

Photovoltaic System Protection Application Guide



www.cooperbussmann.com/Solar

Cooper Bussmann 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.

Cooper Bussmann has worked closely with solar system manufacturers and through coordinated research and development, has produced revolutionary new fuse links which, combined with its range of Surge Protective Devices, offer complete protection for PV systems.



Photovoltaic Powered Distribution Network





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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 1400 Megawatts in 2000 to an estimated 25,900 Megawatts 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 Cooper Bussmann, the leading name in electrical protection, has used to develop PV specific protection devices.



IEC 60269-6 Part 6 Edition One 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 Cooper Bussmann 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.

The International Electrotechnical Commissions (IEC) recognise the protection of PV systems is different to standard electrical installations. This is reflected in IEC 60269-6 (gPV) which defines specific characteristics that a fuse link should meet for protecting PV systems. Cooper Bussmann range of string and branch PV fuse links have been specifically designed to meet this standard. These PV fuse links are fully tested to the requirements of IEC 60269-6 However Cooper Bussmann 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 (see Figure 2 below)

- A number of individual cells are combined in a panel or module.
- A number of PV modules in series is a string.
- A number of strings in parallel is an array.

The voltage output of a Solar Module or Array is defined by the number of individual cells in series. An individual panel is made up of a series string of photovoltaic cells. Each cell is usually between 4" and 6" square.



Photovoltaic Module Output

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 up to approximately 8 amps maximum-power-point current per module with a typical voltage output of around 30 volts.

The maximum-power-point current of the modules can vary as much as 35% 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 panels 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 fault current to damage the conductors, equipment or modules. 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 on each string will protect the conductors 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 module output changes with the module temperature as well as the amount of sun it is 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 the PV fuse links should be derated according to the curves published on page 13 (Rated Current Dimensioning) in the Cooper Bussmann High Speed Fuse Application Guide # 3160 at www.cooperbussmann.com.





For product data sheets, visit www.cooperbussmann.com/DatasheetsIEC



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 which covers most variation due to installation.



 * This is often specified by module manufacturers as the Maximum series fuse rating.

** Iz: Current capability of cables.

String Protection - Worked Example

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





Overview of Array Protection

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

A fuse link on each sub-array will protect the conductors from fault current and help minimise any safety hazards. It will also isolate the faulted sub-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 sub-array fuse links. If a number of sub-arrays are subsequently combined then a further fuse link should be incorporated. This would be termed the array fuse link as shown below.

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.



How to Select Fuse Links for Array 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 which covers most variation due to installation.



* I_z: Current capability of cables.

Array Protection - Worked Example



 * I_Z: Current capability of cables.

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Solar PV Fuse Links Offering Specifications

Body				Rated Current	Rated Voltage		Stan	dards	-	Data Sheet	Page
Туре	Body Size	Fuse Type	Catalogue Symbol	(A)	(Vdc)	gPV*	UL	ccc	CSA	Number	Number
		Ferrule	PVM-(Amp)	4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 25, 30A	600Vdc		\checkmark		\checkmark	2153	15
		Ferrule	PV-(amps)A10F								
cal	10x38mm	Bolt Fixing	PV-(amps)A10-T	1 6 9 10 10 15 004	1000//da			./**			16 17
ylindri		PCB (one pin)	PV-(amps)A10-1P	1-0, 8, 10, 12,15, 20A	TUUUVac	v	v	v	v	720110	10-17
0		PCB (two pins)	PV-(amps)A10-2P								
	14x51mm	Ferrule	PV-(amps)A14F	15, 20, 25. 32A	1000 & 1100Vdc	\checkmark	\checkmark	√ †	à	720132	18
		Ferrule	PV-(amps)A14LF				 ✓ 				19
	14x65mm	With tags	PV-(amps)A14L-T	15, 20, 25, 32A	1300 & 1500Vdc	\checkmark		√ †	à	720139	
		With 10mm fixings	PV-(amps)A14LF10F								
NH	NH1	NH	PV-(amps)ANH1	50, 63, 80, 100, 125, 160A	1000Vdc	\checkmark	\checkmark	√ †	√ †	720133	20
		Bladed	PV-(amps)A-01XL	62 80 100 125 1604	1000\/da	./	./	./.			
	0171	Bolted	PV-(amps)A-01XL-B	03, 80, 100, 125, 160A	1000vac	v	v	V T	VŤ	-	
	UIXL	Bladed	PV-(amps)A-01XL-15	50 62 80 100 125 16000	1500Vdc	./	./		√ +		
		Bolted	PV-(amps)A-01XL-B-15	50, 65, 60, 100, 125, 100 ¹¹ A		v	v		VT		
	171	Bladed	PV-(amps)A-1XL	2004	1000)/- -	\checkmark	./		à		
	IAL	Bolted	PV-(amps)A-1XL-B	200A	1000/00		v	V T			
tody	171	Bladed	PV-(amps)A-1XL-15	100 105 160 2004	1500\/do	./	./				
E E	IAL	Bolted	PV-(amps)A-1XL-B-15	100, 123, 100, 200A	1500/00	v	v		VT	700124	01.00
anbo		Bladed	PV-(amps)A-2XL	200 250 215 2554	1000\/do	./	./			120134	21-23
	271	Bolted	PV-(amps)A-2XL-B	200, 250, 315, 555A	1000/00	v	V	V †	√ †		
	270	Bladed	PV-(amps)A-2XL-15	105 160 000 0504	1500)/da	./	1				
		Bolted	PV-(amps)A-2XL-B-15	125, 160, 200, 250A	1500/00	v	V	∨ †	√ †		
		Bladed	PV-(amps)A-3L	250, 400, 500, 620#4	1000\/do	./	./				
	21	Bolted	PV-(amps)A-3L-B	330, 400, 300, 630 ¹¹ A	1000Vdc		v		Vf		
	32	Bladed	PV-(amps)A-3L-15	250 215 255 4004	1500\/do	./	./				
		Bolted	PV-(amps)A-3L-B-15	200, 310, 300, 400A	1500400	v	v		v †		

