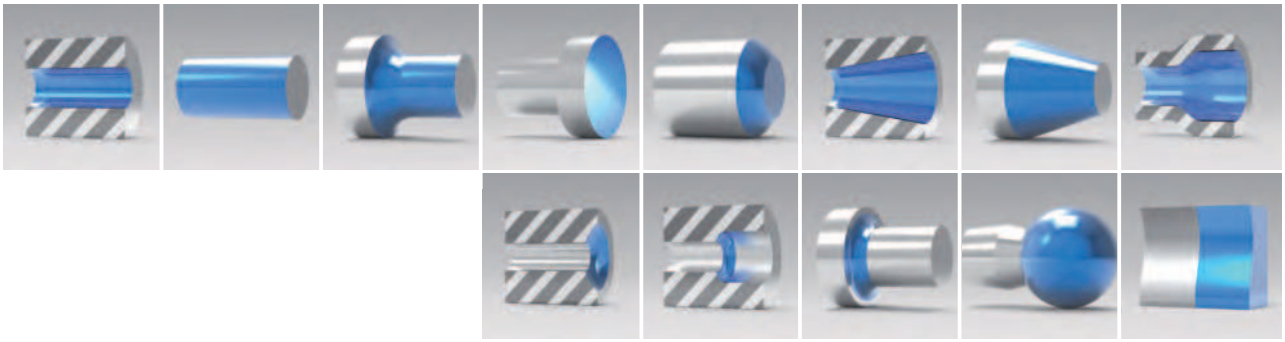
Hydrostatic Tools – HG Series: Overview

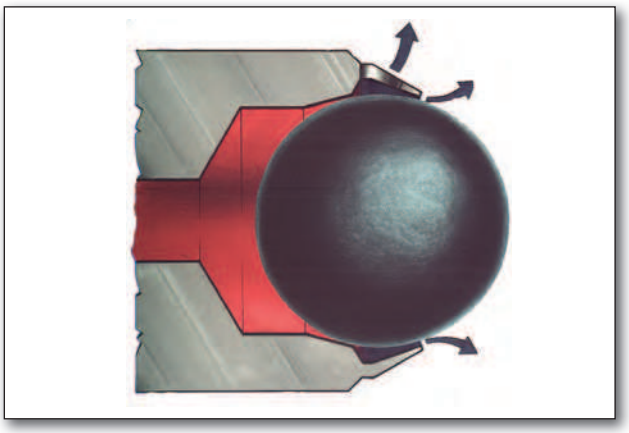


The hydrostatic tools in the ECOROLL HG series are used to roller burnish and deep roll internal and external surfaces, highly complex contours and free-form surfaces. These tools can be used on all common machine tools, e.g. CNC-controlled lathes, milling machines and drilling machines as well as machining centers and conventional machine tools. The universal tool system can be used with both rotating and stationary workpieces. Any metal material up to a hardness of 65 HRC can be machined.

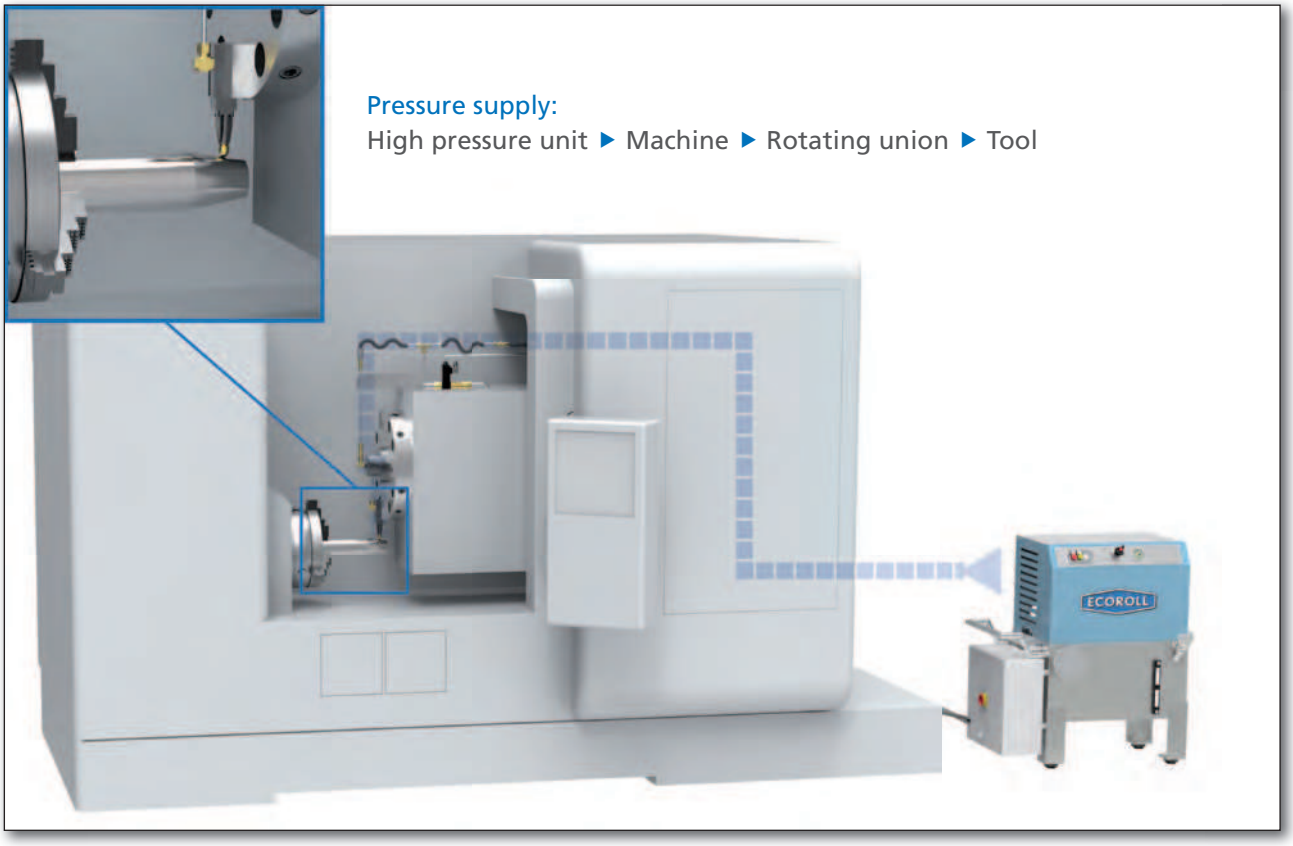
The heart of the tools in the HG series is a roller burnishing element that consists of a ball insert and a following system. The ball insert contains a special ball made of hard material, which functions as a rolling element when it contacts the workpiece surface. To operate the hydrostatic tools, cooling lubricant (emulsion or oil) flows into the tool under high pressure, which creates a hydrostatic bearing for the ball. The pressure medium is used to press the ball into the surface at a defined burnishing pressure, causing surface deformation. To generate this high pressure, ECOROLL offers either various versions of external hydraulic units or driven tools with integrated high pressure pumps.

