Industrial and Traction Technology

Carbon Sliding Strips

for Pantographs and Trolley Pole Systems

HOFFMANN ELEKTROKOHLE

schunk Group

Schunk Kohlenstofftechnik

schunk

Contents

Sliding Strips

It is an imperative prerequisite for the safe and economic operation of both – Light and Heavy Rail transit vehicles – to assure uninterrupted and complete current collection from the catenary – or the power rail.

It is Schunk's worldwide objective to design, manufacture, and provide a variety of individual components to support efficient rail and road operations.

We Supply

- complete pantographs
- carbon current collector strips for roof pantographs
- carbon current collector strips for 3rd & 4th rail applications
- carbon current collector inserts for trolley pole systems

Why Carbon?

The excellent physical properties of carbon have been exploited for many decades to transmit power from overhead contact wires and/or power rails to electrically operated vehicles. Some of those properties are:

- an excellent sliding capability
- great electric and heat conductability
- high mechanical strength
- good damping properties
- no tendency to weld
- formation of protective coating (patina)
- largely corrosion proof
- stable contact conditions
- prevention of radio interference

As the result of the advances made in the design of electrically operated traction units, greater demands have been placed on the contact material, which consequently facilitated the worldwide introduction of carbon components for current transfer. The most important demands are:

- increased vehicle performance expectancy
- superior comfort
- higher speeds
- reduced operating costs

Schunk supplies appropriate carbon grades, and suitable carrier materials, for almost all requirements.

Yarra Tram, Melbourne

Sliding Strips

Operating Reliability

- excellent temperature resistance
- stability up to the wear limit
- emergency operating features
- resistance to corrosion
- safe current collection under all conditions

Electrical Load Capacity

- low contact resistance to counter material
- low resistance to carrier material
- uniform current distribution within the carbon strip
- low electrical power loss
- good contact under different climatic effects

Maintenance Friendly

- easy installation
- maintenance-free during entire life of carbon strip
- complete components

Loco 1016 "Taurus",
Austrian Railways

Long Usable-Life

- long usable-life of catenary or power rail
- high resistance to burnup
- no fusing with catenary or power rail

Environmental Protection

- multiple use of components
- low noise sliding contact
- no radio interference
- lead-free metal impregnation possible and recommended

Grades – Current Load

Grades – Pantograph Sliding Strips
Materials for Local and Long Distance Traffic
Physical Properties

Grade	Type of Carbon Graphite Field of Application	Spec. El. Resis-tivity µΩm	Apparent Density g/cm³	Flexural Strength Mpa	Hardness Rockwell HR 5/150	Typical Load at Operation A/mm
SK85	Pure carbon graphite	34	1.71	30	85	5 – 8
SK85W	= SK85 protected against water	34	1.73	30	85	5 – 8
SK85S	= SK85 for higher mechanical stress	32	1.75	35	95	5 – 8
SK85Cu (SK85M)	= SK85 impregn. with metal for higher electr. stress. LEAD FREE	5	2.18	50	110	10 – 14
SK85CS	= SK85 impregnated with bearing alloy. LEAD FREE	10	2.22	55	120	10 – 14
SK95	Pure carbon graphite for rough catenary conditions	34	1.69	40	100	5 – 8
SK95CS	= SK95 impregnated with bearing alloy. LEAD FREE	9	2.25	65	125	10 – 14
SK01	Pure carbon graphite for special applications	34	1.71	30	90	5 – 8
SK01CS	= SK01 impregnated with bearing alloy. LEAD FREE	9	2.25	50	120	10 – 14
BH424	Pure carbon graphite	34	1.71	30	85	5 – 8
BH424C	= BH424 impregn. with metal for higher electr. stress. LEAD FREE	5	2.18	50	110	10 – 14
BH424D	= BH424 impregnated with lead-bronze	3	2.30	55	110	10 – 14

Guide-Line for Current Load – Pantograph Sliding Strips

All values mentioned are calculated per mm sliding strip width.

