SUPERSCAN IV

SUPERSCAN IV-10, SUPERSCAN IV-15, SUPERSCAN IV-20, SUPERSCAN IV-30

This manual has been created by RAYLASE for its customers and employees.

Information correct at: 2022/10

CONTENTS

1 ABOUT THIS MANUAL

1.1 Basic information

This manual provides general information about handling SUPERSCAN IV series deflection units. In subsequent chapters, the general designations "deflection unit" or "product" are used to refer to the SUPERSCAN IV. The product version is indicated by the type code on the rating plate (see page19, Signage).

This manual contains important information about professional and safe handling of the deflection unit. As a result, you should familiarise yourself with the content of this manual before starting to use the deflection unit. In case of any queries, please contact RAYLASE Customer Service for information (see page 6, Customer service).

The manual must be accessible to anyone involved in developing, installing, uninstalling or using a laser system with a RAYLASE deflection unit. If the deflection unit is sold on, this manual or an authorised copy must be passed on with it.

1.2 Display conventions

The signal word WARNING indicates hazards that can lead to injuries or damage unless precautionary measures are taken.

The signal word NOTE indicates general precautionary measures to be observed when handling the product to prevent damage to the product itself.

- Bullet points in a list are shown with a square at the beginning of the line.

Instructions are introduced with an objective and are shown with numbered actions. If necessary, an intermediate result and a final result are specified.

1. First instruction
2. Second instruction
   - ➢ An intermediate result is represented by an arrow symbol.
3. Further instruction
   - ✓ An end result is represented by a tick.

1.3 Other applicable documents

- Declaration of incorporation
- Production log
- Manuals for optional accessories

1.4 Manufacturer

RAYLASE GmbH
Argelsrieder Feld 2+4
82234 Wessling
Germany
T: +49 8153 9999 699 | F: +49 8153 9999 296
www.raylase.de | info@raylase.de
Referred to in this text as RAYLASE.

1.5 Customer service

The USB stick supplied contains the manual and answers numerous questions about RAYLASE products. If any questions are not answered, RAYLASE Customer Service will be pleased to assist:

Monday to Friday between 08:00 and 17:00
Germany (Wessling)
T: +49 8153 9999 699 | F: +49 8153 9999 296
support@raylase.de

China (Shenzhen)
T: +86 755 2824 8533 | F: +86 755 8222 8193
info@raylase.cn

1.6 Warranty

The customer's rights in the event of any material or legal defects in the product are set out in RAYLASE's general terms and conditions of business. These can be viewed at:
https://www.raylase.de/en/terms-and-conditions.html

RAYLASE GmbH has no obligation to repair any defects occurring under the following circumstances:

- If the product has been operated outside the specifications.
- If unauthorised repairs have been carried out on the product.
- If unauthorised modifications have been made to the product.
- If the product has been connected to non-compatible devices.
- If the product has been damaged by unacceptably high laser power or by focusing the laser on optical surfaces.
- If the product has been damaged by unqualified cleaning of the optics.
- If the warranty has elapsed.

Component Surfaces
Surfaces of aluminium products are either chemically anodised or powder coated to protect the aluminium parts from environmental damage.
Powder coating can cause small visible differences in surface colour or sheen. Anodized surfaces can show milling tracks, areas of slight shading, and localized colour changes.
These variations are due to the production process, and have absolutely no influence on the product's functionality. Such variations are excluded from the warranty.

There is no implicit guarantee or warranty regarding suitability for particular purposes. RAYLASE is not responsible for damage resulting from the application. Individual assemblies or other assemblies manufactured by RAYLASE may be subject to different warranty terms. Further information can be found in the corresponding manuals.

2 GENERAL SAFETY INFORMATION

2.1 Designated use

The deflection unit is intended to deflect laser radiation within an appropriate operating range for the purposes of material processing.

The deflection unit is designed as a sub-assembly for laser systems and is classed as an incomplete machine as defined in the Machine Directive. Each product version may only be operated with the wavelength specified in the type code (see page 19, Signage) and with the specified beam diameter (see page 21, Technical data).

Depending on the version, the SUPERSCAN IV is designed for lasers with wavelengths of 355 nm to 11,000 nm and an input aperture of 10, 15, 20 or 30 mm.

2.2 Classification of laser systems

The deflection unit can be installed on a range of different laser systems. Every laser system is assigned to a laser class, which must be specified at the output location of the laser radiation (e.g. using a laser warning sign).

The following laser classes are defined in DIN EN 60825-1 and described in DGUV Regulation 11:

Class	Description
1	The accessible laser radiation is not dangerous under reasonably foreseeable conditions.
1M	The accessible laser radiation is in the wavelength range 302.5 nm to 4,000 nm. The accessible laser radiation is not dangerous to the eyes, provided the beam cross-section is not reduced by optical instruments (e.g. magnifiers, lenses, telescopes).
2	The accessible laser radiation is in the visible spectral range (400 nm to 700 nm). Short exposure times (up to 0.25 s) are not dangerous to the eyes. Additional beam components outside the wavelength range 400 nm to 700 nm meet the conditions for Class 1.
2M	The accessible laser radiation is in the visible spectral range 400 nm to 700 nm. Short exposure times (up to 0.25 s) are not dangerous to the eyes, provided the beam cross-section is not reduced by optical instruments (e.g. magnifiers, lenses, telescopes). Additional beam components outside the wavelength range 400 nm to 700 nm meet the conditions for Class 1M.
3R	The accessible laser radiation is in the wavelength range 302.5 nm to 10^6 nm and is dangerous to the eyes. The power or energy is a maximum of five times the permitted Class 2 radiation limit in the wavelength range 400 nm to 700 nm and five times the Class 1 limit for other wavelengths.
3B	The accessible laser radiation is dangerous to the eyes and frequently also to the skin.
4	The accessible laser radiation is very dangerous to the eyes and dangerous to the skin. Diffusely scattered radiation can also be dangerous. The laser radiation can cause a risk of fire and explosion.

Note that the deflection unit changes the beam output location of the laser system. The new beam output must be indicated by a laser warning sign on the deflection unit, stating the corresponding classification.

The use of a deflection unit can change the laser system's laser class. This can necessitate additional protective measures.

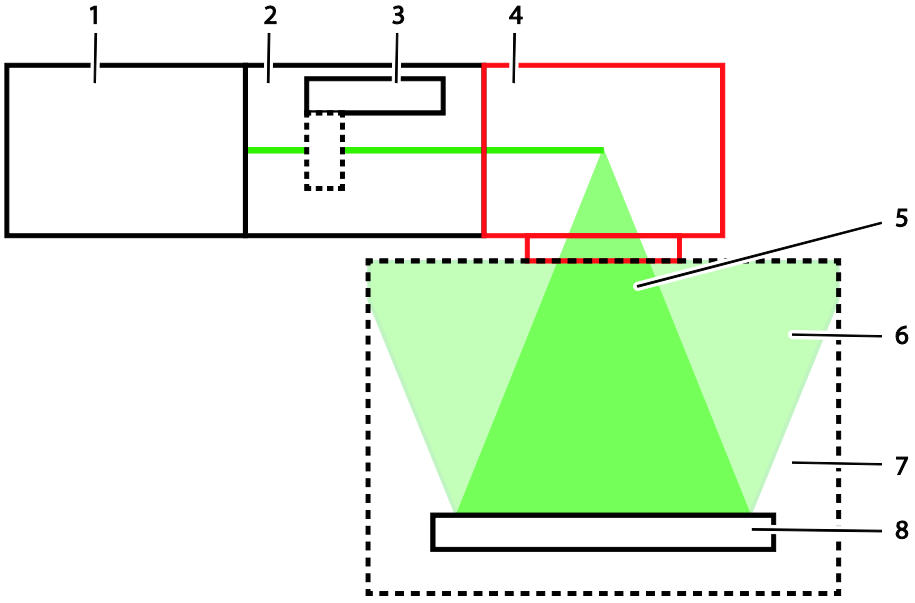
2.3 Laser area

For the purposes of accident prevention, the laser area refers to the area in which the maximum permitted radiation value can be exceeded. Laser systems must be assigned and marked according to their laser class and use.

With a corresponding beam intensity, the laser area is defined by the total radiation angle of the deflection unit and by the reflection of all objects that can be irradiated by it. It is important to note that, in addition to reflective surfaces, matt and dark surfaces can also reflect laser radiation and that a laser beam reflected several times can still be dangerous. In addition, the deflection unit can be destroyed by back reflection.

The laser area must have permanently and legibly attached markings in accordance with DIN EN 60825-1. Laser systems must be fitted with the protective mechanisms required for safe operation according to their class and use.

No combustible or explosive objects and liquids may be located in the laser area, as the energy of the laser beam can ignite them.



1	Laser	5	Deflected laser beam
2	Protective housing	6	Reflected laser beam
3	Beam stop or attenuator (shutter)	7	Laser area
4	Deflection unit	8	Processing area (example)

Fig. 1: Laser area

2.4 Hazards due to laser radiation

⚠ WARNING

This chapter describes hazards that can result due to interaction with the higher-level laser system. The operator of the higher-level laser system is responsible for safe operation and for securing the surrounding area to prevent hazards that can be caused by laser radiation. They must ensure compliance with all applicable conditions, regulations, laws, standards and directives.

