Connection of Inverter Energy Systems to the Grid: New requirements surround residual current devices

The industry has seen rapid uptake of solar PV and energy storage systems connected to multiple mode, or 'hybrid', inverters and battery systems over recent months. This has prompted many questions from installers and designers regarding the connection of inverter energy systems to existing electrical installations. While many common questions regarding connecting IES systems can be clarified by consulting AS/NZS3000:2007 Section 7.3 Alternative Generation Systems, complexity is introduced with the release of AS/NZS4777.2:2015 Grid connection of energy systems via inverters (Part 2: Inverter requirements), and AS/NZS4777.1:2016 Grid connection of energy systems via inverters (Part 1: Installation requirements). GSES wishes to highlight a few key requirements of AS4777.2, which came into effect on October 9th 2016.

Maintaining continuity of the grid neutral in multiple mode inverter installations.

Whilst the switching of incoming neutral has never been allowed at the main / MEN switchboard and has only been allowed in extremely limited situations at downstream distribution boards (refer to AS/NZS3010 Electrical Installations – Generating Sets for details), AS4777.2 now explicitly states the requirement of continuity of grid neutral-earth connection (MEN connection) must be maintained at all times. There is a good reason for this. If the multiple mode inverter disconnects the stand-alone port neutral conductor from the main installation neutral when it switches to stand-alone mode, it will remove both the earth reference required for RCDs (whether RCCB or RCBO) to operate in earth leakage mode, and the low impedance return path required for short circuit protection devices – fuses and circuit breakers (whether MCB or RCBO) to operate in the event of a live conductor coming into contact with an earthed metallic part of the installation. Clearly this becomes a shock hazard and must be avoided at all costs. It is critical for the installer to ensure that the load neutral to MEN connection is maintained during all operating modes of the inverter, including stand-alone mode.

Caution and careful reference to the manufacturer's instructions is required as many multimode inverters in the marketplace currently were originally designed for use in Recreational Vehicles and Boats with an isolation transformer between the inverter and the grid when plugged in. As such both the Active and Neutral conductors were treated as "Active" and dual pole switching used. In some cases an internal relay provides a Neutral to Earth connection (i.e. MEN) during stand-alone mode to enable these isolated systems to take advantage of RCD type protection. Such inverters may not be suitable for hardwired connection or may require specific actions by the installer during installation to make them compliant with applicable standards in this regard.

> AS/NZS4777.2:2015 Clause 6.4.1 "Multiple mode inverters shall be arranged to ensure that the continuity of the neutral conductor to the load from the electrical installation is not interrupted when the inverter disconnects from the grid and supplies a load via the stand-alone port."

RCDs as acceptable mechanical cable protection and isolation means for grid-connect only inverters

Recent changes to AS/NZS4777.1 and AS/NZS4777.2 mean that use of a dedicated RCD between the IES and the MSB, is now permitted as a means to

meet mechanical cable protection requirements unless a multiple mode inverter with standalone functionality is in use. This can allow for slightly easier AC cable installation to grid-connect only inverters. However, AS4777.1: 2016 explicitly precludes the use of RCD for this purpose with multimode inverters with a stand-alone port. Once again, this is because the RCD will typically switch both Active and Neutral conductors, thus breaking the Neutral to MEN connection.

AS/NZS4777.1:2016 Clause 3.4.5 "An RCD dedicated for an IES may be used to meed the mechanical cable protection requirements and isolation requirements of AS/NZS 3000 for the cable from the switchboard to the IES." and AS/NZS4777.1:2016 Clause 5.4.3 "The provision of AS/NZS 3000 for the use RCDs as a method for mechanical protection of the IES grid-interactive port submain is not permitted for the multiple mode IES grid-interactive port.)

Suitability of RCDs for use with inverter output waveform

Any RCDs installed on the same circuit as an inverter must be compatible with the inverter's output waveform, as well as the allowable injected DC current of the inverter. The type and rating of the RCD to use on both the grid-interactive and stand-alone ports of the inverter must be provided to the installer by the manufacturer. This information is important as different levels of DC injection into the grid through the RCD can cause false or late tripping of the RCD. In many cases, a Type A RCD will be specified by the manufacturer, cases with higher levels of DC injection will call for a Type B RCD. In the event that the manufacturer has not provided guidance on the type of RCD to fitted, AS4777.2 specifies that Type B will be used.

