

Operating Manual
Auto Focus equipment

Prior knowledge of this manual is essential for proper operation of the device. You are thus advised to familiarize yourself with its contents and, equally importantly, to follow the special notes and instructions regarding safe handling of the device.

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1 INTRODUCTION

1.1 Notes regarding operational safety

Auto Focus has been designed, manufactured and tested to comply with DIN EN 61010-1 (IEC 61010-1) Safety requirements for electrical equipment for measurement, control and laboratory use.

The device complies with EC Directives 2006/95/EC, Low Voltage Directive and 2004/108/EC, Electromagnetic Compatibility. The device must be disposed of in accordance with the WEEE Directive 2002/96/EC.

Auto Focus carries a **CE** mark.

This operating manual contains information and warnings that must be followed by the owner/operator personnel.

The warnings and advisory notes used throughout this operating manual have the following meanings:

**WARNING**

This symbol indicates a potential hazard to the user.

**WARNING**

This symbol indicates a potential danger of IR radiation exposure created by operator action.

**WARNING**

Disconnect mains plug before opening the device!

**CAUTION**

This symbol indicates a potential hazard to the instrument or system.

**NOTE**

This symbol designates information that should be closely followed.

**STANDBY**

The Auto Focus should not be used in any other way than as described in this operating manual. The microscope manual should also be consulted where appropriate.

The following notes should be strictly observed:



Class 3B IR radiation, invisible LED radiation while the sensor module is open. Do not expose eyes to IR radiation.



The Auto Focus sensor module does not include any special facilities providing protection from samples with a corrosive, potentially infectious, toxic, radioactive or other health-damaging effect. You are under obligation to comply with all legal requirements, in particular national accident prevention regulations, when handling samples of this kind.



Dirt or dust may adversely impact the device's operating capability. For this reason, steps must be taken to eliminate such influences as much as possible.



The device may not be opened except by trained personnel or service technicians. The Auto Focus may not be operated in an explosive atmosphere.



Always pull the main power plug before removing the device or replacing a fuse! Refer to section 5.2 on page 32.



Only fuses of a type specified in the technical data section may be used. The use of makeshift fuses and shorting of fuse holders is prohibited.



The manufacturer cannot accept liability if the device, or individual assemblies or parts thereof, have been used for any other purpose. The same will apply if service or repair work of any kind is not performed by authorized service personnel. In this case all rights to claim warranty / guarantee will be null and void.



The main power plug may only be inserted into a socket with PE contact, and its built-in protection must not be rendered ineffective by using a cable extension without a PE conductor.



Should it be determined that protective measures are no longer effective, shut off the power to the device and take precautions to ensure that it cannot be inadvertently switched on again. Contact the Zeiss Customer Service or Carl Zeiss Microscopy Service to have the device repaired.



Clogged or covered ventilation slots may result in heat build-up with a damaging effect on the device. Always keep the ventilation slots unobstructed and refrain from inserting or dropping objects into a ventilation slot.



A defective controller does not classify as domestic waste. It must be disposed of in accordance with currently valid provisions of law.



Likewise, samples must be disposed of in accordance with currently valid provisions of law and internal work instructions.



Devices may only be operated by duly instructed personnel who must have received proper instructions about the potential danger involved in operation of the Auto Focus. The focus-maintaining controller, which controls the focus drive, is a precision instrument. It may suffer impaired functionality or even destruction as a result of unqualified intervention.



The detachable power cables may not be replaced by cables of inadequate dimensions.



The fc12 focus controller is designed to work within a voltage range of 100 V to 240 V $\pm 10\%$ at 50 to 60 Hz without additional voltage conversion.



Voltage to the Axio Imager 2 is supplied from the separate internal power supply or from the VP232-2 power supply which is an integral part of the stand. Voltage to the Axio Imager Vario is supplied from the VP232-2 power supply which is an integral part of the stand. No voltage conversion is required for operation in a voltage range of 100 V to 240 V $\pm 10\%$, at frequencies from 50 to 60 Hz.



Switching the Auto Focus controller to the "Off" position will only turn off the internal computer. The mains voltage of the controller or the Auto Focus sensor will not be disconnected. To interrupt the mains supply, the main power plug must be pulled.

1.2 Warning and information labels

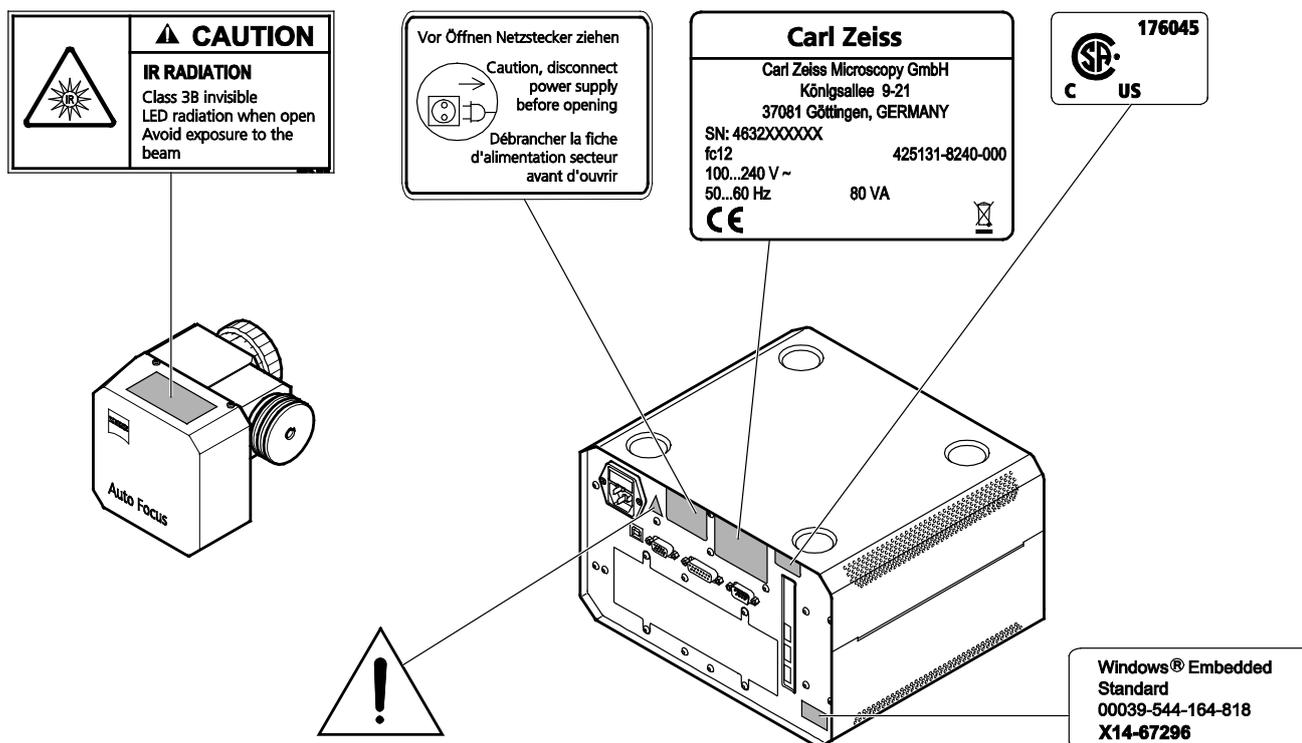


Fig. 1 Warning and information labels

1.3 Notes on warranty

The manufacturer warrants this device to be free from faults in material and workmanship at the time of delivery. Any defects occurring must be notified immediately upon detection and maximum efforts must be undertaken to restrict the damage to a minimum. Upon receiving notice of a defect, the manufacturer will be under obligation to remedy it at his own discretion, either by repairing the device or delivering a faultless replacement. No warranty will be accepted in cases of natural wear (in particular wearing parts) or improper handling.

The manufacturer will refuse any liability for damage resulting from incorrect operation, negligence or unauthorized intervention in the device, in particular from the removal or replacement of device parts or use of accessory parts from other manufacturers. Any such case will void the user's claim for warranty.

