International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.105

(03/2015)

SERIES K: PROTECTION AGAINST INTERFERENCE

Lightning protection of photovoltaic power supply systems feeding radio base stations

Recommendation ITU-T K.105

International Telecommunication Union

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Lightning protection of photovoltaic power supply systems feeding radio base stations

Summary

Recommendation ITU-T K.105 provides lightning protection procedures for protecting dedicated photovoltaic (PV) power supply systems used to provide electric power to radio base stations (RBSs). This Recommendation describes the bonding and earthing procedures applied to the metallic supports of the PV array, considering the following scenarios for the installation of the PV array: ground surfaces, rooftops and towers. For each scenario, the possibility of installing the electronic controller close to the PV array or close to the DC load is considered. This Recommendation also provides the configuration and rating of protection modules required to protect the electronic controller and the PV array against lightning surges.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.105	2015-03-01	5	11.1002/1000/12425

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Lightning protection of photovoltaic power supply systems feeding radio base stations

1 Scope

This Recommendation addresses the lightning protection of photovoltaic (PV) power supply systems that are used exclusively for feeding radio base stations (RBSs). The purpose of this Recommendation is to give guidance on the earthing, bonding and protection of PV power supply systems.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T K.56] Recommendation ITU-T K.56 (2010), *Protection of radio base stations against lightning discharges*.

[ITU-T K.71] Recommendation ITU-T K.71 (2007), *Protection of customer antenna installations*.

[ITU-T K.97] Recommendation ITU-T K.97 (2014), *Lightning protection of distributed base stations*.

[IEC 61643-11] IEC 61643-11 (2011), *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods*.

[IEC 62305-1] IEC 62305-1 (2010), *Protection against lightning – Part 1: General principles*.

[IEC 62305-2] IEC 62305-2 (2010), *Protection against lightning – Part 2: Risk management*.

[IEC 62305-3] IEC 62305-3 (2010), *Protection against lightning – Part 3: Physical damage to structures and life hazard*.

[IEC 62305-4] IEC 62305-4 (2010), *Protection against lightning – Part 4: Electric and electronic systems within structures*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 earthing network: The part of an earthing installation that is restricted to the earth electrodes and their interconnections.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

PV Photovoltaic

RBS Radio Base Station

5 Conventions

None.

6 The photovoltaic power supply system

The photovoltaic (PV) power supply system generates electricity based on the photoelectric effect. It consists of the PV module, PV module support, junction box, PV controller and battery. The PV power supply system considered in this Recommendation is exclusive for feeding the radio base station (RBS) and does not feed the public electric network. Figure 1 shows the diagram of a typical PV power supply system.

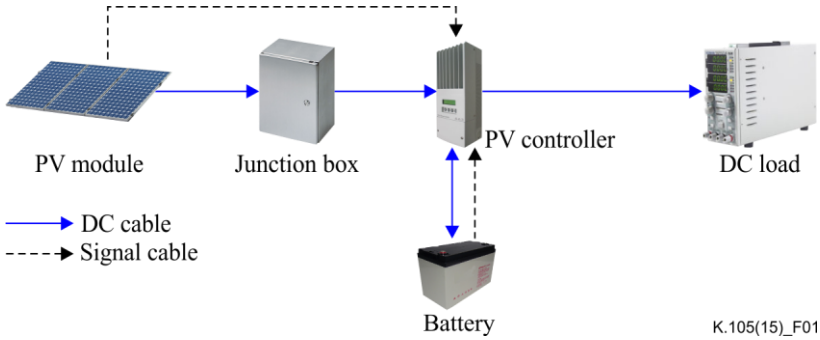

Figure 1 – Photovoltaic power supply system network diagram

7 Direct lightning protection of PV power supply systems

Each part of the PV power supply system should be installed within the protection zone of an RBS air termination system. The design and installation of an air termination system to protect the PV power supply system is outside the scope of this Recommendation. Users are advised to consult the appropriate documents on this topic.

The PV power supply system should share the same earthing network with the radio base station.

8 Earthing and bonding of PV power supply systems

8.1 Earthing and bonding of the PV module support

The PV module support is normally formed by its metallic structure, as illustrated in Figure 2.

If the metallic structure is constructed of many separated supports, the adjacent supports shall be bonded together by a bonding conductor, as shown in Figure 2. The cross-sectional area of the bonding conductor shall not be less than 6 mm^2.

The PV module support should be bonded to the earthing network, at least at two points, as shown in Figure 2. The cross-sectional area of the bonding conductor shall not be less than 16 mm^2.

