Scharfenberg Systems

Voith Turbo Scharfenberg Systems

We are the experts in train front ends and couplers.

Voith Turbo, the specialist in hydrodynamic drive, coupling and braking systems for road, rail and industrial applications as well as for ship propulsion systems, is a Group Division of Voith GmbH.

Voith is one of the largest family-owned companies in Europe with approximately 39,000 employees, annual sales of €5.1 billion in the business year 2008/2009 and over 280 locations worldwide. The company is active in the energy, oil, gas, paper and raw materials markets, as well as the transportation and automotive industry.
A Traditional Company at the Cutting Edge

Voith Turbo Scharfenberg - this name stands for quality and innovation. And this for more than a century, which is when the concept of the automatic Scharfenberg coupler was born. Over the years, incessant technical refinements and up-to-date technology have made the “Schaku” one of the most prominent railway coupler systems in use all over the world, from light rail vehicles up to high speed trains. Today, the company has also made its mark as a system supplier for complete front end solutions, including front nose assemblies with energy absorbing components and control modules. Recent highlight: The modular coupler head One4, offering incomparable maintenance and repair benefits. As is our tradition, we are always up-to-date, or even ahead of our time.

Remaining at your disposal after purchase, we offer a vast range of technical support services over the whole life cycle of your product. Which can amount to 30 years and more – suitable maintenance provided. This way, we are able to maintain the high safety and quality standards our products stand for.

Major milestones on the Scharfenberg track report

Focus on couplers

- 1921: Foundation of the incorporated company “Scharfenbergkupplung Aktiengesellschaft” in Berlin
- 1903: Development of the first automatic “Schaku” by Karl Scharfenberg, German “Reichspatent”
- 1925: Introduction of the “Schaku” at the rapid transit railway “Berliner S-Bahn” and the “Hamburger Hochbahn”
- 1998: Die Scharfenberg GmbH becomes part of the Salzgitter group of companies
- 2002: System supplier for complete train front ends, including: Complete front noses, Joints, System for automatically coupling AAR type couplers including electric head and air pipe connections

System supplier for front systems

- From 1998: The type 10 Scharfenberg coupler is declared standard coupler for high speed trains
- From 2002: System supplier for complete train front ends, including: Complete front noses, Joints, System for automatically coupling AAR type couplers including electric head and air pipe connections
- From 2008: New data transmission concepts, among them the wireless data transmission between couplers through near-field communication (RadiConn), Inauguration of the new GRP production hall
- From 2010: GALEA: Collision safe fibre composite vehicle heads as new energy absorption concept for the vehicle front, CRP adapter, New crash buffer

VT 601, Hamburg
Kuala Lumpur Airport Link, Malaysia
Mumbai Monorail, India
Very high speed train CRH1-380 (ZEFIRO), China

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Scharfenberg Couplers

Coupling Principle – Always on the Safe Side

Basic component of each automatic Scharfenberg coupler is the coupler lock. It consists of a pivoting hooked plate, a coupling link and tension springs. When coupling, the coupling link of one coupler and the hooked plate of the counter coupler – and vice versa – interlock, thus forming an equilibrium of forces. A principle that proves extremely wear-resistant while guaranteeing maximum safety, even in most challenging situations.

The cone and funnel shape design of the coupler front plates establishes a rigid and slack-free connection, thus reducing coupler play to a minimum. Combined with coupler head extensions and a guiding horn, this provides the couplers with a maximum possible gathering range. This way, automatic coupling is possible even under horizontal, vertical or angular offset, as for example in curves or on hilltops.

Prior to the coupling process, the coupling links are visible at the opening of the male cones. When coupling, the special geometry of the hooked plates makes the coupler locks turn against the force of the tension springs until the coupling links slide into the hooked plate recesses. Now the tension springs turn the coupler locks in the opposite direction, locking the parts safely into place.

The couplers have been connected; coupling links and hooked plates are interlocked, establishing a parallelogram of forces. The result is a highly reliable, safe and slack-free connection which at the same time guarantees high driving comfort and prevents an overriding of railway vehicles in case of an incident.

