

Australian/New Zealand Standard™

**Demand response capabilities and
supporting technologies for electrical
products**

**Part 3.5: Interaction of demand
response enabling devices and
electrical products—Operational
instructions and connections for grid-
connected electrical energy storage
(EES) systems**



AS/NZS 4755.3.5:2016

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-054, Remote Demand Management of Electrical Products. It was approved on behalf of the Council of Standards Australia on 18 May 2016 and by the New Zealand Standards Approval Board on 2 June 2016. This Standard was published on 21 June 2016.

The following are represented on Committee EL-054:

Airconditioning and Refrigeration Equipment Manufacturers Association of Australia
Australian Industry Group
Clean Energy Council
Consumer Electronics Suppliers Association
Consumers Federation of Australia
CSIRO
Department of Industry, Innovation and Science, Australia
Electricity Engineers Association, New Zealand
Energy Efficiency and Conservation Authority of New Zealand
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Heating, Ventilation and Air Conditioning New Zealand
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Australian/New Zealand Standard™

Demand response capabilities and supporting technologies for electrical products

Part 3.5: Interaction of demand response enabling devices and electrical products—Operational instructions and connections for grid-connected electrical energy storage (EES) systems

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-054, Remote Demand Management of Electrical Products.

This Standard forms part of the evolving AS/NZS 4755 series of Standards, which is intended to define the nomenclature, architecture and operational instructions for systems that can be used to remotely control electrical products. At the time of publication of this Part, the AS/NZS 4755 series is proposed to comprise the following:

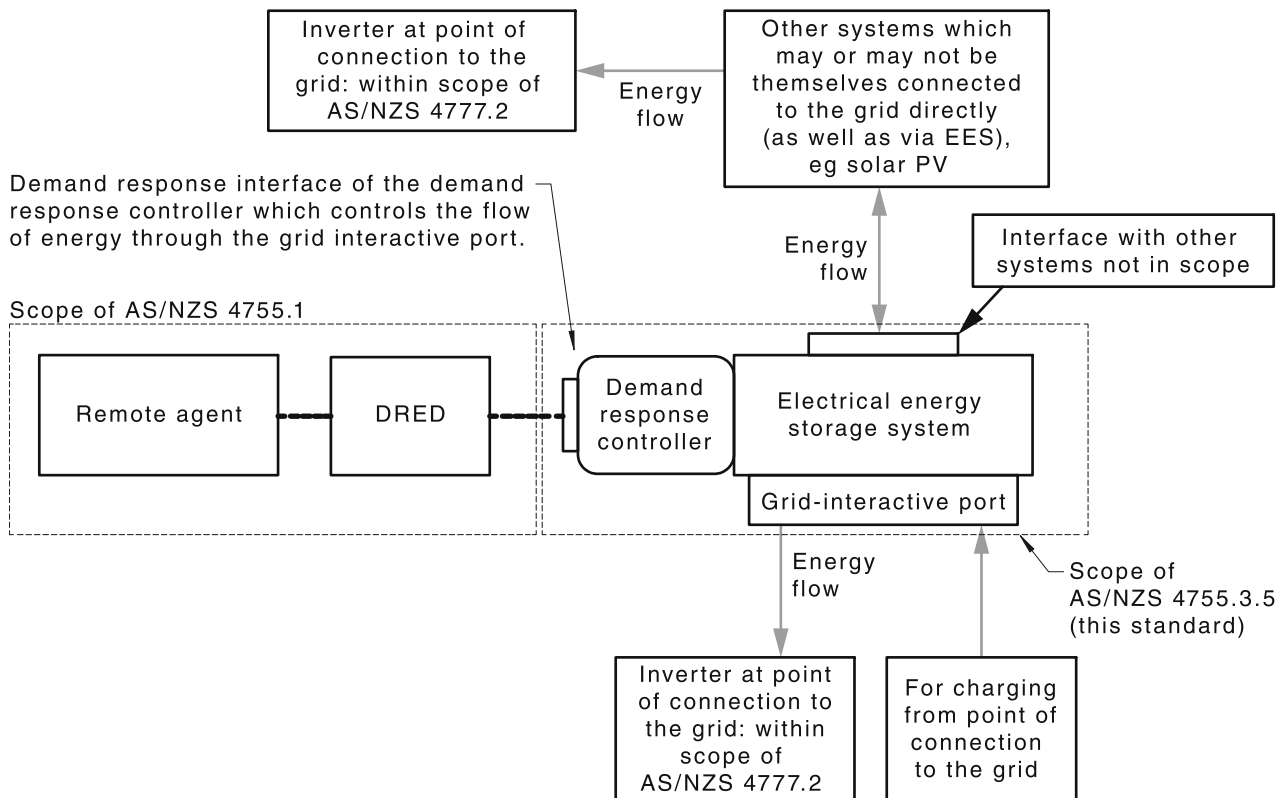
AS/NZS

- 4755 Demand response capabilities and supporting technologies for electrical products
- 4755.1 Part 1: Framework for demand response capabilities and requirements for demand response enabling devices (DREDs) (in preparation to supersede AS 4755—2007)
- 4755.3.1 Part 3.1: Interaction of demand response enabling devices and electrical products—Operational instructions and connections for air conditioners
- 4755.3.2 Part 3.2: Interaction of demand response enabling devices and electrical products—Operational instructions and connections for devices controlling swimming pool pump-units
- 4755.3.3 Part 3.3: Interaction of demand response enabling devices and electrical products—Operational instructions and connections for electric and electric-boosted water heaters
- 4755.3.4 Part 3.4: Interaction of demand response enabling devices and electrical products—Operational instructions and connections for grid-connected charge/discharge controllers for electric vehicles (EVSEs) (proposed new Standard)
- 4755.3.5 Part 3.5: Interaction of demand response enabling devices and electrical products—Operational instructions and connections for grid-connected electrical energy storage (EES) systems (this Standard)

The AS/NZS 4755 framework is also relevant to AS and AS/NZS 4777 series, *Grid connection of energy systems via inverters*.

