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AS/NZS 4509.1:2009
AS/NZS 4509.2:2010

Revisions to the Stand Alone Power Supply Systems Design and Installation Manual, Seventh Edition

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Introduction

Over the last few years Australian Standards relevant to the design and installation of Stand Alone Power Systems have been revised and released. In particular these include:

- AS/NZS4509.1:2009 replacing AS4509.1:1999 and AS4509.3:1999
- AS/NZS4509.2:2010 replacing AS4509.2:2002
- AS/NZS5033:2012 replacing AS/NZS5033:2005

This document is to be used in conjunction with the Stand Alone Power Supply Systems Design and Installation Training Manual 7th Edition (GSES) as a reference source to inform you of the changes which the above standards have had on its content. This summary document includes the amendments to the Seventh Edition of the above publication as required by the updated standards. Please note that the changes in this document are subject to alterations in newer editions of the Stand Alone Power Supply Systems Design and Installation Training Manual and although this document has been prepared with the utmost care, it is the reader's responsibility to review the above standards and apply the changes where deemed necessary.

Changes

Following is the summary of changes to the information currently contained within Stand Alone Power Supply systems Design and Installation Training Manual 7th Edition (GSES).

General

1. All references to AS4509 should be changed to AS/NZS4509.

Chapter 4

2. Section 4.15, page 37 – Licensing requirements

Replace

- *AS4509 Stand-alone Power Systems*
  Part 1: Safety
  Part 2: System design guidelines
  Part 3: Installation and maintenance
- *AS/NZS5033:2005 Installation of photovoltaic (PV) arrays*

With

- *AS/NZS4509:2009 Stand-alone Power Systems*
  Part 1: Safety and Installation
- *AS/NZS4509:2010 Stand-alone Power Systems*
  Part 2: System design guidelines
- *AS/NZS5033:2012 Installation and safety requirements of photovoltaic (PV) arrays*

Chapter 9

3. Section 9.27, page 104 – Installation requirements

Replace

- *AS4509.1 Stand Alone Power Systems- Part 1 Safety;*
- *AS4509.2 Stand Alone Power Systems- Part 2 System Design Guidelines; and*
- *AS4509.3 Stand Alone Power Systems- Part 3 Installation and Maintenance.*

With

- *AS/NZS4509:2009 Stand-alone Power Systems Part 1: Safety and Installation*
- *AS/NZS4509:2010 Stand-alone Power Systems Part 2: System design guidelines*

Chapter 17

4. Section 17.4.1, page 201 – Temperature correction factor

Replace

Typical battery capacity correction factor as a function of temperature is shown in Figure 17.1. (Reproduced from AS4509.2 Figure 5 page 36).

With

Typical battery capacity correction factor as a function of temperature is shown in Figure 17.2 (based on AS/NZS4509.2).

Add

Figure 17.2 (previously referred to as 17.1) is missing from Chapter 17, so is included below:

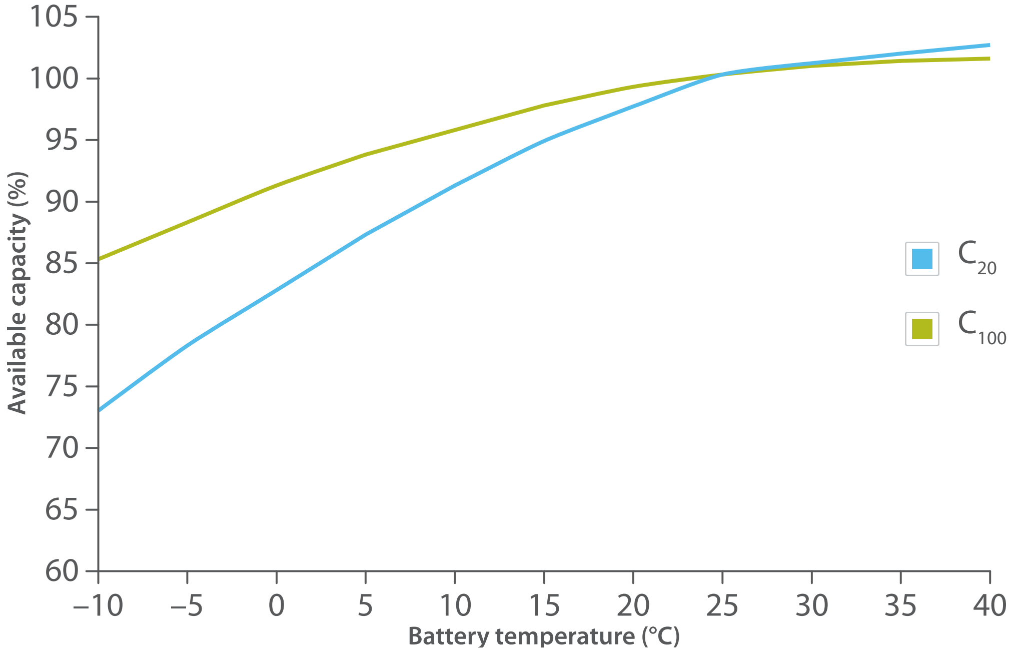


Figure 17.2 Typical battery capacity correction factor as a function of temperature for C_{100} and C_{20} discharge rates.

5. Section 17.4.5, page 203 – Number of parallel battery strings (Example)

With the addition of image 17.2, Figure 17.2 is now Figure 17.3 and Figure 17.3 is now Figure 17.4.

6. Section 17.5, page 204 – Specifying an inverter

Replace

AS4509.2 recommends that inverters be oversized by a minimum of 10%.

With

AS/NZS4509.2 Table B6 suggests that a safety factor for inverters is applied as a design decision only, and Table A6 indicates that it is a decision made at the time of the system's design and that a typical figure of 10% is suggested.

Chapter 20

7. Section 20.0, page 265 – System wiring

Replace

This chapter also refers to AS/NZS5033 Installation of photovoltaic arrays.

With

This chapter also refers to AS/NZS5033:2012 Installation and safety requirements of photovoltaic (PV) arrays.

8. Section 20.4, page 267 – Permissible voltage drop in conductors

After the following paragraph:

Cables from the solar array to the batteries should be selected so that the voltage drop between the array and the batteries is less than 5% of the system voltage. It is also recommended that the voltage drop between the batteries and any load be limited to 5%, especially in 12V systems.

Add the following sentence:

Note that in accordance with AS/NZS5033: 2012 Clause 2.1.9 Paragraph (C) that the maximum voltage drop permissible between the array and controller is 3%.

9. Section 20.8, page 273 – Array fault current protection and cable sizing

AS/NZS5033: 2012 does not allow for fire safety, therefore:

Replace the entire Section 20.8 with:

Fault current protection requirements on strings, sub arrays and arrays as detailed in AS5033.

Fault current protection requirements on strings, sub arrays and arrays is detailed in AS/NZS5033:2012 – Installation and safety requirements of photovoltaic (PV) arrays.

PV array cables in SAPS must always have fault current protection, as stated in Clause 3.3.3 (Page 24) of AS/NZS5033:2012. This is to protect the array cables from battery fault currents.

Clause 3.3.5 (page 25) describes how fault current protection is designed for PV strings, sub arrays and arrays. The fault current protection must be rated as follows:

For strings:

$$1.5 \times I_{SC\ mod} \leq I_{TRIP} \leq 2.4 \times I_{SC\ mod}$$

$I_{SC\ mod}$ = module short circuit current

I_{TRIP} = trip current of fault current protection device

For sub arrays (see Note 2 below):

$$1.25 \times I_{SC\ sub\ array} \leq I_{TRIP} \leq 2.4 \times I_{SC\ sub\ array}$$

$I_{SC\ sub\ array}$ = sub array short circuit current

I_{TRIP} = trip current of fault current protection device

For arrays:

$$1.25 \times I_{SC\ array} \leq I_{TRIP} \leq 2.4 \times I_{SC\ array}$$

$I_{SC\ array}$ = array short circuit current

I_{TRIP} = trip current of fault current protection device

Notes:

1. In small arrays, if all the cables within the array are rated greater than 1.25 × short circuit current of the array, then no sub-array protection is required.

