

Inverter Energy System Embedded Generators Protection Requirements and Settings Summary

(Effective from 18 December 2021)

Purpose:

To assist the installers by providing a clear summary of the protection requirements and settings that are applicable to the:

- Micro Embedded Generator Basic Connection Service with Voltage Response Modes Enabled with inverter installation installed capacity of up to 10 kVA per phase (or 30 kVA per three phase) AND export limit of up to 5 kVA per phase (or 15 kVA three phase);
- Embedded Generator Negotiated Connection Service (Voltage Response Modes Enabled), with inverter installation installed capacity greater than 30 kVA and up to 200 kVA (3 phase).



MICRO EMBEDDED GENERATOR BASIC CONNECTION SERVICE (VOLTAGE RESPONSE MODES ENABLED)

Applies To

- Inverter installation installed capacity is less than or equal to 10 kVA per phase (or 30 kVA per three phase).
- Export limit must not exceed 5 kVA per phase (or 15 kVA three phase).

Central Protection Requirements

None

Inverter Protection Requirements (Australia A parameter set)

Australia A parameter set is expected to be selected for all of the following protection and response modes.

The inverter will have the following set points and disconnection times aligned with AS4777.2:2020:

Protective Function	Protective Function Limit	Trip delay Time	Maximum disconnection Time
Undervoltage 1 (V<)	180 V	10 s	11 s
Undervoltage 2 (V<<)	70 V	1 s	2 s
Overvoltage 1 (V>)	265 V	1 s	2 s
Overvoltage 2 (V>>)	275 V	-	0.2 s
Sustained Overvoltage (10 minutes)	258 V		3 s
Under-frequency (F<)	47 Hz	1 s	2 s
Over-frequency (F>)	52 Hz	-	0.2 s
Active anti-islanding	(3)	-	2 s
Voltage phase angle shift withstand	60 ° (1), 20 ° (2)		2 s
Rate of Change of Frequency (ROCOF)	4.0 Hz/s	-	0.25 s
Reconnection delay			60 s

Notes:

(1) 60 ° - Single phase disturbance

(2) 20 ° - Three phase disturbance

(3) The method used to provide active anti-islanding protection shall be as per AS/NZS 4777.2:2020 Section 4.3

The inverter's **volt-watt** response values must be set at:

Reference	Voltage (V)	Inverter maximum active power output level (P) % of S_{rated}
V1	253 V	100 %
V2	260 V	20 %

The inverter's **volt-var** response values must be set at:

Reference	Voltage (V)	Inverter reactive power level (Q) % of S_{rated}
V1	207 V	44 % supplying (export VAR)
V2	220 V	0 %
V3	240 V	0 %
V4	258 V	60 % absorbing (import VAR)

Volt-watt response mode for inverters with energy storage when charging:

Reference	Voltage (V)	$P_{charge}/P_{rated-ch}$ %
V1	207 V	20 %
V2	215 V	100 %

Sustained operation for frequency variations

Frequency variation withstand limits

Decrease in frequency response lower limit	Lower limit of continuous operation range (f_{LLCO})	Upper limit of continuous operation range (f_{ULCO})	Increase in frequency response upper limit
47 Hz	49.75 Hz	50.25 Hz	52 Hz

Frequency response limits

Decrease in frequency response limits		Increase in frequency response limits	
Frequency where power output level is maximum (f_{Pmax})	Frequency where charging power level is zero ($f_{stop-ch}$)	Frequency where discharging power level is zero ($f_{transition}$)	Frequency where power level is minimum (f_{Pmin})
48 Hz	49 Hz	50.75 Hz	52 Hz

Frequency response – Maximum response times and values for hysteresis margin (f_{hyst})

Response commencement time	Response completion time	f_{hyst}
1 s	10 s	0.1 Hz

The inverter firmware version shall be reported in testing. The inverter firmware version identifier shall be accessible for inspection. Inverter firmware version information may be displayed via a panel/screen, external device or software interface. Inverter firmware changes and updates shall conform to the requirements of the AS4777.2: 2020.