* IEC 60269-6,** 1 to 15A only, † Pending, †† 630A thermally rated to UL only, ††† 160A at 1200Vdc

Fuse Holders & Blocks

Fuse Size	Holder/ Block Series	Part Number	Poles	Rated Voltage	Description	Data Sheet Number
	CHPV	CHPV1U CHPV1IU CHPV2U CHPV2IU	1 1 2 2	600Vdc/	IP20 Finger-Safe Holder IP20 Finger-Safe Holder with Indication IP20 Finger-Safe Holder IP20 Finger-Safe Holder with Indication	3185
10x38	BM	BM6031 (Terminal Type) BM6032 (Terminal Type) BM6033 (Terminal Type)	1 1000 2 3	1000Vdc	Open Fuse Blocks	1104
	HEB	HEB (Loadside and Lineside Terminal)	N/A		In-Line Fuse Holders	2126-2127
14x51	CH14	CH141B-PV	1	1000Vdc ⁺⁺	IP20 Finger-Safe Holder	2053
NH1	SD-D	SD1-D-PV	1	1000Vdc++	IP20 Finger-Safe Holderttt	720149
01XL 1XL 2XL 3L	SD	SD1XL-S SD1XL-S SD2XL-S SD3L-S	1 1 1 1	1500Vdc	Block Block Block Block	720146

† Literature reorder number.

†† Self certified.

††† Requires range of protection accessories.



PVM Fuse Links 10 x 38mm 4 to 30A / 600Vdc

Description:

A range of UL 2579 fast-acting 600Vdc 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 Symbol: PVM-(Amp)

Fuse Size: 10 x 38mm

Catalogue Numbers

Part Number	Rated Current (A)	Rated Voltage (Vdc)
PVM-4	4	
PVM-5	5	
PVM-6	6	
PVM-7	7	
PVM-8	8	
PVM-9	9	600Vda
PVM-10	10	000000
PVM-12	12	
PVM-15	15	
PVM-20	20	
PVM-25	25	
PVM-30	30	

Power Loss (Watts)

Part Number	Amp Rating	Power Loss (Watts)			
i art i diliber		0.8 x l _n	1 x I _n		
PVM-10	10	1.04	1.86		
PVM-15	15	1	1.72		
PVM-30	30	1.65	2.91		



Packaging: 10

Technical Data:Rated Voltage:600Vdc to UL 2579Rated Current:4-30AInterrupting rating:50kA DC (4 - 30A)

Dimensions - mm



Recommended Fuse Blocks/Fuse Holders

- Open fuse blocks:
 - BM Series (data sheet 1104)
- Modular fuse holder:
 - CHPV 1000Vdc (brochure 3185)
 - CHM 600Vdc (brochure 3185)
- Fuseclips:
 - 1A3400 Series (data sheet 2131)
- In-line fuse holders:
 - HEB Series (data sheets 2126 and 2127)





CHPV



CHM



1A3400

HEB

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10 x 38mm Photovoltaic Fuse Links 1 to 20A, 1000Vdc Solar PV Series

ic Joial FV Jenes	OA10F			
A range of fuse links in a 10 x 38mm package specifically designed for the protection and isolation of photovoltaic strings. The fuse links	Standards/Approvals:	IEC 6026 (File num CCC (1 to	9-6, UL 25 ber E33532 o 15A), RoH	79 24), IS compliant,
are capable of interrupting low overcurrents associated with faulted PV (reverse current, multi-array fault)	Packaging:	MOQ: 10 Packagin	g 100% red	cyclable
strings.	Technical Data:			
	Rated Voltage:	1000Vdc		
PV-(amp rating)A10F	Rated Current:	1-6A, 8-1	5A and 20/	4
PV-(amp rating)A10-T	Rated Breaking Capacity:		UL	IEC
PV-(amp rating)A10-1P		1-6A	50kAdc	50kAdc
PV-(amp rating)A10-2P		8-15A	50kAdc	50kAdc
gPV Fuse Links		20A	10kAdc	10kAdc
	Min Interrupting Rating:	1.3 x l _n		
10 x 38mm	PV Fuse Coordination:	Thin film of crystalline	cells and 4 ³ e silicon ce	", 5" and 6" lls.
	Time Constant:	1-3mS		

