

Fiber Optic Sensors Global Market Forecast Service

Published:	August 29, 2011
Fee:	\$6,800
Text Pages:	479 – PDF
Excel File:	Extensive market forecast database spreadsheets
Extra Services:	12-issues of the Fiber Optic Sensor Monthly Journal, plus 12-issues of the Fiber Optic Industry Monthly Review

ElectroniCast report provides our forecast and analysis of the worldwide consumption of Fiber Optic Sensors. In addition to the main report, the service also includes an extensive market forecast database in Microsoft Excel format, as well as 12-issues of the Fiber Optic Sensors Monthly Journal and the ElectroniCast Fiber Optic Industry Monthly Review.

Fiber optic sensors use optical fiber either as the sensing element ("intrinsic sensors"), or as a means of relaying signals from a remote sensor to the electronics that process the signals ("extrinsic sensors"). The 2010-2015 quantitative market forecast data presented in this study report are segmented into the following geographic regions, plus a Global summary:

- The Americas (North America, Central and South America)
- EMEA (Europe, Middle Eastern countries, plus Africa)
- APAC (Asia Pacific)

The market forecast database is also presented and segmented in three main sections:

- Fiber Optic Point Sensors: Component-Level
- Continuous Distributed Fiber Optic Sensors
- Optical Communication Signal Analysis Interface Components/Modules

Fiber Optic Point Sensors Applications covered in this report:

- Manufacturing Process/Factory
- Civil Engineering/Construction (buildings, bridges, tunnels, etc)
- Military/Aerospace/Security
- Test & Measurement used in Telecommunication, CATV, Private/Enterprise
- Biomedical/Science
- Petrochemical/Energy/Utilities/Natural Resources
- Automotive/Vehicle

Sensing/Measuring Quantity (Measurand) The Fiber Optic Point Sensor
Forecast is segment further by the following sensing/measuring quantity
(measurand) types:

- Mechanical Strain
- Temperature
- Pressure
- Chemical, Gas, Liquid
- Vibration, Acoustic, Seismic
- Displacement, Acceleration, Proximity
- Electric and Magnetic Field - Fiber Optic Sensors
- Rotation (such as Fiber Optic Gyroscopes: FOGs)

Continuous Distributed Sensor Applications/Technologies covered in this report:

- Manufacturing Process/Factory
 - Interferometric
 - Raman back-scattering
 - Brillouin waves
- Civil Engineering/Construction (buildings, bridges, tunnels, etc)
 - Interferometric
 - Raman back-scattering
 - Brillouin waves
- Military/Aerospace/Security
 - Interferometric
 - Raman back-scattering
 - Brillouin waves
- Petrochemical/Energy/Utilities/Natural Resources
 - Interferometric
 - Raman back-scattering
 - Brillouin waves
- Biomedical/Science
 - Interferometric
 - Raman back-scattering
 - Brillouin waves

An extensive list of fiber optic sensor manufacturers and related companies is provided, along with a matrix table classifying the types of sensors technologies that they address. Market share estimates for the leading competitors are also provided. The technology trends of other pertinent fiber optic components and devices in the fiber optic marketplace are presented.

Optical Communication Signal Analysis Interface Components/Modules

These include components, sampling/interface modules and intra-enclosure (board-level) elements directly used for fiber optic sensing measurements, used in equipment such as –Oscilloscopes, OTDRs, Bit Error Rate Testers, Signal Generators, Spectrum Analyzers, and numerous other test/measurement/monitoring equipment used for communication/optical signal processing applications. The forecast is segmented by the following applications:

- Telecommunications
- Private Enterprise Data Networks
- Cable TV
- Military/Aerospace/Security
- Other

This study report also provides an extensive review of applicable technologies, including:

- Interferometry
- Intensity
- Polarization
- Fiber Bragg Grating (FBG)
- Raman back-scattering
- Fluorescence
- Brillouin waves
- Doppler Anemometry
- Spectroscopy
- Waveguides/ Specialty Optical Fiber
- Optrode

Fiber Optic Sensors Monthly Journal and the FO Industry Monthly Review

The Fiber Optic Sensors Monthly Journal *and* the Fiber Optic Industry Monthly Review are included with the subscription to the annual Fiber Optic Sensors Global Market Forecast and Analysis Report. Both monthly reports are sent, via e-mail, in PDF file: typically 30-40 pages.