Except for activities explicitly described in this operating manual, no maintenance or repairs of any kind may be performed on the microscopes. Only Zeiss Customer Service personnel or specifically authorized representatives are allowed to handle repair work.

In the event of a malfunction, contact the Carl Zeiss Microscopy Service in Germany (see page 36) or the responsible Carl Zeiss service agency.

2 PRODUCT DESCRIPTION

2.1 Product designation, intended use

Manufacturer's name: Auto Focus

The Auto Focus is designed for use with the Axio Imager 2 and Axio Imager Vario stands with motorized focus. The left camera deflection port serves as the point of coupling.

Auto Focus allows the focal plane to be found automatically and quickly on the sample surfaces and to be maintained when moving the samples along the X or Y axis, or to be adjusted in line with the surface structure.

The focus adjustment is carried out automatically by the focus controller, which controls the motorized focus drive (Z axis) of the microscope.

Use of Auto Focus is recommended for reflective samples such as semiconductors or metals. It is distinguished by its considerably shorter control time in comparison to the software autofocus function and its wide capture range of several hundred depths of field.

The suitability of Auto Focus should be checked for all other surface properties (e.g. partially reflective, diffuse). A selection of different samples / surface properties can be found in Table 3 on page 26.

2.2 Restrictions

The capture range and the accuracy of Auto Focus (see Table 2, page 15) should be taken into consideration for the different objective magnifications. These differ depending on the system configuration, work mode and sample surface. The maximum capture range of Auto Focus (see Table 2, page 15) has been set using highly reflective samples.

Optimum quality of the Auto Focus signal can only be guaranteed if the special left camera deflection for the Auto Focus is used with the appropriate Auto Focus installation set.

Use of the camera deflection prevents use of the Analyzer slider (fixed or rotatable). For transmitted light applications requiring a rotating polarizer / analyzer, the rotating polarizer (427706-0000-000) and the P&C reflector module (424941-9050-000) can be used, and for reflected light applications, the rotating polarizer (427704-9901-000) and the P&C reflector module (424941-9050-000) can be used.

The DIC / Pol ACR P&C reflector module (424939-0000-000) can be used for reflected light polarization applications with fixed polarizers and for DIC applications.

Use of the brightfield reflector module (424928-9901-000) is only possible without grey filter.

Use of the Auto Focus equipment may be limited with polarization applications, especially at greater magnifications.

Use of Auto Focus may be limited with DIC applications.

Use of Auto Focus with C-DIC and fluorescence applications is not possible.

Use of a linear focus sensor (430703-0000-000) for Axio Imager 2 and for Axio Imager Vario (425300-9000-000) in combination with Auto Focus is not possible.

2.3 General view of components

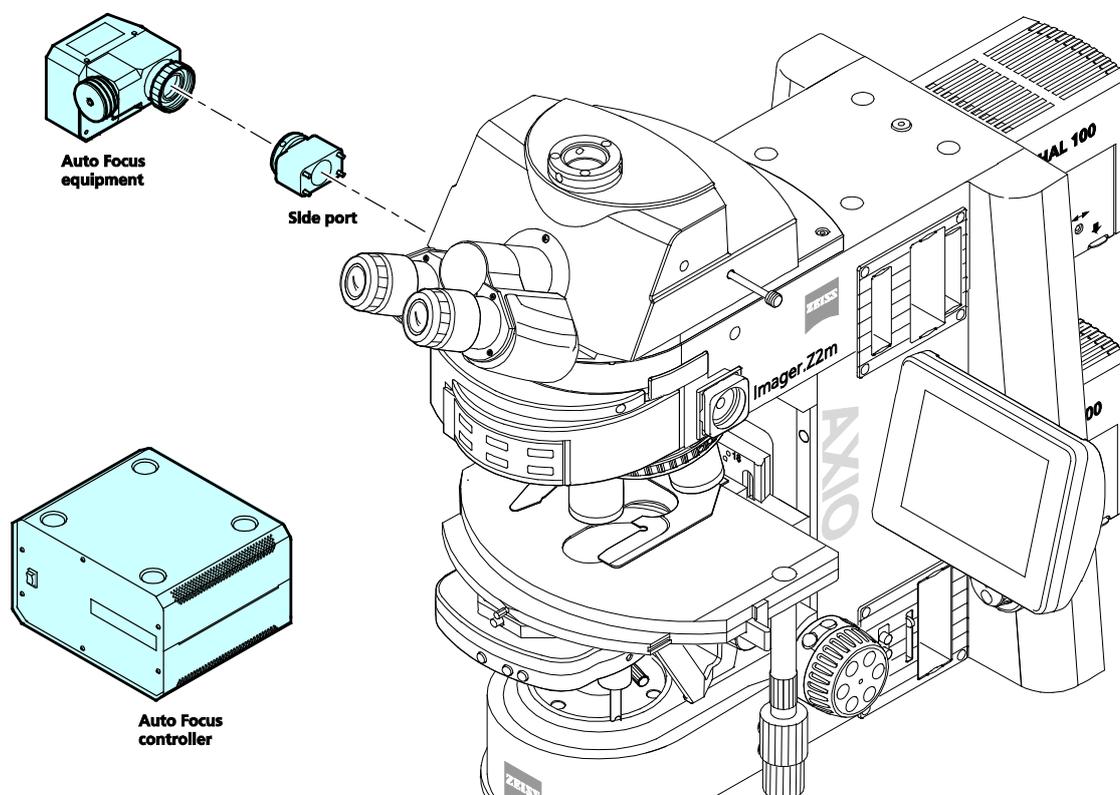


Fig. 2 General view of Auto Focus components

The Auto Focus components include:

- Auto Focus equipment with controller (425131-9000-000)
- Auto Focus installation set (425131-9030-000)

Also required:

- camera deflection (side port) left, manual (425103-0000-000) or successor
- or
- camera deflection (side port) left, motorized (425104-0000-000) or successor

 The following firmware and software versions (or newer versions) are needed to operate the Auto Focus on the Axio Imager 2 and Axio Imager Vario 2 stands:

- Axio Imager 2: 4.051, 4.551
- Axio Imager Vario 2: 5.536
- MTB2011: 2.1.0.8
- AxioVision: DVD 48 Release 4.9.1

 It is not currently possible to operate the Auto Focus with ZEN.

2.4 Compatible Objectives for use with Auto Focus

Series	Objective	Item number
EC Epiplan	EC Epiplan 5x/0.13 H W0.8	442020-9901-000
	EC Epiplan 5x/0.13 H M27	422030-9901-000
	EC Epiplan 5x/0.13 H M27	422030-9902-000
	EC Epiplan 5x/0.13 HD M27	422030-9960-000
	EC Epiplan 5x/0.13 HD M27	422030-9961-000
	EC Epiplan 10x/0.2 H W0.8	442030-9902-000
	EC Epiplan 10x/0.2 H M27	422040-9901-000
	EC Epiplan 10x/0.25 H M27	422040-9902-000
	EC Epiplan 10x/0.2 HD M27	422040-9960-000
	EC Epiplan 10x/0.25 HD M27	422040-9961-000
	EC Epiplan 10x/0.2 Pol W0.8	442033-9901-000
	EC Epiplan 10x/0.2 Pol M27	422043-9901-000
	EC Epiplan 10x/0.25 Pol M27	422043-9902-000
	EC Epiplan 20x/0.4 H W0.8	442040-9901-000
	EC Epiplan 20x/0.4 H M27	422050-9902-000
	EC Epiplan 20x/0.4 H M27	422050-9903-000
	EC Epiplan 20x/0.4 HD M27	422050-9960-000
	EC Epiplan 20x/0.4 HD M27	422050-9961-000
	EC Epiplan 40x/0.6 M27	422060-9901-000
	EC Epiplan 40x/0.6 HD M27	422060-9961-000
	EC Epiplan 50x/0.7 H W0.8	442060-9900-000
	EC Epiplan 50x/0.7 H M27	422070-9901-000
	EC Epiplan 50x/0.75 H M27	422070-9902-000
	EC Epiplan 50x/0.7 HD M27	422070-9960-000
	EC Epiplan 50x/0.75 HD M27	422070-9961-000
	EC Epiplan 50x/0.7 Pol W0.8	442063-9900-000
	EC Epiplan 50x/0.7 Pol M27	422073-9901-000
	EC Epiplan 50x/0.75 Pol M27	422073-9902-000
	EC Epiplan 100x/0.8 H W0.8	442080-9900-000
	EC Epiplan 100x/0.8 H M27	422090-9901-000
	EC Epiplan 100x/0.85 H M27	422090-9902-000
	EC Epiplan 100x/0.8 HD M27	422090-9960-000
	EC Epiplan 100x/0.85 HD M27	422090-9961-000
EC Epiplan-Apochromat	EC Epiplan-Apochromat 10x/0.3 HD DIC M27	422642-9960-000
	EC Epiplan-Apochromat 20x/0.6 HD DIC M27	422652-9960-000
	EC Epiplan-Apochromat 50x/0.95 HD DIC M27	422672-9960-000
	EC Epiplan-Apochromat 100x/0.95 HD DIC M27	422692-9960-000

