Expertise, our source of energy

TRANSPORTATION

CURRENT COLLECTION TECHNICAL GUIDE

- Contact strips
- 3rd rail shoes

CONTENTS

01

WHAT IS CURRENT COLLECTION?

Electric locomotives, metros and tramways need electric power to move. **Power transfer has to be safe and reliable,** both in stationary mode for auxiliary power and for motive power when moving.

Transmission of power is done by either an overhead wire or by rails at ground level.

AC systems always use overhead wires, DC systems can use either an overhead wire or a third rail.

THERE ARE 2 TYPES OF CURRENT COLLECTORS:

Pantograph Systems

- Railways (electric locomotives, Electrical Multiple Units)
- Transit systems (light rail, tramways, some metros)

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Third or Fourth Rail Systems

- Transit systems (metros, light rail, automated light vehicles)
- Monorail (UK)

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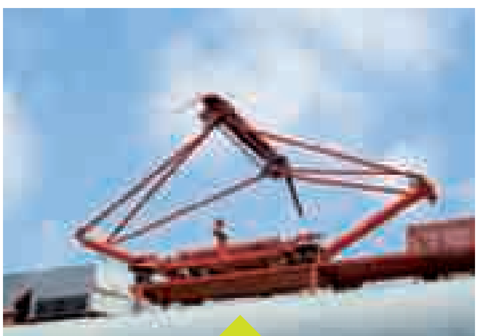
02 CURRENT COLLECTION USING PANTOGRAPH SYSTEMS

The electricity required to power the electric traction motors is collected by means of a pantograph running on a catenary.

A catenary is a system of overhead wires used to supply electricity to an electric unit, such as an electric locomotive or an Electrical Multiple Unit (EMU), which is equipped with a pantograph.

A pantograph is a system of articulated arms fixed on the roof of the locomotive. It unfolds and extends along a vertical axis. Its role is to transfer power from the contact line to the electric traction unit. The principal components of a pantograph are a main frame, an arm, a pantograph head and a drive.

Single arm pantograph



Double arm pantograph

There are two types of pantographs: single arm and double arm.

The most common type of pantograph today is **the single arm pantograph** (sometimes called 'Z'-shaped), which has evolved to provide a more compact and responsive design at high speeds.

The single arm pantograph is used on everything from low-speed urban tram systems to very fast trains (such as the TGV).

The pantograph typically connects to a one-wire or two-wire system, with the track acting as ground return.

Current is collected via **contact strips** mounted on the pantograph head. Their number and type depend on the type and intensity of the current to be transmitted, as well as the condition of the catenary.

The contact strips have to be selected and designed in accordance with the requirements of current transfer both when the vehicle is running and at standstill.

GRADE SELECTION FOR OVERHEAD CURRENT COLLECTION

VOLTAGE FAMILIES

High Voltage AC

- 25 kV @ 50 or 60 Hz
- 15 kV @ 16.7 Hz

	High speed	Standard
Power of locomotive	8-20 MW	4-10 MW

Mainly pure carbon grades will be used
Impregnated grades can be used on poor quality catenary systems.

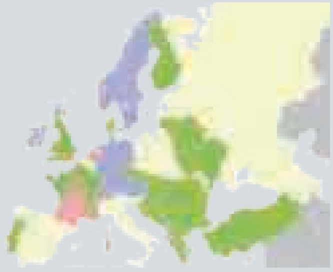
Low Voltage DC

- 3.0 kV
- 1.5 kV

	High speed	Standard
Power of locomotive	8-12 MW	3-4 MW

Metal-graphite or metal-impregnated grades will be used
Some older, heavy freight locomotives use pure copper strips which are gradually being replaced by metal impregnated carbon.

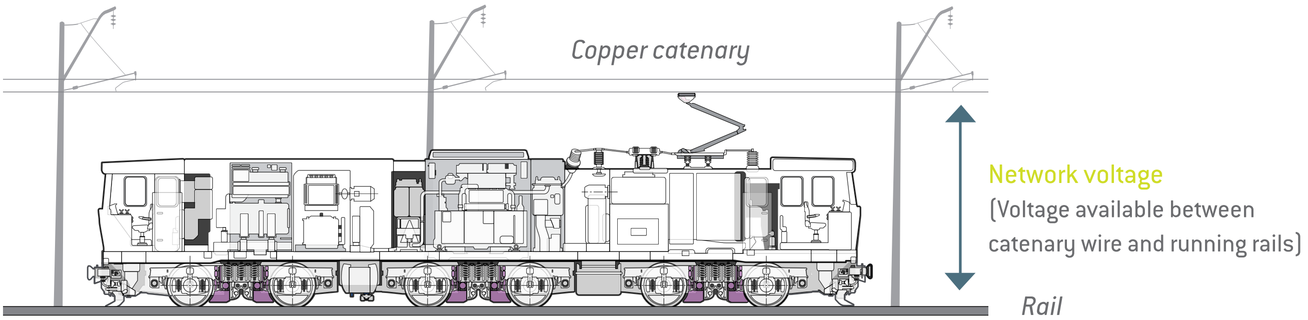
Example of the distribution of the two voltage families in Europe:



High Voltage AC
- 25 kV AC
- 15 kV AC

Low Voltage DC
- 3 kV DC
- 1.5 kV DC
- 750 V DC

- 1.5 kV + 25kV



HOW TO SELECT THE CORRECT GRADE FOR A CARBON STRIP?

