

Measuring and control
technology for the production of

Optical fibers and optical fiber cables

SIKORA
Technology To Perfection



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Introduction

SIKORA AG is a leading manufacturer and supplier of innovative online measuring, control, inspection, analysis and sorting technology for the optical fiber, wire and cable, hose and tube, sheet as well as plastics industries. Worldwide, users of these measuring devices benefit from an increasing quality, profitability and efficiency. Modern laser and X-ray technologies measure product parameters such as the diameter, ovality, wall thickness and eccentricity, precisely and reliably.

Continuous control of production data helps to avoid wall thickness oversizes and leads to a more efficient material usage. The cable manufacturer consumes fewer resources and achieves a more efficient material usage. Every micrometer of material that can be saved by using measuring and control technology makes production more economical and saves increasingly scarce resources.

SIKORA is headquartered in Bremen, Germany. Already since 1973, the high-quality devices have been developed and manufactured and the global service has been coordinated at this site. With 13 operating subsidiaries in Brazil, China, France, India, Italy, Japan, Korea, Malaysia, Mexico, Poland, Turkey, the United Arab Emirates and the USA, SIKORA is always close by. In cooperation with more than 30 local representatives worldwide, SIKORA serves all customer demands with regard to quality, productivity and cost saving.

Since 1993, SIKORA has been certified according to DIN EN ISO 9001. The certification confirms SIKORA's focus on continuous improvement. Customer satisfaction is SIKORA's primary objective.

Innovation, technological know-how, quality and service are the four pillars of SIKORA's company philosophy. A strong research and development team continuously works on the development of new technologies, enabling manufacturers of optical fibers and optical fiber cables, wires, cables, hoses, tubes, sheets as well as raw materials to increase the process reliability, efficiency and ecological balance of their production lines.

Measuring technology for the production of optical fibers and optical fiber cables

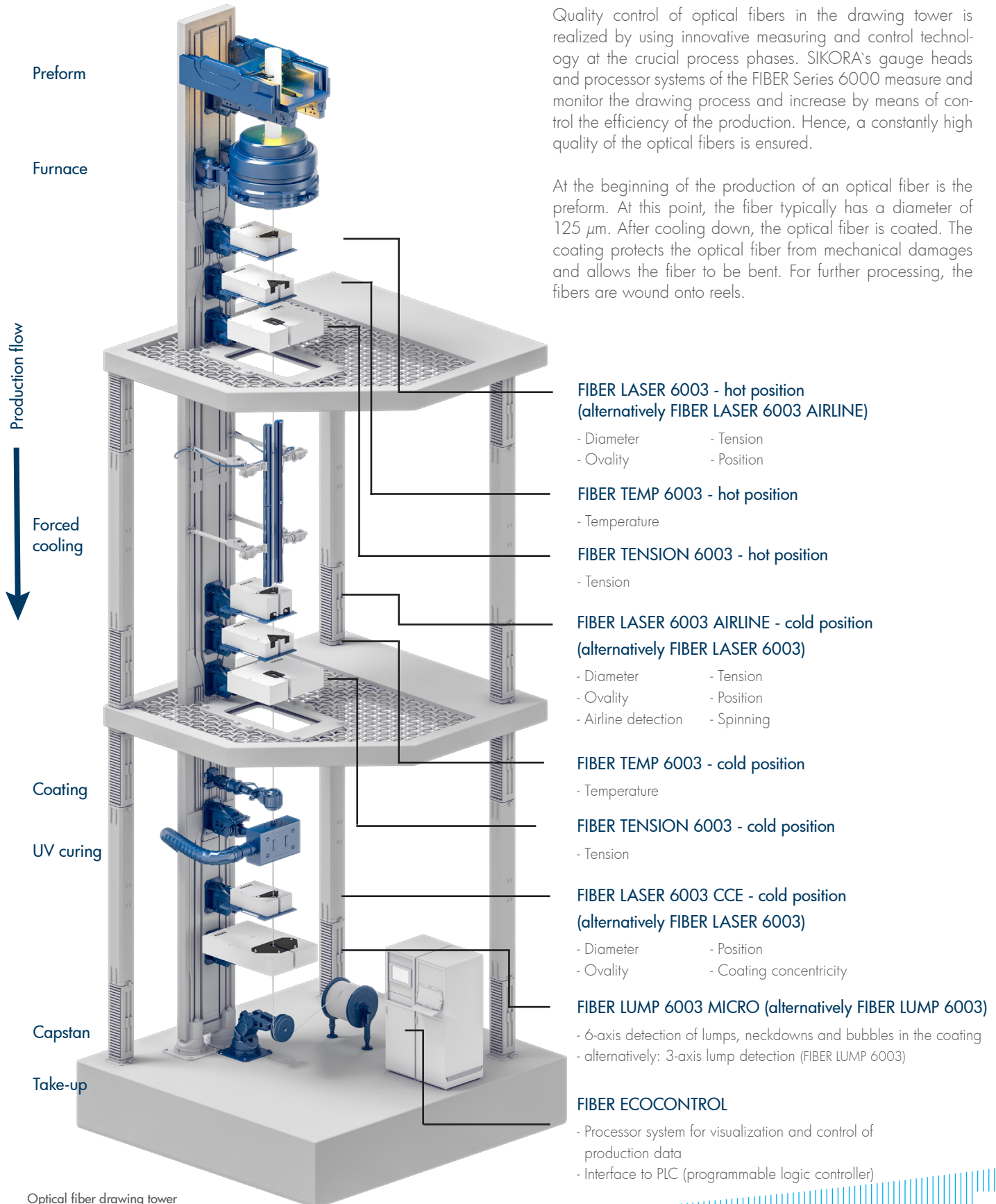
All over the world, large amounts of electronic data are transferred every day – faster and over longer distances. Data transfer is mainly via optical fibers. In order to transmit data without loss, optical fibers have to meet the highest quality requirements. SIKORA offers a complete series of measuring and control devices that are used in the drawing tower during the production of optical fibers. The FIBER Series 6000 monitors and controls the entire drawing process and optimizes productivity. SIKORA is known worldwide for its measuring devices for optical cables.