Statements expressed in mandatory terms in notes and footnotes to tables are deemed to be requirements of this Standard.

The diagram below depicts the relationship of this Standard to other related Standards within the AS/NZS 4755 framework. This Standard covers the interaction of the demand response controllers of electrical energy storage systems with DREDs to control the flow of energy through the grid interactive port of the system.



This Standard is intended to support demand response programs which optimize the operation of the electricity supply system and allow the efficient planning and use of capital equipment, while minimizing the risks to the comfort and amenity of users.

This Standard does not cover all aspects of construction and performance, which may be subject to other standards.

The term 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

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Australian/New Zealand Standard

**Demand response capabilities and supporting technologies for
electrical products**

**Part 3.5: Interaction of demand response enabling devices and electrical
products—Operational instructions and connections for grid-connected
electrical energy storage (EES) systems**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard—

- (a) applies to electrical energy storage (EES) systems that—
 - (i) do not contain a demand response enabling device (DRED);
 - (ii) have a demand response interface intended to connect to a DRED;
 - (iii) have a low voltage, permanently wired connection to the grid (whether single-phase or three-phase); and
 - (iv) are capable of importing energy from the grid, exporting energy to the grid, or both.
- (b) specifies a set of operational instructions to control the demand response of EES systems;
- (c) specifies methods of connecting the demand response interface to the DRED; and
- (d) provides methods of testing to verify compliance.

EES systems covered by this Standard include, but are not restricted to—

- (i) electrochemical storage systems (e.g. batteries);
- (ii) mechanical storage systems (e.g. flywheel);
- (iii) electrical storage systems (e.g. capacitors);
- (iv) uninterruptible power supplies (UPS);
- (v) thermal and chemical systems; and
- (vi) generation systems that are dispatchable.

An EES system may also meet the definition of an inverter energy system as defined in AS/NZS 4777.2.

NOTE: Examples of EES system configurations are given in Appendix E.

An EES system complying with this Standard may also have additional interfaces and other means of achieving demand response.

This Standard does not cover any other electrical product within the scope of AS/NZS 4755.3 series Standards.

NOTE: If compliance with this Standard is made mandatory by the relevant Australian and New Zealand regulatory authorities then any exclusions of EES system types, limitations on storage capacity, energy input or output or other criteria for limiting regulatory scope will be covered in the relevant regulations. In the event of any such regulatory limitations, this Standard can still be used voluntarily for EES systems outside the regulatory scope.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- | | |
|----------|--|
| 4755* | Framework for demand response capabilities and supporting technologies for electrical products |
| 62052 | Electricity metering equipment (ac)—General requirements, tests and test conditions |
| 62052.21 | Part 21: Tariff and load control equipment (IEC 62052-21, Ed. 1.0 (2004) MOD) |

AS/NZS

- | | |
|---------|--|
| 3000 | Electrical installations (known as the Australian/New Zealand Wiring Rules) |
| 4755 | Demand response capabilities and supporting technologies for electrical products |
| 4755.1* | Part 1: Framework for demand response capabilities and requirements for demand response enabling devices |
| 4777 | Grid connection of energy systems via inverters |
| 4777.2 | Part 2: Inverter requirements |
| 60335 | Household and similar electrical appliances—Safety |
| 60335.1 | Part 1: General requirements (IEC 60335-1, Ed.5, MOD) |

ISO/IEC

- | | |
|------|--|
| 8877 | Information technology—Telecommunications and information exchange between systems—Interface connector and contact assignments for ISDN Basic Access Interface located at reference points S and T |
|------|--|

1.3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 4755 (AS/NZS 4755.1)* and those below apply.

1.3.1 Asserted

The condition of a mechanical relay when the relay coil is energized, or the condition of an electronic switch when the load current is present.

1.3.2 Automatic override

A return to normal operation (during a demand response event) that is not initiated by the user or by the remote agent. This feature is intended to address the possibility of malfunction in the DRED.

1.3.3 Charging

The transfer of electrical energy from the grid to an EES system through the grid interactive port.

* AS 4755 is under revision and will be superseded by AS/NZS 4755.1. The relevant definitions now in AS 4755—2007 will be included in the forthcoming AS/NZS 4755.1.

1.3.4 Circumvention device

Any control, control device, software, component or part that alters the operating characteristics during any test procedure, resulting in measurements that are unrepresentative of how that product would perform under comparable conditions in normal operation.

1.3.5 Consume vars

Operation in which vars are drawn, as described in AS/NZS 4777.2.

1.3.6 Demand response (DR)

The automated alteration of an electrical product's normal mode of operation in response to an initiating signal originating from or defined by a remote agent.

1.3.7 Demand response capability

The ability of an electrical product to provide demand response.

NOTE: The capability may reside in the electrical product itself, or in the combination of the product and a separate DRED. If the demand response capability requires any additional external device, other than a DRED, details of the device(s) need to be specified in the manufacturers' or suppliers' documentation.

1.3.8 Demand response controller (DRC) of grid-connected EES system

The part of the EES system with the necessary interface, circuitry and components required for—

- (a) interfacing with a DRED;
- (b) interpreting operational instructions; and
- (c) controlling the flow of electromagnetic energy through the grid-interactive port either directly or via the management of components of the EES system.

1.3.9 Demand response enabling device (DRED)

A device that provides the functionalities and capabilities to achieve demand response.

1.3.10 Demand response event

The period between the initiation and termination of an operational instruction.

