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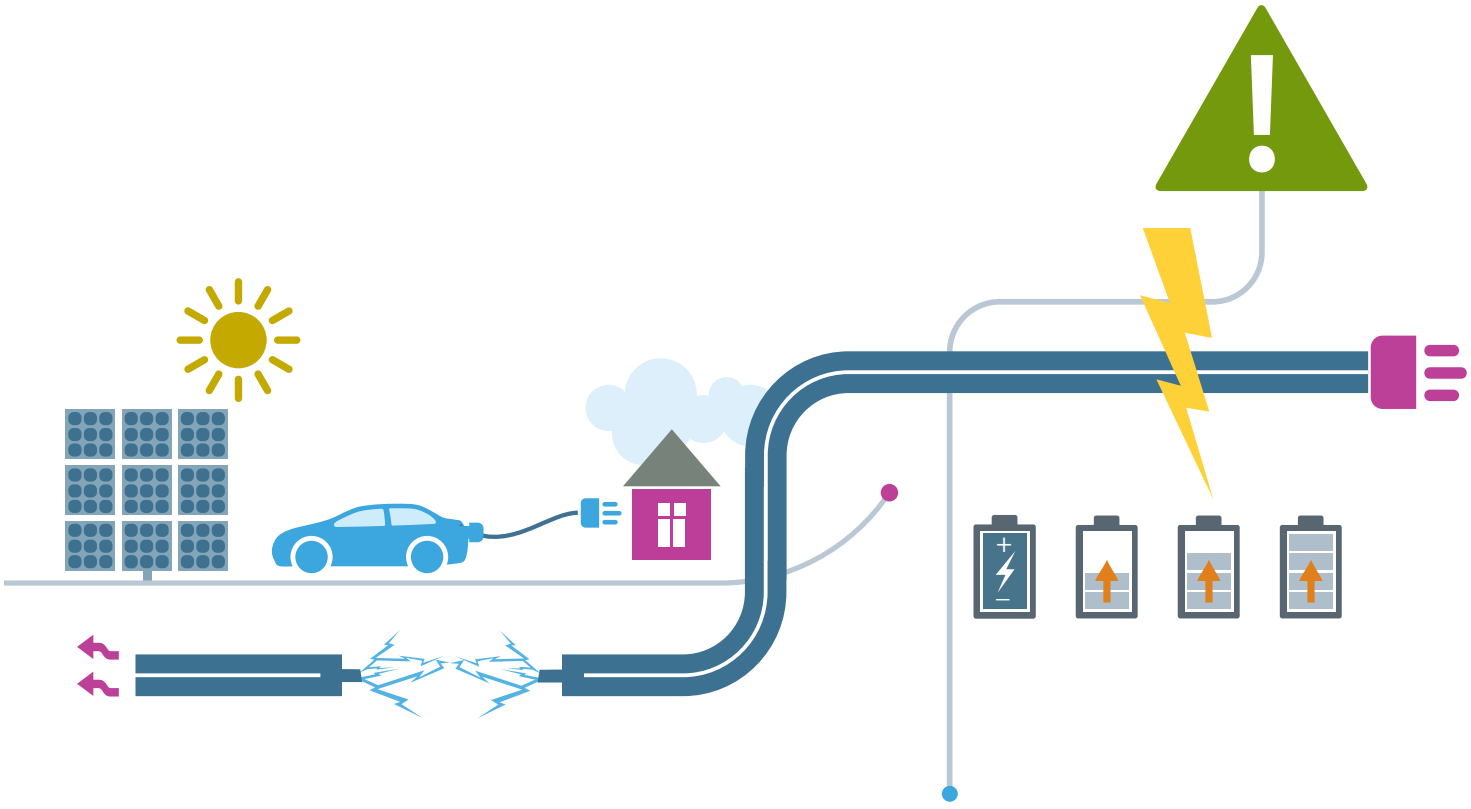
TECHNICAL BULLETIN

Connection of Unidirectional and Bidirectional Residual Current Devices (RCDs) and Miniature Circuit-Breakers (MCBs) to power supplies e.g. battery storage, Photovoltaic (PV) systems, Electric Vehicles (EV) to home, a micro-generator, or grid (mains) supply



August 2023

ABOUT BEAMA

BEAMA is the long established and respected trade association for the electrotechnical sector. The association has a strong history in the development and implementation of standards to promote safety and product performance for the benefit of manufacturers and their customers.

