

INSPECTION REPORT

**Fire Safety Assessment according to
EN 45545-1 and EN 45545-2**

For DC-DC and ACDC Converters

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Revision history

Revision	Status	Date	Author	Modified clauses	Modifications
0.1	Initial	2014-01-27	S. Ehrenberg	All sections	
1.0	Final	2014-02-07	S. Ehrenberg	All sections	
2.0	Final	08.06.2015	Sven Ehrenberg	Title page, 5, 6	Change company name

1. General

1.1. Standards

This document contains the assessment DC-DC and AC-DC converters in terms of their compliance with specific fire protection requirements according to the present state of the art. The assessment is based on the following standards:

No.	Standard	Date	Title
[R01]	EN 45545-1	2013	Railway applications – Fire protection on rail vehicles – Part 1: General
[R02]	EN 45545-2	2013	Railway applications – Fire protection on rail vehicles – Part 2: Requirements for fire behavior of material and components

Table 1: Standards

1.2. Abbreviations

Abbreviation	Definition
HL	Hazard Level

Table 2: Abbreviations

2. Equipment under inspection

2.1. Description of equipment

Bel Power Solutions (former Power One) develops and produces DC-DC and AC-DC converters in various series. Following series are considered under this assessment:

- R-Series
- S Series, S Series with PFC
- K series , K Series with PFC
- P series
- Q series

The DC-DC and AC-DC converters of the above mentioned series are constructed similar with use of identical materials. They consist of a metallic housing, internal PCB's with electronic components and connectors.

Electrical Data:

No.	Series	Input Voltages	Nom. Power	Fuse
1	R Series	16,8 – 150 VDC	144 W / 288 W	External fuse
2	S Series	8 - 385 VDC, 85 - 264 VAC	100 W	Internal input fuse
3	K Series	8 - 385 VDC, 85 - 264 VAC	150 W – 280 W	Internal input fuse
4	P Series	14 – 150 VDC	90 W – 194 W	Internal input fuse
5	Q Series	14 – 150 VDC	66 W – 132 W	Internal input fuse

Table 3: electrical properties of converters



Fig. 1: DC-DC Converter K-Series



Fig. 2: AC-DC / DC-DC Converter S-Series



Fig. 3: DC-DC Converter P-Series



Fig. 4: DC-DC Converter Q-Series



Fig. 5: DC-DC Converter R-Series

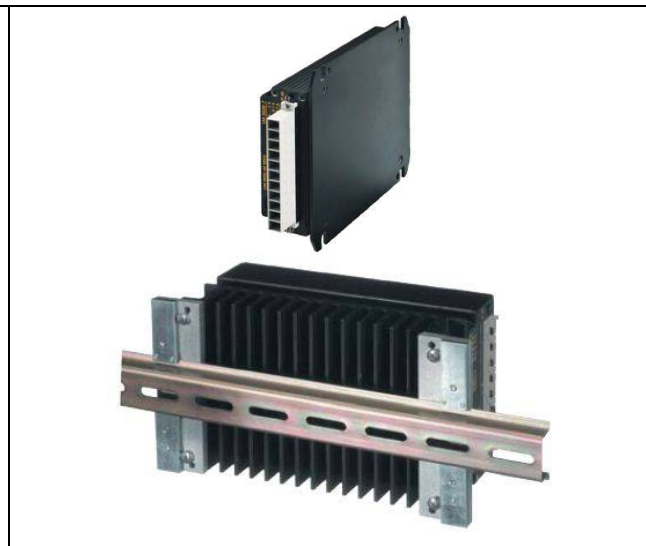


Fig. 6: Installation examples (plate, rail)

Material characteristics:

No.	Component / Material	Fire safety characteristic /
1	PCB – FR4	Glow wire test: 960 °C, LOI > 70 %
2	Connectors Harting	UL 94 Classification V-0
3	Connectors H15-4TE	UL 94 Classification V-0, LOI > 32 %
4	Transformers	UL 94 Classification V-0
5	Electronic components on circuit boards	Approved on functional necessity acc. chapter 4.7 EN 45545-2

Table 4: Combustible materials

2.2. Installation

The DC-DC and AC-DC converters are designed for installation in technical compartments and cabinets. Therefore, the units are not accessible for passengers.

3. Conformity assessment acc. to EN 45545

3.1. Classification following EN 45545-1

The DC-DC and AC-DC converters shall be implemented in railway vehicles of all design classes and for all operation categories (i.e. 1 to 4). Due to integration of the components inside technical compartments, the essential fire safety objectives acc. to clause 4.3 “Fire resulting from technical defects” shall be met.