Highlights FIBER Series 6000

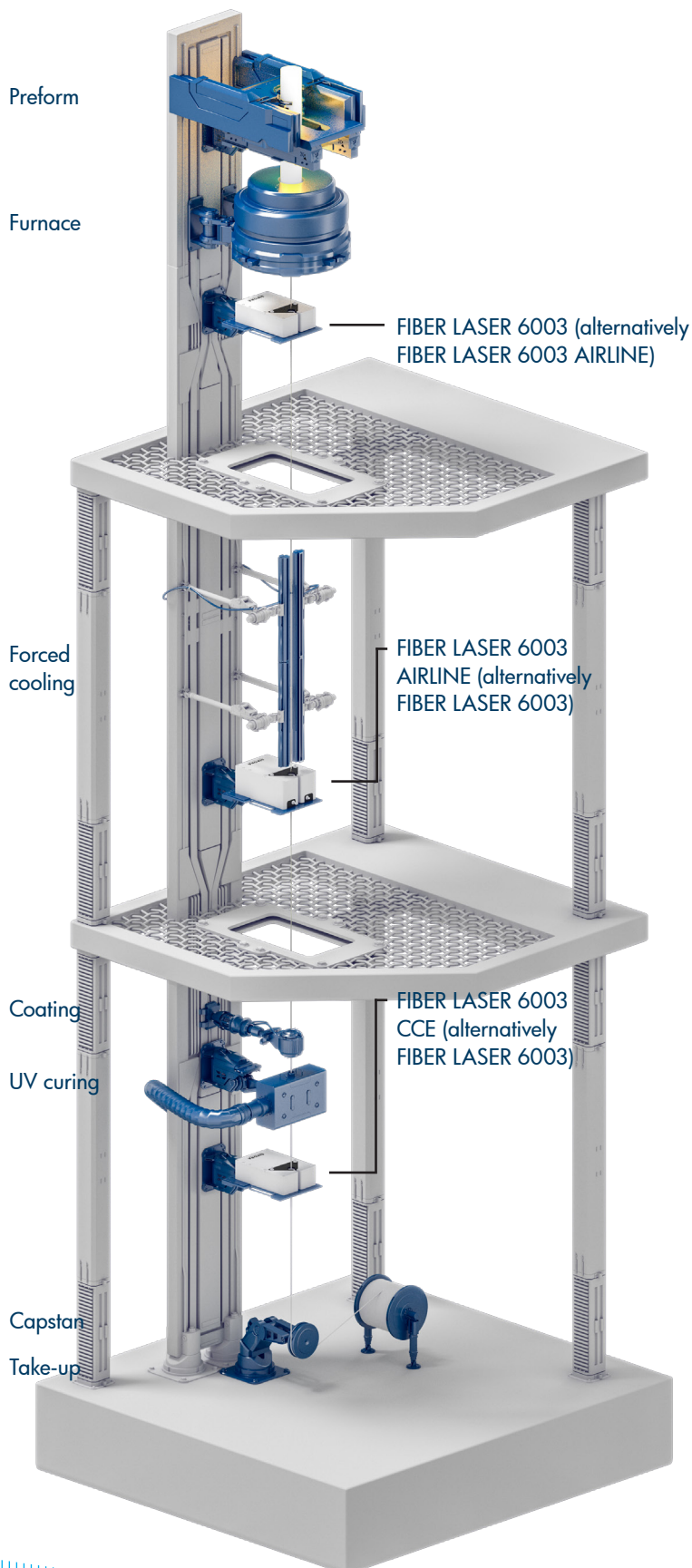
- Measurement of the diameter, position, vibration frequency, tension and spinning
- Detection of airlines and temperature measurement at the bare fiber
- Coating concentricity evaluation
- Reliable detection of lumps, neckdowns and bubbles with double sensor technology and 3-axis or 6-axis measurement

1 Measuring technology for the production of optical fibers

1.1 Overview: Measuring devices for quality assurance in the drawing tower



1.2 FIBER LASER 6003 – Diameter measurement after the furnace, before and after the coating



The FIBER LASER 6003 is an innovative device for diameter measurement of optical fibers, directly in the drawing tower. The unique measuring principle is based on diffraction analysis and assures the highest precision. Using this method, SIKORA has become the worldwide technology leader.

Typically, the first gauge head is installed after the furnace to measure the diameter and position of the bare fiber and to control the process. Based on the vibration of the fiber, this gauge head calculates the tension* at the bare fiber by means of a Fast Fourier Transformation (FFT). The single values of the fiber position are graphically visualized via the processor system FIBER ECOCONTROL, in the form of a scatter plot (see page 10). The scatter plot provides information about the fiber position and the process stability.

A second gauge head, before the coating, measures the cold diameter of the fiber and provides spinning information via FFT of the ovality. The control is carried out either by the hot or cold measuring gauge head. A second diameter measurement follows the coating.

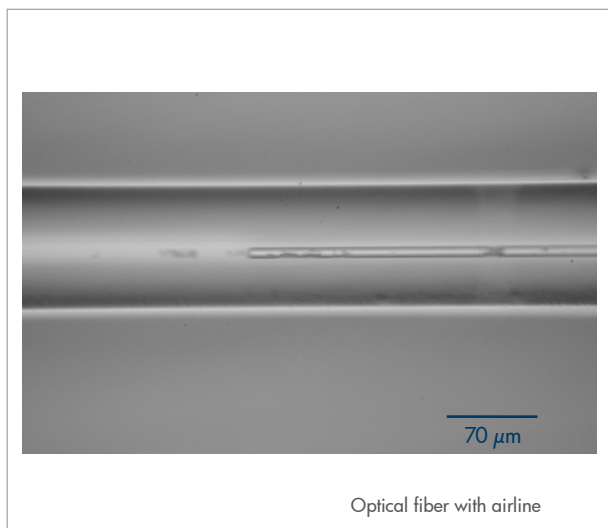
*Alternatively, the stand-alone gauge head FIBER TENSION 6003 is available. See more on p. 8.

