

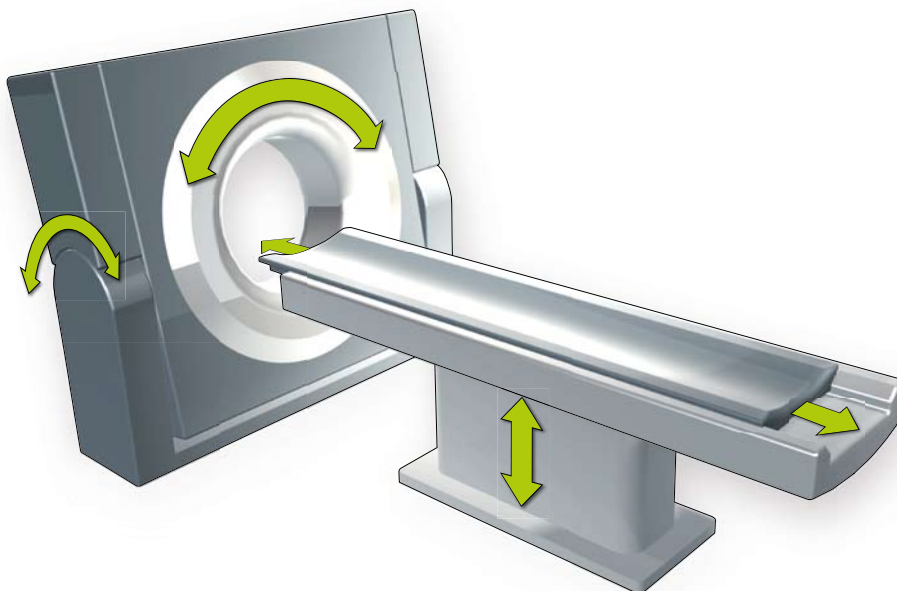


Technical Information

## Solutions for medical technology – precise, reliable and long-lasting

Medical technology is an extremely sensitive industry, in more ways than one. People are in difficult and exceptional circumstances, since their health—one of the most precious goods humans have—is under attack. Fears for one's physical and financial well-being compete with the hope for healing and recuperation. In this situation patients are directly confronted with diagnostic and therapeutic high-tech equipment that exactly mirrors this inner conflict. They cannot understand this technology, and in some cases they even fear it. At the same time, all their hopes depend on the capabilities of these devices and machines. Naturally this also applies to the laboratories, even if the patients are only indirectly aware of these high-tech facilities.

Devices and machines for medical technology must become accepted in this sensitive environment. One way of doing so is by ensuring maximum comfort for the patients. This includes, for example, as smooth as possible a movement of the patient table or dental chair. Another, and very effective, method is through reliable diagnoses and effective therapies, which instill trust in the patient. Highly precise controls are necessary, for example, to exactly position the X-ray system of a CT scanner in very small steps for as many slices as possible at high resolutions, or the linear accelerators of radiation therapy units.



In order to provide patient comfort and to ensure high-precision control of the medical technology, HEIDENHAIN offers a comprehensive range of linear, angle and rotary encoders that optimally fulfill the requirements of medical technology, and furthermore can be customized for specific requirements:

- High positioning accuracy
- Measurement without backlash
- High reliability and availability
- High durability
- Compact design

# HEIDENHAIN solutions for medical technology

## Applications for diagnosis

Along with physical examinations and diagnostics based on laboratory values gleaned from blood and tissue samples, imaging procedures in particular have established themselves for diagnostic procedures. These include X-rays, computer tomography (CT) and magnetic resonance imaging (MRI). They give the doctor an insight into the patient's body without any invasive procedure. However, in these radiological diagnostic procedures the patient is subjected to doses of radiation. The more precisely the patient, the source of radiation (X-ray tube), and the detector can be positioned relative to each other, the slighter the dose is.

### Linear motions

As a rule, linear motions must be measured and controlled when moving the patient table. The patient's comfort is, naturally, a primary concern.

The height of the table can be adjusted so that the patient may easily take place. In modern CT and MRI scanners, the patient is brought into the scanning area while lying on the table. Both the vertical and horizontal motions must be smooth and without jerk, so that the patient feels a sense of safety and security, and, of course, does not come to harm.

In the scanning area of the diagnostic equipment, the patient or the body part to be examined must be positioned exactly before examination can begin. Then, depending on the diagnostic procedure, the patient must be moved through the scanning area in a highly precise and defined manner, so that images with the desired slice thickness and necessary resolution can be generated.

