



# Installation and Operation

## varioSCAN<sub>de</sub> 20i Dynamic Focusing Unit



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## 1 Introduction

This operating manual describes the varioSCAN<sub>de</sub> 20i dynamic focusing unit with ID number 136185.

The manual is a part of the product. Please read these instructions carefully before you proceed with installing and operating the varioSCAN<sub>de</sub>. (If the varioSCAN<sub>de</sub> is used together with an XY scan system, also refer to the manual of the XY scan system.) In particular, observe all safety guidelines in this manual. If there are any questions regarding the contents of this manual, please contact SCANLAB (see page 45).

Keep the manual available for guidance on installation, operation, servicing and repairs. This manual should accompany the product, if ownership changes hands.

SCANLAB reserves the right to update this operating manual at any time and without notification.

### 1.1 Product Overview

This varioSCAN<sub>de</sub> 20i dynamic focusing unit with ID number 136185 is equipped with an aperture of 7 mm, which is prepared for water cooling, and is designed for a laser with a wavelength of 1064 nm.

The varioSCAN<sub>de</sub> is designed for use in a laser scan system. It enables the laser beam to be focused and the laser focus to be moved quickly and precisely along the optical axis. Thereby it supplements an XY scan system (scan head or scan module) to form a 3-axis scan system. The varioSCAN<sub>de</sub>'s optical configuration is optimized for a specific scan system configuration. Depending on the optical configuration of the complete laser scan system, the varioSCAN<sub>de</sub> serves to maintain the laser focus in a planar target area and/or to shift the laser focus inside the working volume in Z-direction for 3D applications.

The technical specifications of the product and the configuration of the 3-axis scan system are summarized on page 48.

### 1.2 Unpacking Instructions and Package Contents

For unpacking the package contents, proceed as follows:



#### Caution!

- When unpacking the package contents, handle all parts with care.
- When handling the electrostatic sensitive electronic box, please follow the ESD guidelines.

- ▶ Carefully remove the varioSCAN<sub>de</sub> and its electronic box from the packaging.
- ▶ Protect the varioSCAN<sub>de</sub> from dust and other contaminants.
- ▶ Keep the packaging the varioSCAN<sub>de</sub> and its electronic box were delivered in, so that in case of repair the varioSCAN<sub>de</sub> and its electronic box can be properly repackaged and returned to SCANLAB.  
The electronic box must always be enclosed (the varioSCAN<sub>de</sub> and its electronic box are one functional unit).
- ▶ Check that all parts have been delivered. The package includes:
  - the varioSCAN<sub>de</sub> 20i,
  - one electronic box with integrated DSCB digital control board and digital interface board and
  - this operating manual.

For digitally controlling the varioSCAN<sub>de</sub>, also an RTC control board and appropriate data cables may be included in the package.

## 1.3 Identification Plate

The identification plate (see figure 1) with the serial number of the varioSCAN<sub>de</sub> is found on the top of its housing.



Identification plate with serial number (SN)

## 2 Principle of Operation

### 2.1 Mechanical and Optical Overview

The varioSCAN<sub>de</sub> 20i is an optical system with a dynamically variable focal length. It consists of the following major parts (see figure 2):

- the square-cut water-cooled entrance aperture,
- the motor block with its diverging optic and its clamping surface for mounting the varioSCAN<sub>de</sub>,
- an objective adapter with a counter-ring and (optionally) with an objective mount,
- the objective with its focusing ring.

The entering laser beam is expanded by the movable diverging optics (a negative lens). Next, the beam is focused by the objective, which consists of a lens system with positive focal length.

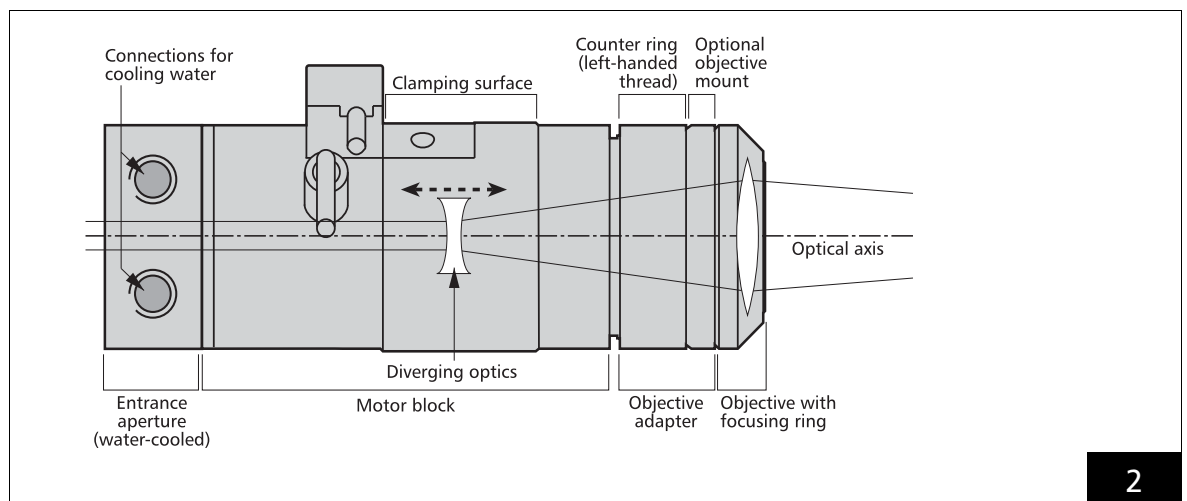
Dynamic variation of the focal length is achieved via a motor which moves the diverging optic along the optical axis under the programmatic control of the user's controlling PC.

SCANLAB creates a working distance and a range of achievable focal lengths appropriate for the customer's particular applications by selecting optics with appropriate characteristics.

The user can fine-tune the working distance by manually turning the varioSCAN<sub>de</sub>'s focusing ring, and thus, moving the objective lens along the optical axis of the varioSCAN<sub>de</sub> (see page 42).

For matching the varioSCAN<sub>de</sub>'s output beam diameter to the entrance aperture of an XY scan system (scan head or scan module), SCANLAB chooses an optical configuration with a suitable expansion factor (see "Technical Specifications" on page 48). Additionally, it may be necessary to place a beam expander into the beam path for this purpose (see figure 14 on page 39).

When mounting the varioSCAN<sub>de</sub> (see chapter 4.1 on page 18), only use the clamping surface indicated in figure 2.



Mechanical setup of the varioSCAN<sub>de</sub> 20i dynamic focusing unit



## Caution!

- Make sure that the aperture and the optical configuration of the varioSCAN<sub>de</sub> meet the requirements of your application (see "Technical Specifications" on page 48). For information on tolerances and deviations, please contact SCANLAB.
- Make sure that the working distance, the typical image field size and the wavelength meet the requirements of your application. If this is not the case, then please contact SCANLAB.
- Check if the wavelength of the input beam and the maximum ratings for beam diameter and laser power match the specifications of the varioSCAN<sub>de</sub> (see "Technical Specifications" on page 48).
- If the varioSCAN<sub>de</sub> is operated together with a 2-axis scan system equipped with an objective, the maximum usable laser power will be usually limited by this objective.



## 2.2 Digital Control Board

For controlling the varioSCAN<sub>de</sub>, a DSCB digital control board is integrated in the supplied electronic box (see figure 9 on page 22). The control board controls the position of the diverging optic in accordance with received data and returns various status informations to the controlling PC (see page 32).

The control board forms a closed servo loop in conjunction with the varioSCAN<sub>de</sub>'s motor. Each digital control board is individually tuned by SCANLAB for its assigned motor-lens configuration.

Together with the digital control board and supplemented by an digital interface board and an RTC control board, the varioSCAN<sub>de</sub> can be controlled via digital signals from a controlling PC (see page 32).

### Configuring the Servo and Start Behavior (iDRIVE Functions)

The varioSCAN<sub>de</sub>'s digital control board allows to configure a number of settings. If used together with an RTC4 or RTC5 board the configuration can be realized via the command **control\_command** (see RTC4 or RTC5 manual).

The user can

- select the data type to be transmitted from the varioSCAN<sub>de</sub> to the RTC control board (see page 34),
- set a desired POSACK threshold value (see "Process Monitoring" on page 36),
- change the varioSCAN<sub>de</sub>'s effective calibration (see "Configuring the Effective Calibration" on page 37),
- configure the varioSCAN<sub>de</sub>'s start behavior (see "Configuring the Start Behavior" on page 37) and
- perform a fault diagnosis or verify intact data transfer capability (see "Fault Diagnosis and Functional Test" on page 47).

## Internal Protective Functions

### Assuring Reliable Power Supply

For safe operation of the varioSCAN<sub>de</sub>, a reliable supply of power is absolutely essential. If the supply voltages deviate excessively from their specified values or if the mechanism for switching on power does not result in symmetrical turn-on of the supply voltages, then unintended movements of the diverging optic may occur. This in turn can damage the varioSCAN<sub>de</sub> or the optics of the scan system and can lead, if the laser is on, to an unintended focal position.

The varioSCAN<sub>de</sub>'s supply voltages are monitored by the varioSCAN<sub>de</sub>'s servo electronic (digital control board). If, during operation, the supply voltage falls below a minimum of approx. 25 V (e.g. due to excessively long or thin cables, a weak power supply or high loads), then the electronics disconnects the varioSCAN<sub>de</sub> from the power supply. In order to restart varioSCAN<sub>de</sub> operation, the supply voltage problem must then be resolved and the varioSCAN<sub>de</sub> switched off and then restarted.

### Monitoring Position Range and Proper Operation

The varioSCAN<sub>de</sub> has a built-in monitoring function to prevent damage to its motor or electronics when a problem occurs.

If the motor's position exceeds the allowed position range due to an operational disturbance or if the diverging optic is not moved to its set position within a certain time, the output stage will be shut down. In such situations, the varioSCAN<sub>de</sub> can no longer be controlled.



### Danger!

If the output stage is shut down due to position range overrun or any other problem, laser power must be switched off immediately. Otherwise, health hazards and severe equipment damage can occur due to uncontrolled laser radiation.

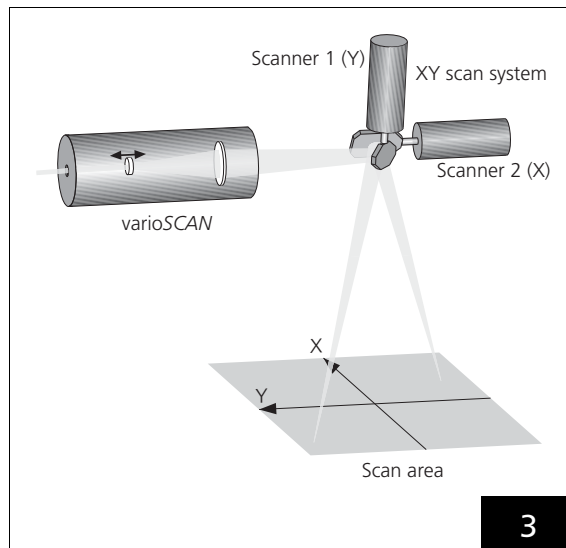
## 2.3 System Integration

### Integration into a 3-Axis Scan System

The varioSCAN<sub>de</sub> is designed to supplement an XY scan system (scan head or scan module) to form a 3-axis scan system.

The XY scan system deflects the laser beam in the XY directions and the varioSCAN<sub>de</sub> and/or an optional scan lens focus the beam at the desired locations. During the scanning process of the XY scan system, the varioSCAN<sub>de</sub>'s diverging optic is positioned with high dynamics along the optical axis with respect to a stationary focusing optic. This produces a change in the system's overall focal length, synchronized with the mirror motion.

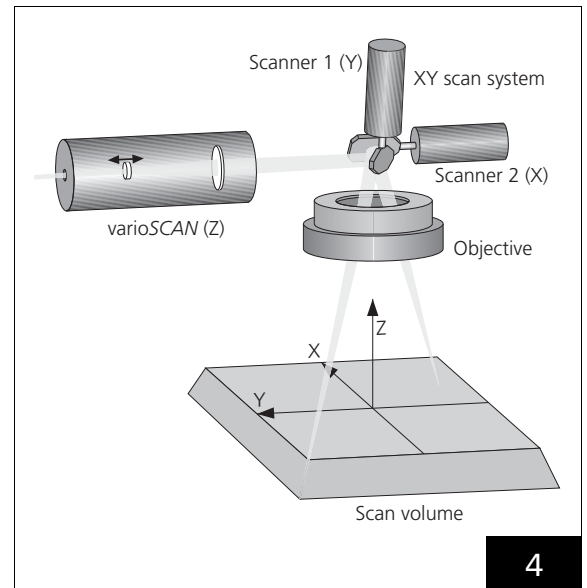
Equipped with an appropriate optical configuration, the varioSCAN<sub>de</sub> can replace a costly flat field objective for processing in two dimensions. Here the varioSCAN<sub>de</sub> is used to focus the laser beam and maintain the laser focus in a planar target area (see figure 3).



3-axis scan system with the varioSCAN<sub>de</sub> as replacement of a scan lens

Equipped with an appropriate optical configuration, the varioSCAN<sub>de</sub> can additionally be used to shift the laser focus in Z direction (i.e. to shift the target area) within a certain working volume. Thereby it expands an XY scan system into a 3D beam deflection system and enables processing in three dimensions (see figure 4).

