d.c.	0.8 I_n	I_n
PV-160AF2	2	160	1000	4600	37000	15	30
PV-200AF2		200		9500	76000	17	34
PV-250AF2		250		17000	136000	19	38
PV-315AF3	3	315	1000	27000	240000	30	49
PV-355AF3		355		37000	350000	31	51
PV-400AF3		400		61500	550000	32	52

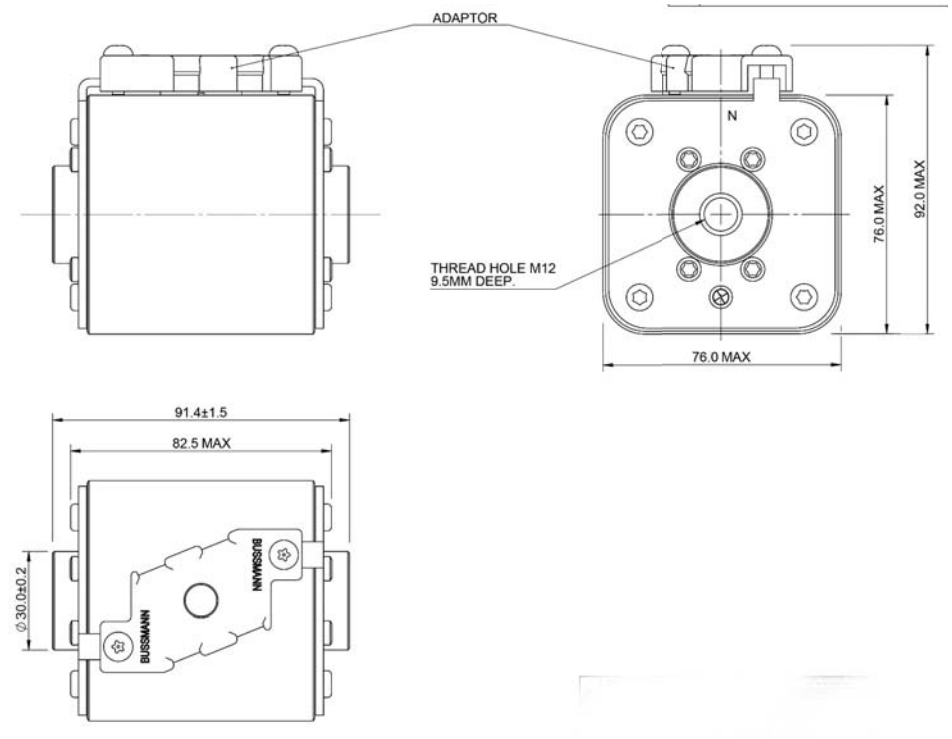
Data sheet: 10370

PV Flush end, 160 to 400 A, 1000 V d.c., PV-AF Series

Dimensions - mm



Flush end - size 2



Flush end - size 3

Data sheet: 10370

XL Style photovoltaic fuse links, 50 to 600 A, 1000/1500 V d.c., PV-XL series

Description

A range of XL package fuse links specifically designed for protecting and isolating photovoltaic array combiners and disconnects. These fuse links are capable of interrupting low overcurrents associated with faulted PV systems (reverse current, multi-array fault).

Catalogue number

PV-(amp rating)A-(size)XL (1000 V d.c. Bladed)

PV-(amp rating)A-(size)XL-B (1000 V d.c. Bolted)

PV-(amp rating)A-2XL-3B[1] (1000 V d.c. Bolted)

PV-(amp rating)A-(size)XL-15 (1500 V d.c. Bladed)

PV-(amp rating)A-(size)XL-B-15 (1500 V d.c. Bolted)

PV-(amp rating)A-2XL-3B-15[1] (1500 V d.c. Bolted)

Class of operation

gPV

Fuse size

01XL, 1XL, 2XL and 3L

Standards / Approvals

IEC 60269-6, UL 2579

(File number E335324)

RoHS compliant, pending CCC and CSA

Packaging

MOQ: 1

Packaging 100% recyclable.

Technical data

Rated Voltage/ Rated breaking capacity	1000 V d.c.	Size 01 and 3 Size 1 and 2	50 kA 33 kA
	1500 V d.c.	Size 01 to 3	30 kA
Current	50 – 600 A		
Min interrupting rating	2 x I_n		
Time constant	1-3 ms		

Recommended single-pole fuse bases

- SB1XL-S (suitable for 01 and 1XL)
- SB2XL-S (suitable for 2XL)
- SB3L-S (suitable for 3L).

Data Sheet 720146

SD_XL-S

Optional microswitches

For Bladed fuse links:

- 170H0235 or 170H0237 for 01XL
- 170H0236 or 170H0238 for 1XL, 2XL and 3L

For Bolted fuse links:

- 170H0069 for all sizes.

170H0236

170H0069

[1] PV-*A-2XL-3B and PV-*A-2XL-3B-15 have revised bolting patterns, which are identical to size 3L bolting pattern. This allows utilisation of both size 2XL and size 3L fuse links without changing the dimensional layout of the inverter, combiners and disconnects.

Data sheet: 10201

XL Style photovoltaic fuse links, 50 to 600 A, 1000/1500 V d.c., PV-XL series

Technical Data - 1000 V d.c.

Catalogue number					Energy integrals I^2t (A^2s)		Watts loss (W)	
Bladed version	Bolted version	Body size	Rated current (A)	Rated voltage (V d.c.)	Pre-arcing	Total at 1000 V d.c.	0.8 I_n	I_n
PV-63A-01XL	PV-63A-01XL-B	01	63	1000 (IEC/UL)	260	1900	13	24
PV-80A-01XL	PV-80A-01XL-B		80		490	3600	17	29
PV-100A-01XL	PV-100A-01XL-B		100		870	6300	18	32
PV-125A-01XL	PV-125A-01XL-B		125		1930	13,900	20	40
PV-160A-01XL	PV-160A-01XL-B		160		3900	28,100	22	44
PV-200A-1XL	PV-200A-1XL-B	1	200		9400	27,260	31	60
PV-160A-2XL	PV-160A-2XL-B	2	160		2780	21,000	25	44
PV-200A-2XL	PV-200A-2XL-B		200		4950	37,000	28	50
PV-250A-2XL	PV-250A-2XL-B		250		9450	70,000	34	60
PV-315A-2XL	PV-315A-2XL-B		315		16,600	123,000	40	66
PV-355A-2XL	PV-355A-2XL-B		355		26,000	192,000	42	68
	PV-160A-2XL-3B[1]		160		2780	21,000	25	44
	PV-200A-2XL-3B[1]		200		4950	37,000	28	50
	PV-250A-2XL-3B[1]		250		9450	70,000	34	60
	PV-315A-2XL-3B[1]		315		16,600	123,000	40	66
	PV-355A-2XL-3B[1]		355		26,000	192,000	42	68
PV-350A-3L	PV-350A-3L-B	3	350		31,000	161,200	40	65
PV-400A-3L	PV-400A-3L-B		400		44,500	231,400	48	82
PV-500A-3L	PV-500A-3L-B		500		85,000	442,000	50	85
PV-600A-3L	PV-600A-3L-B		600		137,000	712,400	80	108

Technical Data - 1500 V d.c.

Catalogue number					Energy integrals I^2t (A^2s)		Watts loss (W)	
Bladed version	Bolted version	Body size	Rated current (A)	Rated voltage (V d.c.)	Pre-arcing	Total at 1500 V d.c.	0.8 I_n	I_n
PV-50A-01XL-15	PV-50A-01XL-B-15	01	50	1500 (IEC/UL)	175	1000	14	25
PV-63A-01XL-15	PV-63A-01XL-B-15		63		362	2250	15	26
PV-80A-01XL-15	PV-80A-01XL-B-15		80		565	3300	19	35
PV-100A-01XL-15	PV-100A-01XL-B-15		100		1100	6600	22	40
PV-125A-01XL-15	PV-125A-01XL-B-15		125		2200	10,500	24	44
PV-160A-01XL-12[2]	PV-160A-01XL-B-12[2]		160	1200 (IEC/UL)	5000	24,000	26	52
PV-100A-1XL-15	PV-100A-1XL-B-15	1	100	1500 (IEC/UL)	1250	6000	24	43
PV-125A-1XL-15	PV-125A-1XL-B-15		125		1950	9360	25	52
PV-160A-1XL-15	PV-160A-1XL-B-15		160		4350	20,880	26	54
PV-200A-1XL-15	PV-200A-1XL-B-15		200		9400	45,120	31	60
PV-125A-2XL-15	PV-125A-2XL-B-15	2	125		2200	15,000	25	44
PV-160A-2XL-15	PV-160A-2XL-B-15		160		5000	32,000	29	48
PV-200A-2XL-15	PV-200A-2XL-B-15		200		8800	51,000	32	57
PV-250A-2XL-15	PV-250A-2XL-B-15		250		16,600	85,000	40	70
	PV-125A-2XL-3B-15[1]		125		2200	15,000	25	44
	PV-160A-2XL-3B-15[1]		160		5000	32,000	29	48
	PV-200A-2XL-3B-15[1]		200		8800	51,000	32	57
	PV-250A-2XL-3B-15[1]		250		16,600	85,000	40	70
PV-250A-3L-15	PV-250A-3L-B-15	3	250		22,300	92,000	32	50
PV-315A-3L-15	PV-315A-3L-B-15		315		38,000	160,000	36	66
PV-355A-3L-15	PV-355A-3L-B-15		355		44,500	184,000	44	80
PV-400A-3L-15	PV-400A-3L-B-15		400		58,000	240,000	49	91

