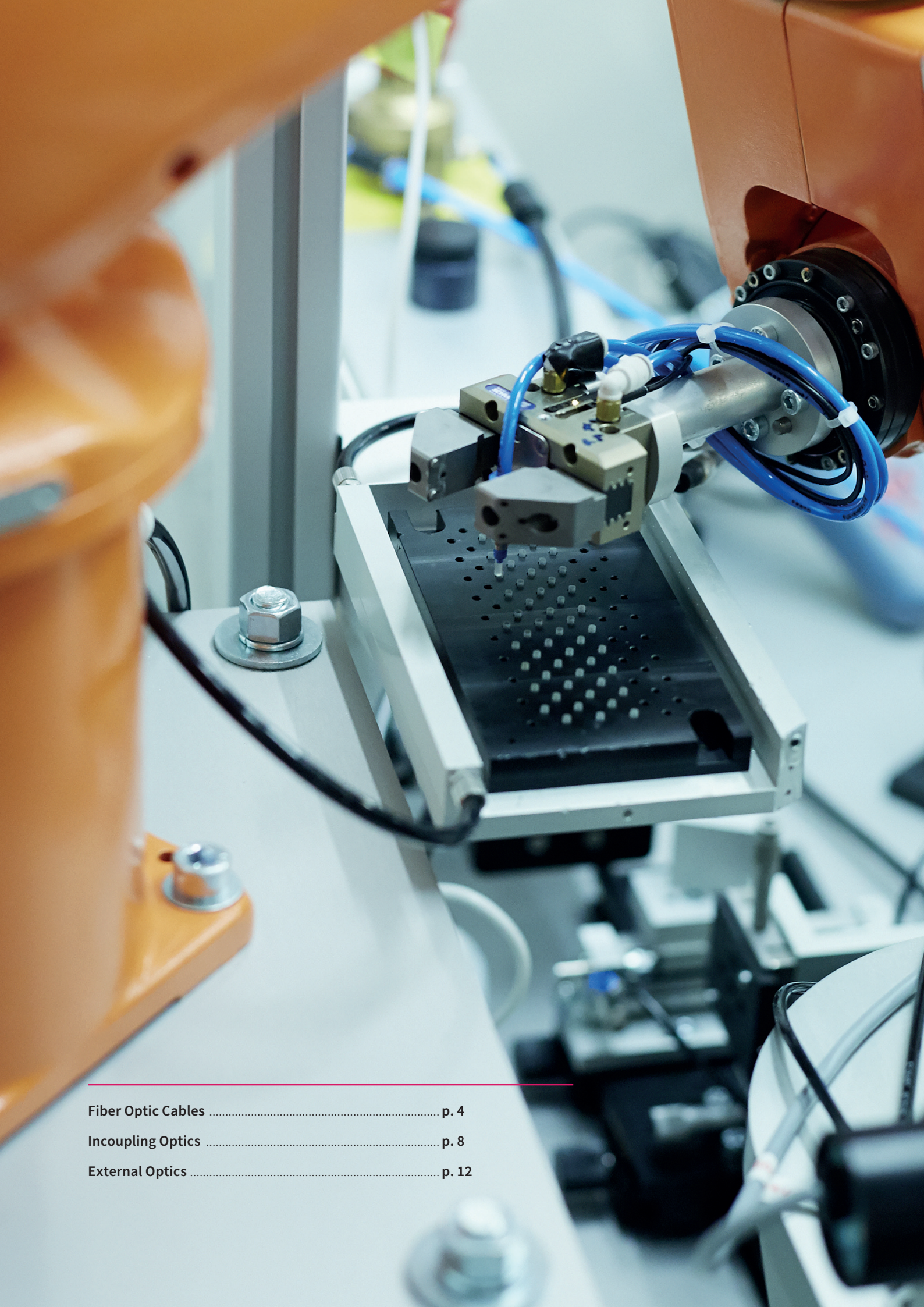


# Beam delivery components

– for high-power lasers







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# 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.

