

Always One Gear Ahead



Synchronizer rings – precision parts for the automotive industry

Challenges

Efficiently advancing technologies



Economic growth and progress depend on mobility. By the year 2025, almost eight billion people will live on our planet. Every day, more and more people and goods are transported across ever increasing distances. The world might be growing together but it is also growing bigger.

Proximity to our customers and directing our development activities to their goals are of utmost importance to us. We support new projects with our expertise, focusing on the required objective, namely smaller units with higher performance and lower consumption as well as weight reduction in the entire vehicle.

Our Solutions

At the heart of every transmission

Diehl Metall Schmiedetechnik is the global market leader in the production of high-performance synchronizer rings made of brass and steel. Our products fulfill the highest requirements with respect to exact geometry, high wear resistance and strength. We guarantee precision and reliability based on new material developments and with our in-house Die Shop.



Multiple-cone synchronizer ring assembly:
patented Diehl solution
for optimum heat balance

Products

Economically and technically optimized concepts



Global market leader for brass synchronizer rings

Due to an unrivaled price / performance ratio, uncoated brass synchronizer rings with friction thread are the standard solution for all passenger car transmissions.

By permanently advancing our high-performance synchronizer ring alloys, Diehl Metall is able to provide efficient solutions, even for modern transmission oils.

Combined with innovative friction layers, brass synchronizer rings may even be used in highly loaded transmissions.





For high-performance transmissions, we recommend our synchronizer rings made of steel. In contrast to conventional brass synchronizer rings, these are produced by means of sheet-metal forming.

Depending on customer requirements, the steel synchronizer rings undergo different heat treatment processes and may also be provided with ground friction surfaces upon request.

With a comprehensive selection of friction layers, Diehl Metall is able to provide efficient synchronizer rings for all application areas.

The brand Formed@Diehl unites the conventional production of forged brass synchronizer rings and the cold forming of steel synchronizer rings. Depending on the requirements in the transmission, we can provide customized solutions from one source.

Production

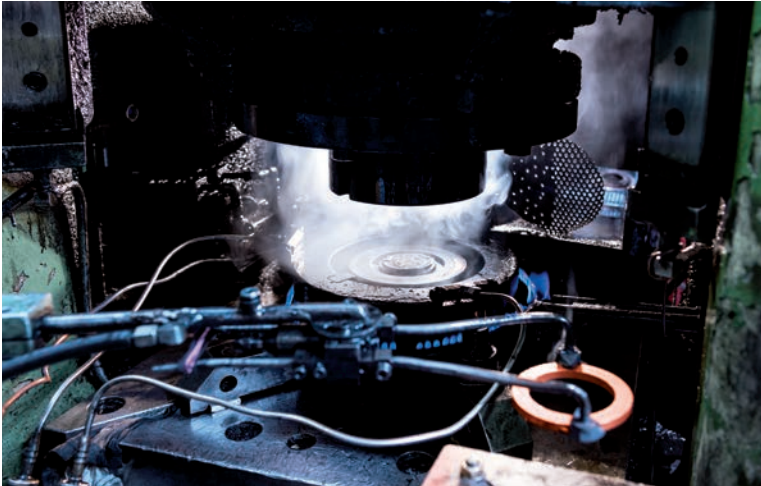
The resilience of brass

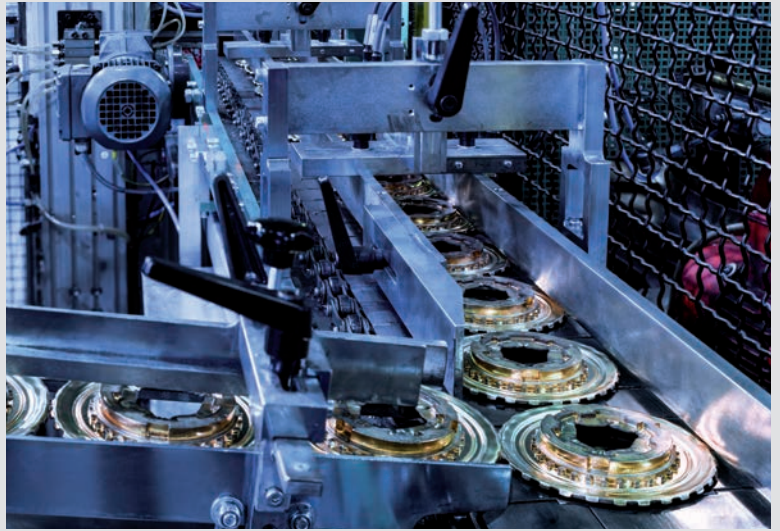
Diehl Advantages and Attributes

- > Very good price/performance ratio
- > Low volumes possible
- > Substituting coatings with high-performance alloys
- > Low tool modification costs



Forging process





From the production of prematerial to the delivery of the finished product, Diehl Metall is able to cover the entire production process for brass synchronizer rings:

Foundry > Semi-Finished Products > Forging > Machining > Die Shop > Laboratory / R&D > Test Benches

Through this integrated value-added chain, we offer brief product development times from inquiry to timely delivery. Another advantage is that we supply directly from our own semi-finished product plant at the same location.

