WARP Radar technology
The next generation of plastic pipe measuring
Plastic pipe measuring – revolutionized!

For several decades now plastic pipes have been measured inline. However, currently used technologies also challenge the user in many ways, either by elaborate conversion work on the system for dimensional changes, by frequent calibration procedures or in some cases the use of water as coupling medium.

To be a trendsetter in new technologies and to bring them to market maturity is part of our corporate philosophy. Since 2011, iNOEX has been investing in the contactless terahertz and radar technology. This technology is completely free of any health risk and was developed with the purpose of raising the terms “measuring accuracy, user comfort and safety” to a new level. The result is impressive all around: a portfolio that is unique in the market. The contactless measuring sensor technology was developed in-house and WARP is one of the product lines. There is still more to come.

Stay curious!

Radar technology – re-invented!

Many have heard of the term radar technology in connection with distance measurement in the automotive or aviation sector. However, the measurement of thin-walled plastic pipes places higher demands on the electronics because a high-resolution capacity is a must when thin layers are measured.

Due to the absence of a suitable product in the market, iNOEX decided to re-invent the core part of radar, the radar technology itself, including the appropriate precision technology and optics, and to adapt the package to the needs of the plastics market. Together with the best experts of the industry, a sensor technology was created that has the right solution for every requirement related to the measurement of pipes. The future trend is moving towards increasingly thin layers and their precise measurement.

Don’t miss it!

Data – put to proper use!

Data collection becomes an end in itself, one might think in view of ever growing data volumes. iNOEX therefore offers intelligent solutions for the meaningful use of and access to collected data by providing added value to our customers.

All WARP inline measuring systems of the latest generation feature intelligent tools for data processing, adapted to the respective group of users. You as a line operator have access to concise assistance information for the ongoing optimization of the production process. You as a quality control officer have access to multiple statistics and diverse production data. This data can be made available easily by way of an online storage (cloud environment). How about a survey of the current production status of all your plants and extrusion lines worldwide? In the future, algorithms for artificial intelligence will make data interpretation even more easy and convenient.

We keep on developing!
iNNOVATE
PLASTICS MEASUREMENT OF THE FUTURE

Precise – Contactless – Safe

WARP radar sensors ensure a high level of efficiency and a full documentation of your production process. A key competitive advantage.

Measuring systems make use of an advanced development of the well-known and secure radar technology used by the automotive industry. Echo detection is used to precisely acquire data on all relevant pipe dimensions. The transmission and receipt of radar waves does not require any coupling medium which makes the application very robust, reliable and independent of production variability. Radar technology is suitable for all common plastic materials such as PE, L-/HDPE, PP, PA6/-12, PVC, PVDF, etc. but as well for other materials, e.g. ceramic or glass, without any limitations as to measuring accuracy.

Measured values such as wall thickness, diameter, ovality, eccentricity or process conditions (e.g. sagging) are recorded with high precision, then documented and used for automatic process control. Ready for Industry 4.0.

ELECTROMAGNETIC SPECTRUM

RADIO WAVES  MICROWAVE  INFRARED RADIATION  VISIBLE LIGHT  ULTRAVIOLET RADIATION  X-RAYS  GAMMA RADIATION
**SCOPE OF PERFORMANCE**

- Highly accurate measuring data
- Up to 100% pipe coverage
- Diameter measurement on up to 19 axes
- Process analysis / process automation
- Full documentation in data bank system
- Standardized process data interface (OPC-UA)

**BENEFITS AT A GLANCE**

- Process optimization
  - Reduced start-up time
  - Automation based on proven control technology
  - Highest process transparency
- Easy use
  - No conversion work for dimensional changes
  - Automatic system centering
  - Automatic calibration
- Maintenance during ongoing production
Innovative radar chip
The heart of measuring: the iNOEX specific chip technology provides highly precise measurements, stable and accurate to a thousandth of a millimeter.

Specific lens geometries
The plastic lens defines the beam geometry. Each WARP system has its own specific lens shape and size which depends on the requested type of measurement.

High-performance electronics
Radar measurement places the highest demands on the electronics. iNOEX boards therefore use special technologies for radar chip control.
Algorithm refers to the mathematic processing and evaluation of e.g. measuring data. To obtain a precise measurement, intelligent algorithms are essential in order to generate a correct and stable measuring value from raw data. This applies in particular to radar systems.

The iNOEX development team has in cooperation with engineers, software designers, mathematicians and physicists developed a variety of intelligent algorithms in order to squeeze the utmost in precision out of our WARP sensor technology. In order to offer you a measuring system with added value.

