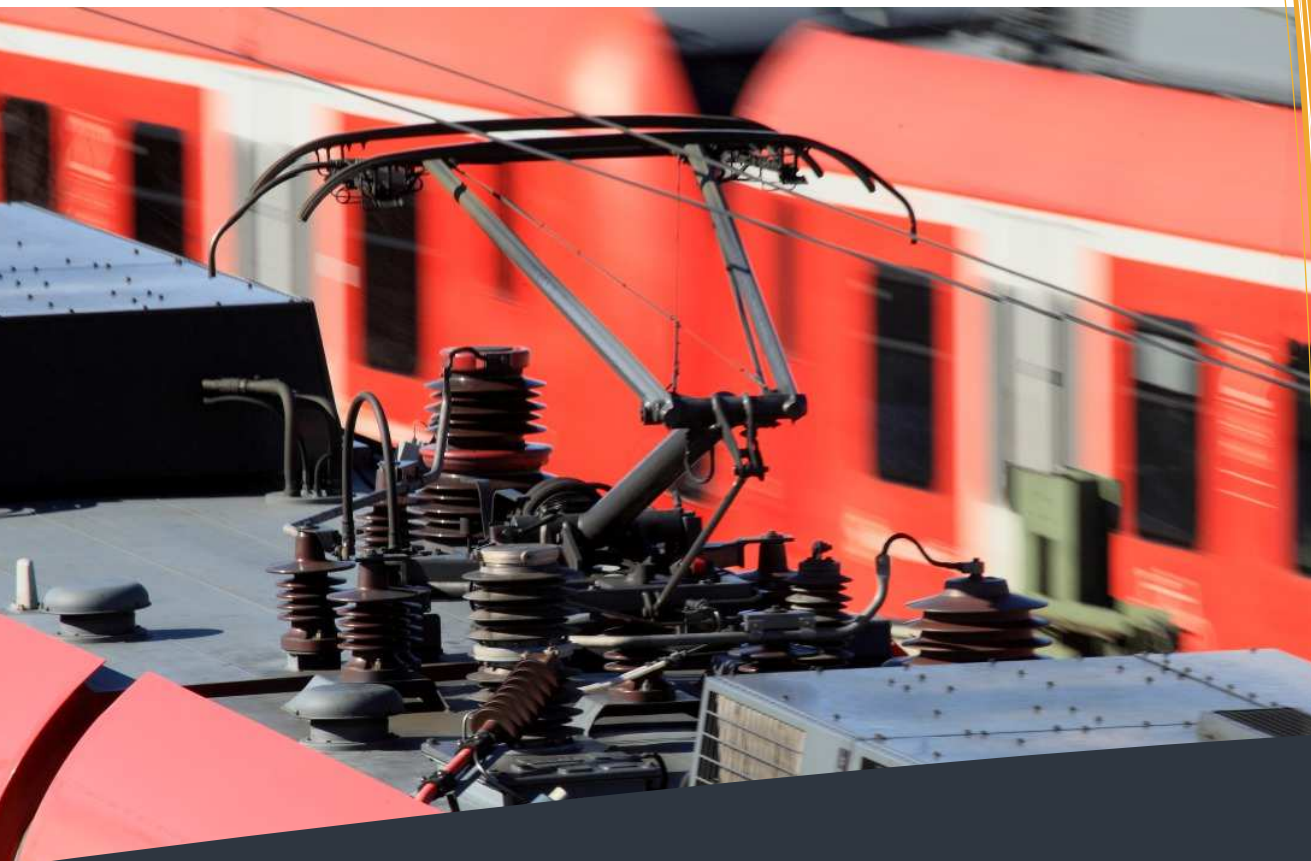


EuroSpec



Specification for contact strips

(Applicable for 1.600 mm and 1.950 mm
pantograph head profiles)



Mobility
Networks
Logistics



Specification for contact strips (Applicable for 1.600 mm and 1.950 mm pantograph head profiles)

3rd edition

Original language: English

© Société Nationale des Chemins de fer Français (SNCF), the Association of Train Operating Companies (ATOC), Deutsche Bahn (DB), Nederlandse Spoorwegen (NS), Danske Statsbaner (DSB), Österreichische Bundesbahnen (ÖBB), Schweizerische Bundesbahnen (SBB)

Paris, London, Munich (München), Utrecht, Kopenhagen (København), Vienna (Wien), Bern

April 2016

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Issue Record

Issue	Date	Comments	Source
1	October 2014	First draft of the specification based on the Summary Report "EuroSpec – Interchangeable spare parts contact strips"	"EuroSpec "Specification for contact strips"
2	June 2015	Second draft based on comments of new active members. Version sent to suppliers	"EuroSpec "Specification for contact strips"
3	April 2016	Third draft of the specification based on suppliers comments	"EuroSpec "Specification for contact strips"

List of open points / non-agreed items

No.	Chap.	Open point / non-agreed item	Finalisation
1	-	void	-

1 FOREWORD

EuroSpec is a group of European train operating companies providing harmonised product specifications for use in train procurement and refurbishment.