Technical Data FIBER LASER 6003

Product Diameter
50 - 500 μm
Repeatability
0.02 μm
Measuring Rate
2,500/sec
Power Supply
100 - 240 V AC \pm 10 %, 50/60 Hz

Interfaces
RS485, service interface RS232, LAN Optional: Industrial fieldbus (e.g. Profinet IO, EtherNet/IP, Profibus-DP, CANopen, DeviceNet), 4 analog outputs unipolar/bipolar
Dimensions
150 x 65 x 225 mm (width x height x depth)
Weight
ca. 3 kg

1.3 FIBER LASER 6003 AIRLINE – Diameter measurement and airline detection



Alternatively to the FIBER LASER 6003, the FIBER LASER 6003 AIRLINE can be installed before the coating. The FIBER LASER 6003 AIRLINE also provides measuring values of the diameter. In addition, it detects the smallest airlines. An installation of the device at the hot position is also possible.

The FIBER LASER 6003 and FIBER LASER 6003 AIRLINE are factory calibrated and keep their absolute accuracy for the entire life-cycle. These gauge heads can be connected via numerous interfaces to the SIKORA processor system FIBER ECOCONTROL as well as to a line computer.

Coloring lines

The diameter gauges of the FIBER Series 6003 are also the optimal equipment for quality control in coloring lines.

FIBER LASER 6003 AIRLINE

As FIBER LASER 6003 plus airline detection

Feature
Airline detection
Smallest Detectable Airline
0.5 μm (diameter)
Detection Rate
100 % detection of airlines up to 0.5 μm
Dimensions
150 x 95 x 225 mm (width x height x depth)
Weight
ca. 4 kg

1.4 FIBER LASER 6003 CCE – Evaluation of the coating concentricity

After the coating, the FIBER LASER 6003 CCE (Coating Concentricity Evaluation) defines the coating concentricity in addition to the diameter values.

The principle is based on the evaluation of the symmetry of the intensity signal recorded by the gauge. Perfect symmetry means perfect concentricity. Increased asymmetry indicates an increased eccentricity. Tolerance levels for a warning and alarm outputs can be arbitrarily set.

As the FIBER LASER 6003 CCE replaces the FIBER LASER 6003 within the drawing tower, an additional diameter gauge head is not required at this position.

FIBER LASER 6003 CCE

FIBER LASER 6003 plus coating concentricity evaluation

Feature
Coating Concentricity Evaluation (CCE)
Dimensions
150 x 65 x 225 mm (width x height x depth)
Weight
ca. 3 kg



FIBER LASER 6003 CCE

Highlights FIBER LASER 6003/AIRLINE/CCE

- Highest accuracy for an optimum quality control during optical fiber production
- Diameter, position, tension, vibration frequency and spinning measurement
- Airline detection (AIRLINE option)
- Coating concentricity evaluation (CCE option)
- No moving parts, no calibration
- Availability 99.8 %

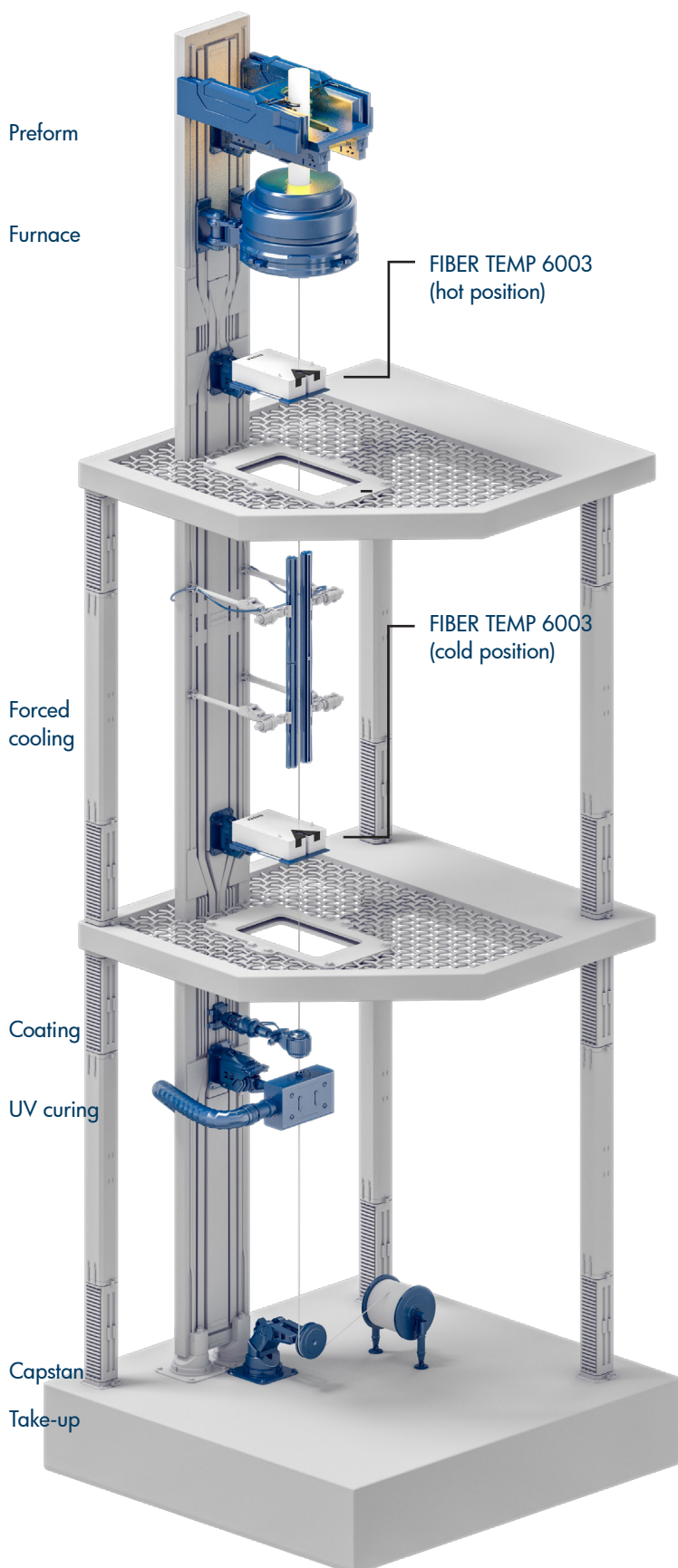
1.5 FIBER TEMP 6003 – Measurement of the fiber temperature