1.3.11 Demand response interface

The physical connections and associated functions that enable an electrical product or demand response controller to receive operational instructions from a DRED, or the physical connections and associated functions that enable a DRED to convey operational instructions to an electrical product or demand response controller.

1.3.12 Demand response mode (DRM)

A mode of operation within specified conditions, constraints or parameters during a demand response event (see Table 1).

1.3.13 Discharging

The transfer of electrical energy from an EES system to the grid through the grid interactive port.

1.3.14 Disconnection device

A device which prevents power (both a.c. and d.c.) from an inverter energy system entering the grid, and which meets the requirements of AS/NZS 4777.2. The disconnection device need not disconnect SELV sensing circuits.

1.3.15 Electrical energy storage (EES) system

A system in which energy may be stored in electrochemical, mechanical, thermal, kinetic, potential or other form and in which the stored energy can be converted to electricity on demand (i.e. is dispatchable).

1.3.16 Electrical product

A system or device that is designed to be connected to the grid and to provide, or control the provision of, an energy service such as cooling, heating, motive power, energy generation or energy storage. Includes all elements required for normal operation and that are generally supplied or installed with the product, such as thermostats or user-operated remote controls.

Examples include air conditioners, water heaters, swimming pool pump-unit controllers, charge/discharge controllers for electric vehicles and controllers for grid-connected inverter energy systems.

1.3.17 Export

The flow of energy to the grid from the EES system through the grid-interactive port, sourced from storage, from other components of the EES system under the control of the demand response controller, or both.

1.3.18 Export reference value

The value to be used in the calculations for DRMs 6, 7 and 8.

1.3.19 Export vars

Operation in which vars are supplied, as described in AS/NZS 4777.2.

1.3.20 Extra-low voltage

Voltage supplied from a source within the electrical product that does not exceed 50 V between conductors, and between conductors and earth, when the electrical product is supplied at rated voltage. (Source: AS/NZS 4755.3.1:2014)

1.3.21 Grid

An alternative term for an electricity distribution network.

1.3.22 Grid interactive port (GIP)

The point of connection in an EES system where—

- (a) electromagnetic energy may be supplied to or received from the grid;
- (b) the device or network variables may be observed or measured; and
- (c) the flow of electromagnetic energy may be controlled by the demand response controller.

1.3.23 Import

The flow of energy from the grid to the EES system through the grid-interactive port, for charging, for other functions of the EES system, or both.

1.3.24 Import reference value

The value to be used in the calculations for DRMs 2, 3, and 4.

1.3.25 Inverter

A device that uses semiconductor devices to transfer power between a d.c. source or load and an a.c. source or load.

1.3.26 Inverter energy system

A system comprising one or more inverters together with one or more energy sources (which may include batteries for energy storage) and controls, and which satisfies the requirements of AS/NZS 4777.2.

1.3.27 Manual override

The capability for the user to initiate a return to normal operation during a demand response event.

1.3.28 Maximum exported value (P_{MERV})

The highest recorded time-averaged power exported from the EES system during a continuous 5-minute period measured at the grid interactive port since the EES system was commissioned following site installation.

1.3.29 Maximum imported value (P_{MIRV})

The highest recorded time-averaged power imported to the EES system during a continuous 5-minute period measured at the grid interactive port since the EES system was commissioned following site installation.

1.3.30 Maintenance or safety mode

A mode of operation, distinct from user operation, that is intended to ensure the reliability or safety of the EES system.

NOTE: Examples include, but are not limited to—thermal management, battery balancing.

1.3.31 Operational instruction (OI)

A signal instructing an electrical product to enter a specific demand response mode (see Table 1).

1.3.32 Reference value

The value used to calculate the maximum energy used or load supplied through the grid interactive port when the rate of importing or exporting energy is limited during a demand response mode.

1.3.33 Remote agent

A person, organization or entity, other than the user, who initiates demand response.

NOTES:

- 1 Examples include: electricity distributor, electricity retailer, electricity system manager and demand response aggregator.
- 2 The remote agent will generally have a contractual relationship with the user in which the user gives prior consent for the remote agent to initiate demand response under agreed conditions.

1.3.34 Response time

The time interval from the receipt on an OI until the initiation of the appropriate DRM.

1.3.35 RJ45 connector

The common name for the 8P8C modular connector specified according to ISO/IEC 8877:1992 that is generally used to terminate communications cables.

1.3.36 Safety extra-low voltage (SELV)

Voltage not exceeding 42 V between conductors and between conductors and earth, with the no-load voltage not exceeding 50 V.

When safety extra-low voltage is obtained from the supply mains, it is to be through a safety isolating transformer or a converter with separate windings, the insulation of which complies with double insulation or reinforced insulation requirements. (Source: AS/NZS 4755.3.1:2014)

NOTE: There are differences between the definitions and requirements of SELV provided in AS/NZS 3000 (where SELV refers to separated extra-low voltage) and AS/NZS 60335.1 (where SELV refers to safety extra-low voltage).

1.3.37 Should

Indicates a recommendation.

1.3.38 Shall

Indicates that a statement is mandatory.

1.3.39 Standby

A state in which the electrical energy storage system is connected to the grid but is neither charging nor discharging.

1.3.40 Switch

A switching device which may be either electromechanical or solid-state.

1.3.41 User

A person or entity who normally regulates the operation of an electrical product.

1.3.42 User operation

Operation under user control, including operation via user-set timers and user-set charging or discharging parameters. An EES system may be charging, discharging, in standby or any other mode under user operation.

1.3.43 Var control capability

The ability to supply or draw vars, as described in AS/NZS 4777.2.

SECTION 2 OPERATIONAL INSTRUCTIONS AND DEMAND RESPONSE MODES

2.1 GENERAL PRINCIPLES

The EES system shall be capable of operating normally with or without a DRED connected to the interface.