2.4.1 General safety measures

The following general safety measures are to be observed:

- To ensure that the laser beam is immediately switched off in the event of a fault, the laser process must always be monitored. Alternatively, the entire beam path can be in a radiation-proof housing.
- The laser system must be designed in such a way that the laser beam can only be emitted at the beam output on the deflection unit.
- Appropriate protection mechanisms must be in place to prevent unauthorised activation or use of the laser system.
- The maximum permitted input beam diameter may not be exceeded.
- If the materials to be processed can result in toxic vapours, safe extraction of these must be ensured. Oxidising material processing and processing with material removal that is precipitated onto the optics must be handled properly.

2.4.2 Measures to prevent uncontrolled escape of laser radiation.

If the mirrors in the deflection unit are destroyed, the laser beam no longer exits the deflection unit at the intended beam output but remains inside the deflection unit. This leads to heating and, in some cases, destruction of the housing and can lead to uncontrolled escape of the laser beam.

To prevent destruction of the mirrors, the following points must be observed:

- At the laser beam input, it is essential that the laser beam strikes the centre of the mirrors. If the laser beam strikes a mirror towards the edge, the mirror can be overheated and destroyed.
- To prevent a loss of control, the plug connections to the deflection unit may only be disconnected when the laser system and the power supply are switched off.
- The deflection unit should always be operated with a lens or protective window.
- The maximum permitted laser power may not be exceeded.
- The deflection unit must be installed in such a way that the mirrors cannot come into contact with liquids. Liquids change the reflective properties of the mirrors, which can lead to them being destroyed by the laser beam.
- Before processing highly reflective materials, RAYLASE must be contacted as reflections can lead to the destruction of the deflection unit.
- In general, correct and careful handling of the optical components must be ensured, particularly during maintenance and cleaning work. Contaminated or scratched optics can absorb unacceptable amounts of laser power and thus be destroyed.

2.5 Required training and instruction of operating personnel

The deflection unit is designed exclusively for use in an industrial environment.

Start-up, operation, installation, maintenance and repairs may only be carried out by trained personnel who have been instructed by the laser protection officer and are sufficiently qualified to perform the relevant work.

2.6 Required protection measures

If present in the laser area, protective equipment such as laser protection goggles or special protective clothing is required. The required protective equipment is stipulated by the laser protection officer based on the individual hazards caused by the laser equipment. The laser area must be marked so that the required protective equipment is clearly indicated to all personnel who intend to enter the laser area.

2.7 Behaviour in case of destroyed zinc selenide (ZnSe) lenses

Only for deflection units with ZnSe F-Theta lens

⚠ WARNING

Zinc selenide properties hazardous to health

- Destruction of zinc selenide lenses can result in dust containing hydrogen selenide and selenium dioxide. This dust can be carcinogenic and is very toxic when inhaled.

To improve the optical properties of the material, zinc selenide is frequently given an anti-reflective coating that may contain thorium fluoride. Thorium is a radioactive element. The quantity of thorium contained in the coating and the relative size of the decomposed area of the lens surface mean that, even in the worst cases, the resulting radioactive exposure levels are normally well below the limits set out in the Radiological Protection Ordinance.

If lenses are damaged:

1. Switch off the laser system immediately.
2. Leave the room for at least 30 minutes.
3. Never remove the lens or the protective window from the deflection unit. Toxic dust or fragments may have been produced in the deflection unit.
4. If the deflection unit should be opened and fragments fall out, the fragments must only be collected up using appropriate protective clothing and breathing apparatus and disposed of as hazardous material in line with the applicable conditions, regulations and legislation.
5. Label the defective deflection unit with a clear warning notice and send the deflection unit to RAYLASE in air-tight protective packaging.
6. The personnel charged with uninstalling the deflection unit must wear appropriate protective clothing and breathing apparatus.
7. The room in which the zinc selenide lens was destroyed must be adequately cleaned, decontaminated and ventilated.
8. Wear gloves and mouth protection when carrying out the subsequent tasks.
9. Carefully collect all fragments and pack them in an air-tight sealable container.
10. Clean all contaminated system components and surfaces with a damp cloth and pack the cleaning cloths in an air-tight sealable container.
11. Send the containers to the supplier of the optics. They are responsible for proper disposal of the material.

3 PRODUCT DESCRIPTION

3.1 Items included, accessories and spare parts

The items included are typically:

- Deflection unit
- USB stick containing manual, declaration of incorporation and design data
- Production log

The product can be expanded with the following optional components:

- F-Theta lens
- Protective window
- Collimator Bracket Set
- Collimator
- Control card
- Adapter card / interface electronics between control card and deflection unit
- Software package

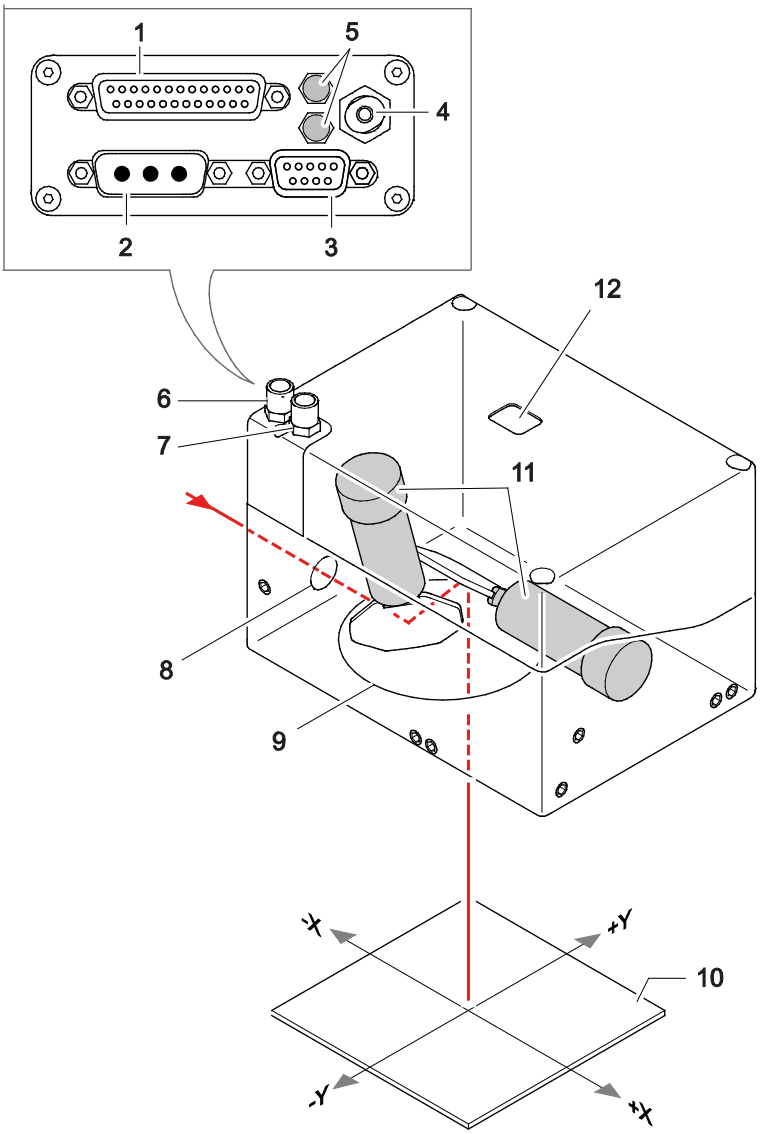
3.2 General description

3.2.1 Deflection unit

The deflection unit can be used to deflect a laser beam in the X and Y direction. This results in a two-dimensional area in which the laser can be directed to any position. This area is referred to as the processing area. Deflection is performed by two mirrors, each of which is moved by a galvanometer scanner.

The beam output can be fitted with an optional focusing lens (see page 14, F-Theta lens) or an optional protective window (see page 14, Protective window).

NOTE
▪ On the input side, the laser beam must be input precisely into the optical axis (see page 32, Installation). ▪ Only suitable lasers may be input (see page 19, Signage).



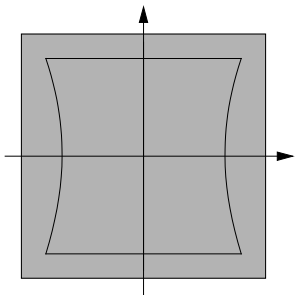
1	XY2-100 interface	7	Cooling water outlet (optional)
2	Power supply	8	Input aperture
3	SL2-100 interface	9	Beam output
4	Air inlet (optional)	10	Processing area
5	Air outlet (optional)	11	Galvanometer scanner with mirror
6	Cooling water inlet (optional)	12	Status LEDs

Fig. 2: Principle of operation

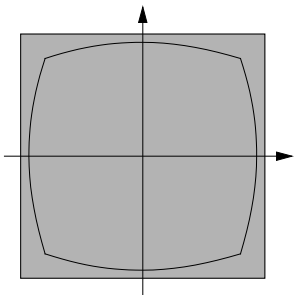
3.2.2 F-Theta lens

Optional

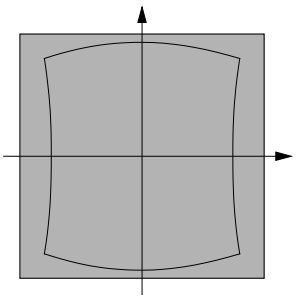
The optional F-Theta lens is specially designed for use with 2-axis deflection units. It focuses the laser beam at maximum quality on any position in the processing area. At the same time, it partially optically compensates for the barrel-shaped distortion that is unavoidably produced by 2-axis deflection units. The remaining distortion (see figure) must be compensated by the deflection unit.