Series	Objective	Item number
EC Epiplan-Neofluar	EC Epiplan-Neofluar 1.25x/0.03 M27	422310-9900-000
	EC Epiplan-Neofluar 2.5x/0.06 M27	422320-9900-000
	EC Epiplan-Neofluar 2.5x/0.06 HD M27	422320-9960-000
	EC Epiplan-Neofluar 2.5x/0.06 HD M27	422322-9960-000
	EC Epiplan-Neofluar 2.5x/0.06 M27	422322-9900-000
	EC Epiplan-Neofluar 2.5x/0.06 Pol	442313-9902-000
	EC Epiplan-Neofluar 2.5x/0.06 Pol M27	422323-9900-000
	EC Epiplan-Neofluar 5x/0.13 DIC M27	000000-1156-511
	EC Epiplan-Neofluar 5x/0.13 HD DIC M27	000000-1156-514
	EC Epiplan-Neofluar 5x/0.13 Pol	442323-9901-000
	EC Epiplan-Neofluar 5x/0.13 Pol M27	000000-1156-512
	EC Epiplan-Neofluar 5x/0.13 HD M27	422330-9960-000
	EC Epiplan-Neofluar 10x/0.25 HD M27	422340-9960-000
	EC Epiplan-Neofluar 10x/0.25 DIC M27	422342-9900-000
	EC Epiplan-Neofluar 10x/0.25 Pol	442333-9901-000
	EC Epiplan-Neofluar 10x/0.25 Pol M27	422343-9900-000
	EC Epiplan-Neofluar 10x/0.25 HD DIC M27	422342-9960-000
	EC Epiplan-Neofluar 20x/0.50 HD M27	422350-9960-000
	EC Epiplan-Neofluar 20x/0.5 DIC M27	000000-1156-521
	EC Epiplan-Neofluar 20x/0.5 HD DIC M27	000000-1156-524
	EC Epiplan-Neofluar 20x/0.5 Pol	000000-1170-667
	EC Epiplan-Neofluar 20x/0.5 Pol	000000-1156-522
	EC Epiplan-Neofluar 50x/0.80 HD M27	422370-9960-000
	EC Epiplan-Neofluar 50x/0.8 DIC M27	000000-1156-527
	EC Epiplan-Neofluar 50x/0.8 HD DIC	000000-1156-528
	EC Epiplan-Neofluar 50x/0.8 Pol	000000-1170-666
	EC Epiplan-Neofluar 50x/0.8 Pol	000000-1156-526
	EC Epiplan-Neofluar 50x/1.0 Oil Pol	422373-9900-000
	EC Epiplan-Neofluar 100x/0.90 HD M27	422390-9960-000
	EC Epiplan-Neofluar 100x/0.90 DIC M27	422392-9900-000
	EC Epiplan-Neofluar 100x/0.90 HD DIC	422392-9960-000
	EC Epiplan-Neofluar 100x/0.90 HD DIC	442385-9902-000
	EC Epiplan-Neofluar 100x/0.90 Pol	442383-9903-000
EC Epiplan-Neofluar 100x/0.90 Pol M27	422393-9900-000	
LD EC Epiplan-Neofluar	LD EC Epiplan-Neofluar 20x/0.22 DIC M27	422452-9900-000
	LD EC Epiplan-Neofluar 20x/0.22 HD DIC M27	422452-9960-000
	LD EC Epiplan-Neofluar 50x/0.55 DIC M27	422472-9900-000
	LD EC Epiplan-Neofluar 50x/0.55 HD DIC M27	422472-9960-000
	LD EC Epiplan-Neofluar 100x/0.75 DIC	000000-1156-532
	LD EC Epiplan-Neofluar 100x/0.75 HD DIC M27	000000-1156-538

Table 1 Compatible objectives for use with Auto Focus

Objective magnification, primary capture range and precision of Auto Focus:

Objective magnification	Max. capture range in μm (highly reflective plain surface)	Maximum precision of the focus position (exact) (~0.3 depth of field of the objective) in μm	Minimum size of focused object in μm
1.25	> 12000	~170.00	~2000
2.5	> 10000	~42.00	~1000
5	> 10000	~8.90	~500
10	> 8000	~2.50	~250
20	> 4000	~0.60	~125
50	> 700	~0.25	~50
100	> 150	~0.20	~25

Table 2 Objective magnification, primary capture range, maximum precision and minimum object size

The precision of the focus position of the Auto Focus varies depending on the type of objective, the objective magnification and the optical characteristics of the sample.

The positioning accuracy and the speed of the Auto Focus vary depending on the type of objective, the objective magnification, the optical characteristics of the sample and the work mode (see section 4.2 on page 23) of the Auto Focus.

 Appropriate HD, DIC, and pol objectives, and objectives with W 0.8 thread are also suitable.

 Only EC Epiplan objectives (with magnification of 10x or less) and EC Epiplan-Neofluar objectives (with magnification of 10x or less) on the list of objectives can be used for samples with a cover slip.

2.5 Selectable stages

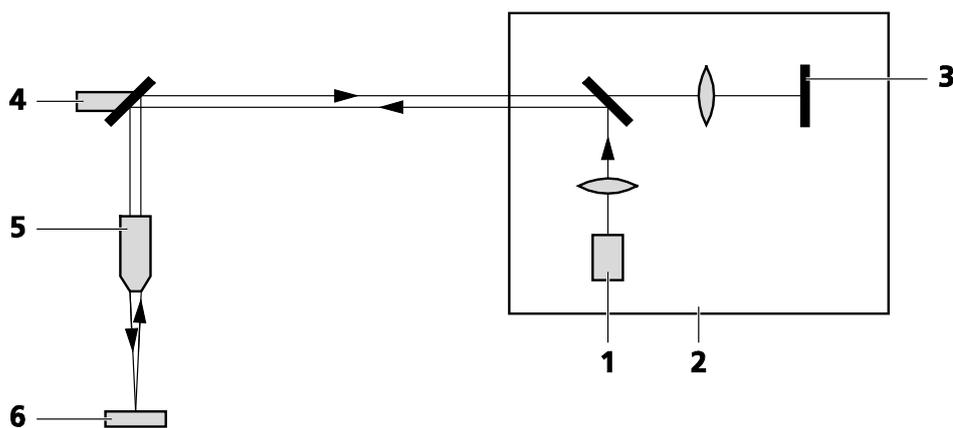
The Auto Focus equipment is compatible with all stages (manual / motorized) on the Axio Imager 2 with motorized Z drive stand and Axio Imager Vario stand with focusing objective turret.

2.6 Functionality

The structured light generated by an LED in the sensor module of the Auto Focus is deflected through the objective onto the sample and reflected from its surface. The Auto Focus automatically seeks the maximum of the reflection signal, thereby bringing the surface of the sample into sharp focus.