Operating Currents above the given range will result in shorter lifetime.

Standstill currents are subject of various factors i.e.: material, cross sectional area, type and state of the catenary, permissible catenary temperature, mean contact force per strip and last but not least the carbon grade in use. Further details will be given by our engineering department or any subsidiary listed on page 14 in this brochure.

Sliding Strips
Catenary Current Collection

Permissible Peak Current Load

Among specific conditions during operation peak currents 50 % higher than the mentioned guideline values are possible. Further details will be given by our engineering department or any subsidiary listed on page 14 in this brochure.

Note: Alternate suggestions to allow greater load than the above maximum ratings:

- usage of higher load capacity grades and designs
- wider contact surface by employing wider carbon profiles
- more current collector strips (e. g. 4 strips instead of 2 strips, or 2 strips and one center, etc.)
- more catenary wires
- acceptance of a higher wear factor

The wear of the carbon current collector strips is influenced by two factors, the electrical and the mechanical wear.

Limiting Quantities on Service Life

- current load
- feeding back of braking currents
- the speed
- environmental influences (i. e. rain, hoar-frost, ice, etc.)
- design of pantograph and/or pan head
- design of current collector strip
- type of current (i. e. AC, DC, or mixed current)
- condition of catenary/stagger
- construction of rail foundation
- pressure force
- mixed operation with metal strips

Loco 189, German Railways

Design Variations – Complete Collector Strips

A complete carbon current collector strip consists of the carbon strip (carbon profile) mounted onto, or into, a socket. The socket takes on the role of conducting the current, and stabilizing the carbon profile against impacts and deflection. In order to be resistant against ambient influences, preferably aluminum, corrosion protected steel and copper, and in special cases stainless steel, are used as socket materials.

In the short distance- and long distance traffic the following designs are employed.

Clamped Version Carbon Strip

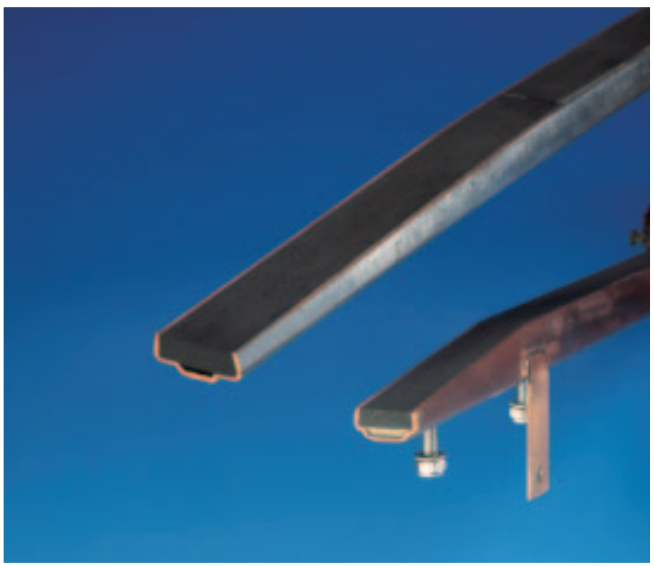
- socket material either steel or copper
- designs: riveting, bolting, flanging, soldering
- multiple use possible for bolted version

Soldered Version Carbon Strip

- bottom surface of carbon profile metalized (e. g. copper sprayed, electroplated)
- low transfer resistance

Composite Carbon Strip

- carbon profile 3-sided encased in copper
- current transmission through copper part of carbon strip
- carbon serves as lubricant
- high mechanical and electrical loading capacity
- operating current approx. 800 A/strip

