

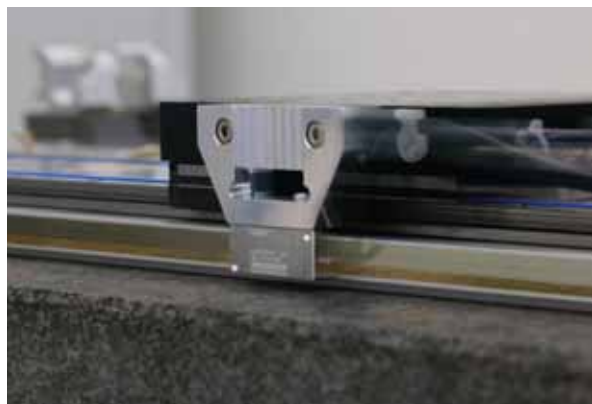


Encoder Opens Way for New Applications—

By Reinhard Kuhn, Senior Product Manager, Electronics Industry for DR. JOHANNES HEIDENHAIN GmbH

By now, linear motors have made irreversible inroads into highly dynamic applications such as manufacturing and measuring equipment in the semiconductor

continuous real-time and exact information on the position of the slide. The accuracy, performance and reliability of the individual axes depend to a great degree on the linear measuring devices on the slides. Primarily, this task is performed by compact, contact-free measuring devices—called exposed linear encoders—which function according to the incremental measuring process. With a new linear encoder on the market, HEIDENHAIN's LIC 4000 offers a significant advancement for servo control and position measurement. This LIC 4000 is an absolute and exposed linear encoder type with EnDat 2.2



industry, PCB assembly machines, textile machine and in automation. Direct drives for open and closed-loop control require

serial interface. Thanks to its resolution of 1 nanometer and the large measuring length up to 27 m, the servo control and position measurement of linear drives moves into a new dimension and opens the way for new applications.

High-quality position signals

Position encoders play a special role as feedback in control loops with direct drives. High control-loop gain can only be reached if the encoder provides high-quality position signals. With the high control-loop gain required, even minor disturbances in the encoder output signal can cause serious trouble in drive performance. The higher quality of the position information therefore contributes substantially to significant improvement in speed control and positioning accuracy.

Contact-free linear encoders—known as exposed linear encoders—that generate a high-quality position signal with low interpolation errors are essential for reliable

Did You Know...

...that an RSF Elektronik ring encoder is a critical component for the latest advancement in the fight against cancer? That advancement is TomoDirect™, a new way to deliver radiation therapy, now available on the innovative TomoTherapy® treatment system.

There are more than 300 TomoTherapy® treatment systems worldwide. The systems are used daily by radiation oncology teams to treat a wide variety of cancers, from the most routine cases to the most complex. The versatility of the system is attributed to its design; TomoTherapy® is the only radiation therapy device built on a CT scanner-based ring gantry platform. This unique design enables pre-treatment CT imaging, used to enhance accuracy, and a continuous 360-degree (helical) delivery pattern, used to increase precision. The recent introduction of TomoDirect™ added a non-rotational delivery mode to the TomoTherapy® platform, furthering increasing its usefulness in treating certain cases, such as breast cancer.

Using the TomoDirect™ software and hardware package, the system's ring gantry can be "parked" at fixed positions, delivering appropriate treatment from just the right angle, depending on the patient's needs. The RSF ring encoder—developed by RSF Elektronik, a wholly owned subsidiary of DR. JOHANNES HEIDENHAIN GmbH—guides the stopping points with extremely high accuracy.

"Within this approximately 2 meter diameter ring, we actually have 0.01 degree accuracy," explained Rob O'Connell, TomoTherapy Systems



TomoTherapy® Hi-Art® system

continued on next page

Contents...

- Page 1-5 **New Applications – Cover Story**
- Page 1-2 **Did You Know...RSF Ring Encoders Aid in Fight Against Cancer**
- Page 5 **New QUADRA-CHEK ND 1300 now Available through HEIDENHAIN**
- Page 6 **Unique Ring Encoder for 6-in. to 6-ft. Diameters**
- Page 7 **Letter from the President – Maximizing Resources for Customers**

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

Engineer. "This is even better than our design requirement."

