RAYLASE
focus on laser

3-Axis Subsystems for Laser Beam Deflection

AXIALSCAN-12

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

RAYLASE reserves the right to change the product described in this manual and the information contained therein without prior notice.

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1 BASIC SAFETY INSTRUCTIONS

1.1 Laser safety

The user is responsible for safe operation and for safeguarding the surrounding area against hazards that can be caused by laser radiation. OEM customers must ensure compliance with all local and national regulations.

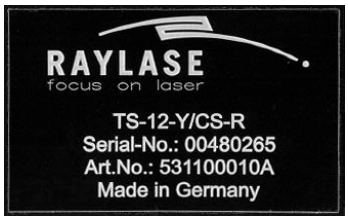
1.2 Laser shutter

The subsystem is designed to focus and deflect an input laser beam and output it again. The subsystem cannot block or weaken the laser beam. To prevent unwanted emission of the laser beam, above a particular danger class the laser device must be fitted with a shutter (⇨ page 5, Classification of laser devices).

The laser device must be of sufficient quality that the laser beam can only be emitted at the beam output on the subsystem.

1.3 Signs

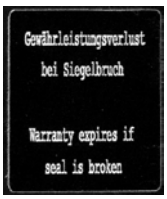
The following signs must be attached to the subsystem. These signs may not be removed. Signs that have become illegible must be replaced.



The **rating plates** and the identification codes printed on them can be used to determine the type of the subsystem (⇨ page 10, Rating plate code). The serial number and the item number are also used to identify the subsystem.

The **ground symbol** identifies the ground connection on the subsystem. This connection can be connected to the laser housing via a plug connection to increase the interference resistance.

The **CE symbol** confirms the subsystem's compliance with European directives. It indicates that the subsystem is approved for free trade within the EU.



The **seal labels** warn against unauthorized opening of the subsystem. If a seal is broken, all warranty claims against RAYLASE are void.

A **laser warning sign** must be attached at the point where laser radiation is emitted. This provides information about the type of radiation, specific hazards and the degree of protection. The laser warning sign is attached by the OEM customer in accordance with the laser device's classification (⇨ page 5, Classification of laser devices).

1.4 Classification of laser devices

The subsystem can be fitted on various laser devices. Every laser device is assigned to a particular danger class, which must be specified at the point where laser radiation is emitted, e.g. using a warning sign. The following classifications are defined in DIN EN 60825-1:

Class	Description
1	The accessible laser radiation is not dangerous under reasonable foreseeable conditions.
1M	The accessible laser radiation is in the wavelength range of 302.5nm to 4,000nm. The accessible laser radiation is not dangerous to the eyes, as long as the cross-section is not reduced by optical instruments (magnifying glasses, lenses, telescopes).
2	The accessible laser radiation is in the visible spectrum (400nm to 700nm). Short-term exposure (up to 0.25s) is not dangerous to the eyes. Additional radiation components outside the wavelength range from 400nm-700nm meet the requirements for class 1.
2M	The accessible laser radiation is in the visible spectrum from 400nm to 700nm. Short-term exposure (up to 0.25s) is not dangerous to the eyes, as long as the cross-section is not reduced by optical instruments (magnifying glasses, lenses, telescopes). Additional radiation components outside the wavelength range from 400nm-700nm meet the requirements for class 1M.
3R	The accessible laser radiation is in a wavelength range of 302.5nm to 10,600nm and is dangerous to the eyes. The power or energy is a maximum of five times the limit for permissible class 2 radiation in the wavelength range from 400nm to 700nm.
3B	The accessible laser radiation is dangerous to the eyes and frequently to the skin.
4	The accessible laser radiation is extremely dangerous to the eyes and dangerous to the skin. Even diffuse scattered radiation can be dangerous. The laser radiation can cause fires or a risk of explosion.

Note: Bear in mind that the subsystem changes the position at which the beam is emitted and the new beam output must be marked with a warning sign showing the appropriate classification.

Note: The subsystem can change the classification of the laser device, particularly if it is fitted with a focusing lens. The laser device may require additional protective equipment as a result.

1.5 Laser area

For the purposes of accident prevention, the laser area is defined as the area in which the maximum permitted radiation value can be exceeded. This is generally applicable for class 3B, 3R and 4 lasers. For class 1 to 2M laser devices, a laser area can be produced by focusing the laser beam.

A sufficient beam intensity produces a laser area that covers the entire radiation angle of the subsystem and includes the reflection from all objects that can be exposed to the radiation as a result. Note that even apparently diffuse surfaces can reflect laser radiation and a laser beam that has been reflected several times can still be dangerous.