Production

The lightness of steel

Diehl Advantages and Attributes

- > High precision without machining
- > Low weight
- > Cost-effective at high volumes
- > Suitable as a counter friction face



Synchronizer rings made of steel were taken up into the product portfolio in 2006.

Both progressive and transfer tools are used on our stamping and forming machines with a pressing force of up to 8,000 kN. Depending on the application, various process steps are carried out in these tools, such as stamping, coining, bending and joining operations.

In contrast to hot-forged brass synchronizer rings, the cold-formed steel synchronizer rings have natural limitations. Primarily these are the material to be shaped and the resultant forming strain.



To exhaust the possibilities of steel synchronizer rings to the limit in a customer-oriented and economic way, Diehl Metall has purposefully evolved to provide everything from product development to efficient serial production, thereby generating core competencies in the areas of part design, tool design, toolmaking and cold forming. These provide the basis for producing high-precision net-shape products using sheet-metal forming.

During sheet-metal forming, the following alloys are processed in the very soft state. By means of a specially developed nitriding process, the finished parts demonstrate hard, wear-resistant rim zones with high ductility at the core.

Diehl Metall DIN EN	DIN EN Symbol [Material Number]	State	Mechanical Properties		
			Rp0.2 [MPa]	Rm [MPa]	Vickers Hardness
16MnCr5	1.7131	nitriert	> 380	> 460	> 600 HV0.5
C35E	1.1181	nitriert	> 420	> 500	> 300 HV0.5
C75S	1.1248	vergütet	< 1200	< 1500	> 500 HV10
HC260LA	1.0480	nitriert	> 340	> 440	> 300 HV0.5

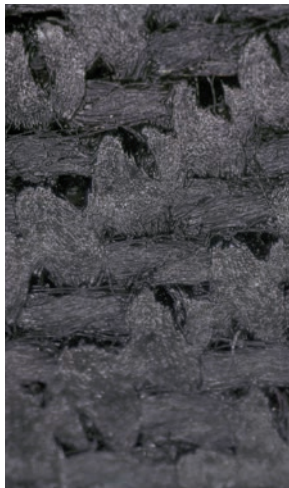
Standard value – Young's modulus $E = 210,000 \text{ N/mm}^2$
 Standard value – Poisson's ratio $\nu = 0.3$

Friction Layers

Customized solutions for every requirement

Diehl Advantages and Attributes

- > Maximum performance
- > Efficiency increase
- > Customized solutions at economic & technical levels



Surface structure
DCA carbon friction layer

Modern, highly loaded transmissions are increasingly using synchronizer rings with tribo-layers to improve friction and wear performance. This applies equally to brass and steel synchronizer rings. For this purpose, we have developed friction materials that cover the entire performance spectrum.



DIEHL **BlackLine**

Carbon coated synchronizer rings are used primarily in high-performance transmissions. Particularly brass or steel synchronizer rings coated with carbon friction layers offer considerable advantages with respect to service life and in the high performance range compared with commonly used wear protection coatings.