2. Manufacturers' specifications may include the module's 'maximum series fuse rating' or 'trip current' or 'fault current'. IF so, this procedure is not required. The lower of these limits (1.25) is chosen so that the protection does not trip in the event of increased irradiance. Since it is often not possible to find protection that exactly matches this limit, a range (1.25 or 1.5 to 2.4) is required.

Often circuit breakers with isolation capabilities are used for fault current protection, thus allowing isolation to work safely on parts of the system.

Under Clause 3.3.5.3 of AS/NS5033: 2012, the array overcurrent protection device can be provided either on the array cable or between the solar controller and the battery as long as it sized appropriately to protect the array cables.

Clause 4.3.6 in AS/NZS2033: 2012 details the current rating requirements for:

- *String/sub array/array cables that require fault current protection, and*
- *String/sub array cables that do not require fault current protection.*

Table 20.5 lists these requirements. When sizing cables, you need to remember that voltage drop requirements must be fulfilled as well.

Table 20.5 Current rating of PV array circuits

Cable	Minimum current used to determine cable size
PV string cable (no protection on string)	Trip current of closest downstream protection device + $1.25 \times I_{sc\ mod} \times$ (number of parallel strings – 1) Note: closest downstream protection device is the sub array protection device (typically fuse), or if there isn't one, the array overcurrent protection device (typically fuse).
PV string cable (protection on string)	Trip current of string protection device
PV sub-array cable (no protection on sub-array)	The larger of: Trip current of the array protection + $1.25 \times I_{sc\text{-}sub\text{-}array} \times$ (number of sub-arrays – 1); or $1.25 \times I_{sc\_sub\text{-}array}$
PV sub-array cable (protection on sub-array)	Trip current of sub-array protection device
PV array cable (protection on array)	Trip current of array protection device

Example:

An array consists of 3 parallel strings. Each string has 2 modules in series, with the following characteristics:

V_{mod}	*24V*
I_{SC}	*5.4A*
$I_{mod\_reverse}$	*15A*

What size array cable and array fuse are required?

What size string cable is required? Does it meet voltage drop requirements?

Is string protection required? If so, what size?

Array fuse

Must be between 1.25 and 2 times the array short circuit current

Hence: *Minimum fuse size = $1.25 \times 3 \times 5.4 = 20.25$A*

Maximum fuse size = $2.4 \times 3 \times 5.4 = 38.9$A

The fuse chosen is 30A.

Array cable

As stated previously, the circuit protection can be smaller than the current carrying capacity of the cable but never larger.

Thus the cable chosen (from Table 20.3) is 7.56mm² with a CCC of 45A.

String cable (without protection)

Must be between the rated trip current of the nearest downstream protection device (the array fuse) + 1.25 × the short circuit current from the other strings

Hence string cable size = 30A (array fuse) + 1.25 × 2 × 5.4 (fault current that can come from the other two strings)

=43.5A

Based on the table above, the cable chosen is 7.56 mm² with a CCC of 45A.

Max. permissible voltage drop (V_d) = 0.05 × 48 = 2.4V between the array and the batteries.

In accordance with AS/NZS5033:2012 the maximum voltage drop between the array and controller is 3%.