When uncoupling, the hooked plates are turned against the force of the tension springs until the coupling links slide out of the hooked plate recesses. Now the couplers can be smoothly separated. The coupler lock design allows the uncoupling of misaligned vehicles, for example on curves or hilltops, and even with vehicles under traction load. For safety reasons, the couplers can only be re-coupled after the vehicles have been separated.
Apart from reliability and safety aspects, flexibility and adaptability are the main requirements a train coupler has to comply with. The modular design of the Scharfenberg couplers and different coupler types allow us to provide the optimum coupler for each and every application and condition.

Benefits of the Schaku design and principle
- Automatic coupling and uncoupling – safe and reliable
- Simultaneous coupling of mechanical, pneumatic and electric components
- Reduced maintenance time and effort due to minimum wear
- Smooth train operation

One4 – the new coupler head generation*
Modularisation at peak level – the new modular coupler head One4 goes along with the existing modular approach. Radically simplified and standardised, this coupler head brings enormous benefits, most notably in the field of maintenance and repair.

One4 concept – all modular, all compatible
The One4 concept separates the coupler head body from the front plate. Benefits: the coupler head body was standardised, while the front plate reflects the characteristics of the particular coupler types. It is attached with a few screws only. A completely new approach that remains fully compatible to existing coupler systems.

*Detailed description on page 10/11
Scharfenberg Couplers

Modular Coupler Head One4 – Revolutionising Maintenance

Up to now, a coupler head was a single, monolithic cast iron component. The modular coupler head concept One4 separates the front plate from the rest of the coupler head. Attached to the standardised coupler head body with screws, the benefits for maintenance and repair are monumental. The One4 is available in four Schaku standard versions, covering the types 10, 35, 330 and 130.

Easy mounting and removal
It used to be necessary to replace the whole coupler head. However, today, in most cases the front plate will do. The separate front plate is screwed to the coupler head body, making it easy to detach and replace. And what is more: all components inside the coupler head are easily accessible, eliminating the need for special tools.

For further information refer to publication G 1989

Heating elements
The heating concept has been standardised as well. No matter if a coupler is delivered with or without heating elements, the coupler heads are by default provided with corresponding grooves, so that heating elements can easily be retrofitted should the necessity arise.

Easy replacing and retrofitting of heating elements
Simplified mounting of air pipe connections
Stainless steel front plates available for improved corrosion protection

One4 – Benefits at a glance
- Considerably reduced maintenance effort
- Compatible to existing coupler systems
- Easy access to components inside coupler head
- Fast replacement of electric head and operating gear through standardised equipment rack
- Simplified mounting of air pipe connections
- Stainless steel front plates available for improved corrosion protection

Modular design of the One4: One4 with different front plate versions and electric head types

One4 with detached front plate
Standardised carrier of the electric head operating gear (for lateral electric heads)
Heating element, placed in groove

Modular electric head operating gear
Another feature of the One4 is a simplified electric head operating gear. A standard interface between coupler head and operating gear allows electric heads to be fixed to the coupler head by means of simplified equipment racks. This guarantees fast and easy mounting and replacement of electric heads and operating gear. Solutions for both lateral and top or bottom mounted heads are available.
Drawgear

Coupler Shank – Energy Absorption

Made to Measure

The drawgear comprises the coupler shank and the drawgear articulation. Integrated energy absorbing components guarantee smooth train operation and protect the vehicle in case of an impact. They compensate tensile and compressive loads up to a defined value, while excessive loads are passed on to the car underframe. Both regenerative and destructive energy absorption devices are available.

**Gas-hydraulic buffer:**

Regenerative energy absorption

In combination with a friction spring, the gas-hydraulic buffer transforms tensile and compressive loads in a regenerative way. An internal valve makes sure that—in case of overload—the whole liquid remains inside the buffer, so that the complete stroke is still available.

**Characteristics:**

- Speed-dependent response
- Pre-loaded system in both directions, tension and compression
- Most effective in combination with a spherical bearing

**Hydrostatic buffer:**

Regenerative energy absorption

The hydrostatic buffer transforms compressive load in a regenerative way.

**Characteristics:**

- Linearly ascending characteristic curve
- Pre-loaded system in direction of compression
- Most effective in combination with a rubber cushion drawgear

**Two in one:**

The TwinStroke buffer compensates both tensile and compressive load without the need for any additional components. A highly sophisticated system of pistons transmits the tensile and compressive load to different nitrogen and oil chambers, compensating every load immediately and nearly wear-free.