If the XY scan system is equipped with a scan lens (for example an F-Theta objective), the laser beam is focused within a planar target area by the scan lens. With the varioSCAN<sub>de</sub> in front of the XY scan system's beam entrance, the working distance (i.e. the distance between the beam entrance and the target plane) can be varied by changing the focal length of the varioSCAN<sub>de</sub>.



3-axis scan system with scan lens (objective)

SCANLAB offers optical configurations for a wide variety of working distances, image field sizes, ranges of achievable focal lengths, beam diameters, wavelengths and laser powers for optimally tuning the system to the customer's particular application. Thus, a maximum image field size is achieved with the minimum spot size.

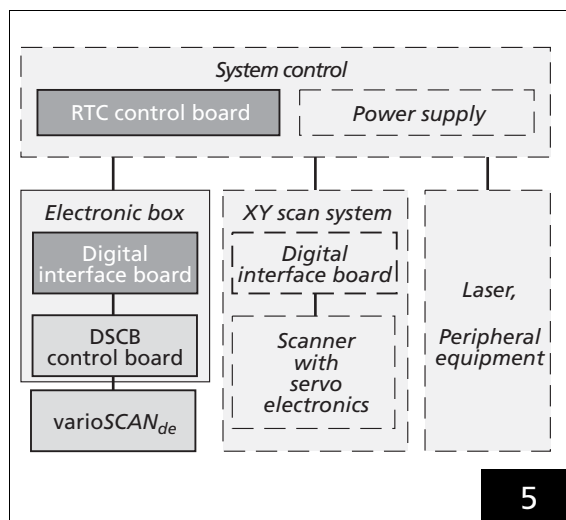
Every varioSCAN<sub>de</sub> is optimized for a specific scan system configuration. The technical specifications of this product and the configuration of the 3-axis scan system are summarized on page 48.

Most laser systems require the varioSCAN<sub>de</sub> and the complete 3-axis scan system to be controllable from a controlling PC via digital data transfer. For this purpose, the varioSCAN<sub>de</sub> and its DSCB board must be supplemented by a SCANLAB digital interface board and a SCANLAB RTC control board (see figure 5):

- The digital interface board, which provides a digital interface to be connected to an RTC board, and the DSCB board are already installed and wired in the electronic box
- The RTC control board must be installed in the controlling PC. It is designed for simultaneous and real-time control of varioSCAN<sub>de</sub>, XY scan system and additional components (laser and peripheral equipment). Easy software commands enable the laser spot to be moved to the desired point in the target field or scan volume.

Usually the varioSCAN<sub>de</sub> and the XY scan system need to be separately supplied with power.

Available SCANLAB interface boards are listed on page 12, SCANLAB RTC control boards on page 13. The data transfer between controlling PC and varioSCAN<sub>de</sub> is explained on page 32.



Digital control of the varioSCAN<sub>de</sub> – schematic diagram

## Digital Interface Boards

The following table shows the digital interface boards, which are available from SCANLAB for this varioSCAN<sub>de</sub>:

Interface board	Digital interface	Data transfer	Resolution of position control	Supported axes
DSIB	XY2-100 Enhanced	electrical	16 bit	X, Y and optional Z
DSIBLWL	XY2-100-O	optical (via polymer optical fiber cable)	16 bit	X, Y and optional Z
DSIB-SL	SL2-100	electrical or optical (depending on the data cable)	16 bit (up to 20 bit for XY scan system)	X and Y or Z

The interface boards have different digital interfaces matching to the corresponding interfaces of the various SCANLAB RTC control boards. The interface boards support different types of data transfer (electrical or optical), different control resolutions and a different number of axes.

If an electronic box is supplied together with the varioSCAN<sub>de</sub>, a suitable interface board is already installed and connected. The varioSCAN<sub>de</sub> and the XY scan system need a separate interface board, each. Both interface boards have to be connected via a separate data cable with the RTC control board (which has two scan head connectors).

## RTC control boards

The following table shows the RTC control boards, which are available from SCANLAB:

RTC board	Support of 3 axes (with enabled 3D option)	Digital interface	Supported interface boards	iDRIVE support
RTC3 (PC interface board)	via one scan head connector	XY2-100	DSIB	no
RTC4 (PC interface board)	via one scan head connector	XY2-100 Enhanced	DSIB	restricted (less iDRIVE commands than with RTC5)
		or with another board version: XY2-100-O	DSIBLWL	
RTC SCANalone (standalone board)	via one scan head connector	XY2-100 Enhanced	DSIB	restricted (only read-out functions)
		or with another board version (with only one scan head connector): XY2-100-O	DSIBLWL	restricted (only read-out functions)
RTC5 (PC interface board or PC/104-Plus module)	X and Y via one scan head connector, Z via the other scan head connector	SL2-100	DSIB-SL	full
		or together with an XY2-100 converter: XY2-100 Enhanced	DSIB	restricted (less read-out functions than with DSIB-SL)

RTC PC interface boards must be integrated into an IBM-compatible PC with a PCI bus interface (installed e.g. in a PC slot). The RTC SCANalone standalone board is designed for operation without requiring a PC. The RTC5 PC/104-Plus board must be integrated into a PC/104-Plus stack.

For controlling a varioSCAN<sub>de</sub>, the RTC's 3D option must be enabled. With enabled 3D option all RTC boards provide data transfer for all three axes of a 3-axis scan system.

All SCANLAB RTC boards provide two scan head connectors.

With most RTC boards, data transfer for all axes occurs (by default only) via one scan head connector (the primary scan head connector). If the 3-axis system has to be controlled via two separate interface boards, the "second scan head" option must be enabled (for enabling data transfer via the secondary scan head connector; this is not possible with an RTC SCANalone board with XY2-100-O interface).

With RTC5 boards, on the other hand, data transfer for the X and Y axes occurs via one scan head connector and for the Z axis via the other scan head connector. Here, a 3-axis scan system can be controlled only via two separate interface boards (but the "second scan head" option does not need to be enabled).

The table above also shows, what interface board can be combined with what RTC control board. For the various combinations, it also shows the degree of iDRIVE support, which is relevant for the varioSCAN<sub>de</sub> and the intelliSCAN, intelliDRILL, intellcube and intelliWELD scan systems from SCANLAB. Here iDRIVE functions allow configuring the servo and start behavior or performing an extended diagnosis of the system's operational state (see page 9, page 36 and the corresponding manuals for details).

### 3 Safety during Installation and Operation

To reduce the risk of injury, please observe the following guidelines.

The safety and warning notices in this manual are indicated by a symbol set against a gray background:



Instructions that may affect a person's health are marked with a warning triangle next to the word "Danger".



Instructions that recommend appropriate use of this device or warn of damage that may occur to it are identified by a circle with an "X" through it, next to the word "Caution".

#### 3.1 Operational Guidelines and Standards

When operating the varioSCAN<sub>de</sub>, the following guidelines and standards should be followed:

- EC Guideline 2014/35/EEC  
Low Voltage Directive
- EC Guideline 2014/30/EEC  
Electromagnetic Compatibility
- EC Guideline 2006/42/EU  
Machinery Directive
- EN 60204-1 (2006)  
Safety of Machinery – Electrical Equipments of Machines, Part 1: General Requirements
- EN 60825-1/VDE 0837 (2015)  
Safety of Laser Products, Part 1: Equipment Classification, Requirements and User's Guide
- EN 60825-4/VDE 0837 (2011)  
Safety of Laser Products, Part 4: Laser Guards
- EN ISO 11553-1 (2005)  
Safety of Machinery - Laser Processing Machines - Part 1: General Safety Requirements

Additional application-dependent guidelines and standards may apply.

#### Complying with the Relevant Standards for the CE Label

The varioSCAN<sub>de</sub> is delivered as an OEM component conceived of for integration into a laser scan system.

The system manufacturer bears the responsibility for complying with the standards and guidelines required for equipment usage and for the CE label.

#### Conformity to EC Guidelines for Electromagnetic Compatibility (EMC)

The varioSCAN<sub>de</sub> and its control board are not shielded against electromagnetic fields. The customer is responsible for the observance of the electromagnetic compatibility, for example by assembling the varioSCAN<sub>de</sub> and its control board in an appropriate housing.

## 3.2 Laser Safety

The varioSCAN<sub>de</sub> is designed to provide variable focusing of a laser beam. Therefore, all applicable rules and regulations for safe operation of lasers must be known and applied when installing the dynamic focusing unit and operating the system in which it is used. Since SCANLAB has no influence over the employed laser or the overall system, the customer is solely responsible for the laser safety of the entire system.



### Danger!

Safety regulations may differ from country to country. The customer bears sole responsibility for compliance with all applicable safety regulations of their respective regulatory jurisdiction.

Follow the instructions for laser safety provided in the "Safety During Installation and Operation" chapter of your SCANLAB XY scan system manual.



### Danger!

- During installation, setup or operation of the varioSCAN<sub>de</sub>, never stare directly into the laser beam or its deflected radiation. Keep all parts of the body away from the laser beam and its deflected radiation. Routine maintenance should be performed as described in "Routine Maintenance and Customer Service" on page 44 and all safety instructions should be observed.
- Adjust the output beam path by means of a laser with a laser class not higher than 2.
- The risk of hazardous deflected radiation can increase when optical instruments are used in combination with the scan system.
- Before inspecting the varioSCAN<sub>de</sub>, make absolutely sure that the laser and the varioSCAN<sub>de</sub> are turned off.



### Danger!

- Cover the path of the laser beam via an appropriate protecting case to block laser radiation!
- Closely follow all IEC 60825-1 laser safety requirements and other applicable accident prevention regulations of your respective regulatory jurisdiction.
- Wear appropriate eye protection at all times.
- Always turn on the controlling PC and the varioSCAN<sub>de</sub>'s and scan system's power supply first before turning on the laser. Otherwise, the laser beam might be deflected and focused to an arbitrary position.







## Maintenance

During maintenance of the laser equipment, the class of the laser can increase. Therefore, the customer must take suitable protective measures.





## Warning Symbols

The area where the emerging beam is harmful must be marked with a warning symbol indicating the class of the employed laser – in accordance with IEC 60825-1 laser safety requirements. In addition, a warning symbol must be placed at the emitting aperture of the laser system. The table on page 16 shows the appropriate warning symbols for the various laser classes specified by IEC 60825-1 (or EN 60825-1 / VDE 0837 T1).

### Laser Classes Specified by IEC 60825-1 (or EN 60825-1 / VDE 0837 T1)

Visible Laser Radiation	Invisible Laser Radiation	Potential Hazards
LASER CLASS 1	LASER CLASS 1	Class 1: This laser radiation is not harmful; is eye-safe.
 <p>LASER RADIATION DO NOT STARE DIRECTLY INTO THE BEAM WITH OR WITHOUT OPTICAL INSTRUMENTS LASER CLASS 1 M</p>	 <p>INVISIBLE LASER RADIATION DO NOT STARE DIRECTLY INTO THE BEAM WITH OR WITHOUT OPTICAL INSTRUMENTS LASER CLASS 1 M</p>	Class 1 M: Exposure to this radiation is harmful to the eyes if optical instruments are used to reduce the cross section of the laser beam. If this is not the case, this laser radiation is not harmful; is eye-safe.
 <p>LASER RADIATION DO NOT STARE DIRECTLY INTO THE BEAM LASER CLASS 2</p>		Class 2: This laser radiation is in the visible spectrum of 400 to 700 nm. Exposure to this radiation for less than 0.25 s is not harmful to the eyes. It is eye-safe due to the eye's natural aversion response and blink reflex.
 <p>LASER RADIATION DO NOT STARE DIRECTLY INTO THE BEAM WITH OR WITHOUT OPTICAL INSTRUMENTS LASER CLASS 2 M</p>		Class 2 M: This laser radiation is in the visible spectrum of 400 to 700 nm. Exposure to this radiation is harmful to the eyes if optical instruments are used to reduce the cross section of the laser beam. If this is not the case, exposure to this radiation for less than 0.25 s is not harmful to the eyes and is eye-safe due to the eye's natural aversion response and blink reflex.
 <p>LASER RADIATION AVOID EXPOSURE OF THE EYES LASER CLASS 3 R</p>	 <p>INVISIBLE LASER RADIATION AVOID EXPOSURE TO THE LASER BEAM LASER CLASS 3 R</p>	Class 3 R: This laser radiation is harmful to the eyes. Eye exposure exceeds the maximum allowable value.