This publication addresses the requirements for the correct connection of Residual Current Devices (RCDs) and Miniature Circuit-Breakers (MCBs) to power supplies e.g. battery storage, Photovoltaic (PV) systems, Electric Vehicles to home, a micro-generator, or grid (mains) supply. The publication aims to clarify the differences between connections for unidirectional and bidirectional RCDs and MCBs. For comprehensive requirements, BS 7671 must be consulted.

This publication has been produced by BEAMA's Building Electrical Systems Sector operating under the guidance and authority of BEAMA, supported by specialist central services for guidance on UK Internal Market, European Single Market, Quality Assurance, Legal and Health & Safety matters. BEAMA's Building Electrical Systems Sector comprises of major UK manufacturing companies.

Details of other BEAMA publications can be found on the BEAMA website **www.beama.org.uk**

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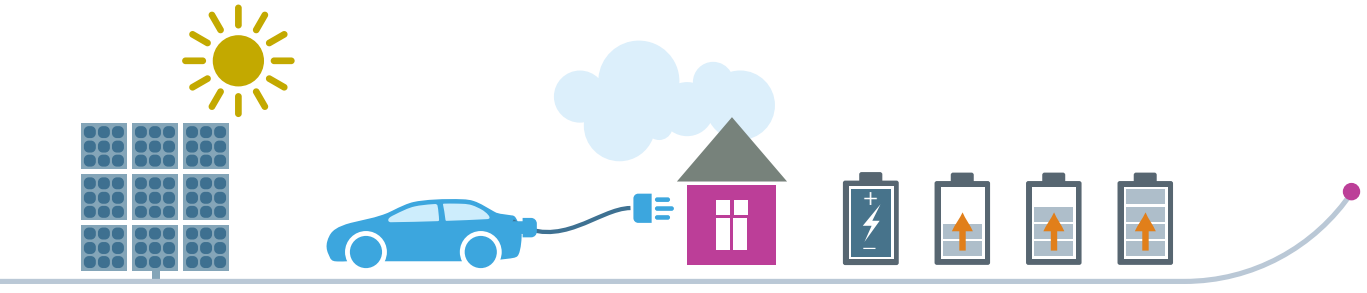

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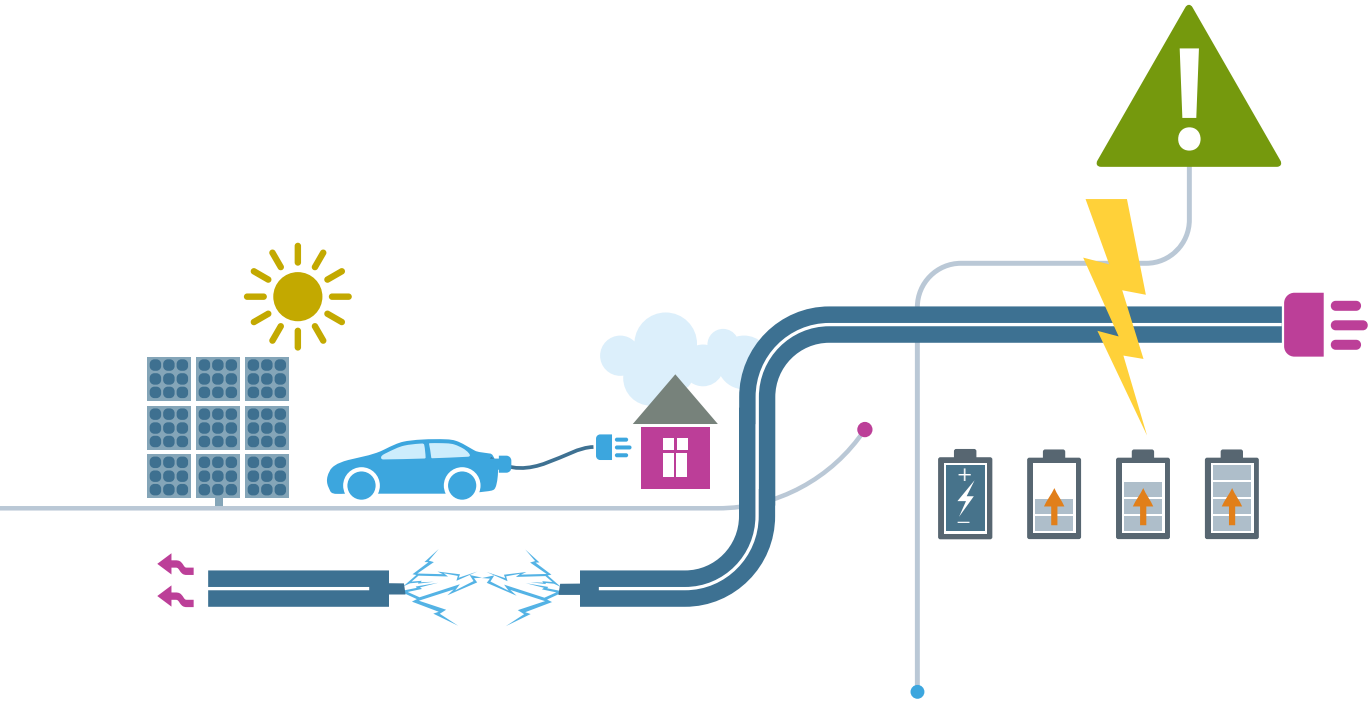

