



New Series of Angle Encoders Offering Advantages for the Machine Tool Builder

For years, HEIDENHAIN has been setting the standard for angular metrology with angle encoders featuring integral bearings in hollow-shaft versions. These encoders are characterized by their simple mounting and high accuracy. They are the encoders of choice for many applications for angle measurement in accuracy grades of a few angular seconds. Particularly on rotational axes in machine tools, such as rotary tables and tilting axes, they are the best solution for position and speed control.

Based on the design of the angle encoders with integral bearings and hollow shaft, with its RCN 5000 HEIDENHAIN has developed a new series of angle encoders with a large number of persuasive properties.



The advantages are found in the following: The design:

- Hollow shaft Ø 35 mm together with small installation space
- Large mounting tolerances without limitation of function or accuracy
- Connectable cable assembly

The scanning:

- Very high signal quality
- High tolerance to contamination
- High permissible shaft speeds

The interface:

- Automatic self-configuration
- Generation of warnings when certain tolerance limits are violated
- Diagnosis by valuation numbers
- Compact connecting elements

Safety technology:

- Single-encoder solution with purely serial interface for use in safety-related applications

Advantages of the mechanical design

One special property of the new series is the large hollow shaft with a diameter of Ø 35 mm and very compact outside dimensions. This

Did You Know...

...that North America's largest five-axis gantry machine is located in Detroit and uses the world's longest HEIDENHAIN linear scales? Called the CyberMill® by machine builder Ingersoll Machine Tools (www.ingersoll.com) in Illinois, this massive machine has an X-axis that is three quarters the length of a football field and is in operation at W Industries (www.w-industries.net), a leader of metal products manufacturing.

Called upon to handle the really big machining jobs, W Industries' gantry machine is 20 feet wide by 204 feet long (with eight feet under its gantry). This CyberMill is running around the clock, guided by two 72 meter HEIDENHAIN LB 382 linear scales – the world's longest – running down the length of the guideway. "The positional accuracy on these long HEIDENHAIN linear scales is ± 5 microns and the repeatability is exceptional," said Martin Honer, a controls project engineer at Ingersoll. "We chose these scales because HEIDENHAIN makes the best feedback equipment in the business, and we were pleased that their LB scales carry distance-coded reference marks." The distance-coded reference marks (semi-absolute) on the LB scales are extremely important on large machines as they allow it to "home" or ascertain its position at startup very quickly.

To put this CyberMill's size into perspective, staff at W Industries estimate that one could stack 78 Hummer H2 sport utility vehicles (without tires) two-high, three-wide, end-to-end within its table. Within that amount of space, many kinds of large structures can be machined, including large molds, jigs, fixtures and composite tooling. Rooted in work for the



W Industries' gantry machine is 20' wide and 204' long.

continued on next page

Contents...

Page 1-4 **New Angle Encoder Series – Cover Story**

Page 1-2 **Did You Know...North America's Largest 5-Axis Gantry Machine**

Page 4-5 **MANUALplus 620: New Drilling and Milling Functions in Two Axis**

Page 6 **Three New Infrared Touch Probes – "Cable-less" Flexibility**

Page 7 **Letter from the President – Maximizing Resources for Customers**

Did You Know... *continued from Page 1*

automotive industry, W Industries is currently taking off into aerospace with this CyberMill routinely doing what others cannot, such as wing and fuselage bond tools. "We plan to also be involved with flight hardware, special aerospace and alternative energy projects in the near future," said Jason Sobiek, Director of Aerospace Manufacturing at W Industries.

"With this giant CyberMill, we are now working on a program for the Airbus A350 airplane for Spirit, borne of a government bond that we believe is the largest to be issued in the state of Michigan," said Sobiek. This high definition, high tolerance project consists of two long tools for the fuselage, both 16 feet by 70 feet, which utilizes about 1/3 of the travel of the CyberMill.

All three of the axes on the mill include linear measurements provided by HEIDENHAIN's LB 382C sealed linear scales (X axis is 200 feet, Y axis is 26 feet and Z axis is 8 feet).



The CyberMill is guided by two 72 meter HEIDENHAIN LB382 linear scales.