Visible Laser Radiation	Invisible Laser Radiation	Potential Hazards
 <p>LASER RADIATION AVOID EXPOSURE TO THE LASER BEAM LASER CLASS 3 B</p>	 <p>INVISIBLE LASER RADIATION AVOID EXPOSURE TO THE LASER BEAM LASER CLASS 3 B</p>	<p>Class 3 B: This laser radiation is harmful to the eyes and in some cases to the skin.</p>
 <p>LASER RADIATION AVOID ANY EXPOSURE OF THE EYES OR THE SKIN TO DIRECT OR SCATTERED RADIATION LASER CLASS 4</p>	 <p>INVISIBLE LASER RADIATION AVOID ANY EXPOSURE OF THE EYES OR THE SKIN TO DIRECT OR SCATTERED RADIATION LASER CLASS 4</p>	<p>Class 4: This laser radiation is very harmful to the eyes and skin. Stray radiation can also be dangerous. This radiation can cause fire or explosion and the generation of toxic gases or vapors.</p>

### 3.3 Electrical Safety

Power is furnished to the varioSCAN<sub>de</sub> by a user-supplied low voltage power supply unit. The power supply unit must meet the following mains insulation requirements:

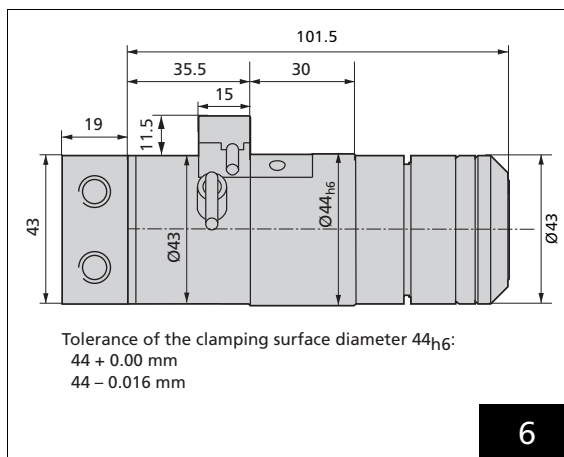
- If the connectors are covered and cannot be reached without tools from the outside, single insulation between the mains and the low voltage circuit is sufficient. The mains insulation must be able to withstand a test voltage of 2 kV AC applied between the mains and the low voltage circuit.
- If the connectors can be reached from the outside, double or reinforced insulation between the mains and the low voltage circuit is necessary. The mains insulation must be able to withstand a test voltage of 4 kV AC applied between the mains and the low voltage circuit.

Additional application-dependent guidelines and standards may apply.

## 4 Installation

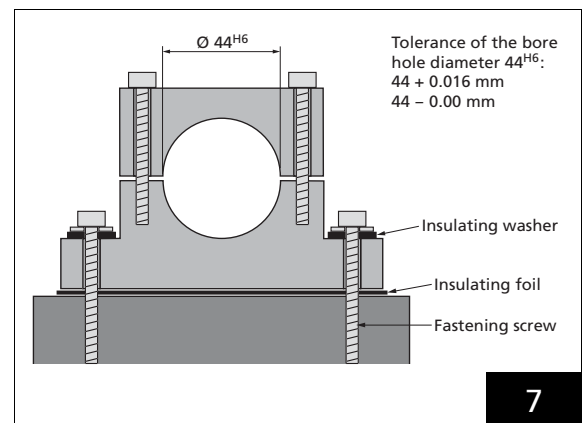
### 4.1 Mounting the varioSCAN<sub>de</sub>

When mounting the system components also consider the cable lengths between the components (see chapter "Electrical Connections" on page 24).



Dimensions of the varioSCAN<sub>de</sub> 20i  
(total length for neutral position, all dimensions in mm)

The varioSCAN<sub>de</sub> must be mounted via its clamping surface (see figure 2 on page 7). SCANLAB recommends to use a clamping block as shown in figure 7 for this purpose. The entire clamping surface should be enclosed by the clamping block, i.e. the bore hole diameter of the clamping block should be identical with the diameter of the clamping surface (44<sup>H6</sup>). The depth of the clamping block should be 30 mm.



Recommended clamping block – cross section;  
Example with insulating foil



### Caution!

- When designing or providing the clamping block, please observe the chapter "Alignment and Adjustment", in particular the recommended tolerances for the beam position (see page 41).
- The clamping block must be mounted firmly onto a sufficiently stable support. If the clamping block is not fastened with sufficient firmness, this can lead to vibrations of the varioSCAN<sub>de</sub> which might result in marking process inaccuracies.

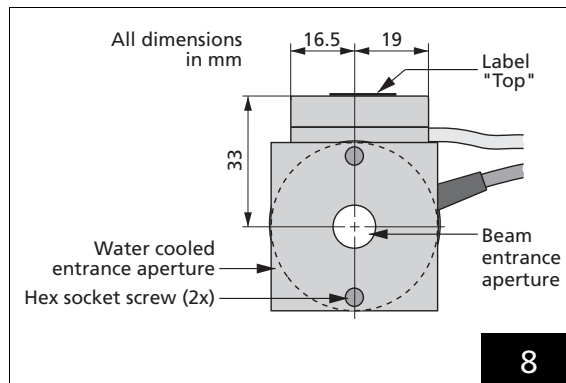
To prevent the temperature of the varioSCAN<sub>de</sub> from rising excessively, the clamping block should be constructed of aluminum or another material with a similar thermal conductivity. Under special operating conditions, it could be appropriate to use a water cooled clamping block (refer to page 43).

The varioSCAN<sub>de</sub> or the clamping block must be electrically insulated to ensure reliable operation. SCANLAB recommends to use one of the two following options:

- An electrically non-conductive foil sheet must be placed between the clamping block and the support (see figure 7).
- The surfaces of the clamping block are galvanically processed in such a way that electrical insulation is automatically provided. Care must be taken to ensure the tolerance of the bore hole diameter (see figure 7).

The attachment of the clamping block to the support with screws must also be electrically non-conductive. Insulating washers must be fitted between the fastening screws and the clamping block for this purpose. However, care must be taken that heat transfer is still ensured.

The clamping block and the varioSCAN<sub>de</sub> must be oriented in such a way, that the label "Top" is on top and the cables exit the varioSCAN<sub>de</sub> at the right side (viewed from the beam entrance side, see figure 8). The optical axis of the varioSCAN<sub>de</sub> must be horizontal.



Correct orientation of the varioSCAN<sub>de</sub> (viewed from the beam entrance side)



## Caution!

- The varioSCAN<sub>de</sub> must not be opened.
- Before mounting the varioSCAN<sub>de</sub>, cover its beam entrance and exit apertures, to protect the optical components from contamination.
- When mounting the varioSCAN<sub>de</sub>, use only the clamping surface shown in figure 2 on page 7. Other parts of the varioSCAN<sub>de</sub> must not be used for mounting the varioSCAN<sub>de</sub>.
- Take care that the varioSCAN<sub>de</sub> or its clamping block is electrically insulated.
- The diverging optic inside the varioSCAN<sub>de</sub>'s motor block cannot be cleaned by the user. If this optic becomes contaminated, the varioSCAN<sub>de</sub> must be returned to SCANLAB for servicing.

For mounting the varioSCAN<sub>de</sub> proceed as follows:

- ▶ Insert the varioSCAN<sub>de</sub> into the clamping block.
- ▶ Orientate the varioSCAN<sub>de</sub> as shown in figure 8 on page 19. The label "Top" must be on top.
- ▶ Fasten the varioSCAN<sub>de</sub> in the clamping block.
- ▶ If necessary, fasten the clamping block.

If your varioSCAN is equipped with an optionalThe water cooled entrance aperture, this can be removed via two hex socket screws (see figure 8 on page 19) by using a 2 mm hex key.

## Note:

If your varioSCAN<sub>de</sub> is not equipped with a label "Top", the identification plate with the serial number indicates the top of the varioSCAN<sub>de</sub>.

## 4.2 Connections for Cooling

It is strongly recommended to operate the varioSCAN<sub>de</sub> only with water cooling to draw off the heat produced by the motor. This water cooling also reduces the heat produced by the absorbed laser power. Depending on the laser wavelength and the varioSCAN<sub>de</sub>'s optical configuration, this may rise the maximum allowed laser power. The maximum allowed laser power **without** cooling is specified on page 48. If you want to use a higher laser power, but no maximum laser power **with** cooling is specified, please ask SCANLAB.

Depending on the application, it might even be necessary to utilize a water-cooled clamping block in addition to a water-cooled entrance aperture.

For water cooling, the user must install appropriate water inputs and outputs to ensure adequate supply and circulation of cooling water.



### Caution!

- Do not operate the varioSCAN<sub>de</sub> with laser powers exceeding the specified maximum laser power (see page 48). If you want to use a higher laser power, but no maximum laser power **with** cooling is specified, please ask SCANLAB.
- SCANLAB strongly recommends to operate the varioSCAN<sub>de</sub> with water cooling only.
- To avoid system damage, the user is asked to check the current consumption and the temperature in new applications:
  - If the temperature of the entrance aperture exceeds a value of 45 °C or/and the current consumption of the DSCB control board exceeds a value of 0.65 A RMS (20 W), appropriate water cooling is required.
  - Even if the temperature of the entrance aperture is cooled to 20...25 °C, the current consumption of the DSCB control board must not exceed 0.85 A RMS (26 W).
- To ensure sufficient cooling, the water flow should be monitored continuously during operation.



### Caution!

- Do not exceed the maximum water pressure of 4.5 bar. The water supply should be adjustable. SCANLAB recommends a water inlet temperature of 20° C, constant to ±1°C.

To connect the water supply to the water cooled entrance aperture and, if necessary, to the water cooled clamping block, suitable adapters and water hoses should be used. SCANLAB recommends 3.2 mm Delrin CPC connectors with automatic stop valves. The CPC connectors can be attached to the water cooled entrance aperture via the G1/8x10 threads of the cooling water connections. The water hoses should be flexible. They should have an inner diameter of 4 mm and an outer diameter of 6 mm.

- ▶ Connect the adapters and water hoses to the varioSCAN<sub>de</sub>'s water cooled entrance aperture (connections, see figure 2 on page 7) and, if used, to the clamping block.
- ▶ Connect the water hoses to the water supply. Make sure that the water flow can be suitably adjusted.

The water flow rate has to be adjusted accordingly. The maximum pressure for the cooling water is 4.5 bar. SCANLAB recommends a water inlet temperature of 20° C, constant to ±1°C.

Water with anticorrosive agent can be used as cooling liquid. The cooling liquid should be free of copper ions and other heavy metal ions. Otherwise enhanced corrosion of the cooling channels can occur. Demineralised water may only be used if supplemented with a corrosion inhibitor and a biocidal additive.

### Note:

If you use the varioSCAN<sub>de</sub> together with an XY scan system, then also refer to the corresponding manual for water cooling supply specifications and installation instructions.

## 4.3 Mounting the SCANLAB Electronic Box

SCANLAB offers an electronic box, which includes the varioSCAN<sub>de</sub>'s DSCB digital control board together with a digital interface board.

Together with a DSIBLWL interface board, the electronic box also includes the LWL adapter board and provides ST connectors at its housing for attaching a fiber optics cable.

The electronic box offers the following benefits:

- The boards are protected from humidity, dust and corrosive vapors as well from damage by mechanical stress and electrostatic charges.
- The boards needn't to be interconnected by the customer.

At its housing, the electronic box provides output connectors for attaching the varioSCAN<sub>de</sub> (see figure 9 on page 22). In addition it provides input connectors for connecting the power supply and the system control. These input connectors can vary depending on the included interface board.

To make sure the temperature of the electronics in the electronic box does not rise too high, it is important to fix the box on a heat sink or an appropriate-sized part of a housing. The material and the dimension of the heat sink must be chosen such that the temperature of the electronic box does not exceed 50 °C.

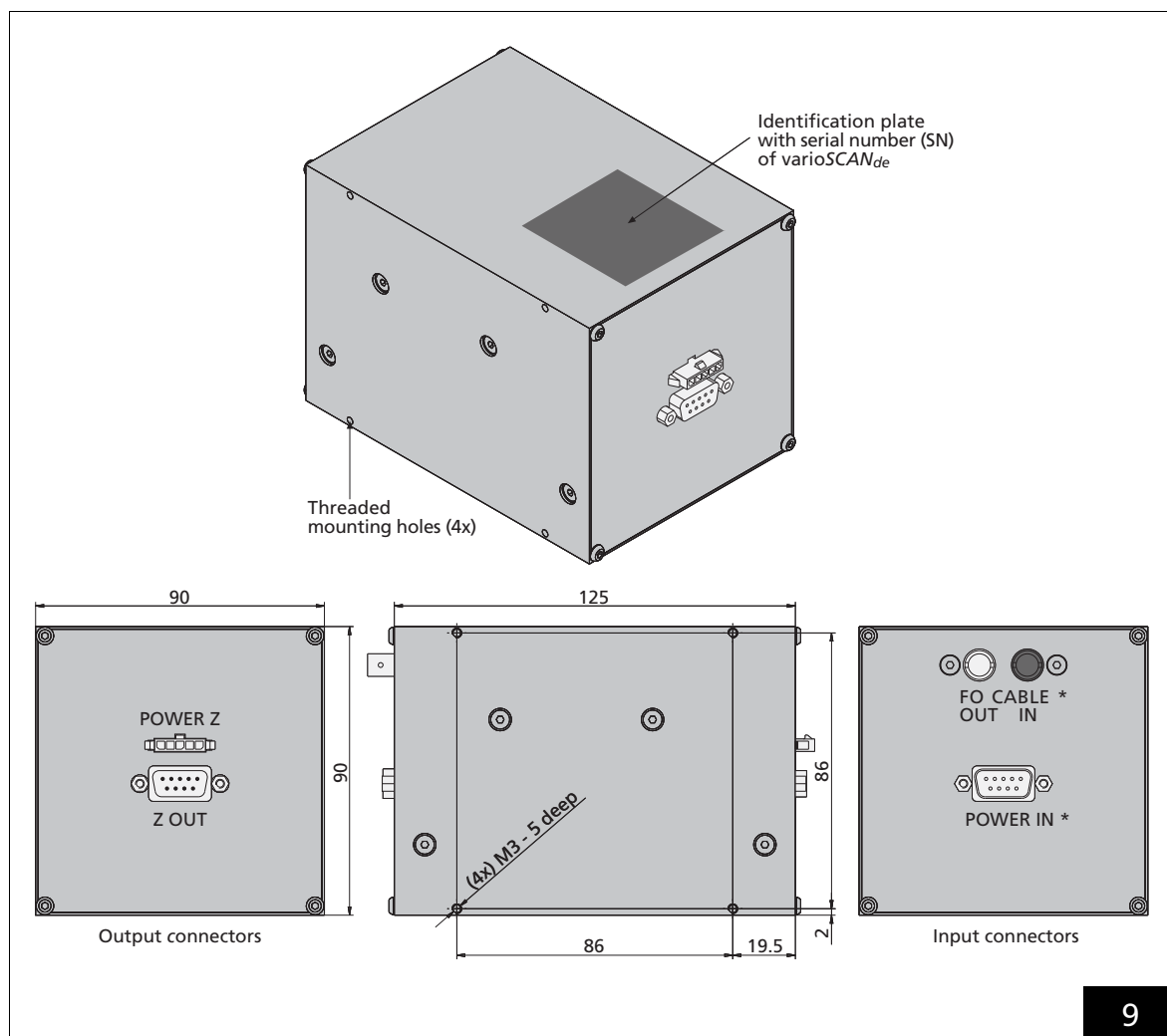
For fastening, the electronic box provides four threaded holes (M3) (see figure 9 on page 22).