Both of these monthly reports provide summary-level information of the latest market and technology trends covering the area of fiber optic communication.

The Fiber Optic Industry Monthly Review is released at the end of each month.

The Fiber Optic Sensor Monthly Journal is released at the beginning of each month.

Fiber Optic Sensor Global Market Forecast

Table of Contents

1.	Executive Summary	1-1
1.1	Overview	1-1
1.2	Use of Fiber Optics in Harsh Environments	1-26
1.3	Fiber Optic Networks – Overview	1-35
1.4	Fiber Optics Industry: Decade-to-Decade	1-77
1.5	Optical Communication Trends	1-85
1.5.1	Fiber Network Technology Trends	1-85
1.5.2	Components	1-102
1.5.2.1	Overview	1-102
1.5.2.2	Transmitters and Receivers	1-103
1.5.2.3	Optical Amplifiers	1-104
1.5.2.4	Dispersion Compensators	1-105
1.5.2.5	Fiber Cable	1-106
1.5.3	Devices and Parts	1-107
1.5.3.1	Overview	1-107
1.5.3.2	Emitters and Detectors	1-109
1.5.3.3	VCSEL & Transceiver Technology Review	1-110
1.5.3.4	Optoelectronic Application-Specific Integrated Circuits (ASICs)	1-118
1.5.3.5	Modulators	1-118
1.5.3.6	Packages	1-122
1.5.3.7	Optoelectronic Integrated Circuits	1-122
2.	Point Fiber Optic Sensor Measurand and Application Market Forecast	2-1
2.1	Overview	2-1
2.2	Point Fiber Optics Sensors Market Forecast: Strain	2-8
2.3	Point Fiber Optics Sensors Market Forecast: Temperature	2-17
2.4	Point Fiber Optics Sensors Market Forecast: Pressure	2-28
2.5	Point Fiber Optics Sensors Market Forecast: Chemical, Gas and Liquid	2-37
2.6	Point Fiber Optics Sensors Market Forecast: Vibration, Acoustic and Seismic	2-51
2.7	Point Fiber Optics Sensors Market Forecast: Displacement, Acceleration and Proximity	2-62
2.8	Point Fiber Optics Sensors Market Forecast: Electric and Magnetic Field	2-75
2.8	Point Fiber Optics Sensors Market Forecast: Rotation	2-82
3.	Continuous Distributed Fiber Optic Sensor Systems Market Forecast	3-1
3.1	Overview	3-1
3.2	Continuous Distributed Fiber Optic Sensors: Manufacturing/Factory Market Forecast	3-30
3.3	Continuous Distributed Fiber Optic Sensors: Civil Engineering/Construction Forecast	3-35
3.4	Continuous Distributed Fiber Optic Sensors: Military/Aerospace/Security Market Forecast	3-39
3.5	Continuous Distributed Fiber Optic Sensors: Petrochemical/Energy/Utilities Forecast	3-43
3.6	Continuous Distributed Fiber Optic Sensors: Biomedical/Science Forecast	3-47
4.	Optical Communication Signal Analysis Interface Components/Modules Market Forecast	4-1
5.	Fiber Optic Sensor Technology	5-1
5.1	Overview	5-1
5.2	Interferometric Fiber Optic Sensors	5-5
5.3	Intensity Fiber Optic Sensors	5-23
5.4	Polarization Fiber Optic Sensors	5-25
5.5	Fiber Bragg Grating (FBG) Fiber Optic Sensors	5-29
5.6	Raman Scattering Fiber Optic Sensors	5-38
5.7	Fluorescence Fiber Optic Sensors	5-43
5.8	Brillouin Scattering Fiber Optic Sensors	5-48
5.9	Doppler Anemometry	5-50
5.10	Spectroscopy	5-54
5.11	Waveguides Fiber Optic Sensors	5-60
5.12	Optrode	5-95