An EES system shall be capable of meeting all the requirements of this Standard when one and only one DRED is connected. If an EES system has more than one interface complying with Section 3, then the connection of a DRED to any one of those interfaces shall render all other interfaces inoperative as long as the DRED remains connected to that interface.

NOTES:

- 1 This refers to EES systems that may be configured so that there is more than one interface where a DRED may be connected, e.g. a storage unit as well as an inverter unit.
- 2 The EES system should comply with the operational instructions in a way that avoids drawing the user's attention to changes in operation at the beginning, during or end of a demand response event.
- 3 Subject to the principles above, the EES system may indicate to users that it is in a demand response mode, by means of indicator lights or the display of text or graphic symbols or other means.

2.2 DEMAND RESPONSE MODES

2.2.1 Mandatory and optional demand response modes

EES system demand response modes are indicated in Table 1.

An EES system that is capable of importing energy through the grid interactive port shall be capable of at least demand response mode 1 (DRM 1).

An EES system that is capable of exporting energy from the EES system through the grid interactive port shall be capable of at least DRM 5.

If an EES system has a disconnection device, it shall be capable of at least DRM 0.

An EES system that is exporting energy to, or importing energy from, the grid at the start of a demand response event or switched to commence exporting to or importing energy from the grid during a demand response event (either directly by the user or via a timer setting or other automatic control) shall enter the relevant demand response mode (if capable of that mode) within the response time as specified in Clause 2.5 and shall remain in that mode for the remainder of the demand response event (e.g. the user cannot override the demand response event solely by switching the EES system off then on again).

The end of the demand response event in itself shall not be interpreted as a signal to either start exporting energy to or importing energy from the grid.

NOTE: If any user settings are affected by a demand response event, the EES system should revert to normal operation once the demand response event terminates. This is intended to preserve user preference settings and programming.

If an EES system initiates operation in a maintenance or safety mode during a demand response event, it may enter that mode and complete that operation. If the EES is already in a maintenance or safety mode when it receives an OI it may continue in that mode and complete that operation. If the demand response event is still current when the operation is complete, the EES system shall enter the required demand response mode within the response time period specified in Clause 2.5.

TABLE 1
EES SYSTEM DEMAND RESPONSE MODES

OI group	Operational instruction (OI)	Demand response mode (DRM)*	Description of operation in this mode*	Mandatory for compliance with AS/NZS 4755.3.5
0	OI 0	DRM 0†	Open the disconnection device, if present.	Yes†
A§	OI 1	DRM 1	Do not import energy through the grid interactive port of the EES system but control and auxiliary functions may continue.	Yes—for EES system capable of importing energy through the grid interactive port.
	OI 2	DRM 2	When importing energy through the grid interactive port of the EES system, limit rate to ≤50% of the import reference value.	No.
	OI 3	DRM 3	When importing energy through the grid interactive port of the EES system, limit rate to ≤75% of import reference value. Provide power quality support if the EES system is capable.	No.
	OI 4	DRM 4	Increase the import of energy through the grid interactive port of the EES system subject to other active DRMs and if able to import energy through the grid interactive port. If not importing at time of OI 4 received then start importing energy through the grid interactive port.	No.
B‡	OI 5	DRM 5	Do not export energy through the grid interactive port.	Yes—for EES systems capable of exporting energy through the grid interactive port.
	OI 6	DRM 6	When exporting energy through the grid interactive port, limit rate to ≤50% of the export reference value.	No.
	OI 7	DRM 7	When exporting energy through the grid interactive port, limit rate to ≤75% of the export reference value. Provide power quality support if capable.	No.
	OI 8	DRM 8	Increase the export of energy through the grid interactive port subject to other active DRMs and if able to export energy through the grid interactive port. If not exporting at time of OI 8 received then start exporting energy through the grid interactive port.	No.

* The ‘description of operation in this mode’ shall apply if that OI is asserted on its own. Where more than one OI is asserted at a time the operation may be modified as indicated in Clause 2.2.10.

† Only applicable to an EES system equipped with a disconnection device.

‡ Only applicable to an EES system that is capable of exporting energy through the grid interactive port to the grid.

§ Only applicable to an EES system that is capable of importing energy through the grid interactive port to the grid.

2.2.2 Permitted combinations of capabilities

2.2.2.1 General

An EES system shall be capable of a number of combinations of DRMs for both Group A and Group B OIs as indicated in Table 1.

2.2.2.2 Group A

An EES system that is capable of importing energy through the grid interactive port shall be capable of only one of the following sets of DRMs:

- (a) DRM 1 only.
- (b) DRM 1, DRM 2 and DRM 3.
- (c) DRM 1, DRM 2, DRM 3 and DRM 4.

NOTE: An EES system capable of DRM 3 should also be capable of DRM 2 and DRM 1, as this EES system will be able to deliver load reductions in a graduated way—from DRM 3 (at least 25% load reduction) to DRM 2 (at least 50% load reduction) to DRM 1 (100% load reduction).

The EES system shall enter the required DRM when the corresponding OI is issued on its own. Where more than one OI is issued at a time the operation may be modified as indicated in Clause 2.2.10.

2.2.2.3 Group B

An EES system that is capable of exporting energy through the grid interactive port shall be capable of only one of the following sets of DRMs:

- (a) DRM 5 only.
- (b) DRM 5, DRM 6 and DRM 7.
- (c) DRM 5, DRM 6, DRM 7 and DRM 8.

NOTE: An EES system capable of DRM 5 and DRM 7 only, and not capable of DRM 6, is prohibited, because such an EES would not be able to deliver the same degree of graduation in source reductions in export—from DRM 7 (at least 25% reduction in export) to DRM 6 (at least 50% reduction) to DRM 5 (no output).