The tools are identified and classified by the size of the balls used. Balls with diameters in a range of 1.2 - 28 mm are available, resulting in a tool series from HG1.2 to HG28. The HG6 tool, for example, has a ball with a diameter of 6 mm.

Following system



HG ball and ball retainer



Schematic of the entire process

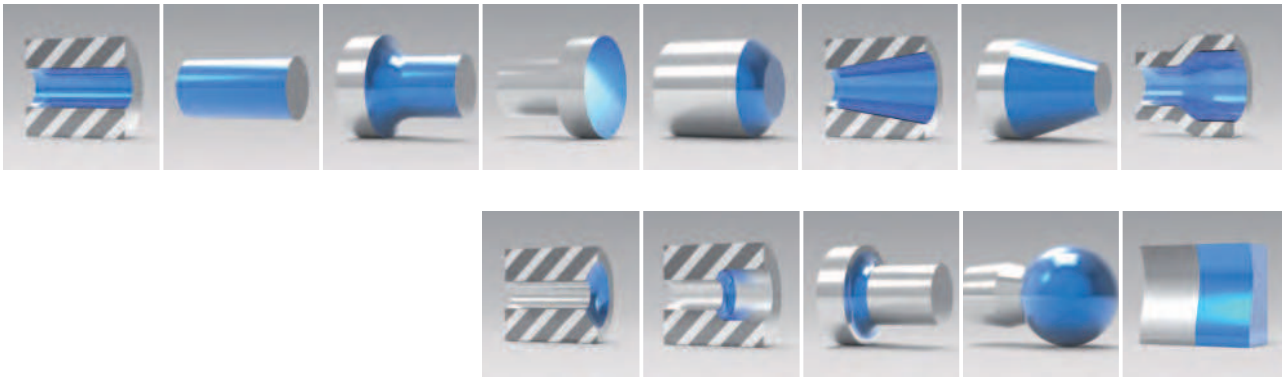
Tools in the HG series can also be used for dry machining. In this case, a mixture of compressed air and oil is used (minimum lubrication) is used as the pressure medium. All of the tools provided with automatic following systems (series tools HG3 through HG13) do not require any conversion in order to function with compressed air and minimum lubrication. In this way, materials up to a hardness of 45 HRC can be machined.

Hard roller burnishing a cam shaft

Deep rolling the lower shank section, radius and plate of a valve

Roller burnishing a ball joint

HG Series



Features

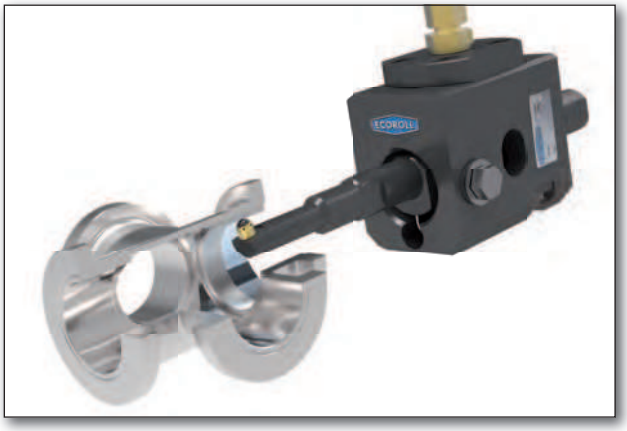
- Used to roller burnish and deep roll complex contours.
- For hard machining of workpieces made of hardened steel and other hardened alloys up to 65 HRC (except for HG2 and HG25).
- All of the tools provided with automatic following systems (series tools HG3 through HG13) and can be operated with compressed air and minimum lubrication.
- Depending on the process, the tool, pressure supply and machine type required for the tool can vary:

