Bulletin 64-1-5
Utility-interactive inverters
Rules 14-402, 14-414, 14-700, 64-060, 64-102, 64-112, 84-010, 84-020, and 84-022

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1) Acceptance of adjustable inverters

With the advancement of electronics providing more accessibility, questions have been raised regarding the acceptance of using inverter derated values for sizing conductors and equipment.

Where a standard kilowatt (kW) rating inverter is not available, an inverter with a higher kW rating may be used which can be derated (curtailed) to a desired lower kW rating.

Question 1
Is it permitted to use the derated value of an inverter, which has been derated at the factory, for determining conductor and equipment ratings?

Answer 1
Yes.

Rationale 1
Inverters that have been factory derated and are certified to CSA 22.2 107.1 are required to have the maximum continuous output in amperes marked on the nameplate. The derated markings are applied in the factory.

Question 2
Is it permitted to use the derated value of an inverter, which has been derated in the field by either the installer or manufacturer, for determining conductor and equipment ratings?

Answer 2
Yes, provided all four conditions are met:

1) Restricted access preventing users from accessing the adjusting means is accomplished by one of the following:
    a) A cover or door that requires the use of a tool to access the adjustments;
    b) A unique password protected commissioning application; or
    c) Software that has a unique password for that site to the adjusting means.
2) Additional field marking is applied to the inverter stating, at minimum:
    a) Maximum continuous derated output current in amperes (A); and
    b) Maximum continuous derated output power in kilowatts (kW).
3) The inverter output conductors (where the ampacity is based on the derated inverter output) are protected in accordance with Rules 8-104, 14-100 and 14-104; and
4) Documentation is provided by the inverter manufacturer that states the maximum continuous derated output current in amperes or the programmed limit is demonstrated to the inspector.

Rationale 2
The Electrical Safety Authority (ESA) continues to review inverter functionality as it is unclear what happens when a field derated inverter is reset and if output settings return to the maximum marked on the nameplate. As such, it shall be required to protect conductors that have been reduced in size as per Rule14-100 (as tap conductors) and considering Rules 8-104 and 14-104 (see note 1).

Note 1
If the derated inverter output conductors cannot satisfy the requirements of Rule 14-100, then the conductors are required to be sized as per the nameplate inverter output value, or an additional overcurrent device is required to be installed.

2) Connection of utility-interactive inverters

a) Background

Rule 64-112 3) permits the output circuit of an interactive inverter to be connected on the load side of the service disconnecting means of other source(s) at any distribution equipment on the premises, with some conditions.

Where distribution equipment such as a switchboard, panelboard, or splitter is supplied simultaneously from a primary power source (the supply authority) and one or more interactive inverters, the conditions outlined in Rule 64-112 4) and 5) must be satisfied in order to have the output circuit of the inverters connected on the load side of the service disconnecting means, otherwise the connection must be made on the supply side of the service disconnecting means.

Note 2
A circuit breaker with ground fault protection that is **not** suitable for back-feeding will have terminals **clearly marked "line" and "load"**. See Bulletin 14-5-* for more information.

b) Point of connection

Rules 64-112 4) e) & f) permit the sum of the ampere ratings of the overcurrent protection devices (OCPD) of the source circuits feeding the equipment to exceed the equipment or conductor rating by a maximum of 125% in dwelling units and 120% in buildings other than dwelling units.

- Where the interactive inverter(s) output circuit **exceeds the limits permitted** in Rule 64-112 4) e) & f), it shall be connected on the supply side, as shown in Diagram B1 or in accordance with Rule 64-112 4) g).