Distortion caused by XY deflection



Distortion caused by F-Theta lens



Distortion caused by XY deflection with F-Theta lens

3.2.3 Protective window

Optional

For operation of the deflection unit without F-Theta lens it is strongly recommended to use a protective window for safety reasons and in order to protect the mirrors from contamination. If the protective window itself becomes contaminated, it must be cleaned (see page 39, Cleaning the protective window).

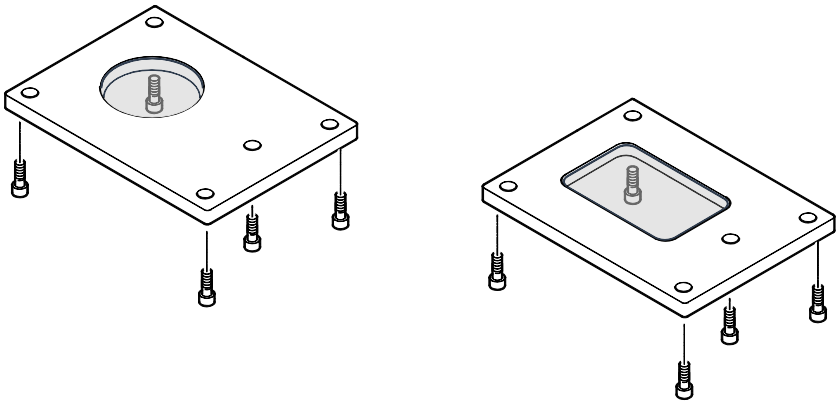


Fig.3: Protective window variations 1 and 2

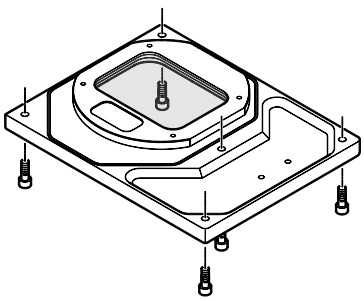


Fig. 4: Protective window variation 3

3.2.4 Collimator Bracket Set

Optional

The optional Collimator Bracket Sets are used to connect a collimator to the deflection unit (see page 34, Installation with Collimator Bracket Set). The Collimator Bracket Set contains the collimator bracket as well as the aligning pins and screws in order to connect it to the deflection unit as shown in the following figures.

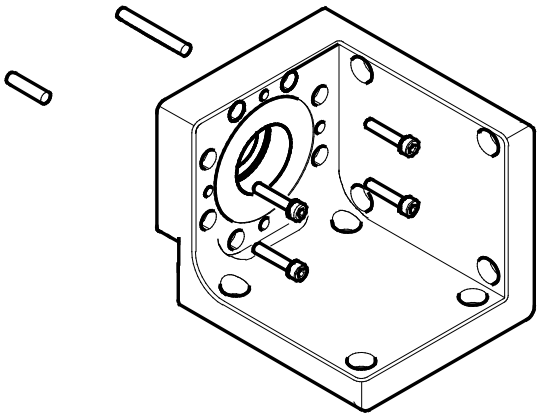


Fig. 5: Collimator Bracket Set 002 for connecting a D25 collimator to SUPERSCAN IV-15

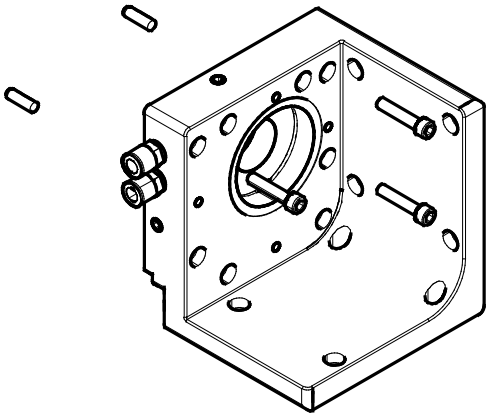


Fig. 6: Collimator Bracket Set 001 for connecting a D50 collimator to SUPERSCAN IV-30

3.2.5 Collimator

Optional

A collimator produces a beam with parallel rays or in other words a collimated beam. A fibre laser can be connected to a RAYLASE deflection unit using a collimator and the corresponding Collimator Bracket Set (see page 34, Installation with Collimator Bracket Set).

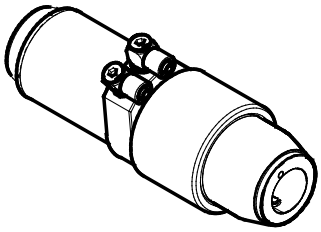


Fig. 7: D25 collimator

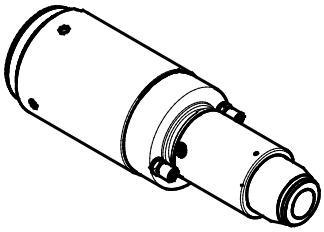


Fig. 8: D50 collimator

A choice of collimators with beam output diameters up to 25 mm (D25) or up to 50 mm (D50) can be purchased from RAYLASE.

3.2.6 Connections

The SUPERSCAN IV has the following connections:

- to a laser system (mechanical and optical)
- to a focusing unit (e.g. F-Theta lens) (optional – see page 14, F-Theta lens) or
- to a protective window (optional – see page 14, Protective window)
- to a water cooling (optional – see page 31, Requirements for cooling water)
- to an air flush for the mirrors (optional – see page 31, Requirements for cooling air)

The power is supplied to a D-SUB-3W3-M connector. Depending on the model the data signals are supplied to a D-SUB-25-F or D-SUB-9-F connector (see page 26 ff.).

NOTE
▪ Controlled deflection is only possible if the specified power supply is connected. In addition proper control using the specified control commands must be guaranteed at all times.

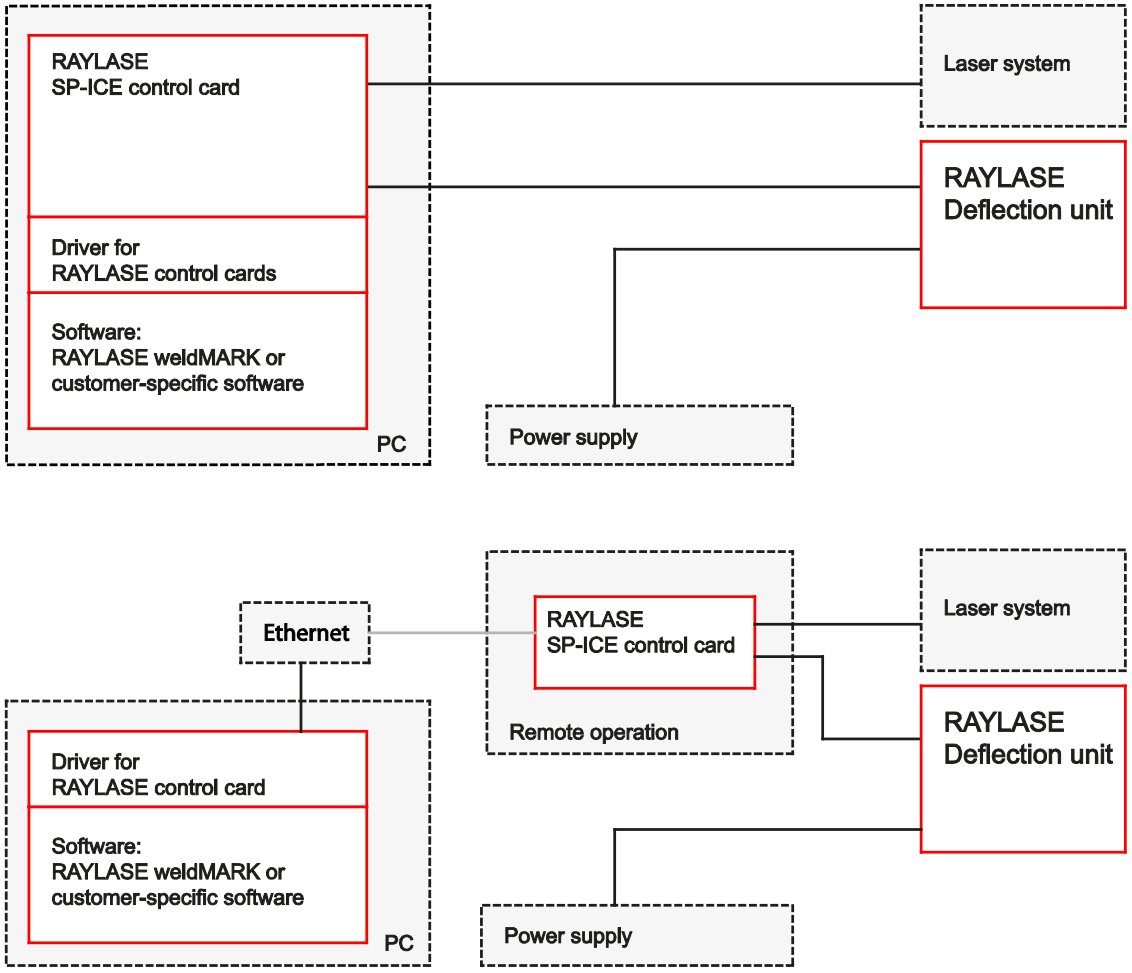
3.3 Product versions

Every deflection unit in the SUPERSCAN IV series is configured for the parameters defined when ordering and can only be used within these parameters. The parameters are specified in the type code on the rating plate. Further information on the specifications on the rating plate can be found on the Internet at:

https://www.raylase.de/en/product-naming.html

3.4 Examples of use

The following graphic shows two typical laser systems realised using RAYLASE modules (red outline) and customer-specific modules (dotted lines).