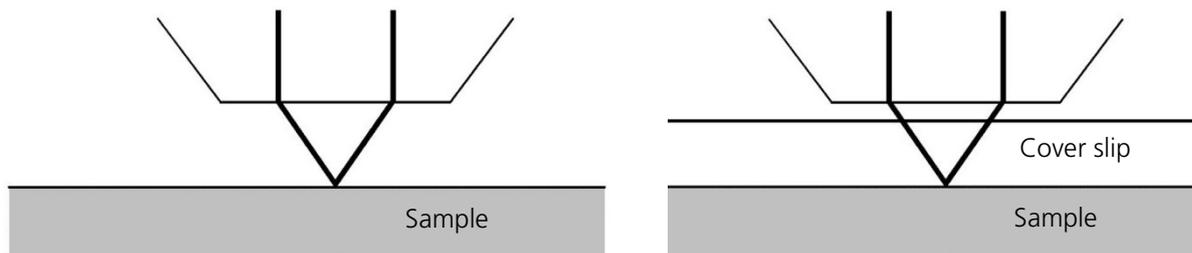
Auto Focus can be operated in three different surface property modes (reflective / partially reflective / diffuse) and with three different levels of precision (exact / balanced / fast). Further details can be found in section 4.2 on page 23.

Changes in the focus position are registered by the sensor, with any deviations being automatically compensated by the direct access of the controller to the Z drive of the microscope.



- 1 LED
- 2 Sensor module
- 3 Sensor
- 4 Beam splitter
- 5 Objective
- 6 Sample

Fig. 3 Function diagram of Auto Focus



Standard mode of Auto Focus, focusing on the surface of the sample

Standard mode for samples with cover slip, focusing through the cover slip on the sample

Fig. 4 Auto Focus working modes

 Samples can be used with or without a cover slip. Only EC Epiplan objectives (with magnification of 10x or less) and EC Epiplan-Neofluar objectives (with magnification of 10x or less) on the list of objectives can be used for samples with a cover slip.

2.7 Technical data**2.7.1 Dimensions and weight****Dimensions**

Sensor module (length x width x height)130 mm x 105 mm x 116 mm
Controller (length x width x height)220 mm x 250 mm x 158 mm

Weight

Sensor moduleca. 1300 g
Controller.....ca. 4800 g

2.7.2 Ambient conditions**Transportation (in packed state):**

Permissible ambient temperature -40 °C to +70 °C

Storage

Permissible ambient temperature +5 °C to +40 °C
Permissible relative air humidity (no condensation)max. 75 % at 35 °C

Operation

Permissible ambient temperature +10 °C to +40 °C
Permissible relative air humidity (no condensation)max. 75 % at 35 °C
Max. altitude of operating site 2000 m
Atmospheric pressure 800 hPa to 1060 hPa
Degree of pollution.....2

2.7.3 Operating data**Sensor module with IR-LED**

Complete device	LED class 1
Internal LED	IRED 850 nm / max. 950 mW / LED class 3B conforming to DIN EN 60825-1:2003
Auto Focus.....	Free group conforming to DIN EN 62471:2009

fc12 focus controller

Type of operation site.....	Closed room facilities
Protection class	I
Ingress protection rating.....	IP 20
Electrical safety	to DIN EN 61010-1 (IEC 61010-1) conforming to CSA and UL regulations
Overvoltage category	II
Radio interference suppression	to EN 55011 Class A
Noise immunity	to DIN EN 61326-1
Line input voltage	100 V AC to 240 V AC ($\pm 10\%$) No line voltage conversion required!
Line frequency.....	50 / 60 Hz
Power consumption	max. 80 VA

Fuses according to IEC 60127

fc12 focus controller	T 2.0 A/H; 250 V; 5x20 mm
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Operating data for Axio Imager 2 / Axio Imager Vario, motorized with external VP232-2 power supply pack.

Type of operating site.....	Closed room facilities
Protection class	I
Ingress protection rating.....	IP 20
Electrical safety	to DIN EN 61010-1 (IEC 61010-1) conforming to CSA and UL directives
Overvoltage category	II
Radio interference suppression	to EN 55011 Class B
Noise immunity	to DIN EN 61326-1
Line input voltage with external power supply VP232-2	100 V AC to 240 V $\pm 10\%$ No line voltage conversion required!
Line frequency.....	50 / 60 Hz
Max. power consumption Axio Imager, motorized.....	max. 190 VA

3 INSTALLATION

The Auto Focus consists of the following main assemblies

- Auto Focus equipment and controller (425131-9000-000) or successor
- Auto Focus installation set (425131-9030-000) or successor

Also required:

- Camera deflection left, manual (425103-0000-000) or successor
- or
- Camera deflection left, motorized (425104-0000-000) or successor

 An Axio Imager 2 / Axio Imager Vario stand with motorized Z-axis drive / focusing objective turret is required in order to operate Auto Focus. Retrofitting to existing older Axio Imager 2 or Axio Imager Vario stands must be carried out by a Carl Zeiss customer service employee. Axio Imager 2 stands without motorized Z-axis drive and all Axio Imager Vario stands without focusing objective turret cannot be equipped with Auto Focus.

 Retrofitting of Axio Imager "1" stands is not possible.

3.1 Connecting Auto Focus

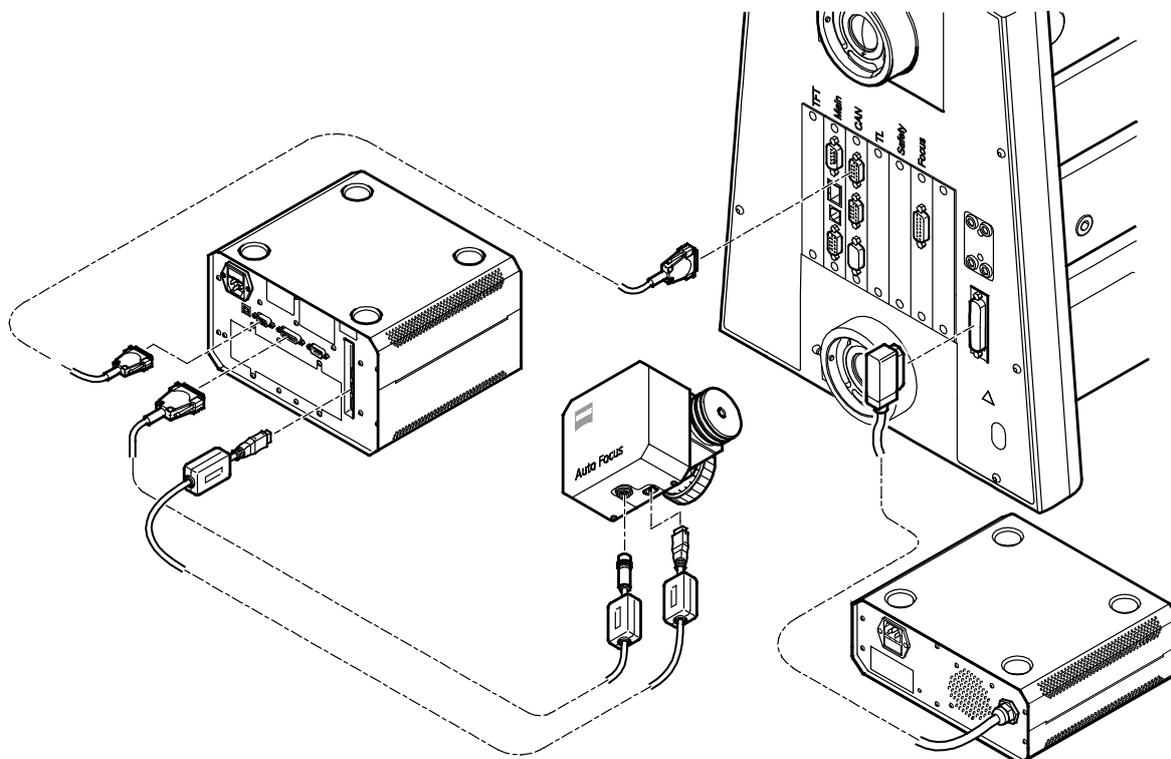
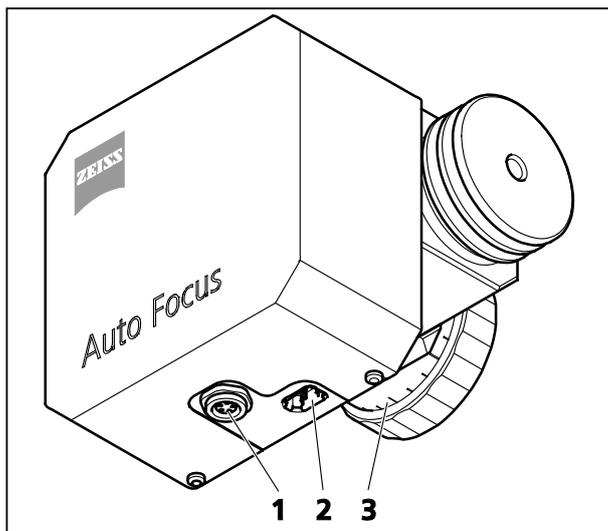
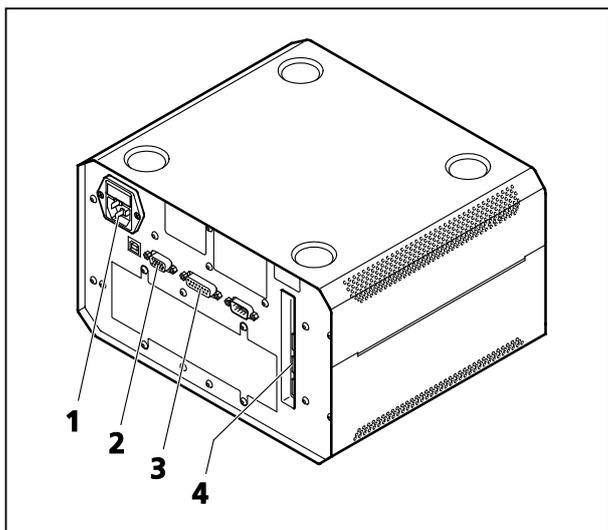