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COLAD DV

Dimensions - mm Cylindrical PV-**A10F

Catalogue Symbol:

Class of Operation:

Fuse Size:

Description:



PCB Fixing PV-**A10-1P



Bolt Fixing PV-**A10-T





10.3±0.1









10 x 38mm Photovoltaic Fuse Links 1 to 20A, 1000Vdc Solar PV Series

Technical Data

Cylindrical PCB Fixing		Bolt Fixing Rated	Rated	Energy Integ	grals I²t (A²s)	Watts Loss (W)		
Part Number	r Part Number Part Number (A)	(Vdc)	Pre-Arcing	Total at 1000V	0.8 I _n	I _n		
PV-1A10F	PV-1A10-1P	PV-1A10-T	1		0.15	0.4	0.8	1.5
PV-2A10F	PV-2A10-1P	PV-2A10-T	2		1.2	3.4	0.6	1.0
PV-3A10F	PV-3A10-1P	PV-3A10-T	3		4	11	0.8	1.3
PV-3-5A10F	PV-3-5A10-1P	PV-3-5A10-T	3.5		6.6	18	0.9	1.4
PV-4A10F	PV-4A10-1P	PV-4A10-T	4		9.5	26	1.0	1.5
PV-5A10F	PV-5A10-1P	PV-5A10-T	5	1000	19	50	1.0	1.6
PV-6A10F	PV-6A10-1P	PV-6A10-T	6	1000	30	90	1.1	1.8
PV-8A10F	PV-8A10-1P	PV-8A10-T	8		3	32	1.2	2.1
PV-10A10F	PV-10A10-1P	PV-10A10-T	10		7	70	1.2	2.3
PV-12A10F	PV-12A10-1P	PV-12A10-T	12		12	120	1.5	2.7
PV-15A10F	PV-15A10-1P	PV-15A10-T	15		22	220	1.7	2.9
PV-20A10F	PV-20A10-1P	PV-20A10-T	20		34	350	2.1	3.6

Recommended Fuse Blocks/Fuse Holders

- Open fuse blocks:
 - BM Series (data sheet 1104), self certified for 1000Vdc
- Modular fuse holders:
 - CHPV (brochure 3185)
- Fuseclips:
 - 1A3400 Series (data sheet 2131)
- In-Line fuse holders:
 - HEB Series (data sheet 2127)



BM Series



CHPV

1A3400



HEB

Photovoltaic System Protection Application Guide

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14 x 51mm Photovoltaic Fuse Links 15 to 32A, 1000/1100Vdc Solar PV Series



Description:	A range of 14 x 51mm fuse links specifically designed for protecting and isolating photovoltaic strings. These fuse links are canable of	Standards/Approvals:	IEC 60269-6, UL 2579 (File number E335324), RoHS compliant, pending CCC
	interrupting low overcurrents associated with faulted PV systems (reverse current, multi-array fault).	Packaging:	MOQ: 10 Packaging 100% recyclable
		Technical Data:	
Catalogue Symbol:	PV-(amp rating)A14F	Rated Voltage:	1000Vdc (25 & 32A) 1100Vdc (15 & 20A)
Class of Operation:	gPV Fuse Links	Rated Current:	15-32A
Fuse Size:	14 x 51mm	Rated Breaking Capacity: Min Interrupting Rating:	10kA 2 x I _n
Dimensions - mm		PV Fuse Coordination w/:	Thin film cells and 4", 5" and 6" crystalline silicon cells
		Time Constant:	1-3mS



Technical Data

	Rated	Rated	Energy Integ	grals I²t (A²s)	Watts Loss (W)		
Part Number	Current (A)	Voltage (Vdc)	Pre-Arcing	Total at Rated Voltage	0.8 l _n	I _n	
PV-15A14F	15	1100Vdc	14	265	2.1	4	
PV-20A14F	20	1100100	27	568	2.7	5	
PV-25A14F	25	1000V/dc	65	943	2.7	5.1	
PV-32A14F	32	TUUUVac	120	1740	3.3	6.2	

Recommended Fuse Holders

- Finger-safe fuse holders: •
 - Without indicator: CH14(number of poles)B-PV coming soon, self certified at 1000Vdc With indicator: CH14(number of poles)BI-PV coming soon, self certified at 1000Vdc



