Beam delivery components
– for high-power lasers

COHERENT®
Maximum performance.
Minimum loss.

Our goal is to optimize the beam delivery from your high-power laser to the work piece. Since our customers demand high performance, flexible solutions and no loss of power or time, we continuously work to improve and increase the possibilities of laser transmission technology.

We have developed and manufactured a wide range of beam delivery products for high-power lasers for our customers: Fiber optic cables, incoupling optics and external optics.

Some of these products are patented and certified, which is a testament of the skill of our innovative R&D engineers.

Our safe and reliable high technology products have only one goal: To optimize your laser!

Martin Uddén
Managing Director, Optoskand AB
Coherent Inc.
The unsurpassed performances of the Optoskand high-power fiber optic cables make them the number one choice for most industrial lasers on the market. Thanks to a well developed technology featuring quartz block, mode stripper and internal water cooling, the fibers can withstand high power levels and offer extremely low transmission losses.

Mode stripping
The built-in chemical-free mode stripper makes sure that laser radiation coupled into the fiber cladding is effectively removed in the fiber connector. This guarantees that no high NA light will exit the fiber cable and potential fiber damage due to cladding power is removed.

Quartz block
Optoskand invented and pioneered the end-cap technology which is the most practiced in the industry. With the quartz block, the beam diverges while still propagating in fused silica. This leads to a much lower power density on the end surface. The quartz block comes with a high-quality AR-coating and with the larger end surface, inspection and cleaning of the fiber end is easy.

Internal water cooling
For maximum high-power performance, cooling of the fiber connector is necessary. Optoskand cooling technology is based on an internal cooling where the radiation is absorbed by the water directly. In combination with the mode stripping technology this leads to the highest power loss capability on the market.

Integrated sensors
The latest development in high-power fiber connectors is to integrate sensors to monitor the condition of the fiber connector. Besides the extra safety function, the sensors also make installation and alignment easier. The sensors can tell exactly how much power losses are present in the connector. All sensors are integrated into the fiber interlock system.

• Robust design
• Extreme power loss capability
• Low transmission losses (1-2%)
• Plug and play within 10 µm
• High-reliability safety interlock

Research & Development
Optoskand’s high-technology and reliable products are the results of more than 30 years of know-how and continuous research and development. With skillful and dedicated engineers this has resulted in several patents and safety certifications.

• Between 10–15% of Optoskand’s turnover is invested in R&D projects
• Participating in larger European Community funded research projects
• A modern test laboratory equipped with a variety of high-power laser sources
QBH Fiber
Designed by Optoskand, the QBH is the number one interface of high-power fiber lasers today. It is a well-proven standard fiber in the industry with a compact design, efficient internal water cooling and a rugged but flexible outer hose. It is capable of handling up to 10 kW (CW) with high power loss capability.

RQB Fiber
The air-cooled version of the QBH fiber optic cable, with identical mechanical interface. The RQB is ideal for lower power levels and more moderate power losses than the QBH. The integrated thermoswitch protects it from being overheated. Perfect for pulsed lasers. Available with an external cooler.

QD Fiber
The standard interface for the European Automotive Industry. Capable of handling up to 20 kW (CW). Includes built-in sensors for monitoring the condition of the fiber connectors during operation. The QD fiber has the highest power loss capability of all Optoskand fiber connectors.

QCR Fiber
Providing a collimated laser beam output. With a compact, air-cooled and robust connector design the QCR fiber optic cable is developed for use also in robotic applications. The QCR interface fits to standard clamping adapters. Built with standard or customized optical fiber. Pigtail for a direct splice to fiber laser.

QCS Fiber
A compact and air-cooled fiber connector design including integrated collimating optics. The QCS is specially designed for diffraction limited medium-power fiber lasers. Built with standard or customized optical fiber. Pigtail for a direct splice to fiber laser.

SMAQ Fiber
This is a SMA fiber with extreme power loss capability. The SMAQ is specially designed for fiber coupling of high-power diode lasers. By combining the standard SMA905 interface with the Optoskand experience of high-power fibers, by far the best high-power SMA fiber connector on the market could be developed.

Beam shaping with optical fibers
With square fiber core geometry the fiber optic not only guides the beam, it also transforms the spot shape. Square formed fiber cables are specially aimed for high precision step-and-repeat processes where the square beam shape minimizes the process overlap.

When square fibers are combined with our asymmetric collimating units containing cylindrical lenses the result is a homogenous rectangular-formed power distribution.

