HEIDENHAIN

# Error-Free Workpiece Transfer

HEIDENHAIN ROQ rotary encoders in INDEX lathes

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Why does INDEX install a second rotary encoder on the Z axis in its lathes for full-surface machining? The answer is safety and accuracy—two unbeatable arguments that customers treasure.

Multifunctional production centers for full-surface machining are the hallmarks of the INDEX Group from Esslingen am Neckar in Germany. Their state-of-the-art CNC lathes offer the user quality and accuracy on the one hand, and economical production costs on the other hand through short door-to-door times. One of the reasons for this is the precise transfer of workpieces from the main spindle to the counter spindle during six-sided full-surface machining. ROQ model HEIDENHAIN rotary encoders with DRIVE-CLiQ interface play a decisive role here.
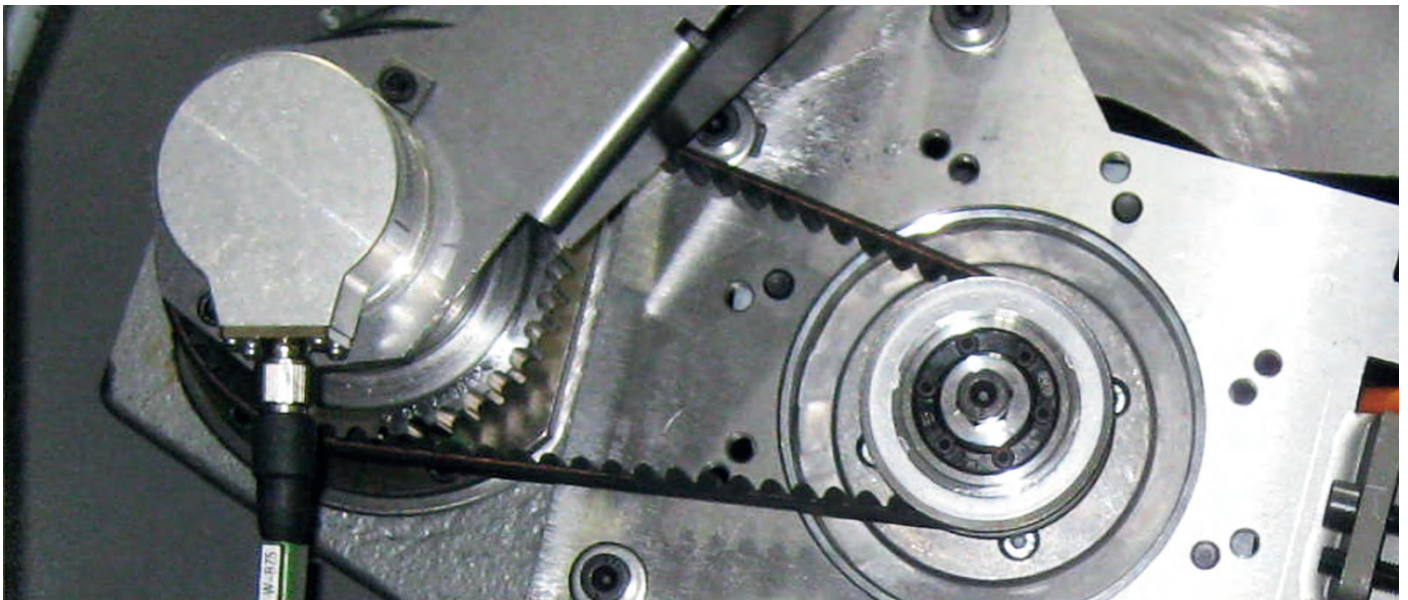
Transfer manager: the ROQ model HEIDENHAIN rotary encoder sits directly on the Z axis, which is driven by a motor through a toothed belt. (Photo and Photo cover: INDEX-Werke)

Like a relay race

"The transfer of a workpiece in the lathe from the main spindle to the coun-
ter spindle is like handing over a baton in a relay in athletics: a tricky thing at
which even professionals at world championships or in the Olympics re-
peatedly make mistakes. Highly complex processes are at play that we want
to master on our machines," Ulrich Baumann explains, Manager of INDEX's
single-spindle design department. Now, no lathe operator has to worry about
a workpiece falling out of the spindle like in a botched baton pass. Reliably
transferring a workpiece from the main spindle to the counter spindle has
long ago been solved. Here the devil is in the detail, or more precisely, in the
accuracy of the transfer.