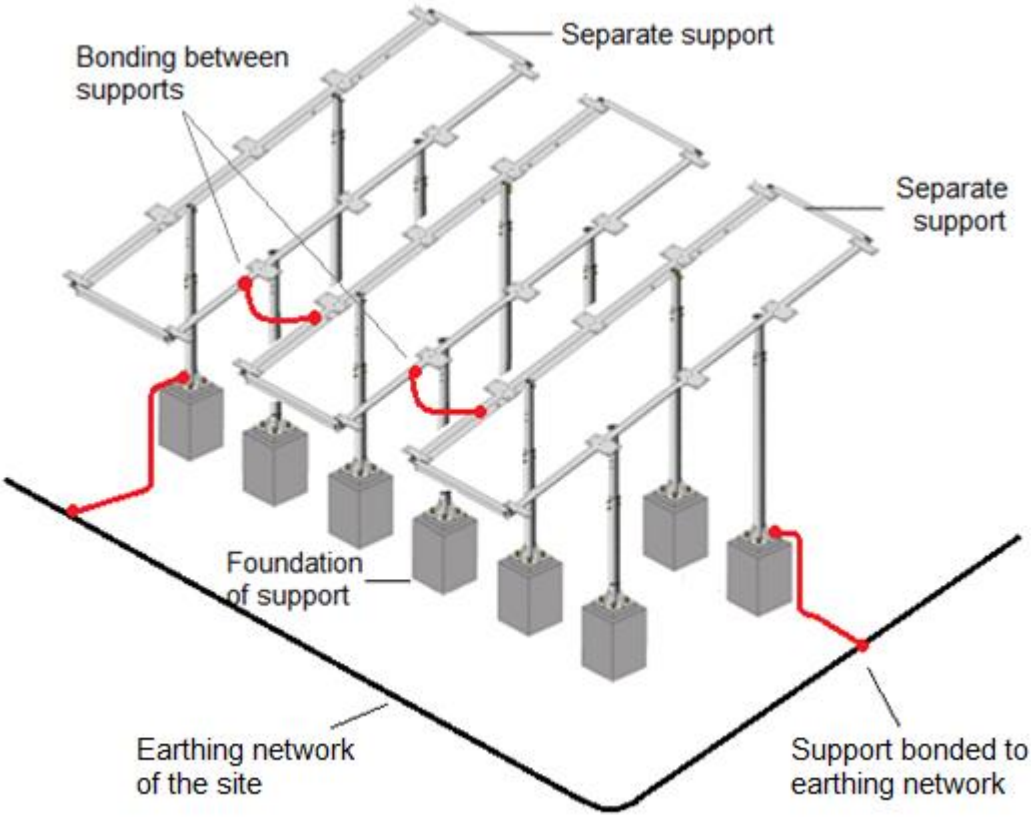

Figure 2 – Bonding connections of separate supports

When the module supports are integrated into a single metallic structure that ensures the electrical continuity between the individual supports, no additional bonding conductor is required between two adjacent supports. The metallic supports shall be bonded to the earthing network, at least at two points, as shown in Figure 3. The cross-sectional area of the bonding conductor shall not be less than 16 mm^2.

