

Motorized Beam Expander

1x-4x / 2x-8x

**Operating Manual including Declaration of
Incorporation
Instructions for Optical and Mechanical
Operation of the Motorized Beam
Expander**

Congratulations on your purchase of the motorized beam expander from Qioptiq. You now have a device for motor-controlled expansion of laser beams in unrivalled Qioptiq quality. This beam expander can help you automate and optimize your productions processes.

Please read this instruction manual carefully and familiarize yourself with all of the hardware, software and particularly the safety information supplied before putting your motorized beam expander into operation.

For technical assistance and consultation, contact your local dealer or the Qioptiq service center.



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1 General Product Description

Qioptiq offers its motorized beam expander in a variety of models.

All models feature either 1x to 4x or 2x to 8x expansion and variable divergence. By adjusting the beam expansion factor or beam divergence you can remotely vary the spot size or the plane of focus. Each of the two independent lens groups is adjusted by one of two independent stepper motors, which in turn can be controlled using the command set implemented in the device electronics.

A replaceable glass cover protects the entrance aperture.

Automatic adjustment of the magnification ensures short setup times. Adjustment of the beam expander does not impinge upon the laser safety class.

1.1 Product Specifications

The motorized beam expander has a magnification range of 1x-4x or 2x-8x. The working wavelength and connection options of your beam expander are model-dependent.

1.1.1 Optical specifications

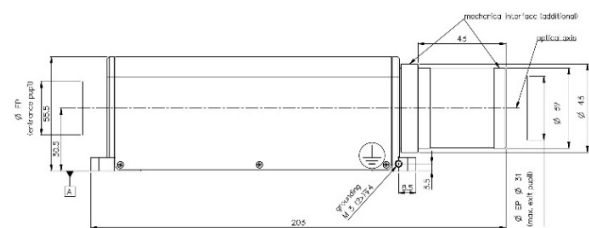
Magnification range	1x - 4x	2x - 8x
Wavelengths (nm)		
Option 1	340 - 360	340 - 360
Option 2	515 - 540	515 - 540
Option 3	1030 - 1080	1030 - 1080

Magnification range	1x - 4x	2x - 8x
Material options	Fused Silica	Fused Silica
Entrance aperture	up to 8mm or up to 6mm @ 340-360nm	up to 8mm or up to 6mm @ 340-360nm
Exit aperture	max. 31mm	max. 31mm
Pointing stability	< 0.3mrad	< 0.5mrad
Adjustment time	up to 7 sec	up to 7 sec

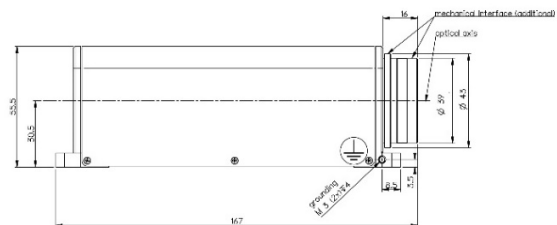
1.1.2 Mechanical specifications

Magnification range	1x - 4x	2x - 8x
Length	167mm	203mm
Width	58mm	58mm
Height	55.5mm	55.5mm

The controller is built into the motorized beam expander; no external controller needed.



Mechanical drawing version 2x-8x



Mechanical drawing version 1x-4x

1.1.3 Electronic specifications

User interface options	a) Terminal program, using the command set described in this manual; b) Actuator software, included in delivery (LabView for Windows™), with functions for storing 10 magnification and divergence settings
Transmission speed	9600bit/s
Input voltage	Power plug: 7-12V; Phoenix contact 7-24V
Connector ports	D-sub 9; USB 2.0; Phoenix contact
Conformity	NRL, EMC, ROHS, WEEE (Declarations of conformity available on request)

1.1.4 Ambient conditions

Operating temperature	15°C to 35°C (50°F to 95°F)
Storage temperature	-10°C to +55°C (14°F to 131°F)
Humidity during operation	< 92% in acc. with ISO 9022 at 40°C (104°F)
Protection type in acc. with EN 60529	IP 20

1.2 Interfaces on the Motorized Beam Expander

There are three options for connecting the motorized beam expander to a computer or PLC (Programmable Logic Control):

a) D-sub 9/RS-232 and power plug for 7 - 12V/1A input range



b) Combicon MC 1.5/6-STF3.81 from Phoenix and industrial interface for RS-232 for 7- 24V/1A input range



c) USB 2.0 and power plug for 7 - 12V/1A input range

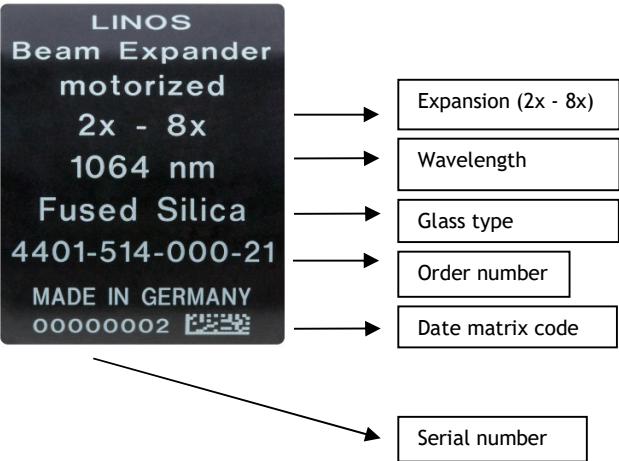


All basic data, including offset-values, wavelength, serial number and parameter settings are stored by Qioptiq in the control unit's non-volatile memory.

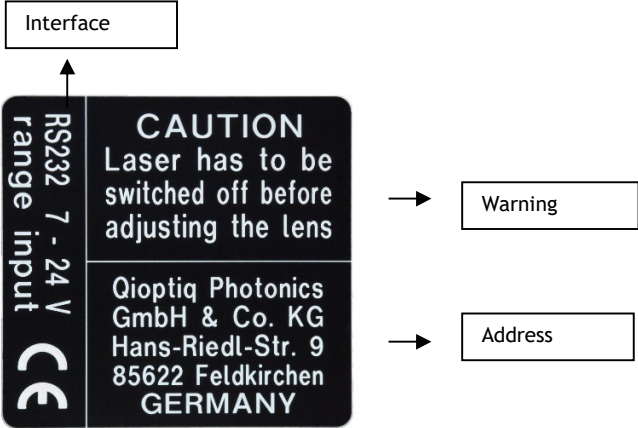
1.3 Product identification

Two nameplates affixed to the beam expander provide unique identification of your device.

1.3.1 Nameplate with serial number indicating application range



1.3.2 Nameplate for interfaces



1.3.3 Models

Motorized Beam Expander Expansion 1x - 4x:

Product number (Order number)	Anti-reflective coating, broadband anti-reflective coating on the lenses* (nm)	Working wavelength (nm)	Max. entrance beam Ø at 1/e ² (mm)**	PC interface/protocol
4401-596-000-20	340 - 360	355	6	SubD9/ RS232
4401-596-000-21	340 - 360	355	6	Phoenix Contact/ RS232
4401-596-000-22	340 - 360	355	6	USB 2.0
4401-597-000-20	515 - 540	532	8	D-sub9/RS-232
4401-597-000-21	515 - 540	532	8	Phoenix contact/RS-232
4401-597-000-22	515 - 540	532	8	USB 2.0
4401-598-000-20	1030 - 1080	1064	8	D-sub9/RS-232
4401-598-000-21	1030 - 1080	1064	8	Phoenix contact/RS-232
4401-598-000-22	1030 - 1080	1064	8	USB 2.0

Motorized Beam Expander Expansion 2x - 8x:

Product number (Order number)	Anti-reflective coating, broadband anti-reflective coating on the lenses* (nm)	Working wavelength (nm)	Max. entrance beam Ø at 1/e ² (mm)**	PC interface/protocol
4401-516-000-20 4401-634-000-20***	340 - 360	355	6	D-sub9/RS-232
4401-516-000-21 4401-634-000-21***	340 - 360	355	6	Phoenix contact/RS-232
4401-516-000-22 4401-634-000-22***	340 - 360	355	6	USB 2.0
4401-515-000-20	515 - 540	532	8	D-sub9/RS-232
4401-515-000-21	515 - 540	532	8	Phoenix contact/RS-232
4401-515-000-22	515 - 540	532	8	USB 2.0
4401-514-000-20	1030 - 1080	1064	8	D-sub9/RS-232
4401-514-000-21	1030 - 1080	1064	8	Phoenix contact/RS-232
4401-514-000-22	1030 - 1080	1064	8	USB 2.0

*Damage thresholds: a) 4J/cm² @355 nm with 6ns pulse length, 100Hz and 0.4J/cm²@343nm with 200fs pulse length, 1kHz
 b) 20J/cm² @532nm with 8ns pulse length, 100Hz and 0.6J/cm²@515nm with 204fs pulse length, 50kHz
 c) 40J/cm² @1064nm with 12ns pulse length, 100Hz and 0.9J/cm²@1030nm with 291fs pulse length, 5kHz

** Max. entrance beam diameter = 31mm / expansion factor

*** For the UV - motorized beam expanders (4401-596-000-20/21/22 and 4401-634-000-20/21/22) the mechanical surfaces are available colorless anodized.

1.3.4 Protective glasses, fused silica

Product number (Order number)	Anti-reflective coating, broadband anti-reflective coating on the lenses* (nm)	Diameter (mm)	Thickness (mm)
4401-516-006-00	340 - 360	17.5	1.6
4401-515-006-00	515 - 540	17.5	1.6
4401-514-006-00	1030 - 1080	17.5	1.6

*Damage thresholds: a) 4J/cm² @355 nm with 6ns pulse length, 100Hz and 0.4J/cm²@343nm with 200fs pulse length, 1kHz
 b) 20J/cm² @532nm with 8ns pulse length, 100Hz and 0.6J/cm²@515nm with 204fs pulse length, 50kHz
 c) 40J/cm² @1064nm with 12ns pulse length, 100Hz and 0.9J/cm²@1030nm with 291fs pulse length, 5kHz

1.4 Equipment Supplied

- Motorized beam expander (order no.: see charts in Section 1.4)
- Protective cover for front lenses
- CD containing software and operating manual (order no. 4402-006-401-00)



Other accessories (e.g. power supply) required for putting your beam expander into operation must be purchased separately; see Section 7.3.

The software has been tested for viruses. Any modification of the files supplied by Qioptiq Photonics will result in forfeiture of all claims, including all claims under the product warranty.

Software updates are not supplied automatically.

1.5 Manufacturer's Address

Qioptiq GmbH & Co. KG
 Laser Material Processing
 Hans-Riedl-Straße 9
 D-85622 Feldkirchen
 Germany
 Phone: +49 (0)89/ 255 458-0
 E-mail: imp@excelitas.com
www.qioptiq.de
www.excelitas.com

2 Important Notes

2.1 About the Technical Documentation

The following two symbols are used to call the reader's attention to important points in the hardware and software descriptions contained in this manual and to facilitate rapid orientation.



