

WARP Terahertz

A new age of product measurement





For some years iNOEX GmbH has placed a special focus on the development and sales of Terahertz wall thickness measuring systems for the plastics industry and can rightfully call itself the pioneer for this key technology. iNOEX has consistently pursued this course and has developed the **WARP** product line featuring transceivers which are able to transmit and receive Terahertz waves for a contactless high-precision measurement of wall thickness, diameters and ovality. Low-frequency Terahertz rays have a wavelength which is between microwaves and infrared radiation. They offer a high penetration power and thus a multitude of possible applications. iNOEX has succeeded in developing ever more efficient Terahertz transceivers, thus preparing the way for an economic use of low-frequency Terahertz technology in the plastics industry.



„WARP 100 is the first Terahertz based measuring system which is able to measure 100 % of the wall thickness of a pipe, both in longitudinal and circumferential direction. Measuring accuracy is $\pm 10 \mu\text{m}^1$ and measuring results are independent of pipe temperatures. Together with gravimetric mass throughput control or weight per metre control WARP 100 is able to significantly reduce production costs. A plus in productivity is a plus in profits.“
Arno Neumeister, Director Marketing

WARP - A NEW AGE OF WALL



WARP 4

WARP 4 stands for highly accurate measuring values ($\pm 10 \mu\text{m}^{\dagger}$) supplied by process-adapted measuring sensors for 4 measuring spots. WARP 4 is operative without any dimensioned accessory parts. An electrically driven XY cross table is required for the fully automated centering process to obtain the optimum operating point.

The new benchmark!



WARP 8

WARP 8 measures wall thickness sizes on 8 measuring spots in a highly accurate process. Simultaneously, a direct measurement of diameters is carried out in 4 axes. Very easy operation due to a fully automated centering procedure.

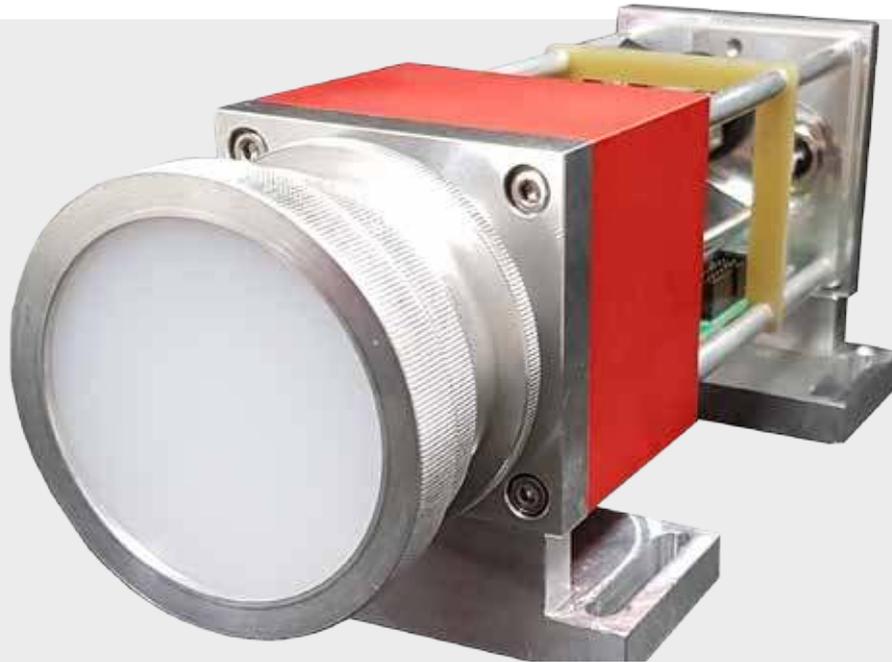
Highly precise wall thickness and diameter measurement on 8 measuring spots!



WARP 100

WARP 100 - designed for a 100 % measurement, especially of gas pipes and pressure pipes. The system impresses with its easy operation thanks to the automated centering process. Direct measurement of diameters in 19 axes.

100 % wall thickness measurement for gas pipes and pressure pipes!