3.2. Assessment according to EN 45545-2

3.2.1. Requirements

Based on the classification acc. to EN 45545-1, the materials/components shall meet the requirements of Hazard Level HL3. The devices are to be regarded as electro-technical equipment covered by the EN 45545-2 standard. Generally, the requirement sets EL9 and EL10 acc. to clause 4.4 “Listed products” are applicable, unless they are covered by clause 4.3 “Grouping rules”:

- § EL9 PCBs [Requirement R25: EN 60695-2-11 Glow wire test: 850 °C or Requirement R24: ISO 4589-2 Oxygen index LOI > = 32 %]
- § EL10 Small electro-technical products [Requirement R26: EN 60695-11-10 vertical small flame test V-0 (identical with UL94)]

In addition to requirements of listed products, the grouping rules applicable for components with low combustible mass and/or surfaces are valid:

- § No requirements apply to products with a combustible mass of < 10 g not in touching contact with another unclassified product.

External connection cables and wires are not part of this assessment report.

No.	Clause	Requirement	Remark
1-1	4.3.2. Grouping rule 1 Products without requirements	< 100 g for interior grouped products	No requirements
1-2		< 400 g for exterior grouped products	No requirements

Table 5: Grouping rule1

No.	Clause	Requirement	Remark
2-1	4.3.3. Grouping rule 2 Products tested acc. to R24	< 500 g for interior grouped products tested acc. to R24	Proof R24 Oxygen index LOI > = 32 %
2-2		< 2000 g for exterior grouped products tested acc. to R24	Proof R24 Oxygen index LOI > = 32 %

Table 6: Grouping rule2

3.2.2. Material verification

The main combustible materials of the converters according to the material tables are the PCB's, the connectors and electronic components on the PCB's. Other minor materials have a single weight < 10g and a total weight < 100g. According to the grouping rules there are no requirements to the minor materials.

PCB

§ Material: FR4

Requirement for HL3	Result	Certificate
R25: Glow wire test 850°C, acc. to EN 60695-2-11	960°C - passed	SGS AJD201302051 /D13/

Table 7: Material test for PCB

The requirements for HL3 are passed.

Connectors Harting

§ Material: Pocan, Xantar /D14/

Requirement for HL3	Result	Certificate
R26: EN 60695-11-10 vertical small flame test V-0	V-0 - passed	UL file no.: E245249 /D24/, E340159 /D25/

Table 8: Material test for PCB of power supply unit

The requirements for HL3 are passed.

Connector H15-4TE (Q and P series)

§ Material: LCP E130i /D21/, /D22/

Requirement for HL3	Result	Certificate
R26: EN 60695-11-10 vertical small flame test V-0	V-0 - passed	UL file no.: E83005 /D23/
Alternatively R24: Oxygen Index LOI > 32 %	LOI > 32 %	Fire classification Report No. 406.350/2 /D19/, /D20/

Table 9: Material test for PCB of power supply unit

The requirements for HL3 are passed.

Other components

According to EN 45545-2 Chapter 4.7 the electronic components on the circuit boards are approved on functional necessity without testing evidence. The fire risk analysis shows no disadvantage on fire risk.

For this reason the requirements for HL3 are passed.

4. Fire risk analysis

A) Ignition and spread of fire starting from device – material and failure analysis

Fire on electronic devices cannot be excluded. Because of the small content of combustible materials and the low electrical power the fire keeps limited inside the housing. The value of power consumption is max. 288 W and is limited by an internal fuse or external fuse. Therefore in the case of a failure an ignition of combustible materials is unlikely and the spreading of fire is limited to a minimum.

B) Ignition of device by external fire – material and constrictive analysis

The components of the DC-DC and AC-DC converters are installed in a metallic enclosure. Because of the proved fire characteristics UL94-V0 of the material and the small amount of combustible material combustion and fire spreading is limited.