1 The first parameter to consider is the current to be collected

The current to be collected depends on locomotive power and network voltage.

$$\text{Current to be collected (A)} = \frac{\text{Power of the locomotive (W)}}{\text{Network Voltage (V)}}$$

When voltage is low, current is high

The power of the locomotive is a fixed value, therefore:

- Higher voltage will mean lower current
- Lower voltage will mean higher current

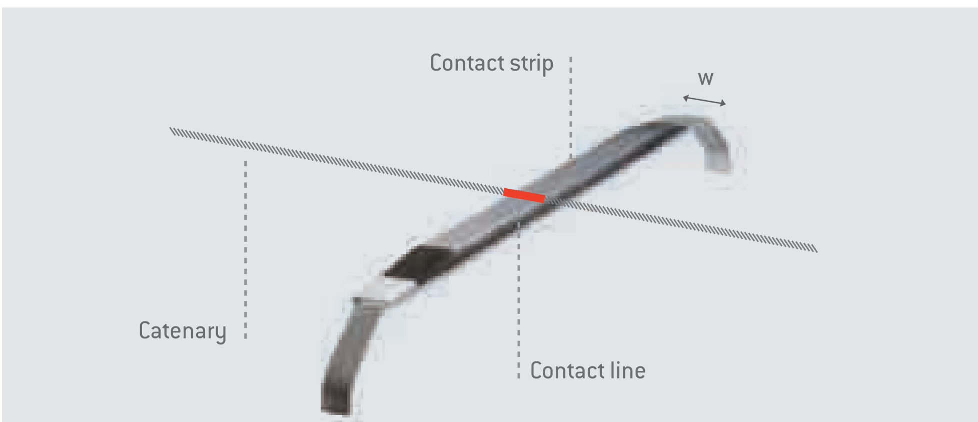
Either we calculate current to be collected using above formula, or in most cases this value is given in the specifications supplied by the customer.

Current is one of the parameters used to calculate the operating linear current density (j).

The value to be considered is the current collected by each pantograph (I_p), meaning it is necessary to divide the current by the number of active pantographs.

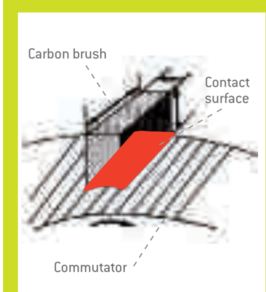
2 The key parameter for grade selection is the operating linear current density (j)

The operating linear current density (j) is the current flowing through the contact line between the contact strip and the catenary.
It is expressed in A/mm.



TO BE NOTED!

For a carbon brush however, we consider the current density in A/cm^2



HOW TO SELECT THE CORRECT GRADE FOR A CARBON STRIP?

A key parameter for grade selection, the operating linear current density j per contact strip:

Calculation of j for your specific situation

j is calculated by the following formula:

$$j = \frac{n}{k} \times \frac{I_p}{w}$$

j	Permanent linear current density for the strip (A/mm)
n	Current distribution factor n = 1 if 1 strip per pantograph n = 0.6 if 2 strips per pantograph n = 0.4 if 3 strips per pantograph n = 0.3 if 4 strips per pantograph
k	Catenary factor k = 1 if single catenary k = 1.5 if double catenary
I_p	Permanent running current per pantograph (A)
w	Width of the strip (mm)

The current distribution factor is used to adjust the current distribution between several strips which are mounted on the same pantograph. The first strip gets more current than the others and we have to choose the grade according to this unfavorable situation. For example, with 2 strips, the first one gets 60% of the total current on the pantograph.

3 The last parameter to consider is current at standstill

After pre-selection of a grade meeting the above j criterion, the grade choice has to be confirmed or adjusted depending on the standstill conditions.

Standstill current is network specific, it depends on the force applied on the contact strip, on the maximum temperature allowed by the network operator... (for more info about the need for low temperature please refer to page 9 of present guide).

Mersen submits its grades to current collection tests at standstill, the data obtained is available from table on page 8.

You can send an email to **info.ptt@mersen.com** to request our complete technical data sheets.

MERSEN GRADES FOR OVERHEAD CURRENT COLLECTION

Each carbon grade was created to withstand a maximum operating linear current density. To select the right grade, one has to consider the permanent linear current density (j), and choose a grade with a j_{max} value at least equal to j.

Recommended j_{max} values for each Mersen grade are tabulated below (Column "Maximum operating linear current density").

Mersen has developed a wide range of carbon grades to meet even the most demanding operating conditions. We recommend that our customers contact our Customer Technical Assistance to correctly select the most suitable grade.

The table below details the main characteristics[1] of our 4 most popular carbon grades.

GRADE	Description	j_{max} Maximum operating linear current density [2] A/mm	Relative density *According to IEC60413*	Electrical resistivity μΩ.m *According to IEC60413*	Flexural strength MPa *According to IEC60413*	Charpy resilience kJ/m² *According to ISO179-1*
AR129	Plain carbon	6	1.70	30.0	30	0.8
P5696	Metal impregnated (22% Cu)	12	2.25	6.0	70	1.2
P2805	Metal-impregnated (28% Cu)	19	2.40	3.5	70	2.2
P3210	Metal-impregnated (32% Cu)	22	2.50	2.2	85	2.5

1 Indicative values

2 Above values were identified by subjecting the materials to a carbon-carrier interface temperature of 160°C (320°F)

Our Customer Technical Assistance Service is at your disposal for any questions.

E-mail: info.ptt@mersen.com

WHY IS THERE A LIMIT TO COPPER CONTENT?