### Linear encoders for a high degree of patient comfort and very exact images

Absolute linear encoders from HEIDENHAIN fulfill all requirements for use in modern diagnostic equipment. Their fine graduations and photoelectric scanning principle transmit absolute, high-resolution position values in short cycle times. This enables highly dynamic closed-loop control of the drive for the patient table, with very steady motions and barely perceptible acceleration and deceleration. Also, thanks to the absolute measurement, the position values are always available immediately.

A high degree of self-monitoring and self-diagnosis guarantee the functional safety of linear encoders from HEIDENHAIN and provides data for preventive service and maintenance scheduling. Electronic and mechanical connection to the respective system is possible without problems.



### Rotary motions

Depending on the diagnostic device and technology, the sender (source) and/or receiver (detector) move in a circle around the patient. In order to achieve a high resolution and excellent image quality, a defined rotational movement at constant angular speed is necessary, possibly also exactly coordinated with the linear motion of the patient table.

### Rotary encoders and angle encoders for perfect rotational motions

Absolute rotary encoders and angle encoders provide the necessary position data for controlling the rotational motion with a high resolution and in short cycle times. Absolute position measurement always provides measured values immediately. A reference run of the diagnostic mechanisms to determine a reference position, i. e. a reset to the home position, is not required.

HEIDENHAIN angle encoders are characterized by high accuracy values in the arc second range and better, down to  $\pm 0.4''$ . Rotary encoders from HEIDENHAIN achieve accuracy grades as good as  $\pm 12''$ . The various design versions, such as with mounted stator coupling or separate shaft coupling, ensure that there are no problems in the mechanical mounting. Common interfaces are used for the electronic connection.



# HEIDENHAIN solutions for medical technology

## Applications for therapy

During the diagnosis, the patient's comfort is of primary concern. But during therapy it is his safety. No matter whether it is radiation therapy or a robot-assisted operation, such procedures often affect highly sensitive areas of the body, such as the brain, spine, nervous system or vital internal organs.

Inaccuracies in the positioning or guidance of the therapy instruments can have far-reaching consequences. An incorrectly targeted or shaped beam in radiation therapy, a brachytherapy seed not placed exactly, an incorrectly guided instrument in a robot-assisted operation, and the therapy will not lead to the desired success, or, even worse, could damage the neighboring and healthy tissue.

Correspondingly important, therefore, is the highly precise positioning of the instruments, including continuous, real-time feedback to the doctor and equipment operators regarding the current status.

### **Positioning of beam paths in radiation therapy**

In radiation therapy, cancer cells are treated by, for example, bombarding them with high-energy photons. One method is to aim the beams at the tumor from different directions outside the body so that they intersect exactly where treatment is necessary. This way, a radiation dosage sufficient for treatment is administered at that point, while at the same time each individual beam poses no danger for the tissue it passes through.

In order for the intersection point of these beams to lie precisely within the desired treatment area, the sources of the beams must be aligned very exactly. First they must be positioned on a radial path around the patient, and then they are focused on the patient at just the right angle. Positioning errors of just a few angular seconds can exponentiate themselves and then, since the beams are all so narrow, there will be no optimal point of intersection.

The high reliability and availability of the linear and angle technology from HEIDENHAIN is definitive here, in particular regarding the high dosages of radiation, which can influence or destroy electrical components.



### Guidance of instruments and seeds

So while in radiation therapy the precise alignment of beam sources outside the patient's body, with a target inside his body, must be ensured, robot-assisted operations and brachytherapy actually move instruments, implants or medical seeds through a patient's body. Especially because these types of therapy are considered to be minimally invasive, they require the highest degree of precision when guiding the instruments past healthy and possibly very sensitive tissue on the way to the actual site of the operation or implantation. Once there, the instruments must continue to be guided with the utmost precision in a minimum of space to the point of actual operation, in order to avoid any unintentional damage to healthy tissue.

The guidance and operation of the instruments in these types of therapy require highly precise linear and angular technology, with the highest possible resolution of the measurement results. The operator must know at every point during the operation exactly where the guided instrument is in the body, and how it is oriented there. This includes, for example, the alignment of a miniature camera or the position of a microgripper or cauter in electrocautery. The instrument must then obey the commands of the operator exactly. Furthermore, the operating system must be guaranteed not to fail; the linear and angle encoders from HEIDENHAIN fulfill all of these requirements safely and reliably. They supply measurement data at a high resolution without backlash, and their interfaces ensure rapid data transfer to the control electronics so that the operation can be performed without delays.



# HEIDENHAIN solutions for medical technology

## Applications in the laboratory

Modern medical laboratories are characterized by highly automated processes with a high degree of repeatability. Their task is the analysis of very small individual samples in large charges within a very brief time. To this end, for example, the cavities on microtiter plates are becoming ever smaller and ever more closely placed. In this manner, large charges of samples can be analyzed with the sparing use of expensive reagents.

