Increased requirements on external DC-breakers for transformerless PV inverters in Australia

Are the requirements also expedient for PV plants with transformerless SMA PV inverters?

Content

The standard AS/NZS 5033:2005 requires that PV plants are fitted with an external DC-breaker on the DC side. The DC-breaker must be able to safely disconnect the open-circuit voltage of the PV array plus a safety reserve of 20 %.

Increased requirements through the "Clean Energy Council" have recently become applicable to PV plants in which transformerless PV inverters are installed. The DC-breaker to be installed externally must now be designed for each the positive and negative poles on the above mentioned voltage, in order to continue to safely disconnect in the event of the following ground fault scenarios.

The safety features integrated in SMA transformerless PV inverters were not however taken into consideration in these requirements.

This technical information explains why the increased requirements on DC-breakers for the use of SMA transformerless PV inverters do not lead to increased safety.

1 Ground fault scenarios

PV plants with transformerless PV inverters are not galvanically isolated from the grid during feed-in operation.

Thus in the event of a ground fault the current can flow through the grid ground electrode. In this case one pole of the DC-breaker is bypassed. Image 1 shows a ground fault on the positive pole of the PV array.

In the event of a ground fault on the negative pole of the PV array the other pole of the DC-breaker is bypassed.

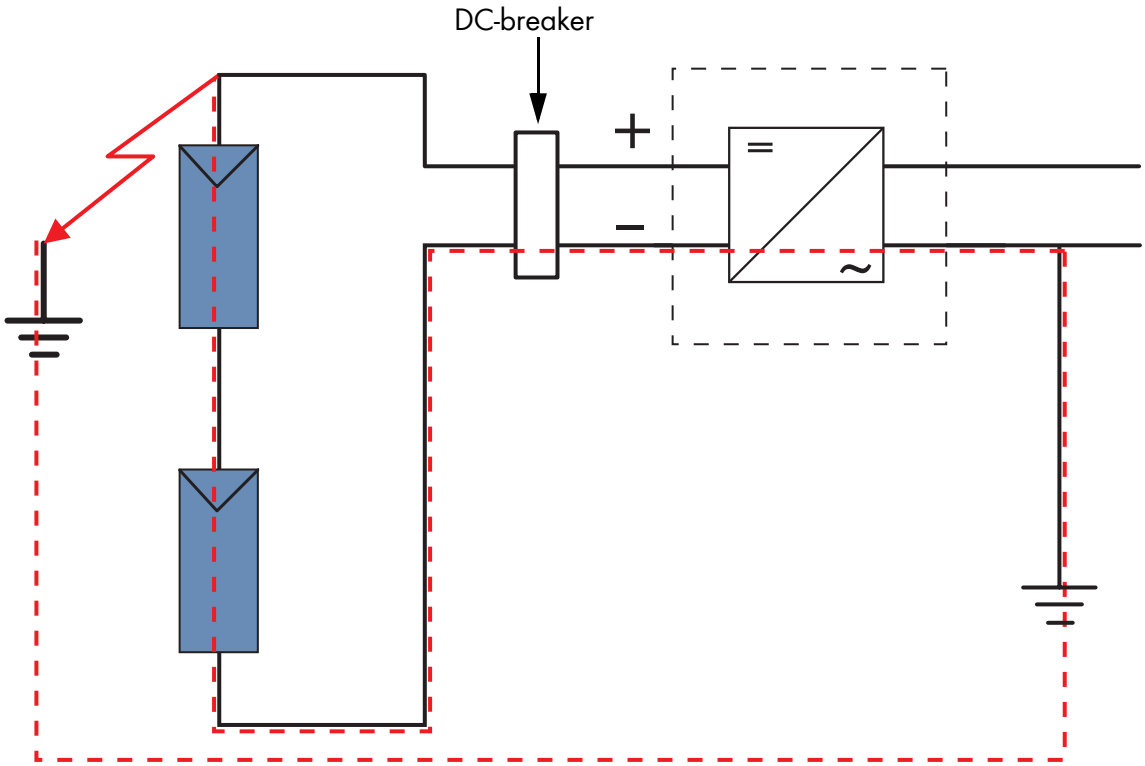

Image 1

Should the DC-breaker be opened in the above described fault cases, the open-circuit voltage is applied to only one pole of the breaker (worst case).

This is however uncritical when SMA transformerless PV inverters are used, since safety features integrated in the inverter safely recognize a ground fault and separate the connection to the grid on all phases within milliseconds.

2 Safety features in SMA transformerless PV inverters

2.1 Isolation resistance measurement

If a ground fault occurs whilst the PV plant is not yet connected to the grid, the isolation resistance measurement of the inverter prevents the closing of the grid relay.

Before each grid connection, the resistance between each the positive and negative pole and ground electrode is measured. This is necessary to safely recognize an isolation fault on each point of the PV array. Even symmetrical isolation faults are safely detected. The simplified principle of the measuring is presented in image 2.