The laser area must be indicated by corresponding warning signs or lamps and protected by appropriate shading and interlock switches.

No flammable or explosive objects or liquids should be located in the laser area.

This operating manual interprets a selection of accident prevention regulations from the point of view of using laser subsystems in industrial plants. However, the applicable local and national standards, rules and regulations are binding.

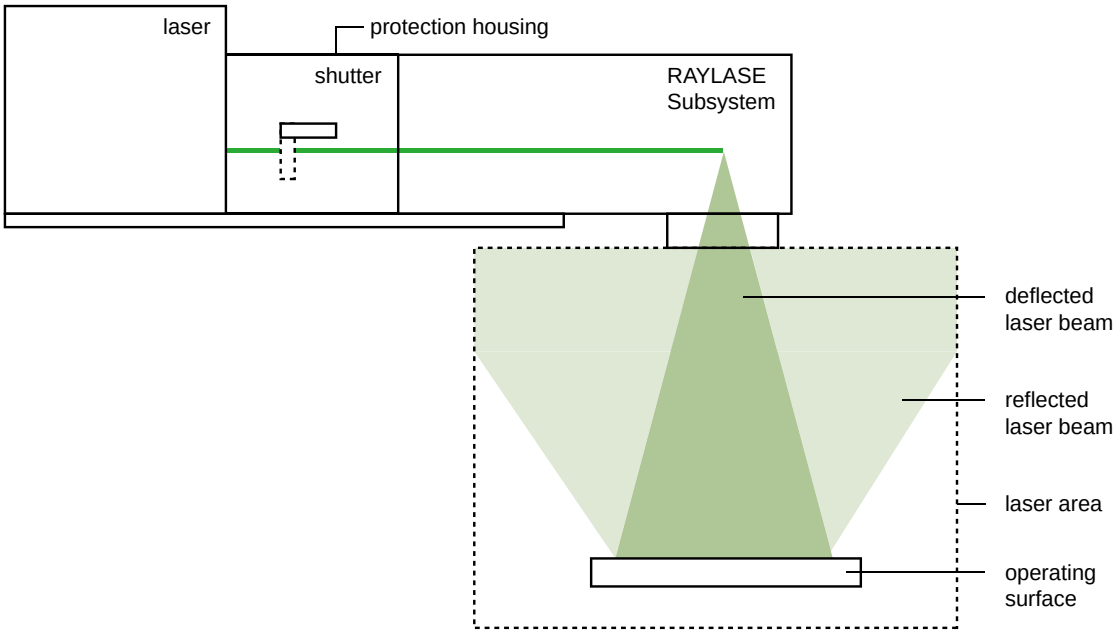


Fig. 1
Laser area

2 BASIC INFORMATION

2.1 Introduction

This manual describe the general handling of subsystems AXIALSCAN-12. See the data sheet in the appendix for the different features. For details of the type you are using, refer to the rating plate.

The manual contains important information on qualified and safe handling of the subsystem. You should therefore familiarize yourself with the content of this manual before using the subsystem for the first time. In case of any queries, please contact RAYLASE.

The manual must be accessible to anyone who will be involved in developing, installing or using a laser device featuring the RAYLASE subsystem. If the subsystem is sold on, this operating manual or an authorized copy must be passed on with it.