Workpiece/Process	Tool/Version	Pressure supply	Machine type
External machining			
Cylindrical contours	HGx-9; HGx-19; HGx-5; HGx-7	HGP3/HGP6 Integrated high pressure pump	Conventional/ CNC-controlled lathe
Tapered contours	HGx-9; HGx-19; HGx-5; HGx-7	HGP3/HGP6 Integrated high pressure pump	CNC-controlled lathe
End faces	HGx-9; HGx-19; HGx-5; HGx-7	HGP3/HGP6 Integrated high pressure pump	CNC-controlled lathe
Transition radii	HGx-9; HGx-19; HGx-5; HGx-7	HGP3/HGP6 Integrated high pressure pump	CNC-controlled lathe (Mill-turn machine)
Free-form surfaces, sealing groove	HGx-9; HGx-19; HGx-5; HGx-7	HGP3/HGP6 Integrated high pressure pump	CNC-controlled lathe, machining center
Ball machining	HGx-10 (swivelling tool)	HGP3/HGP6	CNC-controlled lathe
Narrow cylinders	HGx-20 (3-point tool)	HGP3/HGP6	Conventional/ CNC-controlled lathe
Machines thin-walled components on both sides	HGx-29 (pincer-shaped tool)	HGP3/HGP6	CNC-controlled lathe, machining center
Internal machining			
Cylindrical bores	HGx-1 / HGx-2	HGP3/HGP6	Conventional/ CNC-controlled lathe
Tapered bores, fillets, complex internal contours, cylindrical bores	HGx-2P / HGx -11	HGP3/HGP6	Conventional/ CNC-controlled lathe
Extra-long cylindrical bores	HG13-4	HGP3/HGP6	Deep hole drilling machine/ Conventional lathe

Note: In the designation HGx-y, x indicates the ball size and y the design version (details regarding the versions are found under "Ordering"). For further details regarding the HGP series, see "Accessories for the HG Series".

Advantages

- Increases the fatigue strength and service life of dynamically loaded components.
- Induces compressive stresses in the edge zone.
- Simultaneously smoothes the surface.
- Wide variety of application options reduces production costs.
- The hydrostatically loaded ball rotates completely without contact in all directions – even at high speeds.
- The following system in the burnishing element keeps the gap between the ball and the retainer constant, regardless of the clearance to the workpiece.
- If there is a change in position, the burnishing element follows the workpiece contour within the tool stroke without changing the burnishing force.

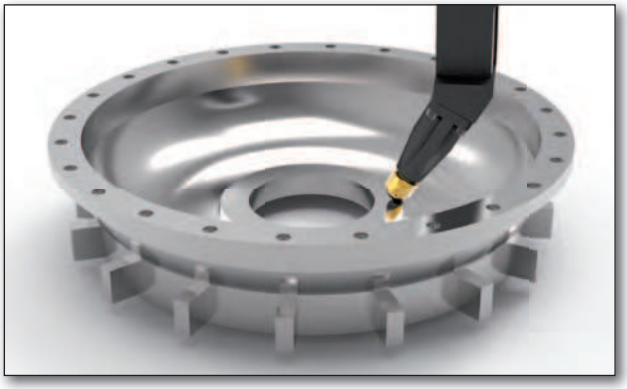


Internal machining with a HG6 tool. Interrupted surfaces can also be machined.

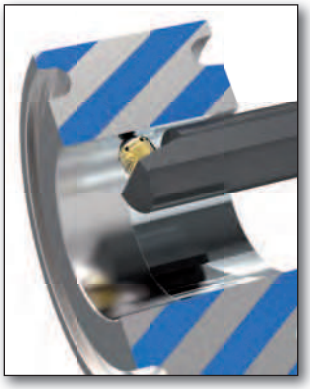
- When the compressed air system is used:
  - Environmental stresses are reduced.
  - Enormous cost saving potential:
    no costs for purchasing or disposing of lubricants.

Machining a hard punch with HG6 saves time because it eliminates another process (polishing).

Deep rolling a control piston to increase its service life.



Machining a torque converter housing with HG13 to optimize sliding properties.

