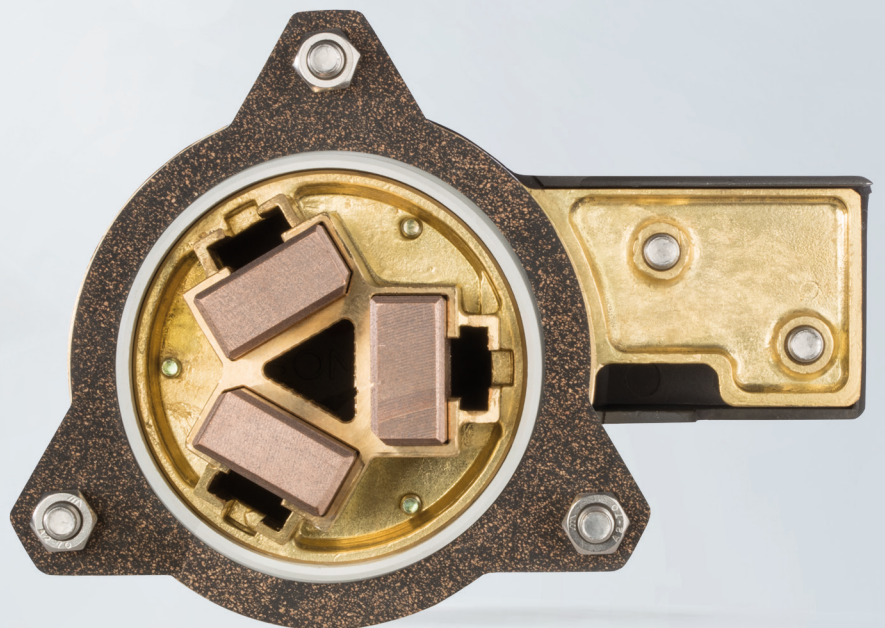




Schunk Carbon Technology

Field Manual

Wear and damage patterns
of carbon brushes in grounding contacts



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General information

Background

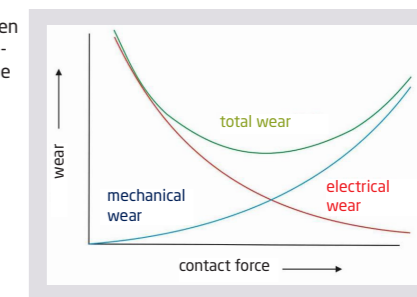
Schunk carbon brushes are used as reliable power transmission elements between fixed and rotating vehicle parts in numerous rail vehicles worldwide. As an integral part of grounding contacts, they ensure uninterrupted traction return current and safety grounding, which are essential for smooth vehicle operation. Due to the friction of the contact surface against the countersurface, as well as numerous environmental influences, carbon brushes are subject to wear and must be replaced at regular intervals. The specified intervals can be found in the relevant assembly and maintenance documentation for the grounding contact. They give reference to each specific design of carbon brush used and are based on the results of measurements as well as the experience gained from a variety of applications. Due to their properties and their positioning, carbon brushes are often an 'underestimated' indicator of a vehicle's operating conditions. Often, conclusions about factors such as vibrations can be drawn based on their condition.

Guidelines for forecasting brush wear

The large number of influencing factors mean an exact prediction of brush wear cannot be made. However, numerous measurement results and empirical values make it possible to provide reliable reference values for the most frequently selected contact pairings, as long as the grounding system is fully designed by Schunk (i.e. grounding contact, carbon brush and opposing body):

Contact	Axial	Radial
Brush material	C40Z3	C40Z3
Counterface material	copper/ bronze	stainless steel
Approx. wear per 100,000 km driving distance	2-3 mm	3-5 mm

The relationship between "electrical" and mechanical wear is shown in the following graph:



Influencing factors on brush wear and functionality of grounding contact system

The following factors can have an influence on the wear of carbon brushes, especially in terms of grounding contacts on rail vehicles. Schunk grounding contacts are designed on a project-specific basis.

Mechanical factors

- Vibrations, shocks and collisions
- Design, parallelism and condition of the countersurface material's contact surface
- Foreign bodies, dirt particles, dust, sand etc.
- Contact pressure from the brush pressure device

Electrical factors

- Current density (overload/underload)
- Current peaks, short circuit
- Frequency

Other factors

- Contamination of the contact area with foreign bodies
 - Water and moisture
 - Oil, grease, lubricants, silicone etc.
- Air humidity
- Temperature
- Incorrect assembly of brush, brush flexes, pressure device etc.
- Material combination of carbon brush and contact surface

Note on wear patterns and existing wear

In order to limit the effects of the numerous influencing factors as far as possible, the instructions in the respective product documentation must be followed.

