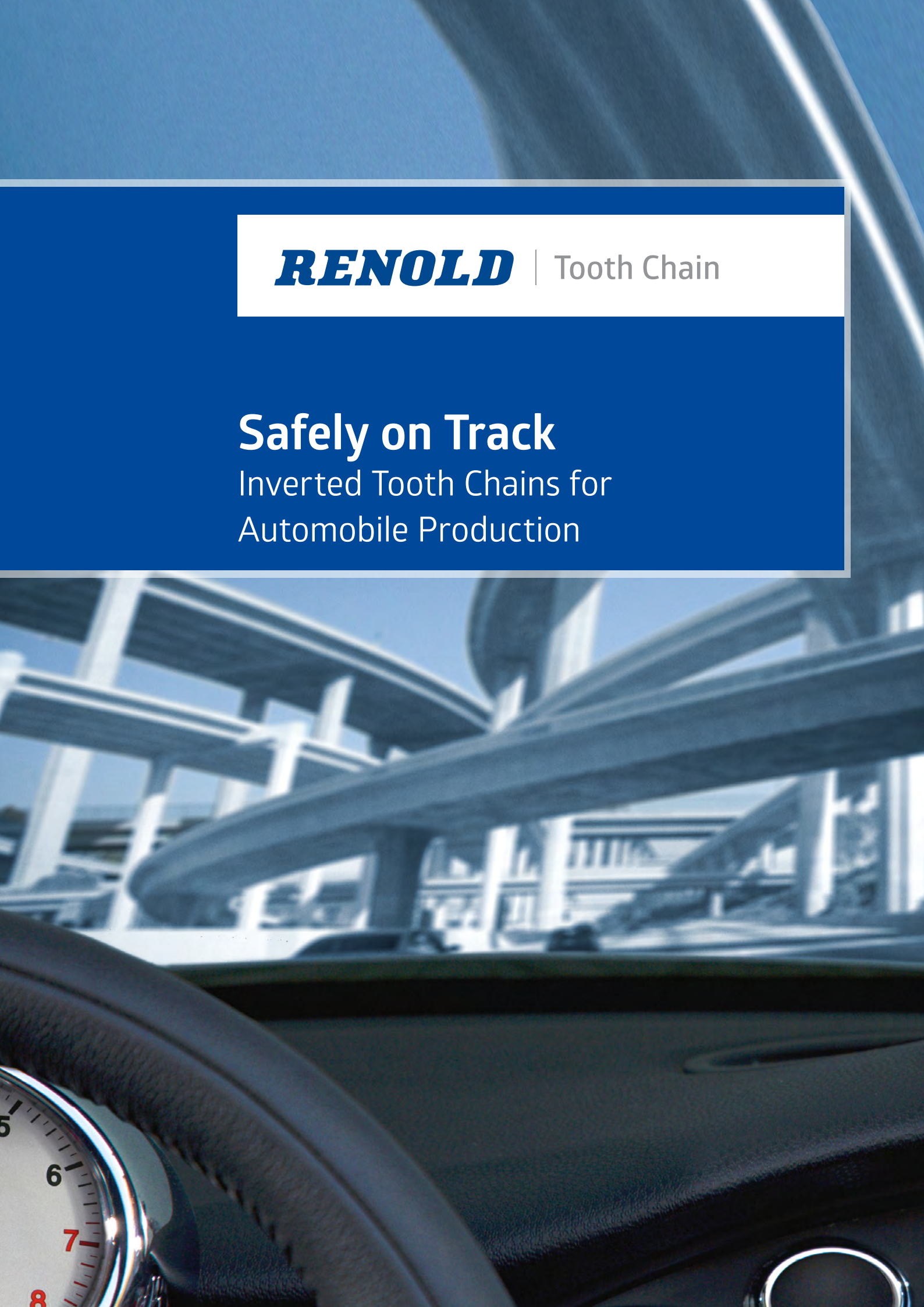
RENOLD | Tooth Chain

# Safely on Track

## Inverted Tooth Chains for Automobile Production



*Safe, robust, and efficient. Beyond the impressive attributes of successful products, inverted tooth chain technology offers an added bonus for the automotive industry: customized variety. Our drive and transport solutions with inverted tooth chains can be optimally adapted to highly specific work processes and environments in automobile production.*

# Experience in the automotive industry

## Automation solutions with inverted tooth chains from Renold ensure a durable economic production.

**Tailor-made for your application: drive and transport solutions with inverted tooth chains**

The diverse tasks and working conditions in the automotive industry require solutions that are just as varied. Based on a comprehensive product range and custom configurations, we developed a wide range of services geared to our users' requirements. We offer precisely tailored, application-specific solutions combined with unparalleled product quality and expert service.

Automation solutions with inverted tooth chains from Renold help you to significantly increase the service life of your systems, minimize downtimes, and ensure sustainable, cost-effective production. Our inverted tooth chains master these goals – every day, around the world.

- Technology leader for inverted tooth chain applications
- Unparalleled variety – the right inverted tooth chain for every application
- Over 100 years of experience, active worldwide

From bodywork and component production to assembly lines, from end-users to suppliers, inverted tooth chains from Renold have been driving and advancing the industry for decades. Together with our customers in automotive plants and supplier companies, we have developed a broad product portfolio that is precisely tailored to meet the needs of the industry. The result? Products, systems, and solutions that are best in class in all respects and exactly fit your purpose. Talk to one of our industry experts available throughout the world.

## Content



# The pinnacle of personal mobility: Autos mobilis

*It started out as the dream of just a few visionaries and remained the luxury of a privileged few for years. Today, it's an attainable reality for practically everyone: the automobile as the pinnacle of individual mobility.*

# And the journey continues

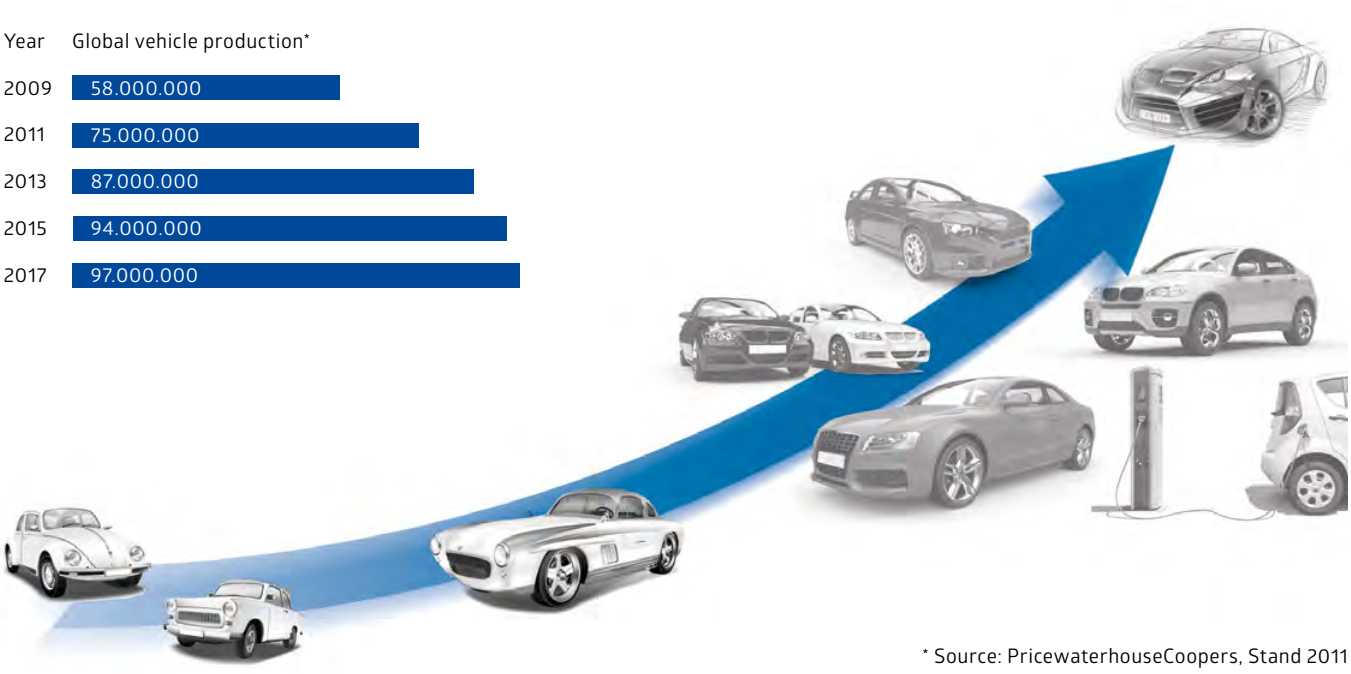
**Global demand for personal mobility is on the rise**
The development of the automobile has had a decisive impact on society. Every new vehicle has increased mobility as a key prerequisite for dynamic, growing economies. Thanks to a continuous stream of new ideas and products, automobile manufacturers have not only boosted sales, but especially increased the technical quality and variety of their offers. Modern vehicles cater to virtually all needs and transportation requirements for both passengers and goods. Nevertheless, this dynamic market is always in need of new, intelligent solutions.

- New drive technologies
- Digital cockpit networking
- New traffic control systems

**Requirements for vehicle technology and production processes are ever-increasing**
The automotive industry has always been highly competitive. The markets are extremely transparent for consumers; products stand in direct competition and the spectrum of international products is growing. However, demand is also on the rise. Manufacturers will need to actively shape new trends to create true interest among consumers. Translating interest into real demand is only possible by offering a superior overall package at an attractive price. Many factors, including the concept, technology, design, quality, and, of course, the price, must be perfectly aligned. This requires innovations at all levels, right down to the technical and economic efficiency of work processes and production methods. Malfunctions and downtimes must be avoided at all times. Thanks to their reliability and durability, drive and transport solutions with inverted tooth chains from Renold can help you achieve these goals.