'Note'
Indicates important information on the beam expander or about this manual



'Caution'
Indicates that failure to observe the designated information may result in damage to the beam expander or connected components, and operator injury cannot be ruled out.

We have checked the hardware and software carefully, as well as the product documentation. However, freedom from defects is not guaranteed.

The contents of this document are the intellectual property of Qioptiq Photonics GmbH & Co. KG and are protected under copyright law.

We are constantly developing our products and reserve the right to make changes without notice. Up-to-date information is available at our website, www.qioptiq.com. You can contact Qioptiq at any time if you have any questions.

2.2 Intended Use

- The motorized beam expander is intended exclusively for expansion (and reduction) of laser beams in the range of 1x - 4x or 2x - 8x and the variation of beam divergence. In the case of expansion, additional optics are usually used, e.g. an F-Theta lens, to focus the beam. The larger the diameter of the entrance beam incident on the focusing optics, the smaller the attainable spot size.
- The beam diameter can be reduced through inverse operation of the beam expander. Reducing the laser beam diameter results in a corresponding magnification of the entrance beam divergence. The power density is increased by the square of the reduction factor, so that the possibility of altered damage thresholds must be taken into account.
- A divergent or convergent laser beam can be collimated using the divergence adjustment function of the variable beam expander. Thus in combination with focusing optics, a selective defocusing or focusing can be achieved.
- The beam expander is a high-precision instrument and, like any opto-electronic device, must be handled with care. Static electricity can cause malfunction or even destruction of electronic components inside the motorized beam expander. Opening the beam expander will result in forfeiture of all claims, including all claims under the product warranty.

In the event of malfunction, contact the service department.

- Qioptiq is not liable for damage or injury resulting directly or indirectly from use of this product for anything other than its intended purpose.
- The motorized beam expander is intended for use only in industrial and scientific environments. If other electrical devices are connected to or used in conjunction with the beam expander, all legal regulations and technical standards that apply to those devices must be observed as well.

2.3 Requirements for Operation

It must be ensured that only those persons are tasked with operation of the beam expander who have read the operating instructions and thus familiarized themselves with the design and the operation of the device.

This operating manual must be available at all times when work is performed on or with the beam expander.



The instructions contained in this operating manual must be followed at all times.

2.4 Safety Precautions



The following list includes the most important safety instructions and warnings, but is by no means exhaustive.

- All safety instructions must be followed.
- Read this operating manual carefully first. This will ensure optimal use of the beam expander and will help prevent problems and damage or injury.
- Never expose the device to dirt.
- Make sure the beam expander is optimally installed and adjusted.
- Make sure the connection is current-proof and the correct connector type is used; watch for imminent cable breakage; make sure cable installations are accident-proof and electromagnetically compatible.
- **Always switch off the laser beam before changing any settings.**
- **Do not switch on the laser immediately following initialization, as this could result in destruction of the instrument. First position the lenses as desired, in accordance with the relevant tables.**



High laser output with suboptimal lens settings may damage or destroy the beam expander.

- The requirements concerning ambient conditions (see Section 1.2.4) must be observed at all times during operation of beam expander.
- Make sure the device is used only in accordance with its intended purpose (see Section 2.2).
- Mechanical interface positions (such as bore holes for mounting pins) must be kept clean and must be handled with care; otherwise the very high accuracy of the device specifications cannot be maintained.



This operating manual is a component of the motorized beam expander and must be kept within reach of the beam expander during use.

If the device is passed on or sold to a third party, this manual must be included in transfer of the device.

2.5 Cleaning Instructions

- Use only isopropyl alcohol and a clean optical cloth to clean the front lenses.



Residues on the front lenses can result in destruction of the lens even at only moderately high laser power.

- Do not attempt to clean the optics inside the beam expander.



Opening the beam expander will result in forfeiture of all claims under the product warranty.

- Use a soft, dry cloth to clean the outside of the beam expander.

2.6 Maintenance Schedule

No maintenance is needed, but strict adherence to the cleaning instructions above is crucial.

The motorized beam expander passed testing that included 250,000 runs.

3 Installation Instructions and Technical Drawings

The motorized beam expander features a smooth base plate and two holes for mounting pins $\varnothing 6_{h6}$ for high-precision installation in an optical system (mounting pins not included). These are the high precision mechanical reference points recommended for use of the instrument.

The optical specifications and the position and direction of the optical axis of the motorized beam expander are defined on the basis of these reference points. The optical axis runs parallel to the base plate in the direction of the two pins, at a defined height of 30.5 mm (see the technical drawings below).

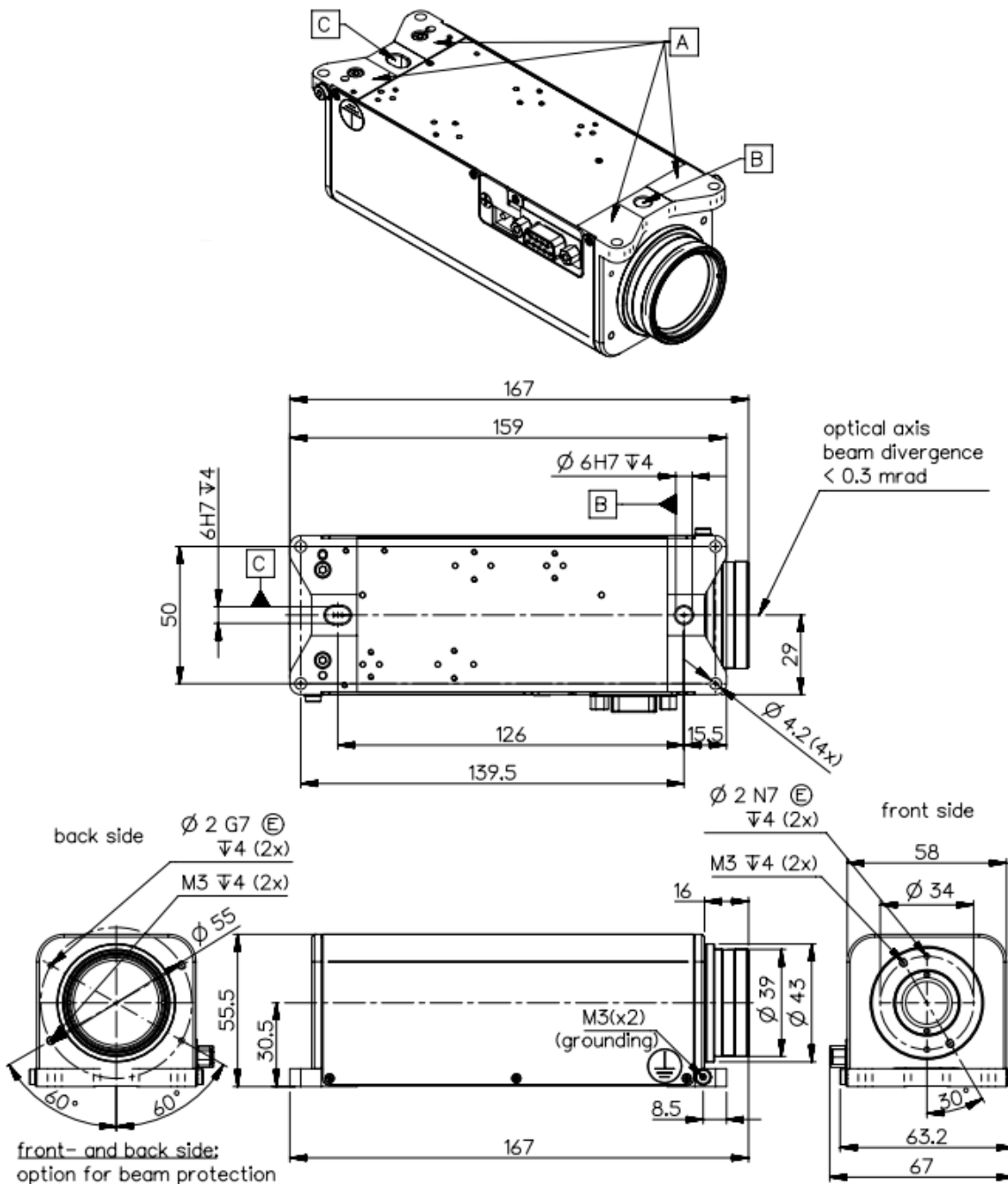
The motorized beam expander is fixed in place by means of four screws. Your optical system must have an equally precise mechanical interface/mount for installation of the beam expander.

For faultless optical functioning, the incoming laser beam must have the same position and direction as the optical axis of the beam expander.

Depending on your system, this may be achieved through a one-time adjustment of the incoming laser beam, or of the motorized beam expander on an adjustable mount. It is helpful to know the metrological data of the calibration beams.

The standard application of the motorized beam expander is expansion; i.e., enlarging the beam diameter. The motorized beam expander can also be operated inversely to reduce beam diameter, under the conditions outlined above (see also Section 2.2). Please contact our support team at tmp@excelitas.com prior to operation.

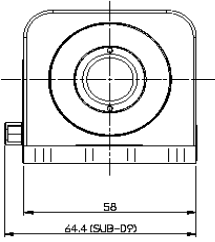
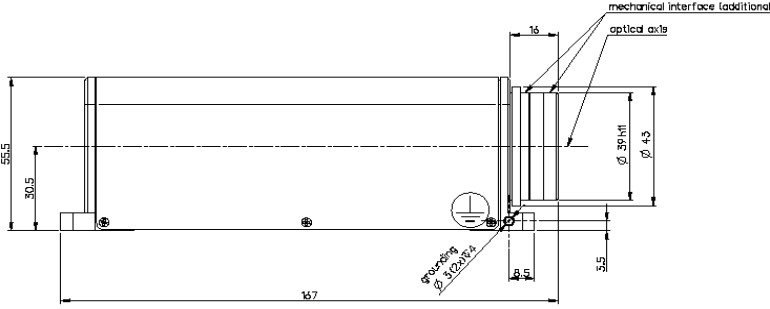
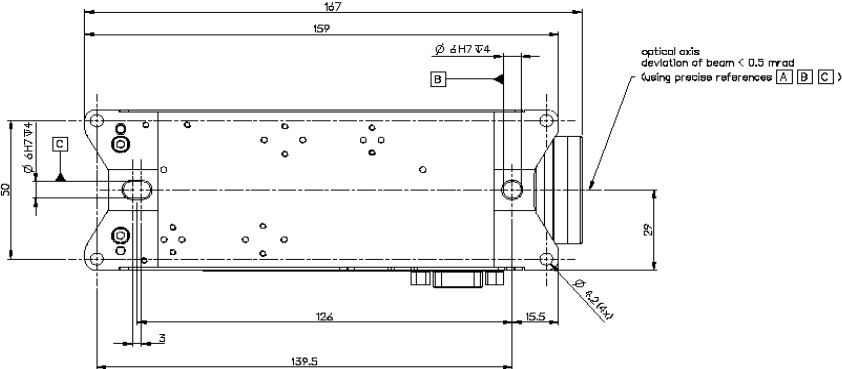
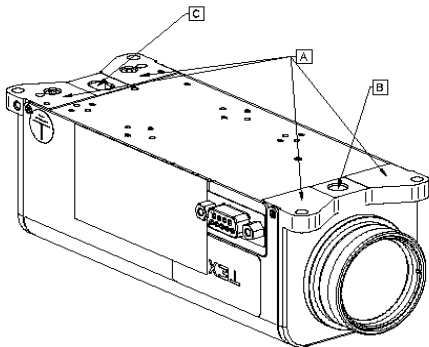
Mechanical drawing motorized beam expander 1x-4x, working wavelength 355 nm:
 Colorless anodized, delivered in low outgassing bags, option for beam protection (front and back side)