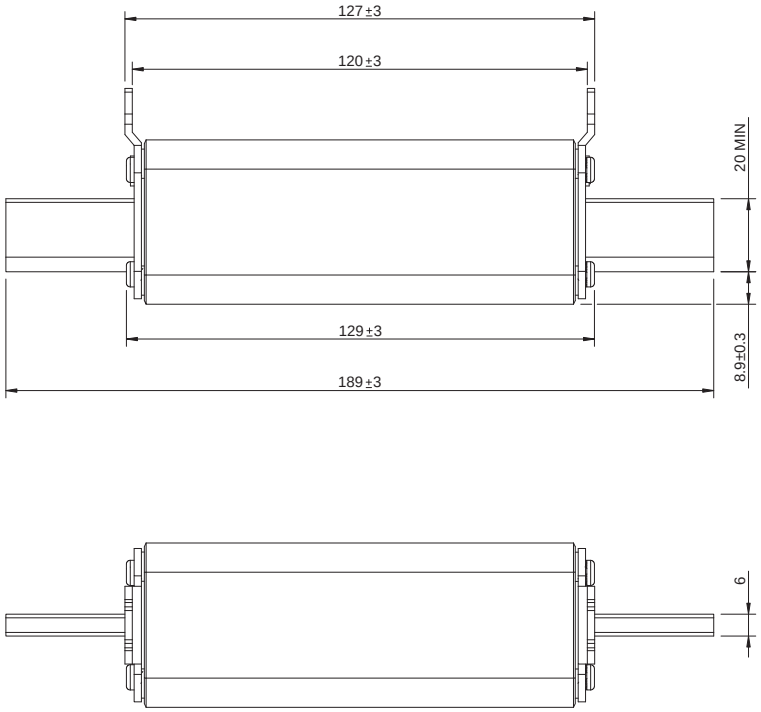
[1] PV-*A-2XL-3B and PV-*A-2XL-3B-15 have revised bolting patterns, which are identical to size 3L bolting pattern. This allows utilisation of both size 2XL and size 3L fuse links without changing the dimensional layout of the inverter, combiners and disconnects.