The FIBER TEMP 6003 is a stand-alone gauge for the measurement of the fiber temperature during the drawing process. The gauge head can be either installed at the cold (measuring range 40° to 200 °C) or at the hot end (measuring range 500° to 1,500 °C) of the drawing tower. With the precise information on the optical fiber temperature, the preform temperature can be controlled or the forced cooling (e.g. helium) can be reduced to a minimum, resulting in reduced costs.

The integration of two FIBER TEMP 6003 devices at the hot respectively cold position guarantees the compliance with optimal temperatures for the highest stability of the process.



FIBER TEMP 6003



In combination with the FIBER ECOCONTROL, the temperature is displayed in real time and in the trend diagram. Besides, the FIBER TEMP 6003 can be connected with the plant computer via one of the numerous interfaces.

Technical Data FIBER TEMP 6003

Temperature Range

Cold: 40 to 200 °C
Hot: 500 to 1,500 °C

Product Diameter

100 - 500 µm

Accuracy

± 1 °C for the cold end

Measuring Rate

100 Hz

Power Supply

100 - 240 V AC ± 10 %, 50/60 Hz

Interfaces

RS485, service interface RS232, LAN; Optional: Wi-Fi, analog outputs unipolar/bipolar, industrial fieldbus (e.g. Profinet IO, EtherNet/IP, Profibus-DP, CANopen, DeviceNet)

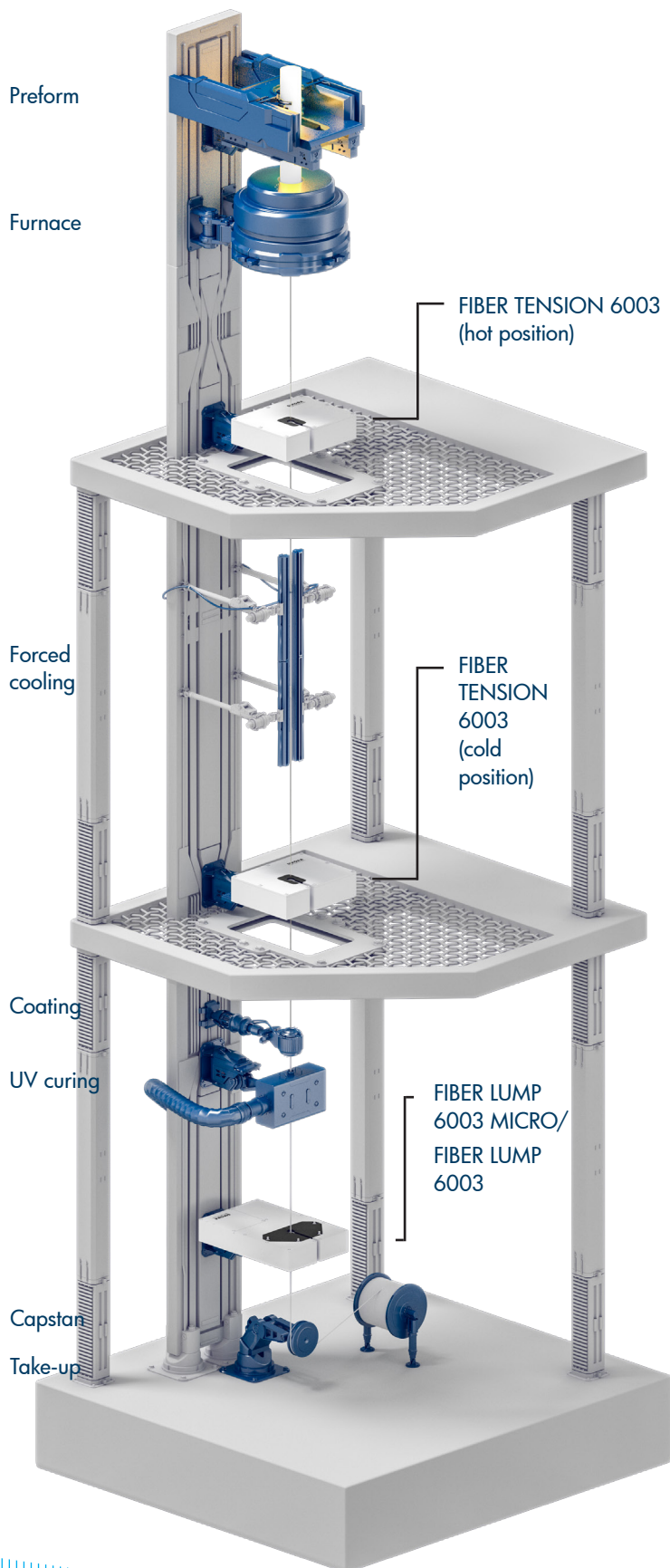
Dimensions

170 x 65 x 265 mm (width x height x depth)

Weight

ca. 1 kg

1.6 FIBER TENSION 6003 – Tension measurement



Typical features FIBER TENSION 6003

- The most accurate tension measurement based on birefringence
- Unique stand-alone gauge head for new and existing drawing towers

The newly developed FIBER TENSION 6003 serves as a supplementary measuring device for an even faster, more robust and improved tension measurement to validate and control this important measuring and control parameter. This is made possible by the remarkable measuring rate of up to 50 kHz and the use of a measuring principle which takes the refractive properties of glass into account.