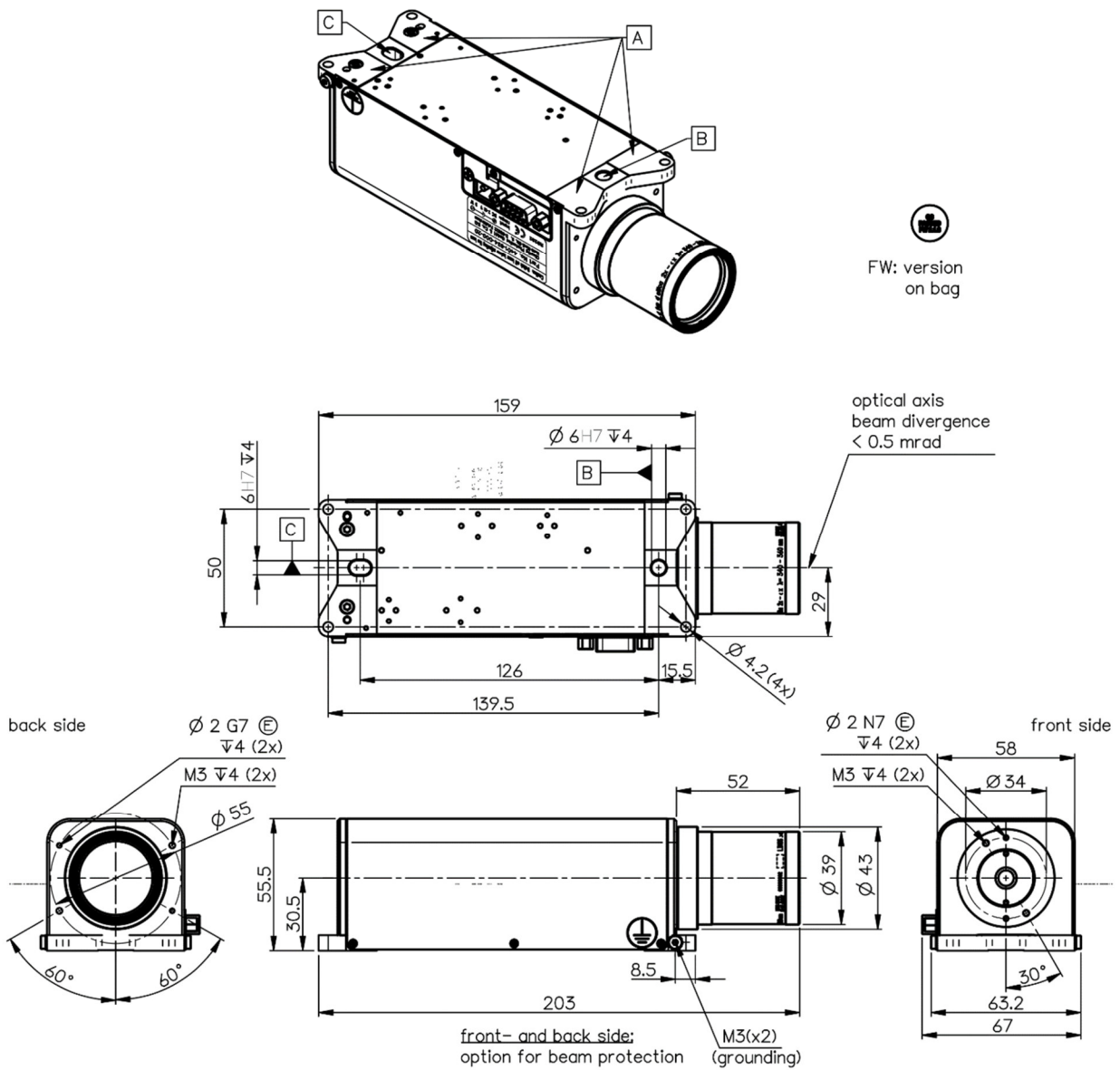
**Mechanical drawing motorized beam expander 1x-4x, working wavelength 532 nm, 1064 nm:
 Black anodized**

mechanical dimension (SUB-D9 / Phoenix / USB 2)

precise references **A** **B** **C** to the optical axis



Mechanical drawing motorized beam expander 2x-8x, working wavelength 355 nm:
 Colorless anodized, delivered in low outgassing bags, option for beam protection (front and back side)

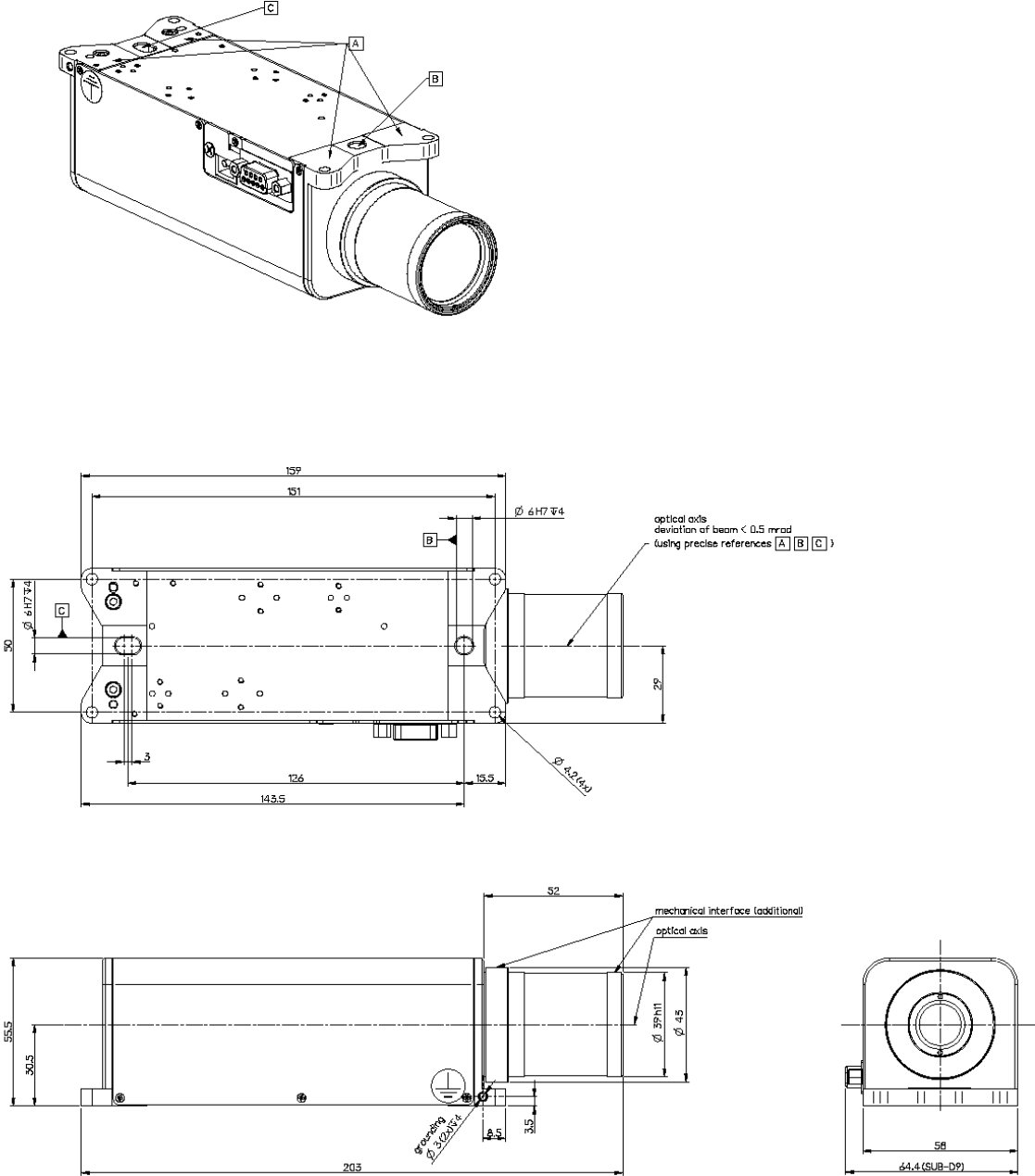


Mechanical drawing motorized beam expander 2x-8x, working wavelength 355, 532, 1064 nm:

Black anodized

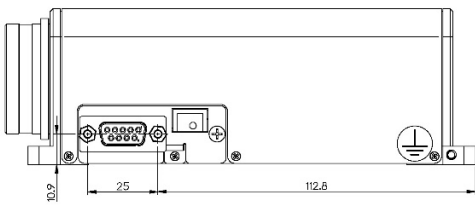
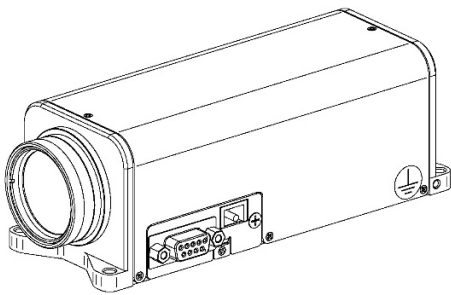
mechanical dimension (SUB-D9 / Phoenix / USB 2)

precise references [A] [B] [C] to the optical axis

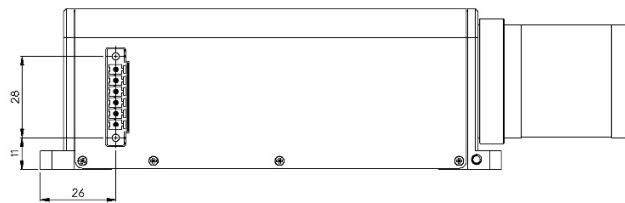
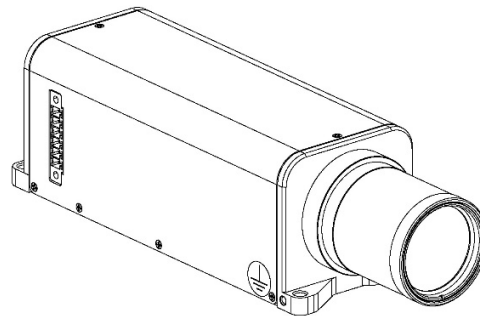


Mechanical drawing interfaces on the motorized beam expander:

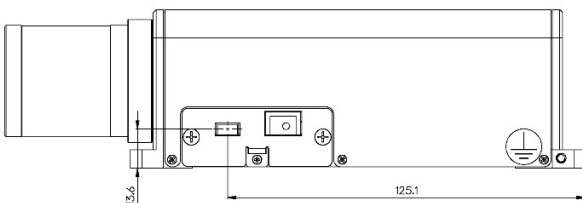
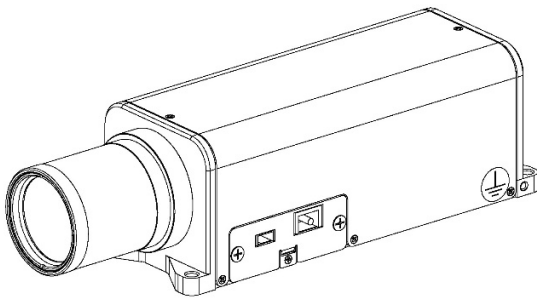
SUB-D9 (RS 232)



Phoenix



USB 2.0



For further technical information please download respective datasheet from our website.