New Series of Angle Encoders *continued from Page 1*

represents a shaft cross section more than three times larger than the RCN 200 series, which is similar in design and has a hollow shaft diameter of \varnothing 20 mm. This provides more area for stiffer machine shafts and hydraulic leads, which are frequently led through hollow shafts. With an outside diameter of \varnothing 110 mm and an overall height of only 42 mm, the RCN 5000 requires less installation space.

Simple mounting is a further advantage of the new angle encoders. Unlike the modular angle encoders, which usually consist only of a scanning unit and a graduation carrier, the hollow-shaft angle encoders with integral bearing feature an integrated stator coupling. In this way, the components involved in scanning are ideally aligned to each other, even if there are deviations of the shaft coupling. Radial and axial error in the measured shaft is assimilated in the stator coupling so that the coupling remains free of torsional rotation. Of course, this principle applies only within certain mounting tolerances. The new stator coupling, conceived and developed for the RCN 5000 is characterized in its axial and radial deflection and torsional rigidity by excellent behavior and operates virtually without angular error. This permits relatively generous mounting tolerances without its limiting function or accuracy. For example, together with the encoder sealing technique, which is also new, it can tolerate deviations in axial direction of up to ± 0.3 mm.

The new series also has an impressive set of design details. The RCN 5000 encoders feature a pluggable cable assembly.



Figure 2: Plug-in adapter cable

Because the separately ordered adapter cable has a quick disconnect, mounting the plug-in cable assembly to the encoder is very simple. No tools are needed. At the same

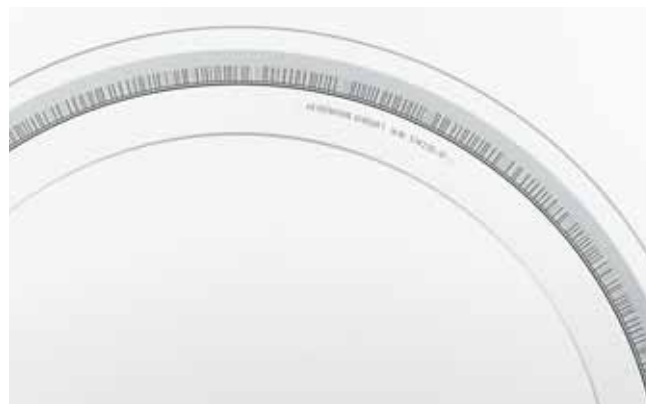


Figure 3: Graduated disk with serial code track and incremental fine track

time, the connecting element has a leak tightness of IP 67 to prevent ingress of liquids through the plug-in connection. The advantages of the connectable cable subassembly are particularly evident when a cable has to be configured during mounting in a tight installation space. The machine tool builder is also more likely to have the encoder on hand because it can be ordered separately and stocked without regard to a specific cable length or type of connecting element. The cable assembly can then be ordered and provided relatively quickly for the specific application. It may also be possible to do without additional cable because a wide range of pluggable cable assembly variants will be available.

Advantages of the scanning technique

The new RCN 5000 encoders operate with two graduation tracks.

The absolute position data on the circular scale is encrypted on one track and never recur within the same revolution. The additional incremental, higher resolution track is scanned according to the single-field scanning principle.

New Series of Angle Encoders *continued from Page 2*

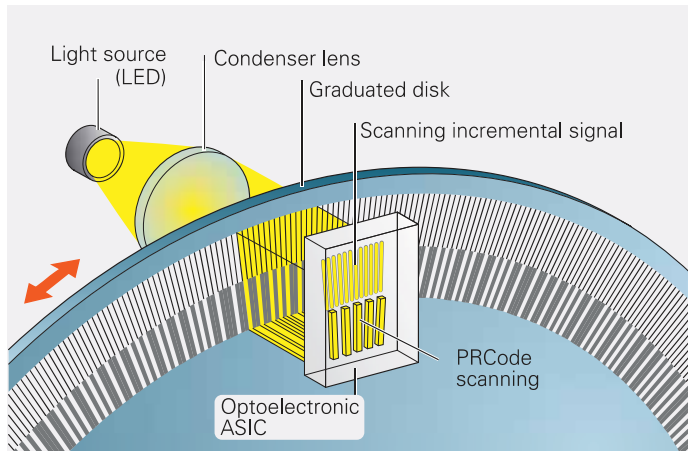


Figure 5: Single-field scanning principle

This principle uses one large grating whose grating period differs slightly from that of the scale. The scanning signals of the incremental fine track are interpolated for the position value and are processed together with the information from the serial code track to obtain absolute position values of high resolution. This enables the encoder to measure to a resolution of more than 268 million positions per revolution. At the same time, the scanning signals of the incremental, fine track are used to generate an optional incremental signal (~ 1 VPP).