The use of the stand alone device is particularly attractive for manufacturers of high-end solutions where the process is controlled by the tension. The FIBER TENSION 6003 is predestined for optical fibers being processed into premium optical fiber cables for which particularly high requirements and standards exist.

The integrated measuring principle is based on the principle of birefringence. The FIBER TENSION 6003 can be used for both hot and cold measurement of the bare fiber, independent of production influences such as the position of the fiber in the measuring field, the production speed and the vibration or oscillation of the fiber. Installed before or after cooling, the system generates reliable and stable measuring values and thus enables direct control of the tension.

Technical Data

FIBER TENSION 6003

Measuring Range (Object Diameter)
2 mm
Repeatability
± 0.1 g
Measuring Rate
up to 50 kHz
Measuring Range (Tension)
20 to 400 g (for standard telecom fibers; other product diameters and materials on demand)
Measuring Field
± 2 mm

Power Supply
PoE+ (Power over Ethernet) 24 V DC ± 10 %
Interfaces
USB service interface, Ethernet (LAN) Optional: industrial fieldbus (e.g. Profinet IO, EtherNet/IP, Profibus-DP, CANopen, DeviceNet), 2 analog inputs, 2 analog outputs, 2 digital inputs, 2 digital outputs
Dimensions
320 x 250 x 86 mm
Weight
ca. 7 kg

1.7 FIBER LUMP 6003/FIBER LUMP 6003 MICRO – Detection of lumps, neckdowns and bubbles on the surface

In addition to diameter, tension, airline, coating concentricity and temperature measurement, lump detectors are used for a continuous quality control in drawing towers.

FIBER LUMP 6003 MICRO

SIKORA's FIBER LUMP 6003 MICRO detects lumps, neck-downs and bubbles from a length of 50 µm to 100 %. The performance is achieved by six measuring axes.

A guarantee for the reliable detection of lumps and neck-downs is the SIKORA double sensor technology. In general, the detection of lumps, neckdowns and bubbles is based on the registration of a change in the amount of light that appears because the fault location passes the measuring plane. Each of the six measuring axes of the FIBER LUMP 6003 MICRO is equipped with a light source and two receiving sensors (double sensor technology). The gauge head recognizes changes in the amount of light, and thus, analyzes these by means of a differential measurement.



Typical features FIBER LUMP 6003 MICRO/ FIBER LUMP 6003

- Highest reliability with double sensor technology
- Detection of the smallest lumps from up to 5 µm height and 50 µm (FIBER LUMP 6003 MICRO) respectively 500 µm (FIBER LUMP 6003) length
- Reliable fault analysis regarding height, length, number and position

FIBER LUMP 6003

For bigger faults, the FIBER LUMP 6003 is available. The 3-axis testing device reliably detects the smallest lumps, neck-downs and bubbles after coating with a length as small as 500 µm.

Visualization and reporting of surface faults

Both gauge heads detect faults as small as of 5 µm. The lump detectors are available for product diameters from 100 to 500 µm and can be easily integrated into a new or already existing drawing tower. The lump detectors can be connected to the SIKORA processor system FIBER ECOCONTROL or to a line computer.

Each surface fault can be found with a report that records the length of the fiber, in which the fault had been detected. This report simultaneously includes information on the total number of faults per spool length and the exact dimensions of each fault.

Coloring lines

The described lump detectors FIBER LUMP 6003 and FIBER LUMP 6003 MICRO are equally applicable in coloring lines.



Technical Data

FIBER LUMP 6003 MICRO/ FIBER LUMP 6003

Product Diameter

100 - 500 µm

Min. Detectable Fault Height

5 µm

Min. Fault Length

FIBER LUMP 6003 MICRO: 50 µm

FIBER LUMP 6003: 500 µm

Speed

1 to 3,000 m/min

Power Supply

100 - 240 V AC ± 10 %, 50/60 Hz

Interfaces

RS485, service interface RS232, fault contact;
Optional: analog input tolerance (lump/neckdown) or alternatively industrial fieldbus (e.g. Profinet IO, EtherNet/IP, Profibus-DP, CANopen, DeviceNet)

Dimensions

FIBER LUMP 6003 MICRO: 420 x 274 x 80 mm

FIBER LUMP 6003: 280 x 150 x 65 mm

(height x width x depth)

Weight

FIBER LUMP 6003 MICRO: ca. 13 kg

FIBER LUMP 6003: ca. 4 kg

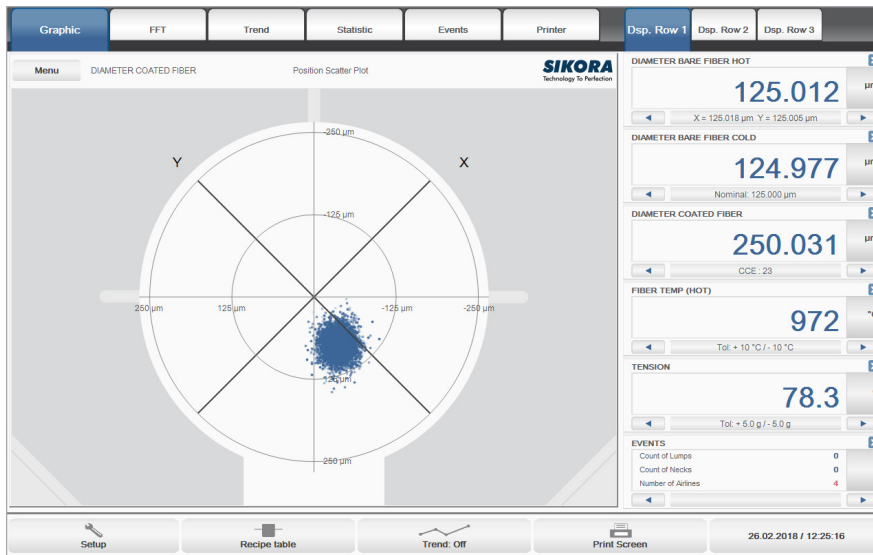
1.8 FIBER ECOCONTROL – Premium processor system for visualization and control of production data

The FIBER ECOCONTROL is an extremely powerful display and control processor system, which clearly visualizes the measuring values of the connected diameter measuring devices, temperature measuring devices and lump detectors of the FIBER Series 6000.