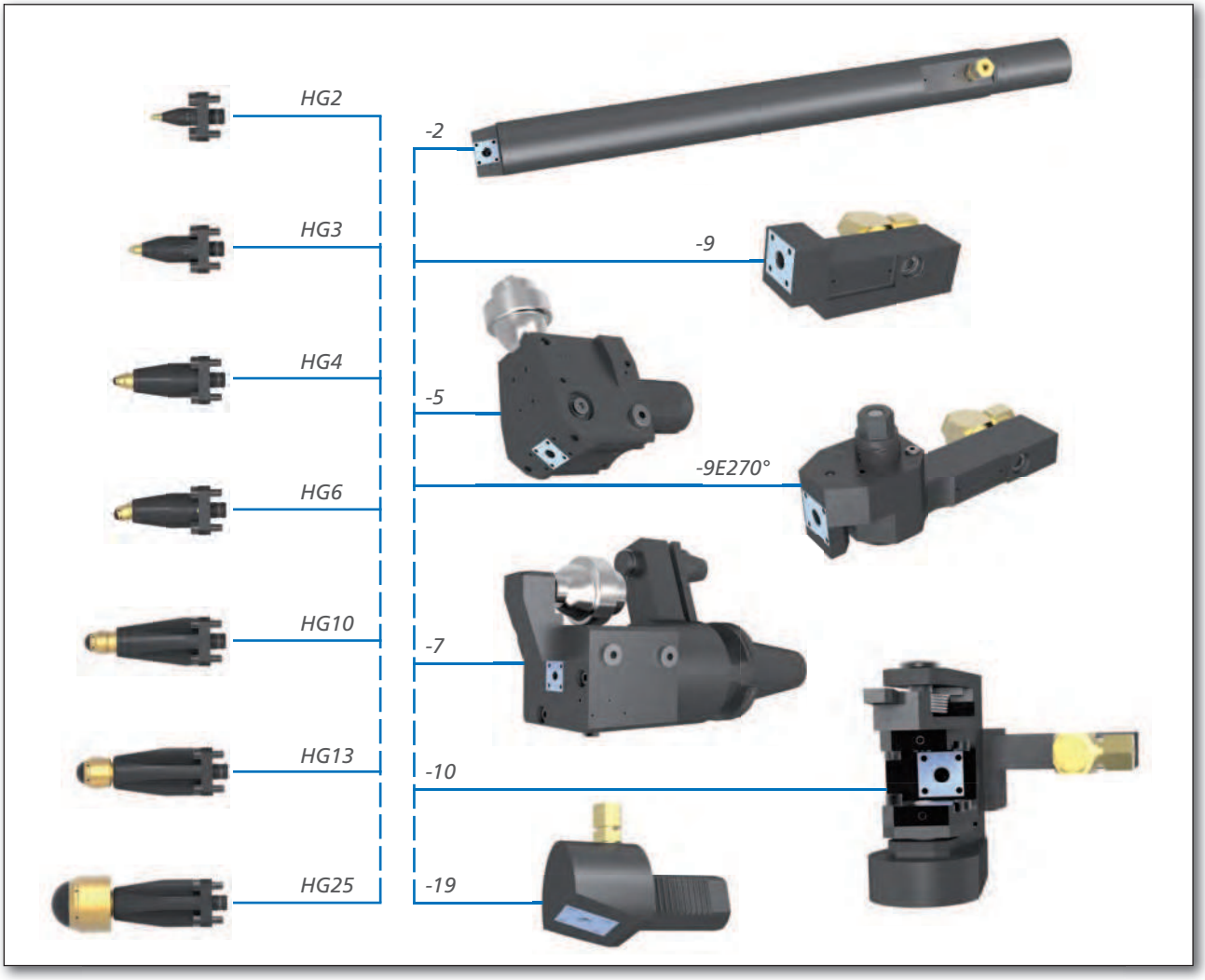


Hard roller burnishing the bore of a roller with HG6 eliminates an extra lapping operation.

Roller burnishing the ball zone of a bevel gear.

Design

- The HG series includes many different versions with modular designs and ball diameters in a range from 2 – 25 mm:



- HG burnishing elements by ball size

Type	Permissible contact angle at the ball's crown point	Stroke (s) in mm	Length (l) in mm
HG2	± 22.5°	4	35
HG3	± 22.5°	4	42
HG4	± 30°	5	50
HG6	± 30°	5	50
HG10	± 30°	8.5	65
HG13	± 35°	8.5	69
HG19	± 35°	10	88
HG25	± 30°	8.5	82

Note: In general, the workpiece contours determine the ball size. To induce the maximum level of compressive stresses by deep rolling, select the tool with the largest possible ball.

Parameters

Tool type	Max. burnishing force in N	Max. circumferential speed in m/min.	Max. feed rate in mm/rev.
HG2	90	250	0.1
HG3	250	250	0.1
HG4	550	250	0.15
HG6	1000	250	0.2
HG10	2200	250	0.25
HG13	4000	250	0.5
HG19	9000	250	0.75
HG25	4000	250	0.75

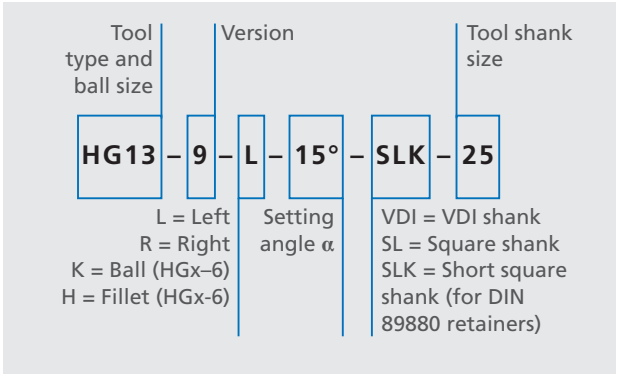
Note: Circumferential speeds can, in certain circumstances, be increased substantially.

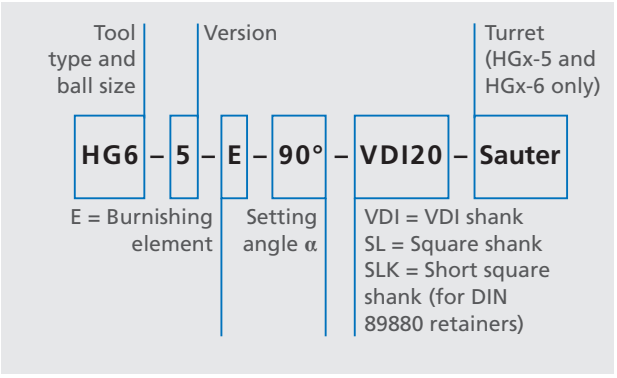
Ordering

Tool in the HG series are available in a wide variety of versions in order to cover many application areas. In addition to the ball size, the tools are classified according to version. In the designation HGx-y, x indicates the ball size and y the design version. For example, HG6-2 contains a ball with a diameter of 6 mm and is suitable for machining cylindrical bores. The following table lists the most significant design versions and their related applications (for further details regarding each version, see the following pages).