The main target is to improve the reliability and quality of trains by using common and standardised functional and non-functional specification and verification methods.

The benefits of using EuroSpecs:

- Increase of reliability by sharing good practice and experience;
- Simplification of the tender process in time and cost as a result of fewer variations in requirements between tenders;
- Standardised products and cost reduction due to harmonisation of train operators' requirements.

The EuroSpec specifications comprise merged functional and product basic requirements. All EuroSpec specifications focus on technical aspects exclusively based on the existing national requirements.

A EuroSpec specification is a voluntary specification designed to be used within the European region. The primary field of application is the European rolling stock domain and all associated interfaces.

Regarding the hierarchy this common specification can be positioned as follows, in order of prevalence:

- EN standards
- UIC/ UNIFE Technical Recommendations (TecRecs)
- UIC Codes (leaflets)
- EuroSpec Specifications
- Company Specifications

2 INTRODUCTION

This document is a voluntary specification, produced by Société nationale des chemins de fer français (SNCF), the Association of Train Operating Companies (ATOC), Deutsche Bahn (DB), Nederlandse Spoorwegen (NS), Danske Statsbaner (DSB), Österreichische Bundesbahnen (ÖBB) and Schweizerische Bundesbahnen (SBB) so called "the Members" in the later sections. Individual companies may choose to mandate it through internal instructions/procedures or contract conditions.

Purpose of this document

- This document provides a voluntary specification for "contact strips" for use by companies in the rail sector if they so choose.
- The document is set out in the same format as EN standards including, where appropriate, normative and informative annexes in order to facilitate the interface with Euro Norms.

Application of this document

- This specification is voluntary. Individual companies may however elect to mandate all or part of its use through company procedures or contract conditions. Where this is the case, the company concerned must specify the nature and extent of application.
- Specific compliance requirements and dates of application have therefore not been identified since these will be the subject of the internal procedures or contract conditions of those companies that choose to adopt this standard.

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3 SCOPE

Contact strips are the replaceable wearing parts of the pantograph head which interface with the overhead line equipment. The contact strip consists of contact material attached to a carrier. European train operating companies are faced with a plethora of different pantograph head designs and a corresponding huge variety of contact strips. Due to this large number of different types, cost-effective management of contact strips is difficult.

Profile of the pantograph head

The LOC and PAS TSI 2014/1302/EC and EN 50367 referenced herein specify that two different pantograph head profile, that is, 1.600 mm and 1.950 mm, are permitted or required depending on the energy supply system. These two dimensions, with associated basic geometry for compliant strips, imply that a single length is not realistic. Nevertheless the variety must thus be limited to two strip lengths for standardisation attempt of this specification. In the same way, contact strip width as a design parameter link to the different current capacity required for alternating current (AC) or direct current (DC) will be also limited.

Contact strip materials

The situation is similar with the contact strip materials. Although the LOC and PAS TSI mentions permitted materials, the use of other materials is expressly marked as an open point. Annex C of EN 50367 gives an informative overview of the materials commonly used in the respective national railway networks. The materials must thus also be excluded from the standardisation attempt of this specification.

The situation is different for other contact strip features. Serving the same function, contact strips nowadays often only differ very slightly from one another and offer a high potential for standardisation.

The objective of this document is a clear definition of the LOC and PAS TSI and EuroNorm compliant yet also standardized contact strips and their interfaces to the pantograph head. This means that once standardised contact strip properties have been firmly established in this specification, future developments of pantographs must respect a standardised interface to ensure the interchangeability of standardised contact strips of different market participants.

In this way, an increasing number of different pantographs will become available, compatible with standardised contact strips. As mentioned above, the parameters "pantograph head profile" and "contact strip material" will continue to differ depending on the area of use. For a given pantograph certified on a vehicle using contact strips complying with this specification, no new assessment is needed when using the same contact strip type compliant with this specification from a different supplier. This EuroSpec specification is a first attempt to standardise contact strips and in due course will be coordinated with the stakeholders in the rail sector. The aim is to establish a coordinated specification for contact strips that will be used by European railway operators in the same way and that form the basis for future developments of pantographs and standardised contact strips.

