Standardisation Bender Group

Smart protection concept *for AC charging infrastructure modelled on* **charging mode 3**

Following the Federal Government's undertaking to reduce greenhouse gas emissions in Germany by a total of 55 % compared with 1990 by 2030, not a day goes by without discussing the electrification of road traffic and the comprehensive, reliable charging infrastructure which is essential for it.

As the value of subsidies for developing such a charging infrastructure increases, more and more players and products enter the market, making it harder for users to understand the situation clearly and compounding their uncertainty.

But amid the confusion of the race to set this undertaking on its feet and in the face of ever more complex requirements combined with shorter time-to-market, it is imperative not to neglect the question of "electrical safety". In essence, the following applies: Particularly in the realm of cable-based AC charging, the requirements governing a safe yet interoperable charging infrastructure are already thoroughly described in the national, European and international standards and have proven themselves in practice.

But at the same time, misunderstandings arise repeatedly regarding certain formulations and requirements of the standards. One misunderstanding that occurs very often on the subject of cable-bound AC charging modelled on charging mode 3 – referred to in the following as mode 3 charging for short – is that a type B residual current device (RCD) must be installed for each charging point. Meanwhile, the solution described as equivalent in the pertinent standards, a type A RCD combined with 6 mA DC fault current monitoring and a disconnecting device (RDC-MD for short according to IEC 62955:2018), is overlooked without reason in many cases, and is even characterised as unsafe.

The purpose of this article is to address this view, which is unsupported by facts. In so doing, this article will also explain the combination of a type A RCD and RDC-MD, which is superior in many ways, as part of the total safety concept of a standard-compliant mode 3 charging device.

Smart protection concept for mode 3 charging infrastructure

At bottom, the argument regarding electrical safety is based on the mistaken belief that when a DC fault current > 6 mA occurs, it is imperative to separate safely from the power source. This, in turn, begs the conclusion that the requirement can only be satisfied with a type B RCD.

In response to this, the existing standard situation must first be explained. The standards considered most significant for the electrical safety of a mode 3 charging infrastructure are the installation standard

DIN VDE 0100-722 (VDE 0100-722) which deals with connection to the low-voltage installation, and the product standard DIN EN IEC 61851-1 (VDE 0122-1) which concerns the AC charging infrastructure, both of which were formulated by the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE (DKE). For the point at issue, the relevant committees are DKE/K221 “Electrical installations and protection against electric shock” and DKE/K353 “Electric vehicles”.

Both of these bodies are in agreement regarding the safety of using the constellation of type A RCD and RDC-MD, as is evidenced in VDE 0100-722:2019-06 section 722.531.3.101 and DIN EN IEC 61851-1:2019-12 section 8.5. In both documents, it is stated unequivocally that

1. the use of a type A RCD in combination with a RDC-MD is unreservedly equivalent to the use of a type B RCD and

2. disconnection following the occurrence and detection of a DC fault current > 6 mA is sufficient, and is not to be confused with safe separation of the power source.

It is most important to draw a clear distinction between the protection function for personal protection and raising the level of protection in order to guarantee performance of the protection function.

The defining issue is:

- The protection function against electric shock is assured at all times by the protective device (type A RCD) which is required in the installation for each charging point and is used explicitly for the safe separation of the AC circuit when a residual current > 30 mA occurs.

- The function of the RDC-MD described in the standardisation community as raising the protection level ensures that the protective function of the type A RCD is maintained in case of a DC fault current > 6 mA, which must be complied with in the field of e-mobility.