2.2 Package contents

- Subsystem

Optional

- Protection window

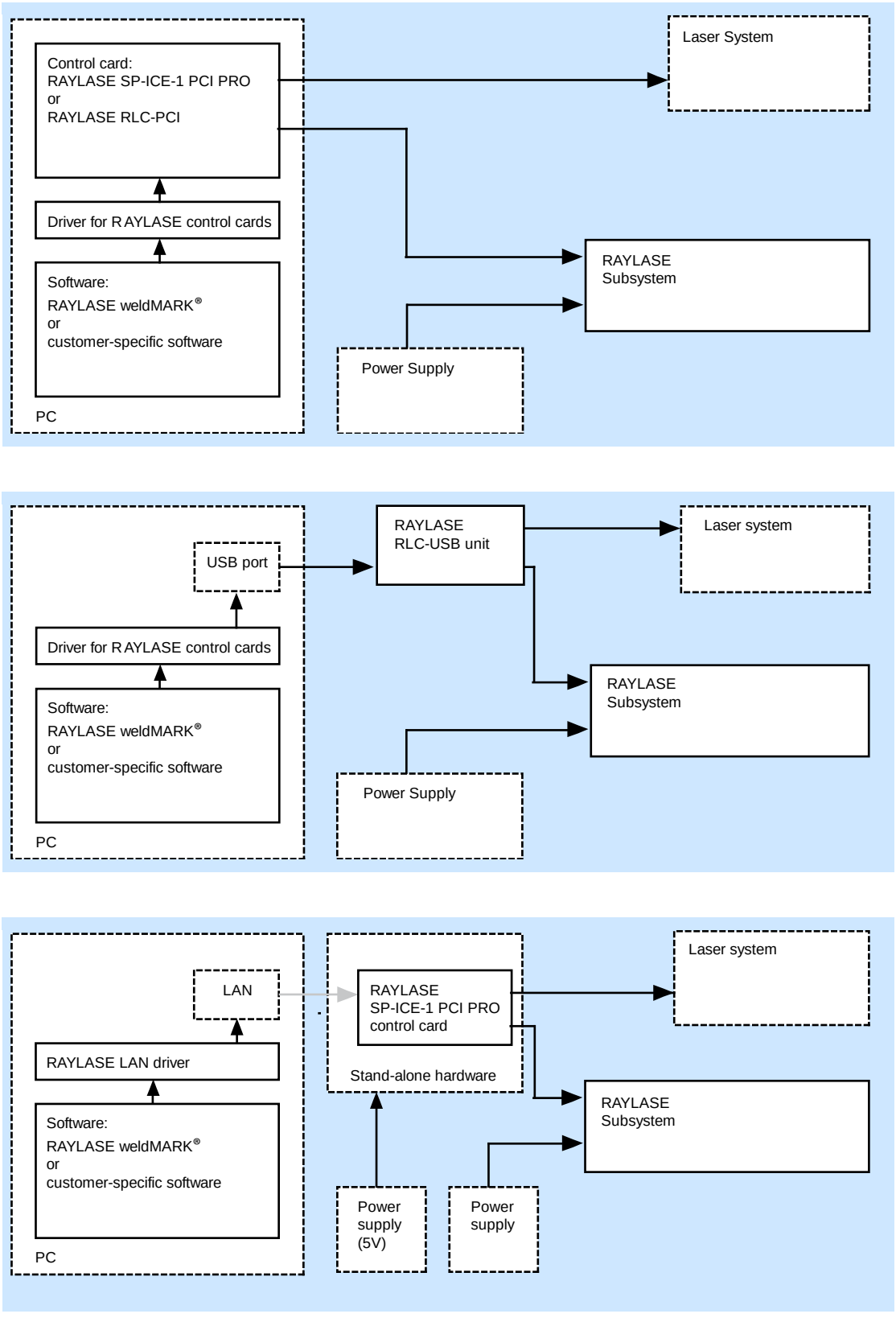
Optional for subsystem with digital interface

- Control card
- Connecting cable between control card and deflection unit
- Software package

2.3 Module overview

The illustration below shows three typical digital laser devices that are equipped with RAYLASE and customer-specific (indicated by dotted lines) modules.

Fig. 2
Module overview



2.4 Warranty

The rights of the customer in respect of any defects in quality or deficiencies in title are governed by the general conditions of business of RAYLASE AG. These conditions are available for review on our website.

Please pack the product in the original packaging or in packaging that provides equivalent protection for shipping.

RAYLASE shall not be obliged to repair defects under the following circumstances:

- If persons not authorized by RAYLASE have attempted to repair the product.
- If the seal label has been broken by the customer.
- If optical components have been damaged.
- If persons not authorized by RAYLASE have modified the product.
- If the product has been used improperly.
- If the product has been connected to incompatible devices.
- If the warranty period is expired.

Note: No implicit guarantee or warranty of suitability for specific purposes has been made. RAYLASE is not responsible for damages arising from use of the product. Individual assemblies or other assemblies manufactured by RAYLASE may be subject to separate warranty conditions. Refer to the corresponding manuals for further information.

2.5 Manufacturer

RAYLASE AG
Argelsrieder Feld 2+4
82234 Wessling
Germany
Tel.: +49 (0) 81 53 - 88 98 - 0
Fax: +49 (0) 81 53 - 88 98 - 10
http://www.raylase.de
E-mail: info@raylase.de

2.6 Customer Service

The RAYLASE support services are available for your problems either in respect to the deflection unit or this manual. Before calling for support, please make sure you refer to any appropriate sections in the manuals on the supplied CD that may answer your questions.

If you need further assistance call RAYLASE customer support department, Monday through Friday between 8 A.M. and 5 P.M. (Middle European Time).

The customer service personnel will be able to give you direct assistance and answers to your questions.