4 Putting the Beam Expander into Operation; Beam Expander Functions

4.1 Connecting the Beam Expander

The beam expander is connected using the D-sub 9 port, Phoenix contact or USB port, depending on model (for details see Section 1.2, 'Interfaces on the Motorized Beam Expander').

4.1.1 Power supply

a) Using the USB 2.0 port:

The motorized beam expander is automatically supplied with 5V/800 mA over the USB connector. If this power supply cannot be maintained with sufficient constancy, the use of an additional power supply unit is recommended, to prevent step loss in the stepper motor.

b) Using an external power supply unit

Make sure the power supply has the correct polarity (outside: +, inside: -) and suitable power level (at least 4 W). There must be no major sources of interference coupled into the power supply line, and the cable placement must follow an electromagnetically compatible design. As soon as the power supply is connected, the USB power supply cuts out and is no longer used.

4.1.2 Wiring

a) D-sub 9

Type	Label	Color	Target conn.
RS-232	Tout/TxD	white	D-sub 9 pin 2
RS-232	Rin/RxD	green	D-sub 9 pin 3
RS-232	DGnd	b/w	D-sub 9 pin 5

b) Phoenix contact

Type	Label	Color	Target conn.
Power +	+Vdd	red	Pin 1
Power -	DGND	b/w	Pin 2
not conn.	-	-	Pin 3
RS-232	Tout/TxD	white	Pin 4
RS-232	Rin/RxD	green	Pin 5
RS-232	DGnd	b/w	Pin 6



Power plug (power supply) polarity: [+(-)+], i.e.: outer: + inner -

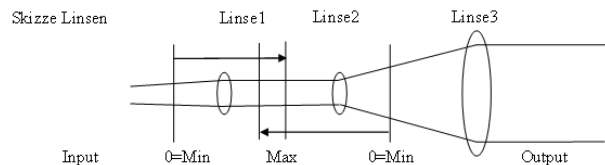


USB cable, serial cable and power supply are not included in delivery of the motorized beam expander. For details on obtaining these parts, see Section 7.3.

Cable length:

The data cable should be as short as possible and must be installed in a manner that ensures electromagnetic compatibility. Recommended length: approximately 2m.

4.2 Description of Functions



Example of lens layout

The motorized beam expander consists of two motorized adjustable entrance lenses (lenses 1 and 2) and one lens system (lens 3). Expansion and collimation of the laser beam is achieved by adjusting the positions of lenses 1 and 2.

Flexible control was one of the main objectives in designing the command set. The commands are public, and are described in detail in Section 5.3.3.

Writing a customized control program, however, should be undertaken only by expert technicians. Alternatively, the device can be actuated using the software supplied with the equipment.



Commands labeled "critical" in this manual should be used only after their descriptions have been read carefully and understood thoroughly.

5 Control

5.1 Drive Mechanism

- The 'Min' position is the mechanical zero point (see diagram in Section 4.2, 'Description of Functions'). The steps are counted, and the distance measured in millimeters, starting from this zero point.
- There are two stepper motors; one for each lens. The step length is 4.15 μm and the motor moves in half steps. 1000 steps = 4.15 mm distance traversed by the lenses.
- Accuracy: +/- 1 full step \pm +/- 8.3 μm
- Due to the design symmetry, the lenses traverse a common linear guide and precise adherence to the optical axis is ensured.
- The motors are actuated separately and independently in sequence, and require approximately 7 seconds to adjust from 1x to 4x or 2x to 8x magnification.



The laser must be off while the lenses are moving; otherwise, the lenses may be damaged or destroyed.

5.2 Initialization



Initialization is required every time the hardware is switched on, as the registers are blank and the current position must be re-detected.

The first step in initialization is detection of the reference point by a Hall-effect sensor. The next step is loading the optical offset value in the step counter, which defines the amount by which the reference point differs from the optical zero point. **The offset is applied in determining the distance of a lens from the optical zero point.** The offset is dependent on the mechanics/ optics, and is determined at the factory when the device is calibrated the first time it is put into operation. This value can be queried using a software command following initialization of the device.



Do not switch on the laser immediately following initialization, as this could result in destruction of the instrument. First the lenses must be positioned as desired, in accordance with the relevant tables.

5.3 Calibration

On completion of the manufacturing process, the beam expander is calibrated the first time it is put into operation at the factory.

When the device is calibrated, the deviation between the Hall reference point and the mechanical stop - the mechanical offset value - is detected and stored in the beam expander's processor register.

This calibration is dependent on the tolerance limits of the mechanics and must be performed again any time the mechanics are dismantled. Calibration is also performed whenever Qioptiq carries out repair work on the instrument.

The Hall reference point and the mechanical stop are approximately 2mm apart.

5.4 Traversing Limits

The traversing limits can be changed by Qioptiq in dependence on the model.



The software supplied with the instrument has a built-in limit of 4750 steps. This corresponds to a distance of 4.15 μm x 4750=19.7125mm. If the limits are exceeded an error message is generated (see Section 5.6.4 for details).

5.5 Setting the Magnification

Set the magnification using the tables in the Appendix as a guide. Which table is applicable depends on the wavelength of the laser and on the lens material.

The tables can also be found on the CD supplied with the device as well as at the Qioptiq website. You can also order them from the service department.



The beam expander must be initialized first, as this sets the reference point.

As long as the beam expander is not switched off or otherwise disconnected from power, the reference point remains set. If it has been switched off, the device must be re-initialized before use.

After initialization, check the relevant table to find the lens 1 and lens 2 positions needed for the desired magnification.

To adjust lens positions, you can send the corresponding commands over RS-232 (using a terminal program) or use the software supplied.

Note:

Both lenses affect the expansion and collimation of the laser beam.

In the lower magnification range, lens 1 is primarily responsible for collimation, and lens 2 primarily for magnification.

The software program gives you the option of storing the values determined so that you can quickly re-set the positions at any time.

Each motor positions its lens with an accuracy of +/- 8.3µm.

5.6 Interface Commands

5.6.1 General note

The beam expander hardware is actuated by the serial interface commands listed in the following table.

All of the commands shown here are also used by the program included in delivery from Qioptiq. They can also be sent to the device using any terminal program, which makes it easy to integrate the instrument into existing automated systems.



Qioptiq has published these commands to give users greater flexibility. Some of the commands, however, should be used only by technicians with the required specialized knowledge and only with caution, as they directly affect the hardware. A careful reading of Section 5.3.3 is strongly recommended before using these commands.

5.6.2 Table of interface commands and configuration

RS232 with 9600 baud rate, 8 data bits, no parity, stop bits 1 or 2

Send ComChar	Par(Type)	Action	Feed(Type)	Typical example
#0:	no	Software reset	!(char)	#0:!
#1:	no	Init motor1 and motor2, Hall_AD value = 1600	!(char)	#1:!
#1:	0-4500(int)	Drive steps, motor1 1 step = 4.15µm	!(char)	#1:2300!
#2:	0-4500(int)	Drive steps, motor2 1 step = 4.15µm	!(char)	#2:2100!
#7:	no	Show step counter, motor1 1 step = 4.15µm	\$7:0-4500(int)	#7:\$7:500
#8:	no	Show step counter, motor2 1 step = 4.15µm	\$8:0-4500(int)	#8:\$8:500
G1:	no	Get Hall value motor1 from AD converter CPU	\$G1:0-2048(int)	G1:\$G1:1599
G2:	no	Get Hall value motor2 from AD converter CPU	\$G2:0-2048(int)	G2:\$G2:1601
G3:	no	Get optical offset motor1 from Flash/EEPROM	0-4500(int)	G3:512
G4:	no	Get optical offset motor2 from Flash/EEPROM	0-4500(int)	G4:485
G5:	no	Get mechanical offset motor1 from Flash/EEPROM	0-4500(int)	G5:512
G6:	no	Get mechanical offset motor2 from Flash/EEPROM	0-4500(int)	G6:512
GS:	no	Get serial number from flash/EEPROM	8 bytes(char)	GS:12059980
GV:	no	Get version from Flash/EEPROM	4 bytes(char)	GV:2120 (=>Version 2.1.2.0)
GI:	no	Get initialization status	'0' = not initialized '1' = initialized	GI:\$GI:0 GI:\$GI:1
<p>Please use the Init (#!) command after stopping, or after the beam expander has been switched off. This is required for alignment of the mechanical/optical distance with the motor steps. One step = 4.15 µm. After Init, the mechanical/ optical offset is automatically loaded from flash memory. Each step is counted from mechanical zero (Hall switch). The lens position is aligned accordingly. See the appended tables for the appropriate zoom values.</p>				
S1:	0-4500	Set step counter motor1	!(char)	S1:500! Change value
S2:	0-4500	Set step counter motor2	!(char)	S1:450! Change value

Remark: # = basic commands; G = 'Get' commands; S = 'Set' commands. All other input is ignored.

Remark: The third 'char' value may be a colon (":"), space or an 'Enter' character. This value is queried only if the frame is OK. Example:
 #0: # = first character; 0 = second character; ; = choice of character



Commands shown here on gray background must be used with caution, as improper use may damage the beam expander.

5.6.3 Details on the main commands

1) Software reset

#0:	no	Software reset	!(char)	#0:!
-----	----	----------------	---------	------

Description: Resets all registers.

2) Beam expander initialization

#1:	no	Init motor1 and motor2, Hall_AD value = 1600	!(char)	#1:!
-----	----	---	---------	------

Description: Detects the reference point for the stepper motor and loads the offset to the optical zero point in the step counter. Also the mechanical offset of the system will be loaded.