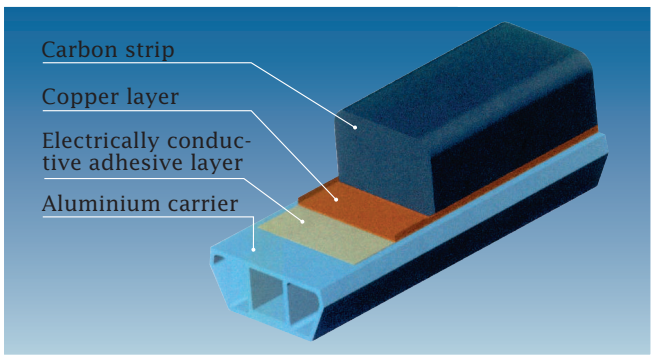


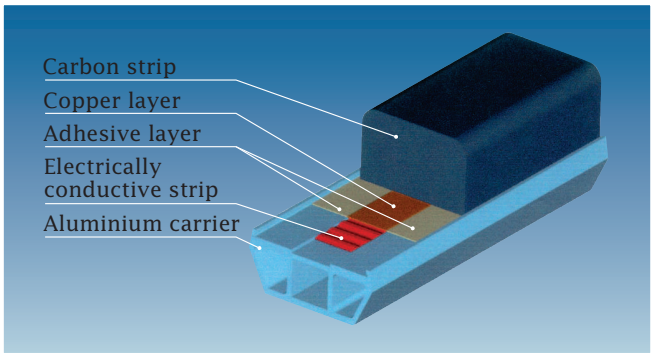
Sliding Strips
Catenary Current Collection

Adhesive Bonded Carbon Strip (ABCS)

- large variety of light-metal socket profiles
- corrosion proof
- multiple chamber design with high stability
- advantages in aerodynamic and weight allow for high speeds
- highly electrical conductive bonding of carbon profile and socket
- max. bending strength approx. 3,500 N

Design of Hoffmann bonding system



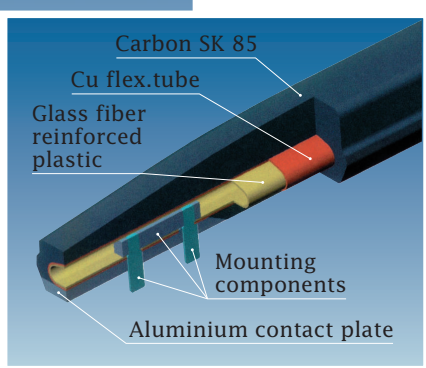


Design of Schunk bonding system

All Carbon Strip

Hoffmann Covered Carrier System (HCCS)

- high arcing resistance by means of carbon jacket (application at frost conditions)
- for railway and light railways
- low thermal expansion
- recyclable
- extremely high corrosion resistance
- excellent emergency running properties
- increased lifetime due to lower wear rates
- available with Automatic Dropping Device (A.D.D.)
- integral construction possible (with integrated run-off horn, also available with carbon coating)
- hollow structure can be applied as fracture and wear detector



Design of All Carbon Strip, System HCCS

Design Variations – Special Design

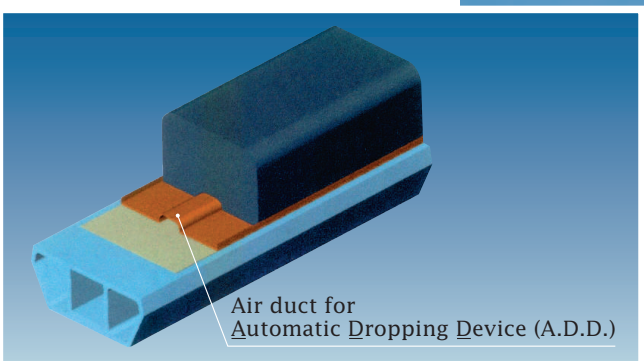
Special Design Carbon Strips

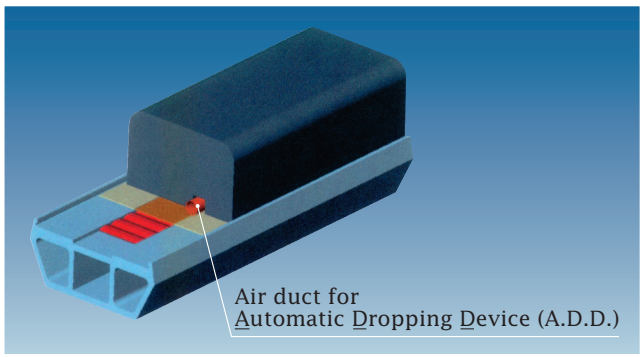
Carbon Strip with Integrated Horn

- easy installation and disassembly
- adaptability to all designs of pan head

Carbon Strip with built-in Working Condition Sensor

- will react when carbon strip gets damaged
- minimizes damage to pantograph and/or catenary





