



*A Furukawa Company*

■ **Glossary** of Fiber Optic Terms

**Absorption** — A source of attenuation due to the material properties of the fiber.

**Acceptance Angle** — the maximum angle at which a light ray entering the core will be guided through the fiber.

**Aramid Yarn** — A type of filament used in the cabling process to provide strength while retaining flexibility. Aramid yarn is sometimes used straight down the length of the cable and sometimes braided along the internal circumference of one of the layers of jacketing, depending upon the application.

**ATM** — Asynchronous Transfer Mode. A protocol used to transmit information over optical fiber.

**Attenuation** — The decrease in signal strength between light entering and leaving the fiber, expressed in dB/km (decibels per kilometer). Attenuation can result from a number of factors and conditions, such as absorption, bend loss, cabling, dispersion, insertion loss, macrobending, microbending, Rayleigh scattering, or water peaking.

**Back Reflection** — Occurs when light propagating through the fiber is mirrored back into the fiber at the endface instead of continuing through to the receiving source..

**Bandwidth** — A measure of the data-carrying capacity of an optical fiber, usually expressed as frequency times distance (MHz-km or GHz-km) (MegaHertz or GigaHertz per kilometer).

**Beat Length** — The length of fiber over which signals propagating in two perpendicular (or orthogonal) orientations become out of phase by  $2\pi$ .

**Bend Loss** — Attenuation due to (1) microscopic imperfections in the fiber due to buckling stresses (microbending); or (2) bending the fiber in a tight radius curve (macrobending).

**Bend Radius** — The minimum radius of curvature in which a fiber can bend without breakage, other adverse mechanical effects, or increased attenuation beyond an acceptable threshold.

**Biocompatibility** — A characteristic of fiber and cable designed for medical uses, having been tested to various classifications for direct use within the human body. Biocompatible fibers and cables are also sterilizable.

**Birefringence** — A condition in an anisotropic medium in which two perpendicular polarizations in a fiber have different refractive indices and thus provide different group velocities.

**Buffer** — A protective polymer layer without optical properties applied over a coating.

**Cable** — One or more fibers combined with at least one layer of protective jacketing for mechanical and environmental protection and ease of handling. May also include strength members and external armor-ing.

**Chromatic Dispersion** — Dispersion caused when different wavelengths of light travel at different speeds through the fiber material.

**Cladding** — Also Clad. Material surrounding the core of a fiber, having a lower refractive index to form a guiding structure for light propagation within the core.

**Coating** — One or more organic or polymer layers surrounding the cladding, usually adhering directly to the glass, to provide mechanical and environmental protection to the light-transmitting region.

**Concentricity** — The degree to which the geometric center points, particularly of the core and cladding of the fiber, coincide. Concentricity is particularly important for geometrically dependent fiber properties such as splice loss.

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**Connector** — Any of the series of standardized mini-assemblies that allow a fiber or cable to be attached firmly to a light source or a receiver. Some connectors are screw-type. Some are designed to snap in tightly. OFS fibers and cables are compatible with a variety of connector types, including ST, SMA, Versatile Link (V-System), and F07.

**Core** — The central, light-transmitting region of the fiber, formed from pure or doped silica.

**Crimp and Cleave** — A process of finishing an end of fiber, allowing it to be terminated. The crimp and cleave process is fast, usually taking less than 2 minutes per end, and uses OFS proprietary tools and processes that are customized by the type of connector desired.

**Crosstalk** — In polarization-maintaining fiber, this measurement indicates the degree to which the light in two orthogonal polarization modes is isolated. This measurement is stated in terms of decibels per kilometer.

**Cutoff Wavelength** — The wavelength below which high-order modes may propagate in a single-mode fiber in addition to the desired fundamental mode. Above the cutoff wavelength, operation in a single-mode is ensured.

**Doped** — Fiber to which has been added any of a number of different chemical elements to alter the properties of glass, such as refractive index.

**Decibel** — Ten times the logarithm of the optical power ratio (power in/power out); a unit of measurement used to define attenuation in a fiber.

**Dispersion** — A broadening of the widths of optical pulses as they travel through a fiber, eventually resulting in pulse overlap and corruption of data. The main factor determining the bandwidth of a fiber.

**Draw** — The process of heating a glass preform rod to the appropriate temperature for its composition on a fiber-draw tower and letting controlled tension and gravity reduce the diameter of the rod to the desired measurement. The draw process includes application of one or more protective coatings and sometimes also the application of a buffer. Drawing fiber in this manner preserves all the geometries of the original preform rod and reduces them such that their proportions remain the same in the finished fiber.

**Dual-window Fiber** — Graded-index fiber in which the refractive index profile is designed to give low modal dispersion at both 850 and 1300 nm.

