Enphase Energy Microinverters: Applications utilising PV Modules with greater than 350 Watts PV power at STC in Australia and New Zealand.

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Purpose:

This white paper addresses the compliance of Enphase Energy Microinverters when used with newer PV Modules with an output power that exceeds the legacy limit set in [1]AS/NZS 5033:2014.

Background: AS/NZS 5033, 4.3.12 (d) 350Watt limit

For Australia and New Zealand, AS/NZS 5033:2014, Clause 4.3.12 provides general component requirements applicable to PV Microinverter systems. This clause was added to the previous AS/NZS 5033:2012 standard that had no specific clauses relating to Microinverters. The following sub section of this clause specifies a power limit for Microinverters,

> *"(d) Each input shall be limited to 350W max PV power at STC, at a maximum input voltage no greater than ELV."*

When AS/NZS5033:2014 was [2]published, PV Microinverters were a relatively new technology so understandably there was limited knowledge and field experience. As PV Module DC power levels were no more than 250 watts at the time, the "350 Watt" limit was settled on to provide some leeway for PV Module development into the foreseeable future.

Current Situation

The substantial shift of focus to Alternative Energy in the six years since AS/NZS 5033 was last published has seen technology develop beyond expectation to meet new and expanding market requirements. For PV Modules, competition between manufacturers has led to power levels greater than 350 Watts becoming commonplace and the new technology benchmark well over 400 Watts.

In the same time frame, Enphase Energy has progressively released new and up-rated Microinverters to embrace this technology however the situation now potentially exists

[1] AS/NZS5033:2014 Installation and safety requirements for photovoltaic (PV) arrays. This update includes several additions and revisions of AS/NZS5033:2012 that was published on 16/10/2012
[2] AS/NZS5033:2014 was published 6/11/2014

where the design of a best practise system could be "un-intentionally limited" by the 350 Watt limit of AS/NZS 5033:2014, Clause 4.3.12 (d).

Standards Australia have a current project to revise AS/NZS 5033:2014 including updates where new and/or improved technology has outdated clauses such as 4.3.12 (d). The updated standard is expected to be published in 2021.

Enphase Energy's Position on the AS/NZS 5033, 4.3.12 (d) 350Watt limit:

The need for smarter "connected" systems that are simple to install and maintain has seen Enphase Energy's class leading technology become globally established in recent years. The experience from over 1 million installations has led to a family of products and safe installation methods that have set a new standard in the PV industry.

Enphase Energy maintains that its electrically isolated transformer based Microinverters and ELV architecture provides an installer and user safe system that meets or exceeds the requirements of AS/NZS5033:2014. Where Microinverters are used with PV Modules with greater than 350W max PV power at STC, AS/NZS5033:2014 Clause 4.3.12 Note 1 applies. This note states,

> *"1. For micro inverters that exceed the limits of this Clause, the normal requirements of this Standard apply."*

The normal requirements of AS/NZS 5033:2014 includes the ability to provide DC disconnection as per Clause 4.3.5 – Disconnecting devices. As an Enphase Energy Microinverter is connected to a single PV Module that has a [3]VOC under 120VDC, this connection is classed as ELV as per AS/NZS 3000:2018, [4]Clause 1.4.128, part (a).

For the DC disconnection of ELV systems, AS/NZS5033:2014 Clause 4.3.5.2 states,

> *"ELV Plug connections for interruption under load may also be used in ELV situations if the equivalent level of safety and performance can be assured"*

The shutdown procedure for an Enphase Energy Microinverter system is no different to any other PV Inverter system. The system is first isolated from the AC mains via the [5]PV "Main Switch (Inverter supply)" located in the building switchboard.

Once the AC mains has been removed, all connected Enphase Microinverters in the PV Array are instantly de-energised, and their respective PV Module ports are dis-connected. As each Microinverter no longer presents any load to the connected PV Module or DC connectors,

[3] PV Modules with greater than 350W max PV power have a typical VOC ranging from 40 to 70 VDC.
[4] AS/NZS 3000:2018 Electrical Installations (known as the Australian/New Zealand Wiring Rules). Clause 1.4.128, part (a) "Extra-low voltage Not exceeding 50 V a.c. or 120 V ripple-free d.c.
[5] AS/NZS4777.1:2016 Clause 3.4.3 Isolation switches

safe ELV disconnection can then be achieved by simply unplugging the [6]MC-4 DC connector(s). This satisfies the requirements of AS/NZS5033:2014 Clause 4.3.5.2.
As all Enphase inverters have an isolating transformer between DC and AC circuits, electrical isolation is achieved by design. Complete galvanic separation is achieved once the Inverter has been unplugged.

Some terms used in this White Paper:

ELV	Extra Low Voltage. Where the maximum voltage employed is less than 120 VDC or 50 VAC
Galvanic Separation	Where both electrical and physical isolation has been provided from the energy source.
ISC	Current (I) Short Circuit. The manufacturers provided rating for the maximum current that a PV Module will deliver into a short circuit at 25 deg C.
MC-4	A PV industry standard connector designed by Multi-Contact (now Staubli Electrical Connectors) for the interconnection of PV Module DC cabling. The connector has both female (positive connection on a PV Module) and male (negative connection of a PV Module). The connector has 1,000 Volt insulation rating and a rating of 30 Amps. The "4" in the part number represents the diameter of the contact pin (4 mm).
Microinverter	A small PV Inverter that is designed to be installed underneath a PV Module. The Microinverter directly converts the PV Modules DC output to 230 VAC mains output. The 230 VAC output of a number of Microinverters (in a PV Array) are then harnessed together and connected to the main switchboard.
PV Array	An assembly of PV Modules sharing the same support structure.
PV Module	Also known as a "Solar Panel", this is an individual module that can have a power rating from 190 Watts (2010) to greater than 440 Watts (2020). The VOC DC output voltage can be between 30 and 65 Volts with a short circuit current between 5 and 11 Amps.
VOC	Voltage (V) Open Circuit. The manufacturers provided rating for the maximum voltage that will appear across the terminals of a PV Module in full sun without load at 25 deg C

[6] An MC-4 DC connector is rated to be able to connect/disconnect cables up to 1000 Volts without load.