Fig. 5 Connection diagram for Auto Focus and controller to the Axio Imager 2 stand



- 1 Control cable connection
- 2 Signal cable connection (Firewire)
- 3 Scale for manual adjustment

Fig. 6 Auto Focus sensor module



- 1 Power connection
- 2 CAN connection
- 3 Control cable connection
- 4 Signal cable connection (Firewire)

Fig. 7 Rear view of controller and connections



Switch off the power supply of the stand and the PC before connecting the controller to the microscope. Ensure that the cable from the Auto Focus sensor to the controller and from the controller to the microscope stand is not too tight, thereby permitting the Z-axis drive and the focusing objective turret to function correctly.

- Convert the standard camera deflection left port with the Auto Focus installation set (425131-9030-000) or successor.
- Fasten the Auto Focus to the left side camera deflection.
- Connect the Auto Focus to the controller. To do so, insert the Firewire cable into the connections of the Auto Focus (Fig. 6/2) and the controller (Fig. 7/4). Then insert the control cable into the connections on the Auto Focus (Fig. 6/1) and the controller (Fig. 7/3).
- Connect the controller to the microscope stand using the CAN cable. To do so, insert the CAN cable into the connection on the controller (Fig. 7/2) and on the microscope.
- Connect the controller to the power supply (Fig. 7/1).

3.2 Camera deflection

The left-side camera deflection is factory-fitted if an Axio Imager 2 / Axio Imager Vario with Auto Focus is ordered.

Both the manual camera deflection (425103-0000-000) and the motorized camera deflection (425104-0000-000) can be used.

If an Axio Imager 2 / Axio Imager Vario is retrofitted with Auto Focus hardware, the camera deflection and the Auto Focus installation set (425131-9030-000) are fitted by a Carl Zeiss customer service employee.

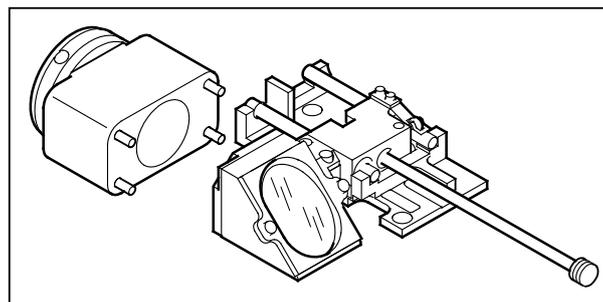


Fig. 8 Manual camera deflection (425103-0000-000) for left side port

 Use of the left-hand camera deflection as a camera connection is no longer possible if the Auto Focus is used.

3.3 Auto Focus objectives

If the objectives used on the microscope stand have not been defined, they must be selected via ACR or entered manually via the TFT display / MTB. This helps ensure that the magnification factor / reference number is stored and that the focus position can be correctly calibrated via the TFT or the MTB for the Auto Focus.

 The objectives suitable for applications with the Auto Focus are listed in Table 1 on page 13.

 The Auto Focus cannot be used with transmitted light objectives or objectives made by other manufacturers. Only objectives from the specified list should be used in conjunction with the Auto Focus.

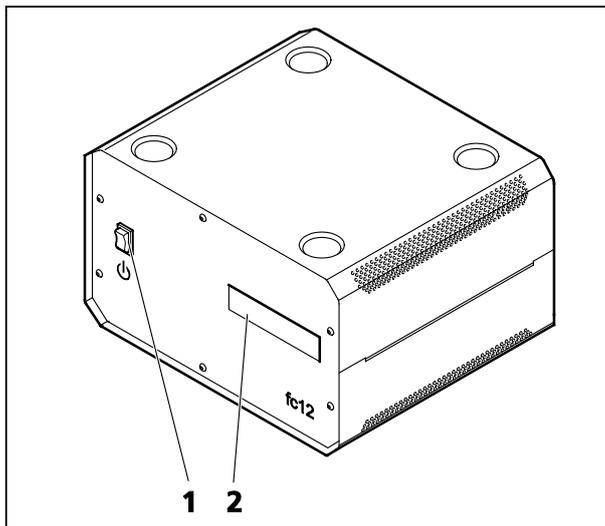
3.4 Insert damping filter

For some Auto Focus applications it is also necessary to insert a BG 39 or BG 40, $d = 23.5$ mm IR damping filter into the camera adapter. The damping filters are included with the Auto Focus.

 If an IR damping filter is used later, the focus reference values will need to be recalibrated, see section 4.8 on page 31.
In AxioVision (version 4.9.1 or later) also use the focus bar beneath the live image.

4 OPERATION

The Auto Focus can be set up and activated via the software interface of the Axio Imager 2 / Axio Imager Vario with the aid of the TFT and / or by imaging software, e.g. AxioVision Version 4.9.1 or higher.



- 1 On/off button
- 2 Status display

Fig. 9 Front view of controller

4.1 Switching on/off

The following switching on/off sequence must be followed each time:

- Switch Auto Focus on or off by briefly pressing the on/off button (Fig. 9/1) on the front panel of the controller.
- Switch the Axio Imager, Axio Imager Vario microscope on or off (see also microscope operating manual)

If the microscope and the focus controller are switched on and off via a main switch, e.g. a switchable multiple extension socket, the focus controller will start automatically or should be shut down in a controlled manner using the on/off button (Fig. 9/1) and then turned off at the multiple extension socket.

Once power is available, the control programs of the Auto Focus and the microscope will start automatically and communication between the two programs will be established via the CAN port.

The initialization state of Auto Focus will be shown on the display (Fig. 9/2) of the controller:

- "Starting System" - System starts
- "System Ready" - Auto Focus controller is fully up and running
- "Detecting Stand" - Searching for microscope stand
- "Standby" - Auto Focus ready, not activated
- "Shutdown" - Shutting down Auto Focus controller

The status (**On / Standby / working / working 'xx' s**, see page 29) of Auto Focus can be viewed on the **Home** screen of the graphic user interface of the TFT of the Axio Imager 2 / Axio Imager Vario (Fig. 10).