The copper content is limited by customers' technical constraints:

- The maximum contact strip weight to ensure pantograph dynamic stability and minimal arcing
- The maximum temperature at standstill conditions (see hereafter why low temperature is required)

These two requirements are contradictory

To limit the weight of the contact strip, the **density** of the impregnated carbon must be **low**

➡ **Low copper content rate**

To limit the temperature of the catenary, the **resistivity** of the impregnated carbon must be **low**

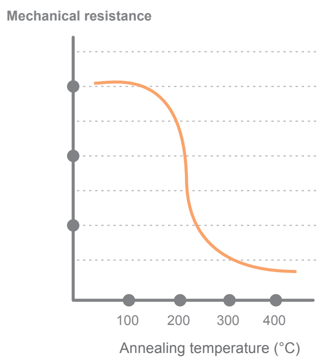
➡ **High copper content rate**

WHY THE NEED FOR LOW TEMPERATURE?

Because it influences the mechanical resistance of the catenary

- The most common material used for catenaries is CuA1 (Electrolytic copper)
- Its mechanical strength is halved at temperatures over 200°C (392°F) (see Figure opposite)

➡ **Risk of catenary rupture**



The most difficult thermal conditions are at standstill for auxiliary power (air-conditioning, light, ventilation, heating, etc)

The standard requirement for overhead line temperature heating at standstill is generally 110°C (230°F) maximum *

* Can vary depending on customer's specifications

CONTACT STRIP DESIGNS

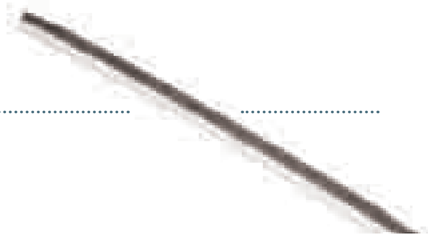
A contact strip consists of a carbon or metal profile mounted on a supporting carrier.

The carrier's role is to support the carbon strip mechanically, to resist deflection and to conduct the current. The carrier can be made of aluminium, galvanised steel or copper to resist atmospheric attack and impact damage.

SOLDERED CARBON STRIP

- Copper electrolytic treatment to facilitate soldering

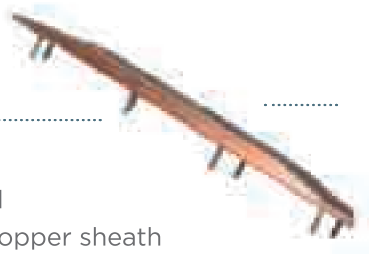
BONDED CARBON STRIP



- Various light-metal (aluminium) profiles
- Corrosion-resistant
- Copper-coating

KASPEROWSKI DESIGN CONTACT STRIP

(also called copper clad contact strip)



- Carrier material: copper
- Assembly: the carbon strip is braised and crimped
- Current transmission is through the carbon strip copper sheath
- Carbon serves as a lubricant
- High mechanical and electrical demands

CARBON STRIP WITH INTEGRATED HORN

- Easy installation and disassembly

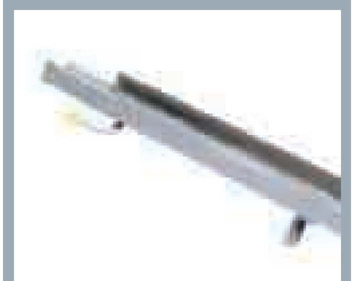
CARBON STRIP FOR AUTOMATIC DROPPING DEVICE (ADD) SYSTEM

- Adaptable to the majority of carbon strips
- Impact and/or wear detection

TO BE NOTED!

Our current collection bonded strips are DIN6701 certified (German standard specific to the adhesive bonding of components used on rail vehicles).

Contact strip for ADD system



This device enables the pantograph to be lowered if an impact severe enough to damage the pantograph head was to occur.

The pantograph head is kept in place against the overhead wire by pneumatic pressure. When the carbon strip wears down to a particular level or is severely damaged, the air pressure is lost and the pantograph head drops away from the wire, preventing further damage.

CONTACT STRIP SERVICE LIFE TIME

The wear of the contact strips is influenced by three factors:
- Electrical (wear is mostly electrical)
- Mechanical
- Environmental

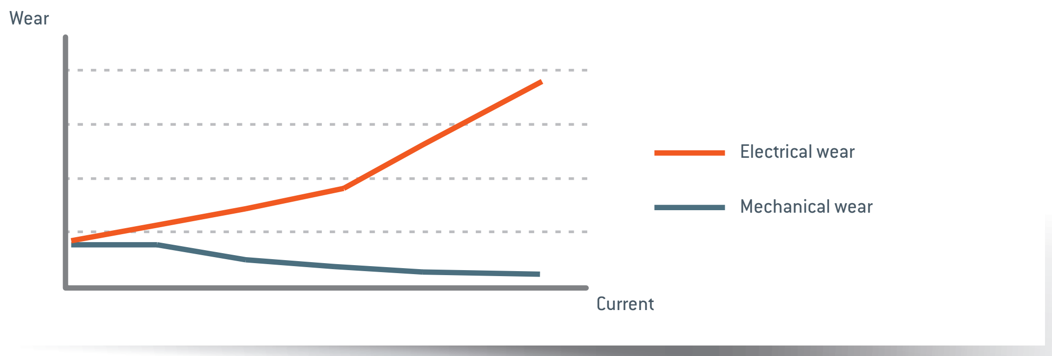
Life time can also be influenced by:
- Pantograph and pantograph head design
- Contact strip design

