Chapter 7 – Special Conditions
Article 705—Interconnected Electric Power Production Sources

Interconnected Electric Power Production Sources
Scope
705.1

Primary Source of Electricity
Inverter
PV Array
Electrical Power Production Source
Meter/Main ac Panelboard
ac Loads

Article 705 covers the installation of electric power production sources (photovoltaic, wind, micro-hydro generators, etc) operating in parallel with a primary source(s) of electricity.
Power Production Equipment
705.2 Definition

The generating source, and all distribution equipment associated that generates electricity from a source other than a utility supplied service.

705.10 Directory
Buildings/structures containing utility service and a PV system must have a permanent plaque identifying location of service and PV system disconnecting means if not at the same location.

705.12 Point of Connection

(A) Supply Side of Service Equipment
Supply Side of Service Disconnecting Means 705.12(A)

Inverter Disconnect as Service Equipment

Service Disconnect

The output of a utility-interactive inverter can be connected to the supply side of the service disconnect as permitted by 230.82(6).

Point of Connection Supply Side of Service 705.12(A)

PV Main Breaker

Service Main Breaker 200A

The ratings of PV system service disconnect isn’t permitted to exceed the rating of the service.
Where the PV system is connected to the supply side of the service disconnecting means, the sum of the ratings of the inverter ac inverter overcurrent protection device(s) must not exceed the rating of the utility service.

When determining the number of service disconnects, don’t count the PV disconnect(s) connected to the supply side of service equipment since it’s not a service disconnect [230.82(6)].
The neutral conductor on the supply-side of service equipment for PV systems must be bonded to the PV disconnect in accordance with 250.24(C).

Metal enclosures and raceways containing service conductors must be bonded together in accordance with 250.92(B).
Methods of Bonding at Service 250.92(B)

Ringed Knockout Raceway Entry

Bonding Bushing with Jumper Required

Bonding jumpers must be used around reducing washers or oversized, concentric, or eccentric knockouts.

Methods of Bonding at Service 250.92(B)

Standard locknuts are permitted to make a mechanical connection of the raceway(s), but they can’t serve as the bonding means required by this section.
Enclosures and supply-side bonding jumpers must be bonded to the service neutral conductor.

A SSBJ isn’t required within nonmetallic conduit, because the service neutral conductor serves as the effective ground-fault current path [352.60 Ex 2].
Methods of Bonding at Service
Threaded Fittings/Entries
250.92(B)(2)

Threaded Hub

Raceways terminated in
threaded hubs or enclosures
require no additional bonding.

Methods of Bonding at Service
Threadless Fittings
250.92(B)(3)

Threadless
Fittings

Raceways are considered suitably bonded
by threadless fittings if made up tight.
Methods of Bonding at Service - Ringed Knockout Entry 250.92(B)(4)

Ringed Knockout Raceway Entry

Bonding Bushing with Jumper Required

Only one end needs to be bonded.

A listed bonding fitting with a bonding jumper to the service neutral conductor is required when a metal raceway terminates to a ringed knockout.

Methods of Bonding at Service No Ringed Knockout Entry 250.92(B)(4)

No Ringed Knockout Raceway Entry

or

Bonding Locknut or Bonding Bushing with Jumper Required

A bonding-type locknut can be used for a metal raceway terminating to an enclosure without a ringed knockout.
Methods of Bonding at Service
250.92(B)(4)

Service bonding at only one end of a service raceway provides the low-impedance path for fault current to flow back to the power supply.

705.12 Point of Connection

(D) Load Side of Service Equipment
705.12(D) Point of Connection
Load Side

Interconnection must comply with (D)(1) through (D)(6) if distribution is capable of supplying branch circuits or feeders.
Dedicated Inverter Circuit
705.12(D)(1)

The ac connection of one or more inverters in one system must be made to a dedicated circuit breaker or fusible disconnect.

Utility-Interactive Inverters
Feeder Conductor Ampere Rating
705.12(D)(2)(1)(a)

PV - 160A Continuous

200A + (160A x 1.25) = 400A
600 kcmil

200A, 3/0 AWG rated 200A at 75°C, Table 310.15(B)(16)

The feeder conductor on the load side of the inverter ac output connection must have an ampacity not less than the feeder overcurrent protection device, plus 125 percent of the inverter output ac circuit current rating.
Utility-Interactive Inverters

Feeder Conductor Ampere Rating

705.12(D)(2)(1)(b)

The feeder conductor on the load side of the inverter ac output connection must have overcurrent protection on the load side of the inverter output ac connection sized not greater than the ampacity of the feeder.