1. Introduction

This publication addresses the requirements for the correct connection of Residual Current Devices (RCDs) and Miniature Circuit-Breakers (MCBs) to power supplies e.g. battery storage, Photovoltaic (PV) systems, Electric Vehicles (EV) to home, a micro-generator, or grid (mains) supply. This publication aims to clarify the differences between connections for unidirectional and bidirectional RCDs and MCBs.

2. BS 7671 Requirements for Electrical Installations

BS 7671:2018 A2:2022 Regulation 551.7.1 Switched Neutral, requires that when a generating set is used as an additional source of supply in parallel with another source e.g. a PV System in conjunction with a mains (grid) supply, an RCD providing additional protection in accordance with Regulation 415.1, shall disconnect all live conductors, **including the neutral conductor.**

The importance/significance of disconnecting all live conductors is not a new requirement. This requirement was addressed in 2007 in the Electrical Safety Council Best Practice Guide on connecting a microgeneration system to a domestic or similar electrical installation (in parallel with the mains supply).

The latest edition of this publication is available on the Electrical Safety First website: **https://www.electricalsafetyfirst.org.uk/professional-resources/best-practice-guides/**

This requirement for switching the neutral was introduced in BS 7671:2008 Seventeenth Edition.

Where an RCD providing additional protection does not meet the requirements of Regulation 551.7.1 for switching the neutral conductor, an assessment is required by an electrical installation inspector to determine the appropriate inspection and testing classification code.

3. Solar PV connections on shared circuit RCCBs in dual / split load consumer units / distribution boards

There is differing guidance from industry bodies on whether a microgenerator should or should not be installed to the load side of any RCCB that is shared with other circuits (see figure 1).