Note: Interchangeable parts are parts or components that are, for practical purposes, functionally identical. They are made to specifications that ensure that they are functionally identical such that they will fit into any assembly of the same type independent of the manufacturer or country of origin. One such part can freely replace another, without any custom fitting.

4 NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this document. ENs are developed by CEN¹ or CENELEC² and are made available from their Members.

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Technical specification for interoperability	Technical specification for interoperability relating to the 'rolling stock, locomotives and rolling stock passenger' subsystem of the rail system in the European union - Commission regulation (EU) N° 1302/2014 published 12/12/2014 (Directive 2008/57/EC)
EN 50367:2012	Railway applications. Current collection systems. Technical criteria for the interaction between pantograph and overhead line
EN 50405:2016	Railway applications. Current collection systems. Pantographs, testing methods for carbon contact strips
EN 50206-1: 2010	Railway applications – Rolling stock – Pantographs: Characteristics and tests – Part 1: Pantographs for main line vehicles
ISO 261:1998	ISO general purpose metric screw thread
ISO 4759-1:2000	Tolerances for fasteners – Part 1: Bolts, screws, studs and nuts Product grade A, B and C
DIN 6796: 2009	Conical washer for screwed connections
EN ISO 7040:2012	Prevailing torque nuts with non metallic insert

¹ Comité Européen de Normalisation/ European Committee for Standardisation - www.cen.eu

² Comité Européen de Normalisation Électrotechnique/ European Committee for Electrotechnical Standardisation - www.cenelec.eu

5 Terms, definitions and abbreviations

A	Ampere - Unit of electric current
V	Volt - Unit of electric potential
bar	Bar - Unit of pressure
kg	Kilogram – Unit of mass
g	Gram - Unit of mass
m	Metre - Unit of length
ADD	Automatic Dropping Device
TSI	Technical specification for interoperability
EN	EuroNorm
AC	Alternating current - A type of electrical current where the current repeatedly changes direction
DC	Direct current - The unidirectional flow of electric charge
Bonding	Adhesive that permanently attaches the carbon material to the carrier
Carrier	A structure which supports the contact strip and is used as an interface to the pantograph head
Trapezium	A convex quadrilateral with at least one pair of parallel sides
Rectangle	Any quadrilateral with four right angles
M	ISO metric screw thread. The "M" designation for metric screws indicates the nominal outer diameter of the screw, in millimetres
Customers	Companies in the rail sector who will use this specification

6 SPECIFICATIONS

6.1 Aim

The aim of this specification is to describe a set of standardised contact strips for different applications which are fully compliant with Technical Specifications for Interoperability (TSI) and referenced Euro Norms (EN).

6.2 Field of application

According to the LOC and PAS TSI and EN 50367, two different pantograph head profiles are required to cover all possible applications in Europe for operation on AC- and DC-lines (specific cases in § 7.3 of the TSI are not in the scope of this specification):

- 1.600 mm according to EN 50367:2012, Annex.A.2.1
- 1.950 mm according to EN 50367:2012, Annex A.2.2

The design of standardised contact strips needs to integrate different geometrical constraints (length, width, shape of contact material, cross section of carrier,...) as well as common interfaces with all pantographs heads (mechanical, electrical and pneumatic).

On this basis, additional features are specified for some applications such as additional conducting connections with the pantograph structure (DC) or special arcing protection.

Table 1 gives an overview of standardized combinations, in terms of length, width, cross section of the carbon strip supporting part, that cover the majority of operational cases in Europe:

Carbon width	Cross section of supporting part of the contact strip	Pan head profile	
		1.950 mm	1.600 mm
35 mm	Trapezium	✓	✓
42 mm	Rectangle	✓	✓
60 mm	Trapezium	✓	✓
60 mm	Rectangle	✓	✓

Table 1 – Combination of length, width and cross sections

Remark: The supporting part of the carbon strip can be the carrier itself or the carrier with additional protections against arcing.

6.3 Geometrical requirements

6.3.1 Front view geometry

Length of contact strip

Contact strips are either designed as short strips forming the “straight” central part of the pan-head profile, or the strip has such a length, that it additionally covers the outer area of the pan head profile (either completely or in parts together with a fixed end horn). These contact strips are called “integral strips”. The outer area of an integral strip can be covered with the contact material, with a conducting material (metal) or formed by an insulating material.

The contact strip consists of the contact material (plain or metallised carbon) and a carrier, usually formed by a metal profile, e.g. an aluminium extrusion.

General requirements for standardised strip:

As a consumable part, the contact strip has to be designed as simply as possible. Therefore the standardised strip is defined as not being an integral strip, but just covering the straight part of the pantograph head profile, where contact material is required.