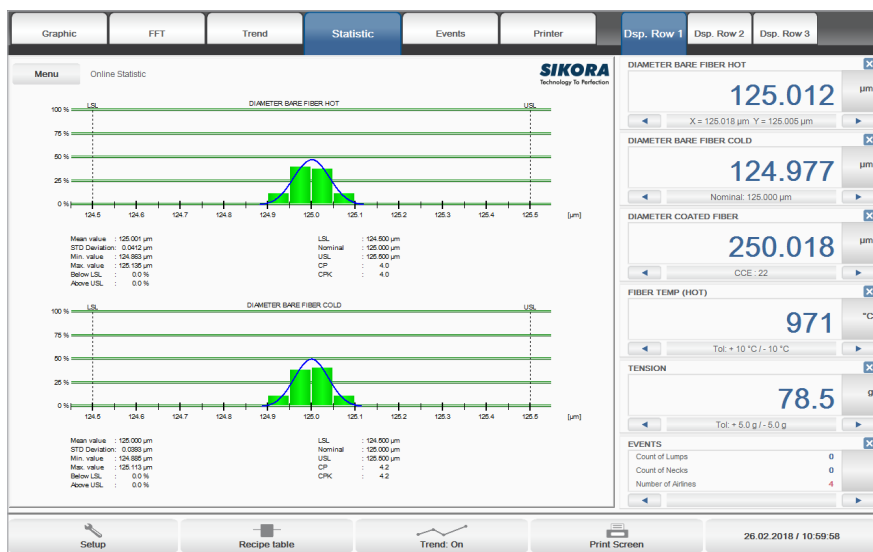
The measuring values are displayed numerically and graphically on a 15" TFT monitor. In addition, it includes a time-related trend diagram of all values and a display of the distribution of

single values (statistical distribution curve) and comprehensive statistics with the minimum, maximum and mean values, standard deviation, Cp and Cpk values. The operation is intuitive and menu-driven via touch screen. Data storage is available.

The FIBER ECOCONTROL is the central interface for the line control, with all signals for a control.



Display of the diameter, position, tension and temperature as well as the number of lumps, neckdowns and airlines and the coating concentricity



Statistics

Technical Data FIBER ECOCONTROL

Display

15" TFT touch monitor

Display of the Following Production and Product Parameters

- Diameter
- Ovality
- Tension
- Spinning
- Airlines
- Vibration frequency
- Concentricity
- Temperature
- Optical fiber position with scatter plot presentation
- Trend and statistics
- Number of lumps/neckdowns

Inputs and Outputs

Up to 4 serial interfaces RS485 for the connection of the measuring systems FIBER LASER 6003, FIBER LUMP 6003, FIBER TEMP 6003 (further interfaces optionally available)

4 analog outputs 16 Bit, unipolar 0 to 10 V or bipolar -10 to +10 V (optional)

4 contact outputs for tolerance or status messages (max. 30 V, max. 0,5 A; optionally 8 outputs available)

1 communication interface via RS232 or LAN (optional)

1 electrically isolated input for rotary pulse generators (0/15 V)

1 USB interface (included as standard) as well as USB interface for a printer (optional)

1 LAN interface (selectable OPC DA/UA/SuiteLink - optional)

Additional inputs and outputs, e.g. Profinet IO, EtherNet/IP (optional)

Data Storage

SSD, USB memory stick or network

Power Supply

100 - 240 V AC \pm 10 %, 50/60 Hz

2 Measuring technology for the production of optical fiber cables in loose tubing, tight buffering and sheathing lines

2.1 LASER Series 2000 – 2-axis and 3-axis diameter measurement



SIKORA's product range also includes measuring and control technologies for the coloring of optical fibers, the loose tubing or tight buffering and extrusion of the outer sheath of optical cables.

Loose tubing lines/Tight buffering lines

The quality control during the production of loose tubes and tight buffered cables is perfectly ensured with the use of an efficient 2-axis or 3-axis diameter gauge head of the LASER Series 2000 for diameter measurement with integrated lump detection.

The LASER Series 2000 gauges offer all kinds of interfaces such as RS485 and optionally Profibus-DP, Profinet IO, CANopen, EtherNet/IP, DeviceNet or OPC UA for a direct connection to a PC or the display and control devices REMOTE 6000 or ECOCONTROL 6000, 1000 or 600 and are therefore, designed for the use under the aspect of Industry 4.0.