**Duplex Cable** — Two, side-by-side simplex cable sub-units surrounded by a single polymer jacket.

**EMI** — Electromagnetic Interference. Electrical charging which can cancel out or interrupt the signal in a non-shielded copper cable as well as in some shielded non-optical cables. Fiber and the signals it carries are unaffected by EMI.

**ETFE** — Ethylene Tetrafluoroethylene. A polymer commonly used to buffer fiber.

**Epoxy/Polish** — A process of finishing a fiber end, allowing it to be terminated. The epoxy/polish process is typically a more time-consuming, complicated process than the crimp and cleave process, but it sometimes produces a stronger hold.

**F07** — A system of cable types commonly used for data transmission in programmable logic controllers and the ATM Forum. The F07 is a connector type associated with duplex constructions.

**Ferrule** — A metal, ceramic, or plastic tube through which the end of a fiber or cable passes as part of a connector assembly.

**Fiber** — A single, optical transmission element consisting of the core, cladding, and coating.

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**Fiber Bragg Gratings (FBGs)** — A photosensitive optical fiber that contains a periodic grating (an area of multiple stripes extending through the cross-section of the fiber, the distance between each stripe defining the period of the grating) written into the core of the fiber by exposure to UV radiation. The central wavelength reflected can be changed by altering the period length. Bragg gratings are used as filters for specific wavelengths or bands of light.

**Filler** — A non-optical cabling material used to keep a cable round for handling purposes. Fillers run the length of the cable in place of an actual optical fiber.

**Fundamental Mode** — In single-mode fiber, the wavelength at which the fiber is designed to operate and at which the light mode travels nearly straight along the fibers' central axis.

**Glass-Reinforced Plastic** — Also GRP. Also Epoxy Rod. A cabling material used to provide strength and rigidity along the length of a cable.

**Graded-Index Fiber** — A multimode fiber in which the refractive index in the core gradually decreases from a maximum in the center to match that of the cladding, resulting in a much higher bandwidth than step-index.

**Insertion Loss** — Attenuation due to the process of plugging a terminated end of fiber or cable into a transmitter or receiver. A less-than-perfect match in concentricity or any airspace between the fiber and the unit will result in some marginal loss of signal. Connectors are designed to allow insertion loss only within a particular tolerance stated on the specification sheet.

**Jacket** — A protective layer of polymer material extruded outside the buffered fibers as part of the cabling process.

**kpsi** — English unit for stress: kilopound per square inch. 100 kpsi is converted to international units as 0.689 Gigapascals (GPa).

**Linear Polarization** — A state in which the electric field of a light wave is oriented in only one direction.

**Low Smoke Zero Halogen (LSZH)** — Materials used for applications where minimum exposure to the corrosive effects and health risks of halogen gas and smoke is a requirement.

**Macrobending** — See bend loss.

**Microbending** — See bend loss.

**Micron ( $\mu\text{m}$ )** — One millionth of a meter; a micrometer.

**Modal Dispersion** — Dispersion resulting from the increased path lengths traveled by light in different modes as they propagate through a multimode fiber.

**Mode** — One of the discrete number of light rays that can propagate in a fiber while maintaining total internal reflection. The fundamental mode travels nearly straight along the fiber axis, while higher-order modes make progressively greater angles with the axis.

**Mode Field Diameter** — The light spot diameter in a single-mode fiber, usually 15 percent larger than the diameter of the core, at which the light intensity has dropped to 1/e<sup>2</sup> of its maximum value at the center of the core.

**Multimode Fiber** — A fiber with a core large enough (typically at least 50  $\mu\text{m}$ ) to allow many modes of light to propagate.

**Nanometer (nm)** — One billionth of a meter; the unit of measure typically used to indicate the wavelength of light.

**Near-IR** — The portion of the spectrum, close to infrared, which is commonly used in spectroscopy applications.

**Numerical Aperture (NA)** — A measure that defines the acceptance angle of a multimode fiber and is nominally stated for single-mode fiber.

**Operating Wavelength** — The wavelength in nanometers at which a single-mode fiber is designed to operate optimally.

**PE** — Polyethylene. A plastic cable jacketing material commonly used in outdoor applications for its excellent UV resistance and weatherability characteristics.

**PFA** — Perfluoro alkoxy fluorocarbon. A thermoplastic used as both a buffer and cable jacket material.

**Plenum** — An Underwriters Laboratories flammability rating (UL 910) for cable in which the cable is certified for use in indoor, horizontal air spaces, such as above suspended ceilings and within air ducts. Common term used for Optical Fiber Nonconductive Plenum (OFNP). Only certified products can be used in plenum-rated applications.

**Polarization-Maintaining Fiber** — An internally stressed fiber designed to keep two signals propagating in perpendicular orientations throughout the length of fiber.

**Polyimide** — A coating designed to boost a fiber's upper temperature limit allowing a fiber to withstand temperatures up to 400°C for short duration and up to 300°C long term.

**Preform** — A glass rod, usually composed of silica to form the core and layered with silica or acrylate to form the cladding and from which fiber is drawn into the appropriate micron thickness.