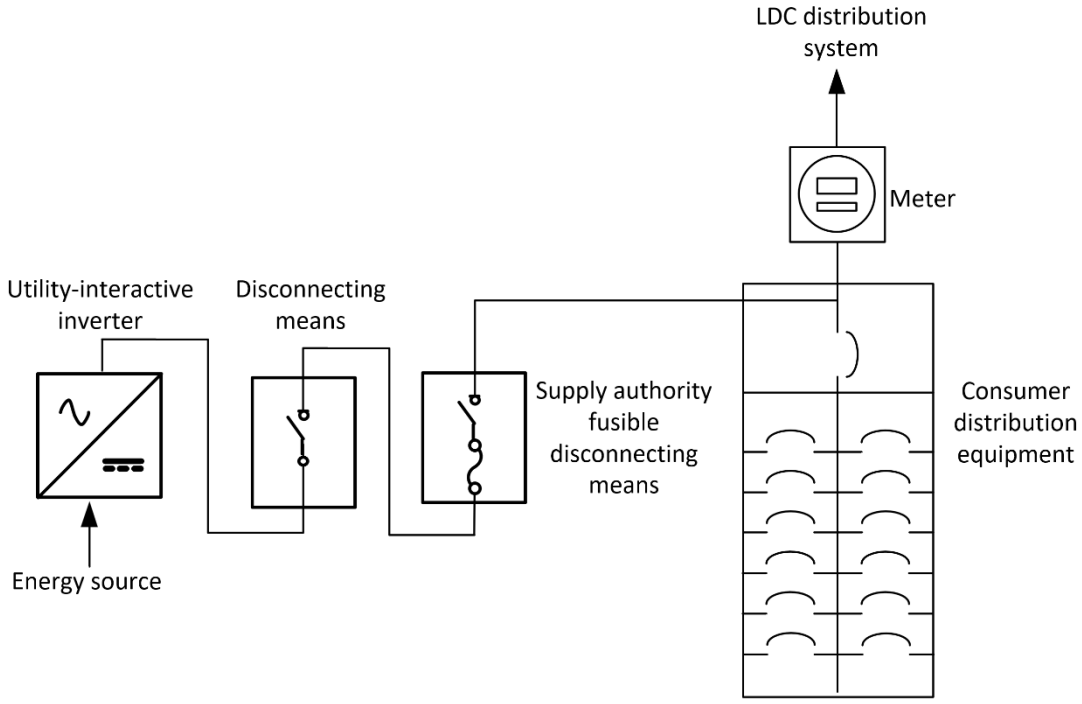
Question 3
When determining compliance with Rule 64-112 4) e) or f), is it permitted to use 125% of the maximum continuous output current rating of the inverter rather than using the output overcurrent device rating as specified in the Rule?

Answer 3
Yes, notwithstanding Rule 64-112 4) e) and f)

Rationale 3
Due to the application of continuous loading requirements imposed by Rule 64-100, designers are often required to install an overcurrent device which is the next standard size up from the minimum required by the Rule. Because this output overcurrent device rating is then incorporated in determining a suitable rating for equipment fed by multiple sources rather than using the rating of the limited source itself, the equipment is often required to be sized larger than the Rule would actually require.

Additionally, some new types of inverters include features such as pass through and supply for electric vehicle supply equipment (EVSE), that require the interconnecting overcurrent device to be sized based on considerations other than just the maximum continuous output current rating making the requirement to sum the ratings of overcurrent devices overly restrictive.

Diagram B1 – Example of connection of interactive inverter output circuit on the supply side of service disconnecting means, when inverter output OCPD rating exceeds limits permitted in Rule 64-112 4) e) and f)