When the clamping elements are loosened and clamped on the main
spindle and the counter spindle, it exerts forces on the workpiece
and thus on the entire slide unit. This results in changes from the
original workpiece position on the main spindle to the workpiece
position on the counter spindle after transfer. "We have to measure
these position changes so that we can compensate them again,"
continues Ulrich Baumann in his statement. "Otherwise, at the end of
a six-sided full-surface machining operation, the overall accuracy of the
workpiece simply cannot be correct if dimensions have to be complied
with beyond the first and second clamping."

Live ascertainment of all factors

Rules of thumb, experience, standard compensation values or a specified allowance cannot
help here. Too many factors influence the displacement: Which clamping devices are used? What
is the workpiece material? How are the surfaces of the chuck and workpiece? Does the workpiece have
thick, stable walls or thin, sensitive walls? With what forces is the workpiece clamped in the main spindle on
the unmachined side, and what forces can be exerted during the transfer from the counter spindle to the side that has
already been machined? Even the cooling lubricant used has an influence on the position shift. "All these factors are machi-
ning-specific and highly individual. Friction, too, is always a factor—and friction is never constant. So we have to measure
the influences in real time if we want to compensate them," concludes Ulrich Baumann.

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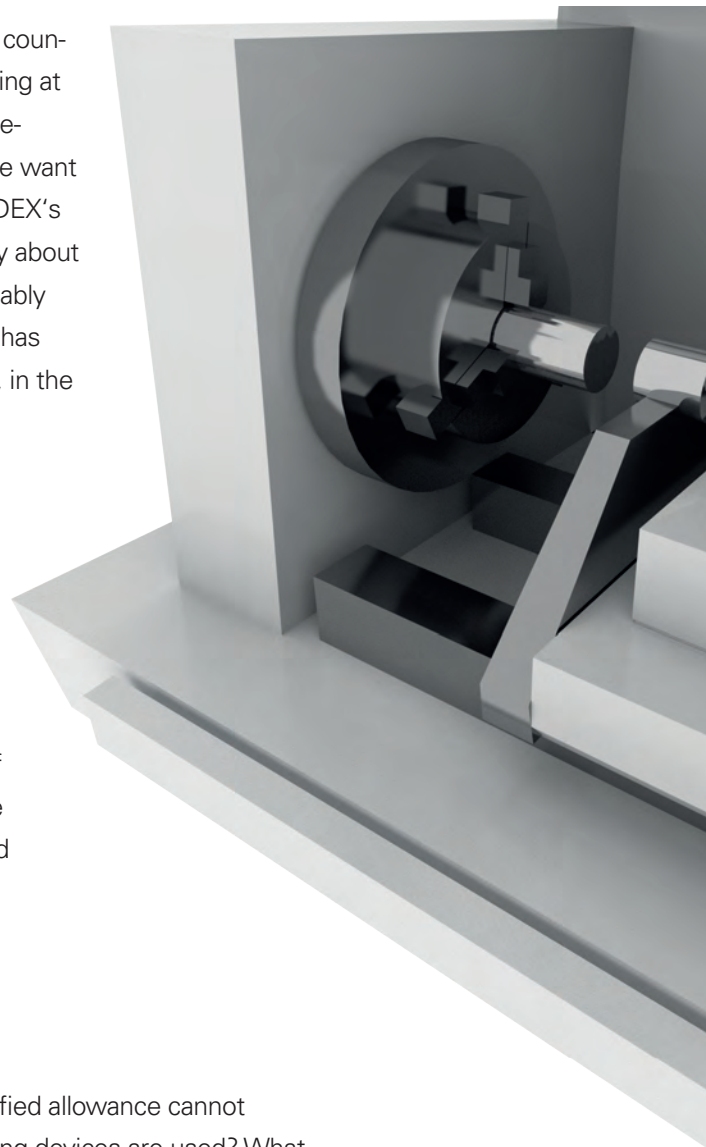
