Mechanical Engineering Elements
Guide Shafts and Rails
The ZOLLERN Group

ZOLLERN is one of the pioneers of the metal industry. 3,000 employees at 14 production locations and seven subsidiaries in Europe, North and South America and Asia develop, manufacture and supervise a range of innovative metal products. ZOLLERN supplies sophisticated solutions for diverse applications through its business units drive technology, plain bearing technology, casting and forging, mechanical engineering elements and steel profiles.
Shafts and flat guide rails
in first-class quality, quickly available

ZOLLERN mechanical engineering elements produces shafts and flat guide rails for me-
chanical engineering, the automotive industry, construction machinery and linear technology
at its Aulendorf site. On a production area of around 10,000 square metres, high-quality
products are produced for further processing or for direct use in assemblies.

ZOLLERN impresses through:

• high quality of the products
• fast processing of orders
• short delivery times
• customised manufacturing
• a broad standard product range
• consistent quality

The principle of the long bar
ZOLLERN mechanical engineering elements works according to the «principle of the long
bar» and was thus a pioneer in Europe.

Semi-finished products are produced in economical batch sizes and held in stock
for customised orders. When the order is received, the main work, such as hardening,
straightening, centreless grinding and hard chrome plating to final dimensions, is already
completed. This saves a lot of time for around 90 per cent of the orders.
Products and designs

ZOLLERN mechanical engineering elements produces and delivers

- Guide shafts
- Steering columns
- Straightening rolls
- Axles
- Bolts
- Columns
- Piston rods
- Flat guide rails

in the dimension range 2 (1*) millimetres diameter to 205 (300*) millimetres diameter.

Features and advantages

- Standard products for linear guides and piston rods as semi-finished products from stock.
- Inductive hardening with CNC process monitoring of all relevant parameters.
- Heat treatment according to customer specifications such as deep-freezing, tempering, etc.
- Patented hardening processes for high-quality through-hardened semi-finished products, e.g. for injectors, throttle solenoid valves, ejector pins and mandrels.
- All processes such as hardening, straightening, centreless grinding and chrome plating at one location.
- Small dimensions 6 mm diameter to 30 mm diameter are chrome plated by means of continuous chrome plating; with tolerances IT7, on request IT6.
- Wide range of thread rolling tools (M5 - M140) for applications where high fatigue strength is required, e.g. steering columns in plastic injection moulding machines.
- Semi-finished products are produced in lengths of up to 7.8 metres.
- Automated test procedures in the manufacture of semi-finished products.

* on request
Application
Automotive

ZOLLERN machine components are used in almost all areas of vehicle construction.

For example as:
• Injection pumps
• Throttle solenoid valves
• Injectors
• Suspension struts / shock absorbers

ZOLLERN mechanical engineering elements supplies semi-finished products for micrometre-accurate machining on high-speed grinding machines. ZOLLERN implements the various heat treatment regulations on its own developed hardening machines with a patented hardening process. The most commonly used materials are 100Cr6, which is deep-frozen and tempered, and HS 6-5-2 (HSS) with subsequent multi-stage tempering to achieve the desired secondary hardness. Other materials, such as X90CrMoV18 and all quenched and tempered, rolling bearing and martensitic stainless steels, and a variety of tool and high-speed steels are also processed.

After grinding, the finished semi-finished products are tested 100 per cent on a test track:
• Diameter inspection with a laser
• Microstructure testing with eddy current testing Förster Magnatest or IBG
• Crack testing with Förster Circograph
• Demagnetisation
• Mechanical ejection of parts that are outside the specifications
Application
Mechanical engineering

ZOLLERN supplies shafts and flat guide rails for
- Rubber and plastics machines
- Printing machines
- Woodworking machinery
- Assembly and handling technology
- Casting machinery
- Machine tools
- Straightening machines

The individual process steps are economically combined when processing products.

CNC-controlled lathes with main and counter spindles are loaded with bars up to eight metres long via bars loaders and unloaded to the same length. The machines allow the complete machining of parts, including gear cutting, inside and outside.

Tools for rolling highly stressed threads, up to M 140 x 4, are used for the production of rods and columns. The transitions are machined with smooth rolling tools in order to meet particularly high requirements.

The machining of bars up to eight metres long on milling and drilling centres is standard. Two shafts or flat guide rails are machined synchronously.

Special surface requirements are fulfilled by finishing with stone or belt, but also with lapping to Ra = < 0.07 micrometre.
For linear technology, ZOLLERN supplies ready-to-install components from prefabricated semi-finished products according to customer drawings. Impeccable surfaces and outstanding mechanical properties characterise these mechanical engineering elements, which support functional reliability and longevity in application.