### Table

<table>
<thead>
<tr>
<th></th>
<th>QBH</th>
<th>RQB</th>
<th>QD</th>
<th>QCR</th>
<th>QCS</th>
<th>SMAQ</th>
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<tbody>
<tr>
<td>Power</td>
<td>10 kW</td>
<td>1.5 / 3.0 kW*</td>
<td>20 kW</td>
<td>750W</td>
<td>300W</td>
<td>500W</td>
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<tr>
<td>Mode Stripper</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Quartz Block</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Water-Cooled</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Integrated Intelligence &amp; Sensors</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<td>No</td>
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<tr>
<td>Integrated Collimating Lens</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Transmission Losses</td>
<td>&lt; 3%, typical 1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>AR-Coatings</td>
<td>1030-1090 nm</td>
<td>780-1100 nm</td>
<td>1030-1090 nm</td>
<td>1030-1090 nm</td>
<td>1030-1090 nm</td>
<td>1030-1090 nm</td>
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<tr>
<td>Fiber Core</td>
<td>SM-1000µm, round/square</td>
<td>SM-300 µm</td>
<td>SM-300 µm</td>
<td>SM-LMA</td>
<td>SM-LMA</td>
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<tr>
<td>Compatible Interface</td>
<td>LLK-Q</td>
<td>HLC-II/LC-8</td>
<td>LLK-D</td>
<td>LCA</td>
<td>Ø30 mm</td>
<td>Ø14 mm</td>
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</table>

*Without/With external cooler  ** Z-plane moved 25 mm

This table is for guidance only, for more specific information please ask for our manuals.
The Optoskand incoupling optics distributes the energy from a laser into one or several process fibers. The system can accept either a free space collimated beam from a laser or a feeding fiber from a fiber laser. It is possible to both time share or energy share a laser source between several work stations. Integrated control and safety electronics guarantee laser safety for the fiber beam delivery.

- Flexible fiber coupling
- <45 ms switch time
- Air- or water cooled units
- High-quality synthetic fused silica optics
- DGUV-certified safety electronics

Time or energy share the laser source
Sometimes one output channel from a laser is not enough. Optoskand offers several solutions for time sharing or energy sharing of the laser source. With different lens configurations available, both power and BPP losses can be minimized.

Protect the feeding fiber
Using the feeding fiber from your fiber laser directly to the application can be risky. If the feeding fiber is damaged, down-time can be long and therefore costly. Using any of the Optoskand fiber-to-fiber switches or couplers (FFS or FFC) the feeding fiber is protected by having a process fiber that could be exchanged in minutes.

Certified safety concept
Laser safety is fundamental for all Optoskand incoupling optics. The integrated electronics monitor fiber breakage, cabinet doors, mirror positions, etc. The DGUV-certified safety electronics makes it easier to integrate our components in industries demanding a high safety level.

Quality & Certifications
Quality is of greatest importance working with high-power laser components. At Optoskand all products are handled as individuals. Test result and manufacturing details are continuously analyzed and recorded for future reference. All products are assembled in the correct environmental conditions to guarantee the highest quality.

- Certified according to ISO 9001:2008
- DGUV-certified safety electronics (PL e)
- Implemented quality tools (e.g., FMEA)
- 1000 m² clean room, class 10 000
Fiber to Fiber Coupler (FFC)
The FFC connects a feeding fiber to one process fiber. It is possible to couple between different fiber interfaces or between different fiber core diameters. It is designed to handle up to 12 kW (CW). This is an eye-safe and stand-alone unit with DGUV-certified safety electronics (PL e).

Fiber to Fiber Switch Air-cooled (FFS ac)
The air-cooled FFS has the same mechanical coupling possibilities as the water-cooled version, but is designed for more moderate power levels. The unit is delivered with a safety cube instead of a beam dump. DGUV-certified safety electronics (PL e) make integration easy.

Fiber to Fiber Switch (FFS)
The FFS can connect one laser source to up to four process fiber cables. Time sharing or energy sharing, coupling between different fiber interfaces or between different fiber core diameters is possible. The FFS is designed for high-power fiber lasers. DGUV-certified safety electronics (PL e) make integration easy.

Fiber to Fiber Coupler Air-cooled (FFC ac)
The air-cooled FFC is designed to handle power levels up to 4.5 kW (CW). Just like the water-cooled coupler, the FFC ac includes built-in sensors for continuous monitoring of the fiber connector. DGUV-certified safety concept (PL e). Minimized outer dimensions.

Fiber Interlock Monitor (FIM)
The FIM is able to monitor the fiber interlock of QB/QD fibers. Both standard fibers (two connectors) and pigtail fibers (one connector) can be monitored. In addition it is possible to monitor temperature and scattered light (FFBD) via a CANopen connection. Fiber safety electronics in a box!

Fast Fiber Break Detection (FFBD)
When coupling a laser beam into a fiber optic cable, scattered light from the launch can be detected. With our integrated FFBD sensor this scattered light can be monitored and minimized when aligning a fiber optic cable in order to optimize the coupling efficiency into the fiber.

All Optoskand incoupling optics are equipped with a FFBD sensor. Besides fiber alignment, the sensor also helps to avoid catastrophic failures if a fiber optic cable breaks.

