COUPLING EFFICIENCY

COUPLING EFFICIENCY FOR LASER BEAM RADIATION OF HIGH QUALITY

A coupling efficiency of >80% is achieved when coupling laser sources with rotationally symmetric beams of high quality (M^2 < 1.05) and no astigmatism.
Loss contributions are mainly through:

- Transmission loss in the laser beam coupler ~ 1%
- Imaging aberration, stray loss and beam distortion (M^2 > 1) ~ 8%
- Fresnel reflection loss at fiber end faces ~ 8%

COUPLING AN EXTENDED LIGHT SOURCE INTO A SINGLE-MODE OR PM FIBER

When coupling the radiation of an extended source into a single-mode or PM fiber, there are principle limitations.

An extended source, e.g. a LED source, a plasma or fluorescent light (any non-directed source) typically emits a beam from a large area and with a large angular spectrum. This beam characteristics (area x angle) is given by the so-called **beam parameter product BPM** or, more precisely, the étendue.

The single-mode fiber however, (as every fiber type), only has a limited acceptance angle (here defined by the numerical aperture) and MFD. Only light that is focused with the right angle (-> numerical aperture) and focus size (-> MFD) is coupled into the fiber, everything else is not transmitted. The single-mode fiber accepts beams with the corresponding BPM.
Every component has different BPMs it emits or accepts (source, optics, as well as fiber). In classical optics, this BPM is an invariant, which means that it is not possible to change the BPM of an optical system by means of optical imaging.

An extended source, e.g. a LED source plasma or fluorescent source emits a beam that automatically has a large BPM as both the emitter area as well as the angular spectrum is large. Since any single-mode fiber has a low BPM, the resulting coupling efficiency will *always* be very low.

If you can also use a multimode-fiber, please refer to this technote for more details.

It is impossible to couple a significant amount of light emitted by an extended source into a single-mode fiber.

This is a printout of the page
https://sukhamburg.com/support/technotes/fiberoptics/coupling/couplingsm/couplingefficiency.html from 5/22/2026

CONTACT

For more information please contact:
Schäfter + Kirchhoff GmbH
Kieler Str. 212
22525 Hamburg
Germany
Tel: +49 40 85 39 97-0
Fax: +49 40 85 39 97-79

info@sukhamburg.com
www.sukhamburg.com

LEGAL NOTICE