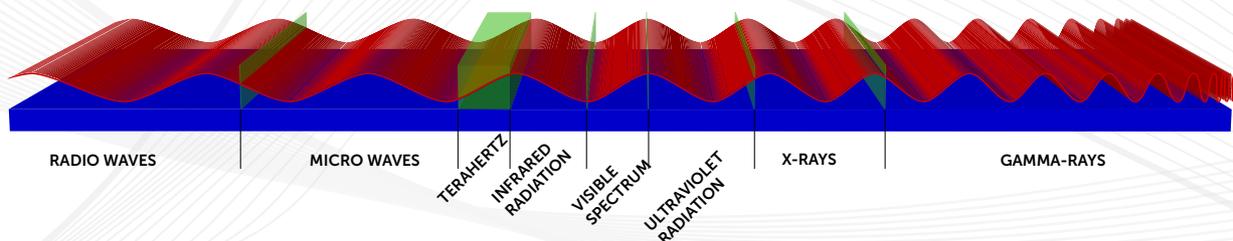
WARP transceiver module with focusing optics

NEW MEASURING PRINCIPLE FOR THE HIGHEST MEASURING ACCURACY!

Only a steady, continuous and overall stabilization of the extrusion process allows an efficient line production and thus ensures competitiveness in the plastics market. This requires a technology which is able to master the required decisive functions „measurement & control“ and the related documentation.

Against this background we created a new product and called it WARP. Several transceivers which are distributed around the circumference of the pipe transmit and receive Terahertz waves in the lower frequency range and use them for a contact-less measurement. Calculation of the delay time of the reflections provides information on wall thickness, diameter, ovality and eccentricity. Measurement of the runtime of electromagnetic waves is also known under the abbreviation RADAR (Radio Detection and Ranking). WARP systems generate a signal and couple this signal into an open space via a suitable antenna of the transceiver and a focusing optical device. The high-frequency wave spreads into space and is reflected by the measured

ELECTROMAGNETIC SPECTRUM



THE NEW BENCHMARK!

EXCELLENT PRICE/PERFORMANCE RATIO.

Due to the integrated kind of THz chip of the latest generation, **WARP 4** can be offered at an excellent price/performance ratio. Another plus is that diameters do not have to be calculated as it is the case with other measuring principles but they are measured directly. As such, the measuring accuracy of the recorded data is substantially higher. Moreover, **WARP 4** is easy to use, has got a very large operating range and it is completely maintenance-free. No need for any dimensioned accessories.

AUTOMATIC CENTERING.

WARP 4 features a motor-driven XY cross table for automatic centering of the **WARP** transceivers. This reduces operating efforts during changes of pipe dimensions to the simple selection of a recipe.

INDEPENDENT OF TEMPERATURES.

WARP 4 is able to carry out measurement without having to know any of the properties of the extruded plastic material or the temperature of a pipe wall. It derives measuring data from 4 measuring points and pipe diameters in 2 axes.



WARP 4 measuring principle



WARP 4 measuring mechanics

PRECISE WALL THICKNESS AND DIAMETER MEASUREMENT ON 8 MEASURING POINTS!



MAJOR SAVINGS POSSIBLE.

Raw material costs amount to a significant proportion of 80 % or more in total production costs of plastic pipes. Depending on the throughput rates of an extrusion line, the used kind of material and the specified standards, an enormous savings potential lies in the difference between minimum and maximum permissible pipe dimensions. The use of an appropriate measuring and control technology, such as e.g. **WARP 8** combined with continuously operating gravimetric systems, offer a savings potential of 5 % or more in used material.

EASY TO USE.

Of importance for the success of a measuring and control system is not only the savings potential but also an easy operation. **WARP 8** is able to set a new standard here. The automatic centering by way of an XY cross table and the fact that no dimensioned components are required simplify enormously the process of putting the system into operation. Another strong point is the visualization software. All the line operator has to do is select the recipe and start the measuring process.

RELIABLE DETECTION OF SAGGING.

On account of the 8 measuring points of **WARP 8**, the system is able to safely detect sagging at the critical points. Further, the operator receives measuring data on diameters, ovality and eccentricity on 4 axes.

