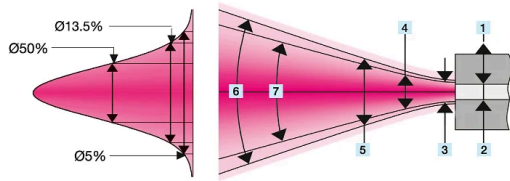


EFFECTIVE NUMERICAL APERTURE



EFFECTIVE NUMERICAL APERTURE NAe^2

For fiber-coupling purposes an effective fiber NAe^2 defined at the $1/e^2$ -level is more convenient than the nominal fiber NA defined by the refractive indices since Gaussian beams generally are defined by their $1/e^2$ diameter, also.

Schäfter+Kirchhoff defines an effective fiber NA which corresponds to the divergence of the power distribution emitted by the fiber taken at the $1/e^2$ -level of the Gaussian angle distribution.

This NA value is the designated effective numerical aperture NAe^2 . For a typical single-mode fiber the value is $NAe^2 = 0.075$.

For single-mode fibers and for polarization-maintaining fibers, the effective NAe^2 typically [decreases slightly with increasing wavelength \$\lambda\$](#) .

- 1 Single-mode fiber
- 2 Core diameter
- 3 Mode-field diameter
- 4 Intensity level (13.5% or $1/e^2$ -level)
- 5 Intensity level (e.g. 5%)
- 6 $2 \times NA$ (e.g. 5%)
- 7 $2 \times NAe^2$ (13.5% or $1/e^2$ -level)

TYPICAL VALUES FOR THE EFFECTIVE NUMERICAL APERTURE

Please find [here](#) some measured (averaged) values for the effective numerical aperture NAe^2 for common fibers at their respective cut-off wavelength.

When purchasing a fiber from Schäfter+Kirchhoff, the fiber is delivered with more accurate measurements of the effective numerical aperture NAe^2 . Schäfter+Kirchhoff determines the NAe^2 of the fiber for each fiber batch by measuring the divergence of the emitted radiation in the far field. Due to the wavelength dependence of the NAe^2 , this is done for several typical wavelengths in the working range of the fiber.

An article on how measured fiber parameters help to choose the best coupling and collimation optics can be found [here](#).

NOMINAL NUMERICAL APERTURE NA

Schäfter+Kirchhoff obtain fibers from different manufacturers.

$$NA = \sqrt{n_{co}^2 - n_{cl}^2}$$

with n_{co} and n_{cl} as the refractive indices of fiber core and cladding, respectively.

For a typical single-mode or a polarization-maintaining fiber, the nominal value is $NA = 0.12$

This NA specification corresponds to the Gaussian angle distribution at a 1 - 5% -level.

FIBER COUPLING

$$f' = \frac{0.5 \cdot \varnothing_{beam}}{NA_{e^2}}$$

More details can be found [here](#).

COLLIMATION

The collimated beam diameter \varnothing_{beam} is a function of the collimating focal length f' and the numerical aperture NA of the single-mode fiber.

$$\varnothing_{beam} = 2 \cdot f' \cdot NA_{e^2}$$

More details can be found [here](#).

This is a printout of the page <https://sukhamburg.com/support/technotes/fiberoptics/cablebasics/NAeff.html> from 4/9/2026

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