3.5 Status LEDs

The status LEDs allow you to check important functions and statuses of the deflection unit. They are located on top of the deflection unit.

The status LEDs are lettered. The first letter refers to the axis (XY) or the supply voltage (V) of the deflection unit. The subsequent letters and their meaning is described below.

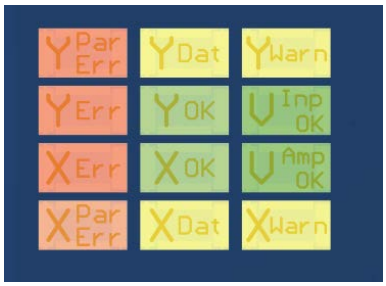


Fig. 9: LED XY

Name	Colour	Meaning	
... Par Err	red	Parity Error	Flashes for each parity error. The flash duration is extended so that even short-lived errors are visible.
			On continuously if the clock or sync signals of the interface are faulty.
... Err	red	Error	On continuously to indicate a general fault on the axis, and also during the boot sequence of the axis.The boot sequence lasts for a few seconds.
			As long as this LED is on, the output stage of the axis is disabled.
... Dat	yellow	Data Change	Flashes whenever data changes on the channel.The flash duration is extended so that even short-lived changes are visible.
... OK	green	Operational	On continuously when the axis is ready for use.
... Warn	yellow	Warning	Flashes whenever the axis is fully loaded. The flash duration is extended so that even short-lived peak loads are visible.
... Inp OK	green	Power input	On when the external supply voltage is applied and within the required range.
... Amp OK	green	Power amplifier	On when the output stage is ready.

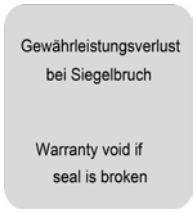
3.6 Signage

The signs listed below must be attached to the deflection unit. These signs must not be removed. Any signs that become illegible must be replaced.

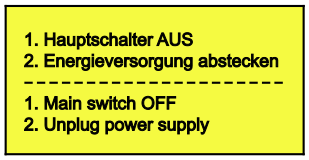
The rating plate and the type code printed on it allow key properties of the product to be determined (see page 17, Product versions). The rating plate contains at least the following information:

- Company name and address
- Product designation
- Wavelength for which the product is designed
- Product number
- Serial number
- Year of production (month)

The product and serial number are also used to identify the product.



The protective seal warns against unauthorised opening of the product. If the seal is broken, all warranty entitlements against RAYLASE are rendered void.



Describes the most important safety measures to be followed before maintenance work is carried out.

A laser warning sign must be attached at the beam output, providing information about the type of radiation, the specific hazards and the protection class. The laser warning sign must be attached in line with DIN EN 60825-1, see page 8, Classification of laser systems, by the manufacturer of the laser system.

The following additional signs may be attached to the deflection unit.

Identifies product variants with digitally controlled position signals of the moving optical elements.

RAYLASE is continuously working on optimizing the manufacturing process for our products in order to save energy and CO_2. Among other things, we do not use surface finishing processes of a cosmetic nature. This can lead to optical deviations in the surfaces, which, however, have no influence on the function of the product.

3.7 Technical data

3.7.1 General specifications

Typical deflection	±0.393 rad
Resolution XY2-100-E 16-Bit	12 µrad
Resolution SL2-100 20-Bit	0.76 µrad
Repeatability (RMS)	< 2.0 µrad
Max. Gain drift [1]	15 ppm/K
Max. Offset drift [1]	10 µrad/K
Long-term drift 8 h without water temperature control [1]	< 60 µrad
Long-term drift 8 h with water temperature control [1, 2]	< 40 µrad
IP-Code	64
Emission sound pressure level	< 70 dB(A)

Remark: All angles optical.
1) Drift per axis. After 30 min warm-up, at constant ambient temperature and process loads.
2) After 30 min warm-up, under varying process loads, with water temperature control set for ≥ 2 l/min and 22°C water temperature.

3.7.2 Power supply

Voltage	+30 or +48 V
Current	2 A, RMS, max. 5 A (< 10 ms)
Ripple/ Noise	Max. 200 mVpp, @ 20 MHz bandwidth

3.7.3 Control signals

Digital	XY2-100-Enhanced protocol
Digital	SL2-100 protocol

3.7.4 Ambient conditions

Ambient temperature at operation	+15 to +35 °C
Storage temperature	-10 to +60 °C
Humidity	≤ 80 % non-condensing

3.7.5 Aperture-specific parameters – SUPERSCAN IV-10

3.7.5.1 Mechanical specifications

Mirror substrate	**SI - Silicon**
Input aperture [mm]	10
Beam displacement [mm]	12.5
Weight without objective [kg]	approx. 3.2
Dimension (L x W x H) [mm]	170 × 125 × 117.5

3.7.5.2 Dynamic behaviour

Mirror substrate	**SI - Silicon**	
Tuning [1]	M	VC
Processing speed at 30 V [rad/s]	30	50
Processing speed at 48 V [rad/s]	30	80
Positioning speed at 30 V [rad/s] [2]	30	50
Positioning speed at 48 V [rad/s] [2]	30	80
Tracking error [ms]	0.10 [3]	0.12 [4]
Step response time at 1 % of full scale [ms] [5]	0.41	0.33
Position noise (RMS) [µrad]	< 4.5	

1) M - Optimized tuning for high precision beam deflection with sharp corners and minimized tracking error.
VC - Optimized tuning for a wide range of applications with emphasis on processing speed.
2) Calculation of the speed in the working field: Focal length F-Theta lens × speed.
Example: Deflection unit with F-Theta lens f = 254 mm, speed 30 rad/s
=> 254/1000 × 30 = 7.6 m/s.
3) Calculation of acceleration time approx. 1.8 × tracking error.
4) Calculation of acceleration time approx. 1.9 × tracking error.
5) Controlled to 1/5,000 of full scale.

3.7.6 Aperture-specific parameters – SUPERSCAN IV-15

3.7.6.1 Mechanical specifications

Mirror substrate	QU - Fused silica	SI - Silicon	SC - Silicon carbide
Input aperture [mm]	15		
Beam displacement [mm]	18.1	18.1	18.0
Weight without objective [kg]	approx. 3.2		
Dimension (L x W x H) [mm]	170 × 125 × 117.5		

3.7.6.2 Dynamic behaviour

Mirror substrate	QU - Fused silica		SI - Silicon	SC - Silicon carbide			
Tuning [1]	VC	W/ C	VC	VC	PL	W	H
Processing speed at 30 V [rad/s]	45	-	50	55	-	-	30
Processing speed at 48 V [rad/s]	50	200	65	75	110	200	30
Positioning speed at 30 V [rad/s] [2]	45	-	50	55	-	-	30
Positioning speed at 48 V [rad/s] [2]	50	200	65	75	110	200	30
Tracking error [ms]	0.19 [4]	0.30 [5]	0.16 [4]	0.14 [4]	0.30 [7]	0.20 [6]	0.12 [4]
Step response time at 1 % of full scale [ms] [3]	0.49	0.65	0.43	0.37	0.80	0.50	0.47
Position noise (RMS) [µrad]	< 4.5						

1) VC - Optimized tuning for a wide range of applications with emphasis on processing speed.
W - Optimized tuning for long vectors at highest speeds and precise beam deflection.
C - Optimized tuning for long vectors at highest speeds.
PL - Optimized tuning for long vectors with high marking speed and very precise beam deflection.
H - Optimized tuning for high precision beam deflection and fastest beam direction change during hatching.
2) Calculation of the speed in the working field: Focal length F-Theta lens × speed.
Example: Deflection unit with F-Theta lens f = 254 mm, speed 30 rad/s
=> 254/1000 × 30 = 7.6 m/s.
3) Controlled to 1/5,000 of full scale.
4) Calculation of acceleration time approx. 1.9 × tracking error.
5) Calculation of acceleration time approx. 2.3 × tracking error.
6) Calculation of acceleration time approx. 2.4 × tracking error.
7) Calculation of acceleration time approx. 2.6 × tracking error.

3.7.7 Aperture-specific parameters – SUPERSCAN IV-20

3.7.7.1 Mechanical specifications

Mirror substrate	QU - Fused silica	SI - Silicon	SC - Silicon carbide
Input aperture [mm]	20		
Beam displacement [mm]	26.0		
Weight without objective [kg]	approx. 5.5		
Dimension (L x W x H) [mm]	203 × 159 × 150/ 160.5 [1]		

1) AXIALSCAN variation, additional output plate for protective window.

3.7.7.2 Dynamic behaviour

Mirror substrate	QU - Fused silica	SI - Silicon	SC - Silicon carbide	
Tuning [1]	VC		VC	W
Processing speed at 30 V [rad/s]	45	45	50	-
Processing speed at 48 V [rad/s]	50	60	75	200
Positioning speed at 30 V [rad/s] [2]	45	45	50	-
Positioning speed at 48 V [rad/s] [2]	50	60	75	200
Tracking error [ms] [3]	0.28 [3]	0.25 [4]	0.20 [3]	0.40 [5]
Step response time at 1 % of full scale [ms] [6]	0.70	0.62	0.50	1.20
Position noise (RMS) [µrad]	< 4.5			

1) VC - Optimized tuning for a wide range of applications with emphasis on processing speed.
2) Calculation of the speed in the working field: Focal length F-Theta lens × speed.
Example: Deflection unit with F-Theta lens f = 254 mm, speed 30 rad/s
=> 254/1000 × 30 = 7.6 m/s.
3) Calculation of acceleration time approx. 1.9 × tracking error.
4) Calculation of acceleration time approx. 2.0 × tracking error.
5) Calculation of acceleration time approx. 3.0 × tracking error.
6) Controlled to 1/5,000 of full scale.

