

Bulletin 64-4-1
Wiring methods for solar photovoltaic systems
Rules 2-034, 64-066, 64-210, 64-216, 64-220, Tables 11 and 19

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 Supersedes Bulletin 64-4-0

Scope

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(1) Introduction

The intent of this bulletin is to clarify some of the wiring method requirements as per Section 50 Rules.

In addition to this Bulletin, the following documents provide additional information on the installation of solar photovoltaic systems:

- Bulletin 64-1-* Connection of utility-interactive inverters on the load side of service disconnecting means
- Bulletin 64-2-* Grounding and Bonding of Solar Photovoltaic Systems
- Bulletin 64-3-* Voltage rating of a photovoltaic source circuit
- Bulletin 64-5-* Installation of solar photovoltaic systems
- Bulletin 64-6-* PV rapid shutdown

(2) Cable types RPV & RPVU

The following table shows different usages of cable types RPV and RPVU, approved to CSA C22.2 No 271, as permitted by Rule 64-210 and listed in Table 19:

Table B1 – Usage of RPV & RPVU conductors

Installation	RPV	RPVU
Raceway (except cable tray) in dry/damp location	Table 19	Table 19 (note 5)
Raceway (except cable tray) in wet location	Table 19	Table 19
Inside building or structure in a raceway	64-210(9)	64-210(9)
Cable tray for interconnection of PV system*	-	64-210(6)
Exposed to weather for interconnection of panels within an array without raceway**	-	64-210(3)
Direct earth burial	-	Table 19
(*) Conductor type RPV is not permitted for cable tray installation, unless marked (TC) or equivalent.		
(**) Provided that conductors are serviced by a qualified person, and inaccessible to the public.		

(3) Wiring methods within photovoltaic array

(a) Acceptable wiring methods within an array

In addition to conductor type RPVU, the following are also permitted for wiring **within an array**:

- Flexible cords for extra-hard usage as listed in Table 11, as per Rule 64-210(1);
- Conductors approved for exposed installations, where subject to the weather, as listed in Table 19 and marked for sunlight resistance. Although not listed in Table 19, type RWU conductors shall also be permitted, provided that they are marked for sunlight resistance and the installation satisfies all conditions listed in Rule 64-210(3); and
- Conductors approved as part of an approved panel assembly, as per Rule 64-210(2);

(b) Photovoltaic combiner box

A photovoltaic combiner box is permitted to be installed on the roof and it is preferred to be as close as possible to the PV modules forming the array. The purpose of the combiner box is to group the wiring from the array into one cable run to other combiners or to the inverter, which reflects the logic of having the combiner box as close as possible to the array (on the roof), as per the Photo B1.

Direction 1

Wiring methods specified above (subject (3)(a) of this bulletin) are acceptable for interconnecting PV modules within an array. If the combiner box is located outside of a building or a structure and within 1 m from the physical edge of the PV modules, acceptable wiring methods permitted within the array are allowed to be extended to the combiner box, provided that they are mechanically protected from damage.

Where a combiner box is **not** located within 1 m of PV modules or where conductors are run inside the building or structure, wiring methods specified in Section 12 are required.

Photo B1 – Combiner box



(c) Cable support

Cables and conduit shall be kept clear of sharp metal, be properly supported and shall not lie loosely on the roofing material.

As per Rule 64-210(4) requirements for wiring support, acceptable supporting means are considered to be straps or other devices located within 300 mm of every box or fitting and at intervals of not more than 1 m throughout the run. Conductors are also required to be kept clear of sharp metal edges. Photo B2 is an example of unacceptable cable support.

Photo B2 – Unacceptable cable support



(d) Mechanical protection against rodents

Rule 64-210(5) requires mechanical protection against rodents for PV source circuit conductors on or above a building, where the dc arc-fault protection (when required) is not located at the module.

The mechanical protection required above for the PV conductors may be in the form of an enclosed raceway or other acceptable material.

The Appendix B Note provides examples of “other acceptable material” such as:

- Expanded metal
- Solid metal; or
- Screening*

(*): Wire screening with openings not greater than **13 mm** is acceptable for protection against rodents.

Notes:

1. When installing wire screening, installer to ensure adequate airflow to avoid potential overheating for PV wires underneath the modules.
2. Drilling of PV modules is not permitted.