### Caution!

- To avoid damaging the electronic box, please handle it with care.
- Prevent the temperature of the box from rising excessively.
- When mounting the board, use only the M3 threaded holes shown figure 9.

- ▶ Mount the electronic box via the four threaded holes (M3) at the side of the housing.



Electronic box – Example

\* The input connectors can vary depending on the included interface board (see chapter 5.1 on page 24).

## 4.4 Operating and Storage Conditions

For operating, storing and servicing the varioSCAN<sub>de</sub>, make sure the following ambient conditions are met:

- The ambient temperature for operation must be between +15 °C and +35 °C.
- The storage temperature must not fall below –35 °C and must not exceed +60 °C.



### Caution!

For storage, make sure to remove all water from the device's water-cooled parts.

- Protect the varioSCAN<sub>de</sub> from humidity, dust and corrosive vapors to avoid damaging the optics and electronics.

Avoid electromagnetic fields and static electricity. These can damage the electronic components on the control board.



### Caution!

SCANLAB strongly recommends to operate the varioSCAN<sub>de</sub> with appropriate water cooling only.

## 5 Electrical Connections

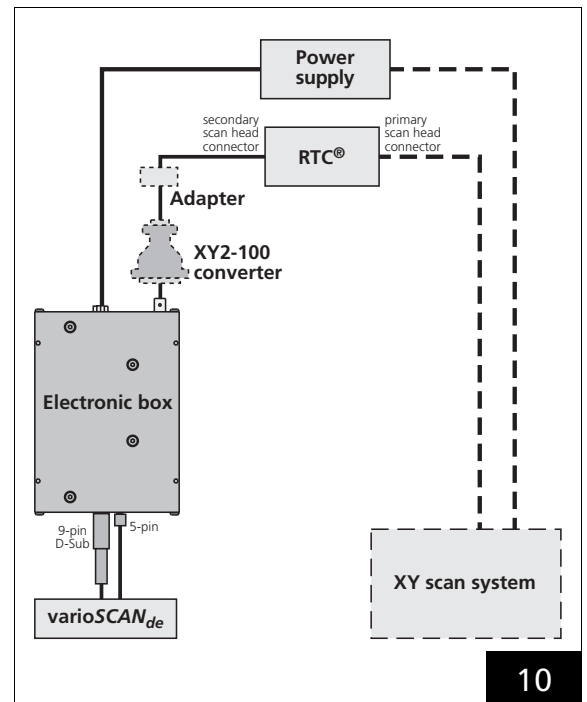
This chapter shows, how the varioSCAN<sub>de</sub> can be connected to an RTC control board and to power supply.

Depending on the used RTC board and the configuration of the entire 3-axis scan system, the varioSCAN<sub>de</sub> will be connected to an RTC control board via the DSCB control board and a SCANLAB digital interface board, both integrated in the SCANLAB electronic box (see chapter 5.1).

Important notes regarding the data cable between interface board and RTC control board are listed in chapter 5.2 on page 28 and regarding the power supply in chapter 5.3 on page 30.

### 5.1 Control via Boards in the SCANLAB Electronic Box

The varioSCAN<sub>de</sub>'s DSCB control board and the SCANLAB digital interface board are integrated into the optional SCANLAB electronic box. Power supply and data transfer occur via this electronic box. After mounting the system components, connect the components as described below.



System cabling

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### Caution!

- When wiring the system, make sure none of the wires carry any voltages. All control devices must be turned off.
- Always turn off the power supply before connecting or disconnecting the power cables or data cables.
- Follow all electrical specifications exactly.



## Connecting the varioSCAN<sub>de</sub>

The varioSCAN<sub>de</sub> and the DSCB control board integrated in the electronic box are one functional unit. Do not interchange the control boards. Optimum positioning quality cannot be guaranteed, if control boards are interchanged. Therefore, if you received more than one electronic box, make sure the various electronic components are properly combined. To help achieve this, the identification plate of each electronic box is marked with the serial number of its assigned varioSCAN<sub>de</sub>.

The two cables connecting varioSCAN<sub>de</sub> and electronic box are part of the varioSCAN<sub>de</sub>. The default cable length including connector is approx. 0.5 m.

- ▶ Connect the varioSCAN<sub>de</sub> to the 9-pin Z OUT D-SUB connector and the 5-pin POWER Z connector of the electronic box (see figure 9 on page 22).

## Connecting the RTC Board

The electronic box provides input connectors at its housing for connecting the power supply and the system control. These input connectors can vary depending on the included interface board (see figure 11 on page 27).

### DSIB Digital Interface Board (XY2-100)

If SCANLAB's DSIB digital interface board is integrated in the electronic box, the box provides a 25-pin DIGITAL IN D-SUB connector for electrical data transfer via the XY2-100 Enhanced protocol (pin-out, see DIGITAL IN in figure 11 on page 27). Here, the DIGITAL IN connector can be connected

- to an RTC3 board (with enabled 3D option and enabled "second scan head" option),
- to an RTC4 or RTC SCANalone board (with XY2-100 interface, with enabled 3D option and enabled "second scan head" option) or
- via an XY2-100 converter to an RTC5 board (with enabled 3D option).

- ▶ Connect the DIGITAL IN connector via an appropriate data cable to a scan head connector of the RTC board.
  - Typically, the XY scan system is connected to the RTC's primary scan head connector and the varioSCAN<sub>de</sub> to the secondary scan head connector, but inverse connection is also possible. Take care to correctly assign the correction file (see page 33).
  - For connecting to an RTC5 board, an XY2-100 converter must be used.

Optionally appropriate data cables are available from SCANLAB. SCANLAB data cables provide 25-pin male D-SUB data connectors at both ends matching the DIGITAL IN connector and the RTC board's primary scan head connectors (25-pin female D-SUB) or the XY2-100 converter (also see page 28).

For connecting a data cable with its D-SUB connector (or the XY2-100 converter) to the RTC board's secondary scan head connector (which is not a D-SUB connector), appropriate adapters are available from SCANLAB.

### DSIBLWL Digital Interface Board (XY2-100-O)

If SCANLAB's DSIBLWL digital interface board is integrated in the electronic box, the box provides a pair of ST connectors for optical data transfer via the XY2-100-O protocol (see FO CABLE in figure 11 on page 27). Here, the pair of ST connectors can be connected

- to an RTC4 board (with XY2-100-O interface, with enabled 3D option and enabled "second scan head" option) or
- to an RTC SCANalone board (with XY2-100-O interface and with enabled 3D option).

### Note:

The RTC SCANalone with XY2-100-O interface board provides only one scan head connector. Therefore, the RTC SCANalone can only control either the varioSCAN<sub>de</sub> or an XY scan system.

Optical data transmission occurs via an optical fiber. SCANLAB recommends to use a 1-mm diameter duplex plastic fiber (POF - Polymer Optical Fiber) with a maximum length of 30 m. Each end of the optical fiber must be terminated with a pair of ST connectors. Optionally an appropriate optical fiber cable is available from SCANLAB.

- ▶ Connect the pair of ST connectors of the electronic box to the pair of ST connectors on the RTC board by using a cross-wired optical fiber (not 1:1).

Typically, the XY scan system is connected to the RTC4's primary scan head connector and the varioSCAN<sub>de</sub> to the secondary scan head connector, but inverse connection is also possible (the RTC SCANalone with XY2-100-O interface board provides only one scan head connector). Take care to correctly assign the correction file (see page 33).

#### DSIB-SL Digital Interface Board (SL2-100)

If SCANLAB's DSIB-SL digital interface board is integrated in the electronic box, the box provides a 9-pin SL2-100 D-SUB connector for electrical data transfer via the SL2-100 protocol (pin-out, see SL2-100 in figure 11 on page 27). Here, the SL2-100 connector can be connected to an RTC5 or RTC5 PC/104-Plus board (with enabled 3D option).

- ▶ Connect the SL2-100 connector via an appropriate data cable to a scan head connector of the RTC board.

Typically, the XY scan system is connected to the RTC's primary scan head connector and the varioSCAN<sub>de</sub> to the secondary scan head connector, but inverse connection is also possible. Take care to correctly assign the correction file (see page 33).

Optionally appropriate data cables are available from SCANLAB. SCANLAB data cables provide 9-pin male D-SUB data connectors at both ends (also see page 28) matching the SL2-100 connector and the RTC5 board's primary scan head connectors (9-pin female D-SUB).

For connecting a data cable with its D-SUB connector to the RTC5 board's secondary scan head connector or to the scan head connectors of the RTC5 PC/104-Plus board (which are not D-SUB connectors), appropriate adapters are available from SCANLAB.

## Connecting the Power Supply

Depending on the included interface board, the electronic box provides a 9-pin male D-SUB or a 3-pin male D-SUB POWER IN connector for the power supply at its housing (pin-out, see POWER IN in figure 11 on page 27).

- ▶ Connect the power supply via an appropriate cable to the POWER IN connector.
- ▶ Exactly follow all electrical specifications in chapter 5.3 on page 30.

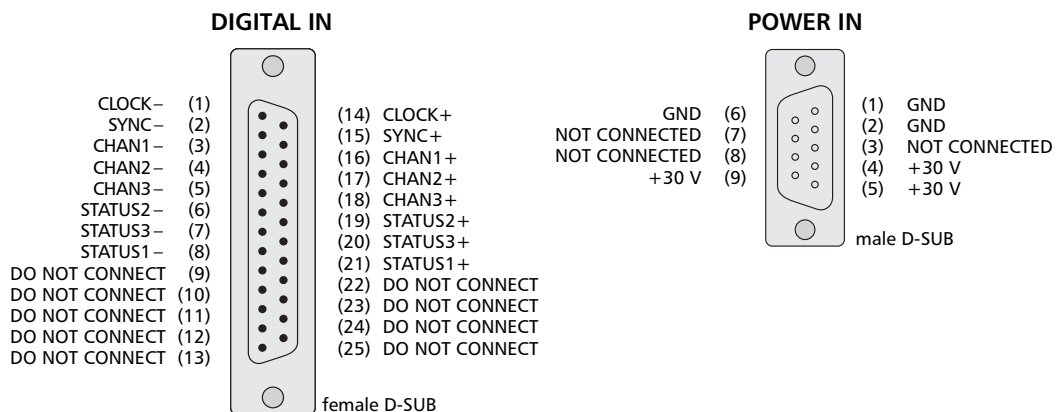
The varioSCAN<sub>de</sub> and the XY scan system need to be separately supplied with power.

The power supply and the data interface are galvanically isolated from each other.

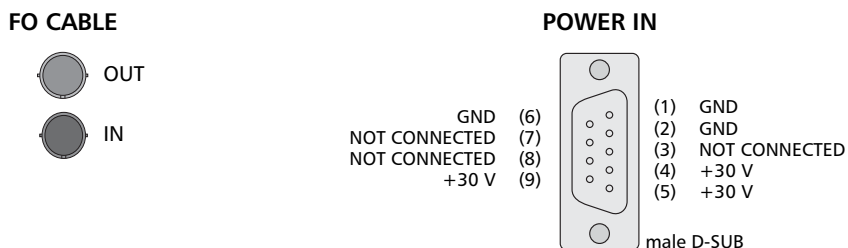
## Connecting the XY Scan System

How to connect the XY scan system to the power supply and to the RTC board, please refer to the corresponding manual.