Let's assume that the voltage drop for the string cables is 1%, the array cable is 2% therefore the respective maximum permissible voltage drops are:

String cable (V_d) = 0.01 × 48 = 0.24V

Array cable (V_d) = 0.02 × 48 = 0.48V

$$V_d = \frac{2 \times L \times I \times R}{A} \quad \text{and} \quad L = \frac{V_d \times A}{2 \times I \times R} = \frac{0.24 \times 7.56}{2 \times 5.4 \times 0.0183} = 9.18m$$

Hence the maximum length you can have is 9.18m (string to string combiner box). This is achieved for string cable.

Hence voltage drop requirements are fulfilled.

In this case, the potential fault current through the string cable is greater than $I_{mod\_reverse}$. Thus string current protection would be required if the installation was not deemed fire safe.

String fuse (where protection is used)

Must be between 1.5 and 2.4 times the module short circuit current.

Hence: Minimum fuse size = 1.5 × 5.4 = 8.1A

Maximum fuse size = 2.4 × 5.4 = 13.1A

The fuse chosen is 10A.

String cable (with protection)

Minimum CCC is 10A.

Hence the cable chosen (from Table 20.3) is 2.09mm² with a CCC of 15A. As you can see, with string protection, the cable required is much smaller (and hence cheaper); however, you need to ensure the voltage drop requirements are still met.

$$V_d = \frac{2 \times L \times I \times R}{A} \quad \text{and} \quad L = \frac{V_d \times A}{2 \times I \times R} = \frac{0.24 \times 2.09}{2 \times 5.4 \times 0.0183} = 2.54m$$

So the string cables must be less than 2.54m to have a voltage drop of less than 1% or if it was allowed to be 2% then the cables would be less than 5.08M, while if the 3% was just on string cables then the string cables must be less than 7.62M.

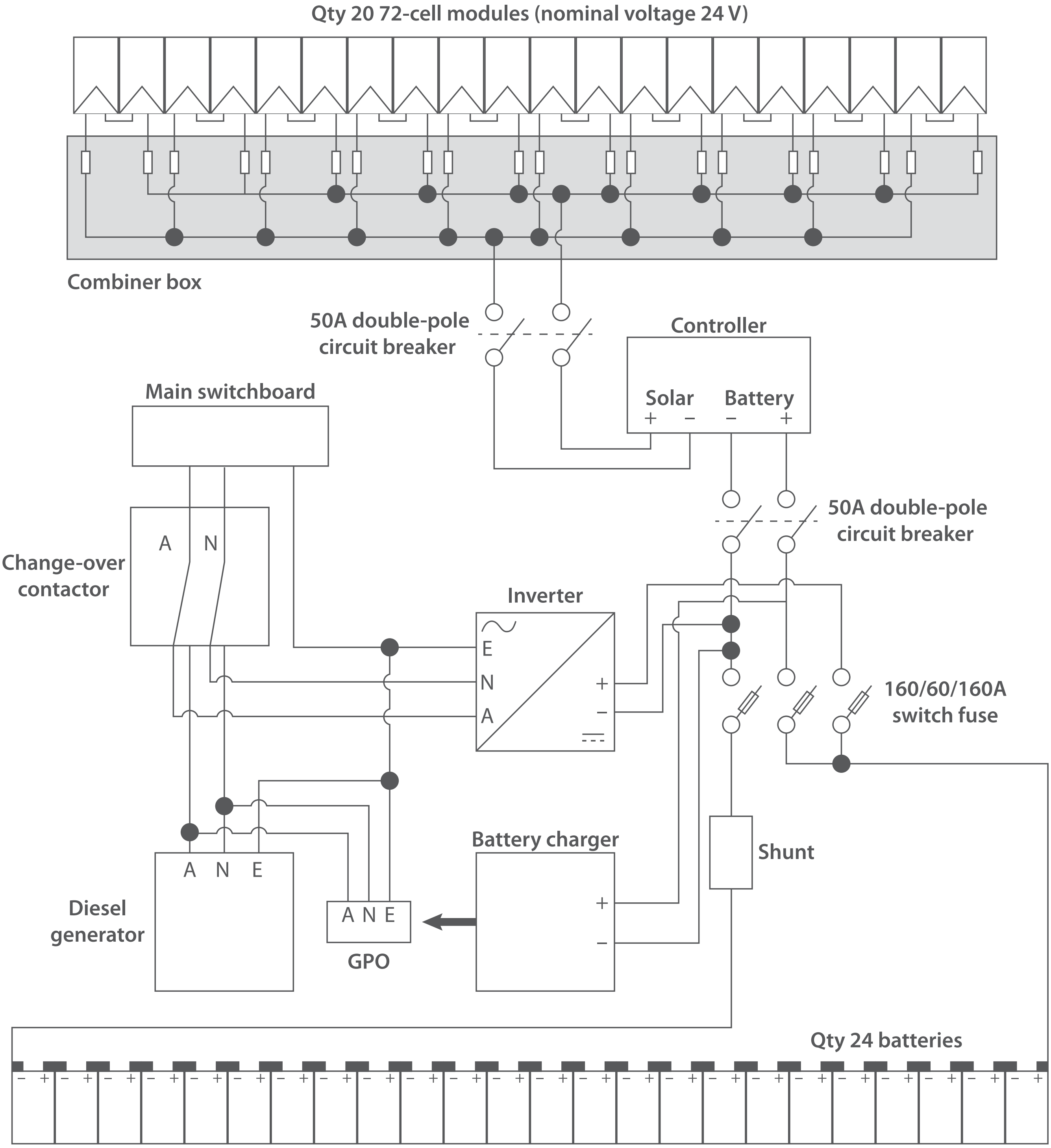
A larger cable might need to be selected depending on the final arrangement of the circuits.