The automotive industry – driving new growth
From compact cars for everyman to automotive diversity

| Year | Global vehicle production* |
|---|---|
| 2009 | 58.000.000 |
| 2011 | 75.000.000 |
| 2013 | 87.000.000 |
| 2015 | 94.000.000 |
| 2017 | 97.000.000 |



* Source: PricewaterhouseCoopers, Stand 2011

# High-tech at every turn

## Automobile production is as complex as innovative in all areas

**Each process stage demands a specific production approach**

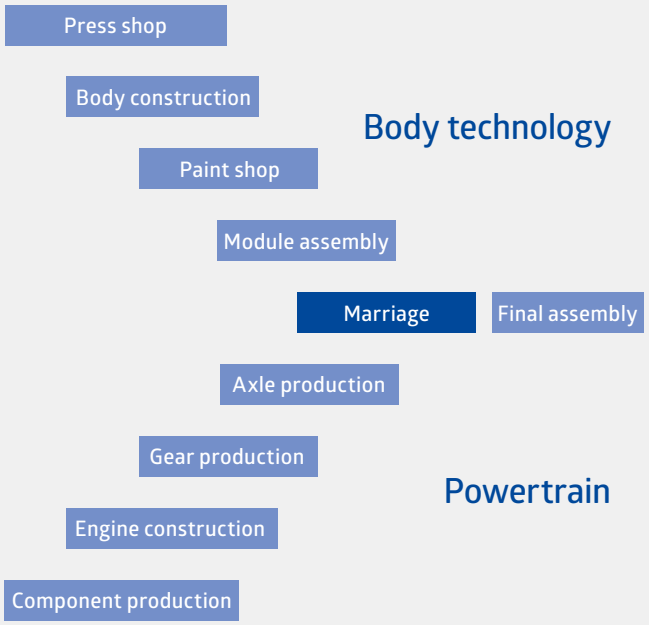
The application options for our inverted tooth chains are as multi-faceted as the production process itself. In this complex symphony of factory automation, tooth chains play an increasingly important, yet mostly inconspicuous role. Their reliability masks their performance. The reason is simple: quiet virtuosity often goes unnoticed. All-round "low-maintenance" is the perfect description of our inverted tooth chains: 15 plus years of continuous operation with just a few service intervals is not the exception, but the rule. A long service life paired with relatively low procurement and operating costs translate to optimal life cycle costs.

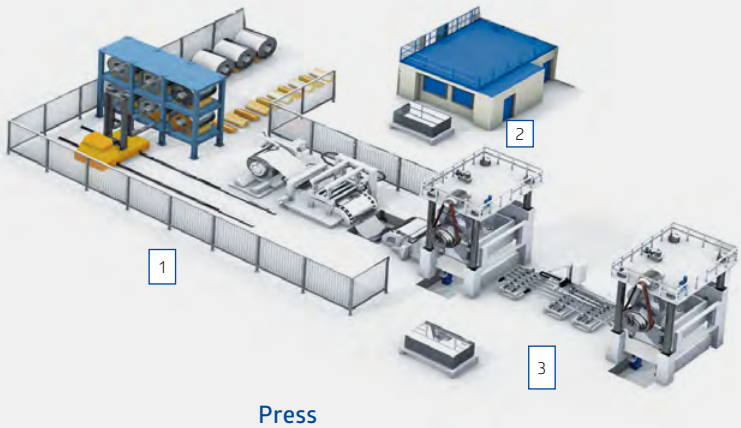
In short: with inverted tooth chain solutions, you achieve maximal operational reliability at a minimal cost.

**From raw materials to molded parts**

Heavy-duty rolls with thin steel and aluminum sheet must be moved. Unwinding, cutting into plates, punching, pressing, and molding. Precisely manufactured molded parts are created in specific processing lines by applying forces in the magnitude of up to several thousand tons. Whether doors, hoods, and roofs, or even entire side walls – millimeters are what counts for a perfect fit during later assembly.

### Automobile production process



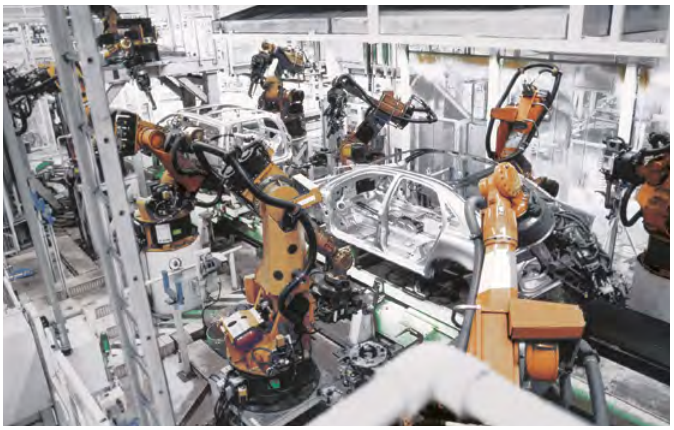




Press

# Press, body, and paint shops

**Hundreds of parts make a body**
Like a huge 3D puzzle, a functional and elegant body is constructed of hundreds of sheet metal parts. Individual component assembly is almost fully automated, step by step – rivet, weld, bond – to the finished product. Industrial robots take over these difficult processes and add power and precision to assembly lines.

**Several coats for excellent protection and an indelible shine**
Color, shine, and corrosion protection – gradually and carefully applied coatings and paint make for a high-quality, attractive body. Fully automated processes for surface finishes in dip tank systems and spray booths ensure consistent quality as well as a customized appearance.



1 | Inverted tooth conveyor chains
2 | Inverted tooth drive chains
3 | Custom solutions

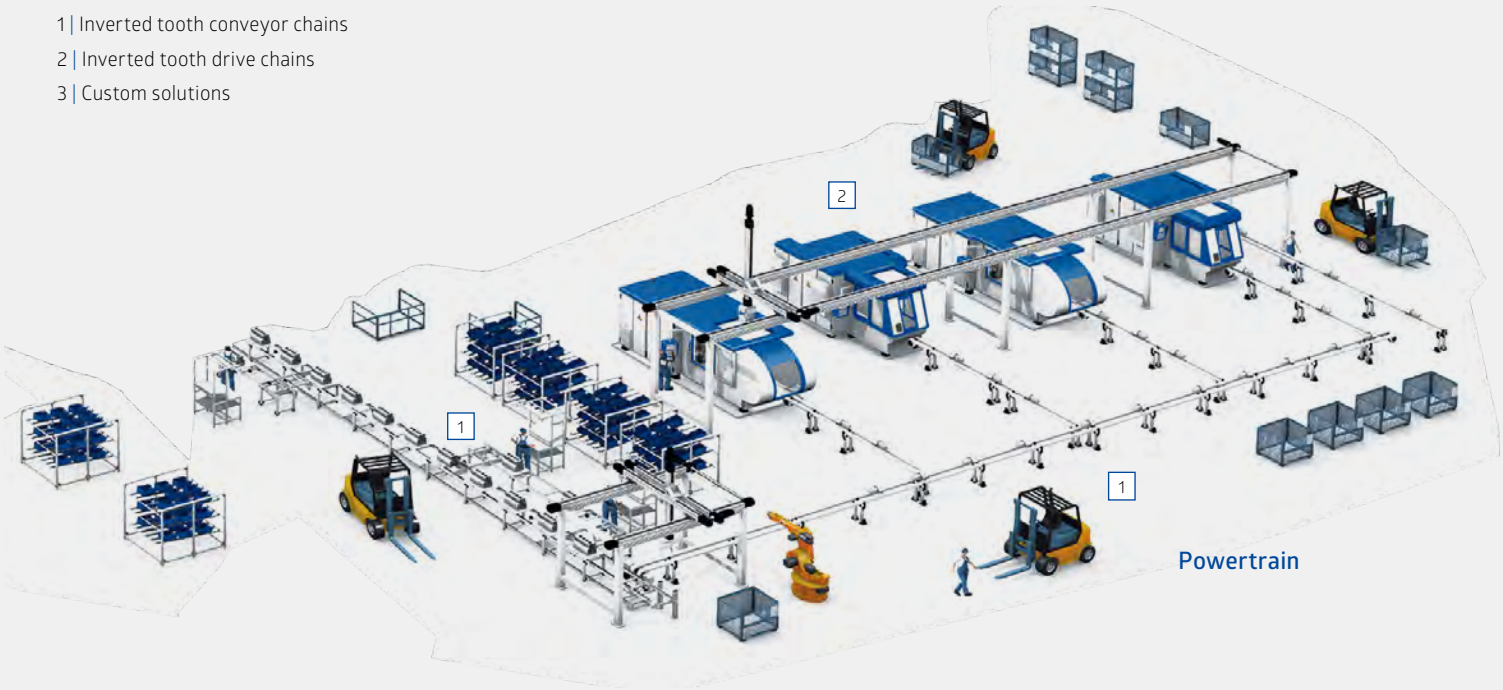

Body Paint shops

# Engine, axle, and transmission manufacturing

**Utmost precision for powertrain construction**
The heart, circulatory system, muscles and bones – a complex and delicate interplay. Individual mechanical and electronic elements, components, and materials need to be manufactured and assembled with care.
Computer-controlled machine tools in specific assembly lines provide absolute precision for the production of individual components. Quality checks and function tests ensure a reliable result. An equal amount of expertise is required for the subsequent assembly of the complete powertrain to join the various parts and components into one functional unit.

- High-tech machine equipment in the powertrain
- High-quality workmanship during assembly

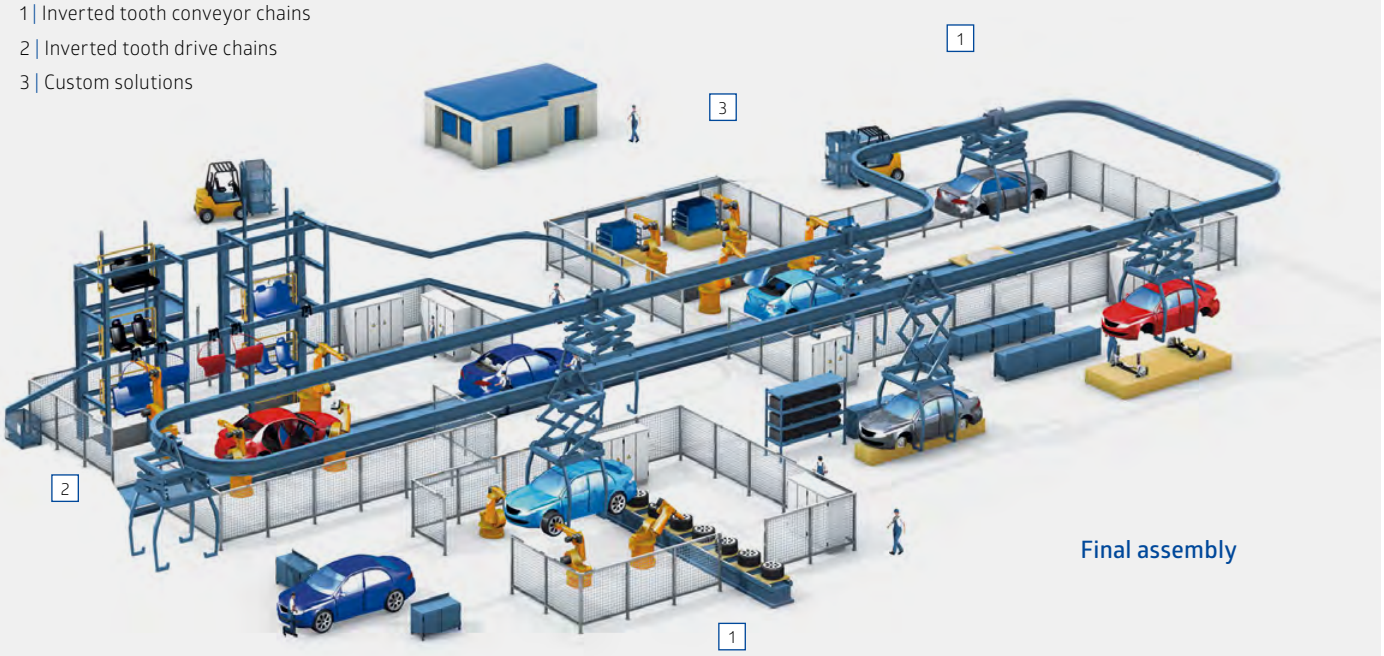
1 | Inverted tooth conveyor chains
2 | Inverted tooth drive chains
3 | Custom solutions



# Powertrain, body and final assembly

**Marriage, final assembly, and quality inspection**
The production process is approaching its peak. The joining of the body and powertrain, i.e. the "marriage" process, results in the lifetime alliance of customer-specified components. The desired combination of engine, transmission, and suspension is now securely tightened with the selected body. During final assembly, the finishing touches are added to the vehicle. Preassembled or supplied modules from other process lines, along with all individual equipment details are assembled manually – with product-specific expertise and enthusiasm. Smooth, efficient assembly requires the reliable supply of vehicle-specific parts, at the right time and in the right sequence. The car can now stand on its own four wheels, is in top functional and visual form, and has been subject to all necessary quality inspections as it rolls off the assembly line.