Germany (Wessling)
+49 (0) 81 53 - 88 98 – 0
E-Mail: support@raylase.de

... ask for the customer support department

3 TECHNICAL DATA

This section outlines the common features of all subsystems AXIALSCAN-12. For type-specific features, refer to the data sheets in the appendix. The individual data can be assigned using the rating plate in conjunction with the identification code (⇨ below, Rating plate code).

3.1 Conformity with directives

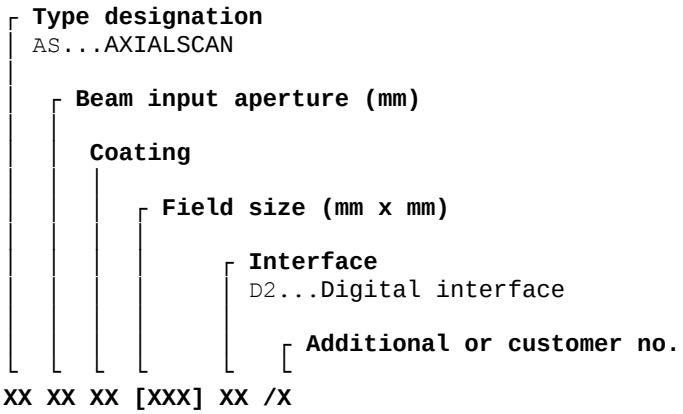
The subsystem conforms to the requirements of the following directives:

- EU Directive 2004/108/EG
- EU Directive 2002/95/EC

For details of conformity with other directives, contact RAYLASE.

3.2 Rating plate code

The following type designation is used in the data sheets in the appendix:



The subsystem is equipped with rating plates. Refer to the following sections to identify the modules.

4 FUNCTIONAL DESCRIPTION

4.1 Subsystem

The subsystem can be used to deflect a laser beam in X, Y and Z directions. This results in a three-dimensional plane, within which a laser can be directed at any position. This area is known as the "operating area" and is shown in fig. 3. Deflection is performed by two mirrors, each of which is moved by a galvanometer scanner.

The focusing of the laser is done by the built-in linear translator. This allows almost three-dimensional operations to be performed. For example, this is useful for deep processing of materials.

The size of the operation area is set by RAYLASE and can not be changed in the field because of the systems dust sensitivity.

4.2 Functional principle

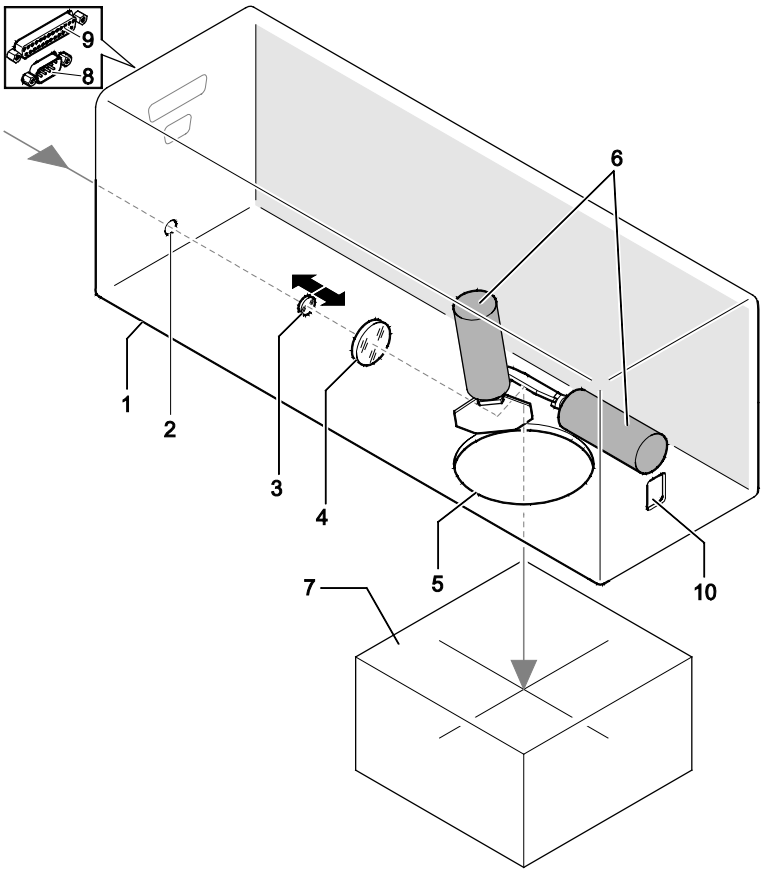


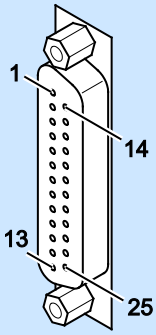
Fig. 3
Functional description

1 Subsystem cpl.
2 Beam input
3 Lens with linear movement
4 Focusing lens (or 2x, depending on model)
5 Beam output
6 Galvanometer scanner with mirror
7 Operating area
8 Power supply of subsystem
9 Digital interface of deflection unit
10 Status LEDs

4.3 Interfaces of the subsystem

4.3.1 Digital Interface

The linear translator is connected to a RAYLASE control card using the 25-pin D-SUB connector. All signals are compatible with RAYLASE's extended function XY2-100 standard.