Typical features LASER Series 2000

- Reliable and precise 2-axis or 3-axis diameter measurement
- State-of-the-art CCD line sensor technique combined with pulse-driven laser light sources
- Extremely short exposure times for highest single value precision
- Complete processing of measured data in the measuring head, including statistic, standard deviation, trend and FFT analysis
- No moving parts, no calibration

Technical Data LASER Series 2000

Gauge Head	Product Diameter	Accuracy*	Repeatability	Exposure Time
LASER 2005 XY	0.05 - 5 mm	± 0.25 µm	± 0.1 µm	0.2 µs
LASER 2010 XY/T	0.2 - 10 mm	± 0.5 µm	± 0.1 µm	0.2 µs
LASER 2025 T	0.2 - 25 mm	± 1.0 µm	± 0.2 µm	0.2 µs
LASER 2030 XY	0.2 - 25 mm	± 1.0 µm	± 0.2 µm	0.2 µs
LASER 2050 XY/T	0.5 - 50 mm	± 2.5 µm	± 0.5 µm	0.2 µs

Measuring Rate	500/sec/axis (higher measuring rates on demand)
Power Supply	100 - 240 V AC ± 10 %, 50/60 Hz
Interfaces	Serial interface RS485, setup and diagnosis interface RS232 Optional: industrial fieldbus (e.g. Profinet IO, EtherNet/IP, Profibus-DP, CANopen, DeviceNet, OPC UA) or analog output

* ± 0.01 % of the measured value

2.2 X-RAY 6000 PRO – Eccentricity, wall thickness and diameter measurement

Sheathing lines

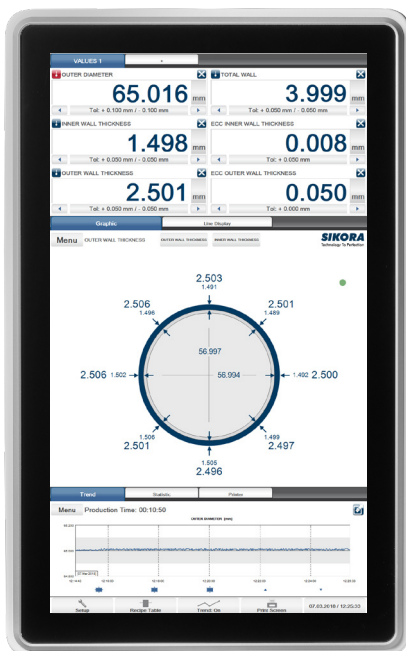
Optical fiber cables of high quality require the latest measuring technology during the manufacturing process. Thereby, the X-ray technology used in the X-RAY 6000 PRO is by far the most interesting option.

The device measures the diameter, wall thickness and eccentricity during the extrusion process and ensures a reduction of material usage, an optimal line productivity and an online quality control by automatically controlling the wall thickness.

The high-performance X-RAY 6000 PRO measures up to three material layers and provides impressive accuracy. Included within the delivery of the device is the processor system ECOCONTROL 6000 for an automatic control of the line speed or extruder rpm. Brilliantly, the ECOCONTROL 6000 visualizes the measuring values graphically and numerically. It provides trend, statistical data and data storage of all measuring values.



X-RAY 6120 PRO



Production data is clearly displayed at the vertical 22" wide-screen monitor of the X-RAY 6000 PRO

Measurement of the average wall thickness according to the differential measuring method

Sheathing lines, for which only a limited budget is available, are controlled conventionally without taking into account the eccentricity. For this, a diameter gauge head is installed before and after the crosshead and the average wall thickness is determined by calculating the difference of the diameter measuring values. The control is carried out via the processor system ECOCONTROL 1000. Depending on the requirements, diameter measuring gauge heads of the LASER Series 2000 may be used.

Hot/Cold Module HC 2000

In combination with an additional diameter gauge head, that is used after the cooling section, a Hot-Cold-Control modul continuously calculates the material shrinkage for final quality control and considers it for controlling the diameter. For this method, the hot and cold measuring values of the diameter are compared by a speed controlled delay time memory. This function requires the ECOCONTROL 6000.

Technical Data X-RAY 6000 PRO

Measuring Principle

Non-contact with state-of-the-art X-ray technology

Application

Insulation, tight buffer, loose tube and sheathing lines, coax and RF cables

Material

PE, PVC, foamed plastic, all typical polymers, nylon, silicone and many others

Calibration

X-RAY 6000 PRO requires no calibration

Safety (Radiation)

Radiation measurements by independent experts have revealed that the radiation of the X-RAY 6000 PRO is below limiting values of all international regulations

Measuring rate

1 to 3 Hz (optional 10 Hz/25* Hz)

Power Supply

100 - 240 V AC \pm 10 %, 50/60 Hz, 1,200 VA

Interfaces

RS232, USB

Optional: industrial fieldbus (e.g. Profinet IO, EtherNet/IP, Profibus-DP, CANopen, DeviceNet), LAN, OPC DA/UA

Typical features X-RAY 6000 PRO

- Measurement of the diameter, the eccentricity and the wall thickness
- Automatic control of the line speed or extruder rpm under consideration of the minimum values
- Selectable measuring rate from 1 to 3 Hz (optional 10/25 Hz)
- Intuitive touch screen operation
- No calibration

* For X-RAY 6035 PRO and X-RAY 6070 PRO

	X-RAY 6020 PRO	X-RAY 6035 PRO	X-RAY 6070 PRO	X-RAY 6120 PRO
Diameter	0.65 - 15 mm min. wall: 0.1 mm	5 - 30 mm	6 - 65 mm	10 - 110 mm
Accuracy	5 μ m	5 μ m	10 μ m	10 μ m
Sight field	20 mm	35 mm	70 mm	120 mm
Opening	25 mm	100 mm	100 mm	180 mm

2.3 LUMP 2000 – 2-axis and 3-axis lump detection



Loose tubing/Tight buffering lines/Sheathing lines

For reliable detection of surface faults like, e. g. lumps and neckdowns, 2-axis lump detectors from the LUMP 2000 XY series are available as well as 3-axis lump detectors from the LUMP 2000 T series. The 3-axis measuring principle is focused on the detection of punctual faults with a constantly high detection probability. The 2-axis lump detectors are perfect for the detection of larger faults and so-called bamboo rings.