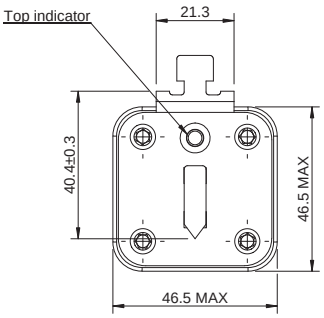
[2] 1200 V d.c. for 160A

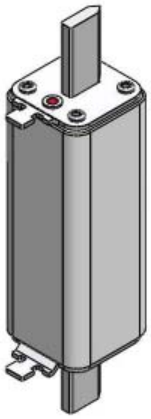
Data sheet: 10201

XL Style photovoltaic fuse links, 50 to 600 A, 1000/1500 V d.c., PV-XL series

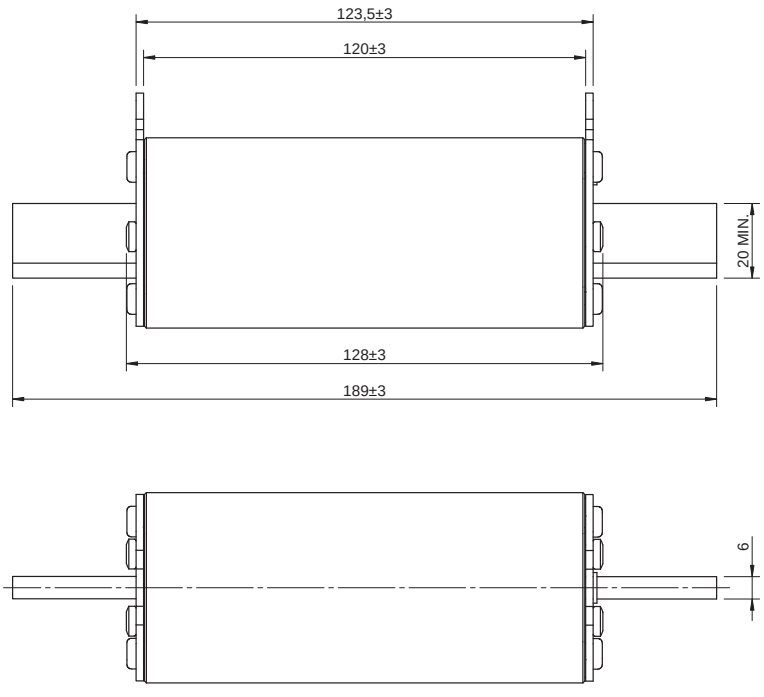
Dimensions - mm

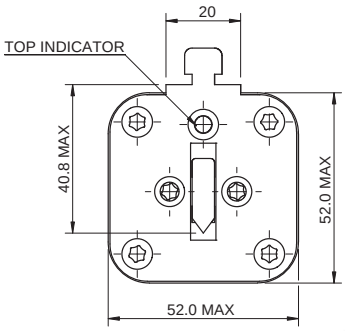


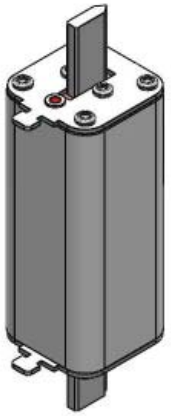




Bladed - Size 01XL





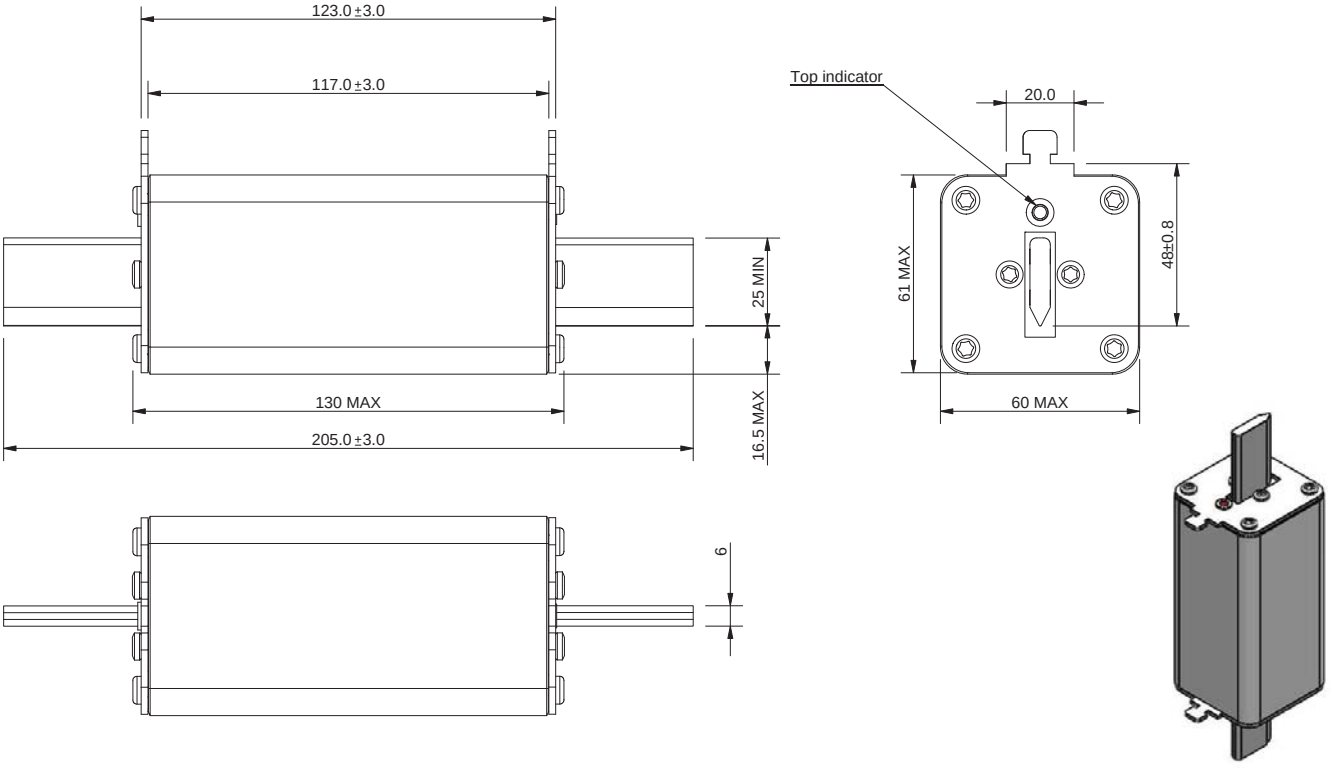


Bladed - Size 1XL

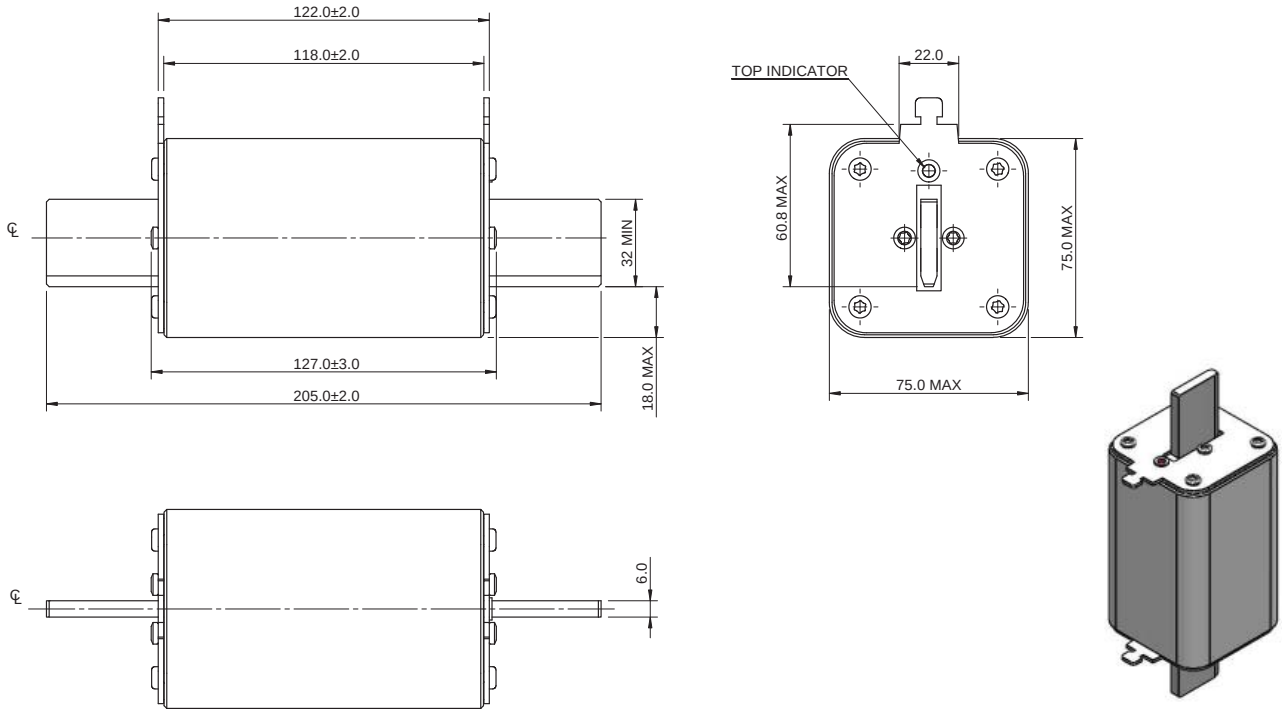
Data sheet: 10201

XL Style photovoltaic fuse links, 50 to 600 A, 1000/1500 V d.c., PV-XL series

Dimensions - mm



Bladed - Size 2XL

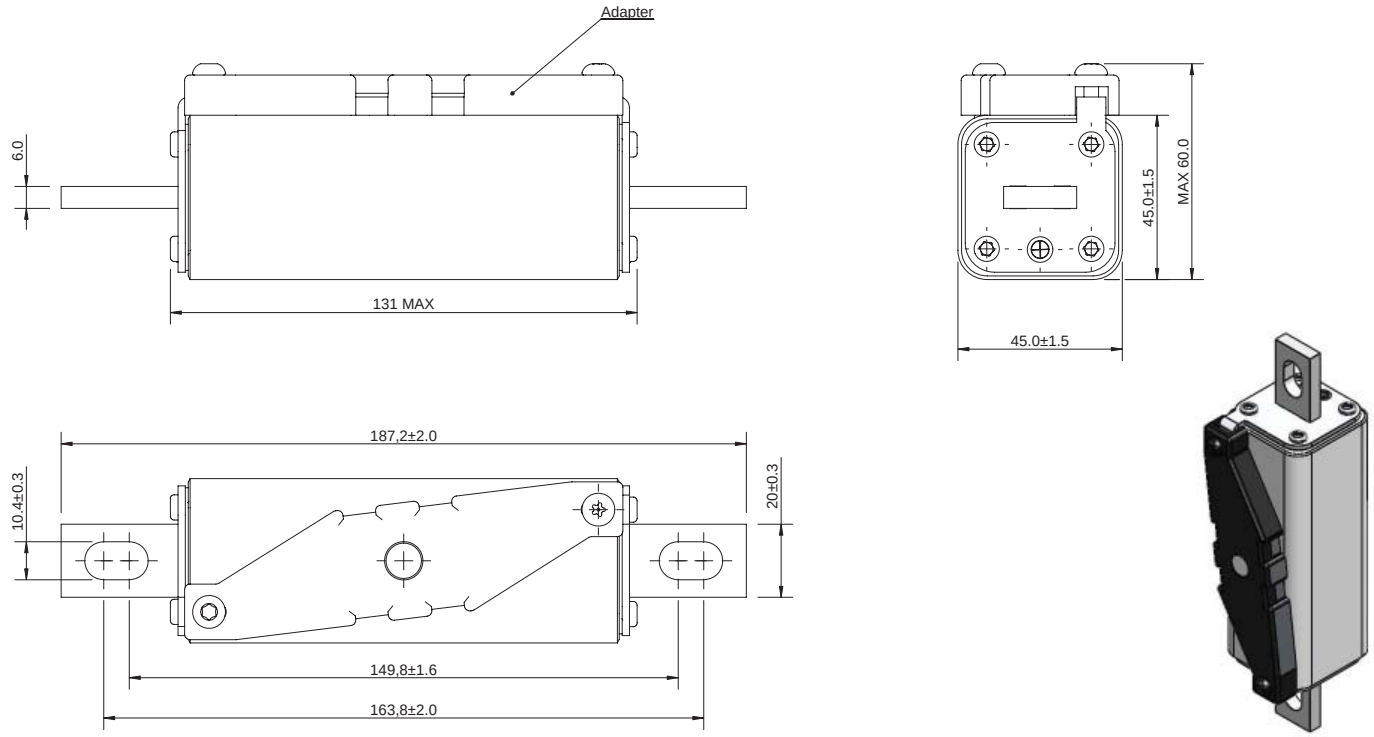


Bladed - Size 3L

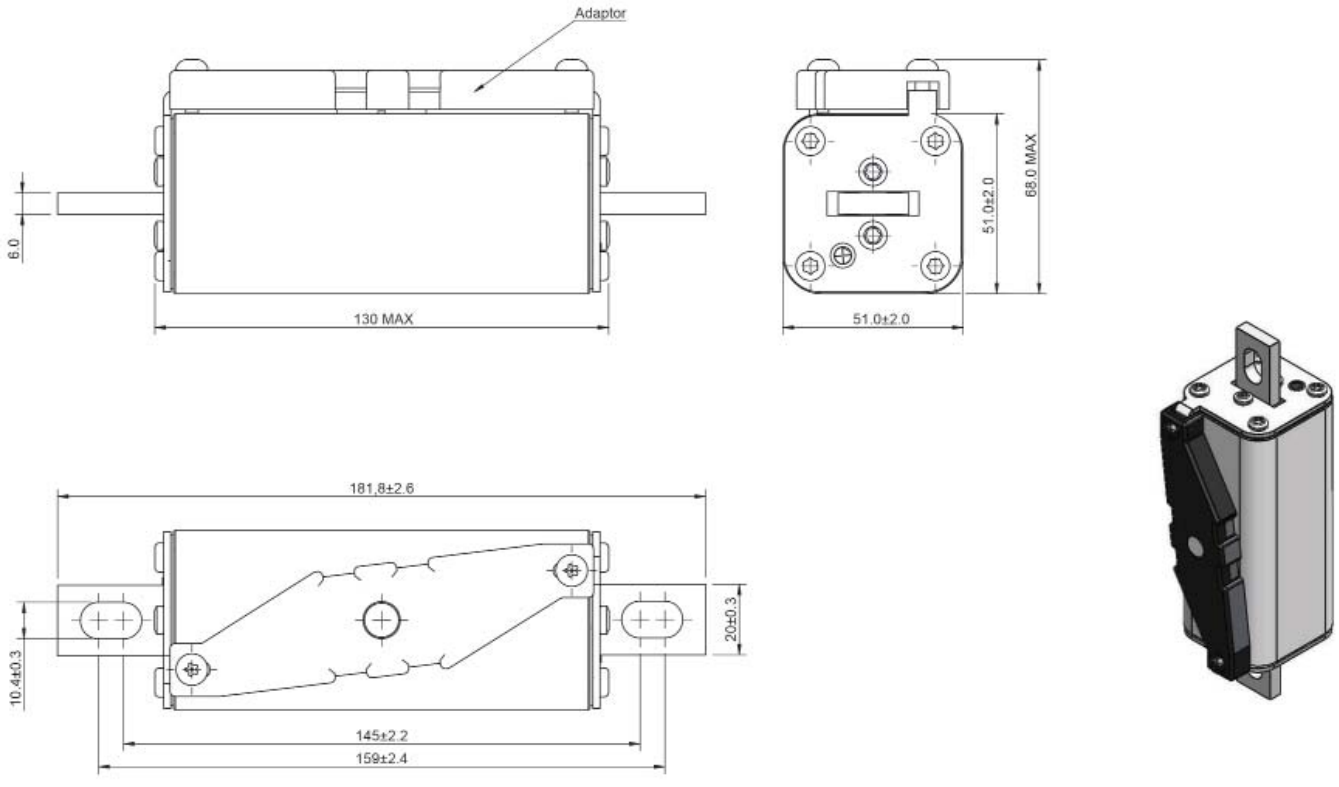
Data sheet: 10201