**Characteristics:**

- Small dimensions
- Low weight
- Reduced expenses
- Small number of wear parts
- High energy absorption, even in case of changing load directions

**Collapsible tube:**

Destructive energy absorption

The collapsible tube converts impact energy into deformation.

**Characteristics:**

- Defined release load without peak value
- Maximum energy absorption (rectangular characteristic curve)
- Most effective in combination with a rubber cushion drawgear

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**Force**

**Stroke**

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**Dynamic curve**

**Static curve**

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**F [kN]**

**Force**

**Stroke on tension**

**Stroke on compression**

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**Static curve**

**Dynamic curve**
Rubber cushion drawgear type 3 with shear-off feature – no load/maximum load exceeded (shear-off case)

Variable cushioning effect:
The rubber cushion drawgear is a bearing bracket with integrated cushioning unit. Available with two or three rubber elements, the rubber cushion drawgear compensates both buff and draft loads - in performance and weight perfectly adapted to its individual applications.

Benefits:
- High cushioning effect through shear stress of the rubber elements
- Low-wear and maintenance-friendly design
- Small dimensions
- Different sizes for various applications

The rubber cushion drawgear is also available with an integrated shear-off feature. If the maximum defined buff load of the rubber cushion drawgear is exceeded, special screws shear off and the coupler is guided through the bearing bracket under the vehicle underframe.

The drawgear articulation connects the coupler to the car underframe, the cardanic movement of the coupler being ensured by cushioning components. Depending on its purpose, the drawgear articulation can be provided with additional energy absorbing components for compensating tensile and compressive loads.

For further information refer to publication G 2043

For further information refer to publication G 2043
Application
Standard Gauge Railway Coupler Type 10 – Full Speed Ahead

The Schaku type 10 coupler can be found in nearly all public railways all around the world, including high speed trains. Among others, it leads the way on high speed trains in Germany (ICE 3), France (TGV), Spain (AVE S-102/S-103) and China. The type 10 excels in strength and rigidity and possesses a particularly wide horizontal and vertical gathering range. This made him first choice when it came to setting a standard for high speed trains – since 2002 this coupler type is an inherent part of the TSI standard.

Characteristics type 10
- Strength:
  - compression: 1 500 kN (up to 2 000 kN)
  - traction: 1 000 kN
- Complies with the U.I.C. standard for standard gauge motor train units
- Two-position coupler lock provides additional safety when coupling

Application
Metropolitan Railway Coupler Type 35 – our Beast of Burden

The type 35 coupler is particularly suitable for all-electric vehicles. It is mainly used in commuter trains, for example those in Shanghai, Singapore or Salt Lake City.

Characteristics type 35
- Strength:
  - compression: 1300 kN
  - traction: 850 kN
- Guiding horn for extension of gathering range
- Two-position coupler lock provides additional safety when coupling
Application
Metropolitan Railway Coupler Type 330 – Versatility in Motion

The type 330 Scharfenberg coupler is mainly found in metropolitan railways and in light rail vehicles. This small-sized coupler offers remarkable strength and the possibility to use underlying electric heads. The extremely narrow dimensions of the tramtrain Avanto in Paris even called for a special coupler design, folding twice along its longitudinal axis. Uncoupled, it is concealed behind front hatches. When coupling, the hatches are automatically opened and the coupler unfolds.

Characteristics type 330
- Strength:
  - compression: 800 kN
  - traction: 600 kN
- Particularly wide gathering range without guiding horn

Application
Urban Railway Coupler Type 430 – Low-Weight Design

Its compact and lightweight design makes the Schaku type 430 an ideal coupler for low-floor urban railways and people movers. Designed as a foldable coupler, it can be combined with front hatches. Amongst others, this type is used in the Berlin urban railway vehicles and in the KL Rapid in Kuala Lumpur.

Characteristics Type 430
- Strength:
  - compression/traction: 300 kN
- Small dimensions, low weight
- Compact design without guiding horn
Semi-Permanent Scharfenberg Couplers
Always Safely Connected

Semi-permanent Scharfenberg couplers represent a safe and reliable permanent connection of intermediate cars. As a standard, the two coupler halves are connected by means of muff couplings, so they can be easily separated, if necessary.

