

DC Isolators: What are the Manufacturer's Specification Sheets Really Telling You?

Solar photovoltaic (PV) systems use rotary DC isolators with multiple current and voltage ratings more commonly than DC rated circuit breakers. However, the flexibility of these DC isolators introduces instances of incorrect wiring when manufacturer's specifications are misunderstood, resulting in DC isolators being underrated for the PV system installed.

This document is written to help with interpreting the product manufacturer's data in the correct selection of DC isolators to meet requirements set out by the Australian Standards.

Definitions

The term 'poles' commonly refers to the positive and negative terminals of an electrical device. For PV systems, this term is used to describe both the isolator terminals and, according to AS/NZS 5033:2014, the array poles, i.e. the PV string conductors. To remove confusion, in this document the term **pole** (or **poles**) is used to describe only the terminals on the isolators, whereas the positive and negative sides of the PV string are referred to as the **string conductors**.

Isolator Rating Requirement

The type of inverter used and whether functional earthing is present determine the required isolator ratings. For an explanation as to why the isolator requirement is determined this way, please see the GSES document *DC Isolator Sizing Requirements*, which is available on the GSES website.

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A summary of DC isolator rating requirements under current standards (AS/NZS 5033:2014) is below:

Array configuration	Non-isolated PV system*	Isolated PV system [†]
Voltage	Isolator is rated to PV array maximum voltage [‡] for each string conductor individually	Isolator is rated to PV array maximum voltage [‡] for both string conductors collectively
Current	$I_{sc} \times 1.25^{\S}$	

*A non-isolated PV system is a system that has a transformerless inverter.

[†]An isolated PV system is a system using a transformer inverter.

[‡]PV array maximum voltage is the maximum system V_{OC} at minimum temperature.

[§]Applicable for the majority of systems, but not all. See AS/NZS 5033:2014 Table 4.2 for more information.

NOTE: Systems with functional earthing require the same isolator ratings as non-isolated PV systems.

This document refers to non-isolated PV systems unless otherwise stated.

Determining isolator rating

Many isolator products have four to eight poles per isolator: the isolator ratings will vary according to the current and wiring configuration. It is important to correctly match the isolator rating to the wiring configuration.

Consider the two wiring configurations shown in [Figure 1](#) and [Figure 2](#).

The isolator rating for each string conductor individually should be at least the PV array maximum voltage. In [Figure 1](#), only one pole of the isolator is connected to each string conductor.



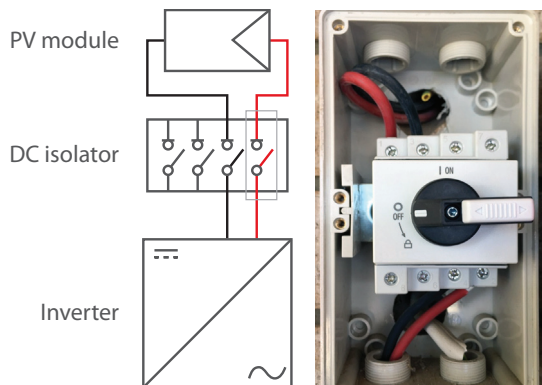


Figure 1: Schematic and photo showing a **single pole** of the isolator used per string conductor.

Therefore, the isolator's **single pole** voltage rating at the current requirement must be greater than the array's maximum voltage as calculated. In **Figure 2**, two poles are connected in series to each string conductor. In this example, the voltage rating of the isolator having **two poles in series** must be greater than the array's maximum voltage.

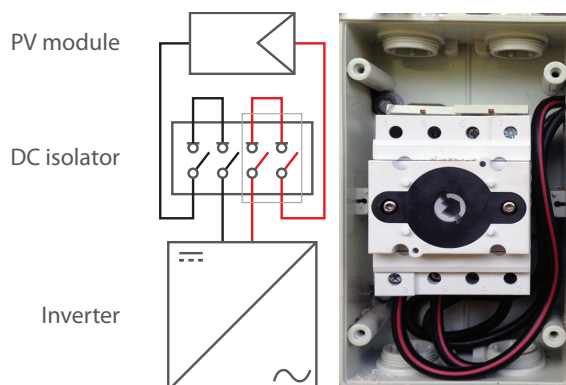





Figure 2: Schematic and photo showing **two poles in series** used per string conductor.