TomoTherapy chose to use the almost 2 m RSF MSR 40 ring encoder because of its high accuracy as well as its steel tape design that could easily be provided at a custom length. The RSF encoder was also the only provider that included an effective single clamp for the ends, eliminating the need for messy glue or a second reader head. "The set up tolerance was

wide too, making this a simple and effective upgrade to our system, both for new and for in-field TomoTherapy® systems," said Tom Finnessy, Director of Systems and Product Development. "We can install this upgrade to our in-field systems in a weekend. We have been and continue to be very pleased with RSF through this whole process."

The ring encoder from RSF Elektronik is a modular steel tape rotary ring encoder, available

for measurement applications from 6 inches (150 mm) to 6 feet (about 2 m). Besides medical applications, it is proving useful in rotary tables and telescopes, to name a few.

Products from RSF Elektronik, based in Austria, **are available in North America through HEIDENHAIN Corporation.**

TomoTherapy Incorporated (www.tomotherapy.com) is based in Madison, WI.

Encoder Opens Way for New Apps *continued from Page 1*

operation of direct drives. This influences servo control and position measurement to a decisive degree.

Encoders that use photoelectric scanning are ideally suited for this task, since very fine graduations can be used as measuring standards by this method. Encoders with optical scanning methods show benefits in the position accuracy, speed stability and thermal behavior of a direct drive, and therefore contribute importantly to the utilization of the potential of direct drives.

Up to now, however, absolute position value formation in exposed linear encoders could not be realized, although absolute encoders offer decisive benefits:

- Availability of the position value immediately upon encoder switch-on, which permits fast position reapproach, especially in concatenated systems or machines with several axes.
- There is no need to move the axes to find the reference position
- Prevention of collisions during initialization of multiple axes

Because high acceleration capability and compact designs are required for applications on direct drives, usually only exposed encoders instead of sealed encoders come into question. They operate without friction and, thanks to the lack of an enclosure, are very small and can be designed with little weight. Up to now, only exposed linear encoders operating according to the incremental measuring method could be used. To realize an optical absolute encoder in exposed design, new technologies and carefully selected manufacturing processes were needed in order to integrate "absolute technology" in the mechanical design of the LIDA 400, which was already well proven on the market. The goal was to ensure in the smallest possible space essential criteria such as high accuracy, high traversing speeds, and the reliability for which HEIDENHAIN is so well known.

Step by step to an exposed absolute encoder

Linear encoders that generate a high-quality position signal with low interpolation error place high demands on their

optical, mechanical and electronic performance. The external dimensions, which are defined in the technical specifications as the maximum for an exposed absolute encoder, demand innovations and new technologies for the final realization. Not only the high quality of the graduation manufactured for the LIC 4000 with the METALLUR process (Fig. 1), but also the scanning method shares responsibility for low interpolation error.

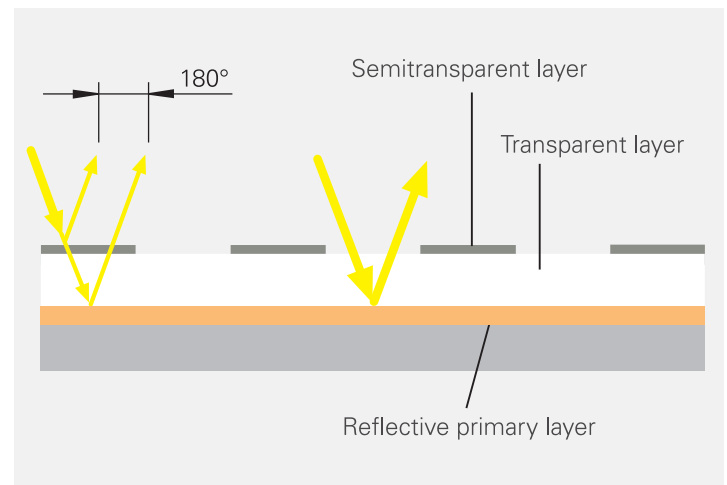


Figure 1: METALLUR design

The graduation carrier—a METALLUR scale tape

HEIDENHAIN has developed a process—known as the METALLUR process—for manufacturing graduations on glass, glass ceramic or steel. The quasi-planar graduation structure is extremely tolerant to contamination and thereby greatly enhances encoder reliability. The manufacturing processes are environmentally friendly and do entirely without chemicals such as those generally needed for etching. A new design using a pulsed laser (Fig. 2) produces the graduation structure. The graduation's high edge definition and homogeneity permit low interpolation error to ensure smooth operation and high controller gain of the linear drive.