Table of Contents - Continued

6.	Competitive Market Share and List of Selected Vendors	6-1
6.1	Overview	6-1
6.2	List of Fiber Optic Sensor and Related Companies (over 130 companies are listed) Note: company Product Matrix in Excel Worksheet Addendum	6-3
7.	Research and Analysis Methodology	7-1
8.	Definitions: Acronyms, Abbreviations, and General Terms	8-1
9.	Market Forecast Data Base Introduction	9-1

Market Forecast Data Base – Excel Spreadsheets:

Global
America
Europe, Middle East, Africa (EMEA)
Asia Pacific (APAC)

List of Figures

1.1.1	Fiber Optic Sensor Forecast, Continuous Distributed and Point Sensors (\$Million)	1-4
1.1.2	Detection Fiber Optic Sensor Used in Automotive/Vehicle	1-15
1.1.3	Detection Fiber Optic Sensor Used in Automotive/Vehicle	1-16
1.1.4	Sensors: Single Helix and Double Helix	1-18
1.1.5	Schematic: Laser Ultrasonic Inspection System	1-19
1.1.6	Harsh Environment Digital Fiber Optic Sensor	1-20
1.1.7	Fiber Optic Sensor Installation	1-21
1.1.8	Fiber Optic Sensors (FOS): Operating Principles, type of Measurands and Applications	1-25
1.3.1	North America Multi-protocol Label Switching (MPLS)	1-50
1.3.2	North America Internet Access	1-51
1.3.3	FTTP PON Architecture	1-52
1.3.4	Next-Generation Wholesale Broadband Network	1-56
1.4.1	Evolution of Research Emphasis during Technology Life Cycle	1-84
1.5.3.3.1	Genealogy of VCSELs	1-111
1.5.3.3.2	Typical Intra-Office Interconnections	1-115
1.5.3.7.1	Trend of Transceiver Packaging Density, Gigabits/Cubic Inch	1-128
2.2.1	PM Photonic Crystal Fiber	2-9
2.2.2	Fiber Optic Strain Sensor	2-11
2.3.1	Fabry-Perot Fiber-Optic Temperature-Sensor	2-18
2.3.2	Fiber Optic Temperature Sensor	2-22
2.4.1	Pre-Clinical Transducer with Fiber Coating	2-32
2.5.1	Fiber Optic Sensor would be implanted through the skin	2-42
2.5.2	Optical Fibers Bundled with a Capillary Tube	2-44
2.7.1	Fiber-optic Vibration & Displacement Sensor	2-65
2.7.2	Fiber Optic Position Sensor (FOPS)	2-67
2.7.3	Optical Displacement Sensor	2-70
2.9.1	Schematic Representation of a Sagnac Interferometer	2-82
2.9.2	Schematic: Frequency Shift of a Rotating Ring Laser Interferometer	2-84
2.9.3	Inertial Navigation System (INS)	2-86
2.9.4	Single-Axis Fiber Optic Gyro (FOG)	2-87
2.9.5	Smallest Fiber Optic Gyro (FOG)	2-89
2.9.6	DSP-based Closed-Loop FOG	2-93
3.1.1	Continuous Distributed Fiber Optic Sensor Systems Global Forecast (Value \$Million)	3-2
3.1.2	Portable DTS System	3-13
3.1.3	Fabry-Perot Fiber-Optic Temperature-Sensor	3-14
3.1.4	Wavelength of Transmission Dip of a Chiral Fiber versus Temperature	3-16
3.1.5	Unmanned Science and Technology Development Aircraft	3-22
3.1.6	Security Fence – In-Ground Fiber Optic Sensor	3-27