- If the work station is equipped with a PC, do not start the imaging software (e.g. AxioVision version 4.9.1 or later) until the microscope has fully booted.
- The shutdown procedure may take several seconds. Appearance of the "shutdown" message on the LCD screen may be delayed depending on the status of the controller.

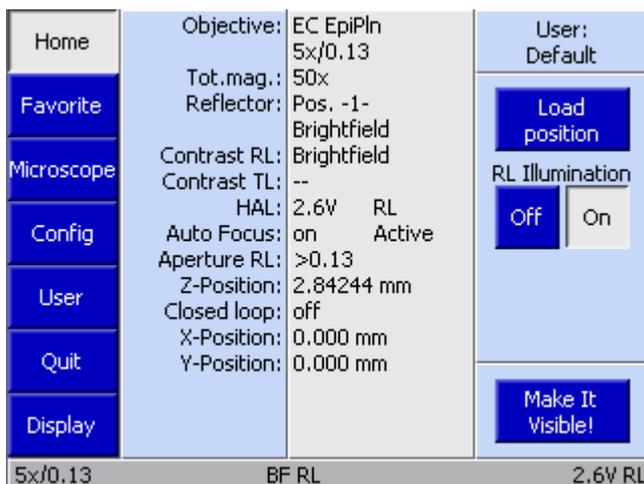


Fig. 10 TFT display, Home screen with Auto Focus status

4.2 Setting up Auto Focus

The Auto Focus settings can be displayed and changed using the **Options** button.

 It is important to follow the instructions for setting up the Auto Focus given in section 4.8 on page 31, Setting focus reference values.

- First press the **Microscope** button on the TFT. Then press **XYZ** (Fig. 10).
- Select the **Auto Focus** tab (Fig. 13).
- Activate the **Options** button.

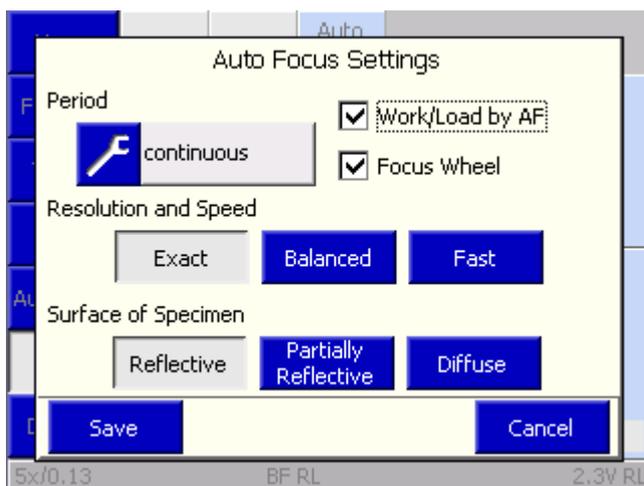


Fig. 11 TFT display, Auto Focus settings

Auto Focus settings (Fig. 11):

- **Period**
- **Work / Load by AF**
- **Focus Wheel**
- **Resolution and Speed**
- **Surface of Specimen**
- **Save**
- **Cancel**

Period:

The **Period** function is used to set the Auto Focus period, i.e. the interval between two auto focus cycles. The time currently set between two auto focus cycles is shown in the **Period** field.

- To change the period, press the **Period** button.
- Select or redefine period (Fig. 12).

The period can be selected using pre-defined periods (continuous, 1 s, 2 s, 5, s etc.) or can be redefined using the numeric pad (entries are made in seconds).

 A period of 0 s also constitutes the **Continuous** mode of Auto Focus.

- Entries are confirmed by pressing **OK**, or cancelled by pressing **Cancel**.

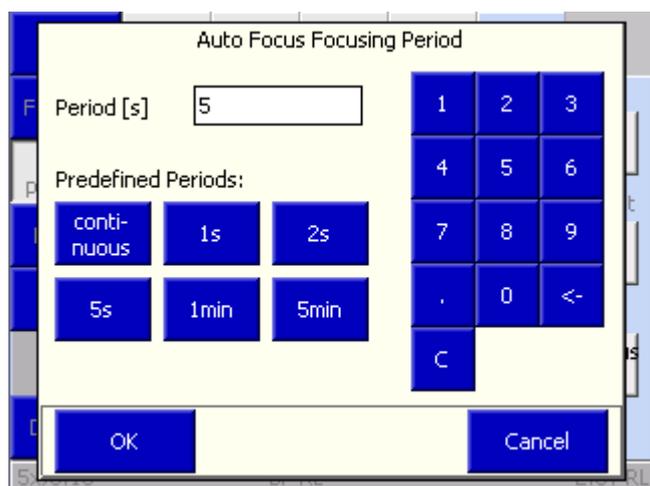


Fig. 12 TFT display, Microscope / xyz / Auto Focus / Options / Period

 It is also possible to reset the period during the On phase of the Auto Focus (see section 4.4, page 28).

 In the **online** application mode, the set-up parameters apply which were entered in AxioVision (version 4.9.1. or later) or other imaging software if this has an interface to Auto Focus and controls set-up parameters.

 Auto Focus generally works in continuous mode, i.e. continuous checks are made as to whether the sample is still in focus.
If imaging software with no interface to Auto Focus is used for the image capture, this may result in poorly focused images during capture if the Auto Focus and image capture activities are simultaneous.

Work / Load by AF:

Selecting this option supports the Auto Focus Work / Load run; see also section 4.7 on page 30.



Selecting this option may result in collisions between the samples and the objectives. For this reason it is important to follow the instructions given in section 4.7 on page 30.

Focus Wheel:

In experiments, this option can be used for switching off manual adjustment of the focus drive via the focus wheel. This prevents inadvertent adjustment of the focus and therefore the creation of an offset. See also section 4.3, page 27. Focusing is carried out entirely by the Auto Focus if activated.

Resolution and Speed:

The **Exact**, **Balanced** and **Fast** options are used to increase the speed of focus during a focus search by reducing the focus resolution.

The focus resolution is:

- Exact: 0.3 times the depth of field of the objective
- Balanced: 1 time the depth of field of the objective
- Fast: 3 times the depth of field of the objective

Surface of Specimen:

The **Reflective**, **Partially Reflective** and **Diffuse** options can be used to specify the type of surface of the sample. See also Table 3 on page 26, Surface of sample and recommended settings.

 If the sample has a structure which is parallel to the grid pattern of the structured light of the Auto Focus during focusing, Auto Focus may jump backwards and forwards between the two different focus planes. To avoid this and to facilitate correct focusing, the Auto Focus sensor can be turned manually on the microscope in 15° steps up to a maximum of +/- 90°. This can also be monitored and manually adjusted for improved visualization of the Auto Focus signal from the sample, using AxioVision (version 4.9.1. and later) under Hardware Auto Focus Control.

Surface of the sample and recommended settings:

Type of sample	Setting for surface (Reflective / Partially reflective / Diffuse)
Solar cells	Diffuse
Ceramic surfaces	Diffuse
Wafer, polished (structured)	Reflective
Wafer, structured	Reflective / Partially reflective
Thin film solar cells	Partially reflective / Diffuse
TFT displays	Reflective
Metallographic sample	Reflective / Partially reflective
Semiconductor masks	Reflective
Particle filters	Diffuse
Lithium ion rechargeable batteries	Partially reflective / Diffuse

Table 3 Samples and recommended sample surface settings for Auto Focus

Save:

Saves the current settings and closes the **Options** window.

Cancel:

Rejects the current settings and closes the **Options** window.

4.3 Auto Focus operation via the TFT display

- Press **Home / Microscope** and then **XYZ** on the TFT display.
- Select the **Auto Focus** tab.

The current operating mode of the Auto Focus is shown in the **Auto Focus** (Fig. 13) tab - where it can also be changed.