Carbon Collector and Holder Profiles

All designs in grade BH424, SK85 and SK85S are available up to the length of 1,300 mm. Metal impregnated variants can be manufactured as an one-part-strip up to the length of 1,150 mm. If necessary a multiple-part-strip must be used. Other designs and special radiuses are available on customer request.

Sliding Strips – 3rd & 4th Rail

Modern METRO- and SUBWAY-Systems utilize 3rd Rail systems to satisfy the current supply. The power rails consist mostly of steel, bronze, or aluminum alloy materials. Typically the contacts are exposed to the following loads:

Requirement Profile

- mechanical impacts
- high starting and stopping currents
- high dust exposure

Compared to conventional current collection systems with metal contacts, carbon grades have the following advantages for those applications:

- careful treatment of power rail
- excellent sliding property
- minimal arcing
- low noise level
- reduced weight

Due to the high mechanical wear and tear, grades with a high density are preferably used. Dependent on the electrical loads, carbon, or metal-impregnated carbon, is utilized.

Application in Metro Systems

Guide-Line Values for Current Load – 3rd & 4th Rail

The 3rd Rail contact is a plane contact. Therefore the standard values are given as an area unit. The maximum permanent current-carrying capacity during operation is 10 A/cm² for plain carbon grades, for metal-impregnated versions 12 A/cm² and 15 A/cm² for the casted design.

Grades – Designs

Grades for 3rd & 4th Rail
Physical Properties

Grade	Type of Carbon Graphite Field of Application	Spec. El. Resis-tivity µΩm	Apparent Density g/cm³	Flexural Strength Mpa	Hardness Rockwell HR 5/150
BH424	Pure carbon graphite extruded	34	1.71	30	85
BH424C	= BH424 impregnated with metal for higher electr. & mech. load; LEAD FREE; extruded	5	2.18	50	110
BH25	Pure carbon graphite	40	1.55	45	115*
BH25C	= BH25 impregn. with metal for higher electr. load	10	2.50	70	120*
BH20C	Carbon graphite impregn. with bearing alloy. LEAD FREE. For diff. cond. and high load	10	2.70	80	120*
SK85	Pure carbon graphite; extruded	34	1.71	30	85
SK85CU	= SK85 impregnated with metal for higher electr. & mech. load; LEAD FREE; extruded	5	2.18	50	110
SK85CS	= SK85 impregn. with bear. alloy. LEAD FREE	10	2.22	55	120
SK95CS	= SK95 impregn. with bear. alloy. LEAD FREE	9	2.25	65	125
SK01CS	= SK01 impregnated with bearing alloy. LEAD FREE	9	2.25	50	120
Casted version					

*HR 5/40

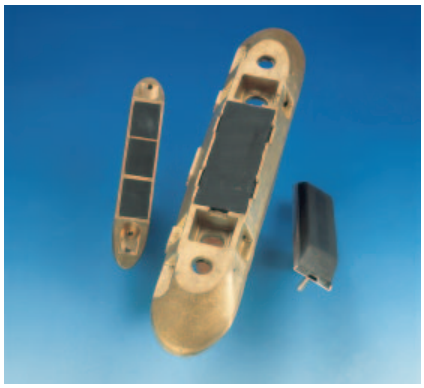
Designs

In one version the complete collector shoe consists of the carbon profile, which is mounted onto a carrier/socket, which preferably is made of zinc plated steel sheet metal or aluminum.
In another design carbon lubrication elements are casted with metals.