The whole length of the contact strip is covered by the contact material (plain carbon/ metallised carbon).

EN 50367:2012 defines only the minimum required lengths for contact strips of both pantograph head profiles (minimum 800 mm for 1.600 mm profile and minimum 1000 mm for 1.950 mm profile). For standardisation purposes, precise dimensions are needed.

To be in line with the standard, the front view geometry is defined as follows:

Contact strip for 1.600 mm profile

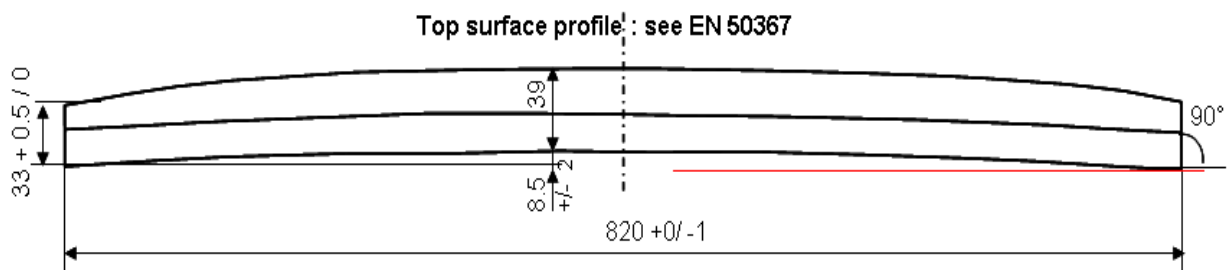


Figure 1 – Contact strip for 1.600 mm profile (main dimensions)

Contact strip for 1.950 mm profile

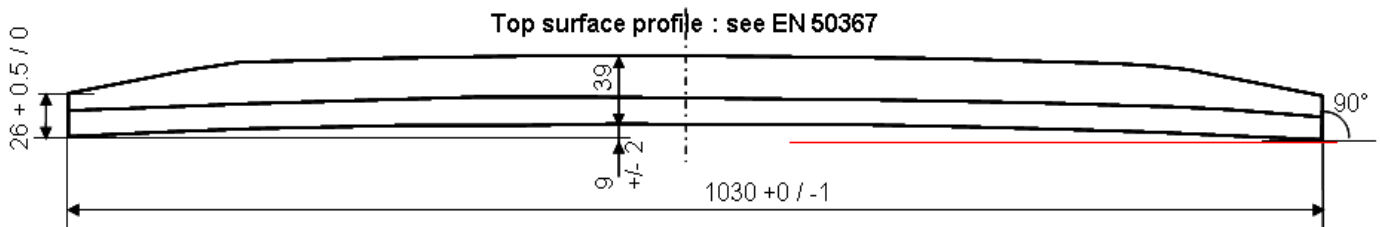


Figure 2 – Contact strip for 1.950 mm profile (main dimensions)

Remarks on pantograph head profiles

Explanation to drawing shown in EN 50367:2012:

“A.2.1 Pantograph head with length of 1.600 mm”

“A.2.2 Pantograph head with length of 1.950 mm”

Remarks for both profiles

Figures 1 and 2 represent the cross section so called A – A in Figure 5

The upper contact strip contour shall remain compliant with the overall contour line defined by EN 50367. Deviation below this contour line is allowed only downwards, but shall respect all geometrical conditions mentioned in EN 50367 § 5.3.2.

Tapers at the ends to blend with the pantograph head lateral parts are permitted.

Grinding the whole length at the upper contour to give a radius is permitted.

6.3.2 Cross section

The contact strip consists of the contact material and a carrier, usually formed by a metal profile, e.g. of extruded aluminium.

Contact material cross section: Rectangular shape, 35 mm, 42 mm or 60 mm wide.

Cross section of supporting part of the contact strip: Rectangular or trapezoidal.

Main external dimensions shown in Figures 3 and 4 and in Tables 2 and 3 shall be respected.