Many 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*



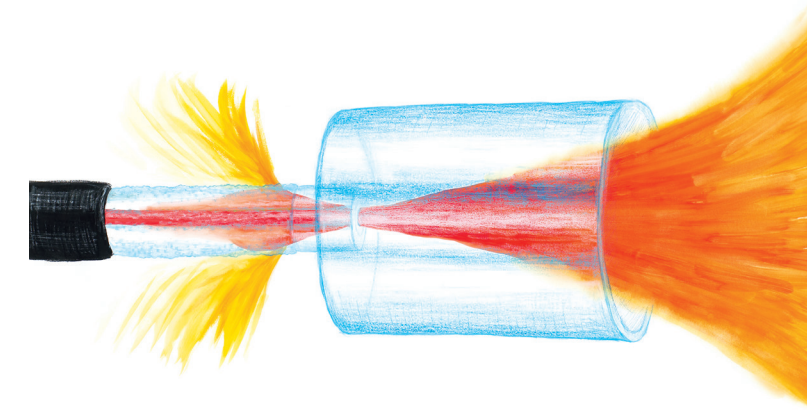


# Fiber Optic Cables

## – made to keep your power

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 and patented design featuring quartz block, mode stripper and internal direct water cooling, the fibers can withstand high power levels and offer extremely low transmission losses.

- Patented technology
- Extreme power loss capability
- Low transmission losses (1–2%)
- Plug and play within 10  $\mu\text{m}$
- High-reliability safety interlock



### 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.

### 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.

### 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 blocks come with a high-quality AR-coating and with the larger end surfaces, inspection and cleaning of the fiber is easy.

### 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.



### 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**  
The number one interface of high-power fiber lasers today. The QBH fiber is a well-proven standard in the industry, designed by Optoskand. 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) and with high power loss capability.



**RQB Fiber**  
The air-cooled version of the QBH fiber connector. Ideal at lower power levels and power losses than the QBH. The integrated thermoswitch protects it from being overheated. Perfect for pulsed lasers.



**QCR Fiber**  
Providing a collimated laser beam output. With a compact, air-cooled and robust connector design the QCR fiber 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 direct splice onto fiber laser.



**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.



**Q5 Fiber**  
Compatible with the Trumpf LLK-B interface. The Q5 fiber is based on the superior Optoskand technology, including quartz block and mode stripper. The integrated thermoswitches protect it from being overheated.



**QCS Fiber**  
A compact and air-cooled fiber connector including integrated collimating optics. Specially designed for diffraction limited medium-power fiber lasers. Built with standard or customized optical fiber. Pigtail for direct splice onto fiber laser.



**SMAQ Fiber**  
The new generation of high-power SMA fiber with extreme power loss capability. Specially designed for fiber coupling of high-power diode lasers. The SMAQ is by far the best high power SMA connector on the market today.

**Fiber Interlock Monitor (FIM)**  
A complete and ready-to-use solution for monitoring the interlock circuit of QB/QD/Q5 fibers. See more on page 10.

	QBH	RQB	QD	Q5	QCR	QCS	SMAQ
Mode stripper	Yes						
Quartz block	Yes						
Water-cooled	Yes	No	Yes	No	No	No	No
Integrated collimating lens	No	No	No	No	Yes	Yes	No
Integrated intelligence & sensors	No	No	Yes	No	No	No	No
AR-coatings	1030-1090nm 780-1100nm 510-550nm				1030-1090nm	1030-1090nm 1530-1570nm	780-1100nm
Fiber core	SM-1000µm, round/square				SM-300µm	SM, LMA	50-300µm
Power handling (CW)	10 kW	2.5 kW	20 kW	5 kW	750 W*	300 W	500 W
Transmission losses	< 3%, typical 1%						
Compatible interface	LLK-Q HLC-8/LC-8		LLK-D LCA LLK-Auto	LLK-B LLK-HP	Ø30 mm	Ø14 mm	SMA905**

\*To be confirmed    \*\* Z-plane moved 25 mm

This table is for guidance only, for more specific information please ask for our manuals.