14 x 65mm Photovoltaic Fuse Links 15 to 32A, 1300 & 1500Vdc Solar PV Series



Description: A range of 14 x 65mm fuse links specifically Standards/Approvals: designed for protecting and isolating IEC 60269-6, UL 2579 (File number E335324), RoHS compliant photovoltaic strings. These fuse links are capable of interrupting low overcurrents Pending: CCC associated with faulted PV systems (reverse current, multi-array fault). Packaging: MOQ: 10 Packaging 100% recyclable Catalogue Symbol: Cylindrical: PV-(amp rating)A14LF Cylindrical with Tags: PV-(amp rating)A14L-T **Technical Data:** Cylindrical with 10mm Fixings: Rated Voltage: 1300Vdc (25 and 32A) PV-(amp rating)A14LF10F 1500Vdc (15 and 20A) Rated Current: 15-32A Class of Operation: gPV Fuse Links Rated Breaking Capacity: 10kA Min Interrupting Rating: $2 \times I_n$

Time Constant:

Fuse Size:14 x 65mm

Dimensions - mm

Cylindrical PV-(amp rating)A14LF



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



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

PV Fuse Coordination w/: Thin film cells and 4", 5" and 6"

1-3mS

crystalline silicon cells





Technical Data

Part Number		Rated Rated	Energy Integ	grals I²t (A²s)	Watts Loss (W)			
Cylindrical	Cylindrical with Tags	Cylindrical with 10mm Fixings	Current (A)	Voltage (Vdc)	Pre-Arcing	Total at rated voltage	0.8 l _n	I _n
PV-15A14LF	PV-15A14L-T	PV-15A14LF10F	15	1500V/dc	14	160	3.2	5.8
PV-20A14LF	PV-20A14L-T	PV-20A14LF10F	20	1000400	34	400	3.6	6.5
PV-25A14LF	PV-25A14L-T	PV-25A14LF10F	25	1300\/dc	65	550	4.1	7.5
PV-32A14LF	PV-32A14L-T	PV-32A14LF10F	32	1000400	105	900	5.7	10.4

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NH Photovoltaic Fuse Links 50 to 160, 1000Vdc PV 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 Symbol:	PV-(amp rating)ANH(size)
Class of Operation:	gPV Fuse Links
Fuse Size:	NH Size 1
Optional Microswitches:	170H0236, 170H0238 and BVL50

Technical Data

Deut Number	Rated	Rated Voltage (Vdc)	Energy Integ	grals I²t (A²s)	Watts Loss (W)		
Part Number	(A)		Pre-Arcing	Total at 1000V	0.8 I _n	I _n	
PV-32ANH1	32		80	720	4.3	8.5	
PV-40ANH1	40		185	1670	4.6	9	
PV-50ANH1	50		400	3600	5.4	10.5	
PV-63ANH1	63	1000	470	4300	6.1	12	
PV-80ANH1	80	1000	640	5760	7.9	15.5	
PV-100ANH1	100		1300	11,700	8.4	16.5	
PV-125ANH1	125		2600	23,400	8.9	17.5	
PV-160ANH1	160		5200	46,800	12.2	24	



Standards/Approvals:	IEC 60269-6, UL 2579 (File number E335324), RoHS compliant, Pending: CCC

Packaging:

MOQ: 3 Packaging 100% recyclable

1000)Vdc
50 -	160A
50k/	4
2 x	In
1-3n	nŚ
	1000 50 - 50k/ 2 x 1-3n

Dimensions - mm

Size 1



Recommended Fuse Bases

• SD(size)-D-PV single-pole, certified at 1500Vdc see data sheet 720149





SD(size)-D-PV

Recommended Microswitches

- 170H0236 or 170H0238
- BVL50





XL Style Phot 50 to 630A, 10	ovoltaic Fuse Links 000 & 1500Vdc PV Series		RADIA RADIA
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).		Т
Catalogue Symbol:	1000Vdc Bladed: PV-(amp rating)A(size)XL 1000Vdc Bolted: PV-(amp rating)A(size)XL-B 1500Vdc Bladed: PV-(amp rating)A(size)XL-15 1500Vdc Bolted: PV-(amp rating)A(size)XL-B-15	Standards/Approvals:	IEC 60269-6, UL 2579 (File number E335324), RoHS compliant. Pending: CCC
Class of Operation:	gPV Fuse Links	Packaging:	MOQ: 1 Packaging 100% recyclable
Fuse Sizes:	01XL, 1XL, 2XL and 3L	Technical Data: Rated Voltage:	1000Vdc: 63 to 630A*
Optional Microswitch For Bladed fuse links: For Bolted fuse links:	es: 170H0235 or 170H0237 for 01XL 170H0236 or 170H0238 for 1XL, 2XL and 3L 170H0069 for all sizes	Rated Current: Min Interrupting Rating Time Constant:	1200Vdc: 160A 1500Vdc: 50 to 400A 50-600A : 2 x I _n 1-3mS