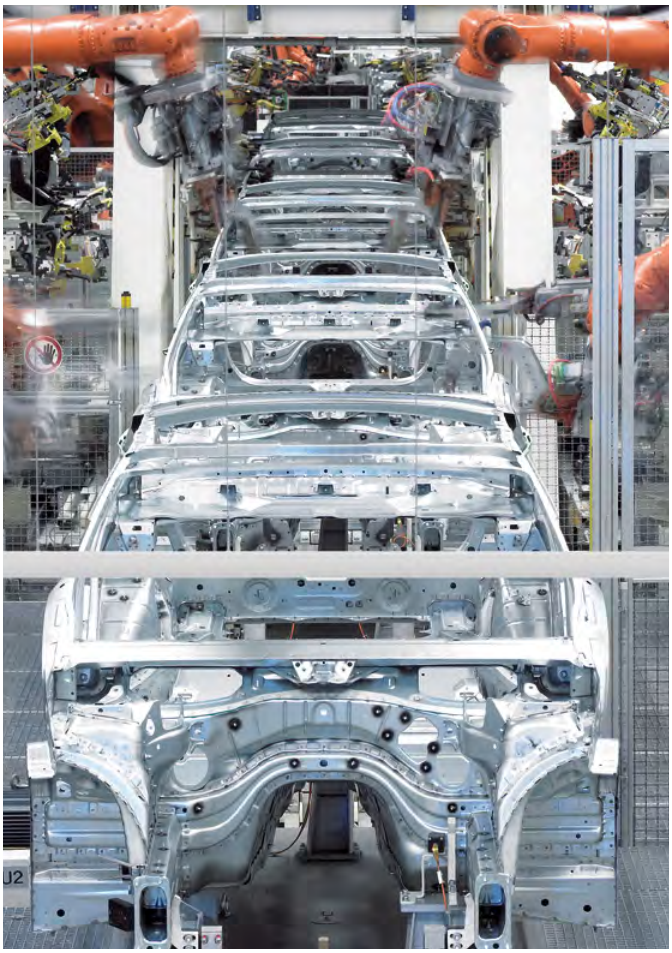
1 | Inverted tooth conveyor chains
2 | Inverted tooth drive chains
3 | Custom solutions




Final assembly

# Reliable, precise, and durable

## Tooth chains for driving and transporting guarantee operational reliability and a long service life



**A wide variety of tasks, always a customized solution**

The tasks required of drive and transport solutions in automation are highly demanding. Whether course or delicate, light or heavy, large or small, bulky, flat, or circular, our inverted tooth chains always transport and convey products, workpieces, and materials safely and reliably to their proper destination. At the right time, in the right position, quickly and slowly.

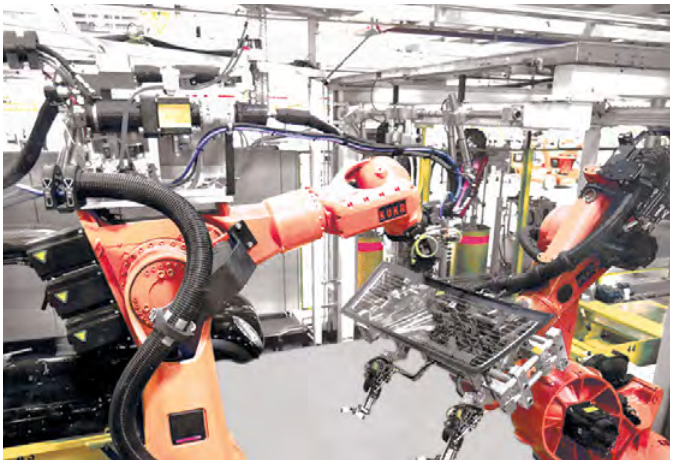
- Great versatility thanks to application-specific designs
- Space-saving and variable in both form and width due to the chain's link plate construction
- Slip-free, quiet operation with involute toothing
- Functional reliability and a long service life with low wear and tear
- Easy assembly/disassembly thanks to the specific inverted tooth chain structure
- Premium materials for a high resistance to ambient conditions
- High-quality surfaces prevent wear on transported goods
- Interlocking driving with link plate form or special drivers

# Function, quality, efficiency

**Inverted tooth chains are the foundation for your processes**
Applications using inverted tooth chains not only aim to directly optimize engines and drives, but also entire processes.

- Extend your system service life
- Reduce maintenance intervals and efforts
- Implement safe, uninterrupted drive and transport solutions
- Ensure gentle handling of system parts
- Minimize system components, create lean machine designs, and get smaller diameters
- Achieve improved accident protection, closed link construction

Inverted tooth chains can contribute to substantial savings for automation. They can also be individually configured and optimized for specific applications.



## Important considerations for engineering drive and transport solutions with inverted tooth chains

**Elongation/service life**
The elongation behavior of an inverted tooth chain refers to the operation-related elongation of the chain under tensile stress. Inverted tooth chains with pivot joints have demonstrated the best elongation properties and thus the lowest wear.

**Installation situation**
For applications with conveyor technology and linked machines, individual solutions must be configured, standardized, and adapted to specific installation situations.

**Assembly/maintenance/safety**
Assembly should be straightforward and maintenance operations flexible and absolutely reliable, without special aids.

**Chain tension/sliding material/lubrication**
It should be easy to correctly tension the chain. Sliding materials and lubrication processes need to be configured for your specific application.

**Choice of materials**
The properties of the inverted tooth chain materials must be optimized for the specific application conditions.

**Variety**
A comprehensive range of individually configurable products, components, and optional extras is required to cater to the wide variety of applications in the automotive industry.

(See more on these topics starting on page 22)

# Application solutions with inverted tooth chains

## Drive and transport tasks in press, body and paint shops

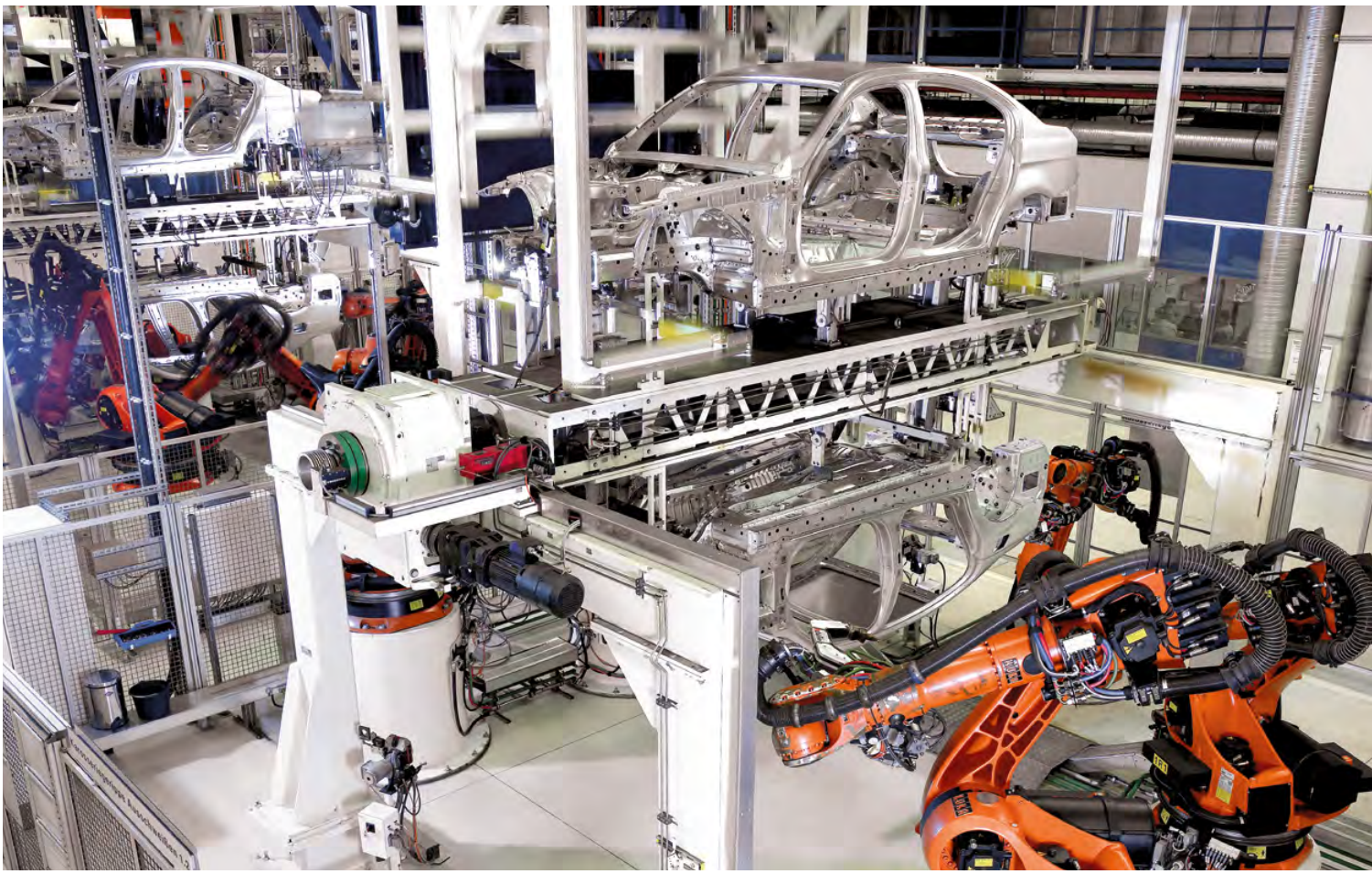
**Destined for the safe lane**

In addition to transporting materials, semi-finished parts, and bodies, inverted tooth chain solutions take over specific driving tasks in machines and systems in body construction. As a long-term partner of the engineering industry, our inverted tooth chains are especially at home in this sector. “Renold inverted tooth chains inside” is a favored approach among engineers. They rely on the power, speed, and reliability of our high-performance inverted tooth chains.