Initialization is required every time the hardware is switched on, as the registers are blank and the current position must be re-detected.

3) Move lens 1/lens 2

#1:	0-4500 (int)	Drive step motor1 1 step = 4.15µm	!(char)	#1: 2300!
#2:	0-4500 (int)	Drive step motor2 1 step = 4.15µm	!(char)	#2: 2100!

Description: Moves lens 1 or lens 2 to the desired position. Commands for motor 1 and motor 2 are transmitted separately.



After each drive command, there must be a pause until ACK=! is returned before the next command is sent.

4) Query counter value

#7:	no	Show step counter, motor1 1 step = 4.15µm	\$7: 0-4500(int)	#7:\$7:500
#8:	no	Show step counter, motor2 1 step = 4.15µm	\$8: 0-4500(int)	#8:\$8:500

Description: Returns the current state of the step counter, which reflects the position as detected by the CPU.



If the value not is not plausible, the device must be initialized.

5) Query analog Hall-effect sensor value

G1:	no	Get Hall value, motor1, from AD converter CPU	\$G1: 0-2048 (int)	G1:\$G1: 1599
G2:	no	Get Hall value, motor2, from AD converter CPU	\$G2: 0-2048 (int)	G2:\$G2:: 1601

Description: An analog Hall-effect sensor is installed for determining the reference point.

Following initialization, this value should be at 1600 +/- 1 increment, which indicates that the reference position has been detected.

This command is implemented as a data query solely for use in monitoring.

6) Read the optical offset stored in flash memory

G3:	no	Get opt. offset motor1 from flash/EEPROM	0-4500 (int)	G3:512
G4:	no	Get opt. offset motor2 from flash/EEPROM	0-4500 (int)	G4:485

Description: This value is stored in a processor register when the device is calibrated and loaded for initialization of the stepper memory. The optical offset deals as a correction value to the nominal optical system.

7) Read the mechanical offset stored in flash memory

G5:	no	Get mech. Offset Motor1 from Flash/EEPROM	0-4500 (int)	G5:512
G6:	no	Get mech. Offset Motor2 from Flash/EEPROM	0-4500 (int)	G6:485

Description: This value is stored in a processor register when the device is calibrated and loaded for initialization of the stepper memory. The mechanical offset is the lower limit of the lens travel range. Values below are therefore forebidden.

8) Read internal device number

GS:	no	Get serial number from flash/EEPROM	8 bytes(char)	GS:12059980
-----	----	-------------------------------------	---------------	-------------

Description: The internal serial number is stored in the device at the factory during commissioning by Qioptiq, and matches the serial number etched on the nameplate.

9) Read internal version status on delivery

GV:	no	Get version from flash/EEPROM	4 bytes (char)	GV:2120 (=Version 2.1.2.0)
-----	----	-------------------------------	----------------	----------------------------

Description: This is the software version, which must be indicated when reporting a problem to the service department. It is stored in the device at the factory during commissioning by Qioptiq.

10) Get initialization status

GI:	no	Get initialization status	'0' = not initialized '1' = initialized	GI:\$GI: 0 GI:\$GI: 1
-----	----	---------------------------	--	--------------------------------

Description: This command can be used to check if the beam expander has already been initialized. Thus storing this information in user application internally can be skipped

11) Set internal counter state

S1:	0-4500	Set step counter, motor1	!(char)	S1:500! Change value
S2:	0-4500	Set step counter, motor2	!(char)	S1:450! Change value

Description: Because the stepper motor recognizes only positive values, the ability to set this value has been implemented so that the coordinate system can be shifted and the motor thus driven "in reverse."



Critical command; for advanced users only

Following initialization, the optical offset value is loaded in the step counter, thus restoring the original state.

The beam expander is controlled using the standardized RS-232 serial protocol. Interface commands and configuration (see Section 5.6.2.).

The commands can be sent to the beam expander by a terminal program, such as the HyperTerminal program supplied with the Windows operating system.

5.6.4 Troubleshooting

If the permissible traversing range is exceeded, the firmware in the motorized beam expander automatically generates an error code:

a) Error code F1

The maximum traversing range of motor 1 has been exceeded

b) Error code F2

The maximum traversing range of motor 2 has been exceeded

c) Error code F3

There is a danger that motor 1 and motor 2 will collide. The minimum distance required between lenses, or "safe space," is programmed into the device at the factory.

d) Error code F4

Instrument is not initialized. Motor1 und motor2 can only be moved after successful initialization.

e) Error code F5

Underrun of the mechanical limit for motor 1. The following condition is violated:

Lensposition 1 \geq (opt. Offset 1 - mech. Offset 1)

opt. Offset 1 > mech. Offset 1

f) Error code F6

Underrun of the mechanical limit for motor 2. The following condition is violated:

Lensposition 2 \geq (opt. Offset 2 - mech. Offset 2)

opt. Offset 2 > mech. Offset 2

Error codes: The limits defining "Motor1 Max", "Motor2 Max", "safe space", "opt. offset 1", "opt. offset 2", "mech. offset 1", "mech. Offset 2" are programmed by Qioptiq				
Command	Input value	Description	Error code	Example
#1:	> Motor1 Max	Mechanical limit, motor 1	F1	#1:5000
#2:	> Motor2 Max	Mechanical limit, motor 2	F2	#2:5000
#1: or #2:	MotorX Max - exclusion zone	Collision of motor 1 with motor 2 possible	F3	Motor1 = 4500 steps Motor2 = move to 4700 error code: 'F3'
#1: or #2:	Any value without previous initialization	Initialization mandatory	F4	
#1	Pos 1 < mech. Limit 1	Underrun mech. Min. of motor 1	F5	
#2	Pos 2 < mech. Limit 2	Underrun mech. Min. of motor 2	F6	

6 Software

6.1 General Description

The software supplied for control of the motorized beam expander was created using the Windows™-based LabView developer environment.

A connection to the hardware is established. The lenses are moved to the desired position following hardware initialization.

Up to 10 positions can be stored in a text file and loaded as desired.

The software can identify the connected beam expander.

6.2 Installing the Software

Insert the program CD supplied with the device, run the Setup file and follow the on-screen instructions.
(For details on installing a virtual COM port, see Section 6.4.)

6.3 Calling the Program

Call the program from the Windows Start menu or using the Windows Explorer.



6.4 COM Port Settings

Follow these steps to select the COM port to which the beam expander is connected.

You can switch ports during operation.

When you use the USB connector, a driver creates a virtual COM port. If you are prompted to specify a driver, stop the setup program and run the \DriverFTDI232RQ\CDM20814_Setup.exe file on the program CD. Once installation has been completed, reconnect the beam expander and select the new COM port.

All available interfaces are shown in the drop-down menu under 'Port Name'. Make sure the beam expander can be addressed over the selected port. The baud rate of 9600 is programmed in the controllers.

When communication is established, the beam expander model is displayed under 'Status Box'.

6.5 Initializing with the Software

After software startup and the selection of the corresponding Com-Port („1. Configuration: Port Name“), the beam expander can be initialized by pressing the button „Initialise Motion“.

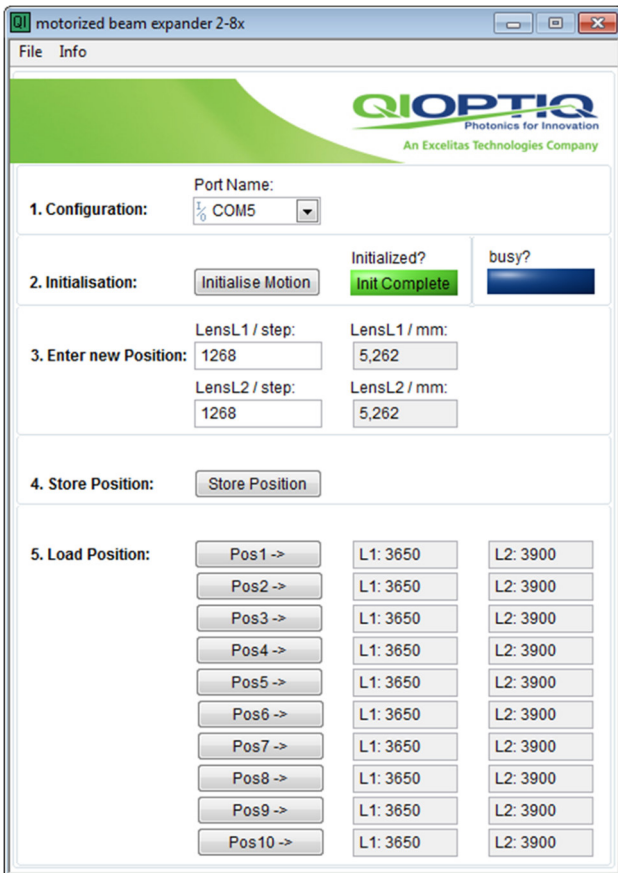


Do not switch on the laser immediately following initialization, as this could damage or destroy the instrument. First the lenses must be positioned as desired, in accordance with the relevant tables.



If the motors are moved before initialization, there is no reference point on which to base the lens positioning. We strongly advise against moving the motors prior to initialization.

For Firmware Version 2.1.4.0 and higher an initialization is mandatory.



Following initialization, the optical offset values are shown in the LensL1 and LensL2 fields.

6.6 Adjusting the Lens Positions



The laser beam must be off while configuring settings in the beam expander.

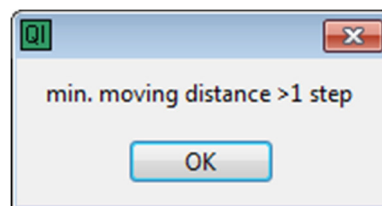
The positions of the lenses for various magnifications can be determined from the model-specific values in the charts or the corresponding graphs.

(See Section 5.2, Setting the Magnification; see Appendix for tables.)

These positions can be entered directly in the LensL1/L2 fields. When you press 'Enter' the lenses are moved to the specified positions.

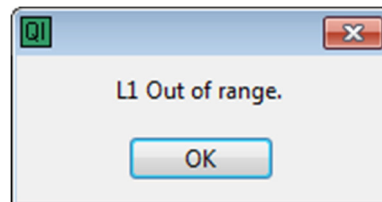
The 'busy' field indicates the operating state of the system. When the desired positions are reached, the values entered match the current positions.

It is not possible to traverse only one step; an attempt to do so returns the following error message:

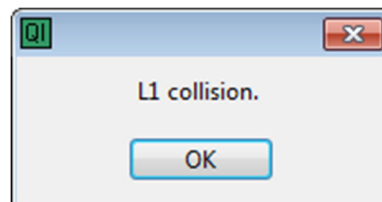


The minimum traversing range is > 1 step. One step equals 4.15 µm.