Thanks to the special optical filtering of the innovative optical scanning lenses, the encoder produces scanning signals of very high quality. Up to now, test results with the RCN 5000 show that the position accuracy relevant to feedback control, often described as position error within one signal period, is superior to the absolute angle encoders of the RCN 200 series by a factor of four. Particularly on direct drives, this high signal quality will have positive effects on the control behavior and result in noticeable quality improvements of the finished workpiece surfaces.

Although the RCN 5000 series encoders are sealed and feature an IP 62 degree of protection, the goal was to further reduce the contamination risk to the point that it could no longer affect proper function. Besides its improved signal quality, the single-field scanning is characterized by a significantly reduced sensitivity to contamination. This has been achieved through the large scanning surface and the special arrangement of scanning fields. Even relatively large contaminate areas result only in slightly smaller scanning signals and somewhat increased signal deviations. In many cases, depending on the contamination, this can even prevent encoder failure where 4-field scanning, which up to now was used in the angle encoders with integral bearings, cannot. The results of testing with the encoders are

also confirmed by positive experience with linear encoders. Here the single-field scanning was introduced some time ago and has since been installed in large quantities in various applications.

To be able to meet the growing demands for better performance on machine tools, design engineers are increasingly using rotational axes that distinguish themselves through high accuracy and high rotational speed. They are intended, for example, to make it economical to run turning and milling operations on the same machine. The new series RCN 5000 are up to this task as well. Thanks to the single-field scanning and the new scanning and evaluation electronics, it became possible to dramatically reduce the influence of the rotational speed on the generation of position values. This ensures that, even at high speeds, the scanning signals have high signal quality and continue to interpolate well. The RCN 5000 with purely serial interface can attain speeds of up to 3,000 rpm (however, at high speeds certain speed cycles have to be considered due to mechanical limitations). The optionally available incremental signals (~ 1 VPP) are likewise relatively stable at high speeds. The specified -3dB cutoff frequency is greater than 400 kHz. This means that with a line count of 16,384 and a speed of 1,500 rpm the maximum amplitude reduction is only 30 %.

Advantages of the interface

The use of the purely serial interface EnDat provides further advantages for applications. As a serial, bidirectional interface, EnDat enables the encoder to configure itself during installation. This is made possible by a memory within the encoder with all encoder-specific information such as resolution, data on the interface, and ID number, which can be transmitted to the subsequent electronics.

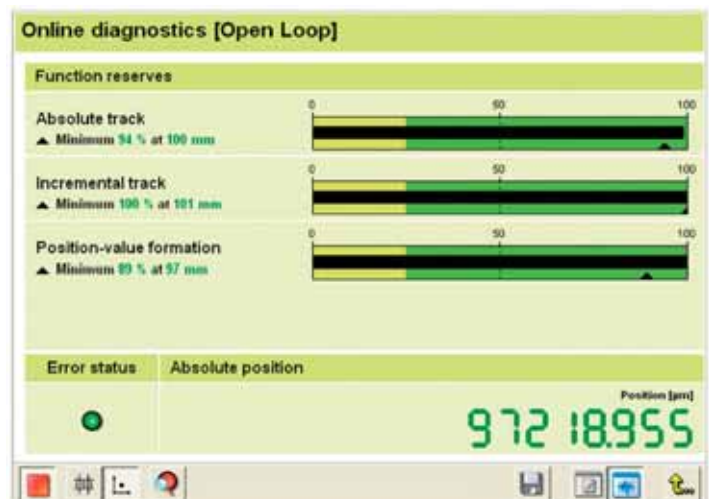


Figure 5: Example of valuation numbers on the RCN 5000

New Series of Angle Encoders *continued from Page 3*

In addition, it is possible to extensively monitor and diagnose the encoder. For example, the encoder generates warnings when it nears certain tolerance limits before it transmits any incorrect position values. The diagnostics make it possible to cyclically read so-called valuation numbers from the encoder. The valuation numbers provide the current state of the encoder and ascertain the encoder's "functional reserves." Proper function of the encoder is assured when the three black bars remain in the green area.