The EES system shall enter the required DRM when the corresponding OI is issued on its own. Where more than one OI is issued at a time the operation may be modified as indicated in Clause 2.2.10.

2.2.3 DRM 0 operation

If an EES system is equipped with a disconnection device, then the EES system shall enter DRM 0 when OI 0 is issued. The disconnection device shall prevent the flow of energy through the grid interactive port whilst in DRM 0. While an EES system is in DRM 0 it shall not respond to any further OIs. The termination of OI 0 shall permit the EES system to reconnect the disconnection device provided the reconnection procedure specified in Clause 2.6 is followed.

2.2.4 DRM 1 operation

If an EES system is capable of importing energy through the grid interactive port, it shall support DRM1 and not import energy through the grid interactive port whilst an OI 1 is issued. If an EES system has entered DRM 1 it may respond to any further OIs of which it is capable, as indicated in Appendix A.

2.2.5 DRM 2 and DRM 3 operations

If an EES system is capable of DRM 2, then when OI 2 is issued the EES system shall limit its rate of import through the grid interactive port in accordance with Equation 1.

If an EES system is capable of DRM 3, then when OI 3 is issued the EES system shall limit its rate of import through the grid interactive port in accordance with Equation 2.

$$E_{I(1)} \leq 0.5 \times P_{IRV} \times TP \times 5 / 60 \quad \dots (1)$$

$$E_{I(2)} \leq 0.75 \times P_{IRV} \times TP \times 5 / 60 \quad \dots (2)$$

where

TP = number of 5 min periods while EES system is operating in the selected DRM

NOTE: In testing TP should not exceed 12.

$E_{I(1)}$ = imported electrical energy (kWh) through the grid interactive port during the TP while operating in DRM 2

$E_{I(2)}$ = imported electrical energy (kWh) through the grid interactive port during the TP while operating in DRM 3

P_{IRV} = import reference value (kW) is the higher of the following two values—

- (a) the average import load (kW) measured over the continuous 5 min period or periods immediately prior to the receipt of OI 2 or OI 3 (P_{IRV}); or
- (b) if P_{IRV} is less than 10% of the maximum average import load (kW) measured over any continuous 5 min period since the EES system was commissioned following site installation (P_{MIRV}) then P_{MIRV} .

For verification of compliance with DRM 2 and DRM 3, a tolerance of 10% is permitted for $E_{I(1)}$ and $E_{I(2)}$.

NOTE: It is possible, indeed likely, that in practice the duration of demand response events will not be exact multiples of 5 min. However, when responding to OI 2 or OI 3, an EES system will need to comply with the following:

- (a) Be capable of continually monitoring import power or energy through the grid interactive port, so that it can measure the energy and calculate the average demand over the previous 5 min whenever an OI 2 or OI 3 might be issued.
- (b) Anticipate the duration of the event so that it can manage operations to meet the demand response mode. For the purpose of the Standard, the anticipated duration should be 5 min. If the duration of the event extends beyond 5 min, the EES system should anticipate that the duration will be a further 5 min, and so on. Verification of compliance will be carried out over one or more complete 5 min periods.

Example 1: DRM 2 response if EES is importing energy through the grid interactive port at start of DR event.

The P_{MIRV} recorded since commissioning of the EES on site was 4.8 kW (measured as 0.4 kWh over a 5 min period).

At the time that OI 2 is issued the EES system was importing energy through the grid interactive port, and recorded that in the 5 min immediately preceding the receipt of the OI, the energy use was 0.35 kWh. This equates to a load of $[0.35 / 5 \times 60 = 4.2 \text{ kW}]$.

4.2 kW is more than 10% of P_{MIRV} [$4.8 \times 0.1 = 0.480 \text{ kW}$], so 4.2 kW becomes the P_{IRV} .

The energy imported through the grid interactive port is then measured over 20 min (i.e. 4 complete intervals of 5 min).

To comply with DRM 2, the EES system shall restrict the imported energy through the grid interactive port to $[0.5 \times 4.2 \times 4 \times 5 / 60 = 0.7 \text{ kWh}]$, in accordance with Equation 1. This is half what the unconstrained consumption would have been over 20 min $[4.2 / 3 = 1.4 \text{ kWh}]$.

Example 2: DRM 2 response if EES is not importing energy through the grid interactive port at start of DR event:

As in the above example (Example 1), P_{MIRV} recorded since commissioning of the EES on site was 4.8 kW (measured as 0.4 kWh over a 5 min period).

At the time that OI 2 is issued the EES system was in standby but not charging, and recorded that in the 5 min immediately preceding the energy use was 0.001 kWh. This equates to a load of $[0.001 / 5 \times 60] = 0.012$ kW].

0.012 kW is less than 10% of the maximum value recorded since commissioning on site, $[4.8 \times 0.1 = 0.480$ kW] so 4.8 kW becomes the P_{IRV} .

If the EES system begins importing energy through the grid interactive port during the OI 2 event, then the EES system shall restrict the imported energy through the grid interactive port over each period of 5 min to $[0.5 \times 4.8 \times 1 \times 5 / 60 = 0.2$ kWh] or $[0.5 \times 4.8 \times 4 \times 5 / 60 = 0.8$ kWh] if measured over 20 min, etc.

2.2.6 DRM 4 operation

An EES system with DRM 4 capability shall, when OI 4 is issued, commence or increase the importing of energy through the grid interactive port within the response time specified in Clause 2.5 subject to other issued OIs.

NOTE: The purpose of DRM 4 is to provide a load to the grid at short notice, for use by remote agents at time when there is excess supply.

The importing of energy through the grid interactive port of the EES system shall continue until either—

- (a) the EES system has reached its maximum storage capacity; or
- (b) OI 4 ceases and the user settings do not permit continuing import.