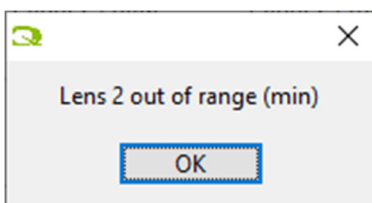
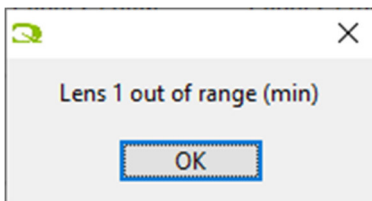
If the maximum traversing range of motor L1 or motor L2 is exceeded, error code F1 or F2 is returned:



Only one lens at a time may occupy a space of a certain size ("safe zone"); otherwise, lenses 1 and 2 may collide. If the "safe space" is breached, the display shows the F3 error code. The exclusion zone is programmed in the device at the factory.



An underrun of the mechanical limit for motor 1 or motor 2 will interfere with the following error message.



6.7 Storing and Loading Positions

a) Storing a lens position:

You can store up to 10 different values for the Lens1/Lens2 fields. Click 'Store position' first, and then enter the desired position (Pos1 to Pos10).

b) Loading a lens position:

Click on the position field to select one of the stored positions. The motors drive automatically to the selected position.



After all desired positions have been stored, click 'File Save' to store them in non-volatile memory.

6.8 Menu

6.8.1 'File' menu

- 'Save' saves the current values stored for up to 10 positions in a text file. You can overwrite the default 'BE_ConfigDefault.txt' file or define a different file. Shortcut: Ctrl+S

- 'Load' loads the stored positions from a text file. The default file, 'BE_ConfigDefault.txt', is loaded automatically if no other file has been defined. Shortcut: Ctrl+L
- 'Exit' closes the program. Shortcut: Ctrl+E

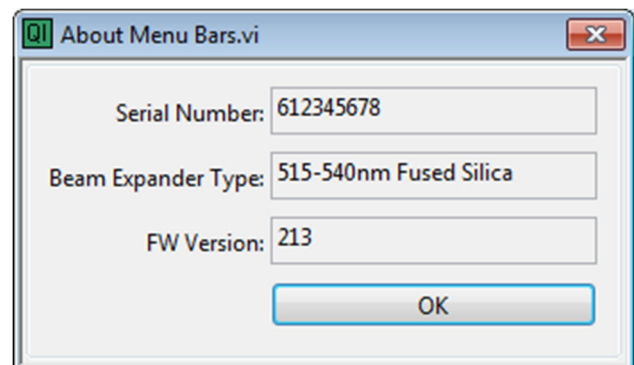


The program automatically loads the default 'BE_ConfigDefault.txt' file on startup. This file must not be deleted.

6.8.2 'Info' menu

Select this menu to view the data stored in the beam expander's flash memory (serial number, model description, software version:).

Shortcut: Ctrl+A



7 Service

7.1 Note on Repairs

In case of malfunction, please contact the person responsible for the product at Qioptiq (see Section 1.6). If the problem cannot be eliminated in consultation with a Qioptiq representative, send the instrument to our service department for repairs. Following incoming inspection, you will be informed as to whether the device can be repaired or must be replaced. Before repairs are carried out, you will be sent a cost estimate free of charge, with no obligation.

7.2 Service Address

Qioptiq GmbH & Co. KG
 Service Department
 Hans-Riedl-Straße 9
 D-85622 Feldkirchen
 Germany
 Phone: +49 (0)89/ 255 458-0
 E-Mail: service.muenchen@excelitas.com

7.3 Obtaining Additional Accessories

7.3.1 Power supply with plug for D-sub 9 and USB

Universal power supply, compatible with all models	Inside (+(-)+)	7-24V/min 5W power
Ansmann APS 1500	7-12V setting	
Voltcraft USPS-1000	12V/1000mA	

7.3.2 D-sub 9 1:1 connecting cable

Serial cable for D-sub 9

D-sub 9 cable 1:1, approx. 2m	Standard cable
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7.3.3 USB-to-PC cable

Mini USB cable

USB, A-plug to 5-pin mini B	1.8m standard cable
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7.3.4 Phoenix Contact plug

For IP20 industrial applications

Plug for Phoenix Contact	MC 1.5/ 6-STF-3.81 with screw
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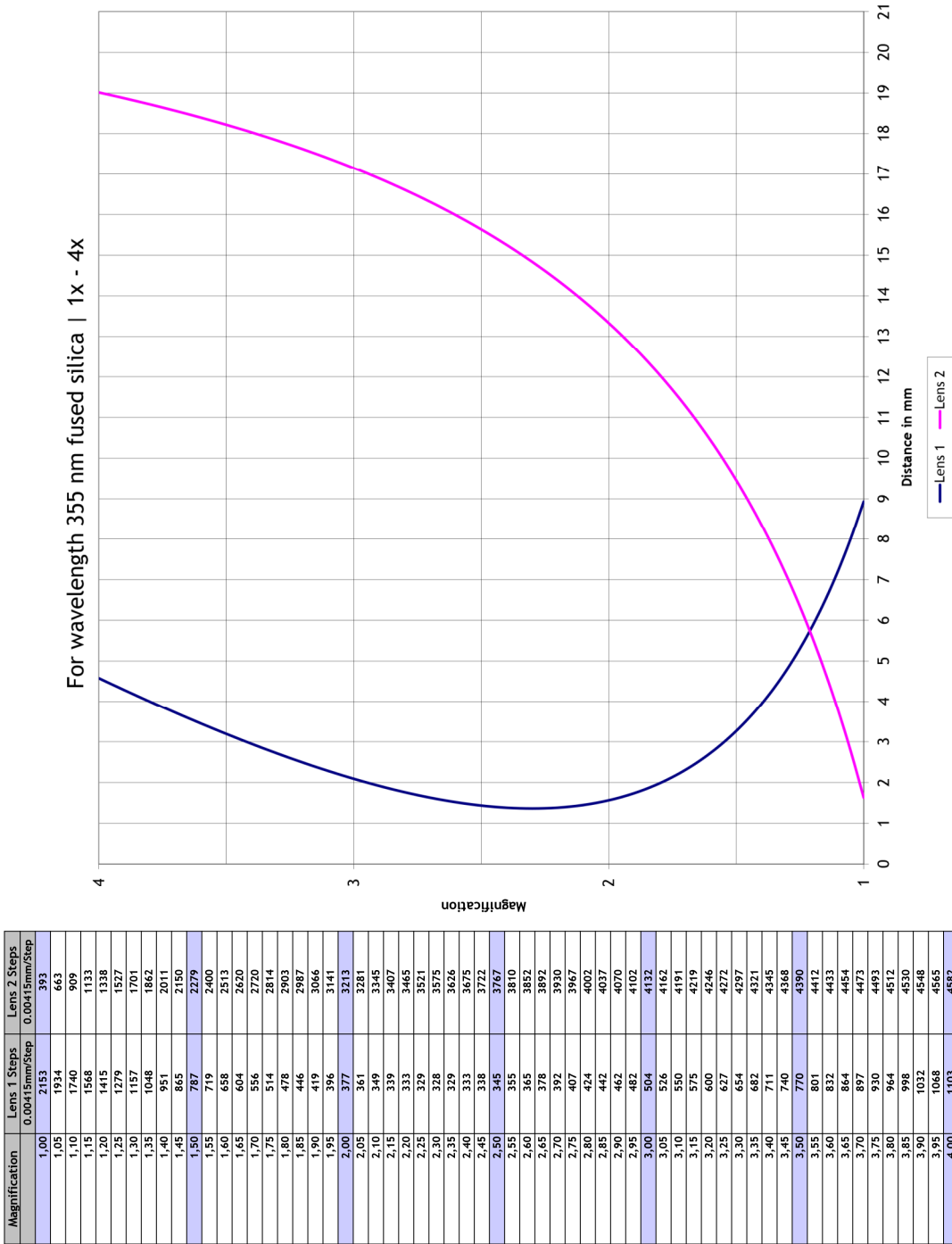
8 Equipment Disposal



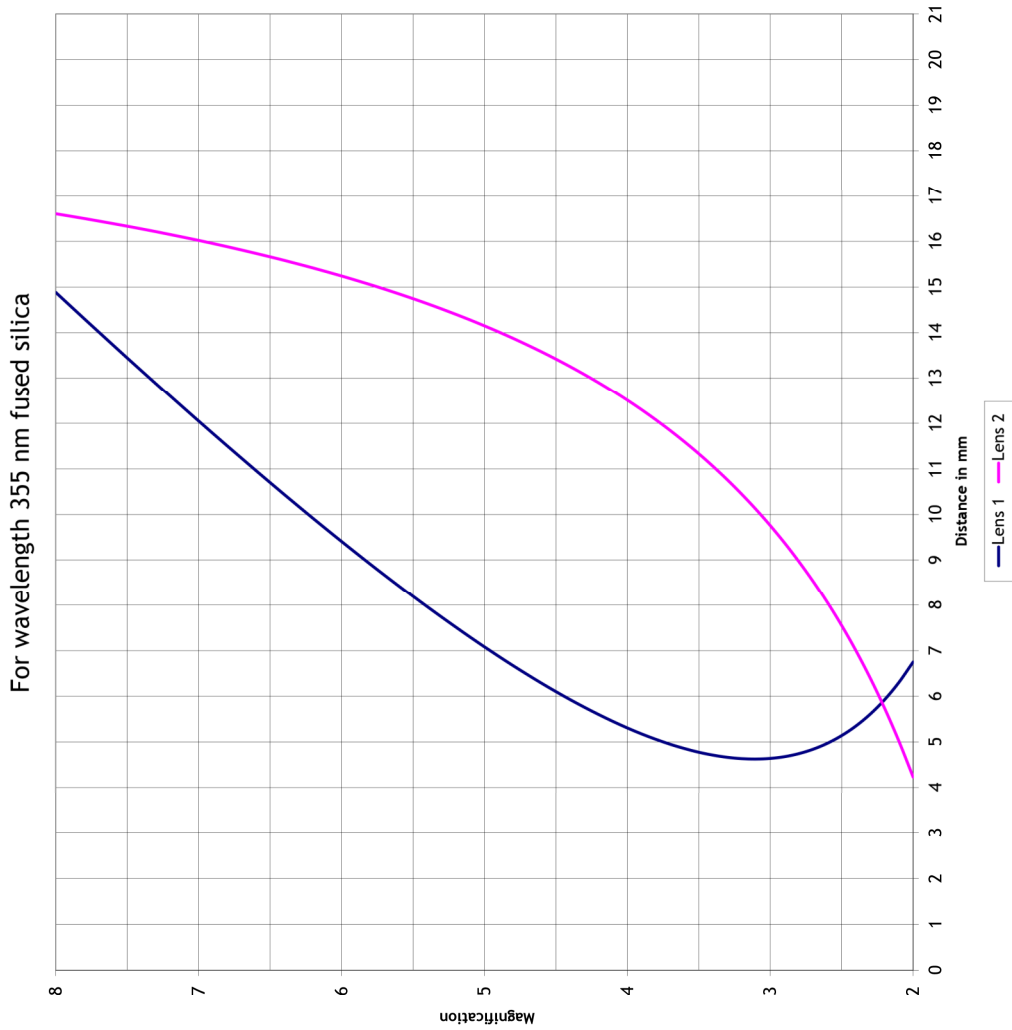
This Qioptiq product must not be disposed of with normal waste. If you no longer need this Qioptiq beam expander and wish to dispose of it, please send it to the service address given above, under 7.2, for proper disposal in accordance with industry standards.