When one of the bars reaches into the yellow area, an examination of the mounting situation or of the encoder is recommended. This, too, does not necessarily indicate that the position value is incorrect. The monitoring and diagnostics can be used to signal the need for preventive maintenance, or it can prevent unnecessary maintenance cycles. This increases machine availability.

M12 connecting elements can also be used with the EnDat interface. This enables you to replace the previously common M23 connectors with smaller connecting elements.

Advantages due to safety technology

The benefits of a purely serial interface can also be used for safety-related applications. Safety-related applications require axes with redundant position information. To obtain independent position values, HEIDENHAIN has decided upon a single-encoder design because two encoders per axis would be both more expensive and unnecessary. HEIDENHAIN is now the only manufacturer who can offer purely serial single-encoder

solutions for safety-related applications. This makes it possible to realize a purely digital machine with safe absolute positions. For the single-encoder version, two independently generated, absolute position values and error bits are produced and provided to the safe control (e.g. the iTNC 530 HSCI soon to be available).

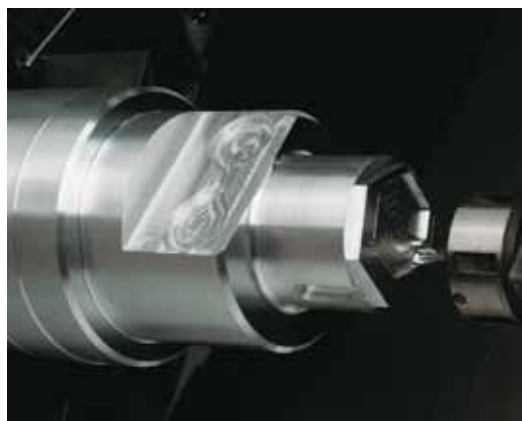
The RCN 5000 encoders can be operated as single-encoder systems in conjunction with a safe control in applications with control category SIL-2 (according to EN 61 508) or performance level "d" (EN ISO 13 849). They represent a qualified subsystem within the larger "safe drive" system. This greatly simplifies the evaluation and realization of safety-related processes for the machine tool builder.

Summary

The new RCN 5000 series distinguishes itself with numerous impressive characteristics. For example, the RCN 5000 features a hollow shaft with a diameter of \varnothing 35 mm, compact outside dimensions, relative large mounting tolerances and a pluggable cable assembly. Its new scanning process and high signal quality that permits comparatively high tolerance to contamination and higher permissible shaft speeds will contribute to the success of this new series. With its monitoring and diagnostic capabilities, the EnDat interface fulfills the requirements for high system availability. It is also possible to install the RCN 5000 with its purely serial interface as a single-encoder system in safety-related applications. The RCN 5000 will prove to be the proper angle encoder for a multiplicity of applications.

The MANUALplus 620: Even More User-Friendly

For years, HEIDENHAIN's MANUALplus controls have been known for their convenience of operation. An additional step in the direction of user friendliness was made with smart.Turn programming, which made it possible to expand the control's range of applications to single-spindle CNC lathes. HEIDENHAIN also used this opportunity to greatly expand the functions of the MANUALplus 620 once again. The new software supports machining with the Y axis, recognizes multipoint tools, monitors tool life and much more.



Facing a part on a lathe using a driven tool

New functions for drilling and milling in the C and Y axes

The new software substantially adds to the control's capabilities in drilling and milling operations: machining with the Y axis, for example, makes it possible to machine slots or pockets with even floor surfaces and vertical groove edges.

The user can choose between various infeed strategies for milling: direct infeed, infeed in a pilot hole or a 3-D approach arc, and helical (spiral) or reciprocating plunge. Appropriate pre-drilling cycles with calculation of the pre-drilling position supplement these new strategies.