Electrical factors

- Current load
- Brake current feeding back

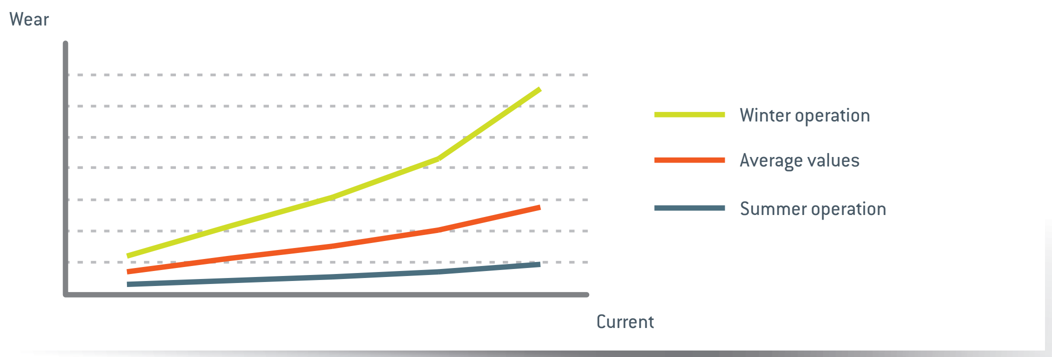
Mechanical factors

- Speed of the vehicle
- Pressure
- Catenary pitch
- Condition of the catenary wire
- Construction of rail foundation
- Mixed operation with metal strips



Environmental factors

- Environment (ambient temperature, humidity, ice / hoarfrost, salt fog, etc)



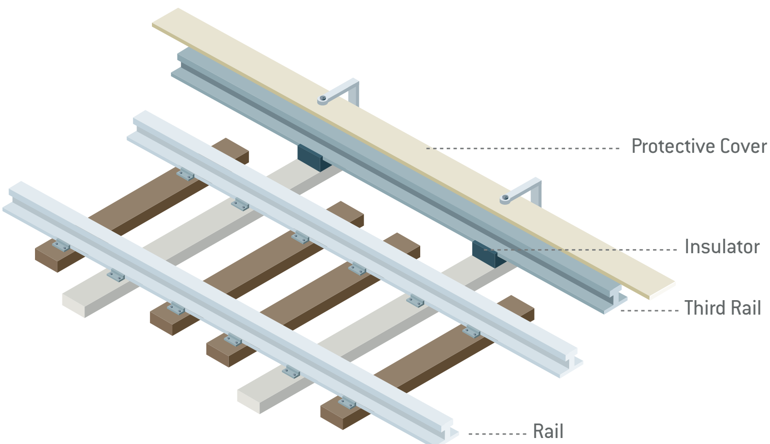
03 CURRENT COLLECTION USING THIRD OR FOURTH RAIL

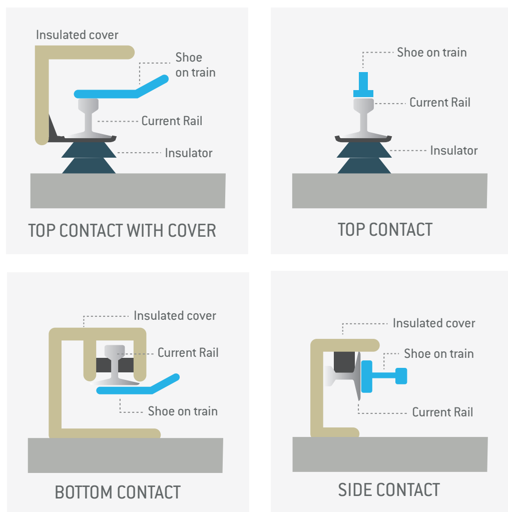
Third Rail

A third rail is a method of providing electrical power to a railway train, through a semi-continuous rigid conductor placed alongside or between the rails of a railway track.

It is used typically in mass transit or rapid transit systems.
Thanks to its large cross-section, the third rail can transmit high currents. It is used when an overhead wire cannot be installed.
Third rails are more compact than overhead wires and can be used in smaller-diameter tunnels, an important factor for subway systems.
Third rail systems can be designed to use top contact, bottom contact or side contact (see picture below).

Current is collected via a positive shoe in contact with the third rail and is returned to ground by a contact between the steel wheel and the running rail. Axle earthing devices are required.





Fourth Rail

The London Underground (UK) is one of the few networks that use a four-rail system.

Current is collected via the positive shoe in contact with the third rail and is returned to ground via a negative shoe in contact with the fourth rail.

Some systems also have a grounding shoe that does not carry current but is used to ensure that the unit is at the same voltage as the ground.

Ground-level power supply

It is a modern method of third-rail electrical pick-up for street trams.
The third rail is constructed in short sections and each section is energised only as the train passes over each section. Therefore, the rail has no voltage and is safe for pedestrians and animals.

CHARACTERISTICS OF CURRENT COLLECTION DEVICE (CCD) SHOES (also called 3rd or 4th rail shoes)

LINKED TO THE FOLLOWING APPLICATION CHARACTERISTICS...

- Frequent stops
- Frequent acceleration and deceleration
- Multiple regenerative braking
- High dust exposure

... CCD SHOES HAVE TO SATISFY 4 MAJOR CRITERIA:

- Resistance to mechanical impact
- Ability to withstand high starting and stopping current loads
- Good sliding properties
- Non-destructive to the power rail

MERSEN GRADES FOR CCD SHOES

GRADE	Description	Relative density *According to IEC60413*	Electrical resistivity µΩ.m *According to IEC60413*	Flexural strength MPa *According to IEC60413*	Charpy resilience kJ/m² *According to ISO179-1*
AR129	Plain carbon	1.70	30.0	30	0.8
P6252	Metal-impregnated (22% Cu)	2.25	6.0	70	1.2

Indicative values

Send an email to info.ptt@mersen.com to request our complete technical data sheets.

CCD SHOE DESIGNS

A CCD shoe consists of a carbon part mounted on a supporting carrier.
The carrier's role is to protect the carbon collector from impacts, to resist deflection and to conduct the current.
The carrier can be made of aluminium, stainless steel or copper.