That's where the additional ROQ rotary encoder from HEIDENHAIN on the Z axis helps. In order to transfer a workpiece from the main spindle to the counter spindle, the machine initially moves the counter spindle over the workpiece and the counter spindle then clamps it. During this clamping process, the axis moves due to the forces that are ascertained by the rotary encoder. The encoder then transmits the measured values to the control via its DRIVE-CLiQ interface, which offsets them during further machining. "With the second rotary encoder on the Z axis, we are closer to the cutting edge and can therefore measure more accurately than with the motor encoder. Thanks to this arrangement, we are able to reliably realize a length deviation of less than 0.02 mm during the workpiece transfer process," adds Eberhard Beck, Head of Control Technology at INDEX.
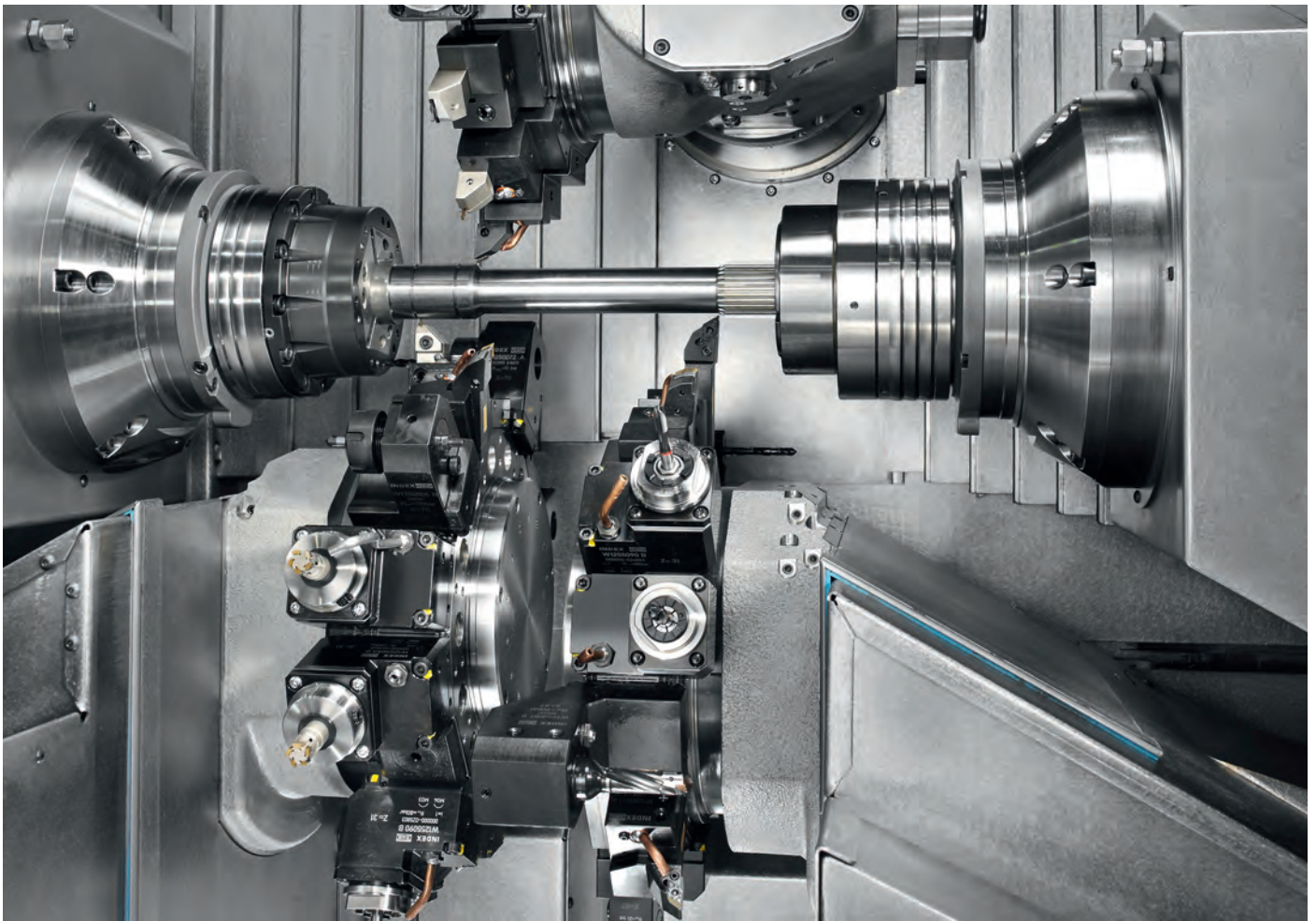

There's a lot happening in an INDEX G200: if you see the full working space, one can well imagine the consequences of a crash of the tool carriers with the opposing spindle. (Photo: INDEX-Werke)

HEIDENHAIN rotary encoders offer safety as added value

When searching for a suitable encoder for this application, the INDEX developers quickly came upon the ROQ encoder from HEIDENHAIN. "It is small, can be built in everywhere and is completely insensitive to contamination," as Eberhard Beck explains the choice. Also, thanks to the DRIVE-CLiQ interface, it can be easily connected to the machine control and has sufficient reserves with a singleturn resolution of 24 bits to ensure the required accuracy.