10. Section 20.9, page 276

Replace

Figure 20.2

With



11. Section 20.12.2, page 278 – Earthing of exposed conductive parts

Replace

Under clause 5.4 of AS5033, exposed conductive parts of the PV array need not be earthed, provided that all wiring is double insulated. However, it is generally advisable that equipment that could be easily touched is still earthed.

Figure 5.9 of AS5033 includes a decision tree that assists in choosing the correct equipment earthing configuration.

With

Under clause 4.4.2 of AS/NZS5033:2012, exposed conductive parts of the PV array need not be earthed (bonded) provided that the array is ELV and all wiring is double insulated. However, it is generally advisable that equipment that could be easily touched is still earthed. All LV arrays shall be earthed

Figure 4.3 of AS/NZS5033:2012 includes a decision tree that assists in choosing the correct equipment for the earthing configuration.

12. Section 20.13, page 278 – Lightning protection

Replace

AS/NZS5033:2009 requires a lightning assessment in accordance with AS1768 shall be undertaken with every system installed. It is important that the system designer and installer become familiar with AS1768 and determine whether lightning protection is required on systems within their installation area.

With

AS/NZS5033:2012 requires a lightning assessment in accordance with IEC62305-2 and if required it should be installed in compliance with IEC 62305, parts 3 and 4. Appendix G of ASNZS5033:2012 includes flash density maps for Australia and New Zealand. It is important that the system designer and installer become familiar with IEC62305 and determine whether lightning protection is required on systems within their installation area.

Chapter 21

13. Section 21.1, page 282 – Australian Standards

Replace

- *AS4509.1* *Stand Alone Power Systems. Part 1: Safety and Installation*
- *AS4509.2* *Stand Alone Power Systems. Part 2: Design Guidelines*
- *AS5033* *Installation of Photovoltaic (PV) Arrays*

With

- *AS/NZS4509:2009* *Stand-alone Power Systems Part 1: Safety and Installation*
- *AS/NZS4509:2010* *Stand-alone Power Systems Part 2: System design guidelines*
- *AS/NZS5033:2012* *Installation and safety requirements of photovoltaic (PV) arrays*