Utility-Interactive Inverters

Feeder - 10 Ft Tap

705.12(D)(2)(2)

Minimum Feeder Tap

[200A + (160A x 1.25)] x 0.10 = 40A, but in no case less than the rating of the 100A OCPD.

Feeder tap between the feeder overcurrent protection device and the inverter ac inverter output protection device, must have an ampacity not less than the feeder overcurrent protection device, plus 125 percent of the inverter output ac circuit current rating in accordance with 240.21(B).
Utility-Interactive Inverters
Feeder - 25 Ft Tap
705.12(D)(2)(2)

Minimum Feeder Tap Size
\[200A + (160A \times 1.25) \times 0.33 = 133A\]

Feeder tap between the feeder overcurrent protection device and the inverter ac inverter output protection device, must have an ampacity not less than the feeder overcurrent protection device, plus 125 percent of the inverter output ac circuit current rating in accordance with 240.21(B).

Panelboard Bus Rating
705.12(D)(2)(3)(a)

If the inverter ac output circuit breaker(s) aren’t located at the opposite end of the feeder terminal on the panelboard, the ampere rating of the panelboard busbar must not be less than the ampere rating of the overcurrent device protecting the panelboard busbar, plus 125% of the inverter ac output current rating.
Panelboard Bus Rating

**705.12(D)(2)(3)(a)**

- **Inverter 1**: 24A
- **Inverter 2**: 24A
- **200A Breaker**
- **225A Bus**

**VIOLATION (CB on Top)**

\[
200A + (24A \times 2 \times 1.25) = 260A
\]

which exceeds 225A bus rating.

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Panelboard Bus Rating

**120% Bus Rule**

**705.12(D)(2)(3)(b)**

- **Inverter 1**
- **Inverter 2**

Two sources (utility/PV) overcurrent protection devices are located at opposite ends of a bus.

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The ampere rating of the overcurrent device protecting the panelboard busbar, plus 125% of the inverter output ac current ratings must not exceed 120% of the ampere rating of the panelboard busbar.
Panelboard Bus Rating
120% Bus Rule
\[ 705.12(D)(2)(3)(b) \]

Okay (CB Opposite End)
\[
\begin{align*}
225A \times 1.20 & => 200A + (24A \times 2 \times 1.25) \\
270A & => 200A + 60A \\
270A & => 260A
\end{align*}
\]

Panelboard Bus Rating
120% Bus Rule
\[ 705.12(D)(2)(3)(b) \]

VIOLATION (CB Opposite End)
\[
\begin{align*}
200A \times 1.20 & => 200A + (24A \times 2 \times 1.25) \\
240A & => 200A + 60A \\
240A & => 260A
\end{align*}
\]
Panelboard Bus Rating
120% Bus Rule
705.12(D)(2)(3)(b)

Inverter 1
24A

Inverter 2
24A

175A Breaker
200A Bus

OKAY (CB Opposite End)
200A x 1.20 => 175A +(24A x 2 x 1.25)
240A => 175A + 60A
240A => 235A

Inverter Output Connection Label
705.12(D)(2)(3)(b)

WARNING
INVERTER OUTPUT CONNECTION. DO NOT RELOCATE THIS OVERCURRENT DEVICE.

Two sources (utility/PV) overcurrent protection devices are located at opposite ends of a bus.

A permanent warning label complying with 110.21(B) must be applied to the distribution equipment adjacent to any back-fed breaker from an inverter.
Panelboards are permitted to have any number of breakers (inverter/load), as long as the total ampere rating of all breakers don’t exceed the panelboard bus ampere rating.

Panelboard Bus Rating

\[ 705.12(D)(2)(3)(c) \]

<table>
<thead>
<tr>
<th>Line 1</th>
<th>Line 2</th>
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<tbody>
<tr>
<td>20A, 240V</td>
<td>20A</td>
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<td>20A, 240V</td>
<td>20A</td>
</tr>
<tr>
<td>Inverter 1, 240V</td>
<td>30A</td>
</tr>
<tr>
<td>Inverter 2, 240V</td>
<td>30A</td>
</tr>
<tr>
<td><strong>Total Per Line</strong></td>
<td><strong>180A</strong></td>
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</tbody>
</table>