3.7.8 Aperture-specific parameters – SUPERSCAN IV-30

3.7.8.1 Mechanical specifications

Mirror substrate	QU - Fused silica	SI - Silicon	SC - Silicon carbide
Input aperture [mm]	30		
Beam displacement [mm]	35.4	36.0	36.0
Weight without objective [kg]	approx. 5.5/ approx. 12 (Type stainless steel "S")		
Dimension (L x W x H) [mm]	203 × 159 × 150/ 160.5 [1]		

1) AXIALSCAN variation, additional output plate for protective window.

3.7.8.2 Dynamic behaviour

Mirror substrate	QU - Fused silica	SI - Silicon	SC - Silicon carbide	
Tuning [1]	VC		VC	FV
Processing speed at 30 V [rad/s]	30	35	40	30
Processing speed at 48 V [rad/s]	50	55	65	50
Positioning speed at 30 V [rad/s] [2]	30	35	40	30
Positioning speed at 48 V [rad/s] [2]	50	55	65	50
Tracking error [ms]	0.48 [3]	0.43 [3]	0.30 [4]	0.24 [3]
Step response time at 1 % of full scale [ms] [5]	1.2	1.0	0.8	0.65
Position noise (RMS) [µrad]	< 3.2			

1) VC - Optimized tuning for a wide range of applications with emphasis on processing speed.
FV - Optimized tuning for the best combination of high dynamic performance and high speed.
2) Calculation of the speed in the working field: Focal length F-Theta lens × speed.
Example: Deflection unit with F-Theta lens f = 254 mm, speed 30 rad/s
=> 254/1000 × 30 = 7.6 m/s.
3) Calculation of acceleration time approx. 1.8 × tracking error.
4) Calculation of acceleration time approx. 2.0 × tracking error.
5) Controlled to 1/5,000 of full scale.

3.7.9 Interfaces

The deflection unit has a connection for SL2-100 data signals, for power supply and optionally for XY2-100 data signals. The details are described in the subsequent chapters.

3.7.9.1 XY2-100 Interface

Optional

This interface can be used to connect the deflection unit to a RAYLASE control card. The detailed information for the interface is set out below.

This interface is compatible to the XY2-100 enhanced protocol of RAYLASE.

The SUPERSCAN IV's digital controller makes it possible to return data-signals to the control card. Data are transferred every 10 µs to the controller card via the interface. There is one return channel for each axis. This allows, for instance, monitoring the current axis positions during processing, or detailed failure analysis following a malfunction.
Each axis also has a forward channel that can transfer a data packet to the scan head every 10 µs: normally, these will be target positions for the axis.
Whenever it becomes necessary to transfer a command to the scan head during processing, e.g. to change the type of information supplied on the return channel, the usual transmission of target positions is suppressed for one 10 µs period. To avoid undesirable processing artefacts due to the missing target position, a minimum interpolation period of 22 µs should be configured on the scan head. The currently configured interpolation period can be retrieved via the command *SetMode Interpolation Configuration 0x0590*, and set with the command *SetInterpolation 0x90*.
If the scan head's interpolation period is re-configured, it will also be necessary to adjust the laser-delay settings to suit. The interpolation period has no effect on the dynamic behaviour of the scan head.

All commands and the extensive capabilities of the functionally enhanced XY2-100 interface are described in detail in the manual *SS-IV and SS-V Enhanced*, which can be found on the supplied USB stick.

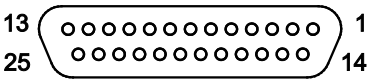


Fig. 10: D-SUB-25-F

PIN assignment

PIN	Signal		PIN	Signal	
1	I	-SENDCLOCK	**14**	I	+SENDCLOCK
2	I	-SYNC	**15**	I	+SYNC
3	I	-X CHANNEL	**16**	I	+X CHANNEL
4	I	-Y CHANNEL	**17**	I	+Y CHANNEL
5	I	-Z CHANNEL (nu)	**18**	I	+Z CHANNEL (nu)
6	O	-Y STATUS	**19**	O	+Y STATUS
7	O	-Z STATUS (nu)	**20**	O	+Z STATUS (nu)
8	O	-X STATUS	**21**	O	+X STATUS
9		nc	**22**		nc
10		nc	**23**		Signal GND
11		Signal GND	**24**		Signal GND
12		nc	**25**		nc
13		nc			

I = diff. input, nc = not connected, nu = not used, O = diff. output

Specifications

Input signals diff.		Output signals diff.		
Voltage	0 to 5 V	**Level low**	max. 0.6 V	at 40 mA
Threshold	±200 mV	**Level high**	min. 2 V	at 40 mA
Hysteresis	typ. 150 mV	**ESD protection**	±10 kV	
Impedance	120 Ω			
ESD protection	±15 kV			

3.7.9.2 SL2-100 Interface

This interface can be used to connect the deflection unit to a RAYLASE control card. The detailed information for the interface is set out below.

This interface is compatible to the SL2-100 protocol.

The SUPERSCAN IV's digital controller makes it possible to return data-signals to the control card. Data are transferred every 10 µs to the controller card via the interface. There is one return channel for each axis. This allows, for instance, monitoring the current axis positions during processing, or detailed failure analysis following a malfunction.
Each axis also has a forward channel that can transfer a data packet to the scan head every 10 µs: normally, these will be target positions for the axis.
Whenever it becomes necessary to transfer a command to the scan head during processing, e.g. to change the type of information supplied on the return channel, the usual transmission of target positions is suppressed for one 10 µs period. To avoid undesirable processing artefacts due to the missing target position, a minimum interpolation period of 22 µs should be configured on the scan head. The currently configured interpolation period can be retrieved via the command *SetMode Interpolation Configuration 0x0590*, and set with the command *SetInterpolation 0x90*.
If the scan head's interpolation period is re-configured, it will also be necessary to adjust the laser-delay settings to suit. The interpolation period has no effect on the dynamic behaviour of the scan head.

All commands and the extensive capabilities of the SL2-100 interface are described in detail in the manual *SS-IV and SS-V Enhanced*, which can be found on the supplied USB stick.

The signal pairs on PIN1/PIN6 and PIN5/PIN9 are each galvanically isolated by an internal transformer. PIN2, PIN7 and PIN8 are intended only for supplying power to an optional external optical fiber transmission unit. Noise immunity will be degraded if they are used for any other purpose, and they should also not be connected to the identically named PINs on the controller card.

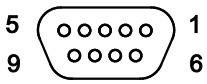


Fig. 11: D-SUB-9-F

PIN assignment

PIN	Signal			PIN	Signal	
1	I	RS422_IN_iso+		**6**	I	RS422_IN_iso-
2		VCC3V3	max. 200 mA	**7**		GND
3		nc		**8**		GND
4		nc		**9**	O	RS422_OUT_iso-
5	O	RS422_OUT_iso+				

I = diff. input, nc = not connected, nu = not used, O = diff. output

Specifications

RS422_IN...		RS422_OUT...		
Differential Input Voltage	max. ±5 V	**Differential Output Voltage**	typ. 2.5 Vpp	at 120 Ω load
Differential Input Termination (AC)	typ. 120 Ω	**Source Impedance**	typ. 120 Ω	
Differential Input Impedance (DC)	<1 Ω			
Hysteresis	typ. 30 mV			

Data Cable

High quality screened twisted-pair cable of type 2-LifYCY 2x2x0.25 mm² must be used for the connection. The wiring is shown below as viewed from the back of the D-SUB-9-M plugs:

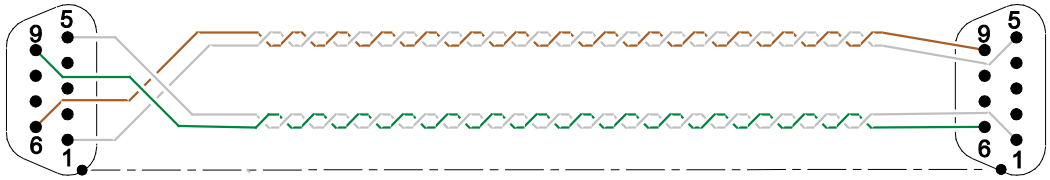


Fig. 12: Wiring SL2-100 Interface

3.7.9.3 Power supply

The pin assignment of the power supply connector of the deflection unit is set out below. The housing of the connector is connected to the housing of the deflection unit but not connected to GND.

Fig. 13: D-SUB-3W3-M

PIN assignment

PIN	Designation
1	Power GND
2	nc
3	VPOWER

nc = not connected

The details for the power supply are set out on page 21, Technical data.

3.7.10 Cabling information

To connect the deflection unit to a RAYLASE control card, it is recommended to use original RAYLASE connection cables. If other connection cables are used, the following description must be strictly adhered to in order to ensure proper functioning of the system.

3.7.10.1 SL2-100 Interface

The following figure describes the cabling of the SL2-100 interface.