The following notes should be understood as a supplement to the statements in the respective product documentation. In case of doubt, the assembly and maintenance instructions should be observed.

Your contact for our grounding systems:



✉ grounding-transit@schunk-group.com

Condition and pictures of damage with remedial measures

01 Contact space

- The general condition of the contact space (i.e. the area within the grounding contact, as well as between the carbon brush and the opposing body) allows direct conclusions to be drawn about the function of the grounding system. A dry contact space without traces of oil or other residues is essential for proper operation.
- Brush abrasion sediment accumulates in cavities within the grounding contact housing and must be removed at regular intervals, no later than every brush change, as specified in the product documentation.
- Brush abrasion sediment should be dusty (very fine-grain) and dry.
- The carbon brush must be able to run freely in the designated brush shaft of the grounding contact and not jam.

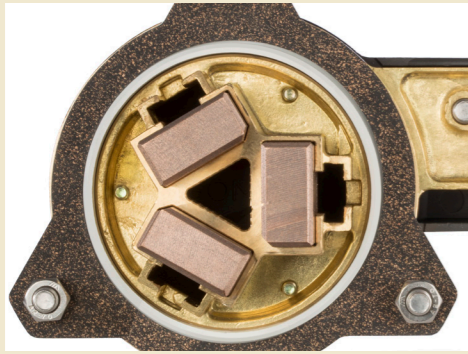


- The brush flexes must be able to follow the descending brush body unhindered with progressive wear.
- In general: Any contamination of the contact space with substances such as silicone, contrasting agent from axle investigations, grease, oil, lubricants etc. can lead to massive impairment or even failure of the grounding contact system.
- Any mechanical alteration to the brush body or the brush guide is not permitted under any circumstances and will result in the immediate cancellation of any warranty claims.

Example	Condition	Possible cause	Measure
	▸ Immaculate contact space with good brush condition and light amount of dust	—	—
	▸ Corrosion of holder and carbon brush	<ul style="list-style-type: none"> ▸ Damaged gasket ▸ improper maintenance with high-pressure cleaner or aggressive cleaning agents 	<ul style="list-style-type: none"> ▸ Replace gasket ▸ Do not clean grounding contact with high-pressure cleaner

Example	Condition	Possible cause	Measure
	<ul style="list-style-type: none"> ▸ Contact space filled with oil, and lump build-up ▸ Large amount of dust 	<ul style="list-style-type: none"> ▸ Contact space contaminated by oil or bearing grease from wheel bearing ▸ Maintenance measures (e.g. axle inspection) ▸ Brush dust not removed when changing the brushes 	<ul style="list-style-type: none"> ▸ Stop source of contamination ▸ Clean contact space ▸ Replace carbon brushes ▸ Remove brush dust according to product documentation
			
			
	▸ Carbon brush stuck in brush shaft	▸ Foreign substances and brush abrasion sediment lead to deposits building up between the brush and the brush shaft	<ul style="list-style-type: none"> ▸ Stop source of contamination ▸ Clean contact space ▸ Replace carbon brushes

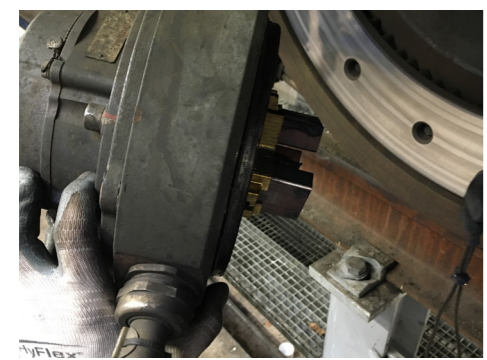
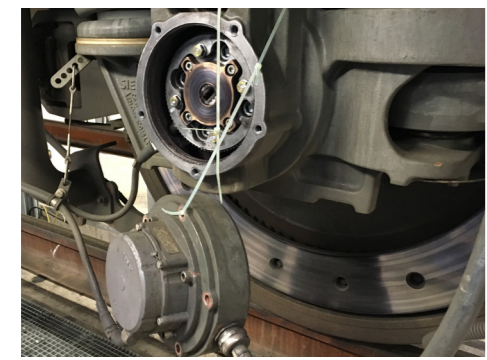
02 Brush bodies

- The brush body is the lower part of the carbon brush, which wears due to the friction against the opposing body. The contact surface is also referred to as the tread.
- The minimum length of the brush body is defined on the technical drawing of the carbon brush. In some designs, it also given with a marking on the brush body.
- As well as regular brush abrasion, under certain operating conditions, other forms of wear and damage can occur to the brush body. Abrasion marks, chipping and discolouration are a clear indication of an issue.