Designation	Applications
HGx-1	Inside diameters (cylindrical and tapered bores) > 19 mm
HGx-2	Internal machining > 70
HGx-4	Internal machining > 50 mm, 2-point tool for long components
HGx-5	For machining external and end faces
HGx-6	Ball machining
HGx-7	End faces and free-form surfaces
HGx-9	External machining of rotationally symmetric surfaces (cylinders, tapers, end faces, fillets, balls)
HGx-10	Ball machining
HGx-11	Internal machining of cylindrical bores > 6 mm, 2-point tool for small and long components
HGx-19	Like HGx-9, but with tool shank according customer requirements
HGx-20	3-point tool (3 balls), for narrow outside diameters
HGx-29	2-point tool (2 balls) for machining both sides of both sides of disc-like and thin-walled components (such as turbine blades) in one pass, starting at a thickness of 0.8 mm

The complete tool designation is generated as follows:





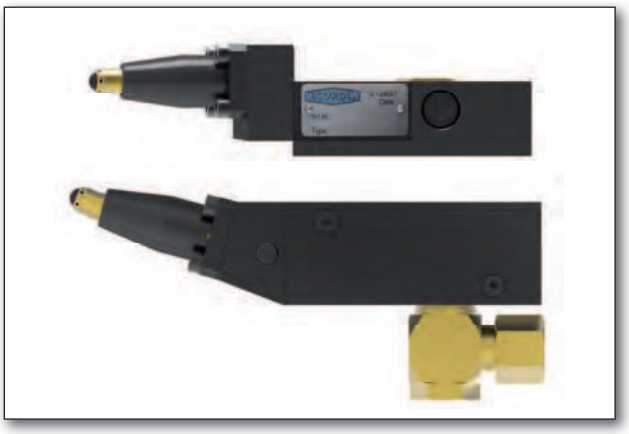
External machining

HGx-9, HGx-19: Operation with external pressure supply

- Also required are a hydraulic unit and high pressure supply.
- For machining any rotationally symmetric component and irregular free-form surfaces.
- For roller burnishing and deep rolling any metal material or hardened material up to a hardness of 65 HRC.
- Burnishing force is pressure dependent, so the process can be monitored for consistent product quality.

HGx-9

- Universal, standard version.
- Can be used with conventional or CNC-controlled lathes.
- Standard square shanks, 20 - 32 mm available (SL = long, SLK = short).
- Versions available for right- or left-handed use.
- Setting angle α = 0 - 90° in 15° increments available.
- Pressure is supplied from the side or rear through the square shank.
- HG2-9 only suitable for use with components with hardnesses ≤ 45 HRC. Tool is mounted on an integrated square shank, but also available with adapter for use with standard square shanks.



Tool	Fillet R	a	b	b_1	c	h	Setting angle α
HG2-9E45°-SL	> 2.5	57	32	61	205	20 25 32	45°
HG2-9V70°-SL		68		72	216		10° or 80°
HG3-9E45°-SL	> 4	69		73	217		45°
HG3-9V70°-SL		80		84	228		10° or 80°
HG6-9._-SL(K)	> 5	66		33	216(148)		0°, 15°, 30°, 60° or 90°
HG13-9._-SL(K)	> 10	80		96	228(160)		
HG6-9E270-SL(K)	> 5			90	276(208)		Can be adjusted in 15° increments
HG13-9E270-SL(K)	> 10			111	298(230)		

HGx-19

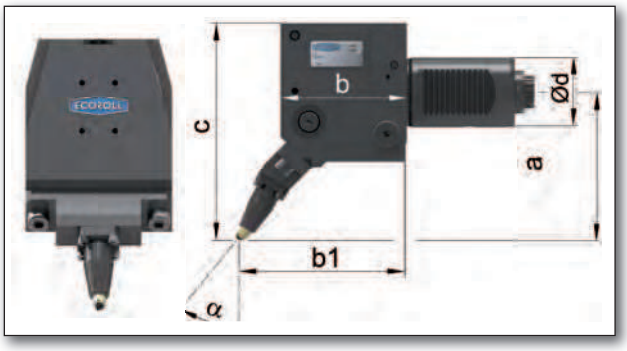
- For use on CNC-controlled lathes with turrets.
- Versions available for right- or left-handed use.
- Setting angle α = 0 - 90° in 15° increments.
- Pressure is supplied from the side at the tool body.
- Interface depends on the machine: ZS, VDI, HSK or Capto shank available.

HGx-5, HGx-7: Operation with integrated high pressure pump

- Machine tool specifically for use with driven tools required.
- For machining any rotationally symmetric components.
- For roller burnishing and deep rolling any metal material or hardened material up to a hardness of 65 HRC.
- Burnishing force is pressure dependent, so the process can be monitored for consistent product quality.

HGx-5

- External machines on CNC-controlled lathes.
- Integrated high pressure pump; pressure supply installation not required.
- Ready for operation as soon as it is inserted in the turret.
- Available with VDI tool retainers (DIN 69880) for a ø range of 20 - 80 mm and all common drive systems.
- Symmetrical tool design and VDI tool retainer allow either right or left hand operation.
- A pressure measurement device is required to set up the tool.