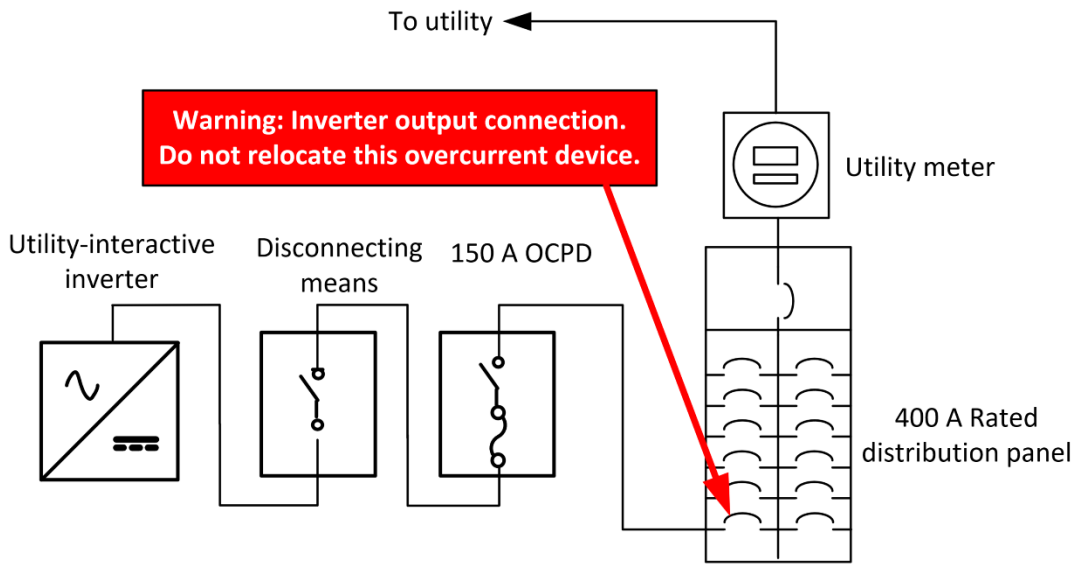
Where the equipment is rated less than the sum of the ampere ratings of all OCPD supplying it, Rule 64-112 4) b) requires the point of interconnection of the interactive inverter(s) output circuit to be at the opposite end from the main input feeder connection as shown in the example illustrated by Diagram B2. The 120% or 125% limitations of 64-112 4) e) or f) are applicable, or equipment shall be provided to limit the input and output current of the interconnected systems to ensure the equipment or conductor cannot be overloaded as per Rule 64-112 4) g) (see note 2).

A warning label shall be posted beside the OCPD to prevent relocating it on the bus, as shown on diagram B2 below.

Note 3

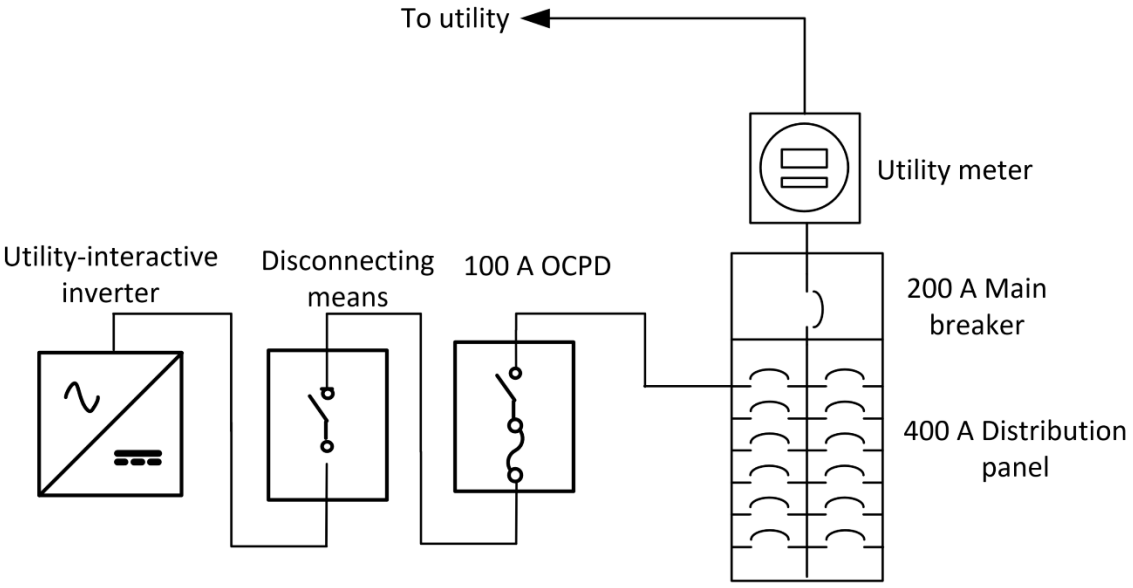
64-112 4) g) permits equipment to allow the sum of the ampere ratings of all OCPD connected to a busbar to exceed the 120% and 125% limitations of 64-112 4) e) & f). This allows the use of any size of interconnected system provided it uses a method of monitoring and controlling the current to ensure the equipment or conductor cannot be overloaded. One acceptable method to meet the requirements of this subrule would be the use of CT's on each source and an associated control system to throttle the current contribution of the interconnected source.