5. Summary

The assessment has shown that DC-DC and AC-DC converters mentioned in chapter 2.1 meet the requirements as laid down in the fire safety standards – considering the installation inside railway vehicles:

- EN 45545-2 for hazard levels HL1 to HL3

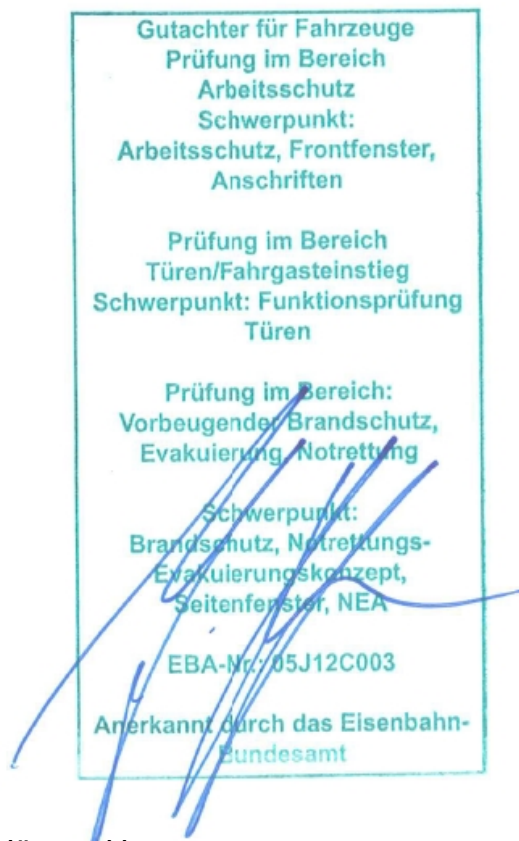
For regular (intended) operation the required level of personal safety is ensured.

The assessment is based on documents provided by the customer (see documents list). The evaluation was conducted following the applicable requirements of EN 45545 parts 1 and 2 „ Railway applications - Fire protection on railway vehicles “.

Bel Power Solutions GmbH confirms that the products, part lists and part numbers were not changed under the new company name /D27/.

TÜV SÜD Rail GmbH

Munich, 2015-06-08



Dr.-Ing. Jürgen Heyn
Gutachter für Brandschutz
(EBA-ID-Nr. 05 J12 C003)

Dipl. Ing. Sven Ehrenberg
Senior Assessor fire safety

6. Documents

Ref.-No.	Document	Supplier
/D1/	R Series Data Sheet BCD.00185_AE 2014-01-29 PREL	Bel Power Solutions
/D2/	Table burnable materials HR2320-9RG_DOC_000_Burnable-Material_02	Bel Power Solutions
/D3/	S Series with PFC Data Sheet BCD20003_AB_2011-01-13+	Bel Power Solutions
/D4/	S Series Data Sheet BCD20004-g_AB--2014-01-31	Bel Power Solutions
/D5/	K Series Data Sheet BCD20002_AC_2014-01-31	Bel Power Solutions
/D6/	K Series with PFC Data Sheet LK-PFC_BCD20001_ac_2010-12-17	Bel Power Solutions
/D7/	K Serie Critical_components_AK2660-7R	Bel Power Solutions
/D8/	K Serie Critical_components_CK2660-7R	Bel Power Solutions
/D9/	K Serie Critical_components_DK2660-7R	Bel Power Solutions
/D10/	S Serie Critical_components_ES1601-7RB1	Bel Power Solutions
/D11/	P-Serie Brennbares Material (models P1000 to P4000)	Bel Power Solutions
/D12/	Q-Serie Brennbares Material Q - 2006_01	Bel Power Solutions
/D13/	SGS Test Report Shengyi technology CCL 201302051	SGS
/D14/	Harting NFF special connectors 222 Declaration	Harting
/D15/	P Series Data Sheet BCD20010-G_AF_2013-12-19	Bel Power Solutions
/D16/	Q Series Data Sheet BCD20011-G_AG_2012-03-12+	Bel Power Solutions
/D17/	S-PFC Serie Critical_components LS5660-7R	Bel Power Solutions
/D18/	K-PFC Serie Critical_components LKP5660-9ER	Bel Power Solutions
/D19/	Fire classification Report 406.305/2	Ofi Technologie & Innovation GmbH
/D20/	Test Report 406.305/3 Oxygen Index	Ofi Technologie & Innovation GmbH
/D21/	Drawing connector H15-4TE ZES.00312.DG	Bel Power Solutions
/D22/	Drawing connector H15S2-4TE ZES.00339.DG	Bel Power Solutions
/D23/	UL Yellow card LCP E130i E83005	UL
/D24/	UL Yellow card Pocan E245249	UL
/D25/	UL Yellow card Xantar E340159	UL
/D26/	Harting PCB Connectors General Information	Harting
/D27/	Declaration of confirmation for products, 2015-05-22	Bel Power Solutions

Table 10: Table of documents