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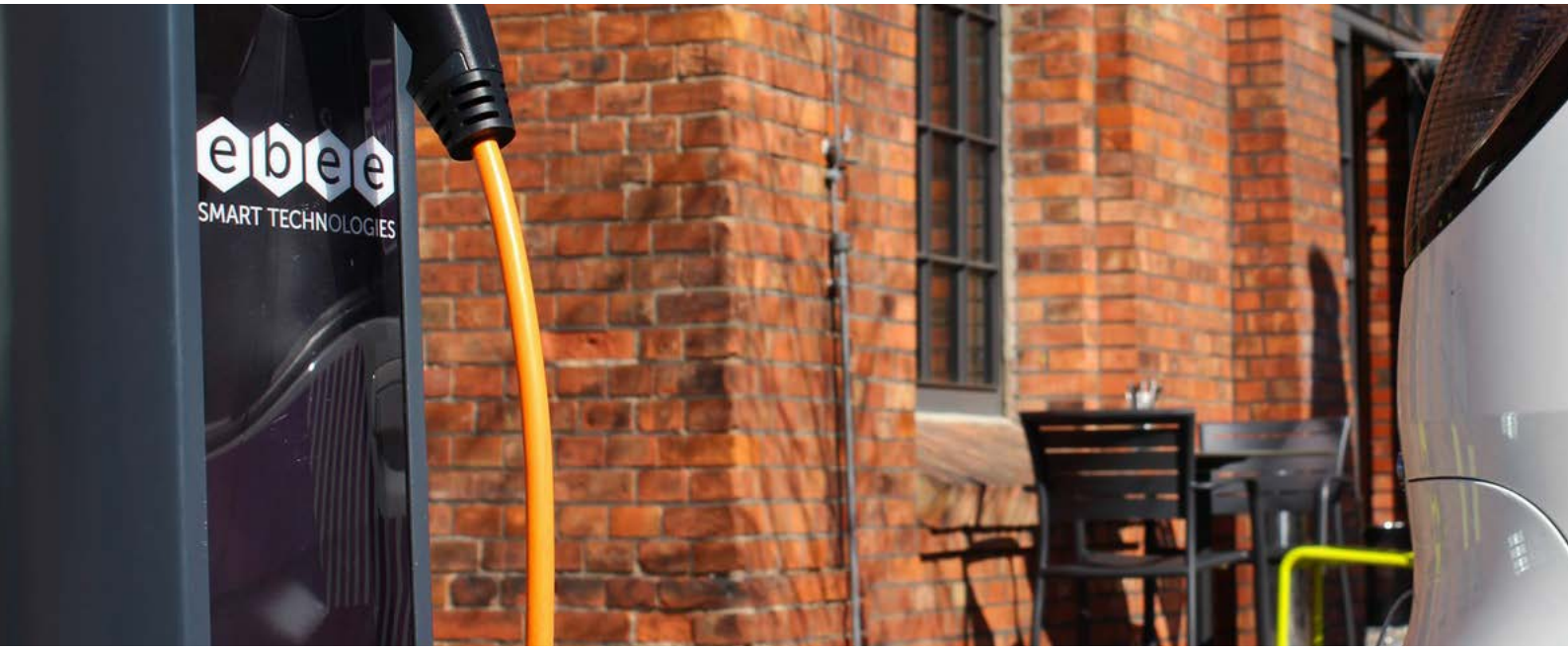

The two committees mentioned above consider that the risk of a dangerous AC residual current > 30 mA occurring together with a DC fault current > 6 mA and at the same time direct contact by the user is sufficiently low, in view of the total safety concept of a mode 3 charging infrastructure, as will be explained below. Therefore, a safe separation of the power supply following detection of a 6 mA DC fault current is explicitly not required.

Pursuant to the opinion from both committees as described earlier, the option exists to use the switching elements which are installed in the charging infrastructure anyway to perform normal operational switching to carry out disconnection upon the occurrence of a 6 mA DC fault current.

Regarding the total safety concept of a mode 3 charging device with a type 2 plug connector conforming to DIN EN 62196-2 (VDE 0623-5-2):2017-11, the following points must be kept in mind:

- In principle, a locking system for the charging plug and the vehicle coupling (case: detachable charging cable) or the vehicle coupling (case: non-detachable charging cable) is always present during the charging process, and consequently while the energy is flowing there is no danger of touching hazardous, live parts.

- For the unlikely event of a defective locking system, IPXXB class contact protection is provided. In keeping with the protection concept of earthed socket-outlets used in residential installations, IPXXB is a suitable basic protection measure compliant with DIN EN 61140:2016-11 which prevents direct contact with live parts. Fault protection is assured by automatic disconnection of the power supply via the protective devices required for the installation.

- Furthermore, a 30 mA RCD is required as additional protection for each charging point to allow operability by members of the public. As explained previously, when a type A RCD is used, measures must be implemented for testing and disconnecting if a DC fault current exceeds 6 mA.

- Besides the normative minimum requirements, the self-test function implemented in the 6 mA DC fault current sensors produced by the Bender company offers a further safety gain, in that the 6 mA DC fault current solution is tested before every charging process. At this point, it is worth nothing that in order for the DC fault current detection to work in the type B RCD that corresponds to the RDC-MD, a voltage-dependent electronic system is used that is not designed to satisfy any higher quality requirements in terms of failure safety and typically does not provide a self-test function.

In summary, the constellation of a type A residual current device (RCD) with RDC-MD is to be recommended for use in mode 3 charging infrastructure in preference to a type B RCD for the following technical and financial reasons:

It is most important to draw a clear distinction between the protection function for personal protection and raising the level of protection in order to guarantee performance of the protection function.

- Lower installation costs (particularly if a type A residual current device (RCD) is already fitted in the existing installation);
- Automatic restart capability after elimination of the DC fault current without a service intervention and the associated loss of availability in the field (manual reset of the protective device by an electrically skilled person or trained electrical engineering personnel is not necessary);
- Cost-efficient use of the switching elements of the charging infrastructure designed for normal operational switching. (Note: Protective devices such as the RCD must not be used for normal operational switching and are only permitted to perform a specific number of switching cycles; this number would undoubtedly be far exceeded in the routine operation of a charging point);
- If a type B RCD is put into operation, any and all type A RCDs in the higher-level associated circuit would have to be replaced with type B RCDs to comply with the normative requirements for coordination as set forth in DIN VDE 0100-530:2018-06;
- The level of safety required according to the standards is raised by the provision of a self-test function of the 6 mA DC fault current detection before every charging process.

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