Tool	Fillet R	a	b[1)]	b_1[1)]	c	d	h	Setting angle α
HG6-5_°-VDI	> 5	100	89	142	130	20 or 30	50	30°[2)]
HG6-5_°-VDI	> 5	109	91	109	164	40 or 50	85 or 100	
HG13-5_°-VDI	> 10	128		162	178	60 or 80	125 or 160	

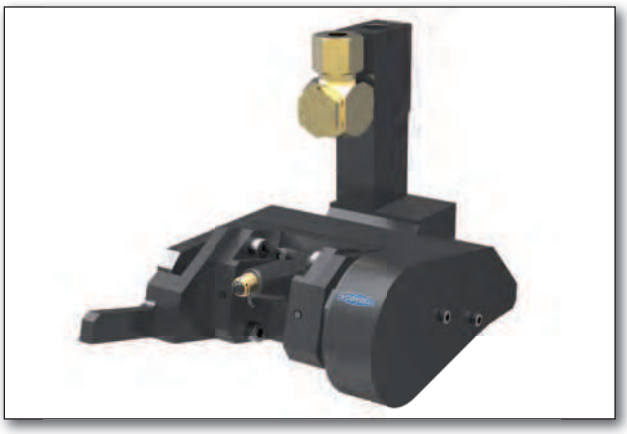
Note: [1)] Other dimensions apply for drives other than the VDI shank. Please contact us.
[2)] Setting angles of 0°, 60° and 90° possible by changing the adapter (please ask about modified dimensions).

HGx-7

- For roller burnishing and deep rolling rotationally symmetric components and free-form surfaces made of any metal material or hardened material up to a hardness of 65 HRC.
- External machining on milling machines, machining centers and lathes (mill-turn).
- For machining complex contours (mold and die production, machining row by row).
- Integrated high pressure pump; pressure supply installation not required.
- Drive adapter with torque support, available tool retainers: SK, CAT, HSK, CAPTO, KM.

HGx-10:
Operation with external pressure supply

- Swivel device enables continuous tool tracking during the process.
- Also required are a hydraulic unit and high pressure supply as well as a guide pin on the lathe.
- Can be used with conventional or CNC-controlled lathes.
- Special version for roller burnishing ball surfaces.
- Standard square shanks, 20 - 32 mm available (SL = long, SLK = short).



HGx-20, HGx-29:
HG special tools

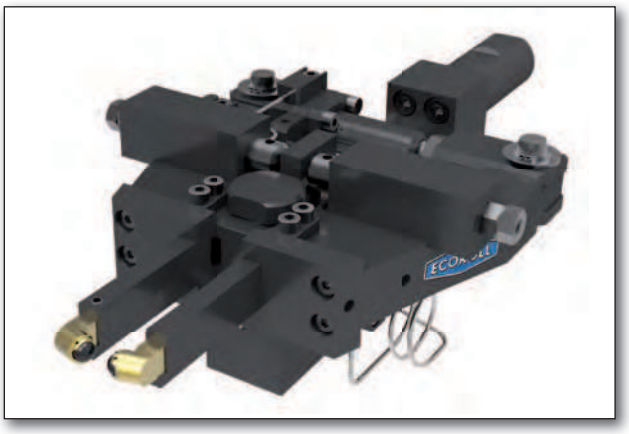
- Operation with external pressure supply; also required are a hydraulic unit and high pressure supply.

HGx-20

- Specially designed for the external machining of narrow, cylindrical round rods ≥ Ø 0.5 mm.
- 3-point tool with three hydrostatically loaded balls prevents the workpiece from flexing.
- Standard version with square shank; alternative tool retainers available.

HGx-29

- For machining both sides of both sides of disc-like and thin-walled components (such as turbine blades) in one pass on CNC-controlled machine tools.
- For roller burnishing and deep rolling any metal material or hardened material up to a hardness of 65 HRC.
- Because the burnishing force is pressure dependent, the process is easy to monitor, enabling consistent product quality.
- Standard version with straight shank; alternative tool retainers available.



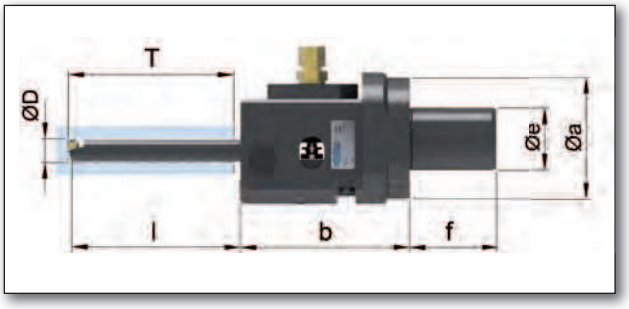
Internal machining

HGx-1, HGx-2, HGx-2P, HGx-4, HGx-11: Operation with external pressure supply

- Also required are a hydraulic unit and high pressure supply.

HGx-1

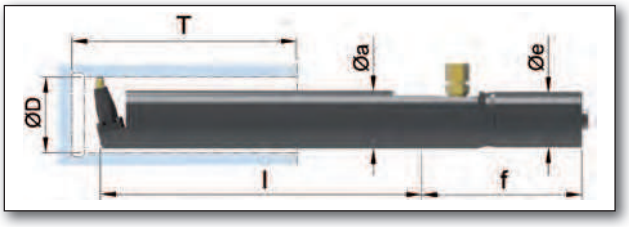
- For bores ≥ 19 mm.
- Ball diameter max. 6 mm.
- For use on lathes, boring mills and machining centers.
- Available as a rotating tool with special rotating union DD.
- The ball insert is at the end of a lever activated by the following system in the tool body.
- Initial, approximate diameter setting by positioning in the radial direction.
- Finer setting takes place automatically with the following system.