Recommended Single-Pole Fuse Bases

- SD1XL-S (suitable for 01 and 1XL)
- SD2XL-S (suitable for 2XL)
- SD3L-S (suitable for 3L)

Data Sheet 720146



SD_XL-S

* 630A thermally rated to UL only

Data sheet: 720134

Recommended Microswitches

For bladed fuse links:

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

For bolted fuse links:

• 170H0069 for all sizes



XL Style Photovoltaic Fuse Links 50 to 630A, 1000 & 1500Vdc PV Series

Technical Data - 1000Vdc

Part Number		Rated	Rated	Energy Integ	grals I²t (A²s)	Watts Loss (W)		
Bladed Version	Bolted Version	Body Size	Current (A)	Voltage (Vdc)	Pre-Arcing	Total at 1000V	0.8 I _n	I _n
PV-63A-01XL	PV-63A-01XL-B		63		260	1900	13	24
PV-80A-01XL	PV-80A-01XL-B		80		490	3600	17	29
PV-100A-01XL	PV-100A-01XL-B	01	100	1000Vdc	870	6300	18	32
PV-125A-01XL	PV-125A-01XL-B	1	125	1	1930	13,900	20	40
PV-160A-01XL	PV-160A-01XL-B		160	1	3900	28,100	22	44
PV-200A-1XL	PV-200A-1XL-B	1	200	1000Vdc	9400	27,260	31	54
PV-160A-2XL	PV-160A-2XL-B		160	1000Vdc	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	2	250		9450	70,000	34	60
PV-315A-2XL	PV-315A-2XL-B	1	315		16,600	123,000	40	66
PV-355A-2XL	PV-355A-2XL-B		355	26,000	192,000	42	68	
PV-350A-3L	PV-350A-3L-B		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	3	500	1000Vdc	85,000	442,000	50	85
PV-600A-3L	PV-600A-3L-B]	600]	137,000	712,400	80	108
PV-630A-3L*	PV-630A-3L-B*]	630*]	137,000	712,400	92	118

Technical Data - 1500Vdc**

Part Number		F	Rated Rated		Energy Integ	grals I²t (A²s)	Watts Loss	
Bladed Version	Bolted Version	Body Size	Current (A)	Voltage (Vdc)	Pre-Arcing	Total at 1500V*	0.8 l _n	I _n
PV-50A-01XL-15	PV-50A-01XL-B-15		50		280	1450	6	26
PV-63A-01XL-15	PV-63A-01XL-B-15		63		420	2250	17	28
PV-80A-01XL-15	PV-80A-01XL-B-15	01	80	1500Vdc	950	5000	18	30
PV-100A-01XL-15	PV-100A-01XL-B-15	01	100	1	1250	6500	22	38
PV-125A-01XL-15	PV-125A-01XL-B-15		125		2200	11,500	27	48
PV-160A-01XL-12	PV-160A-01XL-B-12		160	1200Vdc	5000	19,000	24	48
PV-100A-1XL-15	PV-100A-1XL-B-15	4	100	1500\/do	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	1500000	4200	20,160	30	58
PV-200A-1XL-15	PV-200A-1XL-B-15		200		9400	45,120	31	61
PV-125A-2XL-15	PV-125A-2XL-B-15		125		2200	11,000	23	43
PV-160A-2XL-15	PV-160A-2XL-B-15	2	160	1500V/do	5000	25,000	26	50
PV-200A-2XL-15	PV-200A-2XL-B-15	2	200	1500700	9300	36,000	28	56
PV-250A-2XL-15	PV-250A-2XL-B-15		250		13,700	68,000	38	72
PV-250A-3L-15	PV-250A-3L-B-15		250		20,000	61,000	35	62
PV-315A-3L-15	PV-315A-3L-B-15	2	315	1500\/do	38,000	116,000	40	72
PV-355A-3L-15	PV-355A-3L-B-15		355	1300000	44,500	136,000	46	84
PV-400A-3L-15	PV-400A-3L-B-15		400	1	58,000	177,000	50	91

* 630A thermally rated to UL only **1200Vdc for 160A



XL Style Photovoltaic Fuse Links 50 to 630A, 1000 & 1500Vdc PV Series

Dimensions - mm

Bladed - Size 01XL, 1XL, 2XL and 3L







Size	а	b	С	d	е	f	g	h	i	j
01XL	194	128	125	129	20	8	43	41	22	6
1XL	190	128	120	124	20	13	51	40	20	6
2XL	205	129	120	124	26	14	59	48	20	6
3L	205	128	119	123	33	19	74	60	22	6

Bolted - Size 01XL, 1XL and 2XL







Size	а	b	С	d	е	f	g	h	i
01XL	188	128	6	43	59	165	151	11	20
1XL	184	128	6	51	67	161	147	11	20
2XL	192	129	6	60	75	168	155	11	25

Bolted - Size 3L



а

200

b

129

С

6





Data sheet: 720134

Size

3L

OOPER Bussmann

Surge Protective Device - PV Three Module

Description

The Cooper Bussmann Three Module, modular Surge Protective Device (SPD) (with three-step DC switching device) features easyID™ visual indication and optional remote contact signaling (floating changeover contact) for use in PV systems.