25 PIN D-SUB

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	18	I +Z CHANNEL
6	O -HEAD-STATUS	19	O +HEAD-STATUS
7	nc	20	nc
8	nc	21	nc
9	nc	22	nc
10	nc	23	GND
11	GND	24	GND
12	nc	25	nc
13	nc	---	---

I = Diff. Input, nc = not connected, O = Diff. Output

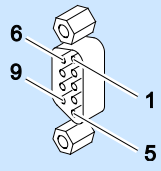
Specifications

Diff. Input-, Diff. Input+	
Input voltage	5V
Input threshold	200mV
Hysteresis	typ. 45mV
Input impedance	120Ω
ESD protection	±15kV

Diff. Output-, Diff. Output+		
Output low	max. 0.6V	max. 40mA
Output high	min. 2V @ 50Ω	max. 40mA
ESD protection	±10kV	

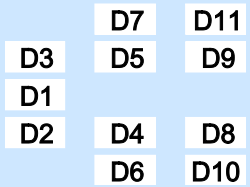
4.3.2 Power supply

The 9-pin D-SUB connector provides the linear translator with power. The power supply must be provided by the OEM customer. Refer to the following connection and parameter table:

	PIN	Designation	PIN	Designation
 9 PIN D-SUB	1	-VSS	6	-VSS
	2	-VSS	7	GND
	3	GND	8	GND
	4	+VSS	9	+VSS
	5	+VSS	---	---

4.4 Status LEDs

The status LEDs allow you to check important functions and statuses on the deflection unit. If the deflection unit has status LEDs (depends on type), they are located behind a window on the rear of the deflection unit.

LED arrangement	Name	Color	Meaning	
	D1	red	CLK error	Data transmission faulty. Cable defective.
	D2	red	Parity error X	
	D3	red	Parity error Y	
	D4	green	Temp. status X	Temperature status available if LEDs are lit.
	D5	green	Temp. status Y	
	D6	orange	New data X	New data is being transferred if status LEDs are lit.
	D7	orange	New data Y	
	D8	red	Error X	Galvanometer scanner or driver electronics defective. Power supply defective if LEDs are flickering.
	D9	red	Error Y	
	D10	green	+VCC	Power supplies are ready for being used if LEDs are lit.
	D11	green	-VCC	

5 INSTALLATION

The following sections describe installation of the subsystem in a laser device. When doing this, it is essential to check that the laser beam is input into the subsystem and output from the subsystem centrally. Otherwise, misalignment of the laser beam will occur each time the focus is changed. The subsystem is adjusted prior to delivery and do not need to be adjusted in the field.

Warning:

- The laser beam can cause severe injury to the eyes and the skin. Note that even apparently matt objects can reflect the wavelength of laser beams. All personnel in the room must wear appropriate laser protection goggles and, if necessary, protective clothing.
- Never look directly at the laser beam, even when wearing protective goggles.
- The subsystem may require the laser device to be assigned to a different danger class (⇨ page 5, Classification of laser devices).
- The laser must be switched off during installation.
- We recommend that the laser area is completely protected by an appropriate working chamber. If this is not possible, appropriate protective measures for the laser class must be implemented.
- The mirrors in the deflection unit must move freely after installation of the deflection unit. No components of the laser device may protrude into the deflection unit.
- The laser device must be of sufficient quality that the laser beam can only be emitted at the beam output on the deflection unit.
- The "Laser radiation" accident prevention regulations (BGV B2) must be observed.
- Connecting cables may not be subjected to mechanical strain.
- The subsystem must be protected against moisture, dust and corrosive vapors.
- The optical components may only be touched when wearing unpowdered latex gloves.
- The subsystem must be protected against static discharge and strong electromagnetic fields.
- The power density of the input laser radiation may not exceed the maximum permissible power density of the optical components in the subsystem.
- The beam path and the function of the subsystem must be tested after installation.
  We recommend performing all tests with a danger class 1 or 2 laser to minimize the risk of injury. If this is not possible, the laser used must be set to the lowest possible power. This setting must be secured against accidental adjustment.

