ofs
A Furukawa Company

Numerical Aperture (NA)

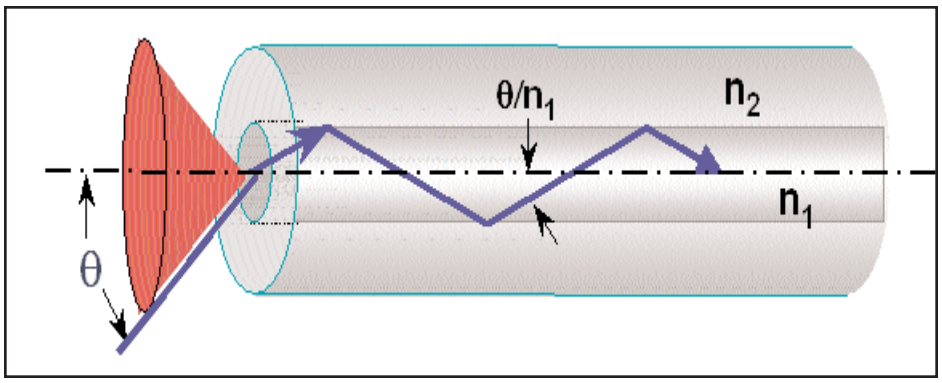
Numerical aperture (NA) is a critical performance specification for multimode fibers. It indicates the maximum angle at which a particular fiber can accept the light that will be transmitted through it. The higher an optical fiber's NA, the larger the cone of light that can be coupled into its core.

Graded-index multimode fibers have a large NA. This is a major advantage of the product: it enables them to be used with relatively low-cost optical components and light sources such as light-emitting diodes (LEDs) and Vertical Cavity Surface Emitting Lasers (VCSELs). LEDs and VCSELs, which have large spot sizes, can be easily coupled to multimode fibers. In contrast, single-mode fibers, which have a small NA, typically use narrow width lasers as power sources and carry only one mode of light straight through a very narrow core. Transmitter alignment and tolerances must be very precise to couple the small beam of light into the tiny core of a single-mode fiber. This drives up the cost of single-mode components.

Multimode fibers allow more modes of light to be transmitted, resulting in greater pulse spreading, or dispersion, and less bandwidth. Consequently, these easily-connectorized, high-NA graded-index multimode fibers are ideal for short-distance (up to several kilometers) data communications applications such as local area networks. For graded-index multimode fiber used in data communications, the standard NAs are 0.20 for 50/125 µm fiber and 0.275 for 62.5/125 µm fiber.

Defining NA

NA is a unitless quantity. It is derived from calculating the sine of the half angle (θ) of acceptance within the cone of light entering the fiber's core. Theoretical NA may be expressed by the equation $NA = (n_1^2 - n_2^2)^{1/2}$, where n_1 is the refractive index of the core and n_2 is the refractive index of the cladding. The refractive index of a material is defined as the ratio of the speed of light in a vacuum to the speed of light in that particular material.



Numerical Aperture defines the maximum angle (the “cone of acceptance”) at which light can be launched into a fiber

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Measuring NA

To measure the NA of its graded-index multimode fibers, OFS uses Fiber Optic Test Procedure (FOTP) 47, one of the three methods specified in FOTP-177 for that purpose. This method specifies "over-filling" a two-meter length of fiber with light from a power source with an NA that is higher than the fiber's, and a launch spot size greater than the fiber core size.

Light exiting the fiber is scanned to provide a far-field intensity profile in terms of power versus angle. The light is scanned angularly, covering an arc sufficient to detect essentially all output from the fiber. However, to ensure a very high degree of reliability, that half angle of acceptance of a graded-index fiber is defined as the half-angle between the two 5 percent power points on the profile.

Using FOTP-177, OFS performs precision measurements to ensure that the NA for every spool of fiber manufactured stays within very narrow tolerances. These standard precision measurements are important, since NA is one of the characteristics affecting ease of installation and cost of components to be used with the fiber.

For additional information please contact your sales representative. You can also visit our website at www.ofsoptics.com/ofs-fiber or call 1-888-fiberhelp. For regional assistance, contact:

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