Encoder Opens Way for New Apps *continued from Page 2*

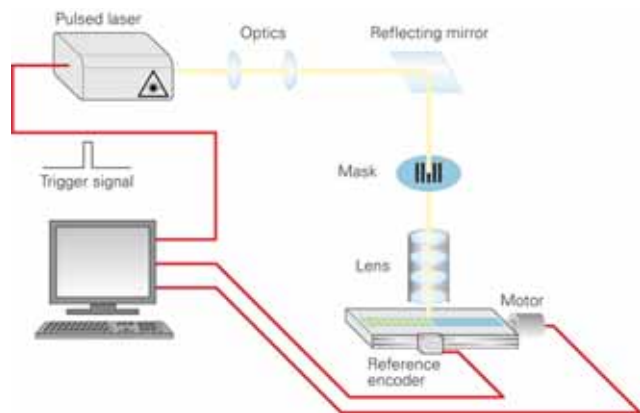


Figure 2: Manufacture of the graduation structure

In the LIC 4000 series with its absolute graduation, the position value is available from the encoder immediately upon equipment switch-on and can be called at any time by the subsequent electronics. There is no need to move the axes individually to find the reference position. The absolute position information is scanned from the scale graduation, which is configured as a pseudo-random-coded (PRC) track with separate incremental track (Figure 4). An innovative scanning method with integrated opto-ASIC contributes to setting new benchmarks for low interpolation error and reliability.

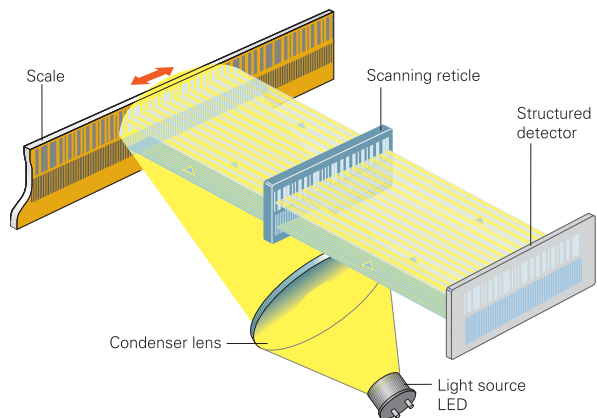


Figure 3: Design and functional principle and design of the optical scanning method of the LIC 4000

Measuring accuracy and high reliability contribute to machine safety

The newly developed scanning method is based on the high quality of the graduation and provides absolute position values with a specified interpolation error of less than ± 40 nm. Measurements resulted in an actual value significantly lower than the specification (Fig. 5). The value of the position noise, which is critical for servo control, even lies below 20 nm RMS (Fig. 6).

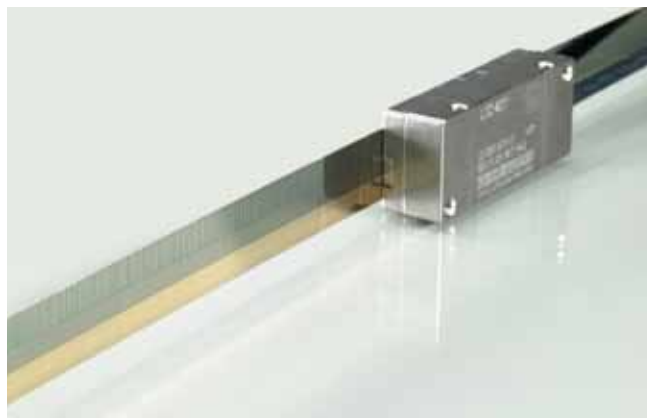


Figure 4: Scale tape of the LIC

Exposed linear encoders of the LIC 4000 series are optimized for use on fast, precise machines. In spite of its exposed design, thanks to the introduction of a new scanning method with absolute technology and the quasi-planar graduation structure manufactured in the METALLUR process, the LIC 4000 is extremely tolerant of contamination and therefore