- Supply of heavy-duty steel/aluminum rolls
- Supply and further transport of plates
- Body-in-white transport in automatic assembly lines
- Inverted tooth drive chains for robot arm movements
- Inverted tooth drive chains for movements in dip tank systems
- Body transport along painting lines

***Crossarms***

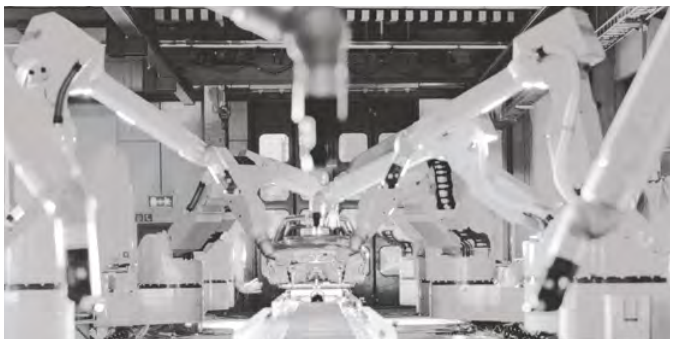
*With application-specific system units, material supply tasks can be efficiently controlled in the press shop. Crossarms with integrated inverted tooth chains pick up pressed parts (plates) and move them to the next workstation.*



***Robot arm***
*Drive for rotary manipulator movements*


**Inverted tooth chains in coating and painting systems**
High-performance inverted tooth chains enable the reliable implementation of traversing and lifting movements in modern coating and pretreatment systems. With a unique combination of dipping, lifting, and turning, the bodies can be individually rotated through the process tanks. The resulting coating process is not only ultra-flexible, but also energy-efficient. Moreover, the process minimizes operating costs while ensuring a high surface quality. These inverted tooth chains can easily handle actual loads of 1000 kg at lifting speeds of up to 20 m/min without a problem.

***Coating systems***
*Body-in-white transport through painting line*



# Application solutions with inverted tooth chains

## Precise part transports in the production of powertrain components: engines, gears, axles

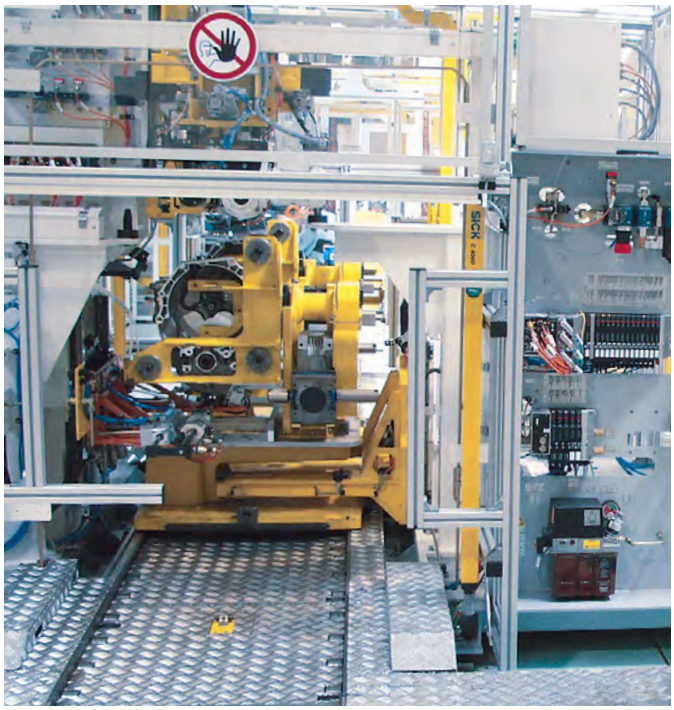
Achieving an enormous variety of models with many different variants and short product cycles is a major challenge for automation in powertrain component production. In these processes, modules produced at different stations as well as supplied components need to be joined successively with extreme precision for subsequent production steps.

- Interlocking driver units can be easily integrated in inverted tooth chains
- High flexibility for changeovers
- Conveyors can be simultaneously loaded with a multitude of workpieces

The inverted tooth chain conveyor sections are designed for maximum loads and versatile applications. Their specific structure ensures that the applied weight is distributed equally over the entire chain width. This results in a large contact surface with very low surface pressure.

***Engines en route to the testing station***
*Engine components are securely positioned on the assembly frame and move safely through the entire measurement and testing station with the inverted tooth chain transport unit.*

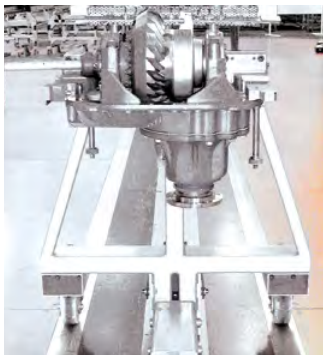
**Secure powertrain assembly**
In the production of engine and transmission components, inverted tooth chains are used to supply and remove components during fine mechanical processing. Their gentle operation and special transport surfaces prevent component damage. The chains are an integral part of custom-designed concepts for component machining and processing.



**Module transport along the tooling line**
Transport modules based on standardized chain conveyors are implemented as floor and overhead conveyors. The assembly frames move through the preassembly section where they are equipped with engine and chassis components and then transported up to the lift station, where the marriage later takes place.

**Conveyor sections for interlinking machines**
Inverted tooth chains are not limited to transport applications. Thanks to their special properties, they also have tasks within production processes, e.g.:

- Conveyor sections for truck transmission components
- Conveyor sections for processed gear sprockets
- Conveyor sections for complex components, e.g. camshafts or crankshafts, also during processing. Resistant to temperatures up to 800 °C



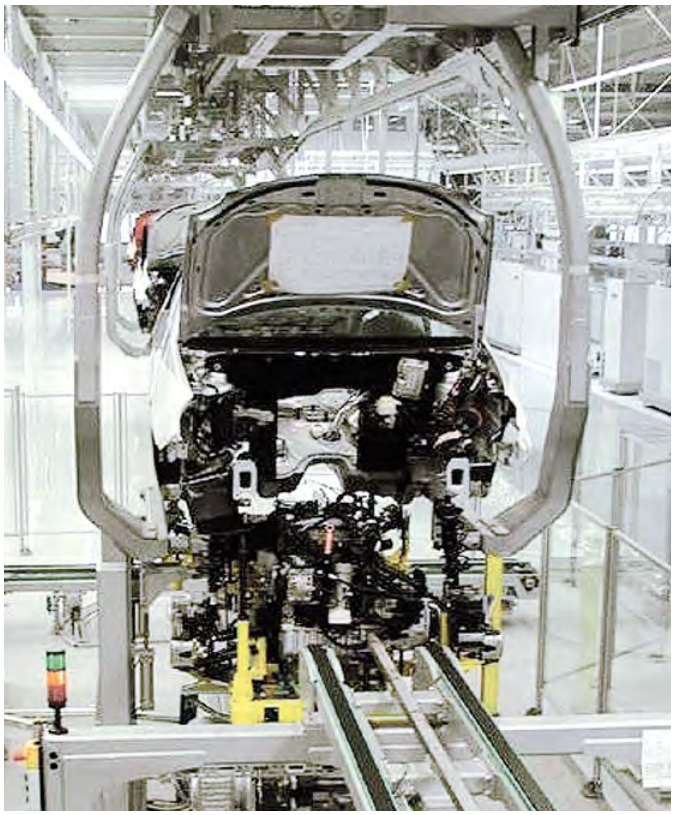
# Application solutions with inverted tooth chains

## Individually made conveyor sections transport the vehicles from marriage to quality control

**No marriage without chains**

During final assembly, inverted tooth chains have an integral role in automated conveyor sections. Chain conveyors in segmented units measuring 5 to 20 m in length, for example, are combined on the required sections and paths to create lines up to several hundred meters configured for specific loads. As longitudinal or cross conveyors, overhead or floor conveyors, they form a vast network of pathways that includes entire assembly lines and joins subsequent processes with just-in-time precision.

Due to the high requirements – for precision, force, service life, and user friendliness – high-performing inverted tooth chains are the primary choice in this application environment. They enable a particularly lean construction for compact machine designs. Even the smallest return diameters can be achieved with a slip-free transmission of power.



***Overhead conveyor sections***
*Certain process stages and procedures require additional functions. Conveyor sections may also require transport solutions that automatically pull along an electric overhead conveyor.*

**Inverted tooth chains: assembly, operation, maintenance, accident prevention**

The assembly of inverted tooth chains is based on a simple principle and can be individually adapted to specific spatial constraints.

Inverted tooth chains can be opened, modified, and closed again at virtually any point.

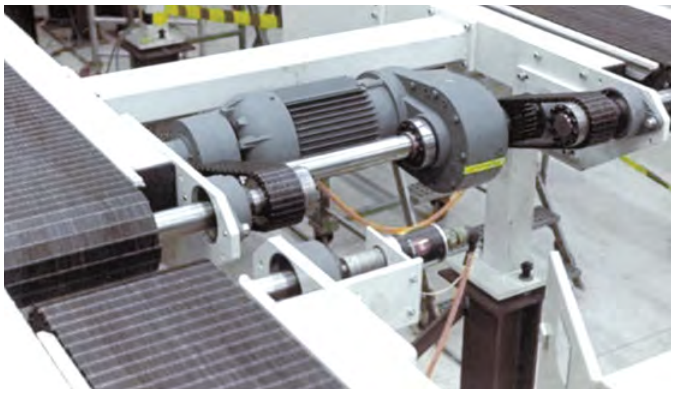
There is no need for any special auxiliary tools. Operation is just as easy and does not require any special tools either. Any subsequent tensioning, for example, can be quickly achieved by adjusting the axle distances. Simplicity goes hand in hand with safety: thanks to their compact design with a closed link construction, inverted tooth chains virtually exclude any hazards caused by reaching into the chain surface.

- Assembly and maintenance without special aids
- Long service life, silent operation
- Compliance with accident prevention guidelines

**Inverted tooth chains – guiding the vehicle through to quality assurance**

On assembly lines, the vehicle gets heavier at every new station. Conveyor sections with inverted tooth chains are fit for this challenge. They are ideally configured for maximum loads and pull their weight with unerring accuracy, setting a clear pace for final assembly. This level of reliability and productivity top the list of requirements in automobile production.