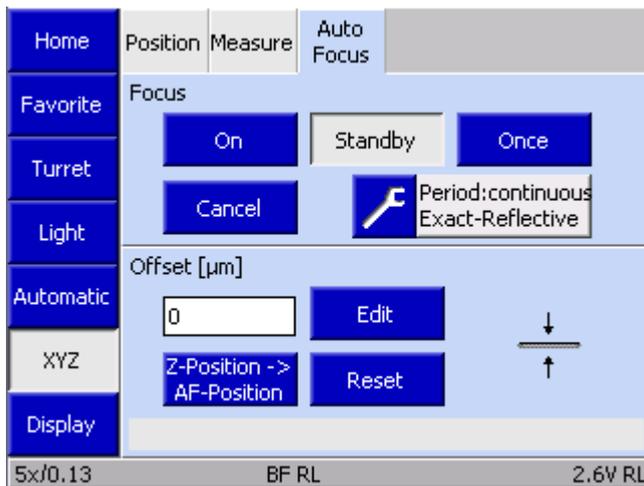


Fig. 13 TFT display, options in the Auto Focus tab

The operating status of Auto Focus can be changed using the following buttons.

Operating status of Auto Focus:

- **On** Turn on the Auto Focus
- **Standby** Turn off the Auto Focus, the Auto Focus is now in standby mode
- **Once** Perform one Auto Focus search
- **Cancel** Cancel the Auto Focus search

Auto Focus options:

- **Options** Call up / change the Auto Focus settings, see **Setting up Auto Focus** on page 23.

Auto Focus offset:

Shows the current **Offset** [in μm] to the detected focus position of the Auto Focus. The offset to the existing focus position is adjusted using the focus wheel on the microscope or via the software (AxioVision, version 4.9.1 or later).

- **Z-Position -> AF-Position** Apply offset.
- **Edit** Manual setting of a specific offset value in $\pm\mu\text{m}$.
- **Reset** Resets the offset value to 0.

4.4 Activate / Deactivate Auto Focus

- Lay the sample on the stage.
- Use the focus drive of the microscope to move the specimen into the capture range of the objective and operate the Auto Focus once or continuously. For this purpose press the **Home / Microscope** button on the TFT display. Then press **XYZ** and select the **Auto Focus** tab.
- Press the **On / Standby** button to activate / deactivate the Auto Focus.
 - "Work / Load" can also be used at smaller magnifications and for reflective surfaces (see section 4.7 on page 30). Note the restrictions given in section 4.7 on page 30.

 To avoid errors, the surface of the sample should always be within the capture range of the objective and be sufficiently reflective. See also Table 3 on page 26, Surface of sample and recommended settings.

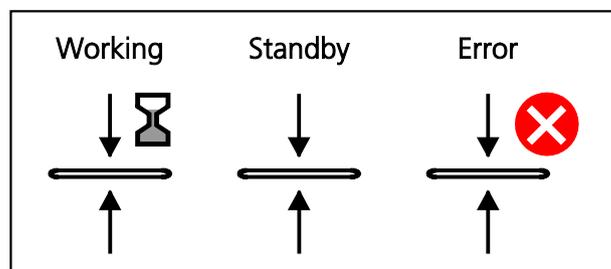


Fig. 14 Display forms of the status icons for Auto Focus on the TFT display in On / Standby status (left and central) and visualization of error messages.

The two statuses **Working / Standby** are shown by a variable status icon (Fig. 14) on the TFT display. During this time the controller shows the status message **Working 'xx' s / Standby**.

Error messages are visualised by means of a red dot with a white "X" next to the status icon.

If the Auto Focus cannot find a clear focal plane during focusing once, it will discontinue the focusing procedure after 6 attempts and an error message will be displayed on the controller.

If error messages appear, consult the **Troubleshooting** section on page 33.

 The Auto Focus can alternatively be activated / deactivated in accordance with the specifications or the menu of the imaging software (Axio Vision, version 4.9.1 or later).

4.5 Auto Focus in "On" and "Once" status

If the Auto Focus is operated in **On** status, the **Working** status message will appear on the TFT display of the microscope and on the controller. This shows continuous operation of the Auto Focus.

If a further period is entered in the Auto Focus options, Auto Focus will be operated continuously at set intervals (e.g. every 5 seconds). This is displayed as the **Working 'xx' s** status message on the TFT display of the microscope and on the controller.

In addition to continuous / periodical operation, Auto Focus can also be operated one single time by using the **Once** option to find the focal plane. First the **Working** status message appears on the TFT display of the microscope and on the controller, followed by **Success – Standby** once the focus has been found.

 It is also possible to change the period of the Auto Focus during the **Working** phase.

Auto Focus uses an LED with a wavelength of 850 nm. The LED is only active when the Auto Focus is actually working (**Working** status). The LED is turned off within a period (**Working 'xx' s** status) or in **Standby** status.

A Z-offset can be set manually in the On status, using the focus wheel, the TFT Display or the imaging software (AxioVision 4.9.1 or later). The Auto Focus operation is interrupted for the time during which the focus wheel is turned, and turned back on once the focus wheel is released and a waiting time of approx. 1.5 s has elapsed.

If the offset is outside the so-called primary capture range, a mode is activated in which the Z drive of the stand tracks permanently back and forth between the two positions. When the Z offset position has been reached, a signal will be sent to the software, thereby allowing e.g. an image to be captured.

If the objective is changed, the Auto Focus remains active in **On** status, merely interrupting its activity for the duration of the change. If the offset defined before the change of the objectives is too large for the now active objective (more than half working distance towards objective), the Auto Focus is deactivated.

4.6 Auto Focus in "Standby" status

If no work has been carried out by the Auto Focus after the Axio Imager has been switched on, the system is in **Standby** status. The **Standby** status message is shown on the TFT display of the microscope and on the controller.

4.7 Set Load Position

If the **Set Load Position** function is selected on the TFT display of the Axio Imager 2 / Axio Imager Vario, the stage automatically travels to its lowest position and the objective turret to its highest position. After a sample change, the Work run is triggered if respectively Auto Focus is switched on and the **Work / Load by AF** option is activated. Here the focus position is constantly checked by the Auto Focus to see whether the surface of the sample is already within the capture range of the objective. As soon as a sufficiently strong signal is detected within the capture range of the objective, the surface of the sample is directly focused upon. If the **Work / Load by AF** option is selected, the Work / Load run is slower than if it is deactivated.

With the Axio Imager Vario it is also important to note that the focal plane must be within the focus range of the objective turret.

-  Work / Load with Auto Focus support only functions fully with **reflective** samples at magnifications of up to a maximum of 20x; with diffuse samples, the capture range is severely restricted.
-  An objective with low magnification (2.5x - 20x) must be used for primary focusing with Work / Load and Auto Focus. Afterwards it can be switched to an objective with higher magnification (40x - 150x).
-  To avoid collisions between an objective and the sample, Work / Load with Auto Focus support is not possible for objectives with high level magnification (40x - 150x).
-  Only EC Epiplan objectives (with magnification of 10x or less) and EC Epiplan-Neofluar objectives (with magnification of 10x or less) can be used for samples with a cover slip.

4.8 Setting focus reference values

The focus reference values of the objectives are obtained by the PC via the configuration program MTB 2011 (2.1.0.8) or higher, or via the parfocality / parcentricity correction on the TFT display of the microscope. A mirror surface serves here as a reference sample.

- The focus reference values must be set individually in the MTB for each objective, one after the other. For the current used objective, the newly, manually set focus position is applied as a reference position.
- Setting the focus reference values replaces the existing list of objectives with a special user objective list. The values obtained during the manual calibration may differ from the existing values, however they reflect the situation of the objectives actually in use. Following a restart of the controller, the values thus received are saved in a special user list and serve as the new reference values. The factory-set reference values will still apply for any non manually-calibrated objectives.
- The focus reference values of individual objectives can be deleted from the user list by using the **Reset** button in the MTB. This deletes the objective currently in use from the user list. The deleted values are removed from the user list when the controller is restarted. The factory settings will then be applied for any of these objectives if no other focus position calibration has been carried out.
- It is also possible to calibrate the Auto Focus using the parfocality / parcentricity correction from the TFT display on the microscope. The values thus obtained are also saved in the special user list at the end of the correction and upon a subsequent restart of the Auto Focus controller. These values will then serve as the new reference values.