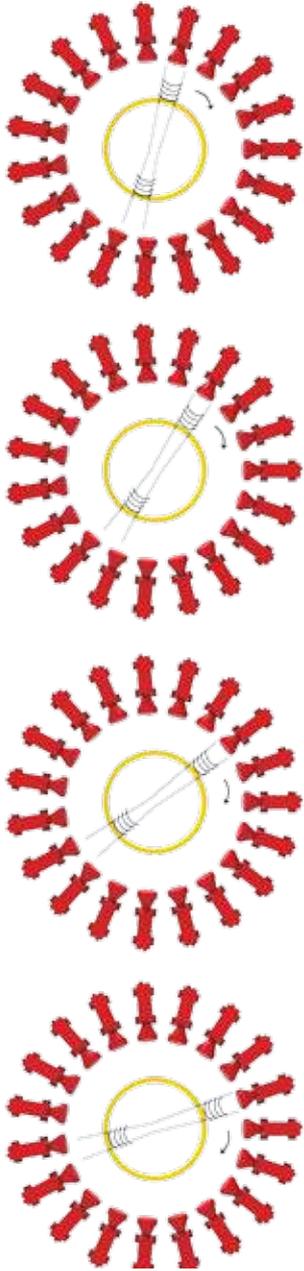
100 % WALL THICKNESS MEASUREMENT FOR GAS AND PRESSURE PIPES!

MEASURING CYCLES ROTATE ELECTRONICALLY AROUND THE MEASURED OBJECT AND CARRY OUT A 100 % CONTROL.

WARP 100 represents a technological quantum leap in pipe measurement. The system is able to comply with the need for higher quality demands in view of product safety, size accuracy, complete proof of quality and a reliable product traceability. **WARP 100** inspects 100 % of a pipe wall thickness in both lengthwise and circumferential direction. All of this up to a line speed of 60 m/min.

The core parts of **WARP 100** are the intelligent **WARP** transceivers developed by iNOEX. These transceivers subsequently transmit and receive Terahertz signals and evaluate the recorded data afterwards by way of algorithms.

Any automation system available on the market is not only judged by its measuring quality but also by its comfortable operation, handling and reliability. Due to its independence of temperatures, the automatic centering via XY cross table and the easy operation of the visualization software **WARP 100** is able to meet these high demands entirely.



WARP 100 Measuring principle



WARP 100

Type	Pipe dimensions [mm]
WARP 100 / 250	90 - 250
WARP 100 / 400	110 - 400
WARP 100 / 630	250 - 630
WARP 100 / 1000	400 - 1000

A SOLUTION FOR ALL LARGE PIPES!



WARP XXL

ENORMOUS SAVINGS POTENTIAL.

For some years now there has been a global trend towards large plastic pipes. Dimensions of up to 2600 mm were produced. Pipe extrusion lines for sizes well above 3000 mm are currently projected. Such dimensions make material savings by reducing the weight per metre very attractive. This is due to the fact that material costs, depending on the pipe type, account for up to 90 % of the total production costs. Especially the keeping of small tolerances in wall thickness, diameter and ovality are of major importance. This is an important requirement for the high-quality welded joints of large pipes at the building site. To this end a pipe production needs an intelligent and workable measuring technology.

IDEAL MEASURING TECHNIQUE.

Especially for thick-walled large pipes WARP XXL convinces due to its high penetration depth. Even the opposite pipe wall as well as the interior and exterior diameters are measured with a high accuracy. Due to its independence of temperatures the system does not need to be calibrated.

EASY OPERATION.

WARP XXL features not only a perfect measuring technique but is also easy to operate. The 4 WARP transceivers are all easily accessible and can be easily centered. Operation of the visualization software is simple, a fact that every line operator will appreciate.

INTERACTION OF MEASURING SYSTEMS.