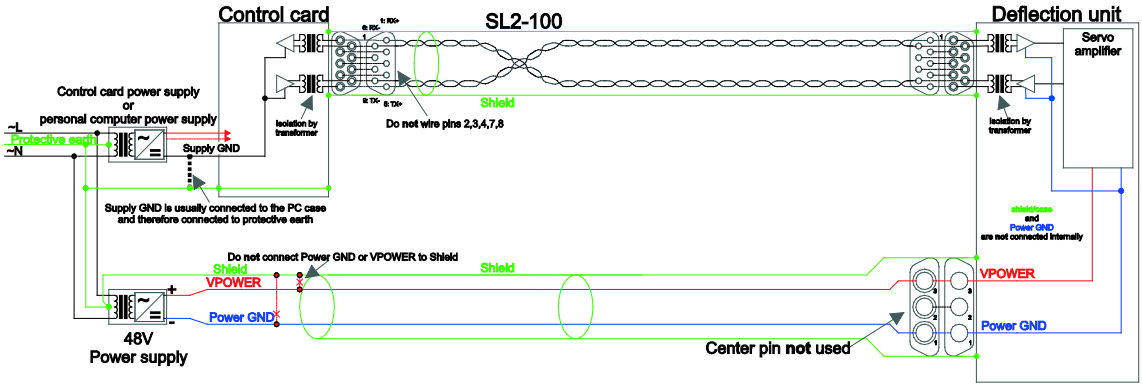


Fig. 14: Cabling of the SL2-100 interface

3.7.10.2 XY2-100 Interface

The following figure describes the cabling of the XY2-100 interface.

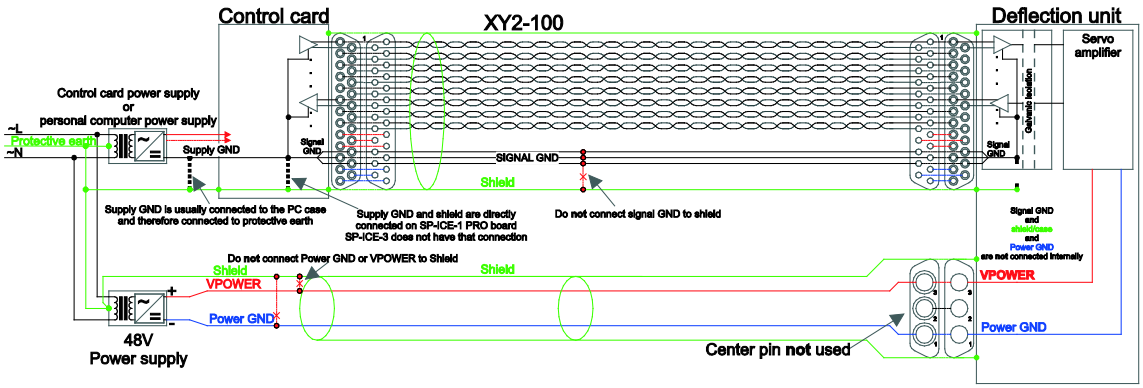


Fig. 15: Cabling of the XY2-100 interface

3.7.11 Requirements for cooling air

Only for deflection units with option "Air Flush"

To avoid contamination of the optical elements and the resulting destruction by the laser beam, the cooling air must meet the requirements of ISO 8573-1:2010 [1:0(0.05):0(0.005)]:

Pore filter	Pore filter ≤ 5 µm
Required air pressure on the deflection unit	1-1.5 bar
Air flow	approx. 20 l/min
Max. water shares	≤ 0.05 g/m³
Max. oil shares	≤ 0.005 mg/m³
Tube outer diameter	4 mm

3.7.12 Requirements for cooling water

Only for water cooled deflection units

To avoid destruction of the aluminium housing by pitting, the cooling water must meet the requirements listed in the following table.

NOTE

Pitting in aluminium cooling channels

- Avoid copper in the cooling circuit. Copper causes pitting in the aluminium cooling channels unless suitable additives are used. Damage caused by pitting is excluded from the warranty.
- The mechanical type „S“ is made of stainless steel. Hence there is no pitting even with copper parts in the cooling circuit.

Cooling water alternatives	Clean drinking water
	Deionized water mixed with 50 % clean drinking water
	Deionized water with additives
	Pre-mixed cooling fluids (no additives necessary) e.g.: CCL105 (Ecolab) Coolflux 42 (Kruckenberg Drucklufttechnik)
Recommended additives [1]	Industrial application: TRAC105A_B (Ecolab)
	Food industry: Dowcal N (Dow Chemicals)
Recommended cooling temperature	22°C to 28°C Avoid condensation
Temperature stability	1 °C
Water pressure at the deflection unit	< 3 bar
Water flow and pressure drop	min. 2 l/min, achievable by 0.4 bar pressure drop per connected unit
Water hardness	< 10 ppm
Recommended pH value	7 to 8.6
Bacterial content	< 1,000 cfu/ml
Tube outer diameter	8 mm

1) Follow the dosage and application instructions of the manufacturer.

3.8 Lifespan

The lifespan of the product is 10 years.

4 INSTALLATION

Installation may only be carried out by trained personnel. These trained personnel must be familiar with the general safety regulations that are applicable for installation and operation of opto-mechatronic systems, machines, and plant.

4.1 Safety during installation

⚠ WARNING

Hazard due to electrical energy

The deflection unit is designed for operation with a safe extra-low voltage supply (< 60 V DC). The operator is responsible for safety of the power supply (voltage limitation, shutdown on overcurrent, line protection).

- Make sure that the power supply does not exceed the specified low voltage.
- During all work on the electrical power supply and the electrical systems, observe the relevant electrical safety regulations.

⚠ WARNING

Risk of injury due to laser radiation

The laser beam (including a reflected beam) can cause severe injuries to the eyes and skin.

- The laser system may only be installed and started up by trained personnel.
- Before carrying out any work, make sure that the laser equipment is switched off and secured against being switched on again.
- After all work, make sure that all housing covers are in place.

⚠ WARNING

Risk of injury due to falling product

A falling product unit can cause injuries.

- The product should be installed by two people wearing suitable safety shoes.
- In case the product fell down it must not be used any more. It has to be sent back to RAYLASE for service.

4.2 Installation location

The deflection unit may only be operated in closed rooms. It must be protected against contact with liquids.

The deflection unit is not suitable for use in potentially explosive environment.

If the materials to be processed can result in toxic vapours, safe extraction of these must be ensured.

Other operating and ambient conditions must be observed (see page 21, Ambient conditions).

4.3 Preparing for installation

1. Make sure that the laser system is prepared in such a way that the laser beam is emitted centrally and at a right angle from the installation surface for the deflection unit.
2. Prepare two aligning pins and four screws. The specifications for these can be found on the USB stick supplied as part of the design data.
3. Carefully remove the deflection unit and any other accessories, for example the lens, from the packaging.
4. Make sure that the specifications of the deflection unit and the lens correspond to the application requirements (see page 21, Technical data and page 19, Signage).
   In case of any variations, contact RAYLASE.

4.4 Installing the lens

Optional

1. Carefully remove the protective cover on the deflection unit beam output and the protective cover on the lens.
2. Check the deflection unit and the lens for impurities and damage.
   - ➢ Impurities must be removed before start-up (see page 38, Cleaning).
   - ➢ Damaged components may not be used.
3. If a lens ring is included in the configuration, screw the lens ring into the deflection unit beam output.
4. Carefully screw the lens into the deflection unit beam output.

4.5 Installing the protective window

Optional

1. Carefully remove the protective cover on the deflection unit beam output.
2. Carefully remove the protective window from the packaging. Only hold the protective window with powder-free latex gloves and only by the edge, as fingerprints contain aggressive substances that can damage the optical surfaces.
3. Check the deflection unit and the protective window for impurities and damage.
   - ➢ Impurities must be removed before start-up (see page 38, Cleaning).
   - ➢ Damaged components may not be used.
4. Install the protective window according to the figure in chapter Replacing the protective window, page 40.

4.6 Installing the deflection unit

The installation of a SUPERSCAN IV with a RAYLASE Collimator Bracket Set for a fibre laser is done according to chapter 4.6.2. A direct installation for example in combination with a solid-state laser is done according to chapter 4.6.1.

4.6.1 Standard installation

1. Fit the prepared aligning pins into the corresponding holes in the installation surface.
2. Carefully remove the protective cover on the deflection unit beam input.
3. Position the deflection unit on the installation surface using the pins.
4. Secure the deflection unit with the prepared screws.
   ➢ The deflection unit is aligned with the laser system beam output using the pin holes.

If the deflection unit has a water cooling option, connect the cooling water to the deflection unit. Pay attention to page 31, Requirements for cooling water.

Complete the installation according to chapter 4.7.