If OI 4 is issued on its own the rate of import shall be determined by the EES system.

If OI 4 is issued in combination with either OI 3 or OI 2 then the response shall be as described in Appendix A.

If OI 4 is issued in combination with OI 2 or OI 3 then import shall commence or increase, but shall be limited in accordance with a reference value.

Example 3: Response to concurrent OI 2 and OI 4 when EES is importing energy through the grid interactive port at start of DR event.

As in Example 1, the maximum 5 min sustained load recorded since commissioning of the EES system on site was 4.8 kW.

At the time that OI 2 and OI 4 were issued the EES system was importing energy through the grid interactive port, and recorded that in the 5 min immediately preceding the receipt of the OI, the energy use was 0.2 kWh. This equates to a load of $[0.2 / 5 \times 60 = 2.4$ kW].

2.4 kW is more than 10% of the highest value recorded since commissioning $[4.8 \times 0.1 = 0.480$ kW], so 2.4 kW becomes the P_{IRV} .

The energy imported through the grid interactive port is then measured over 20 min (i.e. 4 complete intervals of 5 min).

To comply with the requirements of DRM 2 and DRM 4, as long as the EES system continues to import energy through the grid interactive port during the OI 2 and OI 4 event the energy imported over each period of 5 min shall be no greater than $[0.5 \times 2.4 \times 4 \times 5 / 60 = 0.4$ kWh].

Example 4: DRM 2 and DRM 4 response if EES is in standby (neither importing nor exporting energy through the grid interactive port at start of DR event):

As in Example 1, the maximum 5-minute sustained load recorded since commissioning of the EES system on site was 4.8 kW.

At the time that OI 2 and OI 4 were issued the EES system was in standby but not charging, and recorded an energy consumption of 0.035 kWh in the 5 min immediately preceding. This equates to a load of $[0.035 / 5 \times 60 = 0.42 \text{ kW}]$.

0.42 kW is less than 10% of the maximum value recorded since commissioning on site, so 4.8 kW becomes the P_{IRV} .

To comply with the requirements of DRM 2 and DRM 4 the EES system must start importing energy through the grid interactive port (provided its level of charge is such that it is able to import). So long as the EES system continues to import energy through the grid interactive port during the OI 2 and OI 4 event the energy imported over each period of 5 min shall be no greater than $[0.5 \times 4.8 \times 15 / 60 = 0.2 \text{ kWh}]$ or $[0.5 \times 4.8 \times 4 \times 5 / 60 = 0.8 \text{ kWh}]$ if charging continues over 20 min, etc.

2.2.7 DRM 5 operation

If an EES system is capable of exporting energy through the grid interactive port, it shall support the DRM 5 and not export energy through the grid interactive port from the EES system whilst an OI 5 is issued. If an EES system has entered DRM 5 it may respond to any further OIs of which it is capable, provided there is no export through the grid interactive port.

2.2.8 DRM 6 and DRM 7 operations

An EES system is capable of DRM 6, then when OI 6 is issued the EES system shall limit its rate of export through the grid interactive port in accordance with Equation 3.

An EES system is capable of DRM 7, then when OI 7 is issued the EES system shall limit its rate of export through the grid interactive port in accordance with Equation 4.

$$E_{\text{E}(3)} \leq 0.5 \times P_{\text{ERV}} \times \text{TP} \times 5 / 60 \quad \dots (3)$$

$$E_{\text{E}(4)} \leq 0.75 \times P_{\text{ERV}} \times \text{TP} \times 5 / 60 \quad \dots (4)$$

where

TP = number of 5 min periods while EES system is operating in the selected DRM

NOTE: In testing TP should not exceed 12.

$E_{\text{E}(3)}$ = exported electrical energy (kWh) through the grid interactive port during the TP while operating in DRM 6

$E_{\text{E}(4)}$ = exported electrical energy (kWh) through the grid interactive port during the TP while operating in DRM 7

P_{ERV} = export reference value (kW) is the higher of the following two values—

- the average export load (kW) measured over the continuous 5 min period immediately prior to the receipt of OI 6 or OI 7 (P_{ERV}); or
- if P_{ERV} is less than 10% of the maximum average export load (kW) measured over any continuous 5 min period since the EES system was commissioned following site installation (P_{MERV}) then P_{MERV} .

For verification of compliance with DRM 6 and DRM 7, a tolerance of 10% is permitted for $E_{\text{E}(3)}$ and $E_{\text{E}(4)}$.

NOTE: It is possible, indeed likely, that in practice the duration of demand response events will not be exact multiples of 5 min. However, when responding to OI 6 or OI 7, an EES system will need to comply with the following:

- (a) Be capable of continually monitoring export power or energy through the grid interactive port, so that it can measure the energy and calculate the average demand over the previous 5 min whenever an OI 6 or OI 7 might be issued.
- (b) Anticipate the duration of the event so that it can manage operations to meet the demand response mode. For the purpose of the Standard, the anticipated duration should be 5 min. If the duration of the event extends beyond 5 min, the EES system should anticipate that the duration will be a further 5 min, and so on. Verification of compliance will be carried out over one or more complete 5 min periods.

Example 5: DRM 6 response if EES is exporting energy through the grid interactive port at start of DR event.

The P_{MERV} recorded since commissioning of the EES on site was 5.04 kW (measured as 0.42 kWh over a 5 min period).

At the time that OI 6 is issued the EES system was exporting energy through the grid interactive port, and recorded that in the 5 min immediately preceding the receipt of the OI, the energy use was 0.3 kWh. This equates to a load of $[0.3 / 5 \times 60 = 3.6 \text{ kW}]$.

3.6 kW is more than 10% of P_{MERV} $[5.04 \times 0.1 = 0.504 \text{ kW}]$, so 3.6 kW becomes the P_{ERV} .