Semi-finished products for linear technology

- **Precision steel shafts standard CF53/C55E**
  - Induction hardened HRC 60 - 66, ground,
  - Polished Ra ≤ 0.30 µm, Ø 5 mm to Ø 100 mm,
  - Maximum length 7800 mm

- **Precision chrome-plated steel shafts CF53/C55E**
  - Induction hardened HRC 60 - 66, ground,
  - Custom hard chrome plated 10±/- 5 µm,
  - Polished Ra ≤ 0.30 µm, Ø 6 mm to Ø 80 mm,
  - Maximum length 7800 mm

- **Precision steel shafts Niro X46Cr 13**
  - Inductive hardened => HRC 54, ground,
  - Polished Ra ≤ 0.30 µm, Ø 4 mm to Ø 80 mm,
  - Maximum length 6100 mm

- **Precision steel shafts Niro X90CrMoV18**
  - Inductive hardened HRC 54 - 59 ground,
  - Polished Ra ≤ 0.30 µm, Ø 4 mm to Ø 80 mm,
  - Maximum length 6100 mm

- **Precision steel shaft tube C60**
  - Induction hardened HRC 60 - 66, ground,
  - Polished Ra ≤ 0.30 µm, Ø 12 mm to Ø 80 mm,
  - Maximum length 7800 mm

- **Flat guide rails C60 / CF 53**
  - Induction hardened HRC 60 - 66, ground,
  - Polished Ra ≤ 0.30 µm, Ø 12 mm to Ø 80 mm,
  - Maximum length 7800 mm

- **Shafts for ball screws**
  - Material CF53/C55E Rht up to 4 mm
  - Material 42CrMo4Qt Rht up to 8 mm
There are many possible applications and materials of shafts and flat guide rails for construction machinery:

- Piston rods
- Damper pistons for oil / gas
- Hinge pins
- Pump pistons

Special manufacturing processes improve the properties of the chrome-plated surface while inductive hardening increases the wear resistance. No matter in which form or material ZOLLERN machine components are manufactured, they always stand out for their durability and high quality.
Inductive hardening

By means of inductive hardening, ZOLLERN increases the wear resistance of the shafts and rails. All relevant process parameters are CNC-controlled. Hardening depths of 0.5 to 8 millimetres and hardness values of up to 67 HRC can be achieved.

Inductive hardening is used where hard and wear-resistant surfaces or other special physical properties are required. Hardening distortion is reduced to a minimum by targeted hardening. Short heating and austenitisation times prevent scale, edge decarburisation and residual austenite. Toughness and strength are retained in the unhardened areas.

Subsequent machining is possible at any time.

*Induction hardening with holding furnace* - Specifically for the through-hardening of HSS materials in the 2 to 20 mm diameter range.

Furnace hardening with automatic hardening machine

Furnace hardening is a patented in-house development for demanding through-hardening with variable holding times. The hardened bars with dimensions ranging from 3 to 20 millimetres in diameter and a maximum length of 3,500 millimetres are produced by the integrated straightening process with a very high degree of straightness.

Heat treatment

The products are heat-treated by means of annealing plants with an open atmosphere. The temperature range is between 120°C and 680°C. Control occurs via batch elements. The process is completed by annealing and tempering.
Deep-freezing / tempering
Temperature range -150°C to +280°C. The treatment is carried out in a combined process.

Straightening
The shafts or flat guide rails are straightened after the heat treatment processes and between mechanical processing stages. From manual straightening to fully automatic straightening with presses and roller straightening, various straightening methods with forces from 10 tonnes to 315 tonnes are used.

Centreless grinding
Centreless grinding is the most economical grinding variant for bar stock. The geometry is generated during this operation. ZOLLERN grinds in a dimension range from one millimetre to 205 millimetres in diameter and a length of up to 8,000 millimetres. Tolerances of ISO 6 are standard. If required, ISO 5 is possible.

Polishing
The surface structure is optimised by polishing or belt grinding. ZOLLERN uses systems with up to five polishing stations. The desired surface is achieved in coordinated steps, up to a mean roughness value $Ra < 0.15$ micrometres. Polishing is also used after chrome plating.