Photo B3 – Examples of rodent damage and acceptable screening for protection

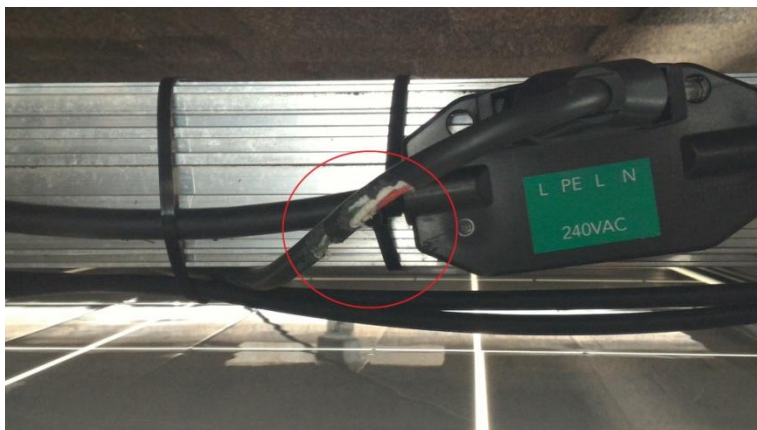


Photo B4 – Examples of acceptable screening for protection against rodents



(4) Wiring method for ungrounded systems

Recently, a new rule has been approved by the Canadian Electrical Code Part I Committee. The new rule will permit non-metallic wiring methods for conductors of ungrounded renewable energy systems. This new rule requirement will be introduced in the 27th Edition of the Ontario Electrical Code (OESC).

In recognition of this exemption and with the added convenience to the industry, effective immediately ESA permits non-metallic wiring methods for conductors of ungrounded renewable energy systems.

For ungrounded system wiring with the array, refer to Section (3) of this bulletin.

Note:

All DC conductors of renewable energy systems, both grounded and ungrounded, installed inside a building or structure will still require metallic raceways cables and enclosures, based on Rule 64-062.

(5) Accessibility to public & guarding of ground-mounted PV installations

With the restrictions on some of the wiring methods within an array, as described in Rule 64-210, and attachment plugs (which do not need a tool to open) which need to be inaccessible to public, the following direction has been developed based on the clarification in the Appendix B Note to Rule 64-210.

Direction 2

The wiring for a solar PV installation is deemed inaccessible to public and not readily accessible if it satisfies one of the following conditions:

- (1) It runs in a raceway;
- (2) By the usage of physical barrier such as wire screening or guarding; (see Note below)
- (3) Isolated by elevation, such that no open wiring below 2.5 m (from finished grade)*; or
- (4) Enclosing the ground mount PV installation inside a fence**.

(*) On sun tracker units, the 2.5 m shall be measured when the array is oriented in its lowest plane.

(**) Fences complying with Rules 26-304, 26-312 and 26-314 are deemed acceptable to enclose ground mounted PV installations. No barb wire is required.

Note:

Wire screening, in item 2 above, with openings not greater than 13 mm is acceptable for making PV system wiring and attachment plugs inaccessible.

Photo B5 – examples of non-compliant installation

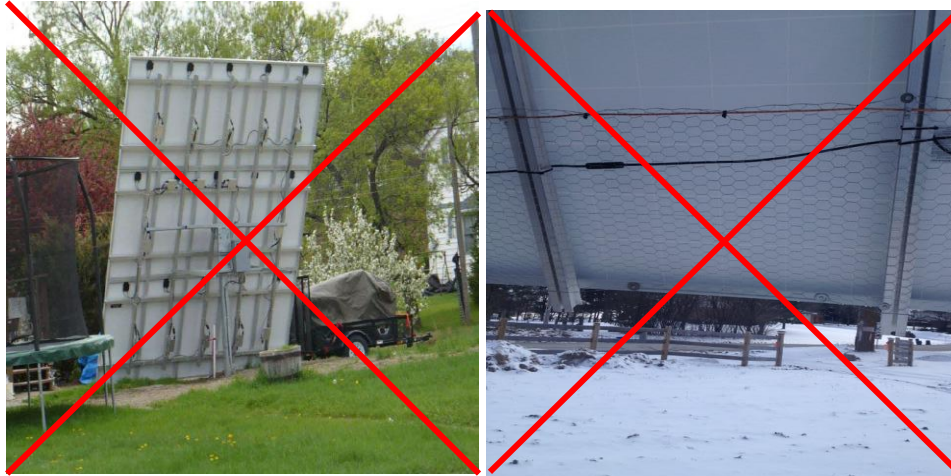


Photo B6 – example of using physical barrier around wiring



(6) AFCI requirements in Rule 64-216

Products, such as arc fault protectors, inverters or combiner boxes that include AFCI protection need to be approved to Canadian Standards.

ESA will also accept the installation of a Field Evaluated assembly that contains Photovoltaic arc fault detectors and interrupters.

Since Field Evaluation is unable to determine the operating parameters of the Arc fault detector, it is a requirement that when assemblies that contain arc fault detectors are Field Evaluated to the SPE-1000, the Photovoltaic arc fault detector contained shall be a certified component, in accordance with applicable CSA Standards or UL Standard 1699B.