Eberhard Beck also brings up another argument for the additional encoder: the gain in safety. In order to save space, INDEX integrates the motor for the Z axis backwards, so to speak, under the axis and drives it with a toothed belt. Depending on the amount of chips and the machine load, this toothed belt can tear and stop the spindle. The rotary encoder already on the motor would not detect such toothed belt failure. The machine would continue machining. "In the worst case, the tool carriers could crash into the stationary counter spindle," Eberhard Beck pointed out: "Then up to one week of machine downtime and damage of several thousand euros are possible—a catastrophe for any company." Preventing such disasters is one of the HEIDENHAIN rotary encoder's tasks.
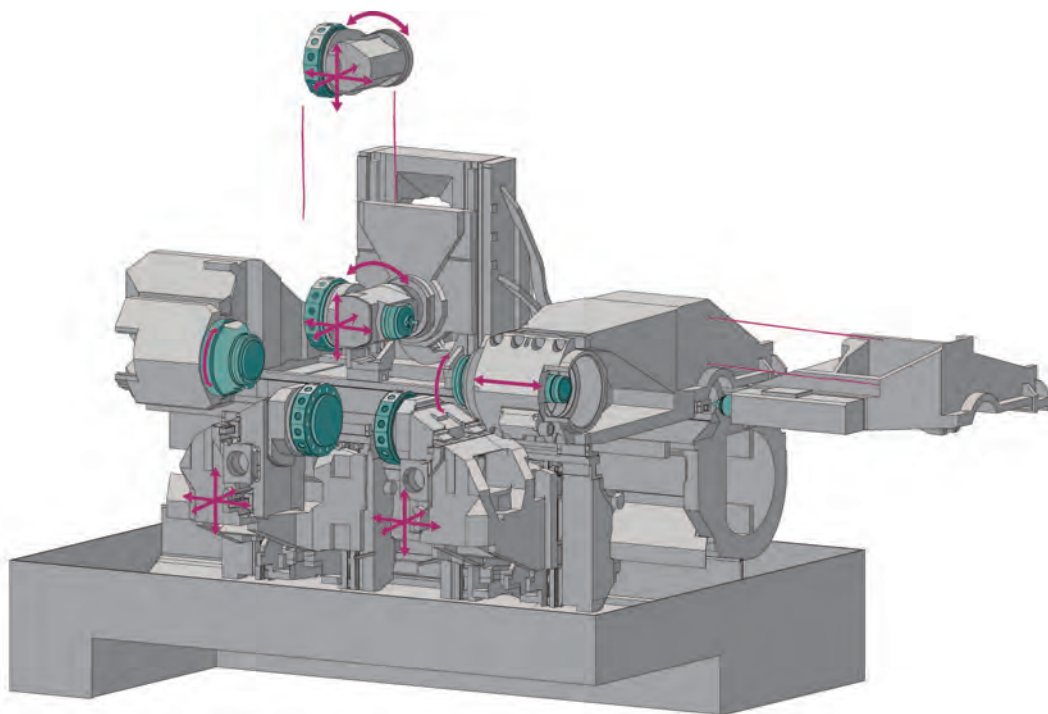

Freedom of movement: for six-sided full-surface machining to become possible, a modern lathe such as the INDEX G200 must coordinate highly complex motion sequences in all axes. (Photo: INDEX-Werke)

TECHNOLOGY REPORT

ROQ 436 S

- Absolute rotary encoder
- Clamping flange with additional slot for fastening with fixing clamps
- Solid shaft for separate shaft coupling
- Siemens DRIVE-CLiQ interface