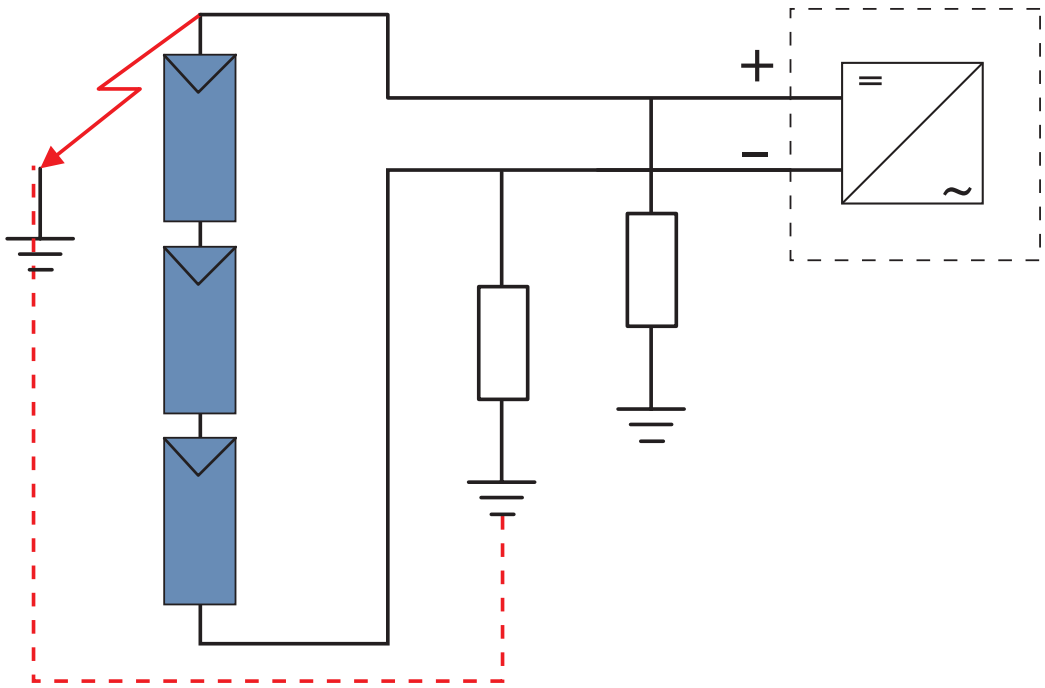

Image 2

If the minimum isolation resistance falls below values defined through international standards the inverter remains disconnected from the grid. The standard DIN EN 61215 for example defines a minimum isolation resistance of 40 M Ω m², multiplied with the module area.

2.2 Residual Current Monitoring Unit (RCMU)

If a ground fault occurs in feed-in operation it is detected by the RCMU and the inverter disconnects from the grid.

The RCMU permanently compares the current from phase and neutral conductor and disconnects in the case of erratic deviations under the following limiting values in accordance with VDE 0126-1-1 and IEC 62109.

Residual current sudden change	Maximum disconnection time
30 mA	0.3 s
60 mA	0.15 s
150 mA	0.04 s

The disconnection time in the event of leakage currents larger than 300 mA amounts to 0.3 s. The RCMU performs a grid separation with the help of the relay, if an exact measurement is no longer guaranteed due to high leakage currents. For further information see the technical information "Capacitive leakage currents" on the SMA homepage at: www.SMA-Australia.com.au.

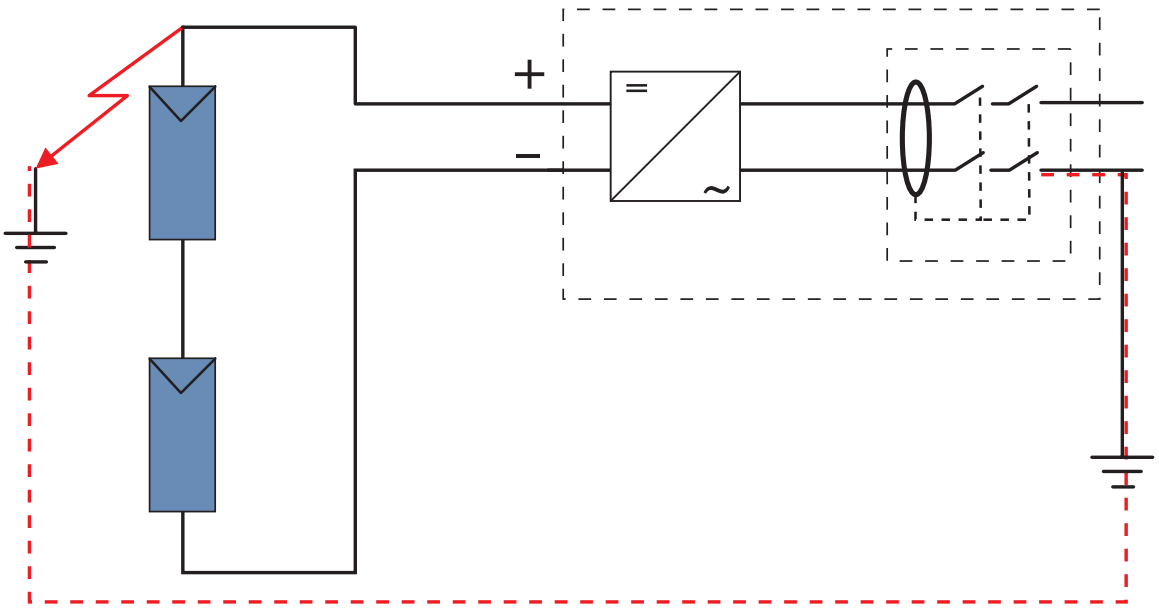

Image 3

As seen in the above image, SMA inverters have two redundant grid relays which are activated by the RCMU in the event of the limiting values being exceeded.

3 Summary

The fault scenarios which lead to the increased requirements on DC-breakers are safely avoided by the integrated safety features in SMA transformerless inverters.

Before connecting to the grid a ground fault is detected by the isolation resistance measurement. During grid feed-in a ground fault is registered through the RCMU and the PV plant is disconnected from the grid within the time limits defined by the standards VDE 0126-1-1 und IEC 62109. Additionally the two safety features perform self-tests before grid connection daily. SMA transformerless inverters therefore follow the principle of the "single fault safety" and nullify the increased requirements on DC-breakers.