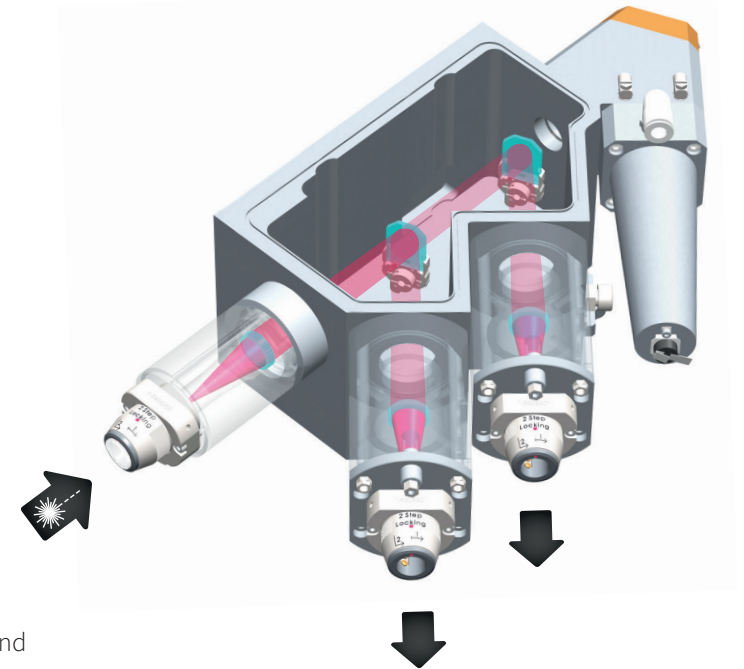
# Incoupling Optics

## – cares for your beam



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.

- Fiber-to-fiber or free space-to-fiber coupling
- <45 ms switch time
- Time or energy sharing
- 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 the Optoskand fiber-to-fiber switch or coupling units (FFS or FFC) the feeding fiber is protected by having a process fiber that could be exchanged in minutes.

### Certified safety concept

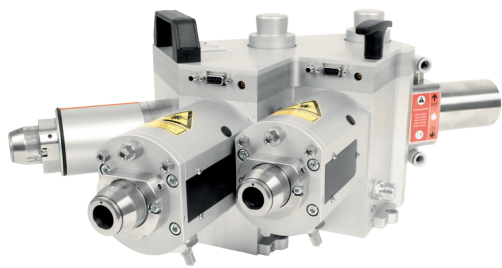
Laser safety is fundamental for all Optoskand incoupling optics. The integrated electronics monitor fiber breakage, cabinet doors, mirror positions, etc. The DGUV-certified safety electronics makes it easier to integrate our components in industries demanding a high safety level.



### 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 (ISO 13849-1:2006)
- Implemented quality tools (e.g. FMEA)
- 1000 m<sup>2</sup> clean room, class 10 000



Fiber to Fiber Switch (FFS)

The FFS can connect up to four process fiber cables to one laser source. 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.



Air-cooled Fiber to Fiber Switch (FFS ac)

The air-cooled FFS has the same fiber coupling possibilities as the standard FFS but is designed for more moderate power levels. The unit requires no water cooling and is delivered with a safety cube instead of beam dump. DGUV-certified safety electronics (PL e) make integration easy.



Fiber to Fiber Coupling Unit (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. This DGUV-certified, eye-safe and stand-alone unit makes integration easy.



Air-cooled Fiber to Fiber Coupling Unit (FFC ac)

The air-cooled FFC is used for lasers up to 4.5 kW (CW). It has a patent pending fiber alignment mechanism. Supporting the Optoskand fiber cables with built-in sensors for continuous monitoring of the fiber connector. DGUV-certified safety concept (PL e).