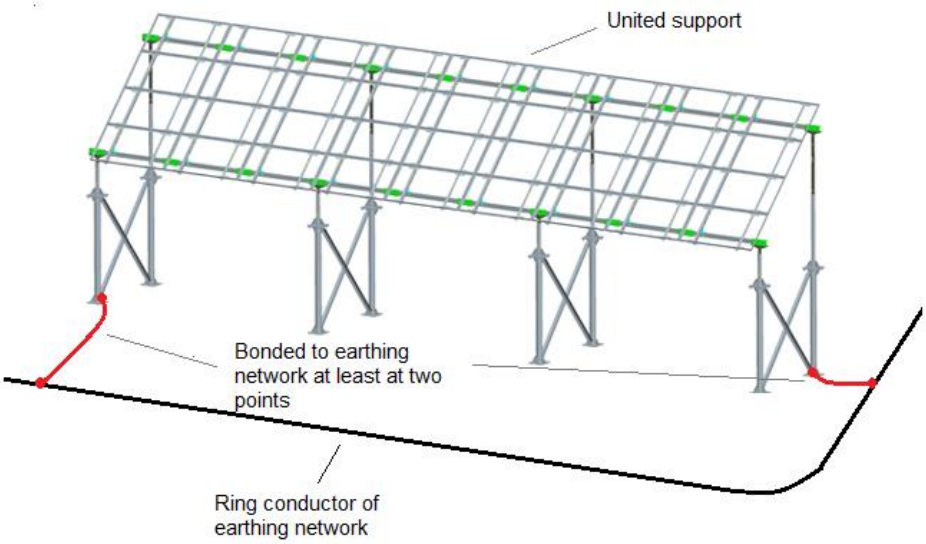

Figure 3 – Earthing and bonding of a united support

8.2 Earthing and bonding of the PV power supply

The junction box that is installed on the PV module support should not be insulated from the support. The bonding conductor of the junction box shall be directly bonded to the PV module support.

The cross-sectional area of the bonding conductors on the PV controller and junction box shall not be less than 6 mm^2.

PV power supply systems are applied in the following three scenarios: PV supports installed on the ground, PV supports installed on a rooftop, and PV supports installed on a tower.

8.2.1 Scenario A: PV support installed on the ground

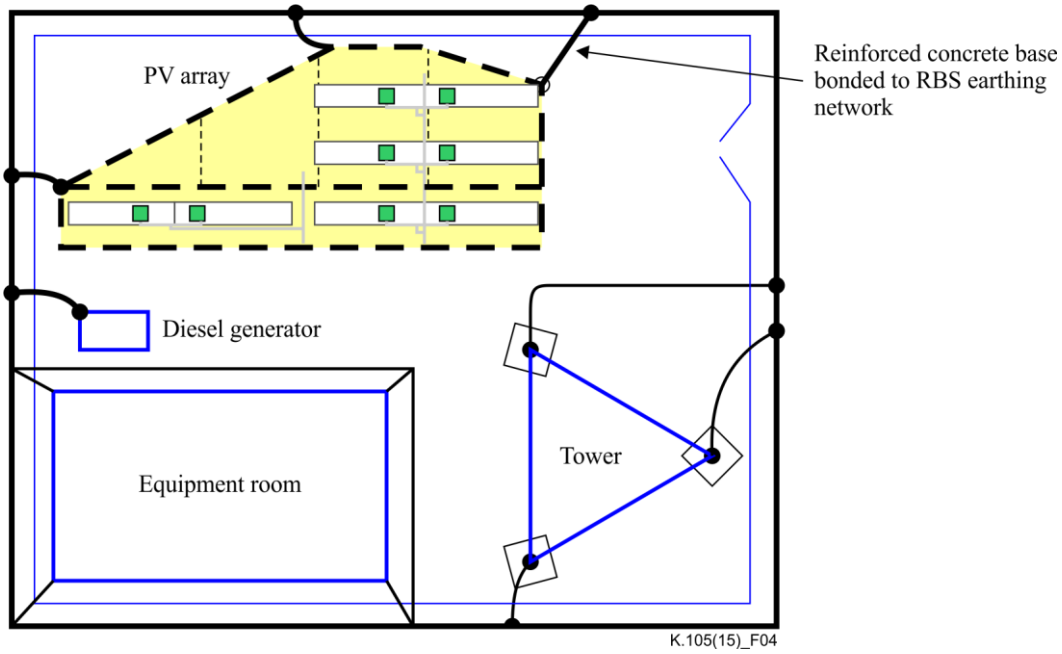

Figure 4 – Earthing and bonding when the PV support is installed on the ground

In this scenario, the reinforced concrete base of the PV support should be bonded to the RBS earthing network at least at two points, as illustrated in Figure 4.

Depending on the installation of the PV controller and the junction box, this scenario can be classified into the scenarios A-1 and A-2, as shown in Figures 5 and 6, respectively.