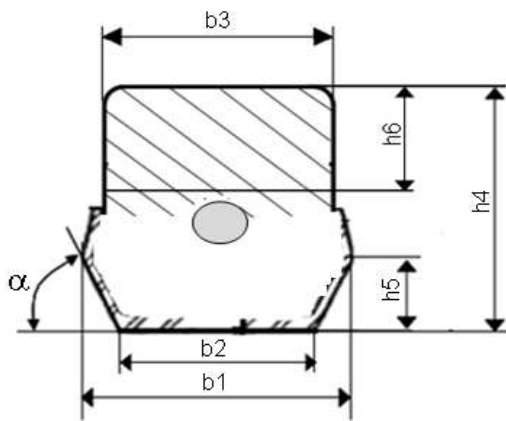


Figure 3 a

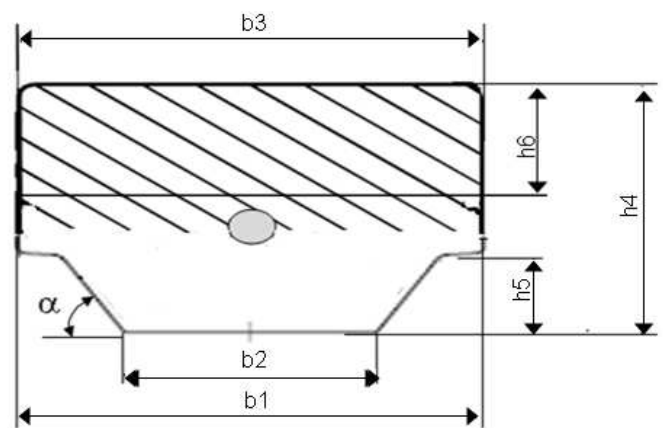


Figure 3 b

Trapezoidal cross sections (main dimensions)

Dimensions	35 mm wide strip	60 mm wide strip	60 mm wide strip
	Figure 3 a Plain or impregnated	Figure 3 b Plain or impregnated	Figure 3 b Thick impregnated carbon
b1	41,5	60	60
b2	30	27	27
b3	35	60	60
h4	39	39	42
h5	12	12	12
h6	17	19	22
α	64° +/- 1°	61° +/- 1°	61° +/- 1°

Table 2 – Trapezoidal cross section (main dimensions)

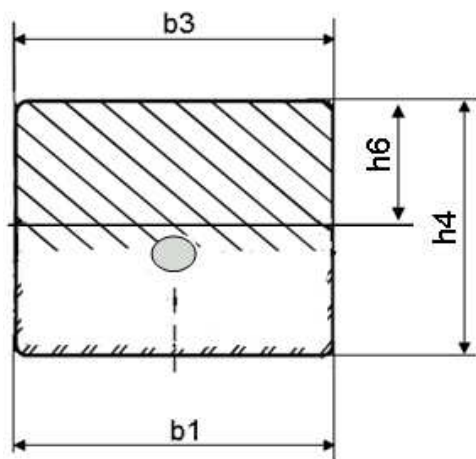


Figure 4 a

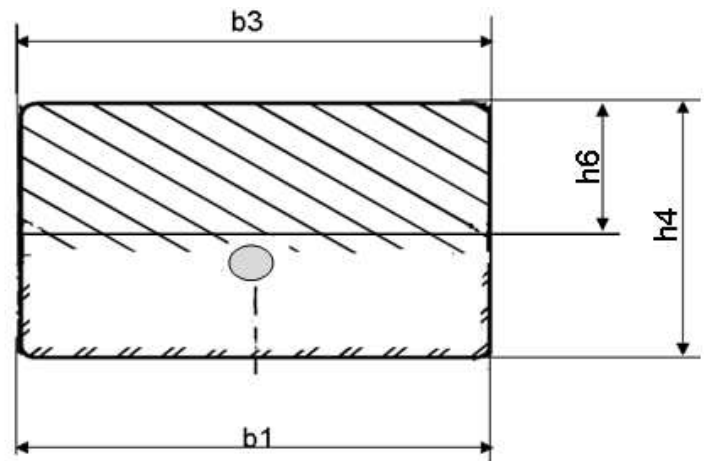


Figure 4 b

Rectangular cross sections (main dimensions)

Dimensions	42 mm wide strip Figure 4 a Plain or impregnated	60 mm wide strip Figure 4 b Plain or impregnated	60 mm wide strip Figure 4 b Thick impregnated carbon
b1	42	60	60
b3	42	60	60
h4	39	39	42
h6	17	17	20

Table 3 – Rectangular cross section (main dimensions)

Remarks for Tables 2 and 3:

Dimension h6 is the minimum guaranteed wear thickness

The surface of the lower part (carrier) can be formed by the carrier profile alone and/or by additional arcing protection material.

All other requirements of this specification are mandatory.

The position of the ADD sensor (shown as grey ellipse on Figures 3 and 4) is to be defined with respect to EN 50405 § 7.5.2 (sealing integrity under 10 bar with the carbon strip machined to its wear limit).