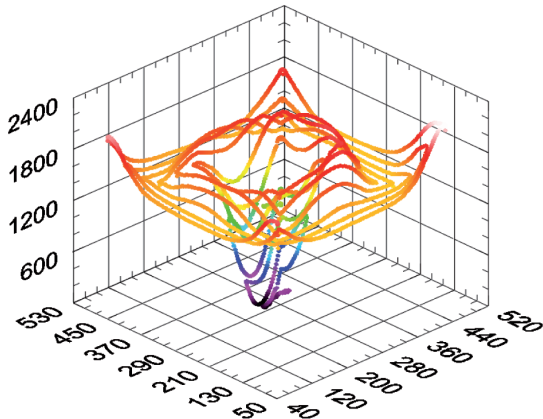
Fiber Coupling Unit (FCU)

The FCU is an interface between the laser source and the fiber optic cable. The free space beam from the laser is focused inside the FCU into the fiber core. It includes safety functions and sensors for improved supervising. The unit has the same alignment mechanism as the FFC ac and is easily integrated to the laser.



Fiber Interlock Monitor (FIM)

The FIM is able to monitor the fiber interlock of QB/QD/Q5 fibers. Standard fibers (two connectors) and even 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 patented 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 our FFBD sensor. Besides fiber alignment, the sensor also helps to avoid catastrophic failures if a fiber optic cable breaks.

	FFS	FFS ac	FFC	FFC ac	FCU	FIM
Time sharing	Yes	Yes	No	No	No	n/a
Energy sharing	Yes	No	No	No	No	n/a
Fiber outputs	1-4	1-4	1	1	1	n/a
AR-coatings	1030-1090nm	1030-1090nm	1030-1090nm	1030-1090nm	1030-1090nm 780-1100 nm 510-550 nm	n/a
Water-cooling	Yes	No	Yes	No	No	No
Control and Safety Electronics (CSE)	Yes					
Power handling (CW)	8 kW	4.5 kW	5 kW	4.5 kW	4.5 kW	n/a
Fiber interfaces	QB*, QD, Q5					

\*QBH & RQB

This table is for guidance only, for more specific information please ask for our manuals.