8.2.1.1 Scenario A-1: PV controller installed close to the junction box

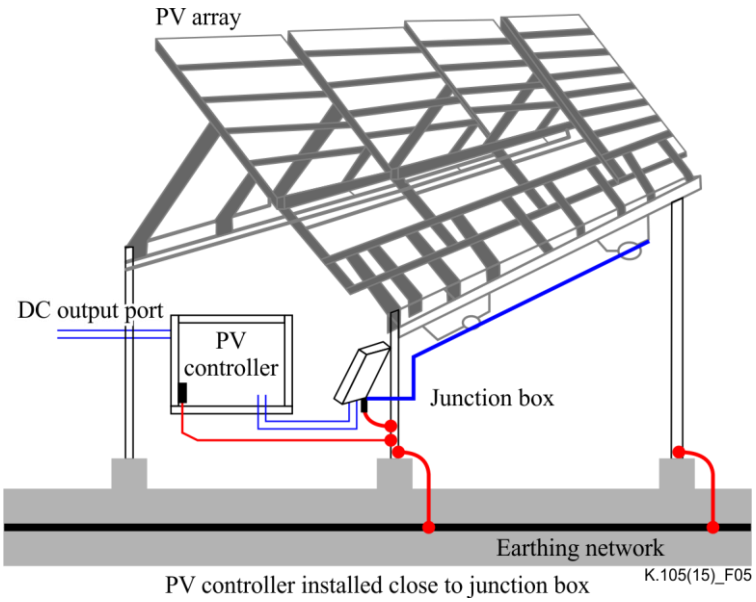

Figure 5 – Earthing and bonding when the PV controller is installed close to the junction box

In this case, the PV controller is usually installed outdoors.

The bonding conductors of the junction box and the PV controller shall be bonded to the metallic support directly and these conductors shall be as short as possible.

The DC power output cable of the PV controller shall be buried in the earth or put in a metallic cable tray above the earth's surface. The cable tray shall be electrical continuous and bonded to the earthing network at both ends.

8.2.1.2 Scenario A-2: PV controller installed close to the DC load

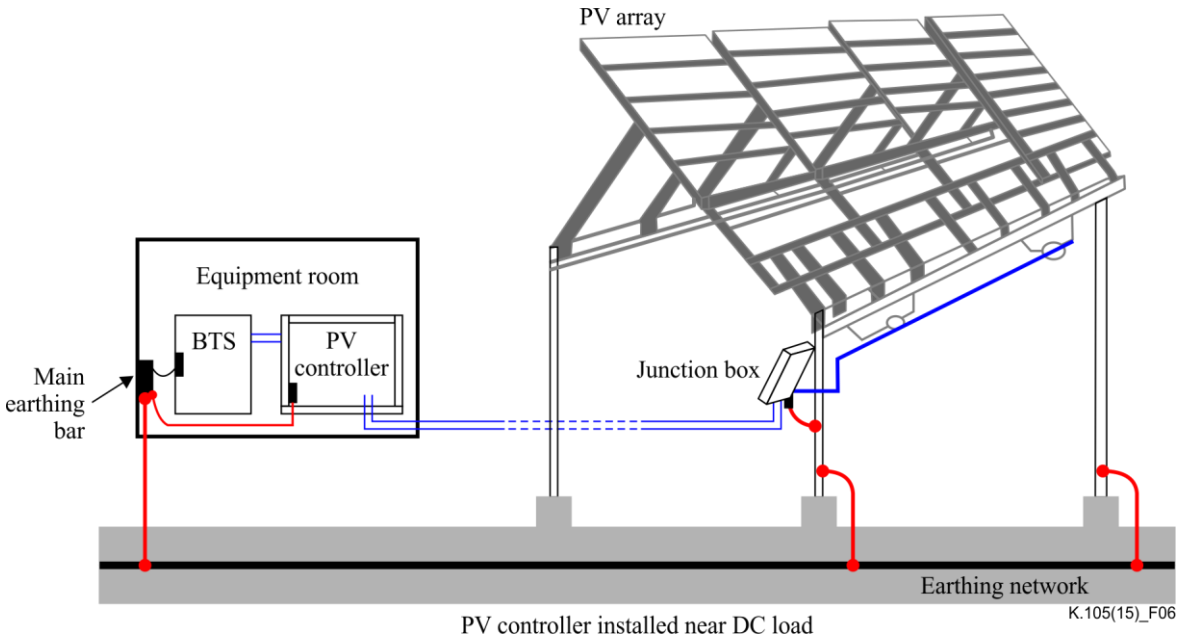

Figure 6 – Earthing and bonding when the PV controller is installed close to the DC load

In this case, the PV controller is usually installed in a traditional equipment room, in an outdoor cabinet or in a mini-shelter.

The bonding conductor of the PV controller shall be bonded to the earthing bar of the equipment room, outdoor cabinet or mini-shelter.

The DC power input cable of the PV controller shall be buried in the earth or put in a metal cable tray above the earth's surface. The cable tray shall be electrical continuous and bonded to the earthing network at both ends.