Diagram B2 – Example of connection of interactive inverter output circuit on the load side of main service disconnecting means, when the sum of the OCPD supplying the bus is greater than the bus rating and within the limits permitted by Rules 64-112 4) e) & f))



Where the sum of the ampere ratings of all OCPD supplying the bus is equal to or less than the bus rating, the connection can be made either on the supply side or load side of the service disconnecting means (with no restrictions on the location of interactive inverter OCPD on the bus), as shown in Diagram B3.

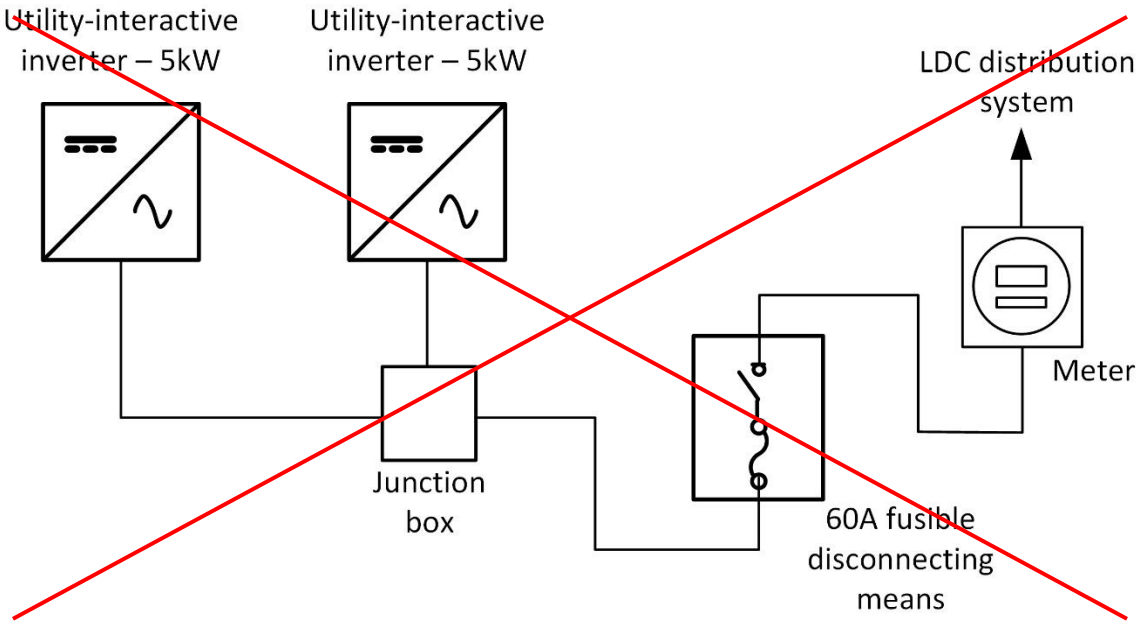
Diagram B3 – Example of connection of interactive inverter output circuit on the load side of main service disconnecting means, when the sum of the OCPD supplying the bus is equal to or less than the bus rating



c) Disconnecting means and overcurrent protection for inverters operating in parallel

Question 5
For an installation that incorporates two inverters tied to a common ac feeder, does a single disconnecting means on the ac common output satisfy Rules 64-060 3)? (See Diagram B5)