The energy exported through the grid interactive port is then measured over 15 min (i.e. 3 complete intervals of 5 min).

To comply with DRM 6, the EES system shall restrict the export of energy through the grid interactive port to $[0.5 \times 3.6 \times 3 \times 5/60 = 0.45 \text{ kWh}]$, in accordance with Equation 3. This is half what the unconstrained generation would have been over 20 min $[3.6 / 4 = 0.9 \text{ kWh}]$.

Example 6: DRM 7 response if EES is not importing energy through the grid interactive port at start of DR event:

As in the above example (Example 5), the maximum 5-minute sustained load recorded since commissioning of the EES system on site was 5.04 kW.

At the time that OI 7 is issued the EES system was in standby but not exporting, and recorded that in the 5 min immediately preceding the energy use was 0.001 kWh. This equates to a load of $[0.001 \times 5 / 60 = 0.012 \text{ kW}]$.

0.012 kW is less than 10% P_{MERV} $[5.04 \times 0.1 = 0.504 \text{ kW}]$, so 5.04 kW becomes the P_{ERV} .

If the EES system begins to export energy through the grid interactive port during the OI 7 event, then the EES system shall restrict the export of energy through the grid interactive port over each period of 5 min to $[0.75 \times 5.04 \times 1 \times 5 / 60 = 0.315 \text{ kWh}]$ or $[0.75 \times 5.04 \times 4 \times (5 / 60) = 1.26 \text{ kWh}]$ if measured over 20 min, etc.

2.2.9 DRM 8 operation

If an EES system is not exporting energy through the grid interactive port and whilst an OI 8 is issued, then the EES system shall enter and remain in a DRM 8 state and commence the export of energy through the grid interactive port subject to other active DRMs.

An EES system with DRM 8 capability shall, when OI 8 is issued, commence or increase the export of energy through the grid interactive port within the response time specified in Clause 2.5 subject to other issued OIs.

NOTE: A purpose of DRM 8 may provide a source to the grid at short notice, for use by remote agents at time when there is a lack in supply.

The exporting of energy through the grid interactive port of the EES system shall continue until either—

- (a) the EES System has depleted its storage capacity; or
- (b) OI 8 ceases and the user settings do not permit continued export.

If OI 8 is issued on its own the rate of export shall be determined by the EES system.

If OI 8 is issued in combination with OI 6 or OI 7 then export shall commence or increase, but shall be limited in accordance with a reference value.

Example 7: DRM 6 and DRM 8 response if EES is exporting energy through the grid interactive port at start of DR event.

As in the above example (Example 5), the maximum 5-minute sustained load recorded since commissioning of the EES system on site was 5.04 kW.

At the time that OI 6 and OI 8 were issued the EES system was exporting energy through the grid interactive port, and recorded that in the 5 min immediately preceding the receipt of the OI, the energy supplied was 0.2 kWh. This equates to a source of $[0.2 / (5 / 60) = 2.4 \text{ kW}]$.

2.4 kW is more than 10% P_{MERV} [$5.04 \times 0.1 = 0.504 \text{ kW}$], so 2.4 kW becomes the P_{ERV} .

The energy exported through the grid interactive port is then measured over 20 min (i.e. 4 complete intervals of 5 min).

To comply with the requirements of DRM 6 and DRM 8, the EES system must continue to export energy through the grid interactive port during the OI 6 and OI 8 event to the restricted rate of $[0.5 \times 2.4 \times 4 \times (5 / 60) = 0.4 \text{ kWh}]$.

Example 8: DRM 7 and DRM 8 response if EES is not exporting energy through the grid interactive port at start of DR event:

As in the above example (Example 5), the maximum 5-minute sustained load recorded since commissioning of the EES system on site was 5.04 kW.

At the time that OI 7 and OI 8 were issued the EES system was on but not discharging, and recorded that in the 5 min immediately preceding the energy use was 0.035 kWh. This equates to a load of $[0.035 / (5 / 60) = 0.42 \text{ kW}]$.

0.42 kW is less than 10% P_{MERV} [$5.04 \times 0.1 = 0.504 \text{ kW}$], so 5.04 kW becomes the P_{ERV} .

To comply with the requirement of DRM 7 and DRM 8 the EES system must start to exporting energy through the grid interactive port during the OI 7 and OI 8 event at a restricted rate over each period of 5 min to $[0.75 \times 5.04 \times 1 \times 5 / 60 = 0.315 \text{ kWh}]$ or $[0.75 \times 5.04 \times 4 \times 5 / 60 = 1.26 \text{ kWh}]$ if measured over 20 min, etc.

2.2.10 Combinations of operational instructions

2.2.10.1 General

An EES shall only respond to the OIs corresponding to the DRMs of which it is capable. It shall not change its mode of operation in response to other OIs of which it is not capable; if it is in user operation at the time it shall remain in user operation, and if it is in a demand response mode it shall remain in that mode.

A DRED may activate more than one OI at a time. An EES system that receives more than one OI at a time shall respond as indicated in Appendix A, provided the EES system is capable of the DRMs corresponding to those OIs.

An EES system shall operate in a mode that logically satisfies the requirements of all OIs in that combination that correspond to DRMs of which it is capable.

Example 9: Operation with combined OIs:

If OI 2 and OI 8 are issued concurrently, then an EES system that is capable of both DRM 2 and DRM 8 would export (if it had sufficient stored energy to be able to do so safely), but if it exhausts its capacity to export during the DR event, it may start importing, but at no more than 50% of the import reference value.

2.2.10.2 *Combinations of operational instructions which include OI 0*

If OI 0 is issued, whether alone or in combination with other DRMs, an EES system with a disconnection device shall enter DRM 0.