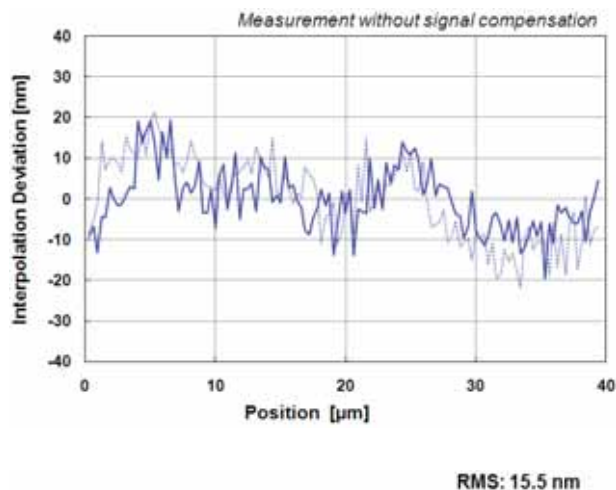


Figure 5: Measured interpolation error

contributes greatly to reliability in diverse applications over a long period of time. The large scanning field and the single-field scanning additionally reduce sensitivity to contamination. The contamination applied in a laboratory (such as oil, dust, fingerprints, hair, wires), which can easily hamper the everyday function of an exposed encoder, show only small effects on the functional safety and measuring accuracy of the new LIC 4000 series (Figure 7).

The LIC 4000 can be installed immediately on machine designs already introduced in the market because compatibility with

Encoder Opens Way for New Apps *continued from Page 3*

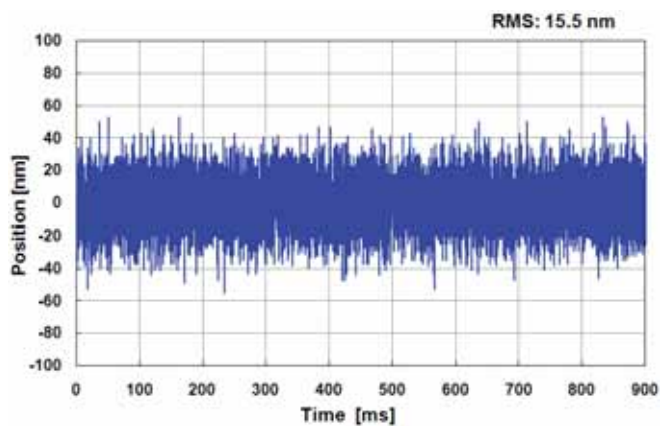


Figure 6: Measured position noise

the field-proven incremental encoder of the LIDA 400 series was already ensured during its design phase. Only the cable outlet at the scanning head has a slight change, so that the mechanical characteristics remain unaffected. The advantages of different design types are also available in the LIC 4000 series to machine-tool builders and plant manufacturers for different applications:

- **LIC 4015 – For large measuring lengths up to 27 meters**
(Steel scale-tape is drawn into aluminum extrusions and tensioned.)
- **LIC 4017 – With defined thermal fixed point**
(Steel scale-tape is drawn into aluminum extrusions and fixed at center)
- **LIC 4019 – With adhesive film, for reduced requirements**
(Steel scale tape is adhered onto mounting surface)
- **LIC 4013 – Version with thermally adapted graduation carriers**
(Glass or glass ceramic scale is cemented to the mounting surface)

Serial position transmission with EnDat 2.2

The EnDat interface from HEIDENHAIN is a digital, bidirectional interface for encoders. It is capable both of transmitting position values as well as transmitting or updating information stored in the encoder, or saving new information. Thanks to the serial transmission method, only four signal lines are required. The data is transmitted in synchronism with the clock signal from the subsequent electronics. The type of transmission (position values, parameters, diagnostics, etc.) is selected through mode commands that the subsequent electronics send to the encoder. The exposed absolute encoders of the LIC 4000

series with EnDat 2.2 interface offer position resolution of 1 nm (nanometer) although, unlike TTL devices, they are not limited in traversing speed. Since the analog scanning signals of the LIC 4000 are digitized and subdivided directly at the place of measurement, the advantages of new absolute scanning methods can be efficiently translated into improved speed stability and positioning behavior of servo motors. Moreover, these very short analog transmission paths provide greater stability in signal quality under the influence of electromagnetic noise. Especially on highly dynamic drives, this permits enhanced accuracy and reduces acoustic noise. The high clock frequency of the EnDat interface also permits very short read-out times for the position data. EnDat 2.2 is now the fastest purely serial interface for position encoders based on the RS 485 transmission characteristics.