6.3.3 Contact strip top view

If a contact wire, e.g. in railway switches, is running in from the outside, the first contact with the pantograph head is not necessarily within the length of the contact strip, but in the outer part of the pantograph head. When the contact point then moves to the centre, the wire shall not meet any raised points at the interfaces with any lateral parts of the strip. For that reason, the contact strip shall have transitions with lateral parts of pantograph head as shown in its top view in Figure 5.

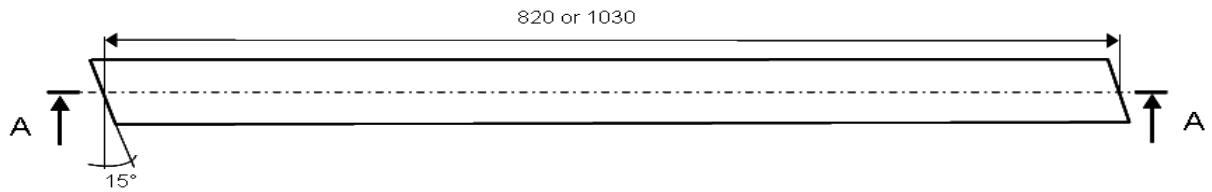


Figure 5 – Contact strip transitions at its extremities

All longitudinal dimensions mentioned in this specification - such as length of the contact strip or the location of mechanical, electrical and pneumatic devices - are to be considered on the section plane A – A at the mid-width of the strip.

6.3.4 Clamping of contact material

In addition to the bonding that can be damaged by overheating, clamping of the contact material by the carrier is:

- Mandatory for DC applications
- Permitted for AC applications

The supplier drawing shall indicate the clamping dimensions. An example is shown in Figure 6.

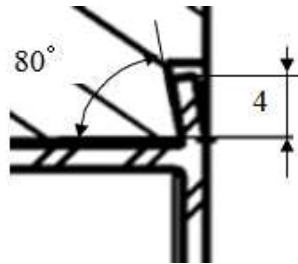


Figure 6 – Clamping (dimensions given as an example)

6.3.5 Dimensions for mechanical fastenings of the contact strip

The contact strips are attached to the pantograph head using threaded studs. The studs with a metric thread are durably affixed to the carrier profile so that they cannot become loose. The studs are part of the contact strip and are to be supplied with washers and nuts.

The contact strip is fixed to the pantograph head with two studs at each of its ends as in Figure 7.

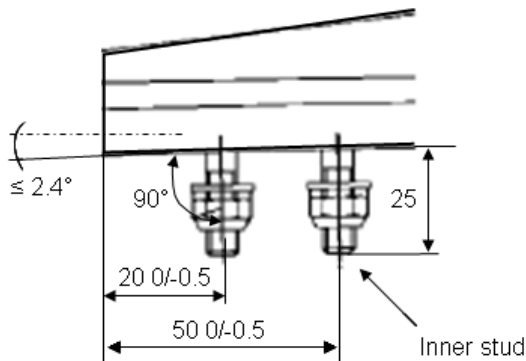


Figure 7a – 1.600 mm contact strip

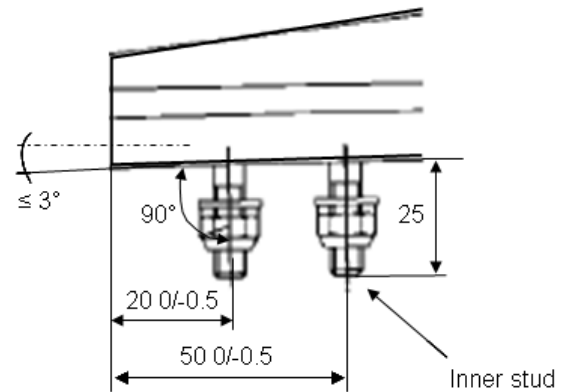


Figure 7b – 1.950 mm contact strip

– Mechanical fixings (details)

The distance of the outer studs from the ends of the strip (reference points A see Figure 5) is 20 mm +0/-0.5 mm.

The distance of the inner studs from the ends of the strip (reference points A see Figure 5) is 50 mm +0/-0.5 mm.

Thread shall be M8 (to ISO 261).

Material is stainless steel quality A2.

Tolerances Grade A (to ISO 4759-1).

The protruding stud length shall be 25 +/- 1 mm and the thread is to cover the whole length. Stud screws are permitted with visible non-threaded length ≤ 4 mm.

Washers and nuts shall be properly selected to fit to the studs. Material shall be stainless steel quality A2.

Conical spring washers (to DIN 6796) are permitted.

The nut characteristics shall prevent potential loosening of the assembly.

For AC and DC, hexagon nuts with prevailing torque or with non-metallic insert (EN ISO 7040) are permitted.