XL Style photovoltaic fuse links, 50 to 600 A, 1000/1500 V d.c., PV-XL series

Dimensions - mm



Bolted - Size 01XL

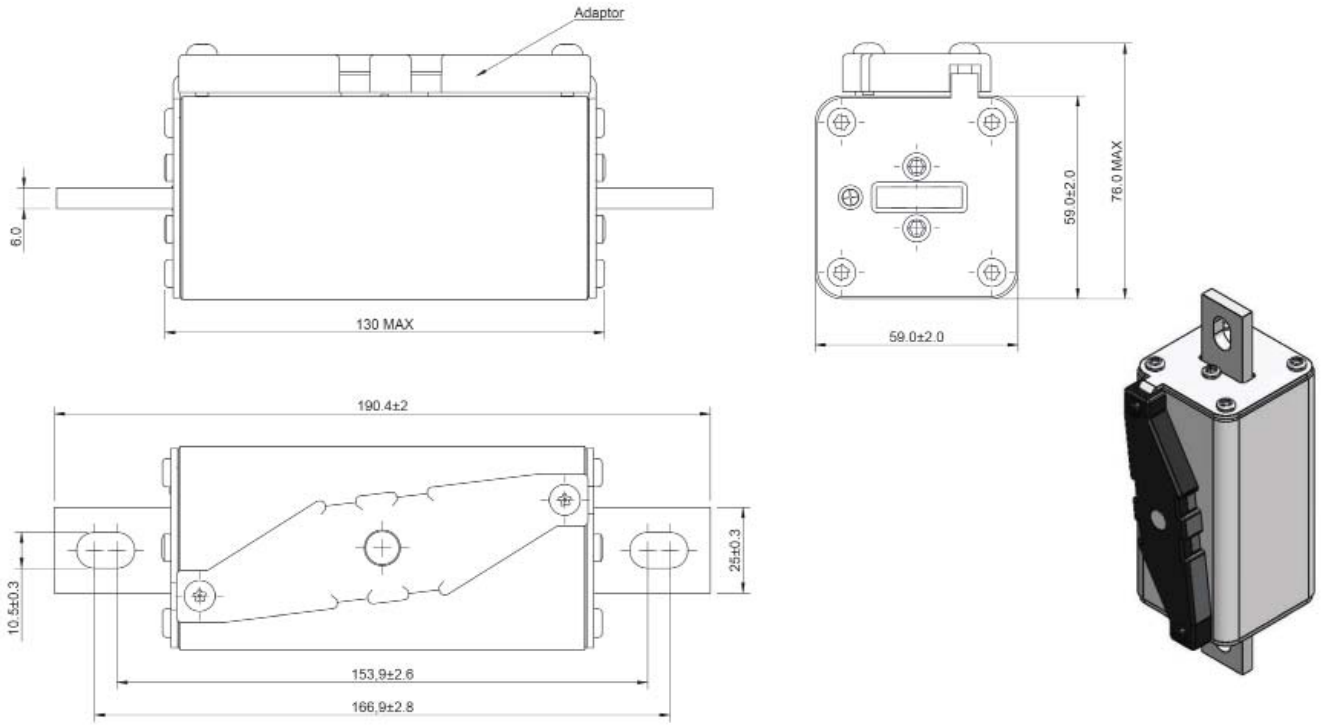


Bolted - Size 1XL

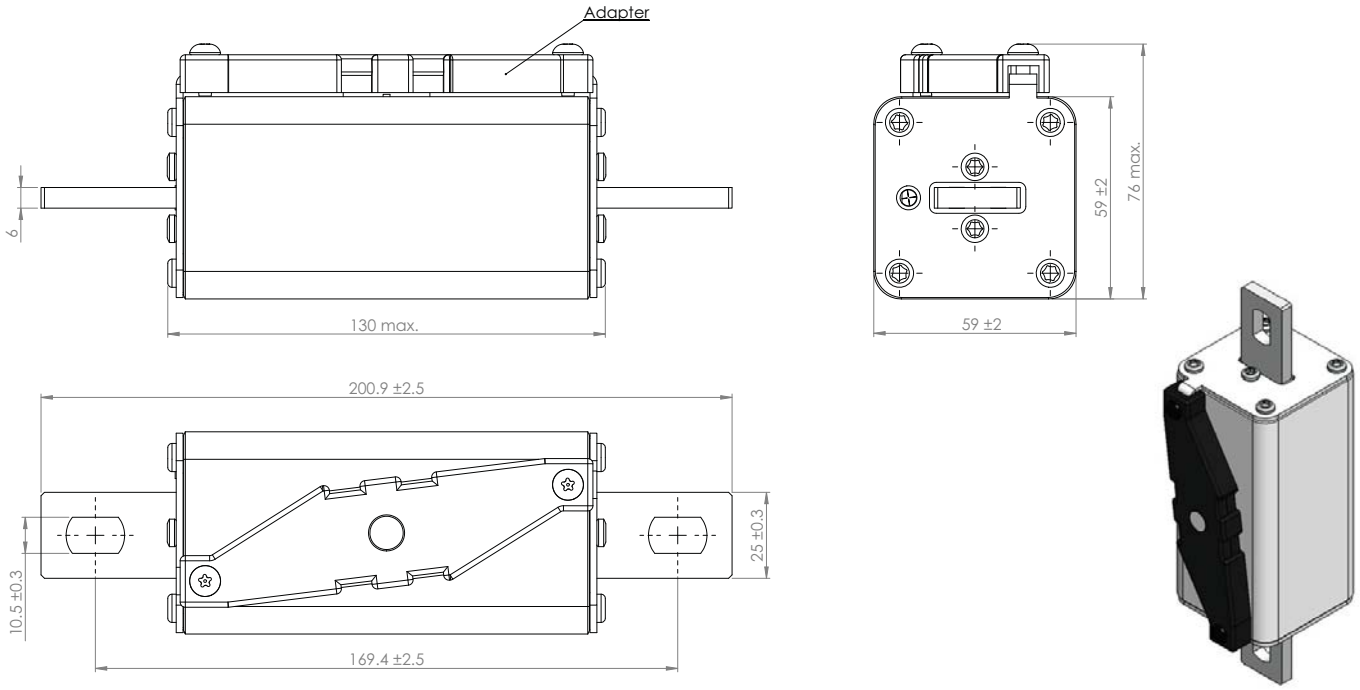
Data sheet: 10201

XL Style photovoltaic fuse links, 50 to 600 A, 1000/1500 V d.c., PV-XL series

Dimensions - mm



Bolted - Size 2XL



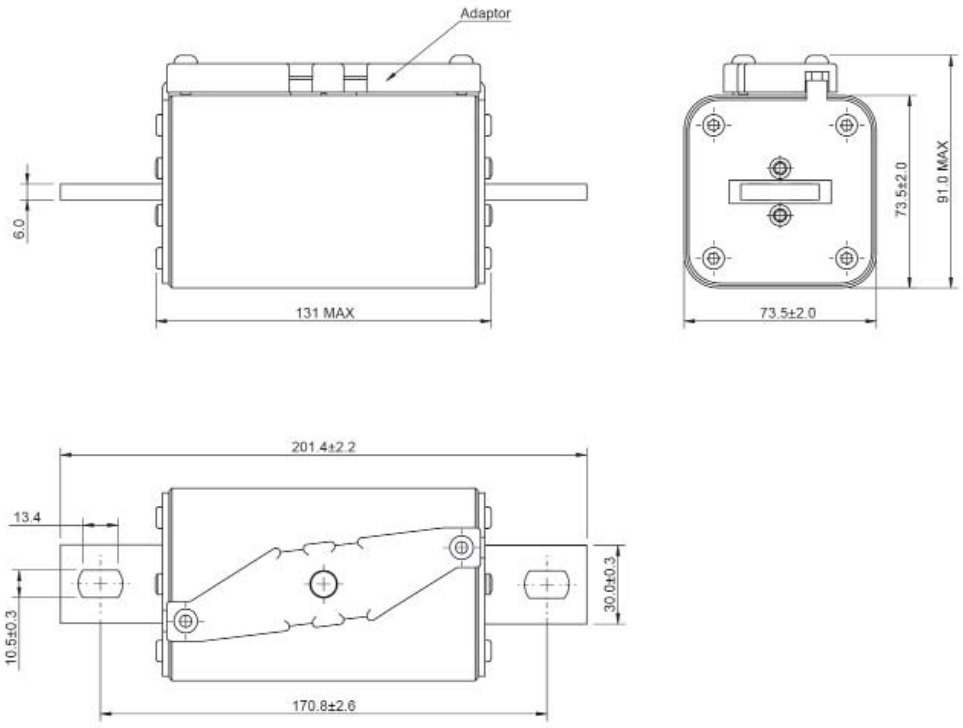
Bolted - Size 2XL-3B

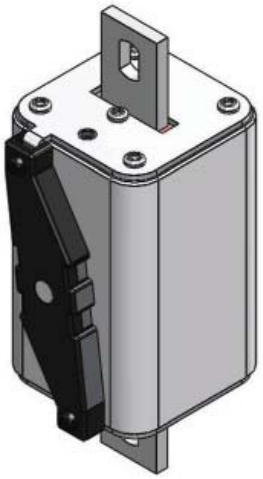
PV-*A-2XL-3B and PV-*A-2XL-3B-15 have revised bolting patterns, which are identical to size 3L bolting pattern. This allows utilisation of both size 2XL and size 3L fuse links without changing the dimensional layout of the inverter, combiners and disconnects.