4.6.2 Installation with Collimator Bracket Set

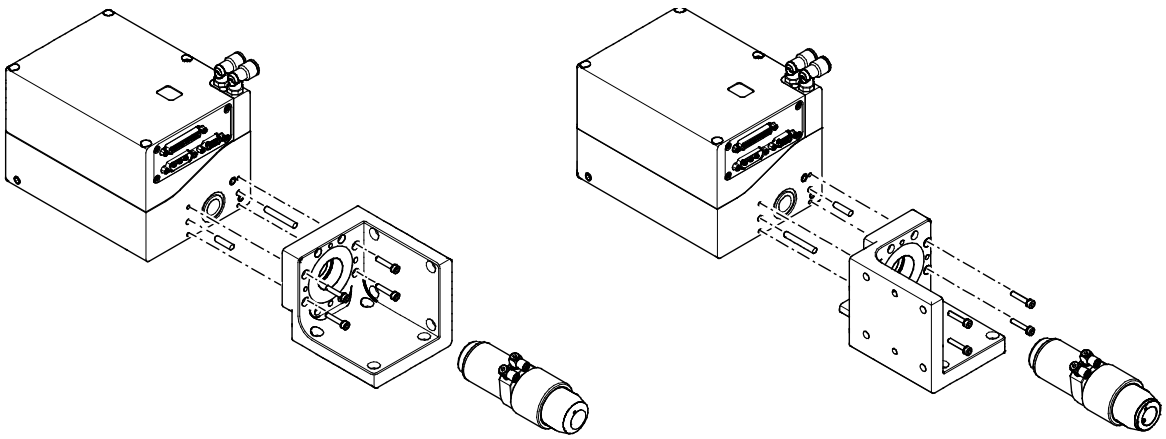


Fig. 16: Installation options SUPERSCAN IV-15 with Collimator Bracket Set 002 and D25 collimator

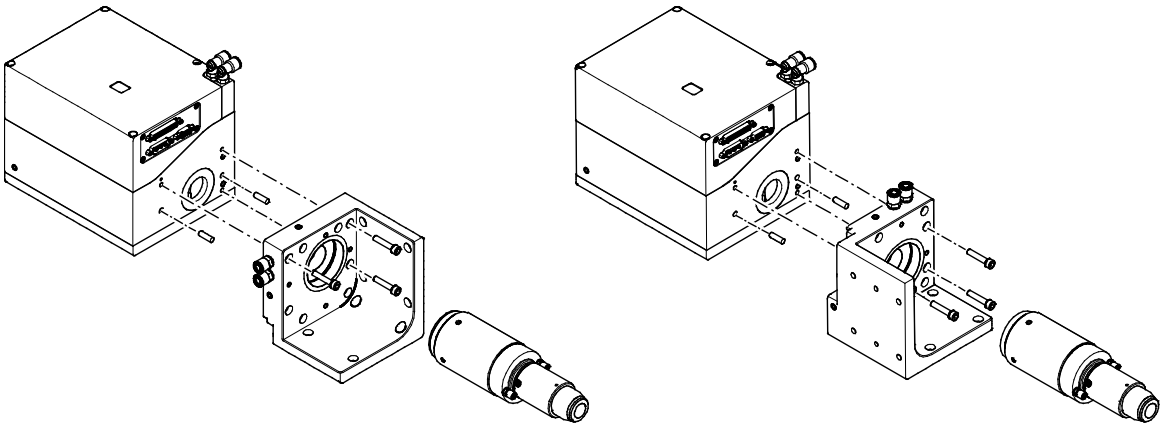


Fig. 17: Installation options SUPERSCAN IV-30 with Collimator Bracket Set 001 and D50 collimator

1. Fit the prepared aligning pins into the corresponding holes in the installation surface used for mounting the collimator bracket.
2. Position the collimator bracket on the installation surface using the pins.
3. Secure the collimator bracket with the four prepared screws.
4. Fit the aligning pins which are included in the Collimator Bracket Set into the collimator bracket according to the figures above.
5. Carefully remove the protective cover on the deflection unit beam input.

6. Position the deflection unit on the installation surface of the collimator bracket using the pins.
7. Secure the deflection unit with the screws included in the Collimator Bracket Set.
8. Screw the collimator into the collimator bracket.
9. Connect the fibre of the laser to the collimator according to the collimator manual.
   ✓ The deflection unit is aligned to the fibre of the laser.

If the deflection unit has a water cooling option, connect the cooling water to the deflection unit. In case of water-cooled collimator brackets for example using Collimator Bracket Set 001 it is recommended to implement the following cooling circuit: chiller flow line - deflection unit inlet - deflection unit outlet - collimator bracket - chiller return flow. There is no preferred water flow direction for the collimator bracket. Pay attention to page 31, Requirements for cooling water.

4.7 Completing installation

1. Make sure that the control signals and the power supply correspond to the relevant specifications.
2. Check whether the connections for the control signals and the power supply are correctly wired (see page 26, Interfaces).
3. Connect the plug connections when not connected to the voltage.
4. Make sure that the working area is clear and there are no reflective materials in it.

5 START-UP

Start-up and operation may only be carried out by trained personnel with regular laser safety training. When preparing for operation, it must be ensured that the mirrors in the deflection unit are always correctly actuated and that the laser beam is switched off when the mirrors are stationary.

5.1 Safety during start-up and operation

⚠ WARNING

Risk of injury due to improper handling

Improper handling can overload and destroy the deflection mirrors during operation. Destroyed mirrors can deflect the laser beam onto the protective housing, heating it severely or destroying it. This can result in a risk of burns or uncontrolled escape of laser radiation from the protective housing.

- Ensure optically correct input of the laser beam into the deflection unit and check this before start-up.
- Observe the specified start-up sequence.
- Make sure that the deflection unit is always operated with a lens or a protective window. The lens or protective window must be suitable for the relevant application and wavelength and must be undamaged.
- Only operate the deflection unit up to the maximum permitted laser power. Refer to the specifications in the technical data for details
- Only operate the deflection unit when it is closed.
- Make sure that no water is splashed onto the deflection unit.
- Check whether the laser wavelength corresponds to the specified wavelength of the deflection unit.
- Do not process any materials which can reflect the laser beam back to the deflection unit.

⚠ WARNING

Risk of burns and fire due to heating

If the diameter of the laser input beam exceeds the permitted value, the mechanical system is severely heated. This results in a risk of burns when touching the hot components. If any highly flammable materials are in the vicinity, it can result in fire.

- Observe the specified maximum input beam diameter.
- Before starting up the deflection unit, make sure that the input beam diameter is not exceeded.

⚠ WARNING

Risk of injury due to laser radiation

The laser beam (including a reflected beam) can cause severe injuries to the eyes and skin.

- The laser system may only be installed and started up by trained personnel.
- Before carrying out any work, make sure that the laser equipment is switched off and secured against being switched on again.
- After all work, make sure that all housing covers are in place.

NOTE
Ejection of mirror fragments If the mirrors are destroyed by overloading, fragments can be ejected from the laser beam output. ▪ Always operate the deflection unit with a lens or a protective window, as this will keep in the fragments in the event of a failure.

5.2 Checking the installation

Before start-up and operation of the deflection unit, check the following points:

1. Check whether the mechanical installation has been carried out completely and correctly (see page 32, Installation).
2. Check whether the electrical connection has been carried out completely and correctly (see page 32, Installation).
3. Check that the deflection unit has suitable mirrors. To do this, refer to the deflection unit rating plate and compare the details with the application (see page19, Signage).
4. Check that a lens or a protective window has been mounted into the deflection unit beam output.
5. Check that the accessible optical components are free of dust and clean. If not, they must be cleaned (see page 38, Cleaning).

5.3 Start-up

Observe the following start-up sequence:

1. Switch on the RAYLASE control card.
2. Start the control software.
3. Switch on the power supply to the deflection unit.
4. Switch on the laser.

When shutting down the laser system, the components must be switched off in precisely the reverse of this sequence.

6 MAINTENANCE

Maintenance may only be carried out by trained personnel. These trained personnel must be familiar with the general safety rules for electrical engineering, optics, mechanics and laser technology.

6.1 Cleaning

⚠ WARNING

Risk of injury due to incorrect cleaning

Incorrect cleaning can cause damage to optical elements (e.g. due to scratching). Damaged optics can then be destroyed during operation, deflecting the laser beam onto the protective housing. This can result in a risk of burns or uncontrolled escape of laser radiation from the destroyed protective housing.

- Only clean optical components if you have sufficient knowledge and experience of handling optics for laser components and laser systems.
- Precisely follow the instructions for cleaning the optics set out in this chapter.

6.1.1 Cleaning the housing

1. When cleaning the housing, do not touch the optical surfaces. Cleaning these is a separate task.
2. Before cleaning, ensure that the laser system is switched off and secured against being accidentally switched on again.
3. Clean the deflection unit housing with a soft lint-free duster.
4. If there is more severe dirt, moisten the cloth with a non-aggressive cleaning solution (e.g. soap solution).

6.1.2 Cleaning the lens

Optional

The lens is very sensitive and may only be cleaned by experienced professionals.

1. Before cleaning, ensure that the laser system is switched off and secured against being accidentally switched on again.
2. Only hold the optical assembly with powder-free latex gloves and only by the edge. Fingerprints contain aggressive substances that damage the optical surfaces.
3. Carefully remove the lens and place it in a safe location protected from dust.
4. Blow off any loose particles from the surface with clean and oil-free compressed air. Note that the compressed air in workshops may contain oil particles and in this case is unsuitable for cleaning optics.
5. Moisten a suitable lens cleaning cloth with high-purity isopropanol or acetone.
6. Place one end of the moistened cloth on the optics and pull it slowly across the optics. Do not exert any pressure and do not rub it over the optics.
7. Remove any remaining solvent residue with a dry lens cleaning cloth.
8. Repeat this procedure until the surface is completely clean. Use a new lens cleaning cloth each time.

6.1.3 Cleaning the protective window

Optional

The protective window is extremely sensitive and may only be cleaned by experienced professionals.

1. Before cleaning, ensure that the laser system is switched off and secured against being accidentally switched on again.
2. Carefully remove the protective window and place it in a safe location protected from dust (see page 40, Replacing the protective window).
3. Only hold the optical assembly with powder-free latex gloves and only by the edge. Fingerprints contain aggressive substances that damage the optical surfaces.
4. Blow off any loose particles from the surface with clean and oil-free compressed air. Note that the compressed air in workshops may contain oil particles and in this case is unsuitable for cleaning optics.
5. Moisten a suitable lens cleaning cloth with high-purity isopropanol or acetone.
6. Place one end of the moistened cloth on the optics and pull it slowly across the optics. Do not exert any pressure and do not rub it over the optics.
7. Remove any remaining solvent residue with a dry lens cleaning cloth.
8. Repeat this procedure until the surface is completely clean. Use a new lens cleaning cloth each time.