5.1 Adjust beam coupling into subsystem

For the correct operation of the AXIALSCAN-12, it is very important that the laser beam is coupled into the subsystem centrally and coaxial. The laser coupling must be tested or adjusted prior to installation of AXIALSCAN-12. To support this, RAYLASE supplies the AXIALSCAN-12 with an adjusting device which can be seen as a dummy deflection unit.

The laser incoupling can be checked as follows:

- o Insert locating pins into the corresponding holes and attach the subsystem to the prepared installation surface using screws.
  Note: The adjusting device may only be installed using the pins and screws specified by RAYLASE. Follow the installation drawing supplied.

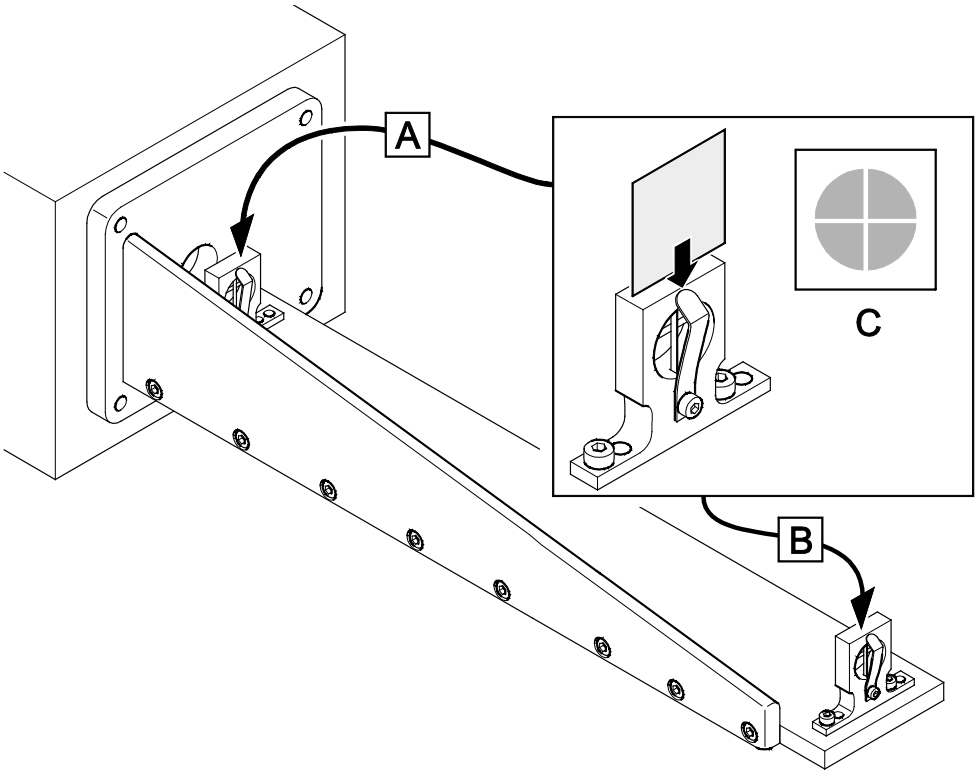


Fig. 4
Adjustment of beam coupling AXIALSCAN-12

Warning:
The laser beam can cause severe injury to the eyes and the skin. Make sure that all personnel in the laser area are wearing appropriate protective goggles and, if necessary, protective clothing.

Checking the input point

- o Insert the cross hair device next to the beam input (A).
- o Hold a piece of thermo transfer paper behind the cross hair device.
- o Turn on the laser at low power for just long enough for a clearly visible effect to appear on the thermo transfer paper (C).
- o Check the beam diameter. It must be smaller than the input aperture specified in the data sheet.
- o Check that the laser beam appears in the center of the cross hairs. If not, the exit point of the laser beam needs to be adjusted.

Checking the input angle

- o Insert the cross hair device next to the beam output (B).
- o Hold a piece of thermo transfer paper behind the cross hair device.
- o Turn on the laser at low power for just long enough for a clearly visible effect to appear on the thermo transfer paper.
- o Check the beam diameter. It must be smaller than the input aperture specified in the data sheet. If the beam diameter at the beam output is greater than that measured at the beam input, this indicates excessive divergence of the laser beam. In this case, collimate the laser beam, for example, with a suitable beam expansion.
- o Check that the laser beam appears in the center of the cross hairs. If not, the exit angle of the laser beam needs to be adjusted.

Optimizing settings

- o Repeat the entire adjustment process until optimum laser beam input point and input angle settings are achieved.