Data sheet: 10201

XL Style photovoltaic fuse links, 50 to 600 A, 1000/1500 V d.c., PV-XL series

Dimensions - mm



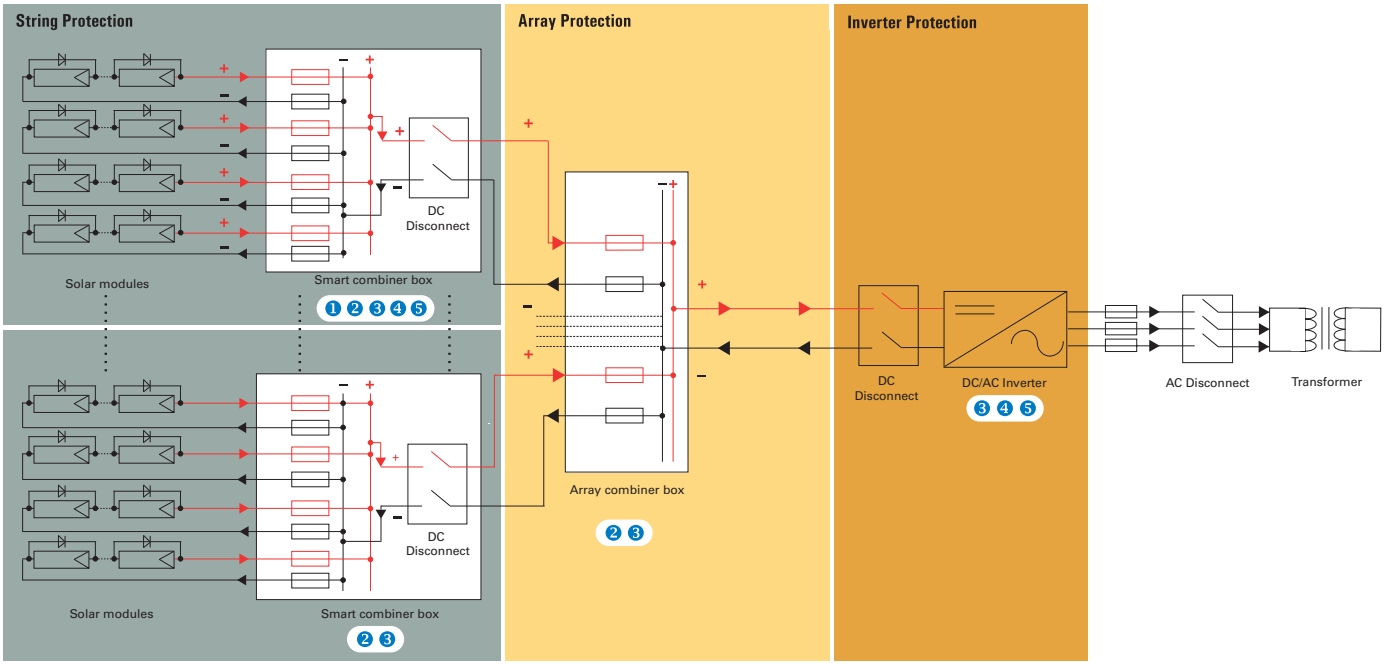


Bolted - Size 3L

Data sheet: 10201

PV SPDs system overview

To ensure full system protection against the propagation of over voltage surges throughout the PV installation it is important to select the correct Surge Protection Device (SPD) for each part of the system in the DC, AC and data-line networks. The network diagram and table helps to identify the key areas of SPD protection.



Look-up table		LV Protection	Inverter Protection	Array Protection	String Protection
Product Line					
❶	DC PV T1/PV T2 - High Performance	These combined PV T1/ PV T2 devices are certified to provide protection for 600V d.c.or 1000V d.c. systems and up to 1000ADC Iscpv.	✓	✓	✓
❷	DC PV T2	The PV T2 devices are specifically designed for use within 600V or 1000V d.c. systems with an Iscpv up to 160ADC.	✓		
❸	DC PV T2 - High Performance	High Performance PV T2 designed for high PV currents up to 1000ADC Iscpv with operating voltages of 600V d.c. or 1000V d.c..	✓	✓	✓
❹	Data line	The Data line range of surge protection devices are specifically designed for communication systems typically found in PV systems, with 4-wire , BNC and RJ45 options.	✓		✓
❺	AC T1/2 and T2	The AC range of devices are suitable for T1&T2 or T2 protection of the LV distribution panels and auxiliary equipment with voltages from 75VAD to 580V a.c..	✓		✓

SPDs - PV T1 / PV T2 DC SPD

Description

This range of modular SPDs are suitable for use within 600V d.c. or 1000V d.c. systems and provide combined PV T1/PV T2 protection. The heavy duty metal oxide varistors provide higher energy dissipation necessary for combined lightning and surge protection.

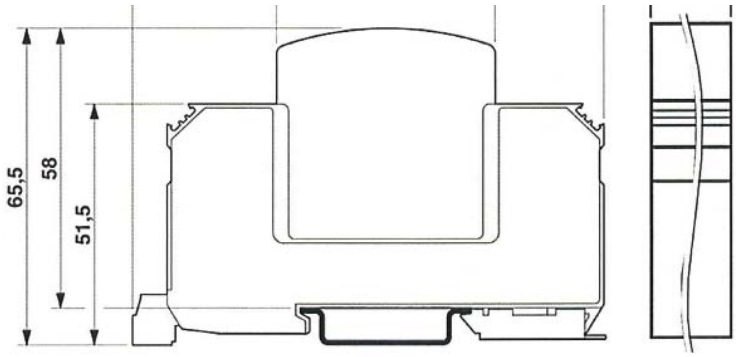
The IP20 finger safe construction has an operating temperature range from –40°C to +80°C, increasing the operational capability and geographical scope which the SPD devices can be installed in.

Tested to 1000A I_{scpv} these combined PV T1/PV T2 SPDs are suitable for use at all levels of the DC element of the photovoltaic system.

Standard Features

- Modular design.
- Keyed plugs and base elements protect against mismatching.
- Local and remote monitoring.
- DIN rail mountable.
- I_{scpv} = 1000A.

Dimensions - mm



Data sheet: 2145

SPDs - PV T1 / PV T2 DC SPD

Catalogue number	**SPPVT12-06-2-PE**	**SPPVT12-10-2-PE**
Catalogue number (with remote indicator)	**SPPVT12-06-2-PE-AX**	**SPPVT12-10-2-PE-AX**
Nominal PV System voltage	600 V d.c.	1000 V d.c.
Max. continuous operating voltage U_{CPV}	720 V d.c.	1050 V d.c.
Open circuit voltage under standard test conditions $U_{OC\ STC}$	≤ 600 V d.c.	≤ 875 V d.c.
Short circuit current rating I_{SCPV}	1000A	1000 A
SPD Overload behaviour mode	OCM (open circuit mode)	OCM (Open Circuit Mode)
Class of test according to EN 50539-11	PV T1/ PV T2	PV T1 / PV T2
Nominal discharge current I_n (8/20)µs:	15 kA	15 kA
Max. discharge current I_{max} (8/20)µs:	40 kA	40 kA
Total discharge current I_{total} (8/20) µs:	40 kA	40 kA
Total discharge current I_{total} (10/350) µs	7 kA	5 kA
Impulse discharge current I_{imp} (10/350) µs	5 kA	5 kA
Voltage protection level U_p (L+/L-) - PE	≤ 2.6 kV	≤ 3.5 kV
Limiting voltage U_{res} (8/20) (L+/L-) - PE at I_n	≤ 2.6 kV	≤ 3.5 kV
at 5 kA	≤ 2.0 kV	≤ 2.9 kV
at 10 kA	≤ 2.3 kV	≤ 3.2 kV
at 20 kA	≤ 2.8 kV	≤ 3.7 kV
at 30 kA	≤ 3.1 kV	≤ 4.1 kV
at 40 kA	≤ 3.6 kV	≤ 4.6 kV
Response time t_A	≤ 25 ns	≤ 25 ns
Max. required series fuse	Not required	Not required
Continuous operating current I_{CPV}	< 20 µA	< 20 µA
Rated load current I_L	80 A	80 A
Residual current I_{PE}	< 20 µA DC / 350 µA AC	< 20 µA DC / 300 µA AC
Standby power consumption P_C	< 20 mVA	< 25 mVA
Temperature range	-40°C to +80°C	-40°C to +80°C
Humidity range	5% … 95%	5% … 95%
Altitude	≤ 3000 m	≤ 3000 m
Degree of protection according to IEC 61643-11:2011	IP20	IP20
Air clearances and creepage distances according to EN 50539-11		
Degree of pollution	2	2
Overvoltage category	III	III
Insulating material		
Housing plug/base element	PA 6.6 / PBT	PA 6.6 / PBT
Inflammability class according to UL 94	V0	V0
CTI According to IEC 112	> 600	> 600
Connection	Terminal blocks / Rail mountable NS 35	Terminal blocks / Rail mountable NS 35
Fine-/solid strand/ AWG	1.5 - 25 mm²/ 1.5 - 35 mm²/ 15-2	1.5 - 25 mm²/ 1.5 - 35 mm²/ 15-2
Terminal blocks	1.5 - 16 mm² with spade lug terminal M6	1.5 - 16 mm² with spade lug terminal M6
Thread / torque / strip length	M5/ 4.5 Nm/ 16 mm	M5/ 4.5 Nm/ 16 mm
Remote indicator contact (..AX parts only)		
Switching function	Single pole changeover contact	Single pole changeover contact
Connection method	Pluggable MC 1.5/3 ST	Pluggable MC 1.5/3 ST
Wire fine/solid strand/AWG	0.14-1.5mm² / AWG 30-16 (CSA) 30-14 (UL)	0.14-1.5mm² / AWG 30-16 (CSA) 30-14 (UL)
Thread / torque / strip length	M2 / 0.25 Nm / 7 mm	M2 / 0.25 Nm / 7 mm
Max admissible operating voltage	250 V a.c. / 30 V d.c.	250 V a.c. / 30 V d.c.
Max admissible power AC	1.5 A / 250 V a.c.	1.5 A / 250 V a.c.
Max admissible power DC	1.5 A / 30 V d.c.	1.5 A / 30 V d.c.
Min admissible power	5 mA / 5 V	5 mA / 5 V
Certified according to	EN 50539-11	EN 50539-11

SPDs - PV T2 Standard / high performance

Description

Designed specifically for PV solar applications, this range of modular PV SPDs are suitable for use within 600V d.c. or 1000V d.c. systems. They provide fast and reliable protection against indirect lightning strikes and voltage surges. The SPDs contain integrated indication of device status with the option for remote indication helping system operators ensure continuous protection.

The IP20 finger-safe construction has an operating temperature range from -40°C to +80°C, increasing the operational capability required for PV environments.

Certified to EN 50539-11 these devices provide effective PV Type 2 protection of the DC element of the photovoltaic system from indirect lightning strikes and surges.

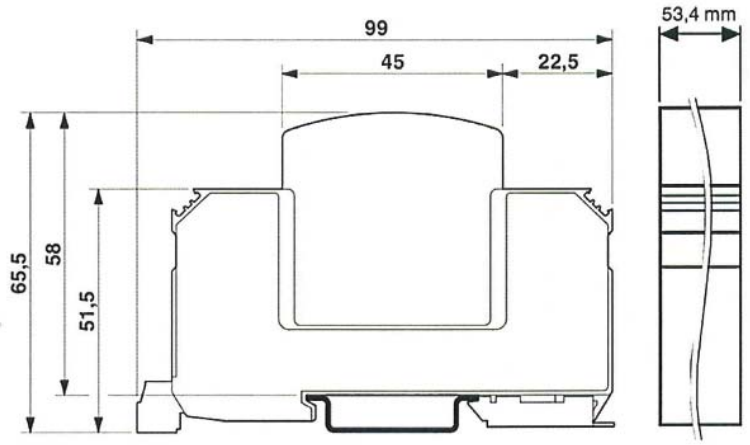
Features for the T2 Standard SPD

- I_{SCPV} = 160A
- Modular design.
- Keyed plugs and base elements protect against mismatching.
- Local and remote monitoring.
- DIN rail mountable.