Typical features LUMP 2000

- Detection of lumps and neckdowns in two or three planes
- Fault analysis regarding type, dimension, length, number and position
- Highest reliability due to double sensor technology*
- Elimination of "ghost faults"***

Technical Data LUMP 2000

Product Name	Product Diameter	Min. Fault Length
LUMP 2010 XY/T	0.5 - 10 mm/0.25 - 10 mm	0.5 mm
LUMP 2025 XY	0.5 - 25 mm	0.5 mm
LUMP 2035 T	0.5 - 35 mm	0.5 mm
Line Speed		
Up to 3,000 m/min		
Power Supply		
100 - 240 V AC \pm 10 %, 50/60 Hz		
Interfaces		
Serial interface RS485, setup and diagnosis interface RS232, fault contact		
Optional: analog input for tolerance (lump/neckdown) or alternatively industrial fieldbus (e.g. Profinet IO, EtherNet/IP, Profibus-DP, CANopen, DeviceNet)		

* See explanation on page 9

*** "Ghost faults" are caused by light fluctuations from the outside, and thus, are no real faults

2.4 ECOCONTROL 6000/1000/600 – Premium processor systems for visualization and control of production data

Premium processor systems with 22", 15" or 10" TFT color monitor and touch screen operation

Three ECOCONTROL processor systems form the SIKORA premium segment of display and control devices. Intelligent software technology, clear arrangements, intuitive structure and usability are their convincing characteristics.

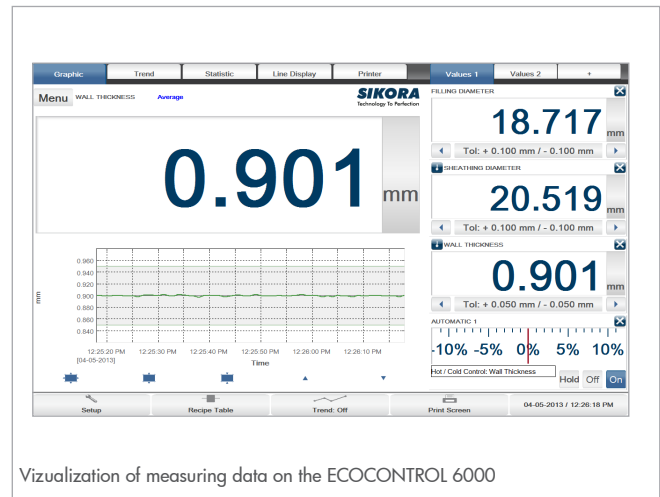
Choose the extremely innovative and powerful ECOCONTROL 6000, the unique ECOCONTROL 1000 or the smart ECOCONTROL 600. Each of these display and control systems exceeds all expectations in their class.

The individual display of the line including pictograms of the connected devices provides a unique overview, while the numeric and graphic display of the measuring values, trend diagrams and statistics fulfill every wish regarding process visualization.

The 22", 15" and 10" TFT monitors and the intuitive touch screen control of the ECOCONTROL 6000, 1000 and 600 processor systems represent an intelligent and cutting edge technology.

Data storage

The data storage on a SSD medium is a standard for the ECOCONTROL 6000 and 1000. For the ECOCONTROL 600, an external media storage (USB, optional LAN) is available. Time, length or reel related production reports are available for each of the three ECOCONTROL devices (6000, 1000 and 600).



Visualization of measuring data on the ECOCONTROL 6000

Software packages (optional)

Automatic diameter/wall thickness control

In combination with the control module SET POINT, the ECOCONTROL systems deliver quality assurance and cost reduction. They ensure a continuous, automatic control of the diameter or wall thickness to the nominal value by controlling either the line speed or the extruder rpm.

Hot/Cold Module HC 2000 (ECOCONTROL 6000/1000)

With the Hot/Cold Module HC 2000, the material shrinkage is continuously calculated and considered automatically for the control of the diameter and/or wall thickness.

FFT analysis

Optionally, the ECOCONTROL 6000 visualizes periodical variations of the product parameter from an FFT analysis of the measuring values. This software package was developed with the support of competent partners within the industry. The FFT analysis leads to transparency of the processes, shows risks, that are caused e.g. by variations of the diameter, and indicates potential causes.

VIRTUAL 2000 – Intelligent software concept

The virtual gauge technology is suitable for all applications, which require a fast wall thickness control, but due to line configuration or the product structure, a diameter or wall thickness measurement directly after the extruder is not possible. Only after the cooling section, that is to say in greater distance from the cross head, the real measurement is done by this technology.

The basis of the design is the simple, but sophisticated idea that an extrusion model knows the volume output of the extruder in its different operating conditions to predict with the highest accuracy the value of the produced cold wall thickness of a cable. The volume output is recorded once in a user friendly way by the ECOCONTROL 6000 in combination with the measuring device.

Technical Data ECOCONTROL

6000

1000

600

Display			
TFT color monitor	22" (vertical) (alternatively 15", horizontal)	15"	10"
Inputs/Outputs			
Serial interface RS485 for the connection to measuring devices	8*	4*	1
Electrically isolated digital inputs for the connection to testing devices	8*	4*	4*
Analog inputs 16 Bit, ± 10 V (bipolar)	8*	4*	-
Analog outputs 16 Bit, ± 10 V (bipolar)	8*	4*	-
Contact outputs for tolerance and status messages (max. 30 V, max. 0.5 A)	8*	4*	4*
Communication interface via RS232 or LAN	1*	1*	1*
Interface for printer	1*	1*	1*
Electrically isolated input for rotary pulse generators (0/15 V)	1	1	1
Electrically isolated interface module for control of the diameter (HC 2000)	1*	1*	-
USB customer interface	1	1	1
Industrial fieldbus (e.g. Profinet IO, EtherNet/IP, Profibus-DP, CANopen, DeviceNet)	Yes*	Yes*	No
LAN interface (selectable OPC DA2/UA/SuiteLink)	1*	1*	1*
Wi-Fi	1*	-	-
Data Storage			
	SSD	SSD	External media*
Power Supply			
	100 - 240 V AC ± 10 %, 50/60 Hz		

* Depending on the equipment

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