DESIGN WITH METAL END PIECE

- Assembly: metal end pieces
- Application: fitted to a new system to create a film or to a rail in bad condition to clean its surface with the bronze contact.

DESIGN AS SOLDERED VERSION

- Assembly: clamped, soldered
- Application: all networks

DESIGN AS CAST VERSION

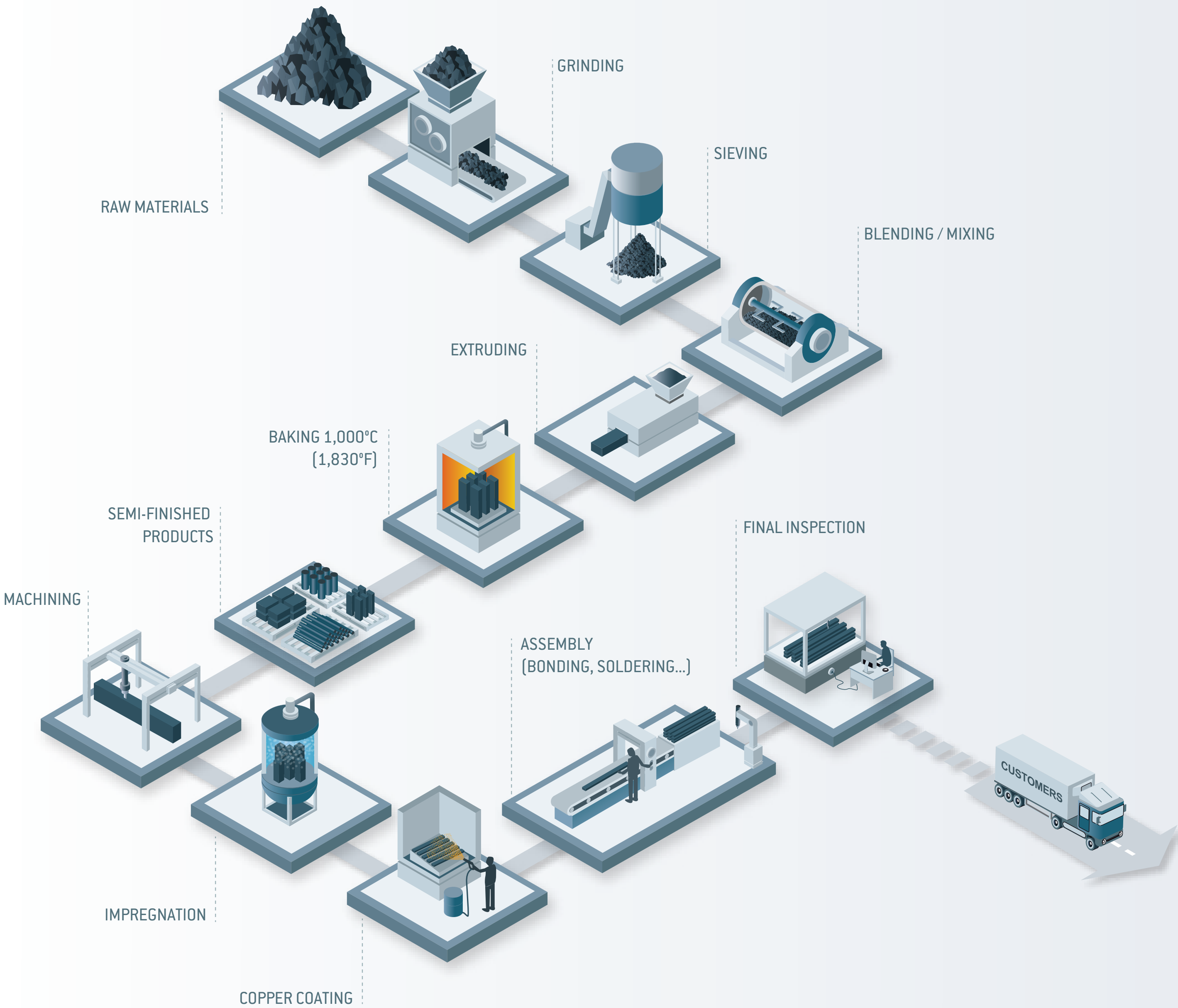
- Assembly: carbon inserts cast in place
- Application: new rail in order to create a patina or rail in bad condition to clean its surface by bronze contact

Winner of the innovation trophy

EcoDesign

- Assembly: clipped
- Application: all networks
- Replacement of the carbon wear strip only
- No more corrosion of the carrier and bolts
- Excellent resistance to shock, vibrations and mechanical stress

OVERVIEW OF CURRENT COLLECTION GRADE MANUFACTURE



THE ADVANTAGES OF CARBON FOR CURRENT COLLECTION

Steel, cast-iron, copper or bronze shoes on third rail collection systems mechanically damage the rail due to their relatively high mass.

Carbon has many advantages over metallic materials, and the benefits to user systems are numerous. As a consequence, more and more railway, third rail and tramway/trolleybus systems have changed to carbon throughout the world.

THE ADVANTAGES OF CARBON FOR PANTOGRAPH AND THIRD RAIL COLLECTION SYSTEMS

Friction behaviour and Self-lubrication

- Elimination or reduction of greasing
- Longer wire and rail life time thanks to proper film creation
- Carbon skin provides the 3rd rail with a de-icing capability
- Maintenance cost reduction

Very low sparking

- Arcing reduction
- Reduced burn or spark damage
- Prevention of radio interference

Weight reduction

- Stable contact
- Better current collection

Resistance

- To high temperatures: no tendency to weld, even after long periods of static current loading
- To thermal shocks
- To chemical attack

Others

- Good electrical and thermal conductivity
- Ability to operate at high speeds (300 km/h / 190 miles/h and more)
- Negligible audible noise between rubbing surfaces
- Recognised corrosion-proof characteristics

MAJOR FACTORS INFLUENCING THE PERFORMANCE OF CONTACT STRIPS OR CCD SHOES

1 CURRENT OVERLOAD

The technical data sheets of our carbon grades provide information of maximum linear current (j_{max}) recommended per carbon strip. This current can be exceeded for a short period of time. Extended periods at current overloads can create technical issues. Standstill current is generally a limiting factor for a grade.