Example	Condition	Possible cause	Measure
	▫ New carbon brush (on delivery, the carbon brush is enclosed loosely with the grounding contact. As a rule, the brush is inserted after the contact disc and brush guide have been installed on the end of axle or gear housing.)	—	—
	▫ Worn carbon brush with proper contact surface	▫ Normal operating conditions	▫ Replace the carbon brush upon reaching the minimum length given in the product documentation
	▫ Abrasion marks on the side of the brush body	▫ Large amount of vibration during operation	▫ Find and turn off cause of vibration ▫ Replace carbon brushes

Example	Condition	Possible cause	Measure
 	▫ Chipping on the tread of the carbon brush	▫ Large amount of vibration during operation ▫ Improper assembly of the grounding contact	▫ Find and turn off cause of vibration ▫ Replace carbon brushes ▫ Do not install grounding contact with preassembled carbon brushes, but first attach grounding contact to the axle end according to the product documentation and then install carbon brushes
	▫ Incorporation of spring into the head of the carbon brush	▫ Large amount of vibration during operation	▫ Find and turn off cause of vibration ▫ Replace carbon brushes
	▫ Significant abrasion marks on the side surfaces ▫ Mechanical wear to brush body	▫ Extreme vibrations	▫ Find and turn off cause of vibration ▫ Replace carbon brush
	▫ Matt brush tread	▫ Impact of oil or grease	▫ Find and stop cause of contamination



Example	Condition	Possible cause	Measure
	<ul style="list-style-type: none"> Uneven wear to carbon brushes within a grounding contact, or within a vehicle 	<ul style="list-style-type: none"> Current selectivity within the vehicle grounding system (e.g. from different contact resistances) Mixed assembly of different brush materials some brushes are stuck/not free to move Different current load on motor and trailer bogies Largely power-less operation of carbon brushes that only carry power in the event of a fault 	<ul style="list-style-type: none"> Avoid mixing different brush materials Check and ensure free movement and function of all brushes and pressure devices If unsure about current selectivity, measuring runs can be used to determine the current distribution (measurement on the main power cable before each grounding contact)


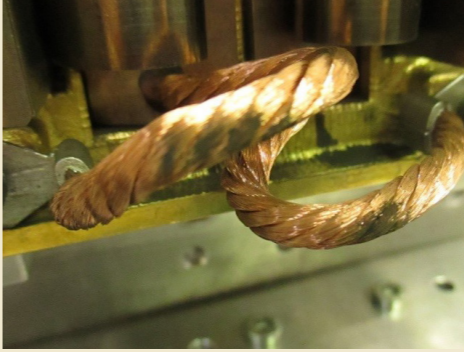

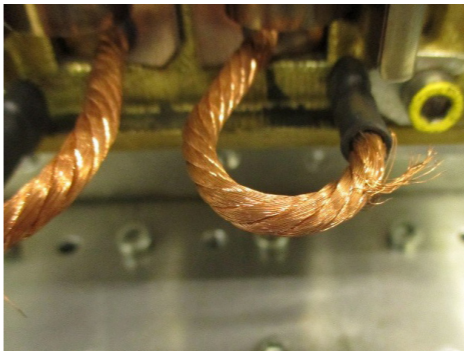



<ul style="list-style-type: none"> Improper maintenance of grounding contact 	<ul style="list-style-type: none"> Complete disassembly and reassembly with built-in carbon brushes can lead to problems during operation Chipping on the tread of the carbon brush, jamming and abrasion of the brush cords and jamming of the carbon brush may be the result of improper installation 	<ul style="list-style-type: none"> Observe the specified sequence of assembly: Screw the grounding contact housing or brush guide to the end of the axle before replacing carbon brushes and pressure devices and closing the cover
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03 Brush flexes

- Brush flexes are made from twisted or braided copper strands. The cross section is designed according to the current density. Cable lugs on the strands constitute the interface to the connection points in the grounding contact. The brush flexes should be free from damage to ensure unobstructed power transmission.
- Connecting the brush flexes and brush body is usually carried out by tamping the cable into the brush body, ensuring a low-impedance connection with sufficiently high strength.
- The above-mentioned influencing factors (see page 02) can also damage the brush flexes. After a certain degree of damage, the carbon brush must be replaced to ensure safe operation. Carbon brushes with heavily frayed or discoloured brush flexes should no longer be used.
- In demanding conditions (e.g. very high speeds, large amounts of vibrations, poor track conditions) carbon brushes with reinforced brush flexes can be used.
- Slight abrasion marks on brush cords be caused by friction on the inside of the grounding contact cover. During assembly, as well as when changing brushes, make sure that the brush flexes are moved slightly to the side, so that their movement is not affected by the cover or the constant force spring.