Tool	Diameter range D (all dimensions in mm)	Burnishing length T	a	b	Ø e	f	l
HG6-1	≥ 19	50/80/125	106	131/161/206	40	136	60/90/135

HGx-2

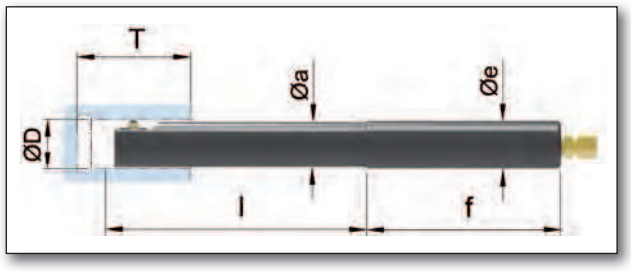
- For bores ≥ 70 mm (HG6-2) and ≥ 125 mm (HG13-2).
- Standard tool retainer, cylindrical Ø 50 mm.
- Rigid, bend-proof version, available for burnishing lengths up to 800 mm.
- Equipped with standard burnishing elements.



Tool	Diameter range D (all dimensions in mm)	Burnishing length T	a	b	Ø e	f	l
HG6-2	≥ 70	200/400/600/800	53		50	145	T+40

HGx-2P

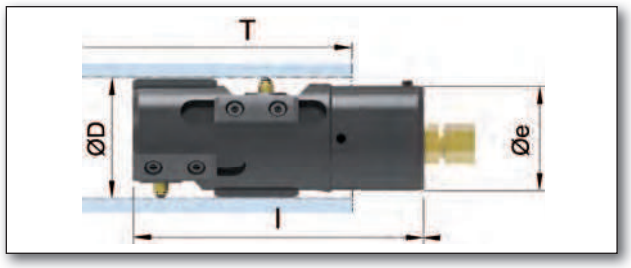
- With cartridge burnishing element HG6 (ball Ø 6 mm).
- For internal machining of narrow, cylindrical bores.
- Can be used with conventional or CNC-controlled lathes.
- Cylindrical tool retainer with clamping face.
- max. burnishing length: 350 mm.



Tool	Diameter range D (all dimensions in mm)	Burnishing length T	a	b	Ø e	f	l
HG6-2P	≥ 40	200/300	38		40	120	200/350

HGx-4

- For extra-long (≥ 800 mm) bores in a Ø range of 50 - 150 mm (larger diameters by request).
- For use on deep hole drilling machines or conventional lathes.
- BTA boring bar connection.
- 2-point tool prevents bending for long burnishing lengths.
- Approximate centering in the bore achieved by the guide pads on the tool body.



Tool	Diameter range D (all dimensions in mm)	Burnishing length T	a	b	Ø e	f	l
HG13-4	≥ 50	Unlimited	49		BTA connection by order		260

HGx-11

- For roller burnishing and deep rolling small bores ≥ 6 mm.
- 2-point tool prevents bending for long burnishing lengths.
- Suitable for use with slightly trumpet-shaped bores (connecting rods).
- Available as a stationary or rotating tool with special rotating union DD.

Accessories for the HG Series: HGP hydraulic units and immersion pump units

Features

HGP hydraulic units provide a source of pressure for operating HG series tools without integrated high pressure pumps:

- For use with all machine tools without tool drives.
- Mobile or fixed versions available.
- Two series:
  - HGP3: $P_{max.}$ = 200 bar
  - HGP6: $P_{max.}$ = 400 bar
- Electric motor drive: 220V, 1 phase or 400 V, 3 phase, depending on the HGP version (motors for other voltages by request).
- Control with M-function for CNC-controlled lathes available.

HGP 6.5

HGP 6.0

Immersion pump unit

Accessories for the HG Series: Rotating Unions

Features

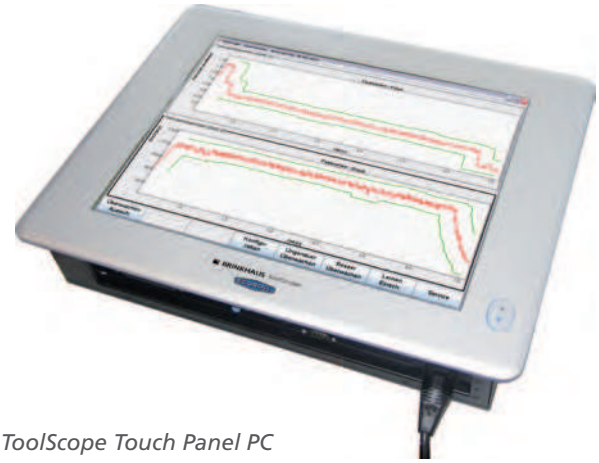
- ECOROLL rotating unions are required if tools with external pressure supply are used on CNC-controlled lathes with turrets. With the rotating union, the turret can function fully and uninterrupted pressure supply is ensured.
- The **DE** rotating union is used to supply a single tool.
- The **DS** rotating union can supply up to 4 tools with pressure.

Selective Rotating Unions (DS)

Accessories for the HG Series: ToolScope

Process monitoring during deep rolling with HG tools

The ToolScope system enables the continuous monitoring and documentation of the critical process parameters used in deep rolling. When using the hydrostatic deep rolling tools in the HG series, the parameters relevant to the process, the operating pressure and the flow rate, are monitored and recorded. ToolScope recognizes deviations from the process parameter specifications immediately, resulting in an error message. The process can only continue after the error has been checked and cleared, which significantly reduces rejects, reworking and related damage. Moreover, ToolScope provides process documentation, which offers proof of adherence to the specified process parameters.