Conception
The safety of both train and passengers requires a perfect co-operation of all couplers within a train. This can only be achieved by perfectly harmonising the characteristics of the semi-permanent couplers and their energy absorbing components with those of the automatic couplers. The distribution of forces over the whole train allows for a lean underframe design. Result: maximum safety at reduced costs.

Benefits
- Rigid, slack-free connection
- Parallel connection of air pipes and electric heads
- Prevents vehicles from overriding
- Prevents rotational movements along the longitudinal vehicle axis
- Also available with gangway support

Semi-permanent coupler half with rear-mounted deformation tube
Semi-permanent coupler with air pipe connections, electric head, energy absorbing components and gangway support
Semi-permanent coupler, connected with muff coupling
Apart from automatic and semi-permanent couplers, Voith Turbo Scharfenberg provides a whole range of different products for a permanent connection of vehicles, such as joints or solutions for special purposes. Adapter couplers are used for connecting two vehicles with non-compatible couplers, while couplers used in industrial environments need to be extremely robust and wear-resistant.

Joints

Joints establish a permanent, non-detachable connection between two vehicles. In contrast to semi-permanent couplers, joints compensate both horizontal and vertical loads. An anti-rolling device provides additional stability.

Joints with energy absorbing components

This type of joint provides additional energy absorption for standard gauge railways connected with Jacobs bogies. Our expert knowledge and extensive experience with energy absorbing components and deformation tubes have been particularly useful when developing these joints. Proven technology in a new garment, offering a whole range of new applications.

Modular adapter couplers

Adapter couplers are used to connect vehicles with non-compatible coupler types or deviating coupling levels, which often occurs when shunting or towing vehicles. So far these differences often called for special coupler designs. The new, modular adapter coupler breaks the coupler down into its integral parts – that is two coupler heads and an adapter piece for compensating different coupling levels, if necessary. This way, adapter couplers of any coupler type combination can be individually assembled, according to given requirements.

Special applications

In industrial applications as well, the Schaku has been demonstrating its reliability and flexibility for many years. It makes coupling safer, in particular shunting or automatic combining of train sets reducing the risk of accidents and hazards to life and health to a minimum.

The Schaku coupler types 55 and 140 designed for heavy-load applications in rough environment are extremely wear-resistant and maintenance friendly.

CRP adapter: Hi-tech towing

Adapter couplers are only needed for towing or shunting trains, so they need to be fitted on track by the operating staff – manually, of course. Thus, an ideal adapter would be one that is light-weight and yet able to bear the heavy load of a whole train.

For common steel couplers used to date, the possibilities for weight reduction are virtually exhausted. Here, the coupler body mainly consists of carbon fibre reinforced plastics, a hightech material often to be found in aviation technology. The new material performed strongly in tests, so that – after some refining and optimising – all lights are green for the lightweight adapter coupler.

Pivotable shunting coupler: Schaku type 55

CFRP adapter
Electric Heads
Signal Transmission – the Clever Way

Electric heads integrate the electric contacts used for transmitting control signals and feeding train information or entertainment systems. Apart from control and line current, the electric contacts can also transmit bus and video signals, up to Fast Ethernet. Uncoupled, a cover protects the contacts from any ingress of dirt and water. Standardised electric head boxes and interfaces allow fast and easy assembly and guarantee an optimum operation of all components.

Casing variants
Depending on the number of contacts required and on the position of the electric head(s), different standard casing types are available; two for lateral arrangement and one for top or bottom mounted electric heads. The standard modules include the contact block with contacts, the cables and the hand plug. Contacts are easily replaceable from the front, cables can be connected by means of crimp or screw connection, or come as a plug-in version. The connection to the vehicle is estab-lished by means of hand plugs – fast and easy.

For further information refer to publications G 2158 and G 2159

Interfaces
Standardised interfaces like guiding rods, the lid control mechanism, the earthing and the interface between electric head and electric head operating gear guarantee an optimum combination and functionality of all components.

Contacts
Signal, bus and power contacts allow for fast and reliable transmission of all kind of data.