DIEHL **GoldLine**

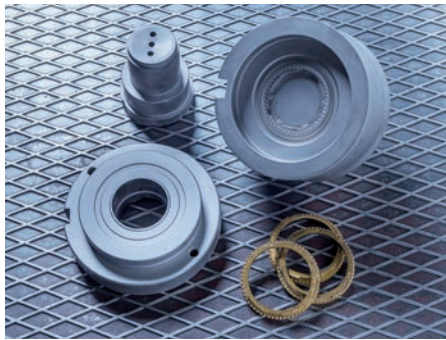
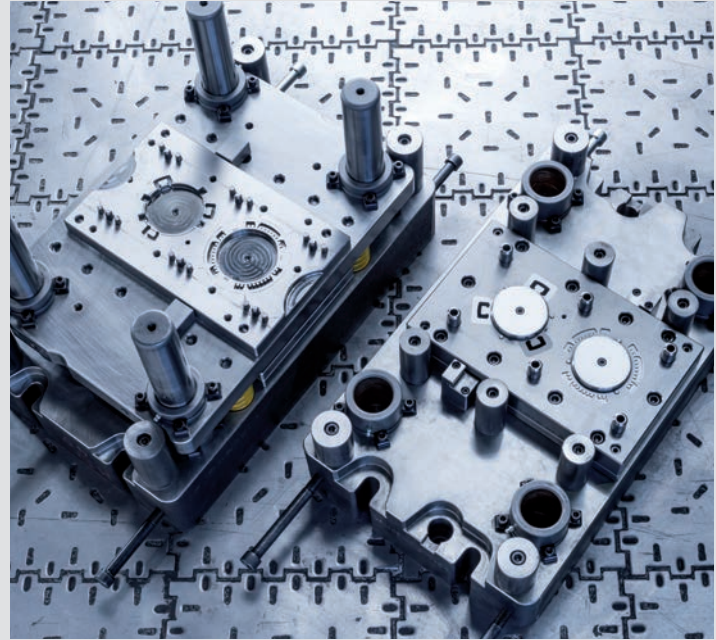
Due to an unrivaled price /performance ratio, uncoated brass synchronizer rings with friction thread are the standard solution for all passenger car transmissions. A tried-and-tested portfolio of alloys produced in-house is available.

Die Shop

Independent production & modification

Diehl Advantages and Attributes

- > In-house Design & Die Shop
- > Production of forging, stamping & sheet-metal forming tools
- > Sample & prototype production
- > Production of measuring equipment & fixtures

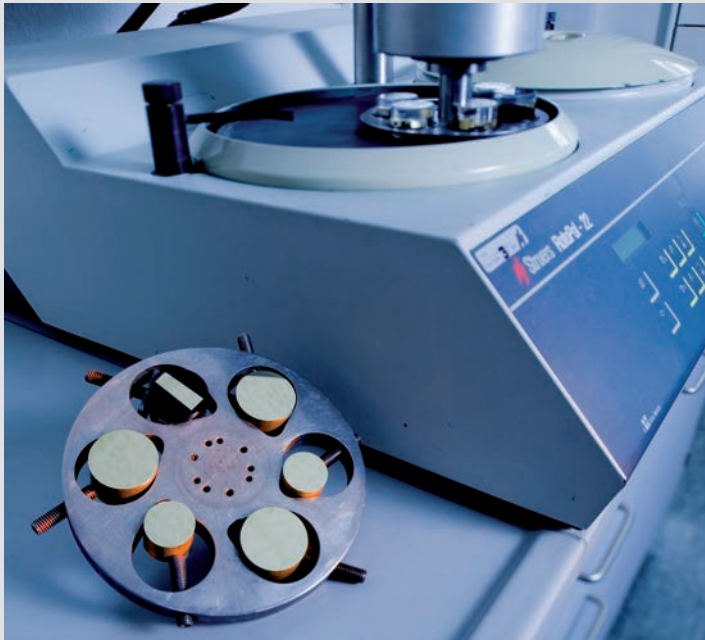


All tools for forging, cutting and non-cutting operations as well as gauges and fixtures are developed and designed by us before being manufactured at the in-house Die Shop.

The latest CAD/CAM systems and state-of-the-art manufacturing methods such as EDM and 5-axis HSC milling not only guarantee high-precision but also cost-effective tool manufacturing as well.

The Development and Design departments as well as the Die Shop provide the foundation for these complex tool technologies. Combined with computer-aided systems for forming simulations (FEM), we determine material flows, tool loads and the characteristics of individual process steps.

Intelligent use of expertise



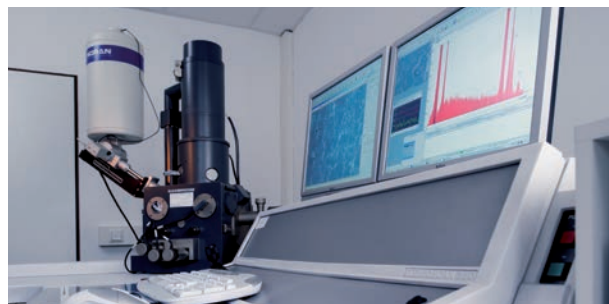
Diehl Advantages and Attributes

- > Support and consultation regarding materials
- > Materials testing
- > Special tests as part of development projects

The service spectrum of our laboratory encompasses quality inspections (mechanical and physical characteristics, grain structure properties) and material tests, all of which we carry out on behalf of our customers. Special tests as part of development projects as well as consulting and support services for our customers on all issues relating to materials complete our portfolio.