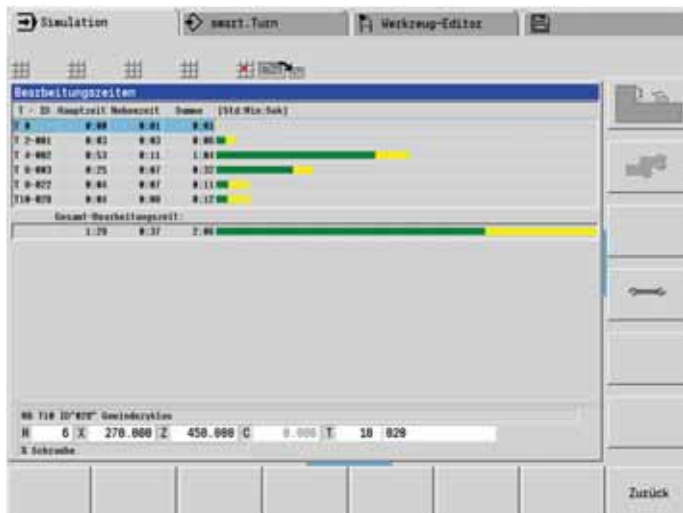
The MANUALplus 620 *continued from Page 4*

Other new cycles are for deburring with the C and Y axes as well as for inscriptions by engraving on a face or lateral surface (XY or YZ plane). For all of these cycles, users only need a few parameters to get the job done.

Also, the graphical interactive ICP contour editor supports work with the C and Y axes in smart.Turn programs. For standard figures such as slots, circles or polygons, only a few parameters are needed. Holes and figures to be milled can be arranged in linear or circular patterns, and even hierarchical arrangements such as figures within other figures are no problem for the MANUALplus 620. One example: the user defines a pocket and, within the pocket, a slot, and then holes within the slot. And all of that without any long-winded computations, because ICP finds the positions of these figures and holes automatically.

Gaining new perspectives: program run simulation

The numerous graphical simulations for material removal, the proportioning of cuts, and the finished contour have always provided valuable support for program verification. Now, with the new software, the control has been expanded with new views and a convenient, well arranged multi-window depiction of the simulation. Besides the "turning view," for operations with the C axis it offers the face and lateral surface views, and for working with the Y axis the XY and YZ views. The user simply selects a window combination with up to four views that give him an optimal perspective for checking the program code and the machining operation.



Bearbeitungszeiten				
T	SP	Arbeitszeit	Wartezeit	Somme (Std:Min:Sek)
T 0-001	0.00	0.01	0.01	0.02
T 0-002	0.03	0.03	0.03	0.09
T 0-003	0.13	0.11	0.04	0.28
T 0-004	0.25	0.07	0.02	0.34
T 0-005	0.04	0.07	0.11	0.22
T 0-006	0.01	0.00	0.17	0.18
Gesamt Bearbeitungszeit				
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Straightforward simulation of the machining times of an NC program

During simulation of an NC program, the control calculates the unit times for the programmed operation. A table clearly shows the machining time and idle time of each working step. That not only helps in calculations, for example to make a quotation

for a customer, it also provides a great perspective for finding opportunities for optimization.

Short setup times, long production times

The new "tool measurement by touch probe" function saves setup time. Finding tool dimensions has become surprisingly easy with the HEIDENHAIN touch probe and the new preprogrammed measuring cycles: simply pre-position the tool, select the measuring direction and start the measuring cycle. From the positions measured, the MANUALplus calculates the tool lengths and loads the dimensions in the tool database.



Clear-cut simulation: the new multi-window view

Another new feature is the tool life monitoring with replacement tools. The permissible tool life in terms of time or number of finished workpieces can be individually defined. If the "interchange chain" is also defined, the MANUALplus has all the information it needs to automatically switch to a "sister tool" when an older tool is worn out. The MANUALplus does not stop production until all of the tools in a "chain" have been exhausted.

Valuing the proven is essential

Of course, the new software on the MANUALplus 620 has kept all the features that for years have made it so valuable in its daily work on cycle and CNC lathes.