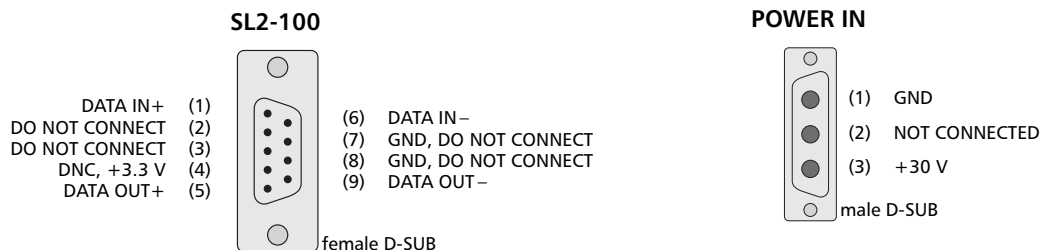
## DSIB (XY2-100 Enhanced)



## DSIBLWL (XY2-100-O)



## DSIB-SL (SL2-100)



Pin-out of electronic box's input connectors (the connectors depend on the integrated interface board)

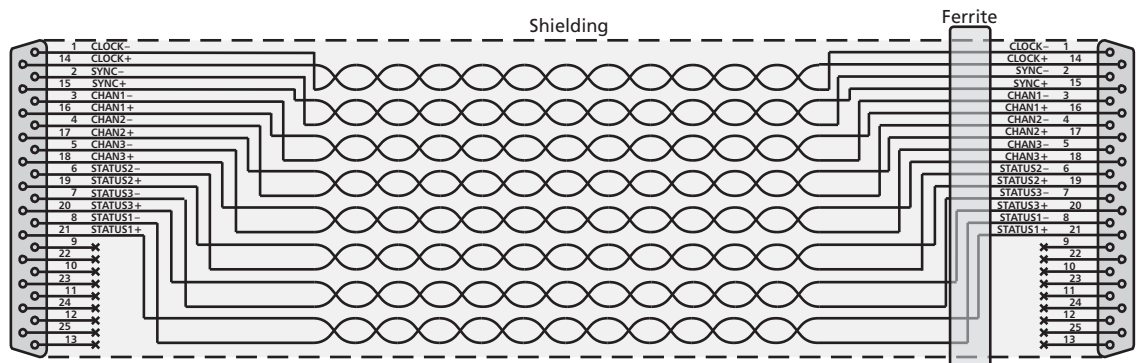
## 5.2 Data Cable Guidelines

If the data cable between RTC control board with XY2-100 Enhanced interface and a DSIB interface board (integrated in the electronic box) or the data cable between RTC5 control board and a DSIB-SL interface board (integrated in the electronic box) is not included in the package, SCANLAB strongly recommends the following cable configuration (data cable layout and pin assignments are shown in figure 12 on page 29):

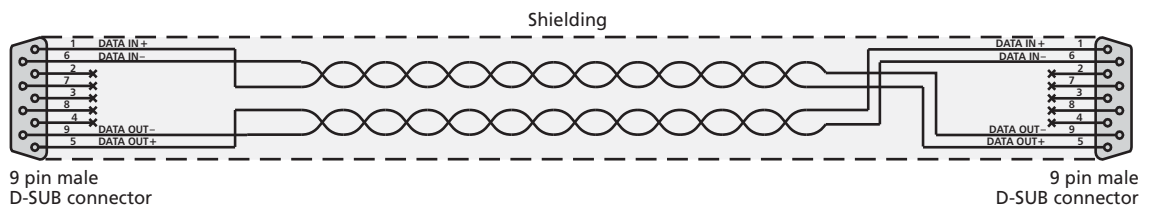
- The data cable between RTC control board with XY2-100 Enhanced interface and a DSIB interface board (for data transfer according to the XY2-100 protocol, see figure 12 top) must be fitted with 25-pin male D-SUB connectors with identical pin-out at both ends.  
The 8 channels  $CLOCK_{\pm}$ ,  $SYNC_{\pm}$ ,  $CHAN1_{\pm}$ ,  $CHAN2_{\pm}$ ,  $CHAN3_{\pm}$ ,  $STATUS2_{\pm}$ ,  $STATUS3_{\pm}$ ,  $STATUS1_{\pm}$  (16 wires) must be realized as twisted cable pair, each.  
The data cable's controller end must be fitted with a ferrite ring (e.g. Würth WE 742 711 32).  
The cable should not be longer than 10 m. If a longer data cable is needed, the signal timing of the RTC control board should be adjusted to ensure correct communication between the RTC and the interface board. (For details, see RTC command **set\_piso\_control** in the RTC manual.)
- The data cable between RTC5 control board and a DSIB-SL interface board (for data transfer according to the SL2-100 protocol, see figure 12 bottom) must be fitted with 9-pin male D-SUB connectors with identical pin-out at both ends.  
The 2 channels  $DATA\ IN_{\pm}$  and  $DATA\ OUT_{\pm}$  (4 wires) must consist of twisted cable pairs and be *cross-connected* at both D-SUB connectors (so that the RTC5 board's DATA OUT signal flows to the focusing unit's DATA IN input).  
The cable length should not exceed 25 m.  
SCANLAB recommends a cable impedance of 110  $\Omega$ , independent from the cable length.

- All data cables must have coaxial copper braided shielding and the D-SUB connectors must have fully shielded metal housings.  
The electrical connection of the cable's braided shielding to the D-SUB housing should *not* be implemented as a wire. Instead, the cable's braided shielding should be *coaxially* connected to the D-SUB housing via shielded clamps.

Data cable for data transfer according to the XY2-100 protocol:



Data cable for data transfer according to the SL2-100 protocol:



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Pin-out and layout of the data cables (25-pin and 9-pin)

## 5.3 Power Supply

### Requirements

The varioSCAN<sub>de</sub> requires a power source of 30 V (29 - 33 V) or alternatively a balance source of  $\pm(15+1.5)$  V DC with a maximum current of 1.5 A. The residual ripple of the power source should not exceed 100 mV<sub>pp</sub>.

The varioSCAN<sub>de</sub> provides reverse-polarity protection and start-up current limiting. The power supply and the data interface are galvanically isolated from each other.

The supply voltages are monitored by the DSCB board (see "Assuring Reliable Power Supply" on page 9).

For information about the power supply requirements of your XY scan system, please refer to the corresponding manual.

### Connection

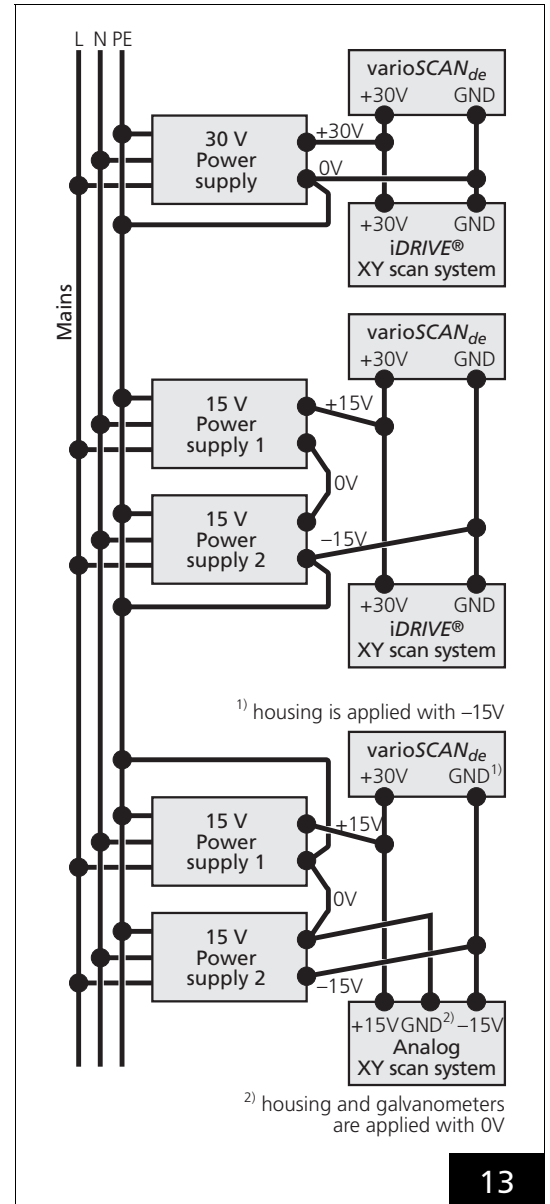
The varioSCAN<sub>de</sub>'s DSCB control board must be connected to a SCANLAB digital interface board and then always receives power via this interface board. If the electronic box is used, control board and interface board are already connected.

**Note:** The varioSCAN<sub>de</sub> and the XY scan system must be separately supplied with power.

When connecting the power supply, please observe the following guidelines:

- ▶ Make sure each power connection has the correct polarity.
- ▶ Connect the poles of the power source via an appropriate cable to the respective pins of the varioSCAN<sub>de</sub>'s connector (at electronic box). The cable connecting the power supply and the varioSCAN<sub>de</sub> must be shielded and should have a cross-sectional area of at least 1.5 mm<sup>2</sup> per pole and a length not exceeding 6 meters. RFI must be minimized by connecting the cable's shielding at one end (utilizing a large surface area) to the power supply's metal shielding and at the varioSCAN<sub>de</sub>-end to the housing's D-SUB connector.

- ▶ If you connect an XY scan system and the varioSCAN<sub>de</sub> to the same power supply but not to a common digital interface board, then please observe the following notes (also see figure 13):



Connection to the mains' grounding wire (PE).

- If a power supply of +30 V is used for the varioSCAN<sub>de</sub> and an iDRIVE scan system (intelliSCAN, intellicube or intelliDRILL), then connect the 0 V connection of the power supply's output side to the mains's grounding wire (PE).
- If a power supply of  $\pm 15$  V is used for the varioSCAN<sub>de</sub> and an iDRIVE scan system, then connect the  $-15$  V connection of the power supply's output side to the mains's grounding wire (PE)
- If a power supply of  $\pm 15$  V is used for the varioSCAN<sub>de</sub> and an analog XY scan system, then connect the 0 V connection of the power supply's output side to the mains's grounding wire (PE).



### Caution!

In this constellation, the varioSCAN<sub>de</sub>'s GND connector, i.e. the varioSCAN<sub>de</sub>'s electronics and housing is connected to  $-15$  V.

The housing must be mounted necessarily potential free.

- If two different power supply units are used, then connect the varioSCAN<sub>de</sub>'s GND connector with the XY scan systems's GND connector.
- In any case, you must insulate the varioSCAN<sub>de</sub> or its clamping block electrically to ensure reliable operation.

## 6 System Control

### 6.1 Position Control

#### Digital control via a SCANLAB digital interface board (without RTC board)

If the varioSCAN<sub>de</sub>'s DSCB digital control board is connected to a SCANLAB digital interface board, the varioSCAN<sub>de</sub> can be controlled via digital signals. The extremal positions of the varioSCAN<sub>de</sub>'s moved diverging optic are reached via the maximum and minimum allowed set values (together with an DSIB or DSIBLWL interface board, these are 65536 and 0; together with an DSIB-SL interface board, these are +524287 and -524288). An increase of the specified value moves the varioSCAN<sub>de</sub>'s diverging optic to the direction of the varioSCAN<sub>de</sub>'s beam exit and increases the varioSCAN<sub>de</sub>'s focal length.

#### Digital control with RTC board

If the varioSCAN<sub>de</sub>'s DSCB digital control board is connected to a SCANLAB RTC control board via a SCANLAB digital interface board, the varioSCAN<sub>de</sub> can be controlled via RTC commands from a controlling PC. These commands can be integrated into a customer-specific application (e.g. a C program) and allow to specify the desired position in the processing volume. The controlling PC with RTC control board delivers the corresponding position signals (set values) for the varioSCAN<sub>de</sub> (and the XY scan system's galvanometer scanners).

Thereby – with the help of a 3D correction table included in a 3D correction file in the RTC software – the RTC control board

- calculates appropriate varioSCAN<sub>de</sub> focal lengths for each XY position sent to the XY scan system and
- compensates distortions of the image field caused by the scan system's two-mirror configuration or by the shift of the working plane.

The correction file is specific for a certain working distance, field size and optical configuration of the varioSCAN<sub>de</sub>. For details, refer to the section "3D Correction Table Assignment" on page 33 or the RTC manual.

In the RTC command set, the desired X, Y and Z values for the XY scan system and the varioSCAN<sub>de</sub> must be specified as bit values, which are calculated via multiplying the desired values in [mm] with the calibration factor K in [bits/mm]. The calibration factor K in [bits/mm], the usable image field size in [mm<sup>2</sup>] and the allowed range for the Z values in [mm] (maximum focus shift in Z direction) are specified in "Technical Specifications" on page 48.

The reference system for the image field which is used by the RTC boards is shown in figure 4 on page 10. The Y axis points in the reverse direction of the input laser beam, the Z axis points in the reverse direction of the output laser beam (X axis, Y axis and Z axis form a right-handed reference system). The extremal positions of the moved diverging optic are reached via the maximum and minimum allowed Z values (set values) +32767 and -32768. An increase of the specified bit value moves the varioSCAN<sub>de</sub>'s diverging optic to the direction of the varioSCAN<sub>de</sub>'s beam input and decreases the varioSCAN<sub>de</sub>'s focal length.

#### Notes:

- Control of the varioSCAN<sub>de</sub> with an RTC board is only possible if the RTC board's 3D option is enabled.
- The RTC commands are described detailed in the manual of your RTC board.
- For RTC3, RTC4 and RTC SCANalone boards, the calibration factor is equal for the X, Y and Z directions. For this boards, ctb correction files must be used.
- For RTC5 and RTC5 PC/104-Plus boards, the calibration factor is equal only for the X and Y directions, but is different for the Z axis:  $K_z = K_{xy} / 16$ . For this boards, ct5 correction files must be used.



## 3D Correction Table Assignment

With the help of 3D correction tables, the RTC control board calculates appropriate varioSCAN<sub>de</sub> focal lengths for each position in the processing field or volume. A correction table can be loaded to the RTC board from a 3D correction file included in the RTC software via the RTC command **load\_correction\_file**. Afterwards, the correction table must be assigned to the desired scan head connector of the RTC board via the RTC command **select\_cor\_table**.