**INNOVATIVE ALGORITHMS**

**EASY TO USE**
- Assistant user interface
- Automatic system centering
- Automatic calibration

**EASY TO SERVICE**
- No conversion work for dimensional changes
- Maintenance possible during ongoing production
- Robust design due to few moving parts

**FULL AUTOMATION**
- Weight per length control in combination with gravimetry
- Thin point control (s-min)
- Thermal die head centering

**MEASURING EXPERTISE FROM A SINGLE SOURCE**
- iNOEX radar chip and sensor
- iNOEX algorithms
- iNOEX 100% pipe measurement

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**Certified technology**
For your safety, all iNOEX radar systems were developed in conformity with international standards and guidelines. They are CE certified and FCC compliant.
**WARP 8**

**HIGH-PRECISION WALL THICKNESS AND DIAMETER MEASUREMENT ON 8 MEASURING POINTS**

**PRODUCT-SPECIFIC BENEFITS AT A GLANCE**
- Diameter range from 60 to 1200 mm (4 sizes)
- Wall thickness range from 5 to 250 mm (depending on material)
- Fast ROI

**Fast ROI – Large dimensional range – Perfect for process optimization**

WARP 8 is an inline pipe measuring system for wall thickness and diameter measurement on 8 points, respectively 4 axes. It supplies all essential measuring data required for manual or automated process optimization and control. This is the perfect measuring device with a short return-of-investment period without losing measuring precision, including comprehensive process automation and documentation features.

Static sensors perform a high resolution of measuring values in extrusion direction – at the point where it matters most. Process variations are thus precisely detected and become visible so that any impacts such as short-term output variations or backlogs during the cutting process are detectable and can thus be eliminated.

WARP 8 has been designed for large wall thickness and diameter sizes and offers a particularly broad application range.

**WARP 8**
**Diameter measurement**

\[ \phi_A = b - Wd_1 - Wd_2 \]

\( \phi_A \) = Outer diameter
\( b \) = Sensor distance
WARP 100

HIGH-PRECISION WALL THICKNESS AND DIAMETER MEASUREMENT ON UP TO 38 MEASURING POINTS

PRODUCT-SPECIFIC BENEFITS AT A GLANCE
- 100% measurement, diameter range from 90 to 630 mm (3 sizes)
- Wall thickness range from 5 to 125 mm (depending on material)
- Detection of thin points inside the pipe

Real 100% measurement – Complete quality evidence – Perfect for pressure and gas pipes

WARP 100 is an inline pipe measuring system for wall thickness and diameter measurement on up to 38 points on 19 axes. More than 1500 measurements per second ensure that a gapless control is carried out on pipes that have to meet with particularly high quality standards, e.g. pressure or gas pipes, at line speeds of up to 15 m/min.

The static sensors allow a high resolution of measuring values in extrusion direction – a decisive aspect. Process variations are thus precisely detected and become visible so that any impacts such as short-term output variations or backlogs during the cutting process are detectable and can thus be eliminated.

A 100% documentation of the production process in accordance with the guidelines becomes possible with this system.
WARP XXL
HIGH-PRECISION WALL THICKNESS AND DIAMETER MEASUREMENT FOR LARGE PIPES ON UP TO 32 MEASURING POINTS

PRODUCT SPECIFIC BENEFITS AT A GLANCE
- Diameter range from 630 to 3500 mm (sizes on demand)
- Wall thickness range from 5 to 250 mm (depending on material)
- Sagging detection
- Very small overall space required in extrusion direction
- Measurement of strong eccentricity and large wall thickness sizes

Sagging alarm function – Flexible number of sensors –
The right solution for large pipes up to 3500 mm

WARP XXL is an inline pipe measuring system for wall thickness and diameter measurement on 8 to 32 points and 4 to 16 axes. With this particularly flexible and modular sensor technology it is possible for the first time to measure pipes with even strong eccentricity in order to identify and quantify any sagging in detail. The sensors automatically adapt their measuring points towards the pipe so that even the largest variations from set standards become measurable. This is another smart idea presented by the iNOEX development team.

The number of sensors is variable so it becomes possible to increase it in those areas where the process may not run perfectly – for example in the lower angular range. This creates optimum conditions in order to centre large pipes very early during the production process and thus to save material and costs.
WARP portable
HIGH-PRECISION MOBILE WALL THICKNESS MEASUREMENT FOR PIPES

PRODUCT-SPECIFIC BENEFITS AT A GLANCE
- Handheld measuring device for a wall thickness range from 5 to 110 mm (depending on material)
- Data logger including measuring position on the pipe
- User-independent measurement
- Intuitive interface
- Splash-water proof housing (IP54)

Mobile wall thickness measuring device – Fast centering and start-up assistance – Low investment costs

WARP portable is a mobile handheld measuring device based on radar technology. It is designed for wall thickness measurement of medium and large-sized pipes. The system can be used flexibly, either as a fast centering aid during the start-up process, for final checks on the finished product or for stock inspection. Not only the wall thickness at the end of a pipe is measurable but also the interior part of a pipe.