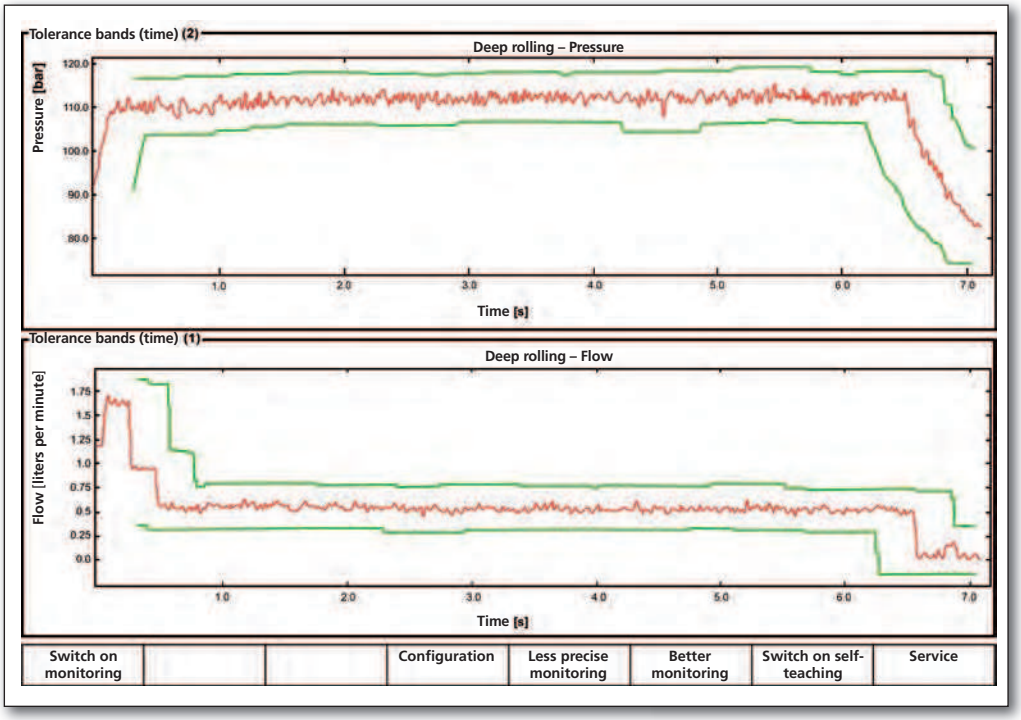
ToolScope Touch Panel PC

Features

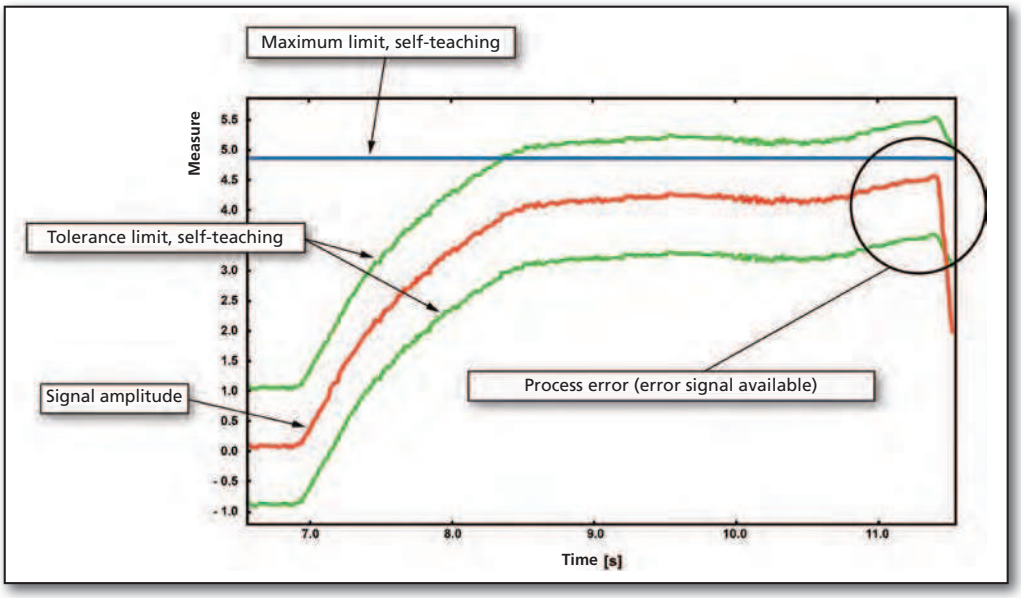
- Self-teaching process monitoring.
- Achieves qualified machining processes.
- Highly accurate signal recording.
- Machining processes can be reproduced.
- Touchscreen operation.

Note: For further information about process monitoring and documentation of deep rolling parameter, see the chapter on “Process Monitoring”.

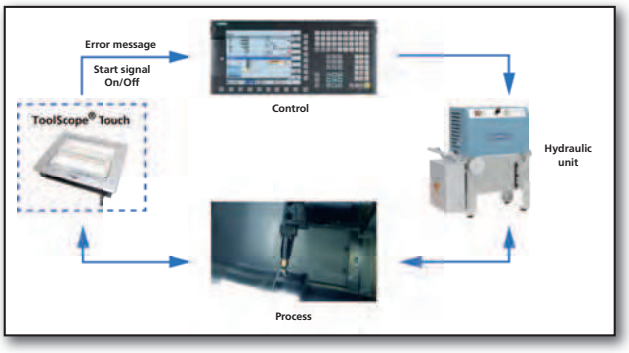
Independent monitoring system



Process monitoring with tolerance bands



Visualization of parameter limit violations



System architecture for Siemens control