2 CONTACT PRESSURE

Contact pressure is determined by the pantograph specifications and needs to be checked regularly.

- Low contact pressure can produce overheating, sparking, and as a consequence high contact strip wear.
- High contact pressure may result in mechanical damage and high wear of the carbon strip.

3 CONTACT STRIP WEIGHT

The pan head weight is determined by the pantograph manufacturer. Low mass is essential for good contact between the contact strip and overhead wire. In case of too heavy a pan head, the contact will be unstable, reducing the life time of the strip.

4 CARBON SECTION

Too small a carbon section can result in electrical difficulties in carrying the current. On the other hand the mass of the carbon strip could be an issue requiring a reduced section.

5 POOR STRIP ASSEMBLY

Poor assembly quality can result in poor electrical contact, so overheating, or possible detachment of the carbon from the carrier.

6 MIXED MATERIALS

We do not recommend mixing different carbon grades or to mix carbon and metal grades on the same pan head or on electrically connected pantographs. It is also not recommended to mix grades from different manufacturers, as the mechanical and electrical material properties are different.

7 WEATHER CONDITIONS

Contact strips must withstand a wide range of environmental conditions. Performance and life time are influenced by the prevailing weather. For example ice formation on overhead lines or third rail surfaces may result in intermittent contact and consequent arc damage. Mersen offers special winter strip designs to tolerate such extreme conditions.

8 NETWORK CONDITIONS

The catenary wire condition and the lack of maintenance affect the contact quality between the contact strip and the wire. For example, high roughness wire will increase the wear of the carbon and can even cause mechanical damage. The use of metal strips can exaggerate the roughness of the catenary wire.

9 POOR WIRE STAGGER

Uneven wear along the strip or grooving could be a result of poor wire stagger. Once the grooving occurs on the carbon, the wire movement becomes limited, exposing the wire to mechanical damage.

TYPICAL EXAMPLES OF CONTACT STRIPS IN SERVICE

Marking type	Homogeneous surface, shiny, some porosity and wear streaks	Burnt carbon surface ● Current overload for a long period ● Arc damage Check the grade characteristics for operating and standstill current capabilities. See “Major factors influencing the performance of contact strips or CCD shoes / Current overload” on previous page	Mechanical damage or loss of the carbon strip ● Mechanical impact ● Contact pressure ● Weather conditions ● Wire condition ● Fixing method ● Poor assembly ● High temperature Determine the reason for the carbon strip damage and propose an adapted solution. See “Major factors influencing the performance of contact strips or CCD shoes” on previous page
Marking not adversely affecting the strip in operation	 		
Marking adversely affecting the strip in operation			

TYPICAL EXAMPLES OF CONTACT STRIPS IN SERVICE

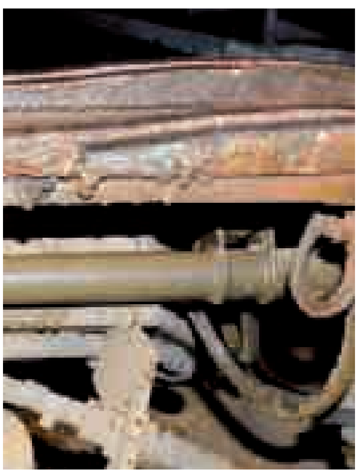
Damage on the sheath

- Arc damage
- Poor contact between carbon and metal sheath (hot spots)
- Poor current path (burning of metal sheaths)

Uneven wear along strip length

- Full surface is not used
- Poor wire stagger
- Network conditions

Corrosion



05 MERSEN'S OFFER FOR CURRENT COLLECTION

OUR RANGE OF SOLUTIONS

- Wide range of carbon sections and carrier profiles (see pages 27 and 28)
- Extruded and machined carbons
- Plain carbon or impregnated with metal (copper), ALL LEAD FREE
- Sheaths in aluminium, copper or steel
- Fitted, soldered, bonded or welded contact strips
- Integral end horn designs available
- Complete offer with Automatic Dropping Device for wear or fault detection
- Kasperowski design (copper clad) contact strip
- Wide range of 3rd rail shoes
- EcoDesign 3rd rail shoes (dismantle and recycle systems)

OUR CONCERN IS TO GUARANTEE OUR CUSTOMERS:

RELIABILITY

- Mechanical stability
- Corrosion resistance
- Safe current collection
- Fault detection

LONGER LIFE TIME OF THE CONTACT STRIP, CATENARY AND POWER RAIL

- Low weight
- Low friction coefficient
- High combustion resistance

ELECTRICAL LOAD CAPACITY

- Good current distribution within the contact strip
- Low electrical losses

ENVIRONMENTALLY FRIENDLY SOLUTIONS

- EcoDesign solutions
- Lead free grades
- Low noise
- No radio interference

EASY TO MAINTAIN SOLUTIONS

- Easy installation and disassembly
- Integral end horns design

Our Customer Technical Assistance Service is at your disposal for any questions.

E-mail:
info.ptt@mersen.com

A CONTINUOUS INNOVATIVE APPROACH

At Mersen, innovation is driven by close cooperation with our customers. Our understanding of the challenges, environments and applications, and our ability to develop highly complex and unique components to meet the specific needs of the leading players in each of our markets ensure our ongoing success.