- Just-in-time vehicle transport
- Precise supply of parts and modules for assembly
- Drive and transport in testing stations



***Test benches***
*Inverted tooth drive chains and inverted tooth chain conveyor sections in the final testing stations for complete vehicles. During automatic wheel measurement and alignment, the wheels are situated between "combing" drivers, which guarantee optimum safety and accident prevention.*

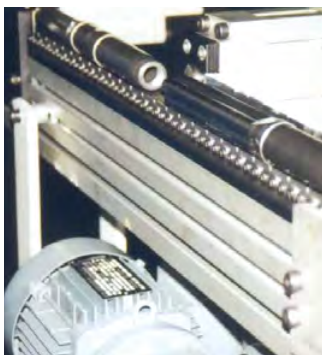
# Special tooth chain solutions

## Special tasks demand special solutions – no problem with our inverted tooth chains

**Absolutely adaptable and always ready – even when the going gets hot**

Inverted tooth chains are often custom-built. Each chain is individually configured and designed with the specific application requirements and working environment in mind. In addition to a variable form and width made possible by the lamellar structure, numerous different toothed link plates and materials are what drive the wide variety of potential applications. Additional equipment options or drivers custom-built for the conveyed goods round off the spectrum. From tricky and heavy to glowing hot or extremely bulky, whatever you need to move, our inverted tooth chains have seen it all.

- Great variety thanks to application-specific designs
- Individual drivers and equipment options
- Also for transport jobs in the direct production process



**Transfer stations, rotary and lift units**

Conveyor sections can be flexibly adapted for the specific movement sequences and spatial conditions of production lines. Lift units can make minor adjustments – with millimeter-level precision – to compensate for changing transport heights.

**Production and transport of drag links**

Thanks to their thermal strength, inverted tooth chains can also be used in direct production lines for steel molding. Drag links are securely conveyed by special V-form link plates or by raised toothed link plates fitted at the sides.

# Inverted tooth chains are spot on

## Tooth chains work fast, precise, and quiet – best arguments for efficient automation

*Skill through and through. Professional equipment, talent, and experience, a secure position, and a focus on the essentials. The perfect mix provides the basis for optimal results. We've made sure all our parts are strategically aligned for the automotive industry.*

**Over 100 years of inverted tooth chain experience in every detail**

Quality has a tradition. We have worked in close cooperation with our customers for decades to consistently optimize our products and systems. All this helps to meet rising demands for higher production speeds and longer service lives. Inverted tooth chains not only fulfill today's requirements, but are also a future-oriented technology with unique advantages.

**A multitude of strengths by design**

The inverted tooth chain is a cohesive network of sturdy links. It is made of numerous link plates and profile pins. The result: a powerful and flexible chain drive that can be perfectly adapted to the task at hand.

**Arguments for automation solutions with inverted tooth chains from Renold**

We have perfected our inverted tooth chain technology and maintain the world's largest delivery program.

- Pivot joint with 2-pin system, laser-welded outer links, unique rounded edges
- Continuous optimization and product variety
- Application-specific versions
- Inverted tooth chains and sprockets from a single source
- Individual configurations based on modular concept
- Various materials, constructions, guide types, pitches

**Continuous optimization of link plate forms**
Improvement through experience. Renold consistently translates practical knowledge into new product solutions. One example is the enlarged contact surface for inverted tooth chains with an extended pitch. Compared to multiguides, the problem of vertical wear caused by abrasion on the teeth is reduced across the entire chain width.

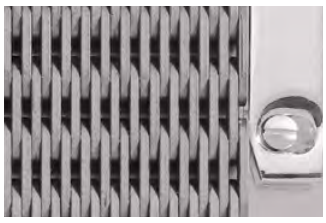
**Special versions and optional extras**
Each day is different from the next. With special link plates and specific contact surfaces, the wide range of applications for inverted tooth conveyor chains can be broadened even further. Some examples include cycle lines with easy-to-integrate solid driver blocks or complete driver chains for drive-in test benches.

**Laser-welded outer links**
Laser-welded inverted tooth chains have a smooth contact surface on both sides and can be routed directly alongside the guide rails, since protruding rivet heads are eliminated. This ensures an even longer service life, as removing obstacles minimizes damage.

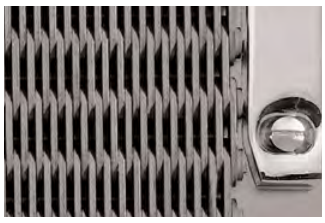
- Connecting links with uniform plate width
- No lateral movement of joint pivots
- Larger side surface prevents lateral wear

*Driver blocks*

*Ground-in longitudinal profiles*



*Laser-welded*



*Riveted*

*Lateral drivers*

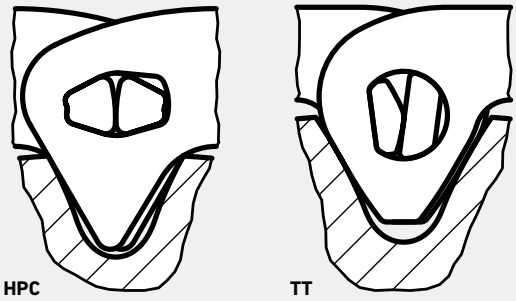
*Inverted tooth chain in mirrored pairs for outfeed lines*

*Biflex: Drive for both sides and directions*

### Why are inverted tooth chains with rolling pivot joints the right choice?

One of the main reasons that account for the superiority solution is the unique two-pin rolling pivot joint of inverted tooth chains from Renold. An axle pivot rolls against a rolling pivot. The pivots are pressed into the link plates under tensile force, preventing any further movement. Because the pins maintain permanent contact, the layout of the inverted tooth chain has no impact. Inverted tooth chains with rolling pivot joints therefore permit more design options and can be tailored to individual production processes and requirements. Because the link plates are static in relation to the pins, any loss of strength due to thermal loads is insignificant. With their extremely low friction coefficient, inverted tooth conveyor chains only require minimal lubrication.

## Optimal joint kinematics

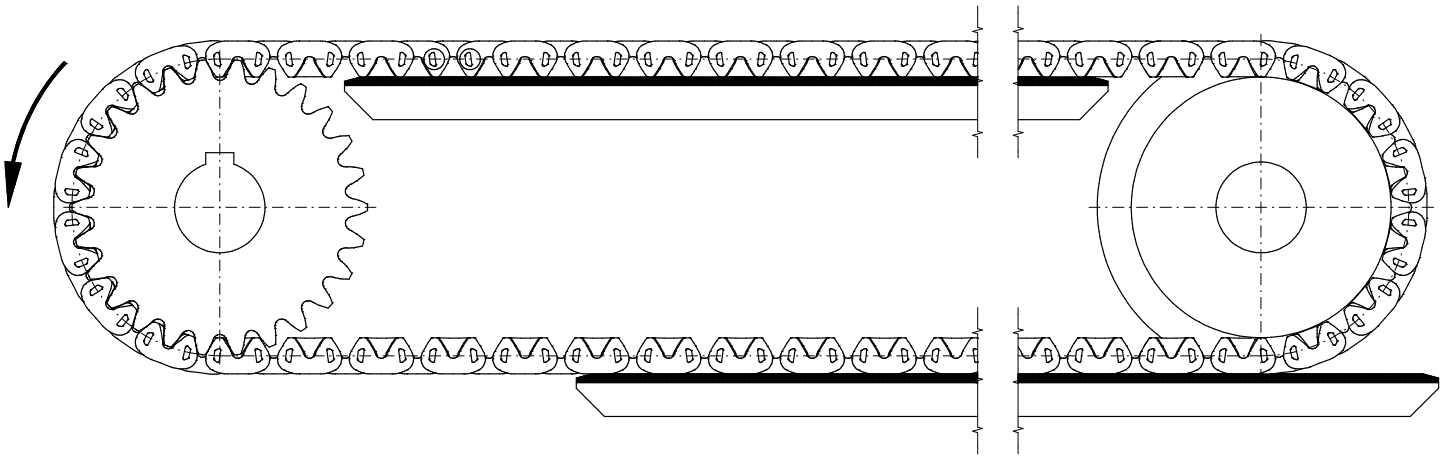



### Two-pin rolling pivot joint

The two-pin pivot joint ensures that only rolling friction is produced during bending in the sprocket.
Sliding friction is virtually eliminated; less force is used and natural wear minimized. The drives consume significantly less energy.

### Interlocking connection: inverted tooth chains and sprocket

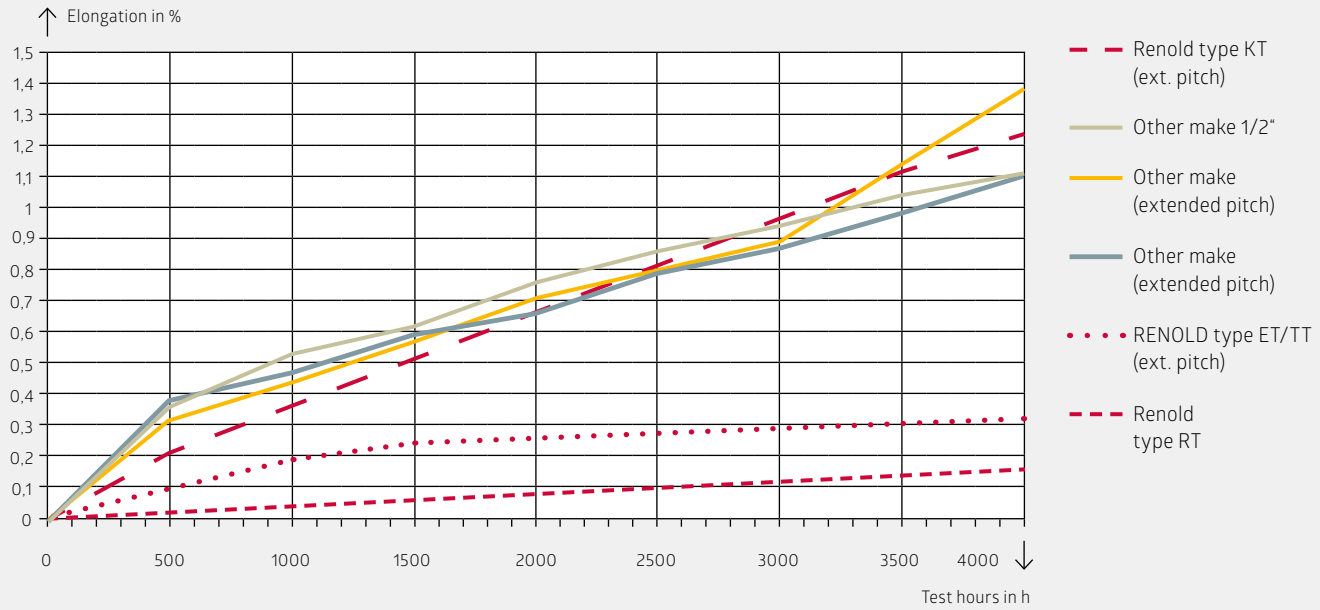
The correct meshing of chain and sprocket is a prerequisite for trouble-free, continuous operation. All relevant dimensions and profiles are optimally aligned to achieve slip-free movement. Whenever technically feasible, sprockets are manufactured according to the specific needs of the customer. The design of the toothing is adapted to the guide type of the selected inverted tooth chain. Of course, all special versions are also available with guide slots for various chain widths and can be prepared for center and side guides. C45 heat-treated steel sprockets with hardened tooth flanks are used as a standard with proven resistance to wear. For an even longer service life without compromising on strength, we also use vacuum-hardened tool steel for extreme thermal loads.