Example	Condition	Possible cause	Measure
	<ul style="list-style-type: none"> New brush flexes attached by tamping contact in the brush body 	—	—
	<ul style="list-style-type: none"> Reinforced brush flexes can be used under extreme conditions (vibrations) to reduce wear on the brush cords. However, stopping the cause of abrasion should be the preferred measure 	—	—

Example	Condition	Possible cause	Measure
	<ul style="list-style-type: none"> Brush flexes and/or inside of cover with abrasion marks 	<ul style="list-style-type: none"> When carbon brushes are new, there is some contact between the brush flexes of some grounding contacts with the inside of the cover 	<ul style="list-style-type: none"> Slight abrasion marks on brush flexes and inside cover are not a problem Bend brush cords slightly to the side during assembly/inspection so that they are not obstructed by the constant force spring or cover
			
			
	<ul style="list-style-type: none"> Slight fraying of brush cords 	<ul style="list-style-type: none"> When there is a large amount of vibrations, brush cables rub against the sharp edges of the pressure device 	<ul style="list-style-type: none"> Find and turn off cause of vibration Ensure brush cords are free to move Fraying and damage to some strands is not critical, as long as only individual strands and not whole 'bundles' are separated If required, shorten the maintenance interval for checks

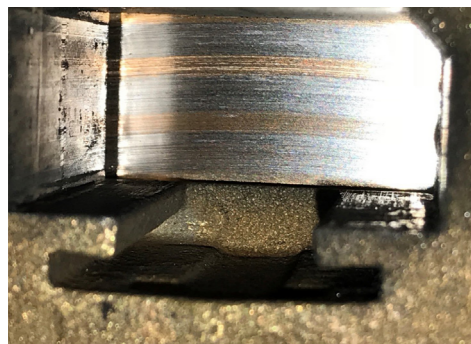
Example	Condition	Possible cause	Measure
	<ul style="list-style-type: none"> Significant damage to brush flexes 	<ul style="list-style-type: none"> Very large amount of vibrations Brush cables rub against the sharp edges of the pressure device 	<ul style="list-style-type: none"> Find and turn off cause of vibration Replace carbon brush and ensure brush flexes are free to move
	<ul style="list-style-type: none"> Broken cable lug 	<ul style="list-style-type: none"> Very large amount of vibrations Incorrect assembly 	<ul style="list-style-type: none"> Find and turn off cause of vibration Replace carbon brush Mount according to product documentation
	<ul style="list-style-type: none"> Tamping contact broken off 	<ul style="list-style-type: none"> Very large amount of vibrations Improper handling 	<ul style="list-style-type: none"> Find and turn off cause of vibration Replace carbon brush Mount according to product documentation
	<ul style="list-style-type: none"> Discolouration of brush flexes 	<ul style="list-style-type: none"> (Too) high current load 	<p>Check:</p> <ul style="list-style-type: none"> Are other grounding contacts on the vehicle damaged or impaired? Has the cross-section of the brush flexes been reduced? Is the current load of the vehicle too high for the number of carbon brushes? Is there a fault (e.g. short circuit)? Stop cause and replace carbon brushes

04 Pressure device

▫ The pressure device refers to the spring assembly which is required for constant contact pressure between the carbon brush and the contact disc / slip ring. The spring element is usually designed as a single or double-layered constant force spring. Their travel is designed to ensure the required contact pressure over the entire wear length of the carbon brush.

▫ The contact pressure of the carbon brush on the contact surface is given in cN/cm^2 . Spring pressure is set by the manufacturer and cannot be changed.
 ▫ Pressure devices may have a different maintenance interval to carbon brushes. However, they must be visually inspected each time the brush is changed and replaced immediately if damaged.