By identifying the number of isolator poles used by each string conductor, designers can ensure that they are referring to the correct isolator rating in the manufacturer's specifications.

Manufacturer's Specifications

Rotary DC isolators generally have varying voltage ratings depending on the system's current. This information is typically presented in the following format:

Array configuration	Voltage rating (V)	Current rating (A)
One pole 	300	23
	500	11
	800	4
Two poles in series 	500	25
	800	20
	1000	11
	1500	4
Four poles in series 	500	25
	800	25
	1000	25
	1500	20

A simplified table is often included on the isolator or isolator enclosure; for example:

	500 V	800 V	1000 V	1500 V
2 P	25 A	20 A	11 A	4A
4 P	25 A	25 A	25 A	20 A

Manufacturer's Connection Diagrams

Connection diagrams are provided by manufacturers to illustrate the isolator's internal connections and isolator ratings at different configurations. However, these diagrams should not be used to determine the isolator rating, as **the connection diagrams generally do not match the ratings needed for non-isolated PV systems.**

For example, a manufacturer can provide the connection diagram shown in **Figure 3** for two poles in series.

When the isolator is connected to a non-isolated system as shown in **Figure 3**, the **single pole** rating, instead of the two poles in series rating, must be used to meet the isolator rating requirements. This is because only one pole is being used per string



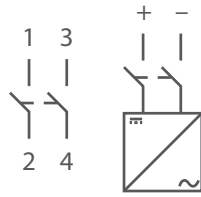


Figure 3: A typical 'two poles in series' connection diagram provided by a manufacturer.

conductor, so each pole must have a rating greater than or equal to the PV array maximum voltage.

Similarly, consider the typical manufacturer-provided four poles in series connection diagram in Figure 4.

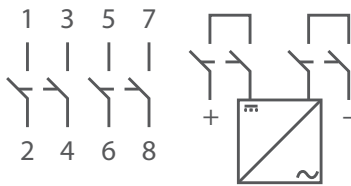


Figure 4: A typical 'four poles in series' connection diagram provided by a manufacturer.

When a non-isolated system is connected as shown in Figure 4, the two poles in series rating, rather than the four poles in series rating, should be used because each string conductor uses two poles of the isolator.

A Common Problem

Because of the lack of clarity in the product information provided by manufacturers for their isolators, GSES has observed numerous systems wired incorrectly to use two out of four poles, resulting in isolators being underrated for voltage and/or current.

This problem can usually be rectified by wiring the isolator to use all four poles of the isolator. However, in some cases, the isolator does need to be replaced to comply with requirements.

Example

Consider the following non-isolated PV system:

Two arrays are connected to a transformerless inverter with dual MPPTs.

The isolators used have the following ratings:

	400 V	500 V	800 V	1000 V	1500 V
1P*	14 A	11 A	4 A	2 A	N/A
2P	N/A	25 A	20 A	11 A	5 A
4P	N/A	25 A	25 A	25 A	20 A

*Single pole ratings are not always provided on the manufacturer's specifications sheet. Ensure this information is available if the wiring configuration requires it.

The respective array's required isolator rating per string conductor and wiring configuration at the isolator are as follows:

Array 1:

$$V_{MAX} = 585.2 \text{ V}$$

$$I_{SC MAX} = 11.58 \text{ A}$$

Isolator wiring for Array 1 is shown in Figure 5.

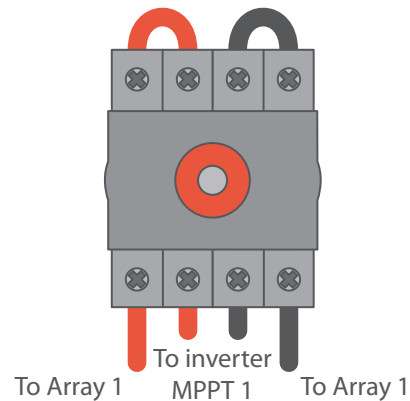


Figure 5: Current Array 1 isolator wiring.