A recalibration requires a regular shut down of the controller; if it is switched off from the circuit breaker of a power stripe multiple socket extension, the data is not permanently saved.



Regarding the parfocality / parcentricity correction, please also read the relevant section in the operating instructions of the Axio Imager 2 / Axio Imager Vario 2.



If an IR damping filter is retrofitted, the focus reference values will need to be recalibrated, see section 4.8 on page 31.
In AxioVision (version 4.9.1 or later), also use the focus bar beneath the live image to assist in the recalibration.

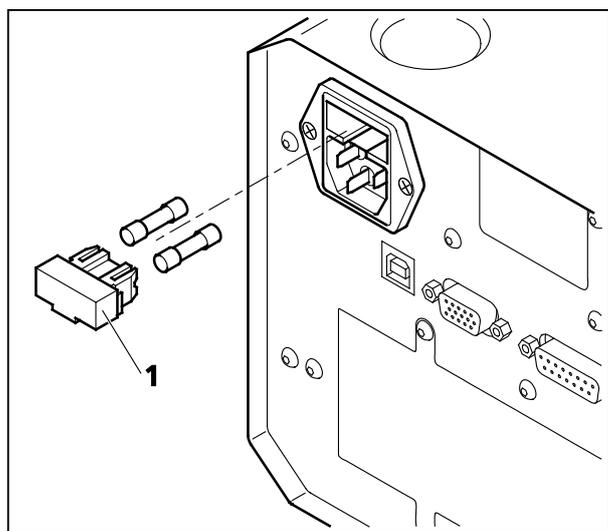
5 MAINTENANCE, REPLACEMENT OF FUSES AND SERVICE

5.1 Maintenance

 Before cleaning, switch off the microscope and the fc12 Auto Focus controller and disconnect the external power unit 232-2 and the Auto Focus controller from the power supply.

The controller and the Auto Focus sensor should only be cleaned with a slightly moist cloth (not dripping wet). No moisture should enter the devices.

Only clean the type plate and the warning sticker with pure water.



1 Fuse carrier

Fig. 15 Replace the fuses in the controller

5.2 Replacement of fuses in the fc12 Auto Focus controller

 Make sure the power cable is disconnected before changing any fuses.

In the event of a fuse failure, the cause must be identified and a possible technical fault must be first remedied in a proper manner.

The fuse holder is located at the back of the controller. It is integrated into the power plug and contains two **T 2.0 A/H** fuses.

- Pull the mains plug.
- Remove the fuse holder (Fig. 15/1) from the fuse box by pulling it towards you. A small screwdriver is suggested for this purpose.
- Remove the fuses from the fuse carrier and replace them with new fuses (type **T 2.0 A/H**).
- Push the fuse holder back into the fuse box as far as it will go.
- Reconnect the mains plug.

5.3 Troubleshooting

General checklist for error situations and non-standard events:

- Has installation or cabling work been correctly performed (see section 3 on page 19)?
Check the cabling of the Auto Focus.
- Are cable ends firmly seated in their sockets?
- Was the Switching on procedure duly followed (see section 4.1 on page 22)?
- Is the beam splitter of the camera deflection in the beam path?
- Is the correct camera deflection installed?
- Are the cables of the Auto Focus under mechanical strain? Check the cables and ensure that they are free from strain.
- Have the objectives been calibrated? Repeat or renew the focal position calibration.
- Is the active objective correctly displayed in the TFT display?
- Has a sample actually been inserted and a typical region on the sample been selected?
Shift to a different XY position of the sample. Pronounced irregularities / scratches on the sample may result in disruptive reflections at the current sample position.
- Does the sample have structures which run parallel to the Auto Focus stripe structures? Reposition the sample or, if this is not possible, select a different angle setting for the Auto Focus sensor.
- Which type of sample has been inserted? It may be necessary to change the surface of specimen setting (Reflective / Partially reflective / Diffuse).
- Is the stage Z-position far outside of the capture range of the objective? Use a lower objective magnification for refocusing or make a rough focus manually.
- Is a sample with a cover glass being used? Only EC Epiplan objectives (with magnification of 10x or less) and EC Epiplan-Neofluar objectives (with magnification of 10x or less) from the list of compatible objectives can be used for samples with a cover slip.

5.4 Error messages and typical background situations

Error message	Meaning	Possible cause	Measure
"Invalid Objective"	No valid objective is currently in position.	<ul style="list-style-type: none"> – Empty objective turret position. – No approved objective configured for the Auto Focus. 	<ul style="list-style-type: none"> – Check configuration
"timeout"	The Auto Focus could not find the focal plane.	<ul style="list-style-type: none"> – The distance between the object and the focal plane is too great (timeout). – Problematic object structure. 	<ul style="list-style-type: none"> – Check the positioning of the object. – Beam splitter of the camera deflection not swiveled into position.
"Err: busy 0x0D"	Due to an error, the Auto Focus is not ready to function	<ul style="list-style-type: none"> – An unsuitable objective has been attempted for use with Auto Focus. This error may occur after reconfiguration when using the Auto Focus again for the first time. – Cable connection interrupted. 	<ul style="list-style-type: none"> – Reactivate the Auto Focus. – If the cable connection was interrupted. Shut down the Auto Focus and the microscope, reconnect the cables and restart the Auto Focus and the microscope.
"Err: camera 0x64"	The Auto Focus sensor cannot operate.	<ul style="list-style-type: none"> – Cable connection interrupted. 	<ul style="list-style-type: none"> – Shut down the Auto Focus and the microscope, reconnect the cables and restart the Auto Focus and the microscope.
"Err: external device 0x10"	The Auto Focus sensor cannot operate.	<ul style="list-style-type: none"> – Cable connection interrupted. 	<ul style="list-style-type: none"> – Shut down the Auto Focus and the microscope, reconnect the cables and restart the Auto Focus and the microscope.
"Detecting Stand"	The Auto Focus is searching for the connection to the stand.	<ul style="list-style-type: none"> – The components are in the start process. – No connection to stand. 	<ul style="list-style-type: none"> – Shut down the Auto Focus and the microscope, connect the CAN cable to the microscope stand and restart the Auto Focus and the microscope.

Table 4 Error messages, typical background situations and possible remedial action

5.5 Other fault events

- I can see a distinct grid and a bright, luminescent area in the live image
 - The Auto Focus signal (wavelength 850 nm) is not being blocked. This problem can be resolved by inserting the IR barrier filter (BG 39 or BG 40) in front of the camera.
- The focus cannot be found.
 - The Auto Focus beam splitter is not in the beam path.
 - The Auto Focus is not switched on.
 - The surface structure of the sample is too rough / diffuse, preventing any Auto Focus signal from being detected.
- The Auto Focus starts to jump between two planes when moving the sample.
 - The structure being focused upon may be parallel to the signal structure of Auto Focus. Rotating the sample or the Auto Focus sensor on the microscope should permit correct focusing of the sample.
- No focal position can be found when fluorescence is used.
 - It is not possible to use the Auto Focus function when fluorescence is used.
- No focal position can be found when DIC/C-DIC is used.
 - C-DIC cannot be used in conjunction with Auto Focus.
 - Use of Auto Focus may be limited with DIC applications.
- The Auto Focus does not function if the reflected light brightfield reflector module is swiveled into position.
 - The grey filter must be removed from the reflector module.

5.6 Service

Work requiring intervention into optical or mechanical motion components inside the device or work on the power supply may not be performed by anyone other than Zeiss Customer Service experts or specially **authorized** technicians.

To request service, please contact your regional representative office or:

For additional information, contact us in the Internet at:

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6 INTELLECTUAL PROPERTY

The products, device parts and procedures described in this manual are protected by patent law.

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