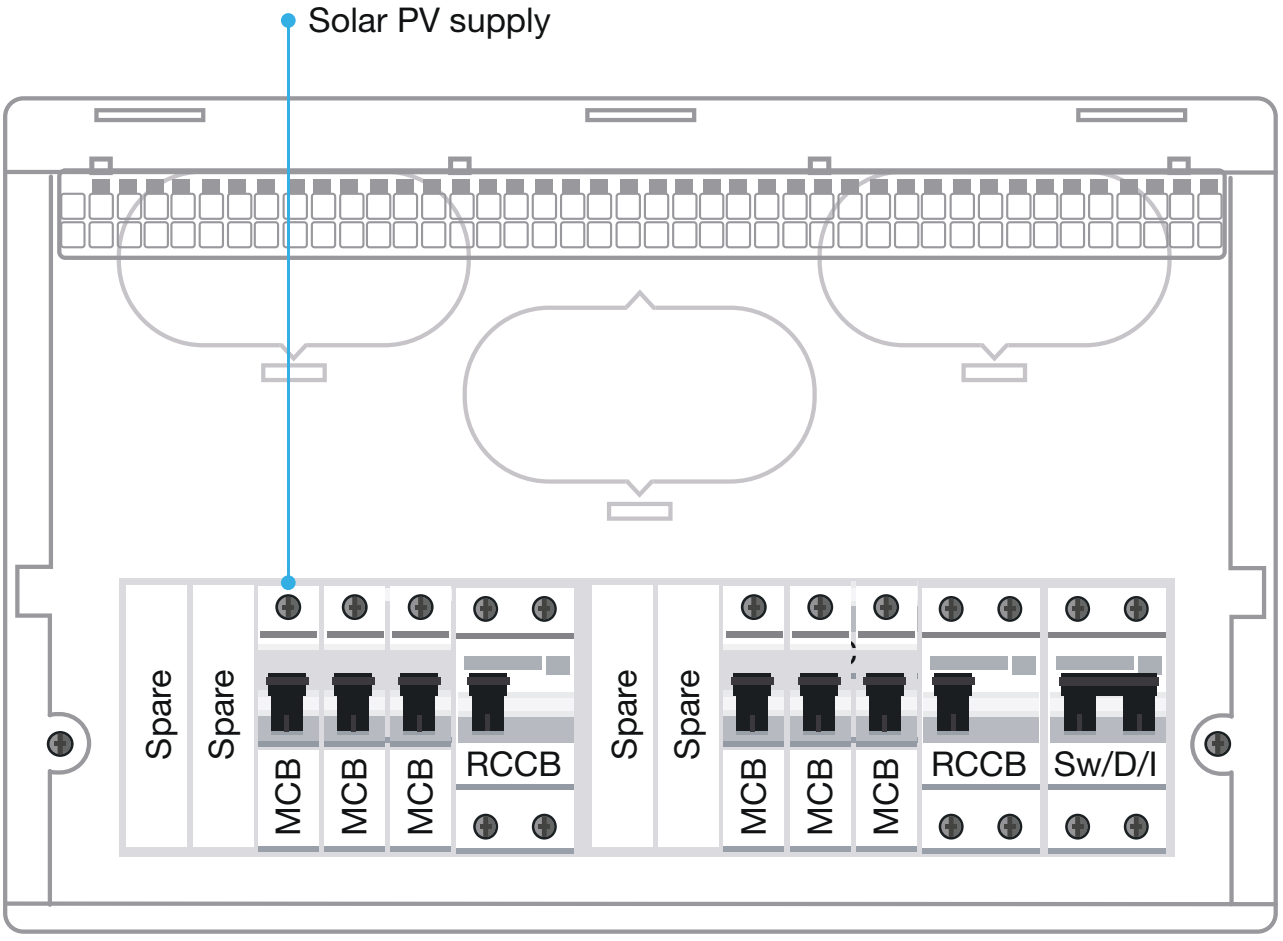

Figure 1. Example of a split-load consumer unit with a solar PV connection where differing guidance questions its acceptability.

Due to this differing guidance:

- Electrical installation designers will need to decide on which method to use for new installations, and
- Electrical installation inspectors will need to determine if any, the appropriate inspection and testing classification code for a shared circuit RCCB with a Solar PV system installed to its load side.

4. Connection of Unidirectional and Bidirectional Residual Current Devices (RCDs) and Miniature Circuit-Breakers (MCBs) to power supplies[1]

RCD and MCB product standards require that if it is necessary to distinguish between the supply and the load terminals, they shall be clearly marked e.g. by "in" and "out" or "line" and "load" placed near the corresponding terminals or by arrows indicating the direction of power flow. Therefore, if an RCD or MCB is marked "in" and "out" or "line" and "load" or with arrows indicating the direction of power flow, this connection method must be followed. **Under no circumstances is it acceptable to connect any power supply e.g. battery storage, PV systems, EV to home, a micro-generator, or grid (mains) supply to the load terminals of such unidirectional devices.**

An RCD marked "in" and "out" or "line" and "load" or with arrows indicating the direction of power flow can have their RCD function rendered permanently inoperable when connected incorrectly e.g. if, under certain conditions, there is a voltage present on their load terminals. The damaged RCD could remain in use without indication that its RCD protective function no longer operates.

Circuit-breakers e.g. an MCB marked "in" and "out" or "line" and "load" or with arrows indicating the direction of power flow can have their arc extinguishing / short-circuit characteristics impaired if they are incorrectly connected.