Custom hard chrome plating
ZOLLERN is one of the first hard chrome plating companies to produce piston rods and linear guide shafts in the manufacture lengths. With the introduction of continuous chrome plating in 1991, ZOLLERN was quick to focus on environmentally friendly processes. The improved deposition results, especially in small dimensions of six to 30 millimetres in diameter, ensure good layer distribution and very good concentricity. The optimum coating thickness for linear guides is 10 micrometres and for piston rods 20 to 30 micrometres. Layer thicknesses up to approx. 50 micrometres are possible.
Production of prefabricated parts

**Turning, conventional**
- Maximum length 6,300 mm
- Diameter 5 to 380 mm
- Maximum weight 2,000 kg

**CNC turning**
- Maximum length 6,280 mm
- Length at least 10 mm
- Diameter 4 to 400 mm

**CNC turning with bar feeder**
- Loading, maximum length 8,000 mm
- Unloading, maximum length 8,000 mm
- Diameter 3 to 80 mm

**CNC milling / drilling**
- Maximum length 8,000 mm
- Synchronous machining 8 to 100 mm, round or flat
- Maximum 2,000 kg

**Chiron milling centre**
- Travel X-axis 8,000 mm, Y-axis 630 mm, Z-axis 550 mm
- NC swivel head, speed range 20 rpm to 12,000 rpm
- NC rotary table, dividing accuracy +/- 2”, face plate diameter 500 mm

**Surface grinding**
- Maximum length 8,000 mm
- Height 280 mm, width 400 mm
- Grind ends at an angle, 50 x 150 mm

**High speed grinding HSG Studer S32**
- Diameter 1 - 10 mm
- Cutting with contour grinding using the plunge-cut method
- Peripheral speed up to 140 rpm
First class quality

At ZOLLERN, high quality is a product feature that goes without saying. In addition to the strict quality assurance of the individual products, the ZOLLERN management system is certified according to the international standards ISO 9001 and IATF 16949. Environmental and energy management in accordance with ISO 14001 and ISO 50001 is also a certified standard that is applied on a daily basis.

- At ZOLLERN, error prevention takes priority over error correction. The goal is zero defects in the sense of complete fulfilment of customer requirements.
- The work at ZOLLERN is accompanied by continuous improvement of the processes, the organisational structure and ultimately the products and services. In addition to continuous further development in the relevant areas, the company suggestion scheme also makes an important contribution to this.
- Employee orientation, training and further education and optimum working conditions are important components of the corporate policy at ZOLLERN - so that top performances are achieved in national and worldwide markets today and tomorrow and so that resources and the environment are conserved.

Quality assurance and material testing

ZOLLERN uses a variety of methods and instruments to ensure product quality. Material tests are certified according to DIN EN 10204 and accompany the entire manufacturing process. Extensive tests are possible on site or in our central laboratory.

**Testing of mechanical and technological properties**
- Tensile testing machines
- Hardness testers
- Fully automatic small load hardness tester
- Notched bar impact test

**Metallographic testing**
- Laboratory for sample preparation, such as hot embedding and preparation of microsections
- Various macroscopes and microscopes enable precise material examination

**Determination of the chemical composition**
- Spectral analysis

**Geometry and surface roughness testing**
- Modern measuring machines
- Roughness testers

**Straightness and torsion testing**
- Measuring tables with measuring bridges in different lengths

**Further development of heat treatment, determination of tempering temperatures**
- Laboratory furnaces

**Non-destructive testing methods**
- Crack testing according to the eddy current principle
- Microstructure testing
- Ultrasonic tests
- Tests for confusion

**Corrosion tests**
- According to EN ISO 10289:2001

**Endurance tests**
- Linear bearings
- Plain bearings
Product range and technical data

1. Hardened piston rods 42CrMo4QT, induction hardened HRC 56-64, ground, custom hard chrome plated 20 +/-5 μm, polished Ra <= 0.30 μm, tolerance f7

2. Precision steel shafts standard Cf53/C55E, induction hardened HRC 60-66, ground, polished Ra <= 0.30 μm, tolerance h6 / h7

3. Precision chrome-plated steel shafts Cf53/C55E, induction hardened HRC 60-66, ground, custom hard chrome plated 10 +/-5 μm, polished Ra <= 0.30 μm, tolerance h6 / h7

4. Precision steel shafts Niro 1.4034 X46Cr13, induction hardened => HRC 54, ground, polished Ra <= 0.30 μm, tolerance h6 / h7

5. Precision steel shafts stainless steel 1.4112, X90CrMoV18 inductively hardened HRC 53-59, ground, polished Ra <= 0.30 μm, tolerance h6 / h7

6. Precision steel shafts tube C 60, induction hardened HRC 60-66, ground, polished Ra <= 0.30 μm, tolerance h6 / h7

7. Flat guide rails C 60, inductively hardened HRC 60-66, Ra <= 0.80 μm, tolerance IT 9, peripheral grinding Ra <= 0.40 μm, tolerance IT 7