These complete surge protective devices are suitable for all PV systems in accordance with UL 1449 3rd Edition and IEC 60364-7-712. Includes a five year limited warranty.

These prewired solutions consist of a base and locking modules that feature a combined disconnection and short-circuiting (shunting) device with safe electrical isolation to prevent fire damage due to DC arcs. An integrated DC fuse allows safe module replacement without arc formation.

In case of insulation faults in the generator circuit, a reliable and tested fault-resistant Y circuit prevents damage to the surge protective devices.

The green and red visual indicator flags show the module protective status (green = good, red = replace). Apart from this visual indication, the remote signaling option features a three terminal floating changeover contact that can be used as a make or break contact depending on the particular monitoring system design employed.

Dimensions - mm



Shown with optional remote contact signaling

Short-Circuit Interrupting (SCI) Technology



Data sheet: 2055



Module Circuit Diagrams



Shown with optional remote contact signaling



Surge Protective Device - PV Three Module

Ordering Information						
Nominal PV System Voltage		600Vdc	600Vdc 1000Vdc 1200Vdc			
Catalog Numbers:	Without Remote Signaling	BSPH3600YPV	BSPH31000YPV	BSPH31200YPV		
(Base + Modules)	With Remote Signaling	BSPH3600YPVR	BSPH31000YPVR	BSPH31200YPVR		
Replacement Modules:	Outer (2)	BPH300YPV	BPH500YPV	BPH600YPV		
	Center (1)	BPM300YPV	BPM500YPV	BPM600YPV		
	Specifications	3				
Nominal PV System Voltage		600V	1000V	1200V		
MCOV [U _{CPV}]		700Vdc	1170Vdc	1200Vdc		
Max System Discharge Current (8/2	20 µs) [I _{max}]	40kA	40kA	30kA		
Voltage Protection Level [U _P]		<u>≤</u> 2.5kV	≤4.0kV	<u>≤</u> 4.5kV		
Voltage Protection Level at 5kA [UP]	<u>≤</u> 2.0kV	<u>≤</u> 3.5kV	≤4.0kV		
Integrated Fuse Breaking Capacity/	Interrupting Rating	30kA/1000Vdc	30kA/1000Vdc	30kA/1200Vdc		
Technology		Short-Circuit Interruption (SCI) Overcurrent Protection				
Operating Temperature Range [T _U]		-40°C to +80°C				
Nominal Discharge Current (8/20 µs	s) [(DC+/DC-)> PE] [I _n]		12.5kA			
Response Time [t _A]			<u>≤</u> 25ns			
Operating State/Fault Indication		Green (good)/Red (replace)				
Conductor Ratings and Cross-Sect	ional Area: Minimum	60/75°C 1.5mm²/14AWG Solid/Flexible				
	Maximum	60/75°C 35mm ² /2AWG Stranded/25mm ² /4AWG Flexible				
Mounting		35mm DIN Rail per EN 60715				
Enclosure Material		UL 94V0 Thermoplastic				
Degree of Protection		IP20				
Capacity		3 Modules, DIN 43880				
Standards Information:	UL	UL 1	449 3 rd Edition (Typ	be 2)*		
	IEC	IEC 6164	3-11 Type 2, IEC 6	1643-1 Class II		
Product Warranty			Five Years**			
	Remote Contact Sig	gnaling				
Remote Contact Signaling Type		(Changeover Contac	t		
AC Switching Capacity (Volts/Amps	8)		250V/0.1A			
DC Switching Capacity (Volts/Amps	6)	250V/0.1A; 125V/0.2A; 75V/0.5A				
Conductor Ratings and Cross-Sectional A	rea for Remote Contact Signal Terminals	60/75°C	Max. 1.5mm ² /14A	VG Solid/Flexible		
Ordering Information		Order from Catalog Numbers Above				

*Does not apply to 1200Vdc.

** See Cooper Bussmann SPD Limited Warranty Statement (3A1502) for details at www.cooperbussmann.com

Typical Application Schematics



***BSPH31000YPV(R) 1000Vdc one energized pole/mode requires the following:

1. Use a suitable electrical insulator to keep a 10mm min. safety distance from the PV-SPD and other grounded

- parts in the housing as shown
- 2. No metal covers are in the area of the module release buttons as shown.

Bussmann

Surge Protective Device - PV Two Module

Description

The Cooper Bussmann[®] modular Surge Protective Device (SPD) (with two-step DC switching device) features *easy*ID[™] visual indication and optional remote contact signaling (floating changeover contact) for use in photovoltaic systems.