6.1.4 Cleaning the mirrors

The mirrors are very sensitive and may only be cleaned by experienced professionals. We recommend sending the deflection unit to RAYLASE for this cleaning.

1. Before cleaning, ensure that the laser system is switched off and secured against being accidentally switched on again.
2. Only hold the optical assembly with powder-free latex gloves and only by the edge. Fingerprints contain aggressive substances that damage the optical surfaces.
3. Blow off any loose particles from the surface with clean and oil-free compressed air. Note that the compressed air in workshops may contain oil particles and in this case is unsuitable for cleaning optics.
4. Moisten a suitable lens cleaning cloth with high-purity isopropanol or acetone.
5. Place one end of the moistened cloth on the relevant mirror and pull it slowly across the mirror. Do not exert any pressure and do not rub it over the mirror.
6. Remove any remaining solvent residue with a dry lens cleaning cloth.
7. Repeat this procedure until the surface is completely clean. Use a new lens cleaning cloth each time.

6.2 Servicing

No specific service interval is specified.

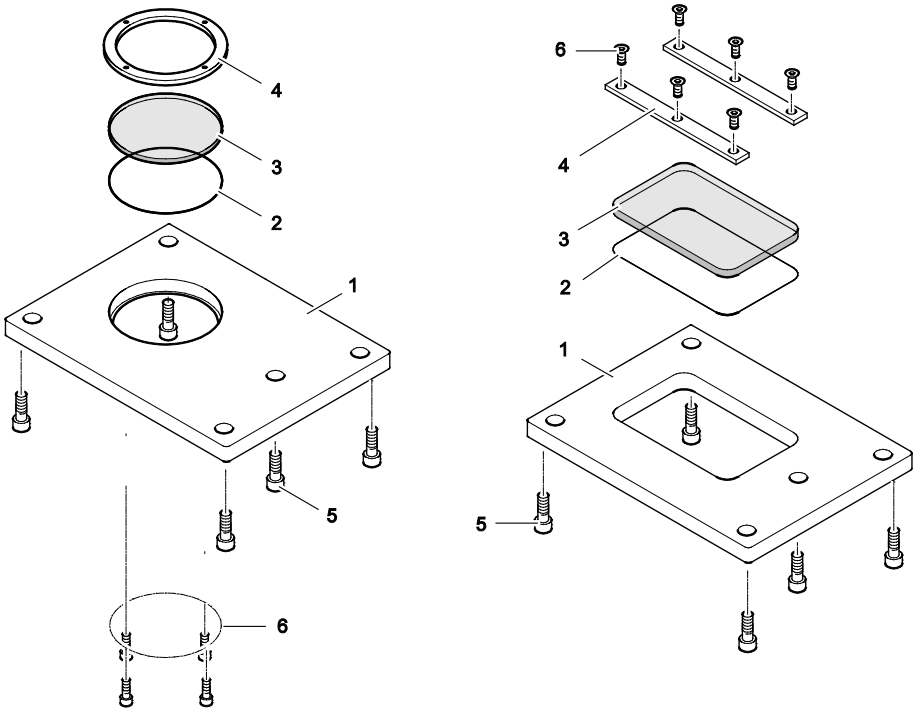
1. Check regularly whether all stickers and signs are present and legible (see page 19, Signage).
2. Replace any missing or illegible stickers or signs.

6.3 Replacing the protective window

The following figure shows how the protective window can be replaced. This, for example, is necessary in case of deposits on the protective window which cannot be removed by cleaning. As an alternative to replacing the protective window, you can also order an Output Plate with the protective window completely assembled from RAYLASE.

Depending on the design of the deflection unit, one of the three variants of the output plates illustrated may be used:

6.3.1 Variations 1 and 2



1	Output plate	4	Retaining ring/strip
2	Compensating ring	5	Screws for the output plate
3	Protective window	6	Screws for the protective window

Fig. 18: Protective window replacing variants 1 and 2

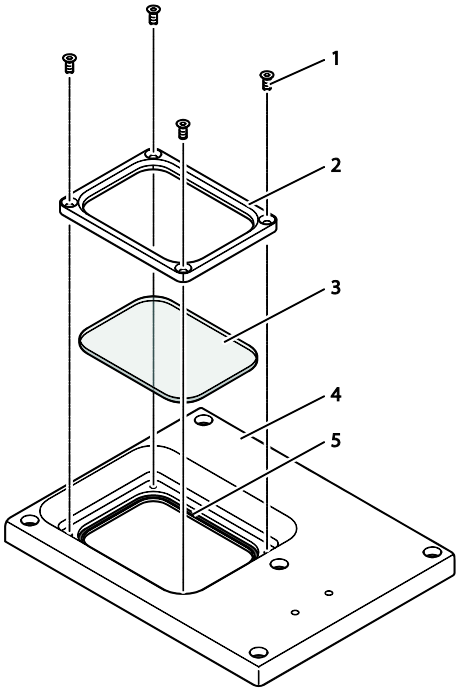
The opening of the deflection unit must be done in a dust-protected environment. If dust deposits on the optics, it burns in during operation by the laser radiation so that the optics will be destroyed.

1. Remove the five screws (5) holding the output plate (1).
2. Lift the output plate carefully from the deflection unit.
3. Remove the retaining screws (6) or the retaining ring (4) of the protective window (3).
4. Remove the protective window.

Install the new protective window in reverse order. Make sure that the compensation/sealing ring(s) are in the correct position. Be careful not to touch the optically relevant surfaces of the protective window and remove dust particles on the optical surfaces.

For variation 2, tighten the screws (6) with "light" threadlocker (e.g. Loctite 222) and a torque of 0.15 Nm. Make sure that you first lightly tighten the two middle screws (6) of each fastening strip (4), then lightly tighten the four outer screws in any order. Finally, tighten all six screws to a torque of 0.15 Nm.

6.3.2 Variation 3



1	Screws for the protective window	4	Output-Plate
2	Retaining frame	5	Compensating ring
3	Protective window		

Fig. 19: Protective window replacing variant 3

The opening of the deflection unit must be done in a dust-protected environment. If dust deposits on the optics, it burns in during operation by the laser radiation so that the optics will be destroyed.

1. Remove the four retaining screws (1) of the protective window (3).
2. Carefully lift the retaining frame (2) off the protective window.
3. Remove the protective window.
4. Check the compensating ring (5) for correct fitting in the output plate (4).

Install the new protective window in reverse order. Make sure that the compensation/sealing ring(s) are in the correct position. Be careful not to touch the optically relevant surfaces of the protective window and remove dust particles on the optical surfaces.

Tighten the four screws (1) with a torque of 0.8 Nm. First lightly tighten all four screws and then tighten them crosswise with a torque of 0.8 Nm.

7 UNINSTALLING

7.1 Safety when uninstalling

⚠ WARNING

Risk of injury due to falling product

A falling product unit can cause injuries.

- The product should be installed by two people wearing suitable safety shoes.
- In case the product fell down it must not be used any more. It has to be sent back to RAYLASE for service.

7.2 Uninstalling the deflection unit

1. Switch off the laser system and secure it against accidentally being switched on again.
2. Detach the plug connections to the deflection unit.
3. Loosen the fastening screws and carefully remove the deflection unit.
4. Cover all connections so that they are dust-protected and safe for transport.
5. Pack the deflection unit in a dust-proof container.

8 STORAGE

The deflection unit must be stored in a dust-free location and under the specified ambient conditions (see page 21, Ambient conditions).

9 TRANSPORTATION

⚠ WARNING

Damage due to improper transportation

During transportation or shipping of the deflection unit there is a risk of it being damaged.

- Seal the deflection unit in a dust-proof container before transportation.
- Transport and ship the deflection unit only in the original packaging.

10 DISPOSAL

Observe the applicable regulations for disposal of the product.

11 TROUBLESHOOTING

⚠ WARNING

The laser beam can cause severe injuries to the eyes and skin.

- During troubleshooting, never look directly or indirectly into the laser beam.
- Do not deactivate any safety precautions designed to protect against laser radiation.
- Wear laser protection clothing and/or goggles appropriate for the relevant danger rating.

1. Make sure that only the necessary professionals are in the room for troubleshooting and that they have protective equipment appropriate to the hazards.
2. In case of malfunctions, check whether the problem and a possible remedy appear in the following checklist.
3. If the fault cannot be resolved, contact RAYLASE Customer Service.

Problem	Possible cause	Remedy
Processing quality is poor	Electrical energy supply defective	
	Processing parameters incorrect	
	Deflection unit unsuitable for selected application	
Processing quality has deteriorated	Lens or protective window dirty	See page 38, Cleaning the lens and page 39, Cleaning the protective window
	Mirror dirty	See page 39, Cleaning the mirrors
	Laser power reduced	The RAYLASE laser processing software weldMARK ® can be used to compensate for a deteriorating laser power. Menu: System > Global Settings
	Processing parameters changed	
	Beam expander changed	
Laser spot changed	Lens or protective window dirty	See page 38, Cleaning the lens and page 39, Cleaning the protective window
	Mirror dirty or damaged	Send deflection unit to RAYLASE for repair
	Laser system badly adjusted	
No laser beam although the laser process has been started	Beam path blocked	Remove protective cover from beam input and/or output
	Laser control defective	
	Laser system defective	
Deflection unit only deflects the laser beam in one direction or not at all	Data line defective	
X and Y axis reversed	Wiring incorrect	

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