

Technical Note 6297:
Neutral Conductor Size for Sunny Boy Inverters



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Distribution:

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Abstract

With the acceptance of IEEE 1574.1 by the UL standards committee, all utility interactive inverters are now required to be connected to a grounded (neutral) conductor if it is present in the electricity distribution system. This is so that the inverter can monitor voltage and phase angle of the utility system both line-to-line and line-to-neutral. Sunny Boy Inverters have historically not required this connection and, as a result, this connection to the neutral (grounded) circuit conductor is for instrumentation purposes only. This is a situation which is not covered by the current version of the code, but will be addressed in the 2008 revision.

Executive Summary

It is the opinion of SMA America, Inc. that the grounded branch circuit conductor should be the same size as the equipment grounding conductor as defined in Table 250.122 of the NEC. However the Authority Having Jurisdiction (AHJ) will always have the final say on all matters concerning the NEC.

Application of this Tech Note

This Tech Note applies to the following inverter models, hereinto referred to as "Inverters":

- § SB 3300U (208 or 240 Vac connection)
- § SB 3800U (208 or 240 Vac connection)
- § SB 6000U (208 or 240 Vac connection)
- § SC 125U (208, 240, or 480 Vac 3-Phase connection)

This Tech Note **does not apply** to the following inverter models due to the fact that either the inverters do not have a provision for a connection to a neutral (grounded) circuit conductor or are already specifically covered by a section of the NEC:

- § SB 6000U (277 Vac connection) (covered by NEC 690.62)
- § SWR 2500U (no provision for connection of a neutral (grounded) conductor)
- § SWR 2100U (no provision for connection of a neutral (grounded) conductor)
- § SWR 1800U (covered by NEC 690.62)
- § SB 1100U (no provision for connection of a neutral (grounded) conductor)
- § SB 700U (covered by NEC 690.62)

Definitions

Branch Circuit

According to NEC 100 a Branch Circuit is "The circuit conductors between the final overcurrent device protecting the circuit conductors and the outlet(s)."

Grounded Conductor

According to NEC 100 a Grounded Conductor is "A system or circuit conductor that is intentionally grounded."

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Interactive System

According to NEC 690.2 an Interactive System is “A solar photovoltaic system that operates in parallel with and may deliver power to an electrical production and distribution network. For the purpose of this definition, and energy storage subsystem of a solar photovoltaic system, such as a battery, is not another electrical production source.”

Inverter Output Circuit

According to NEC 690.2 the Inverter Output Circuit is “Conductors between the inverter and an ac panelboard for stand-alone systems or the conductors between the inverter and the service equipment or another electric power production source, such as a utility, for electrical production and distribution network.”

Inverter

According to NEC 690.2 an Inverter is “Equipment that is used to change voltage level or waveform, or both, of electrical energy. Commonly, an inverter [also known as a power conditioning system (PCU) or power conversion system (PCS)] is a device that changes dc input to an ac output. Inverters may also function as battery chargers that use alternating current from another source and convert it into direct current for charging batteries.”

Branch Circuit Conductors

The NEC when discussing branch circuits does not make any distinction between grounded and ungrounded branch circuit conductors. This is due to basic assumptions in the NEC that except for certain rare exceptions all branch circuits will supply loads connected between one ungrounded conductor and the grounded conductor. In these cases the grounded conductor is a current carrying conductor when it functions as the return for the circuit. Generally, it is assumed that any of the branch circuit conductors, grounded or ungrounded, could carry up to the maximum current allowed by the overcurrent protection device. However, the Inverter Output Circuit connected to an Inverter does not use the neutral (grounded) conductor as a current carrying conductor.

Inverter Output Circuit

NEC 690.62 is titled “Ampacity of Neutral Conductor.” However in this section, only two wire inverter output circuits connected to one grounded and one ungrounded conductor are described. Only three of the inverters made by SMA fit this narrow definition and are therefore not covered in this document. All of the other Inverters are designed to connect to two ungrounded conductors and one grounded conductor, if it exists in the power distribution system. Even when an Inverter is connected to two ungrounded conductors and one grounded conductor the grounded conductor will not carry any currents. It is only used to meet the requirements for voltage and phase sensing described in the new UL 1741 standard described above. This is a case that is currently not covered in the NEC. A new provision proposed for inclusion in the 2008 code revision, which has been “accepted in principle”, would require the neutral (grounded) conductor used only for instrumentation purposes to be not larger than the equipment grounding conductor defined in NEC 250.122.

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Point of Connection to the Utility

In NEC 690.64 the Inverter Output Circuit can be connected in one of two ways, either on the supply side or the load side of a service disconnection means. If the Inverter Output Circuit is connected on the load side then it must be connected via a dedicated circuit breaker or fusible disconnection means. This overcurrent protection is designed to protect the branch circuit conductors from overcurrent conditions sourced from the utility side of the protective device under fault conditions.