- **Powerful teach-in function:** machine your first part interactively while saving your cycle program for the rest of the batch.
- **smart.Turn programming mode:** you can use "intelligent" updating and DIN PLUS for special tasks.
- **ICP interactive graphic contour editor**
- **Tool and technology database:** simplifies the definition of tool parameters and proposes the appropriate feed rate for each machining step (in a three-dimensional table with workpiece materials, cutting materials, and operating modes).

HEIDENHAIN Introduces Three New Infrared Touch Probes

Touch probes are commonly used in NC controls when demanding workpieces have to be measured, usually in small-batch production. Tool touch probes are used to inspect tools, including for wear and breakage, directly on the machine. To meet the demand for simple to use, yet highly accurate touch probes, HEIDENHAIN introduces three new infrared versions.

The key benefit to infrared tool touch probes is the absence of a cable, eliminating any restrictions of movement. The units can be located anywhere, even tilting or rotating work tables. An operator can even simply remount at any time if required. With their optimized optical technology, line of sight issues are mitigated.

HEIDENHAIN's three new infrared touch probes include:



The TT 449 Tool Touch Probe

Based on the highly successful TT 140, this work horse is common in size and suitable for applications where unlimited movements are necessary, such as with tilting and swiveling rotary tables.

This touch probe has protection of IP 67 and boasts continuous duty at typically 200 hours with a lithium battery (included). A battery warning is sent if its capacity falls below 10%, and a rated break point protects the touch probe from damage due to operator error.



The TS 249 – is a small-profile infrared touch probe, primarily used on NC-controlled grinding/turning machines where space is tight. This compact device is based on well proven HEIDENHAIN sensor technology, providing signals used for immediate connection to all common control types.



The TS 642 – features mechanical probe activation and is suitable for both older HEIDENHAIN controls as well as current third party controls where infrared activation is not possible. This is especially useful in machines that are not set up to offer touch probes as standard options.

More information, including videos, on HEIDENHAIN Touch Probes for Machine Tools can be found at http://www.heidenhain.com/en_US/products_and_applications/setup_and_measurement/touch_probes/

Dear Abbé...

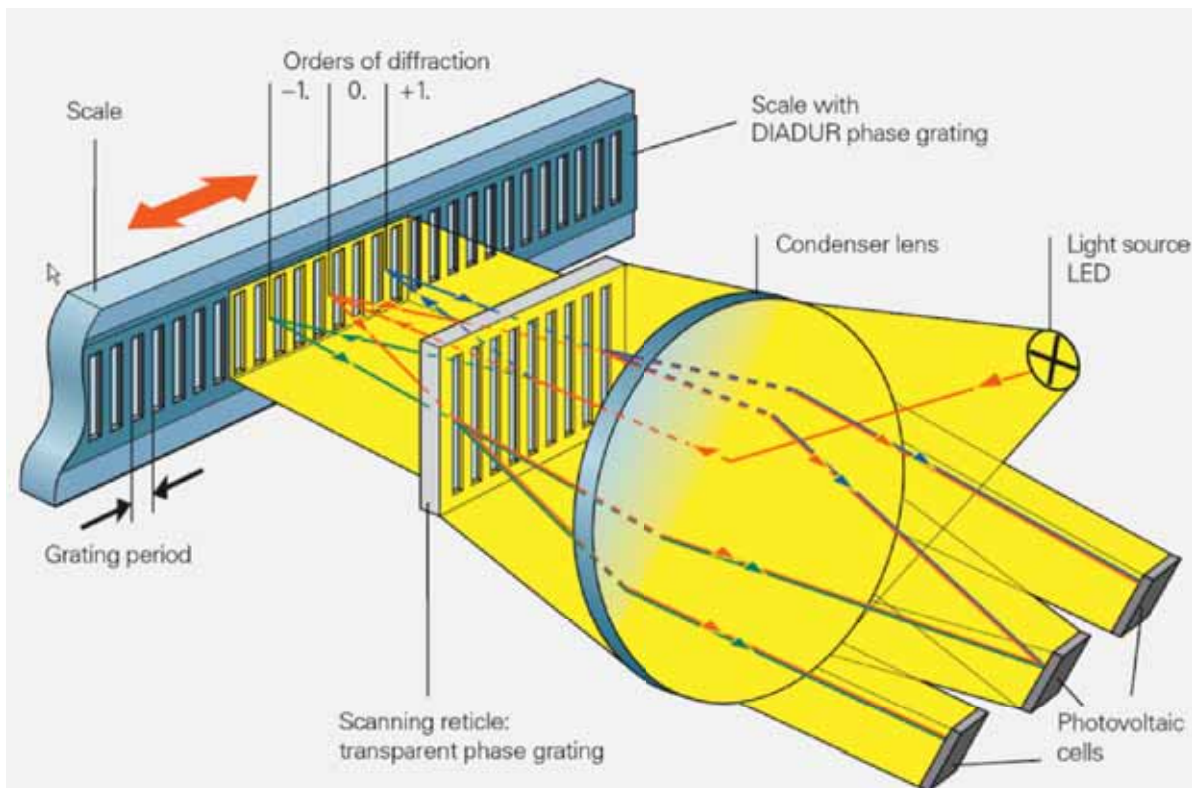
Providing answers to questions of accuracy