### Elongation

Due to sliding friction and increased wear of the joint, elongation in 1-pin chains can be up to three times higher than in 2-pin systems. The 2-pin rolling pivot joint with hardened axle and rolling pivots from Renold only creates rolling friction. Even though some wear also occurs at the contact line of the pins, it is evenly distributed on both pins as well as the inner and outer links. The meshing conditions remain constant over the entire period of use. These characteristics are the basic prerequisite for precise angle synchronization.
As shown in the diagram, studies have demonstrated that the elongation of inverted tooth chains is up to three times less with rolling pivot joints instead of single pin joints. Single pins generate constant sliding friction which accelerates wear. Rolling pivot joints only generate rolling friction.
For a RT type inverted tooth conveyor chain, this means a minimal elongation of only 0.17% after approximately 4000 test hours, i.e. about 1.7 mm elongation per meter of the chain. This elongation is insignificant for the proper functioning of a conveyor chain application.
Inverted tooth chains with a 1-pin system, in contrast, exhibit an elongation of approx. 11 to 14 mm per meter.

**Chain elongation in inverted tooth conveyor chains, dry running, no load, 1/2“ and 1/2“ extended pitch**
**Test speed v = 1 m/s**



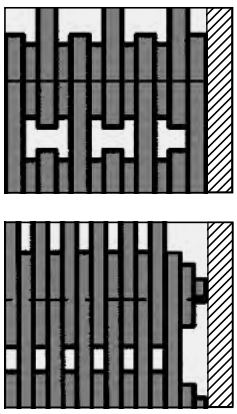

### Rolling friction/sliding friction

A simple comparison of friction coefficient μ for rolling and sliding friction clearly illustrates that rolling friction requires far less force.

**Friction coefficient: steel on steel**
**Sliding friction μ = 0.1, rolling friction μ = 0.01**

Picture a tricycle and a sled: the tricycle uses rolling friction and has a greater ease of motion than a sled with sliding friction. Sliding friction also depends on the sliding quality of the material. This is negligible with rolling friction.

### Laser-welded outer links



Rolling pivots are laser-welded in the outer plates of inverted tooth conveyor chains from Renold. The rivet heads no longer protrude and the inverted tooth chains can be placed flush to the sides with minimal gapping.
This increases the operational reliability and safety of the chain and the chain width remains constant throughout its entire service life.

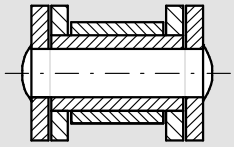
### Requirements for modern production systems are universal

- Achieving flexibility for a wide variety of models
- Maximizing the degree of automation
- Increasing availability for flexible manufacturing processes
- Minimizing changeover times
- Cutting down on maintenance intervals
- Achieving the required or reasonable service life

### All objective factors point to drive and transport solutions with inverted tooth chains from Renold

The advantages of the inverted tooth chain with rolling pivot joint compared to other chain drive systems, especially roller chains, are fundamental and based on their design. Inverted tooth chains ensure that elongation is evenly distributed across all parts of the chain; the pin movements generate minimal friction and the compact link construction enables high tensile forces and heavy conveyed weights. In sum, these superior properties result in reliable, trouble-free continuous operation and long service lives. Given a similar chain width, inverted tooth chains have a much higher breaking load.

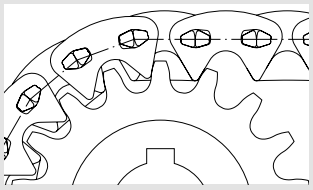
## Comparison roller chain and inverted tooth chain



*Profile/roller chain*

*Rolling pivot joint*

*Roller chain*



*Tooth chain*

The graphic shows a roller chain shortly before failure due to elongation. Friction and wear is visible between the pins and bushings. Because the outer links have a different pitch than the inner links, the chain is also prone to running on different pitch diameters. The result is jerking in the sprocket and a jolting, uneven drive. On the inverted tooth chain, it is clear that there is no friction between the pins and bushings; instead the two pins roll against each other. If wear does occur, the inverted tooth chain readjusts its pitch diameter and can continue to run without jerking.

## Numerous arguments for using tooth chains

### Argument: elongation

| Tooth chain | Roller chain |
|---|---|
| → Equal elongation across all chain parts | → Varying elongation of outer and inner links |
| → Result: reliable functioning and a long service life | → Result: uneven running, poorly distributed strain |

### Argument: friction

| Tooth chain | Roller chain |
|---|---|
| → The two profile pins roll against each other smoothly, ensuring minimal friction and a very long service life | → Sliding friction between the bushings and pins<br>→ Sliding friction between the bushings and rollers<br>→ Two friction surface pairs that require lubrication and regular maintenance |

### Argument: link plate construction

| Tooth chain | Roller chain |
|---|---|
| → Compact link plate construction enabling high tensile forces and heavy conveyed weights<br>→ Laser-welded outer link plates for optimal guiding and protection of the guide bed | → Limited number of link plates, resulting in a lower tensile force<br>→ Protruding rivet heads and connections lead to wear on the guide bed or require special guide bed modifications |

### Argument: accident prevention

| Tooth chain | Roller chain |
|---|---|
| → Compact, dense link construction; laser-welded side plates<br>→ Homogeneous chain surface, protected guide bed | → Relatively open link construction<br>→ Accident prevention regulations demand extensive housing for the rollers |

### Argument: lubrication

| Tooth chain | Roller chain |
|---|---|
| → Rolling pivot joints remain lubricated over a long period with a single application of lubricant | → Dry running quickly leads to heavy wear and destroys the chain in no time |

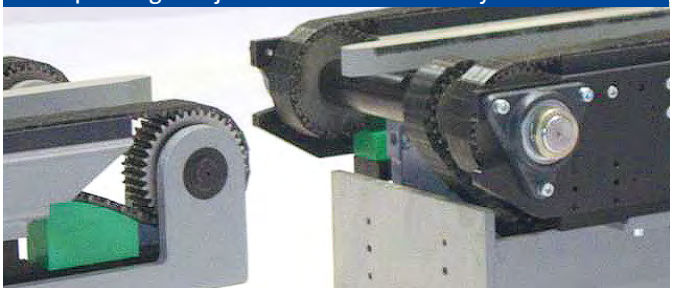
### Inverted tooth chains and inverted tooth conveyor chains

The variable design of inverted tooth chains ensures the optimal solution for every drive and transport task. Conveying sections with inverted tooth chains are precise and reliable, and can be adapted to new requirements at any time and with little effort. In many cases, the transported goods can rest directly on the inverted tooth chain without any additional equipment. Where necessary, special plates can be fitted to mount workpieces onto the conveyor chain. Large and bulky parts are conveyed to the desired position using product carriers configured with two inverted tooth chains.

### Advantages of conveying sections with inverted tooth chains

- Compact, dense link construction, compliant with accident prevention regulations, laser-welded side plates
- Equal distribution of tensile force on all toothed plates
- Supported weight is distributed over the entire chain width
- Low surface pressure increases the service life of the guide bed
- Service life up to 5 x higher than other systems
- Non-critical accumulation operation; reversing operation possible
- Highly compact dimensions with small bending radii
- Changes in cycle times do not affect the chain

### Example: height adjustments on chain conveyors



In practical applications, imprecise height adjustments of the chain conveyor repeatedly lead to differences of 2 to 3 cm. As a result, during load transfers, the entire weight falls on the last tooth and the last link of the inverted tooth chain. In the long term, this irregular load situation can only be successfully handled by inverted tooth chains. Roller chains, in contrast, will quickly exhibit design-based defects! If height differences are present, the assembly frames run up against the first rollers and deform them. This means frequent system inspections and extensive work.

### Automated guided vehicles (AGVs)

- High costs due to floor-bound transport system
- Limited potential for cycle time changes
- Slow driving speeds due to safety considerations
- Maximum speed limited by braking capacity

### Example: cross conveyors

On a cross conveyor, up to four or five assembly frames sit on the same inverted tooth conveyor chain – this can result in a weight of up to approx. 8000 kg. All in a day's work for inverted tooth chains.

One alternative would be a triple roller chain with a 1" pitch as a minimum. This requires larger profiles (steel and guide bed) and results in a roller chain that is open enough to allow small parts to fall into the chain. In addition, other transfer aids would be required: for systems with roller conveyors, the cross conveyor is usually an inverted tooth chain conveyor (problem of interlocking transfer).

### Roller conveyors or roller conveyor lines

- Several individual drives, highly audible running, low precision, no interlocking driving possible
- Small load-bearing surfaces – high surface pressure near individual bearing points
- Due to accident prevention regulations, the rollers can require housings – tightening technology can only be used to a limited extent
- Heavy-duty rollers need to be used for heavy surface loads
- Fluctuating transport heights lead to an uneven load distribution
- Limited potential to change cycle times due to smaller bearing surfaces

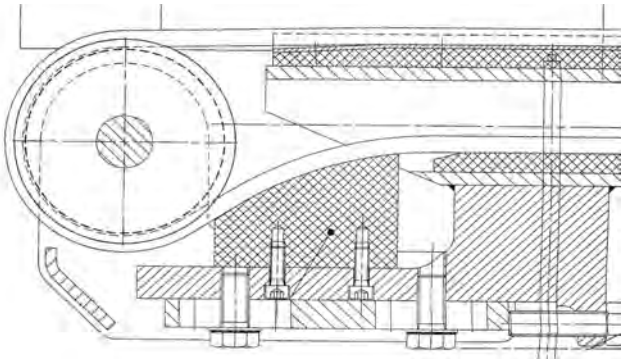
### Chain conveyors as standardized basic units in the automotive industry

Specialized systems manufacturers and line builders have collaborated with the automotive industry for decades in the development of high-performing system units. These modules are integrated in automobile manufacturing processes and can be adapted to implement specific configurations. This approach enables simple and efficient application-specific solutions.
Chain conveyors for longitudinal and transverse conveying make up the basic segments. Conveyors with inverted tooth chains can be universally applied, no matter what load needs to be carried. In automobile production, assembly frames are placed directly on inverted tooth chains and conveyed to the individual stations, up to the marriage of the vehicle.
The reliable functioning of inverted tooth chains, as well as their service life, is increased by selecting the right lubricants. Ambient conditions such as temperature, humidity, dust and the permissible specific pressure load play a key role.