List of Figures - Continued

5.2.1	Schematic Drawing: Fiber-optic Fabry-Perot Interferometers	5-10
5.2.2	Schematic Drawing: Fiber-optic Fabry-Perot Interferometers	5-11
5.2.3	All-Fiber Michelson interferometer	5-12
5.2.4	Measurement of Micron-Scale Deflections	5-13
5.2.5	Michelson Type-Interferometer with Improvements	5-18
5.2.6	Traditional Fourier-Transform Spectrometer	5-21
5.2.7	Electro-Optical Imaging Fourier-Transform Spectrometer	5-22
5.5.1	Structure of a Fiber Bragg Grating	5-30
5.5.2	Fabry-Perot Sensor Fabricated by Micro-machining	5-32
5.5.3	Unpackaged FBG Sensor	5-34
5.5.4	Weldable FBG Strain Sensor	5-35
5.5.6	Hydrostatic Pressure and Temperature Measurements FBG Sensor	5-36
5.5.7	Flexible Optical Sensing	5-37
5.6.1	Hand-Held Raman Scanner	5-40
5.7.1	Fluorescent Long-Line Fiber Optic Position Sensors	5-45
5.7.2	Fluorescent Long-Line Fiber Optic Position Sensors with LED	5-47
5.9.1	Laser Doppler Flowmetry	5-51
5.9.2	Schematic Representation of Zeta Potential	5-53
5.10.1	Schematic of a LIBS system	5-59
5.11.1	Surface Plasmon Sensors	5-62
5.11.2	Polariton fiber sensor configuration	5-65
5.11.3	Polariton Fiber Sensor	5-66
5.11.4	structure with uniform waist	5-67
5.11.5	Surface Plasmon Resonance Sensing Structure	5-68
5.11.6	Hollow core sensing structure with Bragg grating	5-69
5.11.7	Planar SPP sensor with Bragg grating imprinted into the waveguide layer	5-71
5.11.8	Planar SPP sensor with LPG imprinted into the waveguide layer	5-73
5.11.9	MZI branch with the Bragg grating	5-76
5.11.10	Dependence between the refractive index	5-77
5.11.11	A dual LPG-based SPR sensor	5-78
5.11.12	Tilted grating assisted SPR sensor	5-80
5.11.13	Changes in the Intensities	5-81
5.11.14	PVDF Coated Teflon Fiber SPR Gas Sensor	5-82
5.11.15	Hybrid Mode SPR Sensor	5-83
5.11.16	Thin SPP Waveguide	5-84
5.11.17	Gemini Fiber	5-90
5.11.18	Specialty Optical Fibers with Holes for sensors, lasers and components	5-91
5.11.19	Fiber Sensor: LPG and HiBi Fiber	5-93
5.12.1	Use of an Optrode	5-97
7.1.1	Market Research & Forecasting Methodology	6-4

List of Tables

1.1.1	Continuous Distributed Fiber Sensor Global Forecast, By Region (Value Basis, \$Million)	1-5
1.1.2	Continuous Distributed Fiber Sensor Global Forecast, By Application (Value \$Million)	1-7
1.1.3	Point Fiber Sensor Global Forecast, By Region (Value Basis, \$Million)	1-8
1.1.4	Point Fiber Sensor Global Forecast, By Application (Value \$Million)	1-9
1.1.5	Point Fiber Sensor Global Forecast, By Measurand Function Type (Value \$Million)	1-10
1.1.6	Optical Communication Signal Analysis Interface Modules Regional Forecast, (\$Million)	1-11
1.1.7	Optical Communication Signal Analysis Interface Modules Application Forecast, (\$Million)	1-12
1.1.8	Optical Communication Signal Analysis Interface Modules Application Forecast, (Quantity)	1-12
1.3.1	Minimum & Ideal Speeds Necessary for Popular Applications	1-42
1.5.1.1	IEEE 802.3ba 40G/100G - Physical Layer Specifications	1-95
2.1.1	Point Fiber Optic Sensor Global Forecast, By Application (Value, Quantity, ASP)	2-4
2.1.2	Point Fiber Optic Sensor America Forecast, By Application (Value, Quantity, ASP)	2-5
2.1.3	Point Fiber Optic Sensor EMEA Forecast, By Application (Value, Quantity, ASP)	2-6
2.1.4	Point Fiber Optic Sensor APAC Forecast, By Application (Value, Quantity, ASP)	2-7