More information on EnDat is available at www.endat.de.

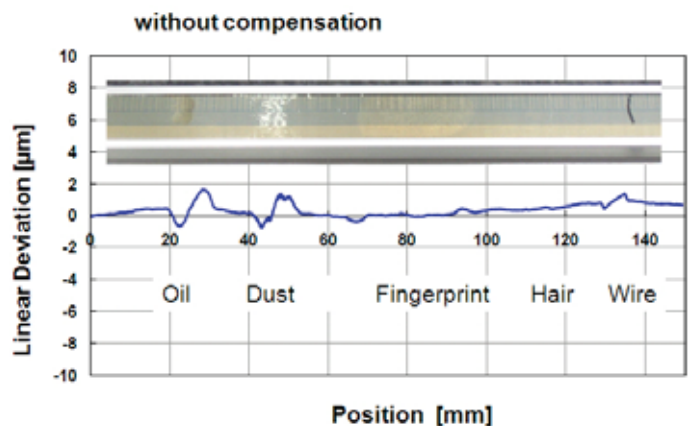


Figure 7: Contamination behavior of the LIC 4000 series

Simple installation with diagnostic capabilities including teleservice

The absolute encoders of the LIC 4000 series feature high accuracy and repeatability, and are especially easy to mount. The valuation numbers provided over EnDat 2.2 for the absolute track, incremental track and position value calculation provide a real-time status report on the condition of the encoder—both at rest and in motion. Mounting tolerances in conjunction with valuation numbers make reliable mounting possible without having to do without a safety margin in the field. The valuation numbers are also used for online diagnosis over the EnDat 2.2 interface. The diagnostic system generates error messages and warnings, and is an essential prerequisite for a high level of availability of the overall system. It enables machine-tool builders and plant manufacturers to communicate directly with the control of a problem machine or system whether it be in Munich, Chicago, Tokyo or Singapore and gain unambiguous information on the condition of the machine in order to initiate

Encoder Opens Way for New Apps *continued from Page 4*

appropriate measures on site. Of course it can also collect statistical information and use it for preventive maintenance.

Summary

The LIC 4000 compact exposed linear encoder is an absolute measuring device with a high resolution of 1 nanometer that sets a new standard for control behavior and positioning accuracy. It is based on the well proven EnDat 2.2 serial interface for fast data transfer. The EnDat protocol makes it possible to transfer various data besides position information.

In addition to the familiar linear encoder using the incremental measuring principle, for demanding positioning and control tasks in various applications such as in the semiconductor industry, metrology, medical technology, automation and textile machines, machine tool builders and plant manufacturers can now make use of an exposed absolute encoder that contributes to a decisive degree to the accuracy, performance and reliability of individual axes both for today's and for future generations.

New QUADRA-CHEK® Available Through HEIDENHAIN

The new QUADRA-CHEK® ND 1300 digital readout (DRO) – especially designed for convenient 2-D measurement and featuring a cutting-edge video system – **is now available exclusively through the global distribution network of HEIDENHAIN Corporation.**

Previously known and sold by the HEIDENHAIN subsidiary, METRONICS, Inc., QUADRA-CHEK DROs continue to hold a top spot when supporting gauging systems. Since 1983, METRONICS has been active in the metrology market with coordinate measuring machines, profile projectors, tool presetters and measuring microscopes.

HEIDENHAIN Corporation has recently undergone successful consolidation efforts and now markets past METRONICS products.

The newest ND 1300 QUADRA-CHEK (one of five of the current HEIDENHAIN QUADRA-CHEK families) sports a new dark gray faceplate while maintaining all the great features of the recent past, including the QUADRA-CHEK brand name. Benefitting from the considerable resources of HEIDENHAIN Corporation, QUADRA-CHEK customers will experience vastly expanded sales, service and technical support. Purchasers of the new ND 1300 DRO can expect a high quality gauging workhorse with support of up to four axes.