We use approved test methods such as:

- Hardness tests (Brinell, Vickers, Rockwell) and micro hardness tests
- Tensile/compression tests
- Metallography (grain structure analysis, corrosion tests, layer assessment)
- Quantitative grain structure analysis (image analysis system)
- Scanning electron microscopy
- EDX micro analysis (spot measurement, surface scan, spectral mapping)
- Chemical analysis

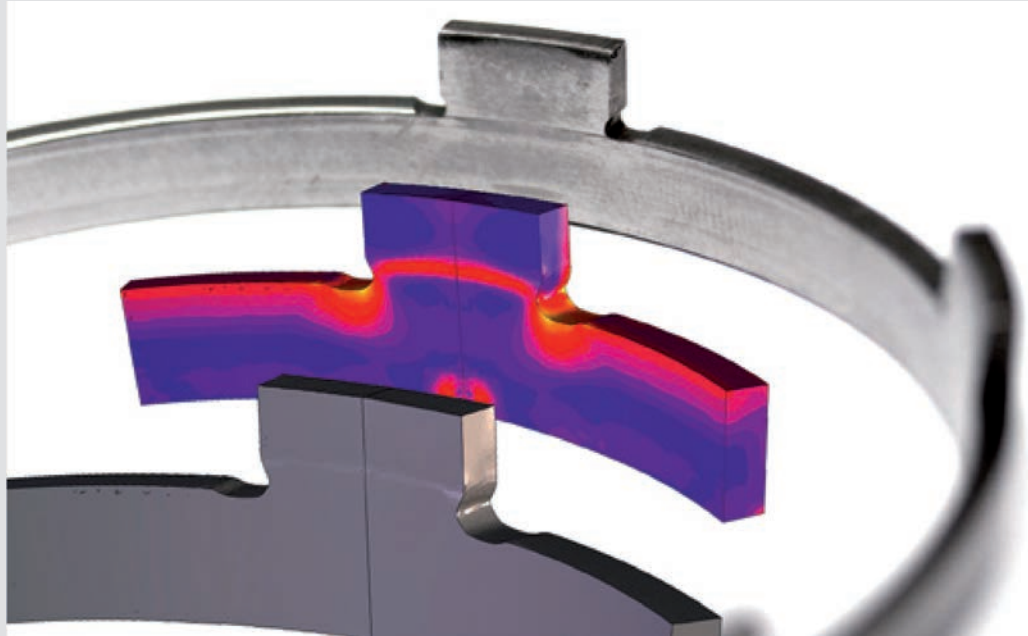


Research & Development

Our ideas for your success

Diehl Advantages and Attributes

- > Integrated product development
- > Engineering support
- > Simultaneous Engineering



Our in-house Research and Development center, including a material laboratory with state-of-the-art equipment, allows us to provide complete support to our customers right from the stage of product design and the product development process (material selection based on the application, optimized design for the forming process).

A particular focus is on the development of synchronization systems for automotive transmission manufacturing (manual and double-clutch transmissions). This is supported by numerous testing and inspection facilities.

Our research into new types of friction systems for synchronizations encompasses detailed system analysis, geometrical design as well as precise material definition.

The foundation of needs-based products

In the area of material development, we carry out in-house design of patented high-performance brasses for synchronizer rings. The broad spectrum of alloys,

including lead-free special brasses, already takes into account the future requirements of the EU guidelines for used cars.

Brass

Diehl Metall DIN EN	DIN EN Symbol	State	Mechanical Properties				Material behavior
			Brinell hardness HBW 2.5/62.5 min.	Tensile strength ¹⁾ R _m (MPa) min.	Yield strength ¹⁾ R _{p0.2} (MPa) min.	Elongation ¹⁾ A ₅ (%) min.	
356 ²⁾ –	CuZn36Mn3Al2Si1		170-220 HBW2.5/62.5	630	330	13	Very high strength, good sliding abrasion properties
452 CW713R	CuZn37Mn3Al2PbSi	H130	130 HBW2.5/62.5	580 550	270 200	20 8	Good wear properties, excellent oil corrosion resistance
455 ²⁾ –	CuTn36Mn2Al1FePbSiSn		160 HBW2.5/62.5	580	270	20	High strength, good toughness, good oil corrosion resistance
458 CW713R	CuZn37Mn3Al2PbSi	H130	130 HBW2.5/62.5	580 550	270 200	20 8	High strength, good sliding abrasion properties
466 CW704R	CuZn23Al6Mn4Fe3Pb		200 HBW2.5/62.5	780 700	540 500	8 5	Very high strength
467 ²⁾ –	CuZn23Al6Mn4Fe3		200 HBW2.5/62.5	780	540	8	Very high strength
470 ²⁾ –	CuZn13Mn8Al5Si2Fe1Pb		180 HBW2.5/62.5	630	430	12	Very high strength
474 ²⁾ –	CuZn13Mn8Al5Si2Fe1		180 HBW2.5/62.5	630	430	12	Lead-free
479 ²⁾ –	CuZn30Mn3Al3Si1NiCr		195-225 HBW2.5/62.5	650	400	15	High hardness, high wear resistance
482 ²⁾ –	CuZn29Al4Ni3Co1SiFePb		190 HBW2.5/62.5	790	710	5	High hardness, high wear resistance
488 ²⁾ –	CuZn32Ni7Al4Si2Fe		240-300 HV50	830	720	3	Highly wear resistant, high strength
489 ²⁾ –	CuZn18Mn8Al5Si2Fe1Pb		220-300 HV50	840	800	5	Highly wear resistant, high strength
490 ²⁾ –	CuZn35Ni14Si4Pb		170 HV50	560	400	4	Maximum wear resistance
492 ²⁾ –	CuZn18Mn8Al5Si2Fe1		220-300 HV50	840	800	5	Highly wear resistant, high strength, lead-free