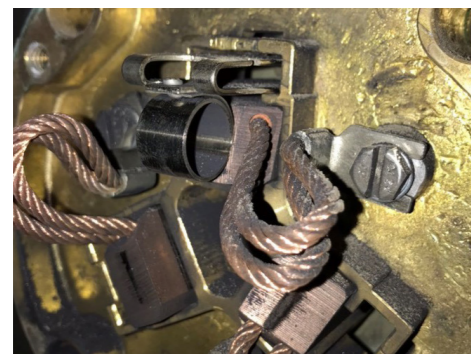
Example	Condition	Possible cause	Measure
	▫ Pressure device with constant force spring in perfect condition	—	—



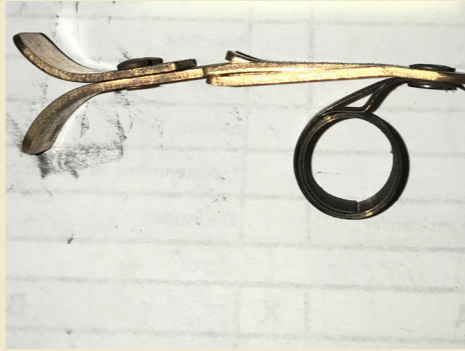


▫ Uneven wear pattern
 ▫ Carbon brush sticking

▫ Pressure device incorrectly mounted

▫ Correctly mount pressure device



*Attention: This image shows a pressure device that is mounted incorrectly (upside down).

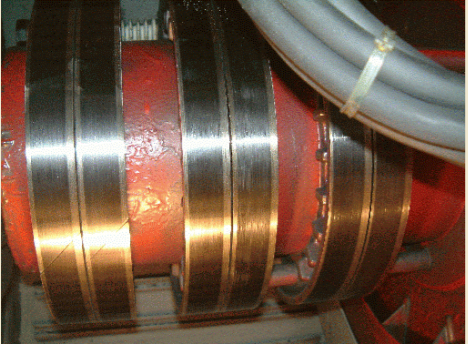

Example	Condition	Possible cause	Measure
	▫ Kink in the spring ▫ Broken spring	▫ Improper handling or assembly ▫ High mechanical load from shocks and vibrations ▫ Maintenance interval for pressure device exceeded	▫ Find and turn off cause of vibration ▫ Replace pressure device
	▫ Spring windings are apart	▫ High mechanical load from shocks and vibrations ▫ Maintenance interval for pressure device exceeded	▫ Find and turn off cause of vibration ▫ Replace pressure device
			

05 Counterface material

- Depending on the application of the grounding contact, the opposing friction contact surface for the carbon brush is designed as either a slip ring (radial contact) or as a contact disc (axial contact). Schunk grounding contacts usually use stainless steel, bronze or copper for counterface material.
- An important indicator of a correctly designed contact system as well as good operating conditions, is the formation of a continuous contact layer (= patina) on the contact disc or slip ring surface. The patina forms during

the running-in phase of the carbon brush and acts as a sliding layer. If removed, brush wear increases.

- Metallic slip rings and contact discs are maintenance-free under normal operating conditions. If there is scoring, a high level of mechanical abrasion or no patina is formed, there is a problem and the cause should be found and remedied before the opposing body is overhauled or replaced (see influencing factors).

Example	Condition	Possible cause	Measure
	Perfect contact surface with patina	—	—
	Contact disc / slip ring with bare contact surface	<ul style="list-style-type: none"> Contact disc in delivery condition (new) Grounding contact is running (nearly) currentless 	<ul style="list-style-type: none"> Wait until the end of the running-in phase of the carbon brushes (approx. 10,000 km) Uneven/insufficient formation of the patina is normal during currentless operation (e.g. if the grounding contact is only present for safety grounding in the event of a fault)

Example	Condition	Possible cause	Measure
 	Light scoring on the contact surface	Foreign body in the contact area (sand, dirt)	Clean contact space
	Heavy scoring	<ul style="list-style-type: none"> Foreign body in the contact area (sand, dirt) Too high temperature, e.g. as a result of very high current load 	<ul style="list-style-type: none"> Clean contact space Check for discolouration of carbon brushes If necessary, switch off cause of excess temperature and replace carbon brushes Rework or replace slip ring/contact disc upon consultation with Schunk (!)
	Uneven slip pattern	<ul style="list-style-type: none"> Screwing surface of the grounding contact and contact disc do not run in parallel Incorrect assembly of contact disc 	<ul style="list-style-type: none"> Ensure that the contact disc is resting on the axle end Ensure that the contact disc and screwing surface of the grounding contact are running in parallel

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