8.2.2 Scenario B: PV Module support installed on a rooftop

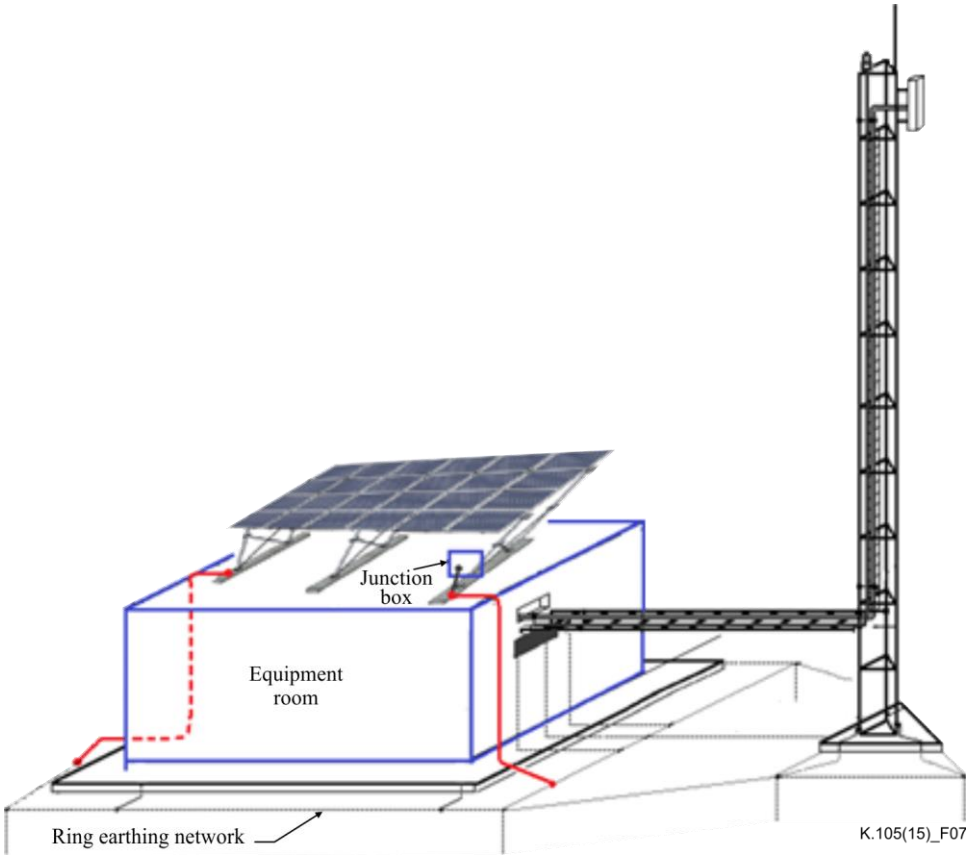

Figure 7 – Earthing and bonding when the PV support is installed on the rooftop

In this case, the metallic PV support should be bonded to the earthing network by at least two down conductors.

Based on the installation of the PV controller and the junction box, this scenario can be classified into the following two sub-scenarios:

8.2.2.1 Scenario B-1: The PV controller is installed close to the junction box

In this case, the PV controller is usually installed outdoor.

The bonding conductors of the junction box and the PV controller should be bonded to the metallic support directly and these conductors shall be as short as possible.

8.2.2.2 Scenario B-2: The PV controller is installed close to the DC load

In this case, the PV controller is usually installed in the equipment room, outdoor cabinet or mini-shelter.

The bonding conductor of the PV controller shall be bonded to the earthing bar of equipment room, cabinet or mini-shelter.

The DC power input cable of the PV controller shall be installed in a metallic cable tray. The cable tray shall be electrical continuous and bonded to the RBS earthing network at both ends.

8.2.3 Scenario C: PV support installed on a tower

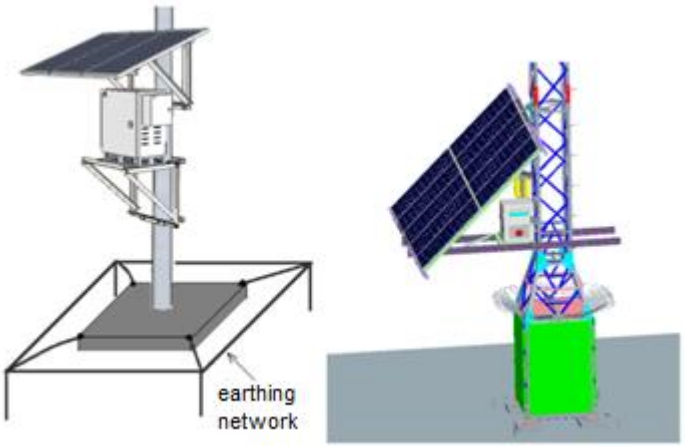

Figure 8 – Earthing and bonding when PV support is installed on the tower

In this scenario, the following requirements should be met:

The PV support shall be bonded to the metallic tower by using appropriate metallic accessories. No dedicated bonding conductor is required. The tower shall be free of paint before the installation of the PV support and anti-corrosion measures should be taken after the PV support is properly installed.