Please note, that the RTC5 board needs other correction files than the RTC3, RTC4 and RTC SCANalone boards and that the correction table assignment for the RTC5 board differs from that for the RTC3, RTC4 and RTC SCANalone boards (also refer to the manual of your RTC board):

### RTC3, RTC4 and RTC SCANalone board

The digital interfaces of the RTC3, RTC4 and RTC SCANalone boards allow transmission of X, Y and Z data via one scan head connector.

Correction tables for these boards can be loaded from 3D correction files with the name/format 3D\_XXX.ctb.

Assign the correction table as follows:

- ▶ If the varioSCAN<sub>de</sub>'s DSCB digital control board is connected to a SCANLAB XY scan module, then assign the correction table to that scan head connector to which the XY scan module is connected.  
Example: If the XY scan module is connected to the primary scan head connector, then assign the 3D correction table to this scan head connector via **select\_cor\_table(1,0)**.
- ▶ If the varioSCAN<sub>de</sub>'s DSCB digital control board is connected to a separate SCANLAB digital interface board, then assign the correction table to that scan head connector to which this digital interface board is connected.  
If – additionally – an XY scan system is connected to the other scan head connector, then assign the same correction table to both scan head connectors via **select\_cor\_table(1,1)** (in this last case, the RTC control board's "second scan head" option must be enabled additionally to the 3D option).

### RTC5 or RTC5 PC/104-Plus board

The digital interfaces of the RTC5 and RTC<sup>®</sup>5 PC/104-Plus boards allow transmission of X, Y data via one scan head connector and of Z data via both channels of the other scan head connector.

Correction tables for these boards can be loaded from 3D correction files with the name/format 3D\_XXX.ct5.

Here the varioSCAN<sub>de</sub> can only be controlled via a separate digital interface board.

- ▶ Assign the correction table to that scan head connector to which the varioSCAN<sub>de</sub>'s digital interface board is *not* connected.  
Example: If the varioSCAN<sub>de</sub>'s digital interface board is connected to the primary scan head connector, then assign the 3D correction table to the secondary scan head connector via **select\_cor\_table(0,1)**.

## 6.2 Returned Signals

### Digital control via a SCANLAB digital interface board (without RTC board)

If the varioSCAN<sub>de</sub>'s DSCB digital control board is connected to a SCANLAB digital interface board, the status signals generated by the varioSCAN<sub>de</sub>'s DSCB board are returned as digital values via the status channel of the digital interface board (for the returned data types see next section).

### Digital control with RTC board

If the varioSCAN<sub>de</sub>'s DSCB digital control board is connected to a SCANLAB RTC control board via a SCANLAB digital interface board, the status signals generated by the varioSCAN<sub>de</sub>'s DSCB board (and the XY scan system) are returned for evaluation to the RTC control board via the digital interface board. RTC commands as **get\_head\_status** or **get\_value** can be used to query the current status. These commands can be integrated into a customer-specific application (e.g. a C program) to define status-dependent process sequences.

The varioSCAN<sub>de</sub>'s digital servo architecture allows a wide variety of data signals to be returned from the DSCB digital control board to the RTC board via the status channel. This opens up possibilities such as monitoring the actual position of the varioSCAN<sub>de</sub> during execution of an application or carrying out comprehensive troubleshooting in case of operational malfunction. For the returned data signals of your XY scan system, please refer to the corresponding manual.

If the varioSCAN<sub>de</sub> is operated via an RTC4 or RTC5 PC interface board, the command **control\_command** can be used for selecting which data the varioSCAN<sub>de</sub> should return to the RTC board. The selected data sources will be transmitted until another source is selected. Data received by the RTC4 or RTC5 can be synchronously or asynchronously read at any time via additional commands (for details, refer to your SCANLAB RTC4 or RTC5 manual).

To facilitate varioSCAN<sub>de</sub> operation via other RTC boards, an XY2-100 status word is transmitted after every reboot or reset on the status channel.

### XY2-100 Status Word

Five seconds after every reboot or reset, an XY2-100 status word is transmitted. The status word contains three status values that can be queried via the RTC command **get\_head\_status**:

- PWROK (i.e. "Power OK")  
PWROK = 0 signifies a problem in the power supply. In normal operation (after the electronic components have reached a stable operating state), the PWROK signal is 1. If the signal switches from 1 to 0 during operation, then the laser must be turned off immediately. Under some circumstances the varioSCAN<sub>de</sub> could focus the laser beam to an unintended position, which may cause health hazards and severe equipment damage. The system should be checked immediately to determine the cause.
- TEMPOK (i.e. "Temperature OK")  
The TEMPOK signal always switches from 0 to 1 within a few seconds after power-up.
- POSACK (i.e. "Position Acknowledge")  
POSACK = 1 signifies that the difference between the set value and the real position is less than 0.56% of the moved diverging optic's maximum travel distance. The POSACK signal normally switches to 1 within a few seconds after power-up. The command **control\_command** allows to set the POSACK threshold value (see "Process Monitoring" on page 36).

The Z return channel returns the varioSCAN<sub>de</sub>'s three XY2-100 status values separately from any status values of an XY scan system (in comparison, the X and Y return channels of an 2-axis or 3-axis scan system both return a logically AND-connected POSACK signal of the X and Y axis).

## Additional Data Types

When the varioSCAN<sub>de</sub> is operated via an RTC4 or RTC5 PC interface board, the command **control\_command** (see RTC4 or RTC5 manual) can be used for selecting which data the varioSCAN<sub>de</sub> should return to the RTC board. Unless the configuration is changed after reset, the XY2-100 status word will be transferred (see the previous section). The selected data is transmitted at 10 µs intervals until a different data type is requested

The following is a description of the data types that may be selected (similar data can be separately evaluated for the X- and Y-axes of a 3-axis scan system).

### Status (XY2-100)

This data type corresponds to the status word specified by the XY2-100 protocol (see the previous section).

### Actual Position

Actual position of the moved diverging optic

### Set Position

Set position of the moved diverging optic

### Position Error

Set position - Actual position  
(difference between the current actual position and the current set position of the moved diverging optic)

### Actual Current

Actual output stage current of the varioSCAN<sub>de</sub> motor

### Relative Motor Control

Control voltage (in per mille of the maximum value) of the varioSCAN<sub>de</sub> motor

### Actual Velocity

Actual velocity of the moved diverging optic

### Operational Status

The varioSCAN<sub>de</sub> provides various blocks of extended status informations.

If the first block is selected to be returned to the RTC board, then the varioSCAN<sub>de</sub>'s DSCB board provides the following information about the current operating state:

- Status of output stage (on/off)
- Status of internal voltages (all voltages o.k. or at least one internal voltage not o.k.)
- Status of external voltage (o.k. or power supply interruption)
- Status of AD converter (successfully initialized or not initialized)
- Status of booting process (complete or not yet completed)
- Status of control parameters (valid or invalid).
- Boot signal: The control is activated, as soon as all necessary flags are set
- Status of positioning (positioning error within the allowed range (< 0.56%) or not in the allowed range)
- Status of positioning (positioning within the allowed range or critical position reached)
- Temperature Status (operating temperature of DSCB board reached or not yet reached)
- Error Status (no critical error or system presently in critical error state). Critical errors are for instance:
  - improper internal voltages
  - external power supply interruption
  - reaching a critical edge position
  - reaching a critical dynamic load

If a critical error occurs, the varioSCAN<sub>de</sub> automatically enters a permanent error state, in which the output stage remains deactivated – even if the critical error was only temporarily present. Normal operation is *not* resumed.

## Note:

During permanent error states, the varioSCAN<sub>de</sub> will continue to transmit data to the RTC board. Even in these states, switching or selection of data signals for diagnostic purposes is still possible.

The second information block can be selected to be returned to the RTC board if more detailed information about the current operation state is desired. This block separately indicates potential error states of the various internal voltages and of the control board temperature.

Alternatively, two further information blocks can be selected to be returned to the RTC board: They indicate the operation states listed above at the moment of the most recently occurred operation interruption. After every successful restart – and, as long as no error has occurred – all status informations of these two blocks are irrelevant. Only, as soon as an error causes a switch into an error state, the current status values will be saved into these blocks. Simultaneously, also an event code is set, indicating which particular event caused the error state. This event code can be read out separately.

#### Temperature

The temperature of the DSCB board can be returned to the RTC board.

#### Internal Voltages

The following internal voltages can be returned to the RTC board:

- DSP core supply voltage (1.8 V)
- DSP IO voltage (3.3 V)
- Analog section voltage (9 V)
- AD converter supply voltage (5 V)

Exact values for the internal voltages can vary for different varioSCAN<sub>de</sub> versions.

#### General Information

Alternatively, the following data types may be selected:

- Serial number
- ID number
- Firmware version number
- Calibration
- Aperture
- Wavelength
- Running time

## 6.3 Process Monitoring

The varioSCAN<sub>de</sub> provides internal protective mechanisms for monitoring

- the power supply
- the position range and proper operation

(also see "Internal Protective Functions" on page 9).

In addition, when the varioSCAN<sub>de</sub> is operated via an RTC4 or RTC5 board, then the user can evaluate a number of various data signals for monitoring the position process or for test purposes (see "Returned Signals" on page 34).

For applications with critical position precision requirements, the actual position value can be monitored during the entire runtime of an application.

Alternatively, other data signals (e.g. actual velocity) can be analyzed during normal operation or even when testing user applications.

Malfunctions can be quickly detected if you regularly query (and store) the varioSCAN<sub>de</sub>'s operational states before, after or during operations. Furthermore, determination of a malfunction's cause is simplified considerably (also see "Fault Diagnosis and Functional Test" on page 47).

If scan and focus precision is monitored via the POSACK signal of the XY2-100 status word, the varioSCAN<sub>de</sub> also enables changing the POSACK threshold value via the command **control\_command**. The default start behavior is for the varioSCAN<sub>de</sub> to set the threshold value to 0.56% of the full position range (i.e. 0.56% of  $2^{16}$  counts) after every power-up or reset. If other threshold values are desired, they must be separately set for each axis.

## 6.4 Configuring the Effective Calibration

The servo electronic (digital control board) of the varioSCAN<sub>de</sub> can be configured to scale the position values received from an RTC4 or RTC5 board by a specific factor (1, 1/2, 1/4 or 1/8). The position signals (optionally) returned by the varioSCAN<sub>de</sub> to the RTC4/RTC5 remain unaffected, as do the pre-configured calibration of the varioSCAN<sub>de</sub>. However, the effective calibration can be thereby reduced to confine the movement of the diverging optic to a smaller position range – with a higher position resolution. If the effective calibration is changed, another 3D correction file has to be used.

The default start behavior is for the varioSCAN<sub>de</sub> to start with a scale factor of 1 (i.e. with SCANLAB's pre-configured calibration) upon power-up or after a reset.

## 6.5 Configuring the Start Behavior

In its default configuration the varioSCAN<sub>de</sub> is pre-configured by SCANLAB so that

- a POSACK threshold value of 0.56% of the full position range (i.e. 0.56% of  $2^{16}$  counts) is set (also see "Process Monitoring" on page 36),
- a scale factor of 1 is set (also see "Configuring the Effective Calibration" on page 37).

The settings can be changed via the **control\_command**. The changed settings are only temporary, however they can be additionally saved as starting settings for subsequent power-ups or resets (power supply switched off and switched on) via the **control\_command**.

As long as the start behavior is not changed as described, the varioSCAN<sub>de</sub> starts with the starting settings pre-configured by SCANLAB on every power-up or reset.

The status return behavior of the varioSCAN<sub>de</sub> can only be temporarily changed. The corresponding start behavior is fixed by SCANLAB: after every restart, the scan system transmits the XY2-100 status word (also see page 34).

## 7 Start-Up and Operation

### 7.1 Checking the Installation

Before starting-up the varioSCAN<sub>de</sub>, carefully check the following:

- If protective covers or stickers have been installed at the varioSCAN<sub>de</sub>'s entrance and exit apertures, have they been removed?
- Were the mechanical installation and electrical wiring fully and correctly carried out as described in the preceding chapters?
- Are the water cooling facilities properly connected to the varioSCAN<sub>de</sub> (see page 20)?
- Is the varioSCAN<sub>de</sub>'s objective clean and free of dust? If necessary, clean the objective as described in "Routine Maintenance and Customer Service" on page 44.

### 7.2 Checking the Laser Parameters

The varioSCAN<sub>de</sub> is designed for a laser beam with defined parameters.

- ▶ Compare the technical specifications on page 48 with the requirements of your application. For information on tolerances and deviations, please contact SCANLAB.
- ▶ Verify that the input beam wavelength, the input beam diameter and the maximum laser power are compatible with the varioSCAN<sub>de</sub>'s specifications.



#### Caution!

- The AR coating of the optics is designed for a laser wavelength of 1030 nm - 1090 nm. The other technical data are specified for a laser wavelength of 1064 nm.
- The beam diameter at the entrance of the varioSCAN<sub>de</sub> must not exceed 7 mm.