List of Tables - Continued

2.2.1	Strain: Point Fiber Optic Sensor Global Forecast, By Application (Value, Quantity, ASP)	2-13
2.2.2	Strain: Point Fiber Optic Sensor America Forecast, By Application (Value, Quantity, ASP)	2-14
2.2.3	Strain: Point Fiber Optic Sensor EMEA Forecast, By Application (Value, Quantity, ASP)	2-15
2.2.4	Strain: Point Fiber Optic Sensor APAC Forecast, By Application (Value, Quantity, ASP)	2-16
2.3.1	Temperature: Point FO Sensor Global Forecast, By Application (Value, Quantity, ASP)	2-24
2.3.2	Temperature: Point FO Sensor America Forecast, By Application (Value, Quantity, ASP)	2-25
2.3.3	Temperature: Point FO Sensor EMEA Forecast, By Application (Value, Quantity, ASP)	2-26
2.3.4	Temperature: Point FO Sensor APAC Forecast, By Application (Value, Quantity, ASP)	2-27
2.4.1	Pressure: Point FO Sensor Global Forecast, By Application (Value, Quantity, ASP)	2-33
2.4.2	Pressure: Point FO Sensor America Forecast, By Application (Value, Quantity, ASP)	2-34
2.4.3	Pressure: Point FO Sensor EMEA Forecast, By Application (Value, Quantity, ASP)	2-35
2.4.4	Pressure: Point FO Sensor APAC Forecast, By Application (Value, Quantity, ASP)	2-36
2.5.1	Chemical: Point FO Sensor Global Forecast, By Application (Value, Quantity, ASP)	2-47
2.5.2	Chemical: Point FO Sensor America Forecast, By Application (Value, Quantity, ASP)	2-48
2.5.3	Chemical: Point FO Sensor EMEA Forecast, By Application (Value, Quantity, ASP)	2-49
2.5.4	Chemical: Point FO Sensor APAC Forecast, By Application (Value, Quantity, ASP)	2-50
2.6.1	Vibration: Point FO Sensor Global Forecast, By Application (Value, Quantity, ASP)	2-58
2.6.2	Vibration: Point FO Sensor America Forecast, By Application (Value, Quantity, ASP)	2-59
2.6.3	Vibration: Point FO Sensor EMEA Forecast, By Application (Value, Quantity, ASP)	2-60
2.6.4	Vibration: Point FO Sensor APAC Forecast, By Application (Value, Quantity, ASP)	2-61
2.7.1	Displacement: Point FO Sensor Global Forecast, By Application (Value, Quantity, ASP)	2-71
2.7.2	Displacement: Point FO Sensor America Forecast, By Application (Value, Quantity, ASP)	2-72
2.7.3	Displacement: Point FO Sensor EMEA Forecast, By Application (Value, Quantity, ASP)	2-73
2.7.4	Displacement: Point FO Sensor APAC Forecast, By Application (Value, Quantity, ASP)	2-74
2.8.1	Electric and Magnetic Field: Point FO Sensor Global Forecast, By Application	2-78
2.8.2	Electric and Magnetic Field: Point FO Sensor America Forecast, By Application	2-79
2.8.3	Electric and Magnetic Field: Point FO Sensor EMEA Forecast, By Application	2-80
2.8.4	Electric and Magnetic Field: Point FO Sensor APAC Forecast, By Application	2-81
2.9.1	Rotation: Point FO Sensor Global Forecast, By Application (Value, Quantity, ASP)	2-95
2.9.2	Rotation: Point FO Sensor America Forecast, By Application (Value, Quantity, ASP)	2-95
2.9.3	Rotation: Point FO Sensor EMEA Forecast, By Application (Value, Quantity, ASP)	2-97
2.9.4	Rotation: Point FO Sensor APAC Forecast, By Application (Value, Quantity, ASP)	2-98