Remarks:

The 90° angle is referenced to the lower carrier surface and not to the horizontal.

In the area of the fastenings, the lower carrier surface shall have an angle less than or equal to 3° for 1.030 mm contact strip and 2,4° for 820 mm when compared to the horizontal.

6.3.6 Electrical interfaces of the contact strip

For AC applications, the design of the mechanical fastening area (see paragraph 6.3.5) shall ensure the transmission of the electric current (up to 700 A for two strip pantograph heads). Electrical connections shall be assured by these mechanical fastenings.

For DC applications, in addition to the mechanical fastening area (paragraph 6.3.5) there shall be two specific additional connections for the electrical interface using threaded studs. These studs with a metric thread are to be durably fixed to the carrier profile so that they cannot become loose. The studs are part of the contact strip and are to be supplied with washers and nuts.

These connections shall be used to convey high currents (up to 2000 A for two strip pantograph heads).

The position of these connections shall respect Figure 8 and geometrical details in Figure 9.

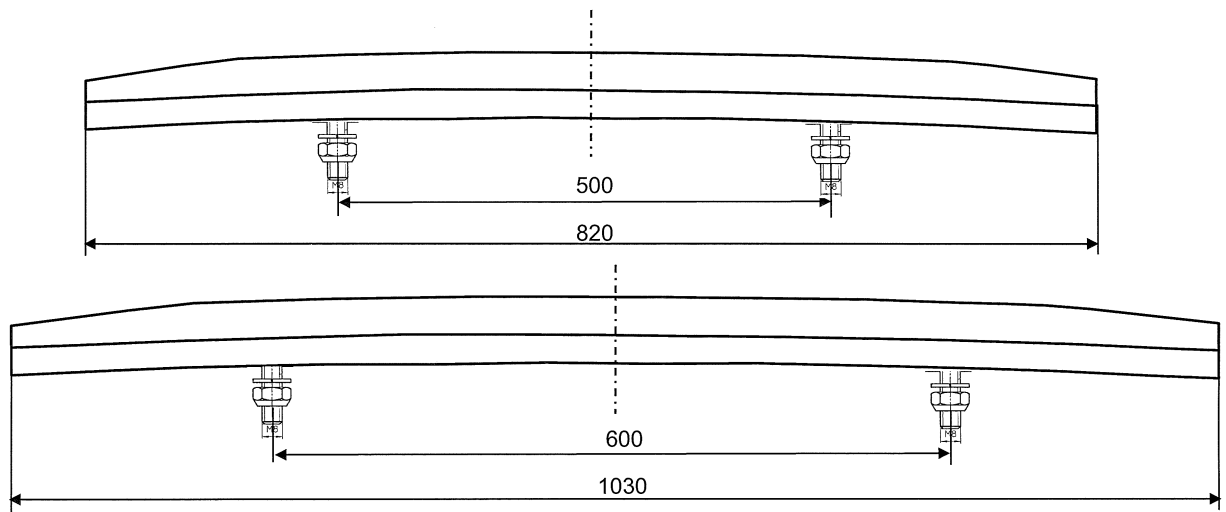


Figure 8 – Electrical connections for DC applications

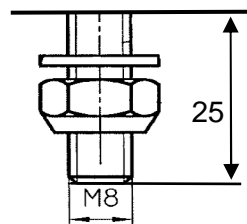


Figure 9 – Electrical connection for DC application

Thread shall be M8 (to ISO 261).
 Material for studs shall be stainless steel quality A2.
 Tolerances Grade A (to ISO 4759-1).

Washers and nuts shall be properly selected to fit to the studs.
 Conical spring washers (to DIN 6796) are permitted.

The nut characteristics shall prevent potential loosening of the assembly.
 For AC and DC, hexagon nuts with prevailing torque or with non-metallic insert (EN ISO 7040) are permitted.
 Material for nuts shall be stainless steel quality A2.

Optionally: An additional bi-metal washer, Cu-Al, is permitted to be used between the aluminium carrier and electrical copper connection if required in the customer specification.

6.3.7 ADD related requirements

The automatic dropping device ADD air channel is connected to the pneumatic system.

The fitting is designed for the attachment of an air hose with an inner diameter of 4 mm and an outer diameter of 6 mm. The fixing method shall be possible by manual tightening without the need of tools.

The distance of both fittings from the ends of the strip (reference points A see Figure 5) shall be 90 mm (Figure 10).

Air fittings shall be available at both ends of the contact strip.