The ND 1300 QUADRA-CHEK digital readout also features an enhanced color touch-screen interface and patented Measure Magic® technology. With its offered optical and video edge detection systems, the ND 1300 is ideal for measuring microscopes, optical comparators, and video systems. All ND 1300 series models include serial and USB ports for use with printers and networks.

The ND 1300 video option enables video cameras with S-Video or composite interfaces to connect simply, making past requirements of a connected PC with a frame grabber or monitor with crosshair generator unnecessary.

The entire line of HEIDENHAIN QUADRA-CHEK families include (past METRONICS model names in parentheses):

- ND 1100 (QC-100) – for simple positioning tasks
- ND 1200 (QC-200) – for 2-D geometries
- ND 1300 (QC-320) – for 2-D with video option
- ND 1400 (QC-330) – for manual 3-D measuring machines
- IK 5000 (QC-5000) – the universal PC package solution

HEIDENHAIN now also offers the GAGE-CHECK model ND 2100G (past METRONICS GC-100) designed for multipoint measurement with inputs for up to eight gages.

For more information on these DROs for metrology applications, contact your HEIDENHAIN sales representative.

A Unique Ring Encoder from RSF

A new modular steel tape ring rotary encoder from RSF Elektronik is now available for measurement applications with diameters from 6 inches (150 mm) to 6 feet (~2 m). Named the MSR 40, this unique and versatile encoder **is available in North**

America through HEIDENHAIN Corporation. Applications for this economical ring encoder include rotary tables, telescopes and medical instrumentation.

The steel tape of the MSR 40 utilizes the proven Single-Field Scanning principle with 200µm grating pitch – offering ease of mounting with high achievable angular resolution. Accuracy of the system is ±30 µm/m with an operating temperature of 0° C to +50° C. With these specifications, this encoder is distinguished by its successful operation at high speeds, especially noteworthy for large measurement applications.

The novelty of the MSR 40 encoder is that it links the ends of the steel tape together with one of two joining mechanisms, depending upon the application. Measurement through a full 360° is thus possible. The MOR version uses a steel ring



ND 1300

tensioning cleat for encoders mounted to a steel surface thus allowing for thermal expansion; the MER version uses a rubber gasket with a low-profile tensioning cleat for other mounting surfaces.

Depending on the shaft diameter, line counts of up to 20,000 are available on the MSR 40. The MSR 40 is easily mountable and is available in both standard and custom sizes. Custom orders are welcomed.

RSF Elektronik is based in Austria **with North American representation and distribution through HEIDENHAIN**

Corporation in Schaumburg, IL, USA. Since 1973, RSF Elektronik has been well known worldwide for offering high quality linear encoders, rotary encoders, digital readouts, and custom measuring systems. In addition to standard product lines, RSF offers customized measuring solutions tailored to the metrology, semiconductor, automation, and medical industries.

For more information on this encoder, visit www.rsf.at

Dear Abbé...

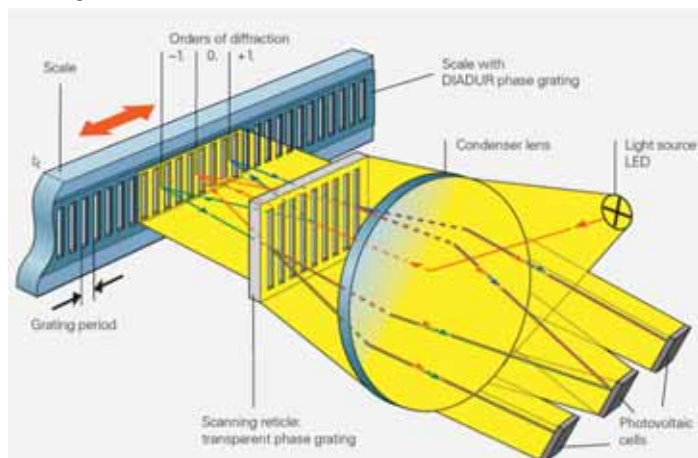
Providing answers to questions of accuracy

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.





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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