Question

In Ontario, is dc arc fault protection required for PV source or output circuits on ground mounted systems (not on a building) operating at 80 V or greater?

Answer

No, notwithstanding Rule 64-216 requirements, dc arc fault protection is NOT required for PV source or output circuits of ground mounted systems. PV dc arc fault protection is only required for PV source and output circuits operating at 80 V or greater **and installed on buildings.**

Rationale

The original intent of arc fault protection requirements is to prevent building fires when PV systems are installed on buildings. When PV systems are ground-mounted or installed on trackers, there is a fire risk limited to PV installation only. NEC 2017 excludes “large PV Systems” from Arc Fault protection requirements, similar to the Ontario Direction above.

(7) PV Connectors

(a) Design requirements

As per Rule 64-220, the plug-in connectors used to connect cables between PV modules are required to be of the locking type and be rated for the voltage and current of the circuit in which they are installed. Below is an example of a connector that meets Rule 64-220(1)(d) requirement.

Photo B7 – Example of a PV wire connector



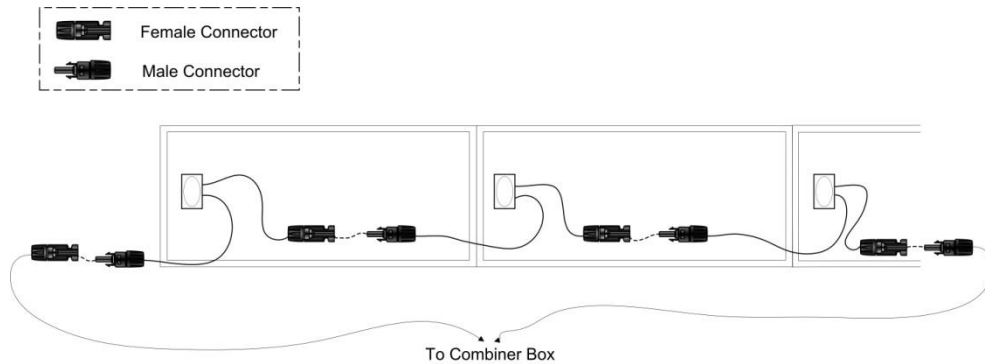
Attachment plugs may not be rated for interrupting the current and must be marked with a warning indicating that disconnection under no load is necessary. In this case, the modules must be disabled before disconnecting the connectors.

Also, attachment plugs and connectors are required to be of a type that requires a tool to open when:

- Readily accessible; and
- Used in circuits operating at over 30 V

(b) Mateability of PV connectors

Diagram B1 - Interconnecting PV modules

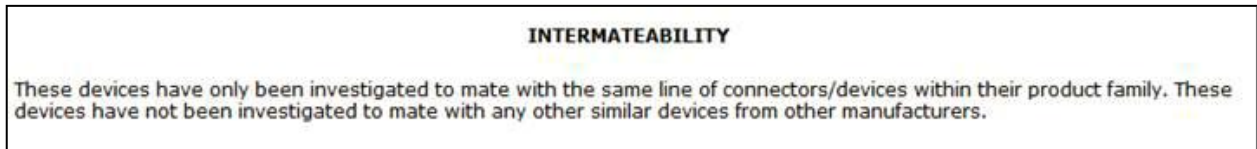


Issue

PV connectors, sleeve and pin type, are approved for use as a mated pair only, i.e. the connectors are certified as a pair. Some connectors from different manufacturers, for example “MC4” (Multi Contact) and “Helios H4 (Amphenol)”, may have a similar design and appear interchangeable. However, interchanging of various manufacturers’ connectors voids their approval and hence is not permitted by the product standard. If a pair is not tested in accordance to the standard requirement, there is no guarantee for the proper connection of PV modules, see Diagram B1.

Each connector manufacturer uses the materials and procedures to manufacture their connectors in a proprietary manner. Even though the connectors might look as if they are electrically and mechanically compatible, there is no evaluation to ensure that the production process of one manufacturer will result in their connectors being compatible with another.

Below is a certification agency requirement for PV connectors:



There are a multitude of PV connectors approved for use in PV installations. Installer shall ensure the connectors used as a pair are from the same manufacturer and installed as per their approval and instructions, see example below.

Photo B7 – Connectors approved as a mated pair



Conclusion

PV installations with connectors that are not used as a mated pair are not permitted as it is considered unapproved product, as per Rule 2-034.

If specified PV equipment has PV connectors from different manufacturers, a change in system design to address mateability and certification issues is needed.

Acceptable corrective actions, if connectors are not approved as mated pairs:

- Replace a connector with a type and model that forms a mated pair; or
- Use certified adapter with the proper connectors for mating, see example below:

Photo B8 – Approved adapter