#### Caution!

- The beam diameter at the entrance of the XY scan system must not exceed 14 mm.
- Do not operate the varioSCAN<sub>de</sub> with laser powers exceeding the specified maximum laser power (see page 48). If you want to use a higher laser power, but no maximum laser power with cooling is specified, please ask SCANLAB.
- At the beam entrance of the varioSCAN<sub>de</sub>, the maximum laser power density of 1000 W/cm<sup>2</sup> (without cooling) / 2000 W/cm<sup>2</sup> (with specified cooling) continuous wave must not be exceeded.
- SCANLAB strongly recommends to operate the varioSCAN<sub>de</sub> with water cooling only.

To integrate the varioSCAN<sub>de</sub> into the 3-axis scan system, SCANLAB recommends the setup shown in figure 14 on page 39.

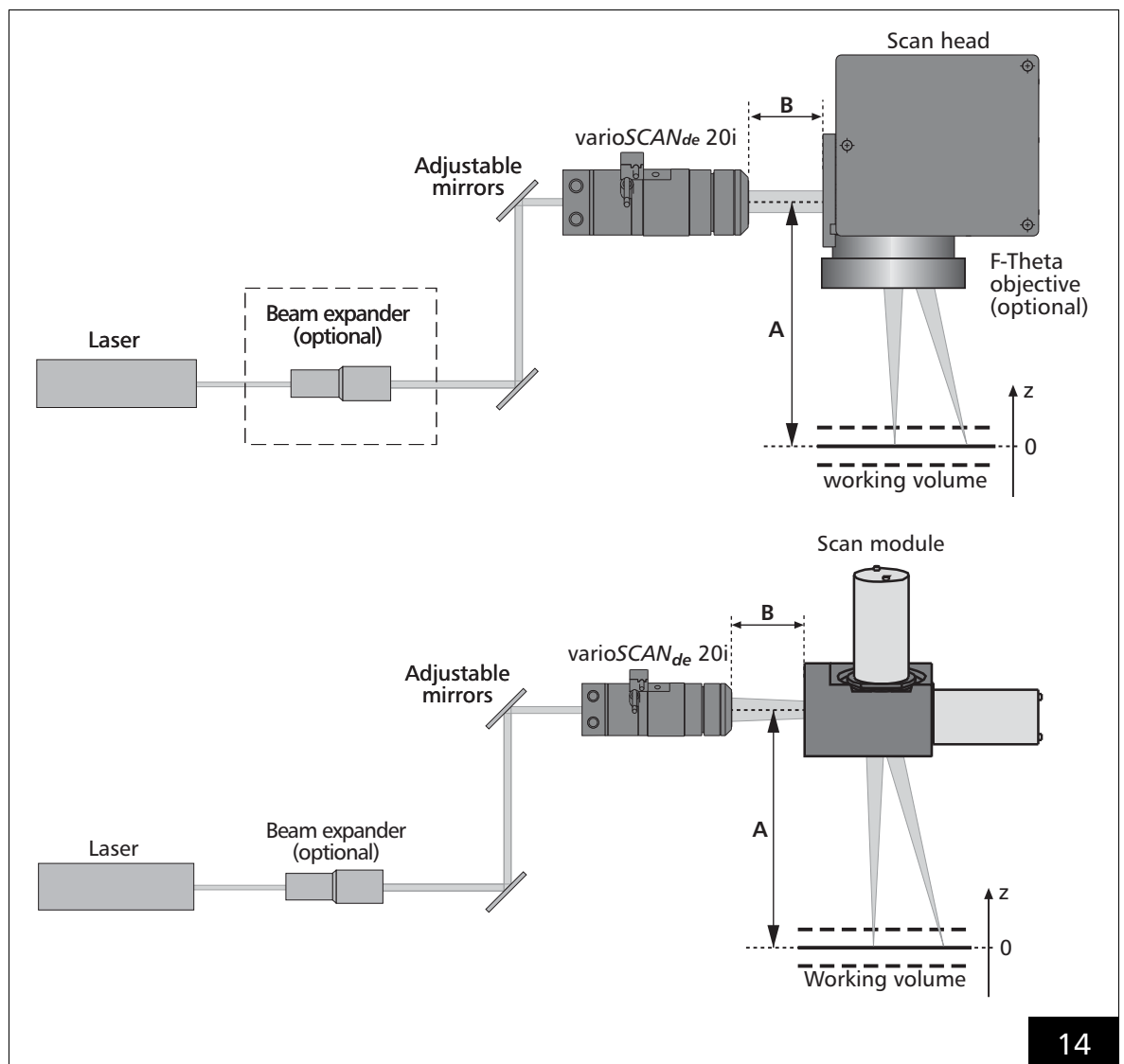
If the beam expansion factor of the varioSCAN<sub>de</sub> is not sufficient to expand the laser beam to the nominal aperture of the XY scan system, then an additional beam-forming device, for example a beam expander, must be added to the system. The beam expansion factor of the varioSCAN<sub>de</sub>'s lens configuration is listed in "Technical Specifications" on page 48.

If the beam is not expanded to match the aperture of the XY scan system, the scanning quality will be reduced. Furthermore, damage to the scan system can occur.

If the diameter of the laser beam entering the XY scan system is too small, the focused spot size on the marking field will not be as small as theoretically possible. Furthermore, the laser power density applied to the optical elements inside the scan system will be higher and this might lead to damage.

If, on the other hand, the diameter of the beam entering the XY scan system is too large, there will be a loss of power at the entrance aperture of the scan system. This will reduce power density at the focused spot and might also lead to damage.

The laser beam must be very precisely aligned with respect to the optical axis of the varioSCAN<sub>de</sub>. Therefore, two adjustable mirrors should be placed in the beam path, ahead of the varioSCAN<sub>de</sub>, as shown in figure 14. For details, see "Alignment and Adjustment" on page 41.



Setup of the 3-axis scan system – Definition of the working distance A, the distance B and the origin of the Z-axis

## 7.3 Safe Start-up and Shutdown Sequences

To assure safety during start-up, proceed exactly as follows:

- (1) Start up the water cooling facilities and monitor the flow to assure reliable cooling.
- (2) Turn on the controlling PC containing the RTC control board and start up the control software.
- (3) Turn on the power supply for the varioSCAN<sub>de</sub> and the XY scan system.
- (4) Turn on the laser.

When shutting down the system, turn off the components exactly in reverse order.



### Caution!

- Operate the varioSCAN<sub>de</sub> only with appropriate water cooling.
- Always turn on the controlling PC with RTC control board and control software and the power supply for the varioSCAN<sub>de</sub> and the XY scan system prior to turning on the laser. Otherwise the laser beam might be deflected in an arbitrary direction and severe equipment damage can occur.
- Power for the varioSCAN<sub>de</sub> and the XY scan system must be applied only when the control is active.



### Caution!

- When switching on the varioSCAN<sub>de</sub>, it will initially drive to its limit stop and subsequently searches the reference mark. If the reference mark is *not* found, the varioSCAN<sub>de</sub>'s offset (focus reference position) may be shifted.
- Together with an RTC4 or RTC5 board, the command **control\_command(Data = 0528<sub>H</sub>)** (see RTC manual) can be used to query, whether the reference mark has been found or not. If the reference mark has been found, flag B6 of the returned data signal is 1 ("AD converter successfully initialized"), otherwise this flag is 0.
- If the reference mark is repeatedly not found, please contact SCANLAB for support.



## 7.4 Alignment and Adjustment

To ensure optimum performance of the laser scanning system, it is crucial that the varioSCAN<sub>de</sub>, the laser beam and the XY scan system (scan head or scan module) are precisely aligned with respect to each other. Incorrect alignment might lead to the following effects:

- vignetting of the laser beam
- a large, irregular spot
- arbitrary translation of the image field

In most cases, vignetting will be the predominant effect. Vignetting occurs if the laser beam is not able to fully pass through or be reflected by the optical components. Part of the beam's diameter will be cut off, resulting in power loss and possible system damage due to excessive absorption of laser power. Therefore, the alignment procedure must be carried out with considerable care.

### Recommended Tolerances

To avoid significant vignetting, the system must be aligned as precisely as possible. If the laser beam profile is gaussian, the maximum tolerances appropriate for most applications are:

#### Beam Position

(relative to the optical axis of the varioSCAN<sub>de</sub>)

- tilt of the laser beam: < 5 mrad
- displacement: < 0.3 mm

#### Position of the XY Scan System with Respect to the varioSCAN<sub>de</sub>

(relative to the input aperture of the XY scan system)

- tilt < 5 mrad
- displacement: < 0.3 mm

If you use a laser with a "flat top" beam profile, it can be necessary to align the scan system with even higher precision. Avoid vignetting, especially with high power lasers. Align carefully and – if necessary – reduce the beam diameter to an appropriate value.

## Aligning the Components

Prior to aligning and adjusting the components, the following steps must have been carried out:

- ▶ Suitable arrange all components of the system, including the laser, the beam expander (optional), the adjustable mirrors and the XY scan system (see figure 14 on page 39).
- ▶ If present, remove the protective covers or stickers from the varioSCAN<sub>de</sub>'s beam entrance and beam exit.

For alignment, follow the steps listed below:



### Danger!

- During installation or operation of the varioSCAN<sub>de</sub>, never stare directly into the laser beam or its deflected radiation. Keep all parts of the body away from the laser beam and the deflected radiation. (Also refer to the chapter "Laser Safety" on page 15.)
- Adjust the output beam path by means of a laser with a laser class not higher than 2.

- ▶ The first element to align is the beam expander. The position of the beam expander should be adjusted so that the laser beam coincides with the optical axis of the beam expander. The beam expander must provide the correct expansion factor – i.e. after the laser beam passes through the beam expander, the diameter of the beam has to match the entrance aperture of the varioSCAN<sub>de</sub> – and after passing the varioSCAN<sub>de</sub>, the diameter of the beam has to match the aperture of the XY scan system – (also see "Checking the Laser Parameters" on page 38).
- ▶ Make sure that the beam is parallel after leaving the beam expander.
- ▶ Remove the varioSCAN<sub>de</sub> temporarily from the beam path.
- ▶ Adjust the adjustable mirrors preceding the XY scan system such that the laser beam enters the scan system in the center of the entrance aperture and perpendicular to the plane of the entrance aperture.

- Place the varioSCAN<sub>de</sub> into the beam path again and make sure that the beam leaving the varioSCAN<sub>de</sub> still enters the XY scan system in the center of the beam entrance aperture and perpendicular to the plane of the entrance aperture. This should be achieved – if possible – by moving *only* the varioSCAN<sub>de</sub> to the correct position and orientation. If additional corrections are necessary, the positions of the adjustable mirrors between the beam expander and the varioSCAN<sub>de</sub> can also be readjusted.

## Adjusting the Distance B

The distance **B** is defined as the distance between the exit of the varioSCAN<sub>de</sub> (with the focusing ring in null position, i.e. 2.5-3 full rotations clockwise from the innermost position) and the entrance of the XY scan system (see figure 14 on page 39).

The correct distance **B** is calculated by SCANLAB based on the optical configuration of the 3-axis scan system and on the used correction file. Please note, that it may also depend on mechanical dimensions and therefore may differ for scan heads and scan modules.

- Adjust the distance **B** to the value provided in "System-specific Characteristics of the 3-Axis Scan System" on page 49.

## Adjusting the Working Distance

To ensure that the scan system delivers good results, the following three important parameters must match:

- the working distance (mechanical distance) between the XY scan system and the  $z=0$  working plane (see **A** in figure 14 on page 39). If the XY scan system is used with an F-Theta objective, the working distance at  $z=0$  corresponds to the nominal working plane of the objective,
- the focus position or back focal length,
- the value of **A** used for control.

If there is a large deviation to the specified values, the size of the image field will change and the correction file will not correctly compensate field distortions.

Thus, the working distance must be accurately adjusted before a 3-axis system can be used for the first time in an application. (The two other parameters do not need to be adjusted.)

The exact procedure for adjusting the working distance depends on the components used. If the RTC board from SCANLAB is used for control, then proceed as follows:

SCANLAB provides you with a correction table matched to your scan system and your requirements. The working distance (mechanical distance **A**) is an important input value used for calculating this correction table. You can find the value used for the working distance in the Readme.txt file of the corresponding correction table as well as in "System-specific Characteristics of the 3-Axis Scan System" on page 49.

- Adjust the working distance (see **A** in figure 14 on page 39) between the XY scan system and the  $z=0$  working plane based on the value for working distance used by the correction table.
- Turn on the controlling PC containing the RTC control board and start up the control software.
- Turn on the power supply for the varioSCAN<sub>de</sub> and the XY scan system.
- Move the laser focus to the reference point given in the Readme.txt file as well as in "System-specific Characteristics of the 3-Axis Scan System" on page 49. If the RTC board is used, use the command `goto_xyz(X, Y, Z)`.
- Turn on the laser.
- Scan a test pattern onto the working plane near the reference point. Suitably set dynamics-related parameters so that the test patterns' target positions will be reliably reached.
- Based on the marking results, manually adjust the varioSCAN<sub>de</sub>'s focusing ring for an optimum focus position<sup>(1)</sup>.

(1) The objective with its focusing ring is fixed by a counter ring (see figure 2 on page 7). For adjusting the working distance, first loosen the counter ring via turning it counterclockwise (viewed from the beam exit side). Then adjust the focusing ring. Afterward tighten the counter ring to refix the objective.

## Checking the Z-Axis Calibration

When the laser focus is moved to an arbitrary point within the image field, the RTC board adjusts the focal length of the varioSCAN<sub>de</sub> accordingly. This requires a lookup table which is included in the 3D correction file supplied with the RTC software (for details, refer to the RTC manual or to the manual "3D Software for RTC boards").