The attention of designers, electricians and installers is drawn to the fact the very popular single DIN RCBO's sold through the majority of electrical wholesalers in Australia are not only Type AC (and thus not suitable for any DC injection) and are generally marked as being line/load sensitive which would preclude their use in an import/export situation even if DC injection was not a factor.

AS/NZS4777.2:2015 Clause 6.4.1 "The type of RCD compatible with and for use on the stand-alone function outputs shall be declared." and AS/NZS4777.2:2015 Clause 9.2.5 "Where and external RCD is required, the inverter shall be marked with a warning along with the rating and type of RCD required."

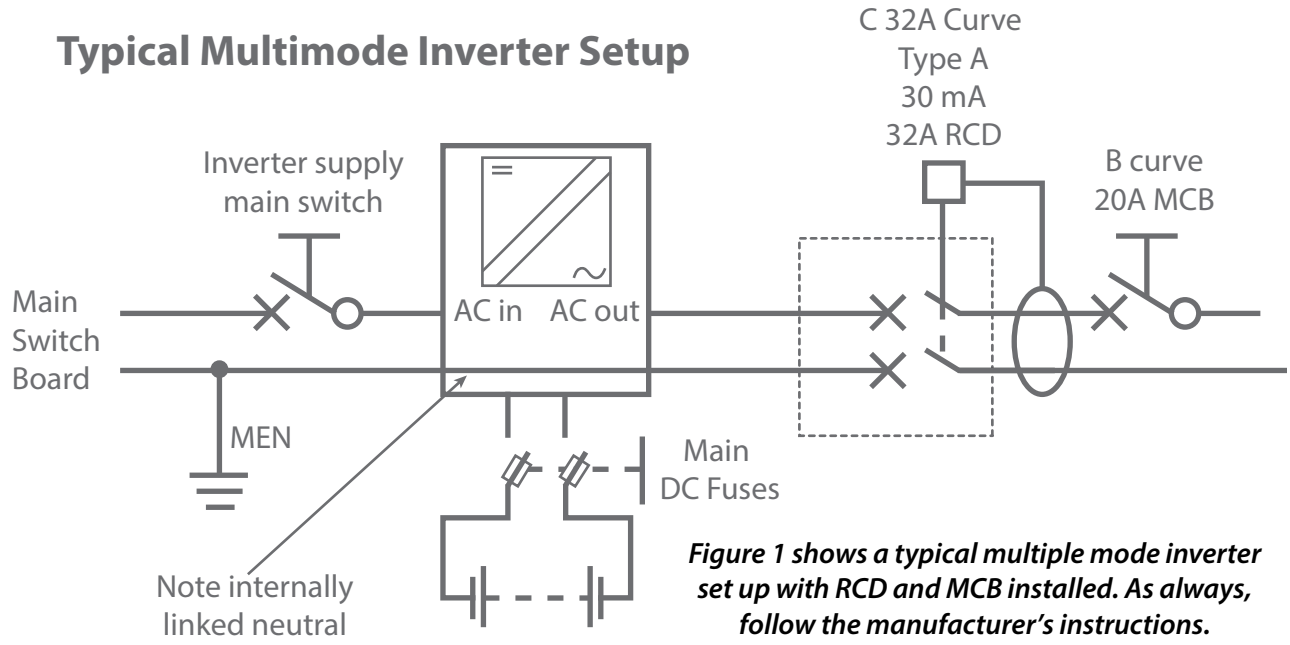

Figure 1 shows a typical multiple mode inverter set up with RCD and MCB installed. As always, follow the manufacturer's instructions.

AS/NZS4777.2:2015 Clause 5.9 limits the D.C. current injection at any a.c. port (grid-interactive and/or stand-alone) to no greater than 0.5% of the inverters rated current or 5mA, whichever is greater.

All RCBOs and/or MCBs downstream of the inverter stand-alone port must be able to trip on a fault current, including the D.C. component, in time to protect the cables. General purpose C curve circuit breaker trip curves generally require a higher fault current to trip than can be readily supplied by the inverter. As a result, B curve circuit breakers are often specified for the outgoing a.c. cables.

While AS4777.2:2015 has been considered a standard for the inverter manufacturers, the contents of this standard can still affect designers and installers of inverter energy systems. Thus it is important that installers and designers gain familiarity with this standard.

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.