Schunk supplies three main versions:

- **design with metal end piece**
- **design as soldered version**
- **design as cast version**

Special designs are available on customer request.



Carbon Inserts – Trolley Pole Systems

With electrically operated busses the current transfer from the catenary to the vehicle is conducted by means of a current collector head, which is mounted to the end of a trolley pole. Contact with the catenary is achieved through a carbon insert, which is clamped exchangeable into a metalshoe.

Requirement Profile

- high service life
- high mechanical strength
- protection of catenary
- low noise level during operation
- proper contact in collector shoe
- safe current transfer
- operation under ice and hoarfrost conditions
- radio interference behaviour

Grades – Trolley Pole Carbon Inserts

Grade	Type of Material	Specific Electrical Resistivity µΩm	Bending Strength N/mm²	Rockwell Hardness HR 5/40	Bulk Density g/cm³	Remarks
BH25	Carbon graphite	40	45	115	1.55	standard grade, pressed to size capable for normal load
BH504Z4	Carbon graphite	40	33	115	1.65	extruded grade with special impregnation, excellent sliding ability at low humidity
BH304B	Carbon graphite metal impregnated	15	55	120	2.40	extruded grade, excellent sliding ability
BH25B	Carbon graphite metal impregnated	10	70	120	2.50	high loads, for poor catenary conditions
BH25C	Carbon graphite metal impregnated	10	70	120	2.50	highest load, for extreme weather conditions
BH20C	Carbon graphite metal impregnated	10	80	120	2.70	highest load, at high air pollution
BH20A	Carbon graphite metal impregnated	10	80	120	2.70	highest load, for poor catenary conditions
BH26D	Carbon graphite metal impregnated	7	80	120	2.60	highest load, for extreme weather conditions
SK95Z4	Carbon graphite metal impregnated	35	50	110	1.75	extruded grade with special impregnation, for bad catenary conditions

Grades – Current Load
Design Variations/Collector Shoe

Standard Values for Current Load – Trolley Inserts

Grade	max. Current Load per mm Contact Length
BH25, BH504Z4, SK95Z4F5	2.5 A
BH304B	3 – 4 A
BH25B, BH25C, BH20A, BH20C, BH26D	3 – 5 A

Design Variations

Schunk supplies carbon inserts in all of the above mentioned grades for all customary collector shoe designs.

The double-wedge-shaped insert proved itself again and again, due to its easy and safe installation and the great fit into the collector shoe.
By tailoring the insert to the cross sectional area of the catenary, an optimization of contact condition can be achieved.

Collector Shoe

In our own foundry Schunk is able to manufacture nearly all collector shoe designs employed worldwide.

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Qualitätsmanagement-Zertifikat

für

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BVQI bestätigt, dass das Management-System der oben genannten Organisation beurteilt wurde und die in den folgenden Normen und Regelwerken festgelegten Anforderungen erfüllt.

Standard

EN ISO 9001:2000

Anwendungsbereich

Entwicklung, Herstellung und Verkauf von Kohlebürsten, Montagetätigkeiten für die Automobilindustrie, Elektrographit- und Glasfaserprodukte für Automobil-, Eisenbahn- und Industrieanwendungen

Datum der Erstzertifizierung: 16.02.2004 (nach ISO 9001:2000)

Während der Gültigkeitsdauer dieses Zertifikates müssen die Anforderungen der Normen/Regelwerke kontinuierlich erfüllt werden, was durch regelmäßige Überwachung durch BVQI nachgewiesen wird.

Zertifizierungsdatum: 16.02.2004 Gültig bis: 16.02.2007

Über die Gültigkeit dieses Zertifikats wird BVQI auf Anfrage jederzeit Auskunft geben.
Weitere Auskünfte über das Managementsystem und den Anwendungsbereich sind über die Organisation selbst zu bekommen.

Datum: 19.05.2004

Zertifikatsnummer: 130318

BVQI (Austria) Ges.m.b.H.
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16.10e/2004

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