In the event of Loss of Interactive System Power the inverter is required to automatically de-energize the Inverter Output Circuit according to NEC 690.61. The UL 1741 testing protocol further refines this to required disconnection from the source of interactive power to 0.02 seconds if the AC voltage or frequency moves out of the defined ranges. The frequency range is the same for all nominal ac voltages below 600 volts and is 59.3 to 60.5 Hz. The voltage ranges are defined as $\pm 10\%$ of nominal, for example 240 volts ac nominal would have a range from 216 to 264 volts ac.

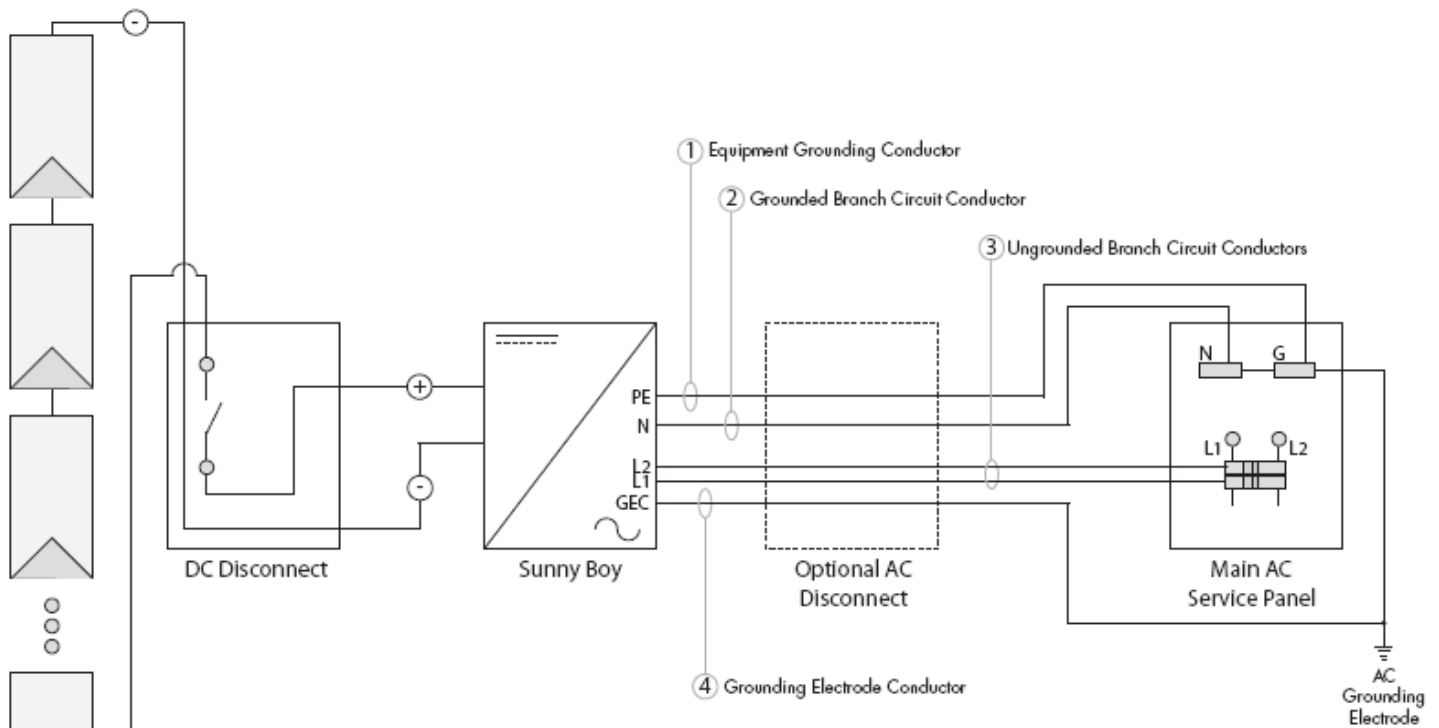
Ampacity of the Grounded Branch Circuit Conductor

Based on all of the points discussed above it is the opinion of SMA that for inverters connected to two ungrounded and one grounded branch circuit conductor, and installed in accordance with all other requirements of the NEC, that the ampacity of the grounded conductor be not less than the size of the equipment grounding conductor defined in NEC 250.122.

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Sample Line Drawing



- 1) Equipment Grounding Conductor sized in accordance with NEC 250.122
- 2) Grounded Branch Circuit Conductor sized not less than the size of the Equipment Grounding Conductor defined by NEC 250.122.
- 3) Ungrounded Branch Circuit Conductors sized in accordance with NEC 310.15
- 4) Grounding Electrode Conductor sized in accordance with NEC 250.166

SMA America, Inc. 112206