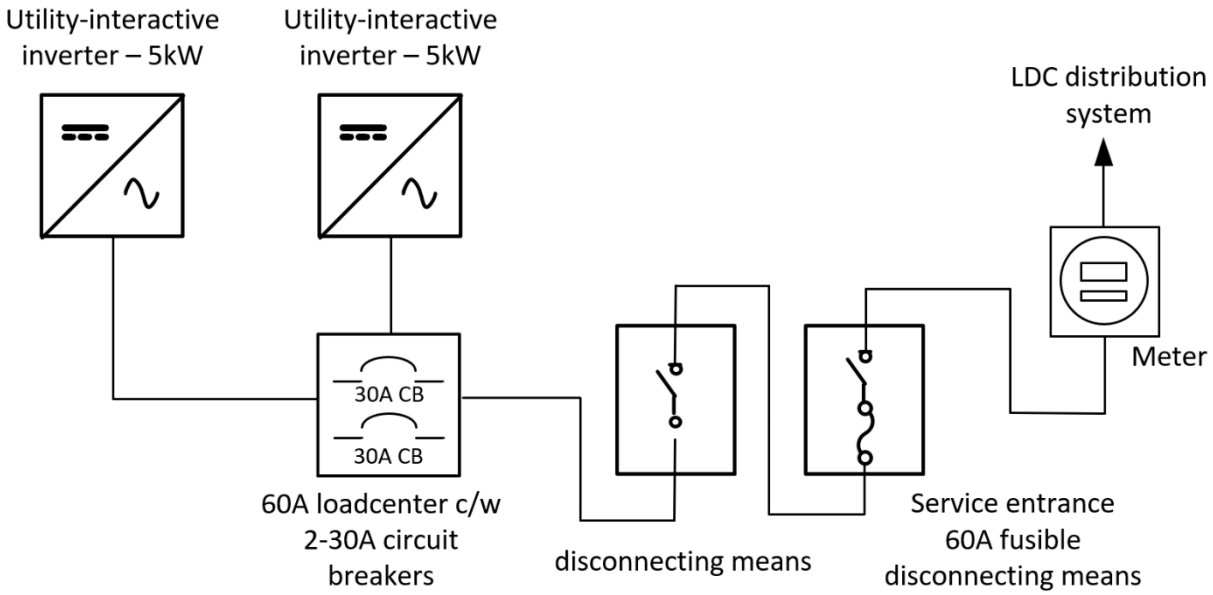
Diagram B5 – Single disconnecting means for multiple inverters, unacceptable design



Answer 5
No.

Rationale 5
The single disconnecting means satisfies requirements related to the system disconnecting means, however, Rule64-060 3) requires separate disconnecting means for each piece of equipment inverter. The separate disconnecting means are also required for compliance with Rule14-414. Diagram B6 shows an example of a code compliant installation.

Diagram B6 – Separate disconnecting means for each inverter



Question 6
For an installation that incorporates two inverters tied to a common ac feeder, does each inverter output require a separate individual overcurrent device to be installed at the tap point, if the output conductors to each inverter are rated for the common feeder overcurrent rating (i.e. 60 A as per Diagram B5).

Answer 6
Yes

Rationale 6
Rules 64-102 b) ii) and 64-112 require individual overcurrent protection to be provided for each inverter output as per Section 14 Rules.. Although the larger tap conductors do not require overcurrent protection, the connected equipment (the inverter) does.

The inverter manufacturer's installation instructions shall also be followed and overcurrent protection shall also meet their requirements (Rule 2-034). Diagram B6 shows an example of a code compliant installation.

i. Inverters with integral overcurrent/disconnecting devices

If the inverters have integral overcurrent protective/disconnecting devices, then external devices, referenced by questions 5 and 6 are not required to be installed; however, the length of the conductors from the inverter to the point of common connection must then comply with Rule 14-100.

ii. AC modules and micro-inverters

AC modules and micro-inverters that operate in a multiple ac module or micro-inverter system configuration are considered as one generation source. The requirement for a separate disconnecting means and overcurrent protection for each inverter, referenced by Questions 5 and 6, is not applicable.

For the maximum number of ac modules or micro-inverters that are permitted to be connected to one branch circuit, manufacturer's installation instructions shall be followed.

3) Inverter fusible disconnecting means

Embedded energy source installations are often encountered with a fusible disconnecting means where the fuses are energized from both sides. Rules 64-060 3) c) and 84-024 2) require disconnecting means for fuses from all sources in accordance with Rule 14-402. The language of Rule 14-402 requires the disconnecting means for fuses to be either integral or adjacent to the fuse holder.

Question 7
Where a utility-interactive inverter is installed, is the anti-islanding feature of the inverter permitted to act as the disconnecting means on the inverter side of the fuse?

Answer 7
No

Rationale 7
Rule 14-700 prohibits solid state devices to act as either an isolating or disconnecting means.

Past allowances have been based on the common practice of installing the fusible disconnecting means adjacent to the inverter which in most cases contained a DC disconnect that meets the requirements of 64-060 3) c). The evolution of design in embedded energy systems now frequently has fusible disconnecting means located remotely from any means to isolate the fuses.