QuatConn
The QuatConn is a 4-pole male/female Ethernet connector allowing for a number of concepts. Data rates up to 100 Mbit/s@100Base-TX make it an ideal choice for infotainment systems and TCMS (Train Control Management Systems).

Data Transmission (also) as Upgrade
Ethernet Meets Coupler

How can you increase coupler performance and yet keep the effort and expenses at a moderate level? This question becomes even more interesting when it comes to upgrades. Here, the two systems RadiConn and TLM (Train Line Modem) developed by Voith Turbo Scharfenberg close a gap. Data are transmitted through Ethernet supporting a data rate of 100 Mbit/s. The wireless RadiConn system, which was developed to minimise failure and maintenance caused by dirt, even works without electric head. In contrast, the TLM needs an electric head to be fitted into, but uses the existing lines and contacts. These two systems offer simple and cost-effective solutions for all kinds of applications.

RadiConn, coupled and uncoupled (detailed view from below)

Wireless data transmission: RadiConn
The RadiConn system consists of an electronic box and a radio coupler pin per mechanical coupler. The pin is located at the train front, while the electronic box is fitted to the vehicle underframe. The two radio coupler pins face each other at a distance of some millimeters, and exchange the data without any physical contact. The electronic box provides the Ethernet connections for the wired LAN of the train. An existing electric head may be used for this system, however it is not required. The robust radio coupler pin (protection class IP68) may as well be fitted directly to the mechanical structure of the coupler.

Cost-effective upgrade: TLM
The TLM system requires an electric head with a shielded pair of contacts, but the lines keep their original function. It uses a modulation technique to merge/separate the signals in front of the coupling plane.

This kind of Ethernet connection requires neither special contacts nor technical modifications, it uses existing male/female or fixed/mobile contacts. This makes the TLM an ideal solution for cost-effective upgrades.

For further information refer to publications G 2044 und G 2120

NF-Communication (ELA, UIC)
Train control signals (Safety)
Databus (WTB)
UBat
Ethernet (CAT5)
Train Line Modem

RadiConn system architecture and function
Systems Engineering
Always in Front – One Stop Shopping for System Solutions

It is a long time since “Schaku” was associated with couplers only. Today, as a system supplier for front end solutions, we provide train manufacturers all over the world with impact protection systems, flexible spoilers, front hatches and energy absorbing components, up to complete front noses including control electronics.

KTX II. Voith Turbo Scharfenberg contributed a system comprising front nose, type 10 automatic coupler and control unit. Comprehensive involvement already in the early design phase of the train allowed all components to be perfectly harmonised. This resulted in simple interfaces and perfect aerodynamic characteristics, at the same time allowing fast assembly and maintenance.

Localisation on a grand scale: due to their huge order quantities, a great part of the front end systems of the CRH3 family was produced in China. The high quality of the systems was obtained by exact calculations and tests preceding the design phase as well as know-how transfer through training and qualified support during production.

In addition to good functionality, what counts for product development are aspects of assembly and maintenance, as well as good handling. In our case, standardised interfaces and modular design of components allow for an easy replacement of parts, thus simplifying maintenance and reducing downtimes to a minimum. Furthermore, the components can be optimally combined and adapted to different requirements and applications. This way Voith Turbo Scharfenberg products enhance train safety and provide the best possible protection for both passengers and trains, even in case of an impact.

Hidden values
Front hatches offer a whole range of benefits, protecting other traffic participants or passers-by from injury and damage, while at the same time preventing the coupler from being effected by dirt and water. Uncoupled, the folded or retracted coupler is concealed behind the closed front hatches and no longer protrudes from the front. This way, perfect aerodynamic characteristics are obtained, a decisive factor in high speed applications. When coupling, the front hatch is automatically opened, and the coupler is extended.

Benefits of the system approach
- Perfectly harmonised components providing maximum possible safety
- Standardised interfaces
- Modular design allows components to be easily maintained and replaced
- Minimised down-times for maintenance and repair operations

For further information refer to publication G 1711

India’s first monorail in Mumbai (Bombay) features a complete Voith Turbo Scharfenberg front end system including driver’s console. At a height of 8 m, the automated train operates with rubber tyres on a mono track made of concrete. Integrated safety feature: the energy absorption system has been designed to completely absorb head-on impacts up to 17 km/h. This is exactly the speed allowed for manual operation.

