

Bulletin 64-3-2
Voltage rating of a photovoltaic source circuit
Rule 64-202

Issued May 2019
Supersedes Bulletin 64-3-1

Scope

- (1) Introduction
- (2) PV module temperature coefficient
- (3) Lowest daily minimum temperature for a location in Ontario
- (4) Section 36 requirement for voltage ratings exceeding 750 V dc

(1) Introduction

Rule 64-202 1) requires the open circuit voltage marked on a PV module to be multiplied by a 125% factor for the temperature adjustment. This adjustment factor is based on a minimum module temperature of – 40 °C.

In addition, Rule 64-202 2) recognizes the use of the temperature coefficient factor listed on the PV module datasheet in conjunction with the lowest daily minimum temperature for the location of the installation to calculate the maximum PV source circuit voltage.

This calculated voltage is to be marked on the label beside the DG disconnect switch (as per Rule 64-200) and is to be used to determine the minimum voltage rating of all system equipment and devices, as per Rule 64-202 3).

(2) PV module temperature coefficient

If the designer or PV installer chooses to use the PV module temperature coefficient listed on the module data sheet to calculate the maximum open circuit voltage of a PV source circuit, Appendix (B) Note to Rule 64-202(2) introduces the following calculation formula:

$$V_{MPC} = V_{ROC} \times [1 + (T_M - 25) \times T_K]$$

Where:

T_M	Lowest daily minimum temperature (°C)
T_K	Temperature coefficient (% / °C), as per the PV module manufacturer data sheet
V_{ROC}	Rated open-circuit voltage of the photovoltaic power source (V)
V_{MPC}	Maximum photovoltaic source circuit and output circuit voltage (V)

Example

What is the maximum PV source circuit voltage for a solar photovoltaic system that is:

- installed in a geographic location where the lowest daily minimum temperature (T_M) is -18 °C;
- PV source circuit consists of 14 modules in series; and
- The manufacturers' data shows the temperature coefficient (T_K) is -0.35% / °C and the rated open circuit voltage (V_{ROC}) is 36.4 V.

Solution

Applying Rule 64-202(2) and the calculation formula in Appendix B, then the maximum open circuit voltage for one PV module is:

$$V_{MPC} = 36.4 \text{ V} \times (1 + ((-18 \text{ }^\circ\text{C} - 25 \text{ }^\circ\text{C}) \times -0.35\% / \text{ }^\circ\text{C}))$$

$$V_{MPC} = 36.4 \text{ V} \times (1 + (-43 \times -0.0035))$$

$$V_{MPC} = 36.4 \text{ V} \times 1.1505$$

$$V_{MPC} = 41.88 \text{ V}$$

Then, the maximum voltage for a PV source circuit consisting of 14 modules connected in series is:

$$14 \times 41.88 = 586.3 \text{ Vdc.}$$

The maximum photovoltaic source and output circuit voltage shall be used to determine the voltage ratings of cables, disconnects, overcurrent protection and other equipment in photovoltaic source or output circuits.

Note

The Rule does NOT recognize any other factors (other than the above mentioned) to calculate the maximum open circuit voltage for a PV source circuit and output circuit.

(3) Lowest daily minimum temperature for a location in Ontario

Question 1

What is an acceptable method to determine the “lowest expected daily minimum temperature” required to calculate the maximum PV output circuit voltage in a specific location?

Answer 1

Refer to Canada Climate Normals website: (http://climate.weatheroffice.gc.ca/climate_normals/stnselect_e.html) and consider the “Extreme Minimum” temperature listed for that location as the lowest expected daily minimum temperature required in the formula to calculate the maximum PV output circuit voltage.

As an alternative in Ontario, it is permitted to use the temperatures in the Ontario Building Code, Supplementary Standard SB-1, listed for the location under “January 2.5% °C” column.

(4) Section 36 requirements for voltage ratings exceeding 750 V dc

Rule 64-202 4) permits the maximum photovoltaic source and output circuit voltage for installations in or on dwelling units to a voltage not exceeding 600 V dc, with some restrictions.

Rule 64-202 5) exempts photovoltaic source and output circuits operating at voltages greater than 750 V dc, but not greater than 1500 V dc, from the requirements of Rules 36-204, 36-208 and 36-214.

Note

This Rule is applicable to installations located on the roof of residential multi-dwelling unit buildings, provided the roof of the building does not also form the roof of the uppermost dwelling units, with access restricted to authorized personnel only.

Question 2

Can PV source and output circuits greater than 750 V dc, but not greater than 1500 V dc, be exempted from the requirements of:

- Rule 36-006 1) b), d), and c), warning label for high voltage cables
- Rules 36-100 and 36-110, for conductors to be enclosed in grounded metal?

Answer 2

Yes, if all of the following conditions are met, as applicable:

- the installation is serviced only by qualified persons;
- the part of the installation exceeding 750 V dc is inaccessible to the public; and

- enclosures in which photovoltaic source and output circuits exceeding 750 V dc are present are marked with the word “DANGER” followed by the maximum rated photovoltaic circuit voltage of the equipment.
- meet the wiring methods identified in Bulletin 64-4-*
- have a permanent, legible warning notice carrying the wording “Danger- High Voltage” on all boundary fences:
 - (i) located immediately adjacent to the locks on all access gates;
 - (ii) installed at all outside corners formed by the fence perimeter; and
 - (iii) installed at intervals not exceeding 15 m of horizontal distance

Notes

1. For rooftop installations, the warning notice shall be installed on all doors providing access to the array area.
2. Any portions of such installations that leave the roof or fenced area, they would be required to follow the requirements of Section 36, except 36-204, 36-208, 36-214 (e.g. PV wiring between separate roof sections or run to a ground mount combiner or inverter).
3. Photovoltaic source and output circuits and equipment connected to or within those circuits are considered inaccessible where:
 - (a) they are located within a fenced enclosure complying with Rules 26-304, 26-312 and 26-314, or equivalent (such as a property boundary fence around an industrial facility with controlled access);
 - (b) guarded by locked doors;
 - (c) elevated 3 m or more above grade level or above any surface that a person can stand on; or
 - (d) where access is restricted by other effective means.

Photo B1 – Examples of PV source and output circuits considered not accessible to the public