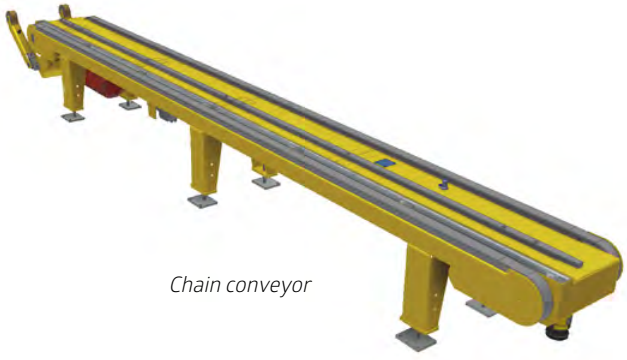
We use:

- PE and PA plastics, similar to DIN 7728
- Spring band steel C75S (hardened and tempered)

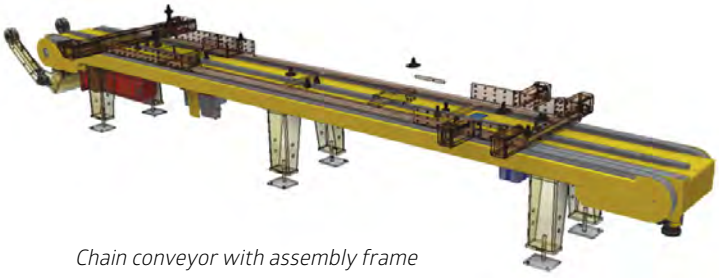
The specific surface pressure for individual applications is calculated for the most frequently used and recommended materials (while taking the contact lengths and chain width into account). The general rule: the lower the surface pressure, the longer the service life of the sliding material.



***Technology***
*Elevation of the guide bed by approx. 3 – 4 mm for a smooth transfer of transport frames, feed slope 10 – 15° on the slide surface. Minimal distance between guide and sprocket to avoid buckling.*

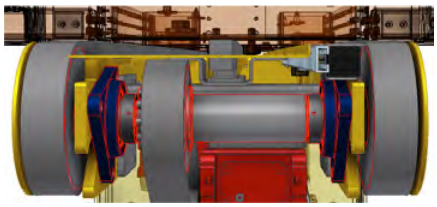


*Chain conveyor*



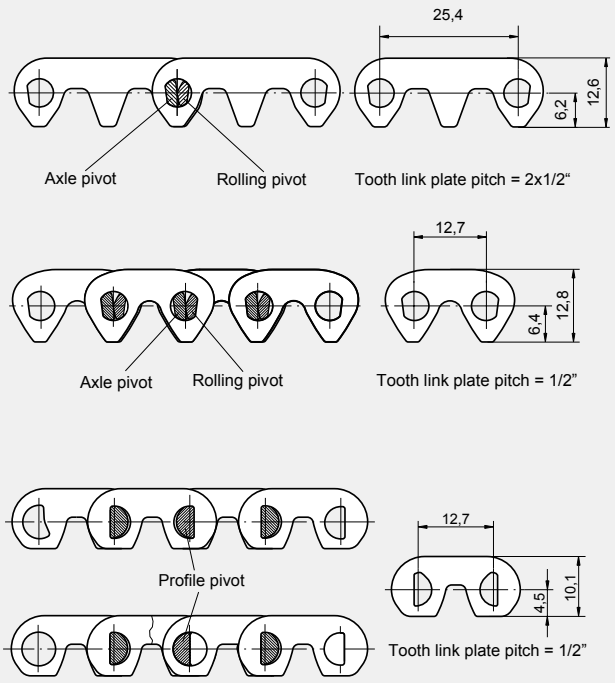
*Chain conveyor with assembly frame*

*Head drive on a chain conveyor*

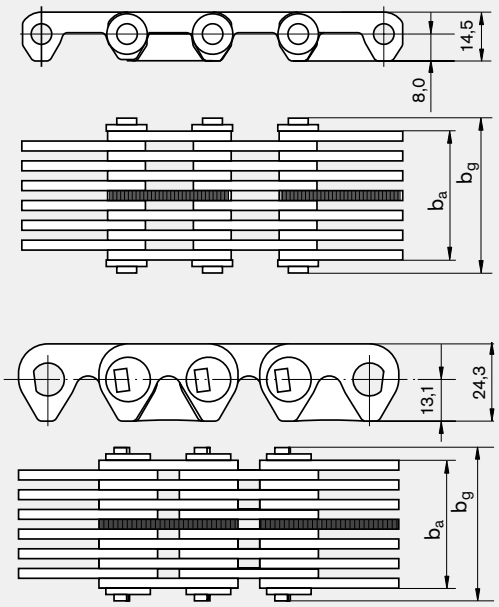


*Head drive on a chain conveyor (housing hidden from view)*
*2 inverted tooth conveyor chains, type TT-55-CL (outside)*
*Reduction gearing: 1 inverted tooth drive chain, type HPC (inside)*

## Design features of ½“ inverted tooth chains for standard applications




## Design features of 1“ inverted tooth chains for heavy-duty applications



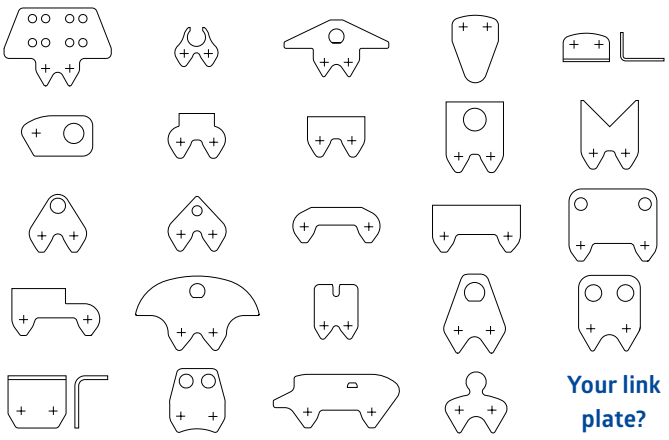

*$b_a$: Working width* *$b_g$: Overall width*

### Selecting the right chain

Selecting the right inverted tooth chain type, in its specific version, including construction and guide, makes it possible to define the chain that is ideally suited to the specific drive and transport requirements of your application. We offer the most comprehensive range of inverted tooth chains worldwide. And our specific expertise in the automotive industry is backed by 30 years of experience.

### Examples of special inverted tooth chain versions

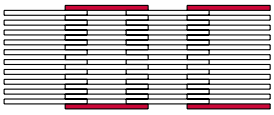
The wide range of applications for inverted tooth chains can be expanded even further by using special link plates, e.g. massive driver blocks for cycle lines, as well as ring links or forked plates. We offer a wide selection of existing special plates. New forms can also be created quickly through laser cutting.




## Standard guide types

### Center guide

A row of guide plates is situated at the center of the inverted tooth chain. These plates enter a guideway in the sprocket and center the chain. For universal use regardless of the existing sprocket width.

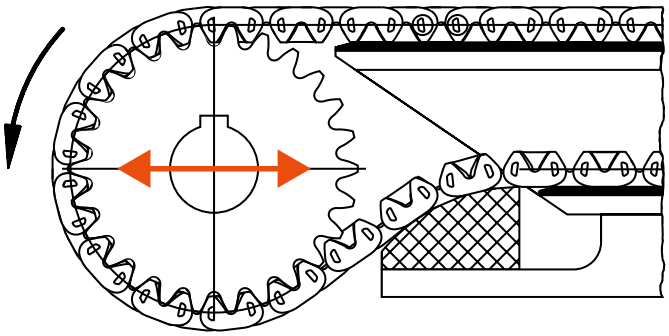


### Side guides

The inverted tooth chain has a row of guide plates on each side which enclose the sprocket teeth and center the chain. The link construction at the center of the chain is completely homogeneous. Adjustment to the sprocket width necessary.

### Assembly and maintenance of inverted tooth chains

Due to the positive sprocket powered drive system, inverted tooth conveyor chains do not require pre-tensioning. Subsequent tensioning is usually accomplished by adjusting the shaft center distance.
If the retensioning stretch has been reached, the inverted tooth chain can easily be shortened.
Inverted tooth chains have a relatively rigid back and cannot be forcibly bent over backwards.
Depending on the type, pitch, and version, returning slack spans with correspondingly large radii can be implemented.
Versions without rigid backing are available for special cases.



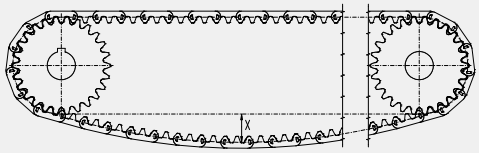
*Changing the shaft center distance*

### Adjusting the chain tension

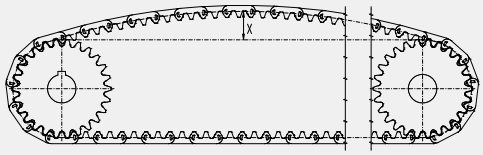
You can set the tension with one of the following methods:

- Removing or adding chain links
- Using an idler sprocket
- Using sliding rails
- Adjusting the shaft center distance

Checking the chain tension
a) With sagging



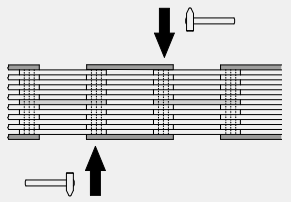

b) If the slack span is supported in the profile



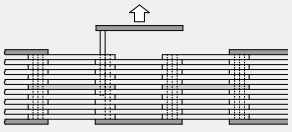

**Approximate values:**
one direction of rotation: x = 0.01 to 0.015 x shaft ctr. distance
reversing operation: x = ≤ 0.01 x shaft ctr. distance

### Shortening or lengthening inverted tooth chains

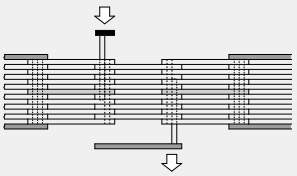
Inverted tooth chains and inverted tooth conveyor chains are generally delivered in the required installation length. For yard goods, the chain lengths of all inverted tooth drive and conveyor chains can be shortened or lengthened by two links or a whole-number multiple of two links without any special tools. Detailed information on shortening and lengthening can be found in the operating instructions.



**Inverted tooth chains with split pin fasteners**
This variant can be opened and closed without damage.

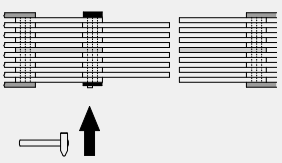


**Riveted inverted tooth chains/riveted closure**
Grind off the rivet head at any point. Create a new riveted closure.



**Laser-welded inverted tooth conveyor chains**
Force open the pins with a blow to the front side at any point and create a new riveted closure.

**Always observe the correct pin assembly**
An incorrect pin arrangement results in uneven running and may lead to chain breakage.