This complete surge protective device is suitable for all PV systems in accordance with UL 1449 3rd Edition and IEC 60364-7-712. Includes a five year limited warranty.

This prewired solution consist of a base and locking modules that feature a combined disconnection and short-circuiting (shunting) device with safe electrical isolation to prevent fire damage due to DC arcs. An integrated DC fuse allows safe module replacement without arc formation.

In case of insulation faults in the generator circuit, a reliable and tested fault-resistant circuit prevents damage to the surge protective devices.

The green and red visual indicator flags show the module protective status (green = good, red = replace). Apart from this visual indication, the remote signaling option features a three terminal floating changeover contact that can be used as a make or break contact depending on the particular monitoring system design employed.

Short-Circuit Interrupting (SCI) Technology

- 1. Original State
- 2. Disconnection Device Response
- 3. Arc Extinguishes 4. Safe Electrical Isolation





Dimensions - mm 30 7 7 43.5 65 15.3 15.3 11 11 1111

Shown with optional remote contact signaling

Module Circuit Diagrams



4



Surge Protective Device - PV Two Module

	Ordering Information						
Nominal PV System Voltage		600Vdc					
Catalog Numbers:	Without Remote Signaling	BSPH2600PV					
(Base + Modules)	With Remote Signaling	BSPH2600PVR					
Replacement Modules:	Left	BPH300YPV					
	Right	BPM300YPV					
	Specifica	tions					
Conformity with prEN 50539-11		Yes					
SPD Classification per EN 61643-11		Type 2					
SPD Classification per IEC 61643-1		Class II					
Max. PV voltage [U _{CPV}]		≤ 600V					
Short-circuit withstand capacity [ISCW	PV]	1000A					
MCOV [U _{CPV}]		700Vdc					
Nominal discharge current (8/20 µs) [(I	DC+/DC-)> PE] [I _n]	12.5kA					
Max. Discharge current (8/20 µs) [(DC-	+/DC-)> PE] [I _{max}]	25kA					
Voltage protection level [U _P]		≤ 2.5kV					
Voltage protection level at 5kA [U _P]		≤ 2kV					
Response time [t _A]		≤ 25 ns					
Operating temperature range [T _U]		-40°C to +80°C					
Operating state/fault indication		Green (good) / Red (replace)					
Number of ports		1					
Cross-sectional area (min.)		60/75°C 1.5mm ² /14AWG Solid/Flexible					
Cross-sectional area (max.)		60/75°C 35mm ² /2AWG Stranded/25mm ² /4AWG Flexible					
For mounting on		35 mm DIN rail per EN 60715					
Enclosure material		Thermoplastic, UL 94V0					
Place of installation		Indoor					
Degree of protection		IP20					
Capacity		2 Modules, DIN 43880					
Standards Information		UL					
Product Warranty		Five Years*					
	Remote Contac	et Signaling					
Remote Contact Signaling Type		Changeover Contact					
AC Switching Capacity (Volts/Amps)		250V/0.1A					
DC Switching Capacity (Volts/Amps)		250V/0.1A; 125V/0.2A; 75V/0.5A					
Conductor Ratings and Cross-Sectional Area for	Remote Contact Signal Terminals	60/75°C Max. 1.5mm²/14AWG Solid/Flexible					
Ordering Information		Order from Catalog Numbers Above					

* See Cooper Bussmann SPD Limited Warranty Statement (3A1502) for details at www.cooperbussmann.com/surge.

Typical Application Schematics



Surge Protective Device - PV One-Pole Current Surge and Lightning Arrester

Description

The Cooper Bussmann combined lightning current and surge arrester (SPD Class I according to IEC 61643-1) is for use in photovoltaic power supply systems.

- Prewired combined lightning current and surge arrester for use in photovoltaic generator circuits
- For use in photovoltaic installations up to 1000V U_{CPV}
- High lightning current discharge capacity using spark gap technology
- Maximum system availability due to spark gap technology with DC current extinction