Features for the T2 High Performance SPD

- I_{SCPV} = 1000A
- Modular design.
- Keyed plugs and base elements protect against mismatching.
- Local and remote monitoring.
- DIN rail mountable.

Dimensions - mm



SPDs- PV T2 High performance

Catalogue number	**SPPVT2H-06-2-PE**	**SPPVT2H-10-2-PE**
Catalogue number (with remote indication)	**SPPVT2H-06-2-PE-AX**	**SPPVT2H-10-2-PE-AX**
Nominal PV System voltage	600 V d.c.	1000 V d.c.
Max. continuous operating voltage U_{CPV}	800 V d.c.	1170 V DC
Open circuit voltage under standard test conditions $U_{DC\ STC}$	≤ 670 V d.c.	≤ 970 V DC
Short circuit current rating I_{SCPV}	1000 A	1000 A
SPD Overload behaviour mode	OCM (Open Circuit Mode)	OCM (Open Circuit Mode)
Class of test according to EN 50539-11	PV T2	PV T2
Nominal discharge current I_n (8/20)µs:	15 kA	15 kA
Max. discharge current I_{max} (8/20)µs:	40 kA	40 kA
Total discharge current I_{total} (8/20) µs:	40 kA	40 kA
Voltage protection level U_p (L+ / L-) - PE	≤ 2.7 kV	≤ 3.7 kV
Limiting voltage U_{res} (8/20) (L+ / L-) - PE at 1_A	≤ 2.7 kV	≤ 3.7 kV
at 2 kA	≤ 1.9 kV	≤ 2.7 kV
at 5 kA	≤ 2.2 kV	≤ 3.1 kV
at 10 kA	≤ 2.5 kV	≤ 3.5 kV
at 20 kA	≤ 2.9 kV	≤ 4.0 kV
at 30 kA	≤ 3.4 kV	≤ 4.6 kV
at 40 kA	≤ 3.8 kV	≤ 5.0 kV
Response time t_A	≤ 25 ns	≤ 25 ns
Max. required series fuse	Not required	Not required
Continuous operating current I_{CPV}	< 20 µA	< 20 µA
Rated load current I_L	80 A	80 A
Residual current I_{PE}	< 20 µA DC / 300 µA AC	< 20 µA DC / 250 µA AC
Standby power consumption P_C	< 20 mVA	< 25 mVA
Temperature range	-40°C to +80°C	-40°C to +80°C
Humidity range	5% … 95%	5% … 95% rel
Altitude	≤ 3000 m	≤ 3000 m
Degree of protection according to IEC 61643-11:2011	IP20	IP20
Air clearances and creepage distances according to EN 50539-11		
degree of pollution	2	2
overvoltage category	III	III
Insulating material		
housing plug/base element	PA 6.6 / PBT	PA 6.6/ PBT
inflammability class according to UL 94	V0	V0
CTI According to IEC 112	> 600	> 600
Connection	Terminal blocks / Rail mountable NS 35	Terminal blocks / Rail mountable NS 35
Fine-/solid strand/ AWG	1.5 - 25 mm²/ 1.5 - 35 mm²/ '15-2	1.5 to 25 mm²/ 1.5 to 35 mm²/ 15-2
Terminal blocks	1.5 - 16 mm² with spade lug terminal M6	1.5 to 16mm² with spade lug terminal M6
Thread/torque/strip length	M5/ 4.5 Nm/ 16 mm	M5/ 4.5 Nm/ 16mm
Remote indicator contact (..AX parts only)		
Switching function	Single pole changeover contact	Single pole changeover contact
Connection method	Pluggable MC 1.5/3 ST	Pluggable MC 1.5/3 ST
Wire fine/solid strand/AWG	0.14-1.5mm² / AWG 30-16 (CSA) 30-14 (UL)	0.14-1.5mm² / AWG 30-16 (CSA) 30-14 (UL)
Thread / torque / strip length	M2 / 0.25 Nm / 7 mm	M2 / 0.25 Nm / 7 mm
Max admissible operating voltage	250 V a.c. / 30 V d.c.	250 V a.c. / 30 V d.c.
Max admissible power AC	1.5 A / 250 V a.c.	1.5 A / 250 V a.c.
Max admissible power DC	1.5 A / 30 V d.c.	1.5 A / 30 V d.c.
Min admissible power	5 mA / 5 V	5 mA / 5 V
Certified according to	EN 50539-11	EN 50539-11

SPDs - PV T2 Standard

Catalogue number	**SPPVT2-06-2-PE**	**SPPVT2-10-2-PE**
Catalogue number (with remote indication)	**SPPVT2-06-2-PE-AX**	**SPPVT2-10-2-PE-AX**
Nominal PV System voltage	600 V d.c.	1000 V d.c.
Max. continuous operating voltage U_{CPV}	800 V d.c.	1170 V DC
Open circuit voltage under standard test conditions $U_{OC\ STC}$	≤ 670 V d.c.	≤ 970 V DC
Short circuit current rating I_{SCPV}	160 A	160 A
SPD Overload behaviour mode	OCM (Open Circuit Mode)	OCM (Open Circuit Mode)
Class of test according to EN 50539-11	PV T2	PV T2
Nominal discharge current I_n (8/20)µs:	15 kA	15 kA
Max. discharge current I_{max} (8/20)µs:	40 kA	40 kA
Total discharge current I_{total} (8/20) µs:	40 kA	40 kA
Voltage protection level U_p (L+ / L-) - PE	≤ 2.7 kV	≤ 3.7 kV
Limiting voltage U_{res} (8/20) (L+ / L-) - PE at 1_A	≤ 2.7 kV	≤ 3.7 kV
at 2 kA	≤ 1.9 kV	≤ 2.7 kV
at 5 kA	≤ 2.2 kV	≤ 3.1 kV
at 10 kA	≤ 2.5 kV	≤ 3.5 kV
at 20 kA	≤ 2.9 kV	≤ 4.0 kV
at 30 kA	≤ 3.4 kV	≤ 4.6 kV
at 40 kA	≤ 3.8 kV	≤ 5.0 kV
Response time t_A	≤ 25 ns	≤ 25 ns
Max. required series fuse	Not required	Not required
Continuous operating current I_{CPV}	< 20 µA	< 20 µA
Rated load current I_L	80 A	80 A
Residual current I_{PE}	< 20 µA DC / 300 µA AC	< 20 µA DC / 250 µA AC
Standby power consumption P_C	< 20 mVA	< 25 mVA
Temperature range	-40°C to +80°C	-40°C to +80°C
Humidity range	5% … 95%	5% … 95% rel
Altitude	≤ 3000 m	≤ 3000 m
Degree of protection according to IEC 61643-11:2011	IP20	IP20
Air clearances and creepage distances according to EN 50539-11		
degree of pollution	2	2
overvoltage category	III	III
Insulating material		
housing plug/base element	PA 6.6 / PBT	PA 6.6/ PBT
inflammability class according to UL 94	V0	V0
CTI According to IEC 112	> 600	> 600
Connection	Terminal blocks / Rail mountable NS 35	Terminal blocks / Rail mountable NS 35
Fine-/solid strand/ AWG	1.5 - 25 mm²/ 1.5 - 35 mm²/ '15-2	1.5 to 25 mm²/ 1.5 to 35 mm²/ 15-2
Terminal blocks	1.5 - 16 mm² with spade lug terminal M6	1.5 to 16mm² with spade lug terminal M6
Thread/torque/strip length	M5/ 4.5 Nm/ 16 mm	M5/ 4.5 Nm/ 16mm
Remote indicator contact (..AX parts only)		
Switching function	Single pole changeover contact	Single pole changeover contact
Connection method	Pluggable MC 1.5/3 ST	Pluggable MC 1.5/3 ST
Wire fine/solid strand/AWG	0.14-1.5mm² / AWG 30-16 (CSA) 30-14 (UL)	0.14-1.5mm² / AWG 30-16 (CSA) 30-14 (UL)
Thread / torque / strip length	M2 / 0.25 Nm / 7 mm	M2 / 0.25 Nm / 7 mm
Max admissible operating voltage	250 V a.c. / 30 V d.c.	250 V a.c. / 30 V d.c.
Max admissible power AC	1.5 A / 250 V a.c.	1.5 A / 250 V a.c.
Max admissible power DC	1.5 A / 30 V d.c.	1.5 A / 30 V d.c.
Min admissible power	5 mA / 5 V	5 mA / 5 V
Certified according to	EN 50539-11	EN 50539-11

Combiner box - Introduction

The intelligent solution to PV System protection

- Designed for harsh environments, Eaton's Bussmann series combiner box has superior thermal characteristics eliminating the need for forced ventilation in extreme ambient temperatures.

- Completely customisable from 3 to 24 strings offering PV Circuit protection with Eaton's industry leading gPV fuses in ratings from 1 A to 32 A, up to 1000 V d.c., PV Overvoltage surge protection and true PV DC rated disconnect switches.

- Engineered to make installation and operation safe and easy, each combiner box is fully IEC Compliant with options for MC4 connectors, glands, surge protection, monitoring and power supply configurations. All this wrapped up in durable IP65 rated enclosure, with breather vent, as standard.

- With a global manufacturing base and an integrated common system approach, Eaton can locally develop and manufacture customised combiner boxes while maintaining exceptional levels of quality.