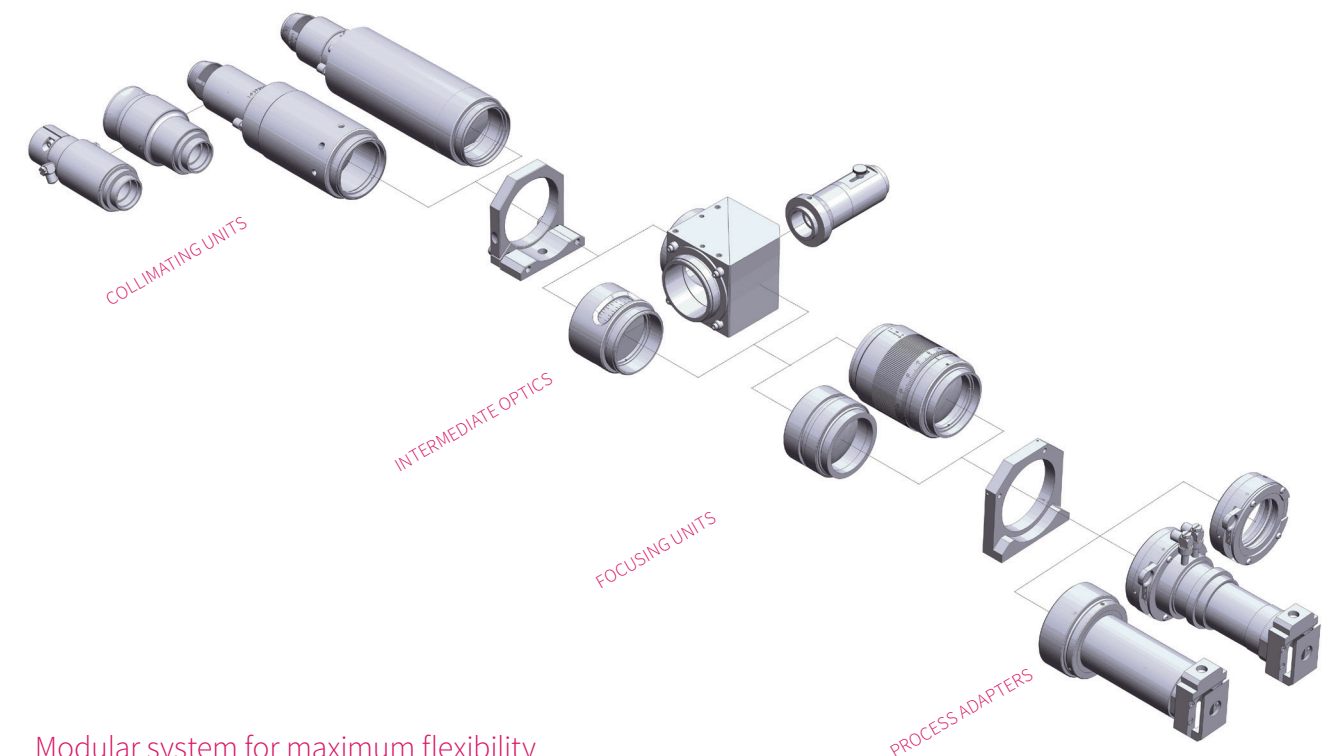


# External Optics

## – 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

A complete process head always has a collimating and a focusing unit, and normally also a process adapter. By combining our different standard modules, with different focal lengths and functions, you can create an optical process head adapted 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





Collimating Units

With a collimating unit the divergent beam out from the fiber cable is made parallel. The Optoskand collimating units are specially designed to be used with fiber optic cables. Every collimating unit has an aperture that makes sure back-reflected light with excessive NA cannot be transmitted. All collimating units are water-cooled for stable performance.



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.



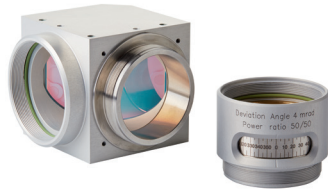
Focusing Units

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.



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).



Intermediate Optics

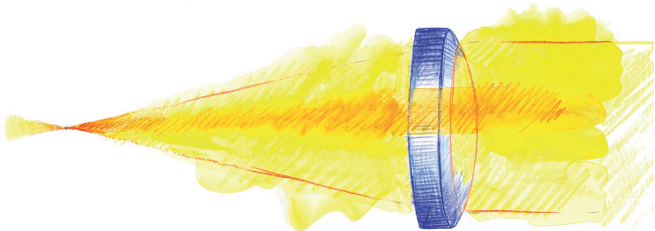
Between the collimating and the focusing unit intermediate optics can be mounted. The beam bending cube turns the collimated beam path 90 degrees. The twin-spot optics divides the laser beam into two parts, resulting in two focused spots after the focusing unit.



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 protective windows, 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.



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	Holders
Prealigned	Yes				
AR-coatings	1030-1090 nm 510-550 nm*	1030-1090 nm	1030-1090 nm 510-550 nm*	1030-1090 nm	n/a
Focal lengths	50-250 mm	n/a	60-500mm	n/a	n/a
Asymmetric aspect ratios	1:1.5, 1:2.0, 1:2.5, 1:3.0	n/a	n/a	n/a	n/a
Lens diameters	25/50 mm			n/a	n/a
Water-cooling	Yes	No	No	Yes/No	n/a
Power handling (CW)	6/10 kW**			n/a	n/a
Fiber interfaces	QB***, QD, Q5	n/a	n/a	n/a	n/a

\* Not all focal lengths are available.    \*\* Both 6 kW and 10 kW units are available.    \*\*\*QBH & RQB

This table is for guidance only, for more specific information please ask for our manuals.





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