9 Appendix

Wavelength 355nm - fused silica - 1x - 4x

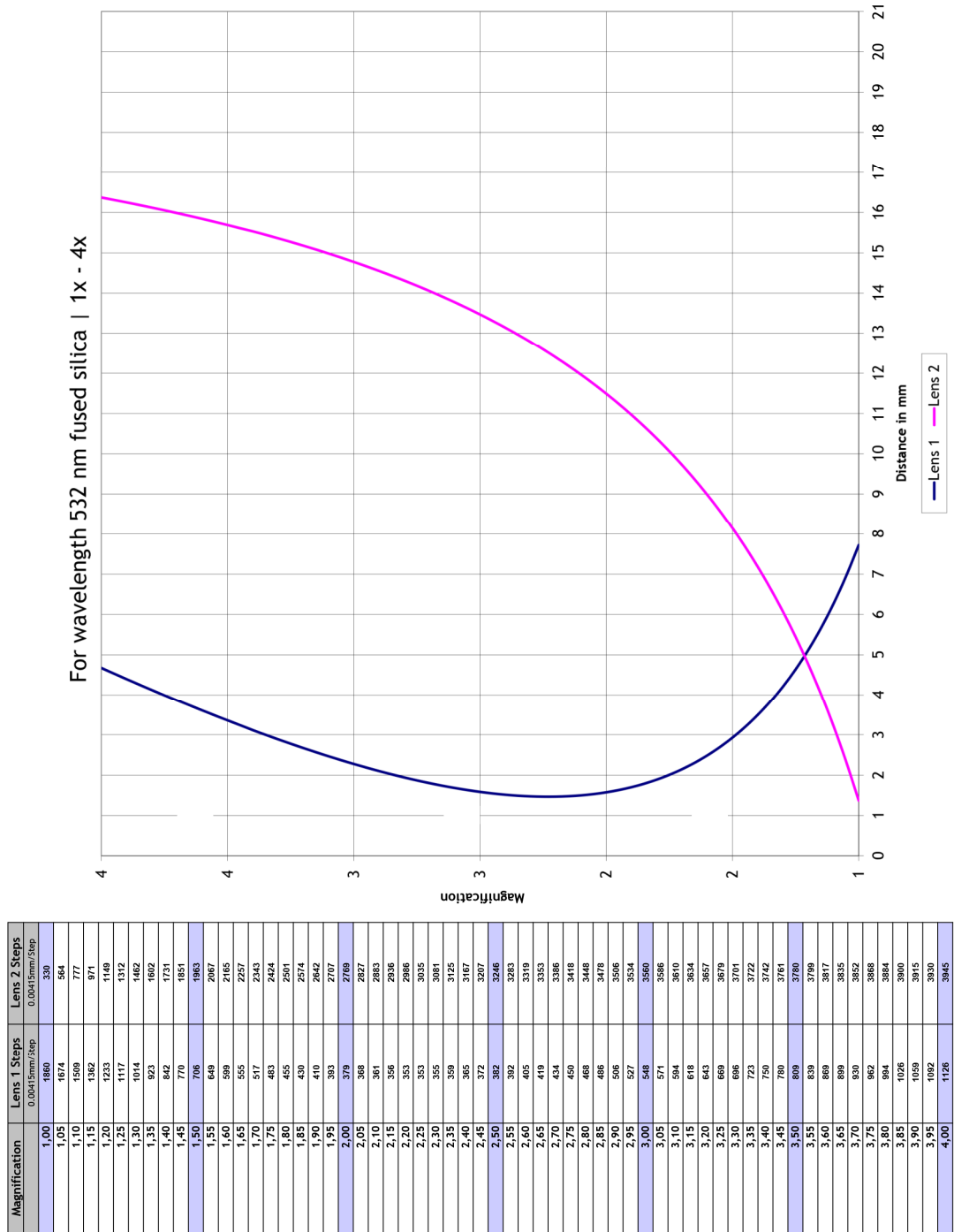


Wavelength 355nm - fused silica - 2x - 8x

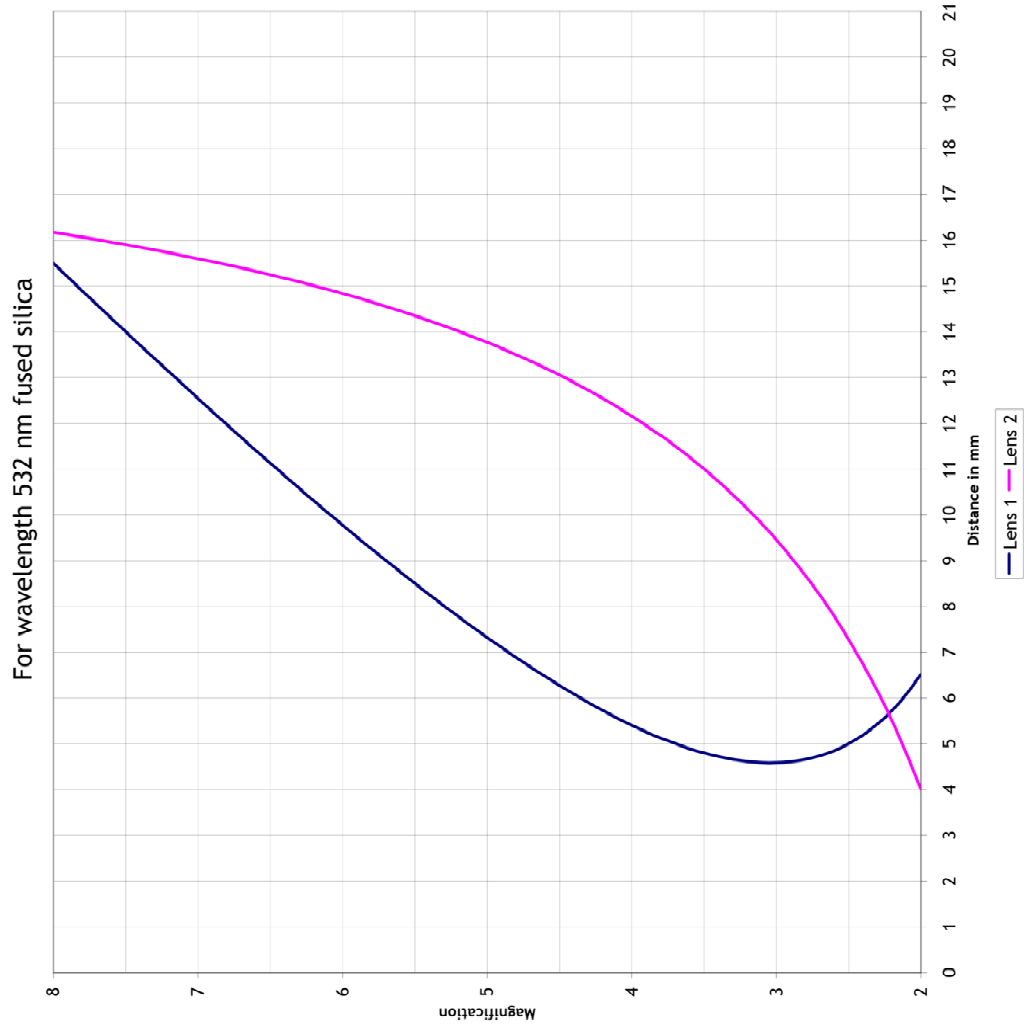


Magnification	Lens 1 Steps 0.00415mm/Step	Lens 2 Steps 0.00415mm/Step
2.0	1626	1020
2.1	1518	1210
2.2	1427	1383
2.3	1351	1541
2.4	1289	1686
2.5	1238	1819
2.6	1198	1942
2.7	1166	2056
2.8	1143	2161
2.9	1127	2260
3.0	1118	2351
3.1	1114	2437
3.2	1117	2517
3.3	1123	2593
3.4	1135	2663
3.5	1150	2730
3.6	1170	2793
3.7	1192	2853
3.8	1218	2909
3.9	1247	2963
4.0	1278	3014
4.1	1313	3062
4.2	1349	3108
4.3	1387	3152
4.4	1428	3194
4.5	1470	3234
4.6	1514	3272
4.7	1560	3309
4.8	1607	3344
4.9	1656	3377
5.0	1706	3410
5.1	1758	3441
5.2	1810	3470
5.3	1864	3499
5.4	1919	3527
5.5	1975	3553
5.6	2031	3579
5.7	2089	3604
5.8	2148	3627
5.9	2207	3650
6.0	2267	3673
6.1	2328	3694
6.2	2389	3715
6.3	2452	3735
6.4	2514	3755
6.5	2578	3774
6.6	2642	3792
6.7	2707	3810
6.8	2772	3827
6.9	2837	3844
7.0	2903	3860
7.1	2970	3876
7.2	3037	3892
7.3	3104	3907
7.4	3172	3921
7.5	3240	3935
7.6	3309	3949
7.7	3378	3963
7.8	3447	3976
7.9	3516	3989
8.0	3586	4001