5.2 Assembling the subsystem

After the laser output is adjusted with the adjusting device the RAYLASE subsystem can be mounted as follows.

- o Remove the adjusting device.
- o Attach the RAYLASE subsystem to the mounting surface of the laser system.
  Note: The subsystem may only be installed using the pins and screws specified by RAYLASE. Follow the installation drawing supplied.
- o Connect the power supply and the control unit

6 MAINTENANCE AND CLEANING

The subsystem doesn‘t contain any components that require regular maintenance.

Repairs may only carried out by RAYLASE or RAYLASE Certified Service Centres because special know-how and comprehensive testing methods are required.

RAYLASE offers worldwide certified service and repair centers.
A service and repair center in your area, see www.raylase.com.

6.1 Cleaning the housing

Warning:
The laser beam can cause severe injury to the eyes and the skin. Before cleaning, make sure that the laser device is switched off and secured against accidentally being switched on.

The subsystem housing is dust proof. It can be cleaned with a duster. If it is very dirty, the duster can be moistened with a light and non-aggressive cleaning solution (e.g. soap solution).

6.2 Cleaning the optical system

Warning:
The laser beam can cause severe injury to the eyes and the skin. Before cleaning, make sure that the laser device is switched off and secured against accidentally being switched on.

Dirty optical surfaces result in increased absorption of the laser radiation. This can cause the dirt to heat up sufficiently for it to burn into the optical surfaces and permanently damage them.

The following circumstances can cause increased accumulation of dirt:

- The ambient atmosphere is contaminated with dirt, grease or other particles.
- Vapors and particles are produced while working.
- Talking, coughing or sneezing close to optical surfaces.

In general, all contamination of the optical system should be avoided wherever possible. However, as contamination cannot be completely avoided, the optical system must be cleaned at appropriate intervals. Regular checking and cleaning of the optical surfaces can prevent permanent damage.

Note: RAYLASE accepts no liability for damaged optical components!

Note: Damage caused during the laser process, e.g. when processing metals, is irreversible and cannot be resolved by cleaning.

6.2.1 Instructions for cleaning protection windows

Warning:
The laser beam can cause severe injury to the eyes and the skin. Before cleaning, make sure that the laser device is switched off and secured against accidentally being switched on.

Fingerprints contain aggressive substances that can damage the optical surfaces. Optical surfaces should therefore only be touched when wearing suitable gloves or with a lens cleaning cloth.

- Only touch the optical elements when wearing unpowdered latex gloves and only touch the edges.
- Blow loose particles from the surface with clean and oil-free compressed air. Note that the compressed air in workshops can contain oil particles and is therefore unsuitable for cleaning the optical system.
- Moisten a suitable lens cleaning cloth with ethanol suitable for cleaning optical components.
- Place one end of the moistened cloth on the optical system and slowly move it over the optical components. Do not exert any pressure and do not rub the optical components.
- Remove any remaining ethanol residue with a dry optical cloth.
- Repeat the procedure until the surface is completely clean. Use a new cleaning cloth for each repetition.

7 TROUBLESHOOTING

Warning:
The laser beam can cause severe injury to the eyes and the skin.

- Never look directly or indirectly into the laser beam during troubleshooting.
- Do not disable any safety precautions to protect against laser radiation.
- Wear protective clothing and/or goggles appropriate for the relevant laser class.

In case of malfunctions, check whether the symptom and a possible remedy are included in the following checklist.

Problem	Possible cause and remedy	
Poor marking quality	Defective power supply	
	Incorrect marking parameters	
Marking quality has deteriorated	Dirty optical system	⇨ page 17, Cleaning the optical system
	Laser power decreasing	The RAYLASE weldMARK® marking software can compensate for a loss of laser power. Menu: System > Global adjustments
	Marking parameters changed	
	Beam expander changed	
Laser spot changed	Dirty optical system	⇨ page 17, Cleaning the optical system
		Send deflection unit in for repair
	Laser system out of adjustment	
No laser beam, although process started from PC.	Beam path blocked.	Remove protective cover from beam input and/or output
	Fault in laser drive	
	Fault in laser system	
The deflection unit only deflects the laser beam in one direction or not at all.	Data cable defective	
X and Y axis reversed	Incorrect cabling	

If the fault cannot be resolved, contact RAYLASE Customer Service for further assistance.