### Proper lubrication for inverted tooth chains

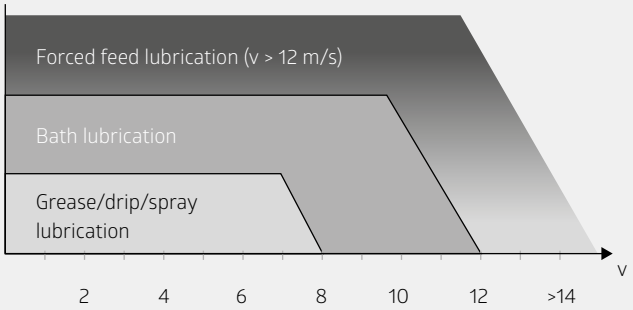
Dry running shortens the service life of a chain considerably. To keep wear to a minimum, inverted tooth chain drives and inverted tooth conveyor chains should be regularly lubricated. The type of lubricant depends on the speed at which the inverted tooth chain operates. The oil film placed on the chain is for corrosion protection only and does not act as a lubricant. A thorough initial lubrication should take place before installing an inverted tooth chain.

### Grease, drip, and spray lubrication

Applications involving conveyor tooth chains normally have far slower operating speeds and thus use grease, drip, and spray lubrication. At room temperature, free-flowing grease with HP additives (high pressure) as well as oils with good adhesion and creeping properties have produced good results. In the automotive industry, approved silicon-free Teflon sprays are also available. If a thorough initial lubrication has been applied, the lubricant will adhere for long intervals near the rolling pivot pin due to the low speeds in the conveying area. This makes the chain virtually maintenance-free.

The lubrication between the inverted tooth chain and sliding material can significantly increase the service life of the guide bed. Lubrication is absolutely mandatory if steel is used as a sliding surface. The lubrication interval depends on a variety of ambient conditions. With their user-friendly application and long-lasting lubrication properties, Teflon sprays are a proven alternative for the sliding surface.

### Lubrication based on the inverted tooth chain speed (v in m/s)




### Grease, drip, and spray lubrication

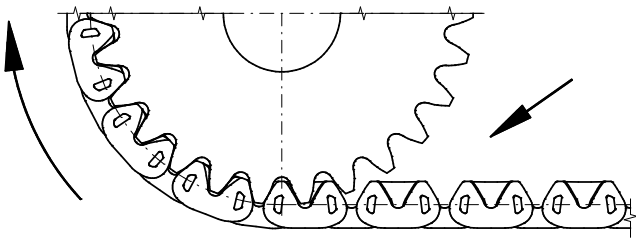
Lubrication with free-flowing greases and oils with good adhesion and creeping characteristics or with volatile elements of diluted lubricants. Regular lubrication depending on speed.

### Bath lubrication

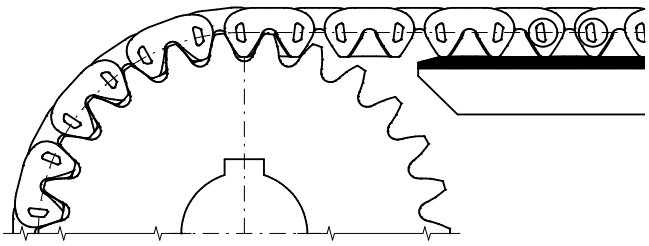
Lubrication by immersion in an oil bath. The inverted tooth chain should be adjusted so that it enters the bath with its joints at the their lowest point when the machine is not operating.

### Forced feed lubrication

Forced feed lubrication requires a closed, oil-tight housing. The inverted tooth chain is above the oil pan; the spray nozzles are pointed at the tooth side.



*Lubrication should always be applied on the tooth side*



*Inverted tooth chain on sliding material*

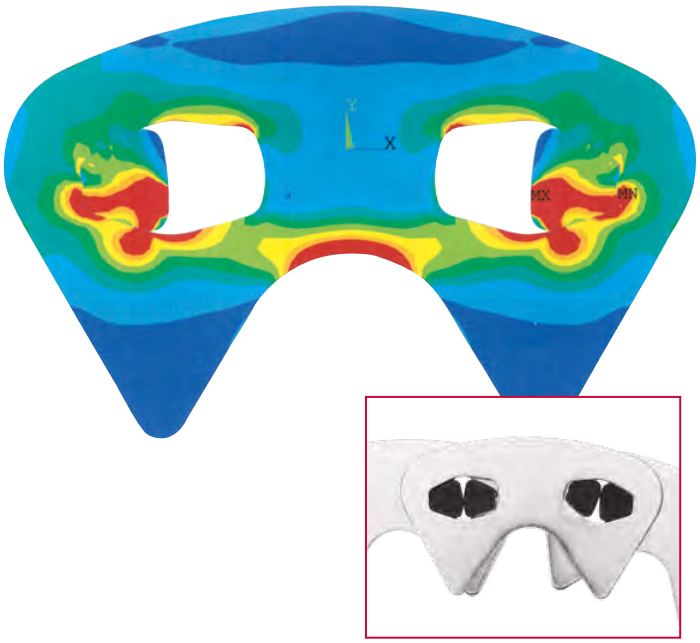
# Always the best for your applications

## Targeted innovations and dedicated service guarantee the best for your applications

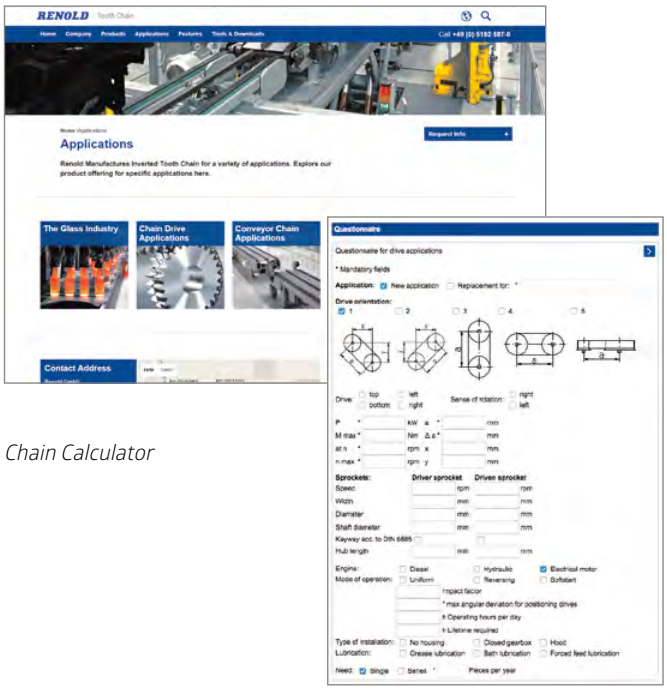
**Our internationally active expert teams for product development and industry solutions help you reach your goals!**
Because requirements change, improvements are always possible, and a technological edge can mean the world, we strive to create even better solutions, day in and day out. Our customers should rest assured that they are receiving the best support and that their inverted tooth chain technology is nothing less than state of the art. We focus on continuous improvements in power transmission, perfecting synchronization, and cutting wear to a bare minimum.

- Industry-specific product innovations
- Components with needs-based add-ons
- Customer-specific overall solutions

Using the latest technical methods and field-specific knowledge needed for the customers' tasks, we calculate and develop the most suitable configuration. Inverted tooth chains and sprockets are perfectly matched throughout our planning. Consult our online Chain Calculator as a first step toward the perfect inverted tooth chain solution. Take advantage of this online tool for your query or drive layout!



*Optimization of link plates*




*Chain Calculator*

# In dialog with our customers

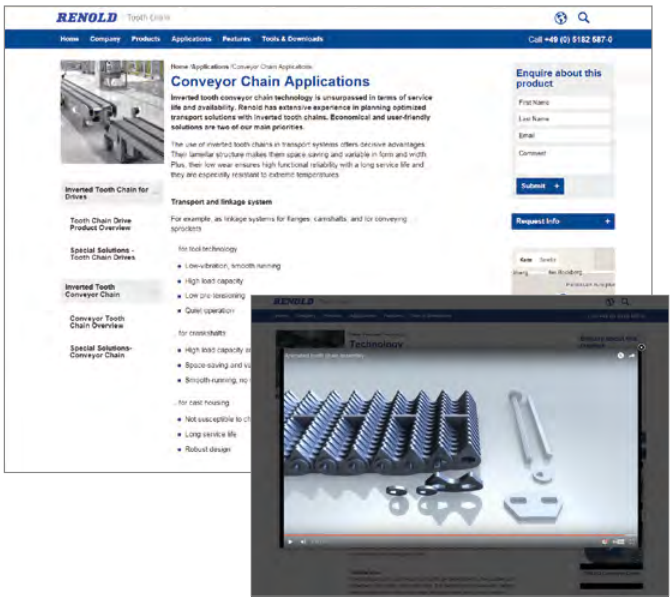
**Based on proven expertise and a first-class product portfolio**
Our understanding of cooperation goes well beyond the boundaries of individual projects. We are constantly in dialog with our customers and are always a competent contact for both technical and economic questions. Our cross-technology expertise creates the solid foundation for our work.

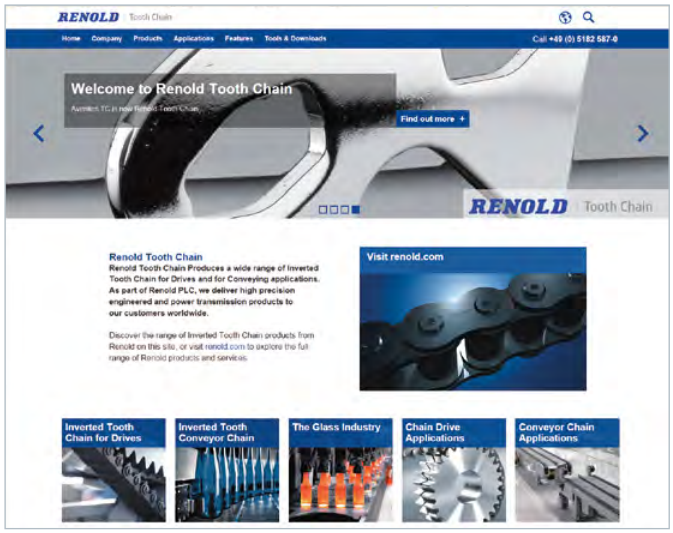
- Inverted tooth conveyor chains
- Inverted tooth drive chains

Understanding our customers allows us to respond more quickly and gives us a head start in achieving tailor-made solutions. Thus, we always remain close to the action and ensure the technological lead for our customers.

**Around-the-clock information**
The Renold Internet Portal never sleeps. Our Internet pages contain a wide variety of technical details for our product spectrum.

- Product highlights
- Internet platform with online tools



RENOLD | Tooth Chain

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**For local support contact your local Renold sales team, visit www.renold.com or call +44 161 498 4600**

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