Wavelength 532nm - fused silica - 1x - 4x

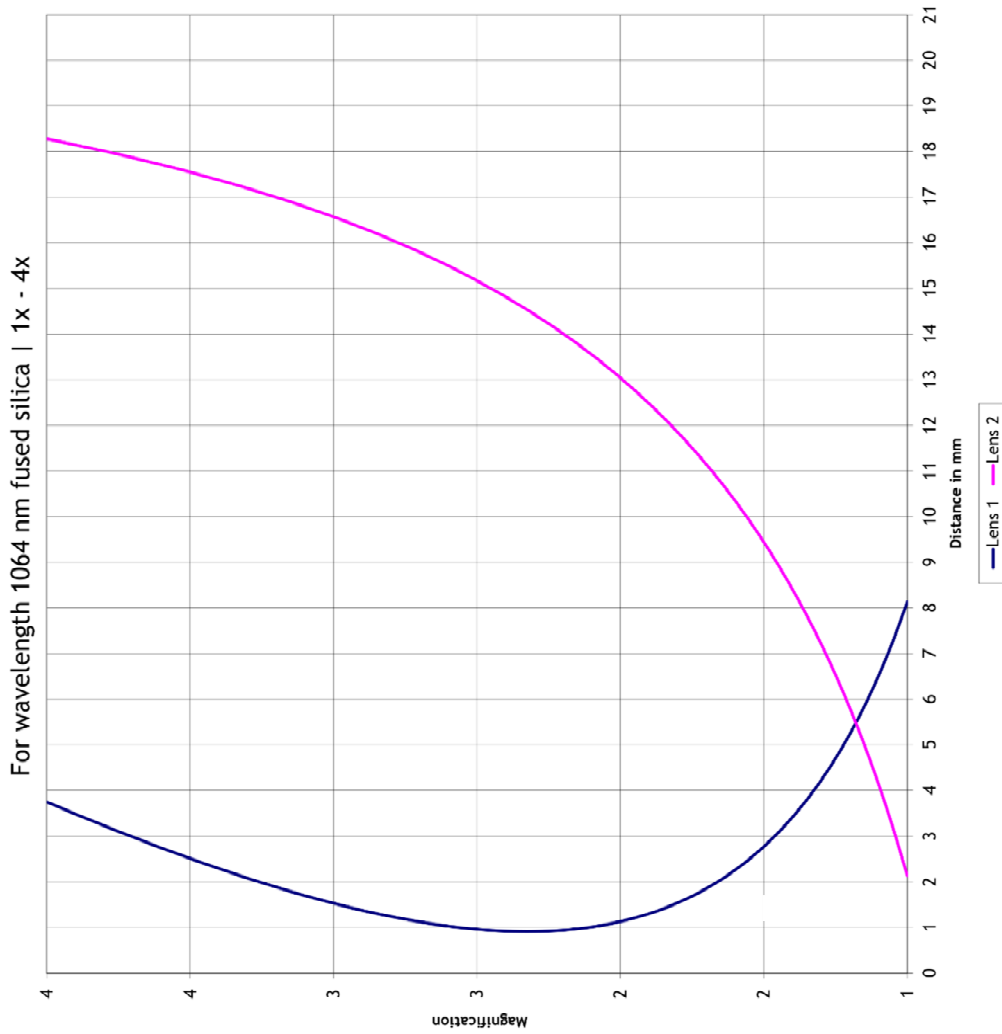


Wavelength 532nm – fused silica - 2x - 8x



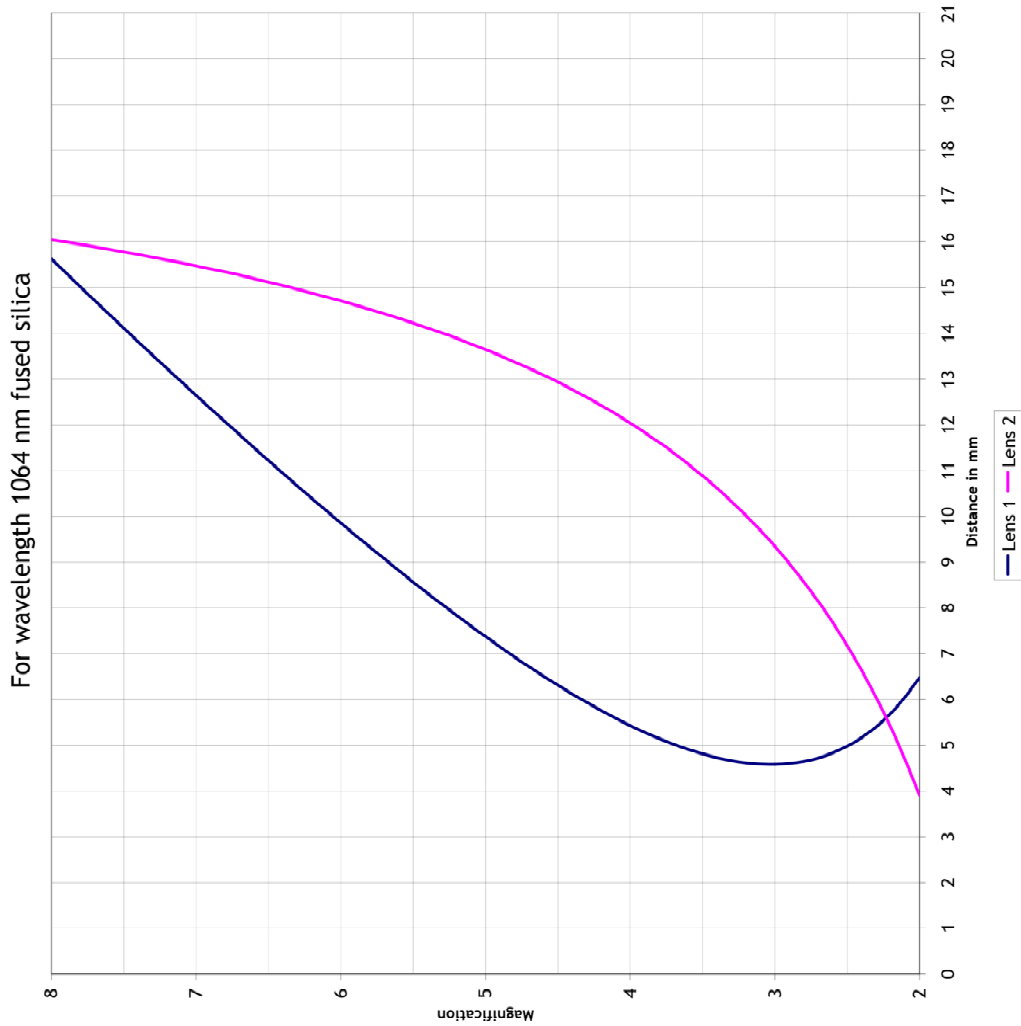
Magnification	Lens 1 Steps 0.0045mm/Step	Lens 2 Steps 0.0045mm/Step
2.0	1371	965
2.1	1467	1153
2.2	1331	1324
2.3	1309	1480
2.4	1251	1623
2.5	1205	1755
2.6	1168	1876
2.7	1141	1988
2.8	1122	2092
2.9	1110	2188
3.0	1105	2279
3.1	1105	2363
3.2	1111	2442
3.3	1122	2516
3.4	1137	2586
3.5	1157	2651
3.6	1179	2713
3.7	1206	2772
3.8	1235	2827
3.9	1268	2880
4.0	1302	2930
4.1	1340	2977
4.2	1380	3022
4.3	1422	3065
4.4	1466	3106
4.5	1512	3145
4.6	1559	3183
4.7	1609	3219
4.8	1659	3253
4.9	1711	3286
5.0	1765	3317
5.1	1819	3347
5.2	1875	3377
5.3	1932	3405
5.4	1990	3432
5.5	2049	3458
5.6	2109	3483
5.7	2170	3507
5.8	2231	3530
5.9	2293	3553
6.0	2357	3575
6.1	2420	3596
6.2	2485	3616
6.3	2550	3636
6.4	2616	3655
6.5	2682	3674
6.6	2749	3692
6.7	2817	3709
6.8	2885	3726
6.9	2953	3743
7.0	3022	3759
7.1	3092	3774
7.2	3162	3789
7.3	3232	3804
7.4	3303	3818
7.5	3374	3832
7.6	3445	3846
7.7	3517	3859
7.8	3589	3872
7.9	3661	3884
8.0	3734	3896

Wavelength 1064nm – fused silica - 1x -4x



Magnification	Lens 1 Steps 0.00415mm/Step	Lens 2 Steps 0.00415mm/Step
1.00	1588.3	514.6
1.05	1752.1	767.7
1.10	1969.4	997.4
1.15	2066.9	1206.8
1.20	2266.3	1389.4
1.25	2130.3	1574.4
1.30	2118.1	1728.7
1.35	2145.2	1868.7
1.40	2231.1	2025.7
1.45	2403.9	2155.0
1.50	2677.5	2275.5
1.55	2822.0	2388.1
1.60	3433.8	2483.5
1.65	4022.0	2562.3
1.70	4463.3	2635.2
1.75	4083.0	2712.7
1.80	3767.7	2852.2
1.85	3389.9	2953.1
1.90	3113.3	3068.8
1.95	2987.7	3076.7
2.00	2711.6	3152.9
2.05	2559.9	3253.8
2.10	2433.3	3265.7
2.15	2335.3	3322.6
2.20	2265.5	3376.9
2.25	2211.9	3432.7
2.30	2186.3	3492.2
2.35	2186.3	3555.5
2.40	2211.6	3570.7
2.45	2255.5	3614.0
2.50	2311.3	3655.6
2.55	2387.7	3665.4
2.60	2477.7	3733.7
2.65	2583.3	3770.4
2.70	2702.2	3805.7
2.75	2835.5	3858.7
2.80	2981.1	3872.4
2.85	3133.9	3903.9
2.90	3303.9	3954.3
2.95	3481.0	3983.8
3.00	3682.0	3991.9
3.05	3882.0	4019.2
3.10	4083.9	4055.5
3.15	4307.7	4071.0
3.20	4553.4	4085.7
3.25	4769.9	4119.8
3.30	5011.2	4152.7
3.35	5266.1	4185.0
3.40	5511.8	4186.7
3.45	5761.1	4207.8
3.50	6005.0	4228.3
3.55	6324.2	4248.2
3.60	6605.5	4267.5
3.65	6881.1	4281.2
3.70	7182.0	4304.5
3.75	7475.3	4322.2
3.80	7763.4	4335.4
3.85	8087.7	4356.1
3.90	8388.8	4372.4
3.95	8711.3	4389.2
4.00	9033.3	4403.7

Wavelength 1064nm – fused silica - 2x - 8x



Magnification	Lens 1 Steps 0.00415mm/Step	Lens 2 Steps 0.00415mm/Step
2.0	1581	940
2.1	1459	1129
2.2	1323	1300
2.3	1193	1455
2.4	1065	1596
2.5	940	1729
2.6	816	1850
2.7	699	1962
2.8	587	2066
2.9	477	2162
3.0	369	2252
3.1	263	2336
3.2	159	2415
3.3	58	2489
3.4	50	2558
3.5	43	2624
3.6	37	2686
3.7	31	2744
3.8	26	2800
3.9	21	2852
4.0	17	2902
4.1	13	2949
4.2	10	2994
4.3	7	3037
4.4	5	3078
4.5	4	3117
4.6	3	3154
4.7	2	3190
4.8	2	3224
4.9	1	3256
5.0	1	3288
5.1	1	3318
5.2	1	3347
5.3	1	3375
5.4	1	3402
5.5	1	3428
5.6	1	3453
5.7	1	3477
5.8	1	3500
5.9	1	3523
6.0	1	3543
6.1	1	3566
6.2	1	3586
6.3	1	3606
6.4	1	3623
6.5	1	3643
6.6	1	3661
6.7	1	3679
6.8	1	3696
6.9	1	3712
7.0	1	3728
7.1	1	3743
7.2	1	3759
7.3	1	3773
7.4	1	3787
7.5	1	3801
7.6	1	3815
7.7	1	3828
7.8	1	3841
7.9	1	3853
8.0	1	3865

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