The exact output values for the varioSCAN<sub>de</sub> depend on various parameters such as beam divergence and the tolerances of the optical components. Therefore, in some cases the pre-calculated correction table might not fit optimally to the individual scan system.

To test whether this is the case, the following procedure is recommended:

- ▶ Run a laser marking test application that covers the entire image field and, if necessary, the maximum focus shift in z-direction. Check if the laser focus meets the requirements of your application.
- ▶ If you find that the spot diameter varies considerably, it might be necessary to re-calibrate the Z-axis correction table. This procedure is described in detail in the RTC manual or the manual "3D Software for RTC boards".

## 7.5 Assuring Safe Operating Temperatures and Current Consumptions

It is strongly recommended to operate the varioSCAN<sub>de</sub> only with water cooling to draw off the heat produced by the absorbed laser power and by the motor. If the system is used without cooling, if excessive laser power or laser power density is applied at the varioSCAN<sub>de</sub> entrance or if the varioSCAN<sub>de</sub> is operated with excessive current consumption, then the varioSCAN<sub>de</sub>'s optics or motor can be destroyed.

Follow the specifications for the maximum allowed laser power in chapter 10 on page 48, the specifications for water cooling and current consumption listed in chapter 4.2 on page 20 and the specifications for the operating temperature listed in chapter 4.4 on page 23.

## 8 Routine Maintenance and Customer Service

### 8.1 Routine Maintenance of the Objective's Optical Surface

A dirty objective increases the absorption of laser power at the optical surface. Dirt, dust and other contaminants can distort the laser beam, burn into the surface and damage the objective. Consequential damage can also occur. The warranty does not cover any damage due to improper use, cleaning or handling.

Regularly check the varioSCAN<sub>de</sub>'s objective. Any additional optical components in your system should also be regularly inspected and, if necessary, cleaned. Consult the manuals of these respective components for appropriate inspection and cleaning procedures.



#### Danger!

Switch off the laser and switch off the power supply prior to performing routine optics maintenance.



#### Caution!

The diverging optic inside the varioSCAN<sub>de</sub>'s motor block is a highly sensitive component that cannot be cleaned by the user. If this optic becomes contaminated, the varioSCAN<sub>de</sub> must be returned to SCANLAB for servicing.

If dirt, dust or other contaminants are found on the varioSCAN<sub>de</sub>'s objective, clean the objective's optical surface as follows:

- ▶ Using a rubber squeeze bulb or compressed clean air, blow air on the objective's surface to remove dust and dirt particles.
- ▶ If the objective is still not clean, then use solvent and lens cleaning tissues as described below:

#### Cleaning Guidelines

- Avoid skin contact with the optics.
- Use only clean lint-free tissues specially manufactured for cleaning optics (e.g. "lens cleaning paper").
- Always use lens tissues with a solvent, because dry tissue can scratch optical surfaces.
- Use a solvent like acetone or isopropanol of high purity (evaporation residue < 0.001%). Read and follow the safety advice and warnings for the solvents you will be using.
- Use clean gloves or finger cots that are impermeable to the organic cleaning solvents you will be using.
- Always wipe slowly but steadily, using a circular motion from the center of the optics around to the outer edges. Do not rub back and forth!
- Only wipe with slight pressure!

- ▶ Create a lens-tissue brush by folding a clean lens tissue so that the fold is about half as wide as the objective's lens surface.
- ▶ Dampen the lens-tissue brush with solvent. Don't use too much solvent, because otherwise drying marks might appear.
- ▶ Carefully grip one end of the dampened lens-tissue brush without touching any part of the tissue that will touch the lens surface.
- ▶ Place the dampened lens-tissue brush in the center of the objective's lens surface. Then use a *circular* motion to wipe slowly but steadily from the center of the optics around to the outer edges.
- ▶ Repeat the above steps until the objective's optical surface is completely clean. For each cleaning swipe, create a new lens-tissue brush.

## 8.2 Customer Service

### Servicing and Repairs

Except for routine maintenance of the objective's external optical surface, the varioSCAN<sub>de</sub> does not contain user-serviceable parts. All servicing and repairs should be performed at SCANLAB. Only SCANLAB has the proper test facilities and procedures to service and repair the varioSCAN<sub>de</sub>.

#### Note:

The varioSCAN<sub>de</sub> and its DSCB control board must always be sent together to SCANLAB – the varioSCAN<sub>de</sub> and the control board are one function unit!

If the DSCB control board is installed in the electronic box, this must be sent together with the varioSCAN<sub>de</sub>.

### Product Warranty

#### Note:

SCANLAB guarantees the product to be free of defects in manufacturing and material.

The varioSCAN<sub>de</sub> is maintenance-free. Routine inspection is only required for dust accumulation on the optical surfaces. Stress to the bearings varies in accordance with usage and installation circumstances.

SCANLAB recommends periodic functional testing particularly if the varioSCAN<sub>de</sub> is used in applications requiring high dynamics and very high precision.

Furthermore, SCANLAB recommends preventive bearing replacement every two to three years, or every year when used in high-dynamics and very-high-precision applications. To do so, send the varioSCAN<sub>de</sub> for servicing.

The warranty is valid for 12 months after delivery. Repairs covered under the warranty will be performed at SCANLAB.

The scope of the warranty is limited to repair or replacement of the SCANLAB product.

SCANLAB is responsible for the return delivery of products repaired under warranty; the customer is responsible for delivery to SCANLAB.

SCANLAB will not be held responsible

- when the product has been damaged through misuse or improper operation,
- for damage due to improper laser power (e.g. focused beam on optical surfaces) or improper adjustment,
- for damage to optical components caused by improper handling or cleaning,
- for consequential damages,
- if the varioSCAN<sub>de</sub> or its electronic box have been altered,
- if the warranty seal on the scan head's housing has been broken.

If a returned varioSCAN<sub>de</sub> must first be brought into a serviceable state by SCANLAB (e.g. by removing customer-added parts or cleaning the varioSCAN<sub>de</sub>) before servicing can begin, then the customer must bear the additional cost.

### Contacting SCANLAB

For service, repairs or information, simply contact SCANLAB using one of the contact possibilities listed below:

SCANLAB GmbH  
Siemensstr. 2a  
82178 Puchheim  
Germany

Tel. +49 (89) 800 746-0  
Fax: +49 (89) 800 746-199

info@scanlab.de  
www.scanlab.de

### Product Disposal

The varioSCAN<sub>de</sub> and its electronic box can be returned to SCANLAB for a fee to be properly disposed of in compliance with environmental regulations.

## 9 Troubleshooting

Problem	Possible Cause
Unable to control the varioSCAN <sub>de</sub>	<ul style="list-style-type: none"> <li>Is the varioSCAN<sub>de</sub> properly connected to the electronic box?</li> <li>Is the electronic box correctly connected to the RTC board?</li> <li>Is the electronic box correctly powered?</li> </ul> <p>Also see "Electrical Connections" on page 24.</p>
Unable to control the XY scan system	<ul style="list-style-type: none"> <li>Is the XY scan system properly connected to the RTC via the data cable?</li> <li>Is a suitable data cable used?</li> <li>Is the XY scan system correctly powered?</li> </ul> <p>Please refer to the manual of the XY scan system.</p>
Distortion of the image field	<ul style="list-style-type: none"> <li>Is the appropriate correction file loaded and activated?</li> </ul> <p>Refer to the Readme.txt file associated with the correction file.</p>
Low laser power	<ul style="list-style-type: none"> <li>Is there dirt or dust on the varioSCAN<sub>de</sub>'s objective or in the XY scan system?</li> <li>Are the XY scan system's mirrors dirty or damaged?</li> </ul> <p>See "Routine Maintenance and Customer Service" on page 44 as well as the operating manual of your SCANLAB XY scan system.</p> <ul style="list-style-type: none"> <li>Is the system correctly aligned (see page 41)?</li> </ul>
Changed laser spot	<ul style="list-style-type: none"> <li>Is the calibration of the Z axis suitably defined and the correction file calculated and loaded correctly.</li> <li>Is the laser beam still correctly adjusted?</li> </ul> <p>For troubleshooting, proceed in the following order:</p> <p>(1) Check the setup of the beam expander: Is the expansion factor appropriate? Is the laser beam parallel when leaving the beam expander?</p> <p>(2) Is the system correctly set with respect to the working distance A between the axis of the beam entering the varioSCAN<sub>de</sub> and the working plane? And is the system correctly set with respect to the distance B between the varioSCAN<sub>de</sub> and the XY scan system? (Also see "Alignment and Adjustment" on page 41.)</p> <p>(3) Verify that the laser beam coincides with the optical axis of the beam expander.</p> <p>(4) Make sure that the laser beam enters the varioSCAN<sub>de</sub> and the XY scan system in the center of the beam entrance aperture and perpendicular to the plane of the entrance aperture.</p> <p>If the "changed laser spot" problem persists, realign your system as described in "Alignment and Adjustment" on page 41.</p>
Error in positioning after a jump	<ul style="list-style-type: none"> <li>Are the values defined for the RTC jump speed set too high (consider the varioSCAN<sub>de</sub>'s dynamics) or the values defined for the jump delays set too short?</li> </ul>

If the problems persist, please contact SCANLAB (see page 45).

## Fault Diagnosis and Functional Test

If a problem occurs, the varioSCAN<sub>de</sub>'s versatile status return functions can be used for varioSCAN<sub>de</sub> diagnosis, too. These functions allow to read for instance

- the current operating state,
- the operating state at the moment of the most recently occurred operation interruption and
- an event code, indicating which particular event caused the varioSCAN<sub>de</sub> to enter an error state.

(Also see "Safety during Installation and Operation" on page 14.)

In general, all status informations can even be read after the varioSCAN<sub>de</sub> has entered an error state due to an internal protective mechanism (provided that the varioSCAN<sub>de</sub> is still sufficiently powered).

To verify that data transfer capability between the RTC board and the varioSCAN<sub>de</sub> is intact, an 8-bit value – separately for each axis – can be transmitted to the varioSCAN<sub>de</sub> via the command

**control\_command**. Subsequently, a 16-bit value will be returned on the corresponding status channel:

If data transfer is error-free, then the upper 8 bits of the returned 16-bit value will be identical with the originally sent 8-bit value, and the lower 8 bits will be identical with the complement of the sent 8-bit value. These 16-bit values will be returned until the **control\_command** is used to select another return data type.

To facilitate – after a data transfer verification – restoration of the status return behavior in effect prior to the data transfer verification, the **control\_command** allows the prior data type to be temporarily stored for later retrieval.



## 10 Technical Specifications

### Characteristics of the varioSCAN<sub>de</sub>

#### Optical Characteristics

Input clear aperture	7 mm
Beam expansion factor	2.00
AR coating	1030 nm - 1090 nm
Working wavelength	1064 nm
Maximum laser power long-term	
• without cooling	60 W
• with specified cooling	200 W
Maximum laser power density at the beam entrance	
• continuous wave, without cooling	1000 W/cm <sup>2</sup>
• continuous wave, with specified cooling	2000 W/cm <sup>2</sup>

#### Electrical Connections

Power supply	30 V DC (29–33 V), maximum 1.5 A or alternatively $\pm(15 + 1.5)$ V DC, max. 1.5 A each pole
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#### Dimensions

varioSCAN <sub>de</sub>	
– length (in neutral position)	101.5 mm
– maximum diameter	Ø44 mm
– clamping surface (see figure 6 on page 18)	Ø44 <sub>h6</sub> mm
Objective	
– outer diameter	Ø43 mm
Water cooled entrance aperture	
– length	19 mm
Electronic box	see figure 9 on page 22

#### Weight

varioSCAN <sub>de</sub> (depending on version)	500–700 g
Electronic box, incl. boards	approx. 1 kg

#### Operating and Storage Conditions

Current consumption of control DSCB board	see chapter 4.2 on page 20
Cooling water pressure	maximum 4.5 bar
Operating temperature of DSCB's angle plate	maximum 50° C
Ambient temperature for operation	25 °C ± 10 °C
Storage temperature	–35 °C to +60 °C
Environment	non-condensing, non-corrosive

Prior to storage, make sure to remove all water remaining in the water-cooled parts of the device.



## System-specific Characteristics of the 3-Axis Scan System

This varioSCAN<sub>de</sub> 20i dynamic focusing unit is designed to be used together with a intelliSCAN<sub>se</sub> 14 scan head (aperture 14 mm, calibration angle  $\pm 0.374$  rad optically with  $\pm 503316$  bit) with an F-Theta objective. The listed technical specifications refer to this scan head and the denoted F-Theta focal length and correction file. If you want to use the varioSCAN<sub>de</sub> in other optical configurations, please contact SCANLAB.

Focal length of the F-Theta objective	170 mm
Correction file (*.ctb or *.ct5)	D3_2066

### Optical Performance

Distance A (working distance, see figure 14 on page 39)	281 mm
Distance B (between the varioSCAN <sub>de</sub> and the XY scan head, see figure 14 on page 39)	107 mm
Calibration factor K (for X-, Y- and Z-axis)	518 bit/mm
Size of the image field	120 mm x 120 mm
Maximum focus shift in Z-direction	$\pm 12$ mm
Reference Point [mm, mm, mm]	(0 / 0 / -0.26)

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