**Propagation** — The movement of light through a fiber from transmitter to receiver, usually constrained to the core of the fiber, but sometimes utilizing the cladding as a portion of the waveguide.

**PVC** — Polyvinyl Chloride. A thermoplastic used as both a buffer and cable jacket material.

**PVDF** — Polyvinylidene Fluoride. A thermoplastic used as both a buffer and cable jacket material.

**Rayleigh Scattering** — A source of attenuation in which light rays are scattered by fluctuations in the refractive index of the fiber material.

**Refractive Index** — The ratio of the speed of light in a vacuum to the speed of light in a material. The difference in refractive indices between the core and clad of a fiber allows light to propagate down a fiber from transmitter to receiver.

**Refractive Index Profile** — A graphical representation showing the refractive index of the core and cladding of a fiber. For a step-index fiber, the graph will show a stair-step-type pattern with the top step at the core of the fiber. For a graded-index fiber, the graph will show a parabolic curve with its peak at the core of the fiber.

**Repeater** — A combination receiver/transmitter used singly or in multiples along the length of a fiber or cable to regenerate an attenuated signal, allowing distance requirements to be met.

**Ripcord** — A string-like material embedded in the length of a multi-fiber cable which, when pulled, splits the outer jacket of the cable lengthwise, revealing the individual fiber sub-units within and allowing them to be routed or connectorized separately from a single cable.

**Riser** — An Underwriters Laboratories flammability rating (UL 1666) for cable in which the cable is certified for use in indoor applications for vertical airspaces rising between building joists. Common term used for Optical Fiber Nonconductive Riser (OFNR). Only certified products can be used in riser-rated applications.

**Rod** — (1) Another term for "Preform," (2) A strength member inserted under the outer jacket along the length of a cable to provide rigidity.

**Signal** — A generic term for light launched from a source, intended for receipt at the other end of an optical fiber.

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**Simplex Cable** — A single fiber with at least one layer of protective jacketing for environmental protection and ease of handling. May also include strength members or external armoring.

**Single-Mode Fiber** — A step-index fiber with a core diameter that allows only the fundamental mode to propagate.

**SMA** — A connector type commonly used in the military and medical markets.

**Splice Bushing** — A connector accessory used to attach two connectorized cables end to end, keep them held in place, and protecting them from disconnecting under normal use.

**ST®** — A connector type featuring a bayonet-style nut and commonly used in telecommunications.

**Step-Index Fiber** — A fiber with a constant refractive index throughout the core.

**Strength Member** — A rigid or flexible element, such as a glass-reinforced plastic rod or aramid yarn, used in cabling fiber to achieve increased tensile strength.

**Stress Applying Parts (SAPs)** — Fillers, usually boron-doped, drilled into preforms to create the appropriate stresses on the core in polarization-maintaining fibers.

**Tensile Strength** — A measure of the maximum resistance a fiber can sustain before breaking under a stretching load.

**Termination** — The process of connectorizing one or both ends of a fiber or cable.

**Tight-Buffer Cable** — A type of cable construction in which the buffer material is extruded directly onto the fiber coating.

**Tolerance** — The accuracy of a specification to within a certain degree of error. Where an indicated specification can safely vary from the stated measurement without detriment to performance or any other vital parameter, a plus-or-minus tolerance is often listed to inform the customer how much the measurement can vary while still remaining within specification.

**Total Internal Reflection** — The condition that occurs when a light ray enters a fiber at an angle greater than the critical value (determined by the refractive indices of the core and clad) and is completely reflected back into the fiber core.

**TPE** — Thermoplastic elastomer.

**Upjacket** — A layer of fiber protection in any of a variety of materials extruded outside the buffered fibers as part of the cabling process, usually refers to a second-or-higher-order after a primary jacket or buffer layer.

**V-System®** — A system of cable types commonly used with transmitters and receivers from Agilent Technologies for which OFS manufacturers compatible crimp and cleave connectors. Also known as Versatile Link.

**Water Peak** — The point or points on the optical attenuation spectrum where water in a particular fiber design causes a spike. System designers choose a fiber to avoid launching light at a water peak wavelength.

**Waveguide Dispersion** — A cause of dispersion due to the geometry of the fiber.

**Waveguide** — The center portion of an optical fiber where light travels, usually limited to the core but sometimes including a fraction of the cladding as well.

**Wavelength** — The distance between successive peaks or nodes of a light wave, measured in nanometers (nm).

**Zero-Dispersion Wavelength** — The wavelength at which there is no broadening of the widths of optical pulses as they travel through a fiber. Operating at the zero-dispersion wavelength results in maximum bandwidth from a fiber.

**Zipcord** — A cable constructed of two simplex cables connected by a bridge or web of jacketing material. The webbing is designed to split length-wise to allow the individual simplex cable units to be separated for connectorizing or routing.

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