Our Research & Development teams are international and, combined with our comprehensive test facilities, work on a wide range of subjects for our sectors of activity, allowing us to meet today the market requirements of tomorrow.

Testing facilities for current collection

- Thermal properties of the contact strip / 3^{rd} rail shoe under electrical load
- Expansion and contraction tests under extreme temperatures
- Flexural test
- Infrared thermography devices
- ADD (Automatic Dropping Device) validation test
- Shear strength test
- Mechanical endurance test
- Assembly's electrical resistance test
- Thermal overheating of catenary wire

Experts of Mersen are members of CENELEC (European committee for Electro-technical Standardisation) and IEC. On request, our bonded contact strips can be certified according to EN50405 (CENELEC).

Winner of the innovation trophy

From R&D to the field

Motivated by the challenge for ever increasing demands, Mersen equipped the high-speed train that broke the world speed record on rails in 2007. Mersen's pantograph strips and earth return current units were mounted on the French TGV that reached 574.8 km/h (357 mph).

Preserving the environment has always been a concern for Mersen. For this reason, we bring together innovative and environmental approach.
Mersen developed and **patented a new EcoDesign 3^{rd} rail** shoe with components designed for multiple usage, reconditioning and recycling for our customers.

Partnerships

Mersen develops partnerships with universities, laboratories, OEMs and other customers to be able to offer innovative solutions adapted to the market's need.

06 APPENDICES

HOW TO ORDER CONTACT STRIPS OR CCD SHOES?

The 4 main characteristics of contact strips and CCD shoes

PART NUMBER ENGRAVED ON THE STRIP OR ON THE SHOE AND ITS GRADE

CARBON SIZE

- Length
- Width
- Thickness
- Radius
- Shape

DESIGN

- Carrier shape
- Power cable connections
- Pan head connections
- ADD system

ASSEMBLY

- Clamped
- Soldered
- Bonded
- Kasperowski design (copper clad)

Our Customer Technical Assistance Service is at your disposal for any questions.

E-mail:
info.ptt@mersen.com

There are also other ways to define a contact strip or a CCD shoe:

- **A sample**, even worn out, will generally enable us to determine the design and main dimensions, except the strip height
- **Drawing**

The application's characteristics

The application's characteristics will help our experts to select the most suitable carbon grade to meet your requirements.

CONTACT STRIP FOR PANTOGRAPHS
CHECK LIST

Customer:

Name:

Email:

Telephone:

Address:

Project's name:

Operating country:

Type of vehicle: ☐ Locomotive ☐ Tramway ☐ EMU

Technical information required to design a strip:

Catenary:

☐ Single wire ☐ Double wire

Voltage		kV
Wire section		mm²

Pantograph:

Pantograph supplier		
Number of traction unit(s)		pc(s)
Number of pantographs per traction unit		pc(s)
Number of contact strips per pantograph		pc(s)
Contact force on the catenary - at standstill		N
Contact force on the catenary - in operation		N

Maximum current collected per pantograph:

At standstill		A	continuously		
		A	peak	Please specify the maximum peak duration:	______ min
Operating		A	continuously		
		A	peak	Please specify the maximum peak duration:	______ min

Operating conditions:

☐ EN50125 ☐ class T1 ☐ class T2 ☐ class T3 ☐ class TX

☐ Or specific: Temperature Min: _________°C or ________°F

Temperature Max: _________°C or ________°F

CONTACT STRIP FOR PANTOGRAPHS
CHECK LIST

● ADD (Automatic Dropping Device):

☐ Wear detection ☐ Impact detection

Minimum air flow rate		ℓ/min
Pneumatic circuit operating pressure		bars minimum
		bars maximum
Minimum airflow leakage rate to trigger ADD		ℓ/min

● Type of connection between carbon profile and metal:

☐ Soldered strip
☐ Bonded strip
☐ Clamped strip
☐ Kasperowski design (copper clad) contact strip

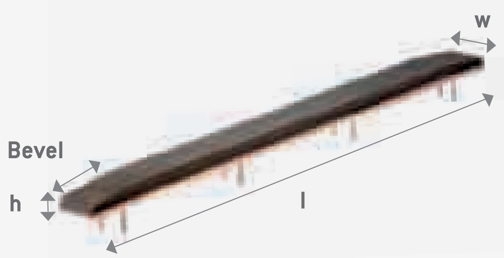
● End horns integrated: ☐ Yes ☐ No

● Carbon strip shape:

☐ Flat
☐ Radius: ☐ 10m ☐ 20m ☐ Other ______________ (please specify)
☐ Dovetail ______________ mm (please specify)
☐ Bevel? If yes, please specify angle______° and length ______ mm

● Carbon strip dimensions:

☐ Length (l): _________ mm
☐ Height (h): _________ mm
☐ Width (w): _________ mm



● Max weight of the contact strip: _________ kg

● Grade used: ______________

● Your drawing Ref: _________________ (to be sent with the check list)

● Technical specifications: ☐ No ☐ Yes (to be sent with the check list)

● Customer's sample: ☐ No ☐ Yes Quantity: _________ pc(s)

● International standards for certification:

☐ EN50405 ☐ STI ☐ DIN6701 ☐ Other ___________ (please specify)

● Scheduled contact strip quantity: _________ pcs per year

CCD SHOES
CHECK LIST

- **Customer:**

Name:
Email:
Telephone:
Address:

- **Project's name:**
- **Operating country:**
- **Type:** ☐ Power transfer ☐ Signal transfer

Technical information required to design CCD shoes:

- **3rd or 4th Rail:**

Material of the rail: ☐ Steel ☐ Aluminium

Condition : please indicate if the 3rd rail is damaged ______________

- **Maximum current collected per 3rd rail shoe:**

Operating		A	continuously		
		A	peak	Please specify the maximum peak duration:	_____ min

- **Operating conditions:** ☐ Humidity

- **Wear detection limit:** ☐ Yes ☐ No

- **Type of connection between carbon profile and metal carrier:**

☐ Soldered and clamped shoe
☐ EcoDesign 3rd rail shoe

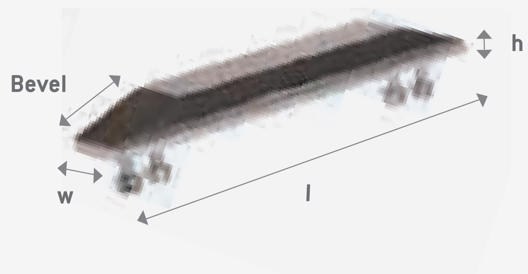
- **CCD shape:**

☐ Dovetail _____________ mm (please specify)
☐ Bevel? If yes, please specify angle _____° and length _____ mm
☐ Wear limit indicator? If yes, please specify its height _____ mm

CCD SHOES
CHECK LIST

- **3rd rail shoe dimensions:**

☐ Length (l): _________ mm
☐ Height (h): _________ mm
☐ Width (w): _________ mm



- **Grade used:** ______________________
- **Your drawing Ref:** ________________ (to be sent with the check list)
- **Technical specifications:** ☐ No ☐ Yes (to be sent with the check list)
- **Customer's sample:** ☐ No ☐ Yes Quantity: _________ pc(s)
- **Scheduled 3rd rail shoe quantity:** ____________ pcs per year

CARBON SECTIONS

STANDARD SHAPES

A	B	C	D	E	F	K
A30-200	B30-255	C36-260	D15-225	E48-320	F22-215	K59-225
A30-240	B30-300	C36-260G	D27-170	E59-270	F24-200	
A35-220	B33-230G	C37-230	D40-240	E59-295	F27-190	
A35-220G	B40-250	C38-220	D41-290	E59-295G	F27-200	
A41-220	B60-260G	C42-260		E59-295		
A50-260		C50-180		E59-320G		
A60-220		C60-220				
A60-260						

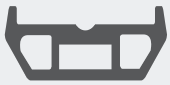
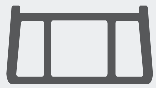
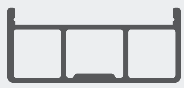
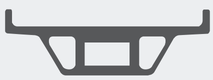
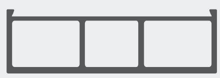
The above are standard carbon patterns, however we can design and manufacture on request. Ask our experts.

? WHAT DO THESE REFERENCES MEAN?

- Letter = shape
- First two digits = minimal contact width with the catenary in mm
- Last three digits = total height in mm x 10
- G (if any) = Groove (if any)

CARRIER PROFILES

BONDED STRIPS

U	V	W	X
 U61-250L	 V35-155L	 W46-150L	 X31-195L
	 V35-180L	 W50-150	 X47-174L
	 V57-150L		 X56-167L
	 V61-150L		

?

WHAT DO THESE REFERENCES MEAN?

- Letter = shape
- First two digits = maximum width of carbon in mm
- Last three digits = height between the carrier base and the carbon strip bottom in mm x 10
- L (if any) = Holding flaps (if any)

The above are standard sheath patterns, however we can design and manufacture on request. Ask our experts.

OCCURRENCE OF TECHNICAL TERMS IN THIS GUIDE

LIST OF MERSEN'S TECHNICAL DATA SHEETS

(also available from **WWW.MERSEN.COM**)

OTHER DOCUMENTS RELATED TO MERSEN'S RANGE OF SOLUTIONS CAN BE SUPPLIED UPON REQUEST. DO NOT HESITATE TO CONTACT US.

TDS/01 Functions of a good carbon brush, what you should know

TDS/02 Condition of the surface of commutators and slip rings - Roughness

TDS/03 Chamfering of commutator bar edges Machining of ring helical grooves

TDS/04 Brush and brush-holder tolerances on "t" and "a" dimensions

TDS/05 Losses in carbon brushes

TDS/06 Setting the neutral at rest

TDS/07 Sandwich brushes – Composite brushes

TDS/08 Preventive maintenance

TDS/09 Circumferential brush stagger

TDS/10 Threading on slip rings

TDS/11 Brush spring pressure

TDS/12 Ventilation

TDS/13 Aspects of commutator / slip ring skins

TDS/14 Brush sparking

TDS/15 Brush wear

TDS/16 Standardization of carbon brush dimensions

TDS/17 Air humidity

TDS/18 Degreasing of commutators and rings

TDS/19 Brush seating

TDS/20 Slip ring brushes

TDS/21 Copper bridging of commutator bars (copper dragging)

TDS/22 Ghost marking on synchronous machines slip rings (ghosting)

TDS/23 Silicones

TDS/24 Dust arising from brush wear

TDS/25 Underloaded machines

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Electronics: • Polysilicon • Power Electronics • Semiconductors • Compound Semiconductors • Optical Fiber Production

Chemicals & Pharmaceuticals: • Organic Chemicals • Inorganic Chemicals • Fine Chemicals & Pharmaceuticals

Process industries: • Metallurgy • Mining • Oil & Gas • Cement • Pulp & Paper • Rubber & Plastic • Water & Wastewater Treatment • Assembly Manufacturing • Mould Industry • Glass Industry • Sintering • Furnace Industry

Other Markets: • Commercial • Residential • Data Communication • Elevators • Forklifts

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