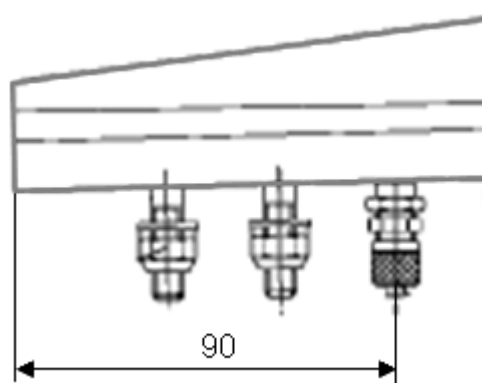


Figure 10 – Positions of air fittings

The type of air fittings shall be a metal connector adapted for $\varnothing 4$ mm inner diameter and $\varnothing 6$ mm outer air hose with 2 possible shapes:

- Straight (preferable version)
- Elbow (optional)

The interface on the contact strip carrier end (same female thread) shall accept both fitting types.

The possible shapes of the fittings are shown in Figure 11.



Figure 11 – Air fittings possible shape

The contact strip can be equipped with two connectors; one connector shall have an additional sealing cap.

The elbow shape connector shall be rotatable in order to optimize the air hose laying, as illustrated in Figure 12.

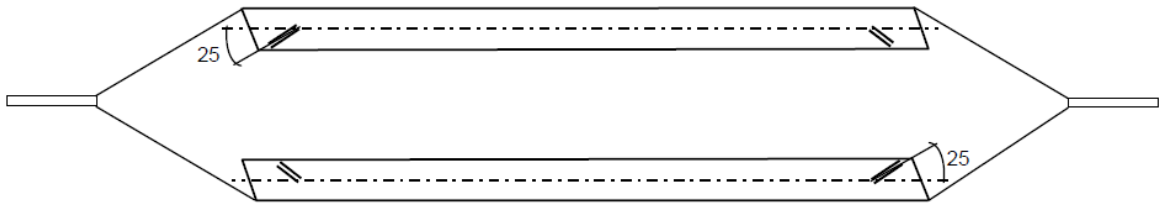


Figure 12 – Orientation of hose fittings with elbow design (example)

The main characteristics of the ADD function shall be tested according to EN 50405 for:

- Sealing integrity (air leakage rate),
- Air flow continuity,
- Impact function of the ADD sensor.

For the standardized strip including its air hose fixings, the following performance checks shall be carried out:

- Maximum operating pressure shall be 10 bar,
- Minimum air flow rate to respect performance (EN 50206-1 § 6.2.5): 80 standard litres per minute at 4 bar.

6.3.8 Contact material

Contact material shall be compliant with the LOC and PAS TSI and EN 50367:2012 requirements.

For DC-applications, higher metal content shall be subject to the Infrastructure Manager's agreement according to the network technical access conditions.

When running, the carbon strip shall be capable of taking the maximum rated current for the vehicles. For general use, a pantograph with two contact strips and an equal distribution (within a range of +/- 20%) of the contact force between the strips shall transmit 700 A for AC-current and 2000 A for DC-current. Contact strips shall be designed for these characteristics.

At standstill, contact strips for DC-applications have to be designed to accept a standstill current of 200 A for 3 kV DC and 300 A for 1.5 kV DC.

Operating wear tests should be done in order to get reliable and comparable values for the wear.

6.3.9 Mass of the contact strip

In order to achieve interchangeability between different contact strips, the contact strip shall respect strictly the design masses in Table 4 in a range of +/- 5 % with a maximum deviation within +/- 150 g.

Pantograph head profile	1.950 mm			1.600 mm		
	Material			Material		
Cross section	Plain	Impregnated	Thick impregnated	Plain	Impregnated	Thick impregnated
35 mm Trapezium	2,6	3,1		2,2	2,6	
42 mm Rectangle	2,8	3,4		2,4	2,9	
60 mm Trapezium	3,7	4,5	4,9	3	3,7	4
60 mm Rectangle	3,7	4,5	4,9	3	3,7	4

Table 4 – Mass [kg] of contact strips

6.3.10 Arcing resistance

As an option the contact strip is permitted to be designed as an arc-resistant version. The characteristic feature of this version is a convenient protection of the metal carrier and the bonding against electrical arcing.

A contact strip in the arc-resistant version shall respect all requirements of this specification.

6.3.11 Further requirements

Mandatory requirements defined in LOC and PAS TSI, EN 50206-1 and EN 50405 have to be fulfilled.

Additional requirements from customers shall be respected within the limits given by this specification for a standardised contact strip.

EuroSpec

“EuroSpec” stands for European Specifications for railway rolling stock. The activity is an initiative of several European train operating companies (TOC). The main focus is on trains consisting of self-propelled carriages, using electricity as the motive power (EMU).

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