Question: Why should encoders with interferential scanning be used when accuracy requirements increase?

Answer: Encoders using traditional scanning methods will typically operate down to a 10 micron grating while those utilizing an interferential system work down to 4 micron, 2 micron, and points below. These graduations are smaller than is possible with any other scanning principle. This ability to obtain smaller graduations results in a smaller signal period during the measurement process. Smaller signal periods result in smaller short wave errors (assuming constant signal quality). Because short wave error is difficult to compensate in real time, it becomes a critical determinant of machine accuracy.

By decreasing the incident of short wave error as done with interferential scanning systems, machine accuracy is naturally increased.

The science behind interferential scanning is based on a light source. Here, light reflects but also refracts when it reflects off (or passes through) a surface. The refraction causes bending of the light; this bending effectively blurs the light/dark patterns that encoders use to generate signals. Rather than be limited by refraction, interferential scanning uses refraction to generate the signals.



Photoelectric scanning in accordance with the interferential scanning principle and single-field scanning.



HEIDENHAIN Maximizes Resources for Customers

*By Rick Korte
President, HEIDENHAIN Holding*

The North American machine equipment business has undergone extraordinary changes in the last couple of years. As an important provider of motion control solutions to this business, we too saw the fluctuations in the marketplace and knew that we needed to adapt to this business climate. To that end, HEIDENHAIN Corporation and its sister companies are in the final stages of successful corporate consolidation efforts. These changes have allowed us to maximize our vast internal resources to better meet the needs of our customers in both the OEM (Original Equipment Manufacturers) and end user markets.

As many know, HEIDENHAIN Corporation is based in Schaumburg, IL and is the North American wholly owned subsidiary of DR. JOHANNES HEIDENHAIN GmbH in Traunreut, Germany. In 2008, a keen watch on the world marketplace set into motion a plan to better meet the business needs of our customers in North America. To this end, the products of many of our sister companies have been melded into the sale and distribution channels that originate out of the HEIDENHAIN headquarters in Schaumburg, IL. This includes those of RENCO Encoders Inc., METRONICS®, Leine & Linde, RSF Elektronik Inc., Numerik Jena, Acu-Rite Companies Inc. and ANILAM. The extremely positive results of this integration are already

being seen by customers in the form of an even broader and more extensive product offering all in one place. The increased amount of available expertise in this field is second to none, and we have taken great strides to simplify the contact channels for all our customers. This now means that a single point-of-contact can help customers with precision measurement components from a uniquely large resource pool. Very specific solutions for small motion applications can be found quickly as well as large package solutions bundled easily.

Because of the many integrations that have taken place, all of our product offerings now originate from our very best production facilities. These world class facilities hold rigorous documentation, procedures and quality control systems firmly in place. And our combined engineering resources have served to only strengthen HEIDENHAIN's already solid and well established R&D departments.

We, at HEIDENHAIN, know that our customers are working harder with less, and we believe our efforts to consolidate many of your motion control sources to one powerful location will serve you well.

CONTACT INFORMATION

For more information about HEIDENHAIN and any of the products or services mentioned here, please feel free to contact us.



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HEIDENHAIN CORPORATION

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