¹⁾Guidelines ²⁾Not standardized according to EN 12420

Information according to Diehl material data sheet

Information according to EN 12420

By using patented layers, ideal friction behavior can be achieved under different load conditions.

Friction Layers

Diehl Metall DIN EN	q [J/mm ²]	p [N/mm ²]	v [m/s]
Diehl BlackLine	1.5 (5.0)	12 (24)	24 (42)
Diehl GoldLine	0.4 (1.5)	10 (16)	8 (12)

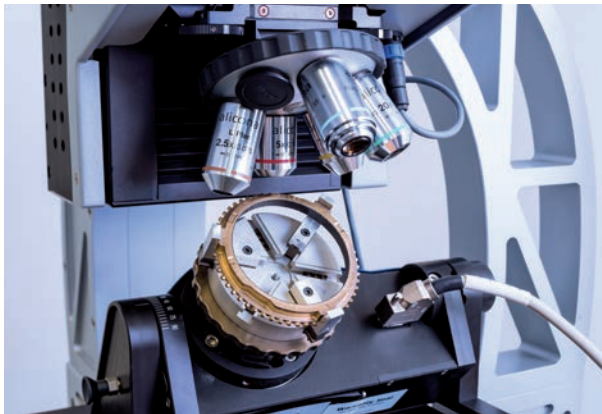
nominal (maximum)

Testbenches

Proven reliability

Diehl Advantages and Attributes

- > Testing in all development phases
– from prototype to series production
- > Understanding operating conditions in practice



We offer all stages of testing, including material, component and service life tests as well as the concluding functional test in the transmission. To do this, we use twelve test benches:

- Material wear test bench
- Diehl obstructing tooth wear test bench
- Diehl component test benches for friction value and wear
- ZF/FZG standard synchronization test bench SSP180
- Transmission test benches

Management Systems

Committed to quality



Diehl Advantages and Attributes

Management systems:

- > Quality: ISO TS 16949 and ISO 9001
- > Environment: ISO 14001
- > Energy: ISO 50001

With our impressive track record when it comes to quality and development, it is our goal to ensure that we are the partner of choice for our customers right from the initial product idea. We have an obligation to fulfill our zero-defect strategy across the entire process.

We practice sustainable management by handling resources carefully, reinforcing recycling efforts and, as an energy-intensive company, by paying particular attention to energy efficiency and reducing CO₂ emissions. With optimized logistics processes at the plant and on the way to the customer, we lay the foundation for sustainable products.



The Company

We are always within reach



Plant in Germany

We are not changing the world from the outside, but from within.

As a comprehensive provider of products made of brass, steel and light metal, almost all renowned automotive and transmission manufacturers belong to our customer base.

We offer customized solutions for every vehicle. After all, the requirements of individual vehicle types are just as varied as the philosophies of our customers.

We set standards for the future.

Diehl Metall Schmiedetechnik is a company of the Diehl Group, a family-run, self-financed enterprise founded in 1902.

The innovative technology know-how of the entire Diehl Group enables us to draw on impetus generated in other technical areas for use in our developments in the powertrain.

São Paulo (Brazil))



Röthenbach (Germany)



Wuxi (P.R. of China)



Pune (India)



Plant in Brazil



Plant in India



Plant in the People's Republic of China

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Diehl Metall Schmiedetechnik
Heinrich-Diehl-Straße 9
90552 Röthenbach a.d. Pegnitz
Germany
Tel. +49 911 5704-0
Fax +49 911 5704-490
www.diehl.com/metall