   Standard dimensions
   50 x 50   60 x 20   70 x 20   80 x 20   100 x 25

8. HS 6-5-2 high-speed steel, through-hardened tempered HRC 62-66, ground, polished Ra <= 0.30 μm, Ø < 20 mm, dimensions by request

9. Rolling bearing steel 100 Cr6, through-hardened tempered HRC 58-62, ground, polished Ra <= 0.30 μm, Ø < 20 mm, dimensions by request
## Design

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The specifications in this data sheet are for informational purposes only and are subject to change without notice.
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Drive technology
- Travel gears from 100,000 Nm to 2m Nm
- Slewing gears from 3,000 Nm to 1.6m Nm
- Planetary plug-in gears from 4,000 Nm to 2.5m Nm
- Rope winches with planetary plug-in gears for lifting/tensile forces from 2 t to 280 t
- Planetary gears from 3,000 Nm to 1.6m Nm
- Industrial gears from 3,000 Nm to 1.6m Nm
- Free-fall winches for free-fall weights from 2 t to 50 t
- Special gears from 5,000 Nm to 6.0m Nm (spur gears, bevel-helical gears, helical-worm gears)
- Aerostatic rotary tables with diameters up to 1,600 mm
- Hydrostatic bearing systems (steady rests, spindles, guides, screw drives, rotary tables)
- Round tables and rotary table combinations for machine tools, table top sizes up to 5,000 mm
- Pallet change systems for machine tools according to DIN 55201 for clamping cones or zero-point clamping systems
- Torque motors with diameters up to 2,200 mm and up to 60,000 Nm
- Asynchronous and standard synchronous motors from 90 to 200 kW, special motors (asynchronous/synchronous) to customer specifications
- Standard linear motors up to 10 m/s and to customer specifications

Automation
- Linear axes (payload: up to 10,000 kg)
- Telescopic axes (payload: up to 1,600 kg)
- Gantry robots (line and gantry portals) (nominal stroke: up to 50 m)
- Plant and system solutions (turnkey)

Plain bearings
- Metallic plain bearings for 4-stroke engines, 2-stroke engines, piston compressors and pumps
- Plain bearing shells up to 1,200 mm in diameter for steel/lead bronze and steel/aluminium applications and up to 1,600 mm for steel/white metal applications
- Bushings with diameters of up to 800 mm for steel/lead bronze and up to 1,600 mm for steel/white metal applications
- Use of solid materials, 2-layer materials and multi-layer composites with metallic or synthetic sliding layers
- Radial, axial and combined radial/axial bearings in fixed-surface and tilting pad designs for shaft diameters up to 800 mm
- Z-type housing plain bearings according to DIN 31690/31693 and 31694 for shaft diameters up to 1,250 mm
- Vertical plain bearings for shaft diameters up to 625 mm
- Industrial plain bearings to specifications for shaft diameters up to 3,000 mm
- Hydro bearings
- Valve plates, control cams, control plates, blank holder segments
**Investment casting**
- Complex components according to lost wax technique (investment casting)
- Open-cast steel alloys up to 180 kg casting weight, max. 760 x 500 mm
- Vacuum-cast superalloys up to 100 kg casting weight, max. 600 x 600 mm
- Low-pressure cast aluminium up to 190 kg casting weight, max. 800 x 600 mm
- Vacuum DS/SX directionally solidified components up to 8 kg, max. 200 mm
- Solidification characteristics: EQX; DS; SX
- Pre-finished components

**Casting and Forging**
- Forgings from high-purity copper and copper alloys up to 3 t each
- Rings for electric motors, roller bearings and guide bushings
- Complex one-off parts and short runs
- Sandcast part weights up to 2 t in steel and 8 t in copper alloys
- Patternless forming using direct machining and printed cores
- Impellers and blades for the hydropower sector
- housings and parts for marine propulsion systems

**Steel profiles**
- Profile types: hot-rolled, cold-rolled, cold-drawn, induction-hardened
- 200 materials with profile cross-sections from 5 mm² to 6,000 mm² (40 g/m to 48 kg/m)
- Surface roughness from Rz 5 µm
- Tolerances from 30 µm
- Near-net shape manufacturing
- Hardness values up to 64 HRC according to choice of material and technique
- Pre-finished components

**Mechanical engineering elements**
- Precision steel shafts, head shafts, columns, bars, straightening rollers, bolts and axes with diameters from 2 to 250 mm and maximum lengths of 8,000 mm
- Guide rails with max. cross-sections of 100 x 25 mm and lengths <= 8,000 mm
- Surfaces hardened, straightened, ground, hard chrome plated and polished
- Finishing including turning, milling, drilling or grinding to customer specifications