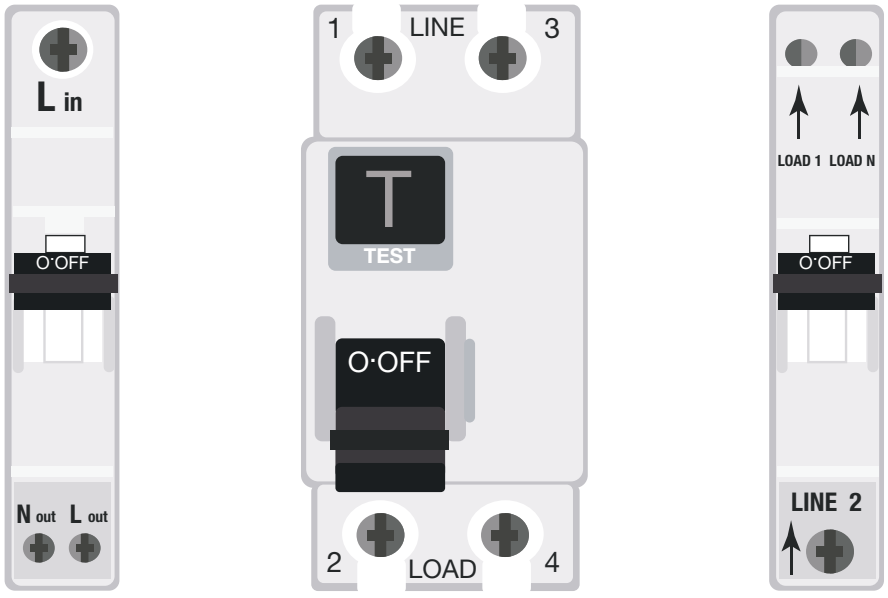

Figure 2.
Examples of devices marked with "in" and "out"or "line" and "load" or arrows indicating the direction of power flow **(unidirectional)** where it is **unacceptable** to connect any power supply[1] to the load and out terminals.

BS 7671 requires persons to employ good workmanship and to use proper materials, as a fundamental principle in Regulation 134.1.1. Additionally, the installation of electrical equipment must take account of the manufacturer's instructions as stated in both Regulation 134.1.1 and Regulation 510.3. Contravening these requirements could be deemed to be non-compliant with BS 7671 and not following manufacturer's instructions **will invalidate any device certification and warranty.**

RCDs and MCBs NOT marked "in" and "out" or "line" and "load" or with arrows indicating the direction of power flow, typically referred to as bidirectional (see figure 3), are available. These devices mitigate any potential safety issues for power supplies connected to either set of terminals.

1 Power supply e.g. battery storage, Photovoltaic (PV) systems, Electric Vehicles (EV) to home, a micro-generator, or grid (mains) supply.