Measurement itself is carried out at the push of a button. The last 100 measuring values are stored including information on the measuring angle on the pipe and a timestamp and may be called up at any time by way of the integrated touch display. Further, it is possible to export data via USB stick or website download via WIFI interface.
**iINTERACT**

**DIGITIZE YOUR PRODUCTION**

**iNOEX iDM & EDGE solution**

- **iDM 4.0**

  - Documentation
  - KPI's (e.g. OEE and CPK)
  - Hall monitor
  - Statistics & analyses
  - Freely configurable dashboards and reports

**iNOEX data manager:**
- Central data logger for the recording of process and quality data
- High-performance database for high sampling rates
- Executable on almost any existing server hardware due to virtualization and docker containers

**Connectivity of devices (also third-party providers) through:**

- **OPC UA**
- **Modbus**

**Connectivity of legacy systems via iDM Gateway**

**iEDGE Gateway**
ALL PROCESSES ON YOUR DISPLAY

The future-oriented and cross-platform control concept allows the visualization as a website through easy integration via browser. As such, display of the iNOEX user interface becomes possible on all web-enabled devices. The multi-touch surface allows the intuitive handling via gestures.

Operation is realized by way of widgets that can be configured, added or removed at the discretion of the user, size and information content can be chosen freely.

iDM 4.0 – iNOEX DATA MANAGER

The iNOEX data manager (iDM) is a central data logger for the complete acquisition of process and quality data of all standard iNOEX systems. The analysis and evaluation of your data is comfortably carried out by the integrated iTREND function. Data can be downloaded e.g. as CSV file for further processing.

iTREND visualizes your production and process values in diagrams. The visualized process data and time periods can be adapted individually. Besides pre-defined diagrams, the user-friendly software also allows you to create your own needs-based combination of process values. Operation of iTREND is intuitive and is done via web browser by way of PC, Notebook or Tablet in your network.
## WARP PRODUCTS AT A GLANCE

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Number of sensors</th>
<th>Pipe dimension</th>
<th>Reproducibility* [mm]</th>
<th>Accuracy* [mm]</th>
<th>Measuring frequency [Hz]</th>
<th>Special feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>WARP 8</td>
<td>250</td>
<td>8</td>
<td>60 - 250 mm 2.375 - 8 inch</td>
<td>± 0.001</td>
<td>± 0.05</td>
<td>320</td>
<td>Fast ROI</td>
</tr>
<tr>
<td></td>
<td>400</td>
<td></td>
<td>90 - 400 mm 3.5 - 16 inch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>630</td>
<td></td>
<td>90 - 630 mm 3.5 - 24 inch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td></td>
<td>250 - 1200 mm 10 - 48 inch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WARP 100</td>
<td>250</td>
<td>13</td>
<td>90 - 250 mm 3.5 - 8 inch</td>
<td>± 0.001</td>
<td>± 0.05</td>
<td>1040</td>
<td>100% measurement</td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>17</td>
<td>110 - 400 mm 4.5 - 16 inch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>630</td>
<td>19</td>
<td>225 - 630 mm 8.625 - 24 inch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WARP XXL</td>
<td>1600</td>
<td>8 - 32</td>
<td>630 - 1600 mm 24 - 64 inch</td>
<td>± 0.01</td>
<td>± 0.075</td>
<td>320 - 1280</td>
<td>Sagging detection</td>
</tr>
<tr>
<td></td>
<td>&gt; 1600 - 3500</td>
<td>on demand</td>
<td>on demand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WARP portable</td>
<td>–</td>
<td>1</td>
<td>60 mm - any 2.375 inch - any</td>
<td>± 0.01</td>
<td>± 0.05</td>
<td>manually (max. 0.5 Hz)</td>
<td>Mobile centering assistance</td>
</tr>
</tbody>
</table>

The combination of the perfectly matched measuring, control and evaluation modules made by iNOEX will enable you to exhaust all possible savings potential from your production process. What is required to this end is the thin point control based on weight per length (including gravimetry) or haul-off speed (s-min), the regulation of the wall thickness profile based on thermal centering, the component dosing or the mass throughput control.

**TALK TO US, WE WILL BE PLEASED TO PROVIDE FURTHER INFORMATION!**