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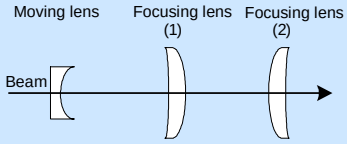
AXIALSCAN-12-Y [120, 180, 300]

General Specifications

Power Supply	Voltage	±15 bis ±18 V
	Current	7 A, RMS, Peak current 10 A
	Ripple/ Noise	Max. 200 mVpp, @20MHz bandwidth
Ambient Temperature		+15 bis +35 °C
Storage Temperature		-10 bis +60 °C
Humidity		≤ 80 % not condensing
Weight		6.5 kg
Dimension (mm) (L x W x H)		370 x114 x126

Interface Signals	Analog	±5 V, ±10 V
	Digital	XY2-100 Protocol
Max. Input Aperture		8 mm
Field Size		120x120 mm², 180x180 mm², 300x300 mm² beam optimised
Lens Position		

Specifications for Linear-Translator-Modules

Field Size	120 x 120 mm²	180 x 180 mm²	300 x 300 mm²
Working Distance[1)]	121 mm	196 mm	344 mm
Spot Diameter 1/e[2)]	26 µm	39 µm	65 µm
Focus range in Z-direction	10 mm	46 mm	221 mm
Resolution	< 4 µm	< 6 µm	< 10 µm
Acceleration Time (10-90%)	1.3 ms	1.3 ms	1.3 ms
Maximal Processing Speed	5.0 m/s	7.5 m/s	12.5 m/s

1) From the edge of the deflection unit to the processing field; the distance will vary with laser divergence and lens tolerance. 2) Input Beam Quality: M^2 = 1,0

Specifications Deflection Unit

	MS-Kit-12
Mechanical Data:	
Beam Displacement	14.4 mm
Dynamic Data:	
Typical Deflection	±0.393 rad
Repeatability (RMS)	2 µrad
Max. Gaindrift[1)]	50 ppm/K
Max. Offsetdrift[1)]	30 µrad/K
Long-term Drift over 8Hours[1, 2)]	< 300 µrad
Acceleration Time (10-90%)	280 µs

1) Drift per Axis 2) After warming-up, variations of ambient temperature < 1K

Specifications for Optics

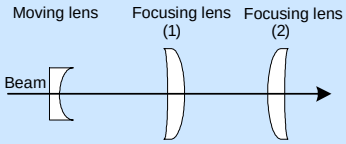
	YAG
Wavelength	1.064 nm
Coating	AR-Coating
Max. Laser Power, cw, 1/e²	1000 W/cm²

The AXIALSCAN-12 is available for other wavelength on request

AXIALSCAN-12-TY [300, 400, 500, 600]

General Specifications

Power Supply	Voltage	±15 bis ±18 V
	Current	7 A, RMS, Peak current 10 A
	Ripple/Noise	Max. 200 mVpp,@20MHz bandwidth
Ambient Temperature		+15 bis +35 °C
Storage Temperature		-10 bis +60 °C
Humidity		≤ 80 % not condensing
Weight		6.5 kg

Interface Signals Digital	XY2-100 Protocol
Max. Input Aperture	5 mm
Field Size	300x300 mm², 400x000 mm², 500x500 mm², 600x600mm² beam optimised
Lens Position	

Specifications Linear-Translator-Module

Field Size	300 x 300 mm²	400 x 400 mm²	500 x 500 mm²	600 x 600 mm²
Working Distance[1)]	344 mm	467.8 mm	591.5 mm	715.3 mm
Average Spot Diameter 1/e[2)]	21 µm	27 µm	34 µm	41 µm
Focus range in Z-direction	289 mm	757 mm	> 1.000	> 1.000
Resolution	< 10 µm	< 13 µm	< 16 µm	< 19 µm
Acceleration Time (10-90%)	1.3 ms	1.3 ms	1.3 ms	1.3 ms
Max. Processing Speed	12.5 m/s	16.7 m/s	20.8 m/s	25.0 m/s

1) From the edge of the deflection unit to the processing field; the distance will vary with laser divergence and lens tolerance. 2) Input Beam Quality: M^2 = 1,0

Specifications Deflection Unit

	MS-KIT-12
Beam Displacement	14.4 mm
Typical Deflection	±0.393 rad
Repeatability (RMS)	2 µrad
Max. Gaindrift[1)]	50 ppm/K
Max. Offsetdrift[1)]	30 µrad/K
Long-term Drift over 24 Hours[1, 2)]	< 300 µrad
Acceleration Time (10-90%)	280 µs

1) Drift per Axis 2) After warming-up, variations of ambient temperature < 1K

Specifications Optics

	TY
Wavelength	355 nm
Coating	AR-Coating
Max. Laser Power, cw, 1/e²	100 W/cm²

The AXIALSCAN-12 is available for other wavelength on request