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm
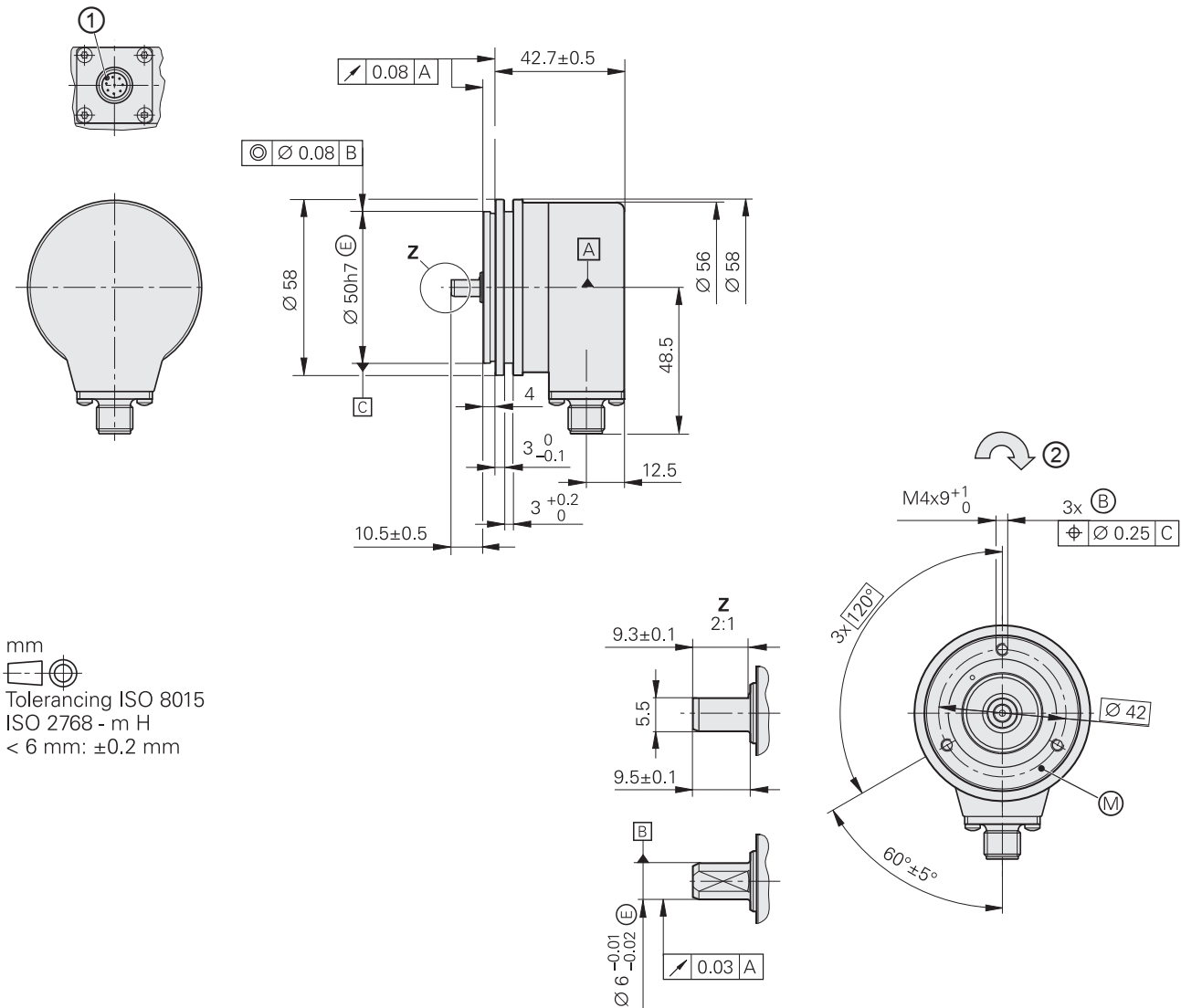
Ⓐ = Bearing
Ⓑ = Threaded mounting hole
Ⓜ = Measuring point for operating temperature
1 = Connector coding
2 = Direction of shaft rotation for output signals as per the interface description

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

	ROQ 436 S
Interface	DRIVE-CLiQ
Ordering designation	DQ01
Positions per revolution	16 777 216 (24 bit)
Revolutions	4096
Code	Pure binary
Elec. permissible speed	≤ 15 000 rpm for continuous position value
Processing time $_{TIME\_MAX\_ACTVAL}$	≤ 8 µs
Incremental signals	Without
System accuracy	±20″
Electrical connection	Flange socket M12, radial
Cable length	≤ 95 m[2]
DC voltage supply	10 V to 36 V
Power consumption (max.)	*10 V:* ≤ 1,4 W *36 V:* ≤ 1,5 W
Current consumption (typical, without load)	*24 V:* 43 mA
Shaft	Solid shaft with flat ∅ 6 mm
Mech. permissible speed n[1]	≤ 15 000 rpm
Starting torque	≤ 0.01 Nm (at 20 °C)
Moment of inertia of rotor	≤ 2,9 x 10^{-6} kgm^2
Shaft load	*Axial:* 40 N; *radial:* 60 N at shaft end (see also *Mechanical design types and mounting*)
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 (EN 60 068-2-6) ≤ 2000 m/s^2 (EN 60 068-2-27)
Max. operating temp.[1]	100 °C
Min. operating temp.	–30 °C
Protection EN 60 529	IP67 at housing; IP64 at shaft inlet
Mass	≈ 0.35 kg
Valid for ID	1036786-xx[3]

[1] For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information.*
[2] See *Interfaces of HEIDENHAIN Encoders* brochure; with number of encoders = 1 (incl. adapter cable)
[3] Also available with **functional safety**; for dimensions and specifications, see the product information document.