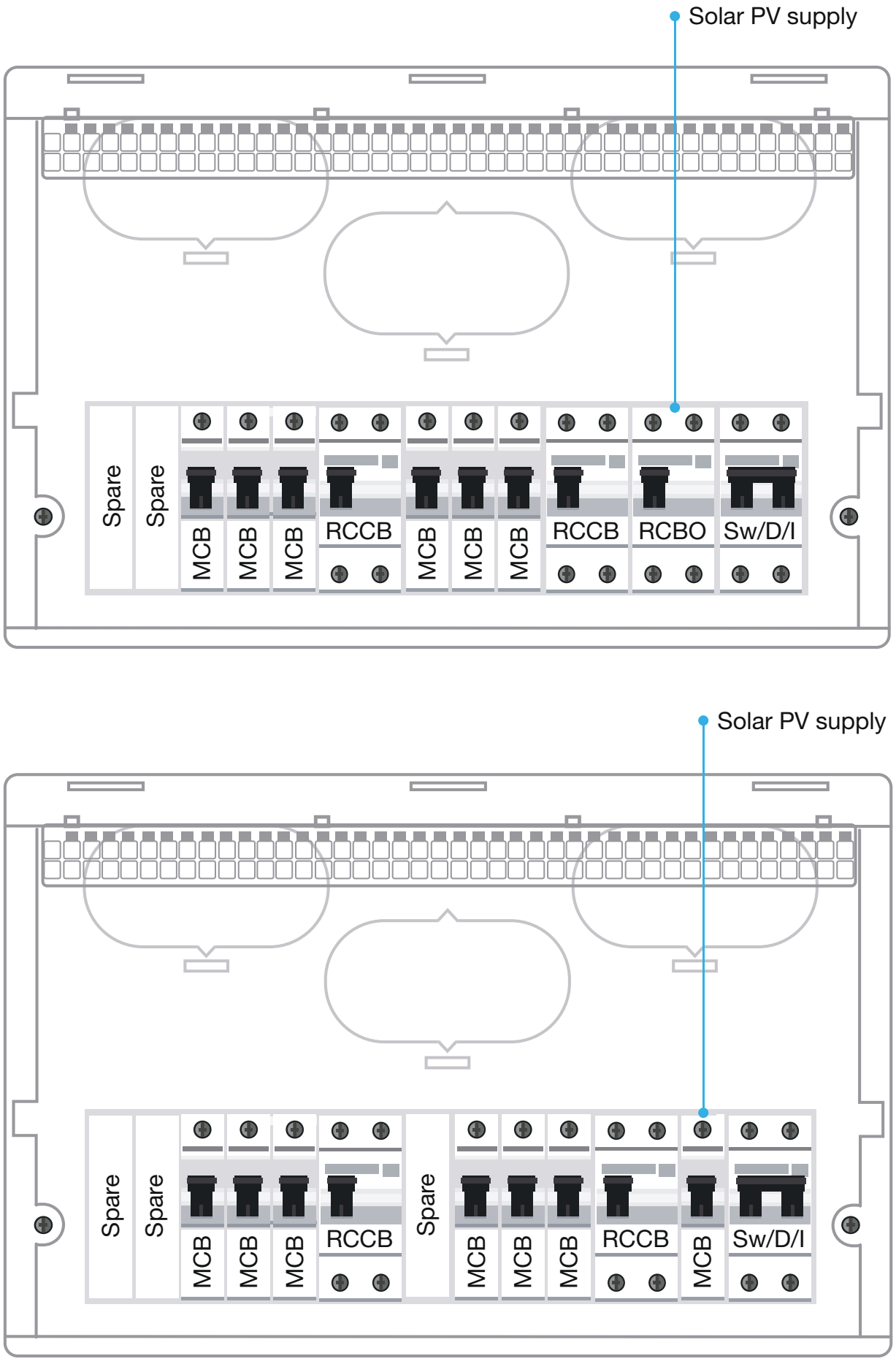

Figure 3. Examples of a consumer unit / distribution board with RCDs, and MCBs (MCBs used when additional protection is not required) NOT marked "in" and "out" or "line" and "load" or arrows indicating the direction of power flow **(bidirectional)** when power supplies[1] **can** be connected to either set of terminals.

1 Power supply e.g. battery storage, Photovoltaic (PV) systems, Electric Vehicles (EV) to home, a micro-generator, or grid (mains) supply.

5. Installed unidirectional RCDs and MCBs incorrectly connected

It is recognised that some installed unidirectional RCDs and MCBs will have been incorrectly connected i.e. a power supply e.g. battery storage, PV, EV to home, a micro-generator, or grid (mains) supply connected to the "load" or "out" terminals.

Proportionate action is required and BEAMA recommends contacting the RCD / MCB manufacturer seeking their advice as to the correct course of action. After obtaining the manufacturer's advice as to the correct course of action, electrical installation inspectors, when carrying out Electrical Installation Condition Reports (EICR) on existing installations, will need to determine if any, the appropriate classification code for an incorrectly installed unidirectional RCD and/or MCB.

6. Product standards

Residual Current Devices (RCDs) in the scope of this publication include:

- Residual Current Operated Circuit-Breaker **without** Integral Overcurrent protection (RCCB) conforming to BS EN 61008 series
- Residual Current Operated Circuit-Breaker **with** Integral Overcurrent protection (RCBO) conforming to BS EN 61009 series

Miniature circuit-breakers (MCBs) in the scope of this publication include:

- Low voltage circuit-breakers for use in household and similar installations such as offices, commercial and industrial premises, hospitals, public buildings, etc conforming to BS EN 60898 series

NOTE: The connection principles in this publication also apply to RCDs and MCBs conforming to withdrawn product standards, e.g., BS 4293 and BS 3871.

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