Dimensions - mm





BSPS31000PV



Module Circuit Diagrams





Surge Protective Device - PV One-Pole Current Surge and Lightning Arrester

Ordering Information						
Max. PV System Voltage	1000Vdc					
Catalog Number:	BSPS31000PV					
Specifications	6					
SPD Classification according to EN 61643-11	Туре 1					
SPD Classification according to IEC 61643-1	Class I					
Max. PV voltage [U _{CPV}] of the PV generator	1000V					
Max. Continuous operating DC voltage [Umax DC]	1000V					
Min. Continuous operating DC voltage [U _{min} DC]	100V					
Follow current extinguishing capability DC [I _{fi} DC]	100A					
Nominal discharge current (8/20 µs) [I _n]	100kA					
Lightning impulse current (10/350 µs) [L+/L> PE] [I _{imp}]	50kA					
Specific energy [L+/L> PE] [W/R]	625.00 kJ/ohms					
Lightning impulse current (10/350 µs) [L+ -> L-] [I _{imp}]	25kA					
Specific energy [L+ -> L-] [W/R]	156.25 kJ/ohms					
Voltage protection level $[L + -> L-]$ $[U_p]$	≤ 3.3kV					
Voltage protection level [(L+/L-) -> PE] [U _p]	≤ 4 kV					
Operating current [I _{IN} DC]	≤ 5mA					
Response time [L+ -> L-] [t _A]	≤ 20 ns					
Protective conductor current [I _{PE}]	≤ 1µA					
Operating temperature range [T _u]	-40°C to +60°C					
Number of ports	1					
Cross-sectional area (min.)	10mm ² /6AWG solid/flexible					
Cross-sectional area (max.)	50mm ² /2AWG stranded/ 35mm ² /1AWG flexible					
Mounting	35mm DIN rail per EN 60715					
Enclosure material	Thermoplastic, UL 94V0					
Place of installation	Indoor					
Degree of protection	IP-20					
Capacity	8 Mods., DIN 4					
Product Warranty	Five Years*					

* See Cooper Bussmann document 3A1502 on the web at www.cooperbussmann.com.

Typical Application Schematics



Cooper Comprehensive Product Solutions for Global Solar Applications

Circuit Management

The AC/DC disconnects are designed to provide an extra measure of protection with flexibility of application. Built-in safety features provide a safer product with reliable protection for your solar equipment.

Rooftop Mounting

The monolithic solar mounting system is designed to deliver labor savings and a lower total cost investment with pre-assembled components. The system easily adapts to both portrait and landscape mounting and accommodates virtually any type and size of solar PV panels.



Combiner & Recombiner

The combiner box offering allows for overcurrent and overvoltage safeguard solutions in-a-box. Solar circuit protection is made simple with a complete combiner box offering that allows for reduced installation and material costs by combining your solar array circuits.

COOPER B-Line

Wire and Cable Management

COOPER Bussmann

Circuit Protection and Electrical Safety

Wireless

Solar wireless products provide secure and reliable communication from combiner boxes to remote networks. Information communicated can include: temperature, voltage, relay controls, and live video delivering critical solar panel performance data and ensuring consistent reliability.

COOPER Crouse-Hinds

Harsh and Hazardous Electrical Solutions

COOPER Lighting **Total Lighting Solutions**



Cable Harness Assemblies

Solar assemblies provide the backbone for the entire Photovoltaic system. Thoughtfully considered designs optimize power output and reduce failures and warranty claims. Core products include jumpers, whips, parallel circuit and homerun harnesses.

Cable Management

The Type 3R wireway is the industry's first quick–connecting solution that is UL listed and CSA certified. The enclosed system protects wire and cable in extreme outdoor conditions.



Ground Mound

The ground mount system can be installed without the use of mechanical assistance and is designed to reduce pier depth. The system is compatible with multiple pier types and each panel support is preassembled to project specific panel specifications.

Grid–Tie & Automation Solutions

A complete portfolio of medium voltage equipment facilitates grid-tie solar generation. They include Envirotemp FR3 fluidfilled transformers, switchgear, and cable connector systems specifically designed for Photovoltaic Solar applications.

COOPER Power Systems Medium Voltage Power Solutions

COOPER Safety

Protection of People and Property

COOPER Wiring Devices Industrial Wiring Solutions

Customer Assistance

Customer Satisfaction Team

The Cooper Bussmann[®] Customer Satisfaction Team is available to answer questions regarding Cooper Bussmann products.

Europe calls can be made between:Monday - Thursday7.30 a.m. - 5.30 p.m. GMTFriday7.30 a.m. - 5.00 p.m. GMT

The Customer Service Satisfaction Team can be reached via:

- Phone: 00 44 (0) 1509 882 600
- Fax: 00 44 (0) 1509 882 786
- Email: bulesales@cooperindustries.com

C³ Cooper Customer Center

The Cooper C³ portal supports the following Cooper Divisions: Cooper B-Line, Cooper Bussmann, Cooper Crouse-Hinds, Cooper Lighting, Cooper Power Systems, Cooper Safety, and Cooper Wiring Devices. Get started today at WWW.COOPERC3.COM by clicking Request User ID and Password.

- Easy to Navigate
- Simple to Use
- Real-Time Data

Online Resources

Visit www.cooperbussmann.com for the following resources:

- Product cross reference
- Product profiles
- Online catalogues for the latest United States and European catalogues

Application Engineering

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.

Europe calls can be made between:

Monday - Thursday	8.30 a.m 4.30 p.m. GM	Τ
Friday	8.30 a.m 4.00 p.m. GM	Τ

Application Engineering can be reached via:

- Phone: 00 44 (0) 1509 882 699
- Fax: 00 44 (0) 1509 882 794
- Email: buletechnical@cooperindustries.com

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