Combiner box

Standard	IEC 61439-1 and -2 and IEC 60363-7-712
Voltage	Up to 1000 V d.c.
Current	1 to 32 A
Number of strings	3 - 24 strings (20 A fuse max), 3 - 16 strings (32 A fuse max)
Operating class	gPV
IP Rating	IP65 (options for IP55)
Enclosure types	Glass reinforced polyester (GRP), painted steel, stainless steel
Overcurrent protection configurations	Positive and negative, positive only, negative only
DC Load isolation	DC switch disconnect 25 A d.c. to 500 A d.c. or fixed output
Input connection types	Bottom or side entry MC4 connectors or glands
Overvoltage protection options (SPD)	PV T1/T2, PVT2, AC T1, T1/T2 & T2. Dataline D1, C2
Monitoring options	8/16/24 string shunt based monitoring.
Communications options	2-Wire modbus
Power supply options	External 24 V d.c., Internal 240 V a.c. to 24 V d.c., Internal 1000 V d.c. to 24 V d.c.
Applications	Solar PV applications including: Large scale residential, small to large scale commercial, large scale utility

Combiner box - Catalogue number system

Cenn-xxAyypsh-vmm

C - Product Series Combiner Box

e - Enclosure Type
G = GRP
M = Painted steel enclosure
S = Stainless
T = GRP with transparent polycarbonate window

nn - Number of Strings
03, 04, 05.....24

xxA - String Current Rating
1 to 6A, 10A, 12A, 15A, 20A, 25A, 32A

yy - System Voltage
06 = 600Vdc
08 = 800Vdc
10 = 1000Vdc
12 = 1000Vdc
15 = 1500Vdc

p - String Protection Type

Indicated Fuse Holders (CHPV1IU)	P = Positive only fuse protection	N = Negative only fuse protection	B = Both positive and negative fuse protection
Non-indicated Fuse Holders (CHPV1U)	Q = Positive only fuse protection	M = Negative only fuse protection	C = Both positive and negative fuse protection

s - Switch Disconnect
D = Disconnect switch
F = Fixed

h - PV String Input Connection Type

Standard Output Glands	Armoured Output Glands
G = Bottom entry glands	U = Bottom entry glands
M = Bottom entry MC4s	W = Bottom entry MC4s
S = Left and right side entry glands	X = Left and right side entry glands
T = Left and right side entry MC4s	Y = Left and right side entry MC4s

v - SPD Overvoltage Protection

A = No SPD
B = T1 PV SPD
C = T2 PV SPD
D = T2 PV SPD with remote
E = T1 PV SPD + T2 TN 240 Vac SPD with remote*
F = T1 PV SPD + T2 TT 240 Vac SPD with remote*
G = T1 PV SPD + T2 TN 240 Vac SPD with remote + C2/D1 Modbus SPD
H = T1 PV SPD + T2 TT 240 Vac SPD with remote + C2/D1 Modbus SPD
J = T1 PV SPD + C2/D1 Modbus SPD*
K = T2 PV SPD with remote + T2 TN 240 Vac SPD with remote*
L = T2 PV SPD with remote + T2 TT 240 Vac SPD with remote*
M = T2 PV SPD with remote + T2 TN 240 Vac SPD with remote + C2/D1 Modbus SPD*
N = T2 PV SPD with remote + T2 TT 240 Vac SPD with remote + C2/D1 Modbus SPD*
P = T2 PV SPD with remote + C2 Modbus SPD*
Q = T1/T2 PV SPD
R = T1/T2 PV SPD with remote
S = T1/T2 PV SPD with remote + T2 TN 240 Vac SPD with remote*
T = T1/T2 PV SPD with remote + T2 TT 240 Vac SPD with remote*
U = T1/T2 PV SPD with remote + T2 TN 240 Vac SPD with remote + C2/D1 Modbus SPD*
V = T1/T2 PV SPD with remote + T2 TT 240 Vac SPD with remote + C2/D1 Modbus SPD*
W = T1/T2 PV SPD with remote + C2/D1 Modbus SPD*

* Monitored box only

mm - Monitoring System

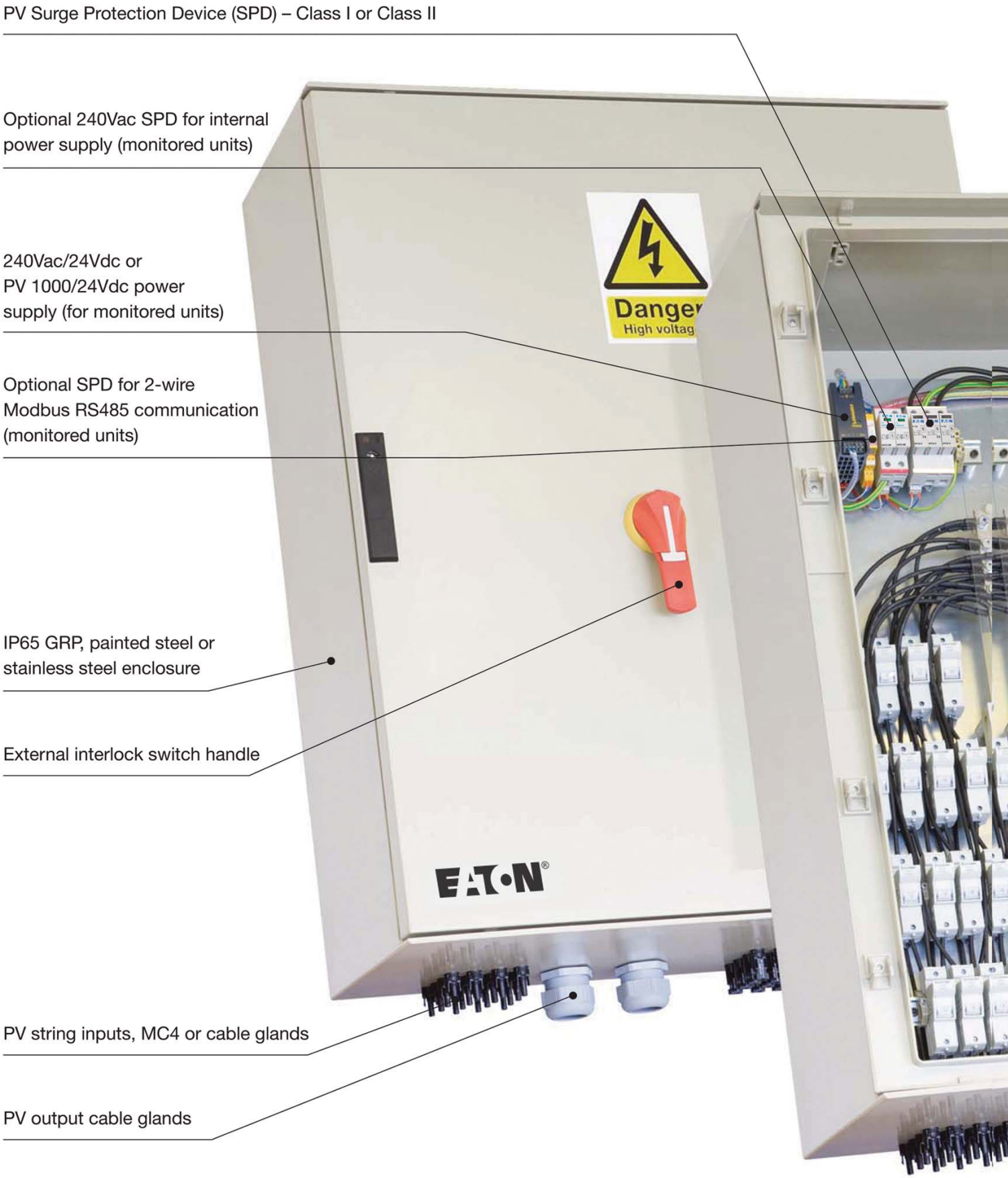
Wired Modbus	Wireless Zigbee	Industrial Wireless
M1 = Type S1 Shunt monitoring with 240Vac power supply	Z1 = Type S1 Shunt monitoring with 240Vac power supply	W1 = Type S1 Shunt monitoring with 240Vac power supply
M2 = Type S1 Shunt monitoring with no power supply	Z2 = Type S1 Shunt monitoring with no power supply	W2 = Type S1 Shunt monitoring no power supply
M3 = Type S1 Shunt monitoring with PV power (self powered)	Z3 = Type S1 Shunt monitoring with PV power (self powered)	W3 = Type S1 Shunt monitoringwith PV power (self powered)