Operating at a speed of 380 km/h, the Chinese very high speed train CRH1-380 (ZEFIRO) will be the fastest commercially operated train. Just like the speed, the dimensions of the front end system are in line for record, which makes high demands on strength, safety, aerodynamics and aeroacoustics.
From the very beginning, our development and design processes are accompanied by and based on FEM (Finite Element Modelling) and MBS (Multi Body Simulation). Our programmes help to assess the responses of component structures to static or dynamic load and to calculate strength properties and crash worthiness aspects. This helps us detect risks and optimise component dimensions and behaviour in early stages of development. This way, development costs and expensive and time-consuming test procedures can be minimised. When it came to developing our new front end systems, as an example, this approach helped us to considerably accelerate the whole process. All this with the clear conscience of providing the best possible solutions in terms of both quality and safety.

Crash worthiness analysis
One of the most advanced technological aids for the analysis of highly dynamic processes – as they occur in crash situations – is the explicit FEM programme LS-DYNA 3D. We use this software to calculate the energy distribution and properties of our energy absorbing components. Optimised on the basis of the results obtained, the components comply with the highest safety standards.

Conclusion
In combination with our long years of experience, the use of these high-end calculation and simulation programmes enables us to provide the cus-tomer with perfectly harmonised systems, specific to his requirements. Systems offering maximum safety at minimum weight.

Components and vehicle dynamics simulations
The MBS software SIMPACK enables us to calculate the strength distribution in the course of dynamic processes, from individual coupler parts up to complete train sets. This way, the interaction between train and coupler components can be evaluated. As a result, a perfect combination of components can be obtained, offering the best possible values and characteristics with regard to the application concerned.

Strength calculations
Together with international regulations, the results obtained from the vehicle dynamics simulations form the basis of strength calculations and component dimensioning. Using the ANSYS software, we calculate displacements and stress and strain distributions within a component under load conditions. The results of these calculations are then used for evaluating the static and cyclic strength values. This helps us to develop perfectly dimensioned components with optimised weight and strength characteristics.

We offer
- Strength calculations and weight optimisation
- Crash worthiness analyses and development of crash concepts
- Components and vehicle dynamics simulations from individual components up to complete train sets
After Sales
Schaku Competence Centre – Wherever You Need Us

The Scharfenberg Competence Centre unites classical after sales service, repair and spare parts management under one umbrella. We have the ambition to offer our customers qualified support for all phases of coupler life, from commissioning via professional operation up to optimum maintenance and repair. Service facilities can be found at our Salzgitter headquarters in Germany as well as in our subsidiaries and representations all over the world. Our skilled service staff is at hand when- and wherever you need them.

Technical consulting
Voith Turbo Scharfenberg takes care of a number of projects world-wide. In these projects we are approached with all kinds of requirements, questions and improvement requests, and together with our customer we try to work out the best possible individual solution. This continuous feedback helps us build up our knowledge and act faster and more flexible. And we are happy to share our competence with you.

Parts management
An optimum utilisation of your trains depends both on the reliability of the automatic couplers and on the availability of parts. Voith Turbo Scharfenberg as the leading system provider offers you technically mature products of the highest quality. Make use of our long years of experience as a coupler and front end system manufacturer, and together let us optimise the availability of your spare parts.

Overhaul – maximum safety at minimum costs
Trains and couplers are extremely durable goods. Their regular overhaul and constant enhancement guarantees maximum safety at minimum costs. However, since couplers are designed project specifically, you will hardly find two projects that are alike. Our knowledge and experience help us find the best solutions for the individual couplers when it comes to maintenance, overhaul or upgrades.

Repairs – as individual as your coupler
The multiple traction operation of your train highly depends on a perfect functioning of the couplers. However, in the course of its lifetime, its exposed position makes the coupler prone to damage, be it through mishandling or accidents. A quick and professional repair will get your train back on track as fast as can be.

Upgrades
Mobility and flexibility have become a matter of course in our modern society. The increased worldwide demand for mobility cannot be handled with new products alone. Upgrade and retrofit of trains already in operation are solutions to enhance both their service life and availability.

For further information refer to publication G 1774