<table>
<thead>
<tr>
<th></th>
<th>FFS</th>
<th>FFS ac</th>
<th>FFC</th>
<th>FFC ac</th>
<th>FCU</th>
<th>FM</th>
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<tbody>
<tr>
<td>Max. Power (CW)</td>
<td>8 kW</td>
<td>4.5 kW</td>
<td>12 kW</td>
<td>4.5 kW</td>
<td>4.5 kW</td>
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<tr>
<td>Fiber Input</td>
<td>1</td>
<td>1</td>
<td>0*</td>
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<td>n/a</td>
<td>n/a</td>
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<tr>
<td>Fiber Output(s)</td>
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<td>n/a</td>
<td>n/a</td>
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<tr>
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<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Energy Sharing</td>
<td>Yes</td>
<td>No</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Water-Cooled</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>AR-Coatings</td>
<td>1030-1090 nm</td>
<td>1030-1090 nm</td>
<td>1030-1090 nm</td>
<td>780-1100 nm</td>
<td>510-550 nm</td>
<td>n/a</td>
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<tr>
<td>Control &amp; Safety Electronics (CSE)</td>
<td>Yes</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>Fiber Interfaces</td>
<td>QB**, QD, Q5</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

*Collimated beam in **QbH & RQB

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External Optics
– brings you into focus

With prealigned external optics from Optoskand you are guaranteed the highest level of performance. The system is based on a modular concept which gives you a high level of flexibility. Build a complete welding head or use only one of our collimating optics. The choice is yours.

- Prealigned for plug & play performance
- High-quality fused silica optics, d25/50 mm
- Minimum focal shift
- Compact housing
- Easy to mount modules

Modular system for maximum flexibility
By combining different Optoskand standard external optics modules, with different focal lengths and functions, you can create an optical process head adapted and optimized for each unique application.

Long term relations
At Optoskand we believe that close support and co-operation from the beginning of a partnership is critical for successful integration of fiber optic components in a laser system. Our technical specialists are always involved, often in direct contact with our customers, whenever technical support is needed. With local support from our distributors we always stay close to our customers.

- R&D involved in pre-sales for test and integration
- Customer driven product development
- Global distributor network
Process Adapters & Holders

Process adapters are mounted between the focusing optics and the workpiece. They support the process and protect the optics. For an easy exchange of cover slides, holders with drawer are available. For the prealigned external optics there are also module holders. These holders make it easy to define the position of the focal point and guarantee small tolerances if one module is exchanged.

Fiber Adapter

With every collimating unit an aperture is included that makes sure back-reflected light with excessive NA cannot be transmitted. All collimating units are water-cooled for stable performance.

Fiber Connector Mounts

The mechanical interface between the fiber optic cable and the external optics. The fiber connector mount is included in all Optoskand collimating units. There are two sizes available, both including a built-in thermoswitch put in series with the interlock circuit. Identical customer interface and fiber end plane position independent of fiber connector (QB/QD/Q5).

Asymmetric Collimating Unit

The asymmetric collimating unit with cylindrical lenses makes beam shaping possible. Square formed beam shapes are transformed into rectangular-formed beam shapes while circular beams are transformed into elliptical beams. Fiber and exit interfaces are the same as for the standard D50 collimators.

Intermediate Optics

Between the collimating and the focusing unit intermediate optics can be mounted. The beam bending cube turns the collimated beam path 90 degrees. The twin-spot optics divides the laser beam into two parts, resulting in two focused spots after the focusing unit.

Focusing Units

With a focusing unit the parallel beam from the collimating unit is focused down to the workpiece. The size of the focused spot and the depth of focus are given by the combination of collimating optics, focusing optics and beam quality. The Optoskand focusing units come either with a fixed or a z-adjustable focus position.

Prealigned optics

The effective focal length of a lens will vary due to manufacturing tolerances. To guarantee plug and play performance these tolerances need to be compensated for. Therefore the Optoskand external optic modules are prealigned during assembly. The alignment process is made with a reference fiber and calibrated measurement equipment. The lens is moved to the position to collimate or focus the beam then fixed.

Collimating Units | Intermediate Optics | Focusing Units | Process Adapters
--- | --- | --- | ---
Prealigned | Yes | n/a | n/a
Lens Diameters | d25: 10 kW d50: 6 kW | d25: 5 kW d50: 6 kW | n/a
Max. Power (CW) | 50-250 mm | n/a | n/a
Focal Lengths | 1.1-5/2.0/2.5/3.0 (F170) | n/a | n/a
Asymmetric Aspect Ratios | 50-250 mm | n/a | n/a
Water-Cooled | Yes | No | No
AR-Coatings | 1030-1090 nm (standard) | n/a | n/a
Fiber Interfaces | QB*, QD, Q5 | n/a | n/a

*QBH & RQB

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