Each string conductor is connected to two poles of the isolator in series; therefore, the two poles in series rating is applicable. Looking at the two pole in series rating of this isolator:

	500 V	800 V	1000 V	1500 V
2P	25 A	20 A	11 A	5 A

Using the compliant current rating, 20A, the isolator is rated to 800 V, which is well above the maximum system voltage. Therefore, this isolator is rated and wired correctly.



Array 2:

$$V_{\text{MAX}} = 498.4 \text{ V}$$

$$I_{\text{SC MAX}} = 11.58 \text{ A}$$

Isolator wiring for Array 2 is shown in Figure 6.

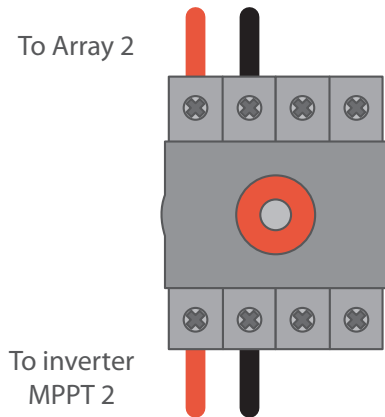


Figure 6: Current Array 2 isolator wiring.

This isolator uses only one pole of the isolator per string conductor, thus the following isolator rating is applicable:

	400 V	500 V	800 V	1000 V
1P	14 A	11 A	4 A	2 A

Wired in this configuration, the isolator is underrated. At the required current rating, 14 A, the voltage rating is 400 V, which is less than the voltage rating required. The isolator should be re-wired so each string conductor is wired with two poles in series to take advantage of the higher isolator rating shown.

Note that the voltage rating at 11A cannot be used as this current rating is lower than the required isolator current rating.

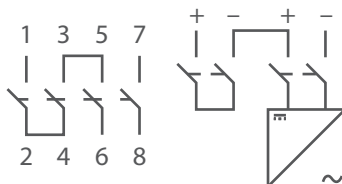


Figure 7: A 'four poles in series' connection diagram.

Other Wiring Configurations

Some manufacturers consider the wiring shown in Figure 7 to be four poles in series.

This configuration is also annotated as '3 + 1' on some specification sheets. For a non-isolated PV system using this configuration, the single pole rating of the isolator needs to be higher than the required isolator rating because the negative string conductor is using only one pole.

Lack of Isolator Information

Some manufacturers do not provide the single pole rating of their isolators on their datasheets. Installers might try to estimate a single pole rating by halving the two pole rating; however, be aware that the relationship between isolator ratings and the number of poles used is not always linear.

Because there is no reliable way to estimate an isolator's breaking capacity, GSES does not recommend installing isolators in configurations for which the manufacturer does not provide the rating.

The following tables show major isolator brands and the non-linear relationship between isolator pole and voltage rating. The ratings shown in bold italics indicate instances where the two pole in series and single pole voltage rating do not share a linear relationship.

Benedikt and Jagar LS32

	Wiring configuration		
Current Rating (A)	Four poles in series	Two poles in series	Single pole
32	1000 V	500 V	N/A
27	1200 V	700 V	300 V
23	1500 V	800 V	300 V
20	1500 V	900 V	300 V
16	1500 V	900 V	400 V
13	1500 V	1000 V	500 V
10	1500 V	1200 V	600 V



Telegron TFFV50 series

Current rating (A)	Wiring configuration		
	Four poles in series	Two poles in series	Single pole
50	1000 V	400 V	200 V
40	1000 V	500 V	250 V
25	1000 V	600 V	300 V
10	1000 V	850 V	450 V
8	1000 V	1000 V	500 V

Zj-BENY BYH-32

Current rating (A)	Wiring configuration		
	Four poles in series	Two poles in series	Single pole
32	1000 V	500 V	N/A
32	1000 V	600 V	N/A
23	1000 V	800 V	N/A
13	1000 V	1000 V	N/A

Conclusion

GSES recommends that installers and designers consult the manufacturer's isolator rating with the system's wiring configuration and the rating requirement in mind and only use configurations that are provided with manufacturer's rating. This will ensure that the PV system can be isolated safely even in fault conditions.

GSES welcomes feedback on technical papers and other resources available on www.gses.com.au, please contact GSES by email at info@gses.com.au or by telephone on 1300 265 525.