In order for the results of the analyses to be absolutely reliable and correct, the laboratory equipment, such as automatic pipettors for liquid handling, must be controlled very precisely. One faulty transfer of liquids would lead to erroneous results and the destruction of valuable and possibly irreplaceable samples. The importance of modern laboratory technology is also shown by the fact that many devices are equipped with redundant measuring technology that continuously monitors the position.

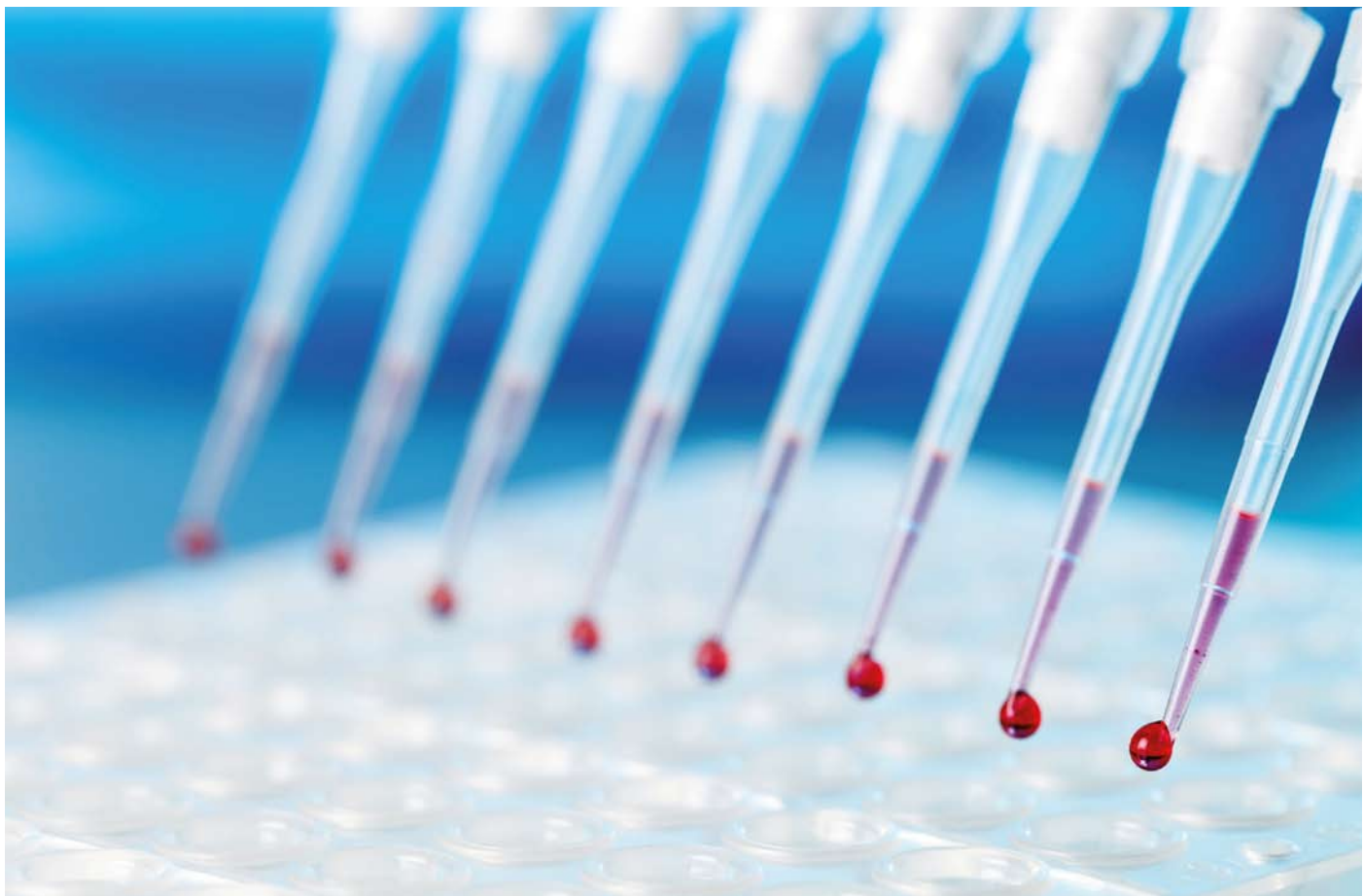
### Absolute positioning accuracy

Linear and angle encoders from HEIDENHAIN ensure a high degree of positioning accuracy at high traverse speeds. Thanks to the absolute position measurement, exact information about the position is available at all times, such as for the pipettes in the automatic pipettors. The high resolution of the encoders and the rapid data transfer to and from the control permit very precise positioning, but at the same time ensure a very steady and even control response for movement of the samples without jerk.