3.1.1	Continuous Distributed Fiber Sensor Global Forecast, By Region (Value Basis, \$Million)	3-3
3.1.2	Continuous Distributed Fiber Sensor Global Forecast, By Region (Quantity of Systems)	3-4
3.1.3	Continuous Distributed Fiber Sensor Global Forecast, By Application (Value \$Million)	3-5
3.1.4	Continuous Distributed Fiber Sensor Global Forecast, By Application (Quantity/Systems)	3-6
3.2.1	Manufacturing/Factory: Continuous Distributed FO Sensor Global (Value, Quantity, ASP)	3-31
3.2.2	Manufacturing/Factory: Continuous Distributed Sensor America (Value, Quantity, ASP)	3-32
3.2.3	Manufacturing/Factory: Continuous Distributed FO Sensor EMEA (Value, Quantity, ASP)	3-33
3.2.4	Manufacturing/Factory: Continuous Distributed FO Sensor APAC (Value, Quantity, ASP)	3-34
3.3.1	Civil Engineering: Continuous Distributed FO Sensor Global (Value, Quantity, ASP)	3-35
3.3.2	Civil Engineering: Continuous Distributed Sensor America (Value, Quantity, ASP)	3-36
3.3.3	Civil Engineering: Continuous Distributed Sensor EMEA (Value, Quantity, ASP)	3-37
3.3.4	Civil Engineering: Continuous Distributed Sensor APAC (Value, Quantity, ASP)	3-38
3.4.1	Military/Aerospace/Sec: Continuous Distributed FO Sensor Global (Value, Quantity, ASP)	3-39
3.4.2	Military/Aerospace/Sec: Continuous Distributed Sensor America (Value, Quantity, ASP)	3-40
3.4.3	Military/Aerospace/Sec: Continuous Distributed Sensor EMEA (Value, Quantity, ASP)	3-41
3.4.4	Military/Aerospace/Sec: Continuous Distributed Sensor APAC (Value, Quantity, ASP)	3-42
3.5.1	Petrochemical/Utility: Continuous Distributed FO Sensor Global (Value, Quantity, ASP)	3-43
3.5.2	Petrochemical/Utility: Continuous Distributed Sensor America (Value, Quantity, ASP)	3-44
3.5.3	Petrochemical/Utility: Continuous Distributed Sensor EMEA (Value, Quantity, ASP)	3-45
3.5.4	Petrochemical/Utility: Continuous Distributed Sensor APAC (Value, Quantity, ASP)	3-46
3.6.1	Biomedical/Science: Continuous Distributed FO Sensor Global (Value, Quantity, ASP)	3-47
3.6.2	Biomedical/Science: Continuous Distributed Sensor America (Value, Quantity, ASP)	3-48

List of Tables - Continued

3.6.3	Biomedical/Science: Continuous Distributed Sensor EMEA (Value, Quantity, ASP)	3-49
3.6.4	Biomedical/Science: Continuous Distributed Sensor APAC (Value, Quantity, ASP)	3-50
4.1	Optical Communication Signal Analysis Interface Modules Global Forecast, By Region	4-1
4.2	Optical Communication Signal Analysis Interface Modules Global Forecast, Application	4-3
4.3	Optical Communication Signal Analysis Interface Modules Global Forecast, (Quantity)	4-4
4.4	Optical Communication Signal Analysis Interface Modules Global Forecast, All Functions	4-6
4.5	Optical Communication Signal Analysis Interface Modules America, All Functions	4-7
4.6	Optical Communication Signal Analysis Interface Modules EMEA Forecast, All Functions	4-8
4.7	Optical Communication Signal Analysis Interface Modules APAC Forecast, All Functions	4-9
6.1.1	Competitor Market Share Estimates: Fiber Optic Sensors (Global: 2010)	6-2