A multi-phase IES shall have a balanced output with respect to its rating with a tolerance of no greater than 5 kVA unbalance between any phases as per clause 2.3 of AS/NZS 4777.1.

EMBEDDED GENERATOR NEGOTIATED CONNECTION SERVICE (VOLTAGE RESPONSE MODES ENABLED)

Applies To

Inverter installation installed capacity is greater than 30 kVA up to 200 kVA (3 phase).

Central Protection Requirements

The central protection relay shall have the following set points and disconnection times:

Protective Function	Protective Function Limit	Maximum disconnection Time
Undervoltage 1 (V<)	180 V	11 s
Undervoltage 2 (V<<)	70 V	2 s
Overvoltage 1 (V>)	265 V	2 s
Overvoltage 2 (V>>)	275 V	0.2s
Sustained Overvoltage (10 minutes)	258 V	3 s
Under-frequency (F<)	47 Hz	2 s
Over-frequency (F>)	52 Hz	2 s
Vector shift	20°	2 s
Rate of Change of Frequency (ROCOF)	4 Hz/s	0.25 s
Current Unbalance	21.7 A	2 s
Reconnection Delay		60 s

Inverter Protection Requirements (Australia A parameter set)

Australia A parameter set is expected to be selected for all of the following protection and response modes.

The inverter will have the following set points and disconnection times aligned with AS4777.2:2020:

Protective Function	Protective Function Limit	Trip delay Time	Maximum disconnection Time
Undervoltage 1 (V<)	180 V	10 s	11 s
Undervoltage 2 (V<<)	70 V	1 s	2 s
Overvoltage 1 (V>)	265 V	1 s	2 s
Overvoltage 2 (V>>)	275 V	-	0.2 s
Sustained Overvoltage (10 minutes)	258 V		3 s
Under-frequency (F<)	47 Hz	1 s	2 s
Over-frequency (F>)	52 Hz	-	0.2 s
Active anti-islanding	(3)	-	2 s
Voltage phase angle shift withstand	60 ° (1), 20 ° (2)		2 s
Rate of Change of Frequency (ROCOF)	4.0 Hz/s	-	0.25 s
Reconnection delay			60 s

Notes:

(1) 60 ° - Single phase disturbance

(2) 20 ° - Three phase disturbance

(3) The method used to provide active anti-islanding protection shall be as per AS/NZS 4777.2:2020 Section 4.3

The inverter's **volt-watt** response values must be set at:

Reference	Voltage (V)	Inverter maximum active power output level (P) % of S_{rated}
V1	253 V	100 %
V2	260 V	20 %

The inverter's **volt-var** response values must be set at:

Reference	Voltage (V)	Inverter reactive power level (Q) % of S_{rated}
V1	207 V	44 % supplying (export VAR)
V2	220 V	0 %
V3	240 V	0 %
V4	258 V	60 % absorbing (import VAR)

Volt-watt response mode for inverters with energy storage when charging

Reference	Voltage (V)	$P_{charge}/P_{rated-ch}$ %
V1	207 V	20 %
V2	215 V	100 %

Sustained operation for frequency variations

Frequency variation withstand limits

Decrease in frequency response lower limit	Lower limit of continuous operation range (f_{LLCO})	Upper limit of continuous operation range (f_{ULCO})	Increase in frequency response upper limit
47 Hz	49.75 Hz	50.25 Hz	52 Hz

Frequency response limits

Decrease in frequency response limits		Increase in frequency response limits	
Frequency where power output level is maximum (f_{Pmax})	Frequency where charging power level is zero ($f_{stop-ch}$)	Frequency where discharging power level is zero ($f_{transition}$)	Frequency where power level is minimum (f_{Pmin})
48 Hz	49 Hz	50.75 Hz	52 Hz

Frequency response – Maximum response times and values for hysteresis margin (f_{hyst})

Response commencement time	Response completion time	f_{hyst}
1 s	10 s	0.1 Hz

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