For rotatory systems there are absolute angle encoders with a measuring accuracy as good as  $\pm 0.4''$ . For linear systems HEIDENHAIN offers linear encoders with an accuracy grade of  $\pm 3 \mu\text{m}$  up to a measuring length of 28 m. This makes high-precision monitoring and controlling of long measuring and control paths in linked laboratory chains possible.

### Perfect radial runout

Numerous laboratory processes require devices that can perform defined rotational cycles with the utmost radial runout precision, even at changing rotational speeds: Absolute angle encoders with shaft speeds up to  $1500 \text{ min}^{-1}$  and rotary encoders with shaft speeds up to  $12\,000 \text{ min}^{-1}$  are ideally suited for this exact rotational control. In this application as well the high resolution of HEIDENHAIN encoders and their rapid data transmission ensure very precise radial runout, gentle acceleration and deceleration, and a quick response to the control commands.



# Encoders from HEIDENHAIN

## Competency in measuring and control technology

HEIDENHAIN is one of the worldwide technological leaders for linear, angle, and rotary encoders, as well as for digital readouts for machines and facilities. HEIDENHAIN achieves this success by combining the continuous drive to provide technically superior products with reliability, closeness to the customer, and a practice-oriented frame of mind. Part of this is the continual dialog with science and research on the one hand and with users and customers on the other.

Competence in the area of linear and angular metrology is reflected by a large number of customized solutions for users. These include the measuring and test equipment developed and built for many of the world's standards laboratories and the angle encoders for various telescopes and satellite receiving antennas. HEIDENHAIN naturally applies the know-how gained from these experiences to all products, ranging from customized solutions for specific industries to series production.

### Measuring standard and absolute measuring principle

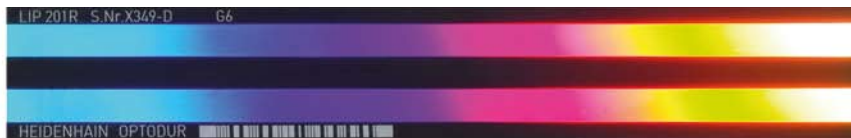
HEIDENHAIN encoders with optical scanning incorporate measuring standards of periodic structures known as graduations. They have grating periods as fine as  $2\ \mu\text{m}$  or even better, combined with high edge definition and good homogeneity of the graduation. Together with the photoelectric scanning method, this fine graduation is a precondition for the high quality of the output signals of HEIDENHAIN's linear, angle and rotary encoders and digital readouts. With the absolute measuring principle the position value is available immediately after the encoder has been switched on. The absolute position information is read from the graduated measuring standard, which is formed from a serial code structure, and from a separate incremental track that is interpolated for the position value.

### Advantages for medical technology

Devices for medical technology must perform many different linear and rotary movements without any positioning errors. Linear, angle and rotary encoders, as well as digital readouts from HEIDENHAIN perfectly fulfill this requirement. After all, the advantages of the fine measuring standard and the absolute measuring procedure are of particular interest for applications in medical technology. They offer:

- High-precision positioning
- Safe position capture even when not under power
- High system accuracy
- High resolution of the control steps

The compact and fully-integrated design of the digital readouts and linear, angle and rotary encoders from HEIDENHAIN permit their installation even where space is limited. At the same time they operate absolutely reliably and with a high degree of availability.



# Encoders from HEIDENHAIN

Further information



Catalog  
**General Catalog**



Catalog  
**Length Gauges**

Contents:  
HEIDENHAIN-ACANTO  
HEIDENHAIN-SPECTO  
HEIDENHAIN-METRO  
HEIDENHAIN-CERTO



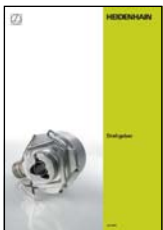
Catalog  
**Exposed Linear Encoders**

Contents:  
Absolute Linear Encoders  
**LIC**  
Incremental Linear Encoders  
**LIP, PP, LIF, LIDA**



Catalog  
**Angle Encoders with Integral Bearing**

Contents:  
Absolute Angle Encoders  
**RCN, ECN**  
Incremental Angle Encoders  
**RON, RPN, ROD**



Catalog  
**Rotary Encoders**

Contents:  
Absolute Rotary Encoders  
**ECN, EQN, ROC, ROQ**  
Incremental Rotary Encoders  
**ERN, ROD**



Catalog  
**Angle Encoders without Integral Bearing**

Contents:  
Incremental Angle Encoders  
**ERA, ERO, ERP**

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