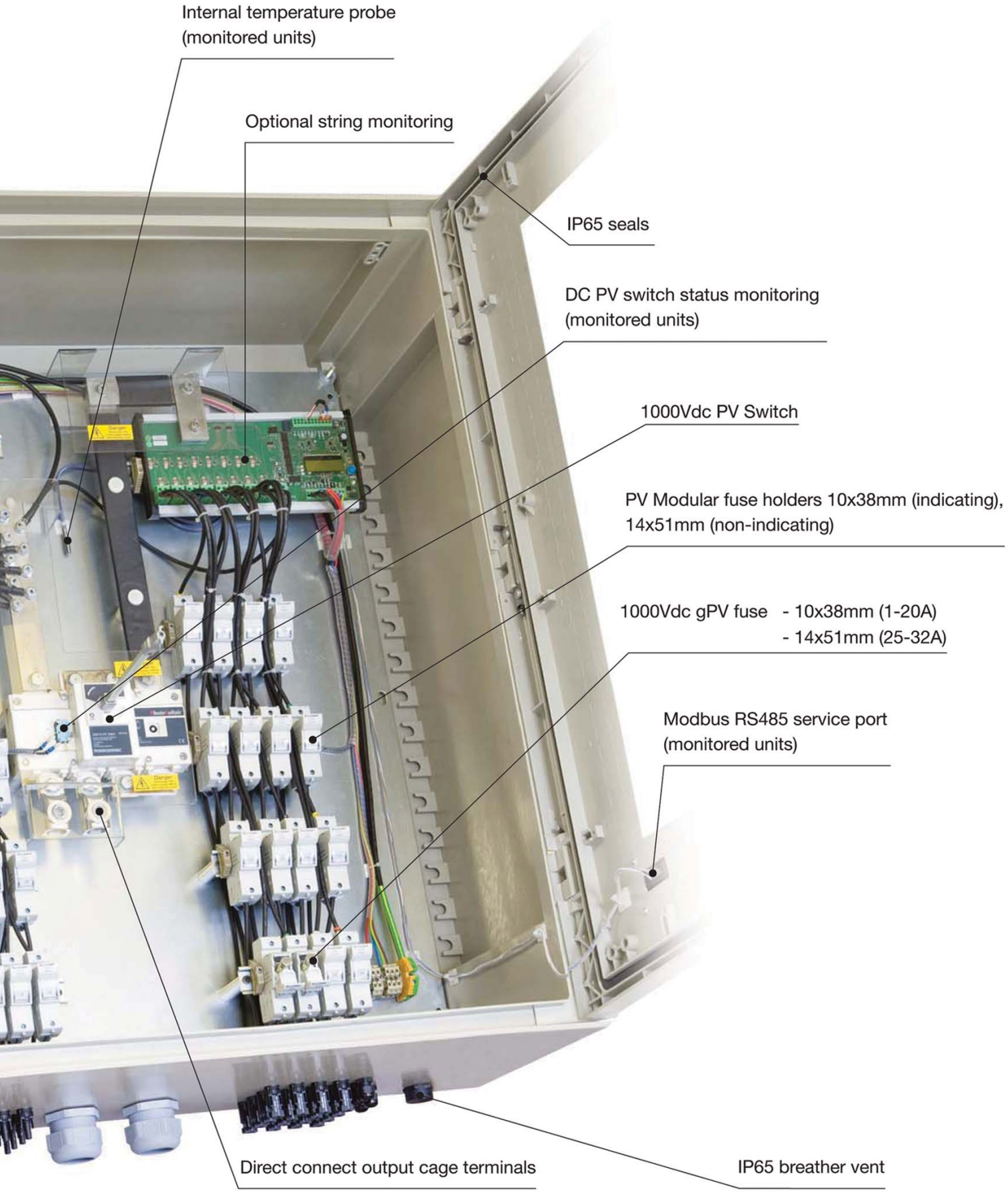
Catalogue numbers example

Complete Catalogue number C08-10A10BDM-C 'Standard box'	**C**	**G**	**08**	**10A**	**10**	**B**	**D**	**M**	**C**
C = Combiner box	C								
e = Enclosure type (G = GRP)		G							
nn = Number of strings (8)			08						
xxA = Rated current (10A)				10A					
yy = System voltage (10 = 1000 V d.c.)					10				
p = String protection (B = Both positive and negative)						B			
s = Switch disconnect (D = Disconnect switch)							D		
h = PV String input connection type (M = Bottom entry MC4s/Standard output glands)								M	
v = Overvoltage protection (C = T2 PV SPD)									C

Complete Catalogue number CG16-12A10BDU-NM1 'Monitored box'	**C**	**G**	**16**	**12A**	**10**	**B**	**D**	**M**	**N**	**M1**
C = Combiner box	C									
e = Enclosure type (G = GRP)		G								
nn = Number of strings (16)			16							
xxA = Rated current (12A)				12A						
yy = System voltage (10 = 1000 V d.c.)					10					
p = String protection (B = Both positive and negative)						B				
s = Switch disconnect (D = Disconnect switch)							D			
h = PV String input connection type (U = Bottom entry glands / Armoured output glands)								M		
v = Overvoltage protection (N = T2 PV SPD with remote + T2 TT 240 V a.c. SPD with remote + C2/D1 Modbus SPD*									N	
mm = Monitoring system (M1 = Type S1 Shunt monitoring with 240 V a.c. power supply - wired mod-bus)										M1

Anatomy of a combiner box




Internal temperature probe
(monitored units)
Optional string monitoring
IP65 seals
DC PV switch status monitoring
(monitored units)
1000Vdc PV Switch
PV Modular fuse holders 10x38mm (indicating),
14x51mm (non-indicating)
1000Vdc gPV fuse - 10x38mm (1-20A)
- 14x51mm (25-32A)
Modbus RS485 service port
(monitored units)
Direct connect output cage terminals
IP65 breather vent

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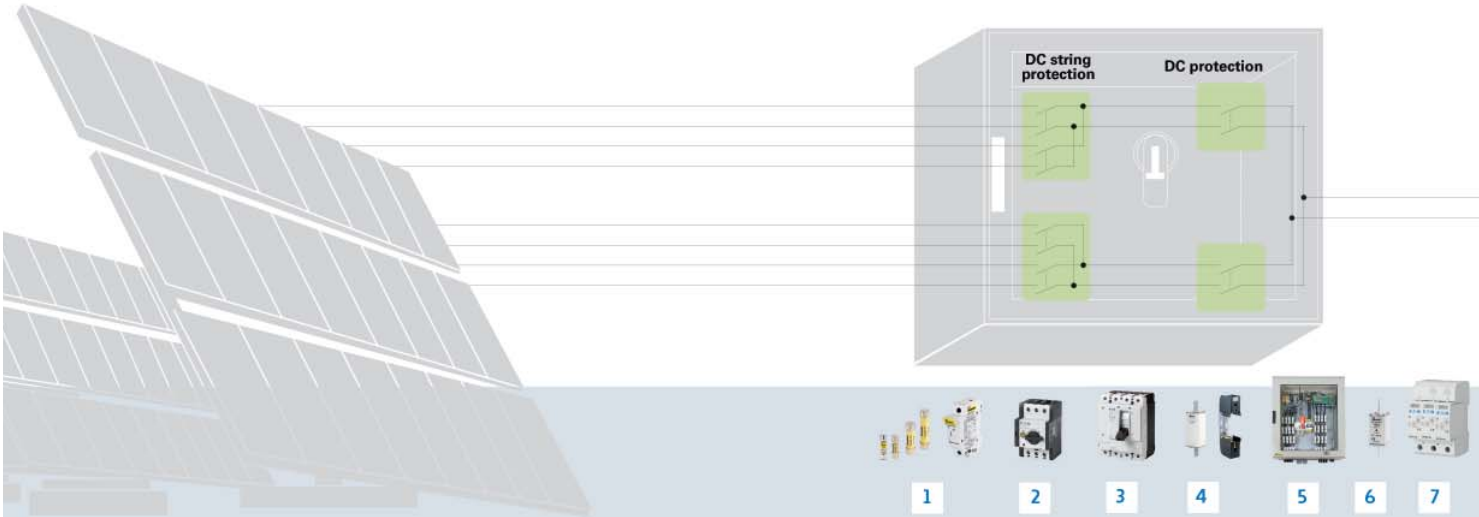
PV module protection and switching



1	2	3	4	5
Ferrule Photovoltaic Fuse Links, 1 to 32A, up to 1500Vdc Modular Fuse Holders, 32A, 1000Vdc	Two-pole Switch Disconnector	Switch-disconnectors 160 - 1600A for up to 1500Vdc	XL Style Photovoltaic Fuse Links, 50 to 630A, up to 1500Vdc XL PV Bases	Combiner Box

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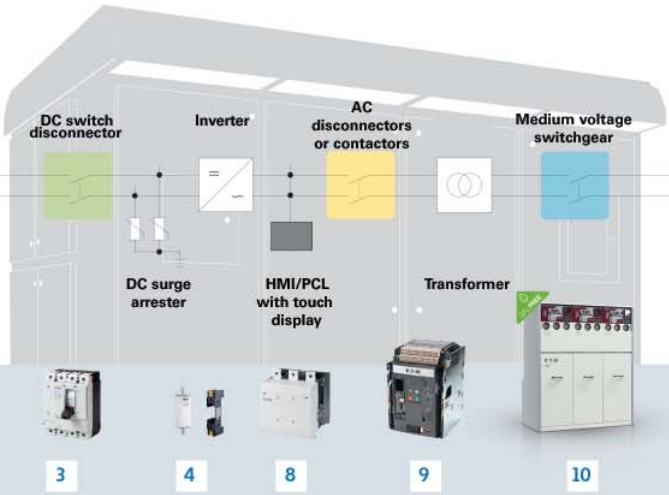
We can help keep your power system safe, efficient, reliable, and up-to-date.

Inverter, grid protection and switching



6 NH PV Fuse Links

7 Surge Protection Devices

8 AC Contactors up to 2600A, 1000Vac

9 Air Circuit Breakers up to 6300A, 690Vac NZM and IZM

10 Medium Voltage Switchgear Xiria Ring Main Unit

Index

Contact details

Customer satisfaction team

Eaton's customer satisfaction team is available to answer questions regarding Eaton's Bussmann series products.

Europe calls can be made between:

Monday — Thursday	7.30 a.m. - 5.30 p.m. GMT
Friday	7.30 a.m. - 5.00 p.m. GMT

The customer satisfaction team can be reached via:

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Application engineering assistance is available to all customers. The application engineering team is staffed by university-qualified electrical engineers who are available with technical and application support.

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Monday — Thursday	8.30 a.m. - 4.30 p.m. GMT
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Customer Satisfaction Team

Bussmannn by Eaton India Customer Satisfaction Team is available in Pondicherry to answer questions regarding Bussmann by Eaton product Sales, Supply and Services. Calls should be made between 9.00am - 5.30pm IST.

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E-mail: technicalhelpindia@eaton.com

Web services

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This website offers free information & resources that include:

- Product data sheets and complete technical information
- Latest catalogues
- Safety BaSICs™ for the essentials of electrical safety
- Training modules for increasing skill levels of customers and end users
- Cross referencing to find the correct Bussmann by Eaton replacement for a competitor's fuse

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