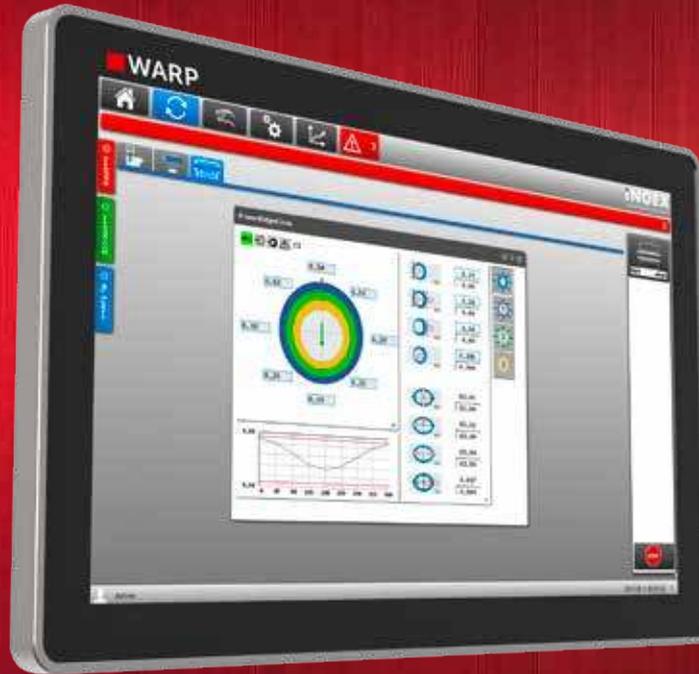
WARP XXL is not only ideal for the measurement of wall thickness sizes and diameters of large pipes but together with a gravimetric system a full automation system will be created. The interaction of both systems may result into material savings of 5 % or more on account of a better pipe centering, weight per metre control and thin points control.

BENEFITS:

- Detailed product information (wall thickness, diameters, eccentricity, ovality)
- **Material savings of 5 % or more through** s-min. control or thin points control, improved centering process and a systematic start-up of the extrusion line
- Maintenance-free
- Independent of temperatures
- Optimum support for the operator, easy operation
- Traceability of the product

Type	Number of sensors	Pipe dimensions [mm]
WARP XXL / 1200	4	630 - 1200
WARP XXL / 1600	4	800 - 1600
WARP XXL / 2000	4	1000 - 2000
WARP XXL / 2500	4	1600 - 2500
WARP XXL / 3000	4	2000 - 3000

NEW VISUALIZATION.



The future-oriented and platform-independent concept allows visualization as a website by way of an easy integration via browser. As such, the iNOEX user interface is displayable on all web-enabled devices. The multi-touch surface allows an intuitive navigation through gestures (zooming, wiping).

Operation is carried out by way of installed widgets. On the interface, the user is free to configure, add or remove the widget's size or information value, just as he wishes. As such, the user has constant access to his most important applications (favourites).

FAST CUSTOMER SUPPORT VIA TEAMVIEWER

- Direct global support via remote control
- Easy configuration, no VPN gateways
- Adherence to the highest safety standards



ENORMOUS SAVINGS POTENTIAL.

WARP systems offer not only an excellent price/performance ratio but also very short pay-back periods. Depending on mass throughput rates and production time, payback may even be within a few months.



WARP 4 (Ø 250 mm PE-PIPE)

Throughput	Production time	Savings	Material costs	Savings p.a.
500 kg/h	16 hrs/day x 350 days/year	2,0 % (WARP 4)	1,30 €/kg	72.800 €
500 kg/h	16 hrs/day x 350 days/year	3 % (gravimetry)	1,30 €/kg	109.200 €
		5,0 % total		182.000 €



WARP 8 (Ø 800 mm PE-PIPE)

Throughput	Production time	Savings	Material costs	Savings p.a.
1400 kg/h	16 hrs/day x 350 days/year	2 % (WARP 8)	1,30 €/kg	203.840 €
1400 kg/h	16 hrs/day x 350 days/year	3,0 % (gravimetry)	1,30 €/kg	305.760 €
		5,0 % total		509.600 €



WARP 100 (Ø 630 mm PE-PIPE)

Throughput	Production time	Savings	Material costs	Savings p.a.
1200 kg/h	16 hrs/day x 350 days/year	2 % (WARP 100)	1,30 €/kg	174.720 €
1200 kg/h	16 hrs/day x 350 days/year	3 % (gravimetry)	1,30 €/kg	262.080 €
		5,0 % total		436.800 €



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