The junction box shall be installed on the PV support, and the bonding conductor of the junction box shall be connected to the metallic PV support directly.

The bonding bar of the PV controller shall be connected to the PV support when the PV controller is installed outdoors, or connected to the main earthing bar of the cabinet when the PV controller is installed in an outdoor cabinet.

9 Current capability of the protective module in PV power supply systems

The PV controller needs to be protected against lightning by a protective module at the PV input port, at the load output port and at the controller signal port. Protective modules can be integrated into the PV controller or installed close to the PV controller. The bonding configurations are shown in Figures 9 and 10.

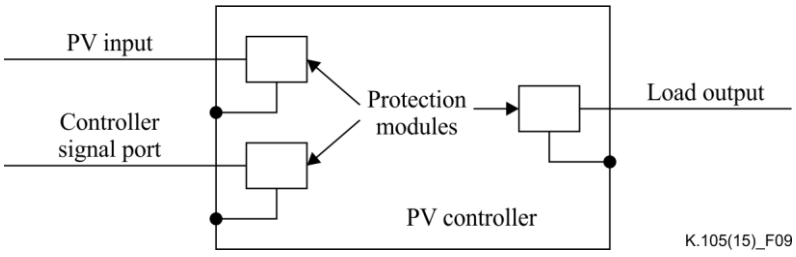

Figure 9 – Bonding of the protective modules when they are installed inside the PV controller

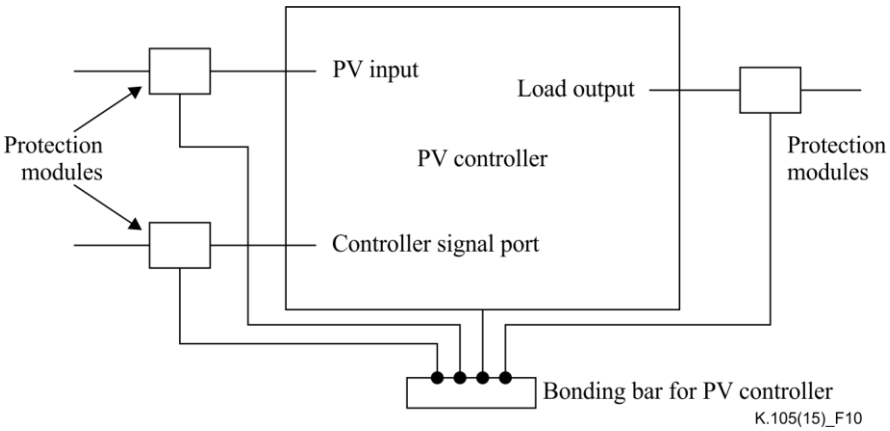

Figure 10 – Bonding of the protective modules when they are installed outside the PV controller

As the configuration shown in Figure 9 requires shorter bonding conductors for the protective modules than the one shown in Figure 10, it provides a more effective protection. Thus, if possible, the configuration shown in Figure 9 should be preferable.

The recommended surge current capability of the protective module of the PV controller is listed in the Table 1. The protection module at each port should withstand the surge current for five times each polarity, as indicated in Table 1.

Table 1 – Minimum current capability of the protective module of the PV controller

Port	Specification	Waveshape	Repetition	Comments
PV input	5 kA	8/20 μs	±5	
Load output	5 kA	8/20 μs	±5	PV controller does not power equipment on the top of the tower
	20 kA	8/20 μs	±5	PV controller powers equipment on the top of the tower directly
Controller signal port	3 kA	8/20 μs	±5	

In some cases, the PV array and the junction box need to be protected by a protective module at the junction box output port. For example, if the diode circuits in the PV array are not insulated from the metallic shell of PV array. In this case, it is recommended to install a protective module into junction box.

The recommended surge current capability of protective module of the junction box is listed in Table 2.

Table 2 – Minimum current capability of the protective module of the junction box

Port	Specification	Waveshape	Repetition	Comments
DC output	5 kA	8/20 μs	±5	Optional

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Printed in Switzerland
Geneva, 2015