Minimum Bus Rating = 180A

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Panelboard Bus Rating

705.12(D)(2)(3)(c)

<table>
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<tr>
<th>Line 1</th>
<th>Line 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter 1, 240V</td>
<td>30A</td>
</tr>
<tr>
<td>Inverter 2, 240V</td>
<td>30A</td>
</tr>
<tr>
<td>Inverter 3, 240V</td>
<td>30A</td>
</tr>
<tr>
<td>Inverter 4, 240V</td>
<td>30A</td>
</tr>
<tr>
<td>Inverter 5, 240V</td>
<td>30A</td>
</tr>
<tr>
<td>Inverter 6, 240V</td>
<td>30A</td>
</tr>
<tr>
<td>One 20A, 120V</td>
<td>20A</td>
</tr>
<tr>
<td><strong>Total Per Line</strong></td>
<td><strong>200A</strong></td>
</tr>
</tbody>
</table>

Minimum Bus Rating = 200A

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Panelboard Bus Rating

705.12(D)(2)(3)(c)

**WARNING**

EQUIPMENT FED BY MULTIPLE SOURCES

TOTAL RATING OF ALL OVERCURRENT DEVICES EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE SHALL NOT EXCEED AMPACITY OF BUSBAR

Where equipment is fed by multiple sources a permanent warning label installed in accordance with 110.21(B) must be applied to distribution equipment.

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705.12(D)(2)(3)(d) Center Fed

Connections are permitted on multiple-ampacity busbars or center-fed panelboards where designed under engineering supervision that includes fault studies and busbar load calculations.

TIA 14-12
(SC 16-8-16 / TIA Log #1234)

Pursuant to Section 5 of the NFPA Regulations Governing the Development of NFPA Standards, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 70®, National Electrical Code®, 2014 edition. The TIA was processed by the NEC Code-Making Panel 4 and the Correlating Committee on National Electrical Code, and was issued by the Standards Council on August 4, 2016, with an effective date of August 24, 2016.

A Tentative Interim Amendment is tentative because it has not been processed through the entire standard-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a public input of the proponent for the next edition of the standard, as such, it then is subject to all of the procedures of the standard-making process.

1. Add new 705.12(D)(2)(3)(e) to read as follows:

   (e) A connection at either end, but not both ends, of a center-fed panel board in dwellings shall be permitted where the sum of 125 percent of the power source(s) output circuit current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.
**Point of Connection - Marking**

705.12(D)(3)

Panelboards containing ac inverter circuit breaker(s) must be marked to indicate the presence of all sources.

PANELBOARD IS ENERGIZED FROM TWO SOURCES OF AC POWER
SOLAR - 24A
UTILITY - 200A at 240V

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**Suitable for Backfeed**

705.12(D)(4)

Conductors from the alternating-current inverter can backfeed dedicated circuit breakers that aren’t marked “Line” and “Load.”
Backfed OCPD - Fastening
705.12(D)(5)

Dedicated ac utility interactive inverter circuit breakers that are backfed, aren’t required to be secured in place by an additional fastener as required by 408.36(D).
705.12(D)(6) Wire Harness Arc-Fault Protection

Utility interactive inverter(s) that have a wire harness must terminate to an AFCI protection device if rated 240V, 30A or less.

Reference: 705.12(D)(6)
TIA 14-11
(SC 16-8-14 / TIA Log #1224)

Pursuant to Section 5 of the NFPA Regulations Governing the Development of NFPA Standards, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 70®, National Electrical Code®, 2014 edition. The TIA was processed by the NEC Code-Making Panel 4 and the Correlating Committee on National Electrical Code, and was issued by the Standards Council on August 4, 2016, with an effective date of August 24, 2016.

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1. Delete 705.12(D)(6) in its entirety:

(6) Wire Harness and Exposed Cable Arc-Fault Protection. A utility-interactive inverter(s) that has a wire harness or cable output circuit rated 240 V, 30 amperes, or less, that is not installed within an enclosed raceway, shall be provided with listed ac AFCI protection:
Conductors for utility interactive inverters on the supply side of the service disconnect must have overcurrent protection within 10 ft of the point where the conductors connected to the service conductors.

THE END  Thank You, and God Bless

Understanding NEC Requirements for SOLAR PHOTOVOLTAIC SYSTEMS

part 1 of 2

Based on the 2017 NEC

www.MikeHolt.com  I  888.NEC.CODE
2014/17 NEC Requirements for PV Installations
AEE Conference
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