If OI 1 and OI 5 are issued together, an EES system with a disconnection device shall enter DRM 0, and an EES system not equipped with a disconnection device shall enter DRM 1 if capable of DRM 1 and DRM 5 if capable of DRM 5.

This means that an EES system capable of exporting and importing energy through the grid interactive port shall do neither so long as OI 0 is activated. An EES system capable of importing energy through the grid interactive port only shall not import energy through the grid interactive port so long as OI 0 is activated. An EES system capable of exporting energy through the grid interactive port only shall not export energy through the grid interactive port so long as OI 0 is activated.

2.3 POWER QUALITY SUPPORT

Where DRM 3 or DRM 7 is supported, the reactive power set-point shall be adjustable in accordance with AS/NZS 4777.2.

2.4 MANUAL OVER-RIDE

No DRM shall be subject to a manual over-ride.

2.5 RESPONSE TIMES

An EES system with a disconnection device shall enter DRM 0 within 2 s of receiving OI 0 from the DRED.

For other DRMs, an EES system shall enter the corresponding DRM (if capable of that DRM) within 20 s of receiving an OI from the DRED. If more than one OI is issued, the EES system shall enter the required DRMs (if capable) within 20 s of the combination being issued.

An EES system that is in a DRM shall return to user operation within 20 s after the cessation of the OI of (or, of in DRMs as a result of a combination of OIs, within 20 s of the cessation of the last OI in the combination).

NOTE: Any randomization (i.e. variation of the time delay between the receipt by the DRED of a signal from the remote agent and the issuing of an operational instruction) will be managed within the DRED.

2.6 RECONNECTION OF DISCONNECTION DEVICE

After cessation of a demand response event which results in disconnection, reconnection to the grid shall occur only after all the conditions described in a connection and reconnection procedure in accordance with AS/NZS 4777.2, Clause 7.7 have been met.

SECTION 3 INTERFACES

3.1 GENERAL

An EES system demand response controller (DRC) shall be capable of detecting the assertion and non-assertion of any switch in a connected DRED that is assigned to an OI corresponding to a DRM of which the EES system is capable, when the electrical properties of the connection comply with Table 4.

3.2 PHYSICAL INTERFACES

The provision for the physical connection with the DRED shall be either via a terminal block or via an RJ45 socket.

If the interface connector is an RJ45 socket, all voltages shall be safety extra-low voltage (SELV) in accordance with AS/NZS 60335.1. If the interface is a terminal block, all voltages shall be SELV or extra-low voltage (ELV) in accordance with AS/NZS 60335.1. No voltage shall exceed 42 V d.c.

3.3 TERMINAL BLOCK

3.3.1 Terminal block assignment

If the provision for the physical connection is a terminal block, the terminal block shall have sufficient terminals to allow a connected DRED to transmit the OIs corresponding to the DRMs of which the EES is capable.

NOTE: For example, if the EES system is only capable of importing energy from the grid, only capable of DRM 1 and does not have a disconnection device, the DRC requires a minimum of two terminals.

3.3.2 Terminal block specifications

The terminal block on the EES system DRC shall comply with AS/NZS 3000.

3.4 RJ45 SOCKET

3.4.1 RJ45 socket pin assignment

If the provision for the physical connection is a RJ45 socket, it shall have its terminals configured as specified in Table 2.

TABLE 2
RJ45 SOCKET PIN ASSIGNMENT

Pin	Assignment for EES system capable of importing energy only	Assignment for EES system capable of exporting energy only	Assignment for EES system capable of both importing and exporting energy
1	DRM 1	DRM 5	DRM 1/5
2	DRM 2	DRM 6	DRM 2/6
3	DRM 3	DRM 7	DRM 3/7
4	DRM 4	DRM 8	DRM 4/8
5	Not used	RefGen	RefGen
6	Com/DRM 0	Com/DRM 0	Com/DRM 0
7	V+ (see Note)	V+ (see Note)	V+ (see Note)
8	V– (see Note)	V– (see Note)	V– (see Note)

NOTE: The EES system DRC may be equipped with a power supply suitable for use by a DRED, in which case pins 7 and 8 may be used for a direct current power supply (≤ 42 V d.c.) with polarity as indicated. If power is not provided, pins 7 and 8 shall be shorted.

If the DRED completes the circuit between pin 1 and pin 6, the EES system DRC shall receive OI 1.

If the DRED completes the circuit between pin 2 and pin 6, the EES system DRC shall receive OI 2.

If the DRED completes the circuit between pin 3 and pin 6, the EES system DRC shall receive OI 3.

If the DRED completes the circuit between pin 4 and pin 6, the EES system DRC shall receive OI 4.

If the DRED completes the circuit between pin 1 and pin 5, the EES system DRC shall receive OI 5.

If the DRED completes the circuit between pin 2 and pin 5, the EES system DRC shall receive OI 6.

If the DRED completes the circuit between pin 3 and pin 5, the EES system DRC shall receive OI 7.

If the DRED completes the circuit between pin 4 and pin 5, the EES system DRC shall receive OI 8.

If the DRED completes the circuit between pin 5 and pin 6 then the EES system DRC shall receive OI 0.

If an EES system does not have a DRM capability corresponding to an operating instruction, it shall ignore the assertion of switches corresponding to that OI (see Clause 2.2.10).

Example: An EES system is capable of DRM 1 only. It is importing energy into the EES for charging storage when the DRED asserts the switches corresponding to OIs 1, 7 and 8 (RJ45 pin pairs 1+6, 3+5 and 4+5). As the EES system has no DRM 7 or DRM 8 capabilities it only ‘sees’ OI 1, and so enters DRM 1.

NOTE: Appendix D depicts an example of a circuit arrangement with 6 pin connections.

3.4.2 RJ45 socket specifications

The RJ45 socket shall meet the criteria in Table 3.